SECTION EM
ENGINE MECHANICAL

CONTENTS

VQ37VHR

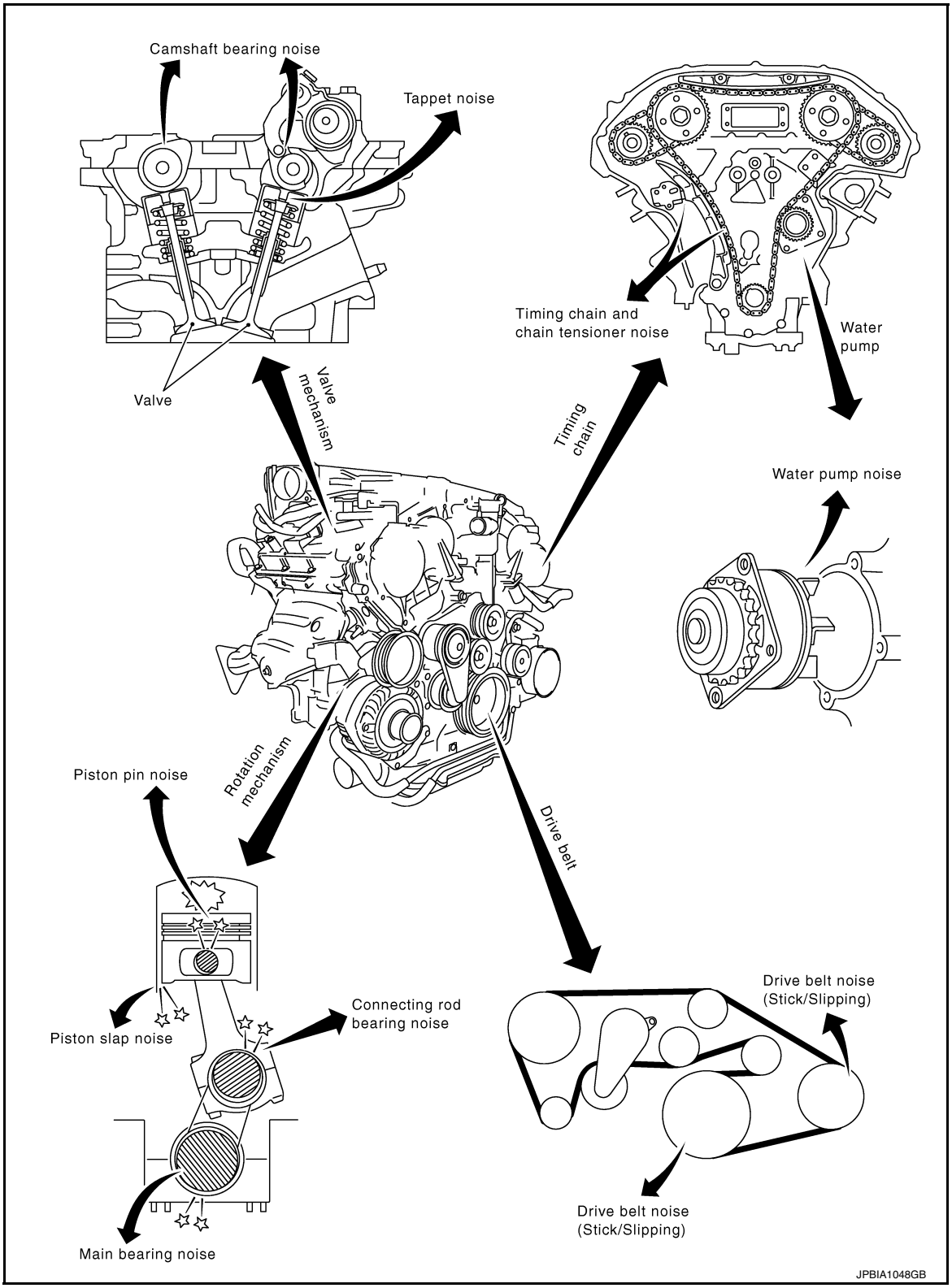
VK50VE

SYMPTOM DIAGNOSIS

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

NVH Troubleshooting - Engine Noise

INFOID:0000000010581953



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

INFOID:0000000010581954

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-20
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft runout Camshaft journal oil clearance	EM-152
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-156
	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-156
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing oil clearance	EM-156 EM-161
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-160 EM-156
Front of engine Timing chain case	Tapping or ticking	A	A	—	B	B	B	Timing chain and timing chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation	EM-69 EM-55
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belt (Sticking or slipping)	Drive belt deflection	EM-15
	Creaking	A	B	A	B	A	B	Drive belt (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	CO-24

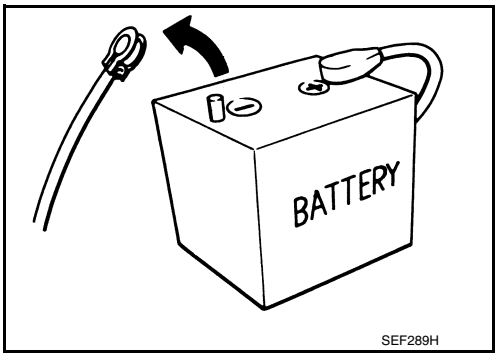
A: Closely related B: Related C: Sometimes related —: Not related

PRECAUTION

PRECAUTIONS

Precautions for Removing Battery Terminal

INFOID:0000000011004843

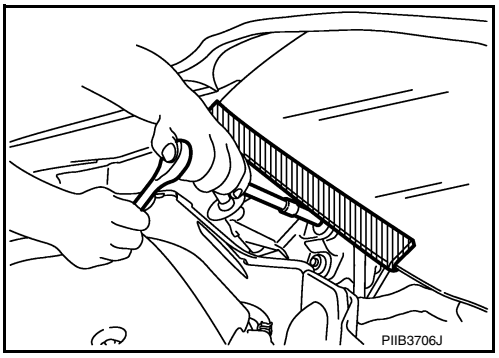


- When removing the 12V battery terminal, turn OFF the ignition switch and wait at least 30 seconds.
  NOTE:
  ECU may be active for several tens of seconds after the ignition switch is turned OFF. If the battery terminal is removed before ECU stops, then a DTC detection error or ECU data corruption may occur.
- For vehicles with the 2-batteries, be sure to connect the main battery and the sub battery before turning ON the ignition switch.
  NOTE:
  If the ignition switch is turned ON with any one of the terminals of main battery and sub battery disconnected, then DTC may be detected.
- After installing the 12V battery, always check "Self Diagnosis Result" of all ECUs and erase DTC.
  NOTE:
  The removal of 12V battery may cause a DTC detection error.

Precaution for Procedure without Cowl Top Cover

INFOID:0000000010581955

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



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

INFOID:0000000010581956

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:

Always observe the following items for preventing accidental activation.

- **To avoid rendering the SRS inoperative, which could increase the risk of personal injury or death in the event of a collision that would result in air bag inflation, all maintenance must be performed by an authorized NISSAN/INFINITI dealer.**
- **Improper maintenance, including incorrect removal and installation of the SRS, can lead to personal injury caused by unintentional activation of the system. For removal of Spiral Cable and Air Bag Module, see “SRS AIR BAG”.**
- **Never use electrical test equipment on any circuit related to the SRS unless instructed to in this Service Manual. SRS wiring harnesses can be identified by yellow and/or orange harnesses or harness connectors.**

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

WARNING:

Always observe the following items for preventing accidental activation.
- **When working near the Air Bag Diagnosis Sensor Unit or other Air Bag System sensors with the ignition ON or engine running, never use air or electric power tools or strike near the sensor(s) with a hammer. Heavy vibration could activate the sensor(s) and deploy the air bag(s), possibly causing serious injury.**
- **When using air or electric power tools or hammers, always switch the ignition OFF, disconnect the battery, and wait at least 3 minutes before performing any service.**

Precautions Necessary for Steering Wheel Rotation After Battery Disconnection

INFOID:0000000010581957

CAUTION:
Comply with the following cautions to prevent any error and malfunction.
- **Before removing and installing any control units, first turn the 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 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 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 ignition switch from ACC position to ON position, then to LOCK position. (The steering wheel will lock when the ignition switch is turned to LOCK position.)
6. Perform self-diagnosis check of all control units using CONSULT.

Precautions For Engine Service

INFOID:0000000010581958

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

DRAINING ENGINE COOLANT
Drain engine coolant and engine oil when the engine is cooled.

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

REMOVAL AND DISASSEMBLY
- When instructed to use SST, use specified tools. Always be careful to work safely, avoid forceful or uninstructed operations.
- Exercise maximum care to avoid damage to mating or sliding surfaces.
- Dowel pins are used for several parts alignment. When replacing and reassembling parts with dowel pins, check that dowel pins are installed in the original position.
- Must cover openings of engine system with a tape or equivalent, to seal out foreign materials.

- Mark and arrange disassembly parts in an organized way for easy troubleshooting and reassembly.
- When loosening nuts and bolts, as a basic rule, start with the one furthest outside, then the one diagonally opposite, and so on. If the order of loosening is specified, do exactly as specified. Power tools may be used in the step.

ASSEMBLY AND INSTALLATION

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

Parts Requiring Angle Tightening

INFOID:0000000010581959

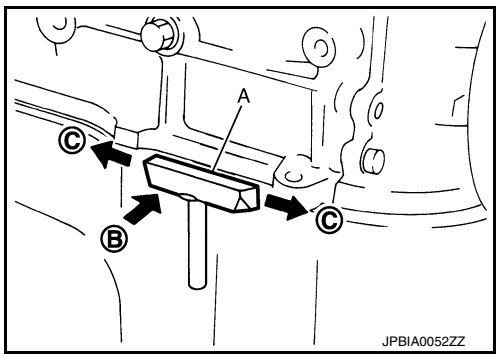
- Use the angle wrench [SST: KV10112100] for the final tightening of the following engine parts:
- Cylinder head bolts
- Lower cylinder block bolts
- Connecting rod cap bolts
- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread and seat surfaces are clean and coated with engine oil.

Liquid Gasket

INFOID:0000000010581960

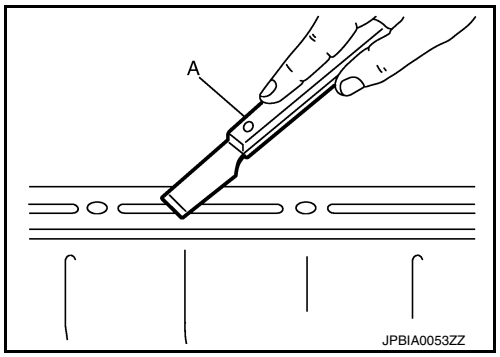
REMOVAL OF LIQUID GASKET SEALING

- After removing mounting bolts and nuts, separate the mating surface using the seal cutter [SST: KV10111100] (A) and remove old liquid gasket sealing.
  CAUTION:
  Be careful not to damage the mating surfaces.
- Tap the seal cutter [SST: KV10111100] to insert it (B), and then slide it (C) by tapping on the side as shown in the figure.
- In areas where the seal cutter [SST: KV10111100] 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.

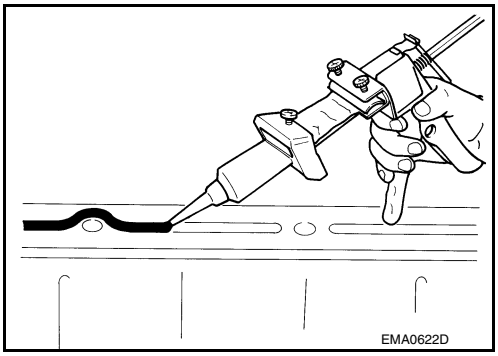


LIQUID GASKET APPLICATION PROCEDURE

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 Liquid Gasket or equivalent.
4. Apply liquid gasket without gaps to the specified location according to the specified dimensions.
   - If there is a groove for liquid gasket application, apply liquid gasket to the groove.

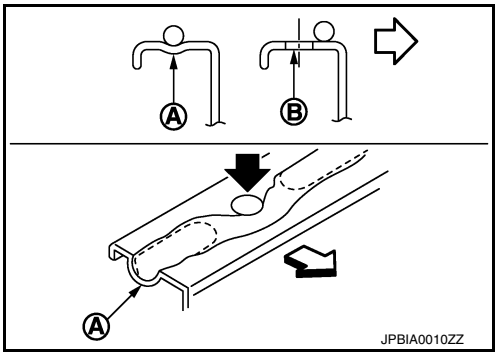


   - As for bolt holes (B), normally apply liquid gasket inside the holes. Occasionally, it should be applied outside the holes. Check to read the text of this manual.

     A : Groove

     ⇦ : Inside

   - Within five minutes of liquid gasket application, install the mating component.
   - If liquid gasket protrudes, wipe it off immediately.
   - Do not retighten 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:0000000010581961

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

  A : Bank 1 (The conventional right bank)

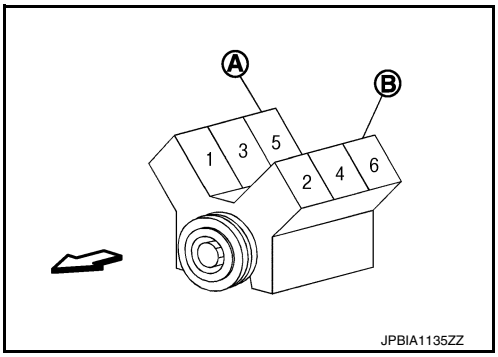
  B : Bank 2 (The conventional left bank)

  ⇦ : Engine front

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

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

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

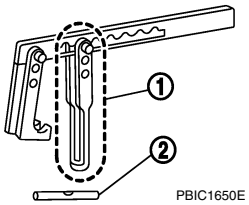
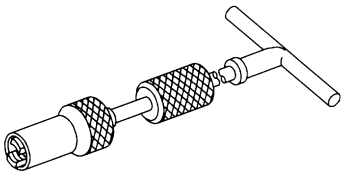
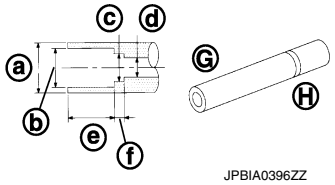
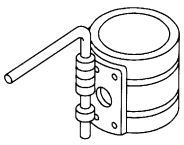
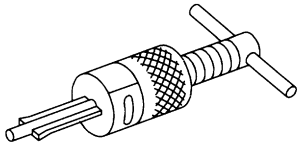
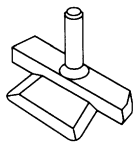


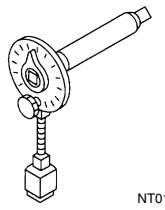
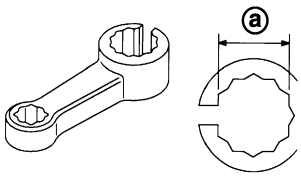
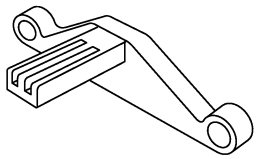
PREPARATION

PREPARATION

Special Service Tools

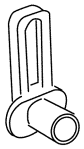
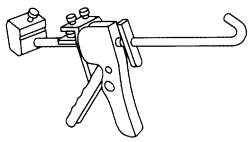
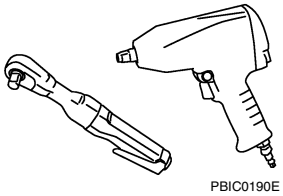
INFOID:0000000010581962

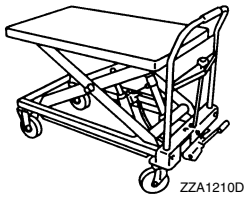
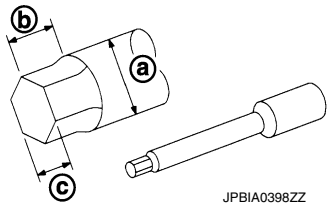
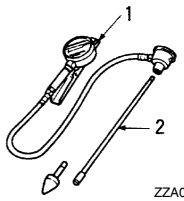
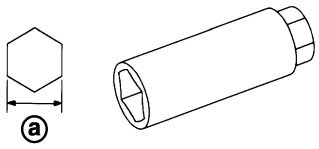
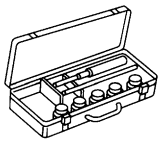
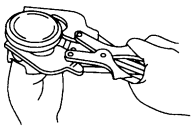
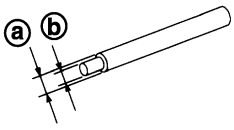
Tool number Tool name	Description
KV10116200 Valve spring compressor 1. KV10115900 Attachment 2. KV10109220 Adapter  PBIC1650E	Disassembling valve mechanism Part (1) is a component of KV10116200, but Part (2) is not so.
KV10107902 Valve oil seal puller  NT011	Replacing valve oil seal
KV10115600 Valve oil seal drift  JPBIA0396ZZ	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 Piston ring compressor  NT044	Installing piston assembly into cylinder bore
ST16610001 Pilot bushing puller  NT045	Removing pilot converter
KV10111100 Seal cutter  NT046	Removing oil pan (lower and upper), front and rear timing chain case, etc.

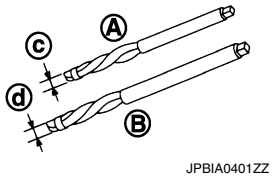
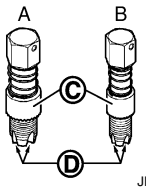
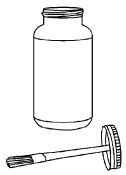
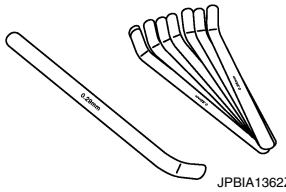
Tool number Tool name	Description
KV10112100 Angle wrench  NT014	Tightening bolts for connecting rod bearing cap, cylinder head, etc. at an angle
KV10114400 Heated oxygen sensor wrench  JPBIA0397ZZ	Loosening or tightening air fuel ratio sensor 1 and heated oxygen sensor 2 **a: 22 mm (0.87 in)**
KV10118600 Ring gear stopper  JPBIA0409ZZ	Removing and installing crankshaft pulley

Commercial Service Tools

INFOID:0000000010581963

Tool name	Description
Quick connector release  PBIC0198E	Removing fuel tube quick connectors in engine room (Available in SEC. 164 of PARTS CATALOG: Part No. 16441 6N210)
Tube presser  NT052	Pressing the tube of liquid gasket
Power tool  PBIC0190E	Loosening bolts and nuts

Tool name	Description
Manual lift table caddy  ZZA1210D	Removing and installing engine
Cylinder head bolt wrench  JPBIA0398ZZ	Loosening and tightening cylinder head bolt, and used with the angle wrench [SST: KV10112100] **a: 13 (0.51) dia.** **b: 12 (0.47)** **c: 10 (0.39)** Unit: mm (in)
1. Compression gauge 2. Adapter  ZZA0008D	Checking compression pressure
Spark plug wrench  JPBIA0399ZZ	Removing and installing spark plug **a: 14 mm (0.55 in)**
Valve seat cutter set  NT048	Finishing valve seat (EXH) dimensions
Piston ring expander  NT030	Removing and installing piston ring
Valve guide drift  JPBIA0400ZZ	Removing and installing valve guide (EXH) **Exhaust:** **a: 9.5 mm (0.374 in) dia.** **b: 5.5 mm (0.217 in) dia.**

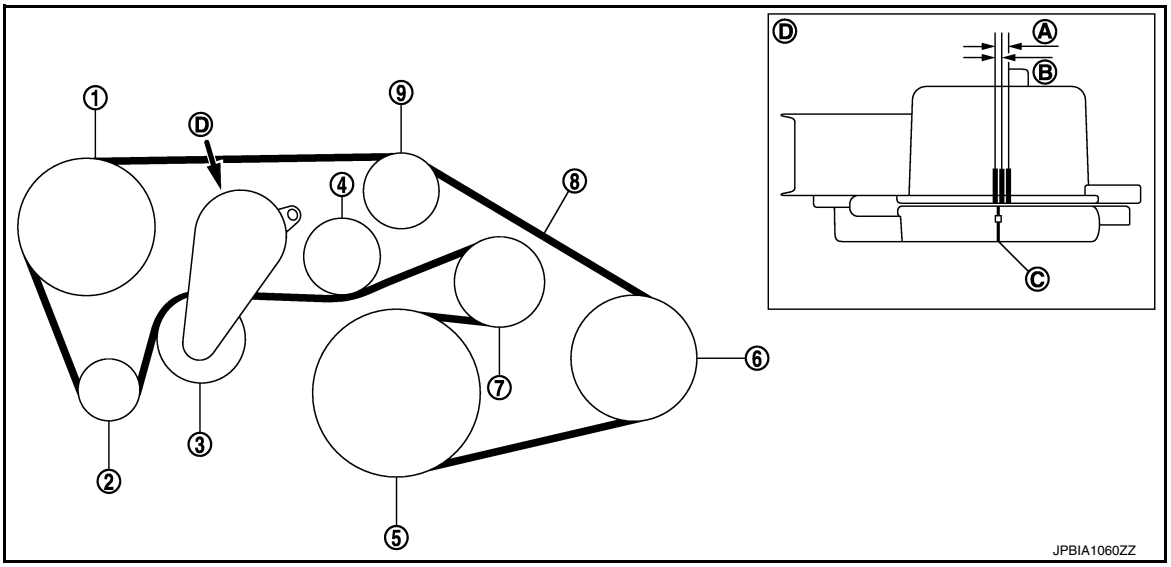
Tool name	Description
Valve guide reamer  JPBIA0401ZZ	A: Reaming valve guide (EXH) inner hole B: Reaming hole for oversize valve guide (EXH) **Exhaust:** **c: 6.0 mm (0.236 in) dia.** **d: 10.2 mm (0.402 in) dia.**
Oxygen sensor thread cleaner  JPBIA0238ZZ	Reconditioning the exhaust system threads before installing a new air fuel ratio sensor and heated oxygen sensor (Use with anti-seize lubricant shown below.) **A: For zirconia heated oxygen sensor and air fuel ratio sensor [18 mm (0.71 in) dia.]** **B: For titania heated oxygen sensor [12 mm (0.47 in) dia.]** C: Mating surface shave cylinder D: Flutes
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
Feeler gauge  JPBIA1362ZZ	Inspection valve clearance (Use a curved-tip gauge)

PERIODIC MAINTENANCE

DRIVE BELT

Exploded View

INFOID:0000000010581964



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

Checking

INFOID:0000000010581965

WARNING:
Be sure to perform this step when engine is stopped.

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

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

Tension Adjustment

INFOID:0000000010581966

Refer to EM-151, "Drive Belt".

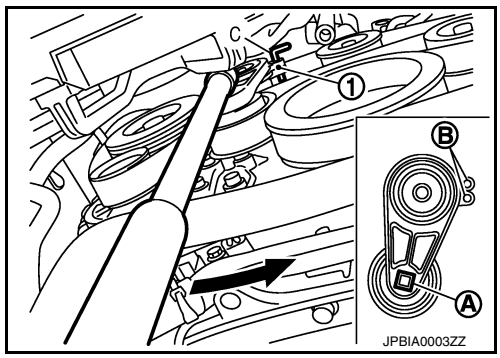
Removal and Installation

INFOID:0000000010581967

REMOVAL

1. Remove engine undercover with power tool.

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



⬅ : Loosening direction of drive belt

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

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

4. Remove drive belt.

INSTALLATION

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

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

Inspection

INFOID:0000000010581968

INSPECTION AFTER INSTALLATION

- Turn crankshaft pulley clockwise several times to equalize tension between each pulley, and then confirm tension of drive belt at indicator (notch on fixed side) is within the possible use range. Refer to EM-15, "Exploded View".

AIR CLEANER FILTER

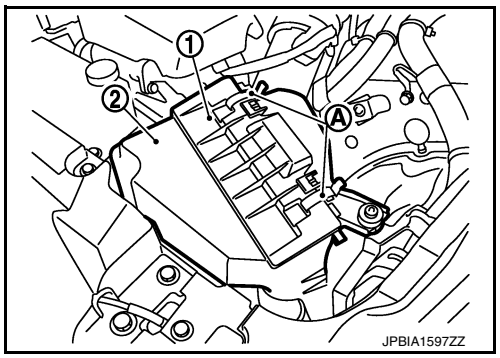
Removal and Installation

INFOID:0000000010581969

REMOVAL

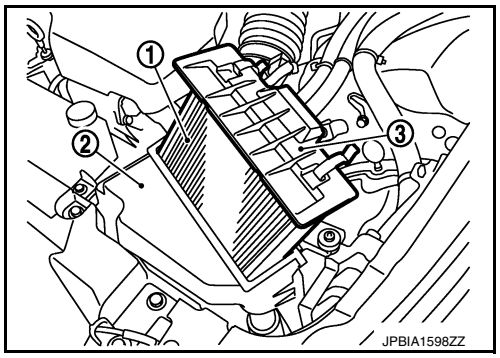
1. Unhook clips (A).

1 : Holder
2 : Air cleaner case



2. Remove air cleaner filter (1) from air cleaner case (2).

3 : Holder



INSTALLATION

Note the following, and install in the reverse order of removal.
- Install the air cleaner filter by aligning the seal with the notch of air cleaner case.

Inspection (Viscous Paper Type)

INFOID:0000000010581970

INSPECTION AFTER REMOVAL

Examine with eyes that there is no stain, clogging, or damage on air cleaner element.
- Remove dusts (such as dead leafs) on air cleaner element surface and inside cleaner case.
- If clogging or damage is observed, replace the air cleaner element.

CAUTION:

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

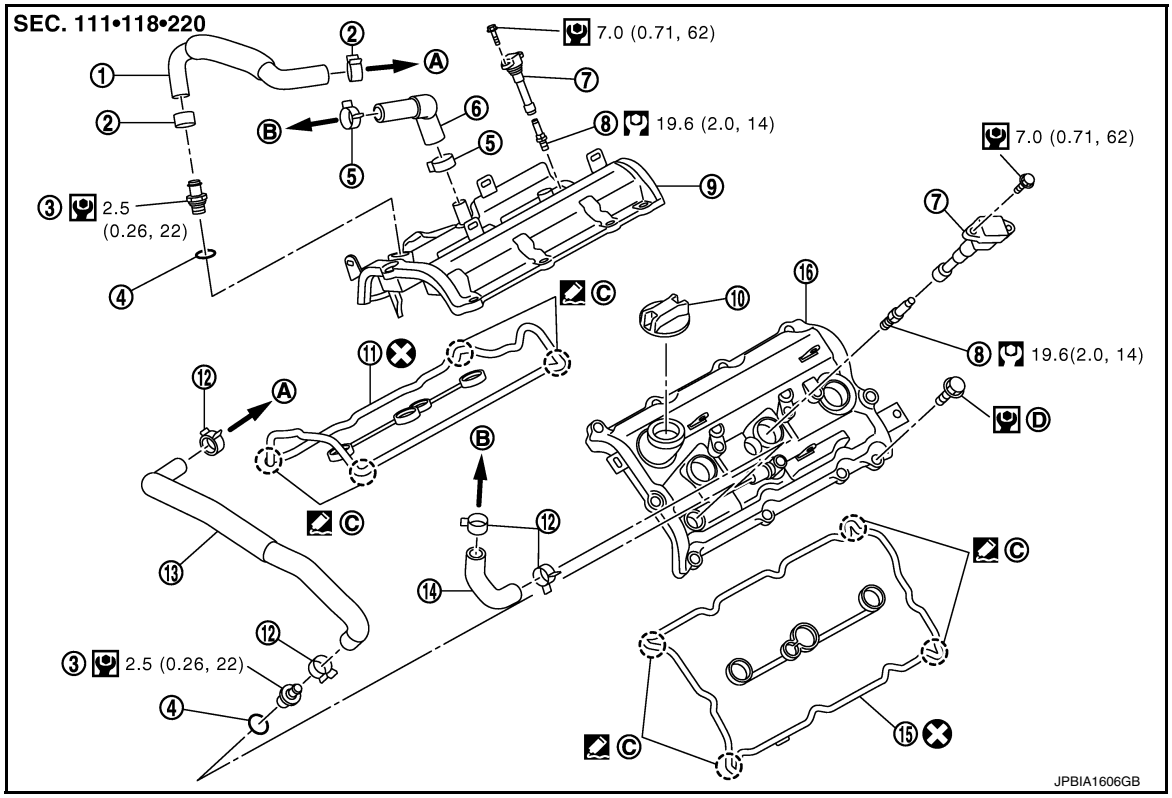
MAINTENANCE INTERVAL

Refer to MA-10, "FOR NORTH AMERICA : Introduction of Periodic Maintenance" (For NORTH AMERICA) or MA-13, "FOR MEXICO : Introduction of Periodic Maintenance" (For MEXICO).

SPARK PLUG

Exploded View

INFOID:0000000010581971



1.	PCV hose	2.	Clamp	3.	PCV valve
4.	O-ring	5.	Clamp	6.	PCV hose
7.	Ignition coil	8.	Spark plug	9.	Rocker cover (bank 1)
10.	Oil filler cap	11.	Rocker cover gasket (bank 1)	12.	Clamp
13.	PCV hose	14.	PCV hose	15.	Rocker cover gasket (bank 2)
16.	Rocker cover (bank 2)				
A.	To intake manifold collector	B.	To air duct	C.	VVEL ladder assembly side
D.	Comply with the installation procedure when tightening. Refer to EM-51				

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

Removal and Installation

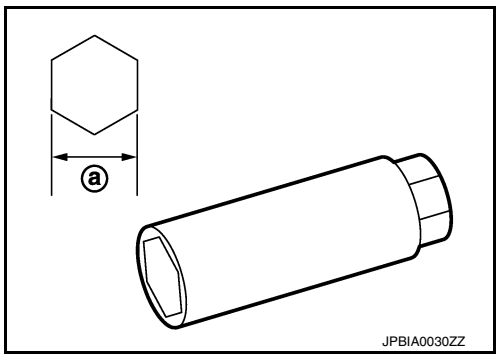
INFOID:0000000010581972

REMOVAL

1. Remove engine cover with power tool. Refer to EM-27, "Exploded View".
2. Remove air cleaner case and air duct. Refer to EM-29, "Exploded View".
3. Remove electric throttle control actuator. Refer to EM-31, "Exploded View".
4. Remove ignition coil.

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

a : 14 mm (0.55 in)



INSTALLATION

Installation is the reverse order of removal.

Inspection

INFOID:0000000010581973

INSPECTION AFTER REMOVAL

Use the standard type spark plug for normal condition.

Spark plug (Standard type) : Refer to EM-151, "Spark Plug".

CAUTION:

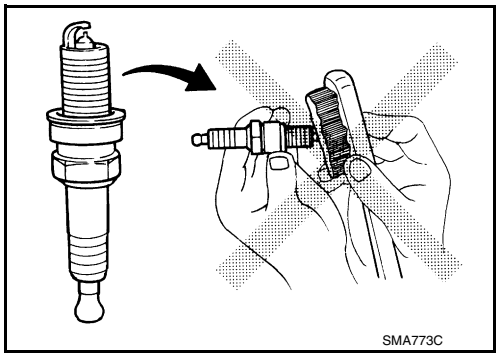
- **Never drop or shock spark plug.**
- **Never use a wire brush for cleaning.**
- **If plug tip is covered with carbon, use spark plug cleaner to clean.**

Cleaner air pressure

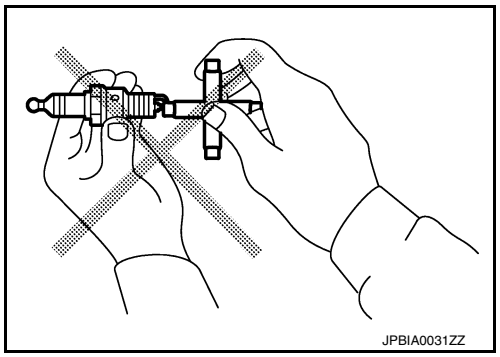
: Less than 588 kPa (5.88 bar, 6 kg/cm^2, 85 psi)

Cleaning time

: Less than 20 seconds



- **Spark plug gap adjustment is not required between replacement intervals.**
- **Measure spark plug gap. When it exceeds the limit, replace spark plug even if it is within the specified replacement mileage. Refer to EM-151, "Spark Plug".**



CAMSHAFT VALVE CLEARANCE

Inspection and Adjustment

INFOID:0000000010581974

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 camshaft (EXH) or valve-related parts, or at the occurrence of malfunction (poor starting, idle malfunction, unusual noise) due to aged deterioration in valve clearance.

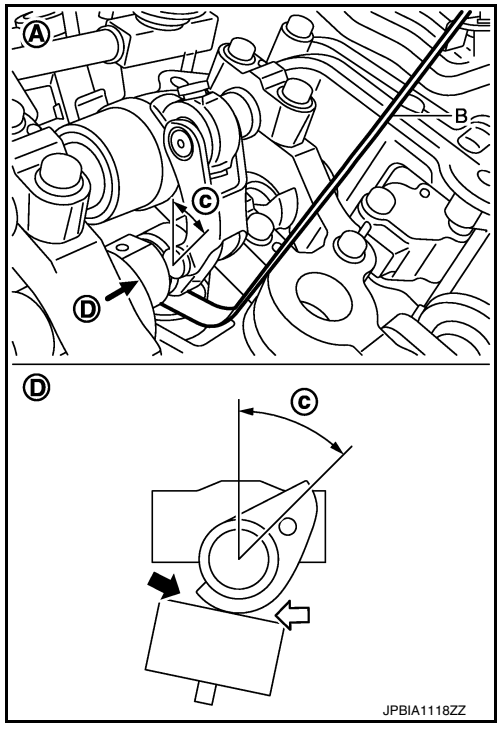
1. Remove rocker covers (bank 1 and bank 2). Refer to EM-51, "Removal and Installation".
2. Measure the valve clearance as follows:
   - Use the feeler gauge (commercial service tool) of curved-tip. This allows the feeler gauge to access the clearance between camshaft and valve lifter with ease.

Valve clearance : Refer to EM-152, "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 1
B : Feeler gauge (commercial service tool)
D : View D
c : 45 degrees (drive shaft nose angle)
⇦ : Insertion direction of feeler gauge on the bank 1
⬅ : Insertion direction of feeler gauge on the bank 2

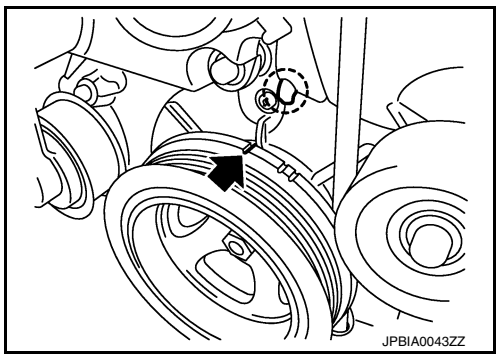
- Refer to the illustration for the insertion direction of the feeler gauge since the direction depends on the bank.



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

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

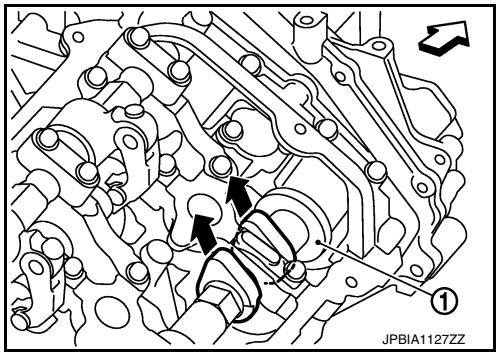
⬅ : Timing mark (grooved line without color)



- Check that exhaust cam nose on No. 1 cylinder (engine front side of bank 1) is located as shown in the figure.
- If not, turn crankshaft one revolution (360 degrees) and align as shown in the figure.

1 : Camshaft (EXH) (bank 1)

⇦ : Engine front

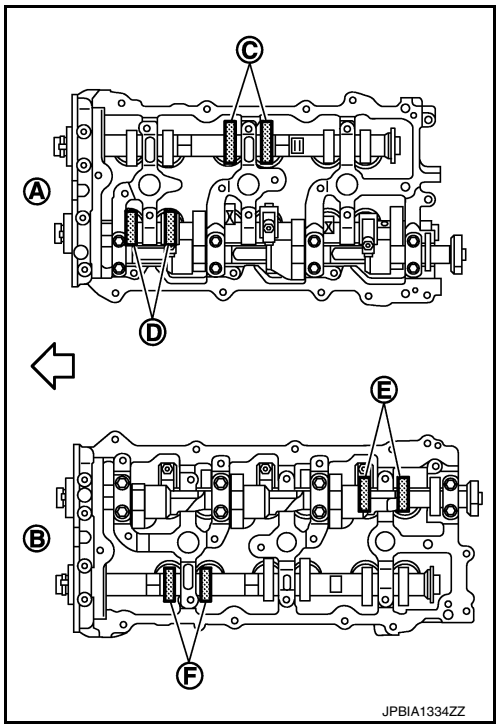


- By referring to the figure, measure the valve clearances at locations marked "×" as shown in the table below (locations indicated in the figure).

⇦ : Engine front

- No. 1 cylinder at compression TDC

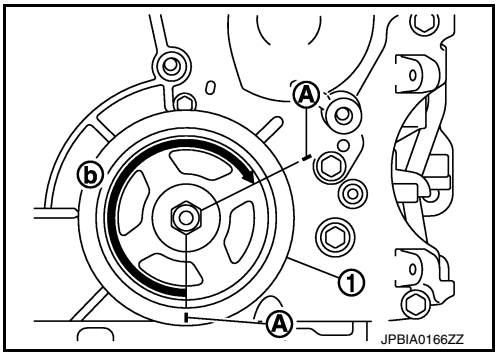
Measuring position [bank 1 (A)]		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.
No. 1 cylinder at compression TDC	EXH		× (C)	
	INT	× (D)		
Measuring position [bank 2 (B)]		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.
No. 1 cylinder at compression TDC	INT			× (E)
	EXH	× (F)		



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

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

1 : Crankshaft pulley
A : Paint mark

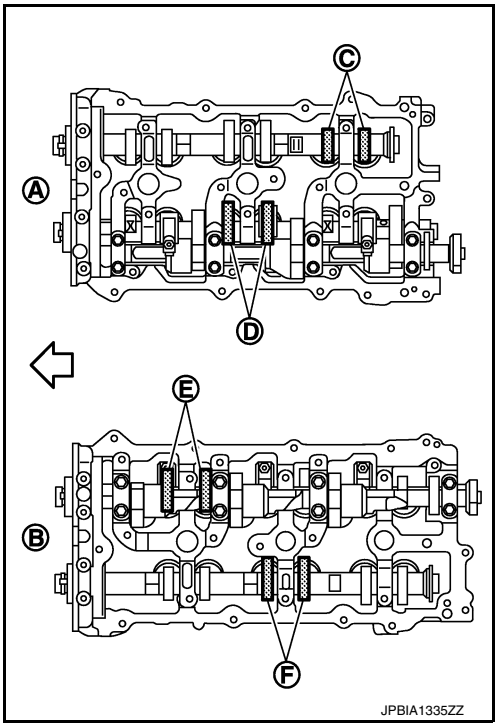


- By referring to the figure, measure the valve clearances at locations marked "×" as shown in the table below (locations indicated in the figure).

⇦ : Engine front

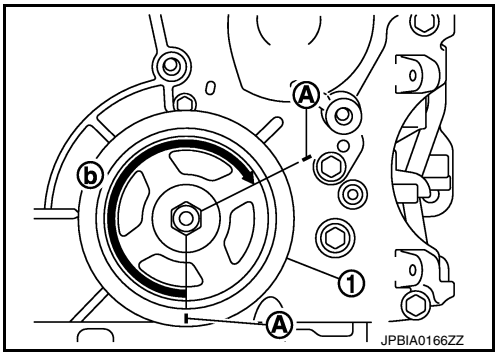
- No. 3 cylinder at compression TDC

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



c. Rotate crankshaft 240 degrees clockwise (when viewed from engine front) to align No. 5 cylinder at TDC of compression stroke.
NOTE:
Mark a position 240 degrees (b) from a corner of the hexagonal part of crankshaft pulley mounting bolt as shown in the figure. Use the hexagonal part as a guide.

1 : Crankshaft pulley
A : Paint mark

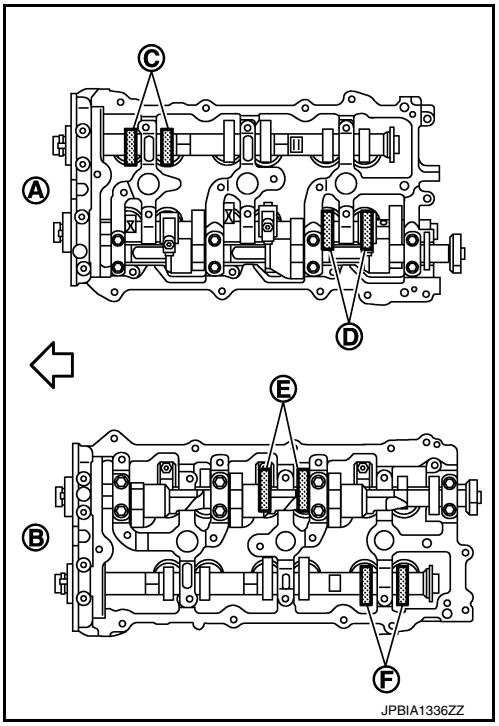


- By referring to the figure, measure the valve clearances at locations marked "×" as shown in the table below (locations indicated in the figure).

⇦ : Engine front

- No. 5 cylinder at compression TDC

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



3. 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.
   - If a valve clearance on the intake side is out of specification, replace VVEL ladder assembly & cylinder head assembly. Refer to EM-98, "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.

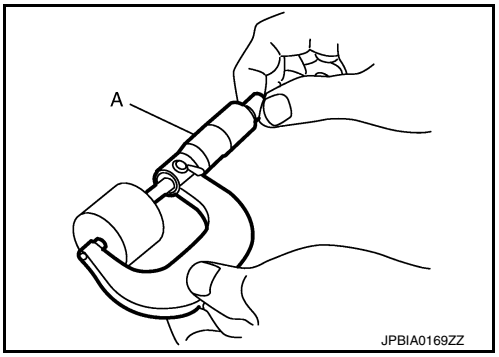
CAMSHAFT (EXH) VALVE CLEARANCE ADJUSTMENT

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

CAUTION:
Never adjust valve clearance on the intake side.

1. Measure the valve clearance. Refer to "INSPECTION".
2. Remove VVEL ladder assembly and camshaft (EXH). Refer to EM-99, "Disassembly and Assembly".

   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

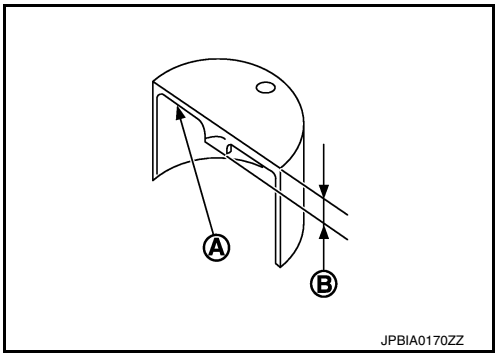
C_2 = Standard valve clearance:

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-152, "Camshaft".

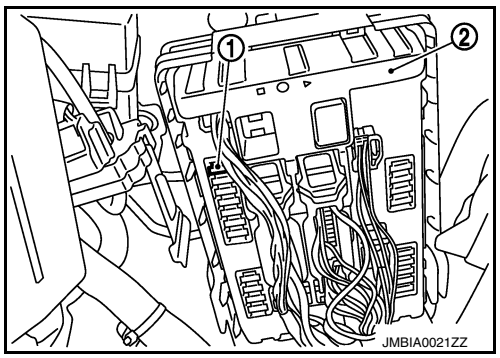
6. Install selected valve lifter (EXH).
7. Install VVEL ladder assembly and camshaft (EXH). Refer to EM-99, "Disassembly and Assembly".
8. Manually turn crankshaft pulley a few turns.
9. Check that the valve clearances for cold engine are within the specifications by referring to the specified values. Refer to EM-152, "Camshaft".
10. Install all removed parts in the reverse order of removal.
11. Warm up the engine, and check for unusual noise and vibration.

COMPRESSION PRESSURE

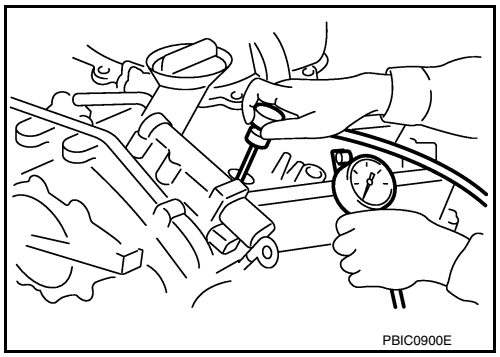
Inspection

INFOID:0000000010581975

1. Warm up engine thoroughly. Then, stop it.
2. Release fuel pressure. Refer to EC-627, "Inspection" (For USA AND CANADA) or EC-1123, "Inspection" (For MEXICO).
3. Disconnect fuel pump fuse (1) from IPDM E/R (2) to avoid fuel injection during measurement.

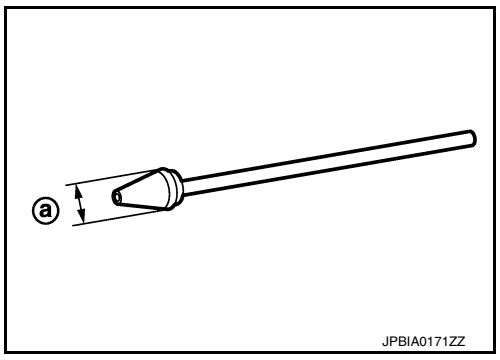


4. Remove engine cover with power tool. Refer to EM-27, "Exploded View".
5. Remove ignition coil and spark plug from each cylinder. Refer to EM-18, "Exploded View".
6. Connect engine tachometer (not required in use of CONSULT).
7. Install compression gauge with an adapter (commercial service tool) onto spark plug hole.



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

  a : 20 mm (0.79 in)



8. With accelerator pedal fully depressed, turn ignition switch to “START” for cranking. When the gauge pointer stabilizes, read the compression pressure and the engine rpm. Perform these steps to check each cylinder.

Compression pressure : Refer to EM-151, "General Specification".

CAUTION:

- **Measure a six-cylinder under the same conditions since a measurement depends on measurement conditions (engine water temperature, etc.).**
- **Always use a fully charged battery to obtain the specified engine speed.**
- If the engine speed is out of the specified range, check battery liquid for proper gravity. Check the engine speed again with normal battery gravity.

- 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, and 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 recheck it for compression.
  - If the added engine oil improves the compression, piston rings may be worn out or damaged. Check piston rings and replace if necessary.
  - If the compression pressure remains at low level despite the addition of engine oil, valves may be malfunctioning. Check valves for damage. Replace valve or valve seat accordingly.
- If two adjacent cylinders have respectively low compression pressure and their compression remains low even after the addition of engine oil, cylinder head gaskets are leaking. In such a case, replace cylinder head gaskets.

9. After inspection is completed, install removed parts.
10. Start the engine, and check that the engine runs smoothly.
11. Perform trouble diagnosis. If DTC appears, erase it. Refer to EC-167, "Description" (For USA AND CANADA) or EC-758, "Description" (For MEXICO).

REMOVAL AND INSTALLATION

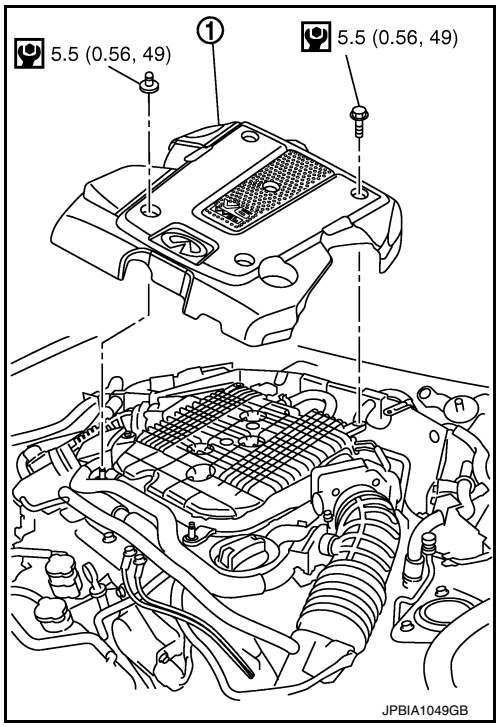
ENGINE COVER

Exploded View

INFOID:0000000010581976

1 : Engine cover

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



Removal and Installation

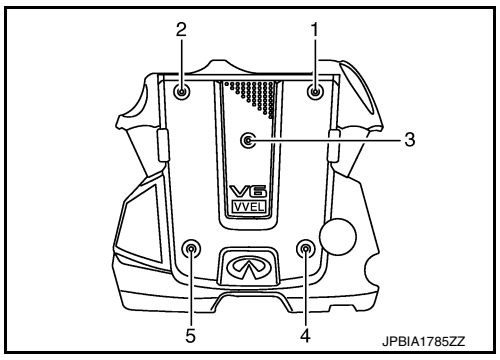
INFOID:0000000010581977

REMOVAL

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

CAUTION:

Never damage or scratch engine cover when installing or removing.

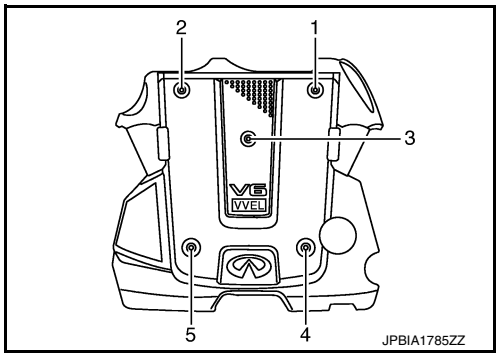


INSTALLATION

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

CAUTION:

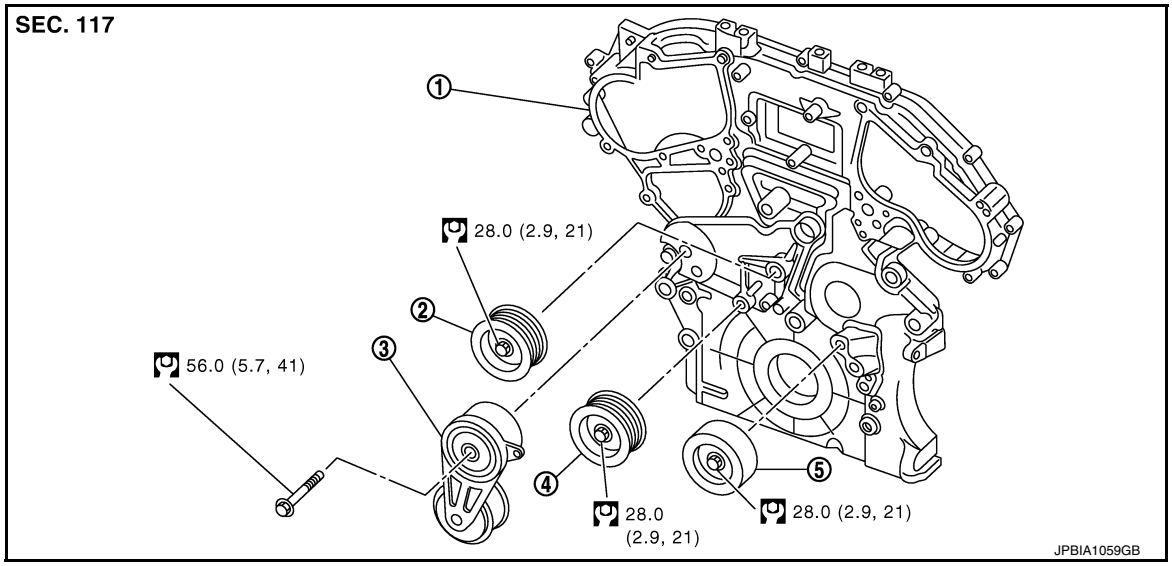
Never damage or scratch engine cover when installing or removing.



DRIVE BELT AUTO TENSIONER AND IDLER PULLEY

Exploded View

INFOID:0000000010581978



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

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

Removal and Installation

INFOID:0000000010581979

Removal

1. Remove drive belt. Refer to EM-15, "Exploded View".
   - Keep auto-tensioner pulley arm locked after drive belt is removed.
2. Remove auto-tensioner and idler pulley.
   - Keep auto-tensioner pulley arm locked to install or remove auto-tensioner.

Installation

Installation is the reverse order of removal.

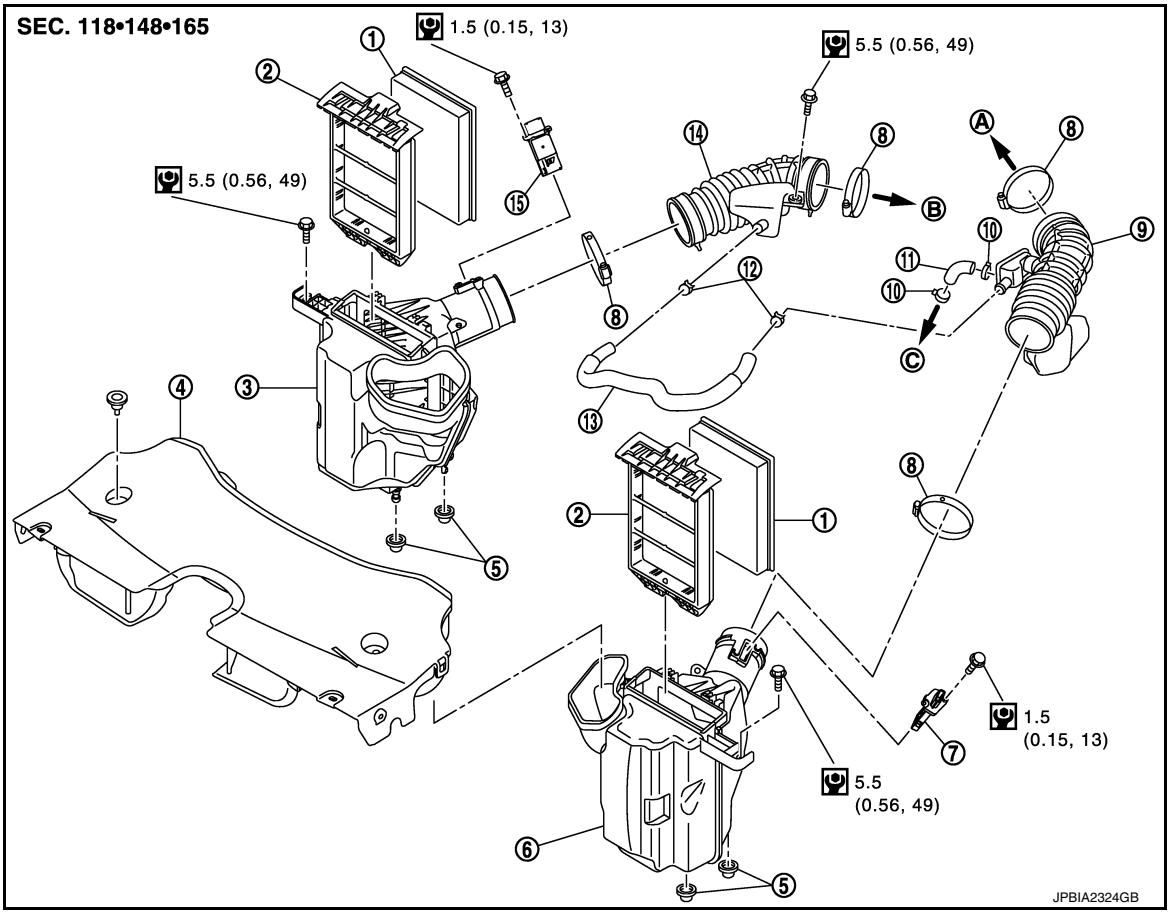
CAUTION:

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

AIR CLEANER AND AIR DUCT

Exploded View

INFOID:0000000010581980



1.	Air cleaner filter	2.	Holder	3.	Air cleaner case (bank 1)
4.	Air duct (inlet)	5.	Grommet	6.	Air cleaner case (bank 2)
7.	Mass air flow sensor (bank 2)	8.	Clamp	9.	Air duct (bank 2)
10.	Clamp	11.	PCV hose	12.	Clamp
13.	PCV hose	14.	Air duct (bank 1)	15.	Mass air flow sensor (bank 1)
A.	To electric throttle control actuator (bank 2)	B.	To electric throttle control actuator (bank 1)	C.	To rocker cover (bank 2)

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

Removal and Installation

INFOID:0000000010581981

REMOVAL

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

CAUTION:

Handle mass air flow sensor according to the following instructions.

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

INSTALLATION

Note the following, and install in the reverse order of removal.
- Align marks. Attach each joint. Screw clamps firmly.

Inspection

INFOID:0000000010581982

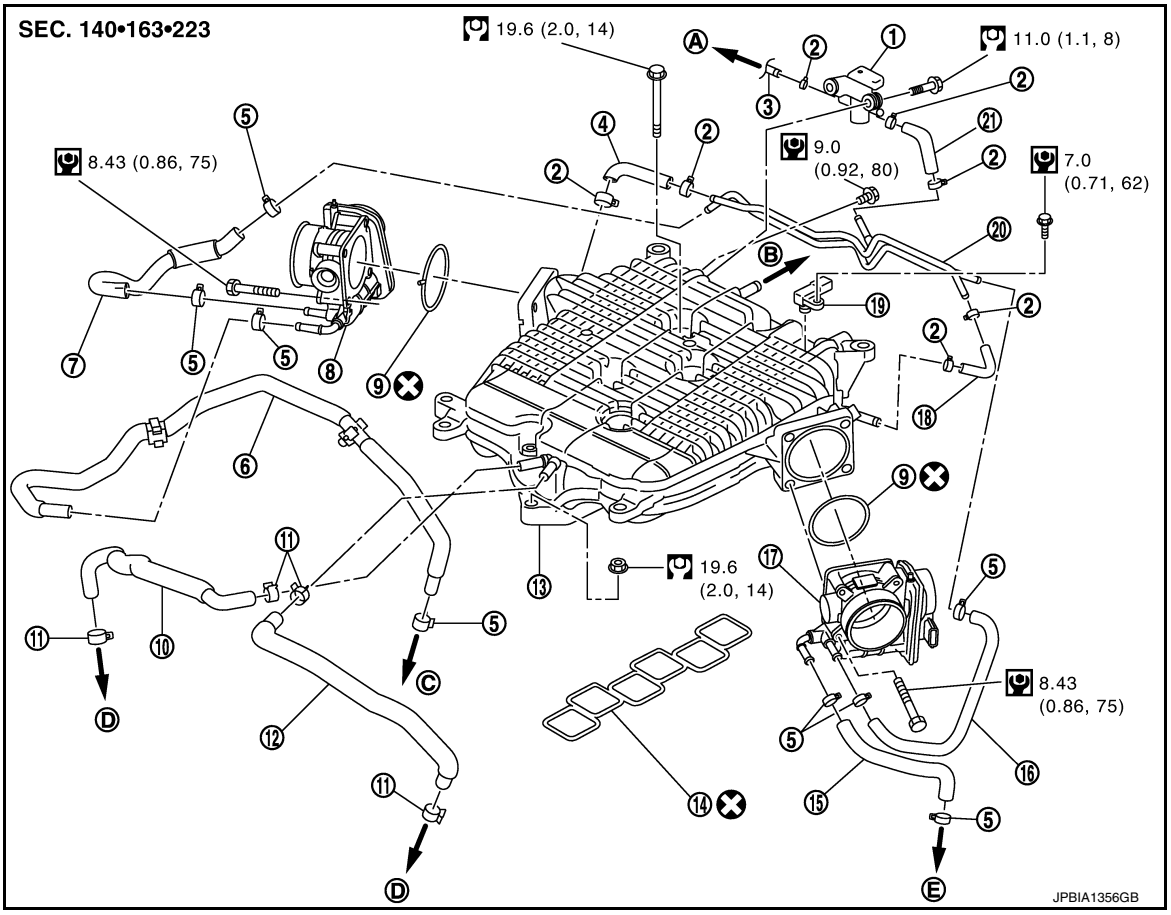
INSPECTION AFTER REMOVAL

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

INTAKE MANIFOLD COLLECTOR

Exploded View

INFOID:0000000010581983



1.	EVAP canister purge volume control solenoid valve	2.	Clamp	3.	EVAP hose
4.	EVAP hose	5.	Clamp	6.	Water hose
7.	Water hose	8.	Electric throttle control actuator (bank 1)	9.	Gasket
10.	PCV hose	11.	Clamp	12.	PCV hose
13.	Intake manifold collector	14.	Gasket	15.	Water hose
16.	Water hose	17.	Electric throttle control actuator (bank 2)	18.	EVAP hose
19.	Manifold absolute Pressure (MAP) sensor	20.	EVAP tube assembly	21.	EVAP hose
A.	To vacuum pipe	B.	To brake booster	C.	To water outlet (rear)
D.	To PCV valve	E.	To heater pipe		

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

Removal and Installation

INFOID:0000000010581984

REMOVAL

WARNING:

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

1. Remove engine cover with power tool. Refer to EM-27, "Exploded View".
2. Remove air cleaner case and air duct. Refer to EM-29, "Exploded View".
3. Remove electric throttle control actuator as follows:

a. Drain engine coolant. When water hoses are disconnected, attach plug to prevent engine coolant leakage.

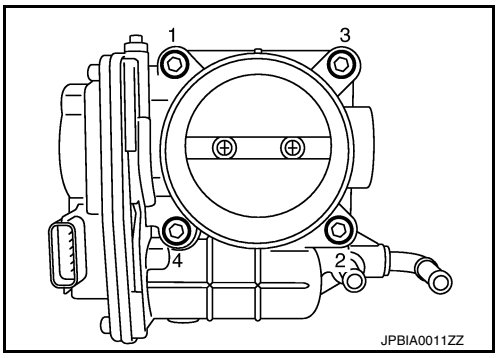
CAUTION:
- **Perform this step when engine is cold.**
- **Never spill engine coolant on drive belt.**

b. Disconnect water hoses from electric throttle control actuator. When engine coolant is not drained from radiator, attach plug to water hoses to prevent engine coolant leakage.

c. Disconnect harness connector.

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

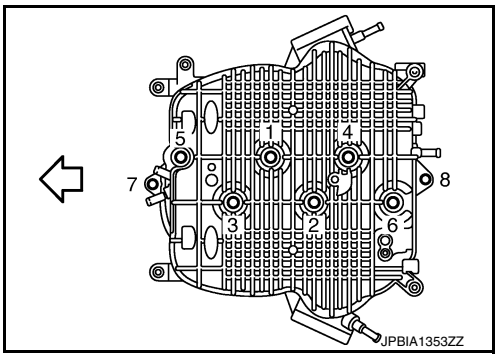
NOTE:
- When removing only intake manifold collector, move electric throttle control actuator without disconnecting the water hose.
- The figure shows the electric throttle control actuator (bank 1) viewed from the air duct side.
- Viewed from the air duct side, the order of loosening mounting bolts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



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

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

⇦ : Engine front



INSTALLATION

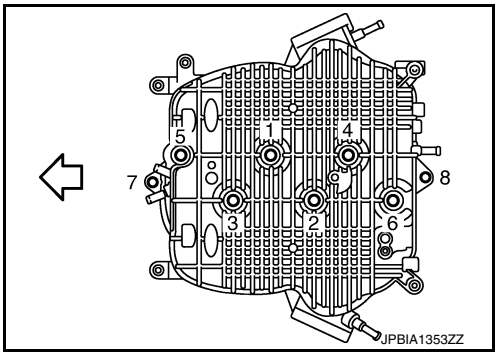
Note the following, and install in the reverse order of removal.

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

: 10.8 N·m (1.1 kg-m, 8 ft-lb)

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

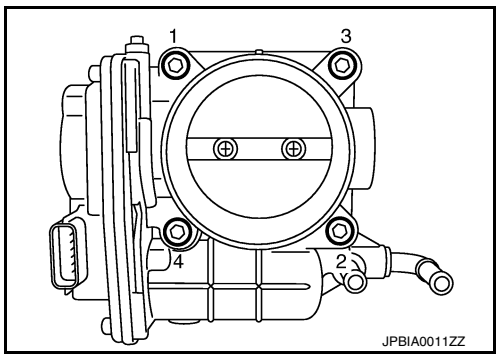
⇦ : Engine front



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

ELECTRIC THROTTLE CONTROL ACTUATOR (BANK 1 AND BANK 2)

- Tighten in numerical order as shown in the figure.
  NOTE:
  - The figure shows the electric throttle control actuator (bank 1) viewed from the air duct side.
  - Viewed from the air duct side, the order of tightening mounting bolts of electric throttle control actuator (bank 2) is the same as that of the electric throttle control actuator (bank 1).

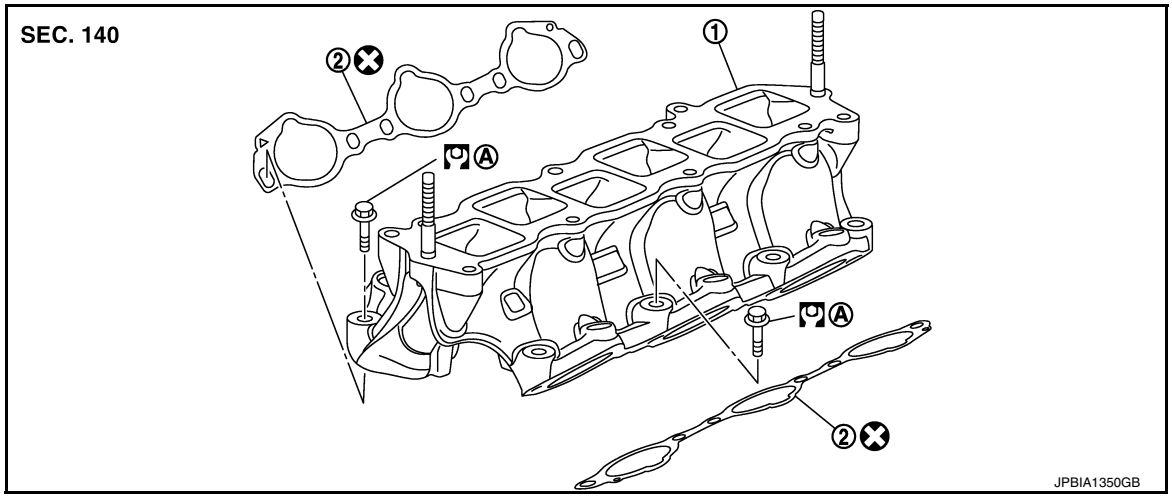


- Perform the “Throttle Valve Closed Position Learning” when harness connector of electric throttle control actuator is disconnected. Refer to EC-33, "THROTTLE VALVE CLOSED POSITION LEARNING : Description" (For USA AND CANADA) or EC-643, "THROTTLE VALVE CLOSED POSITION LEARNING : Description" (For MEXICO).
- Perform the “Idle Air Volume Learning” and “Throttle Valve Closed Position Learning” when electric throttle control actuator is replaced. Refer to EC-33, "IDLE AIR VOLUME LEARNING : Description" (For USA AND CANADA) or EC-643, "IDLE AIR VOLUME LEARNING : Description" (For MEXICO) and EC-33, "THROTTLE VALVE CLOSED POSITION LEARNING : Description" (For USA AND CANADA) or EC-643, "THROTTLE VALVE CLOSED POSITION LEARNING : Description" (For MEXICO).

INTAKE MANIFOLD

Exploded View

INFOID:0000000010581985



1. Intake manifold
2. Gasket
A. Comply with the installation procedure when tightening. Refer to EM-34

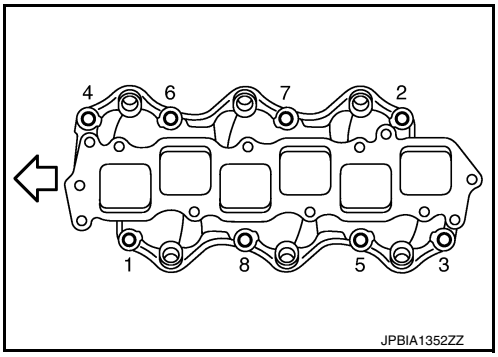
Refer to GI-4, "Components" for symbols in the figure.

Removal and Installation

INFOID:0000000010581986

REMOVAL

1. Release fuel pressure. Refer to EC-627, "Inspection" (For USA AND CANADA) or EC-1123, "Inspection" (For MEXICO).
2. Remove intake manifold collector. Refer to EM-31, "Exploded View".
3. Remove fuel tube and fuel injector assembly. Refer to EM-40, "Exploded View".
4. Loosen mounting bolts in reverse order as shown in the figure to remove intake manifold with power tool.



⇦ : Engine front

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

5. Remove gaskets.

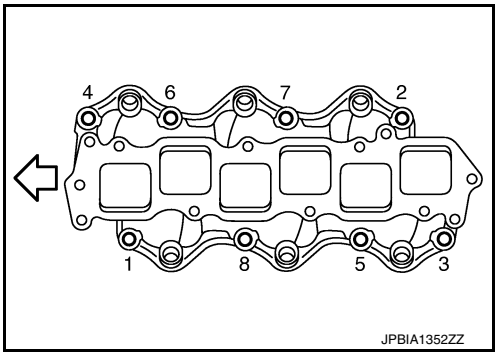
INSTALLATION

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

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

: 10.8 N·m (1.1 kg-m, 8 ft-lb)

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



⇦ : Engine front

CAUTION:

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

1st step:

: 7.4 N·m (0.75 kg-m, 5 ft-lb)

2nd step and after:

: 25.5 N·m (2.6 kg-m, 19 ft-lb)

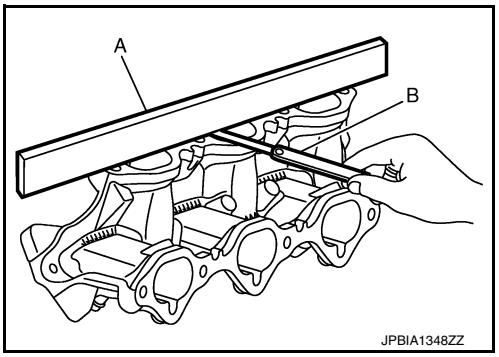
Inspection

INFOID:0000000010581987

INSPECTION AFTER REMOVAL

Surface Distortion

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



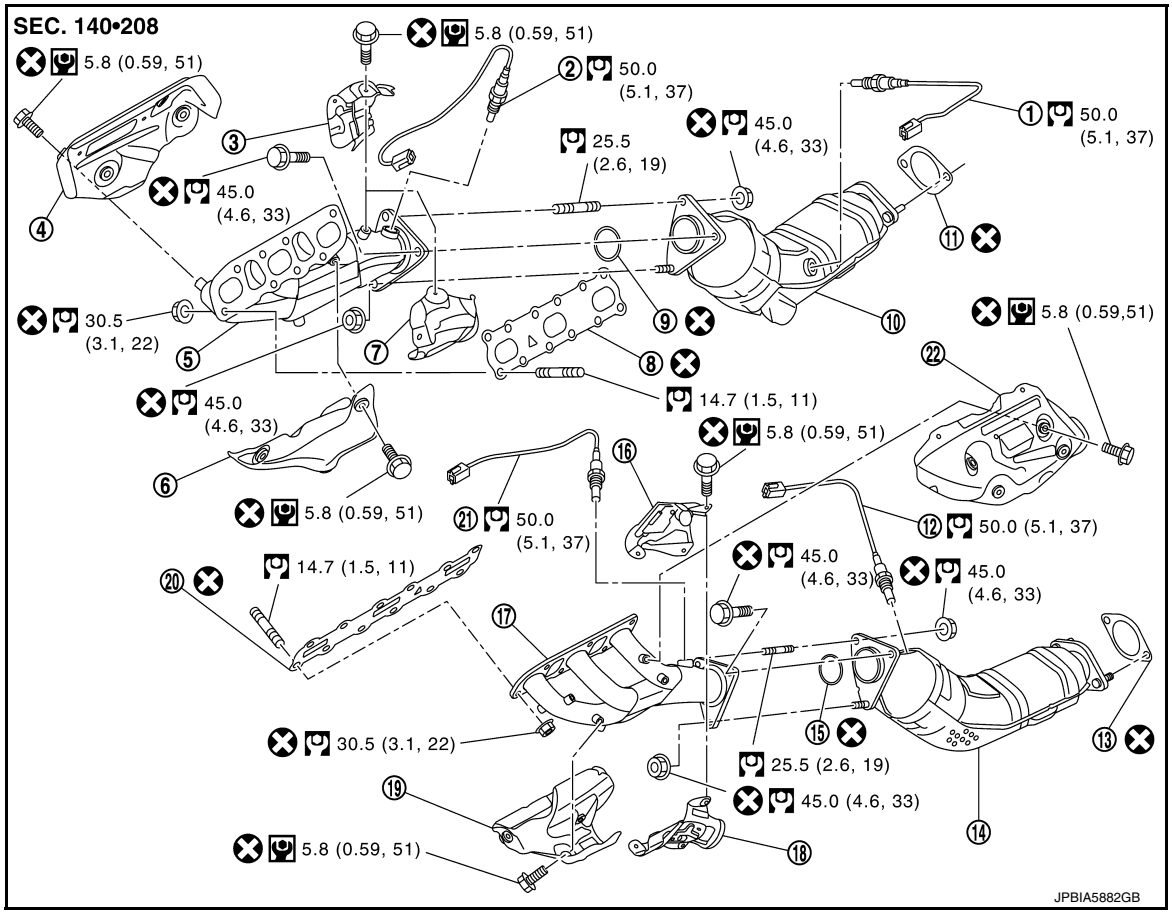
Limit : Refer to EM-152, "Intake Manifold".

- If it exceeds the limit, replace intake manifold.

EXHAUST MANIFOLD

Exploded View

INFOID:0000000011004822



1.	Heated oxygen sensor 2 (bank 1)	2.	Air fuel ratio sensor 1 (bank 1)	3.	Exhaust manifold cover (upper rear) (bank 1)
4.	Exhaust manifold cover (upper) (bank 1)	5.	Exhaust manifold (bank 1)	6.	Exhaust manifold cover (lower) (bank 1)
7.	Exhaust manifold cover (lower rear) (bank 1)	8.	Gasket	9.	Ring gasket
10.	Three way catalyst (bank 1)	11.	Gasket	12.	Heated oxygen sensor 2 (bank 2)
13.	Gasket	14.	Three way catalyst (bank 2)	15.	Ring gasket
16.	Exhaust manifold cover (upper rear) (bank 2)	17.	Exhaust manifold (bank 2)	18.	Exhaust manifold cover (lower rear) (bank 2)
19.	Exhaust manifold cover (lower) (bank 2)	20.	Gasket	21.	Air fuel ratio sensor 1 (bank 2)
22.	Exhaust manifold cover (upper) (bank 2)				

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

Removal and Installation

INFOID:0000000010581989

REMOVAL

WARNING:

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

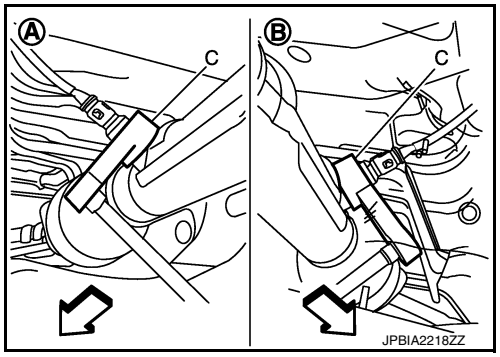
NOTE:

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

1. Remove engine undercover with power tool.
2. Drain engine coolant. Refer to CO-10, "Draining".

3. Remove engine cover with power tool. Refer to EM-31, "Exploded View".
4. Remove air cleaner case and air duct. Refer to EM-29, "Exploded View".
5. Remove heater pipe and water hose. Refer to CO-27, "Exploded View".
6. Remove exhaust front tube. Refer to EX-5, "Exploded View".
7. Disconnect heated oxygen sensor 2 harness connectors (bank 1 and bank 2) and remove harness clip.
8. Using heated oxygen sensor wrench [SST: KV10114400] (C), removal heated oxygen sensor 2.

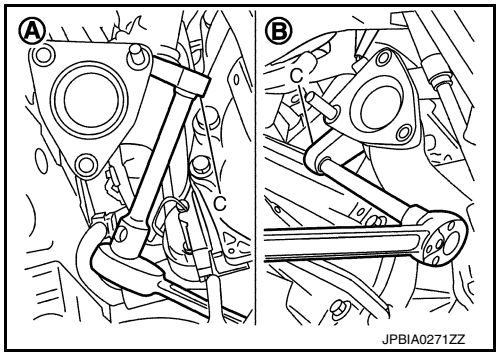
A : Bank 1
B : Bank 2
⇦ : Vehicle front



9. Remove three way catalysts (bank 1 and bank 2).
10. Disconnect steering lower joint at power steering gear assembly side, and release steering lower shaft. Refer to ST-24, "Exploded View".
11. Disconnect air fuel ratio sensor 1 (bank 1 and bank 2) harness connectors and remove harness clip.
12. Using the heated oxygen sensor wrench [SST: KV10114400] (C), remove air fuel ratio sensor 1 (bank 1 and bank 2).

A : Bank 2
B : Bank 1

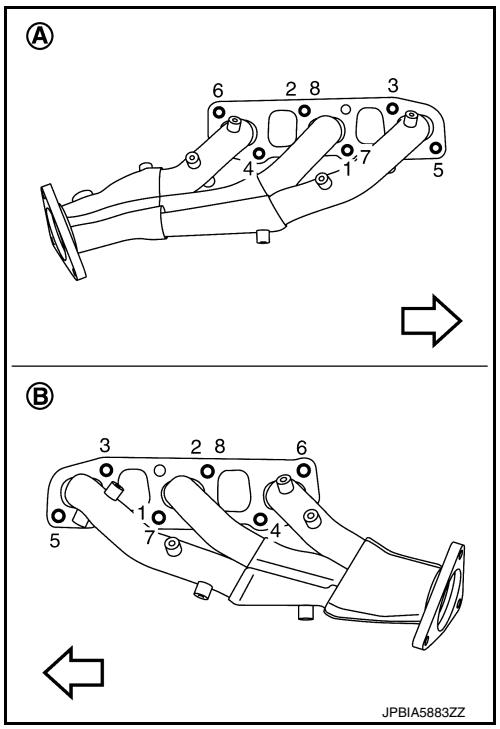
CAUTION:
- **Be careful not to damage air fuel ratio sensor 1.**
- **Discard any air fuel ratio sensor 1 that has been dropped onto a hard surface such as a concrete floor. Replace with a new sensor.**



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

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

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



15. Remove gaskets.

CAUTION:

Cover engine openings to avoid entry of foreign materials.

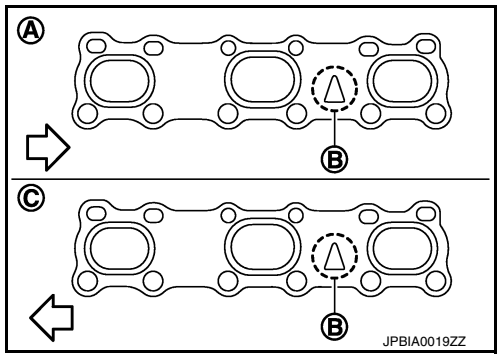
INSTALLATION

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

EXHAUST MANIFOLD GASKET

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

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



EXHAUST MANIFOLD

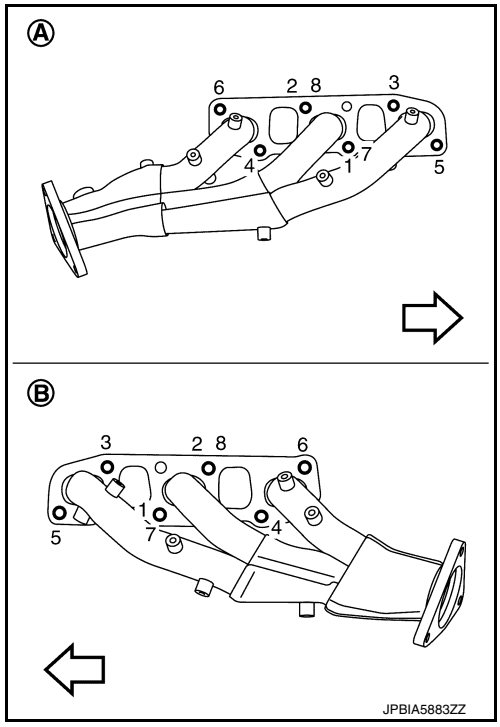
- If stud bolts were removed, install them and tighten to the torque specified below.

Tightening torque : Refer to EM-36, "Exploded View".

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

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

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



Air Fuel Ratio Sensor 1 and Heated Oxygen Sensor 2

CAUTION:

- **Before installing new sensors, clean exhaust system threads using heated oxygen sensor thread cleaner tool (commercial service tool) and apply anti-seize lubricant.**
- **Never apply excessive torque to sensors. Doing so may cause damage to sensors, resulting in the "MI" illuminating.**
- **Prevent rust preventives from adhering to the sensor body.**

Inspection

INFOID:0000000010581990

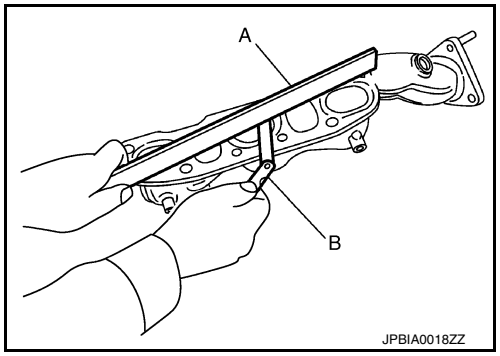
INSPECTION AFTER REMOVAL

Surface Distortion

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

Limit : Refer to EM-152, "Exhaust Manifold".

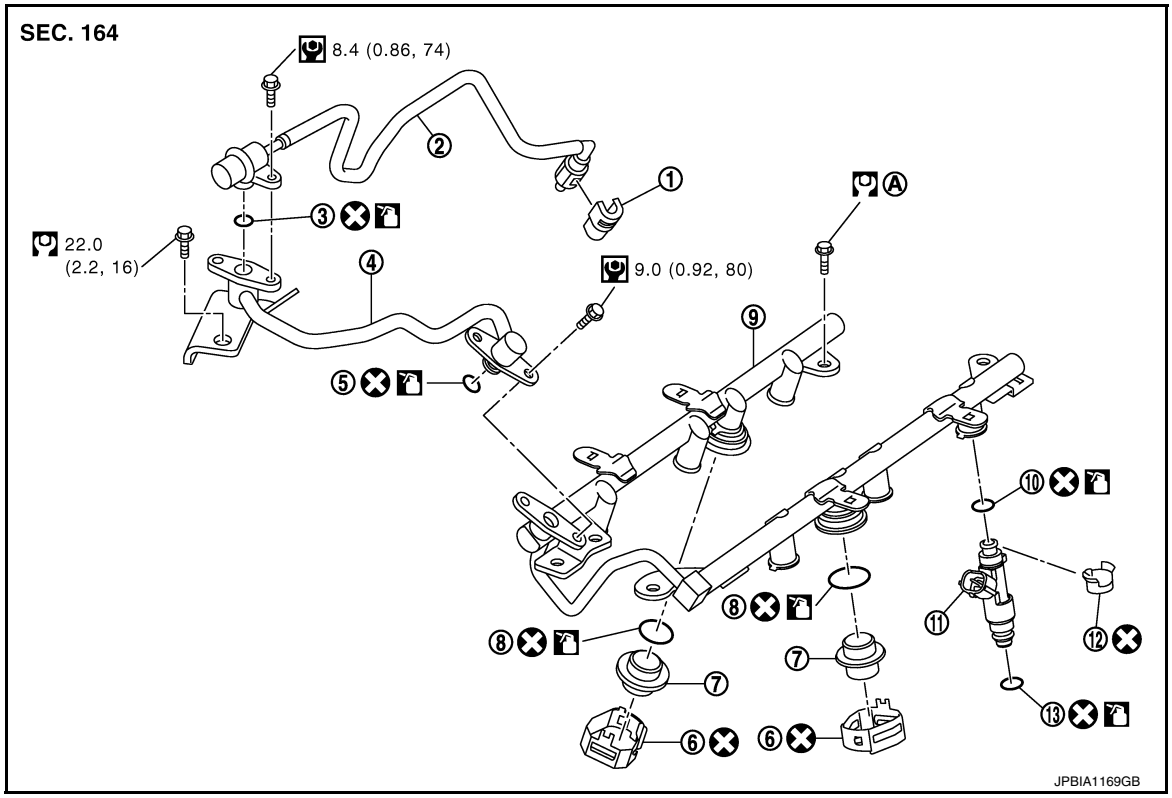
- If it exceeds the limit, replace exhaust manifold.



FUEL INJECTOR AND FUEL TUBE

Exploded View

INFOID:0000000010581991



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

A. Comply with the installation procedure when tightening. Refer to EM-40

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

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

Removal and Installation

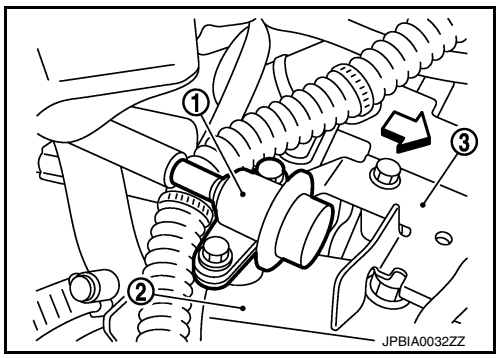
INFOID:0000000010581992

REMOVAL

WARNING:
- **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.**
- **Never drain engine coolant when the engine is hot to avoid the danger of being scalded.**

1. Release fuel pressure. Refer to EC-627, "Inspection" (For USA AND CANADA) or EC-1123, "Inspection" (For MEXICO).
2. Disconnect battery cable from the negative terminal. Refer to PG-126, "Exploded View".
3. Remove engine cover with power tool. Refer to EM-27, "Exploded View".
4. Remove air cleaner case and air duct. Refer to EM-29, "Exploded View".
5. Remove intake manifold collector. Refer to EM-31, "Exploded View".

6. Remove fuel feed hose (with damper) (1) from fuel sub-tube (2) and remove harness bracket (3).



⇦ : Engine front

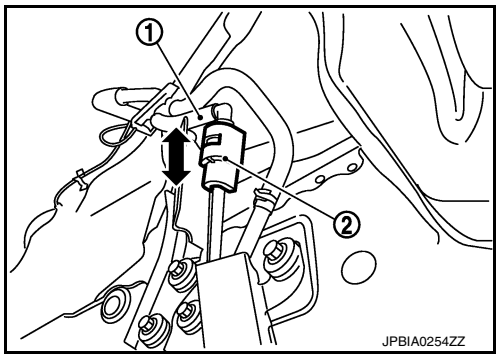
NOTE:
There is no fuel return route.

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

7. When separating fuel feed hose (with damper) and centralized under-floor piping connection, disconnect quick connector as follows:

a. Remove quick connector cap (2) from quick connector connection on right member side.

b. Disconnect fuel feed hose (with damper) (1) from bracket hose clamp.

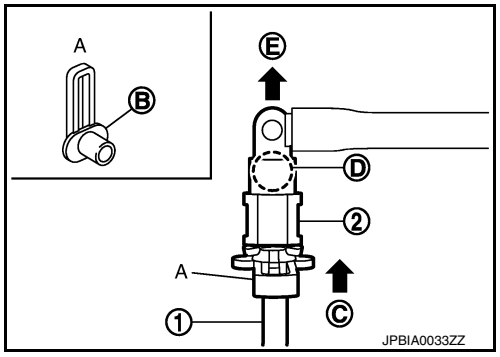


c. Disconnect quick connector from centralized under-floor piping as follows:

CAUTION:
Disconnect quick connector by using quick connector release (commercial service tool), not by picking out retainer tabs.

i. With the sleeve side of quick connector release facing quick connector, install quick connector release onto centralized under-floor piping.

ii. Insert quick connector release (A) into quick connector (2) until sleeve (B) contacts and goes no further. Hold quick connector release on that position.



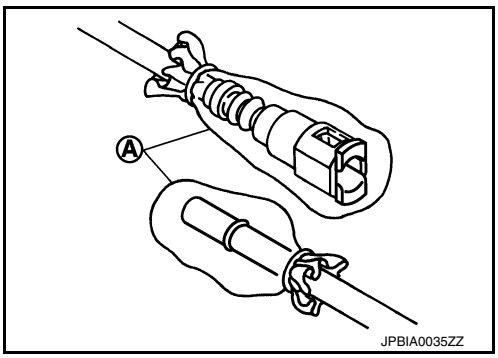
1 : Centralized under-floor piping
C : Insert and retain
D : Holding position
E : Pull quick connector

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

iii. Draw and pull out quick connector straight from centralized under-floor piping.

CAUTION:
- **Pull quick connector holding “D” 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.**

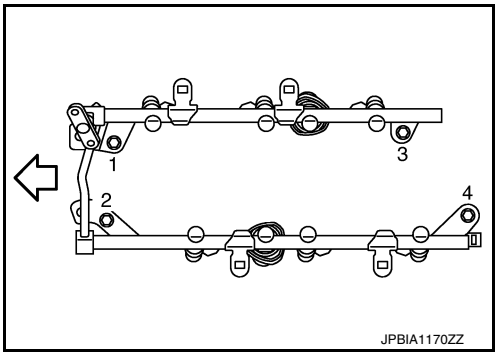
- **To keep the connecting portion clean and to avoid damage and foreign materials, cover them completely with plastic bags, etc. (A) or a similar item.**



8. Remove fuel sub tube mounting bolt.
9. Disconnect harness connector from fuel injector.
10. Loosen mounting bolts in reverse order as shown in the figure, and remove fuel tube and fuel injector assembly.

⇦ : Engine front

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

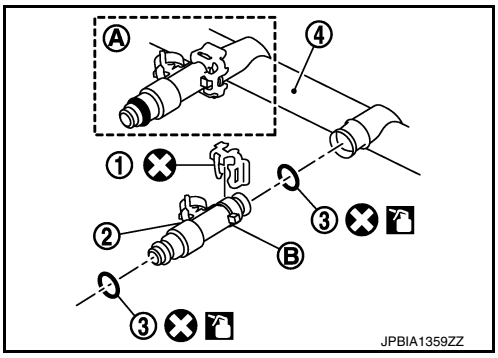


11. Remove fuel injector (2) from fuel tube (4) as follows:

3 : O-ring
A : Installed condition
B : Clip mounting groove

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

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



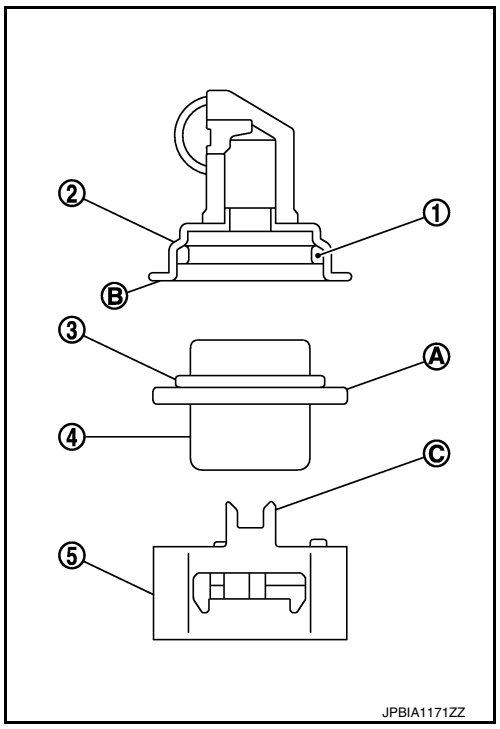
12. Remove fuel sub-tube and fuel damper, if necessary.

INSTALLATION

CAUTION:
Do not reuse O-rings.

1. Install fuel damper (4) as follows:

2 : Cup
5 : Clip
C : Cut-out



a. Install new O-ring (1) to fuel tube as shown. When handling new O-ring, pay attention to the following caution items:
CAUTION:
- **Do not reuse O-rings.**
- **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, do not insert it quickly into fuel tube.**
- **Insert new O-ring straight into fuel tube. Never twist it.**

b. Install spacer (3) to fuel damper.

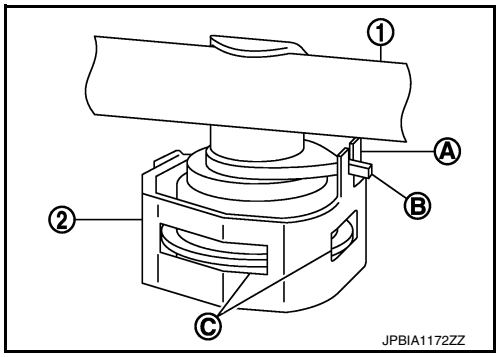
c. Insert fuel damper straight into fuel tube.
CAUTION:
- **Insert straight, checking that the axis is lined up.**
- **Never pressure-fit with excessive force.**

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

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

d. Install the cut-out (A) of the clip (2) to the projection (B), which ensures that the fuel tube does not move or rotate.

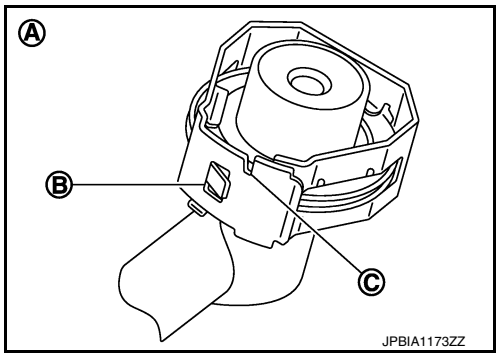
1 : Fuel tube



e. Unlock the clip after checking that the rib of the cup and the brim of the fuel damper are mated each other and positioned in the holes (C) of the clip.

f. Check that the opening (B) and the slit (C) of the clip are positioned and fixed properly so it does not rotate or pull out.

A : Under view



2. Install fuel sub-tube.
- When handling new O-rings, be careful of the following caution items:
CAUTION:
- **Do not reuse O-rings.**
- **Handle O-ring with bare hands. Never wear gloves.**
- **Lubricate O-ring with new engine oil.**
- **Never clean O-ring with solvent.**

- **Check that O-ring and its mating part are free of foreign material.**
- **When installing O-ring, be careful not to scratch it with tool or fingernails. Also be careful not to twist or stretch O-ring. If O-ring was stretched while it was being attached, never insert it quickly into fuel tube.**
- **Insert new O-ring straight into fuel tube. Never decenter or twist it.**
- Insert fuel sub-tube straight into fuel tube.
- Tighten mounting bolts evenly in turn.
- After tightening mounting bolts, check that there is no gap between flange and fuel tube.

3. Install new O-rings to fuel injector, paying attention to the following items.

CAUTION:

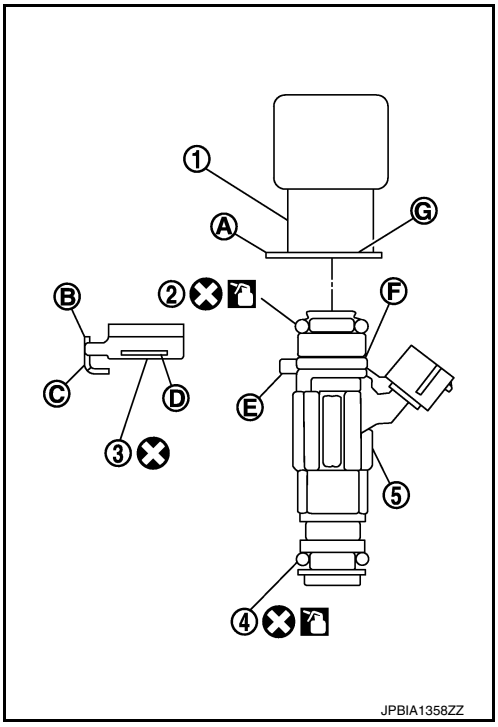
- **Do not reuse O-rings.**
- **Upper and lower O-ring are different. Be careful not to confuse them.**

Fuel tube side	**: Black**
Nozzle side	**: Green**

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

4. Install fuel injector to fuel tube as follows:

2 : O-ring (Black)
4 : O-ring (Green)



a. Insert clip (3) into clip mounting groove (F) on fuel injector (5).

CAUTION:

- **Never reuse clip. Replace it with a new one.**
- **Be careful to keep clip from interfering with O-ring. If interference occurs, replace O-ring.**
- **Insert clip so that protrusion (E) of fuel injector matches cut-out (C) of clip.**

b. Insert fuel injector into fuel tube (1) with clip attached.
- Insert it while matching it to the axial center.
- Insert fuel injector so that protrusion (A) of fuel tube matches cutout (B) of clip.
- Check that fuel tube flange (G) is securely fixed in flange fixing groove (D) on clip.

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

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

CAUTION:

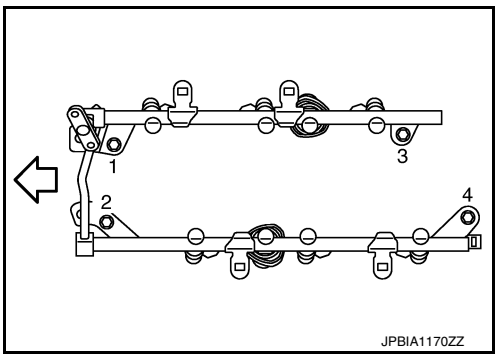
Be careful not to let tip of injector nozzle come in contact with other parts.

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

⇦ : Engine front

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

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



6. Connect injector sub-harness.
7. Install fuel sub tube mounting bolt.
8. Connect fuel feed hose (with damper).
   - Handling procedure of O-ring is the same as that of fuel damper and fuel sub-tube.
   - Insert fuel damper straight into fuel sub-tube.
   - Tighten mounting bolts evenly in turn.
   - After tightening mounting bolts, check that there is no gap between flange and fuel sub-tube.
9. Connect quick connector between fuel feed hose (with damper) and centralized under-floor piping connection as follows:

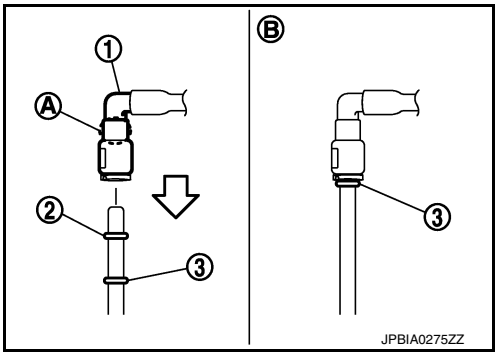
a. Check that no foreign substances are deposited in and around centralized under-floor piping and quick connector, and that there is no damage to them.

b. Thinly apply new engine oil around centralized under-floor piping from tip end to spool end.

c. Align center to insert quick connector (1) straightly into centralized under-floor piping.

B : Fitted condition

⇦ : Upright insertion



- Insert quick connector to centralized under-floor piping until top spool (2) is completely inside quick connector and 2nd level spool (3) exposes just below quick connector.

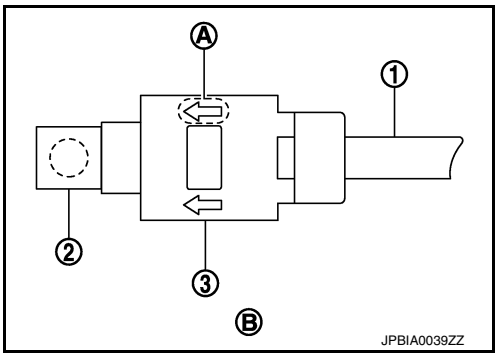
CAUTION:

- **Hold (A) position as shown in the figure when inserting centralized under-floor piping into quick connector.**
- **Carefully align center to avoid inclined insertion to prevent damage to O-ring inside quick connector.**
- **Insert until a "click" sound is heard and the engagement is felt.**
- **To avoid misidentification of engagement with a similar sound, be sure to perform the next step.**

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

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

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



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

CAUTION:

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

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

Inspection

INFOID:0000000010581993

INSPECTION AFTER INSTALLATION

Check for Fuel Leakage

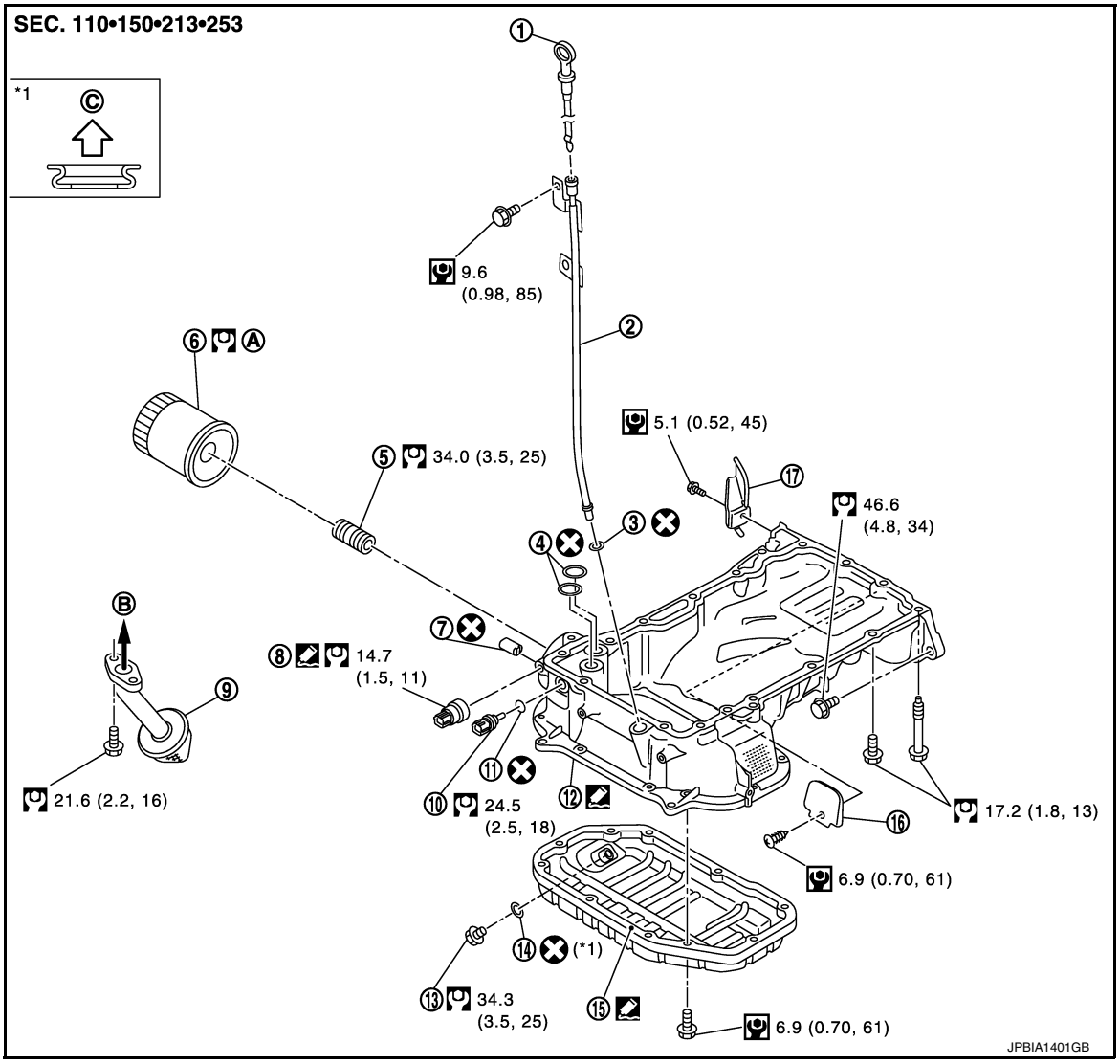
1. Turn ignition switch “ON” (with the engine stopped). With fuel pressure applied to fuel piping, check that there is no fuel leakage at connection points.
   NOTE:
   Use mirrors for checking at points out of clear sight.
2. Start the engine. With engine speed increased, check again that there is no fuel leakage at connection points.
   CAUTION:
   Never touch the engine immediately after it is stopped because the engine is extremely hot.

OIL PAN (LOWER)

Exploded View

INFOID:0000000010581994

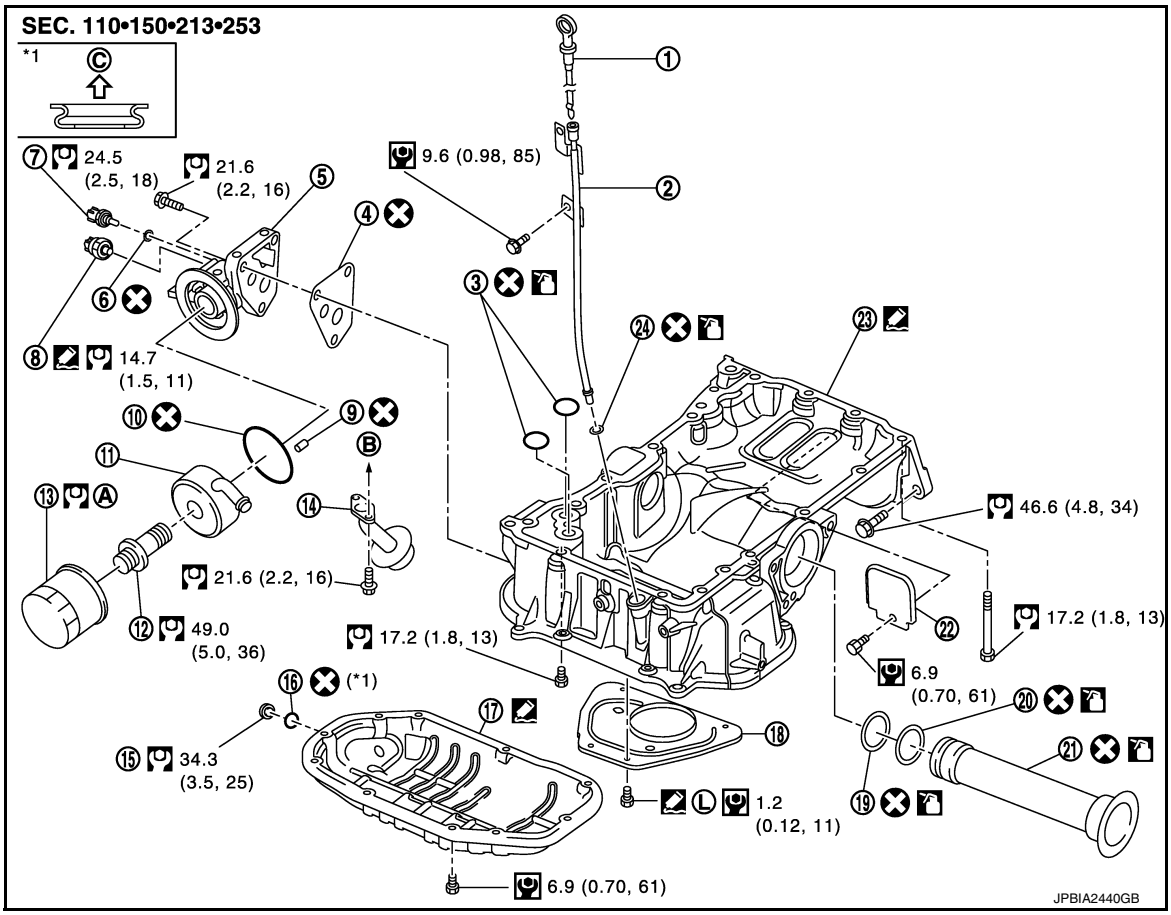
2WD



1.	Oil level gauge	2.	Oil level gauge guide	3.	O-ring
4.	O-ring	5.	Connector bolt	6.	Oil filter
7.	Relief valve	8.	Oil pressure switch	9.	Oil strainer
10.	Oil temperature sensor	11.	Washer	12.	Oil pan (upper)
13.	Drain plug	14.	Drain plug washer	15.	Oil pan (lower)
16.	Rear plate cover	17.	Rear cover plate (M/T models)		
A.	Comply with the installation procedure when tightening. Refer to LU-11	B.	To oil pump	C.	Oil pan side

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

AWD



1. Oil level gauge	2. Oil level gauge guide	3. O-ring
4. Gasket	5. Oil filter bracket	6. Washer
7. Oil temperature sensor	8. Oil pressure switch	9. Relief valve
10. O-ring	11. Oil cooler	12. Connector bolt
13. Oil filter	14. Oil strainer	15. Drain plug
16. Drain plug washer	17. Oil pan (lower)	18. Baffle plate
19. O-ring (small)	20. O-ring (large)	21. Axle pipe
22. Rear plate cover	23. Oil pan (upper)	24. O-ring
A. Comply with the installation procedure when tightening. Refer to LU-11	B. To oil pump	C. Oil pan side

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

Removal and Installation

INFOID:0000000010581995

REMOVAL

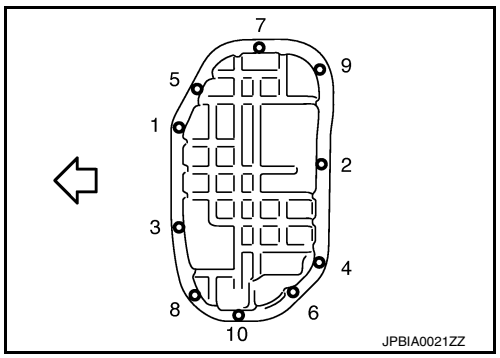
CAUTION:

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

1. Remove engine undercover with power tool.
2. Drain engine oil. Refer to LU-10, "Draining".
3. Remove oil pan (lower) as follows:

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

⇦ : Engine front

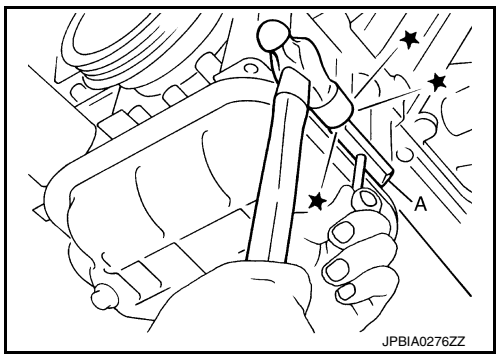


b. Insert the seal cutter [SST: KV10111100] (A) between oil pan (upper) and oil pan (lower).

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).



INSTALLATION

CAUTION:

Do not reuse drain plug washer.

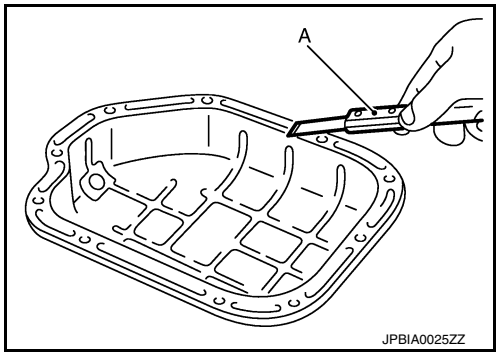
1. Install oil pan (lower) as follows:

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

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

CAUTION:

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



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

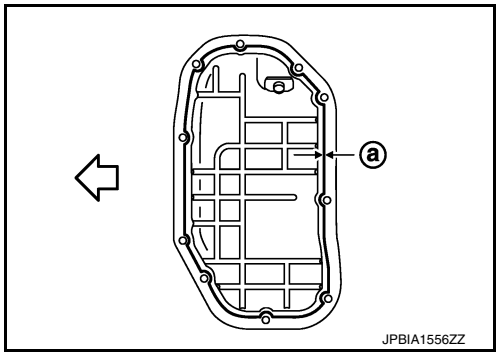
a : ϕ4.0 - 5.0 mm (0.157 - 0.197 in)

⇦ : Engine front

Use Genuine Liquid Gasket or equivalent.

CAUTION:

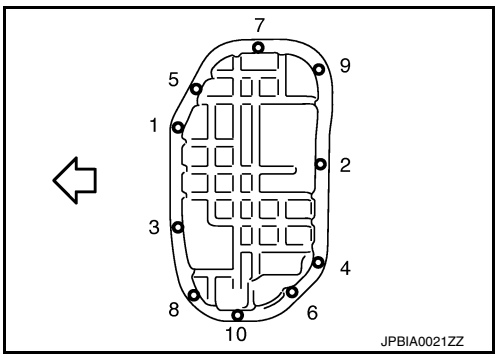
Attaching should be done within 5 minutes after coating.



c. Install oil pan (lower).

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

⇦ : Engine front



2. Install oil pan drain plug.
   CAUTION:
   Do not reuse drain plug washer.
   - Refer to the figure of the components of on the prior page for installation direction of drain plug washer. Refer to EM-47, "Exploded View".
3. Install in the reverse order of removal after this step.
   NOTE:
   Wait at least 30 minutes after oil pan (lower) is installed before pouring engine oil.

Inspection

INFOID:0000000010581996

INSPECTION AFTER REMOVAL

Clean oil strainer if any object is attached.

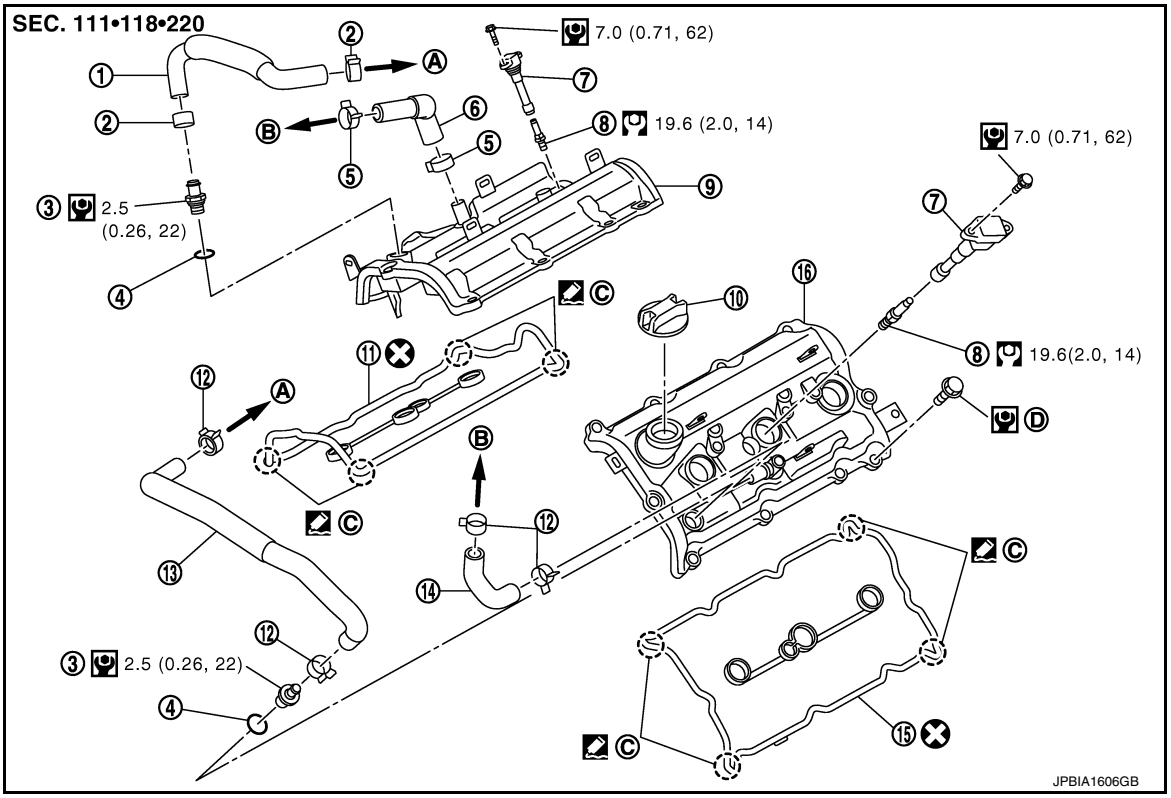
INSPECTION AFTER INSTALLATION

1. Check the engine oil level and adjust engine oil. Refer to LU-8, "Inspection".
2. Start engine, and check there is no leakage of engine oil.
3. Stop engine and wait for 10 minutes.
4. Check the engine oil level again. Refer to LU-8, "Inspection".

IGNITION COIL, SPARK PLUG AND ROCKER COVER

Exploded View

INFOID:0000000010581997



1.	PCV hose	2.	Clamp	3.	PCV valve
4.	O-ring	5.	Clamp	6.	PCV hose
7.	Ignition coil	8.	Spark plug	9.	Rocker cover (bank 1)
10.	Oil filler cap	11.	Rocker cover gasket (bank 1)	12.	Clamp
13.	PCV hose	14.	PCV hose	15.	Rocker cover gasket (bank 2)
16.	Rocker cover (bank 2)				
A.	To intake manifold collector	B.	To air duct	C.	VVEL ladder assembly side
D.	Comply with the installation procedure when tightening. Refer to EM-51				

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

Removal and Installation

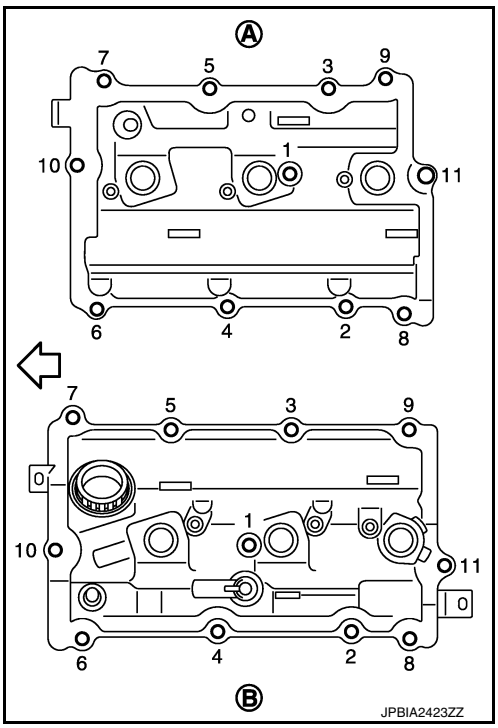
INFOID:0000000010581998

REMOVAL

1. Remove the following parts:
   - Engine cover: Refer to EM-27, "Exploded View".
   - Air cleaner case and air duct: Refer to EM-29, "Exploded View".
   - Intake manifold collector: Refer to EM-31, "Exploded View".
2. Disconnect PCV hose from rocker cover.
3. Remove PCV valve and O-ring from rocker cover, if necessary.
4. Remove oil filler cap from rocker cover, if necessary.
5. Remove ignition coil.
   CAUTION:
   Never shock ignition coil.
6. Remove harness clips on the rocker cover.

7. Loosen bolts in reverse order shown in the figure.

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



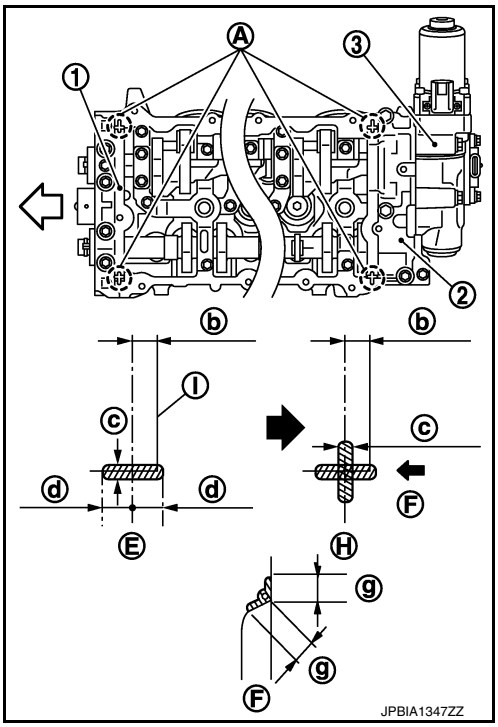
8. Remove rocker cover gasket from rocker cover.
9. Use scraper to remove all traces of liquid gasket from cylinder head and VVEL ladder assembly.
CAUTION:
Never scratch or damage the mating surface when cleaning off old liquid gasket.

INSTALLATION

CAUTION:
Do not reuse O-rings.

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

2 : Actuator bracket (rear)
3 : VVEL actuator sub assembly
A : Liquid gasket application point
F : View F
I : End surface of VVEL ladder assembly
b : 4 mm (0.16 in)
c : ϕ2.5 - 3.5 mm (0.098 - 0.138 in)
d : 5 mm (0.20 in)
g : 10 mm (0.39 in)
⇦ : Engine front



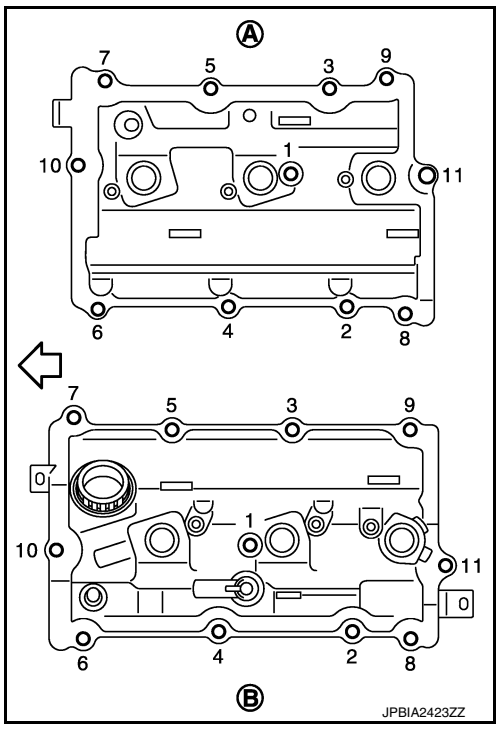
a. Refer to figure (E) to apply liquid gasket to joint part of VVEL ladder assembly (1) and cylinder head.
b. Refer to figure (H) to apply liquid gasket in 90 degrees to figure.
Use Genuine Liquid Gasket or equivalent.

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 1
B : Bank 2
⇦ : Engine front

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

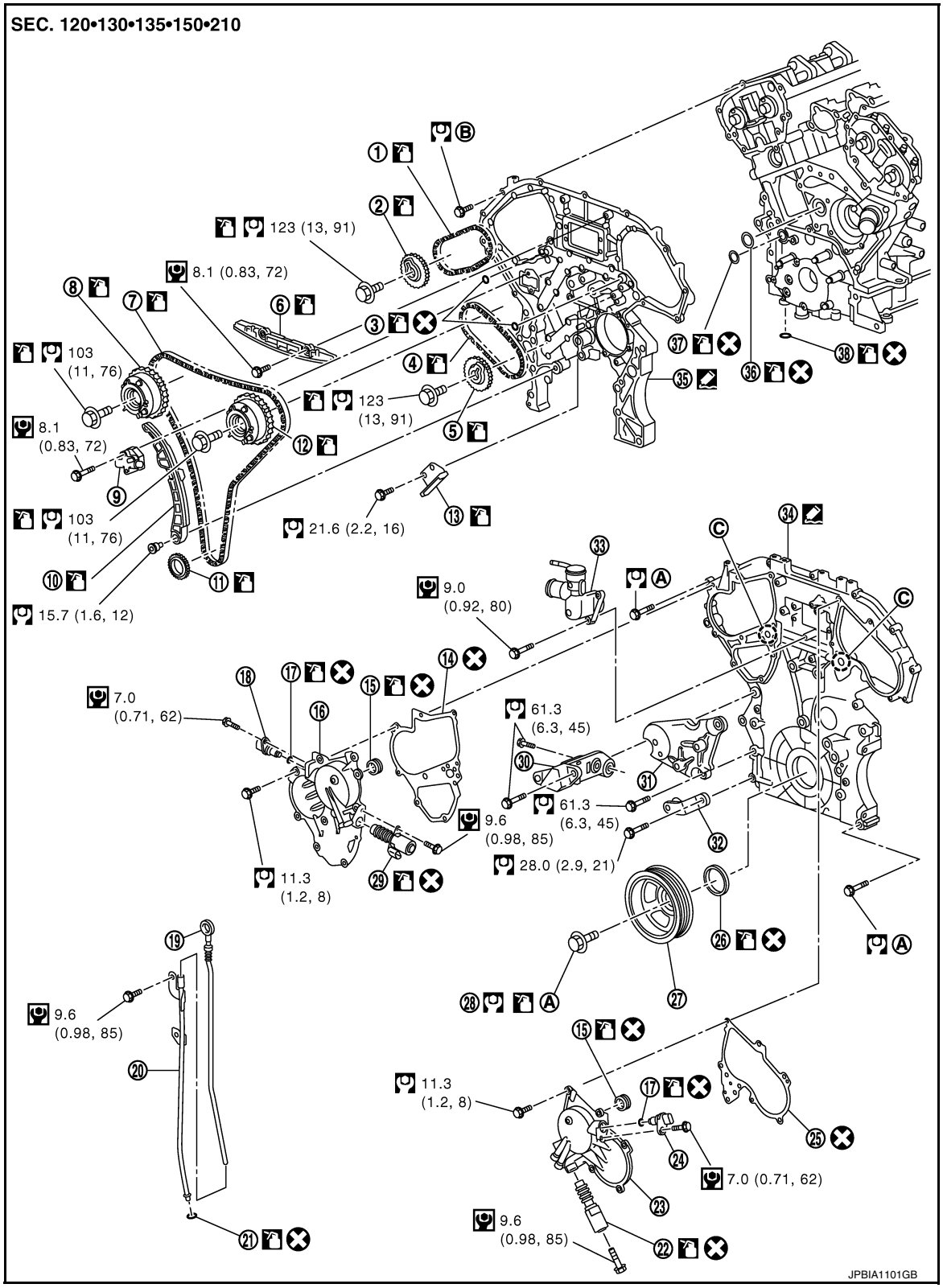


5. Install in the reverse order of removal after this step.

TIMING CHAIN

Exploded View

INFOID:0000000010581999



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

10.	Slack guide	11.	Crankshaft sprocket	12.	Camshaft sprocket (INT)
13.	Tension guide	14.	Intake valve timing control cover gasket (bank 1)	15.	Seal ring
16.	Intake valve timing control cover (bank 1)	17.	O-ring	18.	Camshaft position sensor (PHASE) (bank 1)
19.	Oil level gauge	20.	Oil level gauge guide	21.	O-ring
22.	Intake valve timing control solenoid valve (bank 2)	23.	Intake valve timing control cover (bank 2)	24.	Camshaft position sensor (PHASE) (bank 2)
25.	Intake valve timing control cover gasket (bank 2)	26.	Front oil seal	27.	Crankshaft pulley
28.	Crankshaft pulley bolt	29.	Intake valve timing control solenoid valve (bank 1)	30.	Power steering oil pump bracket
31.	Idler pulley bracket	32.	Alternator bracket	33.	Water outlet (front)
34.	Front timing chain case	35.	Rear timing chain case	36.	O-ring
37.	O-ring	38.	O-ring		
A.	Comply with the installation procedure when tightening. Refer to EM-55	B.	Comply with the installation procedure when tightening. Refer to EM-94	C.	Oil filter

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

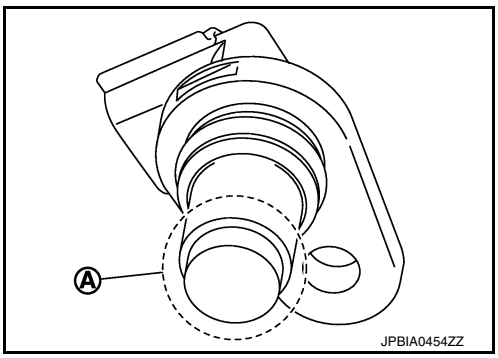
Removal and Installation

INFOID:0000000010582000

REMOVAL

1. Release fuel pressure. Refer to EC-627, "Inspection" (For USA AND CANADA) or EC-1123, "Inspection" (For MEXICO).
2. Disconnect the battery cable from the negative terminal.
3. Remove engine undercover with power tool.
4. Drain engine coolant from radiator. Refer to CO-10, "Draining".
   CAUTION:
   - **Perform this step when the engine is cold.**
   - **Never spill engine coolant on drive belt.**
5. Drain engine oil. Refer to LU-10, "Draining".
   CAUTION:
   Perform this step when the engine is cold.
6. Remove engine cover with power tool. Refer to EM-27, "Exploded View".
7. Remove radiator reservoir tank. Refer to CO-16, "Exploded View".
8. Remove air duct and air cleaner case assembly. Refer to EM-29, "Exploded View".
9. Remove radiator hose (upper and lower). Refer to CO-16, "Exploded View".
10. Remove radiator cooling fan assembly. Refer to CO-20, "Exploded View".
11. Remove drive belt. Refer to EM-15, "Removal and Installation".
12. Separate engine harnesses by removing their brackets from front timing chain case.
13. Remove oil cooler tube. Refer to LU-15, "Exploded View".
14. Remove intake manifold collector. Refer to EM-31, "Exploded View".
15. Remove fuel sub tube mounting bolt. Refer to EM-40, "Exploded View".
16. Remove oil level gauge and oil level gauge guide.
17. Remove A/C compressor from bracket with piping connected, and temporarily secure it aside. Refer to HA-38, "Exploded View".
18. Remove power steering oil pump from bracket with piping connected, and temporarily secure it aside. Refer to ST-48, "VQ37VHR : Exploded View".
19. Remove power steering oil pump bracket.
20. Remove idler pulley, drive belt auto-tensioner and bracket. Refer to EM-28, "Exploded View".
21. Remove alternator and alternator bracket. Refer to CHG-31, "VQ37VHR : Exploded View".
22. Remove water pipe. Refer to LU-15, "Exploded View".

23. Remove camshaft position sensor (PHASE).



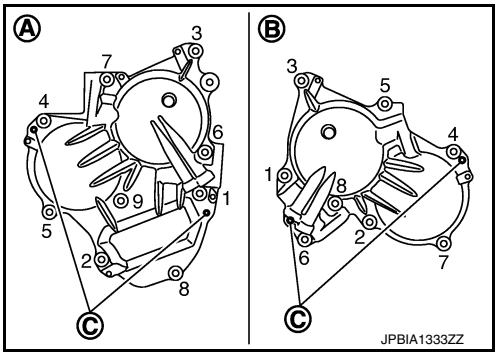
A : Keep free from magnetic materials

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.**

24. Remove intake valve timing control covers and gasket as follows:

a. Disconnect intake valve timing control solenoid valve harness connector.

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



A : Bank 1

B : Bank 2

C : Dowel pin hole

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

c. Shaft is engaged with camshaft sprocket (INT) center hole on inside. Pull straight out so that it does not tilt until the joint is disengaged.

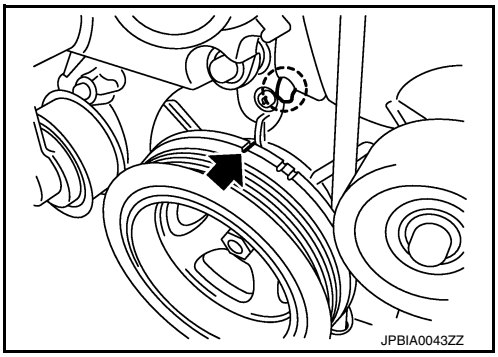
25. Remove intake valve timing control solenoid valve, if necessary.

CAUTION:
Intake valve timing control solenoid valve is nonreusable. Never remove it unless required.

26. Remove rocker covers (bank 1 and bank 2). Refer to EM-51, "Exploded View".

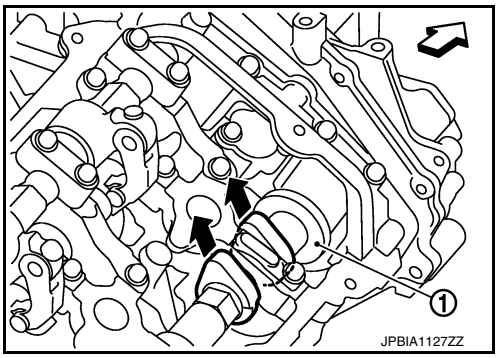
27. Obtain No. 1 cylinder at TDC of its compression stroke as follows:

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



⬅ : Timing mark (grooved line without color)

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



1 : Camshaft (EXH) (bank 1)

⇦ : Engine front

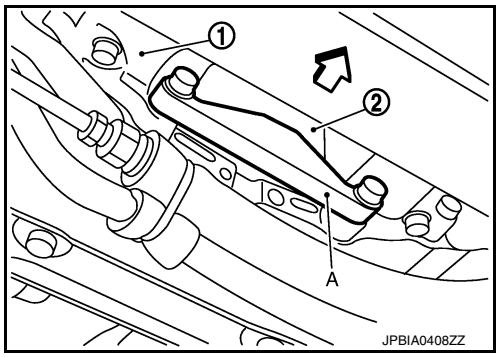
- If not, turn crankshaft one revolution (360 degrees) and align as shown in the figure.

28. Remove crankshaft pulley as follows:

a. Remove front cross bar. Refer to FSU-16, "Exploded View" (2WD) or FSU-36, "Exploded View" (AWD).

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

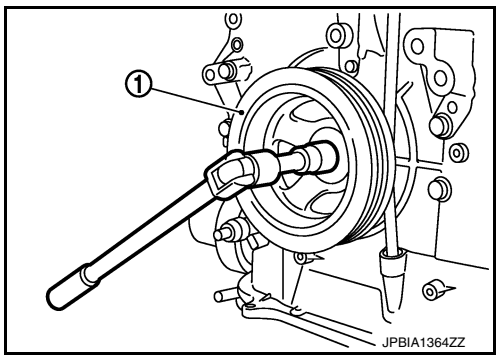
1 : Oil pan (upper)
2 : Drive plate
⇦ : Vehicle front



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

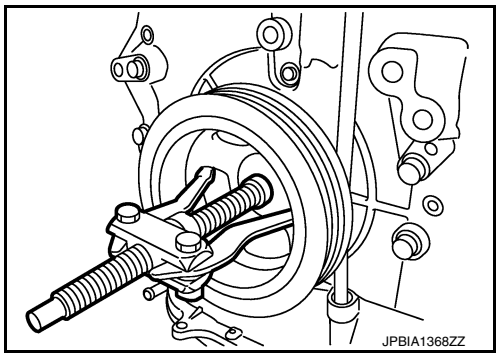
1 : Crankshaft pulley

CAUTION:
Never remove crankshaft pulley bolt because it is used as a supporting point for suitable puller.



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

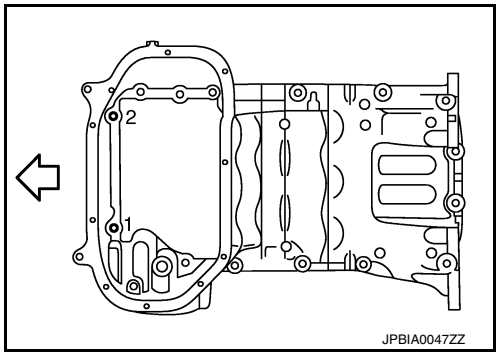
CAUTION:
Never put suitable puller tab on crankshaft pulley periphery, because this damages internal damper.



29. Remove oil pan (lower). Refer to EM-47, "Exploded View".

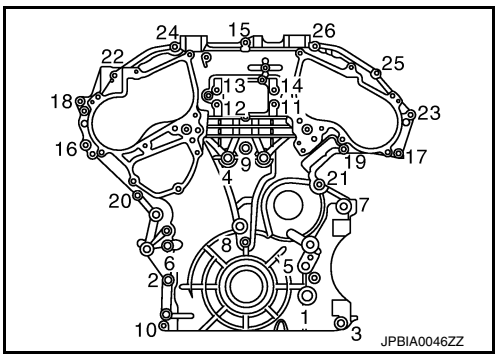
30. Loosen two mounting bolts in front of oil pan (upper) with power tool in reverse order as shown in the figure.

⇦ : Engine front



31. Remove front timing chain case as follows:

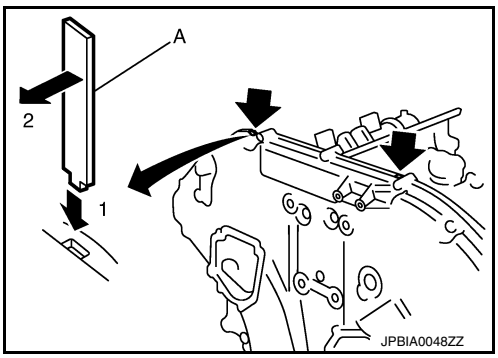
a. Loosen mounting bolts in reverse order as shown in the figure.



b. Insert a suitable tool (A) into the notch at the top of front timing chain case as shown.

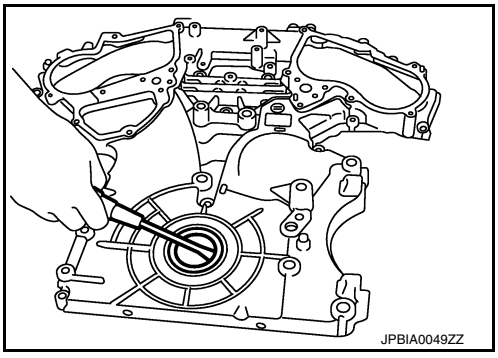
c. Pry off case by moving the suitable tool as shown.
- Use the seal cutter [SST: KV10111100] to cut liquid gasket for removal.

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



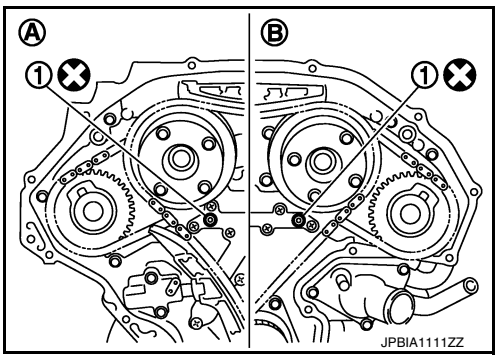
32. Remove front oil seal from front timing chain case using a suitable tool.
- Use a screwdriver for removal.

CAUTION:
Be careful not to damage front timing chain case.



33. Remove O-ring (1) from rear timing chain case.

A : Bank 1
B : Bank 2

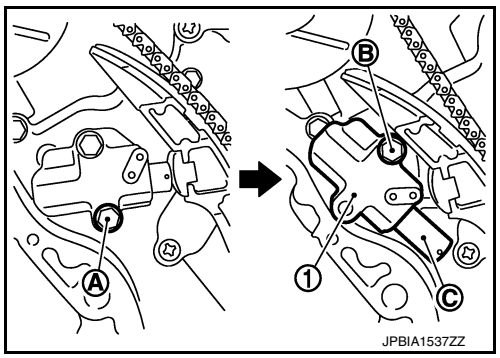


34. Remove timing chain tensioner (primary) as follows:

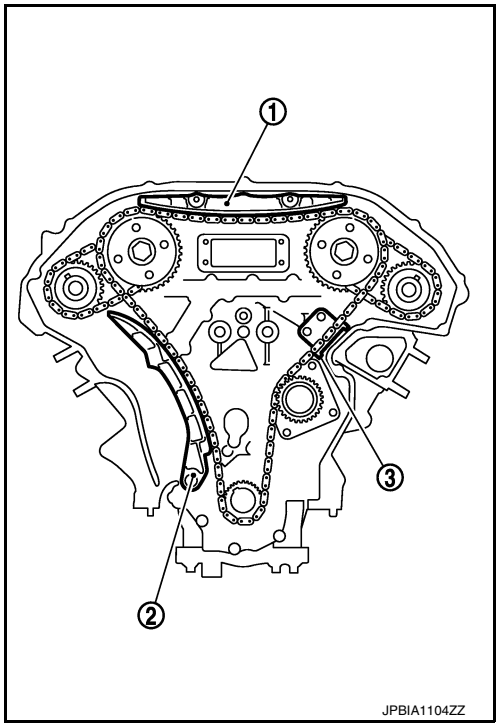
a. Remove lower mounting bolt (A).

b. Loosen upper mounting bolt (B) slowly, and then turn timing chain tensioner (primary) (1) on the upper mounting bolt so that plunger (C) is fully expanded.
NOTE:
Even if plunger is fully expanded, it does not drop from the body of timing chain tensioner (primary).

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



35. Remove internal chain guide (1), slack guide (2), and tension guide (3).



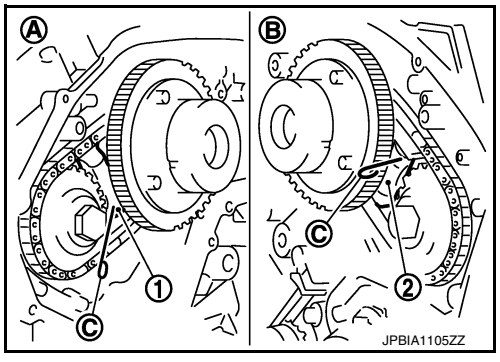
36. Remove timing chain (primary) and crankshaft sprocket.
CAUTION:
After removing timing chain (primary), never turn crankshaft and camshaft separately, or valves strike the piston heads.

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

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

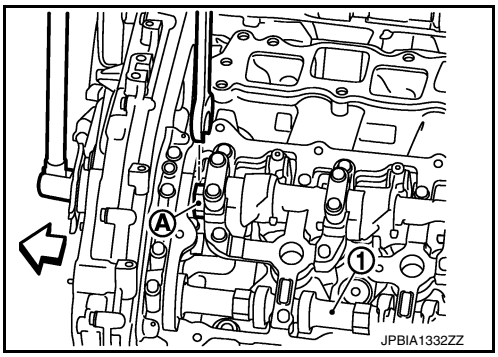
A : Bank 1
B : Bank 2

NOTE:
- Use approximately 0.5 mm (0.02 in) dia. hard metal pin as a stopper pin.
- For removal of timing chain tensioners (secondary), refer to EM-98, "Exploded View". (Removing VVEL ladder assembly is required.)



b. Remove camshaft sprocket (EXH) mounting bolt.
- Secure the hexagonal portion of camshaft (EXH) using a wrench to loosen mounting bolt.
CAUTION:
Never loosen the mounting bolt by securing anything other than the camshaft (EXH) hexagonal portion or with tensioning the timing chain.

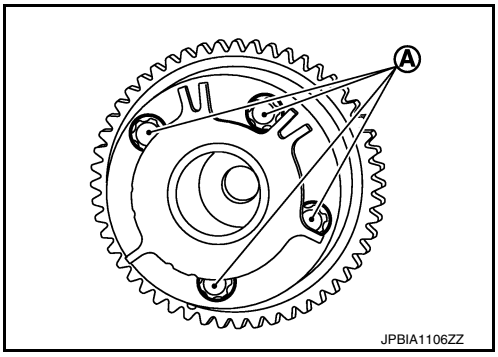
c. Remove camshaft sprocket (INT) mounting bolt.
- Secure the hexagonal portion (located in between journal No. 1 and journal No. 2) of drive shaft (A) using a wrench to loosen mounting bolt.



1 : Camshaft (EXH) (bank 2)

⇦ : Engine front

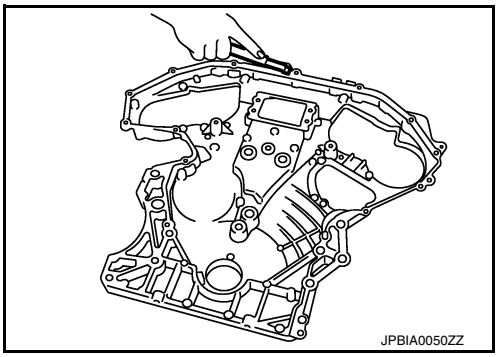
CAUTION:
- **Never loosen the mounting bolt by securing anything other than the drive shaft hexagonal portion or with tensioning the timing chain.**
- **When holding the hexagonal part of drive shaft on the intake side with a wrench, be careful not to allow the wrench to cause interference with other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



d. Remove timing chain (secondary) together with camshaft sprockets.

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

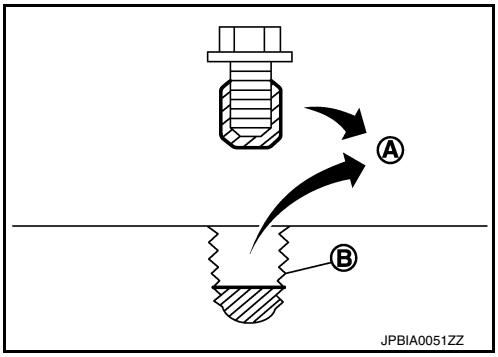
CAUTION:
Be careful not to allow gasket fragments to enter oil pan.



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

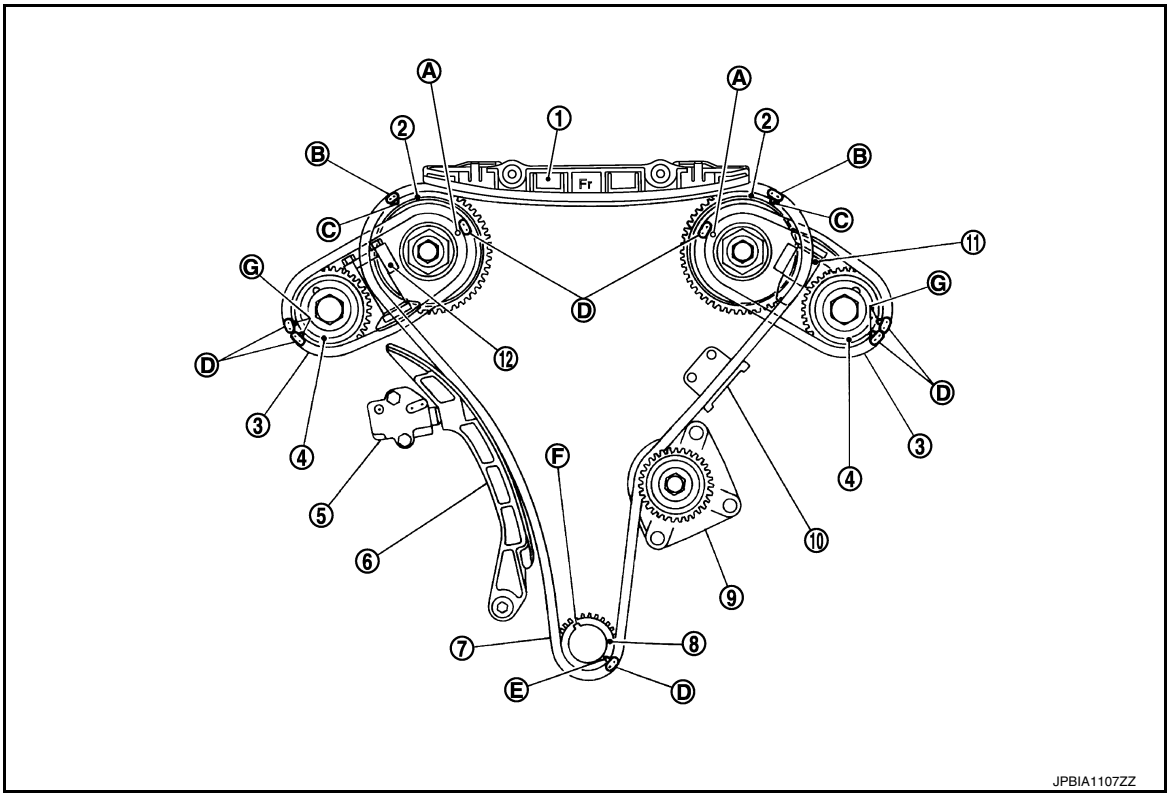
A : Remove old liquid gasket that is stuck

B : Bolt hole



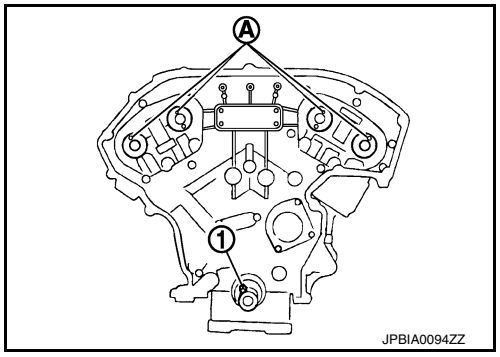
INSTALLATION

CAUTION:
Do not reuse O-rings.
NOTE:
The figure below shows the relationship between the matching mark on each timing chain and that on the corresponding sprocket with the components installed.



1.	Internal chain guide	2.	Camshaft sprocket (INT)	3.	Timing chain (secondary)
4.	Camshaft sprocket (EXH)	5.	Timing chain tensioner (primary)	6.	Slack guide
7.	Timing chain (primary)	8.	Crankshaft sprocket	9.	Water pump
10.	Tension guide	11.	Timing chain tensioner (secondary) (bank 2)	12.	Timing chain tensioner (secondary) (bank 1)
A.	Matching mark [punched (back side)]	B.	Matching mark (yellow link)	C.	Matching mark (punched)
D.	Matching mark (orange link)	E.	Matching mark (notched)	F.	Crankshaft key
G.	Matching mark (punched)				

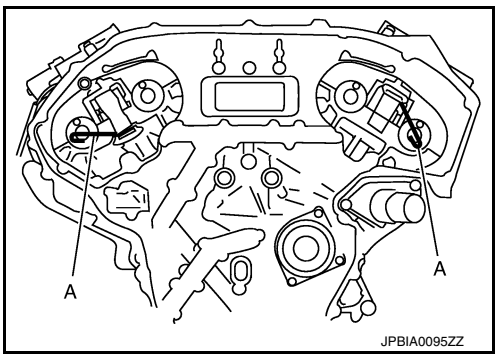
1. Check that dowel pin (A) and crankshaft key (1) are located as shown in the figure. (No. 1 cylinder at compression TDC)
NOTE:
Though camshaft does not stop at the position as shown in the figure, for the placement of cam noses, it is generally accepted that camshaft is placed in the same direction as that of the figure.



Camshaft dowel pin
: At cylinder head upper face side in each bank.
Crankshaft key
: At cylinder head side of bank 1.

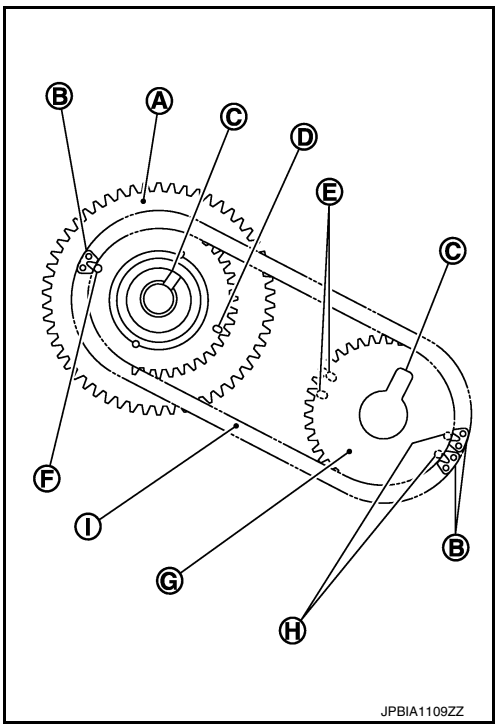
2. Install timing chains (secondary) and camshaft sprockets as follows:
CAUTION:
Matching marks between timing chain and sprockets slip easily. Confirm all matching mark positions repeatedly during the installation process.

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



b. Install timing chains (secondary) and camshaft sprockets.

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



NOTE:
Figure shows bank 1 (rear view).

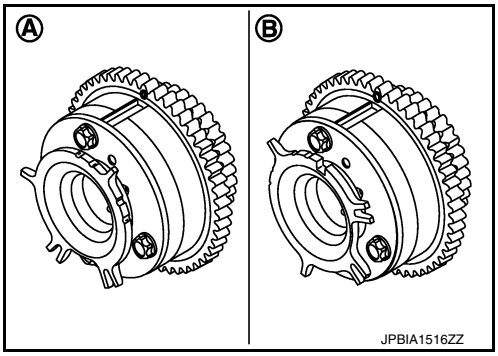
- Align the matching marks on timing chain (secondary) (orange link) with the ones on intake and exhaust camshaft sprockets (punched), and install them.

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

  Bank 1 : Use circle type
  Bank 2 : Use oval type

- Shape (orientation of signal plate) of camshaft sprocket (INT) varies depending on the bank position. See the right figure to install.

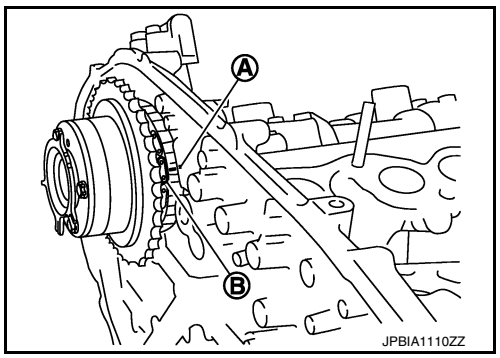
A : Bank 1
B : Bank 2



- Align dowel pin camshafts with the pin groove on sprockets, and install them.
- In case that positions of each matching mark and each dowel pin do not fit with matching parts, make fine adjustment to the position holding the hexagonal portion on camshaft (EXH) or drive shaft with wrench or equivalent tool.
- Mounting bolts for camshaft sprockets must be tightened in the next step. Tightening them by hand is sufficient to prevent the dislocation of dowel pins.

- It may be difficult to visually check the dislocation of matching marks during and after installation. To make the matching easier, make a matching mark on the top of sprocket teeth and its extended line in advance with paint.

A : Matching mark (painted)
B : Matching mark (orange link)

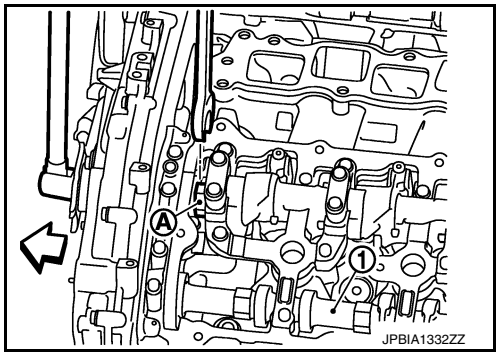


c. Tighten camshaft sprocket (EXH) mounting bolt.
- Secure camshaft (EXH) using a wrench at the hexagonal portion to tighten mounting bolt.

d. After confirming the matching marks are aligned, tighten camshaft sprocket (INT) mounting bolt.
- Secure the hexagonal portion (located in between journal No. 1 and journal No. 2) of drive shaft (A) using a wrench to tighten mounting bolt.

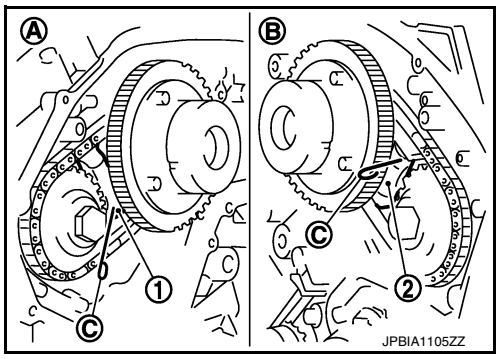
1 : Camshaft (EXH) (bank 2)
⇦ : Engine front

CAUTION:
When holding the hexagonal part of drive shaft on the intake side with a wrench, be careful not to allow the wrench to cause interference with other parts.



e. Pull stopper pins (C) out from timing chain tensioners (secondary) (1), (2).

A : Bank 1
B : Bank 2

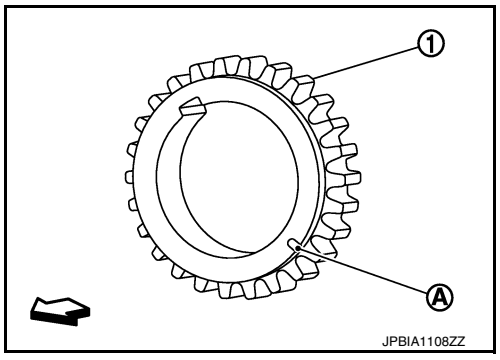


3. Install timing chain (primary) as follows:

a. Install crankshaft sprocket (1).

A : Matching mark (front side)
⇦ : Engine front

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

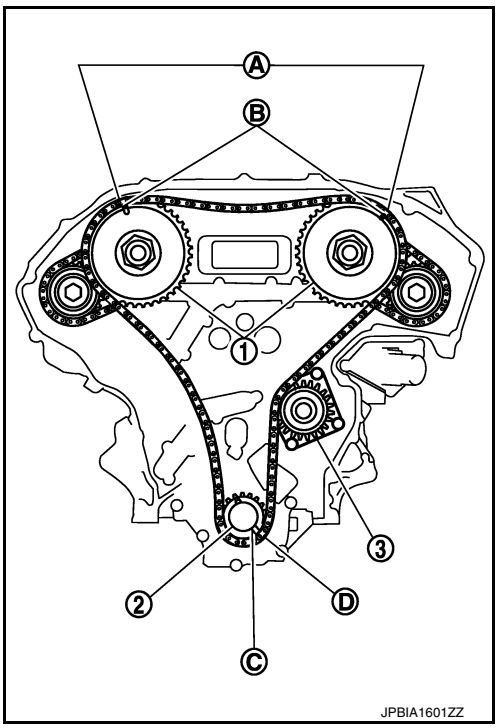


b. Install timing chain (primary).

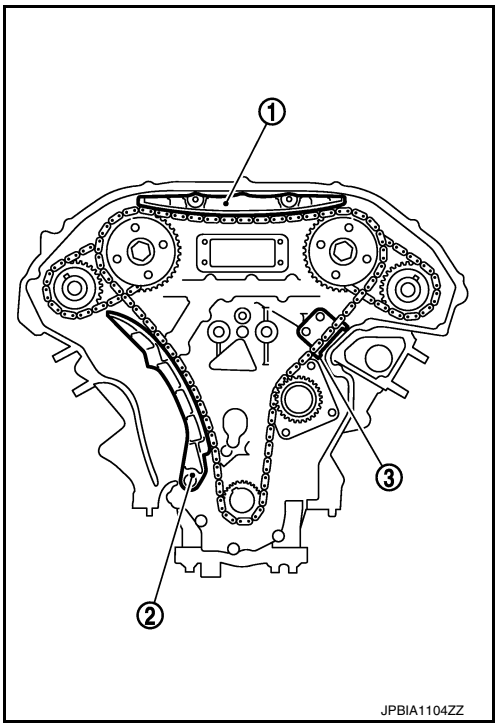
- Install timing chain (primary) so that the matching mark (punched) (B) on camshaft sprocket (INT) (1) is aligned with the yellow link (A) on timing chain, while the matching mark (notched) (C) on crankshaft sprocket (2) is aligned with the orange link (D) one on timing chain, as shown in the figure.

  3 : Water pump

- When it is difficult to align matching marks of timing chain (primary) with each sprocket, gradually turn drive shaft using wrench on the hexagonal portion to align it with the matching marks.



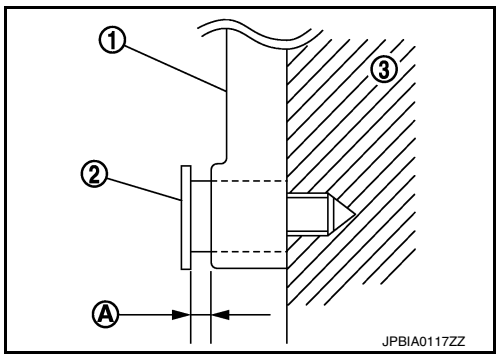
4. Install internal chain guide (1), slack guide (2), and tension guide (3).



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



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

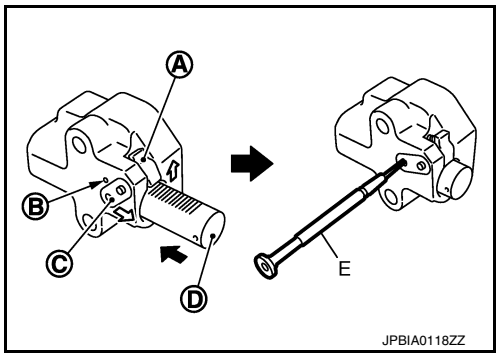
a. Pull plunger stopper tab (A) up (or turn lever downward) so as to remove plunger stopper tab from the ratchet of plunger (D).
NOTE:
Plunger stopper tab and lever (C) are synchronized.

b. Push plunger into the inside of tensioner body.

c. Hold plunger in the fully compressed position by engaging plunger stopper tab with the tip of ratchet.

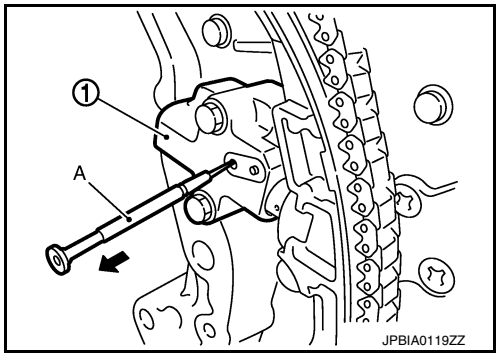
d. To secure lever, insert stopper pin (E) through hole of lever into tensioner body hole (B).
- The lever parts and the plunger stopper tab are synchronized. Therefore, the plunger is secured under this condition.

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



e. Install timing chain tensioner (primary) (1).
- Remove any dirt and foreign materials completely from the back and the mounting surfaces of timing chain tensioner (primary).

f. Pull out stopper pin (A) after installing, and then release plunger.

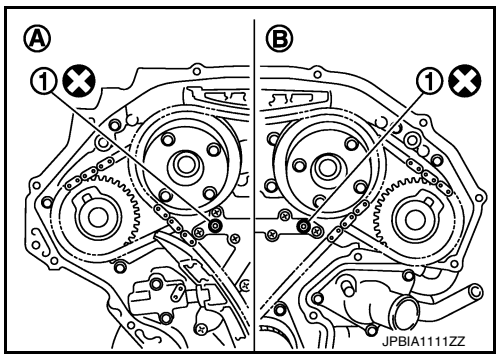


6. Check again that the matching marks on sprockets and timing chain have not slipped out of alignment.

7. Install new O-rings (1) on rear timing chain case.

A : Bank 1
B : Bank 2

CAUTION:
Do not reuse O-rings.

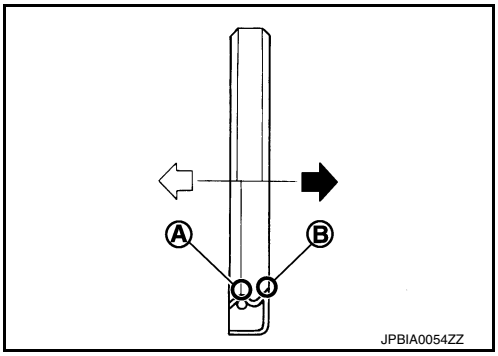


8. Install new front oil seal on front timing chain case.

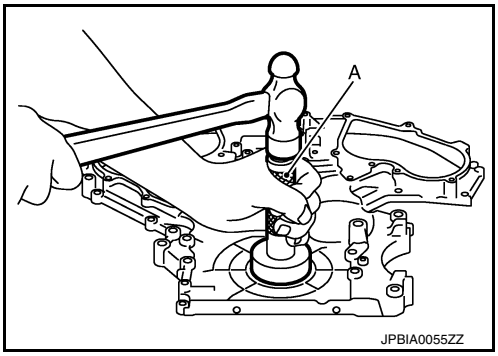
⇦ : Engine inside

⬅ : 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.



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



9. Install front timing chain case as follows:
   - Check that O-rings stay in place during installation to rear timing chain case.

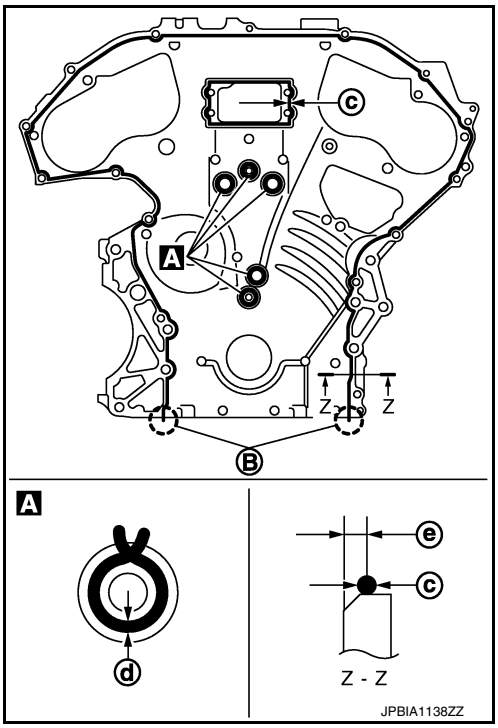
a. Apply a continuous bead of liquid gasket with the tube presser (commercial service tool) to front timing chain case back side as shown in the figure.
Use Genuine Liquid Gasket or equivalent.

B : Protrusion

c : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)

d : ϕ2.6 - 3.6 mm (0.102 - 0.142 in)

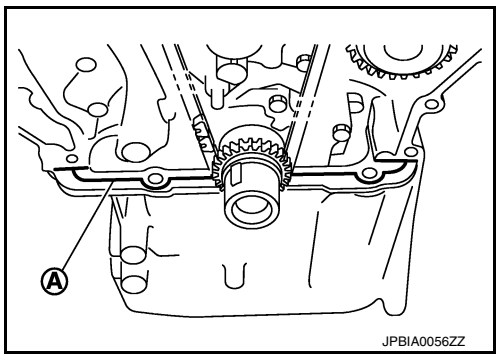
e : 4.0 - 5.6 mm (0.157 - 0.220 in)



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

A : ϕ4.0 - 5.0 mm (0.157 - 0.197 in)

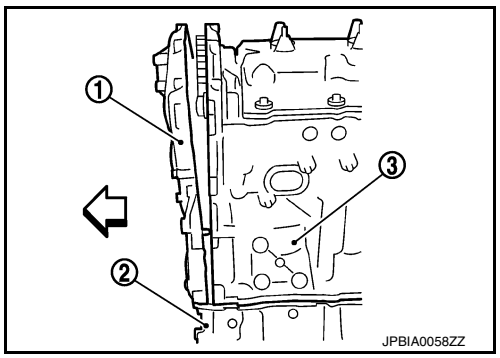
Use Genuine Liquid Gasket or equivalent.



c. Assemble front timing chain case.

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

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



d. Install front timing chain case fitting its dowel pin hole together with dowel pin on rear timing chain case.

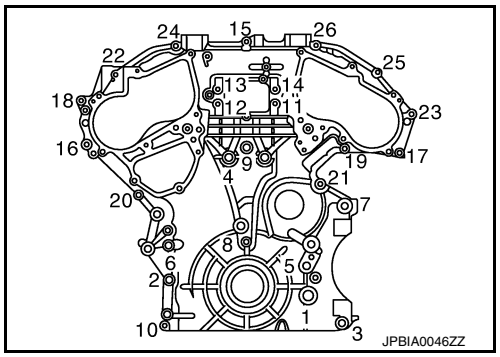
e. Tighten mounting bolts to the specified torque in numerical order as shown in the figure.
- There are two types of mounting bolts. Refer to the following for locating bolts.

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

: 55.0 N·m (5.6 kg-m, 41 ft-lb)

M6 bolts : Except the above

: 12.7 N·m (1.3 kg-m, 9 ft-lb)



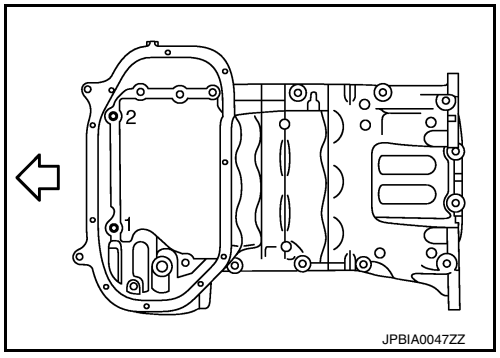
f. After all bolts are tightened, retighten them to the specified torque in numerical order shown in the figure.

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

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

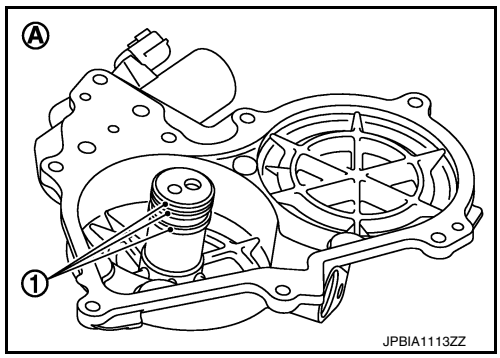
⇦ : Engine front

Tightening torque : Refer to EM-47, "Exploded View".



10. Install intake valve timing control covers as follows:

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

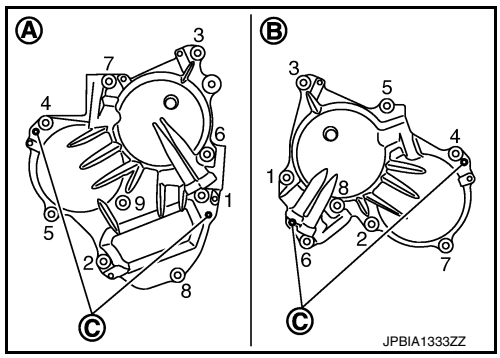


A : Bank 2

CAUTION:
When replacing seal ring, replace all rings with new ones.
NOTE:
The figure shows an example of bank 2.

b. Install intake valve timing control cover with new gasket to front timing chain case.
CAUTION:
- **Align the center of both shaft holes of the shaft and the intake side camshaft sprocket, and then insert them.**
- **Be careful not to drop the seal ring from the shaft groove.**

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



A : Bank 1
B : Bank 2

d. Tighten mounting bolts in numerical order as shown in the figure.
- After all bolts are tightened, tighten No. 1 bolt to the specified torque again.

11. Install oil pan (lower). Refer to EM-47, "Exploded View".
12. Install rocker covers (bank 1 and bank 2). Refer to EM-51, "Exploded View".
13. Install crankshaft pulley as follows:

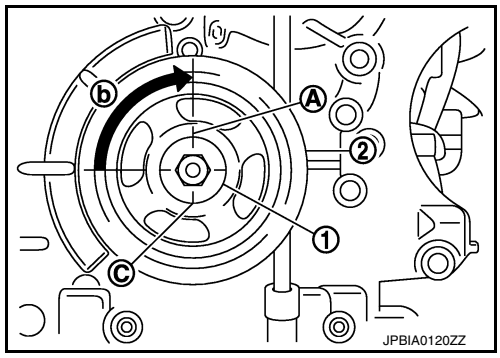
a. Fix crankshaft using the ring gear stopper [SST: KV10118600].

b. Install crankshaft pulley, taking care not to damage front oil seal.
- When press-fitting crankshaft pulley with plastic hammer, tap on its center portion (not circumference).

c. Tighten crankshaft pulley bolt.

: 44.1 N·m (4.5 kg-m, 33 ft-lb)

d. Tighten crankshaft pulley bolt (clockwise).

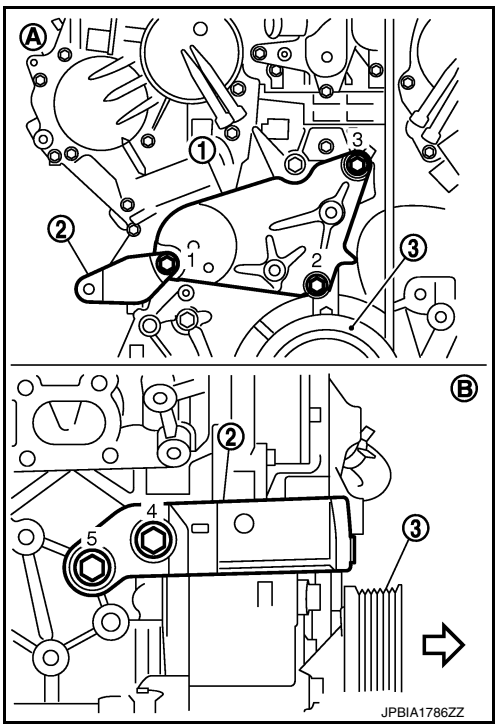


Angle tightening: 90 degrees (b)

- Place a matching mark (A) on crankshaft pulley (2) aligning with the matching (C) of crankshaft pulley bolt (1)

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

14. Install power steering oil pump bracket (2) and idler pulley bracket (1) as follows:



3 : Crankshaft pulley
A : Engine front side
B : Engine right side
⇦ : Engine front

a. Install idler pulley bracket, and tighten mounting bolts No. 2, 3. (temporarily)
b. Tighten mounting bolts No. 2, 3. (specified torque)
c. Install power steering oil pump bracket, and tighten mounting bolts No. 1, 4, 5. (temporarily)
d. Tighten mounting bolts No. 1. (specified torque)
e. Tighten mounting bolts No. 4, 5. (specified torque)

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

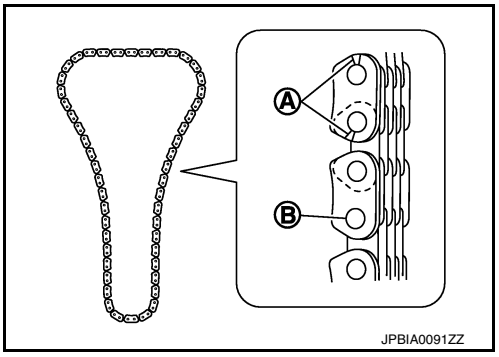
Inspection

INFOID:0000000010582001

INSPECTION AFTER REMOVAL

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 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-17, "FOR NORTH AMERICA : 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.

OIL SEAL

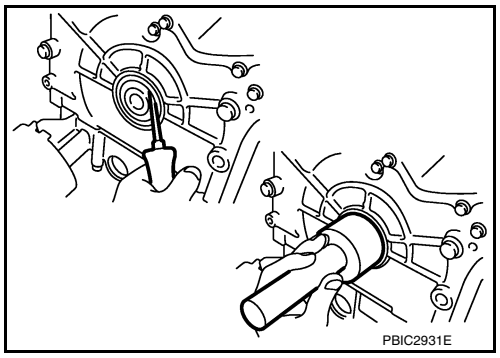
FRONT OIL SEAL

FRONT OIL SEAL : Removal and Installation

INFOID:0000000010582002

REMOVAL

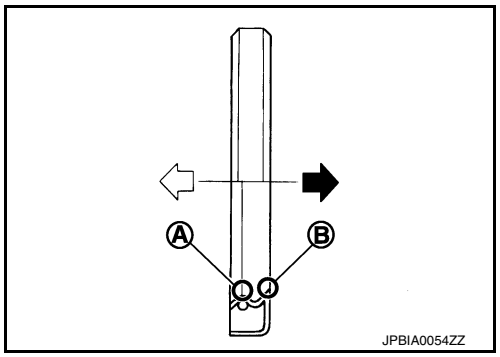
1. Remove the following parts:
   - Engine undercover with power tool.
   - Drive belt: Refer to EM-15, "Exploded View".
   - Crankshaft pulley: Refer to EM-54, "Exploded View".
2. Remove front oil seal using a suitable tool.
   CAUTION:
   Be careful not to damage front timing chain case and crankshaft.



INSTALLATION

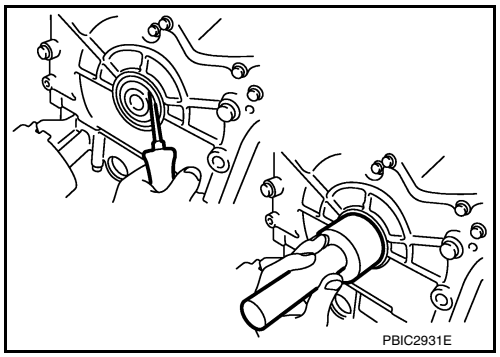
1. Apply new engine oil to both oil seal lip and dust seal lip of new front oil seal.
2. Install front oil seal.
   - Install front oil seal so that each seal lip is oriented as shown in the figure.

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



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

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



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

REAR OIL SEAL

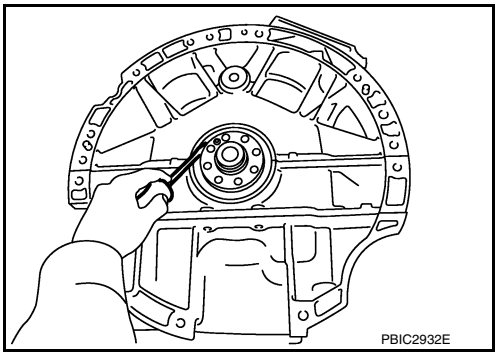
REAR OIL SEAL : Removal and Installation

INFOID:0000000010582003

REMOVAL

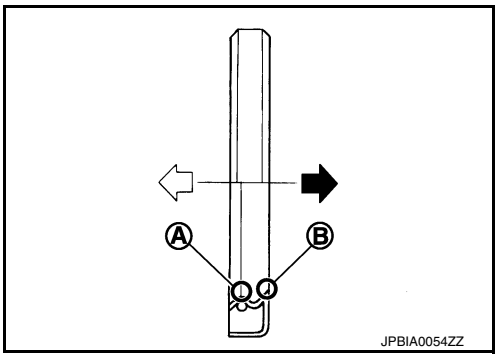
1. Remove transmission assembly. Refer to TM-211, "2WD : Exploded View" (2WD models) or TM-214, "AWD : Exploded View" (AWD models).

2. Remove drive plate. Refer to EM-125, "Exploded View".
3. Remove rear oil seal with a suitable tool.
   CAUTION:
   Be careful not to damage crankshaft and cylinder block.



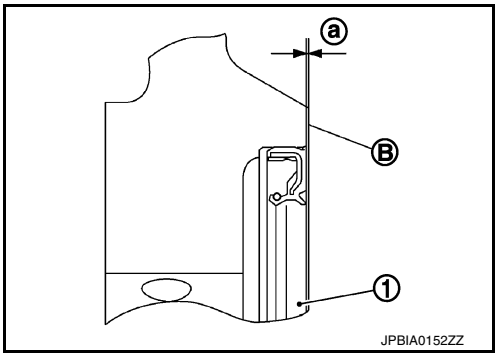
INSTALLATION

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.

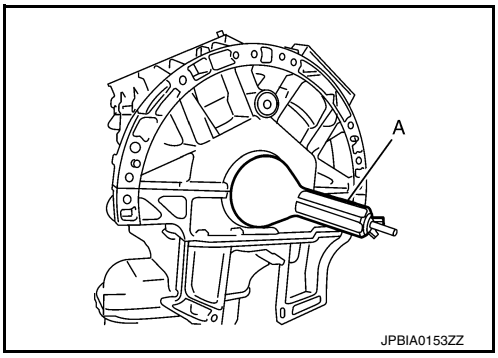


B : Cylinder block rear end face
a : 0 - 0.5 mm (0 - 0.020 in)

- Using a suitable drift (A), press-fit until the height of rear oil seal is level with the mounting surface.

- Suitable drift: outer diameter 100 mm (3.94 in), inner diameter 85 mm (3.35 in).

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



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

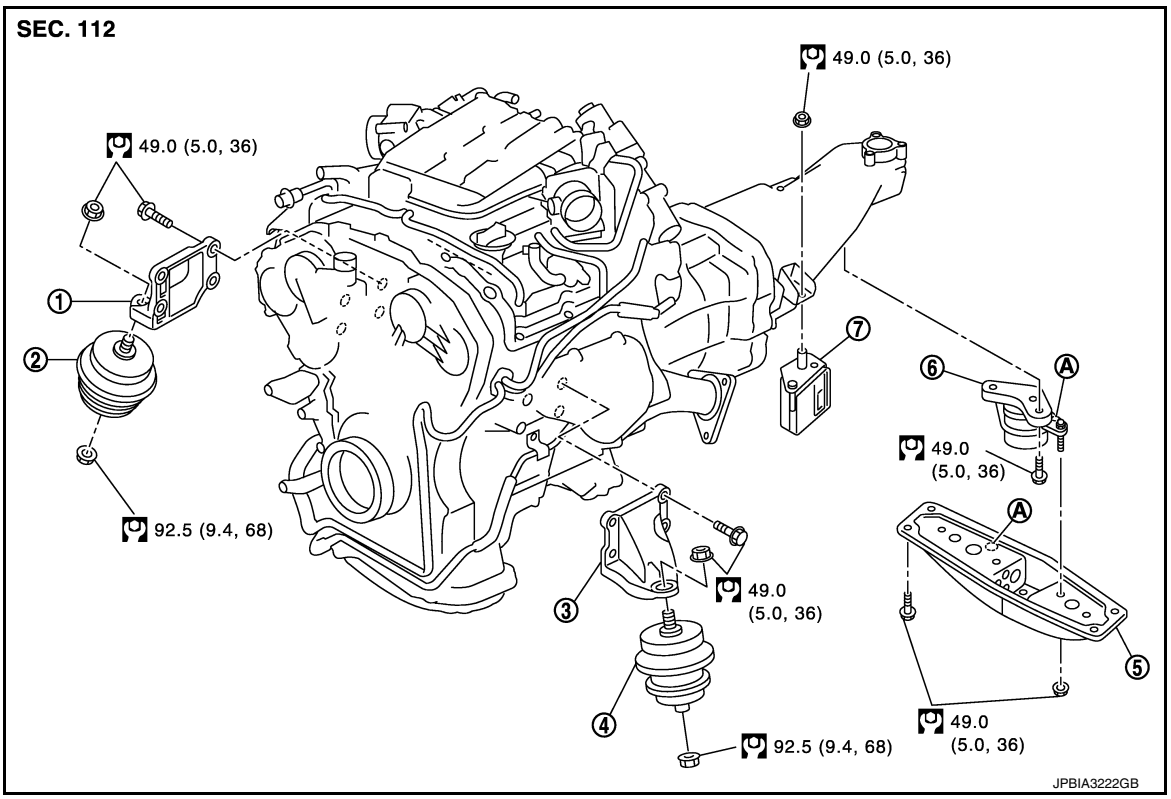
UNIT REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

2WD

2WD : Exploded View

INFOID:0000000010582004



1. Engine mounting bracket (RH)
2. Engine mounting insulator (RH)
3. Engine mounting bracket (LH)
4. Engine mounting insulator (LH)
5. Rear engine mounting member
6. Engine mounting insulator (rear)
7. Dynamic damper (M/T models)

A. Front mark

2WD : Removal and Installation

INFOID:0000000010582005

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-37, "Garage Jack and Safety Stand and 2-Pole Lift".**

NOTE:

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

REMOVAL

Outline

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

Preparation

1. Release fuel pressure. Refer to EC-627, "Inspection" (For USA AND CANADA) or EC-1123, "Inspection" (For MEXICO).
2. Disconnect both battery cables. Refer to PG-126, "Exploded View".
3. Drain engine coolant from radiator. Refer to CO-10, "Draining".
   CAUTION:
   - **Perform this step when engine is cold.**
   - **Never spill engine coolant on drive belt.**
4. Remove the following parts:
   - Radiator reservoir tank: Refer to CO-16, "Exploded View".
   - Engine cover: Refer to EM-27, "Exploded View".
   - Front road wheel and tires (power tool)
   - Engine undercover (power tool)
   - Cowl top cover: Refer to EXT-22, "Exploded View".
   - Air duct and air cleaner case assembly (RH and LH): Refer to EM-29, "Exploded View".
   - Cooling fan assembly: Refer to CO-20, "Exploded View".
5. Discharge refrigerant from A/C circuit. Refer to HA-25, "Collection and Charge".
6. Remove radiator hoses (upper and lower). Refer to CO-16, "Exploded View".

Engine Room LH

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

Engine Room RH

1. Disconnect battery positive cable at vehicle side and temporarily fasten it on engine.
2. Disconnect all clips and connectors of the engine room harness from engine back side.
3. Disconnect fuel feed hose (with damper) and EVAP hose. Refer to HA-42, "Exploded View".
   CAUTION:
   Fit plugs onto disconnected hoses to prevent fuel leakage.
4. Remove reservoir tank of power steering oil pump and piping from vehicle, and temporarily secure them on engine. Refer to ST-48, "VQ37VHR : Exploded View".
   CAUTION:
   When temporarily securing, keep the reservoir tank upright to avoid fluid leakage.

Vehicle Inside

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

1. Remove passenger-side kicking plate and dash side finisher. Refer to INT-18, "Exploded View".
2. Disconnect engine room harness connectors at unit sides TCM, ECM and other locations.
3. Disengage intermediate fixing point. Pull out engine room harnesses to engine room side, and temporarily secure them on engine.
   CAUTION:
   - **When pulling out harnesses, take care not to damage harnesses and connectors.**
   - **After temporarily securing, cover connectors with vinyl or similar material to protect against adhesion of foreign materials.**

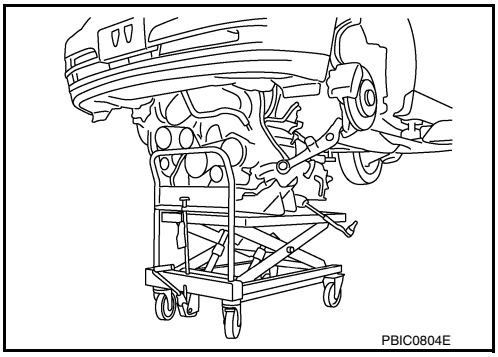
Vehicle Underbody

1. Remove A/T fluid cooler hoses (A/T models) and power steering oil pump oil cooler hoses.
2. Disconnect heated oxygen sensor 2 harness. Refer to EX-5, "Exploded View".

3. Remove three way catalyst and exhaust front tube. Refer to EX-5, "Exploded View".
4. Disconnect steering lower joint at power steering gear assembly side, and release steering lower shaft. Refer to ST-18, "WITHOUT ELECTRIC MOTOR : Exploded View".
5. Remove rear propeller shaft. Refer to DLN-120, "Exploded View" (M/T models) or DLN-130, "Exploded View" (A/T models).
6. Disengage shift lever and remove clutch tube (M/T models). Refer to TM-185, "Exploded View".
7. Disengage A/T control rod at A/T shift selector side. Then, temporarily secure it on the transmission assembly, so that it does not sag (A/T models). Refer to EM-47, "Exploded View".
8. Remove rear plate cover from oil pan (upper). Then remove bolts fixing drive plate to torque converter (A/T models). Refer to EM-47, "Exploded View".
9. Remove transmission joint bolts that pierce at oil pan (upper) lower rear side. Refer to EM-86, "2WD : Exploded View".
10. Remove front stabilizer connecting rod from transverse link. Refer to ST-26, "Exploded View".
11. Remove lower ends of left and right steering knuckle from transverse link. Refer to FSU-14, "Exploded View".
12. Separate steering outer sockets from steering knuckle. Refer to ST-17, "Exploded View".
13. Remove transverse links mounting bolts at suspension member side. Refer to FSU-14, "Exploded View".

Removal Work

1. Use a manual lift table caddy (commercial service tool) or equivalently rigid tool such as a transmission jack. Securely support bottom of suspension member and the transmission assembly.
CAUTION:
Use a piece of wood or a similar item as the supporting surface to secure a completely stable condition.

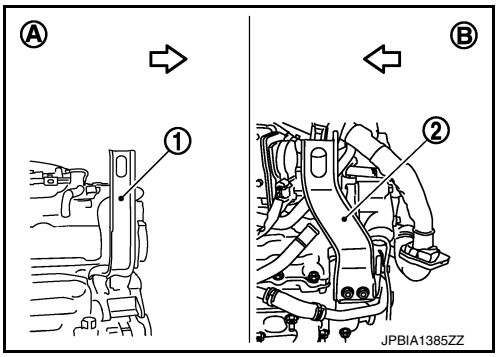

PBIC0804E

2. Remove rear engine mounting member bolts.
3. Remove front suspension member mounting bolts and nuts. Refer to FSU-19, "Exploded View".
4. Carefully lower jack, or raise lift, to remove the engine, the transmission assembly and front suspension member. When performing work, observe the following caution items:
CAUTION:
- **Confirm there is no interference with the vehicle.**
- **Check that all connection points have been disconnected.**
- **Keep in mind that the center of gravity of the vehicle changes. If necessary, use jack(s) to support the vehicle at rear jacking point(s) to prevent it from falling off the lift.**

Separation Work

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

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



JPBIA1385ZZ

Slinger bolts:

: 28.0 N·m (2.9 kg-m, 21 ft-lb)

2. Remove power steering oil pump from engine side. Refer to FSU-19, "Exploded View".
3. Remove engine mounting insulators (RH and LH) under side nuts with power tool.

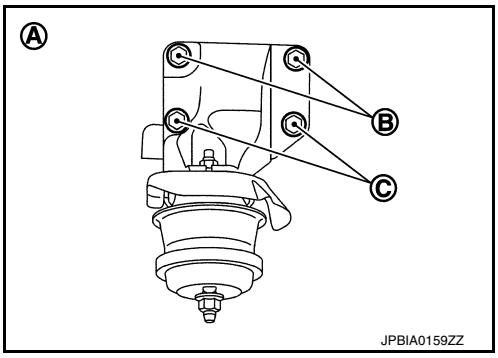
4. Lift with hoist and separate the engine and the transmission assembly from front suspension member.
   CAUTION:
   - **Before and during this lifting, always check that any harnesses are left connected.**
   - **Never damage engine mounting insulator and avoid oil/grease smearing or spills onto engine mounting insulator.**
5. Remove alternator. Refer to CHG-31, "VQ37VHR : Exploded View".
6. Remove starter motor. Refer to STR-21, "VQ37VHR : Exploded View".
7. Remove crankshaft position sensor.
   CAUTION:
   - **Handle it carefully and avoid impacts.**
   - **Never disassemble.**
   - **Never place sensor in a location where it is exposed to magnetism.**
8. Separate the engine from the transmission assembly. Refer to TM-211, "2WD : Exploded View" (M/T models) or TM-214, "AWD : Exploded View" (A/T models).
9. Remove each engine mounting insulator and each engine mounting bracket from the engine with power tool.

INSTALLATION

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

- Do not damage engine mounting insulator and do not spill oil on it.
- For a location with a positioning pin, insert it securely into hole of mating part.
- For a part with a specified installation orientation, refer to component figure in EM-73, "2WD : Exploded View".
- When installing engine mounting bracket (RH and LH) on cylinder block, tighten two upper bolts [shown as (B) in the figure] first. Then tighten two lower bolts [shown as (C) in the figure].

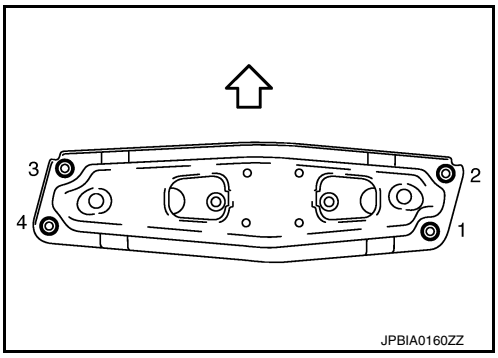
A : Example Left



JPBIA0159ZZ

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

⇦ : Vehicle front



JPBIA0160ZZ

2WD : Inspection

INFOID:0000000010582006

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-17, "FOR NORTH AMERICA : 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 to the specified level, if necessary.

Summary of the inspection items:

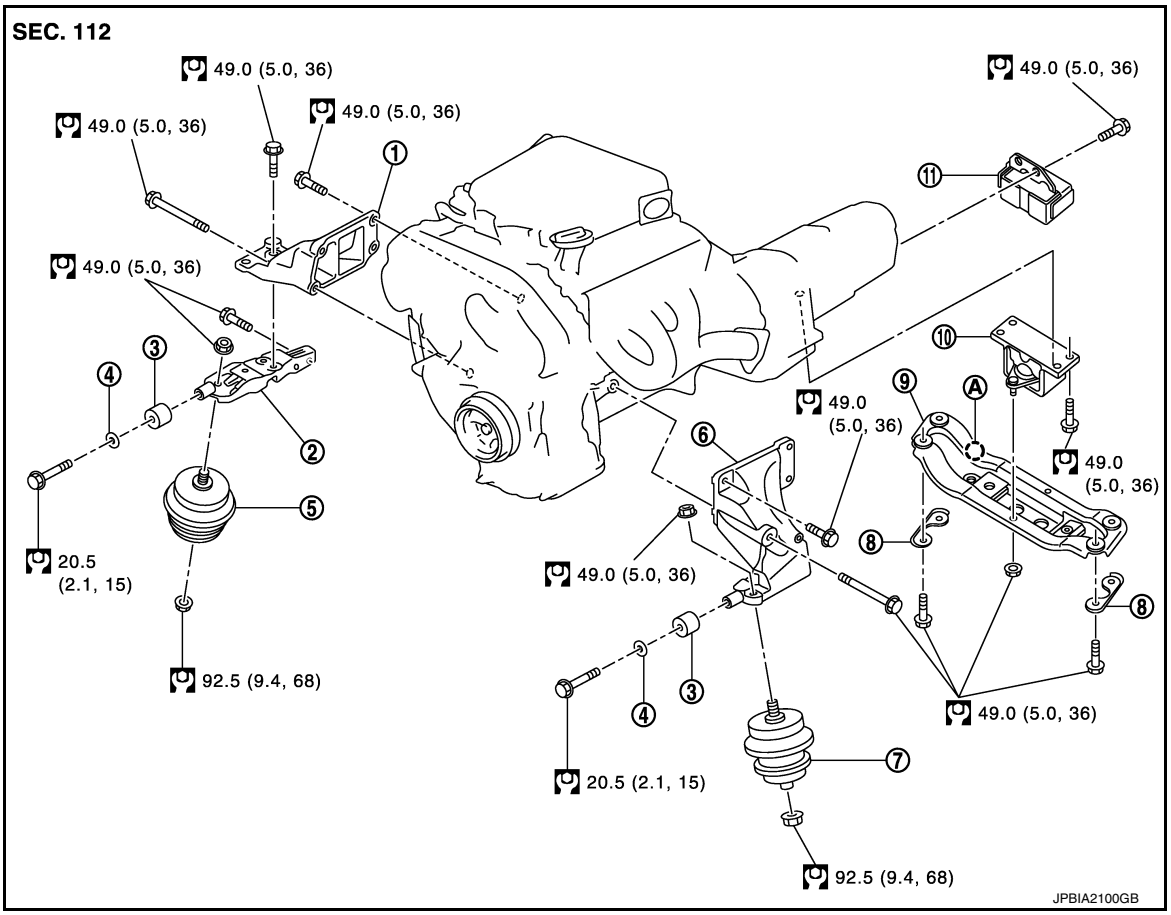
Items		Before starting engine	Engine running	After engine stopped
Engine coolant		Level	Leakage	Level
Engine oil		Level	Leakage	Level
Transmission / transaxle fluid	AT & CVT Models	Leakage	Level / Leakage	Leakage
	MT Models	Level / Leakage	Leakage	Level / Leakage
Other oils and fluids*		Level	Leakage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

*: Power steering fluid, brake fluid, etc.

AWD

AWD : Exploded View

INFOID:0000000010582007



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

A. Front mark

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

AWD : Removal and Installation

INFOID:0000000010582008

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-37, "Garage Jack and Safety Stand and 2-Pole Lift".**

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

REMOVAL

NOTE:
Installation positions of battery and brake related parts differ according to the steering wheel position (LHD or RHD).

Outline

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

Preparation

1. Release fuel pressure. Refer to EC-627, "Inspection" (For USA AND CANADA) or EC-1123, "Inspection" (For MEXICO).
2. Disconnect both battery cables. Refer to PG-126, "Exploded View".
3. Drain engine coolant from radiator. Refer to CO-10, "Draining".
   CAUTION:
   - **Perform this step when engine is cold.**
   - **Never spill engine coolant on drive belt.**
4. Remove the following parts:
   - Radiator reservoir tank: Refer to CO-16, "Exploded View".
   - Engine cover: Refer to EM-27, "Exploded View".
   - Front road wheel and tires
   - Engine undercover
   - Front cross bar: Refer to FSU-19, "Exploded View".
   - Cowl top cover: Refer to EXT-22, "Exploded View".
   - Air duct and air cleaner case assembly: Refer to EM-29, "Exploded View".
   - Cooling fan assembly: Refer to CO-20, "Exploded View".
5. Discharge refrigerant from A/C circuit. Refer to HA-25, "Collection and Charge".
6. Remove radiator hoses (upper and lower). Refer to CO-16, "Exploded View".

Engine Room LH

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

Engine Room RH

1. Disconnect battery positive cable at vehicle side and temporarily fasten it on engine.
2. Disconnect all clips and connectors of the engine room harness from engine back side.
3. Disconnect fuel feed hose (with damper) and EVAP hose. Refer to EM-40, "Exploded View".
   CAUTION:
   Fit plugs onto disconnected hoses to prevent fuel leakage.
4. Remove reservoir tank of power steering oil pump and piping from vehicle, and temporarily secure them on engine. Refer to ST-36, "VQ37VHR : Exploded View".
   CAUTION:
   When temporarily securing, keep the reservoir tank upright to avoid fluid leakage.

Vehicle Inside

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

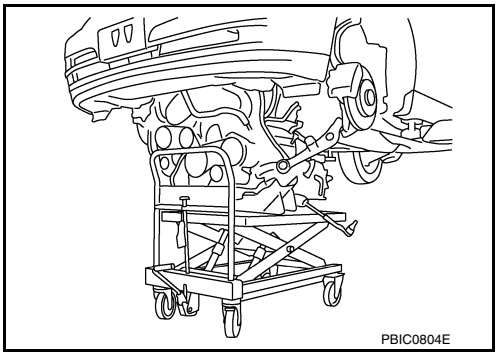
1. Remove glove box assembly and instrument assist lower panel. Refer to IP-12, "Exploded View".
2. Disconnect engine room harness connectors at unit sides and other locations.
3. Disengage intermediate fixing point. Pull out engine room harnesses to engine room side, and temporarily secure them on engine.
   CAUTION:
   - **When pulling out harnesses, take care not to damage harnesses and connectors.**
   - **After temporarily securing, cover connectors with vinyl or similar material to protect against adhesion of foreign materials.**

Vehicle Underbody

1. Remove A/T fluid cooler hoses and power steering oil pump oil cooler hoses.
2. Disconnect heated oxygen sensor 2 harness.
3. Remove three way catalyst and exhaust front tube. Refer to EX-5, "Exploded View".
4. Disconnect steering lower joint at power steering gear assembly side, and release steering lower shaft. Refer to ST-24, "Exploded View".
5. Remove rear propeller shaft. Refer to DLN-130, "Exploded View".
6. Remove front drive shaft (both side). Refer to FAX-19, "Exploded View".
7. Disengage A/T control rod at control device assembly side. Then, temporarily secure it on the transmission assembly, so that it does not sag. Refer to TM-185, "Exploded View".
8. Remove rear plate cover from oil pan (upper). Then remove bolts fixing drive plate to torque converter. Refer to EM-47, "Exploded View".
9. Remove transmission joint bolts that pierce at oil pan (upper) lower rear side. Refer to EM-47, "Exploded View".
10. Remove front stabilizer connecting rod from transverse link. Refer to FSU-18, "Exploded View" (For 2WD) or FSU-38, "Exploded View" (For AWD).
11. Remove lower ends of left and right steering knuckle from transverse link. Refer to FAX-7, "Exploded View" (For 2WD) or FAX-17, "Exploded View" (For AWD).
12. Separate steering outer sockets from steering knuckle. Refer to ST-26, "Exploded View".
13. Remove transverse links mounting bolts at suspension member side. Refer to FSU-14, "Exploded View" (For 2WD) or FSU-34, "Exploded View" (For AWD).

Removal Work

1. Use a manual lift table caddy (commercial service tool) or equivalently rigid tool such as a transmission jack. Securely support bottom of suspension member and the transmission assembly.
CAUTION:
Use a piece of wood or a similar item as the supporting surface to secure a completely stable condition.

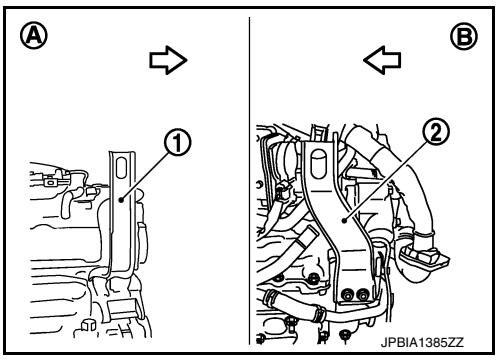


2. Remove rear engine mounting member bolts.
3. Remove front suspension member mounting bolts and nuts. Refer to FSU-19, "Exploded View" (For 2WD) or FSU-39, "Exploded View" (For AWD).
4. Carefully lower jack, or raise lift, to remove the engine, the transmission assembly and front suspension member. When performing work, observe the following caution items:
CAUTION:
- **Confirm there is no interference with the vehicle.**
- **Check that all connection points have been disconnected.**
- **Keep in mind that the center of gravity of the vehicle changes. If necessary, use jack(s) to support the vehicle at rear jacking point(s) to prevent it from falling off the lift.**

Separation Work

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

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



Slinger bolts:

: 28.0 N·m (2.9 kg-m, 21 ft-lb)

2. Remove power steering oil pump from engine side. Refer to ST-36, "VQ37VHR : Exploded View".
3. Remove engine mounting insulators (RH and LH) under side nuts with power tool.
4. Lift with hoist and separate the engine and the transmission assembly from front suspension member.
CAUTION:
- **Before and during this lifting, always check that any harnesses are left connected.**
- **Never damage engine mounting insulator and avoid oil/grease smearing or spills onto engine mounting insulator.**
5. Remove crankshaft position sensor. Refer to EM-125, "Exploded View".
CAUTION:
- **Handle crankshaft position sensor carefully and avoid impacts.**
- **Never disassemble.**
- **Never place crankshaft position sensor in a location where it is exposed to magnetism.**
6. Remove alternator. Refer to CHG-31, "VQ37VHR : Exploded View".
7. Remove starter motor. Refer to STR-21, "VQ37VHR : Exploded View".
8. Remove front propeller shaft from the front final drive assembly side. Refer to DLN-110, "VQ37VHR : Exploded View".
9. Separate the engine from the transmission assembly. Refer to EM-73, "2WD : Exploded View" (For 2WD) or EM-77, "AWD : Exploded View" (For AWD).
10. Remove the front final drive assembly from oil pan (upper). Refer to DLN-157, "VQ37VHR : Exploded View".

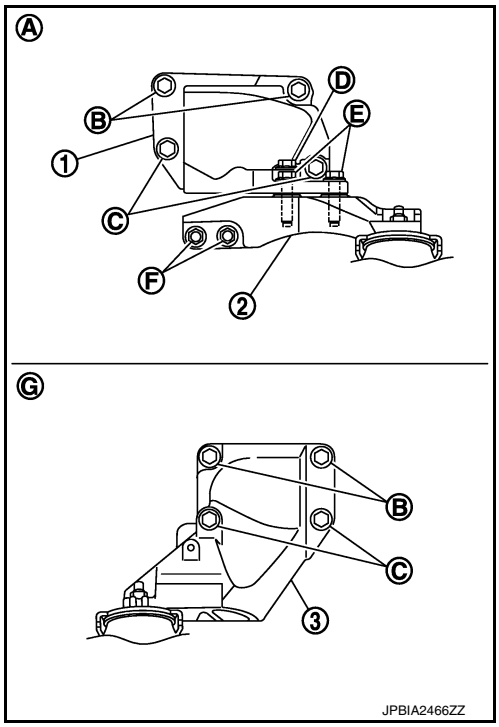
11. Remove each engine mounting insulator and each engine mounting bracket from the engine with power tool.

INSTALLATION

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

- Do not damage engine mounting insulator and do not spill oil on it.
- For a location with a positioning pin, insert it securely into hole of mating part.
- For a part with a specified installation orientation, refer to component figure in EM-77, "AWD : Exploded View".
- When installing engine mounting bracket (RH and LH) on cylinder block, tighten two upper bolts (B) first. Then tighten two lower bolts (C).

3 : Engine mounting bracket (LH)
A : Right side
G : Left side

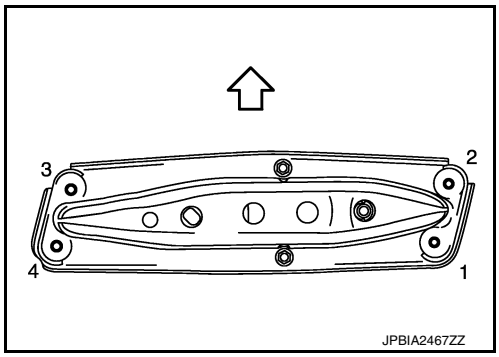


JPBIA2466ZZ

- Install engine mounting bracket (RH) (lower) (2) as follows:
  - Temporarily tighten mounting bolts [shown as (D), (E) and (F) in the figure].
  - Tighten mounting bolts to the specified torque with following mounting surfaces touched.
- Engine mounting bracket (RH) (1) to engine mounting bracket (RH) (lower) [shown as and in figure].
- Front final drive to engine mounting bracket (RH) (lower) [shown as in figure].
- Check all engine mounting insulators are seated properly, and then tighten mounting nuts.

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

⇦ : Vehicle front



JPBIA2467ZZ

AWD : Inspection

INFOID:0000000010582009

INSPECTION AFTER INSTALLATION

Inspection for Leakage

The following are procedures for checking fluid leakage, lubricants leakage, and exhaust gases 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-17, "FOR NORTH AMERICA : Fluids and Lubricants" (For North America) or MA-18, "FOR MEXICO : Fluids and Lubricants" (For Mexico).
- 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

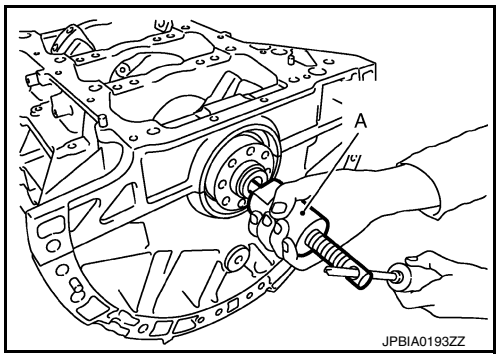
ENGINE STAND SETTING

Setting

INFOID:0000000010582010

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-77, "AWD : Exploded View".
2. Remove the parts that may restrict installation of engine to a widely use engine stand.
   NOTE:
   The procedure is described assuming that you use a widely use engine stand holding the surface, to which transmission is installed.
   - Remove drive plate with power tool. Fix crankshaft with a ring gear stopper [SST: KV10118600], and remove mounting bolts.
   - Loosen mounting bolts in diagonal order.
   - Check for deformation or damage of drive plate.
     CAUTION:
     - **Never disassemble drive plate.**
     - **Never place drive plate with signal plate facing down.**
     - **When handling signal plate, take care not to damage or scratch it.**
     - **Handle signal plate in a manner that prevents it from becoming magnetized.**
3. Remove pilot converter using the pilot bushing puller [SST: ST16610001] (A) if necessary.

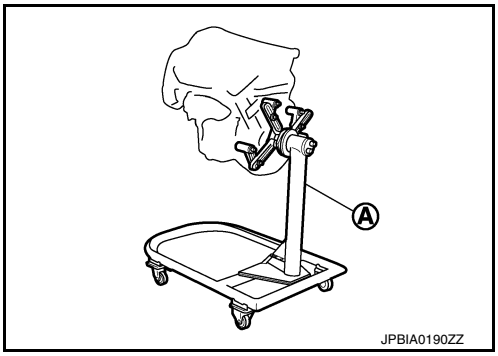


4. Lift the engine with hoist to install it onto the widely use engine stand.
   CAUTION:
   Use an engine stand that has a load capacity [220 kg (485 lb) or more] large enough for supporting the engine weight.
   - If the load capacity of the stand is not adequate, remove the following parts beforehand to reduce the potential risk of overturning the stand.
   - Remove intake manifold collector. Refer to EM-31, "Exploded View".
   - Remove fuel injector and fuel tube assembly. Refer to EM-40, "Exploded View".
   - Remove intake manifold. Refer to EM-34, "Exploded View".
   - Remove ignition coil. Refer to EM-51, "Exploded View".
   - Remove rocker cover. Refer to EM-51, "Exploded View".
   - Remove exhaust manifold. Refer to EM-36, "Exploded View".
   - Other removable brackets.
     NOTE:

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

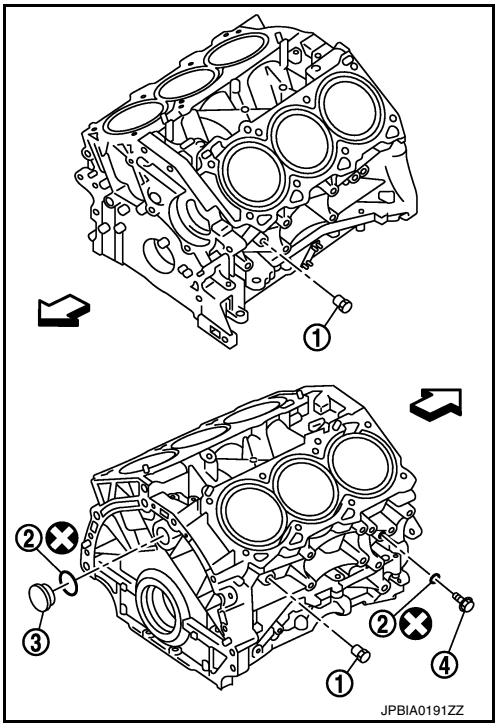
CAUTION:

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



5. Drain engine oil. Refer to LU-10, "Draining".
6. Drain engine coolant by removing water drain plug (1) from both sides of the cylinder block as shown in the figure.

2 : Washer
3 : Plug
4 : Drain plug
⇦ : Engine front



ENGINE UNIT

Disassembly

INFOID:0000000010582011

1. Remove intake manifold collector. Refer to EM-31, "Exploded View".
2. Remove fuel injector and fuel tube. Refer to EM-40, "Exploded View".
3. Remove intake manifold. Refer to EM-34, "Exploded View".
4. Remove exhaust manifold. Refer to EM-36, "Exploded View".
5. Remove oil pan (lower). Refer to EM-47, "Exploded View".
6. Remove ignition coil, spark plug and rocker cover. Refer to EM-51, "Exploded View".
7. Remove timing chain. Refer to EM-54, "Exploded View".
8. Remove rear timing chain case. Refer to EM-93, "Exploded View".
9. Remove camshaft (EXH) and VVEL ladder assembly. Refer to EM-98, "Exploded View".
10. Remove cylinder head. Refer to EM-115, "Exploded View".

Assembly

INFOID:0000000010582012

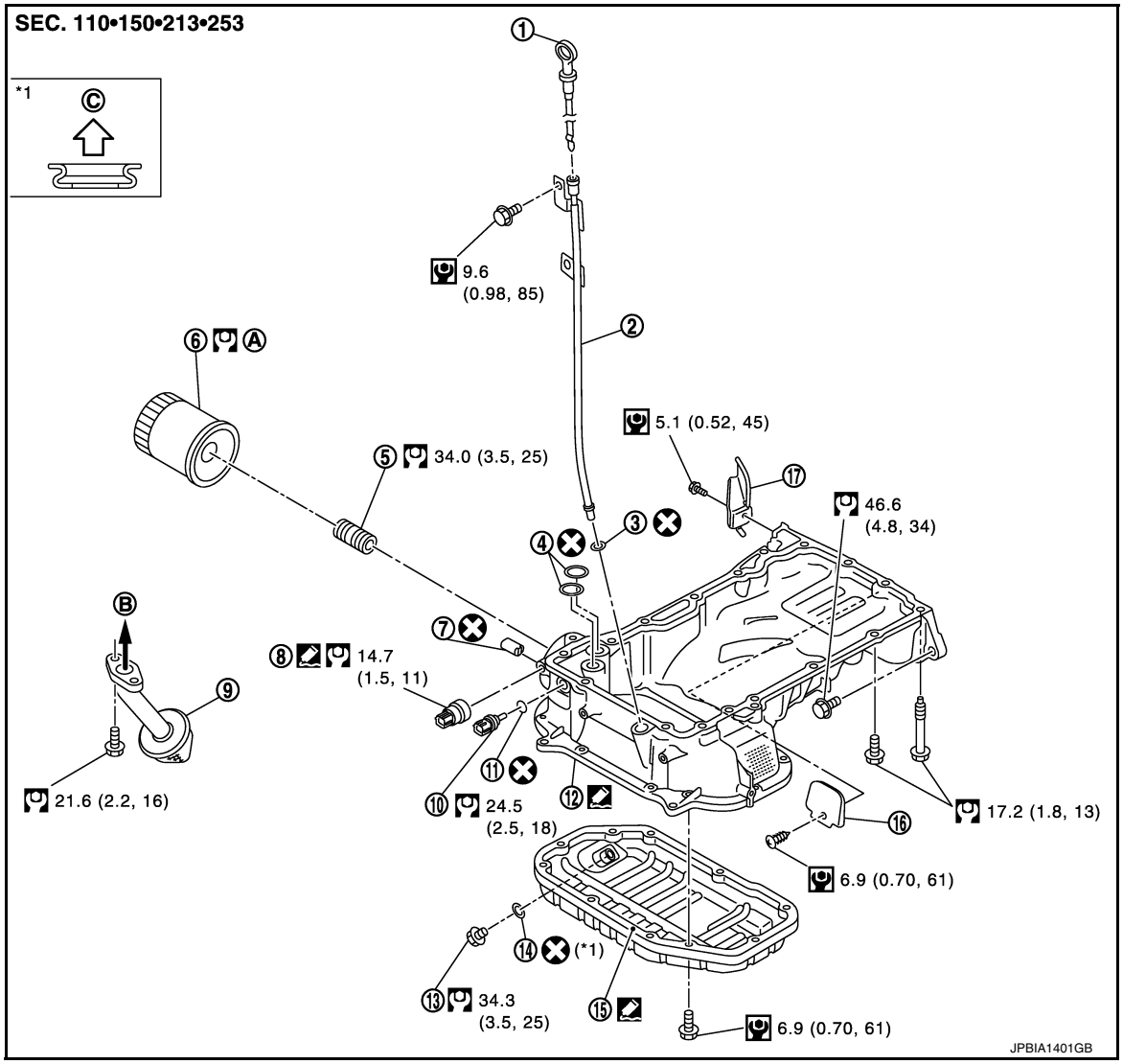
Assemble in the reverse order of disassembly.

OIL PAN (UPPER) AND OIL STRAINER

2WD

2WD : Exploded View

INFOID:0000000010582013



1.	Oil level gauge	2.	Oil level gauge guide	3.	O-ring
4.	O-ring	5.	Connector bolt	6.	Oil filter
7.	Relief valve	8.	Oil pressure switch	9.	Oil strainer
10.	Oil temperature sensor	11.	Washer	12.	Oil pan (upper)
13.	Drain plug	14.	Drain plug washer	15.	Oil pan (lower)
16.	Rear plate cover	17.	Rear cover plate (M/T models)		
A.	Comply with the installation procedure when tightening. Refer to LU-11	B.	To oil pump	C.	Oil pan side

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

2WD : Disassembly and Assembly

INFOID:0000000010582014

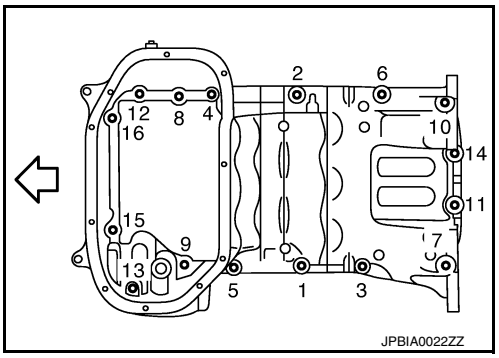
REMOVAL

CAUTION:

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

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

2. Remove oil pan (lower). Refer to EM-47, "Exploded View".
3. Remove oil strainer.
4. Loosen mounting bolts in the reverse order as shown in the figure with power tool to remove.

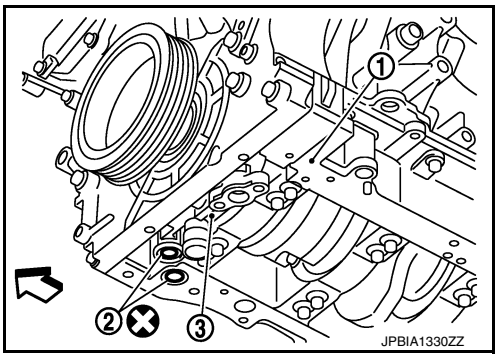


⇦ : Engine front

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

CAUTION:
- **Never damage the mating surfaces.**
- **Never insert a screwdriver, because this damages the mating surfaces.**

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



⇦ : Engine front

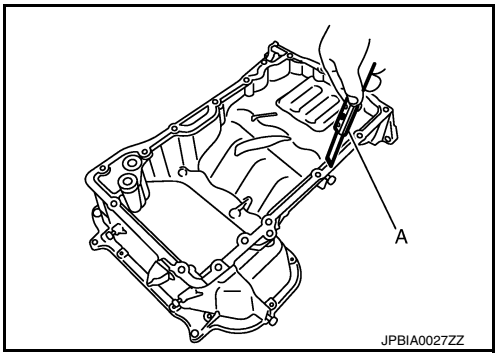
INSTALLATION

CAUTION:
Do not reuse O-rings.

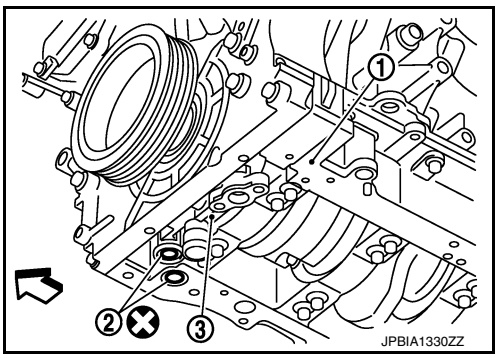
1. Install oil pan (upper) as follows:

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

CAUTION:
Never scratch or damage the mating surfaces when cleaning off old liquid gasket.
- Also remove old liquid gasket from mating surface of lower cylinder block.
- Remove old liquid gasket from the bolt holes and threads.



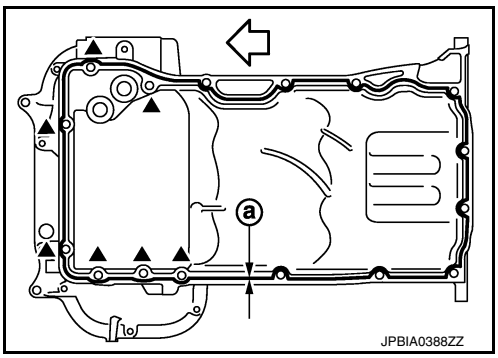
b. Install new O-rings (2) on the bottom of lower cylinder block (1) and oil pump (3).



⇦ : Engine front

CAUTION:
Do not reuse O-rings.

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



a : ϕ4.0 - 5.0 mm (0.157 - 0.197 in)

⇦ : Engine front

Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-24, "Recommended Chemical Products and Sealants".

CAUTION:

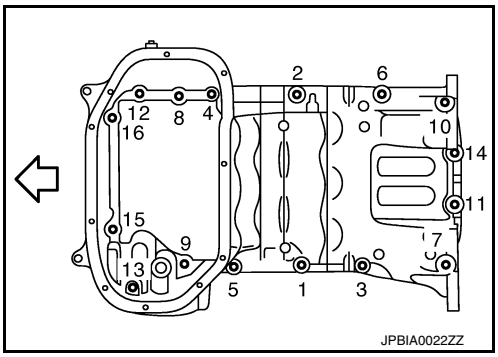
- **For bolt holes with ▲ marks (7 locations), apply liquid gasket outside the holes.**
- **Attaching should be done within 5 minutes after coating.**

d. Install oil pan (upper).

CAUTION:

Never misalign both O-rings during installation.

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



⇦ : Engine front

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

M8 × 90 mm (3.54 in)	**: 7, 10, 13**
M8 × 25 mm (0.98 in)	**: Except the above**

2. Install oil strainer to oil pump.
3. Install oil pan (lower). Refer to EM-47, "Exploded View".
4. Install oil pan drain plug.
   - Refer to the figure of components on the prior page for installation direction of drain plug washer. Refer to EM-47, "Exploded View".
5. 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.

2WD : Inspection

INFOID:0000000010582015

INSPECTION AFTER REMOVAL

Clean oil strainer if any object is attached.

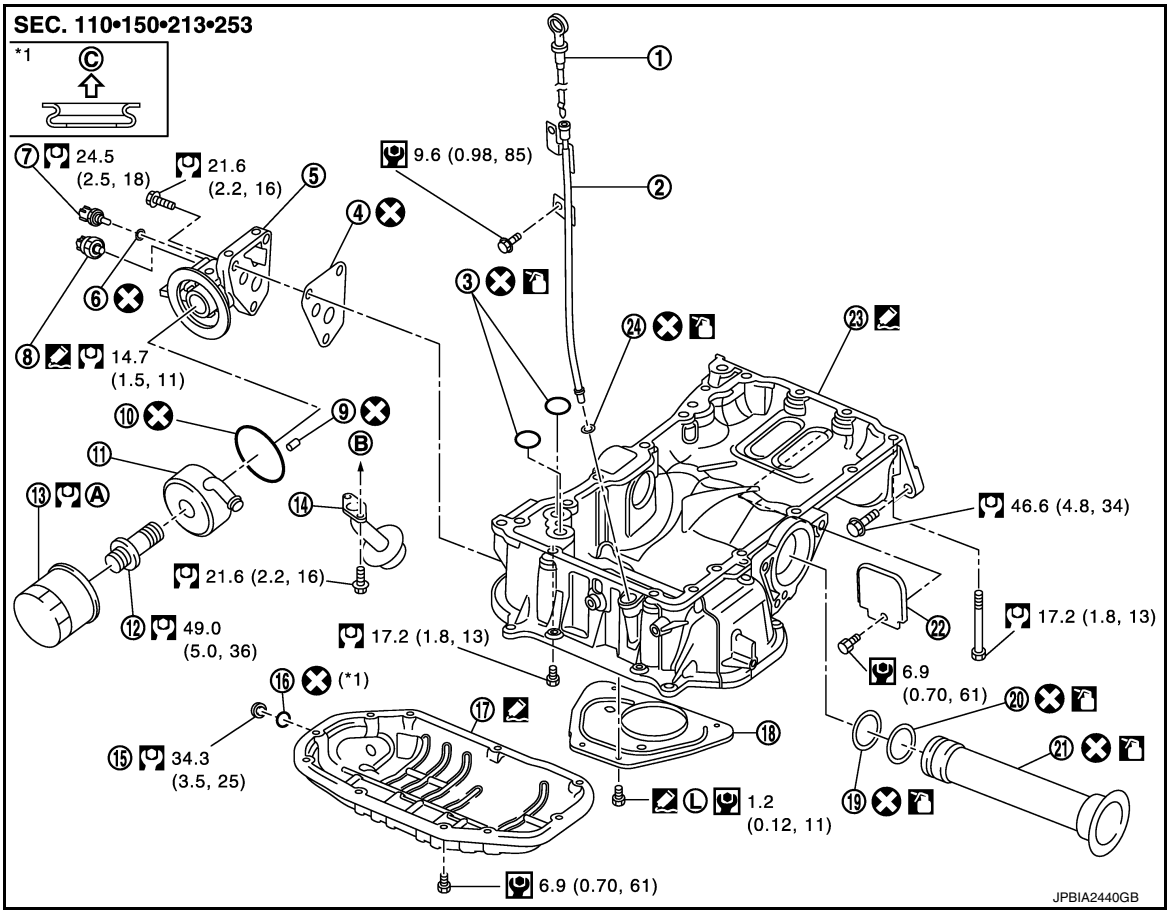
INSPECTION AFTER INSTALLATION

1. Check the engine oil level and adjust engine oil. Refer to LU-8, "Inspection".
2. Start engine, and check there is no leakage of engine oil.
3. Stop engine and wait for 10 minutes.
4. Check the engine oil level again. Refer to LU-8, "Inspection".

AWD

AWD : Exploded View

INFOID:0000000010582016



1. Oil level gauge	2. Oil level gauge guide	3. O-ring
4. Gasket	5. Oil filter bracket	6. Washer
7. Oil temperature sensor	8. Oil pressure switch	9. Relief valve
10. O-ring	11. Oil cooler	12. Connector bolt
13. Oil filter	14. Oil strainer	15. Drain plug
16. Drain plug washer	17. Oil pan (lower)	18. Baffle plate
19. O-ring (small)	20. O-ring (large)	21. Axle pipe
22. Rear plate cover	23. Oil pan (upper)	24. O-ring
A. Comply with the installation procedure when tightening. Refer to LU-11	B. To oil pump	C. Oil pan side

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

AWD : Disassembly and Assembly

INFOID:0000000010582017

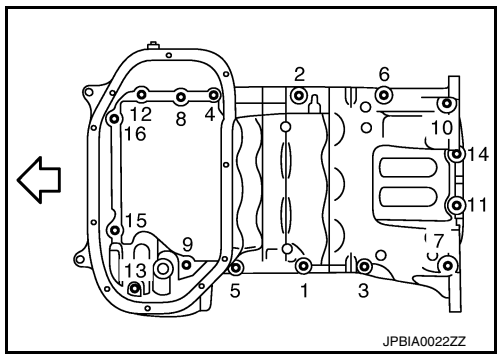
REMOVAL

CAUTION:

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

1. Remove oil level gauge, oil pressure switch and oil temperature sensor.
2. Disconnect oil cooler water hoses, and remove oil cooler water pipe mounting bolt. Refer to LU-15, "Exploded View".
3. Remove oil filter bracket. Refer to LU-13, "Exploded View".
4. Remove oil pan (lower). Refer to EM-47, "Exploded View".
5. Remove baffle plate.
6. Remove oil strainer.

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



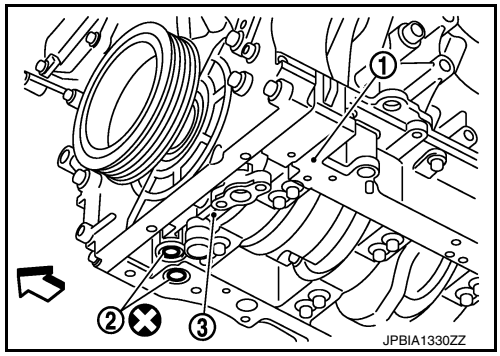
⇦ : Engine front

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

CAUTION:

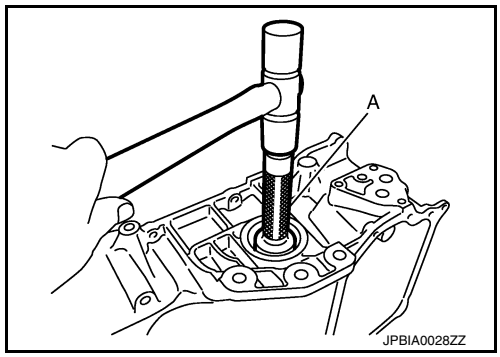
- **Be careful not to damage the mating surfaces.**
- **Never insert a screwdriver, this will damage the mating surfaces.**

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



⇦ : Engine front

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



INSTALLATION

CAUTION:

Do not reuse O-rings or washers.

1. Install axle pipe (3) to oil pan (upper), if removed.

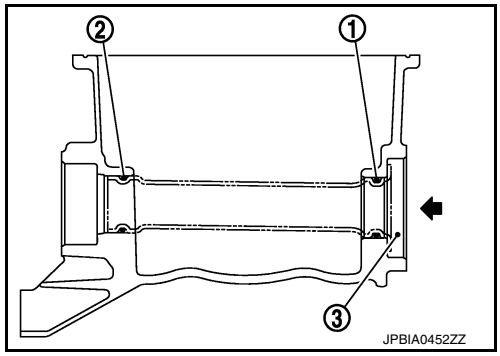
CAUTION:

Do not reuse O-rings.

- Lubricate O-ring groove of axle pipe, O-rings (1), (2), and O-ring joint of oil pan with new engine oil.

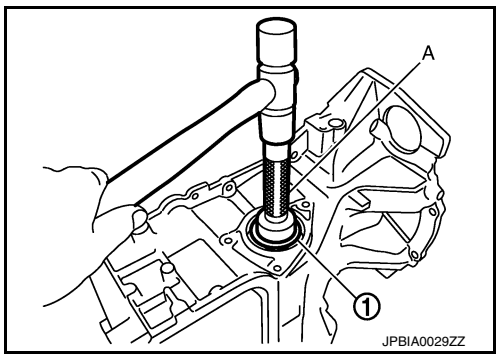
Unit: mm (in)

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



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

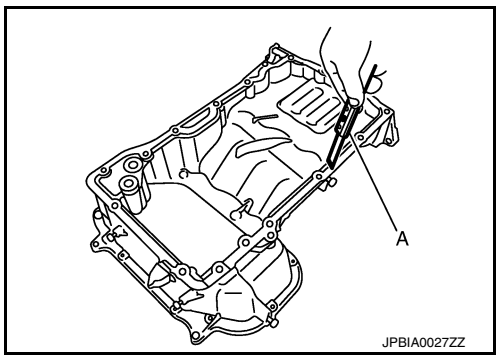
CAUTION:
Insert it with care to prevent O-ring from sliding.



2. Install oil pan (upper) as follows:

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

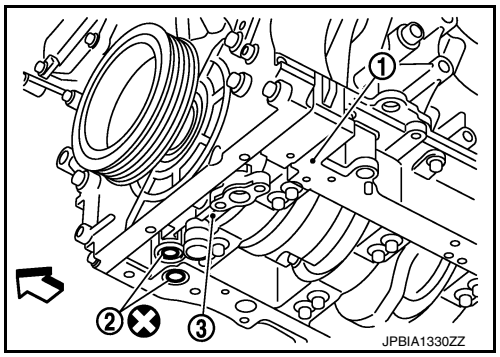
CAUTION:
Never scratch or damage the mating surfaces when cleaning off old liquid gasket.
- Also remove old liquid gasket from mating surface of lower cylinder block.
- Remove old liquid gasket from the bolt holes and threads.



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

⇦ : Engine front

CAUTION:
Do not reuse O-rings.



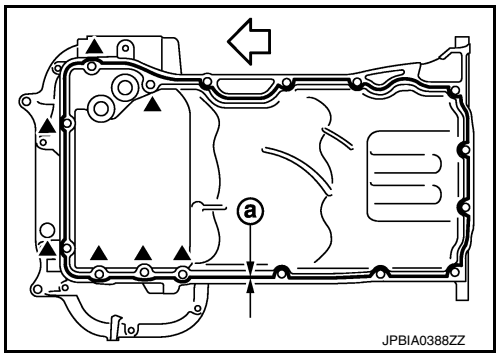
c. Apply a continuous bead of liquid gasket with the tube presser (commercial service tool) to the cylinder block mating surface of oil pan (upper) to a limited portion as shown in the figure.

a :ϕ 4.0 - 5.0 mm (0.157 - 0.197 in)

⇦ : Engine front

Use Genuine Liquid Gasket or equivalent.

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



d. Install oil pan (upper).

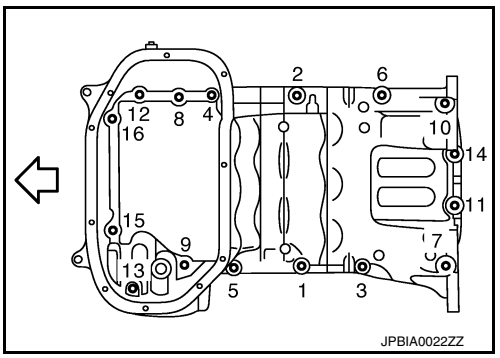
CAUTION:
Install avoiding misalignment of O-rings.

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

⇦ : Engine front

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

M8 × 25 mm (0.98 in) : 3, 6, 8, 9, 11, 12, 14, 15, 16
M8 × 50 mm (1.97 in) : 2
M8 × 90 mm (3.54 in) : 1, 4, 5, 7, 10, 13



3. Install oil strainer to oil pump.
4. Install baffle plate.
5. Install oil pan (lower). Refer to EM-47, "Exploded View".
6. Install oil pan drain plug.
   - Refer to the figure of components of former page for installation direction of drain plug washer. Refer to EM-89, "AWD : Exploded View".
7. Install in the reverse order of removal after this step.
   NOTE:
   At least 30 minutes after oil pan is installed, pour engine oil.

AWD : Inspection

INFOID:0000000010582018

INSPECTION AFTER REMOVAL

Clean oil strainer if any object is attached.

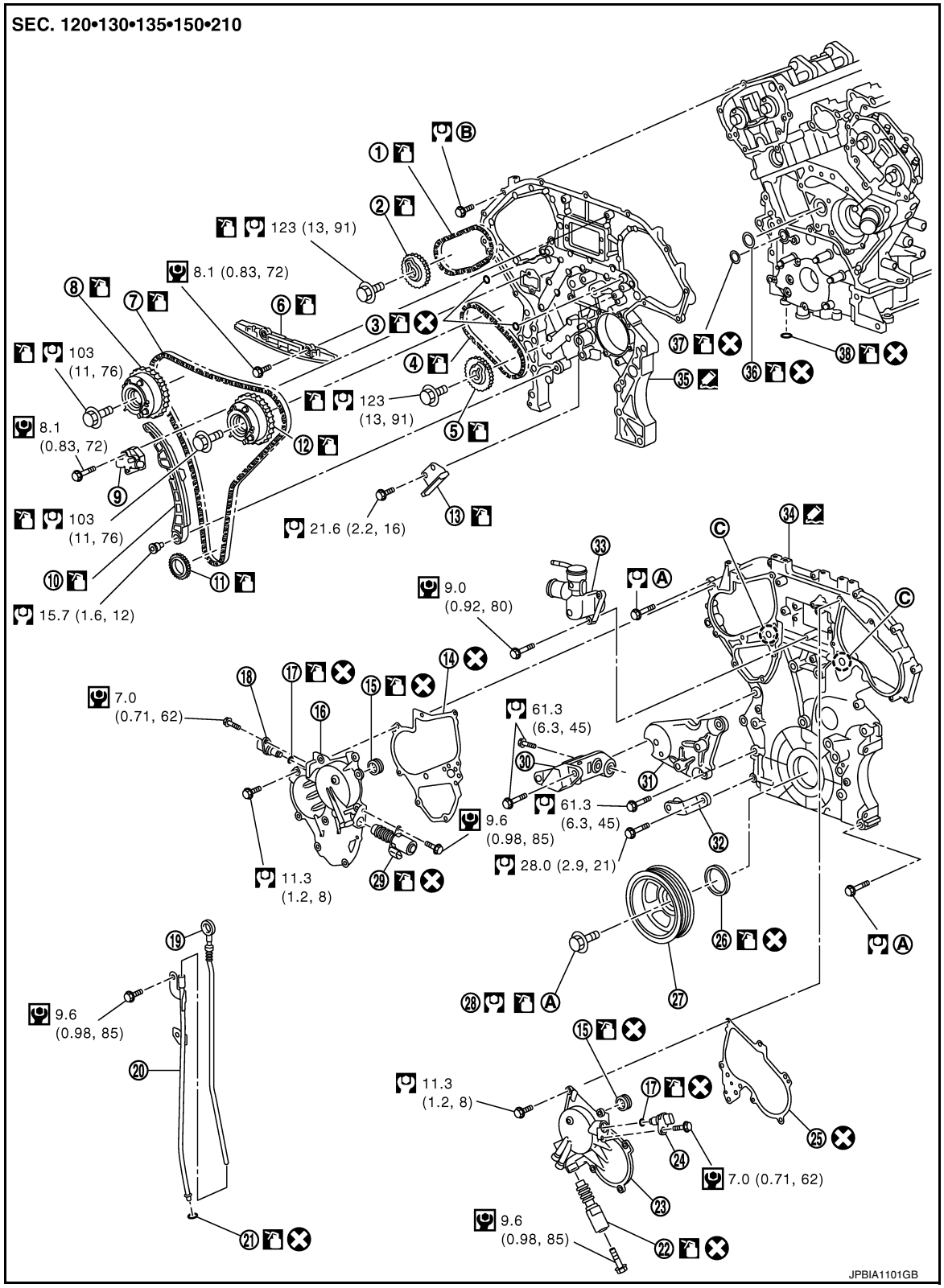
INSPECTION AFTER INSTALLATION

1. Check the engine oil level and adjust engine oil. Refer to LU-8, "Inspection".
2. Start engine, and check there is no leakage of engine oil.
3. Stop engine and wait for 10 minutes.
4. Check the engine oil level again. Refer to LU-8, "Inspection".

REAR TIMING CHAIN CASE

Exploded View

INFOID:0000000010582019



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

10.	Slack guide	11.	Crankshaft sprocket	12.	Camshaft sprocket (INT)
13.	Tension guide	14.	Intake valve timing control cover gasket (bank 1)	15.	Seal ring
16.	Intake valve timing control cover (bank 1)	17.	O-ring	18.	Camshaft position sensor (PHASE) (bank 1)
19.	Oil level gauge	20.	Oil level gauge guide	21.	O-ring
22.	Intake valve timing control solenoid valve (bank 2)	23.	Intake valve timing control cover (bank 2)	24.	Camshaft position sensor (PHASE) (bank 2)
25.	Intake valve timing control cover gasket (bank 2)	26.	Front oil seal	27.	Crankshaft pulley
28.	Crankshaft pulley bolt	29.	Intake valve timing control solenoid valve (bank 1)	30.	Power steering oil pump bracket
31.	Idler pulley bracket	32.	Alternator bracket	33.	Water outlet (front)
34.	Front timing chain case	35.	Rear timing chain case	36.	O-ring
37.	O-ring	38.	O-ring		
A.	Comply with the installation procedure when tightening. Refer to EM-55	B.	Comply with the installation procedure when tightening. Refer to EM-94	C.	Oil filter

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

Disassembly and Assembly

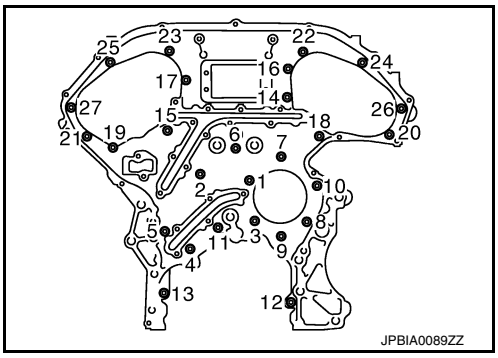
INFOID:0000000010582020

DISASSEMBLY

1. Remove front timing chain case and timing chain. Refer to EM-55, "Removal and Installation".
2. Remove water pump. Refer to CO-22, "Exploded View".
3. Remove oil pan (upper). Refer to EM-89, "AWD : Exploded View".
4. Remove rear timing chain case as follows:

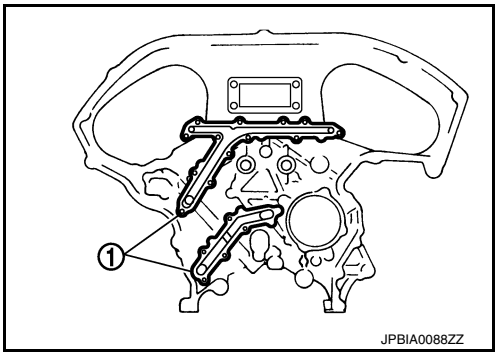
a. Loosen mounting bolts in reverse order as shown in the figure.

b. Cut liquid gasket using the seal cutter [SST: KV10111100] and remove rear timing chain case.



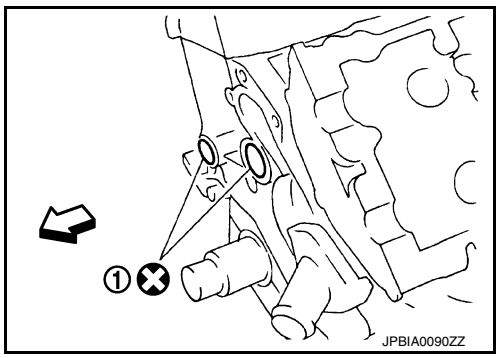
CAUTION:

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



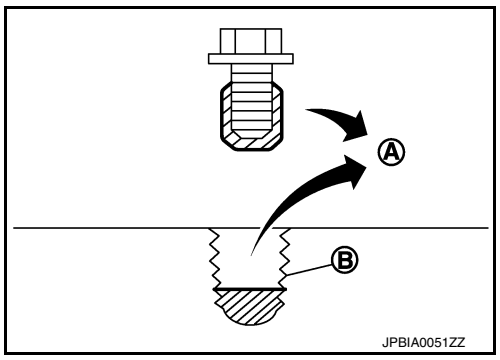
5. Remove O-rings (1) from cylinder block.

⇦ : Engine front



6. Use a scraper to remove all traces of liquid gasket from rear timing chain cases and opposite mating surfaces.
7. Remove old liquid gasket from bolt hole and thread.

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



ASSEMBLY

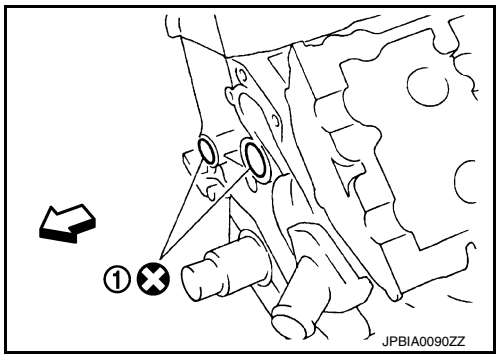
CAUTION:
Do not reuse O-rings.

1. Install rear timing chain case as follows:

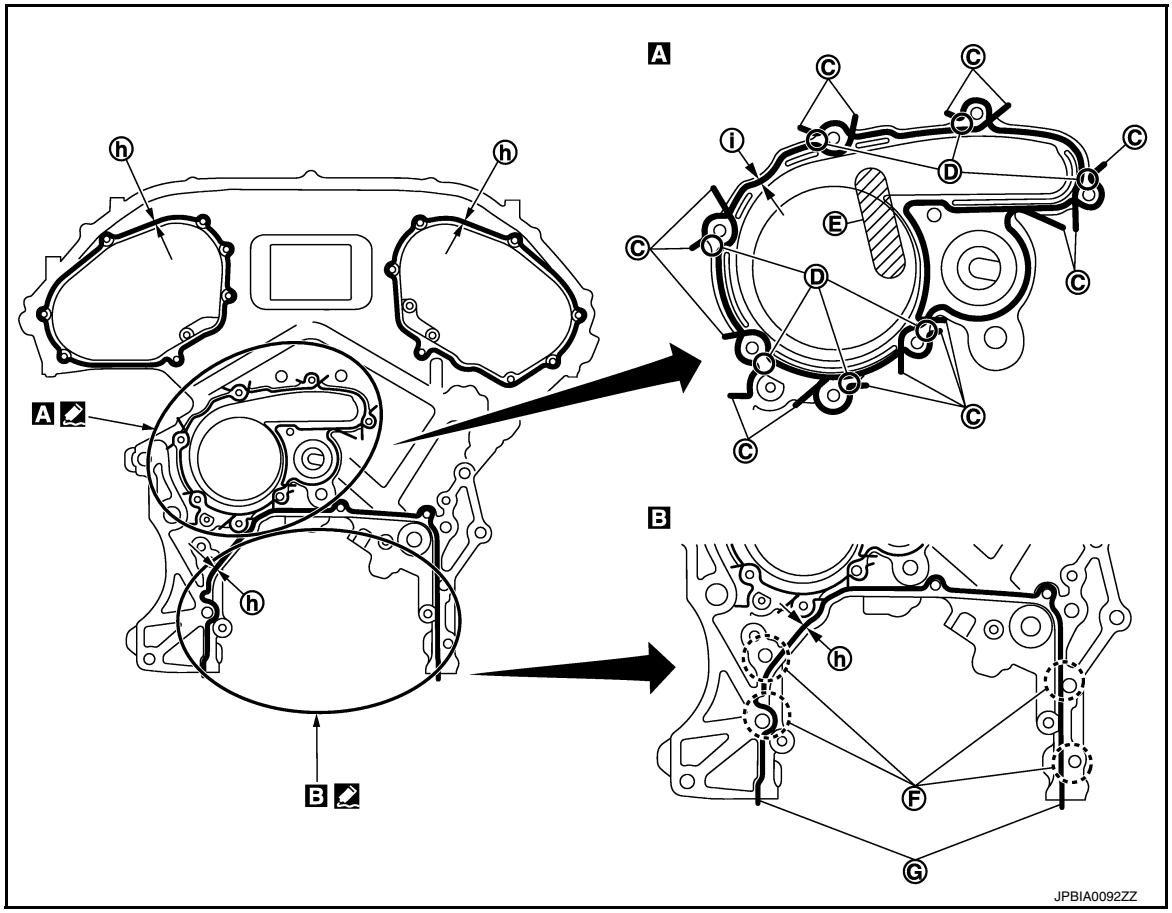
a. Install new O-rings (1) onto cylinder block.

⇦ : Engine front

CAUTION:
Do not reuse O-rings.



b. Apply liquid gasket with the tube presser (commercial service tool) to rear timing chain case back side as shown in the figure.
Use Genuine Liquid Gasket or equivalent.
CAUTION:
- **For A in the figure, completely wipe off liquid gasket extended on a portion touching at engine coolant.**
- **Apply liquid gasket on installation position of water pump and cylinder head completely.**

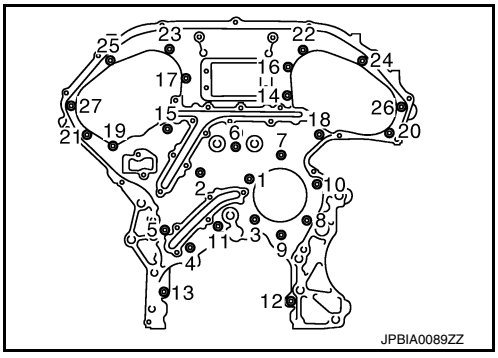


C.	Protrusion	D.	Clearance 1 mm (0.04 in)	E.	Do not protrude in this area
F.	Run along bolt hole inner side	G.	Protrusions at beginning and end of gasket		
h.	ϕ3.4 - 4.4 mm (0.134 - 0.173 in)	i.	ϕ2.6 - 2.8 mm (0.102 - 0.110 in)		

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

c. Align rear timing chain case with dowel pins (bank 1 and bank 2) on cylinder block and install rear timing chain case.
- Check that O-rings stay in place during installation to cylinder block.

d. Tighten mounting bolts in numerical order as shown in the figure.
- There are three types of mounting bolts. Refer to the following for locating bolts.



Bolt length: Bolt position

20 mm (0.79 in) : 1, 2, 3, 6, 7, 8, 9, 10

16 mm (0.63 in) : 4, 5, 11, 12, 13

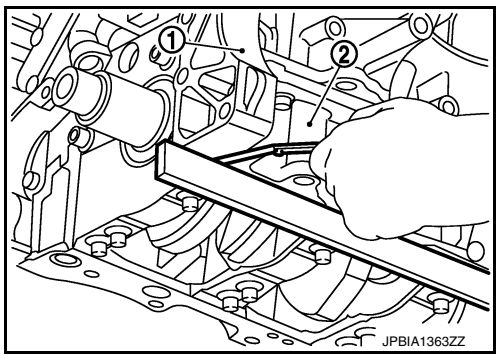
: 12.7 N·m (1.3 kg-m, 9 ft-lb)

16 mm (0.63 in) : Except the above

: 15.0 N·m (1.5 kg-m, 11 ft-lb)

e. After all bolts are tightened, retighten them to the specified torque in numerical order shown in the figure.
- If liquid gasket protrudes, wipe it off immediately.

f. After installing rear timing chain case, check the surface height difference between the following parts on the oil pan (upper) mounting surface.



1 : Rear timing chain case
2 : Lower cylinder block

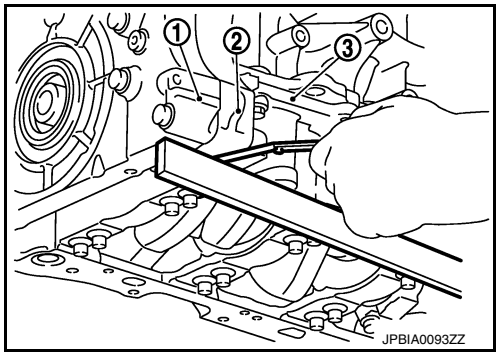
Standard

Rear timing chain case to lower cylinder block:

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

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

2. Install water pump with new O-rings. Refer to CO-22, "Exploded View".
3. Install timing chains, camshaft sprockets, and front timing chain case. Refer to EM-55, "Removal and Installation".
   - After installing front timing chain case, check the surface height difference between the following parts on the oil pan (upper) mounting surface.



1 : Front timing chain case
2 : Rear timing chain case
3 : Lower cylinder block

Standard

Front timing chain case to rear timing chain case:

–0.14 to 0.14 mm (–0.0055 to 0.0055 in)

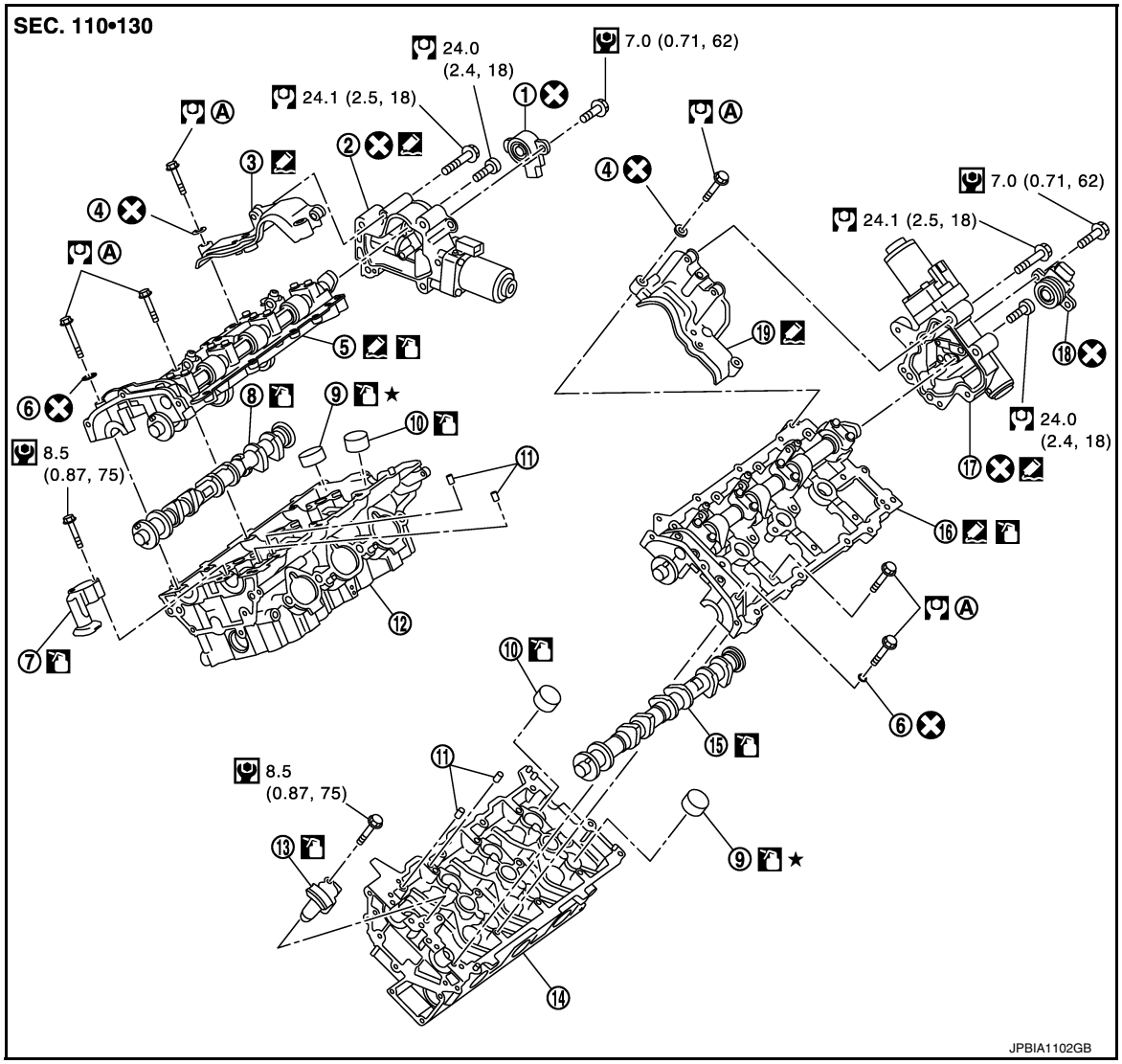
- If not within the standard, repeat the installation procedure.

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

CAMSHAFT

Exploded View

INFOID:0000000010582021



1.	VVEL control shaft position sensor (bank 1)	2.	VVEL actuator sub assembly (bank 1)	3.	Actuator bracket (rear) (bank 1)
4.	Washer	5.	VVEL ladder assembly (bank 1)	6.	Washer
7.	Timing chain tensioner (secondary) (bank 1)	8.	Camshaft (EXH) (bank 1)	9.	Valve lifter (EXH)
10.	Valve lifter (INT)	11.	Oil filter	12.	Cylinder head (bank 1)
13.	Timing chain tensioner (secondary) (bank 2)	14.	Cylinder head (bank 2)	15.	Camshaft (EXH) (bank 2)
16.	VVEL ladder assembly (bank 2)	17.	VVEL actuator sub assembly (bank 2)	18.	VVEL control shaft position sensor (bank 2)
19.	Actuator bracket (rear) (bank 2)				
A.	Comply with the installation procedure when tightening. Refer to EM-99				

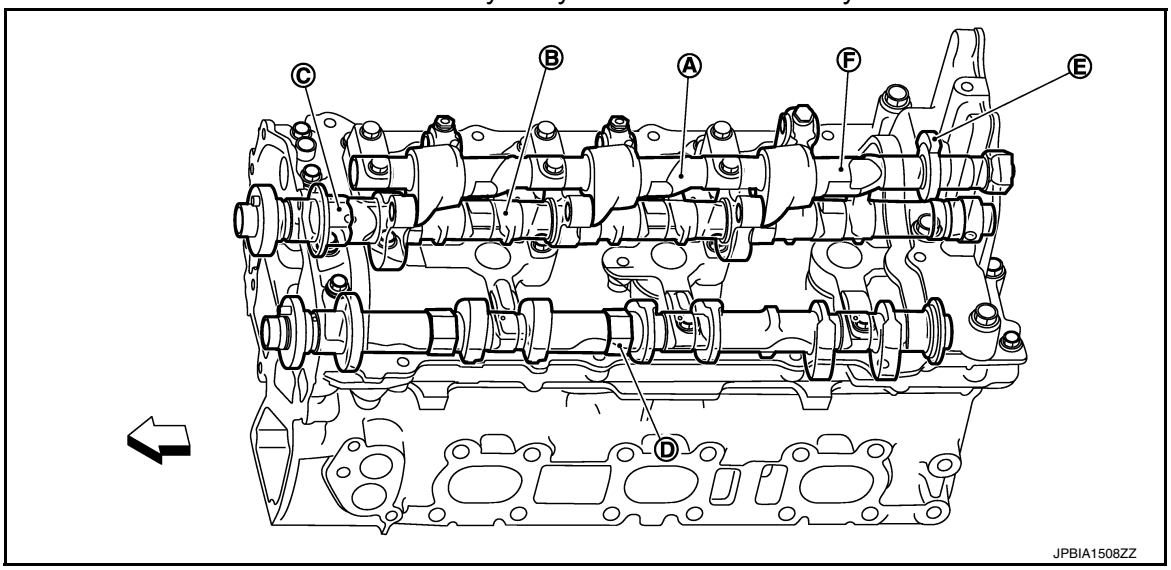
Refer to GI-4, "Components" for symbols in the figure.

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.

VVEL Ladder Assembly & Cylinder Head Assembly Features



A.	Control shaft	B.	Drive shaft	C.	Hexagonal part of drive shaft (for holding)
D.	Hexagonal part of camshaft (EXH) (for holding)	E.	Stopper of control shaft	F.	Two flat area of control shaft (for holding)

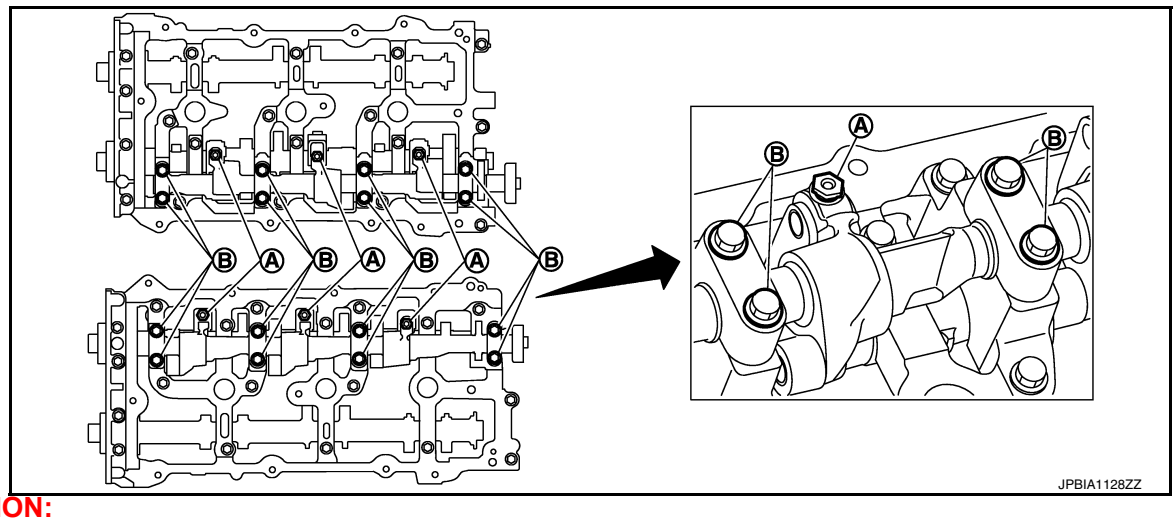
⇦ : Engine front

NOTE:
The figure shows an example of bank 2.

Disassembly and Assembly

INFOID:0000000010582022

DISASSEMBLY



CAUTION:
Never loosen adjusting bolts (A) and mounting bolts (black color) (B) of VVEL ladder assembly. 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.
NOTE:
VVEL ladder assembly cannot be replaced as a single part, because it is machined together with cylinder head assembly.

1. Remove rocker covers (bank 1 and bank 2). Refer to EM-51, "Exploded View".
2. Remove VVEL actuator sub assembly as follows:

CAUTION:
VVEL actuator sub assembly and VVEL control shaft position sensor are nonreusable. Never remove them unless they are required.

a. Remove VVEL control shaft position sensor.

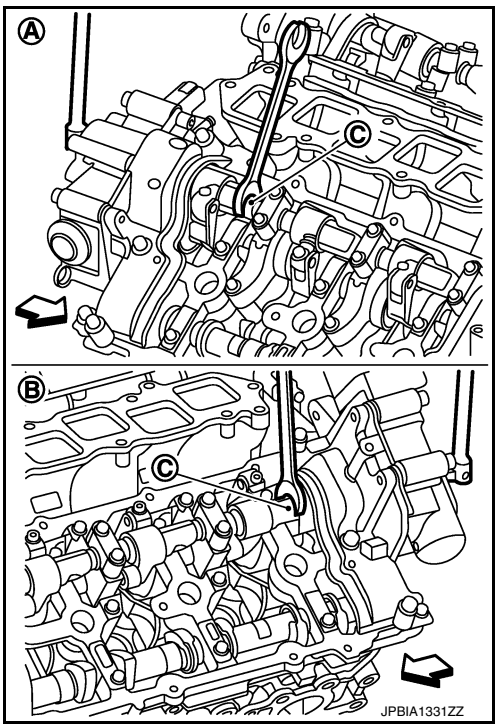
b. Turn control shaft to the large lift side and fix it in order to prevent the interference of the stopper surface.
- If control shaft cannot be moved, set crankshaft in position referring to the information below. (To displace cam nose)

Bank 1 : Turn 120 degrees from No. 1 cylinder at TDC
Bank 2 : No. 1 cylinder at TDC

c. Fix two flat areas (C) of control shaft with a wrench to remove mounting bolts of control shaft.

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

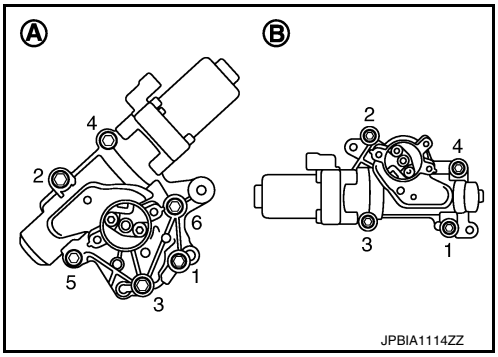
CAUTION:
- **During the operation, never allow a wrench to interfere with other parts.**
- **Fix control shaft to prevent the interference of the stopper surface.**



d. Remove VVEL actuator sub assembly.
- Loosen mounting bolts in the reverse order as shown in the figure.

A : Bank 2
B : Bank 1

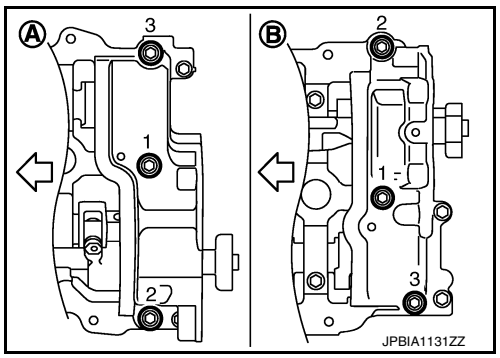
CAUTION:
- **When removing, prepare wastes because oil spills.**
- **When installing, be careful with VVEL actuator sub assembly (bank 2) mounting bolt No. 1 because its length is different.**



e. Remove actuator bracket (rear).

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

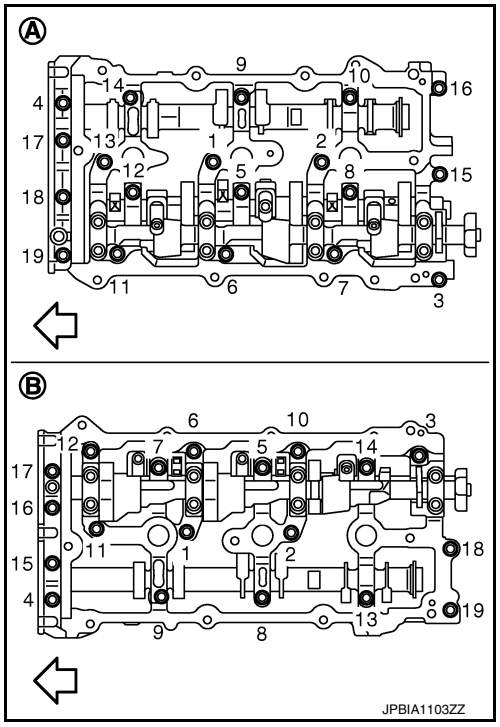
A : Bank 1
B : Bank 2
⇦ : Engine front



3. Remove front timing chain case, camshaft sprockets, and timing chain. Refer to EM-54, "Exploded View".
4. Remove rear timing chain case. Refer to EM-93, "Exploded View".
5. Remove VVEL ladder assembly.
   - Loosen mounting bolts (gold color) in the reverse order as shown in the figure.

A : Bank 1
B : Bank 2
⇦ : 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.**

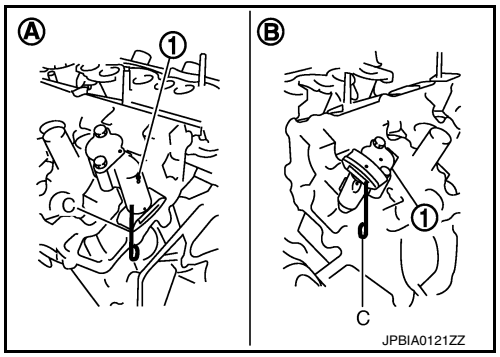


6. Remove camshaft (EXH).
7. Remove valve lifter.
   - Identify installation positions, and store them without mixing them up.
8. Remove timing chain tensioners (secondary) (1) from cylinder head.

A : Bank 1
B : Bank 2

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

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

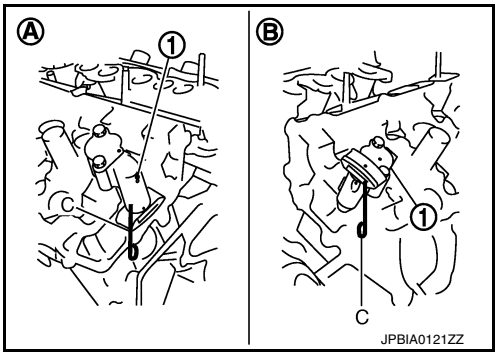


9. Remove oil filter from cylinder head, if necessary.

ASSEMBLY

CAUTION:
Do not reuse washers.

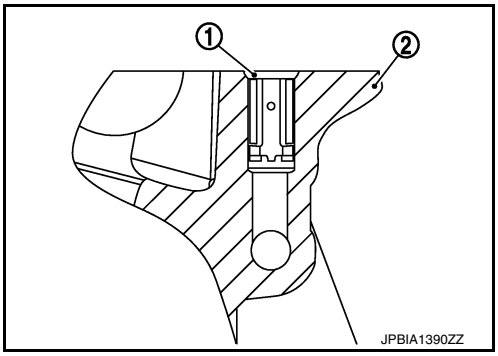
1. Install timing chain tensioners (secondary) (1) on both sides of cylinder head.



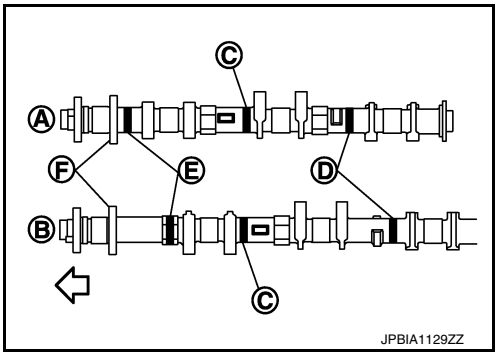
A : Bank 1
B : Bank 2

- Install timing chain tensioner with its stopper pin (C) attached.
- Install timing chain tensioner with sliding part facing downward on cylinder head (bank 1), and with sliding part facing upward on cylinder head (bank 2).

2. Install oil filter (1), if removed.
   - Do not project from the cylinder head (2) surface.



3. Install valve lifter.
   - Install it in the original position.
4. Install camshaft (EXH).
   - Distinction between camshaft (EXH) (bank 1 and bank 2) is performed with the identification mark.



⇦ : Engine front

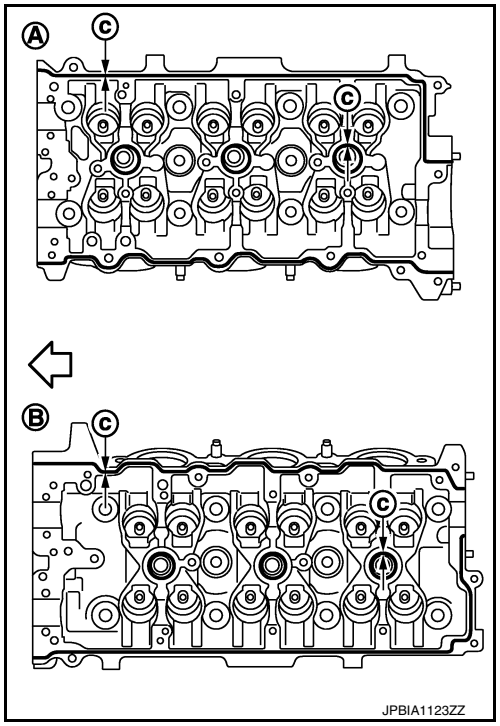
Bank	Paint marks			Identification mark (F)
	M1 (C)	M2 (D)	M3 (E)	
Bank 1 (A)	No	Blue	Light blue	1N
Bank 2 (B)	No	Blue	Light blue	1P

5. Install VVEL ladder assembly as follows:

a. Apply a continuous bead of liquid gasket with tube presser (commercial service tool) to the cylinder head 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 Liquid Gasket or equivalent.



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

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

CAUTION:
Do not reuse washers.

i. Tighten bolts in numerical order as shown.

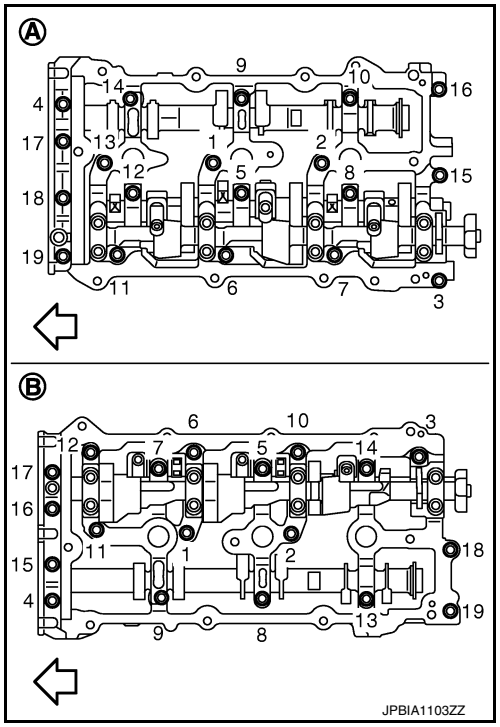
: 1.96 N·m (0.20 kg-m, 1 ft-lb)

ii. Tighten bolts in numerical order as shown.

: 5.88 N·m (0.60 kg-m, 4 ft-lb)

iii. Tighten bolts in numerical order as shown.

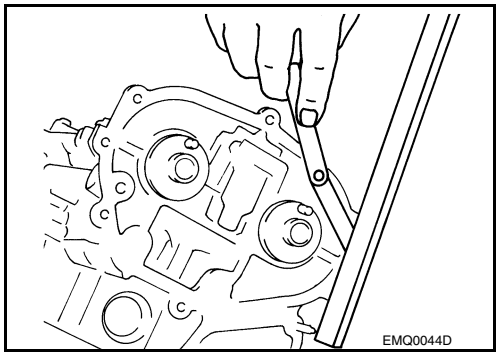
: 10.4 N·m (1.1 kg-m, 8 ft-lb)



6. Measure difference in levels between front end faces of VVEL ladder assembly and cylinder head.

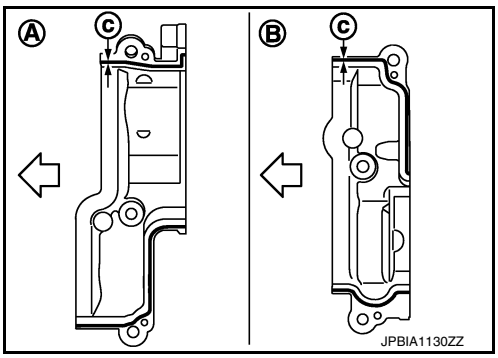
Standard : −0.14 to 0.14 mm (−0.0055 to 0.0055 in)

- Measure two positions (both intake and exhaust side) for a single bank.
- If the measured value is out of the standard, reinstall VVEL ladder assembly.



7. Install rear timing chain case. Refer to EM-93, "Exploded View".
8. Install camshaft sprockets and timing chains. Refer to EM-54, "Exploded View".
9. Install actuator bracket (rear) as follows:

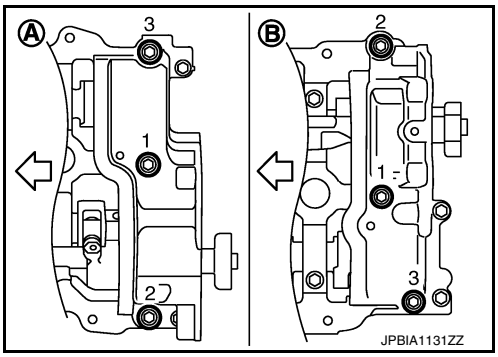
a. Apply a continuous bead of liquid gasket with tube presser (commercial service tool) to the actuator bracket (rear) as shown in the figure.



A : Bank 1
B : Bank 2
c : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)
⇦ : Engine front

Use Genuine Liquid Gasket or equivalent.
CAUTION:
Never apply gasket to the oil passage.

b. Tighten mounting bolts in the following steps, in numerical order as shown in the figure.



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

CAUTION:
Do not reuse washers.

i. Tighten bolts in numerical order as shown.

: 1.96 N·m (0.20 kg-m, 1 ft-lb)

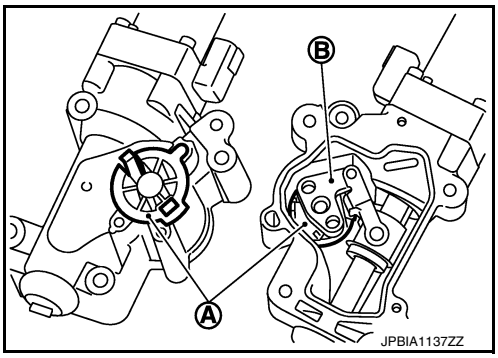
ii. Tighten bolts in numerical order as shown.

: 5.88 N·m (0.60 kg-m, 4 ft-lb)

iii. Tighten bolts in numerical order as shown.

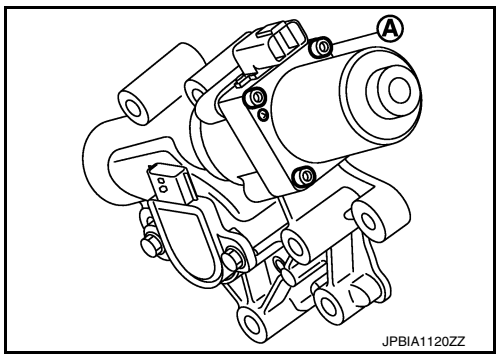
: 31.4 N·m (3.2 kg-m, 23 ft-lb)

10. Install new VVEL actuator sub assembly as follows:
CAUTION:
Regarding replacement, because VVEL actuator sub assembly and VVEL control shaft position sensor are controlled on a one-on-one basis, replace them as a set.
NOTE:
- VVEL actuator arm (B) is factory-fixed at 5.5 degrees from the small lift with a holding jig (A).
- The holding jig is supplied in the new VVEL actuator sub assembly.



CAUTION:

- **Never disassemble VVEL actuator sub assembly. [Never loosen actuator motor mounting bolts (A) shown in the figure]**
- **Never shock VVEL actuator sub assembly.**

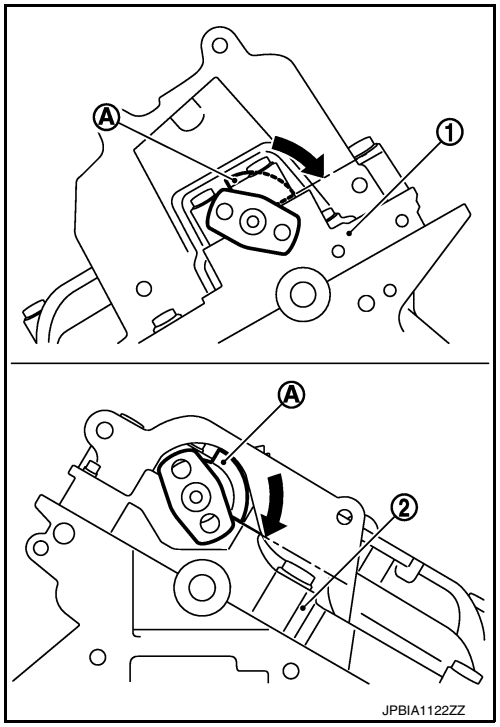


a. Move control shaft to the position of small lift stopper.

1 : VVEL ladder assembly (bank 2)
2 : VVEL ladder assembly (bank 1)
A : Stopper of control shaft
⬅ : Small lift side

- The position where a part of the stopper of control shaft contacts VVEL ladder bracket.

CAUTION:
Be careful not to damage the stopper surface.

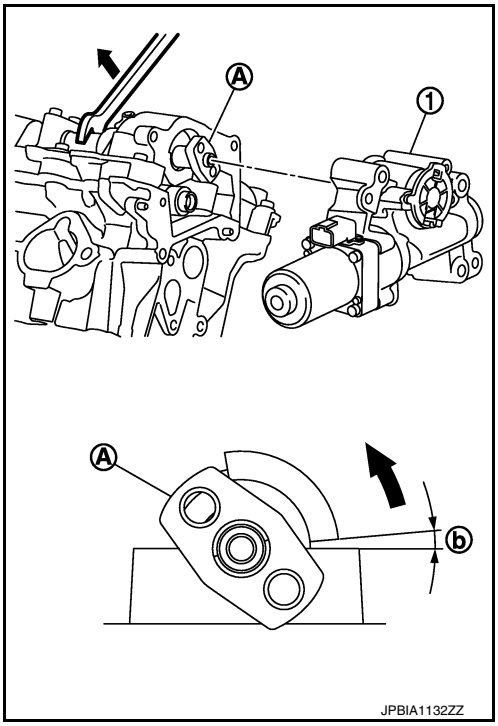


- If control shaft cannot be moved, set crankshaft in position referring to the information below. (To displace cam nose)

Bank 1 : Turn 120 degrees from No. 1 cylinder at TDC
Bank 2 : No. 1 cylinder at TDC

b. Hold two flat areas of control shaft with a wrench, and rotate the control shaft (5.5 degrees from the stopper) to the large lift side. (This is for aligning the bolt hole of control shaft and the hole of VVEL actuator arm.)

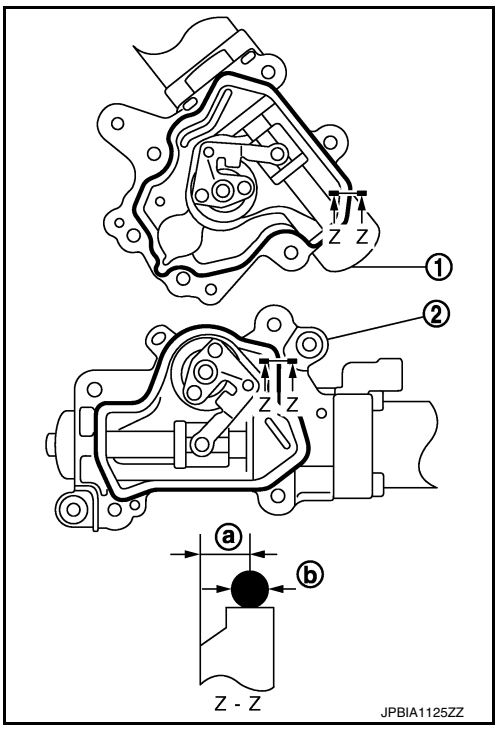
1 : VVEL actuator sub assembly (bank 1)
A : Control shaft
b : 5.5 degrees
⬅ : Large lift side



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

1 : VVEL actuator sub assembly (bank 2)
2 : VVEL actuator sub assembly (bank 1)
a : 4.0 - 5.6 mm (0.157 - 0.220 in)
b : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)

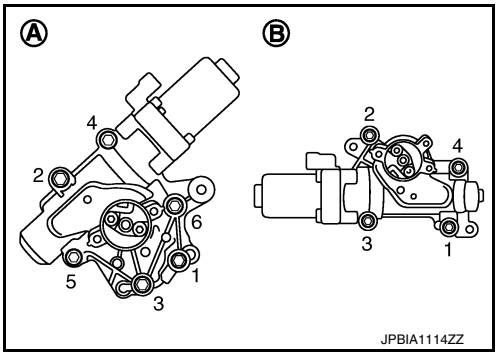
Use Genuine Liquid Gasket or equivalent.
CAUTION:
Never apply gasket to the oil passage.



d. Install new VVEL actuator sub assembly.
- Tighten mounting bolts in the following step, in numerical order as shown in the figure.

A : Bank 2
B : Bank 1

CAUTION:
- **When installing, be careful with VVEL actuator sub assembly (bank 2) mounting bolt No. 1 because its length is different.**



- **Be sure to check that the VVEL actuator sub assembly is in contact with the cylinder head before tightening the mounting bolts.**

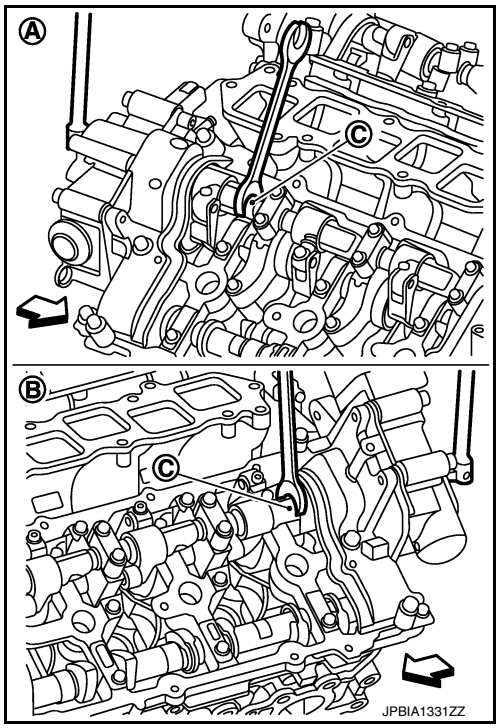
e. Remove holding jig.

f. Check that VVEL actuator arm bolt hole is aligned with control shaft tapped hole. If it is not aligned, turn control shaft for alignment.

g. Fix two flat areas (C) of control shaft with a wrench to install mounting bolts of control shaft.

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

CAUTION:
- **During the operation, never allow a wrench to interfere with other parts.**
- **Fix control shaft to prevent the interference of the stopper surface.**



11. Install new VVEL control shaft position sensor as follows:

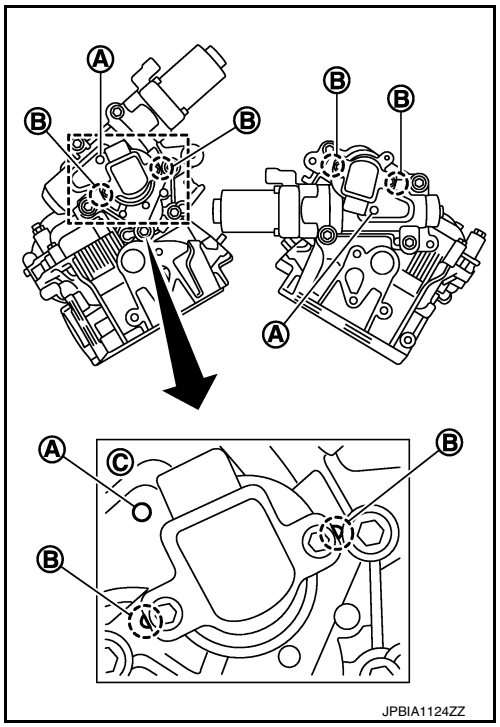
CAUTION:
Regarding replacement, because VVEL actuator sub assembly and VVEL control shaft position sensor are controlled on a one-on-one basis, replace them as a set.

a. Apply engine oil to O-ring or contact surface of O-ring.

b. Align matching marks (B) of VVEL control shaft position sensor and upper housing.

C : Bank 2

- Face connector toward matching mark (A).



c. Temporarily tighten bolt.

d. Adjust VVEL control shaft position sensor after setting the engine assembly in the vehicle. Refer to EC-35, "VVEL CONTROL SHAFT POSITION SENSOR ADJUSTMENT : Description".
CAUTION:
Be sure to adjust VVEL control shaft position sensor.
e. After adjusting VVEL control shaft position sensor, tighten bolts to the specified torque.
12. Inspect the valve clearance. Refer to EM-20, "Inspection and Adjustment".
13. Install in the reverse order of removal after this step.

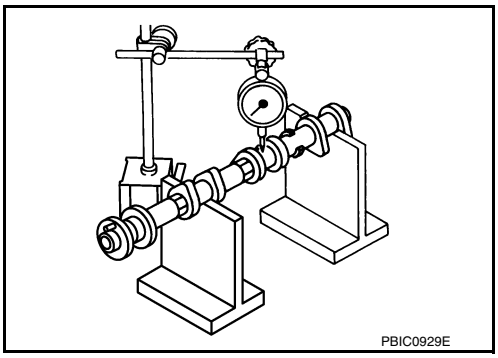
Inspection

INFOID:0000000010582023

INSPECTION AFTER REMOVAL (EXHAUST SIDE)

Camshaft (EXH) Runout

1. Put V-block on precise flat table, and support No. 2 and 4 journals of camshaft.
CAUTION:
Never support No. 1 journal (on the side of camshaft sprocket) because it has a different diameter from the other three locations.
2. Set a dial indicator vertically to No. 3 journal.
3. Turn camshaft (EXH) to one direction with hands, and measure the camshaft runout on a dial indicator. (Total indicator reading)


PBIC0929E

Standard and limit
: Refer to EM-152, "Camshaft".

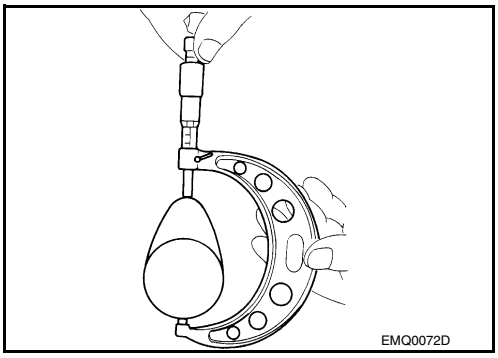
4. If it exceeds the limit, replace camshaft (EXH).

Camshaft (EXH) Cam Height

- Measure the camshaft (EXH) cam height with a micrometer.

Standard : Refer to EM-152, "Camshaft".

- If wear exceeds the limit, replace camshaft (EXH).

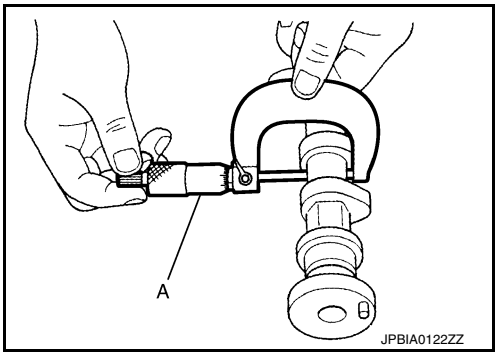

EMQ0072D

Camshaft (EXH) Journal Oil Clearance

CAMSHAFT (EXH) JOURNAL DIAMETER

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

Standard : Refer to EM-152, "Camshaft".



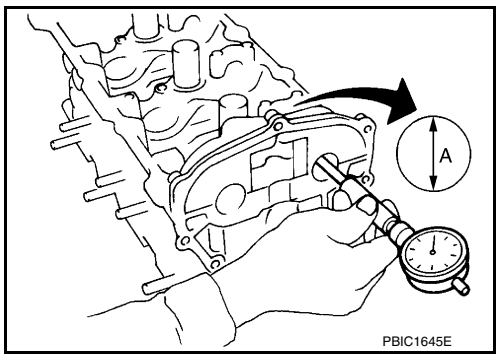
JPBIA0122ZZ

VVEL LADDER ASSEMBLY (EXHAUST SIDE) INNER DIAMETER

- Tighten VVEL ladder assembly bolts to the specified torque. Refer to “INSTALLATION” for the tightening procedure.

- Measure inner diameter (A) of VVEL ladder assembly (Exhaust side) with a bore gauge.

Standard : Refer to EM-152, "Camshaft".



CAMSHAFT (EXH) JOURNAL OIL CLEARANCE

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

Standard and limit : Refer to EM-152, "Camshaft".

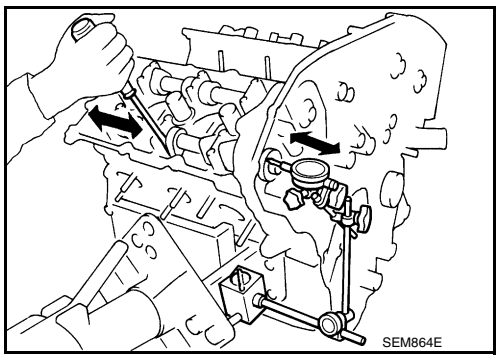
- If the calculated value exceeds the limit, replace either or both camshaft (EXH) and VVEL ladder assembly & cylinder head assembly.

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

Camshaft (EXH) End Play

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

Standard and limit : Refer to EM-152, "Camshaft".



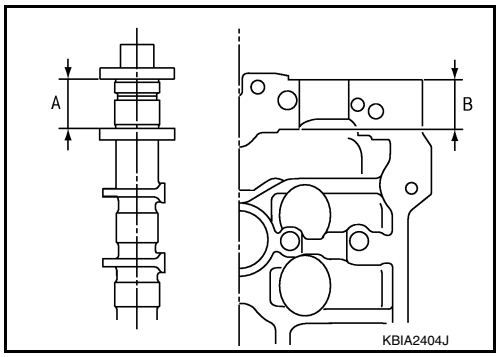
- Measure the following parts if out of the limit.

- Dimension “A” for camshaft (EXH) No. 1 journal

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

- Dimension “B” for cylinder head No. 1 journal bearing

Standard : 27.360 - 27.385 mm (1.0772 - 1.0781 in)



- Refer to the standards above, and then replace camshaft (EXH) 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.

Camshaft Sprocket (EXH) Runout

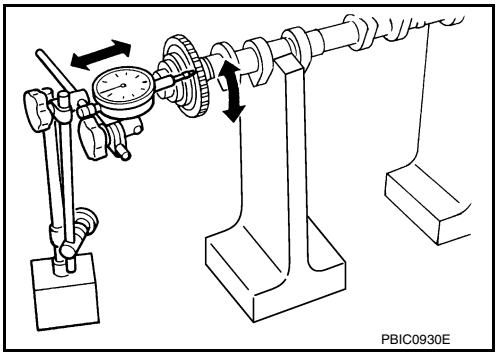
1. Put V-block on precise flat table, and support No. 2 and 4 journals of camshaft (EXH).

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

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

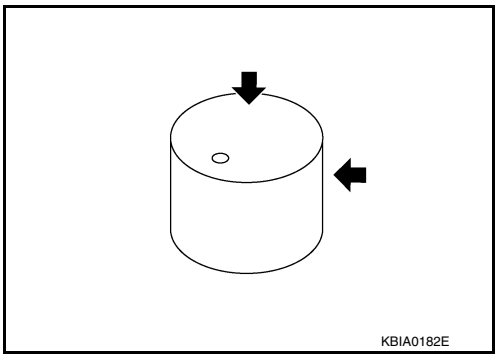
Limit : Refer to EM-152, "Camshaft".

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



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-152, "Camshaft".

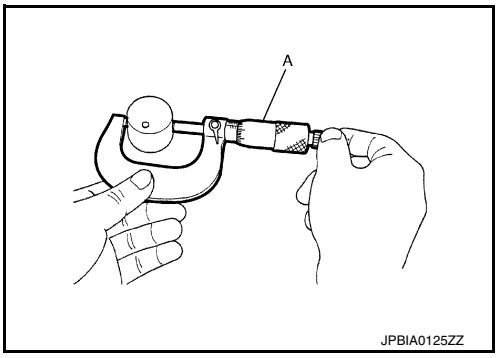


Valve Lifter Clearance (EXH)

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.

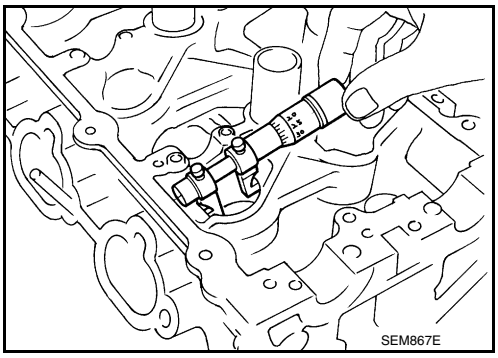
Standard : Refer to EM-152, "Camshaft".



VALVE LIFTER HOLE DIAMETER

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

Standard : Refer to EM-152, "Camshaft".



VALVE LIFTER CLEARANCE

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

Standard : Refer to EM-152, "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.

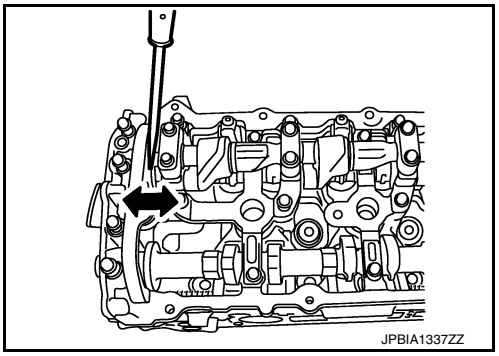
NOTE:
Cylinder head assembly cannot be replaced as a single part, because it is machined together with VVEL ladder assembly.

INSPECTION AFTER REMOVAL (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).

Standard and limit : Refer to EM-152, "Camshaft".



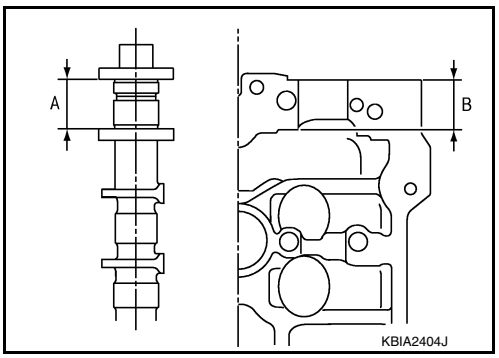
- Measure the following parts if out of the limit.

- Dimension “A” for drive shaft No. 1 journal

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

- Dimension “B” for cylinder head No. 1 journal bearing

Standard : 27.360 - 27.385 mm (1.0772 - 1.0781 in)



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

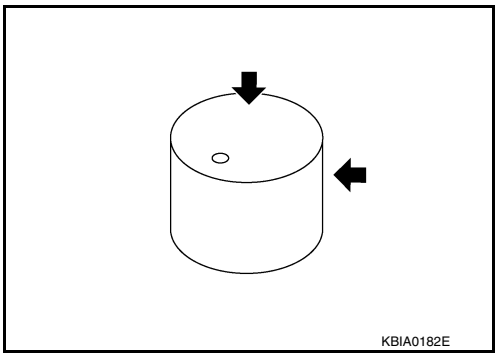
Limit : Refer to EM-152, "Camshaft".

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-152, "Camshaft".

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

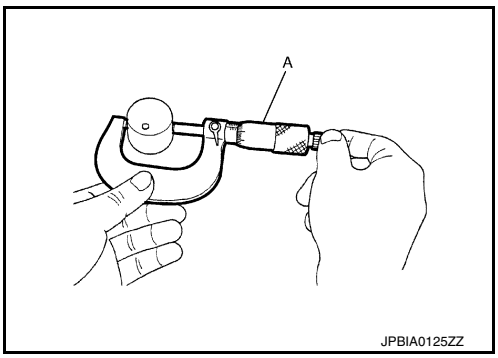


Valve Lifter Clearance (INT)

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.

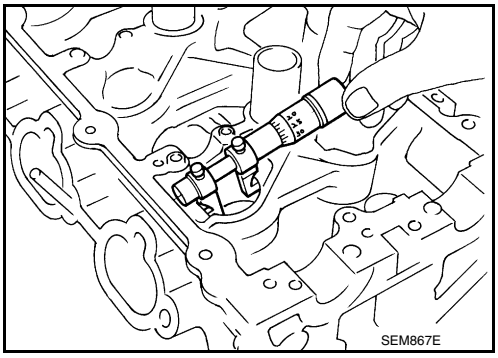
Standard : Refer to EM-152, "Camshaft".



VALVE LIFTER HOLE DIAMETER

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

Standard : Refer to EM-152, "Camshaft".



VALVE LIFTER CLEARANCE

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

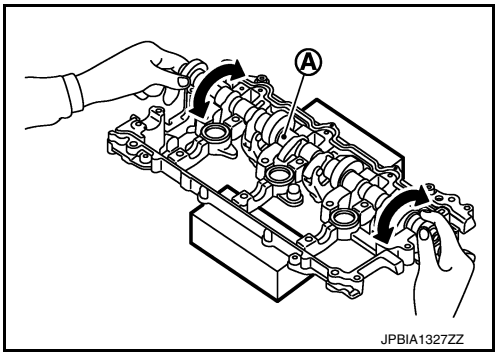
Standard : Refer to EM-152, "Camshaft".

- 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

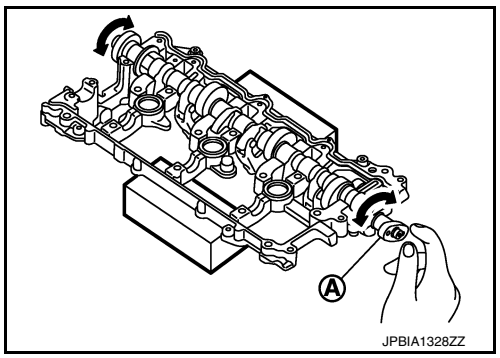
- Hold the both ends of the drive shaft (A) and rotate it to check that it rotates smoothly.
  CAUTION:
  Turn VVEL ladder assembly upside down to prevent the drive shaft from dropping off.



CONTROL SHAFT OPERATIONAL CHECK

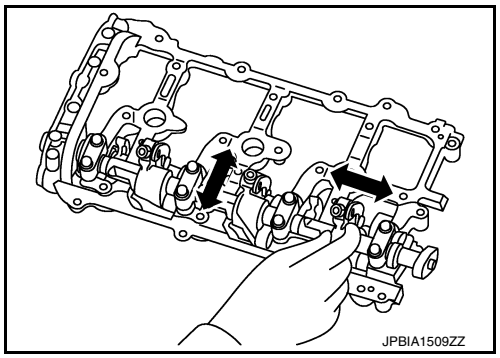
- Move control shaft (A) to the small stopper and large stopper to check that the control shaft functions smoothly.

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



LINK 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, 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 INSTALLATION

Inspection of Camshaft Sprocket (INT) Oil Groove

CAUTION:

- **Perform this inspection only when DTC P0011, P0021 are detected in self-diagnostic results of CONSULT and it is directed according to inspection procedure of EC section. Refer to EC-186, "DTC Logic".**
- **Check when engine is cold to prevent burns from the splashing engine oil.**

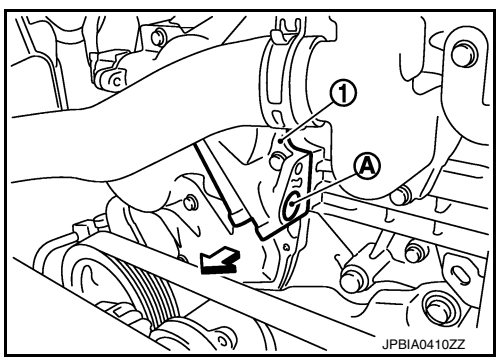
1. Check engine oil level. Refer to LU-8, "Inspection".
2. Perform the following procedure to prevent the engine from being unintentionally started while checking.

a. Release fuel pressure. Refer to EC-627, "Inspection" (For USA AND CANADA) or EC-1123, "Inspection" (For MEXICO).

b. Disconnect ignition coil and injector harness connectors. Refer to EM-40, "Exploded View".

3. Remove intake valve timing control solenoid valve. Refer to EM-54, "Exploded View".
4. Crank engine, and then check that engine oil comes out from intake valve timing control solenoid valve hole (A). End crank after checking.

1 : Intake valve timing control cover (bank 1)
⇦ : Engine front



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

CAUTION:

- **Prevent splashing by using a shop cloth 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 no to apply engine oil to rubber parts of drive belt, engine mounting insulator, etc. Wipe engine oil off immediately if it is splashed.**

5. Perform the following inspection if engine oil does not come out from intake valve timing control solenoid valve oil hole of the cylinder head.
   - Remove oil filter, and then clean it. Refer to EM-54, "Exploded View" or/and EM-98, "Exploded View".
   - Clean oil groove between oil strainer and intake valve timing control solenoid valve. Refer to LU-3, "Engine Lubrication System".
6. Remove components between intake valve timing control solenoid valve and camshaft sprocket (INT), and then check each oil groove for clogging.
   - Clean oil groove if necessary. Refer to LU-3, "Engine Lubrication System".
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-17, "FOR NORTH AMERICA : 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:

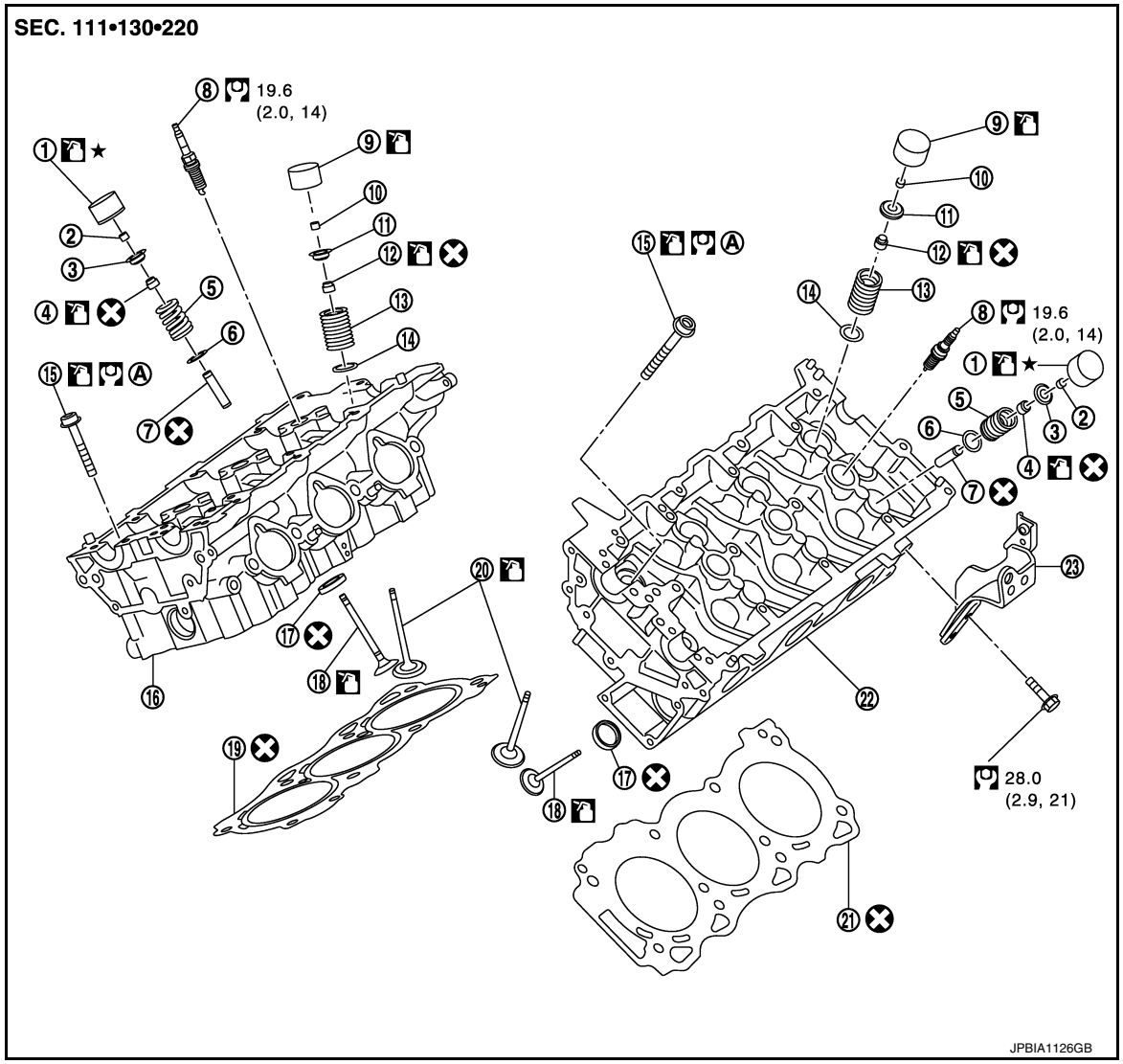
Items		Before starting engine	Engine running	After engine stopped
Engine coolant		Level	Leakage	Level
Engine oil		Level	Leakage	Level
Transmission / transaxle fluid	AT & CVT Models	Leakage	Level / Leakage	Leakage
	MT Models	Level / Leakage	Leakage	Level / Leakage
Other oils and fluids*		Level	Leakage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

*: Power steering fluid, brake fluid, etc.

CYLINDER HEAD

Exploded View

INFOID:0000000010582024



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

A. Comply with the installation procedure when tightening. Refer to EM-116

Refer to GI-4, "Components" for symbols 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.

Disassembly and Assembly

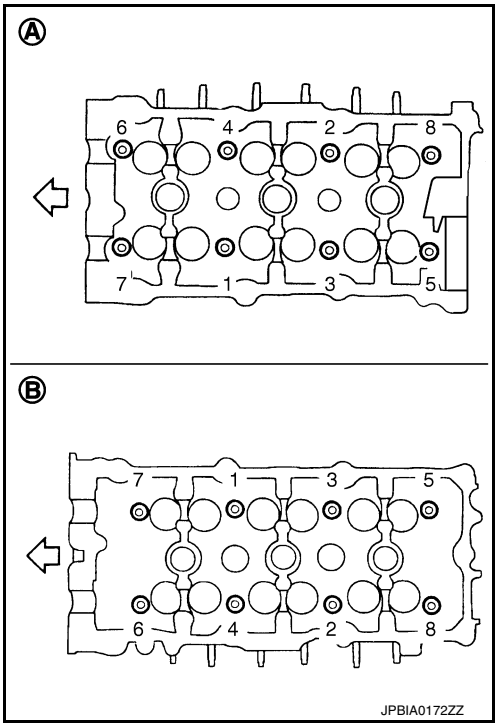
INFOID:0000000010582025

DISASSEMBLY

1. Remove the following parts:
   - Intake manifold collector: Refer to EM-31, "Exploded View".
   - Rocker cover: Refer to EM-51, "Exploded View".
   - Fuel tube and fuel injector assembly: Refer to EM-40, "Exploded View".
   - Intake manifold: Refer to EM-34, "Exploded View".
   - Exhaust manifold: Refer to EM-36, "Exploded View".
   - Water inlet and thermostat assembly: Refer to CO-25, "Exploded View".
   - Water outlet, water pipe and heater pipe: Refer to CO-27, "Exploded View".
   - Timing chain: Refer to EM-54, "Exploded View".
   - Rear timing chain case: Refer to EM-93, "Exploded View".
   - Camshaft (EXH) and VVEL ladder assembly: Refer to EM-98, "Exploded View".
2. Remove cylinder head.
   - Loosen mounting bolts in reverse order as shown in the figure.

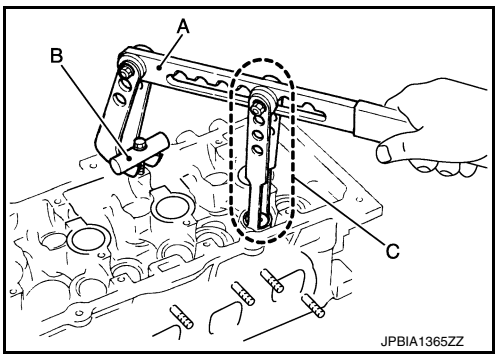
     A : Bank 1
     B : Bank 2
     ⇦ : Engine front

   - Use the cylinder head bolt wrench (commercial service tool) and power tool.

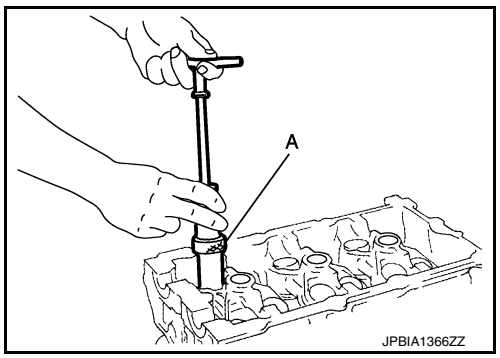


3. Remove cylinder head gaskets.
4. Remove spark plug with spark plug wrench (commercial service tool).
5. Remove valve lifter.
   - Identify installation positions, and store them without mixing them up.
6. Remove valve collet.
   - Compress valve spring with the valve spring compressor [SST: KV10116200] (A), the attachment [SST: KV10115900] (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.

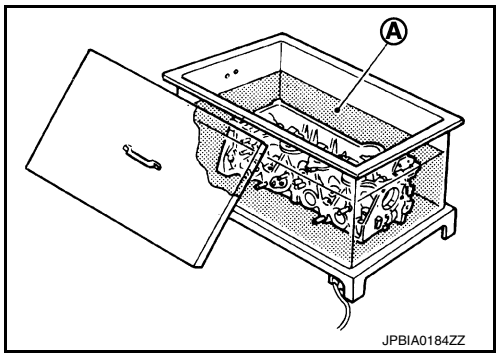


7. Remove valve spring retainer, valve spring and valve spring seat.
8. Push valve stem to combustion chamber side, and remove valve.
   • Identify installation positions, and store them without mixing them up.
9. Remove valve oil seal using the valve oil seal puller [SST: KV10107902] (A).

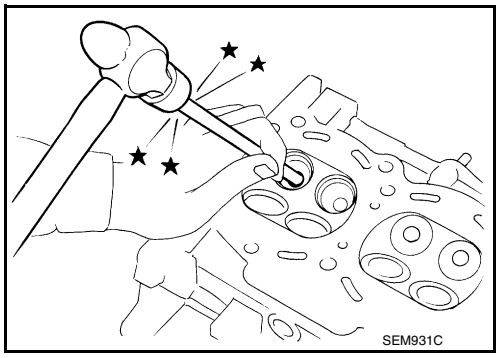


10. Remove valve seat (EXH), if valve seat (EXH) must be replaced.
    • Bore out old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in cylinder head. Set the machine depth stop to ensure this. Refer to EM-154, "Cylinder Head".
    CAUTION:
    Prevent to scratch cylinder head by excessive boring.
11. 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, 2.0 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.

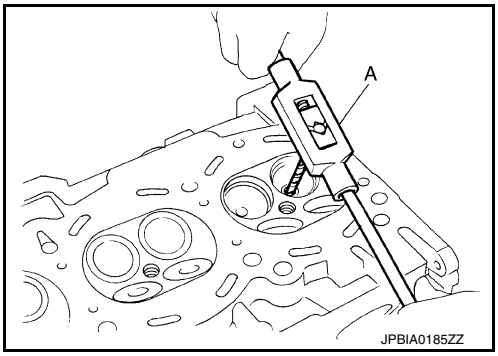


ASSEMBLY

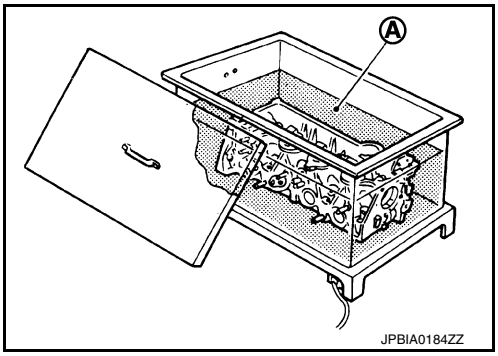
1. If valve guide (EXH) is removed in step 11 (DISASSEMBLY), install it. Replace with oversized [0.2 mm (0.008 in)] valve guide (EXH).

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-154, "Cylinder Head".



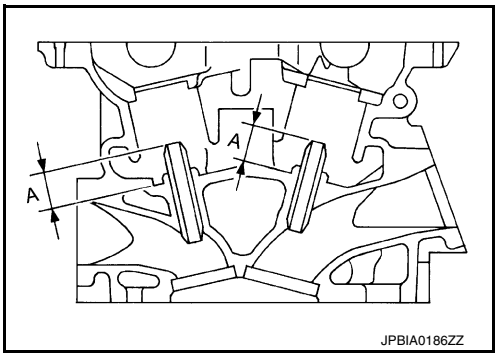
b. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil (A).



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

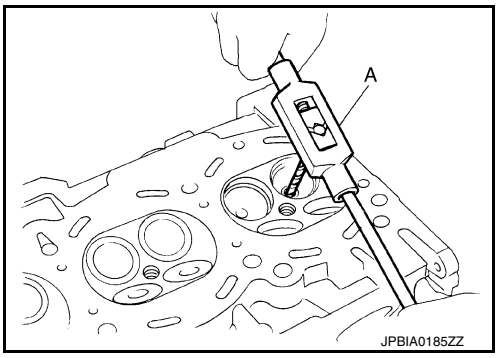
Projection (A)
: Refer to EM-154, "Cylinder Head".

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-154, "Cylinder Head".

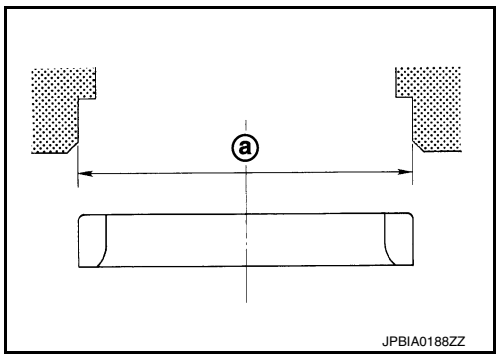


2. If valve seat (EXH) is removed in step 10 (DISASSEMBLY), install it. Replace with oversize [0.5 mm (0.020 in)] valve seat (EXH).

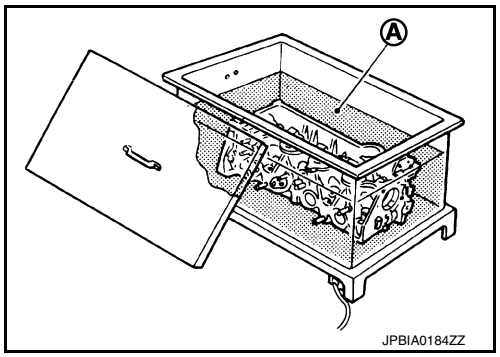
a. Ream cylinder head recess diameter (a) for service valve seat (EXH).

Oversize (service) [0.5 mm (0.020 in)]:
: Refer to EM-154, "Cylinder Head".

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



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

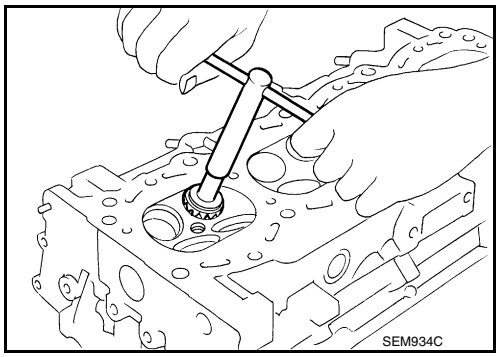


c. Provide valve seats (EXH) cooled well with dry ice. Force fit valve seat (EXH) into cylinder head.

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-154, "Cylinder Head".

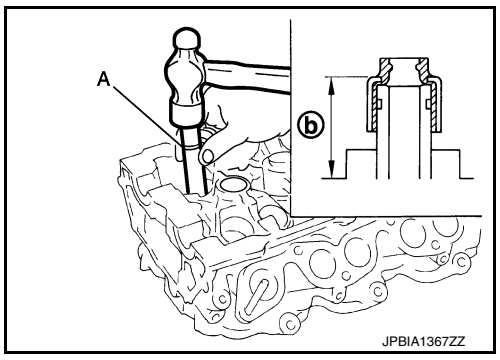
CAUTION:
When using the valve seat cutter, firmly grip cutter handle with both hands. Then, press on the contacting surface all around the circumference to cut in a single drive. Improper pressure on cutter or cutting many different times may result in staged valve seat.



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

Height (b) : 14.3 - 14.9 mm (0.563 - 0.587 in)

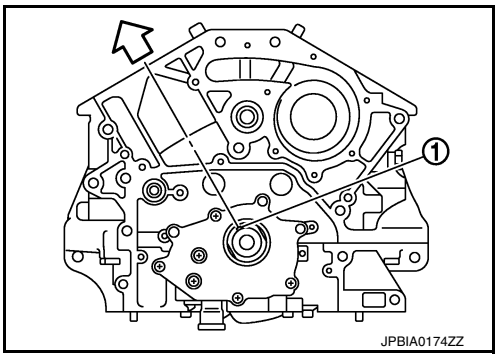
NOTE:
Dimension: Height measured before valve spring seat installation



4. Install valve spring seat.
5. Install valve.
   NOTE:
   Larger diameter valves are for intake side.
6. Install new cylinder head gaskets.
7. Turn crankshaft until No. 1 piston is set at TDC.

   1 : Crankshaft key
   ⇦ : Bank 1 side

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

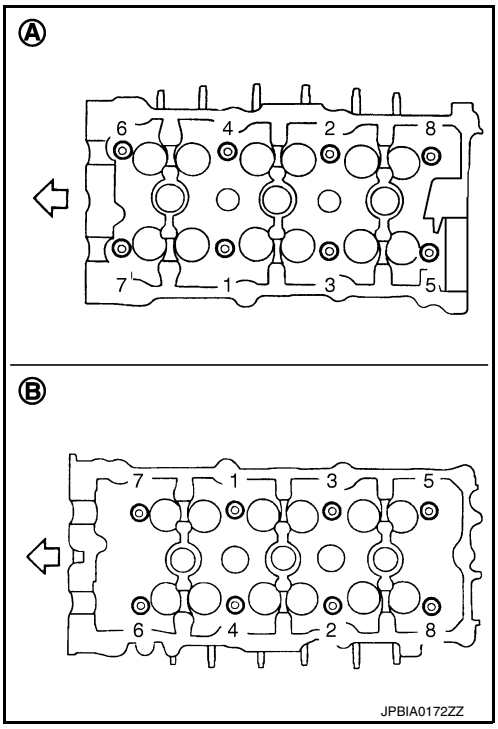


8. Install cylinder head, and tighten cylinder head bolts in numerical order as shown in figure as follows:

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

   • Use the cylinder head bolt wrench (commercial service tool) and power tool.

   CAUTION:
   - **If cylinder head bolts are reused, check their outer diameters before installation. Refer to EM-121, "Inspection".**
   - **Before installing cylinder head, inspect cylinder head distortion. Refer to EM-121, "Inspection".**



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

   : 105 N·m (11 kg-m, 77 ft-lb)

c. Completely loosen all cylinder head bolts.

   : 0 N·m (0 kg-m, 0 ft-lb)

   CAUTION:
   In step “c”, loosen bolts in the reverse order of that indicated in the figure.
d. Tighten all cylinder head bolts.

   : 40.0 N·m (4.1 kg-m, 30 ft-lb)

e. Tighten all cylinder head bolts (clockwise).

   Angle tightening: 95 degrees

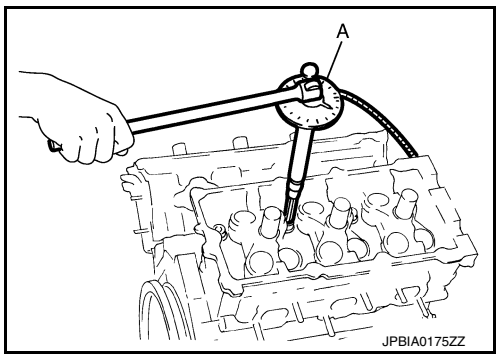
f. Tighten all cylinder head bolts (clockwise).

   Angle tightening: 95 degrees

   CAUTION:

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

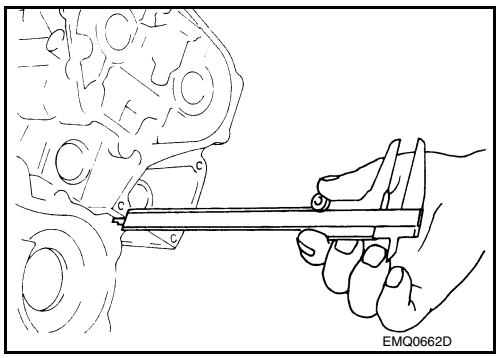
- Check tightening angle indicated on the angle wrench indicator plate.



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

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

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



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

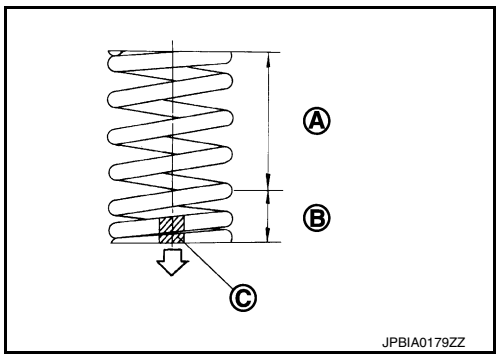
A : Wide pitch

⇦ : Cylinder head side

Paint mark color

Intake : Purple

Exhaust : Yellowish green

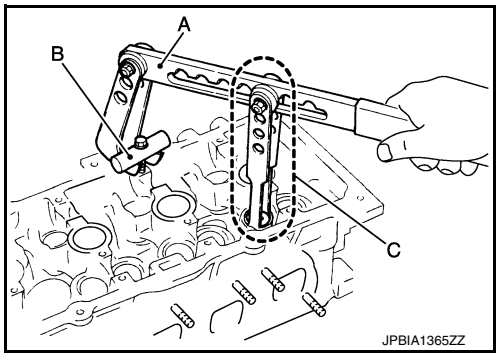


11. Install valve spring retainer.
12. Install valve collet.
    - Compress valve spring with the valve spring compressor [SST: KV10116200] (A), the attachment [SST: KV10115900] (C) and the adapter [SST: KV10109220] (B). Install valve collet with a magnet hand.

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.



13. Install valve lifter.
    - Install it in the original position.
14. Install spark plug with spark plug wrench (commercial service tool).
15. Install in the reverse order of removal after this step.

Inspection

INFOID:0000000010582026

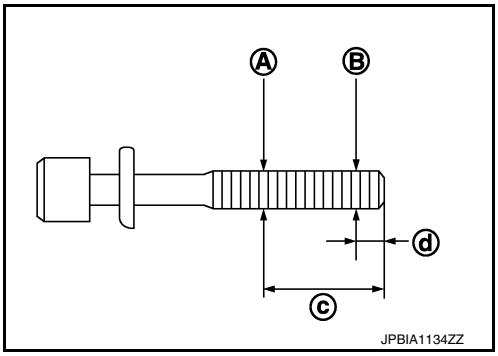
INSPECTION AFTER DISASSEMBLY

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 : 48 mm (1.89 in)
d : 11 mm (0.43 in)



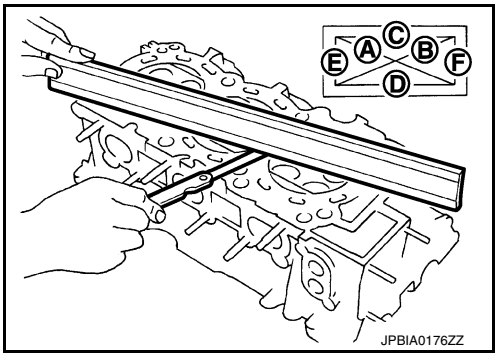
- If reduction of outer diameter appears in a position other than (A), use it as (A) point.

Cylinder Head Distortion

NOTE:
When performing this inspection, cylinder block distortion should be also checked. Refer to EM-134, "Inspection".

1. Using a scraper, wipe off oil, scale, gasket, sealant, and carbon deposits from surface of cylinder head.
   CAUTION:
   Never allow gasket fragments to enter engine oil or engine coolant passages.
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-154, "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-154, "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-98, "Exploded View". (Intake side)

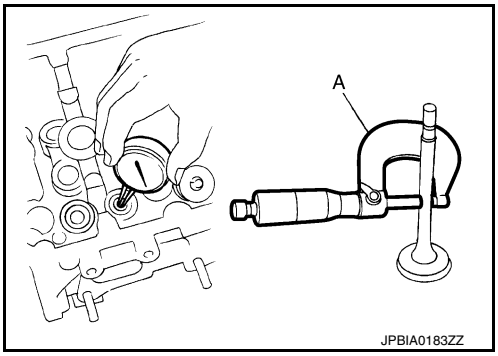
  NOTE:
  Since the valve (INT) cannot be replaced by the piece, VVEL ladder assembly & cylinder head assembly replacement are required.

Valve Guide Clearance

Valve Stem Diameter

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

Standard : Refer to EM-154, "Cylinder Head".



Valve Guide Inner Diameter

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

Standard : Refer to EM-154, "Cylinder Head".

Valve Guide Clearance

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

Standard : Refer to EM-154, "Cylinder Head".

- If the calculated value exceeds the limit.

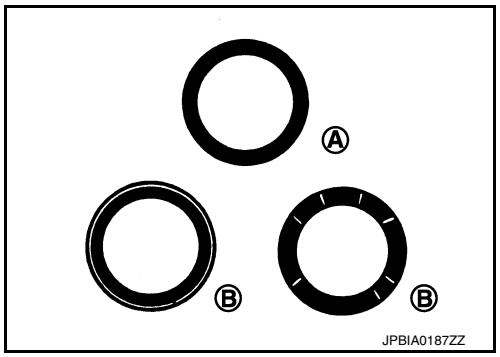
- Replace valve (EXH) and/or valve guide (EXH). Refer to EM-115, "Exploded View". (Exhaust side)
- Replace VVEL ladder assembly & cylinder head assembly. Refer to EM-98, "Exploded View". (Intake side)

  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.



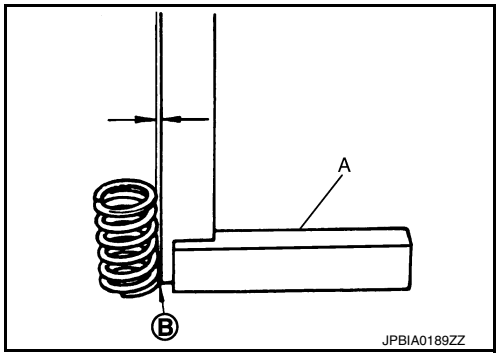
A : OK

- If not, grind to adjust valve fitting and check again. If the contacting surface still has “NG” conditions (B) even after the recheck, replace valve seat (EXH). Refer to EM-115, "Exploded View". (Exhaust side)
- If not, replace VVEL ladder assembly & cylinder head assembly. Refer to EM-98, "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 Squareness

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



B : Contact

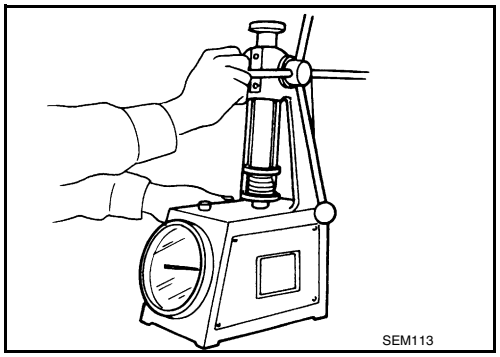
Limit : Refer to EM-154, "Cylinder Head".

- If it exceeds the limit.
- Replace valve spring (EXH). Refer to EM-115, "Exploded View". (Exhaust side)
- Replace VVEL ladder assembly & cylinder head assembly. Refer to EM-98, "Exploded View". (Intake side)

NOTE:
Since the valve spring (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 pressure at specified spring height.



Standard
: Refer to EM-154, "Cylinder Head".

- If the installation load or load with valve open is out of the standard.
- Replace valve spring (EXH). Refer to EM-115, "Exploded View". (Exhaust side)
- Replace VVEL ladder assembly & cylinder head assembly. Refer to EM-98, "Exploded View". (Intake side)

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

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-17, "FOR NORTH AMERICA : 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:

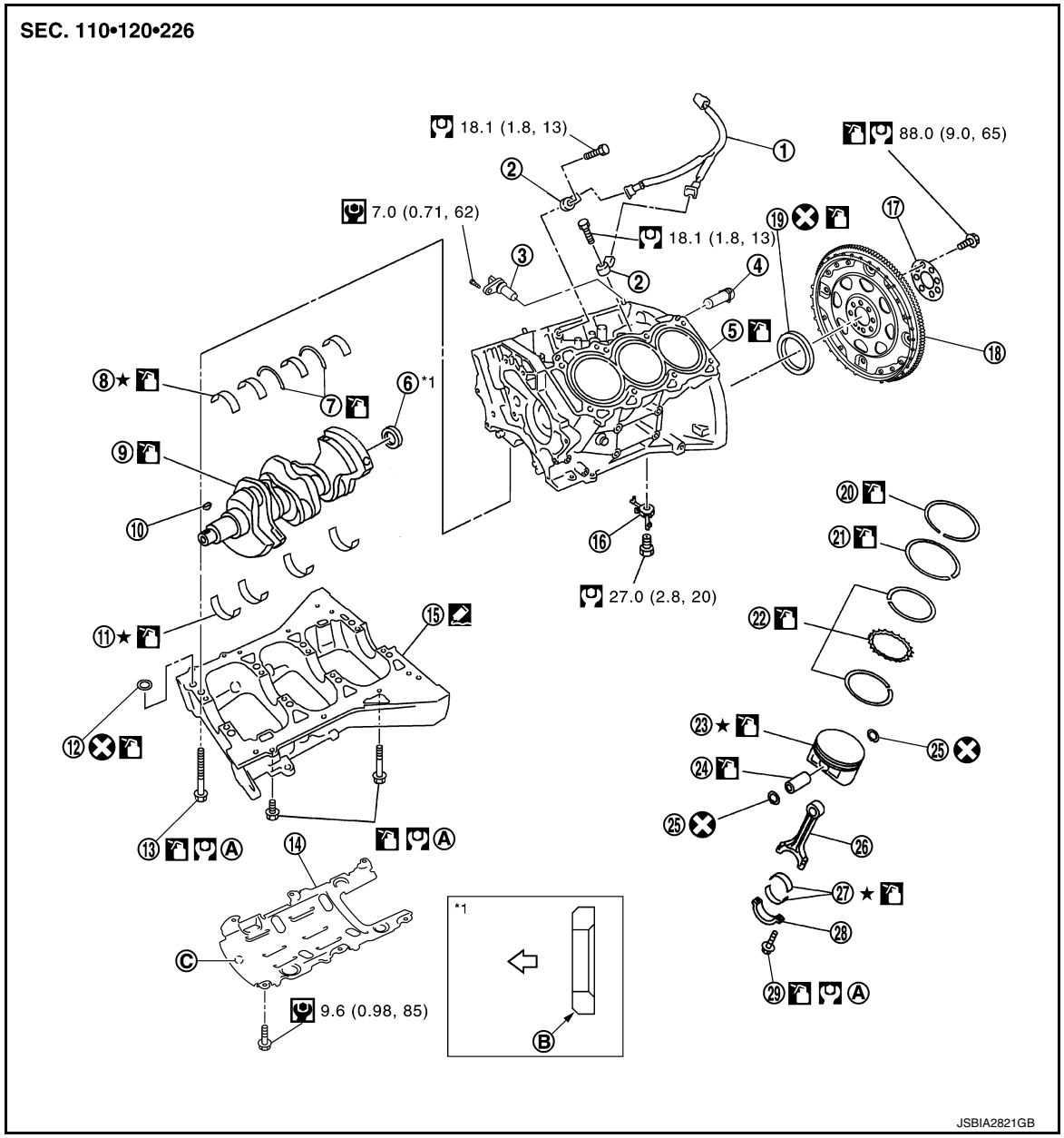
Items		Before starting engine	Engine running	After engine stopped
Engine coolant		Level	Leakage	Level
Engine oil		Level	Leakage	Level
Transmission / transaxle fluid	AT & CVT Models	Leakage	Level / Leakage	Leakage
	MT Models	Level / Leakage	Leakage	Level / Leakage
Other oils and fluids*		Level	Leakage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

*: Power steering fluid, brake fluid, etc.

CYLINDER BLOCK

Exploded View

INFOID:0000000010582027



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

A. Comply with the installation procedure when tightening. Refer to EM-126
B. Chamfered
C. Front mark

⇦ : Crankshaft side

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

Disassembly and Assembly

INFOID:0000000010582028

DISASSEMBLY

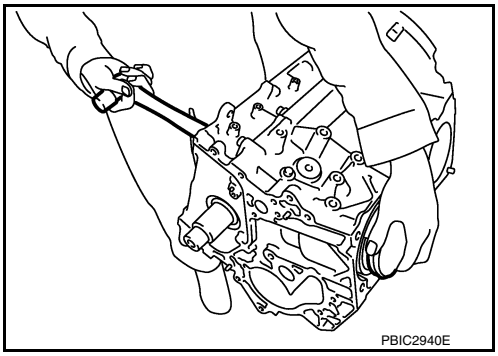
1. Remove the following parts:
   - Oil pans (lower and upper): Refer to EM-89, "AWD : Exploded View".
   - Front and rear timing chain case: Refer to EM-54, "Exploded View" and EM-93, "Exploded View".
   - Cylinder head: Refer to EM-115, "Exploded View".
2. Remove knock sensor.
   CAUTION:
   Carefully handle sensor avoiding shocks.
3. Remove baffle plate from lower cylinder block.
4. Remove piston and connecting rod assembly with the following procedure:
   - Before removing piston and connecting rod assembly, check the connecting rod side clearance. Refer to EM-134, "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.

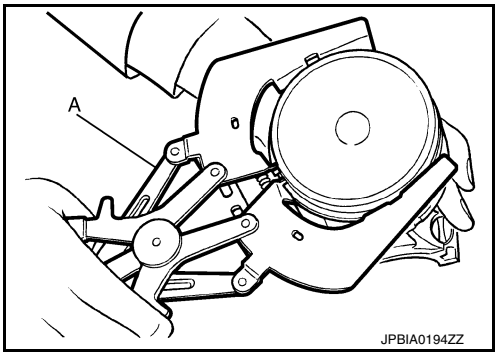
b. Remove connecting rod bearing cap.

c. Using a hammer handle or similar tool, push piston and connecting rod assembly out to the cylinder head side.
   CAUTION:
   Be careful not to damage the cylinder wall and crankshaft pin, resulting from an interference of the connecting rod big end.


PBIC2940E

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-134, "Inspection".
   - Use a piston ring expander (commercial service tool) (A).

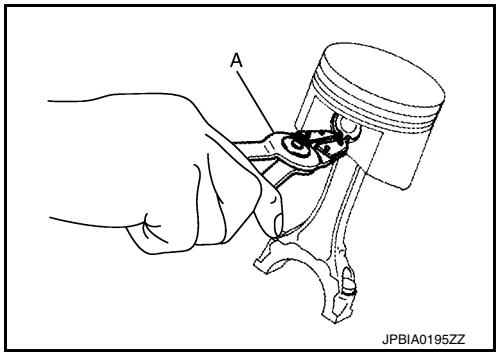
   CAUTION:
   - **When removing piston rings, be careful not to damage piston.**
   - **Be careful not to damage piston rings by expanding them excessively.**



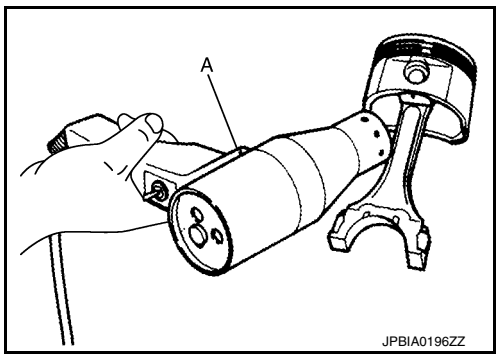
JPBIA0194ZZ

7. Remove piston from connecting rod as follows:

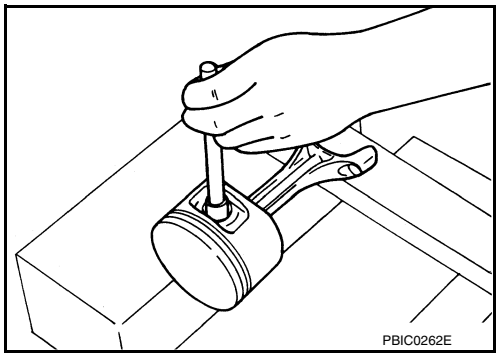
a. Using snap ring pliers (A), remove snap rings.



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

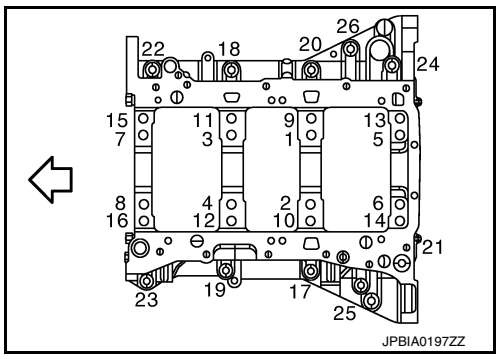


c. Push out piston pin using a stick than has an outer diameter of approximately 20 mm (0.79 in).



8. Remove lower cylinder block bolts.
NOTE:
Use TORX socket for bolts No. 1 to 16.
- Before loosening lower cylinder block bolts, measure the crankshaft end play. Refer to EM-134, "Inspection".
- Loosen lower cylinder block bolts in the reverse order shown in the figure in several different steps.

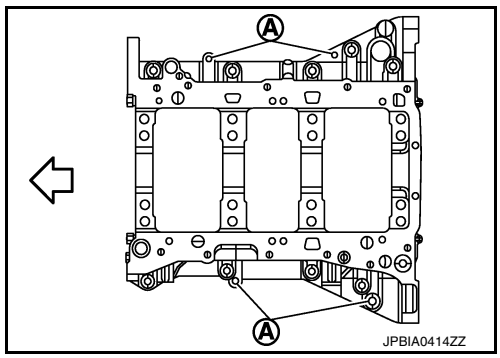
⇦ : Engine front



9. Remove lower cylinder block as follows:

- Screw M8 bolt [pitch: 1.25 mm (0.049 in) length: approximately 50 mm (1.97 in)] into bolt holes (A). Then equally tighten each bolt, and remove lower cylinder block.

⇦ : Engine front



CAUTION:
- **Be careful not to damage the mounting surfaces.**
- **Never tighten bolts excessively.**
- **Never insert screwdriver, this will damage the mating surface.**

10. Remove crankshaft.
11. Pull rear oil seal out from rear end of crankshaft.
12. Remove main bearings and thrust bearings from cylinder block and lower cylinder block.
    CAUTION:
    - **Be careful not to drop main bearing, and to scratch the surface.**
    - **Identify installation positions, and store them without mixing them up.**
13. Remove oil jet.

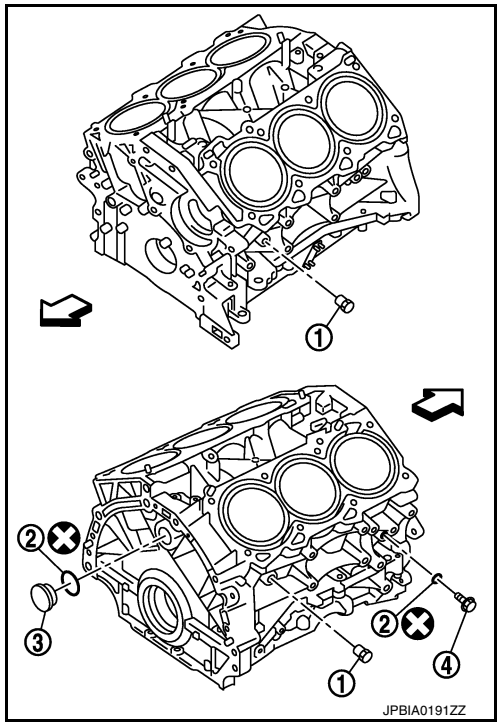
ASSEMBLY

CAUTION:
Do not reuse O-rings or washers.

1. Fully air-blow engine coolant and engine oil passages in cylinder block, cylinder bore and crankcase to remove any foreign material.
   CAUTION:
   Use goggles to protect your eyes.
2. Install each plug to cylinder block as shown in the figure.

3 : Plug

⇦ : Engine front



- Apply sealant to the thread of water drain plug (1).
  Use Genuine Liquid Gasket or equivalent.
- Apply sealant to the thread of plug (4).
  Use high strength thread locking sealant or equivalent.
- Replace washers (2) with new ones.
  CAUTION:
  Do not reuse washers.

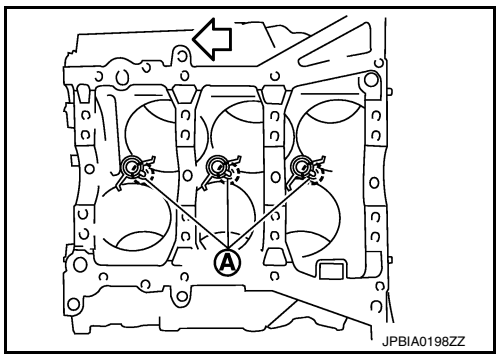
- Tighten each plug as specified below.

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

3. Install oil jet.

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

⇦ : Engine front



4. Install main bearings and thrust bearings as follows:

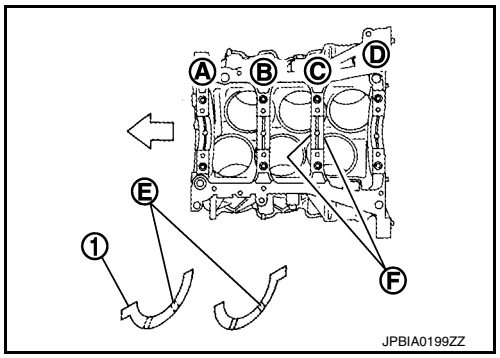
CAUTION:

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

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

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

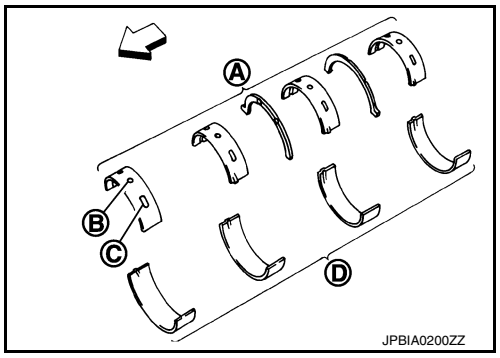
A : No. 1
B : No. 2
C : No. 3
D : No. 4
F : Thrust bearing installation position
⇦ : Engine front



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

c. Install main bearings paying attention to the direction.

A : Cylinder block side
D : Lower cylinder block side
⇦ : Engine front



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

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

CAUTION:

Do not reuse O-ring.

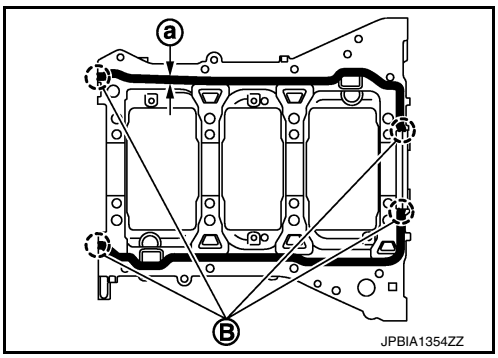
NOTE:

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

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

B : Apply to end
a : ϕ4.0 - 5.0 mm (0.157 - 0.197 in)

Use Genuine Liquid Gasket or equivalent.



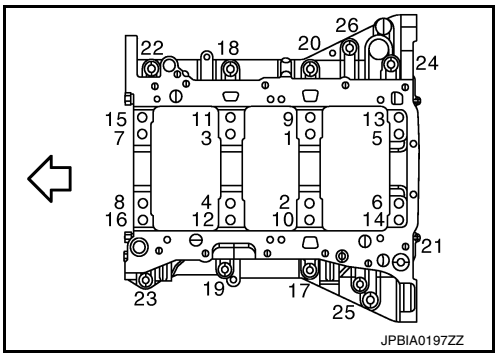
7. Inspect the outer diameter of lower cylinder block bolt. Refer to EM-134, "Inspection".
8. Install lower cylinder block bolts in numerical order as shown in the figure as follows:

a. Apply new engine oil to threads and seat surfaces of lower cylinder block bolts.

b. Tighten lower cylinder block bolts (No. 17 to 26) in numerical order as shown in the figure.

⇦ : Engine front

: 25.0 N·m (2.6 kg-m, 18 ft-lb)



c. Repeat step b.

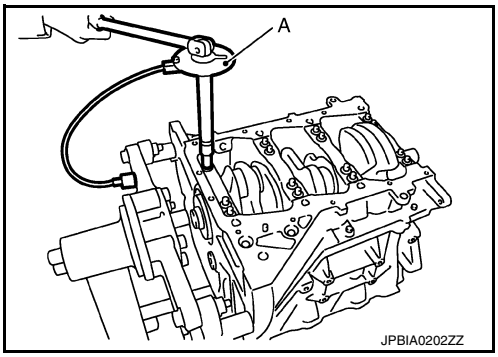
d. Tighten lower cylinder block bolt (No. 1 to 16) in numerical order as shown in the figure.
NOTE:
Use TORX socket for bolts No. 1 to 16.

: 35.3 N·m (3.6 kg-m, 26 ft-lb)

e. Tighten lower cylinder block bolt (No. 1 to 16) (clockwise).

Angle tightening: 90 degrees

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



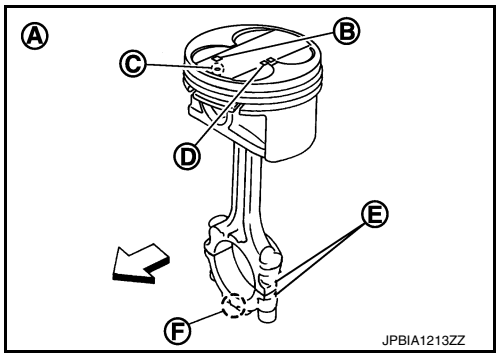
- After installing lower cylinder block bolts, check that crankshaft can be rotated smoothly by hand.
- Check the crankshaft end play. Refer to EM-134, "Inspection".

9. Install piston to connecting rod as follows:

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

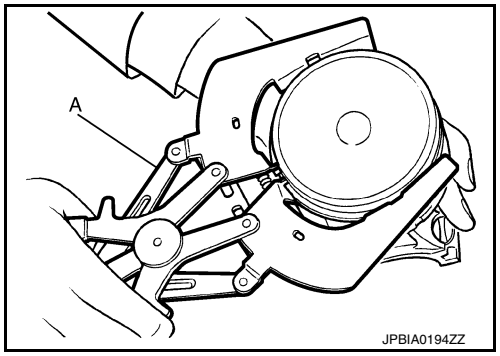


A : Example RH
B : Piston grade number
C : Front mark
D : Pin grade number
E : Cylinder number
F : Front mark
⇦ : Engine front

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

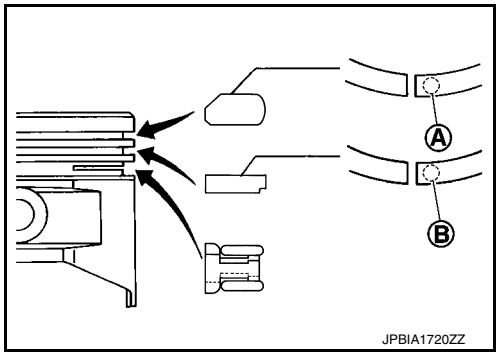
10. Using a piston ring expander (commercial service tool) (A), install piston rings.

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

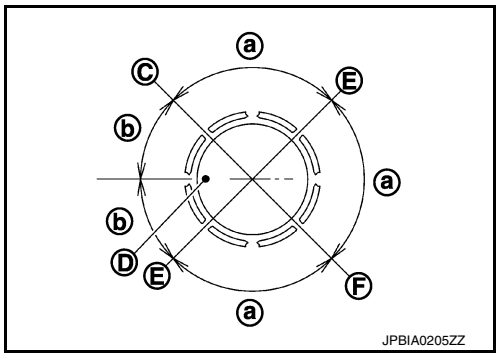


- If there is stamped mark on ring, mount it with marked side up.

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



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



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

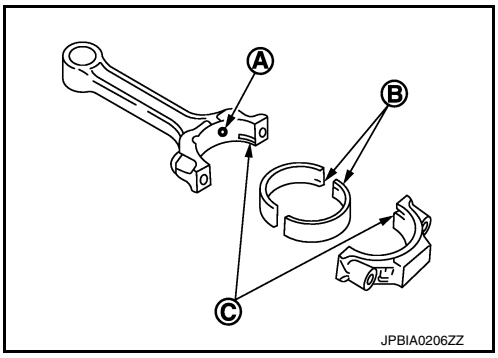
- Check the piston ring side clearance. Refer to EM-134, "Inspection".

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

CAUTION:

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

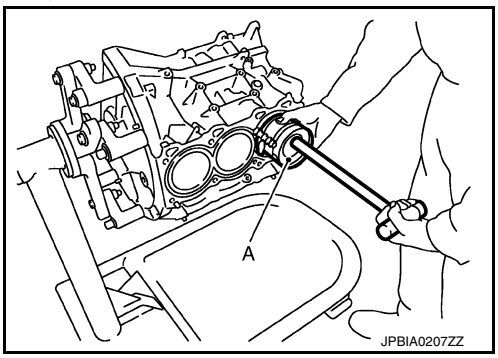
- Before installing connecting rod bearings, apply engine oil to the bearing surface (inside). Do not apply engine oil to the back surface, but thoroughly clean it.
- When installing, align connecting rod bearing stopper protrusion (B) with cutout (C) of connecting rods and connecting rod bearing caps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



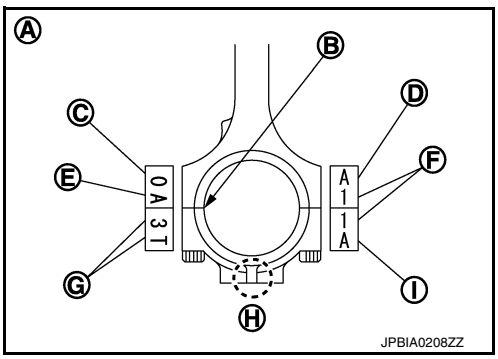
12. Install piston and connecting rod assembly to crankshaft.
    - Position crankshaft pin corresponding to connecting rod to be installed onto the bottom dead center.
    - Apply engine oil sufficiently to the cylinder bore, piston and crankshaft pin journal.
    - Match the cylinder position with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

    CAUTION:

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



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



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

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

14. Tighten connecting rod bolt as follows:

a. Inspect the outer diameter of connecting rod bolt. Refer to EM-134, "Inspection".

b. Apply engine oil to the threads and seats of connecting rod bolts.

c. Tighten connecting rod bolts.

: 28.4 N·m (2.9 kg-m, 21 ft-lb)

d. Completely loosen connecting rod bolts.

: 0 N·m (0 kg-m, 0 ft-lb)

e. Tighten connecting rod bolts.

: 24.5 N·m (2.5 kg-m, 18 ft-lb)

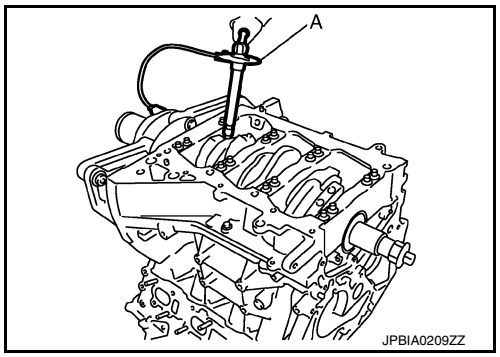
f. Then tighten connecting rod bolts (clockwise).

Angle tightening: 90 degrees

CAUTION:

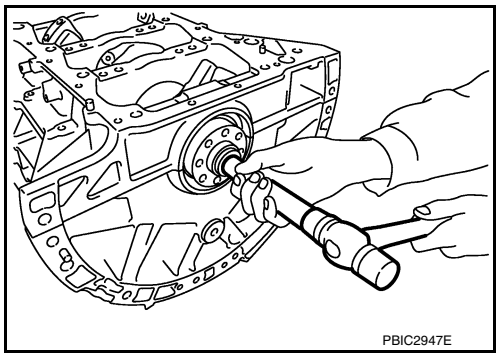
Always use the angle wrench [SST: KV10112100] (A). Never make judgment by visual inspection.

- After tightening connecting rod bolts, check that crankshaft rotates smoothly.
- Check the connecting rod side clearance. Refer to EM-134, "Inspection".



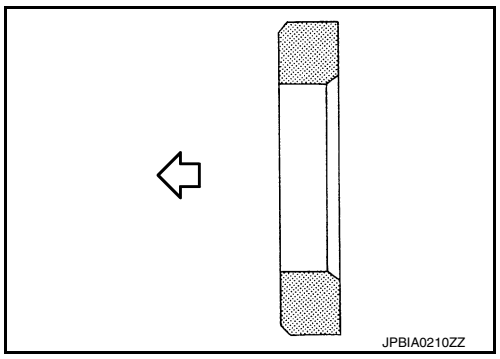
15. Install baffle plate.
16. Install new rear oil seal. Refer to EM-71, "REAR OIL SEAL : Removal and Installation".
    - Apply new engine oil to both oil seal lip and dust seal lip.
17. Install pilot converter.
    - With a drift of the following outer diameter, press-fit as far as it will go.

Pilot converter : Approximately 33 mm (1.30 in)

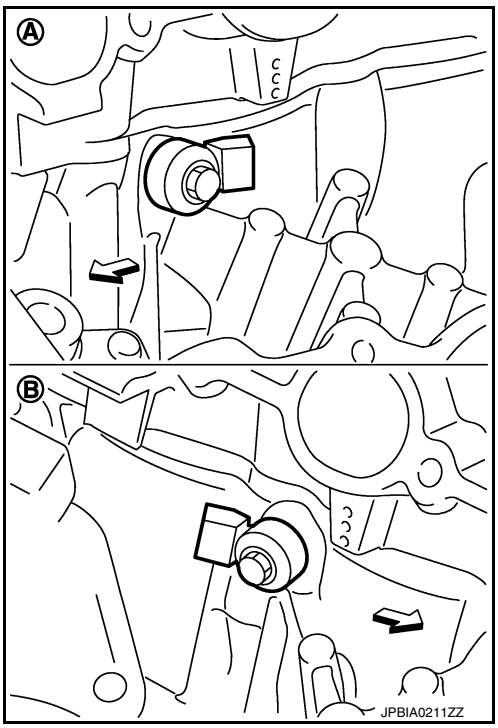


- Press-fit pilot converter with its chamfer facing crankshaft as shown in the figure.

⇦ : Crankshaft side



18. Install knock sensors.



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

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

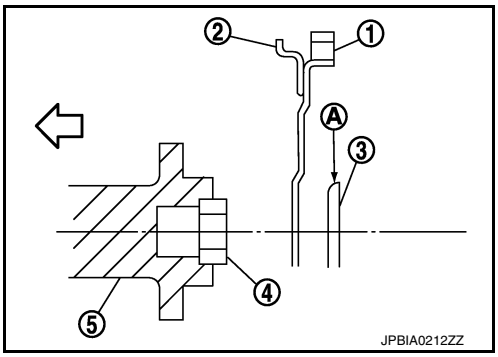
CAUTION:
- **Never tighten mounting bolts while holding connector.**
- **If any impact by dropping is applied to knock sensor, replace it with new one.**

NOTE:
- Check that there is no foreign material on the cylinder block mating surface and the back surface of knock sensor.
- Check that knock sensor does not interfere with other parts.

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

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

CAUTION:
If these are not aligned correctly, engine runs roughly and "MI" illuminates.
- Install drive plate (2) and reinforcement plate (3) as shown in the figure.



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

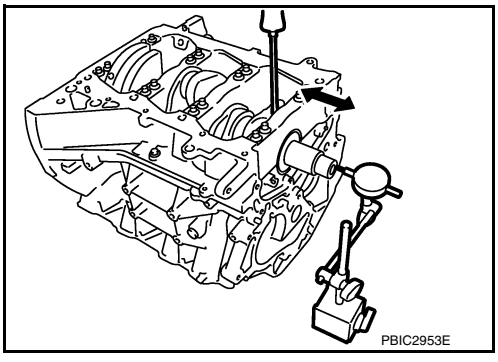
- Holding ring gear with the ring gear stopper [SST: KV10118600].
- Tighten the mounting bolts crosswise over several times.

Inspection

INFOID:0000000010582029

CRANKSHAFT END PLAY

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



Standard and limit : Refer to EM-156, "Cylinder Block".

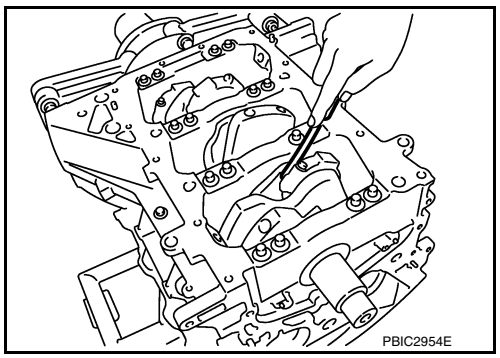
- If the measured value exceeds the limit, replace thrust bearings, and measure again. If it still exceeds the limit, replace crankshaft also.

CONNECTING ROD SIDE CLEARANCE

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

Standard and limit : Refer to EM-156, "Cylinder Block".

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

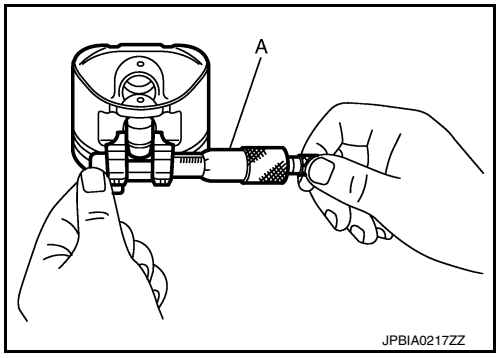


PISTON TO PISTON PIN OIL CLEARANCE

Piston Pin Hole Diameter

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

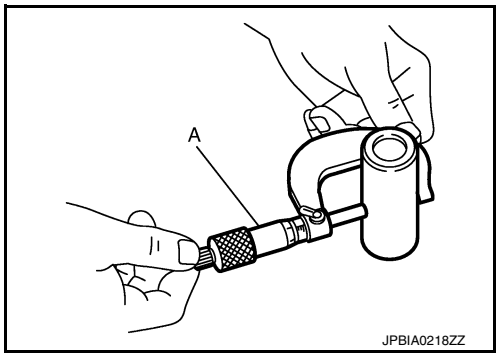
Standard : Refer to EM-156, "Cylinder Block".



Piston Pin Outer Diameter

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

Standard : Refer to EM-156, "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-156, "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-144, "Description".

NOTE:

- Piston is available together with piston pin as assembly.
- Piston pin (piston pin hole) grade is provided only for the parts installed at the plant. For service parts, no piston pin grades can be selected. (Only “0” grade is available.)

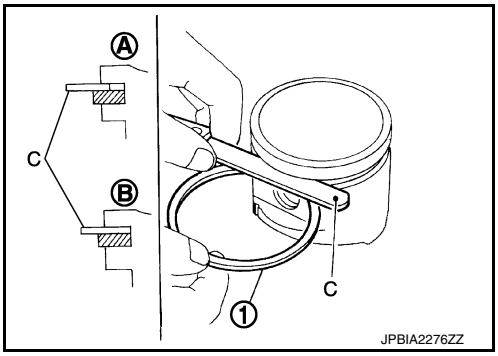
PISTON RING SIDE CLEARANCE

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

A : NG
B : OK

Standard and limit : Refer to EM-156, "Cylinder Block".

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



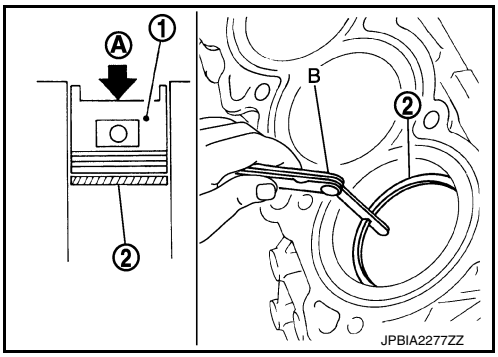
PISTON RING END GAP

- Check that the cylinder bore inner diameter is within the specification. Refer to “PISTON TO CYLINDER BORE CLEARANCE”.
- 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-156, "Cylinder Block".

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



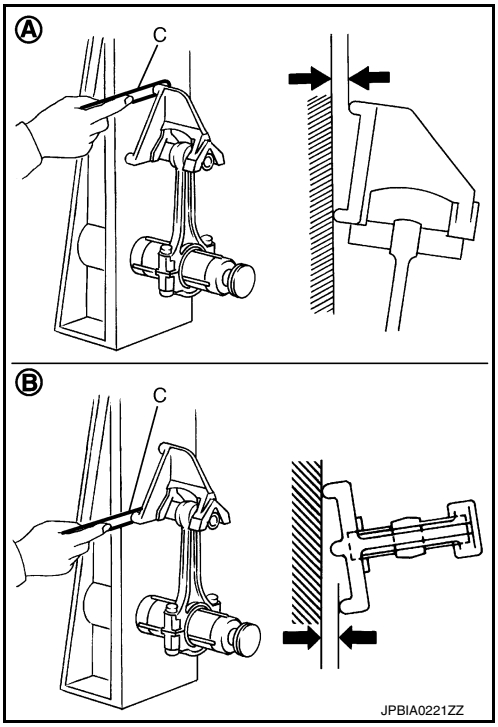
CONNECTING ROD BEND AND TORSION

- Check with a connecting rod aligner.

A : Bend
B : Torsion
C : Feeler gauge

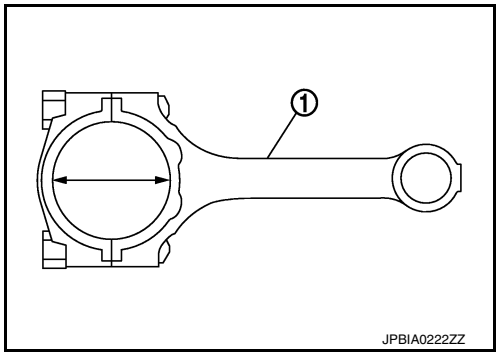
Bend limit
Torsion limit **: Refer to EM-156, "Cylinder Block".**

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



CONNECTING ROD BIG END DIAMETER

- Install connecting rod bearing cap without installing connecting rod bearing, and tighten connecting rod bolts to the specified torque. Refer to EM-126, "Disassembly and Assembly" for the tightening procedure.



1 : Connecting rod

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

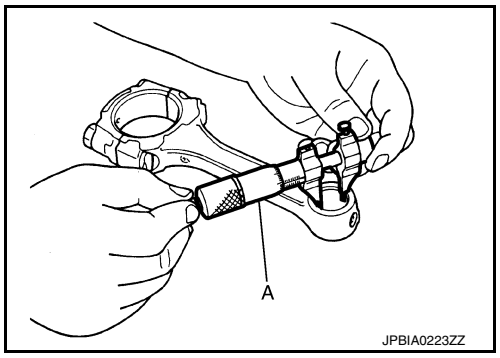
Standard : Refer to EM-156, "Cylinder Block".

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

CONNECTING ROD BUSHING OIL CLEARANCE

Connecting Rod Bushing Inner Diameter

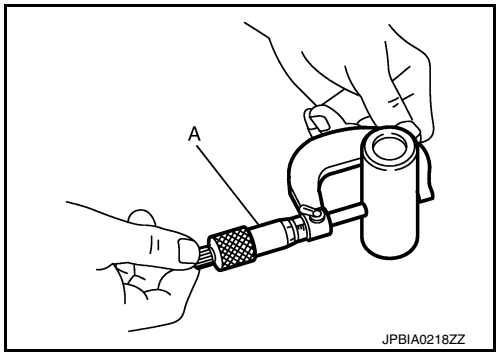
Measure the inner diameter of connecting rod bushing with an inside micrometer (A).



Standard : Refer to EM-156, "Cylinder Block".

Piston Pin Outer Diameter

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



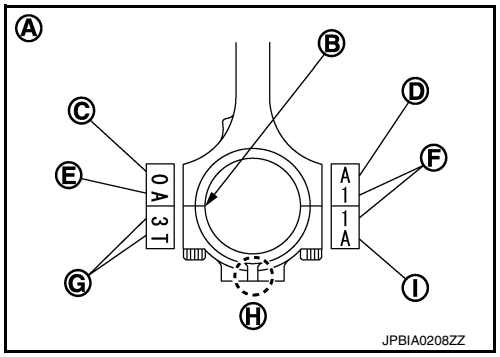
Standard : Refer to EM-156, "Cylinder Block".

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-156, "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-144, "Description".
- If replacing connecting rod assembly, refer to EM-145, "Connecting Rod Bearing" to select the connecting rod bearing.

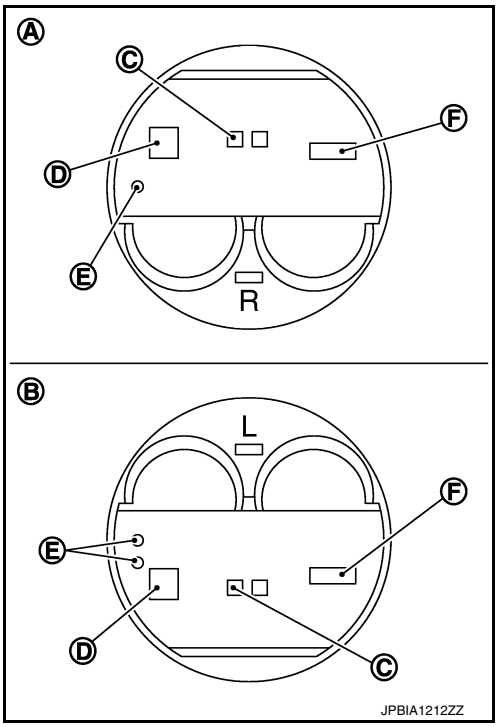


A : Sample codes
B : Bearing stopper groove
C : Small-end diameter grade
D : Big-end diameter grade
E : Weight grade
F : Cylinder No.
G : Management code

H : Front mark
I : Management code

Factory installed parts grading:
• Service parts apply only to grade “0”.

A : RH
B : LH
C : Piston pin grade number
D : Piston grade number
E : Front mark
F : Identification code



Unit: mm (in)

Grade	0	1
Connecting rod bushing inner diameter *	22.000 - 22.006 (0.8661 - 0.8664)	22.006 - 22.012 (0.8664 - 0.8666)
Piston pin hole diameter	21.993 - 21.999 (0.8659 - 0.8661)	21.999 - 22. 005 (0.8661 - 0.8663)
Piston pin outer diameter	21.989 - 21.995 (0.8657 - 0.8659)	21.995 - 22.001 (0.8659 - 0.8662)

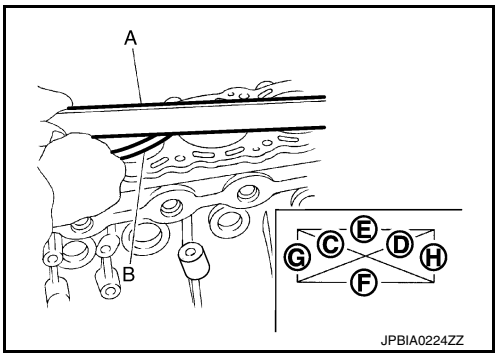
*: After installing in connecting rod

CYLINDER BLOCK DISTORTION

• Using a scraper, remove gasket on the cylinder block surface, and also remove engine oil, scale, carbon, or other contamination.
CAUTION:
Be careful not to allow gasket flakes to enter engine oil or engine coolant passages.
• Measure the distortion on the cylinder block upper face at some different points in six directions (C), (D), (E), (F), (G), and (H) with a straightedge (A) and a feeler gauge (B).

Limit : Refer to EM-156, "Cylinder Block".

• If it exceeds the limit, replace cylinder block.

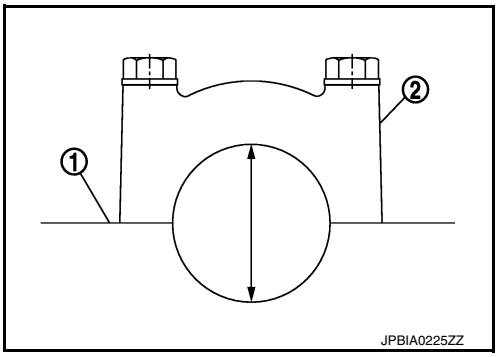


MAIN BEARING HOUSING INNER DIAMETER

• Install lower cylinder block (2) without installing main bearings, and tighten lower cylinder block bolts to the specified torque. Refer to EM-126, "Disassembly and Assembly" for the tightening procedure.
• Measure the inner diameter of main bearing housing with a bore gauge.

Standard : Refer to EM-156, "Cylinder Block".

• If out of the standard, replace cylinder block (1) and lower cylinder block as assembly.
NOTE:
Cylinder block cannot be replaced as a single part, because it is machined together with lower cylinder block.



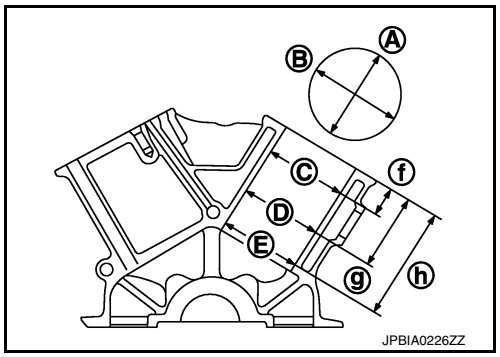
PISTON TO CYLINDER BORE CLEARANCE

Cylinder Bore inner Diameter

- Using a bore gauge, measure cylinder bore for wear, out-of-round and taper at six different points on each cylinder. [(A) and (B) directions at (C), (D), and (E)] is in longitudinal direction of engine.

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

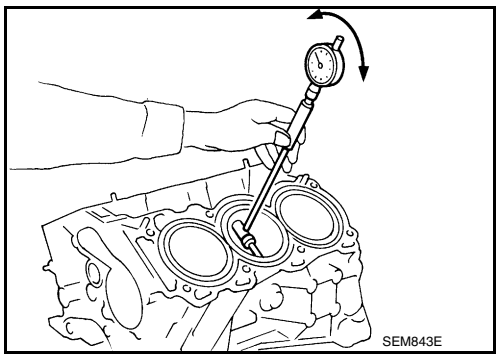
Standard and limit : Refer to EM-156, "Cylinder Block".



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

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

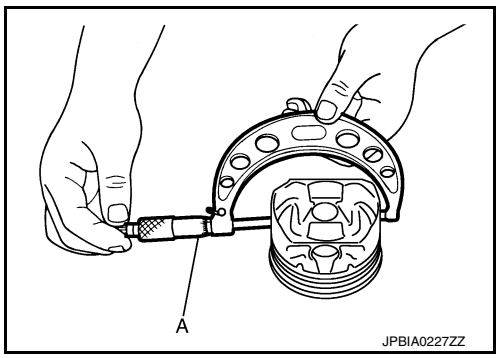
Oversize (O/S) : 0.2 mm (0.008 in)



Piston Skirt Diameter

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

Measure point : Refer to EM-156, "Cylinder Block".
Standard

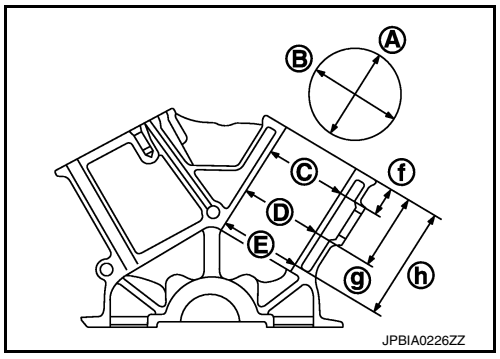


Piston-to-Cylinder Bore Clearance

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

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

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



Standard and limit : Refer to EM-156, "Cylinder Block".

- If the calculated value exceeds the limit, replace piston and piston pin assembly. Refer to EM-156, "Cylinder Block".

Reboring Cylinder Bore

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

Rebored size calculation: D = A + B – C

where,

A: Piston skirt diameter as measured

B: Piston to cylinder bore clearance (standard value)

C: Honing allowance 0.02 mm (0.0008 in)

D: Bored diameter

2. Install lower cylinder block, and tighten to the specified torque. Otherwise, cylinder bores may be distorted in final assembly.
3. Cut cylinder bores.
   NOTE:
   • When any cylinder needs boring, all other cylinders must also be bored.
   • Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.
4. Hone cylinders to obtain the specified piston to cylinder bore clearance.
5. Measure finished cylinder bore for the out-of-round and taper.
   NOTE:
   Perform measurement after cylinder bore cools down.

CRANKSHAFT MAIN JOURNAL DIAMETER

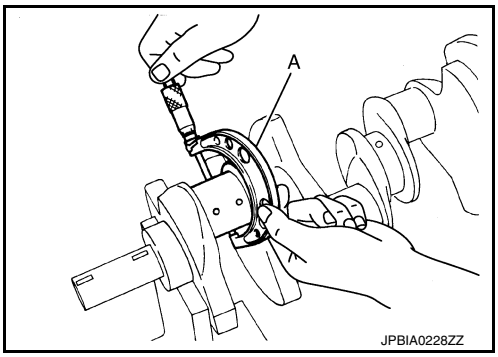
• Measure the outer diameter of crankshaft main journals with a micrometer.

Standard : Refer to EM-156, "Cylinder Block".

• If out of the standard, measure the main bearing oil clearance. Then use undersize bearing. Refer to EM-148, "Main Bearing".

CRANKSHAFT PIN JOURNAL DIAMETER

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

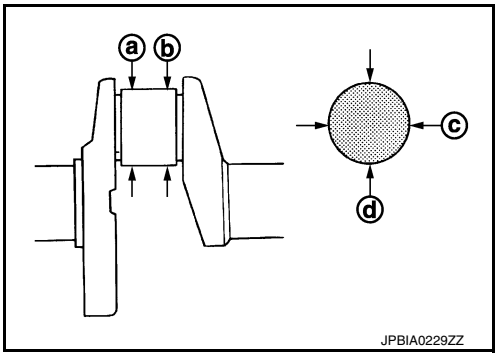


Standard : Refer to EM-156, "Cylinder Block".

• If out of the standard, measure the connecting rod bearing oil clearance. Then use undersize bearing. Refer to EM-145, "Connecting Rod Bearing".

CRANKSHAFT OUT-OF-ROUND AND TAPER

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



Limit : Refer to EM-156, "Cylinder Block".

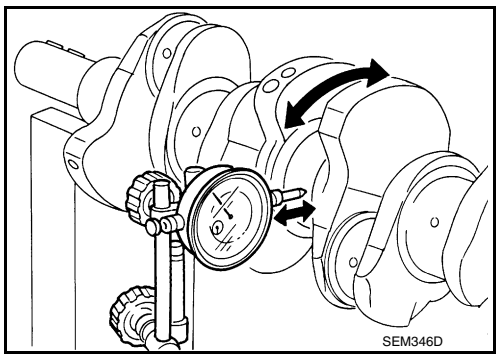
• If the measured value exceeds the limit, correct or replace crankshaft.
• If corrected, measure the bearing oil clearance of the corrected main journal and/or pin journal. Then select the main bearing and/or connecting rod bearing. Refer to EM-148, "Main Bearing" and/or EM-145, "Connecting Rod Bearing".

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-156, "Cylinder Block".

- If it exceeds the limit, replace crankshaft.


SEM346D

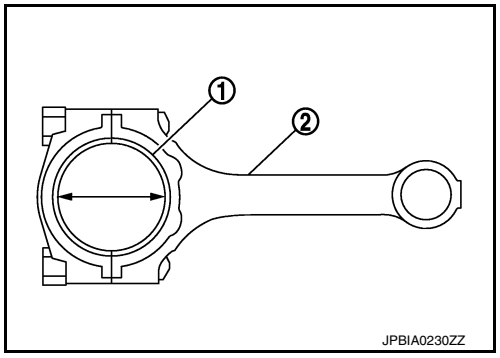
CONNECTING ROD BEARING OIL CLEARANCE

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-126, "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-161, "Connecting Rod Bearing".



JPBIA0230ZZ

- 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-144, "Description".

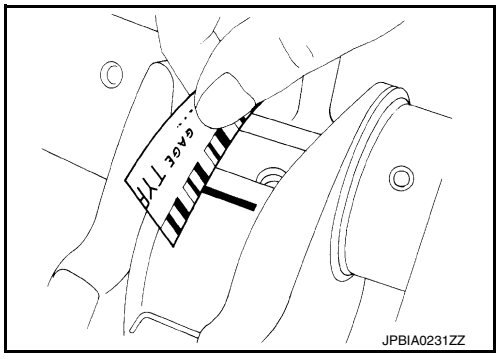
Method of Using Plastigage

- 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-126, "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”.

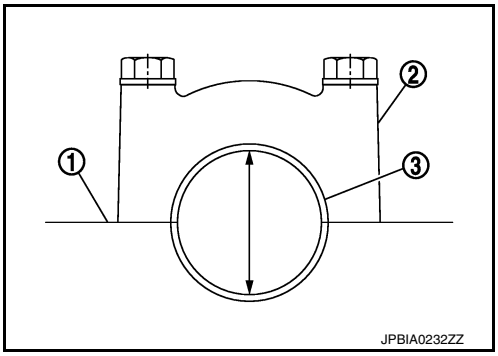

JPBIA0231ZZ

MAIN BEARING OIL CLEARANCE

Method by Calculation

- Install main bearings (3) to cylinder block (1) and lower cylinder block (2), and tighten lower cylinder block bolts to the specified torque. Refer to EM-126, "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-160, "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-144, "Description".

Method of Using Plastigage

- Remove engine oil and dust on crankshaft journal and the surfaces of each bearing completely.
- Cut a plastigage slightly shorter than the bearing width, and place it in crankshaft axial direction, avoiding oil holes.
- Install main bearing to cylinder block and lower cylinder block, and tighten lower cylinder block bolts with lower cylinder block to the specified torque. Refer to EM-126, "Disassembly and Assembly" for the tightening procedure.

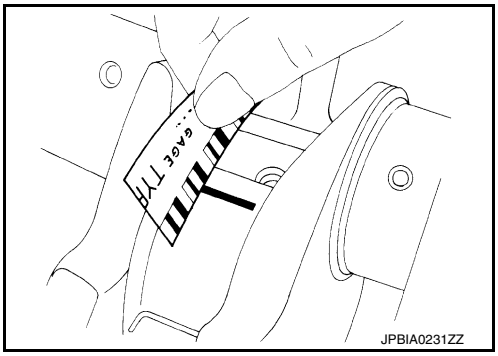
CAUTION:

Never rotate crankshaft.

- Remove lower cylinder block and bearings, and using the scale on the plastigage bag, measure the plastigage width.

NOTE:

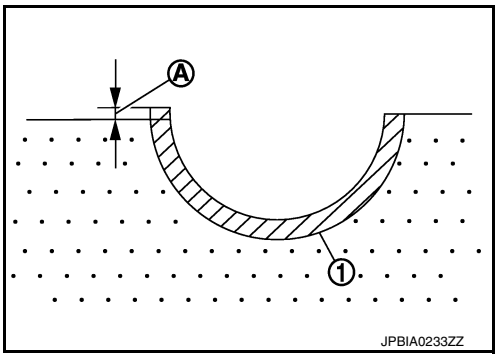
The procedure when the measured value exceeds the limit is the same as that described in the “Method by Calculation”.



MAIN BEARING CRUSH HEIGHT

- When lower cylinder block is removed after being tightened to the specified torque with main bearings (1) installed, the tip end of bearing must protrude. Refer to EM-126, "Disassembly and Assembly" for the tightening procedure.

A : Crush height



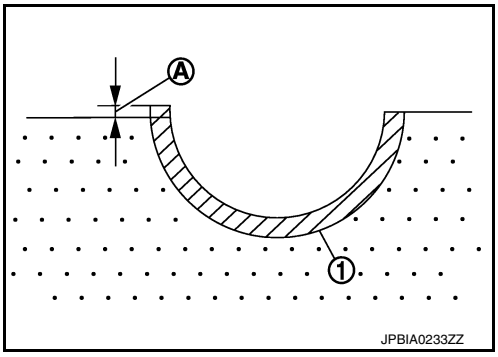
Standard : There must be crush height.

- If the standard is not met, replace main bearings.

CONNECTING ROD BEARING CRUSH HEIGHT

- When connecting rod bearing cap is removed after being tightened to the specified torque with connecting rod bearings (1) installed, the tip end of bearing must protrude. Refer to EM-126, "Disassembly and Assembly" for the tightening procedure.

A : Crush height



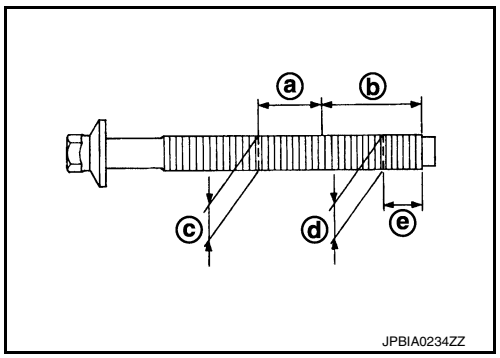
Standard : There must be crush height.

- If the standard is not met, replace connecting rod bearings.

LOWER CYLINDER BLOCK BOLT OUTER DIAMETER

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

  a : 20 mm (0.79 in)
  b : 30 mm (1.18 in)
  e : 10 mm (0.39 in)



- If reduction appears in (a) range, regard it (c).

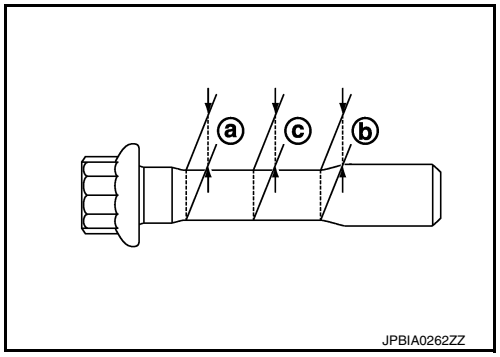
Limit [(d) – (c)] : 0.11 mm (0.0043 in)

- If it exceeds the limit (large difference in dimensions), replace lower cylinder block bolt with new one.

CONNECTING ROD BOLT OUTER DIAMETER

1. Measure the outer diameters [(a), (b), and (c)] at the position shown in the figure.

   a : Value at the end of the smaller diameter of the bolt
   b : Value at the end of the smaller diameter of the bolt [opposite side of (a)]
   c : Value of the smallest diameter of the smaller of the bolt



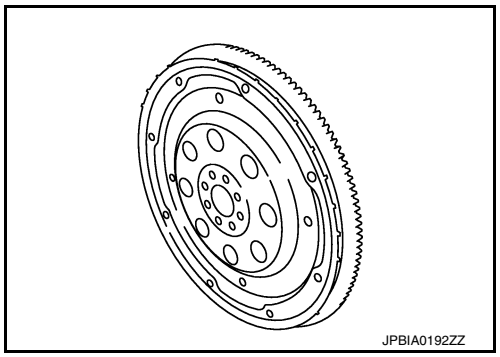
2. Obtain a mean value (d) of (a) and (b).
3. Subtract (c) from (d).

Limit [(d) – (c)] : 0.09 mm (0.0035 in)

4. If it exceeds the limit (large difference in dimensions), replace the bolt with new one.

DRIVE PLATE

- Check drive plate and signal plate for deformation or damage.
  CAUTION:
  - **Never disassemble drive plate.**
  - **Never place drive plate with signal plate facing down.**
  - **When handling signal plate, take care not to damage or scratch it.**
  - **Handle signal plate in a manner that prevents it from becoming magnetized.**
- If anything is found, replace drive plate.

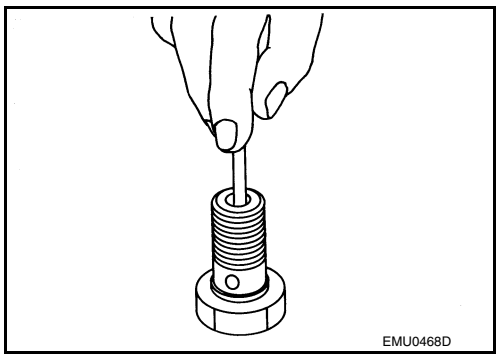


OIL JET

- Check nozzle for deformation and damage.
- Blow compressed air from nozzle, and check for clogs.
- If it is not satisfied, clean or replace oil jet.

OIL JET RELIEF VALVE

- Using a clean plastic stick, press check valve in oil jet relief valve. Check that valve moves smoothly with proper reaction force.
- If it is not satisfied, replace oil jet relief valve.



HOW TO SELECT PISTON AND BEARING

Description

INFOID:0000000010582030

Selection points	Selection parts	Selection items	Selection methods
Between cylinder block and crankshaft	Main bearing	Main bearing grade (bearing thickness)	Determined by match of cylinder block bearing housing grade (inner diameter of housing) and crankshaft journal grade (outer diameter of journal)
Between crankshaft and connecting rod	Connecting rod bearing	Connecting rod bearing grade (bearing thickness)	Combining service grades for connecting rod big end diameter and crankshaft pin outer diameter determine connecting rod bearing selection.
Between cylinder block and piston	Piston and piston pin assembly (Piston is available together with piston pin as assembly.)	Piston grade (piston skirt diameter)	Piston grade = cylinder bore grade (inner diameter of bore)
Between piston and connecting rod*	—	—	—

*: For the service parts, the grade for fitting cannot be selected between piston pin and connecting rod. (Only “0” grade is available.) The information at the shipment from the plant is described as a reference.

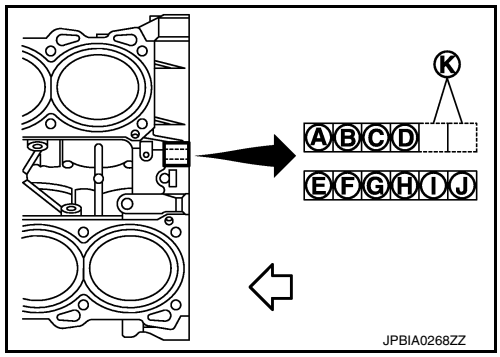
- The identification grade stamped on each part is the grade for the dimension measured in new condition. This grade cannot apply to reused parts.
- For reused or repaired parts, measure the dimension accurately. Determine the grade by comparing the measurement with the values of each selection table.
- For details of the measurement method of each part, the reuse standards and the selection method of the selective fitting parts, refer to the text.

Piston

INFOID:0000000010582031

WHEN NEW CYLINDER BLOCK IS USED

Check the cylinder bore grade (“1”, “2” or “3”) on rear side of cylinder block, and select piston of the same grade.



A : Bearing housing grade No. 1
B : Bearing housing grade No. 2
C : Bearing housing grade No. 3
D : Bearing housing grade No. 4
E : Cylinder bore grade No. 1
F : Cylinder bore grade No. 2
G : Cylinder bore grade No. 3
H : Cylinder bore grade No. 4
I : Cylinder bore grade No. 5
J : Cylinder bore grade No. 6
K : Identification
⇦ : Engine front

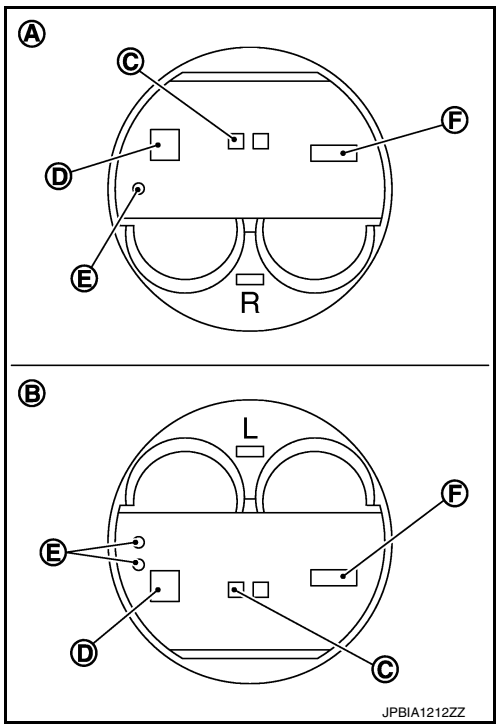
NOTE:
Piston is available with piston pin as a set for the service part. (Only “0” grade piston pin is available.)

WHEN CYLINDER BLOCK IS REUSED

1. Measure the cylinder bore inner diameter. Refer to EM-156, "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 : RH
B : LH
C : Piston pin grade number
D : Piston grade number
E : Front mark
F : Identification code



3. Select piston of the same grade.

PISTON SELECTION TABLE

Unit: mm (in)

Grade	1	2	3
Cylinder bore inner diameter	95.500 - 95.510 (3.7598 - 3.7602)	95.510 - 95.520 (3.7602 - 3.7606)	95.520 - 95.530 (3.7606 - 3.7610)
Piston skirt diameter	95.480 - 95.490 (3.7590 - 3.7594)	95.490 - 95.500 (3.7594 - 3.7598)	95.500 - 95.510 (3.7598 - 3.7602)

NOTE:
- Piston is available together with piston pin as assembly.
- Piston pin (piston pin hole) grade is provided only for the parts installed at the plant. For service parts, no piston pin grades can be selected. (Only “0” grade is available.)
- No second grade mark is available on piston.

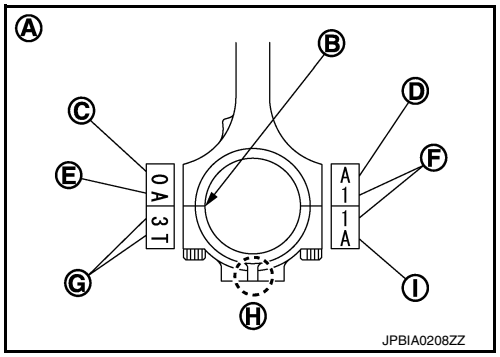
Connecting Rod Bearing

INFOID:0000000010582032

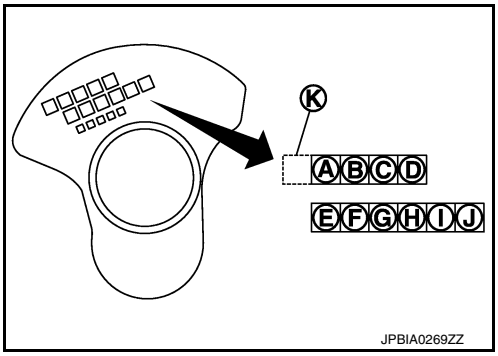
WHEN NEW CONNECTING ROD AND CRANKSHAFT ARE USED

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
I : Management code



2. Apply crankshaft pin journal diameter grade stamped on crankshaft front side to the column in the “CONNECTING ROD BEARING SELECTION TABLE”.



A : Journal diameter grade No. 1
B : Journal diameter grade No. 2
C : Journal diameter grade No. 3
D : Journal diameter grade No. 4
E : Pin diameter grade No. 1
F : Pin diameter grade No. 2
G : Pin diameter grade No. 3
H : Pin diameter grade No. 4
I : Pin diameter grade No. 5
J : Pin diameter grade No. 6
K : Identification

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

WHEN CONNECTING ROD AND CRANKSHAFT ARE REUSED

1. Measure the connecting rod big end diameter. Refer to EM-156, "Cylinder Block".
2. Check that the connecting rod big end diameter is within the standard value.
3. Measure the crankshaft pin journal diameter. Refer to EM-156, "Cylinder Block".
4. Determine the grade of crankshaft pin diameter grade by corresponding to the measured dimension in “Crankshaft pin journal diameter” column of “CONNECTING ROD BEARING SELECTION TABLE”.
5. Select connecting rod bearing of the same grade.

CONNECTING ROD BEARING SELECTION TABLE

Crankshaft pin journal diameter Unit: mm (in) / Connecting rod big end diameter Unit: mm (in)		Mark	A	B	C	D	E	F	G	H	J	K	L	M	N
Mark	Axle diameter	Hole diameter	57.000 - 57.001 (2.2441 - 2.2441)	57.001 - 57.002 (2.2441 - 2.2442)	57.002 - 57.003 (2.2442 - 2.2442)	57.003 - 57.004 (2.2442 - 2.2442)	57.004 - 57.005 (2.2442 - 2.2443)	57.005 - 57.006 (2.2443 - 2.2443)	57.006 - 57.007 (2.2443 - 2.2444)	57.007 - 57.008 (2.2444 - 2.2444)	57.008 - 57.009 (2.2444 - 2.2444)	57.009 - 57.010 (2.2444 - 2.2445)	57.010 - 57.011 (2.2445 - 2.2445)	57.011 - 57.012 (2.2445 - 2.2446)	57.012 - 57.013 (2.2446 - 2.2446)
A	53.974 - 53.973 (2.1250 - 2.1249)		0	0	0	0	0	0	1	1	1	1	1	1	2
B	53.973 - 53.972 (2.1249 - 2.1249)		0	0	0	0	0	1	1	1	1	1	1	2	2
C	53.972 - 53.971 (2.1249 - 2.1248)		0	0	0	0	1	1	1	1	1	1	2	2	2
D	53.971 - 53.970 (2.1248 - 2.1248)		0	0	0	1	1	1	1	1	1	2	2	2	2
E	53.970 - 53.969 (2.1248 - 2.1248)		0	0	1	1	1	1	1	1	2	2	2	2	2
F	53.969 - 53.968 (2.1248 - 2.1247)		0	1	1	1	1	1	1	2	2	2	2	2	2
G	53.968 - 53.967 (2.1247 - 2.1247)		1	1	1	1	1	1	2	2	2	2	2	2	3
H	53.967 - 53.966 (2.1247 - 2.1246)		1	1	1	1	1	2	2	2	2	2	2	3	3
J	53.966 - 53.965 (2.1246 - 2.1246)		1	1	1	1	2	2	2	2	2	2	3	3	3
K	53.965 - 53.964 (2.1246 - 2.1246)		1	1	1	2	2	2	2	2	2	3	3	3	3
L	53.964 - 53.963 (2.1246 - 2.1245)		1	1	2	2	2	2	2	2	3	3	3	3	3
M	53.963 - 53.962 (2.1245 - 2.1245)		1	2	2	2	2	2	2	3	3	3	3	3	3
N	53.962 - 53.961 (2.1245 - 2.1244)		2	2	2	2	2	2	3	3	3	3	3	3	4
P	53.961 - 53.960 (2.1244 - 2.1244)		2	2	2	2	2	3	3	3	3	3	3	4	4
R	53.960 - 53.959 (2.1244 - 2.1244)		2	2	2	2	3	3	3	3	3	3	4	4	4
S	53.959 - 53.958 (2.1244 - 2.1243)		2	2	2	3	3	3	3	3	3	4	4	4	4
T	53.958 - 53.957 (2.1243 - 2.1243)		2	2	3	3	3	3	3	3	4	4	4	4	4
U	53.957 - 53.956 (2.1243 - 2.1242)		2	3	3	3	3	3	3	4	4	4	4	4	4

PBIC5435E

CONNECTING ROD BEARING GRADE TABLE

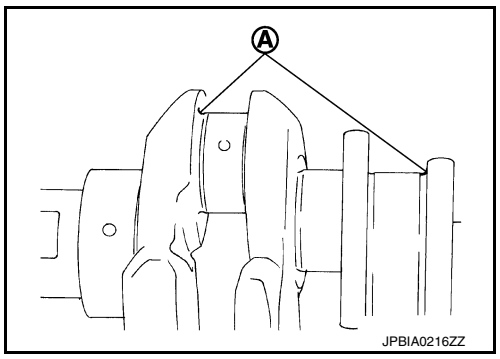
Connecting rod bearing grade table : Refer to EM-161, "Connecting Rod Bearing".

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)].



JPBIA0216ZZ

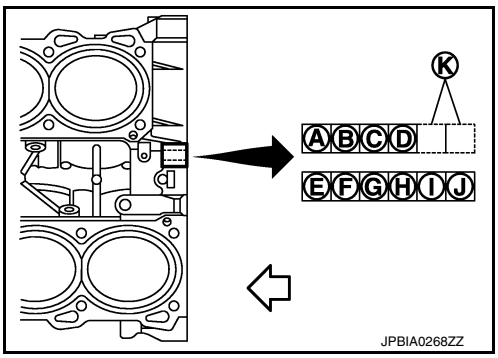
Bearing undersize table : Refer to EM-161, "Connecting Rod Bearing".

Main Bearing

INFOID:0000000010582033

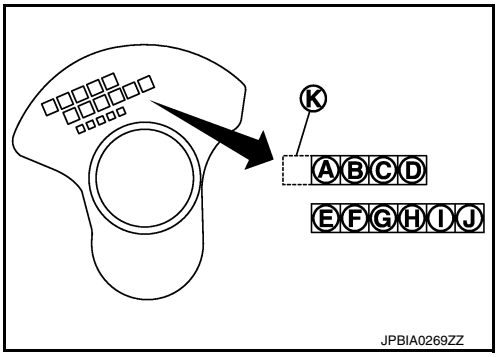
WHEN NEW CYLINDER BLOCK AND CRANKSHAFT ARE USED

1. "MAIN BEARING SELECTION TABLE" rows correspond to bearing housing grade on rear side of cylinder block.



A : Bearing housing grade No. 1
B : Bearing housing grade No. 2
C : Bearing housing grade No. 3
D : Bearing housing grade No. 4
E : Cylinder bore grade No. 1
F : Cylinder bore grade No. 2
G : Cylinder bore grade No. 3
H : Cylinder bore grade No. 4
I : Cylinder bore grade No. 5
J : Cylinder bore grade No. 6
K : Identification code
⇦ : Engine front

2. "MAIN BEARING SELECTION TABLE" columns correspond to journal diameter grade on front side of crankshaft.



A : Journal diameter grade No. 1
B : Journal diameter grade No. 2
C : Journal diameter grade No. 3
D : Journal diameter grade No. 4
E : Pin diameter grade No. 1
F : Pin diameter grade No. 2
G : Pin diameter grade No. 3
H : Pin diameter grade No. 4
I : Pin diameter grade No. 5
J : Pin diameter grade No. 6
K : Identification code

3. Select main bearing grade at the point where selected row and column meet in "MAIN BEARING SELECTION TABLE".
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-134, "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 step 3 and later in "When New Cylinder Block and Crankshaft are Used".

MAIN BEARING SELECTION TABLE

Cylinder block main bearing housing inner diameter
Unit: mm (in)

Crankshaft main journal diameter
Unit: mm (in)

Mark	Axle diameter	Hole diameter: 69.993 - 69.994 (2.7556 - 2.7557)	69.994 - 69.995 (2.7557 - 2.7557)	69.995 - 69.996 (2.7557 - 2.7557)	69.996 - 69.997 (2.7557 - 2.7558)	69.997 - 69.998 (2.7558 - 2.7558)	69.998 - 69.999 (2.7558 - 2.7559)	69.999 - 70.000 (2.7559 - 2.7559)	70.000 - 70.001 (2.7559 - 2.7559)	70.001 - 70.002 (2.7559 - 2.7560)	70.002 - 70.003 (2.7560 - 2.7560)	70.003 - 70.004 (2.7560 - 2.7561)	70.004 - 70.005 (2.7561 - 2.7561)	70.005 - 70.006 (2.7561 - 2.7561)	70.006 - 70.007 (2.7561 - 2.7562)	70.007 - 70.008 (2.7562 - 2.7562)	70.008 - 70.009 (2.7562 - 2.7563)	70.009 - 70.010 (2.7563 - 2.7563)	70.010 - 70.011 (2.7563 - 2.7563)	70.011 - 70.012 (2.7563 - 2.7564)	70.012 - 70.013 (2.7564 - 2.7564)	70.013 - 70.014 (2.7564 - 2.7565)	70.014 - 70.015 (2.7565 - 2.7565)	70.015 - 70.016 (2.7565 - 2.7565)	70.016 - 70.017 (2.7565 - 2.7566)
		A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	4	7
A	64.975 - 64.974 (2.5581 - 2.5580)	0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34
B	64.974 - 64.973 (2.5580 - 2.5580)	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4
C	64.973 - 64.972 (2.5580 - 2.5579)	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4
D	64.972 - 64.971 (2.5579 - 2.5579)	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4
E	64.971 - 64.970 (2.5579 - 2.5579)	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45
F	64.970 - 64.969 (2.5579 - 2.5578)	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45
G	64.969 - 64.968 (2.5578 - 2.5578)	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45
H	64.968 - 64.967 (2.5578 - 2.5578)	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5
J	64.967 - 64.966 (2.5578 - 2.5577)	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5
K	64.966 - 64.965 (2.5577 - 2.5577)	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5
L	64.965 - 64.964 (2.5577 - 2.5576)	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56
M	64.964 - 64.963 (2.5576 - 2.5576)	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56
N	64.963 - 64.962 (2.5576 - 2.5576)	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56
P	64.962 - 64.961 (2.5576 - 2.5575)	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6
R	64.961 - 64.960 (2.5575 - 2.5575)	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6
S	64.960 - 64.959 (2.5575 - 2.5574)	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6
T	64.959 - 64.958 (2.5574 - 2.5574)	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67
U	64.958 - 64.957 (2.5574 - 2.5574)	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67
V	64.957 - 64.956 (2.5574 - 2.5573)	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67
W	64.956 - 64.955 (2.5573 - 2.5573)	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7
X	64.955 - 64.954 (2.5573 - 2.5572)	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7
Y	64.954 - 64.953 (2.5572 - 2.5572)	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7
4	64.953 - 64.952 (2.5572 - 2.5572)	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	X
7	64.952 - 64.951 (2.5572 - 2.5571)	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	X	X

JPBIA0264ZZ

MAIN BEARING GRADE TABLE (ALL JOURNALS)

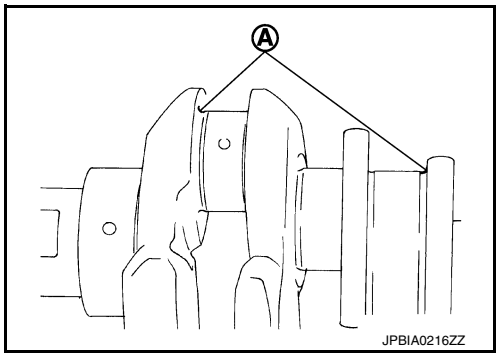
Main bearing grade table (All journals) : Refer to EM-160, "Main Bearing".

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-160, "Main Bearing".

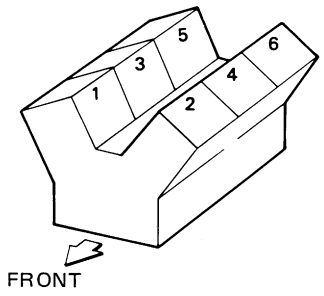
SERVICE DATA AND SPECIFICATIONS (SDS)

SERVICE DATA AND SPECIFICATIONS (SDS)

General Specification

INFOID:0000000010582034

GENERAL SPECIFICATIONS

Cylinder arrangement		V-6
Displacement cm^3 (cu in)		3,696 (225.53)
Bore and stroke mm (in)		95.5 x 86.0 (3.76 x 3.386)
Valve arrangement		DOHC
Firing order		1-2-3-4-5-6
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		4
Compression ratio		11
Compression pressure kPa (kg/cm^2, psi)/200 rpm	Standard	1,667 - 2,354 (17 - 24, 242 - 341)
	Minimum	1,226 (12.5, 178)
	Differential limit between cylinders	98 (1.0, 14)
Cylinder number	 SEM713A	

Unit: degree

Valve timing	Intake valve open (BTDC)	63 - −64
	Intake valve close (ABDC)	−73 - 82
	Exhaust valve open (BBDC)	64
	Exhaust valve close (ATDC)	12

Drive Belt

INFOID:0000000010582035

DRIVE BELT

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

Spark Plug

INFOID:0000000010582036

SPARK PLUG

Unit: mm (in)

Make	DENSO
Standard type	FXE24HR11
Gap (Nominal)	1.1 (0.043)

Intake Manifold

INFOID:0000000010582037

INTAKE MANIFOLD

Unit: mm (in)

Items		Limit
Surface distortion	Intake manifold	0.1 (0.004)

Exhaust Manifold

INFOID:0000000010582038

EXHAUST MANIFOLD

Unit: mm (in)

Items		Limit
Surface distortion	Exhaust manifold	0.7 (0.028)

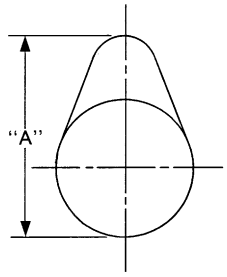
Camshaft

INFOID:0000000010582039

CAMSHAFT (EXH)

Unit: mm (in)

Items		Standard	Limit
Camshaft (EXH) journal oil clearance	No. 1	0.045 - 0.086 (0.0018 - 0.0034)	0.150 (0.0059)
	No. 2, 3, 4	0.035 - 0.076 (0.0014 - 0.0030)	
VVEL ladder assembly bracket inner diameter (EXH)	No. 1	26.000 - 26.021 (1.0236 - 1.0244)	—
	No. 2, 3, 4	23.500 - 23.521 (0.9252 - 0.9260)	—
Camshaft (EXH) journal diameter	No. 1	25.935 - 25.955 (1.0211 - 1.0218)	—
	No. 2, 3, 4	23.445 - 23.465 (0.9230 - 0.9238)	—
Camshaft (EXH) end play		0.115 - 0.188 (0.0045 - 0.0074)	0.24 (0.0094)
Camshaft (EXH) cam height "A"	Bank 1	45.015 - 45.205 (1.7722 - 1.7797)	0.2 (0.008)*1
	Bank 2	46.735 - 46.925 (1.8400 - 1.8474)	
Camshaft (EXH) runout [TIR*2]		Less than 0.02 (0.001)	0.05 (0.002)
Camshaft sprocket (EXH) runout [TIR*2]		—	0.15 (0.0059)



SEM671

*1: Cam wear limit

*2: Total indicator reading

CAMSHAFT (INT)

Unit: mm (in)

Items	Standard	Limit
Drive shaft end play	0.115 - 0.188 (0.0045 - 0.0074)	0.24 (0.0094)
Camshaft sprocket (INT) 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)

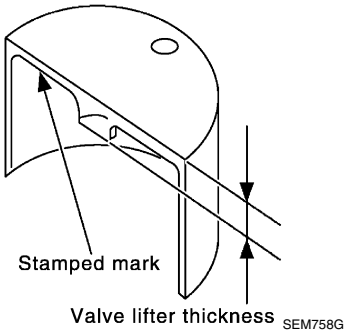
*: Approximately 80°C (176°F)

AVAILABLE VALVE LIFTER

Unit: mm (in)

Identification (stamped) mark	Thickness
788	7.88 (0.3102)
790	7.90 (0.3110)
792	7.92 (0.3118)
794	7.94 (0.3126)
796	7.96 (0.3134)
798	7.98 (0.3142)
800	8.00 (0.3150)
802	8.02 (0.3157)
804	8.04 (0.3165)
806	8.06 (0.3173)
808	8.08 (0.3181)
810	8.10 (0.3189)
812	8.12 (0.3197)
814	8.14 (0.3205)
816	8.16 (0.3213)
818	8.18 (0.3220)
820	8.20 (0.3228)
822	8.22 (0.3236)
824	8.24 (0.3244)
826	8.26 (0.3252)
828	8.28 (0.3260)
830	8.30 (0.3268)
832	8.32 (0.3276)
834	8.34 (0.3283)
836	8.36 (0.3291)
838	8.38 (0.3299)

Identification (stamped) mark	Thickness
840	8.40 (0.3307)



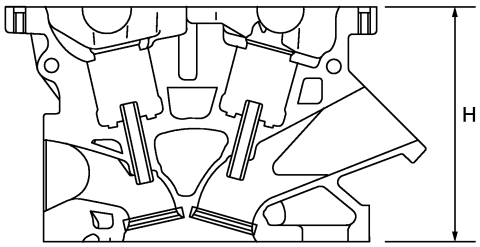
Cylinder Head

INFOID:0000000010582040

CYLINDER HEAD

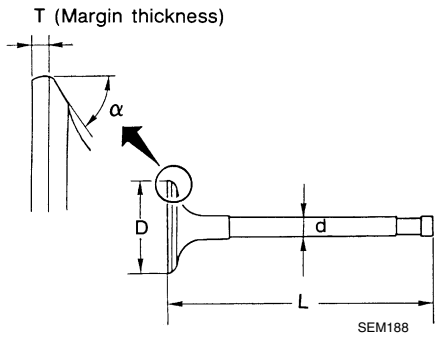
Unit: mm (in)

Items	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)
Normal cylinder head height “H”	126.4 (4.98)	—



VALVE DIMENSIONS

Unit: mm (in)

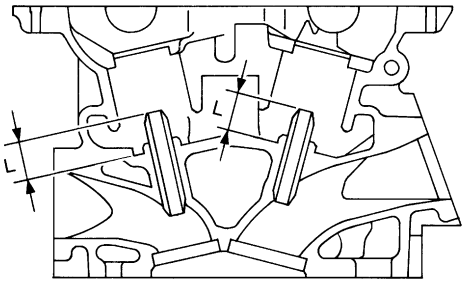


Valve head diameter “D”	Intake	36.6 - 36.9 (1.441 - 1.453)
	Exhaust	30.2 - 30.5 (1.189 - 1.201)
Valve length “L”	Intake	100.11 (3.94)
	Exhaust	94.67 (3.7272)
Valve stem diameter “d”	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.962 - 5.970 (0.2347 - 0.2350)

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)



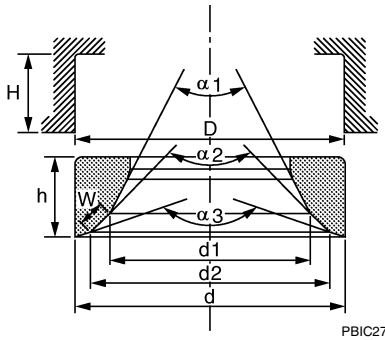
SEM950E

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 - 0.056 (0.0012 - 0.0022)	0.09 (0.004)
Projection length “L”		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	31.600 - 31.616 (1.2441 - 1.2447)	32.100 - 32.116 (1.2638 - 1.2644)*4
Valve seat outer diameter “d”	Intake	38.097 - 38.113 (1.4999 - 1.5005)	—
	Exhaust	31.680 - 31.696 (1.2472 - 1.2479)	32.180 - 32.196 (1.2669 - 1.2676)*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	27.7 (1.091)	
Diameter “d2”*2	Intake	35.9 - 36.4 (1.413 - 1.433)	
	Exhaust	29.3 - 29.8 (1.154 - 1.173)	
Angle “α1”	Intake	60°	
	Exhaust	60°	
Angle “α2”	Intake	88°45′ - 90°15′	
	Exhaust	88°45′ - 90°15′	
Angle “α3”	Intake	120°	
	Exhaust	120°	
Contacting width “W”*3	Intake	1.0 - 1.4 (0.039 - 0.055)	
	Exhaust	1.2 - 1.6 (0.047 - 0.063)	
Height “h”	Intake	5.9 - 6.0 (0.232 - 0.236)	—
	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

Items		Standard	
		Intake	Exhaust
Free height		45.66 mm (1.7976 in)	43.85 mm (1.7264 in)
Pressure	Installation	191.1 - 215.5 N (19.5 - 22 kg, 43 - 48 lb) at 40.90 mm (1.6102 in)	166 - 188 N (16.9 - 19.2 kg, 37 - 42 lb) at 37.00 mm (1.4567 in)
	Valve open	830.9 - 936.9 N (84.8 - 95.6 kg, 187 - 211 lb) at 28.07 mm (1.1051 in)	502 - 566 N (51.2 - 57.7 kg, 113 - 127 lb) at 26.80 mm (1.0551 in)
Identification color		Purple	Yellowish green

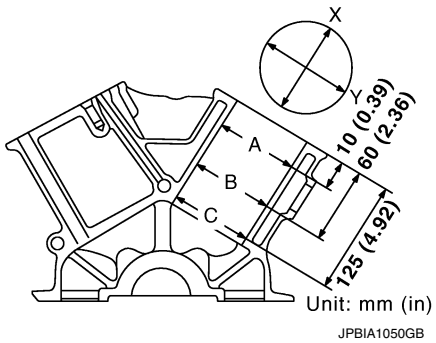
Items	Limit	
	Intake	Exhaust
Out-of-square	2.0 mm (0.079 in)	1.9 mm (0.075 in)

Cylinder Block

INFOID:0000000010582041

CYLINDER BLOCK

Unit: mm (in)

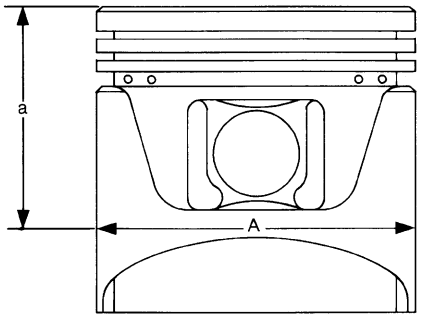


JPBIA1050GB

Surface flatness		Standard		Less than 0.03 (0.0012)
		Limit		0.1 (0.004)
Main bearing housing inner diameter		Standard		69.993 - 70.017 (2.7556 - 2.7566)
Cylinder bore	Inner diameter	Standard	Grade No. 1	95.500 - 95.510 (3.7598 - 3.7602)
			Grade No. 2	95.510 - 95.520 (3.7602 - 3.7606)
			Grade No. 3	95.520 - 95.530 (3.7606 - 3.7610)
		Wear limit		0.2 (0.008)
Out-of-round		Limit		0.015 (0.0006)
Taper				0.010 (0.0004)
Main bearing housing inner diameter grade (Without bearing)			Grade No. A	69.993 - 69.994 (2.7556 - 2.7557)
			Grade No. B	69.994 - 69.995 (2.7557 - 2.7557)
			Grade No. C	69.995 - 69.996 (2.7557 - 2.7557)
			Grade No. D	69.996 - 69.997 (2.7557 - 2.7558)
			Grade No. E	69.997 - 69.998 (2.7558 - 2.7558)
			Grade No. F	69.998 - 69.999 (2.7558 - 2.7559)
			Grade No. G	69.999 - 70.000 (2.7559 - 2.7559)
			Grade No. H	70.000 - 70.001 (2.7559 - 2.7559)
			Grade No. J	70.001 - 70.002 (2.7559 - 2.7560)
			Grade No. K	70.002 - 70.003 (2.7560 - 2.7560)
			Grade No. L	70.003 - 70.004 (2.7560 - 2.7561)
			Grade No. M	70.004 - 70.005 (2.7561 - 2.7561)
			Grade No. N	70.005 - 70.006 (2.7561 - 2.7561)
			Grade No. P	70.006 - 70.007 (2.7561 - 2.7562)
			Grade No. R	70.007 - 70.008 (2.7562 - 2.7562)
			Grade No. S	70.008 - 70.009 (2.7562 - 2.7563)
			Grade No. T	70.009 - 70.010 (2.7563 - 2.7563)
			Grade No. U	70.010 - 70.011 (2.7563 - 2.7563)
			Grade No. V	70.011 - 70.012 (2.7563 - 2.7564)
			Grade No. W	70.012 - 70.013 (2.7564 - 2.7564)
			Grade No. X	70.013 - 70.014 (2.7564 - 2.7565)
			Grade No. Y	70.014 - 70.015 (2.7565 - 2.7565)
			Grade No. 4	70.015 - 70.016 (2.7565 - 2.7565)
			Grade No. 7	70.016 - 70.017 (2.7565 - 2.7566)
Difference in inner diameter between cylinders		Standard		Less than 0.03 (0.0012)

AVAILABLE PISTON

Unit: mm (in)



SEM882E

Items		Standard	Oversize (Service) [0.2 (0.008)]
Piston skirt diameter “A”	Grade No. 1	95.480 - 95.490 (3.7590 - 3.7594)	—
	Grade No. 2	95.490 - 95.500 (3.7594 - 3.7598)	—
	Grade No. 3	95.500 - 95.510 (3.7598 - 3.7602)	—
	Service	—	95.680 - 95.710 (3.7669 - 3.7681)
Items		Standard	Limit
“a” dimension		38.8 (1.528)	—
Piston pin hole diameter	Grade No. 0	21.993 - 21.999 (0.8659 - 0.8661)	—
	Grade No. 1	21.999 - 22.005 (0.8661 - 0.8663)	—
Piston to cylinder bore clearance		0.010 - 0.030 (0.0004 - 0.0012)	0.08 (0.0031)

PISTON RING

Unit: mm (in)

Items		Standard	Limit
Side clearance	Top	0.040 - 0.080 (0.0016 - 0.0031)	0.11 (0.0043)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.10 (0.0039)
	Oil ring	0.055 - 0.155 (0.0022 - 0.0061)	0.19 (0.0075)
End gap	Top	0.23 - 0.33 (0.0091 - 0.0130)	0.42 (0.0169)
	2nd	0.23 - 0.33 (0.0091 - 0.0130)	0.57 (0.0224)
	Oil (rail ring)	0.17 - 0.47 (0.0067 - 0.0185)	0.63 (0.0248)

PISTON PIN

Unit: mm (in)

Items		Standard	Limit
Piston pin outer diameter	Grade No. 0	21.989 - 21.995 (0.8657 - 0.8659)	—
	Grade No. 1	21.995 - 22.001 (0.8659 - 0.8662)	—
Piston to piston pin oil clearance		0.002 - 0.006 (0.0001 - 0.0002)	—
Connecting rod bushing oil clearance		0.005 - 0.017 (0.0002 - 0.0007)	0.030 (0.0012)

CONNECTING ROD

Unit: mm (in)

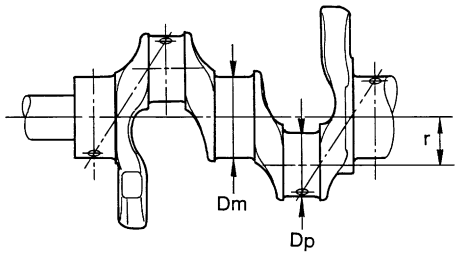
Items		Standard	Limit
Center distance		149.45 - 149.55 (5.88 - 5.89)	—
Bend [per 100 (3.94)]		—	0.15 (0.0059)
Torsion [per 100 (3.94)]		—	0.30 (0.0118)
Connecting rod bushing inner diameter*	Grade No. 0	22.000 - 22.006 (0.8661 - 0.8664)	—
	Grade No. 1	22.006 - 22.012 (0.8664 - 0.8666)	—

Connecting rod big end diameter (Without bearing)	Grade No. A	57.000 - 57.001 (2.2441 - 2.2441)	—
	Grade No. B	57.001 - 57.002 (2.2441 - 2.2442)	—
	Grade No. C	57.002 - 57.003 (2.2442 - 2.2442)	—
	Grade No. D	57.003 - 57.004 (2.2442 - 2.2442)	—
	Grade No. E	57.004 - 57.005 (2.2442 - 2.2443)	—
	Grade No. F	57.005 - 57.006 (2.2443 - 2.2443)	—
	Grade No. G	57.006 - 57.007 (2.2443 - 2.2444)	—
	Grade No. H	57.007 - 57.008 (2.2444 - 2.2444)	—
	Grade No. J	57.008 - 57.009 (2.2444 - 2.2444)	—
	Grade No. K	57.009 - 57.010 (2.2444 - 2.2445)	—
	Grade No. L	57.010 - 57.011 (2.2445 - 2.2445)	—
	Grade No. M	57.011 - 57.012 (2.2445 - 2.2446)	—
	Grade No. N	57.012 - 57.013 (2.2446 - 2.2446)	—
Items		Standard	Limit
Side clearance		0.20 - 0.35 (0.0079 - 0.0138)	0.40 (0.0157)

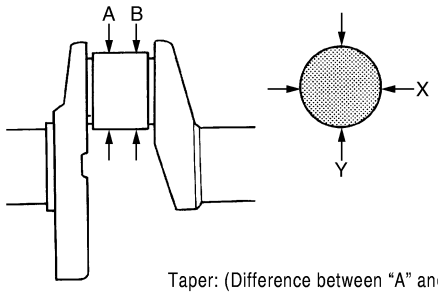
*: After installing in connecting rod

CRANKSHAFT

Unit: mm (in)



SEM645



Taper: (Difference between “A” and “B”)
Out-of-round: (Difference between “X” and “Y”)
SBIA0535E

Main journal diameter. “Dm” grade	Standard	Grade No. A	64.975 - 64.974 (2.5581 - 2.5580)
		Grade No. B	64.974 - 64.973 (2.5580 - 2.5580)
		Grade No. C	64.973 - 64.972 (2.5580 - 2.5579)
		Grade No. D	64.972 - 64.971 (2.5579 - 2.5579)
		Grade No. E	64.971 - 64.970 (2.5579 - 2.5579)
		Grade No. F	64.970 - 64.969 (2.5579 - 2.5578)
		Grade No. G	64.969 - 64.968 (2.5578 - 2.5578)
		Grade No. H	64.968 - 64.967 (2.5578 - 2.5578)
		Grade No. J	64.967 - 64.966 (2.5578 - 2.5577)
		Grade No. K	64.966 - 64.965 (2.5577 - 2.5577)
		Grade No. L	64.965 - 64.964 (2.5577 - 2.5576)
		Grade No. M	64.964 - 64.963 (2.5576 - 2.5576)
		Grade No. N	64.963 - 64.962 (2.5576 - 2.5576)
		Grade No. P	64.962 - 64.961 (2.5576 - 2.5575)
		Grade No. R	64.961 - 64.960 (2.5575 - 2.5575)
		Grade No. S	64.960 - 64.959 (2.5575 - 2.5574)
		Grade No. T	64.959 - 64.958 (2.5574 - 2.5574)
		Grade No. U	64.958 - 64.957 (2.5574 - 2.5574)
		Grade No. V	64.957 - 64.956 (2.5574 - 2.5573)
		Grade No. W	64.956 - 64.955 (2.5573 - 2.5573)
		Grade No. X	64.955 - 64.954 (2.5573 - 2.5572)
		Grade No. Y	64.954 - 64.953 (2.5572 - 2.5572)
		Grade No. 4	64.953 - 64.952 (2.5572 - 2.5572)
		Grade No. 7	64.952 - 64.951 (2.5572 - 2.5571)

Pin journal diameter. “Dp” grade	Standard	Grade No. A	53.974 - 53.973 (2.1250 - 2.1249)
		Grade No. B	53.973 - 53.972 (2.1249 - 2.1249)
		Grade No. C	53.972 - 53.971 (2.1249 - 2.1248)
		Grade No. D	53.971 - 53.970 (2.1248 - 2.1248)
		Grade No. E	53.970 - 53.969 (2.1248 - 2.1248)
		Grade No. F	53.969 - 53.968 (2.1248 - 2.1247)
		Grade No. G	53.968 - 53.967 (2.1247 - 2.1247)
		Grade No. H	53.967 - 53.966 (2.1247 - 2.1246)
		Grade No. J	53.966 - 53.965 (2.1246 - 2.1246)
		Grade No. K	53.965 - 53.964 (2.1246 - 2.1246)
		Grade No. L	53.964 - 53.963 (2.1246 - 2.1245)
		Grade No. M	53.963 - 53.962 (2.1245 - 2.1245)
		Grade No. N	53.962 - 53.961 (2.1245 - 2.1244)
		Grade No. P	53.961 - 53.960 (2.1244 - 2.1244)
		Grade No. R	53.960 - 53.959 (2.1244 - 2.1244)
		Grade No. S	53.959 - 53.958 (2.1244 - 2.1243)
		Grade No. T	53.958 - 53.957 (2.1243 - 2.1243)
		Grade No. U	53.957 - 53.956 (2.1243 - 2.1242)
Center distance “r”			42.96 - 43.04 (1.6913 - 1.6945)
Taper (Difference between “A” and “B”)	Limit		0.0025 (0.0001)
Out-of-round (Difference between “X” and “Y”)			0.0025 (0.0001)
Crankshaft runout [TIR*]	Standard		Less than 0.05 (0.002)
	Limit		0.10 (0.0039)
Crankshaft end play	Standard		0.10 - 0.25 (0.0039 - 0.0098)
	Limit		0.30 (0.0118)

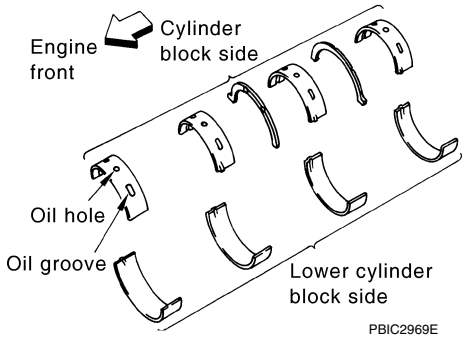
*: Total indicator reading

Main Bearing

INFOID:0000000010582042

MAIN BEARING

Unit: mm (in)



Grade number	Thickness	Width	Identification color	Remarks

0		2.500 - 2.503 (0.0984 - 0.0985)	19.9 - 20.1 (0.783 - 0.791)	Black	Grade is the same for upper and lower bearings.
1		2.503 - 2.506 (0.0985 - 0.0987)		Brown	
2		2.506 - 2.509 (0.0987 - 0.0988)		Green	
3		2.509 - 2.512 (0.0988 - 0.0989)		Yellow	
4		2.512 - 2.515 (0.0989 - 0.0990)		Blue	
5		2.515 - 2.518 (0.0990 - 0.0991)		Pink	
6		2.518 - 2.521 (0.0991 - 0.0993)		Purple	
7		2.521 - 2.524 (0.0993 - 0.0994)		White	
01	UPR	2.503 - 2.506 (0.0985 - 0.0987)		Brown	Grade and color are different for upper and lower bearings.
	LWR	2.500 - 2.503 (0.0984 - 0.0985)		Black	
12	UPR	2.506 - 2.509 (0.0987 - 0.0988)		Green	
	LWR	2.503 - 2.506 (0.0985 - 0.0987)		Brown	
23	UPR	2.509 - 2.512 (0.0988 - 0.0989)		Yellow	
	LWR	2.506 - 2.509 (0.0987 - 0.0988)		Green	
34	UPR	2.512 - 2.515 (0.0989 - 0.0990)		Blue	
	LWR	2.509 - 2.512 (0.0988 - 0.0989)		Yellow	
45	UPR	2.515 - 2.518 (0.0990 - 0.0991)		Pink	
	LWR	2.512 - 2.515 (0.0989 - 0.0990)		Blue	
56	UPR	2.518 - 2.521 (0.0991 - 0.0993)		Purple	
	LWR	2.515 - 2.518 (0.0990 - 0.0991)		Pink	
67	UPR	2.521 - 2.524 (0.0993 - 0.0994)		White	
	LWR	2.518 - 2.521 (0.0991 - 0.0993)		Purple	

UNDERSIZE

Unit: mm (in)

Items	Thickness	Main journal diameter
0.25 (0.0098)	2.633 - 2.641 (0.1037 - 0.1040)	Grind so that bearing clearance is the specified value.

MAIN BEARING OIL CLEARANCE

Unit: mm (in)

Items	Standard	Limit
Main bearing oil clearance	0.035 - 0.045 (0.0014 - 0.0018)*	0.065 (0.0026)

*: Actual clearance

Connecting Rod Bearing

INFOID:0000000010582043

CONNECTING ROD BEARING

Unit: mm (in)

Grade number	Thickness	Identification color (mark)
0	1.497 - 1.500 (0.0589 - 0.0591)	Black
1	1.500 - 1.503 (0.0591 - 0.0592)	Brown
2	1.503 - 1.506 (0.0592 - 0.0593)	Green
3	1.506 - 1.509 (0.0593 - 0.0594)	Yellow
4	1.509 - 1.512 (0.0594 - 0.0595)	Blue

UNDERSIZE

Unit: mm (in)

Items	Thickness	Crank pin journal diameter
0.25 (0.0098)	1.626 - 1.634 (0.0640 - 0.0643)	Grind so that bearing clearance is the specified value.

CONNECTING ROD BEARING OIL CLEARANCE

Unit: mm (in)

Items	Standard	Limit
Connecting rod bearing oil clearance	0.040 - 0.053 (0.0016 - 0.0021)*	0.070 (0.0028)

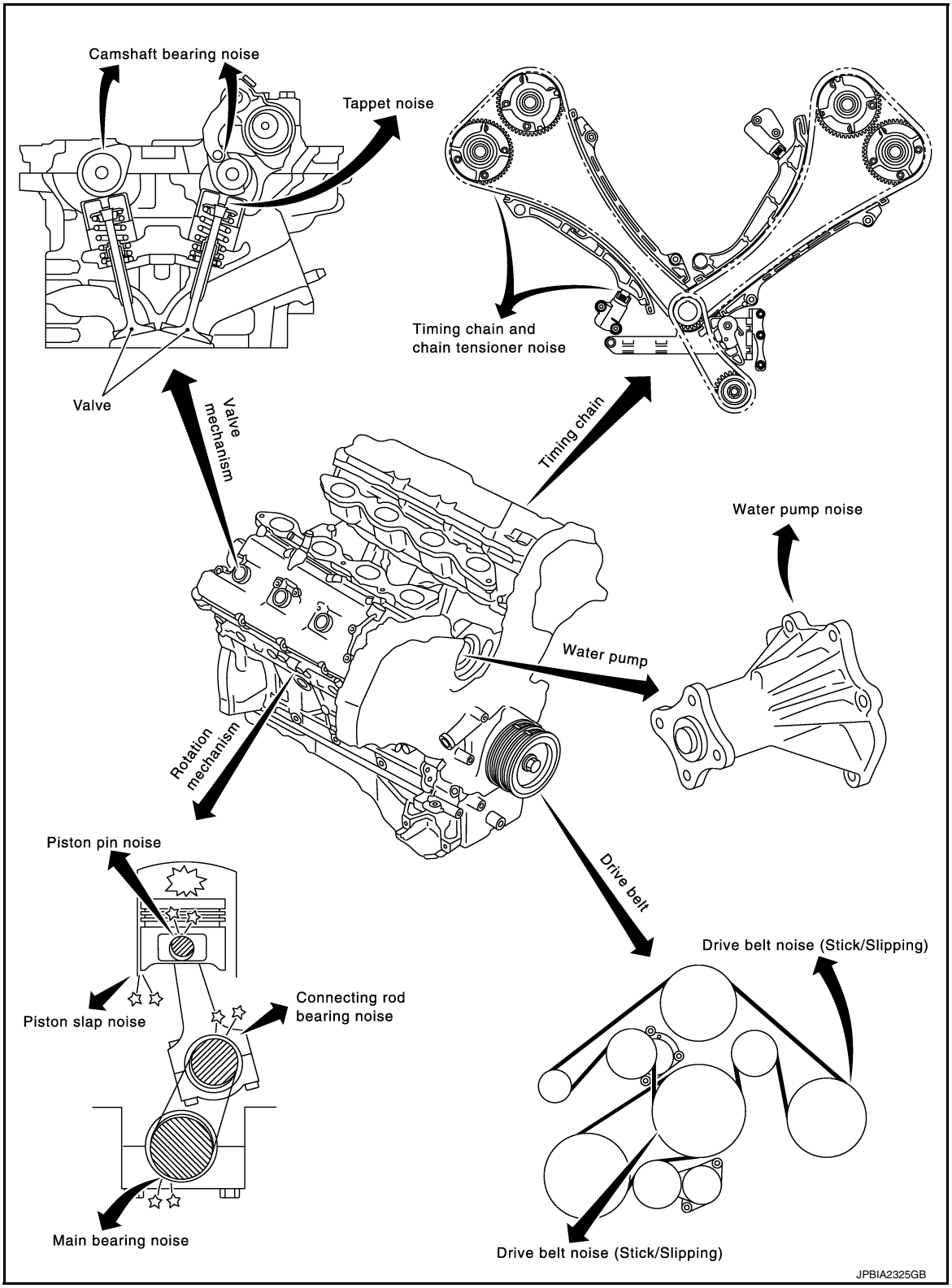
*: Actual clearance

SYMPTOM DIAGNOSIS

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

NVH Troubleshooting - Engine Noise

INFOID:0000000010582044



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

INFOID:0000000010582045

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-179
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft runout Camshaft journal oil clearance	EM-247
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-276
	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-276
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing oil clearance	EM-276
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-276
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-236
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	EM-174
	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-50

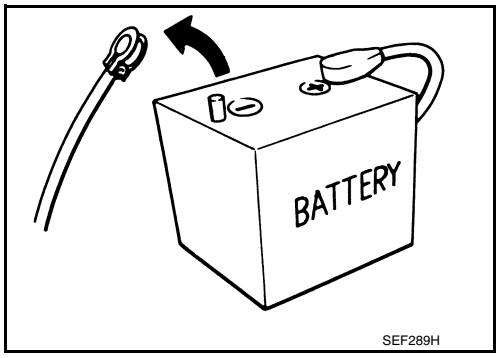
A: Closely related B: Related C: Sometimes related —: Not related

PRECAUTION

PRECAUTIONS

Precautions for Removing Battery Terminal

INFOID:0000000011004844

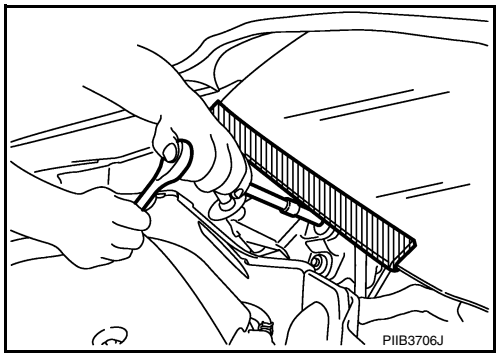


- When removing the 12V battery terminal, turn OFF the ignition switch and wait at least 30 seconds.
  NOTE:
  ECU may be active for several tens of seconds after the ignition switch is turned OFF. If the battery terminal is removed before ECU stops, then a DTC detection error or ECU data corruption may occur.
- For vehicles with the 2-batteries, be sure to connect the main battery and the sub battery before turning ON the ignition switch.
  NOTE:
  If the ignition switch is turned ON with any one of the terminals of main battery and sub battery disconnected, then DTC may be detected.
- After installing the 12V battery, always check "Self Diagnosis Result" of all ECUs and erase DTC.
  NOTE:
  The removal of 12V battery may cause a DTC detection error.

Precaution for Procedure without Cowl Top Cover

INFOID:0000000010582046

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



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

INFOID:0000000010582047

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:

Always observe the following items for preventing accidental activation.

- **To avoid rendering the SRS inoperative, which could increase the risk of personal injury or death in the event of a collision that would result in air bag inflation, all maintenance must be performed by an authorized NISSAN/INFINITI dealer.**
- **Improper maintenance, including incorrect removal and installation of the SRS, can lead to personal injury caused by unintentional activation of the system. For removal of Spiral Cable and Air Bag Module, see “SRS AIR BAG”.**
- **Never use electrical test equipment on any circuit related to the SRS unless instructed to in this Service Manual. SRS wiring harnesses can be identified by yellow and/or orange harnesses or harness connectors.**

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

WARNING:

Always observe the following items for preventing accidental activation.
- **When working near the Air Bag Diagnosis Sensor Unit or other Air Bag System sensors with the ignition ON or engine running, never use air or electric power tools or strike near the sensor(s) with a hammer. Heavy vibration could activate the sensor(s) and deploy the air bag(s), possibly causing serious injury.**
- **When using air or electric power tools or hammers, always switch the ignition OFF, disconnect the battery, and wait at least 3 minutes before performing any service.**

Precautions For Engine Service

INFOID:0000000010582048

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

DRAINING ENGINE COOLANT
Drain engine coolant and engine oil when the engine is cooled.

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

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

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

Parts Requiring Angle Tightening

INFOID:0000000010582049

- 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

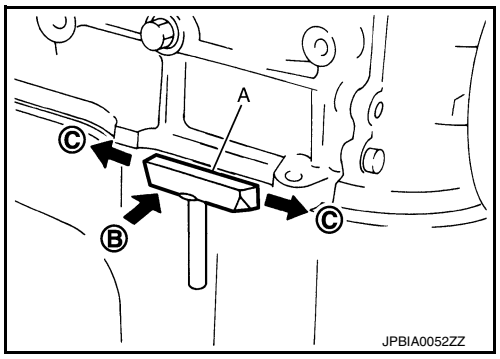
- Crankshaft pulley bolt (No angle wrench is required as the bolt flange is provided with notches for angle tightening)
- Ensure thread and seat surfaces are clean and coated with engine oil.

Precaution for Liquid Gasket

INFOID:0000000010582050

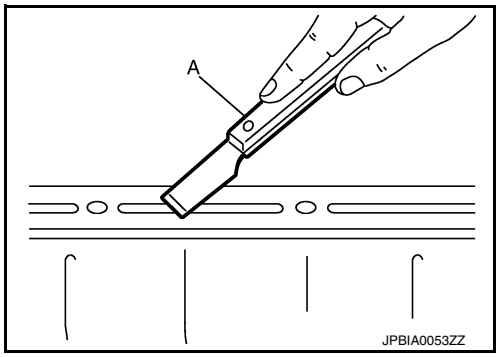
REMOVAL OF LIQUID GASKET SEALING

- 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.

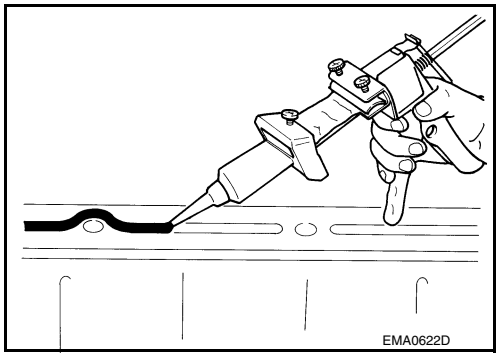


LIQUID GASKET APPLICATION PROCEDURE

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.

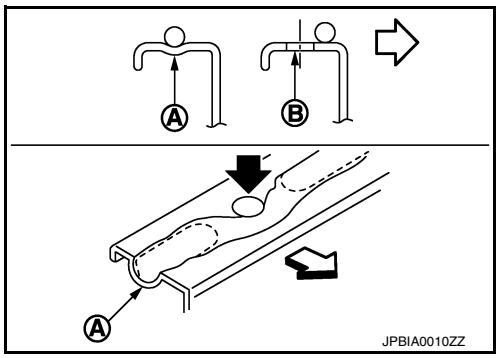


3. Attach liquid gasket tube to the tube presser (commercial service tool).
   Use Genuine RTV Silicone Sealant or an equivalent. Refer to GI-24, "Recommended Chemical Products and Sealants".
4. Apply liquid gasket without gaps to the specified location according to the specified dimensions.
   - If 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.

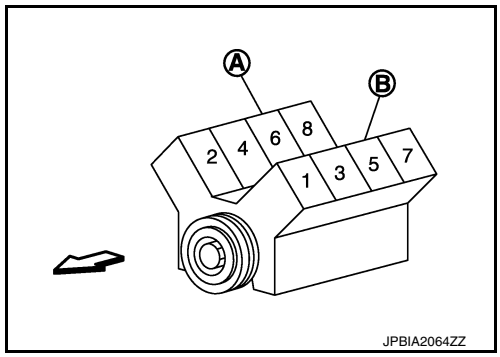
CAUTION:
If there are specific instructions in this manual, observe them.

Definitions of Bank Names

INFOID:0000000010582051

- 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)

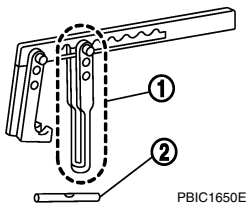
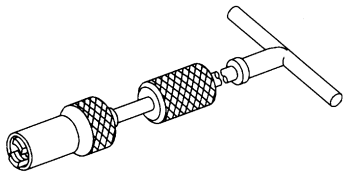
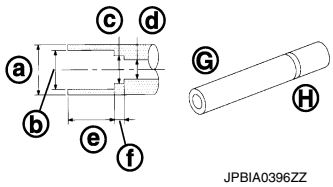
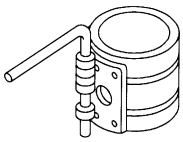
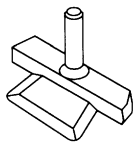
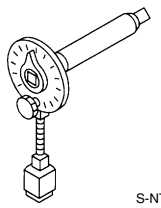
PREPARATION

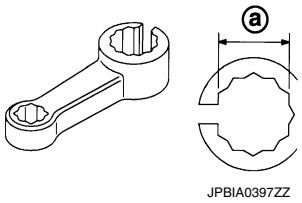
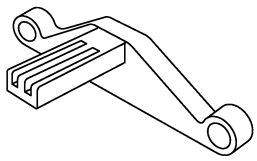
PREPARATION

Special Service Tool

INFOID:0000000010582052

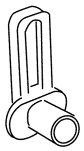
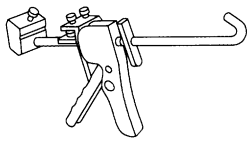
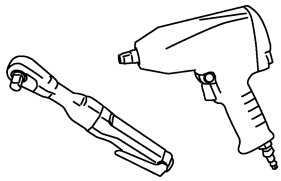
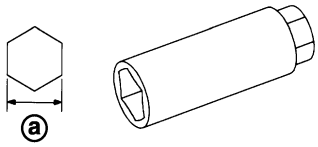
The actual shapes of TechMate tools may differ from those of special service tools illustrated here.

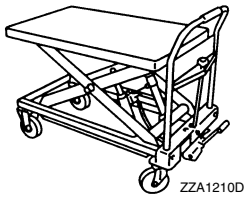
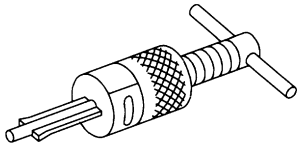
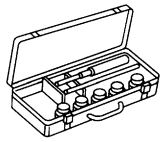
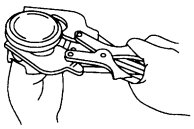
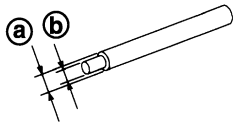
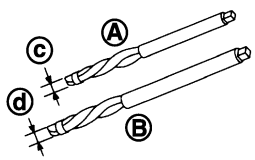
Tool number (TechMate No.) Tool name		Description
KV10116200 (J-26336-A) Valve spring compressor 1. KV10115900 (J-26336-20) Attachment 2. KV10109220 (—) Adapter	 PBIC1650E	Disassembling valve mechanism Part (1) is a component of KV10116200 (J26336-A), but part (2) is not so.
KV10107902 (J-38959) Valve oil seal puller	 S-NT011	Removing valve oil seal
KV10115600 (J-38958) Valve oil seal drift	 JPBIA0396ZZ	Installing valve oil seal **Use side A (G)** **a: 20 (0.79) dia.** **d: 8 (0.31) dia.** **b: 13 (0.51) dia.** **e: 10.7 (0.421)** **c: 10.3 (0.406) dia.** **f: 5 (0.20)** **H: Side B** Unit: mm (in)
EM03470000 (J-8037) Piston ring compressor	 S-NT044	Installing piston assembly into cylinder bore
KV10111100 (J-37228) Seal cutter	 S-NT046	Removing steel oil pan and front cover
KV10112100 (BT8653-A) Angle wrench	 S-NT014	Tightening bolts for bearing cap, cylinder head, etc.

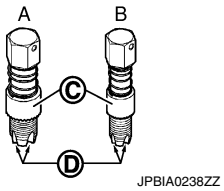
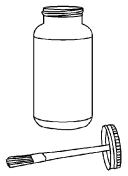
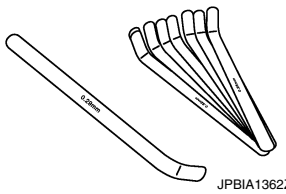
Tool number (TechMate No.) Tool name	Description
KV10114400 (J-38365) Heated oxygen sensor wrench  JPBIA0397ZZ	Loosening or tightening air fuel ratio sensor 1 and heated oxygen sensor 2 **a: 22 mm (0.87 in)**
KV10119200 (J-49277) Ring gear stopper  JPBIA0409ZZ	Removing and installing crankshaft pulley
KV10119300 (—) Adapter and torque wrench assembly	Tightening rocker cover mounting bolts. (specified torque)

Commercial Service Tool

INFOID:0000000010582053

(TechMate No.) Tool name	Description
(J-45488) Quick connector release  PBIC0198E	Removing fuel tube quick connectors in engine room
(—) 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)**

(TechMate No.) Tool name	Description
(—) Manual lift table caddy  ZZA1210D	Removing and installing engine
(—) 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	(1): Reaming valve guide (EXH) inner hole (2): Reaming hole for oversize valve guide (EXH) **c: 6.0 mm (0.236 in) dia.** **d: 10.2 mm (0.402 in) dia.**

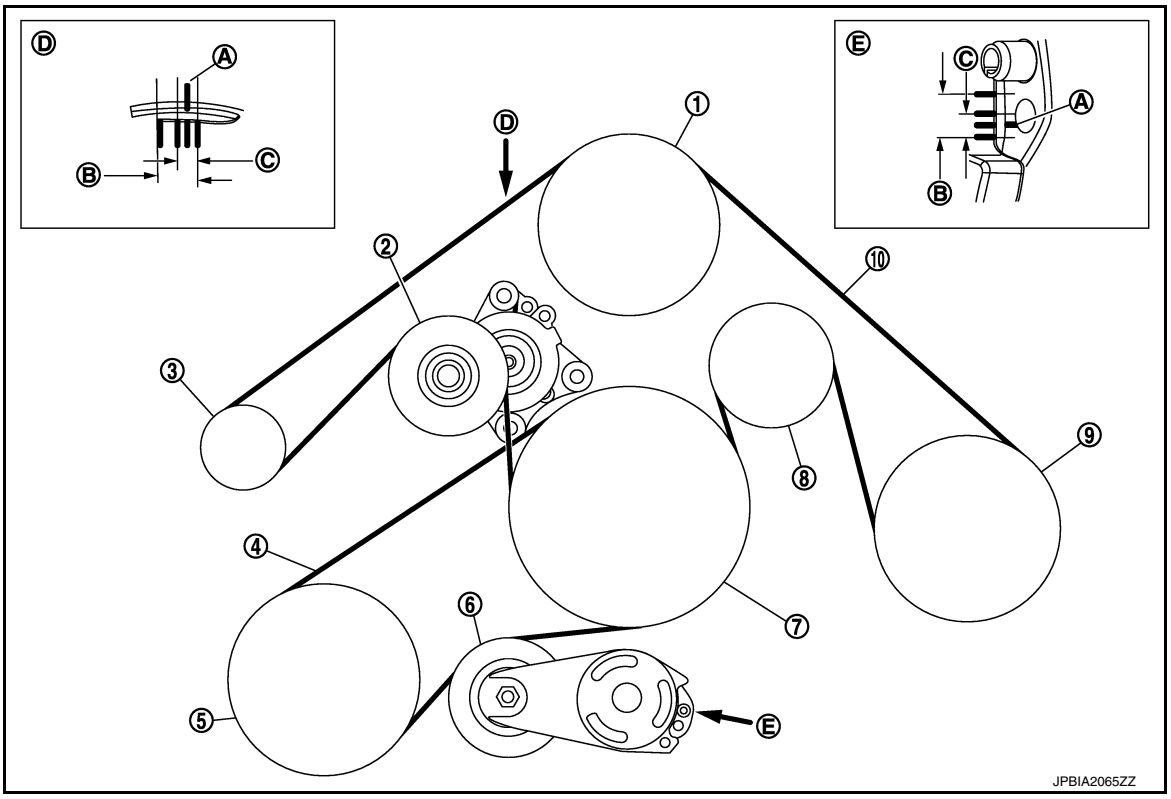
(TechMate No.) Tool name	Description
(J-43897-18) (J-43897-12) Oxygen sensor thread cleaner  JPBIA0238ZZ	Reconditioning the exhaust system threads before installing a new air fuel ratio sensor and heated oxygen sensor (Use with anti-seize lubricant shown below.) **A: J-43897-18 [18 mm (0.71 in) dia.] for zirconia heated oxygen sensor and air fuel ratio sensor** **B: J-43897-12 [12 mm (0.47 in) dia.] for titania heated oxygen sensor** C: Mating surface shave cylinder D: Flutes
(—) 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
(—) Feeler gauge  JPBIA1362ZZ	Inspection valve clearance (use a curved-tip gauge)
(—) Compression gauge with flexible type adapter	Checking compression pressure

PERIODIC MAINTENANCE

DRIVE BELTS

Exploded View

INFOID:0000000010582054



1.	Water pump	2.	Auto-tensioner (for alternator, water pump and A/C compressor belt)	3.	Alternator
4.	Power steering oil pump belt	5.	Power steering oil pump	6.	Auto-tensioner (for power steering oil pump belt)
7.	Crankshaft pulley	8.	Idler pulley	9.	A/C compressor
10.	Alternator, water pump and A/C compressor belt				
A.	Indicator	B.	Possible use range	C.	Range when new drive belt is installed
D.	View D	E.	View E		

Checking

INFOID:0000000010582055

WARNING:

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

- Remove air duct (inlet) when inspecting alternator, water pump and A/C compressor belt.
- Remove engine undercover with power tool when inspecting power steering oil pump belt.
- Check that the indicator (A) (notch on fixed side) of each auto-tensioner is within the possible use range (B).

  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 (C) 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:0000000010582056

Refer to EM-293, "Drive Belts".

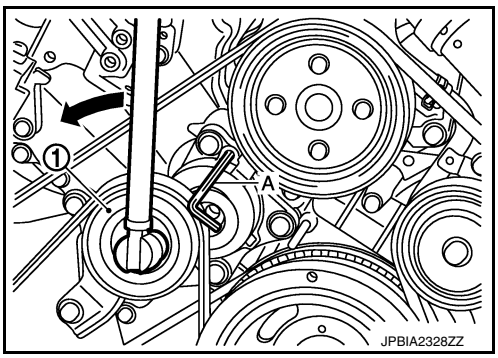
Removal and Installation

INFOID:0000000010582057

REMOVAL

Alternator, Water Pump and A/C Compressor Belt

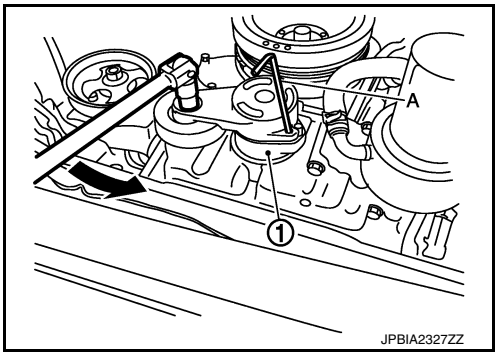
1. Remove air duct (inlet). Refer to EM-187, "Exploded View".
2. Remove reservoir tank. Refer to CO-43, "Exploded View".
3. With box wrench, and while securely holding the hexagonal part in pulley center of auto tensioner (1), move wrench handle in the direction of arrow (loosening direction of belt).
   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 (Never turn it clockwise). If turned clockwise, the complete auto tensioner must be replaced as a unit, including the pulley.**



4. Under the above condition, insert a metallic bar (A) 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.
   - Leave auto tensioner pulley arm locked until belt is installed again.
5. Remove alternator, water pump and A/C compressor belt.

Power Steering Oil Pump Belt

1. Remove engine undercover with power tool.
2. Remove alternator, water pump and A/C compressor belt. Refer to "Alternator, Water Pump and A/C Compressor Belt".
3. With box wrench, and while securely holding the hexagonal part in pulley center of auto tensioner (1), move wrench handle in the direction of arrow (loosening direction of belt).
   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 (Never turn it clockwise). If turned clockwise, the complete auto tensioner must be replaced as a unit, including the pulley.**



4. Under the above condition, insert a metallic bar (A) 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.
   - Leave auto tensioner pulley arm locked until belt is installed again.
5. Remove power steering oil pump 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:0000000010582058

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-173, "Exploded View".

AIR CLEANER FILTER

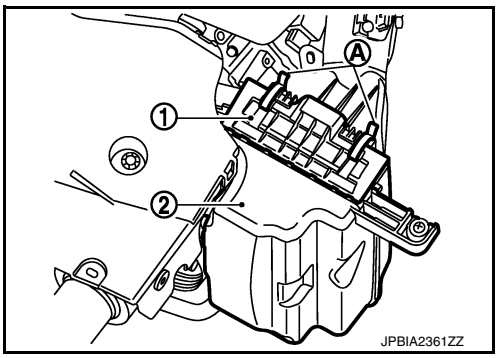
Removal and Installation

INFOID:0000000010582059

REMOVAL

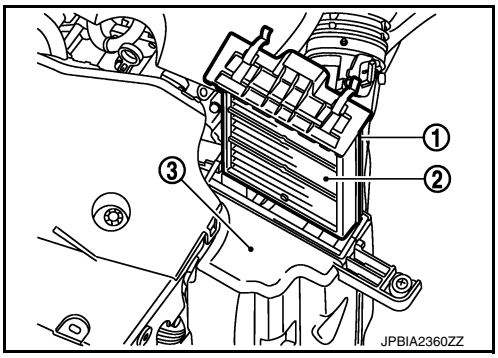
1. Unhook clips (A).

1 : Holder
2 : Air cleaner case



2. Remove air cleaner filter (2) from air cleaner case (3).

1 : Holder



INSTALLATION

Note the following item, and install in the reverse order of removal.
- Install the air cleaner filter by aligning the seal with the notch of air cleaner case.

Inspection (Viscous Paper Type)

INFOID:0000000010582060

INSPECTION AFTER REMOVAL

Examine with eyes that there is no stain, clogging, or damage on air cleaner element.
- Remove dusts (such as dead leafs) on air cleaner element surface and inside cleaner case.
- If clogging or damage is observed, replace the air cleaner element.

CAUTION:

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

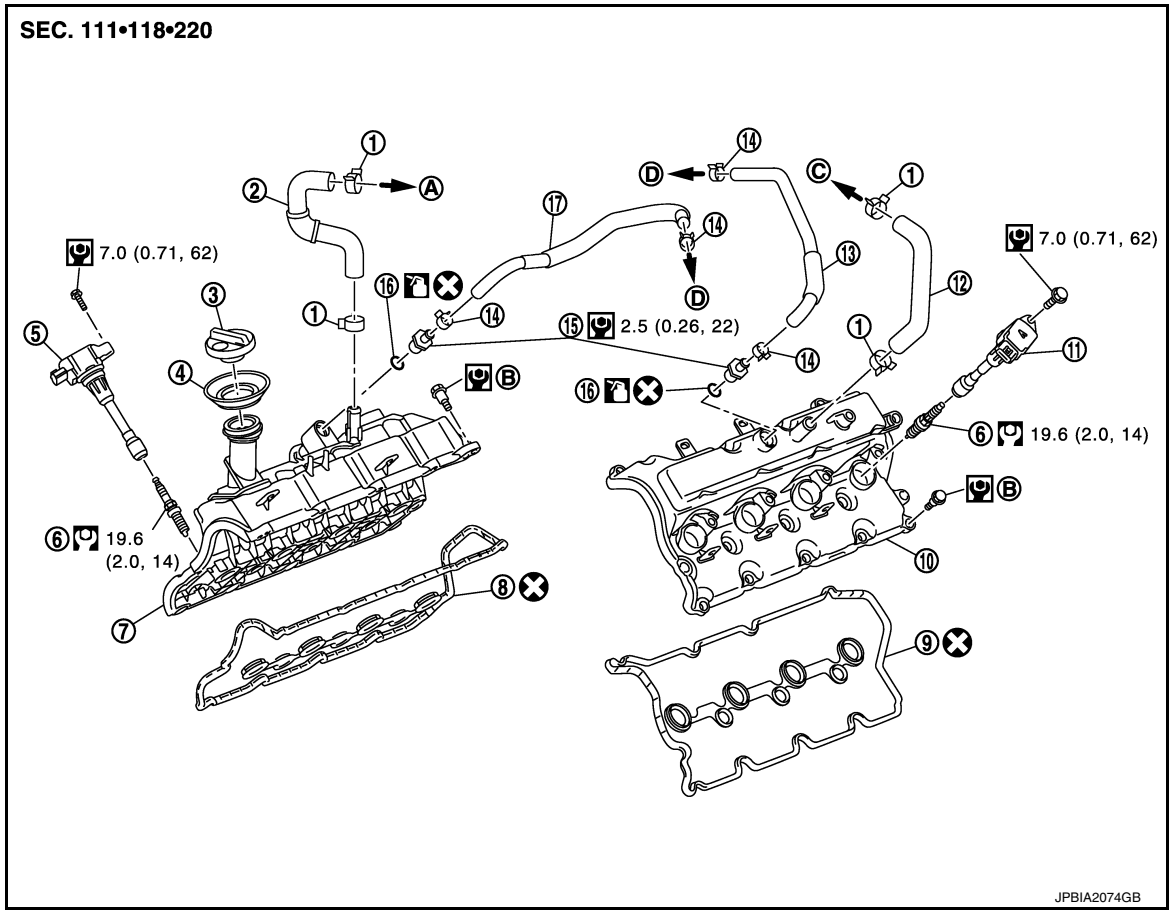
MAINTENANCE INTERVAL

Refer to MA-10, "FOR NORTH AMERICA : Introduction of Periodic Maintenance" (For NORTH AMERICA) or MA-13, "FOR MEXICO : Introduction of Periodic Maintenance" (For MEXICO).

SPARK PLUG

Exploded View

INFOID:0000000010582061



1.	Clamp	2.	PCV hose	3.	Oil filler cap
4.	Oil catcher	5.	Ignition coil (No. 1 - 6)	6.	Spark plug
7.	Rocker cover (bank 2)	8.	Rocker cover gasket (bank 2)	9.	Rocker cover gasket (bank 1)
10.	Rocker cover (bank 1)	11.	Ignition coil (No. 7, 8)	12.	PCV hose
13.	PCV hose	14.	Clamp	15.	PCV valve
16.	O-ring	17.	PCV hose		
A.	To air duct (bank 2)	B.	Comply with the installation procedure when tightening. Refer to EM-201	C.	To air duct (bank 1)
D.	To intake manifold				

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

Removal and Installation

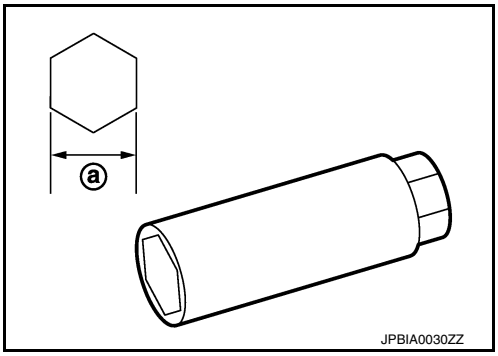
INFOID:0000000010582062

REMOVAL

1. Remove engine cover. Refer to EM-184, "Exploded View".
2. Remove ignition coil. Refer to EM-201, "Exploded View".

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

a : 14 mm (0.55 in)



INSTALLATION

Installation is the reverse order of removal.

Inspection

INFOID:0000000010582063

INSPECTION AFTER REMOVAL

Use the standard type spark plug for normal condition.

Spark plug (Standard type) : Refer to EM-293, "Spark Plug".

CAUTION:

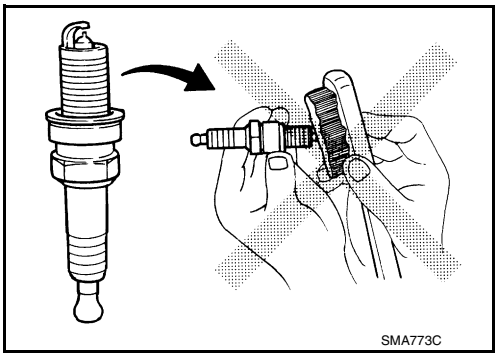
- **Never drop or impact spark plug.**
- **Never use a wire brush for cleaning.**
- **If plug tip is covered with carbon, use spark plug cleaner to clean.**

Cleaner air pressure

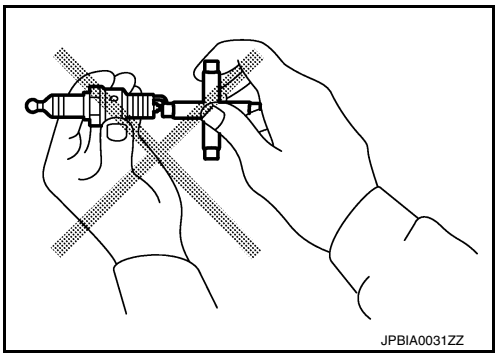
: Less than 588 kPa (6 kg/cm^2, 85 psi)

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-293, "Spark Plug".**
- **Spark plug gap adjustment is not required between replacement intervals.**



CAMSHAFT VALVE CLEARANCE

Inspection

INFOID:0000000010582064

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 camshaft (EXH) or valve-related parts, or at the occurrence of malfunction (poor starting, idle malfunction, unusual noise) due to aged deterioration in valve clearance.

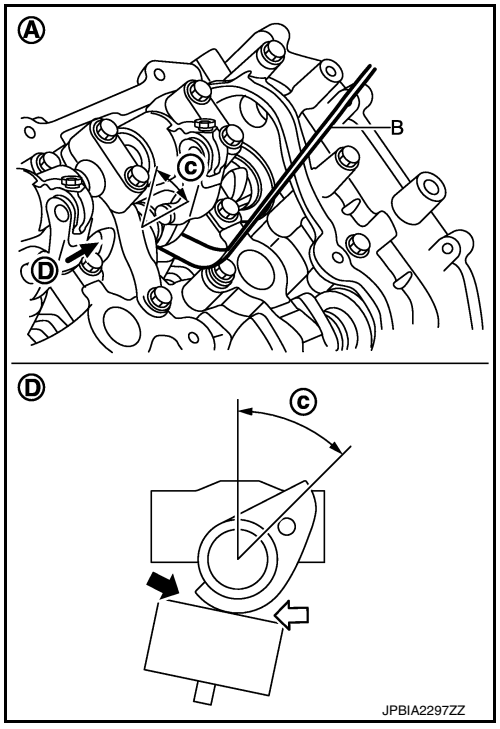
1. Remove rocker covers (bank 1 and bank 2). Refer to EM-201, "Removal and Installation".
2. Measure the valve clearance as per the following:
   - Use the feeler gauge (commercial service tool) of curved-tip. This allows the feeler gauge to access the clearance between camshaft (drive shaft) nose and valve lifter with ease.

   Valve clearance : Refer to EM-294, "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.

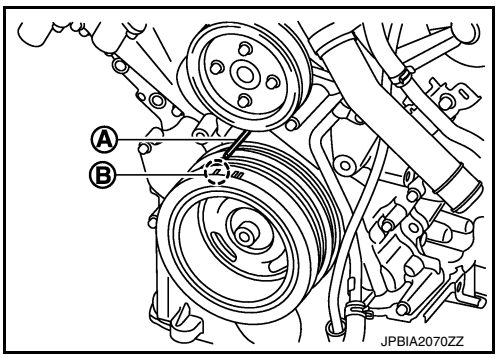
     A : Bank 2
     B : Feeler gauge (commercial service tool)
     c : 45 degrees (drive shaft nose angle)
     D : View D
     ⇦ : Insertion direction of feeler gauge on the bank 2
     ⬅ : Insertion direction of feeler gauge on the bank 1

   - 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).

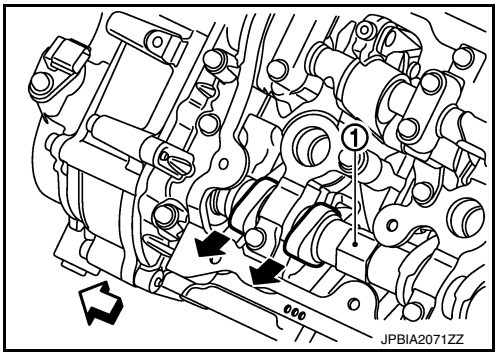


- Check that exhaust cam nose on No. 1 cylinder (engine front side of bank 1) is located as shown in the figure.

  1 : Camshaft (EXH) (bank 1)

  ⇦ : Engine front

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

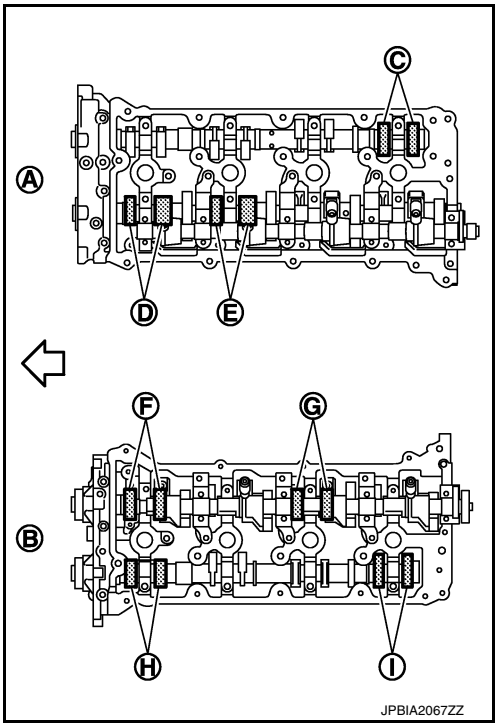


- By referring to the figure, measure the valve clearances at locations marked "×" as shown in the table below (locations indicated in the figure).

  ⇦ : Engine front

- No. 1 cylinder at compression TDC

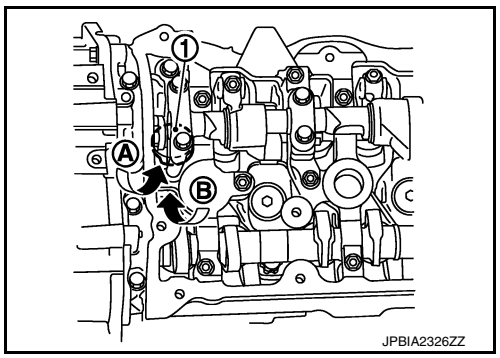
Measuring position [bank 2 (A)]		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.	No. 8 CYL.
No. 1 cylinder at compression TDC	EXH				× (C)
	INT	× (D)	× (E)		
Measuring position [bank 1 (B)]		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.	No. 7 CYL.
No. 1 cylinder at compression TDC	INT	× (F)		× (G)	
	EXH	× (H)			× (I)



NOTE:

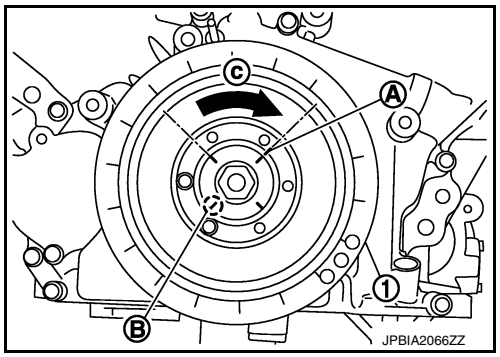
To measure valve clearance of No. 1 cylinder INT valve (front side), insert feeler gauge (commercial service tool) from the front side (A) of the control shaft bracket or camshaft (EXH) side (B).

1 : Valve lifter



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.

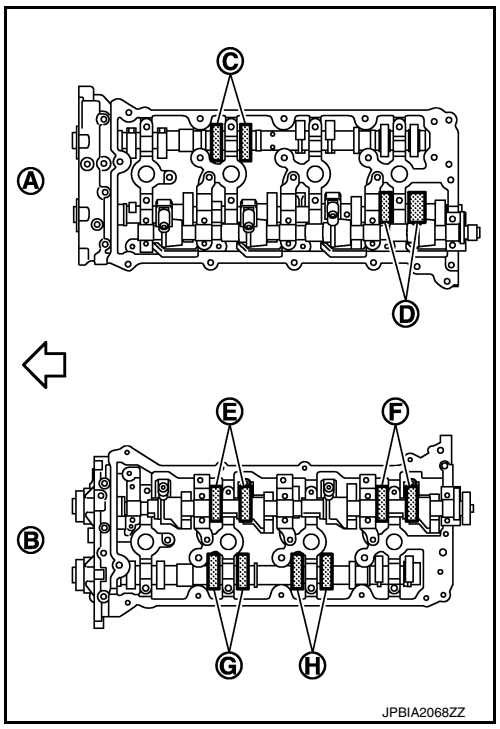
A : Paint mark



- 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

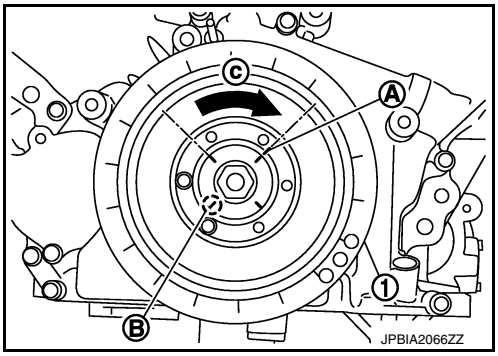


Measuring position [bank 2 (A)]		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.	No. 8 CYL.
No. 3 cylinder at compression TDC	EXH		× (C)		
	INT				× (D)
Measuring position [bank 1 (B)]		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.	No. 7 CYL.
No. 3 cylinder at compression TDC	INT		× (E)		× (F)
	EXH		× (G)	× (H)	

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.

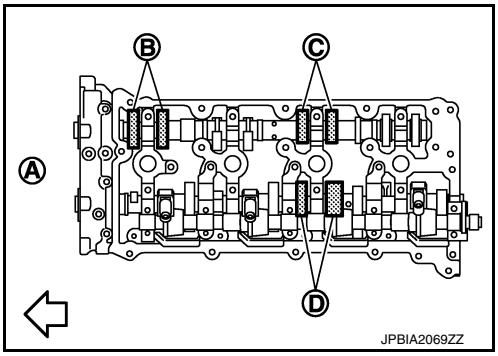
A : Paint mark



- 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)	

3. 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-247, "Inspection".
   - If a valve clearance on the intake side is out of specification, replace VVEL ladder assembly & cylinder head assembly. Refer to EM-238, "Exploded View".

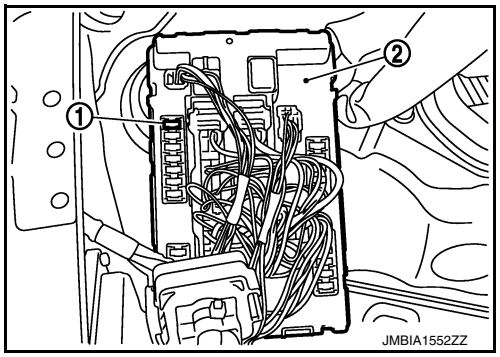
   CAUTION:
   Never adjust valve clearance on the intake side.
   NOTE:
   Since the valve lifter (INT) cannot be replaced by the piece, VVEL ladder assembly & cylinder head assembly replacement are required.

COMPRESSION PRESSURE

Inspection

INFOID:0000000010582065

1. Warm up engine thoroughly. Then, stop it.
2. Release fuel pressure. Refer to EC-1664, "Inspection".
3. Disconnect fuel pump fuse (1) from IPDM E/R (2) to avoid fuel injection during measurement.



4. Remove engine cover. Refer to EM-184, "Exploded View".
5. Remove ignition coil and spark plug from each cylinder. Refer to EM-201, "Exploded View".
6. Connect engine tachometer (not required in use of CONSULT).
7. Measure compression pressure using compression gauge connected with flexible type adapter (commercial service tool).
8. With accelerator pedal fully depressed, turn ignition switch to “START” for cranking. When the gauge pointer stabilizes, read the compression pressure and the engine rpm. Perform these steps to check each cylinder.

Compression pressure : Refer to EM-293, "General Specification".

CAUTION:

- **Measure a six-cylinder under the same conditions since a measurement depends on measurement conditions (engine water temperature, etc.).**
- **Always use a fully charged battery to obtain the specified engine speed.**
- If the engine speed is out of the specified range, check battery liquid for proper gravity. Check the engine speed again with normal battery gravity. Refer to PG-3, "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, and 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 recheck it for compression.
  - If the added engine oil improves the compression, piston rings may be worn out or damaged. Check piston rings and replace if necessary. Refer to EM-267, "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-267, "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-257, "Disassembly and Assembly".

9. After inspection is completed, install removed parts.
10. Start the engine, and check that the engine runs smoothly.
11. Perform trouble diagnosis. If DTC appears, erase it. Refer to EC-1275, "Description".

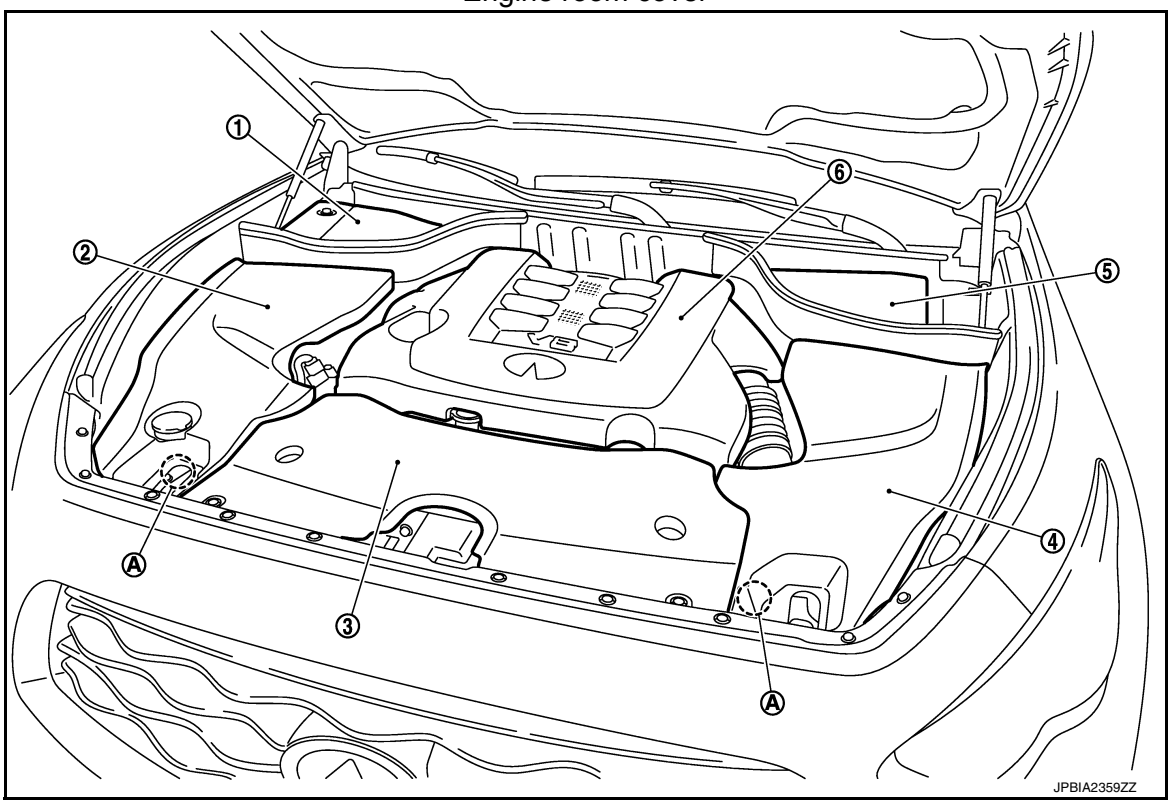
REMOVAL AND INSTALLATION

ENGINE ROOM COVER

Exploded View

INFOID:0000000010582066

Engine room cover

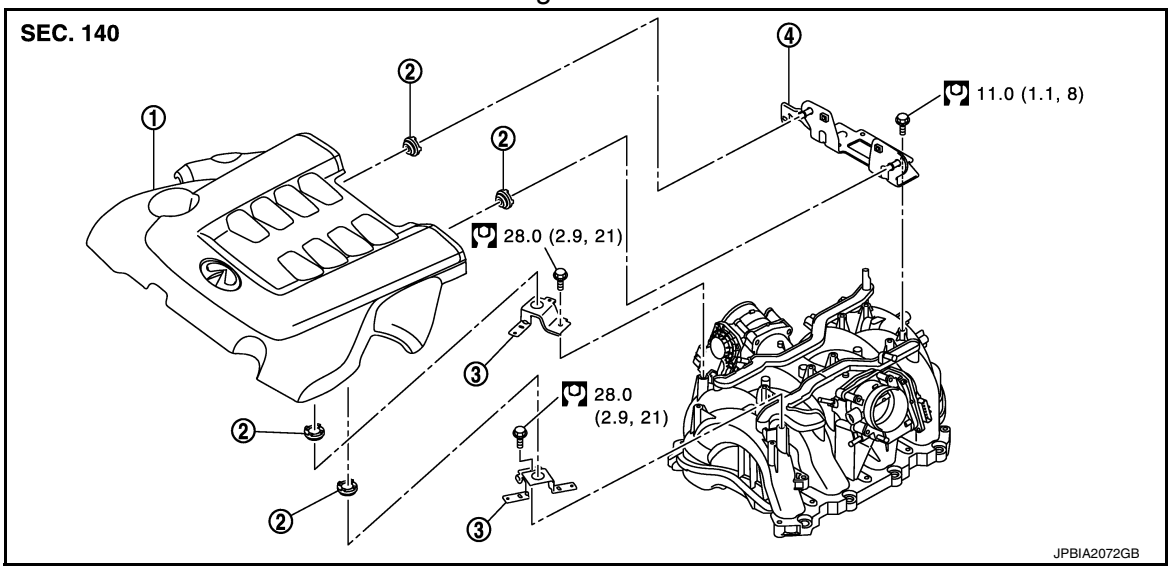


1. Battery cover
2. Engine room cover (RH)
3. Air duct (inlet)
4. Engine room cover (LH)
5. Brake master cylinder cover
6. Engine cover

A. Clip

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

Engine cover



1. Engine cover
2. Grommet
3. Bracket
4. Bracket (rear)

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

Removal and Installation

INFOID:0000000010582067

REMOVAL

CAUTION:

Never damage or scratch engine cover when installing or removing.

1. Remove clip, and remove engine room cover (RH and LH).
2. Remove engine cover as per the following:
   - Front side: Lift and remove fit.
   - Rear side: Pull out to forward and remove fit.
3. Remove battery cover and brake master cylinder cover, if necessary.
4. Remove air duct (inlet). Refer to EM-187, "Exploded View".

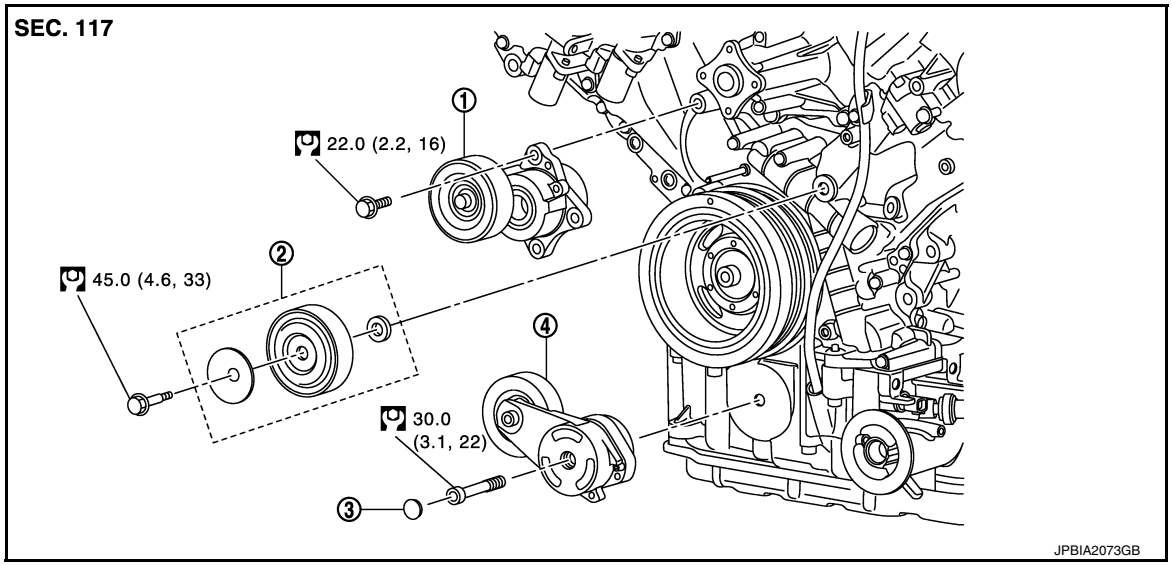
INSTALLATION

Installation is the reverse order of removal.

DRIVE BELT AUTO TENSIONER AND IDLER PULLEY

Exploded View

INFOID:0000000010582068



1. Auto-tensioner (for alternator, water pump and A/C compressor belt)
2. Idler pulley
3. Cover
4. Auto-tensioner (for power steering oil pump belt)

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

Removal and Installation

INFOID:0000000010582069

Removal

CAUTION:

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

1. Remove drive belts. Refer to EM-173, "Exploded View".
   - Keep auto-tensioner pulley arm locked after drive belt is removed.
2. Remove drive belt auto-tensioners.
   - 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.

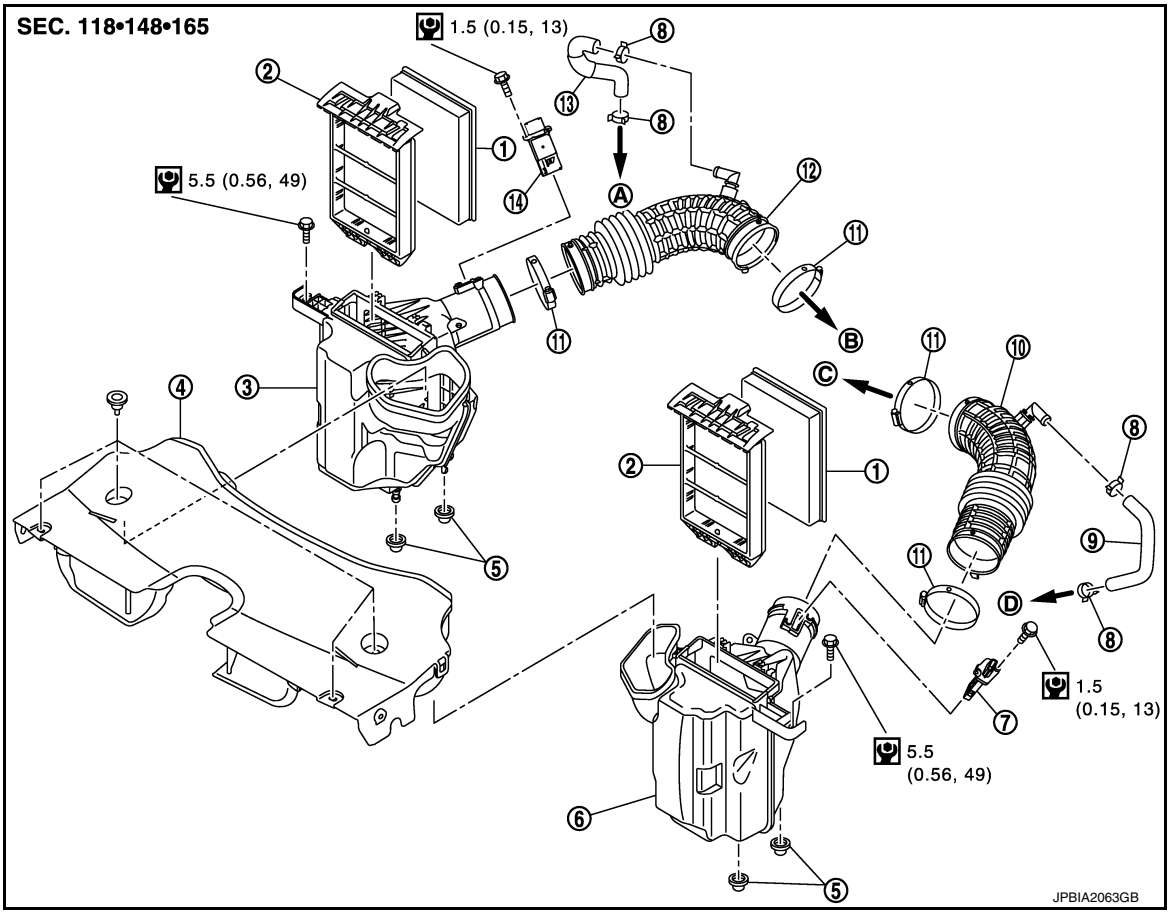
CAUTION:

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

AIR CLEANER AND AIR DUCT

Exploded View

INFOID:0000000010582070



1. Air cleaner filter	2. Holder	3. Air cleaner case (bank 2)
4. Air duct (inlet)	5. Grommet	6. Air cleaner case (bank 1)
7. Mass air flow sensor (bank 1)	8. Clamp	9. PCV hose
10. Air duct (bank 1)	11. Clamp	12. Air duct (bank 2)
13. PCV hose	14. Mass air flow sensor (bank 2)	
A. To rocker cover (bank 2)	B. To electric throttle control actuator (bank 2)	C. To electric throttle control actuator (bank 1)
D. To rocker cover (bank 1)		

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

Removal and Installation

INFOID:0000000010582071

REMOVAL

1. Remove engine cover and engine room cover (RH and LH). Refer to EM-184, "Exploded View".
2. Remove air duct (inlet).
3. Disconnect mass air flow sensor harness connector.
4. Disconnect PCV hose.
5. Remove air cleaner case & mass air flow sensor assembly and air duct by disconnecting their joints.
   • Add matching marks, if necessary for easier installation.
6. Remove mass air flow sensor from air cleaner case, if necessary.
   CAUTION:
   Handle mass air flow sensor according to the following instructions.

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

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:0000000010582072

INSPECTION AFTER REMOVAL

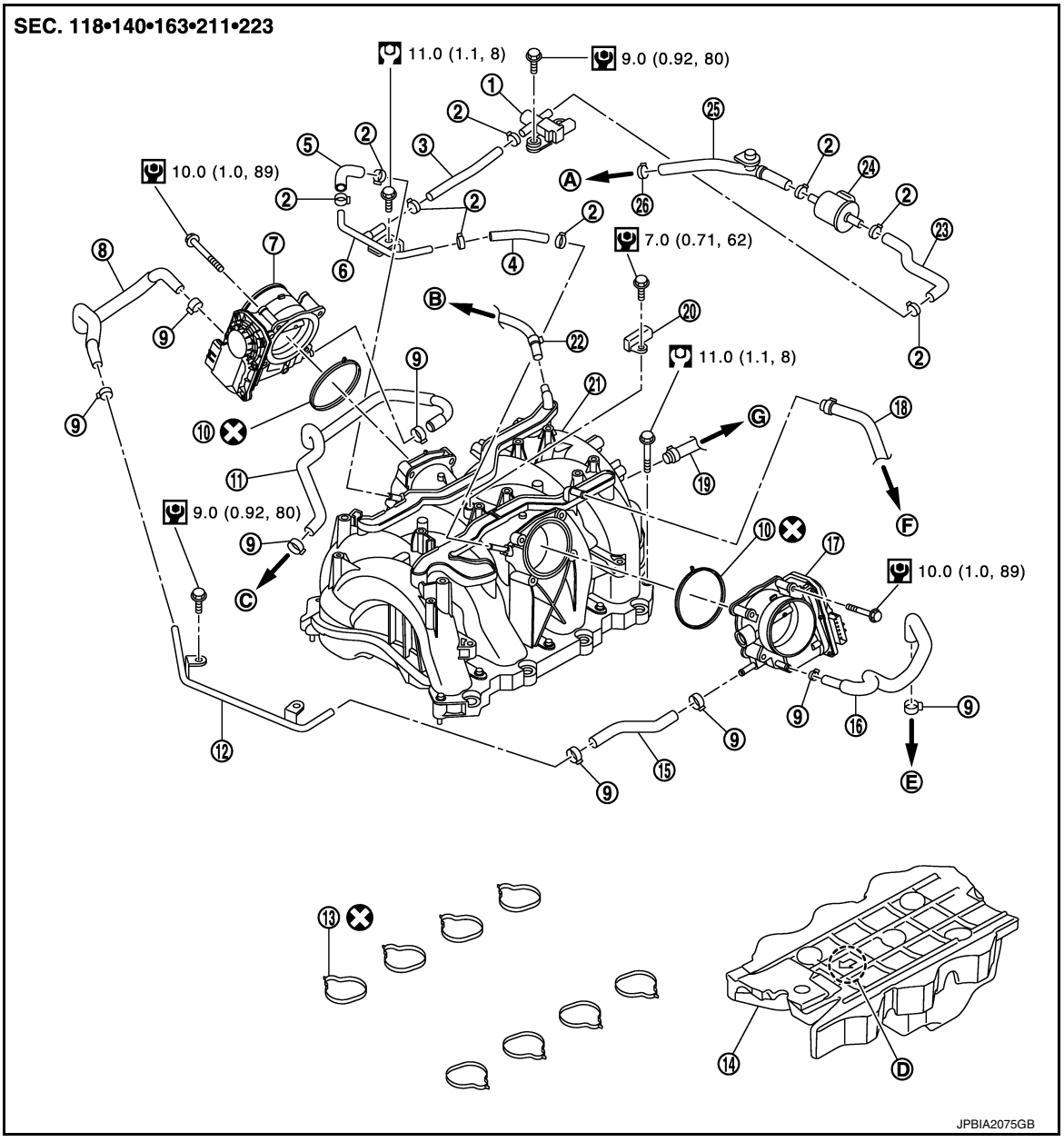
Inspect air duct assembly for crack or tear.

- If damage is found, replace air duct assembly

INTAKE MANIFOLD

Exploded View

INFOID:0000000010582073



1.	EVAP canister purge control solenoid valve	2.	Clamp	3.	EVAP hose
4.	EVAP hose	5.	EVAP hose	6.	EVAP tube
7.	Electric throttle control actuator (bank 2)	8.	Water hose	9.	Clamp
10.	Gasket	11.	Water hose	12.	Water pipe
13.	Gasket	14.	Acoustic absorbent	15.	Water hose
16.	Water hose	17.	Electric throttle control actuator (bank 1)	18.	PCV hose
19.	Vacuum hose	20.	Manifold absolute pressure (MAP) sensor	21.	Intake manifold
22.	PCV hose	23.	EVAP hose	24.	Vacuum tank
25.	EVAP service port hose	26.	Clamp		

A. To centralized under-floor piping B. To rocker cover (bank 2) C. To water inlet
D. Front mark E. To cylinder head F. To rocker cover (bank 1)
G. To brake booster

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

Removal and Installation

INFOID:0000000010582074

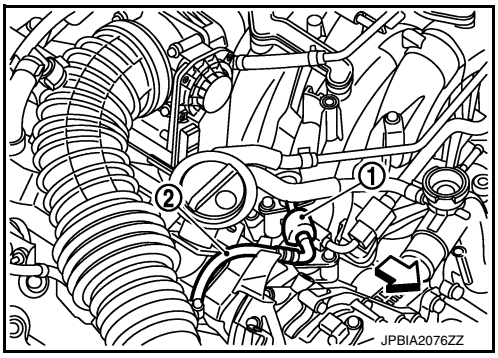
REMOVAL

WARNING:

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

1. Remove engine cover and engine room cover (RH and LH). Refer to EM-184, "Exploded View".
2. Release fuel pressure. Refer to EC-1664, "Inspection".
3. Remove air duct (inlet) and air duct. Refer to EM-187, "Exploded View".
4. Remove quick connector cap (1) and disconnect fuel feed hose (2) on engine side. Refer to EM-192, "Exploded View".

   ⇦ : Engine front



5. Remove engine cover bracket. Refer to EM-184, "Exploded View".
6. Remove fuel injector and fuel tube assembly. Refer to EM-192, "Exploded View".
7. Disconnect manifold absolute pressure (MAP) sensor and air fuel ratio sensor 1 (bank 1) harness connector.
8. Remove vacuum tank, EVAP service port hose and EVAP canister purge control solenoid valve.
9. Disconnect PCV hoses and vacuum hose from intake manifold.
   • Add matching marks as necessary for easier installation.
10. Drain engine coolant from radiator. Refer to CO-37, "Draining".

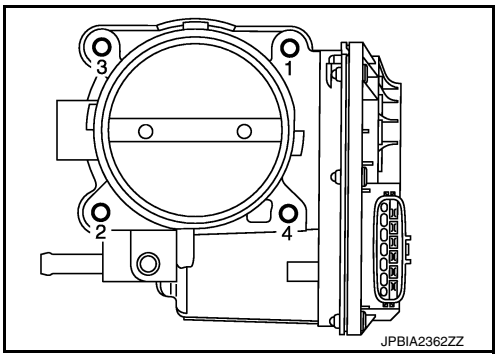
    CAUTION:
    - **Perform this step when the engine is cold.**
    - **Never spill engine coolant on drive belts.**

    NOTE:

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

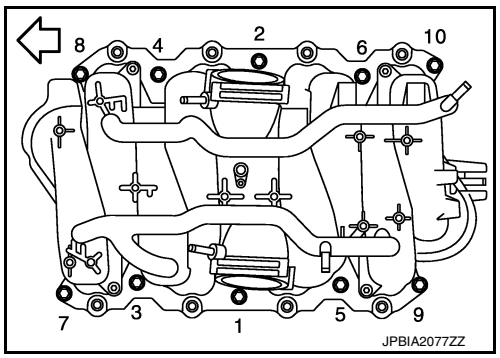
    CAUTION:
    - **Handle carefully to avoid any impact to electric throttle control actuator.**
    - **Never disassemble.**



12. Remove intake manifold with power tool.

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

⇦ : Engine front



13. Remove intake manifold gaskets.
CAUTION:
Cover engine openings to avoid entry of foreign materials.
14. Remove manifold absolute pressure (MAP) sensor, if necessary.
CAUTION:
Handle carefully to avoid any impact to manifold absolute pressure (MAP) sensor.
15. Remove acoustic absorbent.

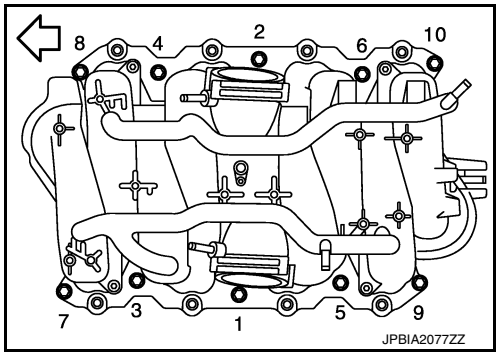
INSTALLATION

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

Intake Manifold

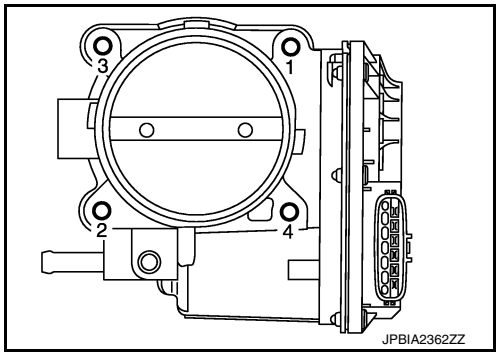
Tighten in numerical order as shown in the figure.

⇦ : Engine front



Electric Throttle Control Actuator

- Tighten in numerical order as shown in the figure.
NOTE:
  - The figure shows the electric throttle control actuator (bank 1) viewed from the air duct side.
  - Viewed from the air duct side, the order of tightening mounting bolts of electric throttle control actuator (bank 1) is the same as that of the electric throttle control actuator (bank 2).
- Perform the “Throttle Valve Closed Position Learning” when harness connector of electric throttle control actuator is disconnected. Refer to EC-1136, "THROTTLE VALVE CLOSED POSITION LEARNING : Description".
- Perform the “Idle Air Volume Learning” and “Throttle Valve Closed Position Learning” when electric throttle control actuator is replaced. Refer to EC-1136, "IDLE AIR VOLUME LEARNING : Description" and EC-1136, "THROTTLE VALVE CLOSED POSITION LEARNING : Description".



Water Hose

Insert hose by 27 to 32 mm (1.06 to 1.26 in) from connector end.

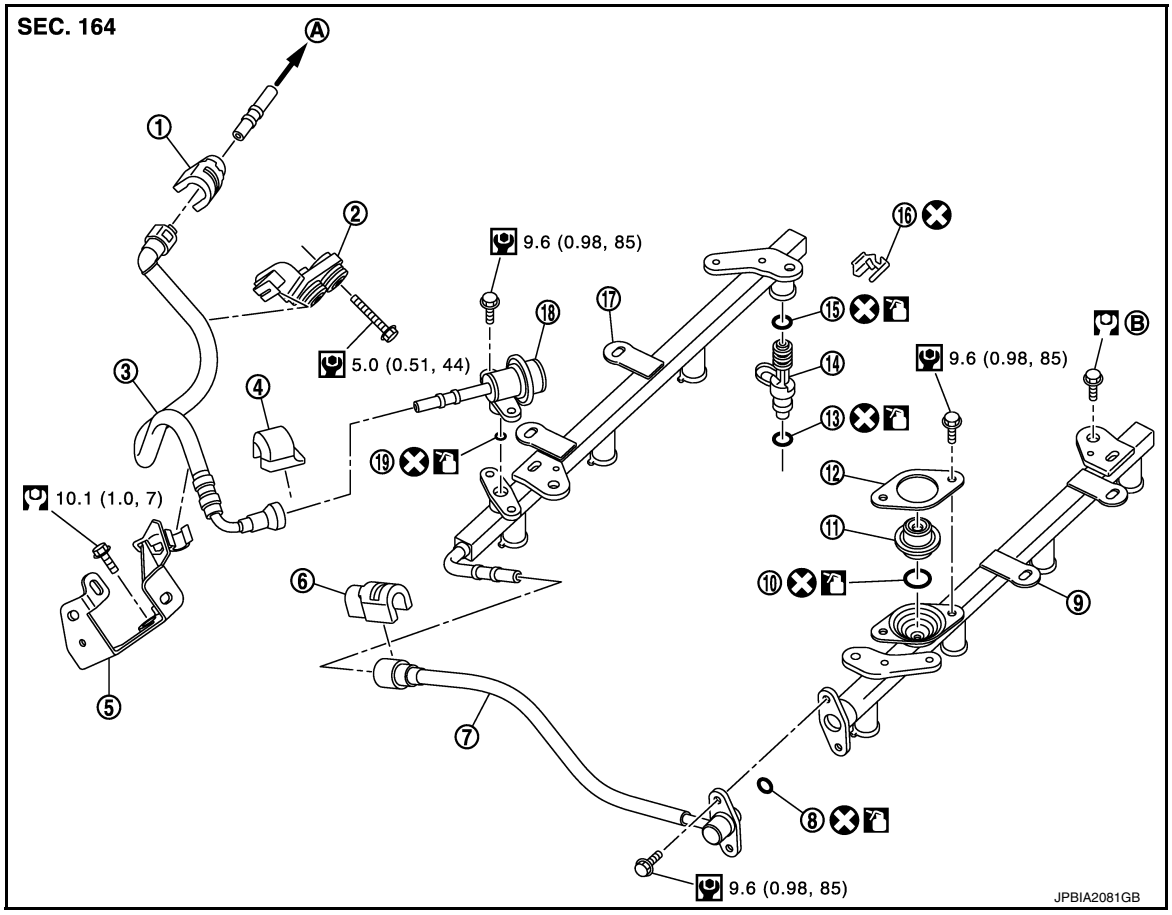
Vacuum Hose

Refer to EC-1665, "Inspection".

FUEL INJECTOR AND FUEL TUBE

Exploded View

INFOID:0000000010582075



1. Quick connector cap	2. Fuel hose bracket	3. Fuel feed hose
4. Quick connector cap	5. Fuel hose bracket	6. Quick connector cap
7. Fuel hose (center)	8. O-ring	9. Fuel tube (bank 1)
10. O-ring	11. Fuel damper	12. Fuel damper cap
13. O-ring (green)	14. Fuel injector	15. O-ring (black)
16. Clip	17. Fuel tube (bank 2)	18. Fuel feed damper
19. O-ring		
A. To centralized under-floor piping	B. Comply with the installation procedure when tightening. Refer to EM-192	

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

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

Removal and Installation

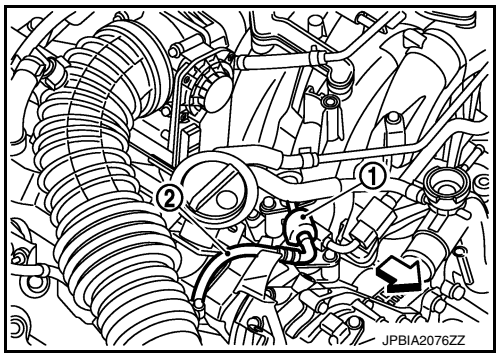
INFOID:0000000010582076

REMOVAL

WARNING:
- **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. Remove engine cover and engine room cover (RH and LH). Refer to EM-184, "Exploded View".

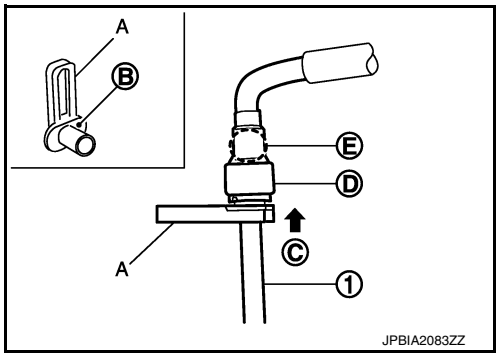
2. Release fuel pressure. Refer to EC-1664, "Inspection".
3. Remove the fuel feed hose (2) on the fuel feed damper side with quick connector release (commercial service tool: J-45488) as per the followings steps.



1. : Quick connector cap
⇦ : Engine front

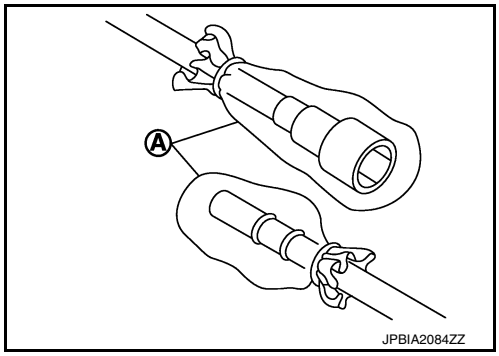
CAUTION:
Use the quick connector release for removing the fuel feed hose on the centralized under-floor piping side as well as the fuel feed damper side although the shape of the quick connector is different.

a. Remove quick connector cap from quick connector connection.
b. With the sleeve side (B) of quick connector release (A) facing to quick connector (D), install quick connector release onto fuel feed hose.



1 : Fuel feed damper
C : Insert and retain

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

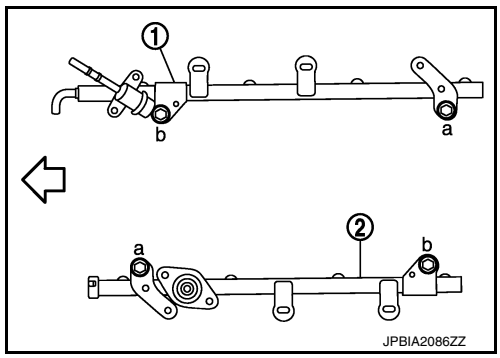


4. Remove air duct. Refer to EM-187, "Exploded View".
5. Remove electric throttle control actuator. Refer to EM-189, "Exploded View".
6. Remove fuel hose (center).
- The procedure for removing the quick connector is the same as for removing the fuel feed damper.

CAUTION:
Disconnect quick connector by using quick connector release (commercial service tool: J-45488), not by picking out retainer tabs.

7. Remove fuel tube and fuel injector assembly.

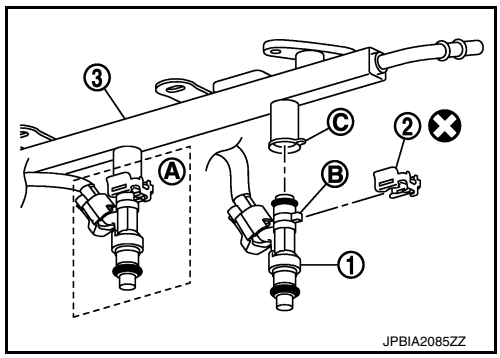
- Loosen mounting bolts (b) first. Then loosen mounting bolts (a) shown in the figure.



1 : Fuel tube (bank 2)
2 : Fuel tube (bank 1)
⇦ : Engine front

CAUTION:
Never tilt it, or remaining fuel in pipes may flow out from pipes.

8. Remove fuel injector (1) from fuel tube (3) as per the following:



A : Installed condition
B : Clip mounting groove
C : Protrusion

a. Open and remove clip (2).
b. Remove fuel injector from fuel tube by pulling straight.

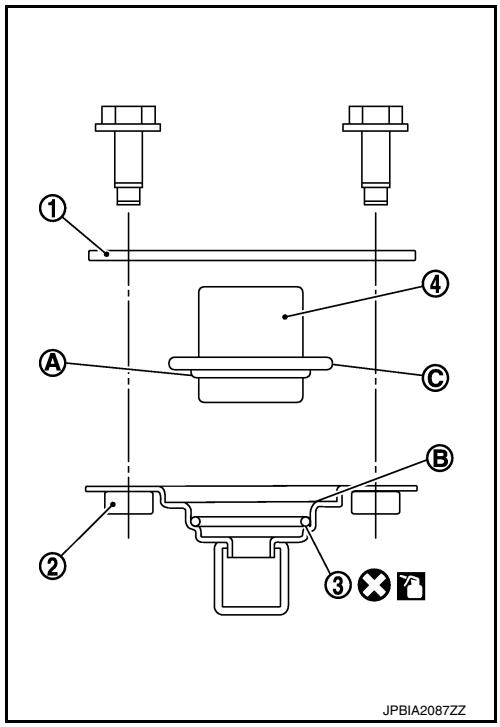
CAUTION:
- **Be careful with remaining fuel that may go out from fuel tube.**
- **Be careful not to damage injector nozzles during removal.**
- **Never bump or drop fuel injector.**
- **Never disassemble fuel injector.**

9. Disconnect sub harness connector from fuel injectors.
10. Remove fuel damper and fuel feed damper, if necessary.

INSTALLATION

CAUTION:
Do not reuse O-rings.

1. Install fuel damper (4) as per the following:



1 : Fuel damper cap

a. Install new O-ring (3) to fuel tube (bank 1) (2) as shown. When handling new O-ring, pay attention to the following caution items:

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

b. Install spacer (A) to fuel damper. Insert fuel damper straight into fuel tube (bank 1).

CAUTION:
- **Insert straight, check that the axis is lined up.**
- **Insert fuel damper at 130 N (13.3 kg, 29.2 lb) or less to prevent damage to the parts**
- **Insert fuel damper until the rim (C) reaches the cap flange (B).**

c. Tighten mounting bolts evenly in turn.

- After tightening mounting bolts, check that there is no gap between flange and fuel tube (bank 1).

2. Install fuel feed damper.
   - Handling procedure of O-ring is the same as that of fuel damper.
   - Insert fuel feed damper straight into fuel tube (bank 2).

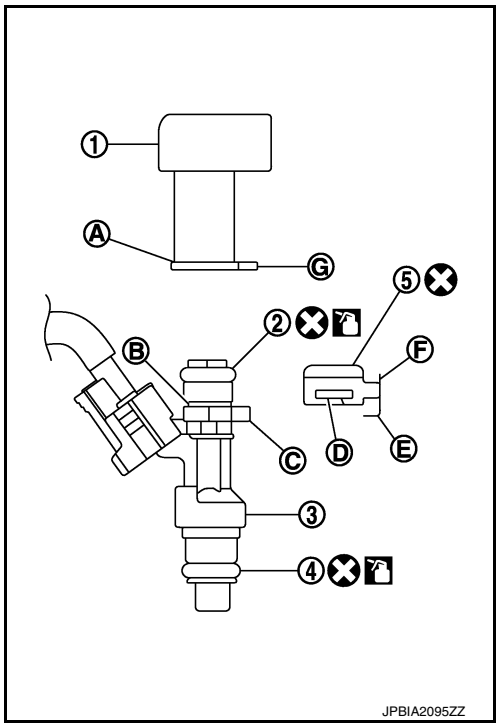
   CAUTION:
   Insert fuel feed damper at 147 N (15 kg, 33.1 lb) or less to prevent damage to the parts
   - Tighten mounting bolts evenly in turn.
   - After tightening mounting bolts, check that there is no gap between flange and fuel tube (bank 2).
3. Install new O-rings to fuel injector paying attention to the following caution.

   CAUTION:
   - **Do not reuse O-rings.**
   - **Upper and lower O-ring are different. Be careful not to confuse them.**

   Fuel tube side : Black
   Nozzle side : Green

   - **Handle O-ring with bare hands. Never wear gloves.**
   - **Lubricate O-ring with new engine oil.**
   - **Never clean O-ring with solvent.**
   - **Check that O-ring and its mating part are free of foreign material.**
   - **When installing O-ring, be careful not to scratch it with tool or fingernails. Also be careful not to twist or stretch O-ring. If O-ring was stretched while it was being attached, never insert it quickly into fuel tube.**
   - **Insert O-ring straight into fuel injector. Never decenter or twist it.**
4. Install fuel injector (3) to fuel tube (1) as per the following:

   2 : O-ring (black)
   4 : O-ring (green)



JPBIA2095ZZ

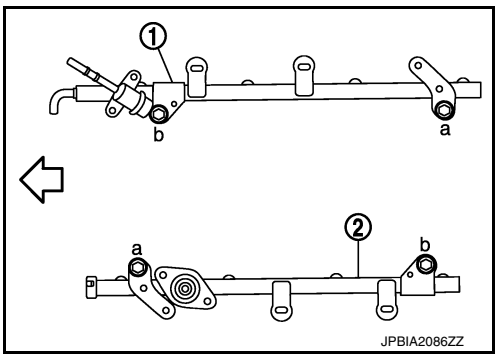
   a. Insert clip (5) into clip mounting groove (B) on fuel injector.
      - Insert clip so that protrusion (C) of fuel injector matches cutout (E) of clip.

      CAUTION:
      - **Never reuse clip. Replace it with a new one.**
      - **Be careful to keep clip from interfering with O-ring. If interference occurs, replace O-ring.**
   b. Insert fuel injector into fuel tube with clip attached.
      - Insert it while matching it to the axial center.
      - Insert fuel injector so that protrusion (G) of fuel tube matches cutout (F) of clip.
      - Check that fuel tube flange (A) is securely fixed in flange fixing groove (D) on clip.

      CAUTION:
      Insert fuel injector at 147 N (15 kg, 33.1 lb) or less to prevent damage to the parts
   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 tube are aligned with cutouts of clips after installation.
5. Install fuel tube and fuel injector assembly.

- Tighten mounting bolts (a) first. Then tighten mounting bolts (b) shown in the figure.

1 : Fuel tube (bank 2)
2 : Fuel tube (bank 1)
⇦ : Engine front



1st step : 10.1 N·m (1.0 kg-m, 7 ft-lb)
2nd step : 23.6 N·m (2.4 kg-m, 17 ft-lb)

CAUTION:
- **Be careful not to let tip of injector nozzle come in contact with other parts.**
- **Insert fuel injector at 147 N (15 kg, 33.1 lb) or less to prevent damage to the parts**

6. Install quick connecters as per the following:
- Unless otherwise indicated, the installation to the engine side and centralized under-floor piping side is exactly alike.

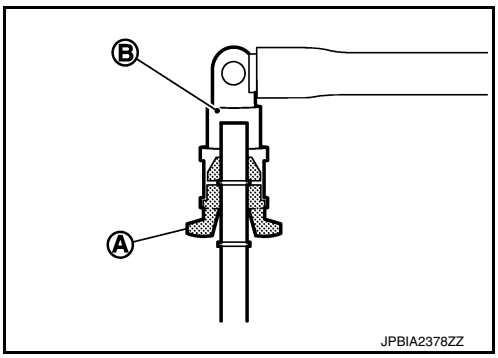
a. Check no foreign substances are deposited in and around fuel piping and quick connector, and no damage on them.

b. Thinly apply new engine oil around fuel piping from tip end to spool end.

c. Align center to insert quick connector straightly into fuel piping.

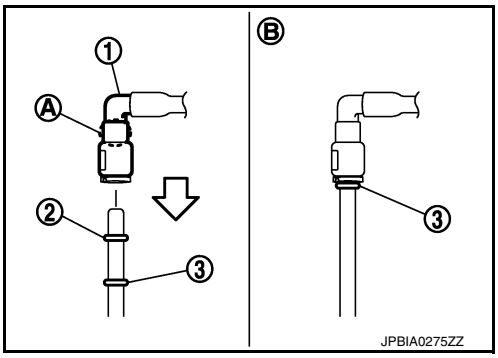
Fuel hose (center) and centralized under-floor piping side:
- Visually confirm that the two retainer tabs (A) are connected to the quick connector (B).

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



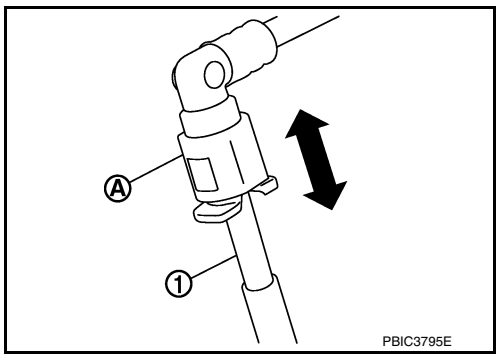
Fuel feed damper side:
- Insert quick connector to fuel feed damper piping until top spool (2) is completely inside quick connector and 2nd level spool (3) exposes just below quick connector.

B : Fitted condition
⇦ : Upright insertion



CAUTION:
- **Hold (A) position as shown in the figure when inserting fuel feed hose (1) 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.**

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

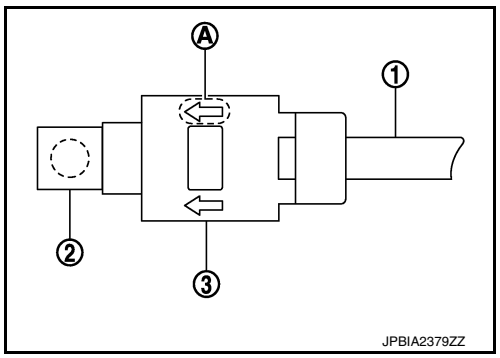


e. Install quick connector cap (3) to quick connector connection.

1 : Fuel tube (bank 1)
2 : Fuel hose (center)

- Install quick connector cap with arrow (A) on surface facing the direction of quick connector.

CAUTION:
If cap cannot be installed smoothly, quick connector may have not be installed correctly. Check connection again.
NOTE:
Figure shows an example fuel feed damper side.



7. Install in the reverse order of removal.

Inspection

INFOID:0000000010582077

INSPECTION AFTER INSTALLATION

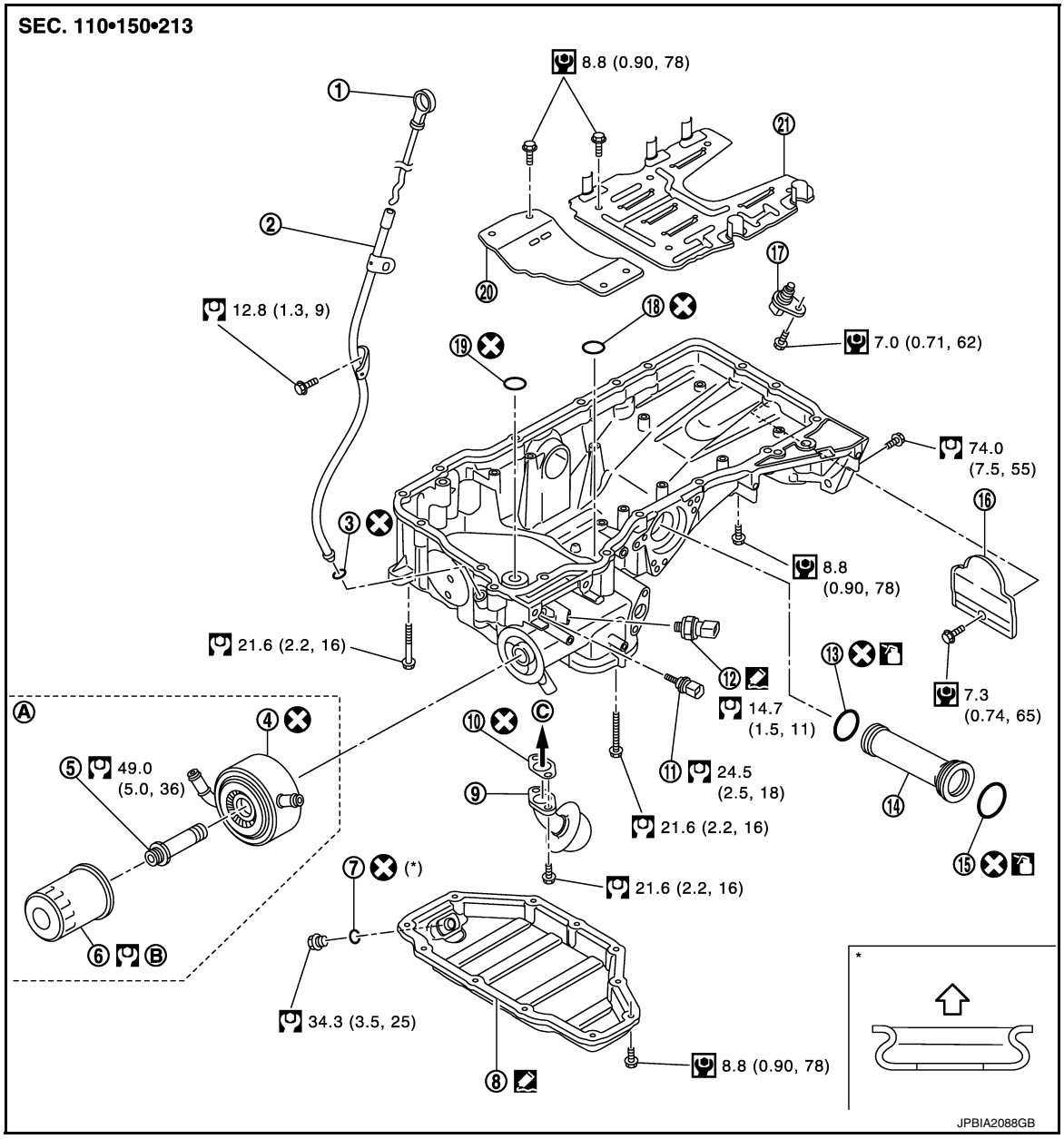
Check for Fuel Leakage

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:0000000010582078



1. Oil level gauge	2. Oil level gauge guide	3. O-ring
4. Oil cooler	5. Connector bolt	6. Oil filter
7. Drain plug washer	8. Oil pan (lower)	9. Oil strainer
10. Gasket	11. Oil temperature sensor	12. Oil pressure switch
13. O-ring	14. Axle pipe	15. O-ring
16. Rear plate cover	17. Crankshaft position sensor (POS)	18. O-ring
19. O-ring	20. Baffle plate	21. Baffle plate
A. Comply with the installation procedure when tightening. Refer to LU-30	B. Comply with the installation procedure when tightening. Refer to LU-29	C. Oil pump side

⇦ : Oil pan side

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

Removal and Installation

INFOID:0000000010582079

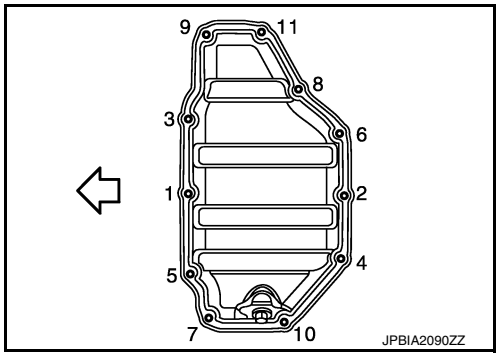
REMOVAL

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

1. Drain engine oil. Refer toLU-27, "Draining".
2. Remove oil pan (lower) as per the following:

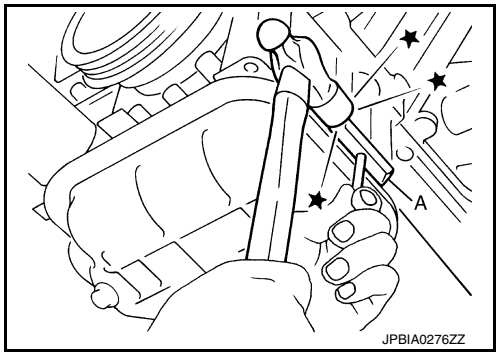
a. Loosen mounting bolts in reverse order as shown in the figure to remove.

⇦ : 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).



3. Remove oil strainer.

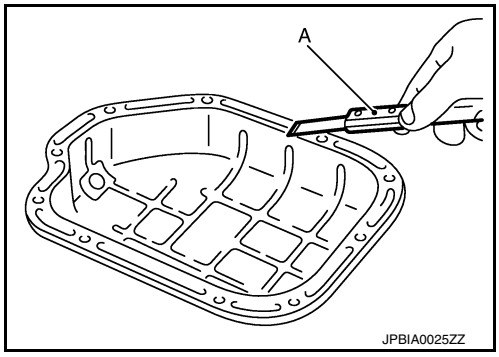
INSTALLATION

CAUTION:
Do not reuse drain plug washer.

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

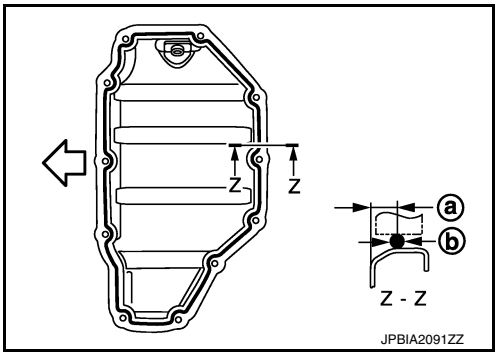
a. Use scraper (A) to remove old liquid gasket from mating surfaces.
- Remove old liquid gasket from the bolt holes and thread.

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



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.

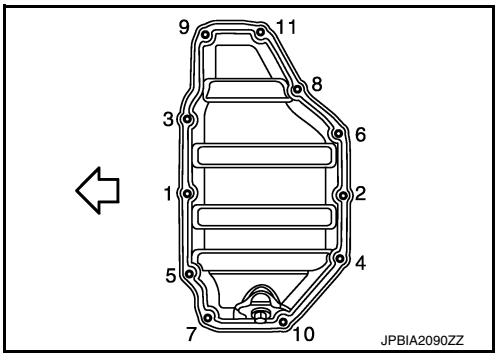
a : 7.5 - 9.5 mm (0.295 - 0.374 in)
b : ϕ4.0 - 5.0 mm (0.157 - 0.197 in)
⇦ : Engine front



Use Genuine RTV Silicone Sealant or an equivalent. Refer to GI-24, "Recommended Chemical Products and Sealants".
CAUTION:
Attaching must be done within 5 minutes after coating.

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

⇦ : Engine front



3. Install oil pan drain plug.
CAUTION:
Do not reuse drain plug washer.
- Refer to the figure of the components of on the prior page for installation direction of drain plug washer. Refer to EM-198, "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:0000000010582080

INSPECTION AFTER REMOVAL

Clean oil strainer if any object is attached.

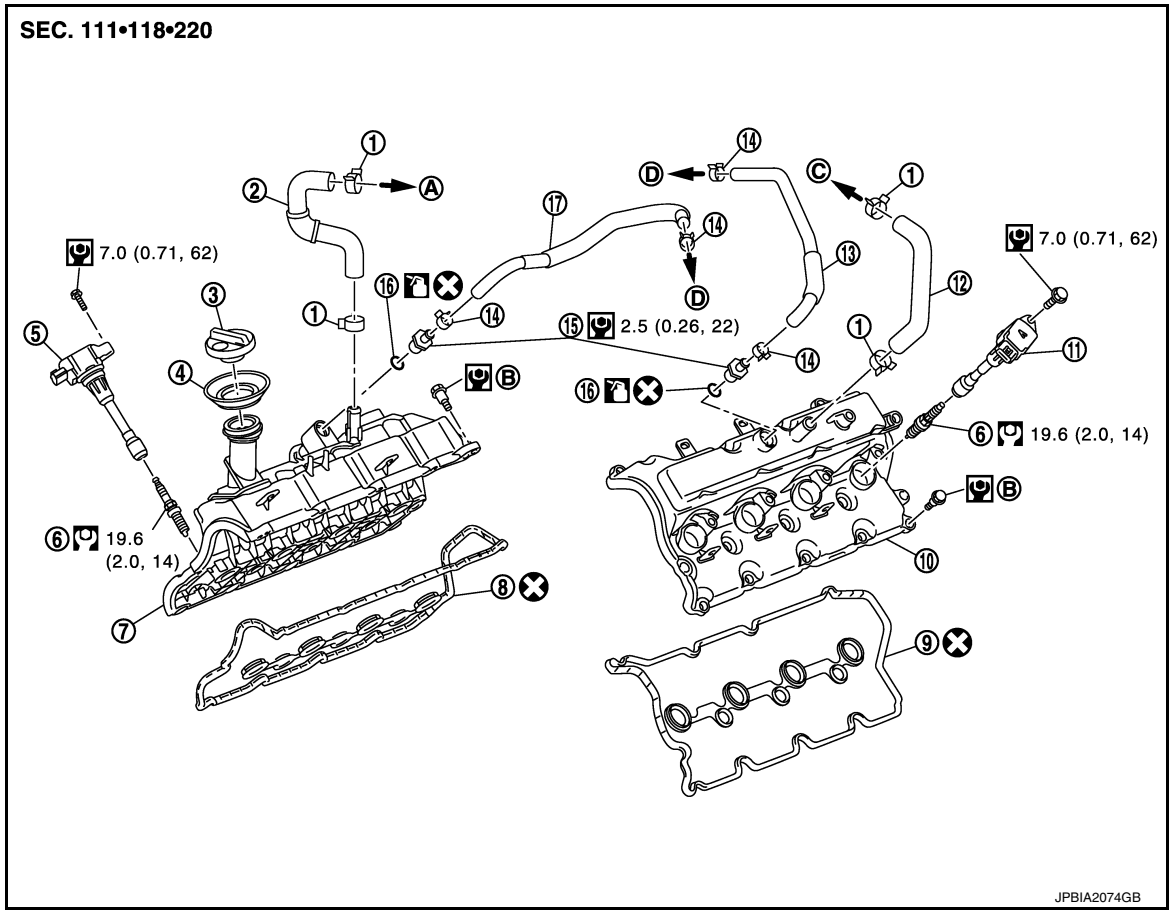
INSPECTION AFTER INSTALLATION

1. Check the engine oil level and adjust engine oil. Refer to LU-26, "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-26, "Inspection".

IGNITION COIL, SPARK PLUG AND ROCKER COVER

Exploded View

INFOID:0000000010582081



1.	Clamp	2.	PCV hose	3.	Oil filler cap
4.	Oil catcher	5.	Ignition coil (No. 1 - 6)	6.	Spark plug
7.	Rocker cover (bank 2)	8.	Rocker cover gasket (bank 2)	9.	Rocker cover gasket (bank 1)
10.	Rocker cover (bank 1)	11.	Ignition coil (No. 7, 8)	12.	PCV hose
13.	PCV hose	14.	Clamp	15.	PCV valve
16.	O-ring	17.	PCV hose		
A.	To air duct (bank 2)	B.	Comply with the installation procedure when tightening. Refer to EM-201	C.	To air duct (bank 1)
D.	To intake manifold				

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

Removal and Installation

INFOID:0000000010582082

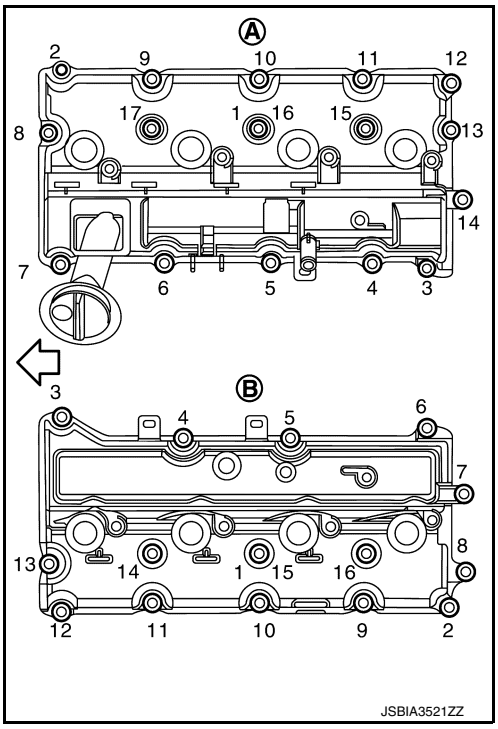
REMOVAL

1. Remove the following parts:
   - Engine cover and engine room cover (RH and LH): Refer to EM-184, "Exploded View".
   - Air cleaner case and air duct: Refer to EM-187, "Exploded View".
   - Fuel feed hose: Refer to EM-192, "Exploded View".
2. Disconnect PCV hose from rocker cover.
3. Remove ignition coil.
   CAUTION:
   Never impact it.

NOTE:
Installation position of Ignition coil depends on cylinder position.

4. Remove spark plugs. Refer to EM-177, "Removal and Installation".
CAUTION:
Never impact it.
5. Remove rocker cover.
• Loosen bolts in reverse order shown in the figure.

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

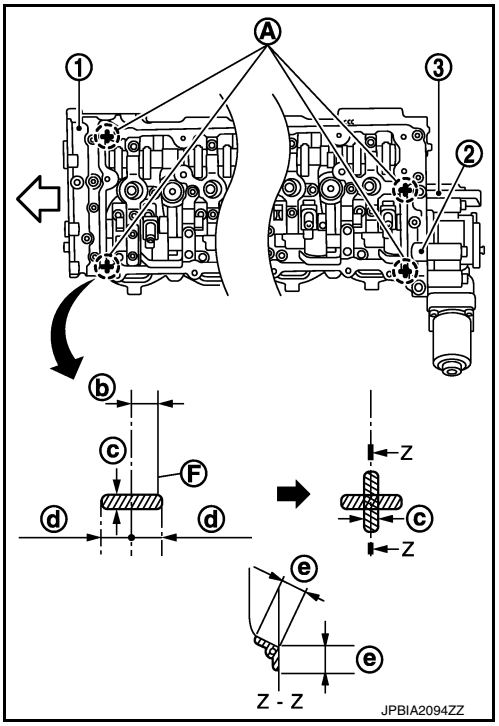


6. Remove rocker cover gasket from rocker cover.
7. Use scraper to remove all traces of liquid gasket from cylinder head & VVEL ladder assembly.
CAUTION:
Never scratch or damage the mating surface when cleaning off old liquid gasket.
8. Remove PCV valve from rocker cover, if necessary.
9. Remove oil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

INSTALLATION

CAUTION:
Do not reuse O-rings.

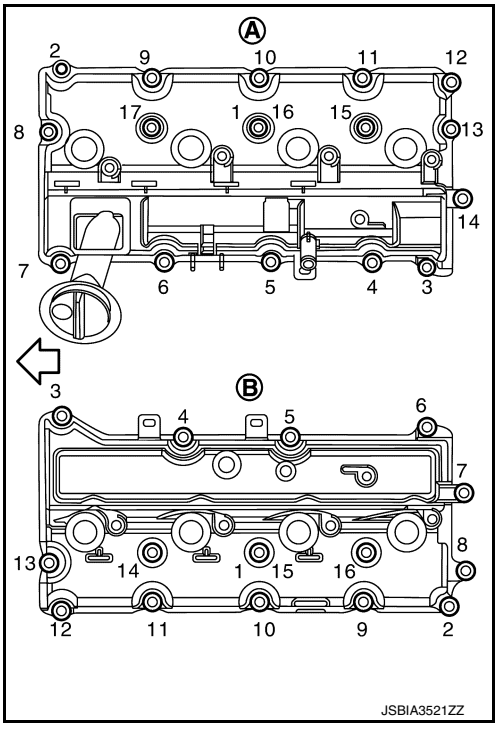
1. Apply liquid gasket with the tube presser (commercial service tool) to VVEL ladder assembly (1) and actuator bracket (rear) (2).



3 : VVEL actuator sub assembly
A : Liquid gasket application point
F : End surface of VVEL ladder assembly
b : 4 mm (0.16 in)
c : 2.5 - 3.5 mm (0.098 - 0.138 in)
d : 5 mm (0.20 in)
e : 10 mm (0.39 in)
⇦ : Engine front

Use Genuine RTV Silicone Sealant or an equivalent. Refer to GI-24, "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.

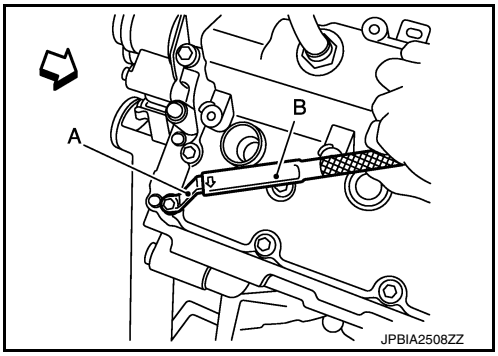


A : Bank 2
B : Bank 1
⇦ : Engine front

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)

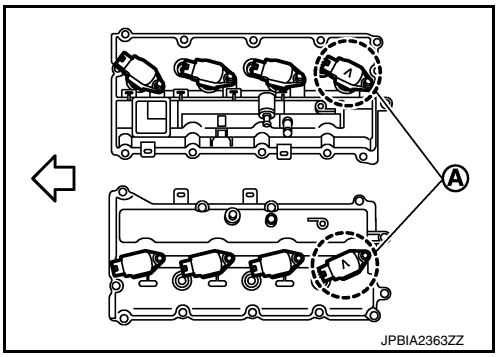
- Because of the limited working space, use adapter (A) and torque wrench (B) assembly [SST: KV10119300 (—)] to tighten bolts (on the No.7 and No. 8 cylinders) to the specified torque.

⇦ : ENgine front



5. Install spark plug. Refer to EM-177, "Removal and Installation".
6. Install ignition coil.
   - Install Ignition coil marked with an identification mark (A) on cylinder No. 7 and 8.

⇦ : Engine front



7. Install in the reverse order of removal.

OIL SEAL

FRONT OIL SEAL

FRONT OIL SEAL : Removal and Installation

INFOID:0000000010582083

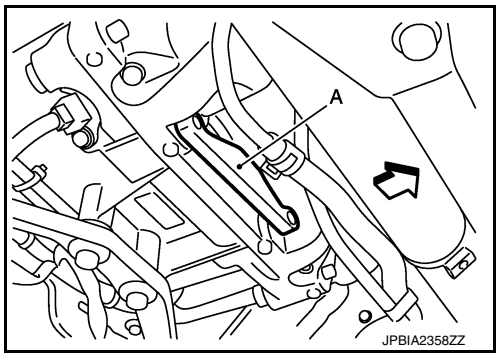
REMOVAL

1. Remove the following parts:
   - Engine undercover with power tool.
   - Drive belts: Refer to EM-173, "Exploded View".
   - Cooling fan assembly: Refer to CO-43, "Exploded View".
   - Front cross bar: Refer to FSU-36, "Exploded View".
2. Remove crankshaft pulley as per the following:

a. Remove rear plate cover. Refer to EM-198, "Exploded View".

b. Set the ring gear stopper [SST: KV10119200 (J-49277)] (A) as shown in the figure.

⇦ : Engine front

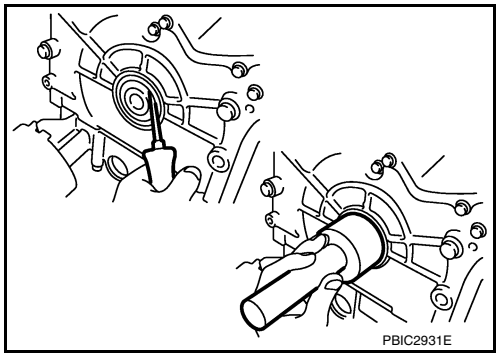


c. Loosen crankshaft pulley bolt, and then pull crankshaft pulley with both hands to remove it.

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.

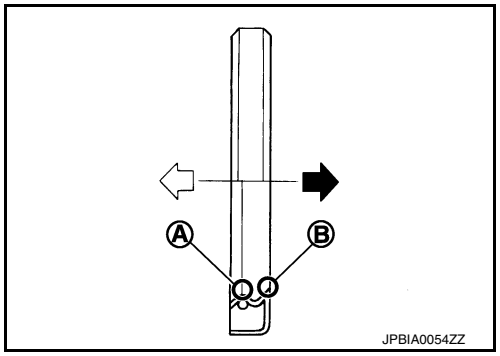
⇦ : Engine inside

⬅ : 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.

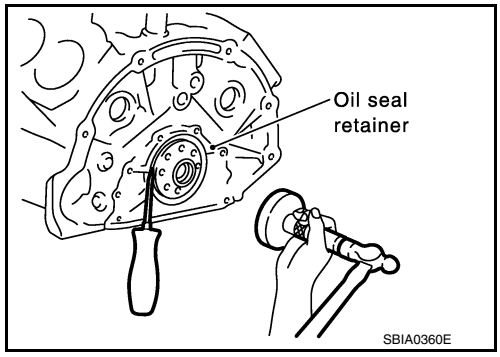
REAR OIL SEAL

REAR OIL SEAL : Removal and Installation

INFOID:0000000010582084

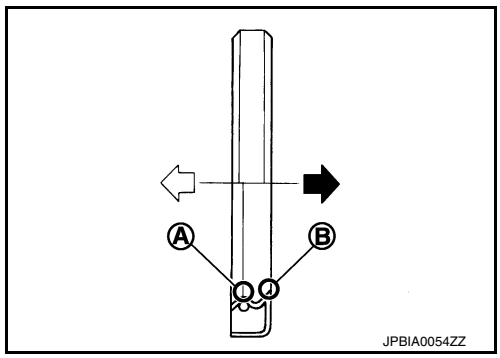
REMOVAL

1. Remove transmission assembly. Refer to TM-496, "Exploded View".
2. Remove drive plate . Refer to EM-266, "Exploded View".
3. Remove rear oil seal with a suitable tool.
   CAUTION:
   Be careful not to damage crankshaft and cylinder block.



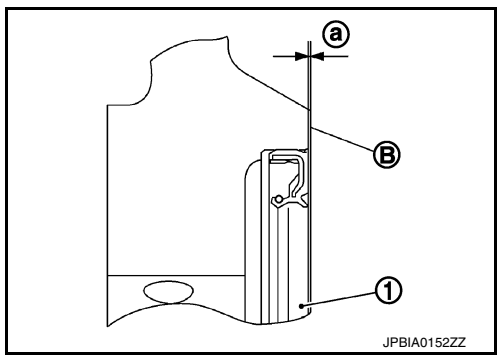
INSTALLATION

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



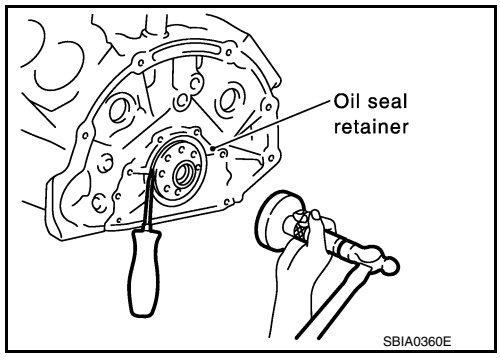
A : Oil seal lip
B : Dust seal lip
⇦ : Engine inside
⬅ : Engine outside

- 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.**



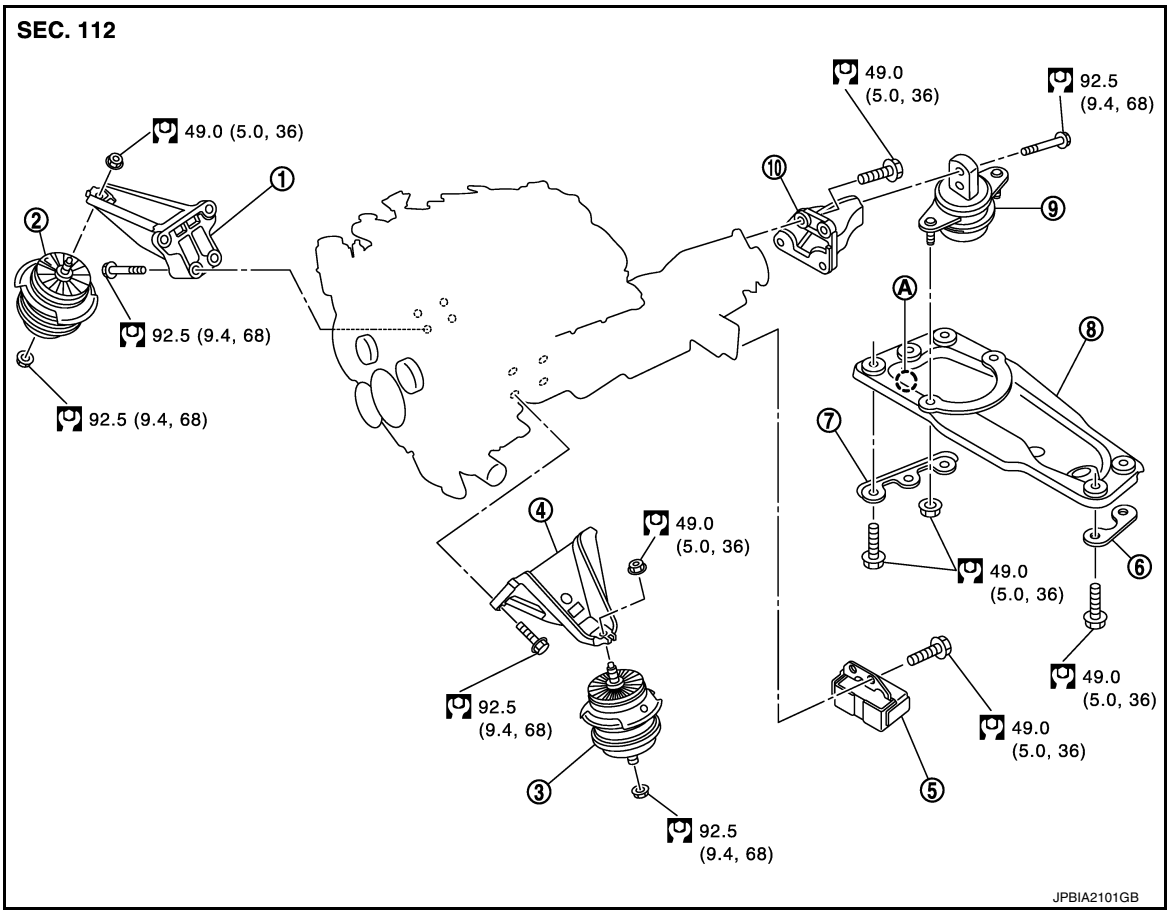
2. Install in the reverse order of removal after this step.

UNIT REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

Exploded View

INFOID:0000000010582085



1. Engine mounting bracket (RH)
2. Engine mounting insulator (RH)
3. Engine mounting insulator (LH)
4. Engine mounting bracket (LH)
5. Dynamic damper
6. Heat insulator (LH)
7. Heat insulator (RH)
8. Rear engine mounting member
9. Engine mounting insulator (rear)
10. Engine mounting bracket (rear)

A. Front mark

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

Removal and Installation

INFOID:0000000010582086

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:

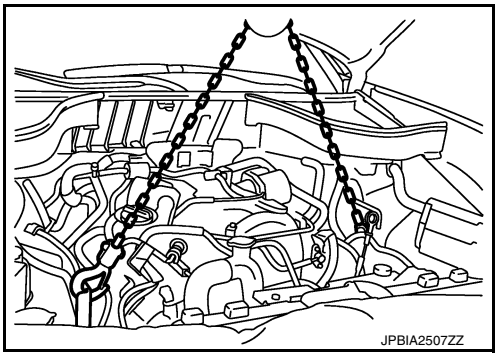
- **Always be careful to work safely, and avoid forceful or uninstructed operations.**
- **Never start working until exhaust system and engine coolant are cool enough.**
- **If items or work required are not covered by the engine section, refer to the applicable sections.**
- **Always use the support 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-37, "Garage Jack and Safety Stand and 2-Pole Lift".**

NOTE:

- When removing/installing only the engine mounting, the hold engine assembly as instructed bellow:
- When removing components such as hoses, tubes/lines, etc., cap or plug openings to prevent fluid from spilling.

1. Remove food assembly. Refer to DLK-304, "HOOD ASSEMBLY : Exploded View".
2. Install engine slinger on both front right and front left sides of the engine.
3. 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 engine, transmission, transfer and front final drive assembly with front suspension member facing downward. Then separate the engine from transmission.

Preparation

1. Remove engine cover, engine room cover (RH and LH), battery cover and brake master cylinder cover. Refer to EM-184, "Exploded View".
2. Release fuel pressure. Refer to EC-1664, "Inspection".
3. Remove the following parts:
   - Engine undercover (power tool)
   - Front road wheel and tires (power tool)
   - Cowl top cover: Refer to EXT-22, "Exploded View".
   - Air duct, air cleaner case assembly and PCV hose: Refer to EM-187, "Exploded View".
   - Drive belts: Refer to EM-174, "Removal and Installation".
   - Front cross bar: Refer to FSU-36, "Exploded View".
4. Disconnect both battery cables. Refer to PG-126, "Exploded View".
5. Drain engine coolant from radiator. Refer to CO-37, "Draining".
   CAUTION:
   Perform this step when engine is cold.
6. Discharge refrigerant from A/C circuit. Refer to HA-83, "Collection and Charge".
7. Remove radiator hoses (upper and lower). Refer to CO-43, "Exploded View".

Engine Room LH

1. Disconnect heater hose at engine side, and fit a plug onto hose end to prevent engine coolant leakage.
2. Disconnect A/C piping from A/C compressor, and temporarily fasten it on vehicle with a rope. Refer to HA-98, "Exploded View".
3. Disconnect vacuum hose from brake booster. Refer to EM-189, "Exploded View".
4. Disconnect ground cable.

Engine Room RH

1. Disconnect all clips and connectors of the engine room harness from engine side.
2. Disconnect fuel feed hose and EVAP service port hose. Refer to EM-192, "Exploded View".
   CAUTION:
   Fit plugs onto disconnected hoses to prevent fuel leakage.
3. Remove reservoir tank of power steering oil pump and piping from vehicle, and temporarily secure them on engine. Refer to ST-49, "VK50VE : Exploded View".

CAUTION:
When temporarily securing, keep the reservoir tank upright to avoid fluid leakage.

Vehicle Inside

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

1. Remove glove box assembly and instrument assist lower panel. Refer to IP-12, "Exploded View".
2. Disconnect engine room harness connectors at unit sides and other locations.
3. Disengage intermediate fixing point. Pull out engine room harnesses to engine room side, and temporarily secure them on engine.

CAUTION:
- **When pulling out harnesses, take care not to damage harnesses and connectors.**
- **After temporarily securing, cover connectors with vinyl or similar material to protect against adhesion of foreign materials.**

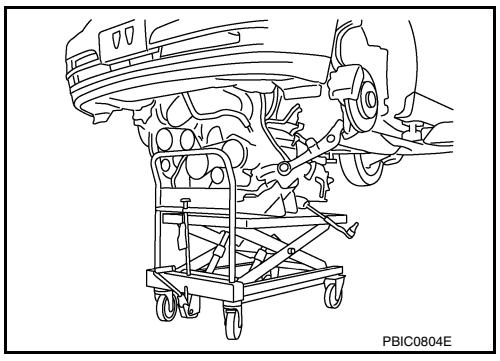
Vehicle Underbody

1. Remove A/T fluid cooler hoses and power steering oil pump oil cooler hoses.
2. Disconnect ground cable from exhaust manifold cover (bank 2).
3. Disconnect heated oxygen sensor 2 harness.
4. Remove three way catalyst and exhaust front tube. Refer to EM-216, "Exploded View" and EX-10, "Exploded View".
5. Remove rear propeller shaft. Refer to DLN-140, "Exploded View".
6. Disconnect lower joint at power steering gear assembly side, and release lower shaft. Refer to ST-18, "WITHOUT ELECTRIC MOTOR : Exploded View" or ST-21, "WITH ELECTRIC MOTOR : Exploded View".
7. Disengage A/T control rod at A/T shift selector side. Then, temporarily secure it on the transmission assembly, so that it does not sag. Refer to TM-185, "Exploded View".
8. Preparation for the separation work of transaxle is as per the following:
   - Remove rear plate cover from oil pan (upper). Then remove bolts fixing drive plate to torque converter. Refer to EM-198, "Exploded View".
   - Remove transmission joint bolts that pierce at oil pan (upper) lower rear side. Refer to EM-198, "Exploded View".
9. Remove front stabilizer connecting rod. Refer to FSU-38, "Exploded View".
10. Remove front wheel sensor for ABS from steering knuckle. Refer to BRC-133, "FRONT WHEEL SENSOR : Exploded View".
11. Remove brake caliper assembly with piping connected from steering knuckle. Temporarily secure it on the vehicle side with a rope to avoid load on it. Refer to BR-49, "BRAKE CALIPER ASSEMBLY (4 PISTON TYPE) : Exploded View".
12. Separate upper link from steering knuckle. Refer to FSU-34, "Exploded View".
13. Separate shock absorber from transverse link. Refer to FSU-34, "Exploded View".

Removal Work

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

CAUTION:
Use a piece of wood or a similar item as the supporting surface to secure a completely stable condition.



2. Loosen rear engine mounting member mounting bolts.
3. Loosen front suspension member mounting bolts. Refer to FSU-39, "Exploded View".

4. Carefully lower jack, or raise lift, to remove the engine, the transmission assembly and front suspension member. When performing work, observe the following caution items:
   CAUTION:
   - **Confirm there is no interference with the vehicle.**
   - **Check that all connection points have been disconnected.**
   - **Keep in mind that the center of gravity of the vehicle changes. If necessary, use jack(s) to support the vehicle at rear jacking point(s) to prevent it from falling off the lift.**

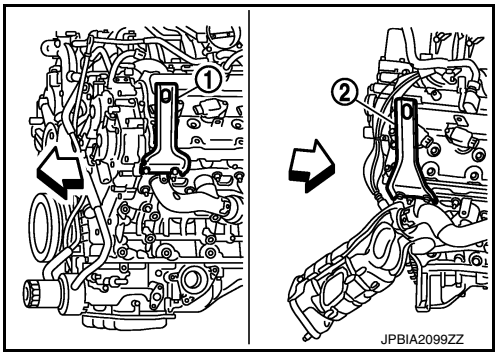
Separation Work

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

   1 : Engine front slinger (bank 1)
   2 : Engine rear slinger (bank 2)
   ⇦ : Engine front

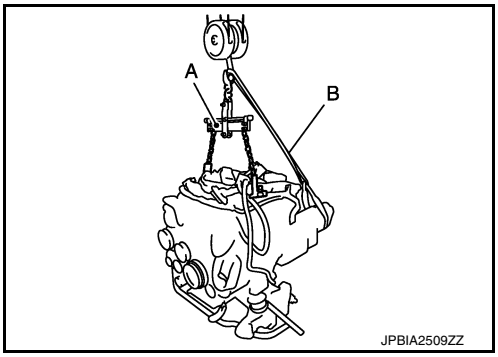
   Slinger bolts:

   : 45.0 N·m (4.6 kg-m, 33 ft-lb)



2. Hang the lifting hook of a two-point engine lifter (commercial service tool) (A) from the front and rear engine slingers to hoist engine and flywheel housing assembly.
   - For the flywheel housing side, use a webbing slinger (B) or an equivalent to hoist the assembly horizontally.

   CAUTION:
   Always hoist the engine by using a two-point engine lifter (i.e. hoisting the front and rear slingers from one point in the air), or the rocker cover and parts around the engine may be damaged due to the fall of the engine slinger.



3. Remove power steering oil pump from engine side. Refer to ST-41, "VK50VE : Exploded View".
4. Remove engine mounting insulators (RH and LH) under side nuts with power tool.
5. Lift with hoist and separate the engine, transmission, transfer and front final drive assembly from front suspension member.
   CAUTION:
   - **Before and during this 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.**
6. Remove alternator. Refer to CHG-34, "VK50VE : Exploded View".
7. Separate the engine from the transmission assembly. Refer to TM-496, "Exploded View".
8. Remove front propeller shaft. Refer to DLN-112, "VK50VE : Exploded View".
9. Remove the front final drive assembly from oil pan (upper). Refer to DLN-158, "VK50VE : Exploded View".
10. Remove each engine mounting insulator and each engine mounting bracket from the engine with power tool.

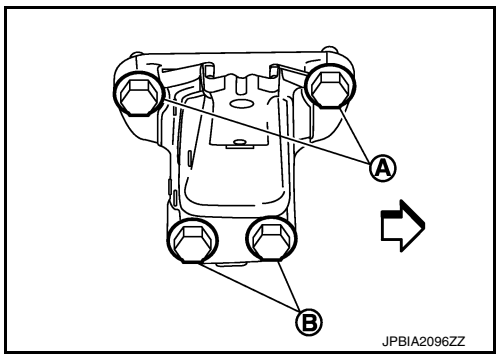
INSTALLATION

Note the following item, and install in the reverse order of removal.
- Do not allow engine mounting insulator to be damage and careful no engine oil gets on it.
- For a location with a positioning pin, insert it securely into hole of matching part.
- For a part with a specified installation orientation, refer to component figure in EM-207, "Exploded View".

- When installing engine mounting bracket (RH and LH) on cylinder block, tighten two upper bolts (A) first. Then tighten two lower bolts (B).

⇦: Engine front

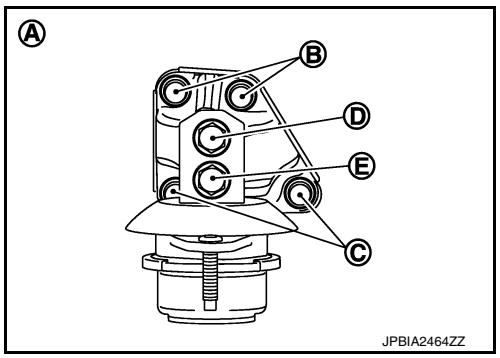
NOTE:
This figure shows an example of bank 2.



- When installing engine mounting bracket (rear) on transfer, tighten two upper bolts (B) first. Then tighten two lower bolts (C).

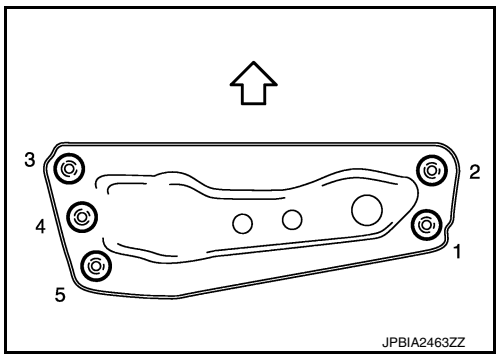
A : Rear view

- When installing engine mounting insulator (rear) on engine mounting bracket (rear), tighten upper bolts (D) first. Then tighten lower bolts (E).



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

⇦: Vehicle front



- Check that all engine mounting insulators are seated properly, then tighten mounting nuts and bolts.

Inspection

INFOID:0000000010582087

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-17, "FOR NORTH AMERICA : 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	A/T and CVT models	Level	Level/Leakage	Level
	M/T models	Level/Leakage	Level	Level/Leakage
Other oils and fluid*		Level	Leakage	Level
Fuel		Leakage	Leakage	Leakage
Exhaust gases		—	Leakage	—

*: Power steering fluid, brake fluid, etc.

UNIT DISASSEMBLY AND ASSEMBLY

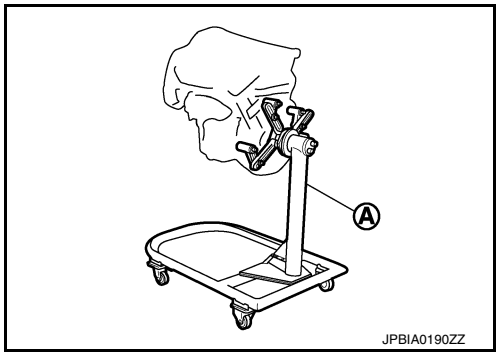
ENGINE STAND SETTING

Setting

INFOID:0000000010582088

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.

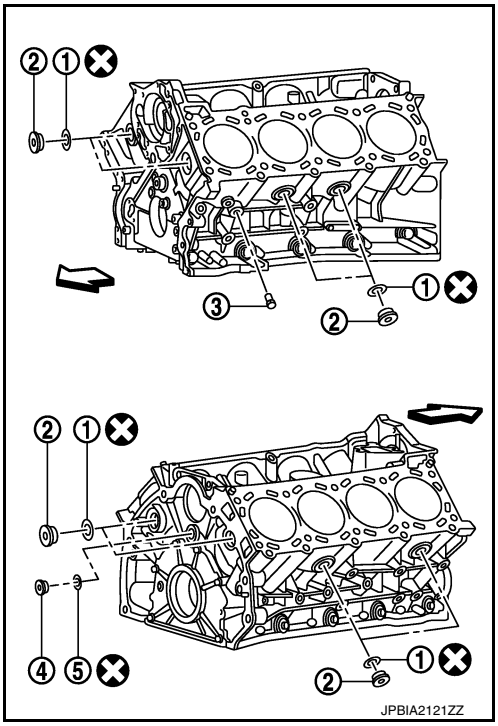
1. Remove the engine assembly from the vehicle. Refer to EM-207, "Exploded View".
2. Remove crankshaft pulley. Refer to EM-205, "FRONT OIL SEAL : Removal and Installation".
   NOTE:
   The drive plate is fixed with a ring gear stopper [SST: KV10119200 (J-49277)]. Loosen the crankshaft pulley mounting 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-276, "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-189, "Exploded View".
   - Remove fuel injector and fuel tube assembly. Refer to EM-192, "Exploded View".
   - Remove ignition coil. Refer to EM-201, "Exploded View".
   - Remove rocker cover. Refer to EM-201, "Exploded View".
   - Remove exhaust manifold. Refer to EM-216, "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-27, "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
4 : Plug
5 : Washer
⇦ : Engine front



ENGINE UNIT

Disassembly

INFOID:0000000010582089

1. Remove intake manifold. Refer to EM-189, "Exploded View".
2. Remove exhaust manifold. Refer to EM-216, "Exploded View".
3. Remove oil pan (lower). Refer to EM-198, "Exploded View".
4. Remove ignition coil, spark plug and rocker cover. Refer to EM-201, "Exploded View".
5. Remove timing chain. Refer to EM-223, "Exploded View".
6. Remove camshaft (EXH) and VVEL ladder assembly. Refer to EM-238, "Exploded View".
7. Remove cylinder head. Refer to EM-256, "Exploded View".

Assembly

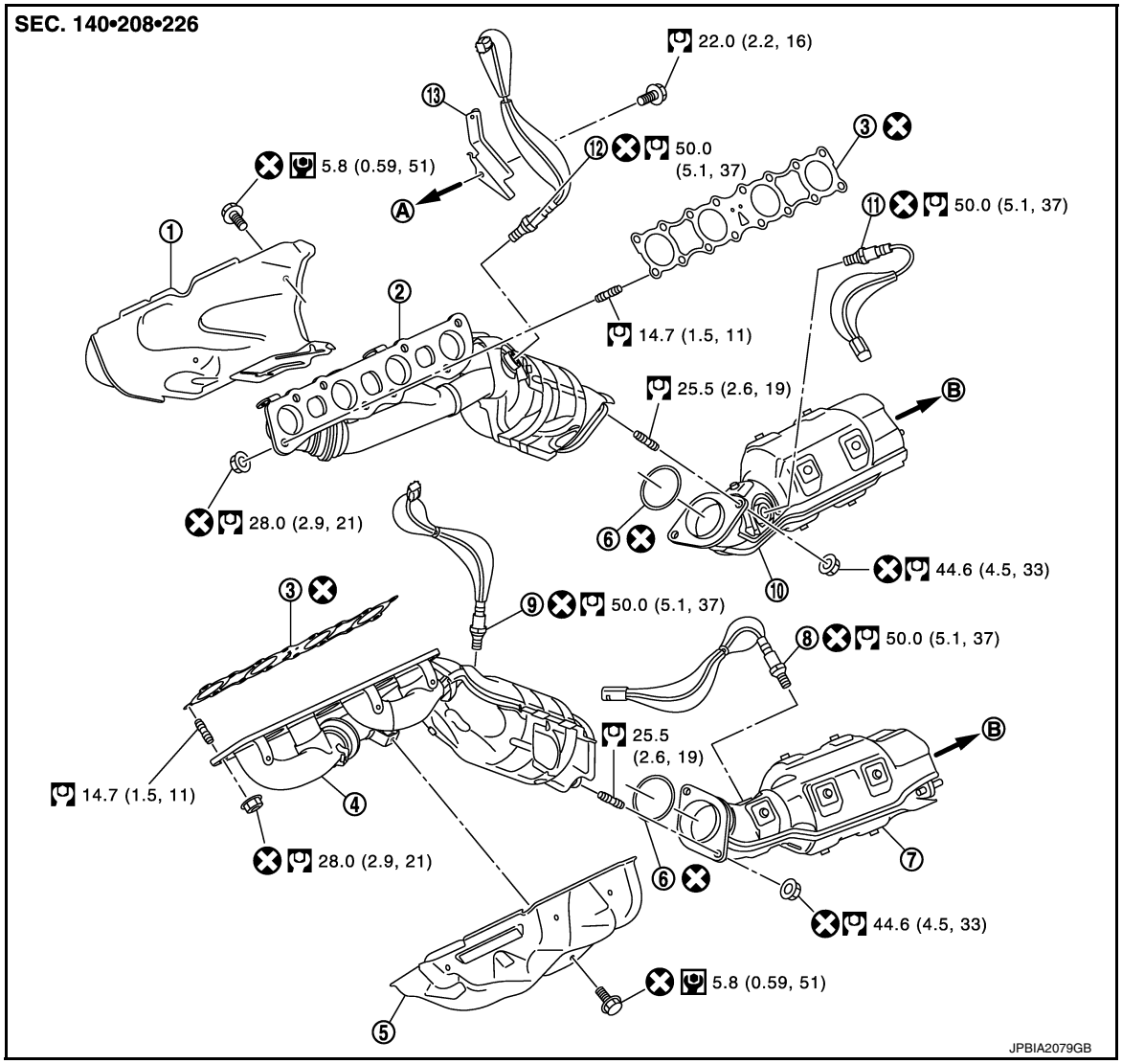
INFOID:0000000010582090

Assemble in the reverse order of disassembly.

EXHAUST MANIFOLD AND THREE WAY CATALYST

Exploded View

INFOID:0000000010582091



1. Exhaust manifold cover (bank 2)
2. Exhaust manifold (bank 2)
3. Gasket
4. Exhaust manifold (bank 1)
5. Exhaust manifold cover (bank 1)
6. Gasket
7. Three way catalyst (bank 1)
8. Heated oxygen sensor 2 (bank 1)
9. Air fuel ratio sensor 1 (bank 1)
10. Three way catalyst (bank 2)
11. Heated oxygen sensor 2 (bank 2)
12. Air fuel ratio sensor 1 (bank 2)
13. Harness bracket

A. To cylinder head (bank 2)
B. To exhaust front tube

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

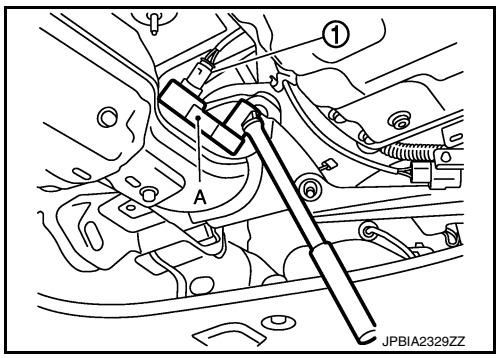
Disassembly and Assembly

INFOID:0000000010582092

DISASSEMBLY

1. Remove heated oxygen sensor 2.
   CAUTION:
   Heated oxygen sensor 2 is not reusable. Never remove heated oxygen sensor 2 unless this is required.

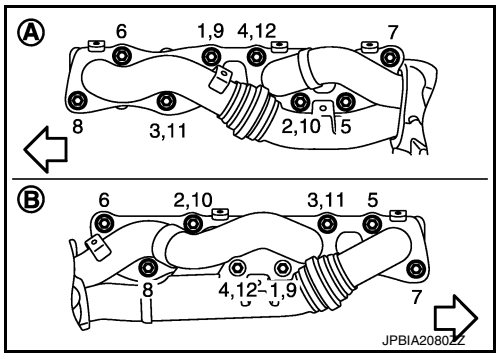
- Using the heated oxygen sensor wrench [SST: KV10114400 (J-38365)] (A), remove heated oxygen sensor 2 (1).
  NOTE:
  - The heated oxygen sensor 2 is removable under vehicle-mounted condition.
  - The figure shows an example of bank 1.



2. Remove three way catalyst (bank 1 and bank 2).
3. Remove air fuel ratio sensor 1as 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: KV10114400 (J-38365)], remove air fuel ratio sensor 1.
     NOTE:
     The air fuel ration sensor 1 is removable under vehicle-mounted condition.
4. Remove exhaust manifold.
   - Loosen nuts in the reverse order of figure to remove exhaust manifold with power tool.

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

     NOTE:
     Disregard No. 9 to No. 12 when loosening.



5. Remove exhaust manifold gaskets.
   CAUTION:
   Cover engine openings to avoid entry of foreign materials.

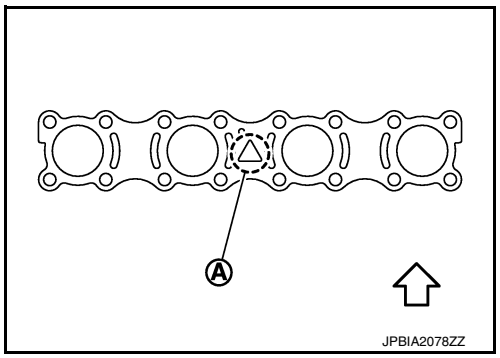
ASSEMBLY

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.

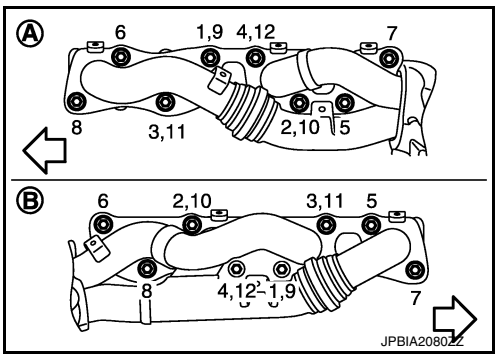
  A : Triangle press
  ⇦ : Above



Exhaust Manifold

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

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



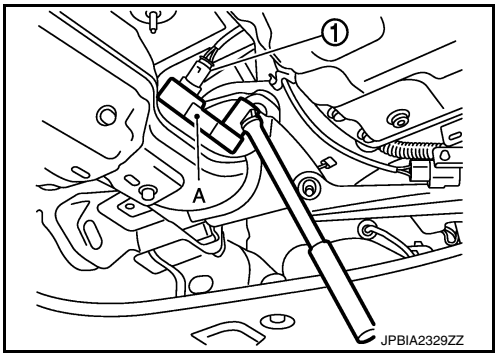
NOTE:
Tighten mounting nuts No. 1 to 4 in two steps. The numerical order No. 9 to 12 shown second steps.

Air Fuel Ratio Sensor 1, Heated Oxygen Sensor 2

CAUTION:

- **Before installing a 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 sensors, set the heated oxygen sensor wrench [SST: KV10114400(J-38365)] (A) in the hexagonal part to tighten the them.**
- **Prevent rust preventives from adhering to the sensor body.**

1 : Heated oxygen sensor 2 (bank 1)



- **Never over torque sensors. Doing so may cause damage to the sensors, resulting in “MIL” coming on.**

Inspection

INFOID:0000000010582093

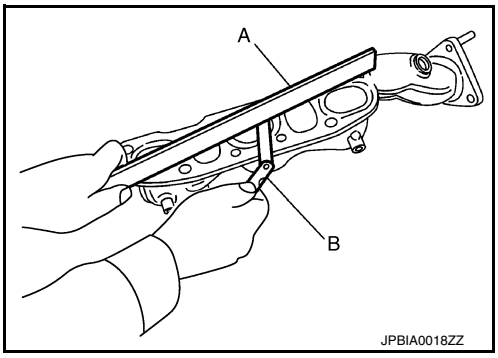
INSPECTION AFTER DISASSEMBLY

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-294, "Exhaust Manifold".

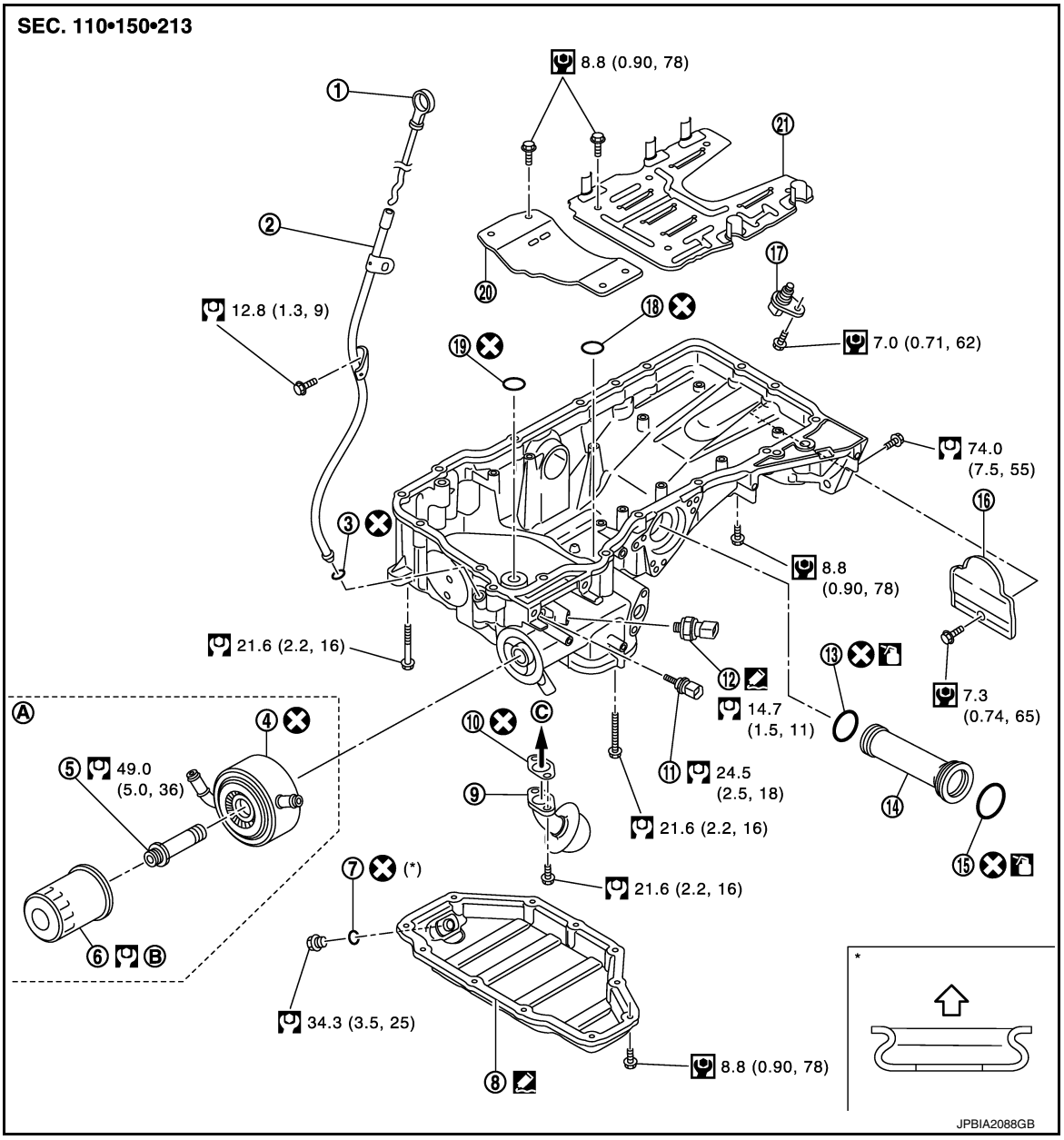
- If it exceeds the limit, replace exhaust manifold.



OIL PAN (UPPER)

Exploded View

INFOID:0000000010582094



1. Oil level gauge	2. Oil level gauge guide	3. O-ring
4. Oil cooler	5. Connector bolt	6. Oil filter
7. Drain plug washer	8. Oil pan (lower)	9. Oil strainer
10. Gasket	11. Oil temperature sensor	12. Oil pressure switch
13. O-ring	14. Axle pipe	15. O-ring
16. Rear plate cover	17. Crankshaft position sensor (POS)	18. O-ring
19. O-ring	20. Baffle plate	21. Baffle plate
A. Comply with the installation procedure when tightening. Refer to LU-30	B. Comply with the installation procedure when tightening. Refer to LU-29	C. Oil pump side

⇦ : Oil pan side

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

Disassembly and Assembly

INFOID:0000000010582095

DISASSEMBLY

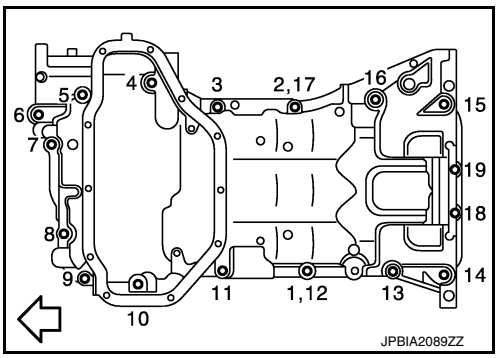
WARNING:
To avoid the danger of being scalded, never drain engine oil when engine is hot.

1. Remove oil filter. Refer to LU-29, "Removal and Installation".
2. Remove oil cooler. Refer to LU-30, "Exploded View".
3. Remove A/C compressor and A/C compressor bracket. Refer to HA-98, "Exploded View" and EM-223, "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 oil pan (lower). Refer toEM-198, "Exploded View".
8. Remove oil strainer. Refer to EM-198, "Exploded View".
9. 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

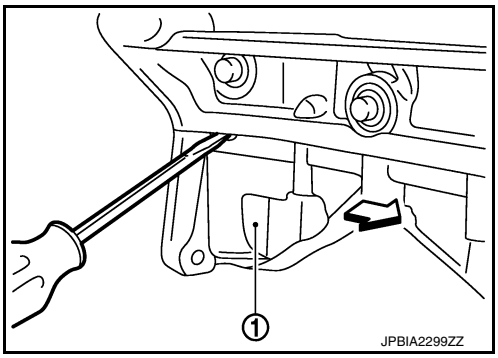
NOTE:
Disregard No. 12, 17 when loosening.



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.



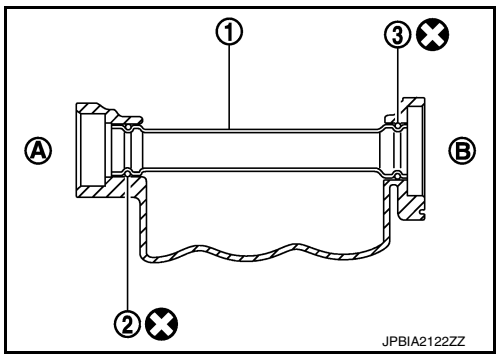
10. Remove O-ring from bottom of cylinder block and oil pump.
11. Remove baffle plate, if necessary.
12. Remove axle pipe from oil pan (upper), if necessary.
- Pull axle pipe from oil pan (upper) using a suitable drift.

ASSEMBLY

CAUTION:
Do not reuse O-rings.

1. Install axle pipe (1) to oil pan (upper), if removed.

CAUTION:
Do not reuse O-rings.



2 : O-ring
3 : O-ring (with identification paint)
A : Front final drive side
B : Drive shaft (LH) side

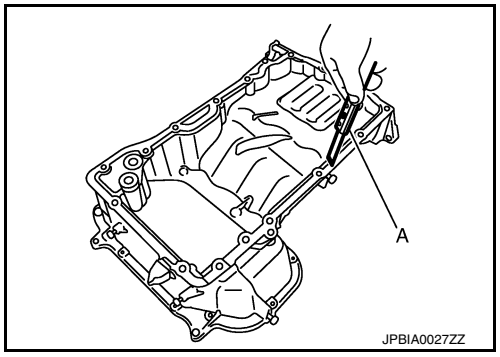
- Lubricate O-ring groove of axle pipe, O-ring, and O-ring joint of oil pan with new engine oil.
- Install axle pipe to oil pan (upper) from drive shaft (LH) side.

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

2. 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.

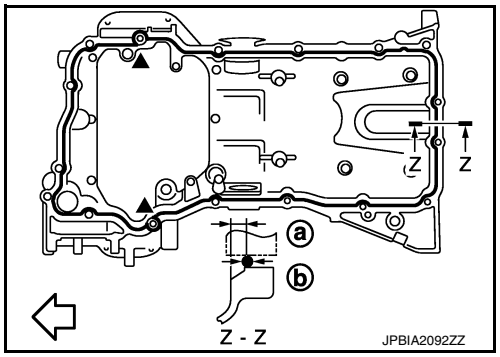
CAUTION:
Never scratch or damage the mating surfaces when cleaning off old liquid gasket.



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

CAUTION:
Do not reuse O-rings.

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

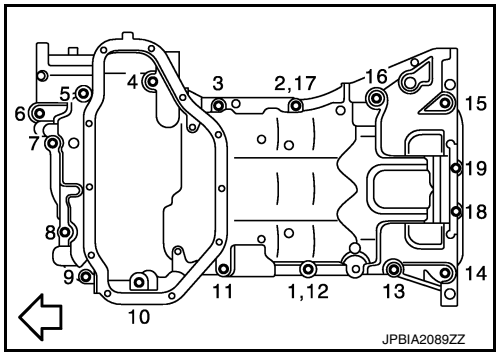


a : 5.5 - 7.5 mm (0.217 - 0.295 in)
b : ϕ4.0 - 5.0 mm (0.157 - 0.197 in)
⇦ : Engine front

Use Genuine RTV Silicone Sealant or an equivalent. Refer to GI-24, "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. 12 and 17 shown second steps.
- There are three types of mounting bolts. Refer to the following for locating bolts.

M6 × 30 mm. (1.18 in) : 18, 19
M8 × 100 mm (3.94 in) : 3, 4, 5, 7, 10, 11, 14, 15
M8 × 45 mm (1.77 in) : Except the above

e. Tighten transmission joint bolts.
f. Install rear plate cover.
3. Install oil strainer.
4. Install oil pan (lower). Refer to EM-199, "Removal and Installation".
5. Install in the reverse order of removal.
NOTE:
At least 30 minutes after oil pan is installed, pour engine oil.

Inspection

INFOID:0000000010582096

INSPECTION AFTER DISASSEMBLY

Clean oil strainer if any object is attached.

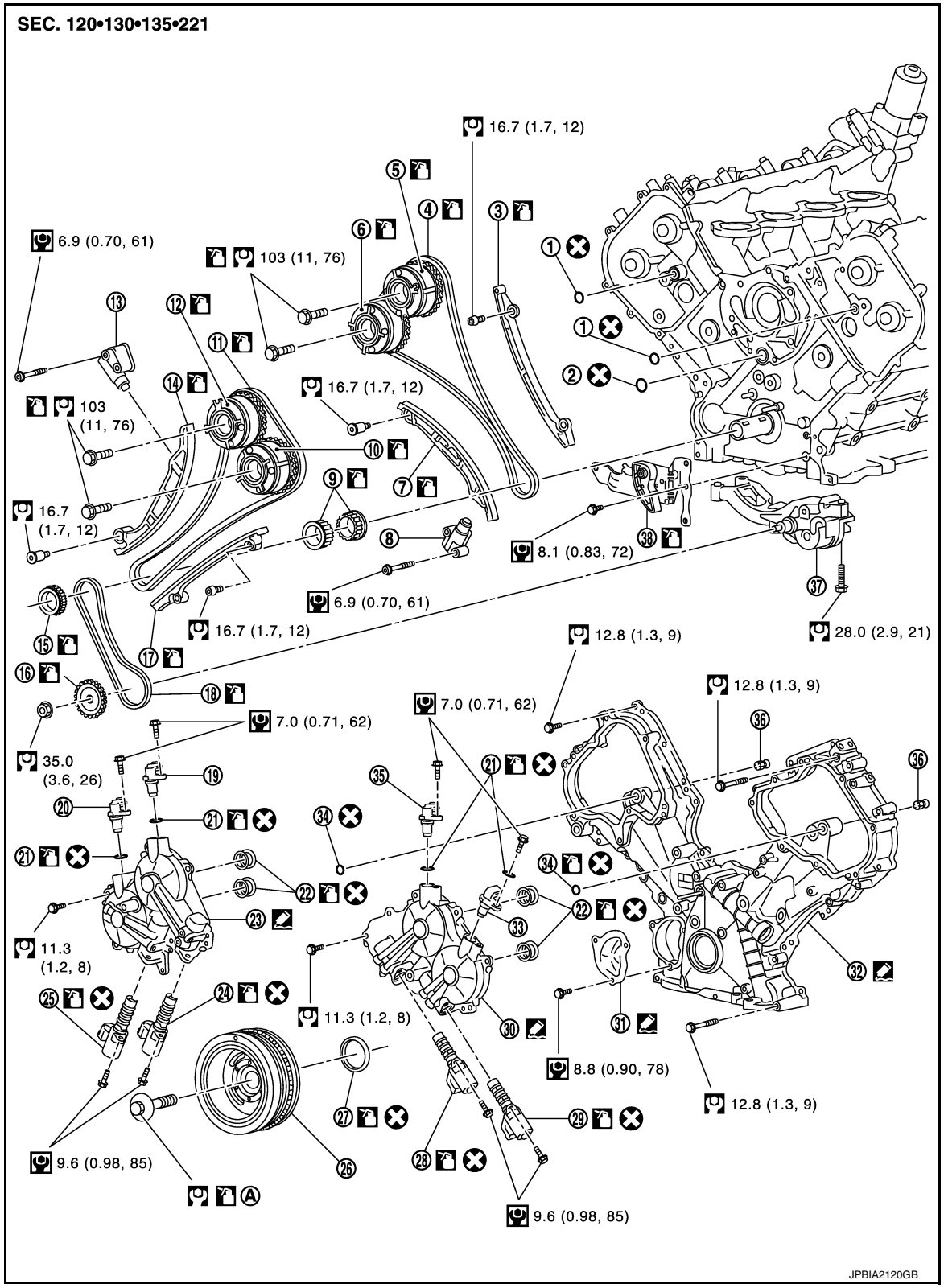
INSPECTION AFTER ASSEMBLY

1. Check the engine oil level and adjust engine oil. Refer to LU-26, "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-26, "Inspection".

TIMING CHAIN

Exploded View

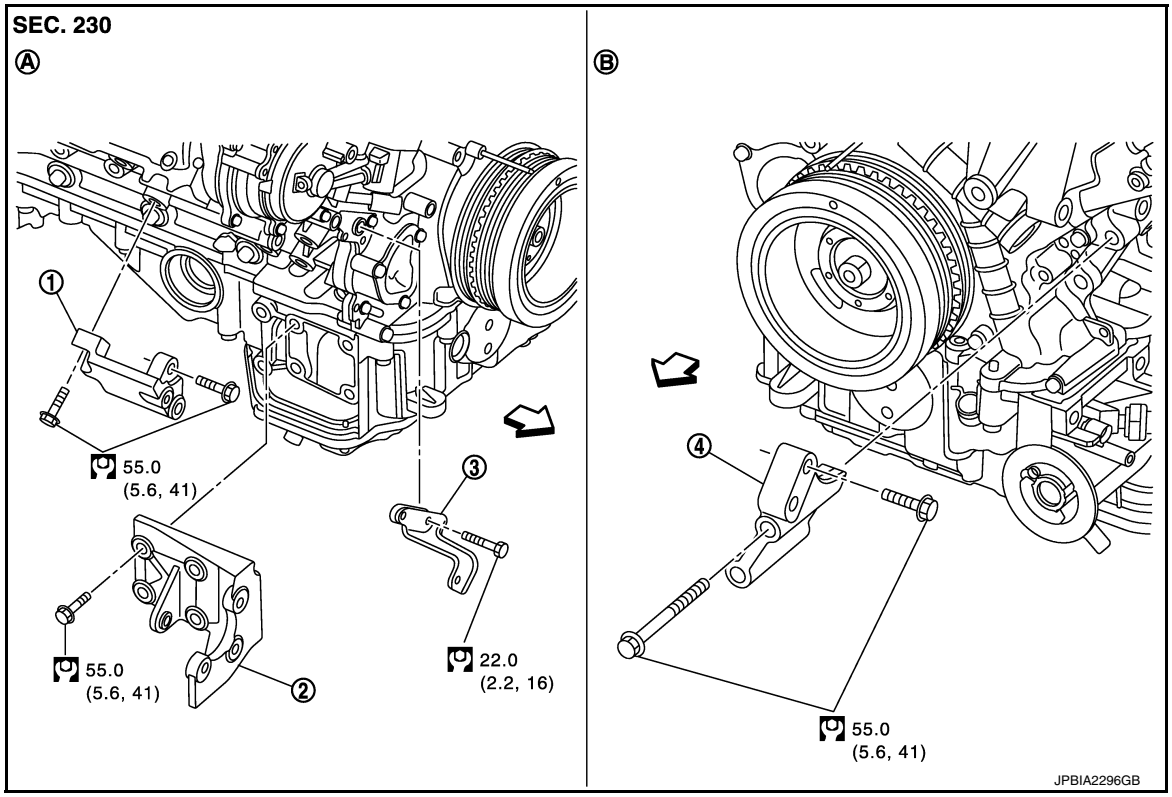
INFOID:0000000010582097



1. O-ring
2. O-ring
3. Tension guide (bank 2)
4. Timing chain (bank 2)
5. Camshaft sprocket (INT) (bank 2)
6. Camshaft sprocket (EXH) (bank 2)
7. Slack guide (bank 2)
8. Timing chain tensioner (bank 2)
9. Crankshaft sprocket

10.	Camshaft sprocket (EXH) (bank 1)	11.	Timing chain (bank 1)	12.	Camshaft sprocket (INT) (bank 1)
13.	Timing chain tensioner (bank 1)	14.	Slack guide (bank 1)	15.	Oil pump sprocket (crankshaft side)
16.	Oil pump sprocket (oil pump side)	17.	Tension guide (bank 1)	18.	Oil pump drive chain
19.	Camshaft position sensor (INT) (bank 2)	20.	Camshaft position sensor (EXH) (bank 2)	21.	O-ring
22.	Seal ring	23.	Valve timing control cover (bank 2)	24.	Intake valve timing control solenoid valve (bank 2)
25.	Exhaust valve timing control solenoid valve (bank 2)	26.	Crankshaft pulley	27.	Front oil seal
28.	Intake valve timing control solenoid valve (bank 1)	29.	Exhaust valve timing control solenoid valve (bank 1)	30.	Valve timing control cover (bank 1)
31.	Timing chain tensioner cover	32.	Front cover	33.	Camshaft position sensor (EXH) (bank 1)
34.	O-ring	35.	Camshaft position sensor (INT) (bank 1)	36.	Oil filter (for valve timing control solenoid valve)
37.	Oil pump	38.	Oil pump drive chain tensioner		
A.	Comply with the installation procedure when tightening. Refer to EM-224				

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



1.	Alternator bracket	2.	Power steering pump bracket	3.	Alternator support
4.	A/C compressor bracket				
A.	Right side	B.	Front side		
⇦	: Engine front				

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

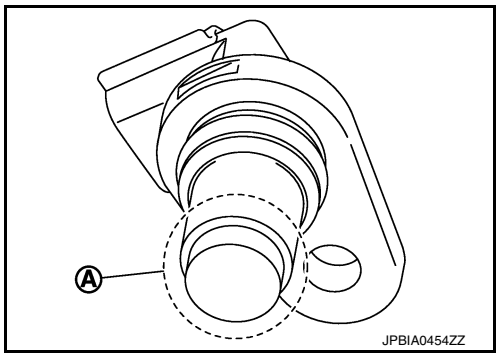
Disassembly and Assembly

INFOID:0000000010582098

DISASSEMBLY

1. Remove auto tensioners and idler pulley. Refer to EM-186, "Exploded View".
2. Remove oil level gauge and oil level gauge guide. Refer to EM-223, "Exploded View".

3. Remove alternator bracket and alternator stay.
4. Remove camshaft position sensors.



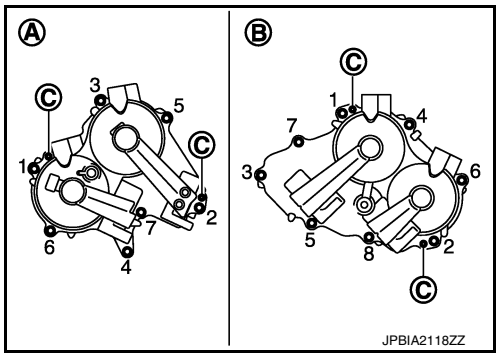
A : Keep free from magnetic materials

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.**

5. 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.



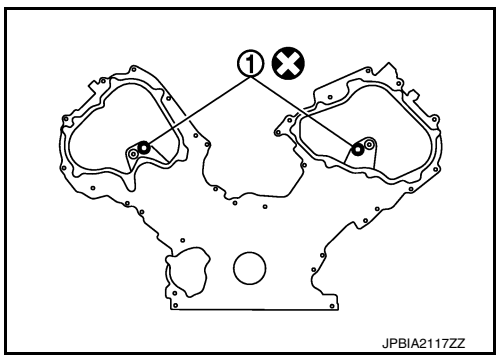
A : Bank 2
B : Bank 1
C : Dowel pin hole

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.**

6. Remove valve timing control solenoid valve (INT and EXH), if necessary.

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

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

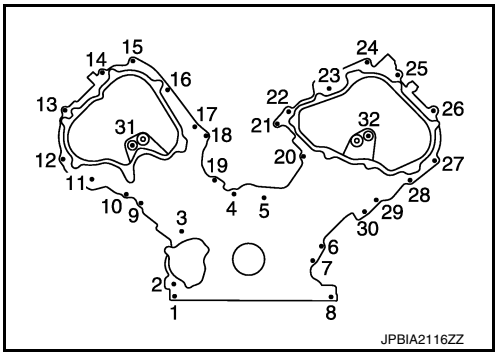


8. Remove rocker cover. Refer to EM-201, "Exploded View".
9. Obtain No. 1 cylinder at TDC of its compression stroke. Refer to EM-179, "Inspection".
10. Remove crankshaft pulley. Refer to EM-205, "FRONT OIL SEAL : Removal and Installation".
11. Remove water pump pulley. Refer to CO-49, "Exploded View".
12. Remove oil pan (lower) and oil strainer. Refer to EM-198, "Exploded View".
13. Remove oil pan (upper). Refer to EM-219, "Exploded View".
14. Remove front cover as per the following:

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

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

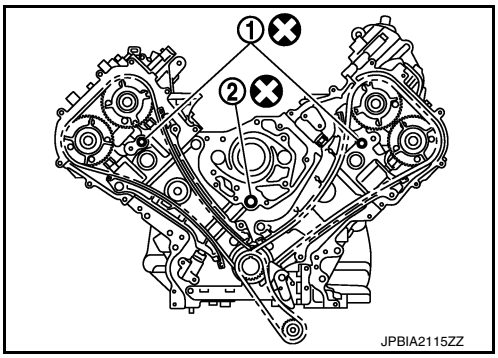
CAUTION:
- **Exercise care not to damage mating surfaces.**
- **After removal, handle front cover carefully so it does not tilt, cant, or warp under a load.**



15. Remove front oil seal from front cover using suitable tool.
- Use screwdriver for removal.

CAUTION:
Be careful not to damage front cover.

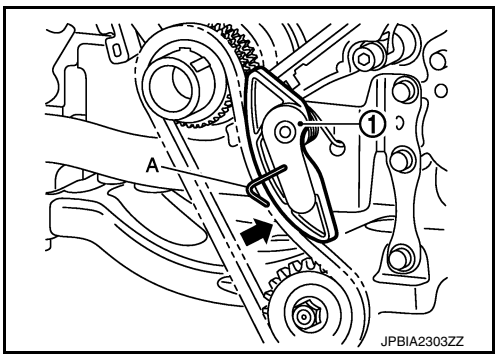
16. Remove O-rings (1), (2) from cylinder heads and cylinder block.



17. Remove oil filter (for valve timing control solenoid valve), if necessary.
18. Remove timing chain tensioner cover from front cover, if necessary.
- Use seal cutter [SST: KV10111100 (J-37228)] to cut liquid gasket for removal.
19. Remove oil pump drive chain as per the following:

a. Push oil pump drive chain tensioner (1).

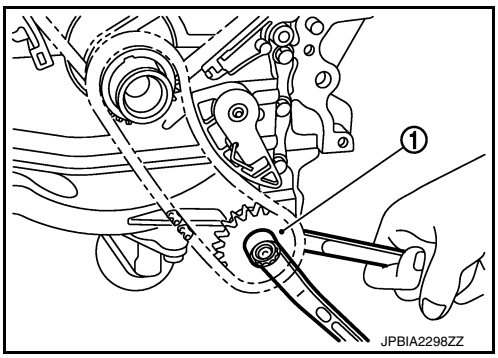
b. Insert a stopper pin (A) into the body hole.



c. Hold the two flat parts of oil pump shaft, and then loosen the oil pump sprocket (oil pump side) nut.

1 : Oil pump sprocket (oil pump side)

CAUTION:
Secure the oil pump unit shaft with the two flat parts.

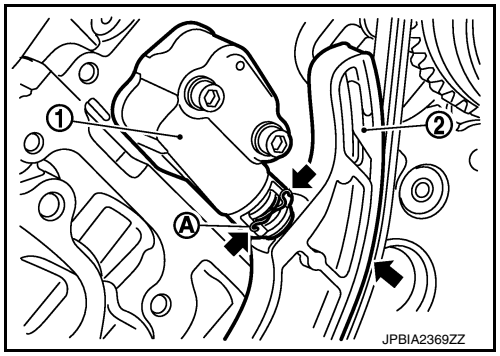


20. Remove oil pump drive chain tensioner.
21. Remove timing chain tensioner (bank 1) as per the following:

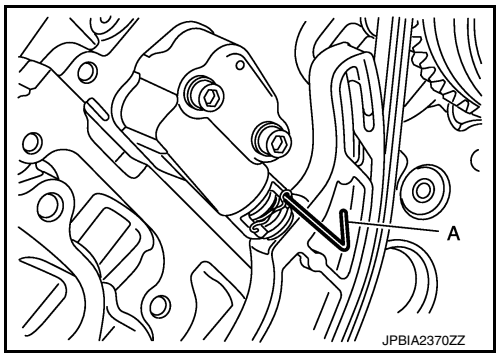
NOTE:
To remove timing chain and related parts, start with those on bank 1. The procedure for removing parts on bank 2 is omitted because it is the same as that for bank 1.

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.



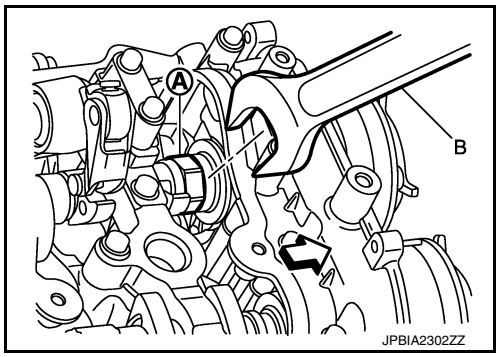
22. Remove tension guide and slack guide.
23. Remove timing chain and crankshaft sprocket.
CAUTION:
After removing timing chain, never turn crankshaft and camshaft separately, or valves will strike the piston head.
24. Remove camshaft sprocket (INT) and (EXH) as per the following:

Exhaust side:
- Secure the hexagonal portion of camshaft (EXH) using a wrench to loosen mounting bolt. Refer to EM-238, "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 loosen mounting bolt. Refer to EM-238, "Exploded View".

⇦ : Engine front

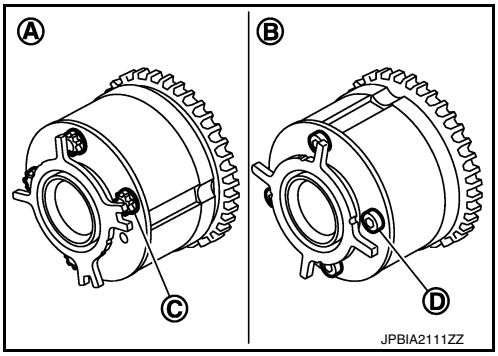
NOTE:
The figure shows an example of bank 2.



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.**

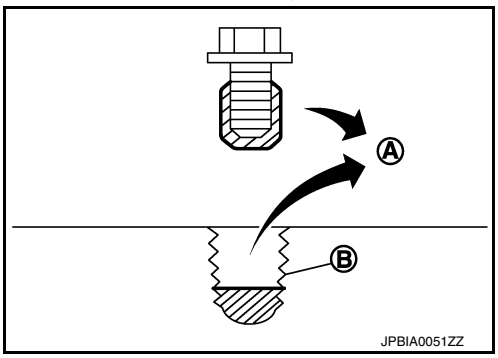
- **Never disassemble camshaft sprocket. [Never loosen bolts (C), (D) as shown in the figure.]**

A : Intake
B : Exhaust



25. 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.

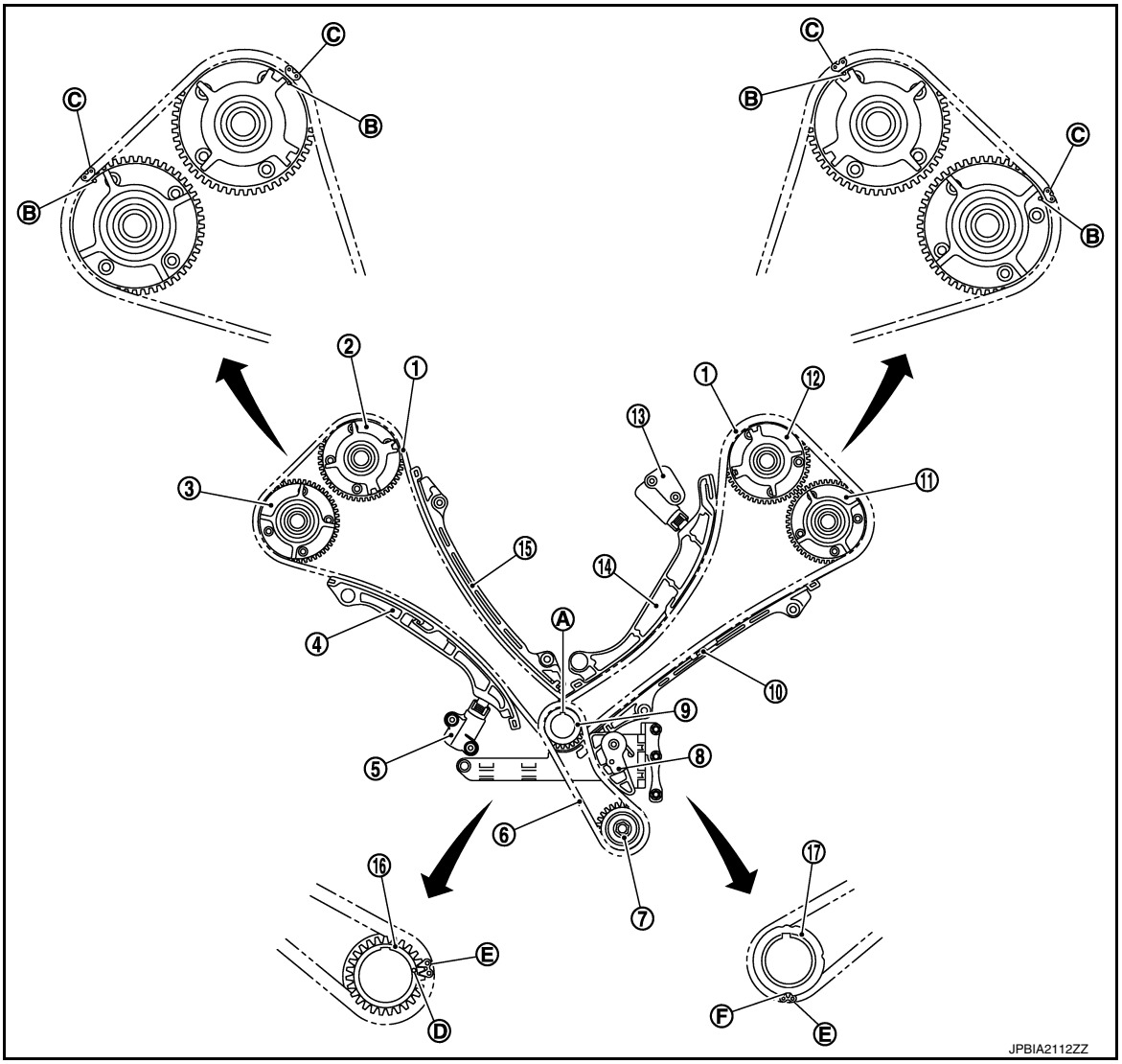
A : Remove old liquid gasket that is stuck
B : Bolt hole



ASSEMBLY

CAUTION:

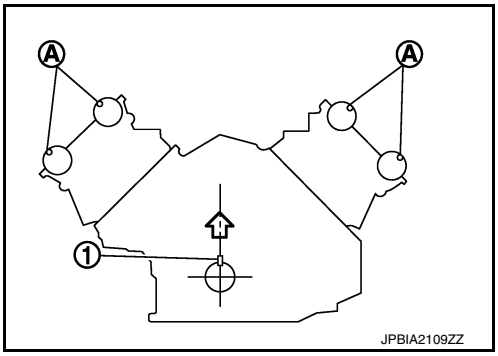
Do not reuse O-rings.



1. Timing chain	2. Camshaft sprocket (INT) (bank 2)	3. Camshaft sprocket (EXH) (bank 2)
4. Slack guide (bank 2)	5. Timing chain tensioner (bank 2)	6. Oil pump drive chain
7. Oil pump sprocket (oil pump side)	8. Oil pump drive chain tensioner	9. Oil pump sprocket (crankshaft side)
10. Tension guide (bank 1)	11. Camshaft sprocket (EXH) (bank 1)	12. Camshaft sprocket (INT) (bank 1)
13. Timing chain tensioner (bank 1)	14. Slack guide (bank 1)	15. Tension guide (bank 2)
16. Crankshaft sprocket (bank 2 side)	17. Crankshaft sprocket (bank 1 side)	
A. Crankshaft key	B. Matching mark (outer groove)	C. Matching mark (copper link)
D. Matching mark (punched)	E. Matching mark (yellow link)	F. Matching mark (notched)

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.
- Camshaft sprocket (INT), camshaft sprocket (EXH)
- 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.
- There is no matching mark in the oil pump related parts.

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



Camshaft dowel pin

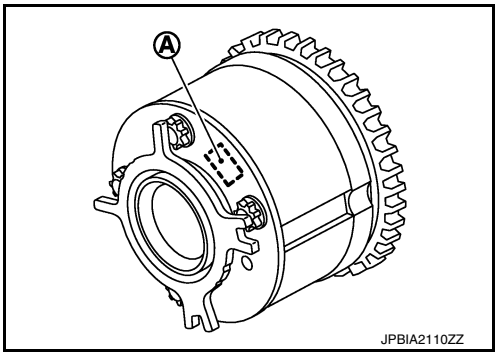
: At cylinder head upper face side in each bank

Crankshaft key

: Straight up

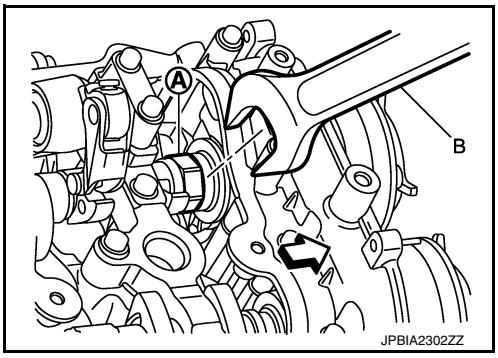
NOTE:
Though camshaft does not stop at the position as shown in the figure, for the placement of cam nose, it is generally accepted camshaft is placed for the same direction of the figure.

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 camshaft (EXH) using a wrench to tighten mounting bolt. Refer to EM-238, "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-238, "Exploded View".

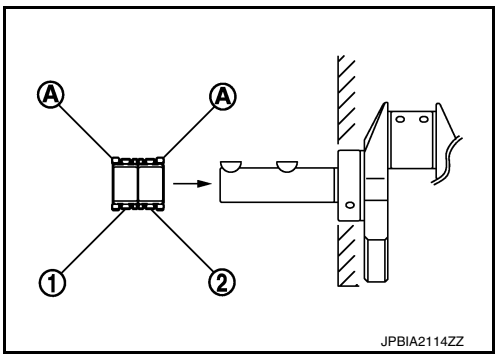


⇦ : Engine front

NOTE:
The figure shows an example of bank 2.

3. 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.



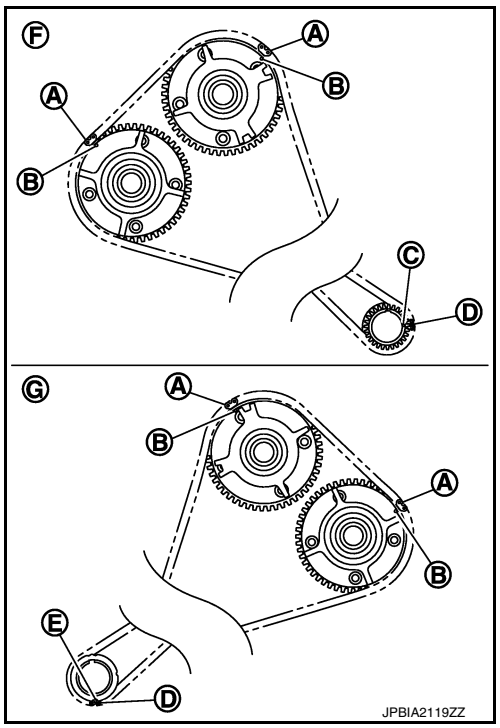
1 : Crankshaft sprocket (bank 1 side)
2 : Crankshaft sprocket (bank 2 side)

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

b. Install timing chains.

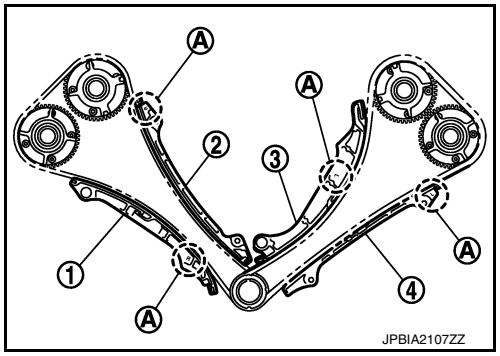
Bank 2 (F):
- Install timing chain so that the matching mark (outer groove) (B) on camshaft sprocket is aligned with the copper link (A) on timing chain, while the matching mark (punched) (C) on crankshaft sprocket is aligned with the yellow link (D) one on timing chain, as shown in the figure.

Bank 1 (G):
- Install timing chain so that the matching mark (outer groove) (B) 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.



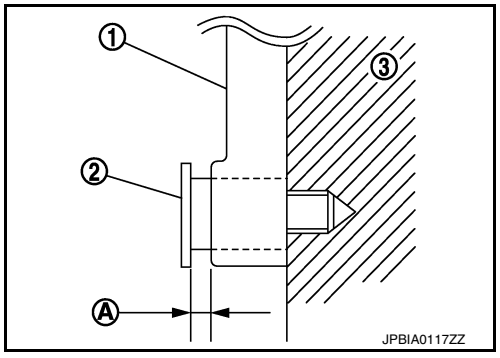
4. Install slack guides and tension guides onto correct side by checking with identification mark (A) on surface.

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



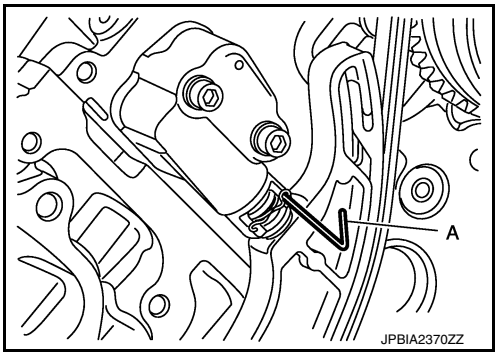
CAUTION:
Never overtighten slack guide mounting bolt (2). It is normal for a gap (A) to exist under the bolt seats when mounting bolt are tightened to the specification.

1 : Slack guide
3 : Cylinder block



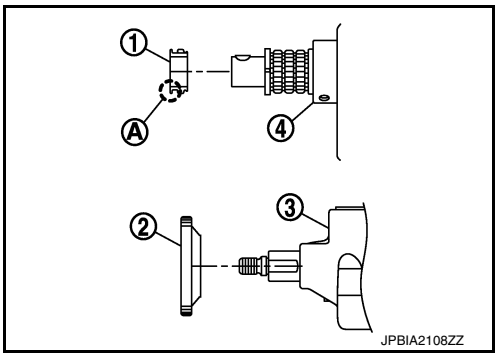
5. Install timing chain tensioner as per the following:

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.



6. Check again that the matching marks on sprockets and timing chain have not slipped out of alignment.
7. Install oil pump drive chain as per the following:

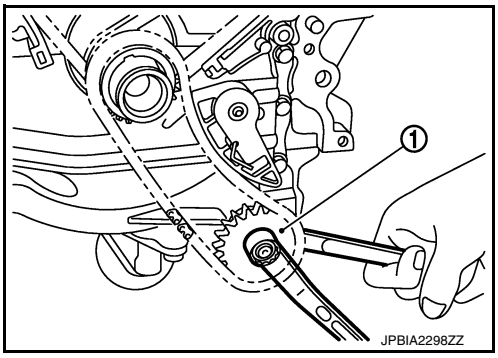
a. Install oil pump drive chain tensioner.
   • Fix the tensioner at the most compressed position using a stopper pin. and then install it.
b. Install the oil pump sprocket (crankshaft side), oil pump sprocket (oil pump side) and oil pump drive chain at the same time.
   • Install each oil pump sprocket so that its flange side (the larger diameter side without teeth) (A) faces in the direction shown in the figure.



   1 : Oil pump sprocket (crankshaft side)
   2 : Oil pump sprocket (oil pump side)
   3 : Oil pump
   4 : Crankshaft

   NOTE:
   There is no matching mark in the oil pump related parts.

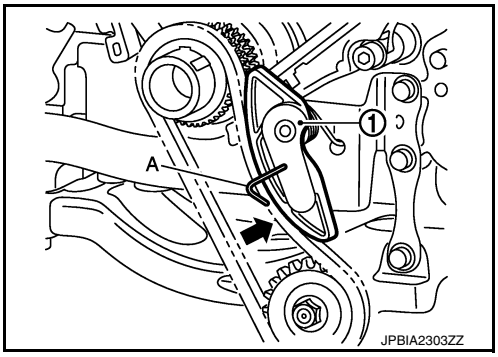
c. Hold the two flat parts of oil pump shaft, and then tighten the oil pump sprocket (oil pump side) nut.



   1 : Oil pump sprocket (oil pump side)

   CAUTION:
   Secure the oil pump shaft with the two flat parts.

d. Securely pull out the stopper pin (A) after installing the oil pump drive chain.
   • Check that the tension is applied to the oil pump drive chain (1) after installing.

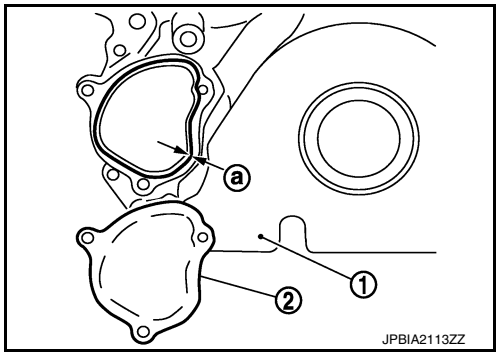


8. Install front oil seal on front cover. Refer to .EM-205, "FRONT OIL SEAL : Removal and Installation".

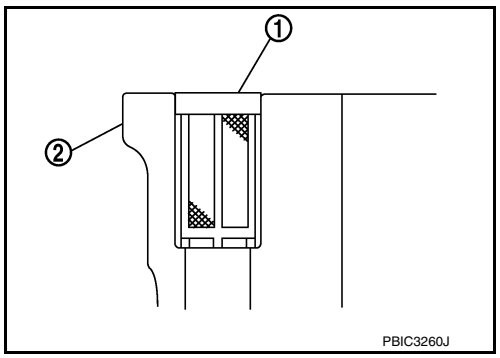
9. Install timing chain tensioner cover (2) to front cover (1).

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 an equivalent. Refer to** **GI-24, "Recommended Chemical Products and Sealants"****.**



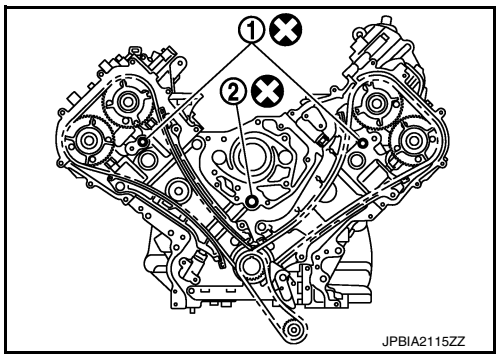
10. Install oil filter (for valve timing control solenoid valve) (1) in the direction shown in the figure, if removed.
- Check that the oil filter does not protrude from the upper surface of front cover (2) after installation.



11. Install front cover as per the following:

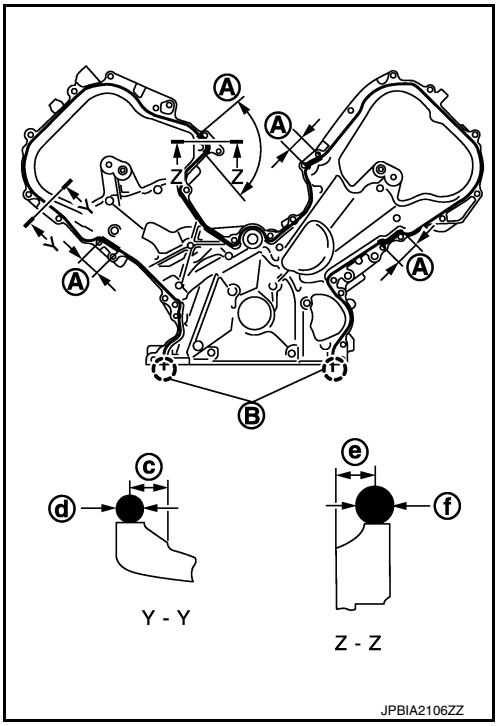
a. Install new O-ring (1), (2) onto cylinder heads and cylinder block.

CAUTION:
Do not reuse O-rings.



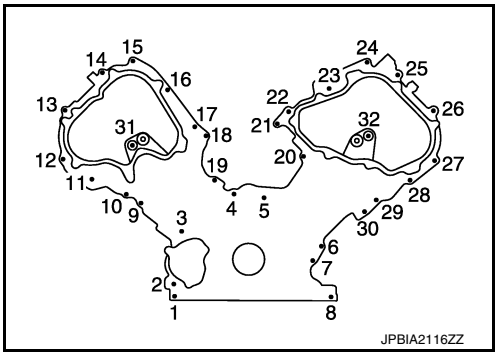
b. Apply a continuous bead of liquid gasket with tube presser (commercial service tool) to front cover as shown in the figure.
Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-24, "Recommended Chemical Products and Sealants".

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)



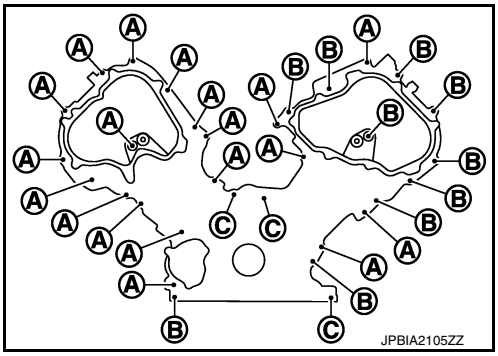
c. Check again that the matching marks on timing chain and that on each sprocket are aligned. Then, install front cover.
CAUTION:
Be careful not to damage front oil seal by interference with front end of crankshaft.

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



- There are three types of mounting bolts.

A : 20 mm (0.79 in)
B : 45 mm (1.77 in)
C : 80 mm (3.15 in)

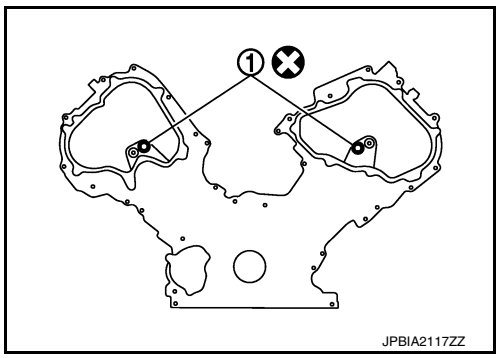


e. After all mounting bolts are tightened, retighten them in numerical order as shown in the figure.
CAUTION:
Be sure to wipe out any excessive liquid gasket leaking onto surface mating with oil pan.

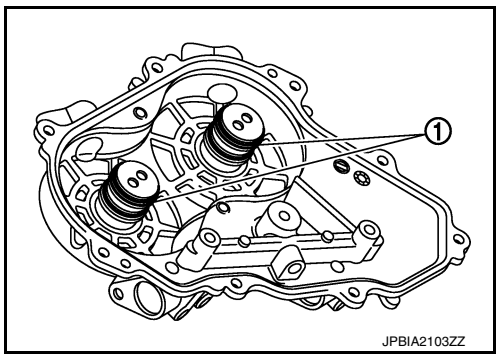
12. Install valve timing control cover as per the following:

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

Do not reuse O-rings.



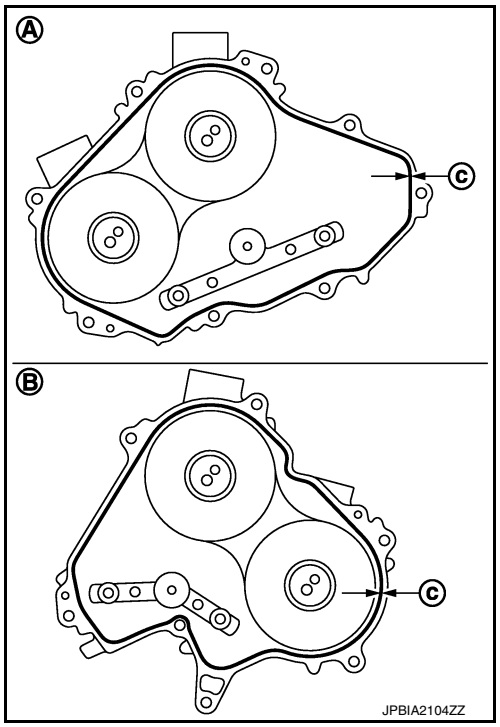
b. Install new seal rings (1) in shaft grooves.
CAUTION:
When replacing seal ring, replace all rings with new ones.



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

A : Bank 1
B : Bank 2
c : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)

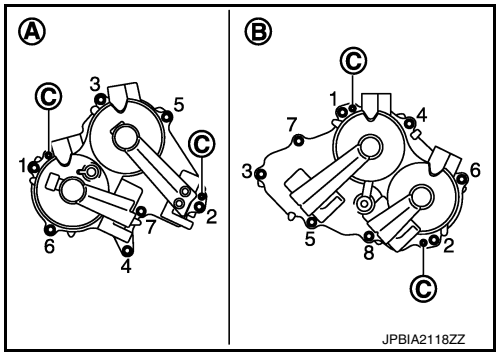
Use Genuine RTV Silicone Sealant or equivalent. Refer to **GI-24, "Recommended Chemical Products and Sealants"**.



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.



13. 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.
14. Install oil pan (lower) and oil strainer. Refer to EM-198, "Exploded View".
15. Install oil pan (upper). Refer to EM-219, "Exploded View".
16. Install water pump pulley. Refer to CO-49, "Exploded View".
17. Install crankshaft pulley.
    • Fix the crankshaft as instructed in the removal procedure. Refer to EM-205, "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.

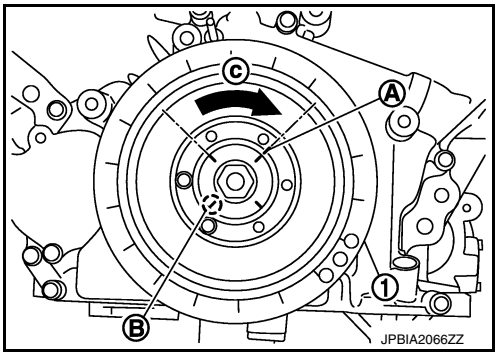
: 157 N·m (16 kg-m, 116 ft-lb)

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.



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

Inspection

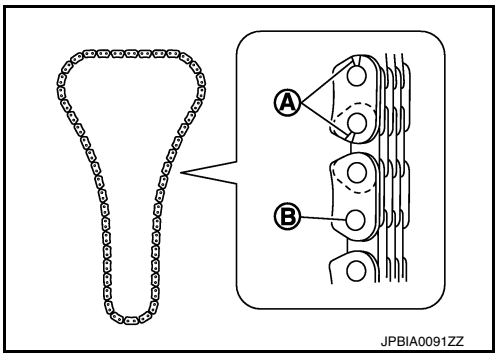
INFOID:0000000010582099

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-17, "FOR NORTH AMERICA : 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:

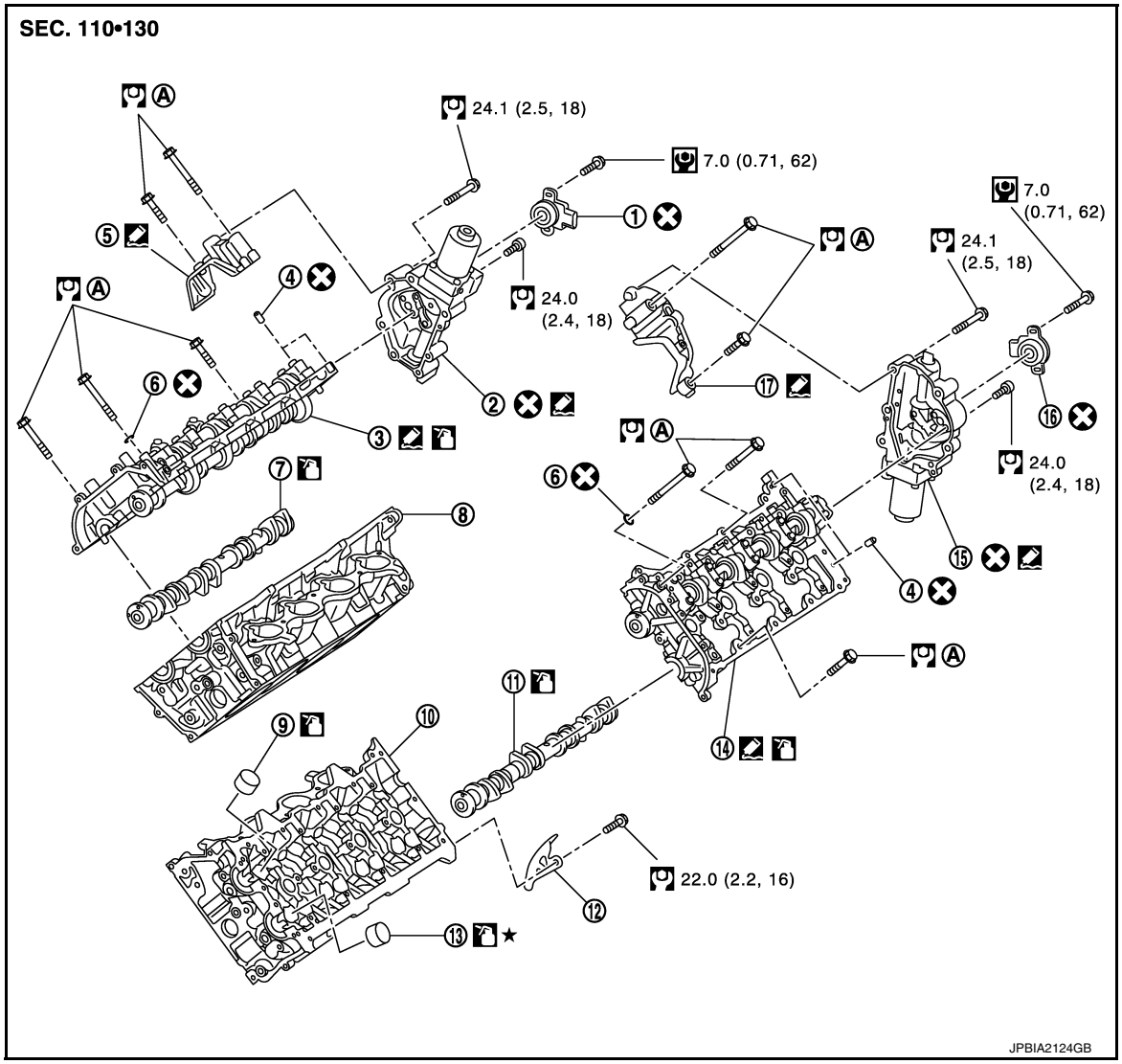
Items		Before starting engine	Engine running	After engine stopped
Engine coolant		Level	Leakage	Level
Engine oil		Level	Leakage	Level
Transmission / transaxle fluid	AT & CVT Models	Leakage	Level / Leakage	Leakage
	MT Models	Level / Leakage	Leakage	Level / Leakage
Other oils and fluids*		Level	Leakage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

*: Power steering fluid, brake fluid, etc.

CAMSHAFT

Exploded View

INFOID:0000000010582100



1.	VVEL control shaft position sensor (bank 2)	2.	VVEL actuator sub assembly (bank 2)	3.	VVEL ladder assembly (bank 2)
4.	Dowel pin	5.	Actuator bracket (rear) (bank 2)	6.	Washer
7.	Camshaft (EXH) (bank 2)	8.	Cylinder head (bank 2)	9.	Valve lifter (INT)
10.	Cylinder head (bank 1)	11.	Camshaft (EXH) (bank 1)	12.	Actuator cover
13.	Valve lifter (EXH)	14.	VVEL ladder assembly (bank 1)	15.	VVEL actuator sub assembly (bank 1)
16.	VVEL control shaft position sensor (bank 1)	17.	Actuator bracket (rear) (bank 1)		
A.	Comply with the installation procedure when tightening. Refer to EM-239				

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

CAUTION:

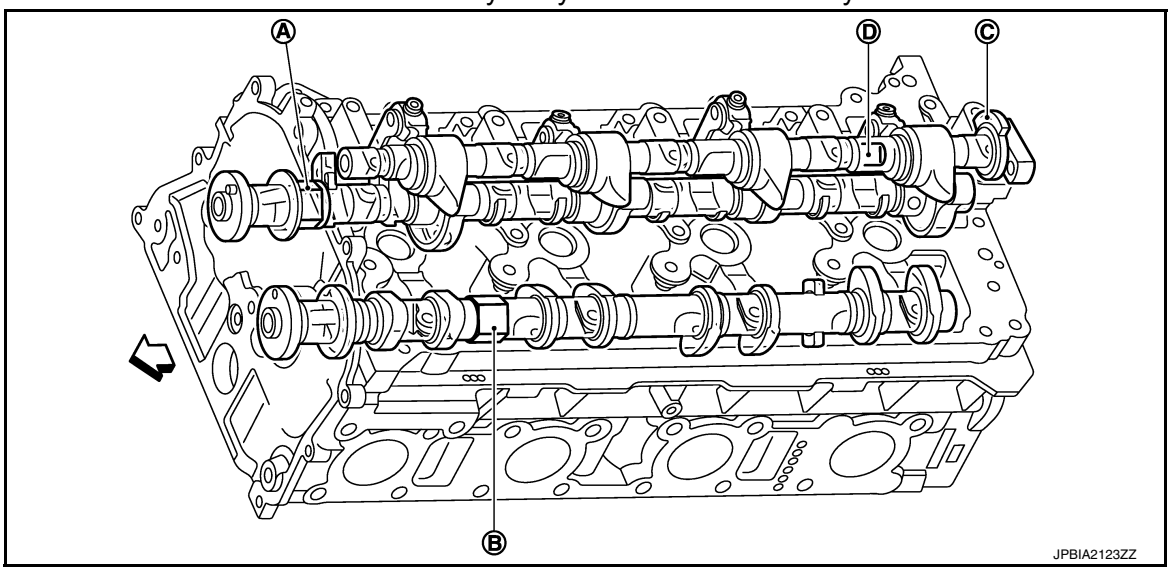
A high degree of precision is required for a valve on the intake side. Never remove the valve related parts unless necessary.

NOTE:

- As for replacement of parts on the intake side as shown in the exploded view, replace VVEL ladder assembly & cylinder head assembly.

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

VVEL Ladder Assembly & Cylinder Head Assembly Features



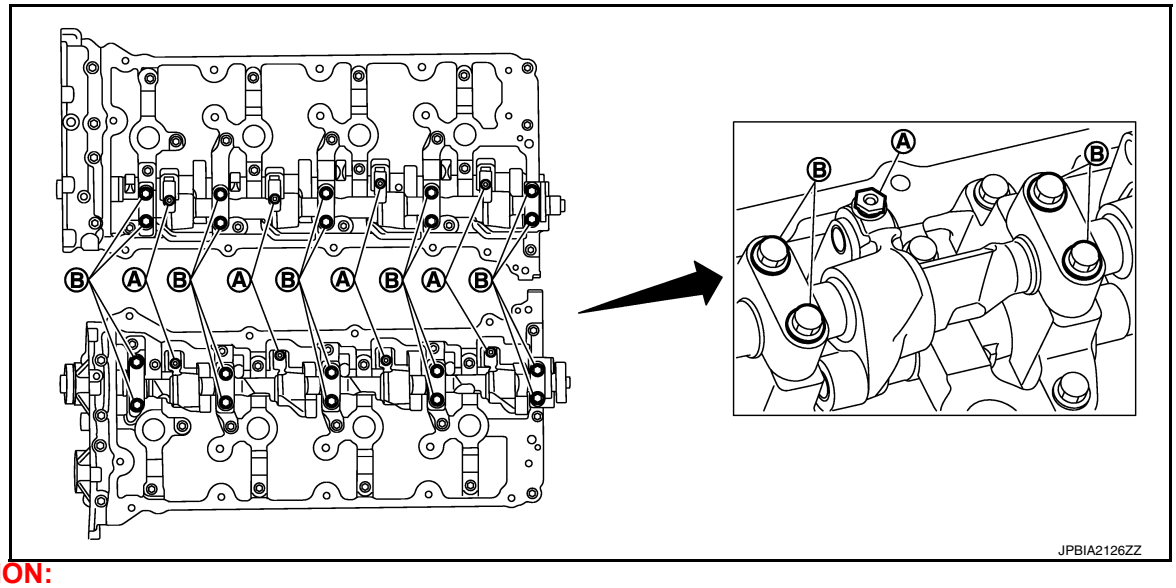
A. Hexagonal part of drive shaft (for holding)
B. Hexagonal part of camshaft (EXH) (for holding)
C. Stopper of control shaft
D. Two flat areas of control shaft (for holding)
⇦ : Engine front

NOTE:
The figure shows an example of bank 1.

Disassembly and Assembly

INFOID:0000000010582101

DISASSEMBLY



CAUTION:
Never loosen adjusting bolts (A) and mounting bolts (black color) (B) of VVEL ladder assembly. 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.
NOTE:
VVEL ladder assembly cannot be replaced as a single part, because it is machined together with cylinder head assembly.

1. Remove rocker covers (bank 1 and bank 2). Refer to EM-201, "Exploded View".

2. Remove VVEL actuator sub assembly as per the following:

CAUTION:

VVEL actuator sub assembly and VVEL control shaft position sensor are not reusable. Never remove them unless they are required.

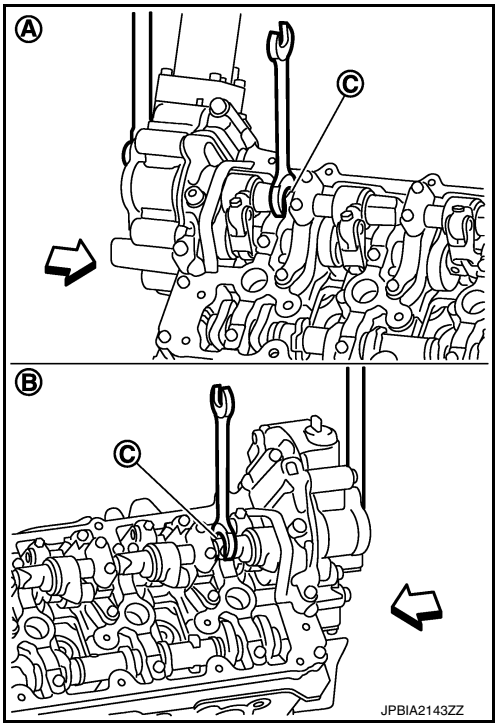
a. Remove VVEL control shaft position sensor.

b. Fix two flat areas (C) of control shaft with a wrench to remove mounting bolts of control shaft.

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

CAUTION:

- **During the operation, never allow a wrench to interfere with other parts.**
- **Fix control shaft to prevent the interference of the stopper surface.**



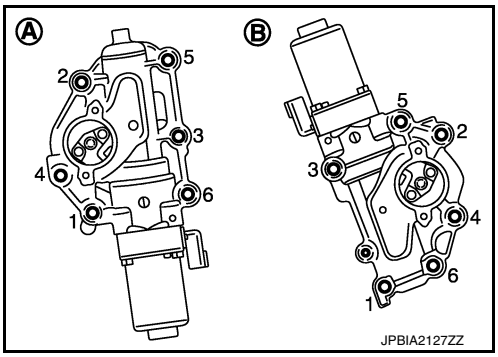
c. Remove VVEL actuator sub assembly.

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

A : Bank 1
B : Bank 2

CAUTION:

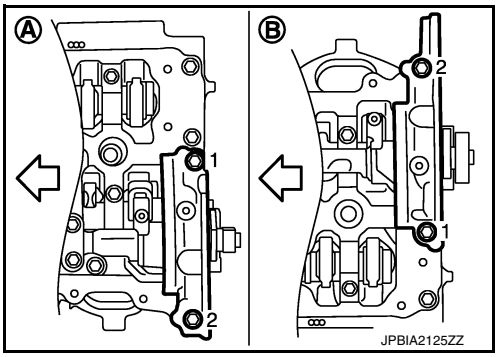
- **When removing, prepare wastes because oil spills.**
- **When installing, be careful with VVEL actuator sub assembly (bank 1) mounting bolt No. 4 because its length is different.**



d. Remove actuator bracket (rear).

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

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

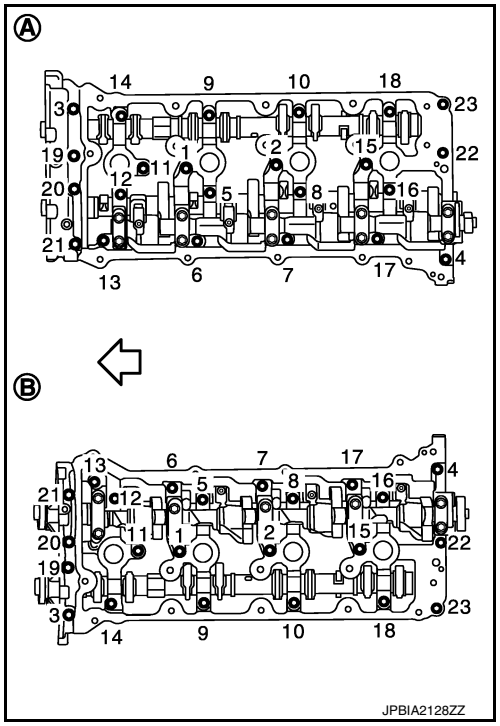


3. Remove front cover, camshaft sprockets, and timing chains. Refer to EM-223, "Exploded View".
4. Remove VVEL ladder assembly.

- 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.**



5. Remove camshaft (EXH).
6. Remove valve lifter, if necessary.
   - Identify installation positions, and store them without mixing them up.

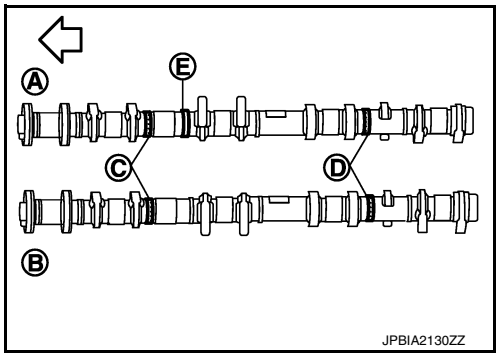
ASSEMBLY

CAUTION:
Do not reuse washers.

1. Install valve lifter.
   - Install it in the original position.
2. Install camshaft (EXH).
   - Distinction between camshaft (EXH) is performed with the identification mark.

⇦ : Engine front

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

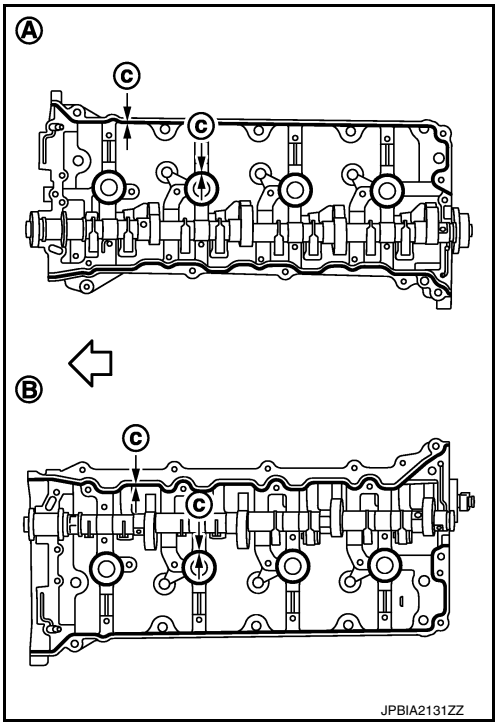


3. Install VVEL ladder assembly as per the following:

a. Apply a continuous bead of liquid gasket with tube presser (commercial service tool) to the cylinder head 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 an equivalent. Refer to GI-24, "Recommended Chemical Products and Sealants".



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

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

CAUTION:
Do not reuse washers.

i. Tighten bolts in numerical order as shown.

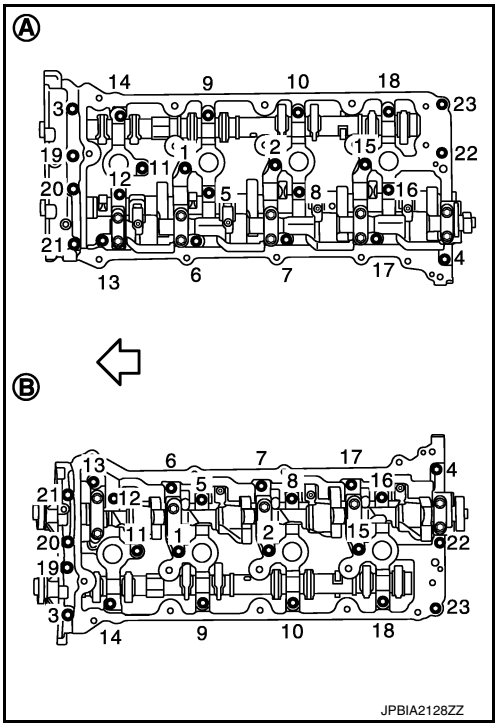
: 1.96 N·m (0.20 kg-m, 1 ft-lb)

ii. Tighten bolts in numerical order as shown.

: 5.88 N·m (0.60 kg-m, 4 ft-lb)

iii. Tighten bolts in numerical order as shown.

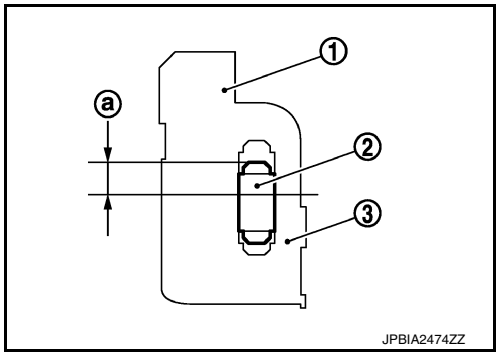
: 10.4 N·m (1.1 kg-m, 8 ft-lb)



4. Install camshaft sprockets and timing chains. Refer to EM-223, "Exploded View".
5. Install actuator bracket (rear) as per the following:

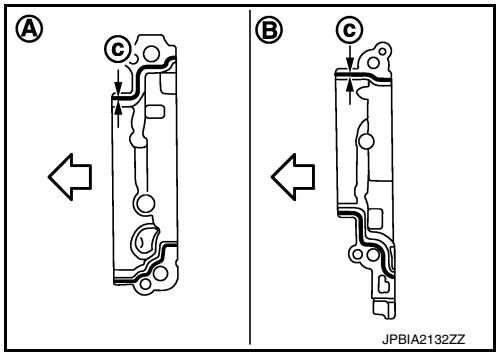
a. Refer to the figure to replace new dowel pins (2), if removed.

1 : Actuator bracket
3 : VVEL ladder assembly
a : 4.0 - 6.0 mm(0.157 - 0.236 in)



b. Apply a continuous bead of liquid gasket with tube presser (commercial service tool) to the actuator bracket (rear) as shown in the figure.

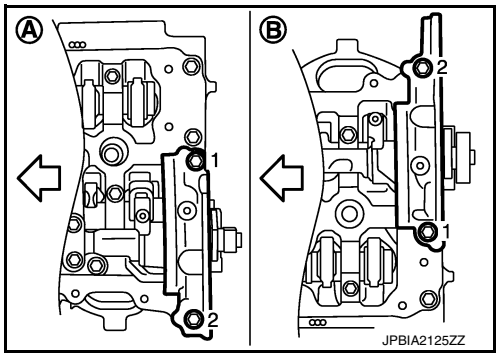
A : Bank 2
B : Bank 1
c : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)
⇦ : Engine front



Use Genuine RTV Silicone Sealant or an equivalent. Refer to GI-24, "Recommended Chemical Products and Sealants".
CAUTION:
Never apply gasket to the oil passage.

c. Tighten mounting bolts in the following steps, in numerical order as shown.

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



CAUTION:
Do not reuse washers.

i. Tighten bolts in numerical order as shown.

: 1.96 N·m (0.20 kg-m, 1 ft-lb)

ii. Tighten bolts in numerical order as shown.

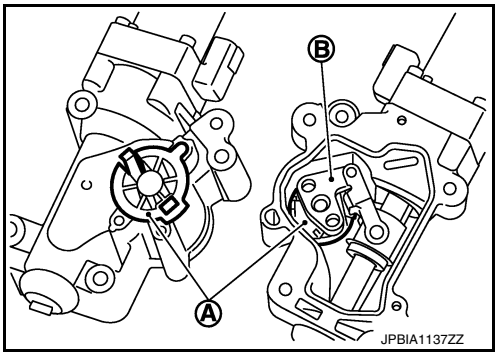
: 5.88 N·m (0.60 kg-m, 4 ft-lb)

iii. Tighten bolts in numerical order as shown.

: 31.4 N·m (3.2 kg-m, 23 ft-lb)

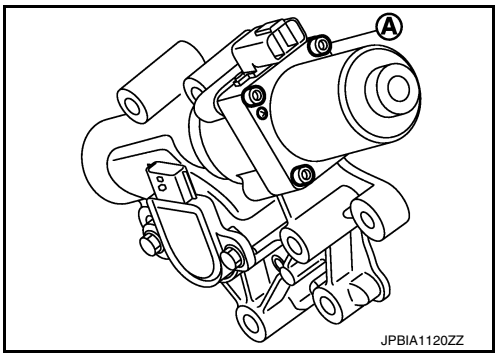
6. Install new VVEL actuator sub assembly as per the following:
CAUTION:
Regarding replacement, because VVEL actuator sub assembly and VVEL control shaft position sensor are controlled on a one-on-one basis, replace them as a set.
NOTE:

- VVEL actuator arm (B) is factory-fixed at 10 degrees from the small lift with a holding jig (A).
- The holding jig is supplied in the new VVEL actuator sub assembly.



CAUTION:

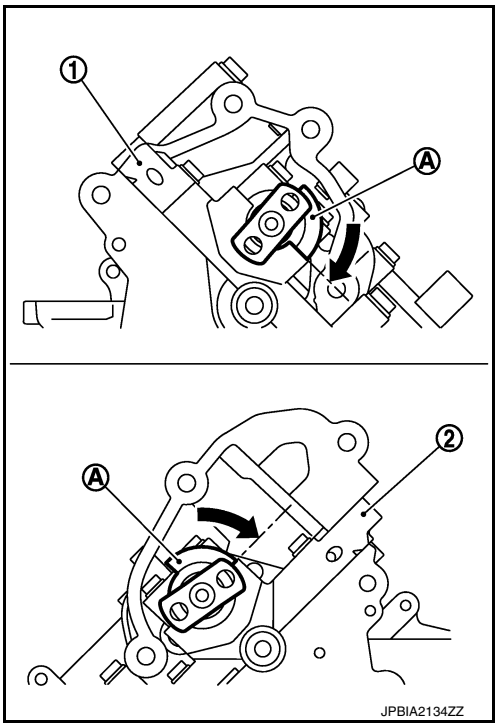
- **Never disassemble VVEL actuator sub assembly. [Never loosen actuator motor mounting bolts (A) shown in the figure]**
- **Never impact VVEL actuator sub assembly.**



a. Move control shaft to the position of small lift stopper.
- The position where a part of the stopper of control shaft contacts VVEL ladder bracket.

1 : VVEL ladder assembly (bank 2)
2 : VVEL ladder assembly (bank 1)
A : Stopper of control shaft
⬅ : Small lift side

CAUTION:
Be careful not to damage the stopper surface.



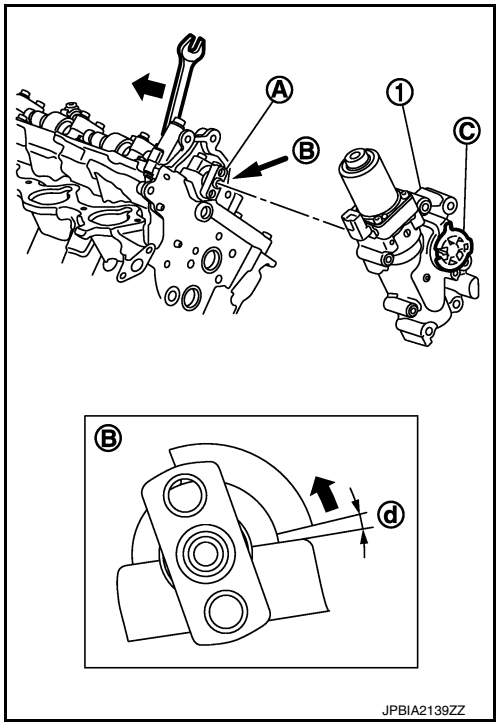
- If control shaft cannot be moved, set crankshaft in position referring to the information below. (To displace cam nose)

Bank 1 : Turn 360 degrees from No. 1 cylinder at TDC
Bank 2 : No. 1 cylinder at TDC

b. Hold two flat areas of control shaft with a wrench, and rotate the control shaft (10 degrees from the stopper) to the large lift side. (This is for aligning the bolt hole of control shaft and the hole of VVEL actuator arm.)

1 : VVEL actuator sub assembly (bank 2)
A : Control shaft
B : View B
C : Holding jig
d : 10 degrees
⬅ : Large lift side

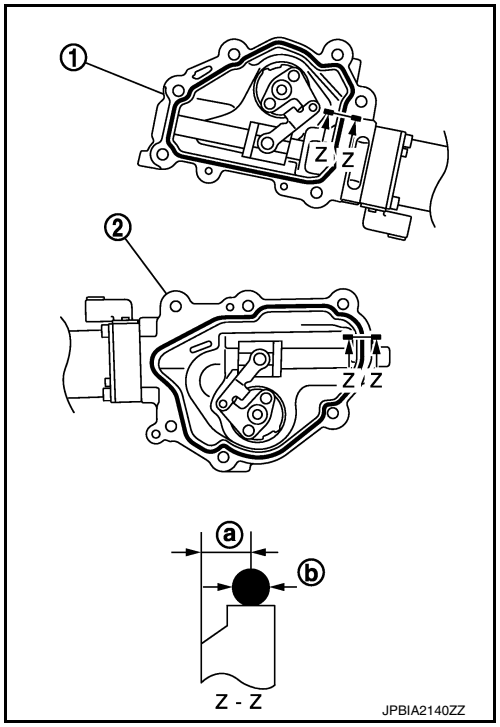
NOTE:
The figure shows an example of bank 2.



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

1 : VVEL actuator sub assembly (bank 2)
2 : VVEL actuator sub assembly (bank 1)
a : 4.0 - 5.6 mm (0.157 - 0.220 in)
b : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)

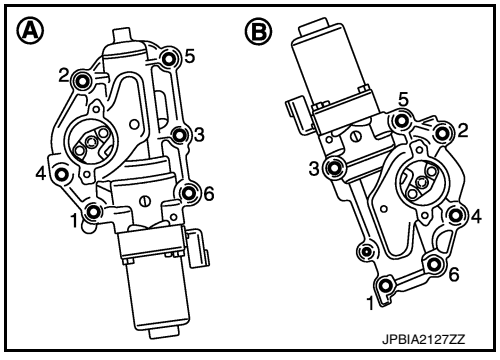
Use Genuine RTV Silicone Sealant or an equivalent. Refer to GI-24, "Recommended Chemical Products and Sealants".
CAUTION:
Never apply gasket to the oil passage.



d. Install new VVEL actuator sub assembly.
- Tighten mounting bolts in the following step, in numerical order as shown.

A : Bank 1
B : Bank 2

CAUTION:
- **When installing, be careful with VVEL actuator sub assembly (bank 1) mounting bolt No. 4 because its length is different.**

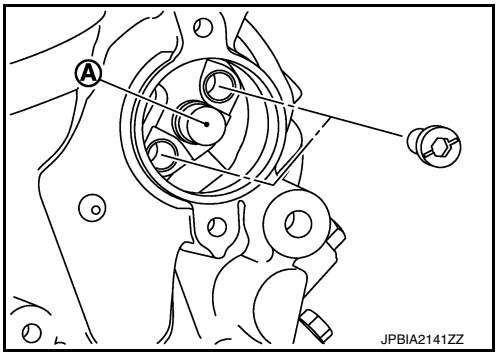


- **Be sure to check that the VVEL actuator sub assembly is in contact with the cylinder head before tightening the mounting bolts.**

e. Remove holding jig.

f. Check that VVEL actuator arm bolt hole is aligned with control shaft tapped hole. If it is not aligned, turn control shaft for alignment.

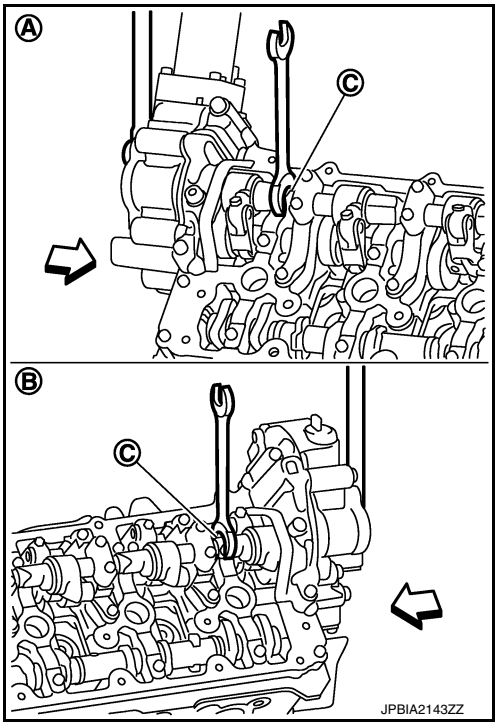
CAUTION:
Never give an impact to the magnet part. (A)



g. Fix two flat areas (C) of control shaft with a wrench to tighten mounting bolts of control shaft.

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

CAUTION:
- **During the operation, never allow a wrench to interfere with other parts.**
- **Fix control shaft to prevent the interference of the stopper surface.**

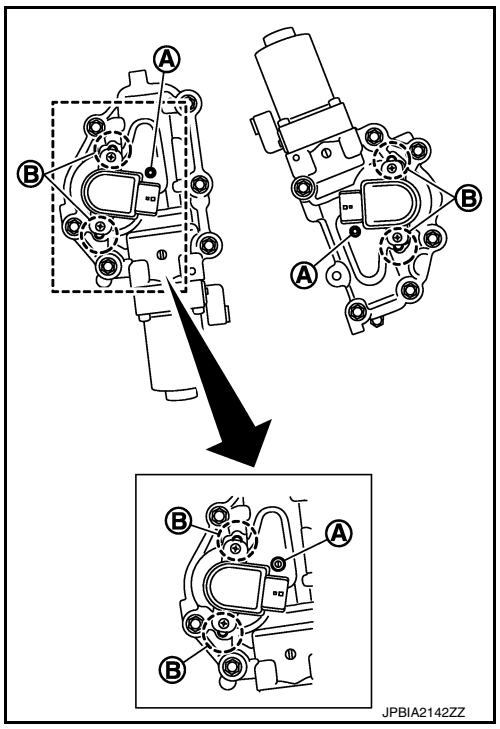


7. Install new VVEL control shaft position sensor as per the following:

CAUTION:
Regarding replacement, because VVEL actuator sub assembly and VVEL control shaft position sensor are controlled on a one-on-one basis, replace them as a set.

a. Apply engine oil to O-ring or contact surface of O-ring.

b. Align matching marks (B) of VVEL control shaft position sensor and upper housing.
• Face connector toward matching mark (A).



JPBIA2142ZZ

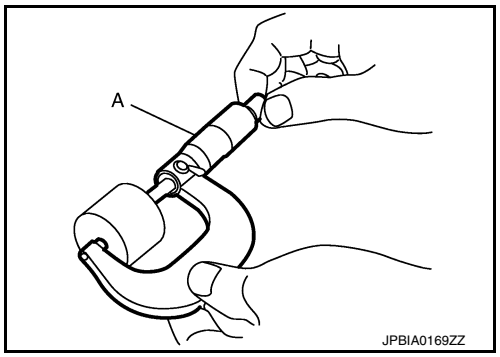
c. Temporarily tighten bolt.
d. Adjust VVEL control shaft position sensor after setting the engine assembly in the vehicle. Refer to EC-1138, "VVEL CONTROL SHAFT POSITION SENSOR ADJUSTMENT : Description".
CAUTION:
Be sure to adjust VVEL control shaft position sensor.
e. After adjusting VVEL control shaft position sensor, tighten bolts to the specified torque.
8. Install actuator cover.
9. Inspect the valve clearance. Refer to EM-179, "Inspection".
10. Install in the reverse order of removal.

Inspection

INFOID:0000000010582102

CAMSHAFT (EXH) VALVE CLEARANCE ADJUSTMENT

• Perform adjustment depending on selected head thickness of valve lifter (EXH).
1. Measure the valve clearance. Refer to EM-179, "Inspection".
2. Remove VVEL ladder assembly and camshaft (EXH). Refer to EM-239, "Disassembly and Assembly".
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).



JPBIA0169ZZ

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

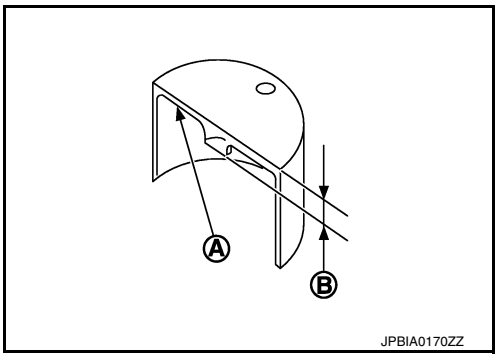
C_2 = Standard valve clearance:

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)



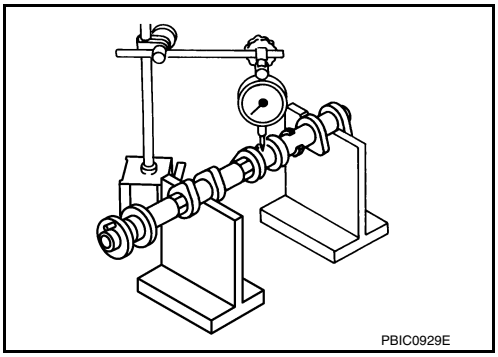
Available thickness of valve lifter (EXH): 27 sizes with range 7.88 to 8.40 mm (0.3102 to 0.3307 in) in steps of 0.02 mm (0.0008 in) (when manufactured at factory). Refer to EM-294, "Camshaft".

6. Install selected valve lifter (EXH).
7. Install VVEL ladder assembly and camshaft (EXH). Refer to EM-239, "Disassembly and Assembly".
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-179, "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)

Camshaft (EXH) 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 camshaft (EXH) to one direction with hands, and measure the camshaft runout on a dial indicator. (Total indicator reading)



Standard and limit

: Refer to EM-294, "Camshaft".

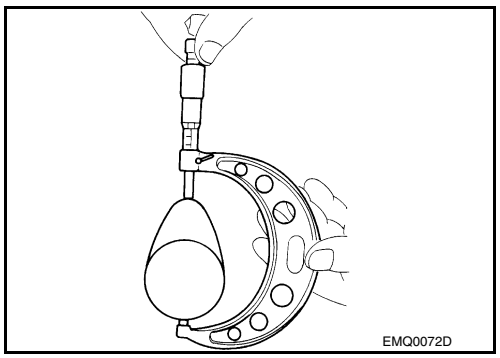
4. If it exceeds the limit, replace camshaft (EXH).

Camshaft (EXH) Cam Height

- Measure the camshaft (EXH) cam height with a micrometer.

Standard and limit
: Refer to EM-294, "Camshaft".

- If wear exceeds the limit, replace camshaft (EXH).

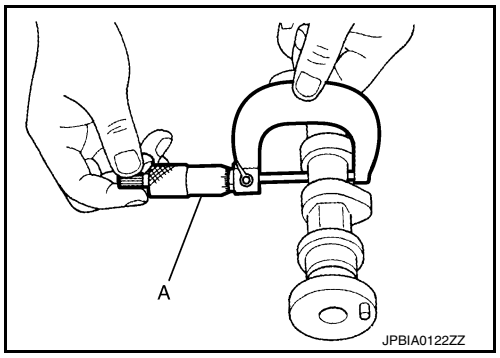


Camshaft (EXH) Journal Oil Clearance

CAMSHAFT (EXH) JOURNAL DIAMETER

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

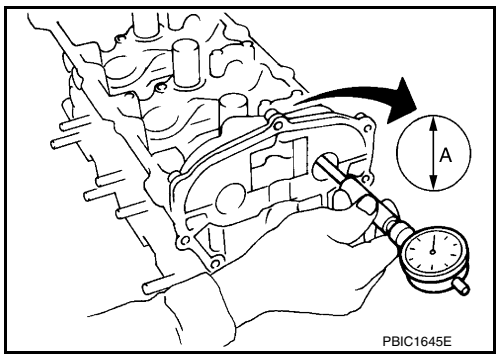
Standard : Refer to EM-294, "Camshaft".



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 (EXH side) with a bore gauge.

Standard : Refer to EM-294, "Camshaft".



CAMSHAFT (EXH) JOURNAL OIL CLEARANCE

- (Oil clearance) = [VVEL ladder assembly (EXH side) inner diameter] – [Camshaft (EXH) journal diameter].

Standard and limit : Refer to EM-294, "Camshaft".

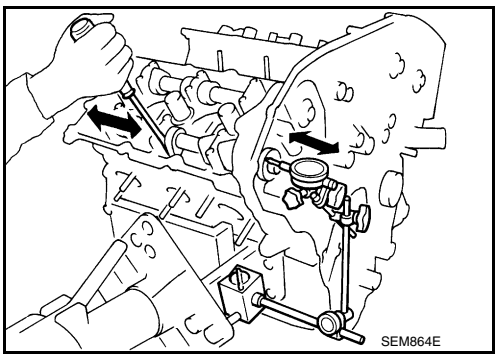
- If the calculated value exceeds the limit, replace either or both camshaft (EXH) and VVEL ladder assembly & cylinder head assembly.

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

Camshaft (EXH) End Play

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

Standard and limit : Refer to EM-294, "Camshaft".



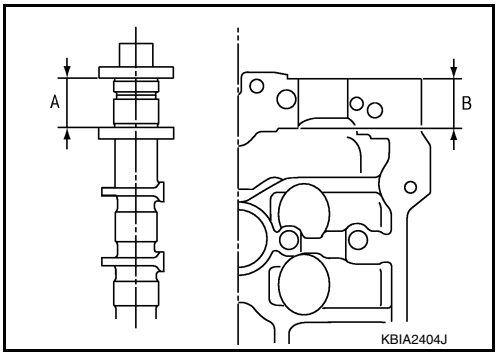
- Measure the following parts if out of the limit.

- Dimension “A” for camshaft (EXH) 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)



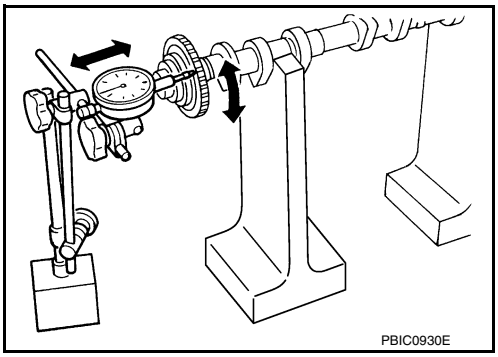
- Refer to the standards above, and then replace camshaft (EXH) and/or VVEL ladder assembly & cylinder head assembly.
  NOTE:
  Cylinder head assembly cannot be replaced as a single part, because it is machined together with VVEL ladder assembly.

Camshaft Sprocket (EXH) Runout

1. Put V-block on precise flat table, and support No. 2 and 5 journals of camshaft (EXH).
   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 (EXH) runout with a dial indicator. (Total indicator reading)

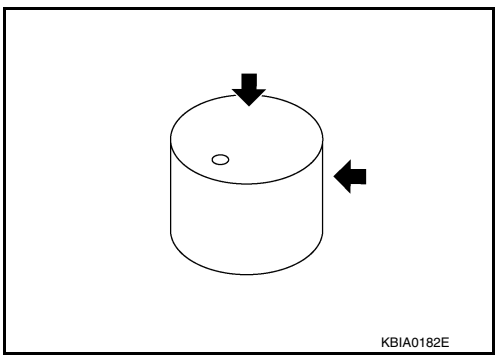
Limit : Refer to EM-294, "Camshaft".

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



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-294, "Camshaft".

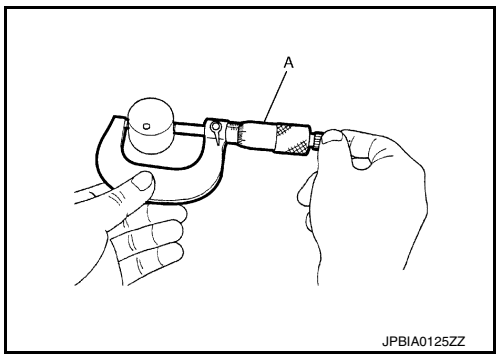


Valve Lifter Clearance (EXH)

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.

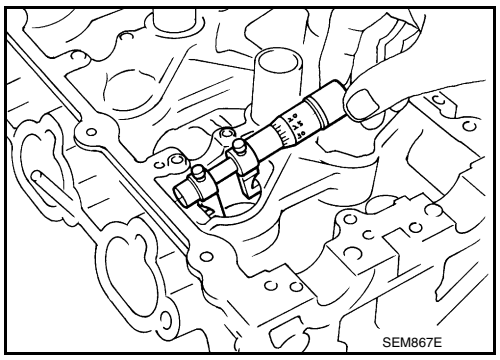
Standard : Refer to EM-294, "Camshaft".



VALVE LIFTER HOLE DIAMETER

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

Standard : Refer to EM-294, "Camshaft".



VALVE LIFTER CLEARANCE

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

Standard : Refer to EM-294, "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.

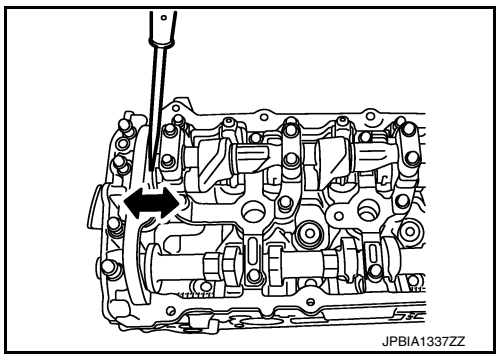
NOTE:
Cylinder head assembly cannot be replaced as a single part, because it is machined together with VVEL ladder assembly.

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).

Standard and limit : Refer to EM-294, "Camshaft".



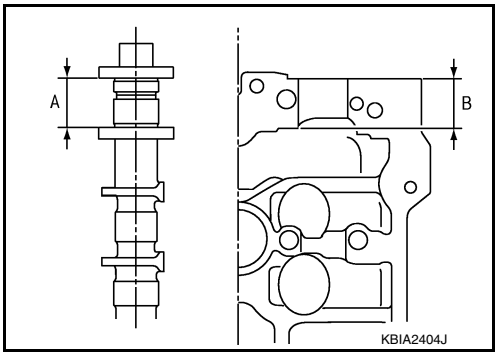
- Measure the following parts if out of the limit.

- 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)

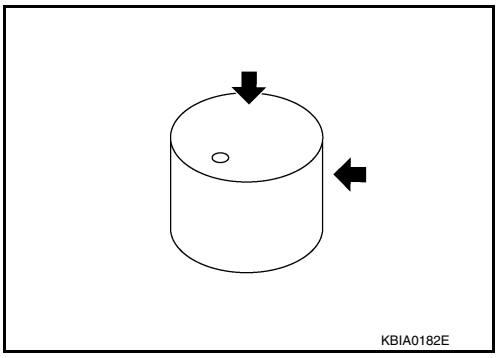
Limit : Refer to EM-294, "Camshaft".

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-294, "Camshaft".

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

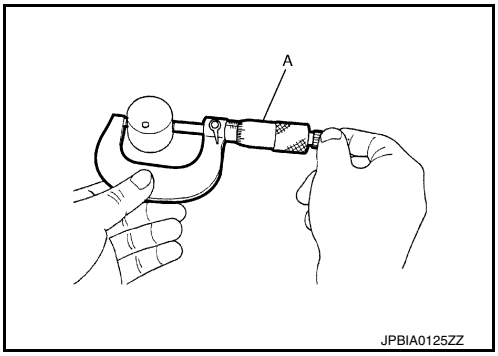


Valve Lifter Clearance (INT)

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.

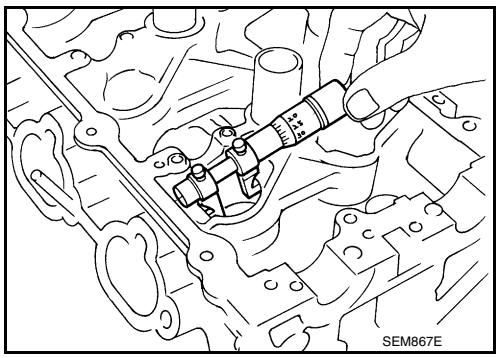
Standard : Refer to EM-294, "Camshaft".



VALVE LIFTER HOLE DIAMETER

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

Standard : Refer to EM-294, "Camshaft".



VALVE LIFTER CLEARANCE

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

Standard : Refer to EM-294, "Camshaft".

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

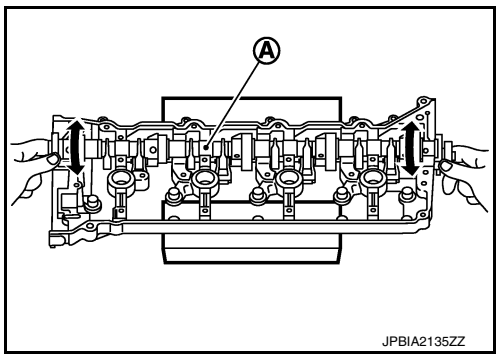
NOTE:
Since the valve lifter (INT) cannot be replaced by the piece, VVEL ladder assembly & cylinder head assembly replacement are required.

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.

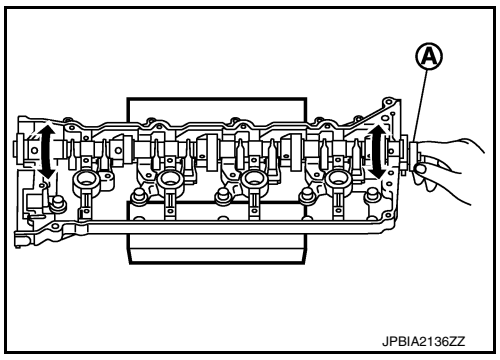
CAUTION:
Turn VVEL ladder assembly upside down to prevent the drive shaft from dropping off.



CONTROL SHAFT OPERATIONAL CHECK

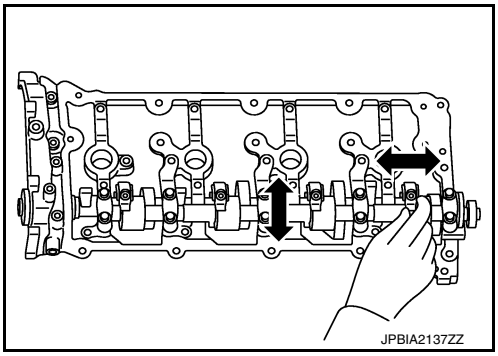
- Move control shaft (A) to the small stopper and large stopper to check that the control shaft functions smoothly.

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



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

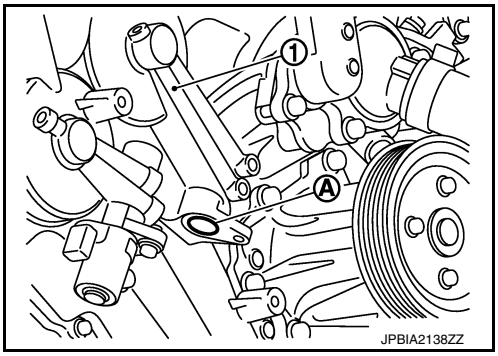
Inspection of Camshaft Sprocket (INT) Oil Groove

CAUTION:
- **Perform this inspection only when DTC P0011, P0012 is detected in self-diagnostic results of CONSULT and it is directed according to inspection procedure of EC section. Refer to EC-1253, "Diagnosis Description".**
- **Check when engine is cold to prevent burns from the splashing engine oil.**

1. Check engine oil level. Refer to LU-26, "Inspection".
2. Perform the following procedure to prevent the engine from being unintentionally started while checking.

a. Release the fuel pressure. Refer to EC-1664, "Inspection".
b. Disconnect ignition coil and injector harness connectors. Refer to EM-201, "Exploded View".

3. Remove valve timing control solenoid valve. Refer to EM-223, "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-223, "Exploded View".
   - Clean oil groove between oil strainer and valve timing control solenoid valve. Refer to LU-21, "Engine Lubrication System" and LU-22, "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-21, "Engine Lubrication System" and LU-22, "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-17, "FOR NORTH AMERICA : 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:

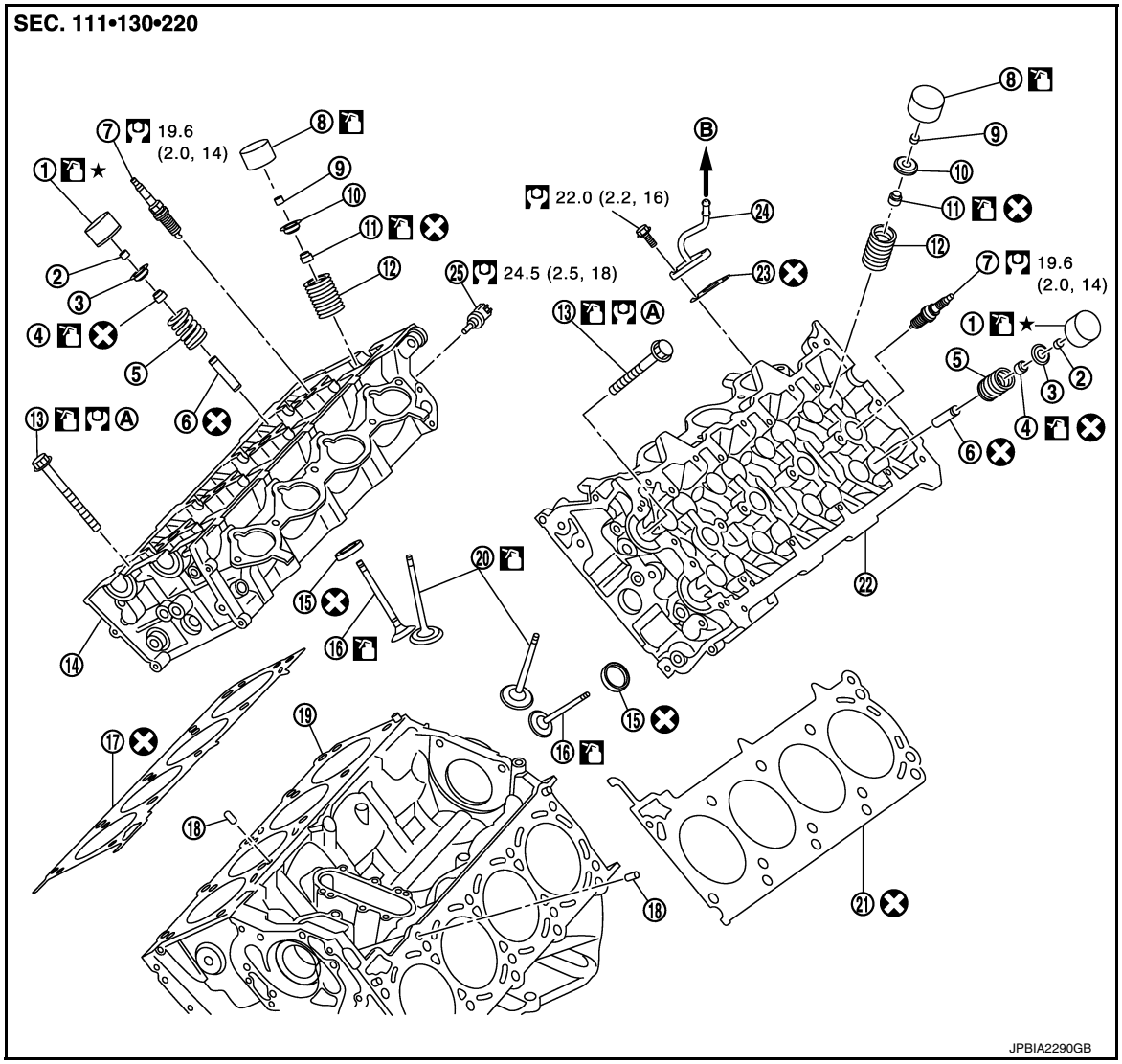
Items		Before starting engine	Engine running	After engine stopped
Engine coolant		Level	Leakage	Level
Engine oil		Level	Leakage	Level
Transmission / transaxle fluid	AT & CVT Models	Leakage	Level / Leakage	Leakage
	MT Models	Level / Leakage	Leakage	Level / Leakage
Other oils and fluids*		Level	Leakage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

*: Power steering fluid, brake fluid, etc.

CYLINDER HEAD

Exploded View

INFOID:0000000010582103



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 seat (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.	Cylinder head gasket (bank 1)
22.	Cylinder head (bank 1)	23.	Gasket	24.	Water pipe
25.	Engine coolant temperature sensor				
A.	Comply with the installation procedure when tightening. Refer to EM-257	B.	To Electric throttle control actuator (bank 1)		

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.

Disassembly and Assembly

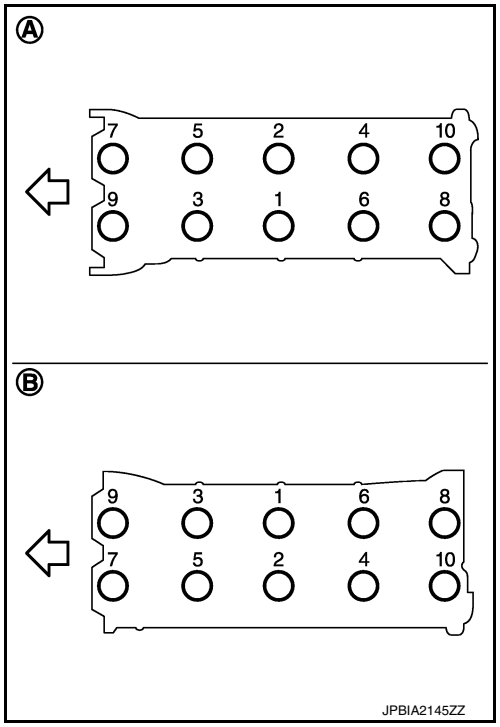
INFOID:0000000010582104

DISASSEMBLY

1. Remove the following parts:
   - Rocker cover and spark plug: Refer to EM-201, "Exploded View".
   - Intake manifold: Refer to EM-189, "Exploded View".
   - Exhaust manifold: Refer to EM-216, "Exploded View".
   - Water inlet and thermostat housing: Refer to CO-51, "Exploded View".
   - Water pipe and heater pipe: Refer to CO-51, "Exploded View".
   - Timing chain: Refer to EM-223, "Exploded View".
   - Camshaft (EXH) and VVEL ladder assembly: Refer to EM-238, "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

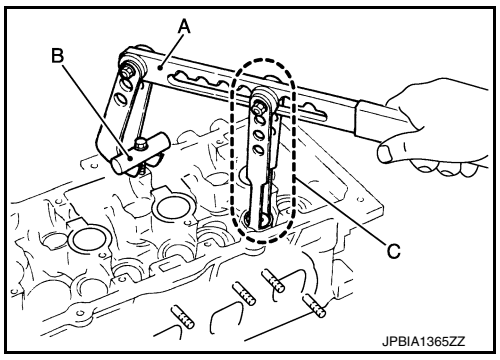
   - Use TORX socket and power tool.



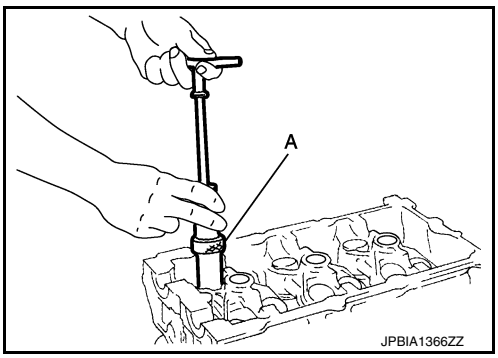
3. Remove cylinder head gaskets.
4. Remove oil filter (for VVEL ladder assembly) from cylinder block, if necessary.
5. Remove valve lifter.
   - Identify installation positions, and store them without mixing them up.
6. Remove valve collet.
   - Compress valve spring with the valve spring compressor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

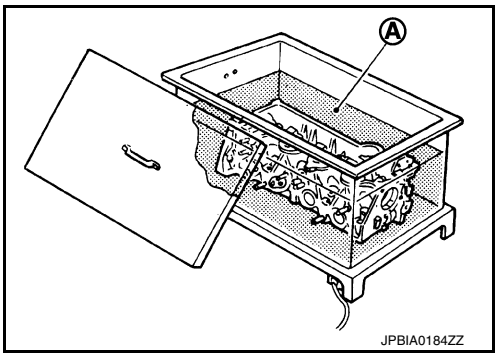


7. Remove valve spring retainer and valve spring (with valve spring seat).
8. Push valve stem to combustion chamber side, and remove valve.
   • Identify installation positions, and store them without mixing them up.
9. Remove valve oil seal using the valve oil seal puller [SST: KV10107902 (J38959)]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

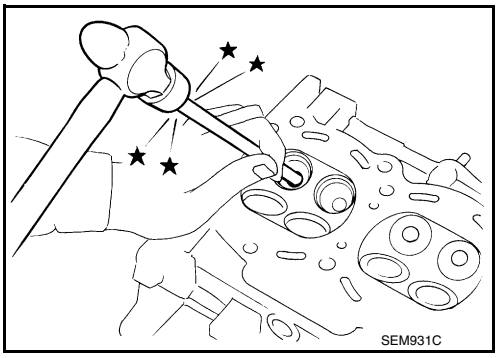


10. Remove valve seat (EXH), if valve seat (EXH) must be replaced.
    • Bore out old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in cylinder head. Set the machine depth stop to ensure this. Refer to EM-296, "Cylinder Head".
    CAUTION:
    Prevent to scratch cylinder head by excessive boring.
11. 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.

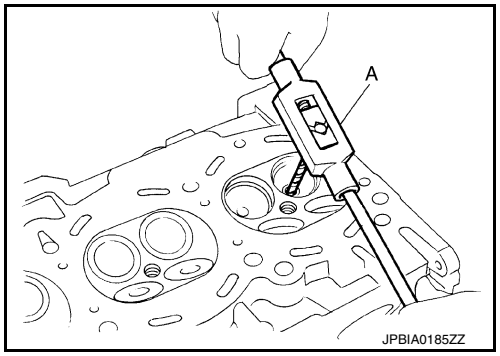


ASSEMBLY

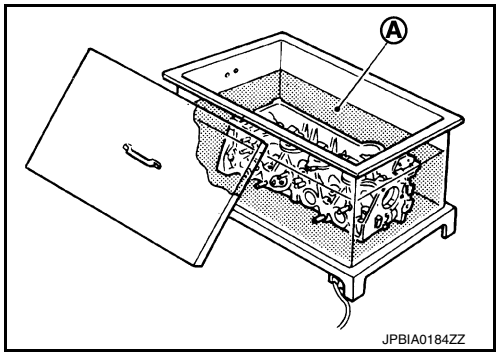
1. Install valve guide (EXH), if removed.
   Replace with oversized [0.2 mm (0.008 in)] valve guide (EXH).

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-296, "Cylinder Head".



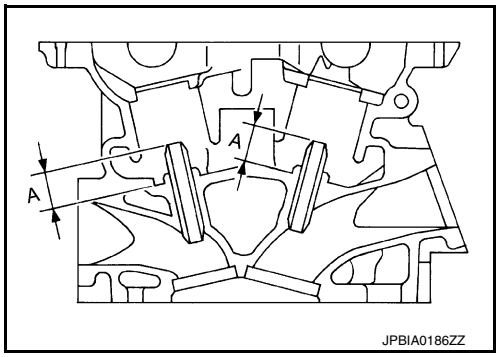
b. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil (A).



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

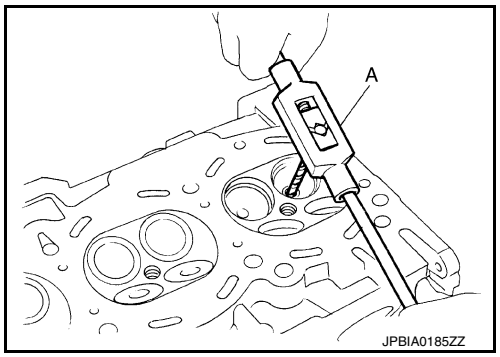
Projection (A)
: Refer to EM-296, "Cylinder Head".

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-296, "Cylinder Head".

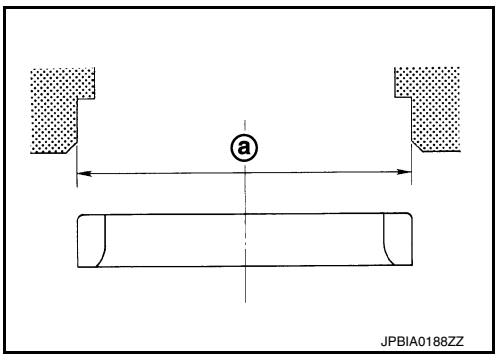


2. Install valve seat (EXH), if removed.
Replace with oversize [0.5 mm (0.020 in)] valve seat (EXH).

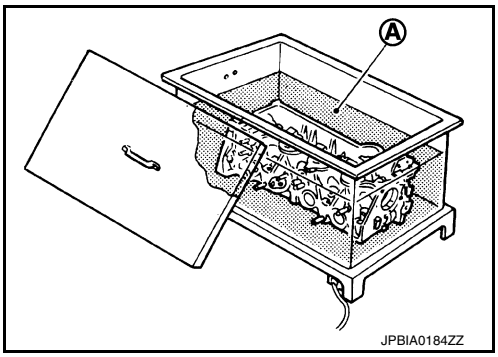
a. Ream cylinder head recess diameter (a) for service valve seat (EXH).

Oversize (service) [0.5 mm (0.020 in)]:
: Refer to EM-296, "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).

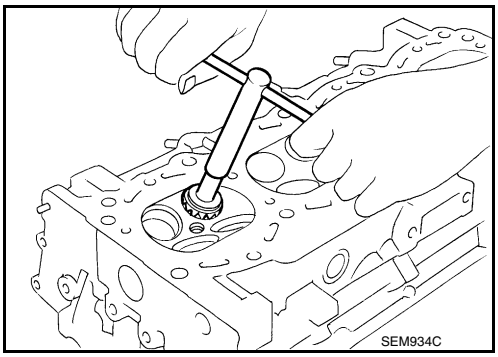


c. Provide valve seats (EXH) cooled well with dry ice. Force fit valve seat (EXH) into cylinder head.

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-296, "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-262, "Inspection".

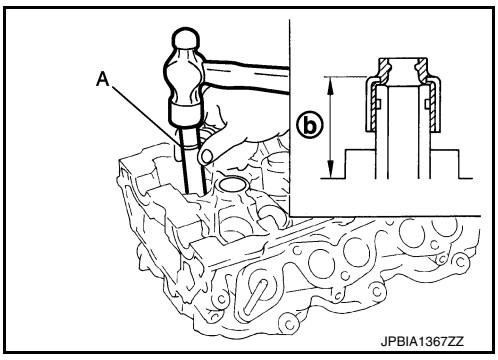
3. Install new valve oil seals as per the following:

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)

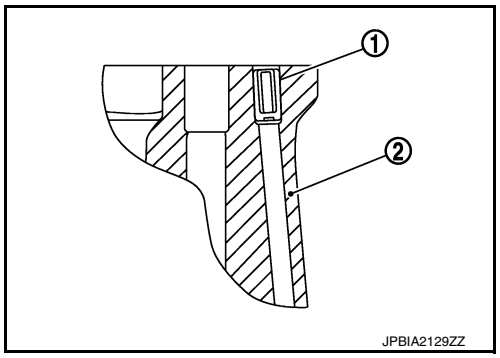
Intake	**: 14.3 - 14.9 mm (0.563 - 0.587 in)**
Exhaust	**: 13.6 - 14.2 mm (0.535 - 0.559 in)**



4. Install valve.

NOTE:
Larger diameter valves are for intake side.

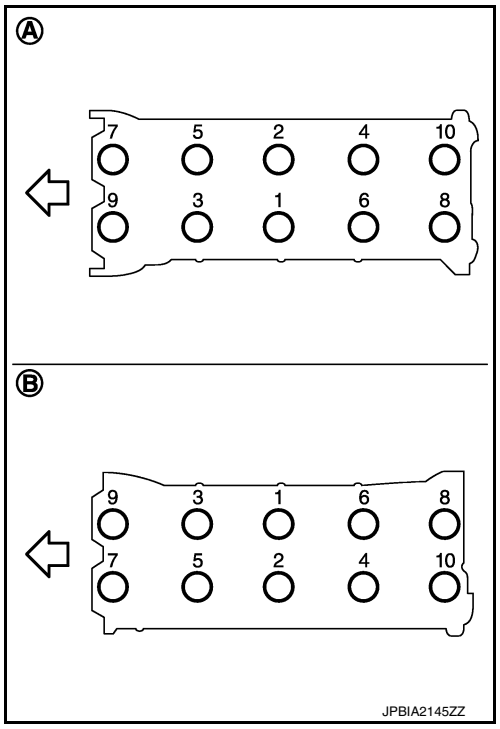
5. Install oil filter (for VVEL ladder assembly) (1) in the direction shown in the figure, if removed.
   - Check that the oil filter does not protrude from the upper surface of cylinder block (2) after installation.



6. Install new cylinder head gaskets.
7. Install cylinder head as per the following:

CAUTION:
- **If cylinder head bolts are re-used, check their outer diameters before installation. Refer to EM-262, "Inspection".**
- **Before installing cylinder head, inspect cylinder head distortion. Refer to EM-262, "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 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.

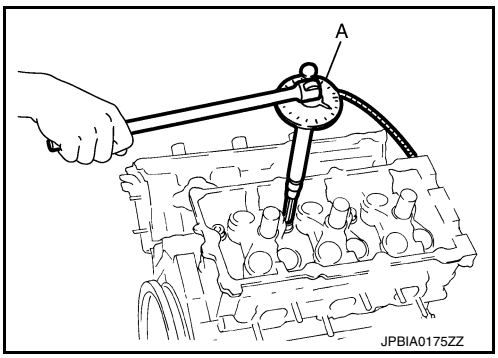
e. Tighten all cylinder head bolts.

: 40.0 N·m (4.1 kg-m, 30 ft-lb)

f. Tighten all cylinder head bolts (clockwise).

Angle tightening: 65 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.

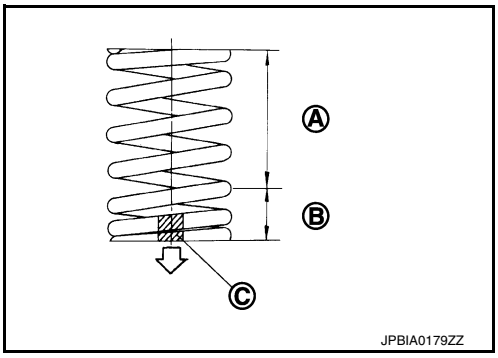


g. Tighten all cylinder head bolts again (clockwise).

Angle tightening: 65 degrees

8. 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

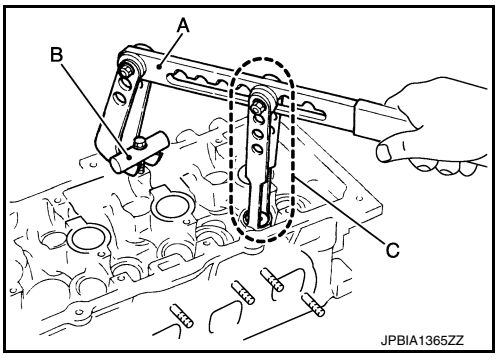


Paint mark color

Intake	**: Yellow**
Exhaust	**: Pink**

9. Install valve spring retainer.
10. 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.



11. Install valve lifter.
    - Install it in the original position.
12. Install in the reverse order of removal.

Inspection

INFOID:0000000010582105

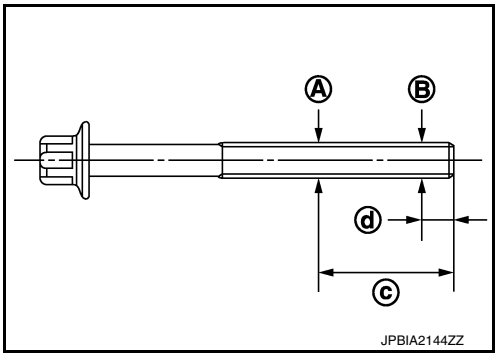
INSPECTION AFTER DISASSEMBLY

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)

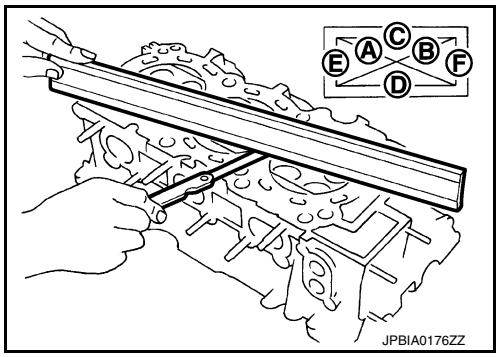


- If reduction of outer diameter appears in a position other than (A), use it as (A) point.

Cylinder Head Distortion

NOTE:
When performing this inspection, cylinder block distortion should be also checked. Refer to EM-276, "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, F).



Limit : Refer to EM-296, "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.

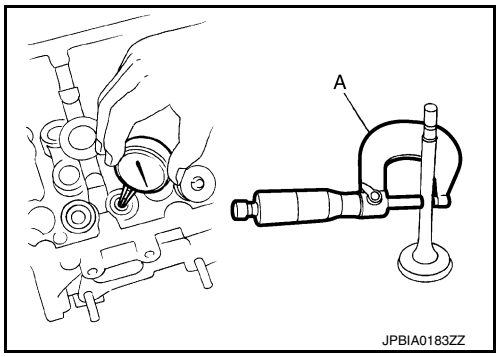
Valve Dimensions

- Check the dimensions of each valve. For the dimensions, refer to EM-296, "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-238, "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-296, "Cylinder Head".

Valve Guide Inner Diameter

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

Standard : Refer to EM-296, "Cylinder Head".

Valve Guide Clearance

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

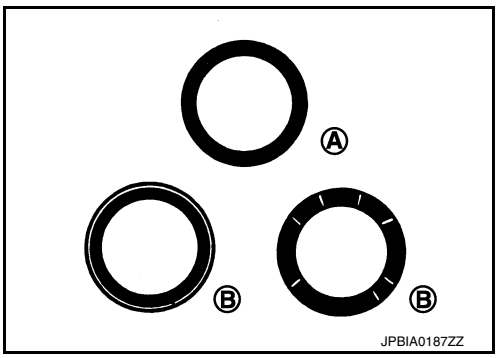
Standard : Refer to EM-296, "Cylinder Head".

- If the calculated value exceeds the limit.
- Replace valve (EXH) and/or valve guide (EXH). Refer to EM-256, "Exploded View". (Exhaust side)
- Replace VVEL ladder assembly & cylinder head assembly. Refer to EM-238, "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.



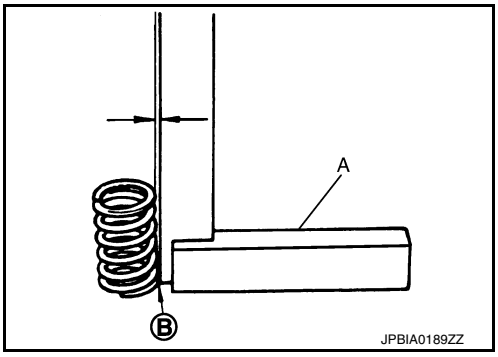
A : OK
B : NG

- 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-256, "Exploded View". (Exhaust side)
- If not, replace VVEL ladder assembly & cylinder head assembly. Refer to EM-238, "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

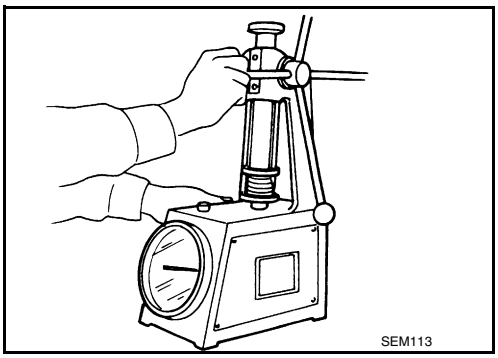
Limit : Refer to EM-296, "Cylinder Head".

- If it exceeds the limit.
- Replace valve spring (with valve spring seat) (EXH). Refer to EM-256, "Exploded View". (Exhaust side)
- Replace VVEL ladder assembly & cylinder head assembly. Refer to EM-238, "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-296, "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-256, "Exploded View". (Exhaust side)
- Replace VVEL ladder assembly & cylinder head assembly. Refer to EM-238, "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-17, "FOR NORTH AMERICA : 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:

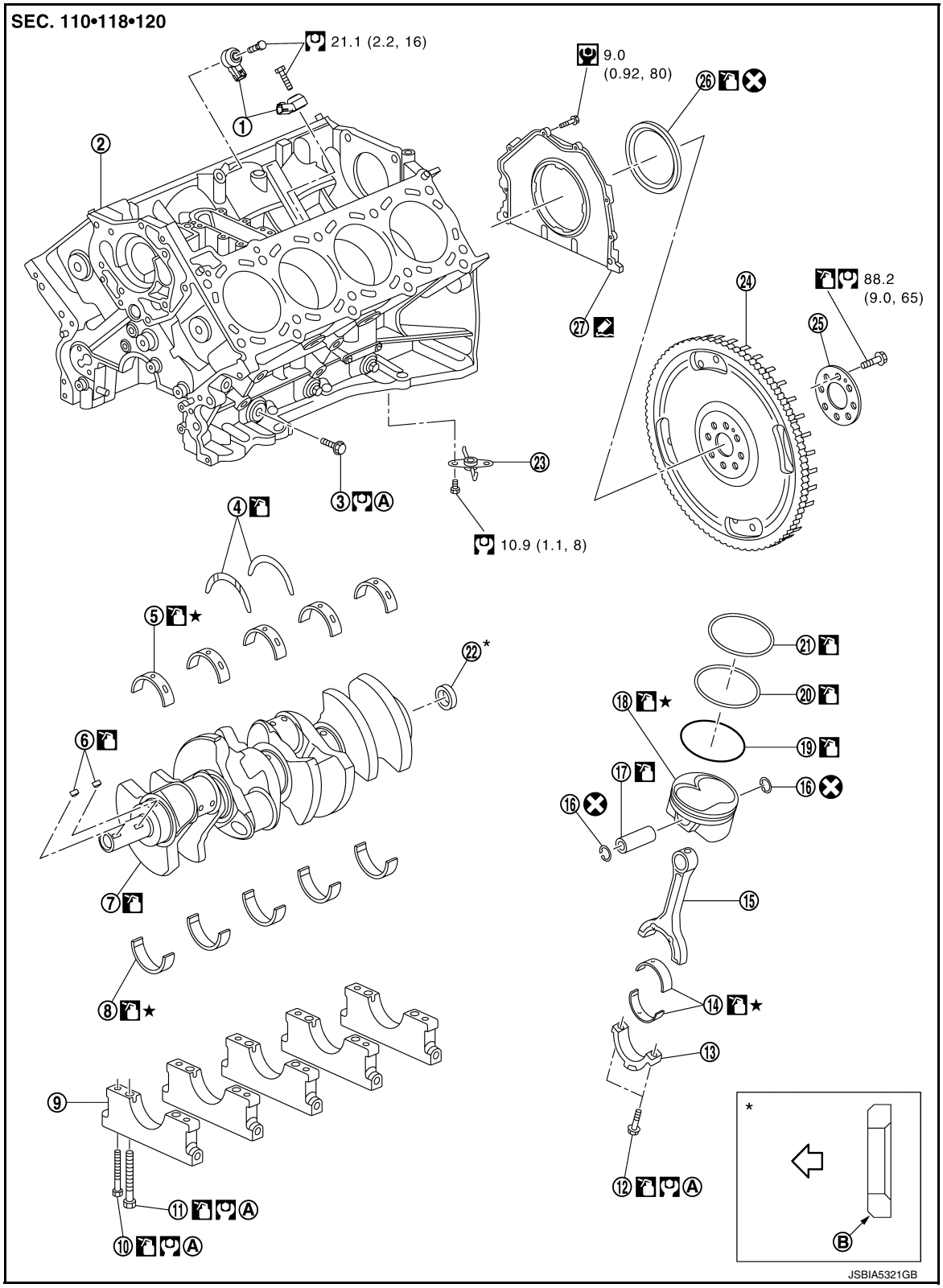
Items		Before starting engine	Engine running	After engine stopped
Engine coolant		Level	Leakage	Level
Engine oil		Level	Leakage	Level
Transmission / transaxle fluid	AT & CVT Models	Leakage	Level / Leakage	Leakage
	MT Models	Level / Leakage	Leakage	Level / Leakage
Other oils and fluids*		Level	Leakage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

*: Power steering fluid, brake fluid, etc.

CYLINDER BLOCK

Exploded View

INFOID:0000000010582106



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. Piston oil jet
24. Drive plate
25. Reinforcement plate
26. Rear oil seal
27. Rear oil seal retainer

A. Comply with the installation procedure when tightening. Refer to EM-267
B. Chamfered

⇦ : Crankshaft side

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

Disassembly and Assembly

INFOID:0000000010582107

DISASSEMBLY

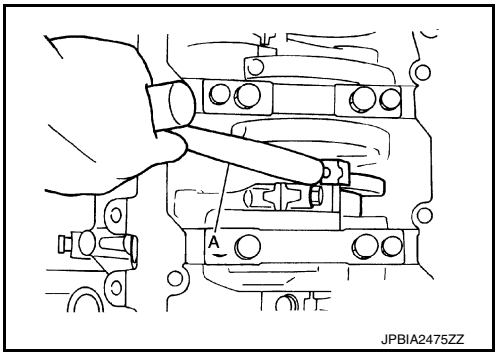
1. Remove the following parts:
   - Oil pans (lower and upper): Refer to EM-219, "Exploded View".
   - Front cover and timing chain: Refer to EM-223, "Exploded View".
   - Cylinder head: Refer to EM-256, "Exploded View".
2. Remove knock sensor.
   CAUTION:
   Carefully handle knock sensor avoiding shocks.
3. Remove oil filter (for VVEL ladder assembly) from cylinder block, if necessary. Refer to EM-256, "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-276, "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.

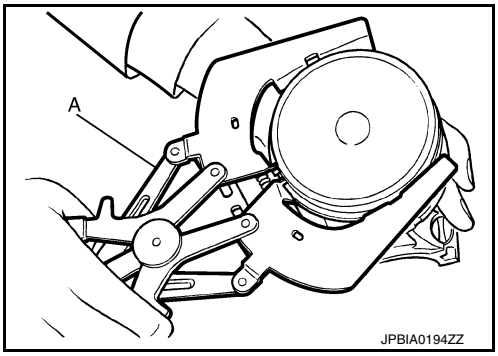


5. Remove connecting rod bearings from connecting rod and connecting rod bearing cap.
   CAUTION:
   - **Be careful not to drop connecting rod bearing, and to scratch the surface.**
   - **Identify installation positions, and store them without mixing them up.**
6. Remove piston rings from piston.
   - Before removing piston rings, check the piston ring side clearance. Refer to EM-276, "Inspection".

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

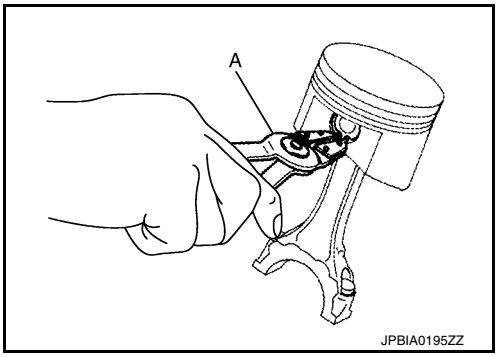
CAUTION:

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

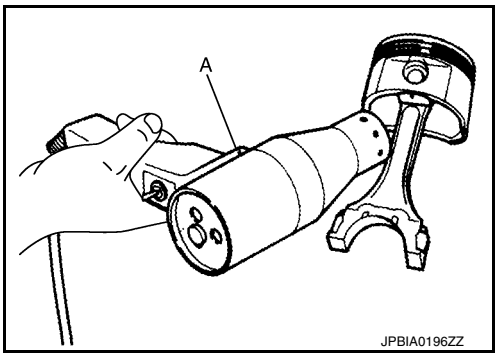


7. Remove piston from connecting rod as per the following:

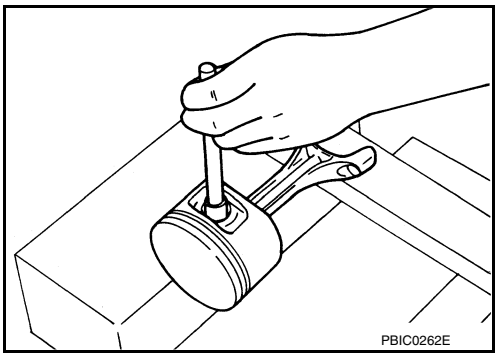
a. Using snap ring pliers (A), remove snap rings.



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:

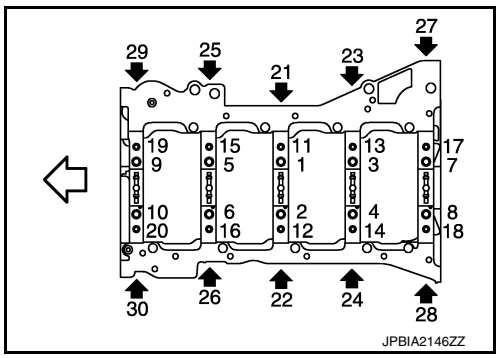
   Be careful not to damage the mating surfaces.
9. Using screwdriver or similar tool, and lever off rear oil seal from rear oil seal retainer.
10. Remove main bearing cap as per the following:
    - Before loosening cylinder block bolts, measure the crankshaft end play. Refer to EM-276, "Inspection".

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

⇦ : Engine front

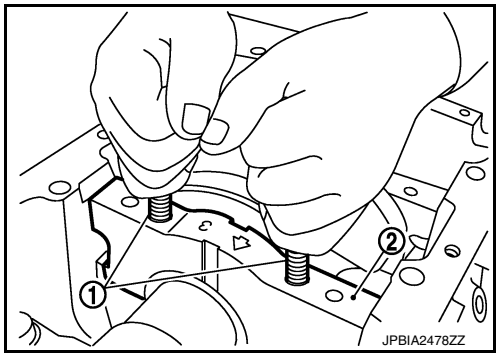
b. Loosen main bearing cap sub bolts starting from No. 20 to 11 to remove.

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.

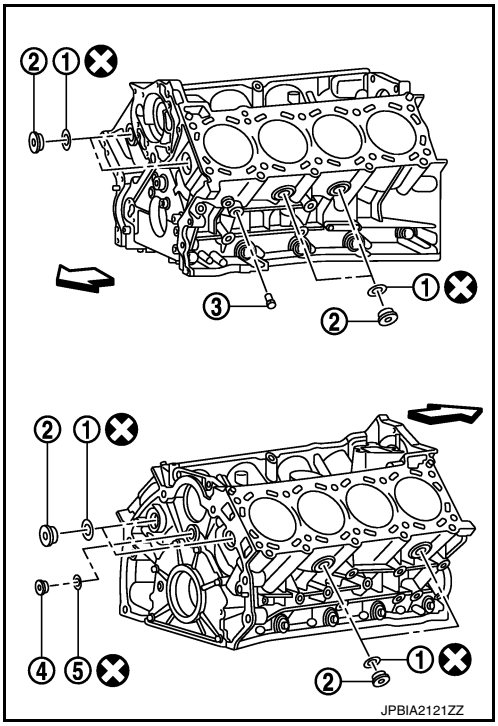
ASSEMBLY

CAUTION:
Do not reuse washers.

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

CAUTION:
Use goggles to protect your eyes.

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



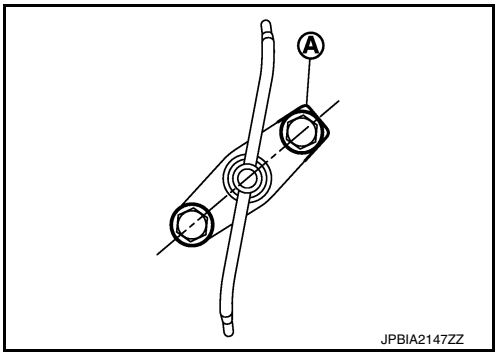
⇦ : Engine front

- Tighten each plug as specified below.

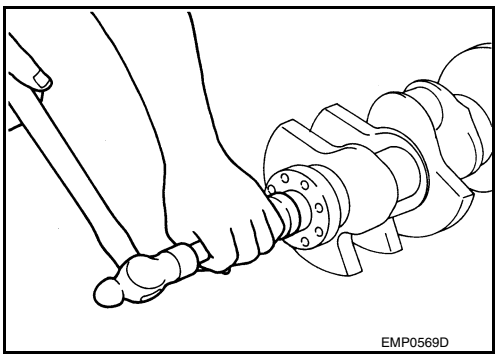
Part	Tightening torque
Plug (2)	78.0 N·m (8.0 kg-m, 58 ft-lb)
Water drain plug (3)	19.6 N·m (2.0 kg-m, 14 ft-lb)
Plug (4)	65.0 N·m (6.6 kg-m, 48 ft-lb)

- Replace washers (1), (5) with new ones.
  CAUTION:
  Do not reuse washers.
- Apply sealant to the thread of water drain plug (3).
  Use Genuine RTV Silicone Sealant or an equivalent. Refer to GI-24, "Recommended Chemical Products and Sealants".
- Apply sealant to the thread of plug (4).
  Use Genuine High Strength Thread Locking Sealant or an equivalent. Refer to GI-24, "Recommended Chemical Products and Sealants".

3. Install oil jet.
   - Insert oil jet into cylinder block hole, and tighten the mounting bolt on the corner side (A) first.

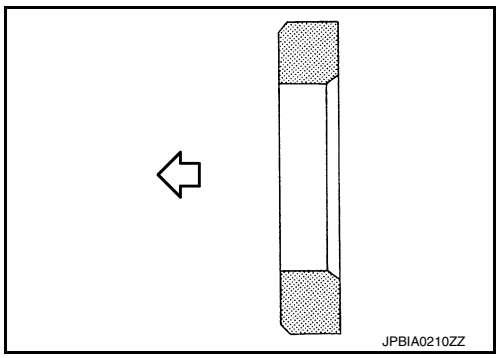


4. Install pilot converter to crankshaft, if removed.
   - With drift [outer diameter: approx. 35 mm (1.38 in)], press-fit as far as it will go.



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

⇦ : Crankshaft side



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

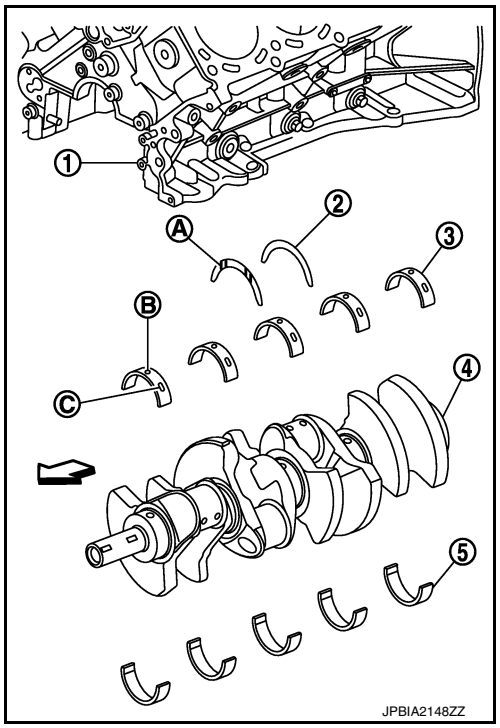
a. Remove dust, dirt, and engine oil on bearing mating surfaces of cylinder block and main bearing caps.

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 cutout of cylinder block and main bearing.
- Ensure the oil holes on cylinder block and those on the corresponding bearing are aligned.

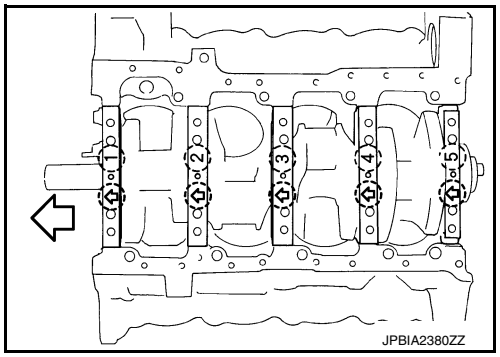


6. Install crankshaft to cylinder block.
- While turning crankshaft by hand, check that it turns smoothly.

7. 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.

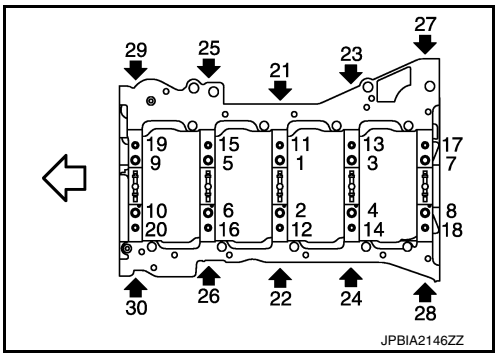


8. Install each main bearing cap bolts as per the following:
CAUTION:
If main bearing cap bolts and sub bolts are re-used, check their outer diameters before installation. Refer to EM-276, "Inspection".

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.

: 53.9 N·m (5.5 kg-m, 40 ft-lb)

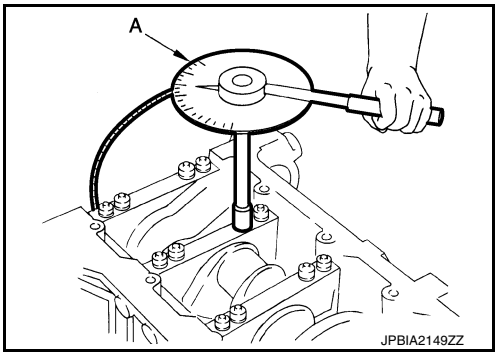
d. Tighten main bearing cap sub bolts (M9) in order of No. 11 - 20.

: 19.6 N·m (2.0 kg-m, 14 ft-lb)

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

Angle tightening: 90 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)

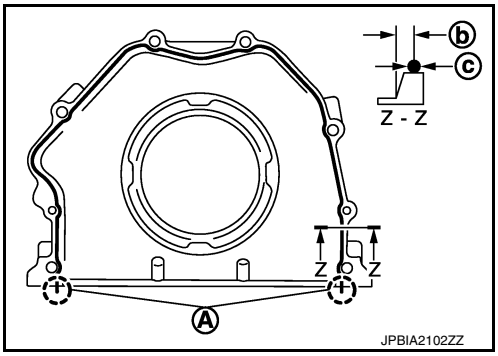
Angle tightening: 90 degrees

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-298, "Cylinder Block".

9. 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.

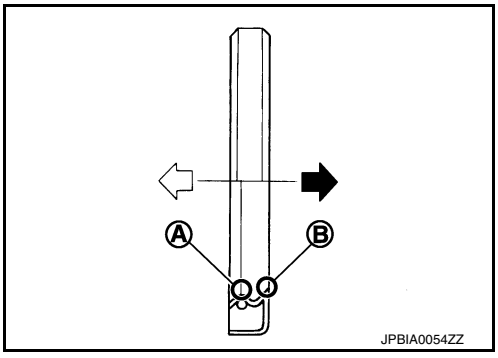


A : Protrusion
b : 4.0 - 5.6 mm (0.157 - 0.220 in)
c : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)

Use Genuine RTV Silicone Sealant or an equivalent. Refer to GI-24, "Recommended Chemical Products and Sealants".

10. Install rear oil seal on rear oil seal retainer.

⇦ : Engine inside
⬅ : Engine outside



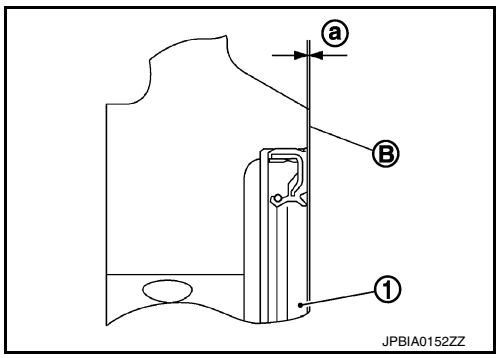
- Apply new engine oil to both oil seal lip (A) and dust seal lip (B).
- Install it so that each seal lip is oriented as shown in the figure.

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.

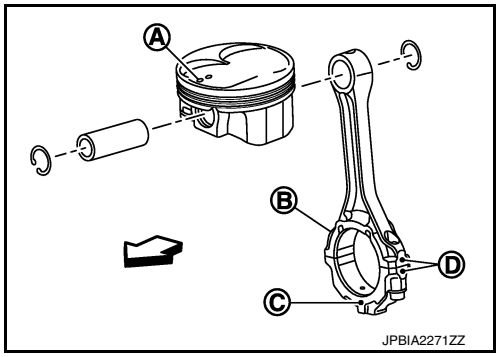
B : Rear oil seal retainer rear end face
a : 0 - 0.5 mm (0 - 0.020 in)

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



11. 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.

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



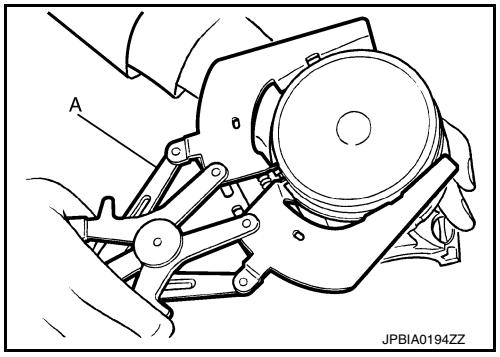
a. Using snap ring pliers, install new snap ring to the groove of piston rear side.
- Insert it fully into groove to install.

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.

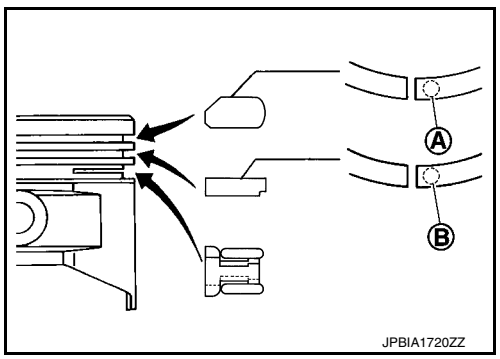
12. Using a piston ring expander (commercial service tool) (A), install piston rings.

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



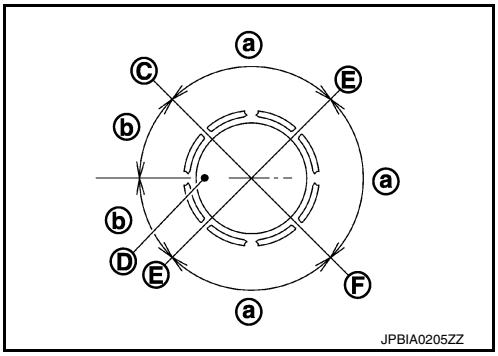
- If there is stamped mark on ring, mount it with marked side up.

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



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

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



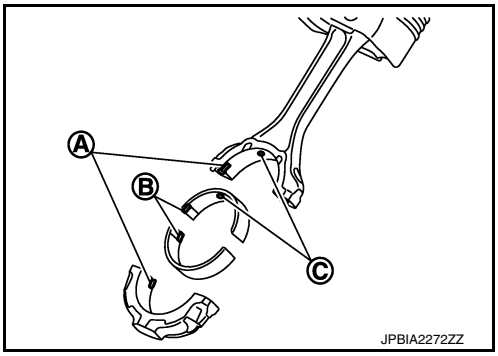
- Check the piston ring side clearance. Refer to EM-276, "Inspection".

13. 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.

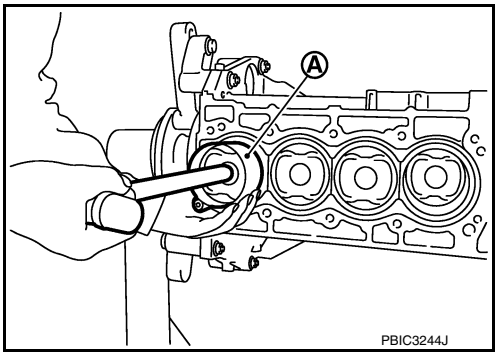
- Before installing connecting rod bearings, apply engine oil to the bearing surface (inside). Do not apply engine oil to the back surface, but thoroughly clean it.
- When installing, align connecting rod bearing stopper protrusion (B) with cutout (A) of connecting rods and connecting rod bearing caps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



14. 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.

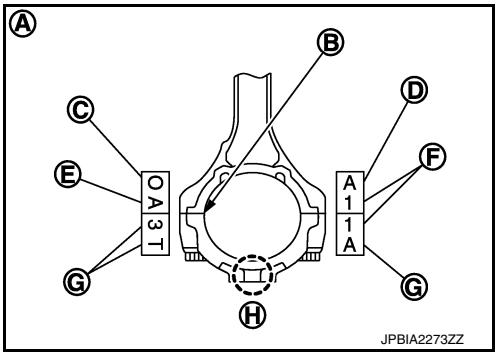
CAUTION:

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



15. 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.

16. Tighten connecting rod bolts as per the following:

a. Inspect the outer diameter of connecting rod bolt. Refer to EM-276, "Inspection".

b. Apply engine oil to the threads and seats of connecting rod bolts.

c. Tighten connecting rod bolts.

: 28.4 N·m (2.9 kg-m, 21 ft-lb)

d. Completely loosen connecting rod bolts.

: 0 N·m (0 kg-m, 0 ft-lb)

e. Tighten connecting rod bolts.

: 24.5 N·m (2.5 kg-m, 18 ft-lb)

f. Tighten connecting rod bolts. (clockwise)

Angle tightening: 90 degrees

CAUTION:

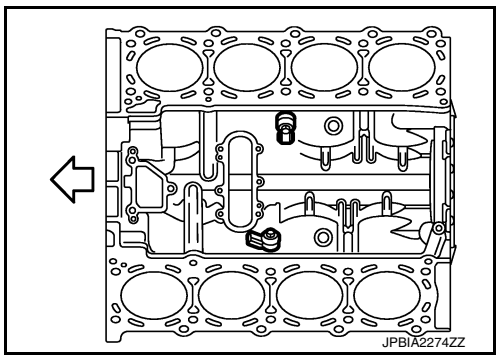
Always use the angle wrench [SST: KV10112100 (BT8653-A)]. Never make judgment by visual inspection.

- After tightening connecting rod bolts, check that crankshaft rotates smoothly.
- Check the connecting rod side clearance. Refer to EM-276, "Inspection".

17. Install knock sensors.

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

⇦ : Engine front



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

CAUTION:

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

NOTE:

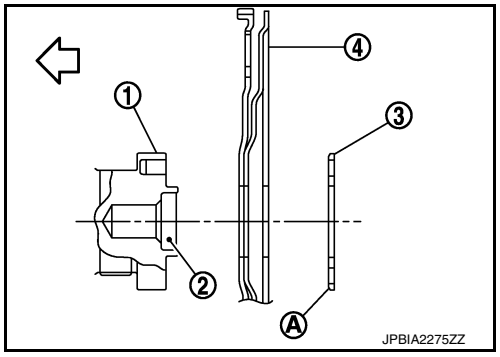
- Check that there is no foreign material on the cylinder block mating surface and the back surface of knock sensor.
- Check that knock sensor does not interfere with other parts.

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

19. Install drive plate.

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

2 : Pilot converter
A : Rounded
⇦ : Engine front



- When installing drive plate to crankshaft (1), be sure to correctly align crankshaft side dowel pin and drive plate side dowel pin hole.

CAUTION:

If these are not aligned correctly, engine runs roughly and "MIL" illuminates.

- Holding ring gear with the ring gear stopper [SST: KV10119200 (J-49277)].
- Tighten the mounting bolts crosswise over several times.

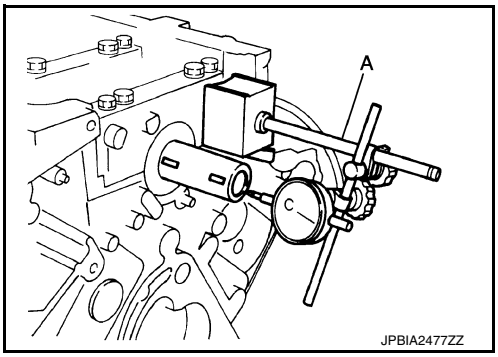
20. Assemble in the reverse order of disassembly.

Inspection

INFOID:0000000010582108

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).

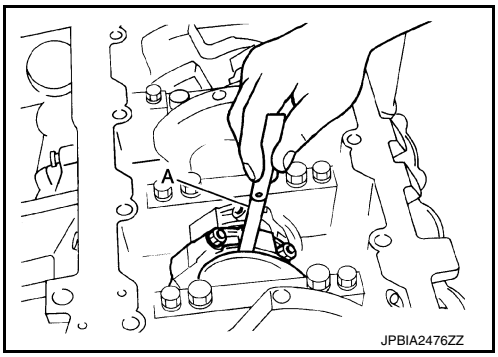


Standard and limit : Refer to EM-298, "Cylinder Block".

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

CONNECTING ROD SIDE CLEARANCE

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



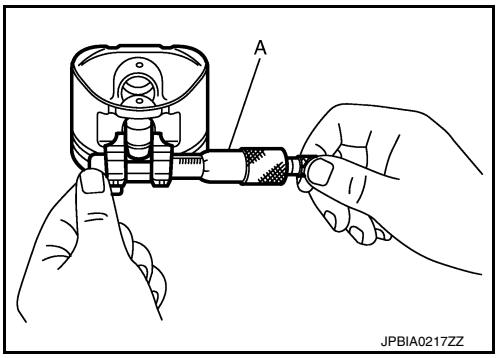
Standard and limit : Refer to EM-298, "Cylinder Block".

- 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

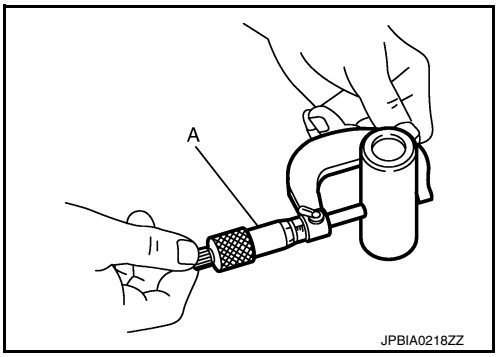
Measure the inner diameter of piston pin hole with an inside micrometer (A).



Standard : Refer to EM-298, "Cylinder Block".

Piston Pin Outer Diameter

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



Standard : Refer to EM-298, "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-298, "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-285, "Description".

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

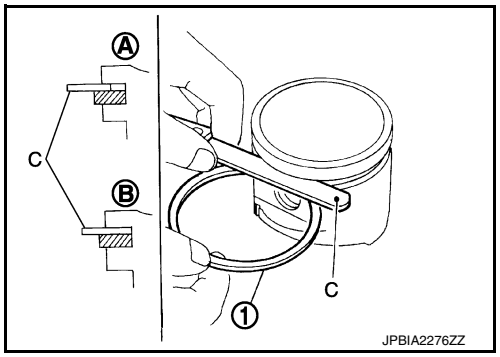
PISTON RING SIDE CLEARANCE

- 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-298, "Cylinder Block".

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



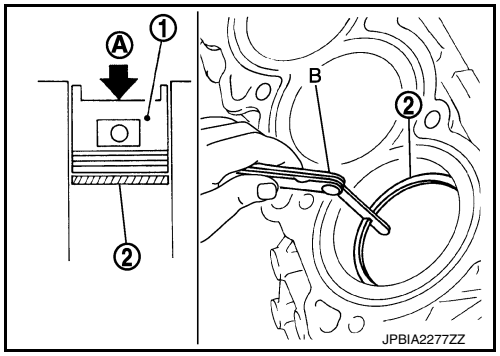
PISTON RING END GAP

- 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-298, "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.



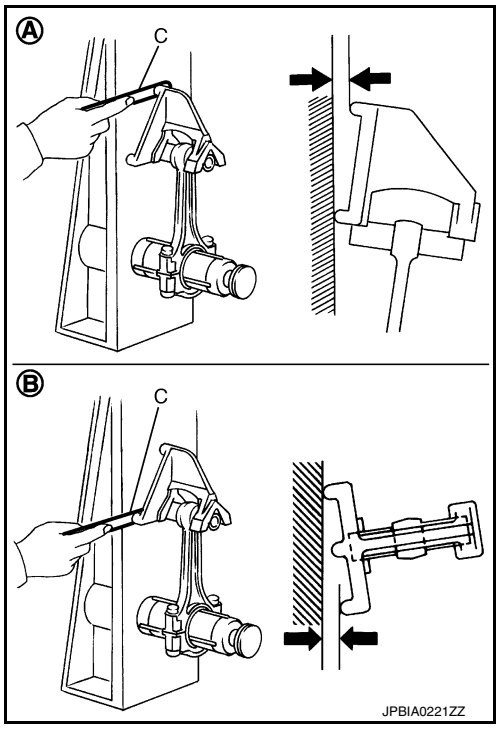
CONNECTING ROD BEND AND TORSION

- Check with a connecting rod aligner.

A : Bend
B : Torsion
C : Feeler gauge

Bend limit **: Refer to EM-298, "Cylinder Block".**
Torsion limit

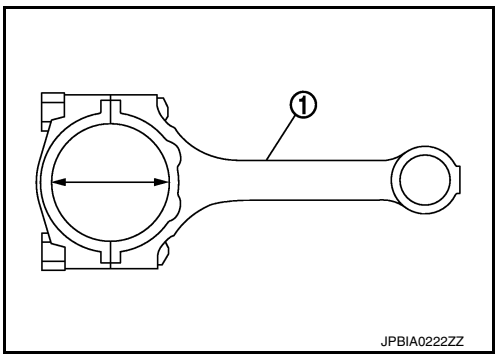
- If it exceeds the limit, replace connecting rod assembly.



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-267, "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-298, "Cylinder Block".

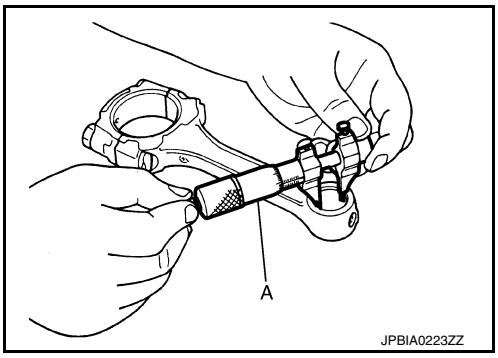
- If out of the standard, replace connecting rod assembly.

CONNECTING ROD BUSHING OIL CLEARANCE

Connecting Rod Bushing Inner Diameter

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

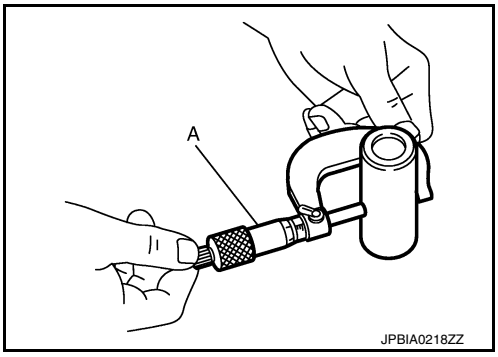
Standard : Refer to EM-298, "Cylinder Block".



Piston Pin Outer Diameter

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

Standard : Refer to EM-298, "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-298, "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-285, "Description".
- If replacing connecting rod assembly, refer to EM-286, "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.

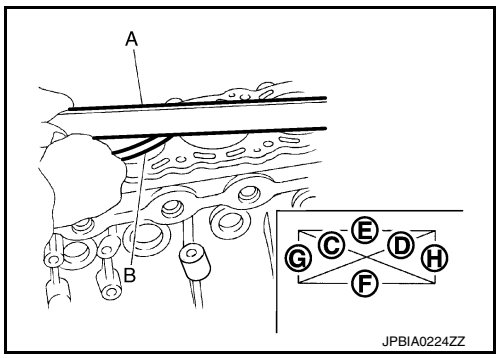
CAUTION:

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-298, "Cylinder Block".

- If it exceeds the limit, replace cylinder block.



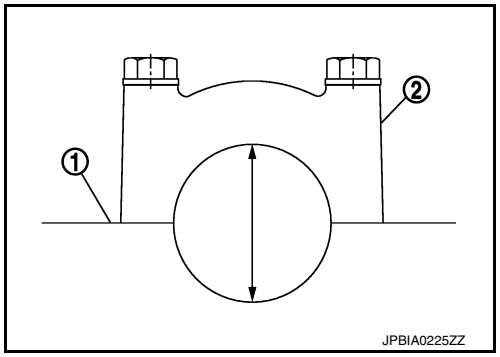
MAIN BEARING HOUSING INNER DIAMETER

- Install main bearing cap (2) without installing main bearings, and tighten main bearing cap bolts to the specified torque. Refer to EM-267, "Disassembly and Assembly" for the tightening procedure.
- Measure the inner diameter of main bearing housing with a bore gauge.

Standard : Refer to EM-298, "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.

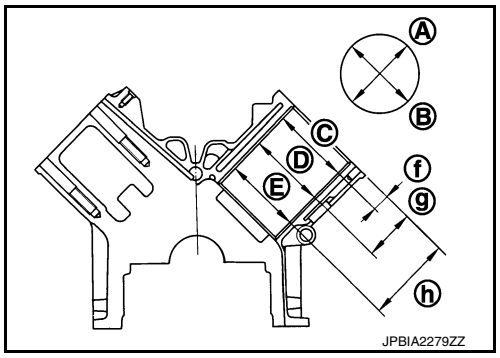


PISTON TO CYLINDER BORE CLEARANCE

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-298, "Cylinder Block".

Taper limit (Difference between “C” and “E”):

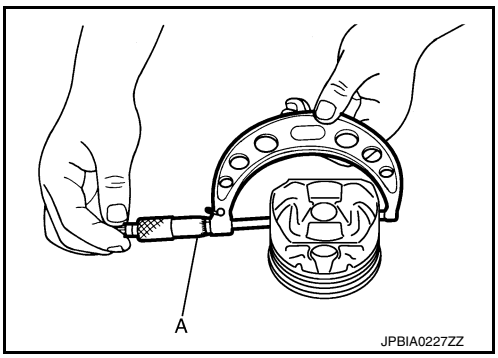
- If the measured value exceeds the limit, or if there are scratches and/or seizure on the cylinder inner wall, hone or re-bore the inner wall.
- Oversize piston is provided. When using oversize piston, re-bore cylinder so that the clearance of the piston-to-cylinder bore satisfies the standard.

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

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

Piston Skirt Diameter

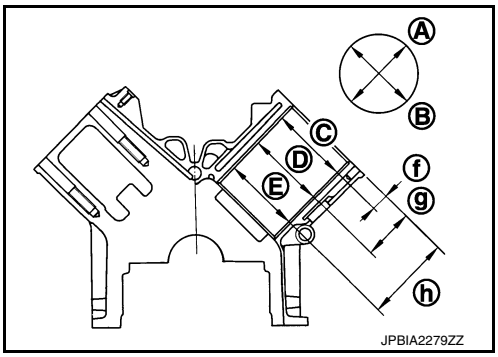
Measure the outer diameter of piston skirt with a micrometer (A).



Measure point **: Refer to EM-298, "Cylinder Block".**
Standard

Piston-to-Cylinder Bore Clearance

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



A : Direction A
C : Position C
E : Position E
f : 10 mm (0.39 in)
g : 60 mm (2.36 in)
h : 125 mm (4.92 in)

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

Standard and limit : Refer to EM-298, "Cylinder Block".

- If the calculated value exceeds the limit, replace piston and piston pin assembly. Refer to EM-298, "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,
A: Piston skirt diameter as measured
B: Piston to cylinder bore clearance (standard value)
C: Honing allowance 0.02 mm (0.0008 in)
D: Bored diameter

2. Install 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

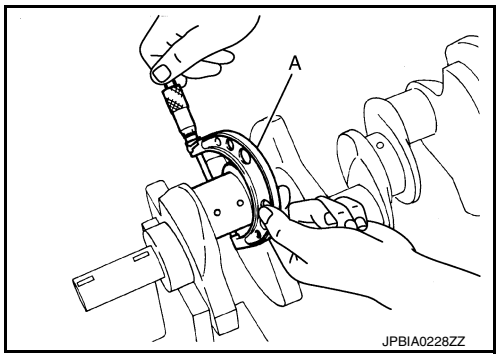
- Measure the outer diameter of crankshaft main journals with a micrometer.

Standard : Refer to EM-298, "Cylinder Block".

- If out of the standard, measure the main bearing oil clearance. Then use undersize bearing. Refer to EM-288, "Main Bearing".

CRANKSHAFT PIN JOURNAL DIAMETER

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

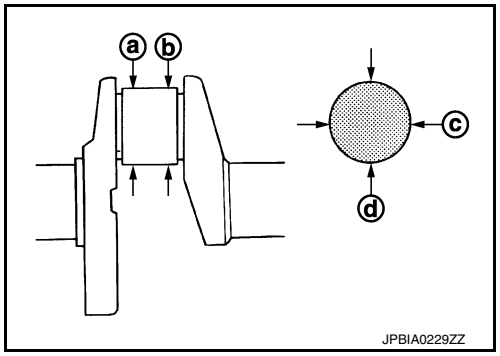


Standard : Refer to EM-298, "Cylinder Block".

- If out of the standard, measure the connecting rod bearing oil clearance. Then use undersize bearing. Refer to EM-286, "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.

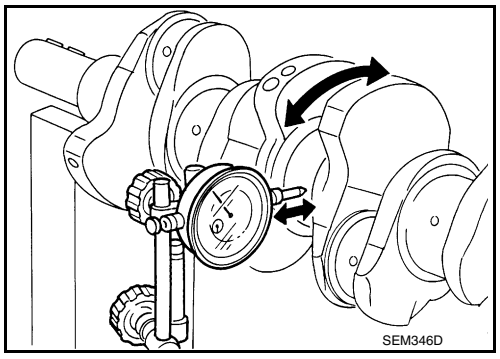


Out-of-round (Difference between “c” and “d”)
Taper (Difference between “a”and “b”)
: Refer to EM-298, "Cylinder Block".

- 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-288, "Main Bearing" and/or EM-286, "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)



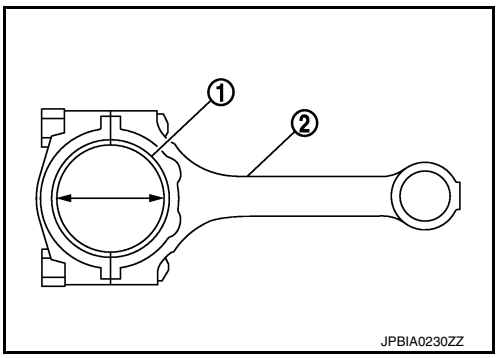
Standard and limit : Refer to EM-298, "Cylinder Block".

- 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-267, "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-303, "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-285, "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-267, "Disassembly and Assembly" for the tightening procedure.

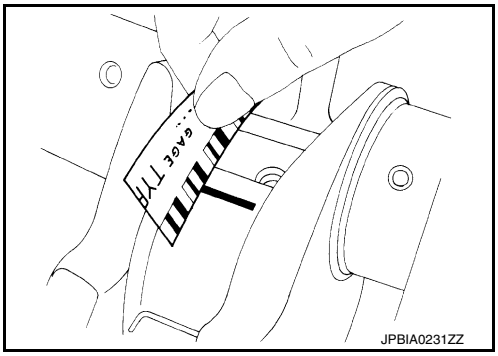
CAUTION:

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”.

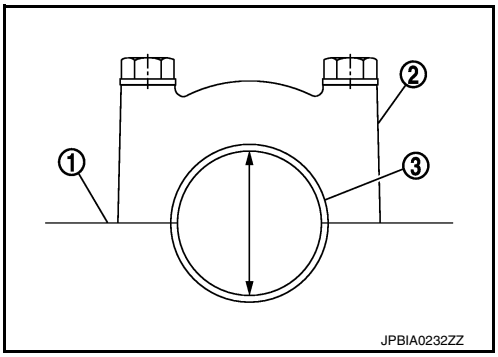


MAIN BEARING OIL CLEARANCE

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-267, "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-302, "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-285, "Description".

Method of Using Plastigage

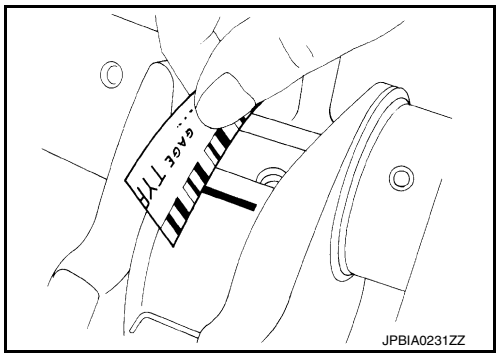
- Remove engine oil and dust on crankshaft journal and the surfaces of each bearing completely.

- 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-267, "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

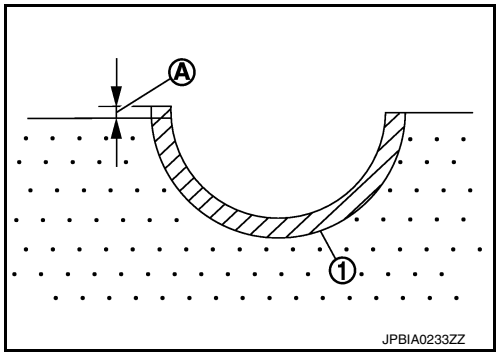
MAIN BEARING CRUSH HEIGHT

- 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-267, "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

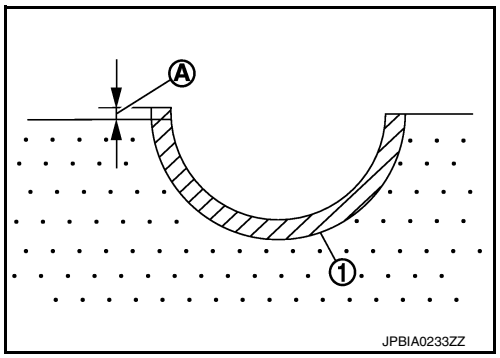
CONNECTING ROD BEARING CRUSH HEIGHT

- 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-267, "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

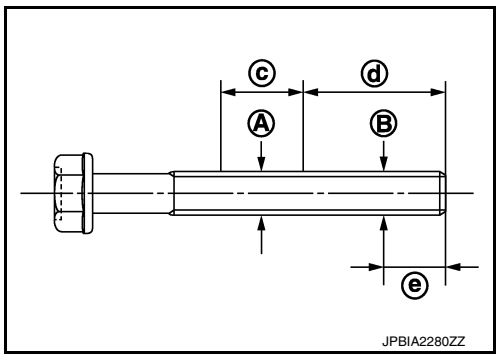
- Measure the outer diameters (A), (B) at two positions as shown in the figure.

c : 20 mm (0.79 in)
d : 50 mm (1.97 in)
e : 22 mm (0.87 in)

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

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

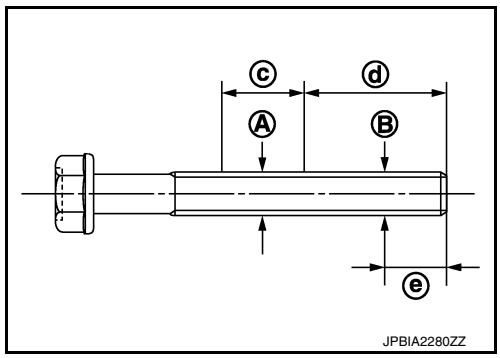
- If it exceeds the limit (large difference in dimensions), replace main bearing cap bolts with new one.



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 : 50 mm (1.97 in)
e : 9 mm (0.35 in)

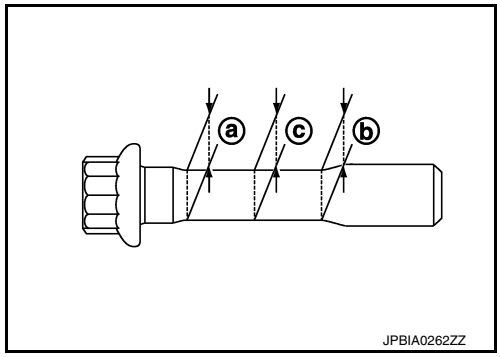
- If reduction appears in (A) range, regard it (B).

Limit [(B) – (A)] : 0.13 mm (0.0051 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

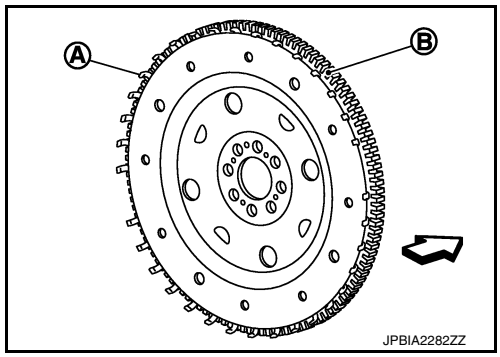
2. Obtain a mean value (d) of (a) and (b).
3. Subtract (c) from (d).

Limit [(d) – (c)] : 0.09 mm (0.0035 in)

4. If it exceeds the limit (large difference in dimensions), replace the bolt with new one.

DRIVE PLATE

- Check drive plate and signal plate (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:0000000010582109

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)

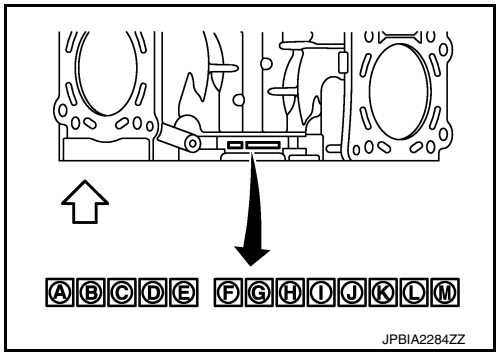
- The identification grade stamped on each part is the grade for the dimension measured in new condition. This grade cannot apply to reused parts.
- For reused or repaired parts, measure the dimension accurately. Determine the grade by comparing the measurement with the values of each selection table.
- 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:0000000010582110

WHEN NEW CYLINDER BLOCK IS USED

Check the cylinder bore grade (“1”, “2” or “3”) on rear side of cylinder block, and select piston of the same grade.



JPBIA2284ZZ

A : Bearing housing grade No. 1
B : Bearing housing grade No. 2
C : Bearing housing grade No. 3
D : Bearing housing grade No. 4
E : Bearing housing grade No. 5
F : Cylinder bore grade No. 1
G : Cylinder bore grade No. 2
H : Cylinder bore grade No. 3
I : Cylinder bore grade No. 4
J : Cylinder bore grade No. 5
K : Cylinder bore grade No. 6
L : Cylinder bore grade No. 7
M : Cylinder bore grade No. 8
⇦ : Engine front

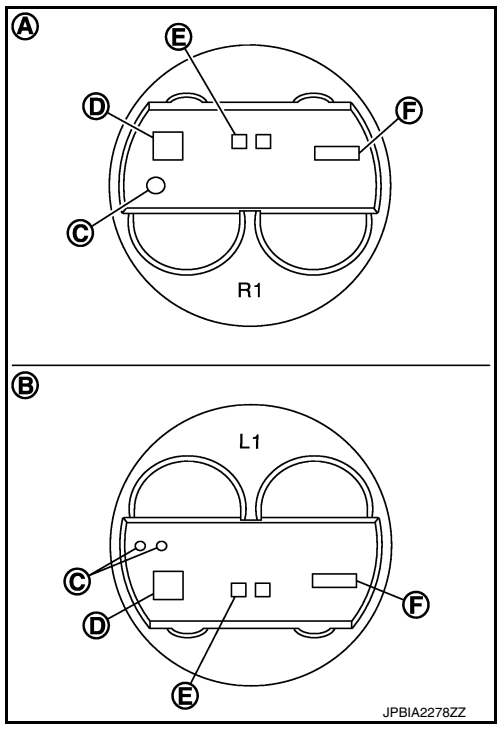
NOTE:
Piston is available with piston pin as a set for the service part.

WHEN CYLINDER BLOCK IS REUSED

1. Measure the cylinder bore inner diameter. Refer to EM-298, "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	95.500 - 95.510 (3.7598 - 3.7602)	95.510 - 95.520 (3.7602 - 3.7606)	95.520 - 95.530 (3.7606 - 3.7610)
Piston skirt diameter	95.480 - 95.490 (3.7590 - 3.7594)	95.490 - 95.500 (3.7594 - 3.7598)	95.500 - 95.510 (3.7598 - 3.7602)

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

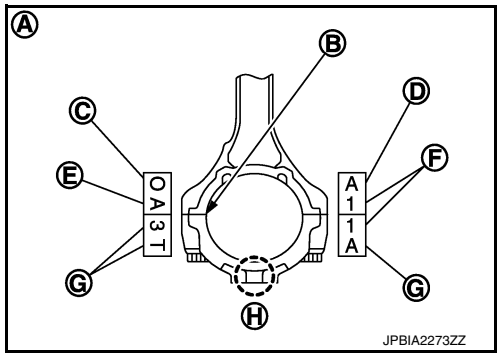
Connecting Rod Bearing

INFOID:0000000010582111

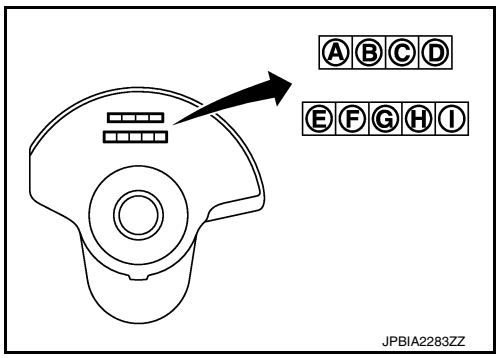
WHEN NEW CONNECTING ROD AND CRANKSHAFT ARE USED

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-276, "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 journal diameter Unit: mm (in) / Mark	Axle diameter	Connecting rod big end diameter Unit: mm (in) / Hole diameter / Mark: A	B	C	D	E	F	G	H	J	K	L	M	N
		57.000 - 57.001 (2.2441 - 2.2441)	57.001 - 57.002 (2.2441 - 2.2442)	57.002 - 57.003 (2.2442 - 2.2442)	57.003 - 57.004 (2.2442 - 2.2442)	57.004 - 57.005 (2.2442 - 2.2443)	57.005 - 57.006 (2.2443 - 2.2443)	57.006 - 57.007 (2.2443 - 2.2444)	57.007 - 57.008 (2.2444 - 2.2444)	57.008 - 57.009 (2.2444 - 2.2444)	57.009 - 57.010 (2.2444 - 2.2445)	57.010 - 57.011 (2.2445 - 2.2445)	57.011 - 57.012 (2.2445 - 2.2446)	57.012 - 57.013 (2.2446 - 2.2446)
A	53.974 - 53.973 (2.1250 - 2.1249)	0	0	0	0	0	0	1	1	1	1	1	1	2
B	53.973 - 53.972 (2.1249 - 2.1249)	0	0	0	0	0	1	1	1	1	1	1	2	2
C	53.972 - 53.971 (2.1249 - 2.1248)	0	0	0	0	1	1	1	1	1	1	2	2	2
D	53.971 - 53.970 (2.1248 - 2.1248)	0	0	0	1	1	1	1	1	1	2	2	2	2
E	53.970 - 53.969 (2.1248 - 2.1248)	0	0	1	1	1	1	1	1	2	2	2	2	2
F	53.969 - 53.968 (2.1248 - 2.1247)	0	1	1	1	1	1	1	2	2	2	2	2	2
G	53.968 - 53.967 (2.1247 - 2.1247)	1	1	1	1	1	1	2	2	2	2	2	2	3
H	53.967 - 53.966 (2.1247 - 2.1246)	1	1	1	1	1	2	2	2	2	2	2	3	3
J	53.966 - 53.965 (2.1246 - 2.1246)	1	1	1	1	2	2	2	2	2	2	3	3	3
K	53.965 - 53.964 (2.1246 - 2.1246)	1	1	1	2	2	2	2	2	2	3	3	3	3
L	53.964 - 53.963 (2.1246 - 2.1245)	1	1	2	2	2	2	2	2	3	3	3	3	3
M	53.963 - 53.962 (2.1245 - 2.1245)	1	2	2	2	2	2	2	3	3	3	3	3	3
N	53.962 - 53.961 (2.1245 - 2.1244)	2	2	2	2	2	2	3	3	3	3	3	3	4
P	53.961 - 53.960 (2.1244 - 2.1244)	2	2	2	2	2	3	3	3	3	3	3	4	4
R	53.960 - 53.959 (2.1244 - 2.1244)	2	2	2	2	3	3	3	3	3	3	4	4	4
S	53.959 - 53.958 (2.1244 - 2.1243)	2	2	2	3	3	3	3	3	3	4	4	4	4
T	53.958 - 53.957 (2.1243 - 2.1243)	2	2	3	3	3	3	3	3	4	4	4	4	4
U	53.957 - 53.956 (2.1243 - 2.1242)	2	3	3	3	3	3	3	4	4	4	4	4	4

JPBIA2287GB

CONNECTING ROD BEARING GRADE TABLE

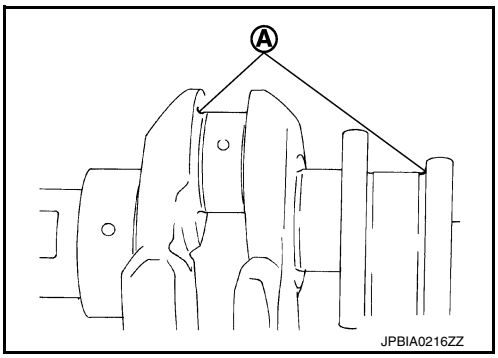
Connecting rod bearing grade table : Refer to EM-303, "Connecting Rod Bearing".

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)].



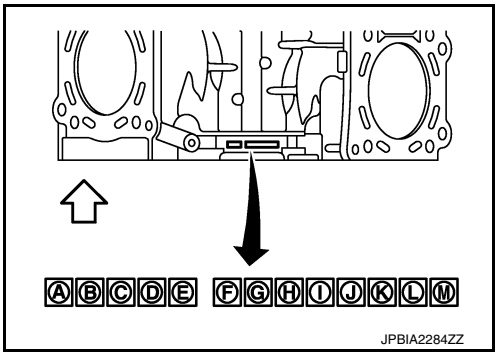
Bearing undersize table : Refer to EM-303, "Connecting Rod Bearing".

Main Bearing

INFOID:0000000010582112

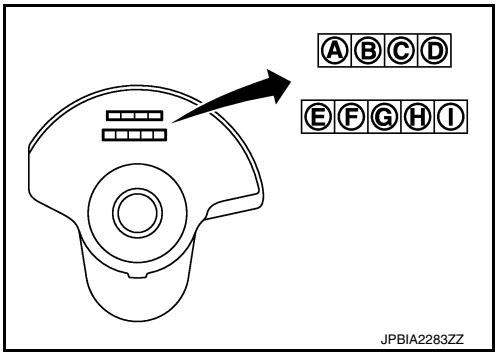
WHEN NEW CYLINDER BLOCK AND CRANKSHAFT ARE USED

1. "MAIN BEARING SELECTION TABLE" rows correspond to bearing housing grade on rear side of cylinder block.



A : Bearing housing grade No. 1
B : Bearing housing grade No. 2
C : Bearing housing grade No. 3
D : Bearing housing grade No. 4
E : Bearing housing grade No. 5
F : Cylinder bore grade No. 1
G : Cylinder bore grade No. 2
H : Cylinder bore grade No. 3
I : Cylinder bore grade No. 4
J : Cylinder bore grade No. 5
K : Cylinder bore grade No. 6
L : Cylinder bore grade No. 7
M : Cylinder bore grade No. 8
⇦ : Engine front

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-276, "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)

Crankshaft main journal diameter: I.D. mark	Crankshaft main journal diameter: Axle diameter Unit: mm (in)	Cylinder block main bearing housing inner 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)
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)

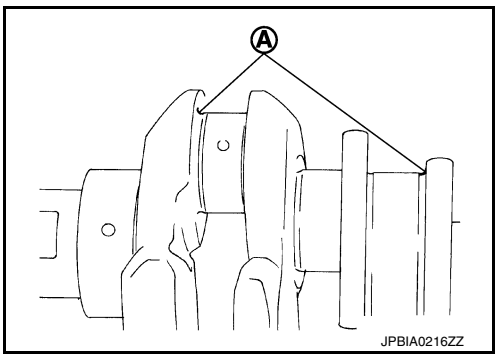
Main bearing grade table (All journals) : Refer to EM-302, "Main Bearing".

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-302, "Main Bearing".

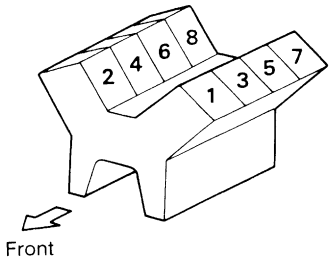
SERVICE DATA AND SPECIFICATIONS (SDS)

SERVICE DATA AND SPECIFICATIONS (SDS)

General Specification

INFOID:0000000010582113

GENERAL SPECIFICATIONS

Cylinder arrangement		V-8
Displacement cm^3 (cu in)		5,026 (306.69)
Bore and stroke mm (in)		95.5 x 87.7 (3.76 x 3.453)
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		10.9
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)	–66 - 61
	Intake valve close (ABDC)	–71 - 84
	Exhaust valve open (BBDC)	32 - 62
	Exhaust valve close (ATDC)	–2 - 28

Drive Belts

INFOID:0000000010582114

DRIVE BELT

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

Spark Plug

INFOID:0000000010582115

SPARK PLUG

Unit: mm (in)

Make	DENSO
Standard type	FXE22HR11

Gap	Standard	1.1 (0.043)
	Limit	1.4 (0.055)

Exhaust Manifold

INFOID:0000000010582116

EXHAUST MANIFOLD

Unit: mm (in)

Items		Limit
Surface distortion	Exhaust manifold	0.7 (0.028)

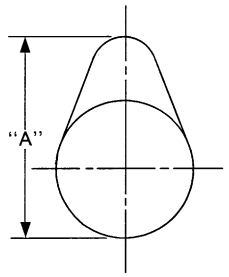
Camshaft

INFOID:0000000010582117

CAMSHAFT (EXH)

Unit: mm (in)

Items		Standard	Limit
Camshaft (EXH) journal oil clearance	No. 1	0.045 - 0.086 (0.0018 - 0.0034)	0.150 (0.0059)
	No. 2, 3, 4, 5	0.030 - 0.071 (0.0012 - 0.0028)	
VVEL ladder assembly bracket inner diameter (EXH side)		26.000 - 26.021 (1.0236 - 1.0244)	—
Camshaft (EXH) journal diameter	No. 1	25.935 - 25.955 (1.0211 - 1.0218)	—
	No. 2, 3, 4, 5	25.950 - 25.970 (1.0217 - 1.0224)	—
Camshaft (EXH) end play		0.115 - 0.188 (0.0045 - 0.0074)	0.24 (0.0094)
Camshaft (EXH) cam height “A”		45.475 - 45.665 (1.7904 - 1.7978)	44.275 (1.7431)
Camshaft (EXH) runout [TIR*]		Less than 0.02 mm (0.0008)	0.05 (0.002)
Camshaft sprocket (EXH) runout [TIR*]		—	0.2 (0.0079)



SEM671

*: Total indicator reading

CAMSHAFT (INT)

Unit: mm (in)

Items	Standard	Limit
Drive shaft end play	0.115 - 0.188 (0.0045 - 0.0074)	0.24 (0.0094)
Camshaft sprocket (INT) 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)

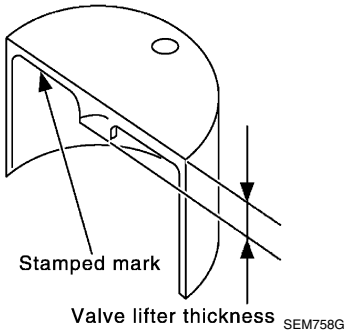
Items	Cold	Hot* (reference data)
Intake	0.26 - 0.34 (0.010 - 0.013)	0.304 - 0.416 (0.012 - 0.016)
Exhaust	0.29 - 0.37 (0.011 - 0.015)	0.308 - 0.432 (0.012 - 0.017)

*: 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)



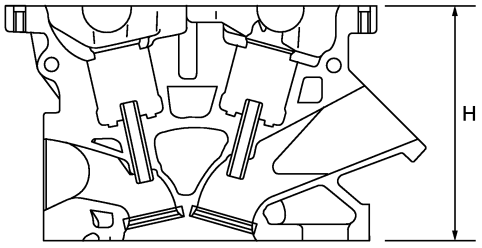
Cylinder Head

INFOID:0000000010582118

CYLINDER HEAD

Unit: mm (in)

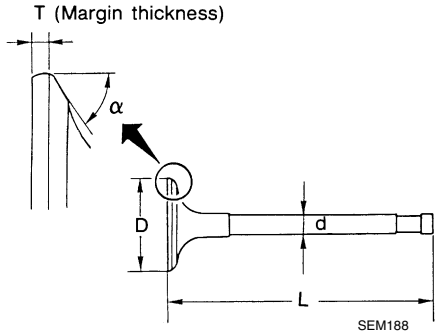
Items	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)
Normal cylinder head height “H”	126.4 (4.98)	—



PBIC0924E

VALVE DIMENSIONS

Unit: mm (in)

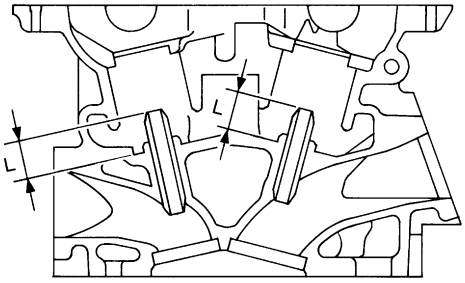


SEM188

Valve head diameter “D”	Intake	36.6 - 36.9 (1.441 - 1.453)
	Exhaust	30.2 - 30.5 (1.189 - 1.201)
Valve length “L”	Intake	100.11 (3.94)
	Exhaust	94.67 (3.7272)
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

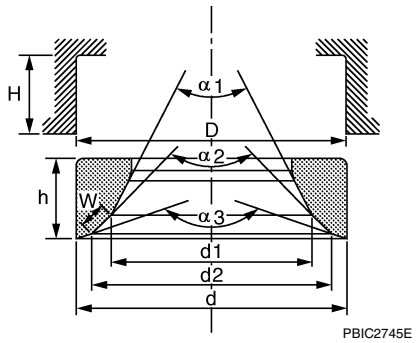
Items		Standard	Oversize (Service) [0.2 (0.008)]*
Valve guide	Outer diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)*
	Inner diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter		9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 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	11.9 - 12.1 (0.469 - 0.476)	

*: 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	31.600 - 31.616 (1.2441 - 1.2447)	32.100 - 32.116 (1.2638 - 1.2644)*4
Valve seat outer diameter “d”	Intake	38.097 - 38.113 (1.4999 - 1.5005)	—
	Exhaust	31.680 - 31.696 (1.2472 - 1.2479)	32.180 - 32.196 (1.2669 - 1.2676)*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	27.7 (1.091)	
Diameter “d2”*2	Intake	35.9 - 36.4 (1.413 - 1.433)	
	Exhaust	29.3 - 29.8 (1.154 - 1.173)	
Angle “α1”		59 - 61°	

Angle “α2”		88°45′ - 90°15′	
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)	4.9 - 5.0 (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		48.69 mm (1.9169 in)	47.35 mm (1.8642 in)
Pressure	Installation	162 - 192 N (16.5 - 19.6 kg, 36 - 43 lb) at 42.40 mm (1.6693 in)	163 - 191 N (16.6 - 19.5 kg, 37 - 43 lb) at 35.45 mm (1.3957 in)
	Valve open	609 - 695 N (62.1 - 70.9 kg, 137 - 156 lb) at 28.83 mm (1.1350 in)	370 - 426 N (37.7 - 43.5 kg, 83 - 96 lb) at 25.65 mm (1.0098 in)
Identification color		Yellow	Pink

Item	Limit	
	Intake	Exhaust
Out-of-square	2.1 mm (0.083 in)	2.0 mm (0.079 in)

Cylinder Block

INFOID:0000000010582119

CYLINDER BLOCK

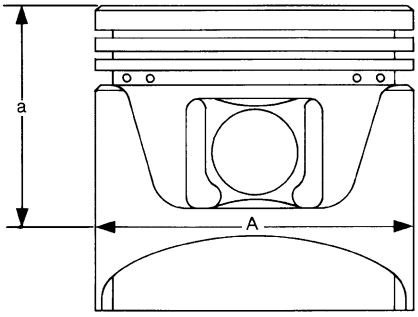
Unit: mm (in)

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	95.500 - 95.510 (3.7598 - 3.7602)
			Grade No. 2	95.510 - 95.520 (3.7602 - 3.7606)
			Grade No. 3	95.520 - 95.530 (3.7606 - 3.7610)
		Wear limit		0.2 (0.008)
Out-of-round		Limit		0.015 (0.0006)
Taper				0.010 (0.0004)

Main bearing housing inner diameter grade (Without bearing)	Grade No. A	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)



SEM882E

Items		Standard	Oversize (Service) [0.2 (0.008)]
Piston skirt diameter “A”	Grade No. 1	95.480 - 95.490 (3.7590 - 3.7594)	—
	Grade No. 2	95.490 - 95.500 (3.7594 - 3.7598)	—
	Grade No. 3	95.500 - 95.510 (3.7598 - 3.7602)	—
	Service	—	95.680 - 95.710 (3.7669 - 3.7681)
Items		Standard	Limit
“a” dimension		38.8 (1.528)	—
Piston pin hole diameter		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	0.055 - 0.155 (0.0022 - 0.0061)	0.19 (0.0075)

End gap	Top	0.23 - 0.33 (0.0091 - 0.0130)	0.55 (0.0217)
	2nd	0.33 - 0.48 (0.0130 - 0.0189)	0.67 (0.0264)
	Oil (rail ring)	0.17 - 0.47 (0.0067 - 0.0185)	0.82 (0.0323)

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

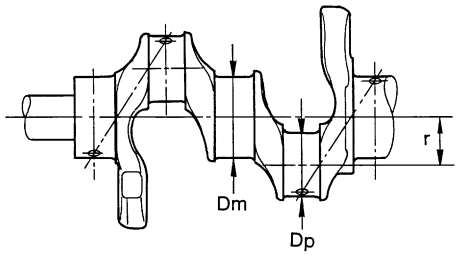
Unit: mm (in)

Items	Standard	Limit
Center distance	157.68 - 157.78 (6.21 - 6.21)	—
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 - 0.35 (0.0079 - 0.0138)	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. A	53.974 - 53.973 (2.1250 - 2.1249)
		Grade No. B	53.973 - 53.972 (2.1249 - 2.1249)
		Grade No. C	53.972 - 53.971 (2.1249 - 2.1248)
		Grade No. D	53.971 - 53.970 (2.1248 - 2.1248)
		Grade No. E	53.970 - 53.969 (2.1248 - 2.1248)
		Grade No. F	53.969 - 53.968 (2.1248 - 2.1247)
		Grade No. G	53.968 - 53.967 (2.1247 - 2.1247)
		Grade No. H	53.967 - 53.966 (2.1247 - 2.1246)
		Grade No. J	53.966 - 53.965 (2.1246 - 2.1246)
		Grade No. K	53.965 - 53.964 (2.1246 - 2.1246)
		Grade No. L	53.964 - 53.963 (2.1246 - 2.1245)
		Grade No. M	53.963 - 53.962 (2.1245 - 2.1245)
		Grade No. N	53.962 - 53.961 (2.1245 - 2.1244)
		Grade No. P	53.961 - 53.960 (2.1244 - 2.1244)
		Grade No. R	53.960 - 53.959 (2.1244 - 2.1244)
		Grade No. S	53.959 - 53.958 (2.1244 - 2.1243)
		Grade No. T	53.958 - 53.957 (2.1243 - 2.1243)
		Grade No. U	53.957 - 53.956 (2.1243 - 2.1242)
Center distance “r”			43.81 - 43.89 (1.7248 - 1.7279)
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:0000000010582120

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	0.035 - 0.045 (0.0014 - 0.0018)*	0.065 (0.0026)

*: Actual clearance

Connecting Rod Bearing

INFOID:0000000010582121

CONNECTING ROD BEARING

Grade number	Thickness mm (in)	Width mm (in)	Identification color (mark)
0	1.497 - 1.500 (0.0589 - 0.0591)	18.1 - 18.3 (0.713 - 0.720)	Red
1	1.500 - 1.503 (0.0591 - 0.0592)		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)	1.626 - 1.634 (0.0640 - 0.0643)	Grind so that bearing clearance is the specified value.

CONNECTING ROD BEARING OIL CLEARANCE

Unit: mm (in)

Items	Standard	Limit
Connecting rod bearing oil clearance	0.040 - 0.053 (0.0016 - 0.0021)*	0.070 (0.0028)

*: Actual clearance