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SECTION **EM**

ENGINE MECHANICAL

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PRECAUTIONS

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PRECAUTIONS

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

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

WARNING:

Always observe the following items for preventing accidental activation.

- 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 "SRS AIR BAG".
- Never 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:

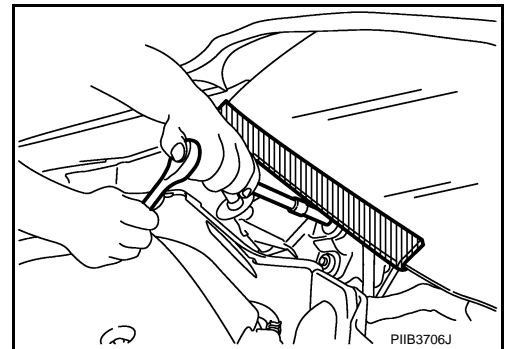
Always observe the following items for preventing accidental activation.

- When working near the Air Bag Diagnosis Sensor Unit or other Air Bag System sensors with the ignition ON or engine running, never 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 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 Handling High Pressure Fuel System

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

Precautions For Engine Service

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DISCONNECTING FUEL PIPING

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

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DRAINING ENGINE COOLANT

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

INSPECTION, REPAIR AND REPLACEMENT

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

REMOVAL AND DISASSEMBLY

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

ASSEMBLY AND INSTALLATION

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

Parts Requiring Angle Tightening

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- Use angle wrench [SST: KV10112100 (BT8653-A)] for the final tightening of the following engine parts:
 - Cylinder head bolts
 - Main bearing cap bolts
 - Main bearing cap sub bolts
 - Connecting rod cap bolts
 - Crankshaft pulley bolt (No angle wrench is required as the bolt flange is provided with notches for angle tightening)
- Ensure thread and seat surfaces are clean and coated with engine oil.

Precaution for Liquid Gasket

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REMOVAL OF LIQUID GASKET SEALING

PRECAUTIONS

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

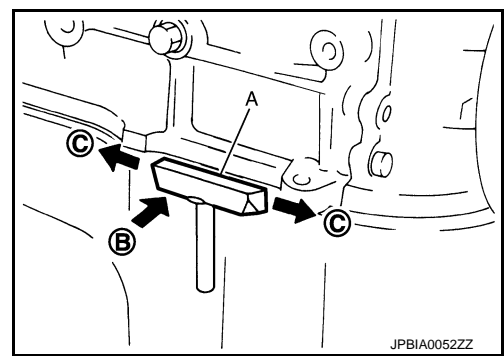
CAUTION:

Be careful not to damage the mating surfaces.

- Tap the seal cutter 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 is difficult to use, lightly tap the parts using a plastic hammer to remove it.

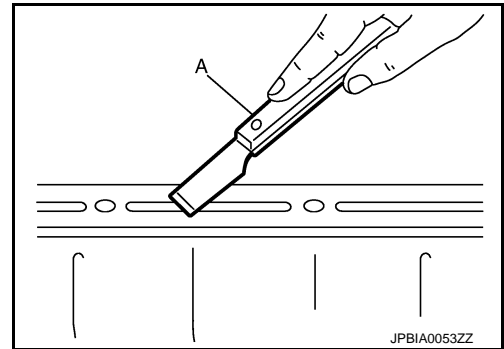
CAUTION:

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

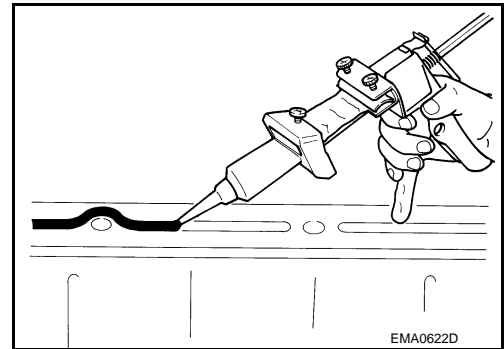


LIQUID GASKET APPLICATION PROCEDURE

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-22, "Recommended Chemical Products and Sealants"](#).
4. Apply liquid gasket without gaps to the specified location according to the specified dimensions.
 - If there is a groove for liquid gasket application, apply liquid gasket to the groove.



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

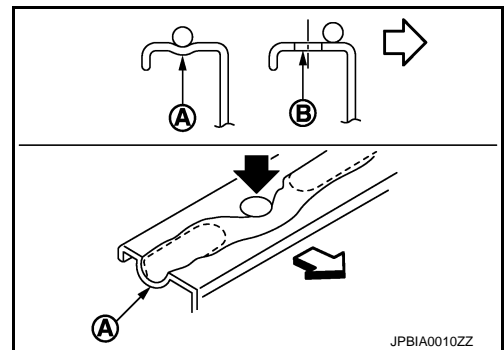
A : Groove

⇐ : Inside

- Within 5 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.



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PRECAUTIONS

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Definitions of Bank Names

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- In this manual, each bank name is defined as per the following:

A : Bank 2 (The conventional right bank)

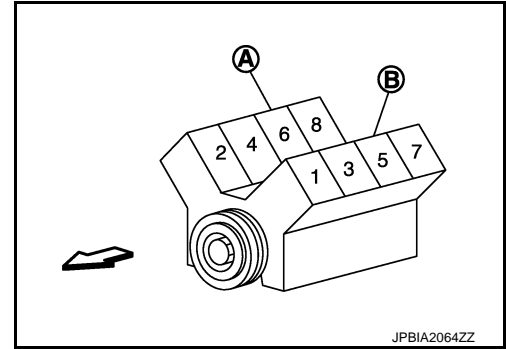
B : Bank 1 (The conventional left bank)

↔ : Engine front

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

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)



Precautions for Removing of Battery Terminal

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- When removing the 12V battery terminal, turn OFF the ignition switch and wait at least 30 seconds.

NOTE:

ECU may be active for several tens of seconds after the ignition switch is turned OFF. If the battery terminal is removed before ECU stops, then a DTC detection error or ECU data corruption may occur.

- For vehicles with the 2-batteries, be sure to connect the main battery and the sub battery before turning ON the ignition switch.

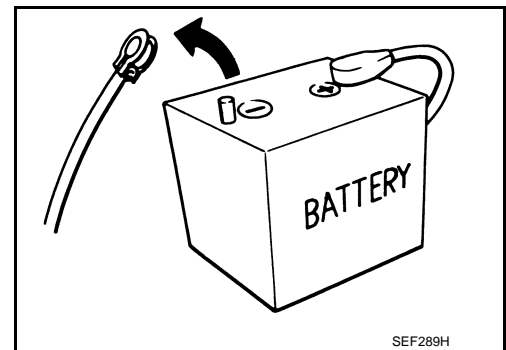
NOTE:

If the ignition switch is turned ON with any one of the terminals of main battery and sub battery disconnected, then DTC may be detected.

- After installing the 12V battery, always check "Self Diagnosis Result" of all ECUs and erase DTC.

NOTE:

The removal of 12V battery may cause a DTC detection error.



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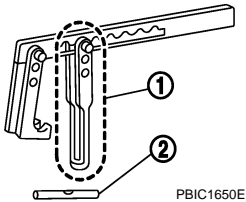
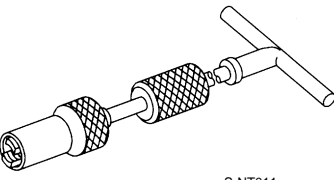
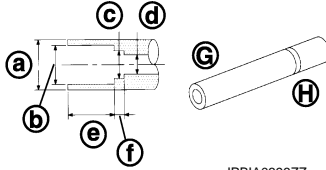
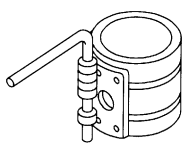
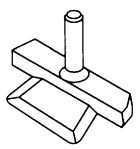
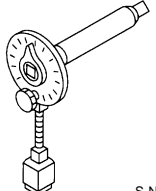
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Special Service Tool

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Tool number (Kent-Moore No.) Tool name	Description
KV10116200 (J-26336-A) Valve spring compressor 1. KV10115900 (J-26336-20) Attachment 2. KV10109220 (—) Adapter	 PBIC1650E Disassembling valve mechanism Part (1) is a component of KV10116200 (J26336-A), but part (2) is not so.
KV10107902 (J-38959) Valve oil seal puller	 S-NT011 Removing valve oil seal
KV10115600 (J-38958) Valve oil seal drift	 JPBA0396ZZ 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)
EM03470000 (J-8037) Piston ring compressor	 S-NT044 Installing piston assembly into cylinder bore
KV10111100 (J-37228) Seal cutter	 S-NT046 Removing steel oil pan and front cover
KV10112100 (BT8653-A) Angle wrench	 S-NT014 Tightening bolts for bearing cap, cylinder head, etc.

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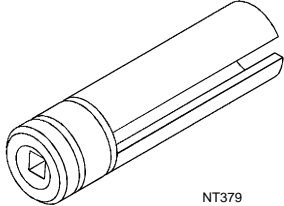
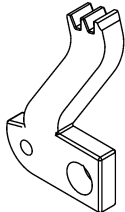

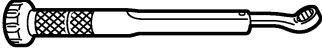
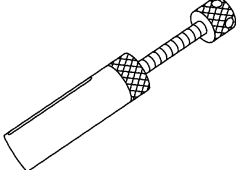
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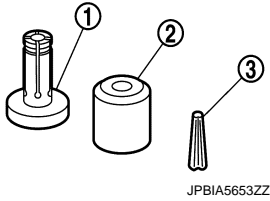


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Tool number (Kent-Moore No.) Tool name	Description
KV10117100 (J-44626) Heated oxygen sensor wrench  <p style="text-align: right; margin-right: 50px;">NT379</p>	Loosening or tightening air fuel ratio sensor 1 a: 22 mm (0.87 in)
KV10120100 (J-47245) Ring gear stopper  <p style="text-align: right; margin-right: 50px;">LBIA0451E</p>	Removing and installing crankshaft pulley
— (J-45488) Quick connector release  <p style="text-align: right; margin-right: 50px;">PBIC0198E</p>	Removing fuel tube quick connectors in engine room (Available in SEC. 164 of PARTS CATALOG:Part No. 16441 6N210)
KV10119300 (—) Adapter and torque wrench assembly  <p style="text-align: right; margin-right: 50px;">JPBIA2623ZZ</p>	Tightening rocker cover mounting bolts. (specified torque)
KV10119600 (—) Injector remover  <p style="text-align: right; margin-right: 50px;">JPBIA3746ZZ</p>	Removing fuel injector

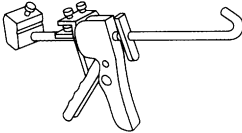
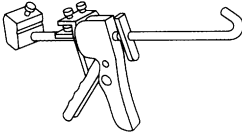
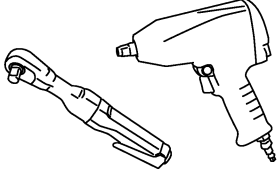
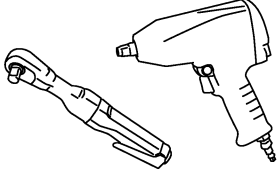
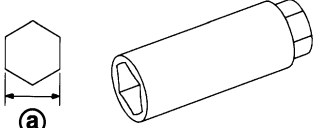
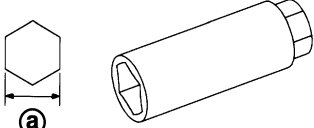
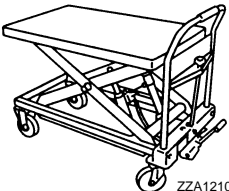
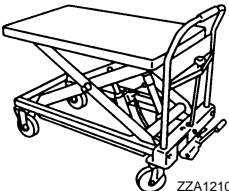
PREPARATION

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Tool number (Kent-Moore No.) Tool name	Description
KV101197S0 (—) Injector seal drift set 1. KV10119730 (—) Seal installer 2. KV10119710 (—) Drift 3. KV10119720 (—) Seal guide	Installing fuel injector seal ring 
EG15050500 (J-45402) Compression gauge adapter 	Checking compression pressure 

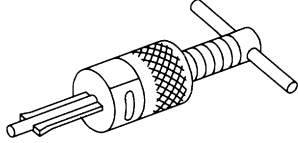
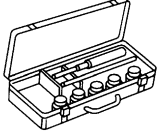
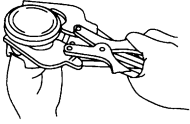
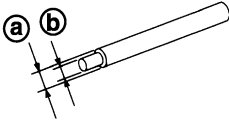
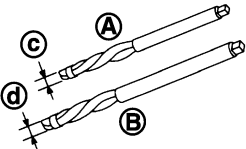
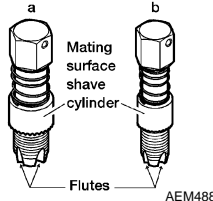
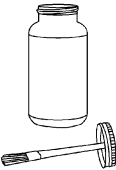
Commercial Service Tool

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(Kent-Moore No.) Tool name	Description
(—) Tube presser 	Pressing the tube of liquid gasket 
(—) Power tool 	Loosening nuts and bolts 
(—) Spark plug wrench 	Removing and installing spark plug a: 14 mm (0.55 in) 
(—) Manual lift table caddy 	Removing and installing engine 

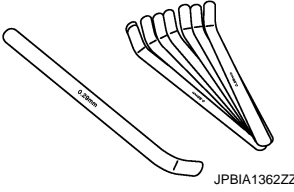
PREPARATION

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(Kent-Moore No.) Tool name	Description
(—) Pilot bushing puller	Removing pilot converter
 NT045	
(—) Valve seat cutter set	Finishing valve seat (EXH) dimensions
 S-NT048	
(—) Piston ring expander	Removing and installing piston ring
 S-NT030	
(—) Valve guide drift	Removing and installing valve guide (EXH) a: 9.5 mm (0.374 in) dia. b: 5.5 mm (0.217 in) dia.
 JPBIA0400ZZ	
(—) Valve guide reamer	(A): Reaming valve guide (EXH) inner hole (B): Reaming hole for oversize valve guide (EXH) c: 6.0 mm (0.236 in) dia. d: 10.2 mm (0.402 in) dia.
 JPBIA0401ZZ	
(J-43897-18) (J-43897-12) Oxygen sensor thread cleaner	Reconditioning the exhaust system threads before installing a new heated oxygen sensor (Use with anti-seize lubricant shown below.) a: J-43897-18 (18 mm dia.) for zirconia heated oxygen sensor and air fuel ratio sensor b: J-43897-12 (12 mm dia.) for titania heated oxygen sensor and air fuel ratio sensor
 AEM488	
(—) Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907)	Lubricating oxygen sensor thread cleaning tool when reconditioning exhaust system threads
 AEM489	

PREPARATION

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(Kent-Moore No.) Tool name	Description
(—) Feeler gauge <div style="text-align: center;">  <p style="text-align: center; font-size: small;">JPBIA1362ZZ</p> </div>	Inspection valve clearance (use a curved-tip gauge)
(—) Compression gauge with flexible type adapter	Checking compression pressure

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CAMSHAFT VALVE CLEARANCE

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BASIC INSPECTION

CAMSHAFT VALVE CLEARANCE

Inspection

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INSPECTION

Check valve clearance if applicable to the following cases:

Intake side:

- At the removal and installation of VVEL ladder assembly or valve-related parts, or at the occurrence of malfunction (poor starting, idle malfunction, unusual noise) due to aged deterioration in valve clearance.

CAUTION:

Valve clearance check on the intake side is not required after replacing the VVEL ladder assembly & cylinder head assembly with a new one. (Install new VVEL ladder assembly & cylinder head assembly in factory-shipped condition because it is factory-adjusted and inspected.)

NOTE:

VVEL ladder assembly cannot be replaced as a single part, because it is machined together with cylinder head assembly.

Exhaust side:

- At the removal, installation, and replacement of exhaust camshaft or valve-related parts, or at the occurrence of malfunction (poor starting, idle malfunction, unusual noise) due to aged deterioration in valve clearance.

1. Remove VVEL actuator motor assembly. Refer to [EM-37, "Removal and Installation"](#).
2. Remove rocker covers (bank 1 and bank 2). Refer to [EM-34, "Removal and Installation"](#).
3. Remove VVEL actuator housing assembly. Refer to [EM-37, "Removal and Installation"](#).
4. Measure the valve clearance as per the following:
 - Use the feeler gauge (commercial service tool) of curved-tip. This allows the feeler gauge to access the clearance between camshaft (drive shaft) nose and valve lifter with ease.

Valve clearance : Refer to [EM-141, "Camshaft"](#).

NOTE:

Be sure to note the following points when measuring valve clearance on the intake side.

- Before measuring, check that the position of drive shaft nose is within the angle shown in the figure.

A : Bank 2

B : Feeler gauge (commercial service tool)

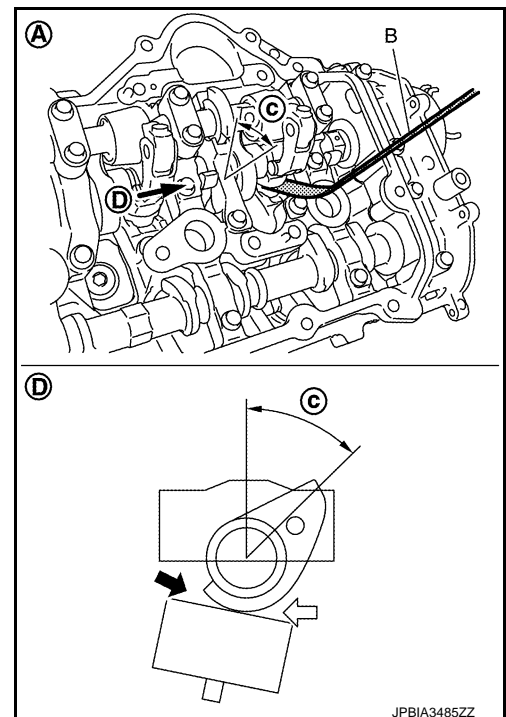
c : 45 degrees (drive shaft nose angle)

D : View D

↙ : Insertion direction of feeler gauge on the bank 2

← : Insertion direction of feeler gauge on the bank 1

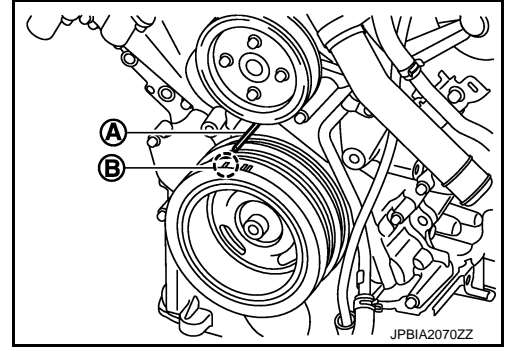
- Refer to the figure for the insertion direction of the feeler gauge since the direction depends on the bank.



CAMSHAFT VALVE CLEARANCE

< BASIC INSPECTION >

- a. Set No. 1 cylinder at TDC of its compression stroke.
- Rotate crankshaft pulley clockwise to align timing mark (grooved line without color) (B) with timing indicator (A).

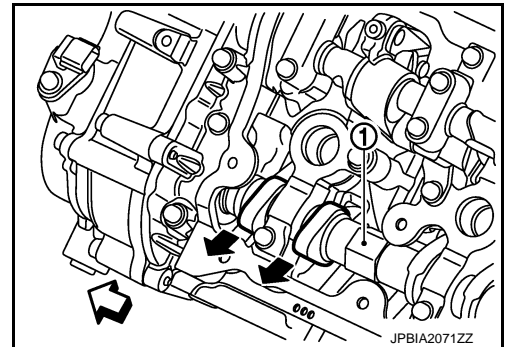


- Check that exhaust cam nose on No. 1 cylinder (engine front side of bank 1) is located as shown in the figure.

1 : Exhaust camshaft (bank 1)

↔ : Engine front

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

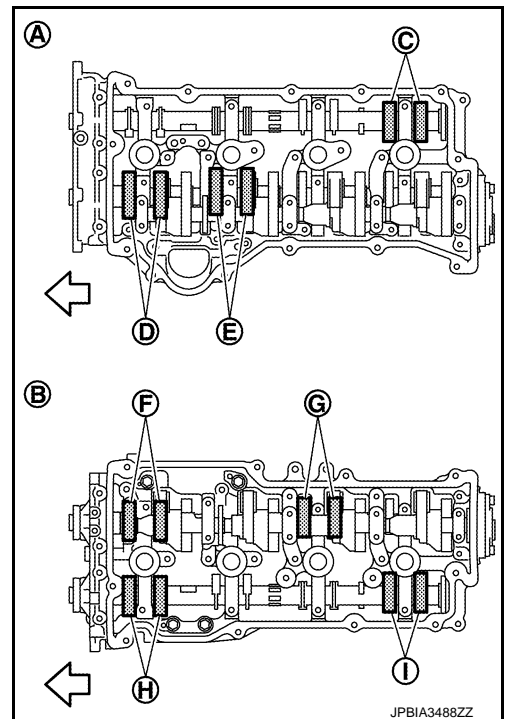


- By referring to the figure, measure the valve clearances at locations marked "x" as shown in the table below (locations indicated in the figure).

↔ : Engine front

- No. 1 cylinder at compression TDC

Measuring position [bank 2 (A)]		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.	No. 8 CYL.
No. 1 cylinder at compression TDC	EXH				× (C)
	INT	× (D)	× (E)		
Measuring position [bank 1 (B)]		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.	No. 7 CYL.
No. 1 cylinder at compression TDC	INT	× (F)		× (G)	
	EXH	× (H)			× (I)



NOTE:

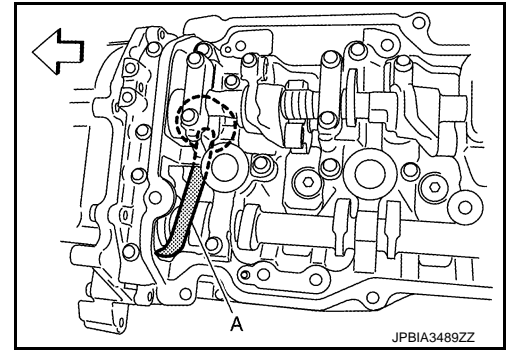
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CAMSHAFT VALVE CLEARANCE

< BASIC INSPECTION >

To measure valve clearance of No. 1 cylinder INT valve (front side), insert feeler gauge (A) (commercial service tool) as shown in the figure.

← : Engine front

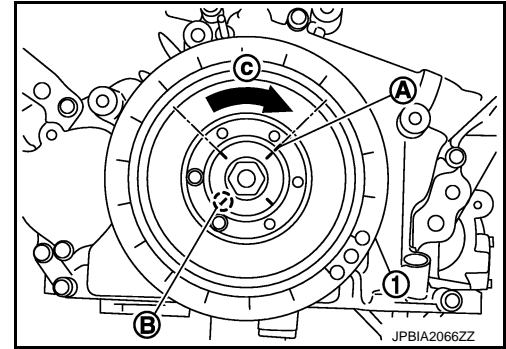


- b. Rotate crankshaft 270 degrees clockwise (when viewed from engine front) to align No. 3 cylinder at TDC its compression stroke.

NOTE:

Crankshaft pulley mounting bolt flange has an angle mark (B) every 90 degrees (c). They can be used as a guide to rotation angle.

A : Paint mark

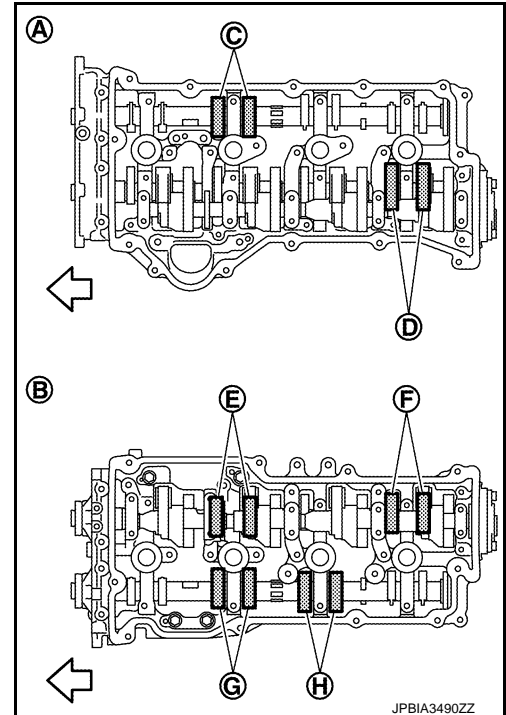


- By referring to the figure, measure the valve clearances at locations marked "x" as shown in the table below (locations indicated in the figure).

← : Engine front

- No. 3 cylinder at compression TDC

Measuring position [bank 2 (A)]		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.	No. 8 CYL.
No. 3 cylinder at compression TDC	EXH		× (C)		
	INT				× (D)
Measuring position [bank 1 (B)]		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.	No. 7 CYL.
No. 3 cylinder at compression TDC	INT		× (E)		× (F)
	EXH		× (G)	× (H)	



- c. Rotate crankshaft 90 degrees clockwise (when viewed from engine front) to align No. 6 cylinder at TDC of compression stroke.

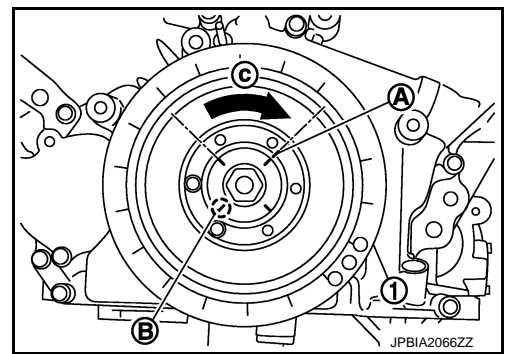
NOTE:

CAMSHAFT VALVE CLEARANCE

< BASIC INSPECTION >

Crankshaft pulley mounting bolt flange has an angle mark (B) every 90 degrees (c). They can be used as a guide to rotation angle.

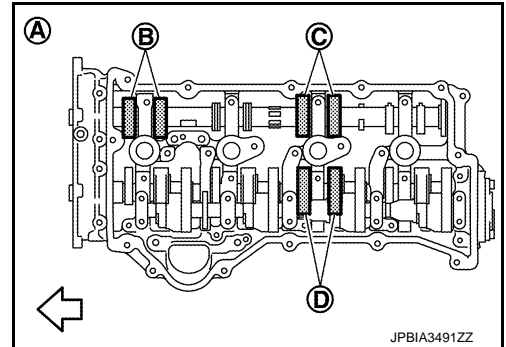
A : Paint mark



- 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. 6 cylinder at compression TDC



Measuring position [bank 2 (A)]		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.	No. 8 CYL.
No. 6 cylinder at compression TDC	EXH	× (B)		× (C)	
	INT			× (D)	

- Perform adjustment or replacement if the measured value is out of the standard.
 - If a valve clearance on the exhaust side is out of specification, adjust the valve clearance. Refer to [EM-83. "Inspection"](#).
 - If a valve clearance on the intake side is out of specification, replace VVEL ladder assembly & cylinder head assembly. Refer to [EM-92. "Exploded View"](#).

CAUTION:

Never adjust valve clearance on the intake side.

NOTE:

Since the valve lifter (INT) cannot be replaced by the piece, VVEL ladder assembly & cylinder head assembly replacement are required.

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COMPRESSION PRESSURE

< BASIC INSPECTION >

COMPRESSION PRESSURE

Inspection

INFOID:000000009010574

1. Warm up engine thoroughly. Then, stop it.
2. Release fuel pressure. Refer to the following table:

ENGINE	Reference page
VK56VD FOR USA AND CANADA	EC-168, "Work Procedure"
VK56VD FOR MEXICO	EC-731, "Work Procedure"

CAUTION:

If **CONSULT** is not used to release fuel pressure leave the fuel pump fuse disconnected until step 7.

3. Remove fuel pump fuse in IPDM E/R.

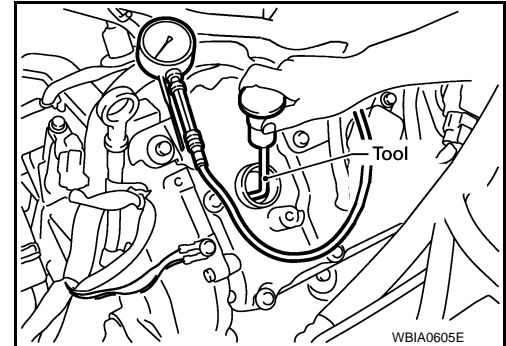
NOTE:

- For the fuse number, refer to the following table:

ENGINE	Reference page
VK56VD FOR USA AND CANADA	EC-125, "Wiring Diagram"
VK56VD FOR MEXICO	EC-689, "Wiring Diagram"

- For the fuse arrangement, refer to [PG-99, "Fuse, Connector and Terminal Arrangement"](#).

4. Remove engine cover. Refer to [EM-26, "Exploded View"](#).
5. Remove ignition coil and spark plug from each cylinder. Refer to [EM-30, "Exploded View"](#).
6. Connect engine tachometer (not required in use of CONSULT).
7. Install the compression tester with Tool [SST: EG15050500 (J-45402)] into the spark plug hole.



8. Measure compression pressure using compression gauge connected with flexible type adapter (commercial service tool).
9. 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-140, "General Specification"](#).

CAUTION:

- Measure a six-cylinder under the same conditions since a measurement depends on measurement conditions (engine water temperature, etc.).
- 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. Refer to [PG-114, "How to Handle Battery"](#).
- If compression pressure is below the minimum value, check valve clearances and parts associated with combustion chamber (valve, valve seat, piston, piston ring, cylinder bore, cylinder head, cylinder head gasket). After checking, measure compression pressure again.
- If a cylinder has low compression pressure, pour a small amount of engine oil into the spark plug hole of the cylinder to re-check it for compression.

COMPRESSION PRESSURE

< BASIC INSPECTION >

- If the added engine oil improves the compression, piston rings may be worn out or damaged. Check piston rings and replace if necessary. Refer to [EM-116, "Disassembly and Assembly"](#).
 - 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. Refer to [EM-116, "Disassembly and Assembly"](#).
 - 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. Refer to [EM-93, "Removal and Installation"](#).
10. After inspection is completed, install removed parts.
11. Start the engine, and check that the engine runs smoothly.
12. Perform trouble diagnosis. If DTC appears, erase it. Refer to the following table:

ENGINE	Reference page
VK56VD FOR USA AND CANADA	EC-183, "Description"
VK56VD FOR MEXICO	EC-739, "Description"

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NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

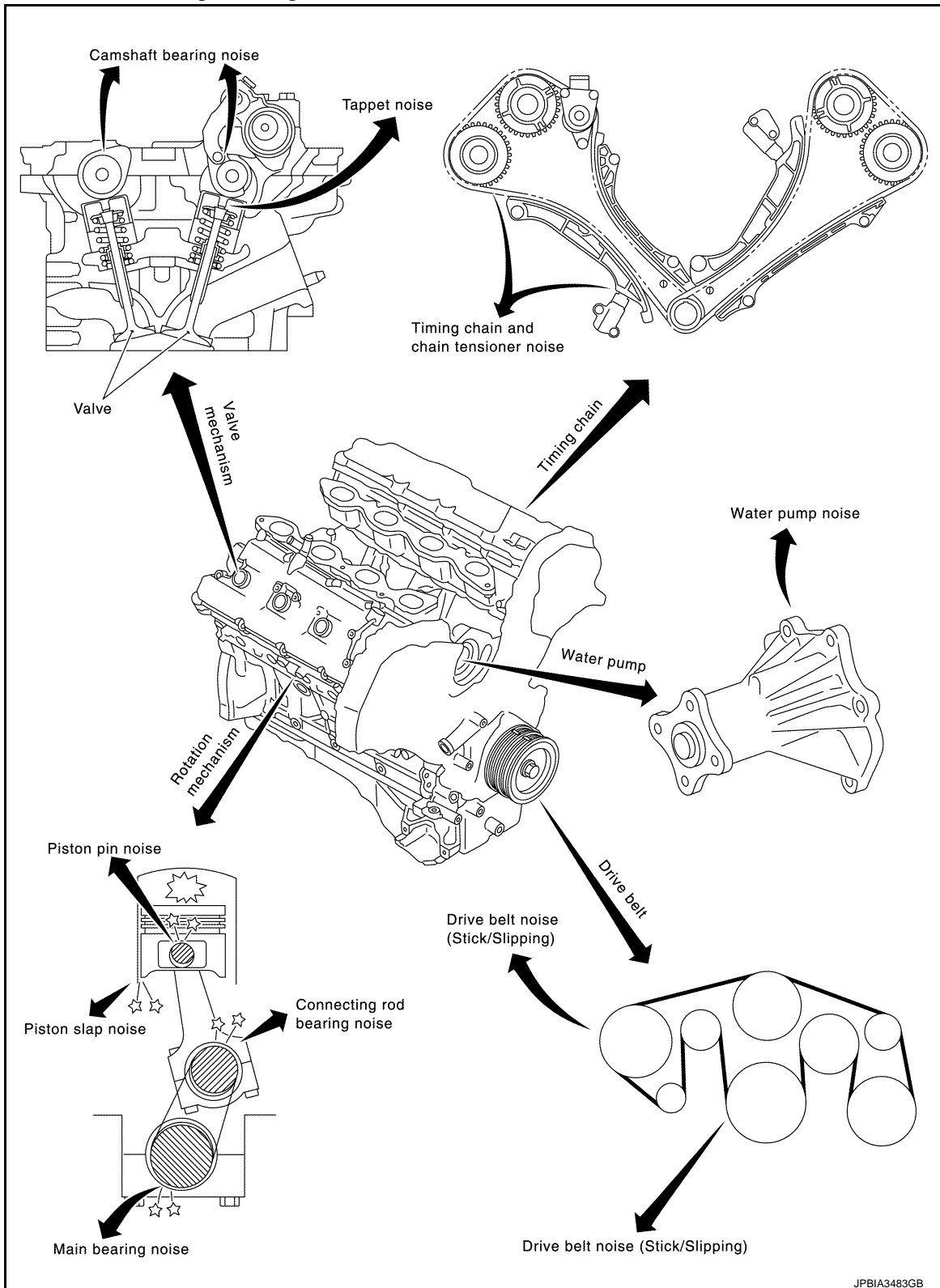
< SYMPTOM DIAGNOSIS >

SYMPTOM DIAGNOSIS

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

NVH Troubleshooting - Engine Noise

INFOID:000000009010575



JPBIA3483GB

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

< SYMPTOM DIAGNOSIS >

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

INFOID:000000009010576

1. Locate the area where noise occurs.
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-12
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft runout Camshaft journal oil clearance	EM-83
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-123
	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-123
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing oil clearance	EM-123
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-123
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 wears Timing chain tensioner operation	EM-77
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	EM-20
	Creaking	A	B	A	B	A	B	Drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	CO-21

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

DRIVE BELTS

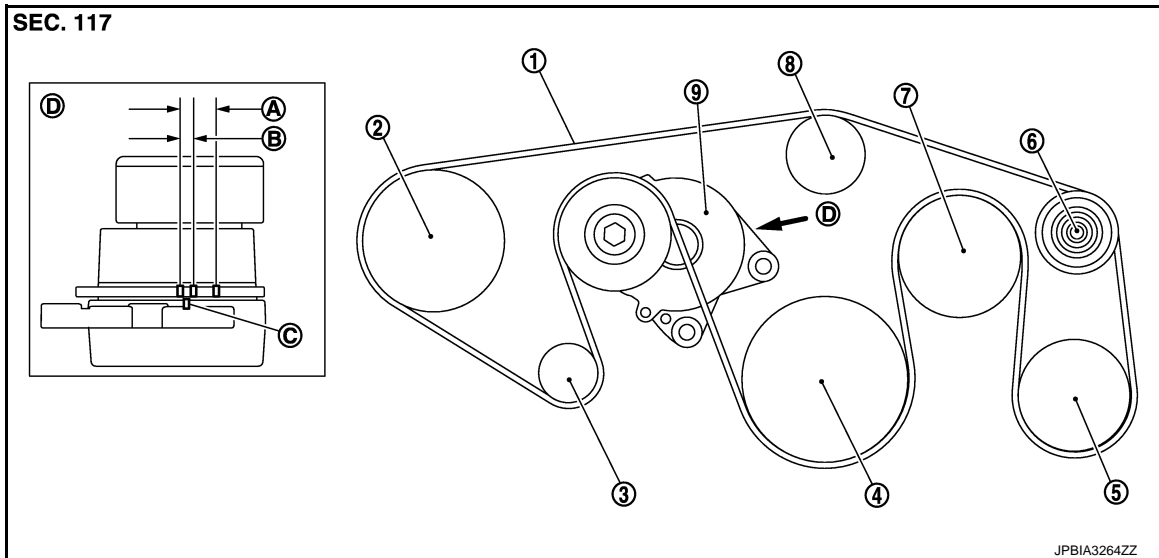
< PERIODIC MAINTENANCE >

PERIODIC MAINTENANCE

DRIVE BELTS

Exploded View

INFOID:000000009010577



- | | | |
|-----------------------|-------------------------------------------|------------------------------|
| 1. Drive belt | 2. Power steering oil pump pulley | 3. Alternator pulley |
| 4. Crankshaft pulley | 5. A/C compressor | 6. Idler pulley |
| 7. Cooling fan pulley | 8. Water pump pulley | 9. Drive belt auto-tensioner |
| A. Possible use range | B. Range when new drive belt is installed | C. Indicator |
| D. View D | | |

Checking

INFOID:000000009010578

WARNING:

Be sure to perform the these steps when engine is stopped.

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

NOTE:

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

Tension Adjustment

INFOID:000000009010579

Refer to [EM-140. "Drive Belts"](#).

Removal and Installation

INFOID:000000009010580

REMOVAL

1. Move reservoir tank to the position without the hindrance for work. Refer to [CO-14. "Exploded View"](#).

DRIVE BELTS

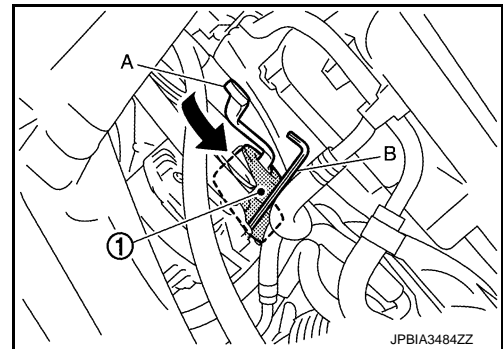
< PERIODIC MAINTENANCE >

2. Install wrench (A) on drive belt auto tensioner pulley bolt, move in the direction of arrow (loosening direction of tensioner) as shown.

CAUTION:

- Never place hand in a location where pinching may occur if the holding tool accidentally comes off.
- Never loosen the hexagonal part in center of auto tensioner pulley (1) (Never turn it clockwise). If turned clockwise, the complete auto tensioner must be replaced as a unit, including the pulley.

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



INSTALLATION

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

CAUTION:

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

Inspection

INFOID:000000009010581

INSPECTION AFTER INSTALLATION

- Turn crankshaft pulley clockwise several times to equalize tension between each pulley, and then confirm tension of drive belts at indicator (notch on fixed side) is within the possible use range. Refer to [EM-20, "Exploded View"](#).

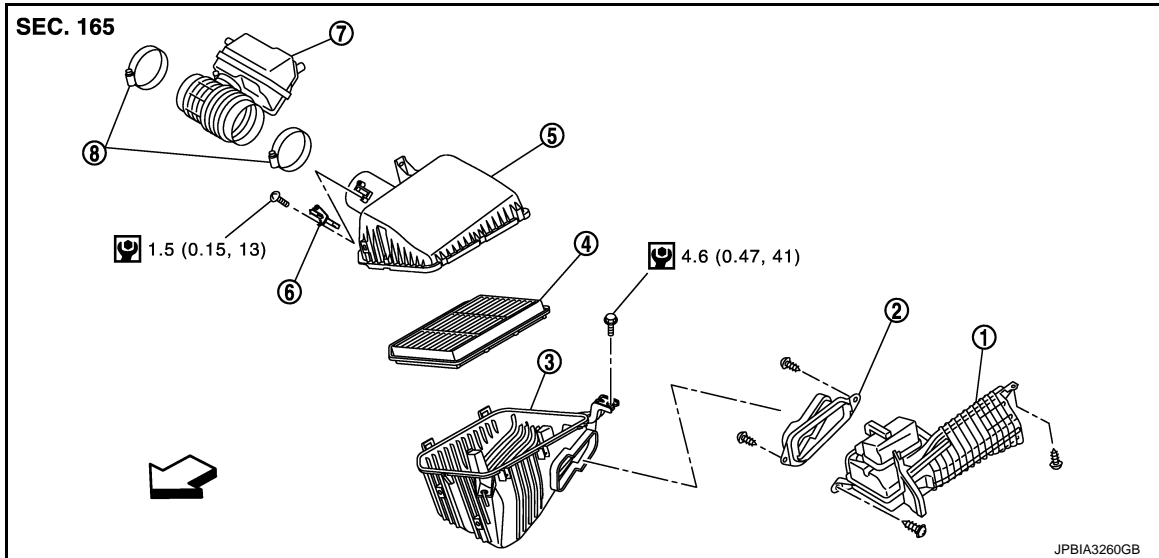
AIR CLEANER FILTER

< PERIODIC MAINTENANCE >

AIR CLEANER FILTER

Exploded View

INFOID:000000009010582



- | | | |
|-----------------------|-----------------------------|-----------------------------|
| 1. Resonator | 2. Adapter | 3. Air cleaner case (lower) |
| 4. Air cleaner filter | 5. Air cleaner case (upper) | 6. Mass air flow sensor |
| 7. Air duct | 8. Clamp | |

← Vehicle front

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

Removal and Installation

INFOID:000000009010583

REMOVAL

NOTE:

- The viscous paper type filter does not need cleaning between replacement intervals.
- Replace the air filter as necessary for periodic maintenance. Refer to the following table:

For NORTH AMERICA	MA-8, "FOR NORTH AMERICA : Introduction of Periodic Maintenance"
For MEXICO	MA-11, "FOR MEXICO : Introduction of Periodic Maintenance"

1. Unhook clips, and lift air cleaner case (upper).
2. Remove air cleaner filter from air cleaner case.

INSTALLATION

Install is the reverse order of removal.

Inspection (Viscous Paper Type)

INFOID:000000009010584

INSPECTION AFTER REMOVAL

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

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

CAUTION:

Never clean the viscous paper type air cleaner element by blowing as there is a risk of deterioration of its performance

MAINTENANCE INTERVAL

AIR CLEANER FILTER

< PERIODIC MAINTENANCE >

Refer to [MA-8, "FOR NORTH AMERICA : Introduction of Periodic Maintenance"](#) (FOR NORTH AMERICA) or [MA-11, "FOR MEXICO : Introduction of Periodic Maintenance"](#) (FOR MEXICO).

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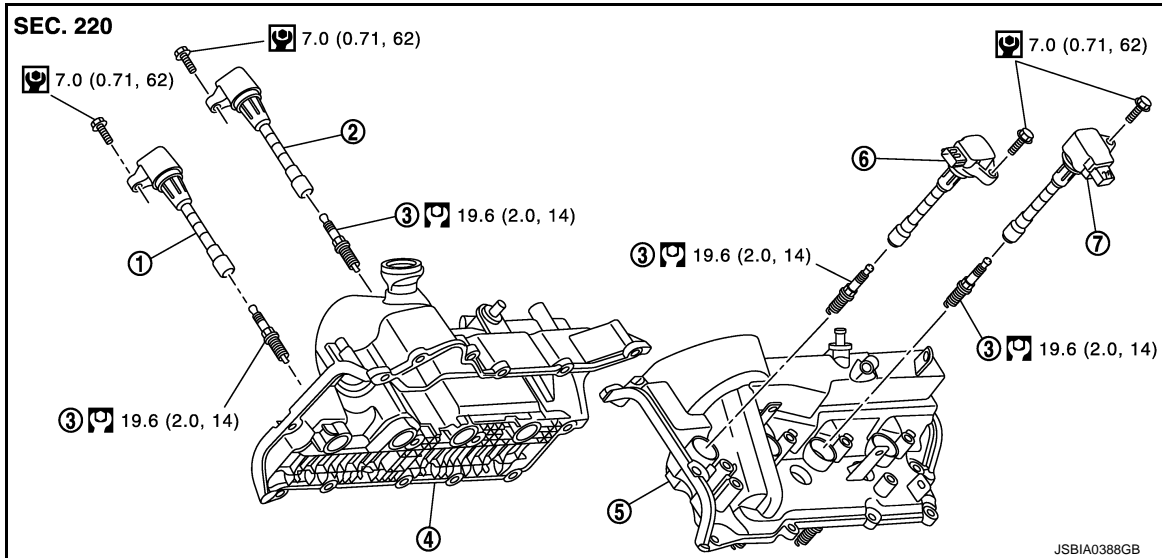
SPARK PLUG

< PERIODIC MAINTENANCE >

SPARK PLUG

Exploded View

INFOID:000000009010585



- | | | |
|-----------------------------|-----------------------------|-----------------------------|
| 1. Ignition coil (No. 2, 4) | 2. Ignition coil (No. 6, 8) | 3. Spark plug |
| 4. Rocker cover (bank 2) | 5. Rocker cover (bank 1) | 6. Ignition coil (No. 1, 3) |
| 7. Ignition coil (No. 5, 7) | | |

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

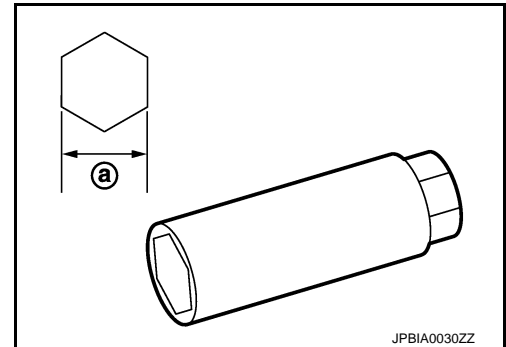
Removal and Installation

INFOID:000000009010586

REMOVAL

1. Remove engine cover. Refer to [EM-26, "Exploded View"](#).
2. Remove ignition coil. Refer to [EM-30, "Exploded View"](#).
3. Remove spark plug with a spark plug wrench (commercial service tool).

a : 14 mm (0.55 in)



INSTALLATION

Note the following item, installa is the reverse order of removal.

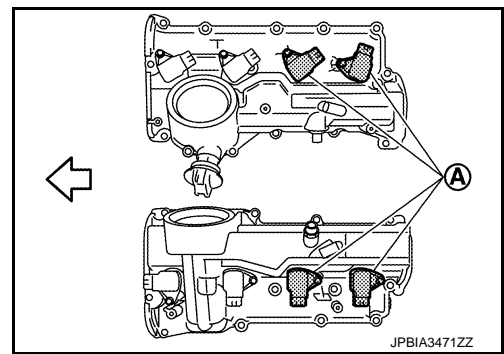
CAUTION:

SPARK PLUG

< PERIODIC MAINTENANCE >

Install ignition coil marked with an identification mark (A) on cylinder No. 5, 6, 7 and 8.

← : Engine front



INFOID:000000009010587

Inspection

INSPECTION AFTER REMOVAL

Use the standard type spark plug for normal condition.

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

CAUTION:

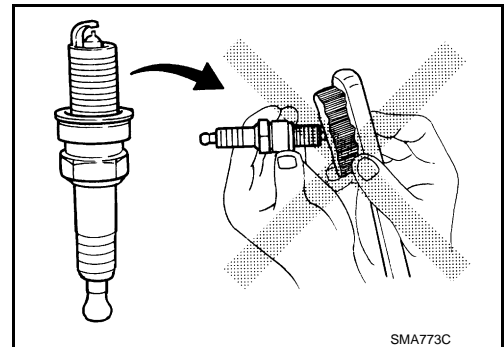
- Never drop or impact spark plug.
- Never use a wire brush for cleaning.
- If plug tip is covered with carbon, use spark plug cleaner to clean.

Cleaner air pressure

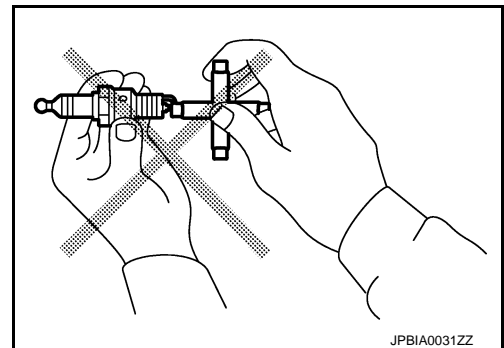
: Less than 588 kPa (6 kg/cm², 85 psi)

Cleaning time

: Less than 20 seconds



- Measure spark plug gap. When it exceeds the limit, replace spark plug even if it is within the specified replacement mileage. Refer to [EM-140, "Spark Plug"](#).
- Spark plug gap adjustment is not required between replacement intervals.



ENGINE COVER

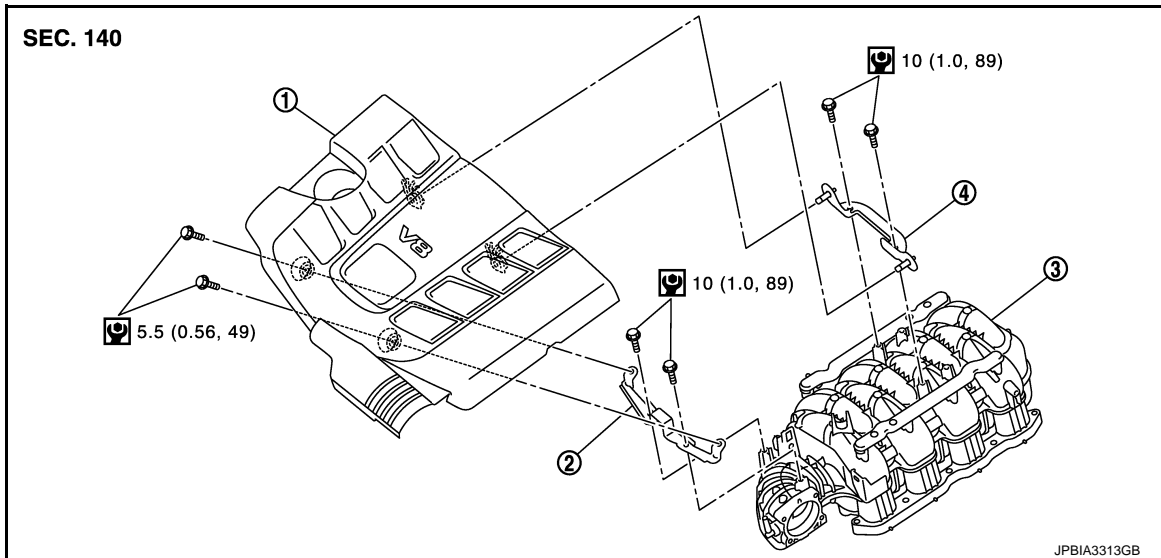
< REMOVAL AND INSTALLATION >

REMOVAL AND INSTALLATION

ENGINE COVER

Exploded View

INFOID:000000009010588



1. Engine cover
2. Bracket (front)
3. Intake manifold
4. Bracket (rear)

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

Removal and Installation

INFOID:000000009010589

REMOVAL

CAUTION:

Never damage or scratch engine cover when installing or removing.

1. Remove mounting bolts.
2. Pull forward and remove engine cover.
3. Remove bracket (front) and bracket (rear).

INSTALLATION

Installation is the reverse order of removal.

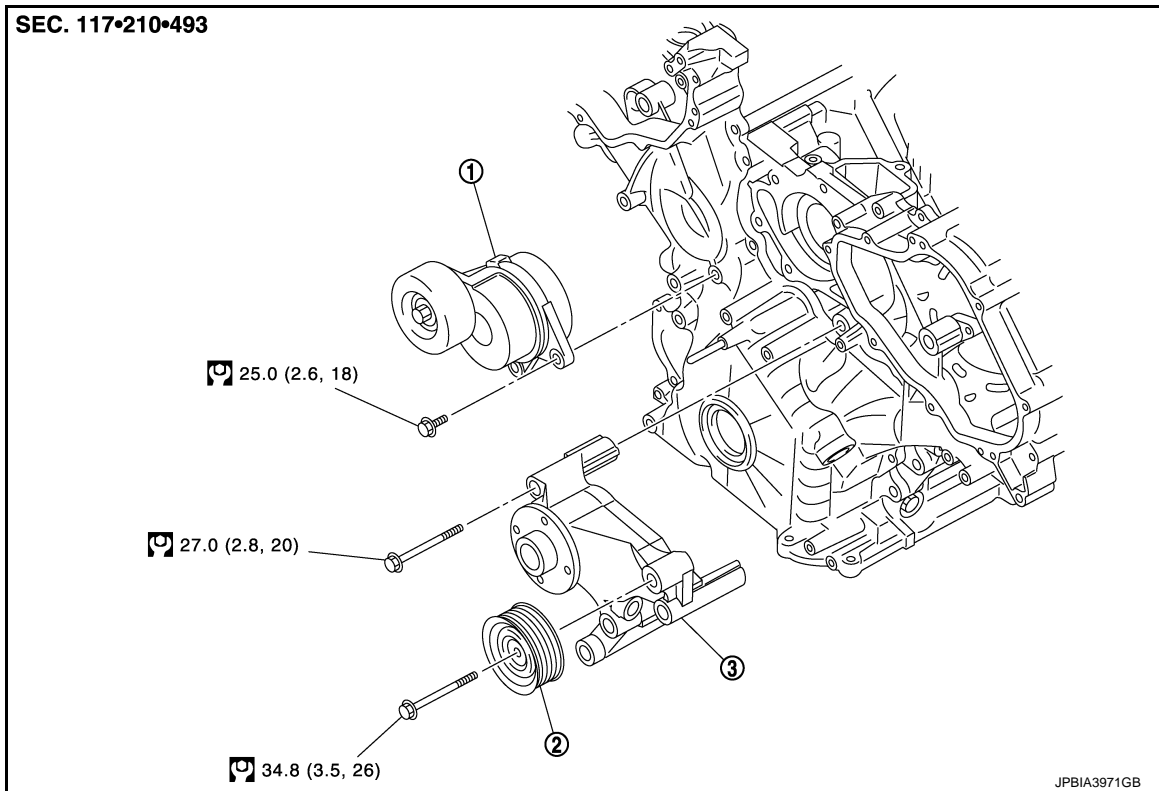
DRIVE BELT AUTO TENSIONER AND IDLER PULLEY

< REMOVAL AND INSTALLATION >

DRIVE BELT AUTO TENSIONER AND IDLER PULLEY

Exploded View

INFOID:000000009010590



1. Drive belt auto-tensioner 2. Idler pulley 3. Fan bracket

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

Removal and Installation

INFOID:000000009010591

Removal

CAUTION:

The complete drive belt auto-tensioner must be replaced as a unit, including the pulley.

1. Remove drive belts. Refer to [EM-20, "Exploded View"](#).
 - Keep auto-tensioner pulley arm locked after drive belt is removed.
2. Remove drive belt auto-tensioner.
 - Keep auto-tensioner pulley arm locked to install or remove auto-tensioner.

CAUTION:

Never loosen the hexagonal part in center of drive belt auto tensioner pulley (Never turn it clockwise). If turned clockwise, the complete drive belt auto tensioner must be replaced as a unit, including the pulley.

3. Remove idler pulley.

Installation

Installation is the reverse order of removal.

CAUTION:

Never swap the pulley between new and old drive belt auto tensioner.

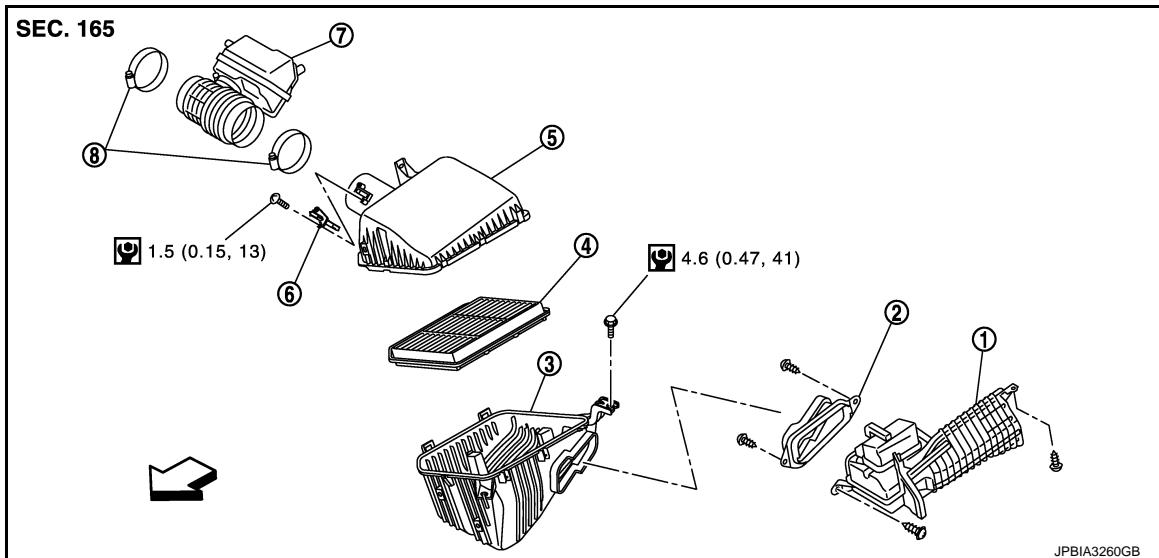
AIR CLEANER AND AIR DUCT

< REMOVAL AND INSTALLATION >

AIR CLEANER AND AIR DUCT

Exploded View

INFOID:000000009010592



- | | | |
|-----------------------|-----------------------------|-----------------------------|
| 1. Resonator | 2. Adapter | 3. Air cleaner case (lower) |
| 4. Air cleaner filter | 5. Air cleaner case (upper) | 6. Mass air flow sensor |
| 7. Air duct | 8. Clamp | |

← Vehicle front

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

Removal and Installation

INFOID:000000009010593

REMOVAL

NOTE:

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

1. Remove engine cover. Refer to [EM-26, "Exploded View"](#).
2. Disconnect mass air flow sensor harness connector.
3. Remove air cleaner case and mass air flow sensor assembly and air duct by disconnecting their joints.
 - Add matching marks, if necessary for easier installation.
4. Remove mass air flow sensor from air cleaner case, if necessary.

CAUTION:

Handle mass air flow sensor according to the following instructions.

- Never impact it.
- Never disassemble it.
- Never touch its sensor.

5. Disconnect PCV hose from air duct.
6. Remove air duct.
7. Remove air cleaner filter.
8. Remove air cleaner case (lower).
9. Remove adapter.
10. If remove resonator (location in wheel house), refer to following.
 - a. Remove LH front wheel and tire.
 - b. Remove fender protector. Refer to [EXT-24, "FENDER PROTECTOR : Exploded View"](#).
 - c. Remove resonator.

INSTALLATION

AIR CLEANER AND AIR DUCT

< REMOVAL AND INSTALLATION >

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

- Align marks. Attach each joint. Screw clamps firmly.

Clamp tightening torque : **4.5 N·m (0.46 kg-m, 40 in-lb)**

Inspection

INFOID:000000009010594

EM

INSPECTION AFTER REMOVAL

Inspect air duct assembly for crack or tear.

- If damage is found, replace air duct assembly

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F

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L

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O

P

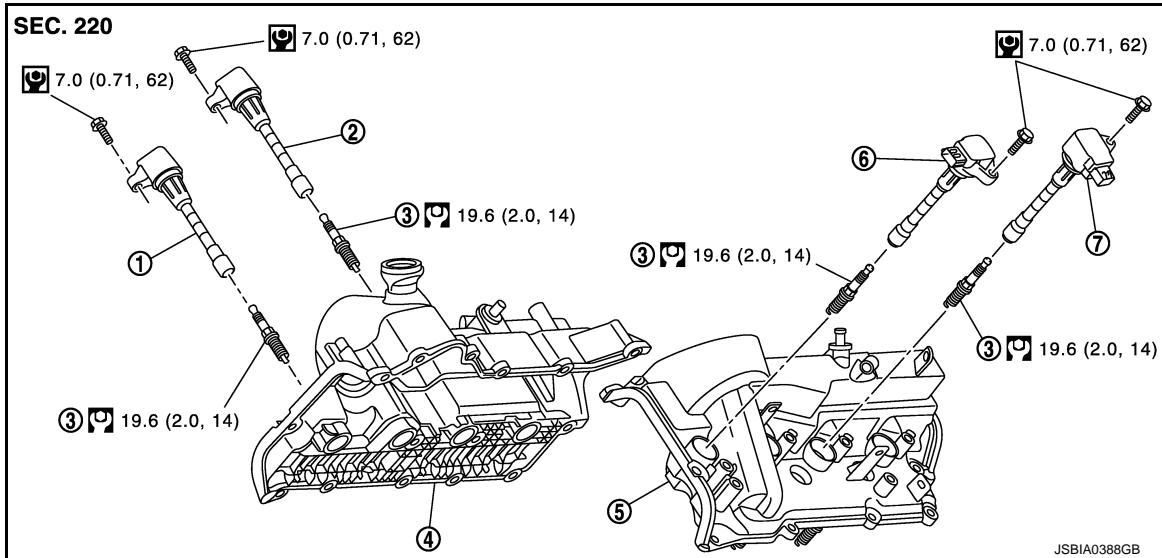
IGNITION COIL

< REMOVAL AND INSTALLATION >

IGNITION COIL

Exploded View

INFOID:000000009010595



- | | | |
|-----------------------------|-----------------------------|-----------------------------|
| 1. Ignition coil (No. 2, 4) | 2. Ignition coil (No. 6, 8) | 3. Spark plug |
| 4. Rocker cover (bank 2) | 5. Rocker cover (bank 1) | 6. Ignition coil (No. 1, 3) |
| 7. Ignition coil (No. 5, 7) | | |

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

Removal and Installation

INFOID:000000009010596

REMOVAL

1. Remove engine cover. Refer to [EM-26, "Exploded View"](#).
2. Remove ignition coil.

CAUTION:

Never impact it.

NOTE:

Installation position of ignition coil depends on cylinder position.

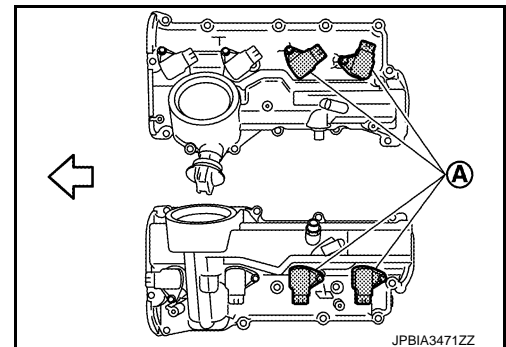
INSTALLATION

1. Install ignition coil.

CAUTION:

- Install ignition coil marked with an identification mark (A) on cylinder No. 5, 6, 7 and 8.

← : Engine front



2. Install engine cover.

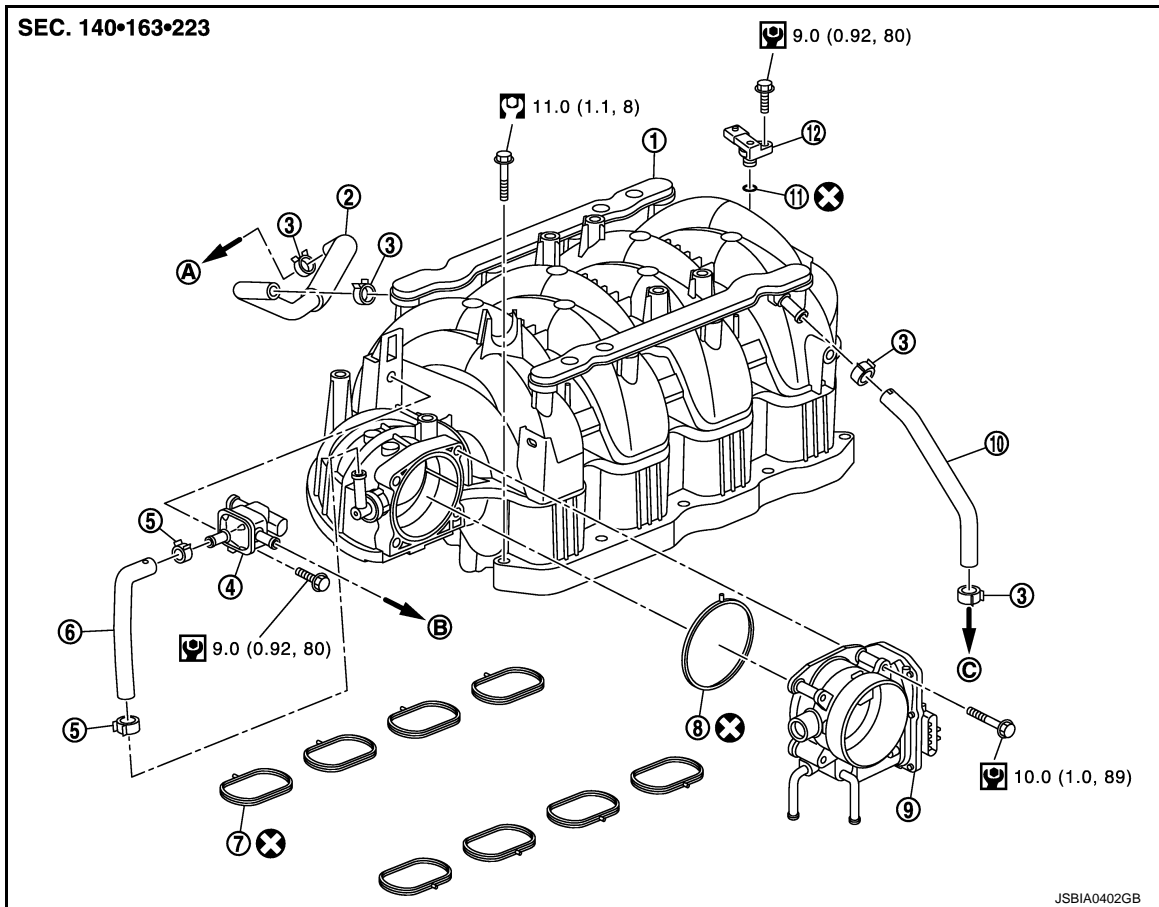
INTAKE MANIFOLD

< REMOVAL AND INSTALLATION >

INTAKE MANIFOLD

Exploded View

INFOID:000000009010597



- | | | |
|-----------------------------------------------|--------------------------------------|---------------------------------------------|
| 1. Intake manifold | 2. PCV hose | 3. Clamp |
| 4. EVAP canister purge control solenoid valve | 5. Clamp | 6. EVAP hose |
| 7. Gasket | 8. Gasket | 9. Electric throttle control actuator |
| 10. PCV hose | 11. O-ring | 12. Manifold absolute pressure (MAP) sensor |
| A. To rocker cover (bank 2) | B. To centralized under-floor piping | C. To rocker cover (bank 1) |

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

Removal and Installation

INFOID:000000009010598

REMOVAL

WARNING:

To avoid the danger of being scalded, never drain the engine coolant when the engine is hot.

1. Remove engine cover and bracket. Refer to [EM-26, "Exploded View"](#).
2. Remove air cleaner case (upper) and air duct. Refer to [EM-28, "Exploded View"](#).
3. Disconnect manifold absolute pressure (MAP) sensor harness connector.
4. Remove EVAP canister purge control solenoid valve.
5. Disconnect PCV hoses from intake manifold.
 - Add matching marks as necessary for easier installation.
6. Drain engine coolant from radiator. Refer to [CO-8, "Draining"](#).

CAUTION:

- Perform this step when the engine is cold.

INTAKE MANIFOLD

< REMOVAL AND INSTALLATION >

- **Never spill engine coolant on drive belts.**

NOTE:

When removing only intake manifold, move electric throttle control actuator without disconnecting the water hoses.

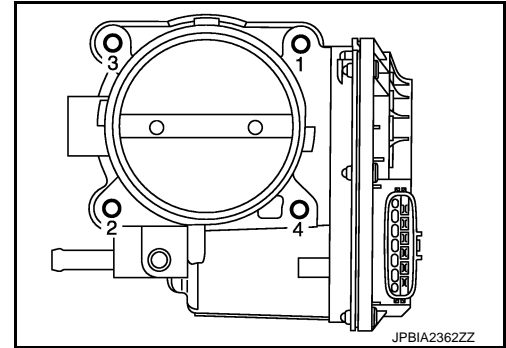
7. Remove electric throttle control actuator.
 - Loosen mounting bolts in reverse order as shown in the figure.

NOTE:

The figure shows the electric throttle control actuator viewed from the air duct side.

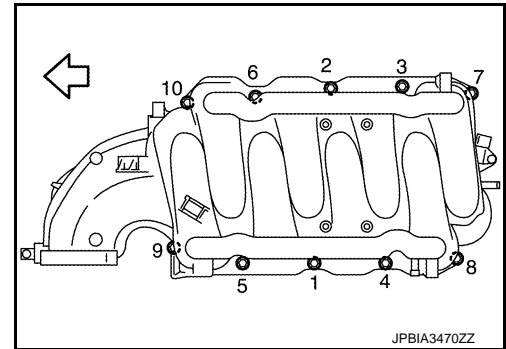
CAUTION:

- **Handle carefully to avoid any impact to electric throttle control actuator.**
- **Never disassemble.**



8. Remove intake manifold, using a power tool.
 - Loosen mounting bolts in reverse order as shown in the figure.

⇐ : Engine front



9. Remove intake manifold gaskets.

CAUTION:

Cover engine openings to avoid entry of foreign materials.

10. Remove manifold absolute pressure (MAP) sensor, if necessary.

CAUTION:

Handle carefully to avoid any impact to manifold absolute pressure (MAP) sensor.

INSTALLATION

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

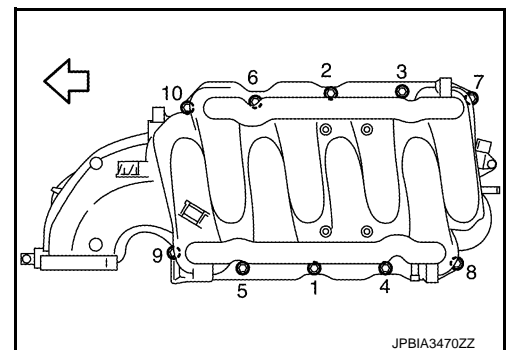
CAUTION:

Do not reuse O-rings.

Intake Manifold

Tighten in numerical order as shown in the figure.

⇐ : Engine front



Electric Throttle Control Actuator

INTAKE MANIFOLD

< REMOVAL AND INSTALLATION >

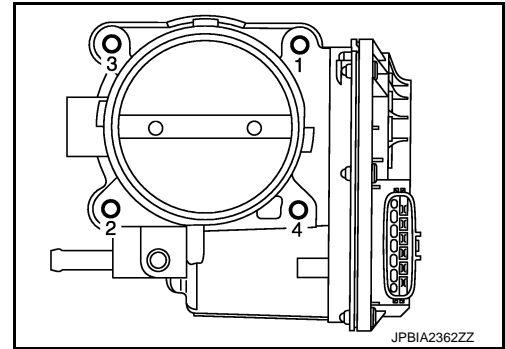
- Tighten in numerical order as shown in the figure.

NOTE:

The figure shows the electric throttle control actuator viewed from the air duct side.

- Perform the “Throttle Valve Closed Position Learning” when harness connector of electric throttle control actuator is disconnected. Refer to the following table:

ENGINE	Reference page
VK56VD FOR USA AND CANADA	EC-162, "Description"
VK56VD FOR MEXICO	EC-725, "Description"



- Perform the “Idle Air Volume Learning” and “Throttle Valve Closed Position Learning” when electric throttle control actuator is replaced. Refer to the following table:

ENGINE	Reference page	
	Idle Air Volume Learning	Throttle Valve Closed Position Learning
VK56VD FOR USA AND CANADA	EC-163, "Description"	EC-162, "Description"
VK56VD FOR MEXICO	EC-726, "Description"	EC-725, "Description"

A
EM
C
D
E
F
G
H
I
J
K
L
M
N
O
P

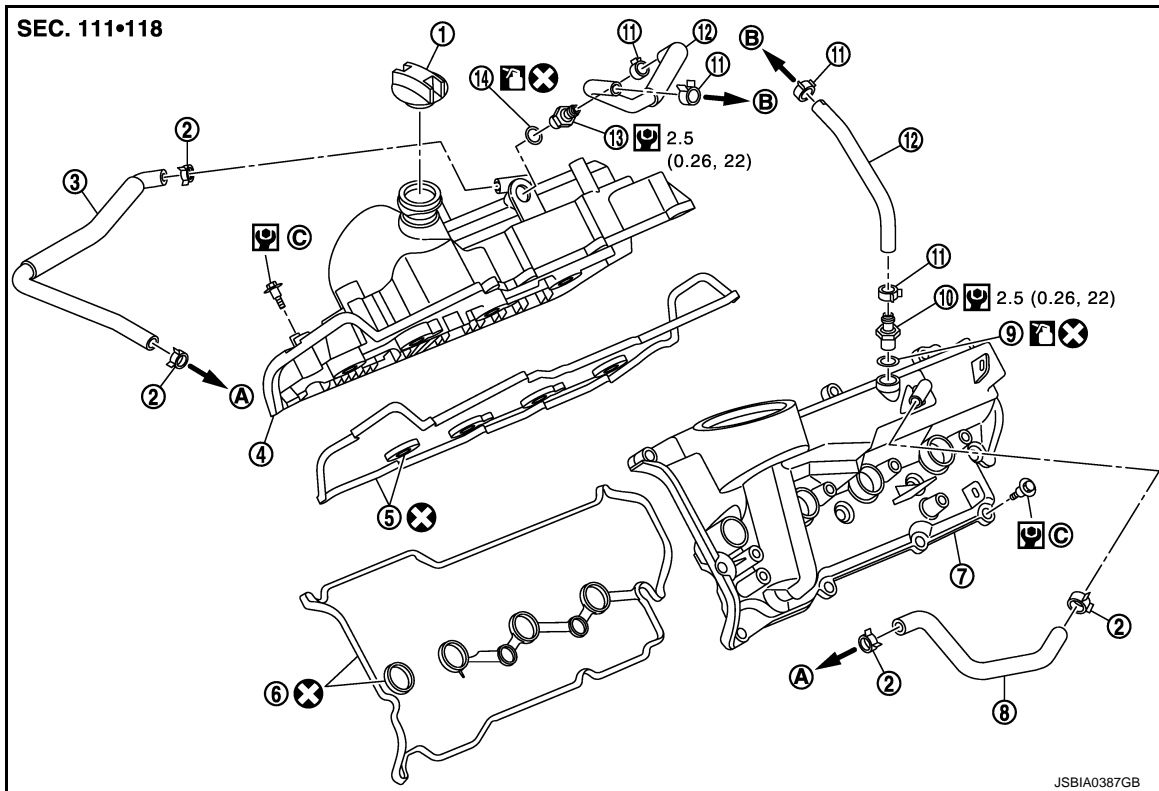
ROCKER COVER

< REMOVAL AND INSTALLATION >

ROCKER COVER

Exploded View

INFOID:000000009010599



- | | | |
|--------------------------|---------------------------------|---------------------------------|
| 1. Oil filler cap | 2. Clamp | 3. PCV hose |
| 4. Rocker cover (bank 2) | 5. Rocker cover gasket (bank 2) | 6. Rocker cover gasket (bank 1) |
| 7. Rocker cover (bank 1) | 8. PCV hose | 9. O-ring |
| 10. PCV valve | 11. Clamp | 12. PCV hose |
| 13. PCV valve | 14. O-ring | |

A. To air duct

B. To intake manifold

C. Comply with the installation procedure when tightening. Refer to [EM-34](#).

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

Removal and Installation

INFOID:000000009010600

REMOVAL

1. Remove engine cover and bracket (rear). Refer to [EM-26, "Exploded View"](#).
 2. Disconnect PCV hose from rocker cover.
 3. Remove air cleaner case (upper) and air duct. Refer to [EM-28, "Exploded View"](#).
 4. Move the following parts to the position without the hindrance for work.
 - Oil level gauge guide. Refer to [EM-59, "Exploded View"](#).
 - Power steering fluid reservoir tank bracket. Refer to [ST-54, "Exploded View"](#).
 - EVAP canister purge control solenoid valve. [EM-31, "Exploded View"](#).
 - Fuel feed hose. Refer to [EM-44, "Exploded View"](#).
 5. Remove VVEL actuator motor assembly. Refer to [EM-37, "Exploded View"](#).
 6. Remove ignition coil. Refer to [EM-30, "Exploded View"](#).
- CAUTION:**
Never impact it.
7. Remove rocker cover.

ROCKER COVER

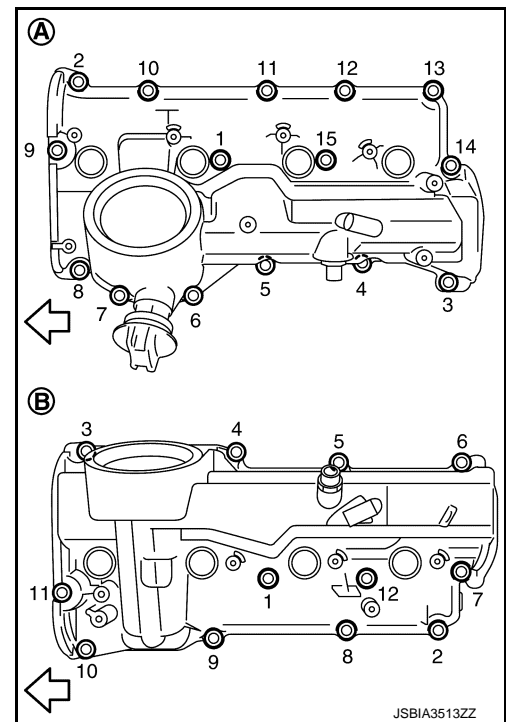
< REMOVAL AND INSTALLATION >

- Loosen bolts in reverse order shown in the figure.

A : Bank 2

B : Bank 1

⇐ : Engine front



- Remove rocker cover gasket from rocker cover.
- Use scraper to remove all traces of liquid gasket from cylinder head & VVEL ladder assembly.
CAUTION:
Never scratch or damage the mating surface when cleaning off old liquid gasket.
- Remove PCV valve from rocker cover, if necessary.
- Remove oil filler cap from rocker cover, if necessary.

INSTALLATION

CAUTION:

Do not reuse O-rings.

- Apply liquid gasket with the tube presser (commercial service tool) to VVEL ladder assembly (1).

A : Liquid gasket application point

F : End surface of VVEL ladder assembly

b : 4.0 mm (0.16 in)

c : 2.5 - 3.5 mm (0.098 - 0.138 in)

d : 5.0 mm (0.20 in)

e : 10.0 mm (0.39 in)

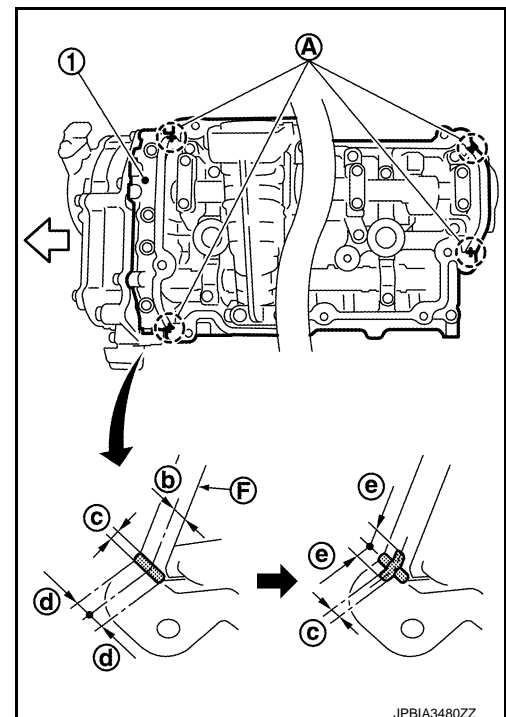
⇐ : Engine front

Use Genuine RTV silicone sealant or equivalent. Refer to [GI-22. "Recommended Chemical Products and Sealants"](#).

NOTE:

The figure shows an example of bank 1 side.

- Apply liquid gasket on the front and rear side of engine first. [5 mm (0.20 in) + 5 mm (0.20 in) side as shown in the figure]



- Install rocker cover gasket to rocker cover.
- Install rocker cover.

ROCKER COVER

< REMOVAL AND INSTALLATION >

- Check that rocker cover gasket does not drop from the installation groove of rocker cover.

4. Tighten bolts in two steps separately in numerical order as shown in the figure.

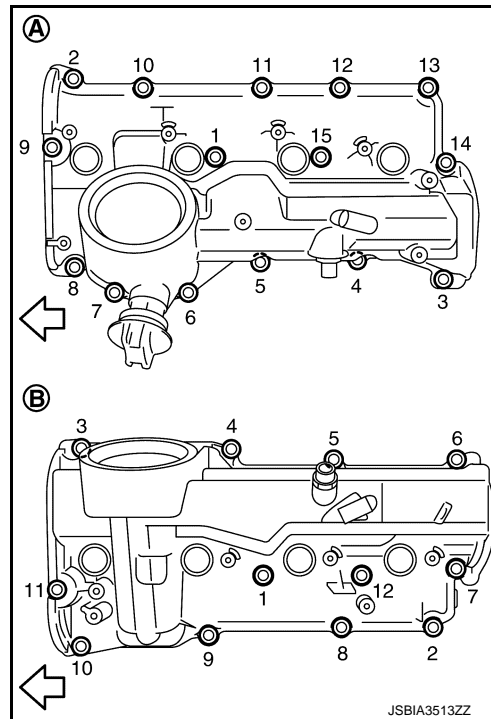
A : Bank 2

B : Bank 1

⇐ : Engine front

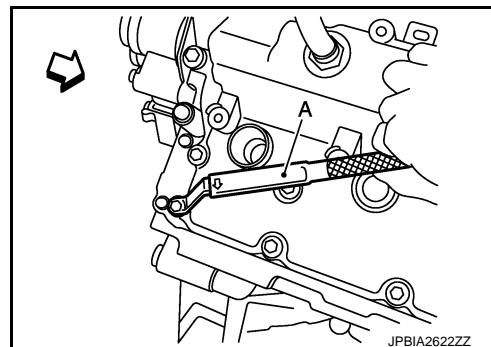
1st step :  **2.0 N·m (0.2 kg·m, 18 in·lb)**

2nd step :  **8.3 N·m (0.85 kg·m, 73 in·lb)**



- Because of the limited working space, use adapter and torque wrench assembly [SST: KV10119300 (—)] (A) to tighten bolts (on the No.7 and No. 8 cylinders) to the specified torque.

⇐ : Engine front

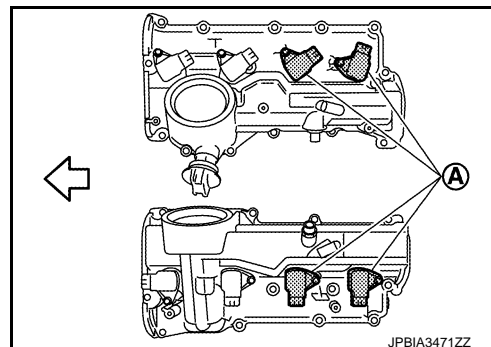


5. Install ignition coil. Refer to [EM-30. "Exploded View"](#).

CAUTION:

- Install Ignition coil marked with an identification mark (A) on cylinder No. 5, 6, 7 and 8.

⇐ : Engine front



6. Install VVEL actuator motor assembly. Refer to [EM-37. "Exploded View"](#).
 7. Install in the reverse order of removal.

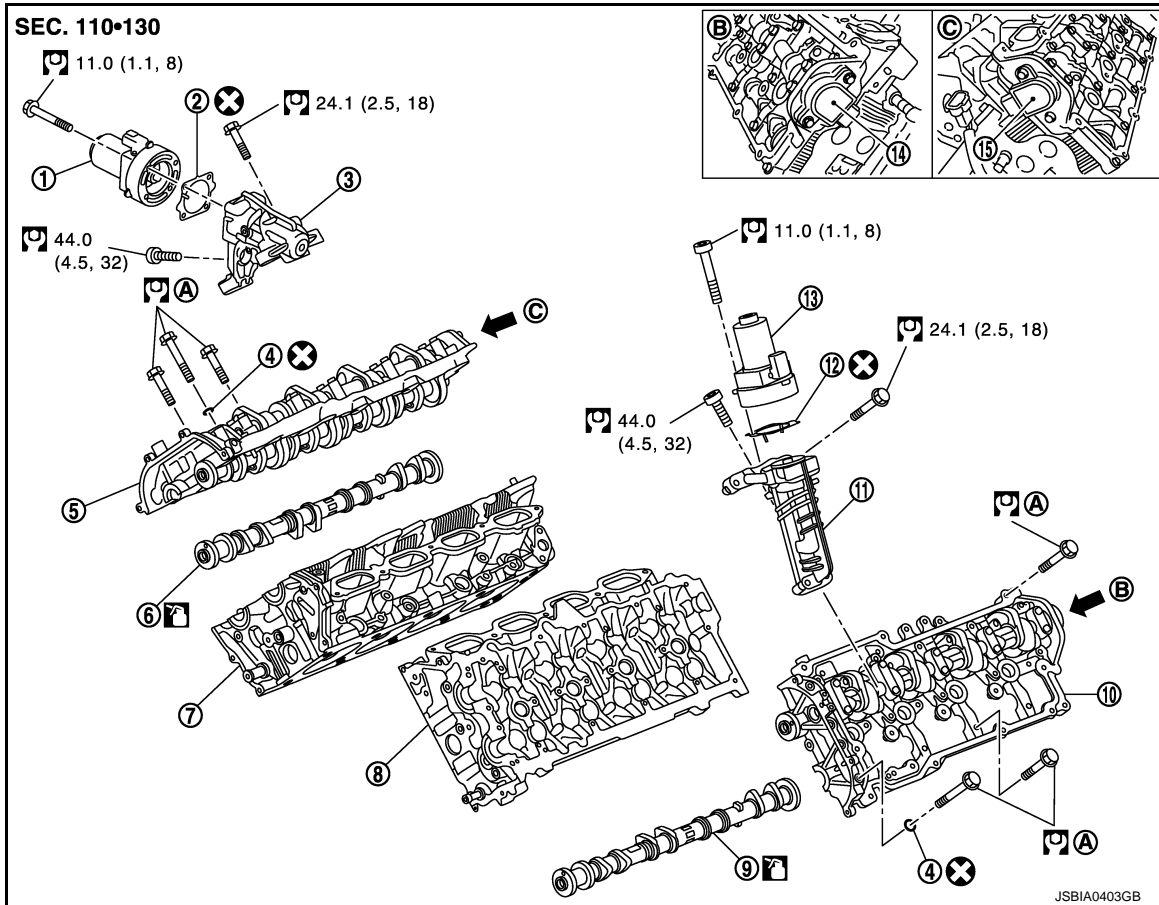
VVEL ACTUATOR ASSEMBLY

< REMOVAL AND INSTALLATION >

VVEL ACTUATOR ASSEMBLY

Exploded View

INFOID:000000009010601



- | | | |
|-------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| 1. VVEL actuator motor assembly (bank 2) | 2. Gasket | 3. VVEL actuator housing assembly (bank 2) |
| 4. Washer | 5. VVEL ladder assembly (bank 2) | 6. Exhaust camshaft (bank 2) |
| 7. Cylinder head (bank 2) | 8. Cylinder head (bank 1) | 9. Exhaust camshaft (bank 1) |
| 10. VVEL ladder assembly (bank 1) | 11. VVEL actuator housing assembly (bank 1) | 12. Gasket |
| 13. VVEL actuator motor assembly (bank 1) | 14. VVEL control shaft position sensor (bank 1) | 15. VVEL control shaft position sensor (bank 2) |

Comply with the installation procedure when tightening. Refer to [EM-80](#).

B. View B

C. View C

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

Removal and Installation

INFOID:000000009010602

REMOVAL

1. Remove engine cover. Refer to [EM-26, "Exploded View"](#).

VVEL ACTUATOR ASSEMBLY

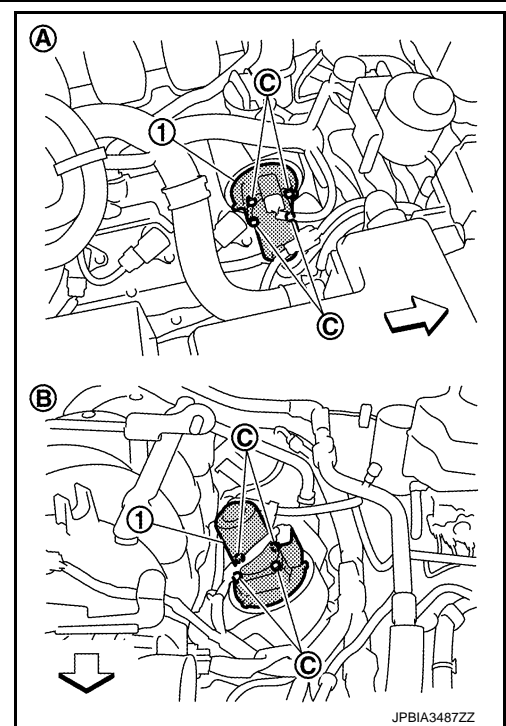
< REMOVAL AND INSTALLATION >

- Loosen mounting bolts (C), and then remove VVEL actuator motor assembly (1).

A : Bank 2

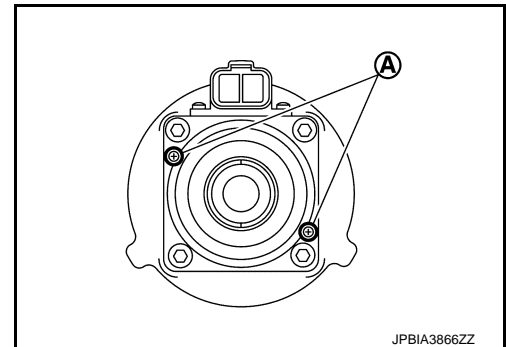
B : Bank 1

⇐ : Engine front

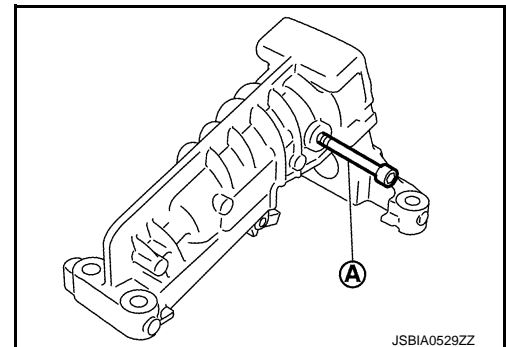


CAUTION:

Never loosen screws (A) of VVEL actuator motor assembly.



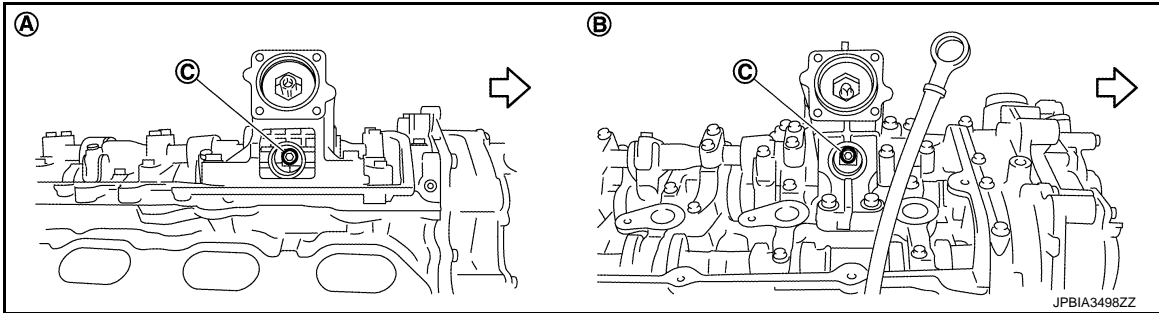
- Remove rocker cover. Refer to [EM-34. "Exploded View"](#).
- Insert mounting bolt (A) removed at step 2 into VVEL actuator housing assembly.



- Loosen mounting bolt (C) to disengage the control shaft and the actuator arm.

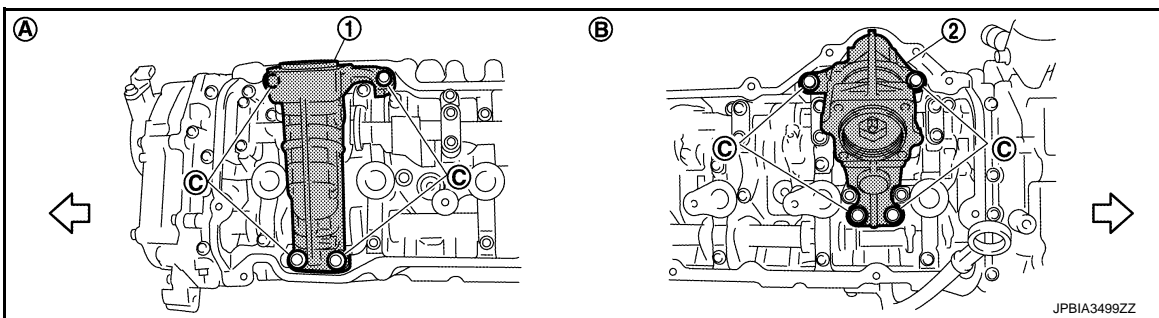
VVEL ACTUATOR ASSEMBLY

< REMOVAL AND INSTALLATION >



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

6. Loosen mounting bolts (C), and then remove VVEL actuator housing assembly.



1. VVEL actuator housing assembly (bank 1) 2. VVEL actuator housing assembly (bank 2)
 A. Bank 1 B. Bank 2
 ⇐ : Engine front

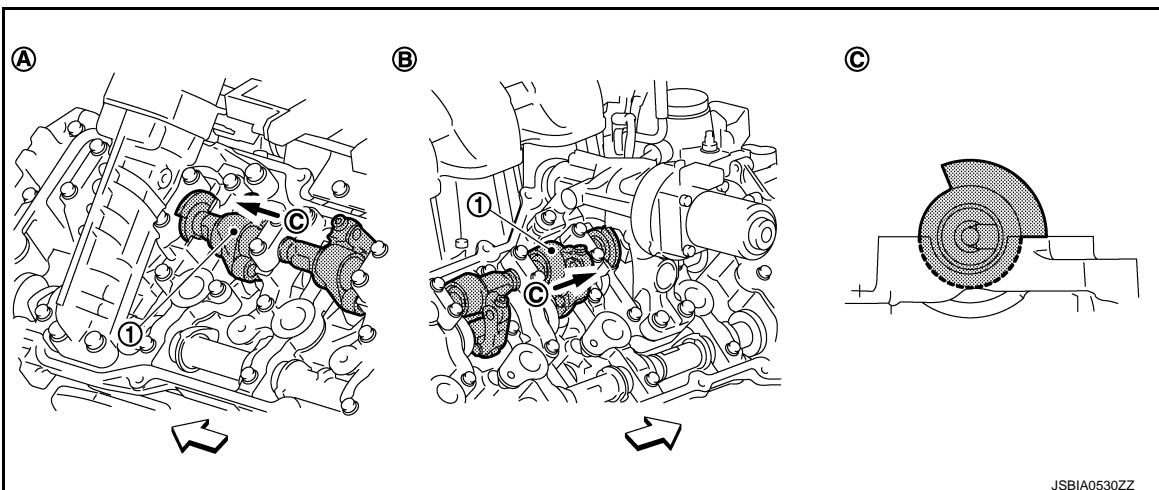
INSTALLATION

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

CAUTION:

Do not reuse washers.

- When disengaging the control shaft (1) and the actuator arm, hold the stopper of the control shaft in the position shown in the figure.



- A. Bank 1 B. Bank 2 C. View C
 ⇐ : Engine front

VVEL ACTUATOR ASSEMBLY

< REMOVAL AND INSTALLATION >

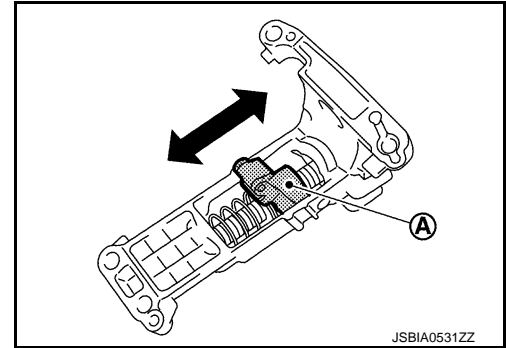
Inspection

INFOID:000000009010603

INSPECTION AFTER REMOVAL

VVEL actuator housing assembly

- Move the ball nut (A) in the axial direction to check the smooth rotation.



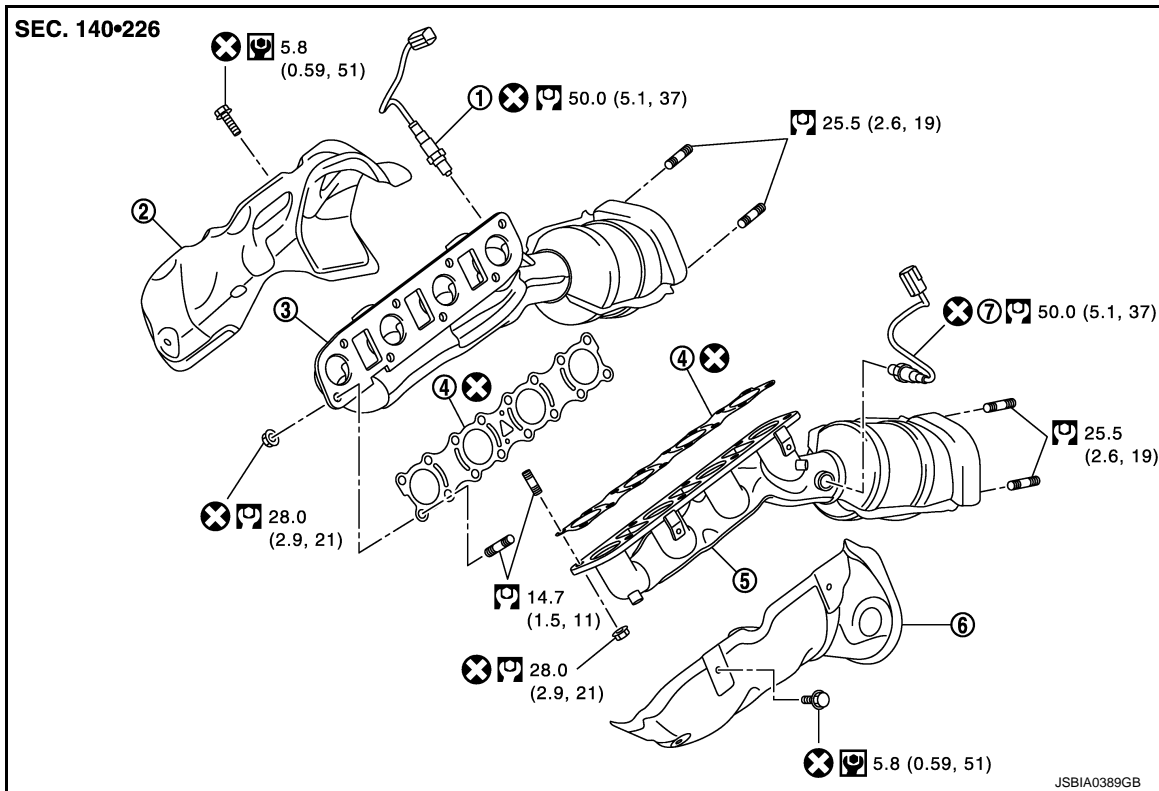
EXHAUST MANIFOLD AND THREE WAY CATALYST

< REMOVAL AND INSTALLATION >

EXHAUST MANIFOLD AND THREE WAY CATALYST

Exploded View

INFOID:000000009010604



- | | | |
|-------------------------------------|-----------------------------------------------------|-----------------------------------------------------|
| 1. Air fuel ratio sensor 1 (bank 2) | 2. Exhaust manifold cover (bank 2) | 3. Exhaust manifold and three way catalyst (bank 2) |
| 4. Gasket | 5. Exhaust manifold and three way catalyst (bank 1) | 6. Exhaust manifold cover (bank 1) |
| 7. Air fuel ratio sensor 1 (bank 1) | | |

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

Removal and Installation

INFOID:000000009010605

REMOVAL

WARNING:

Perform the work when the exhaust and cooling system have cooled sufficiently.

1. Drain engine coolant from radiator. Refer to [CO-8. "Draining"](#).
CAUTION:
 - Perform this step when the engine is cold.
 - Never spill engine coolant on drive belt.
2. Remove reservoir tank. Refer to [CO-14. "Exploded View"](#).
3. Remove drive belt. Refer to [EM-20. "Removal and Installation"](#).
4. Remove power steering oil pump. Refer to [ST-48. "Exploded View"](#).
5. Remove radiator. Refer to [CO-14. "Exploded View"](#).
6. Remove front under cover. Refer to [EXT-26. "Exploded View"](#).
7. Remove front wheels and tires. Refer to [WT-63. "Exploded View"](#).
8. Remove A/C compressor. Refer to [HA-30. "Exploded View"](#).
9. Remove alternator and alternator bracket. Refer to [CHG-28. "Exploded View"](#).
10. Remove exhaust front tube (bank 1 and bank 2). Refer to [EX-5. "Exploded View"](#).

EXHAUST MANIFOLD AND THREE WAY CATALYST

< REMOVAL AND INSTALLATION >

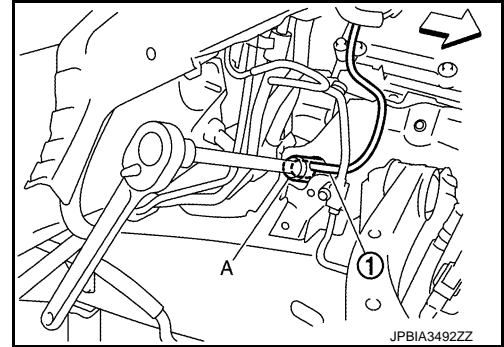
11. Remove front propeller shaft. Refer to [DLN-136, "Exploded View"](#).
12. Disconnect steering lower joint. Refer to [ST-37, "Exploded View"](#).
13. Remove air fuel ratio sensor 1 as per the following:

CAUTION:

Air fuel ratio sensor 1 is not reusable. Never remove air fuel ratio sensor 1 unless this is required.

- Using the heated oxygen sensor wrench [SST: KV10117100 (J-44626)] (A), remove air fuel ratio sensor 1 (1).

↔ : Vehicle front

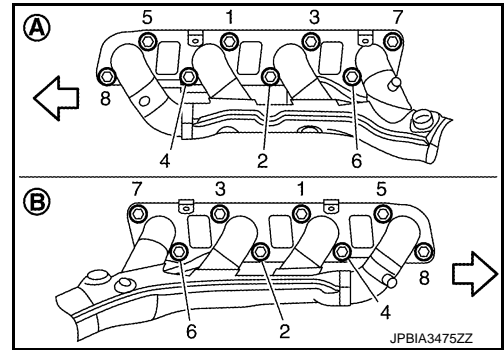


14. Remove exhaust manifold cover.
15. Remove oil level gauge guide. Refer to [EM-59, "Exploded View"](#).
16. Remove exhaust manifold.
 - Loosen nuts in the reverse order of figure to remove exhaust manifold with a power tool.

A : Bank 1

B : Bank 2

↔ : Engine front



17. Remove exhaust manifold gaskets.

CAUTION:

Cover engine openings to avoid entry of foreign materials.

INSTALLATION

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

Exhaust Manifold Gasket

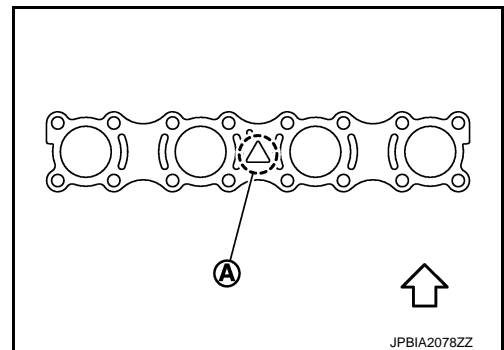
- Install exhaust manifold gasket in directional shown in the figure.

A : Triangle press

↔ : Above

NOTE:

When install exhaust manifold gasket, coating surface (black) shall be located on the exhaust manifold side.



Exhaust Manifold

EXHAUST MANIFOLD AND THREE WAY CATALYST

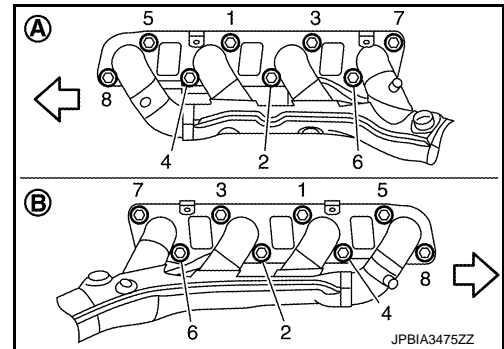
< REMOVAL AND INSTALLATION >

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

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

CAUTION:

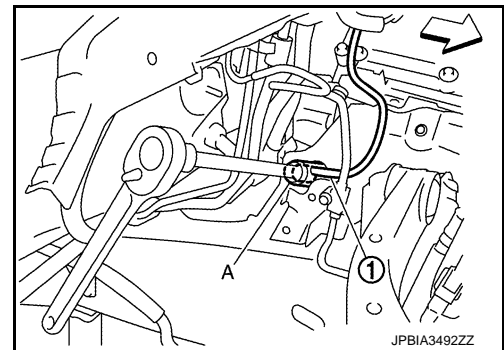
All exhaust manifold nuts are tightened at twice.



Air Fuel Ratio Sensor 1

CAUTION:

- Before installing a new air fuel ratio sensor 1, clean exhaust system threads using oxygen sensor thread cleaner (commercial service tool: J-43897-18 or J-43897-12), and apply anti-seize lubricant (commercial service tool).
- Air fuel ratio sensor 1 is not reusable. Replace them with a new one after removal. When replacing them, handle with care not to impact on them.
- When installing the new air fuel ratio sensors 1 (1), set the heated oxygen sensor wrench [SST: KV10117100(J-44626)] (A) in the hexagonal part to tighten the them.



- Never over torque sensors. Doing so may cause damage to the sensors, resulting in "MIL" coming on.
- Prevent rust preventives from adhering to the sensor body.

Inspection

INFOID:000000009010606

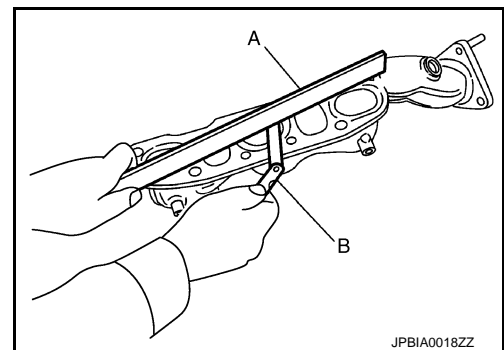
INSPECTION AFTER DISASSEMBLY

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-141, "Exhaust Manifold"](#).

- If it exceeds the limit, replace exhaust manifold.



HIGH PRESSURE FUEL PUMP AND FUEL HOSE

< REMOVAL AND INSTALLATION >

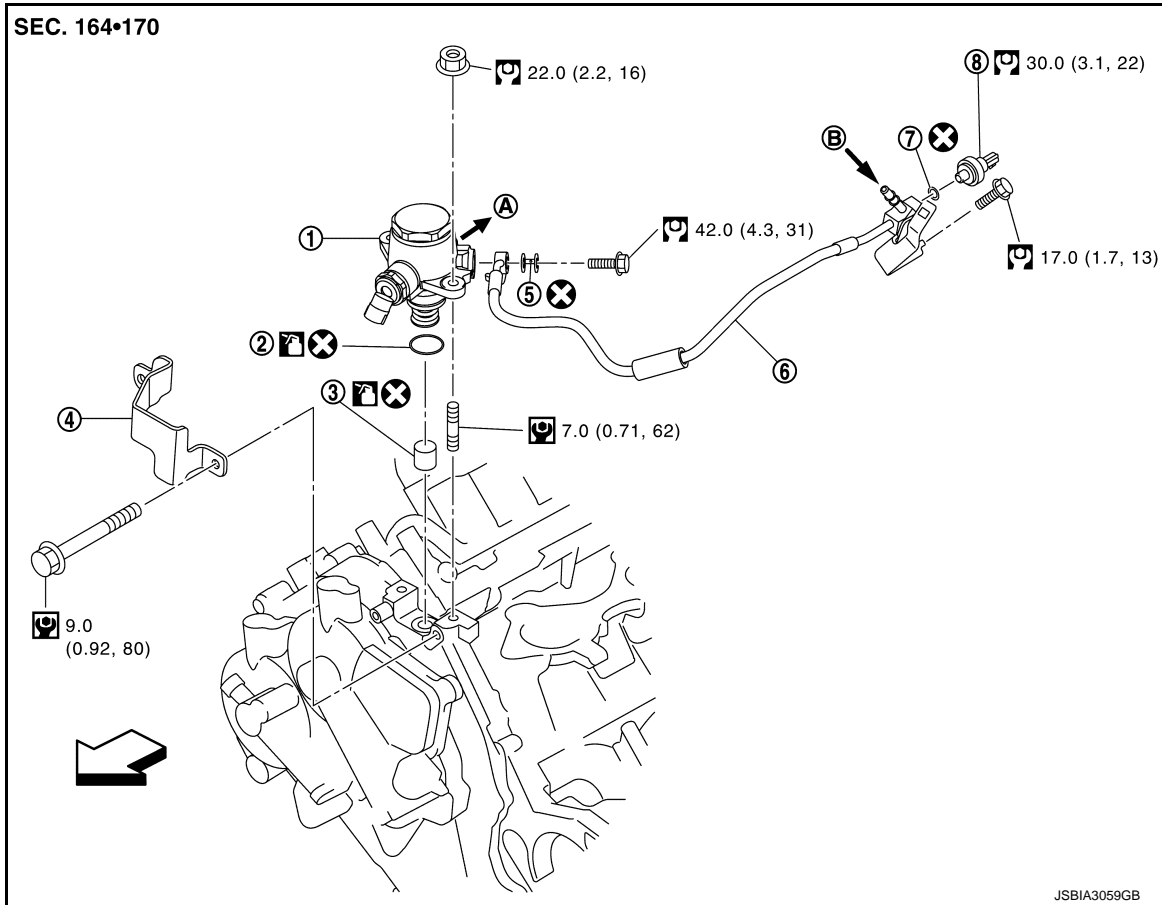
HIGH PRESSURE FUEL PUMP AND FUEL HOSE

Exploded View

INFOID:000000009010607

CAUTION:

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



- | | | |
|----------------------------------|-----------------------------|-------------------|
| 1. High pressure fuel pump | 2. O-ring | 3. Lifter |
| 4. Fuel pump connector protector | 5. Copper washer | 6. Fuel feed hose |
| 7. Copper washer | 8. Low fuel pressure sensor | |
| A. To fuel feed tube (pump side) | B. From fuel tank | |

↔ : Engine front

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

Removal and Installation

INFOID:000000009010608

REMOVAL

WARNING:

- Be sure to read [EM-3, "Precaution for Handling High Pressure Fuel System"](#) when working on the high pressure fuel system.
- Put a "CAUTION: FLAMMABLE" sign in the workshop.
- Be sure to work in a well ventilated area and furnish workshop with a CO₂ fire extinguisher.
- Never smoke while servicing fuel system. Keep open flames and sparks away from the work area.
- To avoid the danger of being scalded, never drain engine coolant when engine is hot.

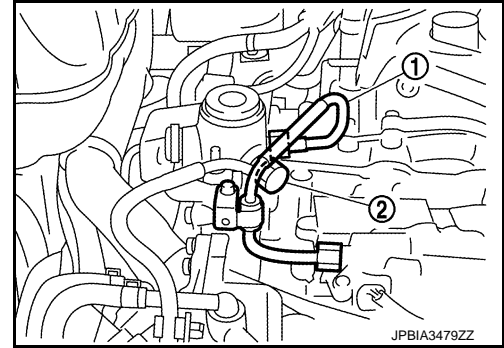
1. Release fuel pressure. Refer to the following table:

HIGH PRESSURE FUEL PUMP AND FUEL HOSE

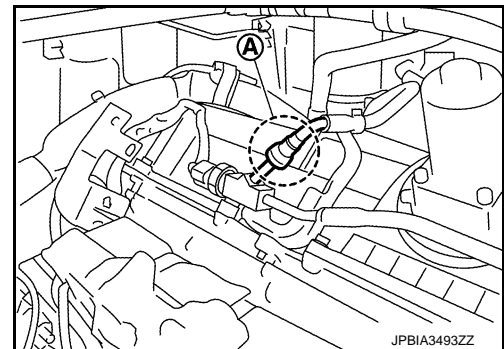
< REMOVAL AND INSTALLATION >

ENGINE	Reference page
VK56VD FOR USA AND CANADA	EC-168. "Work Procedure"
VK56VD FOR MEXICO	EC-731. "Work Procedure"

- Remove intake manifold. Refer to [EM-31. "Removal and Installation"](#).
- Disconnect harness connector from high pressure fuel pump.
- Remove fuel feed tube (pump side) (1). Refer to [EM-49. "Exploded View"](#).
- Disconnect fuel feed hose (2) from high pressure fuel pump.



- Remove high pressure fuel pump and lifter.
CAUTION:
After removing lifter, replace lifter with a new one.
- Disconnect quick connector (A) with the following procedure.



- Remove quick connector cap from quick connector connection.
- With the sleeve side of quick connector release facing quick connector, install quick connector release onto fuel tube.
- Insert quick connector release into quick connector until sleeve contacts and goes no further. Hold quick connector release on that position.

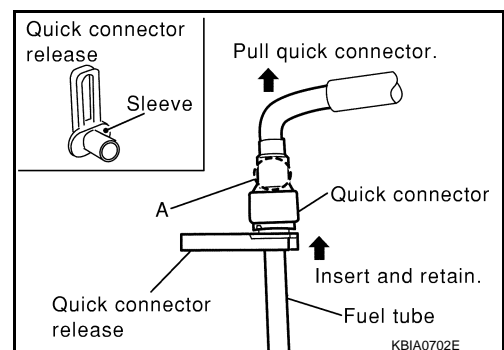
CAUTION:

Inserting quick connector release hard will not disconnect quick connector. Hold quick connector release where it contacts and goes no further.

- Draw and pull out quick connector straight from fuel tube.

CAUTION:

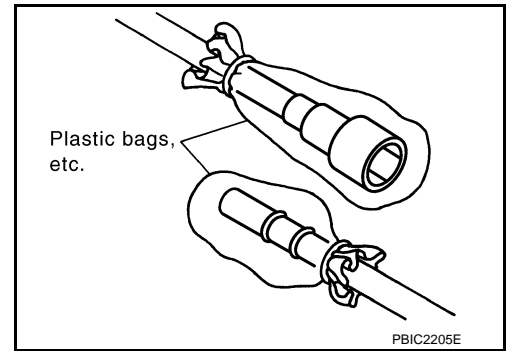
- Pull quick connector holding (A) position as shown in the figure.
- Never pull with lateral force applied. O-ring inside quick connector may be damaged.
- Prepare container and cloth beforehand because fuel will leak out.
- Avoid fire and sparks.
- Keep parts away from heat source. Especially, be careful 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.



HIGH PRESSURE FUEL PUMP AND FUEL HOSE

< REMOVAL AND INSTALLATION >

- To keep clean the connecting portion and to avoid damage and foreign materials, cover them completely with plastic bags, etc. or a similar item.



8. Disconnect harness connector from low fuel pressure sensor.
9. Remove fuel feed hose.
10. Remove low fuel pressure sensor.

CAUTION:

- Never allow water and foreign materials enter into the connector.
- Never reuse the dropped sensor.
- Carefully handle sensor avoiding shocks.
- Use hex head support installation for removal and installation of sensor.
- The contact surface of gasket must not have any stain or scoring by dust etc.

INSTALLATION

CAUTION:

Do not reuse O-rings or washers.

1. Install O-ring to high pressure fuel pump. When handling new O-ring, paying attention to the following caution items:

CAUTION:

- Do not reuse O-ring.
- 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 front cover.
- Insert new O-ring straight into high pressure fuel pump. Never decenter or twist it.

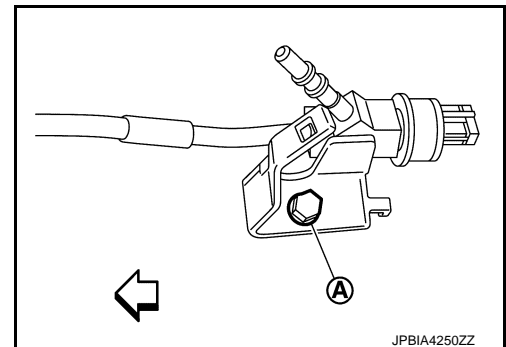
2. Install low fuel pressure sensor.

CAUTION:

Do not reuse copper washer.

3. Install fuel feed hose.
 - Temporarily tighten mounting bolt (A) as shown in the figure.

⇐ : Engine front



4. Install high pressure fuel pump and lifter to front cover.

CAUTION:

After removing lifter, replace lifter with a new one.

5. Connect fuel feed hose and fuel feed tube (pump side) to high pressure fuel pump. Refer to [EM-49, "Exploded View"](#).

CAUTION:

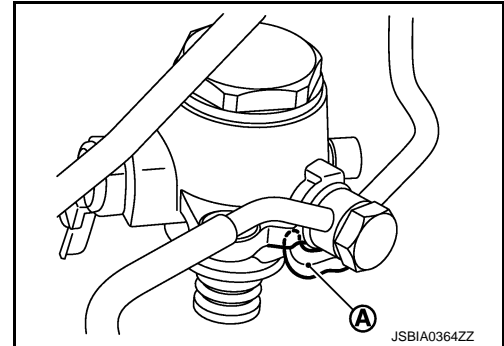
HIGH PRESSURE FUEL PUMP AND FUEL HOSE

< REMOVAL AND INSTALLATION >

- Do not reuse copper washer.
- When removing fuel feed tube (pump side), always replace fuel feed tube (bank side) together with fuel feed tube (pump side).

NOTE:

- Never allow the machined edge of the high pressure fuel pump to contact with gasket.
- The gasket contact area must be free of dust and scratches.
- Check that rotation stopper (A) of fuel feed hose contact high pressure fuel pump.



6. Tighten mounting bolts that are temporarily tightened in step 3.
7. Connect harness connector to high pressure fuel pump.
8. Install fuel pump connector protector.
9. Connect harness connector to low fuel pressure sensor.
10. Note the following, and connect quick connector to install fuel feed hose.
 - a. Check the connection for foreign material and damage.
 - b. Align center to insert quick connector straightly into fuel tube.

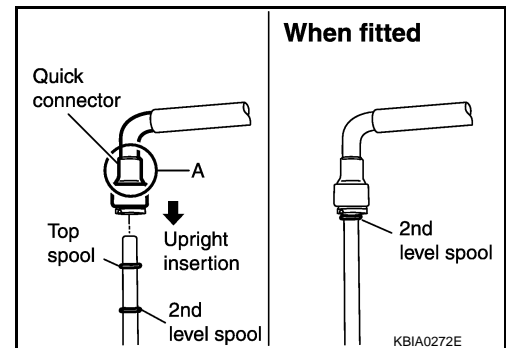
NOTE:

The figure shows engine side as an example.

- Insert fuel tube into quick connector until the top spool on fuel tube is inserted completely and the second level spool is positioned slightly below quick connector bottom end.

CAUTION:

- Hold "A" position in the figure when inserting fuel tube into quick connector.
- 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.



- c. Before clamping fuel feed hose with hose clamps, pull quick connector hard by hand holding "A" position. Check it is completely engaged (connected) so that it does not come out from fuel feed tube.
- d. Install quick connector cap to quick connector connection.
 - Install so that the arrow mark on the side faces up.

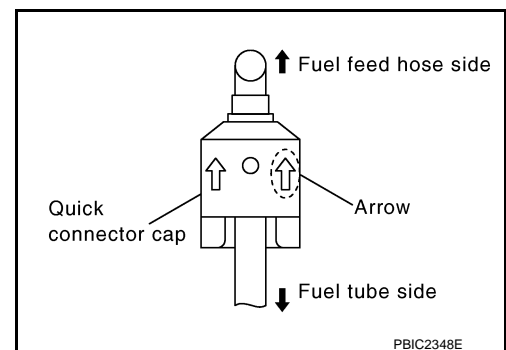
CAUTION:

- Check that quick connector and fuel tube are securely fit into quick connector cap installation groove.
- If quick connector cap cannot be installed smoothly, quick connector may have not been installed correctly. Check connection again.

11. Install in the reverse order of removal.

CAUTION:

After checking fuel leakage, maintain ten minutes of idling to bleed the fuel line.



Inspection

INFOID:000000009010609

INSPECTION AFTER INSTALLATION

Check for Fuel Leakage

HIGH PRESSURE FUEL PUMP AND FUEL HOSE

< REMOVAL AND INSTALLATION >

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

CAUTION:

Never touch the engine immediately after it is stopped because the engine is extremely hot.

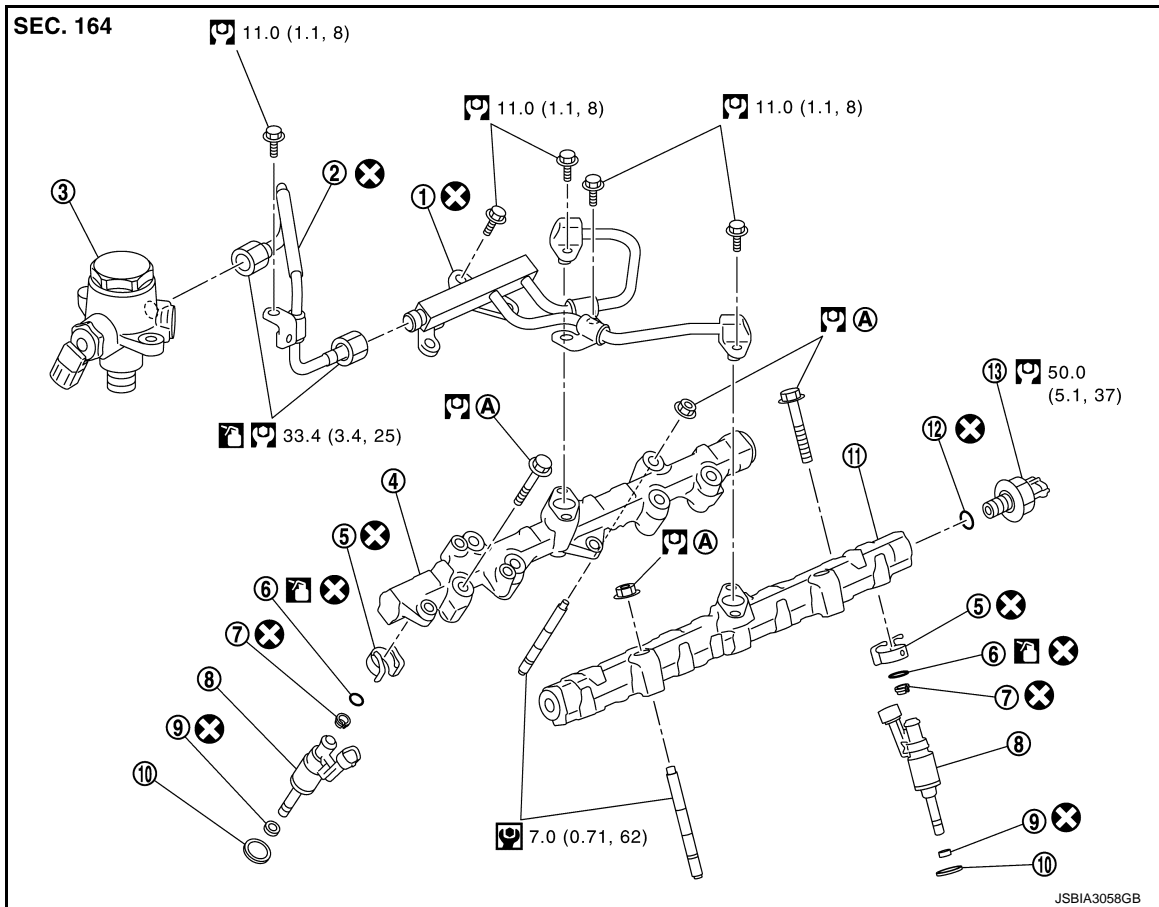
FUEL INJECTOR AND FUEL TUBE

< REMOVAL AND INSTALLATION >

FUEL INJECTOR AND FUEL TUBE

Exploded View

INFOID:000000009010610



- | | | |
|-------------------------------|-------------------------------|----------------------------|
| 1. Fuel feed tube (bank side) | 2. Fuel feed tube (pump side) | 3. High pressure fuel pump |
| 4. Fuel rail (bank 2) | 5. Injector holder | 6. O-ring (blue) |
| 7. Backup ring | 8. Fuel injector | 9. Seal ring |
| 10. Insulator | 11. Fuel rail (bank 1) | 12. Gasket |
| 13. Fuel rail pressure sensor | | |

Comply with the installation procedure when tightening. Refer to [EM-49](#).

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

CAUTION:

- Never remove or disassemble parts unless instructed as shown in the figure.
- Be sure to follow the tightening instruction to avoid fuel leakage.

Removal and Installation

INFOID:000000009010611

REMOVAL

WARNING:

- Be sure to read [EM-3, "Precaution for Handling High Pressure Fuel System"](#) when working on the high pressure fuel system.
- Put a "CAUTION: FLAMMABLE" sign in the workshop.
- Be sure to work in a well ventilated area and furnish workshop with a CO₂ fire extinguisher.
- Never smoke while servicing fuel system. Keep open flames and sparks away from the work area.
- To avoid the danger of being scalded, never drain engine coolant when engine is hot.

FUEL INJECTOR AND FUEL TUBE

< REMOVAL AND INSTALLATION >

1. Release fuel pressure. Refer to the following table:

ENGINE	Reference page
VK56VD FOR USA AND CANADA	EC-168, "Work Procedure"
VK56VD FOR MEXICO	EC-731, "Work Procedure"

2. Remove intake manifold. Refer to [EM-31, "Removal and Installation"](#).
3. Remove fuel feed tube (pump side) and fuel feed tube (bank side).

CAUTION:

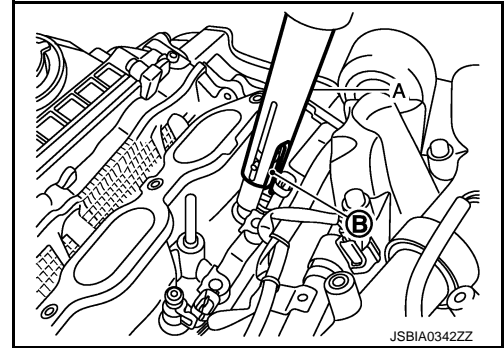
Never reuse fuel feed tube.

4. Remove fuel rail (bank 1) and fuel rail (bank 2).
5. Disconnect harness connector from fuel injectors.
6. Remove fuel injector from cylinder head as per the following:

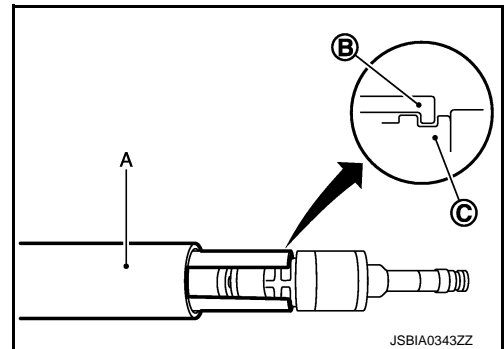
CAUTION:

- 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.

- a. Remove injector holder.
- b. Install an injector remover [SST: KV10119600 (—)] (A) to the injector connector side so that cutout (B) of injector remover faces the injector connector side.



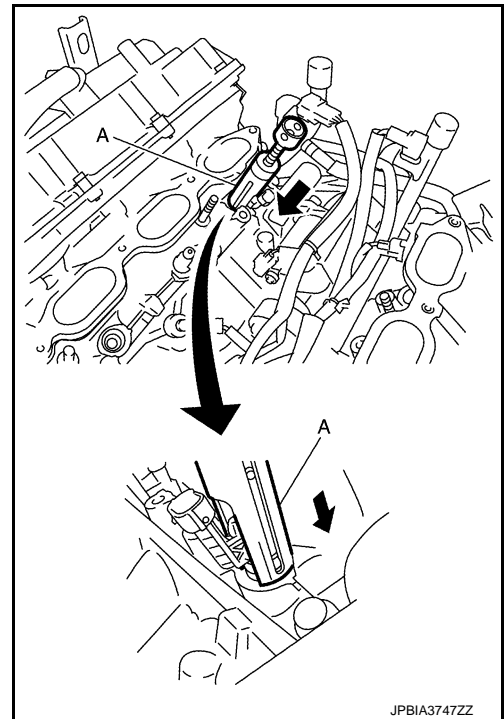
- Hook pawl portion (B) of injector remover [SST: KV10119600 (—)] (A) to groove portion (C) of injector.



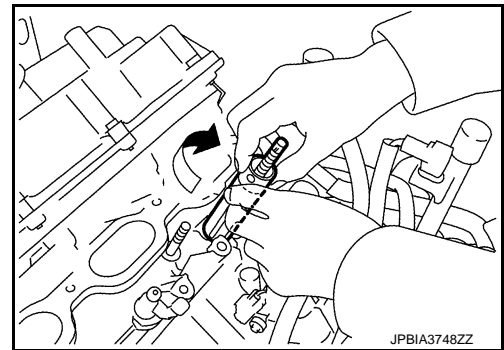
FUEL INJECTOR AND FUEL TUBE

< REMOVAL AND INSTALLATION >

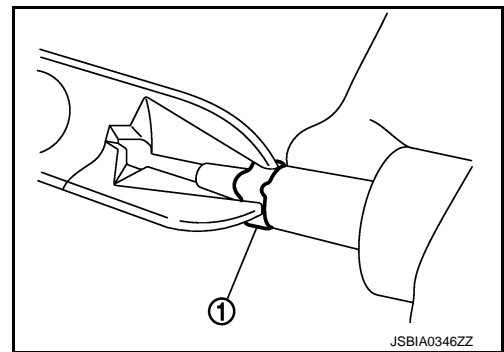
- c. Press down body portion (A) of injector remover [SST: KV10119600 (—)] until it contacts cylinder head.



- d. Tighten injector remover [SST: KV10119600 (—)] clockwise and remove injector from cylinder head.



- e. Cut Teflon seal (1) while pinching it. Be careful not to damage injector.
f. Remove insulator from mounting hole of fuel injector of cylinder head.



7. Remove fuel rail pressure sensor from fuel rail (bank 1), if necessary.

INSTALLATION

CAUTION:

Do not reuse O-rings.

1. Install fuel rail pressure sensor to fuel rail (bank 1), if removed.

CAUTION:

- Use a hexagon support tool to install fuel rail pressure sensor. (Do not use open end tool to install fuel rail pressure sensor.)
- Never use fuel rail pressure sensor, if dropped.

2. Install seal ring to fuel injector as per the following:

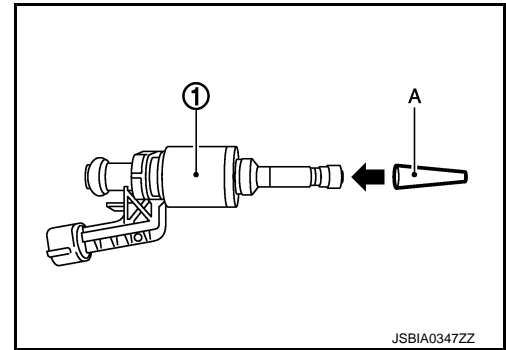
CAUTION:

FUEL INJECTOR AND FUEL TUBE

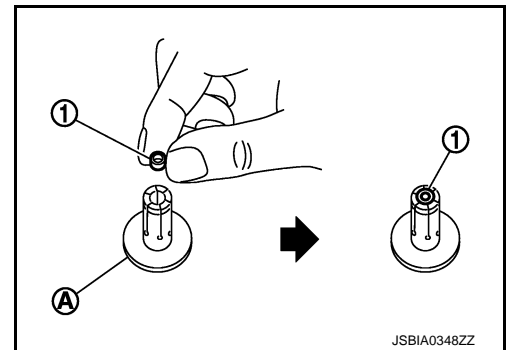
< REMOVAL AND INSTALLATION >

- Handle seal ring with bare hands. Never wear gloves.
- Never apply engine oil to seal ring.
- Never clean seal ring with solvent.

a. Install seal guide [SST: KV10119720 (—)] (A) to fuel injector (1).



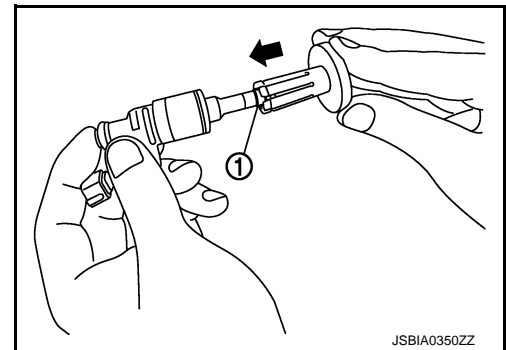
b. Set seal ring (1) to seal installer [SST: KV10119730 (—)] (A).



c. Straightly insert seal ring (1), which is set in precedent step, to fuel injector as shown in the figure and install.

CAUTION:

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



d. Insert drift [SST: KV10119710 (—)] (A) to injector and rotate clockwise and counterclockwise by 90° while pressing seal ring to fit it.

B : Chamfering

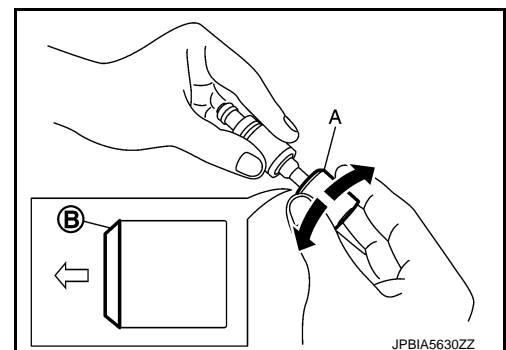
⇐ : Injector side

CAUTION:

Be careful to a direction of the tool.

NOTE:

Compress seal ring, because this operation is for rectifying stretch of seal ring caused by installation and for preventing sticking when inserting injector into cylinder head.



3. Install O-ring and backup ring to fuel injector. When handing new O-ring and backup ring, paying attention to the following caution items:

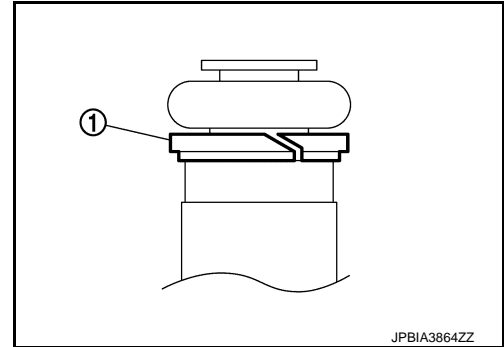
CAUTION:

- Do not reuse O-ring.
- Handle O-ring with bare hands. Never wear gloves.
- Lubricate O-ring with new engine oil.
- Never clean O-ring with solvent.

FUEL INJECTOR AND FUEL TUBE

< REMOVAL AND INSTALLATION >

- 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 rail. Never decenter or twist it.
- Always install the back up ring (1) in the right direction as instructed.



4. Install fuel injector (1) to fuel rail (2) as per the following:

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

a. Install fuel injector holder (5) to fuel injector.

CAUTION:

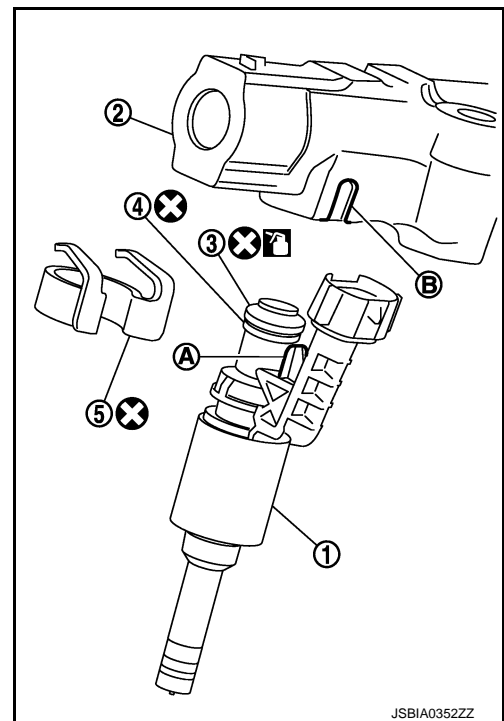
- Never reuse injector holder. Replace it with a new one.
- Be careful to keep fuel injector holder from interfering with O-ring. If interference occurs, replace O-ring.

b. Insert fuel injector into fuel rail with fuel injector holder attached.

- Insert it while matching it to the axial center.
- Insert so that protrusion (A) of fuel injector is aligned to cutout (B).

c. Check that installation is complete by checking that fuel injector does not rotate or come off.

- Check that protrusions of fuel injectors and fuel rail are aligned with cutouts of clips after installation.



5. Insert insulator into mounting hole of fuel injector of cylinder head.

6. Install fuel rail and fuel injector assembly to cylinder head.

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

← : Engine front

1st step : 10.0 N-m (1.0 kg-m, 89 in-lb)

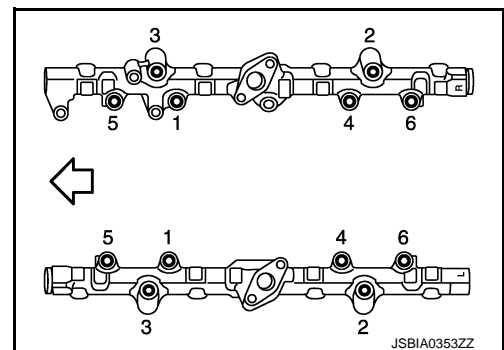
2nd step : 20.5 N-m (2.1 kg-m, 15 ft-lb)

7. Connect injector harness connector.

8. Install fuel feed tube (bank side) to fuel rail.

CAUTION:

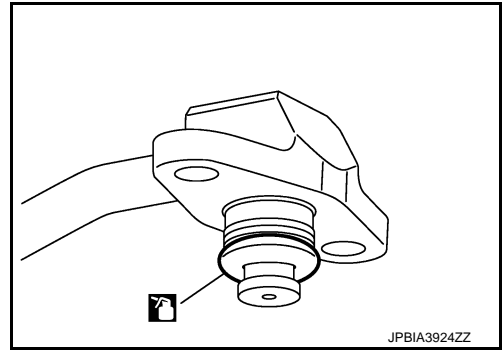
- Never reuse fuel feed tube (bank side).
- When installing fuel feed tube (bank side) to fuel rail, press the flange part to install the tube.
- Handle O-ring with bare hands. Never wear gloves.



FUEL INJECTOR AND FUEL TUBE

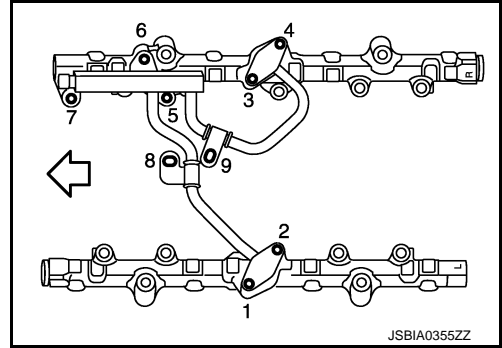
< REMOVAL AND INSTALLATION >

- 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.
- Never scratch O-ring with tools or fingernails when installing fuel feed tube (bank side).
- Insert new fuel feed tube (bank side) straight into fuel rail. Never decenter or twist the fuel feed tube (bank side) during insertion.



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

← : Engine front

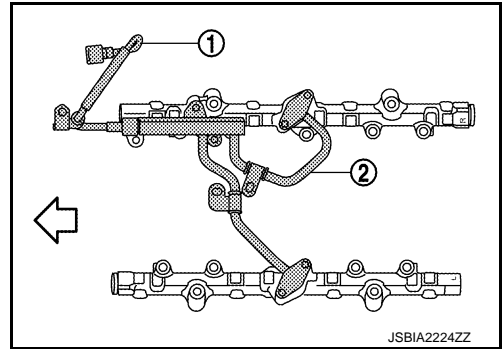


9. Install fuel feed tube (pump side) (1) to fuel feed tube (bank side) (2) as per the following:

← : Engine front

CAUTION:

- When removing fuel feed tube (pump side), always replace fuel feed tube (bank side) together with fuel feed tube (pump side).
- Never reuse fuel feed tube (pump side).
- Never use fuel feed tube (pump side) if its terminal tip is damaged.
- Observe the tightening order and the tightening torque.



- a. Apply engine oil to flare screw parts of high pressure pump and tube between banks.
- b. Manually tighten 2 flare nuts without using a tool until they are seated to screw thread.

CAUTION:

When temporarily tightening flare nut, place pipe in the center of the nut inner diameter.

- c. Tighten mounting bolt (A).

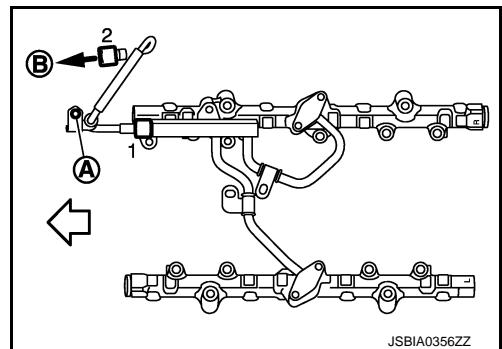
B :To high pressure fuel pump

← : Engine front

- d. Tighten flare nuts in numerical order as shown in the figure.

CAUTION:

Always fit the tool completely with the nut.



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

CAUTION:

After checking fuel leakage, maintain ten minutes of idling to bleed the fuel line.

FUEL INJECTOR AND FUEL TUBE

< REMOVAL AND INSTALLATION >

Inspection

INFOID:000000009010612

A

INSPECTION AFTER INSTALLATION

Check for Fuel Leakage

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

CAUTION:

Never touch the engine immediately after it is stopped because the engine is extremely hot.

EM

C

D

E

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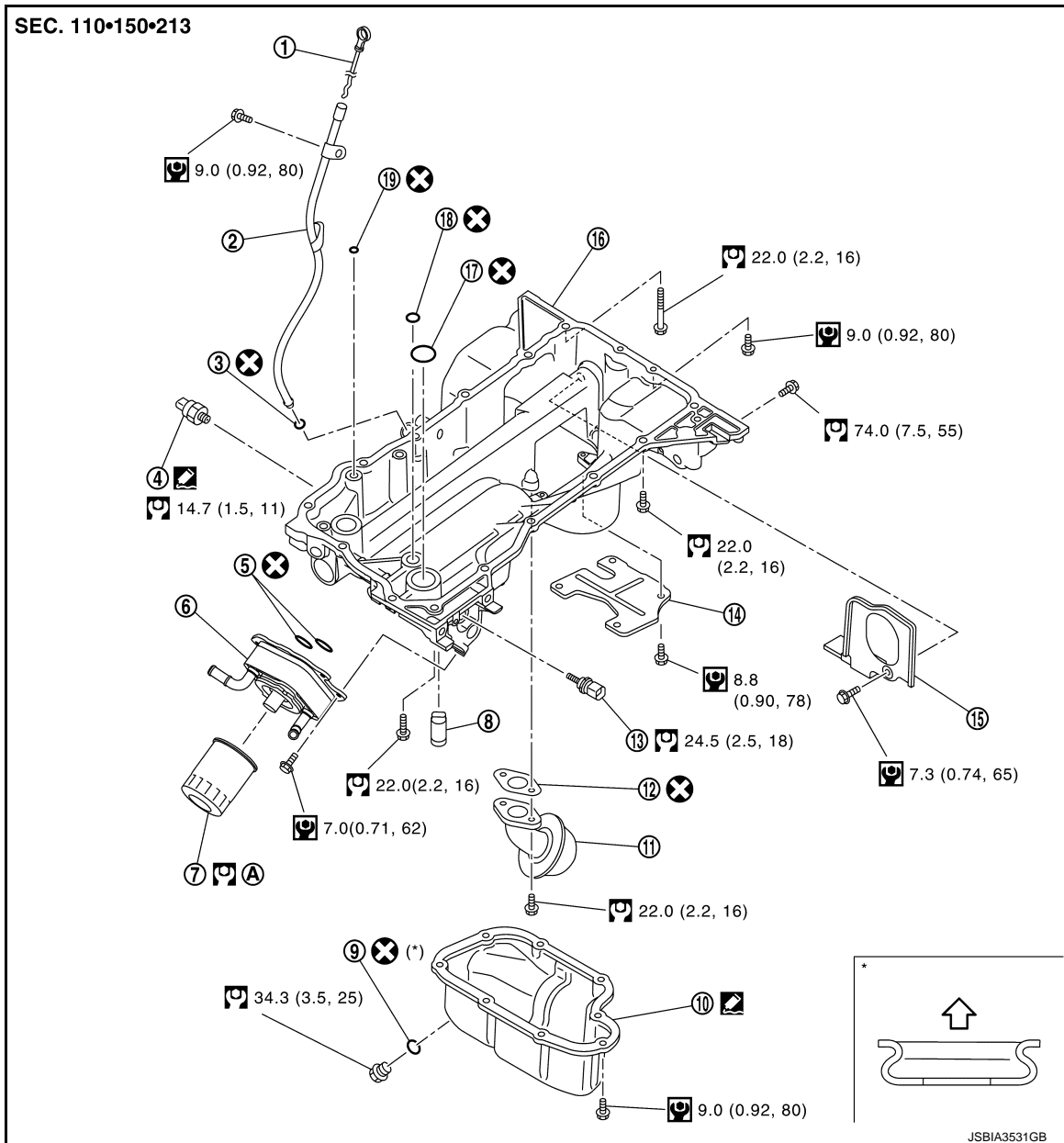
OIL PAN (LOWER) AND OIL STRAINER

< REMOVAL AND INSTALLATION >

OIL PAN (LOWER) AND OIL STRAINER

Exploded View

INFOID:000000009010613



- | | | |
|----------------------------|--------------------------|----------------------|
| 1. Oil level gauge | 2. Oil level gauge guide | 3. O-ring |
| 4. Oil pressure switch | 5. O-ring | 6. Oil cooler |
| 7. Oil filter | 8. Relief valve | 9. Drain plug washer |
| 10. Oil pan (lower) | 11. Oil strainer | 12. Gasket |
| 13. Oil temperature sensor | 14. Baffle plate | 15. Rear plate cover |
| 16. Oil pan (upper) | 17. O-ring | 18. O-ring |
| 19. O-ring | | |

A. Comply with the installation procedure when tightening. Refer to [LU-11](#).

← : Oil pan side

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

OIL PAN (LOWER) AND OIL STRAINER

< REMOVAL AND INSTALLATION >

Removal and Installation

INFOID:000000009010614

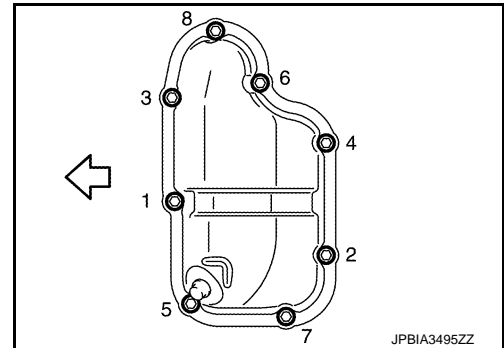
REMOVAL

WARNING:

To avoid the danger of being scalded, never drain engine oil when engine is hot.

1. Drain engine oil. Refer to [LU-9, "Draining"](#).
2. Remove protector A and protector B. Refer to [SCS-32, "FRONT TUBE ASSEMBLY : Exploded View"](#).
3. Remove front suspension rear cross member. Refer to [TM-215, "2WD : Exploded View"](#) (2WD models) or [TM-218, "4WD : Exploded View"](#) (AWD models).
4. Remove oil pan (lower) as per the following:
 - a. Loosen mounting bolts in reverse order as shown in the figure to remove.

⇐ : Engine front

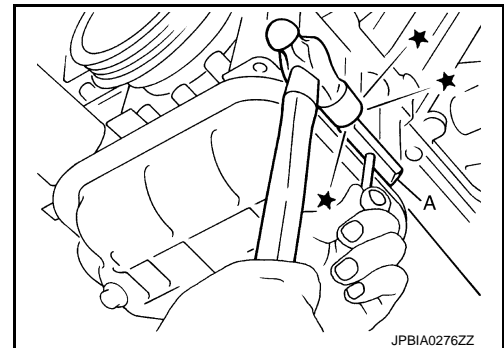


- b. Insert the seal cutter [SST: KV10111100 (J-37228)] (A) between oil pan (upper) and oil pan (lower).

CAUTION:

- Be careful not to damage the mating surfaces.
- Never insert a screwdriver. This damages the mating surfaces.

- c. Slide the seal cutter by tapping on the side of tool with a hammer. Remove oil pan (lower).



5. Remove oil strainer.

INSTALLATION

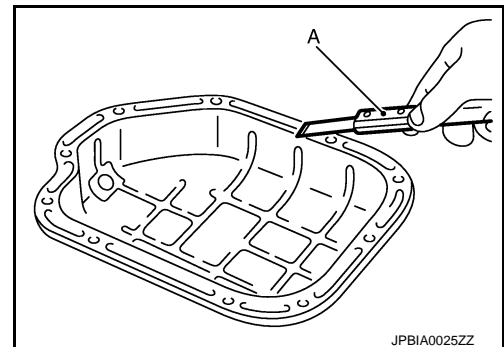
CAUTION:

Do not reuse drain plug washer.

1. Install oil strainer.
2. Install oil pan (lower) as per the following:
 - 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.



OIL PAN (LOWER) AND OIL STRAINER

< REMOVAL AND INSTALLATION >

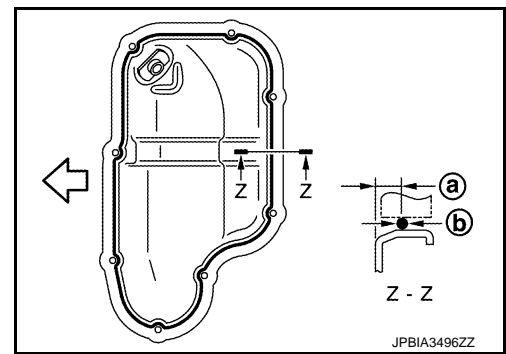
- b. Apply a continuous bead of liquid gasket with the tube presser (commercial service tool) to the oil pan (lower) as shown in the figure.

- a : 7.5 - 9.5 mm (0.295 - 0.374 in)
b : ϕ 4.0 - 5.0 mm (0.157 - 0.197 in)
↔ : Engine front

Use Genuine RTV silicone sealant or equivalent. Refer to [GI-22, "Recommended Chemical Products and Sealants"](#).

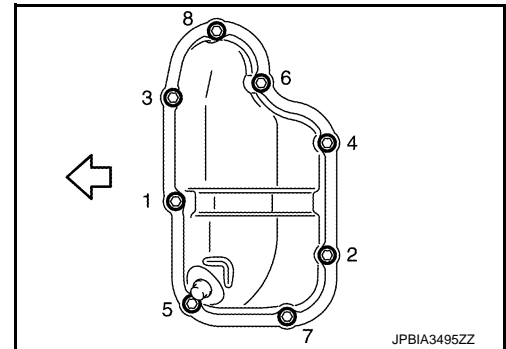
CAUTION:

Attaching must be done within 5 minutes after coating.



- c. Install oil pan (lower).
• Tighten mounting bolts in numerical order as shown in the figure.

↔ : Engine front



3. Install oil pan drain plug.

CAUTION:

Do not reuse drain plug washer.

- Refer to the figure of the components of on the prior page for installation direction of drain plug washer. Refer to [EM-56, "Exploded View"](#).

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

NOTE:

Wait at least 30 minutes after oil pan is installed before pouring engine oil.

Inspection

INFOID:000000009010615

INSPECTION AFTER REMOVAL

Clean oil strainer if any object is attached.

INSPECTION AFTER INSTALLATION

1. Check the engine oil level and adjust engine oil. Refer to [LU-8, "Inspection"](#).
2. Start engine, and check there is no leakage of engine oil.
3. Stop engine and wait for 15 minutes.
4. Check the engine oil level again. Refer to [LU-8, "Inspection"](#).

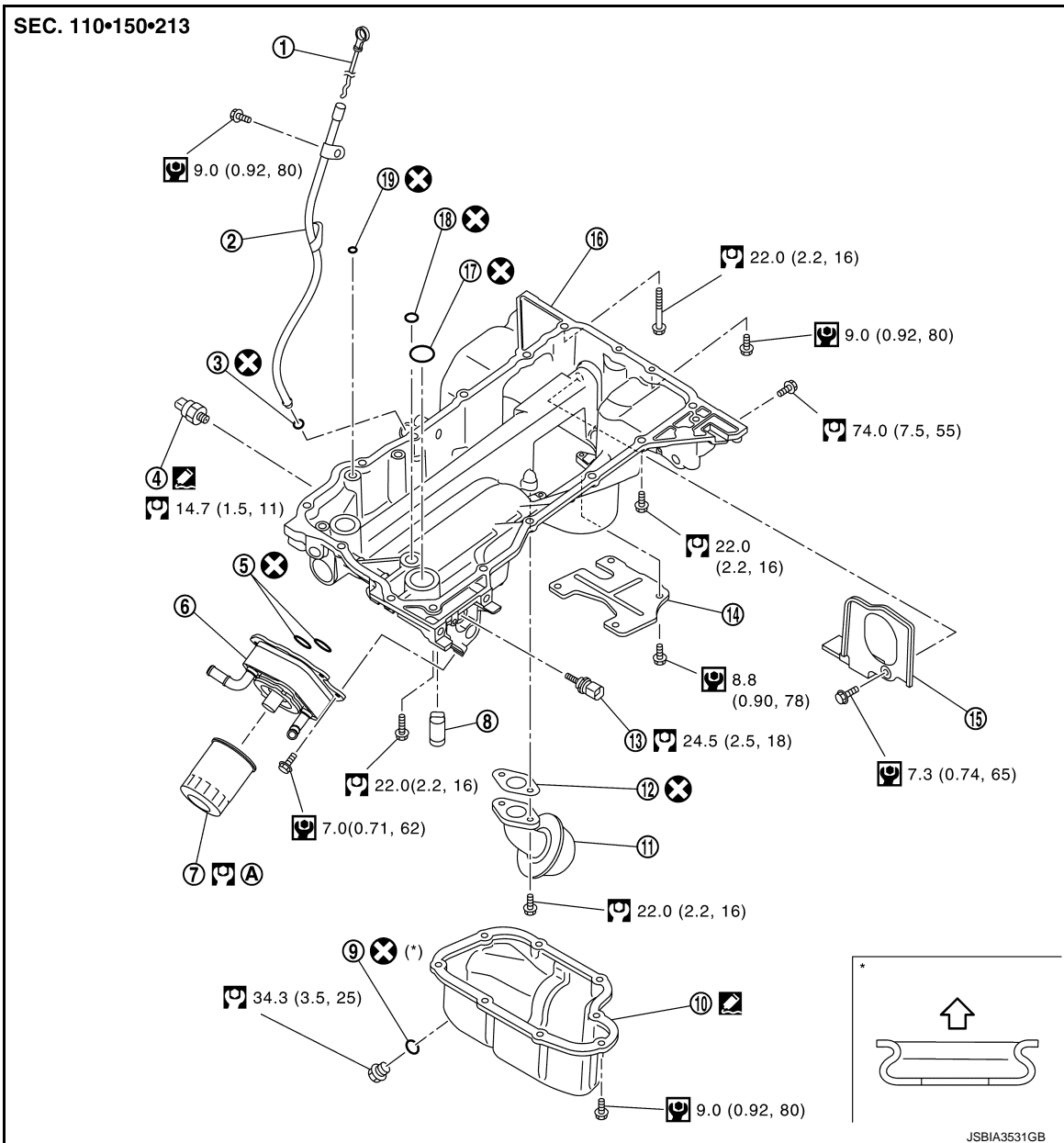
OIL PAN (UPPER)

< REMOVAL AND INSTALLATION >

OIL PAN (UPPER)

Exploded View

INFOID:000000009010616



- | | | |
|----------------------------|--------------------------|----------------------|
| 1. Oil level gauge | 2. Oil level gauge guide | 3. O-ring |
| 4. Oil pressure switch | 5. O-ring | 6. Oil cooler |
| 7. Oil filter | 8. Relief valve | 9. Drain plug washer |
| 10. Oil pan (lower) | 11. Oil strainer | 12. Gasket |
| 13. Oil temperature sensor | 14. Baffle plate | 15. Rear plate cover |
| 16. Oil pan (upper) | 17. O-ring | 18. O-ring |
| 19. O-ring | | |

Comply with the installation procedure when tightening. Refer to [LU-11](#), "Removal and Installation".

↔ : Oil pan side

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

OIL PAN (UPPER)

< REMOVAL AND INSTALLATION >

Removal and Installation

INFOID:000000009010617

REMOVAL

WARNING:

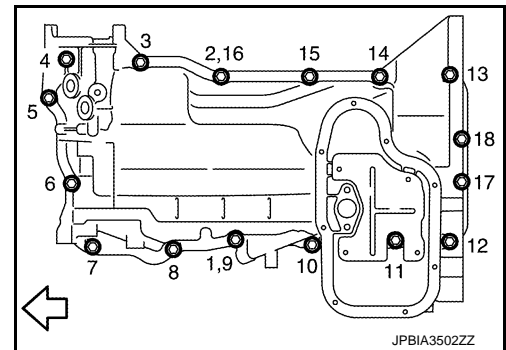
To avoid the danger of being scalded, never drain engine oil when engine is hot.

1. Remove oil filter. Refer to [LU-11, "Removal and Installation"](#).
2. Remove oil cooler. Refer to [LU-13, "Exploded View"](#).
3. Move A/C compressor to the position without the hindrance for work. Refer to [HA-30, "Exploded View"](#).
4. Remove oil level gauge and oil level gauge guide.
5. Remove oil pressure switch and oil temperature sensor if necessary.
6. Remove rear plate cover.
7. Remove protector A and protector B. Refer to [SCS-32, "FRONT TUBE ASSEMBLY : Exploded View"](#).
8. Remove front suspension rear cross member. Refer to [TM-215, "2WD : Exploded View"](#) (2WD models) or [TM-218, "4WD : Exploded View"](#) (AWD models).
9. Remove steering gear assembly. Refer to [ST-41, "Exploded View"](#).
10. Remove front final drive assembly. Refer to [DLN-174, "Exploded View"](#).
11. Remove oil pan (lower). Refer to [EM-56, "Exploded View"](#).
12. Remove oil strainer. Refer to [EM-56, "Exploded View"](#).
13. Remove bolts fixing oil pan (upper) to transmission assembly.
14. Remove oil pan (upper) as per the following:
 - a. Loosen mounting bolts in the reverse order as shown in the figure with power tool to remove.

⇐ : Engine front

NOTE:

Disregard No. 9, 16 when loosening.

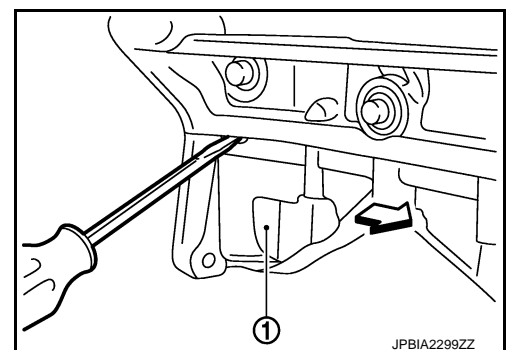


- b. Insert a suitable tool into the notch at oil pan (upper) (1) as shown.
 - Pry off case by moving a suitable tool.

⇐ : Engine front

CAUTION:

Be careful not to damage the mating surfaces.



15. Remove O-ring from bottom of cylinder block and oil pump.
16. Remove oil pressure switch and oil temperature sensor, if necessary.

INSTALLATION

CAUTION:

Do not reuse O-rings.

1. Install oil pan (upper) as per the following:

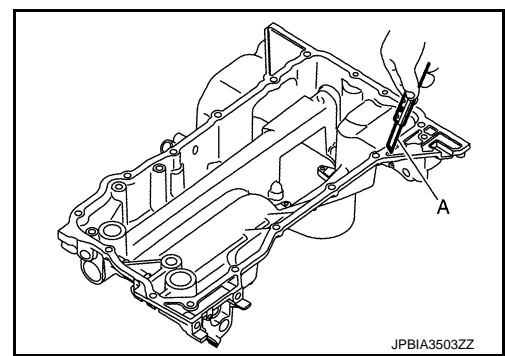
OIL PAN (UPPER)

< REMOVAL AND INSTALLATION >

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

CAUTION:

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

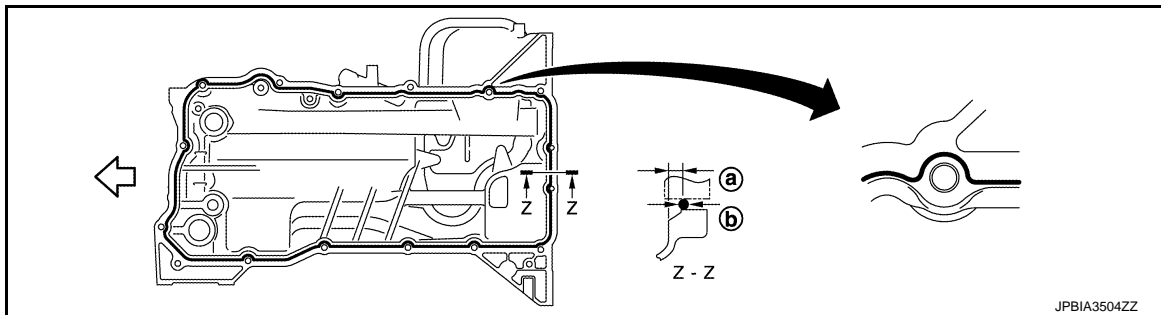


- b. Install new O-rings on the bottom of cylinder block and oil pump.

CAUTION:

Do not reuse O-rings.

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



- a. : 5.5 - 7.5 mm (0.217 - 0.295 in)
- b. : ϕ 4.0 - 5.0 mm (0.157 - 0.197 in)

← : Engine front

Use Genuine RTV silicone sealant or equivalent. Refer to [GI-22. "Recommended Chemical Products and Sealants"](#).

CAUTION:

Attaching must be done within 5 minutes after coating.

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

← : Engine front

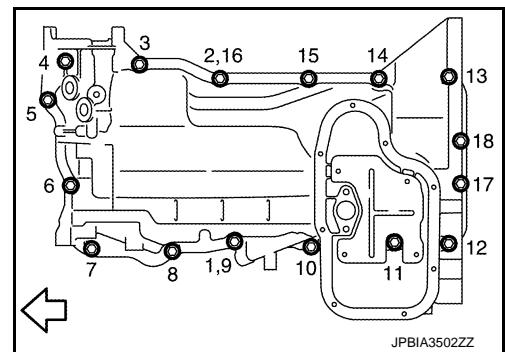
CAUTION:

Install avoiding misalignment of O-rings.

NOTE:

Tighten mounting bolts No. 1 and 2 in two steps. The numerical order No. 9 and 16 shown second steps.

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



Order number for tightening	17, 18	2 (16), 3, 5, 6, 7, 8, 10, 11, 14, 15	1(9), 4	12, 13
Bolt size	M6		M8	
Bolt length ℓ	45 mm (1.77 in)	25 mm (0.98 in)	30.0 mm (1.18 in)	120 mm (4.72 in)
Tightening torque	9.0 N·m (0.92 kg-m, 80 in-lb)	22.0 N·m (2.2 kg-m, 16 ft-lb)		

- e. Tighten transmission joint bolts.
- f. Install rear plate cover.

OIL PAN (UPPER)

< REMOVAL AND INSTALLATION >

2. Install oil strainer.
3. Install oil pan (lower). Refer to [EM-57, "Removal and Installation"](#).
4. Install in the reverse order of removal.

NOTE:

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

Inspection

INFOID:000000009010618

INSPECTION AFTER DISASSEMBLY

Clean oil strainer if any object is attached.

INSPECTION AFTER ASSEMBLY

1. Check the engine oil level and adjust engine oil. Refer to [LU-11, "Inspection"](#).
2. Start engine, and check there is no leakage of engine oil.
3. Stop engine and wait for 15 minutes.
4. Check the engine oil level again. Refer to [LU-11, "Inspection"](#).

TIMING CHAIN

< REMOVAL AND INSTALLATION >

TIMING CHAIN

Exploded View

INFOID:000000009010619

A

EM

C

D

E

F

G

H

I

J

K

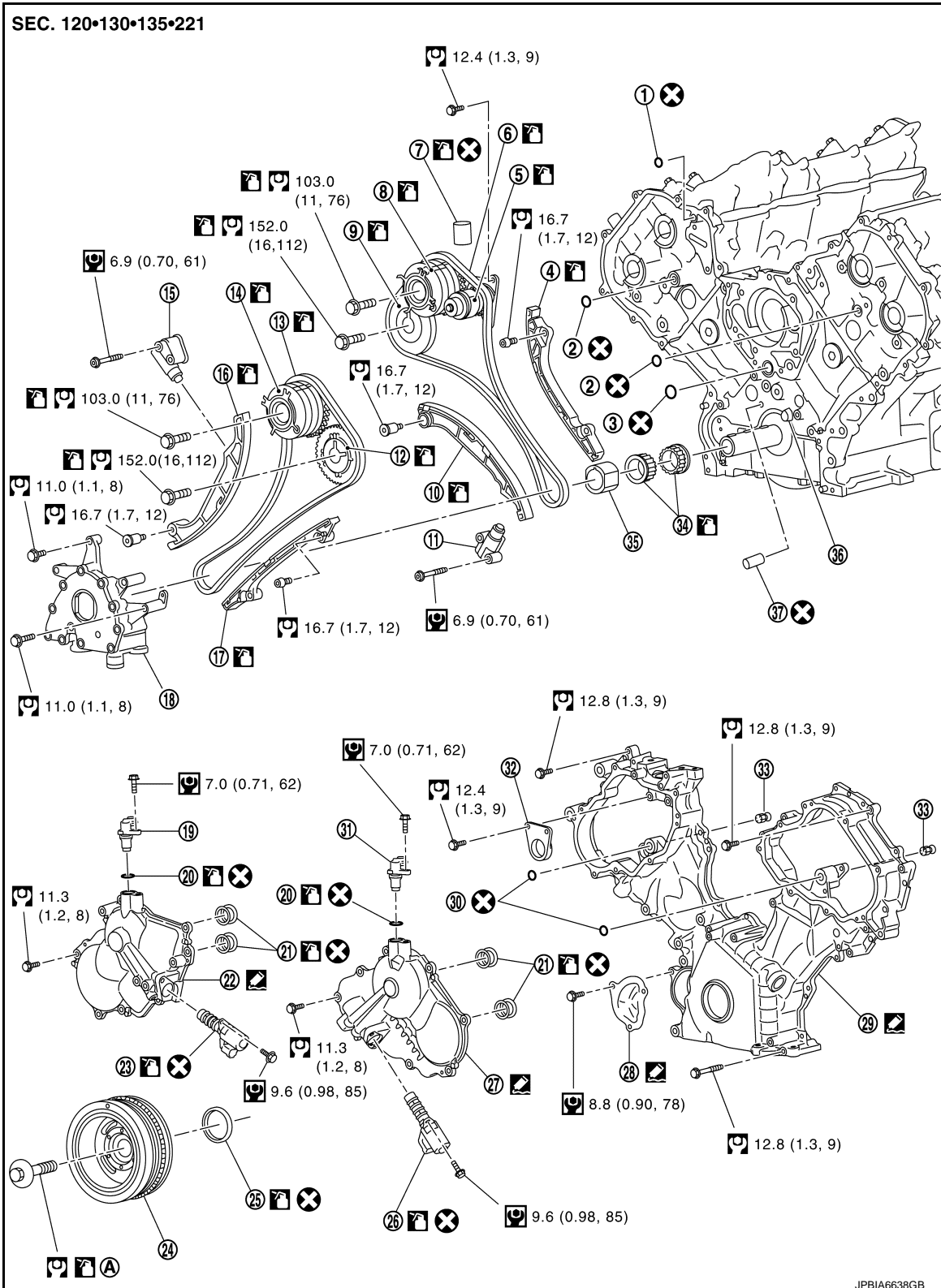
L

M

N

O

P



- | | | |
|---------------------------|--------------------------------------|---------------------------------------|
| 1. O-ring | 2. O-ring | 3. O-ring |
| 4. Tension guide (bank 2) | 5. High pressure fuel pump camshaft | 6. Timing chain (bank 2) |
| 7. Lifter | 8. Intake camshaft sprocket (bank 2) | 9. Exhaust camshaft sprocket (bank 2) |

TIMING CHAIN

< REMOVAL AND INSTALLATION >

- | | | |
|-----------------------------------------|---------------------------------------------------------|----------------------------------------------------------|
| 10. Slack guide (bank 2) | 11. Timing chain tensioner (bank 2) | 12. Exhaust camshaft sprocket (bank 1) |
| 13. Timing chain (bank 1) | 14. Intake camshaft sprocket (bank 1) | 15. Timing chain tensioner (bank 1) |
| 16. Slack guide (bank 1) | 17. Tension guide (bank 1) | 18. Oil pump |
| 19. Camshaft position sensor (bank 2) | 20. O-ring | 21. Seal ring |
| 22. Valve timing control cover (bank 2) | 23. Intake valve timing control solenoid valve (bank 2) | 24. Crankshaft pulley |
| 25. Front oil seal | 26. Intake valve timing control solenoid valve (bank 1) | 27. Valve timing control cover (bank 1) |
| 28. Timing chain tensioner cover | 29. Front cover | 30. O-ring |
| 31. Camshaft position sensor (bank 1) | 32. Camshaft bracket | 33. Oil filter (for valve timing control solenoid valve) |
| 34. Crankshaft sprocket | 35. Oil pump drive spacer | 36. Oil jet (bank 1) |
| 37. Oil jet (bank 2) | | |

- Comply with the installation procedure when tightening. Refer to [EM-64](#).

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

Removal and Installation

INFOID:000000009010620

REMOVAL

1. Release fuel pressure. Refer to the following table:

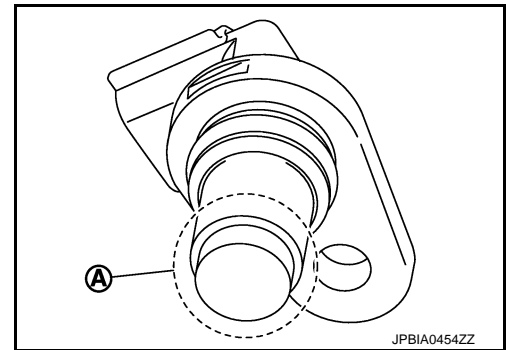
ENGINE	Reference page
VK56VD FOR USA AND CANADA	EC-168, "Work Procedure"
VK56VD FOR MEXICO	EC-731, "Work Procedure"

2. Drain engine coolant from radiator. Refer to [CO-8, "Draining"](#).
3. Remove fan shroud (lower). Refer to [CO-14, "Exploded View"](#).
4. Remove fan bracket. Refer to [CO-18, "Exploded View"](#).
5. Remove drive belt auto-tensioner. Refer to [EM-27, "Exploded View"](#).
6. Remove oil level gauge and oil level gauge guide. Refer to [EM-59, "Exploded View"](#).
7. Move power steering oil pump to the position without the hindrance for work. Refer to [ST-48, "Exploded View"](#).
8. Remove alternator, alternator bracket and alternator stay. Refer to [CHG-28, "Exploded View"](#).
9. Move power steering reservoir tank to the position without the hindrance for work, and then remove Reservoir tank bracket. Refer to [ST-54, "Exploded View"](#).
10. Remove camshaft position sensors.

A : Keep free from 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.



11. Remove high pressure fuel pump and lifter. Refer to [EM-44, "Exploded View"](#).

CAUTION:

After removing lifter, replace lifter with a new one.

12. Remove radiator hose (upper) and radiator hose (lower). Refer to [CO-14, "Exploded View"](#).
13. Remove water suction pipe. Refer to [CO-22, "Exploded View"](#).
14. Remove valve timing control cover as per the following:

TIMING CHAIN

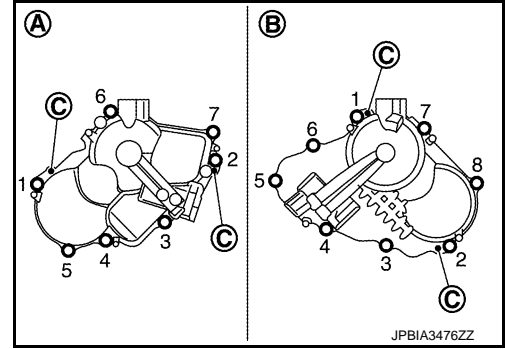
< REMOVAL AND INSTALLATION >

- a. Disconnect valve timing control solenoid valve harness connector.
- b. Loosen mounting bolts in the reverse order as shown in the figure.

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

CAUTION:

- Exercise care not to damage mating surfaces.
- Shaft is internally jointed with camshaft sprocket center hole. When removing, keep it horizontal until it is completely disconnected.

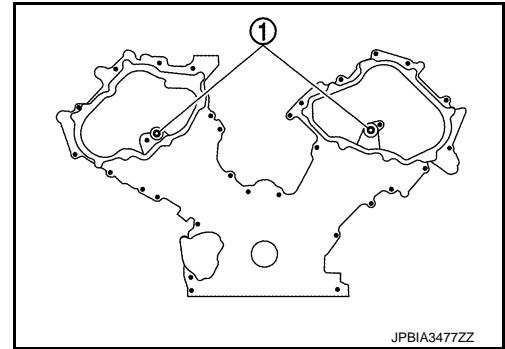


15. Remove intake valve timing control solenoid valve (bank 1 and bank 2), if necessary.

CAUTION:

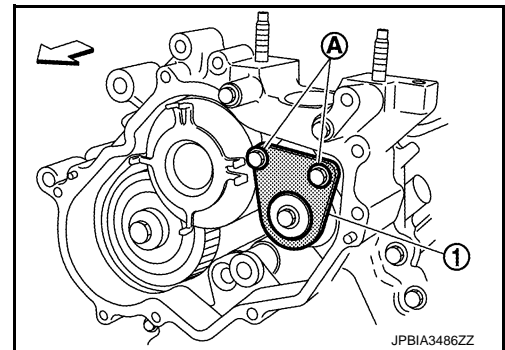
Valve timing control solenoid valve is not reusable. Never remove it unless required.

16. Remove O-rings (1) from front cover.



17. Remove rocker cover. Refer to [EM-34, "Exploded View"](#).
18. Obtain No. 1 cylinder at TDC of its compression stroke. Refer to [EM-12, "Inspection"](#).
19. Remove crankshaft pulley. Refer to [EM-102, "FRONT OIL SEAL : Removal and Installation"](#).
20. Remove water pump pulley. Refer to [CO-20, "Exploded View"](#).
21. Remove oil pan (lower) and oil strainer. Refer to [EM-56, "Exploded View"](#).
22. Remove oil pan (upper). Refer to [EM-59, "Exploded View"](#).
23. Remove front cover as per the following:

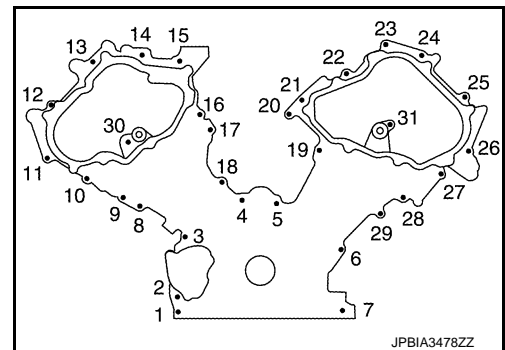
- a. Loosen mounting bolts (A), and then remove camshaft bracket (1).



- b. Loosen mounting bolts in reverse order as shown in the figure.
- c. Insert a suitable tool into the notch at front cover.

CAUTION:

- Exercise care not to damage mating surfaces.
- After removal, handle front cover carefully so it does not tilt, cant, or warp under a load.



TIMING CHAIN

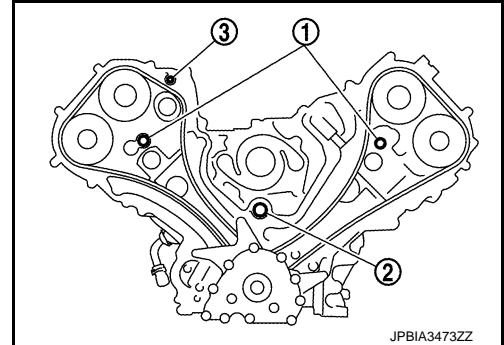
< REMOVAL AND INSTALLATION >

24. Remove oil pump and oil pump drive spacer.
25. Remove front oil seal from front cover using suitable tool.
 - Use screwdriver for removal.

CAUTION:

Be careful not to damage front cover.

26. Remove O-rings (1), (2), (3) from cylinder heads and cylinder block.



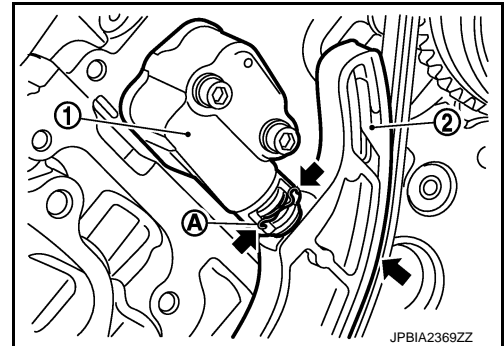
27. Remove oil filter (for valve timing control solenoid valve), if necessary.
28. Remove timing chain tensioner cover from front cover, if necessary.
 - Use seal cutter [SST: KV10111100 (J-37228)] to cut liquid gasket for removal.
29. Remove timing chain tensioner (bank 1) as per the following:

NOTE:

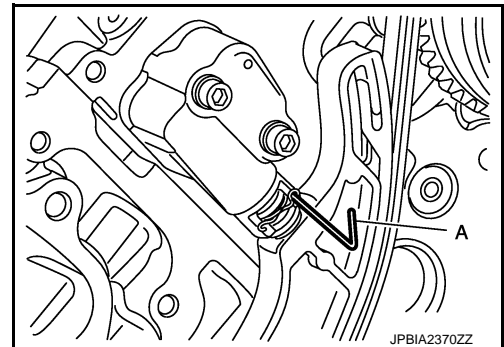
To remove timing chain and related parts, start with those on bank 1. The procedure for removing parts on bank 2 is omitted because it is the same as that for bank 1.

- a. Push both sides of spring (A) against spring tension, and then press in plunger with a slack guide (2).

1 : Timing chain tensioner (bank 1)



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



30. Remove high pressure fuel pump camshaft.
31. Remove tension guide and slack guide.
32. Remove exhaust camshaft sprocket as per the following:
 - Secure the hexagonal portion of exhaust camshaft using a wrench to loosen mounting bolt.
33. Remove timing chain and crankshaft sprocket.

CAUTION:

After removing timing chain, never turn crankshaft and camshaft separately, or valves will strike the piston head.

34. Remove intake camshaft sprocket as per the following:

TIMING CHAIN

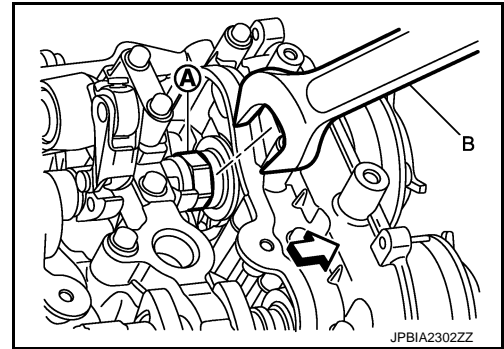
< REMOVAL AND INSTALLATION >

- Secure the hexagonal portion (located in between journal No. 1 and journal No. 2) of drive shaft (A) using a wrench (B) to loosen mounting bolt.

← : Engine front

NOTE:

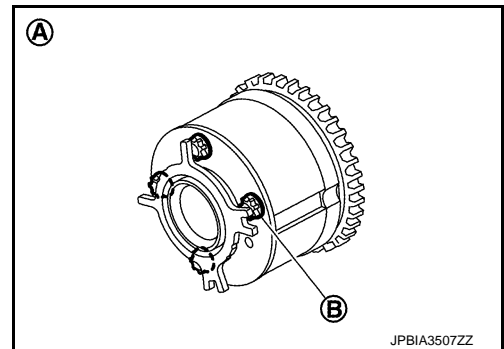
The figure shows an example of bank 2.



CAUTION:

- Never loosen the mounting bolt by securing anything other than the camshaft (drive shaft) hexagonal portion or with tensioning the timing chain.
- When holding the hexagonal part of camshaft (drive shaft) with a wrench, be careful not to allow the wrench to cause interference with other parts.
- Never disassemble camshaft sprocket. [Never loosen bolts (B) as shown in the figure.]

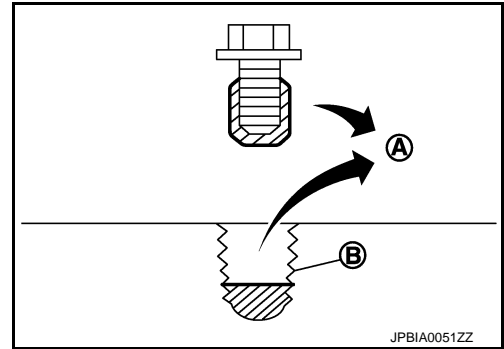
A : Intake



35. Use scraper to remove all traces of old liquid gasket from front cover and opposite mating surfaces.
- Remove old liquid gasket from bolt hole and thread.

A : Remove old liquid gasket that is stuck

B : Bolt hole



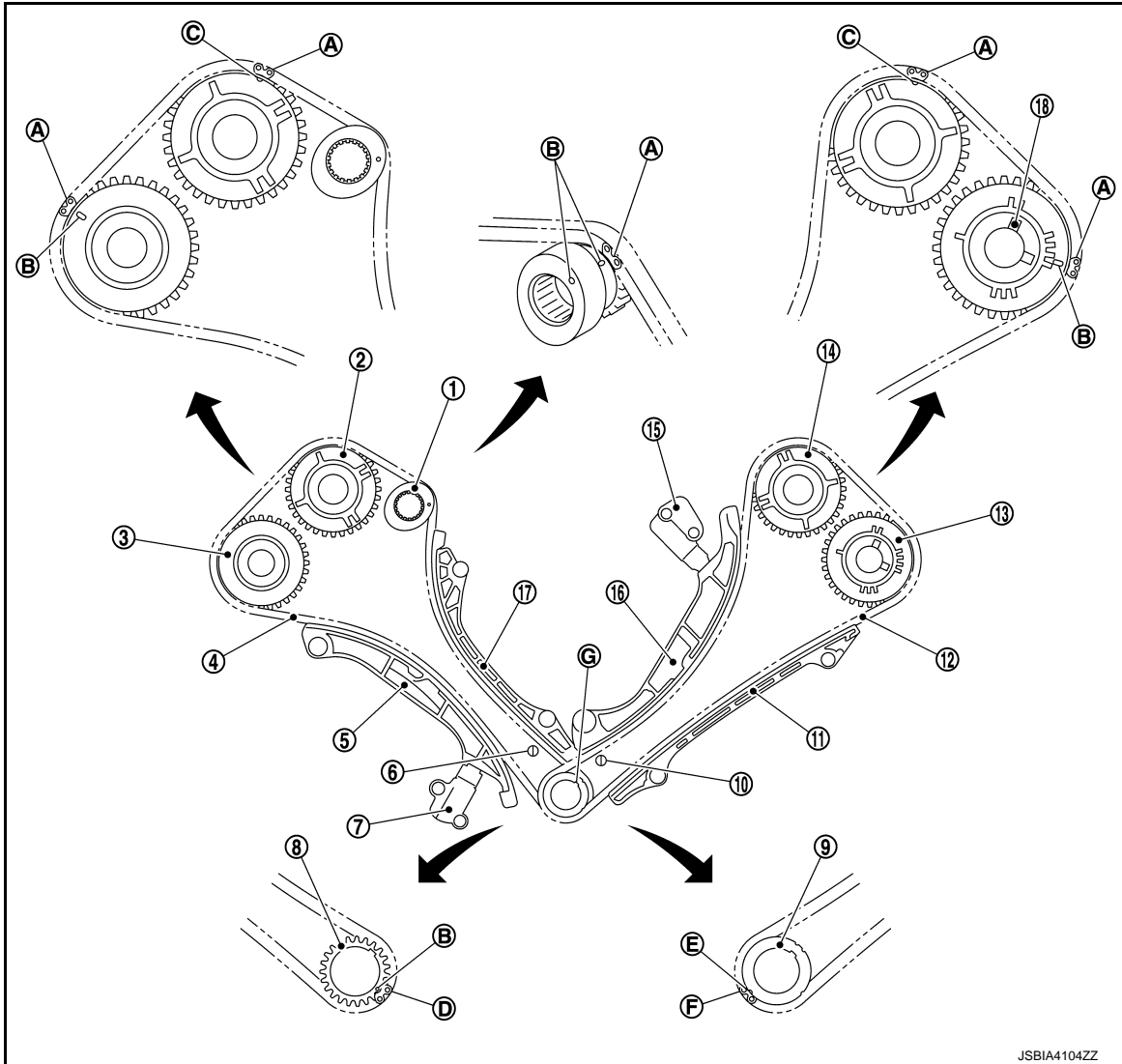
INSTALLATION

CAUTION:

Do not reuse O-rings.

TIMING CHAIN

< REMOVAL AND INSTALLATION >



- | | | |
|----------------------------------------|---------------------------------------|---------------------------------------|
| 1. High pressure fuel pump camshaft | 2. Intake camshaft sprocket (bank 2) | 3. Exhaust camshaft sprocket (bank 2) |
| 4. Timing chain (bank 2) | 5. Slack guide (bank 2) | 6. Chain oil jet (bank 2) |
| 7. Timing chain tensioner (bank 2) | 8. Crankshaft sprocket (bank 2 side) | 9. Crankshaft sprocket (bank 1 side) |
| 10. Chain oil jet (bank 1) | 11. Tension guide (bank 1) | 12. Timing chain (bank 1) |
| 13. Exhaust camshaft sprocket (bank 1) | 14. Intake camshaft sprocket (bank 1) | 15. Timing chain tensioner (bank 1) |
| 16. Slack guide (bank 1) | 17. Tension guide (bank 2) | 18. Dowel pin |
| A: Matching mark (copper link) | B: Matching mark (punched) | C: Matching mark (outer groove) |
| D: Matching mark (white link) | E: Matching mark (notched) | F: Matching mark (yellow link) |
| G: Crankshaft key | | |

NOTE:

- The above figure shows the relationship between the matching mark on each timing chain and that on the corresponding sprocket, with the components installed.
- Parts with an identification mark (R or L) should be installed on the corresponding bank according to the mark.
 - Intake camshaft sprocket, exhaust camshaft sprocket
 - Tension guide
 - Slack guide
- To install timing chain and related parts, start with those on bank 2. The procedure for installing parts on bank 1 is omitted because it is the same as that for installation on bank 2.

TIMING CHAIN

< REMOVAL AND INSTALLATION >

1. Check that crankshaft key (1) and dowel pin (A) of each camshaft are located as shown in the figure.

Camshaft dowel pin

: At cylinder head upper face side in each bank

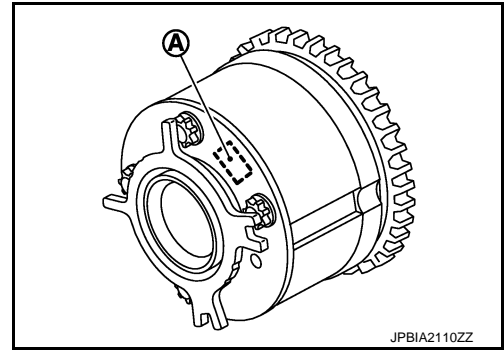
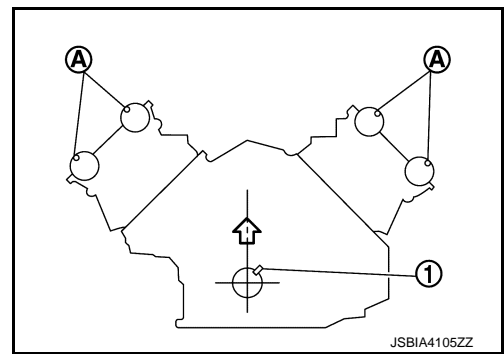
Crankshaft key

: At cylinder head upper face side in bank 1

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.

2. Install camshaft sprockets (INT and EXH).
 - Install onto correct side by checking with identification mark (A) on surface.



Exhaust side:

- Secure the hexagonal portion of exhaust camshaft using a wrench to tighten mounting bolt. Refer to [EM-79, "Exploded View"](#).

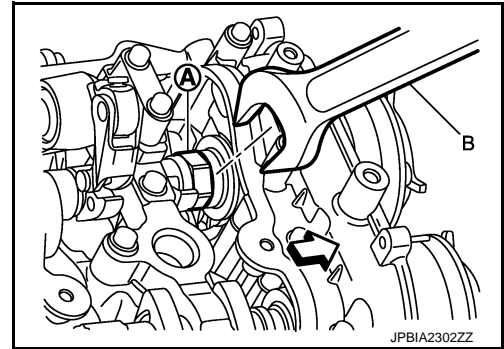
Intake side:

- Secure the hexagonal portion (located in between journal No.1 and journal No. 2) of drive shaft (A) using a wrench (B) to tighten mounting bolt. Refer to [EM-79, "Exploded View"](#).

← : Engine front

NOTE:

The figure shows an example of bank 2.



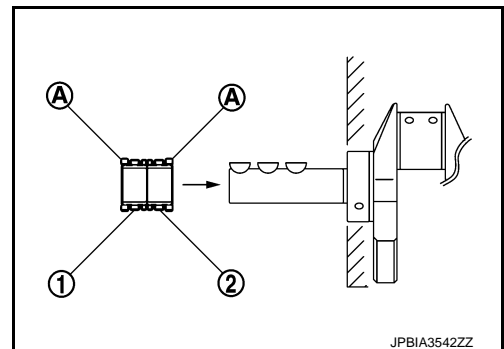
3. Install high pressure fuel pump camshaft.
4. Install timing chains as per the following:
 - a. Install crankshaft sprockets for both banks.
 - Install each crankshaft sprocket so that its flange side (the larger diameter side without teeth) (A) faces in the direction shown in the figure.

1 : Crankshaft sprocket (bank 1 side)

2 : Crankshaft sprocket (bank 2 side)

NOTE:

The same parts are used but facing directions are different.



TIMING CHAIN

< REMOVAL AND INSTALLATION >

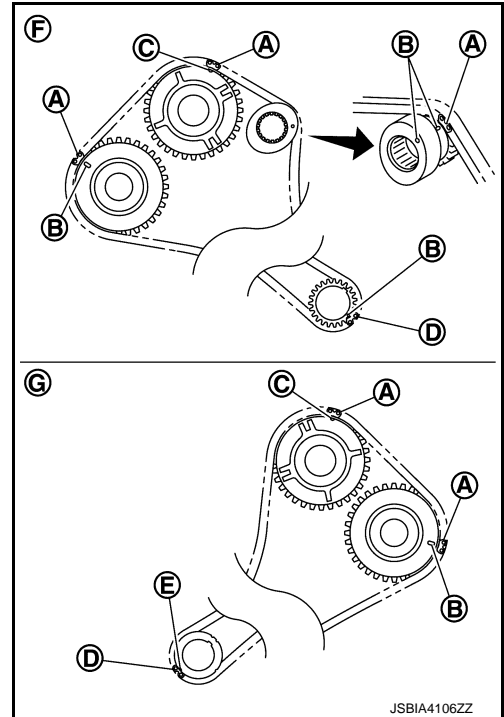
b. Install timing chains.

Bank 2 (F):

- Install timing chain so that the matching mark (punched) (B) and the matching mark (outer groove) (C) on camshaft sprocket is aligned with the copper link (A) on timing chain, while the matching mark (punched) (B) on crankshaft sprocket is aligned with the yellow link (D) one on timing chain, as shown in the figure.

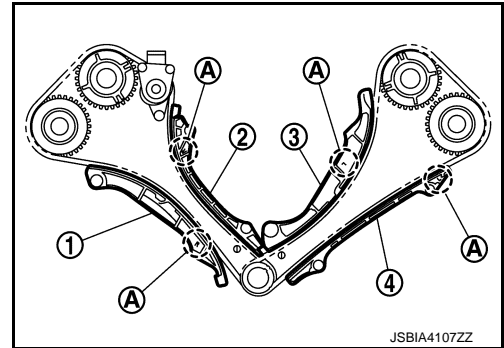
Bank 1 (G):

- Install timing chain so that the matching mark (punched) (B) and the matching mark (outer groove) (C) on camshaft sprocket is aligned with the copper link (A) on timing chain, while the matching mark (notched) (E) on crankshaft sprocket is aligned with the yellow link (D) one on timing chain, as shown in the figure.



5. Install slack guides and tension guides onto correct side by checking with identification mark (A) on surface.

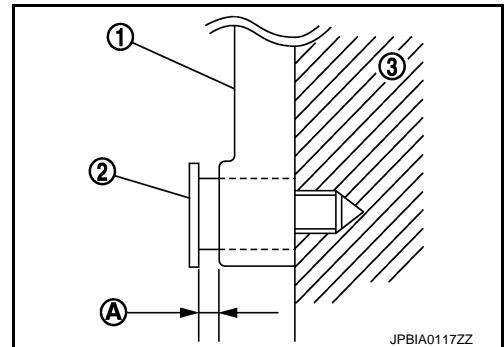
- 1 : Slack guide (bank 2)
- 2 : Tension guide (bank 2)
- 3 : Slack guide (bank 1)
- 4 : Tension guide (bank 1)



CAUTION:

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

- 1 : Slack guide
- 3 : Cylinder block

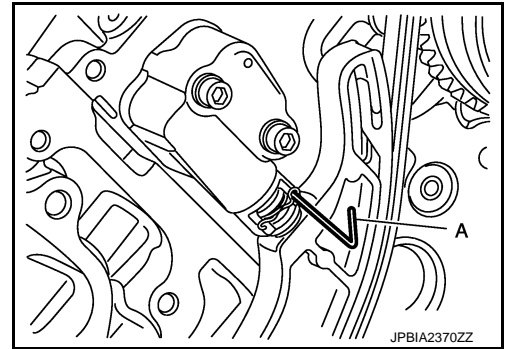


6. Install timing chain tensioner as per the following:

TIMING CHAIN

< REMOVAL AND INSTALLATION >

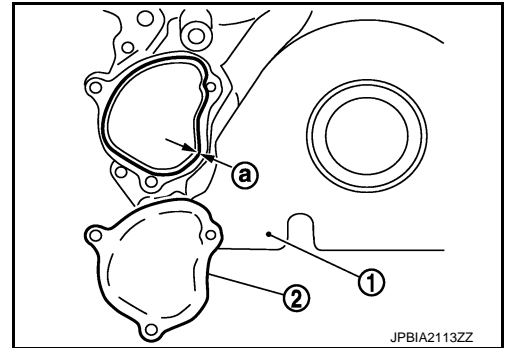
- a. Fix the plunger at the most compressed position using a stopper pin (A).
 - Remove any dirt and foreign materials completely from the back and the mounting surfaces of timing chain tensioner.
- b. Pull out stopper pin after installing, and then release plunger.



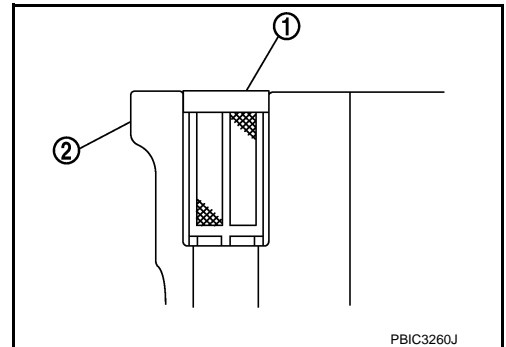
7. Check again that the matching marks on sprockets and timing chain have not slipped out of alignment.
8. Install oil pump and oil pump drive spacer. Refer to [LU-15, "Exploded View"](#).
9. Install front oil seal on front cover. Refer to [EM-102, "FRONT OIL SEAL : Removal and Installation"](#).
10. Install timing chain tensioner cover (2) to front cover (1).

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

- Apply a continuous bead of liquid gasket with tube presser (commercial service tool) to front cover as shown in the figure. **Use Genuine RTV silicone sealant or equivalent. Refer to [GI-22, "Recommended Chemical Products and Sealants"](#).**



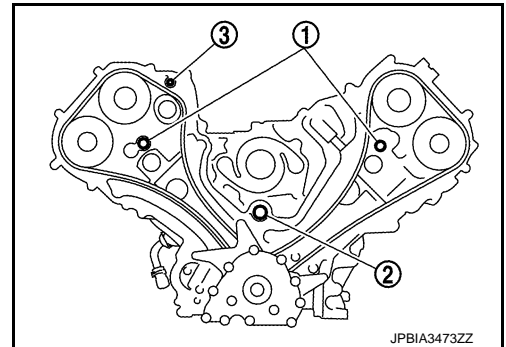
11. Install oil filter (for valve timing control solenoid valve) (1) in the direction shown in the figure, if removed.
 - Check that the oil filter does not protrude from the upper surface of front cover (2) after installation.



12. Install front cover as per the following:

- a. Install new O-ring (1), (2), (3) onto cylinder heads and cylinder block.

CAUTION:
Do not reuse O-rings.



TIMING CHAIN

< REMOVAL AND INSTALLATION >

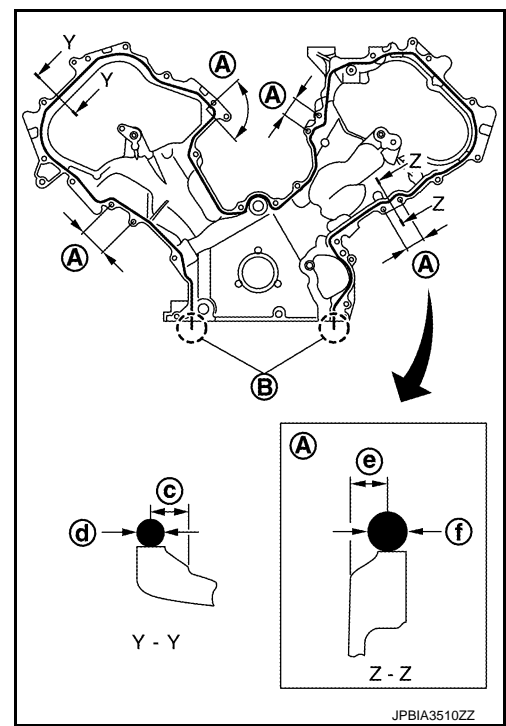
- b. Apply a continuous bead of liquid gasket with tube presser (commercial service tool) to front cover as shown in the figure. **Use Genuine RTV silicone sealant or equivalent. Refer to GI-22. "Recommended Chemical Products and Sealants".**

- A : Junction between cylinder block and cylinder head
- B : Protrusion
- c : 4.3 - 5.3 mm (0.169 - 0.209 in)
- d : $\phi 3.4 - 4.4$ mm (0.134 - 0.173 in)
- e : $\phi 4.0 - 5.6$ mm (0.157 - 0.220 in)
- f : $\phi 4.8 - 5.8$ mm (0.189 - 0.228 in)

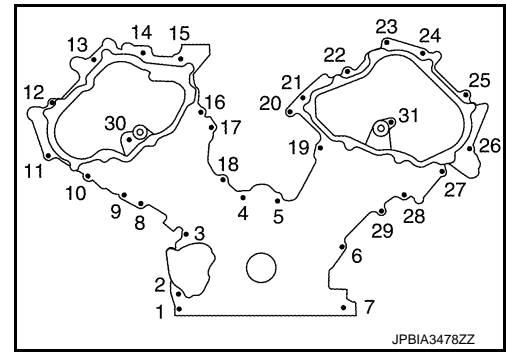
- c. Check again that the matching marks on timing chain and that on each sprocket are aligned. Then, install front cover.

CAUTION:

Be careful not to damage front oil seal by interference with front end of crankshaft.

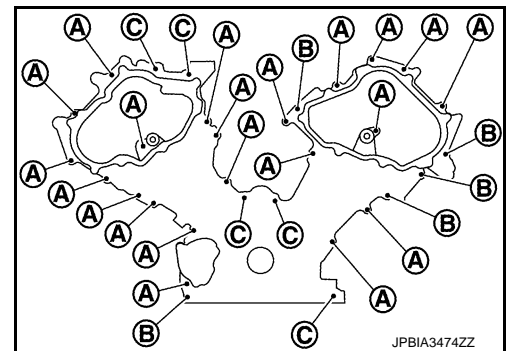


- d. Tighten mounting bolts in numerical order as shown in the figure.



- There are three types of mounting bolts.

- A : 20 mm (0.79 in)**
- B : 50 mm (1.97 in)**
- C : 80 mm (3.15 in)**



- e. After all mounting bolts are tightened, retighten them in numerical order as shown in the figure.

CAUTION:

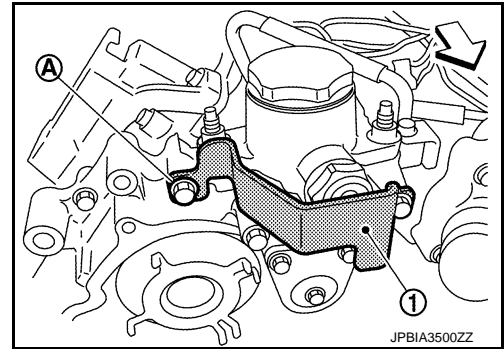
Be sure to wipe out any excessive liquid gasket leaking onto surface mating with oil pan.

13. Install valve timing control cover as per the following:

TIMING CHAIN

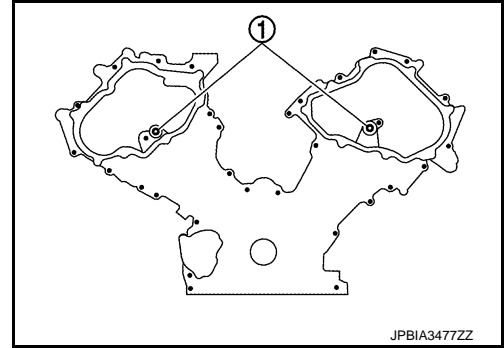
< REMOVAL AND INSTALLATION >

- Bolt (A) of fuel pump connector protector (1) cannot be installed after installing valve timing control cover. Therefore, install fuel pump connector protector in advance, if it is being removed.



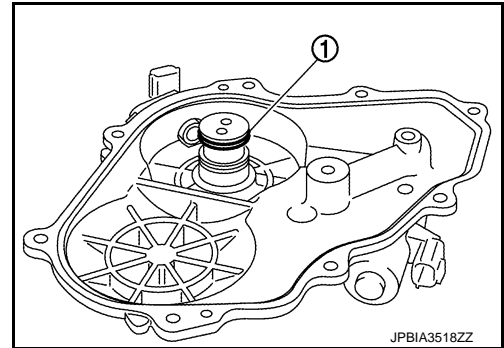
- a. Install new O-rings (1) on front cover.

CAUTION:
Do not reuse O-rings.



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

CAUTION:
When replacing seal ring, replace all rings with new ones.



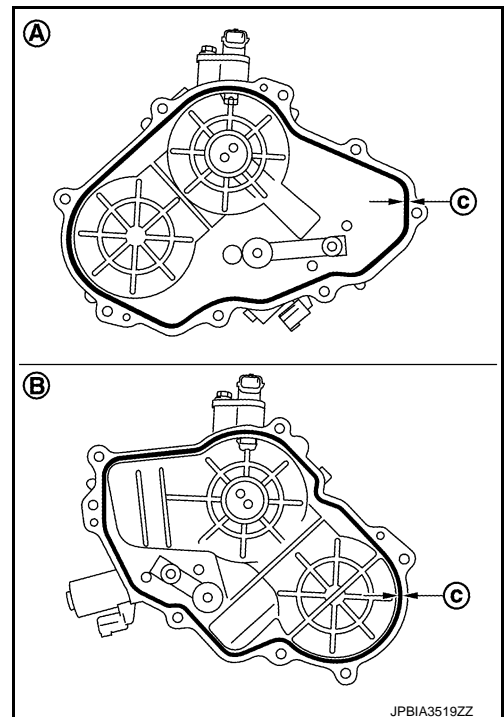
- c. Apply a continuous bead of liquid gasket with tube presser (commercial service tool) to valve timing control covers as shown in the figure.

A : Bank 1

B : Bank 2

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

Use Genuine RTV silicone sealant or equivalent. Refer to [GI-22. "Recommended Chemical Products and Sealants"](#).



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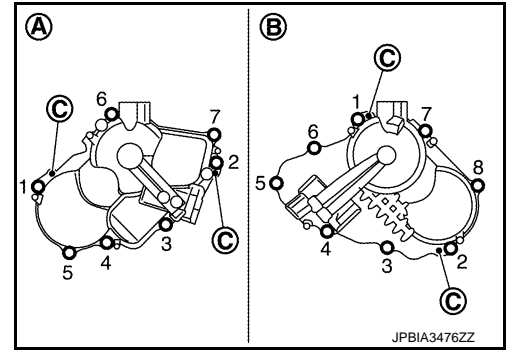
TIMING CHAIN

< REMOVAL AND INSTALLATION >

- d. Being careful not to move seal ring from the installation groove, align dowel pins on front cover with dowel pin holes (C) to install valve timing control covers.

A : Bank 2
B : Bank 1

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



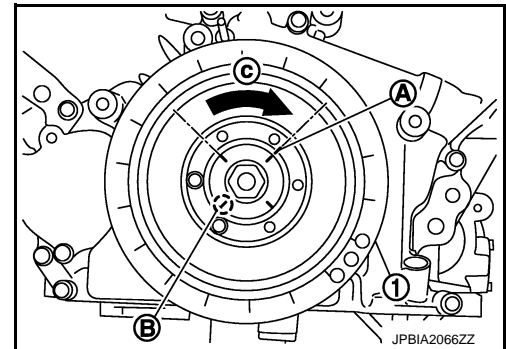
14. Install camshaft position sensor and valve timing control solenoid valve (RH and LH) to valve timing control cover, if removed.
- Be sure to tighten mounting bolts with flanges completely seated.
15. Install oil pan (upper). Refer to [EM-59, "Exploded View"](#).
16. Install oil pan (lower) and oil strainer. Refer to [EM-56, "Exploded View"](#).
17. Install water pump pulley. Refer to [CO-20, "Exploded View"](#).
18. Install crankshaft pulley.
- Fix the crankshaft as instructed in the removal procedure. Refer to [EM-102, "FRONT OIL SEAL : Removal and Installation"](#).
- a. Install crankshaft pulley, taking care not to damage front oil seal.
- b. Apply engine oil onto threaded parts of crankshaft pulley bolt and seating area.
- Lightly tapping its center with plastic hammer, insert crankshaft pulley.
- CAUTION:**
Never tap crankshaft pulley on the side surface where belt is installed (outer circumference).
- c. Tighten crankshaft pulley bolt.

: 205 N·m (21 kg·m, 151 ft·lb)

- d. Put a paint mark (A) on crankshaft pulley (1) aligning with angle mark (B) on crankshaft pulley bolt.
- e. Tighten crankshaft pulley bolt (clockwise).

Angle tightening: 90 degrees (c)

- Check the tightening angle by referencing to the notches. The angle between two notches is 90 degrees.



19. Rotate crankshaft pulley in normal direction (clockwise when viewed from engine front) to confirm it turns smoothly.
20. Install in the reverse order of removal.

Replacement [Oil Jet (Bank 2)]

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When the chain elongates and interferes with oil-jet which makes oil jet nozzle deformed or damaged, replace oil jet in the following procedures.

JIGS FOR REPLACEMENT

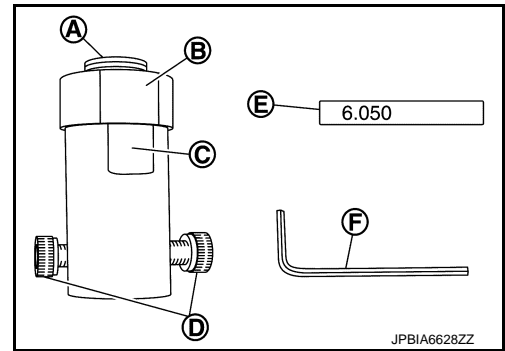
Check if the following jigs are prepared.

TIMING CHAIN

< REMOVAL AND INSTALLATION >

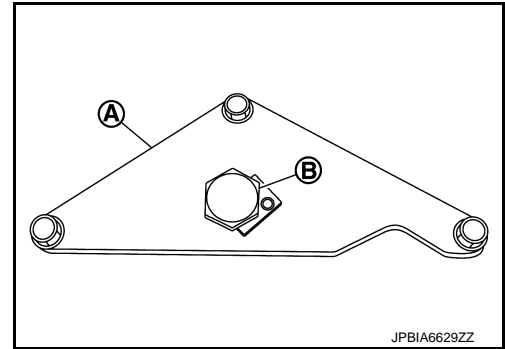
• Disassembly jig (130811LA0B)

- A : Disassembly jig inner
- B : Nut (M14)
- C : Disassembly jig outer
- D : Bolt (M5)
- E : Pin gauge (ϕ 6.050 mm)
- F : Hexagon wrench



• Assembly jig (130811LA0C)

- A : Assembly jig base
- B : Assembly bolt (M10)



REPLACEMENT PROCEDURE

Disassembly

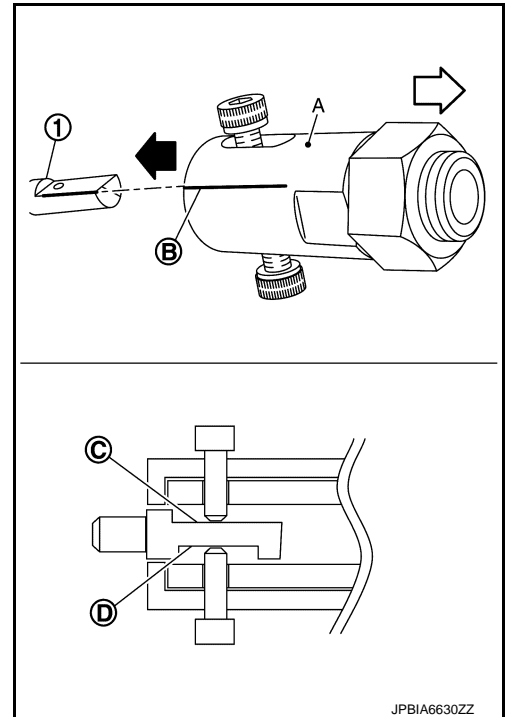
- Turning the base line (B) upwards, insert oil jet (1) into disassembly jig (130811LA0B) (A).

← : Vehicle front

CAUTION:

There is no base line before service part is setup. (Base line is applied from service part.)

Set jig so that position matches ground-side (D) and flat side (C) shown in the figure.



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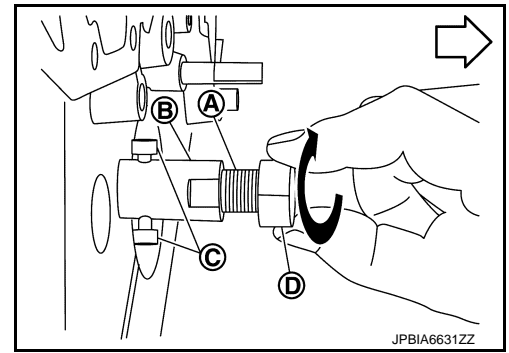
TIMING CHAIN

< REMOVAL AND INSTALLATION >

2. After pushing disassembly jig inner (A) into end-face of disassembly jig outer (B), tighten bolt (M5) (C) using hexagon wrench.

← : Vehicle front

3. Tighten nut (M14) (D) by hand.

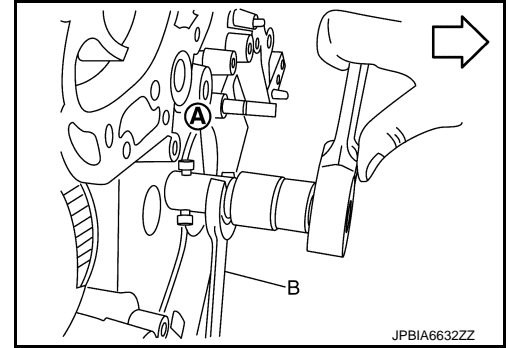


4. Hold disassembly jig outer (A) using wrench [WAF: 17 mm (0.67 in)] (B). Tighten nut (M14) and then disassemble oil-jet.

← : Vehicle front

CAUTION:

Beware of enlarging the hole diameter caused by tilting the jig.



Confirm the Hole Diameter

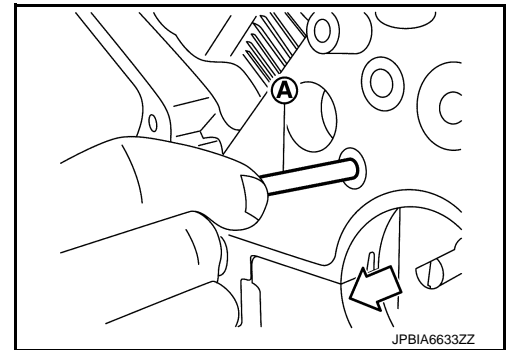
1. After disassembling oil-jet, use pin gauge (A) to confirm the hole diameter.

← : Vehicle front

Unable to insert pin gauge deeper than 3 mm (0.118 in)

NOTE:

In case of pin gauge being inserted deeper than 3 mm (0.118 in), replace cylinder block and oil-jet.

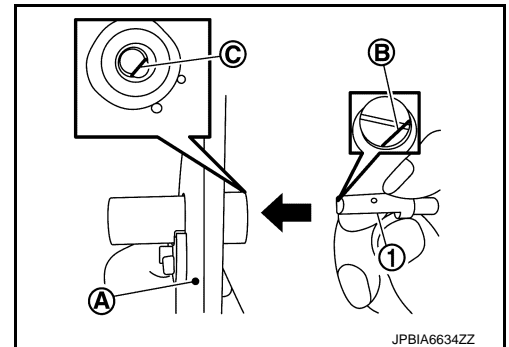


Assembly

1. Insert new oil jet (1) into assembly jig base (130811LA0C) (A) in the direction shown by arrow.

NOTE:

When inserting new oil jet (1), be sure that D-cut (B) surface on oil jet and the location plate (C) are parallel to each other.



TIMING CHAIN

< REMOVAL AND INSTALLATION >

2. Tighten M6 bolt (A) temporarily by hand.

B : Assembly bolt (M10)

← : Vehicle front

3. Tighten the assembly bolt (M10) by hand until you feel the pressure from oil jet. Then tighten the bolt (M10) rotating twice with a wrench and center the oil jet and the hole.

CAUTION:

Do not tighten completely until the end of process.

4. Tighten the M6 bolt.

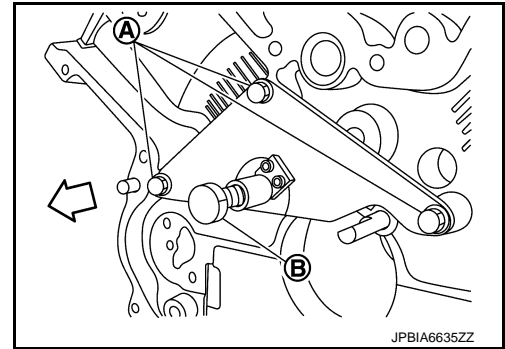
NOTE:

Make assembly jig base and oil-jet be concentricity.

5. Assemble oil-jet by tightening assembly bolt (M10) until it stops.

6. Loosen the M6 bolt, and remove assembly jig from cylinder block.

7. Confirm the positional limitation of adjustment notch (A) on oil-jet (1) is within $\pm 10^\circ$ (b).



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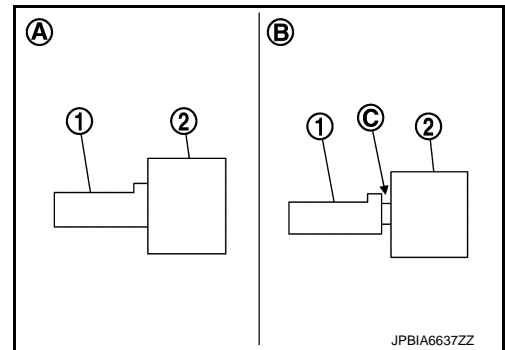
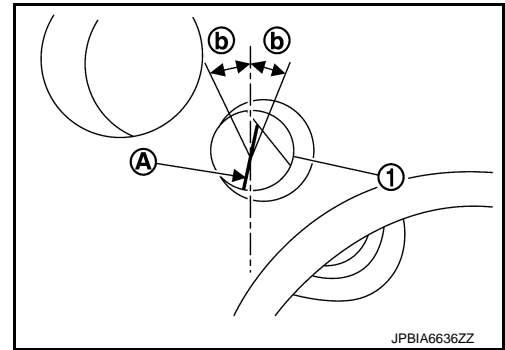
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8. If there is a gap (C) between oil-jet (1) and cylinder block (2) surface, repeat the steps 2 to 6 again.

A : OK

B : NG



Inspection

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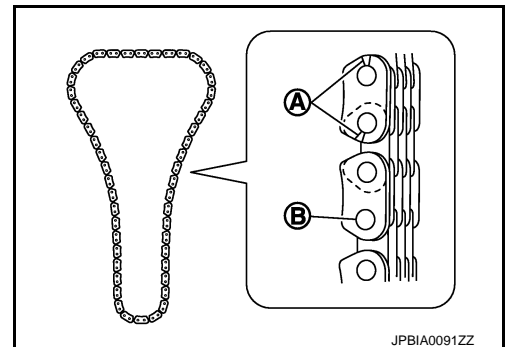
INSPECTION AFTER DISASSEMBLY

Timing Chain

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 ASSEMBLY

Inspection for Leakage

TIMING CHAIN

< REMOVAL AND INSTALLATION >

The following are procedures for checking fluid leakage, lubricant leakage.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If any are less than the required quantity, fill them to the specified level. Refer to the following table:

For NORTH AMERICA	MA-15. "FOR NORTH AMERICA : Fluids and Lubricants"
For MEXICO	MA-16. "FOR MEXICO : Fluids and Lubricants"

- Follow the procedure below to check for fuel leakage.
 - Turn ignition switch to the "ON" position (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 a malfunction. The noise will stop after hydraulic pressure rises.

- Warm up engine thoroughly to check that 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 them to the specified level, if necessary.

Summary of the inspection items:

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

* Power steering fluid, brake fluid, etc.

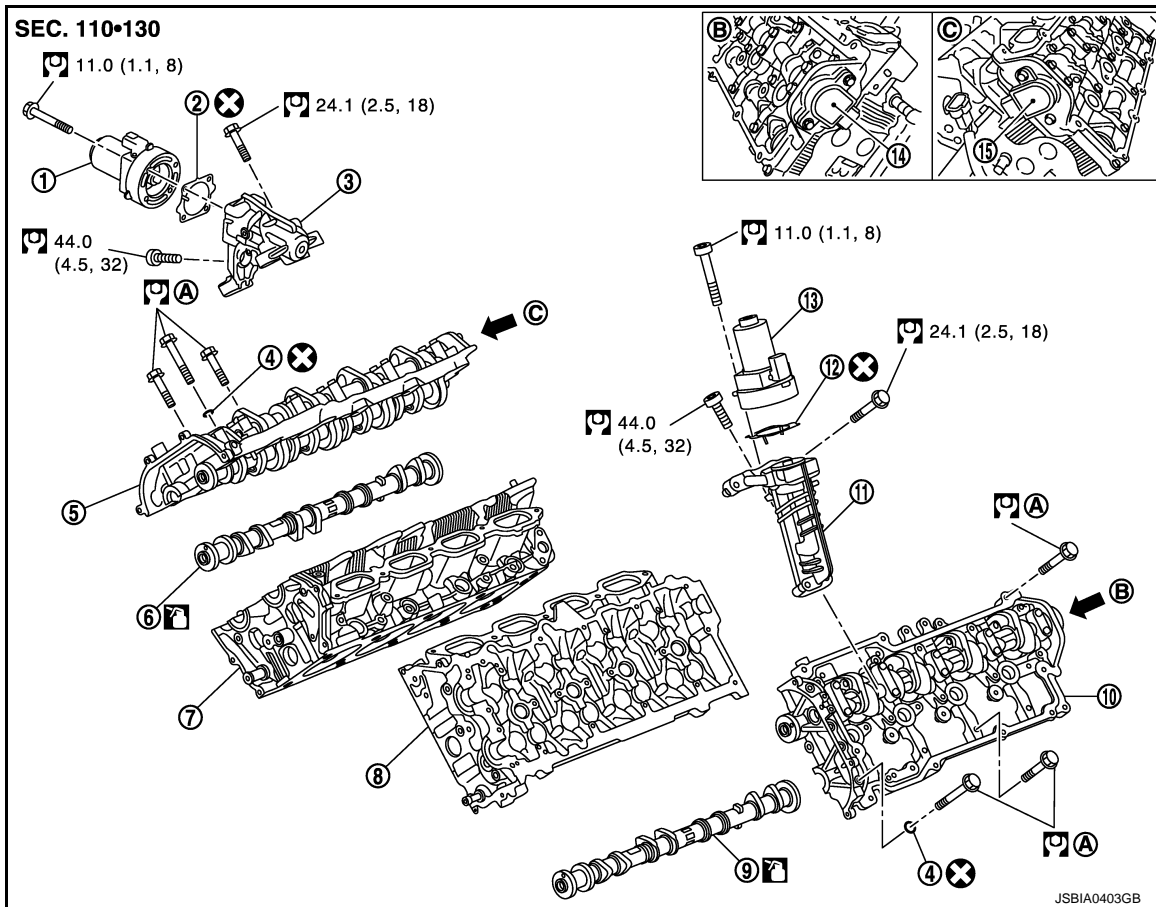
CAMSHAFT

< REMOVAL AND INSTALLATION >

CAMSHAFT

Exploded View

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- | | | |
|-------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| 1. VVEL actuator motor assembly (bank 2) | 2. Gasket | 3. VVEL actuator housing assembly (bank 2) |
| 4. Washer | 5. VVEL ladder assembly (bank 2) | 6. Exhaust camshaft (bank 2) |
| 7. Cylinder head (bank 2) | 8. Cylinder head (bank 1) | 9. Exhaust camshaft (bank 1) |
| 10. VVEL ladder assembly (bank 1) | 11. VVEL actuator housing assembly (bank 1) | 12. Gasket |
| 13. VVEL actuator motor assembly (bank 1) | 14. VVEL control shaft position sensor (bank 1) | 15. VVEL control shaft position sensor (bank 2) |

Comply with the installation procedure when tightening. Refer to [EM-80](#).

B. View B

C. View C

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

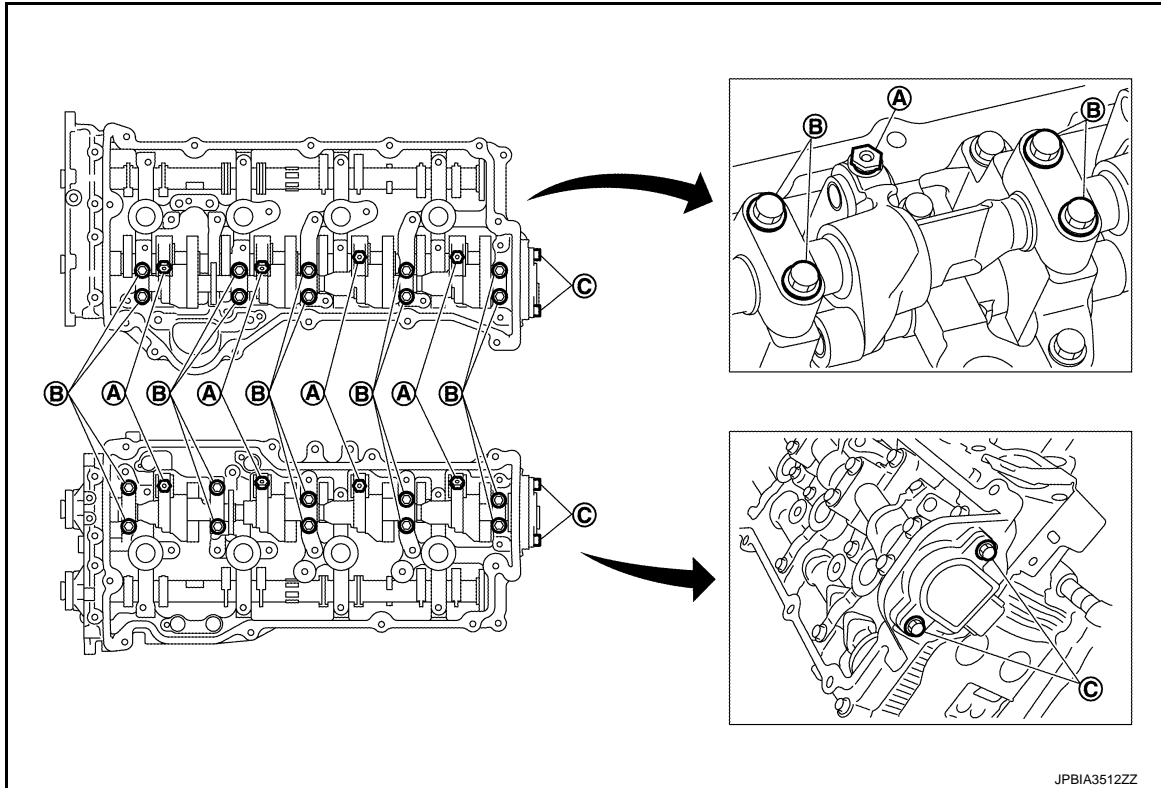
CAMSHAFT

< REMOVAL AND INSTALLATION >

Removal and Installation

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REMOVAL



CAUTION:

- Never loosen adjusting bolts (A), mounting bolts (black color) (B) of VVEL ladder assembly and mounting bolts (C) of VVEL control shaft position sensor. If loosened, the stroke of cam lift becomes out of adjustment. In such case, replacement of VVEL ladder assembly and cylinder head assembly is required.
- Never loosen the mounting bolts (C) of the VVEL control shaft position sensor. VVEL control shaft position sensor mounting bolts are required to be loosened for adjustment only when using a new VVEL ladder assembly. Refer to the following table:

ENGINE	Reference page
VK56VD FOR USA AND CANADA	EC-165, "Work Procedure"
VK56VD FOR MEXICO	EC-728, "Work Procedure"

VVEL control shaft position sensor mounting bolt

 : 7.0 N·m (0.71 kg-m, 62 in-lb)

NOTE:

VVEL ladder assembly cannot be replaced as a single part, because it is machined together with cylinder head assembly.

1. Remove VVEL actuator motor assembly. Refer to [EM-37, "Exploded View"](#).
2. Remove rocker covers (bank 1 and bank 2). Refer to [EM-34, "Exploded View"](#).
3. Remove VVEL actuator housing assembly. Refer to [EM-37, "Exploded View"](#).
4. Remove front cover, camshaft sprockets, and timing chains. Refer to [EM-63, "Exploded View"](#).
5. Remove VVEL ladder assembly.

CAMSHAFT

< REMOVAL AND INSTALLATION >

- Loosen mounting bolts (gold color) in the reverse order as shown in the figure.

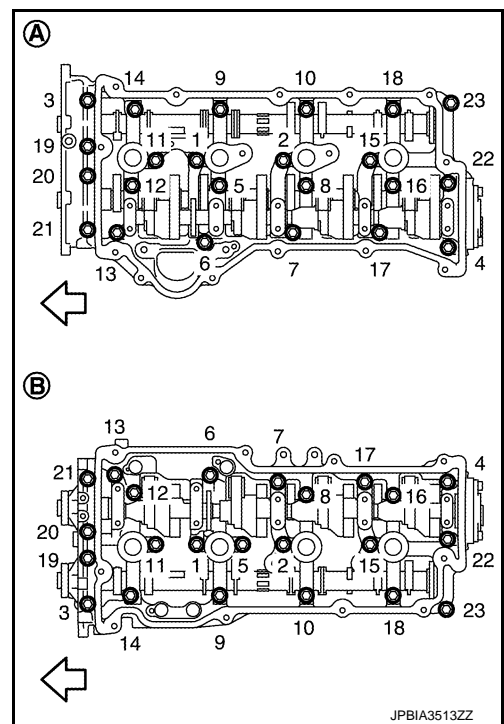
A : Bank 2

B : Bank 1

← : Engine front

CAUTION:

- Never loosen adjusting bolts and mounting bolts (black color).
- When removing VVEL ladder assembly, hold the drive shaft from below so as not to drop it.



- Remove exhaust camshaft.
- Remove valve lifter, if necessary.
 - Identify installation positions, and store them without mixing them up.

INSTALLATION

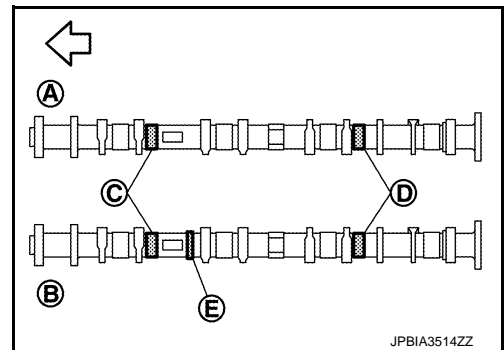
CAUTION:

Do not reuse washers.

- Install valve lifter.
 - Install it in the original position.
- Install exhaust camshaft.
 - Distinction between exhaust camshaft is performed with the identification mark.

← : Engine front

Bank	Paint marks		Identification rib (E)
	M1 (C)	M2 (D)	
Bank 1 (A)	No	Purple	Yes
Bank 2 (B)	No	Purple	No




- Install VVEL ladder assembly as per the following:

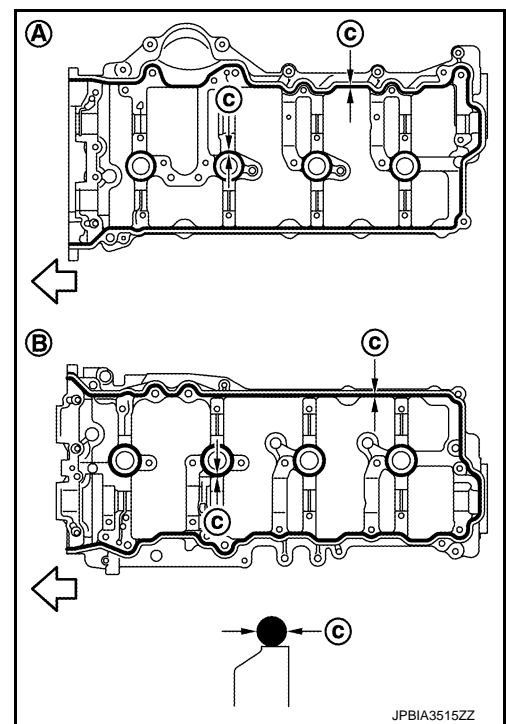
CAMSHAFT

< REMOVAL AND INSTALLATION >


- a. Apply a continuous bead of liquid gasket with tube presser (commercial service tool) to the VVEL ladder assembly as shown in the figure.

- A : Bank 1
- B : Bank 2
- c : $\phi 3.4 - 4.4$ mm (0.134 - 0.173 in)
-  : Engine front

Use Genuine RTV silicone sealant or equivalent. Refer to [GI-22, "Recommended Chemical Products and Sealants"](#).



- b. Tighten mounting bolts in the following step, in numerical order as shown.

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

CAUTION:
Do not reuse washers.


- i. Tighten bolts in numerical order as shown.

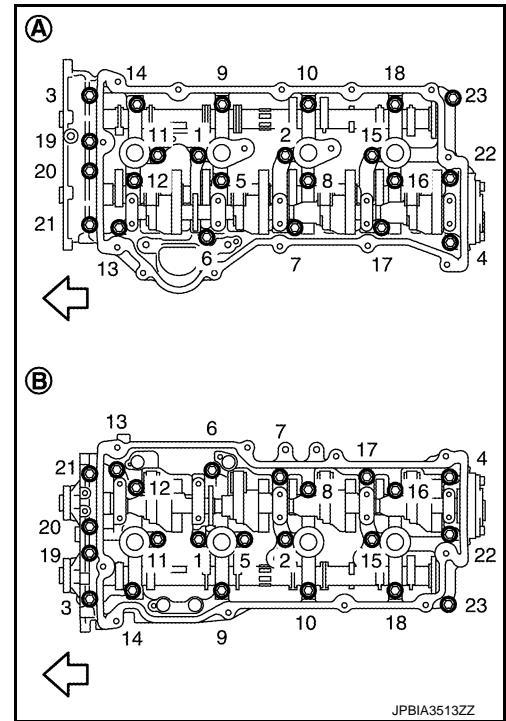
 : 1.96 N·m (0.20 kg·m, 1 ft·lb)

- ii. Tighten bolts in numerical order as shown.

 : 5.88 N·m (0.60 kg·m, 4 ft·lb)

- iii. Tighten bolts in numerical order as shown.

 : 10.4 N·m (1.1 kg·m, 8 ft·lb)



4. Install camshaft sprockets and timing chains. Refer to [EM-63, "Exploded View"](#).
5. Install VVEL actuator housing assembly. Refer to [EM-37, "Removal and Installation"](#).
6. Inspect the valve clearance. Refer to [EM-12, "Inspection"](#).
7. Install in the reverse order of removal.
8. When New VVEL ladder assembly used. Adjust VVEL control shaft position sensor. Refer to the following table:

ENGINE	Reference page
VK56VD FOR USA AND CANADA	EC-165, "Work Procedure"
VK56VD FOR MEXICO	EC-728, "Work Procedure"

CAMSHAFT

< REMOVAL AND INSTALLATION >

Inspection

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EXHAUST CAMSHAFT VALVE CLEARANCE ADJUSTMENT

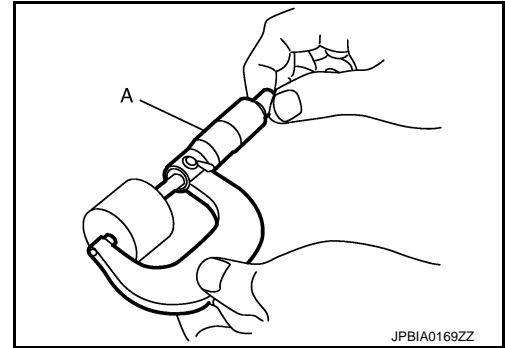
- Perform adjustment depending on selected head thickness of valve lifter (EXH).

1. Measure the valve clearance. Refer to [EM-12, "Inspection"](#).
2. Remove VVEL ladder assembly and exhaust camshaft. Refer to [EM-80, "Removal and Installation"](#).

CAUTION:

Never loosen adjusting bolts and mounting bolts (black color) of VVEL ladder assembly.

3. Remove valve lifter (EXH) at the locations that are out of the standard.
4. Measure the center thickness of the removed valve lifters (EXH) with a micrometer (A).



5. Use the equation below to calculate valve lifter (EXH) thickness for replacement.

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

t = Valve lifter (EXH) thickness to be replaced

t₁ = Removed valve lifter (EXH) thickness

C₁ = Measured valve clearance

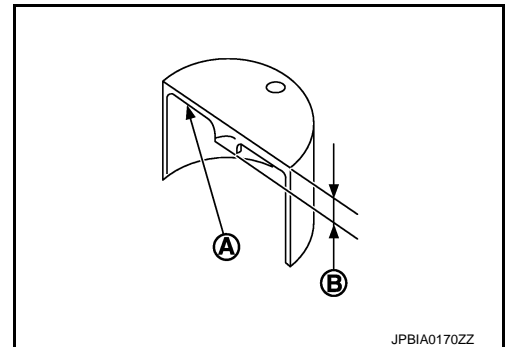
C₂ = Standard valve clearance:

Exhaust : 0.33 mm (0.013 in)

- Thickness of new valve lifter (EXH) 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 (EXH)



Available thickness of valve lifter (EXH): 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-141, "Camshaft"](#).

6. Install selected valve lifter (EXH).
7. Install VVEL ladder assembly and exhaust camshaft. Refer to [EM-80, "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-12, "Inspection"](#).
10. Install all removed parts in the reverse order of removal.
11. Warm up the engine, and check for unusual noise and vibration.

INSPECTION AFTER DISASSEMBLY (EXHAUST SIDE)

Exhaust Camshaft Runout

CAMSHAFT

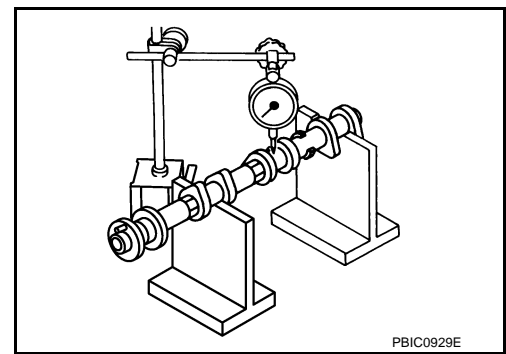
< REMOVAL AND INSTALLATION >

1. Put V-block on precise flat table, and support No. 2 and 5 journals of camshaft.

CAUTION:

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

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



Standard and limit

: Refer to [EM-141, "Camshaft"](#).

4. If it exceeds the limit, replace exhaust camshaft.

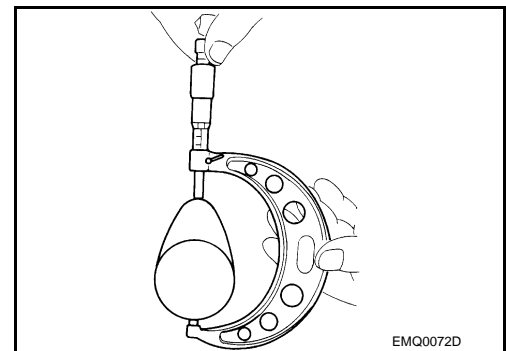
Exhaust Camshaft Cam Height

- Measure the exhaust camshaft cam height with a micrometer.

Standard and limit

: Refer to [EM-141, "Camshaft"](#).

- If wear exceeds the limit, replace exhaust camshaft.

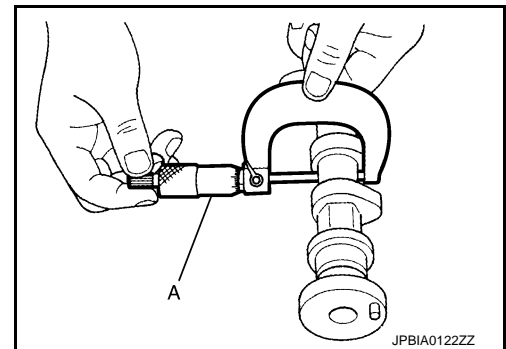


Exhaust Camshaft Journal Oil Clearance

EXHAUST CAMSHAFT JOURNAL DIAMETER

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

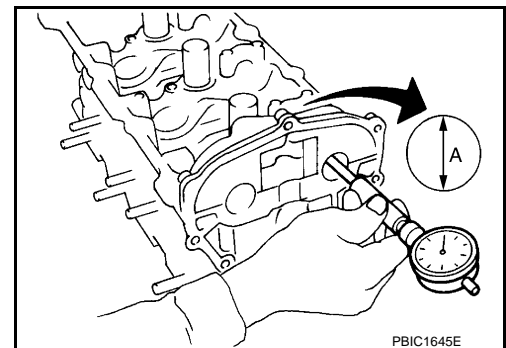
Standard : Refer to [EM-141, "Camshaft"](#).



VVEL LADDER ASSEMBLY (EXH SIDE) INNER DIAMETER

- Tighten VVEL ladder assembly bolts to the specified torque. Refer to "ASSEMBLY" for the tightening procedure.
- Measure inner diameter (A) of VVEL ladder assembly (exhaust side) with a bore gauge.

Standard : Refer to [EM-141, "Camshaft"](#).



EXHAUST CAMSHAFT JOURNAL OIL CLEARANCE

CAMSHAFT

< REMOVAL AND INSTALLATION >

- (Oil clearance) = [VVEL ladder assembly (exhaust side) inner diameter] – [Exhaust camshaft journal diameter].

Standard and limit : Refer to [EM-141, "Camshaft"](#).

- If the calculated value exceeds the limit, replace either or both exhaust camshaft and VVEL ladder assembly & cylinder head assembly.

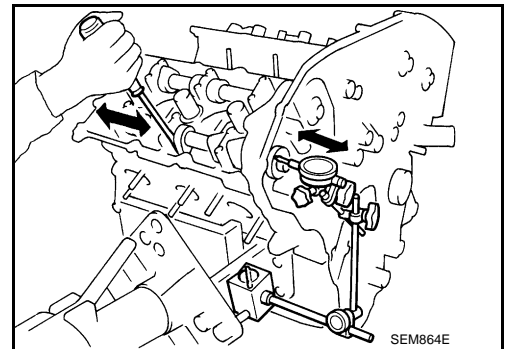
NOTE:

VVEL ladder assembly cannot be replaced as a single part, because it is machined together with cylinder head assembly.

Exhaust Camshaft End Play

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

Standard and limit : Refer to [EM-141, "Camshaft"](#).



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

Standard : 30.500 - 30.548 mm (1.2008 - 1.2027 in)

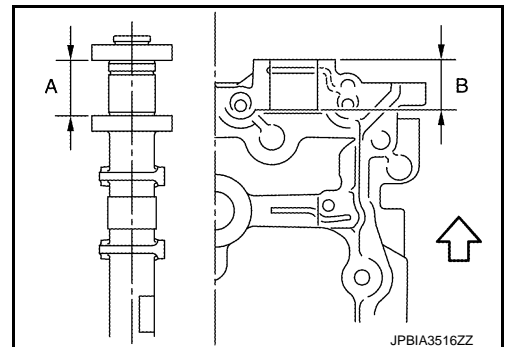
- Dimension "B" for cylinder head No. 1 journal bearing

Standard : 30.360 - 30.385 mm (1.1953 - 1.1963 in)

- Refer to the standards above, and then replace exhaust camshaft and/or VVEL ladder assembly & cylinder head assembly.

NOTE:

Cylinder head assembly cannot be replaced as a single part, because it is machined together with VVEL ladder assembly.



Exhaust Camshaft Sprocket Runout

1. Put V-block on precise flat table, and support No. 2 and 5 journals of exhaust camshaft.

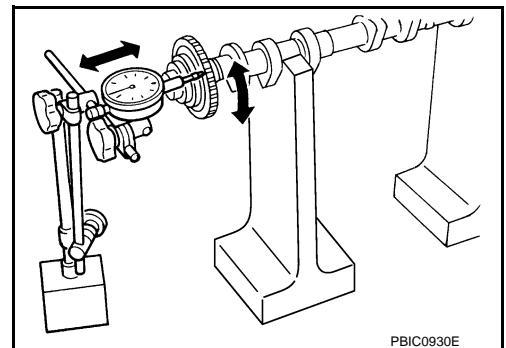
CAUTION:

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

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

Limit : Refer to [EM-141, "Camshaft"](#).

3. If it exceeds the limit, replace exhaust camshaft sprocket.

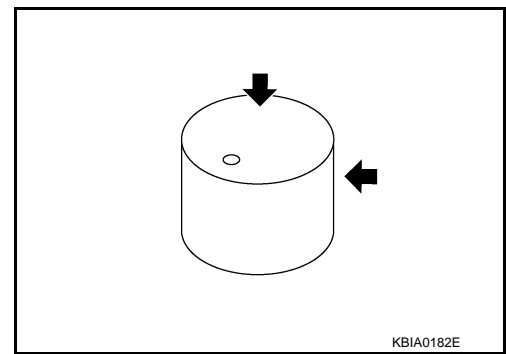


Valve Lifter (EXH)

CAMSHAFT

< REMOVAL AND INSTALLATION >

- Check if surface of valve lifter has any wear or crack.
- If wear or crack is found, replace valve lifter (EXH). Refer to [EM-141, "Camshaft"](#).

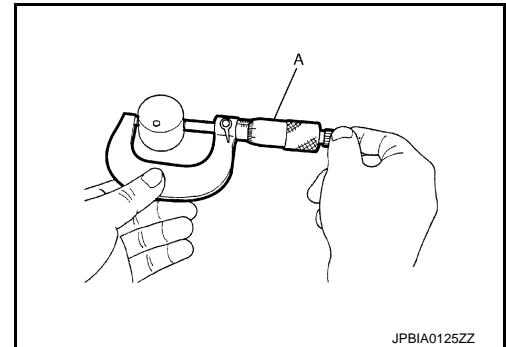


Valve Lifter Clearance (EXH)

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.

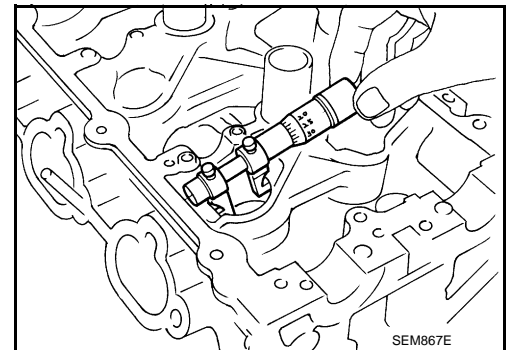
Standard : Refer to [EM-141, "Camshaft"](#).



VALVE LIFTER HOLE DIAMETER

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

Standard : Refer to [EM-141, "Camshaft"](#).



VALVE LIFTER CLEARANCE

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

Standard : Refer to [EM-141, "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 VVEL ladder assembly & cylinder head assembly.

NOTE:

Cylinder head assembly cannot be replaced as a single part, because it is machined together with VVEL ladder assembly.

INSPECTION AFTER DISASSEMBLY (INTAKE SIDE)

Drive Shaft End Play

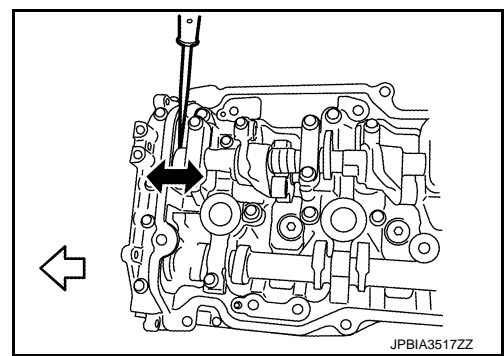
CAMSHAFT

< REMOVAL AND INSTALLATION >

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

← : Engine front

Standard and limit : Refer to [EM-141, "Camshaft"](#).



- Measure the following parts if out of the limit.

← : Engine front

- Dimension "A" for drive shaft No. 1 journal

Standard : 30.500 - 30.548 mm (1.2008 - 1.2027 in)

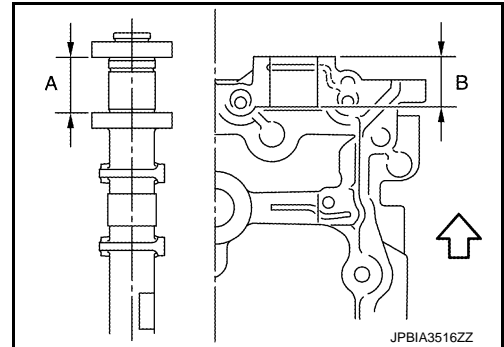
- Dimension "B" for cylinder head No. 1 journal bearing

Standard : 30.360 - 30.385 mm (1.1953 - 1.1963 in)

- If it exceeds the limit, replace VVEL ladder assembly & cylinder head assembly.

NOTE:

Cylinder head assembly cannot be replaced as a single part, because it is machined together with VVEL ladder assembly.



Camshaft Sprocket (INT) Runout

1. Put V-block on precise flat table, and support No. 2 and 5 journals of drive shaft.

CAUTION:

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

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

Limit : Refer to [EM-141, "Camshaft"](#).

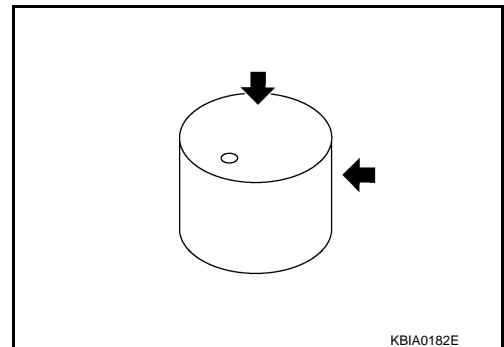
3. If it exceeds the limit, replace camshaft sprocket (INT).

Valve Lifter (INT)

- Check if surface of valve lifter has any wear or crack.
- If wear or crack is found, replace VVEL ladder assembly & cylinder head assembly. Refer to [EM-141, "Camshaft"](#).

NOTE:

Since the valve lifter (INT) cannot be replaced by the piece, VVEL ladder assembly & cylinder head assembly replacement are required.



Valve Lifter Clearance (INT)

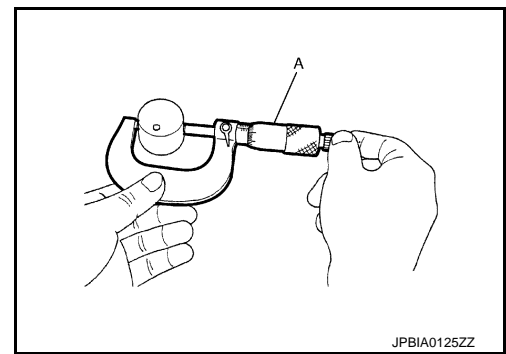
VALVE LIFTER OUTER DIAMETER

CAMSHAFT

< REMOVAL AND INSTALLATION >

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

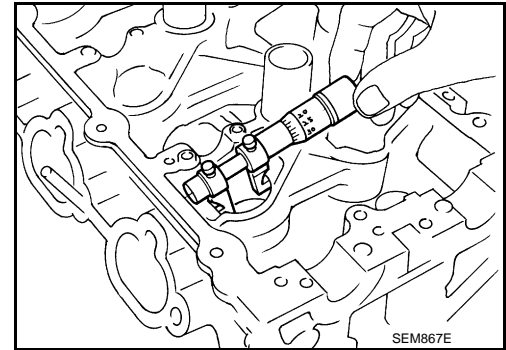
Standard : Refer to [EM-141, "Camshaft"](#).



VALVE LIFTER HOLE DIAMETER

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

Standard : Refer to [EM-141, "Camshaft"](#).



VALVE LIFTER CLEARANCE

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

Standard : Refer to [EM-141, "Camshaft"](#).

- If the calculated value is out of the standard, replace VVEL ladder assembly & cylinder head assembly.

NOTE:

Since the valve lifter (INT) cannot be replaced by the piece, VVEL ladder assembly & cylinder head assembly replacement are required.

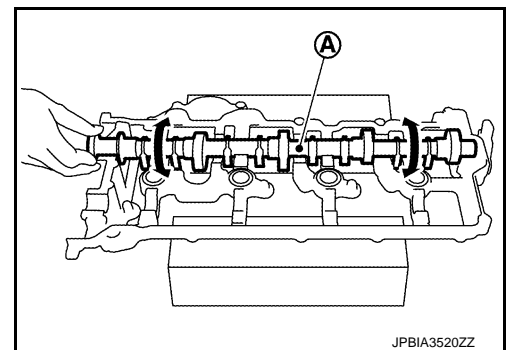
VVEL Ladder Assembly

DRIVE SHAFT OPERATIONAL CHECK

- Hold the both ends of the drive shaft (A) and rotate it to check that it rotates smoothly.

CAUTION:

Turn VVEL ladder assembly upside down to prevent the drive shaft from dropping off.



CONTROL SHAFT OPERATIONAL CHECK

CAMSHAFT

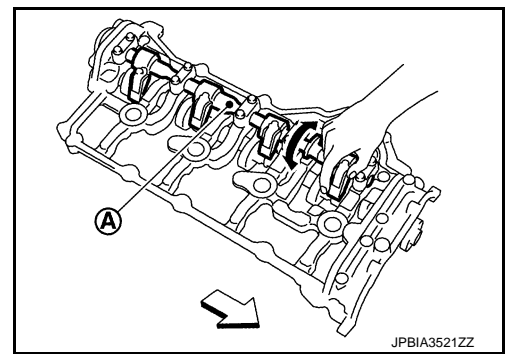
< REMOVAL AND INSTALLATION >

- Move control shaft (A) to the small stopper and large stopper to check that the control shaft functions smoothly.

CAUTION:

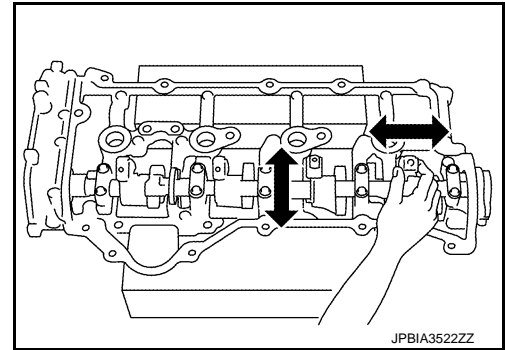
Turn VVEL ladder assembly upside down to prevent the drive shaft from dropping off.

⇐ : Engine front



RINK CHECK FOR BACK-LASH (BONDING)

- Check that the link and the shaft of drive shaft and control shaft are not fixed.
- Check this by moving drive shaft and control shaft in the axial and rotation directions.



- If there is an unusualness related to the above three items, replace VVEL ladder assembly & cylinder head assembly.

NOTE:

VVEL ladder assembly cannot be replaced as a single part, because it is machined together with cylinder head assembly.

INSPECTION AFTER ASSEMBLY

Inspection of Camshaft Sprocket (INT) Oil Groove

CAUTION:

- Perform this inspection only when DTC P0011, P0021 are detected in self-diagnostic results of CONSULT and it is directed according to inspection procedure of EC section. Refer to the following table:

ENGINE	Reference page
VK56VD FOR USA AND CANADA	EC-199. "DTC Logic"
VK56VD FOR MEXICO	EC-755. "DTC Logic"

- Check when engine is cold to prevent burns from the splashing engine oil.

1. Check engine oil level. Refer to [LU-8. "Inspection"](#).
2. Perform the following procedure to prevent the engine from being unintentionally started while checking.
 - a. Release the fuel pressure. Refer to the following table:

ENGINE	Reference page
VK56VD FOR USA AND CANADA	EC-168. "Work Procedure"
VK56VD FOR MEXICO	EC-731. "Work Procedure"

- b. Disconnect ignition coil and injector harness connectors.
3. Remove valve timing control solenoid valve. Refer to [EM-63. "Exploded View"](#).

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CAMSHAFT

< REMOVAL AND INSTALLATION >

4. Crank engine, and then check that engine oil comes out from valve timing control solenoid valve hole (A). End crank after checking.

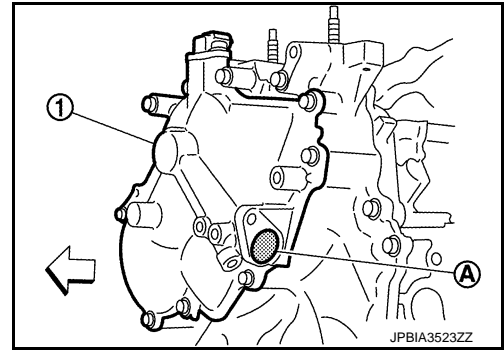
1 : Valve timing control cover (bank 2)

WARNING:

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

CAUTION:

- Prevent splashing by using a shop cloth to prevent the worker from injury from engine oil and to prevent engine oil contamination.
- Prevent splashing by using a shop cloth to prevent engine oil from being splashed to engine and vehicle. Especially, be careful not to apply engine oil to rubber parts of drive belt, engine mounting insulator, etc. Wipe engine oil out immediately if it is splashed.



5. Perform the following inspection if engine oil does not come out from valve timing control solenoid valve oil hole of the valve timing control cover.
 - Remove oil filter, and then clean it. Refer to [EM-63, "Exploded View"](#).
 - Clean oil groove between oil strainer and valve timing control solenoid valve. Refer to [LU-6, "Engine Lubrication System"](#) and [LU-7, "Engine Lubrication System Schematic"](#).
6. Remove components between valve timing control solenoid valve and camshaft sprocket, and then check each oil groove for clogging.
 - Clean oil groove if necessary. Refer to [LU-6, "Engine Lubrication System"](#) and [LU-7, "Engine Lubrication System Schematic"](#).
7. After inspection, install removed parts in the reverse order.

Inspection for Leakage

The following are procedures for checking fluid leakage, lubricant leakage.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If any are less than the required quantity, fill them to the specified level. Refer to the following table:

For NORTH AMERICA	MA-15, "FOR NORTH AMERICA : Fluids and Lubricants"
For MEXICO	MA-16, "FOR MEXICO : Fluids and Lubricants"

- Follow the procedure below to check for fuel leakage.
 - Turn ignition switch to the "ON" position (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 a malfunction. The noise will stop after hydraulic pressure rises.

- Warm up engine thoroughly to check that 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 them to the specified level, if necessary.

Summary of the inspection items:

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

CAMSHAFT

< REMOVAL AND INSTALLATION >

Other oils and fluids*	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage

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* Power steering fluid, brake fluid, etc.

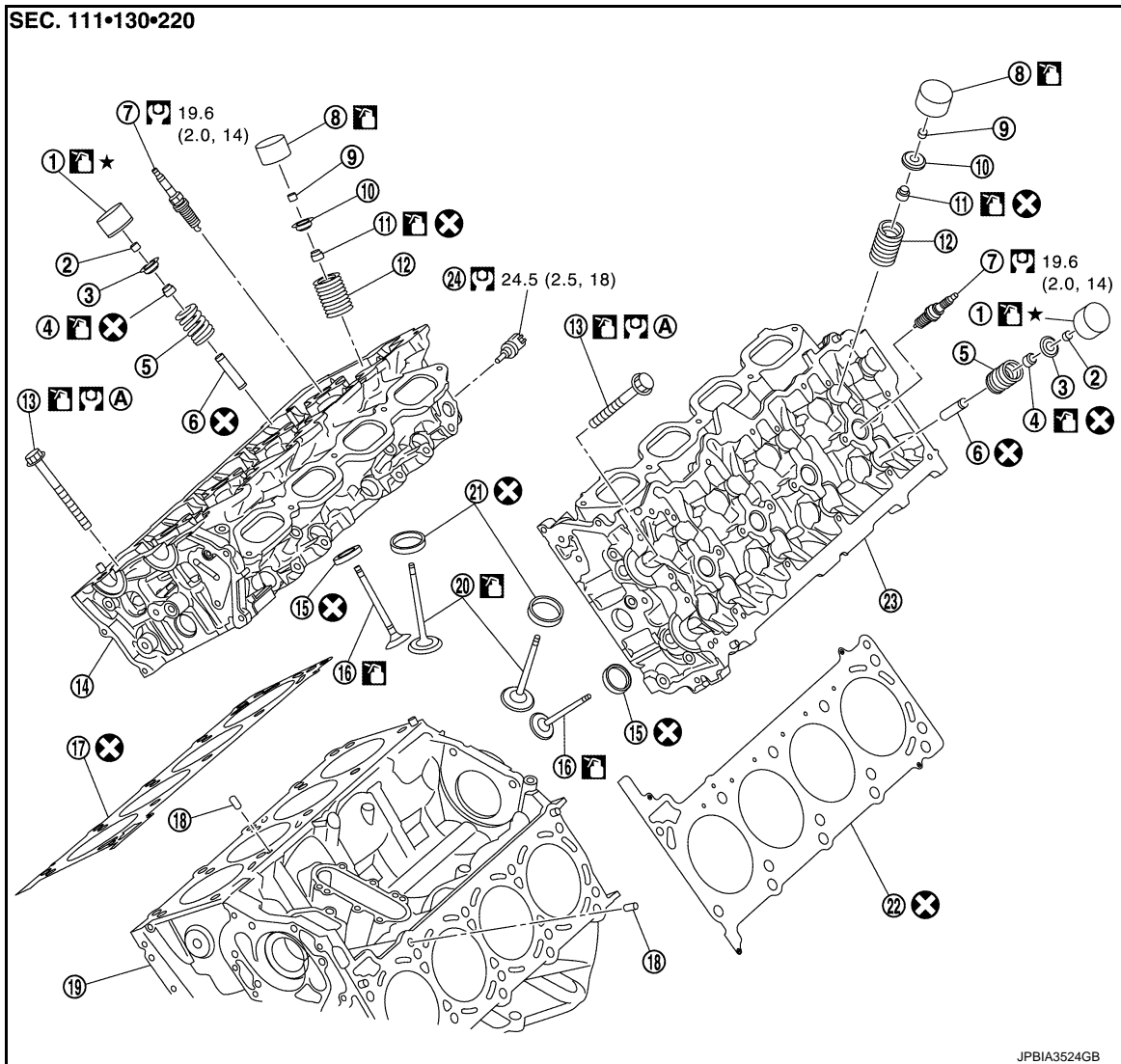
CYLINDER HEAD

< REMOVAL AND INSTALLATION >

CYLINDER HEAD

Exploded View

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- | | | |
|-----------------------------------|------------------------------------------------|-------------------------------------------------|
| 1. Valve lifter (EXH) | 2. Valve collet (EXH) | 3. Valve spring retainer (EXH) |
| 4. Valve oil seal (EXH) | 5. Valve spring (with valve spring seat) (EXH) | 6. Valve guide (EXH) |
| 7. Spark plug | 8. Valve lifter (INT) | 9. Valve collet (INT) |
| 10. Valve spring retainer (INT) | 11. Valve oil seal (INT) | 12. Valve spring (with valve spring seat) (INT) |
| 13. Cylinder head bolt | 14. Cylinder head (bank 2) | 15. Valve seat (EXH) |
| 16. Valve (EXH) | 17. Cylinder head gasket (bank 2) | 18. Oil filter (for VVEL ladder assembly) |
| 19. Cylinder block | 20. Valve (INT) | 21. Valve seat (INT) |
| 22. Cylinder head gasket (bank 1) | 23. Cylinder head (bank 1) | 24. Engine coolant temperature sensor |

Comply with the installation procedure when tightening. Refer to [EM-93](#).

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

CAUTION:

A high degree of precision is required for a valve on the intake side. Never remove the valve related parts unless necessary.

CYLINDER HEAD

< REMOVAL AND INSTALLATION >

NOTE:

- As for replacement of parts on the intake side as shown in the exploded view, replace VVEL ladder assembly & cylinder head assembly. (Only valve oil seals are replaceable as a single part.)
- VVEL ladder assembly cannot be replaced as a single part, because it is machined together with cylinder head assembly.

Removal and Installation

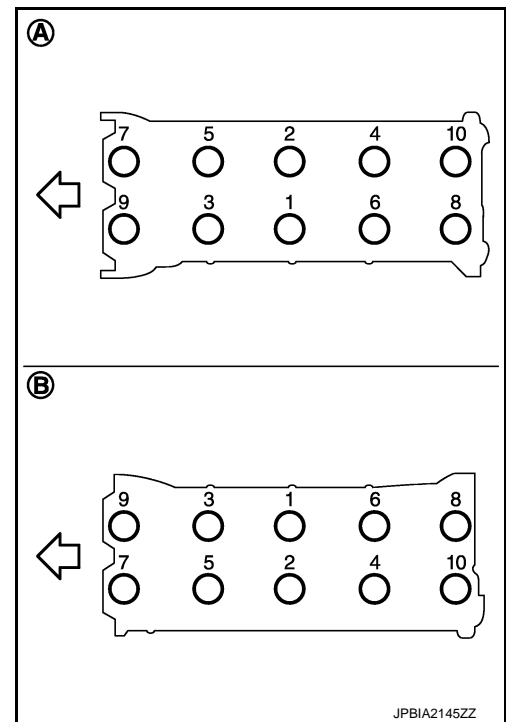
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REMOVAL

1. Remove the following parts:
 - Rocker cover and spark plug: Refer to [EM-34, "Exploded View"](#).
 - Intake manifold: Refer to [EM-31, "Exploded View"](#).
 - Exhaust manifold: Refer to [EM-41, "Exploded View"](#).
 - Water inlet and thermostat housing: Refer to [CO-22, "Exploded View"](#).
 - Water pipe and heater pipe: Refer to [CO-22, "Exploded View"](#).
 - Timing chain: Refer to [EM-63, "Exploded View"](#).
 - Camshaft (EXH) and VVEL ladder assembly: Refer to [EM-79, "Exploded View"](#).
2. Remove cylinder head.
 - Loosen mounting bolts in reverse order as shown in the figure.

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

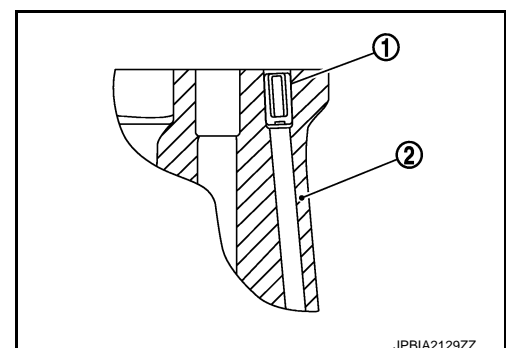
- Use TORX socket and power tool.



3. Remove cylinder head gaskets.
4. Remove oil filter (for VVEL ladder assembly) from cylinder block, if necessary.
5. Remove valve lifter.
 - Identify installation positions, and store them without mixing them up.

INSTALLATION

1. Install oil filter (for VVEL ladder assembly) (1) in the direction shown in the figure, if removed.
 - Check that the oil filter does not protrude from the upper surface of cylinder block (2) after installation.



CYLINDER HEAD

< REMOVAL AND INSTALLATION >

2. Install new cylinder head gaskets.
3. Install cylinder head as per the following:

CAUTION:

- If cylinder head bolts are re-used, check their outer diameters before installation. Refer to [EM-98, "Inspection"](#).
- Before installing cylinder head, inspect cylinder head distortion. Refer to [EM-98, "Inspection"](#).
- Tighten cylinder head bolts in numerical order as shown in figure.

A : Bank 2

B : Bank 1

⇐ : Engine front

- Use TORX socket.

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

: 40.0 N·m (4.1 kg-m, 30 ft-lb)

- c. Tighten all cylinder head bolts (clockwise).

Angle tightening: 75 degrees

- d. Completely loosen all cylinder head bolts.

: 0 N·m (0 kg-m, 0 ft-lb)

CAUTION:

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

- e. Tighten all cylinder head bolts.

: 40.0 N·m (4.1 kg-m, 30 ft-lb)

- f. Tighten all cylinder head bolts (clockwise).

Angle tightening: 90 degrees

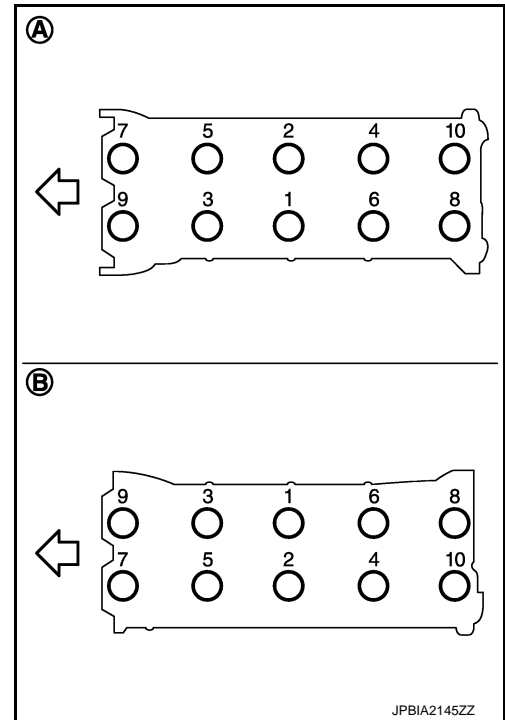
- g. Tighten all cylinder head bolts again (clockwise).

Angle tightening: 90 degrees

CAUTION:

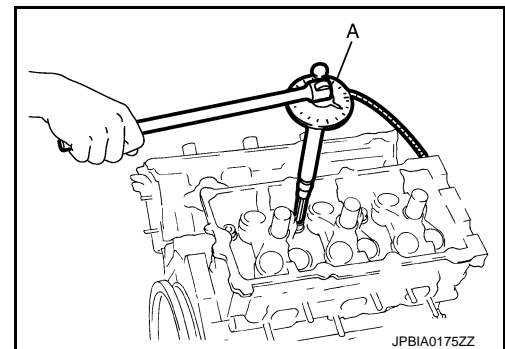
Check the tightening angle using the angle wrench [SST: KV10112100 (BT8653-A)] (A). Never make judgment by visual inspection.

- Check tightening angle indicated on the angle wrench indicator plate.



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4. Install valve lifter.
 - Install it in the original position.
5. Install in the reverse order of removal.



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CYLINDER HEAD

< REMOVAL AND INSTALLATION >

Disassembly and Assembly

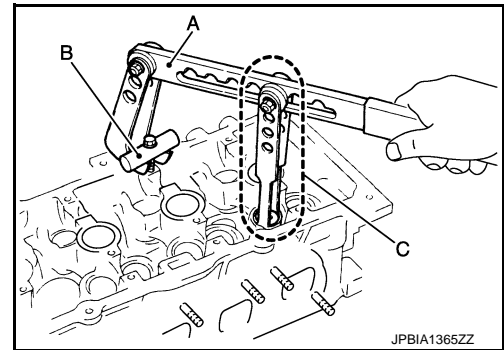
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DISASSEMBLY

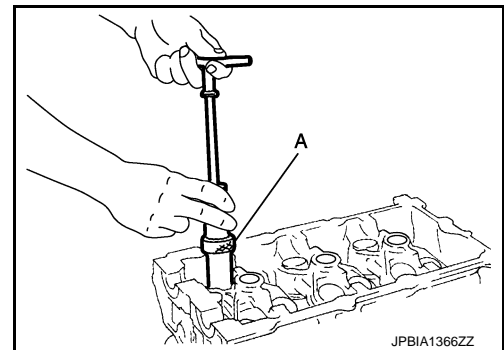
1. Remove valve collet.
 - Compress valve spring with the valve spring compressor [SST: KV10116200 (J-26336-A)] (A), the attachment [SST: KV10115900 (J-26336-20)] (C) and the adapter [SST: KV10109220 (—)] (B). Remove valve collet with a magnet hand.

CAUTION:

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



2. Remove valve spring retainer and valve spring (with valve spring seat).
3. Push valve stem to combustion chamber side, and remove valve.
 - Identify installation positions, and store them without mixing them up.
4. Remove valve oil seal using the valve oil seal puller [SST: KV10107902 (J38959)] (A).

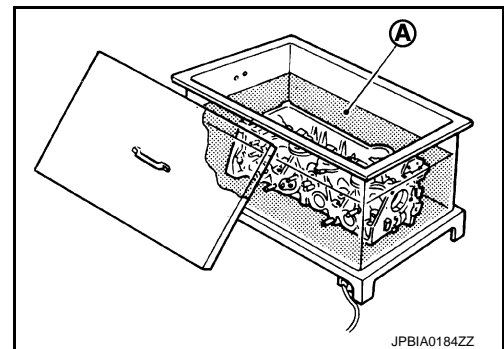


5. Remove valve seat (EXH), if valve seat (EXH) must be replaced.
 - Bore out old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in cylinder head. Set the machine depth stop to ensure this. Refer to [EM-143, "Cylinder Head"](#).

CAUTION:

Prevent to scratch cylinder head by excessive boring.

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



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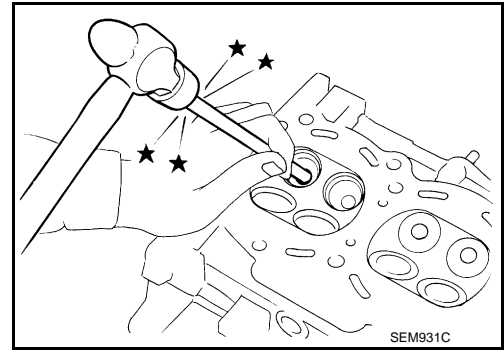
CYLINDER HEAD

< REMOVAL AND INSTALLATION >

- b. Drive out valve guide (EXH) 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:

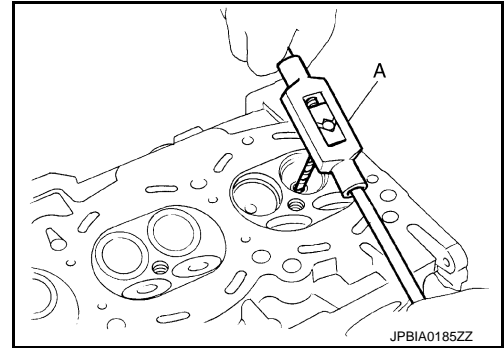
Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.



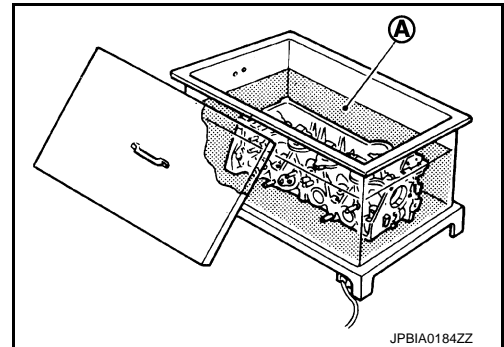
ASSEMBLY

- 1. Install valve guide (EXH), if removed.
Replace with oversized [0.2 mm (0.008 in)] valve guide (EXH).
- a. Using the valve guide reamer (commercial service tool) (A), ream cylinder head valve guide (EXH) hole.

Oversize (service) [0.2 mm (0.008 in)]:
: Refer to [EM-143, "Cylinder Head"](#).



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

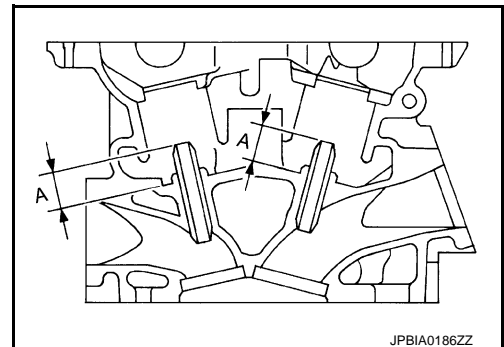


- c. Using the valve guide drift (commercial service tool), press valve guide (EXH) from camshaft side to the dimensions as shown in the figure.

Projection (A)
: Refer to [EM-143, "Cylinder Head"](#).

WARNING:

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

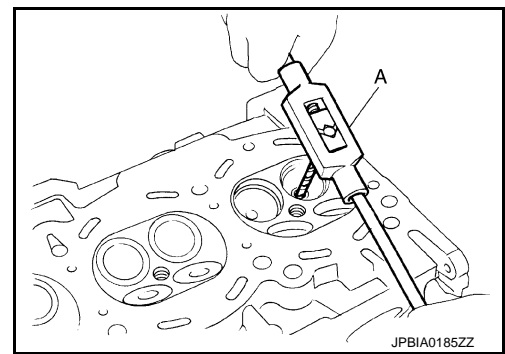


CYLINDER HEAD

< REMOVAL AND INSTALLATION >

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

Standard : Refer to [EM-143, "Cylinder Head"](#).

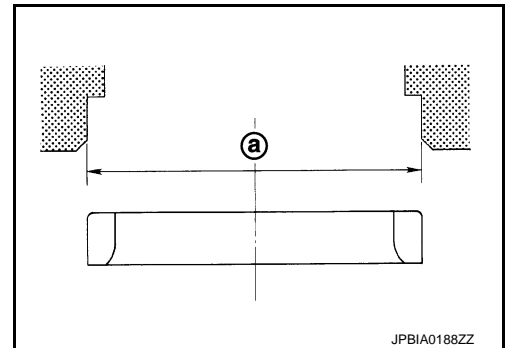


2. Install valve seat (EXH), if removed.
Replace with oversize [0.5 mm (0.020 in)] valve seat (EXH).
- a. Ream cylinder head recess diameter (a) for service valve seat (EXH).

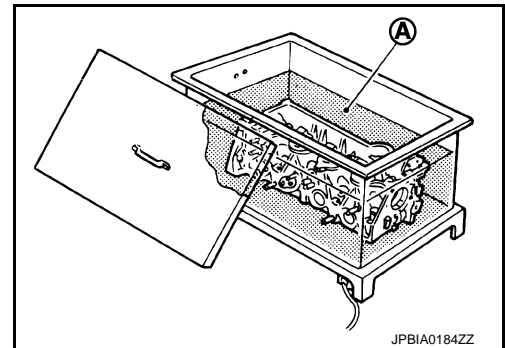
Oversize (service) [0.5 mm (0.020 in)]:

: Refer to [EM-143, "Cylinder Head"](#).

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



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



- c. Provide valve seats (EXH) cooled well with dry ice. Force fit valve seat (EXH) into cylinder head.

WARNING:

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

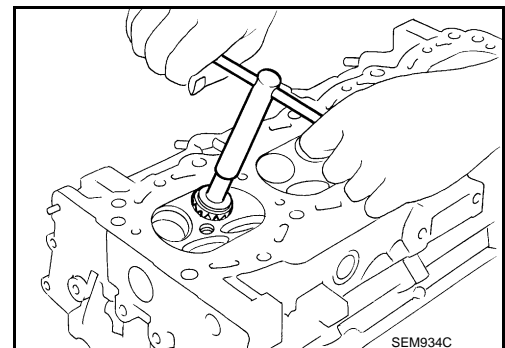
CAUTION:

Avoid 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-143, "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 cutter or cutting many different times may result in staged valve seat.



- e. Using compound, grind to adjust valve fitting.
f. Check again for normal contact. Refer to [EM-98, "Inspection"](#).
3. Install new valve oil seals as per the following:

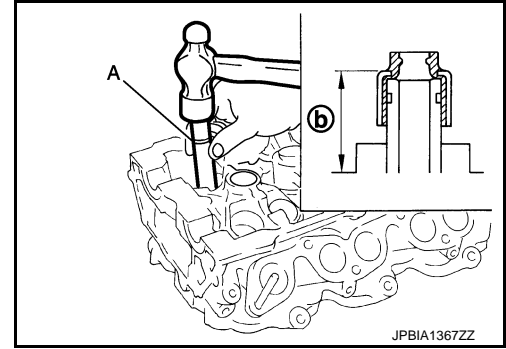
CYLINDER HEAD

< REMOVAL AND INSTALLATION >

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

Height (b)

Intake, Exhaust : 14.3 - 14.9 mm (0.563 - 0.587 in)



- Install valve.

NOTE:

Larger diameter valves are for intake side.

- Install valve spring (with valve spring seat).
 - Install narrow pitch (B) end [paint mark (C)] to cylinder head side (valve spring seat side).

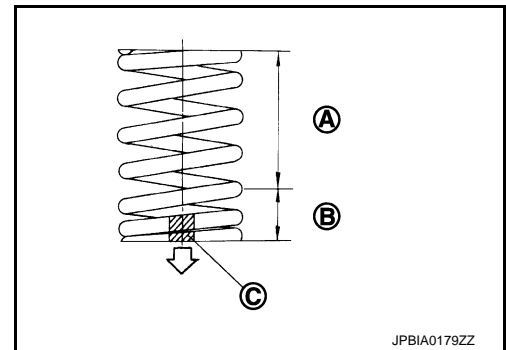
A : Wide pitch

↔ : Cylinder head side

Paint mark color

Intake : Light green

Exhaust : Light blue



- Install valve spring retainer.

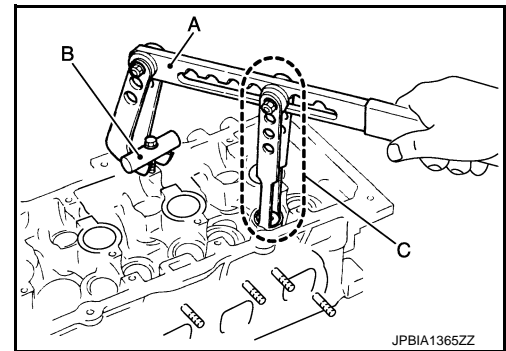
- Install valve collet.

- Compress valve spring with the valve spring compressor [SST: KV10116200 (J26336-A)] (A), the attachment [SST: KV10115900 (J26336-20)] (C) and the adapter [SST: KV10109220 (—)] (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.



Inspection

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INSPECTION AFTER DISASSEMBLY

Cylinder Head Bolts Outer Diameter

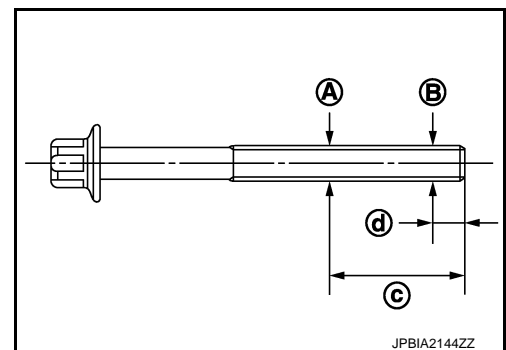
- Cylinder head bolts are tightened by plastic zone tightening method. Whenever the size difference between (B) and (A) exceeds the limit, replace them with new one.

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

c : 55 mm (2.17 in)

d : 12 mm (0.47 in)

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



CYLINDER HEAD

< REMOVAL AND INSTALLATION >

Cylinder Head Distortion

NOTE:

When performing this inspection, cylinder block distortion should be also checked. Refer to [EM-123, "Inspection"](#).

1. Using a scraper, wipe out 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.

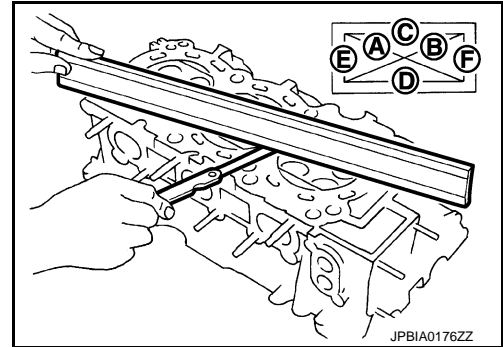
2. At each of several locations on bottom surface of cylinder head, measure the distortion in six directions (A), (B), (C), (D), (E), and (F).

Limit : Refer to [EM-143, "Cylinder Head"](#).

- If it exceeds the limit, replace VVEL ladder assembly & cylinder head assembly.

NOTE:

Cylinder head assembly cannot be replaced as a single part, because it is machined together with VVEL ladder assembly.



Valve Dimensions

- Check the dimensions of each valve. For the dimensions, refer to [EM-143, "Cylinder Head"](#).
- If dimensions are out of the standard.
 - Replace valve (EXH) and check valve seat contact. Refer to "VALVE SEAT CONTACT". (Exhaust side)
 - Replace VVEL ladder assembly & cylinder head assembly. Refer to [EM-92, "Exploded View"](#). (Intake side)

NOTE:

Since the valve (INT) cannot be replaced by the piece, VVEL ladder assembly & cylinder head assembly replacement are required.

Valve Guide Clearance

Valve Stem Diameter

- Measure the diameter of valve stem with micrometer (A).

Standard : Refer to [EM-143, "Cylinder Head"](#).

Valve Guide Inner Diameter

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

Standard : Refer to [EM-143, "Cylinder Head"](#).

Valve Guide Clearance

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

Standard : Refer to [EM-143, "Cylinder Head"](#).

- If the calculated value exceeds the limit.

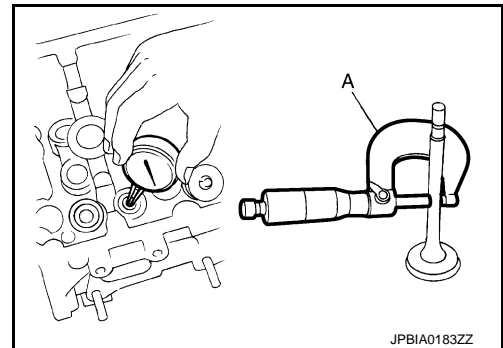
- Replace valve (EXH) and/or valve guide (EXH). Refer to [EM-92, "Exploded View"](#). (Exhaust side)
- Replace VVEL ladder assembly & cylinder head assembly. Refer to [EM-92, "Exploded View"](#). (Intake side)

NOTE:

Since the valve (INT) and valve guide (INT) cannot be replaced by the piece, VVEL ladder assembly & cylinder head assembly replacement are required.

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.



CYLINDER HEAD

< REMOVAL AND INSTALLATION >

- Check if the contact area band is continuous all around the circumference.

A : OK
B : NG

- If not, grind to adjust valve fitting and check again. If the contacting surface still has "NG" conditions even after the re-check, replace valve seat (EXH). Refer to [EM-92, "Exploded View"](#). (Exhaust side)
- If not, replace VVEL ladder assembly & cylinder head assembly. Refer to [EM-92, "Exploded View"](#). (Intake side)

NOTE:

Since the valve seat (INT) cannot be replaced by the piece, VVEL ladder assembly & cylinder head assembly replacement are required.

Valve Spring (with valve spring seat) Squareness

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

B : Contact

Limit : Refer to [EM-143, "Cylinder Head"](#).

- If it exceeds the limit.
- Replace valve spring (with valve spring seat) (EXH). Refer to [EM-92, "Exploded View"](#). (Exhaust side)
- Replace VVEL ladder assembly & cylinder head assembly. Refer to [EM-92, "Exploded View"](#). (Intake side)

NOTE:

Since the valve spring (with valve spring seat) (INT) cannot be replaced by the piece, VVEL ladder assembly & cylinder head assembly replacement are required.

Valve Spring Dimensions and Valve Spring Pressure Load

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

Standard

: Refer to [EM-143, "Cylinder Head"](#).

- If the installation load or load with valve open is out of the standard.
- Replace valve spring (with valve spring seat) (EXH). Refer to [EM-92, "Exploded View"](#). (Exhaust side)
- Replace VVEL ladder assembly & cylinder head assembly. Refer to [EM-92, "Exploded View"](#). (Intake side)

NOTE:

Since the valve spring (with valve spring seat) (INT) cannot be replaced by the piece, VVEL ladder assembly & cylinder head assembly replacement are required.

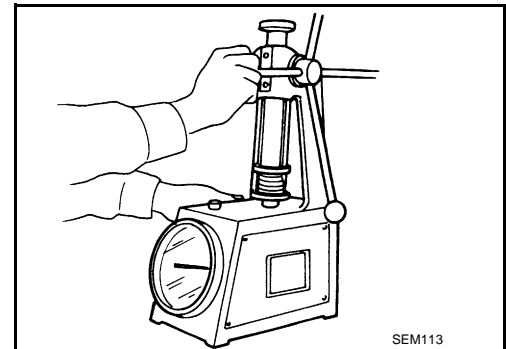
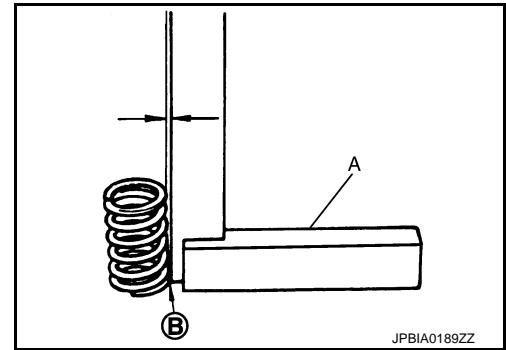
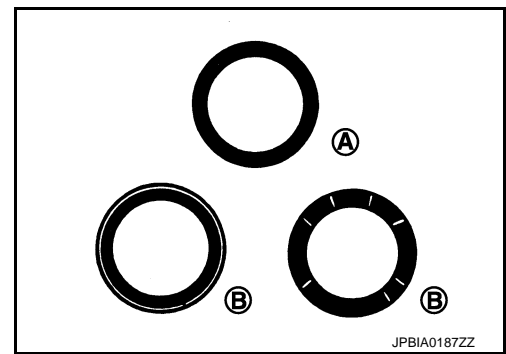
INSPECTION AFTER ASSEMBLY

Inspection for Leakage

The following are procedures for checking fluid leakage, lubricant leakage.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If any are less than the required quantity, fill them to the specified level. Refer to the following table:

For NORTH AMERICA	MA-15, "FOR NORTH AMERICA : Fluids and Lubricants"
For MEXICO	MA-16, "FOR MEXICO : Fluids and Lubricants"



CYLINDER HEAD

< REMOVAL AND INSTALLATION >

- Follow the procedure below to check for fuel leakage.
- Turn ignition switch to the "ON" position (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.

A

EM

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 a malfunction. The noise will stop after hydraulic pressure rises.

C

- Warm up engine thoroughly to check that 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 them to the specified level, if necessary.

D

Summary of the inspection items:

E

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

F

G

* Power steering fluid, brake fluid, etc.

H

I

J

K

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N

O

P

OIL SEAL

< REMOVAL AND INSTALLATION >

OIL SEAL

FRONT OIL SEAL

FRONT OIL SEAL : Removal and Installation

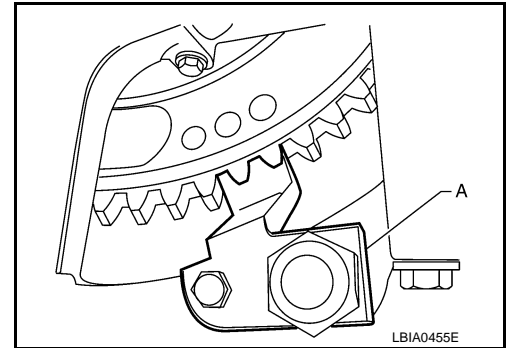
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REMOVAL

1. Remove the following parts:
 - Front under cover, using a power tool. Refer to [EXT-26, "Exploded View"](#).
 - Drive belt: Refer to [EM-20, "Exploded View"](#).
 - Cooling fan: Refer to [CO-18, "Exploded View"](#).
2. Remove crankshaft pulley as per the following:
 - a. Remove rear plate cover. Refer to [EM-56, "Exploded View"](#).
 - b. Set the ring gear stopper [SST: KV10120100 (J-47245)] (A) as shown in the figure.
 - c. Loosen crankshaft pulley bolt, and then pull crankshaft pulley with both hands to remove it.

CAUTION:

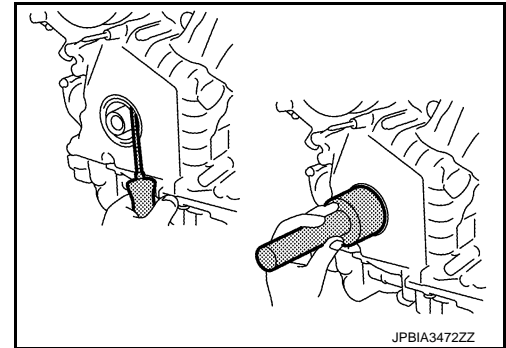
Never remove crankshaft pulley bolt. Keep loosened crankshaft pulley bolt in place to protect removed crankshaft pulley from dropping.



3. Remove front oil seal using a suitable tool.

CAUTION:

Be careful not to damage front cover and crankshaft.



INSTALLATION

1. Install front oil seal on front cover.

⇐ : Engine inside

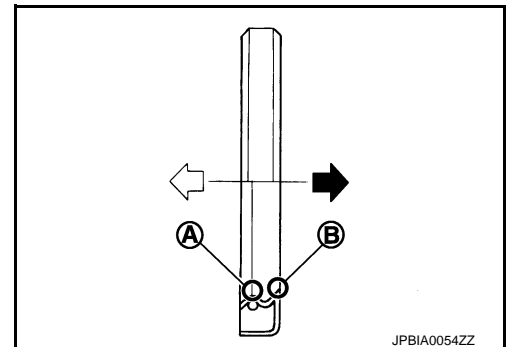
➡ : Engine outside

- Apply new engine oil to both oil seal lip (A) and dust seal lip (B).
- Install it so that each seal lip is oriented as shown in the figure.

CAUTION:

Be careful not to scratch or make burrs on circumference of oil seal.

- Using a suitable drift [outer diameter: 56 mm (2.20 in)], press-fit oil seal until it becomes flush with front cover end face.
- Check the garter spring is in position and seal lips are not inverted.



2. Install in the reverse order of removal.

REAR OIL SEAL

OIL SEAL

< REMOVAL AND INSTALLATION >

REAR OIL SEAL : Removal and Installation

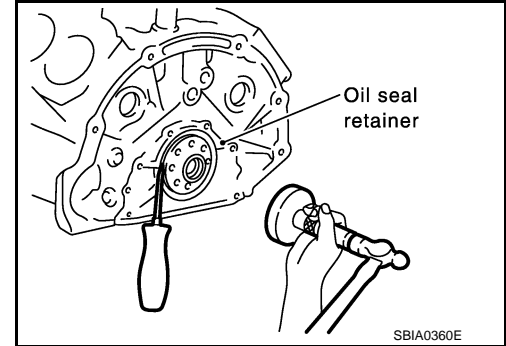
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REMOVAL

1. Remove transmission assembly. Refer to [TM-215, "2WD : Exploded View"](#) (2WD models) or [TM-218, "4WD : Exploded View"](#) (AWD models).
2. Remove drive plate. Refer to [EM-115, "Exploded View"](#).
3. Remove rear oil seal with a suitable tool.

CAUTION:

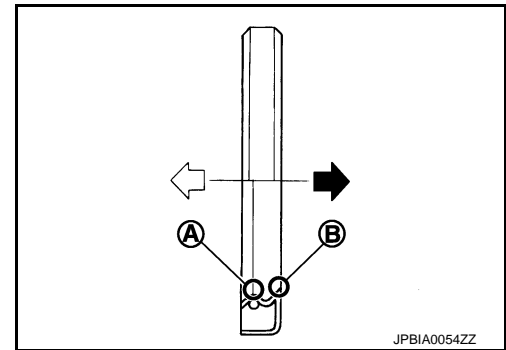
Be careful not to damage crankshaft and cylinder block.



INSTALLATION

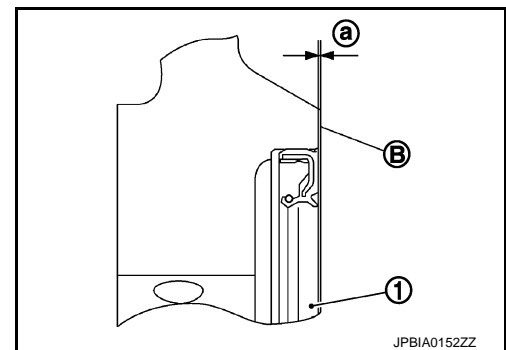
1. Install rear oil seal.
 - Install rear oil seal so that each seal lip is oriented as shown in the figure.

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

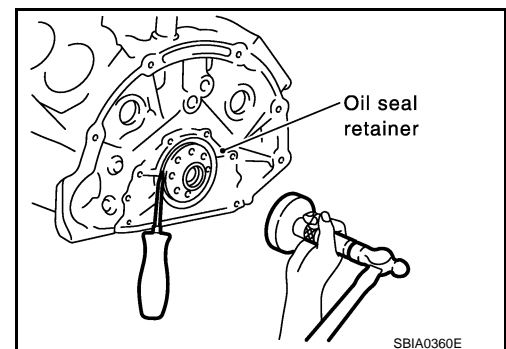


- Press in rear oil seal (1) to the position as shown in the figure.

- B : Rear oil seal retainer rear end face
- a : 0 - 0.5 mm (0 - 0.020 in)



- Using a suitable drift [outer diameter 101 mm (3.98 in)], press-fit until the height of rear oil seal is level with the mounting surface.
 - Check the garter spring is in position and seal lips are not inverted.
- #### **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 >

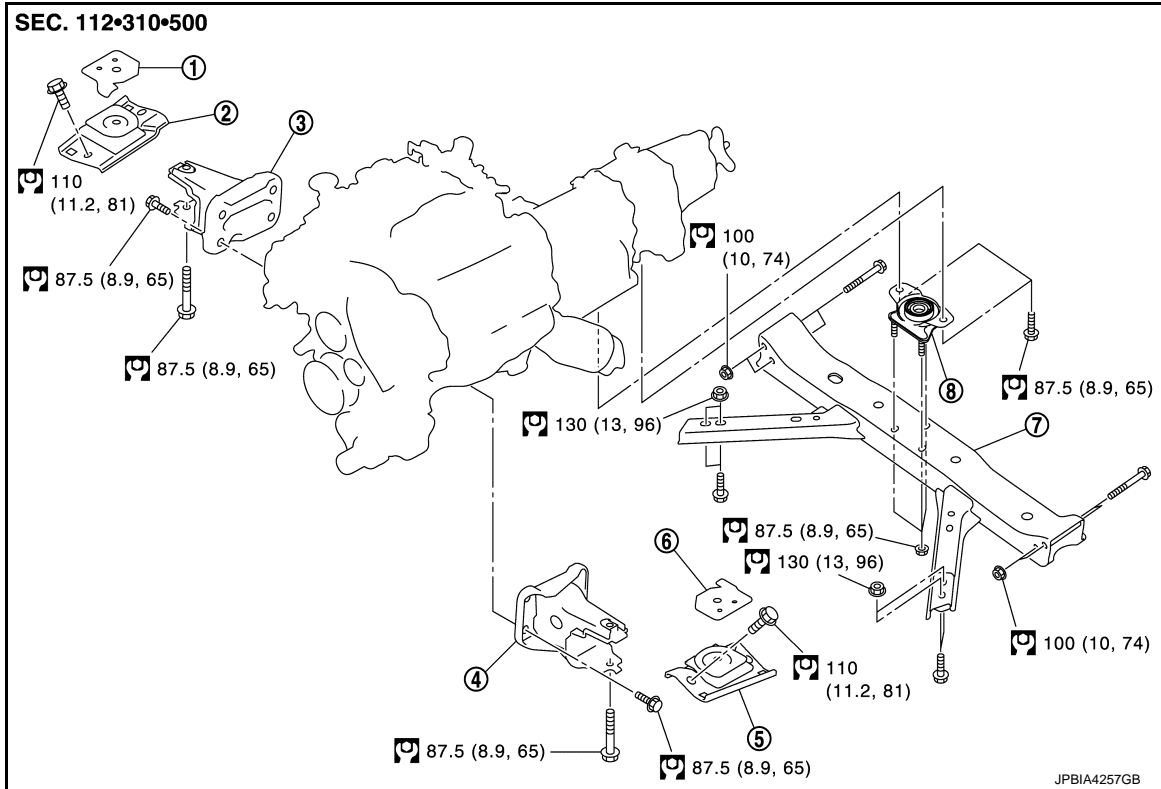
UNIT REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

Exploded View

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2WD models



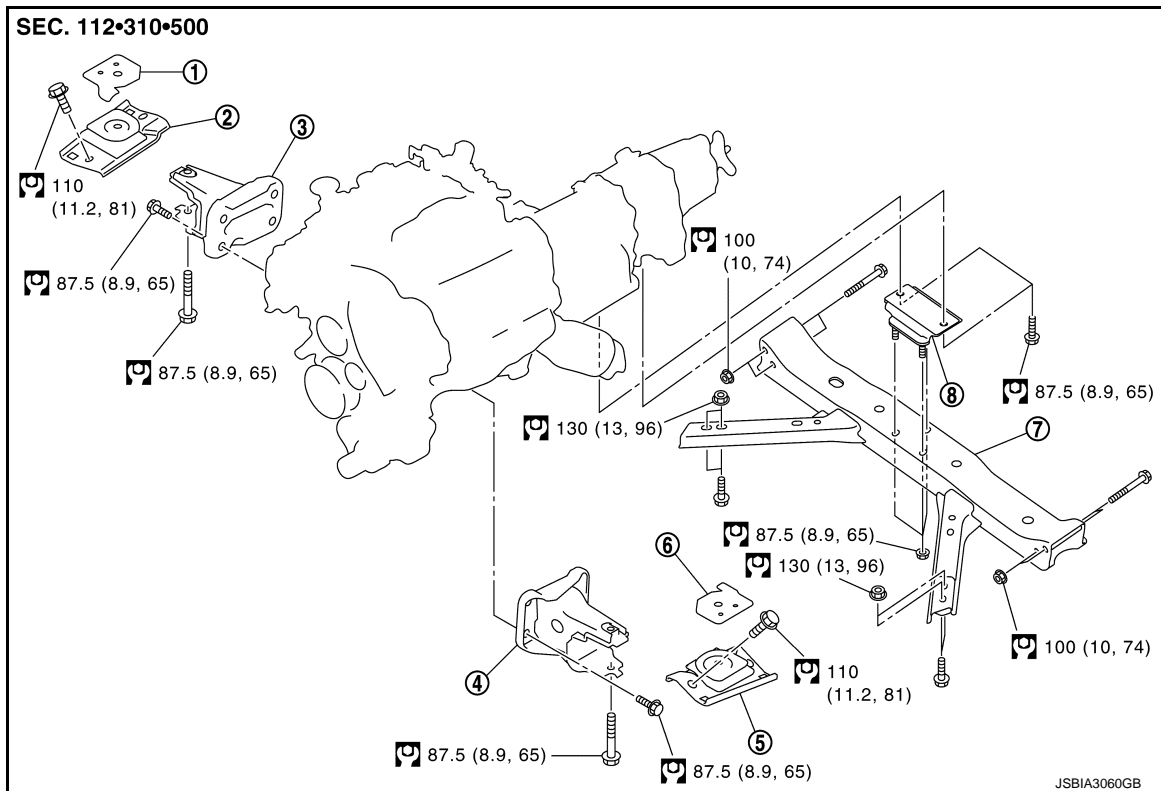
- | | | |
|--------------------------------------|-----------------------------------|---------------------------------|
| 1. Heat shield plate (RH) | 2. Engine mounting insulator (RH) | 3. Engine mounting bracket (RH) |
| 4. Engine mounting bracket (LH) | 5. Engine mounting insulator (LH) | 6. Heat shield plate (LH) |
| 7. Rear engine mounting cross member | 8. Rear engine mounting insulator | |

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

ENGINE ASSEMBLY

< UNIT REMOVAL AND INSTALLATION >

AWD models



- | | | |
|--------------------------------------|-----------------------------------|---------------------------------|
| 1. Heat shield plate (RH) | 2. Engine mounting insulator (RH) | 3. Engine mounting bracket (RH) |
| 4. Engine mounting bracket (LH) | 5. Engine mounting insulator (LH) | 6. Heat shield plate (LH) |
| 7. Rear engine mounting cross member | 8. Rear engine mounting insulator | |

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

Removal and Installation

INFOID:000000009010632

WARNING:

- Situate the vehicle on a flat and solid surface.
- Place chocks at the 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, and 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 much as possible. 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 the center of gravity.
- For supporting points for lifting and jacking point at rear axle, refer to [GI-34, "Garage Jack and Safety Stand"](#).

NOTE:

- When removing components such as hoses, tube/lines, etc., cap or plug openings to prevent fluid from spilling.
- When removing/installing only the engine mounting, the hold engine assembly as instructed bellow:
 1. Remove hood assembly. Refer to [DLK-221, "Exploded View"](#).
 2. Remove the following components and related parts:
 - Battery. Refer to [PG-122, "Exploded View"](#).
 - Battery tray.
 - Power steering reservoir tank bracket. Refer to [ST-54, "Exploded View"](#).
 - Air cleaner case assembly and air duct. Refer to [EM-28, "Exploded View"](#).

ENGINE ASSEMBLY

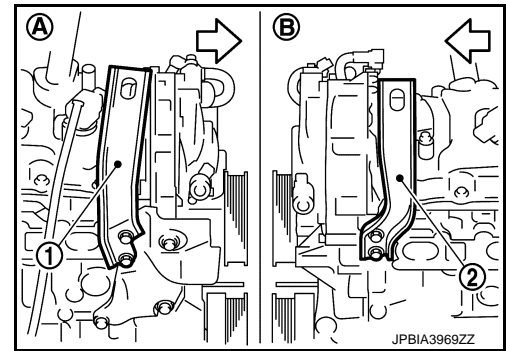
< UNIT REMOVAL AND INSTALLATION >

- Install engine slinger on both front right and front left sides of the engine.

- A : Engine front slinger (bank 2)
- B : Engine front slinger (bank 1)

Slinger bolts:

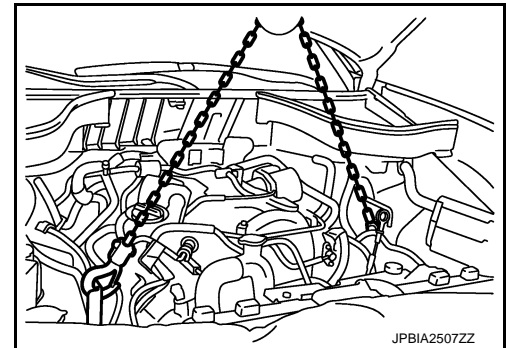
: 45.0 N-m (4.6 kg-m, 33 ft-lb)



- Hoist the slinger to obtain room for engine assembly.

CAUTION:

Use an engine lifter to prevent the engine slinger from falling and damaging the rocker cover.



REMOVAL

Outline

At first, remove the transmission and transfer assembly, steering gear and front final drive facing downward. Then remove the engine.

Preparation

- Remove engine cover. Refer to [EM-26, "Exploded View"](#).
- Release fuel pressure. Refer to the following table:

ENGINE	Reference page
VK56VD FOR USA AND CANADA	EC-168, "Work Procedure"
VK56VD FOR MEXICO	EC-731, "Work Procedure"

- Remove battery and tray. Refer to [PG-122, "Exploded View"](#).
- Remove the following components and related parts:
 - Hood assembly. Refer to [DLK-221, "Exploded View"](#).
 - Front under cover. Refer to [EXT-26, "Exploded View"](#).
 - Front road wheel and tires. Refer to [WT-63, "Exploded View"](#).
- Drain engine oil. Refer to [LU-9, "Draining"](#).
- Drain engine coolant. Refer to [CO-8, "Draining"](#).
 - CAUTION:**
 - Perform this step when engine is cold.
 - Never spill engine coolant on drive belts.
- Drain power steering fluid. Refer to [ST-54, "Exploded View"](#).

Engine Room Front

- Remove drive belt. Refer to [EM-20, "Exploded View"](#).
- Remove fan shroud. Refer to [CO-14, "Exploded View"](#).
- Remove cooling fan and fan coupling. Refer to [CO-18, "Exploded View"](#).
- Remove radiator hoses (upper and lower).
- Remove radiator.

Vehicle Underbody

- Remove exhaust front tube. Refer to [EX-5, "Exploded View"](#).

ENGINE ASSEMBLY

< UNIT REMOVAL AND INSTALLATION >

- Remove protector A and B. Refer to [SCS-32, "FRONT TUBE ASSEMBLY : Exploded View"](#).
- Remove front suspension rear cross member. Refer to [TM-215, "2WD : Exploded View"](#) (2WD models) or [TM-218, "4WD : Exploded View"](#) (AWD models).
- Remove oil cooler. Refer to [LU-13, "Exploded View"](#).
- Remove A/T assembly. Refer to [TM-215, "2WD : Exploded View"](#) (2WD models) or [TM-218, "4WD : Exploded View"](#) (AWD models).
- Remove steering gear assembly. Refer to [ST-41, "Exploded View"](#).
- Remove front final drive assembly. Refer to [DLN-174, "Exploded View"](#).
- Remove exhaust manifold. Refer to [EM-41, "Exploded View"](#).
- Remove alternator. Refer to [CHG-28, "Exploded View"](#).

Engine Room LH

- Remove air cleaner and air duct. Refer to [EM-28, "Exploded View"](#).
- Remove A/C compressor. Refer to [HA-30, "Exploded View"](#).
- Disconnect fuel feed hose and EVAP hose. Refer to [EM-44, "Exploded View"](#).

CAUTION:

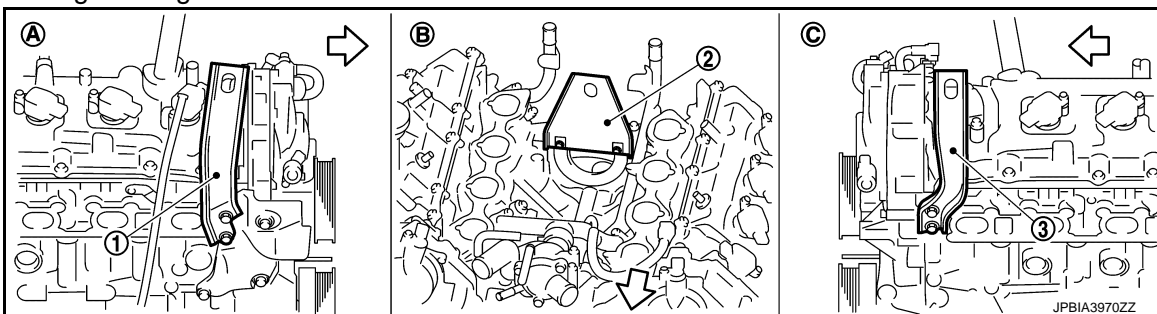
Fit plugs onto disconnected hoses to prevent fuel leakage.

Engine Room RH

- Remove power steering oil pump and reservoir tank. Refer to [ST-48, "Exploded View"](#).
- Disconnect heater hose at heater core side, and fit a plug onto hose end to prevent engine coolant leakage.
- Disconnect ground cable.
- Disconnect all clips and connectors of the engine harness from vehicle side.

Removal Work

- Install alternator bracket. Refer to [CHG-28, "Exploded View"](#).
 - Temporarily tighten mounting bolts.
- Remove intake manifold. Refer to [EM-31, "Exploded View"](#).
- Remove starter motor. Refer to [STR-18, "Exploded View"](#).
- Install engine slingers.



A Engine front slinger (bank 2)

B Engine rear slinger

C Engine front slinger (bank 1)

Slinger bolts:

 **45.0 N·m (4.6 kg·m, 33 ft·lb)**

- Lift using a hoist and secure the engine in position.
- Remove engine mounting bracket (LH, RH) and engine mounting insulator (LH, RH). Refer to [EM-104, "Exploded View"](#).

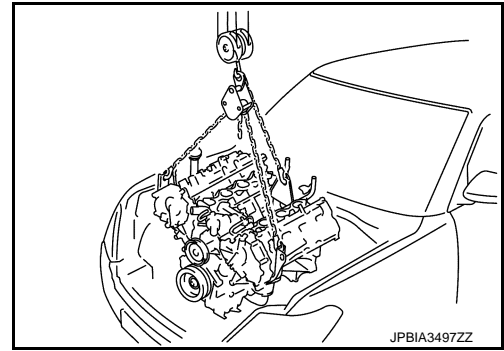
ENGINE ASSEMBLY

< UNIT REMOVAL AND INSTALLATION >

7. Remove the engine from the vehicle, avoid interference with the vehicle body.

CAUTION:

- Before and during lifting, always check that any harnesses are left connected.
- Never damage engine mounting insulator and avoid oil/grease smearing or spills onto engine mounting insulator.



INSTALLATION

Install in the reverse order of removal.

CAUTION:

- When replacing an engine or transmission you must make sure the dowels are installed correctly during re-assembly. Improper alignment caused by missing dowels may cause vibration, oil leaks or breakage of drivetrain components.

Inspection

INFOID:000000009010633

INSPECTION AFTER INSTALLATION

Inspection for Leakage

The following are procedures for checking fluid leakage, lubricant leakage.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If any are less than the required quantity, fill them to the specified level. Refer to the following table:

For NORTH AMERICA	MA-15. "FOR NORTH AMERICA : Fluids and Lubricants"
For MEXICO	MA-16. "FOR MEXICO : Fluids and Lubricants"

- Follow the procedure below to check for fuel leakage.
 - Turn ignition switch to the "ON" position (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 a malfunction. The noise will stop after hydraulic pressure rises.

- Warm up engine thoroughly to check that 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 them to the specified level, if necessary.

Summary of the inspection items:

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

*: Power steering fluid, brake fluid, etc.

ENGINE STAND SETTING

< UNIT DISASSEMBLY AND ASSEMBLY >

UNIT DISASSEMBLY AND ASSEMBLY

ENGINE STAND SETTING

Setting

INFOID:000000009010634

A

EM

NOTE:

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

1. Remove the engine assembly from the vehicle. Refer to [EM-104, "Exploded View"](#).
2. Remove crankshaft pulley. Refer to [EM-102, "FRONT OIL SEAL : Removal and Installation"](#).

NOTE:

The drive plate is fixed with a ring gear stopper [SST: KV10120100 (J-47245)]. Loosen the crankshaft pulley mounting bolts before installing the engine stand.

3. Remove the parts that may restrict installation of engine to a widely used engine stand.
 - Drive plate: Refer to [EM-112, "Exploded View"](#).
4. Lift the engine with hoist to install it onto the widely used engine stand.

CAUTION:

Use an engine stand that has a load capacity [240 kg (529 lb) or more] large enough for supporting the engine weight.

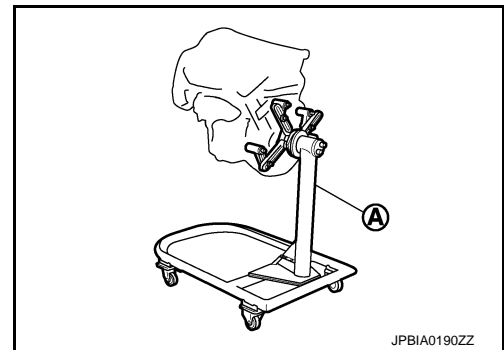
- If the load capacity of the stand is not adequate, remove the following parts beforehand to reduce the potential risk of overturning the stand.
 - Remove intake manifold. Refer to [EM-31, "Exploded View"](#).
 - Remove fuel injector and fuel tube assembly. Refer to [EM-49, "Exploded View"](#).
 - Remove ignition coil. Refer to [EM-30, "Exploded View"](#).
 - Remove rocker cover. Refer to [EM-34, "Exploded View"](#).
 - Remove exhaust manifold. Refer to [EM-41, "Exploded View"](#).
 - Other removable brackets.

NOTE:

The figure shows an example of widely used 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-9, "Draining"](#).

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ENGINE STAND SETTING

< UNIT DISASSEMBLY AND ASSEMBLY >

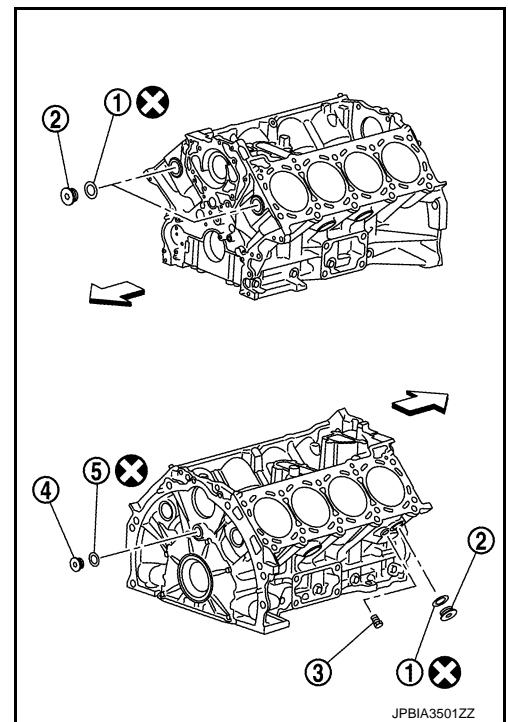
6. Drain engine coolant by removing water drain plug (3) from both sides of the cylinder block as shown in the figure.

- 1 : Washer
- 2 : Plug (engine coolant)
- 4 : Plug (engine oil)
- 5 : Washer
- ⇐ : Engine front

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

Water drain plug torque

: 19.6 N·m (2.0 kg/m, 14 ft-lb)



ENGINE UNIT

< UNIT DISASSEMBLY AND ASSEMBLY >

ENGINE UNIT

Disassembly

INFOID:000000009010635

1. Remove intake manifold. Refer to [EM-31, "Exploded View"](#).
2. Remove exhaust manifold. Refer to [EM-41, "Exploded View"](#).
3. Remove oil pan (lower). Refer to [EM-56, "Exploded View"](#).
4. Remove ignition coil and spark plug. Refer to [EM-24, "Exploded View"](#).
5. Remove rocker cover. Refer to [EM-34, "Exploded View"](#).
6. Remove timing chain. Refer to [EM-63, "Exploded View"](#).
7. Remove exhaust camshaft and VVEL ladder assembly. Refer to [EM-79, "Exploded View"](#).
8. Remove cylinder head. Refer to [EM-92, "Exploded View"](#).

Assembly

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Assemble in the reverse order of disassembly.

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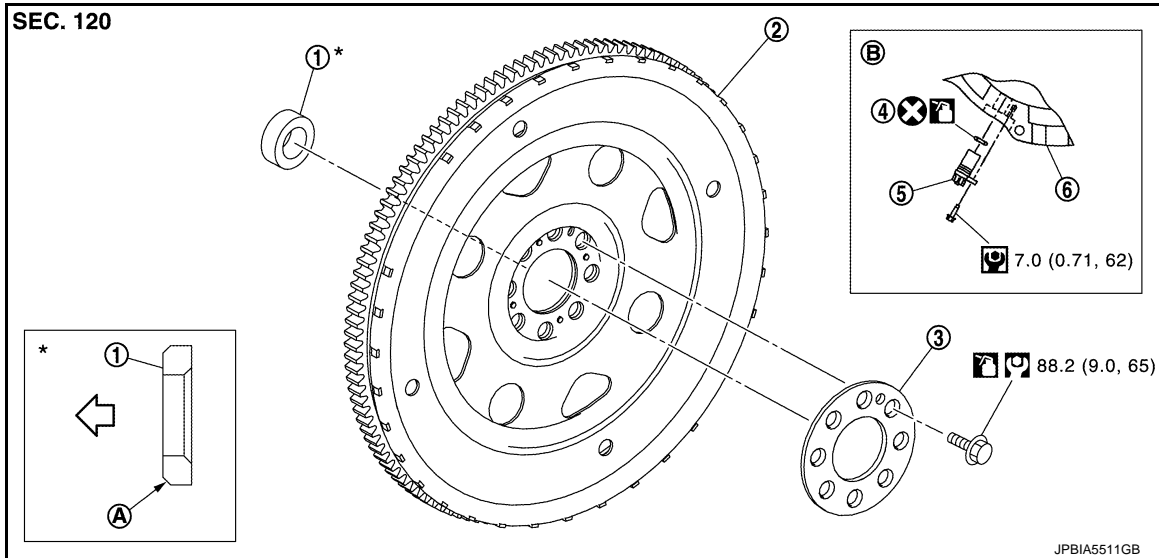
DRIVE PLATE

< UNIT DISASSEMBLY AND ASSEMBLY >

DRIVE PLATE

Exploded View

INFOID:00000009010637



- | | | |
|--------------------|-------------------------------------|------------------------|
| 1. Pilot converter | 2. Drive plate | 3. Reinforcement plate |
| 4. O-ring | 5. Crankshaft position sensor (POS) | 6. Transmission |
| A. Chamfered | B. Installed on transmission | |

⇐ :Crankshaft side

: N·m (kg·m, in·lb)

: N·m (kg·m, ft·lb)

: Always replace after every disassembly.

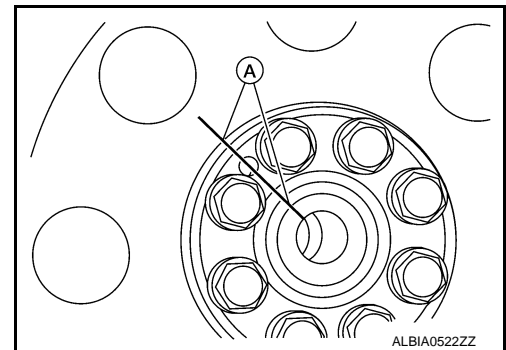
: Should be lubricated with oil.

Removal and Installation

INFOID:00000009010638

REMOVAL

1. Remove transmission assembly. Refer to [TM-215. "2WD : Exploded View"](#) (2WD models) or [TM-218. "4WD : Exploded View"](#) (AWD models).
2. Before removing the drive plate, put a match mark (A) on the crankshaft and drive plate for alignment during installation.



3. Remove drive plate as par the following procedure.

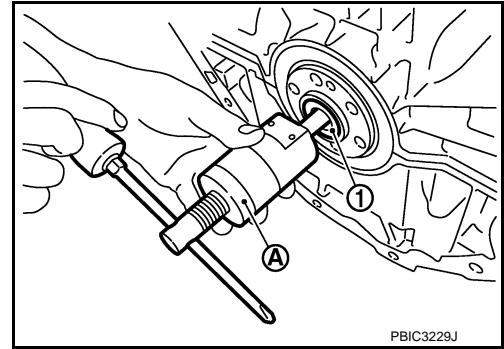
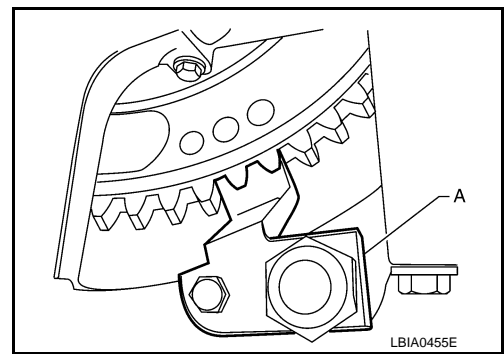
DRIVE PLATE

< UNIT DISASSEMBLY AND ASSEMBLY >

- a. Set the ring gear stopper [SST: KV10120100 (J-47245)] (A) as shown in the figure.
- b. Loosen the bolts diagonally, and then pull drive plate with both hands to remove it.

CAUTION:

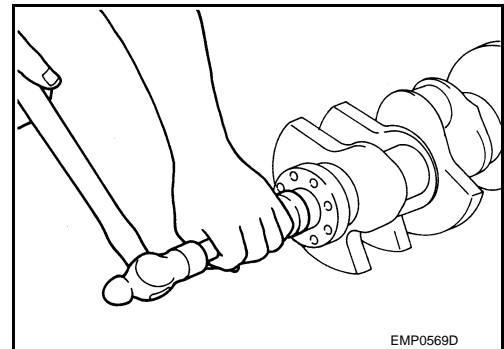
- Never disassemble them.
 - Never place them with signal plate facing down.
 - When handling signal plate, take care not to damage or scratch them.
 - Handle signal plate in a manner that prevents them from becoming magnetized.
 - Take care not to damage the periphery of the sensing area.
 - Any dropped drive plate shall not be used. (The drive plate to which the sensing area shall not be placed on the floor.)
 - Never touch drive plate with bare hands. Always use urethane coating gloves or skin gloves when removing these parts.
 - Never use torn glove.
4. Remove pilot converter (1) using the pilot bushing puller (commercial service tool) (A), if necessary.



INSTALLATION

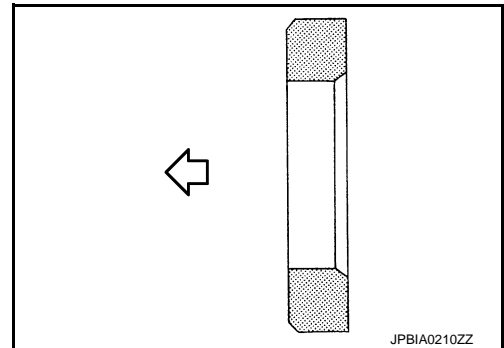
1. Install pilot converter to the crankshaft using suitable tool, if removed.
 - With a drift of the following outer diameter, press-fit as far as it will go.

Pilot converter : Approx. 35 mm (1.38 in)



- Press-fit pilot converter with its chamfering side facing crankshafts shown in the figure.

← : Crankshaft side



2. Install drive plate in the reverse order of removal.

DRIVE PLATE

< UNIT DISASSEMBLY AND ASSEMBLY >

- Install drive plate (4) and reinforcement plate (3) as shown in the figure.

2 : Pilot converter

A : Rounded

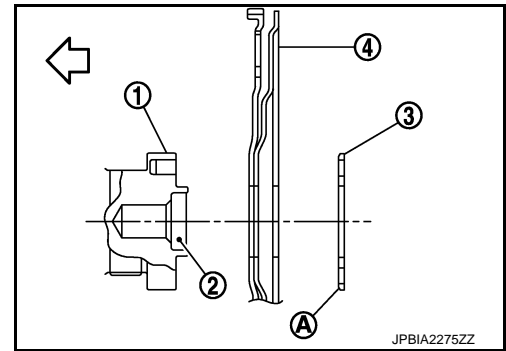
⇐ : Engine front

- When installing drive plate to crankshaft (1), 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" illuminates.

- Holding ring gear with the ring gear stopper [SST: KV10120100 (J-47245)].
- Tighten the mounting bolts crosswise over several times.



Inspection

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DRIVE PLATE DEFLECTION

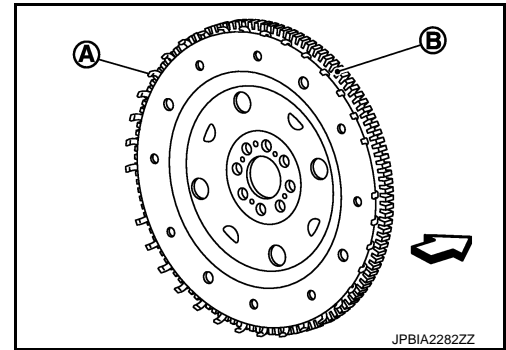
- Check drive plate and signal plate (A) for deformation or damage.

B : Ring gear

⇐ : Engine front

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 damage is found, replace drive plate.



- Measure the deflection of drive plate contact surface to torque converter with a dial indicator (A).
- Measure the deflection at the area (B).

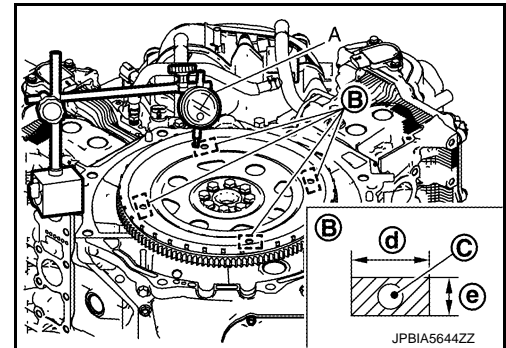
C : Hole of torque converter bolt

d : 34 mm (1.34 in)

e : 21 mm (0.83 in)

Limit : 0.35 mm (0.0138 in) or less.

- If measured value is out of the standard, replace drive plate.



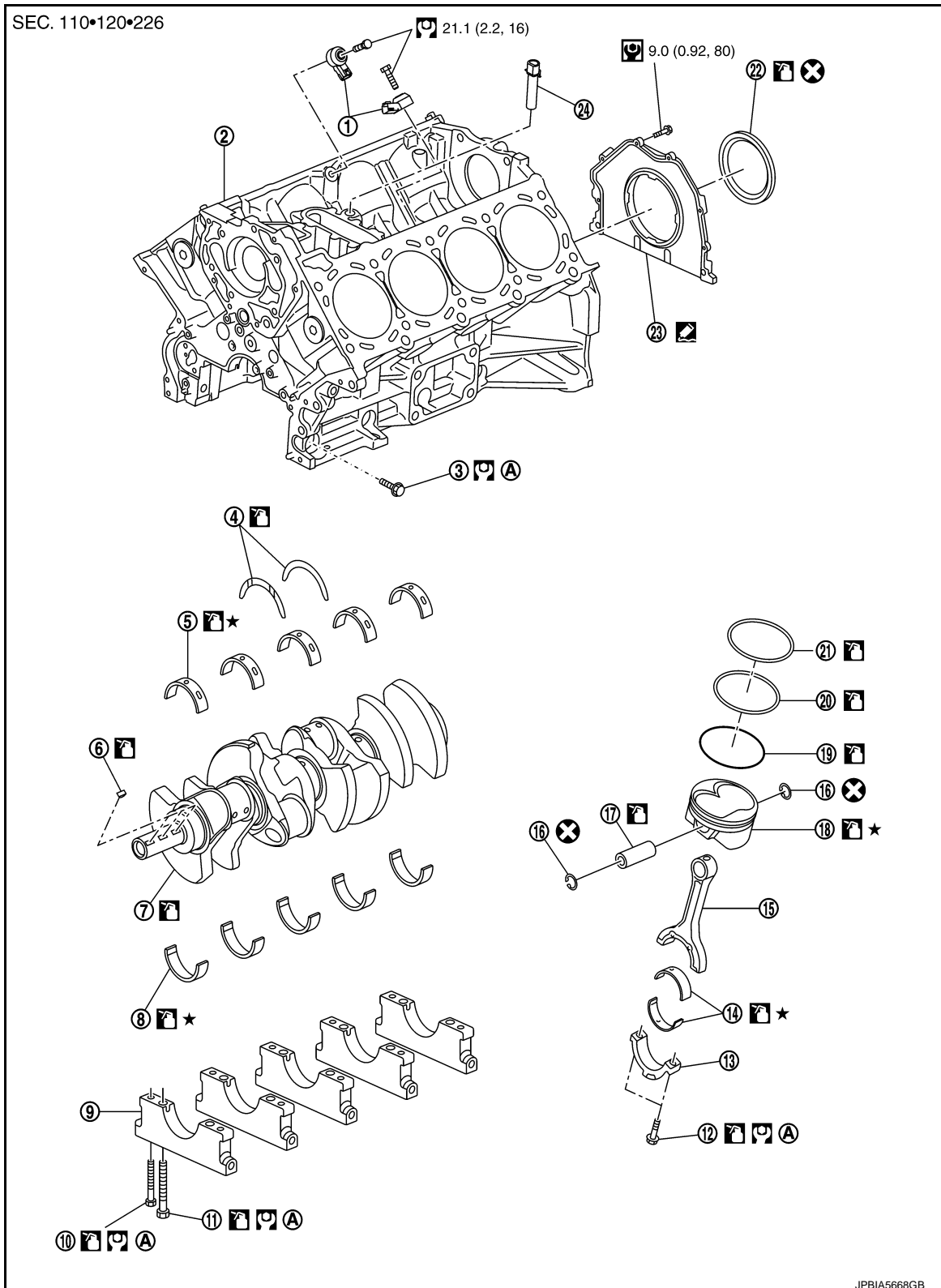
CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

CYLINDER BLOCK

Exploded View

INFOID:000000009010640



- 1. Knock sensor
- 4. Thrust bearing
- 7. Crankshaft

- 2. Cylinder block
- 5. Main bearing (upper)
- 8. Main bearing (lower)

- 3. Side bolt
- 6. Crankshaft key
- 9. Main bearing cap

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CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- | | | |
|-------------------------------|----------------------------|----------------------------------------|
| 10. Main bearing cap sub bolt | 11. Main bearing cap bolt | 12. Connecting rod cap bolt |
| 13. Connecting rod cap | 14. Connecting rod bearing | 15. Connecting rod |
| 16. Snap ring | 17. Piston pin | 18. Piston |
| 19. Oil ring | 20. Second ring | 21. Top ring |
| 22. Rear oil seal | 23. Rear oil seal retainer | 24. Cylinder block heater (for Canada) |

- A. Comply with the assembly procedure when tightening. Refer to [EM-116](#).

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

Disassembly and Assembly

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DISASSEMBLY

- Remove the following parts:
 - Oil pans (lower and upper): Refer to [EM-56, "Exploded View"](#) and [EM-59, "Exploded View"](#).
 - Front cover and timing chain: Refer to [EM-63, "Exploded View"](#).
 - Cylinder head: Refer to [EM-92, "Exploded View"](#).
- Remove knock sensor.
CAUTION:
Carefully handle knock sensor avoiding shocks.
- Remove oil filter (for VVEL ladder assembly) from cylinder block, if necessary. Refer to [EM-92, "Exploded View"](#).
- Remove piston and connecting rod assembly as per the following:
 - Before removing piston and connecting rod assembly, check the connecting rod side clearance. Refer to [EM-123, "Inspection"](#).

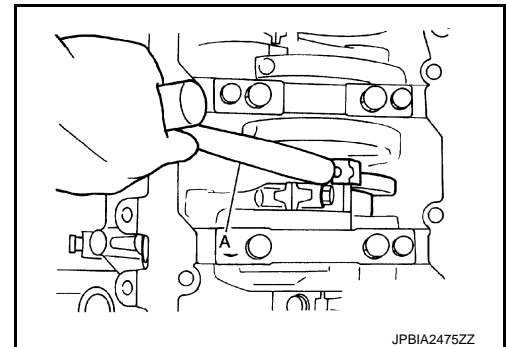
CAUTION:

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

- Position crankshaft pin corresponding to connecting rod to be removed onto the bottom dead center.
- Loosen mounting bolts, and remove connecting rod bearing cap.
- Using a hammer handle (A) or similar tool, push piston and connecting rod assembly out to the cylinder head side.

CAUTION:

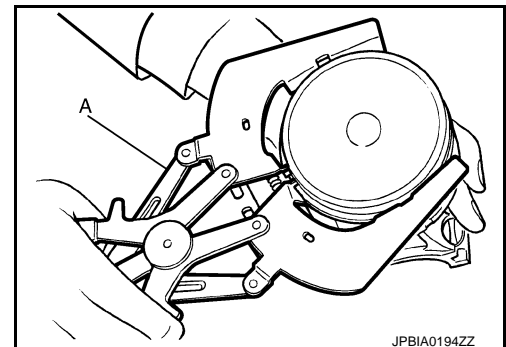
Be careful not to damage the cylinder wall and crankshaft pin, resulting from an interference of the connecting rod big end.



- 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.**
- Remove piston rings from piston.
 - Before removing piston rings, check the piston ring side clearance. Refer to [EM-123, "Inspection"](#).
 - Use a piston ring expander (commercial service tool) (A).

CAUTION:

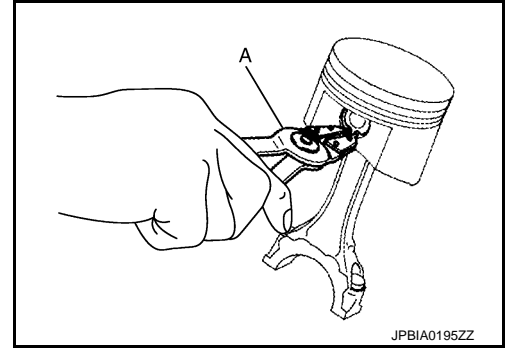
- When removing piston rings, be careful not to damage piston.**
- Be careful not to damage piston rings by expanding them excessively.**



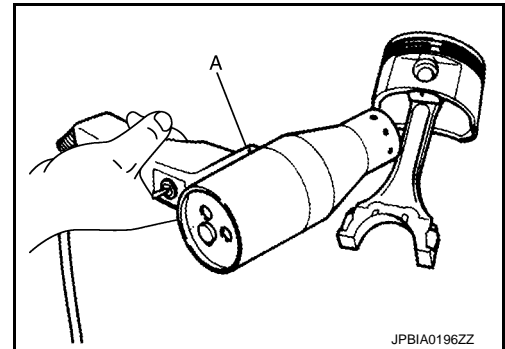
CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

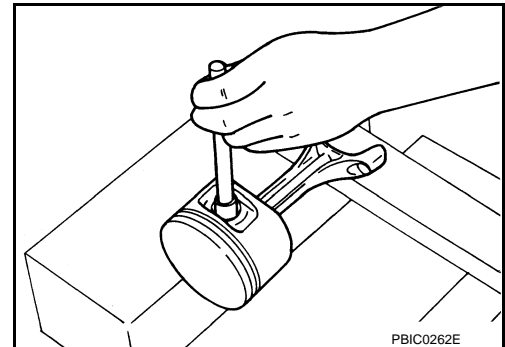
7. Remove piston from connecting rod as per the following:
 - a. Using snap ring pliers (A), remove snap rings.



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



- c. Push out piston pin using a stick that has an outer diameter of approximately 20 mm (0.79 in).



8. Remove rear oil seal and rear oil seal retainer assembly from cylinder block.
 - Insert screwdriver or similar tool between rear end of crankshaft counter weight and rear oil seal retainer, and separate liquid gasket to remove.

CAUTION:

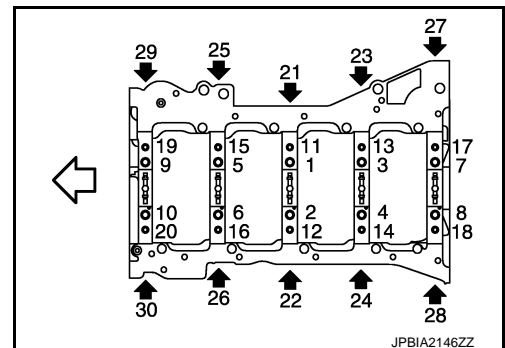
Be careful not to damage the mating surfaces.

9. Using screwdriver or similar tool, and lever off rear oil seal from rear oil seal retainer.
10. Remove main bearing cap as per the following:
 - Before loosening cylinder block bolts, measure the crankshaft end play. Refer to [EM-123. "Inspection"](#).

- a. Loosen side bolts starting from No. 30 to 21 to remove.

← : Engine front

- b. Loosen main bearing cap sub bolts starting from No. 20 to 11 to remove.
 - c. Loosen main bearing cap bolts starting from No. 10 to 1 to remove.



- d. Remove the main bearing cap.

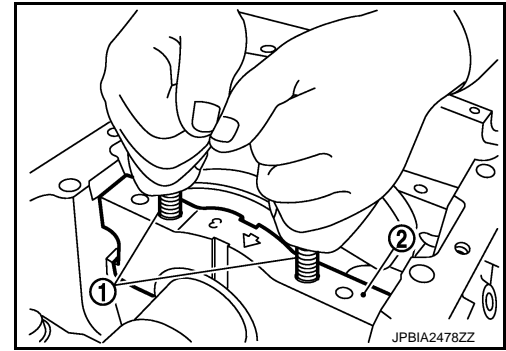
CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- Insert bolts (1) into bolt holes, and then remove main bearing cap (2) by lifting up and shaking forward and backward.

CAUTION:

Be careful not to damage the mounting surface.



11. Remove crankshaft.
12. Remove main bearings and thrust bearings from main bearing cap and 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

CAUTION:

Do not reuse washers.

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

CAUTION:

Use goggles to protect your eyes.

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

↔ : Engine front

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

- Tighten each plug as specified below.

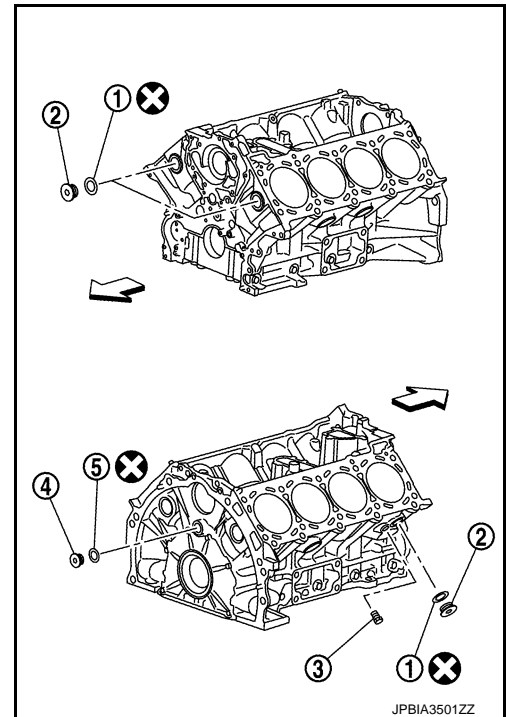
Part	Tightening torque
Plug (2)	78.0 N·m (8.0 kg·m, 58 ft·lb)
Water drain plug (3)	19.6 N·m (2.0 kg·m, 14 ft·lb)
Plug (4)	53.9 N·m (5.5 kg·m, 40 ft·lb)

- Replace washers (1), (5) with new ones.

CAUTION:

Do not reuse washers.

- Apply sealant to the thread of water drain plug (3).
Use Genuine RTV silicone sealant or equivalent. Refer to [GI-22, "Recommended Chemical Products and Sealants"](#).
- Apply sealant to the thread of plug (4).
Use high strength thread locking sealant or equivalent. Refer to [GI-22, "Recommended Chemical Products and Sealants"](#).



3. Install main bearings and thrust bearings as per the following:

CAUTION:

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

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

CYLINDER BLOCK

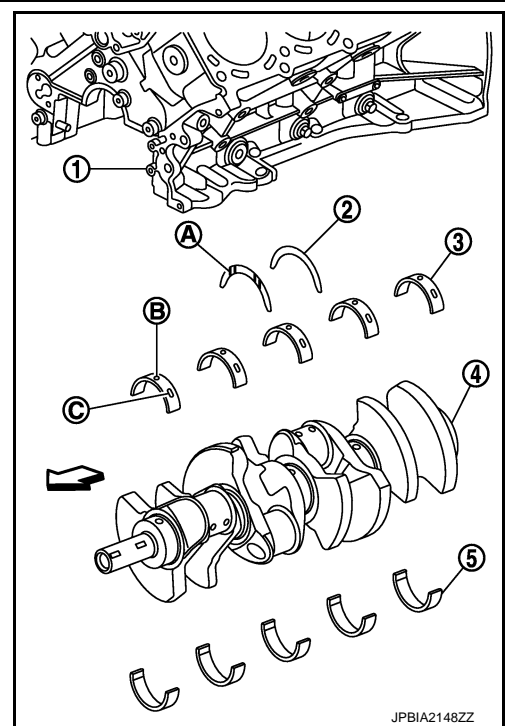
< UNIT DISASSEMBLY AND ASSEMBLY >

- b. Install thrust bearings (2) to both sides of the No. 3 journal housing on cylinder block (1).

- 3 : Main bearing (upper) (cylinder block side)
- 4 : Crankshaft
- 5 : Main bearing (lower) (main bearing cap side)
- ⇐ : Engine front

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

- c. Install main bearings paying attention to the direction.
- Main bearing with oil hole (B) and groove (C) goes on cylinder block. The one without them goes on main bearing cap.
 - 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 main bearing.
 - Ensure the oil holes on cylinder block and those on the corresponding bearing are aligned.



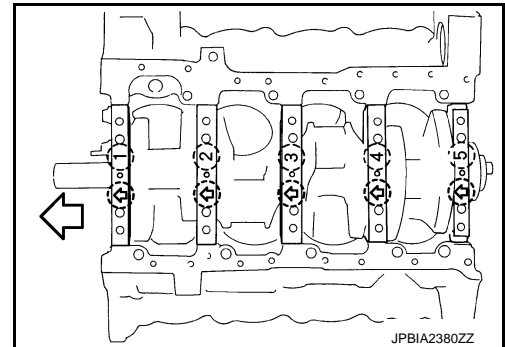
4. Install crankshaft to cylinder block.
- While turning crankshaft by hand, check that it turns smoothly.
5. Install main bearing caps as per the following:
- Align the identification number to the journal position to install.

⇐ : Engine front

- Install it with the front mark (indicated by stamping) facing the front of engine.
- Using plastic hammer or similar tool, tap them lightly to seat them on the installation position.

NOTE:

Main bearing cap cannot be replaced as a single parts, because it is machined together with cylinder block.



6. Install each main bearing cap bolts as per the following:

CAUTION:

If main bearing cap bolts and sub bolts are re-used, check their outer diameters before installation. Refer to [EM-123. "Inspection"](#).

- a. Apply new engine oil to threads and seat surfaces of main bearing cap bolts and sub bolts.
- b. Tighten all bolts in order of (No. 1 - 30) temporarily.

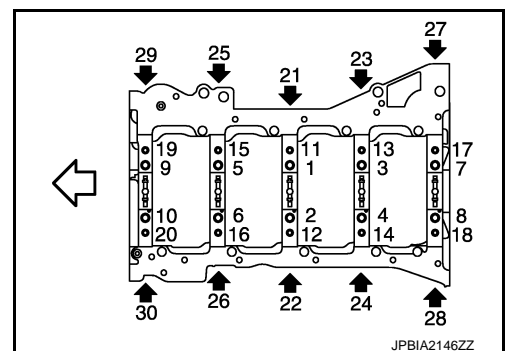
⇐ : Engine front

- c. Tighten main bearing cap bolts (M12) in order of No. 1 - 10.

: 39.2 N·m (4.0 kg·m, 29 ft·lb)

- d. Tighten main bearing cap sub bolts (M9) in order of No. 11 - 20.

: 29.4 N·m (3.0 kg·m, 22 ft·lb)



CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- e. Tighten main bearing cap bolts (M12) in order of No. 1 - 10 (clockwise).

Angle tightening: 40 degrees

CAUTION:

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

- f. Tighten main bearing cap sub bolts (M9) in order of No. 11 - 20. (clockwise)

Angle tightening: 30 degrees

- g. Tighten side bolts (M10) in order of No. 21 - 30.

Torque: 49.0 N·m (5.0 kg-m, 36 ft-lb)

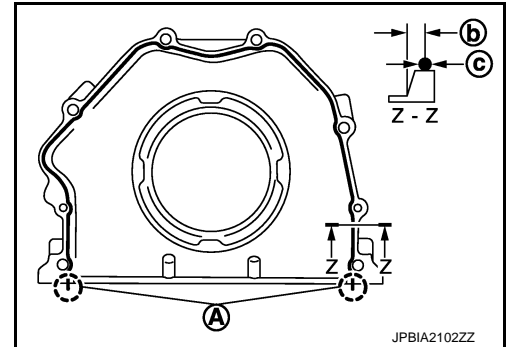
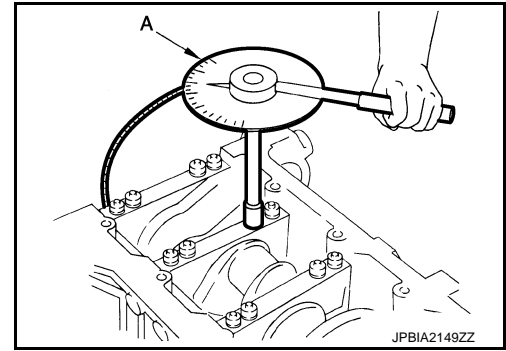
- After installing bolts, check that crankshaft can be rotated smoothly by hand.
- Check the crankshaft end play. Refer to [EM-145. "Cylinder Block"](#).

7. Install rear oil seal retainer.

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

- A : Protrusion
 b : 4.0 - 5.6 mm (0.157 - 0.220 in)
 c : ϕ 3.4 - 4.4 mm (0.134 - 0.173 in)

Use Genuine RTV silicone sealant or equivalent. Refer to [GI-22. "Recommended Chemical Products and Sealants"](#).



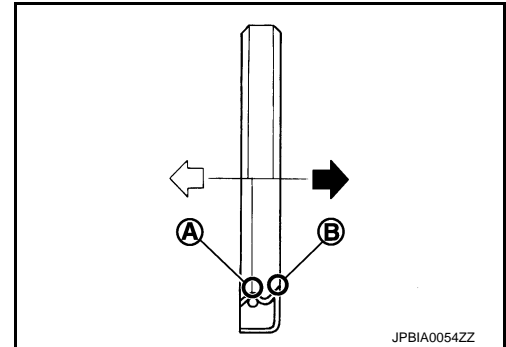
8. Install rear oil seal on rear oil seal retainer.

- ⇐ : Engine inside
 ⇨ : Engine outside

- Apply new engine oil to both oil seal lip (A) and dust seal lip (B).
- Install it so that each seal lip is oriented as shown in the figure.

CAUTION:

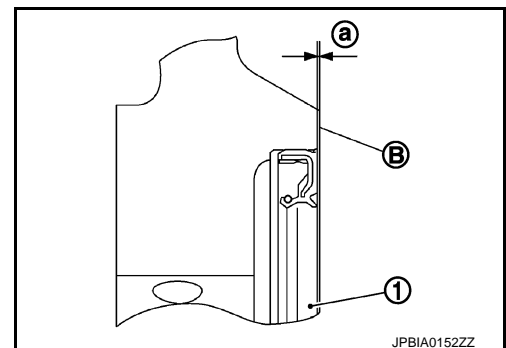
Be careful not to scratch or make burrs on circumference of oil seal.



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

- B : Rear oil seal retainer rear end face
 a : 0 - 0.5 mm (0 - 0.020 in)

- Using a suitable drift [outer diameter: 101 mm (3.98 in)].
- Check the garter spring is in position and seal lips are not inverted.



9. Install piston to connecting rod as per the following:

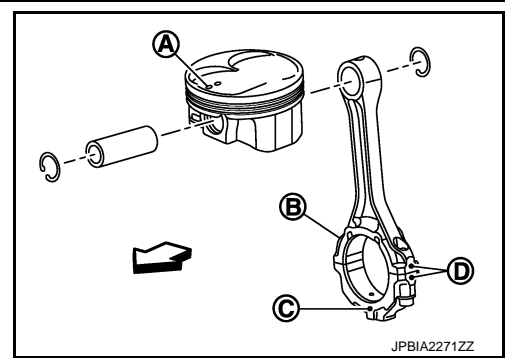
CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- Assemble so that the front mark (A) on the piston head and the cylinder number (D) on connecting rod are positioned as shown in the figure.

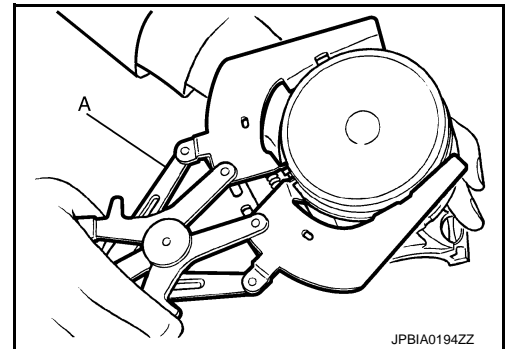
- B : Oil hole
- C : Front mark
- ↔ : Engine front

- a. Using snap ring pliers, install new snap ring to the groove of piston rear side.
 - Insert it fully into groove to install.
 - b. Install piston to connecting rod.
 - Using an industrial use dryer 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.
 - 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:

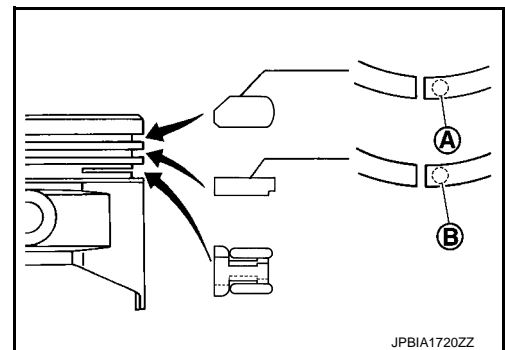
- When installing piston rings, be careful not to damage piston.
- Be careful not to damage piston rings by expanding them excessively.



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

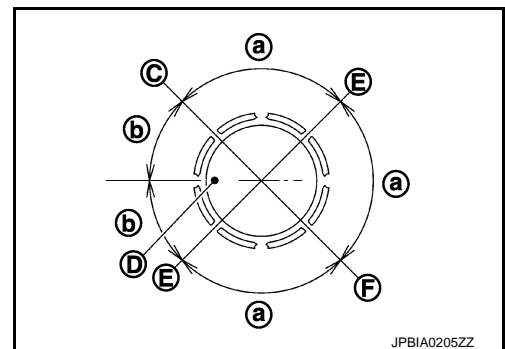
Stamped mark:

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



- 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-123. "Inspection"](#).

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

CAUTION:

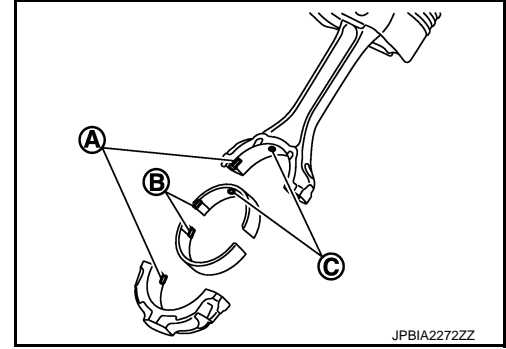
- Be careful not to drop connecting rod bearing, and to scratch the surface.

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CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- 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 (A) of connecting rods and connecting rod bearing caps to install.
- Ensure the oil hole (C) on connecting rod and that on the corresponding bearing are aligned.



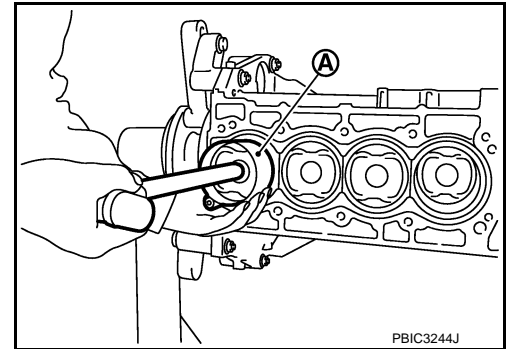
JPBIA2272ZZ

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 the front of the 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.

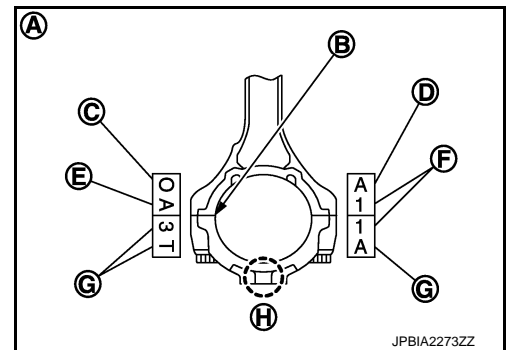


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13. Install connecting rod bearing cap.

- 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



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

14. Tighten connecting rod bolts as per the following:

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

: **29.4 N·m (3.0 kg-m, 21.7 ft-lb)**

- d. Completely loosen connecting rod bolts.

: **0 N·m (0 kg-m, 0 ft-lb)**

- e. Tighten connecting rod bolts.

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

: 19.6 N·m (2.0 kg·m, 14.5 ft·lb)

f. Tighten connecting rod bolts. (clockwise)

Angle tightening: 90 degrees


CAUTION:

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

- After tightening connecting rod bolts, check that crankshaft rotates smoothly.
- Check the connecting rod side clearance. Refer to [EM-123, "Inspection"](#).

15. Install knock sensors (1).

- Install knock sensors in the direction shown in the figure.

 : Engine front

- After installing knock sensor, connect harness connector, and lay it out to front 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.

16. Install oil filter (for VVEL ladder assembly).

17. Assemble in the reverse order of disassembly.

Inspection

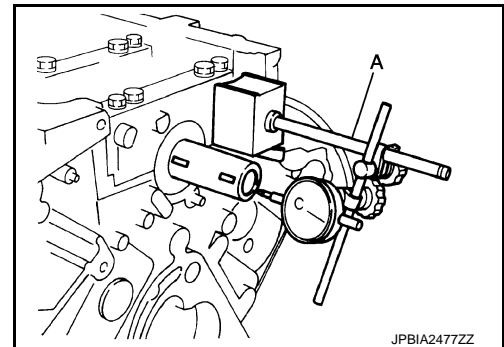
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CRANKSHAFT END PLAY

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

Standard and limit : Refer to [EM-145, "Cylinder Block"](#).

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

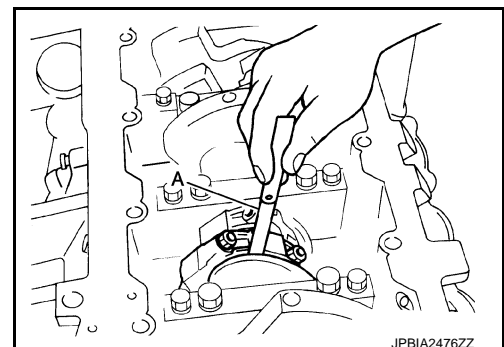


CONNECTING ROD SIDE CLEARANCE

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

Standard and limit : Refer to [EM-145, "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

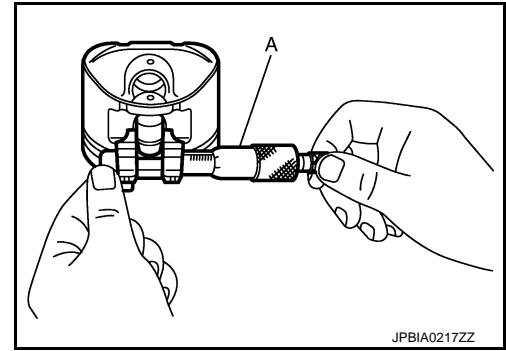
Piston Pin Hole Diameter

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

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

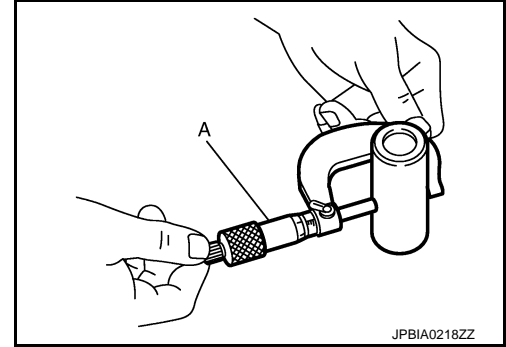
Standard : Refer to [EM-145, "Cylinder Block"](#).



Piston Pin Outer Diameter

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

Standard : Refer to [EM-145, "Cylinder Block"](#).



Piston to Piston Pin Oil Clearance

(Piston to piston pin oil clearance) = (Piston pin hole diameter) – (Piston pin outer diameter)

Standard : Refer to [EM-145, "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 RING SIDE CLEARANCE

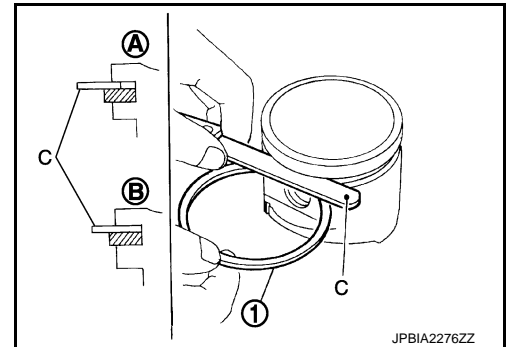
- Measure the side clearance of piston ring (1) and piston ring groove with a feeler gauge (C).

A : OK

B : NG

Standard and limit : Refer to [EM-145, "Cylinder Block"](#).

- If the measured value exceeds the limit, replace piston ring, and measure again. If it still exceeds the limit, replace piston also.



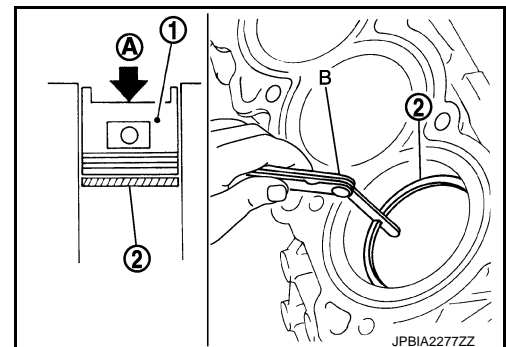
PISTON RING END GAP

- Check that the cylinder bore inner diameter is within the specification.
- 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

Standard and limit : Refer to [EM-145, "Cylinder Block"](#).

- If the measured value exceeds the limit, replace piston ring, and measure again. If it still exceeds the limit, re-bore cylinder and use oversize piston and piston rings.



CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

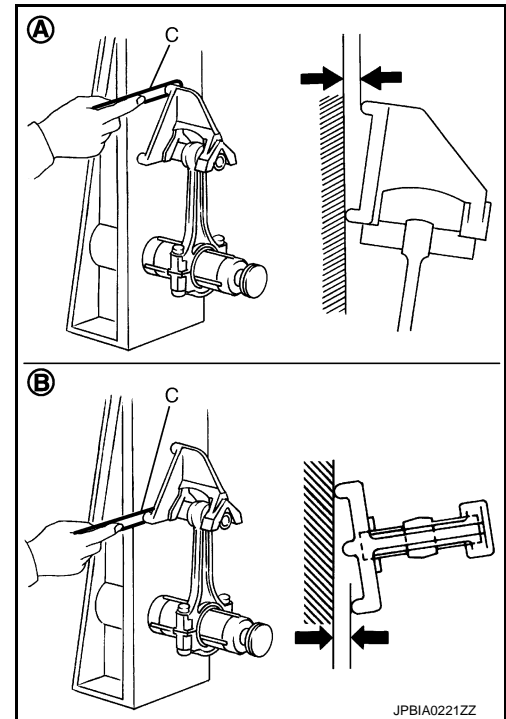
CONNECTING ROD BEND AND TORSION

- Check with a connecting rod aligner.

- A : Bend
B : Torsion
C : Feeler gauge

Bend limit : Refer to [EM-145](#),
Torsion limit "[Cylinder Block](#)".

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



CONNECTING ROD BIG END DIAMETER

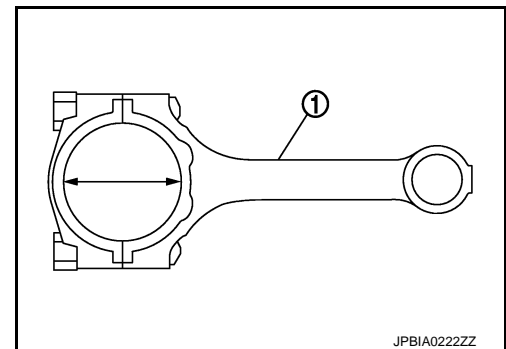
- Install connecting rod bearing cap without installing connecting rod bearing, and tighten connecting rod bolts to the specified torque. Refer to [EM-116](#), "[Disassembly and Assembly](#)" for the tightening procedure.

- 1 : Connecting rod

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

Standard : Refer to [EM-145](#), "[Cylinder Block](#)".

- If out of the standard, replace connecting rod assembly.

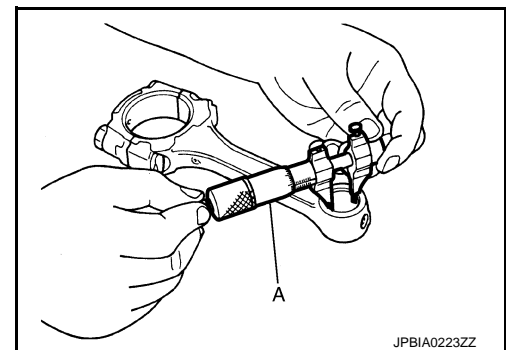


CONNECTING ROD BUSHING OIL CLEARANCE

Connecting Rod Bushing Inner Diameter

Measure the inner diameter of connecting rod bushing with an inside micrometer (A).

Standard : Refer to [EM-145](#), "[Cylinder Block](#)".



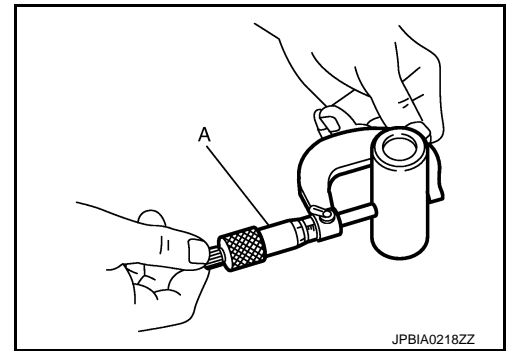
Piston Pin Outer Diameter

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

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

Standard : Refer to [EM-145, "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-145, "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.

CYLINDER BLOCK DISTORTION

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

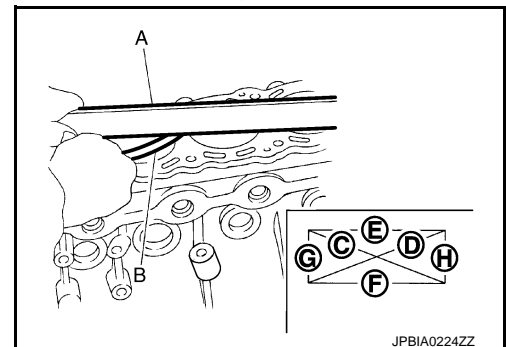
CAUTION:

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-145, "Cylinder Block"](#).

- If it exceeds the limit, replace cylinder block.



MAIN BEARING HOUSING INNER DIAMETER

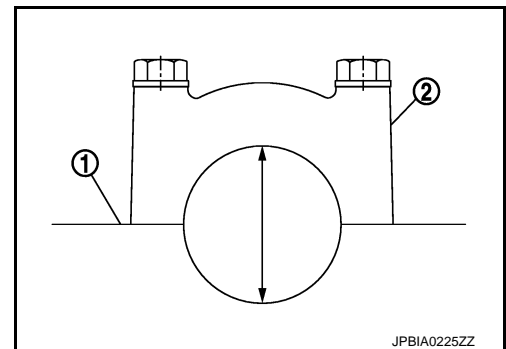
- Install main bearing cap (2) without installing main bearings, and tighten main bearing cap bolts to the specified torque. Refer to [EM-116, "Disassembly and Assembly"](#) for the tightening procedure.
- Measure the inner diameter of main bearing housing with a bore gauge.

Standard : Refer to [EM-145, "Cylinder Block"](#).

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

NOTE:

Cylinder block cannot be replaced as a single part, because it is machined together with main bearing cap.



PISTON TO CYLINDER BORE CLEARANCE

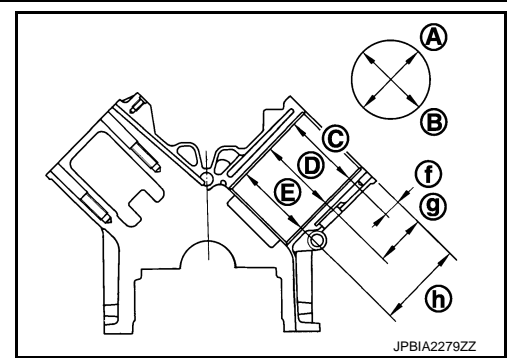
Cylinder Bore inner Diameter

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 : 120 mm (4.72 in)



Wear limit:

Out-of-round (Difference between "A" and "B"): Refer to [EM-145, "Cylinder Block"](#).

Taper limit (Difference between "C" and "E"):

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

CAUTION:

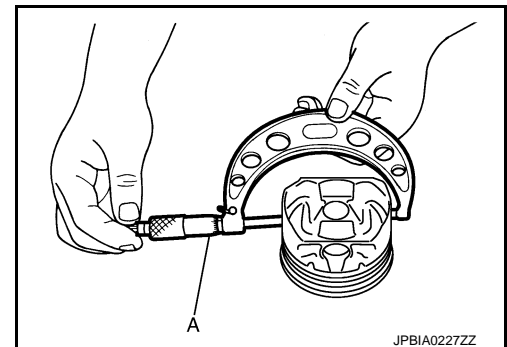
When using oversize piston, use oversize pistons for all cylinders with oversize piston rings.

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

Piston Skirt Diameter

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

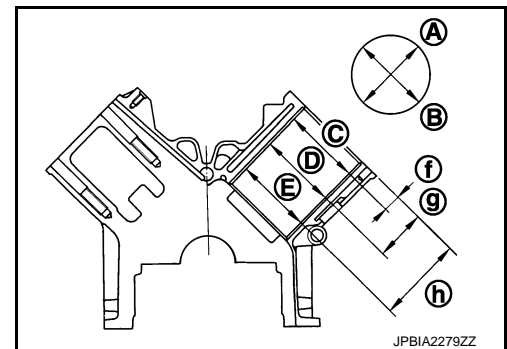
Measure point : Refer to [EM-145, "Cylinder Block"](#).
Standard



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 : 120 mm (4.72 in)



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

Standard and limit : Refer to [EM-145, "Cylinder Block"](#).

- If the calculated value exceeds the limit, replace piston and piston pin assembly. Refer to [EM-145, "Cylinder Block"](#).

Re-boring Cylinder Bore

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

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

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

where,

D: Bored diameter

A: Piston skirt diameter as measured

B: Piston to cylinder bore clearance (standard value)

C: Honing allowance 0.02 mm (0.0008 in)

2. Install main bearing cap, 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:

Perform measurement after cylinder bore cools down.

CRANKSHAFT MAIN JOURNAL DIAMETER

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

Standard : Refer to [EM-145, "Cylinder Block"](#).

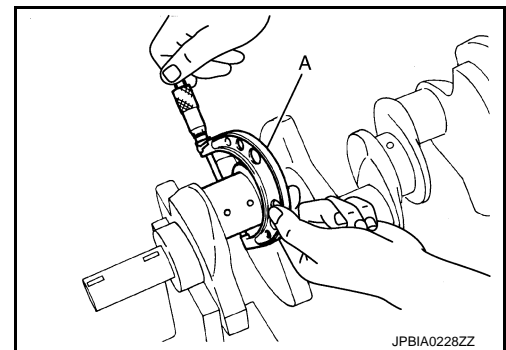
- If out of the standard, measure the main bearing oil clearance. Then use undersize bearing. Refer to [EM-136, "Main Bearing"](#).

CRANKSHAFT PIN JOURNAL DIAMETER

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

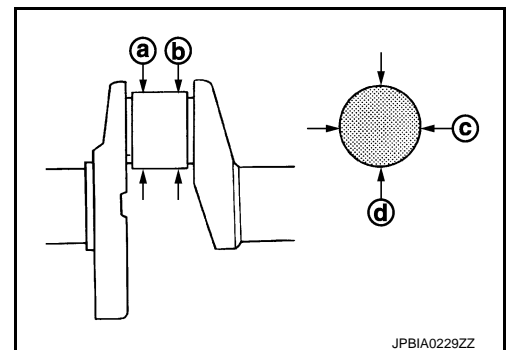
Standard : Refer to [EM-145, "Cylinder Block"](#).

- 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.



Out-of-round (Difference between "c" and "d")

Taper (Difference between "a" and "b")

: Refer to [EM-145, "Cylinder Block"](#).

CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

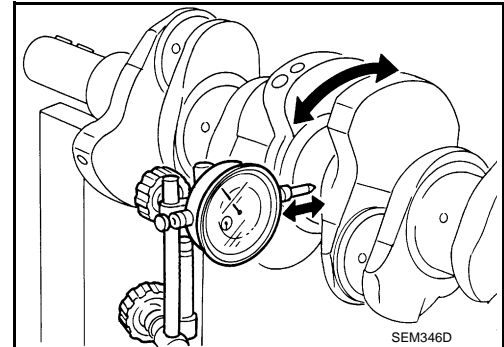
- If the measured value exceeds the limit, correct or replace crankshaft.
- If corrected, measure the bearing oil clearance of the corrected main journal and/or pin journal. Then select the main bearing and/or connecting rod bearing. Refer to [EM-136. "Main Bearing"](#) and/or [EM-134. "Connecting Rod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

CRANKSHAFT RUNOUT

- Place V-block on precise flat table, and support the journals on both ends 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-145. "Cylinder Block"](#).

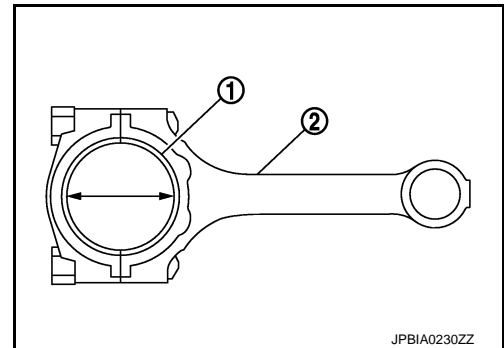
- If it exceeds the limit, replace crankshaft.



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-116. "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-150. "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-116. "Disassembly and Assembly"](#) for the tightening procedure.

CAUTION:

Never rotate crankshaft.

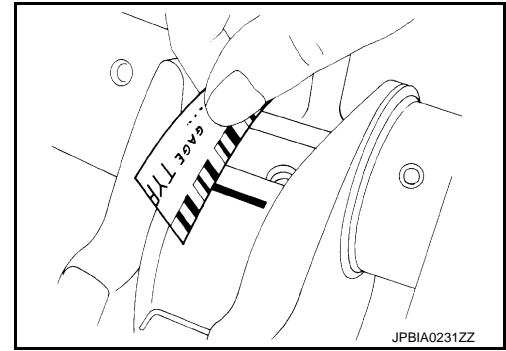
CYLINDER BLOCK

< UNIT DISASSEMBLY AND ASSEMBLY >

- Remove connecting rod bearing cap and bearings, and using the scale on the plastigage bag, measure the plastigage width.

NOTE:

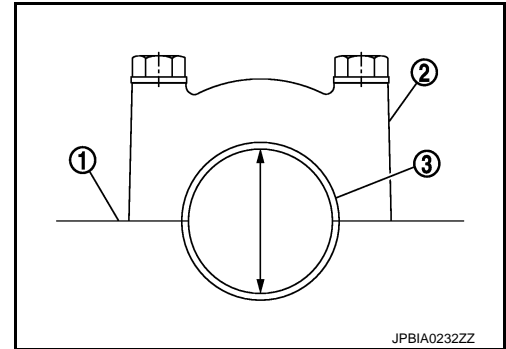
The procedure when the measured value exceeds the limit is the same as that described in the “Method by Calculation”.



MAIN BEARING OIL CLEARANCE

Method by Calculation

- Install main bearings (3) to cylinder block (1) and main bearing cap (2), and tighten main bearing cap bolts to the specified torque. Refer to [EM-116, "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-149, "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 main bearing cap, and tighten main bearing cap bolts with main bearing cap to the specified torque. Refer to [EM-116, "Disassembly and Assembly"](#) for the tightening procedure.

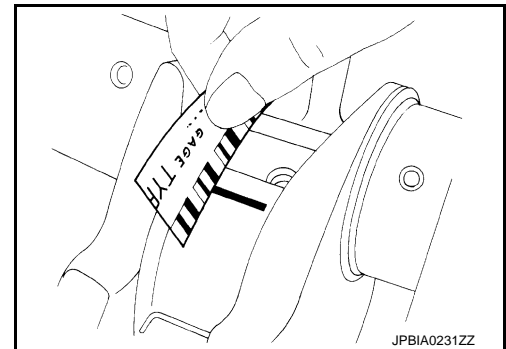
CAUTION:

Never rotate crankshaft.

- Remove main 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 the same as that described in the “Method by Calculation”.



MAIN BEARING CRUSH HEIGHT

CYLINDER BLOCK

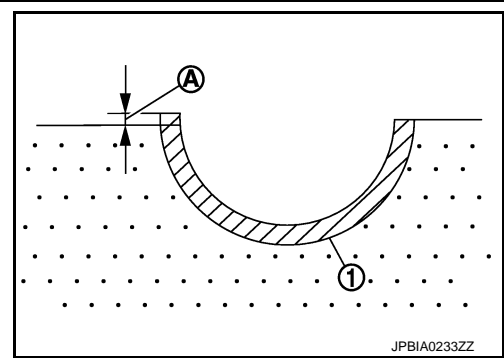
< UNIT DISASSEMBLY AND ASSEMBLY >

- When main bearing cap is removed after being tightened to the specified torque with main bearings (1) installed, the tip end of bearing must protrude. Refer to [EM-116, "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.



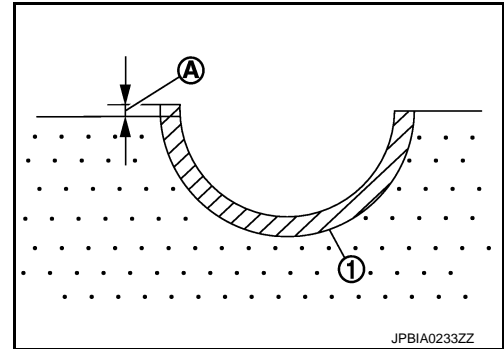
CONNECTING ROD BEARING CRUSH HEIGHT

- 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-116, "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.



MAIN BEARING CAP BOLT OUTER DIAMETER

- Measure the outer diameters (A), (B) at two positions as shown in the figure.

c : 20 mm (0.79 in)

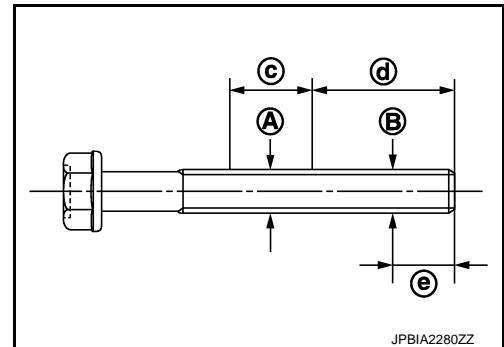
d : 55 mm (2.17 in)

e : 12 mm (0.47 in)

- If reduction appears in (A) range, regard it (B).

Limit [(B) – (A)] : 0.15 mm (0.0059 in)

- If it exceeds the limit (large difference in dimensions), replace main bearing cap bolts with new one.



MAIN BEARING CAP SUB BOLT OUTER DIAMETER

- Measure the outer diameters (A), (B) at two positions as shown in the figure.

c : 20 mm (0.79 in)

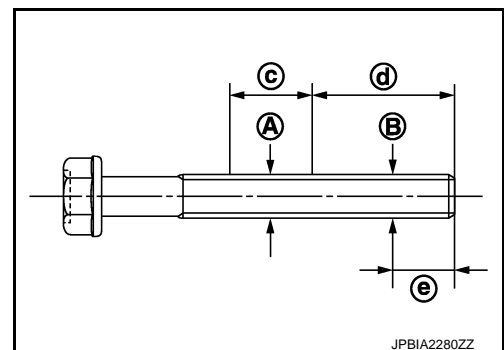
d : 15 mm (0.59 in)

e : 9 mm (0.35 in)

- If reduction appears in (A) range, regard it (B).

Limit [(B) – (A)] : 0.10 mm (0.0039 in)

- If it exceeds the limit (large difference in dimensions), replace main bearing cap sub bolts with new one.



CONNECTING ROD BOLT OUTER DIAMETER

CYLINDER BLOCK

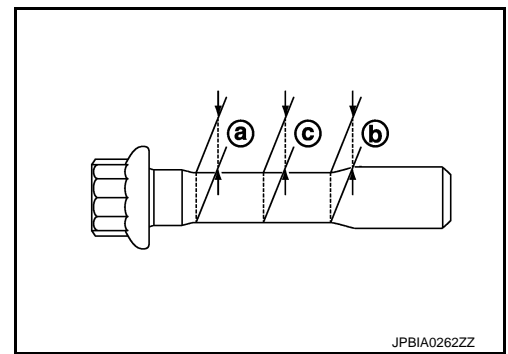
< UNIT DISASSEMBLY AND ASSEMBLY >

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)] : 0.08 mm (0.0032 in)



4. If it exceeds the limit (large difference in dimensions), replace the bolt with new one.

OIL JET

- Check nozzle for deformation and damage.
- Blow compressed air from nozzle, and check for clogs.
- 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, clean or replace oil jet.

HOW TO SELECT PISTON AND BEARING

< UNIT DISASSEMBLY AND ASSEMBLY >

HOW TO SELECT PISTON AND BEARING

Description

INFOID:000000009010643

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)	Determined by match of connecting rod big end diameter grade (inner diameter of housing) and crankshaft pin outer diameter.
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)

- 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

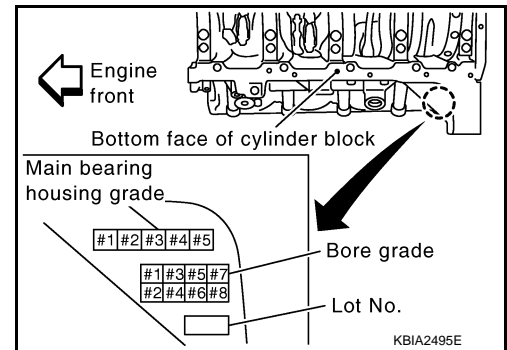
INFOID:000000009010644

WHEN NEW CYLINDER BLOCK IS USED

Check the cylinder bore grade on the bottom face of the cylinder block, and select the piston of the same grade.

NOTE:

Piston is available with piston pin as a set for the service part.



WHEN CYLINDER BLOCK IS REUSED

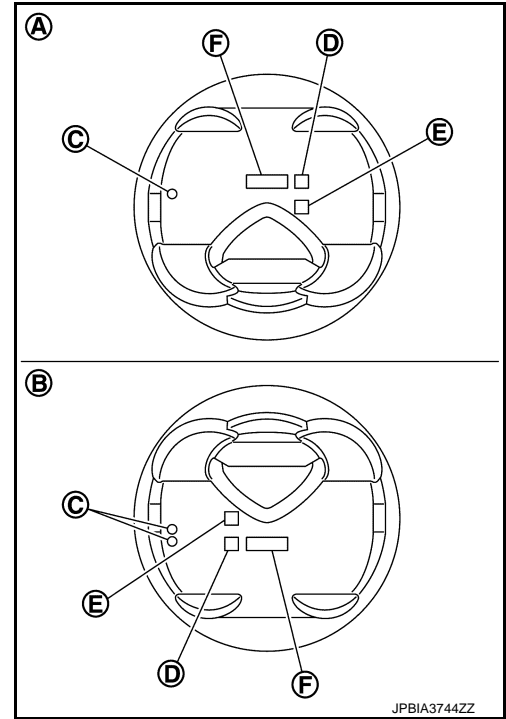
1. Measure the cylinder bore inner diameter. Refer to [EM-145, "Cylinder Block"](#).

HOW TO SELECT PISTON AND BEARING

< UNIT DISASSEMBLY AND ASSEMBLY >

2. Determine the bore grade by comparing the measurement with the values under the cylinder bore inner diameter of the "PISTON SELECTION TABLE".

- A : Bank 2
- B : Bank 1
- C : Front mark
- D : Piston grade number
- E : Piston pin grade number
- F : Identification code



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3. Select piston of the same grade.

PISTON SELECTION TABLE

Unit: mm (in)

Grade	1	2	3
Cylinder bore inner diameter	98.000 - 98.010 (3.8583 - 3.8587)	98.010 - 98.020 (3.8587 - 3.8590)	98.020 - 98.030 (3.8590 - 3.8594)
Piston skirt diameter	97.980 - 97.990 (3.8575 - 3.8579)	97.990 - 98.000 (3.8579 - 3.8583)	98.000 - 98.010 (3.8583 - 3.8587)

NOTE:

Piston is available together with piston pin as assembly.

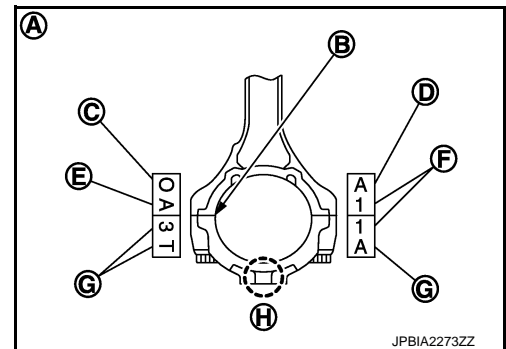
Connecting Rod Bearing

INFOID:000000009010645

WHEN NEW CONNECTING ROD AND CRANKSHAFT ARE USED

1. 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

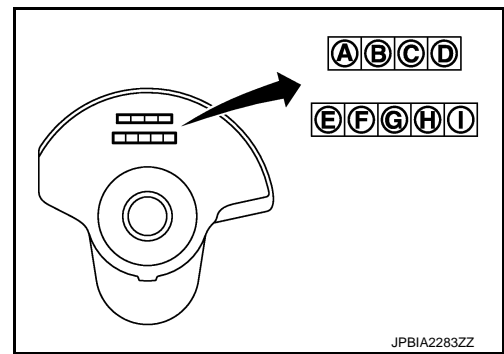


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HOW TO SELECT PISTON AND BEARING

< UNIT DISASSEMBLY AND ASSEMBLY >

- Apply crankshaft pin journal diameter grade stamped on crankshaft front side to the column in the "CONNECTING ROD BEARING SELECTION TABLE".



- A : Pin diameter grade No. 1
- B : Pin diameter grade No. 2
- C : Pin diameter grade No. 3
- D : Pin diameter grade No. 4
- E : Journal diameter grade No. 1
- F : Journal diameter grade No. 2
- G : Journal diameter grade No. 3
- H : Journal diameter grade No. 4
- I : Journal diameter grade No. 5

- 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 connecting rod big end diameter and crankshaft pin journal diameter. Refer to [EM-123. "Inspection"](#).
- Correspond the measured dimension in connecting rod big end diameter row of "CONNECTING ROD BEARING SELECTION TABLE".
- Correspond the measured dimension in crankshaft pin journal diameter column of "CONNECTING ROD BEARING SELECTION TABLE".
- Follow from step 3 in "WHEN NEW CONNECTING ROD AND CRANKSHAFT ARE USED".

CONNECTING ROD BEARING SELECTION TABLE

Connecting rod big end inner diameter		Mark	Inner diameter Unit: mm (in)														
			A	B	C	D	E	F	G	H	J	K	L	M	N		
Crankshaft pin outer diameter	Mark	Outer diameter Unit: mm (in)	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 – 2.2443)	57.004 – 57.005 (2.2443 – 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)		
			0	53.968 – 53.974 (2.1247 – 2.1250)	1	1	1	1	1	1	2	2	2	2	2	2	3
			1	53.962 – 53.968 (2.1245 – 2.1247)	2	2	2	2	2	2	3	3	3	3	3	3	3
2	53.956 – 53.962 (2.1243 – 2.1245)	3	3	3	3	3	3	4	4	4	4	4	4	4	4		

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CONNECTING ROD BEARING GRADE TABLE

Connecting rod bearing grade table : Refer to [EM-150. "Connecting Rod Bearing"](#).

UNDERSIZE BEARING USAGE GUIDE

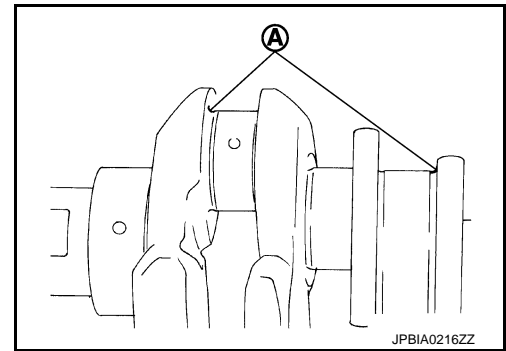
- When the specified connecting rod bearing oil clearance is not obtained with standard size connecting rod bearings, use undersize (US) bearings.
- When using undersize (US) bearing, measure the connecting rod bearing inner diameter with bearing installed, and grind crankshaft pin so that the connecting rod bearing oil clearance satisfies the standard.

CAUTION:

HOW TO SELECT PISTON AND BEARING

< UNIT DISASSEMBLY AND ASSEMBLY >

In grinding crankshaft pin to use undersize bearings, keep the fillet R (A) [1.5 - 1.7 mm (0.059 - 0.067 in)].



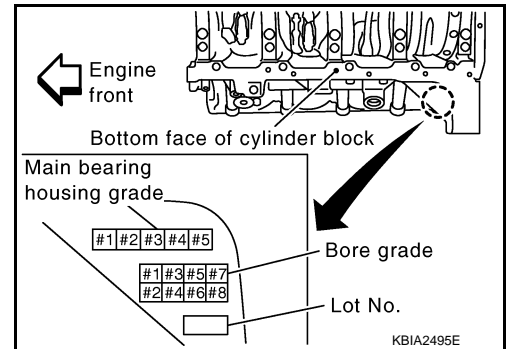
Bearing undersize table : Refer to [EM-150, "Connecting Rod Bearing"](#).

Main Bearing

INFOID:000000009010646

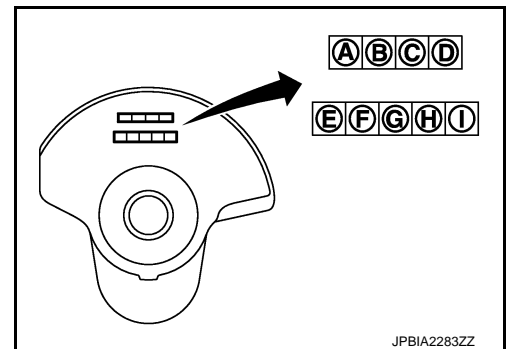
WHEN NEW CYLINDER BLOCK AND CRANKSHAFT ARE USED

1. Apply the main bearing housing grade on the bottom face of the cylinder block to the row in "MAIN BEARING SELECTION TABLE".



2. "MAIN BEARING SELECTION TABLE" columns correspond to journal diameter grade on front side of crankshaft.

- A : Pin diameter grade No. 1
- B : Pin diameter grade No. 2
- C : Pin diameter grade No. 3
- D : Pin diameter grade No. 4
- E : Journal diameter grade No. 1
- F : Journal diameter grade No. 2
- G : Journal diameter grade No. 3
- H : Journal diameter grade No. 4
- I : Journal diameter grade No. 5



3. Select main bearing grade at the point where selected row and column meet in "MAIN BEARING SELECTION TABLE".

CAUTION:

- Initial clearance for No. 1, 5 journal and No. 2, 3, 4 journal is different. Use two different selection table for each part.
- No. 1, 5 journal and No. 2, 3, 4 journal have the same signs but different measures. Never confuse.

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 are 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-123, "Inspection"](#).

HOW TO SELECT PISTON AND BEARING

< UNIT DISASSEMBLY AND ASSEMBLY >

- Correspond the measured dimension in "Cylinder block main bearing housing inner diameter" row of "MAIN BEARING SELECTION TABLE".
- Correspond the measured dimension in "Crankshaft main journal diameter" column of "MAIN BEARING SELECTION TABLE".
- Follow from step 3 in "When New Cylinder Block and Crankshaft are Used".

MAIN BEARING SELECTION TABLE (No. 1 and 5 Journal)

Cylinder block main bearing housing inner diameter	I.D. mark	Hole diameter Unit: mm (in)																									
		A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	4	7		
Crankshaft main journal diameter	I.D. mark	68.944 - 68.945 (2.7143 - 2.7144)	68.945 - 68.946 (2.7144 - 2.7144)	68.946 - 68.947 (2.7144 - 2.7144)	68.947 - 68.948 (2.7144 - 2.7145)	68.948 - 68.949 (2.7145 - 2.7145)	68.949 - 68.950 (2.7145 - 2.7146)	68.950 - 68.951 (2.7146 - 2.7146)	68.951 - 68.952 (2.7146 - 2.7146)	68.952 - 68.953 (2.7146 - 2.7147)	68.953 - 68.954 (2.7147 - 2.7147)	68.954 - 68.955 (2.7147 - 2.7148)	68.955 - 68.956 (2.7148 - 2.7148)	68.956 - 68.957 (2.7148 - 2.7148)	68.957 - 68.958 (2.7148 - 2.7149)	68.958 - 68.959 (2.7149 - 2.7149)	68.959 - 68.960 (2.7149 - 2.7150)	68.960 - 68.961 (2.7150 - 2.7150)	68.961 - 68.962 (2.7150 - 2.7150)	68.962 - 68.963 (2.7150 - 2.7151)	68.963 - 68.964 (2.7151 - 2.7151)	68.964 - 68.965 (2.7151 - 2.7152)	68.965 - 68.966 (2.7152 - 2.7152)	68.966 - 68.967 (2.7152 - 2.7152)	68.967 - 68.968 (2.7152 - 2.7153)		
G	63.964 - 63.963 (2.5183 - 2.5182)	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	
H	63.963 - 63.962 (2.5182 - 2.5182)	1	12	12	12	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	
J	63.962 - 63.961 (2.5182 - 2.5181)	12	12	12	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5		
K	63.961 - 63.960 (2.5181 - 2.5181)	12	12	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5		
L	63.960 - 63.959 (2.5181 - 2.5181)	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5		
M	63.959 - 63.958 (2.5181 - 2.5180)	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	5		
N	63.958 - 63.957 (2.5180 - 2.5180)	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	5	5		
P	63.957 - 63.956 (2.5180 - 2.5179)	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	5	5	5		
R	63.956 - 63.955 (2.5179 - 2.5179)	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	5	5	5	5		
S	63.955 - 63.954 (2.5179 - 2.5179)	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	5	5	5	5	5		
T	63.954 - 63.953 (2.5179 - 2.5178)	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	5	5	5	5	5	5		
U	63.953 - 63.952 (2.5178 - 2.5178)	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	5	5	5	5	5	5	5		
V	63.952 - 63.951 (2.5178 - 2.5178)	3	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	5	5	5	5	5	5	5	5		
W	63.951 - 63.950 (2.5178 - 2.5177)	3	34	34	34	4	4	4	45	45	45	5	5	5	5	5	5	5	5	5	5	5	5	5	5		
X	63.950 - 63.949 (2.5177 - 2.5177)	34	34	34	4	4	4	45	45	45	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		
Y	63.949 - 63.948 (2.5177 - 2.5176)	34	34	4	4	4	45	45	45	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		
1	63.948 - 63.947 (2.5176 - 2.5176)	34	4	4	4	45	45	45	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		
2	63.947 - 63.946 (2.5176 - 2.5176)	4	4	4	45	45	45	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		
3	63.946 - 63.945 (2.5176 - 2.5175)	4	4	45	45	45	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		
4	63.945 - 63.944 (2.5175 - 2.5175)	4	45	45	45	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		
5	63.944 - 63.943 (2.5175 - 2.5174)	45	45	45	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		
6	63.943 - 63.942 (2.5174 - 2.5174)	45	45	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		
7	63.942 - 63.941 (2.5174 - 2.5174)	45	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		
9	63.941 - 63.940 (2.5174 - 2.5173)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		

JPBIA2285GB

HOW TO SELECT PISTON AND BEARING

< UNIT DISASSEMBLY AND ASSEMBLY >

MAIN BEARING SELECTION TABLE (No. 2, 3 and 4 Journal)

Cylinder block main bearing housing inner diameter		I.D. mark	Hole diameter Unit: mm (in)																																
		A B C D E F G H J K L M N P R S T U V W X Y 4 7																																	
I.D. mark	Axle diameter Unit: mm (in)	Crankshaft main journal diameter																																	
		A B C D E F G H J K L M N P R S T U V W X Y 4 7																																	
A	63.964 - 63.963 (2.5183 - 2.5182)	0	0	01	01	01	1	1	1	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12		
B	63.963 - 63.962 (2.5182 - 2.5182)	0	01	01	01	1	1	1	1	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	
C	63.962 - 63.961 (2.5182 - 2.5181)	01	01	01	1	1	1	1	1	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	
D	63.961 - 63.960 (2.5181 - 2.5181)	01	01	1	1	1	1	1	1	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	
E	63.960 - 63.959 (2.5181 - 2.5181)	01	1	1	1	1	1	1	1	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	
F	63.959 - 63.958 (2.5181 - 2.5180)	1	1	1	1	1	1	1	1	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	
G	63.958 - 63.957 (2.5180 - 2.5180)	1	1	1	1	1	1	1	1	1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	
H	63.957 - 63.956 (2.5180 - 2.5179)	1	12	12	12	2	2	2	2	2	2	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	
J	63.956 - 63.955 (2.5179 - 2.5179)	12	12	12	2	2	2	2	2	2	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	
K	63.955 - 63.954 (2.5179 - 2.5179)	12	12	2	2	2	2	2	2	2	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
L	63.954 - 63.953 (2.5179 - 2.5178)	12	2	2	2	2	2	2	2	2	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
M	63.953 - 63.952 (2.5178 - 2.5178)	2	2	2	2	2	2	2	2	2	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
N	63.952 - 63.951 (2.5178 - 2.5178)	2	2	2	2	2	2	2	2	2	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
P	63.951 - 63.950 (2.5178 - 2.5177)	2	23	23	23	3	3	3	3	3	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
R	63.950 - 63.949 (2.5177 - 2.5177)	23	23	23	3	3	3	3	3	3	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
S	63.949 - 63.948 (2.5177 - 2.5176)	23	23	3	3	3	3	3	3	3	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
T	63.948 - 63.947 (2.5176 - 2.5176)	23	3	3	3	3	3	3	3	3	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
U	63.947 - 63.946 (2.5176 - 2.5176)	3	3	3	3	3	3	3	3	3	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
V	63.946 - 63.945 (2.5176 - 2.5175)	3	3	3	3	3	3	3	3	3	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
W	63.945 - 63.944 (2.5175 - 2.5175)	3	3	3	3	3	3	3	3	3	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
X	63.944 - 63.943 (2.5175 - 2.5174)	34	34	34	4	4	4	4	4	4	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	
Y	63.943 - 63.942 (2.5174 - 2.5174)	34	34	4	4	4	4	4	4	4	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	
1	63.942 - 63.941 (2.5174 - 2.5174)	34	4	4	4	4	4	4	4	4	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	
2	63.941 - 63.940 (2.5174 - 2.5173)	4	4	4	4	4	4	4	4	4	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	

JPBIA2286GB

MAIN BEARING GRADE TABLE (ALL JOURNALS)

Main bearing grade table (All journals) : Refer to EM-149, "Main Bearing".

UNDERSIZE BEARING USAGE GUIDE

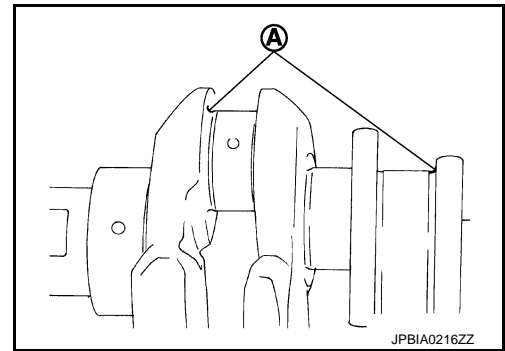
- When the specified main bearing oil clearance is not obtained with standard size main bearings, use under-side (US) bearing.
- When using undersize (US) bearing, measure the main bearing inner diameter with bearing installed, and grind main journal so that the main bearing oil clearance satisfies the standard.

CAUTION:

HOW TO SELECT PISTON AND BEARING

< UNIT DISASSEMBLY AND ASSEMBLY >

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-149, "Main Bearing"](#).

A

EM

C

D

E

F

G

H

I

J

K

L

M

N

O

P

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

SERVICE DATA AND SPECIFICATIONS (SDS)

SERVICE DATA AND SPECIFICATIONS (SDS)

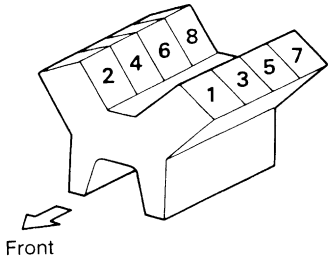
General Specification

INFOID:000000009010647

GENERAL SPECIFICATIONS

Cylinder arrangement	V-8	
Displacement cm ³ (cu in)	5,552 (338.80)	
Bore and stroke mm (in)	98.0 x 92.0 (3.86 x 3.62)	
Valve arrangement	DOHC	
Firing order	1-8-7-3-6-5-4-2	
Number of piston rings	Compression	2
	Oil	1
Number of main bearings	5	
Compression ratio	10.8	
Compression pressure kPa (kg/cm ² , psi)/200 rpm	Standard	1,667 (17, 242)
	Minimum	1,226 (12.5, 178)
	Differential limit between cylinders	98 (1.0, 14)

Cylinder number



SEM957C

Unit: degree

Valve timing	Intake valve open (BTDC)	(-61) - (+ 58)
	Intake valve close (ABDC)	(-76) - (+ 69)
	Exhaust valve open (BBDC)	56
	Exhaust valve close (ATDC)	8

Drive Belts

INFOID:000000009010648

DRIVE BELT

Tension of drive belts	Belt tension is not necessary, as it is automatically adjusted by drive belt auto-tensioner.
------------------------	----------------------------------------------------------------------------------------------

Spark Plug

INFOID:000000009010649

SPARK PLUG

Unit: mm (in)

Make	NGK
Standard type	DILKAR7B11

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

Gap	Standard	1.1 (0.043)
	Limit	1.25 (0.049)

Exhaust Manifold

INFOID:000000009010650

EXHAUST MANIFOLD

Unit: mm (in)

Items		Limit
Surface distortion	Exhaust manifold	0.7 (0.028)

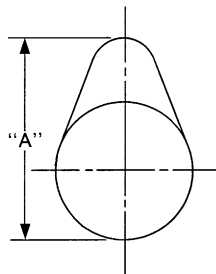
Camshaft

INFOID:000000009010651

EXHAUST CAMSHAFT

Unit: mm (in)

Items	Standard	Limit
Exhaust camshaft journal oil clearance	0.030 - 0.071 (0.0012 - 0.0028)	0.150 (0.0059)
VVEL ladder assembly bracket inner diameter (EXH side)	26.000 - 26.021 (1.0236 - 1.0244)	—
Exhaust camshaft journal diameter	25.935 - 25.955 (1.0211 - 1.0218)	—
Exhaust camshaft end play	0.115 - 0.188 (0.0045 - 0.0074)	0.24 (0.0094)
Exhaust camshaft cam height "A"	45.475 - 45.665 (1.7904 - 1.7978)	45.275 (1.7825)
Exhaust camshaft runout [TIR*]	Less than 0.02 (0.0008)	0.05 (0.002)
Exhaust camshaft sprocket runout [TIR*]	—	0.2 (0.0079)



SEM671

*: Total indicator reading

INTAKE CAMSHAFT

Unit: mm (in)

Items	Standard	Limit
Drive shaft end play	0.115 - 0.188 (0.0045 - 0.0074)	0.24 (0.0094)
Intake camshaft sprocket runout [TIR* ¹]	—	0.15 (0.0059)

*¹: 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

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

Unit: mm (in)

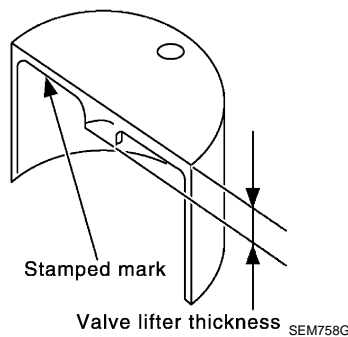
Items	Cold	Hot* (reference data)
Intake	0.26 - 0.34 (0.010 - 0.013)	0.304 - 0.416 (0.012 - 0.016)
Exhaust	0.29 - 0.37 (0.011 - 0.015)	0.308 - 0.432 (0.012 - 0.017)

*: Approximately 80°C (176°F)

AVAILABLE VALVE LIFTER

Unit: mm (in)

Identification (stamped) mark	Thickness
788P	7.88 (0.3102)
790P	7.90 (0.3110)
792P	7.92 (0.3118)
794P	7.94 (0.3126)
796P	7.96 (0.3134)
798P	7.98 (0.3142)
800P	8.00 (0.3150)
802P	8.02 (0.3157)
804P	8.04 (0.3165)
806P	8.06 (0.3173)
808P	8.08 (0.3181)
810P	8.10 (0.3189)
812P	8.12 (0.3197)
814P	8.14 (0.3205)
816P	8.16 (0.3213)
818P	8.18 (0.3220)
820P	8.20 (0.3228)
822P	8.22 (0.3236)
824P	8.24 (0.3244)
826P	8.26 (0.3252)
828P	8.28 (0.3260)
830P	8.30 (0.3268)
832P	8.32 (0.3276)
834P	8.34 (0.3283)
836P	8.36 (0.3291)
838P	8.38 (0.3299)
840P	8.40 (0.3307)



SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

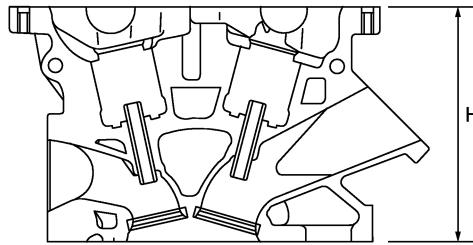
INFOID:000000009010652

Cylinder Head

CYLINDER HEAD

Unit: mm (in)

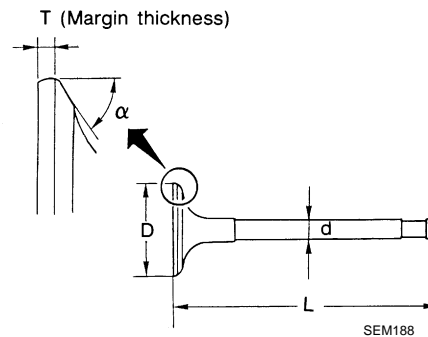
Items	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)
Normal cylinder head height "H"	126.3 (4.97)	—



PBIC0924E

VALVE DIMENSIONS

Unit: mm (in)



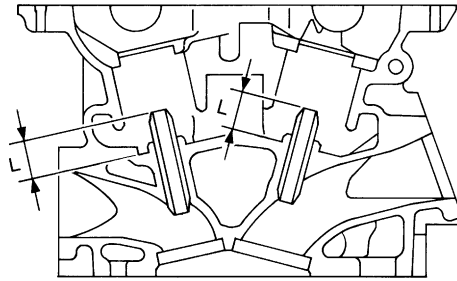
Valve head diameter "D"	Intake	36.6 - 36.9 (1.441 - 1.453)
	Exhaust	31.2 - 31.5 (1.228 - 1.240)
Valve length "L"	Intake	99.19 - 99.69 (3.9051 - 3.9248)
	Exhaust	93.74 - 94.24 (3.6905 - 3.7102)
Valve stem diameter "d"	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.955 - 5.970 (0.2344 - 0.2350)
Valve 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

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

Unit: mm (in)



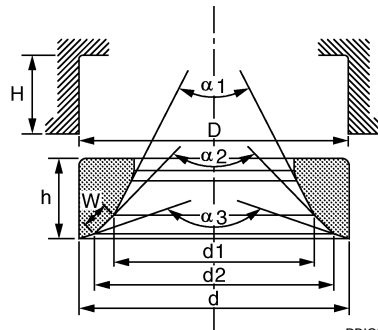
SEM950E

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 (0.003)
	Exhaust	0.030 - 0.063 (0.0012 - 0.0025)	0.09 (0.004)
Projection length "L"	Intake	12.6 - 12.8 (0.496 - 0.504)	
	Exhaust	12.6 - 12.8 (0.496 - 0.504)	

*: Parts settings are for exhaust side only

VALVE SEAT

Unit: mm (in)



PBIC2745E

Items		Standard	Oversize (Service) [0.5 (0.02)] *4
Cylinder head seat recess diameter "D"	Intake	38.000 - 38.016 (1.4961 - 1.4967)	—
	Exhaust	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)*4
Valve seat outer diameter "d"	Intake	38.097 - 38.113 (1.4999 - 1.5005)	—
	Exhaust	32.280 - 32.296 (1.2709 - 1.2715)	32.780 - 32.796 (1.2906 - 1.2912)*4
Valve seat interference fit	Intake	0.081 - 0.113 (0.0032 - 0.0044)	
	Exhaust	0.064 - 0.096 (0.0025 - 0.0038)	
Diameter "d1"*1	Intake	34.6 (1.362)	
	Exhaust	28.7 (1.130)	
Diameter "d2"*2	Intake	35.9 - 36.4 (1.413 - 1.433)	
	Exhaust	30.3 - 30.8 (1.193 - 1.213)	
Angle "alpha 1"		59 - 61°	

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

Angle "α2"		88°75' - 90°25'	
Angle "α3"		119 - 121°	
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)	—
	Exhaust	5.9 - 6.0 (0.232 - 0.236)	4.95 - 5.05 (0.1949 - 0.1988)*4
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

*4: Parts settings are for exhaust side only

VALVE SPRING

Item		Standard	
		Intake	Exhaust
Free height		47.28 mm (1.8614 in)	48.06 mm (1.8921 in)
Pressure	Installation	166 - 188 N (16.9 - 19.2 kg, 37 - 42 lb) at 41.0 mm (1.614 in)	166 - 188 N (16.9 - 19.2 kg, 37 - 42 lb) at 34.45 mm (1.3563 in)
	Valve open	541 - 611 N (55.2 - 62.3 kg, 122 - 137 lb) at 29.6 mm (1.165 in)	320.1 - 360.1 N (32.7 - 36.7 kg, 72 - 81 lb) at 24.65 mm (0.9705 in)
Identification color		Light green	Light blue

Item		Limit	
		Intake	Exhaust
Out-of-square		2.1 mm (0.083 in)	2.0 mm (0.079 in)

Cylinder Block

INFOID:000000009010653

CYLINDER BLOCK

Unit: mm (in)

Surface flatness		Limit		0.1 (0.004)
Main bearing housing inner diameter		Standard		68.944 - 68.968 (2.7143 - 2.7153)
Cylinder bore	Inner diameter	Standard	Grade No. 1	98.000 - 98.010 (3.8583 - 3.8587)
			Grade No. 2	98.010 - 98.020 (3.8587 - 3.8590)
			Grade No. 3	98.020 - 98.030 (3.8590 - 3.8594)
		Wear limit		0.2 (0.008)
Out-of-round		Limit		0.015 (0.0006)
Taper				0.010 (0.0004)

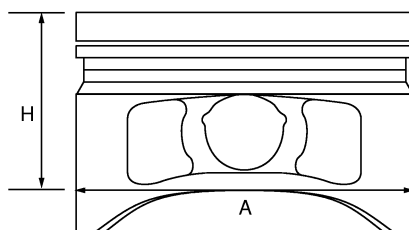
SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

Main bearing housing inner diameter grade (Without bearing)	Grade No. A	68.944 - 68.945 (2.7143 - 2.7144)
	Grade No. B	68.945 - 68.946 (2.7144 - 2.7144)
	Grade No. C	68.946 - 68.947 (2.7144 - 2.7144)
	Grade No. D	68.947 - 68.948 (2.7144 - 2.7145)
	Grade No. E	68.948 - 68.949 (2.7145 - 2.7145)
	Grade No. F	68.949 - 68.950 (2.7145 - 2.7146)
	Grade No. G	68.950 - 68.951 (2.7146 - 2.7146)
	Grade No. H	68.951 - 68.952 (2.7146 - 2.7146)
	Grade No. J	68.952 - 68.953 (2.7146 - 2.7147)
	Grade No. K	68.953 - 68.954 (2.7147 - 2.7147)
	Grade No. L	68.954 - 68.955 (2.7147 - 2.7148)
	Grade No. M	68.955 - 68.956 (2.7148 - 2.7148)
	Grade No. N	68.956 - 68.957 (2.7148 - 2.7148)
	Grade No. P	68.957 - 68.958 (2.7148 - 2.7149)
	Grade No. R	68.958 - 68.959 (2.7149 - 2.7149)
	Grade No. S	68.959 - 68.960 (2.7149 - 2.7150)
	Grade No. T	68.960 - 68.961 (2.7150 - 2.7150)
	Grade No. U	68.961 - 68.962 (2.7150 - 2.7150)
	Grade No. V	68.962 - 68.963 (2.7150 - 2.7151)
Grade No. W	68.963 - 68.964 (2.7151 - 2.7151)	
Grade No. X	68.964 - 68.965 (2.7151 - 2.7152)	
Grade No. Y	68.965 - 68.966 (2.7152 - 2.7152)	
Grade No. 4	68.966 - 68.967 (2.7152 - 2.7152)	
Grade No. 7	68.967 - 68.968 (2.7152 - 2.7153)	
Difference in inner diameter between cylinders	Standard	Less than 0.03 (0.0012)

AVAILABLE PISTON

Unit: mm (in)



PBIC0188E

Items		Standard	Oversize (Service) [0.2 (0.008)]
Piston skirt diameter "A"	Grade No. 1	97.980 - 97.990 (3.8575 - 3.8579)	—
	Grade No. 2	97.990 - 98.000 (3.8579 - 3.8583)	—
	Grade No. 3	98.000 - 98.010 (3.8583 - 3.8587)	—
	Service	—	98.190 - 98.200 (3.8657 - 3.8661)
Items		Standard	Limit
"H" dimension		40.0 (1.5748)	—
Piston pin hole diameter		21.993 - 21.999 (0.8659 - 0.8661)	—
Piston to cylinder bore clearance		0.010 - 0.030 (0.0004 - 0.0012)	0.08 (0.0031)

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	0.015 - 0.185 (0.0006 - 0.00728)	0.22 (0.0087)

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

End gap	Top	0.23 - 0.28 (0.0091 - 0.0110)	0.50 (0.0197)
	2nd	0.50 - 0.65 (0.0197 - 0.0256)	0.84 (0.0331)
	Oil (rail ring)	0.20 - 0.60 (0.0079 - 0.0236)	0.95 (0.0374)

PISTON PIN

Unit: mm (in)

Items	Standard	Limit
Piston pin outer diameter	21.989 - 21.995 (0.8657 - 0.8659)	—
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	154.45 - 154.55 (6.08 - 6.08)	—
Bend [per 100 (3.94)]	—	0.15 (0.0059)
Torsion [per 100 (3.94)]	—	0.30 (0.0118)
Connecting rod bushing inner diameter*	22.000 - 22.006 (0.8661 - 0.8664)	—
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)	
Side clearance	0.20 - 0.40 (0.0079 - 0.0158)	0.40 (0.0157)

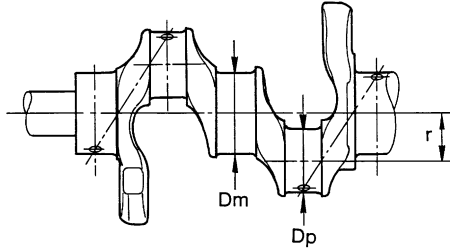
*: After installing in connecting rod

CRANKSHAFT

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

Unit: mm (in)



SEM645

Main journal diameter. "Dm" grade (No. 1 and 5 journal)	Standard	Grade No. G	63.964 - 63.963 (2.5183 - 2.5182)
		Grade No. H	63.963 - 63.962 (2.5182 - 2.5182)
		Grade No. J	63.962 - 63.961 (2.5182 - 2.5181)
		Grade No. K	63.961 - 63.960 (2.5181 - 2.5181)
		Grade No. L	63.960 - 63.959 (2.5181 - 2.5181)
		Grade No. M	63.959 - 63.958 (2.5181 - 2.5180)
		Grade No. N	63.958 - 63.957 (2.5180 - 2.5180)
		Grade No. P	63.957 - 63.956 (2.5180 - 2.5179)
		Grade No. R	63.956 - 63.955 (2.5179 - 2.5179)
		Grade No. S	63.955 - 63.954 (2.5179 - 2.5179)
		Grade No. T	63.954 - 63.953 (2.5179 - 2.5178)
		Grade No. U	63.953 - 63.952 (2.5178 - 2.5178)
		Grade No. V	63.952 - 63.951 (2.5178 - 2.5178)
		Grade No. W	63.951 - 63.950 (2.5178 - 2.5177)
		Grade No. X	63.950 - 63.949 (2.5177 - 2.5177)
		Grade No. Y	63.949 - 63.948 (2.5177 - 2.5176)
		Grade No. 1	63.948 - 63.947 (2.5176 - 2.5176)
		Grade No. 2	63.947 - 63.946 (2.5176 - 2.5176)
		Grade No. 3	63.946 - 63.945 (2.5176 - 2.5175)
		Grade No. 4	63.945 - 63.944 (2.5175 - 2.5175)
Grade No. 5	63.944 - 63.943 (2.5175 - 2.5174)		
Grade No. 6	63.943 - 63.942 (2.5174 - 2.5174)		
Grade No. 7	63.942 - 63.941 (2.5174 - 2.5174)		
Grade No. 9	63.941 - 63.940 (2.5174 - 2.5173)		
Main journal diameter. "Dm" grade (No. 2, 3 and 4 journal)	Standard	Grade No. A	63.963 - 63.964 (2.5182 - 2.5183)
		Grade No. B	63.962 - 63.963 (2.5182 - 2.5182)
		Grade No. C	63.961 - 63.962 (2.5181 - 2.5182)
		Grade No. D	63.960 - 63.961 (2.5181 - 2.5181)
		Grade No. E	63.959 - 63.960 (2.5181 - 2.5181)
		Grade No. F	63.958 - 63.959 (2.5180 - 2.5181)
		Grade No. G	63.957 - 63.958 (2.5180 - 2.5180)
		Grade No. H	63.956 - 63.957 (2.5179 - 2.5180)
		Grade No. J	63.955 - 63.956 (2.5179 - 2.5179)
		Grade No. K	63.954 - 63.955 (2.5179 - 2.5179)
		Grade No. L	63.953 - 63.954 (2.5178 - 2.5179)
		Grade No. M	63.952 - 63.953 (2.5178 - 2.5178)
		Grade No. N	63.951 - 63.952 (2.5178 - 2.5178)
		Grade No. P	63.950 - 63.951 (2.5177 - 2.5178)
		Grade No. R	63.949 - 63.950 (2.5177 - 2.5177)
		Grade No. S	63.948 - 63.949 (2.5176 - 2.5177)
		Grade No. T	63.947 - 63.948 (2.5176 - 2.5176)
		Grade No. U	63.946 - 63.947 (2.5176 - 2.5176)
		Grade No. V	63.945 - 63.946 (2.5175 - 2.5176)
		Grade No. W	63.944 - 63.945 (2.5175 - 2.5175)
		Grade No. X	63.943 - 63.944 (2.5174 - 2.5175)
		Grade No. Y	63.942 - 63.943 (2.5174 - 2.5174)
Grade No. 1	63.941 - 63.942 (2.5174 - 2.5174)		
Grade No. 2	63.940 - 63.941 (2.5173 - 2.5174)		
Pin journal diameter. "Dp" grade	Standard	Grade No. 0	53.968 - 53.974 (2.1247 - 2.1250)
		Grade No. 1	53.962 - 53.968 (2.1245 - 2.1247)
		Grade No. 2	53.956 - 53.962 (2.1243 - 2.1245)

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

Center distance "r"		45.96 - 46.04 (1.8095 - 1.8126)
Taper	Limit	0.0025 (0.0001)
Out-of-round		0.0025 (0.0001)
Crankshaft runout [TIR*]	Standard	Less than 0.05 (0.002)
	Limit	0.10 (0.0039)
Crankshaft end play	Standard	0.10 - 0.26 (0.0039 - 0.0102)
	Limit	0.30 (0.012)

*: Total indicator reading

Main Bearing

INFOID:000000009010654

MAIN BEARING

Grade number	Thickness mm (in)	Width mm (in)	Identification color	Remarks	
0	2.483 - 2.486 (0.0978 - 0.0979)	19.9 - 20.1 (0.783 - 0.791)	Black	Grade is the same for upper and lower bearings.	
1	2.486 - 2.489 (0.0979 - 0.0980)		Brown		
2	2.489 - 2.492 (0.0980 - 0.0981)		Green		
3	2.492 - 2.495 (0.0981 - 0.0982)		Yellow		
4	2.495 - 2.498 (0.0982 - 0.0983)		Blue		
5	2.498 - 2.501 (0.0983 - 0.0985)		Pink		
6	2.501 - 2.504 (0.0985 - 0.0986)		Purple		
7	2.504 - 2.507 (0.0986 - 0.0987)		White		
8	2.507 - 2.510 (0.0987 - 0.0988)		Red		
01	UPR		2.483 - 2.486 (0.0978 - 0.0979)	Black	Grade and color are different for upper and lower bearings.
	LWR		2.486 - 2.489 (0.0979 - 0.0980)	Brown	
12	UPR		2.486 - 2.489 (0.0979 - 0.0980)	Brown	
	LWR		2.489 - 2.492 (0.0980 - 0.0981)	Green	
23	UPR		2.489 - 2.492 (0.0980 - 0.0981)	Green	
	LWR		2.492 - 2.495 (0.0981 - 0.0982)	Yellow	
34	UPR		2.492 - 2.495 (0.0981 - 0.0982)	Yellow	
	LWR	2.495 - 2.498 (0.0982 - 0.0983)	Blue		
45	UPR	2.495 - 2.498 (0.0982 - 0.0983)	Blue		
	LWR	2.498 - 2.501 (0.0983 - 0.0985)	Pink		
56	UPR	2.498 - 2.501 (0.0983 - 0.0985)	Pink		
	LWR	2.501 - 2.504 (0.0985 - 0.0986)	Purple		
67	UPR	2.501 - 2.504 (0.0985 - 0.0986)	Purple		
	LWR	2.504 - 2.507 (0.0986 - 0.0987)	White		
78	UPR	2.504 - 2.507 (0.0986 - 0.0987)	White		
	LWR	2.507 - 2.510 (0.0987 - 0.0988)	Red		

UNDERSIZE

Unit: mm (in)

Items	Thickness	Main journal diameter
0.25 (0.0098)	2.618 - 2.626 (0.1031 - 0.1034)	Grind so that bearing clearance is the specified value.

MAIN BEARING OIL CLEARANCE

SERVICE DATA AND SPECIFICATIONS (SDS)

< SERVICE DATA AND SPECIFICATIONS (SDS)

Unit: mm (in)

Items	Standard	Limit
Main bearing oil clearance	No.1 and 5 0.001 - 0.011 (0.00004 - 0.00043)*	0.065 (0.0026)
	No.2, 3 and 4 0.007 - 0.017 (0.0003 - 0.0007)*	

*: Actual clearance

Connecting Rod Bearing

INFOID:000000009010655

CONNECTING ROD BEARING

Grade number	Thickness mm (in)	Width mm (in)	Identification color (mark)
1	1.500 - 1.503 (0.0591 - 0.0592)	18.1 - 18.3 (0.713 - 0.720)	Black
2	1.503 - 1.506 (0.0592 - 0.0593)		Brown
3	1.506 - 1.509 (0.0593 - 0.0594)		Green
4	1.509 - 1.512 (0.0594 - 0.0595)		Yellow

UNDERSIZE

Unit: mm (in)

Items	Thickness	Pin journal diameter
0.25 (0.0098)	1.627 - 1.635 (0.0641 - 0.0644)	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	0.020 - 0.039 (0.0008 - 0.0015)*	0.070 (0.0028)

*: Actual clearance