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# SECTION **EM**

## ENGINE MECHANICAL

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# PRECAUTIONS

## PRECAUTIONS

PF0:00001

### Precautions for Drain Engine Coolant

EBS00I28

Drain engine coolant when engine is cooled.

### Precautions for Disconnecting Fuel Piping

EBS00I29

- Before starting work, make sure 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.

### Precautions for Removal and Disassembly

EBS00I2A

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

### Precautions for Inspection, Repair and Replacement

EBS00I2B

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

### Precautions for Assembly and Installation

EBS00I2C

- 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.
- Release air within route when refilling after draining engine coolant.
- Before starting engine, apply fuel pressure to fuel lines with turning ignition switch ON (with engine stopped). Then make sure that there are no leaks at fuel line connections.
- After repairing, start engine and increase engine speed to check engine coolant, fuel, oil, and exhaust systems for leakage.

### Parts Requiring Angular Tightening

EBS00I2D

- Use an angle wrench for the final tightening of the following engine parts:

**Tool number** : **KV10112100 (BT-8653-A)**

- Cylinder head bolts
- Main bearing cap bolts
- Connecting rod cap bolts
- Crankshaft pulley bolt (No angle wrench is required as the bolt flange is provided with notches for angular tightening)
- 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 lightly coated with engine oil.

# PRECAUTIONS

EBS0012E

## Precautions for Liquid Gasket REMOVAL OF LIQUID GASKET SEALING

- After removing the mounting bolts and nuts, separate the mating surface using Tool and remove the old liquid gasket sealing.

**Tool number** : KV10111100 (J-37228)

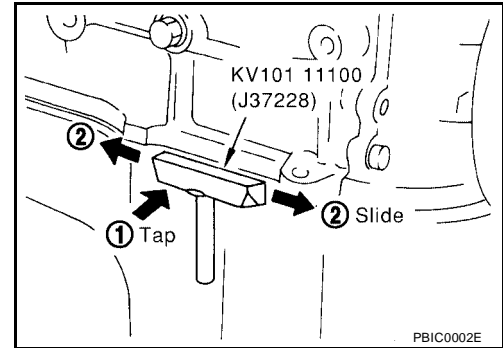
### CAUTION:

**Be careful not to damage the mating surfaces.**

- In areas where the tool is difficult to use, use a plastic hammer to lightly tap (1) the seal cutter where the liquid gasket is applied. Use a plastic hammer to slide the seal cutter (2) by tapping on the side.

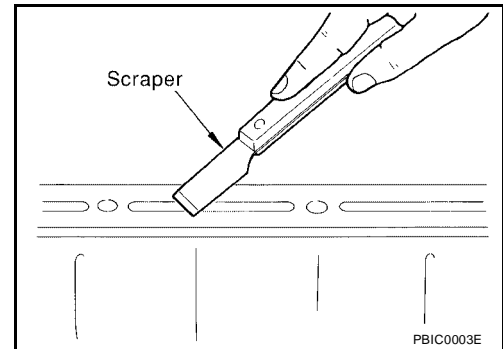
### CAUTION:

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



## LIQUID GASKET APPLICATION PROCEDURE

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

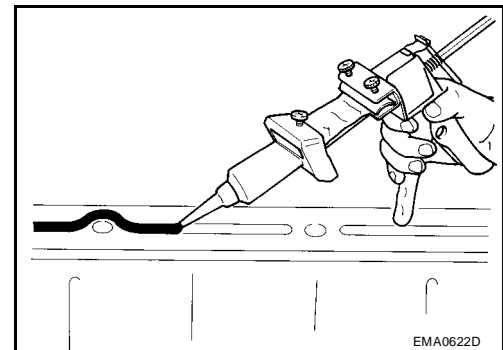


- Attach the liquid gasket tube to the Tool.

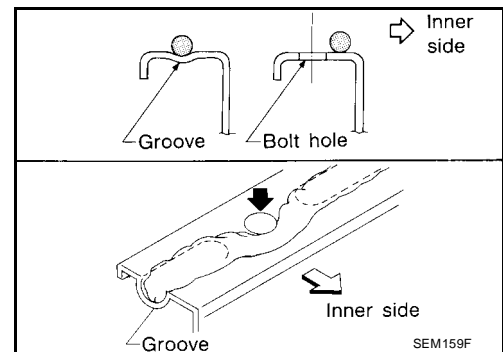
**Tool number** : WS39930000 ( — )

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#).**

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



- As for the bolt holes, normally apply the liquid gasket inside the holes. Occasionally, it should be applied outside the holes. Make sure to read the text of this manual.
- Within five minutes of liquid gasket application, install the mating component.
- If the liquid gasket protrudes, wipe it off immediately.
- Do not retighten after the installation.
- Wait 30 minutes or more after installation before refilling the engine with engine oil and engine coolant.



# PREPARATION

## PREPARATION

PFP:00002

### Special Service Tools

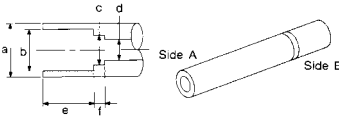
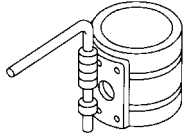
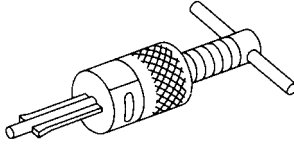
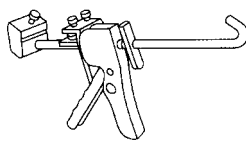
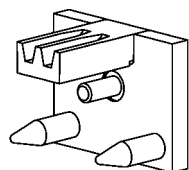

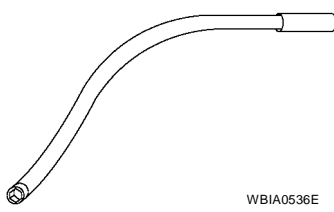
EBS00J90

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
KV10111100 (J-37228) Seal cutter	Removing steel oil pan and rear timing chain case
— (J-44626) Air fuel sensor Socket	Loosening or tightening air fuel ratio A/F sensor <b>a: 22 mm (0.87 in)</b>
EG15050500 (J-45402) Compression gauge adapter	Inspecting compression pressure
KV10116200 (J-26336-A) Valve spring compressor 1. KV10115900 (J-26336-20) Attachment 2. KV10109220 ( — ) Adapter	Disassembling valve mechanism Part (1) is a component of KV10116200 (J-26336-A), but part (2) is not so.
KV10112100 (BT-8653-A) Angle wrench	Tightening bolts for bearing cap, cylinder head, etc.
KV10107902 (J-38959) Valve oil seal puller	Removing valve oil seal

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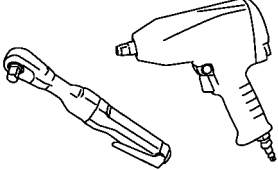
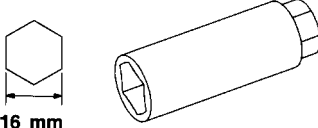
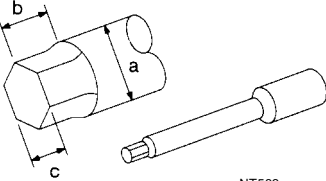
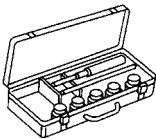
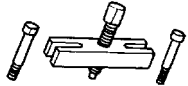
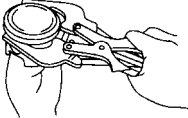
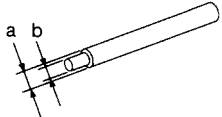
# PREPARATION

Tool number (Kent-Moore No.) Tool name	Description
KV10115600 (J-38958) Valve oil seal drift <div style="text-align: center;">  <p style="margin-top: 10px;">S-NT603</p> </div>	Installing valve oil seal <b>Use side A.</b> <b>a: 20 (0.79) dia.</b> <b>d: 8 (0.31) dia.</b> <b>b: 13 (0.51) dia.</b> <b>e: 10.7 (0.421) dia.</b> <b>c: 10.3 (0.406) dia.</b> <b>f: 5 (0.20) dia.</b> <div style="text-align: right;">Unit: mm (in)</div>
EM03470000 (J-8037) Piston ring compressor <div style="text-align: center;">  <p style="margin-top: 10px;">S-NT044</p> </div>	Installing piston assembly into cylinder bore
ST16610001 (J-23907) Pilot bushing puller <div style="text-align: center;">  <p style="margin-top: 10px;">S-NT045</p> </div>	Removing crankshaft pilot bushing
WS39930000 ( — ) Tube presser <div style="text-align: center;">  <p style="margin-top: 10px;">S-NT052</p> </div>	Pressing the tube of liquid gasket
— (J-45476) Ring gear stopper <div style="text-align: center;">  <p style="margin-top: 10px;">PBIC1655E</p> </div>	Removing and installing crankshaft pulley
16441 6N210 (J-45488) Quick connector release <div style="text-align: center;">  <p style="margin-top: 10px;">PBIC0198E</p> </div>	Removing fuel tube quick connectors in engine room (Available in SEC. 164 of PARTS CATALOG: Part No. 16441 6N210)
— (J-46535) Drive belt tension releaser <div style="text-align: center;">  <p style="margin-top: 10px;">WBIA0536E</p> </div>	Releasing drive belt tension

# PREPARATION

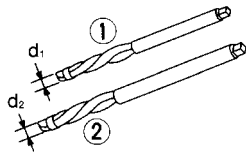
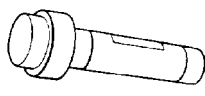
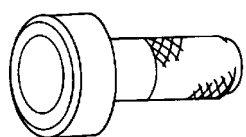
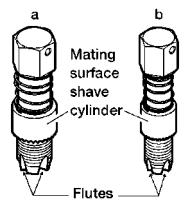
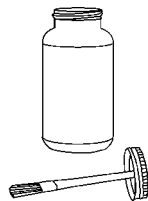
## Commercial Service Tools

EBS00J9P

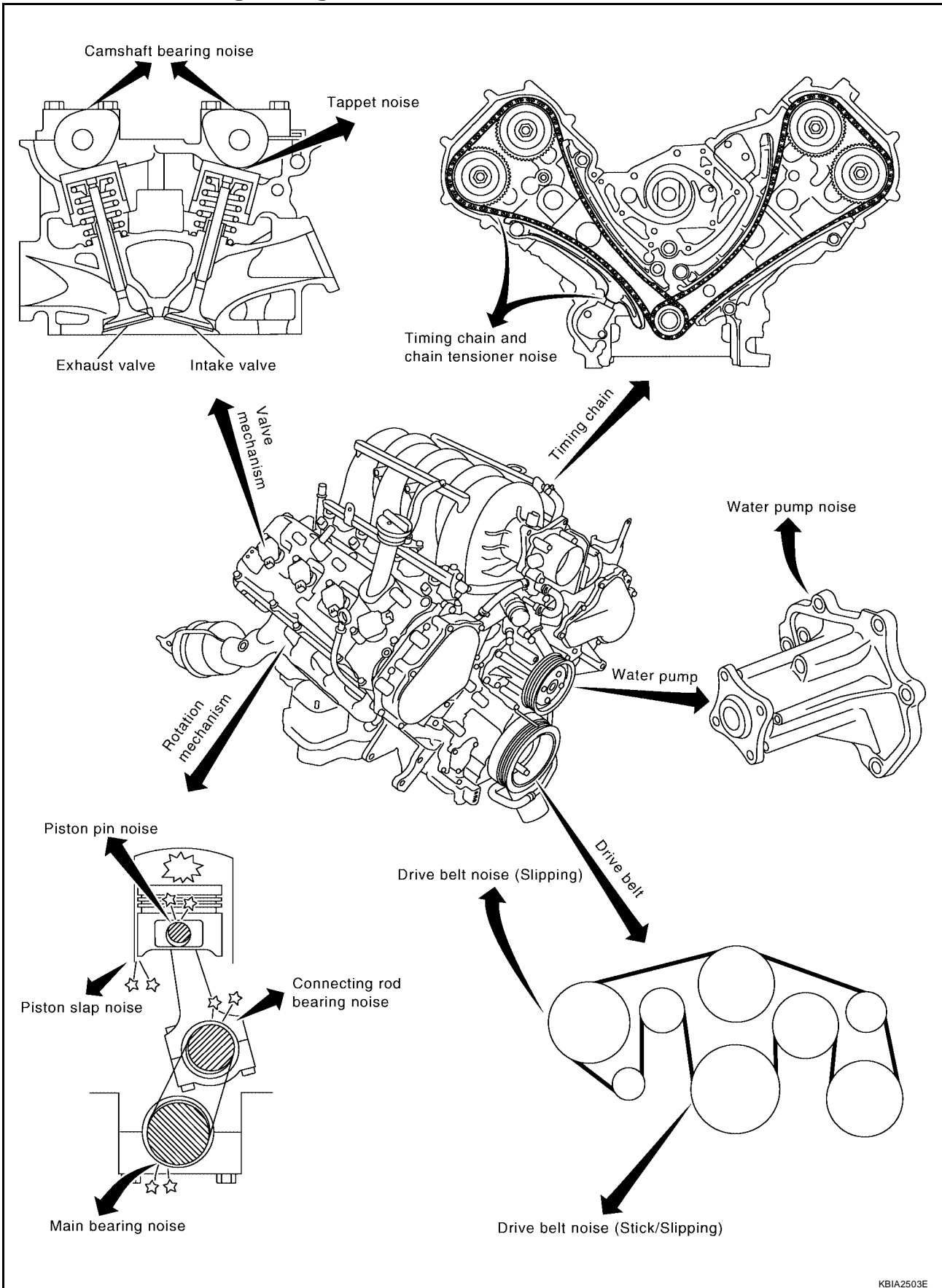
(Kent-Moore No.) Tool name	Description
Power tool   PBIC0190E	Loosening bolts and nuts
Spark plug wrench   16 mm (0.63 in)  S-NT047	Removing and installing spark plug
(J-24239-01) Cylinder head bolt wrench   NT583	Loosening and tightening cylinder head bolt, and use with angle wrench [SST: KV10112100 (BT-8653-A)] <b>a: 13 (0.51) dia.</b> <b>b: 12 (0.47)</b> <b>c: 10 (0.39)</b> Unit: mm (in)
Valve seat cutter set   S-NT048	Finishing valve seat dimensions
Pulley puller   ZZA0010D	Removing crankshaft pulley
Piston ring expander   S-NT030	Removing and installing piston ring
Valve guide drift   S-NT015	Removing and installing valve guide <b>Intake &amp; Exhaust:</b> <b>a: 9.5 mm (0.374 in) dia.</b> <b>b: 5.5 mm (0.217 in) dia.</b>

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(Kent-Moore No.) Tool name	Description
Valve guide reamer   <small>S-NT016</small>	1: Reaming valve guide hole 2: Reaming hole for oversize valve guide <b>Intake &amp; Exhaust:</b> <b>d1 : 6.0 mm (0.236 in) dia.</b> <b>d2 : 10.2 mm (0.402 in) dia.</b>
Front oil seal drift   <small>ZZA0012D</small>	Installing front oil seal
Rear oil seal drift   <small>ZZA0025D</small>	Installing rear oil seal
(J-43897-18) (J-43897-12) Oxygen sensor thread cleaner   <small>AEM488</small>	Reconditioning the exhaust system threads before installing a new A/F sensor and heated oxygen sensor (Use with anti-seize lubricant shown below.) <b>a: J-43897-18 (18 mm dia.) (0.71 in) for zirconia heated oxygen sensor</b> <b>b: J-43897-12 (12 mm dia.) (0.55 in) for titanium heated oxygen sensor</b>
Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907)   <small>AEM489</small>	Lubricating A/F sensors and heated oxygen sensor thread cleaning tool when reconditioning exhaust system threads





# NOISE, VIBRATION, AND HARSHNESS (NVH) TROUBLESHOOTING

EBS00121

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

1. Locate the area where noise occurs.
2. Confirm the type of noise.
3. Specify the operating condition of engine.
4. Check specified noise source.

If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	<a href="#">EM-52</a>
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	<a href="#">EM-47</a> <a href="#">EM-46</a>
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance	<a href="#">EM-91</a> <a href="#">EM-93</a>
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston-to-bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	<a href="#">EM-95</a> <a href="#">EM-91</a> <a href="#">EM-91</a> <a href="#">EM-92</a>
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance (Small end) Connecting rod bearing clearance (Big end)	<a href="#">EM-93</a> <a href="#">EM-92</a>
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	<a href="#">EM-97</a> <a href="#">EM-96</a>
Front of engine Chain case cover Front cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation	<a href="#">EM-38</a> <a href="#">EM-35</a>
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	<a href="#">EM-12</a>
	Creaking	A	B	A	B	A	B	Drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creaking	A	B	—	B	A	B	Water pump noise	Water pump operation	<a href="#">CO-15</a>

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

# ENGINE ROOM COVER

## ENGINE ROOM COVER

PFP:14049

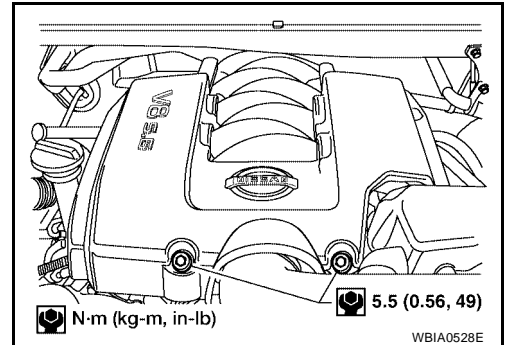
### Removal and Installation

EBS00J9Q

- Remove the engine cover bolts and cover.

**CAUTION:**

Do not damage or scratch cover when installing or removing.



### INSTALLATION

Installation is in the reverse order of removal.

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

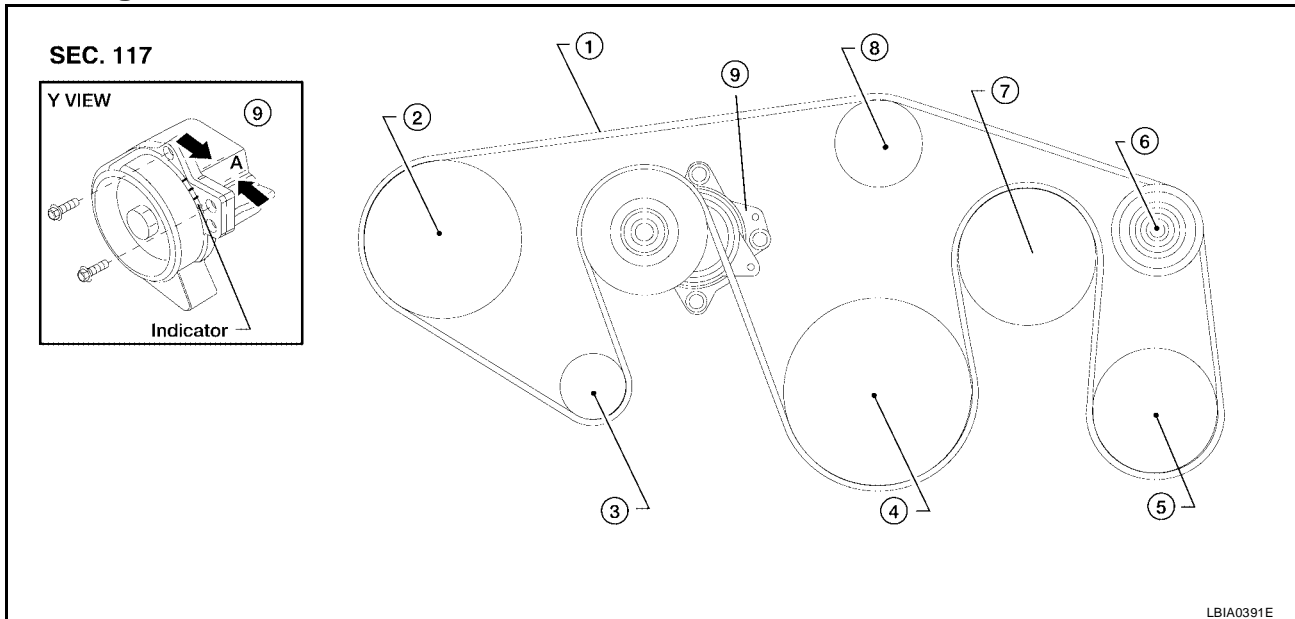
# DRIVE BELTS

## DRIVE BELTS

PFP:02117

### Checking Drive Belts

EBS00J9R



- |                       |                                   |                         |
|-----------------------|-----------------------------------|-------------------------|
| 1. Drive belt         | 2. Power steering oil pump pulley | 3. Generator pulley     |
| 4. Crankshaft pulley  | 5. A/C compressor                 | 6. Idler pulley         |
| 7. Cooling fan pulley | 8. Water pump pulley              | 9. Drive belt tensioner |

#### WARNING:

Be sure to perform when the engine is stopped.

1. Remove air duct and resonator assembly (inlet) when inspecting drive belt. Refer to [EM-14, "REMOVAL"](#).
2. Make sure that indicator (single line notch) of each auto tensioner is within the allowable working range "A" (between three line notches).

#### NOTE:

- Check the auto tensioner indication when the engine is cold.
  - When the new drive belt is installed, the range should be as shown.
  - The indicator notch is located on the moving side of the auto tensioner.
3. Visually check entire belt for wear, damage or cracks.
  4. If the indicator is out of allowable working range or belt is damaged, replace the belt.

### Tension Adjustment

EBS00J9S

Belt tensioning is not necessary, as it is automatically adjusted by auto tensioner.

### Removal and Installation DRIVE BELT

EBS00J9T

#### Removal

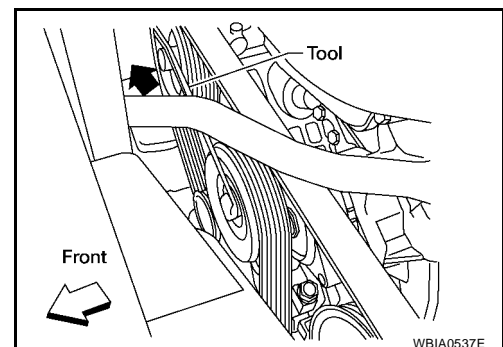
1. Remove air duct and resonator assembly (inlet). Refer to [EM-14, "REMOVAL"](#).
2. Install Tool on auto tensioner pulley bolt, move in the direction of arrow (loosening direction of tensioner) as shown.

Tool number : — (J-46535)

#### CAUTION:

Avoid placing hand in a location where pinching may occur if the holding tool accidentally comes off.

3. Remove the drive belt.



# DRIVE BELTS

## INSTALLATION

Installation is in the reverse order of removal.

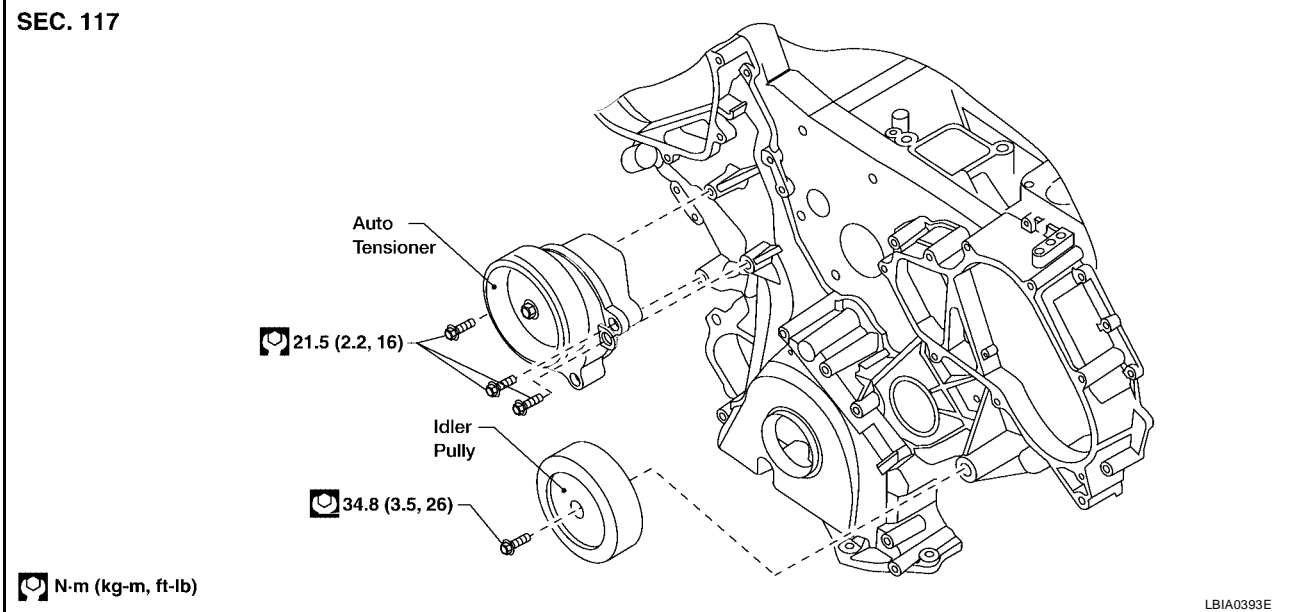
### CAUTION:

**Make sure belt is securely installed around all pulleys.**

- Rotate crankshaft pulley several turns clockwise to equalize belt tension between pulleys.
- Make sure belt tension is within the allowable working range, using indicator notch on the auto tensioner. Refer to [EM-12, "Checking Drive Belts"](#) .

## Drive Belt Auto Tensioner and Idler Pulley

EBS00J9U



## REMOVAL

1. Remove air duct and resonator assembly (inlet). Refer to [EM-14, "REMOVAL"](#) .
2. Remove drive belt. Refer to [EM-12](#) .
3. Remove auto tensioner and idler pulley using power tool.

## INSTALLATION

Installation is in the reverse order of removal.

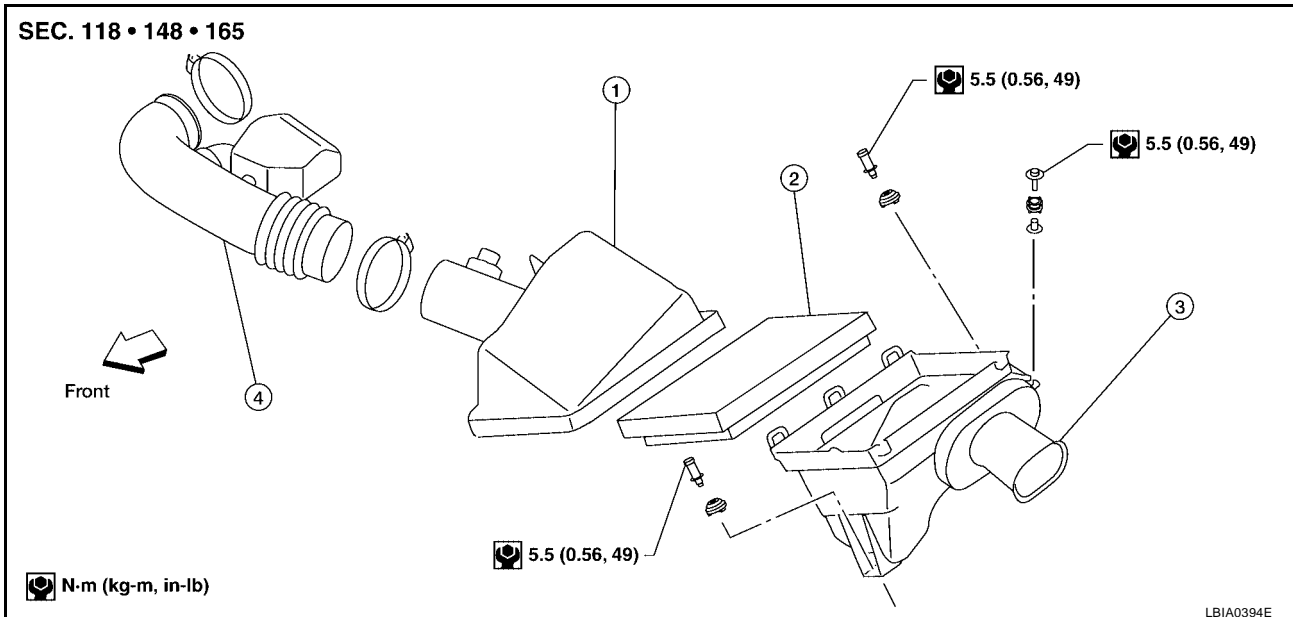
# AIR CLEANER AND AIR DUCT

## AIR CLEANER AND AIR DUCT

PF16500

### Removal and Installation

EBS0012P



1. Air cleaner case (upper)
2. Air cleaner filter
3. Air cleaner case (lower)
4. Air duct and resonator assembly

### REMOVAL

1. Remove engine room cover using power tool. Refer to [EM-14, "REMOVAL"](#).
2. Disconnect harness connector from air cleaner case (upper).
3. Remove air duct and resonator assembly (inlet), air cleaner case.
  - Add marks as necessary for easier installation.

### INSTALLATION

Installation is in the reverse order of removal.

### CHANGING AIR CLEANER FILTER

1. Remove air duct and resonator assembly (inlet) and air cleaner case (upper).
2. Remove air cleaner filter from air cleaner case.
3. Installation is in the reverse order of removal.

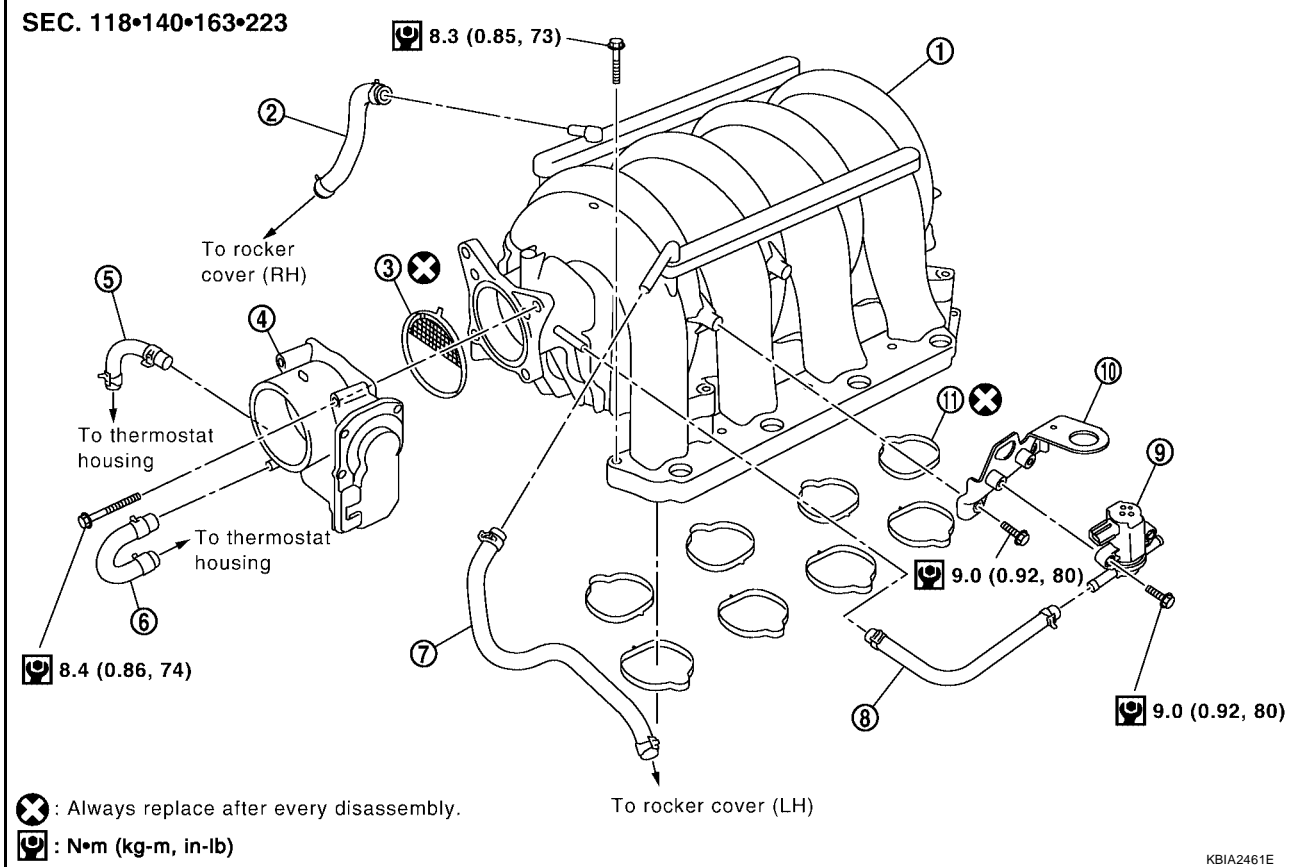
# INTAKE MANIFOLD

PFP:14003

## INTAKE MANIFOLD

### Removal and Installation

EBS0012Q



- |                                       |               |   |
|---------------------------------------|---------------|---|
| 1. Intake manifold                    | 2. PCV hose   | 3. Gasket                                     |
| 4. Electric throttle control actuator | 5. Water hose | 6. Water hose                                 |
| 7. PCV hose                           | 8. EVAP hose  | 9. EVAP canister purge control solenoid valve |
| 10. Bracket                           | 11. Gasket    |   |

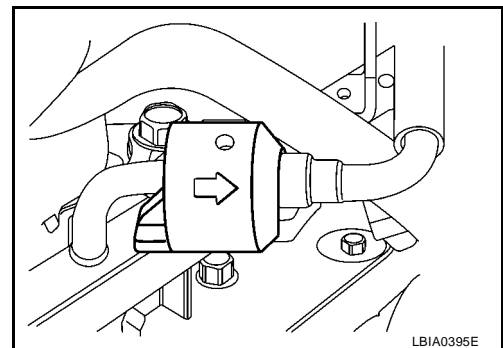
### REMOVAL

- Partially drain the engine coolant. Refer to [MA-13, "DRAINING ENGINE COOLANT"](#).

#### **WARNING:**

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

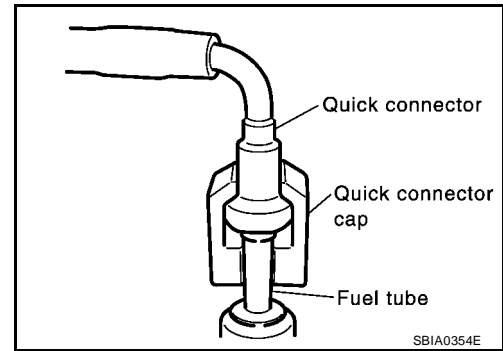
- Remove engine room cover with power tool. Refer to [EM-11, "REMOVAL"](#).
- Release fuel pressure. Refer to [EC-46, "FUEL PRESSURE RELEASE"](#).
- Remove air duct and resonator assembly (inlet). Refer to [EM-14, "REMOVAL"](#).
- Disconnect fuel tube quick connector on engine side.



# INTAKE MANIFOLD

- Using tool perform the following steps to disconnect quick connector.

**Tool number** : — (J-45488)



- Remove quick connector cap (engine side only).
- With the sleeve side of quick connector release facing quick connector, install quick connector release onto fuel tube.
- Insert quick connector release into quick connector until sleeve contacts and goes no further. Hold the quick connector release in that position.

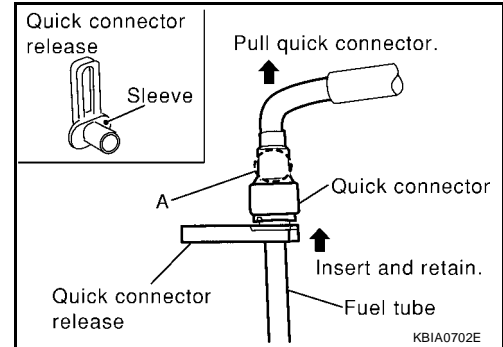
**CAUTION:**

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

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

**CAUTION:**

- Pull quick connector holding A position in illustration.
- Do not pull with lateral force applied. O-ring inside quick connector may be damaged.
- Prepare container and cloth beforehand as fuel will leak out.
- Avoid fire and sparks.
- Be sure to cover openings of disconnected pipes with plug or plastic bag to avoid fuel leakage and entry of foreign materials.



- Remove or disconnect harnesses, brackets, vacuum hose, vacuum gallery and PCV hose and tube from intake manifold.
- Remove electric throttle control actuator by loosening bolts diagonally.

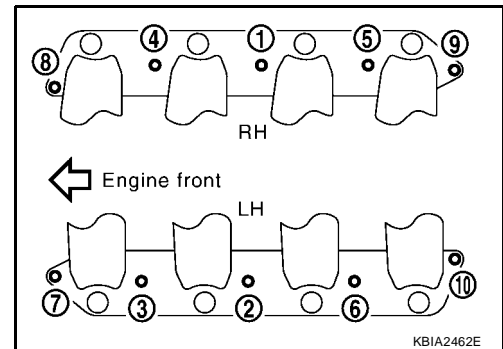
**CAUTION:**

- Handle carefully to avoid any damage to the electric throttle control actuator.
- Do not disassemble.

- Remove fuel injectors and fuel tube assembly. Refer to [EM-29, "Removal and Installation"](#).
- Loosen bolts in reverse order of illustration to remove intake manifold with power tool.

**CAUTION:**

**Cover engine openings to avoid entry of foreign materials.**



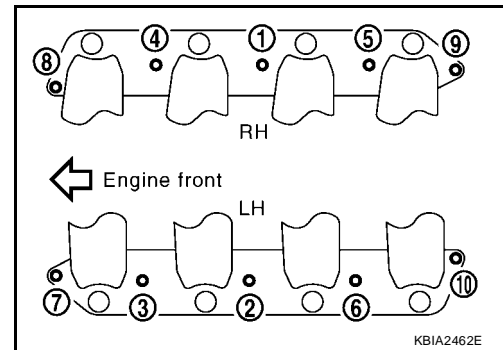


# INTAKE MANIFOLD

## INSTALLATION

Installation is in the reverse order of removal.

- Tighten the intake manifold bolts in numerical order as shown.



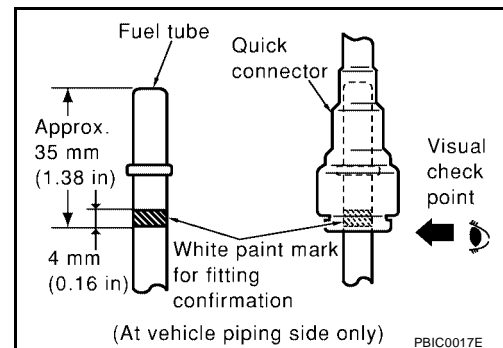
- Install the EVAP canister purge control solenoid valve connector with it facing front of engine.
- Tighten the electronic throttle control actuator bolts of electric throttle control actuator equally and diagonally in several steps.
- After installation perform procedure in [EM-18, "INSPECTION AFTER INSTALLATION"](#).
- Install water hose so that its overlap width for connection is between 27 mm (1.06 in) and 32 mm (1.26 in) (target: 27 mm 1.06 in).

## Connecting Quick Connector of Fuel Tube

Install quick connector as follows. (The steps are the same for quick connectors on both engine side and vehicle side except for the quick connector cap.)

1. Make sure no foreign substances are deposited in and around tube and quick connector, and no damage to them.
2. Thinly apply new engine oil around the fuel tube from tip end to the spool end.
3. Align center to insert quick connector straight into fuel tube.

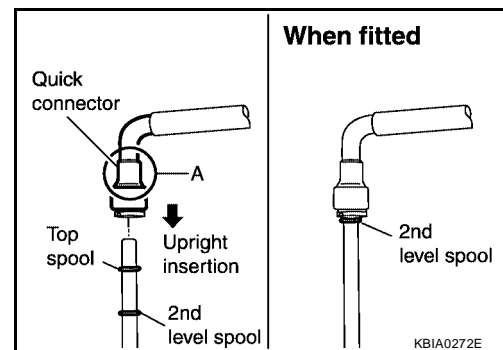
- Insert until the paint mark for engagement identification (white) goes completely inside quick connector so that you cannot see it from the straight side of the connected part. Use a mirror to check this where it is not possible to view directly from the straight side, such as quick connector on vehicle side.



- Insert fuel tube into quick connector until top spool is completely inside quick connector, and 2nd level spool exposes right below quick connector on engine side.

### CAUTION:

- Hold A position in illustration when inserting fuel tube into quick connector.
- Carefully align center to avoid inclined insertion to prevent damage to O-ring inside quick connector.
- Insert until you hear a “click” sound and actually feel the engagement.
- To avoid misidentification of engagement with a similar sound, be sure to perform the next step.



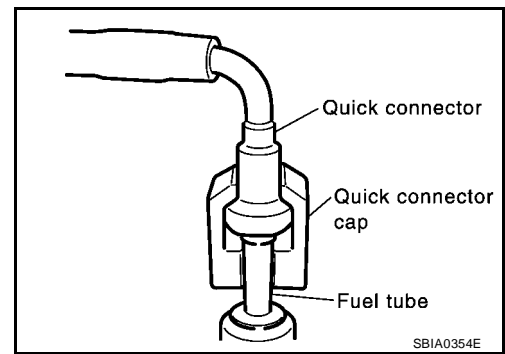
4. Pull quick connector by hand holding A position. Make sure it is completely engaged (connected) so that it does not come out from fuel tube.

### NOTE:

Recommended pulling force is 50 N (5.1 kg, 11.2 lb).

## INTAKE MANIFOLD

5. Install quick connector cap on quick connector joint (on engine side only).
6. Install fuel hose and tube to hose clamps.
7. Refill engine coolant. Refer to [MA-14, "REFILLING ENGINE COOLANT"](#).



### INSPECTION AFTER INSTALLATION

- After installing fuel tubes, make sure there is no fuel leakage at connections in the following steps.
  - Apply fuel pressure to fuel lines with turning ignition switch ON (with engine stopped). Then check for fuel leaks at connections.
  - Start the engine and rev it up and check for fuel leaks at connections.
- Perform procedures for "Throttle Valve Closed Position Learning" after finishing repairs. Refer to [EC-44, "OPERATION PROCEDURE"](#).
- If electric throttle control actuator is replaced, perform procedures for "Idle Air Volume Learning" after finishing repairs. Refer to [EC-45, "OPERATION PROCEDURE"](#).

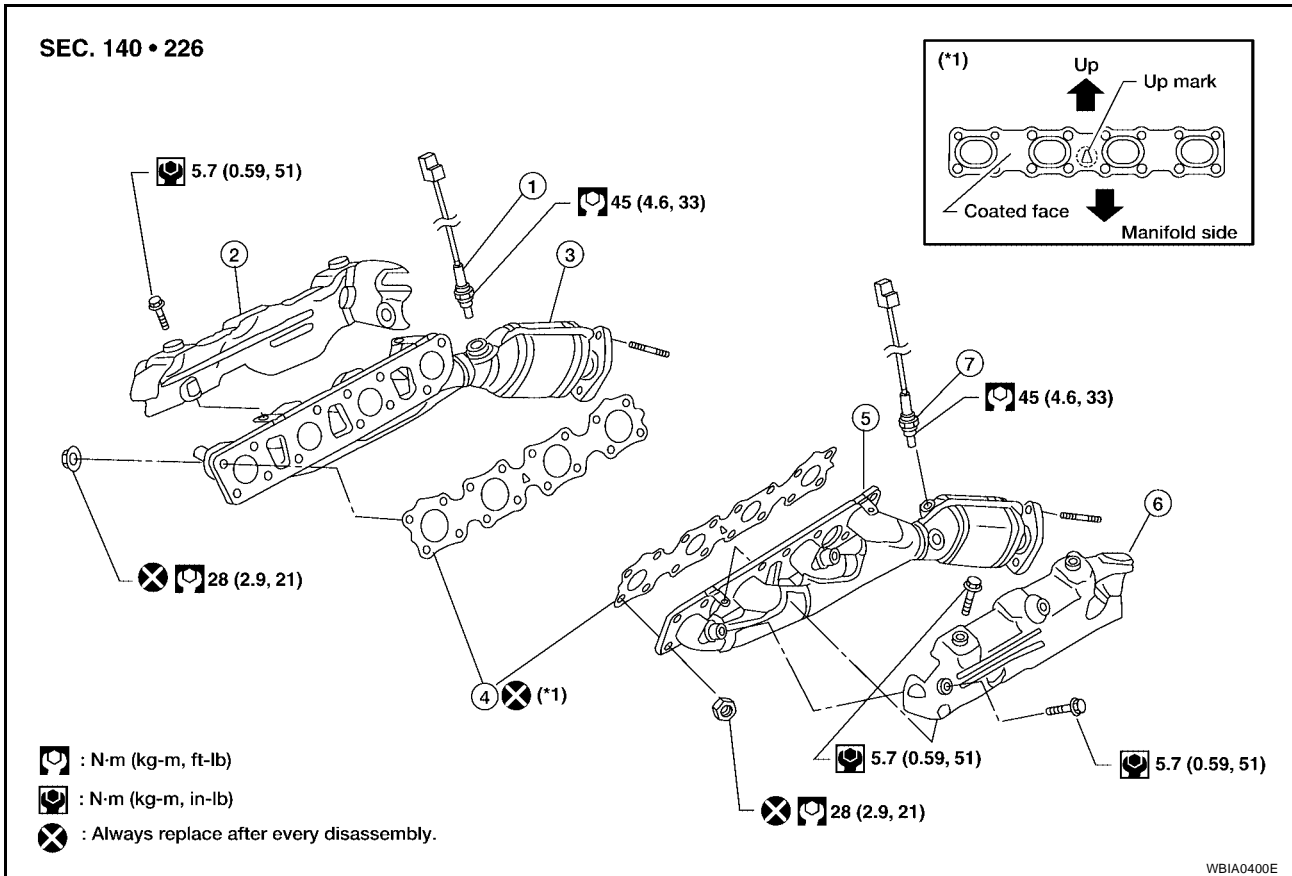
# EXHAUST MANIFOLD AND THREE WAY CATALYST

PDF:14004

EBS0012R

## EXHAUST MANIFOLD AND THREE WAY CATALYST

### Removal and Installation



1. Air fuel ratio (A/F) sensor 1 (right bank)
2. Exhaust manifold cover (right bank)
3. Exhaust manifold (right bank)
4. Gaskets
5. Exhaust manifold (left bank)
6. Exhaust manifold cover (left bank)
7. Air fuel ratio (A/F) sensor 1 (left bank)

### REMOVAL

#### **WARNING:**

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

1. Remove air duct and resonator assembly (inlet). Refer to [EM-14, "REMOVAL"](#).
2. Drain engine coolant from the radiator. Refer to [MA-13, "DRAINING ENGINE COOLANT"](#).
3. Remove engine undercover with power tool.
4. Remove the radiator and radiator hoses. Refer to [CO-10, "REMOVAL"](#).
5. Remove drive belts. Refer to [EM-12, "Removal"](#).
6. Remove the air fuel ratio A/F sensors (right bank, left bank).
  - Follow steps below to remove each air fuel ratio A/F sensors.
- a. Remove engine room cover with power tool. Refer to [EM-11, "REMOVAL"](#).
- b. Remove harness connector of each air fuel ratio A/F sensors, and harness from bracket and middle clamp.

# EXHAUST MANIFOLD AND THREE WAY CATALYST

- c. Remove the air fuel ratio A/F sensors from both left and right exhaust manifolds using Tool.

**Tool number** : — (J-44626)

## CAUTION:

- Do not damage the air fuel ratio A/F sensors
- Discard any air fuel ratio A/F sensor which has been dropped from a height of more than 0.5m (19.7 in) onto a hard surface such as a concrete floor. Replace it with a new one.

7. Remove front cross bar. Refer to [FSU-5, "Components"](#).

8. Remove exhaust manifold (left bank) in steps below.

- a. Remove exhaust front tube with power tool. Refer to [EX-4, "REMOVAL"](#).

- b. Remove the exhaust manifold cover.

- c. Loosen nuts in reverse order of illustration with power tool.

- d. Remove exhaust studs from positions 2, 4, 6, 8 and remove left exhaust manifold

9. Remove exhaust manifold (right bank) in steps below.

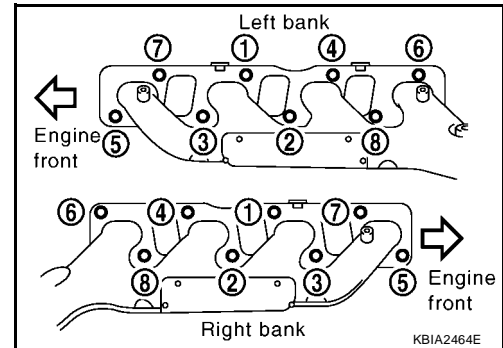
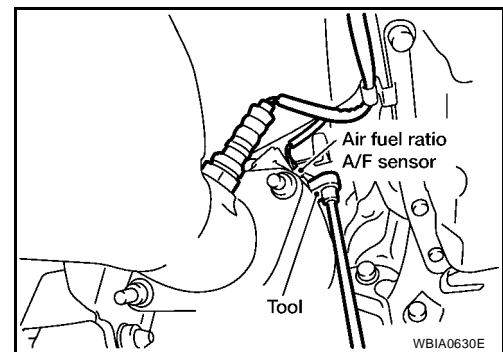
- a. Remove exhaust front tube with power tool. Refer to [EX-4, "REMOVAL"](#).

- b. Remove oil level gauge guide. Refer to [EM-22, "REMOVAL"](#).

- c. Remove the exhaust manifold cover.

- d. Loosen nuts in reverse order of illustration with power tool.

- e. Remove exhaust studs from positions 2, 4, 6, 8 and remove right exhaust manifold.



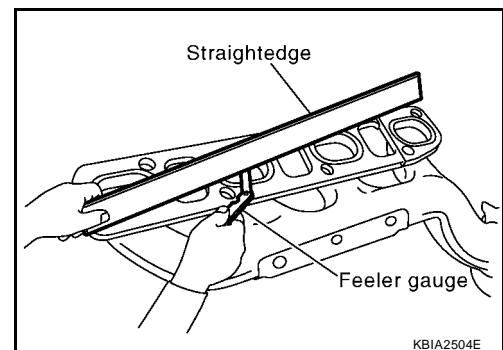
## INSPECTION AFTER REMOVAL

### Surface Distortion

- Use a reliable straightedge and feeler gauge to check the flatness of each exhaust manifold flange surface.

**Flatness limit** : 0.3 mm (0.012 in)

- If it exceeds the limit, replace exhaust manifold.

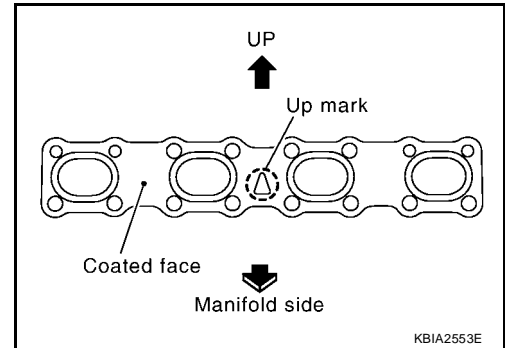


# EXHAUST MANIFOLD AND THREE WAY CATALYST

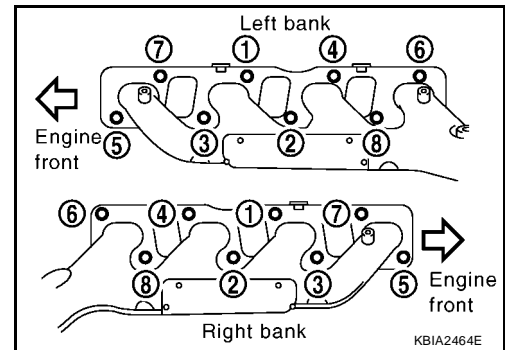
## INSTALLATION

Installation is in the reverse order of removal paying attention to the following:

- Install new exhaust manifold gasket with the top of the triangular up mark on it facing up and its coated face (gray side) toward the exhaust manifold side.



- Tighten the exhaust manifold nuts in the numerical order shown. Then recheck the torque of the nuts.



- Before installing a new **air fuel ratio A/F sensors** , clean exhaust system threads using Tool. oxygen sensor thread cleaner (commercial service tool: J-43897-18 or J-43897-12), and apply anti-seize lubricant.

**Tool number** : ( — ) J-43897-12  
: ( — ) J-43897-18

### CAUTION:

- Do not over tighten the air fuel ratio A/F sensors . Doing so may cause damage to the sensor, resulting in the MIL coming on.

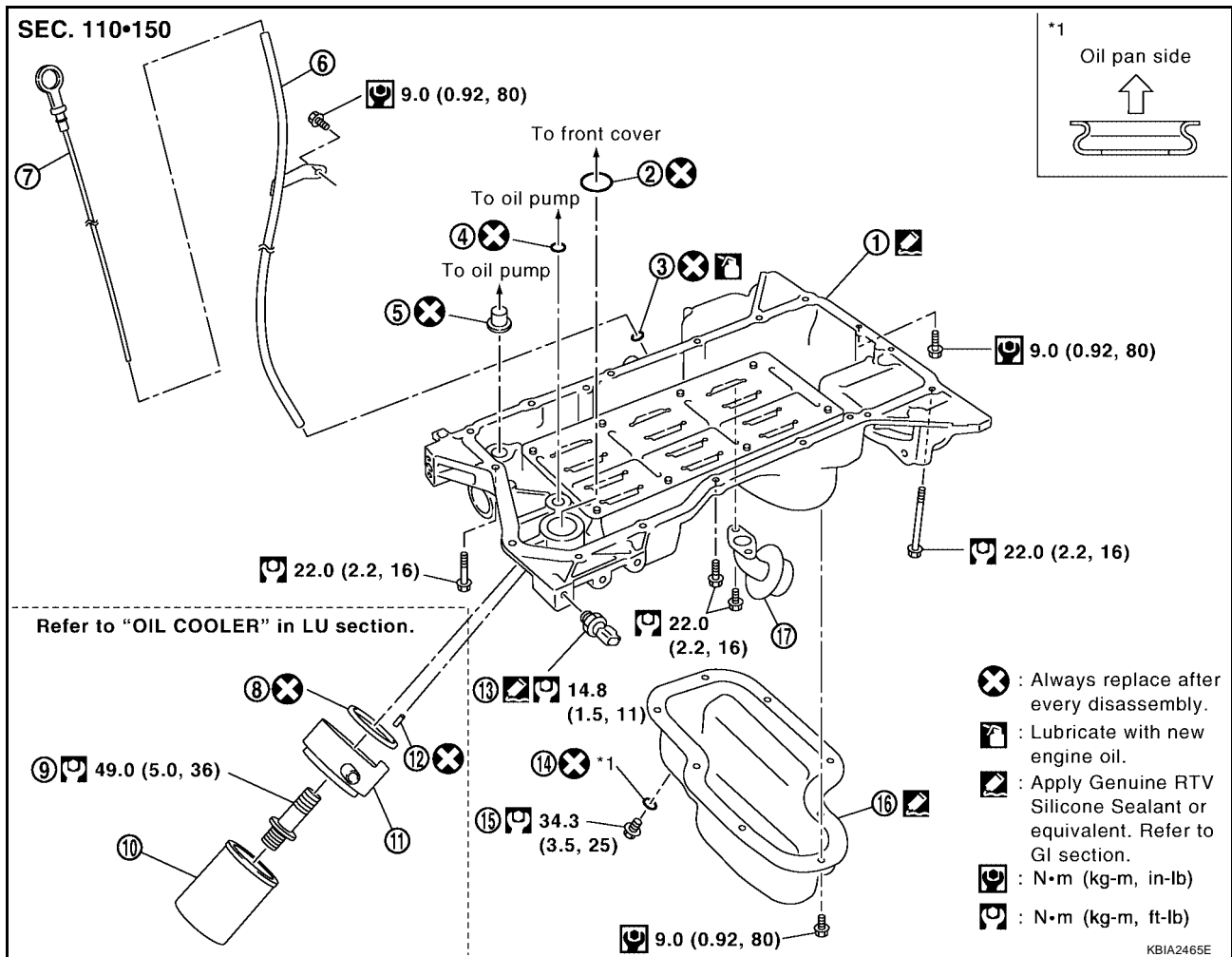
# OIL PAN AND OIL STRAINER

PFP:11110

EBS00J9V

## OIL PAN AND OIL STRAINER

### Removal and Installation



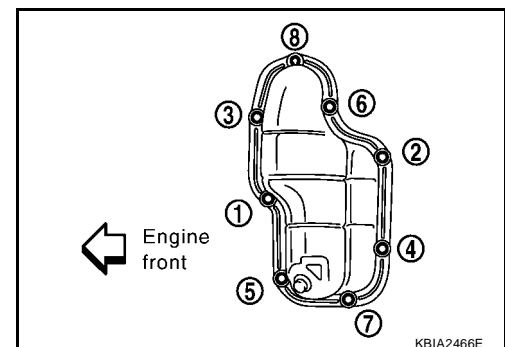
- |                         |                         |                          |
|-------------------------|-------------------------|--------------------------|
| 1. Oil pan (Upper)      | 2. O-ring               | 3. O-ring                |
| 4. O-ring               | 5. O-ring (with collar) | 6. Oil level gauge guide |
| 7. Oil level gauge      | 8. O-ring               | 9. Connector bolt        |
| 10. Oil filter          | 11. Oil cooler          | 12. Relief valve         |
| 13. Oil pressure sensor | 14. Gasket              | 15. Drain plug           |
| 16. Oil pan (Lower)     | 17. Oil strainer        |                          |

### REMOVAL

#### WARNING:

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

1. Remove the engine. Refer to [EM-70, "REMOVAL"](#).
2. Remove oil pan (lower).
  - a. Remove oil pan bolts with power tool in reverse order of illustration to remove.

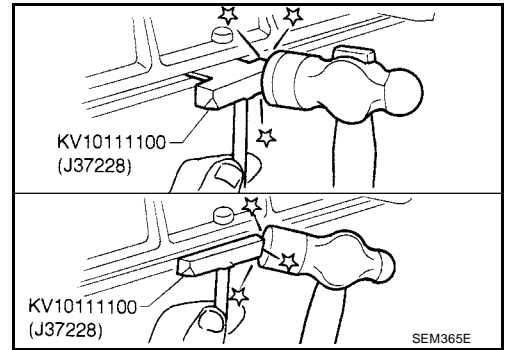


# OIL PAN AND OIL STRAINER

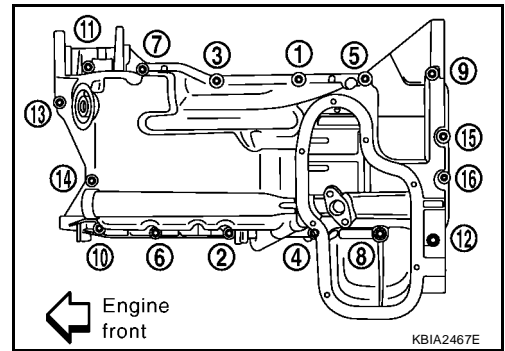
- b. Remove the oil pan (lower). Using Tool.

**Tool number:** KV10111100 (J-37228)

**CAUTION:**  
Use care not to damage mating surface.

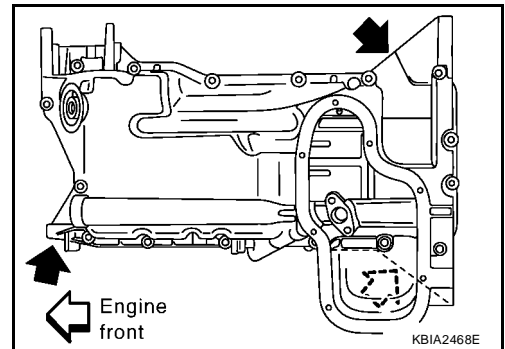


3. Remove oil strainer from oil pan (upper).  
4. Remove oil pan (upper).  
a. Remove oil pan bolts in reverse order of illustration to remove.



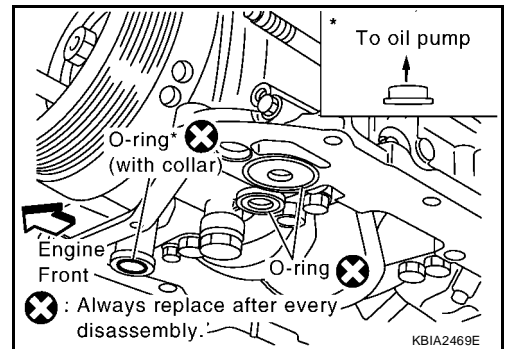
- b. Using a suitable tool insert into the gap between cylinder block and front cover indicated by the arrow in illustration, and pry it. Remove oil pan (upper).

**CAUTION:**  
Use care not to damage mating surface.



5. Remove O-rings from oil pump and front cover.

**NOTE:**  
Do not reuse O-rings.



## INSPECTION AFTER REMOVAL

Clean oil strainer.

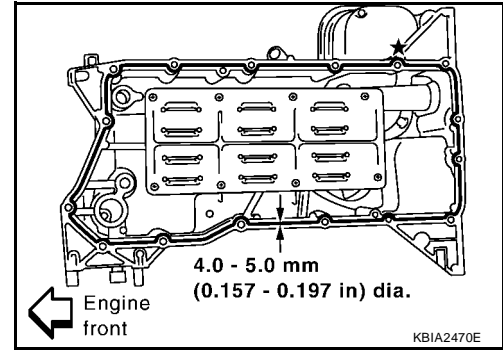
# OIL PAN AND OIL STRAINER

## INSTALLATION

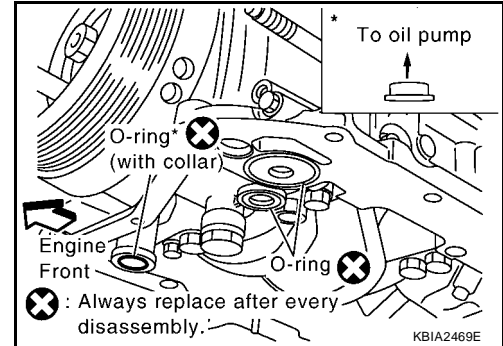
1. Install oil pan (upper) in the order below.
- a. Apply liquid gasket thoroughly as in illustration. Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#).

**CAUTION:**

Apply liquid gasket to outside of bolt hole for the hole shown by ★.



- b. Install new O-rings to oil pump and front cover side.



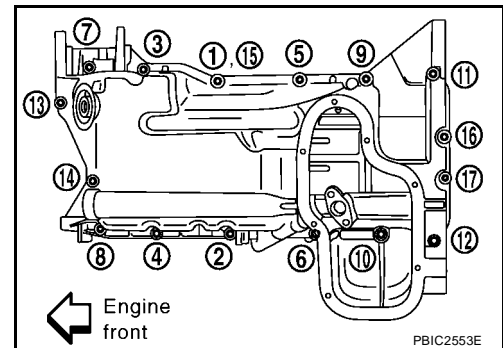
- c. Tighten bolts in numerical order as shown.

**M6 × 30 mm (1.18 in) : No. 15, 16**

**M8 × 25 mm (0.98in) : No. 1, 3, 5, 7, 11, 13**

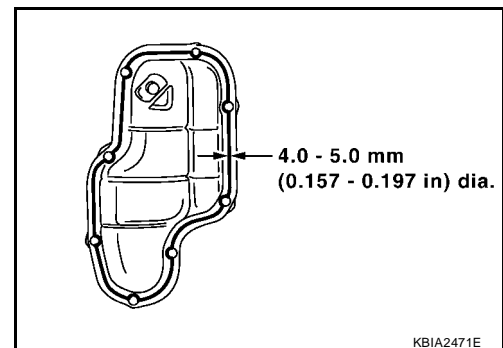
**M8 × 45 mm (1.77 in) : No. 2, 4, 6, 8, 10, 14**

**M8 × 123 mm (4.84in) : No. 9, 12**



- d. Install rear plate cover.
2. Install oil strainer to upper oil pan (upper).
3. Install oil pan (lower).

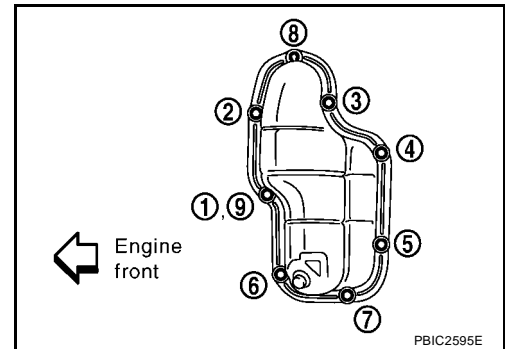
- a. Apply liquid gasket thoroughly as shown. Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#).





## OIL PAN AND OIL STRAINER

- b. Tighten lower oil pan bolts in numerical order as shown.



4. Install oil pan drain plug.
5. Installation of the remaining components is in the reverse order of removal.
  - Do not fill the engine oil for at least 30 minutes after oil pan is installed.

### INSPECTION AFTER INSTALLATION

1. Check engine oil level and add engine oil as required. Refer to [LU-7, "OIL LEVEL"](#).
2. Start the engine, and check there is no leak of engine oil.
3. Stop engine and wait for 10 minutes.
4. Check engine oil level and add engine oil as required. Refer to [LU-7, "OIL LEVEL"](#).

A

EM

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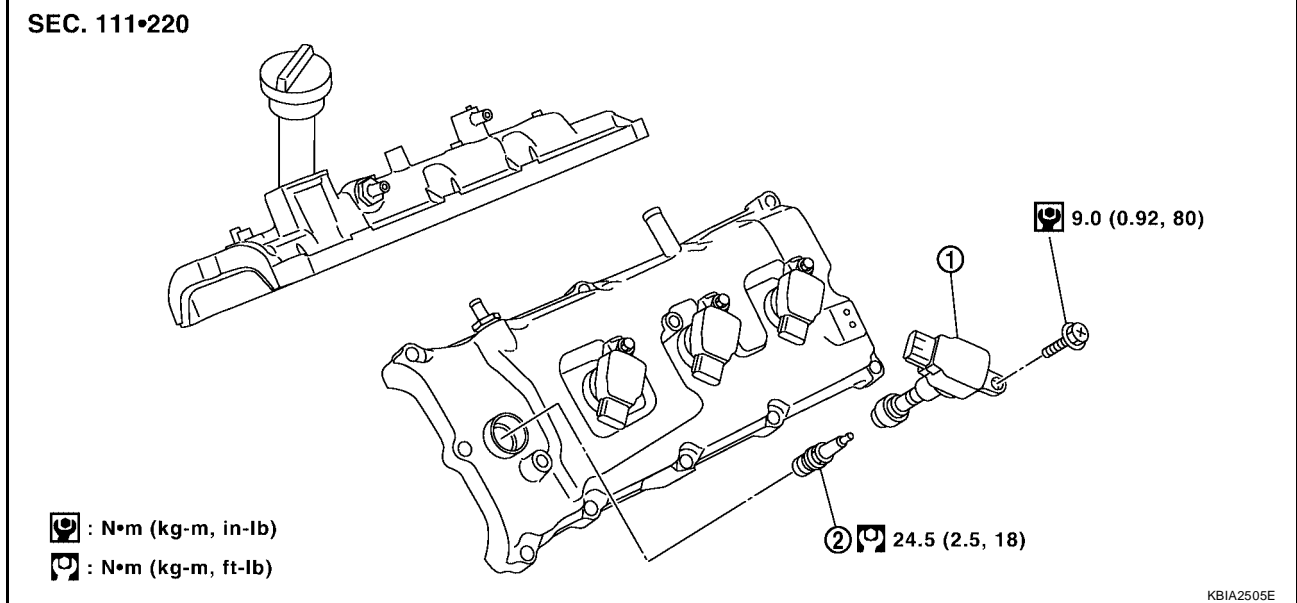
# IGNITION COIL

## IGNITION COIL

PF2:22448

## Removal and Installation

EBS0012T



1. Ignition coil

2. Spark plug

### REMOVAL

1. Remove engine room cover using power tool. Refer to [EM-11, "REMOVAL"](#).
2. Disconnect harness connector from ignition coil.
3. Remove ignition coil.

#### **CAUTION:**

**Do not shock it.**

### INSTALLATION

Installation is in the reverse order of removal.

# SPARK PLUG (PLATINUM-TIPPED TYPE)

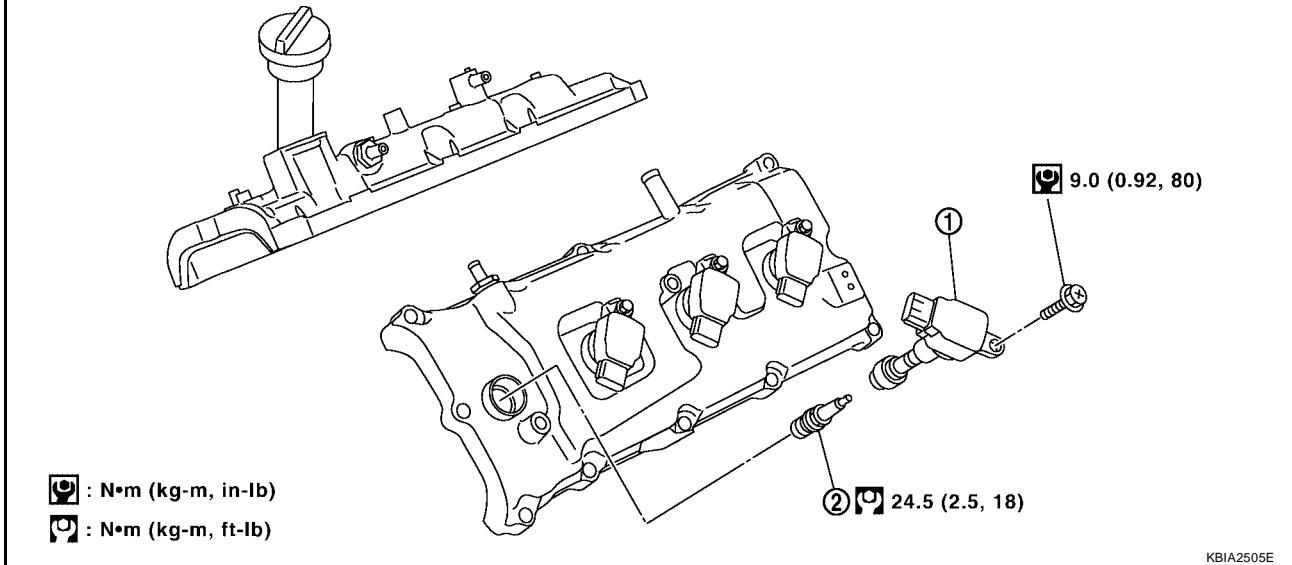
## SPARK PLUG (PLATINUM-TIPPED TYPE)

PF2:22401

### Removal and Installation

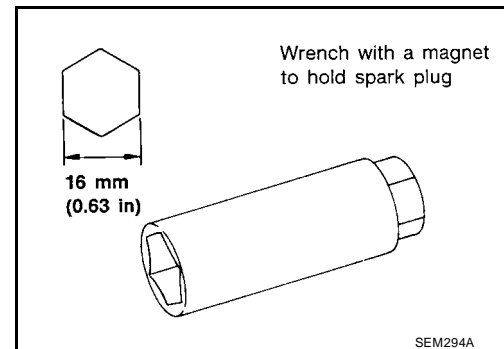
EBS0012U

SEC. 111•220



### REMOVAL

1. Remove engine room cover using power tool. Refer to [EM-11, "REMOVAL"](#).
2. Remove ignition coil. Refer to [EM-26, "REMOVAL"](#).
3. Using a suitable tool remove spark plug.



### INSPECTION AFTER REMOVAL

Use standard type spark plug for normal condition.

The hot type spark plug is suitable when fouling occurs with the standard type spark plug under conditions such as:

- Frequent engine starts
- Low ambient temperatures

The cold type spark plug is suitable when spark knock occurs with the standard type spark plug under conditions such as:

- Extended highway driving
- Frequent high engine revolution

Make	NGK
Standard type	PLFR5A-11
Hot type	PLFR4A-11
Cold type	PLFR6A-11

# SPARK PLUG (PLATINUM-TIPPED TYPE)

Gap (Nominal) : 1.1 mm (0.043 in)

**CAUTION:**

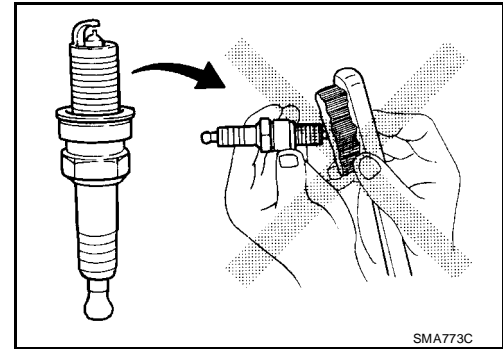
- Do not drop or shock spark plug.
- Do not use a wire brush for cleaning.
- If plug tip is covered with carbon, spark plug cleaner may be used.

Cleaner air pressure:

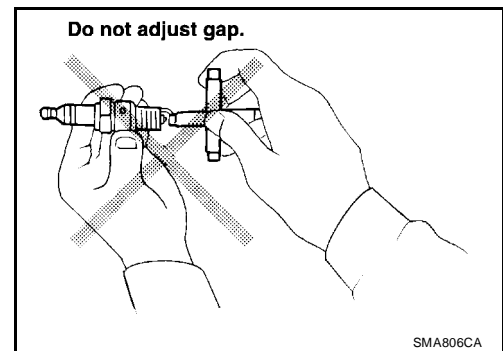
Less than 588 kPa (5.9 bar, 6 kg/cm<sup>2</sup> , 85 psi)

Cleaning time:

Less than 20 seconds



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



## INSTALLATION

Installation is in the reverse order of removal.

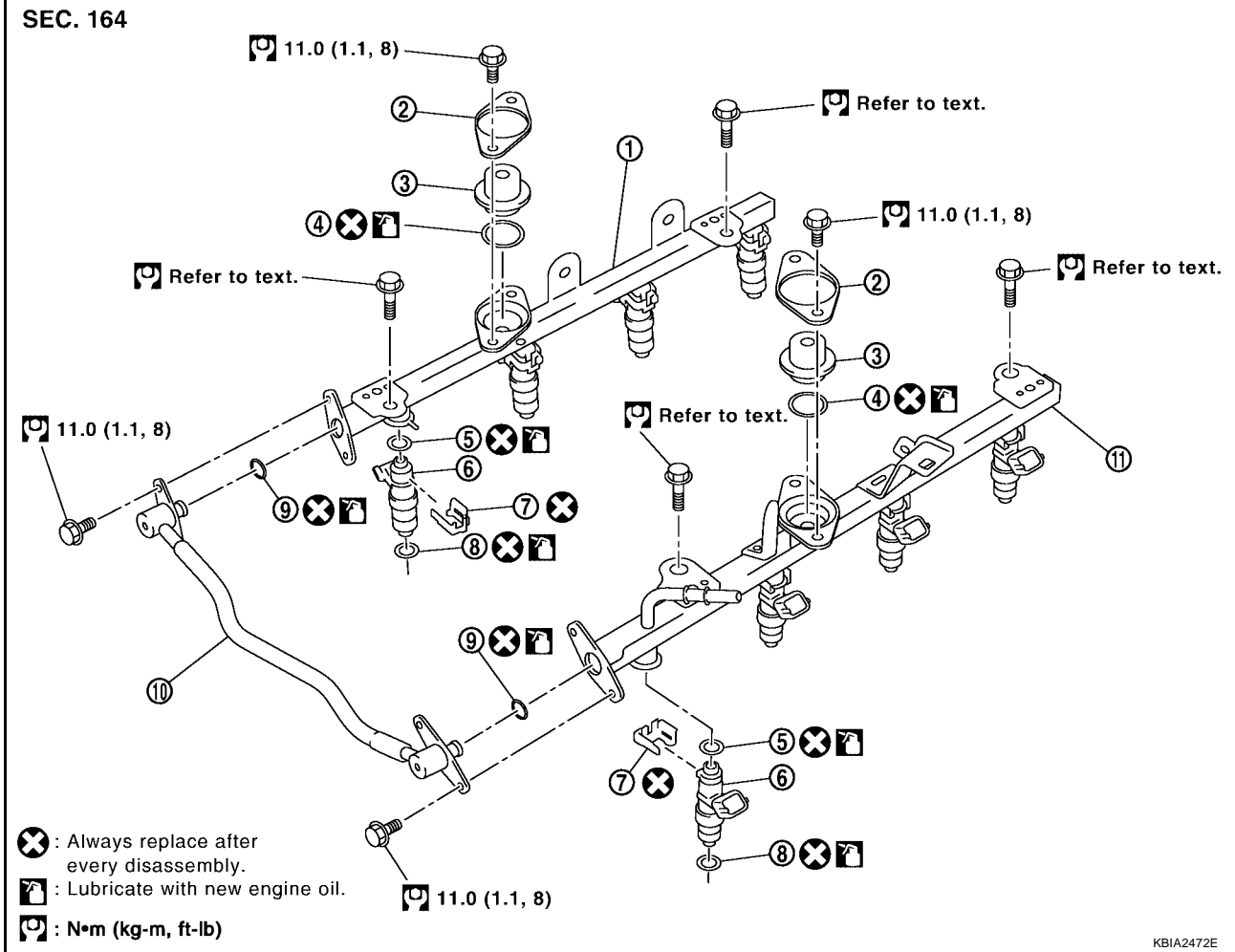
# FUEL INJECTOR AND FUEL TUBE

PFP:16600

EBS0012V

## FUEL INJECTOR AND FUEL TUBE

### Removal and Installation



- |                           |                           |                  |
|---------------------------|---------------------------|------------------|
| 1. Fuel tube (right bank) | 2. Cap                    | 3. Fuel damper   |
| 4. O-ring                 | 5. O-ring (Blue)          | 6. Fuel injector |
| 7. Clip                   | 8. O-ring (Brown)         | 9. O-ring        |
| 10. Fuel hose assembly    | 11. Fuel tube (left bank) |                  |

#### CAUTION:

Do not remove or disassemble parts unless instructed as shown in the figure.

#### REMOVAL

- Remove engine room cover using power tool. Refer to [EM-11, "REMOVAL"](#).
- Release fuel pressure. Refer to [EC-46, "FUEL PRESSURE RELEASE"](#).
- Disconnect the negative battery terminal.
- Disconnect fuel injector harness connectors.
- Disconnect fuel hose assembly from fuel tube right bank and left bank.

#### CAUTION:

- While hoses are disconnected, plug them to prevent fuel from draining.
- Do not separate fuel connector and fuel hose.

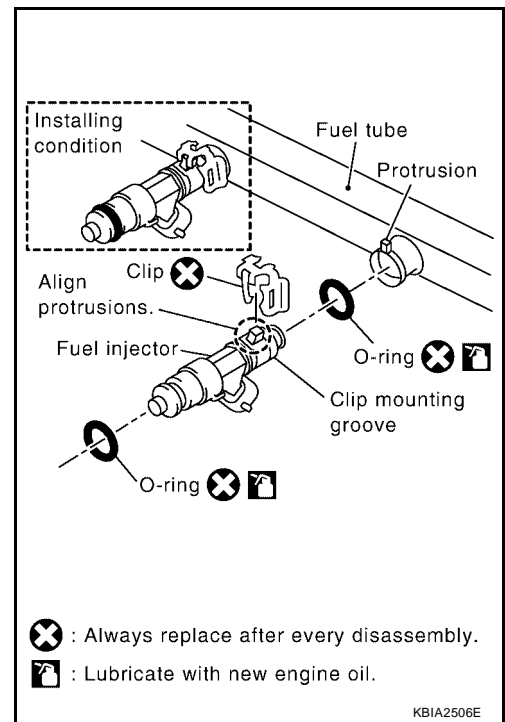
- Remove fuel injectors with fuel tube assembly.

## FUEL INJECTOR AND FUEL TUBE

7. Remove fuel injector from fuel tube.
  - a. Spread open to remove clip.
  - b. Remove fuel injector from the fuel tube by pulling straight out.

### CAUTION:

- Be careful with remaining fuel that may leak out from fuel tube.
- Be careful not to damage injector nozzles during removal.
- Do not bump or drop fuel injectors.
- Do not disassemble fuel injectors.



8. Remove fuel damper from each fuel tube.

### INSTALLATION

1. Install fuel damper to each fuel tube.
  - a. Apply engine oil to O-ring and set it into the cap of fuel tube.

### CAUTION:

- Handle O-ring with bare hands. Never wear gloves.
- Lubricate O-ring with new engine oil.
- Do not clean O-ring with solvent.
- Make sure that O-ring and its mating part are free of foreign material.
- When installing O-ring, be careful not to scratch it with tool or fingernails. Also be careful not to twist or stretch O-ring.

- b. Make sure that backup spacer is in the O-ring connecting surface of fuel damper.

### NOTE:

Backup spacer is fuel damper assembly part.

- c. Insert fuel damper until it seats on fuel tube.

### CAUTION:

- Insert straight, making sure that the axis is lined up.
- Do not pressure-fit with excessive force.

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

- d. Install cap, and then tighten mounting bolts evenly by turns.
    - After tightening mounting bolts, make sure that there is no gap between cap and fuel tube.
2. Install O-rings to fuel injector paying attention to the items below.

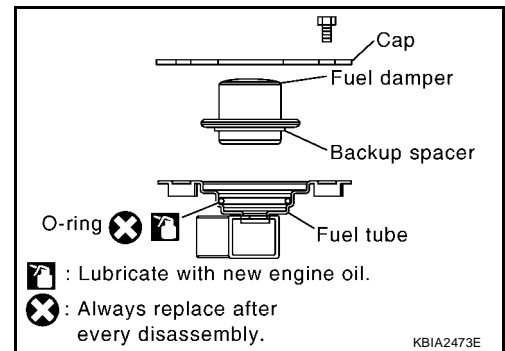
### CAUTION:

- Upper and lower O-ring are different.

**Fuel tube side** : Blue

**Nozzle side** : Brown

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



# FUEL INJECTOR AND FUEL TUBE

- Lubricate O-ring with new engine oil.
- Do not clean O-ring with solvent.
- Make sure that O-ring and its mating part are free of foreign material.
- When installing O-ring, be careful not to scratch it with tool or fingernails. Also be careful not to twist or stretch O-ring. If O-ring was stretched while it was being attached, do not insert it quickly into fuel tube.
- Insert O-ring straight into fuel tube. Do not angle or twist it.

3. Install fuel injector to fuel tube.

a. Insert clip into clip mounting groove on fuel injector.

- Insert clip so that lug "A" of fuel injector matches notch "A" of the clip.

**CAUTION:**

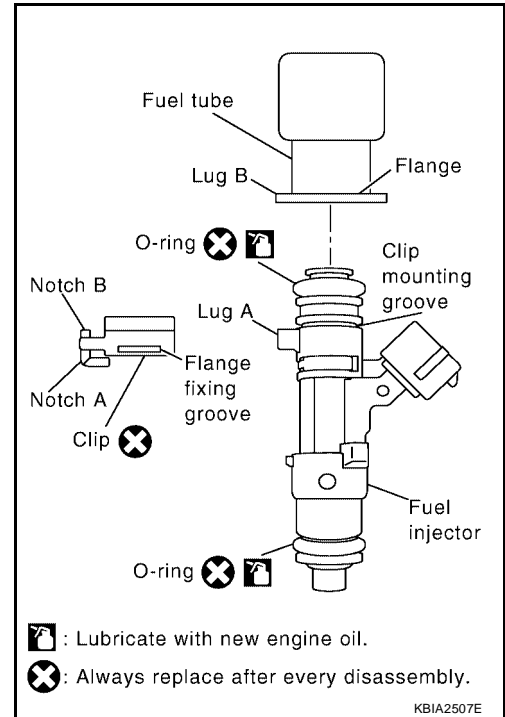
- Do not reuse clip. Replace it with a new one.
- Be careful to keep clip from interfering with O-ring. If interference occurs, replace O-ring.

b. Insert fuel injector into fuel tube with clip attached.

- Insert it while matching it to the axial center.
- Insert fuel injector so that lug "B" of fuel tube matches notch "B" of the clip.
- Make sure that fuel tube flange is securely fixed in flange fixing groove on clip.

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

- Make sure that protrusions of fuel injectors are aligned with cutouts of clips after installation.



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

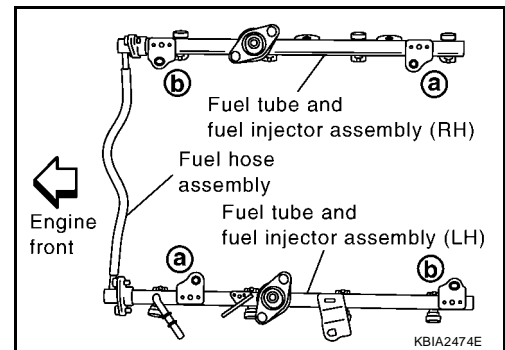
**CAUTION:**

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

- Tighten fuel tube assembly mounting bolts "a" to "b" in illustration and in two steps.

**1st step : 12.8 N·m (1.3 kg-m, 9 ft-lb)**

**2nd step : 24.5 N·m (2.5 kg-m, 18 ft-lb)**



5. Install fuel hose assembly.

- Refer to precautions for fuel injector when handling O-ring.
- Insert connectors straight, making sure that the axis is lined up with fuel tube side to prevent O-ring from being damaged.
- Tighten bolts evenly in several steps.
- Make sure that there is no gap between flange and fuel tube after tightening bolts.

6. Installation of the remaining components is in the reverse order of removal.

## INSPECTION AFTER INSTALLATION

After installing fuel tubes, make sure there are no fuel leaks at connections using the following steps.

## FUEL INJECTOR AND FUEL TUBE

---

1. Apply fuel pressure to fuel lines by turning ignition switch ON (with engine stopped). Then check for fuel leaks at connections.
2. Start the engine and rev it up and check for fuel leaks at connections.

**NOTE:**

Use mirrors for checking on hidden points.

**CAUTION:**

**Do not touch the engine immediately after stopping, as engine becomes extremely hot.**



# ROCKER COVER

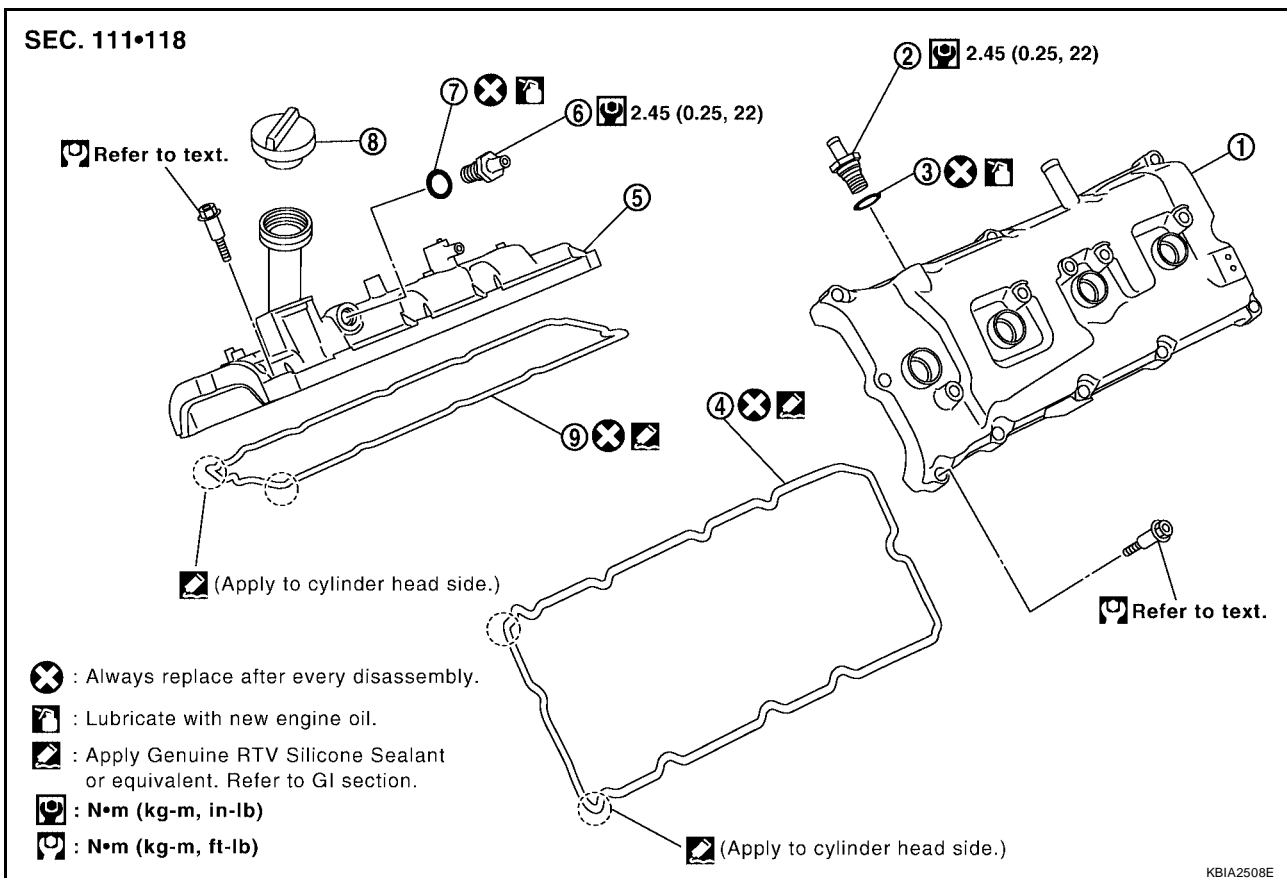
PFP:13264

EBS002W

## ROCKER COVER

### Removal and Installation

SEC. 111•118



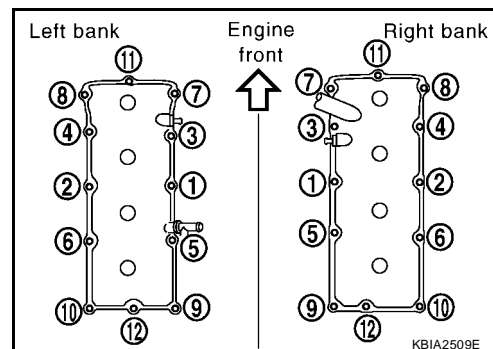
- |                                    |                              |                                     |
|------------------------------------|------------------------------|-------------------------------------|
| 1. Rocker cover (left bank)        | 2. PCV control valve         | 3. O-ring                           |
| 4. Rocker cover gasket (left bank) | 5. Rocker cover (right bank) | 6. PCV control valve                |
| 7. O-ring                          | 8. Oil filler cap            | 9. Rocker cover gasket (right bank) |

### REMOVAL

1. Remove engine room cover with power tool. Refer to [EM-11, "REMOVAL"](#).
2. Remove air duct and resonator assembly (inlet). Refer to [EM-14, "REMOVAL"](#) (for left bank only).
3. Move harness on upper rocker cover and its peripheral aside.
4. Remove electric throttle control actuator loosening bolts diagonally (for left bank only).
5. Remove ignition coil. Refer to [EM-26, "REMOVAL"](#).
6. Remove PCV hose from PCV control valve.
7. Loosen bolts in reverse order shown using power tool.

#### CAUTION:

Do not hold the rocker cover by the oil filler neck (right bank).



# ROCKER COVER

## INSTALLATION

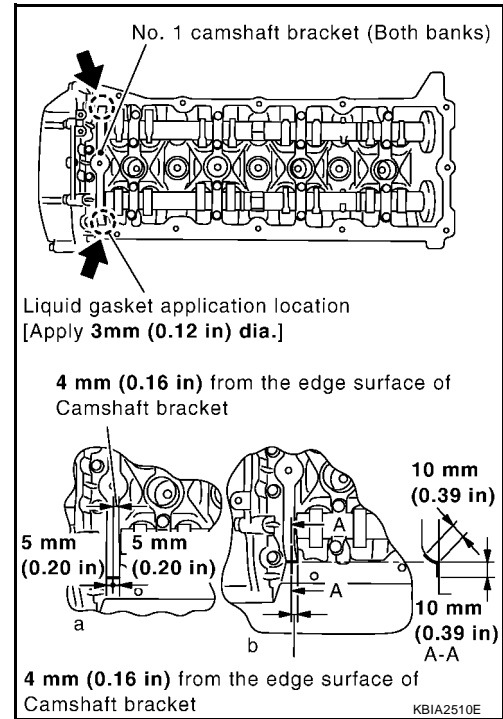
1. Apply liquid gasket to joint part of cylinder head and camshaft bracket following the steps below.

### NOTE:

Illustration shows an example of left bank side (zoomed in shows No.1 camshaft bracket).

- a. Refer to illustration "a" to apply liquid gasket to joint part of No.1 camshaft bracket and cylinder head.
- b. Refer to illustration "b" to apply liquid gasket in 90° degrees to illustration "a".

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45. "Recommended Chemical Products and Sealants"](#) .**



2. Install rocker cover.

- Check if rocker cover gasket has dropped from installation groove of rocker cover.
- Tighten bolts in two steps separately in the numerical order shown in the figure.

**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)

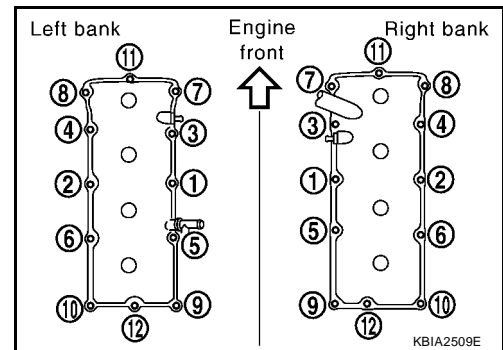
### CAUTION:

**Do not hold the rocker cover by the oil filler neck (right bank).**

3. Install PCV hose with the following procedure:

- Remove foreign materials from inside hose with compressed air using an air gun.
- The inserted length is within 25 - 30 mm (0.98 - 1.18 in) [Target: 25 mm (0.98 in)].

4. Installation of the remaining components is in the reverse order of removal.





# TIMING CHAIN

- |  |   |   |
|--|---|---|
| 1. Camshaft sprocket (left bank EXH)     | 2. Camshaft sprocket (left bank INT)        | 3. Camshaft sprocket (right bank INT)     |
| 4. Camshaft sprocket (right bank EXH)    | 5. Front cover                              | 6. Chain case cover (right bank)          |
| 7. Chain case cover (left bank)          | 8. Crankshaft pulley bolt                   | 9. Crankshaft pulley                      |
| 10. Chain tensioner cover                | 11. Front oil seal                          | 12. Oil pump drive spacer                 |
| 13. Oil pump assembly                    | 14. Crankshaft sprocket                     | 15. Bracket                               |
| 16. O-ring                               | 17. Timing chain tension guide (right bank) | 18. Timing chain slack guide (right bank) |
| 19. Timing chain (right bank)            | 20. Timing chain (left bank)                | 21. Chain tensioner (right bank)          |
| 22. Timing chain slack guide (left bank) | 23. Timing chain tension guide (left bank)  | 24. Chain tensioner (left bank)           |
| 25. Rear cover                           |   |   |

## NOTE:

- Left bank timing chain must be removed before right side,
- The following procedure has only left side removal due to the right bank removal is the same as the left bank removal.

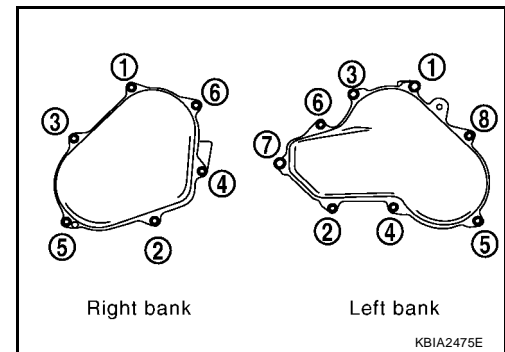
## REMOVAL

1. Remove engine assembly from vehicle. Refer to [EM-70, "REMOVAL"](#).
2. Remove the following components and related parts:
  - Drive belt auto tensioner and idler pulley. Refer to [EM-12, "Removal"](#).
  - Thermostat housing and water hose. Refer to [CO-17, "Removal of Thermostat Housing, Water Outlet and Heater Pipe"](#).
  - Power steering pump bracket. Refer to [PS-27, "POWER STEERING OIL PUMP"](#).
  - Oil pan (lower) (upper) and oil strainer. Refer to [EM-22, "REMOVAL"](#).
  - Ignition coil. Refer to [EM-26, "IGNITION COIL"](#).
  - Rocker cover. Refer to [EM-33, "ROCKER COVER"](#).
3. Remove chain case cover (right bank) and (left bank).
  - a. Loosen and remove bolts in the reverse order of shown in the figure.
  - b. Using tool, cut liquid gasket and remove covers.

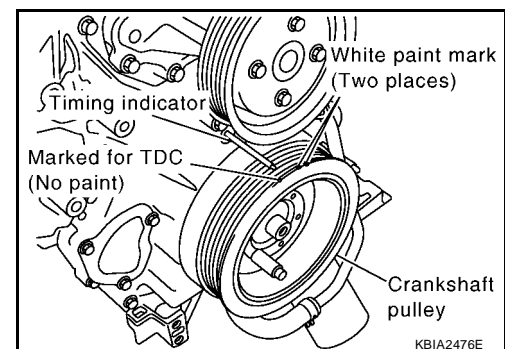
**Tool number:** KV10111100 (J-37228)

## CAUTION:

**Use care not to damage mating surfaces.**

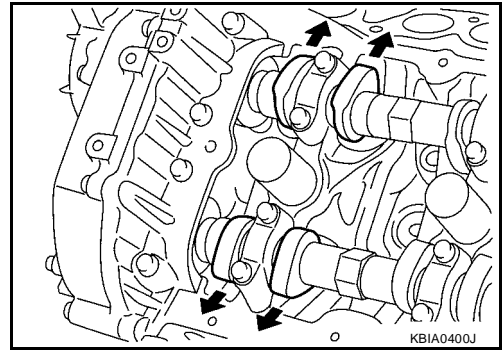


4. Obtain compression TDC of No. 1 cylinder as follows:
  - a. Turn crankshaft pulley clockwise to align the TDC identification notch (without paint mark) with timing indicator on front cover.

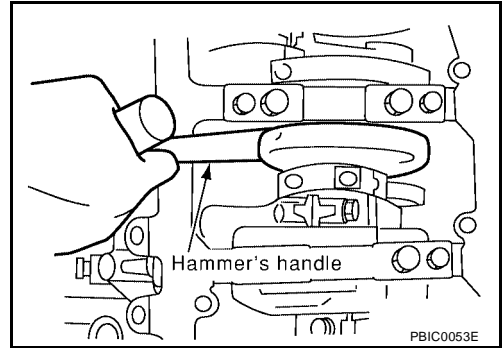


# TIMING CHAIN

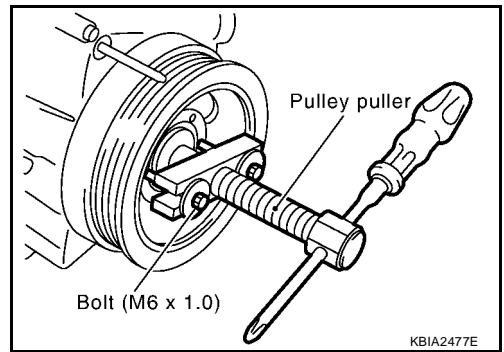
- b. At this time, make sure the both intake and exhaust cam lobes of No. 1 cylinder (top front on left bank) point outside.
- If they do not point outside, turn crankshaft pulley once more.



5. Remove crankshaft pulley.
- a. Using a suitable tool to assist, loosen bolts.



- b. Remove crankshaft pulley from the crankshaft.
- Set bolts in the two bolts holes [M6 x 1.0 mm (0.04 in)] on the front surface. Using a small puller, remove crankshaft pulley.
- NOTE:**
- The dimension between the centers of the two bolt holes is 61 mm (2.40 in).
  - Use suitable pulley puller.



6. Remove front cover.
- a. Loosen and remove bolts in the reverse of order shown in the figure.
- b. Using too, cut liquid gasket and remove covers.

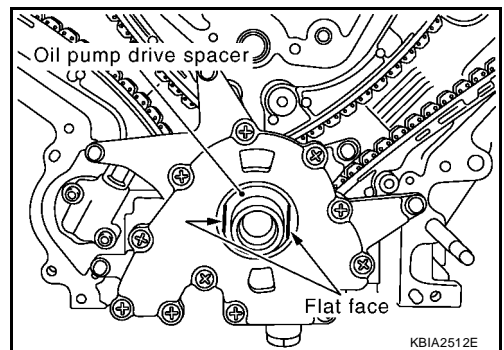
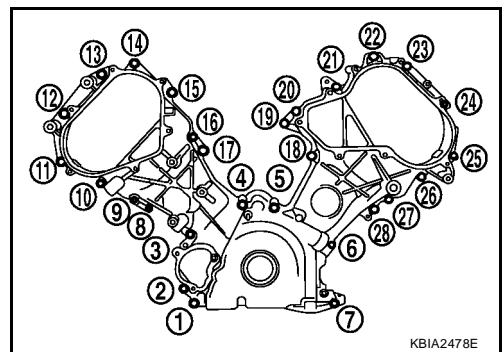
**Tool number : KV10111100 (J-37228)**

**CAUTION:**  
Use care not to damage mating surfaces.

7. Using a suitable tool remove the front oil seal.

**CAUTION:**  
Use care not to damage front cover.

8. Remove oil pump drive spacer.
- Hold and remove flat space of oil pump drive spacer by pulling it forward.



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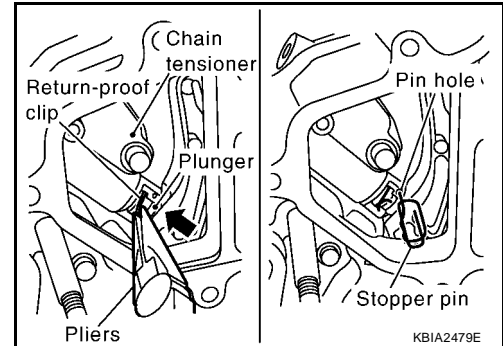
# TIMING CHAIN

9. Remove oil pump. Refer to .
10. Remove chain tensioner on left bank.

## NOTE:

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

- a. Using a suitable tool or fingers squeeze return-proof clip ends and push the plunger into the tensioner body.
- b. Secure plunger using stopper pin.
  - Stopper pin is made from hard wire approximately 1 mm (0.04 in) in diameter.
- c. Remove the bolts and the chain tensioner.

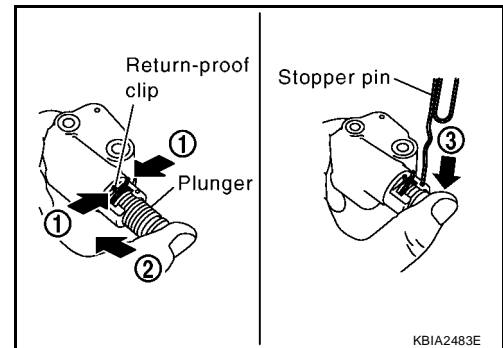


## NOTE:

- Stop plunger in the fully extended position by return-proof clip 1 if stopper pin is removed.
- Push the plunger in tensioner body while pushing plunger head and squeezing return-proof clip with fingers 2. Secure it using stopper pin 3.

## CAUTION:

**Plunger, spring, and spring seat pop out when (squeezing) return-proof clip without holding plunger head. It may cause serious injuries. Always hold plunger head when removing.**

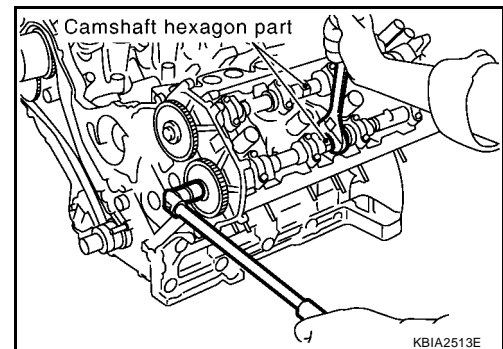


11. Remove chain tension guide and slack guide.
12. Remove timing chain and crankshaft sprocket.
13. Using a suitable tool to assist, loosen bolts securing camshaft sprocket to remove camshaft sprocket.

## CAUTION:

**To avoid interference between valves and pistons, do not turn crankshaft or camshaft when timing chain is disconnected.**

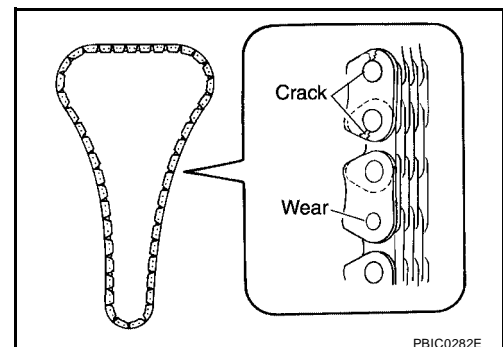
14. Repeat the same procedure to remove the right timing chain and associated parts.



## INSPECTION AFTER REMOVAL

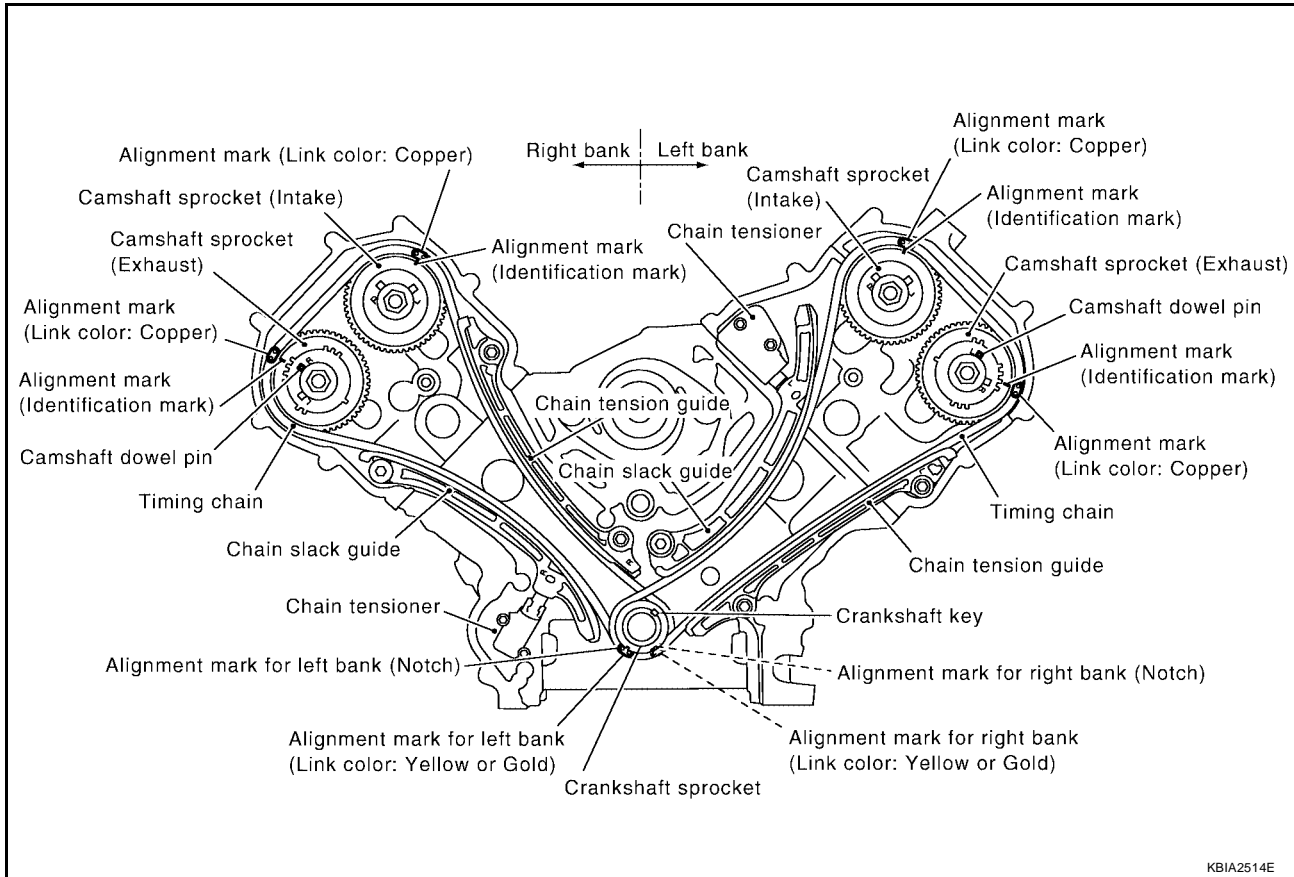
**Check for cracks and any excessive wear at link plates. Replace chain if necessary.**

- In the same way as for left bank, inspect timing chain and associated parts on right bank.



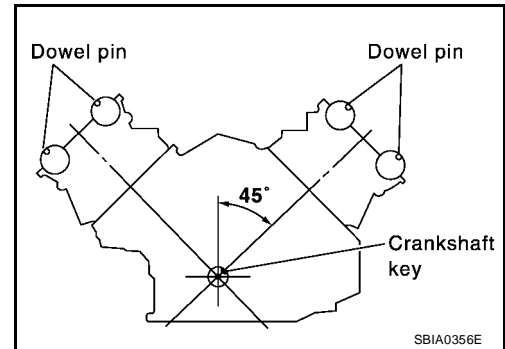
# TIMING CHAIN

## INSTALLATION



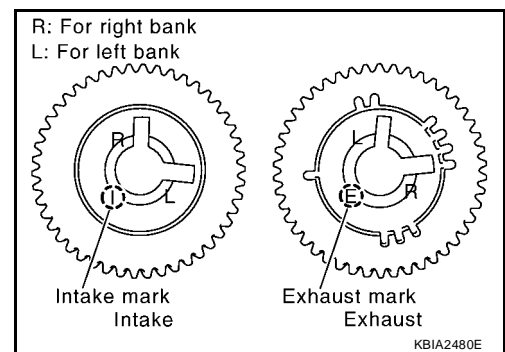
### NOTE:

- The above figure shows the relationship between the mating mark on each timing chain and that of the corresponding sprocket, with the components installed.
  - To install timing chain and associated parts, start with those on right bank. The procedure for installing parts on left bank is omitted because it is the same as that for installation on right bank.
1. Make sure the crankshaft key and dowel pin of each camshaft are facing in the direction as shown.



2. Install camshaft sprockets.

- Install intake and exhaust camshaft sprocket by selectively using the groove of dowel pin according to the bank. (Common part used for both banks.)
- Lock the hexagonal part of camshaft in the same way as for removal, and tighten bolts.



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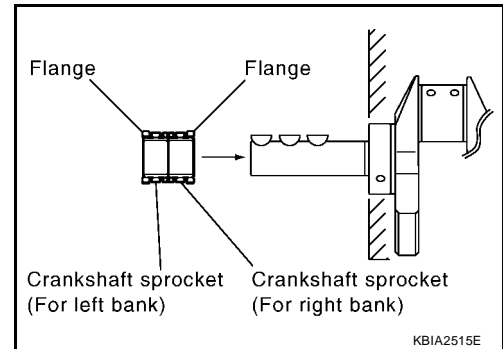
## TIMING CHAIN

### 3. Install crankshaft sprockets for both banks.

- Install each crankshaft sprocket so that its flange side (the larger diameter side without teeth) faces in the direction as shown.

**NOTE:**

The same parts are used but facing directions are different.



### 4. Install timing chains and associated parts.

- Align the mating mark on each sprocket and the timing chain for installation.

**CAUTION:**

- **Before installing chain tensioner, it is possible to change the position of mating mark on timing chain and each sprocket, after the mating marks are aligned, keep them aligned by holding them by hand.**
- Install slack guides and tension guides onto correct side by checking with identification mark on surface.
- Install chain tensioner with plunger locked in with stopper pin.

**CAUTION:**

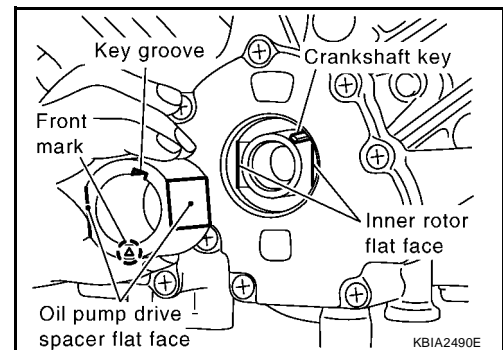
- **Before and after the installation of chain tensioner, make sure that the mating mark on timing chain is not out of alignment.**
- **After installing chain tensioner, remove the stopper pin to release tensioner. Make sure tensioner is released.**
- **To avoid chain-link skipping of timing chain, never move crankshaft or camshafts until front cover is installed.**

### 5. In the same way as for right bank, install timing chain and associated parts on left side.

### 6. Install oil pump.

### 7. Install oil pump drive spacer as follows:

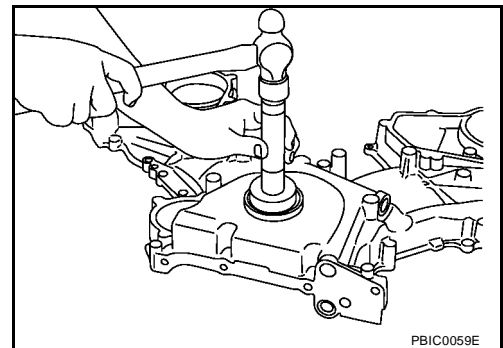
- Install so that front mark on front edge of oil pump drive spacer faces the front of engine.
- Insert oil pump drive spacer according to the directions of crankshaft key and the two flat surfaces of oil pump inner rotor.
- If the positional relationship does not allow the insertion, rotate oil pump inner rotor with a finger to allow the oil pump drive spacer.



### 8. Using a suitable tool, install front oil seal.

**CAUTION:**

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

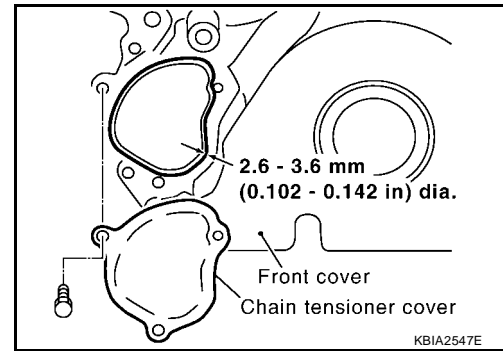




# TIMING CHAIN

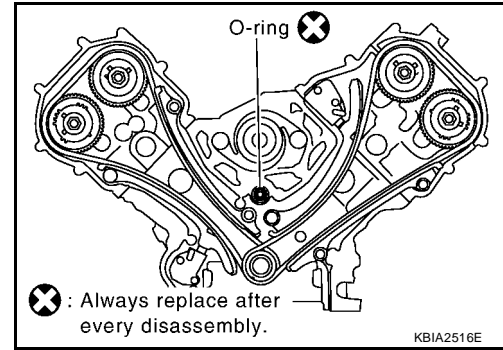
9. Install chain tensioner cover.

- Apply liquid gasket as shown in the figure.  
**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#)**



10. Install front cover as follows:

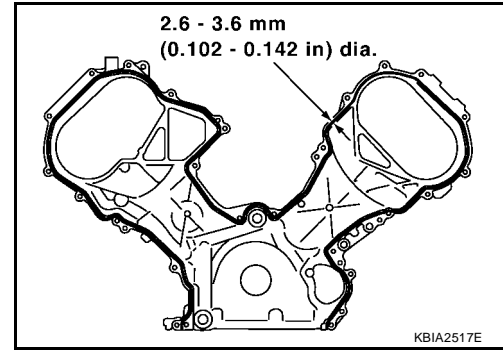
a. Install new O-ring on cylinder block.



b. Apply liquid gasket as shown in the figure.

- **Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#).**

c. Check again that the timing mating mark on timing chain and that on each sprocket are aligned. Then, install front cover.



d. Install bolts in the numerical order shown in the figure.

e. After tightening, re-tighten to the specified torque.

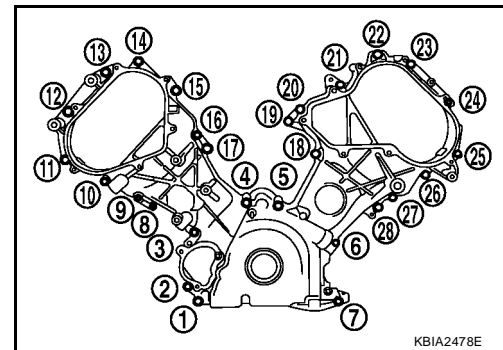
**CAUTION:**

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

**M6 × 50 mm (1.97 in) : No. 1, 20, 25, 26, 27**

**M6 × 80 mm (3.15 in) : No. 4, 5, 7**

**M6 × 20 mm (0.79 in) : Except the above**



11. Install chain case cover (right bank) and (left bank) as follows:

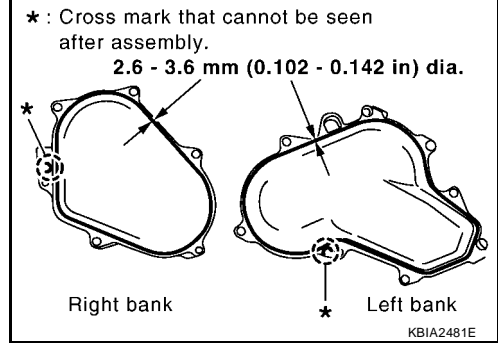
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M

# TIMING CHAIN

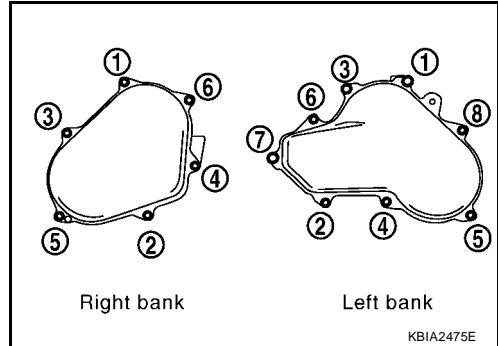
- a. Apply liquid gasket as shown in the figure.  
**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#).**

**CAUTION:**

**Both the start and end of application of liquid gasket should be crossed at an invisible position after attaching the chain case cover.**



- b. Install bolts in the numerical order shown in the figure.



12. Install crankshaft pulley.
- Install key of crankshaft.
  - Lightly tapping its center with plastic hammer, insert pulley.

**CAUTION:**

**Do not tap pulley on the side surface where belt is installed (outer circumference).**

13. Tighten crankshaft pulley bolt.
- Lock crankshaft with a hammer handle or similar tool to tighten bolt.
  - Perform the following steps for angular tightening:

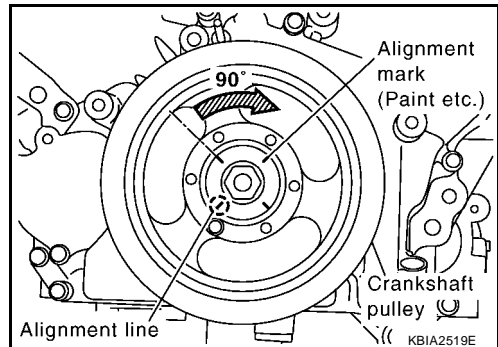
- Apply engine oil onto threaded parts of bolt and seating area.
- Select one most visible notch of the four on bolt flange. Corresponding to the selected notch, put a mating mark (such as paint) on crankshaft pulley.

**Crankshaft pulley bolt torque**

**Step 1 : 93.1 N·m (9.5 kg-m, 69 ft-lb)**

**Step 2 : additional 90° (angle tightening)**

- Rotate crankshaft pulley in normal direction (clockwise when viewed from engine front) to check for parts interference.
- Installation of the remaining components is in the reverse order of removal.



# CAMSHAFT

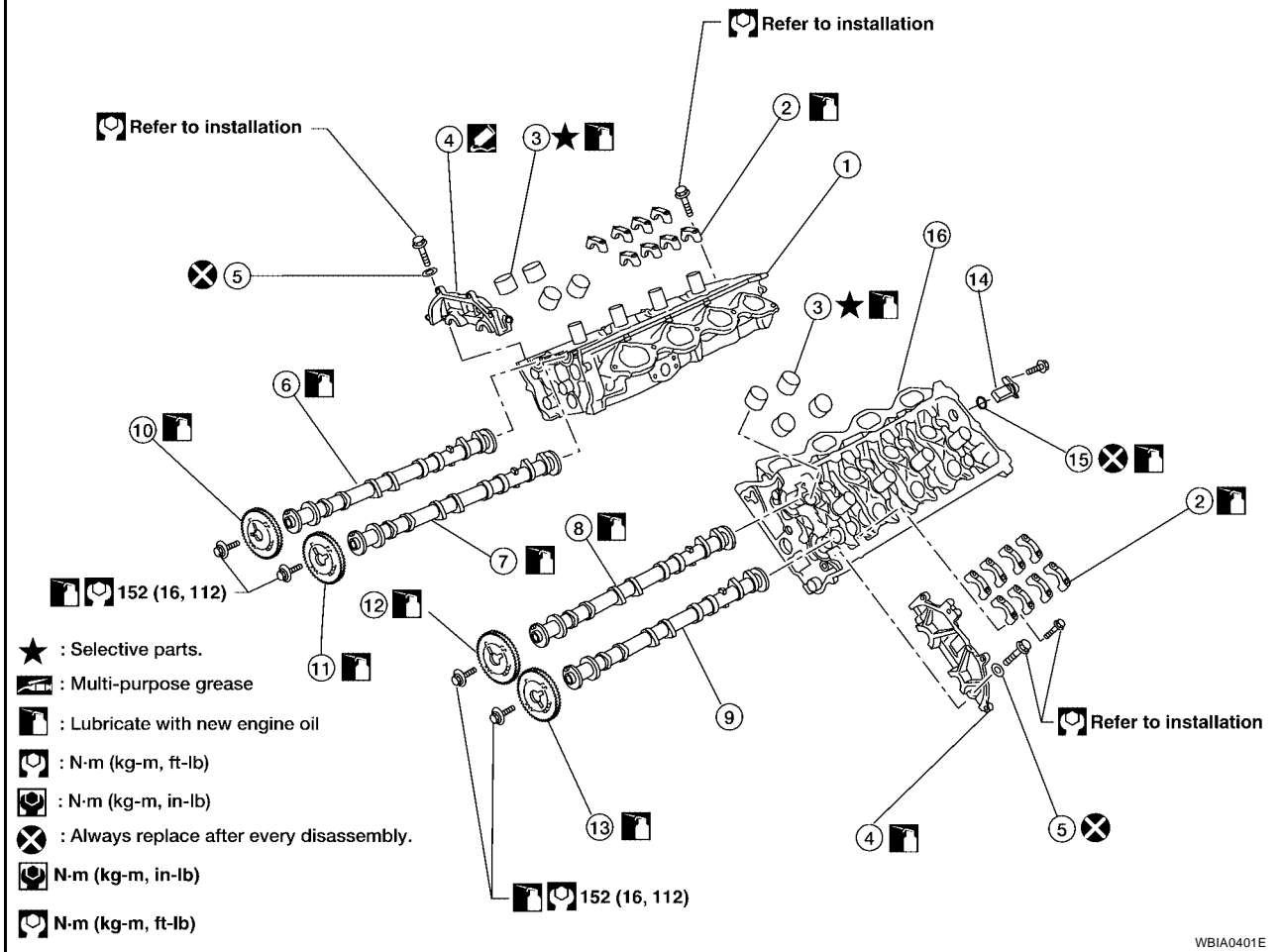
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EBS0012Y

## CAMSHAFT

### Removal and Installation

SEC. 111 • 130 • 135 • 221



- |  |  |                                       |
|--|--|---------------------------------------|
| 1. Cylinder head (right bank)          | 2. Camshaft bracket (No.2,3,4,5)       | 3. Valve lifter                       |
| 4. Camshaft bracket (No. 1)            | 5. Seal washer                         | 6. Camshaft (right bank EXH)          |
| 7. Camshaft (right bank INT)           | 8. Camshaft (left bank INT)            | 9. Camshaft (left bank EXH)           |
| 10. Camshaft sprocket (right bank EXH) | 11. Camshaft sprocket (right bank INT) | 12. Camshaft sprocket (left bank INT) |
| 13. Camshaft sprocket (left bank EXH)  | 14. Camshaft position sensor (PHASE)   | 15. O-ring                            |
| 16. Cylinder head (left bank)          |  |                                       |

## REMOVAL

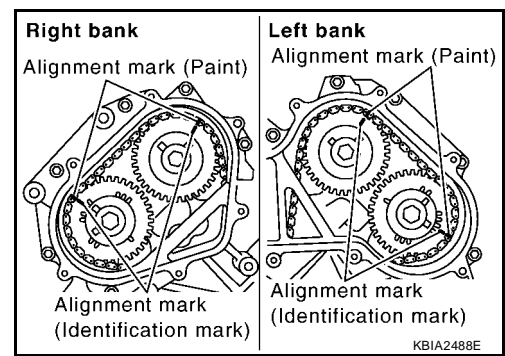
### NOTE:

For removal without specified sequence, perform the removal same as right and left bank.

1. Remove rocker cover (right bank) and (left bank). Refer to [EM-33, "ROCKER COVER"](#).
2. Obtain compression TDC of No. 1 cylinder. Refer to [EM-35, "TIMING CHAIN"](#).
3. Remove chain case cover (right bank) and (left bank). Refer to [EM-35, "TIMING CHAIN"](#).

# CAMSHAFT

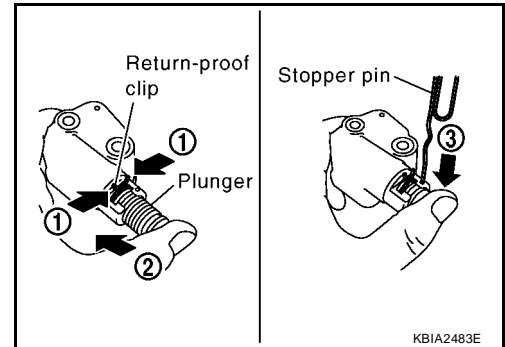
4. Paint matching marks on the timing chain links aligning with camshaft sprocket matching marks.



5. Remove chain tensioner on left bank.

**NOTE:**

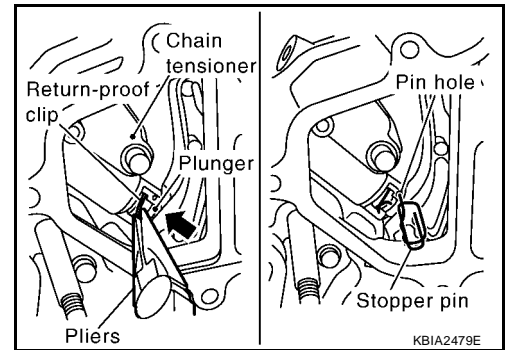
- Stop plunger in the fully extended position by return-proof clip 1 if stopper pin is removed.
- Push the plunger in tensioner body while pushing plunger head and squeezing return-proof clip with fingers 2. Secure it using stopper pin 3.



- a. Using a suitable tool or fingers, squeeze return-proof clip ends and push the plunger into the tensioner body.
- b. Secure plunger using stopper pin.
  - Stopper pin is made from hard wire approximately 1 mm (0.04 in) in diameter.
- c. Remove the bolts and the chain tensioner.

**CAUTION:**

**Plunger, spring, and spring seat pop out when (squeezing) clip without holding plunger head. It may cause serious injuries. Always hold plunger head when removing.**

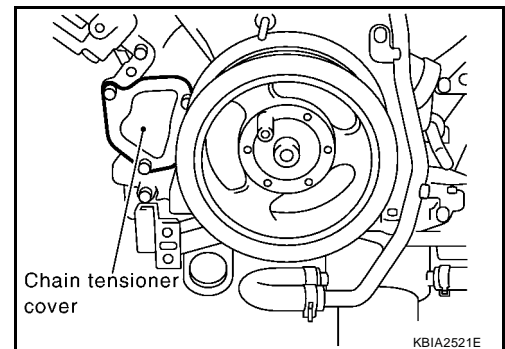


6. Remove chain tensioner on right bank.
  - a. Using tool remove chain tensioner cover from front cover.

**Tool number : KV10111100 (J-37228)**

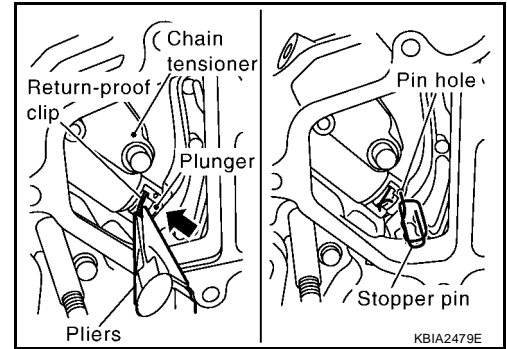
**CAUTION:**

**Use care not to damage mating surfaces.**



# CAMSHAFT

- b. Using a suitable tool or fingers, squeeze return-proof clip ends and push the plunger into the tensioner body.



- c. Secure plunger using stopper pin.  
● Stopper pin is made from hard wire approximately 1 mm (0.04 in) in diameter.

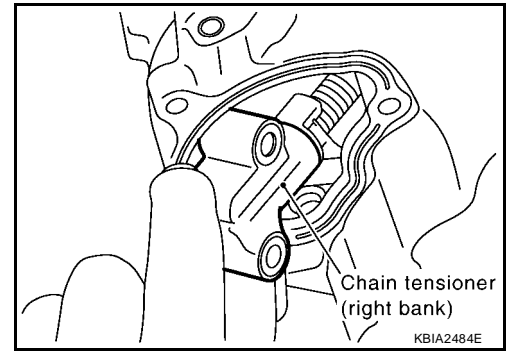
**CAUTION:**

Plunger, spring, and spring seat pop out when squeezing return-proof clip without holding plunger head. It may cause serious injuries. Always hold plunger head when removing.

- d. Remove the bolts and the right bank chain tensioner.

**NOTE:**

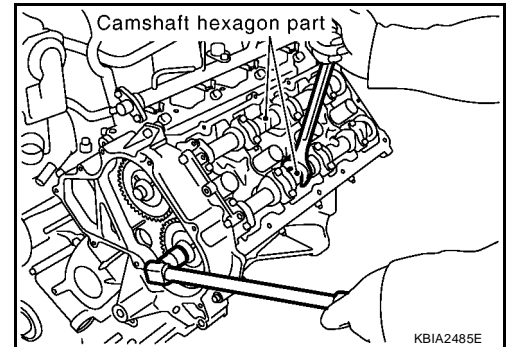
It is difficult to push plunger on right bank chain tensioner. Remove the plunger under extended condition.



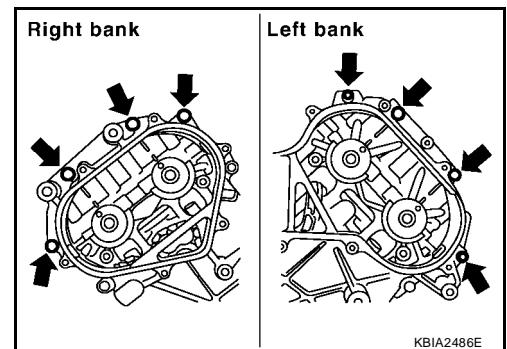
7. With hexagonal part of camshaft locked with wrench, loosen bolts securing camshaft sprocket to remove camshaft sprocket.

**CAUTION:**

To avoid interference between valves and pistons, do not turn crankshaft or camshaft with timing chain disconnected.



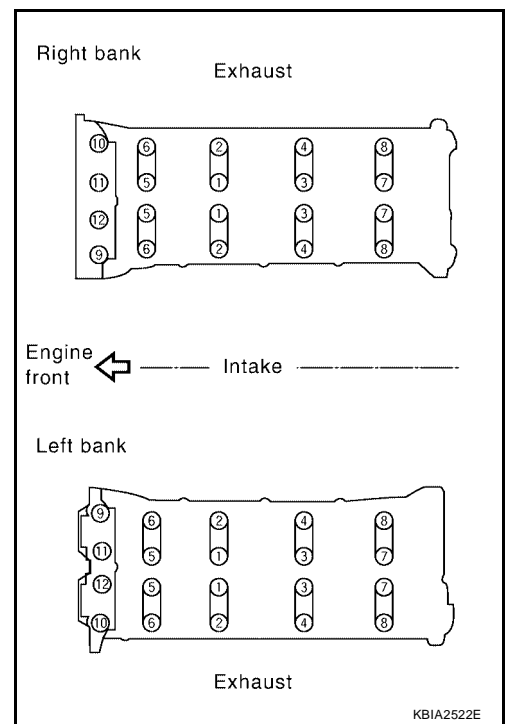
8. Remove front cover bolts.



# CAMSHAFT

9. Remove bolts in the reverse order as shown to remove camshaft brackets.
  - Using a suitable tool, remove No. 1 camshaft bracket.

**NOTE:**  
The bottom and front surface of bracket will be stuck because of liquid gasket.
10. Remove camshaft.
11. Remove valve lifters if necessary.
  - Correctly identify location where each part is removed from. Keep parts organized to avoid mixing them up.



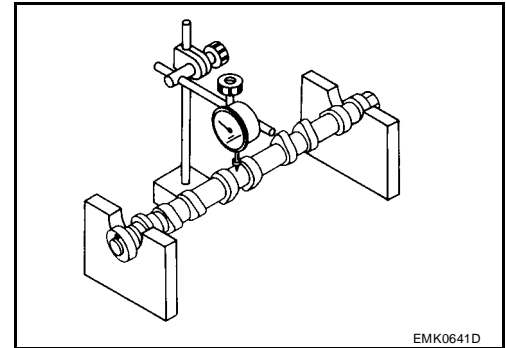
## INSPECTION AFTER REMOVAL

### Camshaft Runout

1. Put V block on precise flat work bench, and support No. 1 and No. 5 journal of camshaft.
2. Set dial gauge vertically to No. 3 journal.
3. Turn camshaft to one direction with hands, and measure camshaft runout on dial gauge.
  - 1/2 of runout is bend.

**Standard : Less than 0.02 mm (0.0008 in)**

- If it exceeds the specification, replace camshaft.



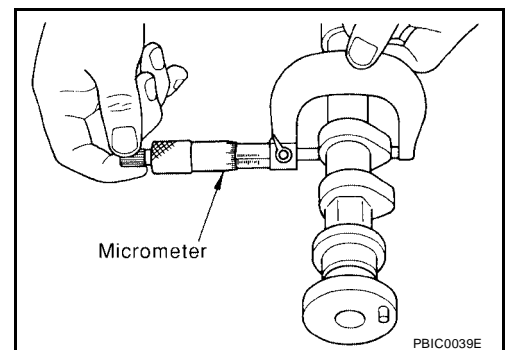
### Camshaft Cam Height

- Measure camshaft cam height.

**Standard cam height : 44.465 - 44.655 mm (1.7506 - 1.7581 in)**  
(intake & exhaust)

**Cam wear limit : 0.02 mm (0.0008 in)**  
(intake & exhaust)

- If wear is not within the specifications, replace camshaft.



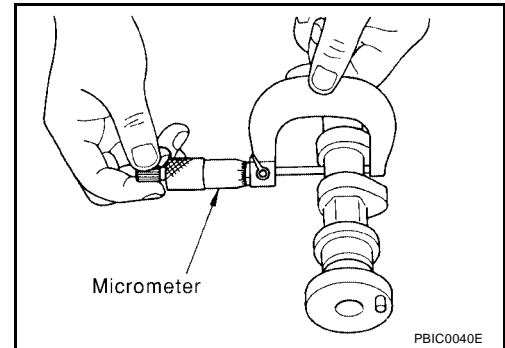
# CAMSHAFT

## Camshaft Journal Clearance

### Camshaft Journal Diameter

- Measure diameter of camshaft journal.

**Standard diameter : 25.953 - 25.970 mm  
(1.0218 - 1.0224 in)**



### Camshaft Bracket Inner Diameter

- Tighten camshaft bracket bolt with specified torque.
- Using inside micrometer, measure inner diameter of camshaft bracket.

**Standard : 26.000 - 26.021 mm (1.0236 - 1.0244 in)**

### Calculation of Camshaft Journal Clearance

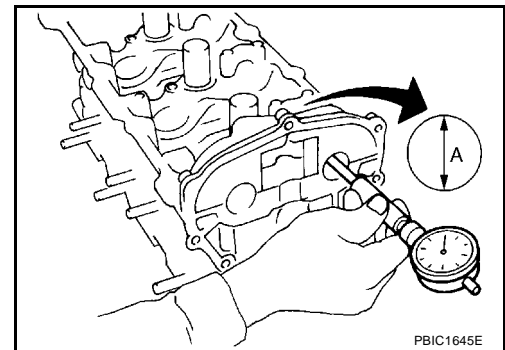
(Journal clearance) = (camshaft bracket inner diameter) – (camshaft journal diameter)

**Standard : 0.030 - 0.068 mm (0.0012 - 0.0027 in)**

- When out of the specified range above, replace either or both camshaft and cylinder head.

#### NOTE:

Inner diameter of camshaft bracket is manufactured together with cylinder head. Replace the whole cylinder head assembly.

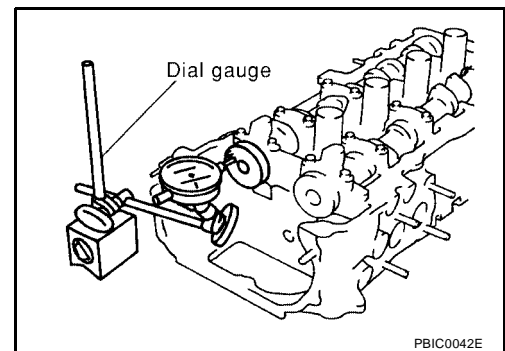


## Camshaft End Play

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

**Standard : 0.115 - 0.188 mm (0.0045 - 0.0074 in)**

- When out of the specified range, replace with new camshaft and measure again.
- When out of the specified range again, replace with new cylinder head.



- Measure the following parts if outside the specified value.

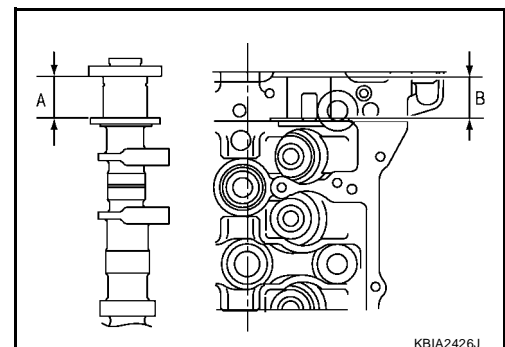
- Dimension A for camshaft No. 1 journal

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

- Dimension B for cylinder head No. 1 journal

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

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





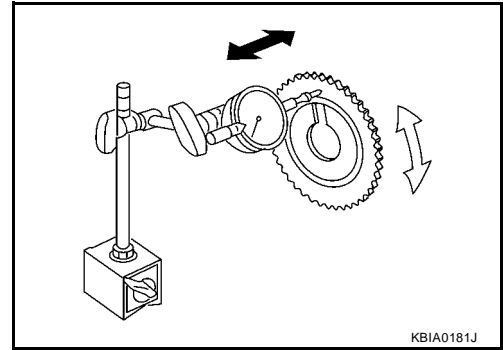
# CAMSHAFT

## Camshaft Sprocket Runout

1. Install camshaft in cylinder head.
2. Install camshaft sprocket to camshaft.
3. Measure camshaft sprocket runout.

**Runout : Less than 0.15 mm (0.0059 in)**

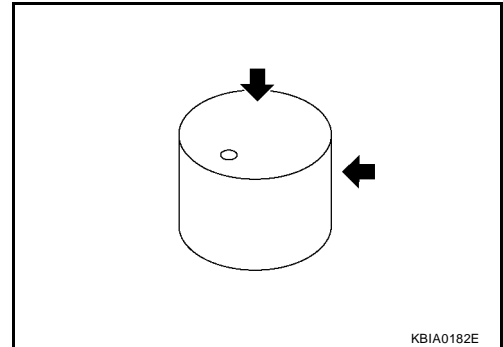
- If it exceeds the specification, replace camshaft sprocket.



## Valve Lifter

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

- If any damage is found, replace valve lifter.
- Select the thickness of the head so that valve clearance is the standard when replacing. Refer to [EM-52, "Valve Clearance"](#).

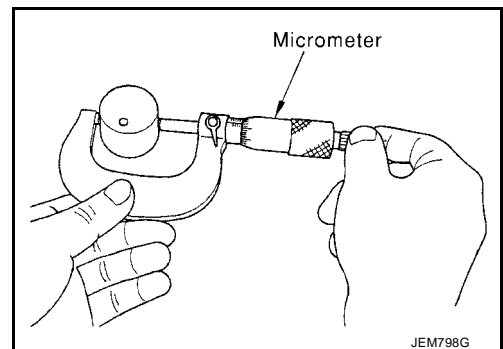


## Valve Lifter Clearance

### Valve Lifter Diameter

- Measure diameter of valve lifter.

**Standard : 33.977 - 33.987 mm (1.3377 - 1.3381 in)**



### Valve Lifter Hole Diameter

- Using inside micrometer, measure diameter of valve lifter hole of cylinder head.

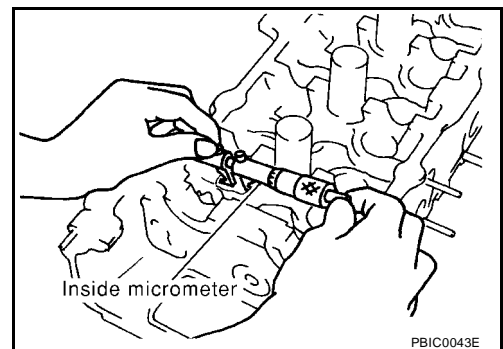
**Standard : 34.000 - 34.016 mm (1.3386 - 1.3392 in)**

### Calculation of Valve Lifter Clearance

(Valve lifter clearance) = (valve lifter hole diameter) - (valve lifter diameter)

**Standard : 0.013 - 0.039 mm (0.0005 - 0.0015 in)**

- When out of specified range, referring to each specification of valve lifter diameter and hole diameter, replace either or both valve lifter and cylinder head.



## INSTALLATION

### NOTE:

For removal without specified sequence, perform the removal same as right and left bank.

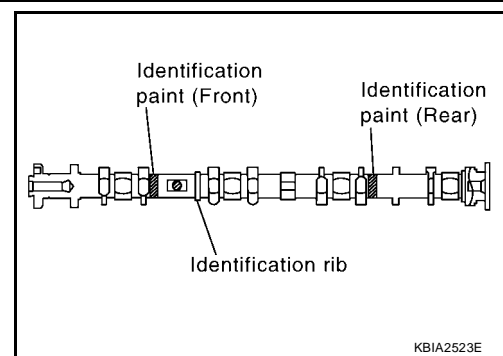
1. Install valve lifters if removed.
  - Install removed parts in their original locations.



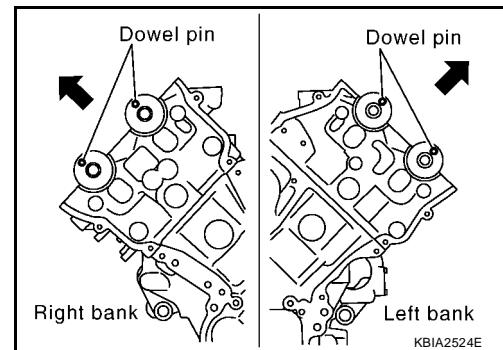
# CAMSHAFT

2. Install camshafts. Refer to the table below for identification of right and left bank, and intake and exhaust.

Bank	INT EXH	Identification paint (front)	Identification paint (rear)	Identification rib
RH	INT	White	—	Yes.
	EXH	—	Light blue	Yes.
LH	INT	White	—	No.
	EXH	—	Light blue	No.

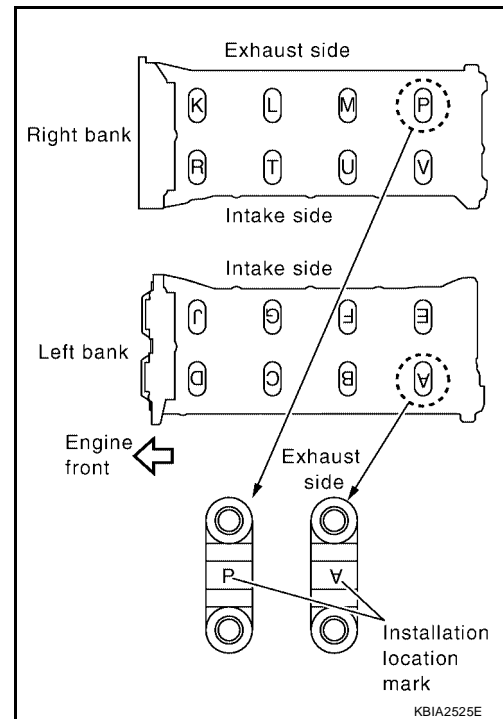


- Install so that dowel pin at the front of camshaft face is in the direction shown.



3. Install camshaft brackets.

- Install by referring to installation location mark on upper surface.
- Install so that installation location mark can be correctly read when viewed from the intake manifold side.



- Install No.1 camshaft bracket using the following procedure:

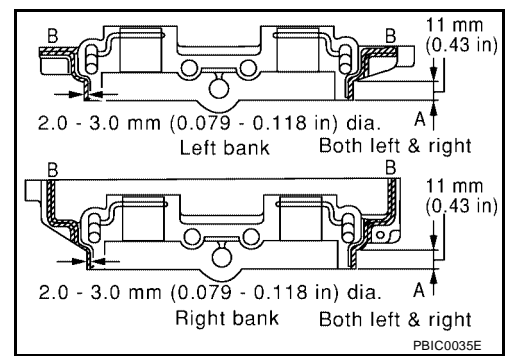
A  
EM  
C  
D  
E  
F  
G  
H  
I  
J  
K  
L  
M

# CAMSHAFT

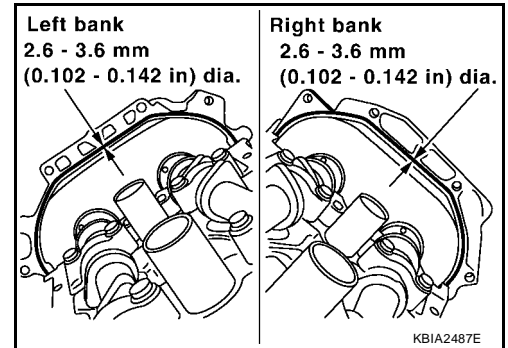
- Apply liquid gasket to No.1 camshaft bracket as in illustration. Use **Genuine RTV Silicone Sealant or equivalent**. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#).

**CAUTION:**

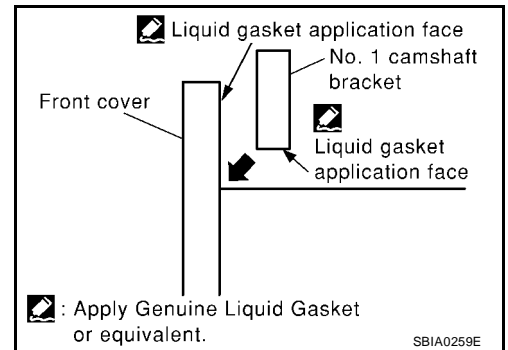
- After installation, be sure to wipe off any excessive liquid gasket leaking from part "A" and "B" (both on right and left sides).
- Remove completely any excess of liquid gasket inside bracket.



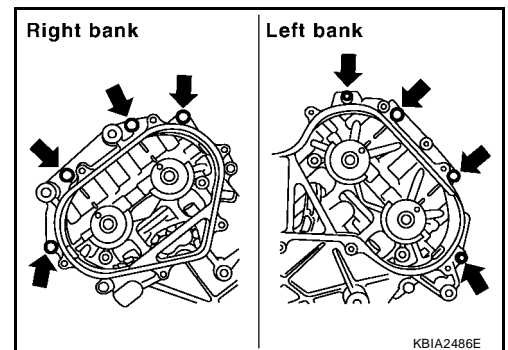
- Apply liquid gasket to the back side of front cover as shown. Use **Genuine RTV Silicone Sealant or equivalent**. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#).



- Position No.1 camshaft bracket close to mounting position, and then install it to prevent from touching liquid gasket applied to each surface.



- Temporarily tighten front cover bolts (4 for each bank) as shown.



# CAMSHAFT

4. Tighten fixing bolts of camshaft brackets as follows:

## Camshaft bracket bolts

Step 1 (bolts 9 - 12) : 1.96 N·m (0.2 kg·m, 17 in·lb)

Step 2 (bolts 1 - 8) : 1.96 N·m (0.2 kg·m, 17 in·lb)

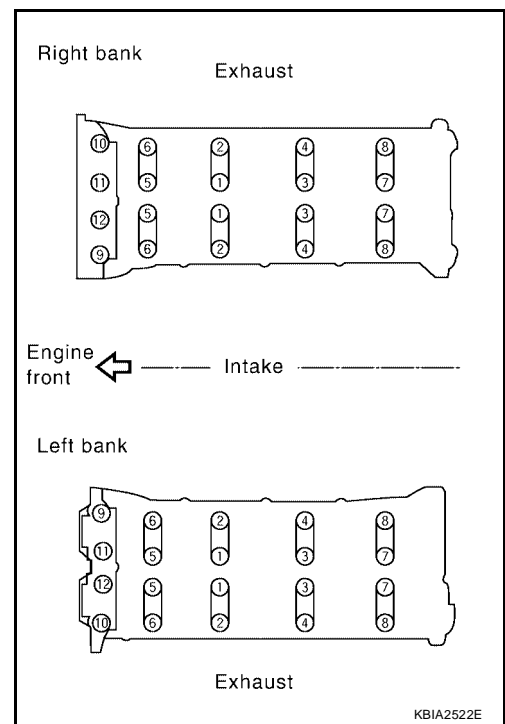
Step 3 (all bolts) : 5.88 N·m (0.6 kg·m, 52 in·lb)

Step 4 (all bolts) : 10.4 N·m (1.1 kg·m, 92 in·lb)

### CAUTION:

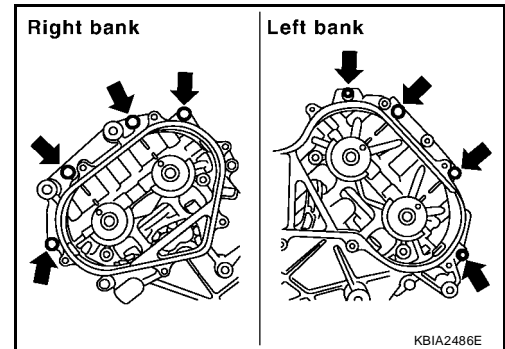
After tightening bolts of the camshaft brackets, be sure to wipe off excessive liquid gasket from the parts listed below.

- Mating surface of rocker cover
- Mating surface of front cover



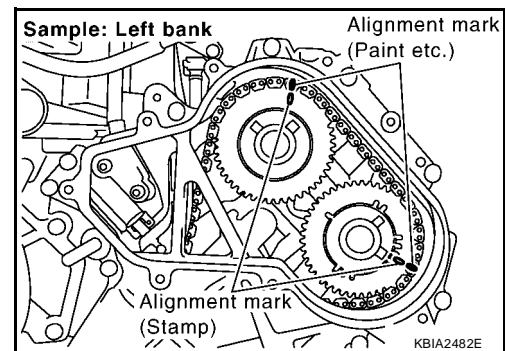
a. Tighten front cover bolts (4 for each bank) as shown in the figure to the specified torque.

Front cover bolts : 11.0 N·m (1.1 kg·m, 8ft - lb)



5. Install camshaft sprocket with the following procedure:

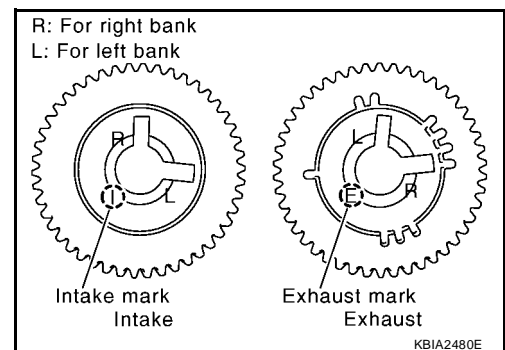
a. Install camshaft sprocket aligning with matching marks painted on timing chain when removed. Align camshaft sprocket key groove with dowel pin on camshaft front edge at the same time, and then temporarily tighten bolts.



- Install intake and exhaust side camshaft sprocket by selectively using the groove of dowel pin according to the bank. (Common part used for both banks.)

b. Lock the hexagonal part of camshaft in the same way as for removal, and tighten bolts.

c. Check again that the timing mating mark on timing chain and on each sprocket are aligned.



# CAMSHAFT

6. Install chain tensioner with the following procedure:

**NOTE:**

Left bank is shown.

a. Install chain tensioner.

- Compress plunger and hold it with a stopper pin when installing.
- Loosen the slack guide side timing chain by rotating camshaft hexagonal part using the wrench if mounting space is small.

**Chain tensioner bolts : 6.9 N-m (0.70 kg-m, 61 in-lb)**

b. Remove stopper pin and release plunger, and then apply tension to timing chain.

c. Install chain tensioner cover onto front cover. (RH bank)

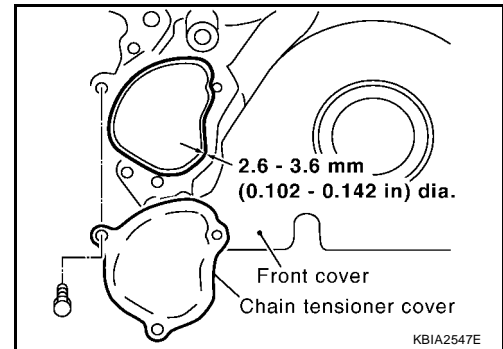
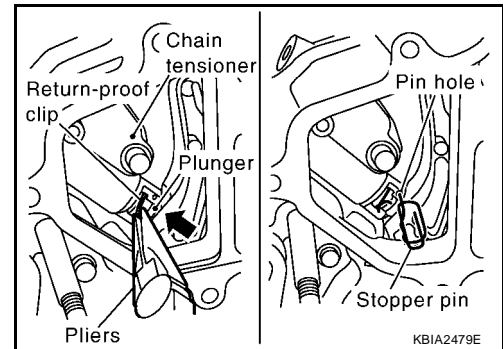
- Apply liquid gasket as shown in the figure.

**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#)**

**Tensioner cover bolts : 9.0 N-m (0.92 kg-m, 80 in-lb)**

7. Check and adjust valve clearances. Refer to [EM-52, "Valve Clearance"](#).

8. Installation of the remaining components is in the reverse order of removal.

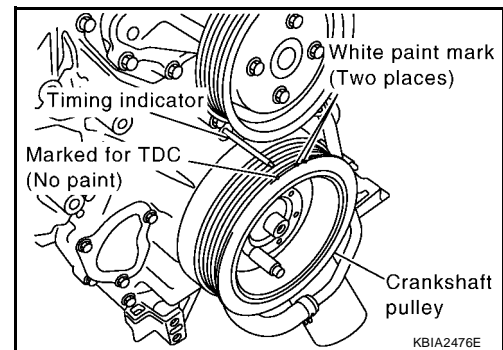


## Valve Clearance INSPECTION

**NOTE:**

Perform inspection as follows after removal, installation or replacement of camshaft or valve-related parts, or if there are unusual engine conditions due to changes in valve clearance over time (starting, idling, and/or noise).

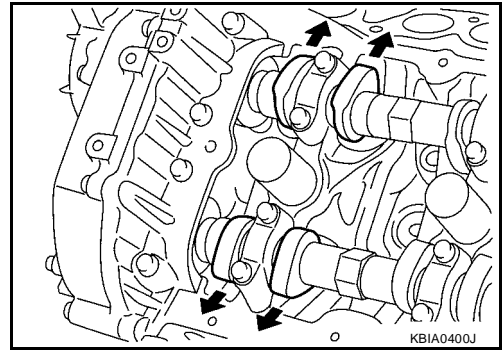
1. Warm up engine. Then stop it.
2. Remove engine cover, battery cover and air duct (inlet). Refer to [EM-11, "REMOVAL"](#), [SC-9, "REMOVAL"](#) and [EM-14, "REMOVAL"](#).
3. Remove right bank and left bank rocker covers with power tool. Refer to [EM-33, "Removal and Installation"](#).
4. Turn crankshaft pulley in normal direction (clockwise when viewed from engine front) to align TDC identification notch (without paint mark) with timing indicator.



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# CAMSHAFT

- At this time, make sure both the intake and exhaust cam noses of No. 1 cylinder (top front on left bank) face outside.
  - If they do not face outside, turn crankshaft pulley once more.



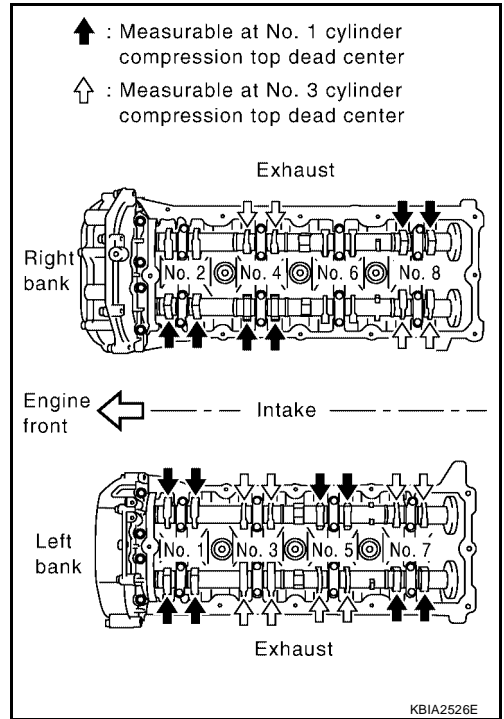
- Measure valve clearances at locations marked "x" as shown in the table below (locations indicated with black arrow) with a thickness gauge.

**NOTE:**

Firing order 1-8-7-3-6-5-4-2

- No.1 cylinder compression TDC

Measuring position (RH bank)		No.2 CYL	No.4 CYL	No.6 CYL	No. 8 CYL
No. 1 cylinder at TDC	EXH				x
	INT	x	x		
Measuring position (LH bank)		No.1 CYL	No. 3 CYL	No. 5 CYL	No. 7 CYL
No. 1 cylinder at TDC	INT	x		x	
	EXH	x			x



- Use a fine thickness gauge.

**Valve clearance standard:**

**Hot**

**Intake : 0.304 - 0.416 mm (0.012 - 0.016 in)**

**Exhaust : 0.308 - 0.432 mm (0.012 - 0.017 in)**

**Cold\***

**Intake : 0.26 - 0.34 mm (0.010 - 0.013 in)**

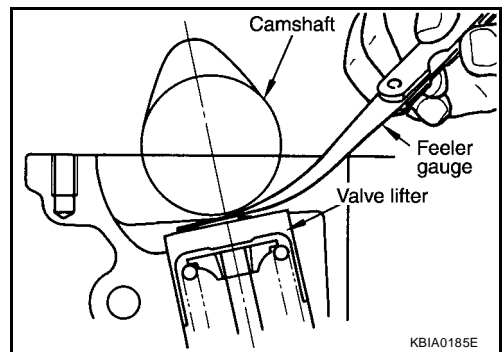
**Exhaust : 0.29 - 0.37 mm (0.011 - 0.015 in)**

\*Reference data at approximately 20°C (68°F)

**CAUTION:**

**If inspection was carried out with cold engine, make sure values with fully warmed up engine are still within specifications.**

- Turn crankshaft pulley clockwise by 270° degrees from the position of No. 1 cylinder compression TDC to obtain No. 3 cylinder compression TDC.

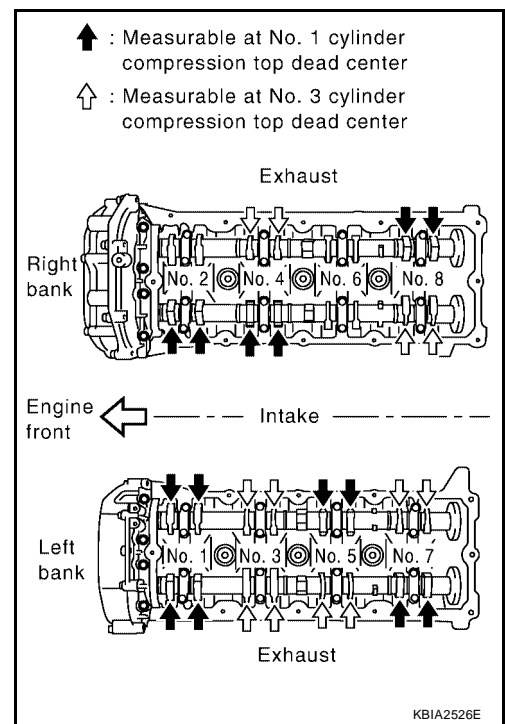


# CAMSHAFT

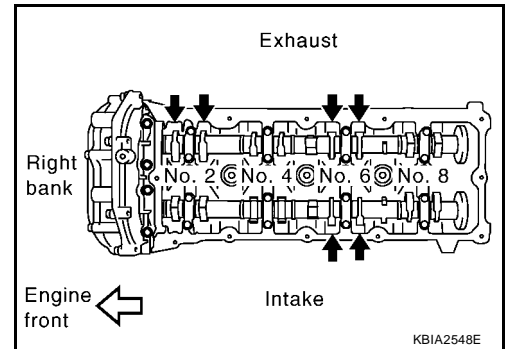
8. Measure valve clearances at locations marked "x" as shown in the table below (locations indicated with white arrow)

- No.3 cylinder compression TDC

Measuring position (RH bank)		No.2 CYL	No.4 CYL	No.6 CYL	No. 8 CYL
No. 3 cylinder at TDC	EXH		x		
	INT				x
Measuring position (LH bank)		No.1 CYL	No. 3 CYL	No. 5 CYL	No. 7 CYL
No. 3 cylinder at TDC	INT		x		x
	EXH		x	x	



9. Turn crankshaft pulley clockwise by 90° degrees from the position of No. 3 cylinder compression TDC (clockwise by 360° degrees from the position of No. 1 cylinder compression TDC) to measure intake and exhaust valve clearances of No. 6 cylinder and exhaust valve clearance of No.2 cylinder.

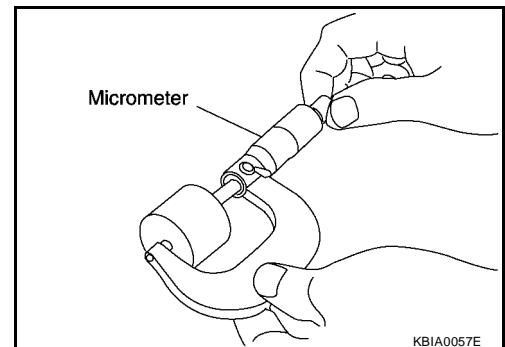


10. If out of specifications, adjust as necessary, Refer to [EM-54, "ADJUSTMENT"](#) :

## ADJUSTMENT

### NOTE:

- Perform adjustment depending on selected head thickness of valve lifter.
  - The specified valve lifter thickness is the dimension at normal temperatures. Ignore dimensional differences caused by temperature. Use the specifications for hot engine condition to adjust.
1. Remove camshaft. Refer to [EM-43, "Removal and Installation"](#) .
  2. Remove the valve lifters at the locations that are out of specification.
  3. Measure the center thickness of the removed valve lifters with a micrometer.



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

- Valve lifter thickness calculation:

# CAMSHAFT

Thickness of replacement valve lifter =  $t_1 + (C_1 - C_2)$

$t_1$  = Thickness of removed valve lifter

$C_1$  = Measured valve clearance

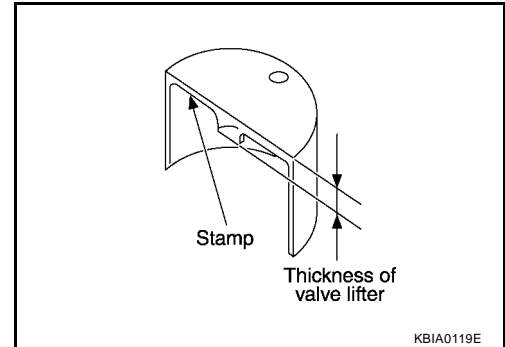
$C_2$  = Standard valve clearance:

**Intake : 0.36 mm (0.0142 in)\***

**Exhaust : 0.37 mm (0.0146 in)\***

**\*: Approximately 80°C (176°F)**

- Thickness of a new valve lifter can be identified by stamp marks on the reverse side (inside the cylinder). Stamp mark N788 indicates 7.88 mm (0.3102 in) in thickness.
- Available thickness of valve lifter: 25 sizes with range 7.88 to 8.36 mm (0.3102 to 0.3291 in) in steps of 0.02 mm (0.0008 in) (when manufactured at factory). Refer to [EM-102, "Available Valve Lifter"](#) .



5. Install the selected valve lifter.
6. Install camshaft.
7. Manually turn crankshaft pulley a few turns.
8. Make sure valve clearances for cold engine are within specifications by referring to the specified values.
9. After completing the repair, check valve clearances again with the specifications for warmed engine. Make sure the values are within specifications.

## Valve clearance standard:

### Hot

**Intake : 0.304 - 0.416 mm (0.012 - 0.016 in)**

**Exhaust : 0.308 - 0.432 mm (0.012 - 0.017 in)**

### Cold\*

**Intake : 0.26 - 0.34 mm (0.010 - 0.013 in)**

**Exhaust : 0.29 - 0.37 mm (0.011 - 0.015 in)**

## OIL SEAL

### Removal and Installation of Valve Oil Seal REMOVAL

EBS00130

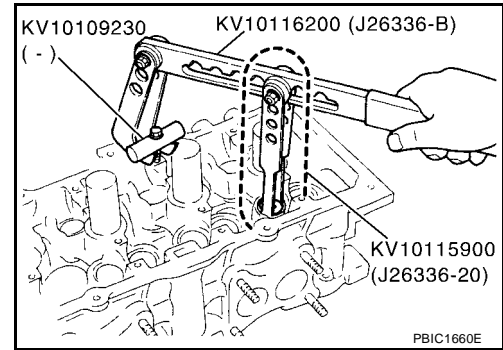
1. Remove camshaft relating to valve oil seal to be removed. Refer to [EM-43, "REMOVAL"](#) .
2. Remove valve lifters. Refer to [EM-43, "REMOVAL"](#) .
  - Correctly identify location where each part is removed. Keep parts organized to avoid mixing them up.
3. Turn crankshaft until the cylinder requiring new oil seals is at TDC. This will prevent the valve from dropping into the cylinder.
4. Remove valve collet using tool.

**Tool number:**                      **KV10116200 (J-26336-B)**  
    **KV10115900 (J-26336-20)**  
    **KV10109230 ( — )**

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

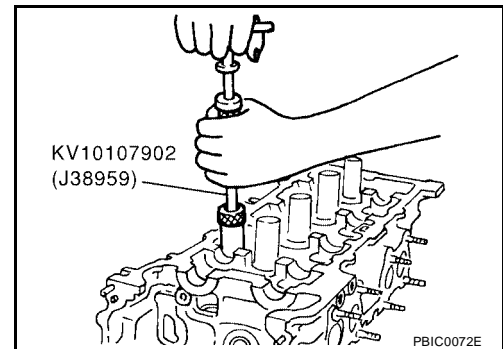
5. Remove valve spring retainer and valve spring.

**CAUTION:**  
**Do not remove valve spring seat from valve spring.**



6. Remove valve oil seal using tool.

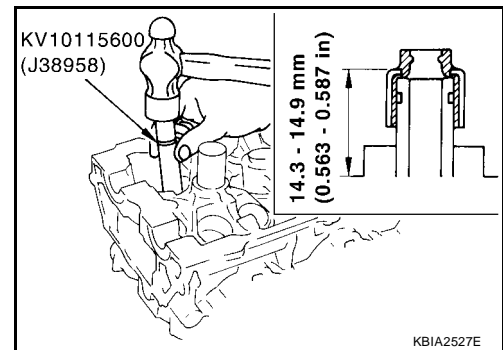
**Tool number:**                      **KV10107902 (J-38959)**



### INSTALLATION

1. Installation is in the reverse order of removal.
  - Apply engine oil on new valve oil seal joint and seal lip
  - Install valve oil seal using tool.

**Tool number:**                      **KV10115600 (J-38958)**





# OIL SEAL

EBS00131

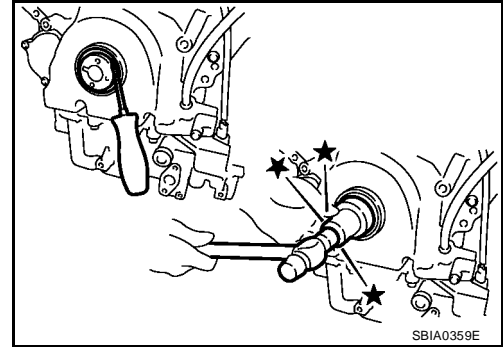
## Removal and Installation of Front Oil Seal

### REMOVAL

1. Remove the engine. Refer to [EM-70, "REMOVAL"](#).
2. Remove crankshaft pulley. Refer to [EM-35, "TIMING CHAIN"](#).
3. Remove the front oil seal using a suitable tool.

**CAUTION:**

Be careful not to damage front cover and oil pump drive spacer.

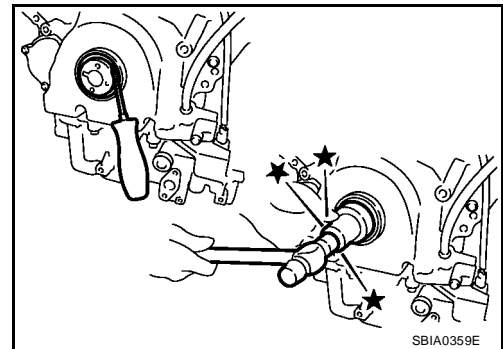


### INSTALLATION

1. Using a suitable tool, install front oil seal onto front cover.

**NOTE:**

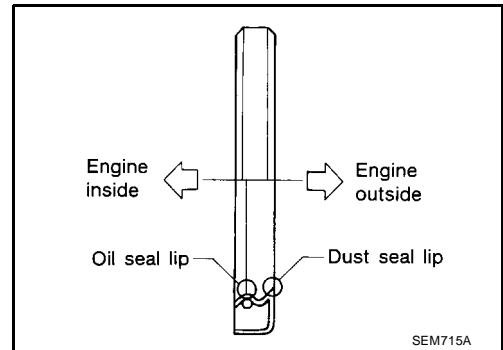
Apply engine oil on new front oil seal.



- Install new front oil seal in the direction as shown.

**CAUTION:**

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



2. Installation of the remaining components is in the reverse order of removal.

## Removal and Installation of Rear Oil Seal

EBS00132

### REMOVAL

1. Remove transmission assembly. Refer to [AT-269, "REMOVAL"](#) (4X2), [AT-272, "REMOVAL"](#) (4X4).
- a. Remove drive plate.

- Holding crankshaft pulley mounting bolts, lock crankshaft to remove drive plate bolts.
- Remove the bolts diagonally.

**CAUTION:**

- Be careful not to damage drive plate. Especially, avoid deforming and damaging of signal plate teeth (circumference position).
- Place the drive plate with signal plate surface facing other than downward.
- Keep magnetic materials away from signal plate.

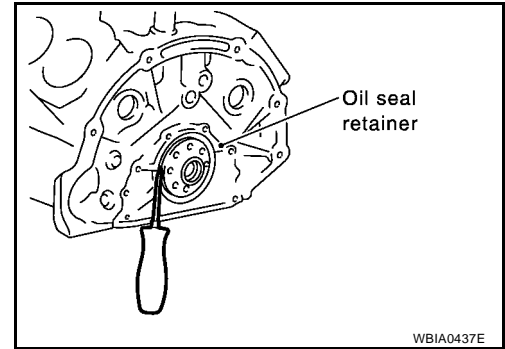
- b. Remove engine rear plate.

## OIL SEAL

- Remove the rear oil seal using a suitable tool.

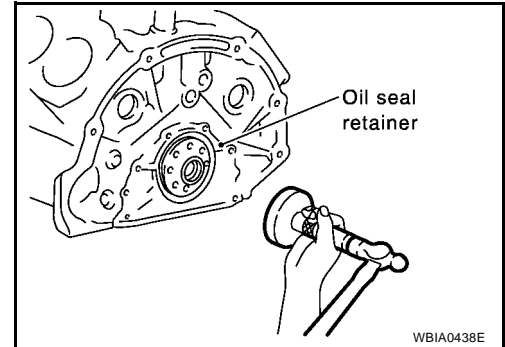
**CAUTION:**

Be careful not to damage crankshaft and oil seal retainer surface.



### INSTALLATION

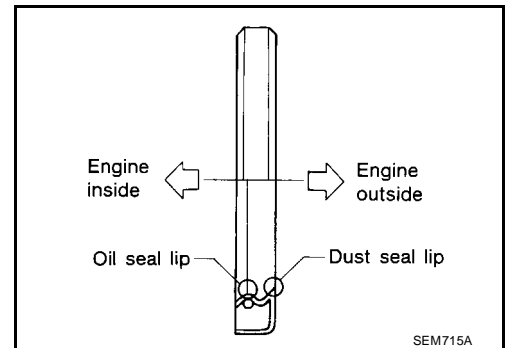
- Install the rear oil seal to oil seal retainer using a suitable tool.
  - Tap until flattened with front edge of oil seal retainer. Do not damage or scratch outer circumference of rear oil seal.



- Install new oil seal in the direction as.

**CAUTION:**

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



- Installation of the remaining components is in the reverse order of removal.

# CYLINDER HEAD

PFP:11041

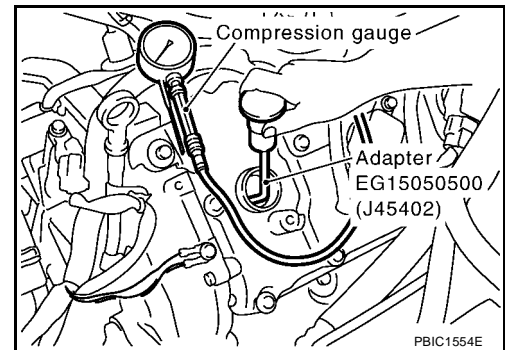
EBS00133

## CYLINDER HEAD

### On-Vehicle Service

#### CHECKING COMPRESSION PRESSURE

1. Warm up engine thoroughly. Then, stop it.
2. Release fuel pressure. Refer to [EC-46, "FUEL PRESSURE RELEASE"](#).
- a. Remove fuel pump fuse, and start engine.  
Refer to [PG-79, "FUSE AND RELAY BOX"](#) or fuel pump fuse location.
  - Let fuel pump fuse removed until the end of step 7.
- b. After engine stalls, crank it two or three times to release all fuel pressure.
3. Remove ignition coil and spark plug from each cylinder.  
Refer to [EM-27, "REMOVAL"](#).
4. Connect engine tachometer (not required in use of CONSULT-II).
5. Use a suitable tool and thread into spark plug hole.
6. With accelerator pedal fully depressed, turn ignition switch to "START" for cranking. When the gauge pointer stabilizes, read the compression pressure and engine rpm. Perform these steps to check each cylinder.



Unit: kPa (kg/cm <sup>2</sup> , psi) /rpm		
Standard	Minimum	Deference limit between cylinders
1,520 (15.5, 220) / 200	1,324 (13.5, 192) / 200	98 (1.0, 14) / 300

#### CAUTION:

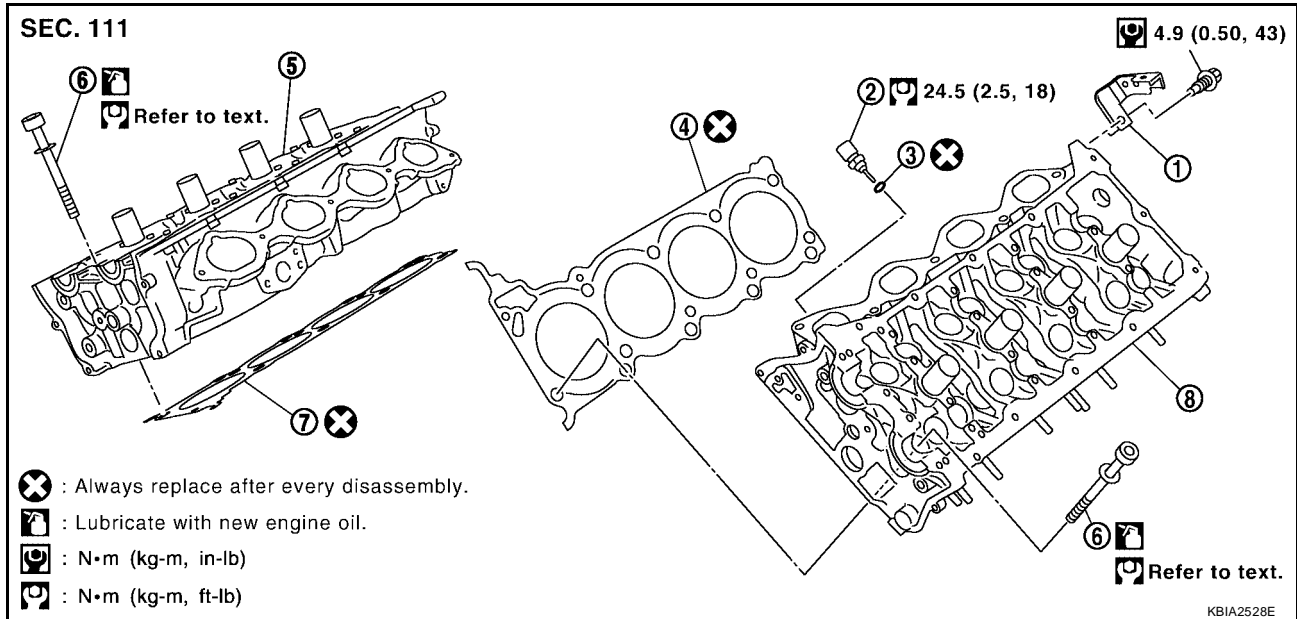
**Always use a fully charged battery to obtain specified engine speed.**

- If the engine speed is out of specified range, check battery liquid for proper gravity. Check engine speed again with normal battery gravity.
  - If compression pressure is below minimum value, check valve clearances and parts associated with combustion chamber (valve, valve seat, piston, piston ring, cylinder bore, cylinder head, cylinder head gasket). After the checking, measure compression pressure again.
  - If some cylinders have low compression pressure, pour small amount of engine oil into the spark plug hole of the cylinder to re-check it for compression.
    - If the added engine oil improves the compression, the piston rings may be worn out or damaged. Check the piston rings and replace if necessary.
    - If the compression pressure remains at low level despite the addition of engine oil, the valves may be malfunctioning. Check the valves for damage. Replace the 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, the gaskets may be leaking, or valve in adjacent cylinders may be damaged. Inspect and repair as required.
7. Installation of the remaining components is in the reverse order of removal.
  8. Start engine, and confirm that engine runs smoothly.
  9. Perform trouble diagnosis. If DTC appears, erase it. Refer to [EC-71, "TROUBLE DIAGNOSIS"](#).

# CYLINDER HEAD

EBS00134

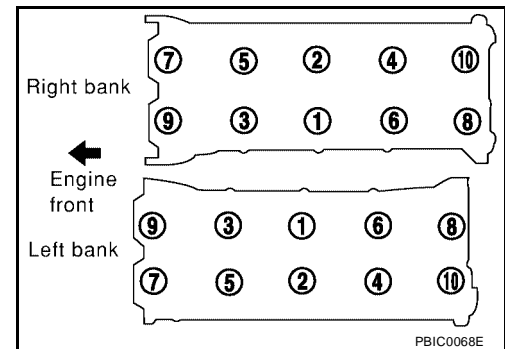
## Removal and Installation



- |                                      |                                      |                       |
|--------------------------------------|--------------------------------------|-----------------------|
| 1. Harness bracket                   | 2. Engine coolant temperature sensor | 3. Washer             |
| 4. Cylinder head gasket (left bank)  | 5. Cylinder head (right bank)        | 6. Cylinder head bolt |
| 7. Cylinder head gasket (right bank) | 8. Cylinder head (left bank)         |                       |

### REMOVAL

- Remove engine assembly from vehicle. Refer to [EM-70, "REMOVAL"](#).
- Remove the following components and related parts:
  - Auto tensioner of drive belts and idler pulley. Refer to [EM-12, "Removal"](#).
  - Thermostat housing and hose. Refer to [CO-17, "Removal of Thermostat Housing, Water Outlet and Heater Pipe"](#).
  - Oil pan and oil strainer. Refer to [EM-22, "REMOVAL"](#).
  - Fuel tube and fuel injector assembly. Refer to [EM-29, "FUEL INJECTOR AND FUEL TUBE"](#).
  - Intake manifold. Refer to [EM-15, "INTAKE MANIFOLD"](#).
  - Ignition coil. Refer to [EM-26, "IGNITION COIL"](#).
  - Rocker cover. Refer to [EM-33, "ROCKER COVER"](#).
- Remove crankshaft pulley, front cover, oil pump, and timing chain. Refer to [EM-35, "TIMING CHAIN"](#).
- Remove camshaft sprockets and camshafts. Refer to [EM-43, "CAMSHAFT"](#).
- Remove cylinder head bolts in reverse order shown in the figure, using a suitable tool.



# CYLINDER HEAD

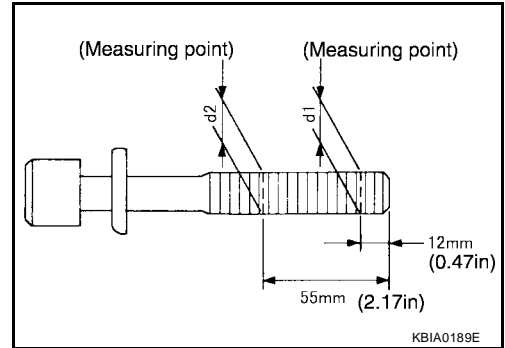
## INSPECTION AFTER REMOVAL

### Cylinder Head Bolts Diameter

- Cylinder head bolts are tightened by plastic zone tightening method. Whenever the size difference between d1 and d2 exceeds the limit, replace the bolts with new one.

**Limit (d1 - d2) : 0.18 mm (0.0071 in)**

- If reduction of diameter appears in a position other than d2, use it as d2 point.



## INSTALLATION

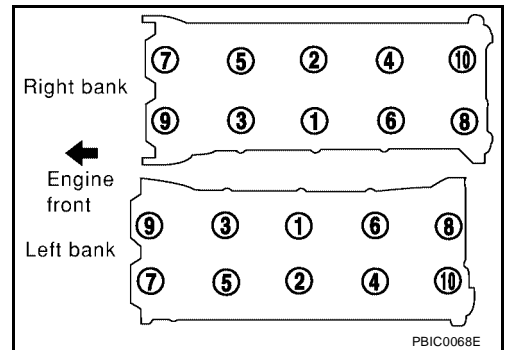
1. Install cylinder head gasket.
2. Follow the steps below to tighten the bolts in the numerical order shown in the figure to install cylinder head.

### CAUTION:

- If cylinder head bolts are re-used, check their diameters before installation. Refer to [EM-61, "Cylinder Head Bolts Diameter"](#).

### NOTE:

Apply engine oil to threads and seating surface of bolts.



**Tool number : KV10112100 (BT-8653-A)**

**Step a : 98.1 N-m (10 kg-m, 72 ft-lb)**

**Step b : 0 N-m Loosen in the reverse order of tightening.**

**Step c : 44.1 N-m (4.5 kg-m, 33 ft-lb)**

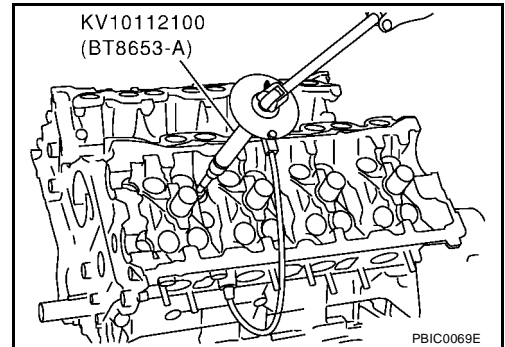
**Step d : 60° degrees clockwise**

**Step e : 60° degrees clockwise**

### CAUTION:

Check and confirm the tightening angle by using suitable tool. Avoid judgment by visual inspection without the tool.

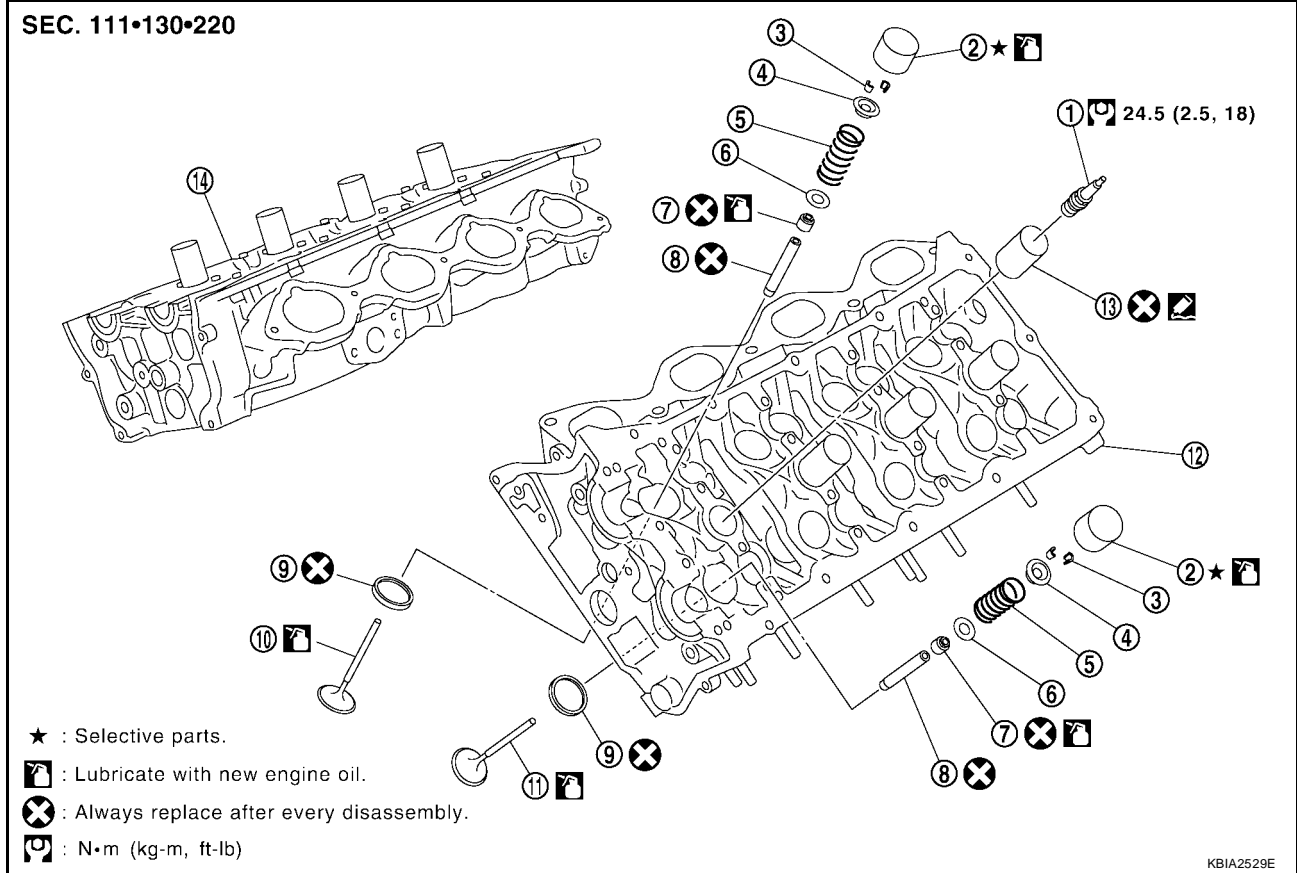
3. Installation of the remaining components is in the reverse order of removal.



# CYLINDER HEAD

## Disassembly and Assembly

EBS00135



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

### DISASSEMBLY

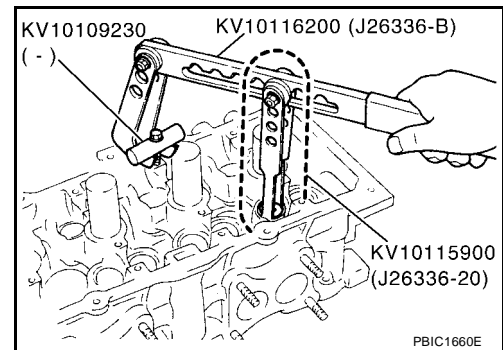
- Remove spark plug with spark plug wrench (commercial service tool). Refer to [EM-27, "REMOVAL"](#).
- Remove valve lifter.
  - Confirm installation point and keep parts in an organized way to avoid mixing them up.
- Using tool remove valve collet.

**Tool number:**  
 KV10116200 (J-26336-B)  
 KV10115900 (J-26336-20)  
 KV10109230 ( — )

### CAUTION:

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

- Remove valve spring retainer, valve spring and valve spring seat.
- Push valve stem to combustion chamber side, and remove valve.
  - Inspect valve guide clearance before removal. Refer to [EM-65, "Valve Guide Clearance"](#).
  - Confirm installation point and keep parts in an organized way to avoid mixing then up.



# CYLINDER HEAD

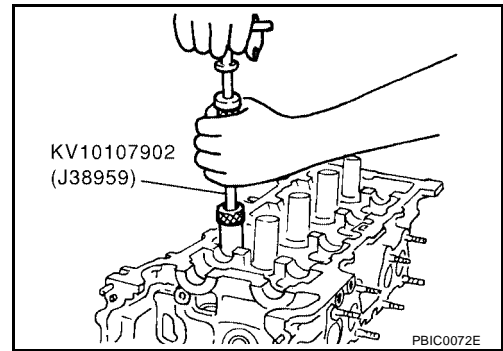
6. Using tool remove valve oil seal.

**Tool number:** KV10107902 (J-38959)

7. If valve seat must be replaced, refer to [EM-68, "VALVE SEAT REPLACEMENT"](#) .
8. If valve guide must be replaced, refer to [EM-68, "VALVE SEAT REPLACEMENT"](#) .
9. Remove spark plug tube, as necessary.
- Using a suitable tool, pull spark plug tube out of cylinder head.

**CAUTION:**

- Take care not to damage cylinder head.
- Once removed, a spark plug tube will be deformed and cannot be reused. Do not remove it unless absolutely necessary.

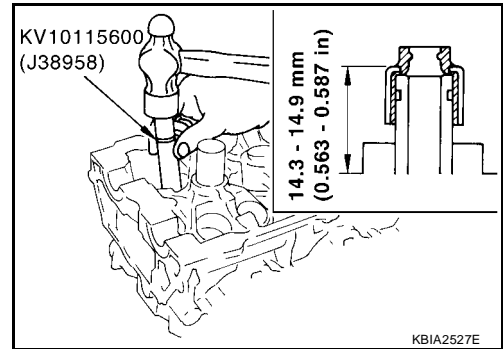


## ASSEMBLY

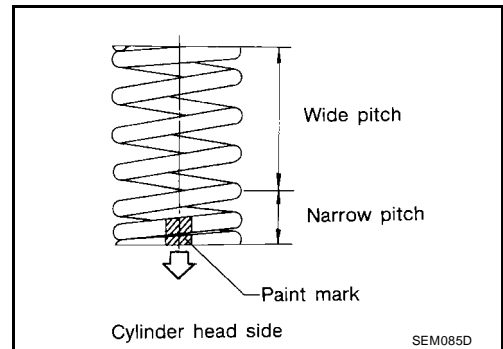
1. If necessary install the valve guide. Refer to [EM-65, "VALVE GUIDE REPLACEMENT"](#) .
2. If necessary install valve seat. Refer to [EM-68, "VALVE SEAT REPLACEMENT"](#) .
3. Using tool install valve oil seal.
- Apply engine oil on new valve oil seal joint and seal lip.

**Tool number:** KV10115600 (J-38958)

4. Install valves.
- Install larger diameter to intake side.



5. Install valve spring seats.
6. Install valve springs.
- Install narrow pitch (Paint mark side) to cylinder head side.
7. Install valve spring retainers.



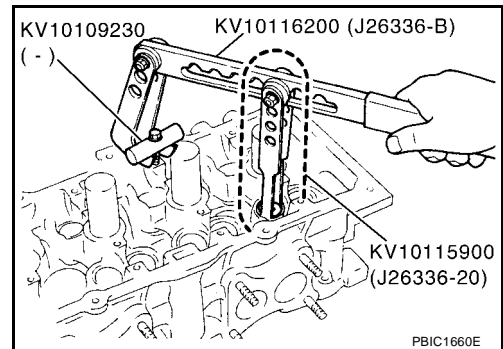
8. Using tool install valve collets.

**Tool number:** KV10116200 (J-26336-B)  
KV10115900 (J-26336-20)  
KV10109230 ( - )

**CAUTION:**

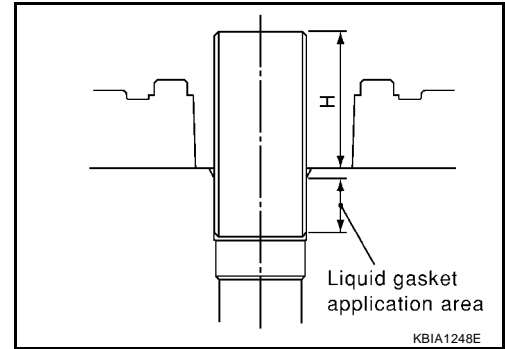
**When working, take care not to damage valve lifter holes.**

9. Install valve lifters.
- Install removed parts in there same locations.
  - If installing new lifters, select the correct size lifter for proper valve clearance. Refer to [EM-52, "Valve Clearance"](#) .



# CYLINDER HEAD

10. Install spark plug tube.
  - Press-fit spark plug tube following procedure below.
  - a. Remove old liquid gasket adhering to cylinder-head mounting hole.
  - b. Apply liquid gasket to area within approximately 12 mm (0.47 in) from edge of spark plug tube press-fit side.  
**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#).**
  - c. Using a drift, press-fit spark plug tube so that its height "H" is as specified in the figure.



**Standard press-fit height "H":**

**38.4 - 39.4 mm (1.512 - 1.551 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 plugs.

## Inspection After Disassembly CYLINDER HEAD DISTORTION

EBS00136

1. Wipe off oil and remove water scale (like deposit), gasket, sealer, carbon, etc. with scraper.

**CAUTION:**

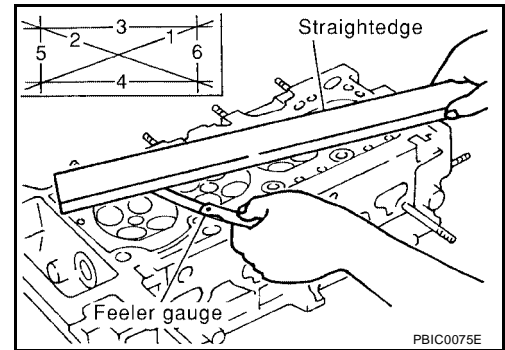
**Use utmost care not to allow gasket debris to enter passages for oil or water.**

2. At each of several locations on bottom surface of cylinder head, measure distortion in six directions.

**Standard : 0.03 mm (0.0012 in)**

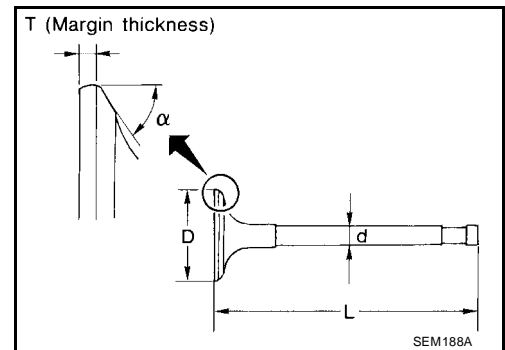
**Limit : 0.1mm (0.004 in)**

- If it exceed the limit, replace cylinder head.



## VALVE DIMENSIONS

- Check dimensions of each valve. For dimensions, refer to [EM-64, "VALVE DIMENSIONS"](#).
- If dimensions are out of the standard, replace valve.





# CYLINDER HEAD

## VALVE GUIDE CLEARANCE

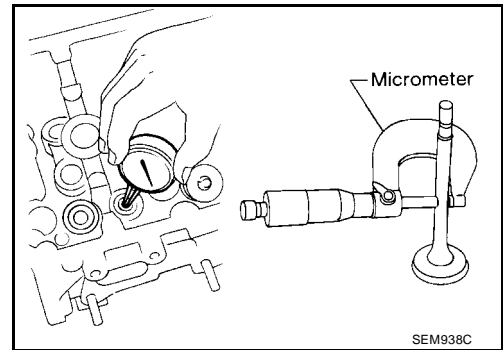
### Valve Stem Diameter

Measure diameter of valve stem with micrometer.

#### Standard

**Intake : 5.965 - 5.980 mm (0.2348 - 0.2354 in)**

**Exhaust : 5.955 - 5.970 mm (0.2344 - 0.2350 in)**



### Valve Guide Inside Diameter

Measure inside diameter of valve guide with inside micrometer.

#### Standard

**Intake and Exhaust : 6.000 - 6.018 mm (0.2362 - 0.2369 in)**

### Valve Guide Clearance

- (Valve guide clearance) = (Valve guide inside diameter) – (Valve stem diameter).

#### Valve guide clearance:

##### Standard

**Intake : 0.020 - 0.053 mm (0.0008 - 0.0021 in)**

**Exhaust : 0.030 - 0.063 mm (0.0012 - 0.0025 in)**

##### Limit

**Intake : 0.08 mm (0.0031 in)**

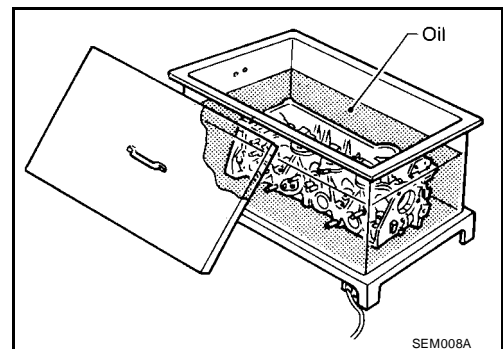
**Exhaust : 0.09 mm (0.0035 in)**

- If it exceeds the limit, replace valve guide.

## VALVE GUIDE REPLACEMENT

When valve guide is removed, replace with oversized (0.2 mm, 0.008 in) valve guide.

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

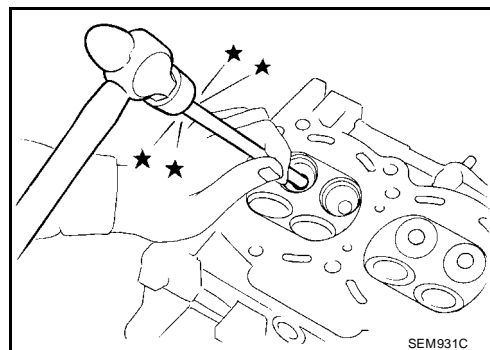


# CYLINDER HEAD

2. Using a suitable tool remove the valve guide.

**CAUTION:**

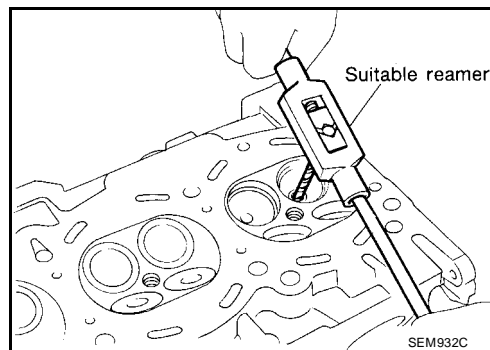
Cylinder head contains heat, when working, wear protective equipment to avoid getting burned.



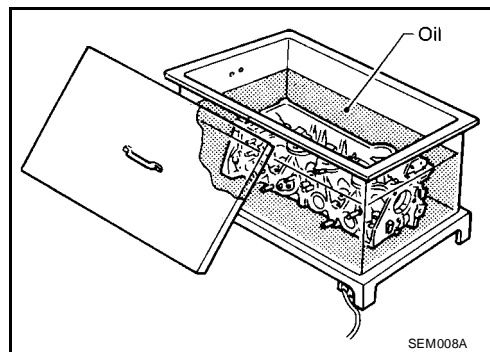
3. Using a suitable tool ream cylinder head valve guide hole.

**Valve guide hole diameter (for service parts)**

**Intake and exhaust : 10.175 - 10.196 mm (0.4006 - 0.4014 in)**



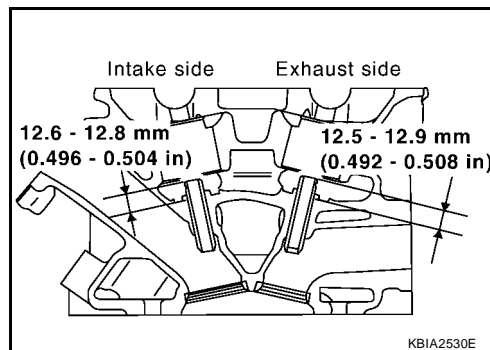
4. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.



5. Press valve guide from camshaft side to dimensions as in illustration.

**CAUTION:**

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

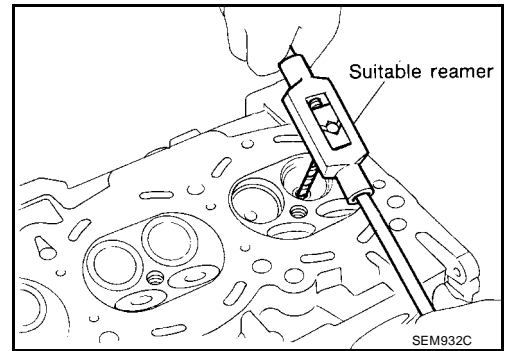


## CYLINDER HEAD

6. Using a suitable tool ream cylinder head valve guide hole.

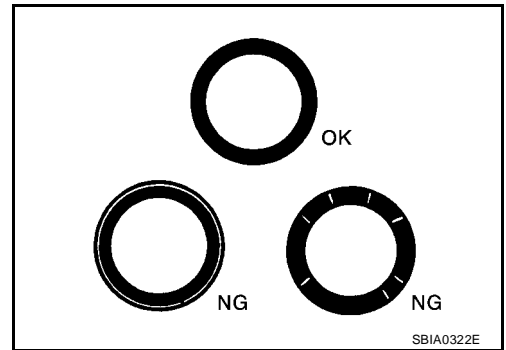
**Valve guide hole diameter (for service parts)**

**Intake and exhaust : 10.175 - 10.196 mm  
(0.4006 - 0.4014 in)**



### VALVE SEAT CONTACT

- After confirming that the dimensions of valve guides and valves are within 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 conditions even after the re-check, replace valve seat.



A

EM

C

D

E

F

G

H

I

J

K

L

M

# CYLINDER HEAD

## VALVE SEAT REPLACEMENT

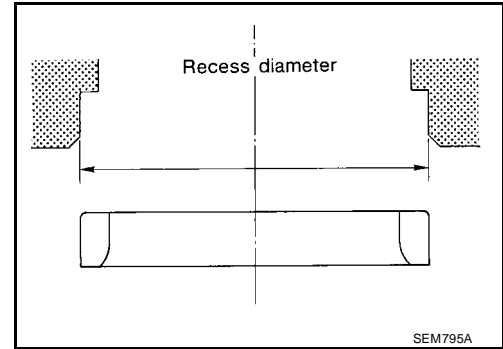
When valve seat is removed, replace with oversized (0.5 mm, 0.020 in) valve seat.

1. 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.
2. Ream cylinder head recess diameter for service valve seat.

### Oversize [0.5 mm (0.020 in)] (Service):

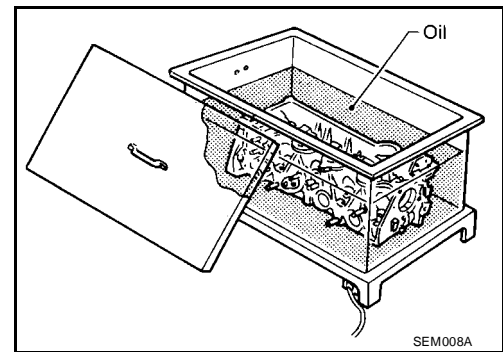
**Intake : 38.500 - 38.516 mm (1.5157 - 1.5164 in)**  
**Exhaust : 32.700 - 32.716 mm (1.2874 - 1.2880 in)**

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



SEM795A

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



SEM008A

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

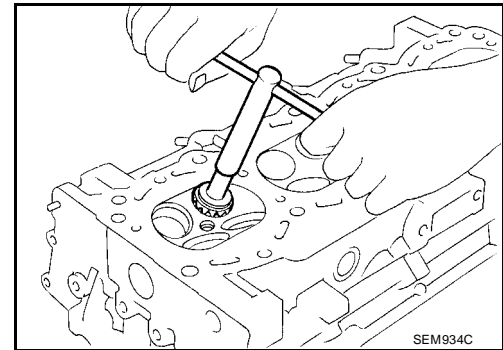
### CAUTION:

- Avoid directly touching cold valve seats.
- Cylinder head contains heat, when working, wear protective equipment to avoid getting burned.

5. Using a suitable tool, finish the seat to the specified dimensions.

### CAUTION:

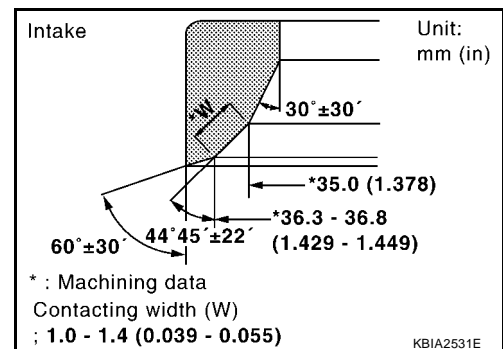
When using valve seat cutter, firmly grip the cutter handle with both hands. Then, press on the contacting surface all around the circumference to cut in a single drive. Improper pressure on with the cutter or cutting many different times may result in stage valve seat.



SEM934C

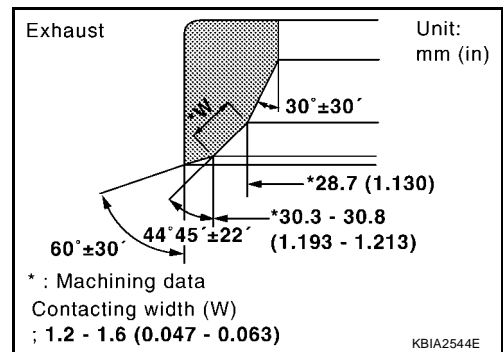
Grind to obtain the dimensions indicated in figure.

6. Using compound, grind to adjust valve fitting.
7. Check again for normal contact.



KBIA2531E

# CYLINDER HEAD

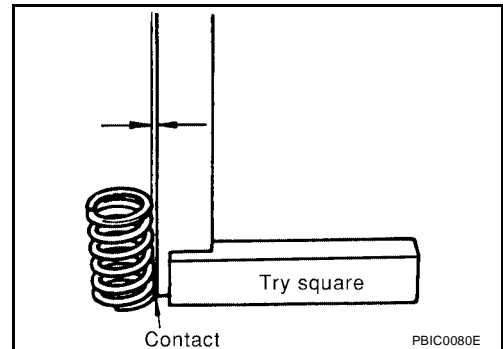


## VALVE SPRING SQUARENESS

- Set try square along the side of valve spring and rotate the spring. Measure the maximum clearance between the top face of spring and try square.

**Limit : Less than 2.2 mm (0.087 in)**

- If it is not within specifications, replace valve spring.



## VALVE SPRING DIMENSIONS AND VALVE SPRING PRESSURE LOAD

- Check valve spring pressure at specified spring height.

### Standard:

#### Intake and exhaust

#### Free height:

50.58 mm (1.9913 in)

#### Installation height:

37.0 mm (1.457 in)

#### Installation load:

165.8 - 187.0 N (16.9 - 19.1 kg, 37 - 42 lb)

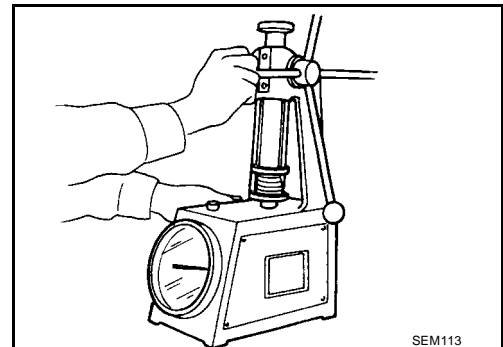
#### Height during valve open:

28.2 mm (1.110 in)

#### Load with valve open:

314.8 - 355.0 N (32.1 - 36.2 kg, 71 - 80 lb)

- If it is not within specifications, replace the valve spring.



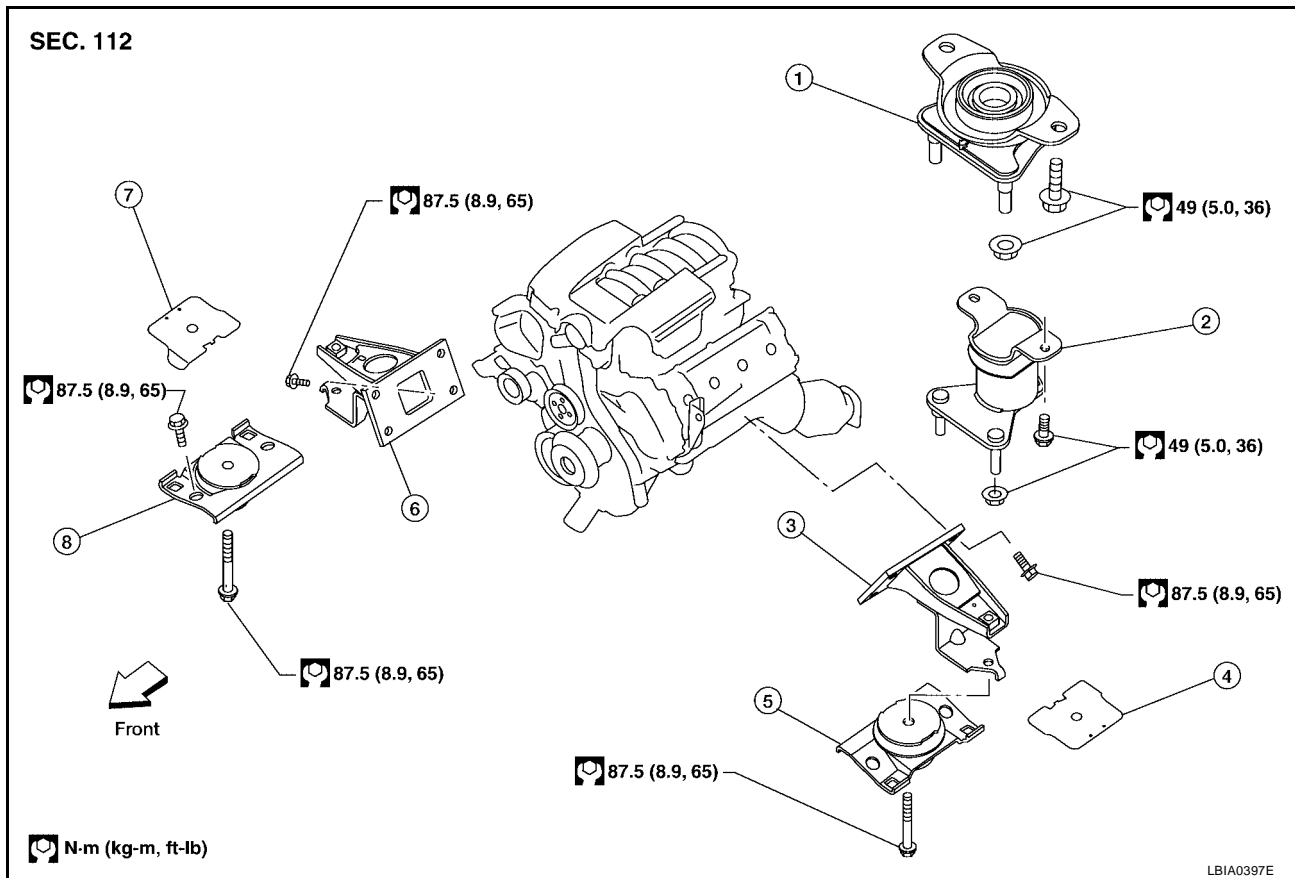
# ENGINE ASSEMBLY

## ENGINE ASSEMBLY

PF1:10001

### Removal and Installation

EBS00J9W



- |                                       |                                       |                               |
|---------------------------------------|---------------------------------------|-------------------------------|
| 1. Rear engine mounting insulator 4x4 | 2. Rear engine mounting insulator 4x2 | 3. LH engine mounting bracket |
| 4. LH Heat shield plate               | 5. LH engine mounting insulator       | 6. RH engine mounting bracket |
| 7. RH Heat shield plate               | 8. RH engine mounting insulator       |                               |

#### WARNING:

- Situate 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.
- Do not start working until exhaust system and engine coolant are cooled sufficiently.
- 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-point lift type or separate type lift. If board-on type is used for unavoidable reasons, support at the 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-40, "Garage Jack and Safety Stand"](#).

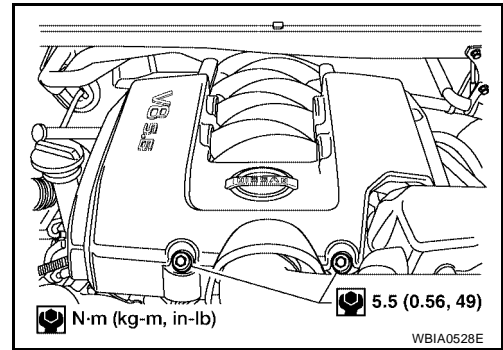
#### REMOVAL

##### Preparation

1. Drain engine coolant from radiator drain plug. Refer to [MA-13, "DRAINING ENGINE COOLANT"](#).
2. Partially drain A/T fluid. Refer to [MA-23, "Changing A/T Fluid"](#).
3. Release fuel pressure. Refer to [EC-46, "FUEL PRESSURE RELEASE"](#).
4. Remove the engine hood. Refer to [BL-13, "Removal and Installation of Hood Assembly"](#).

# ENGINE ASSEMBLY

5. Remove the cowl extension. Refer to [EI-21, "Removal and Installation"](#) .
6. Remove engine room cover using power tools.



7. Remove the air duct and air cleaner case assembly [EM-14, "REMOVAL"](#) .
8. Disconnect vacuum hose between vehicle and engine and set it aside.
9. Remove the radiator assembly and hoses. Refer to [CO-10, "REMOVAL"](#) .
10. Remove the drive belts. Refer to [EM-12, "Removal"](#) .
11. Remove the fan blade. Refer to [CO-13, "REMOVAL"](#) .
12. Disconnect the engine room harness from the fuse box and set it aside for easier work.
13. Disconnect the ECM.
14. Disconnect the engine room harness from the engine side and set it aside for easier work.
15. Disconnect the engine harness grounds.
16. Disconnect the reservoir tank for power steering from engine and move it aside for easier work.
17. Disconnect power steering oil pump from engine. Move it from its location and secure with a rope for easier work. Refer to [PS-27, "REMOVAL"](#) .
18. Remove the A/C compressor bolts and set aside. Refer to [MTC-114, "REMOVAL"](#) .
19. Disconnect brake booster vacuum line.
20. Disconnect EVAP line.
21. Disconnect the fuel hose at the engine side connection. Refer to [EM-29, "REMOVAL"](#) .
22. Disconnect the heater hoses at cowl, and install plugs to avoid leakage of engine coolant.
23. Remove the A/T oil level indicator and indicator tube upper bolts.
24. Remove front final drive assembly (4x4 only). Refer to [FFD-12, "REMOVAL"](#) .
25. Remove exhaust manifolds. Refer to [EM-19, "REMOVAL"](#) .
26. Install engine slingers into left bank cylinder head and right bank cylinder head.

**Engine slinger torque: 45.0 N-m (4.6 kg-m, 33 ft-lb)**

27. Remove transmission. Refer to [AT-269, "REMOVAL"](#) (4X2) or [AT-272, "REMOVAL"](#) (4X4).
28. Lift with hoist and secure the engine in position.
29. Remove engine assembly from vehicle, avoiding interference with vehicle body.

**CAUTION:**

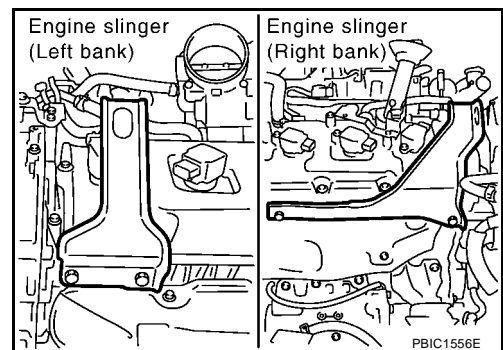
- **Before and during this lifting, always check if any harnesses are left connected.**

30. Remove the parts that may restrict installation of engine to engine stand.

**NOTE:**

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

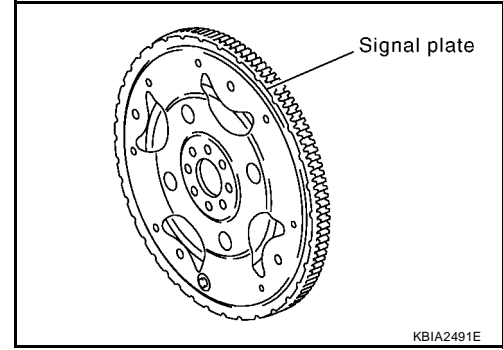
- a. Remove drive plate.
  - Holding crankshaft pulley bolts, lock crankshaft to remove drive plate bolts.
  - Loosen bolts diagonally.



# ENGINE ASSEMBLY

**CAUTION:**

- Be careful not to damage drive plate. Especially avoid deforming and damaging of signal plate teeth (circumference position).
- Place the drive plate with signal plate surface facing other than downward.
- Keep magnetic materials away from signal plate.



**CAUTION:**

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

- If the load capacity of the stand is not adequate, remove the following parts beforehand to reduce the potential risk of overturning the stand.
  - Remove fuel tube and fuel injector assembly. Refer to [EM-29, "REMOVAL"](#) .
  - Remove intake manifold. Refer to [EM-15, "REMOVAL"](#) .
  - Remove ignition coil. Refer to [EM-26, "REMOVAL"](#) .
  - Remove rocker cover. Refer to [EM-33, "REMOVAL"](#) .
  - Other removable brackets.

**CAUTION:**

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

31. Remove alternator. Refer to [SC-27, "REMOVAL"](#) .
32. Remove engine mounting insulator and bracket with power tool.

## INSTALLATION

Installation is in the reverse order of removal.

**CAUTION:**

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

## INSPECTION AFTER INSTALLATION

- Before starting the engine, check oil/fluid levels including engine coolant and engine oil. If the levels are lower than required quantity, fill to the specified level. Refer to [MA-11, "RECOMMENDED FLUIDS AND LUBRICANTS"](#) .
- Use procedure below to check for fuel leakage.
- Turn ignition switch ON (with engine stopped). With fuel pressure applied to the fuel piping, check for fuel leakage at the connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gas, or any oils/fluids including engine oil and engine coolant.
- Bleed air from passages in lines and hoses, such as in cooling system.
- After cooling down the engine, again check oil/fluid levels including engine oil and engine coolant. Refill to specified level if necessary.
- Summary of the inspection items:

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level



# ENGINE ASSEMBLY

Item	Before starting engine	Engine running	After engine stopped
Other oils and fluids*	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage
Exhaust gas	—	Leakage	—

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

A  
EM

C

D

E

F

G

H

I

J

K

L

M

# CYLINDER BLOCK

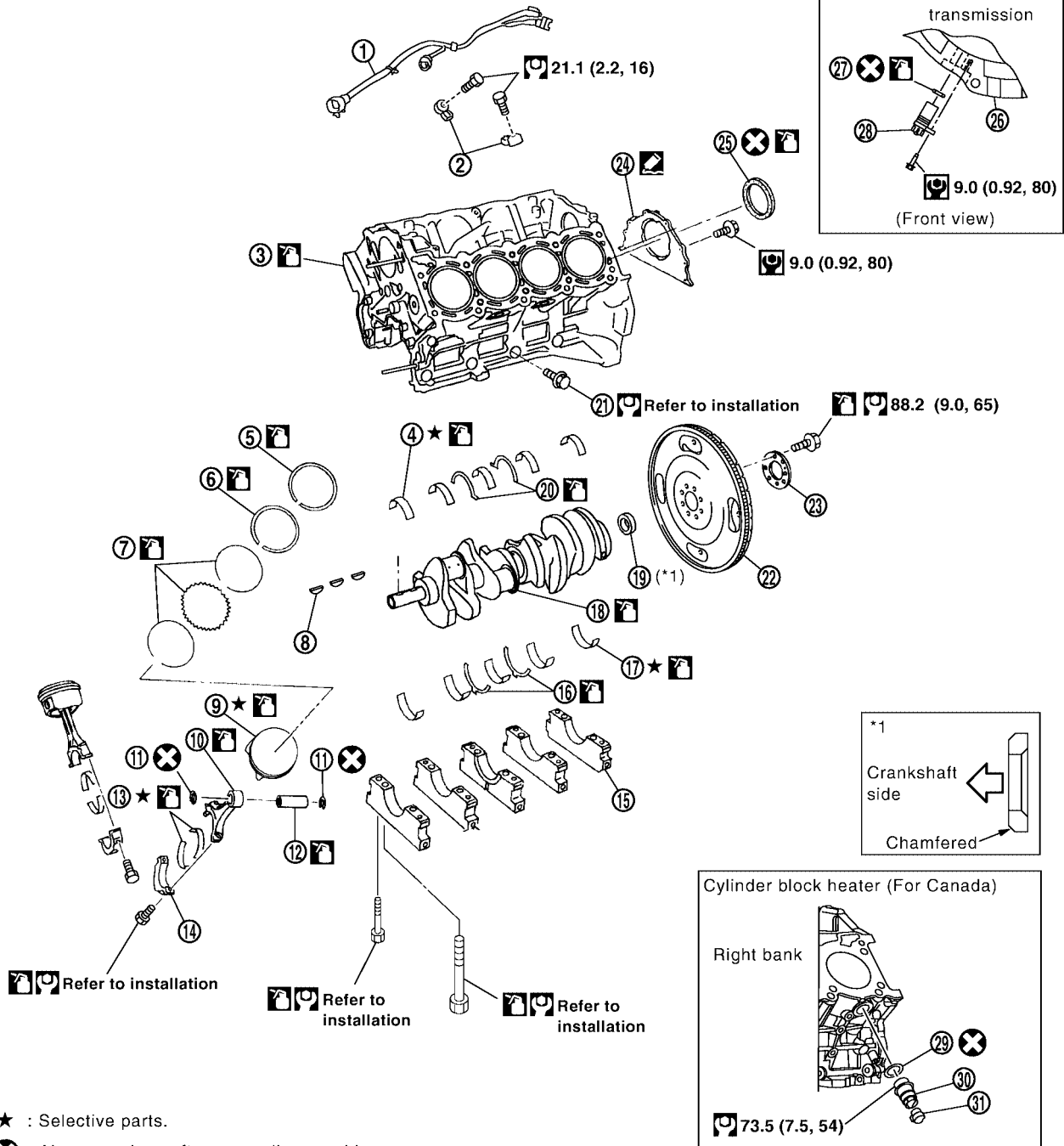
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EBS00138

## CYLINDER BLOCK

### Disassembly and Assembly

SEC. 110•120•226



WBIA0402E

- |                             |                   |                   |
|-----------------------------|-------------------|-------------------|
| 1. Knock sensor sub-harness | 2. Knock sensor   | 3. Cylinder block |
| 4. Main bearing             | 5. Top ring       | 6. Second ring    |
| 7. Oil ring                 | 8. Crankshaft key | 9. Piston         |
| 10. Connecting rod          | 11. Snap ring     | 12. Piston pin    |

# CYLINDER BLOCK

- |                                      |                                |                            |
|--------------------------------------|--------------------------------|----------------------------|
| 13. Connecting rod bearing           | 14. Connecting rod bearing cap | 15. Main bearing cap       |
| 16. Thrust bearing                   | 17. Main bearing               | 18. Crankshaft             |
| 19. Pilot converter                  | 20. Thrust bearing             | 21. Side bolt              |
| 22. Drive plate                      | 23. Reinforcement plate        | 24. Rear oil seal retainer |
| 25. Rear oil seal                    | 26. Transmission               | 27. O-ring                 |
| 28. Crankshaft position sensor (POS) | 29. Gasket                     | 30. Cylinder block heater  |
| 31. Connector cap                    |                                |                            |

## DISASSEMBLY

### NOTE:

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

1. Remove engine assembly. Refer to [EM-70, "REMOVAL"](#).
2. Remove the parts that may restrict installation of engine to engine stand.

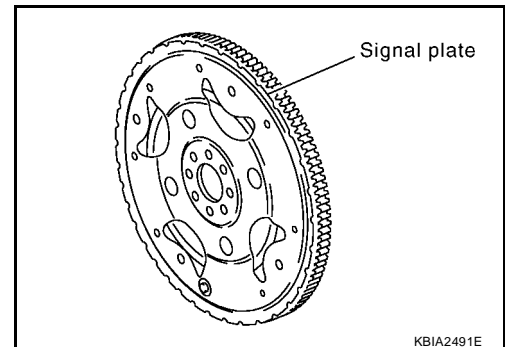
### NOTE:

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

- a. Remove transmission . Refer to [AT-269, "REMOVAL"](#) (4X2) or [AT-272, "REMOVAL"](#) (4X4)
- b. Remove front final drive assembly (4x4 only). Refer to [FFD-12, "REMOVAL"](#).
- c. Remove drive plate.
  - Holding crankshaft pulley mounting bolts, lock crankshaft to remove drive plate bolts.
  - Loosen bolts diagonally.

### CAUTION:

- **Be careful not to damage drive plate. Especially avoid deforming and damaging of signal plate teeth (circumference position).**
- **Place the drive plate with signal plate surface facing other than downward.**
- **Keep magnetic materials away from signal plate.**



3. Lift the engine with hoist to install it onto engine stand. Refer to [EM-70, "REMOVAL"](#).

### CAUTION:

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

- If the load capacity of the stand is not adequate, remove the following parts beforehand to reduce the potential risk of overturning the stand.
  - Remove fuel tube and fuel injector assembly. Refer to [EM-29, "REMOVAL"](#).
  - Remove intake manifold. Refer to [EM-15, "REMOVAL"](#).
  - Remove exhaust manifold. Refer to [EM-19, "REMOVAL"](#).
  - Remove A/C compressor fitting bolts and brackets (with power tool). Refer to [MTC-113, "Components"](#).
  - Remove ignition coil. Refer to [EM-26, "REMOVAL"](#).
  - Remove rocker cover. Refer to [EM-33, "REMOVAL"](#).
  - Other removable brackets.

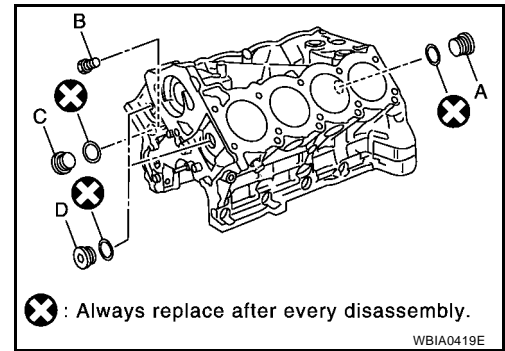
### CAUTION:

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

4. Drain engine oil. Refer to [MA-17, "Changing Engine Oil"](#).

# CYLINDER BLOCK

5. Drain engine coolant by removing cylinder block drain plug "A", "B", "C" and "D" as shown in the figure.

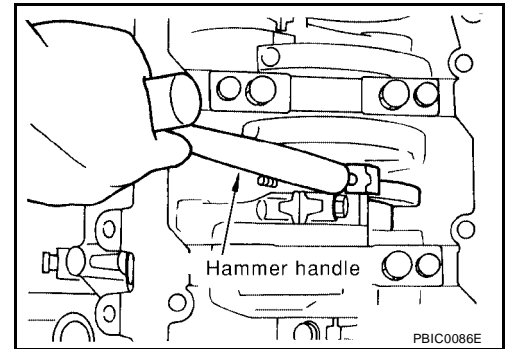


6. Remove the following components and associated parts (The parts listed in step 3 are not included here.)
- Oil pan and oil strainer. Refer to [EM-22, "REMOVAL"](#).
  - Crankshaft pulley, front cover and timing chain. Refer to [EM-36, "REMOVAL"](#).
  - Camshaft. Refer to [EM-43, "REMOVAL"](#).
  - Cylinder head. Refer to [EM-60, "REMOVAL"](#).
7. Remove knock sensor.

**CAUTION:**

**Carefully handle the sensor, avoiding shocks.**

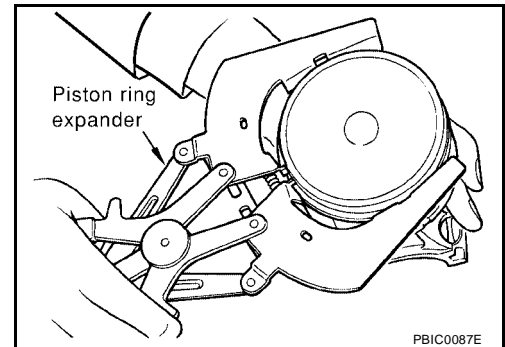
8. Remove the piston and connecting rod assembly as follows.
- Before removing the piston and connecting rod assembly, check the connecting rod side clearance. Refer to [EM-90, "CONNECTING ROD SIDE CLEARANCE"](#).
- a. Position the crankshaft pin corresponding to the connecting rod to be removed onto the bottom dead center.
- b. Remove the connecting rod cap.
- c. Using a suitable tool, push the piston and connecting rod assembly out to the cylinder head side.
9. Remove the connecting rod bearings.



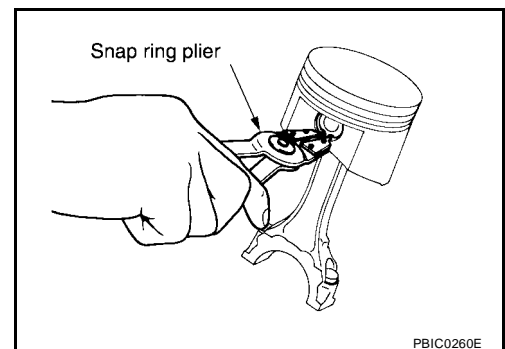
**CAUTION:**

**When removing them, note the installation position. Keep them in the correct order.**

10. Using a suitable tool, remove the piston rings from the piston.
- CAUTION:**
- **When removing the piston rings, be careful not to damage the piston.**
  - **Be careful not to damage piston rings by expanding them excessively.**
- Before removing the piston rings, check the piston ring side clearance. Refer to [EM-91, "PISTON RING SIDE CLEARANCE"](#).

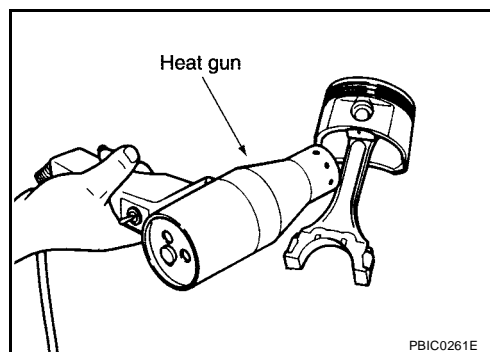


11. Remove the piston from the connecting rod as follows.
- a. Using a suitable tool, remove the snap ring.

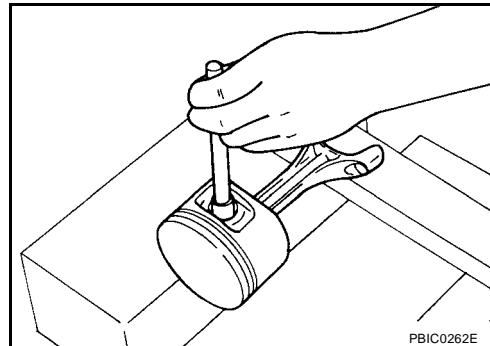


# CYLINDER BLOCK

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



- c. Using a suitable tool, push out piston pin.



12. Remove the rear oil seal retainer from the cylinder block.

- Using a suitable tool between the rear end of the crankshaft counterweight and rear oil seal retainer, separate the liquid gasket to remove.

**CAUTION:**

**Be careful not to damage the mating surface.**

13. Using a suitable tool, remove the rear oil seal from the rear oil seal retainer.

14. Remove the main bearing cap as follows:

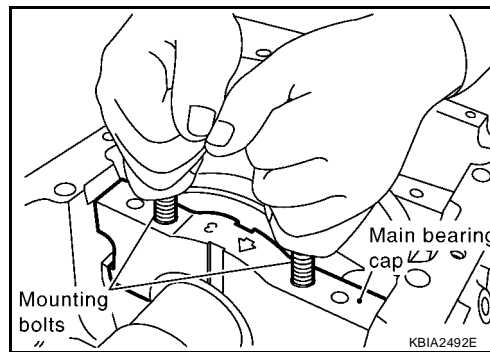
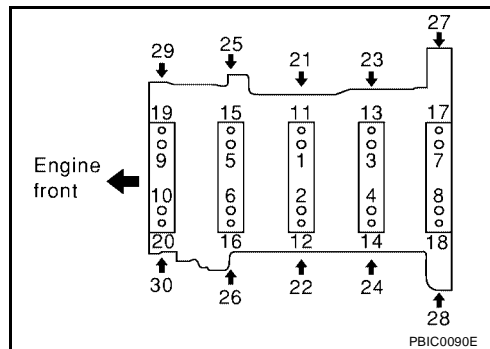
- Before loosening the main bearing cap bolts, measure the crankshaft side clearance.

Refer to [EM-90, "CRANKSHAFT END PLAY"](#) .

- Loosen bolts in several different steps.

- Loosen the side bolts (M10) starting from 30 to 21 to remove.
- Loosen the main bearing cap sub bolts (M9) starting from 20 to 11 to remove.
- Loosen the main bearing cap bolts (M12) starting from 10 to 1 to remove.
- Remove the main bearing cap.

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



15. Remove the crankshaft.

16. Remove the main bearings and thrust bearings from the cylinder block and main bearing caps.

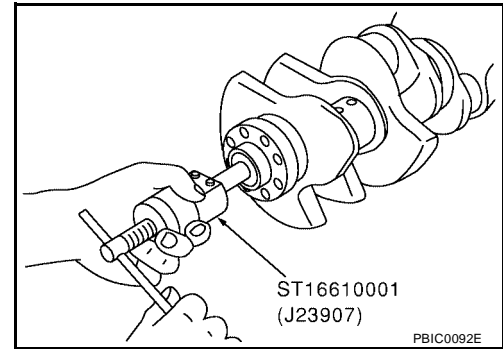
- When removing them, note the installation position. Keep them in the correct order.

# CYLINDER BLOCK

17. Using tool remove the pilot converter if necessary.

**Tool number : ST16610001 (J-23907)**

- Removal and installation without the engine stand is possible.



## ASSEMBLY

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

### CAUTION:

**Use a goggles to protect your eyes.**

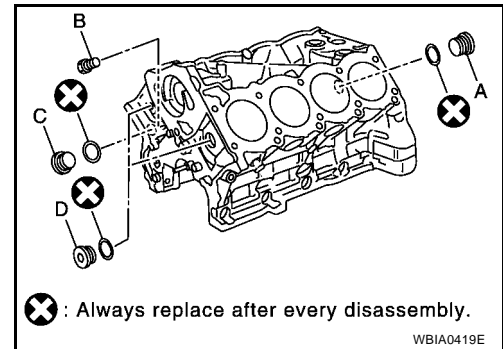
2. Install each plug to the cylinder block. (Only screwed-type plugs are shown in the figure.)

- Apply liquid gasket.

**Use Genuine Thread Sealant or equivalent. Refer to [GL-45. "Recommended Chemical Products and Sealants"](#).**

- Replace the copper washers with new ones.
- Tighten each plug as specified below.

Part	Washer	Tightening torque
A	Yes	53.9 N·m (5.5 kg·m, 40 ft·lb)
B	No	19.6 N·m (2.0 kg·m, 15 ft·lb)
C	Yes	62.7 N·m (6.4 kg·m, 46 ft·lb)
D	Yes	62.7 N·m (6.4 kg·m, 46 ft·lb)

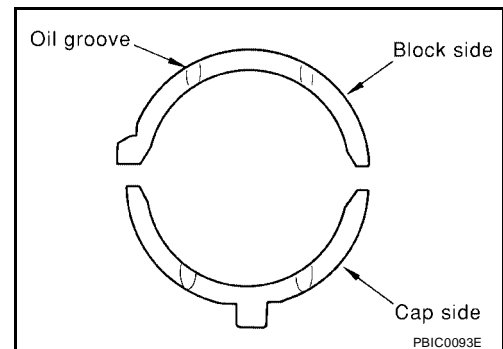


3. Install the main bearings and the thrust bearings.

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

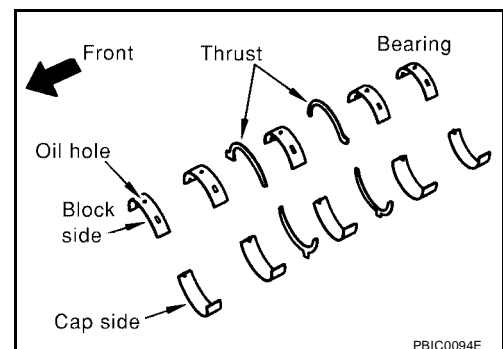
b. Install the thrust bearings to the both sides of the No. 3 journal housing on the cylinder block and main bearing caps

- Install the thrust bearings with the oil groove facing the crankshaft arm (outside).
- Install the thrust bearings with a protrusion in the center on the main bearing caps.



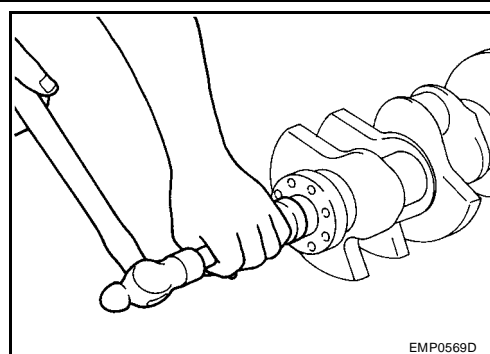
c. Install the main bearings paying attention to the direction.

- Install the one with oil holes onto the cylinder block and the one without oil holes onto the main bearing cap.
- Before installing the bearings, apply engine oil to the bearing surface (inside). Do not apply oil to the back surface, but thoroughly clean it.
- When installing, align the bearing stopper to the notch.
- Insure the oil holes on cylinder block and those on the corresponding bearing are aligned.

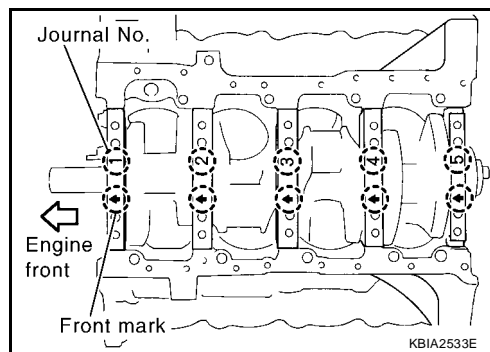


# CYLINDER BLOCK

4. Using a suitable tool install the pilot converter to the crankshaft.
5. Install the crankshaft to the cylinder block.
  - While turning the crankshaft by hand, make sure it turns smoothly.



6. Install the main bearing caps.
  - Align the identification number to the journal position to install.
  - Install it with front mark (indicated by the arrow) facing front of engine.
  - Using a suitable tool, tap the caps lightly to seat them on the installation position.

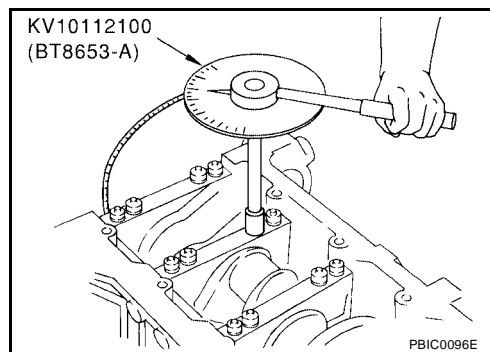
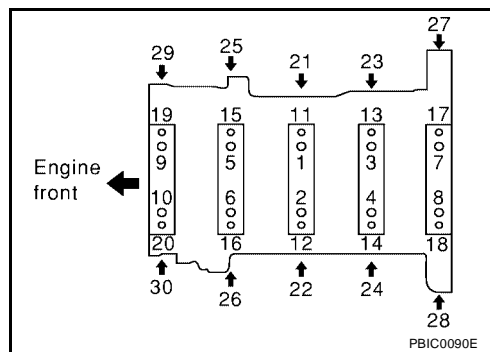


7. Follow the steps below to tighten each main bearing cap bolts.
  - a. Apply engine oil to threads and seating surface of bolts, and tighten all bolts temporarily.

**Main bearing cap bolts : 39.2 N-m (4.0 kg-m, 29 ft.-lb) in order of 1 to 10**

**Main bearing cap sub bolt : 29.4 N-m (3.0 kg-m, 22 ft.-lb) in order of 11 to 20**

**Main bearing cap bolts : 40° in order of 1 to 10**



## CAUTION:

Measure tighten angle in step “d” and “e” with angle wrench (SST). Do not measure visually.

**Main bearing cap sub bolt : 30° in order of 11 to 20**

**Side bolt to in order of 21 : 49 N-m (5.0 kg-m, 36 ft.-lb) to 30**

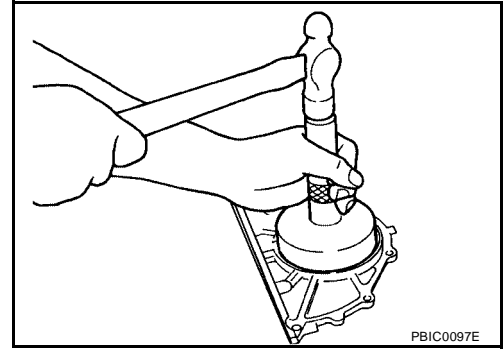
- Rotate crankshaft by hands after bolts are tightened. Check if it rotates smoothly.
  - Check the crankshaft side clearance. Refer to [EM-90, "CRANKSHAFT END PLAY"](#).
8. Using a suitable tool install rear oil seal to rear oil seal retainer.

# CYLINDER BLOCK

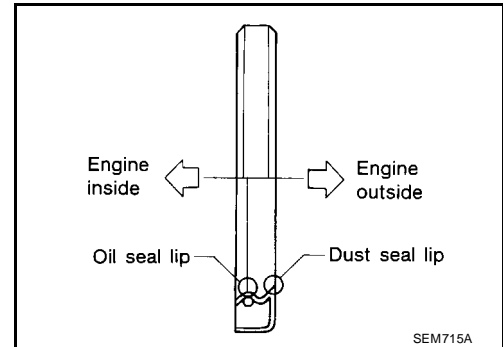
## CAUTION:

Do not damage or scratch outer circumference of oil seal.

- Tap until flattened with front edge of rear oil seal retainer.
- Fit the rear oil seal until it is level with the rear end surface of rear oil seal retainer.

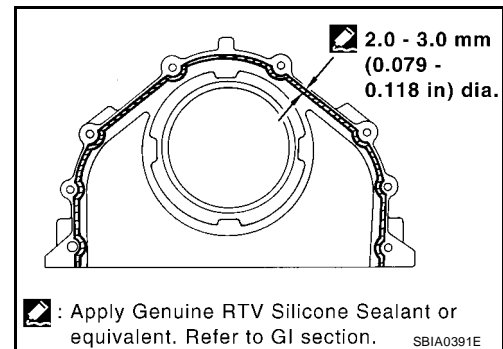


- Install new rear oil seal in the direction shown in the figure.



## 9. Install rear oil seal retainer.

- Apply liquid gasket thoroughly to rear oil seal retainer.  
**Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#).**
- Apply new engine oil on lips of rear oil seal. Do not touch.



## 10. Install the piston to the connecting rod.

### a. Using a suitable tool, install the snap ring to the grooves of the piston rear side.

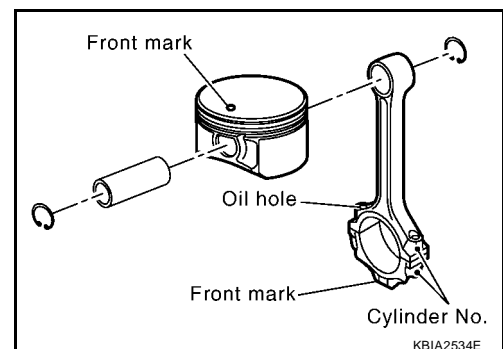
- Insert it fully into groove to install.

### b. Install the piston to the connecting rod.

- Using suitable tool, heat the piston until the piston pin can be pushed in by hand without excess force [approx. 60° to 70 C° (140° to 158 °F)]. From the front to the rear, insert the piston pin into the piston and the connecting rod.
- Assemble so that the front mark on the piston crown and the oil holes and the cylinder No. on the connecting rod are positioned as shown in the figure.

### c. Using a suitable tool, install the snap ring to the grooves of the piston front side.

- Insert it fully into groove to install.
- After installing, make sure the connecting rod moves smoothly.





# CYLINDER BLOCK

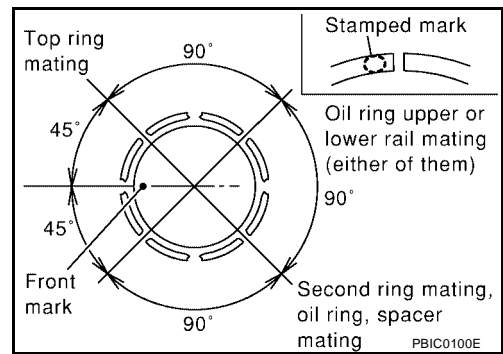
11. Using a suitable tool, install the piston rings.

**CAUTION:**

**Be careful not to damage the piston.**

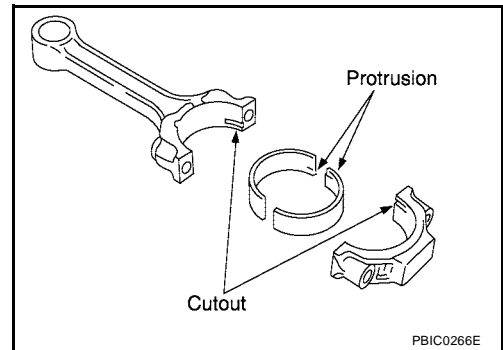
- Position each ring with the gap as shown in the figure, referring to the piston front mark.
- Install the second ring with the stamped surface facing upward.

**Stamped mark      Second ring      : 2N**



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

- When installing the connecting rod bearings, apply engine oil to the bearing surface (inside). Do not apply oil to the back surface, but thoroughly clean it.
- When installing, align the connecting rod bearing stopper protrusion with the cutout of the connecting rod to install.
- Check the oil holes on the connecting rod and those on the corresponding bearing are aligned.



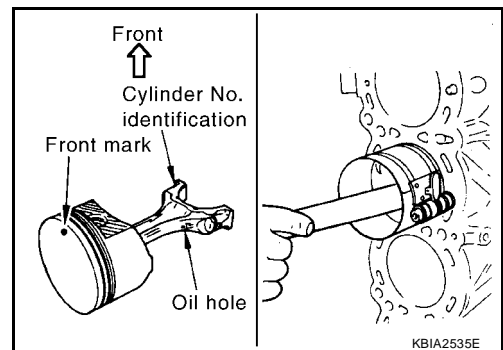
13. Using Tool, install the piston and connecting rod assembly to the crankshaft.

**Tool number      : EM03470000 (J-8037)**

- Position the crankshaft pin corresponding to the connecting rod to be installed onto the bottom dead center.
- Apply engine oil sufficiently to the cylinder bore, piston, and crankshaft pin.
- Match the cylinder position with the cylinder No. on the connecting rod to install.
- Install the piston with the front mark on the piston crown facing the front of the engine.

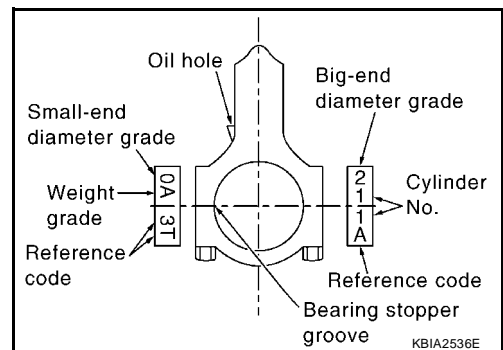
**CAUTION:**

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



14. Install the connecting rod cap.

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



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# CYLINDER BLOCK

15. Using Tool tighten the connecting rod bolts.

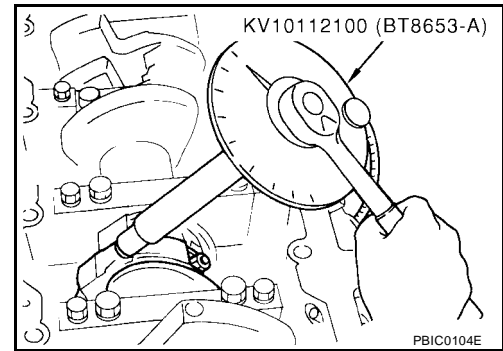
**Tool number** : KV10112100 (BT-8653-A)

**Connecting rod bolts**

**Step 1** : 19.6 N·m (1.5 kg·m, 11 ft·lb)

**Step 2** : 90° Angle tightening

- Apply engine oil to the threads and seats of the connecting rod bolts.
- Put mating (with paint) on each bolt and connecting rod cap, all in the same direction (when using a protractor).
- Tighten all connecting rod bolts degrees clockwise (angle tightening).
- After tightening the bolts, make sure that the crankshaft rotates smoothly.
- Check the connecting rod side clearance. Refer to [EM-90, "CONNECTING ROD SIDE CLEARANCE"](#)

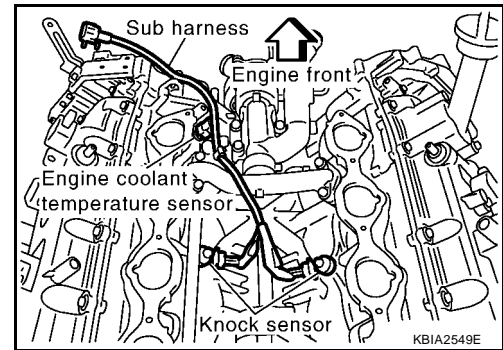
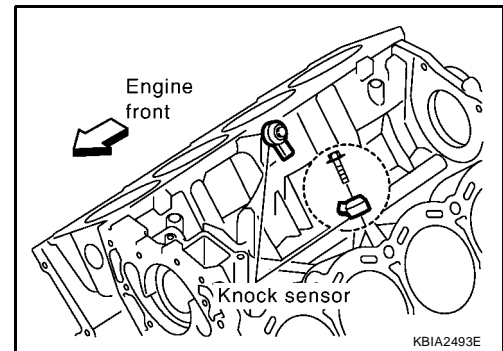


16. Install knock sensor.

**CAUTION:**

**If any impact by dropping is applied to the knock sensor, replace it with new one.**

- Make sure that there is no foreign material on the cylinder block mating surface and the back surface of the knock sensor.
- Install it with its connector facing the center of cylinder block side.
- Do not tighten the mounting bolts while holding the connector.
- Make sure that the knock sensor does not interfere with other parts.
- Position sub-harness as shown in the figure before installing intake manifold.

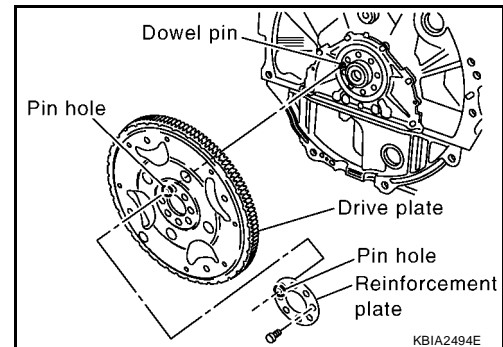


17. Installation of the remaining components is in the reverse order of removal.

18. Remove engine assembly from engine stand.

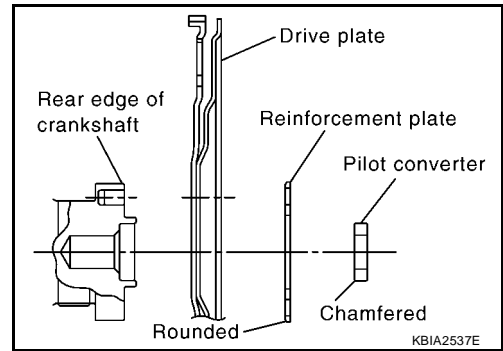
19. Install drive plate.

- Align dowel pin of crankshaft rear end with pin holes of each parts to install.



# CYLINDER BLOCK

- Install drive plate, reinforcement plate and pilot converter (if not installed in step 4) as shown in figure.
- Face chamfered or rounded edge side to crankshaft.



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## How to Select Piston and Bearing DESCRIPTION

Connecting points	Connecting parts	Selection items	Selection methods
Between cylinder block to crankshaft	Main bearing	Main bearing grade (bearing thickness)	Determined by match of cylinder block bearing housing grade (Housing inside diameter) and crankshaft journal grade (journal outside diameter)
Between crankshaft to connecting rod	Connecting rod bearing	Connecting rod bearing grade (bearing thickness)	Connecting rod bearing grade = crankshaft pin grade (pin diameter). No grade exists for inside diameter of connecting rod large end.
Between cylinder block to piston	Piston and piston pin assembly. The piston is available together with piston pin as an assembly.	Piston grade (piston diameter)	Piston grade = cylinder bore grade (diameter of bore)
*Between piston to connecting rod	—	—	—

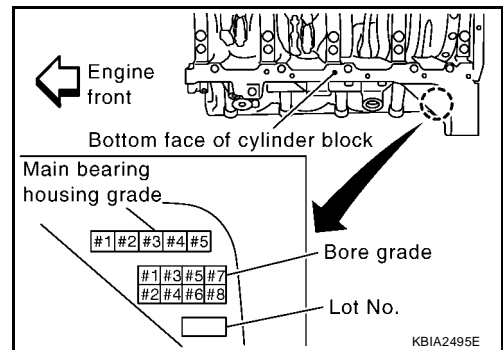
\*For the service parts, the grade for fitting cannot be selected between a piston pin and a connecting rod. (Only 0 grade is available.) The information at the shipment from the plant is described as a reference.

- 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.

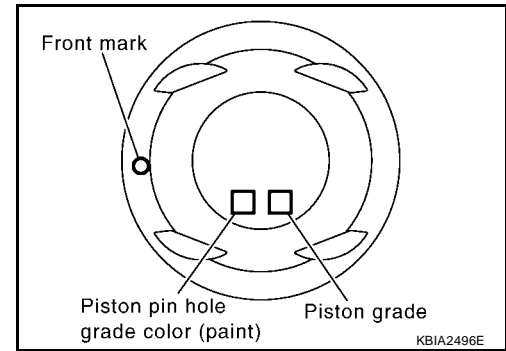
## HOW TO SELECT PISTON

### Piston Selective Fitting When New Cylinder Block is Used:

- Check the cylinder bore grade on the bottom face of cylinder block, and select the piston of the same grade.



# CYLINDER BLOCK



## When Cylinder Block is Reused

1. Measure the cylinder block bore diameter.
2. Determine the bore grade by comparing the measurement with the values under the "Cylinder bore diameter" of the piston selection table. Use oversized piston if clearance of standard grade piston is outside the specified value.

## Piston Selection Table

Unit: mm (in)

Grade number (Mark)	1	2	3
Cylinder bore diameter	98.000-98.010 (3.8583-3.8587)	98.010-98.020 (3.8587-3.8590)	93.020-98.030 (3.8590-3.8594)
Piston diameter	97.980-97.990 (3.8575-3.8579)	97.990-98.000 (3.8579-3.8583)	98.000-98.010 (3.8583-3.8587)

### CAUTION:

Oversize must be used in all cylinders when using oversized parts.

**Piston oversize (Service) : 0.20 mm (0.0079 in)**

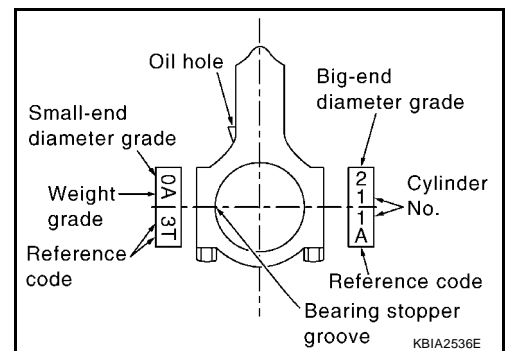
### NOTE:

- The piston is available together with piston pin as an assembly.
- The piston pin (piston pin bore) grade is provided only for the parts installed at the plant. For service parts, no grades can be selected (Only 0 grade is available.).
- Hone cylinder to obtain specified clearance between piston and cylinder bore when using an oversized piston. Be sure to use the same oversized piston rings.

## HOW TO SELECT CONNECTING ROD BEARING

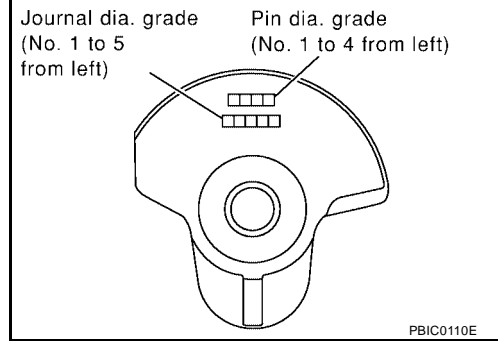
### When New Connecting Rod and Crankshaft are Used

1. Apply big end inside diameter grade stamped on connecting rod side face to the row in the "Connecting Rod Bearing Selection Table".



# CYLINDER BLOCK

- Apply pin diameter grade stamped on crankshaft front side to the column in the "Connecting Rod Bearing Selection Table".
- Read the symbol at the cross point of selected row and column in the "Connecting Rod Bearing Selection Table".
- Apply the symbol obtained to connecting rod bearing grade table to select.



## When Crankshaft and Connecting Rod are Reused

- Measure dimensions of the big end inside diameter of connecting rod and diameter of crankshaft pin individually.
- Apply the measured dimension to the "Connecting Rod Bearing Selection Table".
- The following steps are same as in "When New Connecting Rod and Crankshaft are Used". Refer to [EM-84](#).

## Connecting Rod Bearing Selection Table

Mark	Outer diameter Unit: mm (in)	Connecting rod big end. inner diameter		Crankshaft pin outer diameter												
		Mark	Inner diameter Unit: mm (in)	0	1	2	3	4	5	6	7	8	9	A	B	C
0	53.968 – 53.974 (2.1247 – 2.1250)		57.000 – 57.001 (2.2441 – 2.2441)	0	0	0	0	0	0	1	1	1	1	1	1	2
1	53.962 – 53.968 (2.1245 – 2.1247)		57.001 – 57.002 (2.2441 – 2.2442)	1	1	1	1	1	1	2	2	2	2	2	2	3
2	53.956 – 53.962 (2.1243 – 2.1245)		57.002 – 57.003 (2.2442 – 2.2442)	2	2	2	2	2	2	3	3	3	3	3	3	3
			57.003 – 57.004 (2.2442 – 2.2443)													
			57.004 – 57.005 (2.2443 – 2.2443)													
			57.005 – 57.006 (2.2443 – 2.2443)													
			57.006 – 57.007 (2.2443 – 2.2444)													
			57.007 – 57.008 (2.2444 – 2.2444)													
			57.008 – 57.009 (2.2444 – 2.2444)													
			57.009 – 57.010 (2.2444 – 2.2445)													
			57.010 – 57.011 (2.2445 – 2.2445)													
			57.011 – 57.012 (2.2445 – 2.2446)													
			57.012 – 57.013 (2.2446 – 2.2446)													

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## Connecting Rod Bearing Grade Table.

Grade number	Thickness "T" mm (in)	Identification color (mark)
0	1.500 - 1.503 (0.0591 - 0.0592)	Black
1	1.503 - 1.506 (0.0592 - 0.0593)	Brown
2	1.506 - 1.509 (0.0593 - 0.0594)	Green
3	1.509 - 1.512 (0.0594 - 0.0595)	Yellow

## Undersize Bearings Usage Guide

- When the specified oil clearance is not obtained with standard size connecting rod bearings, use undersize (US) bearings.
- When using undersize bearing, measure the bearing inside diameter with bearing installed, and grind the crankshaft pin so that the oil clearance satisfies the standard.

# CYLINDER BLOCK

## Bearing undersize table

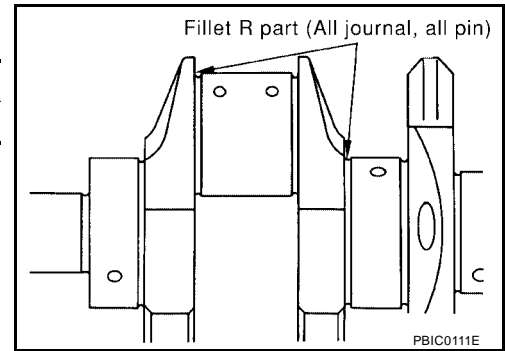
Unit: mm (in)

Undersize	Thickness
0.25 (0.0098)	1.627 - 1.635 (0.0641 - 0.0644)

### CAUTION:

In grinding the crankshaft pin to use undersize bearings, keep the fillet R (All crankshaft pins).

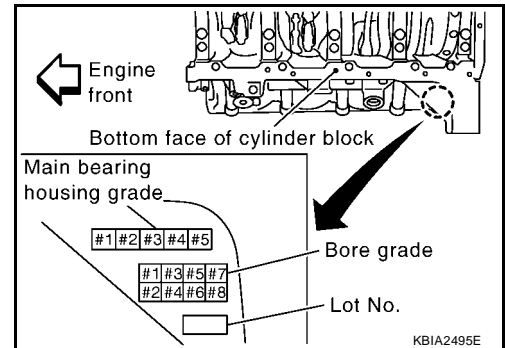
Fillet R : 1.5 - 1.7 mm (0.059 - 0.067 in)



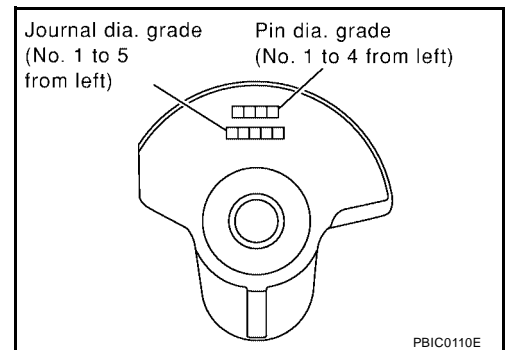
## HOW TO SELECT MAIN BEARING

### When New Cylinder Block and Crankshaft are Used

1. Apply main bearing housing grade on bottom face of cylinder block to row in Main Bearings Selection Table.



2. Apply journal diameter grade on crankshaft front to column in Main Bearings Selection Table.



3. Find sign at crossing of row and column in Main Bearings Selection Table.

### CAUTION:

- Initial clearance for No.1, 5 journal and No. 2, 3, 4 journal is different. Use two different selection lists for each part.
- No.1, 5 journal and No. 2, 3, 4 journal have the same signs but different measures. Do not confuse.

4. Apply sign at crossing in above step 3 to Main Bearings grade table.

### NOTE:

- Grade list applies to all journals.
- Service parts are available as a set of both upper and lower.

### When Cylinder Block and Crankshaft are Reused

1. Measure inside diameter of cylinder block main bearings housing and outside diameter of crankshaft journal.
2. Apply measurement in above step 1 to Main Bearings Selection Table.
3. The following steps are same as in "When New Cylinder Block and Crankshaft are Used". Refer to [EM-86](#).

# CYLINDER BLOCK

## Main Bearings Selection Table (No. 1 and No. 5 journal)

I.D. mark	Outer diameter Unit: mm (in)	Cylinder block main bearing housing inner diameter	Crankshaft journal outer diameter	I.D. mark																								
				A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	4	7	
				68.944 – 68.945 (2.7143 – 2.7144)	68.945 – 68.946 (2.7144 – 2.7144)	68.946 – 68.947 (2.7144 – 2.7144)	68.947 – 68.948 (2.7144 – 2.7145)	68.948 – 68.949 (2.7145 – 2.7145)	68.949 – 68.950 (2.7145 – 2.7146)	68.950 – 68.951 (2.7146 – 2.7146)	68.951 – 68.952 (2.7146 – 2.7146)	68.952 – 68.953 (2.7146 – 2.7147)	68.953 – 68.954 (2.7147 – 2.7147)	68.954 – 68.955 (2.7147 – 2.7148)	68.955 – 68.956 (2.7148 – 2.7148)	68.956 – 68.957 (2.7148 – 2.7148)	68.957 – 68.958 (2.7148 – 2.7149)	68.958 – 68.959 (2.7149 – 2.7149)	68.959 – 68.960 (2.7149 – 2.7150)	68.960 – 68.961 (2.7150 – 2.7150)	68.961 – 68.962 (2.7150 – 2.7150)	68.962 – 68.963 (2.7150 – 2.7151)	68.963 – 68.964 (2.7151 – 2.7151)	68.964 – 68.965 (2.7151 – 2.7152)	68.965 – 68.966 (2.7152 – 2.7152)	68.966 – 68.967 (2.7152 – 2.7152)	68.967 – 68.968 (2.7152 – 2.7153)	
G	63.964 – 63.963 (2.5183 – 2.5182)	1	1	12	12	12	2	2	2	2	23	23	23	3	3	3	34	34	34	34	4	4	4	45	45	45	5	5
H	63.963 – 63.962 (2.5182 – 2.5182)	1	12	12	12	2	2	2	2	23	23	23	3	3	3	34	34	34	34	4	4	4	45	45	45	5	5	
J	63.962 – 63.961 (2.5182 – 2.5181)	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	34	4	4	4	4	45	45	45	5	5	5	
K	63.961 – 63.960 (2.5181 – 2.5181)	12	12	2	2	2	23	23	23	3	3	3	34	34	34	34	4	4	4	4	45	45	45	5	5	5	56	
L	63.960 – 63.959 (2.5181 – 2.5181)	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	4	45	45	45	5	5	5	56	56	
M	63.959 – 63.958 (2.5181 – 2.5180)	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	56	
N	63.958 – 63.957 (2.5180 – 2.5180)	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	56	6	
P	63.957 – 63.956 (2.5180 – 2.5179)	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	56	6	6	
R	63.956 – 63.955 (2.5179 – 2.5179)	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	56	6	6	6	
S	63.955 – 63.954 (2.5179 – 2.5179)	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	56	6	6	6	67	
T	63.954 – 63.953 (2.5179 – 2.5178)	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	56	6	6	6	67	67	
U	63.953 – 63.952 (2.5178 – 2.5178)	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	56	6	6	6	67	67	67	
V	63.952 – 63.951 (2.5178 – 2.5178)	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	56	6	6	6	67	67	67	7	
W	63.951 – 63.950 (2.5178 – 2.5177)	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	56	6	6	6	67	67	67	7	7	
X	63.950 – 63.949 (2.5177 – 2.5177)	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	56	6	6	6	67	67	67	7	7	7	
Y	63.949 – 63.948 (2.5177 – 2.5176)	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	56	6	6	6	67	67	67	7	7	7	78	
1	63.948 – 63.947 (2.5176 – 2.5176)	34	4	4	4	4	45	45	45	5	5	5	56	56	56	56	6	6	6	67	67	67	7	7	7	78	78	
2	63.947 – 63.946 (2.5176 – 2.5176)	4	4	4	4	45	45	45	5	5	5	56	56	56	56	6	6	6	67	67	67	67	7	7	7	78	78	
3	63.946 – 63.945 (2.5176 – 2.5175)	4	4	45	45	45	5	5	5	56	56	56	56	6	6	6	67	67	67	67	7	7	7	78	78	78	8	
4	63.945 – 63.944 (2.5175 – 2.5175)	4	45	45	45	5	5	5	56	56	56	56	6	6	6	67	67	67	67	7	7	7	78	78	78	8	8	
5	63.944 – 63.943 (2.5175 – 2.5174)	45	45	45	5	5	5	56	56	56	56	6	6	6	67	67	67	67	7	7	7	78	78	78	8	8	8	
6	63.943 – 63.942 (2.5174 – 2.5174)	45	45	5	5	5	56	56	56	56	6	6	6	67	67	67	67	7	7	7	78	78	78	8	8	8	8	
7	63.942 – 63.941 (2.5174 – 2.5174)	45	5	5	5	56	56	56	56	6	6	6	67	67	67	67	7	7	7	78	78	78	8	8	8	8	8	
9	63.941 – 63.940 (2.5174 – 2.5173)	5	5	5	56	56	56	56	6	6	6	67	67	67	67	7	7	7	78	78	78	8	8	8	8	8	8	

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# CYLINDER BLOCK

## Main Bearings Selection Table (No. 2, 3 and 4 journal)

Cylinder block main bearing housing inner diameter  Crankshaft journal outer diameter		I.D. mark																												
		Inner diameter Unit: mm (in)	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	4	7				
I.D. mark	Outer diameter Unit: mm (in)		68.944 – 68.945 (2.7143 – 2.7144)	68.945 – 68.946 (2.7144 – 2.7144)	68.946 – 68.947 (2.7144 – 2.7144)	68.947 – 68.948 (2.7144 – 2.7145)	68.948 – 68.949 (2.7145 – 2.7145)	68.949 – 68.950 (2.7145 – 2.7146)	68.950 – 68.951 (2.7146 – 2.7146)	68.951 – 68.952 (2.7146 – 2.7146)	68.952 – 68.953 (2.7146 – 2.7147)	68.953 – 68.954 (2.7147 – 2.7147)	68.954 – 68.955 (2.7147 – 2.7148)	68.955 – 68.956 (2.7148 – 2.7148)	68.956 – 68.957 (2.7148 – 2.7148)	68.957 – 68.958 (2.7148 – 2.7149)	68.958 – 68.959 (2.7149 – 2.7149)	68.959 – 68.960 (2.7149 – 2.7150)	68.960 – 68.961 (2.7150 – 2.7150)	68.961 – 68.962 (2.7150 – 2.7150)	68.962 – 68.963 (2.7150 – 2.7151)	68.963 – 68.964 (2.7151 – 2.7151)	68.964 – 68.965 (2.7151 – 2.7152)	68.965 – 68.966 (2.7152 – 2.7152)	68.966 – 68.967 (2.7152 – 2.7152)	68.967 – 68.968 (2.7152 – 2.7153)				
A	63.964 – 63.963 (2.5183 – 2.5182)	0	0	01	01	01	1	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4		
B	63.963 – 63.962 (2.5182 – 2.5182)	0	01	01	01	1	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4			
C	63.962 – 63.961 (2.5182 – 2.5181)	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	4			
D	63.961 – 63.960 (2.5181 – 2.5181)	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	4	45			
E	63.960 – 63.959 (2.5181 – 2.5181)	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	4	45	45			
F	63.959 – 63.958 (2.5181 – 2.5180)	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	4	45	45	45			
G	63.958 – 63.957 (2.5180 – 2.5180)	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	4	45	45	45	5			
H	63.957 – 63.956 (2.5180 – 2.5179)	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	4	45	45	45	5	5			
J	63.956 – 63.955 (2.5179 – 2.5179)	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5			
K	63.955 – 63.954 (2.5179 – 2.5179)	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56			
L	63.954 – 63.953 (2.5179 – 2.5178)	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56			
M	63.953 – 63.952 (2.5178 – 2.5178)	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56			
N	63.952 – 63.951 (2.5178 – 2.5178)	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	6			
P	63.951 – 63.950 (2.5178 – 2.5177)	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6			
R	63.950 – 63.949 (2.5177 – 2.5177)	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6			
S	63.949 – 63.948 (2.5177 – 2.5176)	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6	67			
T	63.948 – 63.947 (2.5176 – 2.5176)	23	3	3	3	34	34	34	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6	67			
U	63.947 – 63.946 (2.5176 – 2.5176)	3	3	3	34	34	34	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6	67			
V	63.946 – 63.945 (2.5176 – 2.5175)	3	3	34	34	34	4	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6	67			
W	63.945 – 63.944 (2.5175 – 2.5175)	3	34	34	34	4	4	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6	67			
X	63.944 – 63.943 (2.5175 – 2.5174)	34	34	34	4	4	4	4	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67			
Y	63.943 – 63.942 (2.5174 – 2.5174)	34	34	4	4	4	4	4	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67			
1	63.942 – 63.941 (2.5174 – 2.5174)	34	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4			
2	63.941 – 63.940 (2.5174 – 2.5173)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4			

WBIA0609E



# CYLINDER BLOCK

## Main Bearings Grade Table (All Journals)

Unit: mm (in)

Grade number	UPR/LWR	Thickness	Identification color	Remarks
0	—	2.483 - 2.486 (0.0978 - 0.0979)	Black	Grade and color are different for upper and lower bearings.
1	—	2.486 - 2.489 (0.0979 - 0.0980)	Brown	
2	—	2.489 - 2.492 (0.0980 - 0.0981)	Green	
3	—	2.492 - 2.495 (0.0981 - 0.0982)	Yellow	
4	—	2.495 - 2.498 (0.0982 - 0.0983)	Blue	
5	—	2.498 - 2.501 (0.0983 - 0.0985)	Pink	
6	—	2.501 - 2.504 (0.0985 - 0.0986)	Purple	
7	—	2.504 - 2.507 (0.0986 - 0.0987)	White	
8	—	2.507 - 2.510 (0.0987 - 0.0988)	Red	
01	UPR	2.483 - 2.486 (0.0978 - 0.0979)	Black	
	LWR	2.486 - 2.489 (0.0979 - 0.0980)	Brown	
12	UPR	2.486 - 2.489 (0.0979 - 0.0980)	Brown	
	LWR	2.489 - 2.492 (0.0980 - 0.0981)	Green	
23	UPR	2.489 - 2.492 (0.0980 - 0.0981)	Green	
	LWR	2.492 - 2.495 (0.0981 - 0.0982)	Yellow	
34	UPR	2.492 - 2.495 (0.0981 - 0.0982)	Yellow	
	LWR	2.495 - 2.498 (0.0982 - 0.0983)	Blue	
45	UPR	2.495 - 2.498 (0.0982 - 0.0983)	Blue	
	LWR	2.498 - 2.501 (0.0983 - 0.0985)	Pink	
56	UPR	2.498 - 2.501 (0.0983 - 0.0985)	Pink	
	LWR	2.501 - 2.504 (0.0985 - 0.0986)	Purple	
67	UPR	2.501 - 2.504 (0.0985 - 0.0986)	Purple	
	LWR	2.504 - 2.507 (0.0986 - 0.0987)	White	
78	UPR	2.504 - 2.507 (0.0986 - 0.0987)	White	
	LWR	2.507 - 2.510 (0.0987 - 0.0988)	Red	

### Use Undersize Bearing Usage Guide

- Use undersize (US) bearing when oil clearance with standard size main bearing is not within specification.
- When using undersize (US) bearing, measure inside diameter of bearing installed and grind journal until oil clearance falls within specification.

#### Bearing undersize table

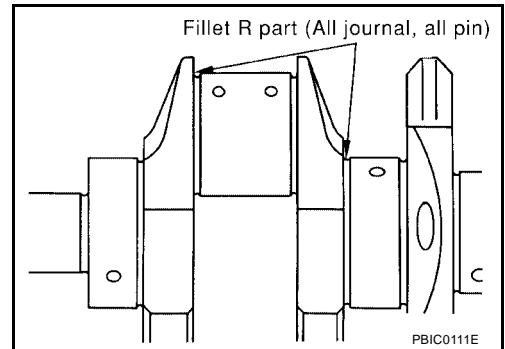
Unit: mm (in)

Undersize	Thickness
0.25 (0.0098)	2.618 - 2.626 (0.1031 - 0.1034)

**CAUTION:**

**Do not damage fillet R when grinding crankshaft journal in order to use undersized bearing (All journals).**

**Fillet R : 1.5 - 1.7 mm (0.059 - 0.067 in)**



PBIC0111E

# CYLINDER BLOCK

EBS0013A

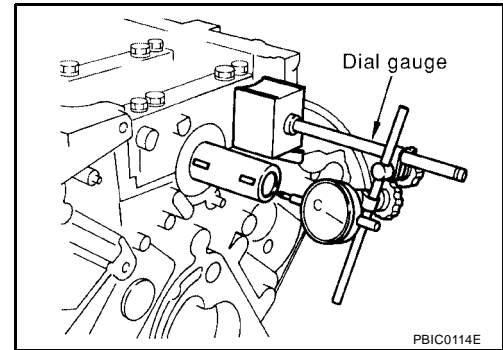
## Inspection After Disassembly CRANKSHAFT END PLAY

- Using a suitable tool, measure the clearance between the thrust bearings and the crankshaft arm when the crankshaft is moved fully forward or backward.

**Standard : 0.10 - 0.26 mm (0.0039 - 0.0102 in)**

**Limit : 0.30 mm (0.0118 in)**

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



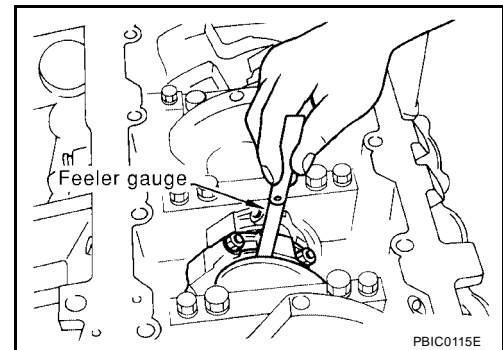
## CONNECTING ROD SIDE CLEARANCE

- Using a suitable tool, measure side clearance between connecting rod and crankshaft arm.

**Standard : 0.20 - 0.40 mm (0.0079 - 0.0157 in)**

**Limit : 0.40 mm (0.0157 in)**

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

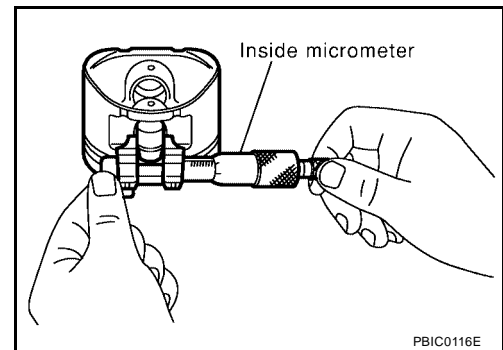


## PISTON AND PISTON PIN CLEARANCE

### Piston Pin Hole Diameter

- Using a suitable tool, measure the diameter of piston pin hole.

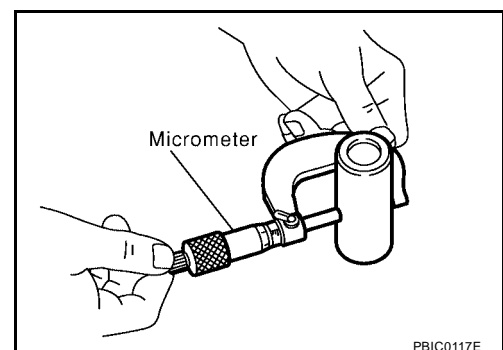
**Standard : 21.993 - 21.999 mm (0.8659 - 0.8661 in)**



### Piston Pin Diameter

- Using a suitable tool, measure diameter of piston pin.

**Standard : 21.989 - 21.995 mm (0.8657 - 0.8659 in)**



# CYLINDER BLOCK

## Piston and Piston Pin Clearance

(Piston pin clearance) = (Piston pin hole diameter) – (Piston pin diameter)

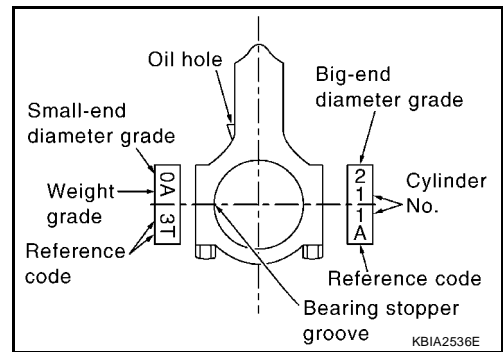
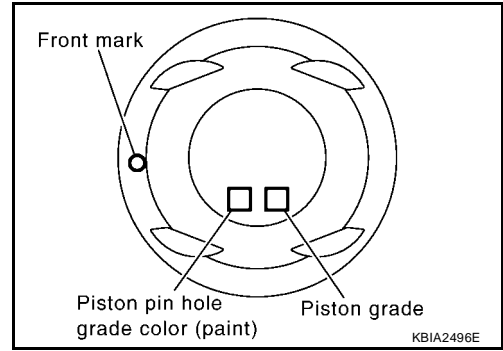
**Standard** : 0.002 - 0.006 mm (0.0001 - 0.0002 in)

- If clearance exceeds specification, replace either or both of piston/piston pin assembly and connecting rod assembly with reference to specification of each part.
- Refer to piston selection table to replace piston/piston pin assembly. Refer to [EM-83, "HOW TO SELECT PISTON"](#).
- Refer to connecting rod bearing selection table to replace connecting rod. Refer to [EM-84, "HOW TO SELECT CONNECTING ROD BEARING"](#).

### NOTE:

The connecting rod small end grade and piston pin hole (piston pin) grade are provided only for the parts installed at the plant. For service parts, no grades can be selected. (Only 0 grade is available.)

- Refer to [EM-93, "Connecting Rod Bushing Oil Clearance \(Small End\)"](#) for the values for each grade at the plant.



## PISTON RING SIDE CLEARANCE

- Using a suitable tool, measure side clearance of piston ring and piston ring groove.

### Standard:

**Top ring** : 0.035 - 0.085 mm (0.0014 - 0.0033 in)

**2nd ring** : 0.030 - 0.070 mm (0.0012 - 0.0028 in)

**Oil ring** : 0.015 - 0.050 mm (0.0006 - 0.0020 in)

### Limit:

**Top ring** : 0.11 mm (0.0043 in)

**2nd ring** : 0.10 mm (0.0039 in)

- If out of specification, replace piston and/or piston ring assembly.

## PISTON RING END GAP

- Check if diameter of cylinder bore is within specification. Refer to [EM-95, "Piston to Cylinder Bore Clearance"](#).
- Insert piston ring until middle of cylinder with piston, and measure gap.

### Standard:

**Top ring** : 0.23 - 0.33 mm (0.0091 - 0.0130 in)

**2nd ring** : 0.25 - 0.40 mm (0.0098 - 0.0157 in)

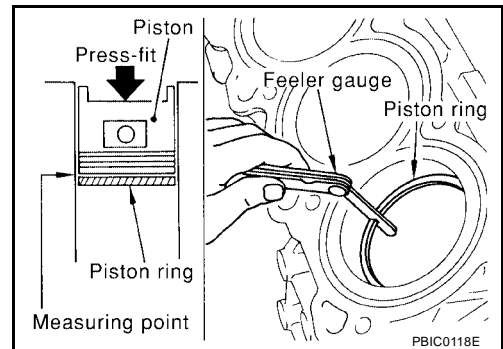
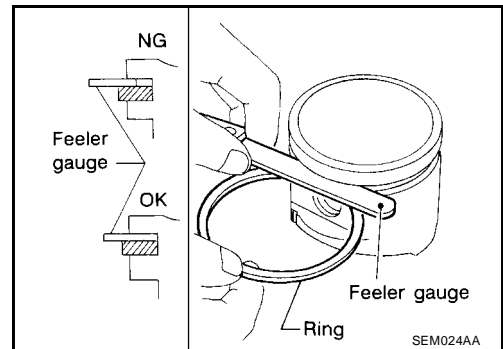
**Oil ring** : 0.20 - 0.60 mm (0.0079 - 0.0236 in)

### Limit:

**Top ring** : 0.56 mm (0.0220 in)

**2nd ring** : 0.52 mm (0.0205 in)

**Oil ring** : 0.96 mm (0.0378 in)



# CYLINDER BLOCK

- If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, re-bore cylinder and use oversized piston and piston ring.

## CONNECTING ROD BEND AND TORSION

- Using a suitable tool, check with connecting rod alignment.

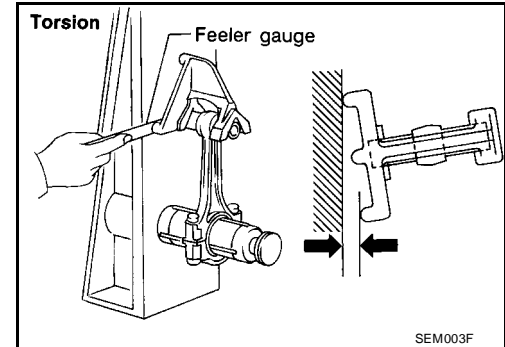
### Limit:

#### Bend

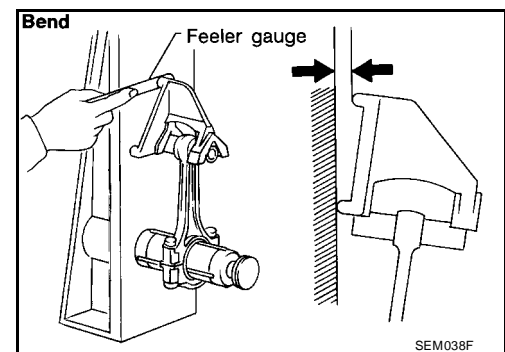
: 0.15 mm (0.0059 in) per 100 mm (3.94 in) length

#### Torsion

: 0.30 mm (0.0118 in) per 100 mm (3.94 in) length



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

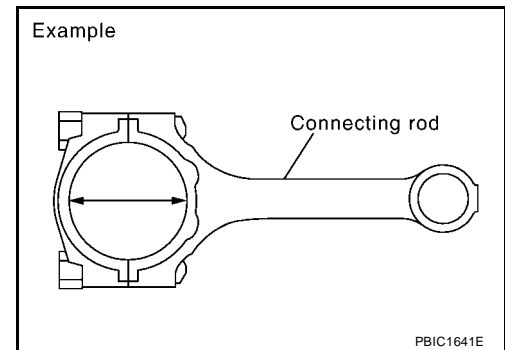


## CONNECTING ROD BEARING (BIG END)

- Using a suitable tool, install the connecting rod cap without the connecting rod bearing installed. After tightening the connecting rod bolt to the specified torque, measure the connecting rod large end inside diameter. Refer to [EM-78, "ASSEMBLY"](#).

**Standard** : 57.000 - 57.013 mm (2.2441 - 2.2446 in)

- If it exceeds the standard, replace the connecting rod.

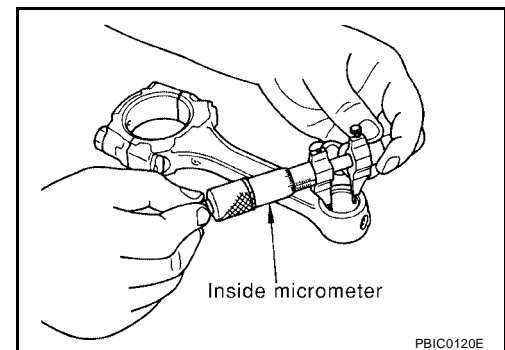


## CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)

### Connecting Rod Inside Diameter (Small End)

- Using a suitable tool, measure inside diameter of bushing.

**Standard** : 22.000 - 22.006 mm (0.8661 - 0.8664 in)

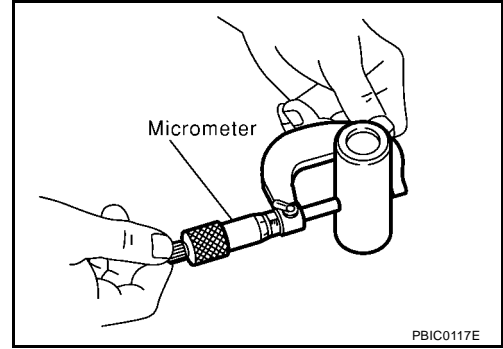


# CYLINDER BLOCK

## Piston Pin Diameter

- Using a suitable tool, measure diameter of piston pin.

**Standard : 21.989 - 21.995 mm (0.8657 - 0.8659 in)**

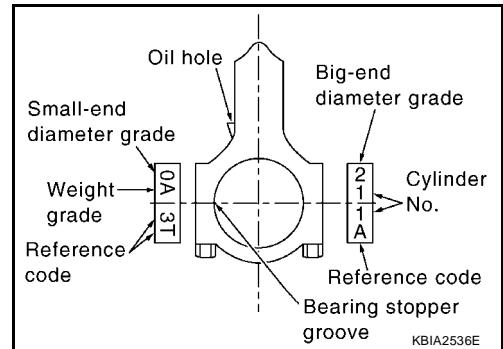


## Connecting Rod Bushing Oil Clearance (Small End)

(Connecting rod small end oil clearance) = (Inside diameter of connecting rod small end) – (Piston pin diameter)

**Standard : 0.005 - 0.017 mm (0.0002 - 0.0007 in)**

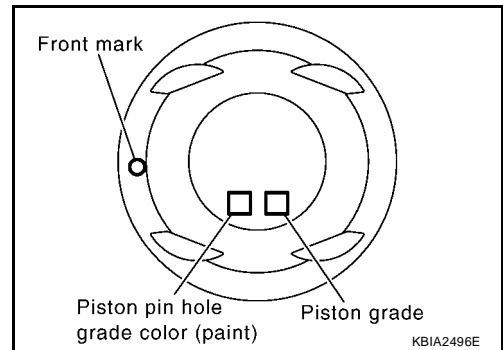
- If the measured value exceeds the standard, replace the connecting rod assembly and/or piston and piston pin assembly.
- If replacing the piston and piston pin assembly, refer to the Table for Selective Fitting for Piston to select the piston corresponding to the applicable bore grade of the cylinder block to be used. Refer to [EM-83, "HOW TO SELECT PISTON"](#).



## Factory installed parts grading:

- Only grade 0 is available.

	Unit: mm (in)
Grade	0
Connecting rod bushing inside diameter	22.000 - 22.006 (0.8661 - 0.8664)
Piston pin diameter	21.989 - 21.995 (0.8657 - 0.8659)
Piston pin hole diameter	21.993 - 21.999 (0.8659 - 0.8661)



## CYLINDER BLOCK DISTORTION

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

### CAUTION:

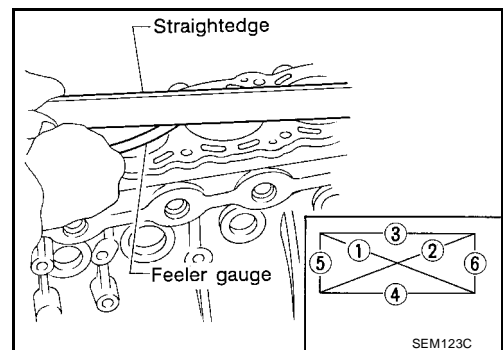
**Be careful not to allow gasket flakes to enter the engine oil or engine coolant passages.**

- Using a suitable tool, measure the distortion on the block upper face at some different points in 6 directions.

**Standard : 0.03 mm (0.0012 in)**

**Limit : 0.1 mm (0.004 in)**

- If out of the distortion limit, replace the cylinder block.



# CYLINDER BLOCK

## MAIN BEARING HOUSING INSIDE DIAMETER

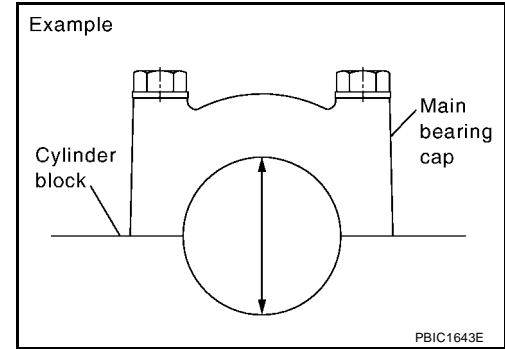
- Install the main bearing caps with the main bearings removed, and tighten the mounting bolts to the specified torque. Refer to [EM-78, "ASSEMBLY"](#).
- Using a suitable tool, measure the inside diameter of the main bearing housing.

**Standard** : 68.944 - 68.968 mm (2.7143 - 2.7153 in)

- If out of the standard, replace the cylinder block and main bearing caps as an assembly.

### NOTE:

These components must be replaced as a single unit, because they were processed together.



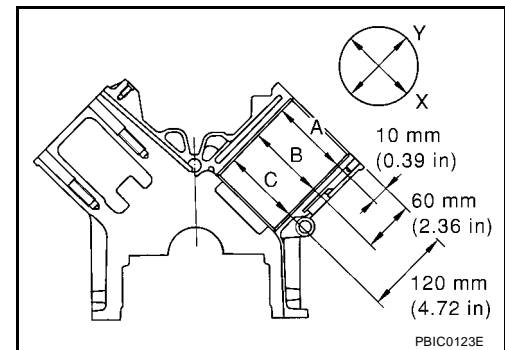
## PISTON TO CYLINDER BORE CLEARANCE

### Cylinder Bore Diameter

- Using a suitable tool, measure cylinder bore for wear, out-of-round and taper at 6 different points on each cylinder. (X and Y directions at A, B and C)

### NOTE:

When determining cylinder bore grade, measure cylinder bore at B position.



### Standard diameter:

98.000 - 98.030 mm (3.8583 - 3.8594 in)

### Wear limit:

0.20 mm (0.0079 in)

### Out-of-round (Difference between X and Y):

Limit: 0.015 mm (0.0006 in)

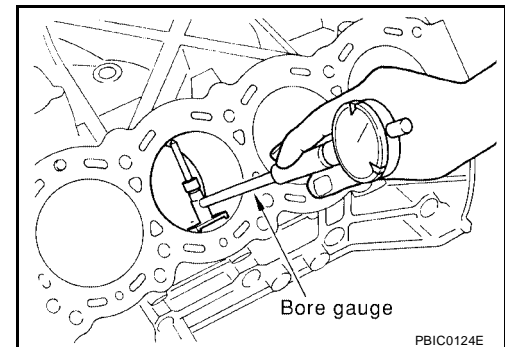
### Taper limit (Difference between A and C):

Limit: 0.010 mm (0.0004 in)

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

**Piston oversize Grade No. 0 (Service)** : 0.20 mm (0.0079 in)

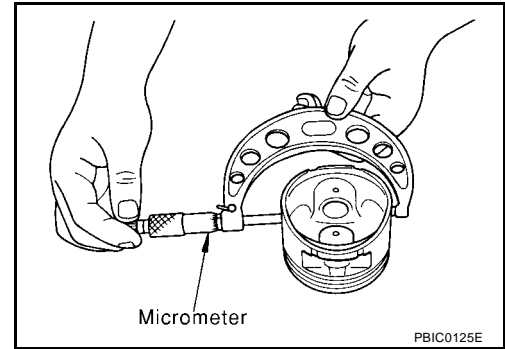
- If oversize piston is used, use it for all cylinders with oversize piston rings.



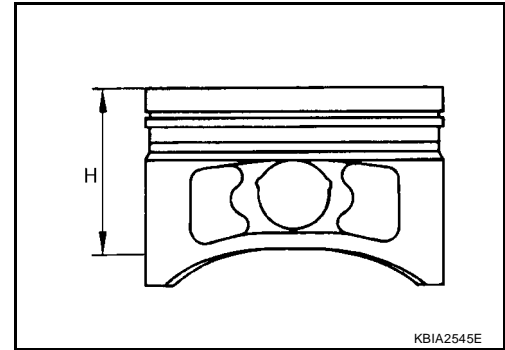
# CYLINDER BLOCK

## Piston Skirt Diameter

- Using a suitable tool, measure piston skirt diameter.  
**Standard : 97.980 - 98.010 mm (3.8575 - 3.8587 in)**



- Measure point "H"  
**Distance from the top : 39 mm (1.54 in)**



## Piston to Cylinder Bore Clearance

- Calculate by diameter of piston skirt and cylinder bore diameter (direction X, position B).  
(Clearance) = (Cylinder bore diameter) – (piston skirt diameter)  
**Standard : 0.010 - 0.030 mm (0.0004 - 0.0012 in)**  
**Limit : 0.08 mm (0.0031 in)**
- If it exceeds the limit, replace piston/piston pin assembly.

## Reboring Cylinder Bore

- Cylinder bore size is determined by adding piston-to-bore clearance to piston diameter "A".

**Rebored size calculation:  $D = A + B - C$**

**where,**

**D: Bored diameter**

**A: Piston diameter as measured**

**B: Piston - to - bore clearance (standard value)**

**C: Honing allowance 0.02 mm (0.0008 in)**

- Install main bearing caps, and tighten to the specified torque. Otherwise, cylinder bores may be distorted in final assembly.
- 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.

- Hone cylinders to obtain specified piston-to-bore clearance.

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

### NOTE:

Measurement should be done after cylinder bore cools down.

## CRANKSHAFT JOURNAL DIAMETER

- Measure diameter of crankshaft journals.

# CYLINDER BLOCK

**Standard : 63.940 - 63.964 mm (2.5173 - 2.5183 in)**

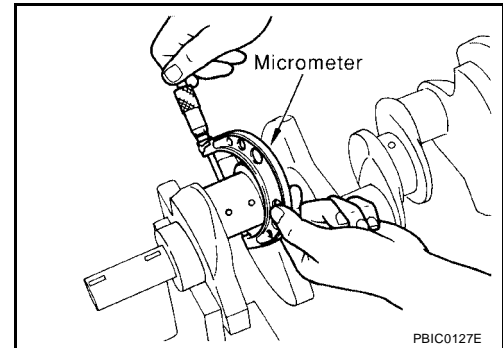
- If it is out of standard, measure the main bearing oil clearance. Then use the undersize bearing. Refer to [EM-97, "MAIN BEARING OIL CLEARANCE"](#).

## CRANKSHAFT PIN DIAMETER

- Using a suitable tool, measure diameter of crankshaft pin.

**Standard : 53.956 - 53.974 mm (2.1243 - 2.1250 in)**

- If it is out of standard, measure the connecting rod bearing oil clearance. Then use the undersize bearing. Refer to [EM-96, "CONNECTING ROD BEARING OIL CLEARANCE"](#).



## OUT-OF-ROUND AND TAPER OF CRANKSHAFT

- Using a suitable tool, measure the dimensions at 4 different points shown in the figure on each journal and pin.
- Out-of-roundness is indicated by the difference in dimension between X and Y at A and B.
- Taper is indicated by the difference in dimension between A and B at X and Y.

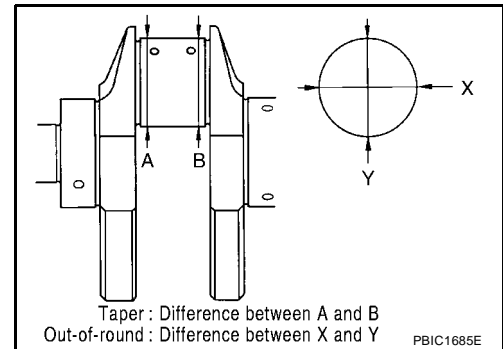
### Limit

**Out-of-round (Difference between X and Y)**

**: 0.002 mm (0.0001 in)**

**Taper (Difference between A and B)**

**: 0.002 mm (0.0001 in)**



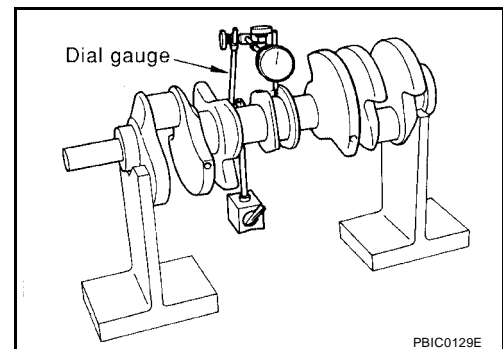
- If the measured value exceeds the standard, correct or replace the crankshaft.
- If corrected, measure the bearing oil clearance of the corrected journal or pin. Then select the main bearing or connecting rod bearing. Refer to [EM-97, "MAIN BEARING OIL CLEARANCE"](#) or [EM-96, "CONNECTING ROD BEARING OIL CLEARANCE"](#).

## CRANKSHAFT RUNOUT

- Place a V-block on a precise flat table to support the journals on both ends of the crankshaft.
- Using suitable tool, straight up on the No. 3 journal.
- While rotating the crankshaft, read the movement of the pointer on the dial gauge.
- Half of the movement shows the runout.

**Limit : Less than 0.05 mm (0.002 in)**

- If it exceeds the limit, replace the crankshaft.



## CONNECTING ROD BEARING OIL CLEARANCE

### Method of Measurement

- Install the connecting rod bearings to the connecting rod and the cap, and tighten the connecting rod bolt to the specified torque. Refer to [EM-78, "ASSEMBLY"](#).



# CYLINDER BLOCK

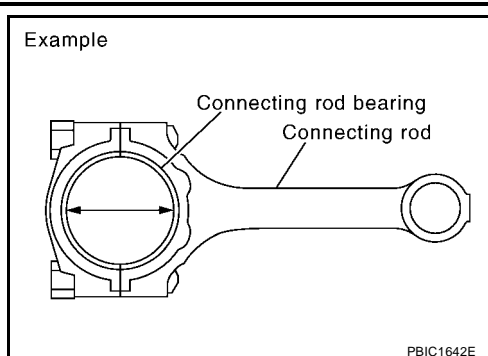
Using a suitable tool, measure the inside diameter of connecting rod bearing.

(Oil clearance) = (Inside diameter of connecting rod bearing) – (Crankshaft pin diameter)

**Standard** : 0.020 - 0.039 mm (0.0008 - 0.0015 in)

**Limit** : 0.055 mm (0.0022 in)

- If clearance cannot be adjusted within the standard, grind crankshaft pin and use undersized bearing. Refer to [EM-86, "HOW TO SELECT MAIN BEARING"](#) .



## Method of Using Plastigage

- Remove oil and dust on the crankshaft pin 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 the connecting rod bearings to the connecting rod and connecting rod bearing cap, and tighten the connecting rod bolt to the specified torque.

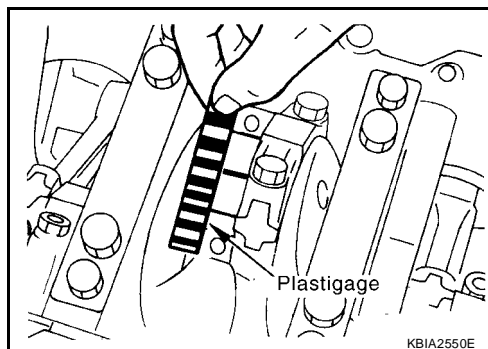
### CAUTION:

**Never rotate the crankshaft.**

- Remove the 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 repair limit is same as that described in "Method of Measurement."



## MAIN BEARING OIL CLEARANCE

### Method of Measurement

- Install the main bearings to the cylinder block and main bearing cap. Measure the main bearing inside diameter with the bearing cap bolt tightened to the specified torque. Refer to [EM-78, "ASSEMBLY"](#) .  
(Oil clearance) = (Inside diameter of main bearing) – (Crankshaft journal diameter)

### Standard:

**No. 1 and 5 journals**

: 0.001 - 0.011 mm (0.00004 - 0.0004 in)

**No. 2, 3 and 4 journals**

: 0.007 - 0.017 mm (0.0003 - 0.0007 in)

### Limit:

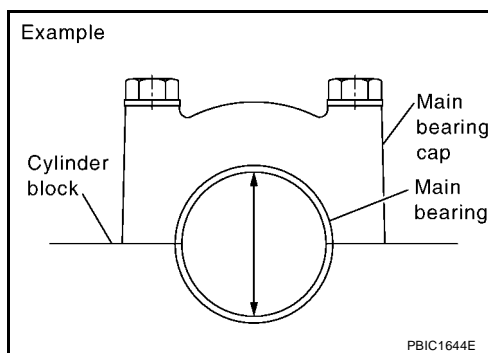
**No.1 and 5 journals**

: 0.021 mm (0.0008 in)

**No. 2, 3 and 4 journals**

: 0.027 mm (0.0011 in)

- If the measured value exceeds the repair limit, select main bearings referring to the main bearing inside diameter and crankshaft journal diameter, so that the oil clearance satisfies the standard. Refer to [EM-86](#) .



# CYLINDER BLOCK

## Method of Using Plastigage

- Remove oil and dust on the 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 the main bearings to the cylinder block and main bearing cap, and tighten the main bearing bolts to the specified torque.

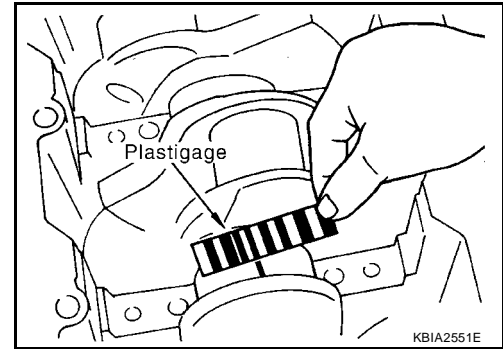
### CAUTION:

**Never rotate the crankshaft.**

- Remove the 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 repair limit is same as that described in "Method of Measurement".

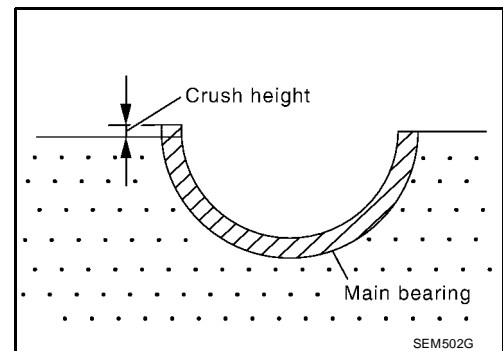


## CRUSH HEIGHT OF MAIN BEARING

- When the bearing cap is removed after being tightened to the specified torque with main bearings installed, the tip end of bearing must protrude. Refer to [EM-78, "ASSEMBLY"](#) for the tightening procedure.

**Standard** : There must be crush height

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

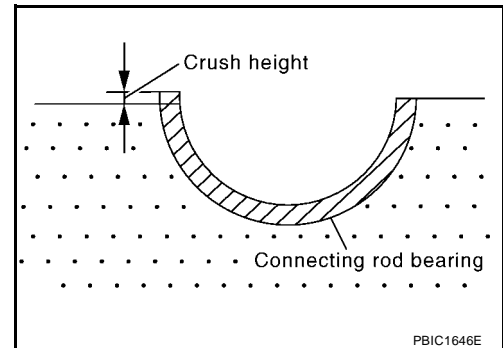


## CRUSH HEIGHT OF CONNECTING ROD BEARING

- When the connecting rod bearing cap is removed after being tightened to the specified torque with connecting rod bearings installed, the tip end of bearing must protrude. Refer to [EM-78, "ASSEMBLY"](#) for the tightening procedure.

**Standard** : There must be crush height.

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



## MAIN BEARING CAP BOLT DIAMETER

- Check for bolts (M9) (M12) installed from lower side with the following procedure.

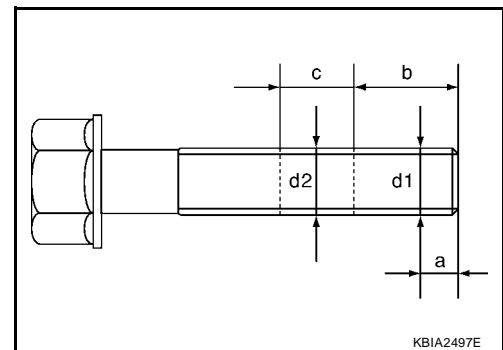
### NOTE:

- Side bolt (M10) is outside the target.
- Figure shows M12 bolt.
- Measure bolt diameter d1 from the tip of bolt to dimension a.
- Measure bolt diameter d2 from the dimension between the tip of bolt and dimension b as base station to dimension c.

### NOTE:

Measure d2 at that point if narrower part in the threads is determined by visual check.

- Calculate the difference between d1 and d2.



# CYLINDER BLOCK

## M9 bolt

Dimension "a"	: 9 mm (0.35 in)
Dimension "b"	: 15 mm (0.59 in)
Dimension "c"	: 20 mm (0.79 in)
Limit	: 0.10 mm (0.0039 in)

## M12 bolt

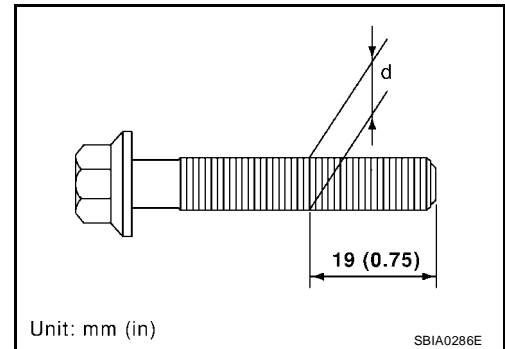
Dimension "a"	: 12 mm (0.47 in)
Dimension "b"	: 55 mm (2.17 in)
Dimension "c"	: 20 mm (0.79 in)
Limit	: 0.15 mm (0.0059 in)

- Replace applicable bolts if outside the limit.

## CONNECTING ROD BOLT DIAMETER

- Measure diameter (d) at position shown in the figure.
- When "d" exceeds the limit (when it becomes thinner), replace the bolt with a new one.

**Limit : 7.75 mm (0.3051 in) or less.**



A

EM

C

D

E

F

G

H

I

J

K

L

M

# SERVICE DATA AND SPECIFICATIONS (SDS)

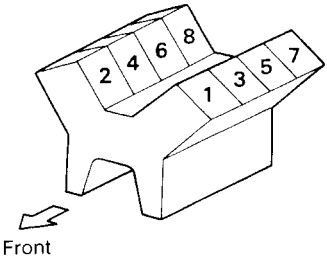
## SERVICE DATA AND SPECIFICATIONS (SDS)

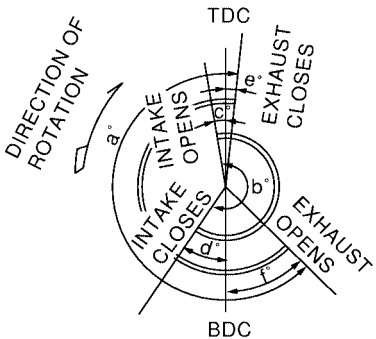
PFP:00030

### Standard and Limit GENERAL SPECIFICATIONS

EBS0013B

Cylinder arrangement		V-8
Displacement cm <sup>3</sup> (cu in)		5,552 (338.80)
Bore and stroke mm (in)		98 x 92 (3.86 x 3.62)
Valve arrangement		DOHC
Firing order		1-8-7-3-6-5-4-2
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		5
Compression ratio		9.8
Compression pressure kPa (kg/cm <sup>2</sup> , psi)/rpm	Standard	1,520 (15.5, 220)/200
	Minimum	1,324 (13.5, 192)/200
	Differential limit between cylinders	98 (1.0, 14)/300

Cylinder number	 <p style="text-align: right;">SEM957C</p>
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Valve timing	 <p style="text-align: right;">PBIC0187E</p>
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Unit: degree

a	b	c	d	e	f
232	230	2	48	3	49

### DRIVE BELTS

Tension of drive belts	Auto adjustment by auto tensioner
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### EXHAUST MANIFOLD

Unit: mm (in)

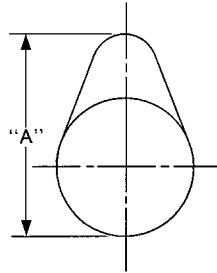
Items	Exhaust manifold	Limit
Surface distortion	Exhaust manifold	0.3 (0.012)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

Items	Standard
Camshaft runout [TIR*]	Less than 0.02 (0.0008)



Camshaft cam height "A"	Intake & Exhaust	44.465 - 44.655 (1.7506 - 1.7581)	
		Cam wear limit	0.02 (0.0008)
Outside diameter of camshaft journal		25.953 - 25.970 (1.0218 - 1.0224)	
Camshaft bracket inside diameter		26.000 - 26.021 (1.0236 - 1.0244)	
Camshaft journal clearance		0.030 - 0.068 (0.0012 - 0.0027)	
Camshaft end play		0.115 - 0.188 (0.0045 - 0.0074)	
Camshaft sprocket runout [TIR*]		Less than 0.15 (0.0059)	

\*: Total indicator reading

### Valve Lifter

Unit: mm (in)

Items	Standard
Valve lifter diameter	33.977 - 33.987 (1.3377 - 1.3381)
Valve lifter hole diameter	34.000 - 34.016 (1.3386 - 1.3392)
Clearance between lifter and lifter guide	0.013 - 0.039 (0.0005 - 0.0015)

### Valve Clearance

Unit: mm (in)

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

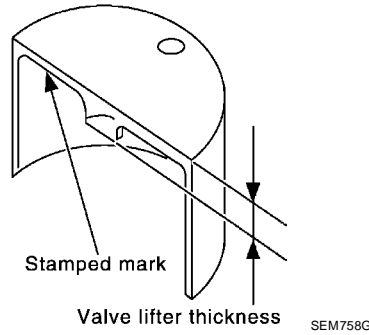
\*: Approximately 20°C (68 °F)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Available Valve Lifter

Unit: mm (in)

Identification (stamped) Mark	Thickness
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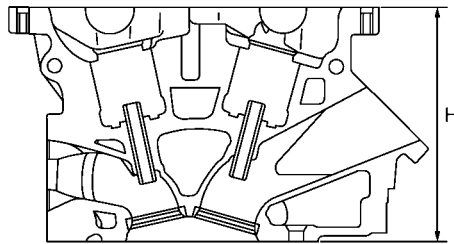
N788	7.88 (0.3102)
N790	7.90 (0.3110)
N792	7.92 (0.3118)
N794	7.94 (0.3126)
N796	7.96 (0.3134)
N798	7.98 (0.3142)
N800	8.00 (0.3150)
N802	8.02 (0.3157)
N804	8.04 (0.3165)
N806	8.06 (0.3173)
N808	8.08 (0.3181)
N810	8.10 (0.3189)
N812	8.12 (0.3197)
N814	8.14 (0.3205)
N816	8.16 (0.3213)
N818	8.18 (0.3220)
N820	8.20 (0.3228)
N822	8.22 (0.3236)
N824	8.24 (0.3244)
N826	8.26 (0.3252)
N828	8.28 (0.3260)
N830	8.30 (0.3268)
N832	8.32 (0.3276)
N834	8.34 (0.3283)
N836	8.36 (0.3291)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## CYLINDER HEAD

Unit: mm (in)

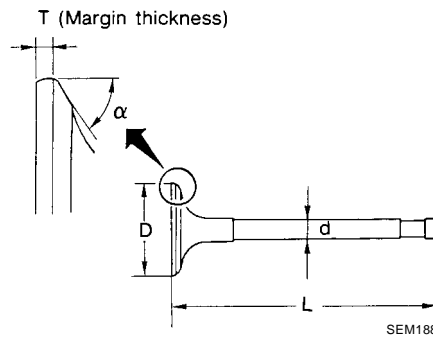
Items	Standard	Limit
Head surface distortion	0.03 (0.0012)	0.1 (0.004)
Nominal cylinder head height "H"	126.3 (4.97)	



KBIA2554E

## Valve Dimensions

Unit: mm (in)

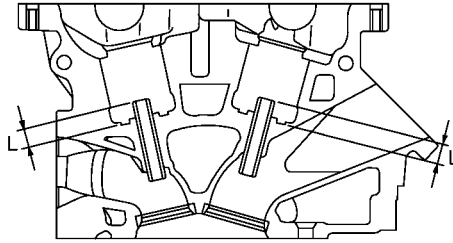


Valve head diameter "D"	Intake	37.0 - 37.3 (1.457 - 1.469)
	Exhaust	31.2 - 31.5 (1.228 - 1.240)
Valve length "L"	Intake	96.21 - 96.71 (3.7878 - 3.8075)
	Exhaust	93.74 - 94.24 (3.6905 - 3.7102)
Valve stem diameter "d"	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.955 - 5.970 (0.2344 - 0.2350)
Valve seat angle "alpha"	Intake	45°15' - 45°45'
	Exhaust	
Valve margin "T"	Intake	1.1 (0.043)
	Exhaust	1.3 (0.051)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Valve Guide

Unit: mm (in)

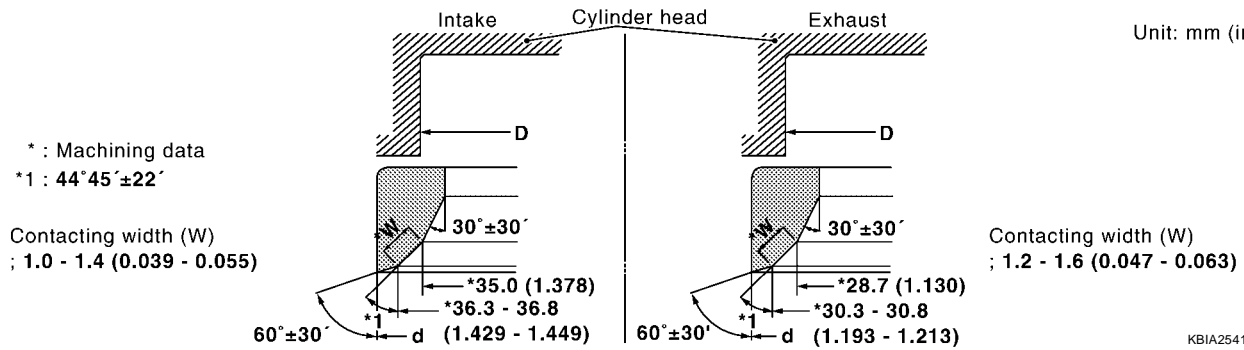


KBIA2555E

Items		Standard	Oversize [0.2 (0.008)] (service)
Valve guide	Outside diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
	Inside 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
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
	Exhaust	0.030 - 0.063 (0.0012 - 0.0025)	0.09 (0.0035)
Projection length "L"	Intake	12.6 - 12.8 (0.496 - 0.504)	
	Exhaust	12.5 - 12.9 (0.492 - 0.508)	

## Valve Seat

Unit: mm (in)



Items		Standard	Oversize [0.5 (0.020)] (Service)
Cylinder head seat recess diameter (D)	Intake	38.000 - 38.016 (1.4961 - 1.4967)	38.500 - 38.516 (1.5157 - 1.5164)
	Exhaust	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)
Valve seat interference fit	Intake	0.081 - 0.113 (0.0032 - 0.0044)	
	Exhaust	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat diameter (d)	Intake	38.097 - 38.113 (1.4999 - 1.5005)	38.597 - 38.613 (1.5196 - 1.5202)
	Exhaust	32.280 - 32.296 (1.2709 - 1.2715)	32.780 - 32.796 (1.2905 - 1.2912)

## Valve Spring

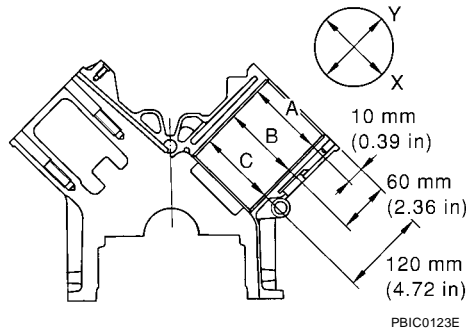
Free height	mm (in)	50.58 (1.9913)
Pressure	N (kg, lb) at height mm (in)	165.8 - 187.0 (16.9 - 19.1, 37 - 42) at 37.0 (1.457)
	Valve open	314.8 - 355.0 (32.1 - 36.2, 71 - 80) at 28.2 (1.110)
Out-of-square	mm (in)	Less than 2.2 (0.087)



# SERVICE DATA AND SPECIFICATIONS (SDS)

## CYLINDER BLOCK

Unit: mm (in)



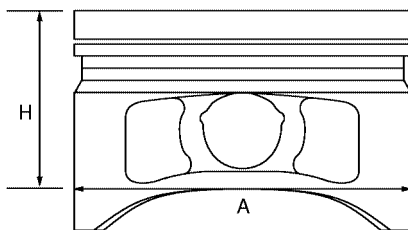
Surface flatness	Standard	0.03 (0.0012)	
	Llimit	0.1 (0.004)	
Main bearing housing inside diameter	Standard	68.944 - 68.968 (2.7143 - 2.7153)	
Cylinder bore diameter	Standard	Grade No. 1	98.000 - 98.010 (3.8583 - 3.8587)
		Grade No. 2	98.010 - 98.020 (3.8587 - 3.8590)
		Grade No. 3	98.020 - 98.030 (3.8590 - 3.8594)
	Wear limit	0.20 (0.0079)	
Out-of-round (Difference between X and Y)	Limit	0.015 (0.0006)	
Taper (Difference between A and C)		0.010 (0.0004)	
Main journal inside diameter grade (Without bearing)	Grade No. A	68.944 - 68.945 (2.7143 - 2.7144)	
	Grade No. B	68.945 - 68.946 (2.7144 - 2.7144)	
	Grade No. C	68.946 - 68.947 (2.7144 - 2.7144)	
	Grade No. D	68.947 - 68.948 (2.7144 - 2.7145)	
	Grade No. E	68.948 - 68.949 (2.7145 - 2.7145)	
	Grade No. F	68.949 - 68.950 (2.7145 - 2.7146)	
	Grade No. G	68.950 - 68.951 (2.7146 - 2.7146)	
	Grade No. H	68.951 - 68.952 (2.7146 - 2.7146)	
	Grade No. J	68.952 - 68.953 (2.7146 - 2.7147)	
	Grade No. K	68.953 - 68.954 (2.7147 - 2.7147)	
	Grade No. L	68.954 - 68.955 (2.7147 - 2.7148)	
	Grade No. M	68.955 - 68.956 (2.7148 - 2.7148)	
	Grade No. N	68.956 - 68.957 (2.7148 - 2.7148)	
	Grade No. P	68.957 - 68.958 (2.7148 - 2.7149)	
	Grade No. R	68.958 - 68.959 (2.7149 - 2.7149)	
	Grade No. S	68.959 - 68.960 (2.7149 - 2.7150)	
	Grade No. T	68.960 - 68.961 (2.7150 - 2.7150)	
	Grade No. U	68.961 - 68.962 (2.7150 - 2.7150)	
	Grade No. V	68.962 - 68.963 (2.7150 - 2.7151)	
Grade No. W	68.963 - 68.964 (2.7151 - 2.7151)		
Grade No. X	68.964 - 68.965 (2.7151 - 2.7152)		
Grade No. Y	68.965 - 68.966 (2.7152 - 2.7152)		
Grade No. 4	68.966 - 68.967 (2.7152 - 2.7152)		
Grade No. 7	68.967 - 68.968 (2.7152 - 2.7153)		
Difference in bore diameter between cylinders	Standard	Less than 0.03 (0.0012)	

# SERVICE DATA AND SPECIFICATIONS (SDS)

## PISTON, PISTON RING AND PISTON PIN

### Available Piston

Unit: mm (in)



PBIC0188E

Items		Standard	Limit
Piston skirt diameter "A"	Grade No. 1	97.980 - 97.990 (3.8575 - 3.8579)	—
	Grade No. 2	97.990 - 98.000 (3.8579 - 3.8583)	—
	Grade No. 3	98.000 - 98.010 (3.8583 - 3.8587)	—
	Grade No. 0 (Service)	98.180 - 98.210 (3.8653 - 3.8665)	0.20 (0.0079)
"H" dimension		39 (1.54)	—
Piston pin hole diameter	Grade No. 0	21.993 - 21.999 (0.8659 - 0.8661)	—
Piston to cylinder bore clearance		0.010 - 0.030 (0.0004 - 0.0012)	0.08 (0.0031)

### Piston Ring

Unit: mm (in)

Items		Standard	Limit
Side clearance	Top	0.035 - 0.085 (0.0014 - 0.0033)	0.11 (0.0043)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.10 (0.0039)
	Oil ring	0.015 - 0.050 (0.0006 - 0.0020)	—
End gap	Top	0.23 - 0.33 (0.0091 - 0.0130)	0.56 (0.0220)
	2nd	0.25 - 0.40 (0.0098 - 0.0157)	0.52 (0.0205)
	Oil ring	0.20 - 0.60 (0.0079 - 0.0236)	0.96 (0.0378)

### Piston Pin

Unit: mm (in)

Items		Standard
Piston pin diameter	Grade No. 0	21.989 - 21.995 (0.8657 - 0.8659)
Piston to piston pin clearance		0.002 - 0.006 (0.0001 - 0.0002)
Connecting rod bushing oil clearance		0.005 - 0.017 (0.0002 - 0.0007)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## CONNECTING ROD

Unit: mm (in)

Items		Standard	Limit
Center distance		154.45 - 154.55 (6.08 - 6.08)	—
Bend [per 100 (3.94)]		—	0.15 (0.0059)
Torsion [per 100 (3.94)]		—	0.30 (0.0118)
Connecting rod bushing inside diameter* (small end)	Grade No. 0	22.000 - 22.006 (0.8661 - 0.8664)	—
Connecting rod big end inside diameter (without bearing)		57.000 - 57.013 (2.2441 - 2.2446)	—
Side clearance		0.20 - 0.40 (0.0079 - 0.0157)	0.40 (0.0157)
Connecting rod bearing housing	Grade No. 0	57.000 - 57.001 (2.2441 - 2.2441)	
	Grade No. 1	57.001 - 57.002 (2.2441 - 2.2442)	
	Grade No. 2	57.002 - 57.003 (2.2442 - 2.2442)	
	Grade No. 3	57.003 - 57.004 (2.2442 - 2.2443)	
	Grade No. 4	57.004 - 57.005 (2.2443 - 2.2443)	
	Grade No. 5	57.005 - 57.006 (2.2443 - 2.2443)	
	Grade No. 6	57.006 - 57.007 (2.2443 - 2.2444)	
	Grade No. 7	57.007 - 57.008 (2.2444 - 2.2444)	
	Grade No. 8	57.008 - 57.009 (2.2444 - 2.2444)	
	Grade No. 9	57.009 - 57.010 (2.2444 - 2.2445)	
	Grade No. A	57.010 - 57.011 (2.2445 - 2.2445)	
	Grade No. B	57.011 - 57.012 (2.2445 - 2.2446)	
	Grade No. C	57.012 - 57.013 (2.2446 - 2.2446)	

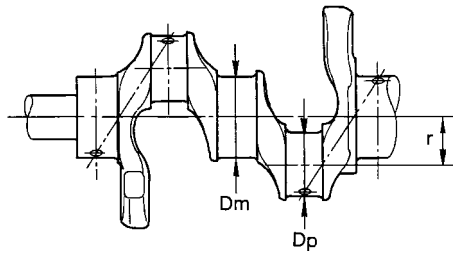
\*: After installing in connecting rod

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

# SERVICE DATA AND SPECIFICATIONS (SDS)

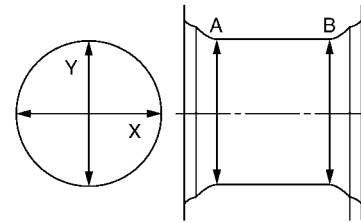
## CRANKSHAFT

Unit: mm (in)



SEM645

Out-of-round : Difference between X and Y.  
Taper : Difference between A and B.



PBIC1686E

Main journal dia. "Dm" grade (No. 1 and 5)	Standard	Grade No. G	63.963 - 63.964 (2.5182 - 2.5183)
		Grade No. H	63.962 - 63.963 (2.5182 - 2.5182)
		Grade No. J	63.961 - 63.962 (2.5181 - 2.5182)
		Grade No. K	63.960 - 63.961 (2.5181 - 2.5181)
		Grade No. L	63.959 - 63.960 (2.5181 - 2.5181)
		Grade No. M	63.958 - 63.959 (2.5180 - 2.5181)
		Grade No. N	63.957 - 63.958 (2.5180 - 2.5180)
		Grade No. P	63.956 - 63.957 (2.5179 - 2.5180)
		Grade No. R	63.955 - 63.956 (2.5179 - 2.5179)
		Grade No. S	63.954 - 63.955 (2.5179 - 2.5179)
		Grade No. T	63.953 - 63.954 (2.5178 - 2.5179)
		Grade No. U	63.952 - 63.953 (2.5178 - 2.5178)
		Grade No. V	63.951 - 63.952 (2.5178 - 2.5178)
		Grade No. W	63.950 - 63.951 (2.5177 - 2.5178)
		Grade No. X	63.949 - 63.950 (2.5177 - 2.5177)
		Grade No. Y	63.948 - 63.949 (2.5176 - 2.5177)
		Grade No. 1	63.947 - 63.948 (2.5176 - 2.5176)
		Grade No. 2	63.946 - 63.947 (2.5176 - 2.5176)
		Grade No. 3	63.945 - 63.946 (2.5175 - 2.5176)
		Grade No. 4	63.944 - 63.945 (2.5175 - 2.5175)
Grade No. 5	63.943 - 63.944 (2.5174 - 2.5175)		
Grade No. 6	63.942 - 63.943 (2.5174 - 2.5174)		
Grade No. 7	63.941 - 63.942 (2.5174 - 2.5174)		
Grade No. 9	63.940 - 63.941 (2.5173 - 2.5174)		
Main journal dia. "Dm" grade (No. 2, 3 and 4)	Standard	Grade No. A	63.963 - 63.964 (2.5182 - 2.5183)
		Grade No. B	63.962 - 63.963 (2.5182 - 2.5182)
		Grade No. C	63.961 - 63.962 (2.5181 - 2.5182)
		Grade No. D	63.960 - 63.961 (2.5181 - 2.5181)
		Grade No. E	63.959 - 63.960 (2.5181 - 2.5181)
		Grade No. F	63.958 - 63.959 (2.5180 - 2.5181)
		Grade No. G	63.957 - 63.958 (2.5180 - 2.5180)
		Grade No. H	63.956 - 63.957 (2.5179 - 2.5180)
		Grade No. J	63.955 - 63.956 (2.5179 - 2.5179)
		Grade No. K	63.954 - 63.955 (2.5179 - 2.5179)
		Grade No. L	63.953 - 63.954 (2.5178 - 2.5179)
		Grade No. M	63.952 - 63.953 (2.5178 - 2.5178)
		Grade No. N	63.951 - 63.952 (2.5178 - 2.5178)
		Grade No. P	63.950 - 63.951 (2.5177 - 2.5178)
		Grade No. R	63.949 - 63.950 (2.5177 - 2.5177)
		Grade No. S	63.948 - 63.949 (2.5176 - 2.5177)
		Grade No. T	63.947 - 63.948 (2.5176 - 2.5176)
		Grade No. U	63.946 - 63.947 (2.5176 - 2.5176)
		Grade No. V	63.945 - 63.946 (2.5175 - 2.5176)
		Grade No. W	63.944 - 63.945 (2.5175 - 2.5175)
Grade No. X	63.943 - 63.944 (2.5174 - 2.5175)		
Grade No. Y	63.942 - 63.943 (2.5174 - 2.5174)		
Grade No. 1	63.941 - 63.942 (2.5174 - 2.5174)		
Grade No. 2	63.940 - 63.941 (2.5173 - 2.5174)		

## SERVICE DATA AND SPECIFICATIONS (SDS)

Pin journal dia. "Dp"	Standard	Grade No. 0	53.968 - 53.974 (2.1247 - 2.1250)	A
		Grade No. 1	53.962 - 53.968 (2.1245 - 2.1247)	
		Grade No. 2	53.956 - 53.962 (2.1243 - 2.1245)	
Center distance "r"			45.96 - 46.04 (1.8094 - 1.8126)	<b>EM</b>
Out-of-round (Difference between X and Y)	Limit		0.002 (0.0001)	
Taper (Difference between A and B)			0.002 (0.0001)	
Runout [TIR*]			Less than 0.05 (0.002)	C
Crankshaft end play	Standard		0.10 - 0.26 (0.0039 - 0.0102)	
	Limit		0.30 (0.0118)	D

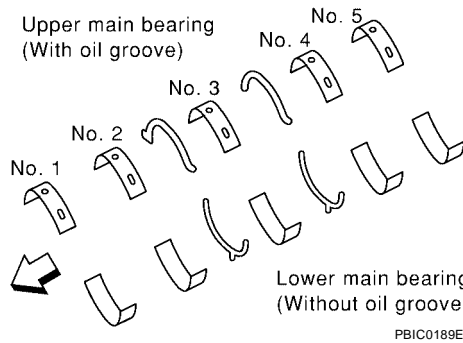
\*: Total indicator reading

E  
F  
G  
H  
I  
J  
K  
L  
M

# SERVICE DATA AND SPECIFICATIONS (SDS)

## MAIN BEARING

Unit: mm (in)



Grade number	UPR/LWR	Thickness	Identification color	Remarks
0	—	2.483 - 2.486 (0.0978 - 0.0979)	Black	Grade is the same for upper and lower bearings
1	—	2.486 - 2.489 (0.0979 - 0.0980)	Brown	
2	—	2.489 - 2.492 (0.0980 - 0.0981)	Green	
3	—	2.492 - 2.495 (0.0981 - 0.0982)	Yellow	
4	—	2.495 - 2.498 (0.0982 - 0.0983)	Blue	
5	—	2.498 - 2.501 (0.0983 - 0.0985)	Pink	
6	—	2.501 - 2.504 (0.0985 - 0.0986)	Purple	
7	—	2.504 - 2.507 (0.0986 - 0.0987)	White	
8	—	2.507 - 2.510 (0.0987 - 0.0988)	Red	
01	UPR	2.483 - 2.486 (0.0978 - 0.0979)	Black	Grade is different for upper and lower bearings.
	LWR	2.486 - 2.489 (0.0979 - 0.0980)	Brown	
12	UPR	2.486 - 2.489 (0.0979 - 0.0980)	Brown	
	LWR	2.489 - 2.492 (0.0980 - 0.0981)	Green	
23	UPR	2.489 - 2.492 (0.0980 - 0.0981)	Green	
	LWR	2.492 - 2.495 (0.0981 - 0.0982)	Yellow	
34	UPR	2.492 - 2.495 (0.0981 - 0.0982)	Yellow	
	LWR	2.495 - 2.498 (0.0982 - 0.0983)	Blue	
45	UPR	2.495 - 2.498 (0.0982 - 0.0983)	Blue	
	LWR	2.498 - 2.501 (0.0983 - 0.0985)	Pink	
56	UPR	2.498 - 2.501 (0.0983 - 0.0985)	Pink	
	LWR	2.501 - 2.504 (0.0985 - 0.0986)	Purple	
67	UPR	2.501 - 2.504 (0.0985 - 0.0986)	Purple	
	LWR	2.504 - 2.507 (0.0986 - 0.0987)	White	
78	UPR	2.504 - 2.507 (0.0986 - 0.0987)	White	
	LWR	2.507 - 2.510 (0.0987 - 0.0988)	Red	

## Undersize

Unit: mm (in)

Undersize	Thickness	Main journal diameter
0.25 (0.0098)	2.618 - 2.626 (0.1031 - 0.1034)	Grind so that bearing clearance is the specified value.

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Main Bearing Oil Clearance

Unit: mm (in)

Items		Standard	Limit
Main bearing oil clearance	No.1 and 5	0.001 - 0.011 (0.00004 - 0.0004)	0.021 (0.0008)
	No.2, 3 and 4	0.007 - 0.017 (0.0003 - 0.0007)	0.027 (0.0011)

## Connecting Rod Bearing

Grade number	Thickness "T" mm (in)	Identification color (mark)
0	1.500 - 1.503 (0.0591 - 0.0592)	Black
1	1.503 - 1.506 (0.0592 - 0.0593)	Brown
2	1.506 - 1.509 (0.0593 - 0.0594)	Green
3	1.509 - 1.512 (0.0594 - 0.0595)	Yellow

## Undersize

Unit: mm (in)

Undersize	Thickness	Crank pin journal diameter "Dp"
0.25 (0.0098)	1.627 - 1.635 (0.0641 - 0.0644)	Grind so that bearing clearance is the specified value.

## Connecting Rod Bearing Oil Clearance

Unit: mm (in)

Items	Standard	Limit
Connecting rod bearing oil clearance	0.020 - 0.039 (0.0008 - 0.0015)	0.055 (0.0022)

# SERVICE DATA AND SPECIFICATIONS (SDS)

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