SECTION EM
ENGINE MECHANICAL

CONTENTS

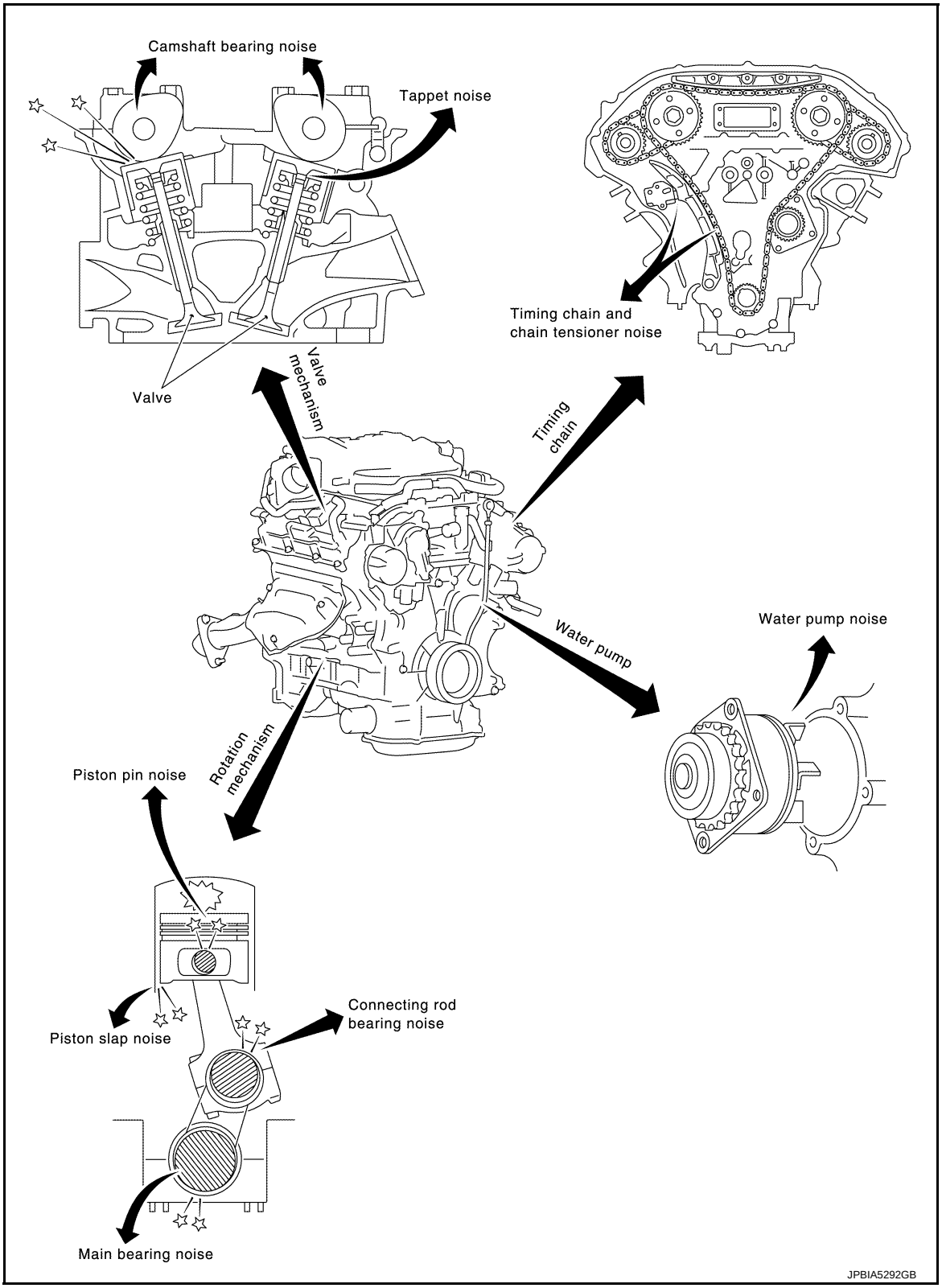
VQ35HR

SYMPTOM DIAGNOSIS

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

NVH Troubleshooting - Engine Noise

INFOID:0000000008141142



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

INFOID:0000000008141143

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	Refer-ence page
		Before warm-up	After warm-up	When start-ing	When idling	When racing	While driving			
Top of en-gine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-17
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft runout Camshaft journal oil clearance	EM-135
Crank-shaft pul-ley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston to piston pin oil clearance Connecting rod bushing oil clearance	EM-139
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston to cylinder bore clearance Piston ring side clear-ance Piston ring end gap Connecting rod bend and torsion	EM-139
	Knock	A	B	C	B	B	B	Connect-ing rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing oil clearance	EM-139 EM-144
	Knock	A	B	—	A	B	C	Main bear-ing noise	Main bearing oil clear-ance Crankshaft runout	EM-143 EM-139
Front of engine Timing chain case	Tapping or ticking	A	A	—	B	B	B	Timing chain and timing chain ten-sioner noise	Timing chain cracks and wear Timing chain tensioner operation	EM-63 EM-50
Front of engine	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	CO-19

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

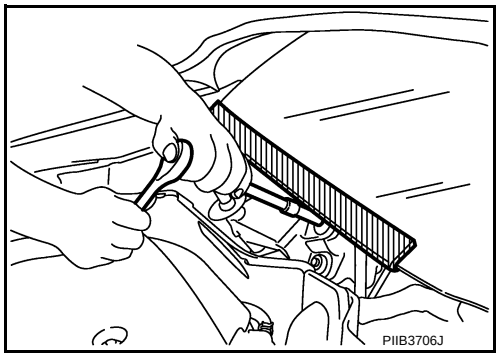
PRECAUTION

PRECAUTIONS

Precaution for Procedure without Cowl Top Cover

INFOID:0000000008141144

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:0000000008141145

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 12V battery, and wait at least 3 minutes before performing any service.**

Precautions Concerning On-board Servicing of Hybrid Systems

INFOID:0000000008141146

CAUTION:

Be sure to turn the ignition switch OFF before performing inspection and servicing inside the engine compartment or underneath the vehicle. If the ignition switch is ON (vehicle READY state), even if the engine is stopped, the conditions of the vehicle may cause the engine to start automatically.
If it is necessary to continually operate the engine during inspection or servicing, use the designated inspection mode. HBC-89, "Description".

Precaution Necessary for Steering Wheel Rotation after 12V Battery Disconnect

INFOID:0000000008141147

For vehicle with steering lock unit, if the 12V battery is disconnected or discharged, the steering wheel will lock and cannot be turned.
If turning the steering wheel is required with the 12V battery disconnected or discharged, follow the operation procedure below before starting the repair operation.

OPERATION PROCEDURE

1. Connect both 12V battery cables.
   NOTE:
   Supply power using jumper cables if 12V battery is discharged.
2. Turn the ignition switch to ACC position.
   (At this time, the steering lock will be released.)
3. Disconnect both 12V battery cables. The steering lock will remain released with both 12V 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 12V 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 All DTC Reading using CONSULT and delete DTC.
   NOTE:
   Multiple DTCs are detected when 12V battery cable is disconnected while ignition switch is in ACC position.

Precautions For Engine Service

INFOID:0000000008274415

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:0000000008141153

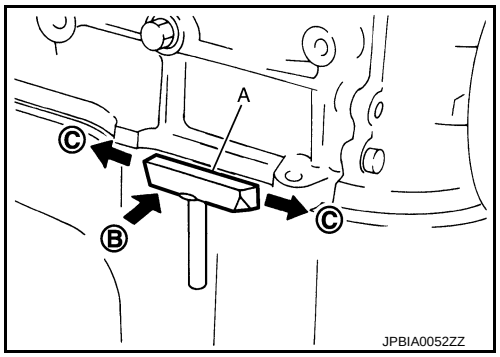
- Use the angle wrench [SST: KV10112100] for the final tightening of the following engine parts:
- Cylinder head bolts
- Lower cylinder block bolts
- Connecting rod cap bolts
- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread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

Liquid Gasket

INFOID:0000000008141154

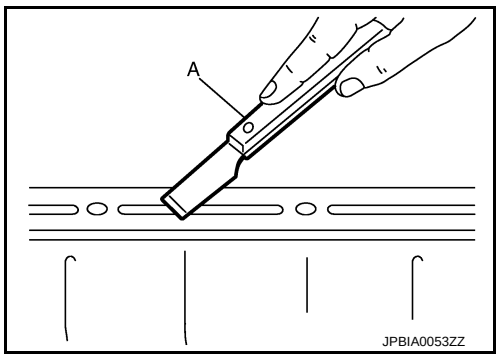
REMOVAL OF LIQUID GASKET SEALING

- 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:
  Never damage the mating surfaces.
- Tap the seal cutter [SST: KV10111100 (J-37228)] to insert it (B), and then slide it (C) by tapping on the side as shown in the figure.
- In areas where the seal cutter [SST: KV10111100 (J-37228)] is difficult to use, lightly tap the parts using a plastic hammer to remove it.
  CAUTION:
  Never damage the mating surface if a tool (e.g. screwdriver) is used by necessity.

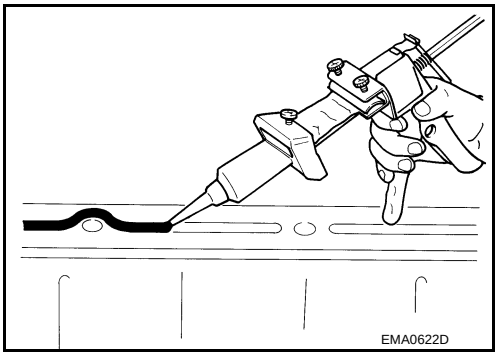


LIQUID GASKET APPLICATION PROCEDURE

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



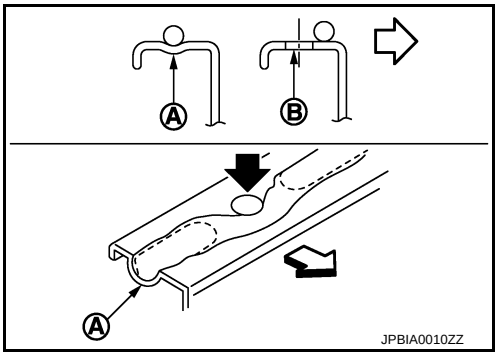
3. Attach liquid gasket tube to the tube presser (commercial service tool).
   Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-23, "Recommended Chemical Products and Sealants".
4. Apply liquid gasket without gaps to the specified location according to the specified dimensions.
   - If there 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. Make sure 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

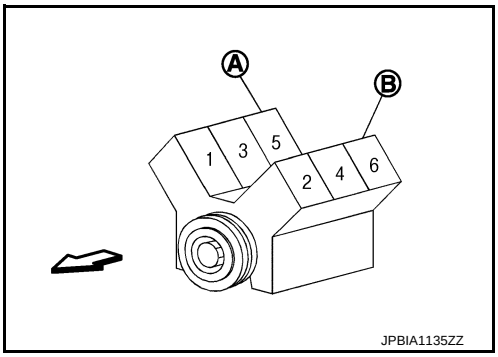
INFOID:0000000008141155

- 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)

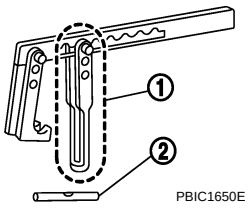
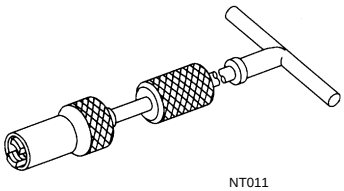
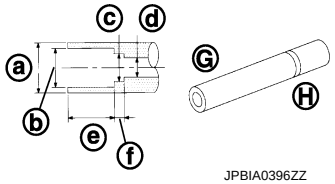
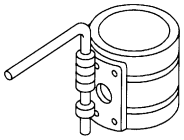
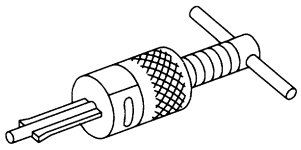
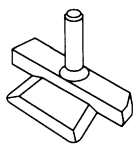
PREPARATION

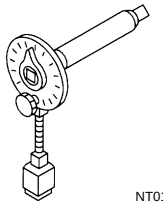
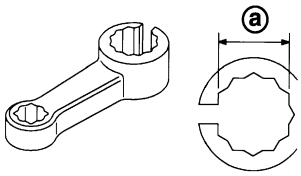
PREPARATION

Special Service Tools

INFOID:0000000008141156

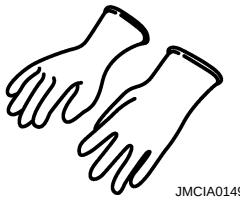
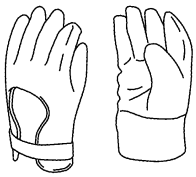
The actual shapes of Kent-Moore tools may differ from those of special service tools illustrated here.

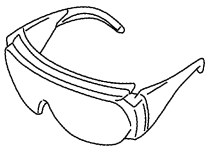
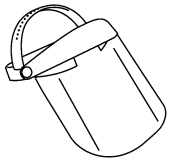
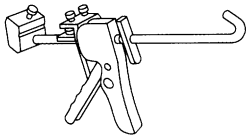
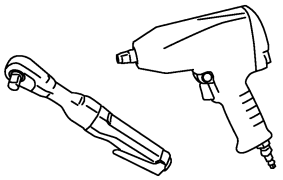
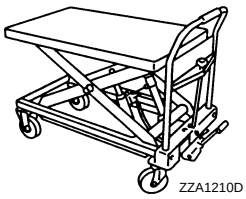
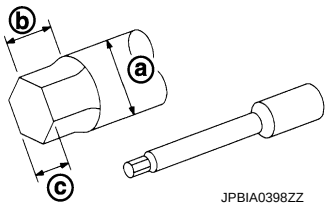
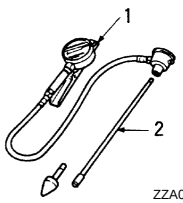
Tool number (Kent-Moore No.) Tool name	Description
KV10116200 (J-26336-A) Valve spring compressor 1. KV10115900 (J-26336-20) Attachment 2.KV10109220 (—) Adapter  PBIC1650E	Disassembling valve mechanism Part (1) is a component of KV10116200 (J-26336-A), but Part (2) is not so.
KV10107902 (J-38959) Valve oil seal puller  NT011	Replacing 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  NT044	Installing piston assembly into cylinder bore
ST16610001 (J-23907) Pilot bushing puller  NT045	Removing pilot converter
KV10111100 (J-37228) Seal cutter  NT046	Removing oil pan (lower and upper), front and rear timing chain case, etc.

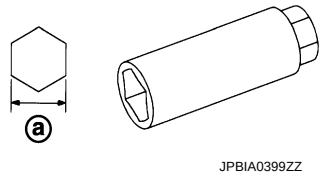
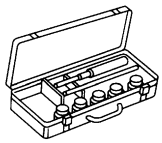
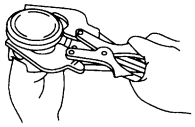
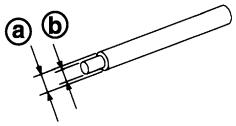
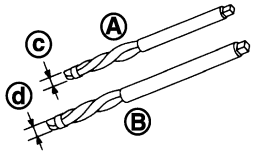
Tool number (Kent-Moore No.) Tool name		Description
KV10112100 (BT8653-A) Angle wrench	 NT014	Tightening bolts for connecting rod bearing cap, cylinder head, etc. at an angle
KV10114400 (J-38365) Heated oxygen sensor wrench	 JPBIA0397ZZ	Loosening or tightening air fuel ratio sensor 1 **a: 22 mm (0.87 in)**

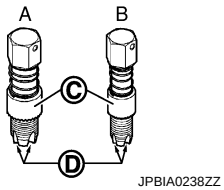
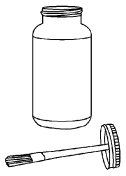
Commercial Service Tools

INFOID:0000000008141157

(Kent-Moore No.) Tool name		Description
(—) Insulated gloves	 JMCIA0149ZZ	Removing and installing high voltage components
(—) Leather gloves	 JPCIA0066ZZ	• Removing and installing high voltage components • Protect insulated glove
(—) Insulated safety shoes	 JPCIA0011ZZ	Removing and installing high voltage components

(Kent-Moore No.) Tool name		Description
(—) Safety glasses / Face shield protection	 JPCIA0012ZZ  JPCIA0167ZZ	• Removing and installing high voltage components • To protect eyes and face from the spatter on the work to electric line
(—) Tube presser	 NT052	Pressing the tube of liquid gasket
(—) Power tool	 PBIC0190E	Loosening nuts and bolts
(—) Manual lift table caddy	 ZZA1210D	Removing and installing engine
(J-24239-01) Cylinder head bolt wrench	 JPBIA0398ZZ	Loosening and tightening cylinder head bolt, and used with the angle wrench [SST: KV10112100 (BT8653-A)] **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

(Kent-Moore No.) Tool name	Description
(—) 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.**
(—) 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.**

(Kent-Moore 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

PERIODIC MAINTENANCE

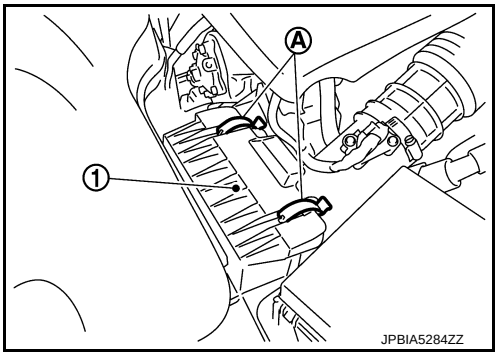
AIR CLEANER FILTER

Removal and Installation

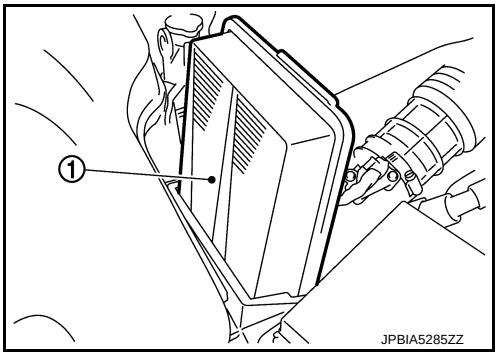
INFOID:0000000008141158

REMOVAL

1. Unhook clips (A), and remove holder (1).



2. Remove air cleaner filter (1).



INSTALLATION

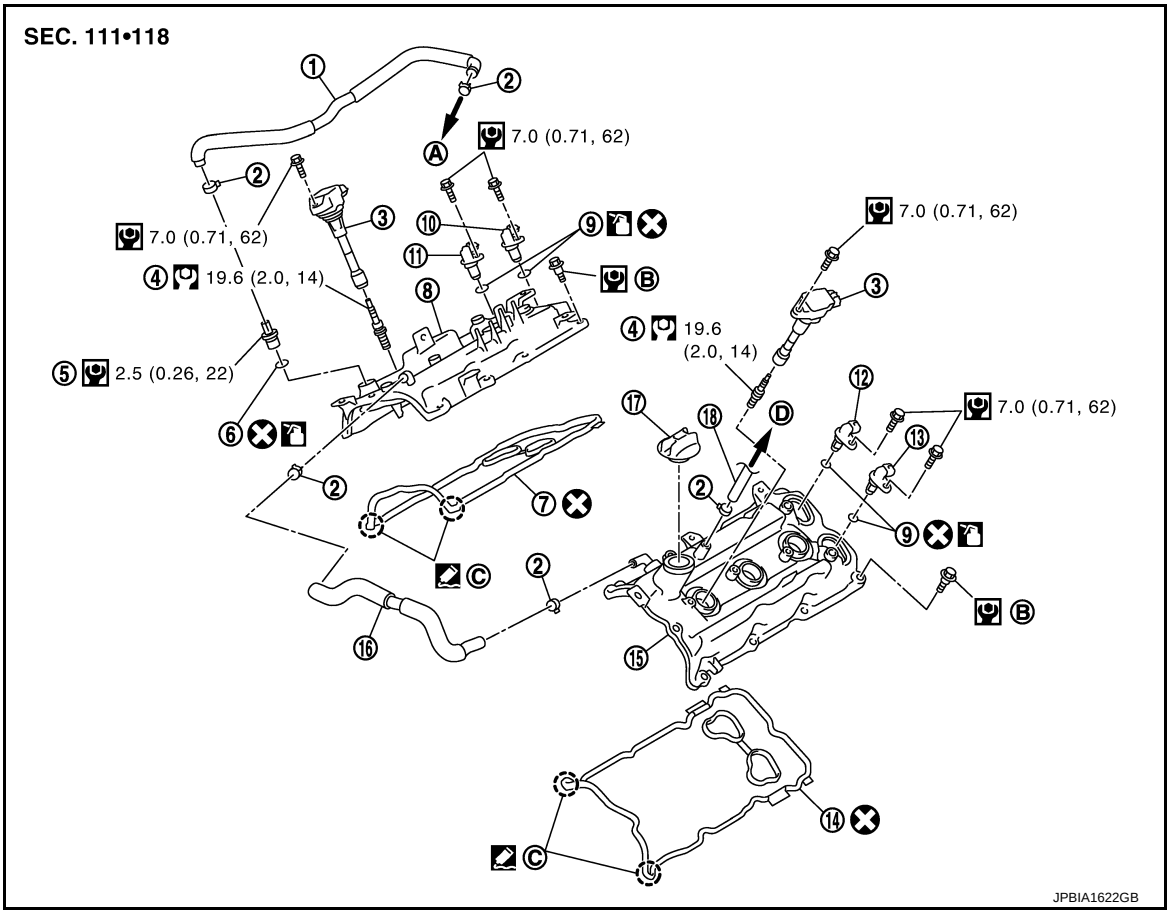
Note the following, and install in the reverse order of removal.

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

SPARK PLUG

Exploded View

INFOID:0000000008141159



1.	PCV hose	2.	Clamp	3.	Ignition coil
4.	Spark plug	5.	PCV valve	6.	O-ring
7.	Rocker cover gasket (bank 1)	8.	Rocker cover (bank 1)	9.	O-ring
10.	Camshaft position sensor (PHASE) (bank 1)	11.	Exhaust valve timing control position sensor (bank 1)	12.	Camshaft position sensor (PHASE) (bank 2)
13.	Exhaust valve timing control position sensor (bank 2)	14.	Rocker cover gasket (bank 2)	15.	Rocker cover (bank 2)
16.	PCV hose	17.	Oil filler cap	18.	PCV hose
A.	To intake manifold collector	B.	Comply with the installation procedure when tightning. Refer to EM-46	C.	Camshaft bracket side
D.	To air duct				

: N·m (kg-m, in-lb)

: Always replace after every disassembly.

: Should be lubricated with oil.

: Sealing point

Removal and Installation

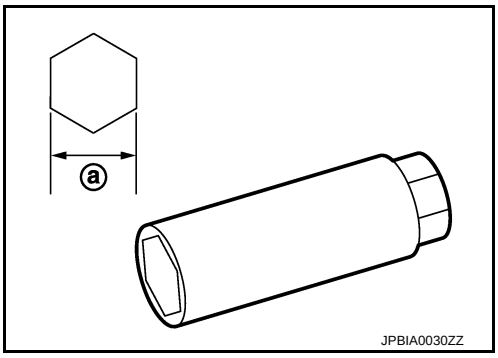
INFOID:0000000008141160

REMOVAL

1. Remove engine cover. Refer to EM-25, "Exploded View".
2. Remove air cleaner case and air duct (bank 1 and bank 2). Refer to EM-26, "Exploded View".

3. Remove ignition coil. Refer to EM-46, "Removal and Installation".
4. 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:0000000008141161

INSPECTION AFTER REMOVAL

Use the standard type spark plug for normal condition.

Spark plug (Standard type) : Refer to EM-134, "Spark Plug".

CAUTION:

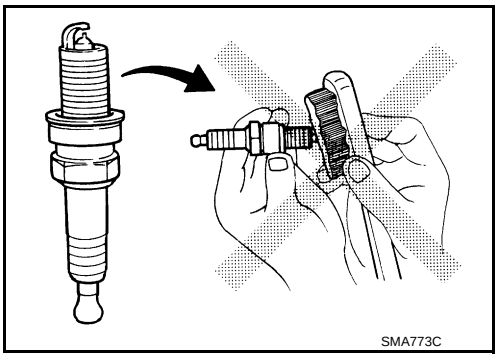
- **Never drop or shock spark plug.**
- **Never use a wire brush for cleaning.**
- **If plug tip is covered with carbon, use spark plug cleaner to clean.**

Cleaner air pressure

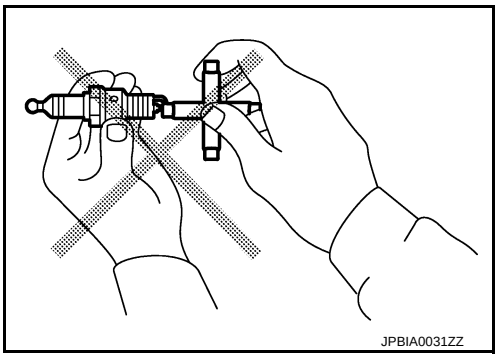
: Less than 588 kPa (6 kg/cm^2, 85 psi)

Cleaning time

: Less than 20 seconds



- **Check and adjustment of plug gap is not required between change intervals.**



CAMSHAFT VALVE CLEARANCE

Inspection and Adjustment

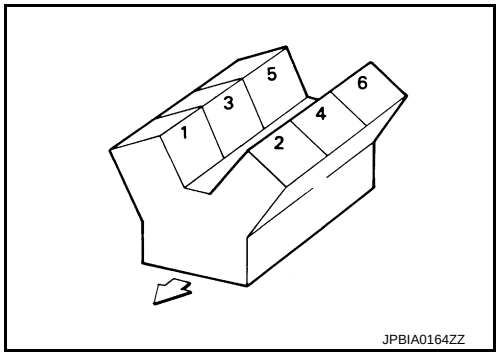
INFOID:0000000008141162

INSPECTION

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

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

⇦ : Engine front



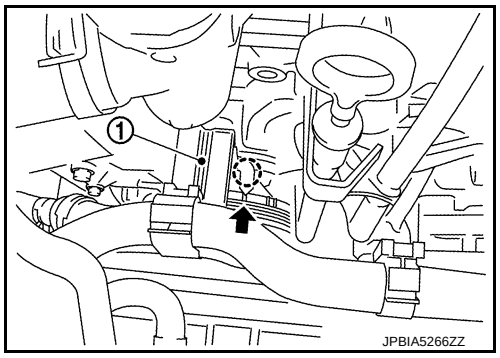
1. Remove rocker covers (bank 1 and bank 2). Refer to EM-46, "Removal and Installation".
2. Measure the valve clearance as follows:

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

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

1 : Heater pipe bracket

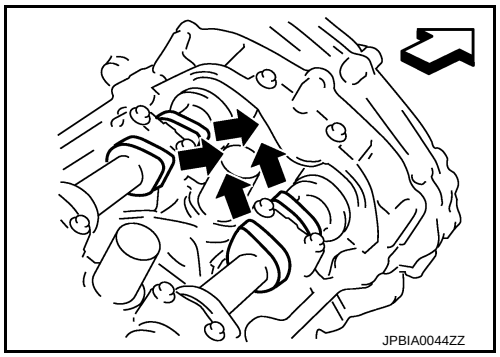
⬅ : Timing mark (grooved line without color)



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

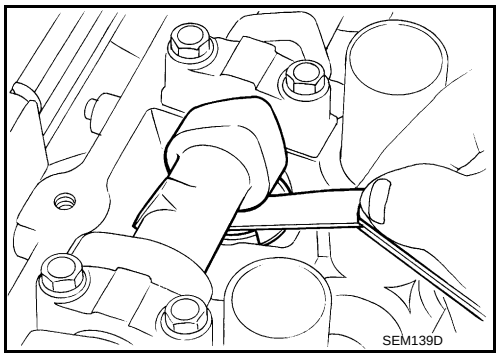
⇦ : Engine front

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



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

Valve clearance : Refer to EM-135, "Camshaft".

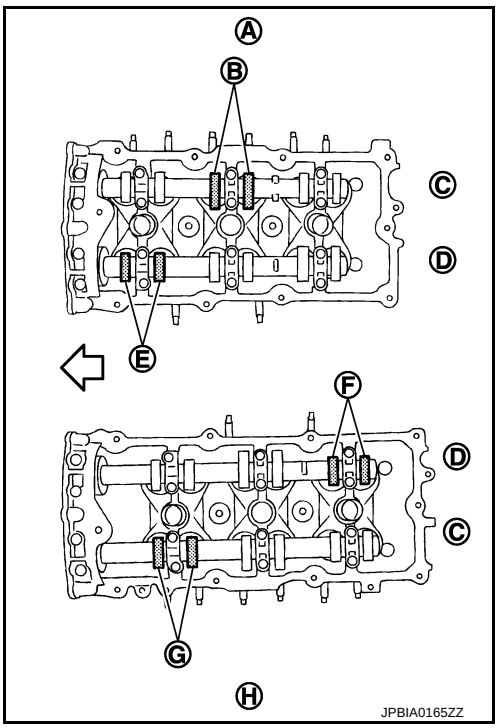


- By referring to the figure, measure the valve clearances at locations marked "×" as shown in the table below (locations indicated in the figure).

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



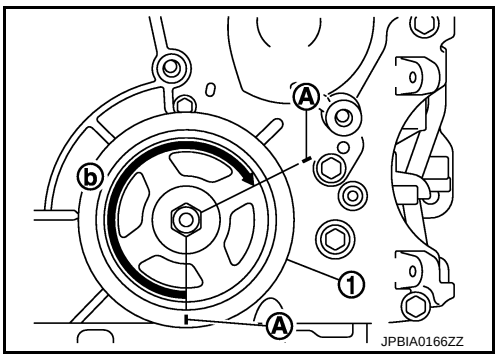
c. Rotate crankshaft 240 degrees clockwise (when viewed from engine front) to align No. 3 cylinder at TDC its compression stroke.

NOTE:

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

1 : Crankshaft pulley

A : Paint mark

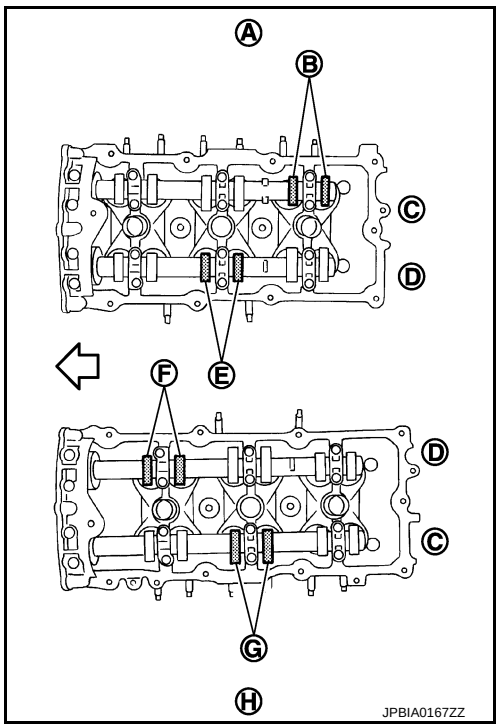


- By referring to the figure, measure the valve clearances at locations marked "×" as shown in the table below (locations indicated in the figure).

⇦ : Engine front

- No. 3 cylinder at compression TDC

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



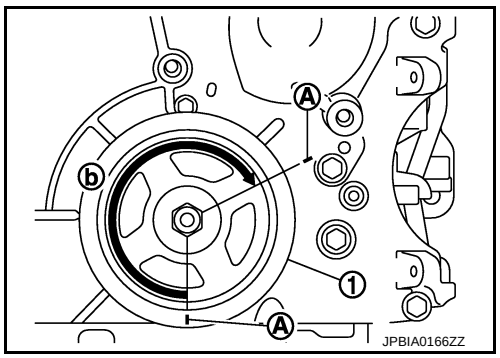
d. Rotate crankshaft 240 degrees clockwise (when viewed from engine front) to align No. 5 cylinder at TDC of compression stroke.

NOTE:

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

1 : Crankshaft pulley

A : Paint mark

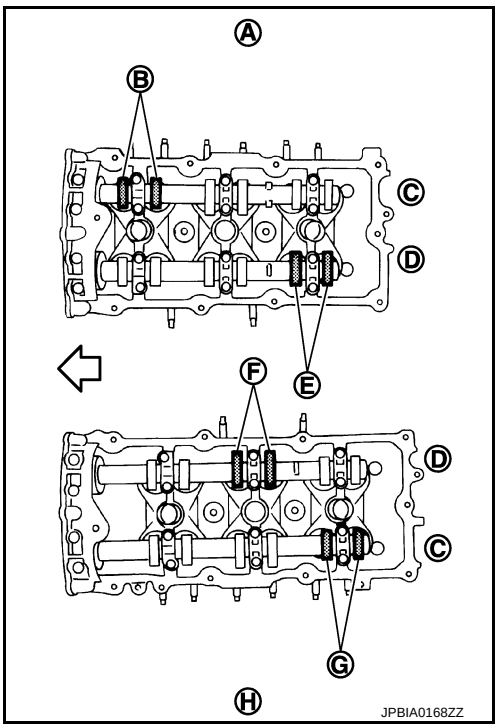


- By referring to the figure, measure the valve clearances at locations marked "×" as shown in the table below (locations indicated in the figure).

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

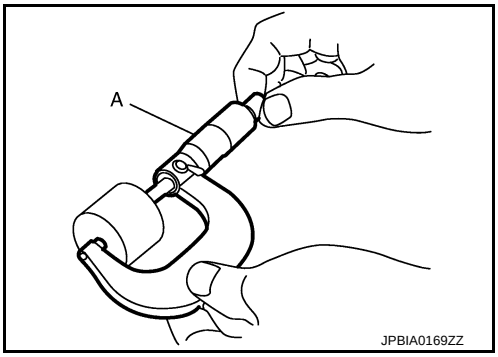


3. Perform adjustment if the measured value is out of the standard. Refer to "ADJUSTMENT".

ADJUSTMENT

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

1. Measure the valve clearance. Refer to "INSPECTION".
2. Remove camshaft. Refer to EM-65, "Exploded View".
3. Remove valve lifters at the locations that are out of the standard.
4. Measure the center thickness of the removed valve lifters with a micrometer (A).



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

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

t = Valve lifter thickness to be replaced

t_1 = Removed valve lifter thickness

C_1 = Measured valve clearance

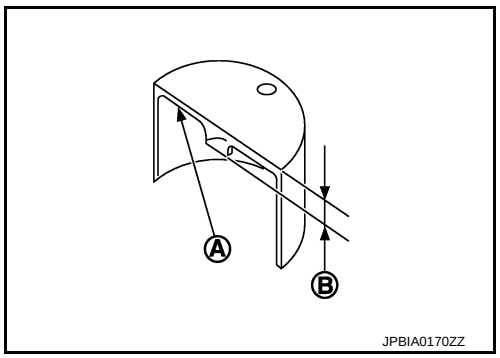
C_2 = Standard valve clearance:

Intake : 0.30 mm (0.012 in)

Exhaust : 0.33 mm (0.013 in)

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

  A : Stamp
  B : Thickness of valve lifter



Available thickness of valve lifter: 27 sizes with range 7.88 to 8.40 mm (0.3102 to 0.3307 in) in steps of 0.02 mm (0.0008 in) (when manufactured at factory). Refer to EM-135, "Camshaft".

6. Install selected valve lifter.
7. Install camshaft. Refer to EM-65, "Exploded View".
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.
10. Install all removal parts in the reverse order of removal.
11. Warm up the engine, and check for unusual noise and vibration.

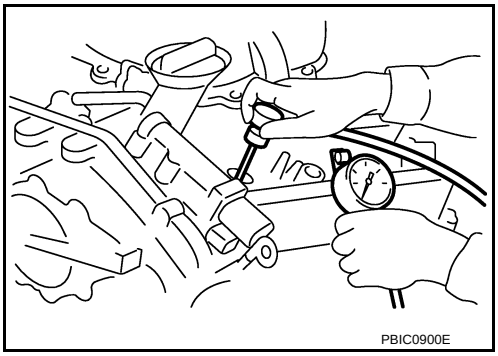
COMPRESSION PRESSURE

Inspection

INFOID:0000000008141163

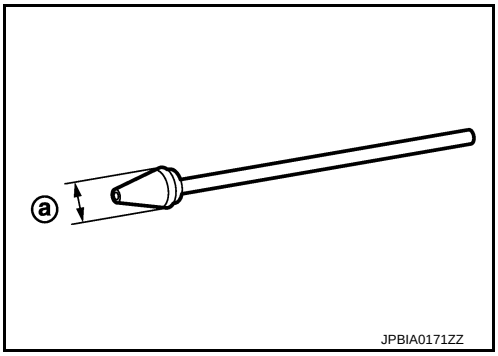
With CONSULT

1. Warm up engine thoroughly. Then, stop it.
2. Remove ignition coil and spark plug from each cylinder. Refer to EM-46, "Exploded View".
3. Connect engine tachometer.
4. 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)



5. Connect CONSULT and select “ACTIVE TEST” mode in “EV/HEV” to perform “ENGINE CRANKING”. Refer to HBC-89, "Description".
   - 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-134, "General Specification".

CAUTION:

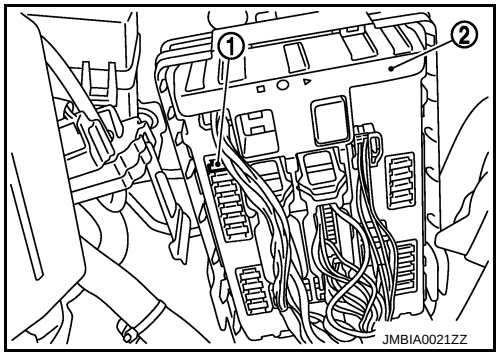
- **Measure a six-cylinder under the same conditions since a measurement depends on measurement conditions (engine water temperature, etc.).**
- **Always use a fully charged 12V battery to obtain the specified engine speed.**
- If the engine speed is out of the specified range, check 12V battery liquid 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, 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.

6. After inspection is completed, install removed parts.

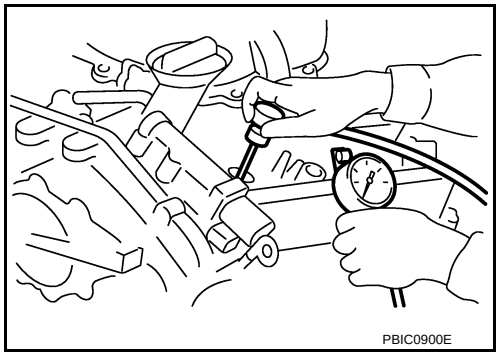
7. Start the engine, and check that the engine runs smoothly.
8. Perform trouble diagnosis. If DTC appears, erase it. Refer to EC-129, "Description".

Without CONSULT

1. Release fuel pressure. Refer to EC-115, "Work Procedure".
2. Disconnect fuel pump fuse (1) from IPDM E/R (2) to avoid fuel injection during measurement.

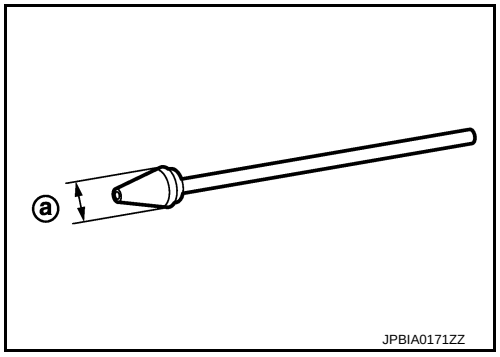


3. Remove engine cover. Refer to EM-25, "Exploded View".
4. Remove ignition coil and spark plug from each cylinder. Refer to EM-15, "Exploded View".
5. Connect engine tachometer.
6. Install compression gauge with an adapter (commercial service tool) onto spark plug hole.



- 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)



7. Perform maintenance mode 5. Refer to HBC-89, "Description".
   - 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-134, "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 12V battery to obtain the specified engine speed.**
- If the engine speed is out of the specified range, check 12V 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, 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.

8. After inspection is completed, install removed parts.
9. Start the engine, and check that the engine runs smoothly.
10. Perform trouble diagnosis. If DTC appears, erase it. Refer to EC-129, "Description".

REMOVAL AND INSTALLATION

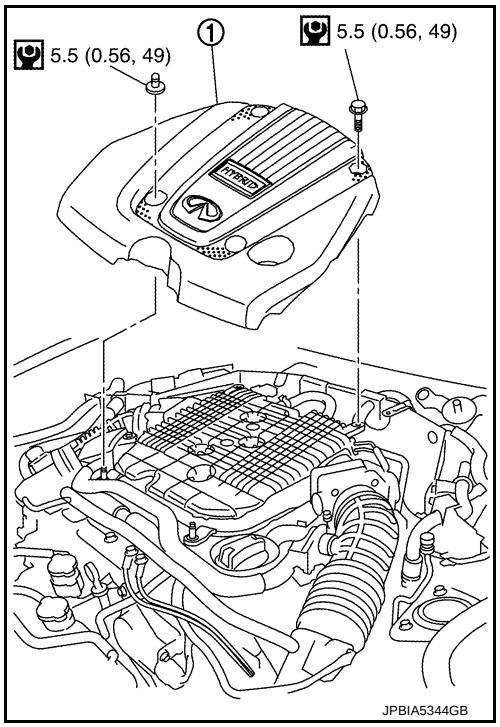
ENGINE COVER

Exploded View

INFOID:0000000008141164

1 : Engine cover

: N·m (kg-m, in-lb)



Removal and Installation

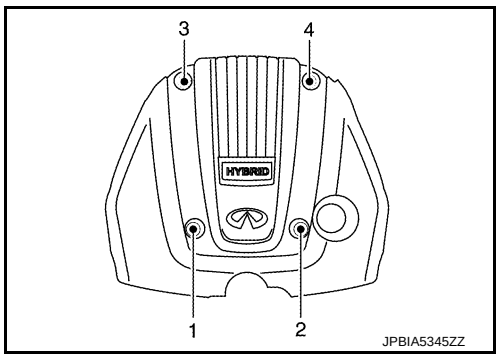
INFOID:0000000008141165

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.

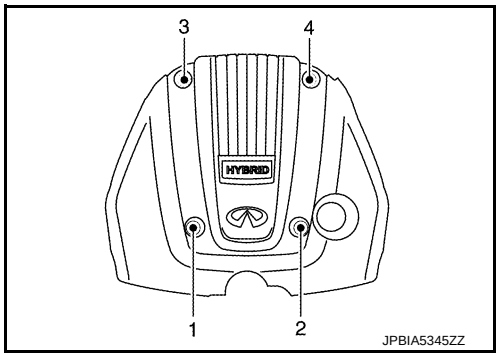


INSTALLATION

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

CAUTION:

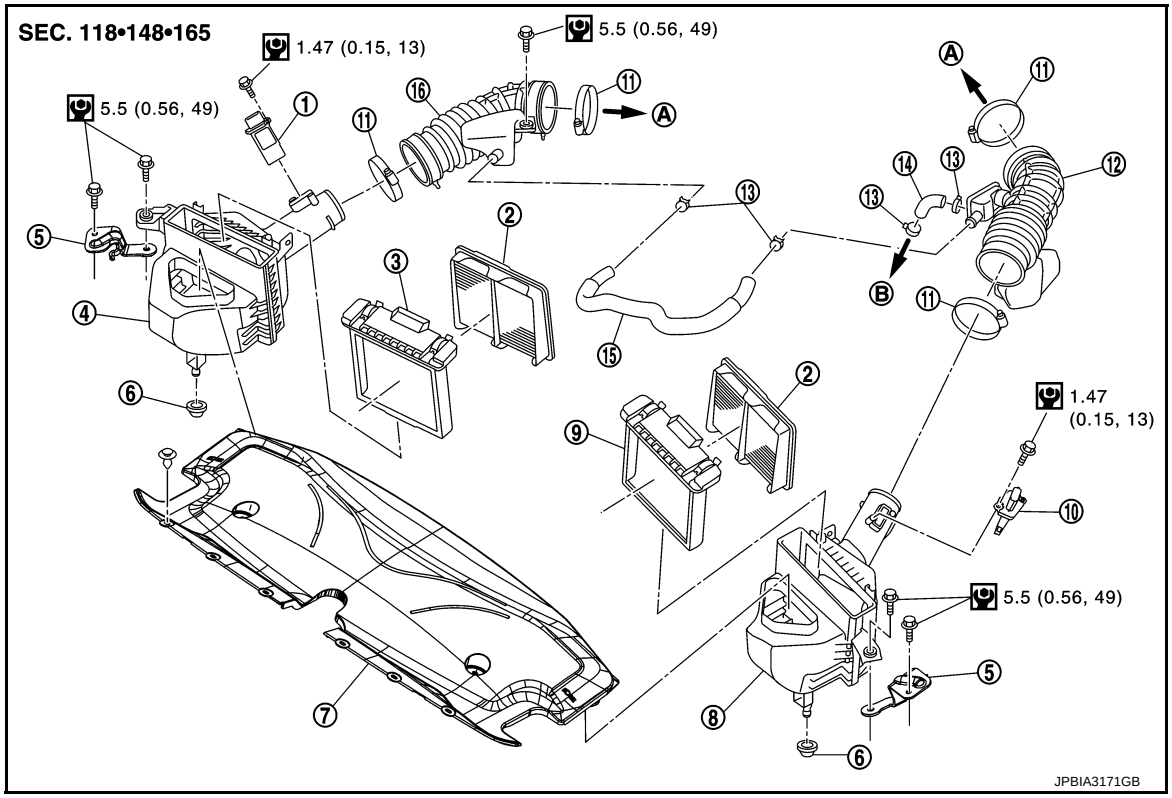
Never damage or scratch engine cover when installing or removing.



AIR CLEANER AND AIR DUCT

Exploded View

INFOID:0000000008141166



1. Mass air flow sensor (bank 1)
2. Air cleaner filter
3. Holder
4. Air cleaner case (bank 1)
5. Bracket
6. Grommet
7. Air duct (inlet)
8. Air cleaner case (bank 2)
9. Holder
10. Mass air flow sensor (bank 2)
11. Clamp
12. Air duct (bank 2)
13. Clamp
14. PCV hose
15. PCV hose
16. Air duct (bank 1)

A. To electric throttle control actuator
B. To rocker cover (bank 2)

: N·m (kg-m, in-lb)

Removal and Installation

INFOID:0000000008141167

REMOVAL

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

1. Disconnect mass air flow sensor harness connector.
2. Disconnect PCV hose.
3. Remove air cleaner case with mass air flow sensor and air duct, disconnecting each joints.
   - Add marks if necessary for easier installation.
4. Remove mass air flow sensor from air cleaner case if necessary.
   CAUTION:
   Handle mass air flow sensor according to the following instructions. Failure to do this may cause damage to the parts.
   - **Never shock mass air flow sensor.**
   - **Never disassemble mass air flow sensor.**
   - **Never touch mass air flow sensor.**

INSTALLATION

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

Inspection

INFOID:0000000008141168

INSPECTION AFTER REMOVAL

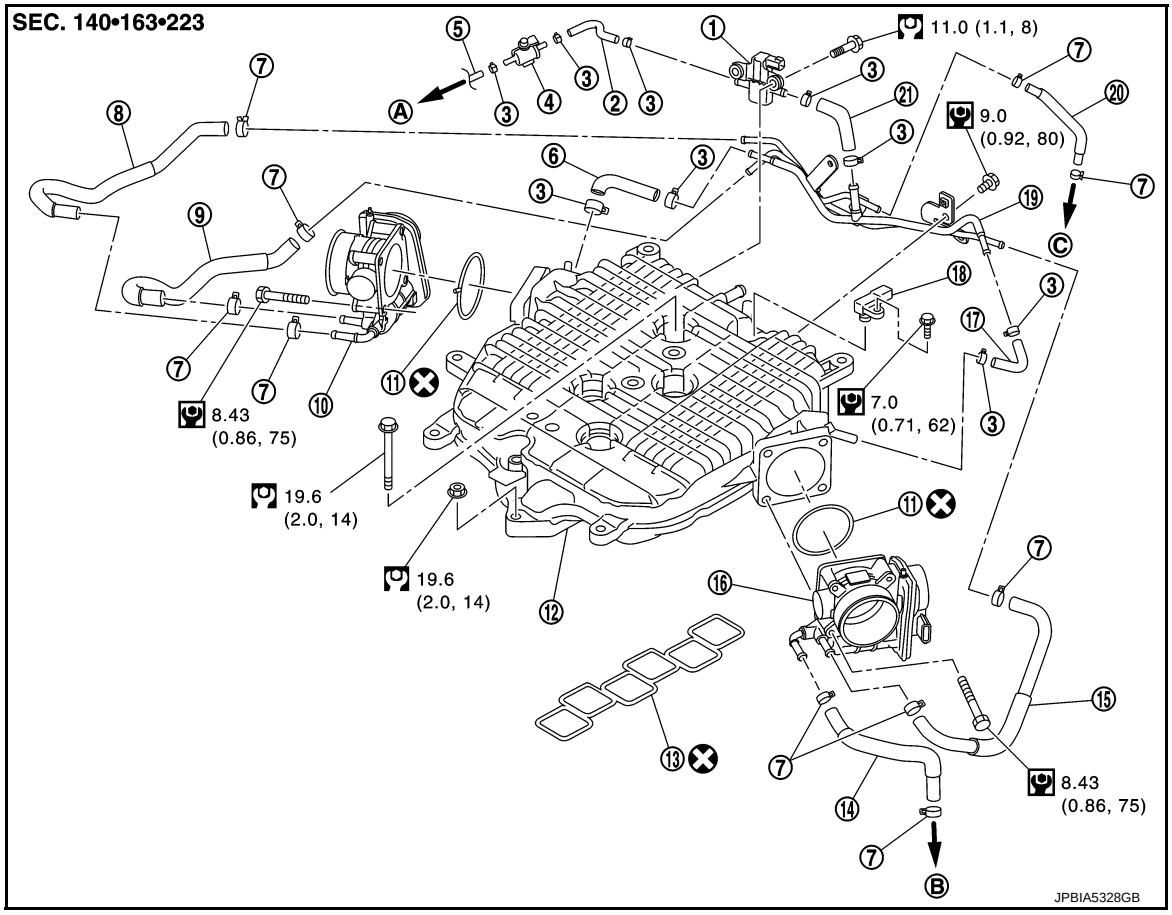
Inspect air duct and resonator assembly for crack or tear.

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

INTAKE MANIFOLD COLLECTOR

Exploded View

INFOID:0000000008141169



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

: N·m (kg-m, ft-lb)

: N·m (kg-m, in-lb)

: Always replace after every disassembly.

Removal and Installation

INFOID:0000000008141170

REMOVAL

WARNING:

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

1. Remove engine cover. Refer to EM-25, "Exploded View".
2. Remove air cleaner case and air duct (bank 1 and bank 2). Refer to EM-26, "Exploded View".

3. Remove electric throttle control actuator as follows:

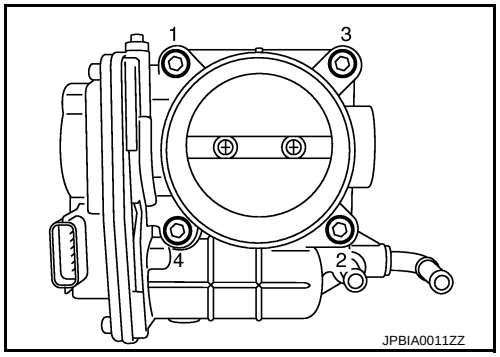
a. Drain engine coolant. When water hoses are disconnected, attach plug to prevent engine coolant leakage.
CAUTION:
- **Perform this step when engine is cold.**

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:
To prevent damage to the parts, handle carefully to avoid any shock to electric throttle control actuator.

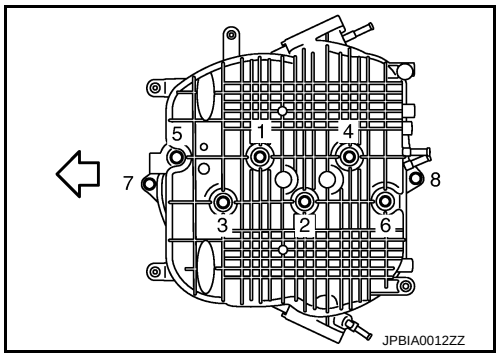


4. Disconnect vacuum hose, PCV hose and EVAP hose from intake manifold collector.

5. Remove EVAP canister purge volume control solenoid valve and EVAP tube assembly from intake manifold collector.

6. Loosen mounting bolts and nuts, using a power tool in the reverse order as shown in the figure to remove intake manifold collector.

⇦ : Engine front



INSTALLATION

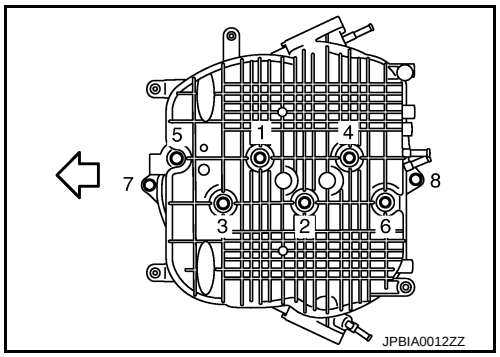
Note the following, and install in the reverse order of removal.

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.

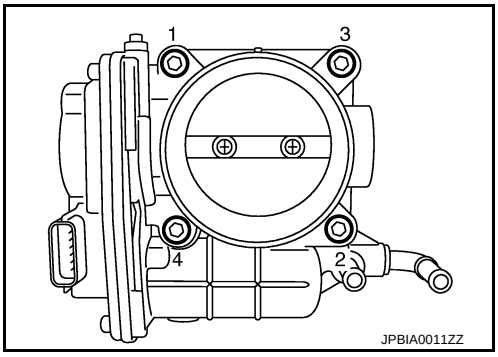
⇦ : Engine front



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)

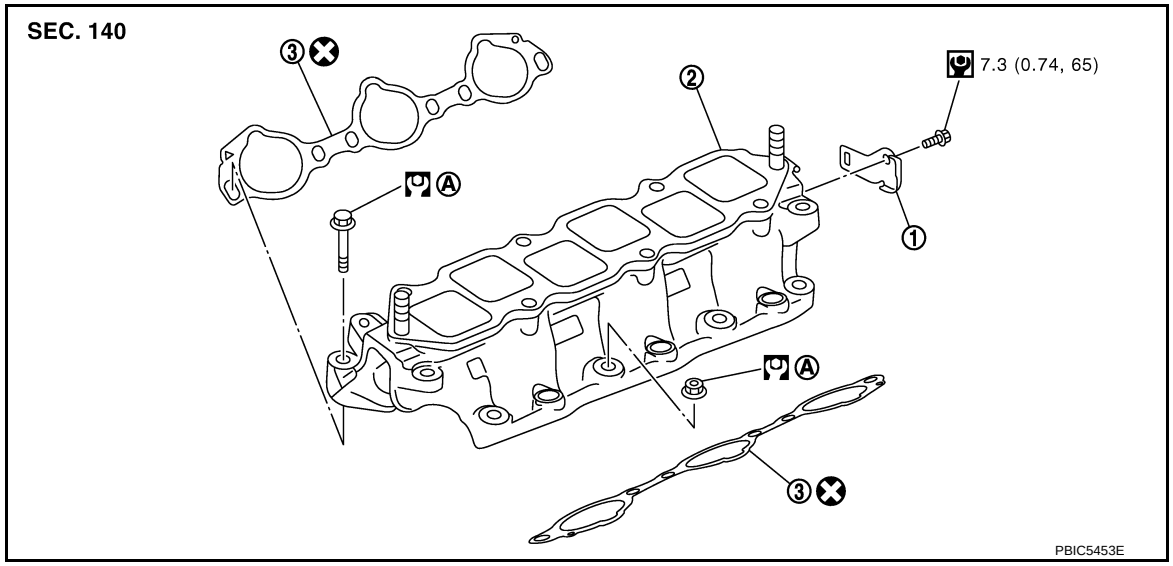
- Tighten in numerical order as shown in the figure.
  NOTE:
  - The figure shows the electric throttle control actuator (bank 1) viewed from the air duct side.
  - Viewed from the air duct side, the order of tightening mounting bolts of electric throttle control actuator (bank 2) is the same as that 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-107, "Description".
- Perform the “Idle Air Volume Learning” and “Throttle Valve Closed Position Learning” when electric throttle control actuator is replaced. Refer to EC-108, "Description" and EC-107, "Description".



INTAKE MANIFOLD

Exploded View

INFOID:0000000008141171



1. Harness bracket
2. Intake manifold
3. Gasket

A. Comply with the installation procedure when tightening. Refer to EM-31

: N·m (kg-m, ft-lb)

: N·m (kg-m, in-lb)

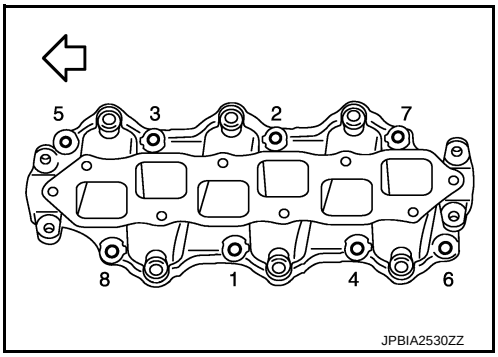
: Always replace after every disassembly.

Removal and Installation

INFOID:0000000008141172

REMOVAL

1. Release fuel pressure. Refer to EC-115, "Work Procedure".
2. Remove intake manifold collector. Refer to EM-28, "Exploded View".
3. Remove fuel tube and fuel injector assembly. Refer to EM-37, "Exploded View".
4. Loosen mounting bolts in reverse order as shown in the figure to remove intake manifold, using a 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.

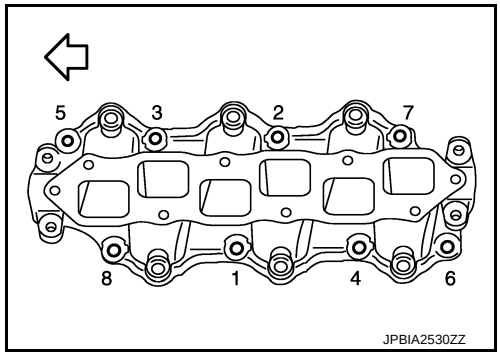
INSTALLATION

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:

: 29.0 N·m (3.0 kg-m, 21 ft-lb)

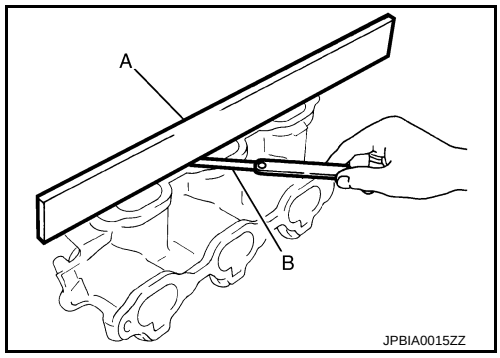
Inspection

INFOID:0000000008141173

INSPECTION AFTER REMOVAL

Surface Distortion

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



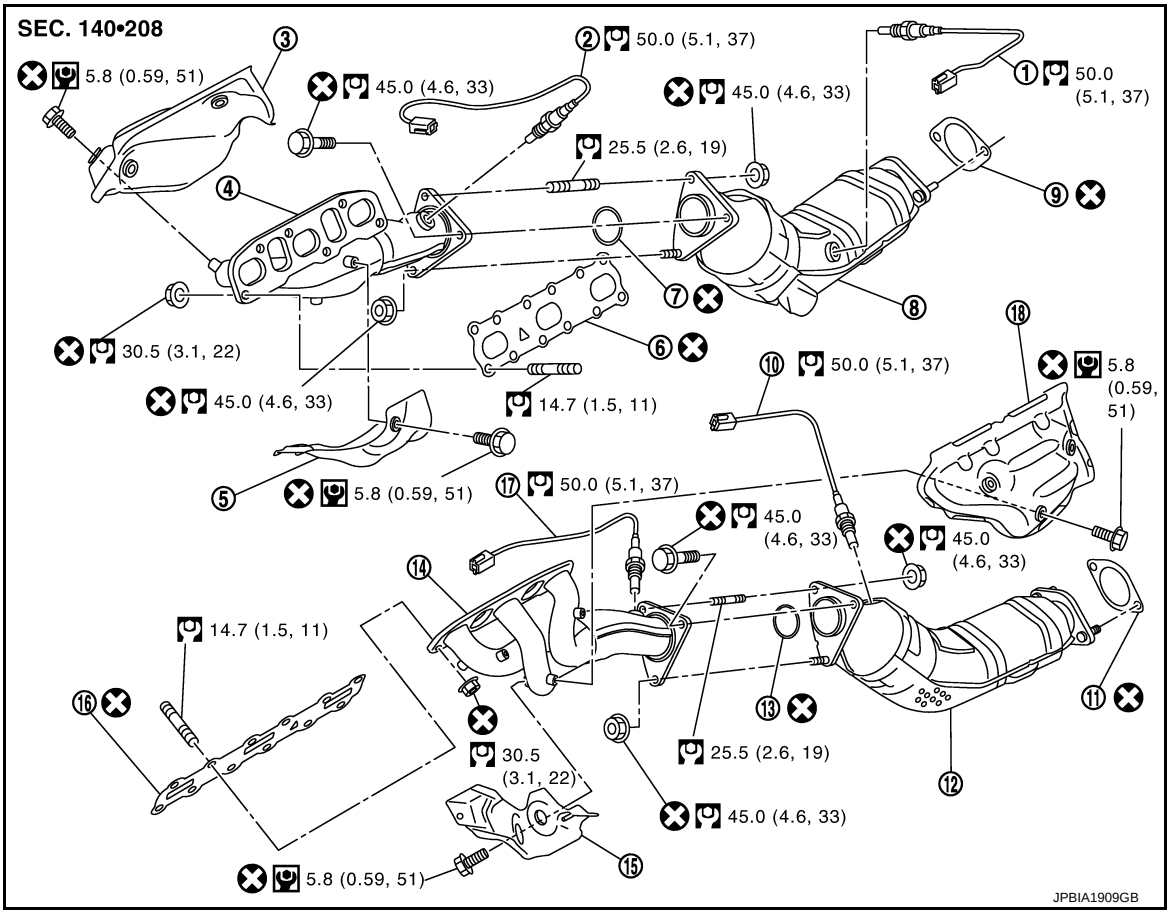
Limit : Refer to EM-135, "Intake Manifold".

- If it exceeds the limit, replace intake manifold.

EXHAUST MANIFOLD

Exploded View

INFOID:0000000008141174



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

: N·m (kg-m, ft-lb)

: N·m (kg-m, in-lb)

: Always replace after every disassembly.

Removal and Installation

INFOID:0000000008141175

REMOVAL

WARNING:

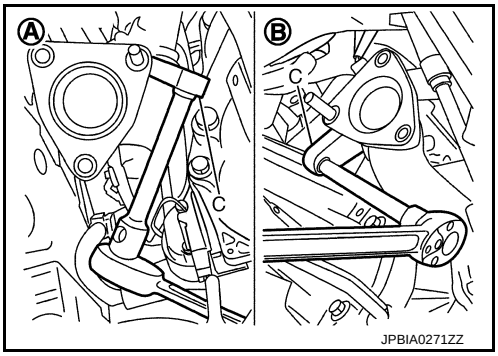
Perform the work when the exhaust and cooling system have completely cooled down.

NOTE:

When removing bank 1 side parts only, steps 1and 4 are unnecessary.

1. Drain engine coolant. Refer to CO-7, "Draining".

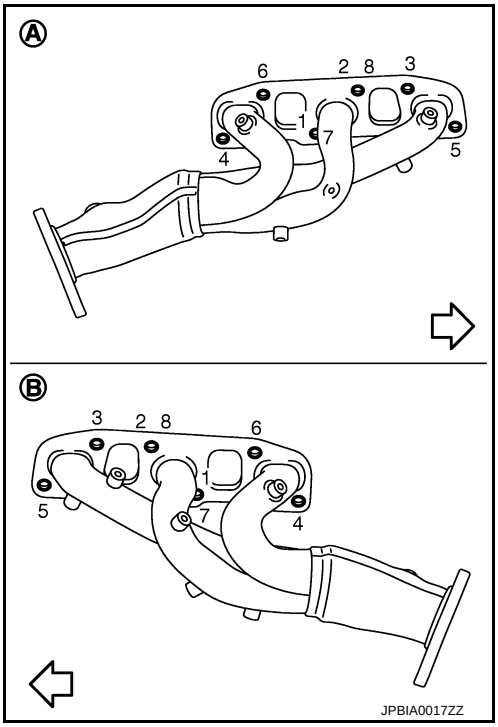
2. Remove engine cover. Refer to EM-25, "Exploded View".
3. Remove air cleaner case and air duct (bank 1 and bank 2). Refer to EM-26, "Exploded View".
4. Remove water pipe and water hose. Refer to CO-24, "Exploded View".
5. Remove engine undercover, using a power tool.
6. Remove exhaust front tube and three way catalysts (bank 1 and bank 2). Refer to EX-5, "Exploded View".
7. Disconnect steering lower joint at power steering gear assembly side, and release steering lower shaft. Refer to ST-34, "Exploded View" (WITH HEATED STEERING WHEEL) or ST-61, "Exploded View" (WITHOUT HEATED STEERING WHEEL).
8. Disconnect air fuel ratio sensor 1 (bank 1 and bank 2) harness connectors and remove harness clip.
9. 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:
- **Never damage air fuel ratio sensor 1.**
- **Discard any sensor which has been dropped from a height of more than 0.5 m (19.7 in) onto a hard surface such as a concrete floor; use a new one.**

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



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

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

12. Remove gaskets.
CAUTION:
Cover engine openings to avoid entry of foreign materials.

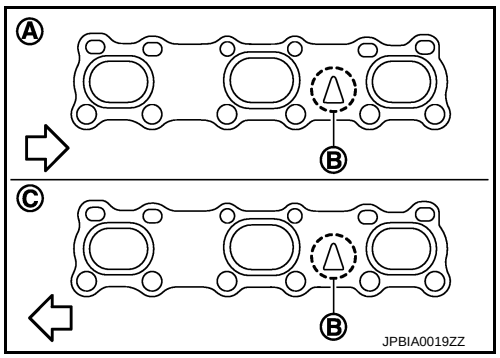
INSTALLATION

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

EXHAUST MANIFOLD GASKET

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

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



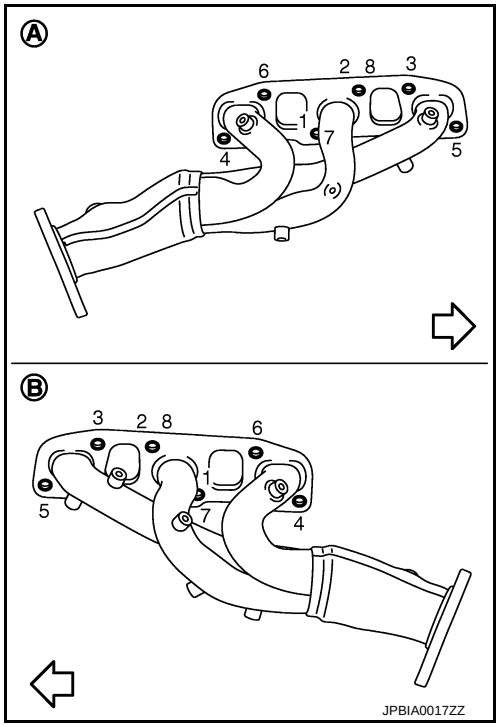
EXHAUST MANIFOLD
- If stud bolts were removed, install them and tighten to the torque specified below.

Tightening torque : Refer to EM-33, "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

CAUTION:
- **Before installing a new air fuel ratio sensor 1, clean exhaust system threads using heated oxygen sensor thread cleaner tool (commercial service tool) and apply anti-seize lubricant.**
- **Never apply excessive torque to air fuel ratio sensor 1. Doing so may cause damage to air fuel ratio sensor 1, resulting in the "MI" illuminating.**
- **Prevent rust preventives from adhering to the sensor body.**

Inspection

INFOID:0000000008141176

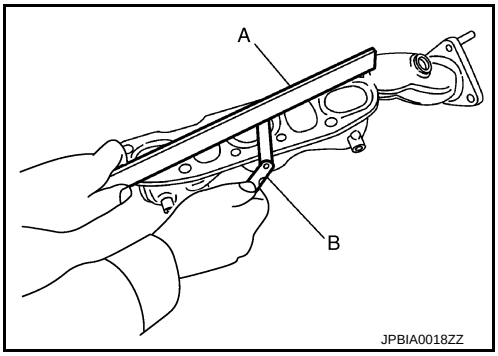
INSPECTION AFTER REMOVAL

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-135, "Exhaust Manifold".

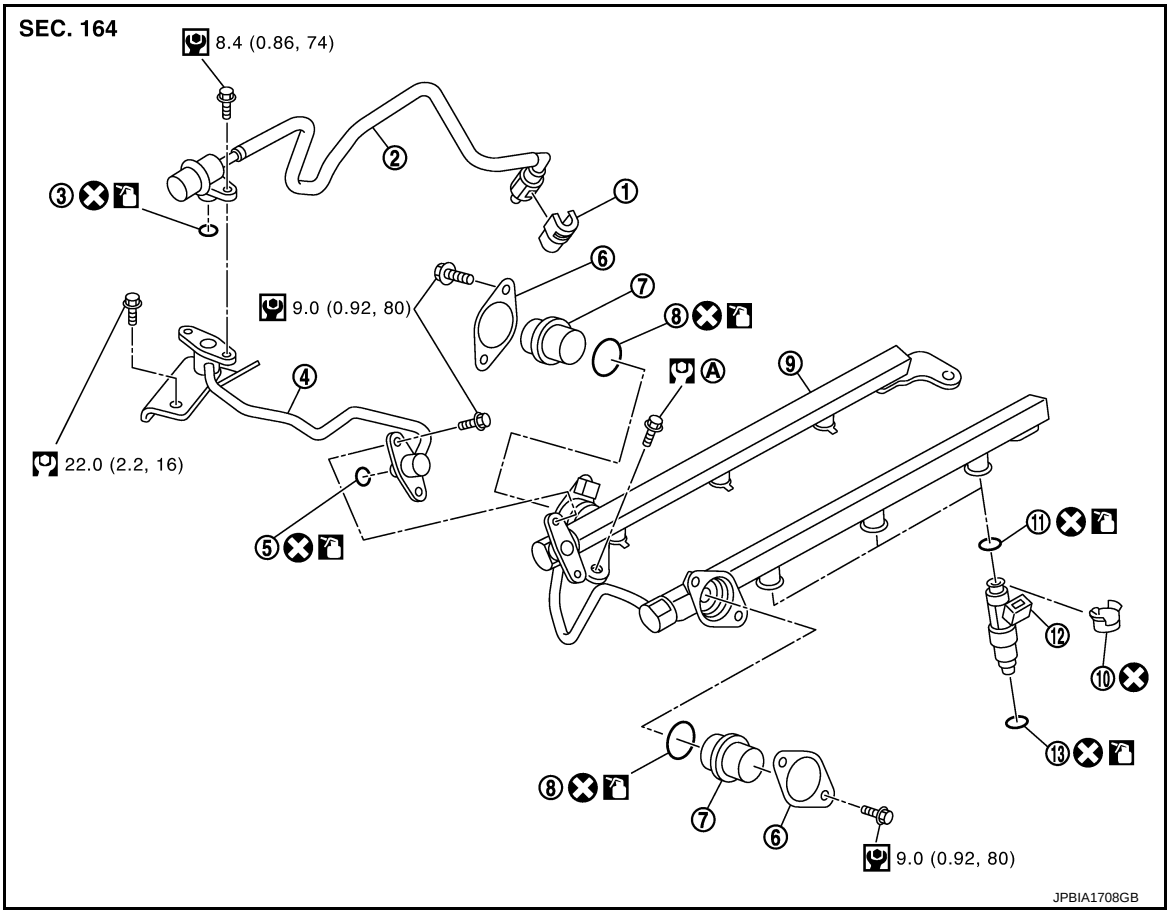
- If it exceeds the limit, replace exhaust manifold.



FUEL INJECTOR AND FUEL TUBE

Exploded View

INFOID:0000000008141177



1.	Quick connector cap	2.	Fuel feed hose (with damper)	3.	O-ring
4.	Fuel sub tube	5.	O-ring	6.	Fuel damper cap
7.	Fuel damper	8.	O-ring	9.	Fuel tube
10.	Clip	11.	O-ring (black)	12.	Fuel injector
13.	O-ring (green)				
A.	Comply with the installation procedure when tightening. Refer to EM-37				

: N·m (kg-m, ft-lb)

: N·m (kg-m, in-lb)

: Always replace after every disassembly.

: Should be lubricated with oil.

CAUTION:

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

Removal and Installation

INFOID:0000000008141178

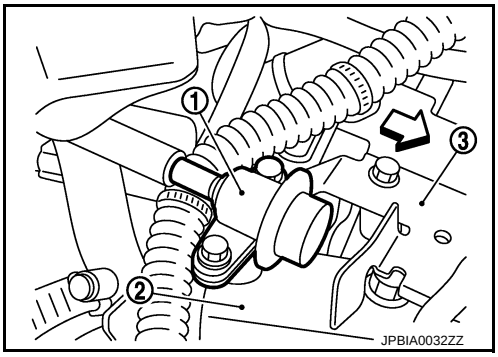
REMOVAL

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-115, "Work Procedure".
2. Disconnect 12V battery cable from the negative terminal. Refer to PG-141, "Exploded View".
3. Remove engine cover. Refer to EM-25, "Exploded View".
4. Remove air cleaner case and air duct (bank 1 and bank 2). Refer to EM-26, "Exploded View".
5. Remove fuel feed hose (with damper) (1) from fuel sub-tube (2) and remove harness bracket (3).

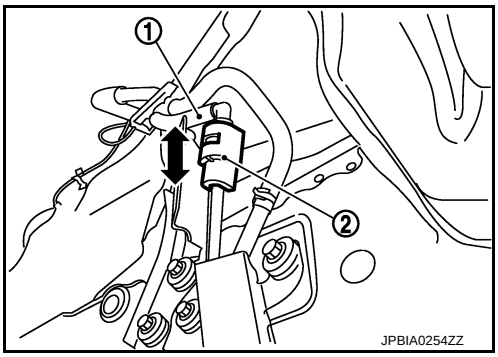


⇦ : Engine front

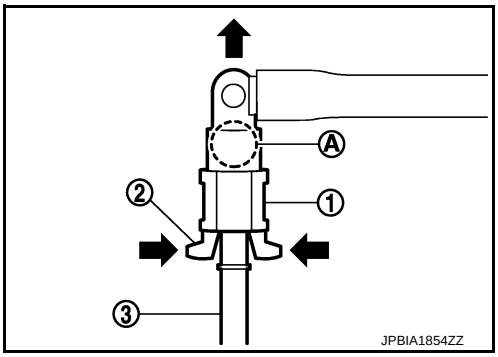
NOTE:
There is no fuel return route.
CAUTION:
- **While hoses are disconnected, plug them to prevent fuel from draining.**
- **Never separate damper and hose.**

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

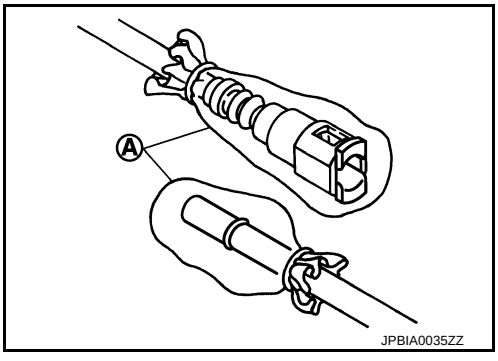
a. Remove quick connector cap (2) from quick connector connection on right member side.
b. Disconnect fuel feed hose (with damper) (1) from bracket hose clamp.



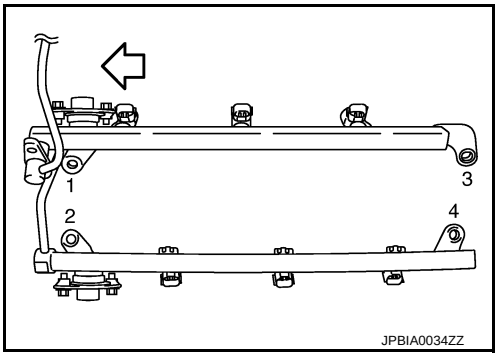
c. Push in retainer tabs (2).
d. Draw and pull out quick connector (1) straight from centralized under-floor piping (3).



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



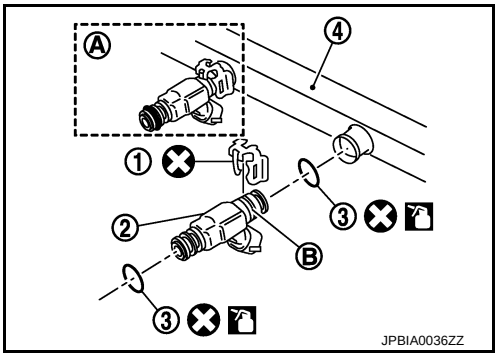
7. Remove intake manifold collector. Refer to EM-28, "Exploded View".
8. Disconnect harness connector from fuel injector.
9. Loosen mounting bolts in reverse order as shown in the figure, and remove fuel tube and fuel injector assembly.



⇦ : Engine front

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

10. 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.

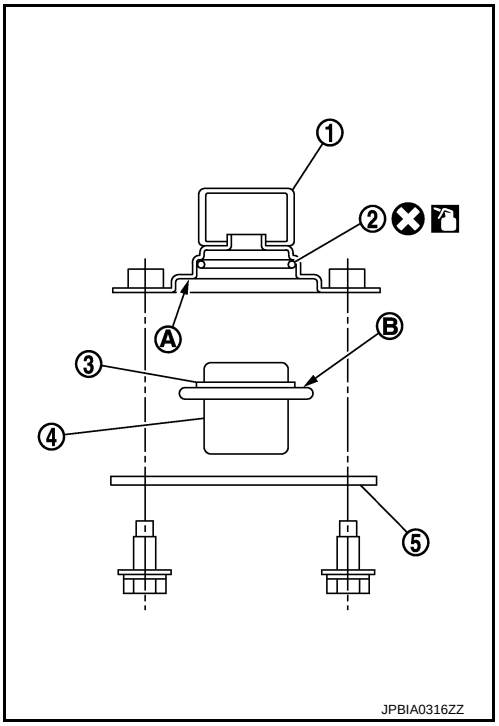
CAUTION:
- **Be careful with remaining fuel that may go out from fuel tube.**
- **Never damage injector nozzles during removal.**
- **Never bump or drop fuel injector.**
- **Never disassemble fuel injector.**

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

INSTALLATION

CAUTION:
Do not reuse O-rings.

1. Install fuel damper (4) as follows:



1 : Fuel tube
3 : Spacer
5 : Fuel damper cap

a. Install new O-ring (2) to fuel tube as shown in the figure. To prevent leakage of oil, follow the instructions below when handling O-ring.

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.**
- **Never scratch O-ring with tools or fingernails. Check O-ring for twist or stretch. If O-ring is stretched during installation, wait until it returns to the original condition before inserting it to fuel tube.**
- **Insert new O-ring straight into fuel tube. Never twist it.**

b. Install spacer to fuel damper.
c. Insert fuel damper straight into fuel tube.

CAUTION:
- **Insert straight, checking that the axis is lined up.**

- **Never apply excessive force to fuel damper.**

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

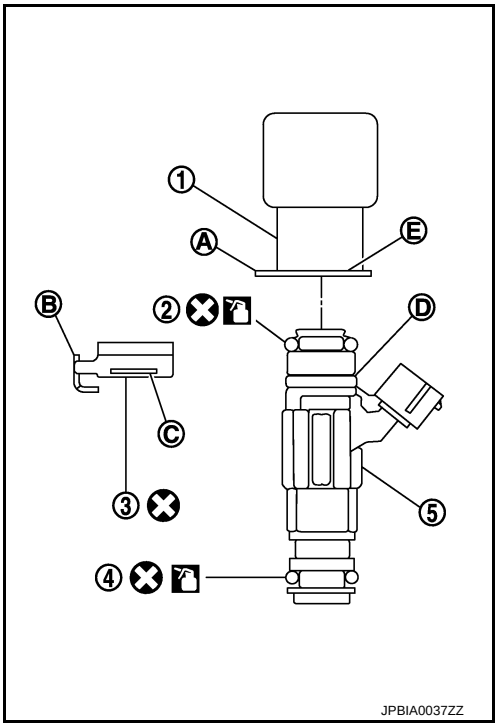
- **Insert fuel damper until (B) is touching (A) of fuel tube.**

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, never scratch it with tool or fingernails. Also never 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. Never 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, never scratch it with tool or fingernails. Also never 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 (D) 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.**
b. Insert fuel injector into fuel tube (1) with clip attached.
   - Insert it while matching it to the axial center.
   - Insert fuel injector so that protrusion (A) of fuel tube matches cutout (B) of clip.
   - Check that fuel tube flange (E) is securely fixed in flange fixing groove (C) on clip.
c. Check that installation is complete by checking that fuel injector does not rotate or come off.
   - Check that protrusions of fuel injectors and fuel tube are aligned with cutouts of clips after installation.

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

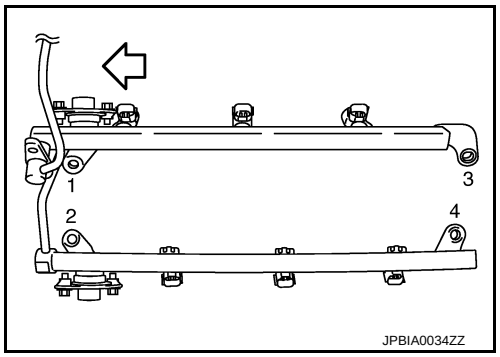
Never let tip of injector nozzle come in contact with other parts.

- 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:

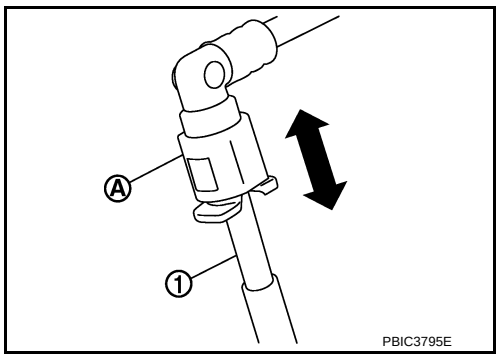
a. Check that no foreign substances are deposited in and around centralized under-floor piping and quick connector, and that there is no damage to them.

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

c. Align center to insert quick connector straightly into centralized under-floor piping.
   - Insert quick connector to centralized under-floor piping until top spool is completely inside quick connector and 2nd level spool exposes right below quick connector.

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

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

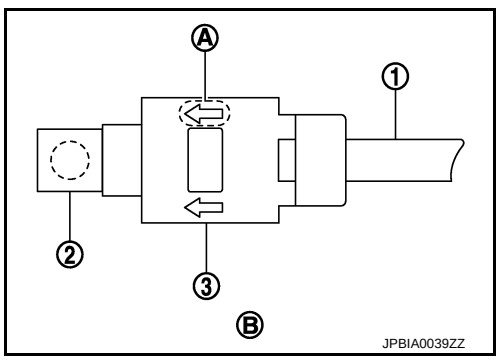


e. Install quick connector cap (3) to quick connector connection.

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

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

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



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

Inspection

INFOID:0000000008141179

INSPECTION AFTER INSTALLATION

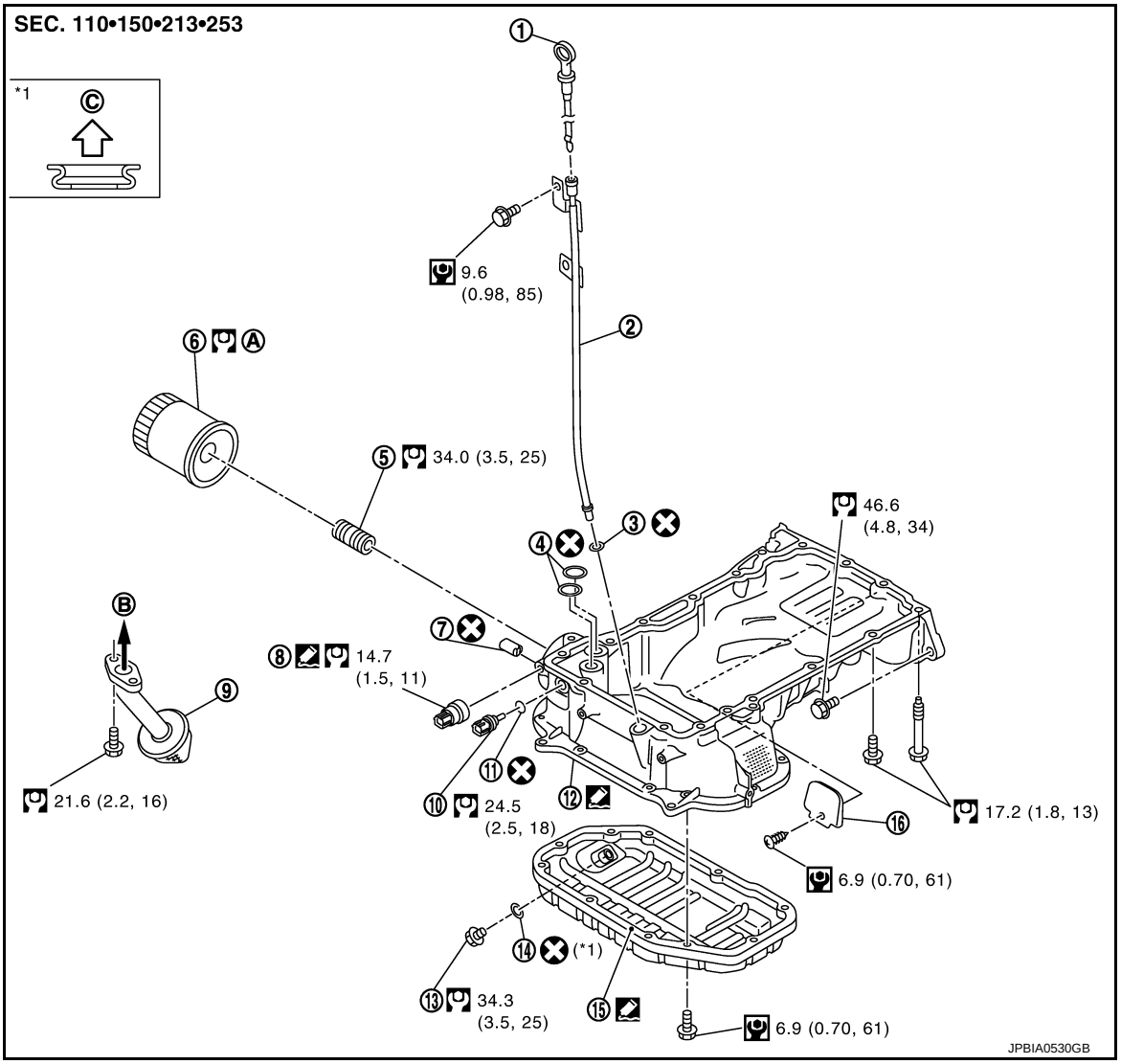
Check for Fuel Leakage

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 that 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.
   NOTE:
   Perform maintenance mode 5 and maintain the engine speed. Refer to EC-129, "Description".

OIL PAN (LOWER)

Exploded View

INFOID:0000000008141180



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

: N·m (kg-m, ft-lb)

: N·m (kg-m, in-lb)

: Always replace after every disassembly.

: Sealing point

Removal and Installation

INFOID:0000000008141181

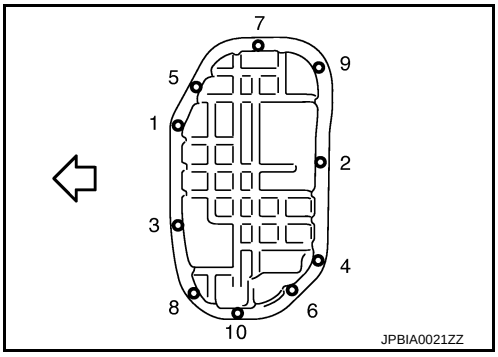
REMOVAL

CAUTION:
Never drain engine oil when the engine is hot to avoid the danger of being scalded. Failure to do this may cause burns.

1. Remove engine undercover, using a power tool.
2. Drain engine oil.
3. Remove oil pan (lower) as follows:

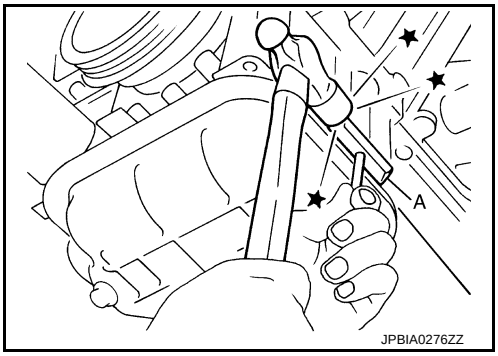
a. Loosen mounting bolts in reverse order as shown in the figure to remove.

⇦ : Engine front



b. Insert the seal cutter [SST: KV10111100] (A) between oil pan (upper) and oil pan (lower).
CAUTION:
- **Never 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).



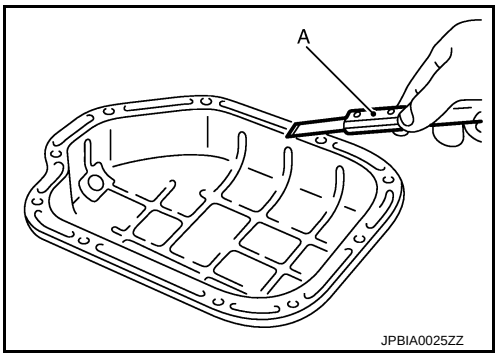
INSTALLATION

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.



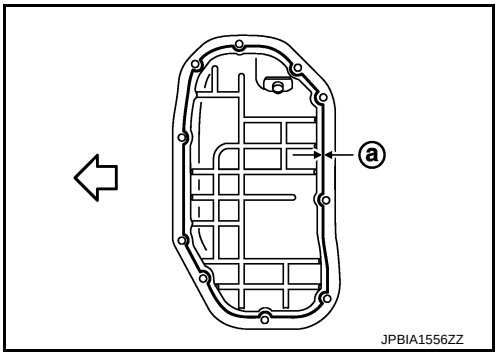
b. Apply a continuous bead of liquid gasket with the tube presser (commercial service tool) to the oil pan (lower) as shown in the figure.

⇦ : Engine front

a : ϕ4.0 - 5.0 mm (0.157 - 0.197 in)

Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-23, "Recommended Chemical Products and Sealants".

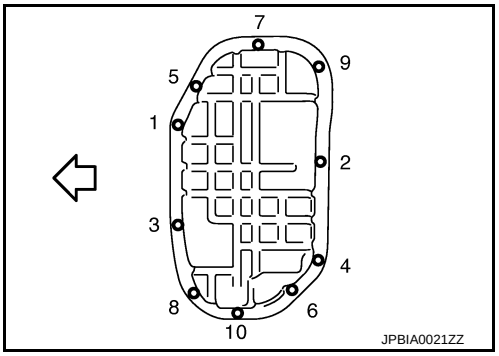
CAUTION:



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-43, "Exploded View".

3. 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:0000000008141182

INSPECTION AFTER REMOVAL

Clean oil strainer if any object is attached.

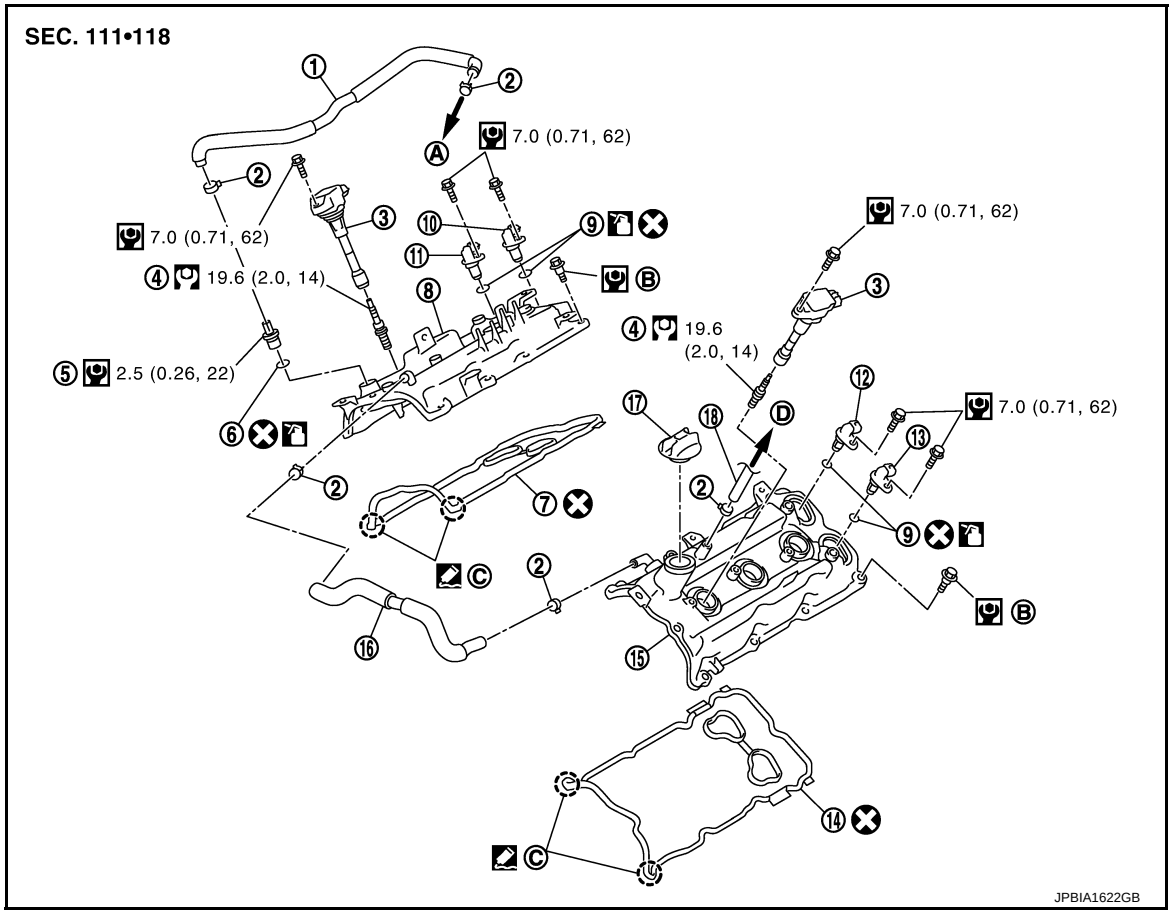
INSPECTION AFTER INSTALLATION

1. Check the engine oil level and adjust engine oil. Refer to LU-7, "Inspection".
2. Start engine, and check there is no leakage of engine oil.
NOTE:
Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-89, "Description".
3. Stop engine and wait for 10 minutes.
4. Check the engine oil level again. Refer to LU-7, "Inspection".

IGNITION COIL, SPARK PLUG AND ROCKER COVER

Exploded View

INFOID:0000000008141183



1.	PCV hose	2.	Clamp	3.	Ignition coil
4.	Spark plug	5.	PCV valve	6.	O-ring
7.	Rocker cover gasket (bank 1)	8.	Rocker cover (bank 1)	9.	O-ring
10.	Camshaft position sensor (PHASE) (bank 1)	11.	Exhaust valve timing control position sensor (bank 1)	12.	Camshaft position sensor (PHASE) (bank 1)
13.	Exhaust valve timing control position sensor (bank 2)	14.	Rocker cover gasket (bank 2)	15.	Rocker cover (bank 2)
16.	PCV hose	17.	Oil filler cap	18.	PCV hose
A.	To intake manifold collector	B.	Comply with the installation procedure when tightening. Refer to EM-46	C.	Camshaft bracket side
D.	To air duct				

: N·m (kg-m, in-lb)

: Always replace after every disassembly.

: Should be lubricated with oil.

: Sealing point

Removal and Installation

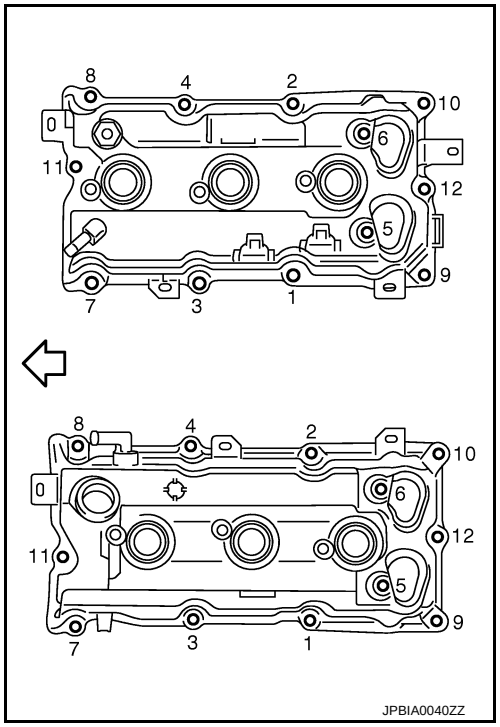
INFOID:0000000008141184

REMOVAL

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

2. Remove air cleaner case and air duct (bank 1 and bank 2). Refer to EM-26, "Exploded View".
3. Remove intake manifold collector. Refer to EM-28, "Exploded View".
4. Disconnect PCV hose from rocker cover.
5. Remove PCV valve and O-ring from rocker cover, if necessary.
6. Remove camshaft position sensor and exhaust valve timing control position sensor.
   CAUTION:
   Never shock camshaft position sensor and exhaust valve timing control position sensor.
7. Remove oil filler cap from rocker cover, if necessary.
8. Remove ignition coil.
   CAUTION:
   Never shock ignition coil. Failure to do this may cause damage to the parts.
9. Loosen bolts in reverse order shown in the figure.

⇦ : Engine front



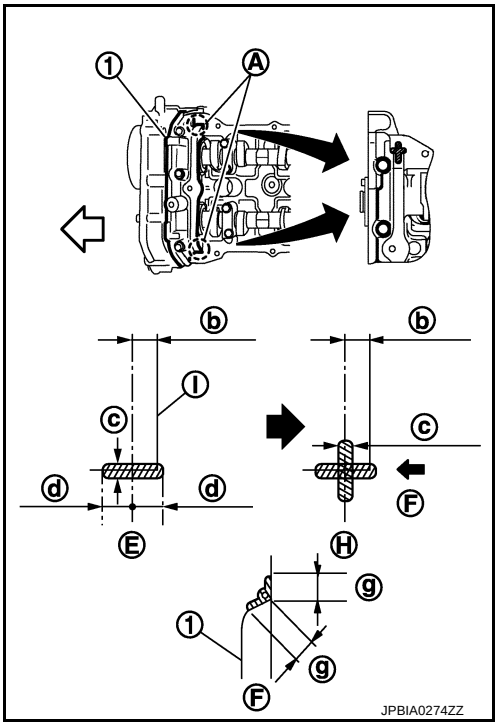
10. Remove rocker cover gasket from rocker cover.

INSTALLATION

CAUTION:
Do not reuse O-rings.

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

A : Liquid gasket application point
F : View F
I : End surface of 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



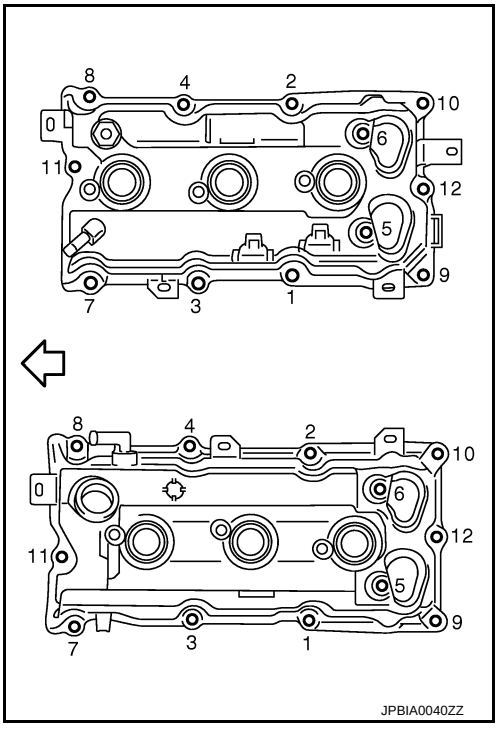
Use Genuine Liquid Gasket or equivalent.

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

2. Install rocker cover gasket to rocker cover.
3. Install rocker cover.
   • Check 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.

⇦ : 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)

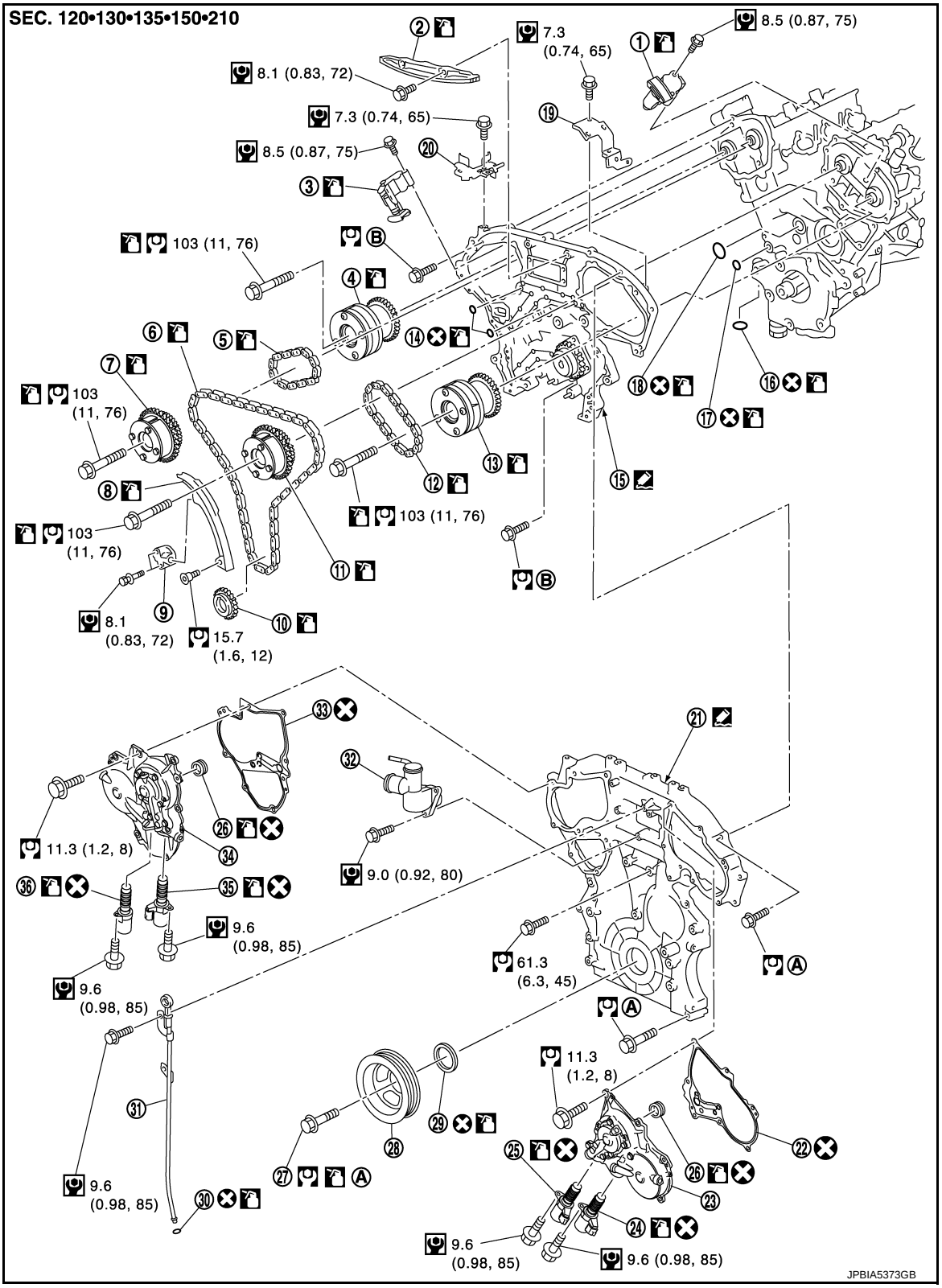


5. Install in the reverse order of removal after this step.

TIMING CHAIN

Exploded View

INFOID:0000000008141185



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

10.	Crankshaft sprocket	11.	Camshaft sprocket (INT)	12.	Timing chain (secondary)
13.	Camshaft sprocket (EXH)	14.	O-ring	15.	Rear timing chain case
16.	O-ring	17.	O-ring	18.	O-ring
19.	Bracket	20.	Bracket	21.	Front timing chain case
22.	Valve timing control cover gasket (bank 2)	23.	Valve timing control cover (bank 2)	24.	Exhaust valve timing control solenoid valve (bank 2)
25.	Intake valve timing control solenoid valve (bank 2)	26.	Seal ring	27.	Crankshaft pulley bolt
28.	Crankshaft pulley	29.	Front oil seal	30.	O-ring
31.	Oil level gauge guide	32.	Water outlet (front)	33.	Valve timing control cover gasket (bank 1)
34.	Valve timing control cover (bank 1)	35.	Intake valve timing control solenoid valve (bank 1)	36.	Exhaust valve timing control solenoid valve (bank 1)
A.	Comply with the installation procedure when tightening. Refer to EM-50.	B.	Comply with the installation procedure when tightening. Refer to EM-92		

: N·m (kg-m, ft-lb)

: N·m (kg-m, in-lb)

: Always replace after every disassembly.

: Should be lubricated with oil.

: Sealing point

Removal and Installation

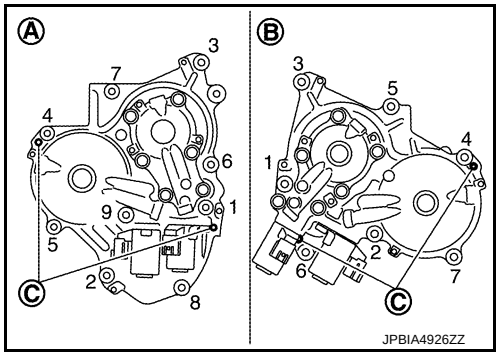
INFOID:0000000008141186

REMOVAL

1. Release the fuel pressure. Refer to EC-115, "Work Procedure".
2. Disconnect the 12V battery cable from the negative terminal.
3. Remove engine cover. Refer to EM-25, "Exploded View".
4. Remove radiator reservoir tank. Refer to CO-13, "Exploded View".
5. Remove air duct and air cleaner case assembly (bank 1 and bank 2). Refer to EM-26, "Exploded View".
6. Remove engine undercover, using a power tool.
7. Drain engine coolant from radiator. Refer to CO-7, "Draining".
   CAUTION:
   - **Perform this step when the engine is cold.**
8. Remove radiator hose (upper and lower). Refer to CO-13, "Exploded View".
9. Drain engine oil. Refer to LU-8, "Draining".
   CAUTION:
   - **Perform this step when the engine is cold.**
10. Remove radiator cooling fan assembly. Refer to CO-17, "Exploded View".
11. Separate engine harnesses removing their brackets from front timing chain case.
12. Remove intake manifold collector. Refer to EM-28, "Exploded View".
13. Remove intake manifold. Refer to EM-31, "Exploded View".
14. Remove fuel sub tube mounting bolt. Refer to EM-37, "Exploded View".
15. Remove oil level gauge and oil level gauge guide.
16. Remove water outlet (front) and water piping. Refer to CO-24, "Exploded View".
17. Remove valve timing control covers (bank 1 and bank 2) and gasket as follows:

a. Disconnect valve timing control harness connector.

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



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

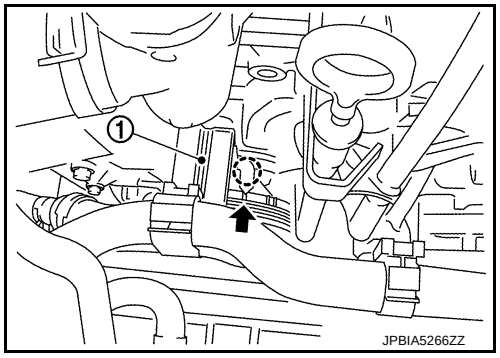
CAUTION:
Shaft is internally jointed with camshaft sprocket center hole. When removing, keep it horizontal until it is completely disconnected.

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

18. Remove rocker covers (bank 1 and bank 2). Refer to EM-46, "Exploded View".

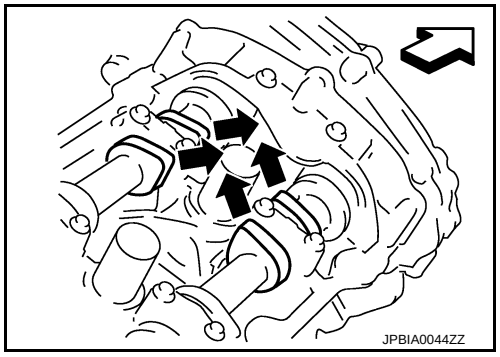
19. Obtain No. 1 cylinder at TDC of its compression stroke as follows:

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



1. Heater pipe bracket
⬅ : Timing mark (grooved line without color)

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

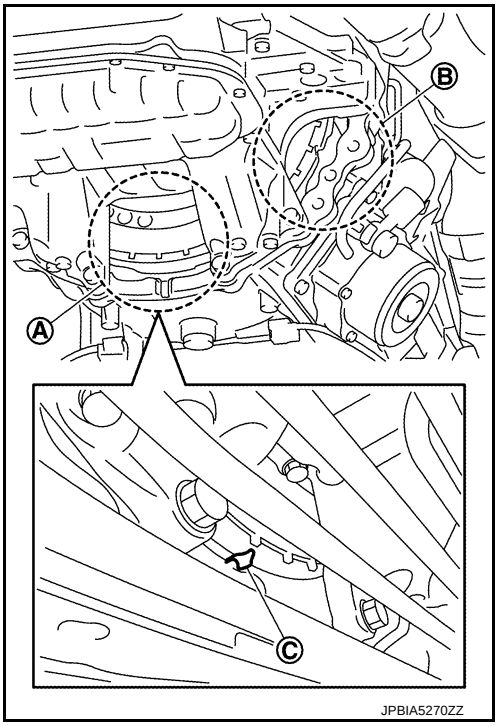


⇦ : Engine front

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

20. Remove crankshaft pulley as follows:

a. Remove the plate of transmission joint (A) or (B) and turn the flywheel to a position where the notch (C) on the flywheel becomes visible.

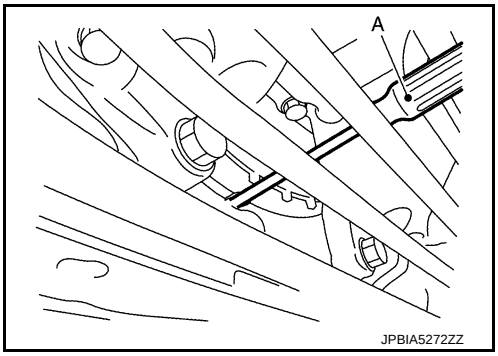


b. Place a flat-blade screwdriver (A) in the notch of flywheel as shown in the figure and turn the crankshaft pulley in the loosening direction until it reaches the oil pan (upper).

CAUTION:

Since the notch is not deep enough, securely fix the flywheel with a flat-blade screwdriver.

c. After checking that the flywheel is securely fixed, turn the crankshaft pulley in the loosening direction to loosen crankshaft pulley bolt.

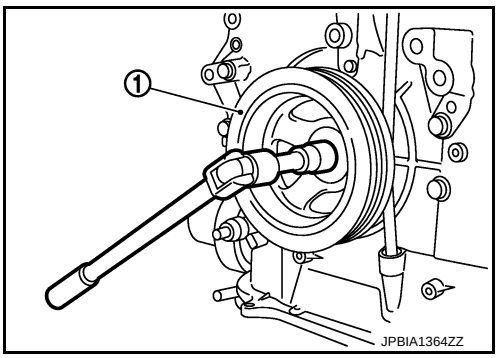


d. Loosen crankshaft pulley bolt and rotate bolt seating surface at 10 mm (0.39 in) from its original position.

1 : Crankshaft pulley

CAUTION:

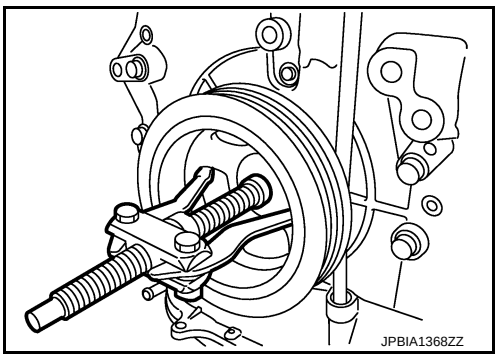
Never remove crankshaft pulley bolt as it will be used as a supporting point for suitable puller.



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

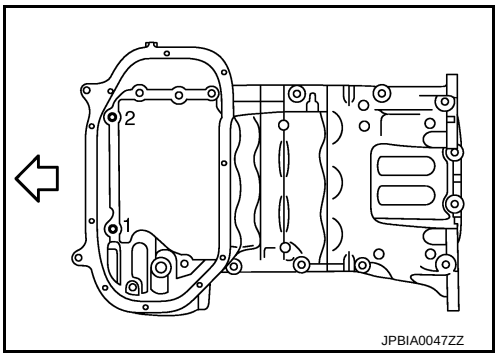
CAUTION:

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



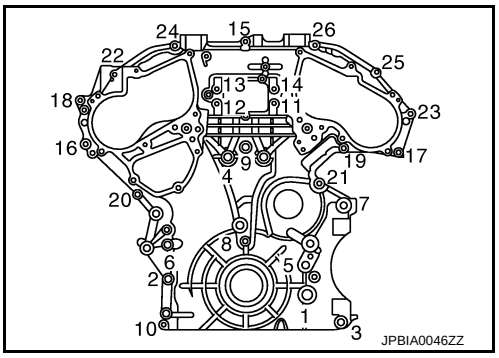
21. Remove oil pan (lower). Refer to EM-43, "Exploded View".
22. Loosen two mounting bolts in front of oil pan (upper), using a power tool in reverse order as shown in the figure.

⇦ : Engine front



23. Remove front timing chain case as follows:

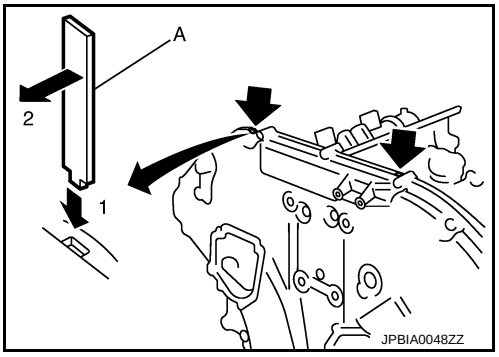
a. Loosen mounting bolts in reverse order as shown in the figure.



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

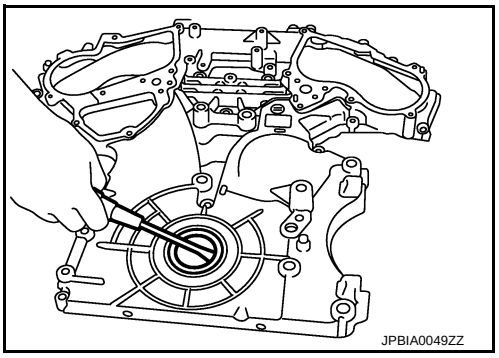
c. Pry off case by moving the suitable tool as shown.
- Use the seal cutter [SST: KV10111100] to cut liquid gasket for removal.

CAUTION:
- **Never use a screwdriver or something similar. Failure to do this may cause damage to the parts.**
- **After removal, handle front timing chain case carefully so it does not tilt, cant, or warp under a load.**



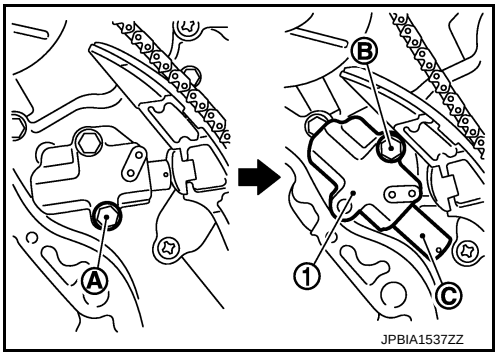
24. Remove front oil seal from front timing chain case using a suitable tool.
- Use a screwdriver for removal.

CAUTION:
Never damage front timing chain case.

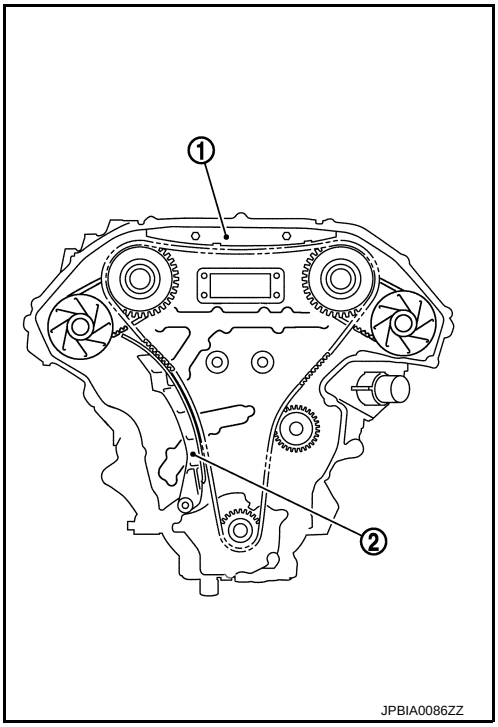


25. Remove timing chain tensioner (primary) as follows:

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 is not dropped from the body of timing chain tensioner (primary).
c. Remove upper mounting bolt, and then remove timing chain tensioner (primary).



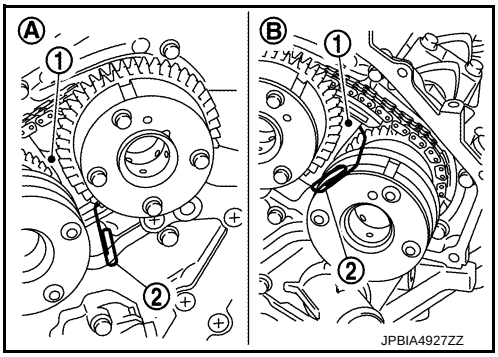
26. Remove internal chain guide (1) and slack guide (2).



27. Remove timing chain (primary) and crankshaft sprocket.
CAUTION:
After removing timing chain tensioner (primary), never turn crankshaft and camshaft separately, or valves will strike the piston heads.
28. Remove timing chain (secondary) and camshaft sprockets as follows:
a. Attach suitable stopper pin (2) to the timing chain tensioners (secondary) (1).

A : Bank 1
B : Bank 2

NOTE:
- Use approximately 0.5 mm (0.02 in) dia. hard metal pin as a stopper pin.
- For removal of timing chain tensioners (secondary), refer to EM-65, "Exploded View". [Removing camshaft bracket (No. 1) is required.]



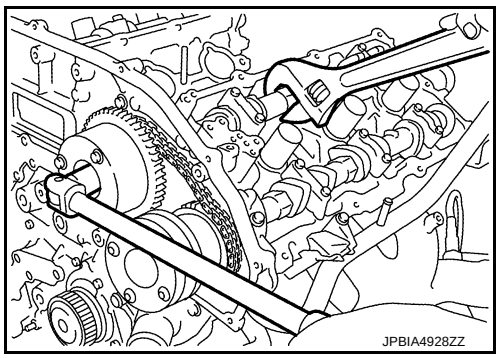
b. Remove camshaft sprocket mounting bolts (INT and EXH).

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

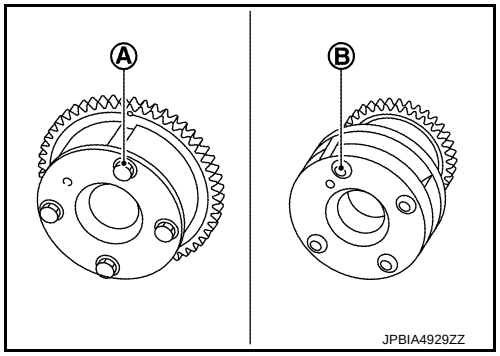
c. Remove timing chain (secondary) together with camshaft sprockets.

CAUTION:

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



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



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

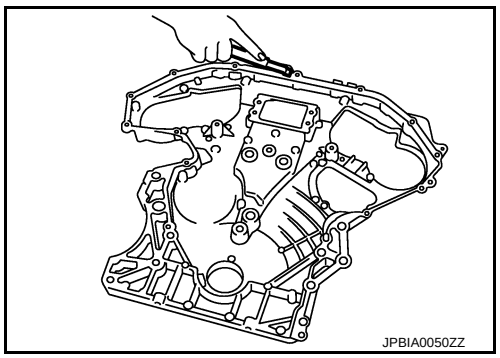
a. Remove camshaft brackets (No. 1). Refer to EM-65, "Exploded View".

b. Remove timing chain tensioners (secondary) with a stopper pin attached.

30. 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.

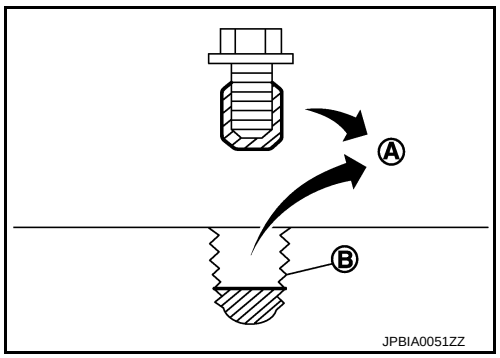
CAUTION:

Never allow gasket fragments to enter oil pan.



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

A : Remove sticking old liquid gasket
B : Bolt hole



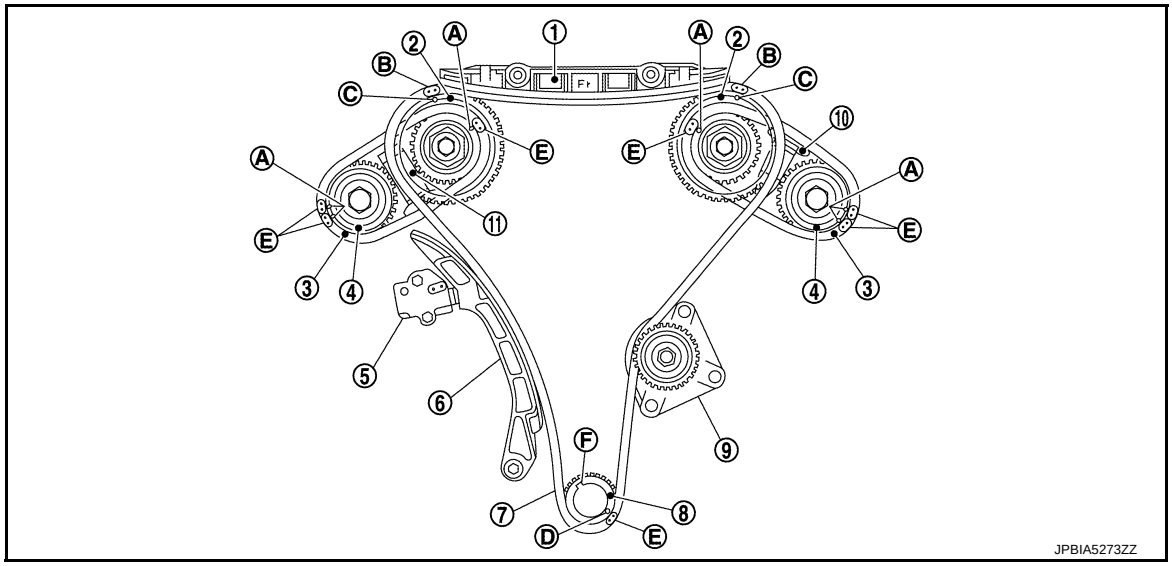
INSTALLATION

CAUTION:

Do not reuse O-rings.

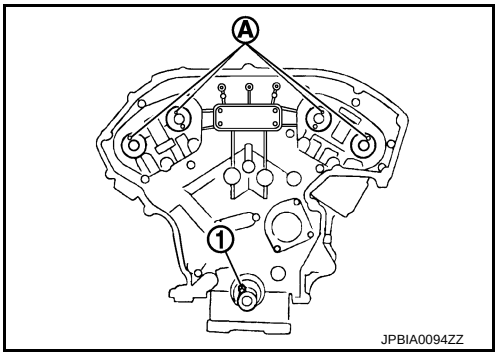
NOTE:

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



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

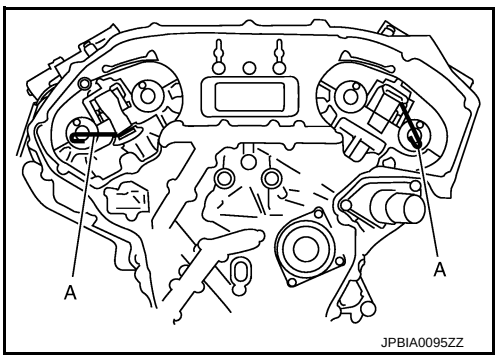
1. Install timing chain tensioners (secondary) to cylinder head as follows if removed. Refer to EM-65, "Exploded View".
2. Check that dowel pin (A) and crankshaft key (1) are located as shown in the figure. (No. 1 cylinder at compression TDC)
NOTE:
Though camshaft does not stop at the position as shown in the figure, for the placement of cam noses, it is generally accepted camshaft is placed for the same direction of the figure.



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

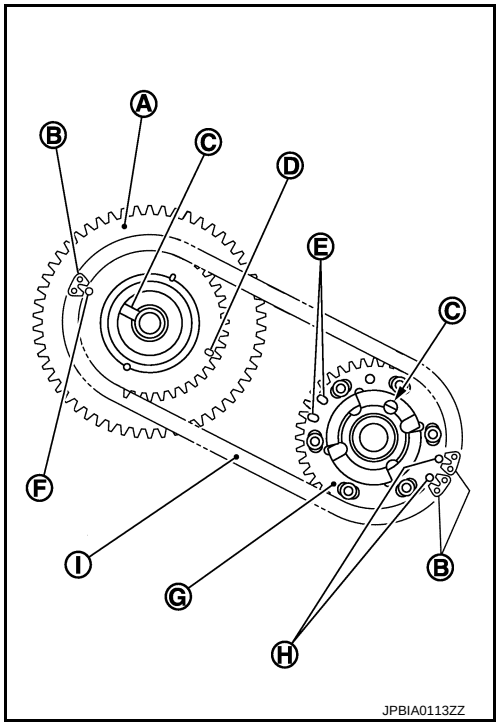
3. Install timing chains (secondary) and camshaft sprockets as follows:
CAUTION:
Matching marks between timing chain and sprockets slip easily. Confirm all matching mark positions repeatedly during the installation process.

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



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

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

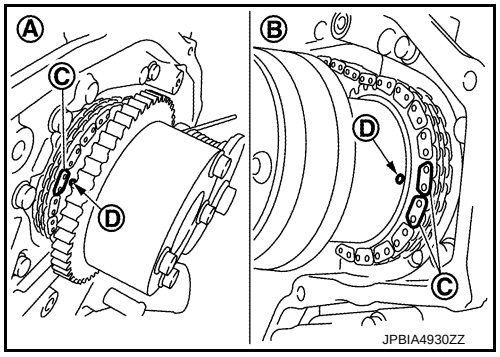


A : Camshaft sprocket (INT) back face
B : Orange link
C : Dowel groove or hole
D : Matching mark (Oval)
E : Matching mark (2 oval)
F : Matching mark (circle)
G : Camshaft sprocket (EXH) back face
H : Matching mark (2 circle)
I : Timing chain (secondary)

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

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

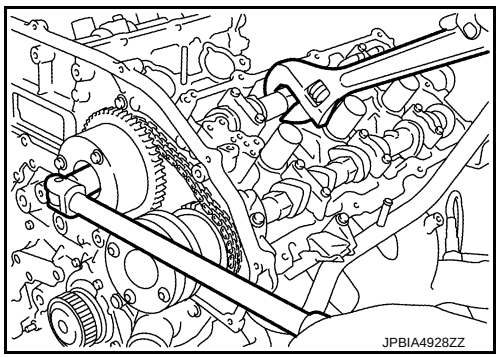
- Align dowel pin camshafts with the groove or dowel hole on sprockets, and install them.
- On the intake side, align dowel pin on camshaft front end with pin groove on the back side of camshaft sprocket, and install them.
- On the exhaust side, align dowel pin on camshaft front end with pin hole on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



A : Intake side
B : Exhaust side

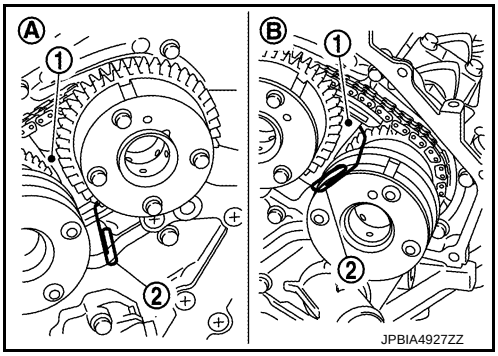
NOTE:
Matching mark (punched) in the figure is for checking loose at this step.

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



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

A : Bank 1
B : Bank 2

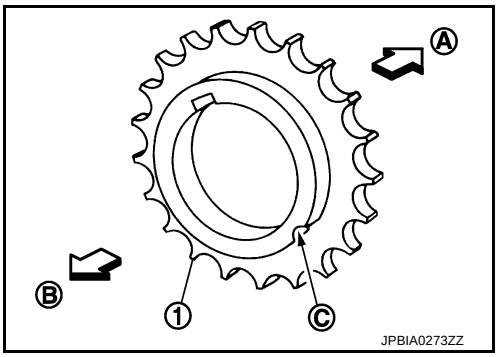


4. Install timing chain (primary) as follows:

a. Install crankshaft sprocket (1).

A : Crankshaft side
B : Engine front
C : Matching mark (Front side)

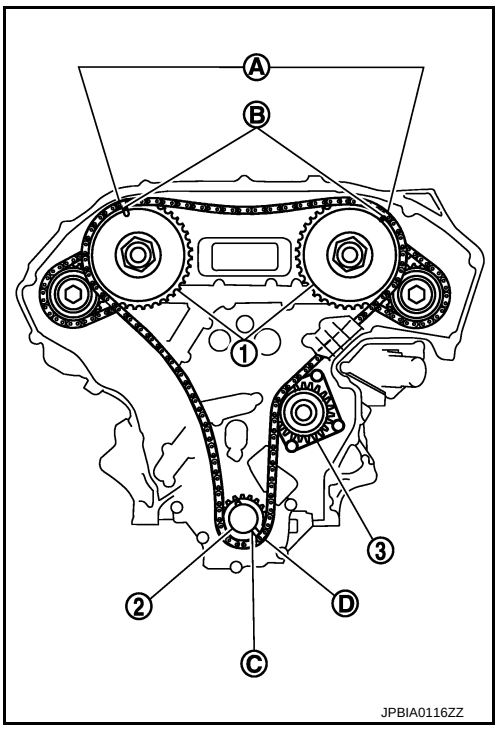
- Check the matching marks on crankshaft sprocket face the front of the engine.



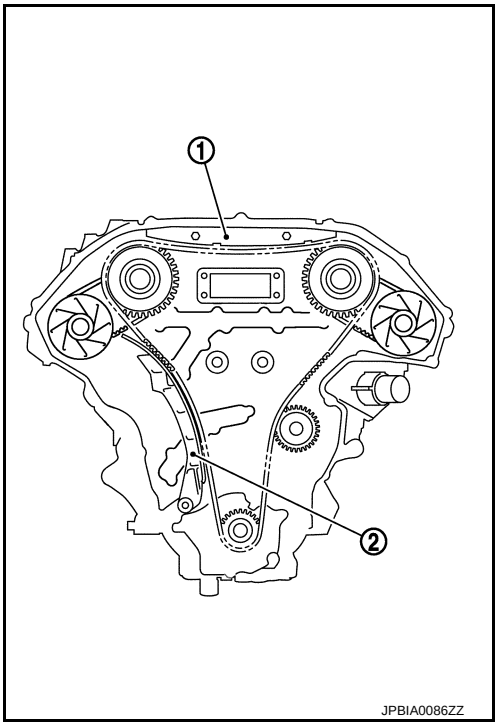
b. Install timing chain (primary).
- Install timing chain (primary) so the matching mark (punched) (B) on camshaft sprocket (INT) (1) is aligned with the yellow link (A) on timing chain, while the matching mark (notched) (C) on crankshaft sprocket (2) is aligned with the orange link (D) one on timing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

3 : Water pump

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

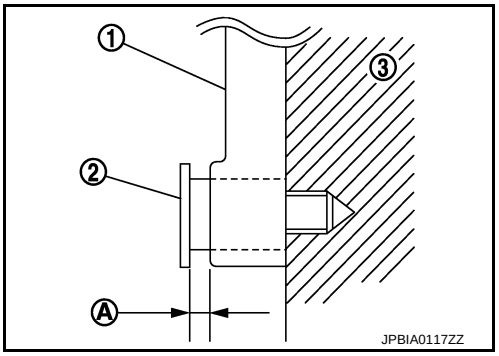


5. Install internal chain guide (1) and slack guide (2).



CAUTION:
Never overtighten slack guide (1) mounting bolts (2). It is normal for a gap (A) to exist under the bolt seats when mounting bolts are tightened to the specification.

3 : Cylinder block



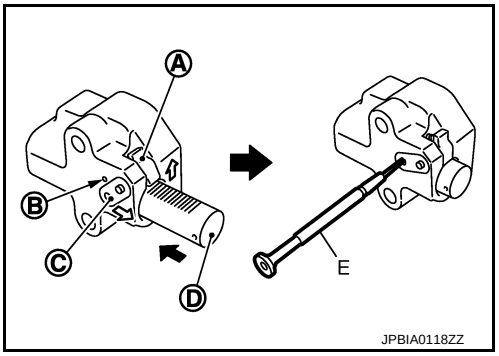
6. Install the timing chain tensioner (primary) with the following procedure:

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

b. Push plunger into the inside of tensioner body.

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

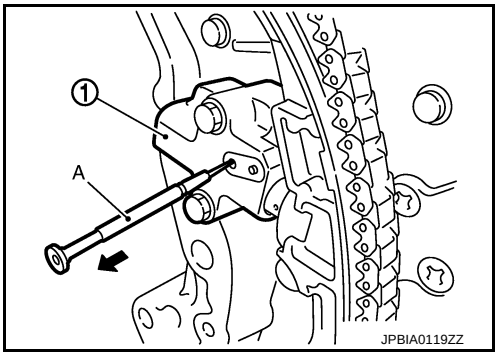
d. To secure lever, insert stopper pin (E) through hole of lever into tensioner body hole (B).
- The lever parts and the plunger stopper tab are synchronized. Therefore, the plunger will be secured under this condition.



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

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

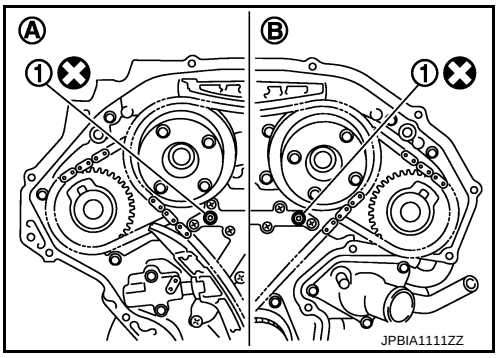
f. Pull out stopper pin (A) after installing, and then release plunger.



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

A : Bank 1
B : Bank 2

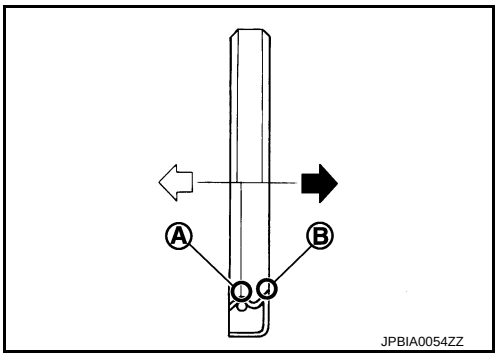
CAUTION:
Do not reuse O-rings.



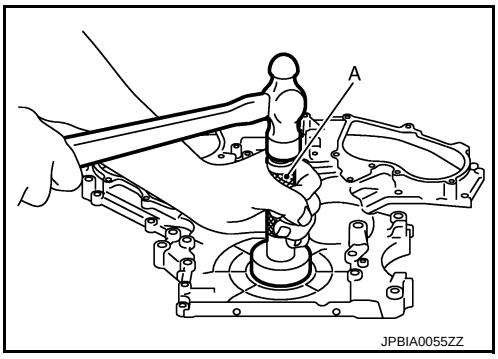
9. Install new front oil seal on front timing chain case.
- Apply new engine oil to both oil seal lip (A) and dust seal lip (B).

⇦ : Engine inside
⬅ : Engine outside

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



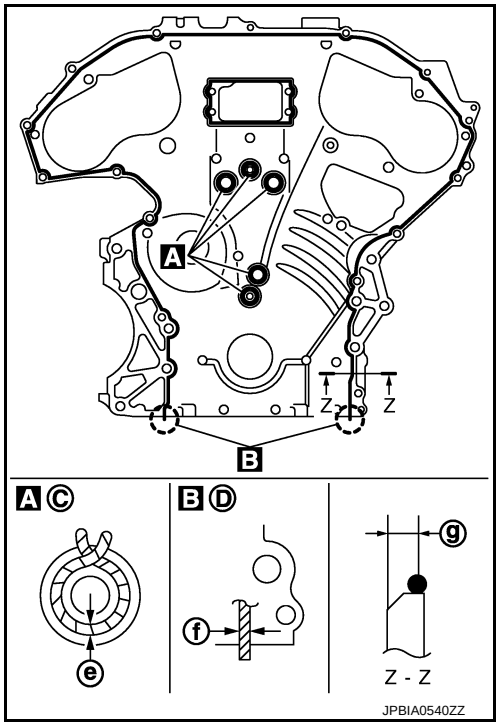
- Using a suitable drift [outer diameter: 60 mm (2.36 in)] (A), press-fit oil seal until it becomes flush with front timing chain case end face.
- Check the garter spring is in position and seal lip is not inverted.



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

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 RTV Silicone Sealant or equivalent. Refer to GI-23, "Recommended Chemical Products and Sealants".

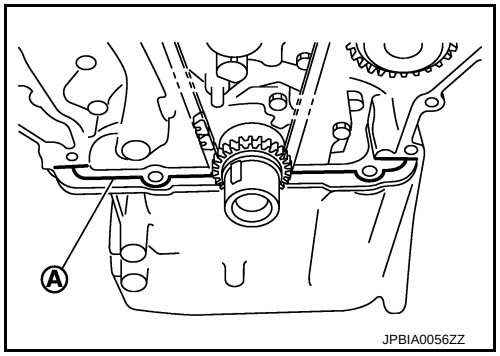
C : Bolt hole
D : Protrusion
e : ϕ2.6 - 3.6 mm (0.102 - 0.142 in)
f : ϕ3.4 - 4.4 mm (0.134 - 0.173 in)
g : 4.0 - 5.6 mm (0.157 - 0.220 in)



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)

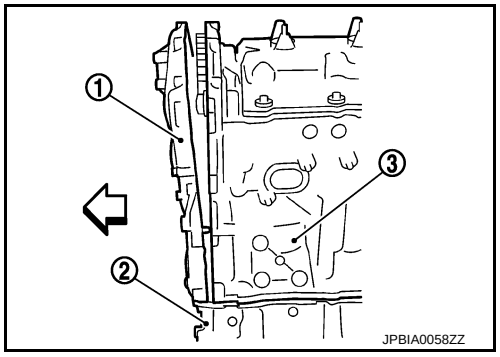
Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-23, "Recommended Chemical Products and Sealants".



c. Assemble front timing chain case.

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

CAUTION:
- **Never damage front oil seal by interference with front end of crankshaft.**
- **Attaching should be done within 5 minutes after liquid gasket application.**



d. Install front timing chain case as to fit its dowel pin hole together dowel pin on rear timing chain case.
e. Tighten mounting bolts to the specified torque in numerical order as shown in the figure.

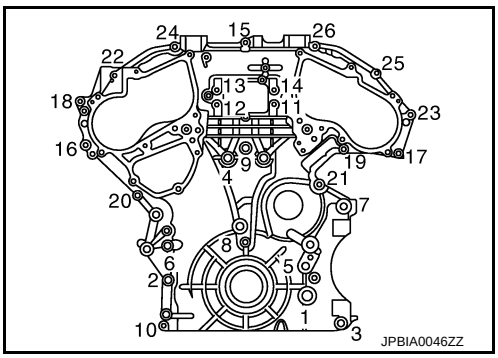
- There are two types of mounting bolts. Refer to the following for locating bolts.

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

: 55.0 N·m (5.6 kg-m, 41 ft-lb)

M6 bolts : Except the above

: 12.7 N·m (1.3 kg-m, 9 ft-lb)



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

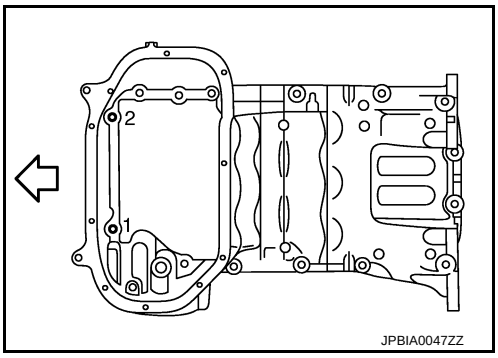
CAUTION:

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

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

⇦ : Engine front

Tightening torque : Refer to EM-88, "Exploded View".



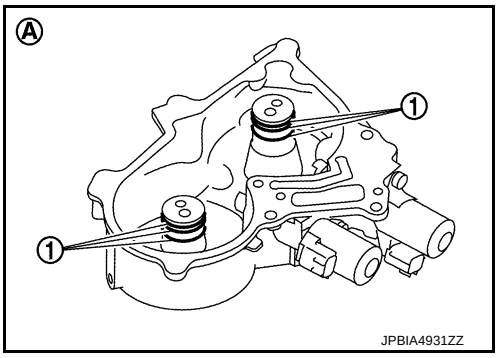
11. Install valve timing control covers (bank 1 and bank 2) as follows:

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

A : Bank 2

CAUTION:

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



b. Install 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 camshaft sprocket, and then insert them.**
- **Never 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 holes to install valve timing control covers.

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

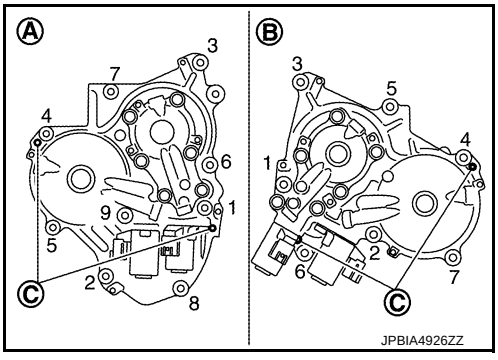
A : Bank 1

B : Bank 2

C : Dowel pin hole

Tightening torque : Refer to EM-49, "Exploded View".

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

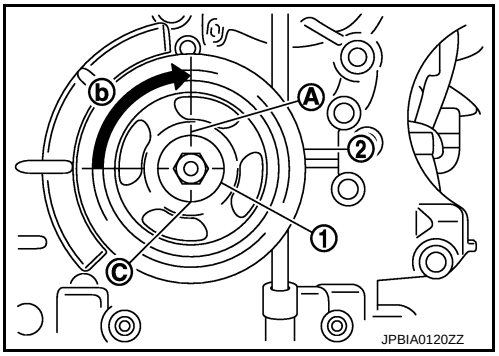


12. Install oil pan (lower). Refer to EM-43, "Exploded View".
13. Install rocker covers (bank 1 and bank 2). Refer to EM-46, "Exploded View".
14. Install crankshaft pulley as follows:

a. Fix the crankshaft in the same way as in removal.
b. Install crankshaft pulley, taking care not to damage front oil seal.
   • When press-fitting crankshaft pulley with plastic hammer, tap on its center portion (not circumference).
c. Tighten crankshaft pulley bolt.

: 44.1 N·m (4.5 kg-m, 33 ft-lb)

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



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

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

Inspection

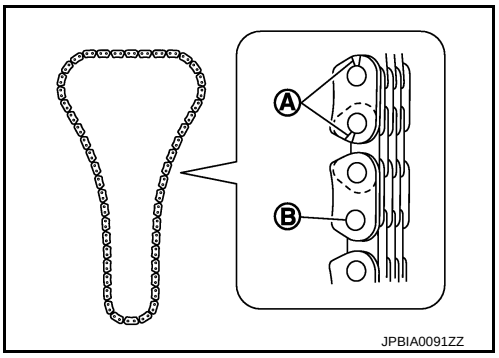
INFOID:0000000008141187

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 fluids leakage, lubricates leakage.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to MA-10, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.

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

- Warm up engine thoroughly to check there is no leakage of fuel, or any oil/fluids including engine oil and engine coolant.
  NOTE:
  Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-89, "Description".
- 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:

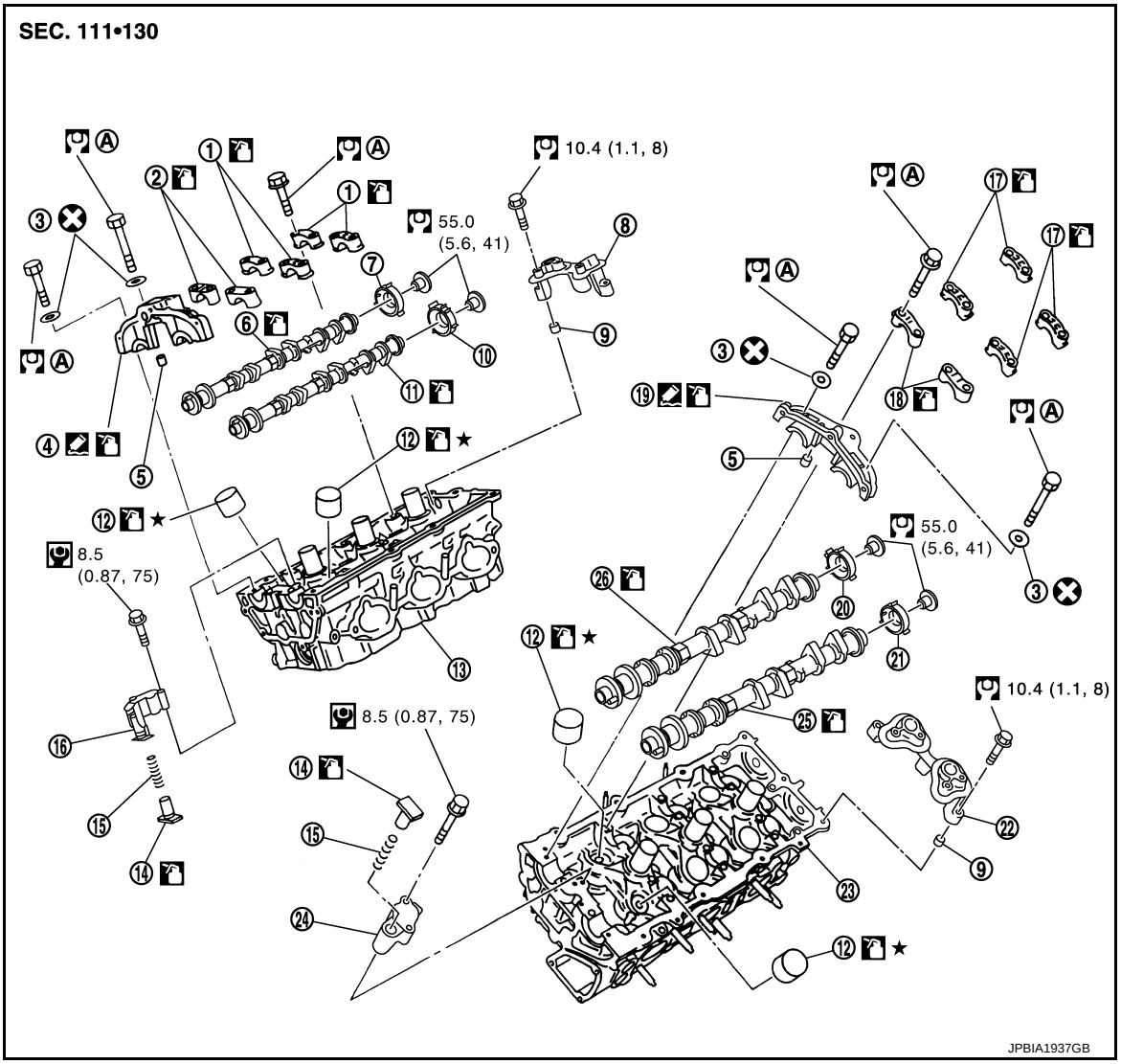
Items		Before starting engine	Engine running	After engine stopped
Engine coolant		Level	Leakage	Level
Engine oil		Level	Leakage	Level
Transmission / transaxle fluid	AT & CVT Models	Leakage	Level / Leakage	Leakage
	MT Models	Level / Leakage	Leakage	Level / Leakage
Other oils and fluids*		Level	Leakage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

*: Power steering fluid, brake fluid, etc.

CAMSHAFT

Exploded View

INFOID:0000000008141188



1.	Camshaft bracket (No. 3, 4)	2.	Camshaft bracket (No. 2)	3.	Seal washer
4.	Camshaft bracket (No. 1) (bank 1)	5.	Dowel pin	6.	Camshaft (EXH) (bank 1)
7.	Camshaft signal plate (EXH)	8.	Camshaft sensor bracket (bank 1)	9.	Dowel pin
10.	Camshaft signal plate (INT)	11.	Camshaft (INT) (bank 1)	12.	Valve lifter
13.	Cylinder head (bank 1)	14.	Plunger	15.	Spring
16.	Timing chain tensioner (secondary) (bank 1)	17.	Camshaft bracket (No. 3, 4)	18.	Camshaft bracket (No. 2)
19.	Camshaft bracket (No. 1) (bank 2)	20.	Camshaft signal plate (INT)	21.	Camshaft signal plate (EXH)
22.	Camshaft sensor bracket (bank 2)	23	Cylinder head (bank 2)	24	Timing chain tensioner (secondary) (bank 2)
25	Camshaft (EXH) (bank 2)	26	Camshaft (INT) (bank 2)		
A.	Comply with the assembly procedure when tightening. Refer to EM-66.				

: N·m (kg-m, ft-lb)

: N·m (kg-m, in-lb)

: Always replace after every disassembly.

: Should be lubricated with oil.

: Sealing point

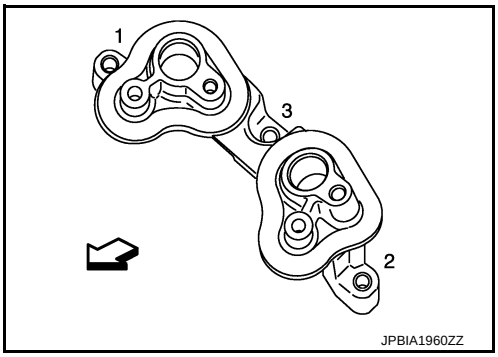
★ : Select with proper thickness.

Removal and Installation

INFOID:0000000008141189

REMOVAL

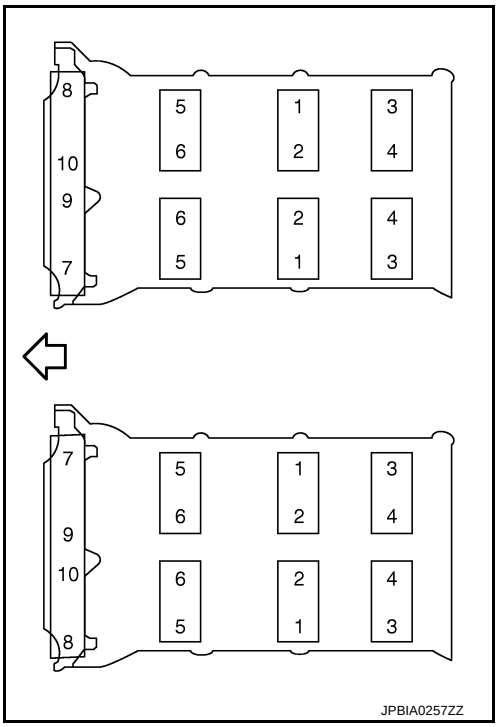
1. Remove front timing chain case, camshaft sprocket and timing chain. Refer to EM-49, "Exploded View".
2. Remove fuel sub tube. Refer to EM-37, "Exploded View".
3. Loosen camshaft sensor bracket bolts in reverse order as shown in the figure.



⇦ : Engine front

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

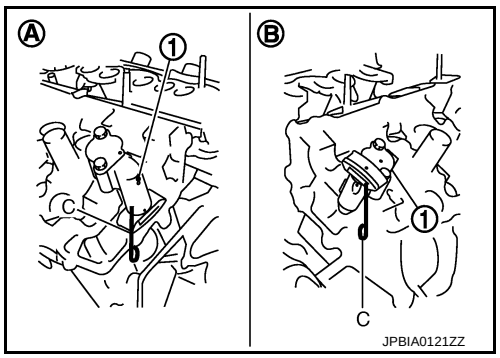
4. Remove camshaft brackets.
   - Mark camshafts, camshaft brackets and bolts so they are placed in the same position and direction for installation.
   - Equally loosen camshaft bracket bolts in several steps in reverse order as shown in the figure.



⇦ : Engine front

5. Remove camshaft.
6. Remove valve lifter.
   - Identify installation positions, and store them without mixing them up.

7. Remove timing chain tensioners (secondary) (1) from cylinder head.



A : Bank 1
B : Bank 2

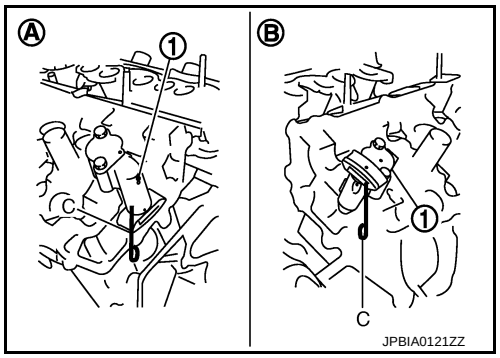
- Remove timing chain tensioners (secondary) with its stopper pin (C) attached.

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

INSTALLATION

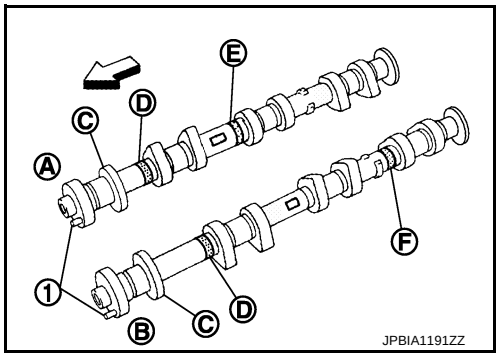
CAUTION:
Do not reuse washers.

1. Install timing chain tensioners (secondary) on both sides of cylinder head.
   - Install timing chain tensioners (1) with its stopper pin (C) attached.



Bank 1 side (A) : Sliding part facing downward
Bank 2 side (B) : Sliding part facing upward

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



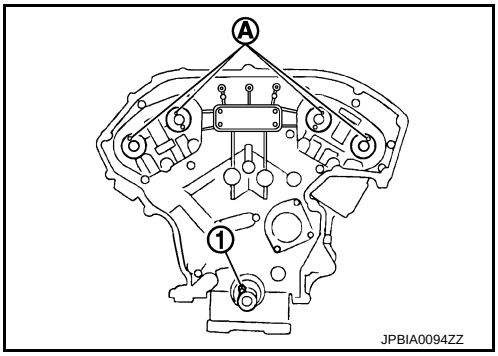
⇦ : Engine front

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

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

1 : Crankshaft key

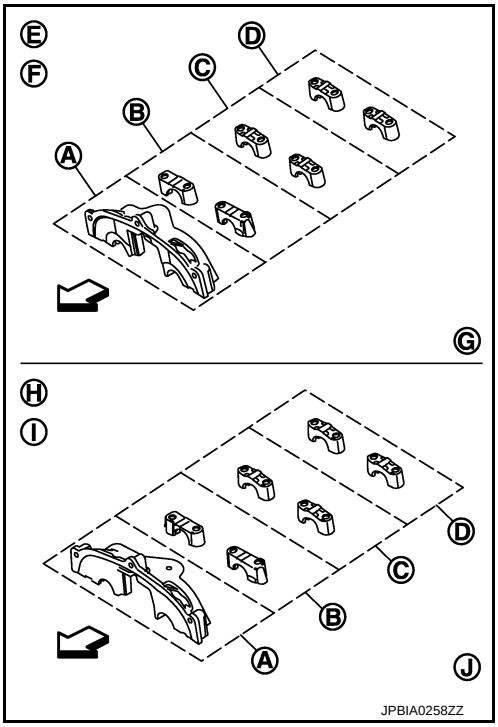
NOTE:
Though camshaft does not stop at the portion as shown in the figure, for the placement of cam nose, it is generally accepted camshaft is placed for the same direction of the figure.



4. Install camshaft brackets.

A : No. 1
B : No. 2
C : No. 3
D : No. 4
E : Bank 1
F : Exhaust side
G : Intake side
H : Bank 2
I : Intake side
J : Exhaust side
⇦ : Engine front

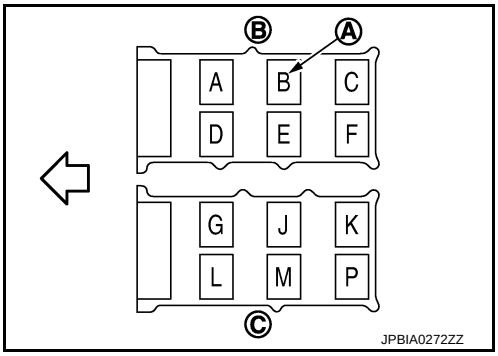
- Remove foreign material completely from camshaft bracket backside and from cylinder head installation face.
- Install camshaft bracket in original position and direction as shown in figure.



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

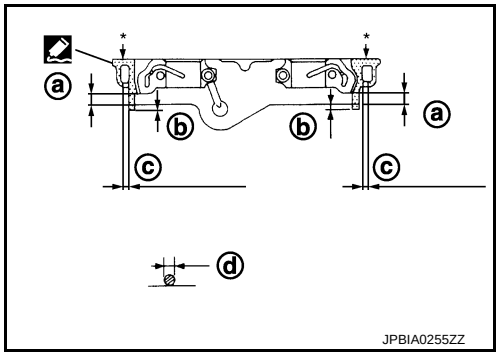
B : Bank 1
C : Bank 2
⇦ : Engine front

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



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

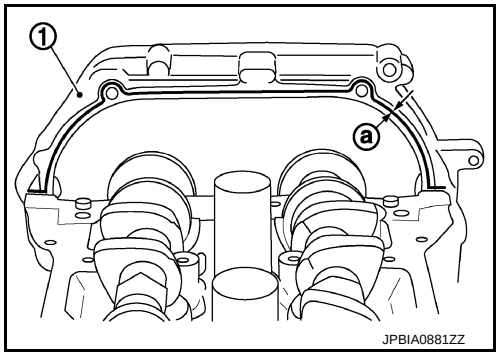
a : 8.5 mm (0.335 in)
b : 2 mm (0.08 in)
c : Clearance 5 mm (0.20 in)
d : ϕ2.5 mm (0.098 in)
* : Apply liquid gasket to rear timing chain side



Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-23, "Recommended Chemical Products and Sealants".

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

1 : Rear timing chain case
a : ϕ3.9 mm (0.154 in)



Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-23, "Recommended Chemical Products and Sealants".

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

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

⇦ : Engine front

CAUTION:
Do not reuse washers.

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

: 1.96 N·m (0.20 kg-m, 1 ft-lb)

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

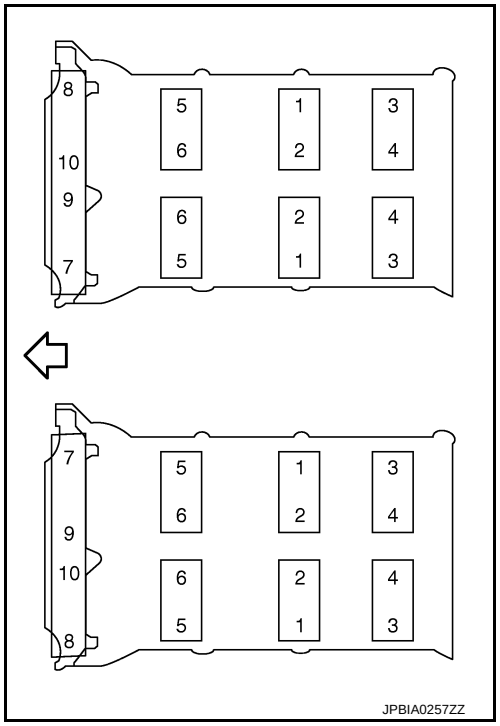
: 1.96 N·m (0.20 kg-m, 1 ft-lb)

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

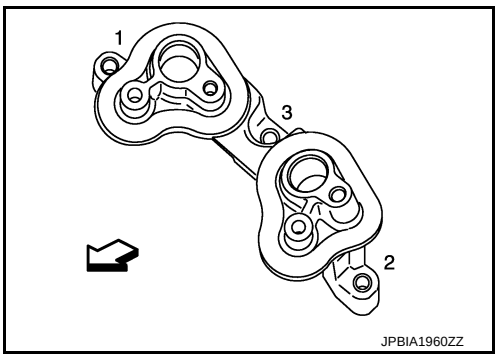
: 5.88 N·m (0.60 kg-m, 4 ft-lb)

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

: 10.4 N·m (1.1 kg-m, 8 ft-lb)



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



⇦ : Engine front

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

7. Inspect and adjust the valve clearance. Refer to EM-17, "Inspection and Adjustment".
8. Install in the reverse order of removal after this step.

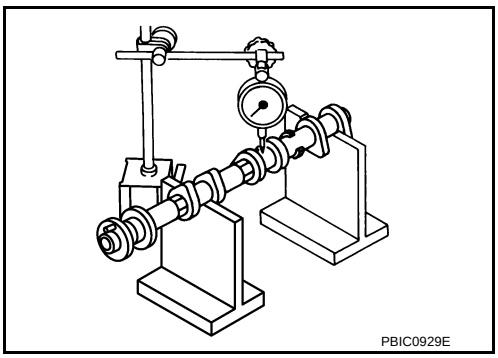
Inspection

INFOID:0000000008141190

INSPECTION AFTER REMOVAL

Camshaft 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 to one direction with hands, and measure the camshaft runout on a dial indicator. (Total indicator reading)



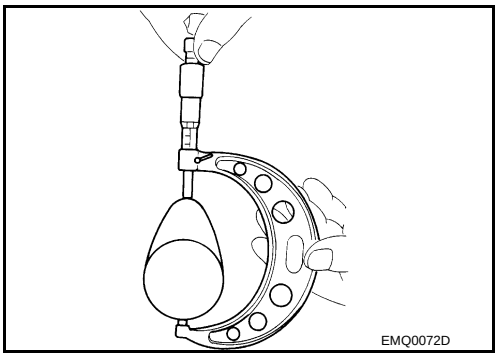
Standard and limit : Refer to EM-135, "Camshaft".

4. If it exceeds the limit, replace camshaft.

Camshaft Cam Height

1. Measure the camshaft cam height with a micrometer.

Standard cam height
(Intake and exhaust) : Refer to EM-135, "Camshaft".
Cam wear limit



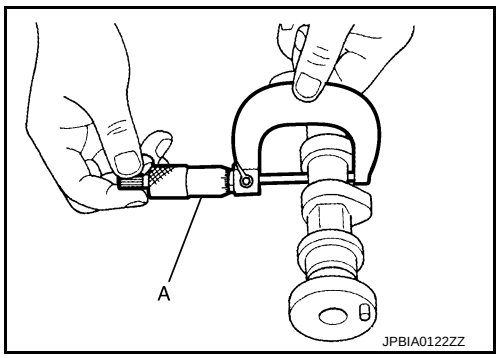
2. If wear exceeds the limit, replace camshaft.

Camshaft Journal Oil Clearance

CAMSHAFT JOURNAL DIAMETER

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

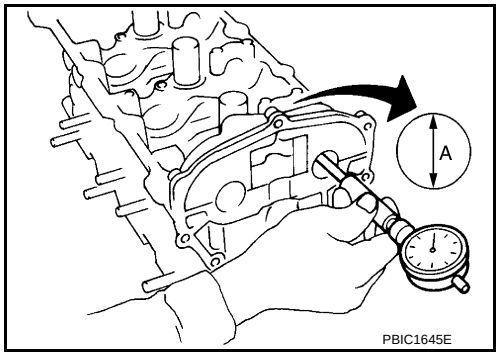
Standard : Refer to EM-135, "Camshaft".



CAMSHAFT BRACKET INNER DIAMETER

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

Standard : Refer to EM-135, "Camshaft".



CAMSHAFT JOURNAL OIL CLEARANCE

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

Standard and limit : Refer to EM-135, "Camshaft".

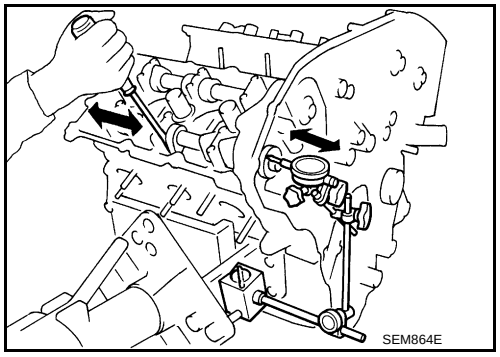
- If the calculated value exceeds the limit, replace either or both camshaft and cylinder head.

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

Camshaft End Play

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

Standard and limit : Refer to EM-135, "Camshaft".



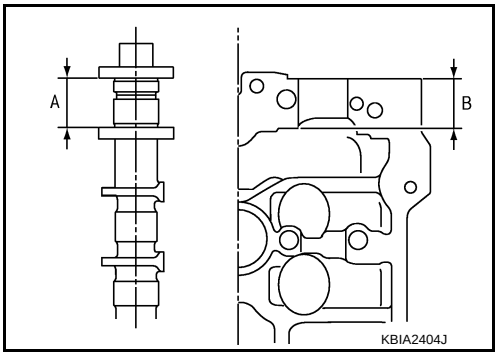
- Measure the following parts if out of the limit.
- Dimension “A” for camshaft No. 1 journal

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

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

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

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

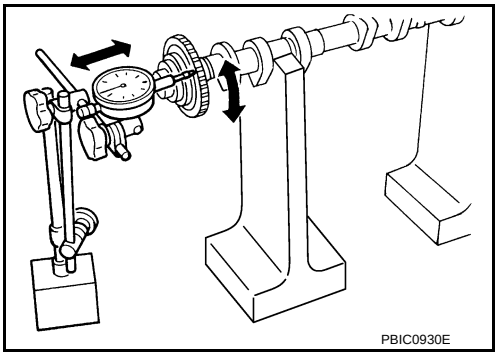


Camshaft Sprocket Runout

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

Limit : Refer to EM-135, "Camshaft".

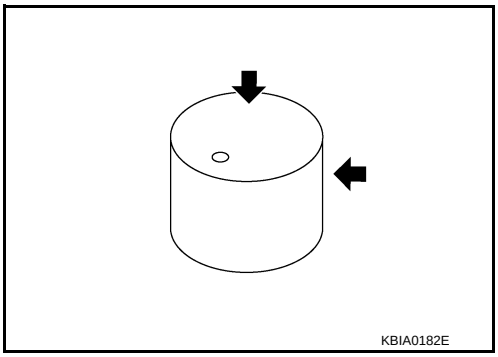
- If it exceeds the limit, replace camshaft sprocket.



Valve Lifter

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

- If anything above is found, replace valve lifter. Refer to EM-135, "Camshaft".

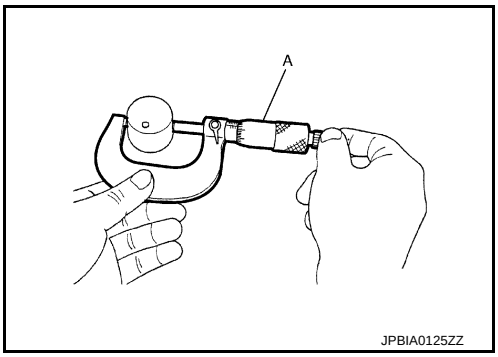


Valve Lifter Clearance

VALVE LIFTER OUTER DIAMETER

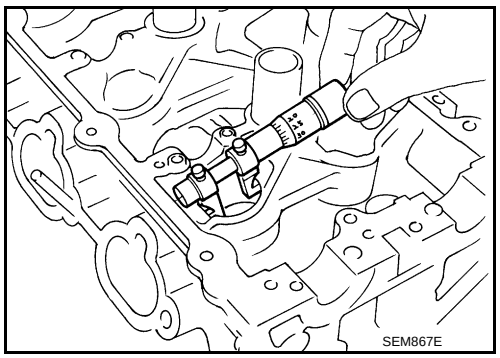
- Measure the outer diameter at 1/2 height of valve lifter with a micrometer (A) since valve lifter is in barrel shape.

Standard (Intake and exhaust) : Refer to EM-135, "Camshaft".



VALVE LIFTER HOLE DIAMETER

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



Standard (Intake and exhaust)	**: Refer to EM-135, "Camshaft".**

VALVE LIFTER CLEARANCE

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

Standard (Intake and exhaust)	**: Refer to EM-135, "Camshaft".**

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

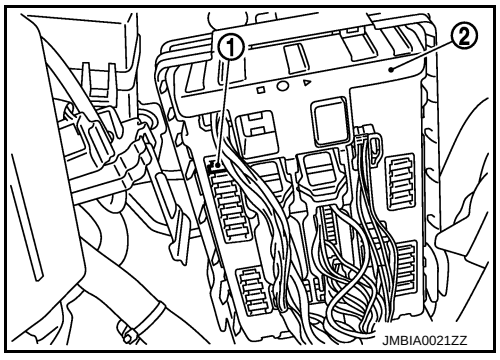
INSPECTION AFTER INSTALLATION

Inspection of Camshaft Sprocket (INT) Oil Groove

CAUTION:

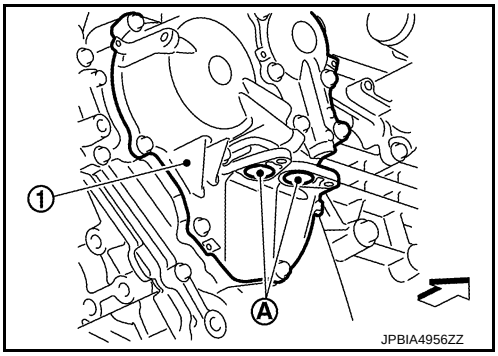
- **Perform this inspection only when DTC P0011, P0021, P0014, P0024 is detected in self-diagnostic results of CONSULT and it is directed according to inspection procedure of EC section. Refer to EC-146, "DTC Logic" (P0011, P0021) or EC-150, "DTC Logic" (P0014, P0024).**
- **Check when engine is cold so as to prevent burns from the splashing engine oil.**

1. Check engine oil level. Refer to LU-7, "Inspection".
2. Turn ignition switch to “START” for cranking.
   - With CONSULT
   - Remove intake/exhaust valve timing control solenoid valve. Refer to EM-49, "Exploded View"
   - Connect CONSULT and select “ACTIVE TEST” mode in “EV/HEV” to perform “ENGINE CRANKING” Refer to HBC-49, "CONSULT Function".
   - Without CONSULT
   - Release the fuel pressure. Refer to EC-115, "Work Procedure".
   - Disconnect fuel pump fuse (1) from IPDM E/R (2) to avoid fuel injection during measurement.



   - Remove intake/exhaust valve timing control solenoid valve. Refer to EM-49, "Exploded View".
   - Perform maintenance mode 5 for cranking.

3. 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 1)

⇦ : Engine front

WARNING:
Never touch rotating parts. (crankshaft pulley, etc.)
CAUTION:
- **Prevent splashing by using a shop cloth so as to prevent the worker from injury from engine oil and so as to prevent engine oil contamination.**
- **Use waste to protect the engine and vehicle from the splattering of engine oil. Special care must be taken on the protection of rubber parts, such as engine mount insulator. If engine oil splatters to the rubber parts, immediately wipe it out.**

4. 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 LU-10, "Removal and Installation".
   - Clean oil groove between oil strainer and intake valve timing control solenoid valve. Refer to LU-6, "Engine Lubrication System".
5. Remove components between intake valve timing control solenoid valve and camshaft sprocket, and then check each oil groove for clogging.
   - Clean oil groove if necessary. Refer to LU-6, "Engine Lubrication System".
6. After inspection, install removed parts in the reverse order.

Inspection for Leakage

The following are procedures for checking fluids leakage, lubricates leakage.
- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to MA-10, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.

  NOTE:
  Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-89, "Description".
- Run engine to check for unusual noise and vibration.

  NOTE:
  If hydraulic pressure inside timing chain tensioner drops after removal/installation, slack in the guide may generate a pounding noise during and just after engine start. However, this is normal. Noise will stop after hydraulic pressure rises.
- Warm up engine thoroughly to check there is no leakage of fuel, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill 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

VALVE OIL SEAL

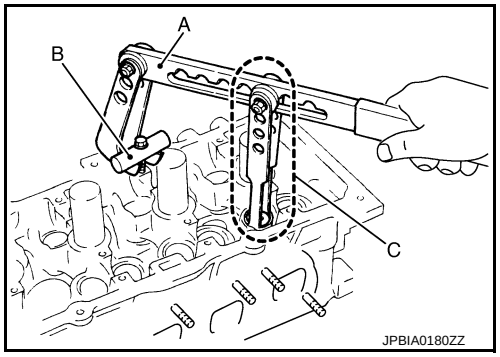
VALVE OIL SEAL : Removal and Installation

INFOID:0000000008141191

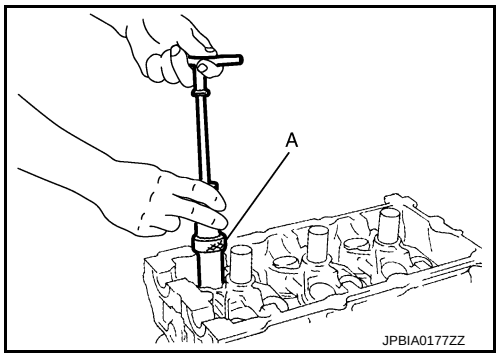
REMOVAL

1. Remove camshaft relating to valve oil seal to be removed. Refer to EM-97, "Exploded View".
2. Remove valve lifters. Refer to EM-65, "Exploded View".
3. Turn crankshaft until the cylinder requiring new oil seals is at TDC. This will prevent valve from dropping into cylinder.
4. Remove valve collet.
   - Compress valve spring with the valve spring compressor [SST: KV10116200 (J26336-A)] (A), the attachment [SST: KV10115900 (J26336-20)] (C), the adapter [SST: KV10109220 (—)] (B). Remove valve collet with a magnet hand.

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



5. Remove valve spring retainer, and valve spring.
6. Remove valve oil seal using the valve oil seal puller [SST: KV10107902 (J38959)] (A).

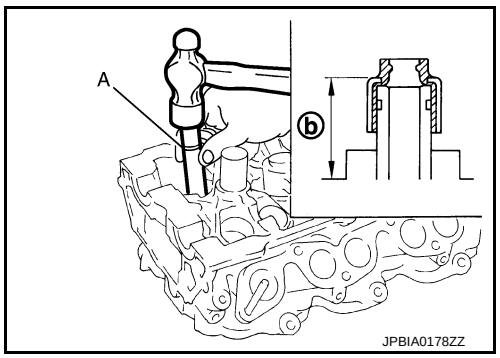


INSTALLATION

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

   NOTE:
   Dimension: Height measured before valve spring seat installation

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



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

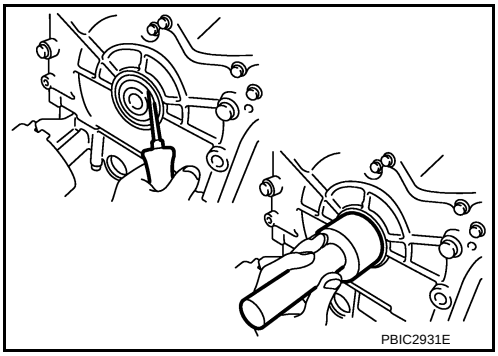
FRONT OIL SEAL

FRONT OIL SEAL : Removal and Installation

INFOID:0000000008141192

REMOVAL

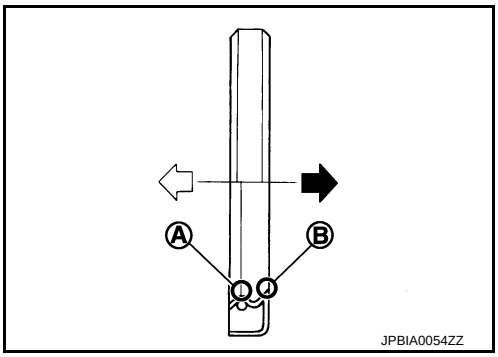
1. Remove the following parts:
   - Engine undercover, using a power tool.
   - Crankshaft pulley: Refer to EM-49, "Exploded View".
2. Remove front oil seal using a suitable tool.
   CAUTION:
   Never damage front timing chain case and crankshaft. Failure to do this may cause the leakage of oil.



INSTALLATION

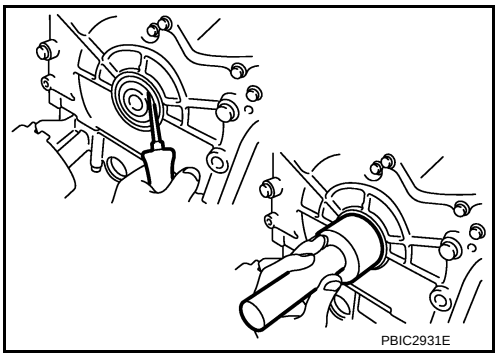
1. Apply new engine oil to both oil seal lip and dust seal lip of new front oil seal.
2. Install front oil seal.
   - Install front oil seal so that each seal lip is oriented as shown in the figure.

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



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

   CAUTION:
   - **Never damage front timing chain case and crankshaft. Failure to do this may cause the leakage of oil.**
   - **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

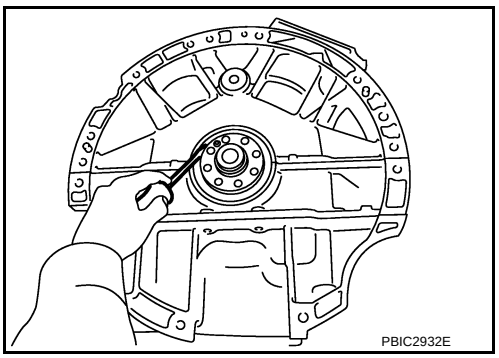
REAR OIL SEAL : Removal and Installation

INFOID:0000000008141193

REMOVAL

1. Remove engine assembly. Refer to EM-78, "Removal and Installation".
2. Remove transmission assembly. Refer to TM-190, "Exploded View".
3. Remove flywheel. Refer to EM-108, "Exploded View".

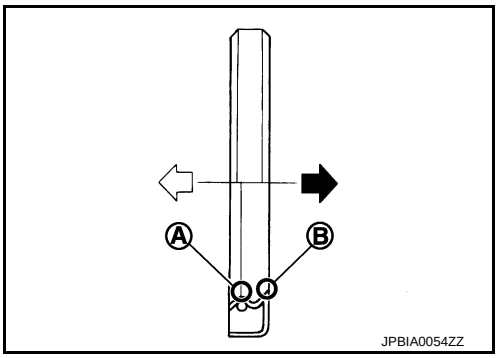
4. Remove rear oil seal with a suitable tool.
CAUTION:
Never damage crankshaft and cylinder block. Failure to do this may cause the leakage of oil.



INSTALLATION

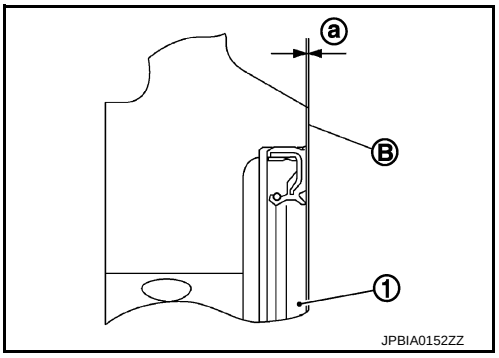
1. Install rear oil seal.
- Install rear oil seal so that each seal lip is oriented as shown in the figure.

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

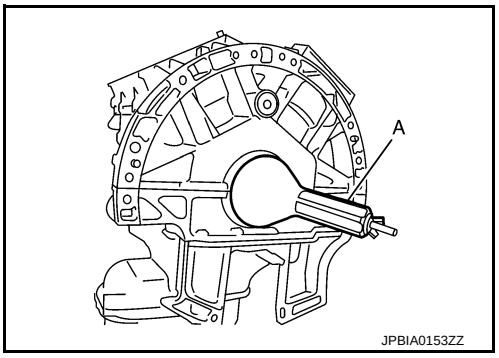


- Press in rear oil seal (1) to the position as shown in the figure.

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:
- **Never damage crankshaft and cylinder block.**
- **Press-fit straight and avoid causing burrs or tilting oil seal.**



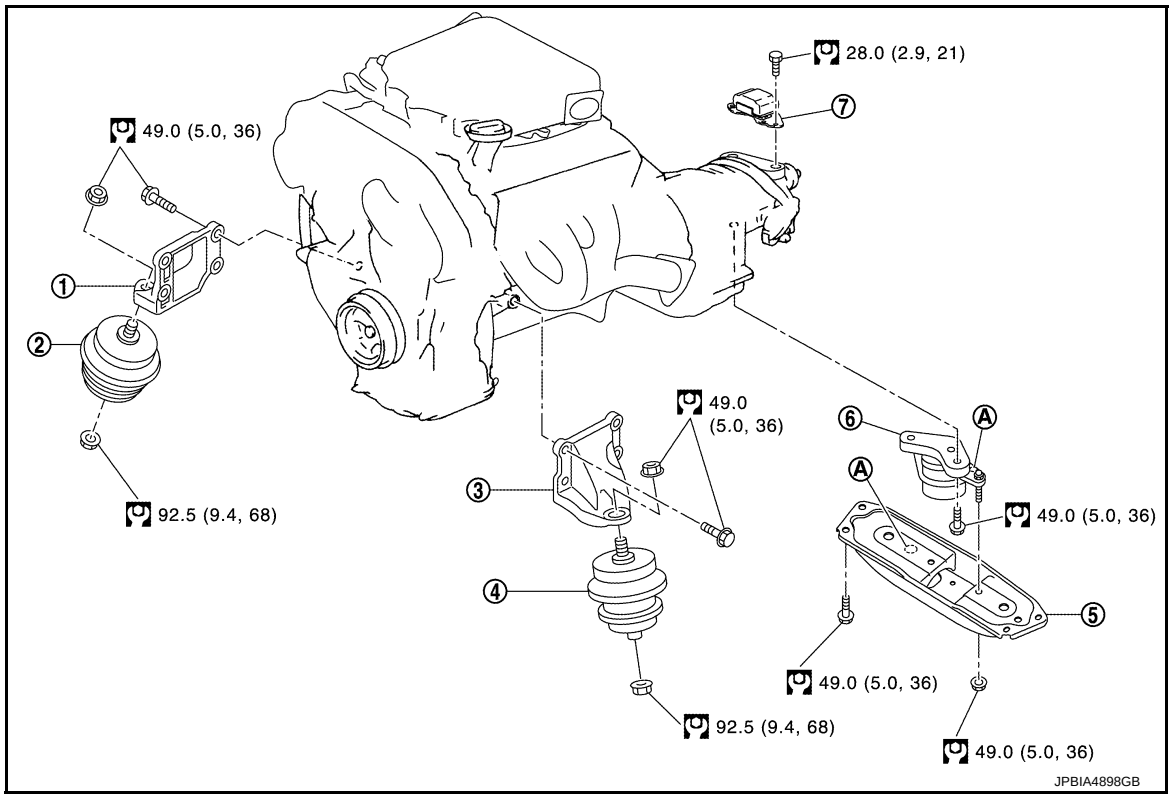
2. Install in the reverse order of removal after this step.

UNIT REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

Exploded View

INFOID:0000000008141194



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

A. Front mark

: N·m (kg-m, ft-lb)

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

CAUTION:
- **Always be careful to work safely, avoid forceful or uninstructed operations.**
- **Never start working until exhaust system and engine coolant are cool enough.**
- **If items or work required are not covered by the engine section, refer to the applicable sections.**
- **Always use the support point specified for lifting.**
- **Use either 2-pole lift type or separate type lift as best you can. If board-on type is used for unavoidable reasons, support at rear axle jacking point with transmission jack or similar tool before starting work, in preparation for the backward shift of center of gravity.**
- **For supporting points for lifting and jacking point at rear axle, refer to GI-38, "Garage Jack and Safety Stand and 2-Pole Lift".**

Removal and Installation

INFOID:0000000008141195

WARNING:

- **Because hybrid vehicles and electric vehicles contain a high voltage battery, there is the risk of electric shock, electric leakage, or similar accidents if the high voltage component and vehicle are handled incorrectly. Be sure to follow the correct work procedures when performing inspection and maintenance.**
- **Be sure to remove the service plug in order to shut off the high voltage circuits before performing inspection or maintenance of high voltage system harnesses and parts.**
- **Be sure to put the removed service plug in your pocket and carry it with you so that another person does not accidentally connect it while work is in progress.**
- **Be sure to wear insulating protective equipment consisting of glove, shoes and glasses before beginning work on the high voltage system.**
- **Clearly identify the persons responsible for high voltage work and ensure that other persons do not touch the vehicle. When not working, cover high voltage parts with an insulating cover sheet or similar item to prevent other persons from contacting them.**
- **Refer to GI-31, "High Voltage Precautions".**

CAUTION:

- **Replace A/T assembly when separate engine and A/T assembly. Because CSC (Concentric Slave Cylinder) slides back to the original position every time when removing A/T assembly. At this timing, dust on the sliding parts may damage a seal of CSC and may cause A/T fluid leakage.**
- **There is the possibility of a malfunction occurring if the vehicle is changed to READY status while the service plug is removed. Therefore do not change the vehicle to READY status unless instructed to do so in the Service Manual.**

NOTE:

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

REMOVAL

Outline

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

Preparation

1. Release fuel pressure. Refer to EC-115, "Work Procedure".

WARNING:

Shut off high voltage circuit. Refer to GI-30, "How to Cut Off High Voltage".

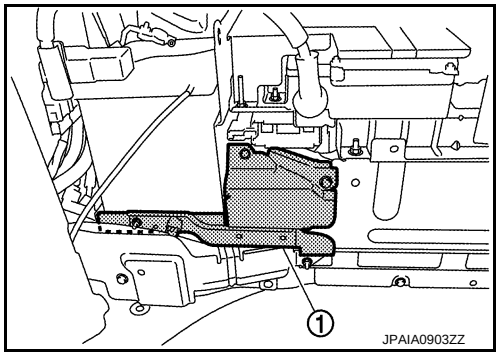
2. Check voltage in high voltage circuit. (Check that condenser are discharged.)

a. Remove trunk finisher front. Refer toINT-52, "TRUNK FINISHER FRONT : Removal and Installation".

b. Remove harness cover (1).

DANGER:

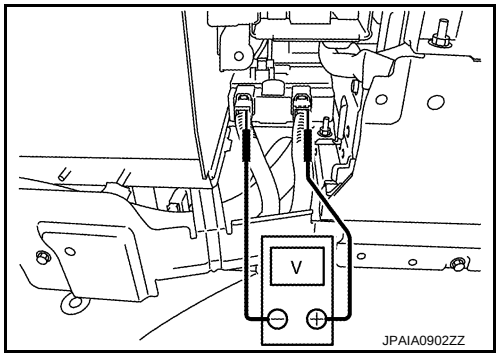
Touching high voltage components without using the appropriate protective equipment will cause electrocution.



c. Measure voltage between high voltage harness terminals.

DANGER:

Touching high voltage components without using the appropriate protective equipment will cause electrocution.



Standard : 5 V or less

CAUTION:

For voltage measurements, use a tester which can measure to 500 V or higher.

3. Drain engine coolant from radiator. Refer to CO-7, "Draining".
   CAUTION:
   - **Perform this step when engine is cold.**
4. Remove the following parts:
   - Radiator reservoir tank: Refer to CO-13, "Exploded View".
   - Engine cover: Refer to EM-25, "Exploded View".
   - Front road wheel and tires (power tool)
   - Engine undercover (power tool)
   - Hoodledge cover: Refer to EXT-21, "Exploded View".
   - Cowl top cover: Refer to EXT-21, "Exploded View".
   - Air duct and air cleaner case assembly (bank 1 and bank 2): Refer to EM-26, "Exploded View".
   - Cooling fan assembly: Refer to CO-17, "Exploded View".
5. Discharge refrigerant from A/C circuit. Refer to HA-21, "Recycle Refrigerant".
6. Remove radiator hose (upper and lower). Refer to CO-13, "Exploded View".

Engine Room LH

1. Disconnect heater hose from engine side, and fit a plug onto hose end to prevent coolant leak.
2. Disconnect A/C piping from electric compressor. Refer to HA-34, "Exploded View".
3. Disconnect ground cable.

Engine Room RH

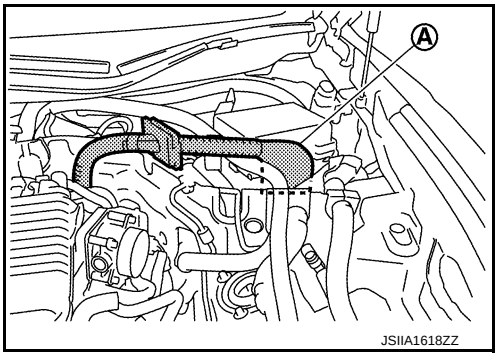
1. Disconnect high voltage harness connector (A) from inverter, and temporarily fasten it on engine.
   - For removal method of high voltage connector, refer to TMS-121, "Removal and Installation".

   WARNING:

   - **To prevent electric shock hazards, be sure to wear protective gear.**

   - **Protect the terminals of disconnected high voltage harness connector with insulation tape so that they are not exposed.**

   CAUTION:
   - **Take care that coolant does not contact the high voltage harness connectors.**
   - **To prevent performance degradation, if coolant contacts a high voltage harness connector, immediately dry the high voltage harness connector completely with an air blow gun.**
2. Disconnect all clips and connectors of the engine room harness from engine back side.
3. Disconnect fuel feed hose (with damper) and EVAP hose. Refer to EM-37, "Exploded View".
   CAUTION:
   Fit plugs onto disconnected hoses to prevent fuel leakage.
4. Remove two eyebolts of hydraulic piping on the power steering oil pump assembly side and bracket mounting bolt. Temporarily fix the hydraulic piping on the engine side. Refer to ST-44, "Exploded View" (WITH HEATED STEERING WHEEL) or ST-71, "Exploded View" (WITHOUT HEATED STEERING WHEEL).

Vehicle Inside

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

1. Remove passenger-side kicking plate and dash side finisher. Refer to INT-31, "Exploded View".
2. Disconnect engine room harness connectors at unit sides ECM and other.
3. Disengage intermediate fixing point. Pull out engine room harnesses to engine room side, and temporarily secure them on engine.
   CAUTION:
   - **When pulling out harnesses, take care not to damage harnesses and connectors.**

- **After temporarily securing, cover connectors with vinyl or similar material to protect against foreign material adhesion.**

Vehicle Underbody

1. Remove A/T oil fluid warmer hose (between A/T oil fluid warmer and heater pump).
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-34, "Exploded View" (WITH HEATED STEERING WHEEL) or ST-61, "Exploded View" (WITHOUT HEATED STEERING WHEEL).
5. Remove rear propeller shaft. Refer to DLN-7, "Exploded View".
6. Disconnect harness connector from transmission assembly.
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-181, "Exploded View".
8. Preparation for the separation work of transaxle is as per the following.
   CAUTION:
   Never separate the transmission unless otherwise needed. The transmission must be replaced if it is separated from the engine.
   - Remove bolts fixing the transmission assembly to lower rear side of oil pan (upper). Refer to EM-88, "Exploded View".
9. Remove front stabilizer connecting rod from transverse link. Refer to FSU-17, "Exploded View".
10. Remove lower ends of left and right steering knuckle from transverse link. Refer to FAX-7, "Exploded View".
11. Separate steering outer sockets from steering knuckle. Refer to ST-36, "Exploded View" (WITH HEATED STEERING WHEEL) or ST-63, "Exploded View" (WITHOUT HEATED STERING WHEEL).
12. Remove transverse links mounting bolts at suspension member side. Refer to FSU-13, "Exploded View".

Removal Work

CAUTION:
Never separate the transmission unless otherwise needed. The transmission must be replaced if it is separated from the engine.

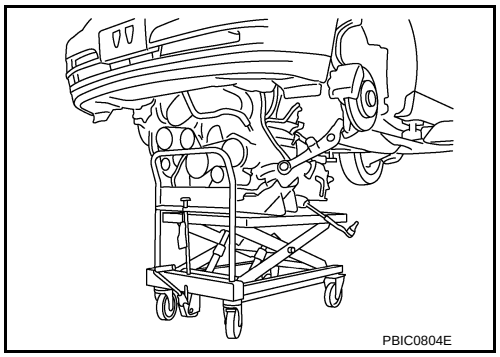
1. Use a manual lift table caddy (commercial service tool) or equivalently rigid tool such as a transmission jack. Securely support bottom of suspension member and transmission.

   WARNING:

   To prevent electric shock hazards, be sure to wear protective gear.

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



2. Remove rear engine mounting member bolts.

   WARNING:

   To prevent electric shock hazards, be sure to wear protective gear.

3. Remove front suspension member mounting bolts and nuts. Refer to FSU-18, "Exploded View".
4. Carefully lower jack, or raise lift to remove the engine, transmission assembly, transfer, front final drive assembly and front suspension member. When performing work, observe the following caution and warning:

   WARNING:

To prevent electric shock hazards, be sure to wear protective gear.

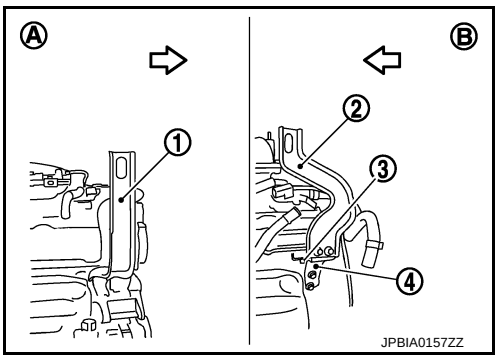
CAUTION:
- **Confirm there is no interference with the vehicle.**
- **Check that all connection points have been disconnected.**
- **Keep in mind the center of the vehicle gravity changes. If necessary, use jack(s) to support the vehicle at rear jacking point(s) to prevent it from falling it off the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

Separation Work

CAUTION:

Never separate the transmission unless otherwise needed. The transmission must be replaced if it is separated from the engine.

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

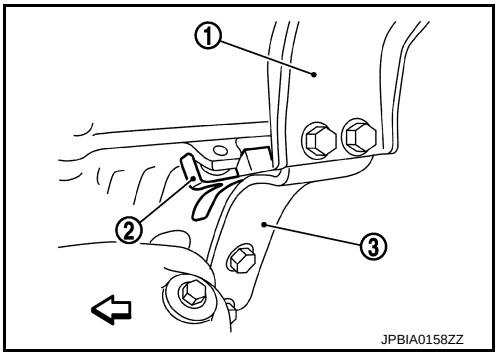


1 : Engine front slinger
2 : Engine rear upper slinger
3 : Spacer
4 : Engine rear lower slinger
A : Bank 1
B : Bank 2
⇦ : Engine front

Slinger bolts:

: 28.0 N·m (2.9 kg-m, 21 ft-lb)

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



1 : Engine rear upper slinger
⇦ : Engine front

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

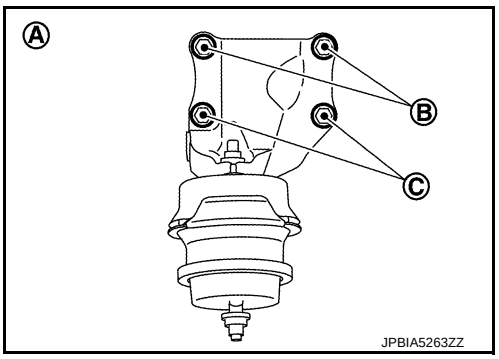
2. Remove engine mounting insulators (RH and LH) under side nuts using a power tool.
3. Lift with hoist and separate the engine and the transmission assembly from front suspension member.
   CAUTION:
   - **Before and during this lifting, always check to see if any harnesses are left connected.**
   - **Never damage to and oil/grease smearing or spills onto engine mounting insulator.**
4. Remove crankshaft position sensor.
   CAUTION:
   - **Handle the sensor carefully and avoid impacts to the sensor.**
   - **Never disassemble to the sensor.**
   - **Never place sensor in a location where it is exposed to magnetism.**
5. Separate the engine from the transmission assembly. Refer to TM-190, "Exploded View".
6. Remove each engine mounting insulator and each engine mounting bracket from the engine using a power tool.

INSTALLATION

Note the following, and install in the reverse order of removal.
- Do not allow engine mounting insulator to be damage and careful no engine oil gets on it.

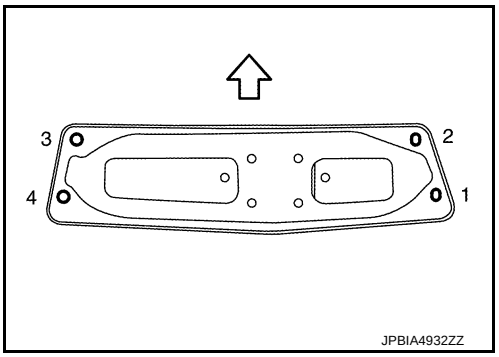
- For a location with a positioning pin, insert it securely into hole of mating part.
- For a part with a specified installation orientation, refer to component figure in EM-78, "Exploded View".
- When installing engine mounting bracket (RH and LH) on cylinder block, tighten two upper bolts [shown as (B) in the figure] first. Then tighten two lower bolts [shown as (C) in the figure].

A : Example left side



- Check 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



Inspection

INFOID:0000000008141196

INSPECTION AFTER INSTALLATION

Equipotential test

- Perform equipotential test after installing the engine assembly. Refer to TM-192, "Inspection and Adjustment".

Inspection for Leakage

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

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to MA-10, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.

NOTE:
Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-89, "Description".

- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to check there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill 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.

ADJUSTMENT AFTER INSTALLATION

Perform the clutch 1 position learning after the removal procedure of transmission. Refer to HBC-88, "Description".

UNIT DISASSEMBLY AND ASSEMBLY

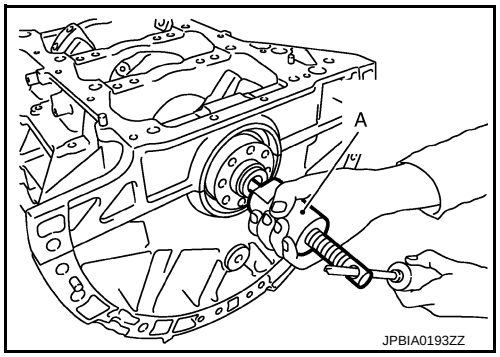
ENGINE STAND SETTING

Setting

INFOID:0000000008141197

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-78, "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 flywheel, using a power tool. Fix crankshaft, and remove mounting bolts.
   - Loosen mounting bolts in diagonal order.
   - Check for deformation or damage of flywheel.
     CAUTION:
     - **Never disassemble flywheel.**
     - **Never place flywheel 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.

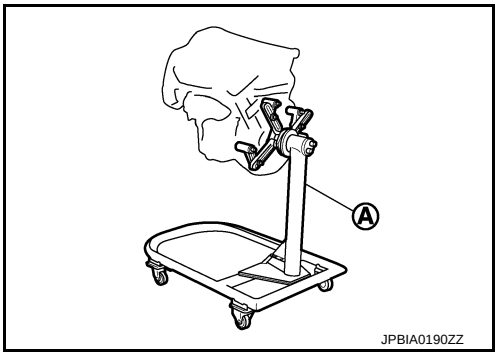


4. Lift the engine with hoist to install it onto the widely use engine stand.
   CAUTION:
   Use an engine stand that has a load capacity [220 kg (441 lb) or more] large enough for supporting the engine weight.
   - If the load capacity of the stand is not adequate, remove the following parts beforehand to reduce the potential risk of overturning the stand.
   - Remove intake manifold collector. Refer to EM-28, "Exploded View".
   - Remove fuel injector and fuel tube assembly. Refer to EM-37, "Exploded View".
   - Remove intake manifold. Refer to EM-31, "Exploded View".
   - Remove ignition coil. Refer to EM-46, "Exploded View".
   - Remove rocker cover. Refer to EM-46, "Exploded View".
   - Remove exhaust manifold. Refer to EM-33, "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 flywheel removed.

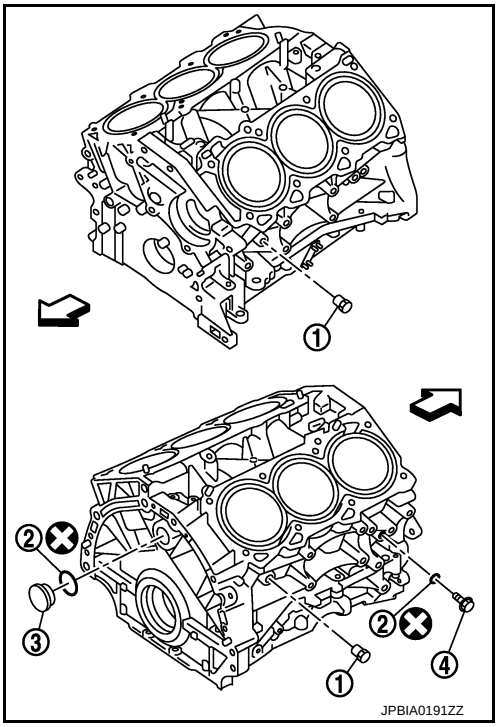
CAUTION:

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



5. Drain engine oil. Refer to LU-8, "Draining".
6. Drain engine coolant by removing water drain 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:0000000008141198

1. Remove intake manifold collector. Refer to EM-28, "Exploded View".
2. Remove fuel injector and fuel tube. Refer to EM-37, "Exploded View".
3. Remove intake manifold. Refer to EM-31, "Exploded View".
4. Remove exhaust manifold. Refer to EM-33, "Exploded View".
5. Remove oil pan (lower). Refer to EM-43, "Exploded View".
6. Remove ignition coil, spark plug and rocker cover. Refer to EM-46, "Exploded View".
7. Remove timing chain. Refer to EM-49, "Exploded View".
8. Remove rear timing chain case. Refer to EM-91, "Exploded View".
9. Remove camshaft (EXH). Refer to EM-65, "Exploded View".
10. Remove cylinder head. Refer to EM-97, "Exploded View".

Assembly

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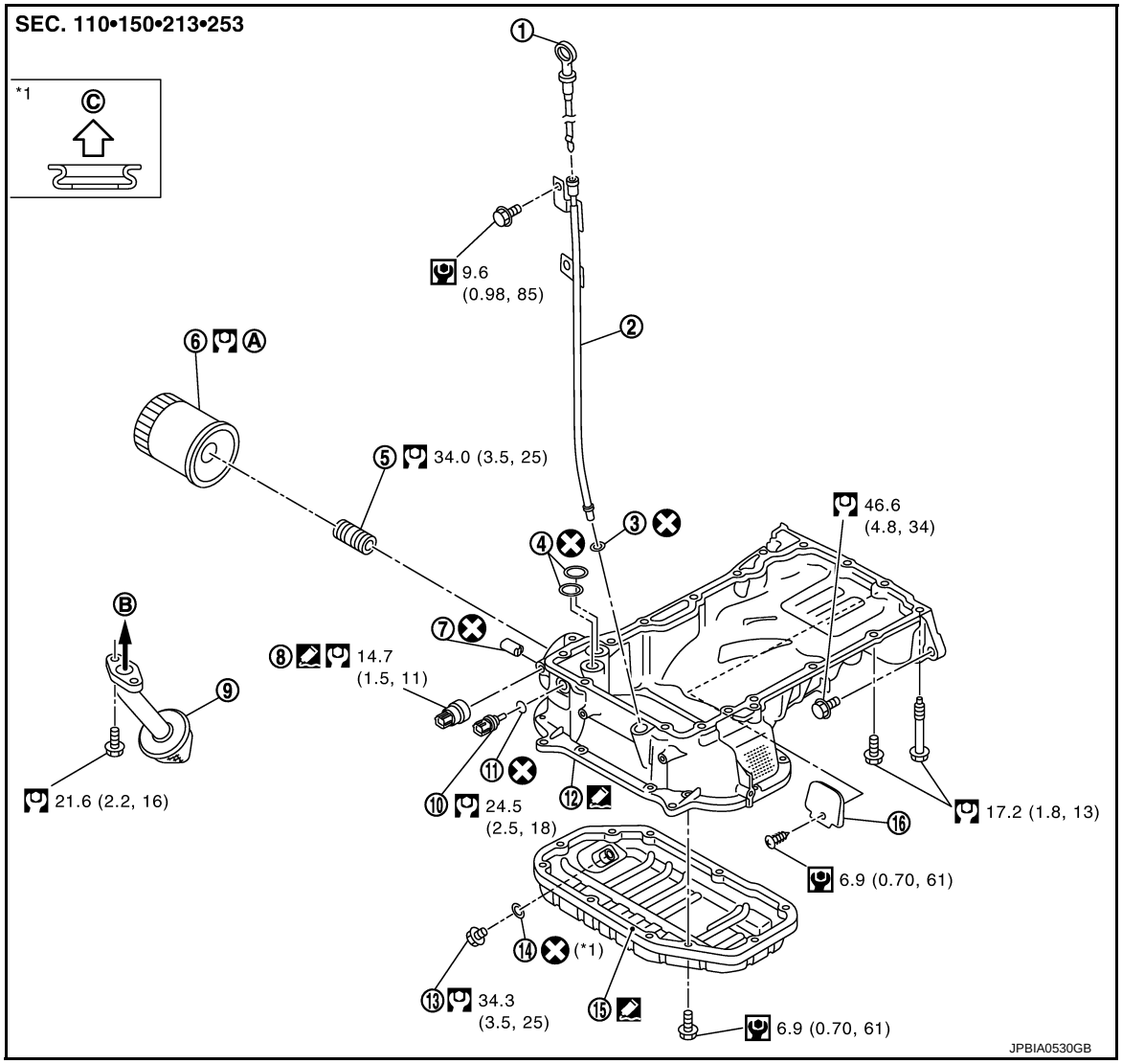
Assemble in the reverse order of disassembly.

OIL PAN (UPPER) AND OIL STRAINER

Exploded View

INFOID:0000000008141200



1. Oil level gauge
2. Oil level gauge guide
3. O-ring
4. O-ring
5. Connector bolt
6. Oil filter
7. Plug
8. Oil pressure sensor
9. Oil strainer
10. Oil temperature sensor
11. Washer
12. Oil pan (upper)
13. Drain plug
14. Washer
15. Oil pan (lower)
16. Rear plate cover

A. Refer to LU-10
B. To oil pump
C. Oil pan (lower) side

: N·m (kg-m, ft-lb)

: N·m (kg-m, in-lb)

: Always replace after every disassembly.

: Sealing point

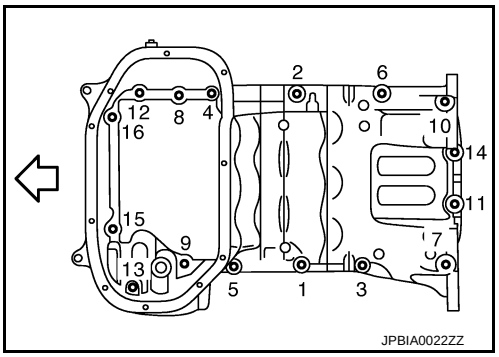
Disassembly and Assembly

INFOID:0000000008141201

REMOVAL

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

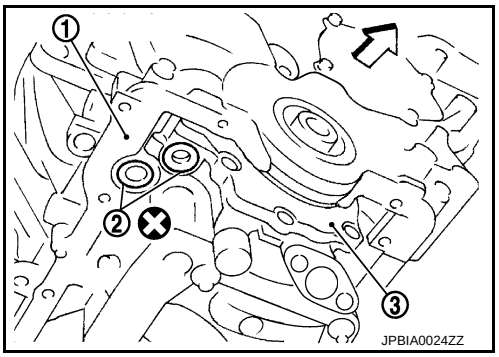
1. Remove oil pan (lower). Refer to EM-43, "Exploded View".
2. Remove oil strainer.
3. Loosen mounting bolts in the reverse order as shown in the figure, using a power tool to remove.



⇦ : 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.**

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



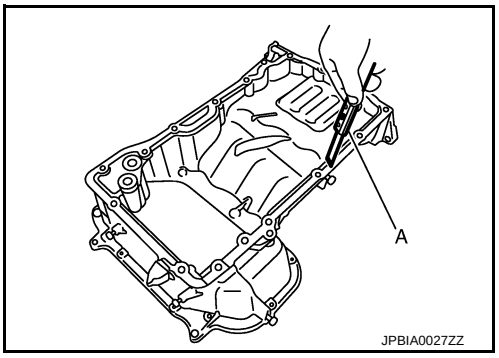
⇦ : Engine front

INSTALLATION

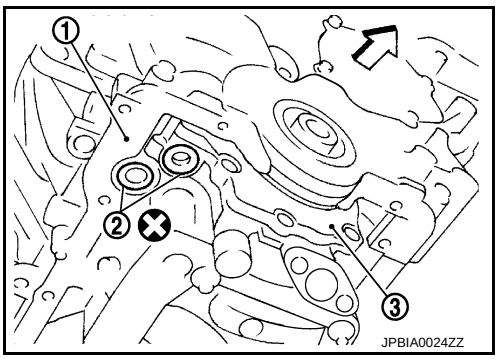
CAUTION:
Do not reuse O-rings.

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.



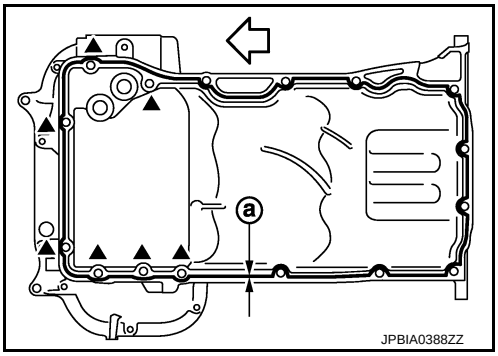
b. Install O-ring (2) on the bottom of lower cylinder block (1) and oil pump (3).



⇦ : 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 - 5.0mm (0.157 - 0.197 in)

⇦ :Engine front

Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-23, "Recommended Chemical Products and Sealants".

CAUTION:

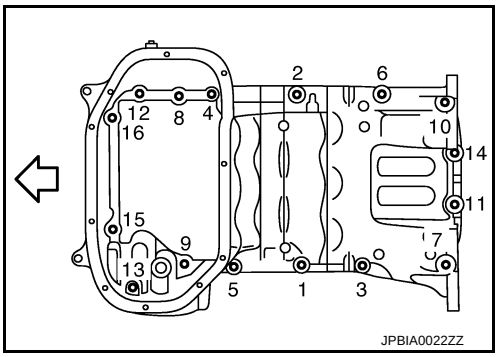
- **For bolt holes with ▲ marks (7 locations), apply liquid gasket outside the holes.**
- **Attaching should be done within 5 minutes after coating.**

d. Install oil pan (upper).

CAUTION:

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 × 92 mm (3.94 in)	**: 7, 10, 13**
M8 × 25 mm (0.98 in)	**: Except the adove**

2. Install oil strainer to oil pump.
3. Install oil pan (lower). Refer to EM-43, "Exploded View".
4. Install oil pan drain plug.
   - Refer to the figure of components of former page for installation direction of drain plug washer. Refer to EM-43, "Exploded View".
5. Install in the reverse order of removal after this step.

   NOTE:

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

Inspection

INFOID:0000000008141202

INSPECTION AFTER REMOVAL

Clean oil strainer if any object is attached.

INSPECTION AFTER INSTALLATION

1. Check the engine oil level and adjust engine oil. Refer to LU-7, "Inspection".
2. Start engine, and check there is no leakage of engine oil.

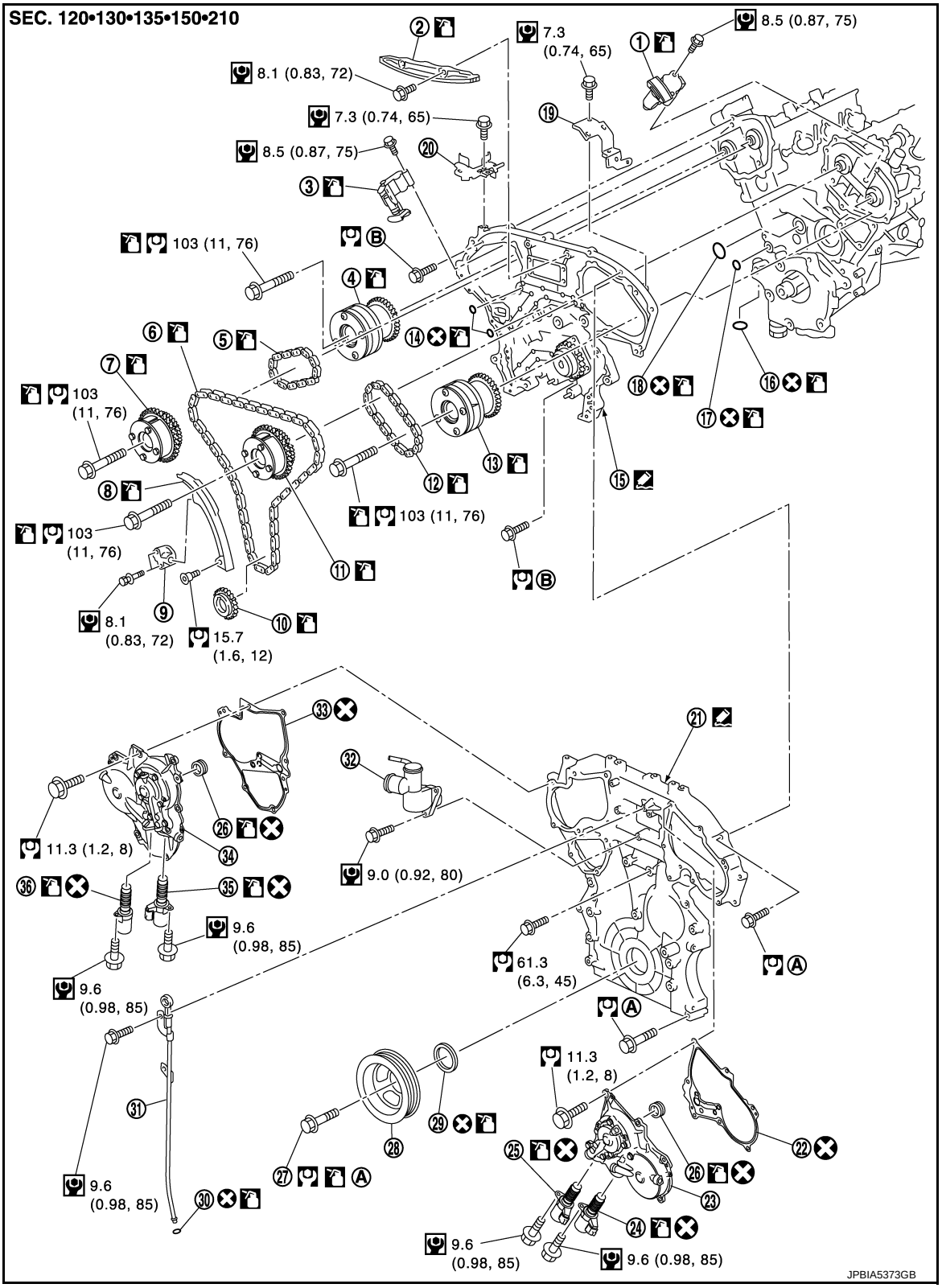
   NOTE:

   Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-89, "Description".
3. Stop engine and wait for 10 minutes.
4. Check the engine oil level again. Refer to LU-7, "Inspection".

REAR TIMING CHAIN CASE

Exploded View

INFOID:0000000008141203



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

10.	Crankshaft sprocket	11.	Camshaft sprocket (INT)	12.	Timing chain (secondary)
13.	Camshaft sprocket (EXH)	14.	O-ring	15.	Rear timing chain case
16.	O-ring	17.	O-ring	18.	O-ring
19.	Bracket	20.	Bracket	21.	Front timing chain case
22.	Valve timing control cover gasket (bank 2)	23.	Valve timing control cover (bank 2)	24.	Exhaust valve timing control solenoid valve (bank 2)
25.	Intake valve timing control solenoid valve (bank 2)	26.	Seal ring	27.	Crankshaft pulley bolt
28.	Crankshaft pulley	29.	Front oil seal	30.	O-ring
31.	Oil level gauge guide	32.	Water outlet (front)	33.	Valve timing control cover gasket (bank 1)
34.	Valve timing control cover (bank 1)	35.	Intake valve timing control solenoid valve (bank 1)	36.	Exhaust valve timing control solenoid valve (bank 1)
A.	Comply with the assembly procedure when tightening. Refer to EM-50.	B.	Comply with the assembly procedure when tightening. Refer to EM-92		

: N·m (kg-m, ft-lb)

: N·m (kg-m, in-lb)

: Always replace after every disassembly.

: Should be lubricated with oil.

: Sealing point

Disassembly and Assembly

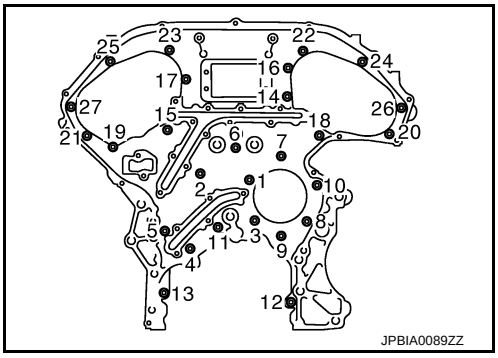
INFOID:0000000008141204

DISASSEMBLY

1. Remove front timing chain case and timing chain. Refer to EM-50, "Removal and Installation".
2. Remove water pump. Refer to CO-19, "Exploded View".
3. Remove oil pan (upper). Refer to EM-88, "Exploded View".
4. Remove rear timing chain case as follows:

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

A : Dowel hole

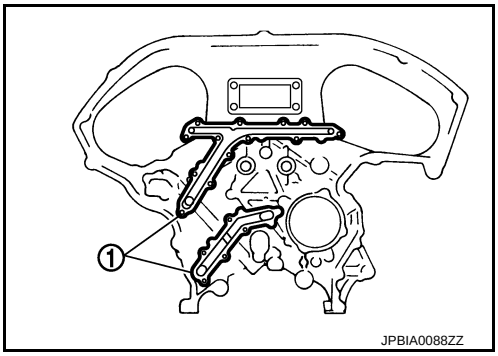


JPBIA0089ZZ

b. Cut liquid gasket using the seal cutter [SST: KV10111100 (J-37228)] and remove rear timing chain case.

CAUTION:

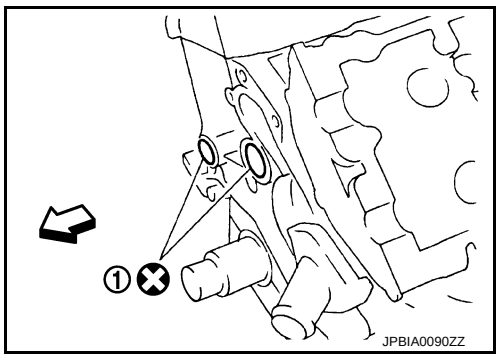
- **Never remove plate metal cover (1) of oil passage.**
- **After removal, handle rear timing chain case carefully so it does not tilt, cant, or warp under a load.**



JPBIA0088ZZ

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

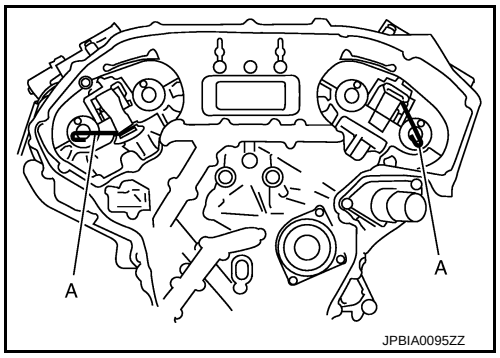
⇦ : Engine front



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

a. Remove camshaft brackets (No. 1). Refer to EM-65, "Exploded View".

b. Remove timing chain tensioners (secondary) with a stopper pin (A) attached.



ASSEMBLY

CAUTION:
Do not reuse O-rings.

1. Install timing chain tensioners (secondary) to cylinder head as follows if removed. Refer to EM-65, "Exploded View".

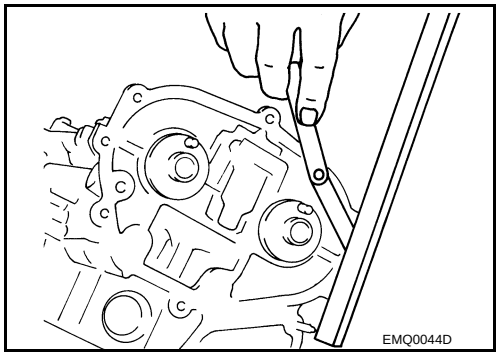
a. Install timing chain tensioners (secondary) with a stopper pin attached and new O-rings.

b. Install camshaft brackets (No. 1). Refer to EM-65, "Exploded View".

c. Measure difference in levels between front end faces of camshaft bracket (No. 1) and cylinder head.

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

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

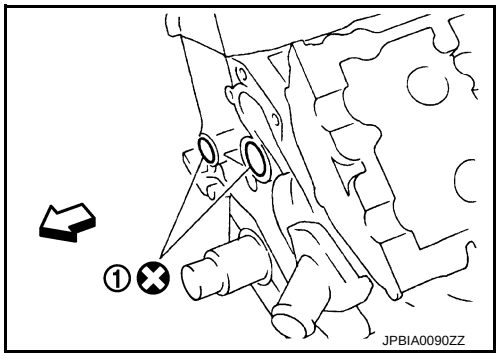


2. Install rear timing chain case as follows:

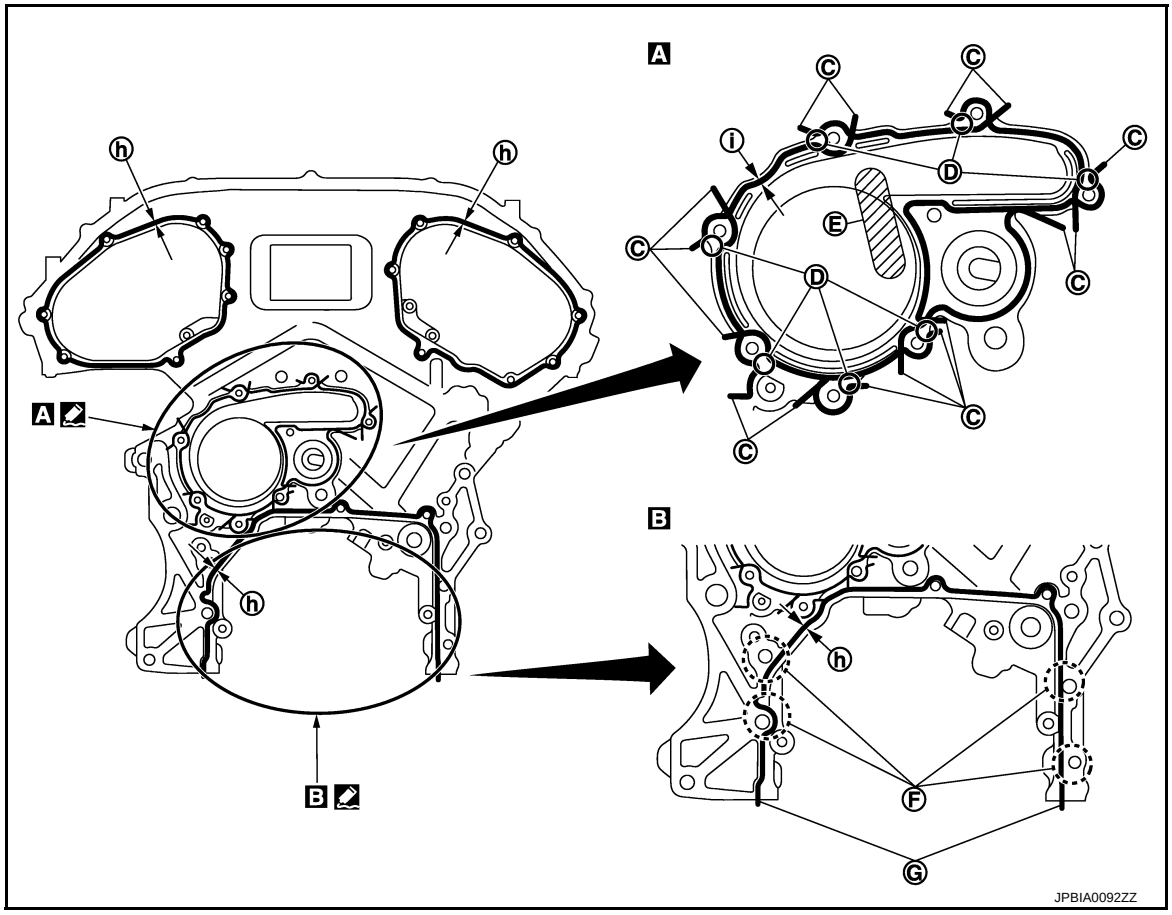
a. Install new O-rings (1) onto cylinder block.

⇦ : 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 RTV Silicone Sealant or equivalent. Refer to GI-23, "Recommended Chemical Products and Sealants".
CAUTION:
- **For (A) in the figure, completely wipe out liquid gasket extended on a portion touching at engine coolant.**
- **Apply liquid gasket on installation position of water pump and cylinder head very completely.**



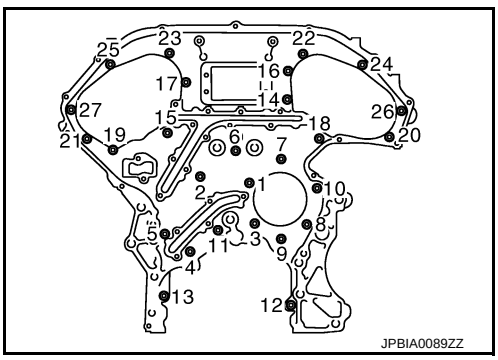
C.	Protrusion	D.	Clearance 1mm (0.04 in)	E.	Don not protrude in this area
F.	Run along bolt hole inner side	G.	Protrusions at beginning and end of gasket		
h.	ϕ3.9mm (0.154 in)	j.	ϕ2.7mm (0.106 in)		

: Sealing point

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

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

A : Dowel pin hole



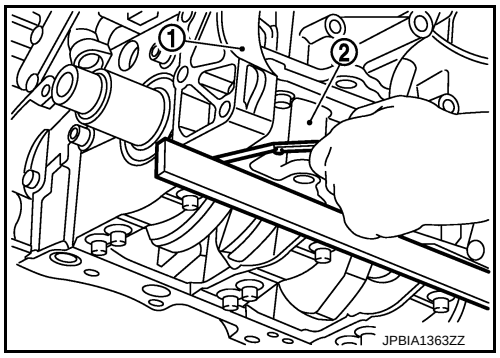
Bolt length: Bolt position
20 mm (0.79 in) : 1, 2, 3, 6, 7, 8, 9, 10
16 mm (0.63 in) : 4,5,11
: 12.7 N·m (1.3 kg-m, 9 ft-lb)

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)

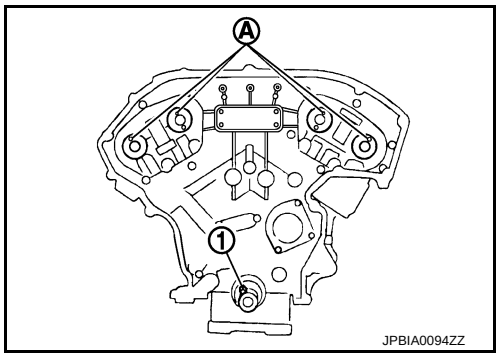
- If not within the standard, repeat the installation procedure.

3. Install water pump with new O-rings. Refer to CO-19, "Exploded View".

4. Check that dowel pin (A) and crankshaft key (1) are located as shown in the figure. (No. 1 cylinder at compression TDC)

NOTE:

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



Camshaft dowel pin

: At cylinder head upper face side in each bank.

Crankshaft key

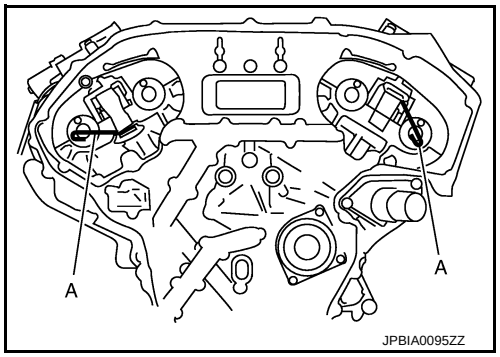
: At cylinder head side of bank 1.

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

CAUTION:

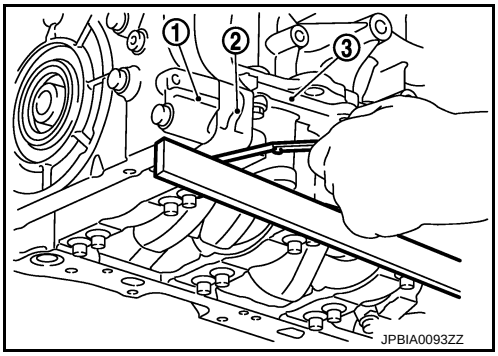
Matching marks between timing chain and sprockets slip easily. Confirm all matching mark positions repeatedly during the installation process.

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



6. Install timing chains, camshaft sprockets and front timing chain case. Refer to EM-50, "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

Rear timing chain case to lower cylinder block:

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

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

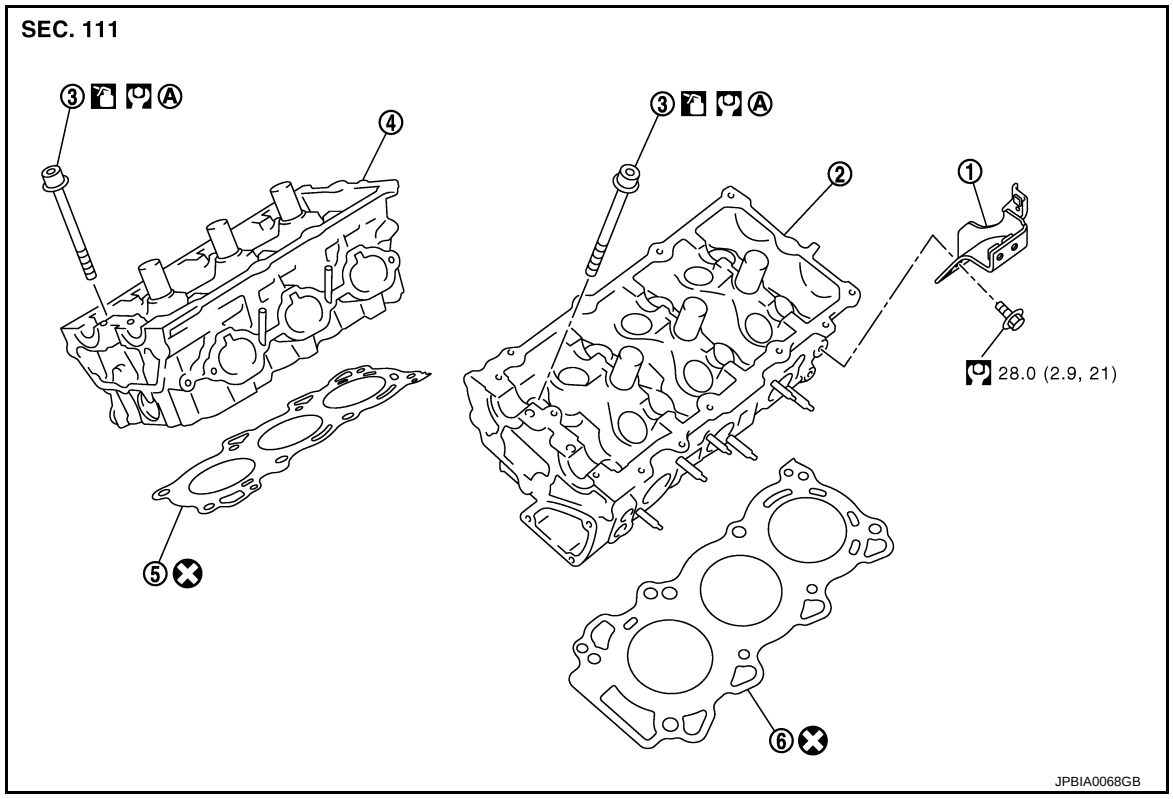
7. Install in the reverse order of removal after this step.

CYLINDER HEAD

Exploded View

INFOID:0000000008141205

REMOVAL



1. Engine rear lower slinger
2. Cylinder head (bank 2)
3. Cylinder head bolt
4. Cylinder head (bank 1)
5. Cylinder head gasket (bank 1)
6. Cylinder head gasket (bank 2)

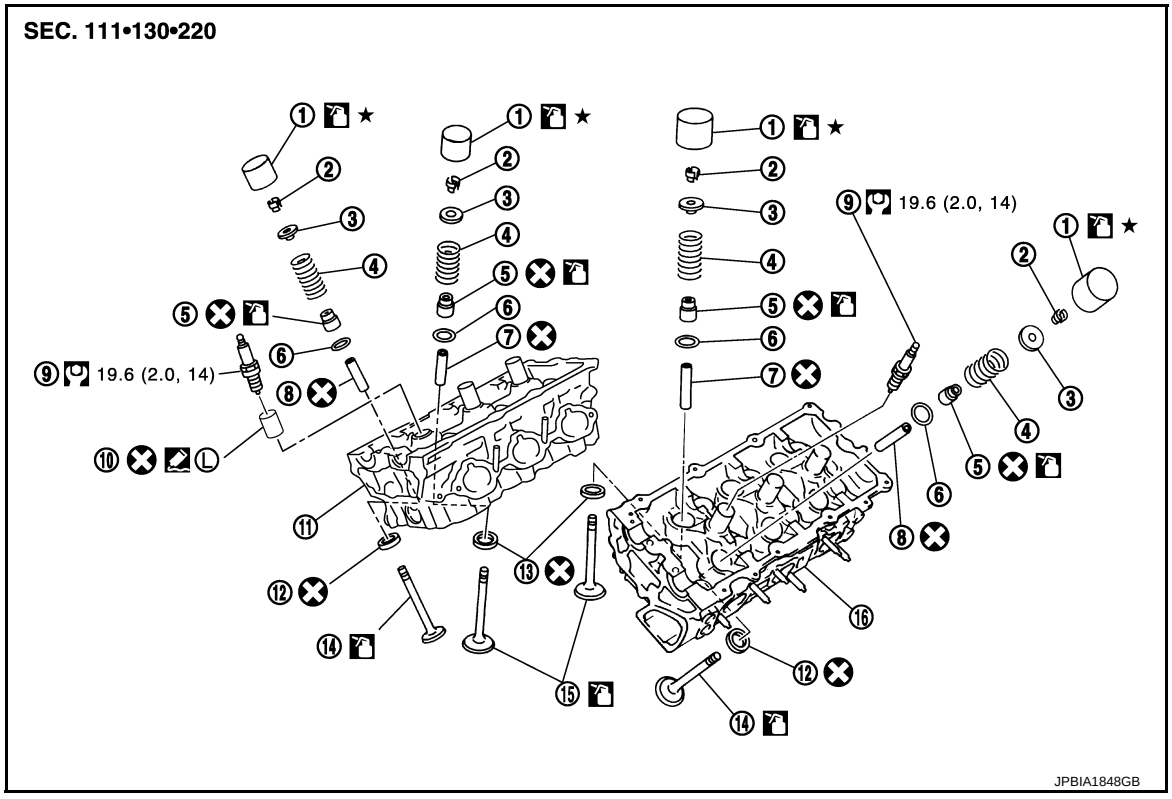
A. Comply with the assembly procedure when tightening. Refer to EM-101.

: N·m (kg-m, ft-lb)

: Always replace after every disassembly.

: Should be lubricated with oil.

DISASSEMBLY



1. Valve lifter
2. Valve collet
3. Valve spring retainer
4. Valve spring
5. Valve oil seal
6. Valve spring seat
7. Valve guide (INT)
8. Valve guide (EXT)
9. Spark plug
10. Spark plug tube
11. Cylinder head (bank 1)
12. Valve seat (EXH)
13. Valve seat (INT)
14. Valve (EXH)
15. Valve (INT)
16. Cylinder head (bank 2)

⊗ : Always replace after every disassembly.

: Should be lubricated with oil.

Ⓛ: Sealing point with locking sealant.

★ : Select with proper thickness.

Removal and Installation

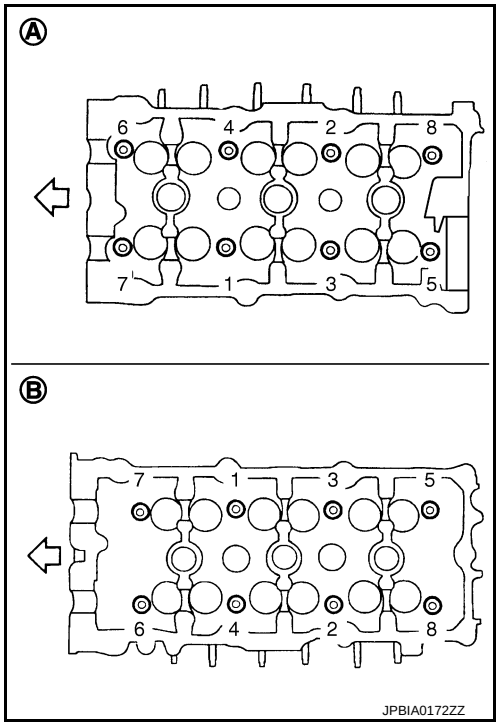
INFOID:0000000008141206

REMOVAL

1. Remove the following parts:
   - Intake manifold collector: Refer to EM-28, "Exploded View".
   - Rocker cover: Refer to EM-46, "Exploded View".
   - Fuel tube and fuel injector assembly: Refer to EM-37, "Exploded View".
   - Intake manifold: Refer to EM-31, "Exploded View".
   - Exhaust manifold: Refer to EM-33, "Exploded View".
   - Water inlet and thermostat assembly: Refer to CO-22, "Exploded View".
   - Water outlet, water pipe and heater pipe: Refer to CO-24, "Exploded View".
   - Timing chain: Refer to EM-49, "Exploded View".
   - Rear timing chain case: Refer to EM-91, "Exploded View".
   - Camshaft: Refer to EM-65, "Exploded View".

2. Remove cylinder head bolts in reverse order as shown in the figure with cylinder head bolt wrench (commercial service tool) and power tool to remove cylinder heads (bank 1 and bank 2).

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



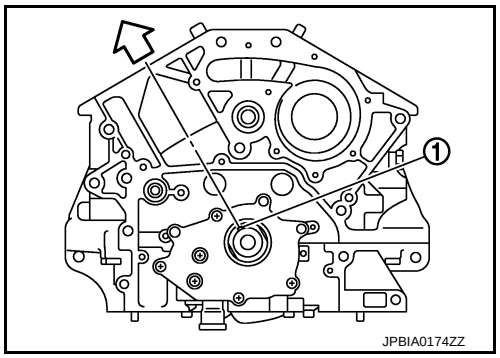
3. Remove cylinder head gaskets.

INSTALLATION

1. Install new cylinder head gaskets.
2. Turn crankshaft until No. 1 piston is set at TDC.

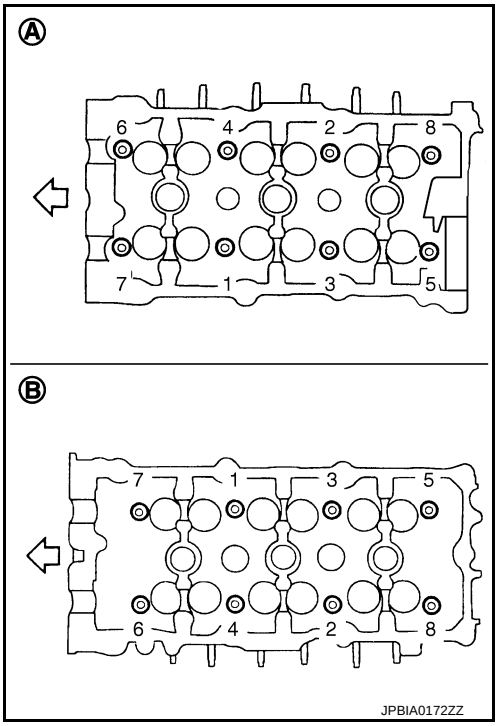
1 : Crankshaft key
⇦ : Bank 1 side

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



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

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



CAUTION:
- **If cylinder head bolts re-used, check their outer diameters before installation. Refer to EM-105, "Inspection".**
- **Before installing cylinder head, inspect cylinder head distortion. Refer to EM-105, "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)

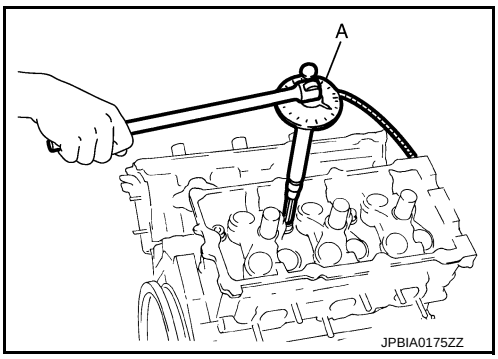
CAUTION:
In step “c”, loosen bolts in reverse order of that indicated in the figure.

d. Tighten all cylinder head bolts.

: 40.0 N·m (4.1 kg-m, 30 ft-lb)

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

CAUTION:
Check the tightening angle by using the angle wrench [SST: KV10112100 (BT8653-A)] (A). Avoid judgment by visual inspection without.
- Check tightening angle indicated on the angle wrench indicator plate.

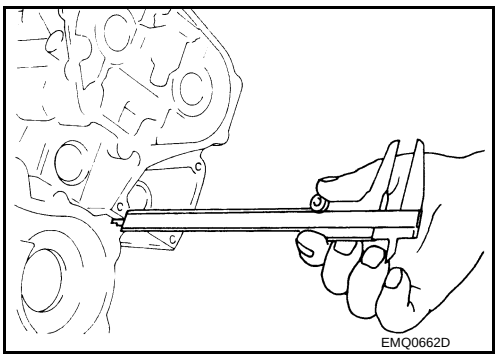


f. Turn all cylinder head bolts 95 degrees clockwise again (angle tightening).

4. 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, re-install cylinder head.



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

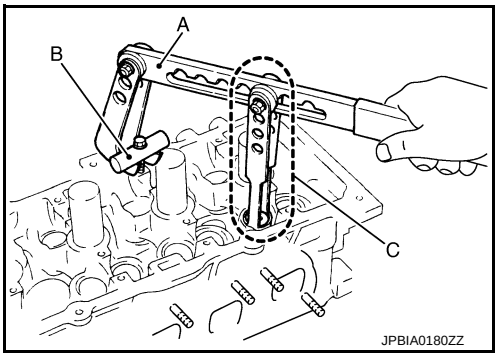
Disassembly and Assembly

INFOID:0000000008141207

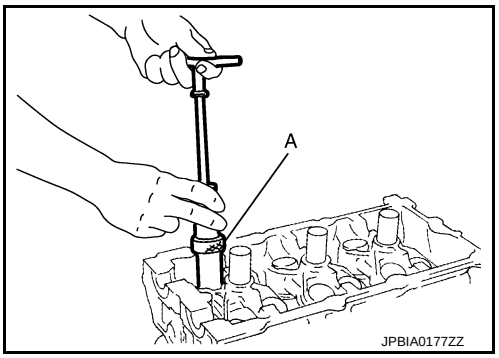
DISASSEMBLY

1. Remove valve lifter.
   - Identify installation positions, and store them without mixing them up.
2. 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.



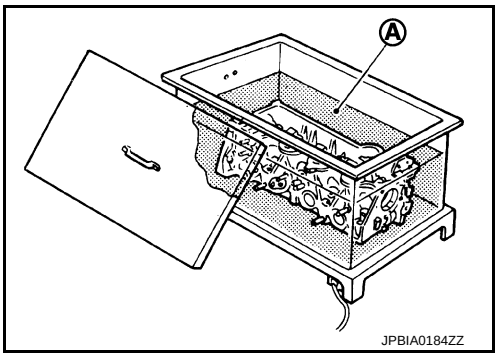
3. Remove valve spring retainer, valve spring and valve spring seat.
4. Push valve stem to combustion chamber side, and remove valve.
   - Identify installation positions, and store them without mixing them up.
5. Remove valve oil seal using the valve oil seal puller [SST: KV10107902 (J-38959)] (A).



6. Remove valve seat, if valve seat 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-137, "Cylinder Head".

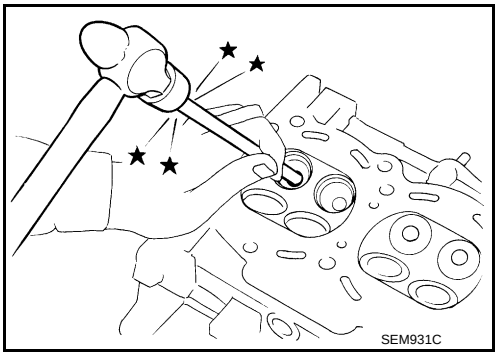
   CAUTION:
   Prevent to scratch cylinder head by excessive boring.
7. Remove valve guide, if valve guide must be replaced.

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



b. Drive out valve guide with a press [under a 20 kN (2 ton, 2.0 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.



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

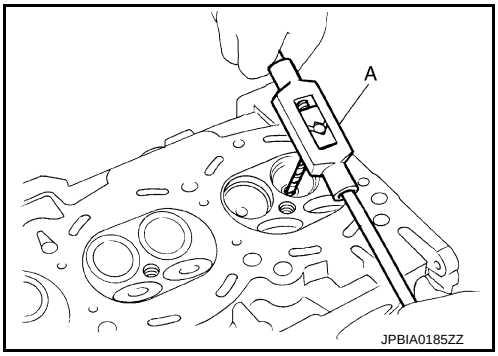
CAUTION:
- **Take care not to damage cylinder head.**
- **Once removed, spark plug tube will be deformed and cannot be reused. Never remove it unless absolutely necessary.**

ASSEMBLY

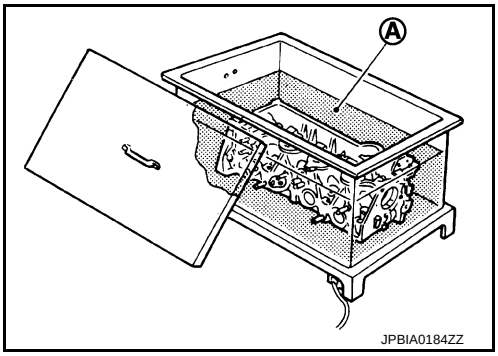
1. If valve guide is removed in step 10 (DISASSEMBLY), install it. Replace with oversized [0.2 mm (0.008 in)] valve guide.

a. Using the valve guide reamer (commercial service tool) (A), ream cylinder head valve guide hole.

Valve guide hole diameter (for service parts):
Intake and exhaust
: Refer to EM-137, "Cylinder Head".



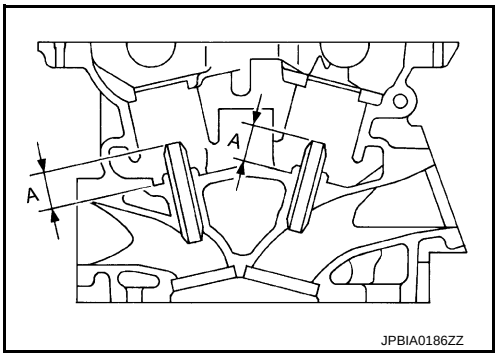
b. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil (A).



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

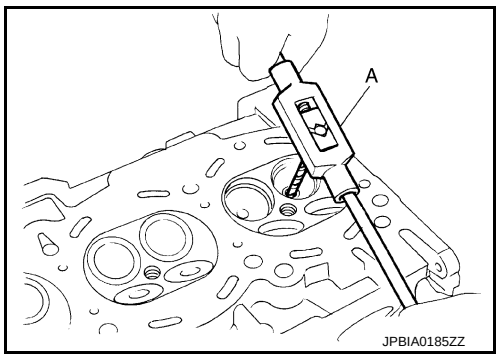
Projection (A)
Intake and exhaust
: Refer to EM-137, "Cylinder Head".

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



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

Standard (Intake and exhaust) : **Refer to EM-137, "Cylinder Head".**

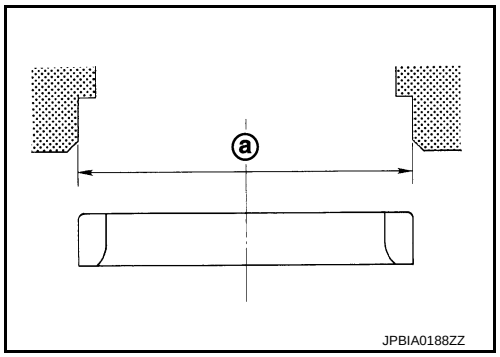


2. If valve seat is removed in step 9 (DISASSEMBLY), install it. Replace with oversize [0.5 mm (0.020 in)] valve seat.

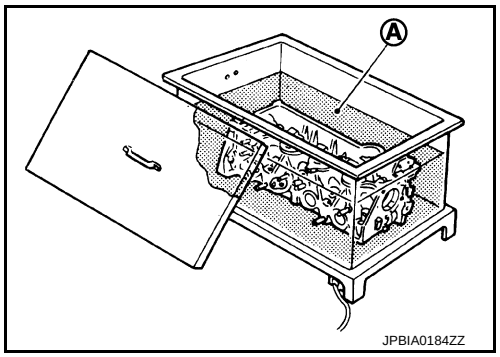
a. Ream cylinder head recess diameter (a) for service valve seat.

Oversize (Intake and exhaust) : **Refer to EM-137, "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).

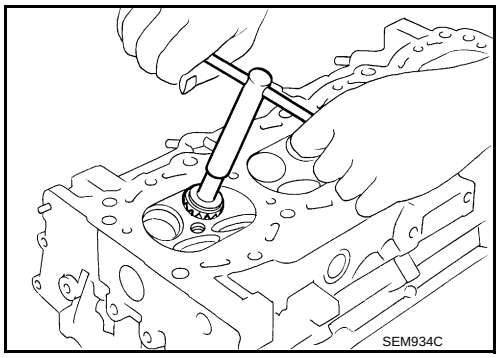


c. Provide valve seats cooled well with dry ice. Force fit valve seat into cylinder head.

WARNING:
Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.
CAUTION:
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-137, "Cylinder Head".

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



e. Using compound, grind to adjust valve fitting.

f. Check again for normal contact. Refer to "VALVE SEAT CONTACT".

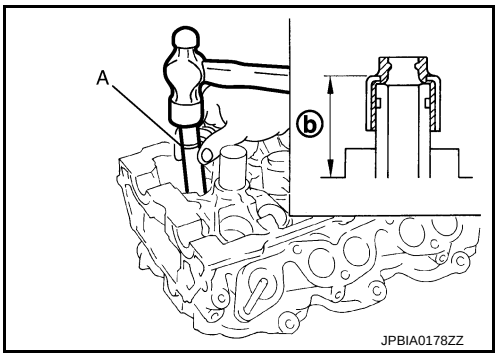
3. Install new valve oil seals as follows:

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

b. Install with the valve oil seal drift [SST: KV10115600 (J-38958)] (A) to match dimension in the figure.

Height (b) (Without valve spring seat installed)

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



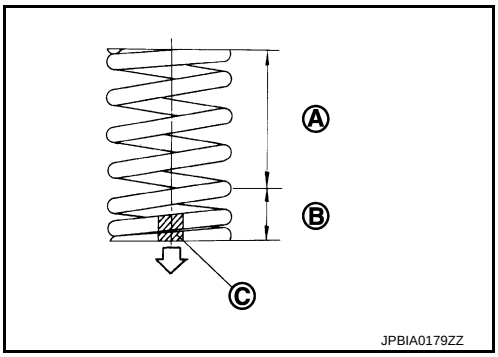
4. Install valve spring seat.

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

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

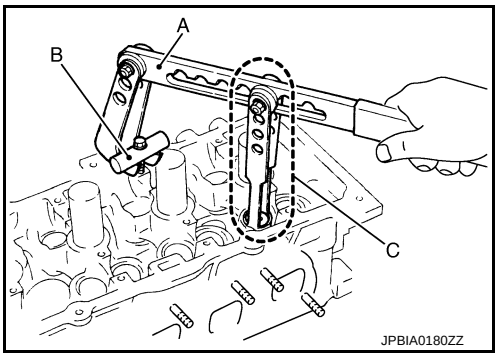
A : Wide pitch
B : Narrow pitch
C : Paint mark
⇦ : Cylinder head side

Paint mark color : Yellowish green



7. Install valve spring retainer.

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



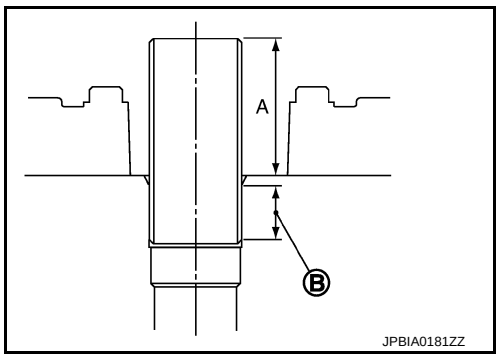
9. Install valve lifter.
- Install it in the original position.

10. Install spark plug tube.
- Press-fit spark plug tube as follows:

a. Remove old locking sealant adhering to cylinder head mounting hole.

b. Apply sealant to area within approximately 12 mm (0.47 in) from edge of spark plug tube press-fit side.
Use high strength thread locking sealant or equivalent.

c. Using drift, press-fit spark plug tube so that its height (A) is as specified in the figure.



B : High strength thread locking sealant application area

Standard press-fit height:

: 37.7 - 38.7 mm (1.484 - 1.524 in)

CAUTION:

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

11. Install spark plug with spark plug wrench (commercial service tool).
12. Install in the reverse order of removal after this step.

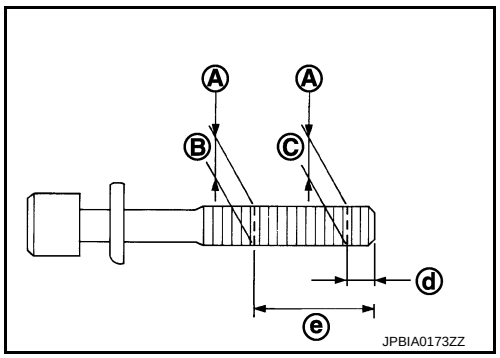
Inspection

INFOID:0000000008141208

INSPECTION AFTER REMOVAL

Cylinder Head Bolts Outer Diameter

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



A : Measuring point
d : 11 mm (0.43 in)
e : 48 mm (1.89 in)

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

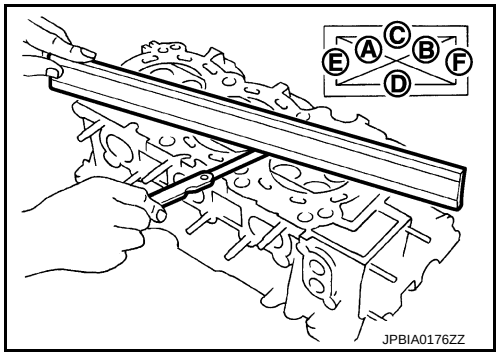
- If reduction of outer diameter appears in a position other than (B), use it as (B) point.

Cylinder Head Distortion

NOTE:

When performing this inspection, cylinder block distortion should be also checking. Refer to EM-139, "Cylinder Block".

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-137, "Cylinder Head".

- If it exceeds the limit, replace cylinder head.

INSPECTION AFTER DISASSEMBLY

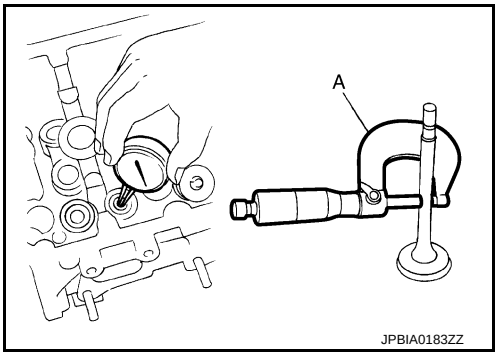
Valve Dimensions

- Check the dimensions of each valve. For the dimensions, refer to EM-137, "Cylinder Head".
- If dimensions are out of the standard, replace valve and check valve seat contact. Refer to "VALVE SEAT CONTACT".

Valve Guide Clearance

Valve Stem Diameter

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



Standard (Intake and exhaust) : **Refer to EM-137, "Cylinder Head".**

Valve Guide Inner Diameter

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

Standard (Intake and exhaust) : **Refer to EM-137, "Cylinder Head".**

Valve Guide Clearance

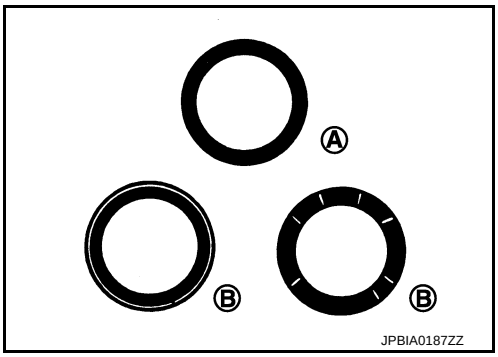
- (Valve guide clearance) = (Valve guide inner diameter) – (Valve stem diameter)

Valve guide clearance Standard and limit (Intake and exhaust) : **Refer to EM-137, "Cylinder Head".**

- If the calculated value exceeds the limit, replace valve and/or valve guide. When valve guide must be replaced, refer to EM-101, "Disassembly and Assembly".

Valve Seat Contact

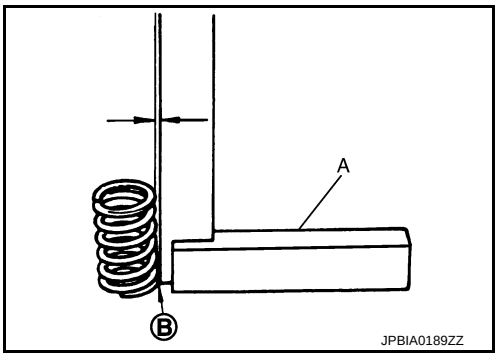
- After confirming that the dimensions of valve guides and valves are within the specifications, perform this procedure.
- Apply prussian blue (or white lead) onto contacting surface of valve seat to check the condition of the valve contact on the surface.
- Check if the contact area band is continuous all around the circumference.
- If not, grind to adjust valve fitting and check again. If the contacting surface still has “NG” (B) conditions even after the recheck, replace valve seat. Refer to EM-101, "Disassembly and Assembly".



A : OK

Valve Spring Squareness

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



B : Contact

Limit : **Refer to EM-137, "Cylinder Head".**

- If it exceeds the limit, replace valve spring.

Valve Spring Dimensions and Valve Spring Pressure Load

- Check the valve spring pressure at specified spring height.

Standard (Intake and exhaust)

Free height

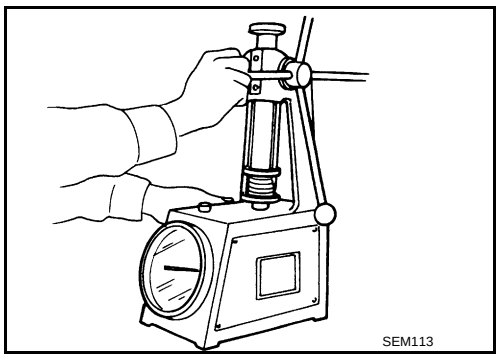
Installation height

Installation load

Height during valve open

Load with valve open

: Refer to EM-137, "Cylinder Head".



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

INSPECTION AFTER INSTALLATION

Inspection for Leakage

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

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to MA-10, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.

NOTE:

Perform maintenance mode 5 and maintain the engine speed. Refer to HBC-89, "Description".

- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to check there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill 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

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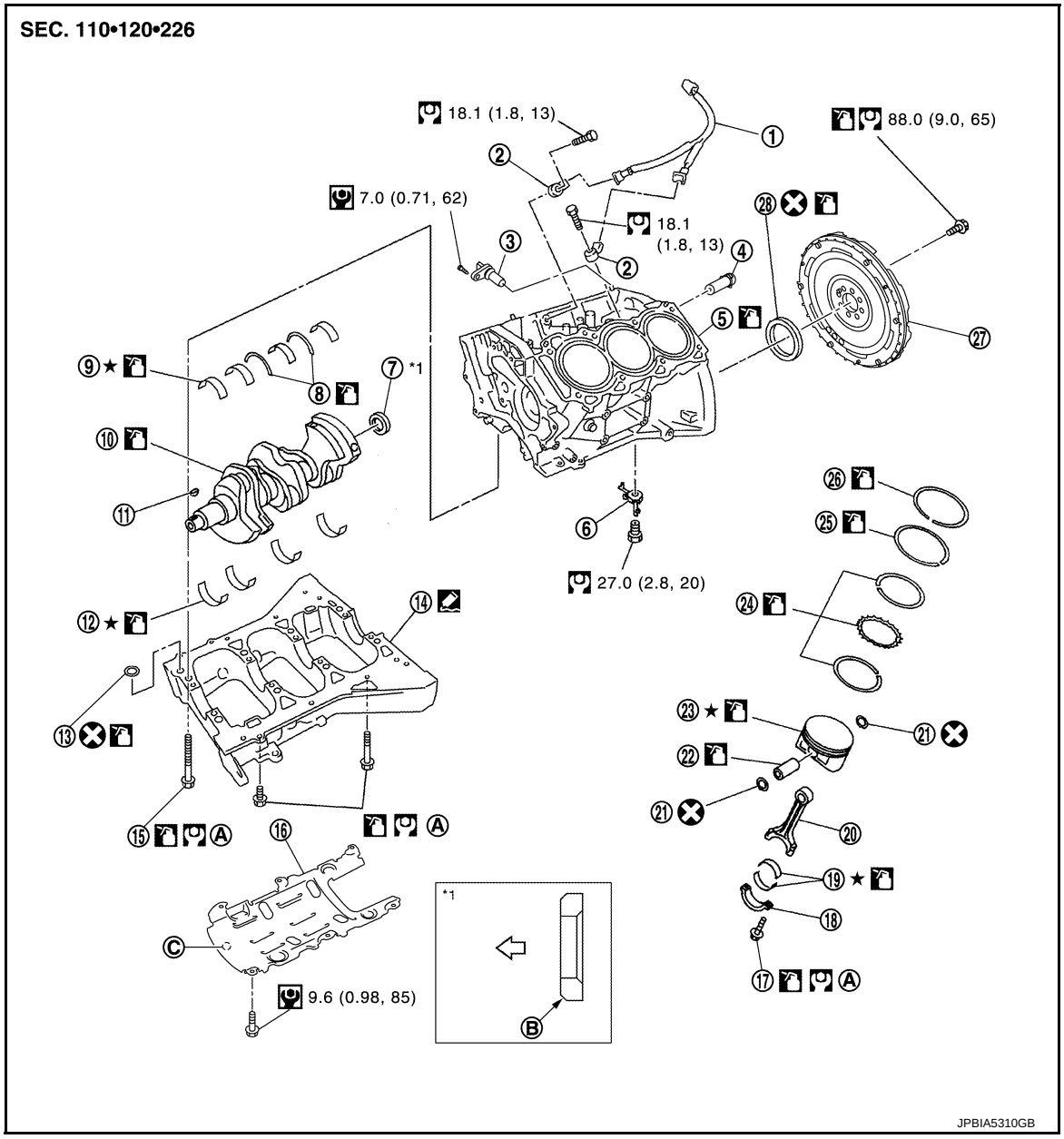


1. Sub harness
2. Knock sensor
3. Crankshaft position sensor
4. Cylinder block heater (For Canada)
5. Cylinder block
6. Oil jet
7. Pilot converter
8. Thrust bearing
9. Main bearing (upper)
10. Crankshaft
11. Crankshaft key
12. Main bearing (lower)
13. O-ring
14. Lower cylinder block
15. Lower cylinder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

A. Comply with the assembly procedure when tightening. Refer to EM-109.
B. Chamfered

: Crankshaft side

: N·m (kg-m, ft-lb)

: N·m (kg-m, in-lb)

: Always replace after every disassembly.

: Should be lubricated with oil.

: Sealing point

★ : Select with proper thickness.

Disassembly and Assembly

INFOID:0000000008141210

DISASSEMBLY

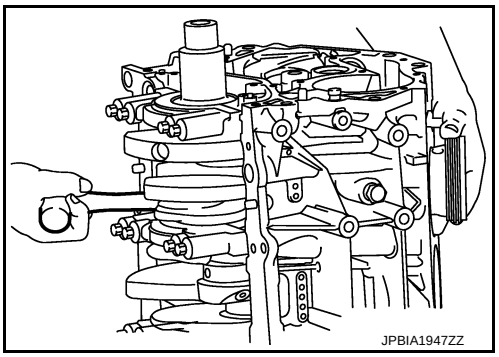
1. Remove the following parts:
   - Oil pans (lower and upper): Refer to EM-88, "Exploded View".
   - Timing chain: Refer to EM-49, "Exploded View".
   - Rear timing chain case. Refer to EM-91, "Exploded View".
   - Cylinder head: Refer to EM-97, "Exploded View".
2. Remove knock sensor.
   CAUTION:
   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.

   CAUTION:
   Never 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:
   Never damage the cylinder wall and crankshaft pin, resulting from an interference of the connecting rod big end.

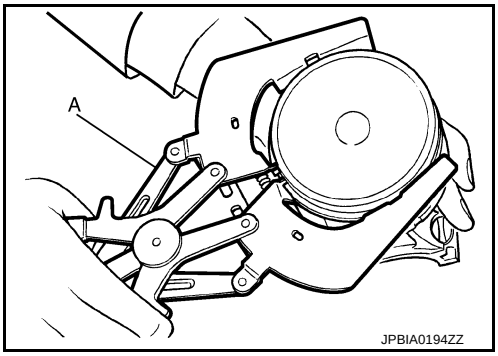


5. Remove connecting rod bearings from connecting rod and connecting rod bearing cap.
   CAUTION:
   - **Never drop connecting rod bearing, and to scratch the surface.**
   - **Identify installation positions, and store them without mixing them up.**
6. Remove piston rings from piston.
   - Before removing piston rings, check the piston ring side clearance. Refer to EM-139, "Cylinder Block".

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

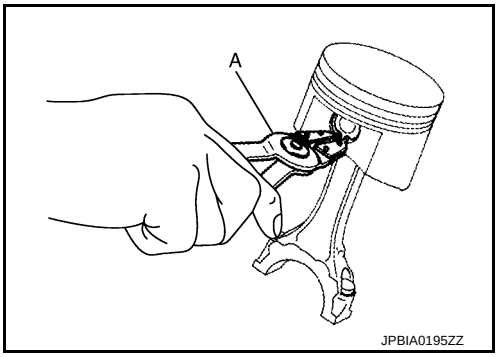
CAUTION:

- **When removing piston rings, be careful not to damage piston.**
- **Never damage piston rings by expanding them excessively.**

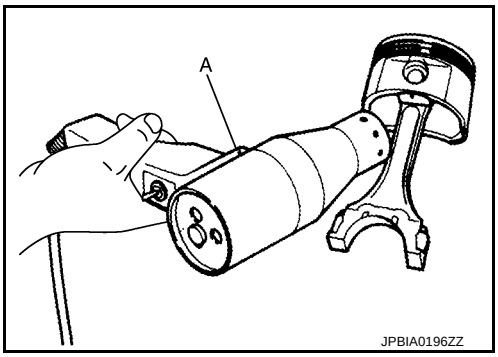


7. Remove piston from connecting rod as follows:

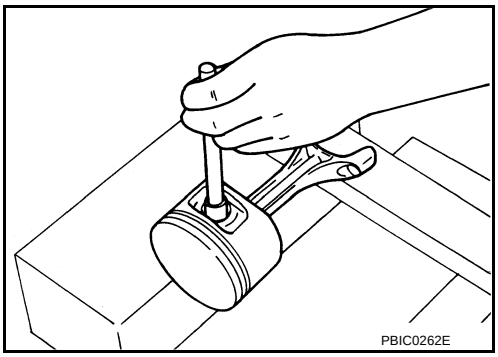
a. Using a snap ring pliers (A), remove snap rings.



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



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



8. Remove lower cylinder block bolts.

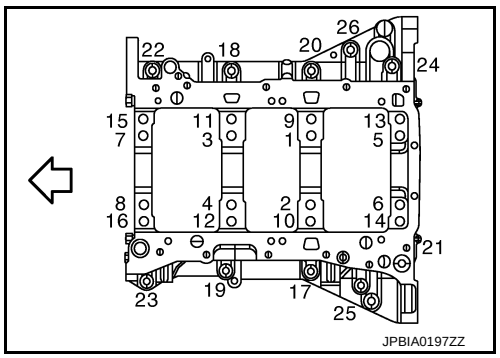
NOTE:

Use TORX socket (size E14) for bolts No. 1 to 16.

- Before loosening lower cylinder block bolts, measure the crankshaft end play. Refer to EM-118, "Inspection".

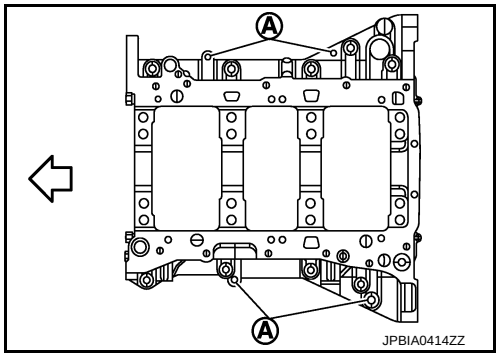
- Loosen lower cylinder block bolts in the reverse order shown in the figure in several different steps.

⇦ : Engine front



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

⇦ : Engine front



CAUTION:
- **Never damage the mounting surfaces.**
- **Never tighten bolts too much.**
- **Never insert screw driver, this will damage the mating surface.**

10. Remove crankshaft.
11. Pull rear oil seal out from rear end of crankshaft.
12. Remove main bearings and thrust bearings from cylinder block and lower cylinder block.
CAUTION:
- **Never drop main bearing, and to scratch the surface.**
- **Identify installation positions, and store them without mixing them up.**

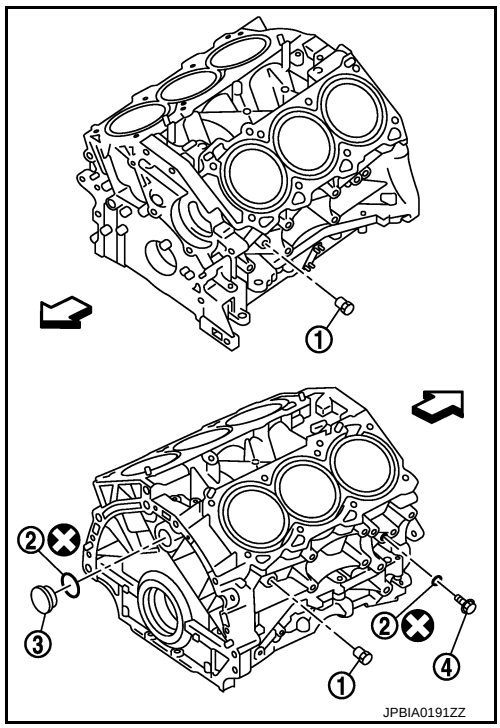
13. Remove oil jet.

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 a goggles to protect your eye.

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

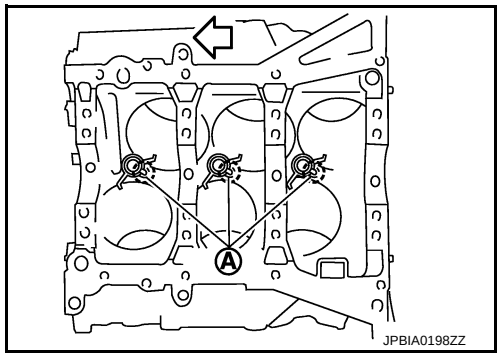


3 : Plug
⇦ : Engine front

CAUTION:
Do not reuse washers.
- Apply sealant to the thread of water drain plugs (1) (4).
  Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-23, "Recommended Chemical Products and Sealants".
- Apply sealant to the thread of plugs.
  Use Genuine High Strength Thread Locking Sealant or equivalent. Refer to GI-23, "Recommended Chemical Products and Sealants".
- Replace washers (2) with new one.
- Tighten each plug as specified below.

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

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

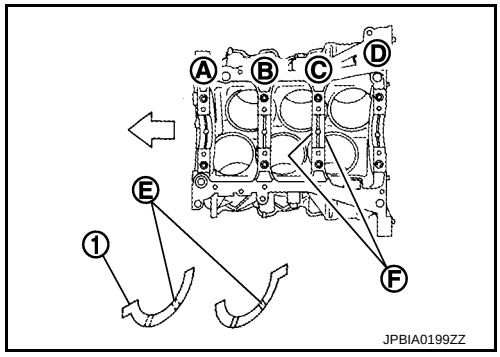


⇦ : Engine front

4. Install main bearings and thrust bearings as follows:
CAUTION:
Never 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.

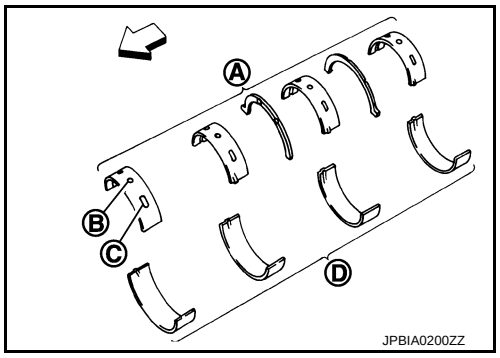
b. Install thrust bearings (1) to the both sides of the No. 3 journal housing on cylinder block.



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

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

c. Install main bearings paying attention to the direction.



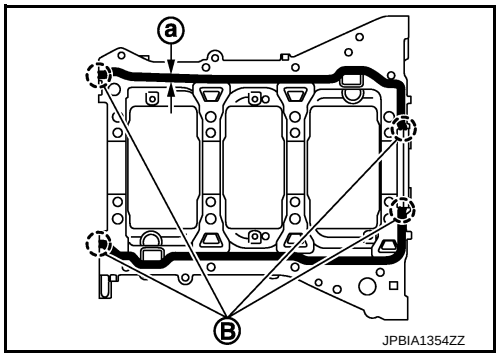
A : Cylinder block side
D : Lower cylinder block side
⇦ : Engine front

- 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-rings.
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.



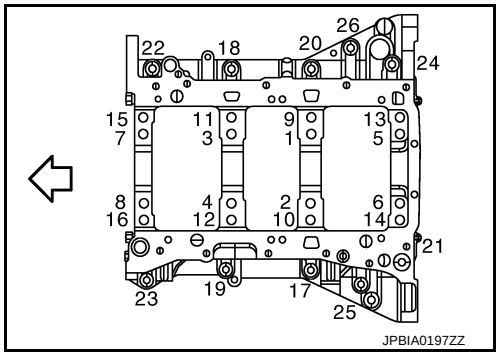
a : 4.0 - 5.0 mm (0.157 - 0.197 in) dia
B : Apply to end

Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-23, "Recommended Chemical Products and Sealants".

7. Inspect the outer diameter of lower cylinder block bolt. Refer to EM-118, "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

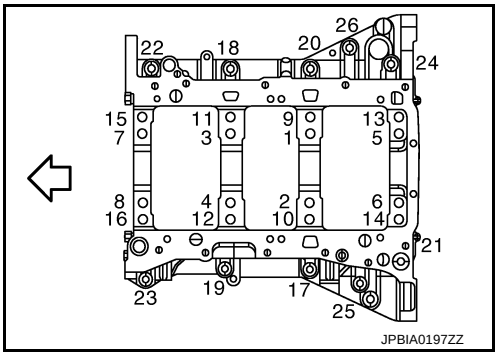
: 25.0 N·m (2.6 kg-m, 18 ft-lb)

c. Repeat step b.

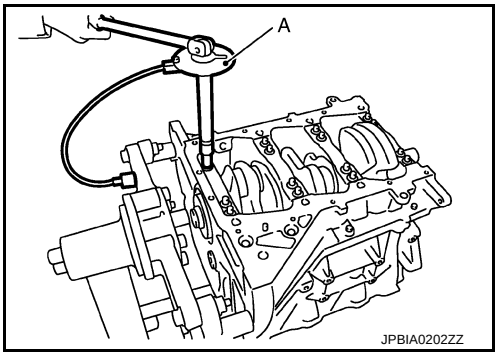
d. Tighten lower cylinder block bolt (No. 1 to 16) in numerical order as shown in the figure.
NOTE:
Use TORX socket (size E14) for bolts No. 1 to 16.

⇦ : Engine front

: 35.3 N·m (3.6 kg-m, 26 ft-lb)



e. Turn lower cylinder block bolt (No. 1 to 16) 90 degrees clockwise (angle tightening).
CAUTION:
Use the angle wrench [SST: KV10112100 (BT8653-A)] (A) to check tightening angle. Never make judgment by visual inspection.



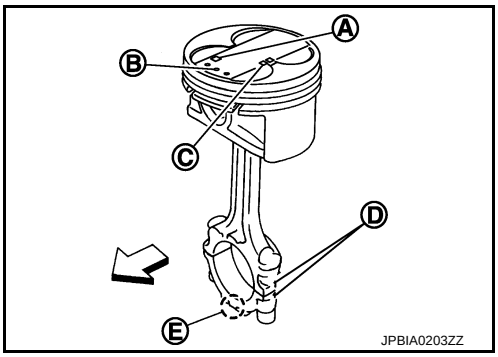
- After installing lower cylinder block bolts, check that crankshaft can be rotated smoothly by hand.
- Check the crankshaft end play. Refer to EM-118, "Inspection".

9. Check the outside diameter of connecting rod bolt. Refer to EM-118, "Inspection"
10. Install piston to connecting rod as follows:

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

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

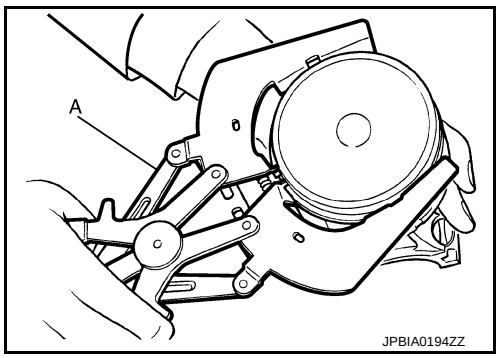


c. Install new snap ring to the groove of the piston front side.
- Insert it fully into groove to install.
- After installing, check that connecting rod moves smoothly.

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

CAUTION:

- **When installing piston rings, be careful not to damage piston.**
- **Never damage piston rings by expending them excessively.**

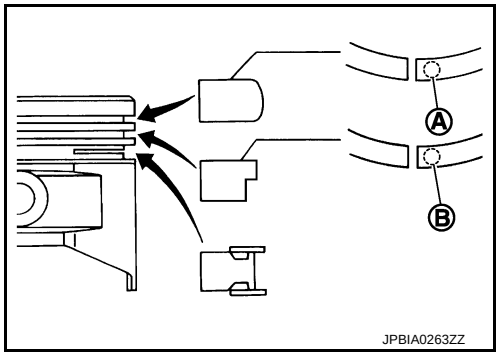


- If there is stamped mark on ring, mount it with marked side up.

Stamped mark:

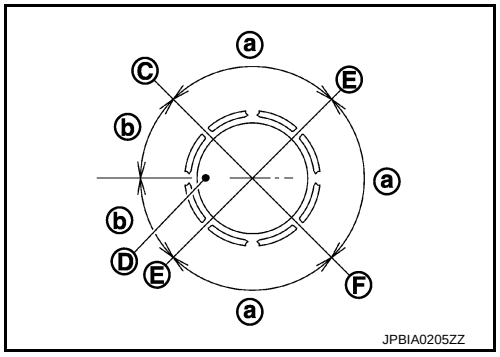
Top ring (A) : 1N

Second ring (B) : 2N



- 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



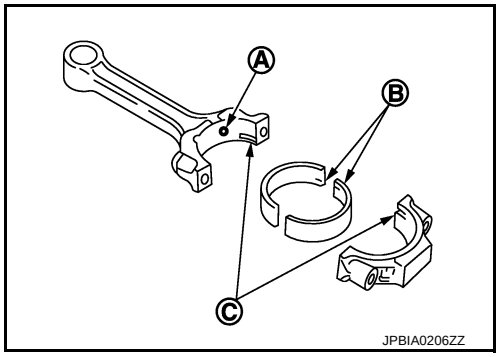
- Check the piston ring side clearance. Refer to EM-139, "Cylinder Block".

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

CAUTION:

Never drop connecting rod bearing, and to scratch the surface.

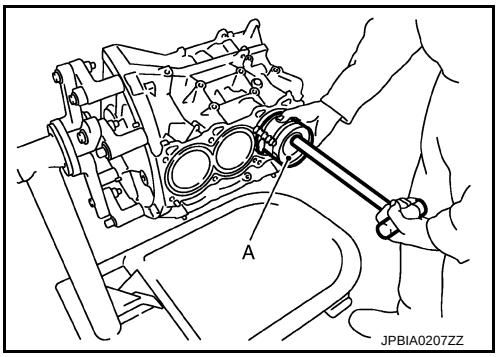
- Before installing connecting rod bearings, apply engine oil to the bearing surface (inside). Do not apply engine oil to the back surface, but thoroughly clean it.
- When installing, align connecting rod bearing stopper protrusion (B) with cutout (C) of connecting rods and connecting rod bearing caps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



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

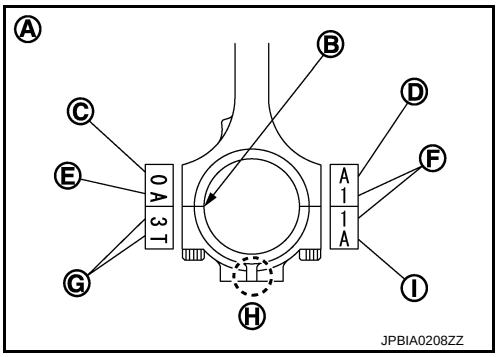
- Be sure that front mark on piston crown is facing front of engine.
- Using a piston ring compressor [SST: EM03470000 (J-8037)] (A) or suitable tool, install piston with the front mark on the piston crown facing the front of the engine.

CAUTION:
Never damage the cylinder wall and crankshaft pin, resulting from an interference of the connecting rod big end.



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

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



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

15. Tighten connecting rod bolt as follows:

a. Apply engine oil to the screw and the bearing surface of connecting rod.

b. Tighten the connecting rod bolts.

: 28.4 N·m (2.9 kg-m, 21 ft-lb)

c. Completely loosen connecting rod bolts.

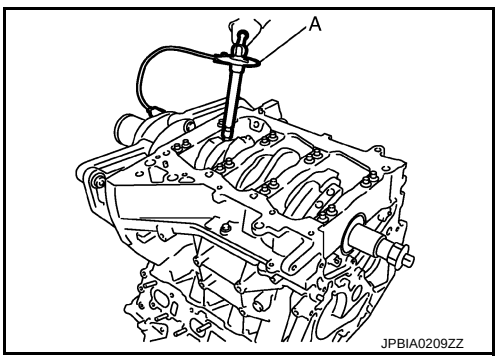
: 0 N·m (0 kg-m, 0 ft-lb)

d. Tighten connecting rod bolts.

: 24.5 N·m (2.5 kg-m, 18 ft-lb)

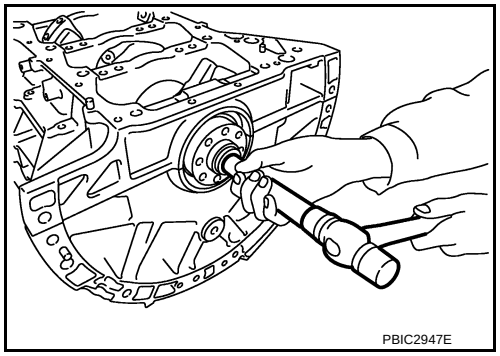
e. Tighten the connecting rod bolt by 90 degrees. (Angular tightening)

CAUTION:
Use angle wrench [SST: KV10112100 (BT8653-A)] (A) for angular tightening. Never judge by visual check.
- After tightening bolts, check that the crankshaft rotates smoothly.
- Check the piston ring side clearance. Refer to EM-118, "Inspection".



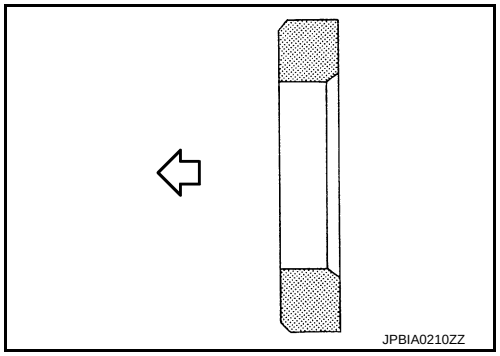
16. Install pilot converter.

- Press pilot converter into the cylinder block all the way to the end with a drift (general purpose tool) measuring approximately 33mm (1.30 in) in outside diameter.



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

⇦ : Crankshaft side



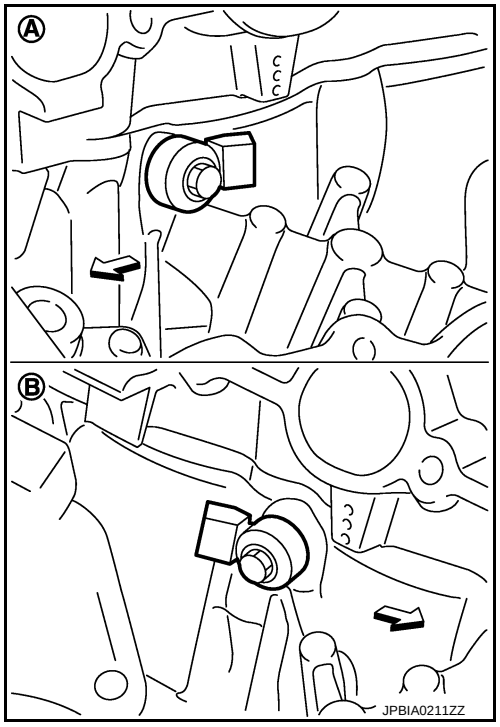
17. Install knock sensors.

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

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

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

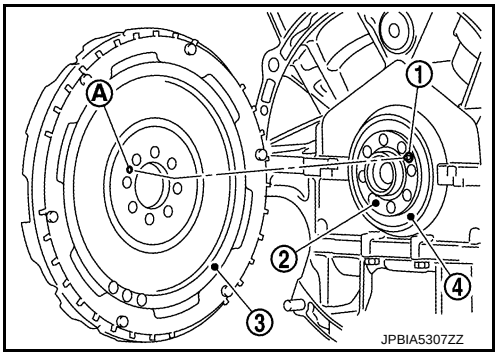
NOTE:
- Check that there is no foreign material on the cylinder block mating surface and the back surface of knock sensor.
- Check that knock sensor does not interfere with other parts.



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

- Ensure the dowel pin (1) is installed in the crankshaft (2).

3 : Flywheel
4 : Rear oil seal
A : Dowel pin hole



Inspection

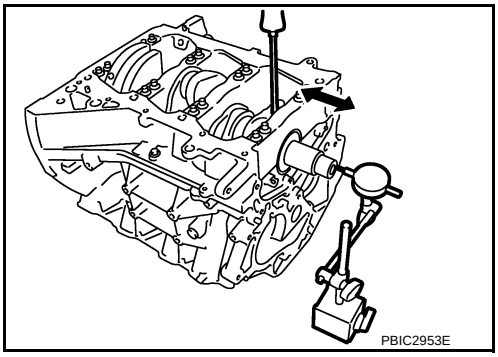
INFOID:0000000008141211

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-139, "Cylinder Block".

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

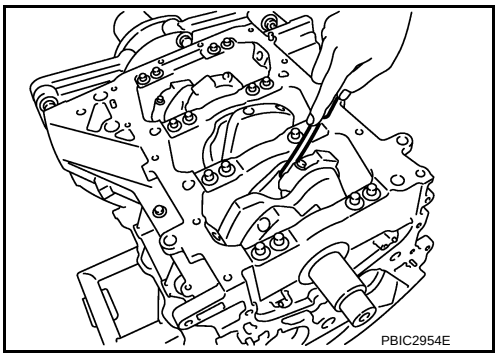


CONNECTING ROD SIDE CLEARANCE

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

Standard and limit : Refer to EM-139, "Cylinder Block".

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

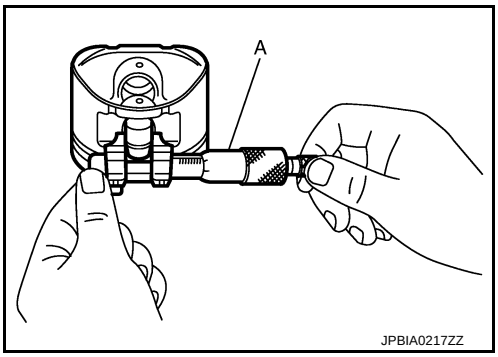


PISTON TO PISTON PIN OIL CLEARANCE

Piston Pin Hole Diameter

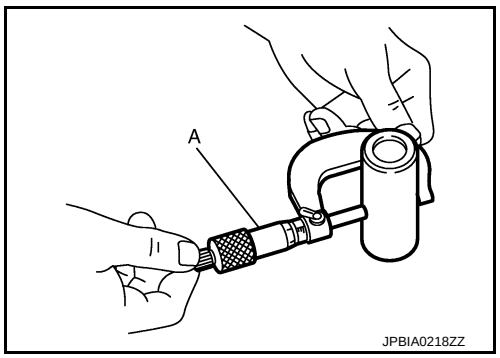
Measure the inner diameter of piston pin hole with an inside micrometer (A).

Standard : Refer to EM-139, "Cylinder Block".



Piston Pin Outer Diameter

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



Standard : Refer to EM-139, "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-139, "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-128, "Description".

NOTE:

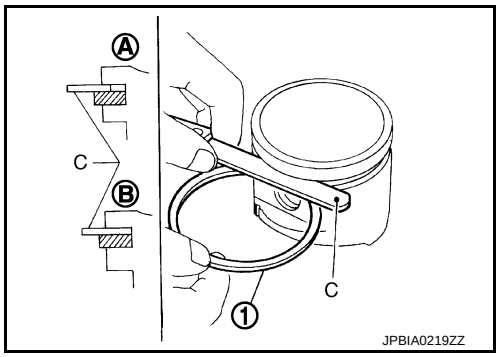
- Piston is available together with piston pin as assembly.
- Piston pin (piston pin hole) grade is provided only for the parts installed at the plant. For service parts, no piston pin grades can be selected. (Only “0” grade is available.)

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-139, "Cylinder Block".

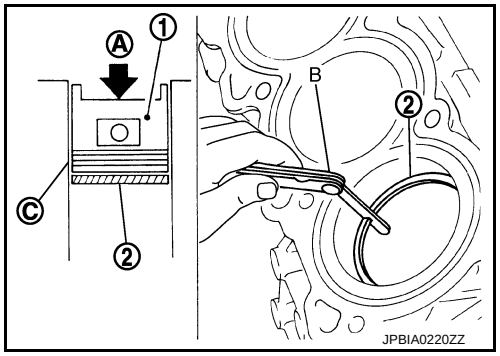
- If the measured value exceeds the limit, replace piston ring, and measure again. If it still exceeds the limit, replace piston also.

PISTON RING END GAP

- Check that the cylinder bore inner diameter is within the specification. Refer to EM-109, "Disassembly and Assembly".
- Lubricate with new engine oil to piston (1) and piston ring (2), and then insert piston ring until middle of cylinder with piston, and measure the piston ring end gap with a feeler gauge (B).

A : Press-fit

C : Measuring point



Standard and limit : Refer to EM-139, "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.

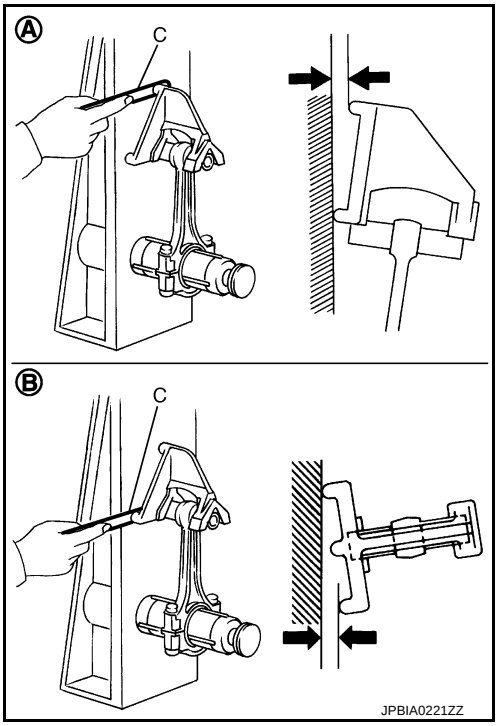
CONNECTING ROD BEND AND TORSION

- Check with a connecting rod aligner.

A : Bend
B : Torsion
C : Feeler gauge

Bend limit
Torsion limit **: Refer to EM-139, "Cylinder Block".**

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



CONNECTING ROD BIG END DIAMETER

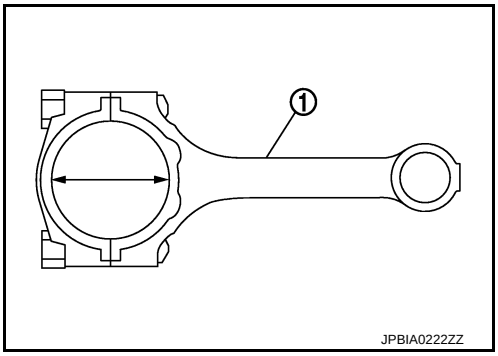
- Install connecting rod bearing cap without installing connecting rod bearing, and tightening connecting rod bolts to the specified torque. Refer to EM-109, "Disassembly and Assembly" for the tightening procedure.

1 : Connecting rod

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

Standard **: Refer to EM-139, "Cylinder Block".**

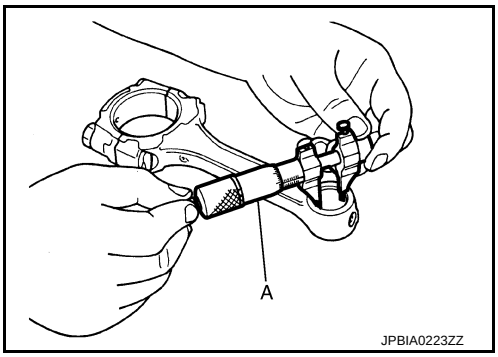
- If out of the standard, replace connecting rod assembly.



CONNECTING ROD BUSHING OIL CLEARANCE

Connecting Rod Bushing Inner Diameter
Measure the inner diameter of connecting rod bushing with an inside micrometer (A).

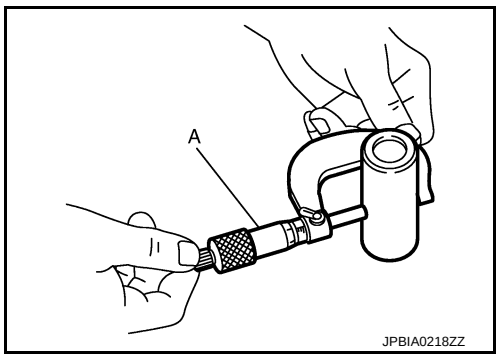
Standard **: Refer to EM-139, "Cylinder Block".**



Piston Pin Outer Diameter

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

Standard : Refer to EM-139, "Cylinder Block".

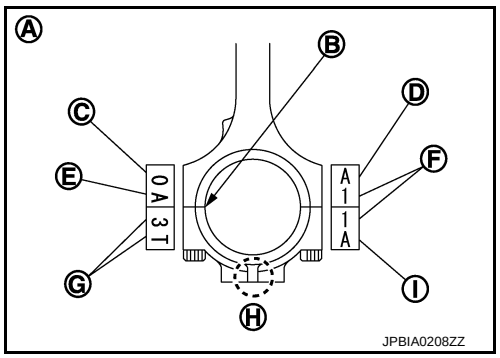


Connecting Rod Bushing Oil Clearance

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

Standard and limit : Refer to EM-139, "Cylinder Block".

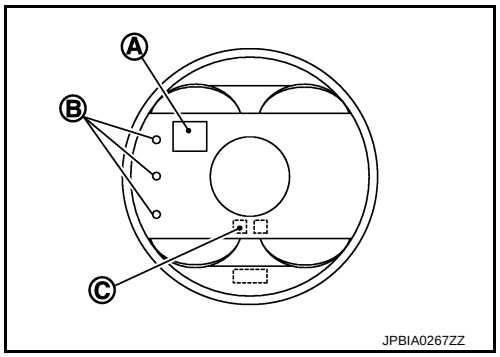
- If the calculated value exceeds the limit, replace connecting rod assembly and/or piston and piston pin assembly.
- If replacing piston and piston pin assembly, refer to EM-128, "Description".
- If replacing connecting rod assembly, refer to EM-129, "Connecting Rod Bearing" to select the connecting 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 : Piston grade number
B : Front mark
C : Piston pin grade number

Unit: mm (in)

Grade	0	1
Connecting rod bushing inner diameter *	Refer to EM-139, "Cylinder Block"	
Piston pin hole diameter		
Piston pin outer diameter		

CYLINDER BLOCK DISTORTION

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

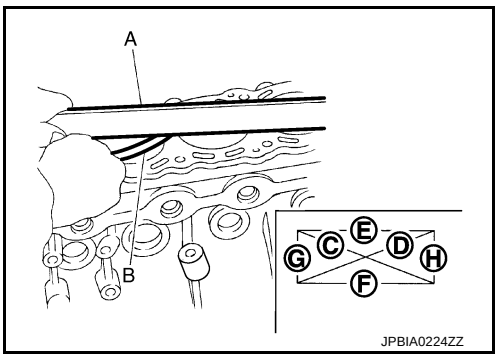
CAUTION:

Never 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-139, "Cylinder Block".

- If it exceeds the limit, replace cylinder block.



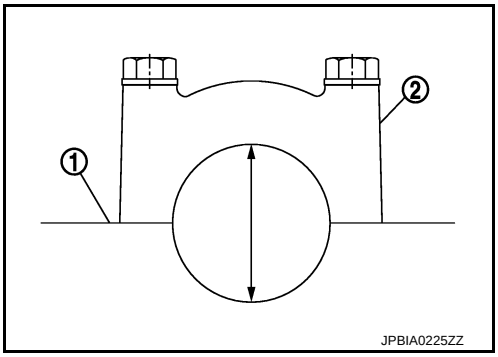
MAIN BEARING HOUSING INNER DIAMETER

- Install lower cylinder block (2) without installing main bearings, and tighten lower cylinder block bolts to the specified torque. Refer to EM-109, "Disassembly and Assembly" for the tightening procedure.
- Measure the inner diameter of main bearing housing with a bore gauge.

Standard : Refer to EM-139, "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.



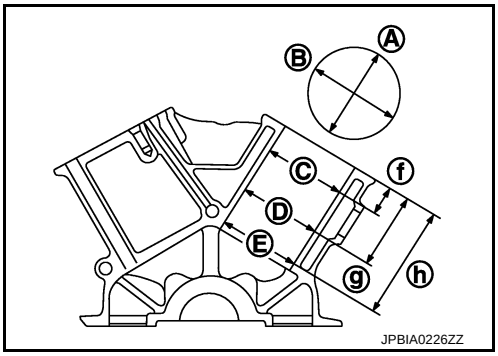
PISTON TO CYLINDER BORE CLEARANCE

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 : 20 mm (0.79 in)
g : 60 mm (2.36 in)
h : 120 mm (4.72 in)

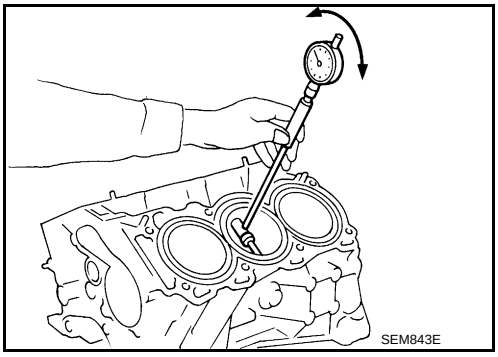
Standard and limit : Refer to EM-139, "Cylinder Block".



- 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.

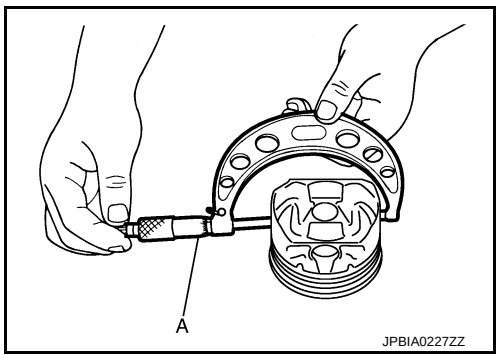
Oversize (O/S) : 0.2 mm (0.008 in)



Piston Skirt Diameter

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

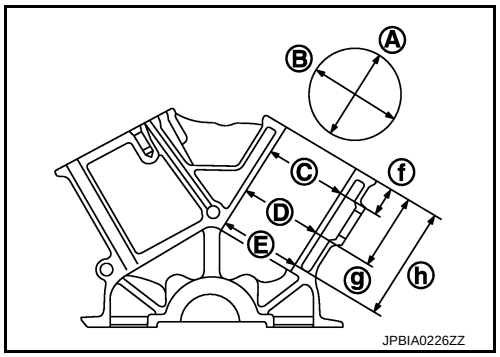
Measure point **: Refer to EM-139, "Cylinder Block".**
Standard



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 : 120 mm (1.72 in)



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

Standard and limit **: Refer to EM-139, "Cylinder Block".**

- If the calculated value exceeds the limit, replace piston and piston pin assembly. Refer to EM-139, "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 lower cylinder block, and tighten to the specified torque. Otherwise, cylinder bores may be distorted in final assembly.
3. Cut cylinder bores.
NOTE:
- When any cylinder needs boring, all other cylinders must also be bored.
- Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.
4. Hone cylinders to obtain the specified piston to cylinder bore clearance.
5. Measure finished cylinder bore for the out-of-round and taper.
NOTE:
Measurement should be done after cylinder bore cools down.

CRANKSHAFT MAIN JOURNAL DIAMETER

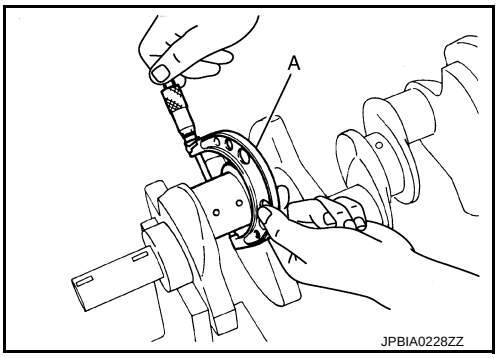
- Measure the outer diameter of crankshaft main journals with a micrometer.

Standard **: Refer to EM-139, "Cylinder Block".**

- If out of the standard, measure the main bearing oil clearance. Then use undersize bearing. Refer to EM-129, "Connecting Rod Bearing".

CRANKSHAFT PIN JOURNAL DIAMETER

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

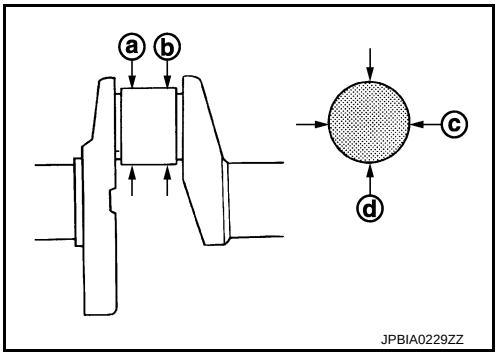


Standard : Refer toEM-139, "Cylinder Block".

- If out of the standard, measure the connecting rod bearing oil clearance. Then use undersize bearing. Refer to EM-129, "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.

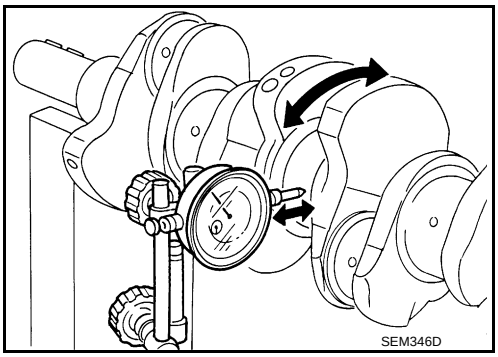


Limit : Refer to EM-139, "Cylinder Block".

- 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-131, "Main Bearing" and/or EM-129, "Connecting Rod Bearing".

CRANKSHAFT RUNOUT

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



Standard and limit : Refer to EM-139, "Cylinder Block".

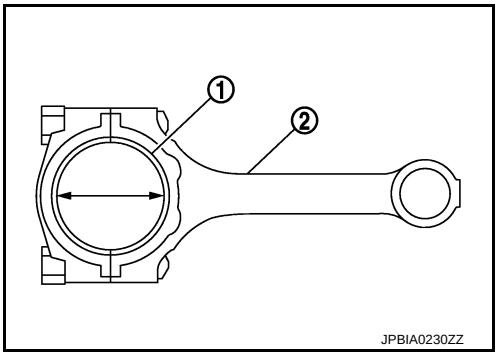
- If it exceeds the limit, replace crankshaft.

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-109, "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-144, "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-128, "Description".

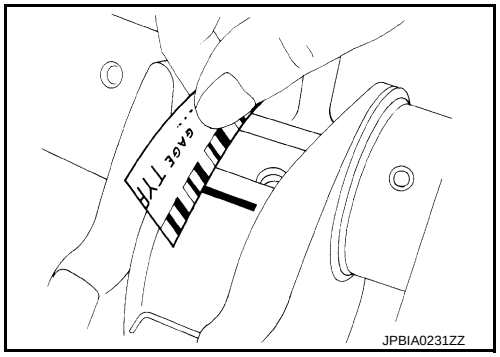
Method of Using Plastigage

- 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-109, "Disassembly and Assembly" for the tightening procedure.

CAUTION:
Never rotate crankshaft.

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

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



MAIN BEARING OIL CLEARANCE

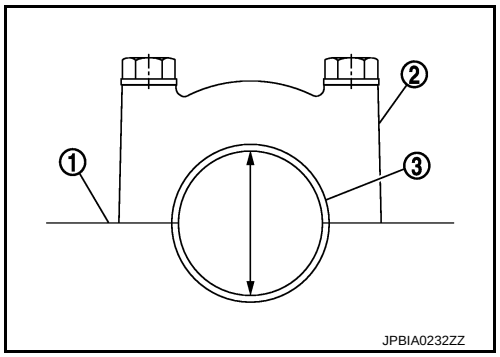
Method by Calculation

- 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-109, "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-143, "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-128, "Description".



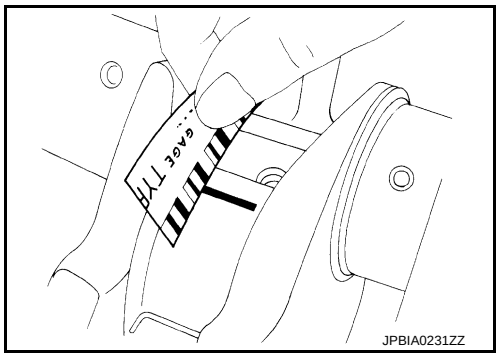
Method of Using Plastigage

- 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-109, "Disassembly and Assembly" for the tightening procedure.

CAUTION:
Never rotate crankshaft.

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

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



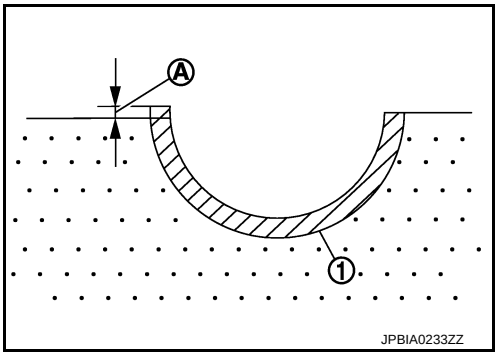
MAIN BEARING CRUSH HEIGHT

- When lower cylinder block is removed after being tightened to the specified torque with main bearings (1) installed, the tip end of bearing must protrude. Refer to EM-109, "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.



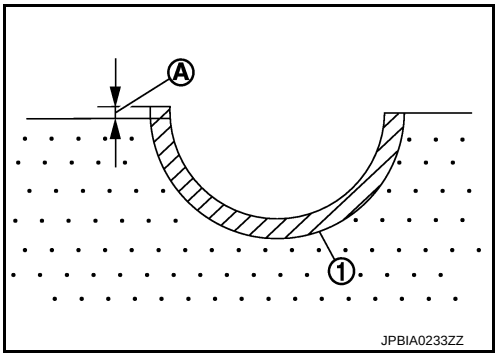
CONNECTING ROD BEARING CRUSH HEIGHT

- 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-109, "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

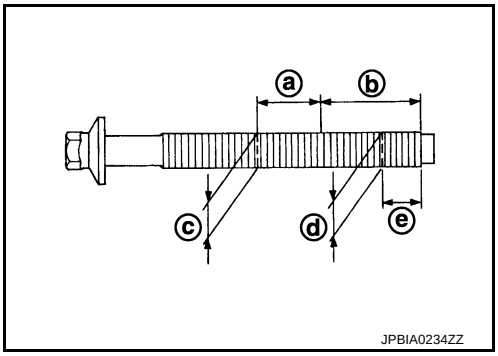
- Measure the outer diameters (c), (d) at two positions as shown in the figure.

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.



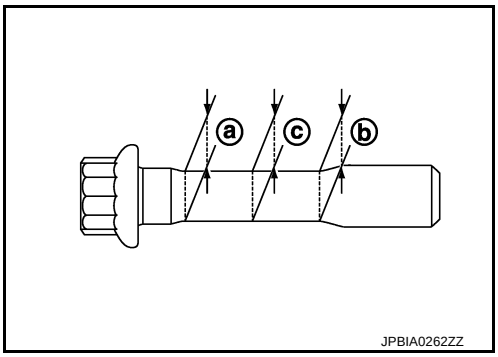
CONNECTING ROD BOLT OUTER DIAMETER

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)

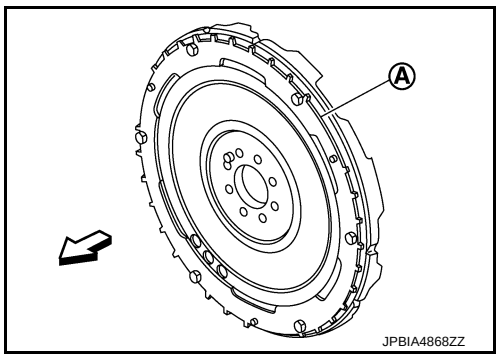


4. If it exceeds the limit (large difference in dimensions), replace the bolt with new one.

SIGNAL PLATE

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

⇦ : Engine front



- If anything is found, replace flywheel.

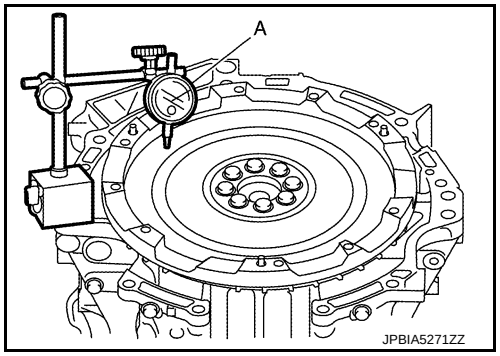
FLYWHEEL

Check that the joint surface engaging with the clutch cover and the sliding surface contacting the clutch disc do not have dents and scratches. If there is damage, replace clutch disc, and flywheel simultaneously.

FLYWHEEL DEFLECTION

- Measure the deflection of flywheel contact surface to clutch with a dial indicator (A).
- Measure the deflection at 240 mm (9.45 in) dia.

Standard : 0.45 mm (0.0177 in) or less



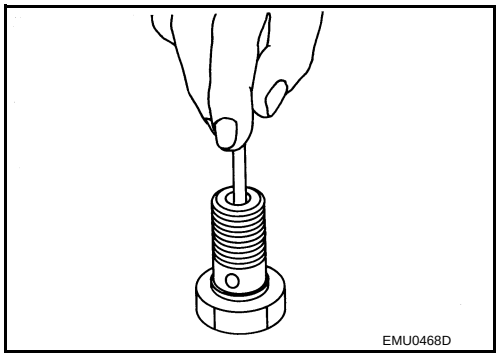
- If measured valve is out of the standard, replace flywheel

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:0000000008141212

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.

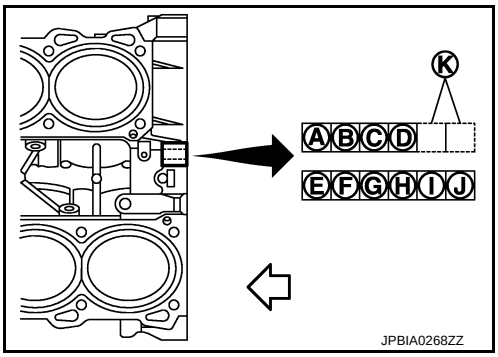
- The identification grade stamped on each part is the grade for the dimension measured in new condition. This grade cannot apply to reused parts.
- For reused or repaired parts, measure the dimension accurately. Determine the grade by comparing the measurement with the values of each selection table.
- 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:0000000008141213

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.



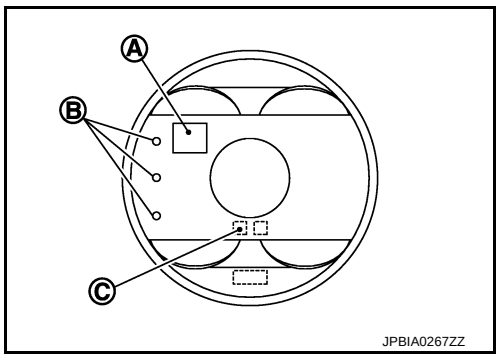
A : Bearing housing grade No. 1
B : Bearing housing grade No. 2
C : Bearing housing grade No. 3
D : Bearing housing grade No. 4
E : Cylinder bore grade No. 1
F : Cylinder bore grade No. 2
G : Cylinder bore grade No. 3
H : Cylinder bore grade No. 4
I : Cylinder bore grade No. 5
J : Cylinder bore grade 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-139, "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 : Piston grade number
B : Front mark
C : Piston pin grade number

3. Select piston of the same grade.

PISTON SELECTION TABLE

Unit: mm (in)

Grade	1	2	3
Cylinder bore inner diameter	Refer to EM-139, "Cylinder Block"		
Piston skirt diameter			

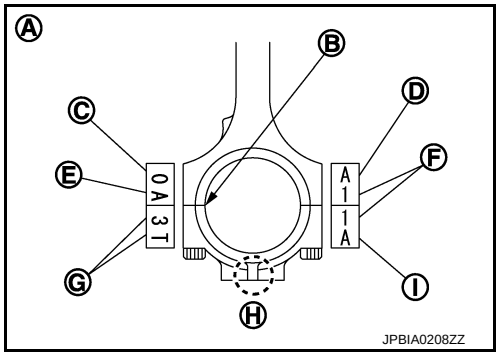
NOTE:
- Piston is available together with piston pin as assembly.
- Piston pin (piston pin hole) grade is provided only for the parts installed at the plant. For service parts, no piston pin grades can be selected. (Only “0” grade is available.)
- No second grade mark is available on piston.

Connecting Rod Bearing

INFOID:0000000008141214

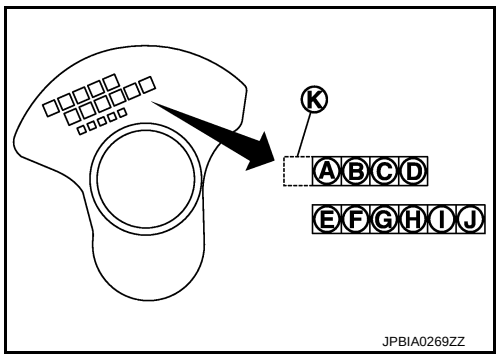
WHEN NEW CONNECTING ROD AND CRANKSHAFT ARE USED

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-139, "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-139, "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) / 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

PBIC5435E

CONNECTING ROD BEARING GRADE TABLE

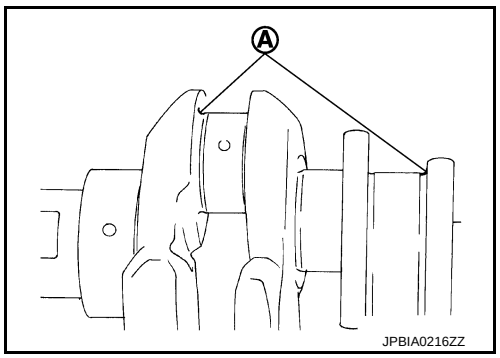
Connecting rod bearing grade table : Refer to EM-144, "Connecting Rod Bearing".

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)].



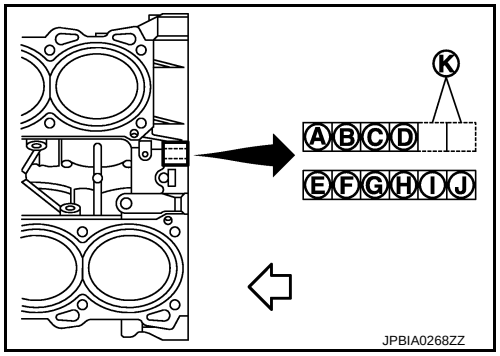
Bearing undersize table : Refer to EM-144, "Connecting Rod Bearing".

Main Bearing

INFOID:0000000008141215

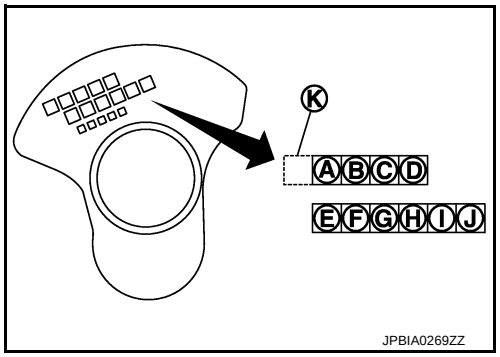
WHEN NEW CYLINDER BLOCK AND CRANKSHAFT ARE USED

1. "MAIN BEARING SELECTION TABLE" rows correspond to bearing housing grade on rear left side of cylinder block.



A : Bearing housing grade No. 1
B : Bearing housing grade No. 2
C : Bearing housing grade No. 3
D : Bearing housing grade No. 4
E : Cylinder bore grade No. 1
F : Cylinder bore grade No. 2
G : Cylinder bore grade No. 3
H : Cylinder bore grade No. 4
I : Cylinder bore grade No. 5
J : Cylinder bore grade No. 6
K : Identification code
⇦ : Engine front

2. "MAIN BEARING SELECTION TABLE" columns correspond to journal diameter grade on front side of crankshaft.



A : Journal diameter grade No. 1
B : Journal diameter grade No. 2
C : Journal diameter grade No. 3
D : Journal diameter grade No. 4
E : Pin diameter grade No. 1
F : Pin diameter grade No. 2
G : Pin diameter grade No. 3
H : Pin diameter grade No. 4
I : Pin diameter grade No. 5
J : Pin diameter grade No. 6
K : Identification code

3. Select main bearing grade at the point where selected row and column meet in "MAIN BEARING SELECTION TABLE".
4. Apply sign at crossing in above step 3 to "MAIN BEARING GRADE TABLE".
NOTE:
- "MAIN BEARING GRADE TABLE" applies to all journals.
- Service parts is available as a set of both upper and lower.

WHEN CYLINDER BLOCK AND CRANKSHAFT ARE REUSED

1. Measure cylinder block main bearing housing inner diameter and crankshaft main journal diameter. Refer to EM-139, "Cylinder Block" and Main Bearing.
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)
	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
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

- If the intersection of a column and a row is "X" (as shown in the bottom right of the figure), use Grade 7.
- **NOTE:**
  Bearing: A set of top and bottom.

MAIN BEARING GRADE TABLE (ALL JOURNALS)

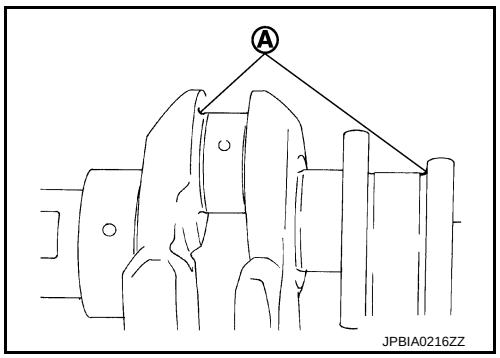
Main bearing grade table (All journals) : Refer to EM-143, "Main Bearing".

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-143, "Main Bearing".

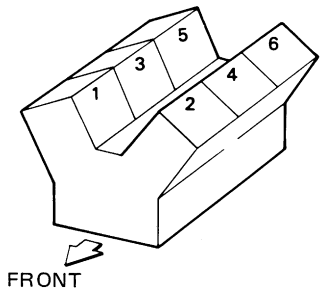
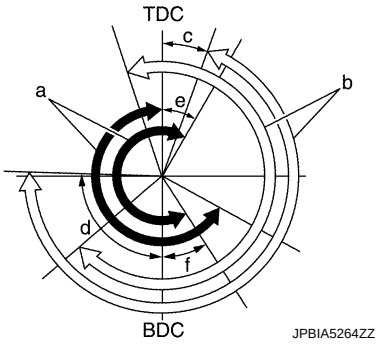
SERVICE DATA AND SPECIFICATIONS (SDS)

SERVICE DATA AND SPECIFICATIONS (SDS)

General Specification

INFOID:0000000008141216

GENERAL SPECIFICATIONS

Cylinder arrangement		V-6
Displacement cm^3 (cu in)		3,498 (213.45)
Bore and stroke mm (in)		95.5 x 81.4 (3.760 x 3.205)
Valve arrangement		DOHC
Firing order		1-2-3-4-5-6
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		4
Compression ratio		10.6
Compression pressure kPa (kg/cm^2, psi)/300 rpm	Standard	950 (9.69, 138)
	Minimum	730 (7.45, 106)
	Differential limit between cylinders	100 (1.0, 14.5)
Cylinder number	 SEM713A	
Valve timing (Valve timing control - “OFF”)	 JPBIA5264ZZ	

Unit: degree

a	b	c	d	e	f
248	248	–25 (23) BTDC	93 (45) ABDC	0 (35) ATDC	68 (33) BBDC

Spark Plug

INFOID:0000000008141217

SPARK PLUG

Unit: mm (in)

Make	DENSO
Standard type	FXE22HR11
Gap (Nominal)	1.1 (0.043)

Intake Manifold

INFOID:0000000008141218

INTAKE MANIFOLD

Unit: mm (in)

Items		Limit
Surface distortion	Intake manifold	0.1 (0.004)

Exhaust Manifold

INFOID:0000000008141219

EXHAUST MANIFOLD

Unit: mm (in)

Items		Limit
Surface distortion	Exhaust manifold	0.7 (0.028)

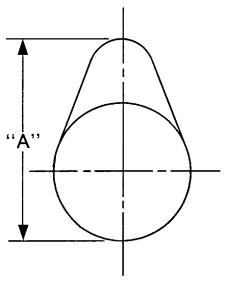
Camshaft

INFOID:0000000008141220

CAMSHAFT

Unit: mm (in)

Items		Standard	Limit
Camshaft journal oil clearance	No. 1	0.045 - 0.086 (0.0018 - 0.0034)	0.15 (0.0059)
	No. 2, 3, 4	0.035 - 0.076 (0.0014 - 0.0030)	
Camshaft bracket inner diameter	No. 1	26.000 - 26.021 (1.0236 - 1.0244)	—
	No. 2, 3, 4	23.500 - 23.521 (0.9252 - 0.9260)	—
Camshaft journal diameter	No. 1	25.935 - 25.955 (1.0211 - 1.0218)	—
	No. 2, 3, 4	23.445 - 23.465 (0.9230 - 0.9238)	—
Camshaft end play		0.115 - 0.188 (0.0045 - 0.0074)	0.24 (0.0094)
Camshaft cam height “A”	Intake	45.865 - 46.055 (1.8057 - 1.8132)	0.2 (0.008)*1
	Exhaust	45.875 - 46.065 (1.8061 - 1.8136)	0.2 (0.008)*1
Camshaft runout [TIR*2]		Less than 0.02 mm (0.0008)	0.05 (0.0020)
Camshaft sprocket runout [TIR*2]		—	0.15 (0.0059)



SEM671

*1: Cam wear limit

*2: Total indicator reading

VALVE LIFTER

Unit: mm (in)

Items	Standard
Valve lifter outer diameter	33.980 - 33.990 (1.3378 - 1.3382)
Valve lifter hole diameter	34.000 - 34.016 (1.3386 - 1.3392)
Valve lifter clearance	0.010 - 0.036 (0.0004 - 0.0014)

VALVE CLEARANCE

Unit: mm (in)

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

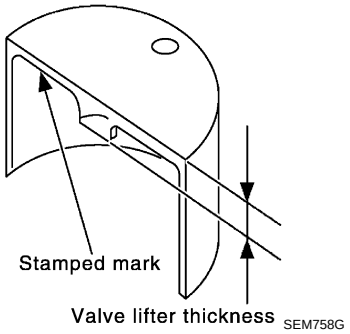
*: Approximately 80°C (176°F)

AVAILABLE VALVE LIFTER

Unit: mm (in)

Identification (stamped) mark	Thickness
788	7.88 (0.3102)
790	7.90 (0.3110)
792	7.92 (0.3118)
794	7.94 (0.3126)
796	7.96 (0.3134)
798	7.98 (0.3142)
800	8.00 (0.3150)
802	8.02 (0.3157)
804	8.04 (0.3165)
806	8.06 (0.3173)
808	8.08 (0.3181)
810	8.10 (0.3189)
812	8.12 (0.3197)
814	8.14 (0.3205)
816	8.16 (0.3213)
818	8.18 (0.3220)
820	8.20 (0.3228)
822	8.22 (0.3236)
824	8.24 (0.3244)
826	8.26 (0.3252)
828	8.28 (0.3260)
830	8.30 (0.3268)
832	8.32 (0.3276)
834	8.34 (0.3283)
836	8.36 (0.3291)
838	8.38 (0.3299)

Identification (stamped) mark	Thickness
840	8.40 (0.3307)



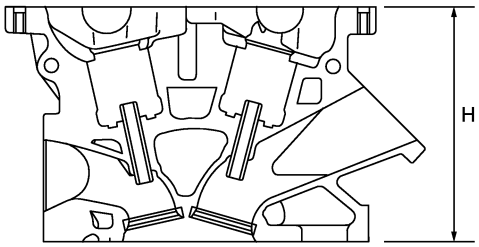
Cylinder Head

INFOID:0000000008141221

CYLINDER HEAD

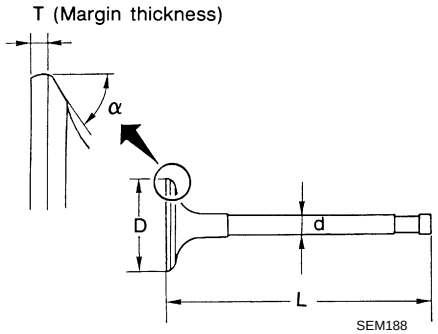
Unit: mm (in)

Items	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)
Normal cylinder head height “H”	126.3 - 126.5 (4.97 - 4.98)	—



VALVE DIMENSIONS

Unit: mm (in)

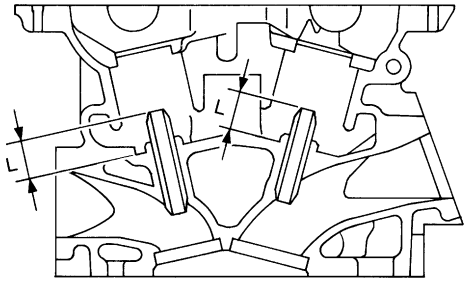


Valve head diameter “D”	Intake	36.6 - 36.9 (1.441 - 1.453)
	Exhaust	30.2 - 30.5 (1.189 - 1.201)
Valve length “L”	Intake	97.13 (3.8240)
	Exhaust	94.67 (3.7272)
Valve stem diameter “d”	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.962 - 5.970 (0.2347 - 0.2350)

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)



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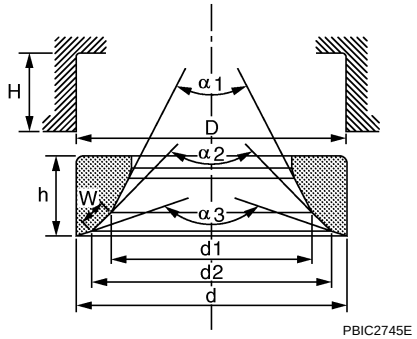
Items		Standard	Oversize (Service) [0.2 (0.008)]
Valve guide	Outer diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
	Inner diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter		9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
Items		Standard	Limit
Valve guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
	Exhaust	0.030 - 0.056 (0.0012 - 0.0022)	0.09 (0.0035)
Projection length “L”		12.6 - 12.8 (0.496 - 0.504)	

VALVE SEAT

Unit: mm (in)



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Items		Standard	Oversize (Service) [0.5 (0.02)]
Cylinder head seat recess diameter “D”	Intake	38.000 - 38.016 (1.4961 - 1.4967)	38.500 - 38.516 (1.5157 - 1.5164)
	Exhaust	31.600 - 31.616 (1.2441 - 1.2447)	32.100 - 32.116 (1.2638 - 1.2644)
Valve seat outer diameter “d”	Intake	38.097 - 38.113 (1.4999 - 1.5005)	38.597 - 38.613 (1.5196 - 1.5202)
	Exhaust	31.680 - 31.696 (1.2472 - 1.2479)	32.180 - 32.196 (1.2669 - 1.2676)
Valve seat interference fit	Intake	0.081 - 0.113 (0.0032 - 0.0044)	
	Exhaust	0.064 - 0.096 (0.0025 - 0.0038)	

Diameter “d1”*1	Intake	34.6 (1.362)	
	Exhaust	27.7 (1.091)	
Diameter “d2”*2	Intake	35.9 - 36.4 (1.413 - 1.433)	
	Exhaust	29.3 - 29.8 (1.154 - 1.173)	
Angle “α1”	Intake	60°	
	Exhaust	60°	
Angle “α2”	Intake	88°45′ - 90°15′	
	Exhaust	88°45′ - 90°15′	
Angle “α3”	Intake	120°	
	Exhaust	120°	
Contacting width “W”*3	Intake	1.0 - 1.4 (0.039 - 0.055)	
	Exhaust	1.2 - 1.6 (0.047 - 0.063)	
Height “h”	Intake	5.9 - 6.0 (0.232 - 0.236)	5.05 - 5.15 (0.1988 - 0.2028)
	Exhaust	5.9 - 6.0 (0.232 - 0.236)	4.95 - 5.05 (0.1949 - 0.1988)
Depth “H”		6.0 (0.236)	

*1: Diameter made by intersection point of conic angles “α1” and “α2”

*2: Diameter made by intersection point of conic angles “α2” and “α3”

*3: Machining data

VALVE SPRING

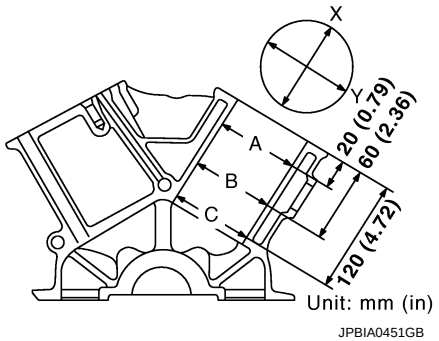
Items	
Free height	43.85 (1.7264)
Installation height	37.00 (1.4567)
Installation load	166 - 188 N (16.9 - 19.2 kg, 37 - 42 lb)
Height during valve open	26.8 (1.055)
Load with valve open	502 - 566 N (51.2 - 57.7 kg, 113 - 127 lb)
Squareness	1.9 (0.075)

Cylinder Block

INFOID:0000000008141222

CYLINDER BLOCK

Unit: mm (in)



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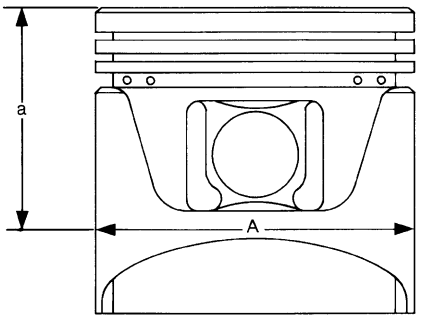
Surface flatness	Standard	Less than 0.03 (0.0012)
	Limit	0.1 (0.004)
Main bearing housing inner diameter	Standard	69.993 - 70.017 (2.7556 - 2.7566)

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)



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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)	—
End gap	Top	0.23 - 0.33 (0.0091 - 0.0130)	0.42 (0.0165)
	2nd	0.33 - 0.48 (0.0130 - 0.0189)	0.57 (0.0224)
	Oil (rail ring)	0.17 - 0.47 (0.0067 - 0.0185)	0.63 (0.0248)

PISTON PIN

Unit: mm (in)

Items		Standard	Limit
Piston pin outer diameter	Grade No. 0	21.989 - 21.995 (0.8657 - 0.8659)	—
	Grade No. 1	21.995 - 22.001 (0.8659 - 0.8662)	—
Piston to piston pin oil clearance		0.002 - 0.006 (0.0001 - 0.0002)	—
Connecting rod bushing oil clearance		0.005 - 0.017 (0.0002 - 0.0007)	0.030 (0.0012)

CONNECTING ROD

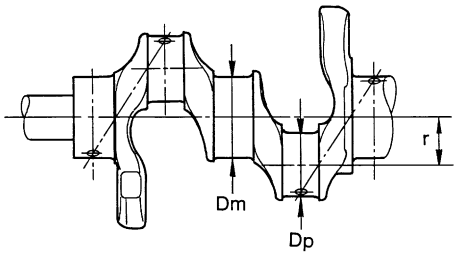
Unit: mm (in)

Items		Standard	Limit
Center distance		144.15 - 144.25 (5.68 - 5.68)	—
Bend [per 100 (3.94)]		—	0.15 (0.0059)
Torsion [per 100 (3.94)]		—	0.30 (0.0118)
Connecting rod bushing inner diameter*	Grade No. 0	22.000 - 22.006 (0.8661 - 0.8664)	—
	Grade No. 1	22.006 - 22.012 (0.8664 - 0.8666)	—
Connecting rod big end diameter (Without bearing)	Grade No. A	57.000 - 57.001 (2.2441 - 2.2441)	—
	Grade No. B	57.001 - 57.002 (2.2441 - 2.2442)	—
	Grade No. C	57.001 - 57.002 (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)

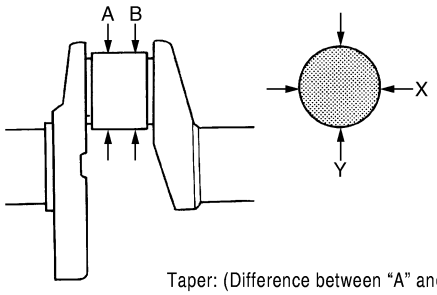
*: After installing in connecting rod

CRANKSHAFT

Unit: mm (in)



SEM645



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”	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”			40.66 - 40.74 (1.6008 - 1.6039)

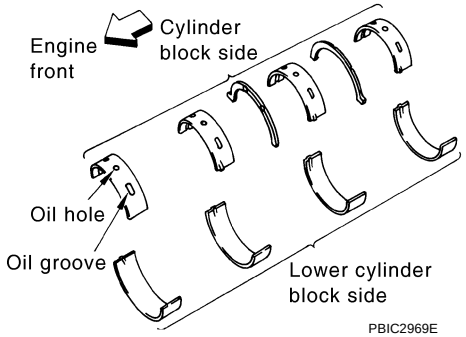
Taper (Difference between “A” and “B”)	Limit	0.0025 (0.0001)
Out-of-round (Difference between “X” and “Y”)		0.0025 (0.0001)
Crankshaft runout [TIR*]	Standard	Less than 0.05 (0.0020)
	Limit	0.10 (0.0039)
Crankshaft end play	Standard	0.10 - 0.25 (0.0039 - 0.0098)
	Limit	0.30 (0.012)

*: Total indicator reading

Main Bearing

INFOID:0000000008141223

MAIN BEARING



Grade number		Thickness mm (in)	Width mm (in)	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:0000000008141224

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