SECTION EM
ENGINE MECHANICAL

CONTENTS

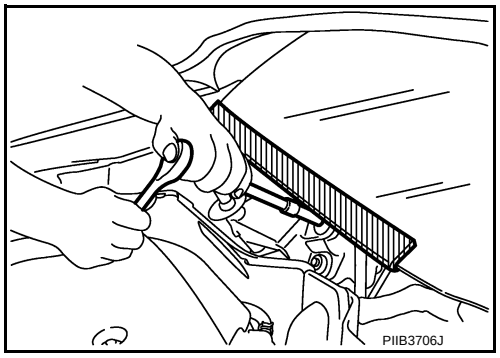
PRECAUTION

PRECAUTIONS

Precaution for Procedure without Cowl Top Cover

INFOID:0000000006289506

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



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

INFOID:0000000006417202

The Supplemental Restraint System such as “AIR BAG” and “SEAT BELT PRE-TENSIONER”, used along with a front seat belt, helps to reduce the risk or severity of injury to the driver and front passenger for certain types of collision. This system includes seat belt switch inputs and dual stage front air bag modules. The SRS system uses the seat belt switches to determine the front air bag deployment, and may only deploy one front air bag, depending on the severity of a collision and whether the front occupants are belted or unbelted.
Information necessary to service the system safely is included in the “SRS AIR BAG” and “SEAT BELT” of this Service Manual.

WARNING:

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

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

WARNING:

- **When working near the Air Bag Diagnosis Sensor Unit or other Air Bag System sensors with the ignition ON or engine running, DO NOT use air or electric power tools or strike near the sensor(s) with a hammer. Heavy vibration could activate the sensor(s) and deploy the air bag(s), possibly causing serious injury.**
- **When using air or electric power tools or hammers, always switch the ignition OFF, disconnect the battery, and wait at least 3 minutes before performing any service.**

Precaution Necessary for Steering Wheel Rotation after Battery Disconnect

INFOID:0000000006289508

NOTE:

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

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

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

OPERATION PROCEDURE

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

Precaution for Drain Engine Coolant and Engine Oil

INFOID:0000000006289509

Drain engine coolant and engine oil when engine is cooled.

Precaution for Disconnecting Fuel Piping

INFOID:0000000006289510

- 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.

Precaution for Handling High Pressure Fuel System

INFOID:0000000006289511

- 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.

Precaution for Removal and Disassembly

INFOID:0000000006289512

- When instructed to use SST, use specified tools. Always be careful to work safely, avoid forceful or uninstructed operations.
- Exercise maximum care to avoid damage to mating or sliding surfaces.
- Cover openings of engine system with tape or the equivalent, if necessary, to seal out foreign materials.
- Mark and arrange disassembly parts in an organized way for easy troubleshooting and assembly.
- When loosening nuts and bolts, as a basic rule, start with the one furthest outside, then the one diagonally opposite, and so on. If the order of loosening is specified, do exactly as specified. Power tools may be used where noted in the step.

Precaution for Inspection, Repair and Replacement

INFOID:0000000006289513

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

Precaution for Assembly and Installation

INFOID:0000000006289514

- 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.
- 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.

- Avoid damaging sliding or mating surfaces. Completely remove foreign materials such as cloth lint or dust. Before assembly, oil sliding surfaces well.
- Release air within route when refilling after draining engine coolant.
- After repairing, start engine and increase engine speed to check engine coolant, fuel, engine oil, and exhaust gases for leakage.

Parts Requiring Angle Tightening

INFOID:0000000006289515

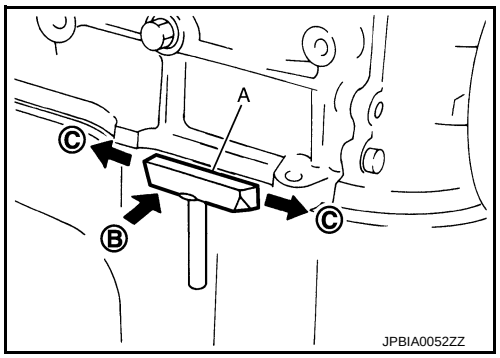
- Use angle wrench [SST: KV10112100 (BT8653-A)] for the final tightening of the following engine parts:
- Cylinder head bolts
- Main bearing cap bolts
- Main bearing cap sub bolts
- Connecting rod cap bolts
- Crankshaft pulley bolt (No angle wrench is required as the bolt flange is provided with notches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

Precaution for Liquid Gasket

INFOID:0000000006289516

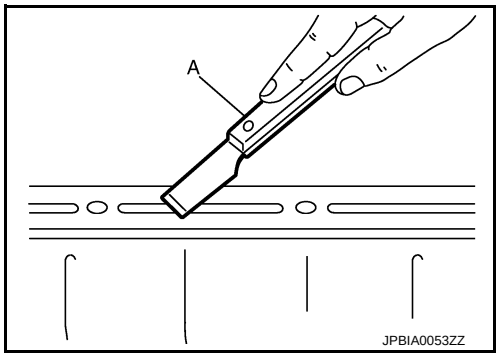
REMOVAL OF LIQUID GASKET SEALING

- 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.

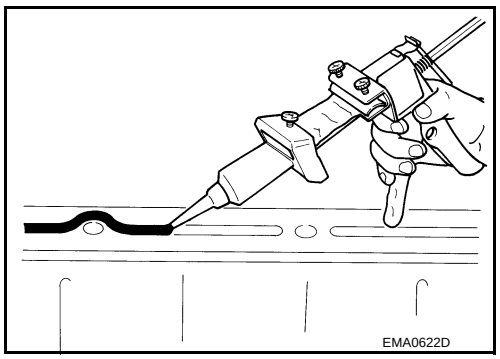


LIQUID GASKET APPLICATION PROCEDURE

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.



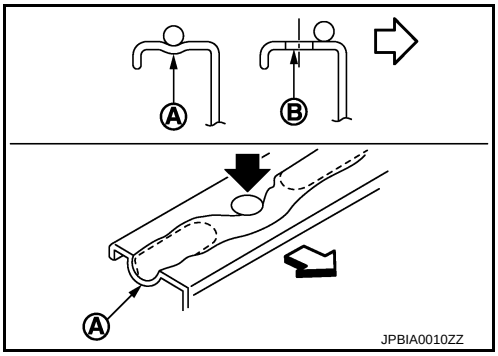
3. Attach liquid gasket tube to the tube presser (commercial service tool).
   Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".
4. Apply liquid gasket without gaps to the specified location according to the specified dimensions.
   - If there 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.

Definitions of Bank Names

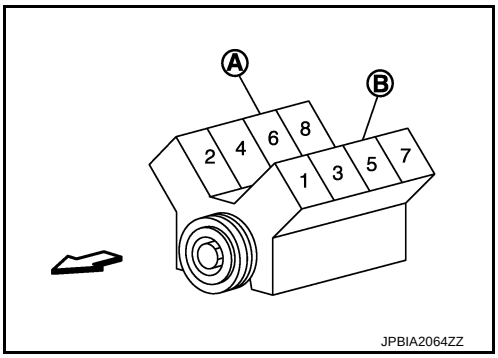
INFOID:0000000006289517

- 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)

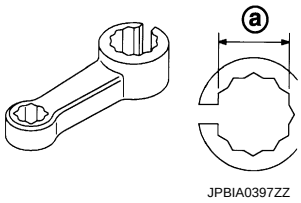
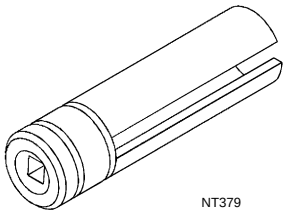
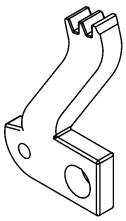
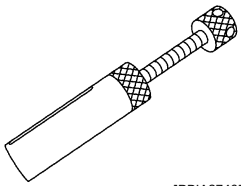
PREPARATION

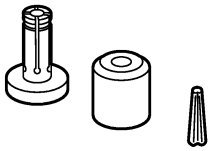
PREPARATION

Special Service Tool

INFOID:0000000006289518

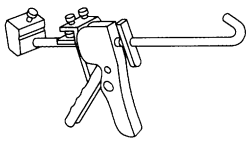
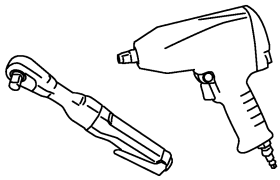
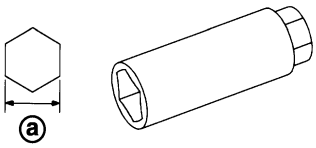
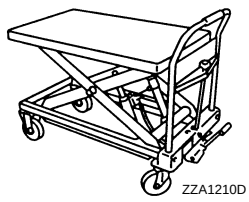
Tool number (Kent-Moore No.) Tool name	Description
KV10116200 (J-26336-A) Valve spring compressor 1. KV10115900 (J-26336-20) Attachment 2. KV10109220 (—) Adapter	Disassembling valve mechanism Part (1) is a component of KV10116200 (J26336-A), but part (2) is not so.
KV10107902 (J-38959) Valve oil seal puller	Removing valve oil seal
KV10115600 (J-38958) Valve oil seal drift	Installing valve oil seal **Use side A (G)** **a: 20 (0.79) dia.** **d: 8 (0.31) dia.** **b: 13 (0.51) dia.** **e: 10.7 (0.421)** **c: 10.3 (0.406) dia.** **f: 5 (0.20)** **H: Side B** Unit: mm (in)
EM03470000 (J-8037) Piston ring compressor	Installing piston assembly into cylinder bore
KV10111100 (J-37228) Seal cutter	Removing steel oil pan and front cover
KV10112100 (BT8653-A) Angle wrench	Tightening bolts for bearing cap, cylinder head, etc.

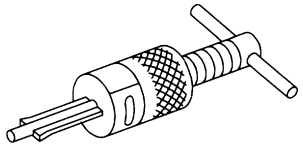
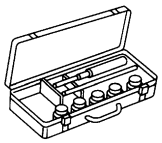
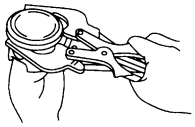
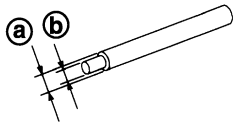
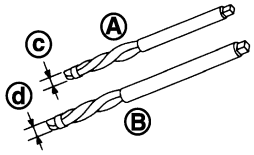
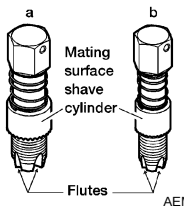
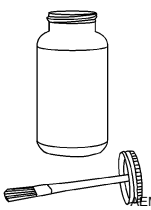
Tool number (Kent-Moore No.) Tool name	Description
KV10114400 (J-38365) Heated oxygen sensor wrench  JPBIA0397ZZ	Loosening or tightening heated oxygen sensor 2 **a: 22 mm (0.87 in)**
KV10117100 (J-44626) Heated oxygen sensor wrench  NT379	Loosening or tightening air fuel ratio sensor 1 **a: 22 mm (0.87 in)**
KV10120100 (J-47245) Ring gear stopper  LBIA0451E	Removing and installing crankshaft pulley
— (J-45488) Quick connector release  PBIC0198E	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  JPBIA2623ZZ	Tightening rocker cover mounting bolts. (specified torque)
KV10119600 (—) Injector remover  JPBIA3746ZZ	Removing fuel injector

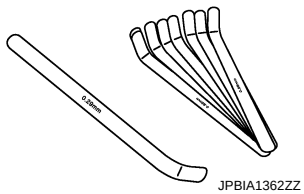
Tool number (Kent-Moore No.) Tool name	Description
KV101197S0 (—) Injector seal drift set  JPBIA3281ZZ	Installing fuel injector seal ring
EG15050500 (J-45402) Compression gauge adapter  ZZA1225D	Checking compresion pressure

Commercial Service Tool

INFOID:0000000006289519

(Kent-Moore No.) Tool name	Description
(—) Tube presser  S-NT052	Pressing the tube of liquid gasket
(—) Power tool  PBIC0190E	Loosening nuts and bolts
(—) Spark plug wrench  JPBIA0399ZZ	Removing and installing spark plug **a: 14 mm (0.55 in)**
(—) Manual lift table caddy  ZZA1210D	Removing and installing engine

(Kent-Moore No.) Tool name	Description
(—) Pilot bushing puller  NT045	Removing pilot converter
(—) Valve seat cutter set  S-NT048	Finishing valve seat (EXH) dimensions
(—) Piston ring expander  S-NT030	Removing and installing piston ring
(—) Valve guide drift  JPBIA0400ZZ	Removing and installing valve guide (EXH) **a: 9.5 mm (0.374 in) dia.** **b: 5.5 mm (0.217 in) dia.**
(—) Valve guide reamer  JPBIA0401ZZ	(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.**
(J-43897-18) (J-43897-12) Oxygen sensor thread cleaner  AEM488	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**
(—) Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907)  AEM489	Lubricating oxygen sensor thread cleaning tool when reconditioning exhaust system threads

(Kent-Moore No.) Tool name	Description
(—) Feeler gauge  JPBIA1362ZZ	Inspection valve clearance (use a curved-tip gauge)
(—) Compression gauge with flexible type adapter	Checking compression pressure

BASIC INSPECTION

CAMSHAFT VALVE CLEARANCE

Inspection

INFOID:0000000006289520

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.

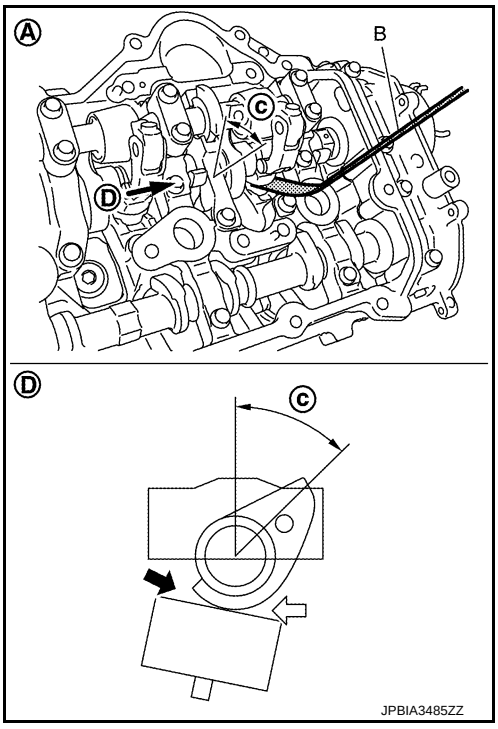
1. Remove VVEL actuator motor assembly. Refer to EM-36, "Removal and Installation".
2. Remove rocker covers (bank 1 and bank 2). Refer to EM-33, "Removal and Installation".
3. Remove VVEL actuator housing assembly. Refer to EM-36, "Removal and Installation".
4. Measure the valve clearance as per the 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-133, "Camshaft".

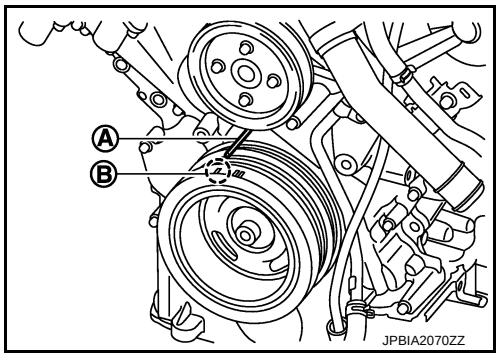
NOTE:
Be sure to note the following points when measuring valve clearance on the intake side.
- Before measuring, check that the position of drive shaft nose is within the angle shown in the figure.

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.



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).

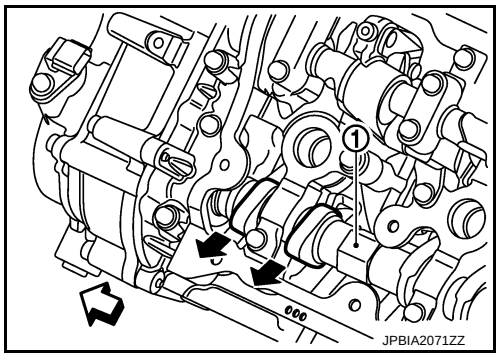


- Check that exhaust cam nose on No. 1 cylinder (engine front side of bank 1) is located as shown in the figure.

  1 : Exhaust camshaft (bank 1)

  ⇦ : Engine front

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

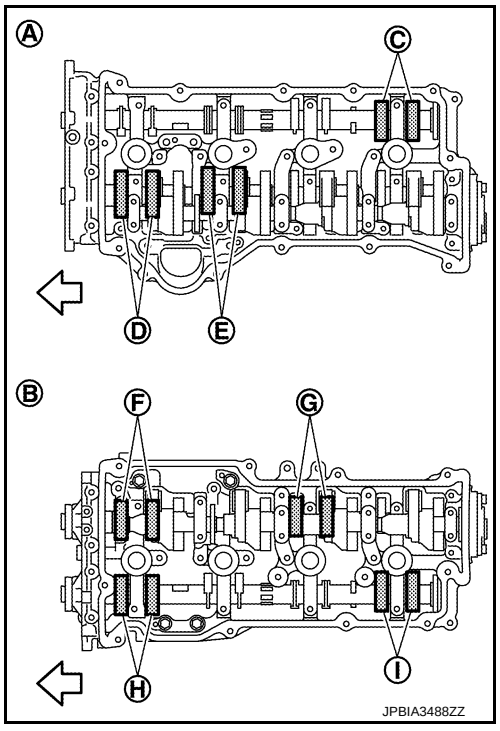


- By referring to the figure, measure the valve clearances at locations marked "×" as shown in the table below (locations indicated in the figure).

  ⇦ : Engine front

- No. 1 cylinder at compression TDC

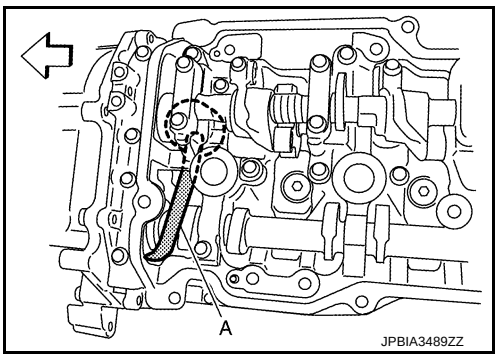
Measuring position [bank 2 (A)]		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.	No. 8 CYL.
No. 1 cylinder at compression TDC	EXH				× (C)
	INT	× (D)	× (E)		
Measuring position [bank 1 (B)]		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.	No. 7 CYL.
No. 1 cylinder at compression TDC	INT	× (F)		× (G)	
	EXH	× (H)			× (I)



NOTE:

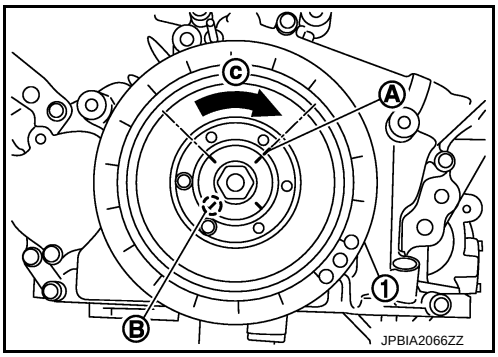
To measure valve clearance of No. 1 cylinder INT valve (front side), insert feeler gauge (A) (commercial service tool) as shown in the figure.

⇦ : 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.

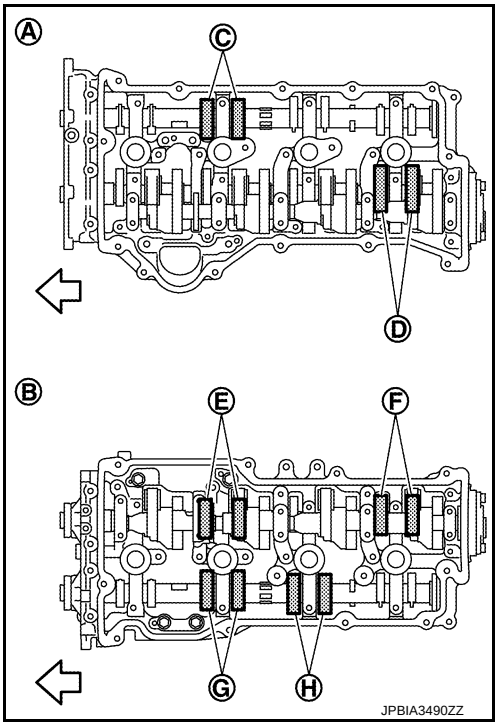
A : Paint mark



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

⇦ : Engine front

- No. 3 cylinder at compression TDC

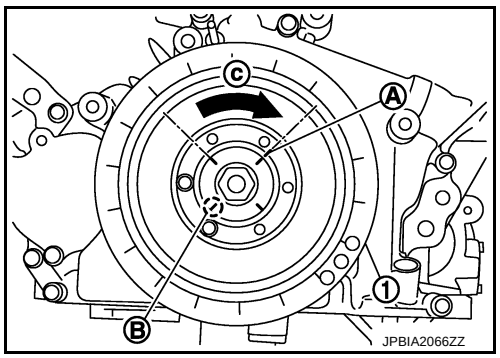


Measuring position [bank 2 (A)]		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.	No. 8 CYL.
No. 3 cylinder at compression TDC	EXH		× (C)		
	INT				× (D)
Measuring position [bank 1 (B)]		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.	No. 7 CYL.
No. 3 cylinder at compression TDC	INT		× (E)		× (F)
	EXH		× (G)	× (H)	

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

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

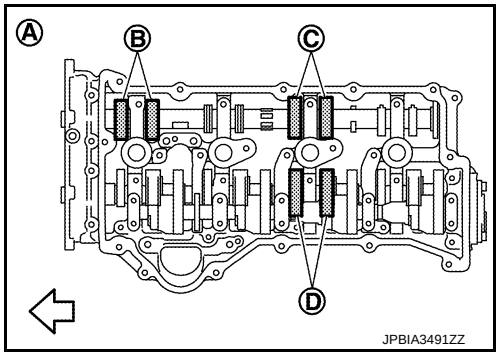
A : Paint mark



- By referring to the figure, measure the valve clearances at locations marked "×" 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)	

5. 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-77, "Inspection".
   - If a valve clearance on the intake side is out of specification, replace VVEL ladder assembly & cylinder head assembly. Refer to EM-86, "Exploded View".

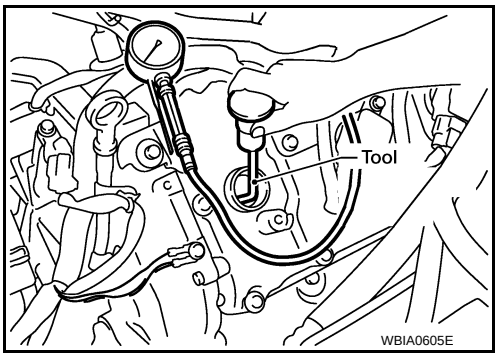
   CAUTION:
   Never adjust valve clearance on the intake side.
   NOTE:
   Since the valve lifter (INT) cannot be replaced by the piece, VVEL ladder assembly & cylinder head assembly replacement are required.

COMPRESSION PRESSURE

Inspection

INFOID:0000000006289521

1. Warm up engine thoroughly. Then, stop it.
2. Release fuel pressure. Refer to EC-153, "Work Procedure".
   CAUTION:
   If CONSULT-III 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 EC-114, "Wiring Diagram".
   - For the fuse arrangement, refer to PG-143, "Fuse, Connector and Terminal Arrangement".
4. Remove engine cover. Refer to EM-25, "Exploded View".
5. Remove ignition coil and spark plug from each cylinder. Refer to EM-29, "Exploded View".
6. Connect engine tachometer (not required in use of CONSULT-III).
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-132, "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 changed 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-159, "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.
  - 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-107, "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-107, "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-87, "Removal and Installation".

10. After inspection is completed, install removed parts.
11. Start the engine, and check that the engine runs smoothly.

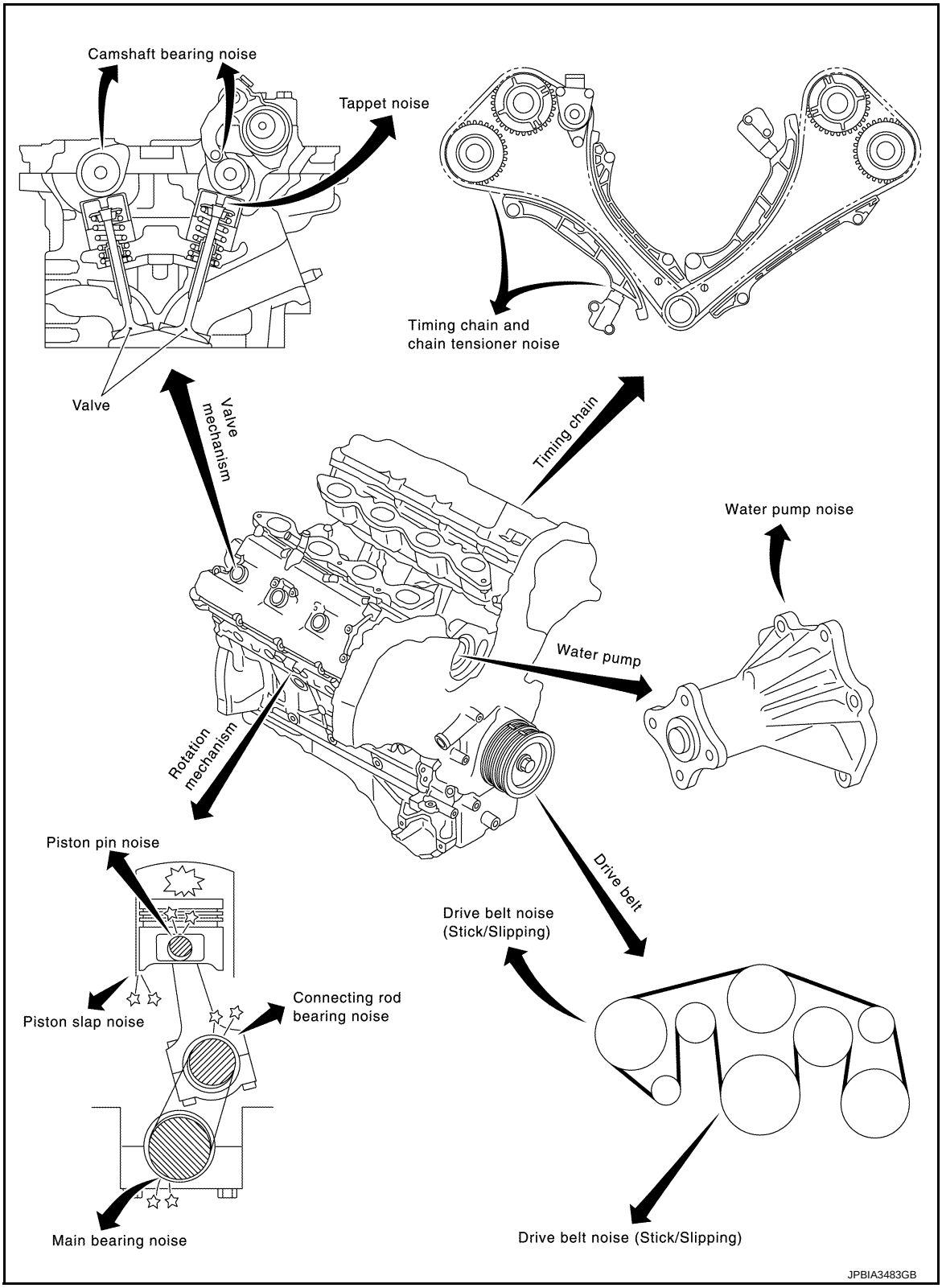
12. Perform trouble diagnosis. If DTC appears, erase it. Refer to EC-161, "Description".

SYMPTOM DIAGNOSIS

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

NVH Troubleshooting - Engine Noise

INFOID:0000000006289522



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

INFOID:0000000006289523

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-77
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-115
	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-115
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing oil clearance	EM-115
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-115
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-72
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-19

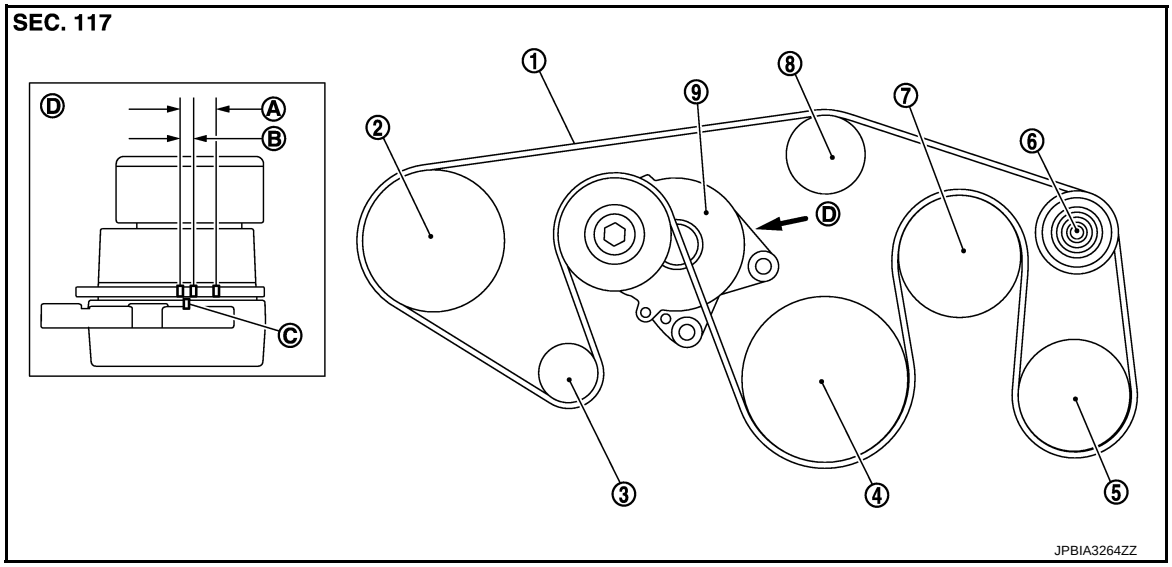
A: Closely related B: Related C: Sometimes related —: Not related

PERIODIC MAINTENANCE

DRIVE BELTS

Exploded View

INFOID:0000000006289524



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:0000000006289525

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:0000000006289526

Refer to EM-132, "Drive Belts".

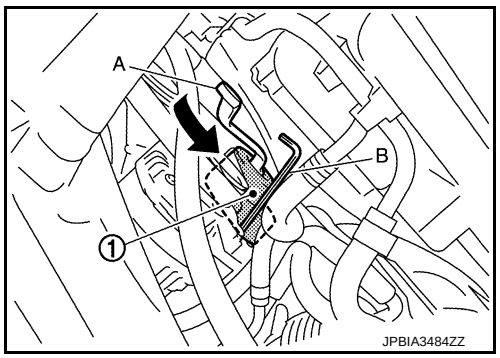
Removal and Installation

INFOID:0000000006289527

REMOVAL

1. Move reservoir tank to the position without the hindrance for work. Refer to CO-13, "Exploded View".

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:0000000006289528

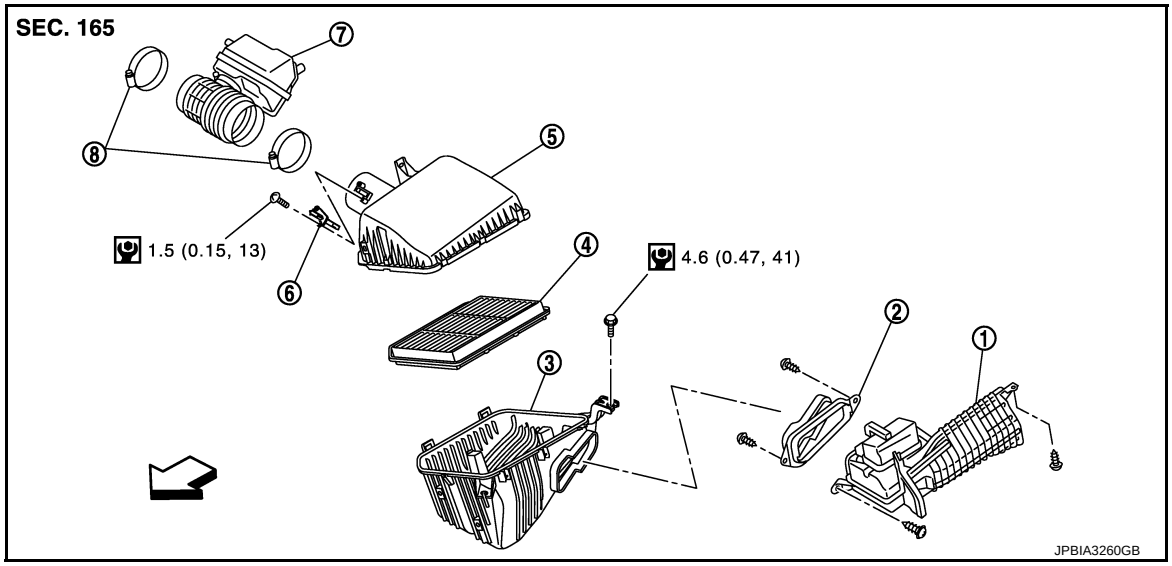
INSPECTION AFTER INSTALLATION

- 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

Exploded View

INFOID:0000000006289529



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:0000000006289530

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 MA-6, "Introduction of Periodic Maintenance".

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

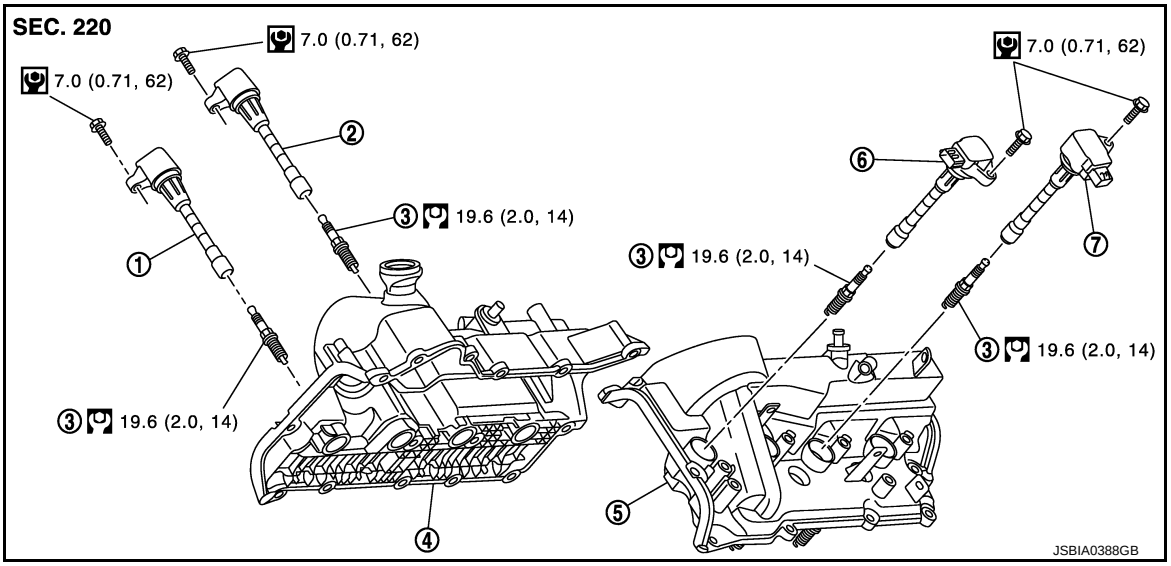
INSTALLATION

Install is the reverse order of removal.

SPARK PLUG

Exploded View

INFOID:0000000006289531



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.

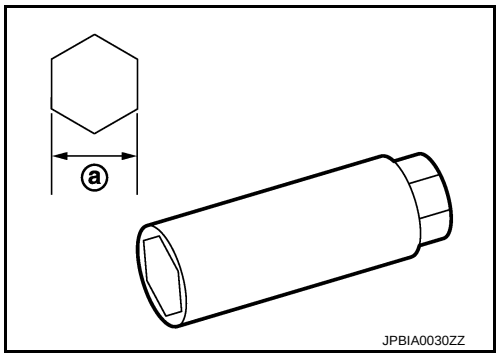
Removal and Installation

INFOID:0000000006289532

REMOVAL

1. Remove engine cover. Refer to EM-25, "Exploded View".
2. Remove ignition coil. Refer to EM-29, "Exploded View".
3. Remove spark plug with a spark plug wrench (commercial service tool).

a : 14 mm (0.55 in)



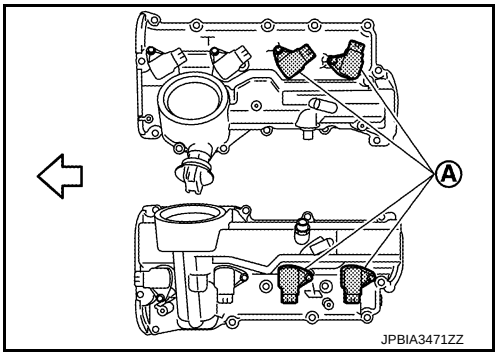
INSTALLATION

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

CAUTION:

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

⇦ : Engine front



Inspection

INFOID:0000000006289533

INSPECTION AFTER REMOVAL

Use the standard type spark plug for normal condition.

Spark plug (Standard type) : Refer to EM-132, "Spark Plug".

CAUTION:

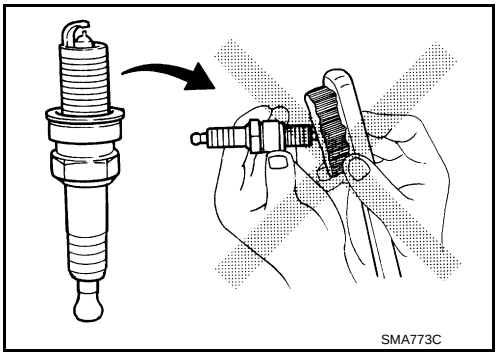
- **Never drop or impact spark plug.**
- **Never use a wire brush for cleaning.**
- **If plug tip is covered with carbon, use spark plug cleaner to clean.**

Cleaner air pressure

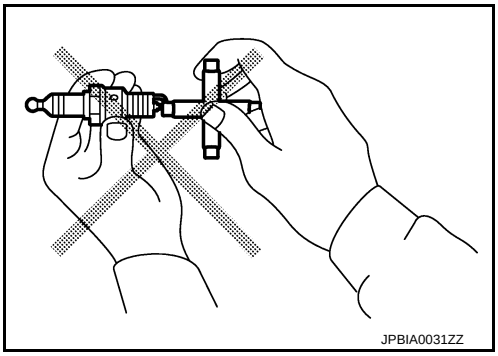
: Less than 588 kPa (5.9 bar, 6 kg/cm^2, 85 psi)

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-132, "Spark Plug".**
- **Spark plug gap adjustment is not required between replacement intervals.**

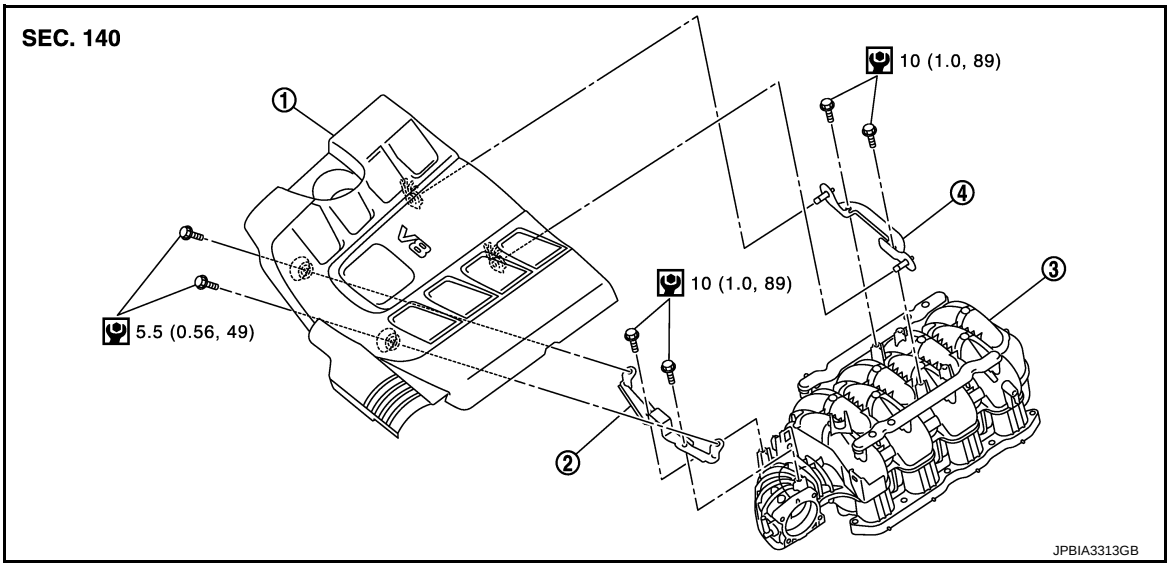


REMOVAL AND INSTALLATION

ENGINE COVER

Exploded View

INFOID:0000000006289534



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:0000000006289535

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).

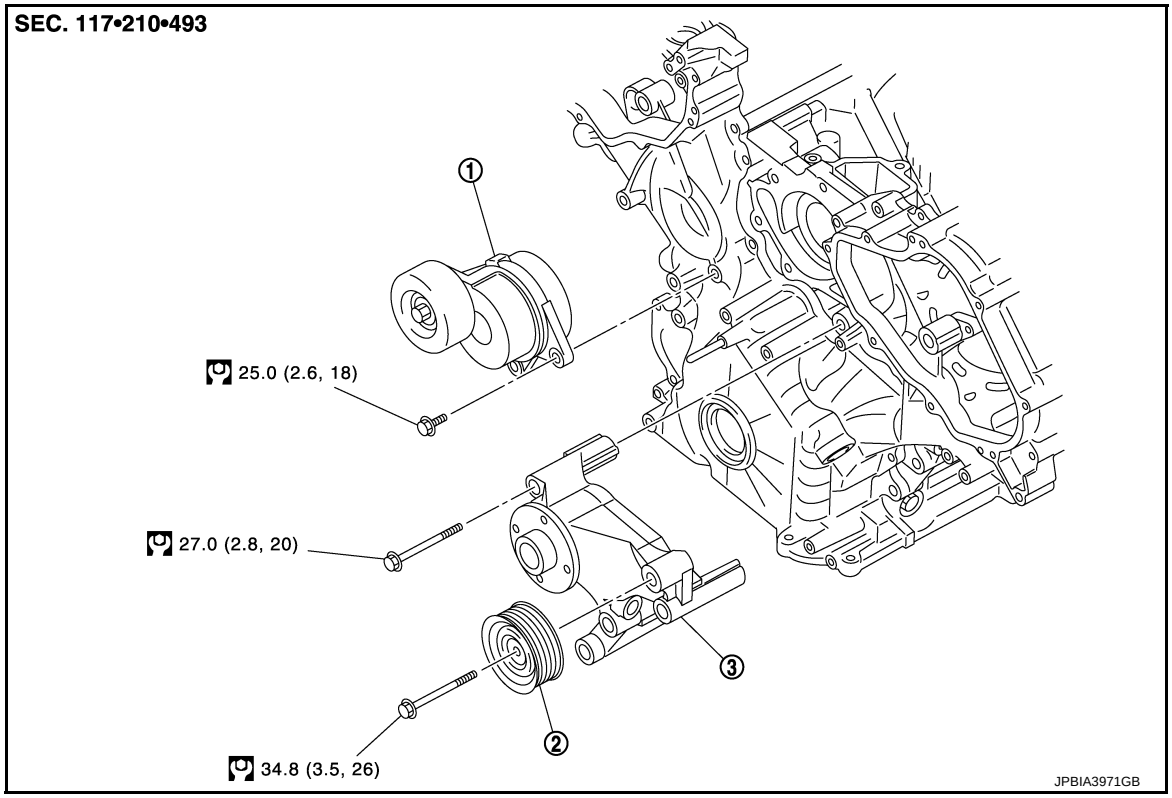
INSTALLATION

Installation is the reverse order of removal.

DRIVE BELT AUTO TENSIONER AND IDLER PULLEY

Exploded View

INFOID:0000000006289536



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:0000000006289537

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.

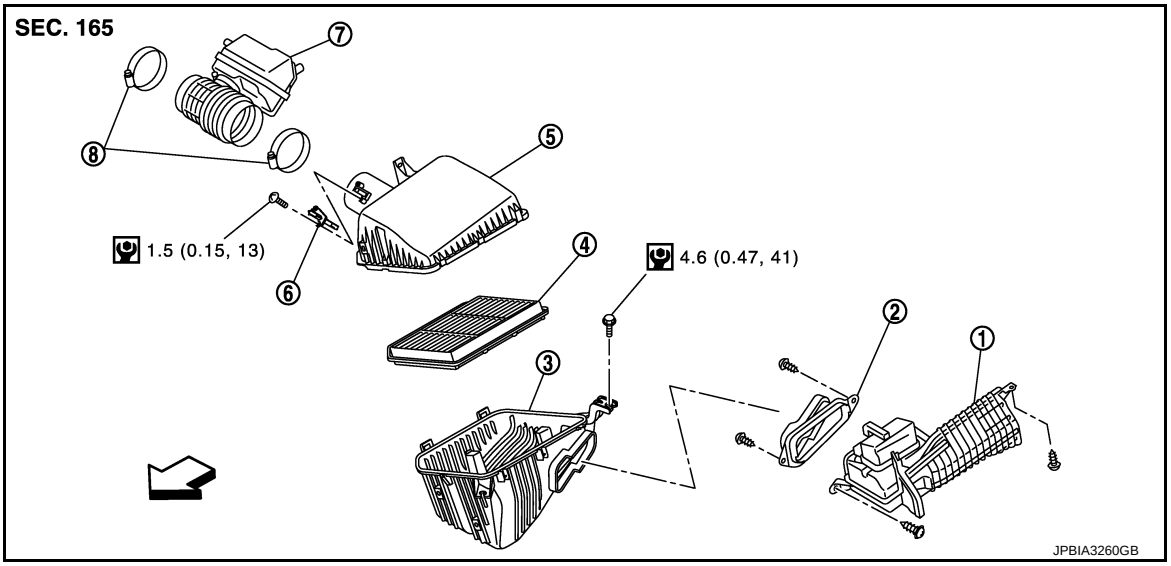
CAUTION:

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

AIR CLEANER AND AIR DUCT

Exploded View

INFOID:0000000006289538



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:0000000006289539

REMOVAL

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

1. Remove engine cover. Refer to EM-25, "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-23, "FENDER PROTECTOR : Exploded View".
c. Remove resonator.

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:0000000006289540

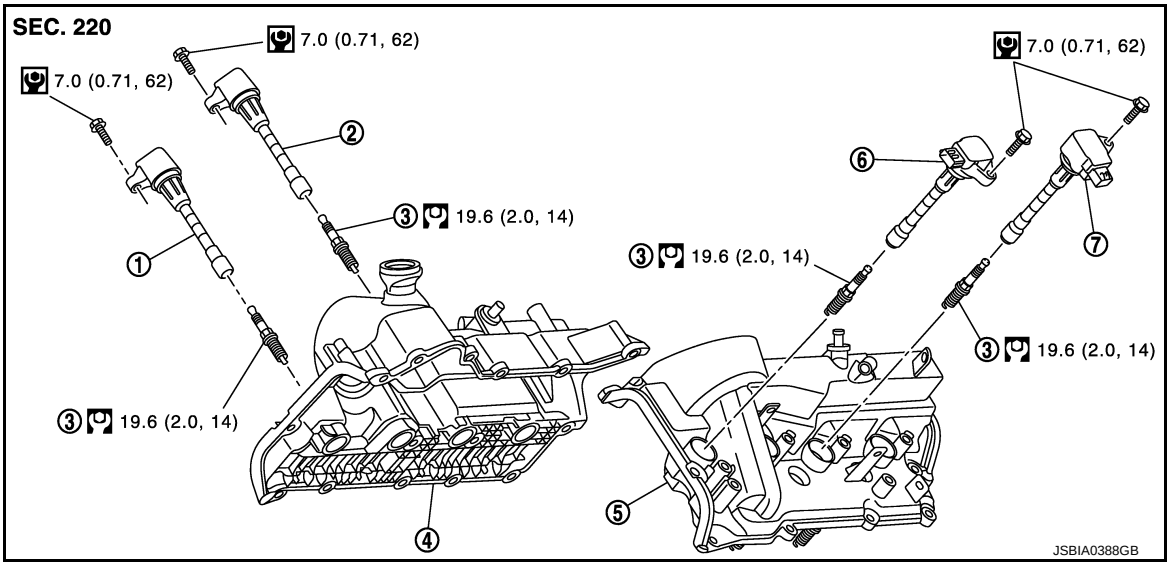
INSPECTION AFTER REMOVAL

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

IGNITION COIL

Exploded View

INFOID:0000000006289541



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:0000000006289542

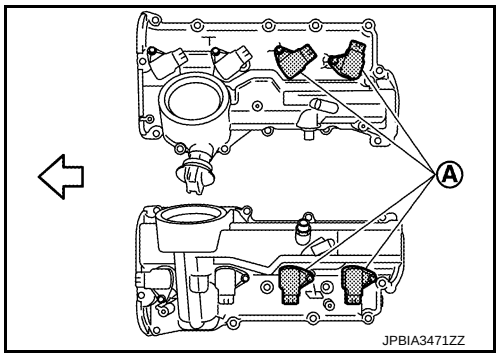
REMOVAL

1. Remove engine cover. Refer to EM-25, "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

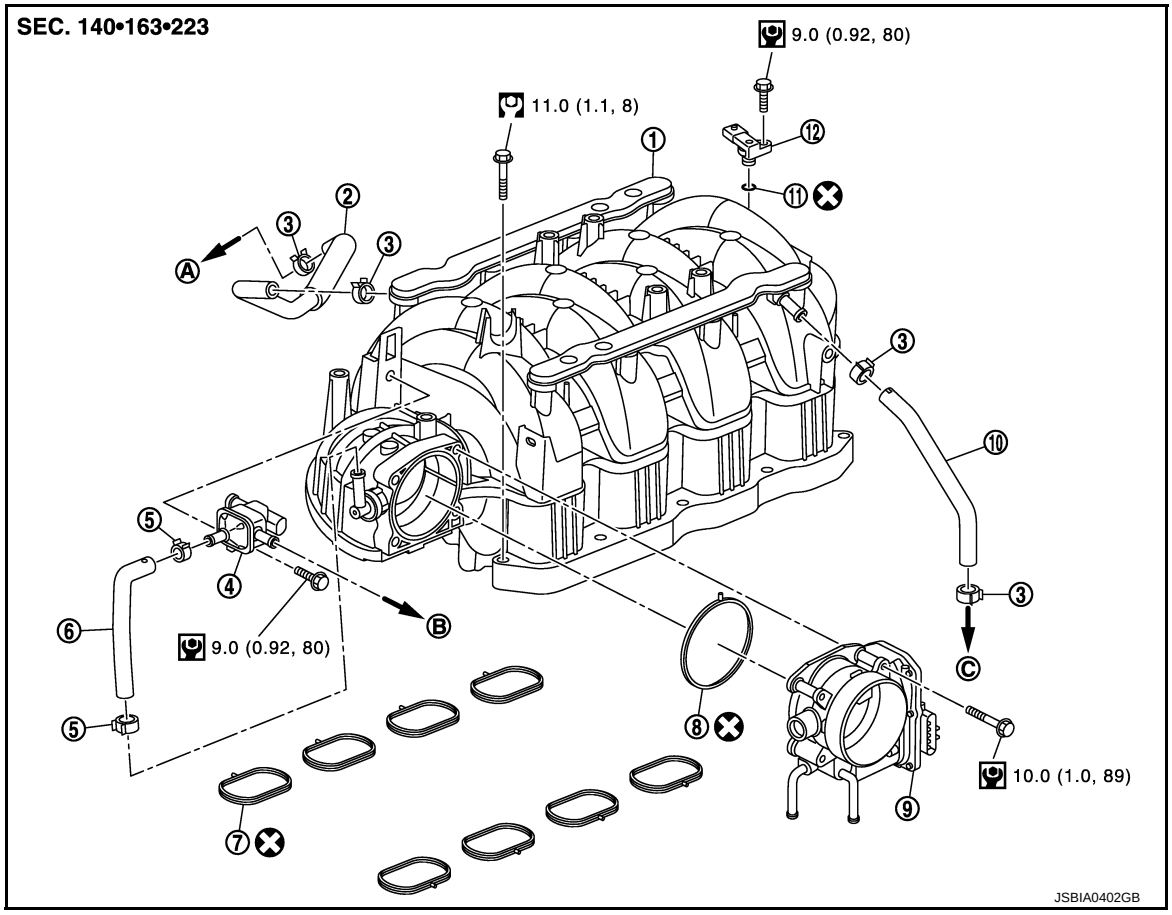


2. Install engine cover.

INTAKE MANIFOLD

Exploded View

INFOID:0000000006289543



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:0000000006289544

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-25, "Exploded View".
2. Remove air cleaner case (upper) and air duct. Refer to EM-27, "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.**

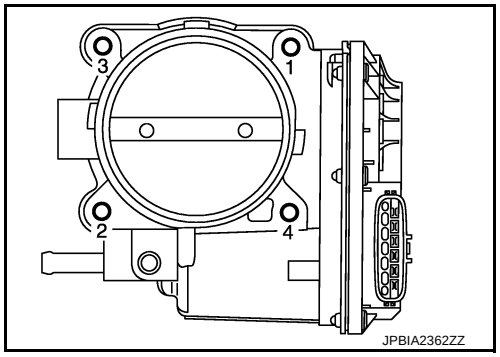
- **Never spill engine coolant on drive belts.**

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.

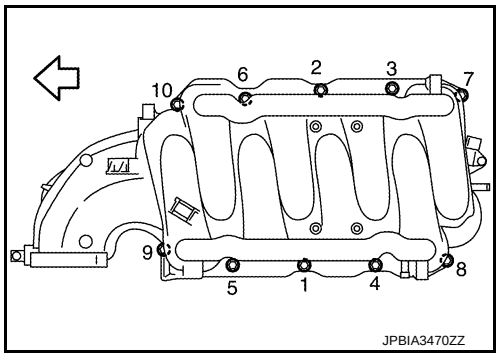
NOTE:
The figure shows the electric throttle control actuator viewed from the air duct side.

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.

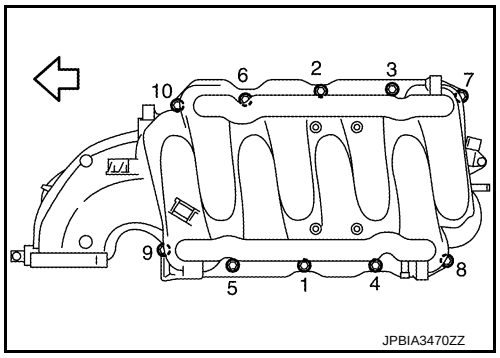
INSTALLATION

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

Intake Manifold

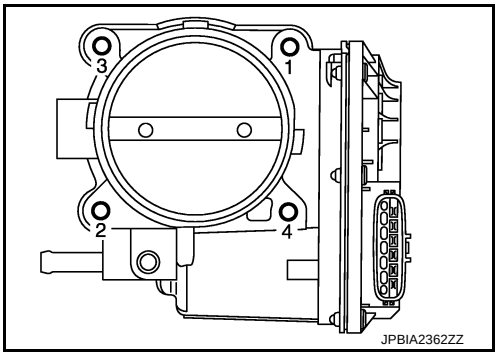
Tighten in numerical order as shown in the figure.

⇦ : Engine front



Electric Throttle Control Actuator

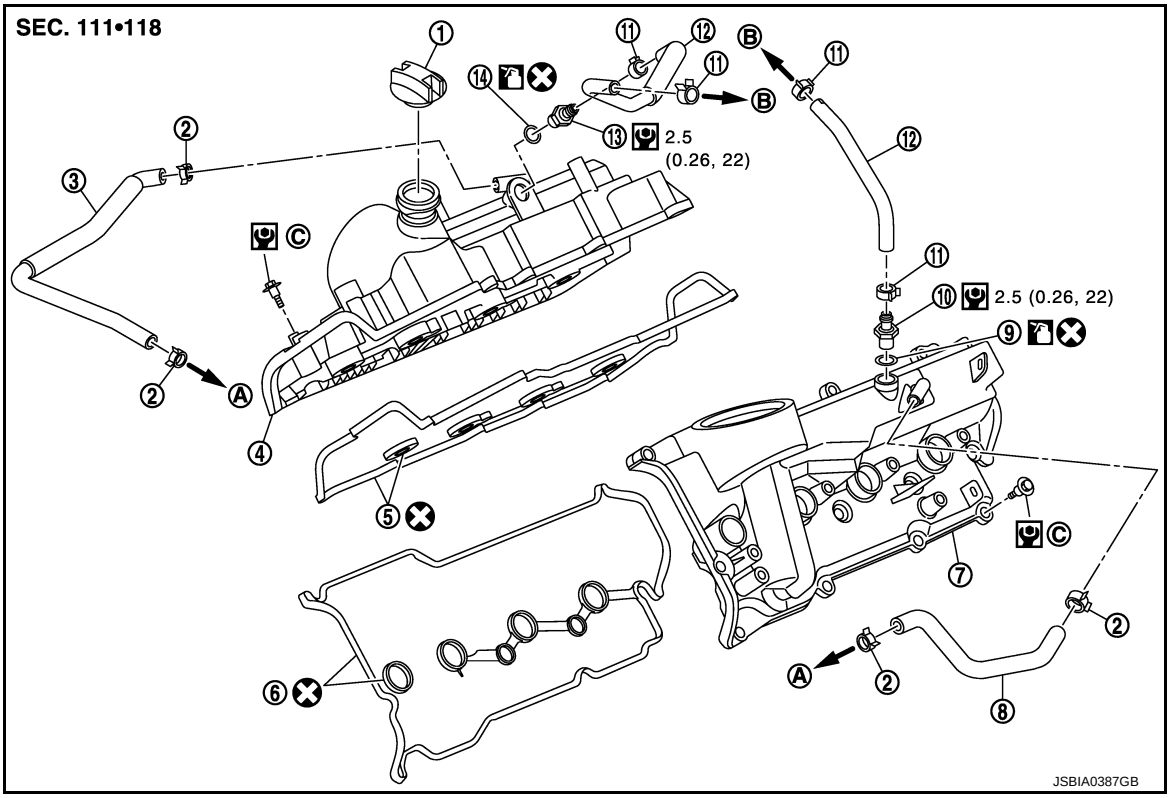
- Tighten in numerical order as shown in the figure.
  NOTE:
  The figure shows the electric throttle control actuator viewed from the air duct side.
- Perform the “Throttle Valve Closed Position Learning” when harness connector of electric throttle control actuator is disconnected. Refer to EC-147, "Description".
- Perform the “Idle Air Volume Learning” and “Throttle Valve Closed Position Learning” when electric throttle control actuator is replaced. Refer to EC-148, "Description" and EC-147, "Description".



ROCKER COVER

Exploded View

INFOID:0000000006289545



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-33, "Removal and Installation".

Refer to GI-4, "Components" for symbols in the figure.

Removal and Installation

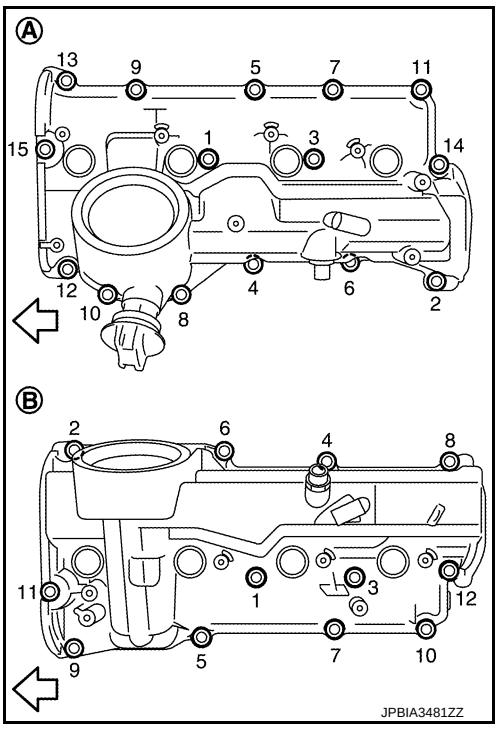
INFOID:0000000006289546

REMOVAL

1. Remove engine cover and bracket (rear). Refer to EM-25, "Exploded View".
2. Disconnect PCV hose from rocker cover.
3. Remove air cleaner case (upper) and air duct. Refer to EM-27, "Exploded View".
4. Move the following parts to the position without the hindrance for work.
   - Oil level gauge guide. Refer to EM-57, "Exploded View".
   - Power steering fluid reservoir tank bracket. Refer to ST-54, "Exploded View".
   - EVAP canister purge control solenoid valve. EM-30, "Exploded View".
   - Fuel feed hose. Refer to EM-43, "Exploded View".
5. Remove VVEL actuator motor assembly. Refer to EM-36, "Exploded View".
6. Remove ignition coil. Refer to EM-29, "Exploded View".
   CAUTION:
   Never impact it.
7. Remove rocker cover.

- Loosen bolts in reverse order shown in the figure.

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



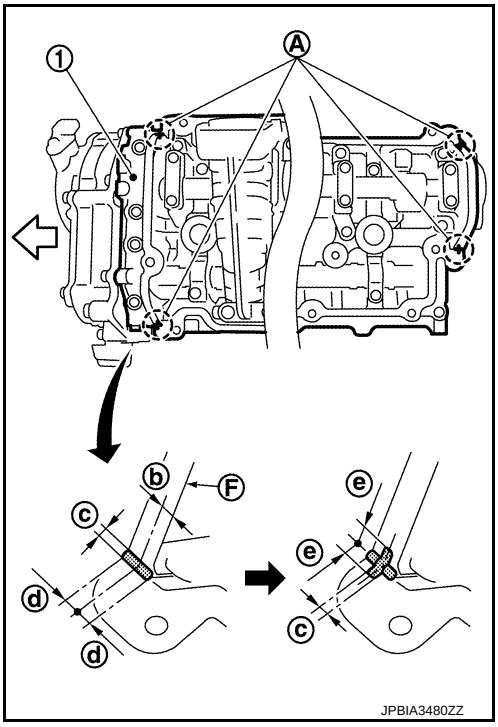
8. Remove rocker cover gasket from rocker cover.
9. Use scraper to remove all traces of liquid gasket from cylinder head & VVEL ladder assembly.
   CAUTION:
   Never scratch or damage the mating surface when cleaning off old liquid gasket.
10. Remove PCV valve from rocker cover, if necessary.
11. Remove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

INSTALLATION

1. 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]

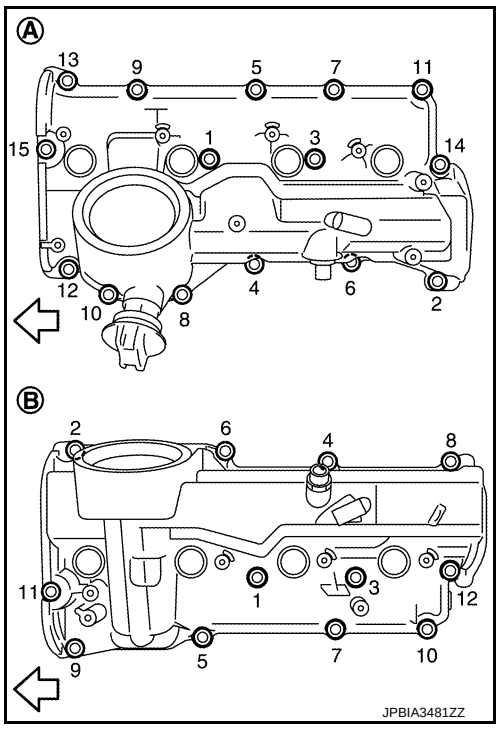


2. Install rocker cover gasket to rocker cover.
3. Install rocker cover.
   - Check that rocker cover gasket does not drop from the installation groove of rocker cover.

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

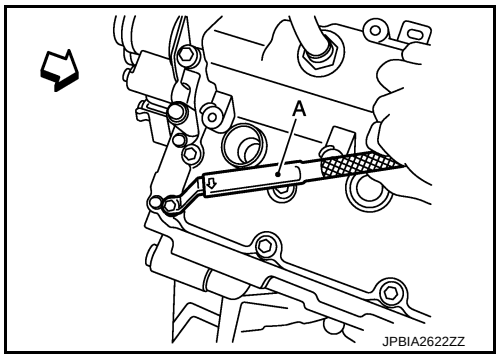
A : Bank 2
B : Bank 1
⇦ : Engine front

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.

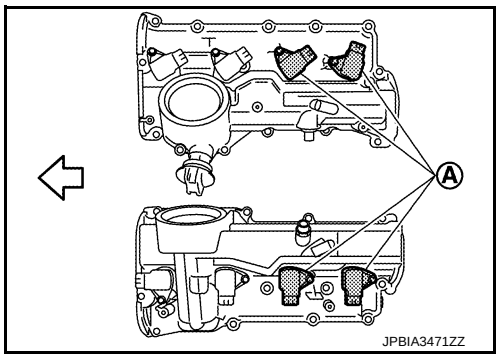
⇦ : Engine front



5. Install ignition coil. Refer to EM-29, "Exploded View".

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

⇦ : Engine front

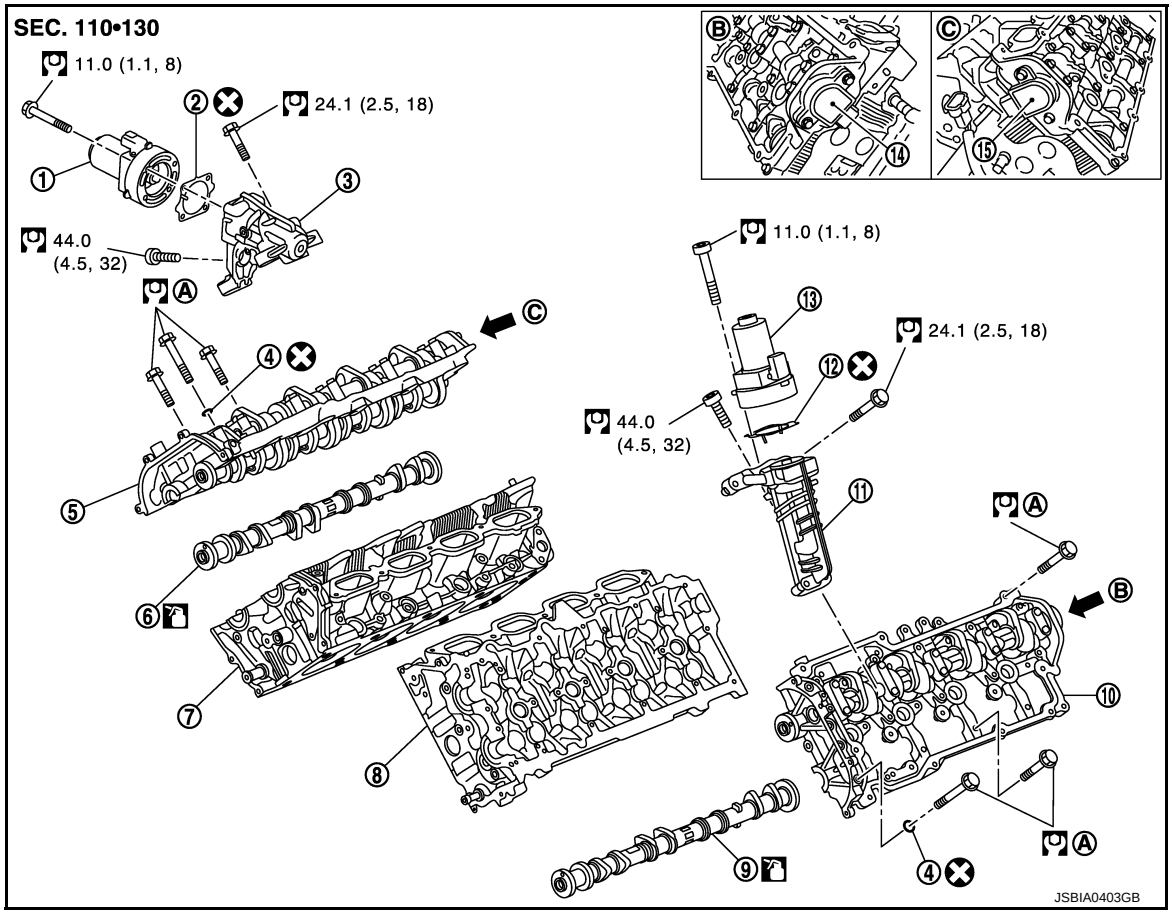


6. Install VVEL actuator motor assembly. Refer to EM-36, "Exploded View".
7. Install in the reverse order of removal.

VVEL ACTUATOR ASSEMBLY

Exploded View

INFOID:0000000006289547



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)
A.	Comply with the installation procedure when tightening. Refer to EM-75, "Removal and Installation".	B.	View B	C.	View C

Refer to GI-4, "Components" for symbols in the figure.

Removal and Installation

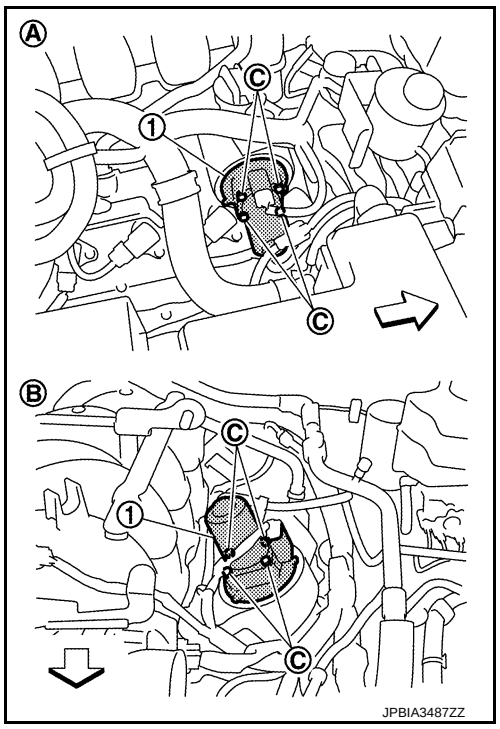
INFOID:0000000006289548

REMOVAL

1. Remove engine cover. Refer to EM-25, "Exploded View".

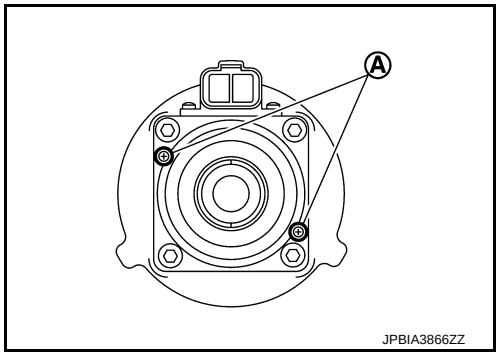
2. Loosen mounting bolts (C), and then remove VVEL actuator motor assembly (1).

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



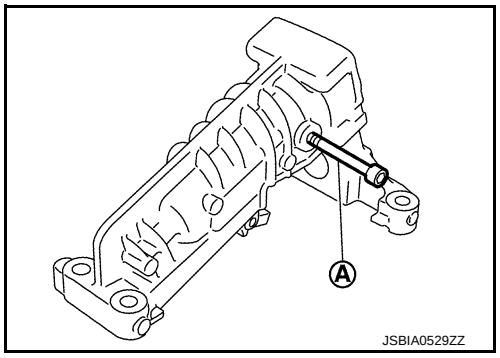
JPBIA3487ZZ

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



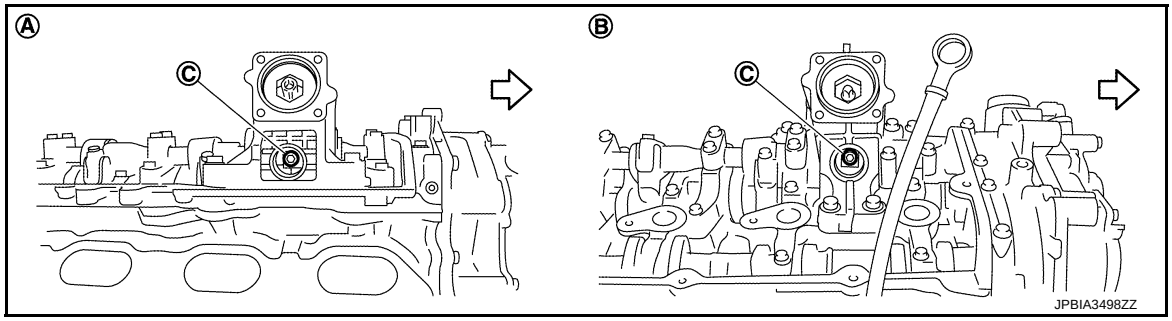
JPBIA3866ZZ

3. Remove rocker cover. Refer to EM-33, "Exploded View".
4. Insert mounting bolt (A) removed at step 2 into VVEL actuator housing assembly.



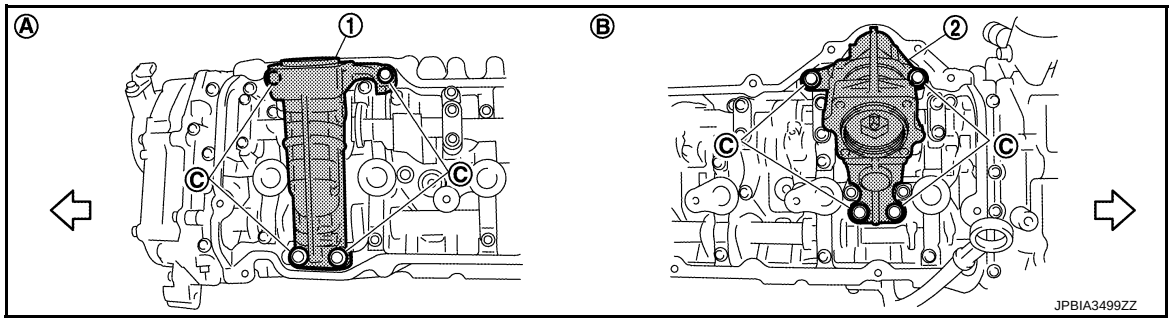
JSBIA0529ZZ

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



A. Bank 1
B. Bank 2
⇦ : Engine front

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

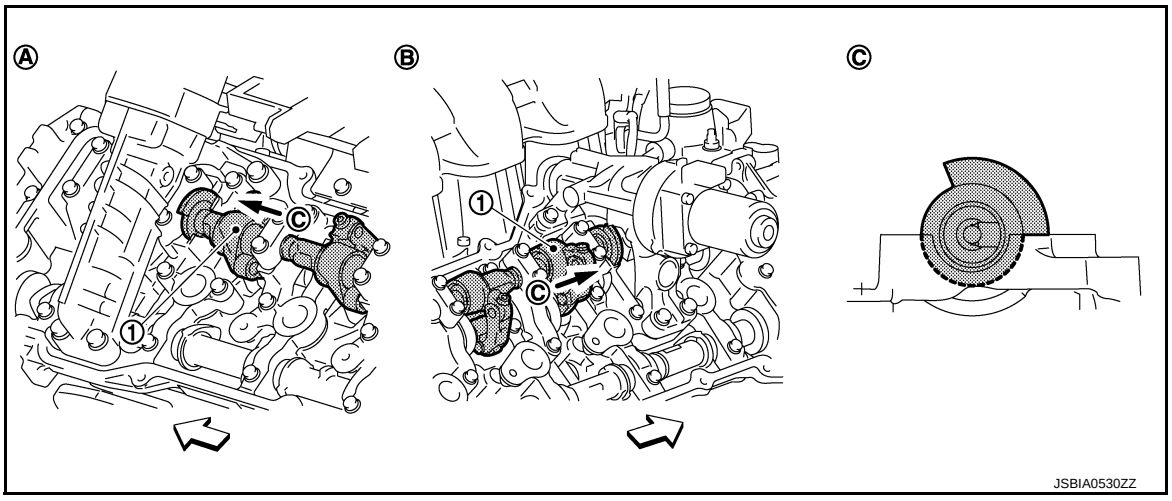


1. VVEL actuator housing assembly (bank 1)
2. VVEL actuator housing assembly (bank 2)
A. Bank 1
B. Bank 2
⇦ : Engine front

INSTALLATION

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

- 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

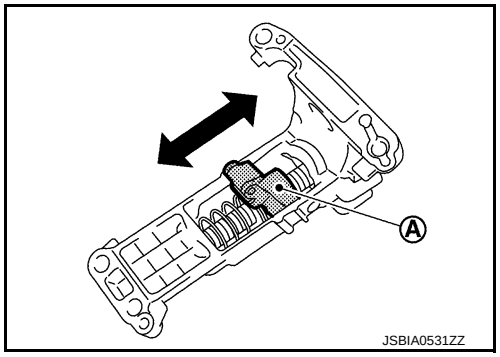
Inspection

INFOID:0000000006289549

INSPECTION AFTER REMOVAL

VVEL actuator housing assembly

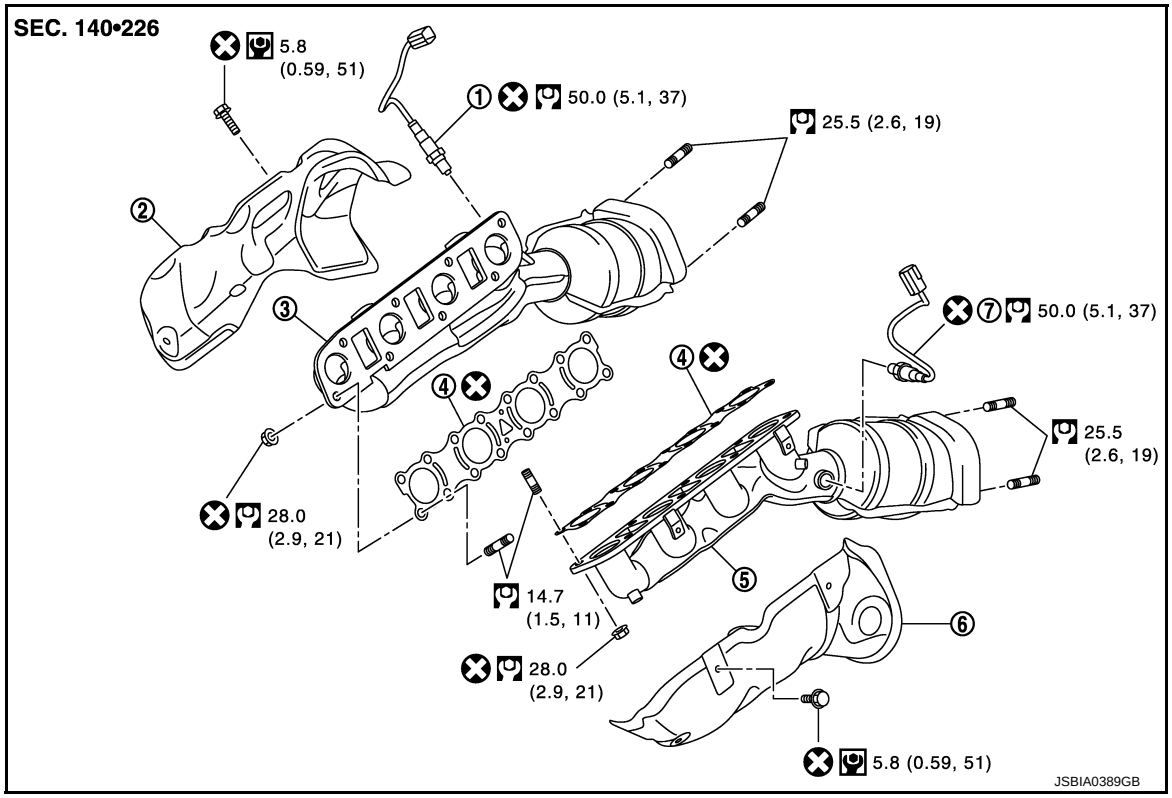
- Move the ball nut (A) in the axial direction to check the smooth rotation.



EXHAUST MANIFOLD AND THREE WAY CATALYST

Exploded View

INFOID:0000000006289550



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:0000000006289551

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-13, "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-13, "Exploded View".
6. Remove front under cover. Refer to EXT-25, "Exploded View".
7. Remove front wheels and tires. Refer to WT-64, "Exploded View".
8. Remove A/C compressor. Refer to HA-30, "Exploded View".
9. Remove alternator and alternator bracket. Refer to CHG-25, "Exploded View".
10. Remove exhaust front tube (bank 1 and bank 2). Refer to EX-5, "Exploded View".

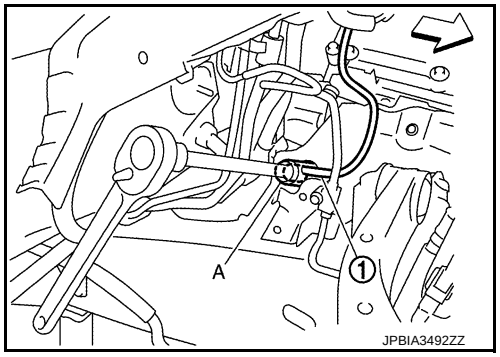
11. Remove front propeller shaft. Refer to DLN-128, "Exploded View".
12. Disconnect steering lower joint. Refer to ST-37, "Exploded View".
13. Remove air fuel ratio sensor 1 as per the following:

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

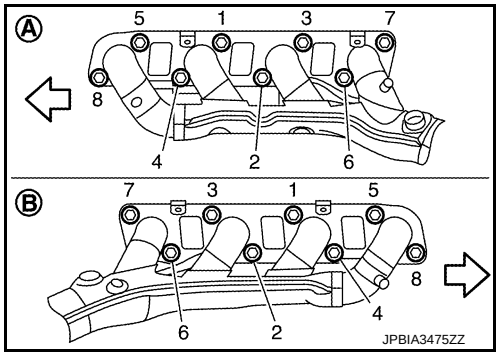


14. Remove exhaust manifold cover.
15. Remove oil level gauge guide. Refer to EM-57, "Exploded View".
16. Remove exhaust manifold.
    - Loosen nuts in the reverse order of figure to remove exhaust manifold with a power tool.

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

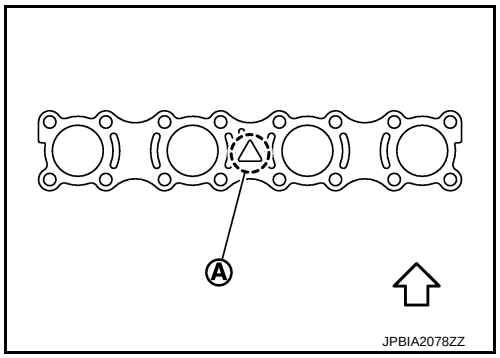
- Install exhaust manifold gasket in directional shown in the figure.

A : Triangle press

⇦ : Above

NOTE:

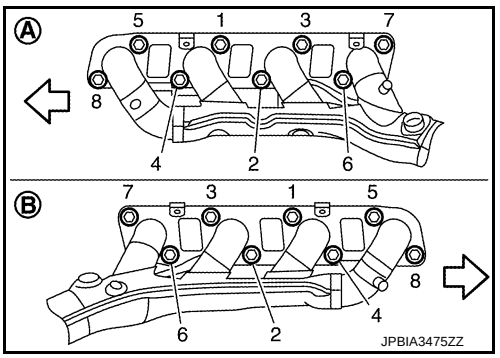
When install exhaust manifold gasket, coating surface (black) shall be located on the exhaust manifold side.



Exhaust Manifold

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

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

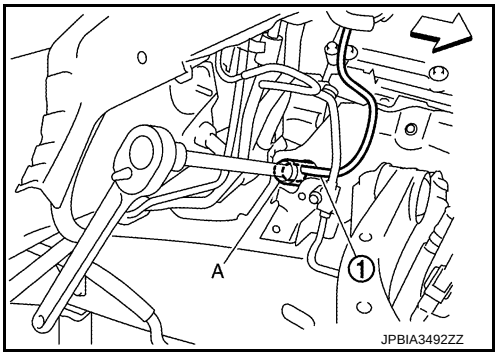


CAUTION:
All exhaust manifold nuts are tightened at twice.

Air Fuel Ratio Sensor 1, Heated Oxygen Sensor 2

CAUTION:

- **Before installing new sensors, 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).**
- **Sensors are 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.**

Inspection

INFOID:0000000006289552

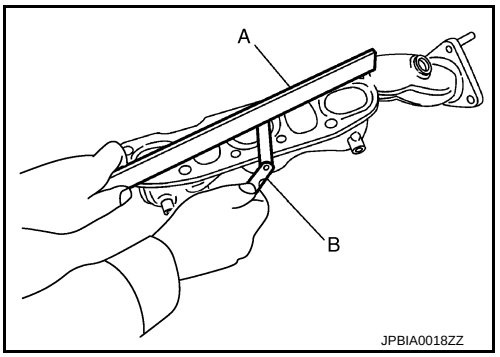
INSPECTION AFTER DISASSEMBLY

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-133, "Exhaust Manifold".

- If it exceeds the limit, replace exhaust manifold.

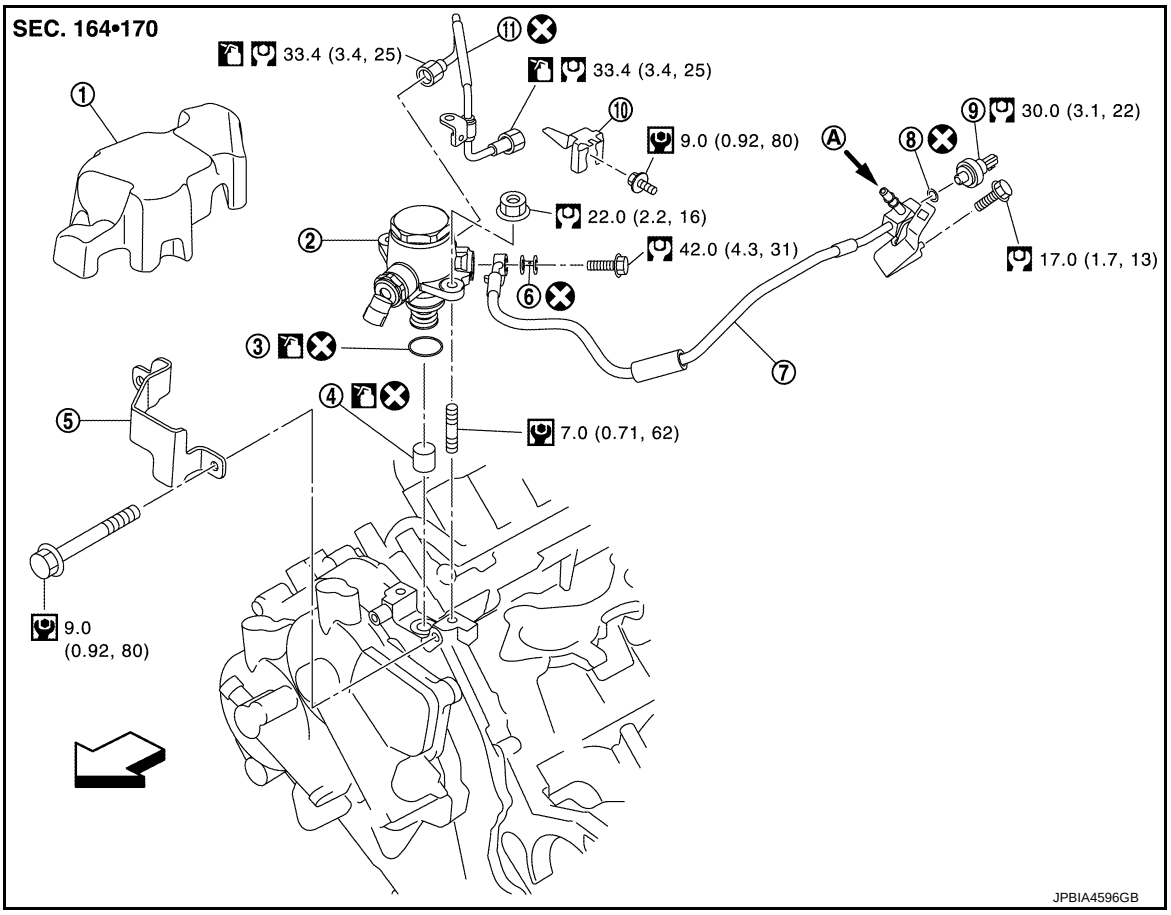


HIGH PRESSURE FUEL PUMP AND FUEL HOSE

Exploded View

INFOID:0000000006289553

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



1. High pressure fuel pump insulator
2. High pressure fuel pump
3. O-ring
4. Lifter
5. Fuel pump connector protector
6. Copper washer
7. Fuel feed hose
8. Copper washer
9. Low fuel pressure sensor
10. Bracket
11. Fuel feed tube (pump side)

A. From fuel tank

⇦ : Engine front

Refer to GI-4, "Components" for symbols in the figure.

Removal and Installation

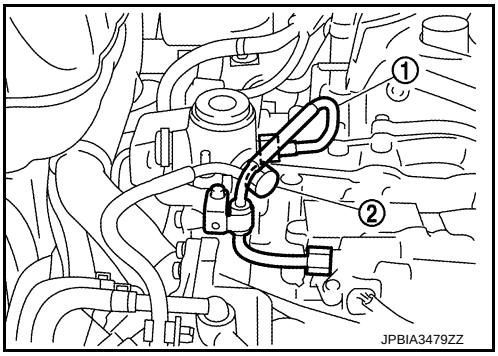
INFOID:0000000006289554

REMOVAL

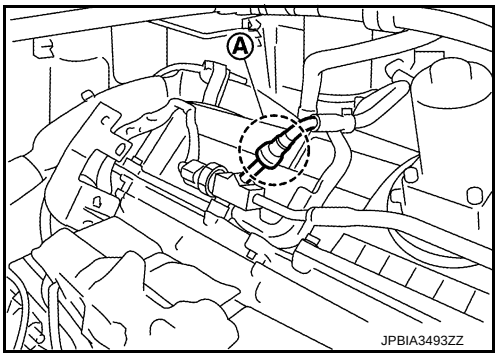
WARNING:
- **Be sure to read EM-4, "Precaution for Handling High Pressure Fuel System" when working on the high pressure fuel system.**
- **Put a “CAUTION: FLAMMABLE” sign in the workshop.**
- **Be sure to work in a well ventilated area and furnish workshop with a CO_2 fire extinguisher.**
- **Never 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 EC-153, "Work Procedure".
2. Remove intake manifold. Refer to EM-30, "Removal and Installation".
3. Disconnect harness connector from high pressure fuel pump.

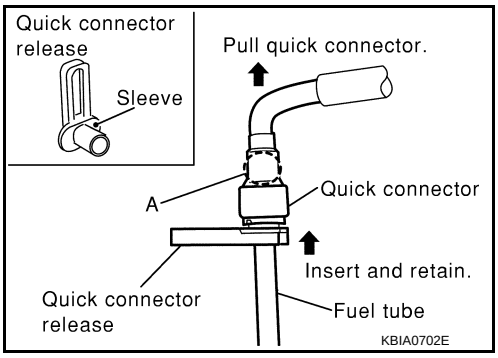
4. Remove fuel feed tube (pump side) (1).
5. Disconnect fuel hose (2) from high pressure fuel pump.



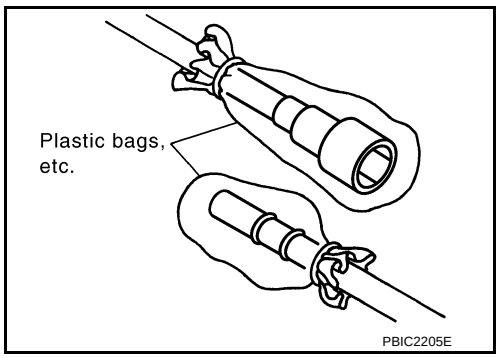
6. Remove high pressure fuel pump and lifter.
   CAUTION:
   After removing lifter, replace lifter with a new one.
7. Disconnect quick connector (A) with the following procedure.



a. Remove quick connector cap from quick connector connection.
b. With the sleeve side of quick connector release facing quick connector, install quick connector release onto fuel tube.
c. 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.
d. 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.**



- **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 hose assembly.
10. Remove 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.**

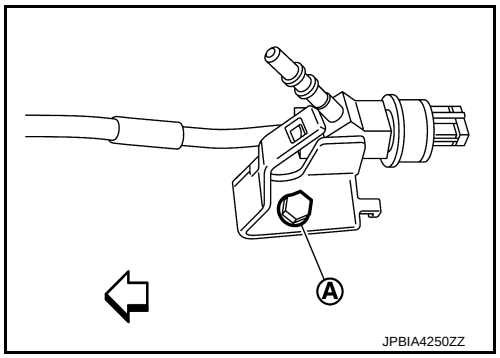
INSTALLATION

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

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

2. Install fuel pressure sensor.
3. Install fuel hose assembly.
   - Temporarily tighten mounting bolt (A) as shown in the figure.

⇦ : Engine front



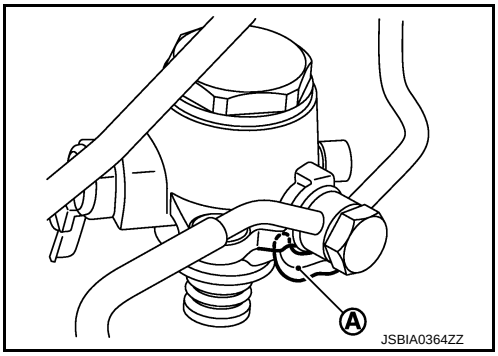
4. Install high pressure fuel pump to front cover.

CAUTION:
After removing lifter, replace lifter with a new one.

5. Connect fuel feed hose to high pressure fuel pump.

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.

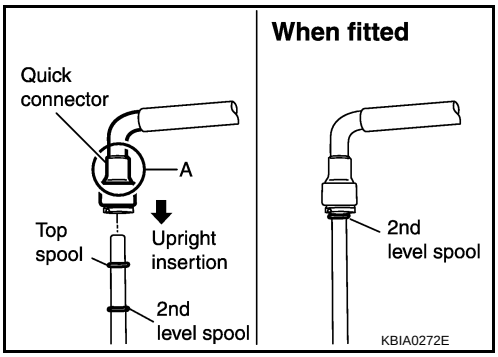


6. Tighten mounting bolts that are temporarily tightened in step 3.
7. Connect harness connector to high pressure fuel pump.
8. Install fuel pump connector protector.
9. Connect harness connector to low fuel pressure sensor.
10. Note the following, and connect quick connector to install fuel feed hose.

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.**

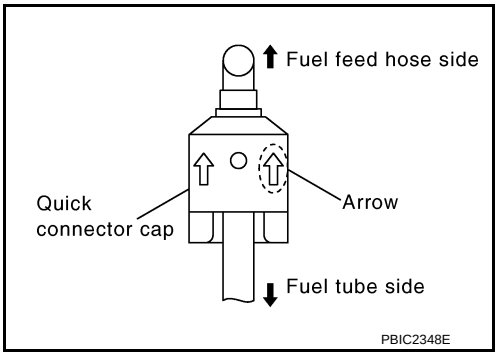


c. Before clamping fuel feed hose with hose clamps, pull quick connector hard by hand holding "A" position. Check it is completely engaged (connected) so that it does not come out from fuel feed tube.

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.



Inspection

INFOID:0000000006289555

INSPECTION AFTER INSTALLATION

Check for Fuel Leakage

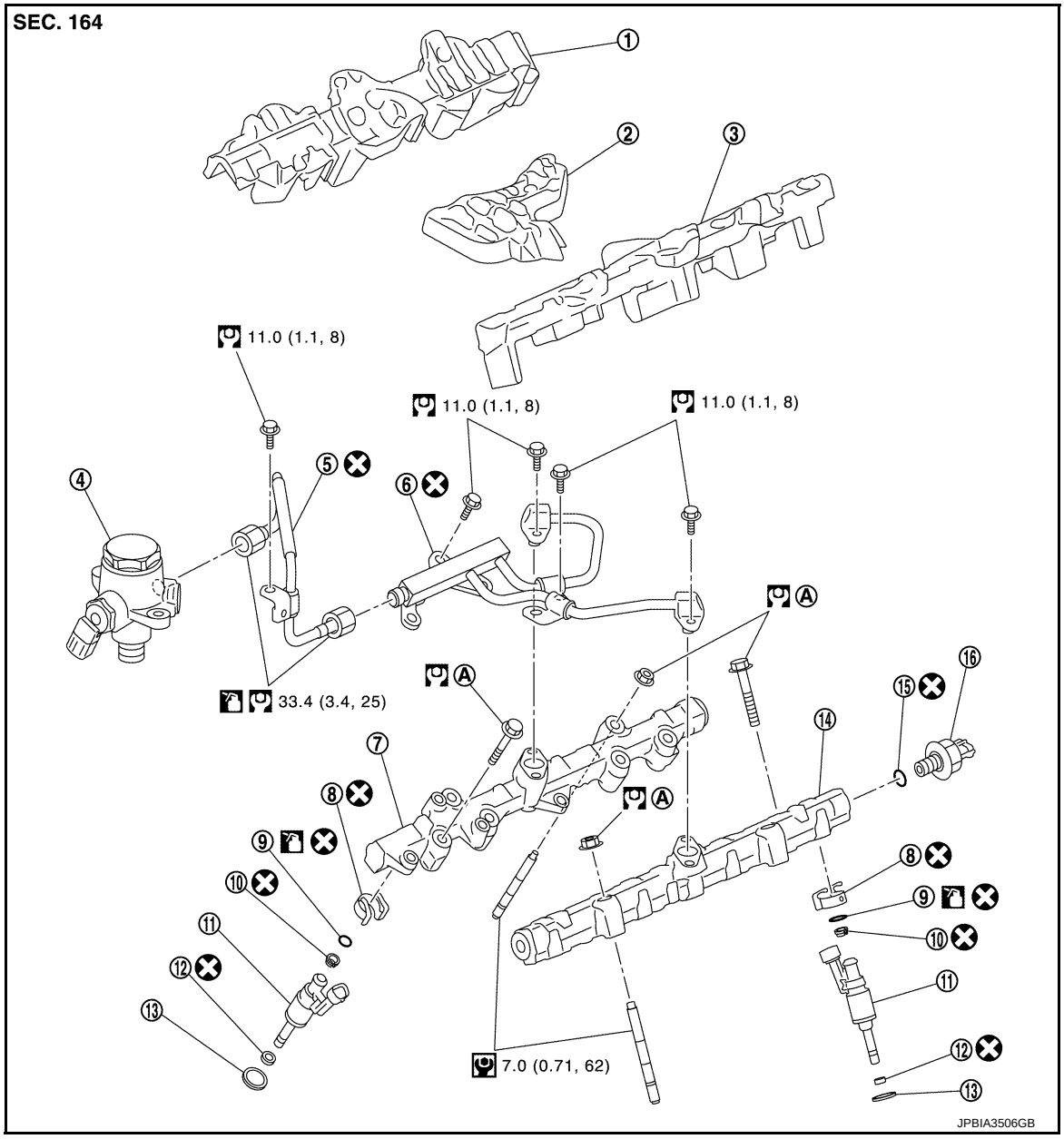
1. Turn ignition switch "ON" (with the engine stopped). With fuel pressure applied to fuel piping, check that there is no fuel leakage at connection points.
NOTE:
Use mirrors for checking at points out of clear sight.
2. Start the engine. With engine speed increased, check again that there is no fuel leakage at connection points.

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

FUEL INJECTOR AND FUEL TUBE

Exploded View

INFOID:0000000006289556



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

A. Comply with the installation procedure when tightening. Refer to EM-49, "Removal and Installation".

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:0000000006289557

REMOVAL

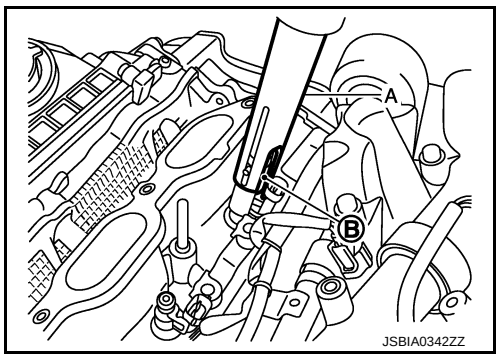
WARNING:

- **Be sure to read EM-4, "Precaution for Handling High Pressure Fuel System" when working on the high pressure fuel system.**
- **Put a "CAUTION: FLAMMABLE" sign in the workshop.**
- **Be sure to work in a well ventilated area and furnish workshop with a CO_2 fire extinguisher.**
- **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.**

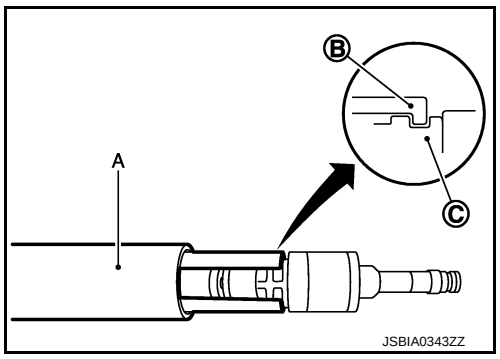
1. Release fuel pressure. Refer to EC-153, "Work Procedure".
2. Remove intake manifold. Refer to EM-30, "Removal and Installation".
3. Remove fuel feed tube (pump side) and fuel feed tube (bank side).
   CAUTION:
   Never reuse fuel feed tube.
4. Remove fuel rail (bank 1) and fuel rail (bank 2).
5. Disconnect 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.

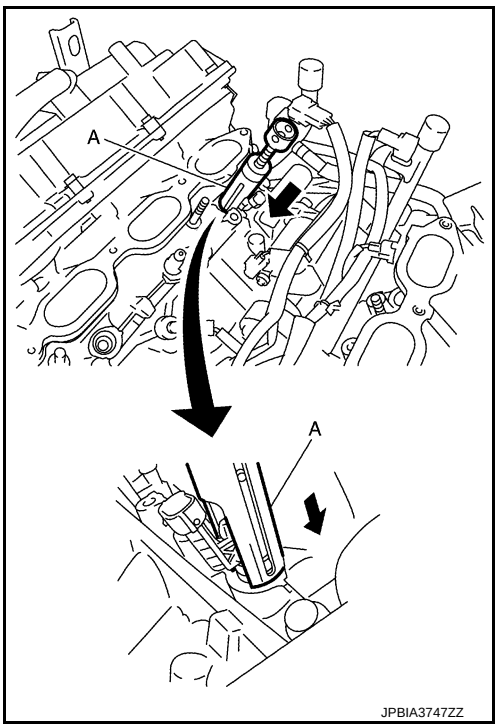
b. Install an injector remover [SST: KV10119600 (—)] (A) to the injector connector side so that cutout (B) of injector remover faces the injector connector side.



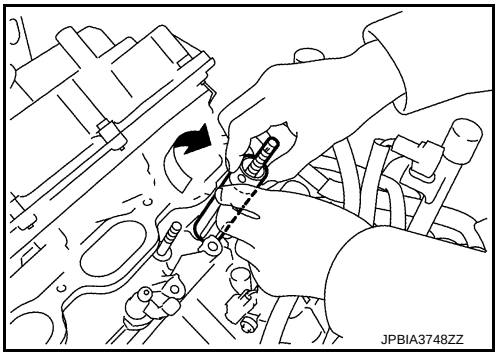
- Hook pawl portion (B) of injector remover [SST: KV10119600 (—)] (A) to groove portion (C) of injector.



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

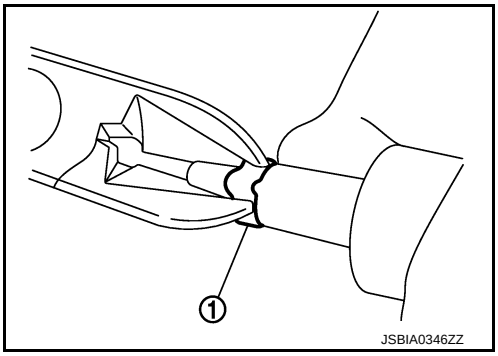


d. Tighten injector remover [SST: KV10119600 (—)] clockwise and remove injector from cylinder head.



e. Cut Teflon seal (1) while pinching it. Be careful not to damage injector.

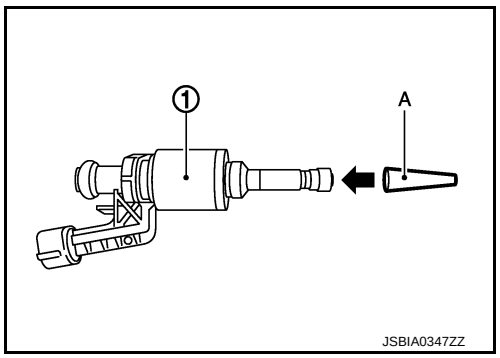
f. Remove insulator from mounting hole of fuel injector of cylinder head.



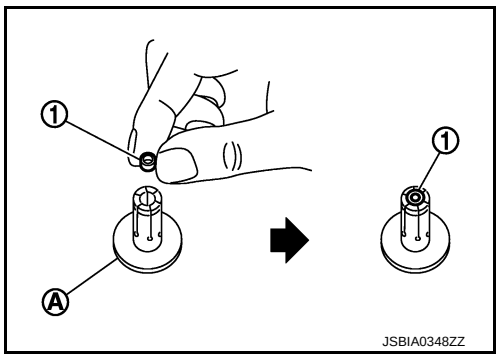
INSTALLATION

1. Install seal ring to fuel injector as per the following:
   CAUTION:
   - **Handle seal ring with bare hands. Never wear gloves.**
   - **Never apply engine oil to seal ring.**
   - **Never clean seal ring with solvent.**

a. Install an injector seal drift set [SST: KV101197S0 (—)] (A) to fuel injector (1).



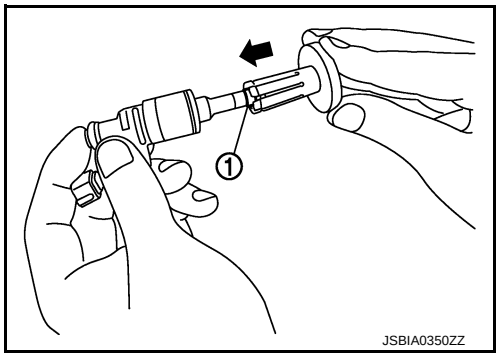
b. Set seal ring (1) to injector seal drift set [SST: KV101197S0 (—)] (A).



c. Straightly insert seal ring (1), which is set in step 2, to fuel injector as shown in the figure and install.

CAUTION:

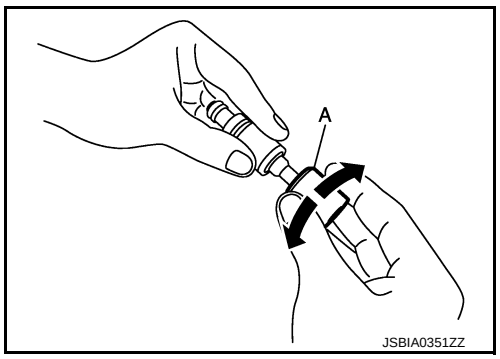
Be careful that seal ring does not exceed the groove portion of fuel injector.



d. Insert injector seal drift set [SST: KV101197S0 (—)] (A) to injector and rotate clockwise and counterclockwise by 90° while pressing seal ring to fit it.

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.

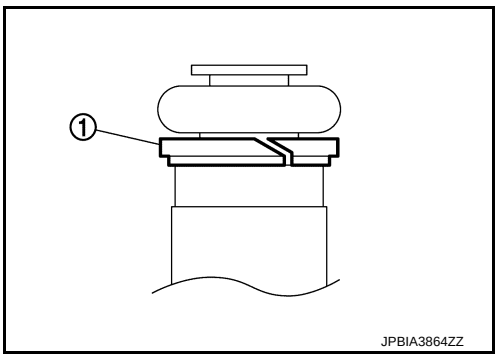


2. Install O-ring and backup ring to fuel injector. When handing new O-ring and backup ring, paying attention to the following caution items:

CAUTION:

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

- **Always install the back up ring (1) in the right direction as instructed.**



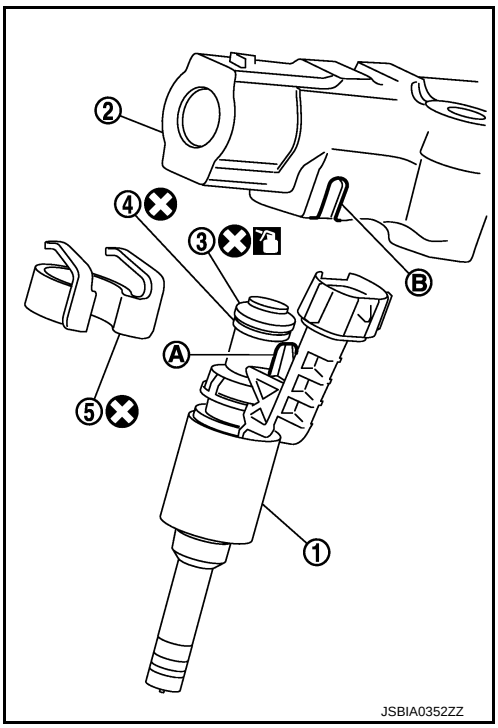
3. Install fuel injector (1) to fuel rail (2) as per the following:

   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).

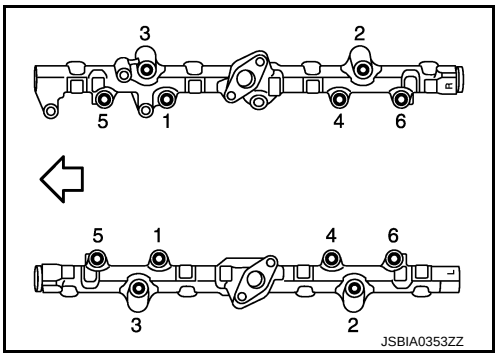
c. Check that installation is complete by checking that fuel injector does not rotate or come off.
- Check that protrusions of fuel injectors and fuel rail are aligned with cutouts of clips after installation.



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

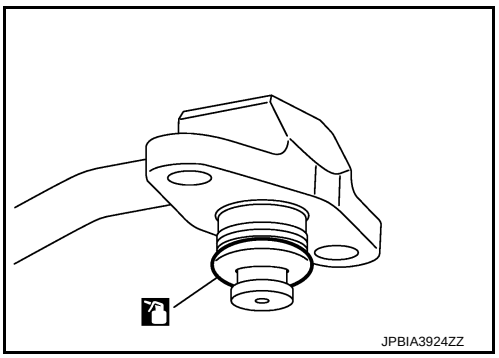
   ⇦ : Engine front

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)



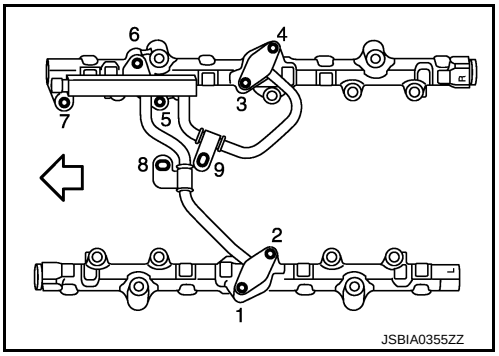
6. Connect injector harness connector.
7. Install fuel feed tube (bank side) to fuel rail.
CAUTION:
- **When inserting fuel feed tube (bank side) to fuel rail, press the flange part to install the tube.**
- **Never use O-ring with any scoring.**
- **Never reuse fuel feed tube (bank side), O-ring and back up ring.**

- Apply engine oil to O-ring.


JPBIA3924ZZ

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

⇦ : Engine front



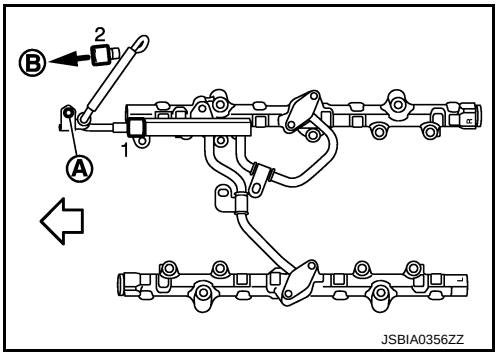
JSBIA0355ZZ

8. Install fuel feed tube (pump side) to fuel feed tube (bank side) as per the following:
CAUTION:
Never reuse fuel feed tube (pump side).

a. Apply engine oil to flare screw parts of high pressure pump side and fuel feed tube (bank side) side.
b. Manually tighten 2 flare nuts without using a tool until they are seated to screw thread.
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.



JSBIA0356ZZ

9. Install in the reverse order of removal.

Inspection

INFOID:0000000006289558

INSPECTION AFTER INSTALLATION

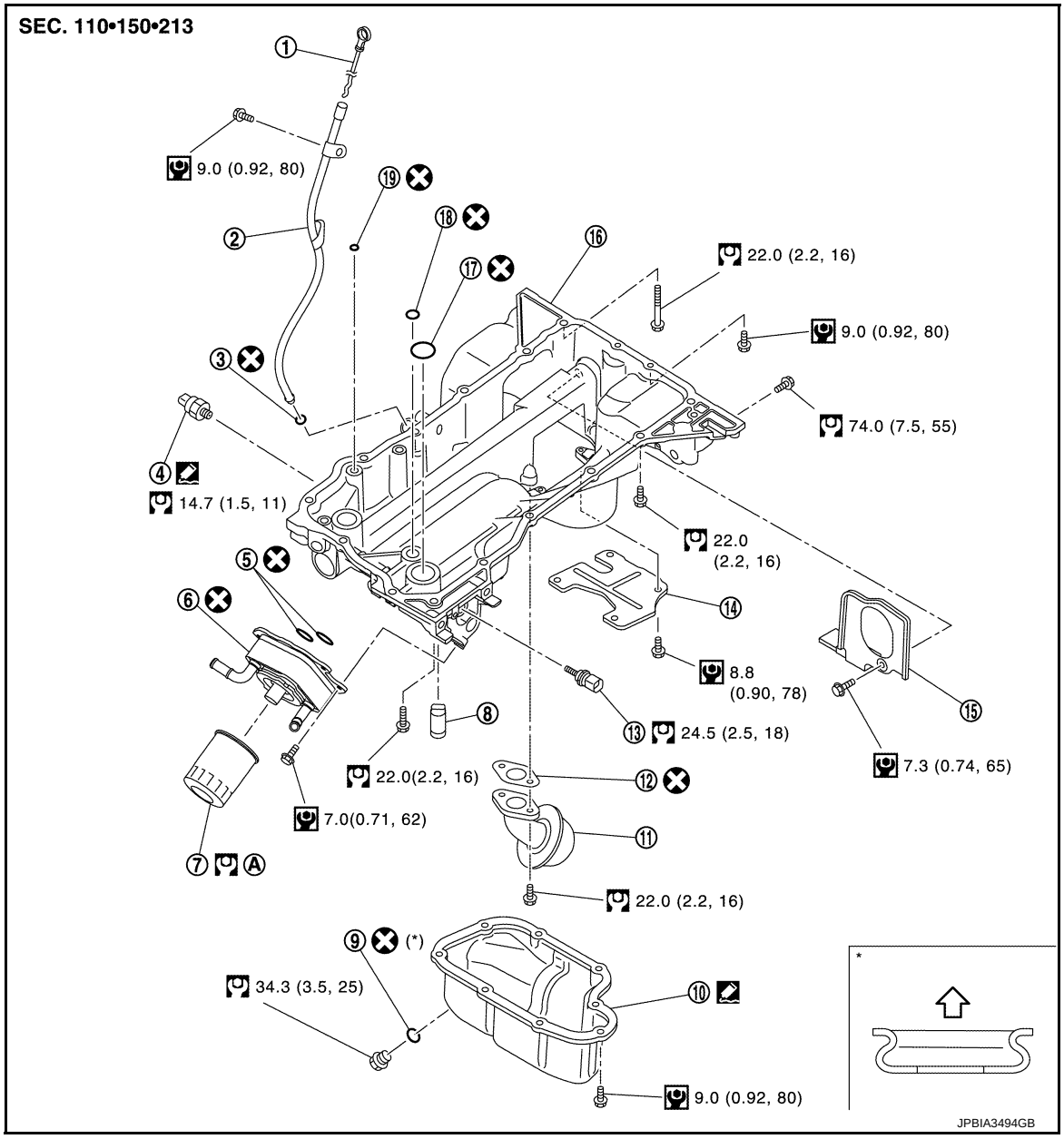
Check for Fuel Leakage

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.

OIL PAN (LOWER) AND OIL STRAINER

Exploded View

INFOID:0000000006289559



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-9, "Removal and Installation".

⇦ : Oil pan side

Refer to GI-4, "Components" for symbols in the figure.

Removal and Installation

INFOID:0000000006289560

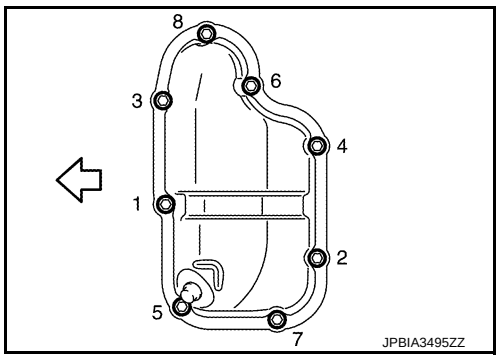
REMOVAL

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

1. Drain engine oil. Refer to LU-8, "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-205, "2WD : Exploded View" (2WD models) or TM-208, "4WD : Exploded View" (4WD models).
4. Remove oil pan (lower) as per the following:

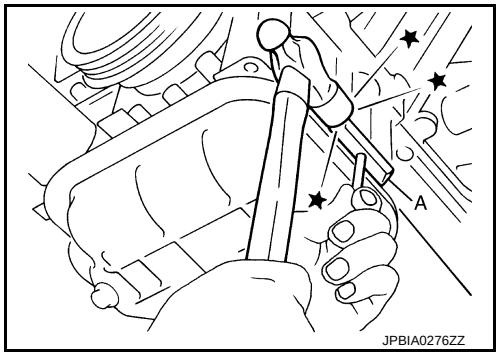
a. Loosen mounting bolts in reverse order as shown in the figure to remove.

⇦ : 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).



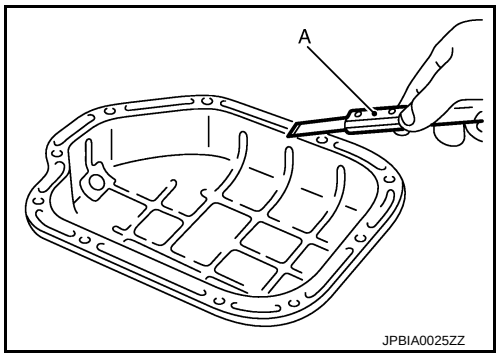
5. Remove oil strainer.

INSTALLATION

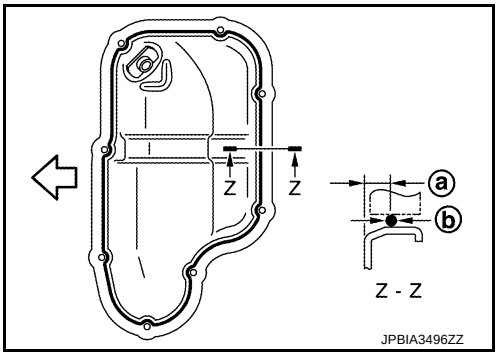
1. Install oil strainer.
2. Install oil pan (lower) as per the following:

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.



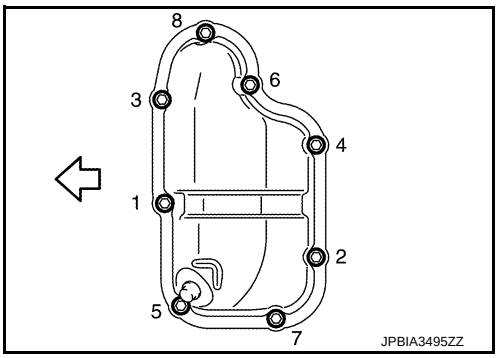
b. Apply a continuous bead of liquid gasket with the tube presser (commercial service tool) to the oil pan (lower) as shown in the figure.



a : 7.5 - 9.5 mm (0.295 - 0.374 in)
b : ϕ4.0 - 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.
- Refer to the figure of the components of on the prior page for installation direction of drain plug washer. Refer to EM-54, "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:0000000006289561

INSPECTION AFTER REMOVAL

Clean oil strainer if any object is attached.

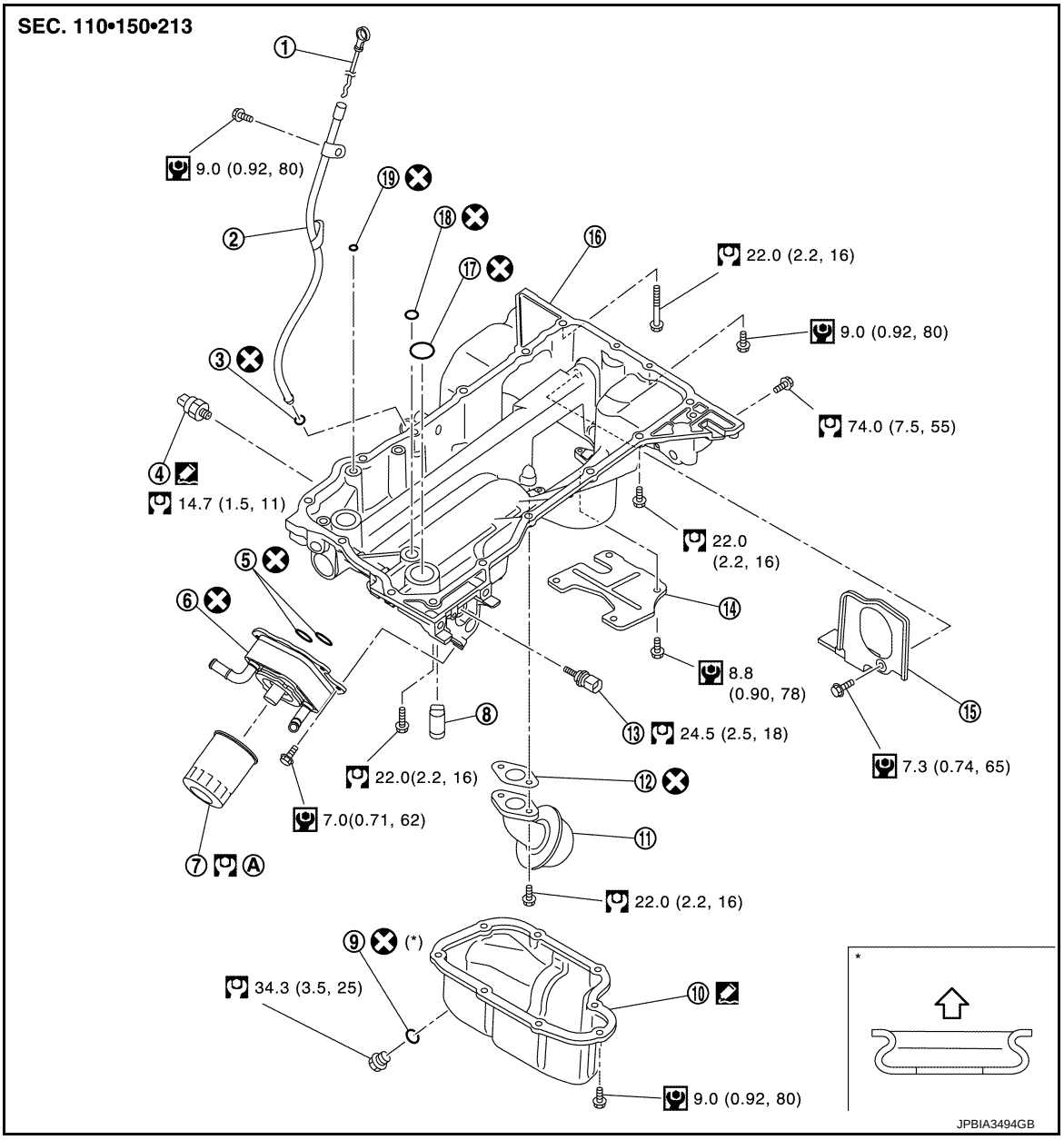
INSPECTION AFTER INSTALLATION

1. Check the engine oil level and adjust engine oil. Refer to LU-7, "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-7, "Inspection".

OIL PAN (UPPER)

Exploded View

INFOID:0000000006289562



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-9, "Removal and Installation".

⇦ : Oil pan side

Refer to GI-4, "Components" for symbols in the figure.

Removal and Installation

INFOID:0000000006289563

REMOVAL

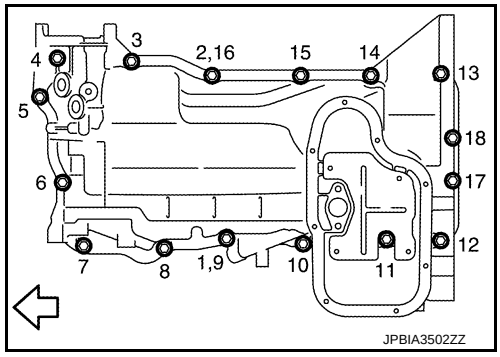
WARNING:
To avoid the danger of being scalded, never drain engine oil when engine is hot.

1. Remove oil filter. Refer to LU-9, "Removal and Installation".
2. Remove oil cooler. Refer to LU-11, "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-205, "2WD : Exploded View" (2WD models) or TM-208, "4WD : Exploded View" (4WD models).
9. Remove steering gear assembly. Refer to ST-41, "Exploded View".
10. Remove front final drive assembly. Refer to DLN-162, "Exploded View".
11. Remove oil pan (lower). Refer to EM-54, "Exploded View".
12. Remove oil strainer. Refer to EM-54, "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

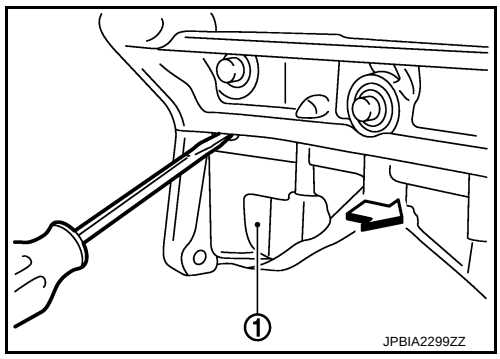
NOTE:
Disregard No. 9, 16 when loosening.



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.



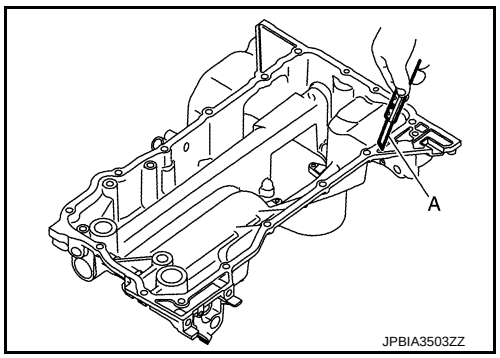
15. Remove O-ring from bottom of cylinder block and oil pump.
16. Remove oil pressure switch and oil temperature sensor, if necessary.

INSTALLATION

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

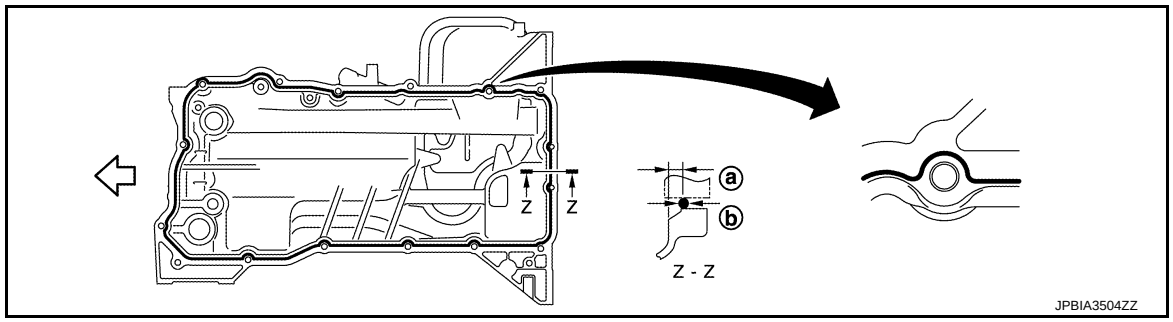
a. Use a scraper (A) to remove old liquid gasket from mating surfaces.
   - Also remove the old liquid gasket from mating surface of cylinder block.
   - Remove old liquid gasket from the bolt holes and threads.

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.

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. : ϕ4.0 - 5.0 mm (0.157 - 0.197 in)

⇦ : Engine front

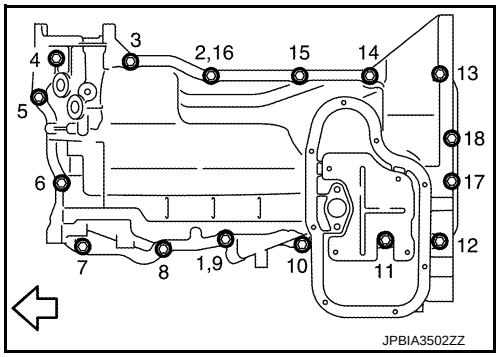
Use Genuine RTV silicone sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".

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· (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.

2. Install oil strainer.

3. Install oil pan (lower). Refer to EM-55, "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:0000000006289564

INSPECTION AFTER DISASSEMBLY

Clean oil strainer if any object is attached.

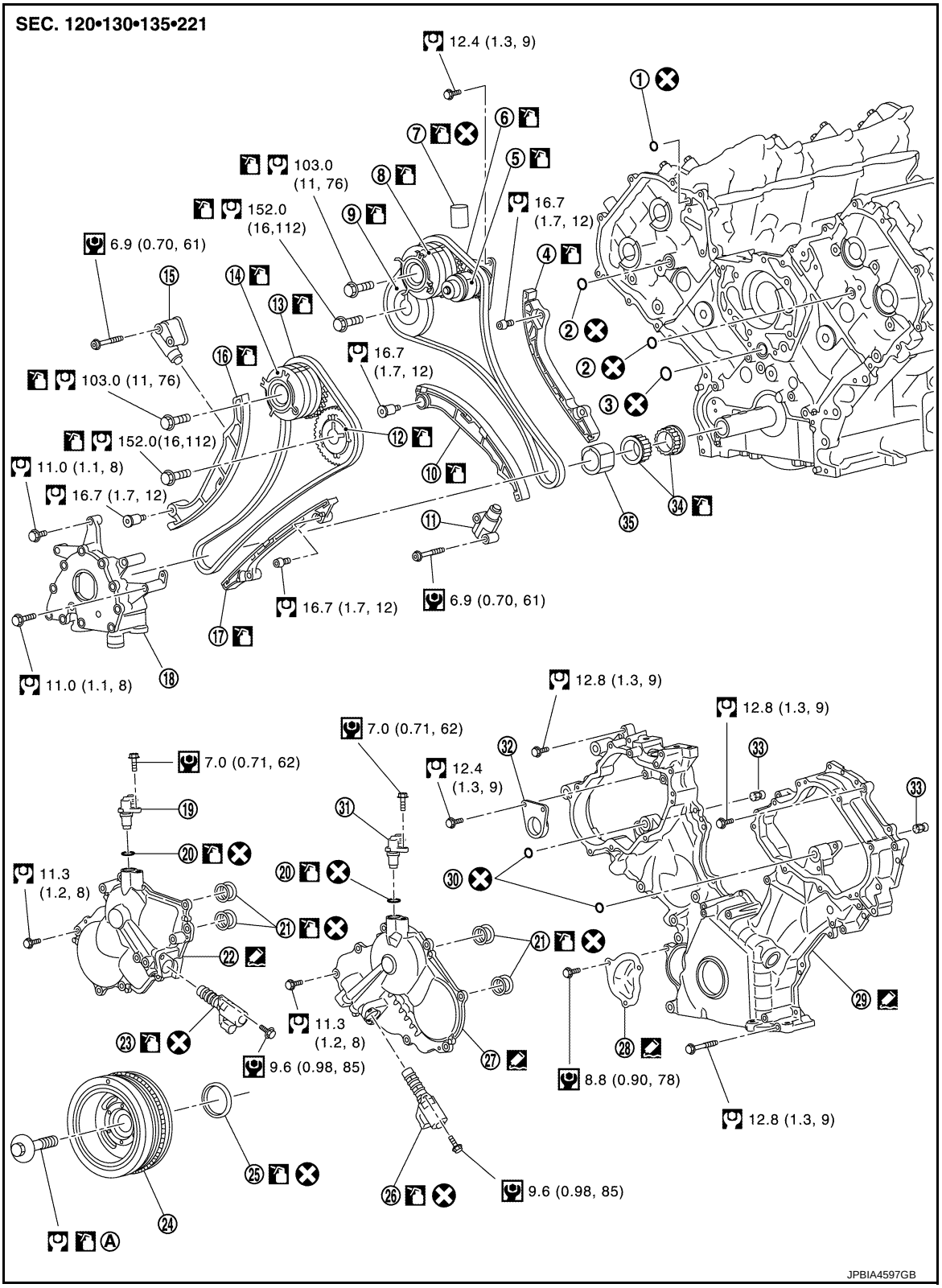
INSPECTION AFTER ASSEMBLY

1. Check the engine oil level and adjust engine oil. Refer to LU-9, "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-9, "Inspection".

TIMING CHAIN

Exploded View

INFOID:0000000006289565



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)

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		

A. Comply with the installation procedure when tightening. Refer to EM-62, "Removal and Installation".

Refer to GI-4, "Components" for symbol marks in the figure.

Removal and Installation

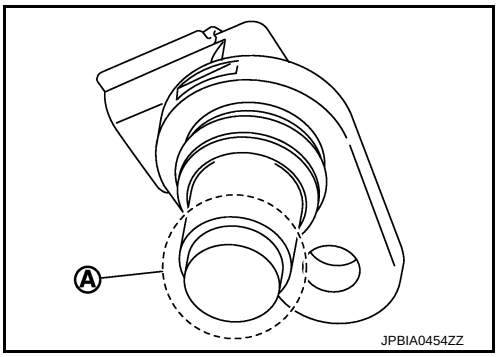
INFOID:0000000006289566

REMOVAL

1. Release fuel pressure. Refer to EC-153, "Work Procedure".
2. Drain engine coolant from radiator. Refer to CO-8, "Draining".
3. Remove fan shroud (lower). Refer to CO-13, "Exploded View".
4. Remove fan bracket. Refer to CO-16, "Exploded View".
5. Remove drive belt auto-tensioner. Refer to EM-26, "Exploded View".
6. Remove oil level gauge and oil level gauge guide. Refer to EM-57, "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-25, "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

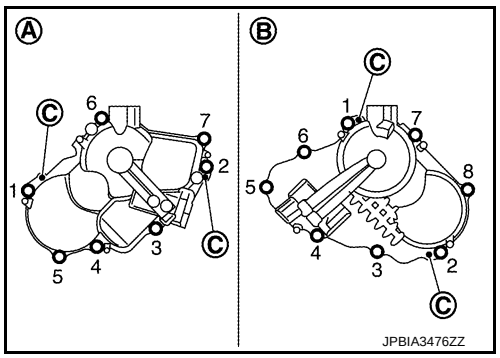
CAUTION:
- **Handle carefully to avoid dropping and shocks.**
- **Never disassemble.**
- **Never allow metal powder to adhere to magnetic part at sensor tip.**
- **Never place sensors in a location where they are exposed to magnetism.**



11. Remove high pressure fuel pump and lifter. Refer to EM-43, "Exploded View".
CAUTION:
After removing lifter, replace lifter with a new one.
12. Remove radiator hose (upper) and radiator hose (lower). Refer to CO-13, "Exploded View".
13. Remove water suction pipe. Refer to CO-20, "Exploded View".
14. Remove valve timing control cover as per the following:

a. Disconnect valve timing control solenoid valve harness connector.

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



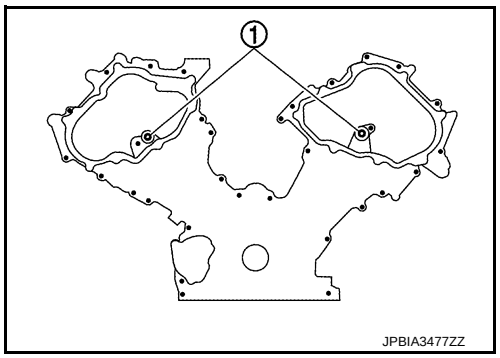
A : Bank 2
B : Bank 1
C : Dowel pin hole

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.

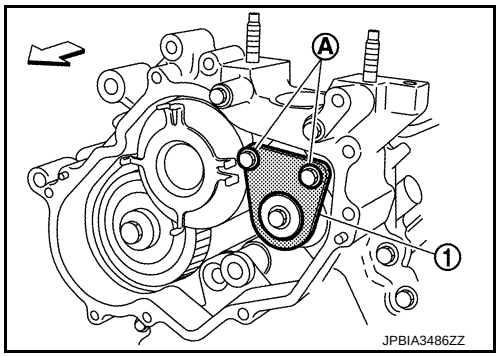
CAUTION:
Valve timing control solenoid valve is not reusable. Never remove it unless required.

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

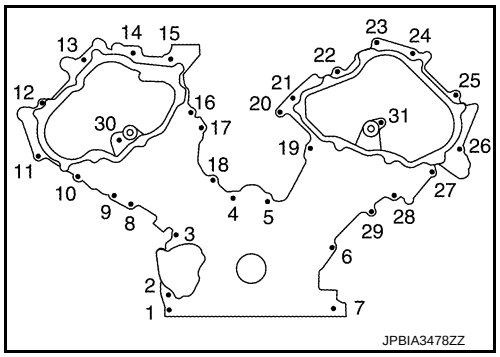


17. Remove rocker cover. Refer to EM-33, "Exploded View".
18. Obtain No. 1 cylinder at TDC of its compression stroke. Refer to EM-12, "Inspection".
19. Remove crankshaft pulley. Refer to EM-96, "FRONT OIL SEAL : Removal and Installation".
20. Remove water pump pulley. Refer to CO-18, "Exploded View".
21. Remove oil pan (lower) and oil strainer. Refer to EM-54, "Exploded View".
22. Remove oil pan (upper). Refer to EM-57, "Exploded View".
23. Remove front cover as per the following:

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



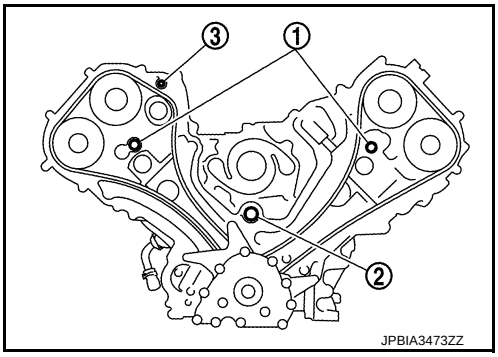
b. Loosen mounting bolts in reverse order as shown in the figure.



c. Insert a suitable tool into the notch at front cover.
- Pry off case by moving a suitable tool.

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.**

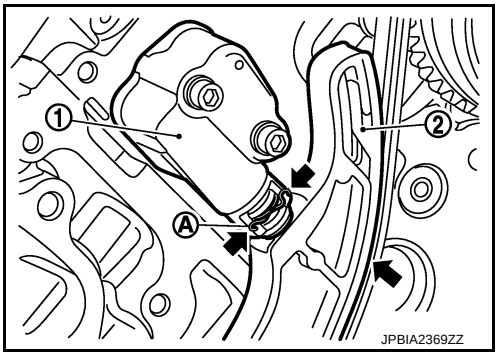
24. Remove oil pump and oil pump drive spacer.
25. Remove front oil seal from front cover using suitable tool.
    • Use screwdriver for removal.
    CAUTION:
    Be careful not to damage front cover.
26. Remove O-rings (1), (2), (3) from cylinder heads and cylinder block.



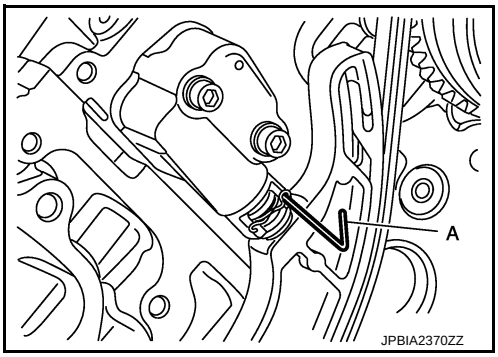
27. Remove oil filter (for valve timing control solenoid valve), if necessary.
28. Remove timing chain tensioner cover from front cover, if necessary.
    • Use seal cutter [SST: KV10111100 (J-37228)] to cut liquid gasket for removal.
29. Remove timing chain tensioner (bank 1) as per the following:
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

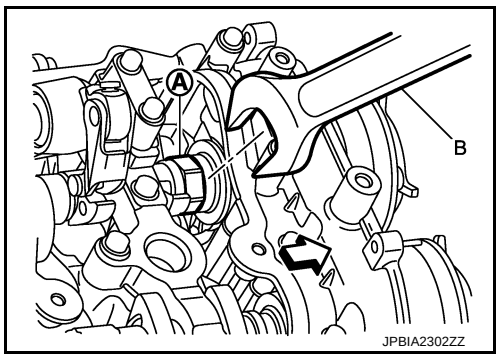


30. Remove high pressure fuel pump camshaft.
31. Remove tension guide and slack guide.
32. Remove exhaust camshaft sprocket as per the following:
    • Secure the hexagonal portion of exhaust camshaft using a wrench to loosen mounting bolt.
33. Remove timing chain and crankshaft sprocket.
    CAUTION: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

- 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.

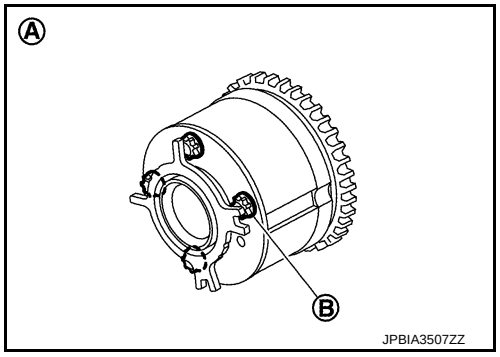
⇦ : Engine front

NOTE:
The figure shows an example of bank 2.



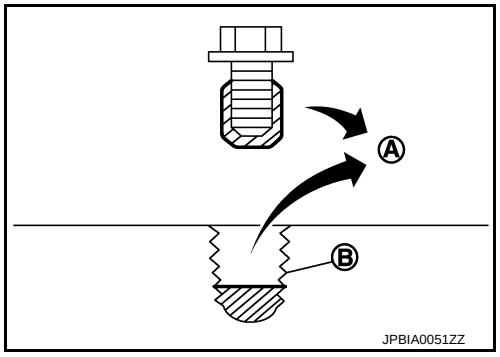
CAUTION:
- **Never loosen the mounting bolt by securing anything other than the camshaft (drive shaft) hexagonal portion or with tensioning the timing chain.**
- **When holding the hexagonal part of camshaft (drive shaft) with a wrench, be careful not to allow the wrench to cause interference with other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

A : Intake

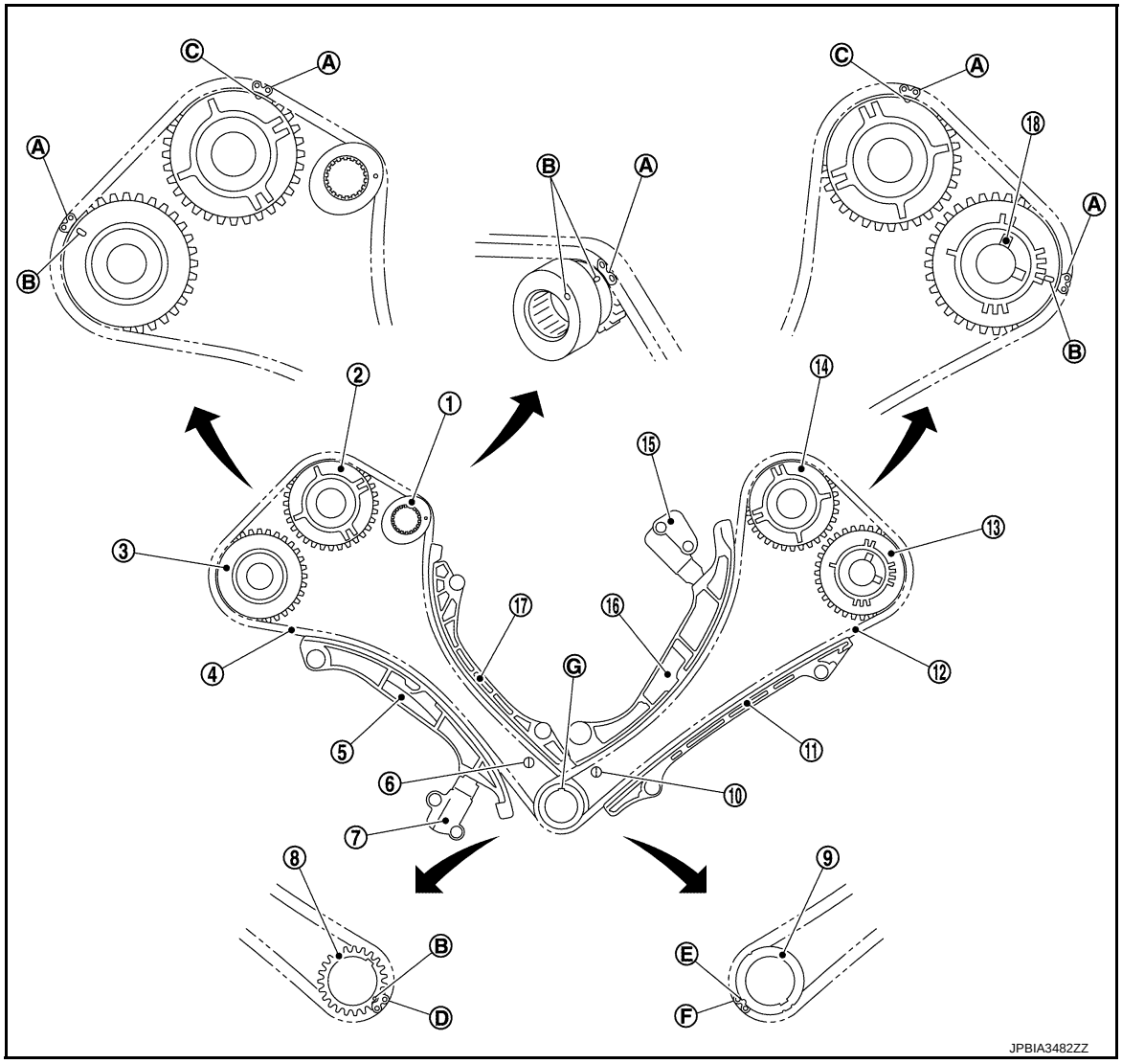


35. Use scraper to remove all traces of old liquid gasket from front cover and opposite mating surfaces.
- Remove old liquid gasket from bolt hole and thread.

A : Remove old liquid gasket that is stuck
B : Bolt hole



INSTALLATION



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				

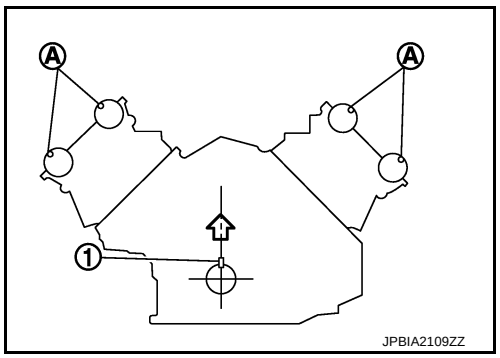
NOTE:

- 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.

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



Camshaft dowel pin

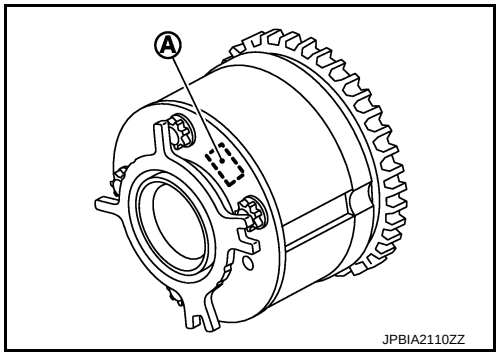
: At cylinder head upper face side in each bank

Crankshaft key

: Straight up

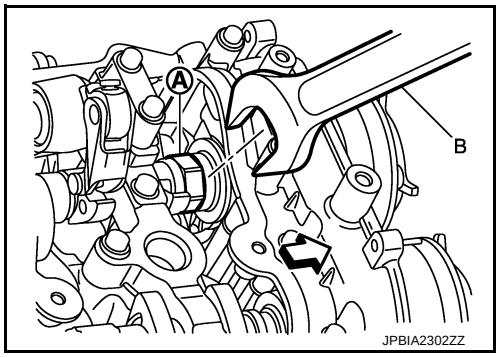
NOTE:
Though camshaft does not stop at the position as shown in the figure, for the placement of cam nose, it is generally accepted camshaft is placed for the same direction of the figure.

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-74, "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-74, "Exploded View".

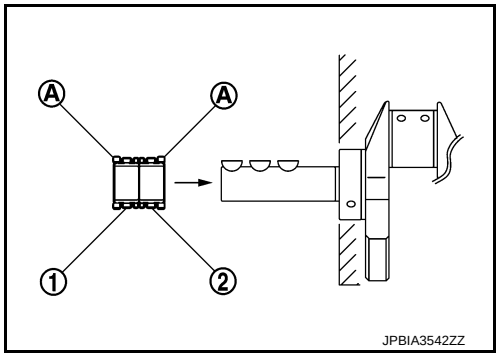


⇦ : Engine front

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.



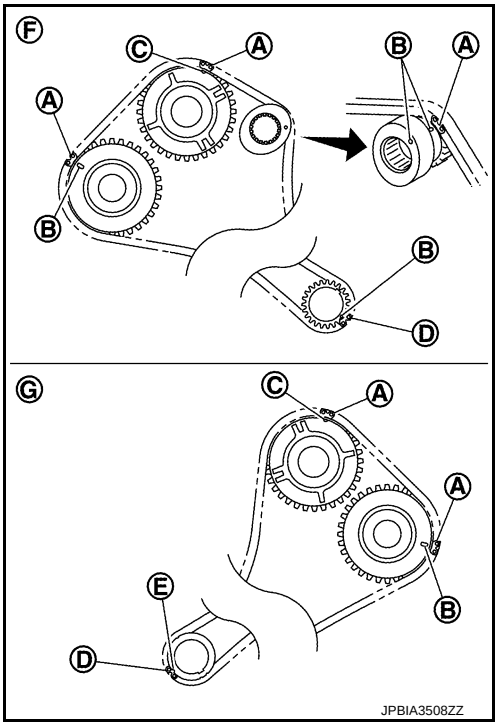
1 : Crankshaft sprocket (bank 1 side)
2 : Crankshaft sprocket (bank 2 side)

NOTE:
The same parts are used but facing directions are different.

b. Install timing chains.

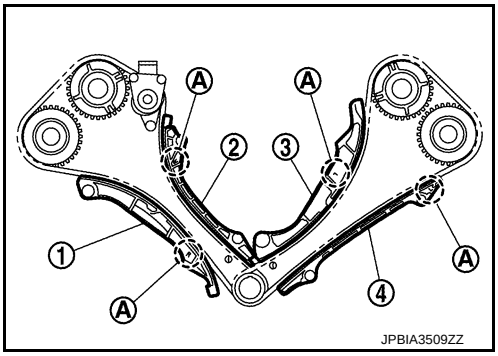
Bank 2 (F):
- Install timing chain so that the matching mark (punched) (B) and the matching mark (outer groove) (C) on camshaft sprocket is aligned with the copper link (A) on timing chain, while the matching mark (punched) (B) on crankshaft sprocket is aligned with the yellow link (D) one on timing 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.



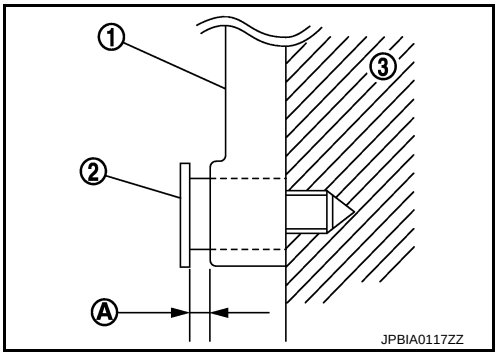
5. Install slack guides and tension guides onto correct side by checking with identification mark (A) on surface.

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



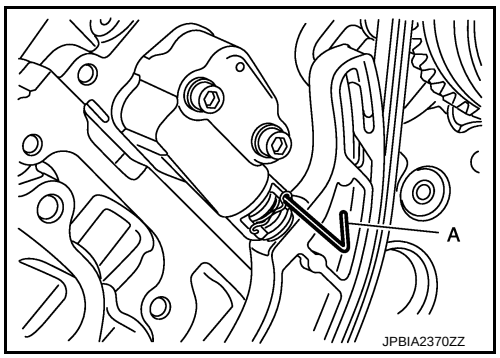
CAUTION:
Never overtighten slack guide mounting bolt (2). It is normal for a gap (A) to exist under the bolt seats when mounting bolt are tightened to the specification.

1 : Slack guide
3 : Cylinder block



6. Install timing chain tensioner as per the following:

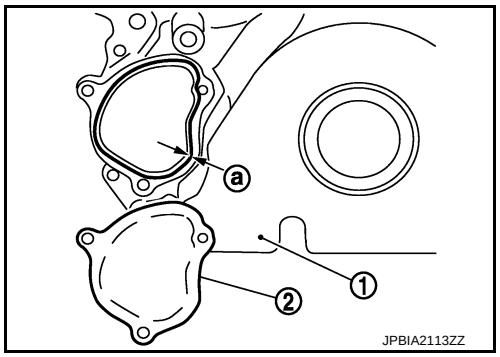
a. Fix the plunger at the most compressed position using a stopper pin (A).
   • Remove any dirt and foreign materials completely from the back and the mounting surfaces of timing chain tensioner.
b. Pull out stopper pin after installing, and then release plunger.



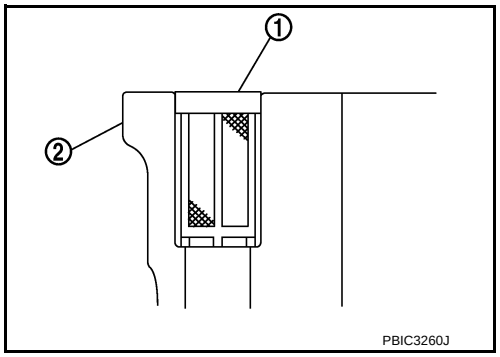
7. Check again that the matching marks on sprockets and timing chain have not slipped out of alignment.
8. Install oil pump and oil pump drive spacer. Refer to LU-13, "Exploded View".
9. Install front oil seal on front cover. Refer to EM-96, "FRONT OIL SEAL : Removal and Installation".
10. Install timing chain tensioner cover (2) to front cover (1).

    a : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)

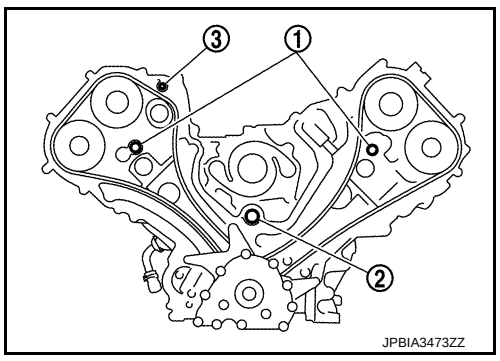
    • Apply a continuous bead of liquid gasket with tube presser (commercial service tool) to front cover as shown in the figure. **Use Genuine RTV silicone sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".**



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.

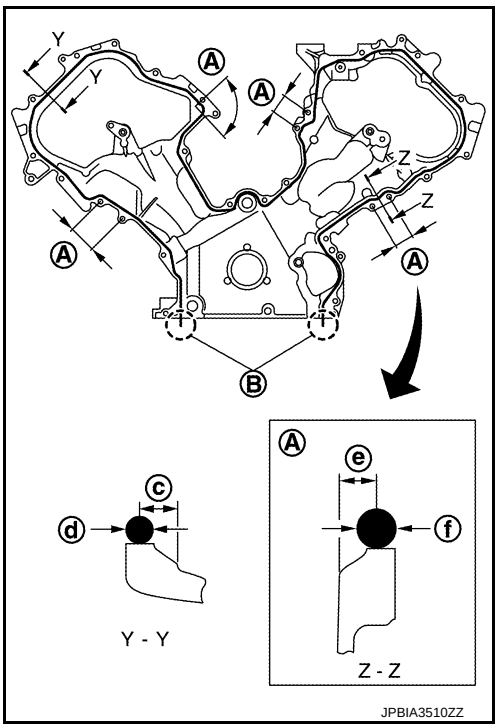


12. Install front cover as per the following:
a. Install new O-ring (1), (2), (3) onto cylinder heads and cylinder block.



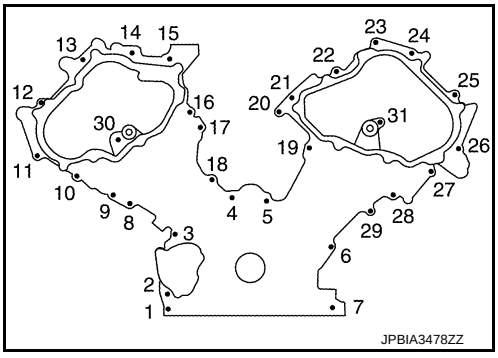
b. Apply a continuous bead of liquid gasket with tube presser (commercial service tool) to front cover as shown in the figure.
Use Genuine RTV silicone sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".

A : Junction between cylinder block and cylinder head
B : Protrusion
c : 4.3 - 5.3 mm (0.169 - 0.209 in)
d : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)
e : ϕ4.0 - 5.6 mm (0.157 - 0.220 in)
f : ϕ4.8 - 5.8 mm (0.189 - 0.228 in)



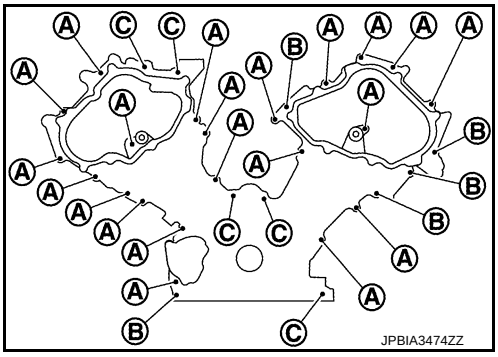
c. Check again that the matching marks on timing chain and that on each sprocket are aligned. Then, install front cover.
CAUTION:
Be careful not to damage front oil seal by interference with front end of crankshaft.

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



- There are three types of mounting bolts.

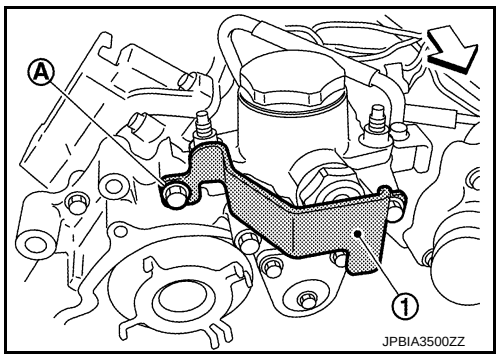
A : 0.79 in (0.79 in)
B : 1.77 in (1.77 in)
C : 3.15 in (3.15 in)



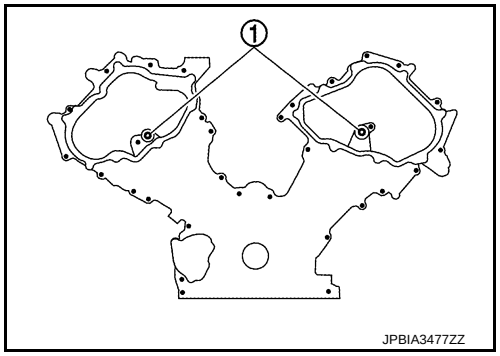
e. After all mounting bolts are tightened, retighten them in numerical order as shown in the figure.
CAUTION:
Be sure to wipe out any excessive liquid gasket leaking onto surface mating with oil pan.

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

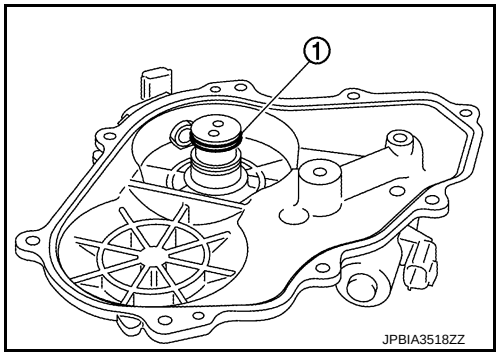
- Bolt (A) of fuel pump connector protector (1) cannot be installed after installing valve timing control cover. Therefore, install fuel pump connector protector in advance, if it is being removed.



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



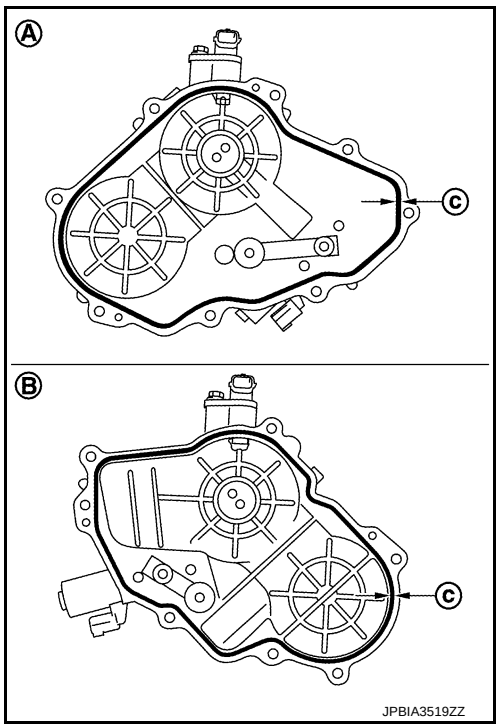
b. Install new seal rings (1) in shaft grooves.
CAUTION:
When replacing seal ring, replace all rings with new ones.



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 : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)

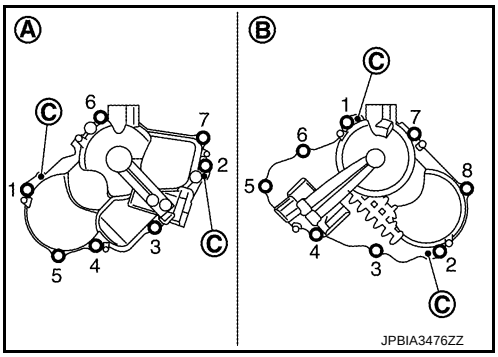
Use Genuine RTV silicone sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".



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-57, "Exploded View".
16. Install oil pan (lower) and oil strainer. Refer to EM-54, "Exploded View".
17. Install water pump pulley. Refer to CO-18, "Exploded View".
18. Install crankshaft pulley.
    • Fix the crankshaft as instructed in the removal procedure. Refer to EM-96, "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.

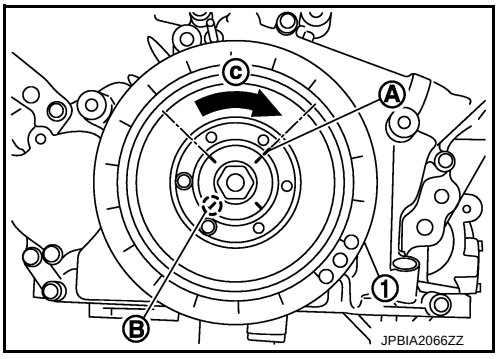
: 205 N·m (21 kg-m, 151 ft-lb)

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.

Inspection

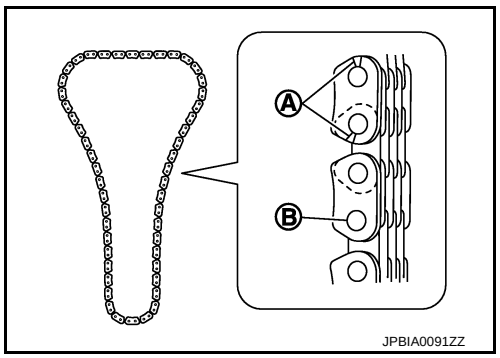
INFOID:0000000006289567

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

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 MA-10, "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:

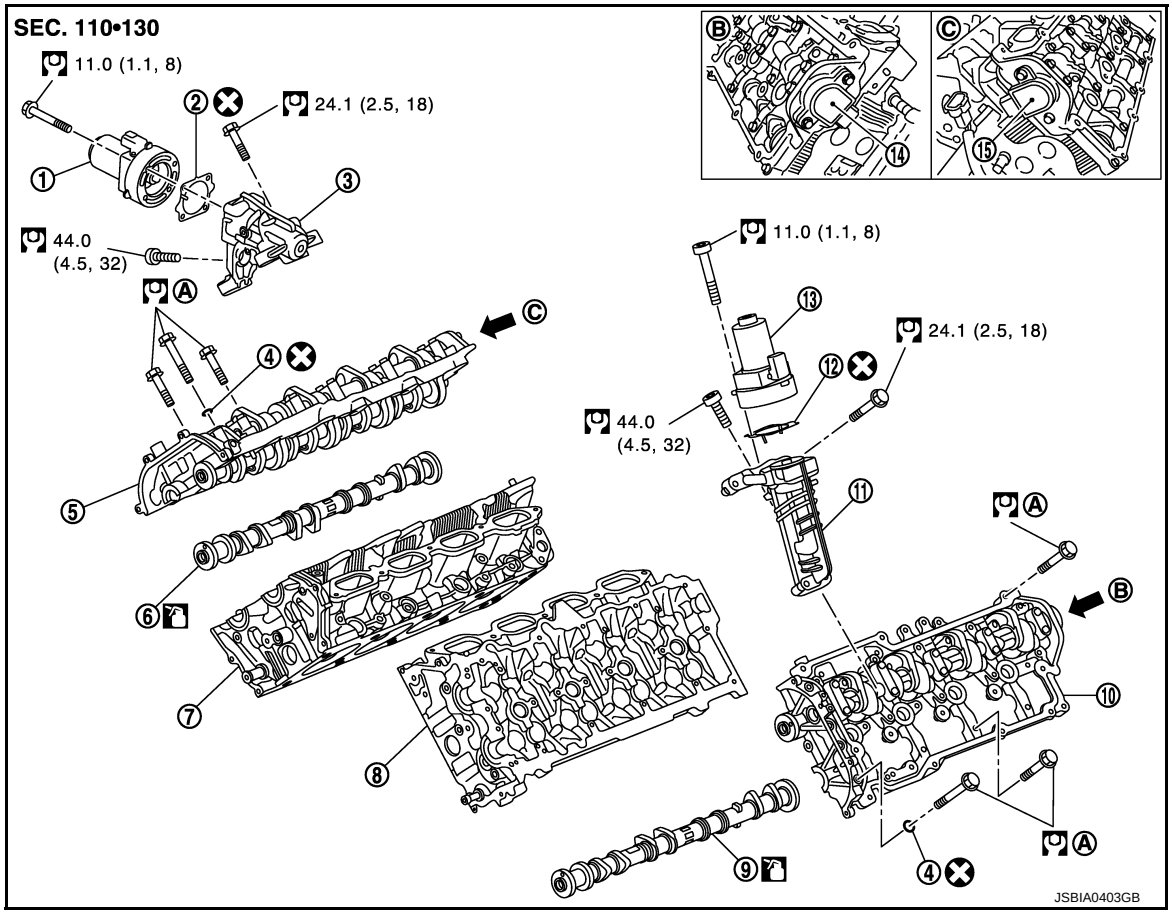
Items		Before starting engine	Engine running	After engine stopped
Engine coolant		Level	Leakage	Level
Engine oil		Level	Leakage	Level
Transmission / transaxle fluid	AT & CVT Models	Leakage	Level / Leakage	Leakage
	MT Models	Level / Leakage	Leakage	Level / Leakage
Other oils and fluids*		Level	Leakage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

* Power steering fluid, brake fluid, etc.

CAMSHAFT

Exploded View

INFOID:0000000006289568



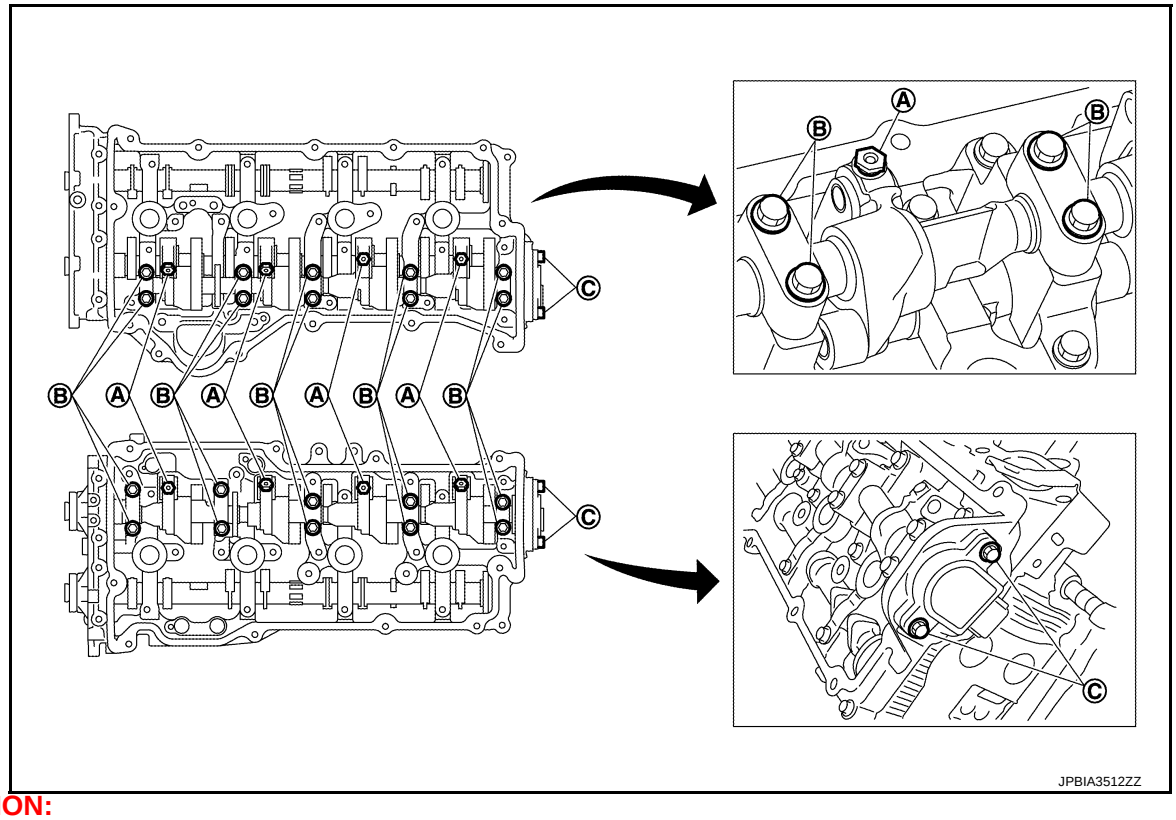
1.	VVEL actuator motor assembly (bank 2)	2.	Gasket	3.	VVEL actuator housing assembly (bank 2)
4.	Washer	5.	VVEL ladder assembly (bank 2)	6.	Exhaust camshaft (bank 2)
7.	Cylinder head (bank 2)	8.	Cylinder head (bank 1)	9.	Exhaust camshaft (bank 1)
10.	VVEL ladder assembly (bank 1)	11.	VVEL actuator housing 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)
A.	Comply with the installation procedure when tightening. Refer to EM-75, "Removal and Installation".	B.	View B	C.	View C

Refer to GI-4, "Components" for symbols in the figure.

Removal and Installation

INFOID:0000000006289569

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 EC-150, "Work Procedure".**

VVEL control shaft position sensor mounting bolt

: 7.0 N·m (0.71 kg-m, 62 in-lb)

NOTE:

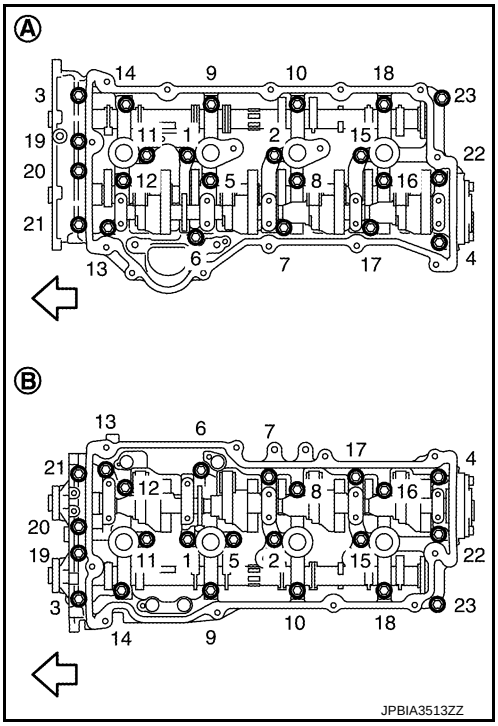
VVEL ladder assembly cannot be replaced as a single part, because it is machined together with cylinder head assembly.

1. Remove VVEL actuator motor assembly. Refer to EM-36, "Exploded View".
2. Remove rocker covers (bank 1 and bank 2). Refer to EM-33, "Exploded View".
3. Remove VVEL actuator housing assembly. Refer to EM-36, "Exploded View".
4. Remove front cover, camshaft sprockets, and timing chains. Refer to EM-61, "Exploded View".
5. Remove VVEL ladder assembly.

- 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.**



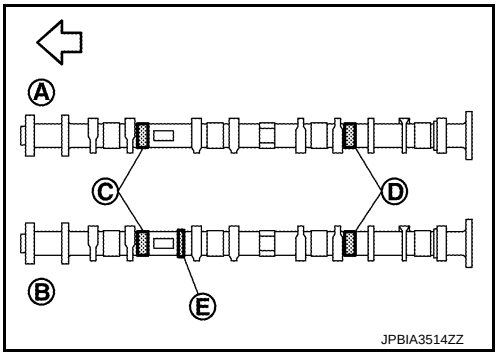
6. Remove exhaust camshaft.
7. Remove valve lifter, if necessary.
   - Identify installation positions, and store them without mixing them up.

INSTALLATION

1. Install valve lifter.
   - Install it in the original position.
2. 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

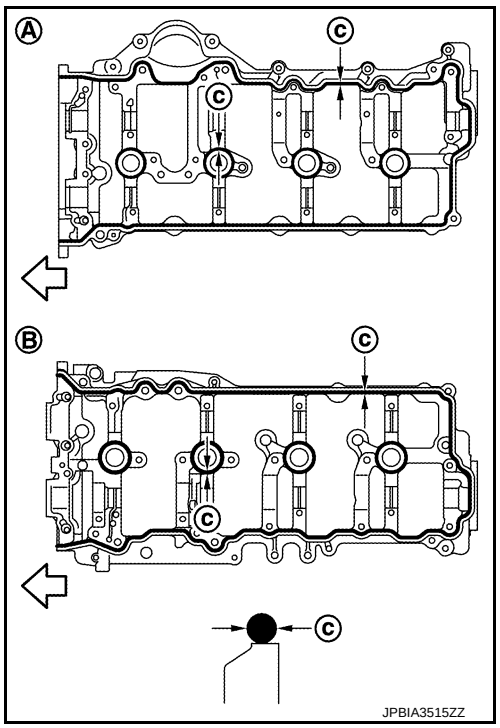


3. Install VVEL ladder assembly as per the following:

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 : ϕ3.4 - 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

i. Tighten bolts in numerical order as shown.

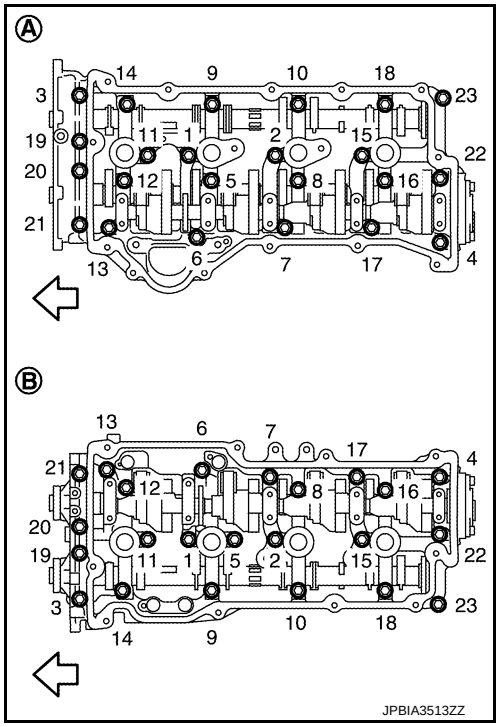
: 1.96 N·m (0.20 kg-m, 1 ft-lb)

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-61, "Exploded View".
5. Install VVEL actuator housing assembly. Refer to EM-36, "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 ladar assembly used. Adjust VVEL control shaft position sensor. Refer to EC-150, "Work Procedure".

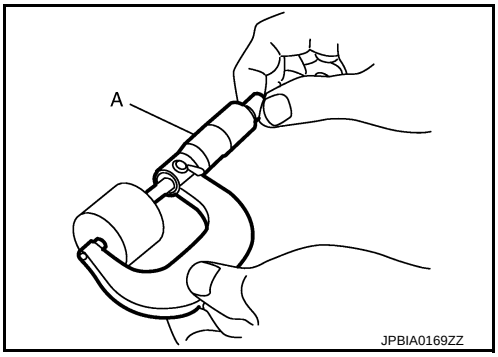
Inspection

INFOID:0000000006289570

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-75, "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

t_1 = Removed valve lifter (EXH) thickness

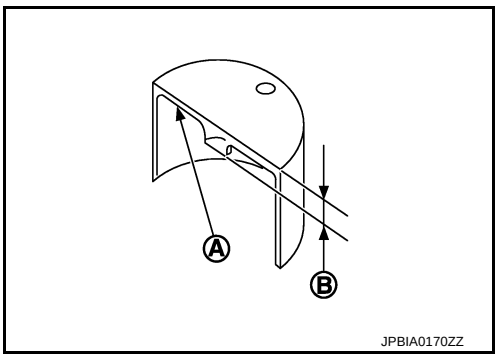
C_1 = Measured valve clearance

C_2 = 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)



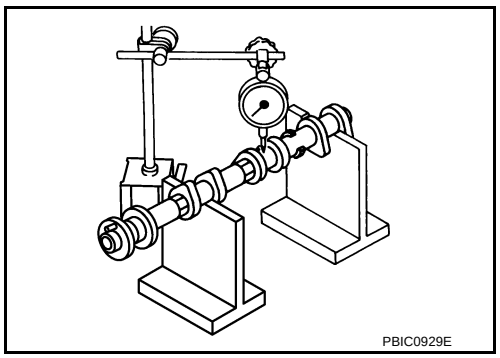
Available thickness of valve lifter (EXH): 27 sizes with range 7.88 to 8.40 mm (0.3102 to 0.3307 in) in steps of 0.02 mm (0.0008 in) (when manufactured at factory). Refer to EM-133, "Camshaft".

6. Install selected valve lifter (EXH).
7. Install VVEL ladder assembly and exhaust camshaft. Refer to EM-75, "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

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-133, "Camshaft".

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

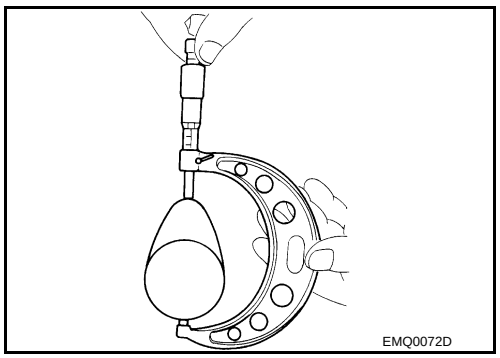
Exhaust Camshaft Cam Height

- Measure the exhaust camshaft cam height with a micrometer.

Standard and limit

: Refer to EM-133, "Camshaft".

- If wear exceeds the limit, replace exhaust camshaft.

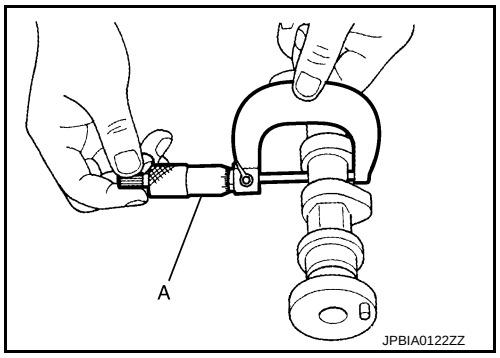


Exhaust Camshaft Journal Oil Clearance

EXHAUST CAMSHAFT JOURNAL DIAMETER

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

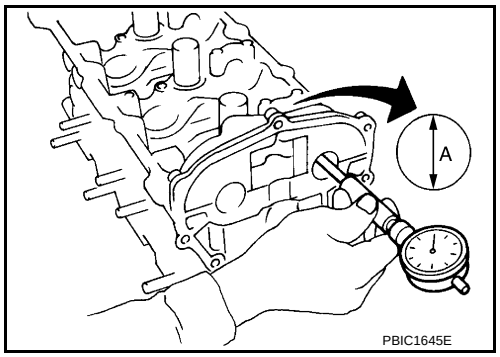
Standard : Refer to EM-133, "Camshaft".



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-133, "Camshaft".



EXHAUST CAMSHAFT JOURNAL OIL CLEARANCE

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

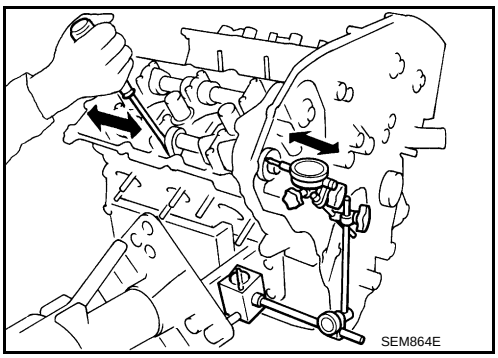
Standard and limit : Refer to EM-133, "Camshaft".

- 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-133, "Camshaft".

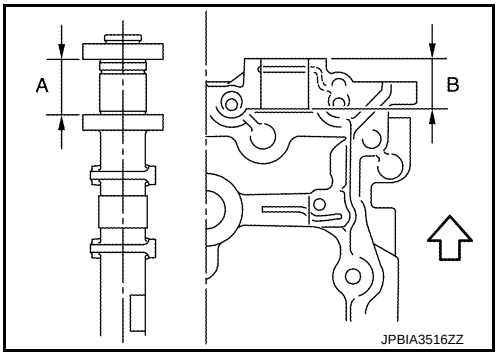


- Measure the following parts if out of the limit.
- Dimension “A” for exhaust camshaft No. 1 journal

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)



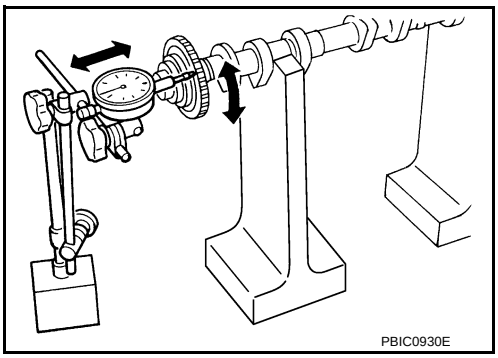
- Refer to the standards above, and then replace exhaust camshaft and/or VVEL ladder assembly & cylinder head assembly.
  NOTE:
  Cylinder head assembly cannot be replaced as a single part, because it is machined together with VVEL ladder assembly.

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)

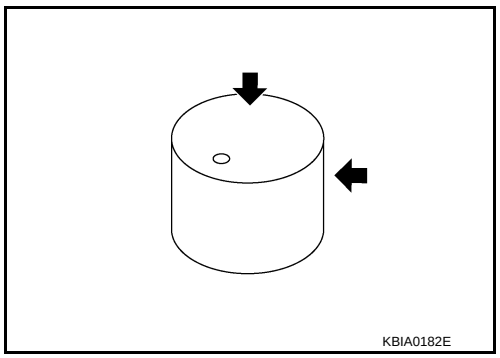
Limit : Refer to EM-133, "Camshaft".

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



Valve Lifter (EXH)

- Check if surface of valve lifter has any wear or crack.
- If wear or crack is found, replace valve lifter (EXH). Refer to EM-133, "Camshaft".

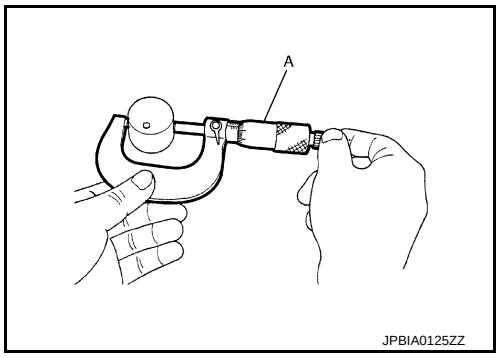


Valve Lifter Clearance (EXH)

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.

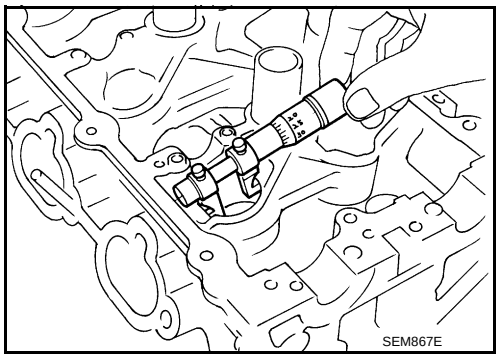
Standard : Refer to EM-133, "Camshaft".



VALVE LIFTER HOLE DIAMETER

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

Standard : Refer to EM-133, "Camshaft".



VALVE LIFTER CLEARANCE

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

Standard : Refer to EM-133, "Camshaft".

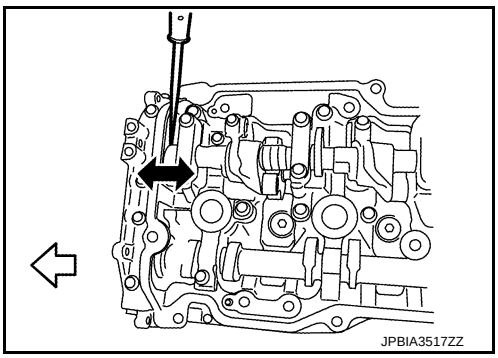
- If the calculated value is out of the standard, referring to each standard of valve lifter outer diameter and valve lifter hole diameter, replace either or both valve lifter and VVEL ladder assembly & cylinder head assembly.

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

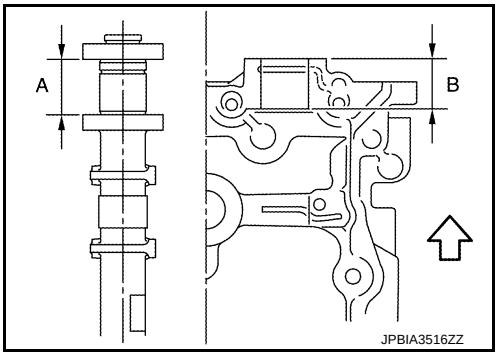
- Install a dial indicator in thrust direction on front end of drive shaft. Measure the end play of a dial indicator when drive shaft is moved forward/backward (in direction of axis).



⇦ : Engine front

Standard and limit : Refer to EM-133, "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)

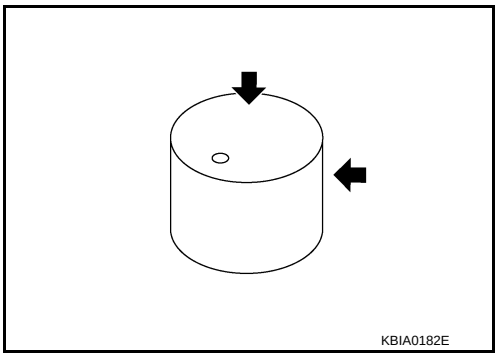
Limit : Refer to EM-133, "Camshaft".

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-133, "Camshaft".

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

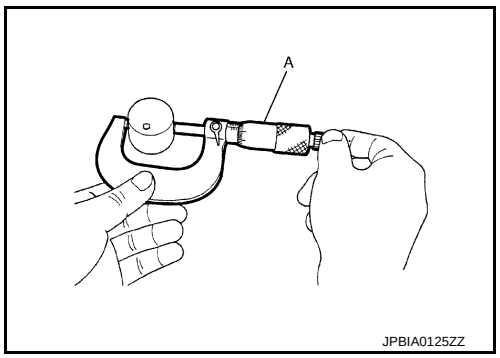


Valve Lifter Clearance (INT)

VALVE LIFTER OUTER DIAMETER

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

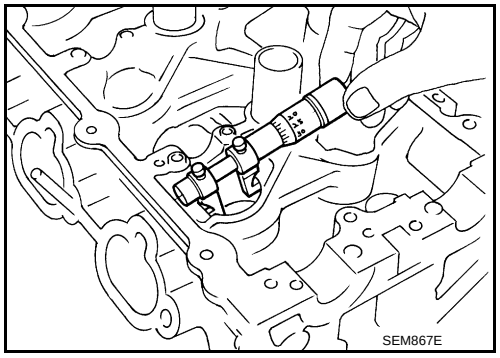
Standard : Refer to EM-133, "Camshaft".



VALVE LIFTER HOLE DIAMETER

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

Standard : Refer to EM-133, "Camshaft".



VALVE LIFTER CLEARANCE

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

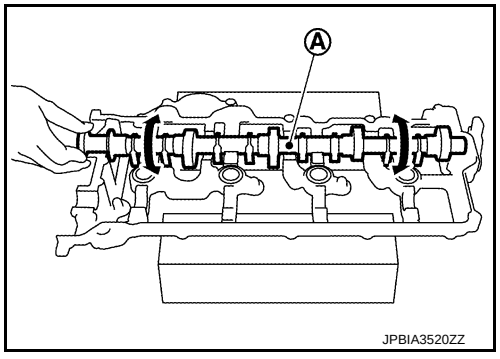
Standard : Refer to EM-133, "Camshaft".

- 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.

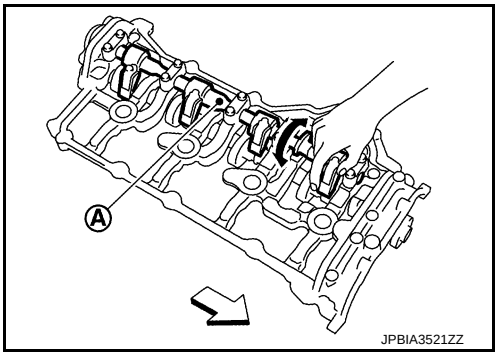


CONTROL SHAFT OPERATIONAL CHECK

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

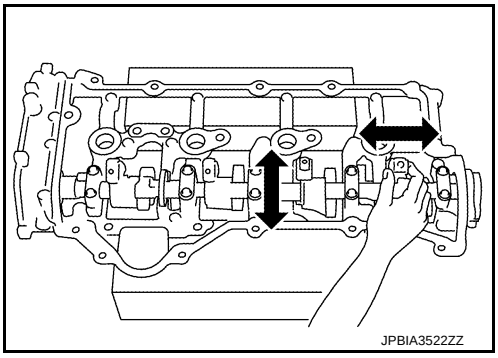
CAUTION:
Turn VVEL ladder assembly upside down to prevent the drive shaft from dropping off.

⇦ : 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:

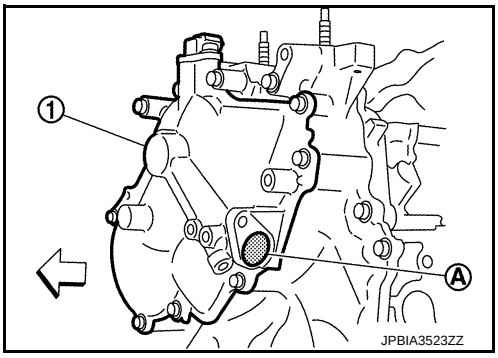
- **Perform this inspection only when DTC P0011, P0021 are detected in self-diagnostic results of CONSULT-III and it is directed according to inspection procedure of EC section. Refer to EC-177, "DTC Logic".**
- **Check when engine is cold to prevent burns from the splashing engine oil.**

1. Check engine oil level. Refer to LU-7, "Inspection".
2. Perform the following procedure to prevent the engine from being unintentionally started while checking.

a. Release the fuel pressure. Refer to EC-153, "Work Procedure".
b. Disconnect ignition coil and injector harness connectors.

3. Remove valve timing control solenoid valve. Refer to EM-61, "Exploded View".
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-61, "Exploded View".
   - Clean oil groove between oil strainer and valve timing control solenoid valve. Refer to LU-5, "Engine Lubrication System" and LU-6, "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-5, "Engine Lubrication System" and LU-6, "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 MA-10, "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:

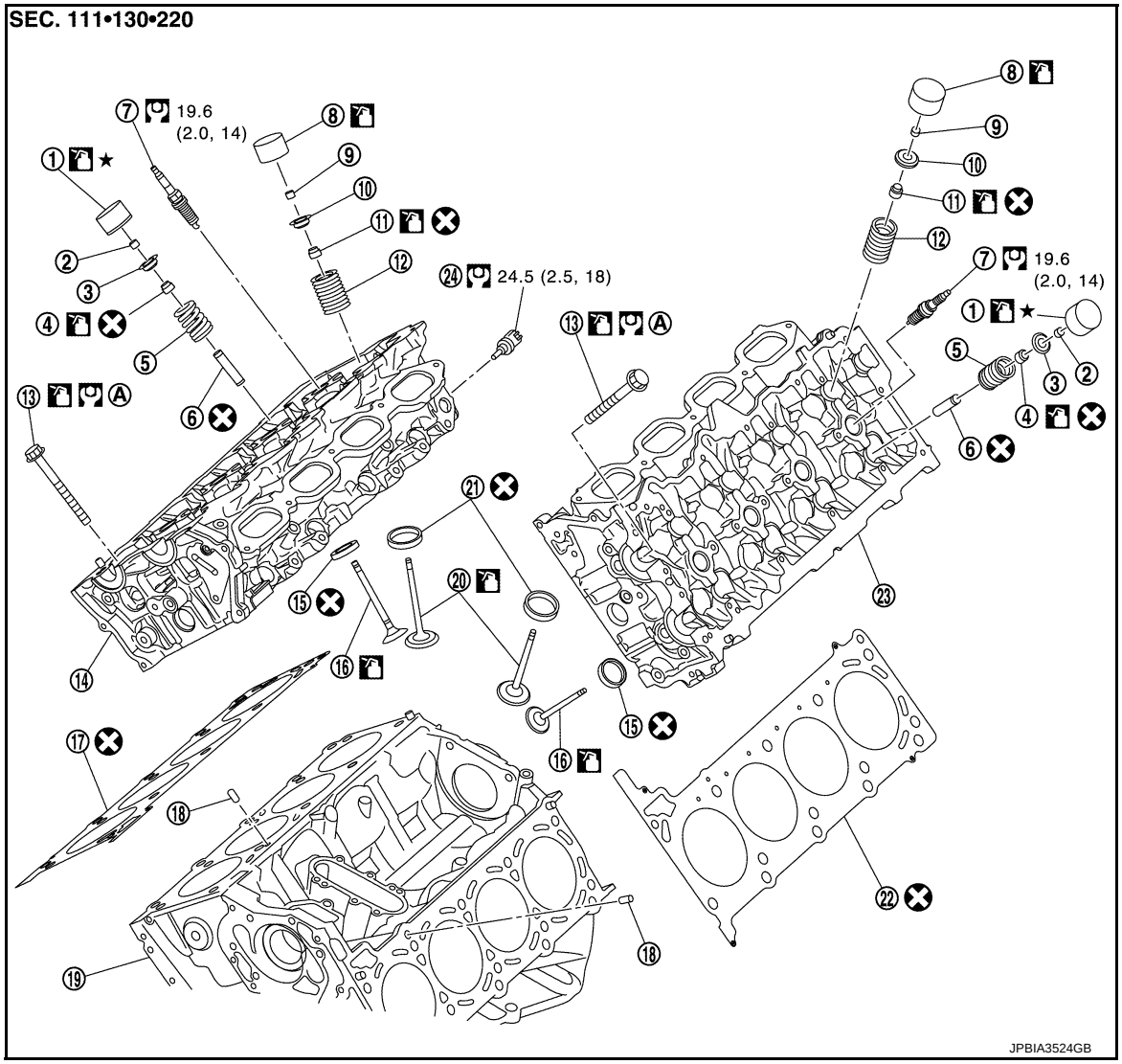
Items		Before starting engine	Engine running	After engine stopped
Engine coolant		Level	Leakage	Level
Engine oil		Level	Leakage	Level
Transmission / transaxle fluid	AT & CVT Models	Leakage	Level / Leakage	Leakage
	MT Models	Level / Leakage	Leakage	Level / Leakage
Other oils and fluids*		Level	Leakage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

* Power steering fluid, brake fluid, etc.

CYLINDER HEAD

Exploded View

INFOID:0000000006289571



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

A. Comply with the installation procedure when tightening. Refer to EM-87, "Removal and Installation".

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.

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

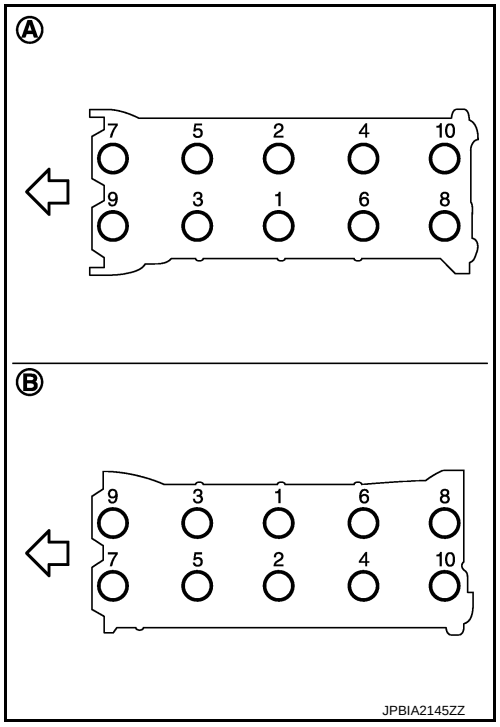
INFOID:0000000006289572

REMOVAL

1. Remove the following parts:
   - Rocker cover and spark plug: Refer to EM-33, "Exploded View".
   - Intake manifold: Refer to EM-30, "Exploded View".
   - Exhaust manifold: Refer to EM-40, "Exploded View".
   - Water inlet and thermostat housing: Refer to CO-20, "Exploded View".
   - Water pipe and heater pipe: Refer to CO-20, "Exploded View".
   - Timing chain: Refer to EM-61, "Exploded View".
   - Camshaft (EXH) and VVEL ladder assembly: Refer to EM-74, "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

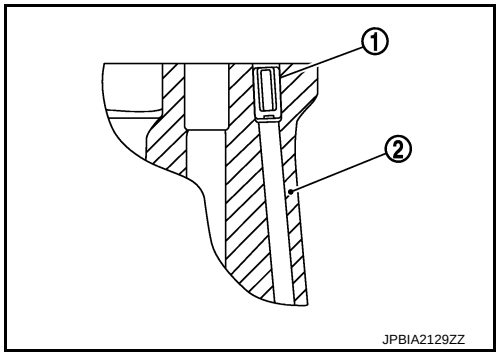
   - Use TORX socket and power tool.



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.

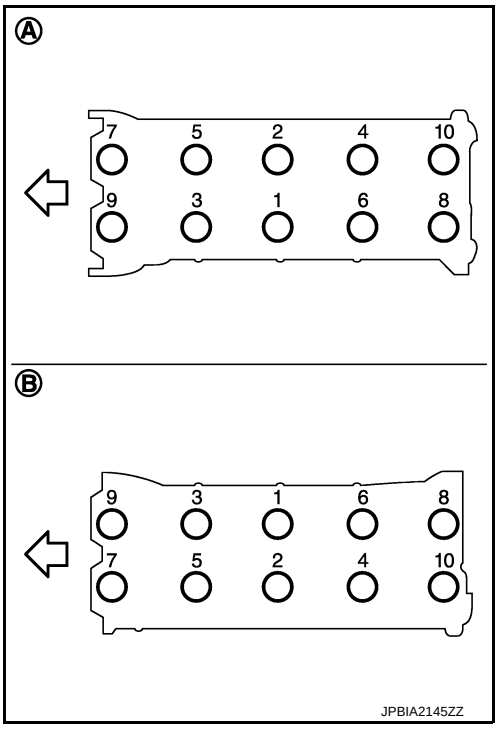


2. Install new cylinder head gaskets.
3. Install cylinder head as per the following:

CAUTION:

- **If cylinder head bolts are re-used, check their outer diameters before installation. Refer to EM-92, "Inspection".**
- **Before installing cylinder head, inspect cylinder head distortion. Refer to EM-92, "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

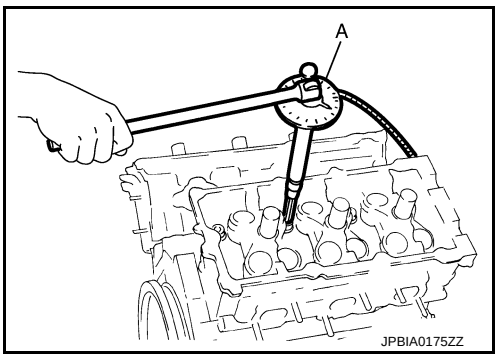
g. Tighten all cylinder head bolts again (clockwise).

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.



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

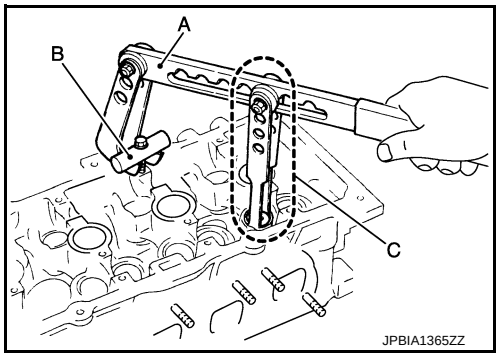
Disassembly and Assembly

INFOID:0000000006365632

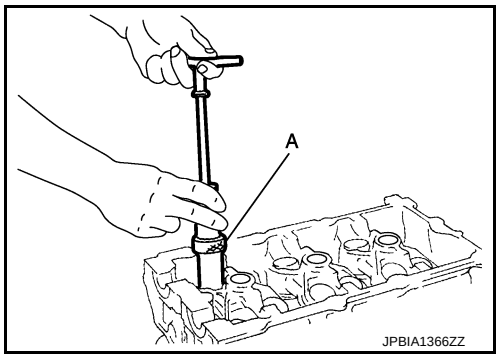
DISASSEMBLY

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.



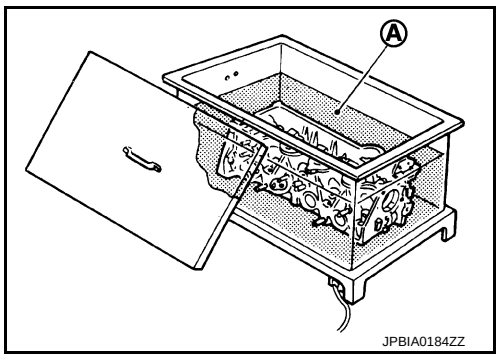
2. Remove valve spring retainer and valve spring (with valve spring seat).
3. Push valve stem to combustion chamber side, and remove valve.
   - Identify installation positions, and store them without mixing them up.
4. Remove valve oil seal using the valve oil seal puller [SST: KV10107902 (J38959)] (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-135, "Cylinder Head".

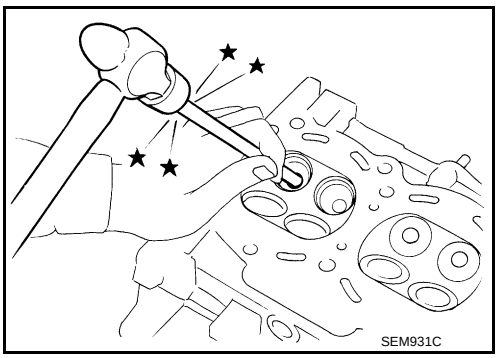
   CAUTION:
   Prevent to scratch cylinder head by excessive boring.
6. Remove valve guide (EXH), if valve guide (EXH) must be replaced.

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



b. Drive out valve guide (EXH) with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 lmp 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.

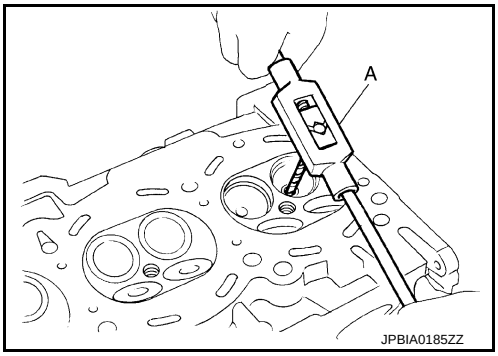


ASSEMBLY

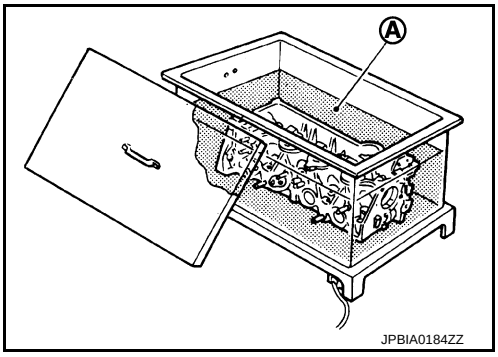
1. Install valve guide (EXH), if removed.
Replace with oversized [0.2 mm (0.008 in)] valve guide (EXH).

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-135, "Cylinder Head".



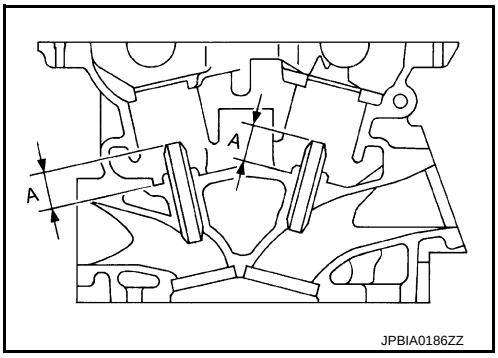
b. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil (A).



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

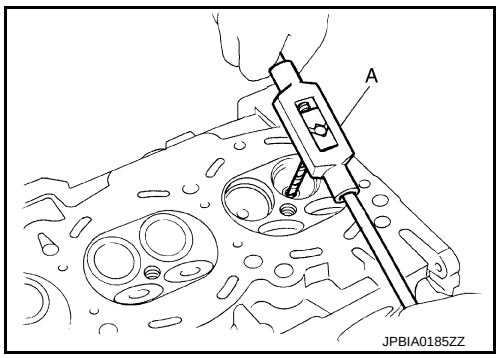
Projection (A)
: Refer to EM-135, "Cylinder Head".

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



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

Standard : Refer to EM-135, "Cylinder Head".

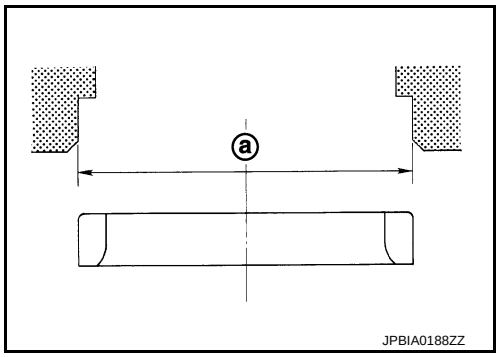


2. Install valve seat (EXH), if removed.
Replace with oversize [0.5 mm (0.020 in)] valve seat (EXH).

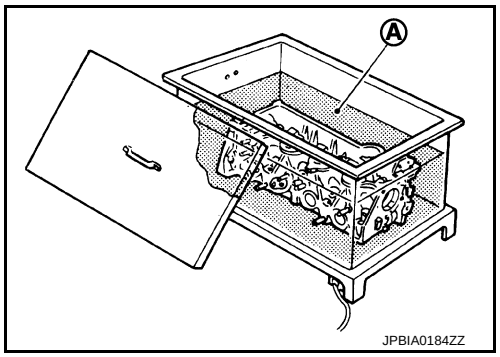
a. Ream cylinder head recess diameter (a) for service valve seat (EXH).

Oversize (service) [0.5 mm (0.020 in)]:
: Refer to EM-135, "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).

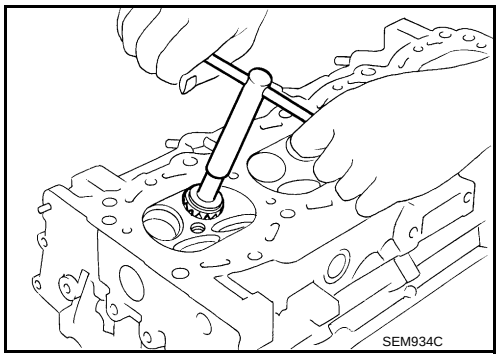


c. Provide valve seats (EXH) cooled well with dry ice. Force fit valve seat (EXH) into cylinder head.

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-135, "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-92, "Inspection".

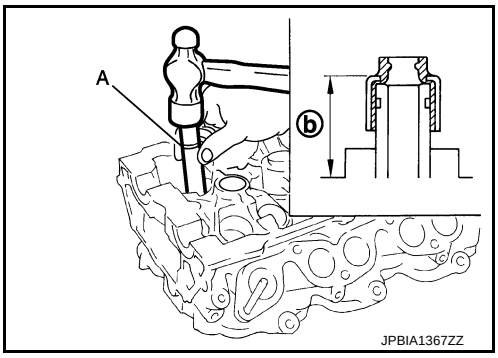
3. Install new valve oil seals as per the following:

a. Apply new engine oil on new valve oil seal joint and seal lip.

b. 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)



4. Install valve.
NOTE:
Larger diameter valves are for intake side.

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

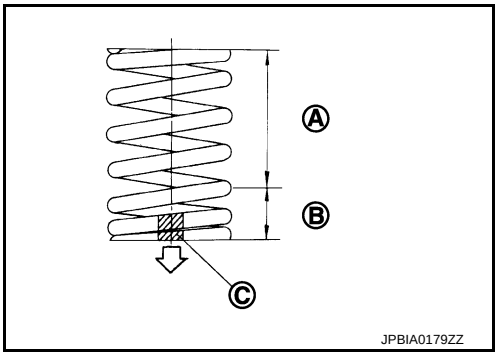
A : Wide pitch

⇦ : Cylinder head side

Paint mark color

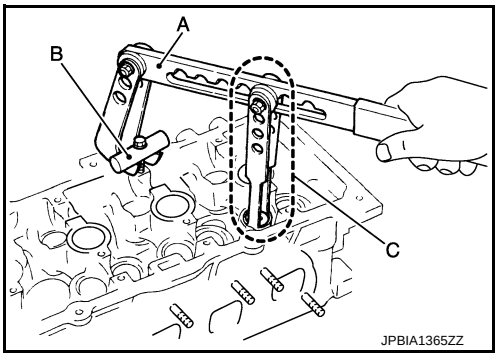
Intake : Light green

Exhaust : Light blue



6. Install valve spring retainer.

7. 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

INFOID:0000000006289573

INSPECTION AFTER DISASSEMBLY

Cylinder Head Bolts Outer Diameter

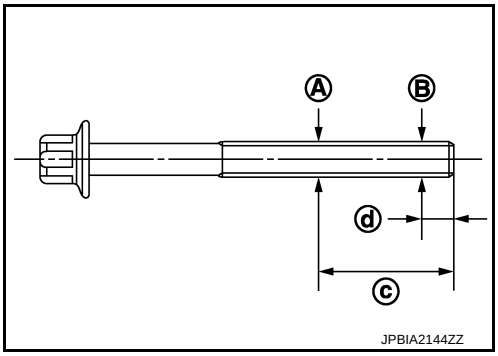
- Cylinder head bolts are tightened by plastic zone tightening method. Whenever the size difference between (B) and (A) exceeds the limit, replace them with new one.

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

c : 55 mm (2.17 in)

d : 12 mm (0.47 in)

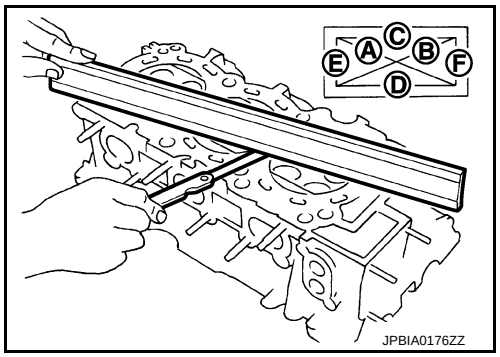
- If reduction of outer diameter appears in a position other than (A), use it as (A) point.



Cylinder Head Distortion

NOTE:
When performing this inspection, cylinder block distortion should be also checked. Refer to EM-115, "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-135, "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.

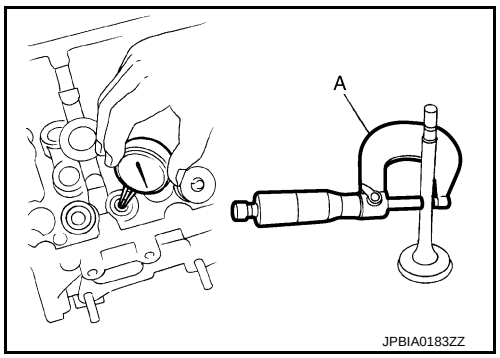
Valve Dimensions

- Check the dimensions of each valve. For the dimensions, refer to EM-135, "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-86, "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-135, "Cylinder Head".

Valve Guide Inner Diameter

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

Standard : Refer to EM-135, "Cylinder Head".

Valve Guide Clearance

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

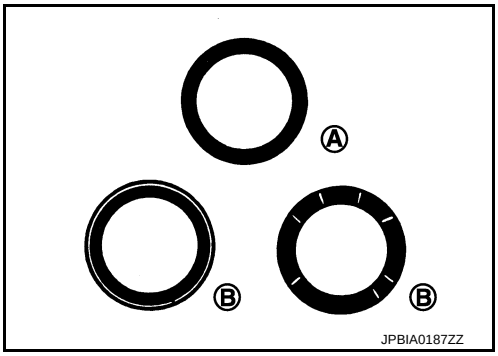
Standard : Refer to EM-135, "Cylinder Head".

- If the calculated value exceeds the limit.
  - Replace valve (EXH) and/or valve guide (EXH). Refer to EM-86, "Exploded View". (Exhaust side)
  - Replace VVEL ladder assembly & cylinder head assembly. Refer to EM-86, "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.

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



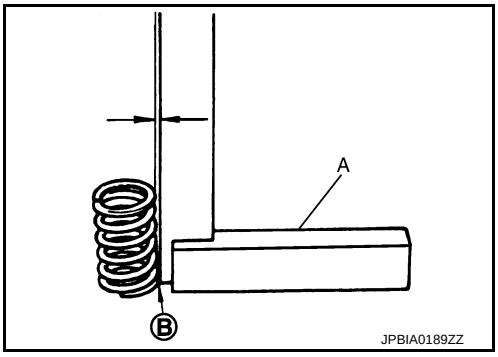
A : OK
B : NG

- 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-86, "Exploded View". (Exhaust side)
- If not, replace VVEL ladder assembly & cylinder head assembly. Refer to EM-86, "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

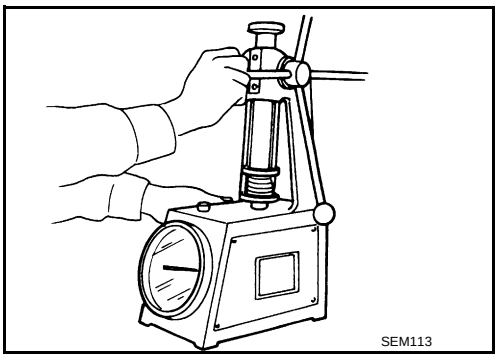
Limit : Refer to EM-135, "Cylinder Head".

- If it exceeds the limit.
- Replace valve spring (with valve spring seat) (EXH). Refer to EM-86, "Exploded View". (Exhaust side)
- Replace VVEL ladder assembly & cylinder head assembly. Refer to EM-86, "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-135, "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-86, "Exploded View". (Exhaust side)
- Replace VVEL ladder assembly & cylinder head assembly. Refer to EM-86, "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 MA-10, "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.

OIL SEAL

FRONT OIL SEAL

FRONT OIL SEAL : Removal and Installation

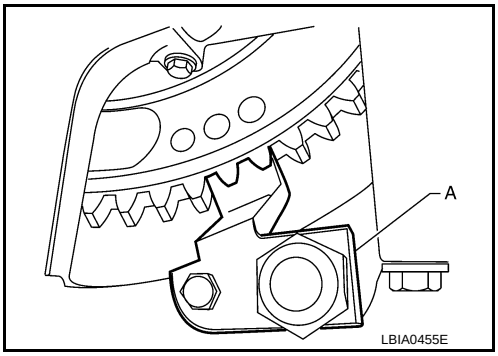
INFOID:0000000006289574

REMOVAL

1. Remove the following parts:
   - Front under cover, using a power tool. Refer to EXT-25, "Exploded View".
   - Drive belt: Refer to EM-20, "Exploded View".
   - Cooling fan: Refer to CO-16, "Exploded View".
2. Remove crankshaft pulley as per the following:

a. Remove rear plate cover. Refer to EM-54, "Exploded View".

b. Set the ring gear stopper [SST: KV10120100 (J-47245)] (A) as shown in the figure.

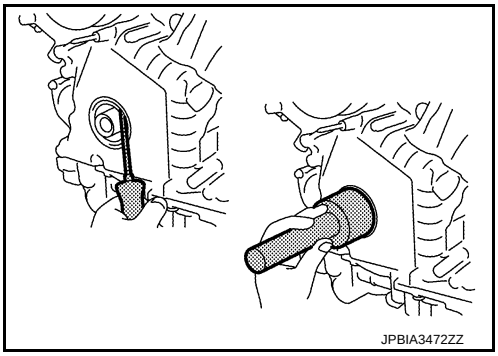


c. Loosen crankshaft pulley bolt, and then pull crankshaft pulley with both hands to remove it.

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.

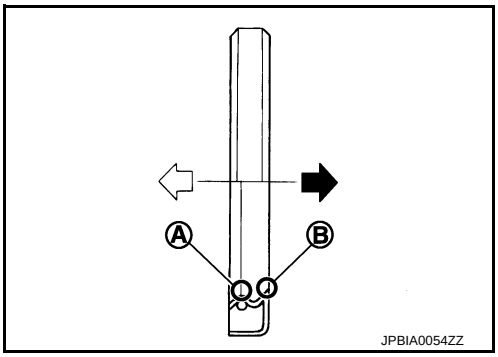


INSTALLATION

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.

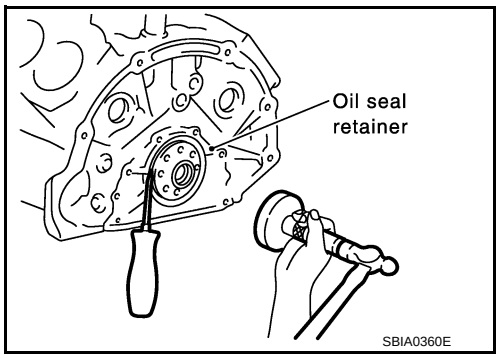
REAR OIL SEAL

REAR OIL SEAL : Removal and Installation

INFOID:0000000006289575

REMOVAL

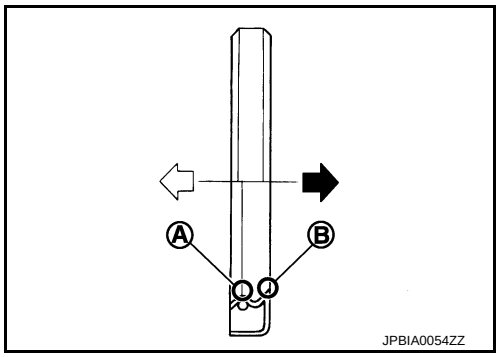
1. Remove transmission assembly. Refer to TM-205, "2WD : Exploded View" (2WD models) or TM-208, "4WD : Exploded View" (4WD models).
2. Remove drive plate. Refer to EM-106, "Exploded View".
3. Remove rear oil seal with a suitable tool.
   CAUTION:
   Be careful not to damage crankshaft and cylinder block.



INSTALLATION

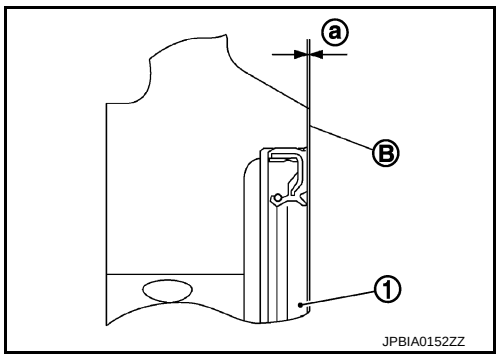
1. Install rear oil seal.
   - Install rear oil seal so that each seal lip is oriented as shown in the figure.

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

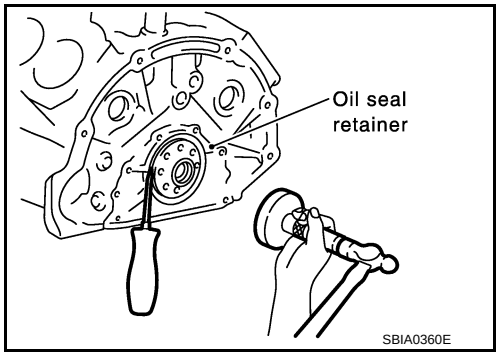


- Press in rear oil seal (1) to the position as shown in the figure.

   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.

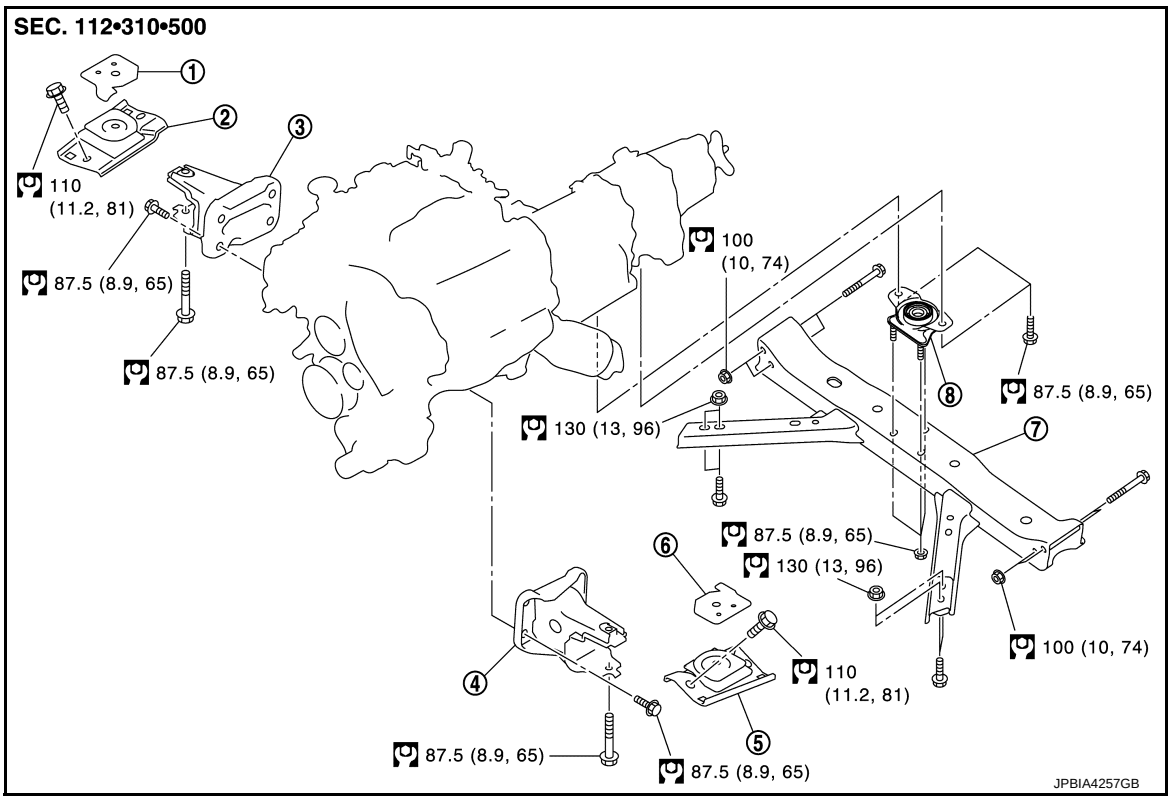
UNIT REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

Exploded View

INFOID:0000000006289576

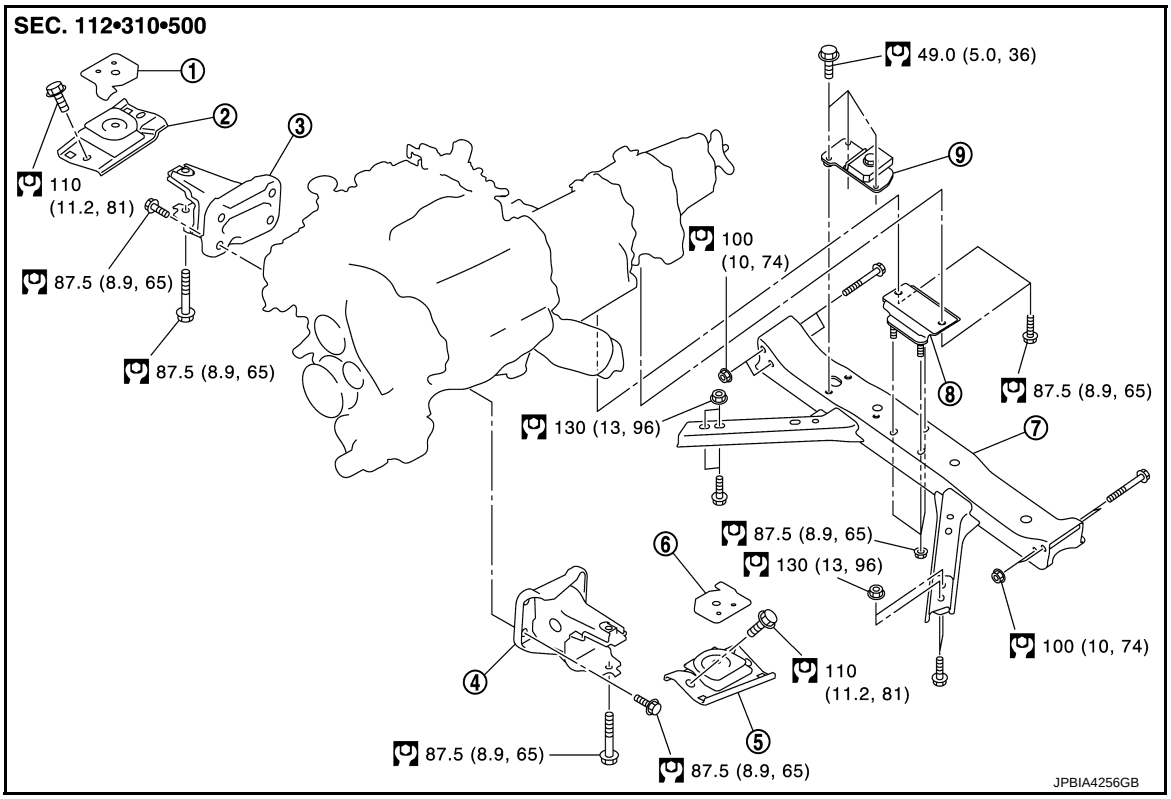
2WD models



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.

4WD 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
9. Dynamic damper

Refer to GI-4, "Components" for symbols in the figure.

Removal and Installation

INFOID:0000000006289577

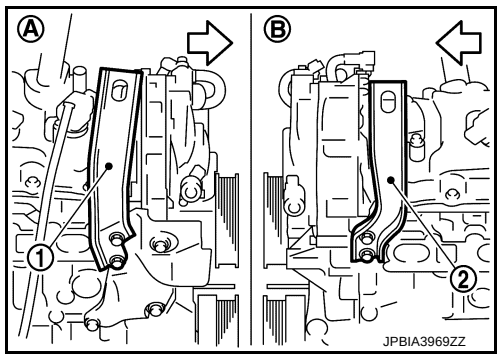
WARNING:
- **Situate the vehicle on a flat and solid surface.**
- **Place chocks at the front and back of rear wheels.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.**

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-32, "Garage Jack and Safety Stand".**

NOTE:
When removing/installing only the engine mounting, the hold engine assembly as instructed bellow:

1. Remove hood assembly. Refer to DLK-215, "Exploded View".
2. Remove the following components and related parts:
   - Battery. Refer to PG-164, "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-27, "Exploded View".

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

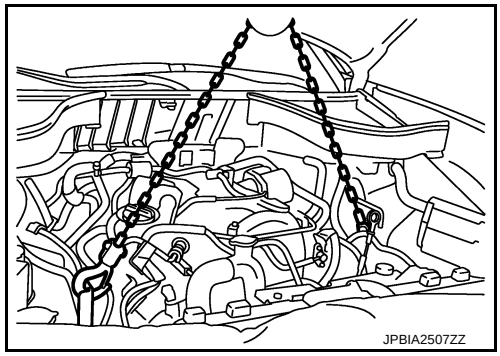


A : Engine front slinger (bank 2)
B : Engine front slinger (bank 1)

Slinger bolts:

: 45.0 N·m (4.6 kg-m, 33 ft-lb)

4. 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

1. Remove engine cover. Refer to EM-25, "Exploded View".
2. Release fuel pressure. Refer to EC-153, "Work Procedure".
3. Remove battery and tray. Refer to PG-164, "Exploded View".
4. Remove the following components and related parts:
   - Hood assembly. Refer to DLK-215, "Exploded View".
   - Front under cover. Refer to EXT-25, "Exploded View".
   - Front road wheel and tires. Refer to WT-64, "Exploded View".
5. Drain engine oil. Refer to LU-8, "Draining".
6. Drain engine coolant. Refer to CO-8, "Draining".
   CAUTION:
   - **Perform this step when engine is cold.**
   - **Never spill engine coolant on drive belts.**
7. Drain power steering fluid. Refer to ST-54, "Exploded View".

Engine Room Front

1. Remove drive belt. Refer to EM-20, "Exploded View".
2. Remove fan shroud. Refer to CO-13, "Exploded View".
3. Remove cooling fan and fan coupling. Refer to CO-16, "Exploded View".
4. Remove radiator hoses (upper and lower).
5. Remove radiator.

Vehicle Underbody

1. Remove exhaust front tube. Refer to EX-5, "Exploded View".
2. Remove protector A and B. Refer to SCS-32, "FRONT TUBE ASSEMBLY : Exploded View".
3. Remove front suspension rear cross member. Refer to TM-205, "2WD : Exploded View" (2WD models) or TM-208, "4WD : Exploded View" (4WD models).
4. Remove oil cooler. Refer to LU-11, "Exploded View".

5. Remove A/T assembly. Refer to TM-205, "2WD : Exploded View" (2WD models) or TM-208, "4WD : Exploded View" (4WD models).
6. Remove steering gear assembly. Refer to ST-41, "Exploded View".
7. Remove front final drive assembly. Refer to DLN-162, "Exploded View".
8. Remove exhaust manifold. Refer to EM-40, "Exploded View".
9. Remove alternator. Refer to CHG-25, "Exploded View".

Engine Room LH

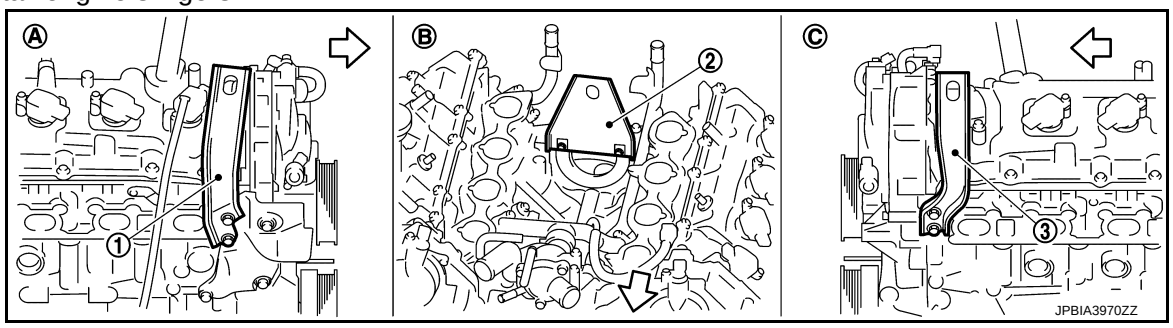
1. Remove air cleaner and air duct. Refer to EM-27, "Exploded View".
2. Remove A/C compressor. Refer to HA-30, "Exploded View".
3. Disconnect fuel feed hose and EVAP hose. Refer to EM-43, "Exploded View".
   CAUTION:
   Fit plugs onto disconnected hoses to prevent fuel leakage.

Engine Room RH

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

Removal Work

1. Install alternator bracket. Refer to CHG-25, "Exploded View".
   - Temporarily tighten mounting bolts.
2. Remove intake manifold. Refer to EM-30, "Exploded View".
3. Remove starter motor. Refer to STR-17, "Exploded View".
4. Install engine slingers.

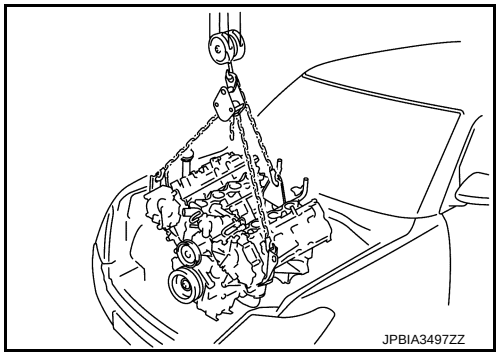


A Engine front slinger (bank 2) B Engine rear slinger C Engine front slinger (bank 1)

Slinger bolts:

: 45.0 N·m (4.6 kg-m, 33 ft-lb)

5. Lift using a hoist and secure the engine in position.
6. Remove engine mounting bracket (LH, RH) and engine mounting insulator (LH, RH). Refer to EM-98, "Exploded View".
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:0000000006289578

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 MA-10, "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.

UNIT DISASSEMBLY AND ASSEMBLY

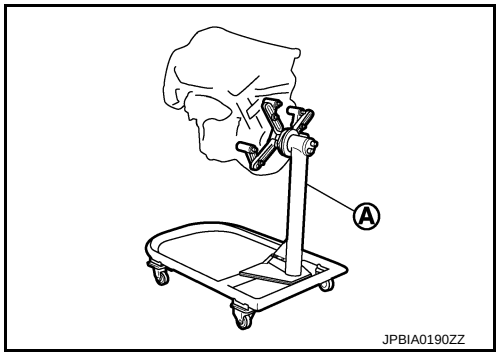
ENGINE STAND SETTING

Setting

INFOID:0000000006289579

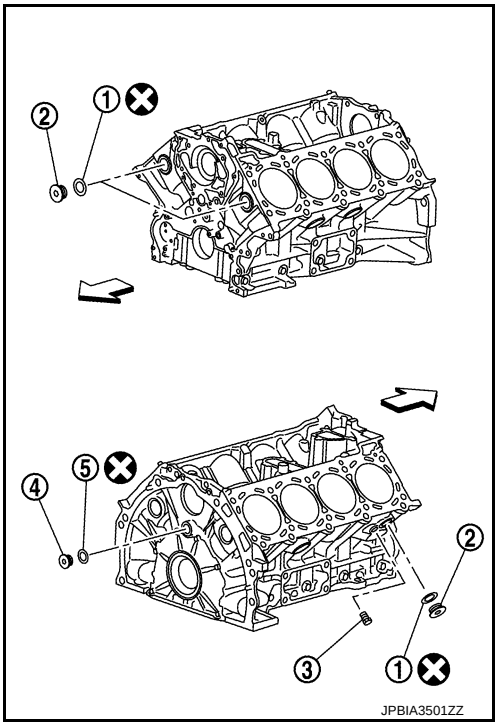
NOTE:
Explained here is how to disassemble with engine stand supporting transmission surface. When using a different type of engine stand, note the difference in the steps, etc.

1. Remove the engine assembly from the vehicle. Refer to EM-98, "Exploded View".
2. Remove crankshaft pulley. Refer to EM-96, "FRONT OIL SEAL : Removal and Installation".
   NOTE:
   The drive plate is fixed with a ring gear stopper [SST: KV10119200 (J-49277)]. 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.
   • Fix crankshaft with a ring gear stopper [SST: KV10119200 (J-49277)]. Loosen drive plate mounting bolt with power tool.
   • Check for deformation or damage of drive plate. Refer to EM-115, "Inspection".
   NOTE:
   The procedure is described assuming that you use a widely used engine stand holding the surface, to which transmission is installed.
4. Remove pilot converter using the pilot bushing puller (commercial service tool), if necessary.
5. 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-30, "Exploded View".
   - Remove fuel injector and fuel tube assembly. Refer to EM-48, "Exploded View".
   - Remove ignition coil. Refer to EM-29, "Exploded View".
   - Remove rocker cover. Refer to EM-33, "Exploded View".
   - Remove exhaust manifold. Refer to EM-40, "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.



6. Drain engine oil. Refer to LU-8, "Draining".

7. 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

Disassembly

INFOID:0000000006289580

1. Remove intake manifold. Refer to EM-30, "Exploded View".
2. Remove exhaust manifold. Refer to EM-40, "Exploded View".
3. Remove oil pan (lower). Refer to EM-54, "Exploded View".
4. Remove ignition coil and spark plug. Refer to EM-23, "Exploded View".
5. Remove rocker cover. Refer to EM-33, "Exploded View".
6. Remove timing chain. Refer to EM-61, "Exploded View".
7. Remove exhaust camshaft and VVEL ladder assembly. Refer to EM-74, "Exploded View".
8. Remove cylinder head. Refer to EM-86, "Exploded View".

Assembly

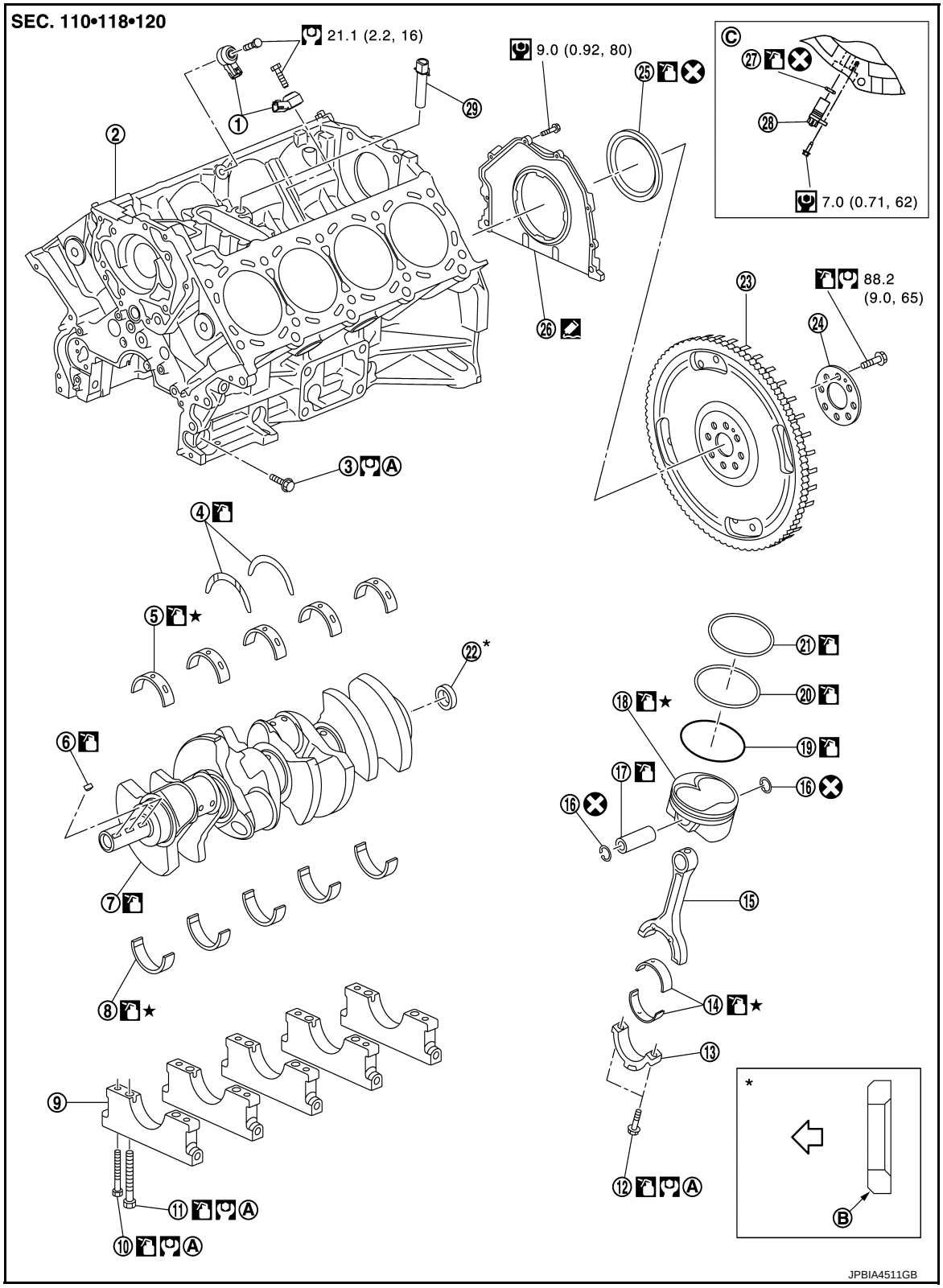
INFOID:0000000006289581

Assemble in the reverse order of disassembly.

CYLINDER BLOCK

Exploded View

INFOID:0000000006289582



1. Knock sensor
2. Cylinder block
3. Side bolt
4. Thrust bearing
5. Main bearing (upper)
6. Crankshaft key
7. Crankshaft
8. Main bearing (lower)
9. Main bearing cap

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. Pilot converter	23. Drive plate	24. Reinforcement plate
25. Rear oil seal	26. Rear oil seal retainer	27. O-ring
28. Crankshaft position sensor (POS)	29. Cylinder block heater (for Canada)	
A. Comply with the assembly procedure when tightening. Refer to EM-107.	B. Chamfered	C. Installed on transmission

⇦ : Crankshaft side

Refer to GI-4, "Components" for symbol marks in the figure.

Disassembly and Assembly

INFOID:0000000006289583

DISASSEMBLY

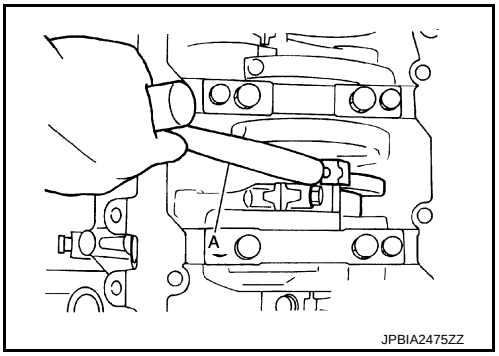
1. Remove the following parts:
   - Oil pans (lower and upper): Refer to EM-54, "Exploded View" and EM-57, "Exploded View".
   - Front cover and timing chain: Refer to EM-61, "Exploded View".
   - Cylinder head: Refer to EM-86, "Exploded View".
2. Remove knock sensor.
   CAUTION:
   Carefully handle knock sensor avoiding shocks.
3. Remove oil filter (for VVEL ladder assembly) from cylinder block, if necessary. Refer to EM-86, "Exploded View".
4. 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-115, "Inspection".

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

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

b. Loosen mounting bolts, and remove connecting rod bearing cap.

c. 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.

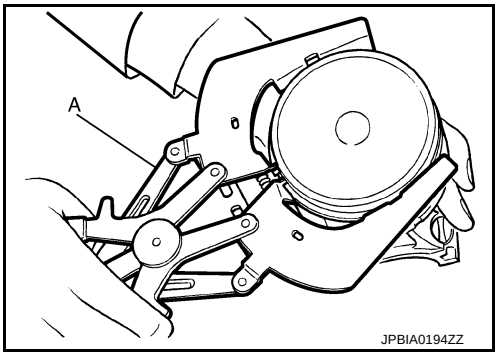


5. Remove connecting rod bearings from connecting rod and connecting rod bearing cap.
   CAUTION:
   - **Be careful not to drop connecting rod bearing, and to scratch the surface.**
   - **Identify installation positions, and store them without mixing them up.**
6. Remove piston rings from piston.
   - Before removing piston rings, check the piston ring side clearance. Refer to EM-115, "Inspection".

- Use a piston ring expander (commercial service tool) (A).

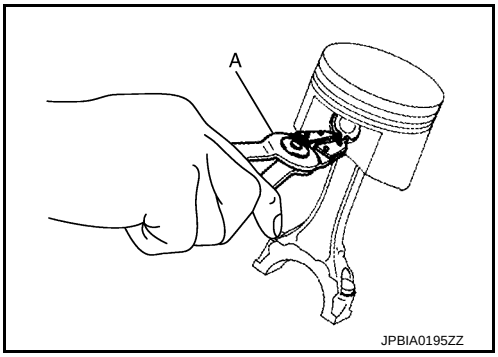
CAUTION:

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

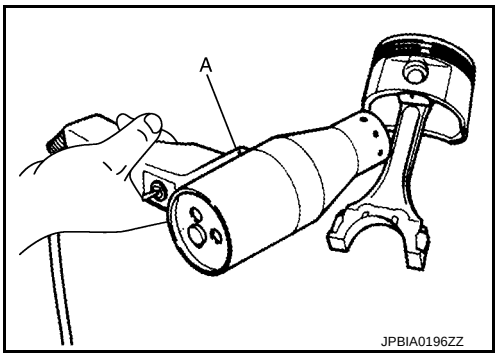


7. Remove piston from connecting rod as per the following:

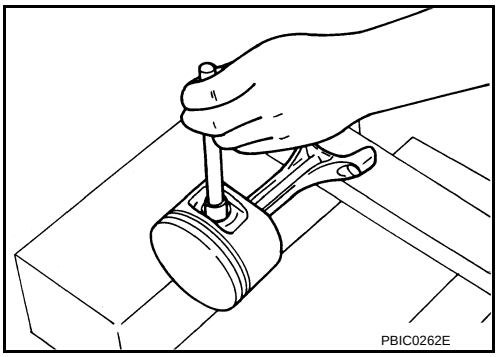
a. Using snap ring pliers (A), remove snap rings.



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:

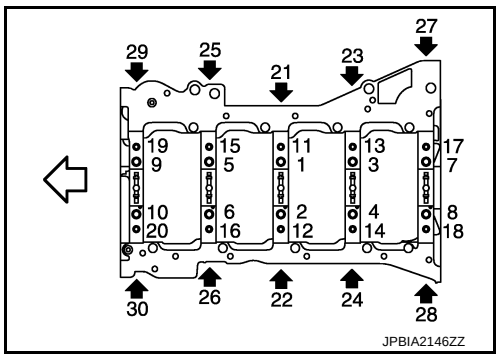
   Be careful not to damage the mating surfaces.
9. Using screwdriver or similar tool, and lever off rear oil seal from rear oil seal retainer.
10. Remove main bearing cap as per the following:
    - Before loosening cylinder block bolts, measure the crankshaft end play. Refer to EM-115, "Inspection".

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

⇦ : Engine front

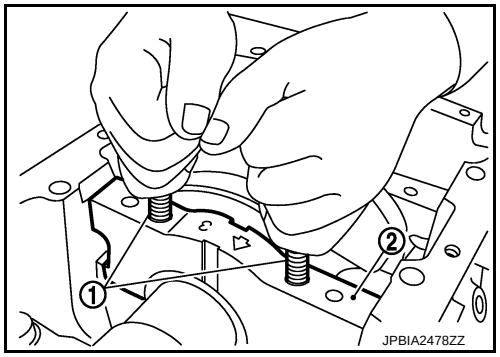
b. Loosen main bearing cap sub bolts starting from No. 20 to 11 to remove.

c. Loosen main bearing cap bolts starting from No. 10 to 1 to remove.



d. Remove the main bearing cap.
- 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.**

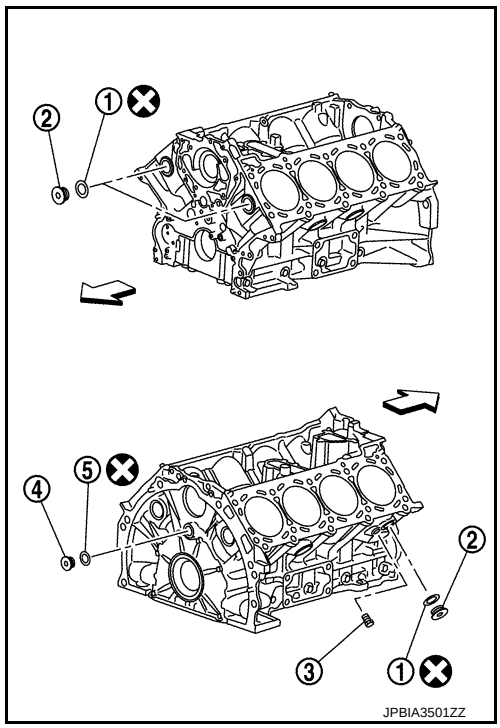
13. Remove pilot converter using the pilot bushing puller (commercial service tool), if necessary.
14. Remove oil jet.

ASSEMBLY

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

CAUTION:
Use goggles to protect your eyes.

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



⇦ : Engine front

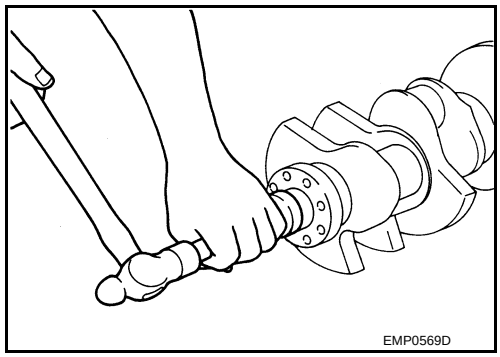
Refer to GI-4, "Components" for symbols in the figure.

- 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)

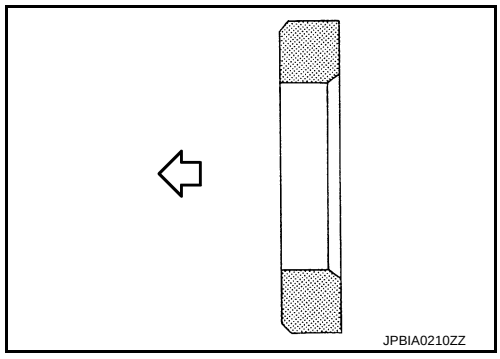
- Replace washers (1), (5) with new ones.
- Apply sealant to the thread of water drain plug (3).
  Use Genuine RTV silicone sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".
- Apply sealant to the thread of plug (4).
  Use high strength thread locking sealant or equivalent. Refer to GI-22, "Recommended Chemical Products and Sealants".

3. Install pilot converter to crankshaft, if removed.
   - With drift [outer diameter: approx. 35 mm (1.38 in)], press-fit as far as it will go.



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

⇦ : Crankshaft side



4. Install main bearings and thrust bearings as per the following:
   CAUTION:
   Be careful not to drop main bearing, and to scratch the surface.

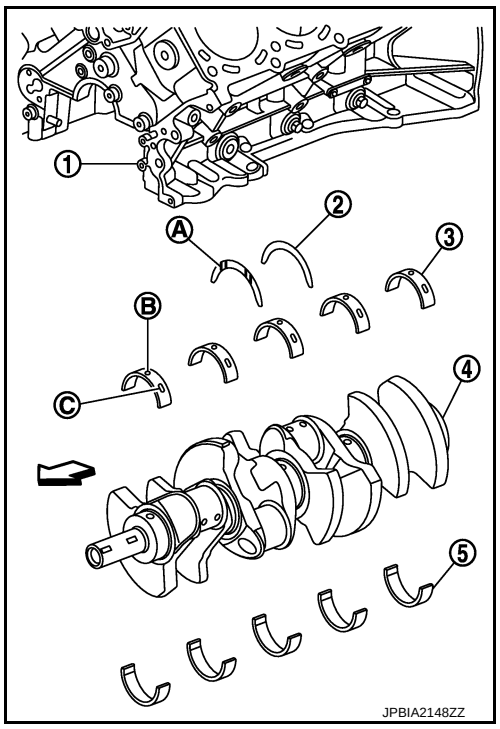
a. Remove dust, dirt, and engine oil on bearing mating surfaces of cylinder block and main bearing caps.

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.



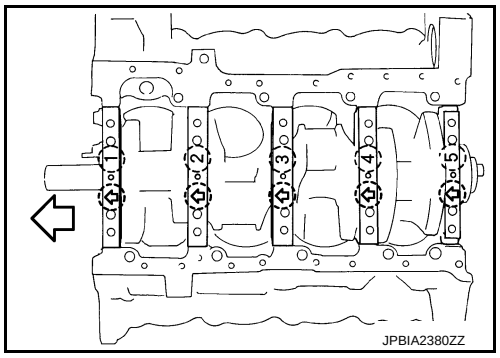
5. Install crankshaft to cylinder block.
- While turning crankshaft by hand, check that it turns smoothly.

6. 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.



7. 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-115, "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.

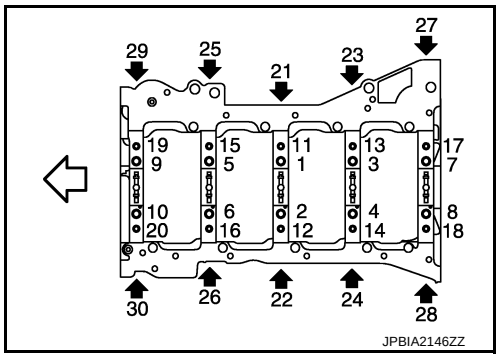
⇦ : Engine front

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.

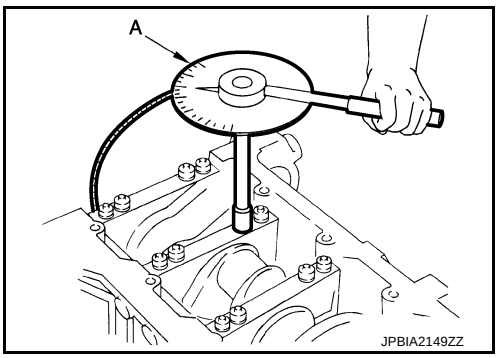
: 29.4 N·m (3.0 kg-m, 22 ft-lb)



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)

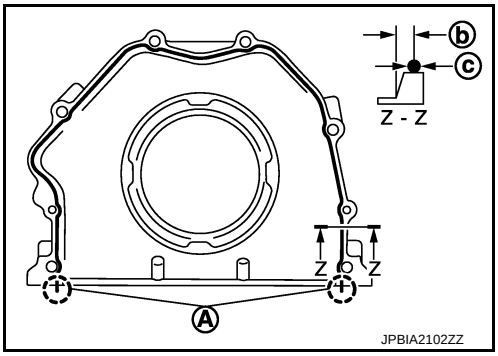
Angle tightening: 30 degrees

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

: 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-137, "Cylinder Block".

8. 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.

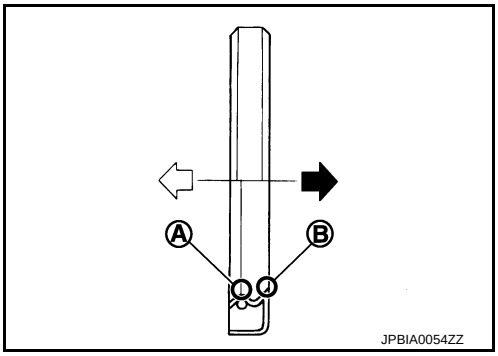


A : Protrusion
b : 4.0 - 5.6 mm (0.157 - 0.220 in)
c : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)

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

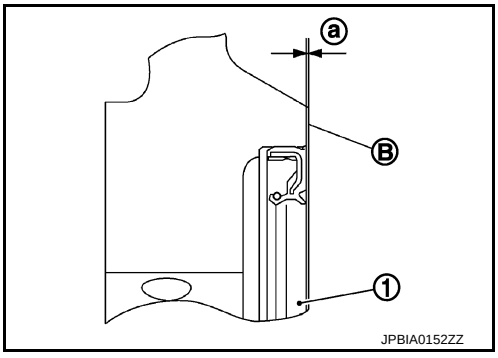
9. Install rear oil seal on rear oil seal retainer.

⇦ : 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.

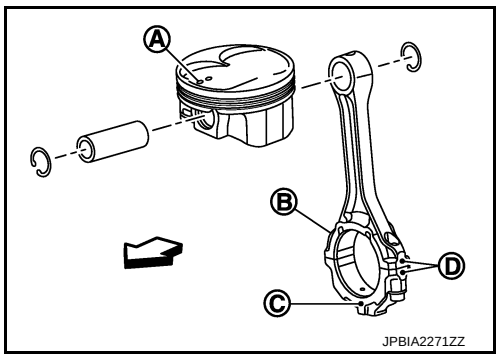


B : Rear oil seal retainer rear end face
a : 0 - 0.5 mm (0 - 0.020 in)

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

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

- 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.



JPBIA2271ZZ

B : Oil hole
C : Front mark
⇦ : Engine front

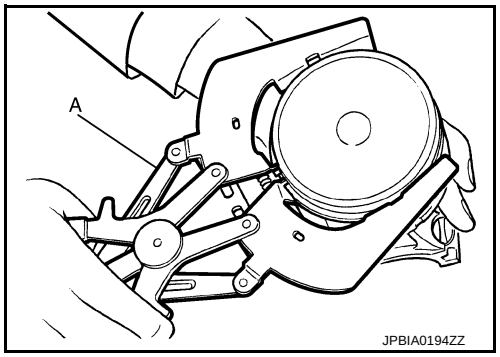
a. Using snap ring pliers, install new snap ring to the groove of piston rear side.
   - Insert it fully into groove to install.

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.

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

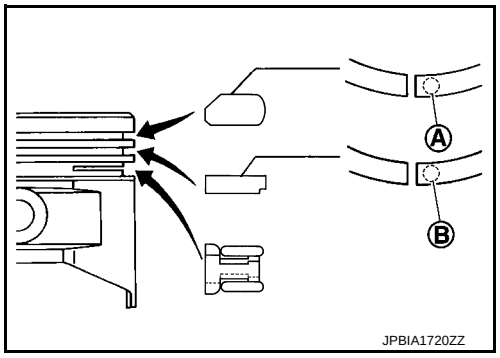
CAUTION:
- **When installing piston rings, be careful not to damage piston.**
- **Be careful not to damage piston rings by expending them excessively.**



JPBIA0194ZZ

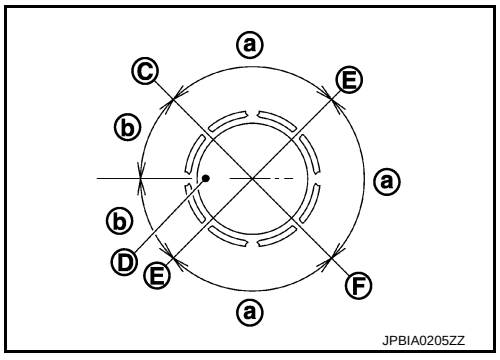
- If there is stamped mark on ring, mount it with marked side up.

Stamped mark:
Top ring (A) : 1 K
Second ring (B) : 2 K



JPBIA1720ZZ

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



JPBIA0205ZZ

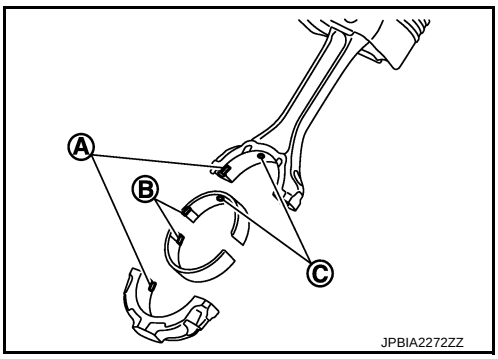
C : Top ring gap
E : Oil ring upper or lower rail gap (either of them)
F : Second ring and oil ring spacer gap
a : 90 degrees
b : 45 degrees

- Check the piston ring side clearance. Refer to EM-115, "Inspection".

12. 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.

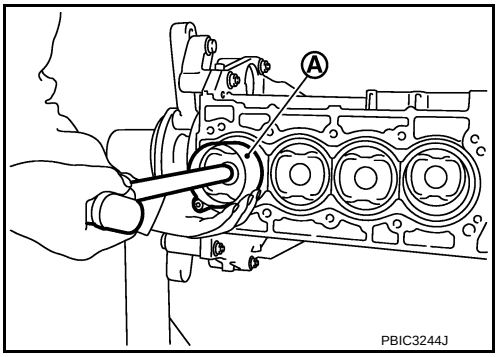
- Before installing connecting rod bearings, apply engine oil to the bearing surface (inside). Do not apply engine oil to the back surface, but thoroughly clean it.
- When installing, align connecting rod bearing stopper protrusion (B) with cutout (A) of connecting rods and connecting rod bearing caps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



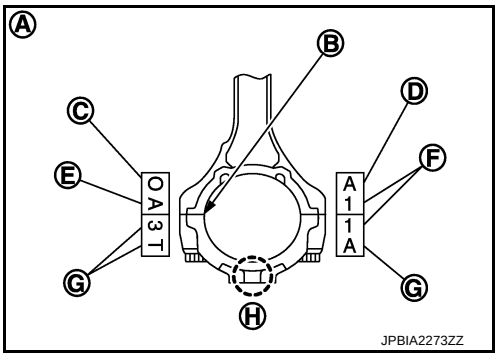
13. Install piston and connecting rod assembly to crankshaft.
    - Position crankshaft pin corresponding to connecting rod to be installed onto the bottom dead center.
    - Apply engine oil sufficiently to the cylinder bore, piston and crankshaft pin journal.
    - Match the cylinder position with 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.



14. 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

    - Be sure that front mark (H) on connecting rod bearing cap is facing the front of the engine.
15. Tighten connecting rod bolts as per the following:

a. Inspect the outer diameter of connecting rod bolt. Refer to EM-115, "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.

: 19.6 N·m (2.0 kg-m, 14.5 ft-lb)

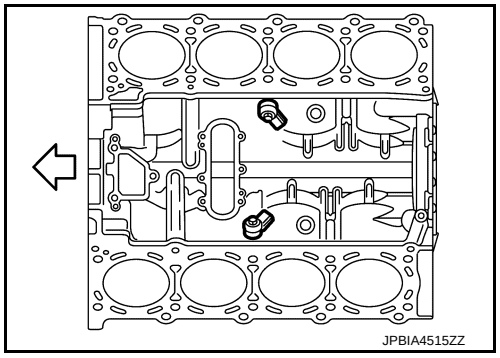
f. Tighten connecting rod bolts. (clockwise)

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-115, "Inspection".

16. Install knock sensors (1).
- Install knock sensors in the direction shown in the figure.

⇦ : Engine front


JPBIA4515ZZ

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

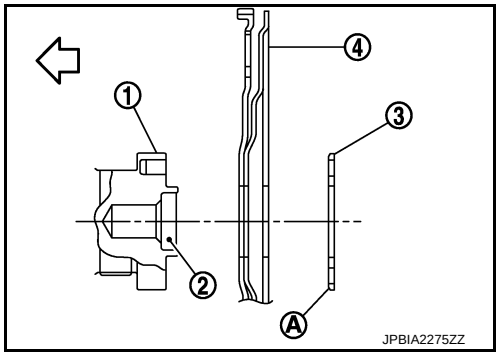
CAUTION:
- **Never tighten mounting bolts while holding connector.**
- **If any impact by dropping is applied to knock sensor, replace it with new one.**

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.

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

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

2 : Pilot converter
A : Rounded
⇦ : Engine front



JPBIA2275ZZ

- 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: KV10119200 (J-49277)].
- Tighten the mounting bolts crosswise over several times.

19. Assemble in the reverse order of disassembly.

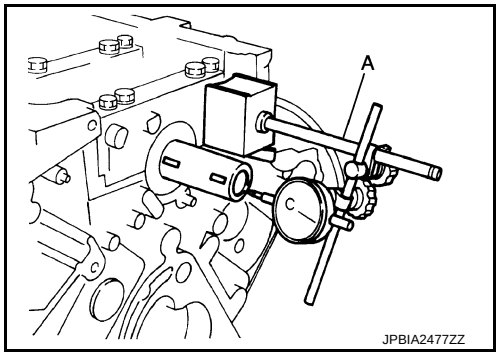
Inspection

INFOID:0000000006289584

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-137, "Cylinder Block".



JPBIA2477ZZ

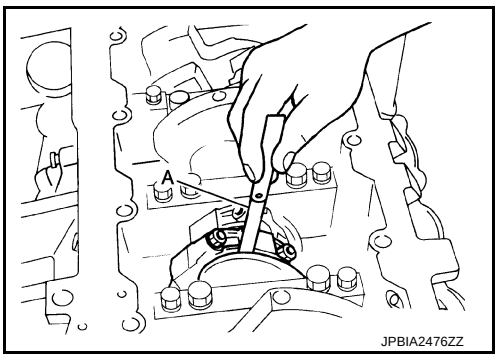
- If the measured value exceeds the limit, replace thrust bearings, and measure again. If it still exceeds the limit, replace crankshaft also.

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-137, "Cylinder Block".

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

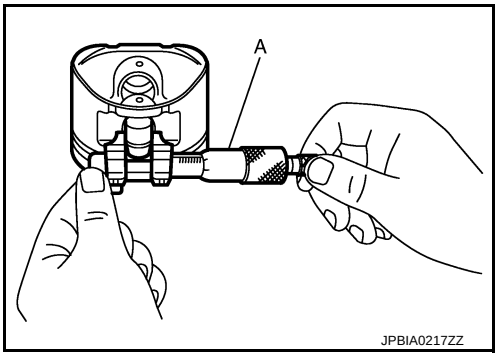


PISTON TO PISTON PIN OIL CLEARANCE

Piston Pin Hole Diameter

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

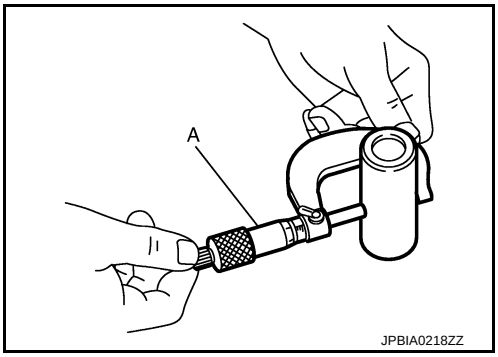
Standard : Refer to EM-137, "Cylinder Block".



Piston Pin Outer Diameter

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

Standard : Refer to EM-137, "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-137, "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-125, "Description".

NOTE:
Piston is available together with piston pin as assembly.

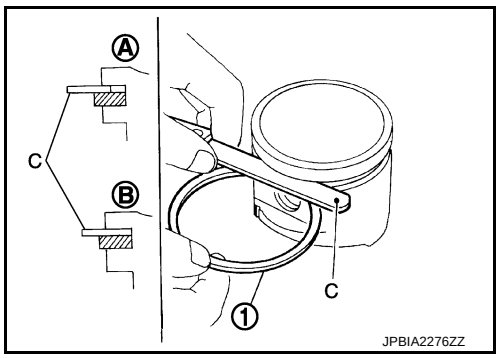
PISTON RING SIDE CLEARANCE

- 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-137, "Cylinder Block".

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



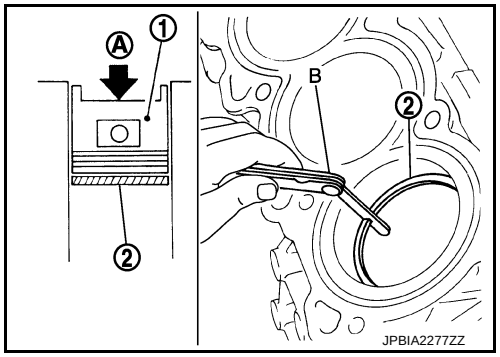
PISTON RING END GAP

- 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-137, "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.



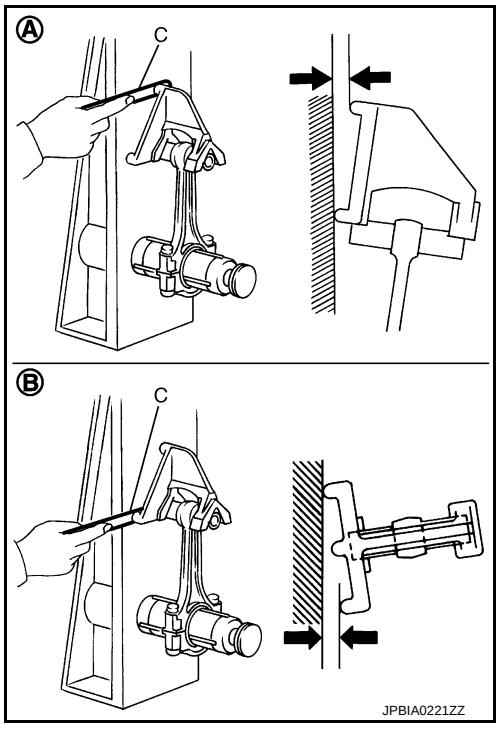
CONNECTING ROD BEND AND TORSION

- Check with a connecting rod aligner.

A : Bend
B : Torsion
C : Feeler gauge

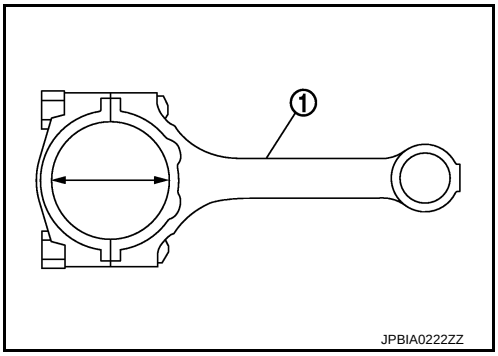
Bend limit **: Refer to EM-137, "Cylinder Block".**
Torsion limit

- 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-107, "Disassembly and Assembly" for the tightening procedure.



1 : Connecting rod

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

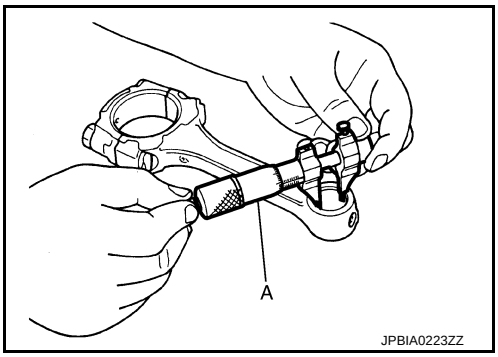
Standard : Refer to EM-137, "Cylinder Block".

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

CONNECTING ROD BUSHING OIL CLEARANCE

Connecting Rod Bushing Inner Diameter

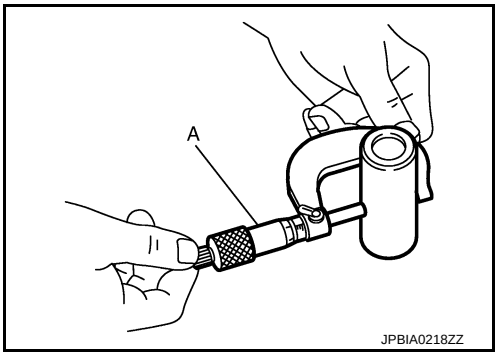
Measure the inner diameter of connecting rod bushing with an inside micrometer (A).



Standard : Refer to EM-137, "Cylinder Block".

Piston Pin Outer Diameter

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



Standard : Refer to EM-137, "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-137, "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-125, "Description".
- If replacing connecting rod assembly, refer to EM-126, "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.

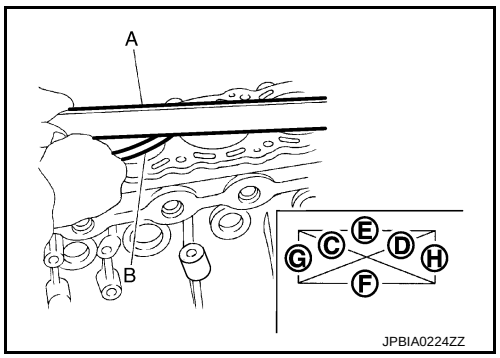
CAUTION:

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-137, "Cylinder Block".

- If it exceeds the limit, replace cylinder block.



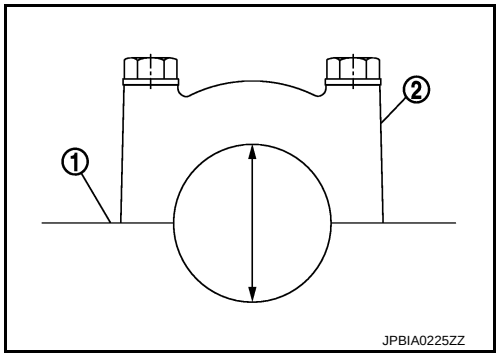
MAIN BEARING HOUSING INNER DIAMETER

- Install main bearing cap (2) without installing main bearings, and tighten main bearing cap bolts to the specified torque. Refer to EM-107, "Disassembly and Assembly" for the tightening procedure.
- Measure the inner diameter of main bearing housing with a bore gauge.

Standard : Refer to EM-137, "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.

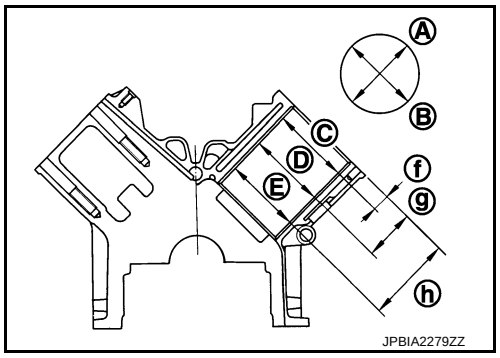


PISTON TO CYLINDER BORE CLEARANCE

Cylinder Bore inner Diameter

- 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-137, "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.

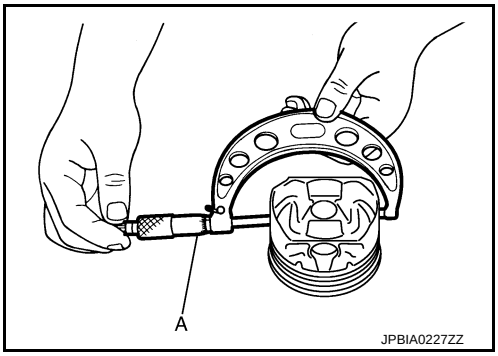
CAUTION:
When using oversize piston, use oversize pistons for all cylinders with oversize piston rings.

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

Piston Skirt Diameter

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

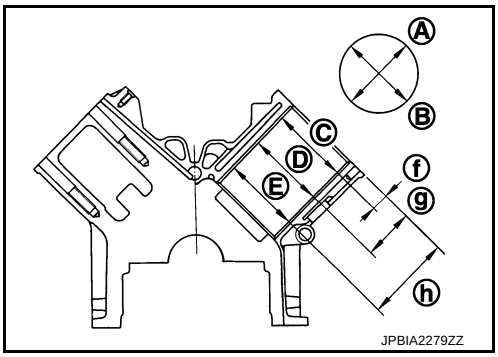
Measure point
Standard **: Refer to EM-137, "Cylinder Block".**



Piston-to-Cylinder Bore Clearance

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

A : Longitudinal direction
C : Top position
E : Bottom position
f : 10 mm (0.39 in)
g : 60 mm (2.36 in)
h : 120 mm (4.72 in)



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

Standard and limit **: Refer to EM-137, "Cylinder Block".**

- If the calculated value exceeds the limit, replace piston and piston pin assembly. Refer to EM-137, "Cylinder Block".

Re-boring Cylinder Bore

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

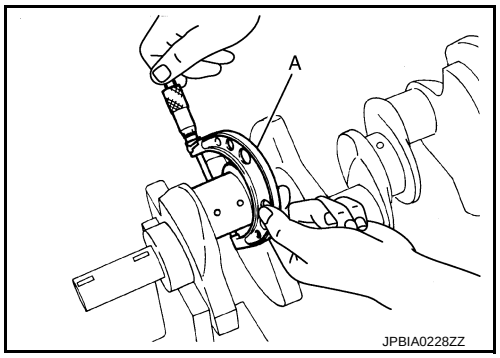
- Measure the outer diameter of crankshaft main journals with a micrometer.

Standard **: Refer to EM-137, "Cylinder Block".**

- If out of the standard, measure the main bearing oil clearance. Then use undersize bearing. Refer to EM-128, "Main Bearing".

CRANKSHAFT PIN JOURNAL DIAMETER

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

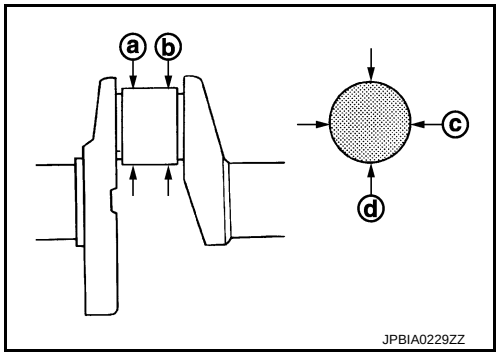


Standard : Refer to EM-137, "Cylinder Block".

- If out of the standard, measure the connecting rod bearing oil clearance. Then use undersize bearing. Refer to EM-126, "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.

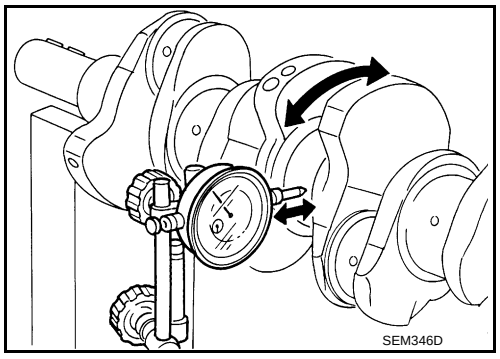


Out-of-round (Difference between “c” and “d”)
Taper (Difference between “a”and “b”) : Refer to EM-137, "Cylinder Block".

- If the measured value exceeds the limit, correct or replace crankshaft.
- If corrected, measure the bearing oil clearance of the corrected main journal and/or pin journal. Then select the main bearing and/or connecting rod bearing. Refer to EM-128, "Main Bearing" and/or EM-126, "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)



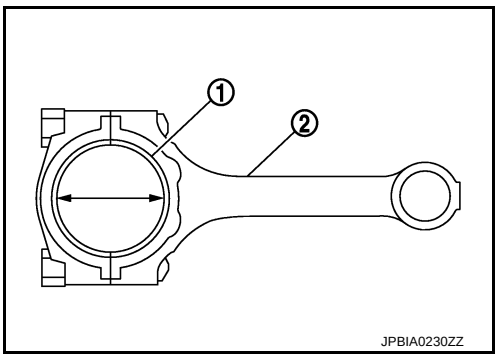
Standard and limit : Refer to EM-137, "Cylinder Block".

- 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-107, "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-142, "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-125, "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-107, "Disassembly and Assembly" for the tightening procedure.

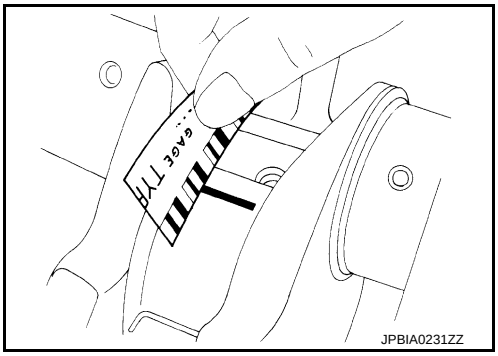
CAUTION:

Never rotate crankshaft.

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

NOTE:

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

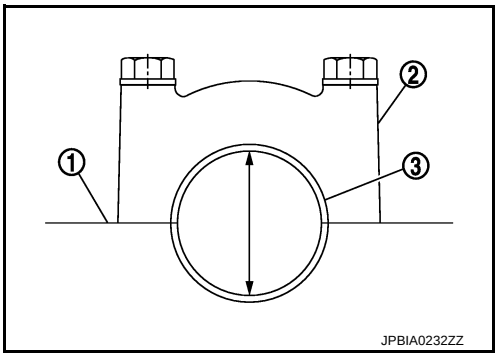


MAIN BEARING OIL CLEARANCE

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-107, "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-141, "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-125, "Description".

Method of Using Plastigage

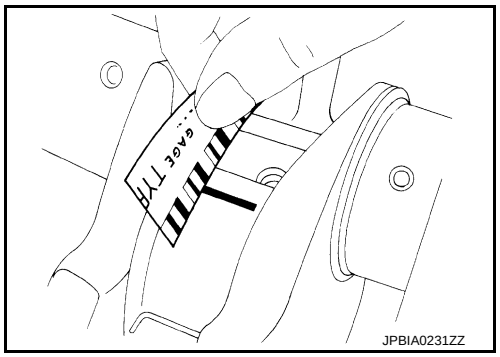
- Remove engine oil and dust on crankshaft journal and the surfaces of each bearing completely.

- 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-107, "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”.



JPBIA0231ZZ

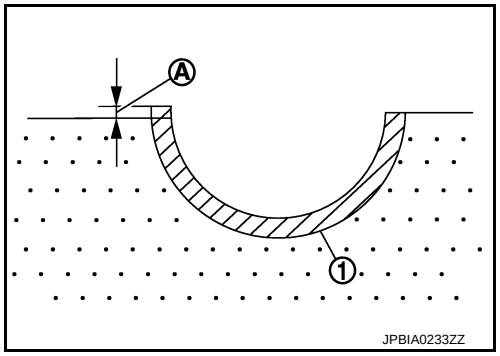
MAIN BEARING CRUSH HEIGHT

- When main bearing cap is removed after being tightened to the specified torque with main bearings (1) installed, the tip end of bearing must protrude. Refer to EM-107, "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.



JPBIA0233ZZ

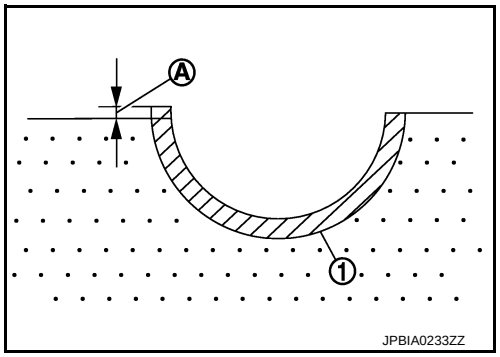
CONNECTING ROD BEARING CRUSH HEIGHT

- 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-107, "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.



JPBIA0233ZZ

MAIN BEARING CAP BOLT OUTER DIAMETER

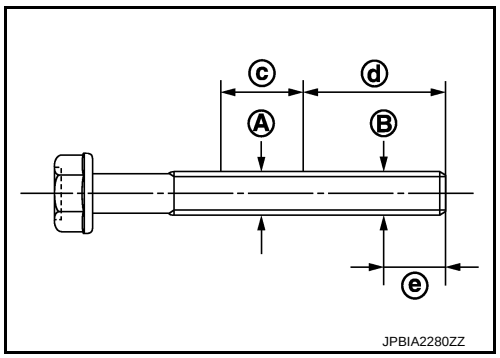
- Measure the outer diameters (A), (B) at two positions as shown in the figure.

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)

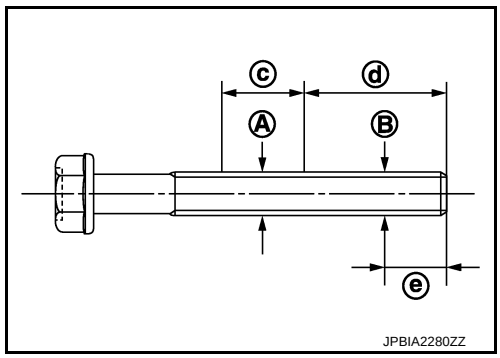
- If it exceeds the limit (large difference in dimensions), replace main bearing cap bolts with new one.



JPBIA2280ZZ

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)

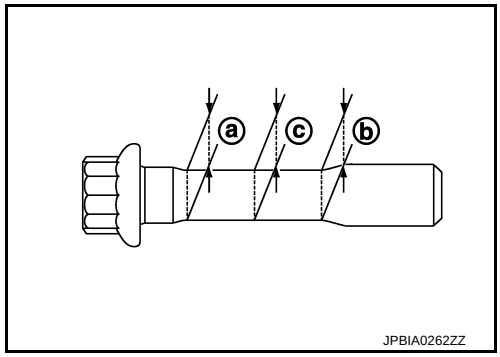
- If reduction appears in (A) range, regard it (B).

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

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

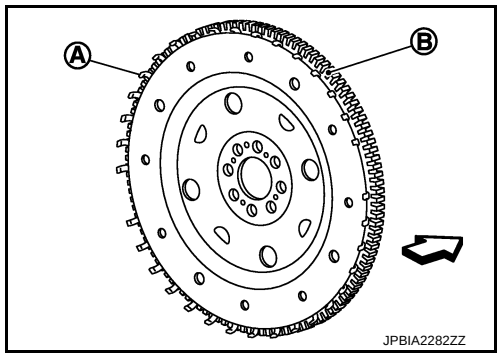
2. Obtain a mean value (d) of (a) and (b).
3. Subtract (c) from (d).

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.

DRIVE PLATE

- 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.

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

Description

INFOID:0000000006289585

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

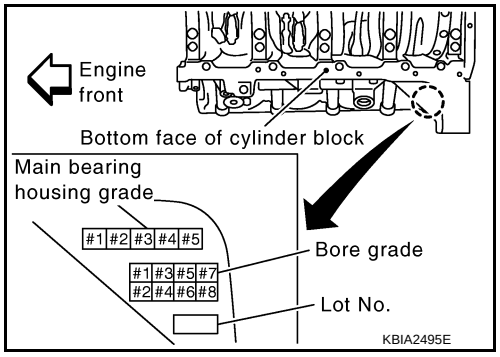
INFOID:0000000006289586

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:

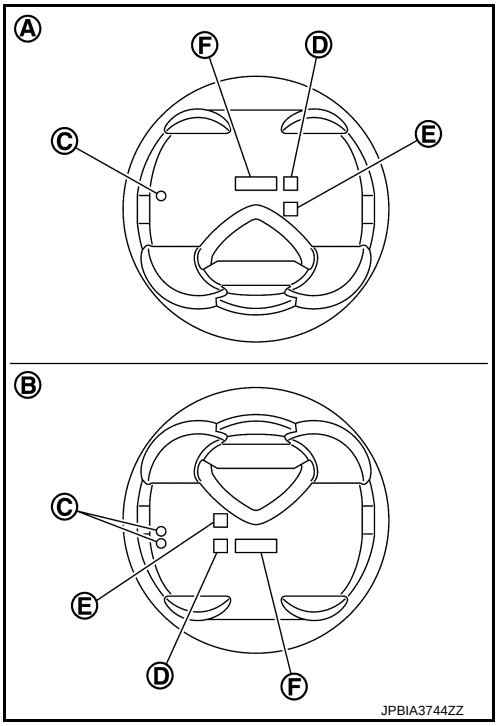
Piston is available with piston pin as a set for the service part.



WHEN NEW CYLINDER BLOCK IS REUSED

1. Measure the cylinder bore inner diameter. Refer to EM-137, "Cylinder Block".

2. Determine the bore grade by comparing the measurement with the values under the cylinder bore inner diameter of the “PISTON SELECTION TABLE”.



A : Bank 2
B : Bank 1
C : Front mark
D : Piston grade number
E : Piston pin grade number
F : Identification code

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)

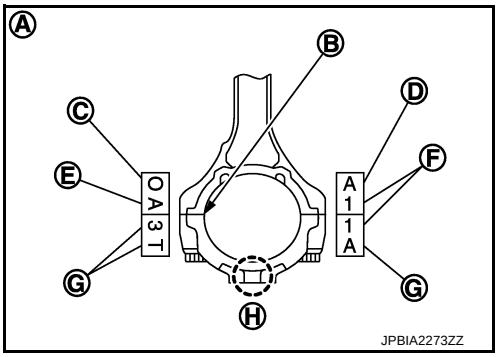
NOTE:
Piston is available together with piston pin as assembly.

Connecting Rod Bearing

INFOID:0000000006289587

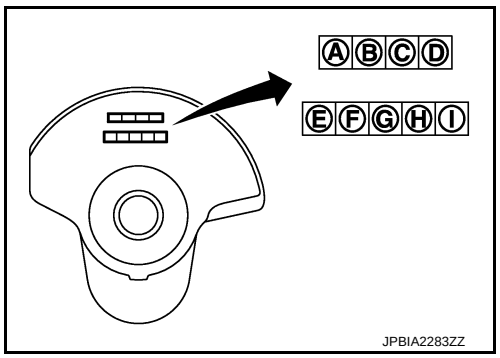
WHEN NEW CONNECTING ROD AND CRANKSHAFT ARE USED

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

2. 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

3. Read the symbol at the cross point of selected row and column in the “CONNECTING ROD BEARING SELECTION TABLE”.
4. Apply the symbol obtained to the “CONNECTING ROD BEARING GRADE TABLE” to select connecting rod bearing.

WHEN CONNECTING ROD AND CRANKSHAFT ARE REUSED

1. Measure connecting rod big end diameter and crankshaft pin journal diameter. Refer to EM-115, "Inspection".
2. Correspond the measured dimension in connecting rod big end diameter row of “CONNECTING ROD BEARING SELECTION TABLE”.
3. Correspond the measured dimension in crankshaft pin journal diameter column of “CONNECTING ROD BEARING SELECTION TABLE”.
4. Follow from step 3 in “WHEN NEW CONNECTING ROD AND CRANKSHAFT ARE USED”.

CONNECTING ROD BEARING SELECTION TABLE

Crankshaft pin outer diameter: Mark	Crankshaft pin outer diameter: Outer diameter Unit: mm (in)	Connecting rod big end. inner diameter: Mark	Inner diameter Unit: mm (in) A: 57.000 – 57.001 (2.2441 – 2.2441)	B: 57.001 – 57.002 (2.2441 – 2.2442)	C: 57.002 – 57.003 (2.2442 – 2.2442)	D: 57.003 – 57.004 (2.2442 – 2.2443)	E: 57.004 – 57.005 (2.2443 – 2.2443)	F: 57.005 – 57.006 (2.2443 – 2.2443)	G: 57.006 – 57.007 (2.2443 – 2.2444)	H: 57.007 – 57.008 (2.2444 – 2.2444)	J: 57.008 – 57.009 (2.2444 – 2.2444)	K: 57.009 – 57.010 (2.2444 – 2.2445)	L: 57.010 – 57.011 (2.2445 – 2.2445)	M: 57.011 – 57.012 (2.2445 – 2.2446)	N: 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	4
2	53.956 – 53.962 (2.1243 – 2.1245)		3	3	3	3	3	3	4	4	4	4	4	4	4

JSBIA0535GB

CONNECTING ROD BEARING GRADE TABLE

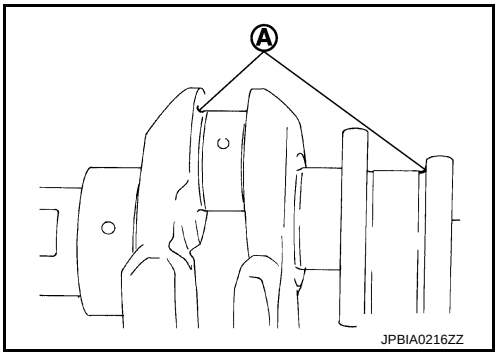
Connecting rod bearing grade table : Refer to EM-142, "Connecting Rod Bearing".

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:

In grinding crankshaft pin to use undersize bearings, keep the fillet R (A) [1.5 - 1.7 mm (0.059 - 0.067 in)].



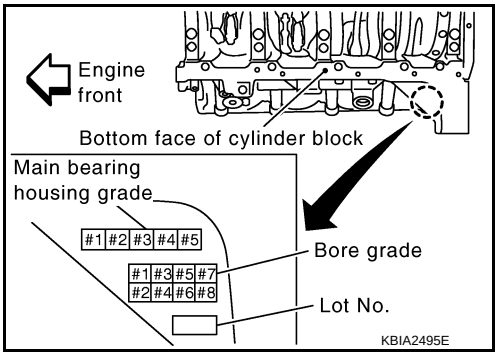
Bearing undersize table : Refer to EM-142, "Connecting Rod Bearing".

Main Bearing

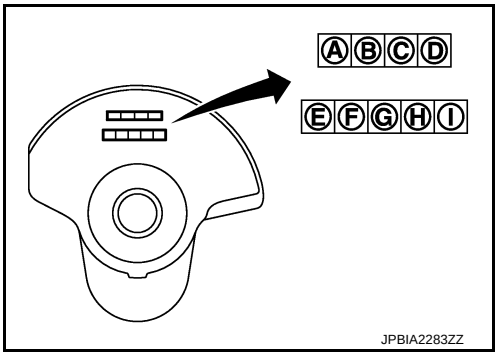
INFOID:0000000006289588

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-115, "Inspection".

2. Correspond the measured dimension in “Cylinder block main bearing housing inner diameter” row of “MAIN BEARING SELECTION TABLE”.
3. Correspond the measured dimension in “Crankshaft main journal diameter” column of “MAIN BEARING SELECTION TABLE”.
4. Follow 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 / Crankshaft main journal diameter	I.D. mark	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) / Hole diameter Unit: mm (in)	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
H	63.963 - 63.962 (2.5182 - 2.5182)	1	12	12	12	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	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5
K	63.961 - 63.960 (2.5181 - 2.5181)	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56
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	56	56
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	56	56	56
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	56	56	56	6
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	56	56	56	6	6
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	56	56	56	6	6	6
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	56	56	56	6	6	6	67
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	56	56	56	6	6	6	67	67
U	63.953 - 63.952 (2.5178 - 2.5178)	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67
V	63.952 - 63.951 (2.5178 - 2.5178)	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7
W	63.951 - 63.950 (2.5178 - 2.5177)	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7
X	63.950 - 63.949 (2.5177 - 2.5177)	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7
Y	63.949 - 63.948 (2.5177 - 2.5176)	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78
1	63.948 - 63.947 (2.5176 - 2.5176)	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78
2	63.947 - 63.946 (2.5176 - 2.5176)	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78
3	63.946 - 63.945 (2.5176 - 2.5175)	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8
4	63.945 - 63.944 (2.5175 - 2.5175)	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8
5	63.944 - 63.943 (2.5175 - 2.5174)	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8
6	63.943 - 63.942 (2.5174 - 2.5174)	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	X
7	63.942 - 63.941 (2.5174 - 2.5174)	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	X	X
9	63.941 - 63.940 (2.5174 - 2.5173)	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78	8	8	8	X	X	X

JPBIA2285GB

MAIN BEARING SELECTION TABLE (No. 2, 3 and 4 Journal)

Cylinder block main bearing housing inner diameter / Crankshaft main journal diameter	I.D. mark	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	4	7
	Hole diameter Unit: mm (in)	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)
I.D. mark	Axle diameter Unit: mm (in)																								
A	63.964 - 63.963 (2.5183 - 2.5182)	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4
B	63.963 - 63.962 (2.5182 - 2.5182)	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4
C	63.962 - 63.961 (2.5182 - 2.5181)	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4
D	63.961 - 63.960 (2.5181 - 2.5181)	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45
E	63.960 - 63.959 (2.5181 - 2.5181)	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45
F	63.959 - 63.958 (2.5181 - 2.5180)	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45
G	63.958 - 63.957 (2.5180 - 2.5180)	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5
H	63.957 - 63.956 (2.5180 - 2.5179)	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5
J	63.956 - 63.955 (2.5179 - 2.5179)	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5
K	63.955 - 63.954 (2.5179 - 2.5179)	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56
L	63.954 - 63.953 (2.5179 - 2.5178)	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56
M	63.953 - 63.952 (2.5178 - 2.5178)	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56
N	63.952 - 63.951 (2.5178 - 2.5178)	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6
P	63.951 - 63.950 (2.5178 - 2.5177)	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6
R	63.950 - 63.949 (2.5177 - 2.5177)	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6
S	63.949 - 63.948 (2.5177 - 2.5176)	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67
T	63.948 - 63.947 (2.5176 - 2.5176)	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67
U	63.947 - 63.946 (2.5176 - 2.5176)	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67
V	63.946 - 63.945 (2.5176 - 2.5175)	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7
W	63.945 - 63.944 (2.5175 - 2.5175)	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7
X	63.944 - 63.943 (2.5175 - 2.5174)	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7
Y	63.943 - 63.942 (2.5174 - 2.5174)	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78
1	63.942 - 63.941 (2.5174 - 2.5174)	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78
2	63.941 - 63.940 (2.5174 - 2.5173)	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78

JPBIA2286GB

MAIN BEARING GRADE TABLE (ALL JOURNALS)

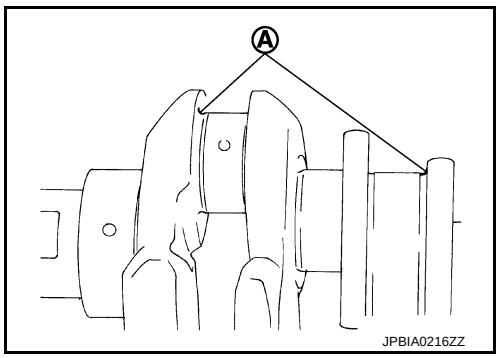
Main bearing grade table (All journals) : Refer to EM-141, "Main Bearing".

UNDERSIZE BEARING USAGE GUIDE

- When the specified main bearing oil clearance is not obtained with standard size main bearings, use undersize (US) bearing.
- When using undersize (US) bearing, measure the main bearing inner diameter with bearing installed, and grind main journal so that the main bearing oil clearance satisfies the standard.

CAUTION:

In grinding crankshaft main journal to use undersize bearings, keep the fillet R (A) [1.5 - 1.7 mm (0.059 - 0.067 in)].



Bearing undersize table : Refer to EM-141, "Main Bearing".

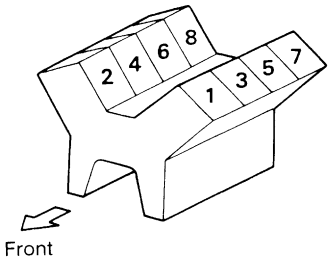
SERVICE DATA AND SPECIFICATIONS (SDS)

SERVICE DATA AND SPECIFICATIONS (SDS)

General Specification

INFOID:0000000006289589

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:0000000006289590

DRIVE BELT

Tension of drive belts	Belt tension is not necessary, as it is automatically adjusted by drive belt auto-tensioner.

Spark Plug

INFOID:0000000006289591

SPARK PLUG

Unit: mm (in)

Make	NGK
Standard type	DILKAR7B11

Gap	Standard	1.1 (0.043)
	Limit	1.25 (0.049)

Exhaust Manifold

INFOID:0000000006289592

EXHAUST MANIFOLD

Unit: mm (in)

Items		Limit
Surface distortion	Exhaust manifold	0.7 (0.028)

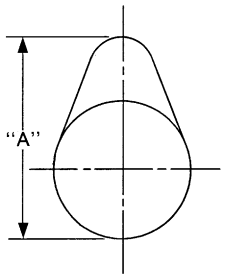
Camshaft

INFOID:0000000006289593

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

Unit: mm (in)

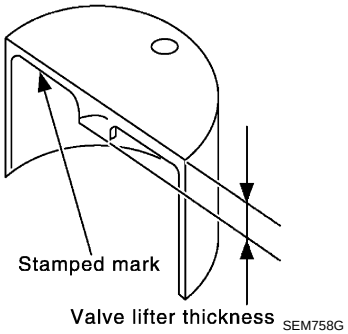
Items	Cold	Hot* (reference data)
Intake	0.26 - 0.34 (0.010 - 0.013)	0.304 - 0.416 (0.012 - 0.016)
Exhaust	0.29 - 0.37 (0.011 - 0.015)	0.308 - 0.432 (0.012 - 0.017)

*: 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)



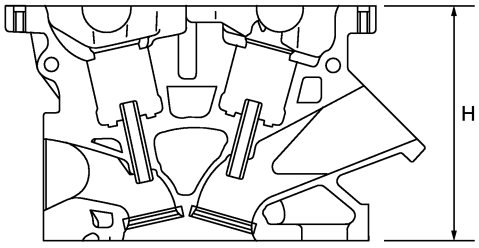
Cylinder Head

INFOID:0000000006289594

CYLINDER HEAD

Unit: mm (in)

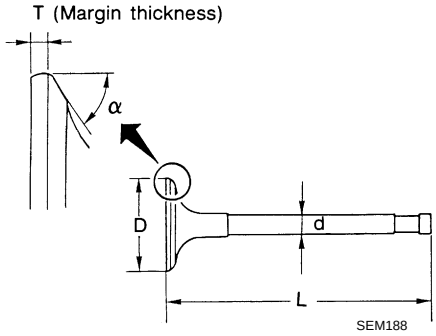
Items	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)
Normal cylinder head height “H”	126.3 (4.97)	—



PBIC0924E

VALVE DIMENSIONS

Unit: mm (in)

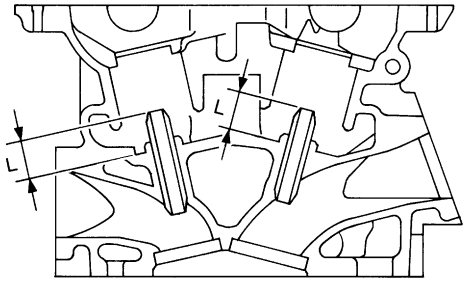


SEM188

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

Unit: mm (in)



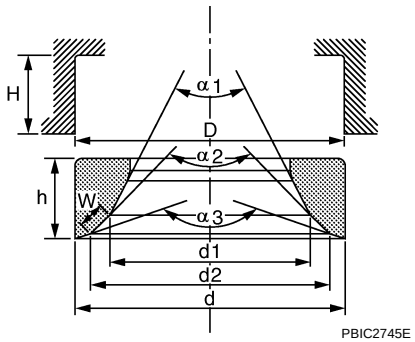
SEM950E

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 “α1”		59 - 61°	

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:0000000006289595

CYLINDER BLOCK

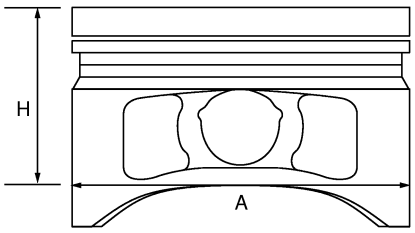
Unit: mm (in)

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)

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	—	95.680 - 95.710 (3.7669 - 3.7681)
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)

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

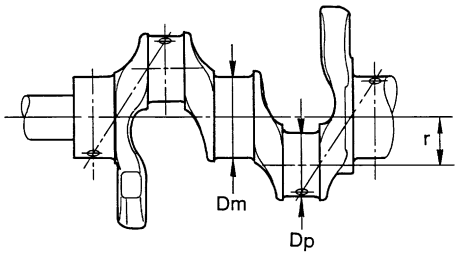
Unit: mm (in)

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

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)

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:0000000006289596

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

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:0000000006289597

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