

SECTION **EM**

ENGINE MECHANICAL

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NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

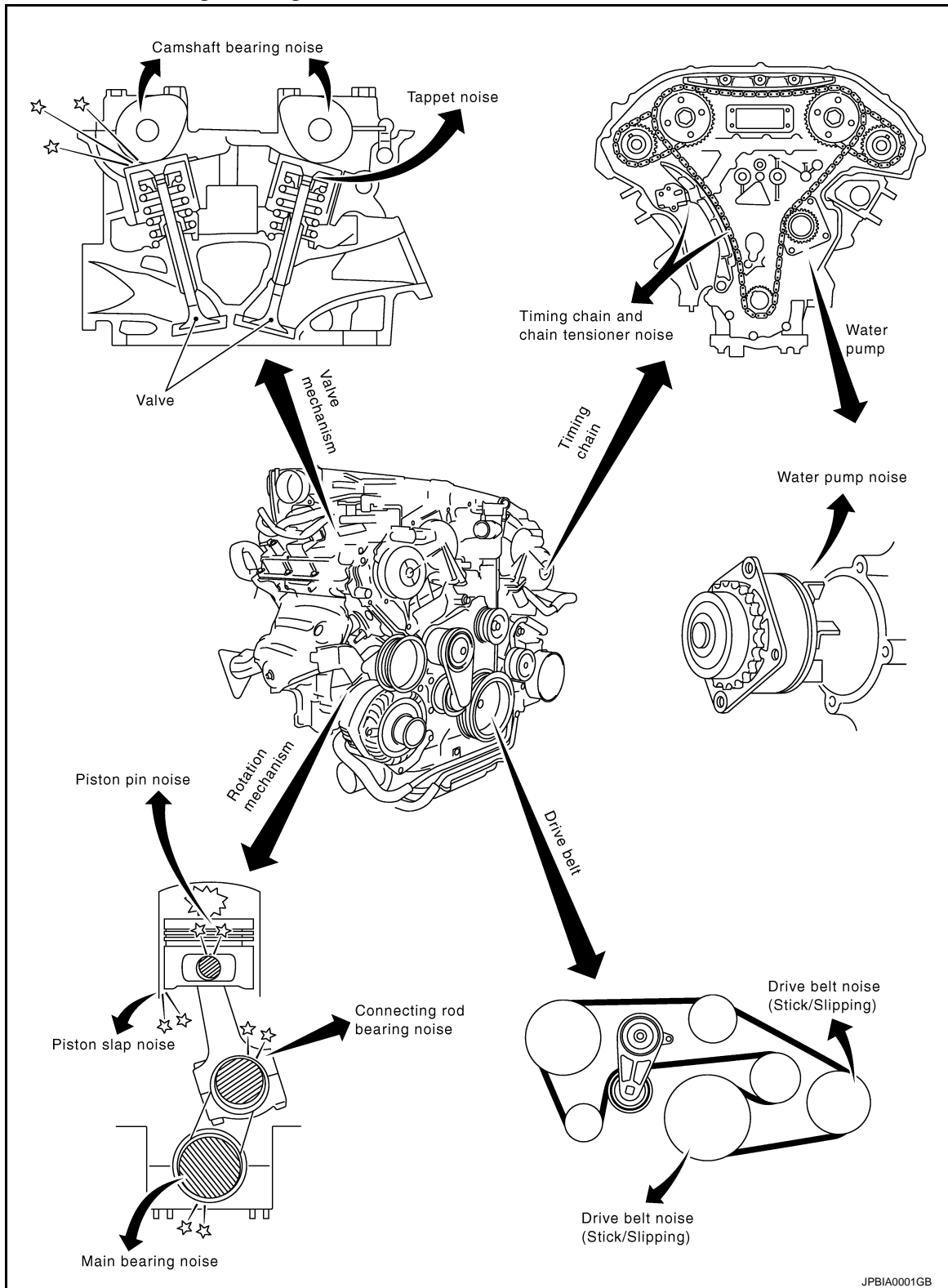
< SYMPTOM DIAGNOSIS >

SYMPTOM DIAGNOSIS

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

NVH Troubleshooting - Engine Noise

INFOID:000000004348823



Use the Chart Below to Help You Find the Cause of the Symptom

INFOID:000000004348824

1. Locate the area where noise occurs.

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

< SYMPTOM DIAGNOSIS >

2. Confirm the type of noise.
3. Specify the operating condition of the 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 | Reference page |
|---|----------------------|-------------------------------|---------------|---------------|-------------|-------------|---------------|---|---|--|
| | | Before warm-up | After warm-up | When starting | When idling | When racing | While driving | | | |
| Top of engine Rocker cover Cylinder head | Ticking or clicking | C | A | — | A | B | — | Tappet noise | Valve clearance | EM-18 |
| | Rattle | C | A | — | A | B | C | Camshaft bearing noise | Camshaft runout Camshaft journal oil clearance | EM-140 |
| Crankshaft pulley 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-144 |
| | Slap or rap | A | — | — | B | B | A | Piston slap noise | Piston to cylinder bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion | EM-144 |
| | Knock | A | B | C | B | B | B | Connecting rod bearing noise | Connecting rod bushing oil clearance Connecting rod bearing oil clearance | EM-144 EM-149 |
| | Knock | A | B | — | A | B | C | Main bearing noise | Main bearing oil clearance Crankshaft runout | EM-148 EM-144 |
| Front of engine Timing chain case | Tapping or ticking | A | A | — | B | B | B | Timing chain and timing chain tensioner noise | Timing chain cracks and wear Timing chain tensioner operation | EM-65 EM-51 |
| Front of engine | Squeaking or fizzing | A | B | — | B | — | C | Drive belt (Sticking or slipping) | Drive belt deflection | EM-13 |
| | Creaking | A | B | A | B | A | B | Drive belt (Slipping) | Idler pulley bearing operation | |
| | Squall Creak | A | B | — | B | A | B | Water pump noise | Water pump operation | CO-17 , "Exploded View" |

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

PRECAUTIONS

< PRECAUTION >

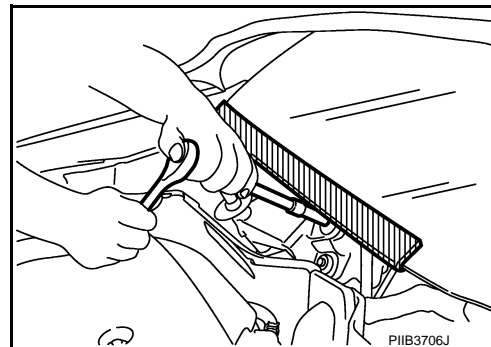
PRECAUTION

PRECAUTIONS

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.



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

INFOID:000000004348826

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. This system includes seat belt switch inputs and dual stage front air bag modules. The SRS system uses the seat belt switches to determine the front air bag deployment, and may only deploy one front air bag, depending on the severity of a collision and whether the front occupants are belted or unbelted. Information necessary to service the system safely is included in the "SRS AIR BAG" and "SEAT BELT" 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 that would result in air bag inflation, all maintenance must be performed by an authorized NISSAN/INFINITI dealer.
- Improper maintenance, 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 "SRS AIR BAG".
- 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, and wait at least 3 minutes before performing any service.

Precaution Necessary for Steering Wheel Rotation after Battery Disconnect

INFOID:000000004348827

NOTE:

- Before removing and installing any control units, first turn the push-button ignition switch to the LOCK position, then disconnect both battery cables.
- After finishing work, confirm that all control unit connectors are connected properly, then re-connect both battery cables.
- Always use CONSULT-III to perform self-diagnosis as a part of each function inspection after finishing work. If a DTC is detected, perform trouble diagnosis according to self-diagnosis results.

For vehicle with steering lock unit, if the battery is disconnected or discharged, the steering wheel will lock and cannot be turned.

PRECAUTIONS

< PRECAUTION >

If turning the steering wheel is required with the battery disconnected or discharged, follow the operation procedure below before starting the repair operation.

OPERATION PROCEDURE

1. Connect both battery cables.

NOTE:

Supply power using jumper cables if battery is discharged.

2. Turn the push-button ignition switch to ACC position.
(At this time, the steering lock will be released.)
3. Disconnect both battery cables. The steering lock will remain released with both battery cables disconnected and the steering wheel can be turned.
4. Perform the necessary repair operation.
5. When the repair work is completed, re-connect both battery cables. With the brake pedal released, turn the push-button ignition switch from ACC position to ON position, then to LOCK position. (The steering wheel will lock when the push-button ignition switch is turned to LOCK position.)
6. Perform self-diagnosis check of all control units using CONSULT-III.

Draining Engine Coolant

INFOID:0000000004348828

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

Disconnecting Fuel Piping

INFOID:0000000004348829

- 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.

Removal and Disassembly

INFOID:0000000004348830

- 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.
- Cover openings of engine system with a tape or equivalent, if necessary, to seal out foreign materials.
- Mark and arrange disassembly parts in an organized way for easy troubleshooting and re-assembly.
- 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.

Inspection, Repair and Replacement

INFOID:0000000004348831

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

Assembly and Installation

INFOID:0000000004348832

- Use torque wrench to tighten bolts or nuts to specification.
- When tightening bolts and nuts, 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.
- 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.
- 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.
- 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.

PRECAUTIONS

< PRECAUTION >

Parts Requiring Angle Tightening

INFOID:000000004348833

- Use the angle wrench [SST: KV10112100 (BT8653-A)] for the final tightening of the following engine parts:
 - Cylinder head bolts
 - Lower cylinder block bolts
 - Connecting rod cap bolts
- 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:000000004348834

REMOVAL OF LIQUID GASKET SEALING

- After removing mounting bolts and nuts, separate the mating surface using the seal cutter [SST: KV10111100 (J-37228)] (A) and remove old liquid gasket sealing.

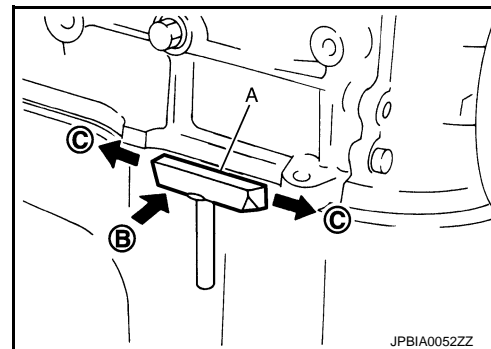
CAUTION:

Be careful not to damage the mating surfaces.

- Tap the seal cutter [SST: KV10111100 (J-37228)] to insert it (B), and then slide it (C) by tapping on the side as shown in the figure.
- In areas where the seal cutter [SST: KV10111100 (J-37228)] is difficult to use, use a plastic hammer to lightly tap the parts, to remove it.

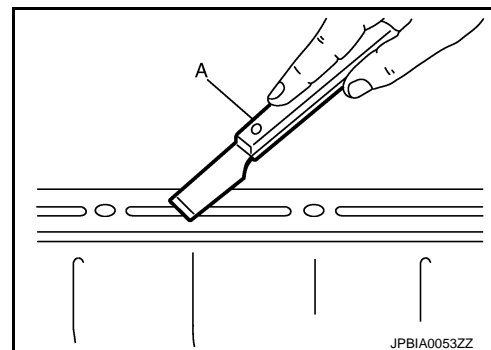
CAUTION:

If for some unavoidable reason tool such as a screwdriver is used, be careful not to damage the mating surfaces.



LIQUID GASKET APPLICATION PROCEDURE

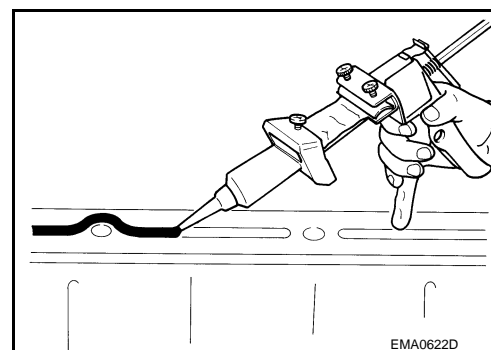
1. Using a scraper (A), remove old liquid gasket adhering to the liquid gasket application surface and the mating surface.
 - Remove liquid gasket completely from the groove of the liquid gasket application surface, mounting bolts, and bolt holes.
2. Wipe the liquid gasket application surface and the mating surface with white gasoline (lighting and heating use) to remove adhering moisture, grease and foreign materials.



3. Attach liquid gasket tube to the tube presser (commercial service tool).

Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-17, "Recommended Chemical Products and Sealants"](#).

4. Apply liquid gasket without breaks to the specified location with the specified dimensions.
 - If there is a groove for liquid gasket application, apply liquid gasket to the groove.



PRECAUTIONS

< PRECAUTION >

- 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.

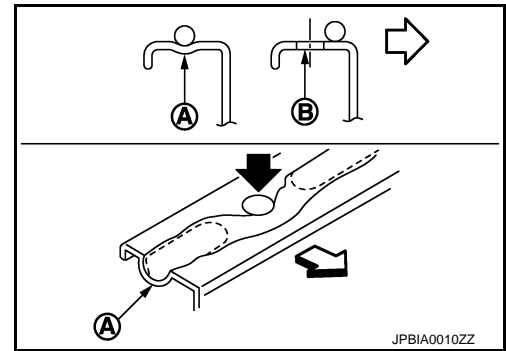
A : Groove

⇐ : Inside

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

CAUTION:

If there are specific instructions in this manual, observe them.



Definitions of Bank Names

INFOID:000000004348835

- In this manual, each bank name is defined as follows:

A : Bank 1 (The conventional right bank)

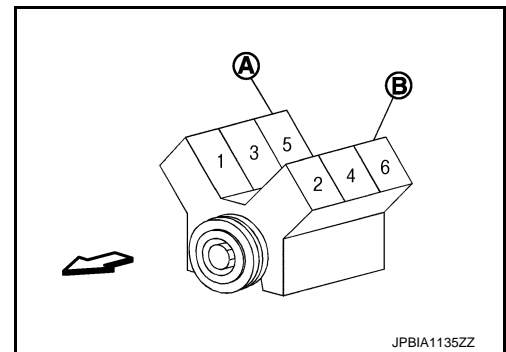
B : Bank 2 (The conventional left bank)

⇐ : Engine front

- For cylinder numbers and bank layout, refer to the illustration.

Bank 1 : The bank side including cylinder No. 1 (odd-numbered cylinder side)

Bank 2 : The other bank side of the above (even-numbered cylinder side)



PREPARATION

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PREPARATION

PREPARATION

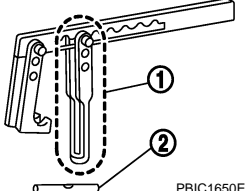
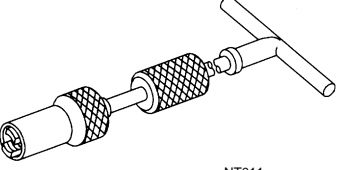
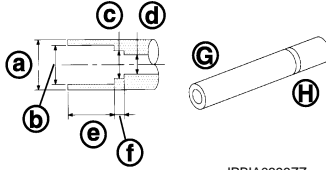
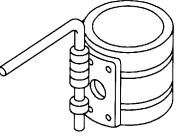
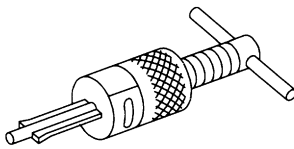
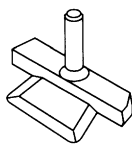
Special Service Tools

INFOID:000000004348836

A

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The actual shapes of Kent-Moore tools may differ from those of special service tools illustrated here.

| Tool number (Kent-Moore No.) Tool name | Description | |
|--|---|---|
| KV10116200 (J-26336-A) Valve spring compressor 1. KV10115900 (J-26336-20) Attachment 2. KV10109220 (—) Adapter | Disassembling valve mechanism Part (1) is a component of KV10116200 (J-26336-A), but Part (2) is not so. | C |
| |  | D |
| KV10107902 (J-38959) Valve oil seal puller | Replacing valve oil seal | E |
| |  | F |
| KV10115600 (J-38958) Valve oil seal drift | Installing valve oil seal Use side A (G). 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) H: side B Unit: mm (in) | G |
| |  | H |
| EM03470000 (J-8037) Piston ring compressor | Installing piston assembly into cylinder bore | I |
| |  | J |
| ST16610001 (J-23907) Pilot bushing puller | Removing pilot converter | K |
| |  | L |
| KV10111100 (J-37228) Seal cutter | Removing oil pan (lower and upper), front and rear timing chain case, etc. | M |
| |  | N |

C

D

E

F

G

H

I

J

K

L

M

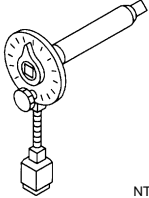
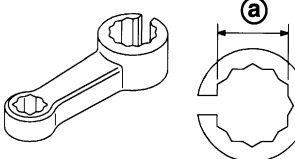
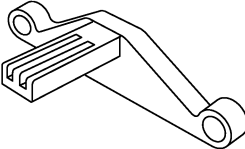
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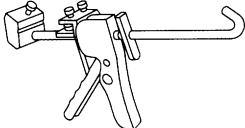
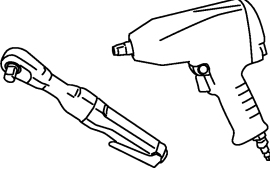
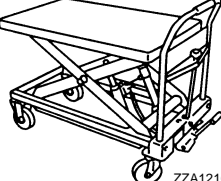
PREPARATION

< PREPARATION >

| Tool number (Kent-Moore No.) Tool name | Description |
|--|---|
| KV10112100 (BT8653-A) Angle wrench | Tightening bolts for connecting rod bearing cap, cylinder head, etc. in angle |
|  NT014 | |
| KV10114400 (J-38365) Heated oxygen sensor wrench | Loosening or tightening air fuel ratio sensor 1 a: 22 mm (0.87 in) |
|  JPBIA0397ZZ | |
| KV10118600 (J-48641) Ring gear stopper | Removing and installing crankshaft pulley |
|  JPBIA0409ZZ | |

Commercial Service Tools

INFOID:000000004348837

| (Kent-Moore No.) Tool name | Description |
|--|------------------------------------|
| (—) Tube presser | Pressing the tube of liquid gasket |
|  NT052 | |
| (—) Power tool | Loosening bolts and nuts |
|  PBIC0190E | |
| (—) Manual lift table caddy | Removing and installing engine |
|  ZZA1210D | |

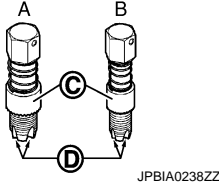

< PREPARATION >

A

EM

PREPARATION

< PREPARATION >

| (Kent-Moore No.) Tool name | Description |
|--|--|
| <p>(J-43897-18) (J-43897-12) Oxygen sensor thread cleaner</p>  | <p>Reconditioning the exhaust system threads before installing a new air fuel ratio sensor and heated oxygen sensor (Use with anti-seize lubricant shown below.) A: J-43897-18 [18 mm (0.71 in) dia.] for zirconia heated oxygen sensor and air fuel ratio sensor B: J-43897-12 [12 mm (0.47 in) dia.] for titania heated oxygen sensor C: Mating surface shave cylinder D: Flutes</p> |
| <p>(—) Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907)</p>  | <p>Lubricating oxygen sensor thread cleaning tool when reconditioning exhaust system threads</p> |

DRIVE BELT

< PERIODIC MAINTENANCE >

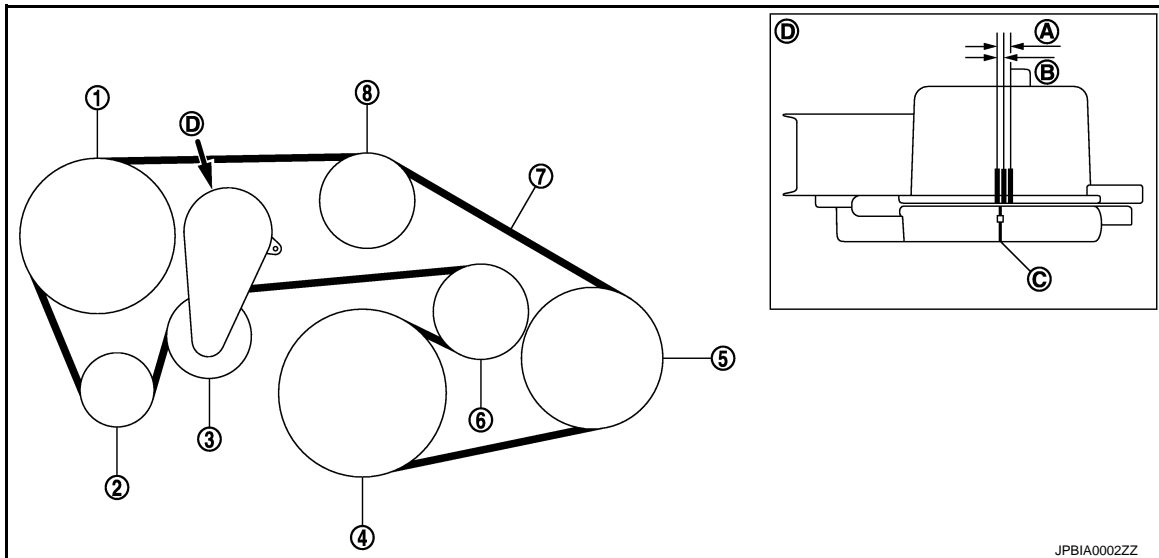
PERIODIC MAINTENANCE

DRIVE BELT

Exploded View

INFOID:000000004348838

EM



- | | | |
|----------------------------|---|------------------------------|
| 1. Power steering oil pump | 2. Alternator | 3. Drive belt auto-tensioner |
| 4. Crankshaft pulley | 5. A/C compressor | 6. Idler pulley |
| 7. Drive belt | 8. Idler pulley | |
| A. Possible use range | B. Range when new drive belt is installed | C. Indicator |
| D. View D | | |

Checking

INFOID:000000004348839

WARNING:

Be sure to perform this step when engine is stopped.

- Check that the indicator (C) (notch on fixed side) of drive belt auto-tensioner is within the possible use range (A).

NOTE:

- Check the drive belt auto-tensioner indication when the engine is cold.
- When new drive belt is installed, the indicator (notch on fixed side) should be within the range (B) in the figure.
- Visually check entire drive belt for wear, damage or cracks.
- If the indicator (notch on fixed side) is out of the possible use range or belt is damaged, replace drive belt.

Tension Adjustment

INFOID:000000004348840

Refer to [EM-139. "Drive Belt"](#).

Removal and Installation

INFOID:000000004348841

REMOVAL

1. Remove engine undercover with power tool.

DRIVE BELT

< PERIODIC MAINTENANCE >

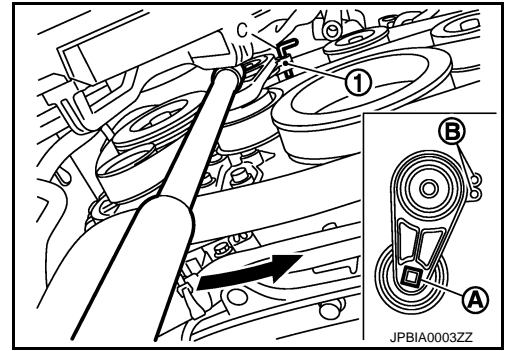
2. While securely holding the square hole (A) in pulley center of auto tensioner (1) with a spinner handle, move spinner handle in the direction of arrow (loosening direction of drive belt).

← : Loosening direction of drive belt

CAUTION:

Never place hand in a location where pinching may occur if the holding tool accidentally comes off.

3. Under the above condition, insert a metallic bar of approximately 6 mm (0.24 in) in diameter [hexagonal wrench (C) shown as example in the figure] through the holding boss (B) to lock auto-tensioner pulley arm.
4. Remove drive belt.



INSTALLATION

Note the following, and install in the reverse order of removal.

CAUTION:

- Check drive belt is securely installed around all pulleys.
- Check drive belt is correctly engaged with the pulley groove.
- Check for engine oil and engine coolant are not adhered drive belt and pulley groove.

Inspection

INFOID:0000000004348842

INSPECTION AFTER INSTALLATION

- Turn crankshaft pulley clockwise several times to equalize tension between each pulley, and then confirm tension of drive belt at indicator (notch on fixed side) is within the possible use range. Refer to [EM-13, "Exploded View"](#).

AIR CLEANER FILTER

< PERIODIC MAINTENANCE >

AIR CLEANER FILTER

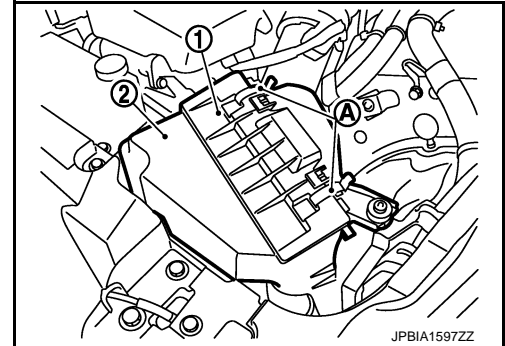
Removal and Installation

INFOID:000000004348843

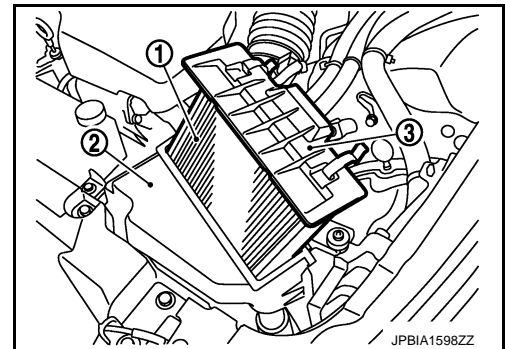
REMOVAL

1. Unhook clips (A).

- 1 : Holder
- 2 : Air cleaner case



2. Remove holder (3) from air cleaner case (2), and then remove air cleaner filter (1) from holder.



INSTALLATION

Note the following, and install in the reverse order of removal.

- Install the air cleaner filter by aligning the seal with the notch of air cleaner case.

A

EM

C

D

E

F

G

H

I

J

K

L

M

N

O

P

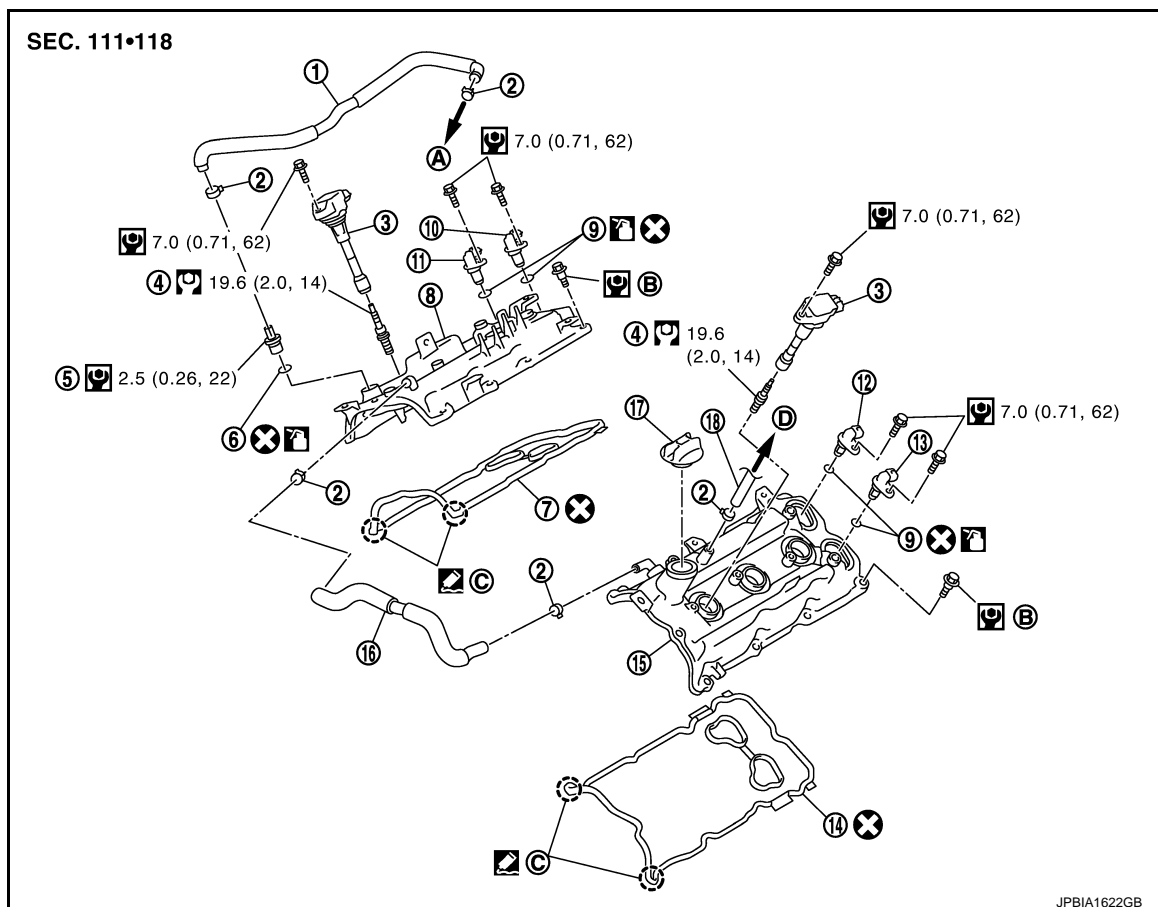
SPARK PLUG

< PERIODIC MAINTENANCE >

SPARK PLUG

Exploded View

INFOID:000000004348844



- | | | |
|---|---|---|
| 1. PCV hose | 2. Clamp | 3. Ignition coil |
| 4. Spark plug | 5. PCV valve | 6. O-ring |
| 7. Rocker cover gasket (bank 1) | 8. Rocker cover (bank 1) | 9. O-ring |
| 10. Camshaft position sensor (PHASE) (bank 1) | 11. Exhaust valve timing control position sensor (bank 1) | 12. Camshaft position sensor (PHASE) (bank 2) |
| 13. Exhaust valve timing control position sensor (bank 2) | 14. Rocker cover gasket (bank 2) | 15. Rocker cover (bank 2) |
| 16. PCV hose | 17. Oil filler cap | 18. PCV hose |
| A. To intake manifold collector | B. Refer to EM-47 | C. Camshaft bracket side |
| D. To air duct | | |

Refer to [GI-4, "Components"](#) for symbols in the figure.

Removal and Installation

INFOID:000000004348845

REMOVAL

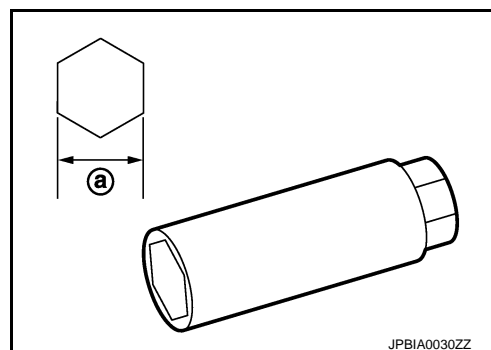
1. Remove engine cover with power tool. Refer to [EM-25, "Exploded View"](#).
2. Remove air duct (RH and LH). Refer to [EM-27, "Exploded View"](#).
3. Remove electric throttle control actuator. Refer to [EM-29, "Exploded View"](#).
4. Remove ignition coil. Refer to [EM-47, "Removal and Installation"](#).

SPARK PLUG

< PERIODIC MAINTENANCE >

5. Remove spark plug with a spark plug wrench (commercial service tool).

a : 14 mm (0.55 in)



INSTALLATION

Installation is the reverse order of removal.

Inspection

INFOID:000000004348846

INSPECTION AFTER REMOVAL

Use the standard type spark plug for normal condition.

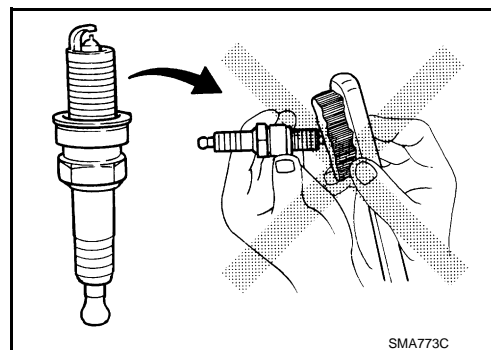
Spark plug (Standard type) : Refer to [EM-140, "Spark Plug"](#).

CAUTION:

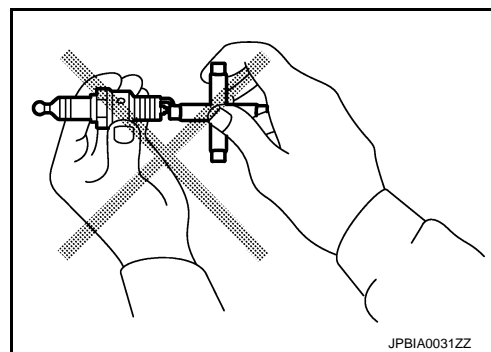
- Never drop or shock spark plug.
- Never use a wire brush for cleaning.
- If plug tip is covered with carbon, spark plug cleaner may be used.

Cleaner air pressure: Less than 588 kPa (6 kg/cm², 85 psi)

Cleaning time: Less than 20 seconds



- Checking and adjusting plug gap is not required between change intervals.



CAMSHAFT VALVE CLEARANCE

< PERIODIC MAINTENANCE >

CAMSHAFT VALVE CLEARANCE

Inspection and Adjustment

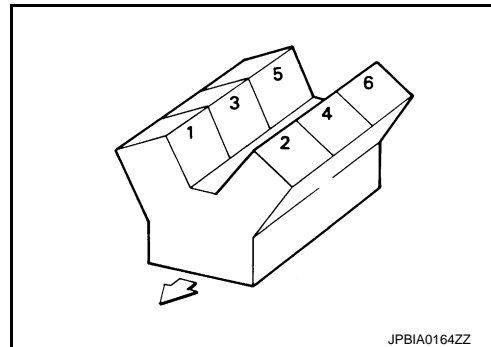
INFOID:000000004348847

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.

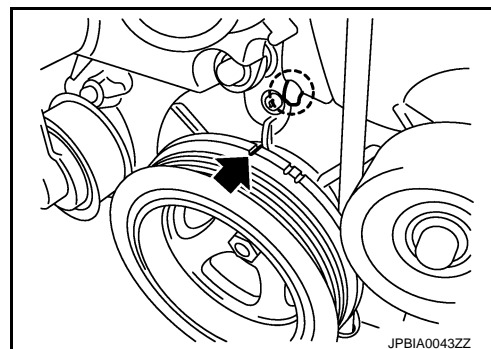
In cases of removing/installing or replacing camshaft and valve-related parts, or of unusual engine conditions due to changes in valve clearance (found malfunctions during starting, idling or causing noise), perform inspection as follows:

⇐ : Engine front



1. Remove rocker covers (bank 1 and bank 2). Refer to [EM-47. "Removal and Installation"](#).
2. Measure the valve clearance as follows:
 - a. Set No. 1 cylinder at TDC of its compression stroke.
 - Rotate crankshaft pulley clockwise to align timing mark (grooved line without color) with timing indicator.

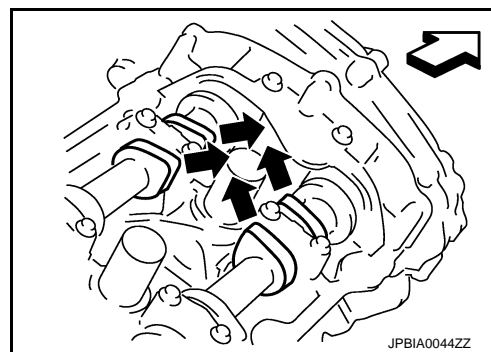
◀ : Timing mark (grooved line without color)



- Check that intake and exhaust cam nose on No. 1 cylinder (engine front side of bank 1) are located as shown in the figure.

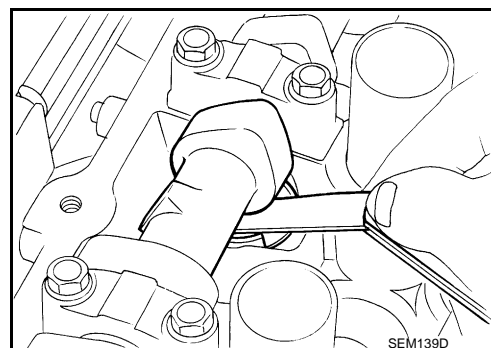
⇐ : Engine front

- If not, turn crankshaft one revolution (360 degrees) and align as shown in the figure.



- b. Use a feeler gauge, measure the clearance between valve lifter and camshaft.

Valve clearance : Refer to [EM-140. "Camshaft"](#).



CAMSHAFT VALVE CLEARANCE

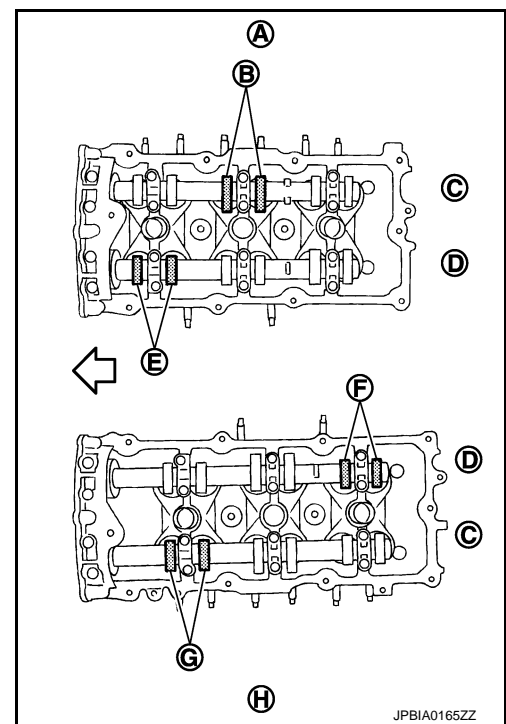
< PERIODIC MAINTENANCE >

- By referring to the figure, measure the valve clearances at locations marked "x" as shown in the table below (locations indicated in the figure).

← : Engine front

- No. 1 cylinder at compression TDC

| Measuring position [bank 1 (A)] | | No. 1 CYL. | No. 3 CYL. | No. 5 CYL. |
|-----------------------------------|---------|------------|------------|------------|
| No. 1 cylinder at compression TDC | EXH (C) | | × (B) | |
| | INT (D) | × (E) | | |
| Measuring position [bank 2 (H)] | | No. 2 CYL. | No. 4 CYL. | No. 6 CYL. |
| No. 1 cylinder at compression TDC | INT (D) | | | × (F) |
| | EXH (C) | × (G) | | |

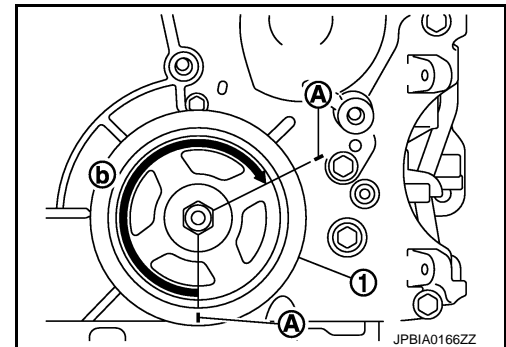


- c. Rotate crankshaft 240 degrees clockwise (when viewed from engine front) to align No. 3 cylinder at TDC its compression stroke.

NOTE:

Mark a position 240 degrees (b) from a corner of the hexagonal part of crankshaft pulley mounting bolt as shown in the figure. Use the hexagonal part as a guide.

- 1 : Crankshaft pulley
- A : Paint mark



CAMSHAFT VALVE CLEARANCE

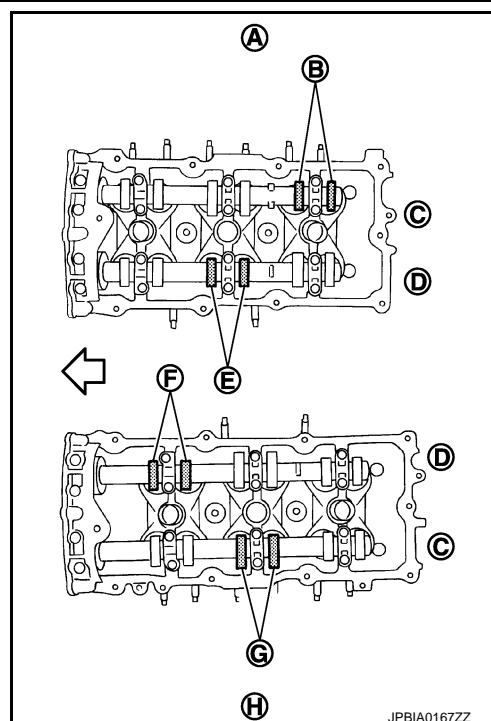
< PERIODIC MAINTENANCE >

- By referring to the figure, measure the valve clearances at locations marked "×" as shown in the table below (locations indicated in the figure).

← : Engine front

- No. 3 cylinder at compression TDC

| Measuring position [bank 1 (A)] | | No. 1 CYL. | No. 3 CYL. | No. 5 CYL. |
|-----------------------------------|---------|------------|------------|------------|
| No. 3 cylinder at compression TDC | EXH (C) | | | × (B) |
| | INT (D) | | × (E) | |
| Measuring position [bank 2 (H)] | | No. 2 CYL. | No. 4 CYL. | No. 6 CYL. |
| No. 3 cylinder at compression TDC | INT (D) | × (F) | | |
| | EXH (C) | | × (G) | |



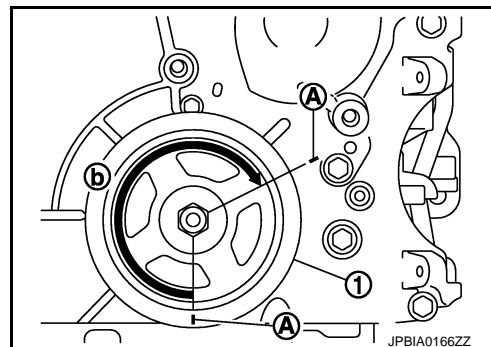
- d. Rotate crankshaft 240 degrees clockwise (when viewed from engine front) to align No. 5 cylinder at TDC of compression stroke.

NOTE:

Mark a position 240 degrees (b) from a corner of the hexagonal part of crankshaft pulley mounting bolt as shown in the figure. Use the hexagonal part as a guide.

1 : Crankshaft pulley

A : Paint mark



CAMSHAFT VALVE CLEARANCE

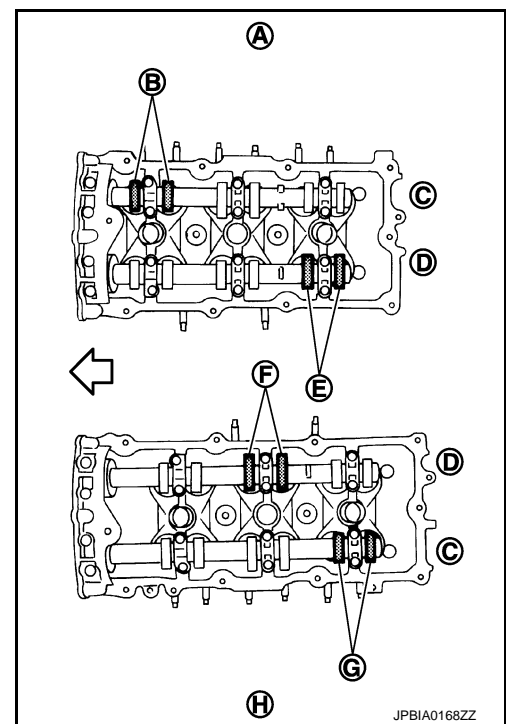
< PERIODIC MAINTENANCE >

- By referring to the figure, measure the valve clearances at locations marked "x" as shown in the table below (locations indicated in the figure).

← : Engine front

- No. 5 cylinder at compression TDC

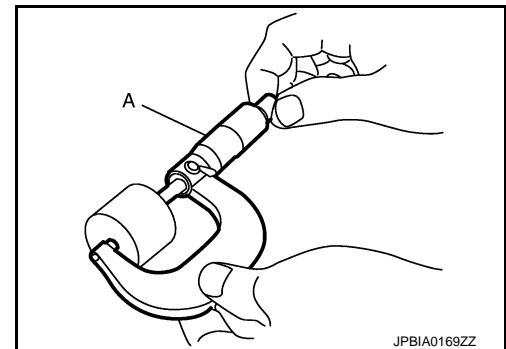
| Measuring position [bank 1 (A)] | | No. 1 CYL. | No. 3 CYL. | No. 5 CYL. |
|-----------------------------------|---------|------------|------------|------------|
| No. 5 cylinder at compression TDC | EXH (C) | × (B) | | |
| | INT (D) | | | × (E) |
| Measuring position [bank 2 (H)] | | No. 2 CYL. | No. 4 CYL. | No. 6 CYL. |
| No. 5 cylinder at compression TDC | INT (D) | | × (F) | |
| | EXH (C) | | | × (G) |



- Perform adjustment if the measured value is out of the standard. Refer to "ADJUSTMENT".

ADJUSTMENT

- Perform adjustment depending on selected head thickness of valve lifter.
- Measure the valve clearance. Refer to "INSPECTION".
 - Remove camshaft. Refer to [EM-67. "Removal and Installation"](#).
 - Remove valve lifters at the locations that are out of the standard.
 - Measure the center thickness of the removed valve lifters with a micrometer (A).



- 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

t₁ = Removed valve lifter thickness

C₁ = Measured valve clearance

C₂ = Standard valve clearance:

Intake : 0.30 mm (0.012 in)

Exhaust : 0.33 mm (0.013 in)

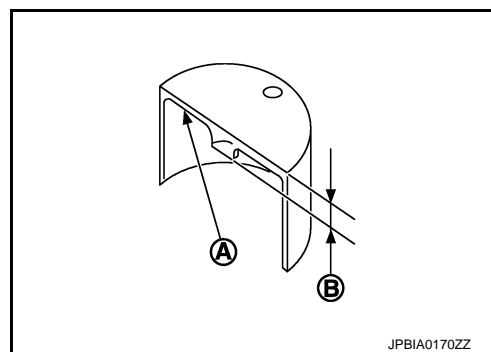
CAMSHAFT VALVE CLEARANCE

< PERIODIC MAINTENANCE >

- Thickness of new valve lifter can be identified by stamp marks on the reverse side (inside the cylinder).
Stamp mark 788 indicates 7.88 mm (0.3102 in) in thickness.

A : Stamp

B : Thickness of valve lifter



Available thickness of valve lifter: 27 sizes with range 7.88 to 8.40 mm (0.3102 to 0.3307 in) in steps of 0.02 mm (0.0008 in) (when manufactured at factory). Refer to [EM-140, "Camshaft"](#).

6. Install selected valve lifter.
7. Install camshaft. Refer to [EM-67, "Removal and Installation"](#).
8. Manually turn crankshaft pulley a few turns.
9. Check that the valve clearances for cold engine are within the specifications by referring to the specified values. Refer to [EM-18, "Inspection and Adjustment"](#).
10. Install all removal parts in the reverse order of removal.
11. Warm up the engine, and check for unusual noise and vibration.

COMPRESSION PRESSURE

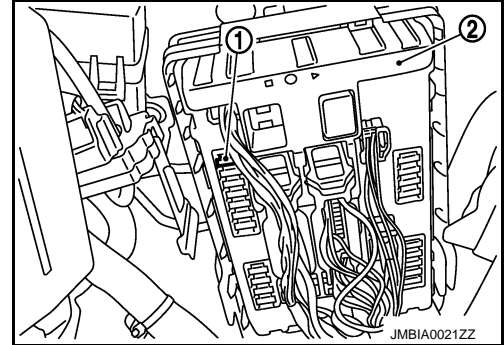
< PERIODIC MAINTENANCE >

COMPRESSION PRESSURE

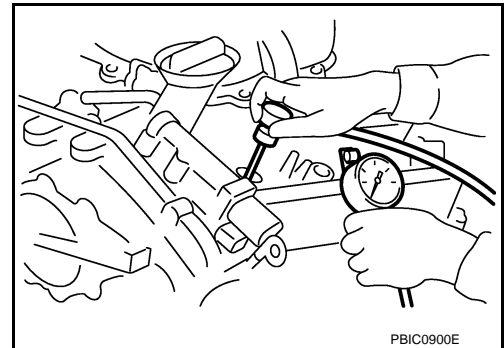
Inspection

INFOID:000000004348848

1. Warm up engine thoroughly. Then, stop it.
2. Release fuel pressure. Refer to [EC-559, "Inspection"](#).
3. Disconnect fuel pump fuse (1) from IPDM E/R (2) to avoid fuel injection during measurement.

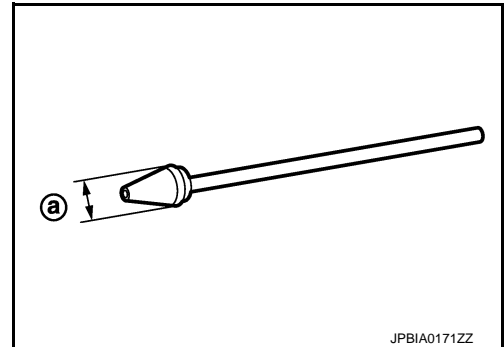


4. Remove engine cover with power tool. Refer to [EM-25, "Exploded View"](#).
5. Remove ignition coil and spark plug from each cylinder. Refer to [EM-16, "Exploded View"](#).
6. Connect engine tachometer (not required in use of CONSULT-III).
7. Install compression gauge with an adapter (commercial service tool) 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)



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-139, "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, and cylinder head gasket). After the checking, measure compression pressure again.

COMPRESSION PRESSURE

< PERIODIC MAINTENANCE >

- If some cylinder has low compression pressure, pour small amount of engine oil into the spark plug hole of the cylinder to re-check 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, install removed parts.
 10. Start the engine, and check that the engine runs smoothly.
 11. Perform trouble diagnosis. If DTC appears, erase it. Refer to [EC-129, "Description"](#).

ENGINE COVER

< REMOVAL AND INSTALLATION >

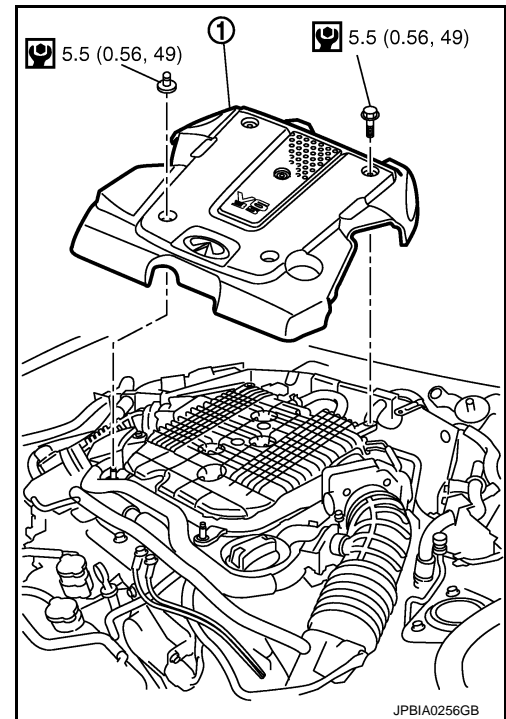
REMOVAL AND INSTALLATION

ENGINE COVER

Exploded View

INFOID:000000004348849

1 : Engine cover



Removal and Installation

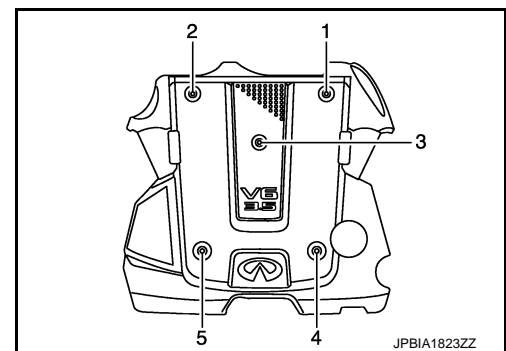
INFOID:000000004348850

REMOVAL

Loosen mounting bolts and nuts in the reverse order as shown in the figure, and then remove engine cover.

CAUTION:

Never damage or scratch engine cover when installing or removing.

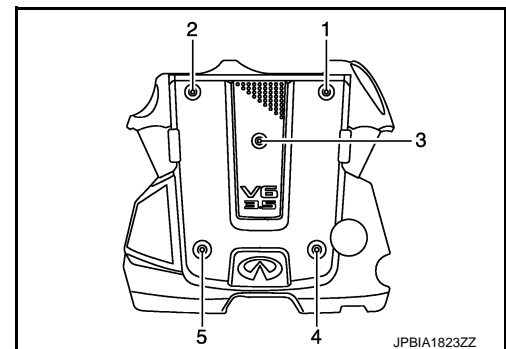


INSTALLATION

Install engine cover, and then tighten mounting bolts and nuts in numerical order as shown in the figure.

CAUTION:

Never damage or scratch engine cover when installing or removing.



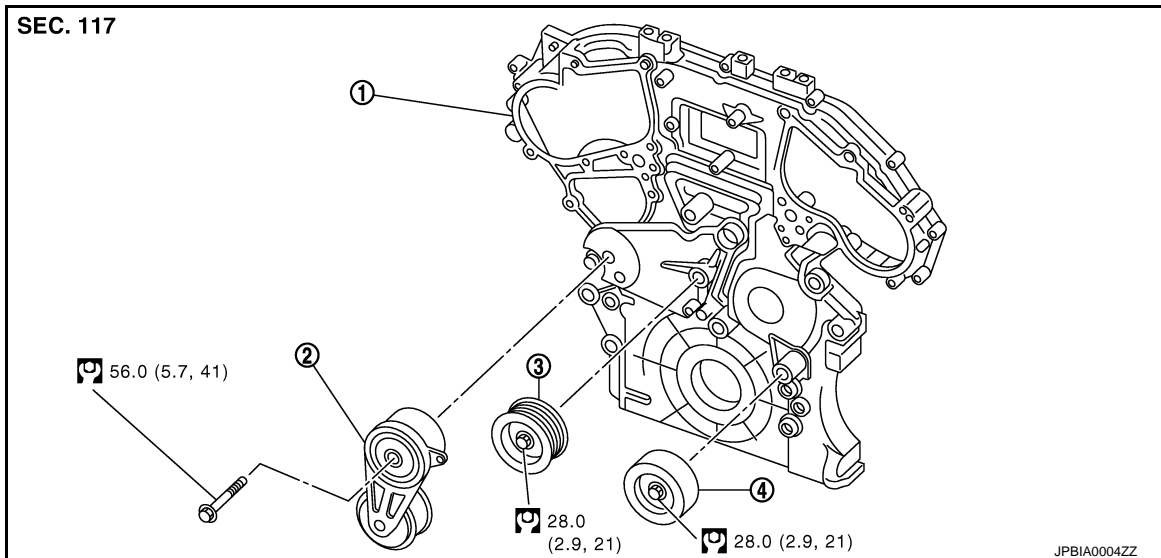
DRIVE BELT AUTO TENSIONER AND IDLER PULLEY

< REMOVAL AND INSTALLATION >

DRIVE BELT AUTO TENSIONER AND IDLER PULLEY

Exploded View

INFOID:000000004348851



1. Front timing chain case
2. Drive belt auto-tensioner
3. Idler pulley
4. Idler pulley

Refer to [GI-4, "Components"](#) for symbols in the figure.

Removal and Installation

INFOID:000000004348852

Removal

1. Remove drive belt. Refer to [EM-13, "Exploded View"](#).
 - Keep auto-tensioner pulley arm locked after drive belt is removed.
2. Remove auto-tensioner and idler pulley. Refer to [EM-13, "Exploded View"](#).
 - Keep auto-tensioner pulley arm locked to install or remove auto-tensioner.

Installation

Installation is the reverse order of removal.

CAUTION:

If there is damage greater than peeled paint, replace drive belt auto-tensioner.

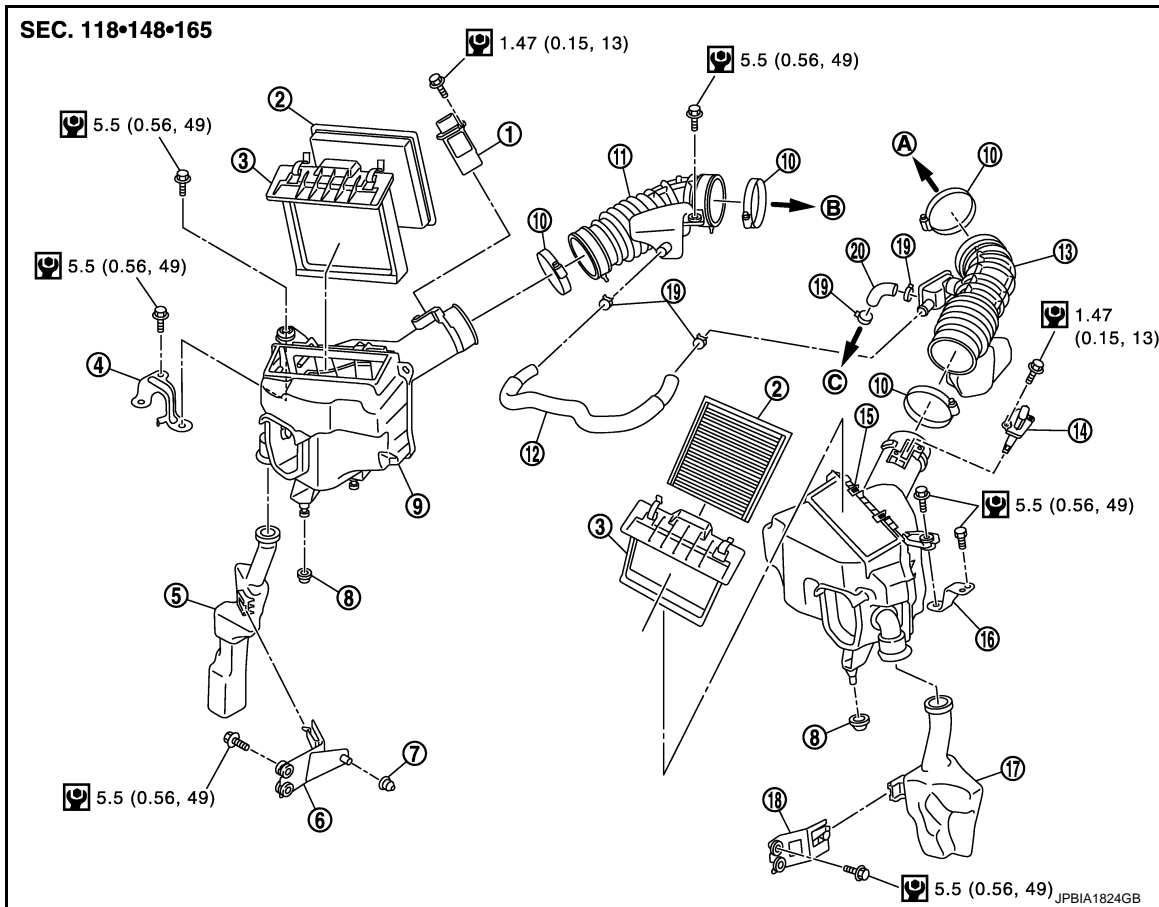
AIR CLEANER AND AIR DUCT

< REMOVAL AND INSTALLATION >

AIR CLEANER AND AIR DUCT

Exploded View

INFOID:000000004348853



- | | | |
|---|---|-----------------------------|
| 1. Mass air flow sensor (bank 1) | 2. Air cleaner filter | 3. Holder |
| 4. Bracket | 5. Resonator (RH) | 6. Bracket |
| 7. Grommet | 8. Grommet | 9. Air cleaner case (RH) |
| 10. Clamp | 11. Air duct (RH) | 12. PCV hose |
| 13. Air duct (LH) | 14. Mass air flow sensor (bank 2) | 15. Air cleaner case (LH) |
| 16. Bracket | 17. Resonator (LH) | 18. Bracket |
| 19. Clamp | 20. PCV hose | |
| A. To electric throttle control actuator (bank 2) | B. To electric throttle control actuator (bank 1) | C. To rocker cover (bank 2) |

Refer to [GI-4, "Components"](#) for symbols in the figure.

Removal and Installation

INFOID:000000004348854

REMOVAL

NOTE:

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

1. Disconnect mass air flow sensor harness connector.
2. Disconnect PCV hose.
3. Remove air cleaner case with mass air flow sensor and air duct, disconnecting each joints.
 - Add marks if necessary for easier installation.
4. Remove mass air flow sensor from air cleaner case if necessary.

CAUTION:

Handle mass air flow sensor with the following cares.

AIR CLEANER AND AIR DUCT

< REMOVAL AND INSTALLATION >

- **Never shock mass air flow sensor.**
- **Never disassemble mass air flow sensor.**
- **Never touch mass air flow sensor.**

INSTALLATION

Note the following, and install in the reverse order of removal.

Inspection

INFOID:000000004348855

INSPECTION AFTER REMOVAL

Inspect air duct and resonator assembly for crack or tear.

- If anything found, replace air duct and resonator assembly.

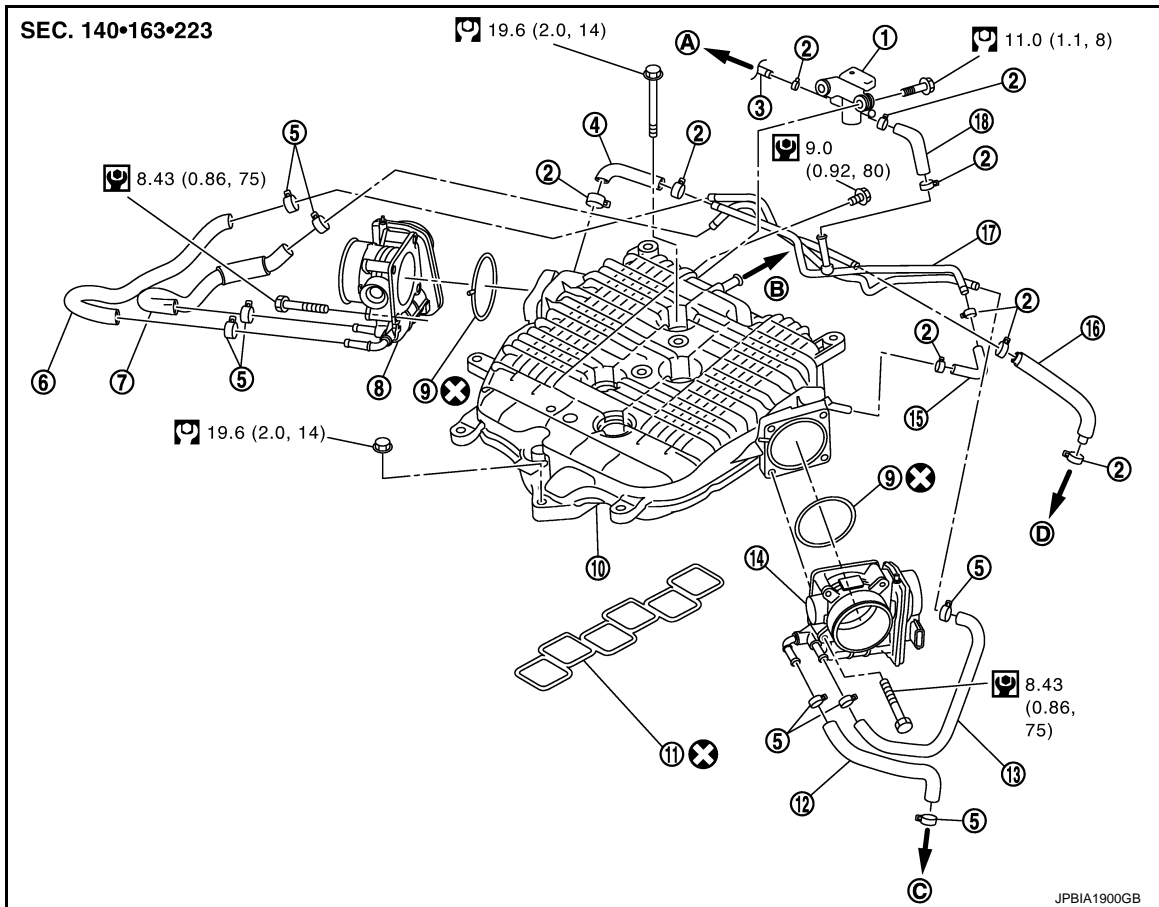
INTAKE MANIFOLD COLLECTOR

< REMOVAL AND INSTALLATION >

INTAKE MANIFOLD COLLECTOR

Exploded View

INFOID:000000004348856



- | | | |
|---|--|-------------------|
| 1. EVAP canister purge control solenoid valve | 2. Clamp | 3. EVAP hose |
| 4. EVAP hose | 5. Clamp | 6. Water hose |
| 7. Water hose | 8. Electric throttle control actuator (bank1) | 9. Gasket |
| 10. Intake manifold collector | 11. Gasket | 12. Water hose |
| 13. Water hose | 14. Electric throttle control actuator (bank2) | 15. EVAP hose |
| 16. Water hose | 17. EVAP tube assembly | 18. EVAP hose |
| A. To vacuum pipe | B. To brake booster | C. To heater pipe |
| D. To water outlet (rear) | | |

Refer to [GI-4, "Components"](#) for symbols in the figure.

Removal and Installation

INFOID:000000004348857

REMOVAL

WARNING:

Never drain engine coolant when the engine is hot to avoid the danger of being scalded.

1. Remove engine cover with power tool. Refer to [EM-25, "Exploded View"](#).
2. Remove air cleaner case and air duct (RH and LH). Refer to [EM-27, "Exploded View"](#).
3. Remove electric throttle control actuator as follows:
 - a. Drain engine coolant, or when water hoses are disconnected, attach plug to prevent engine coolant leakage.

INTAKE MANIFOLD COLLECTOR

< REMOVAL AND INSTALLATION >

CAUTION:

- Perform this step when engine is cold.
- Never spill engine coolant on drive belt.

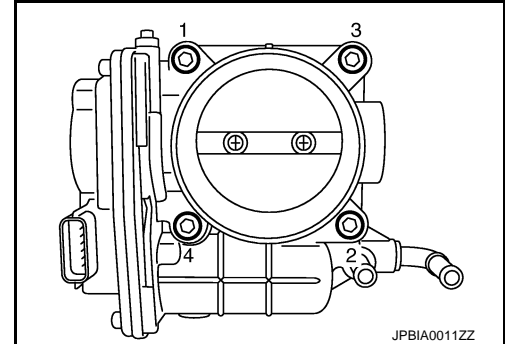
- Disconnect water hoses from electric throttle control actuator. When engine coolant is not drained from radiator, attach plug to water hoses to prevent engine coolant leakage.
- Disconnect harness connector.
- Loosen mounting bolts in reverse order as shown in the figure.

NOTE:

- When removing only intake manifold collector, move electric throttle control actuator without disconnecting the water hose.
- The figure shows the electric throttle control actuator (bank 1) viewed from the air duct side.
- Viewed from the air duct side, order of loosening mounting bolts of electric throttle control actuator (bank 2) is the same as that of the electric throttle control actuator (bank 1).

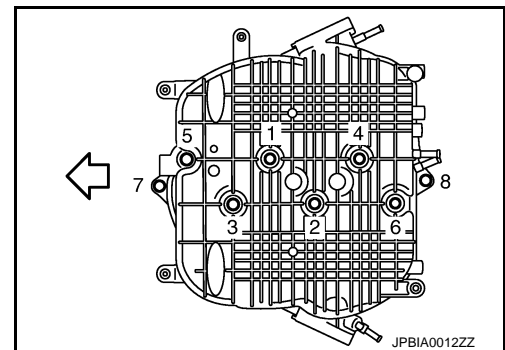
CAUTION:

Handle carefully to avoid any shock to electric throttle control actuator.



- Disconnect vacuum hose, PCV hose and EVAP hose from intake manifold collector.
- Remove EVAP canister purge volume control solenoid valve and EVAP tube assembly from intake manifold collector.
- Loosen mounting bolts and nuts with power tool in the reverse order as shown in the figure to remove intake manifold collector.

↩ : Engine front




INSTALLATION

Note the following, and install in the reverse order of removal.

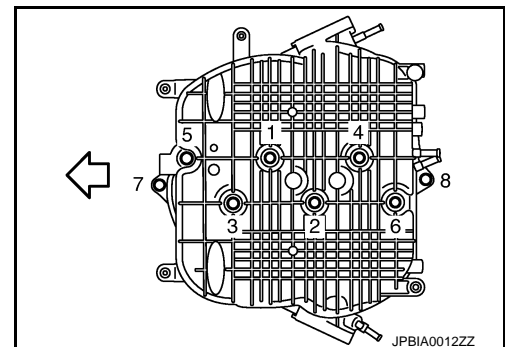
INTAKE MANIFOLD COLLECTOR

- If stud bolts were removed, install them and tighten to the specified torque below.

: 10.8 N·m (1.1 kg-m, 8 ft-lb)

- Tighten mounting bolts and nuts in numerical order as shown in the figure.

↩ : Engine front



WATER HOSE

- Insert hose by 27 to 32 mm (1.06 to 1.26 in) from connector end.
- Clamp hose at location of 3 to 7 mm (0.12 to 0.28 in) from hose end.

ELECTRIC THROTTLE CONTROL ACTUATOR (BANK 1 AND BANK 2)

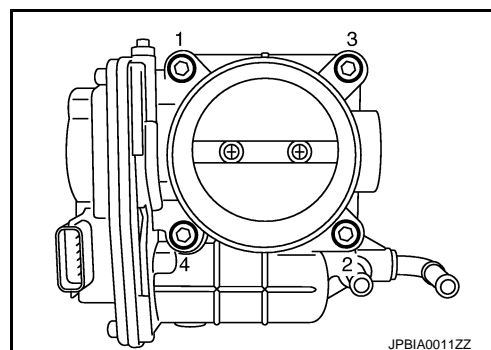
INTAKE MANIFOLD COLLECTOR

< REMOVAL AND INSTALLATION >

- Tighten in numerical order as shown in the figure.

NOTE:

- The figure shows the electric throttle control actuator (bank 1) viewed from the air duct side.
- Viewed from the air duct side, order of tightening mounting bolts of electric throttle control actuator (bank 2) is the same as that of the electric throttle control actuator (bank 1).
- Perform the "Throttle Valve Closed Position Learning" when harness connector of electric throttle control actuator is disconnected. Refer to [EC-18, "THROTTLE VALVE CLOSED POSITION LEARNING : Description"](#).
- Perform the "Idle Air Volume Learning" and "Throttle Valve Closed Position Learning" when electric throttle control actuator is replaced. Refer to [EC-18, "IDLE AIR VOLUME LEARNING : Description"](#) and [EC-18, "THROTTLE VALVE CLOSED POSITION LEARNING : Description"](#).



A

EM

C

D

E

F

G

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I

J

K

L

M

N

O

P

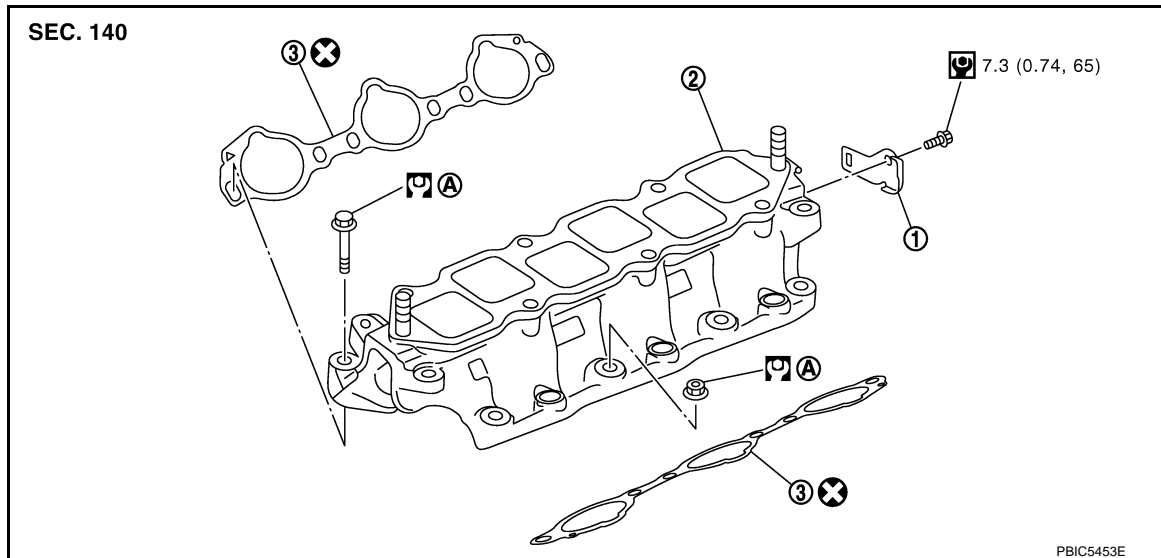
INTAKE MANIFOLD

< REMOVAL AND INSTALLATION >

INTAKE MANIFOLD

Exploded View

INFOID:000000004348858



1. Harness bracket

2. Intake manifold

3. Gasket

A. Refer to [EM-32](#)

Refer to [GI-4, "Components"](#) for symbols in the figure.

Removal and Installation

INFOID:000000004348859

REMOVAL

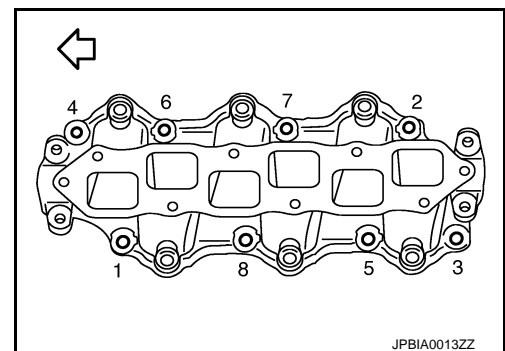
1. Release fuel pressure. Refer to [EC-559, "Inspection"](#).
2. Remove intake manifold collector. Refer to [EM-29, "Exploded View"](#).
3. Remove fuel tube and fuel injector assembly. Refer to [EM-37, "Exploded View"](#).
4. Remove harness bracket.
5. Loosen mounting bolts and nuts in reverse order as shown in the figure to remove intake manifold with power tool.

← : Engine front

CAUTION:

- Cover engine openings to avoid entry of foreign materials.
- Put a mark on the intake manifold and the cylinder head with paint before removal because they need installed in the specified direction.

6. Remove gaskets.



INSTALLATION

Note the following, and install in the reverse order of removal.

INTAKE MANIFOLD

- If stud bolts were removed, install them and tighten to the specified torque below.

: 10.8 N·m (1.1 kg-m, 8 ft-lb)

INTAKE MANIFOLD

< REMOVAL AND INSTALLATION >

- Tighten all mounting bolts and nuts to the specified torque in two or more steps in numerical order as shown in the figure.

↶ : Engine front

CAUTION:

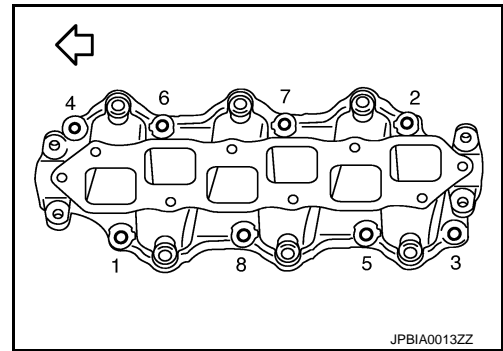
Install intake manifold with the marks (put on the intake manifold and the cylinder head before removal) aligned.

1st step:

: 7.4 N·m (0.75 kg-m, 5 ft-lb)

2nd step and after:

: 25.5 N·m (2.6 kg-m, 19 ft-lb)



Inspection

INFOID:000000004348860

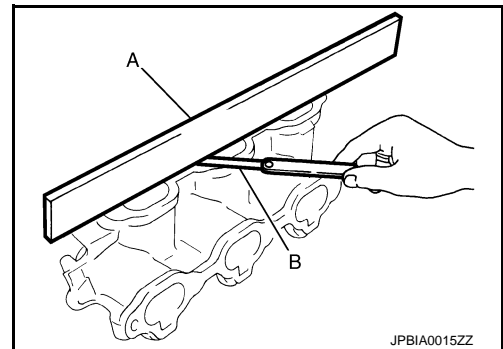
INSPECTION AFTER REMOVAL

Surface Distortion

- Check the surface distortion of the intake manifold mating surface with a straightedge (A) and a feeler gauge (B).

Limit : Refer to [EM-140, "Intake Manifold"](#).

- If it exceeds the limit, replace intake manifold.



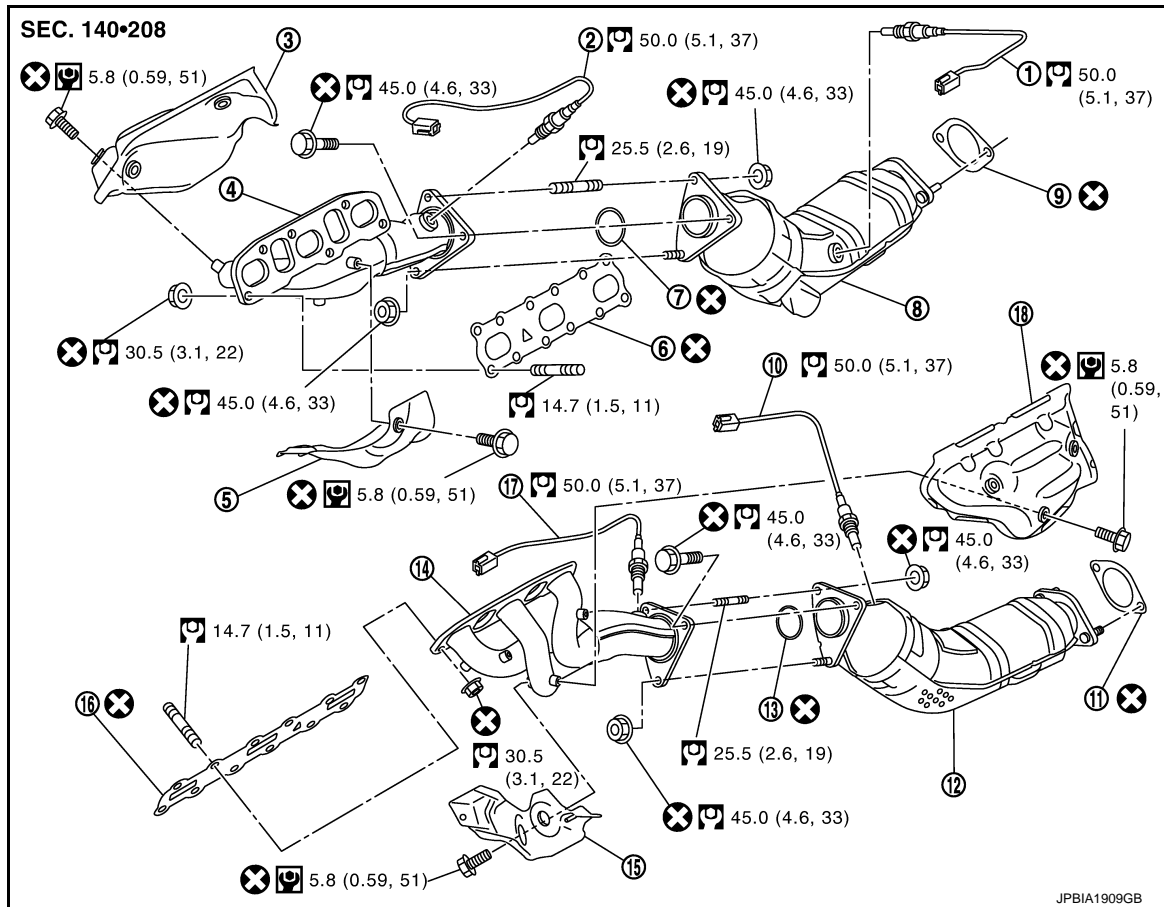
EXHAUST MANIFOLD

< REMOVAL AND INSTALLATION >

EXHAUST MANIFOLD

Exploded View

INFOID:000000004348861



- | | | |
|-------------------------------------|--------------------------------------|------------------------------------|
| 1. Heated oxygen sensor 2 (bank 1) | 2. Air fuel ratio sensor 1 (bank 1) | 3. Exhaust manifold cover (upper) |
| 4. Exhaust manifold (bank 1) | 5. Exhaust manifold cover (lower) | 6. Gasket |
| 7. Ring gasket | 8. Three way catalyst (bank 1) | 9. Gasket |
| 10. Heated oxygen sensor 2 (bank 2) | 11. Gasket | 12. Three way catalyst (bank 2) |
| 13. Ring gasket | 14. Exhaust manifold (bank 2) | 15. Exhaust manifold cover (lower) |
| 16. Gasket | 17. Air fuel ratio sensor 1 (bank 2) | 18. Exhaust manifold cover (upper) |

Refer to [GI-4, "Components"](#) for symbols in the figure.

Removal and Installation

INFOID:000000004348862

REMOVAL

WARNING:

Perform the work when the exhaust and cooling system have completely cooled down.

NOTE:

When removing bank 1 side parts only, step 2, 5, and 7 are unnecessary.

1. Remove engine undercover with power tool.
2. Drain engine coolant. Refer to [CO-7, "Draining"](#).
3. Remove engine cover with power tool. Refer to [EM-25, "Exploded View"](#).
4. Remove air cleaner case and air duct (RH and LH). Refer to [EM-27, "Exploded View"](#).
5. Remove heater pipe and water hose. Refer to [CO-22, "Exploded View"](#).
6. Remove exhaust front tube and three way catalysts (bank 1 and bank 2). Refer to [EX-5, "Exploded View"](#).

EXHAUST MANIFOLD

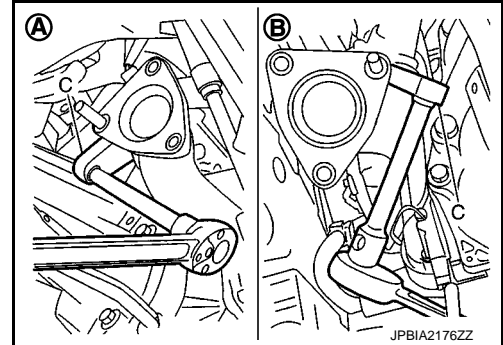
< REMOVAL AND INSTALLATION >

7. Disconnect steering lower joint at power steering gear assembly side, and release steering lower shaft. Refer to [ST-22, "Exploded View"](#).
8. Disconnect air fuel ratio sensor 1 harness connectors (bank 1 and bank 2) and remove harness clip.
9. Using the heated oxygen sensor wrench [SST: KV10114400 (J-38365)] (C), remove air fuel ratio sensor 1 (bank 1 and bank 2).

A : Bank 1
B : Bank 2

CAUTION:

- Be careful not to damage air fuel ratio sensor 1.
- Discard any air fuel ratio sensor 1 which has been dropped onto a hard surface such as a concrete floor. Replace with a new sensor.

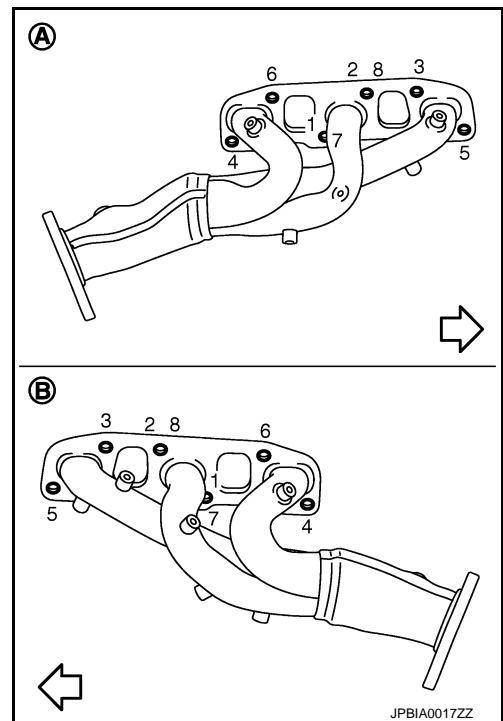


10. Remove exhaust manifold cover (upper) (bank 1 and bank 2).
11. Loosen mounting nuts in the reverse order as shown in the figure to remove exhaust manifold.

A : Bank 1
B : Bank 2
⇐ : Engine front

NOTE:

Disregard the numerical order No. 7 and 8 in removal.



12. Remove gaskets.

CAUTION:

Cover engine openings to avoid entry of foreign materials.

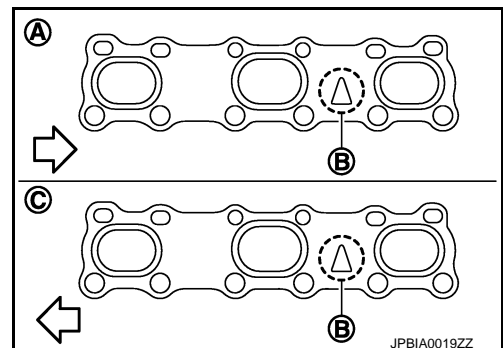
INSTALLATION

Note the following, and install in the reverse order of removal.

EXHAUST MANIFOLD GASKET

- Install exhaust manifold gasket in direction shown in the figure. (Follow same procedure for both banks.)

A : Bank 1
B : Triangle press
C : Bank 2
⇐ : Engine front



EXHAUST MANIFOLD

< REMOVAL AND INSTALLATION >

EXHAUST MANIFOLD

- If stud bolts were removed, install them and tighten to the specified torque below.

Tightening torque : Refer to [EM-34, "Exploded View"](#).

- Install exhaust manifold and tighten mounting nuts in numerical order as shown in the figure.

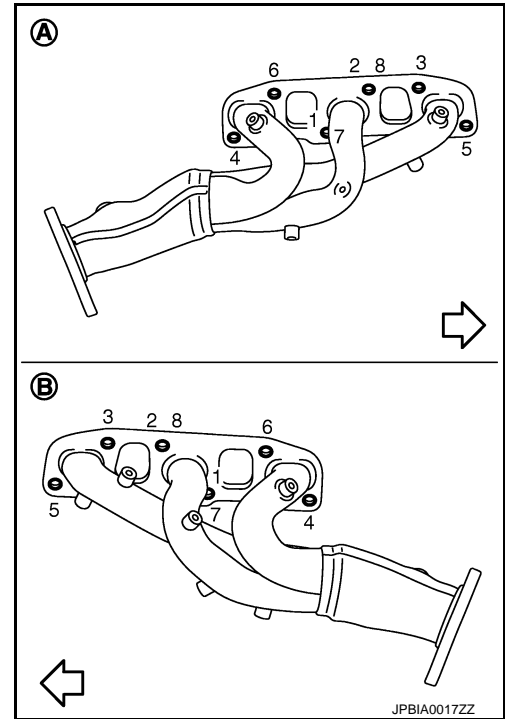
A : Bank 1

B : Bank 2

⇐ : Engine front

NOTE:

Tighten nuts No. 1 and 2 in two steps. The numerical order No. 7 and 8 shows second step.



AIR FUEL RATIO SENSOR 1

CAUTION:

- Before installing a new air fuel ratio sensor 1, clean exhaust system threads using heated oxygen sensor thread cleaner tool (commercial service tool: J-43897-18 or J-43897-12) and apply anti-seize lubricant.
- Never over torque air fuel ratio sensor 1. Doing so may cause damage to air fuel ratio sensor 1, resulting in the "MIL" coming on.

Inspection

INFOID:000000004348863

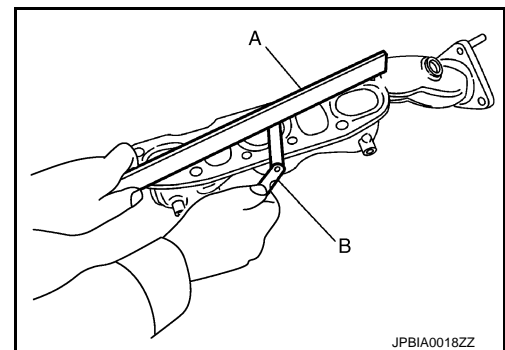
INSPECTION AFTER REMOVAL

Surface Distortion

- Check the surface distortion of the exhaust manifold mating surface with a straightedge (A) and a feeler gauge (B).

Limit : Refer to [EM-140, "Exhaust Manifold"](#).

- If it exceeds the limit, replace exhaust manifold.



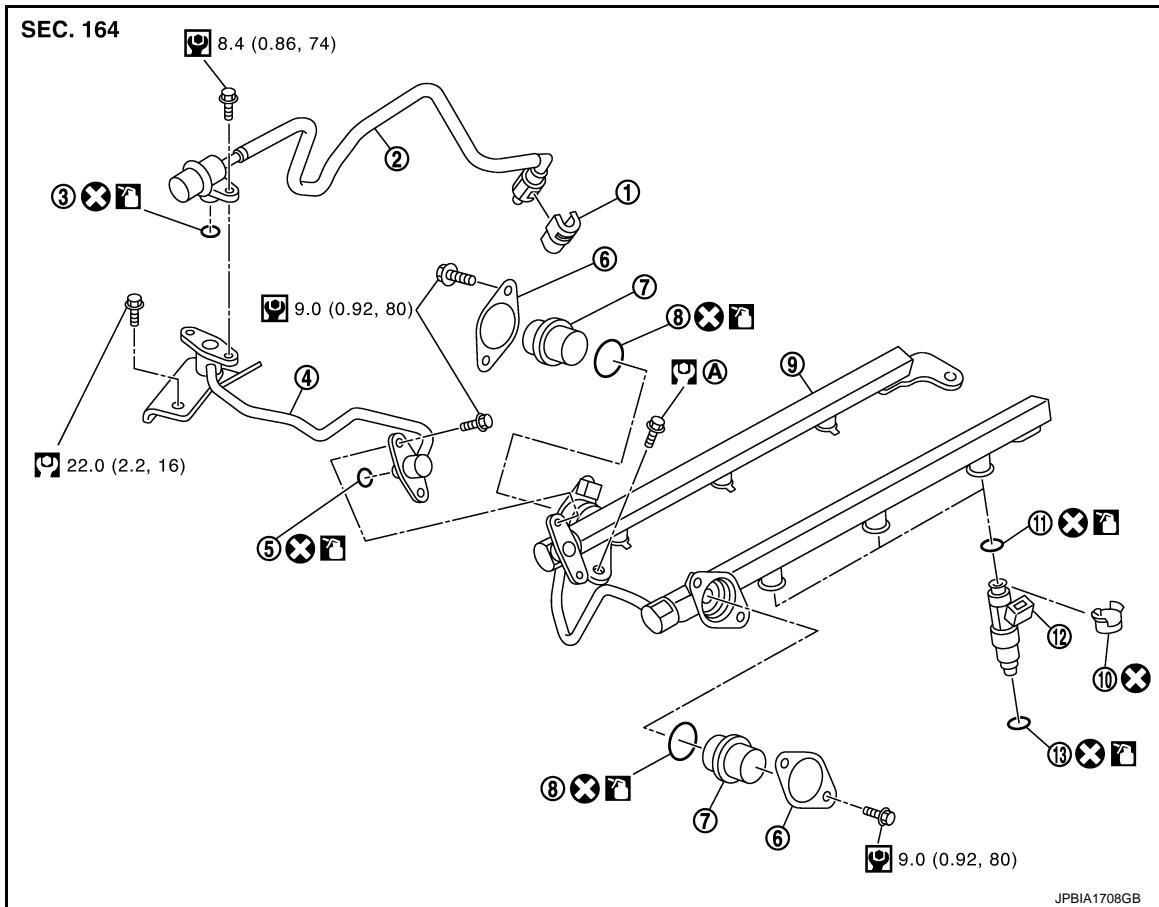
FUEL INJECTOR AND FUEL TUBE

< REMOVAL AND INSTALLATION >

FUEL INJECTOR AND FUEL TUBE

Exploded View

INFOID:000000004348864



- | | | |
|------------------------|---------------------------------|--------------------|
| 1. Quick connector cap | 2. Fuel feed hose (with damper) | 3. O-ring |
| 4. Fuel sub tube | 5. O-ring | 6. Fuel damper cap |
| 7. Fuel damper | 8. O-ring | 9. Fuel tube |
| 10. Clip | 11. O-ring (black) | 12. Fuel injector |
| 13. O-ring (green) | | |

A. Refer to [EM-37](#)

Refer to [GI-4, "Components"](#) for symbols in the figure.

CAUTION:

Never remove or disassemble parts unless instructed as shown in the figure.

Removal and Installation

INFOID:000000004348865

REMOVAL

WARNING:

- Put a "CAUTION: FLAMMABLE" sign in the workshop.
- Be sure to work in a well ventilated area and furnish workshop with a CO₂ fire extinguisher.
- Never smoke while servicing fuel system. Keep open flames and sparks away from the work area.
- Never drain engine coolant when the engine is hot to avoid the danger of being scalded.

1. Release fuel pressure. Refer to [EC-559, "Inspection"](#).
2. Disconnect battery cable from the negative terminal. Refer to [PG-104, "Exploded View"](#).
3. Remove engine cover with power tool. Refer to [EM-25, "Exploded View"](#).
4. Remove air cleaner case and air duct (RH and LH). Refer to [EM-27, "Exploded View"](#).

FUEL INJECTOR AND FUEL TUBE

< REMOVAL AND INSTALLATION >

5. Remove intake manifold collector. Refer to [EM-29, "Exploded View"](#).
6. Remove fuel feed hose (with damper) (1) from fuel sub-tube (2) and remove harness bracket (3).

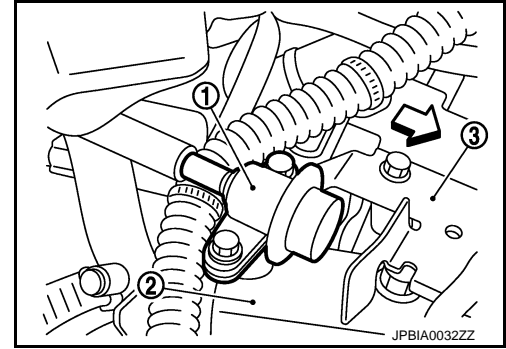
⇐ : Engine front

NOTE:

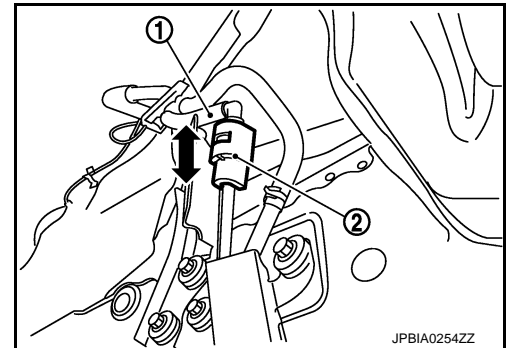
There is no fuel return route.

CAUTION:

- While hoses are disconnected, plug them to prevent fuel from draining.
- Never separate damper and hose.



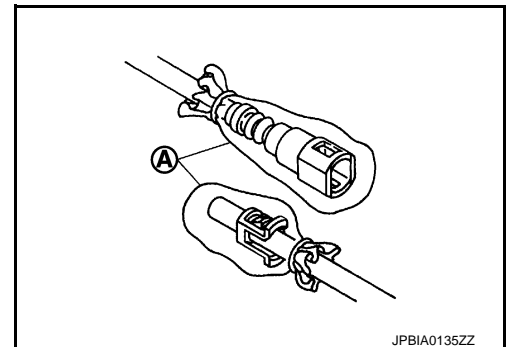
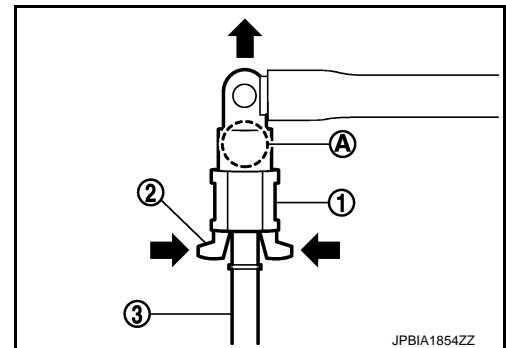
7. When separating fuel feed hose (with damper) and centralized under-floor piping connection, disconnect quick connector as follows:
 - a. Remove quick connector cap (2) from quick connector connection on right member side.
 - b. Disconnect fuel feed hose (with damper) (1) from bracket hose clamp.



- c. Push in retainer tabs (2).
 - d. Draw and pull out quick connector (1) straight from centralized under-floor piping (3).

CAUTION:

- Pull quick connector holding position (A) as shown in the figure.
- Never pull with lateral force applied. O-ring inside quick connector may be damaged.
- Prepare container and cloth beforehand as fuel will leak out.
- Avoid fire and sparks.
- Keep parts away from heat source. Especially, be careful when welding is performed around them.
- Never expose parts to battery electrolyte or other acids.
- Never bend or twist connection between quick connector and fuel feed hose (with damper) during installation/removal.
- To keep clean the connecting portion and to avoid damage and foreign materials, cover them completely with plastic bags, etc. (A) or something similar.



8. Remove fuel sub tube mounting bolt.
9. Disconnect harness connector from fuel injector.

FUEL INJECTOR AND FUEL TUBE

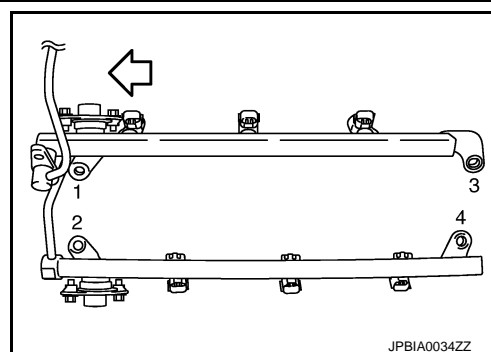
< REMOVAL AND INSTALLATION >

10. Loosen mounting bolts in reverse order as shown in the figure, and remove fuel tube and fuel injector assembly.

← : Engine front

CAUTION:

Never tilt fuel tube, or remaining fuel in pipes may flow out from pipes.



11. Remove fuel injector (2) from fuel tube (4) as follows:

3 : O-ring

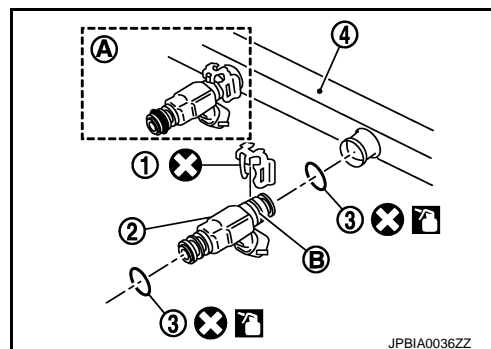
A : Installed condition

B : Clip mounting groove

- a. Open and remove clip (1).
- b. Remove fuel injector from fuel tube by pulling straight.

CAUTION:

- Be careful with remaining fuel that may go out from fuel tube.
- Be careful not to damage injector nozzles during removal.
- Never bump or drop fuel injector.
- Never disassemble fuel injector.



12. Remove fuel sub-tube and fuel damper, if necessary.

INSTALLATION

1. Install fuel damper (4) as follows:

- a. Install new O-ring (2) to fuel tube (1) as shown. When handling new O-ring, be careful of the following caution:

CAUTION:

- Handle O-ring with bare hands. Never wear gloves.
- Lubricate O-ring with new engine oil.
- Never clean O-ring with solvent.
- Check that O-ring and its mating part are free of foreign material.
- When installing O-ring, be careful not to scratch it with tool or fingernails. Also be careful not to twist or stretch O-ring. If O-ring was stretched while it was being attached, never insert it quickly into fuel tube.
- Insert new O-ring straight into fuel tube. Never twist it.

- b. Install spacer (3) to fuel damper.
- c. Insert fuel damper straight into fuel tube.

CAUTION:

- Insert straight, checking that the axis is lined up.
- Never pressure-fit with excessive force.

Reference value : 130 N (13.3 kg, 29.2 lb)

- Insert fuel damper until (B) is touching (A) of fuel tube.

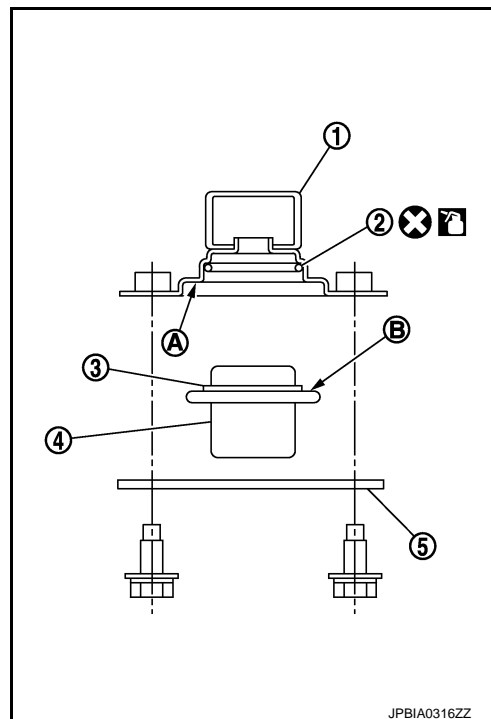
- d. Tighten bolts evenly in turn.
- After tightening bolts, check that there is no gap between fuel damper cap (5) and fuel tube.

2. Install fuel sub-tube.

- When handling new O-rings, be careful of the following caution:

CAUTION:

- Handle O-ring with bare hands. Never wear gloves.



FUEL INJECTOR AND FUEL TUBE

< REMOVAL AND INSTALLATION >

- Lubricate O-ring with new engine oil.
 - Never clean O-ring with solvent.
 - Check that O-ring and its mating part are free of foreign material.
 - When installing O-ring, be careful not to scratch it with tool or fingernails. Also be careful not to twist or stretch O-ring. If O-ring was stretched while it was being attached, never insert it quickly into fuel tube.
 - Insert new O-ring straight into fuel tube. Never decenter or twist it.
- Insert fuel sub-tube straight into fuel tube.
- Tighten mounting bolts evenly in turn.
 - After tightening mounting bolts, check that there is no gap between flange and fuel tube.
3. Install new O-rings to fuel injector, paying attention to the following.
- CAUTION:**
- Upper and lower O-rings are different. Be careful not to confuse them.

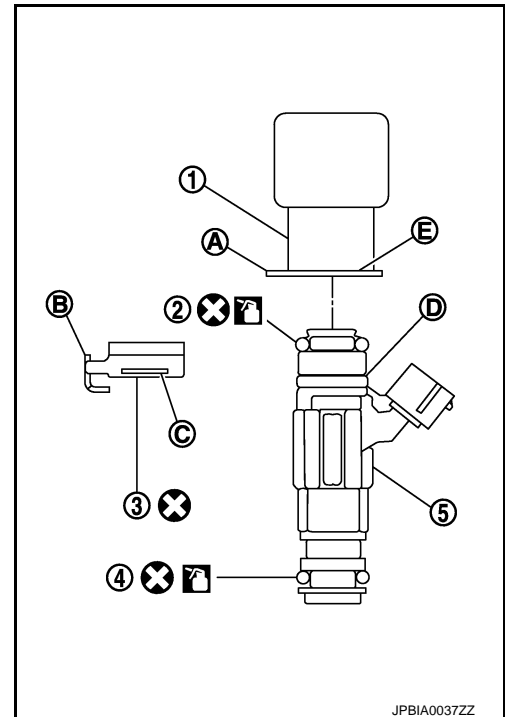
Fuel tube side : Black

Nozzle side : Green

- Handle O-ring with bare hands. Never wear gloves.
 - Lubricate O-ring with new engine oil.
 - Never clean O-ring with solvent.
 - Check that O-ring and its mating part are free of foreign material.
 - When installing O-ring, be careful not to scratch it with tool or fingernails. Also be careful not to twist or stretch O-ring. If O-ring was stretched while it was being attached, never insert it quickly into fuel tube.
 - Insert O-ring straight into fuel injector. Never decenter or twist it.
4. Install fuel injector to fuel tube as follows:
- a. Insert clip (3) into clip mounting groove (D) on fuel injector (5).
- 2 : O-ring (Black)
4 : O-ring (Green)

CAUTION:

- Never reuse clip. Replace it with a new one.
 - Be careful to keep clip from interfering with O-ring. If interference occurs, replace O-ring.
- b. Insert fuel injector into fuel tube (1) with clip attached.
- Insert it while matching it to the axial center.
 - Insert fuel injector so that protrusion (A) of fuel tube matches cutout (B) of clip.
 - Check that fuel tube flange (E) is securely fixed in flange fixing groove (C) on clip.
- c. Check that installation is complete by checking that fuel injector does not rotate or come off.
- Check that protrusions of fuel injectors are aligned with cut-outs of clips after installation.



5. Install fuel tube and fuel injector assembly to intake manifold.

CAUTION:

Be careful not to let tip of injector nozzle come in contact with other parts.

FUEL INJECTOR AND FUEL TUBE

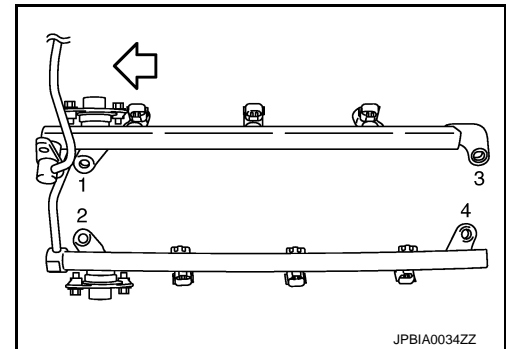
< REMOVAL AND INSTALLATION >

- Tighten mounting bolts in two steps in numerical order as shown in the figure.

↶ : Engine front

 **1st step** : 10.1 N·m (1.0 kg-m, 7 ft-lb)

 **2nd step** : 23.6 N·m (2.4 kg-m, 17 ft-lb)

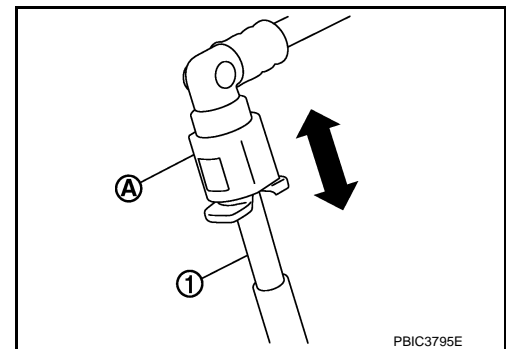


6. Connect injector sub-harness.
7. Install fuel sub tube mounting bolt.
8. Connect fuel feed hose (with damper).
 - Handling procedure of O-ring is the same as that of fuel damper and fuel sub-tube.
 - Insert fuel damper straight into fuel sub-tube.
 - Tighten mounting bolts evenly in turn.
 - After tightening mounting bolts, check that there is no gap between flange and fuel sub-tube.
9. Connect quick connector between fuel feed hose (with damper) and centralized under-floor piping connection as follows:
 - a. Check no foreign substances are deposited in and around centralized under-floor piping and quick connector, and no damage on them.
 - b. Thinly apply new engine oil around centralized under-floor piping from tip end to spool end.
 - c. Align center to insert quick connector straightly into centralized under-floor piping.
 - Insert quick connector to centralized under-floor piping until top spool is completely inside quick connector and 2nd level spool exposes right below quick connector.

CAUTION:

- **Carefully align center to avoid inclined insertion to prevent damage to O-ring inside quick connector.**
- **Insert until you hear a “click” sound and actually feel the engagement.**
- **To avoid misidentification of engagement with a similar sound, be sure to perform the next step.**

- d. Pull quick connector by hand holding position (A). Check it is completely engaged (connected) so that it does not come out from centralized under-floor piping (1).



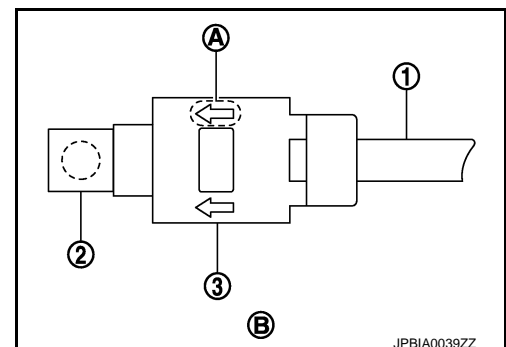
- e. Install quick connector cap (3) to quick connector connection.

- 1 : Centralized under-floor piping
- 2 : Fuel feed hose
- B : Under view

- Install quick connector cap with arrow (A) on surface facing in direction of quick connector (fuel feed hose side).

CAUTION:

If quick connector cap cannot be installed smoothly, quick connector may have not been installed correctly. Check the connection again.



10. Install in the reverse order of removal after this step.

FUEL INJECTOR AND FUEL TUBE

< REMOVAL AND INSTALLATION >

Inspection

INFOID:000000004348866

INSPECTION AFTER INSTALLATION

Check on Fuel Leakage

1. Turn ignition switch "ON" (with the engine stopped). With fuel pressure applied to fuel piping, check there are no fuel leakage 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 leakage at connection points.

CAUTION:

Never touch the engine immediately after stopped, as the engine becomes extremely hot.

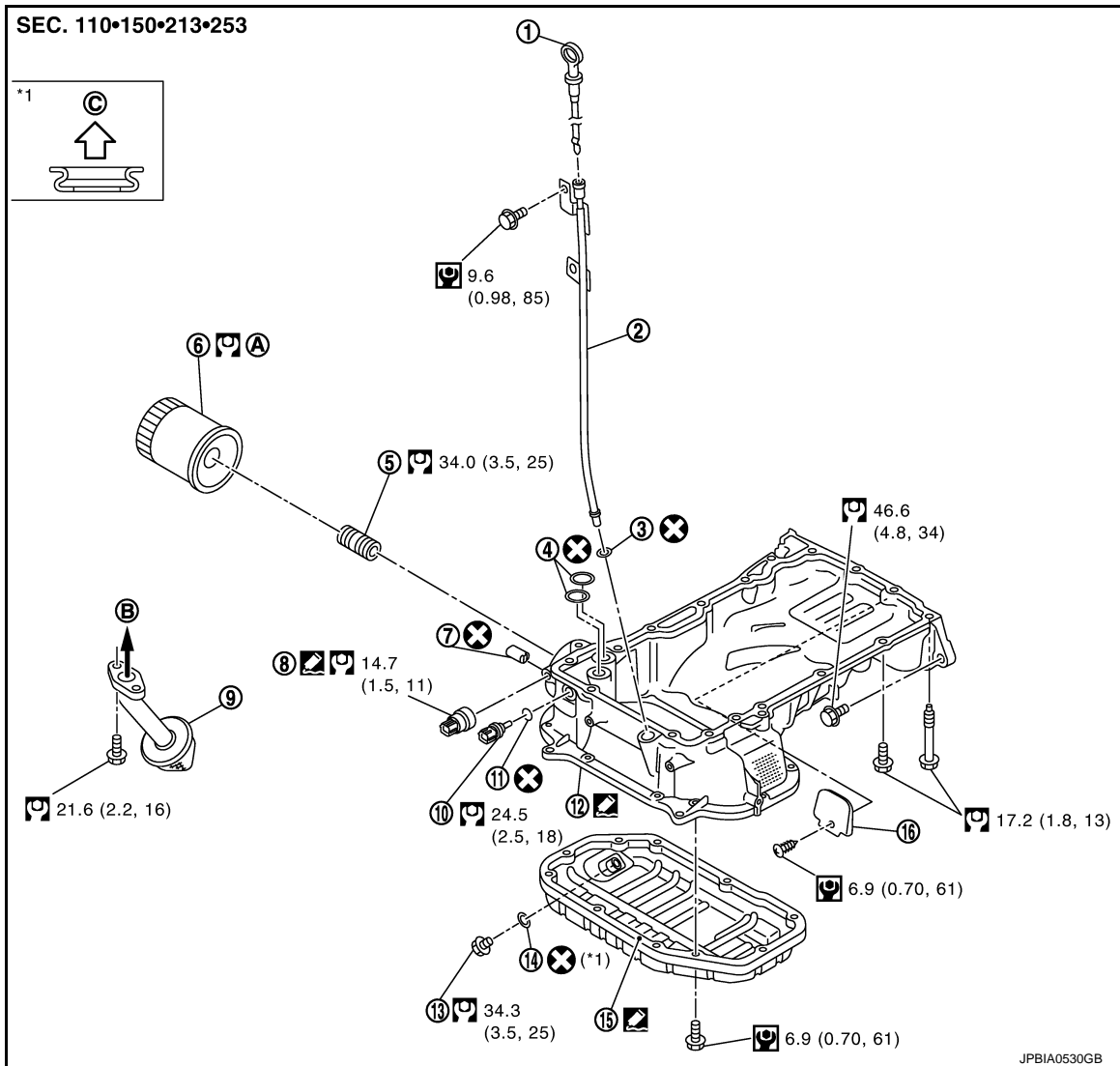
OIL PAN (LOWER)

< REMOVAL AND INSTALLATION >

OIL PAN (LOWER)

Exploded View (2WD)

INFOID:000000004348867



- | | | |
|----------------------------------|--------------------------|---------------------|
| 1. Oil level gauge | 2. Oil level gauge guide | 3. O-ring |
| 4. O-ring | 5. Connector bolt | 6. Oil filter |
| 7. Plug | 8. Oil pressure switch | 9. Oil strainer |
| 10. Oil temperature sensor | 11. Washer | 12. Oil pan (upper) |
| 13. Drain plug | 14. Drain plug washer | 15. Oil pan (lower) |
| 16. Rear plate cover | | |
| A. Refer to LU-9 | B. To oil pump | C. Oil pan side |

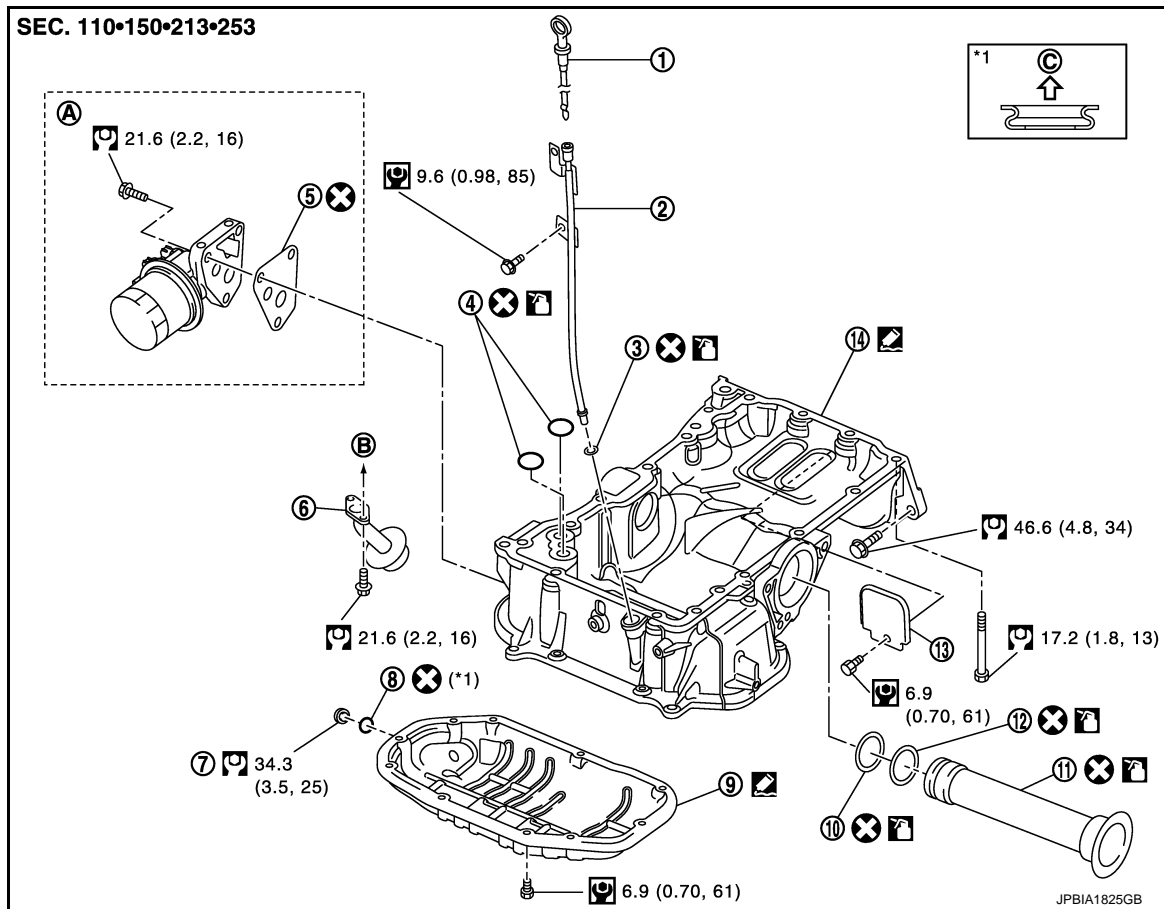
Refer to [GI-4, "Components"](#) for symbols in the figure.

OIL PAN (LOWER)

< REMOVAL AND INSTALLATION >

Exploded View (AWD)

INFOID:000000004348868



- | | | |
|-----------------------------------|--------------------------|--------------------|
| 1. Oil level gauge | 2. Oil level gauge guide | 3. O-ring |
| 4. O-ring | 5. Gasket | 6. Oil strainer |
| 7. Drain plug | 8. Drain plug washer | 9. Oil pan (lower) |
| 10. O-ring (small) | 11. Axle pipe | 12. O-ring (large) |
| 13. Rear plate cover | 14. Oil pan (upper) | |
| A. Refer to LU-11 | B. To oil pump | C. Oil pan side |

Refer to [GI-4, "Components"](#) for symbols in the figure.

Removal and Installation

INFOID:000000004348869

REMOVAL

CAUTION:

Never drain engine oil when the engine is hot to avoid the danger of being scalded.

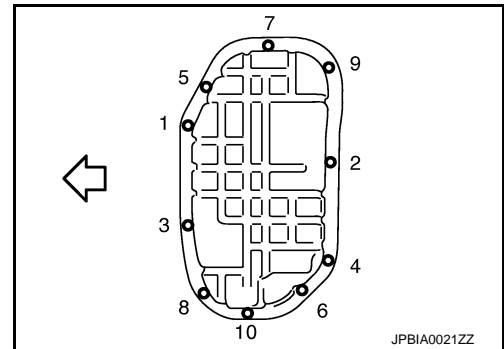
1. Remove engine undercover with power tool.
2. Drain engine oil. Refer to [LU-8, "Draining"](#).
3. Remove oil pan (lower) as follows:

OIL PAN (LOWER)

< REMOVAL AND INSTALLATION >

- a. Loosen mounting bolts in reverse order as shown in the figure to remove.

⇐ : Engine front

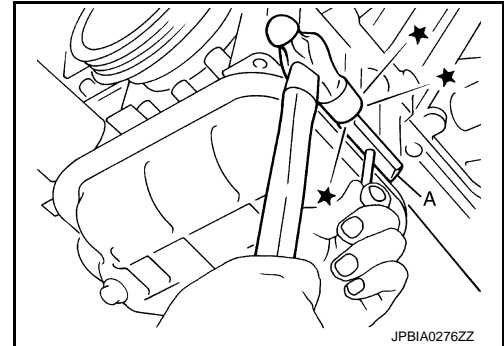


- b. Insert the seal cutter [SST: KV10111100 (J-37228)] (A) between oil pan (upper) and oil pan (lower).

CAUTION:

- Be careful not to damage the mating surfaces.
- Never insert a screwdriver, this will damage the mating surfaces.

- c. Slide the seal cutter [SST: KV10111100 (J-37228)] by tapping on the side of tool with a hammer. Remove oil pan (lower).



INSTALLATION

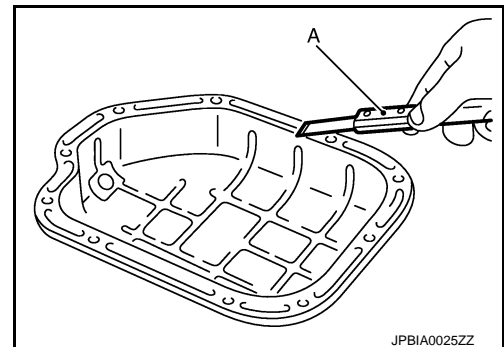
1. Install oil pan (lower) as follows:

- a. Use scraper (A) to remove old liquid gasket from mating surfaces.

- Remove old liquid gasket from the bolt holes and thread.

CAUTION:

Never scratch or damage the mating surfaces when cleaning off old liquid gasket.



- b. Apply a continuous bead of liquid gasket with the tube presser (commercial service tool) to the oil pan (lower) as shown in the figure.

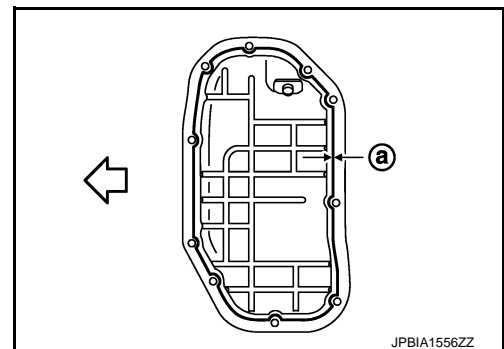
⇐ : Engine front

a : $\phi 4.0 - 5.0$ mm (0.157 - 0.197 in)

Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-17, "Recommended Chemical Products and Sealants"](#).

CAUTION:

Attaching should be done within 5 minutes after coating.



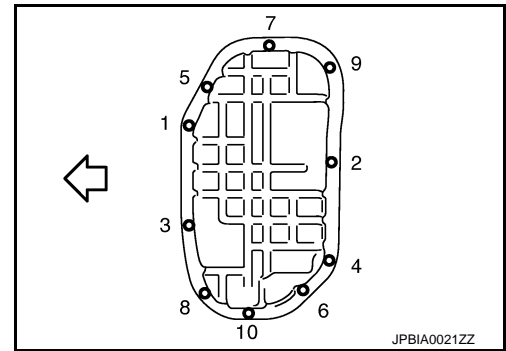
- c. Install oil pan (lower).

OIL PAN (LOWER)

< REMOVAL AND INSTALLATION >

- Tighten mounting bolts in numerical order as shown in the figure.

⇐ : Engine front



2. Install oil pan drain plug.
 - Refer to the figure of components of former page for installation direction of drain plug washer. Refer to [EM-43, "Exploded View \(2WD\)"](#) (2WD models) and [EM-44, "Exploded View \(AWD\)"](#) (AWD models).
3. Install in the reverse order of removal after this step.
NOTE:
At least 30 minutes after oil pan is installed, pour engine oil.

Inspection

INFOID:000000004348870

INSPECTION AFTER REMOVAL

Clean oil strainer if any object attached.

INSPECTION AFTER INSTALLATION

1. Check the engine oil level and adjust engine oil. Refer to [LU-6, "Inspection"](#).
2. Start engine, and check there is no leakage of engine oil.
3. Stop engine and wait for 10 minutes.
4. Check the engine oil level again. Refer to [LU-6, "Inspection"](#).

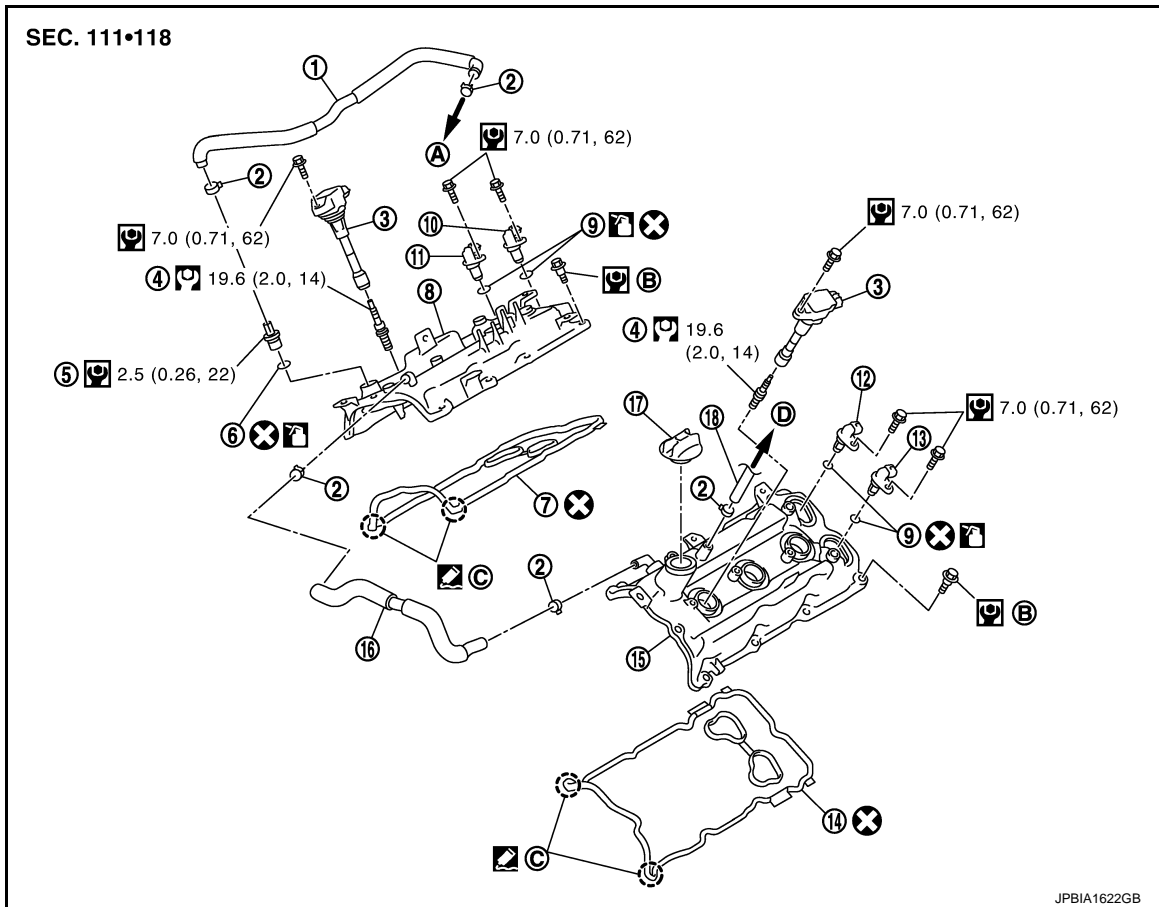
IGNITION COIL, SPARK PLUG AND ROCKER COVER

< REMOVAL AND INSTALLATION >

IGNITION COIL, SPARK PLUG AND ROCKER COVER

Exploded View

INFOID:000000004348871



- | | | |
|---|---|---|
| 1. PCV hose | 2. Clamp | 3. Ignition coil |
| 4. Spark plug | 5. PCV valve | 6. O-ring |
| 7. Rocker cover gasket (bank 1) | 8. Rocker cover (bank 1) | 9. O-ring |
| 10. Camshaft position sensor (PHASE) (bank 1) | 11. Exhaust valve timing control position sensor (bank 1) | 12. Camshaft position sensor (PHASE) (bank 2) |
| 13. Exhaust valve timing control position sensor (bank 2) | 14. Rocker cover gasket (bank 2) | 15. Rocker cover (bank 2) |
| 16. PCV hose | 17. Oil filler cap | 18. PCV hose |
| A. To intake manifold collector | B. Refer to EM-47 | C. Camshaft bracket side |
| D. To air duct | | |

Refer to [GI-4, "Components"](#) for symbols in the figure.

Removal and Installation

INFOID:000000004348872

REMOVAL

- Remove the following parts:
 - Engine cover: Refer to [EM-25, "Exploded View"](#).
 - Air cleaner case and air duct (RH and LH): Refer to [EM-27, "Exploded View"](#).
 - Intake manifold collector: Refer to [EM-29, "Exploded View"](#).
- Disconnect PCV hose from rocker cover.

IGNITION COIL, SPARK PLUG AND ROCKER COVER

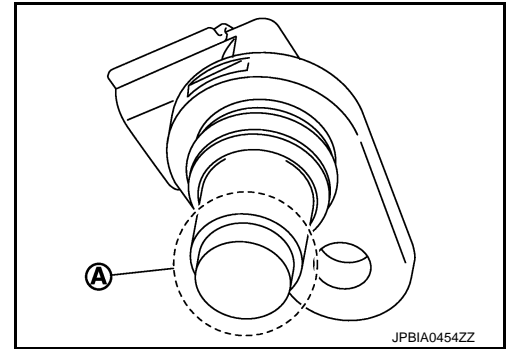
< REMOVAL AND INSTALLATION >

3. Remove camshaft position sensor (PHASE) and exhaust valve timing control position sensor. (bank 1 and bank 2)

A : Keep off any magnetic materials

CAUTION:

- Handle carefully to avoid dropping and shocks.
- Never disassemble.
- Never allow metal powder to adhere to magnetic part at sensor tip.
- Never place sensors in a location where they are exposed to magnetism.



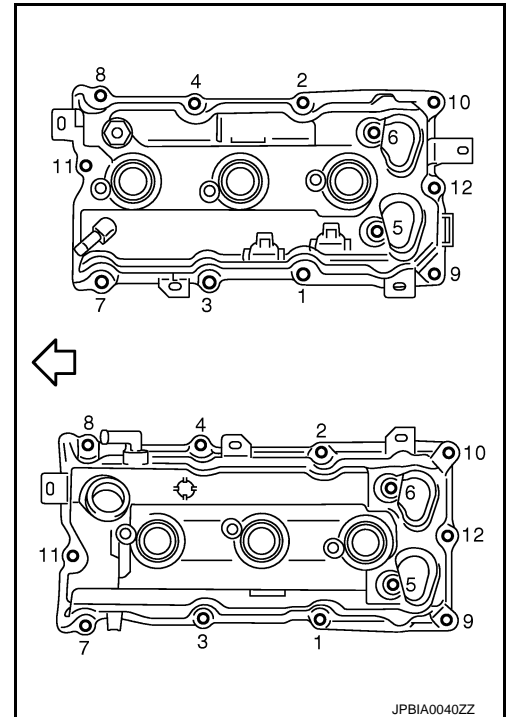
4. Remove PCV valve and O-ring from rocker cover, if necessary.
5. Remove oil filler cap from rocker cover, if necessary.
6. Remove ignition coil.

CAUTION:

Never shock ignition coil.

7. Remove harness clips on the rocker cover.
8. Loosen mounting bolts with power tool in reverse order shown in the figure.

⇐ : Engine front



9. Remove rocker cover gasket from rocker cover.
10. Use scraper to remove all traces of liquid gasket from cylinder head and camshaft bracket (No. 1).

CAUTION:

Never scratch or damage the mating surface when cleaning off old liquid gasket.

INSTALLATION

IGNITION COIL, SPARK PLUG AND ROCKER COVER

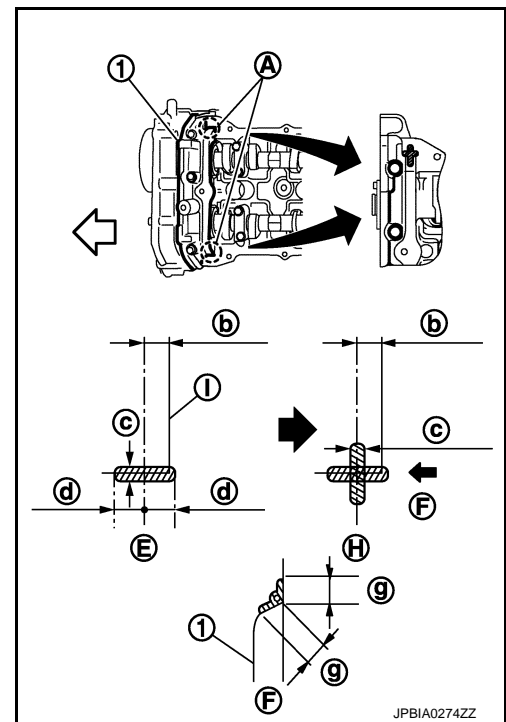
< REMOVAL AND INSTALLATION >

1. Apply liquid gasket to the position shown in the figure with the following procedure:

- A : Liquid gasket application point
 F : View F
 I : End surface of camshaft bracket (No. 1)
 b : 4 mm (0.16 in)
 c : $\phi 2.5 - 3.5$ mm (0.098 - 0.138 in)
 d : 5 mm (0.20 in)
 g : 10 mm (0.39 in)
 ⇐ : Engine front

Use Genuine RTV silicone sealant or equivalent. Refer to [GI-17](#), "Recommended Chemical Products and Sealants".

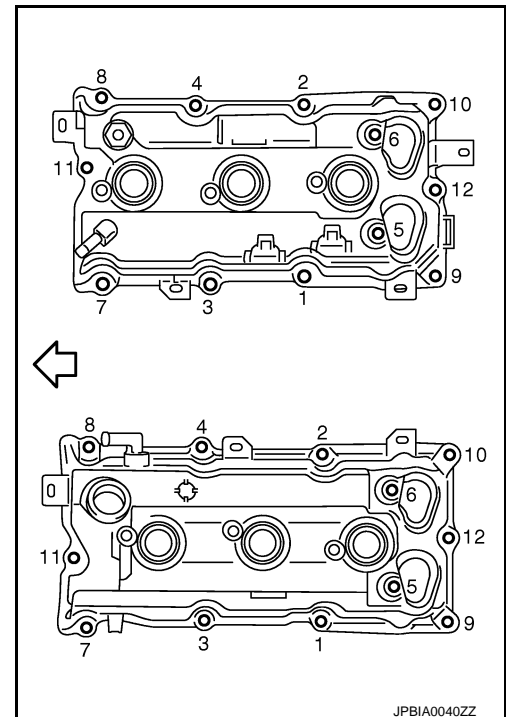
- a. Refer to figure (E) to apply liquid gasket to joint part of camshaft bracket (No. 1) (1) and cylinder head.
- b. Refer to figure (H) to apply liquid gasket in 90 degrees to figure.



2. Install rocker cover gasket to rocker cover.
3. Install rocker cover.
 - Check if rocker cover gasket is not dropped from the installation groove of rocker cover.
4. Tighten bolts in two steps separately in numerical order as shown in the figure.

⇐ : Engine front

- 1st step** : 2.0 N·m (0.2 kg-m, 18 in-lb)
2nd step : 8.3 N·m (0.85 kg-m, 73 in-lb)



5. Install in the reverse order of removal after this step.

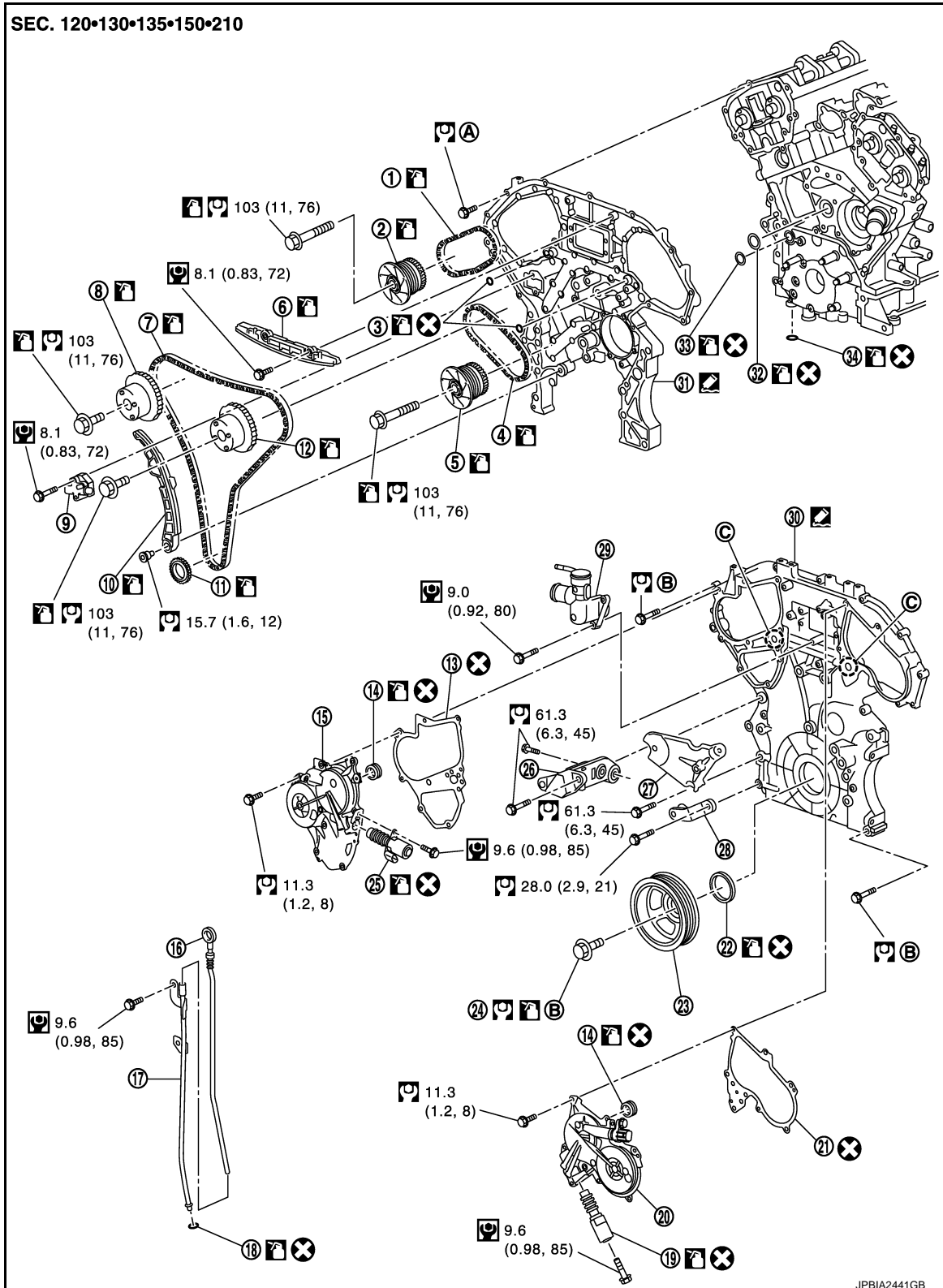
TIMING CHAIN

< REMOVAL AND INSTALLATION >

TIMING CHAIN

Exploded View

INFOID:000000004348873



- | | | |
|-----------------------------|----------------------------|-------------------------------------|
| 1. Timing chain (secondary) | 2. Camshaft sprocket (EXH) | 3. O-ring |
| 4. Timing chain (secondary) | 5. Camshaft sprocket (EXH) | 6. Internal chain guide |
| 7. Timing chain (primary) | 8. Camshaft sprocket (INT) | 9. Timing chain tensioner (primary) |

TIMING CHAIN

< REMOVAL AND INSTALLATION >

| | | |
|---|---|--|
| 10. Slack guide | 11. Crankshaft sprocket | 12. Camshaft sprocket (INT) |
| 13. Valve timing control cover gasket (bank 1) | 14. Seal ring | 15. Valve timing control cover (bank 1) |
| 16. Oil level gauge | 17. Oil level gauge guide | 18. O-ring |
| 19. Intake valve timing control solenoid valve (bank 2) | 20. Valve timing control cover (bank 2) | 21. Valve timing control cover gasket (bank 2) |
| 22. Front oil seal | 23. Crankshaft pulley | 24. Crankshaft pulley bolt |
| 25. Intake valve timing control solenoid valve (bank 1) | 26. Power steering oil pump bracket | 27. Idler pulley bracket |
| 28. Alternator bracket | 29. Water outlet (front) | 30. Front timing chain case |
| 31. Rear timing chain case | 32. O-ring | 33. O-ring |
| 34. O-ring | | |
| A. Refer to EM-94 | B. Refer to EM-51 | C. Oil filter |

Refer to [GI-4, "Components"](#) for symbols in the figure.

Removal and Installation

INFOID:000000004348874

REMOVAL

- Release the fuel pressure. Refer to [EC-559, "Inspection"](#).
- Disconnect the battery cable from the negative terminal.
- Remove engine cover with power tool. Refer to [EM-25, "Exploded View"](#).
- Remove radiator reservoir tank. Refer to [CO-12, "Exploded View"](#).
- Remove air duct and air cleaner case assembly (RH and LH). Refer to [EM-27, "Exploded View"](#).
- Remove engine undercover with power tool.
- Drain engine coolant from radiator. Refer to [CO-7, "Draining"](#).
CAUTION:
 - Perform this step when the engine is cold.
 - Never spill engine coolant on drive belt.
- Remove radiator hose (upper and lower). Refer to [CO-12, "Exploded View"](#).
- Drain engine oil. Refer to [LU-8, "Draining"](#).
CAUTION:
 - Perform this step when the engine is cold.
 - Never spill engine oil on drive belt.
- Remove drive belt. Refer to [EM-13, "Exploded View"](#).
- Remove radiator cooling fan assembly. Refer to [CO-15, "Exploded View"](#).
- Separate engine harnesses removing their brackets from front timing chain case.
- Remove intake manifold collector. Refer to [EM-29, "Exploded View"](#).
- Remove intake manifold. Refer to [EM-32, "Exploded View"](#).
- Remove fuel sub tube mounting bolt. Refer to [EM-37, "Exploded View"](#).
- Remove oil level gauge and oil level gauge guide.
- Remove A/C compressor from bracket with piping connected, and temporarily secure it aside. Refer to [HA-38, "Exploded View"](#).
- Remove power steering oil pump from bracket with piping connected, and temporarily secure it aside. Refer to [ST-44, "Exploded View"](#).
- Remove power steering oil pump bracket. Refer to [EM-50, "Exploded View"](#).
- Remove idler pulley, auto tensioner and bracket. Refer to [EM-50, "Exploded View"](#).
- Remove alternator and alternator bracket. Refer to [CHG-25, "2WD : Exploded View"](#) (2WD models) or [CHG-27, "AWD : Exploded View"](#) (AWD models).
- Remove water outlet (front) and water piping. Refer to [CO-22, "Exploded View"](#).
- Remove valve timing control covers (bank 1 and bank 2) and gasket as follows:
 - Disconnect valve timing control harness connector.

TIMING CHAIN

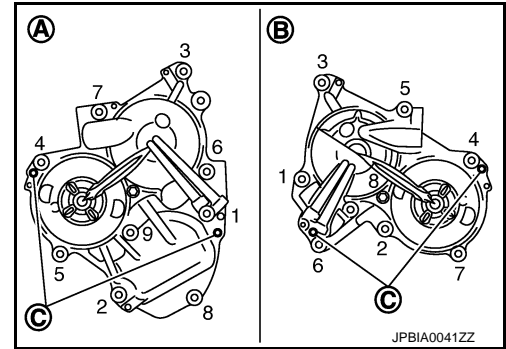
< REMOVAL AND INSTALLATION >

b. Loosen mounting bolts in reverse order as shown in the figure.

- A : Bank 1
- B : Bank 2
- C : Dowel pin hole

CAUTION:

Shaft is internally jointed with camshaft sprocket (INT) center hole. When removing, keep it horizontal until it is completely disconnected.

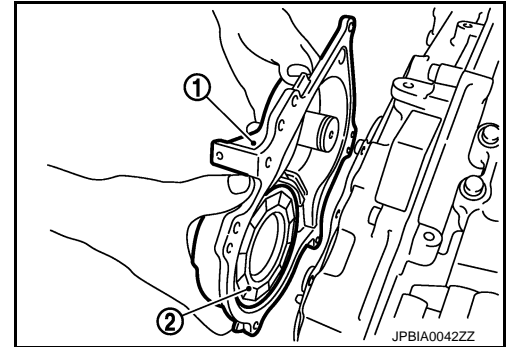


c. Shaft is engaged with intake side camshaft sprocket center hole on inside. pull straight out so as not to tilt until the joint is disengaged.

- The mating surface of magnet retarder (2) may be fitted with the exhaust side camshaft sprocket via the engine oil. Open valve timing control cover (1) carefully
- If the mating surface of magnet retarder is fitted with the camshaft sprocket, open the cover within the range that the load is not applied to the harness. And then, remove it so as to prevent magnet retarder from dropping.

CAUTION:

- Be careful not to damage magnet retarder.
- When carrying valve timing control cover, face the magnet retarder side up to prevent the cover from falling from magnet retarder.
- Never remove magnet retarder from valve timing control cover. (Disassembly prohibited parts)

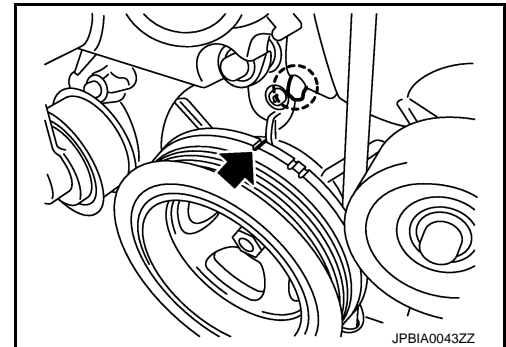


24. Remove rocker covers (bank 1 and bank 2). Refer to [EM-47, "Exploded View"](#).

25. Obtain No. 1 cylinder at TDC of its compression stroke as follows:

a. Rotate crankshaft pulley clockwise to align timing mark (grooved line without color) with timing indicator.

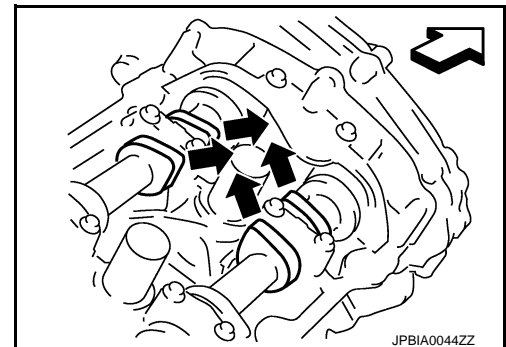
← : Timing mark (grooved line without color)



b. Check that intake and exhaust cam noses on No. 1 cylinder (engine front side of bank 1) are located as shown in the figure.

⇐ : Engine front

- If not, turn crankshaft one revolution (360 degrees) and align as shown in the figure.



26. Remove crankshaft pulley as follows:

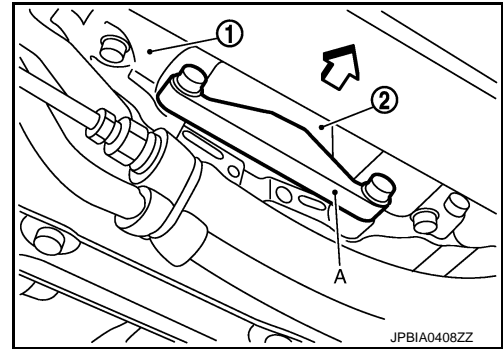
- a. Remove front cross bar. Refer to [FSU-37, "Exploded View"](#). (AWD models)
- b. Remove power steering pipe mounting bolt. Refer to [ST-50, "2WD : Exploded View"](#).

TIMING CHAIN

< REMOVAL AND INSTALLATION >

- c. Remove rear cover plate and set the ring gear stopper [SST: KV10118600 (J-48641)] (A) as shown in the figure.

- 1 : Oil pan (upper)
2 : Drive plate
⇐ : Vehicle front

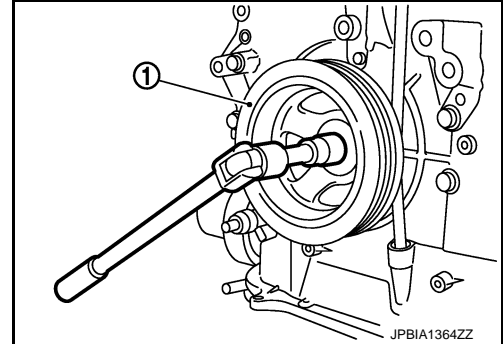


- d. Loosen crankshaft pulley bolt and rotate bolt seating surface at 10 mm (0.39 in) from its original position.

- 1 : Crankshaft pulley

CAUTION:

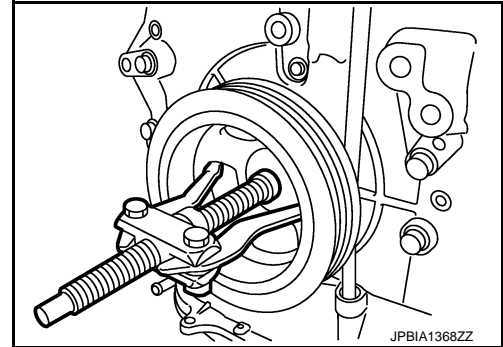
Never remove crankshaft pulley bolt as it will be used as a supporting point for suitable puller.



- e. Place suitable puller tab on holes of crankshaft pulley, and pull crankshaft pulley through.

CAUTION:

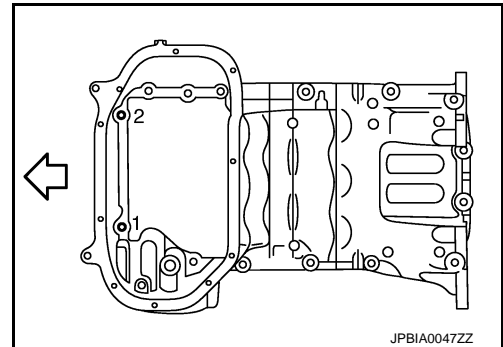
Never put suitable puller tab on crankshaft pulley periphery, as this will damage internal damper.



27. Remove oil pan (lower). Refer to [EM-43, "Exploded View \(2WD\)"](#) (2WD models) or [EM-44, "Exploded View \(AWD\)"](#) (AWD models).

28. Loosen two mounting bolts in front of oil pan (upper) with power tool in reverse order as shown in the figure.

- ⇐ : Engine front

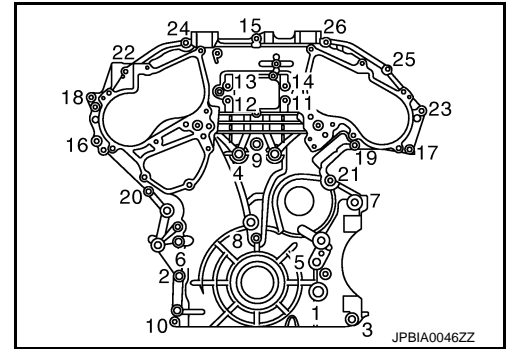


29. Remove front timing chain case as follows:

TIMING CHAIN

< REMOVAL AND INSTALLATION >

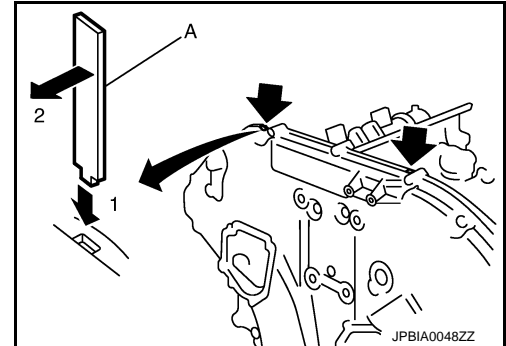
- a. Loosen mounting bolts in reverse order as shown in the figure.



- b. Insert a suitable tool (A) into the notch at the top of front timing chain case as shown.
- c. Pry off case by moving the suitable tool as shown.
- Use the seal cutter [SST: KV10111100 (J-37228)] to cut liquid gasket for removal.

CAUTION:

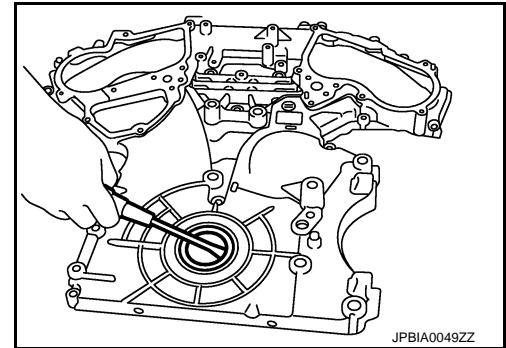
- **Never use a screwdriver or something similar.**
- **After removal, handle front timing chain case carefully so it does not tilt, cant, or warp under a load.**



30. Remove front oil seal from front timing chain case using a suitable tool.
- Use a screwdriver for removal.

CAUTION:

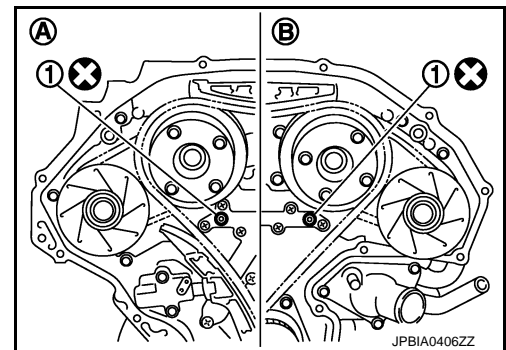
Be careful not to damage front timing chain case.



31. Remove O-rings (1) from rear timing chain case.

A : Bank 1

B : Bank 2



32. Remove timing chain tensioner (primary) as follows:

TIMING CHAIN

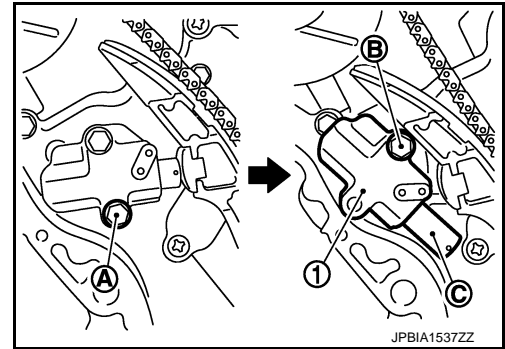
< REMOVAL AND INSTALLATION >

- a. Remove lower mounting bolt (A).
- b. Loosen upper mounting bolt (B) slowly, and then turn timing chain tensioner (primary) (1) on the upper mounting bolt so that plunger (C) is fully expanded.

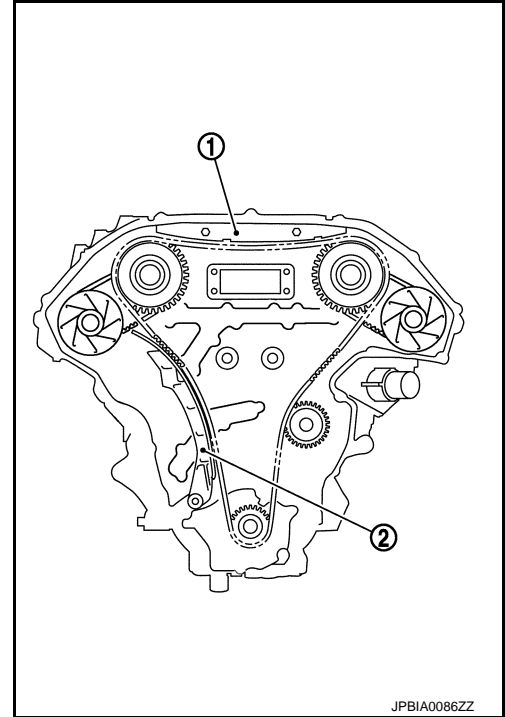
NOTE:

Even if plunger is fully expanded, it is not dropped from the body of timing chain tensioner (primary).

- c. Remove upper mounting bolt, and then remove timing chain tensioner (primary).



33. Remove internal chain guide (1), and slack guide (2).



34. Remove timing chain (primary) and crankshaft sprocket.

CAUTION:

After removing timing chain tensioner (primary), never turn crankshaft and camshaft separately, or valves will strike the piston heads.

35. Remove timing chain (secondary) and camshaft sprockets as follows:

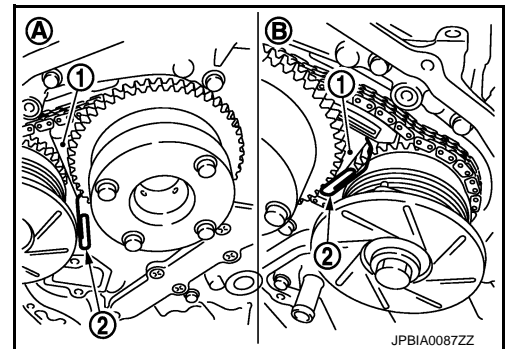
- a. Attach suitable stopper pin (2) to the timing chain tensioners (secondary) (1).

A : Bank 1

B : Bank 2

NOTE:

- Use approximately 0.5 mm (0.02 in) dia. hard metal pin as a stopper pin.
- For removal of timing chain tensioners (secondary), refer to [EM-67. "Exploded View"](#). [Removing camshaft bracket (No. 1) is required.]



- b. Remove camshaft sprocket mounting bolts (INT and EXH).

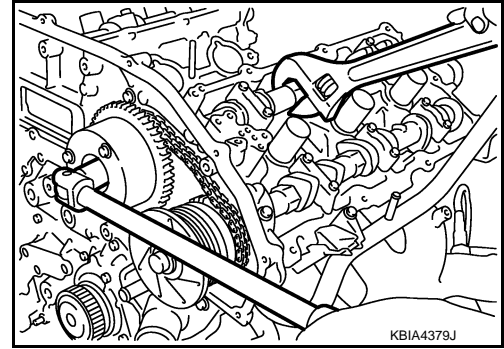
TIMING CHAIN

< REMOVAL AND INSTALLATION >

- Secure the hexagonal portion of camshaft using a wrench to loosen mounting bolts.

CAUTION:

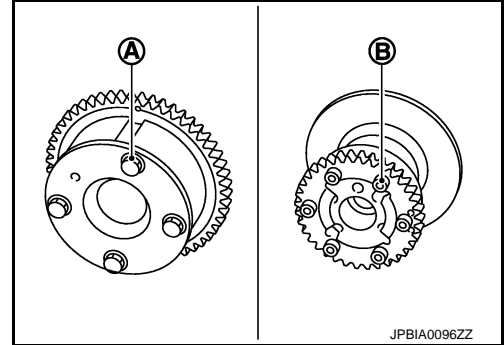
Never loosen the mounting bolts with securing anything other than the camshaft hexagonal portion or with tensioning the timing chain.



- c. Remove timing chain (secondary) together with camshaft sprockets.

CAUTION:

Never disassemble. [Never loosen bolts (A) and (B) as shown in the figure.]



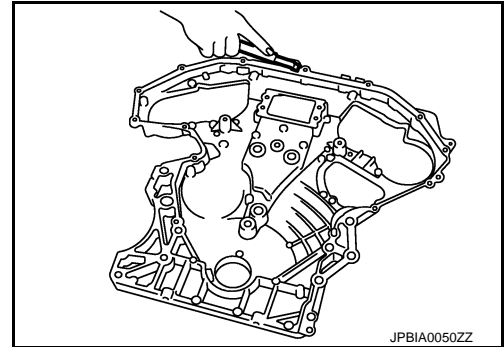
36. Remove timing chain tensioners (secondary) from cylinder head as follows, if necessary.

- a. Remove camshaft brackets (No. 1). Refer to [EM-67. "Exploded View"](#).
b. Remove timing chain tensioners (secondary) with a stopper pin attached.

37. Use a scraper to remove all traces of old liquid gasket from front and rear timing chain cases and oil pan (upper), and liquid gasket mating surfaces.

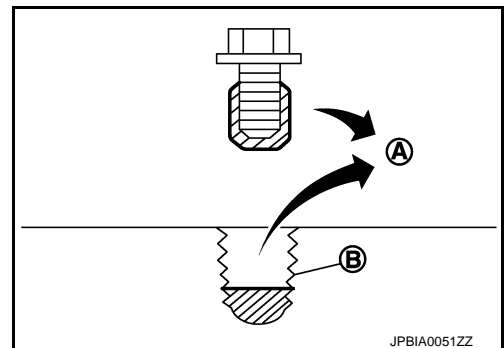
CAUTION:

Be careful not to allow gasket fragments to enter oil pan.



38. Remove old liquid gasket from bolt hole and thread.

- A : Remove sticking old liquid gasket
B : Bolt hole



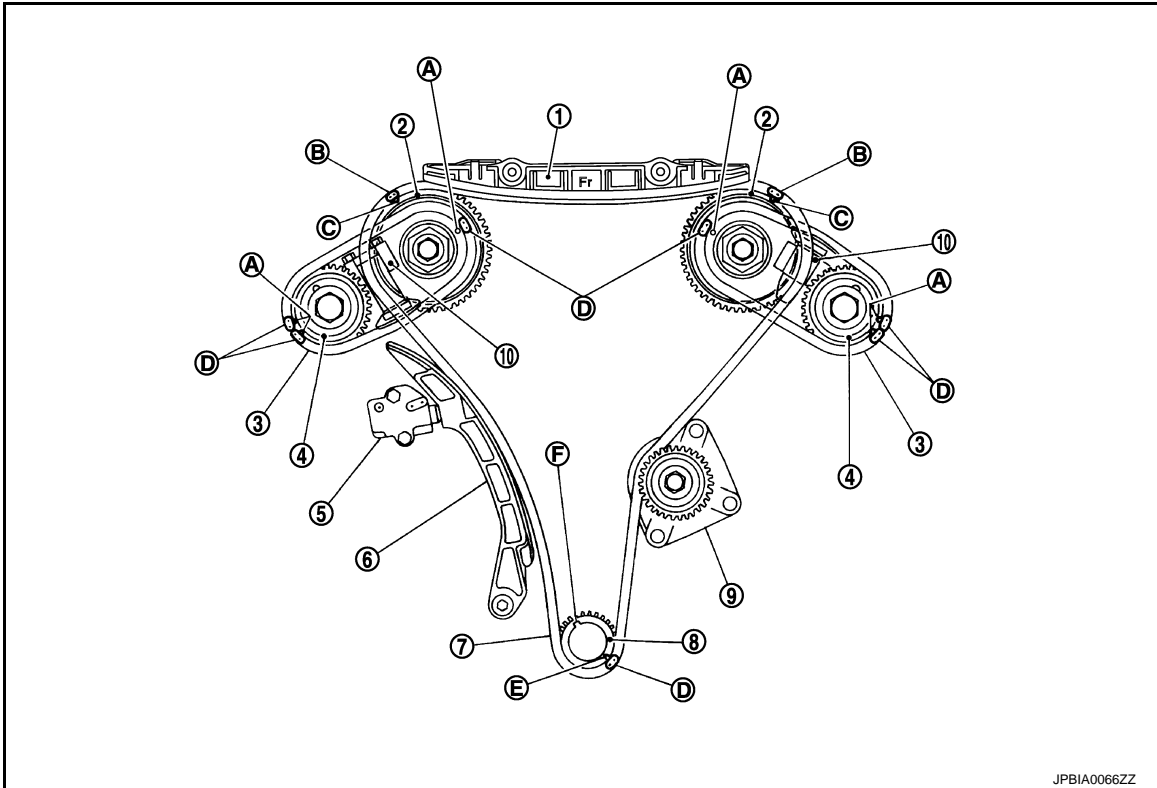
INSTALLATION

NOTE:

The below figure shows the relationship between the matching mark on each timing chain and that on the corresponding sprocket, with the components installed.

TIMING CHAIN

< REMOVAL AND INSTALLATION >



- | | | |
|--|-------------------------------------|-----------------------------|
| 1. Internal chain guide | 2. Camshaft sprocket (INT) | 3. Timing chain (secondary) |
| 4. Camshaft sprocket (EXH) | 5. Timing chain tensioner (primary) | 6. Slack guide |
| 7. Timing chain (primary) | 8. Crankshaft sprocket | 9. Water pump |
| 10. Timing chain tensioner (secondary) | | |
| A. Matching mark [punched (back side)] | B. Matching mark (yellow link) | C. Matching mark (punched) |
| D. Matching mark (orange link) | E. Matching mark (notched) | F. Crankshaft key |

1. Install timing chain tensioners (secondary) to cylinder head as follows if removed. Refer to [EM-50, "Exploded View"](#).
2. Check that dowel pin (A) and crankshaft key (1) are located as shown in the figure. (No. 1 cylinder at compression TDC)

NOTE:

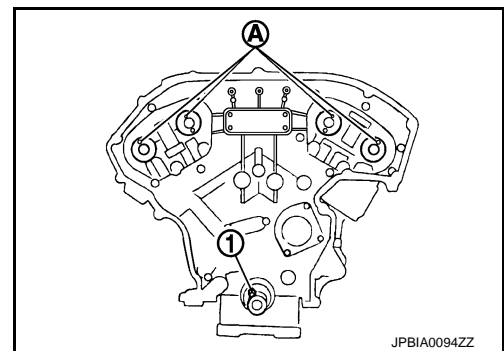
Though camshaft does not stop at the position as shown in the figure, for the placement of cam noses, it is generally accepted camshaft is placed for the same direction of the figure.

Camshaft dowel pin

: At cylinder head upper face side in each bank.

Crankshaft key

: At cylinder head side of bank 1.



3. Install timing chains (secondary) and camshaft sprockets as follows:

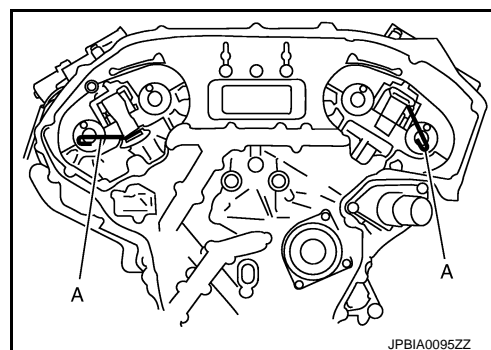
CAUTION:

Matching marks between timing chain and sprockets slip easily. Confirm all matching mark positions repeatedly during the installation process.

TIMING CHAIN

< REMOVAL AND INSTALLATION >

- a. Push plunger of timing chain tensioner (secondary) and keep it pressed in with a stopper pin (A).

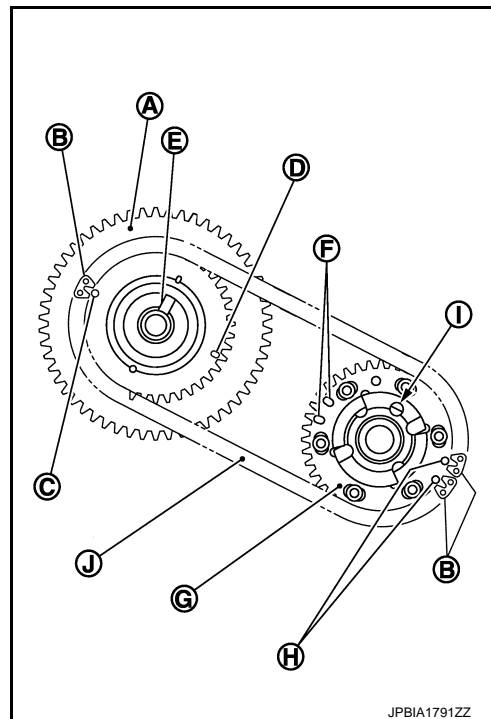


- b. Install timing chains (secondary) and camshaft sprockets.
 - Align the matching marks on timing chain (secondary) (orange link) with the ones on intake and exhaust camshaft sprockets (punched), and install them.

- A : Camshaft sprocket (INT) back face
- B : Orange link
- C : Matching mark (Circle)
- D : Matching mark (Oval)
- E : Dowel groove
- F : Matching mark (2 oval)
- G : Camshaft sprocket (EXH) back face
- H : Matching mark (2 circle)
- I : Dowel hole
- J : Timing chain (secondary)

NOTE:

- Figure shows bank 1 (rear view).
- Matching marks for camshaft sprockets are on the back side of camshaft sprockets (secondary).
- There are two types of matching marks, circle and oval types. They should be used for the bank 1 and bank 2, respectively.



Bank 1 : Use circle type.

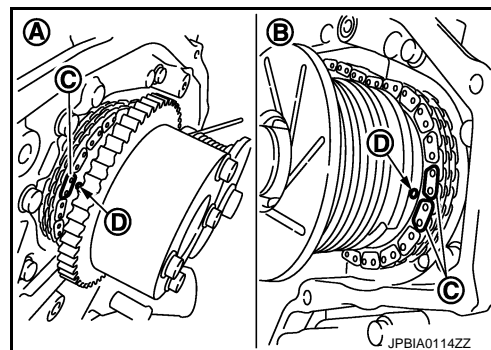
Bank 2 : Use oval type.

- Align dowel pin camshafts with the groove or dowel hole on sprockets, and install them.
- On the intake side, align dowel pin on camshaft front end with pin groove on the back side of camshaft sprocket, and install them.
- On the exhaust side, align dowel pin on camshaft front end with pin hole on camshaft sprocket, and install them.
- In case that positions of each matching mark and each dowel pin are not fit on matching parts, make fine adjustment to the position holding the hexagonal portion on camshaft with wrench or equivalent.
- Mounting bolts for camshaft sprockets must be tightened in the next step. Tightening them by hand is enough to prevent the dislocation of dowel pins.
- Check the matching marks (punched) (D) on each camshaft sprocket are positioned on the matching marks (orange link) (C) on timing chain (secondary).

- A : Intake side
- B : Exhaust side

NOTE:

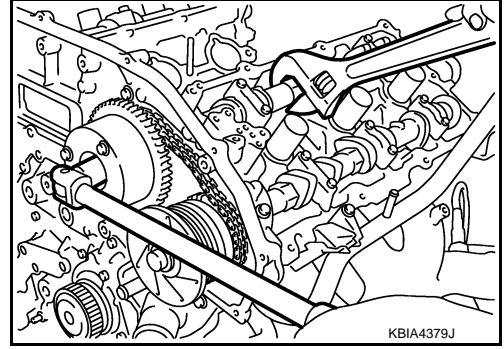
Matching mark (punched) in the figure is for checking loose at this step.



TIMING CHAIN

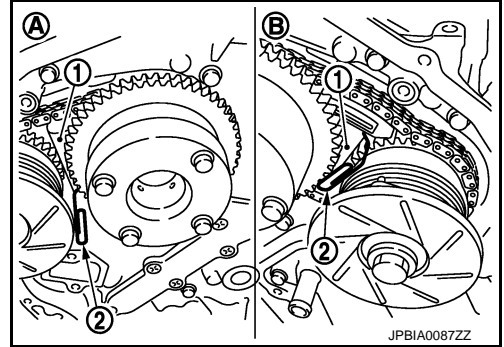
< REMOVAL AND INSTALLATION >

- c. After confirming the matching marks are aligned, tighten camshaft sprocket mounting bolts.
- Secure camshaft using a wrench at the hexagonal portion to tighten mounting bolts.



- d. Pull stopper pins (2) out from timing chain tensioners (secondary) (1).

- A : Bank 1
B : Bank 2

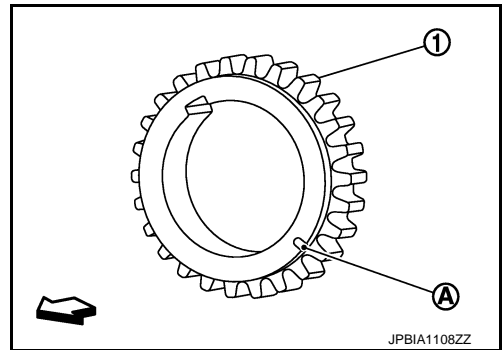


4. Install timing chain (primary) as follows:

- a. Install crankshaft sprocket (1).

- A : Matching mark (Front side)
⇐ : Engine front

- Check the matching marks on crankshaft sprocket face the front of the engine.



- b. Install timing chain (primary).

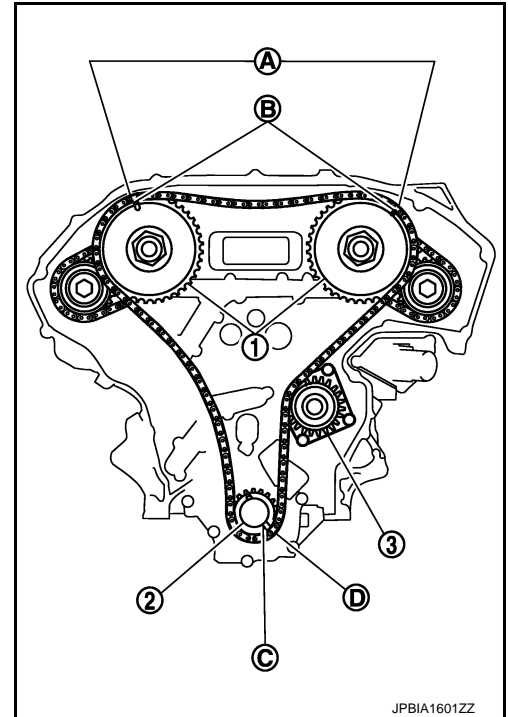
TIMING CHAIN

< REMOVAL AND INSTALLATION >

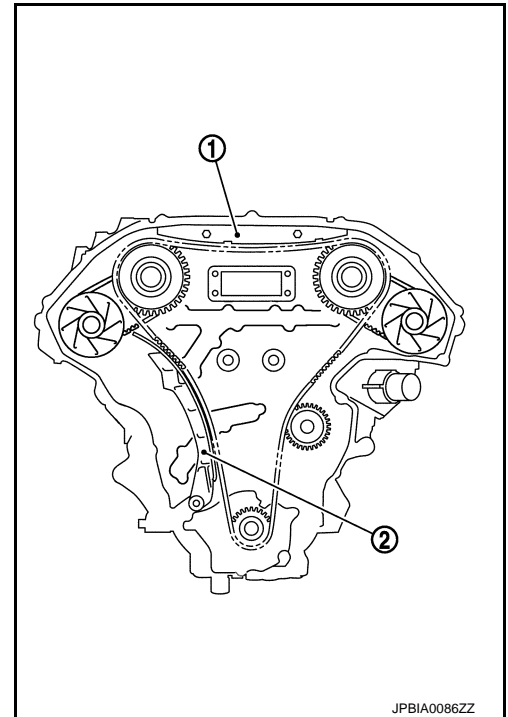
- Install timing chain (primary) so the matching mark (punched) (B) on camshaft sprocket (INT) (1) is aligned with the yellow link (A) on timing chain, while the matching mark (notched) (C) on crankshaft sprocket (2) is aligned with the orange link (D) one on timing chain, as shown in the figure.

3 : Water pump

- When it is difficult to align matching marks of timing chain (primary) with each sprocket, gradually turn camshaft using wrench on the hexagonal portion to align it with the matching marks.
- During alignment, be careful to prevent dislocation of matching mark alignments of timing chains (secondary).



5. Install internal chain guide (1), slack guide (2).



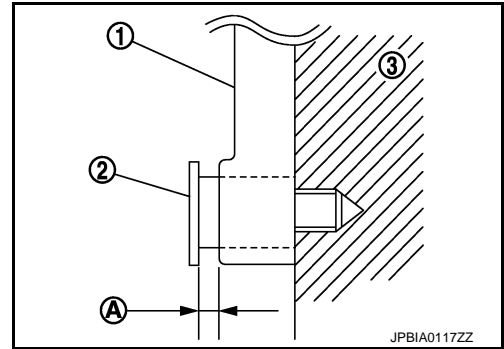
CAUTION:

TIMING CHAIN

< REMOVAL AND INSTALLATION >

Never overtighten slack guide mounting bolts (2). It is normal for a gap (A) to exist under the bolt seats when mounting bolts are tightened to the specification.

- 1 : Slack guide
- 2 : Slack guide mounting bolt
- 3 : Cylinder block



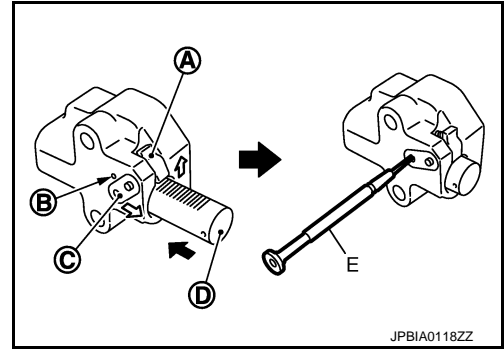
6. Install the timing chain tensioner (primary) with the following procedure:

- a. Pull plunger stopper tab (A) up (or turn lever downward) so as to remove plunger stopper tab from the ratchet of plunger (D).

NOTE:

Plunger stopper tab and lever (C) are synchronized.

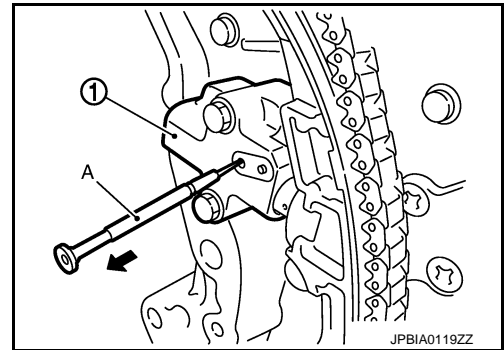
- b. Push plunger into the inside of tensioner body.
- c. Hold plunger in the fully compressed position by engaging plunger stopper tab with the tip of ratchet.
- d. To secure lever, insert stopper pin (E) through hole of lever into tensioner body hole (B).
 - The lever parts and the plunger stopper tab are synchronized. Therefore, the plunger will be secured under this condition.



NOTE:

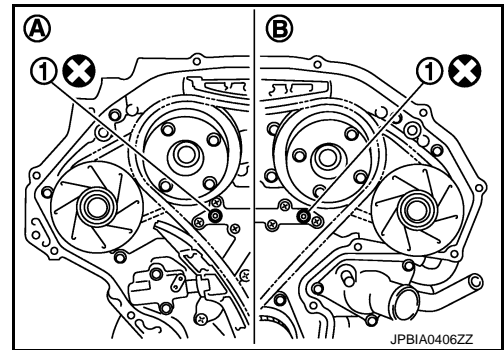
Figure shows the example of 1.2 mm (0.047 in) diameter thin screwdriver being used as the stopper pin.

- e. Install timing chain tensioner (primary) (1).
 - Remove any dirt and foreign materials completely from the back and the mounting surfaces of timing chain tensioner (primary).
- f. Pull out stopper pin (A) after installing, and then release plunger.



7. Check again that the matching marks on sprockets and timing chain have not slipped out of alignment.
8. Install new O-rings (1) on rear timing chain case.

- A : Bank 1
- B : Bank 2



9. Install new front oil seal on front timing chain case.

TIMING CHAIN

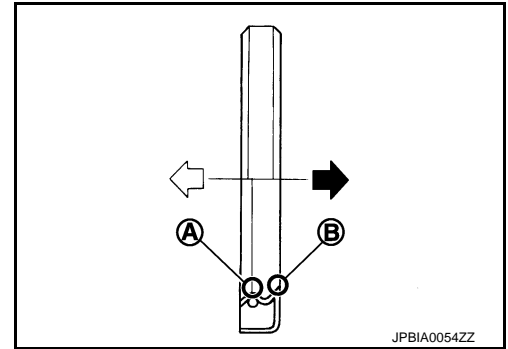
< REMOVAL AND INSTALLATION >

- Apply new engine oil to both oil seal lip (A) and dust seal lip (B).

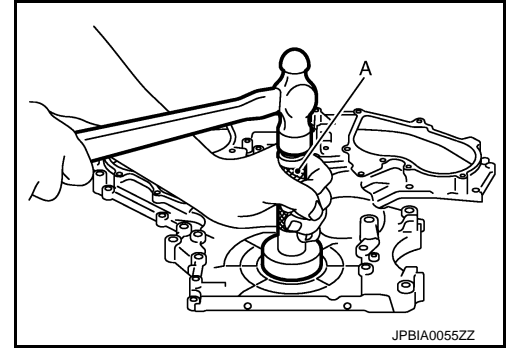
⇐ : Engine inside

➡ : Engine outside

- Install it so that each seal lip is oriented as shown in the figure.



- Using a suitable drift [outer diameter: 60 mm (2.36 in)] (A), press-fit oil seal until it becomes flush with front timing chain case end face.
- Check the garter spring is in position and seal lip is not inverted.



10. Install front timing chain case as follows:

- Check O-rings stay in place during installation to rear timing chain case.

- Apply a continuous bead of liquid gasket with the tube presser (commercial service tool) to front timing chain case back side as shown in the figure.

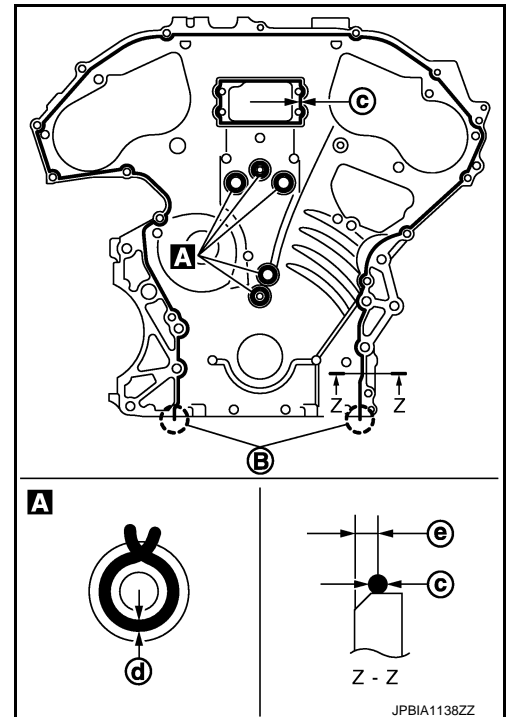
B : Protrusion

c : $\phi 3.4 - 4.4$ mm (0.134 - 0.173 in)

d : $\phi 2.6 - 3.6$ mm (0.102 - 0.142 in)

e : 4.0 - 5.6 mm (0.157 - 0.220 in)

Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-17, "Recommended Chemical Products and Sealants"](#).



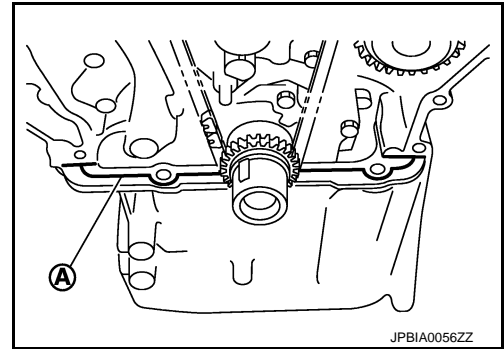
TIMING CHAIN

< REMOVAL AND INSTALLATION >

- b. Apply liquid gasket to top surface of oil pan (upper) as shown in the figure.

A : $\phi 4.0 - 5.0$ mm (0.157 - 0.197 in)

Use Genuine RTV silicone Sealant or equivalent. Refer to [GI-17, "Recommended Chemical Products and Sealants"](#).

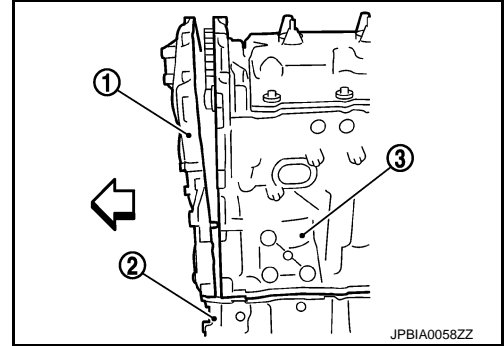


- c. Assemble front timing chain case.

- 1 : Front timing chain case
 2 : Oil pan (upper)
 3 : Cylinder block
 ⇐ : Engine front

CAUTION:

- Be careful not to damage front oil seal by interference with front end of crankshaft.
- Attaching should be done within 5 minutes after liquid gasket application.



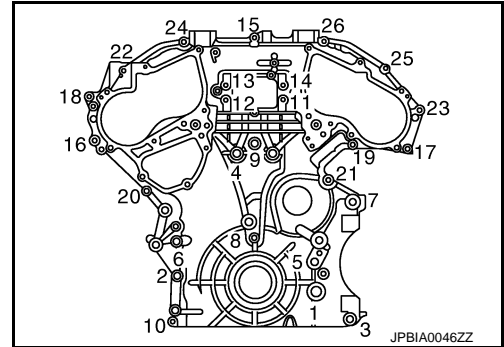
- d. Install front timing chain case as to fit its dowel pin hole together dowel pin on rear timing chain case.
 e. Tighten mounting bolts to the specified torque in numerical order as shown in the figure.
 • There are two types of mounting bolts. Refer to the following for locating bolts.

M10 bolts : 1, 2, 3, 4, 5, 6, 7

: 55.0 N·m (5.6 kg-m, 41 ft-lb)

M6 bolts : Except the above

: 12.7 N·m (1.3 kg-m, 9 ft-lb)



- f. After all bolts are tightened, retighten them to the specified torque in numerical order shown in the figure.

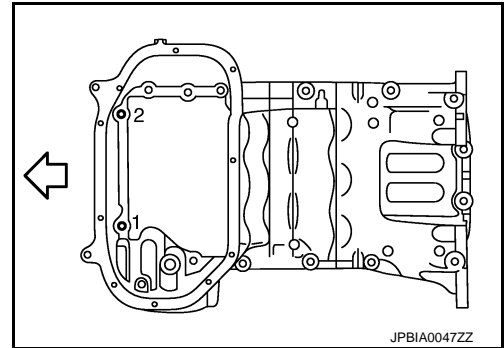
CAUTION:

Be sure to wipe off any excessive liquid gasket leaking on surface mating with oil pan (upper).

- g. Install two mounting bolts in front of oil pan (upper) in numerical order shown in the figure.

⇐ : Engine front

Tightening torque : Refer to [EM-97, "2WD : Exploded View"](#).



11. Install valve timing control covers (bank 1 and bank 2) as follows:

TIMING CHAIN

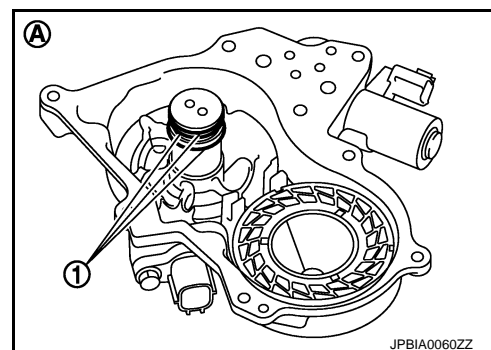
< REMOVAL AND INSTALLATION >

- a. Install new seal rings (1) in shaft grooves.

A : Bank 2

CAUTION:

When replacing seal ring, replace all rings with new one.



- b. To check the joint between dowel pins and dowel pin holes, check the looseness in the axle direction by pushing the circumferential looseness (between dowel pins and dowel pin holes) by twisting in the circumferential direction.

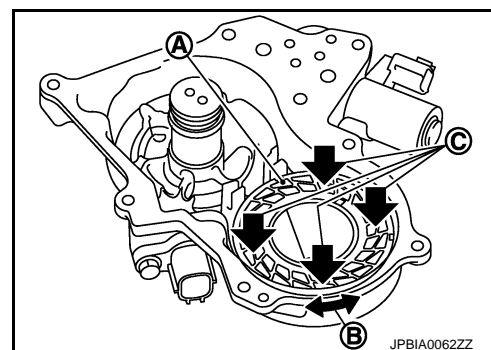
A : Mating surface of magnet retarder

B : Moves slightly

C : Not shaken

CAUTION:

Always perform this procedure when removing because the gap between dowel pins and dowel pin holes may not be caused on purpose.



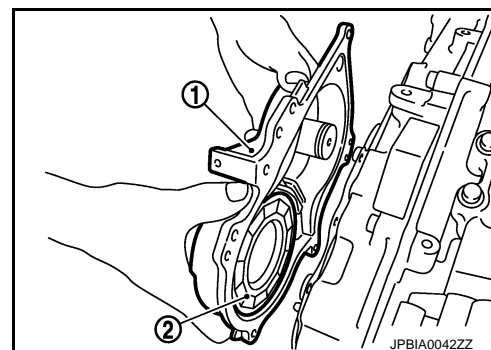
- c. Install valve timing control cover with new gasket to front timing chain case.

1 : Valve timing control cover

2 : Magnet retarder

CAUTION:

- **Never face the magnet retarder side down to prevent magnet retarder from dropping.**
- **Check the mating surface of magnet retarder and the drum of exhaust side camshaft sprocket for foreign materials.**
- **Align the center of both shaft holes of the shaft and the intake side camshaft sprocket, and then insert them.**
- **Be careful not to drop the seal ring from the shaft groove.**
- **When setting the valve timing control cover in position by hand, if valve timing control cover is not contacting with the front timing chain case, the dowel pin of magnet retarder may not be aligned with the dowel pin holes of cover. In this case, return to step "b".**



- d. Being careful not to move seal ring from the installation groove, align dowel pins on front timing chain case with holes to install valve timing control covers.
- e. Tighten mounting bolts in numerical order as shown in the figure.

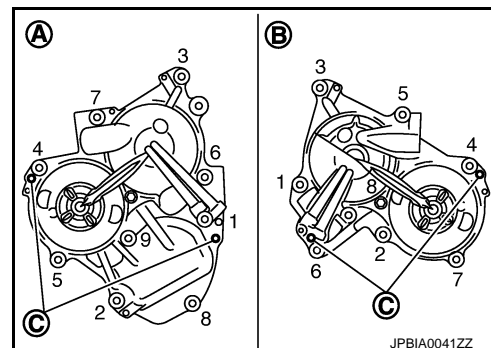
A : Bank 1

B : Bank 2

C : Dowel pin hole

Tightening torque : Refer to EM-50. "Exploded View".

- After all bolts are tightened, tighten No. 1 bolt to the specified torque again.



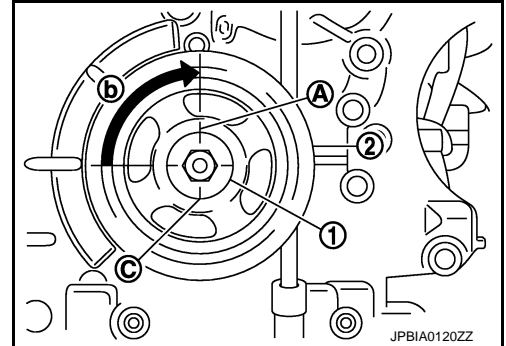
TIMING CHAIN

< REMOVAL AND INSTALLATION >

12. Install oil pan (lower). Refer to [EM-43. "Exploded View \(2WD\)"](#) (2WD models) or [EM-44. "Exploded View \(AWD\)"](#) (AWD models).
13. Install rocker covers (bank 1 and bank 2). Refer to [EM-47. "Exploded View"](#).
14. Install crankshaft pulley as follows:
 - a. Fix crankshaft using the ring gear stopper [SST: KV10118600 (J-48641)].
 - b. Install crankshaft pulley, taking care not to damage front oil seal.
 - When press-fitting crankshaft pulley with plastic hammer, tap on its center portion (not circumference).
 - c. Tighten crankshaft pulley bolt.

: **44.1 N·m (4.5 kg-m, 33 ft-lb)**

- d. Place a matching mark (A) on crankshaft pulley (2) aligning with the matching mark (C) of crankshaft pulley bolt (1). Tighten the bolt 90 degrees (one marks) (b).



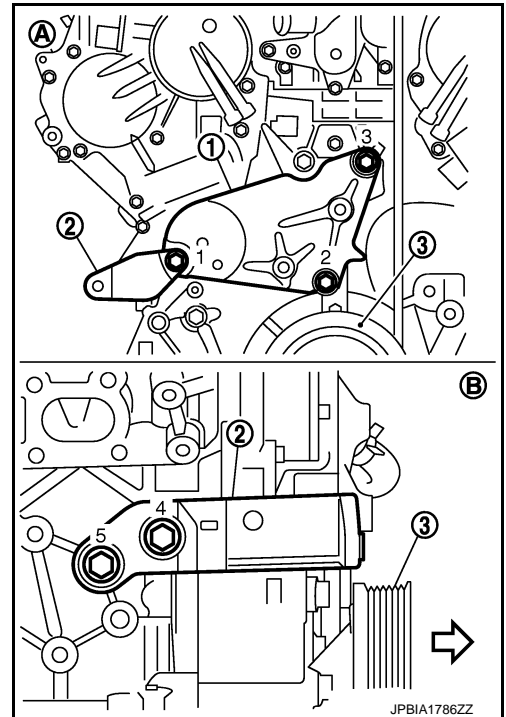
- e. Rotate crankshaft pulley in normal direction (clockwise when viewed from front) to confirm it turns smoothly.

15. Install power steering oil pump bracket and idler pulley bracket as follows:

- a. Tighten mounting bolts in numerical order as shown in the figure. (temporarily)

- 1 : Idler pulley bracket
- 2 : Power steering oil pump bracket
- 3 : Crankshaft pulley
- A : Engine front side
- B : Engine right side
- ⇐ : Engine front

- b. Tighten mounting bolts to specified torque in numerical order as shown in the figure.



16. For the following operations, perform steps in the reverse order of removal.

Inspection

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INSPECTION AFTER REMOVAL

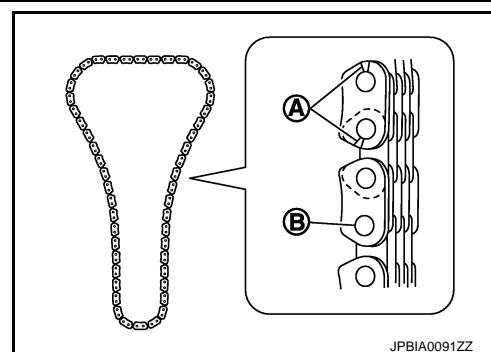
Timing Chain

TIMING CHAIN

< REMOVAL AND INSTALLATION >

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

- A : Crack
- B : Wear



INSPECTION AFTER INSTALLATION

Inspection for Leakage

The following are procedures for checking fluids leakage, lubricates 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-10, "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.
- Run engine to check for unusual noise and vibration.

NOTE:

If hydraulic pressure inside 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 |
| Other oils and fluid* | Level | Leakage | Level |
| Fuel | Leakage | Leakage | Leakage |

*: Transmission/transaxle/CVT fluid, power steering fluid, brake fluid, etc.

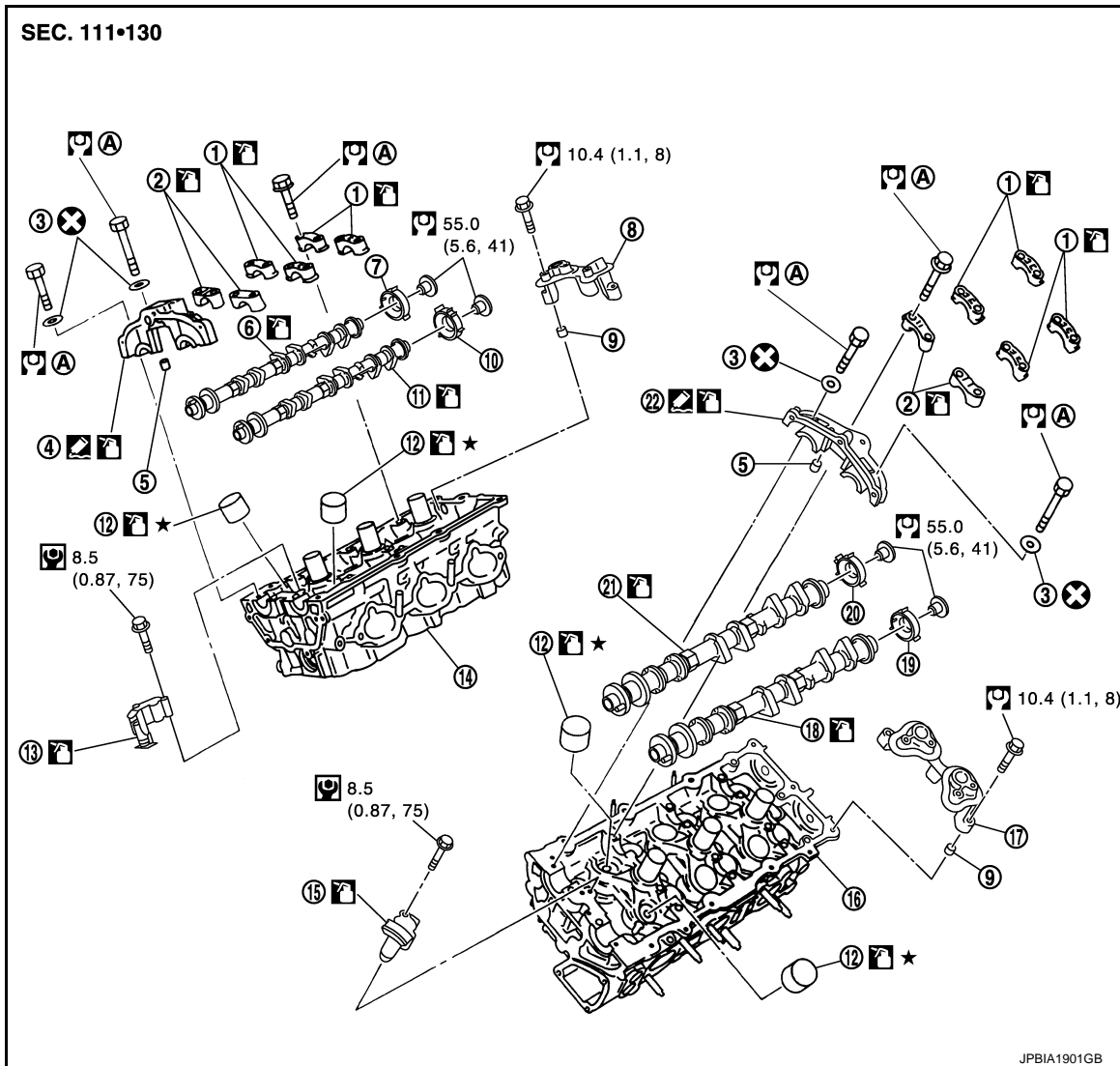
CAMSHAFT

< REMOVAL AND INSTALLATION >

CAMSHAFT

Exploded View

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- | | | |
|---|-------------------------------------|---|
| 1. Camshaft bracket (No. 3, 4) | 2. Camshaft bracket (No. 2) | 3. Seal washer |
| 4. Camshaft bracket (No. 1) (bank 1) | 5. Dowel pin | 6. Camshaft (EXH) (bank 1) |
| 7. Camshaft signal plate (EXH) | 8. Camshaft sensor bracket (bank 1) | 9. Dowel pin |
| 10. Camshaft signal plate (INT) | 11. Camshaft (INT) (bank 1) | 12. Valve lifter |
| 13. Timing chain tensioner (secondary) (bank 1) | 14. Cylinder head (bank 1) | 15. Timing chain tensioner (secondary) (bank 2) |
| 16. Cylinder head (bank 2) | 17. Camshaft sensor bracket | 18. Camshaft (EXH) |
| 19. Camshaft signal plate (EXH) | 20. Camshaft signal plate (INT) | 21. Camshaft (INT) |
| 22. Camshaft bracket (No. 1) (bank 2) | | |

A. Refer to [EM-67](#)

Refer to [GI-4, "Components"](#) for symbols in the figure.

Removal and Installation

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REMOVAL

1. Remove front timing chain case, camshaft sprocket and timing chain. Refer to [EM-50, "Exploded View"](#).
2. Remove fuel sub tube. Refer to [EM-37, "Exploded View"](#).

CAMSHAFT

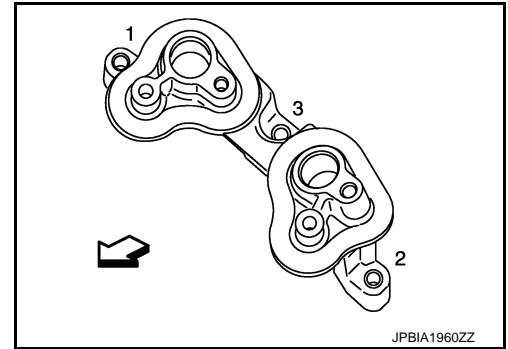
< REMOVAL AND INSTALLATION >

- Loosen camshaft sensor bracket bolts in reverse order as shown in the figure.

⇐ : Engine front

NOTE:

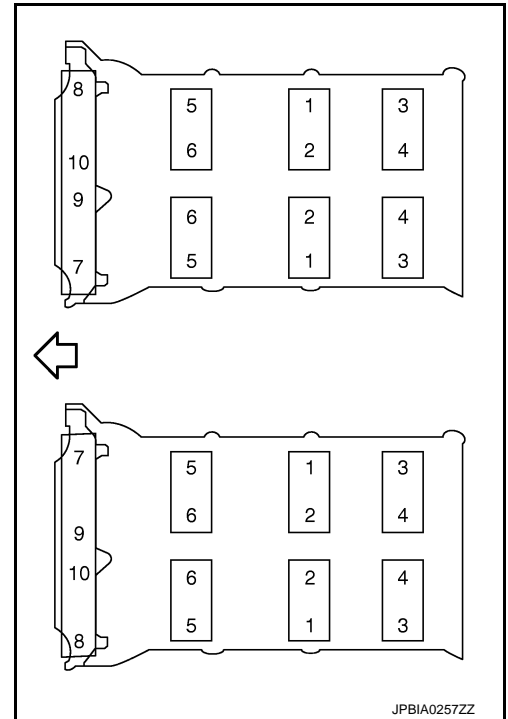
The order of loosening bolts is the same for bank 1 and bank 2.



- Remove camshaft brackets.

- Mark camshafts, camshaft brackets and bolts so they are placed in the same position and direction for installation.
- Equally loosen camshaft bracket bolts in several steps in reverse order as shown in the figure.

⇐ : Engine front



- Remove camshaft.
- Remove valve lifter.
 - Identify installation positions, and store them without mixing them up.
- Remove timing chain tensioners (secondary) (1) from cylinder head.

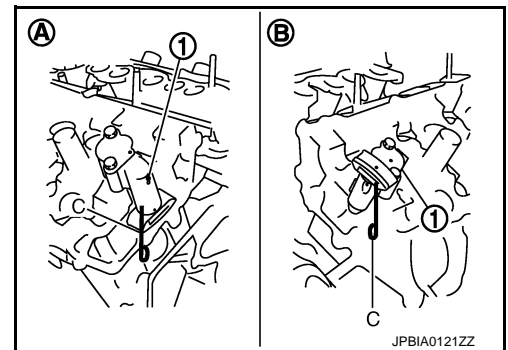
A : Bank 1

B : Bank 2

- Remove timing chain tensioners (secondary) with its stopper pin (C) attached.

NOTE:

Stopper pin should be attached when timing chain (secondary) is removed.



INSTALLATION

- Install timing chain tensioners (secondary) on both sides of cylinder head.

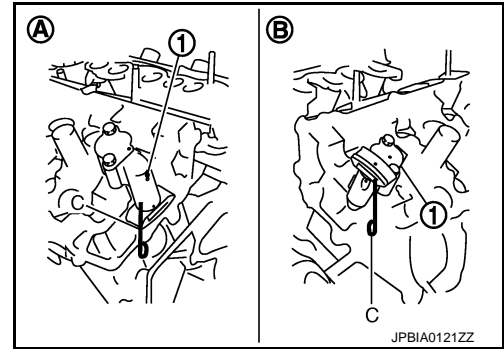
CAMSHAFT

< REMOVAL AND INSTALLATION >

- Install timing chain tensioners (1) with its stopper pin (C) attached.

Bank 1 side (A) : Sliding part facing downward

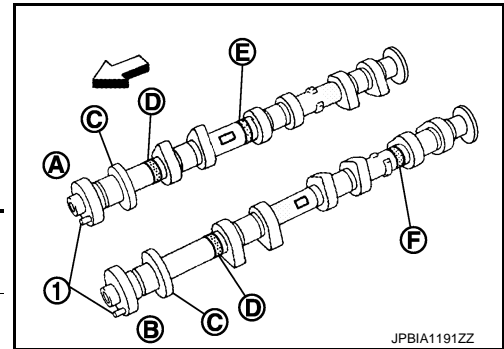
Bank 2 side (B) : Sliding part facing upward



- Install valve lifter.
 - Install it in the original position.
- Install camshafts.
 - Follow your identification marks made during removal, or follow the identification marks that are present on new camshafts for proper placement and direction.

↩ : Engine front

| Bank | INT/EXH | Dowel pin (1) | Paint marks | | | Identification mark (C) |
|------|---------|---------------|-------------|--------|------------|-------------------------|
| | | | M1 (E) | M2 (F) | M3 (D) | |
| 1 | EXH (B) | Yes | No | Green | Light blue | 1F |
| | INT (A) | Yes | Green | No | Light blue | 1E |
| 2 | INT (A) | Yes | Green | No | Light blue | 1G |
| | EXH (B) | Yes | No | Green | Light blue | 1H |

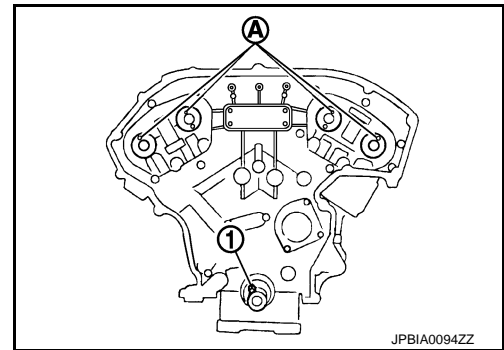


- Install camshaft so that dowel pin (A) on front end face are positioned as shown in the figure. (No. 1 cylinder TDC on its compression stroke)

1 : Crankshaft key

NOTE:

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



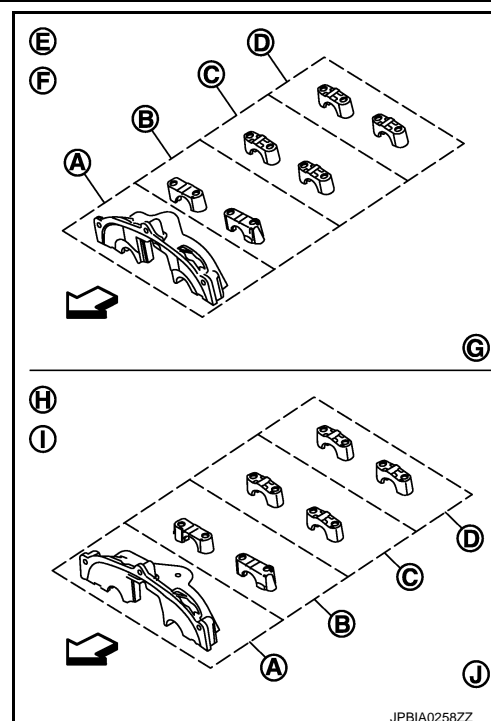
CAMSHAFT

< REMOVAL AND INSTALLATION >

4. Install camshaft brackets.

- A : No. 1
- B : No. 2
- C : No. 3
- D : No. 4
- E : Camshaft brackets (bank 1)
- F : Exhaust side
- G : Intake side
- H : Camshaft brackets (bank 2)
- I : Intake side
- J : Exhaust side
- ⇐ : Engine front

- Remove foreign material completely from camshaft bracket backside and from cylinder head installation face.
- Install camshaft bracket in original position and direction as shown in figure.

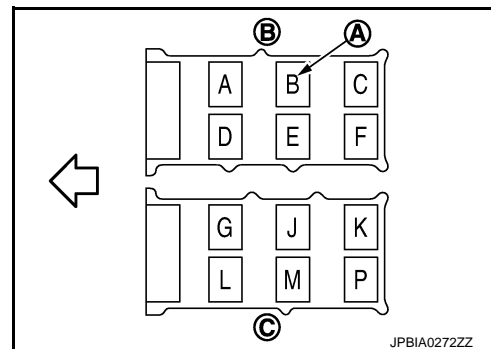


- Install camshaft brackets (No. 2 to 4) aligning the stamp marks (A) as shown in the figure.

- B : Bank 1
- C : Bank 2
- ⇐ : Engine front

NOTE:

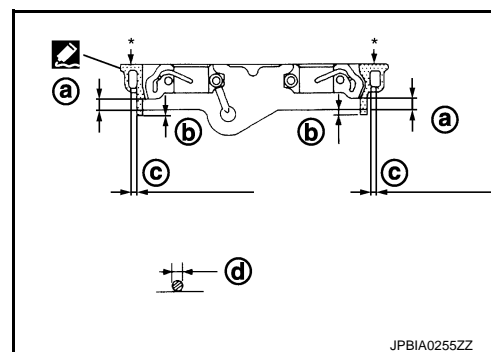
There are no identification marks indicating bank 1 and bank 2 for camshaft bracket (No. 1).



- Apply liquid gasket to mating surface of camshaft bracket (No. 1) as shown on both bank 1 and bank 2.

- a : 8.5 mm (0.335 in)
- b : 2 mm (0.08 in)
- c : Clearance 5 mm (0.20 in)
- d : $\phi 2.5$ mm (0.098 in)
- * : Apply liquid gasket to rear timing chain side

Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-17, "Recommended Chemical Products and Sealants"](#).



CAMSHAFT

< REMOVAL AND INSTALLATION >

- Apply liquid gasket to camshaft bracket (No. 1) contact surface on the rear timing chain case backside as shown on both bank 1 and bank 2.

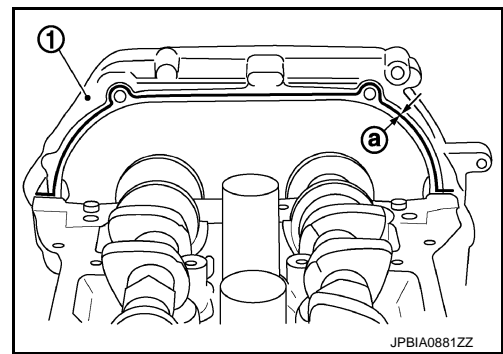
1 : Rear timing chain case

a : $\phi 3.9$ mm (0.154 in)

Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-17, "Recommended Chemical Products and Sealants"](#).

CAUTION:

For camshaft bracket (No. 1) near installation position, and install it without disturbing the liquid gasket applied to the surfaces.



5. Tighten camshaft bracket bolts in the following steps, in numerical order as shown in the figure.

← : Engine front

- a. Tighten No. 7 to 10 in numerical order as shown.

: **1.96 N·m (0.20 kg-m, 1 ft-lb)**

- b. Tighten No. 1 to 6 in numerical order as shown.

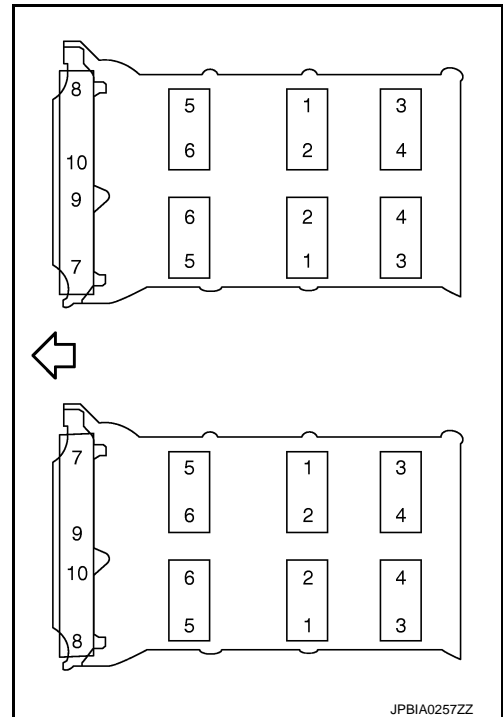
: **1.96 N·m (0.20 kg-m, 1 ft-lb)**

- c. Tighten No. 1 to 10 in numerical order as shown.

: **5.88 N·m (0.60 kg-m, 4 ft-lb)**

- d. Tighten No. 1 to 10 in numerical order as shown.

: **10.4 N·m (1.1 kg-m, 8 ft-lb)**

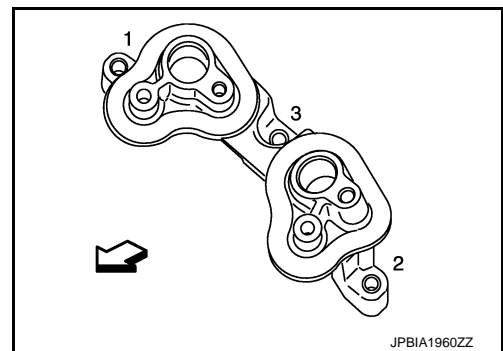


6. Tighten camshaft sensor bracket bolts in numerical order as shown in the figure.

← : Engine front

NOTE:

The order of tightening bolts is the same for bank 1 and bank 2.



7. Inspect and adjust the valve clearance. Refer to [EM-18, "Inspection and Adjustment"](#).
8. Install in the reverse order of removal after this step.

Inspection

INSPECTION AFTER REMOVAL

Camshaft Runout

INFOID:000000004348878

CAMSHAFT

< REMOVAL AND INSTALLATION >

1. Put V-block on precise flat table, and support No. 2 and 4 journals of camshaft.

CAUTION:

Never support No. 1 journal (on the side of camshaft sprocket) because it has a different diameter from the other three locations.

2. Set a dial indicator vertically to No. 3 journal.
3. Turn camshaft to one direction with hands, and measure the camshaft runout on a dial indicator. (Total indicator reading)

Standard and limit : Refer to [EM-140, "Camshaft"](#).

4. If it exceeds the limit, replace camshaft.

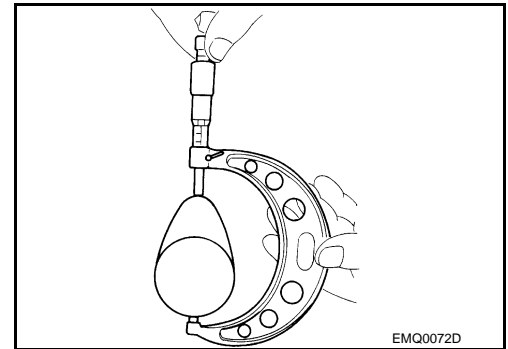
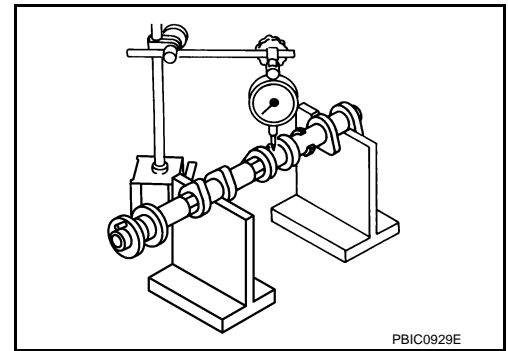
Camshaft Cam Height

1. Measure the camshaft cam height with a micrometer.

Standard cam height (Intake and exhaust) : Refer to [EM-140, "Camshaft"](#).

Cam wear limit : Refer to [EM-140, "Camshaft"](#).

2. If wear exceeds the limit, replace camshaft.

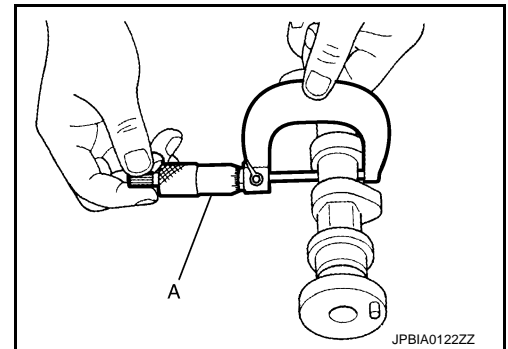


Camshaft Journal Oil Clearance

CAMSHAFT JOURNAL DIAMETER

- Measure the outer diameter of camshaft journal with a micrometer (A).

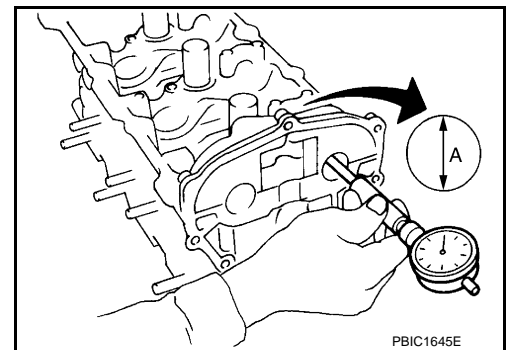
Standard : Refer to [EM-140, "Camshaft"](#).



CAMSHAFT BRACKET INNER DIAMETER

- Tighten camshaft bracket bolt with the specified torque. Refer to "INSTALLATION" for the tightening procedure.
- Measure inner diameter (A) of camshaft bracket with a bore gauge.

Standard : Refer to [EM-140, "Camshaft"](#).



CAMSHAFT JOURNAL OIL CLEARANCE

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

CAMSHAFT

< REMOVAL AND INSTALLATION >

Standard and limit : Refer to [EM-140, "Camshaft"](#).

- If the calculated value exceeds the limit, replace either or both camshaft and cylinder head.

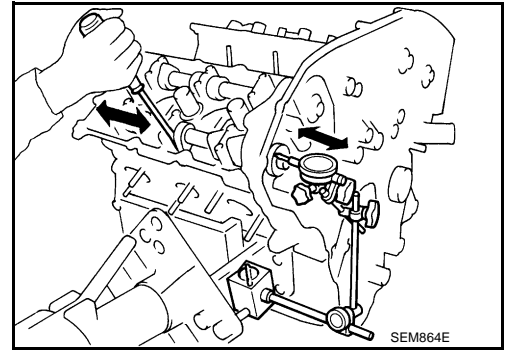
NOTE:

Camshaft brackets cannot be replaced as single parts, because there are machined together with cylinder head. Replace whole cylinder head assembly.

Camshaft End Play

- Install a dial indicator in thrust direction on front end of camshaft. Measure the end play of a dial indicator when camshaft is moved forward/backward (in direction to axis).

Standard and limit : Refer to [EM-140, "Camshaft"](#).



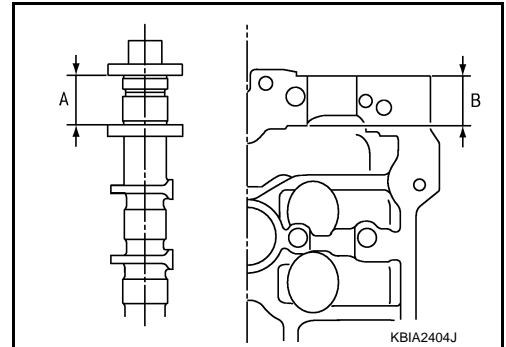
- Measure the following parts if out of the limit.
 - Dimension "A" for camshaft No. 1 journal

Standard : 27.500 - 27.548 mm (1.0827 - 1.0846 in)

- Dimension "B" for cylinder head No. 1 journal bearing

Standard : 27.360 - 27.385 mm (1.0772 - 1.0781 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 4 journals of camshaft.

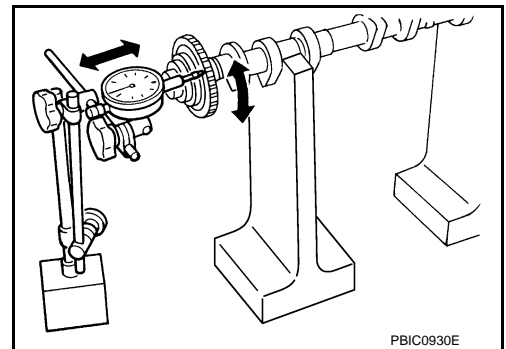
CAUTION:

Never support No. 1 journal (on the side of camshaft sprocket) because it has a different diameter from the other three locations.

2. Measure the camshaft sprocket runout with a dial indicator. (Total indicator reading)

Limit : Refer to [EM-140, "Camshaft"](#).

- If it exceeds the limit, replace camshaft sprocket.



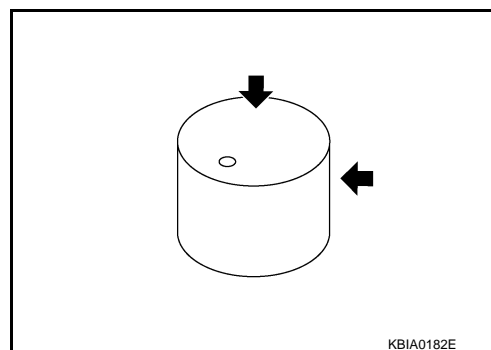
Valve Lifter

CAMSHAFT

< REMOVAL AND INSTALLATION >

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

- If anything above is found, replace valve lifter. Refer to [EM-140, "Camshaft"](#).

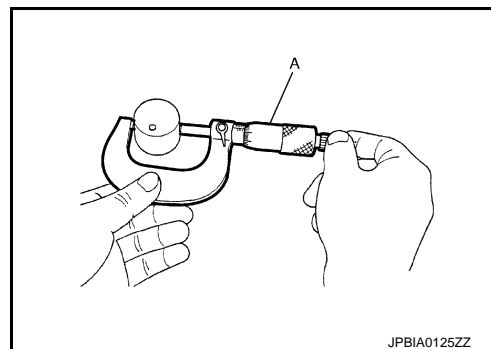


Valve Lifter Clearance

VALVE LIFTER OUTER DIAMETER

- Measure the outer diameter at 1/2 height of valve lifter with a micrometer (A) since valve lifter is in barrel shape.

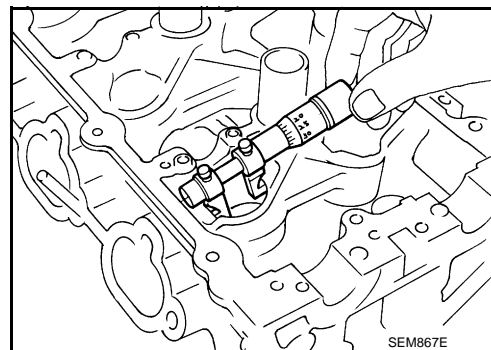
Standard
(Intake and exhaust) : Refer to [EM-140, "Camshaft"](#).



VALVE LIFTER HOLE DIAMETER

- Measure the inner diameter of valve lifter hole of cylinder head with an inside micrometer.

Standard
(Intake and exhaust) : Refer to [EM-140, "Camshaft"](#).



VALVE LIFTER CLEARANCE

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

Standard
(Intake and exhaust) : Refer to [EM-140, "Camshaft"](#).

- If the calculated value is out of the standard, referring to 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) Oil Groove

CAUTION:

- Perform this inspection only when DTC P0011 is detected in self-diagnostic results of CONSULT-III and it is directed according to inspection procedure of EC section. Refer to [EC-104, "Diagnosis Description"](#).
- Check when engine is cold so as to prevent burns from the splashing engine oil.
 1. Check engine oil level. Refer to [LU-6, "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-559, "Inspection"](#).

CAMSHAFT

< REMOVAL AND INSTALLATION >

- b. Disconnect ignition coil and injector harness connectors. Refer to [EM-47. "Exploded View"](#) and [EM-37. "Exploded View"](#).
3. Remove intake valve timing control solenoid valve. Refer to [EM-50. "Exploded View"](#).
4. Crank engine, and then check that engine oil comes out from intake valve timing control solenoid valve hole (A). End crank after checking.

1 : Valve timing control cover (bank 1)

↔ : Engine front

WARNING:

Be careful not to touch rotating parts. (drive belt, idler pulley, and crankshaft pulley, etc.)

CAUTION:

- 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 no to apply engine oil to rubber parts of drive belt, engine mounting insulator, etc. Wipe engine oil off immediately if it is splashed.

5. Perform the following inspection if engine oil does not come out from intake valve timing control solenoid valve oil hole of the cylinder head.
 - Remove oil filter, and then clean it. Refer to [EM-50. "Exploded View"](#).
 - Clean oil groove between oil strainer and intake valve timing control solenoid valve. Refer to [LU-2. "Engine Lubrication System"](#).
6. Remove components between intake valve timing control solenoid valve and camshaft sprocket (INT), and then check each oil groove for clogging.
 - Clean oil groove if necessary. Refer to [LU-2. "Engine Lubrication System"](#).
7. After inspection, install removed parts in the reverse order.

Inspection for Leakage

The following are procedures for checking fluids leakage, lubricates 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-10. "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.
- Run engine to check for unusual noise and vibration.

NOTE:

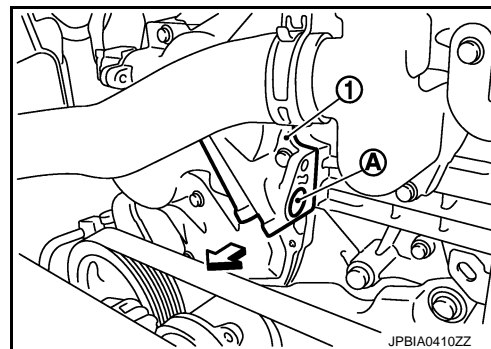
If hydraulic pressure inside timing chain tensioner drops after removal/installation, slack in the guide may generate a pounding noise during and just after engine start. However, this is normal. Noise will stop after hydraulic pressure rises.

- 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 |
| Other oils and fluid* | Level | Leakage | Level |
| Fuel | Leakage | Leakage | Leakage |

*: Transmission/transaxle/CVT fluid, power steering fluid, brake fluid, etc.



OIL SEAL

< REMOVAL AND INSTALLATION >

OIL SEAL

VALVE OIL SEAL

VALVE OIL SEAL : Removal and Installation

INFOID:000000004348879

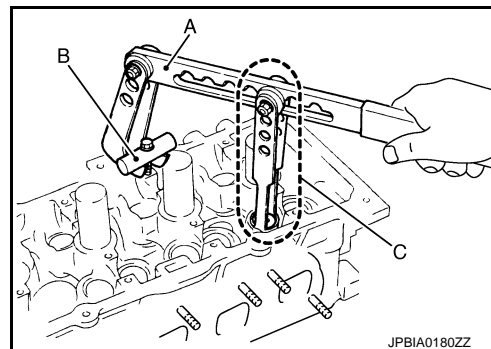
REMOVAL

1. Remove camshaft relating to valve oil seal to be removed. Refer to [EM-104. "Exploded View"](#).
2. Remove valve lifters. Refer to [EM-67. "Exploded View"](#).
3. Turn crankshaft until the cylinder requiring new oil seals is at TDC. This will prevent valve from dropping into cylinder.
4. Remove valve collet.

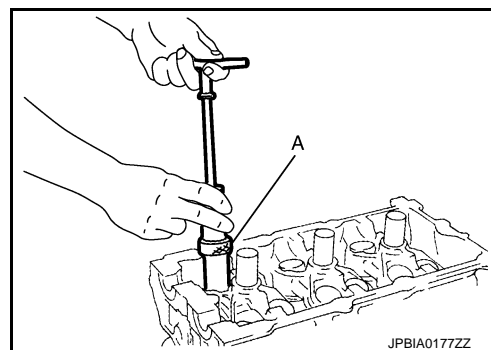
- Compress valve spring with the valve spring compressor [SST: KV10116200 (J-26336-A)] (A), the attachment [SST: KV10115900 (J-26336-20)] (C), the adapter [SST: KV10109220 (—)] (B). Remove valve collet with a magnet hand.

CAUTION:

When working, take care not to damage valve lifter holes.



5. Remove valve spring retainer, and valve spring.
6. Remove valve oil seal using the valve oil seal puller [SST: KV10107902 (J-38959)] (A).



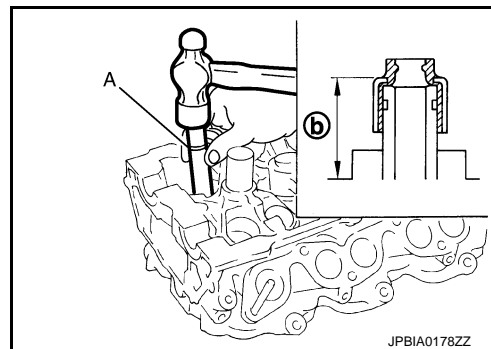
INSTALLATION

1. Apply new engine oil on new valve oil seal joint and seal lip.
2. Using the valve oil seal drift [SST: KV10115600 (J-38958)] (A), press fit valve seal to height (b) shown in the figure.

NOTE:

Dimension: Height measured before valve spring seat installation

Intake and exhaust : 14.3 - 14.9 mm (0.563 - 0.587 in)



3. Install in the reverse order of removal after this step.

FRONT OIL SEAL

FRONT OIL SEAL : Removal and Installation

INFOID:000000004348880

REMOVAL

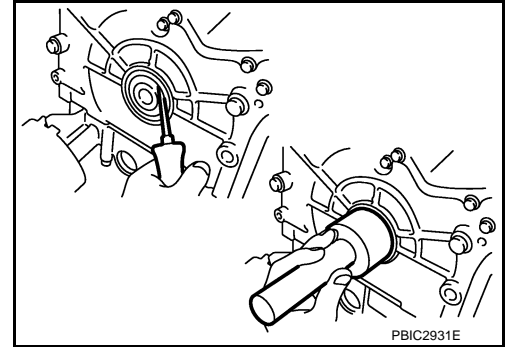
OIL SEAL

< REMOVAL AND INSTALLATION >

1. Remove the following parts:
 - Engine undercover with power tool.
 - Drive belt: Refer to [EM-13. "Exploded View"](#).
 - Crankshaft pulley: Refer to [EM-50. "Exploded View"](#).
2. Remove front oil seal using a suitable tool.

CAUTION:

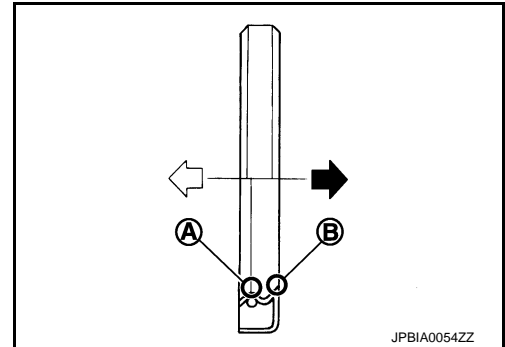
Be careful not to damage front timing chain case and crankshaft.



INSTALLATION

1. Apply new engine oil to both oil seal lip and dust seal lip of new front oil seal.
2. Install front oil seal.
 - Install front oil seal so that each seal lip is oriented as shown in the figure.

- A : Oil seal lip
B : Dust seal lip
⇐ : Engine inside
➡ : Engine outside

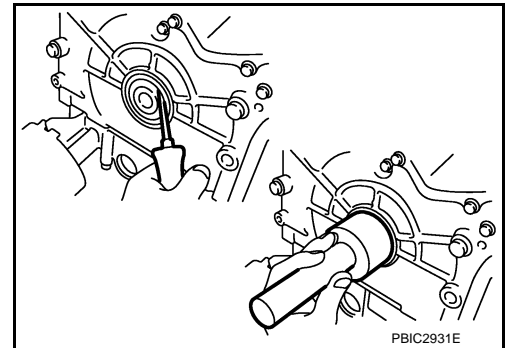


- Using a suitable drift, press-fit until the height of front oil seal is level with the mounting surface.
- Suitable drift: outer diameter 60 mm (2.36 in), inner diameter 50 mm (1.97 in).
- Check the garter spring is in position and seal lips not inverted.

CAUTION:

- **Be careful not to damage front timing chain case and crankshaft.**
- **Press-fit straight and avoid causing burrs or tilting oil seal.**

3. Install in the reverse order of removal after this step.



REAR OIL SEAL

REAR OIL SEAL : Removal and Installation

INFOID:000000004348881

REMOVAL

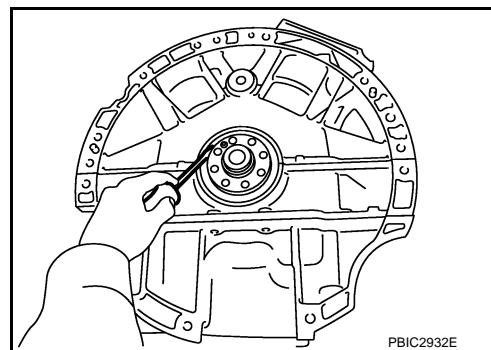
1. Remove transmission assembly. Refer to [TM-195. "2WD : Exploded View"](#) (2WD models) or [TM-198. "AWD : Exploded View"](#) (AWD models).
2. Remove drive plate. Refer to [EM-114. "Exploded View"](#).
3. Remove rear oil seal with a suitable tool.

CAUTION:

OIL SEAL

< REMOVAL AND INSTALLATION >

Be careful not to damage crankshaft and cylinder block.

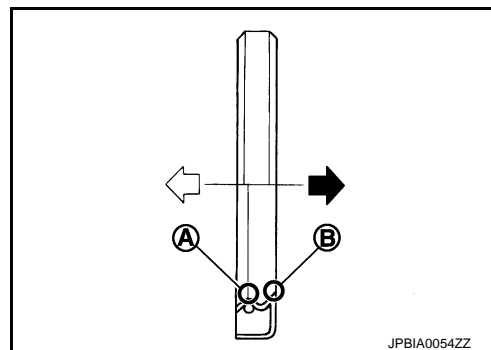


INSTALLATION

1. Install rear oil seal.

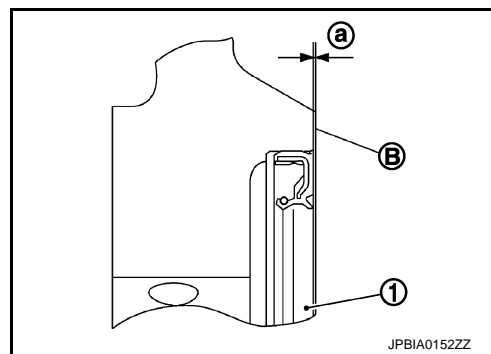
- Install rear oil seal so that each seal lip is oriented as shown in the figure.

- A : Oil seal lip
B : Dust seal lip
⇐ : Engine inside
➡ : Engine outside



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

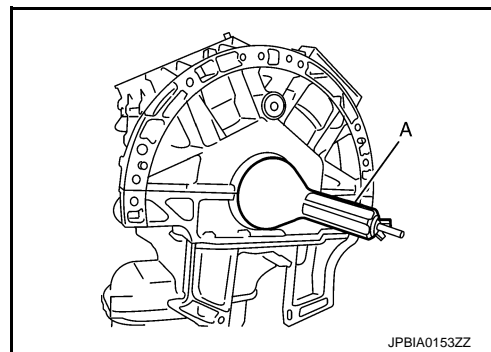
- B : Cylinder block rear end face
a : 0 - 0.5 mm (0 - 0.020 in)



- Using a suitable drift (A), press-fit until the height of rear oil seal is level with the mounting surface.
- Suitable drift: outer diameter 100 mm (3.94 in), inner diameter 85 mm (3.35 in).

CAUTION:

- **Be careful not to damage crankshaft and cylinder block.**
- **Press-fit straight and avoid causing burrs or tilting oil seal.**



2. Install in the reverse order of removal after this step.

ENGINE ASSEMBLY

< UNIT REMOVAL AND INSTALLATION >

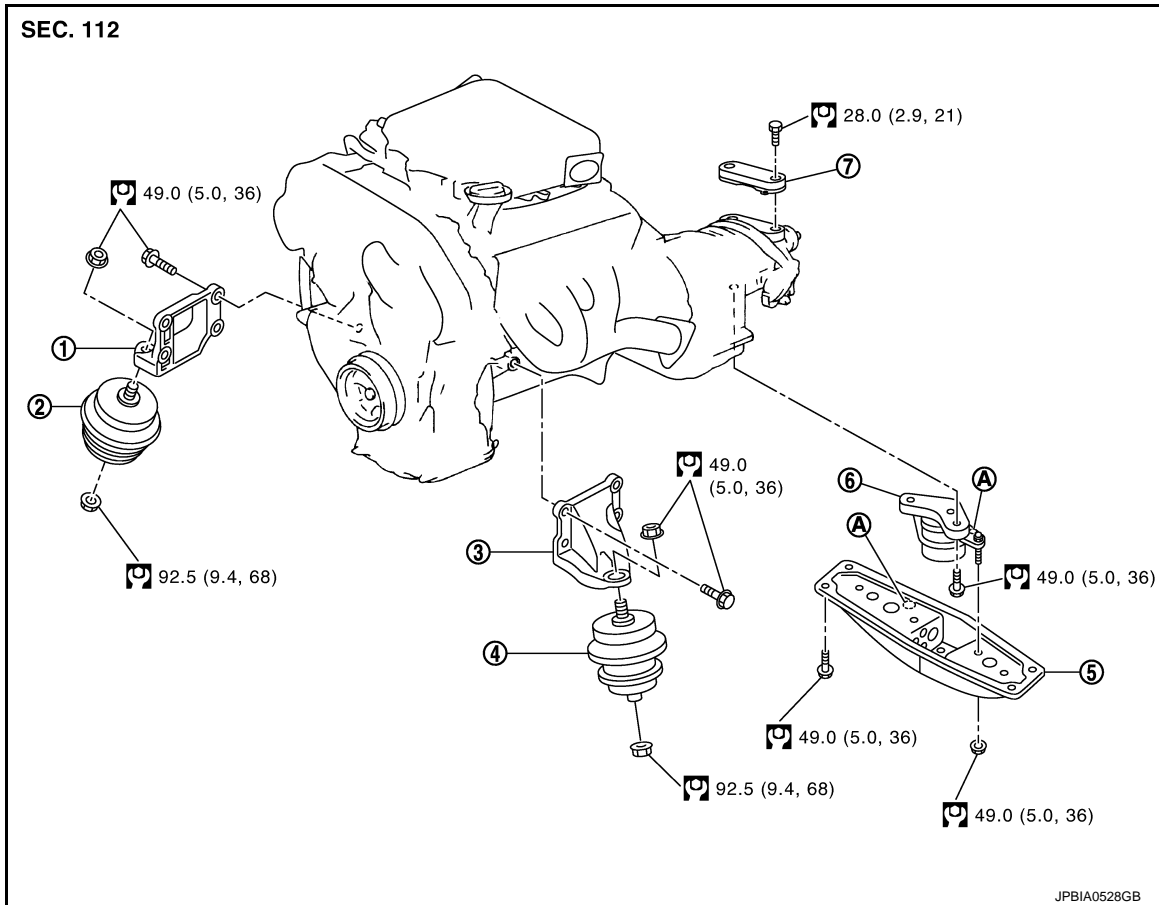
UNIT REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

2WD

2WD : Exploded View

INFOID:000000004348882



- | | | |
|-----------------------------------|-----------------------------------|-------------------------------------|
| 1. Engine mounting bracket (RH) | 2. Engine mounting insulator (RH) | 3. Engine mounting bracket (LH) |
| 4. Engine mounting insulator (LH) | 5. Rear engine mounting member | 6. Engine mounting insulator (rear) |
| 7. Dynamic damper | | |
| A. Front mark | | |

Refer to [GI-4, "Components"](#) for symbols in the figure.

2WD : Removal and Installation

INFOID:000000004348883

WARNING:

- Situate the vehicle on a flat and solid surface.
- Place chocks at front and back of rear wheels.
- For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.

CAUTION:

- Always be careful to work safely, avoid forceful or uninstructed operations.
- Never start working until exhaust system and engine 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 rear axle jacking point with transmission jack or similar tool before starting work, in preparation for the backward shift of center of gravity.

ENGINE ASSEMBLY

< UNIT REMOVAL AND INSTALLATION >

- For supporting points for lifting and jacking point at rear axle, refer to [GI-31, "Garage Jack and Safety Stand and 2-Pole Lift"](#).

REMOVAL

Outline

At first, remove the engine and the transmission assembly with front suspension member downward. Then separate the engine from transmission.

Preparation

1. Release fuel pressure. Refer to [EC-559, "Inspection"](#).
2. Disconnect both battery cables. Refer to [PG-104, "Exploded View"](#).
3. Drain engine coolant from radiator. Refer to [CO-7, "Draining"](#).
CAUTION:
 - Perform this step when engine is cold.
 - Never spill engine coolant on drive belt.
4. Remove the following parts:
 - Radiator reservoir tank: Refer to [CO-12, "Exploded View"](#).
 - Engine cover: Refer to [EM-25, "Exploded View"](#).
 - Front road wheel and tires (power tool)
 - Engine undercover (power tool)
 - Cowl top cover: Refer to [EXT-22, "Exploded View"](#).
 - Air duct and air cleaner case assembly (RH and LH): Refer to [EM-27, "Exploded View"](#).
 - Cooling fan assembly: Refer to [CO-15, "Exploded View"](#).
5. Discharge refrigerant from A/C circuit. Refer to [HA-25, "Collection and Charge"](#).
6. Remove radiator hoses (upper and lower). Refer to [CO-12, "Exploded View"](#).

Engine Room LH

1. Disconnect heater hose from vehicle-side, and fit a plug onto hose end to prevent engine coolant leakage.
2. Disconnect A/C piping from A/C compressor, and temporarily fasten it on vehicle with a rope. Refer to [HA-42, "Exploded View"](#).
3. Disconnect brake booster vacuum hose.
4. Disconnect ground cable.

Engine Room RH

1. Disconnect battery positive cable at vehicle side and temporarily fasten it on engine.
2. Disconnect all clips and connector of the engine room harness from engine back side.
3. Disconnect fuel feed hose (with damper) and EVAP hose. Refer to [EM-37, "Exploded View"](#).
CAUTION:
Fit plugs onto disconnected hoses to prevent fuel leakage.
4. Remove reservoir tank of power steering oil pump and piping from vehicle, and temporarily secure them on engine. Refer to [ST-50, "2WD : Exploded View"](#).
CAUTION:
When temporarily securing, keep the reservoir tank upright to avoid a fluid leakage.

Vehicle Inside

Follow procedure below to disconnect engine room harness connectors at passenger room side, and temporarily secure them on engine.

1. Remove passenger-side kicking plate and dash side finisher. Refer to [INT-20, "Exploded View"](#).
2. Disconnect engine room harness connectors at unit sides TCM, ECM and other.
3. Disengage intermediate fixing point. Pull out engine room harnesses to engine room side, and temporarily secure them on engine.
CAUTION:
 - When pulling out harnesses, take care not to damage harnesses and connectors.
 - After temporarily securing, cover connectors with vinyl or similar material to protect against foreign material adhesion.

Vehicle Underbody

1. Remove A/T fluid cooler hoses and power steering oil pump oil cooler hoses.

ENGINE ASSEMBLY

< UNIT REMOVAL AND INSTALLATION >

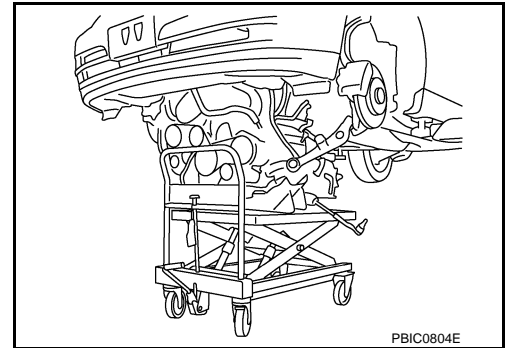
- Install plug to avoid leakage of A/T fluid and power steering fluid.
2. Disconnect heated oxygen sensor 2 harness.
3. Remove three way catalyst and exhaust front tube. Refer to [EX-5, "Exploded View"](#).
4. Disconnect steering lower joint at power steering gear assembly side, and release steering lower shaft. Refer to [ST-22, "Exploded View"](#).
5. Remove rear propeller shaft. Refer to [DLN-91, "Exploded View"](#).
6. Disengage A/T control rod at A/T shift selector side. Then, temporarily secure it on the transmission assembly, so that it does not sag. Refer to [TM-157, "2WD : Exploded View"](#).
7. Remove rear plate cover from oil pan (upper). Then remove bolts fixing drive plate to torque converter. Refer to [EM-97, "2WD : Exploded View"](#).
8. Remove transmission joint bolts which pierce at oil pan (upper) lower rear side. Refer to [EM-43, "Exploded View \(2WD\)"](#).
9. Remove front stabilizer connecting rod from transverse link. Refer to [FSU-17, "Exploded View"](#).
10. Remove lower ends of left and right steering knuckle from transverse link. Refer to [FAX-7, "Exploded View"](#).
11. Separate steering outer sockets from steering knuckle. Refer to [ST-24, "2WD : Exploded View"](#).
12. Remove transverse links mounting bolts at suspension member side. Refer to [FSU-13, "Exploded View"](#).

Removal Work

1. Use a manual lift table caddy (commercial service tool) or equivalently rigid tool such as a transmission jack. Securely support bottom of suspension member and the transmission assembly.

CAUTION:

Put a piece of wood or something similar as the supporting surface, secure a completely stable condition.



2. Remove rear engine mounting member bolts.
3. Remove front suspension member mounting bolts and nuts. Refer to [FSU-18, "Exploded View"](#).
4. Carefully lower jack, or raise lift to remove the engine, the transmission assembly and front suspension member. When performing work, observe the following caution:

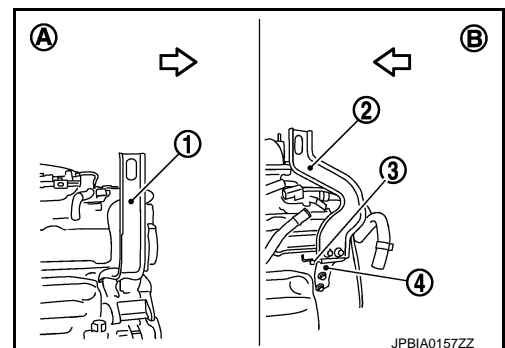
CAUTION:

- Confirm there is no interference with the vehicle.
- Check that all connection points have been disconnected.
- Keep in mind the center of vehicle gravity changes. If necessary, use jack(s) to support the vehicle at rear jacking point(s) to prevent it from falling off the lift.

Separation Work

1. Install engine slingers into front of cylinder head (bank 1) and rear of cylinder head (bank 2).

- 1 : Engine front slinger
- 2 : Engine rear upper slinger
- 3 : Spacer
- 4 : Engine rear lower slinger
- A : Bank 1
- B : Bank 2
- ⇐ : Engine front



Slinger bolts:

: 28.0 N·m (2.9 kg-m, 21 ft-lb)

ENGINE ASSEMBLY

< UNIT REMOVAL AND INSTALLATION >

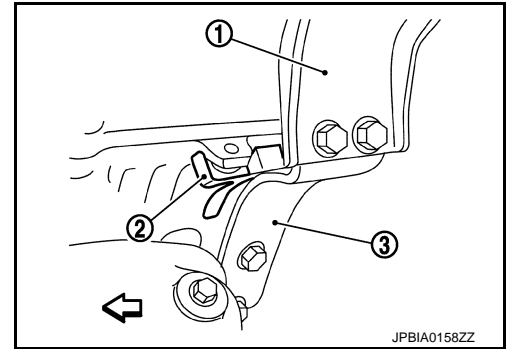
- To protect rocker cover against damage caused by tilting of engine slinger, insert spacer between cylinder head and engine rear lower slinger (3), in direction shown in the figure.

1 : Engine rear upper slinger

⇐ : Engine front

NOTE:

Spacer (2) is a component part of engine rear upper slinger assembly.



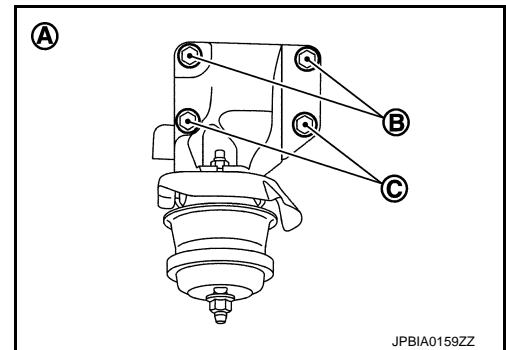
- Remove power steering oil pump from engine side. Refer to [ST-44, "Exploded View"](#).
- Remove engine mounting insulators (RH and LH) under side nuts with power tool.
- Lift with hoist and separate the engine and the transmission assembly from front suspension member.
CAUTION:
 - Before and during this lifting, always check that any harnesses are left connected.
 - Never damage to and oil/grease smearing or spills onto engine mounting insulator.
- Remove alternator. Refer to [CHG-25, "2WD : Exploded View"](#).
- Remove starter motor. Refer to [STR-15, "Exploded View"](#).
- Separate the engine from the transmission assembly. Refer to [TM-195, "2WD : Exploded View"](#).
- Remove each engine mounting insulator and each engine mounting bracket from the engine with power tool.

INSTALLATION

Note the following, and install in the reverse order of removal.

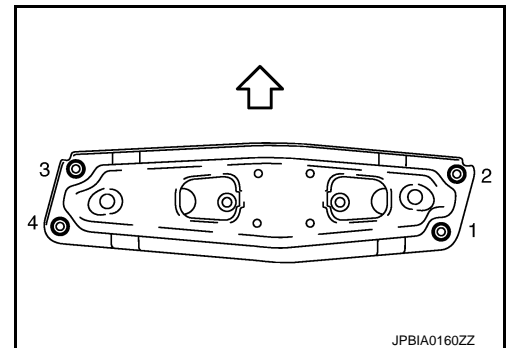
- Do not allow engine mounting insulator to be damage and careful no oil gets on it.
- For a location with a positioning pin, insert it securely into hole of mating part.
- For a part with a specified installation orientation, refer to component figure in [EM-79, "2WD : Exploded View"](#).
- When installing engine mounting bracket (RH and LH) on cylinder block, tighten two upper bolts [shown as (B) in the figure] first. Then tighten two lower bolts [shown as (C) in the figure].

A : Example left



- Check all engine mounting insulators are seated properly, and then tighten mounting nuts.
- Tighten rear engine mounting member bolts in numerical order as shown in the figure.

⇐ : Vehicle front



2WD : Inspection

INFOID:0000000004348884

INSPECTION AFTER INSTALLATION

A

FM

C

D

- F

F

G

H

1

INFOID:0000000004348885



K

1

M

N

0

D

ENGINE ASSEMBLY

< UNIT REMOVAL AND INSTALLATION >

- | | | |
|--------------------------------------|---|---------------------------------|
| 1. Engine mounting bracket (RH) | 2. Engine mounting bracket (RH) (lower) | 3. Dynamic damper |
| 4. Washer | 5. Engine mounting insulator (RH) | 6. Engine mounting bracket (LH) |
| 7. Engine mounting insulator (LH) | 8. Heat insulator | 9. Rear engine mounting member |
| 10. Engine mounting insulator (rear) | | |
| A. Front mark | | |

Refer to [GI-4, "Components"](#) for symbols in the figure.

AWD : Removal and Installation

INFOID:000000004348886

WARNING:

- Situate the vehicle on a flat and solid surface.
- Place chocks at front and back of rear wheels.
- For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.

CAUTION:

- Always be careful to work safely, avoid forceful or uninstructed operations.
- Never start working until exhaust system and engine 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 rear axle jacking point with 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-31, "Garage Jack and Safety Stand and 2-Pole Lift"](#).

REMOVAL

Outline

At first, remove the engine, the transmission assembly, the transfer assembly and the front final drive assembly with front suspension member downward. Then separate the engine, the transmission assembly, the transfer and the front final drive assembly.

Preparation

1. Release fuel pressure. Refer to [EC-559, "Inspection"](#).
2. Disconnect both battery terminals. Refer to [PG-104, "Exploded View"](#).
3. Drain engine coolant from radiator. Refer to [CO-7, "Draining"](#).

CAUTION:

- Perform this step when engine is cold.
 - Never spill engine coolant on drive belt.
4. Remove the following parts:
 - Radiator reservoir tank: Refer to [CO-12, "Exploded View"](#).
 - Engine cover: Refer to [EM-25, "Exploded View"](#).
 - Front road wheel and tires (power tool)
 - Engine undercover (power tool)
 - Front cross bar: Refer to [FSU-37, "Exploded View"](#).
 - Cowl top cover: Refer to [EXT-22, "Exploded View"](#).
 - Air duct and air cleaner case assembly (RH and LH): Refer to [EM-27, "Exploded View"](#).
 - Cooling fan assembly: Refer to [CO-15, "Exploded View"](#).
 5. Discharge refrigerant from A/C circuit. Refer to [HA-25, "Collection and Charge"](#).
 6. Remove radiator hoses (upper and lower). Refer to [CO-12, "Exploded View"](#).

Engine Room LH

1. Disconnect heater hose from vehicle-side, and fit a plug onto hose end to prevent engine coolant leakage.
2. Disconnect A/C piping from A/C compressor, and temporarily fasten it on vehicle with a rope. Refer to [HA-42, "Exploded View"](#).
3. Disconnect brake booster vacuum hose.
4. Disconnect ground cables.

ENGINE ASSEMBLY

< UNIT REMOVAL AND INSTALLATION >

Engine Room RH

1. Disconnect battery positive cable vehicle side and temporarily fasten it on engine.
2. Disconnect all clips and connectors of the engine room harness from engine back side.
3. Disconnect fuel feed hose (with damper) and EVAP hose. Refer to [EM-37, "Exploded View"](#).
CAUTION:
Fit plugs onto disconnected hoses to prevent fuel leakage.
4. Remove reservoir tank of power steering oil pump and piping from vehicle, and temporarily secure them on engine. Refer to [ST-51, "AWD : Exploded View"](#).
CAUTION:
When temporarily securing, keep the reservoir tank upright to avoid a fluid leakage.

Vehicle Inside

Follow procedure below to disconnect engine room harness connectors at passenger room side, and temporarily secure them on engine.

1. Remove passenger-side kicking plate and dash side finisher. Refer to [INT-20, "Exploded View"](#).
2. Disconnect engine room harness connectors at unit sides TCM, ECM and other.
3. Disengage intermediate fixing point. Pull out engine room harnesses to engine room side, and temporarily secure them on engine.
CAUTION:
 - When pulling out harnesses, take care not to damage harnesses and connectors.
 - After temporarily securing, cover connectors with vinyl or similar material to protect against foreign material adhesion.

Vehicle Underbody

1. Remove A/T fluid cooler hoses and power steering oil pump oil cooler hoses.
 - Install plug to avoid leakage of A/T fluid and power steering fluid.
2. Disconnect heated oxygen sensor 2 harness. Refer to [EX-6, "Removal and Installation"](#).
3. Remove three way catalyst and exhaust front tube. Refer to [EX-5, "Exploded View"](#).
4. Disconnect steering lower joint at power steering gear assembly side, and release steering lower shaft. Refer to [ST-22, "Exploded View"](#).
5. Remove rear propeller shaft. Refer to [DLN-91, "Exploded View"](#).
6. Remove front drive shaft (both side). Refer to [FAX-24, "Exploded View"](#).
7. Disconnect harness connector from transmission assembly and transfer assembly.
8. Disengage A/T control rod at A/T shift selector side. Then, temporarily secure it on the transmission assembly, so that it does not sag. Refer to [TM-160, "AWD : Exploded View"](#).
9. Remove rear plate cover from oil pan (upper). Then remove bolts fixing drive plate to torque converter. Refer to [EM-100, "AWD : Exploded View"](#).
10. Remove bolts fixing the transmission assembly to lower rear side of oil pan (upper). Refer to [EM-100, "AWD : Exploded View"](#).
11. Remove front stabilizer connecting rod from transverse link. Refer to [FSU-36, "Exploded View"](#).
12. Remove lower ends of left and right steering knuckle from transverse link. Refer to [FAX-17, "Exploded View"](#).
13. Separate steering outer sockets from steering knuckle. Refer to [ST-33, "AWD : Exploded View"](#).
14. Remove transverse links mounting bolts at suspension member side. Refer to [FSU-32, "Exploded View"](#).

Removal Work

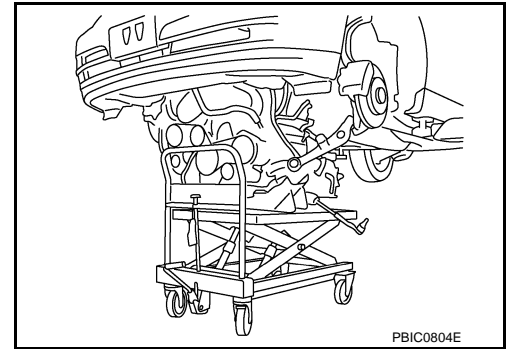
ENGINE ASSEMBLY

< UNIT REMOVAL AND INSTALLATION >

1. Use a manual lift table caddy (commercial service tool) or equivalently rigid tool such as a transmission jack. Securely support bottom of suspension member and transmission.

CAUTION:

Put a piece of wood or something similar as the supporting surface, secure a completely stable condition.



2. Remove rear engine mounting member bolts.
3. Remove front suspension member mounting bolts and nuts. Refer to [FSU-37, "Exploded View"](#).
4. Carefully lower jack, or raise lift to remove the engine, transmission assembly, transfer, front final drive assembly and front suspension member. When performing work, observe the following caution:

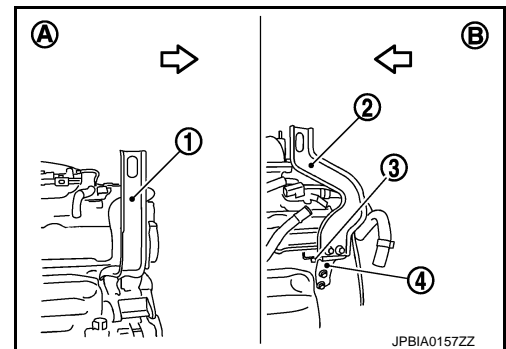
CAUTION:

- Confirm there is no interference with the vehicle.
- Check that all connection points have been disconnected.
- Keep in mind the center of the vehicle gravity changes. If necessary, use jack(s) to support the vehicle at rear jacking point(s) to prevent it from falling off the lift.

Separation Work

1. Install engine slingers into front of cylinder head (bank 1) and rear of cylinder head (bank 2).

- 1 : Engine front slinger
- 2 : Engine rear upper slinger
- 3 : Spacer
- 4 : Engine rear lower slinger
- A : Bank 1
- B : Bank 2
- ⇐ : Engine front



Slinger bolts:

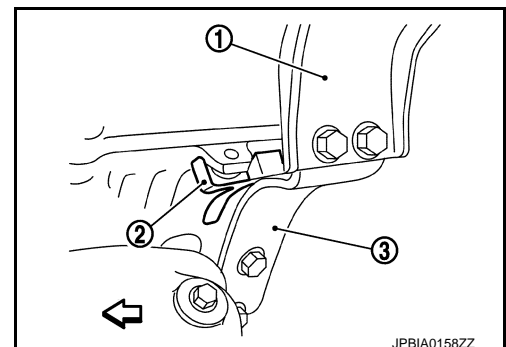
: **28.0 N·m (2.9 kg-m, 21 ft-lb)**

- To protect rocker cover against damage caused by tilting of engine slinger, insert spacer between cylinder head and engine rear lower slinger (3), in direction shown in the figure.

- 1 : Engine rear upper slinger
- ⇐ : Engine front

NOTE:

Spacer (2) is a component part of engine rear upper slinger assembly.



2. Remove power steering oil pump from engine side. Refer to [ST-44, "Exploded View"](#).
 3. Remove engine mounting insulators (RH and LH) under side nuts with power tool.
 4. Lift with hoist and separate the engine, the transmission assembly, the transfer assembly and the front final drive assembly from front suspension member.
- CAUTION:**
- Before and during this lifting, always check if any harnesses are left connected.
 - Never damage to and oil/grease smearing or spills onto engine mounting insulator.
5. Remove alternator. Refer to [CHG-27, "AWD : Exploded View"](#).

ENGINE ASSEMBLY

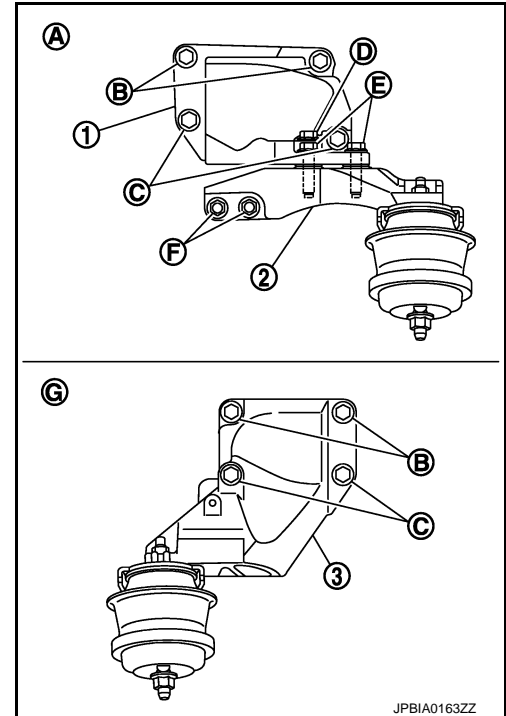
< UNIT REMOVAL AND INSTALLATION >

6. Remove starter motor. Refer to [STR-15, "Exploded View"](#).
7. Remove front propeller shaft from the front final drive assembly side. Refer to [DLN-76, "Exploded View"](#).
8. Separate the engine from the transmission assembly. Refer to [TM-198, "AWD : Exploded View"](#).
9. Remove the front final drive assembly from oil pan (upper). Refer to [DLN-107, "Exploded View"](#).
10. Remove each engine mounting insulator and each engine mounting bracket from the engine with power tool.

INSTALLATION

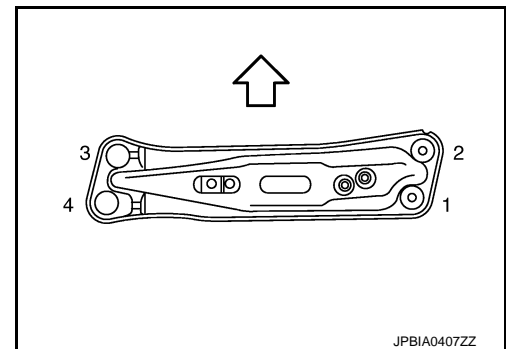
Note the following, and install in the reverse order of removal.

- Do not allow engine mounting insulator to be damage and careful no engine oil gets on it.
 - For a location with a positioning pin, insert it securely into hole of mating part.
 - For a part with a specified installation orientation, refer to component figure in [EM-83, "AWD : Exploded View"](#).
 - When installing engine mounting bracket (RH and LH) on cylinder block, tighten two upper bolts [shown as (B) in the figure] first. Then tighten two lower bolts [shown as (C) in the figure].
- 3 : Engine mounting bracket (LH)
A : Right side
G : Left side
- Install engine mounting bracket (RH) (lower) (2) as follows:
 - Temporarily tighten mounting bolts [shown as (D), (E), and (F) in the figure].
 - Tighten mounting bolts to the specified torque with following mounting surfaces touched.
 - Engine mounting bracket (RH) (1) to engine mounting bracket (RH) (lower) [shown as (D) and (E) in the figure].
 - Front final drive to engine mounting bracket (RH) (lower) [shown as (F) in the figure].
 - Check all engine mounting insulators are seated properly, and then tighten mounting nuts.



- Tighten rear engine mounting member bolts in numerical order as shown in the figure.

↔ : Vehicle front



AWD : Inspection

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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-10, "Fluids and Lubricants"](#).
- Use procedure below to check for fuel leakage.

ENGINE ASSEMBLY

< UNIT REMOVAL AND INSTALLATION >

- 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.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to check there is no leakage of fuel, exhaust gases, 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 |
| Other oils and fluid* | Level | Leakage | Level |
| Fuel | Leakage | Leakage | Leakage |
| Exhaust gases | — | Leakage | — |

*: Transmission/transaxle/CVT fluid, power steering fluid, brake fluid, etc.

ENGINE STAND SETTING

< UNIT DISASSEMBLY AND ASSEMBLY >

UNIT DISASSEMBLY AND ASSEMBLY

ENGINE STAND SETTING

Setting

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EM

NOTE:

Explained here is how to disassemble with engine stand supporting transmission surface. When using different type of engine stand, note with difference in steps and etc.

1. Remove the engine assembly from the vehicle. Refer to [EM-79, "2WD : Exploded View"](#) (2WD models) or [EM-83, "AWD : Exploded View"](#) (AWD models).
2. Remove the parts that may restrict installation of engine to widely use engine stand.

NOTE:

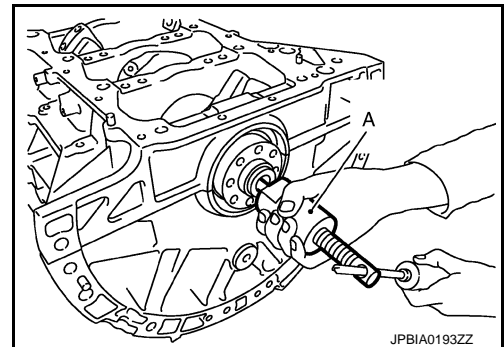
The procedure is described assuming that you use a widely use engine stand holding the surface, to which transmission is installed.

- Remove drive plate with power tool. Fix crankshaft with a ring gear stopper [SST: KV10118600 (J-48641)], and remove mounting bolts.
- Loosen mounting bolts in diagonal order.
- Check for deformation or damage drive plate.

CAUTION:

- **Never disassemble drive plate.**
- **Never place drive plate with signal plate facing down.**
- **When handling signal plate, take care not to damage or scratch it.**
- **Handle signal plate in a manner that prevents it from becoming magnetized.**

3. Remove pilot converter using the pilot bushing puller [SST: ST16610001 (J-23907)] (A) if necessary.



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

CAUTION:

Use an engine stand that has a load capacity [220 kg (485 lb) or more] large enough for supporting the engine weight.

- If the load capacity of the stand is not adequate, remove the following parts beforehand to reduce the potential risk of overturning the stand.
 - Remove intake manifold collector. Refer to [EM-29, "Exploded View"](#).
 - Remove fuel injector and fuel tube assembly. Refer to [EM-37, "Exploded View"](#).
 - Remove intake manifold. Refer to [EM-32, "Exploded View"](#).
 - Remove ignition coil and rocker cover. Refer to [EM-47, "Exploded View"](#).
 - Remove exhaust manifold. Refer to [EM-34, "Exploded View"](#).
 - Other removable brackets.

NOTE:

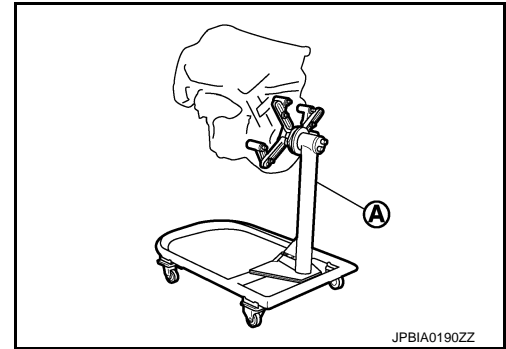
ENGINE STAND SETTING

< UNIT DISASSEMBLY AND ASSEMBLY >

The figure shows an example of widely use engine stand (A) that can hold mating surface of transmission with drive plate removed.

CAUTION:

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

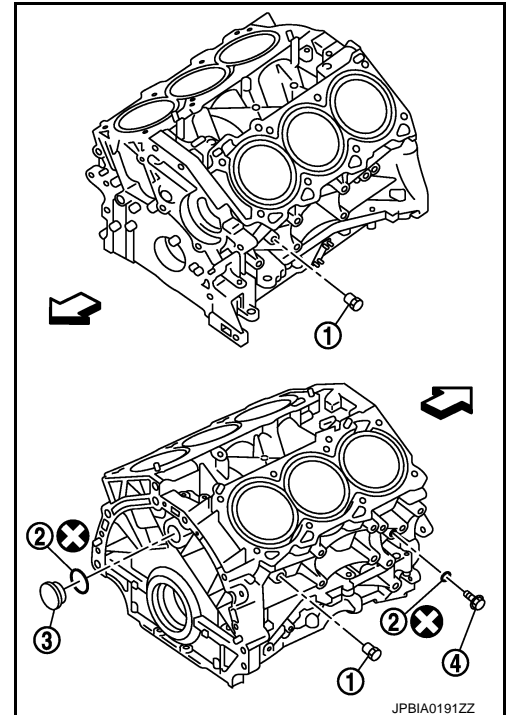


5. Drain engine oil. Refer to [LU-8. "Draining"](#).
6. Drain engine coolant by removing water drain plugs (1) and (4) from cylinder block both sides as shown in the figure.

2 : Washer

3 : Plug

⇐ : Engine front



ENGINE UNIT

< UNIT DISASSEMBLY AND ASSEMBLY >

ENGINE UNIT

Disassembly

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1. Remove intake manifold collector. Refer to [EM-29, "Exploded View"](#).
2. Remove fuel injector and fuel tube. Refer to [EM-37, "Exploded View"](#).
3. Remove intake manifold. Refer to [EM-32, "Exploded View"](#).
4. Remove exhaust manifold. Refer to [EM-34, "Exploded View"](#).
5. Remove oil pan (lower). Refer to [EM-43, "Exploded View \(2WD\)"](#) (2WD models) or [EM-44, "Exploded View \(AWD\)"](#) (AWD models).
6. Remove ignition coil, spark plug and rocker cover. Refer to [EM-47, "Exploded View"](#).
7. Remove timing chain. Refer to [EM-50, "Exploded View"](#).
8. Remove rear timing chain case. Refer to [EM-92, "Exploded View"](#).
9. Remove camshaft. Refer to [EM-67, "Exploded View"](#).
10. Remove cylinder head. Refer to [EM-104, "Exploded View"](#).

Assembly

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Assembly in the reverse order of disassembly.

A

EM

C

D

E

F

G

H

I

J

K

L

M

N

O

P

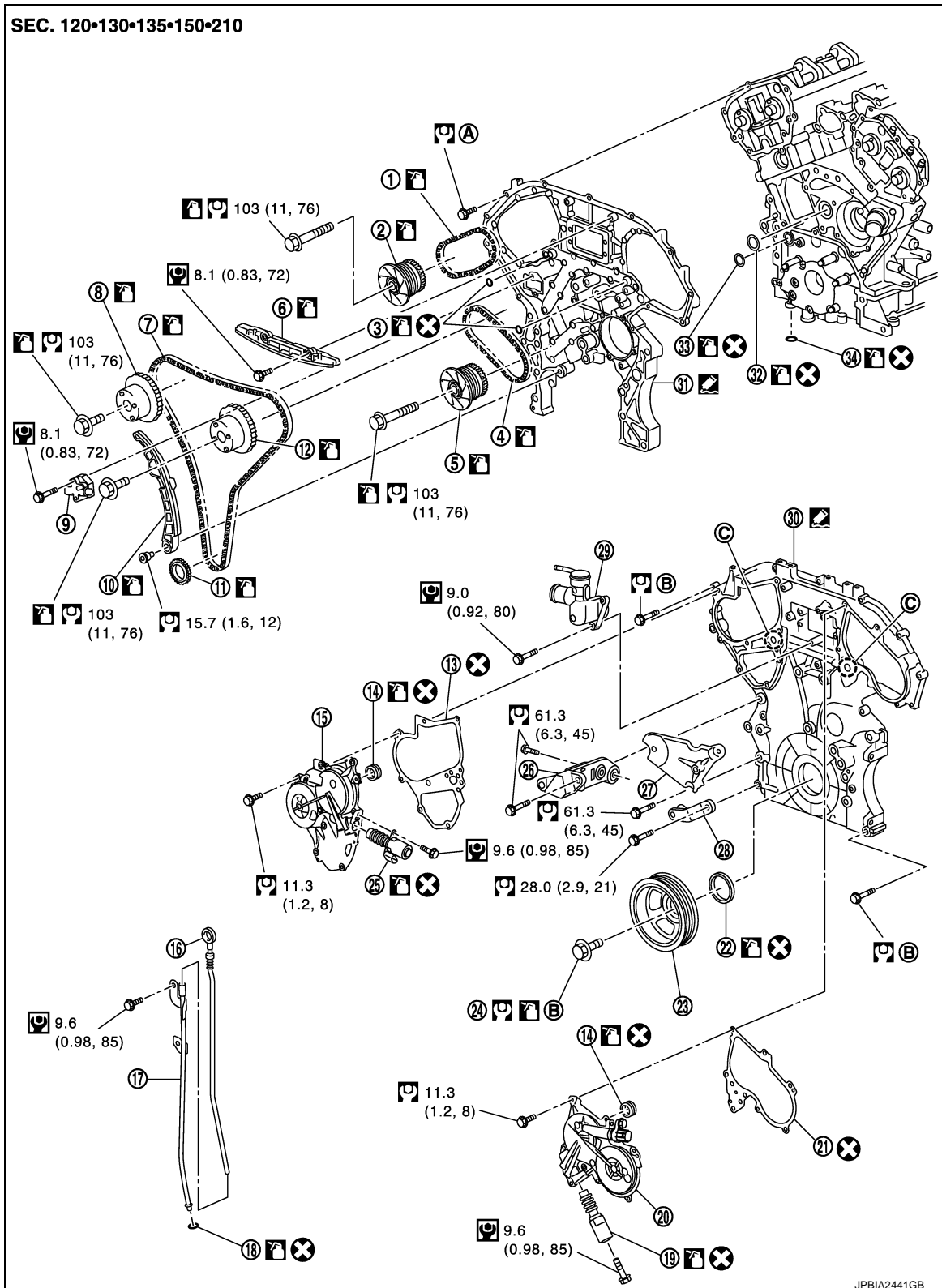
REAR TIMING CHAIN CASE

< UNIT DISASSEMBLY AND ASSEMBLY >

REAR TIMING CHAIN CASE

Exploded View

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JPBIA2441GB

- | | | |
|-----------------------------|----------------------------|-------------------------------------|
| 1. Timing chain (secondary) | 2. Camshaft sprocket (EXH) | 3. O-ring |
| 4. Timing chain (secondary) | 5. Camshaft sprocket (EXH) | 6. Internal chain guide |
| 7. Timing chain (primary) | 8. Camshaft sprocket (INT) | 9. Timing chain tensioner (primary) |

REAR TIMING CHAIN CASE

< UNIT DISASSEMBLY AND ASSEMBLY >

- | | | |
|---|---|--|
| 10. Slack guide | 11. Crankshaft sprocket | 12. Camshaft sprocket (INT) |
| 13. Valve timing control cover gasket (bank 1) | 14. Seal ring | 15. Valve timing control cover (bank 1) |
| 16. Oil level gauge | 17. Oil level gauge guide | 18. O-ring |
| 19. Intake valve timing control solenoid valve (bank 2) | 20. Valve timing control cover (bank 2) | 21. Valve timing control cover gasket (bank 2) |
| 22. Front oil seal | 23. Crankshaft pulley | 24. Crankshaft pulley bolt |
| 25. Intake valve timing control solenoid valve (bank 1) | 26. Power steering oil pump bracket | 27. Idler pulley bracket |
| 28. Alternator bracket | 29. Water outlet (front) | 30. Front timing chain case |
| 31. Rear timing chain case | 32. O-ring | 33. O-ring |
| 34. O-ring | | |

A. Refer to [EM-94](#)

B. Refer to [EM-51](#)

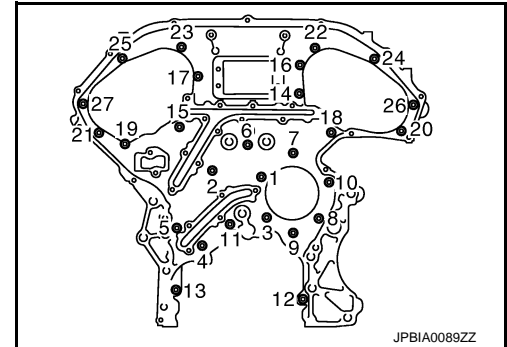
C. Oil filter

Refer to [GI-4, "Components"](#) for symbols in the figure.

Disassembly

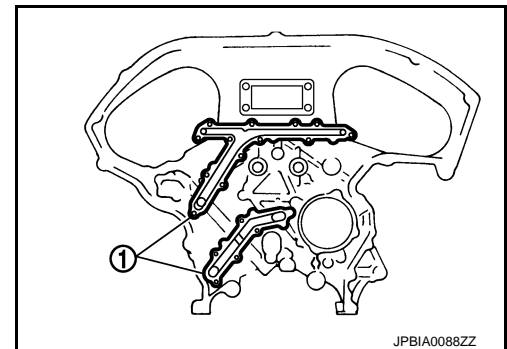
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1. Remove front timing chain case and timing chain. Refer to [EM-50, "Exploded View"](#).
2. Remove water pump. Refer to [CO-17, "Exploded View"](#).
3. Remove oil pan (upper). Refer to [EM-97, "2WD : Exploded View"](#) (2WD models) or [EM-100, "AWD : Exploded View"](#) (AWD models).
4. Remove rear timing chain case as follows:
 - a. Loosen and remove mounting bolts in reverse order as shown in the figure.
 - b. Cut liquid gasket using the seal cutter [SST: KV10111100 (J-37228)] and remove rear timing chain case.



CAUTION:

- Never remove plate metal cover (1) of oil passage.
- After removal, handle rear timing chain case carefully so it does not tilt, cant, or warp under a load.

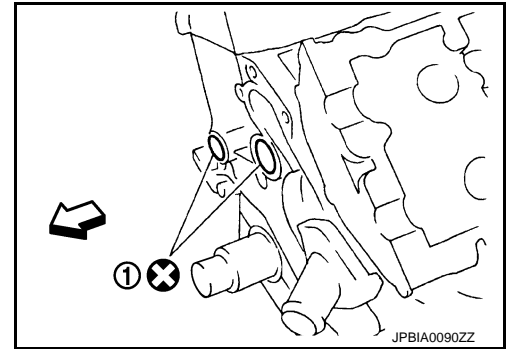


REAR TIMING CHAIN CASE

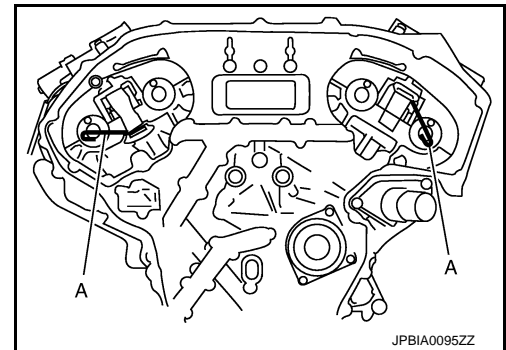
< UNIT DISASSEMBLY AND ASSEMBLY >

5. Remove O-rings (1) from cylinder block.

⇐ : Engine front



6. Remove timing chain tensioners (secondary) from cylinder head as follows, if necessary.
- Remove camshaft brackets (No. 1). Refer to [EM-67, "Exploded View"](#).
 - Remove timing chain tensioners (secondary) with a stopper pin (A) attached.



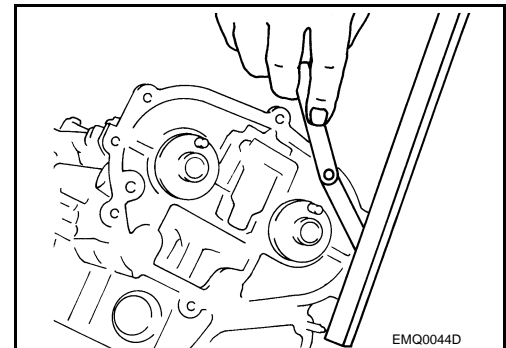
Assembly

INFOID:000000004348893

- Install timing chain tensioners (secondary) to cylinder head as follows if removed. Refer to [EM-67, "Exploded View"](#).
 - Install timing chain tensioners (secondary) with a stopper pin attached and new O-rings.
 - Install camshaft brackets (No. 1). Refer to [EM-67, "Exploded View"](#).
 - Measure difference in levels between front end faces of camshaft bracket (No. 1) and cylinder head.

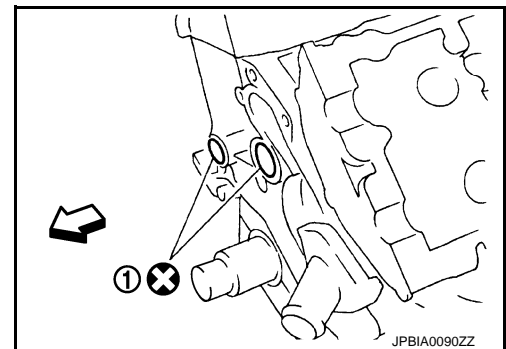
Standard : -0.14 to 0.14 mm (-0.0055 to 0.0055 in)

- Measure two positions (both intake and exhaust side) for a single bank.
- If the measured value is out of the standard, re-install camshaft bracket (No. 1).



- Install rear timing chain case as follows:
 - Install new O-rings (1) onto cylinder block.

⇐ : Engine front



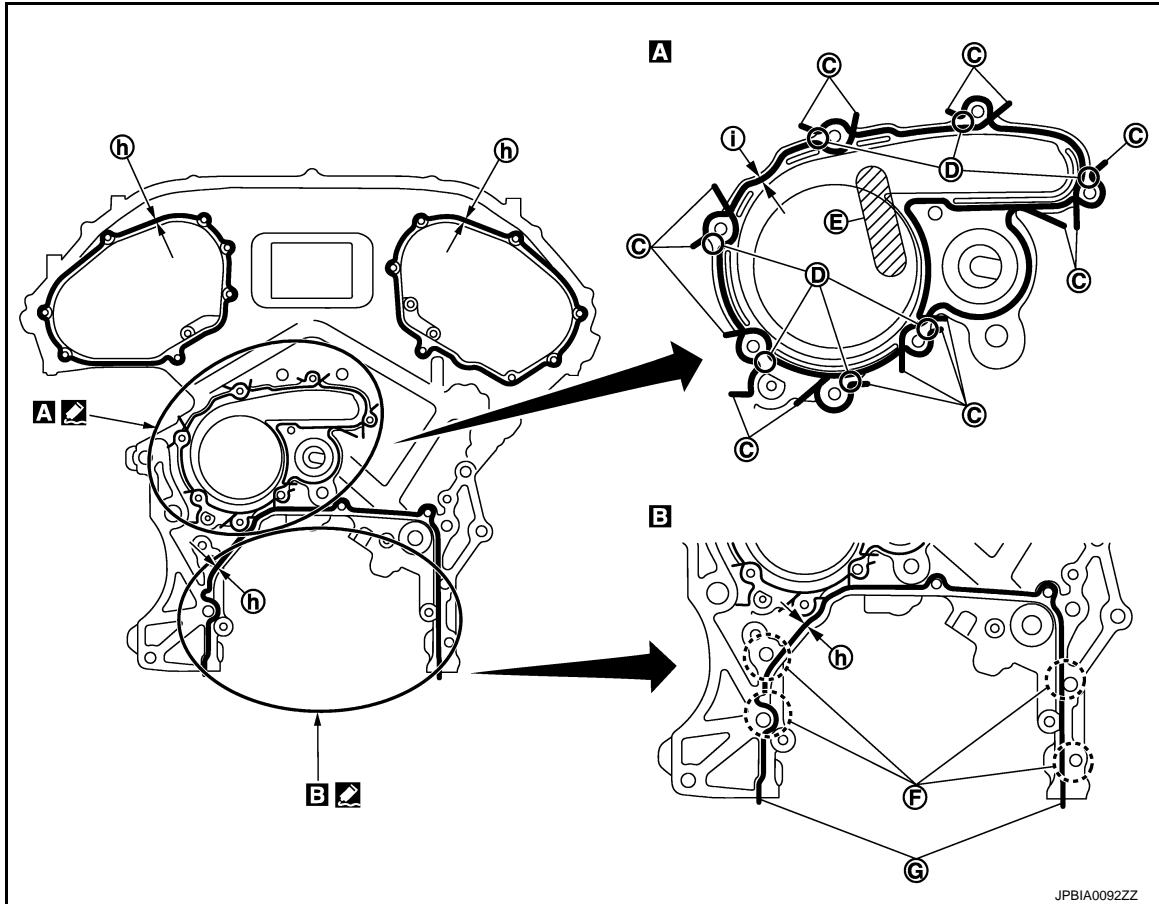
REAR TIMING CHAIN CASE

< UNIT DISASSEMBLY AND ASSEMBLY >

- b. Apply liquid gasket with the tube presser (commercial service tool) to rear timing chain case back side as shown in the figure.
Use **Genuine RTV Silicone Sealant** or equivalent. Refer to [GI-17. "Recommended Chemical Products and Sealants"](#).

CAUTION:

- For (A) in the figure, completely wipe out liquid gasket extended on a portion touching at engine coolant.
- Apply liquid gasket on installation position of water pump and cylinder head very completely.




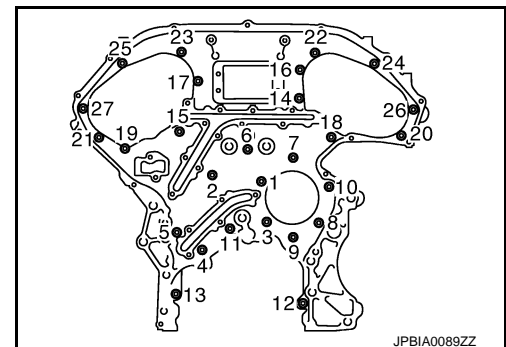
- | | | |
|-----------------------------------|---|---------------------------------|
| C. Protrusion | D. Clearance 1 mm (0.04 in) | E. Do not protrude in this area |
| F. Run along bolt hole inner side | G. Protrusions at beginning and end of gasket | |
| h. $\phi 3.9$ mm (0.154 in) | i. $\phi 2.7$ mm (0.106 in) | |

Refer to [GI-4. "Components"](#) for symbols in the figure.

- c. Align rear timing chain case with dowel pins (bank 1 and bank 2) on cylinder block and install rear timing chain case.
- Check O-rings stay in place during installation to cylinder block and cylinder head.
- d. Tighten mounting bolts in numerical order as shown in the figure.
- There are two types of mounting bolts. Refer to the following for locating bolts.

| Bolt length: | Bolt position |
|-----------------|---------------------------|
| 20 mm (0.79 in) | : 1, 2, 3, 6, 7, 8, 9, 10 |
| 16 mm (0.63 in) | : Except the above |

 : 12.7 N·m (1.3 kg·m, 9 ft·lb)



REAR TIMING CHAIN CASE

< UNIT DISASSEMBLY AND ASSEMBLY >

- e. After all bolts are tightened, retighten them to the specified torque in numerical order shown in the figure.
 - If liquid gasket protrudes, wipe it off immediately.
- f. After installing rear timing chain case, check the surface height difference between the following parts on the oil pan (upper) mounting surface.

- 1 : Rear timing chain case
- 2 : Lower cylinder block

Standard

Rear timing chain case to lower cylinder block:

−0.24 to 0.14 mm (−0.0094 to 0.0055 in)

- If not within the standard, repeat the installation procedure.

3. Install water pump with new O-rings. Refer to [CO-17. "Exploded View"](#).
4. Check that dowel pin (A) and crankshaft key (1) are located as shown in the figure. (No. 1 cylinder at compression TDC)

NOTE:

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

Camshaft dowel pin

: At cylinder head upper face side in each bank.

Crankshaft key

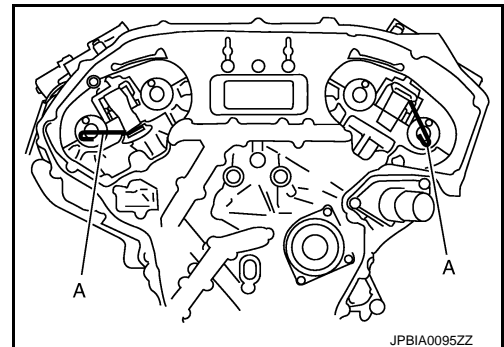
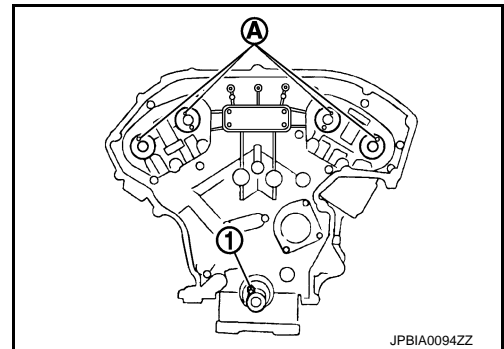
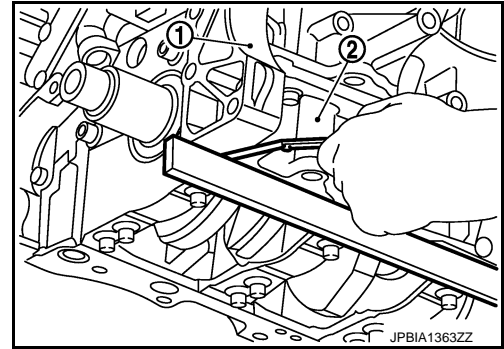
: At cylinder head side of bank 1.

5. Install timing chains (secondary) and camshaft sprockets as follows:

CAUTION:

Matching marks between timing chain and sprockets slip easily. Confirm all matching mark positions repeatedly during the installation process.

- a. Push plunger of timing chain tensioner (secondary) and keep it pressed in with a stopper pin (A).



6. For the following operations, perform steps in the reverse order of removal.

OIL PAN (UPPER) AND OIL STRAINER

< UNIT DISASSEMBLY AND ASSEMBLY >

OIL PAN (UPPER) AND OIL STRAINER

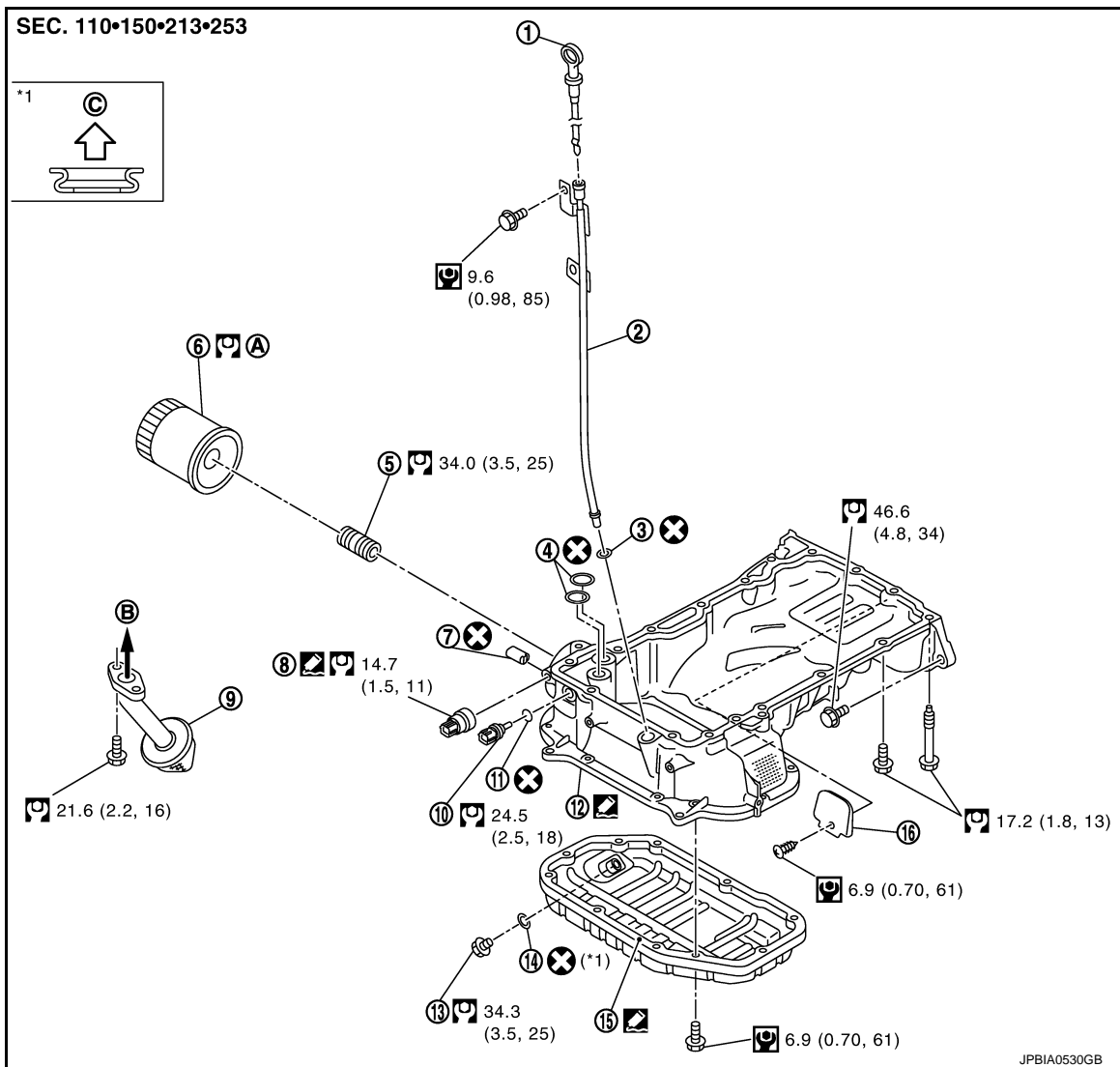
2WD

2WD : Exploded View

INFOID:000000004348894

A

EM



- | | | |
|----------------------------------|--------------------------|---------------------|
| 1. Oil level gauge | 2. Oil level gauge guide | 3. O-ring |
| 4. O-ring | 5. Connector bolt | 6. Oil filter |
| 7. Plug | 8. Oil pressure switch | 9. Oil strainer |
| 10. Oil temperature sensor | 11. Washer | 12. Oil pan (upper) |
| 13. Drain plug | 14. Drain plug washer | 15. Oil pan (lower) |
| 16. Rear plate cover | | |
| A. Refer to LU-9 | B. To oil pump | C. Oil pan side |

Refer to [GI-4, "Components"](#) for symbols in the figure.

2WD : Disassembly and Assembly

INFOID:000000004348895

REMOVAL

CAUTION:

Never drain engine oil when the engine is hot to avoid the danger of being scalded.

1. Remove oil level gauge, oil pressure switch and oil temperature sensor.

OIL PAN (UPPER) AND OIL STRAINER

< UNIT DISASSEMBLY AND ASSEMBLY >

2. Remove oil pan (lower). Refer to [EM-43, "Exploded View \(2WD\)"](#).
3. Remove oil strainer.
4. Loosen mounting bolts in the reverse order as shown in the figure with power tool to remove.

⇐ : Engine front

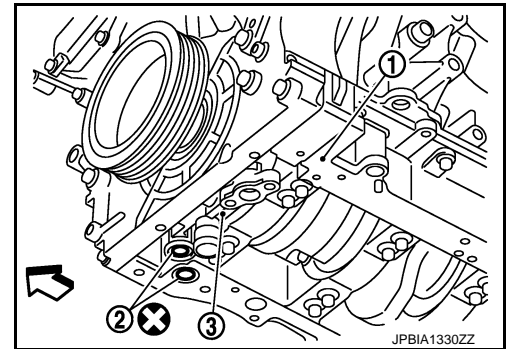
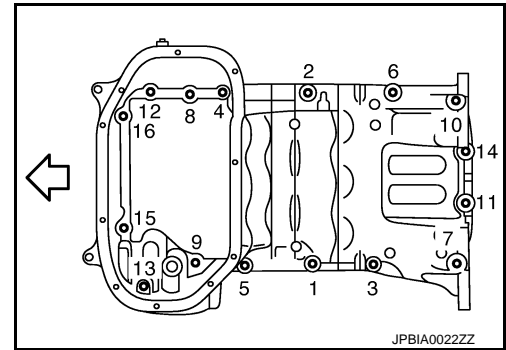
- Insert the seal cutter [SST: KV10111100 (J-37228)] between oil pan (upper) and lower cylinder block. Slide seal cutter by tapping on the side of tool with a hammer. Remove oil pan (upper).

CAUTION:

- **Be careful not to damage the mating surfaces.**
- **Never insert a screwdriver, this will damage the mating surfaces.**

5. Remove o-rings (2) from bottom of lower cylinder block (1) and oil pump (3).

⇐ : Engine front



INSTALLATION

1. Install oil pan (upper) as follows:
 - a. Use a scraper (A) to remove old liquid gasket from mating surfaces.

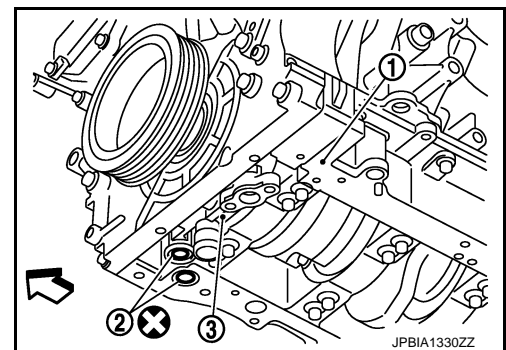
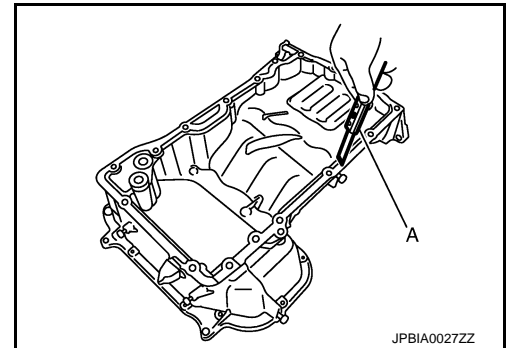
CAUTION:

Never scratch or damage the mating surfaces when cleaning off old liquid gasket.

- Also remove old liquid gasket from mating surface of lower cylinder block.
- Remove old liquid gasket from the bolt holes and threads.

- b. Install new O-rings (2) on the bottom of lower cylinder block (1) and oil pump (3).

⇐ : Engine front



OIL PAN (UPPER) AND OIL STRAINER

< UNIT DISASSEMBLY AND ASSEMBLY >

- c. Apply a continuous bead of liquid gasket with the tube presser (commercial service tool) to the cylinder block mating surface of oil pan (upper) to a limited portion as shown in the figure.

a : $\phi 4.0 - 5.0$ mm (0.157 - 0.197 in)

↩ : Engine front

Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-17, "Recommended Chemical Products and Sealants"](#).

CAUTION:

- For bolt holes with ▲ marks (7 locations), apply liquid gasket outside the holes.
- Attaching should be done within 5 minutes after coating.

- d. Install oil pan (upper).

CAUTION:

Be careful not to drop O-rings from the lower cylinder block and oil pump.

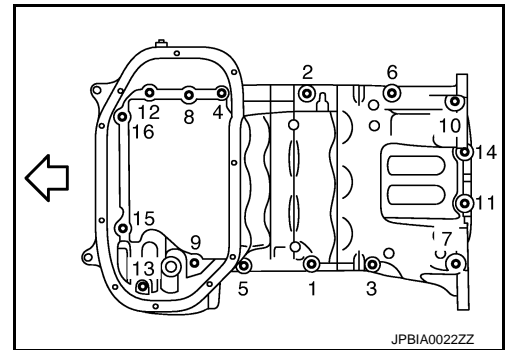
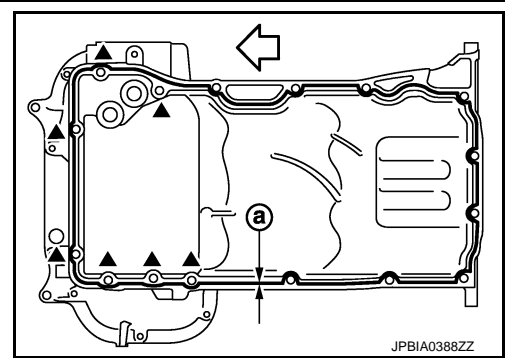
- Tighten mounting bolts in numerical order as shown in the figure.

↩ : Engine front

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

M8 × 90 mm (3.54 in) : 7, 10, 13

M8 × 25 mm (0.98 in) : Except the above



2. Install oil strainer to oil pump.
3. Install oil pan (lower). Refer to [EM-43, "Exploded View \(2WD\)"](#).
4. Install oil pan drain plug.
- Refer to the figure of components of former page for installation direction of drain plug washer. Refer to [EM-43, "Exploded View \(2WD\)"](#).

5. Install in the reverse order of removal after this step.

NOTE:

At least 30 minutes after oil pan is installed, pour engine oil.

2WD : Inspection

INFOID:000000004348896

INSPECTION AFTER REMOVAL

Clean oil strainer if any object attached.

INSPECTION AFTER INSTALLATION

1. Check the engine oil level and adjust engine oil. Refer to [LU-6, "Inspection"](#).
2. Start engine, and check there is no leakage of engine oil.
3. Stop engine and wait for 10 minutes.
4. Check the engine oil level again. Refer to [LU-6, "Inspection"](#).

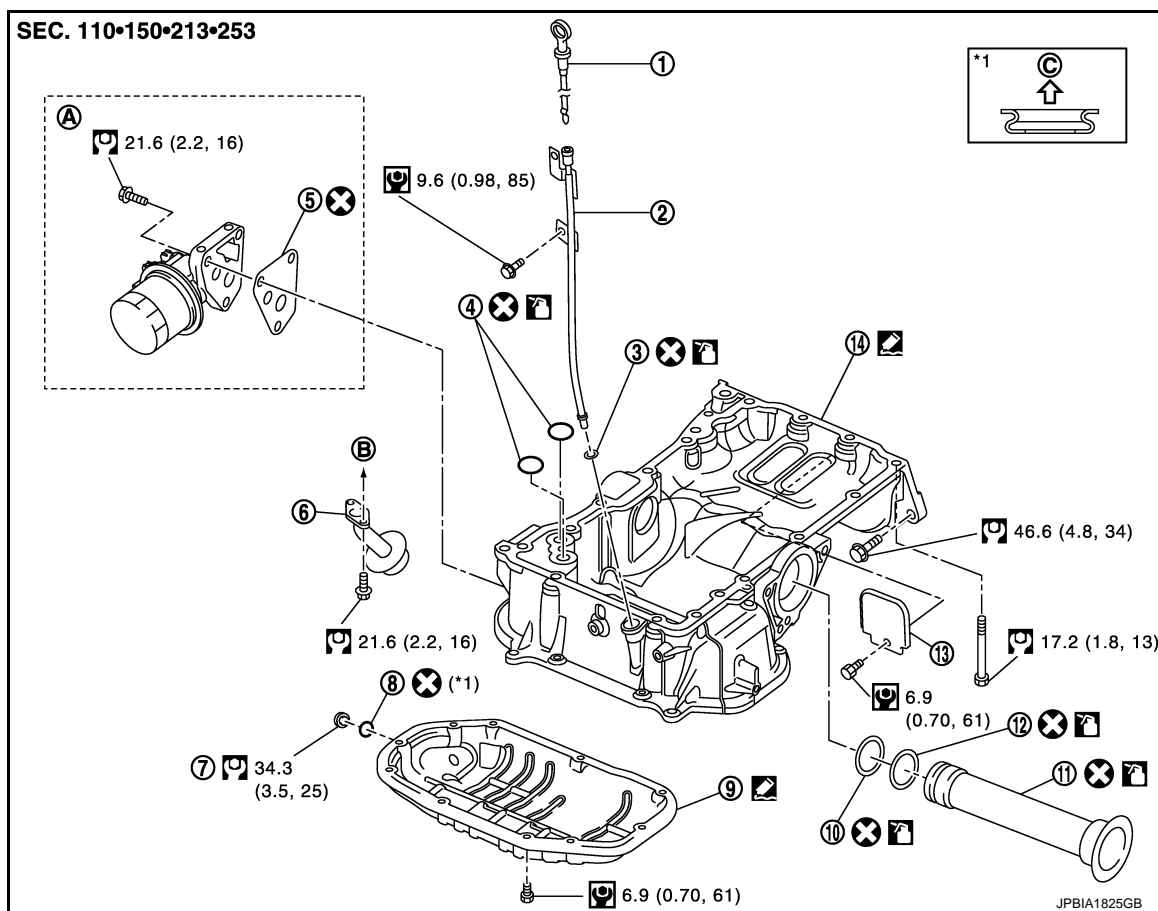
AWD

OIL PAN (UPPER) AND OIL STRAINER

< UNIT DISASSEMBLY AND ASSEMBLY >

AWD : Exploded View

INFOID:000000004348897



- | | | |
|-----------------------------------|--------------------------|--------------------|
| 1. Oil level gauge | 2. Oil level gauge guide | 3. O-ring |
| 4. O-ring | 5. Gasket | 6. Oil strainer |
| 7. Drain plug | 8. Drain plug washer | 9. Oil pan (lower) |
| 10. O-ring (small) | 11. Axle pipe | 12. O-ring (large) |
| 13. Rear plate cover | 14. Oil pan (upper) | |
| A. Refer to LU-11 | B. To oil pump | C. Oil pan side |

Refer to [GI-4, "Components"](#) for symbols in the figure.

AWD : Disassembly and Assembly

INFOID:000000004348898

REMOVAL

CAUTION:

Never drain engine oil when the engine is hot to avoid the danger of being scalded.

1. Remove oil level gauge, oil pressure switch and oil temperature sensor.
2. Remove oil filter bracket. Refer to [LU-11, "Exploded View"](#).
3. Remove oil pan (lower). Refer to [EM-44, "Exploded View \(AWD\)"](#).
4. Remove oil strainer.

OIL PAN (UPPER) AND OIL STRAINER

< UNIT DISASSEMBLY AND ASSEMBLY >

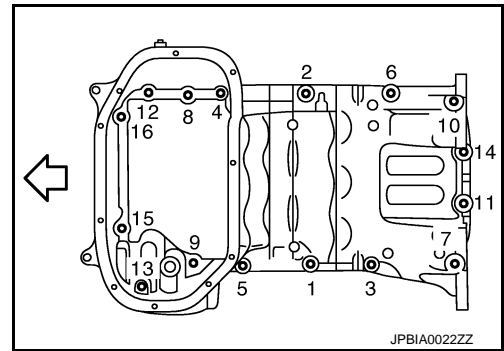
- Loosen mounting bolts in the reverse order as shown in the figure with power tool to remove.

↩ : Engine front

- Insert the seal cutter [SST: KV10111100 (J-37228)] between oil pan (upper) and lower cylinder block. Slide seal cutter by tapping on the side of tool with a hammer. Remove oil pan (upper).

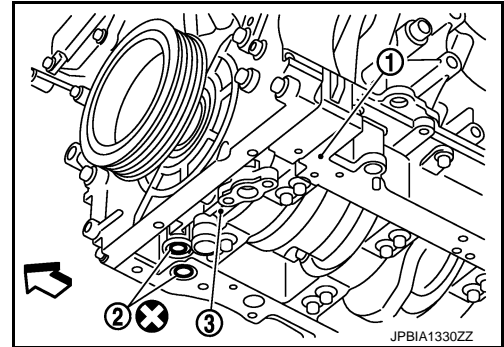
CAUTION:

- Be careful not to damage the mating surfaces.
- Never insert a screwdriver, this will damage the mating surfaces.



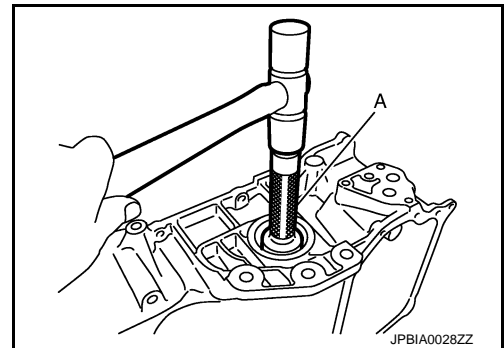
- Remove O-rings (2) from bottom of lower cylinder block (1) and oil pump (3).

↩ : Engine front



- Remove axle pipe, if necessary.

- Remove axle pipe from oil pan (upper) using a suitable drift (A) [outer diameter: 37 mm (1.46 in)].

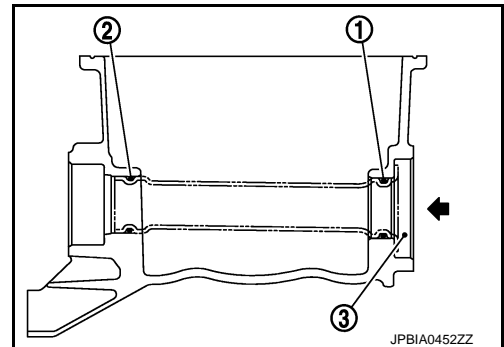


INSTALLATION

- Install axle pipe (3) to oil pan (upper), if removed.
 - Lubricate O-ring groove of axle pipe, O-rings (1), (2), and O-ring joint of oil pan with new engine oil.

Unit: mm (in)

| Items | O-ring inner diameter |
|-----------------------------------|-----------------------|
| Final drive side (right side) | 31.4 (1.236) |
| Axle pipe flange side (left side) | 33.6 (1.323) |



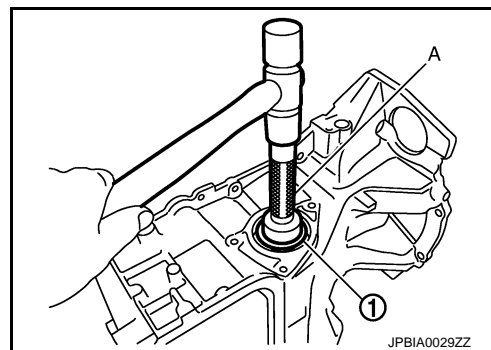
OIL PAN (UPPER) AND OIL STRAINER

< UNIT DISASSEMBLY AND ASSEMBLY >

- Install axle pipe (1) to oil pan (upper) from axle pipe flange side (left side) using a suitable drift (A) [outer diameter: 43 to 57 mm (1.69 to 2.24 in)].

CAUTION:

Insert it with care to prevent O-ring from sliding.



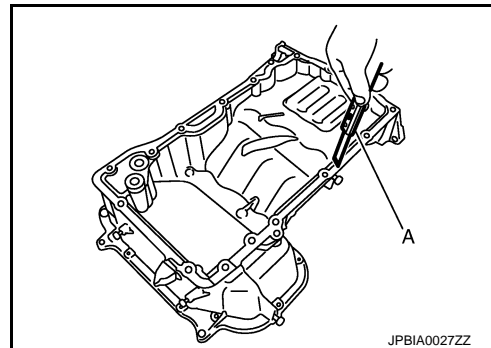
2. Install oil pan (upper) as follows:

- a. Use a scraper (A) to remove old liquid gasket from mating surfaces.

CAUTION:

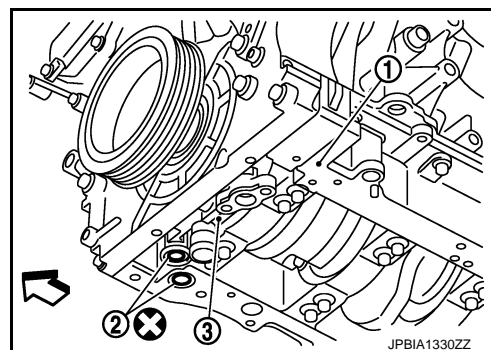
Never scratch or damage the mating surfaces when cleaning off old liquid gasket.

- Also remove old liquid gasket from mating surface of lower cylinder block.
- Remove old liquid gasket from the bolt holes and threads.



- b. Install new O-rings (2) on the bottom of lower cylinder block (1) and oil pump (3).

⇐ : Engine front



- c. Apply a continuous bead of liquid gasket with the tube presser (commercial service tool) to the cylinder block mating surface of oil pan (upper) to a limited portion as shown in the figure.

a : $\phi 4.0 - 5.0$ mm (0.157 - 0.197 in)

⇐ : Engine front

Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-17, "Recommended Chemical Products and Sealants"](#).

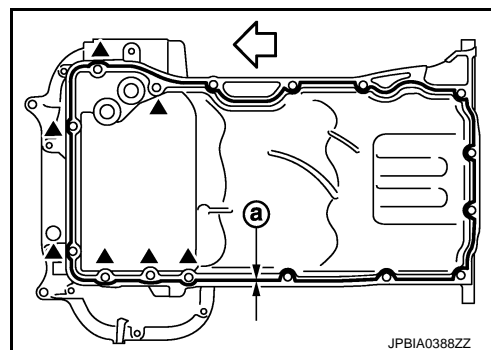
CAUTION:

- For bolt holes with ▲ marks (7 locations), apply liquid gasket outside the holes.
- Attaching should be done within 5 minutes after coating.

- d. Install oil pan (upper).

CAUTION:

Be careful not to drop O-rings from the lower cylinder block and oil pump.



OIL PAN (UPPER) AND OIL STRAINER

< UNIT DISASSEMBLY AND ASSEMBLY >

- Tighten mounting bolts in numerical order as shown in the figure.

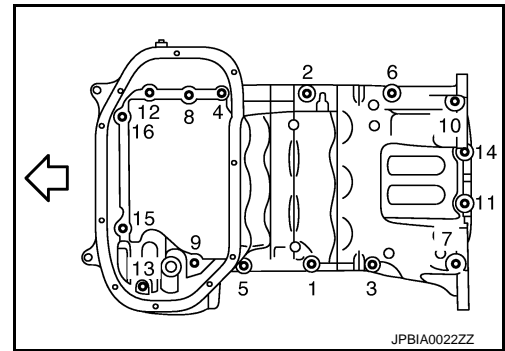
⇐ : Engine front

- There are three types of mounting bolts. Refer to the following for locating bolts.

M8 × 25 mm (0.98 in) : 3, 6, 8, 9, 11, 12, 14, 15, 16

M8 × 50 mm (1.97 in) : 2

M8 × 90 mm (3.54 in) : 1, 4, 5, 7, 10, 13



3. Install oil strainer to oil pump.
4. Install oil pan (lower). Refer to [EM-44. "Exploded View \(AWD\)"](#).
5. Install oil pan drain plug.
 - Refer to the figure of components of former page for installation direction of drain plug washer. Refer to [EM-44. "Exploded View \(AWD\)"](#).
6. Install in the reverse order of removal after this step.

NOTE:

At least 30 minutes after oil pan is installed, pour engine oil.

AWD : Inspection

INFOID:000000004348899

INSPECTION AFTER REMOVAL

Clean oil strainer if any object attached.

INSPECTION AFTER INSTALLATION

1. Check the engine oil level and adjust engine oil. Refer to [LU-6. "Inspection"](#).
2. Start engine, and check there is no leakage of engine oil.
3. Stop engine and wait for 10 minutes.
4. Check the engine oil level again. Refer to [LU-6. "Inspection"](#).

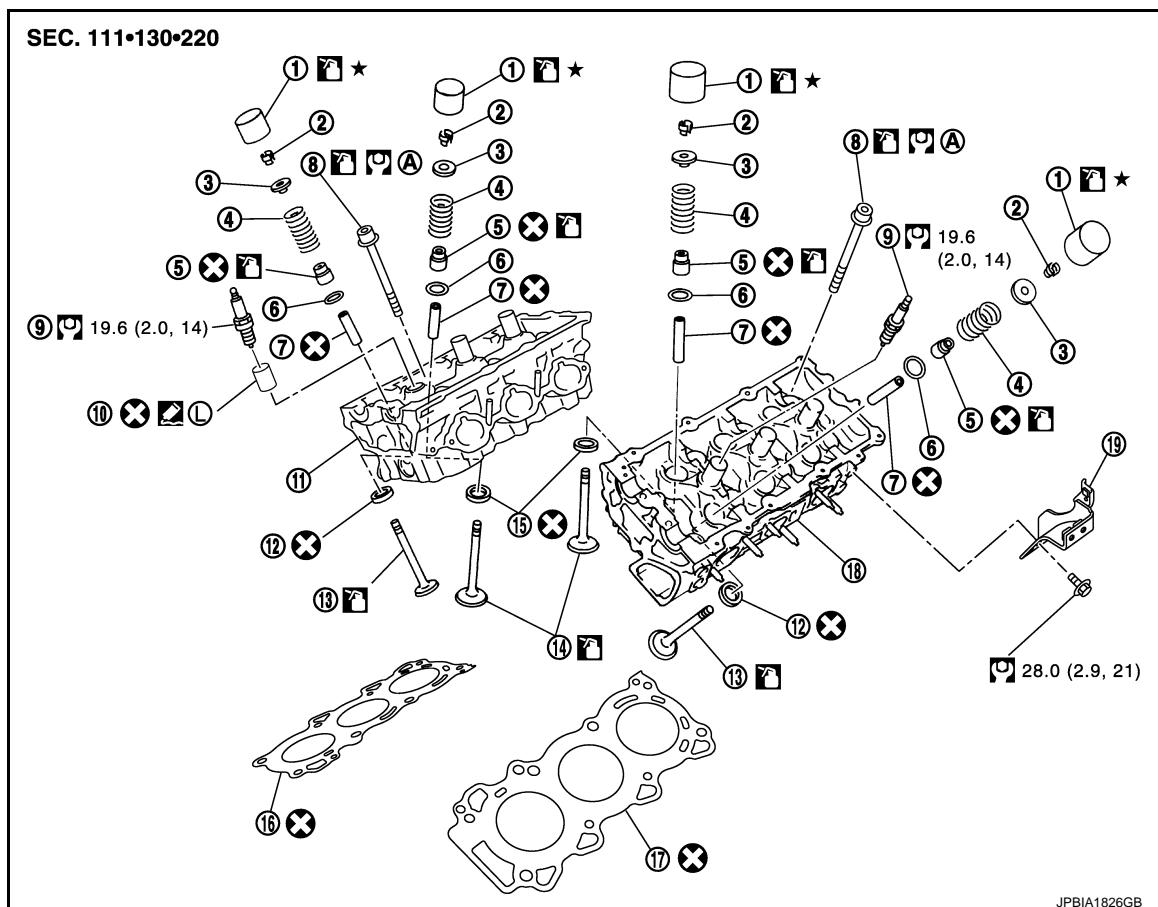
CYLINDER HEAD

< UNIT DISASSEMBLY AND ASSEMBLY >

CYLINDER HEAD

Exploded View

INFOID:000000004348900



- | | | |
|-----------------------------------|-----------------------------------|----------------------------|
| 1. Valve lifter | 2. Valve collet | 3. Valve spring retainer |
| 4. Valve spring | 5. Valve oil seal | 6. Valve spring seat |
| 7. Valve guide | 8. Cylinder head bolt | 9. Spark plug |
| 10. Spark plug tube | 11. Cylinder head (bank 1) | 12. Valve seat (EXH) |
| 13. Valve (INT) | 14. Valve (EXH) | 15. Valve seat (EXH) |
| 16. Cylinder head gasket (bank 1) | 17. Cylinder head gasket (bank 2) | 18. Cylinder head (bank 2) |
| 19. Engine rear lower slinger | | |

A. Refer to [EM-104](#)

: Apply high strength thread locking sealant or equivalent.

Refer to [GI-4, "Components"](#) for symbols not described on the above.

Disassembly and Assembly

INFOID:000000004348901

DISASSEMBLY

- Remove the following parts:
 - Intake manifold collector: Refer to [EM-29, "Exploded View"](#).
 - Fuel tube and fuel injector assembly: Refer to [EM-37, "Exploded View"](#).
 - Intake manifold: Refer to [EM-32, "Exploded View"](#).
 - Rocker cover and spark plug: Refer to [EM-47, "Exploded View"](#).
 - Exhaust manifold: Refer to [EM-34, "Exploded View"](#).
 - Water inlet and thermostat assembly: Refer to [CO-20, "Exploded View"](#).
 - Water outlets (front and rear), water pipe and heater pipe: Refer to [CO-22, "Exploded View"](#).
 - Timing chain: Refer to [EM-50, "Exploded View"](#).

CYLINDER HEAD

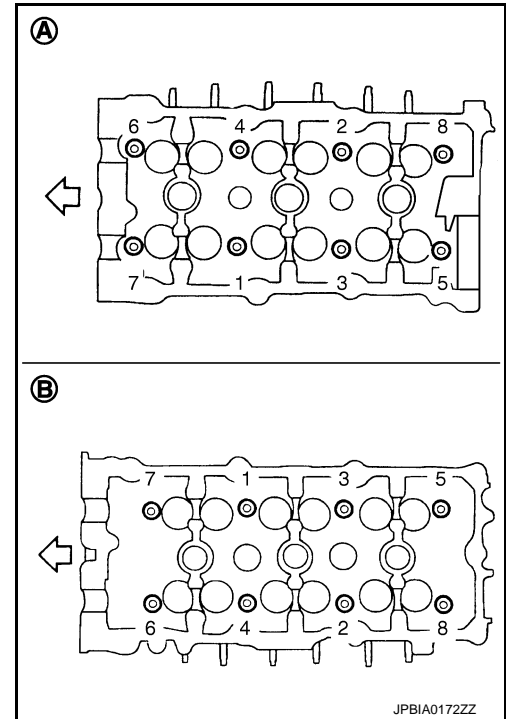
< UNIT DISASSEMBLY AND ASSEMBLY >

- Rear timing chain case: Refer to [EM-92. "Exploded View"](#).
- Camshaft: Refer to [EM-67. "Exploded View"](#).

2. Remove cylinder head.

- Loosen cylinder head bolts in reverse order as shown in the figure with cylinder head bolt wrench (commercial service tool) and power tool.

A : Bank 1
B : Bank 2
← : Engine front



3. Remove cylinder head gaskets.

4. Remove valve lifter.

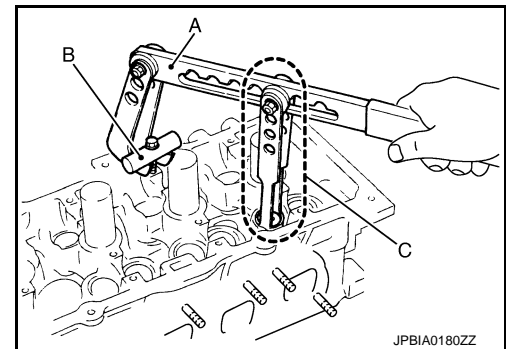
- Identify installation positions, and store them without mixing them up.

5. Remove valve collet.

- Compress valve spring with the valve spring compressor [SST: KV10116200 (J-26336-A)] (A), the attachment [SST: KV10115900 (J-26336-20)] (C) and the adapter [SST: KV10109220 (—)] (B). Remove valve collet with a magnet hand.

CAUTION:

When working, take care not to damage valve lifter holes.

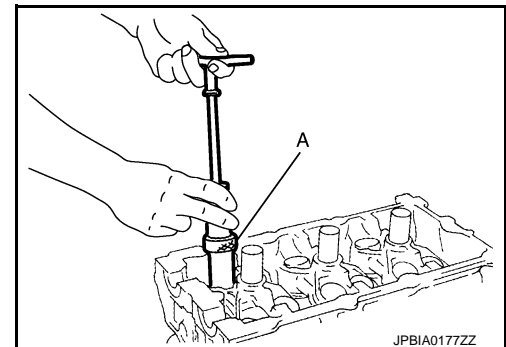


6. Remove valve spring retainer, valve spring and valve spring seat.

7. Push valve stem to combustion chamber side, and remove valve.

- Identify installation positions, and store them without mixing them up.

8. Remove valve oil seal using the valve oil seal puller [SST: KV10107902 (J-38959)] (A).



9. Remove valve seat, if valve seat must be replaced.

CYLINDER HEAD

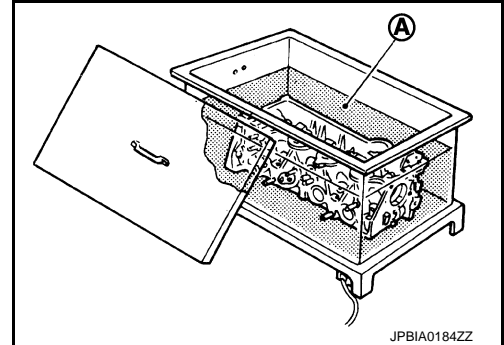
< UNIT DISASSEMBLY AND ASSEMBLY >

- Bore out old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in cylinder head. Set the machine depth stop to ensure this. Refer to [EM-142, "Cylinder Head"](#).

CAUTION:

Prevent to scratch cylinder head by excessive boring.

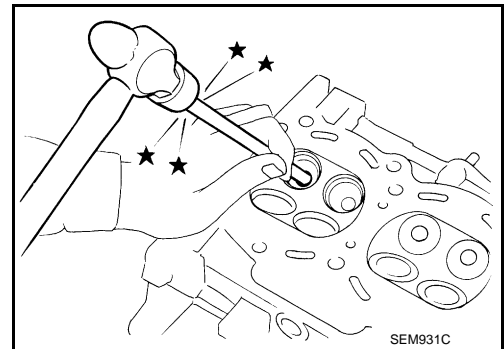
10. Remove valve guide, if valve guide must be replaced.
 - a. To remove valve guide, heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil (A).



- b. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or a hammer and the valve guide drift (commercial service tool).

WARNING:

Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.



11. Remove spark plug tube, if necessary.
 - Using a pliers, pull spark plug tube out of cylinder head.

CAUTION:

- Take care not to damage cylinder head.
- Once removed, spark plug tube will be deformed and cannot be reused. Never remove it unless absolutely necessary.

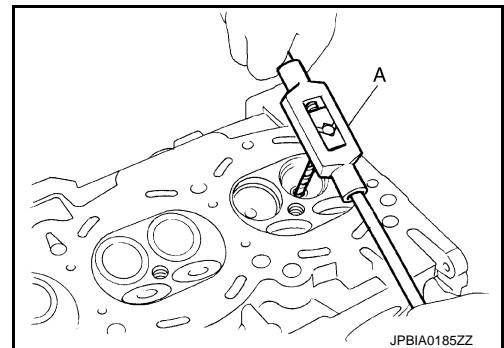
ASSEMBLY

1. If valve guide is removed in step 10 (DISASSEMBLY), install it.
Replace with oversized [0.2 mm (0.008 in)] valve guide.
 - a. Using the valve guide reamer (commercial service tool) (A), ream cylinder head valve guide hole.

Valve guide hole diameter (for service parts):

Intake and exhaust

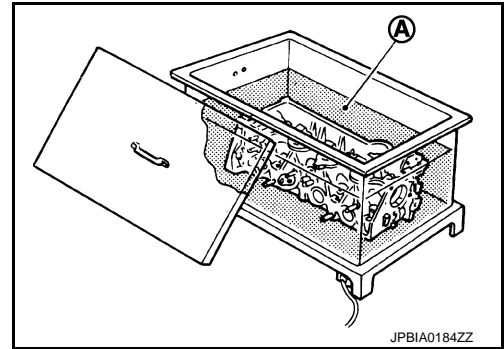
: Refer to [EM-142, "Cylinder Head"](#).



CYLINDER HEAD

< UNIT DISASSEMBLY AND ASSEMBLY >

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



- c. Using the valve guide drift (commercial service tool), press valve guide from camshaft side to the dimensions as shown in the figure.

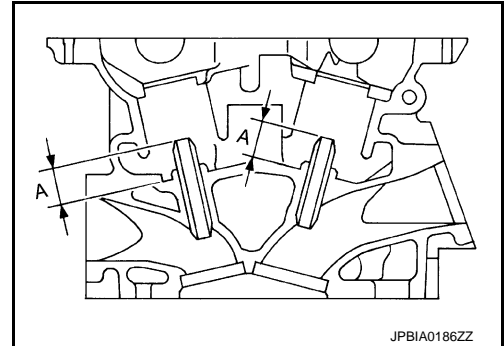
Projection (A)

Intake and exhaust

: Refer to [EM-142, "Cylinder Head"](#).

WARNING:

Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.



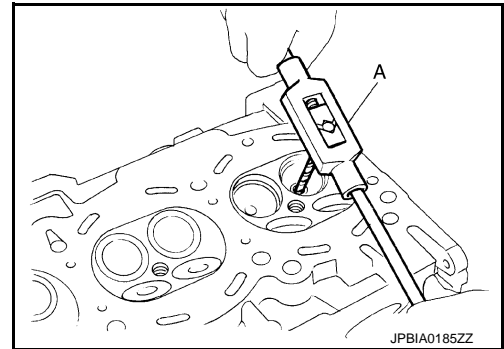
- d. Using the valve guide reamer (commercial service tool) (A), apply reamer finish to valve guide.

Standard

: Refer to [EM-142,](#)

(Intake and exhaust)

["Cylinder Head"](#).



2. If valve seat is removed in step 9 (DISASSEMBLY), install it. Replace with oversize [0.5 mm (0.020 in)] valve seat.
- a. Ream cylinder head recess diameter (a) for service valve seat.

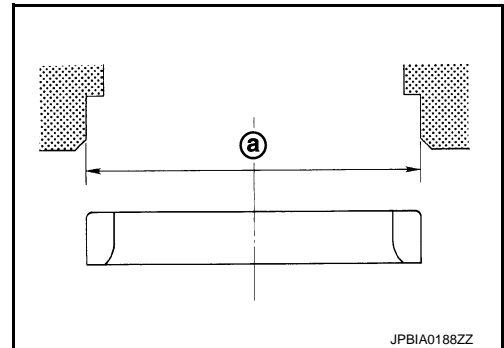
Oversize

: Refer to [EM-142,](#)

(Intake and exhaust)

["Cylinder Head"](#).

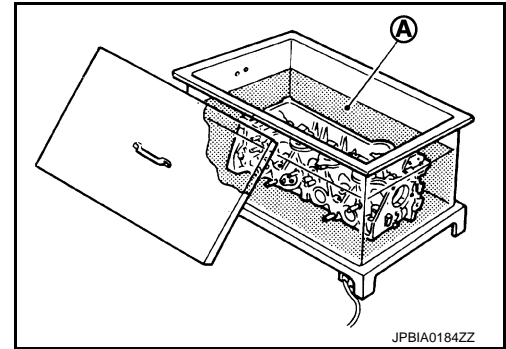
- Be sure to ream in circles concentric to valve guide center. This will enable valve to fit correctly.



CYLINDER HEAD

< UNIT DISASSEMBLY AND ASSEMBLY >

- 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. Force fit valve seat into cylinder head.

WARNING:

Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.

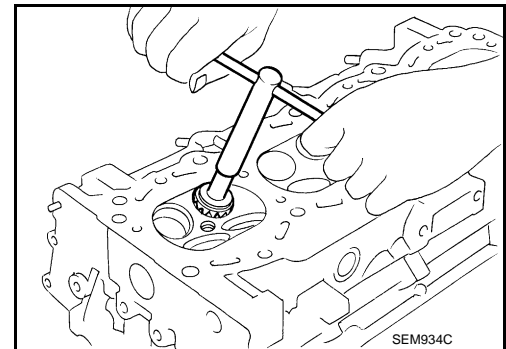
CAUTION:

Never directly touching cold valve seats.

- d. Using the valve seat cutter set (commercial service tool) or valve seat grinder, finish seat to the specified dimensions. Refer to [EM-142, "Cylinder Head"](#).

CAUTION:

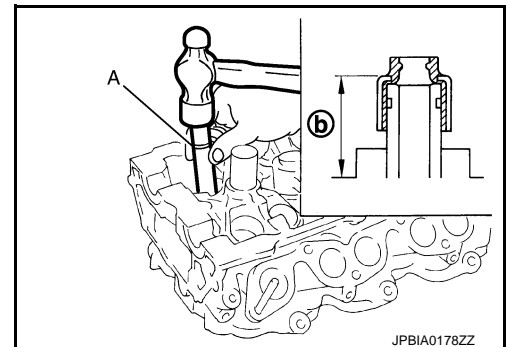
When using the valve seat cutter, firmly grip cutter handle with both hands. Then, press on the contacting surface all around the circumference to cut in a single drive. Improper pressure on with cutter or cutting many different times may result in stage valve seat.



- e. Using compound, grind to adjust valve fitting.
f. Check again for normal contact. Refer to "VALVE SEAT CONTACT".
3. Install new valve oil seals as follows:
a. Apply new engine oil on valve oil seal joint and seal lip.
b. Install with the valve oil seal drift [SST: KV10115600 (J-38958)] (A) to match dimension in the figure.

Height (b) (Without valve spring seat installed)

Intake and exhaust : 14.3 - 14.9 mm (0.563 - 0.587 in)



4. Install valve spring seat.
5. Install valve.
NOTE:
Larger diameter valves are for intake side.
6. Install valve spring (uneven pitch type).

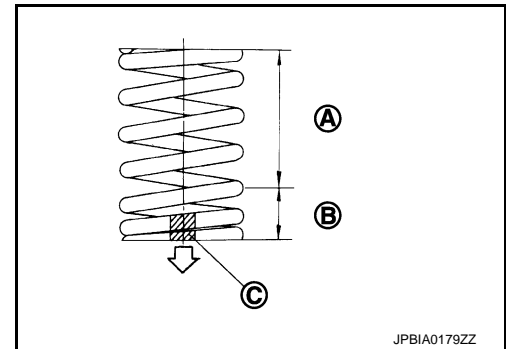
CYLINDER HEAD

< UNIT DISASSEMBLY AND ASSEMBLY >

- Install narrow pitch end to cylinder head side (valve spring seat side).

A : Wide pitch
 B : Narrow pitch
 C : Paint mark
 ⇐ : Cylinder head side

Paint mark color : Yellowish green



7. Install valve spring retainer.

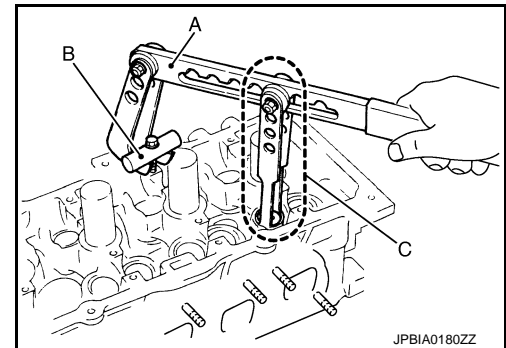
8. Install valve collet.

- Compress valve spring with the valve spring compressor [SST: KV10116200 (J-26336-A)] (A), the attachment [SST: KV10115900 (J-26336-20)] (C) and the adapter [SST: KV10116200 (—)] (B). Install valve collet with a magnet hand.

CAUTION:

When working, take care not to damage valve lifter holes.

- Tap valve stem edge lightly with plastic hammer after installation to check its installed condition.

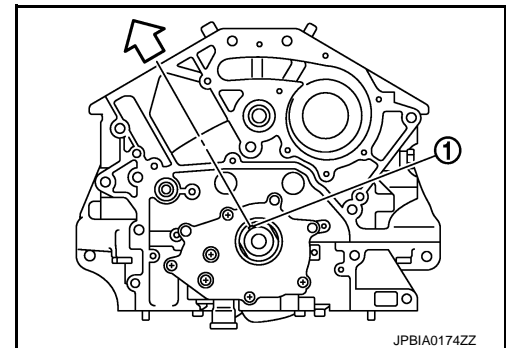


9. Install new cylinder head gaskets.

10. Turn crankshaft until No. 1 piston is set at TDC.

1 : Crankshaft key
 ⇐ : Bank 1 side


- Crankshaft key should line up with the bank 1 cylinder center line as shown in the figure.



CYLINDER HEAD

< UNIT DISASSEMBLY AND ASSEMBLY >

11. Install cylinder head follow the steps below to tighten cylinder head bolts in numerical order as shown in the figure with cylinder head bolts wrench (commercial service tool).

A : Bank 1
 B : Bank 2
 : Engine front

CAUTION:

- If cylinder head bolts reused, check their outer diameters before installation. Refer to [EM-111, "Inspection"](#).
- Before installing cylinder head, inspect cylinder head distortion. Refer to [EM-111, "Inspection"](#).

- Apply new engine oil to threads and seat surfaces of cylinder head bolts.
- Tighten all cylinder head bolts.

: 105 N·m (11 kg·m, 77 ft·lb)

- Completely loosen all cylinder head bolts.

: 0 N·m (0 kg·m, 0 ft·lb)

CAUTION:

In step "c", loosen bolts in reverse order of that indicated in the figure.

- Tighten all cylinder head bolts.

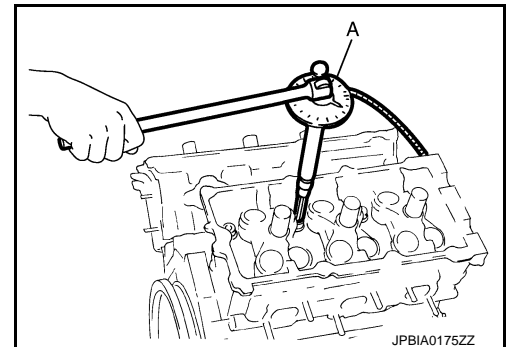
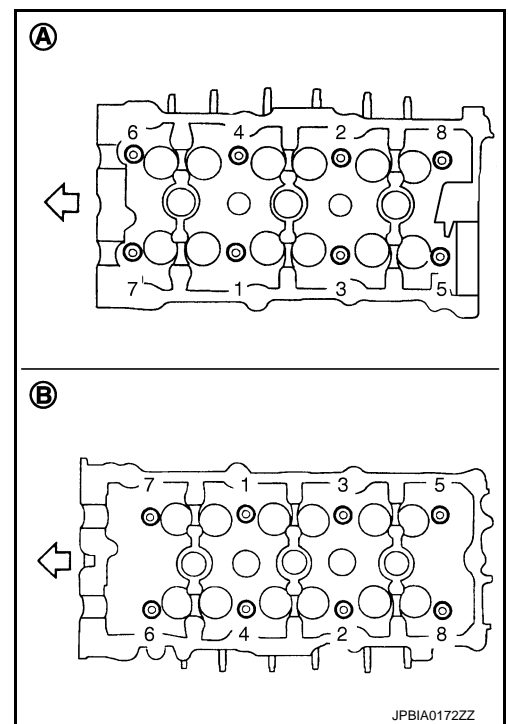
: 40.0 N·m (4.1 kg·m, 30 ft·lb)

- Turn all cylinder head bolts 95 degrees clockwise (angle tightening).

CAUTION:

Check the tightening angle by using the angle wrench [SST: KV10112100 (BT8653-A)] (A). Never make judgment by visual inspection.

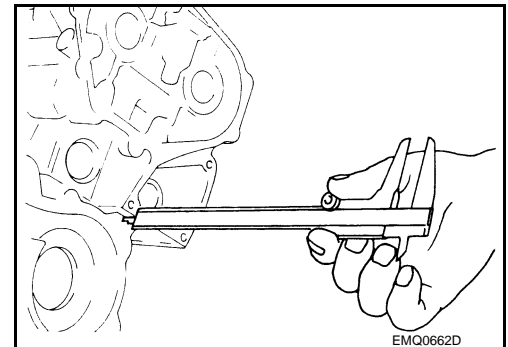
- Check tightening angle indicated on the angle wrench indicator plate.
- Turn all cylinder head bolts 95 degrees clockwise again (angle tightening).



12. After installing cylinder head, measure distance between front end faces of cylinder block and cylinder head (bank 1 and bank 2).

Standard : 14.1 - 14.9 mm (0.555 - 0.587 in)

- If measured value is out of the standard, reinstall cylinder head.



- Install valve lifter.
 - Install it in the original position.
- Install spark plug tube.
 - Press-fit spark plug tube as follows:

CYLINDER HEAD

< UNIT DISASSEMBLY AND ASSEMBLY >

- Remove old locking sealant adhering to cylinder head mounting hole.
- Apply sealant to area within approximately 12 mm (0.47 in) from edge of spark plug tube press-fit side.
Use genuine high strength thread locking sealant or equivalent. Refer to [GI-17, "Recommended Chemical Products and Sealants"](#).
- Using drift, press-fit spark plug tube so that its height (A) is as specified in the figure.

B : High strength thread locking sealant application area

Standard press-fit height:

: 37.7 - 38.7 mm (1.484 - 1.524 in)

CAUTION:

- When press-fitting, take care not to deform spark plug tube.
- After press-fitting, wipe off liquid gasket protruding onto cylinder-head upper face.

15. Install spark plug with spark plug wrench (commercial service tool).

16. Install in the reverse order of removal after this step.

Inspection

INFOID:000000004348902

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 new one.

Limit [(C) - (B)] : 0.18 mm (0.0071 in)

A : Measuring point
e : 48 mm (1.89 in)
d : 11 mm (0.43 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 checking. Refer to [EM-144, "Cylinder Block"](#).

- Using a scraper, wipe off oil, scale, gasket, sealant and carbon deposits from surface of cylinder head.

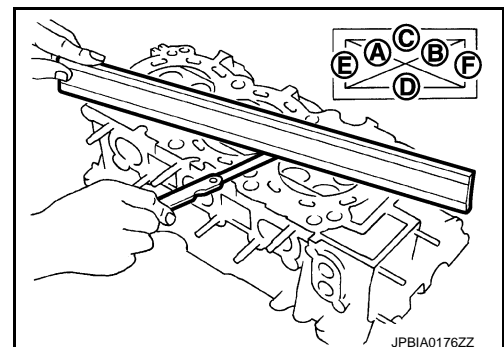
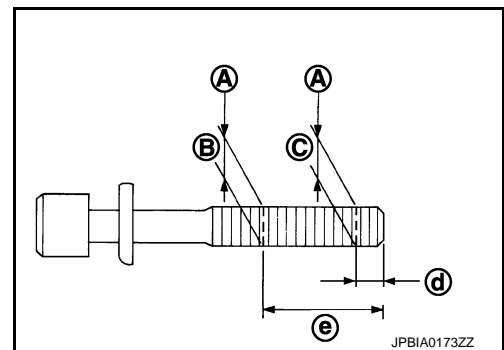
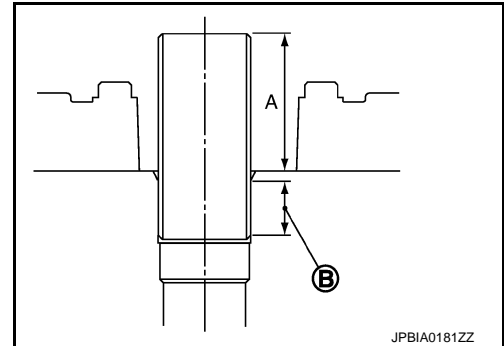
CAUTION:

Never allow gasket fragments to enter engine oil or engine coolant passages.

- At each of several locations on bottom surface of cylinder head, measure the distortion in six directions (A), (B), (C), (D), (E), and (F).

Limit : Refer to [EM-142, "Cylinder Head"](#).

- If it exceeds the limit, replace cylinder head.



INSPECTION AFTER DISASSEMBLY

Valve Dimensions

CYLINDER HEAD

< UNIT DISASSEMBLY AND ASSEMBLY >

- Check the dimensions of each valve. For the dimensions, refer to [EM-142, "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 micrometer (A).

Standard : Refer to [EM-142, "Cylinder Head"](#).
(Intake and exhaust)

Valve Guide Inner Diameter

- Measure the inner diameter of valve guide with bore gauge.

Standard : Refer to [EM-142, "Cylinder Head"](#).
(Intake and exhaust)

Valve Guide Clearance

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

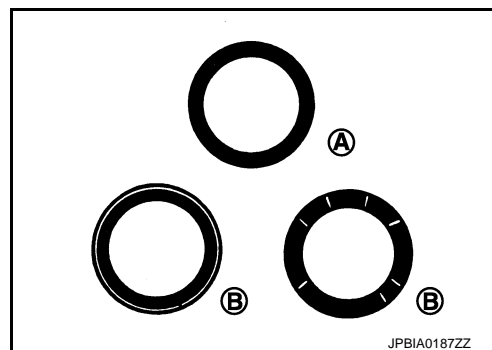
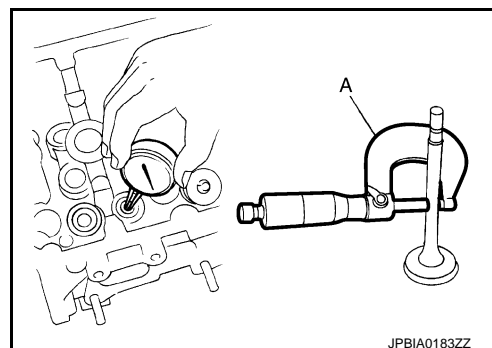
Valve guide clearance : Refer to [EM-142, "Cylinder Head"](#).
Standard and limit (Intake and exhaust)

- If the calculated value exceeds the limit, replace valve and/or valve guide. When valve guide must be replaced, refer to [EM-104, "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.
- If not, grind to adjust valve fitting and check again. If the contacting surface still has "NG" (B) conditions even after the recheck, replace valve seat. Refer to [EM-104, "Disassembly and Assembly"](#).

A : OK



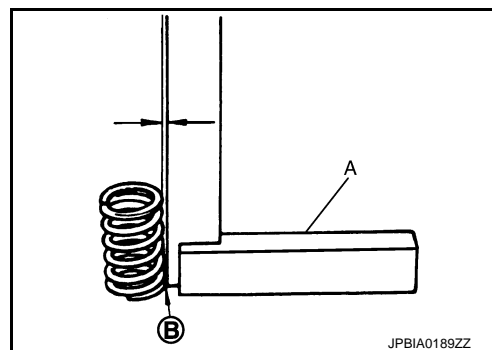
Valve Spring Squareness

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

B : Contact

Limit : Refer to [EM-142, "Cylinder Head"](#).

- If it exceeds the limit, replace valve spring.



Valve Spring Dimensions and Valve Spring Pressure Load

CYLINDER HEAD

< UNIT DISASSEMBLY AND ASSEMBLY >

- Check the valve spring pressure at specified spring height.

Standard (Intake and exhaust)

Free height

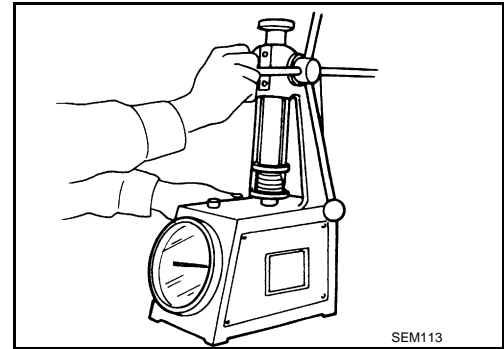
Installation height

Installation load

Height during valve open

Load with valve open

: Refer to [EM-142](#).
["Cylinder Head"](#).



SEM113

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

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-10. "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.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to check there is no leakage of fuel, exhaust gases, 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 |
| Other oils and fluid* | Level | Leakage | Level |
| Fuel | Leakage | Leakage | Leakage |
| Exhaust gases | — | Leakage | — |

*: Transmission/transaxle/CVT fluid, power steering fluid, brake fluid, etc.

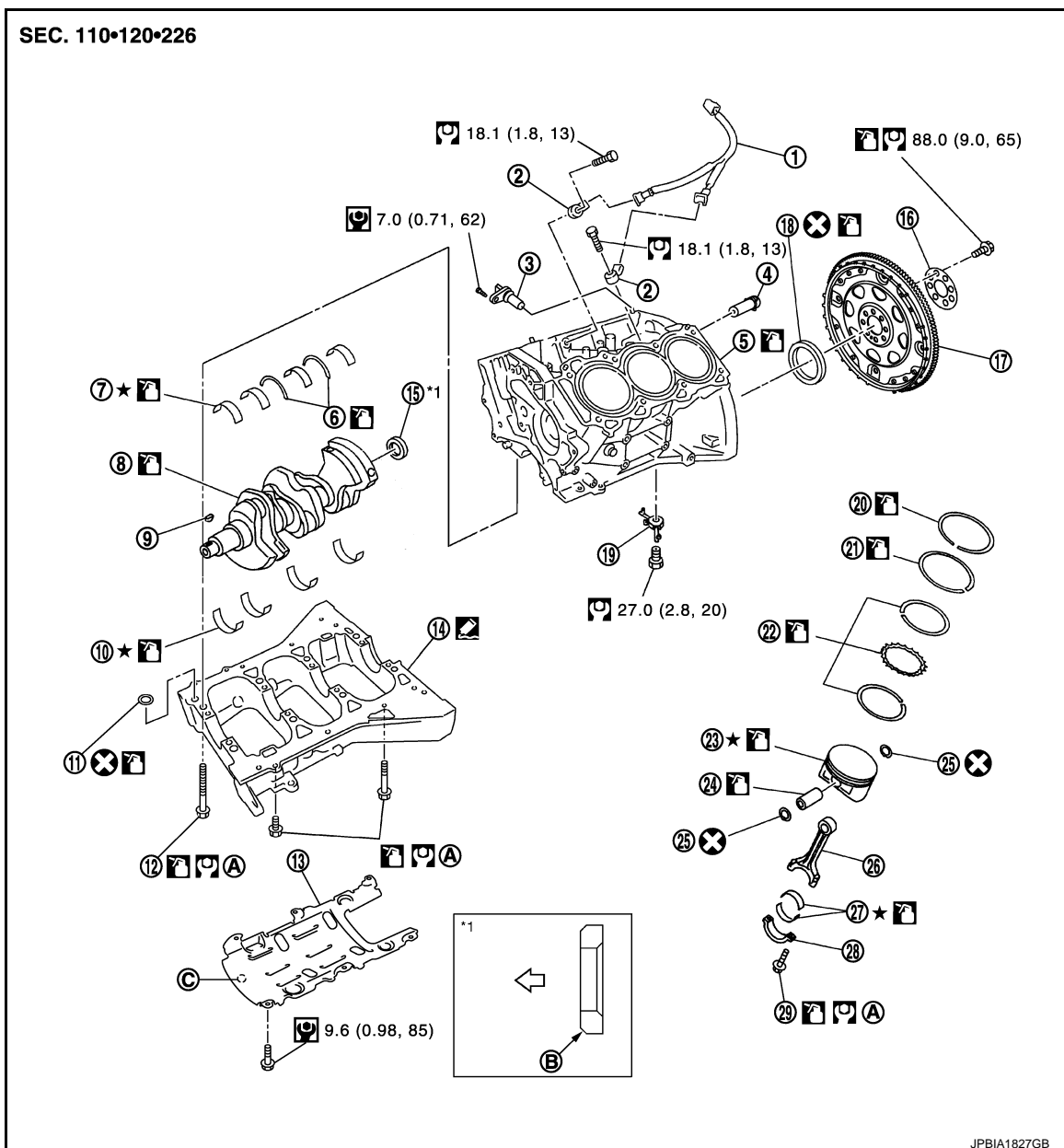
CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

CYLINDER BLOCK

Exploded View

INFOID:000000004348903



- | | | |
|---------------------------------------|--------------------------|-------------------------------|
| 1. Sub harness | 2. Knock sensor | 3. Crankshaft position sensor |
| 4. Cylinder block heater (for Canada) | 5. Cylinder block | 6. Thrust bearing |
| 7. Main bearing (upper) | 8. Crankshaft | 9. Crankshaft key |
| 10. Main bearing (lower) | 11. O-ring | 12. Lower cylinder block bolt |
| 13. Baffle plate | 14. Lower cylinder block | 15. Pilot converter |
| 16. Reinforcement plate | 17. Drive plate | 18. Rear oil seal |
| 19. Oil jet | 20. Top ring | 21. Second ring |
| 22. Oil ring | 23. Piston | 24. Piston pin |
| 25. Snap ring | 26. Connecting rod | 27. Connecting rod bearing |
| 28. Connecting rod bearing cap | 29. Connecting rod bolt | |
| A. Refer to EM-115 | B. Chamfered | C. Front mark |

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

↩ : Crankshaft side

Refer to [GI-4, "Components"](#) for symbols in the figure.

Disassembly and Assembly

INFOID:000000004348904

A

EM

DISASSEMBLY

1. Remove the following parts:
 - Oil pans (lower and upper): Refer to [EM-97, "2WD : Exploded View"](#) (2WD models) or [EM-100, "AWD : Exploded View"](#) (AWD models).
 - Front and rear timing chain case: Refer to [EM-50, "Exploded View"](#) and [EM-92, "Exploded View"](#).
 - Cylinder head: Refer to [EM-104, "Exploded View"](#).
2. Remove knock sensor.
CAUTION:
Carefully handle sensor avoiding shocks.
3. Remove baffle plate from lower cylinder block.
4. Remove piston and connecting rod assembly with the following procedure:
 - Before removing piston and connecting rod assembly, check the connecting rod side clearance. Refer to [EM-144, "Cylinder Block"](#).

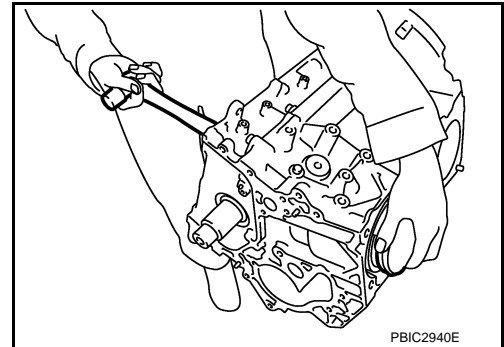
CAUTION:

Be careful not to drop connecting rod bearing, and to scratch the surface.

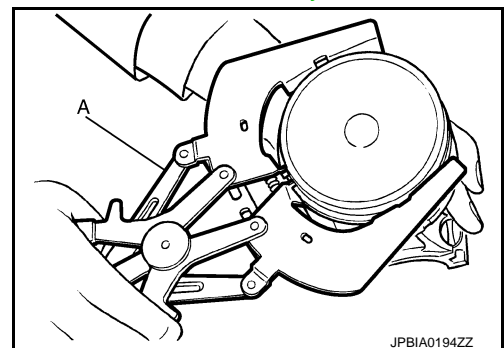
- a. Position crankshaft pin corresponding to connecting rod to be removed onto the bottom dead center.
- b. Remove connecting rod bearing cap.
- c. Using a hammer handle or similar tool, push piston and connecting rod assembly out to the cylinder head side.

CAUTION:

Be careful not to damage the cylinder wall and crankshaft pin, resulting from an interference of the connecting rod big end.



5. Remove connecting rod bearings from connecting rod and connecting rod bearing cap.
CAUTION:
 - **Be careful not to drop connecting rod bearing, and to scratch the surface.**
 - **Identify installation positions, and store them without mixing them up.**
6. Remove piston rings from piston.
 - Before removing piston rings, check the piston ring side clearance. Refer to [EM-144, "Cylinder Block"](#).
 - Use a piston ring expander (commercial service tool) (A).
CAUTION:
 - **When removing piston rings, be careful not to damage piston.**
 - **Be careful not to damage piston rings by expanding them excessively.**

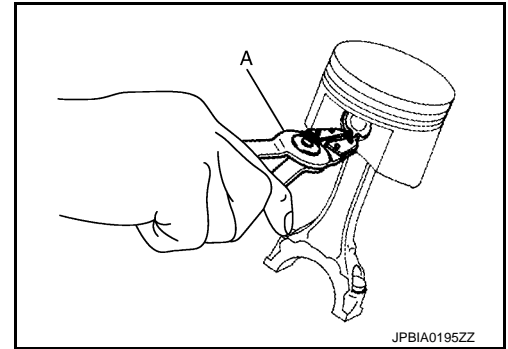


7. Remove piston from connecting rod as follows:

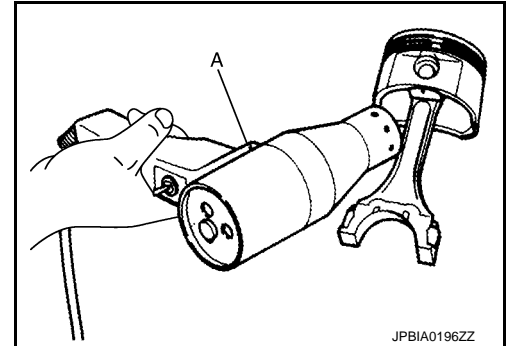
CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

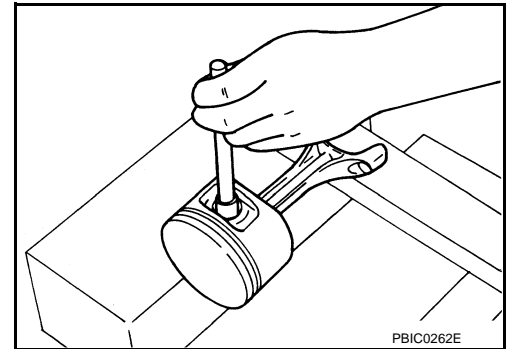
- a. Using a snap ring pliers (A), remove snap rings.



- b. Heat piston to 60 to 70°C (140 to 158°F) with an industrial use drier (A) or equivalent.

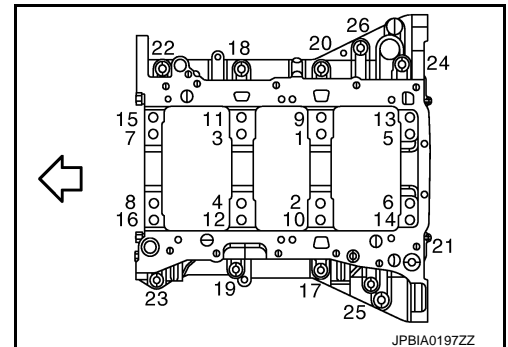


- c. Push out piston pin with stick of outer diameter approximately 20 mm (0.79 in).



8. Remove lower cylinder block bolts.
- Before loosening lower cylinder block bolts, measure the crankshaft end play. Refer to [EM-144](#), "[Cylinder Block](#)".
 - Loosen lower cylinder block bolts in the reverse order shown in the figure in several different steps.

← : Engine front



9. Remove lower cylinder block as follows:

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

Screw M8 bolt [pitch: 1.25 mm (0.0492 in) length: approximately 50 mm (1.97 in)] into bolt holes (A). Then equally tighten each bolt, and remove lower cylinder block.

← : Engine front

CAUTION:

- Be careful not to damage the mounting surfaces.
- Never tighten bolts too much.
- Never insert screw driver, this will damage the mating surface.

10. Remove crankshaft.

11. Pull rear oil seal out from rear end of crankshaft.

12. Remove main bearings and thrust bearings from cylinder block and lower cylinder block.

CAUTION:

- Be careful not to drop main bearing, and to scratch the surface.
- Identify installation positions, and store them without mixing them up.

13. Remove oil jet.

ASSEMBLY

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

CAUTION:

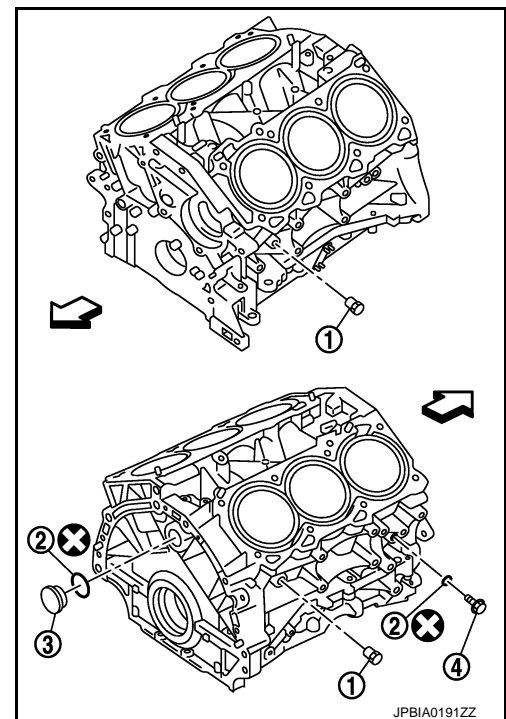
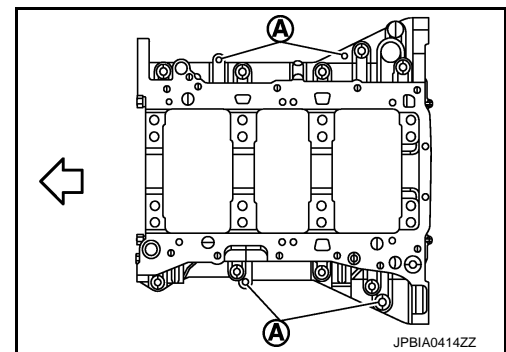
Use a goggles to protect your eye.

2. Install each plug to cylinder block as shown in the figure.

3 : Plug

← : Engine front

- Apply sealant to the thread of water drain plugs (1), (4).
Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-17, "Recommended Chemical Products and Sealants"](#).
- Apply sealant to the thread of plugs.
Use Genuine high strength thread locking sealant or equivalent. Refer to [GI-17, "Recommended Chemical Products and Sealants"](#).
- Replace washers (2) with new one.



- Tighten each plug as specified below.

| Part | Washer | Tightening torque |
|------|--------|-------------------------------|
| 1 | No | 19.6 N·m (2.0 kg-m, 14 ft-lb) |
| 3 | Yes | 78.0 N·m (8.0 kg-m, 58 ft-lb) |
| 4 | Yes | 12.3 N·m (1.3 kg-m, 9 ft-lb) |

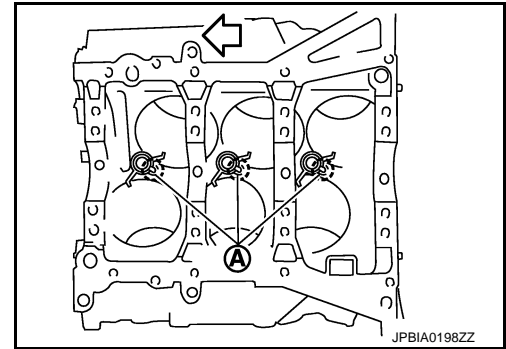
3. Install oil jet.

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- Insert oil jet dowel pin (A) into cylinder block dowel pin hole, and tighten mounting bolts.

↶ : Engine front



4. Install main bearings and thrust bearings as follows:

CAUTION:

Be careful not to drop main bearing, and to scratch the surface.

- Remove dust, dirt, and engine oil on bearing mating surfaces of cylinder block and lower cylinder block.
- Install thrust bearings (1) to the both sides of the No. 3 journal housing on cylinder block.

A : No. 1

B : No. 2

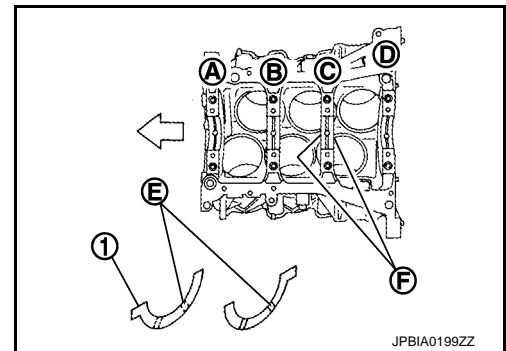
C : No. 3

D : No. 4

F : Thrust bearing installation position

↶ : Engine front

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



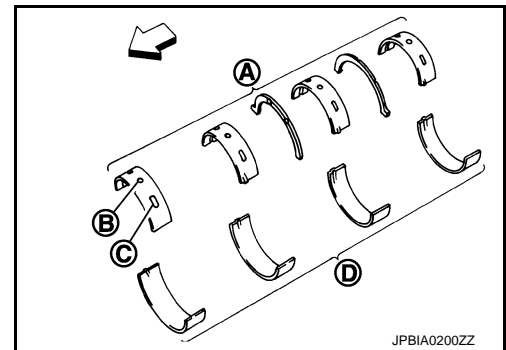
- Install main bearings paying attention to the direction.

A : Cylinder block side

D : Lower cylinder block side

↶ : Engine front

- Main bearing with oil hole (B) and groove (C) goes on cylinder block. The one without them goes on lower cylinder block.
- Before installing main bearings, apply engine oil to the bearing surface (inside). Do not apply engine oil to the back surface, but thoroughly clean it.
- When installing, align main bearing stopper protrusion to cut-out of cylinder block and lower cylinder block.
- Ensure the oil holes on cylinder block and those on the corresponding bearing are aligned.



5. Install crankshaft to cylinder block.
 - While turning crankshaft by hand, check that it turns smoothly.
6. Install lower cylinder block.

NOTE:

Lower cylinder block cannot be replaced as a single part, because it is machined together with cylinder block.

CYLINDER BLOCK

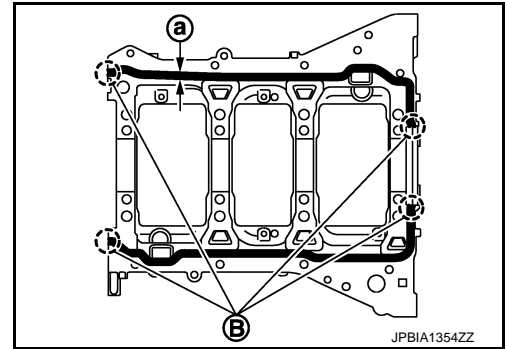
< UNIT DISASSEMBLY AND ASSEMBLY >

- Apply a continuous bead of liquid gasket with the tube presser (commercial service tool) to lower cylinder block as shown in the figure.

B : Apply to end

a : $\phi 4.0 - 5.0$ mm (0.157 - 0.197 in)

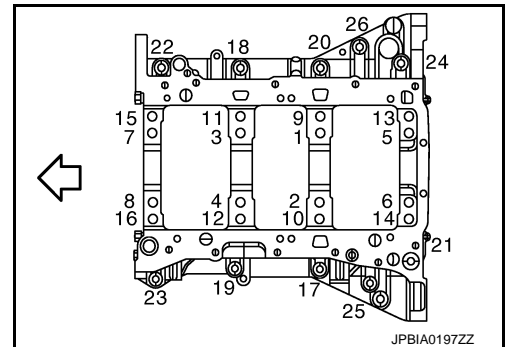
Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-17, "Recommended Chemical Products and Sealants"](#).



7. Inspect the outer diameter of lower cylinder block bolt. Refer to [EM-123, "Inspection"](#).
8. Install lower cylinder block bolts in numerical order as shown in the figure as follows:
 - a. Apply new engine oil to threads and seat surfaces of lower cylinder block bolts.
 - b. Tighten lower cylinder block bolts (No. 17 to 26) in numerical order as shown in the figure.

← : Engine front

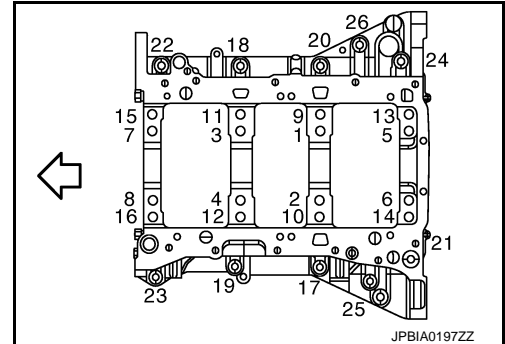
: **25.0 N·m (2.6 kg-m, 18 ft-lb)**



- c. Repeat step b.
- d. Tighten lower cylinder block bolt (No. 1 to 16) in numerical order as shown in the figure.

← : Engine front

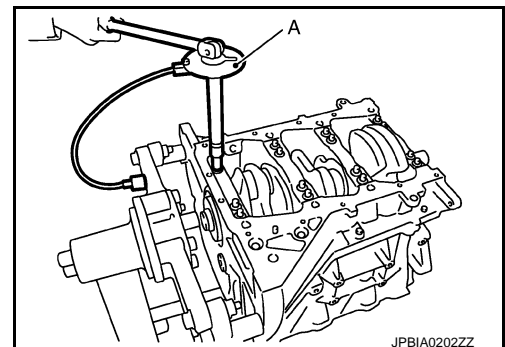
: **35.3 N·m (3.6 kg-m, 26 ft-lb)**



- e. Turn lower cylinder block bolt (No. 1 to 16) 90 degrees clockwise (angle tightening).

CAUTION:

Use the angle wrench [SST: KV10112100 (BT8653-A)] (A) to check tightening angle. Never make judgment by visual inspection.



- After installing lower cylinder block bolts, check that crankshaft can be rotated smoothly by hand.
- Check the crankshaft end play. Refer to [EM-144, "Cylinder Block"](#).

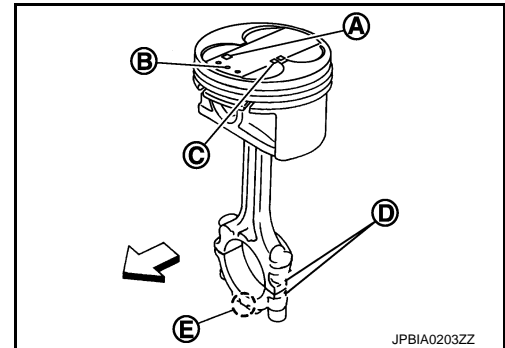
9. Install piston to connecting rod as follows:
 - a. Using a snap ring pliers, install new snap ring to the groove of piston rear side.

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- Insert it fully into groove to install.
- b. Install piston to connecting rod.
 - Using an industrial use drier or similar tool, heat piston until 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 on the piston head and the cylinder number on connecting rod are positioned as shown in the figure.

- A : Piston grade number
- B : Front mark
- C : Pin grade number
- D : Cylinder number
- E : Front mark
- ⇐ : Engine front

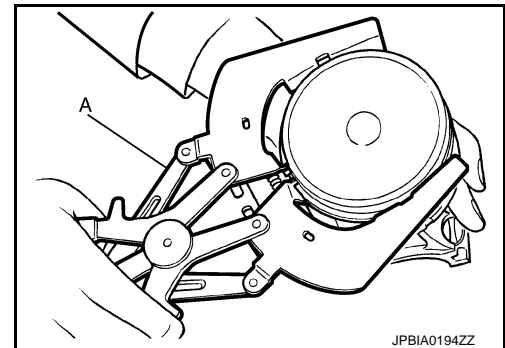


- c. Install new snap ring to the groove of the piston front side.
 - Insert it fully into groove to install.
 - After installing, check that connecting rod moves smoothly.

- 10. Using a piston ring expander (commercial service tool) (A), install piston rings.

CAUTION:

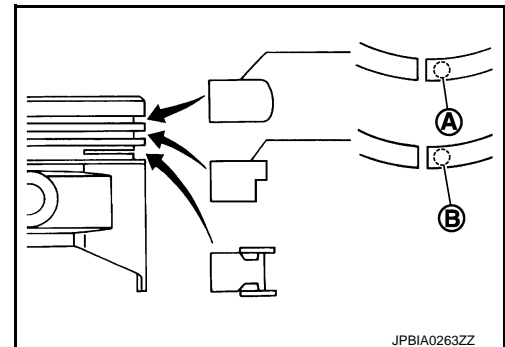
- When installing piston rings, be careful not to damage piston.
- Be careful not to damage piston rings by expanding them excessively.



- If there is stamped mark on ring, mount it with marked side up.

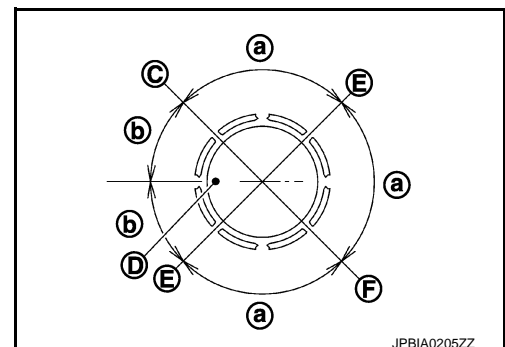
Stamped mark:

- Top ring (A) : 1 N
- Second ring (B) : 2 N



- Position each ring with the gap as shown in the figure referring to the piston front mark (D).

- C : Top ring gap
- E : Oil ring upper or lower rail gap (either of them)
- F : Second ring and oil ring spacer gap
- a : 90 degrees
- b : 45 degrees



- Check the piston ring side clearance. Refer to [EM-144, "Cylinder Block"](#).

- 11. Install connecting rod bearings to connecting rod and connecting rod bearing cap.

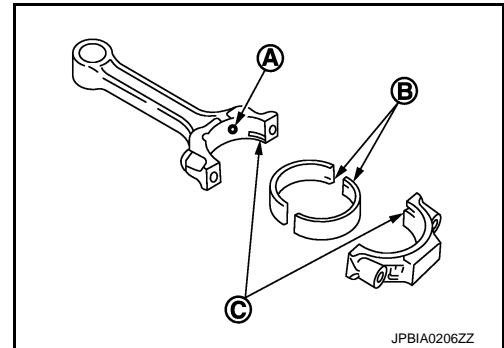
CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

CAUTION:

Be careful not to drop connecting rod bearing, and to scratch the surface.

- Before installing connecting rod bearings, apply engine oil to the bearing surface (inside). Do not apply engine oil to the back surface, but thoroughly clean it.
- When installing, align connecting rod bearing stopper protrusion (B) with cutout (C) of connecting rods and connecting rod bearing caps to install.
- Ensure the oil hole (A) on connecting rod and that on the corresponding bearing are aligned.

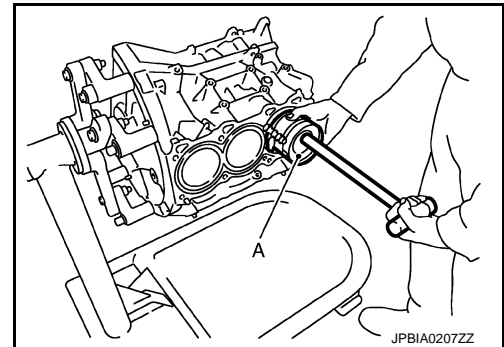


12. Install piston and connecting rod assembly to crankshaft.

- Position crankshaft pin corresponding to connecting rod to be installed onto the bottom dead center.
- Apply engine oil sufficiently to the cylinder bore, piston and crankshaft pin journal.
- Match the cylinder position with the cylinder number on connecting rod to install.
- Be sure that front mark on piston crown is facing front of engine.
- Using a piston ring compressor [SST: EM03470000 (J-8037)] (A) or suitable tool, install piston with the front mark on the piston crown facing the front of the engine.

CAUTION:

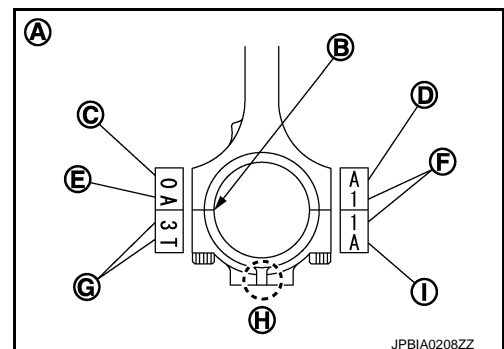
Be careful not to damage the cylinder wall and crankshaft pin, resulting from an interference of the connecting rod big end.



13. Install connecting rod bearing cap.

- Match the stamped cylinder number marks on connecting rod with those on connecting rod bearing cap to install.

- A : Sample codes
- B : Bearing stopper groove
- C : Small-end diameter grade
- D : Big-end diameter grade
- E : Weight grade
- F : Cylinder No.
- G : Management code
- I : Management code



- Be sure that front mark (H) on connecting rod bearing cap is facing front of the engine.

14. Tighten connecting rod bolt as follows:

- Inspect the outer diameter of connecting rod bolt. Refer to [EM-123, "Inspection"](#).
- Apply engine oil to the threads and seats of connecting rod bolts.
- Tighten connecting rod bolts.

28.4 N·m (2.9 kg-m, 21 ft-lb)

- Completely loosen connecting rod bolts.

0 N·m (0 kg-m, 0 ft-lb)

- Tighten connecting rod bolts.

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

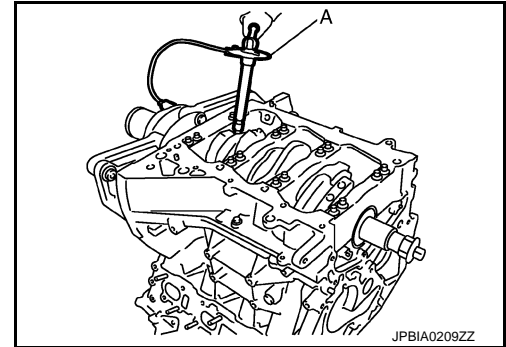
: 24.5 N·m (2.5 kg-m, 18 ft-lb)

- f. Then turn connecting rod bolts 90 degrees clockwise (angle tightening).

CAUTION:

Always use the angle wrench [SST: KV10112100 (BT8653-A)] (A). Never tightening based on visual check alone.

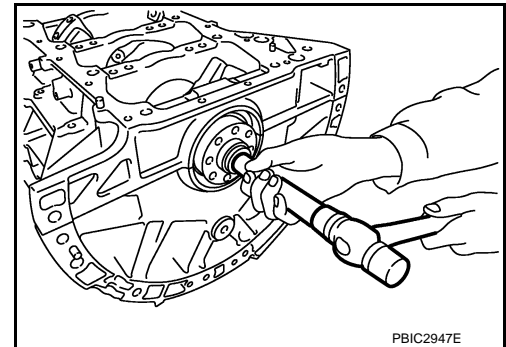
- After tightening connecting rod bolts, check that crankshaft rotates smoothly.
- Check the connecting rod side clearance. Refer to [EM-144, "Cylinder Block"](#).




15. Install baffle plate.
16. Install new rear oil seal. Refer to [EM-77, "REAR OIL SEAL : Removal and Installation"](#).
- Apply new engine oil to both oil seal lip and dust seal lip.

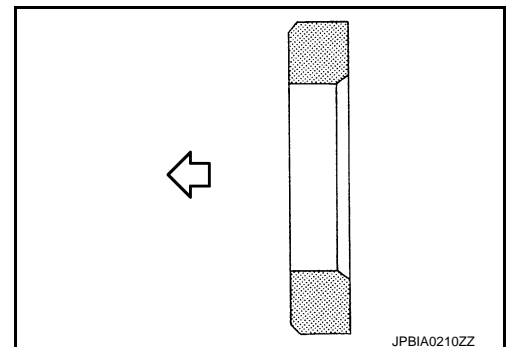
17. Install pilot converter.
- With a drift of the following outer diameter, press-fit as far as it will go.

Pilot converter : Approximately 33 mm (1.30 in)



- Press-fit pilot converter with its chamfer facing crankshaft as shown in the figure.

 : Crankshaft side



CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

18. Install knock sensors.

- A : Bank 1
 B : Bank 2
 ⇐ : Engine front

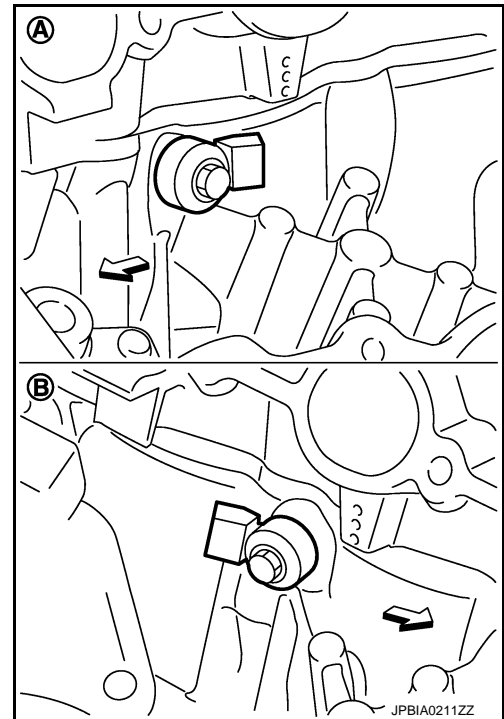
- Install knock sensor so that connector faces rear of the engine.
- After installing knock sensor, connect harness connector, and lay it out to rear of the engine.

CAUTION:

- **Never tighten mounting bolts while holding connector.**
- **If any impact by dropping is applied to knock sensor, replace it with 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.



19. Note the following, and assemble in the reverse order of disassembly after this step.

Drive plate

- When installing drive plate to crankshaft, be sure to correctly align crankshaft side dowel pin and drive plate side dowel pin hole.

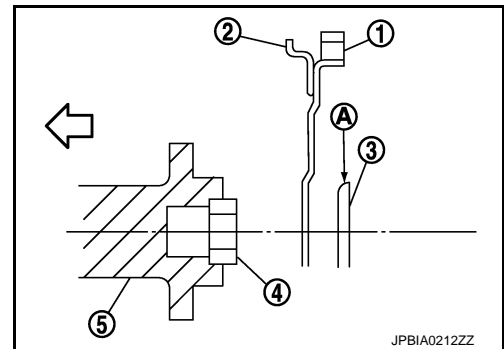
CAUTION:

If these are not aligned correctly, engine runs roughly and “MIL” turns on.

- Install drive plate (2) and reinforcement plate (3) as shown in the figure.

- 1 : Ring gear
 4 : Pilot converter
 5 : Crankshaft
 A : Rounded
 ⇐ : Engine front

- Holding ring gear with the ring gear stopper [SST: KV10118600 (J-48641)].
- Tighten the mounting bolts crosswise over several times.



Inspection

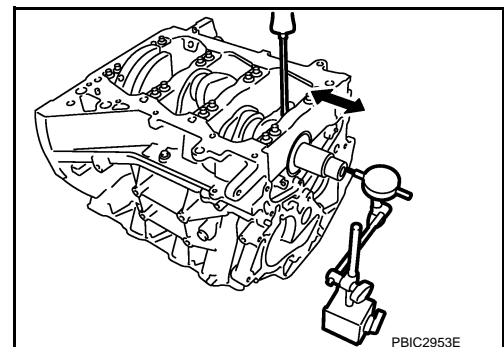
INFOID:000000004348905

CRANKSHAFT END PLAY

- Measure the clearance between thrust bearings and crankshaft arm when crankshaft is moved fully forward or backward with a dial indicator.

Standard and limit : Refer to EM-144, "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

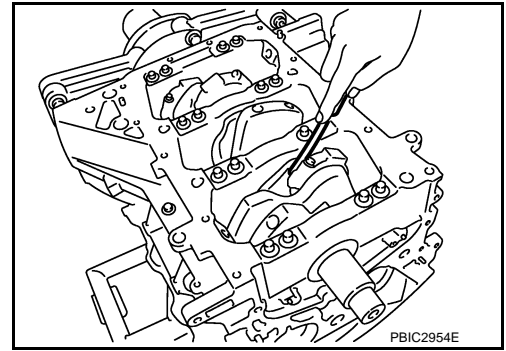
CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- Measure the side clearance between connecting rod and crankshaft arm with a feeler gauge.

Standard and limit : Refer to [EM-144, "Cylinder Block"](#).

- If the measured value exceeds the limit, replace connecting rod, and measure again. If it still exceeds the limit, replace crankshaft also.

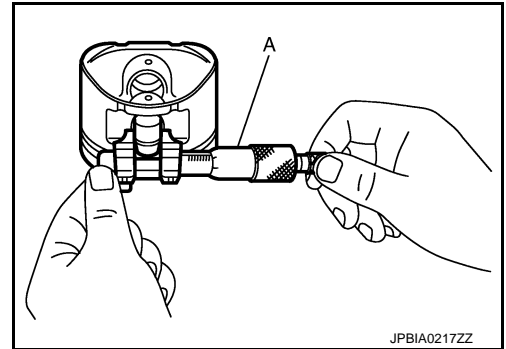


PISTON TO PISTON PIN OIL CLEARANCE

Piston Pin Hole Diameter

Measure the inner diameter of piston pin hole with an inside micrometer (A).

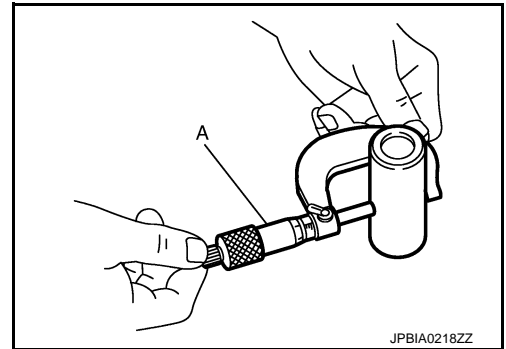
Standard : Refer to [EM-144, "Cylinder Block"](#).



Piston Pin Outer Diameter

Measure the outer diameter of piston pin with a micrometer (A).

Standard : Refer to [EM-144, "Cylinder Block"](#).



Piston to Piston Pin Oil Clearance

$(\text{Piston to piston pin oil clearance}) = (\text{Piston pin hole diameter}) - (\text{Piston pin outer diameter})$

Standard : Refer to [EM-144, "Cylinder Block"](#).

- If the calculated value is out of the standard, replace piston and piston pin assembly.
- When replacing piston and piston pin assembly, refer to [EM-133, "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 piston pin grades can be selected. (Only "0" grade is available.)

PISTON RING SIDE CLEARANCE

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

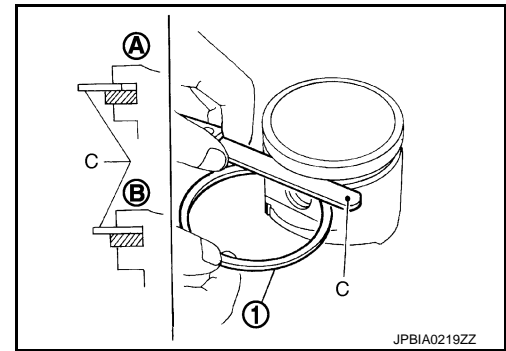
- Measure the side clearance of piston ring (1) and piston ring groove with a feeler gauge (C).

A : NG

B : OK

Standard and limit : Refer to [EM-144, "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

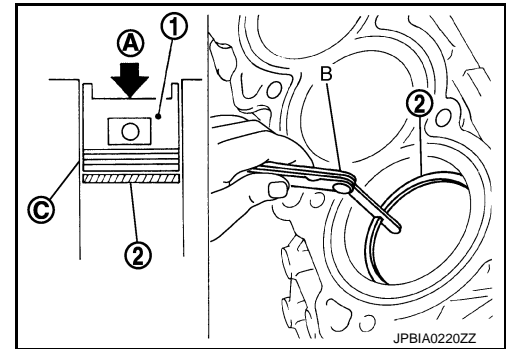
- Check that the cylinder bore inner diameter is within the specification. Refer to [EM-115, "Disassembly and Assembly"](#).
- Lubricate with new engine oil to piston (1) and piston ring (2), and then insert piston ring until middle of cylinder with piston, and measure the piston ring end gap with a feeler gauge (B).

A : Press-fit

C : Measuring point

Standard and limit : Refer to [EM-144, "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 oversize piston and piston rings.



CONNECTING ROD BEND AND TORSION

- Check with a connecting rod aligner.

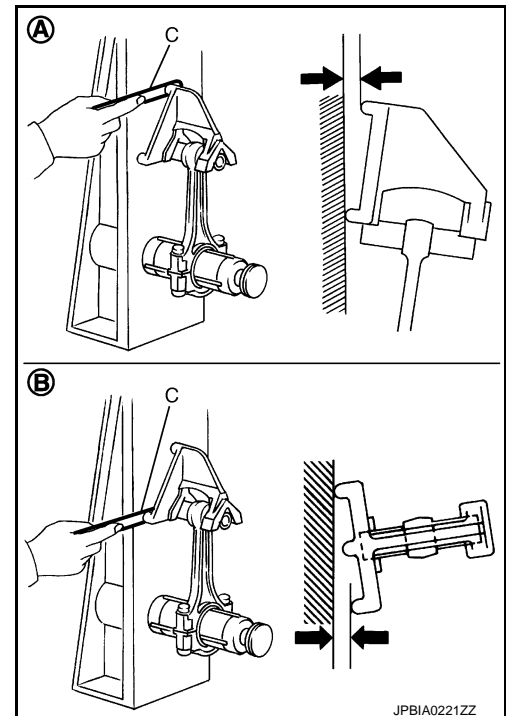
A : Bend

B : Torsion

C : Feeler gauge

Bend limit
Torsion limit : Refer to [EM-144, "Cylinder Block"](#).

- If it exceeds the limit, replace connecting rod assembly.



CONNECTING ROD BIG END DIAMETER

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- Install connecting rod bearing cap without installing connecting rod bearing, and tightening connecting rod bolts to the specified torque. Refer to [EM-115, "Disassembly and Assembly"](#) for the tightening procedure.

1 : Connecting rod

- Measure the inner diameter of connecting rod big end with an inside micrometer.

Standard : Refer to [EM-144, "Cylinder Block"](#).

- 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 an inside micrometer (A).

Standard : Refer to [EM-144, "Cylinder Block"](#).

Piston Pin Outer Diameter

Measure the outer diameter of piston pin with a micrometer (A).

Standard : Refer to [EM-144, "Cylinder Block"](#).

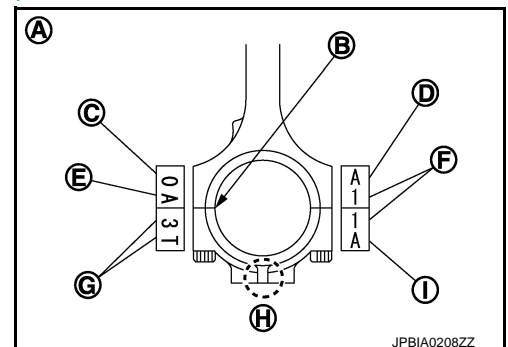
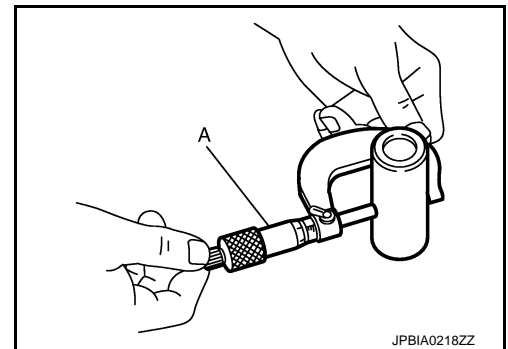
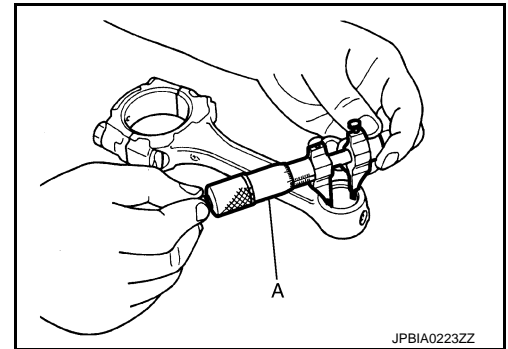
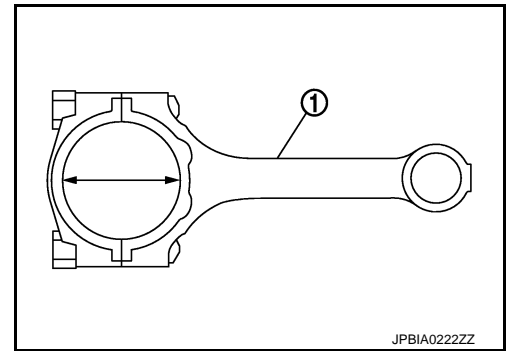
Connecting Rod Bushing Oil Clearance

(Connecting rod bushing oil clearance) = (Connecting rod bushing inner diameter) – (Piston pin outer diameter)

Standard and limit : Refer to [EM-144, "Cylinder Block"](#).

- If the calculated value exceeds the limit, replace connecting rod assembly and/or piston and piston pin assembly.
- If replacing piston and piston pin assembly, refer to [EM-133, "Description"](#).
- If replacing connecting rod assembly, refer to [EM-134, "Connecting Rod Bearing"](#) to select the connecting rod bearing.

- A : Sample codes
- B : Bearing stopper groove
- C : Small-end diameter grade
- D : Big-end diameter grade
- E : Weight grade
- F : Cylinder No.
- G : Management code



CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- H : Front mark
I : Management code

Factory installed parts grading:

- Service parts apply only to grade "0".

- A : Piston grade number
B : Front mark
C : Piston pin grade number

Unit: mm (in)

| Grade | 0 | 1 |
|---|--------------------------------------|--------------------------------------|
| Connecting rod bushing inner diameter * | 22.000 - 22.006 (0.8661 - 0.8664) | 22.006 - 22.012 (0.8664 - 0.8666) |
| Piston pin hole diameter | 21.993 - 21.999 (0.8659 - 0.8661) | 21.999 - 22.005 (0.8661 - 0.8663) |
| Piston pin outer diameter | 21.989 - 21.995 (0.8657 - 0.8659) | 21.995 - 22.001 (0.8659 - 0.8662) |

*: After installing in connecting rod

CYLINDER BLOCK DISTORTION

- Using a scraper, remove gasket on the cylinder block surface, and also remove engine oil, scale, carbon, or other contamination.

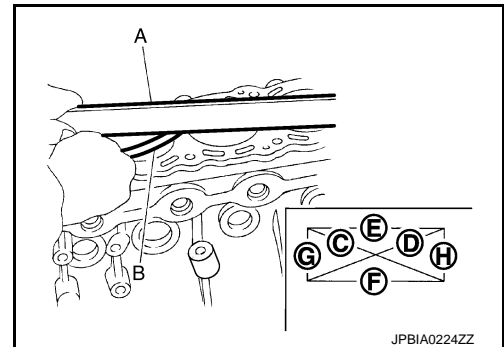
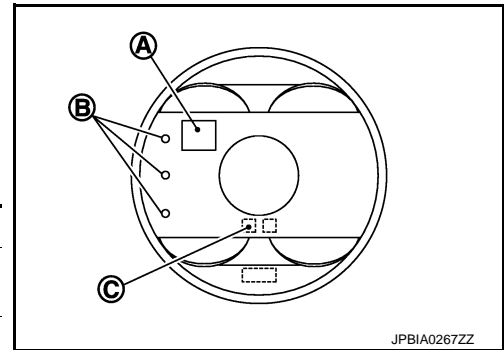
CAUTION:

Be careful not to allow gasket flakes to enter engine oil or engine coolant passages.

- Measure the distortion on the cylinder block upper face at some different points in six directions (C), (D), (E), (F), (G), and (H) with a straightedge (A) and a feeler gauge (B).

Limit : Refer to [EM-144, "Cylinder Block"](#).

- If it exceeds the limit, replace cylinder block.



MAIN BEARING HOUSING INNER DIAMETER

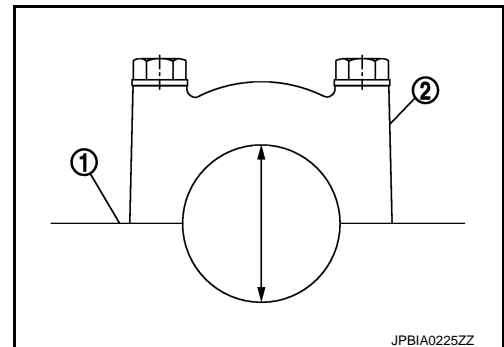
- Install lower cylinder block (2) without installing main bearings, and tighten lower cylinder block bolts to the specified torque. Refer to [EM-115, "Disassembly and Assembly"](#) for the tightening procedure.
- Measure the inner diameter of main bearing housing with a bore gauge.

Standard : Refer to [EM-144, "Cylinder Block"](#).

- If out of the standard, replace cylinder block (1) and lower cylinder block as assembly.

NOTE:

Cylinder block cannot be replaced as a single part, because it is machined together with lower cylinder block.



PISTON TO CYLINDER BORE CLEARANCE

Cylinder Bore Inner Diameter

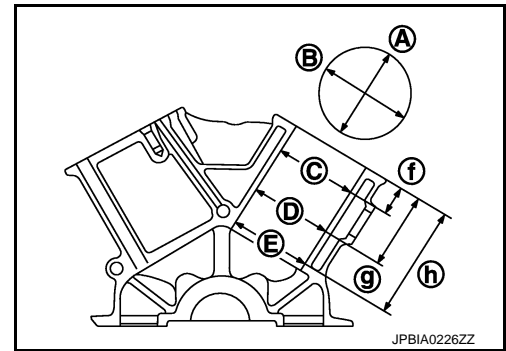
CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- Using a bore gauge, measure 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)] is in longitudinal direction of engine.

f : 10 mm (0.39 in)
g : 60 mm (2.36 in)
h : 125 mm (4.92 in)

Standard and limit : Refer to [EM-144, "Cylinder Block"](#).

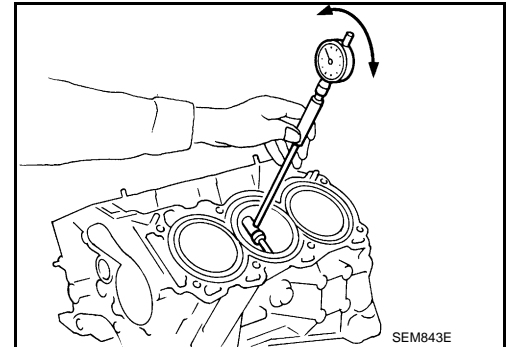


- If the measured value exceeds the limit, or if there are scratches and/or seizure on the cylinder inner wall, hone or rebore the inner wall.
- Oversize piston is provided. When using oversize piston, rebore cylinder so that the clearance of the piston to cylinder bore satisfies the standard.

CAUTION:

When using oversize piston, use oversize pistons for all cylinders with oversize piston rings.

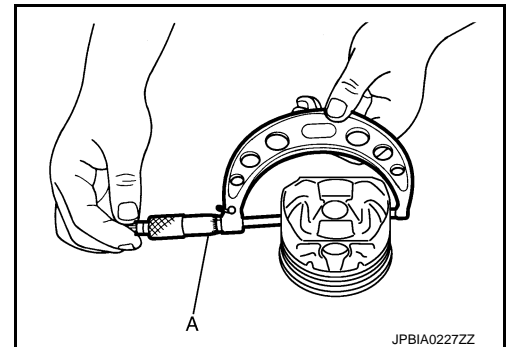
Oversize (O/S) : 0.2 mm (0.008 in)



Piston Skirt Diameter

Measure the outer diameter of piston skirt with a micrometer (A).

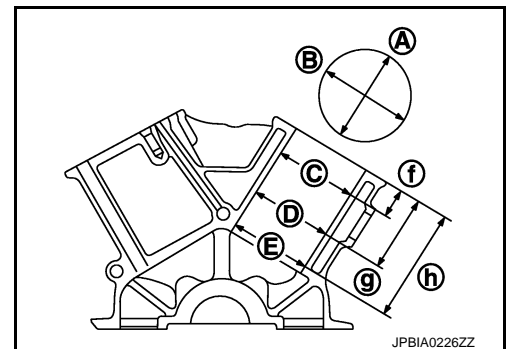
Measure point
Standard : Refer to [EM-144, "Cylinder Block"](#).



Piston-to-Cylinder Bore Clearance

Calculate by piston skirt diameter and cylinder bore inner diameter [direction (B), position (D)].

A : Longitudinal direction
C : Top position
E : Bottom position
f : 10 mm (0.39 in)
g : 60 mm (2.36 in)
h : 125 mm (4.92 in)



(Clearance) = (Cylinder bore inner diameter) – (Piston skirt diameter).

Standard and limit : Refer to [EM-144, "Cylinder Block"](#).

- If the calculated value exceeds the limit, replace piston and piston pin assembly. Refer to [EM-144, "Cylinder Block"](#).

Re-boring Cylinder Bore

- Cylinder bore size is determined by adding piston to cylinder bore clearance to piston skirt diameter.

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

Re-bored size calculation: $D = A + B - C$

where,

A: Piston skirt diameter as measured

B: Piston to cylinder bore clearance (standard value)

C: Honing allowance 0.02 mm (0.0008 in)

D: Bored diameter

2. Install lower cylinder block, and tighten to the specified torque. Otherwise, cylinder bores may be distorted in final assembly.

3. Cut cylinder bores.

NOTE:

- When any cylinder needs boring, all other cylinders must also be bored.
- Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.

4. Hone cylinders to obtain the specified piston to cylinder bore clearance.

5. Measure finished cylinder bore for the out-of-round and taper.

NOTE:

Measurement should be done after cylinder bore cools down.

CRANKSHAFT MAIN JOURNAL DIAMETER

- Measure the outer diameter of crankshaft main journals with a micrometer.

Standard : Refer to [EM-144, "Cylinder Block"](#).

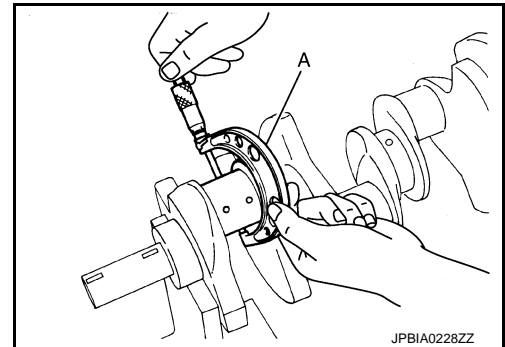
- If out of the standard, measure the main bearing oil clearance. Then use undersize bearing. Refer to [EM-136, "Main Bearing"](#).

CRANKSHAFT PIN JOURNAL DIAMETER

- Measure the outer diameter of crankshaft pin journal with a micrometer (A).

Standard : Refer to [EM-144, "Cylinder Block"](#).

- If out of the standard, measure the connecting rod bearing oil clearance. Then use undersize bearing. Refer to [EM-134, "Connecting Rod Bearing"](#).

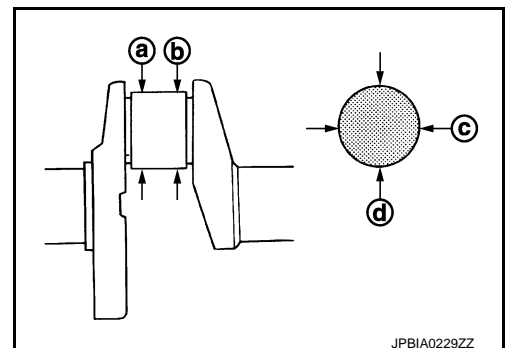


CRANKSHAFT OUT-OF-ROUND AND TAPER

- Measure the dimensions at four different points as shown in the figure on each main journal and pin journal with a micrometer.
- Out-of-round is indicated by the difference in the dimensions between (d) and (c) at (a) and (b).
- Taper is indicated by the difference in the dimensions between.

Limit : Refer to [EM-144, "Cylinder Block"](#).

- If the measured value exceeds the limit, correct or replace crankshaft.
- If corrected, measure the bearing oil clearance of the corrected main journal and/or pin journal. Then select the main bearing and/or connecting rod bearing. Refer to [EM-136, "Main Bearing"](#) and/or [EM-134, "Connecting Rod Bearing"](#).



CRANKSHAFT RUNOUT

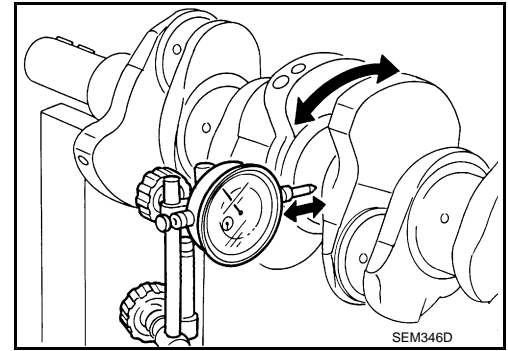
CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- Place V-block on precise flat table, and support the journals on the both end of crankshaft.
- Place a dial indicator straight up on the No. 3 journal.
- While rotating crankshaft, read the movement of the pointer on a dial indicator. (Total indicator reading)

Standard and limit : Refer to [EM-144, "Cylinder Block"](#).

- If it exceeds the limit, replace crankshaft.



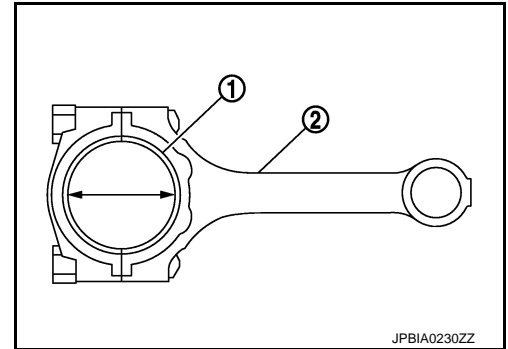
CONNECTING ROD BEARING OIL CLEARANCE

Method by Calculation

- Install connecting rod bearings (1) to connecting rod (2) and connecting rod cap, and tighten connecting rod bolts to the specified torque. Refer to [EM-115, "Disassembly and Assembly"](#) for the tightening procedure.
- Measure the inner diameter of connecting rod bearing with an inside micrometer.

(Oil clearance) = (Connecting rod bearing inner diameter) – (Crankshaft pin journal diameter)

Standard and limit : Refer to [EM-149, "Connecting Rod Bearing"](#).



- If the calculated value exceeds the limit, select proper connecting rod bearing according to connecting rod big end diameter and crankshaft pin journal diameter to obtain the specified bearing oil clearance. Refer to [EM-133, "Description"](#).

Method of Using Plastigage

- Remove oil and dust on crankshaft pin 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 connecting rod bearings to connecting rod and connecting rod bearing cap, and tighten connecting rod bolts to the specified torque. Refer to [EM-115, "Disassembly and Assembly"](#) for the tightening procedure.

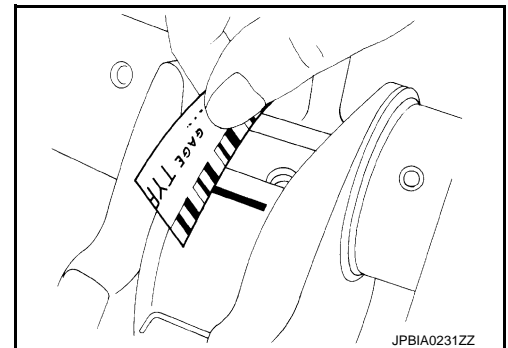
CAUTION:

Never rotate crankshaft.

- Remove connecting rod bearing cap and bearings, and using the scale 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".



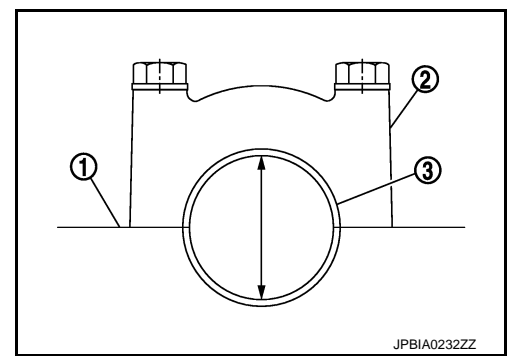
MAIN BEARING OIL CLEARANCE

Method by Calculation

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- Install main bearings (3) to cylinder block (1) and lower cylinder block (2), and tighten lower cylinder block bolts to the specified torque. Refer to [EM-115. "Disassembly and Assembly"](#) for the tightening procedure.
- Measure the inner diameter of main bearing with a bore gauge.
(Oil clearance) = (Main bearing inner diameter) – (Crankshaft main journal diameter)



Standard and limit : Refer to [EM-148. "Main Bearing"](#).

- If the calculated value exceeds the limit, select proper main bearing according to main bearing inner diameter and crankshaft main journal diameter to obtain the specified bearing oil clearance. Refer to [EM-133. "Description"](#).

Method of Using Plastigage

- Remove engine oil and dust on crankshaft 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 bearing to cylinder block and lower cylinder block, and tighten lower cylinder block bolts with lower cylinder block to the specified torque. Refer to [EM-115. "Disassembly and Assembly"](#) for the tightening procedure.

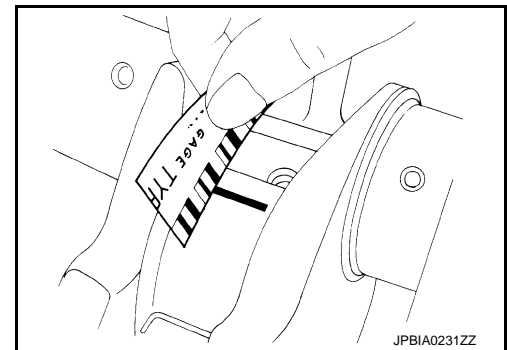
CAUTION:

Never rotate crankshaft.

- Remove lower cylinder block and bearings, and using the scale 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".



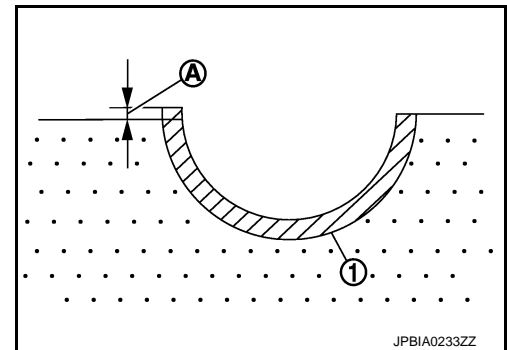
MAIN BEARING CRUSH HEIGHT

- When lower cylinder block is removed after being tightened to the specified torque with main bearings (1) installed, the tip end of bearing must protrude. Refer to [EM-115. "Disassembly and Assembly"](#) for the tightening procedure.

A : Crush height

Standard : There must be crush height.

- If the standard is not met, replace main bearings.



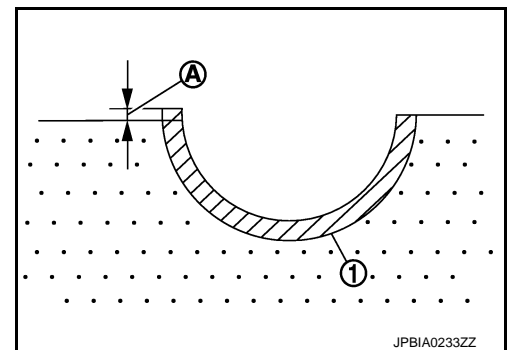
CONNECTING ROD BEARING CRUSH HEIGHT

- When connecting rod bearing cap is removed after being tightened to the specified torque with connecting rod bearings (1) installed, the tip end of bearing must protrude. Refer to [EM-115. "Disassembly and Assembly"](#) for the tightening procedure.

A : Crush height

Standard : There must be crush height.

- If the standard is not met, replace connecting rod bearings.



CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

LOWER CYLINDER BLOCK BOLT OUTER DIAMETER

- Measure the outer diameters (c), (d) at two positions as shown in the figure.

- a : 20 mm (0.79 in)
- b : 30 mm (1.18 in)
- e : 10 mm (0.39 in)

- If reduction appears in (a) range, regard it (c).

Limit [(d) – (c)] : 0.11 mm (0.0043 in)

- If it exceeds the limit (large difference in dimensions), replace lower cylinder block bolt with new one.

CONNECTING ROD BOLT OUTER DIAMETER

1. Measure the outer diameters [(a), (b) and (c)] at the position shown in the figure.

- a : Value at the end of the smaller diameter of the bolt
- b : Value at the end of the smaller diameter of the bolt [opposite side of (a)]
- c : Value of the smallest diameter of the smaller of the bolt

2. Obtain a mean value (d) of (a) and (b).
3. Subtract (c) from (d).

Limit [(d) – (c)] : 0.09 mm (0.0035 in)

4. If it exceeds the limit (large difference in dimensions), replace the bolt with new one.

DRIVE PLATE

- Check drive plate and signal plate for deformation or damage.

CAUTION:

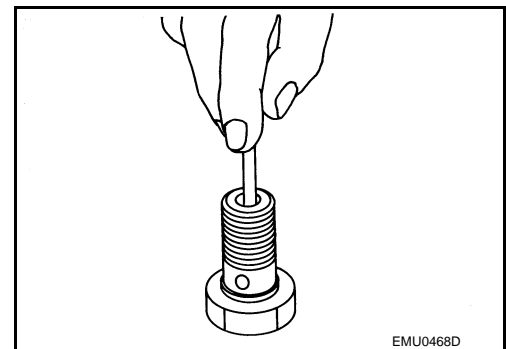
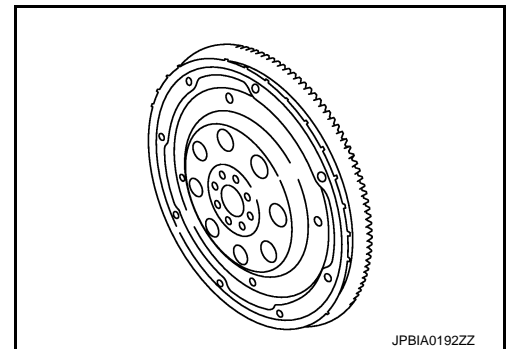
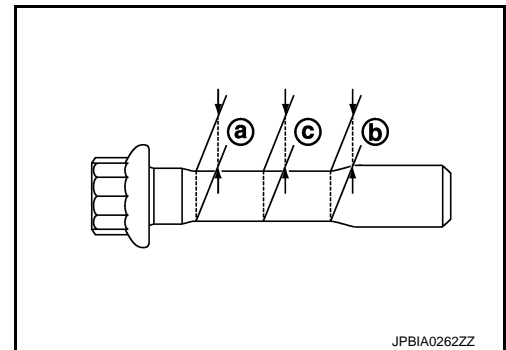
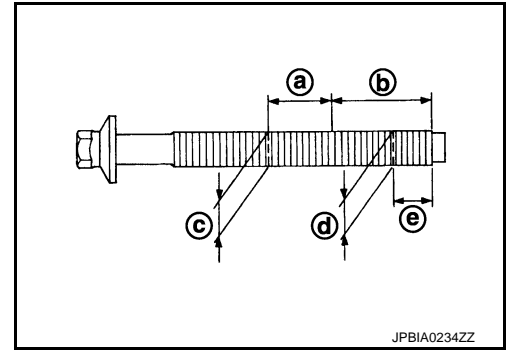
- **Never disassemble drive plate.**
- **Never place drive plate with signal plate facing down.**
- **When handling signal plate, take care not to damage or scratch it.**
- **Handle signal plate in a manner that prevents it from becoming magnetized.**
- If anything is found, replace drive plate.

OIL JET

- Check nozzle for deformation and damage.
- Blow compressed air from nozzle, and check for clogs.
- If it is not satisfied, clean or replace oil jet.

OIL JET RELIEF VALVE

- Using a clean plastic stick, press check valve in oil jet relief valve. Check that valve moves smoothly with proper reaction force.
- If it is not satisfied, replace oil jet relief valve.



HOW TO SELECT PISTON AND BEARING

< UNIT DISASSEMBLY AND ASSEMBLY >

HOW TO SELECT PISTON AND BEARING

Description

INFOID:000000004348906

| 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 assembly.) | Piston grade (piston skirt diameter) | Piston grade = cylinder bore grade (inner diameter of bore) |
| Between piston and connecting rod* | — | — | — |

*: For the service parts, the grade for fitting cannot be selected between piston pin and connecting rod. (Only "0" grade is available.) The information at the shipment from the plant is described as a reference.

- 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.

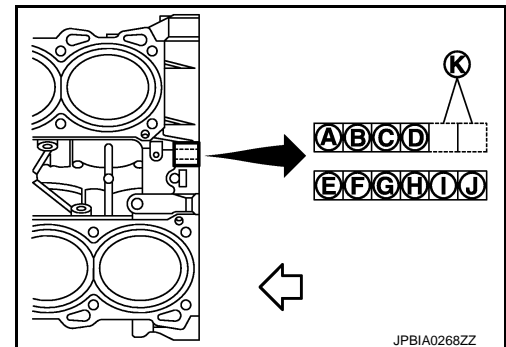
Piston

INFOID:000000004348907

WHEN NEW CYLINDER BLOCK IS USED

Check the cylinder bore grade ("1", "2" or "3") on rear side of cylinder block, and select piston of the same grade.

- A : Bearing housing grade No. 1
- B : Bearing housing grade No. 2
- C : Bearing housing grade No. 3
- D : Bearing housing grade No. 4
- E : Cylinder bore grade No. 1
- F : Cylinder bore grade No. 2
- G : Cylinder bore grade No. 3
- H : Cylinder bore grade No. 4
- I : Cylinder bore grade No. 5
- J : Cylinder bore grade No. 6
- K : Identification
- ↔ : Engine front



NOTE:

Piston is available with piston pin as a set for the service part. (Only "0" grade piston pin is available.)

WHEN NEW CYLINDER BLOCK IS REUSED

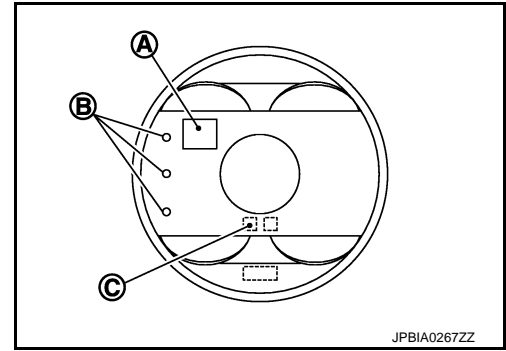
1. Measure the cylinder bore inner diameter. Refer to [EM-144, "Cylinder Block"](#).

HOW TO SELECT PISTON AND BEARING

< UNIT DISASSEMBLY AND ASSEMBLY >

- Determine the bore grade by comparing the measurement with the values under the cylinder bore inner diameter of the "PISTON SELECTION TABLE".

- A : Piston grade number
B : Front mark
C : Piston pin grade number



- Select piston of the same grade.

PISTON SELECTION TABLE

Unit: mm (in)

| Grade | 1 | 2 | 3 |
|------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| Cylinder bore inner diameter | 95.500 - 95.510 (3.7598 - 3.7602) | 95.510 - 95.520 (3.7602 - 3.7606) | 95.520 - 95.530 (3.7606 - 3.7610) |
| Piston skirt diameter | 95.480 - 95.490 (3.7590 - 3.7594) | 95.490 - 95.500 (3.7594 - 3.7598) | 95.500 - 95.510 (3.7598 - 3.7602) |

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 piston pin grades can be selected. (Only "0" grade is available.)
- No second grade mark is available on piston.

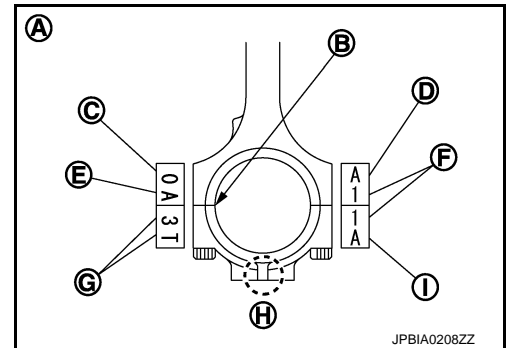
Connecting Rod Bearing

INFOID:000000004348908

WHEN NEW CONNECTING ROD AND CRANKSHAFT ARE USED

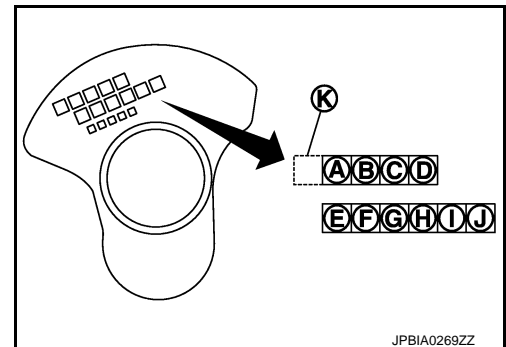
- Apply connecting rod big end diameter grade stamped (D) on connecting rod side face to the row in the "CONNECTING ROD BEARING SELECTION TABLE".

- A : Sample codes
B : Bearing stopper groove
C : Small-end diameter grade
E : Weight grade
F : Cylinder No.
G : Management code
H : Front mark
I : Management code



- Apply crankshaft pin journal diameter grade stamped on crankshaft front side to the column in the "CONNECTING ROD BEARING SELECTION TABLE"

- A : Journal diameter grade No. 1
B : Journal diameter grade No. 2
C : Journal diameter grade No. 3
D : Journal diameter grade No. 4
E : Pin diameter grade No. 1
F : Pin diameter grade No. 2
G : Pin diameter grade No. 3
H : Pin diameter grade No. 4
I : Pin diameter grade No. 5



HOW TO SELECT PISTON AND BEARING

< UNIT DISASSEMBLY AND ASSEMBLY >

J : Pin diameter grade No. 6

K : Identification

- Read the symbol at the cross point of selected row and column in the "CONNECTING ROD BEARING SELECTION TABLE".
- Apply the symbol obtained to the "CONNECTING ROD BEARING GRADE TABLE" to select connecting rod bearing.

WHEN CONNECTING ROD AND CRANKSHAFT ARE REUSED

- Measure the connecting rod big end diameter. Refer to [EM-144, "Cylinder Block"](#).
- Check that the connecting rod big end diameter is within the standard value.
- Measure the crankshaft pin journal diameter. Refer to [EM-144, "Cylinder Block"](#).
- Determine the grade of crankshaft pin diameter grade by corresponding to the measured dimension in "Crankshaft pin journal diameter" column of "CONNECTING ROD BEARING SELECTION TABLE".
- Select connecting rod bearing of the same grade.

CONNECTING ROD BEARING SELECTION TABLE

| <div> <div>Connecting rod big end diameter Unit: mm (in)</div> <div>Crankshaft pin journal diameter Unit: mm (in)</div> </div> | | Mark | | A | B | C | D | E | F | G | H | J | K | L | M | N |
|--|-----------------------------------|---------------|---|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| | | Hole diameter | | 57.000 - 57.001 (2.2441 - 2.2441) | 57.001 - 57.002 (2.2441 - 2.2442) | 57.002 - 57.003 (2.2442 - 2.2442) | 57.003 - 57.004 (2.2442 - 2.2442) | 57.004 - 57.005 (2.2442 - 2.2443) | 57.005 - 57.006 (2.2443 - 2.2443) | 57.006 - 57.007 (2.2443 - 2.2444) | 57.007 - 57.008 (2.2444 - 2.2444) | 57.008 - 57.009 (2.2444 - 2.2444) | 57.009 - 57.010 (2.2444 - 2.2445) | 57.010 - 57.011 (2.2445 - 2.2445) | 57.011 - 57.012 (2.2445 - 2.2446) | 57.012 - 57.013 (2.2446 - 2.2446) |
| Mark | Axle diameter | | | | | | | | | | | | | | | |
| A | 53.974 - 53.973 (2.1250 - 2.1249) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| B | 53.973 - 53.972 (2.1249 - 2.1249) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| C | 53.972 - 53.971 (2.1249 - 2.1248) | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| D | 53.971 - 53.970 (2.1248 - 2.1248) | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 |
| E | 53.970 - 53.969 (2.1248 - 2.1248) | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| F | 53.969 - 53.968 (2.1248 - 2.1247) | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| G | 53.968 - 53.967 (2.1247 - 2.1247) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| H | 53.967 - 53.966 (2.1247 - 2.1246) | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 |
| J | 53.966 - 53.965 (2.1246 - 2.1246) | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| K | 53.965 - 53.964 (2.1246 - 2.1246) | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| L | 53.964 - 53.963 (2.1246 - 2.1245) | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| M | 53.963 - 53.962 (2.1245 - 2.1245) | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| N | 53.962 - 53.961 (2.1245 - 2.1244) | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 |
| P | 53.961 - 53.960 (2.1244 - 2.1244) | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 |
| R | 53.960 - 53.959 (2.1244 - 2.1244) | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 |
| S | 53.959 - 53.958 (2.1244 - 2.1243) | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 |
| T | 53.958 - 53.957 (2.1243 - 2.1243) | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 |
| U | 53.957 - 53.956 (2.1243 - 2.1242) | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

PBIC5435E

CONNECTING ROD BEARING GRADE TABLE

Connecting rod bearing grade table : Refer to [EM-149, "Connecting Rod Bearing"](#).

UNDERSIZE BEARING USAGE GUIDE

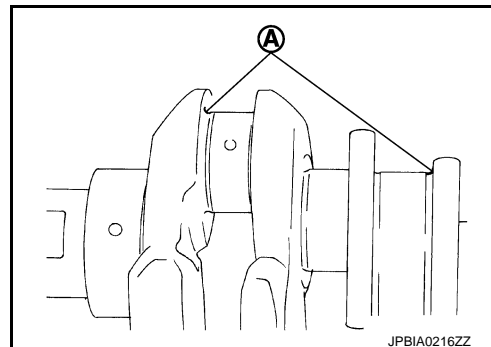
HOW TO SELECT PISTON AND BEARING

< UNIT DISASSEMBLY AND ASSEMBLY >

- 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 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 (A) [1.5 - 1.7 mm (0.059 - 0.067 in)].



Bearing undersize table : Refer to [EM-149, "Connecting Rod Bearing"](#).

Main Bearing

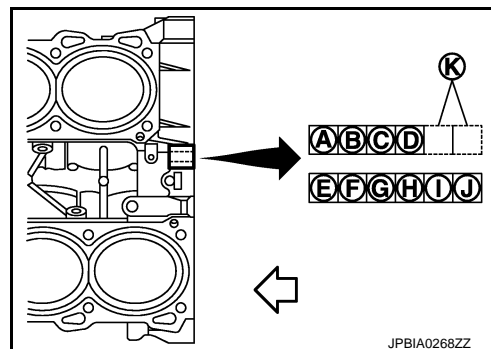
INFOID:000000004348909

WHEN NEW CYLINDER BLOCK AND CRANKSHAFT ARE USED

1. "MAIN BEARING SELECTION TABLE" rows correspond to bearing housing grade on rear left side of cylinder block.

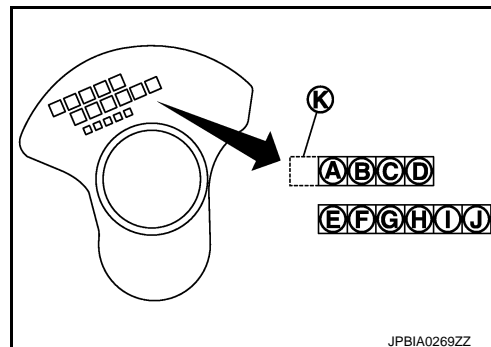
- A : Bearing housing grade No. 1
- B : Bearing housing grade No. 2
- C : Bearing housing grade No. 3
- D : Bearing housing grade No. 4
- E : Cylinder bore grade No. 1
- F : Cylinder bore grade No. 2
- G : Cylinder bore grade No. 3
- H : Cylinder bore grade No. 4
- I : Cylinder bore grade No. 5
- J : Cylinder bore grade No. 6
- K : Identification code

⇐ : Engine front



2. "MAIN BEARING SELECTION TABLE" columns correspond to journal diameter grade on front side of crankshaft.

- A : Journal diameter grade No. 1
- B : Journal diameter grade No. 2
- C : Journal diameter grade No. 3
- D : Journal diameter grade No. 4
- E : Pin diameter grade No. 1
- F : Pin diameter grade No. 2
- G : Pin diameter grade No. 3
- H : Pin diameter grade No. 4
- I : Pin diameter grade No. 5
- J : Pin diameter grade No. 6
- K : Identification code



3. Select main bearing grade at the point where selected row and column meet in "MAIN BEARING SELECTION TABLE".

A

< UNIT DISASSEMBLY AND ASSEMBLY >

4. Apply sign at crossing in above step 3 to "MAIN BEARING GRADE TABLE".

NOTE:

- “MAIN BEARING GRADE TABLE” applies to all journals.
- Service parts is available as a set of both upper and lower.

WHEN CYLINDER BLOCK AND CRANKSHAFT ARE REUSED

1. Measure cylinder block main bearing housing inner diameter and crankshaft main journal diameter. Refer to [EM-136, "Main Bearing"](#) and [EM-144, "Cylinder Block"](#).
2. Correspond the measured dimension in "Cylinder block main bearing housing inner diameter" row of "MAIN BEARING SELECTION TABLE".
3. Correspond the measured dimension in "Crankshaft main journal diameter" column of "MAIN BEARING SELECTION TABLE".
4. Follow step 3 and later in "When New Cylinder Block and Crankshaft are Used".

MAIN BEARING SELECTION TABLE

[illegible]

JPBIA026477

MAIN BEARING GRADE TABLE (ALL JOURNALS)

Main bearing grade table (All journals) : Refer to EM-148, "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.

M

C

D

E

F

G

H

1

J

K

L

M

N

O

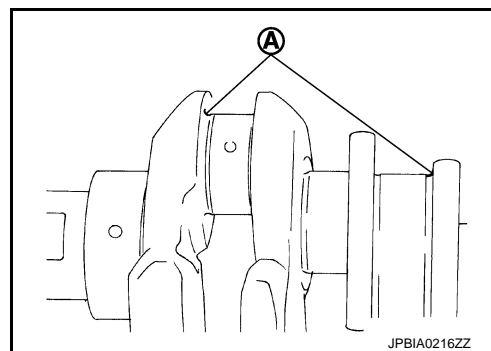
P

HOW TO SELECT PISTON AND BEARING

< UNIT DISASSEMBLY AND ASSEMBLY >

CAUTION:

In grinding crankshaft main journal to use undersize bearings, keep the fillet R (A) [1.5 - 1.7 mm (0.059 - 0.067 in)].



Bearing undersize table : Refer to [EM-148, "Main Bearing"](#).

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

SERVICE DATA AND SPECIFICATIONS (SDS)

SERVICE DATA AND SPECIFICATIONS (SDS)

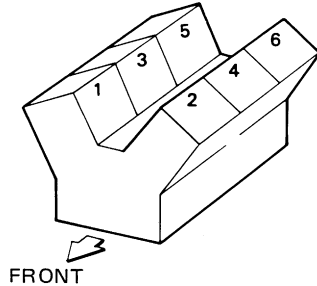
General Specification

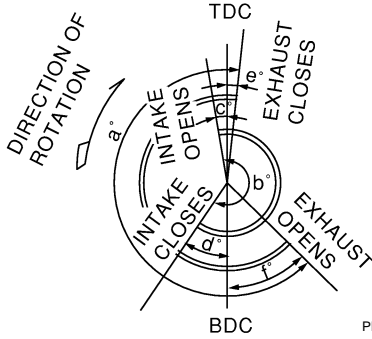
INFOID:0000000004348910

EM

GENERAL SPECIFICATIONS

| | | |
|---|--------------------------------------|-----------------------------|
| Cylinder arrangement | | V-6 |
| Displacement cm^3 (cu in) | | 3,498 (213.45) |
| Bore and stroke mm (in) | | 95.5 x 81.4 (3.760 x 3.205) |
| Valve arrangement | | DOHC |
| Firing order | | 1-2-3-4-5-6 |
| Number of piston rings | Compression | 2 |
| | Oil | 1 |
| Number of main bearings | | 4 |
| Compression ratio | | 10.6 |
| Compression pressure kPa (kg/cm^2 , psi)/300 rpm | Standard | 1,275 (13.0, 185) |
| | Minimum | 981 (10.0, 142) |
| | Differential limit between cylinders | 98 (1.0, 14) |

| | |
|-----------------|---|
| Cylinder number |  <p>FRONT</p> <p>SEM713A</p> |
|-----------------|---|

| | |
|--|---|
| Valve timing (Valve timing control - "OFF") |  <p>PBIC0187E</p> |
|--|---|

Unit: degree

| a | b | c | d | e | f |
|-----|-----|---|----|---|----|
| 248 | 248 | 2 | 66 | 0 | 68 |

Drive Belt

INFOID:0000000004348911

DRIVE BELT

| | |
|-----------------------|--|
| Tension of drive belt | Belt tension is not necessary, as it is automatically adjusted by drive belt auto-tensioner. |
|-----------------------|--|

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

Spark Plug

INFOID:000000004348912

SPARK PLUG

Unit: mm (in)

| | |
|---------------|-------------|
| Make | DENSO |
| Standard type | FXE22HR11 |
| Gap (Nominal) | 1.1 (0.043) |

Intake Manifold

INFOID:000000004348913

INTAKE MANIFOLD

Unit: mm (in)

| Items | | Limit |
|--------------------|-----------------|-------------|
| Surface distortion | Intake manifold | 0.1 (0.004) |

Exhaust Manifold

INFOID:000000004348914

EXHAUST MANIFOLD

Unit: mm (in)

| Items | | Limit |
|--------------------|------------------|-------------|
| Surface distortion | Exhaust manifold | 0.7 (0.028) |

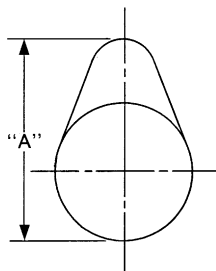
Camshaft

INFOID:000000004348915

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 | 0.035 - 0.076 (0.0014 - 0.0030) | |
| Camshaft bracket inner diameter | No. 1 | 26.000 - 26.021 (1.0236 - 1.0244) | — |
| | No. 2, 3, 4 | 23.500 - 23.521 (0.9252 - 0.9260) | — |
| Camshaft journal diameter | No. 1 | 25.935 - 25.955 (1.0211 - 1.0218) | — |
| | No. 2, 3, 4 | 23.445 - 23.465 (0.9230 - 0.9238) | — |
| Camshaft end play | | 0.115 - 0.188 (0.0045 - 0.0074) | 0.24 (0.0094) |
| Camshaft cam height "A" | Intake | 45.865 - 46.055 (1.8057 - 1.8132) | 0.2 (0.008)* ¹ |
| | Exhaust | 45.875 - 46.065 (1.8061 - 1.8136) | 0.2 (0.008)* ¹ |
| Camshaft runout [TIR* ²] | | Less than 0.02 (0.0008) | 0.05 (0.0020) |
| Camshaft sprocket runout [TIR* ²] | | — | 0.15 (0.0059) |



SEM671

*¹: Cam wear limit

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

*2: Total indicator reading

VALVE LIFTER

Unit: mm (in)

| Items | Standard |
|-----------------------------|-----------------------------------|
| Valve lifter outer diameter | 33.980 - 33.990 (1.3378 - 1.3382) |
| Valve lifter hole diameter | 34.000 - 34.016 (1.3386 - 1.3392) |
| Valve lifter clearance | 0.010 - 0.036 (0.0004 - 0.0014) |

VALVE CLEARANCE

Unit: mm (in)

| Items | Cold | Hot* (reference data) |
|---------|-----------------------------|-------------------------------|
| Intake | 0.26 - 0.34 (0.010 - 0.013) | 0.304 - 0.416 (0.012 - 0.016) |
| Exhaust | 0.29 - 0.37 (0.011 - 0.015) | 0.308 - 0.432 (0.012 - 0.017) |

*: Approximately 80°C (176°F)

AVAILABLE VALVE LIFTER

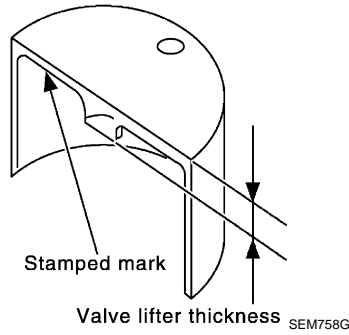
Unit: mm (in)

| Identification (stamped) mark | Thickness |
|-------------------------------|---------------|
| 788 | 7.88 (0.3102) |
| 790 | 7.90 (0.3110) |
| 792 | 7.92 (0.3118) |
| 794 | 7.94 (0.3126) |
| 796 | 7.96 (0.3134) |
| 798 | 7.98 (0.3142) |
| 800 | 8.00 (0.3150) |
| 802 | 8.02 (0.3157) |
| 804 | 8.04 (0.3165) |
| 806 | 8.06 (0.3173) |
| 808 | 8.08 (0.3181) |
| 810 | 8.10 (0.3189) |
| 812 | 8.12 (0.3197) |
| 814 | 8.14 (0.3205) |
| 816 | 8.16 (0.3213) |
| 818 | 8.18 (0.3220) |
| 820 | 8.20 (0.3228) |
| 822 | 8.22 (0.3236) |
| 824 | 8.24 (0.3244) |
| 826 | 8.26 (0.3252) |
| 828 | 8.28 (0.3260) |
| 830 | 8.30 (0.3268) |
| 832 | 8.32 (0.3276) |
| 834 | 8.34 (0.3283) |
| 836 | 8.36 (0.3291) |
| 838 | 8.38 (0.3299) |

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

| Identification (stamped) mark | Thickness |
|-------------------------------|---------------|
| 840 | 8.40 (0.3307) |



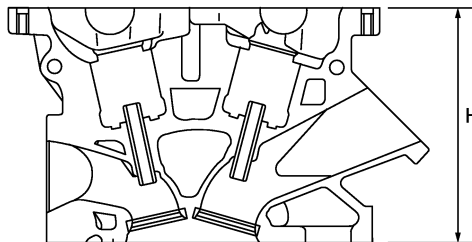
Cylinder Head

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CYLINDER HEAD

Unit: mm (in)

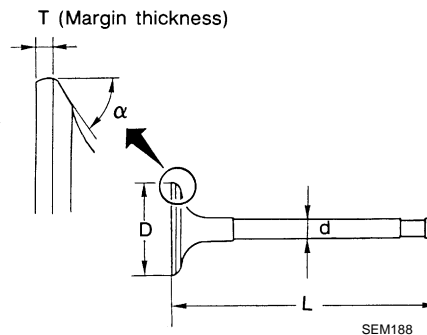
| Items | Standard | Limit |
|---------------------------------|-----------------------------|-------------|
| Head surface distortion | Less than 0.03 (0.0012) | 0.1 (0.004) |
| Normal cylinder head height "H" | 126.3 - 126.5 (4.97 - 4.98) | — |



PBIC0924E

VALVE DIMENSIONS

Unit: mm (in)



| | | |
|-------------------------|---------|---------------------------------|
| Valve head diameter "D" | Intake | 36.6 - 36.9 (1.441 - 1.453) |
| | Exhaust | 30.2 - 30.5 (1.189 - 1.201) |
| Valve length "L" | Intake | 97.13 (3.8240) |
| | Exhaust | 94.67 (3.7272) |
| Valve stem diameter "d" | Intake | 5.965 - 5.980 (0.2348 - 0.2354) |
| | Exhaust | 5.962 - 5.970 (0.2347 - 0.2350) |

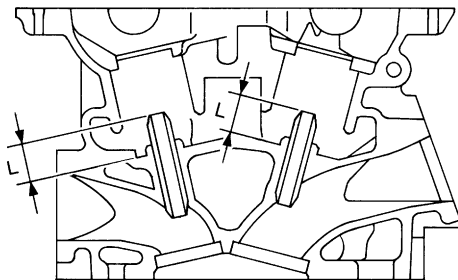
SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

| | | |
|---------------------------------------|---------|-----------------|
| Valve seat angle "α" | Intake | 45°15' - 45°45' |
| | Exhaust | |
| Valve margin "T" | Intake | 1.1 (0.043) |
| | Exhaust | 1.3 (0.051) |
| Valve margin "T" limit | | 0.5 (0.020) |
| Valve stem end surface grinding limit | | 0.2 (0.008) |

VALVE GUIDE

Unit: mm (in)

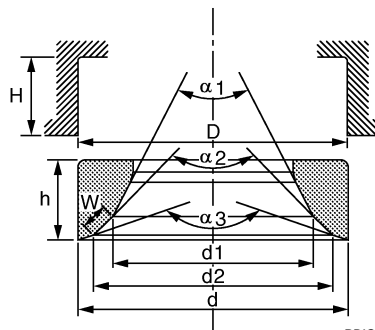


SEM950E

| Items | | Standard | Oversize (Service) [0.2 (0.008)] |
|---|--------------------------------|-----------------------------------|-----------------------------------|
| Valve guide | Outer diameter | 10.023 - 10.034 (0.3946 - 0.3950) | 10.223 - 10.234 (0.4025 - 0.4029) |
| | Inner diameter (Finished size) | 6.000 - 6.018 (0.2362 - 0.2369) | |
| Cylinder head valve guide hole diameter | | 9.975 - 9.996 (0.3927 - 0.3935) | 10.175 - 10.196 (0.4006 - 0.4014) |
| 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) | 0.08 (0.0031) |
| | Exhaust | 0.030 - 0.056 (0.0012 - 0.0022) | 0.09 (0.0035) |
| Projection length "L" | | 12.6 - 12.8 (0.496 - 0.504) | |

VALVE SEAT

Unit: mm (in)



PBIC2745E

| Items | | Standard | Oversize (Service) [0.5 (0.02)] |
|--|---------|-----------------------------------|-----------------------------------|
| Cylinder head seat recess diameter "D" | Intake | 38.000 - 38.016 (1.4961 - 1.4967) | 38.500 - 38.516 (1.5157 - 1.5164) |
| | Exhaust | 31.600 - 31.616 (1.2441 - 1.2447) | 32.100 - 32.116 (1.2638 - 1.2644) |
| Valve seat outer diameter "d" | Intake | 38.097 - 38.113 (1.4999 - 1.5005) | 38.597 - 38.613 (1.5196 - 1.5202) |
| | Exhaust | 31.680 - 31.696 (1.2472 - 1.2479) | 32.180 - 32.196 (1.2669 - 1.2676) |
| Valve seat interference fit | Intake | 0.081 - 0.113 (0.0032 - 0.0044) | |
| | Exhaust | 0.064 - 0.096 (0.0025 - 0.0038) | |

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

| | | | |
|------------------------|---------|-----------------------------|-------------------------------|
| Diameter "d1"*1 | Intake | 34.6 (1.362) | |
| | Exhaust | 27.7 (1.091) | |
| Diameter "d2"*2 | Intake | 35.9 - 36.4 (1.413 - 1.433) | |
| | Exhaust | 29.3 - 29.8 (1.154 - 1.173) | |
| Angle "α1" | Intake | 60° | |
| | Exhaust | 60° | |
| Angle "α2" | Intake | 88°45' - 90°15' | |
| | Exhaust | 88°45' - 90°15' | |
| Angle "α3" | Intake | 120° | |
| | Exhaust | 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) | 5.05 - 5.15 (0.1988 - 0.2028) |
| | Exhaust | 5.9 - 6.0 (0.232 - 0.236) | 4.95 - 5.05 (0.1949 - 0.1988) |
| Depth "H" | | 6.0 (0.236) | |

*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 |
|--------------------------|--|
| Free height | 43.85 mm (1.7264 in) |
| Installation height | 37.00 mm (1.4567 in) |
| Installation load | 166 - 188 N (16.9 - 19.2 kg, 37 - 42 lb) |
| Height during valve open | 26.8 mm (1.055 in) |
| Load with valve open | 502 - 566 N (51.2 - 57.7 kg, 113 - 127 lb) |

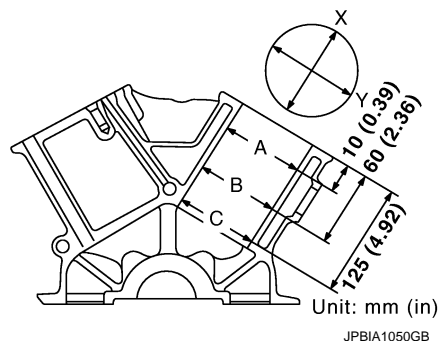
| Items | Limit |
|---------------|-------------------|
| Out-of-square | 1.9 mm (0.075 in) |

Cylinder Block

INFOID:0000000004348917

CYLINDER BLOCK

Unit: mm (in)



| | | |
|-------------------------------------|----------|-----------------------------------|
| Surface flatness | Standard | Less than 0.03 (0.0012) |
| | Limit | 0.1 (0.004) |
| Main bearing housing inner diameter | Standard | 69.993 - 70.017 (2.7556 - 2.7566) |

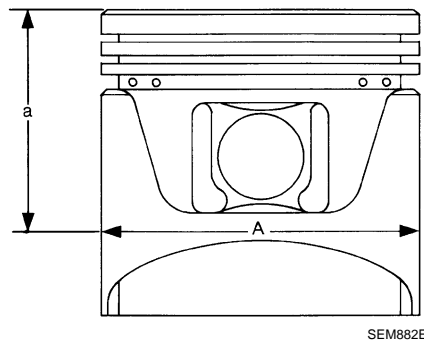
SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

| | | | | | |
|---|----------------|------------|-------------|-----------------------------------|--|
| Cylinder bore | Inner diameter | Standard | Grade No. 1 | 95.500 - 95.510 (3.7598 - 3.7602) | |
| | | | Grade No. 2 | 95.510 - 95.520 (3.7602 - 3.7606) | |
| | | | Grade No. 3 | 95.520 - 95.530 (3.7606 - 3.7610) | |
| | | Wear limit | | 0.2 (0.008) | |
| Out-of-round | | Limit | | 0.015 (0.0006) | |
| Taper | | | | 0.010 (0.0004) | |
| Main bearing housing inner diameter grade (Without bearing) | | | Grade No. A | 69.993 - 69.994 (2.7556 - 2.7557) | |
| | | | Grade No. B | 69.994 - 69.995 (2.7557 - 2.7557) | |
| | | | Grade No. C | 69.995 - 69.996 (2.7557 - 2.7557) | |
| | | | Grade No. D | 69.996 - 69.997 (2.7557 - 2.7558) | |
| | | | Grade No. E | 69.997 - 69.998 (2.7558 - 2.7558) | |
| | | | Grade No. F | 69.998 - 69.999 (2.7558 - 2.7559) | |
| | | | Grade No. G | 69.999 - 70.000 (2.7559 - 2.7559) | |
| | | | Grade No. H | 70.000 - 70.001 (2.7559 - 2.7559) | |
| | | | Grade No. J | 70.001 - 70.002 (2.7559 - 2.7560) | |
| | | | Grade No. K | 70.002 - 70.003 (2.7560 - 2.7560) | |
| | | | Grade No. L | 70.003 - 70.004 (2.7560 - 2.7561) | |
| | | | Grade No. M | 70.004 - 70.005 (2.7561 - 2.7561) | |
| | | | Grade No. N | 70.005 - 70.006 (2.7561 - 2.7561) | |
| | | | Grade No. P | 70.006 - 70.007 (2.7561 - 2.7562) | |
| | | | Grade No. R | 70.007 - 70.008 (2.7562 - 2.7562) | |
| | | | Grade No. S | 70.008 - 70.009 (2.7562 - 2.7563) | |
| | | | Grade No. T | 70.009 - 70.010 (2.7563 - 2.7563) | |
| | | | Grade No. U | 70.010 - 70.011 (2.7563 - 2.7563) | |
| | | | Grade No. V | 70.011 - 70.012 (2.7563 - 2.7564) | |
| | | | Grade No. W | 70.012 - 70.013 (2.7564 - 2.7564) | |
| | | | Grade No. X | 70.013 - 70.014 (2.7564 - 2.7565) | |
| | | | Grade No. Y | 70.014 - 70.015 (2.7565 - 2.7565) | |
| | | | Grade No. 4 | 70.015 - 70.016 (2.7565 - 2.7565) | |
| | | | Grade No. 7 | 70.016 - 70.017 (2.7565 - 2.7566) | |
| Difference in inner diameter between cylinders | | Standard | | Less than 0.03 (0.0012) | |

AVAILABLE PISTON

Unit: mm (in)



| Items | | Standard | Oversize (Service) [0.2 (0.008)] |
|-----------------------------------|-------------|-----------------------------------|-----------------------------------|
| Piston skirt diameter "A" | Grade No. 1 | 95.480 - 95.490 (3.7590 - 3.7594) | — |
| | Grade No. 2 | 95.490 - 95.500 (3.7594 - 3.7598) | — |
| | Grade No. 3 | 95.500 - 95.510 (3.7598 - 3.7602) | — |
| | Service | — | 95.680 - 95.710 (3.7669 - 3.7681) |
| Items | | Standard | Limit |
| "a" dimension | | 38.8 (1.528) | — |
| Piston pin hole diameter | Grade No. 0 | 21.993 - 21.999 (0.8659 - 0.8661) | — |
| | Grade No. 1 | 21.999 - 22.005 (0.8661 - 0.8663) | — |
| Piston to cylinder bore clearance | | 0.010 - 0.030 (0.0004 - 0.0012) | 0.08 (0.0031) |

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

PISTON RING

Unit: mm (in)

| Items | | Standard | Limit |
|----------------|-----------------|---------------------------------|---------------|
| Side clearance | Top | 0.040 - 0.080 (0.0016 - 0.0031) | 0.11 (0.0043) |
| | 2nd | 0.030 - 0.070 (0.0012 - 0.0028) | 0.10 (0.0039) |
| | Oil ring | 0.055 - 0.155 (0.0022 - 0.0061) | — |
| End gap | Top | 0.23 - 0.33 (0.0091 - 0.0130) | 0.42 (0.0165) |
| | 2nd | 0.33 - 0.48 (0.0130 - 0.0189) | 0.57 (0.0224) |
| | Oil (rail ring) | 0.17 - 0.47 (0.0067 - 0.0185) | 0.63 (0.0248) |

PISTON PIN

Unit: mm (in)

| Items | | Standard | Limit |
|--------------------------------------|-------------|-----------------------------------|----------------|
| Piston pin outer diameter | Grade No. 0 | 21.989 - 21.995 (0.8657 - 0.8659) | — |
| | Grade No. 1 | 21.995 - 22.001 (0.8659 - 0.8662) | — |
| Piston to piston pin oil clearance | | 0.002 - 0.006 (0.0001 - 0.0002) | — |
| Connecting rod bushing oil clearance | | 0.005 - 0.017 (0.0002 - 0.0007) | 0.030 (0.0012) |

CONNECTING ROD

Unit: mm (in)

| Items | | Standard | Limit |
|---|-------------|-----------------------------------|---------------|
| Center distance | | 144.15 - 144.25 (5.68 - 5.68) | — |
| Bend [per 100 (3.94)] | | — | 0.15 (0.0059) |
| Torsion [per 100 (3.94)] | | — | 0.30 (0.0118) |
| Connecting rod bushing inner diameter* | Grade No. 0 | 22.000 - 22.006 (0.8661 - 0.8664) | — |
| | Grade No. 1 | 22.006 - 22.012 (0.8664 - 0.8666) | — |
| Connecting rod big end diameter (Without bearing) | Grade No. A | 57.000 - 57.001 (2.2441 - 2.2441) | — |
| | Grade No. B | 57.001 - 57.002 (2.2441 - 2.2442) | — |
| | Grade No. C | 57.002 - 57.003 (2.2442 - 2.2442) | — |
| | Grade No. D | 57.003 - 57.004 (2.2442 - 2.2442) | — |
| | Grade No. E | 57.004 - 57.005 (2.2442 - 2.2443) | — |
| | Grade No. F | 57.005 - 57.006 (2.2443 - 2.2443) | — |
| | Grade No. G | 57.006 - 57.007 (2.2443 - 2.2444) | — |
| | Grade No. H | 57.007 - 57.008 (2.2444 - 2.2444) | — |
| | Grade No. J | 57.008 - 57.009 (2.2444 - 2.2444) | — |
| | Grade No. K | 57.009 - 57.010 (2.2444 - 2.2445) | — |
| | Grade No. L | 57.010 - 57.011 (2.2445 - 2.2445) | — |
| | Grade No. M | 57.011 - 57.012 (2.2445 - 2.2446) | — |
| | Grade No. N | 57.012 - 57.013 (2.2446 - 2.2446) | — |
| Items | | Standard | Limit |
| Side clearance | | 0.20 - 0.35 (0.0079 - 0.0138) | 0.40 (0.0157) |

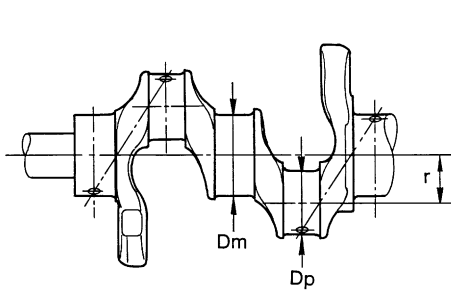
*: After installing in connecting rod

CRANKSHAFT

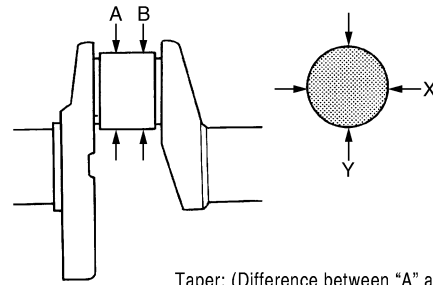
SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

Unit: mm (in)



SEM645



Taper: (Difference between "A" and "B")
Out-of-round: (Difference between "X" and "Y")

SBIA0535E

| | | | |
|-----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|
| Main journal diameter. “Dm” grade | Standard | Grade No. A | 64.975 - 64.974 (2.5581 - 2.5580) |
| | | Grade No. B | 64.974 - 64.973 (2.5580 - 2.5580) |
| | | Grade No. C | 64.973 - 64.972 (2.5580 - 2.5579) |
| | | Grade No. D | 64.972 - 64.971 (2.5579 - 2.5579) |
| | | Grade No. E | 64.971 - 64.970 (2.5579 - 2.5579) |
| | | Grade No. F | 64.970 - 64.969 (2.5579 - 2.5578) |
| | | Grade No. G | 64.969 - 64.968 (2.5578 - 2.5578) |
| | | Grade No. H | 64.968 - 64.967 (2.5578 - 2.5578) |
| | | Grade No. J | 64.967 - 64.966 (2.5578 - 2.5577) |
| | | Grade No. K | 64.966 - 64.965 (2.5577 - 2.5577) |
| | | Grade No. L | 64.965 - 64.964 (2.5577 - 2.5576) |
| | | Grade No. M | 64.964 - 64.963 (2.5576 - 2.5576) |
| | | Grade No. N | 64.963 - 64.962 (2.5576 - 2.5576) |
| | | Grade No. P | 64.962 - 64.961 (2.5576 - 2.5575) |
| | | Grade No. R | 64.961 - 64.960 (2.5575 - 2.5575) |
| | | Grade No. S | 64.960 - 64.959 (2.5575 - 2.5574) |
| | | Grade No. T | 64.959 - 64.958 (2.5574 - 2.5574) |
| | | Grade No. U | 64.958 - 64.957 (2.5574 - 2.5574) |
| | | Grade No. V | 64.957 - 64.956 (2.5574 - 2.5573) |
| | | Pin journal diameter. “Dp” grade | Standard |
| Grade No. X | 64.955 - 64.954 (2.5573 - 2.5572) | | |
| Grade No. Y | 64.954 - 64.953 (2.5572 - 2.5572) | | |
| Grade No. 4 | 64.953 - 64.952 (2.5572 - 2.5572) | | |
| Grade No. 7 | 64.952 - 64.951 (2.5572 - 2.5571) | | |
| Grade No. A | 53.974 - 53.973 (2.1250 - 2.1249) | | |
| Grade No. B | 53.973 - 53.972 (2.1249 - 2.1249) | | |
| Grade No. C | 53.972 - 53.971 (2.1249 - 2.1248) | | |
| Grade No. D | 53.971 - 53.970 (2.1248 - 2.1248) | | |
| Grade No. E | 53.970 - 53.969 (2.1248 - 2.1248) | | |
| Grade No. F | 53.969 - 53.968 (2.1248 - 2.1247) | | |
| Grade No. G | 53.968 - 53.967 (2.1247 - 2.1247) | | |
| Grade No. H | 53.967 - 53.966 (2.1247 - 2.1246) | | |
| Grade No. J | 53.966 - 53.965 (2.1246 - 2.1246) | | |
| Grade No. K | 53.965 - 53.964 (2.1246 - 2.1246) | | |
| Grade No. L | 53.964 - 53.963 (2.1246 - 2.1245) | | |
| Grade No. M | 53.963 - 53.962 (2.1245 - 2.1245) | | |
| Grade No. N | 53.962 - 53.961 (2.1245 - 2.1244) | | |
| Grade No. P | 53.961 - 53.960 (2.1244 - 2.1244) | | |
| Grade No. R | 53.960 - 53.959 (2.1244 - 2.1244) | | |
| Grade No. S | 53.959 - 53.958 (2.1244 - 2.1243) | | |
| Grade No. T | 53.958 - 53.957 (2.1243 - 2.1243) | | |
| Grade No. U | 53.957 - 53.956 (2.1243 - 2.1242) | | |
| Center distance “r” | | | 40.66 - 40.74 (1.6008 - 1.6039) |

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

| | | |
|---|----------|-------------------------------|
| Taper (Difference between "A" and "B") | Limit | 0.0025 (0.0001) |
| Out-of-round (Difference between "X" and "Y") | | 0.0025 (0.0001) |
| Crankshaft runout [TIR*] | Standard | Less than 0.05 (0.0020) |
| | Limit | 0.10 (0.0039) |
| Crankshaft end play | Standard | 0.10 - 0.25 (0.0039 - 0.0098) |
| | Limit | 0.30 (0.0118) |

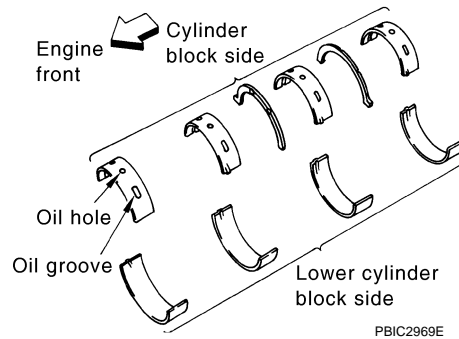
*: Total indicator reading

Main Bearing

INFOID:000000004348918

MAIN BEARING

Unit: mm (in)



| Grade number | | Thickness | Width | Identification color | Remarks |
|--------------|-----|---------------------------------|--------------------------------|----------------------|---|
| 0 | | 2.500 - 2.503 (0.0984 - 0.0985) | 19.9 - 20.1 (0.783 - 0.791) | Black | Grade is the same for upper and lower bearings. |
| 1 | | 2.503 - 2.506 (0.0985 - 0.0987) | | Brown | |
| 2 | | 2.506 - 2.509 (0.0987 - 0.0988) | | Green | |
| 3 | | 2.509 - 2.512 (0.0988 - 0.0989) | | Yellow | |
| 4 | | 2.512 - 2.515 (0.0989 - 0.0990) | | Blue | |
| 5 | | 2.515 - 2.518 (0.0990 - 0.0991) | | Pink | |
| 6 | | 2.518 - 2.521 (0.0991 - 0.0993) | | Purple | |
| 7 | | 2.521 - 2.524 (0.0993 - 0.0994) | | White | |
| 01 | UPR | 2.503 - 2.506 (0.0985 - 0.0987) | | Brown | Grade and color are different for upper and lower bearings. |
| | LWR | 2.500 - 2.503 (0.0984 - 0.0985) | | Black | |
| 12 | UPR | 2.506 - 2.509 (0.0987 - 0.0988) | | Green | |
| | LWR | 2.503 - 2.506 (0.0985 - 0.0987) | | Brown | |
| 23 | UPR | 2.509 - 2.512 (0.0988 - 0.0989) | | Yellow | |
| | LWR | 2.506 - 2.509 (0.0987 - 0.0988) | | Green | |
| 34 | UPR | 2.512 - 2.515 (0.0989 - 0.0990) | | Blue | |
| | LWR | 2.509 - 2.512 (0.0988 - 0.0989) | | Yellow | |
| 45 | UPR | 2.515 - 2.518 (0.0990 - 0.0991) | | Pink | |
| | LWR | 2.512 - 2.515 (0.0989 - 0.0990) | | Blue | |
| 56 | UPR | 2.518 - 2.521 (0.0991 - 0.0993) | | Purple | |
| | LWR | 2.515 - 2.518 (0.0990 - 0.0991) | | Pink | |
| 67 | UPR | 2.521 - 2.524 (0.0993 - 0.0994) | | White | |
| | LWR | 2.518 - 2.521 (0.0991 - 0.0993) | | Purple | |

UNDERSIZE

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

Unit: mm (in)

| Items | Thickness | Main journal diameter |
|---------------|---------------------------------|---|
| 0.25 (0.0098) | 2.633 - 2.641 (0.1037 - 0.1040) | Grind so that bearing clearance is the specified value. |

MAIN BEARING OIL CLEARANCE

Unit: mm (in)

| Items | Standard | Limit |
|----------------------------|----------------------------------|----------------|
| Main bearing oil clearance | 0.035 - 0.045 (0.0014 - 0.0018)* | 0.065 (0.0026) |

*: Actual clearance

Connecting Rod Bearing

INFOID:000000004348919

CONNECTING ROD BEARING

Unit: mm (in)

| Grade number | Thickness | Identification color (mark) |
|--------------|---------------------------------|-----------------------------|
| 0 | 1.497 - 1.500 (0.0589 - 0.0591) | Black |
| 1 | 1.500 - 1.503 (0.0591 - 0.0592) | Brown |
| 2 | 1.503 - 1.506 (0.0592 - 0.0593) | Green |
| 3 | 1.506 - 1.509 (0.0593 - 0.0594) | Yellow |
| 4 | 1.509 - 1.512 (0.0594 - 0.0595) | Blue |

UNDERSIZE

Unit: mm (in)

| Items | Thickness | Crank pin journal diameter |
|---------------|---------------------------------|---|
| 0.25 (0.0098) | 1.626 - 1.634 (0.0640 - 0.0643) | Grind so that bearing clearance is the specified value. |

CONNECTING ROD BEARING OIL CLEARANCE

Unit: mm (in)

| Items | Standard | Limit |
|--------------------------------------|----------------------------------|----------------|
| Connecting rod bearing oil clearance | 0.040 - 0.053 (0.0016 - 0.0021)* | 0.070 (0.0028) |

*: Actual clearance