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SECTION **EM**

ENGINE MECHANICAL

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PRECAUTIONS

PRECAUTIONS

PPF:00001

Precautions for Drain Engine Coolant

EBS002QC

Drain engine coolant when engine is cooled.

Precautions for Disconnecting Fuel Piping

EBS002QD

- 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

EBS002QE

- 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 re-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

EBS002QF

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

Precautions for Assembly and Installation

EBS002QG

- 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 liquid 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, engine oil sliding surfaces well.
- Release air within route when refilling after draining engine coolant.
- After repairing, start engine and increase engine speed to check engine coolant, fuel, engine oil, and exhaust systems for leakage.

Parts Requiring Angular Tightening

EBS001LP

- Use an angle wrench for the final tightening of the following engine parts:
 - Cylinder head bolts
 - Main bearing cap bolts
 - Connecting rod cap nuts
 - 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 coated with engine oil.

PRECAUTIONS

EBS001LQ

Precautions for Liquid Gasket REMOVAL OF LIQUID GASKET SEALING

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

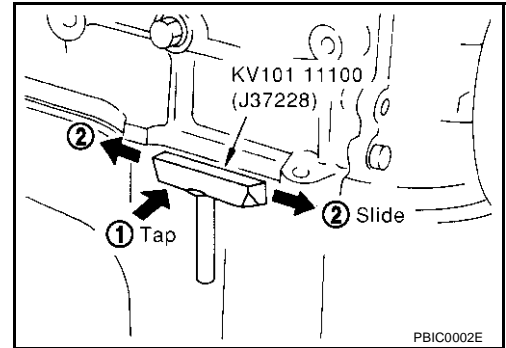
CAUTION:

Be careful not to damage the mating surfaces.

- In areas where the cutter is difficult to use, use a plastic hammer to lightly tap the areas where the liquid gasket is applied.

CAUTION:

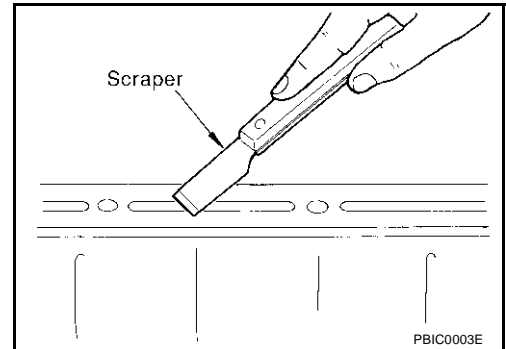
If for some unavoidable reason a tool such as a flat-bladed screwdriver is used, be careful not to damage the mating surfaces.



PBIC0002E

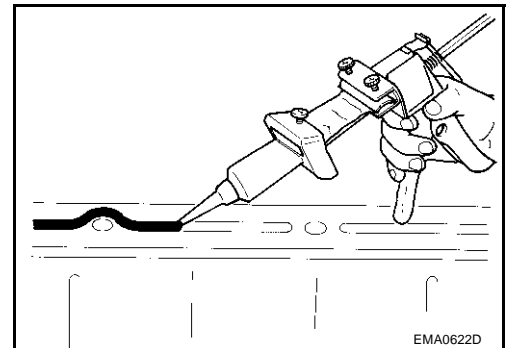
LIQUID GASKET APPLICATION PROCEDURE

- 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 white gasoline (lighting and heating use) to remove adhering moisture, grease and foreign materials.



PBIC0003E

- Attach the liquid gasket tube to the tube presser.
Use Genuine Thread Sealant or equivalent. Refer to [GI-46, "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.

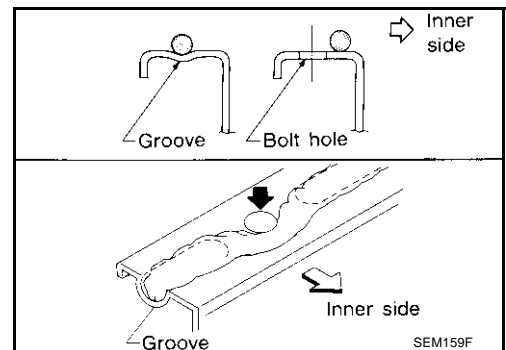


EMA0622D

- 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.
- After 30 minutes or more have passed from the installation, fill the engine oil and engine coolant.

CAUTION:

If there are specific instructions in this manual, observe them.



SEM159F

PREPARATION

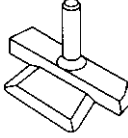
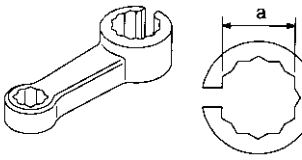

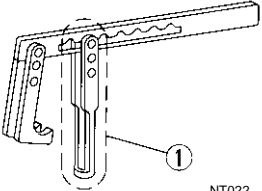
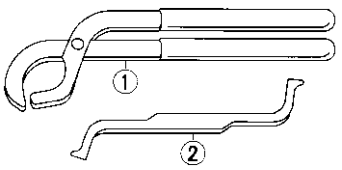
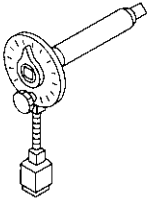
PREPARATION

PPF:00002

Special Service Tools

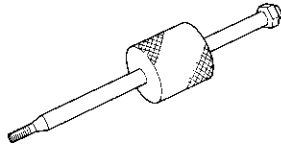
EBS001L5

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

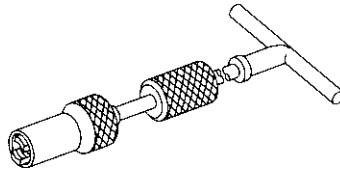
Tool number (Kent-Moore No.) Tool name	Description
KV10111100 (J37228) Seal cutter  <p style="text-align: center;">S-NT046</p>	Removing steel oil pan and rear timing chain case <p style="text-align: right;">C</p> <p style="text-align: right;">D</p>
KV10114400 (J-38365) Heated oxygen sensor wrench  <p style="text-align: center;">S-NT636</p>	Loosening or tightening heated oxygen sensors a: 22 mm (0.87 in) <p style="text-align: right;">E</p> <p style="text-align: right;">F</p>
EG15050500 (J45402) Compression gauge adapter  <p style="text-align: center;">ZZA1225D</p>	Inspection of compression pressure on No.7 and No.8 cylinders <p style="text-align: right;">G</p> <p style="text-align: right;">H</p>
KV10116200 (J26336-A) Valve spring compressor 1. KV10115900 (J26336-20) Attachment  <p style="text-align: center;">NT022</p>	Disassembling valve mechanism <p style="text-align: right;">I</p> <p style="text-align: right;">J</p>
KV101151S0 (J38972) Lifter stopper set 1. KV10115110 (J38972-1) Camshaft pliers 2. KV10115120 (J38972-2) Lifter stopper  <p style="text-align: center;">S-NT041</p>	Changing valve lifter shims <p style="text-align: right;">K</p> <p style="text-align: right;">L</p> <p style="text-align: right;">M</p>
KV10112100 (BT8653-A) Angle wrench  <p style="text-align: center;">S-NT014</p>	Tightening bolts for bearing cap, cylinder head, etc.

PREPARATION

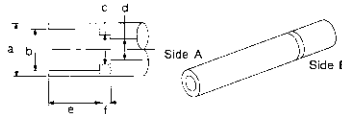
Tool number (Kent-Moore No.) Tool name	Description
KV10114700 (J38139) Main bearing cap remover	Removing crankshaft main bearing cap
KV10107902 (J38959) Valve oil seal puller	Removing valve oil seal
KV10115600 (J38958) Valve oil seal drift	Installing valve oil seal Use side A. a: 20 (0.79) dia. d: 8 (0.31) dia. b: 13 (0.51) dia. e: 10.7 (0.421) dia. c: 10.3 (0.406) dia. f: 5 (0.20) dia. Unit: mm (in)
EM03470000 (J8037) Piston ring compressor	Installing piston assembly into cylinder bore
ST16610001 (J23907) Pilot bushing puller	Removing crankshaft pilot bushing
WS39930000 (—) Tube presser	Pressing the tube of liquid gasket



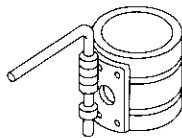
ZZA0023D



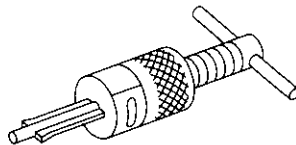
S-NT011



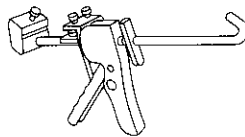
S-NT603



S-NT044

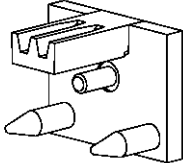
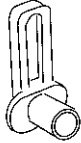


S-NT045



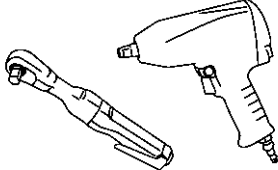
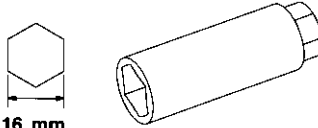
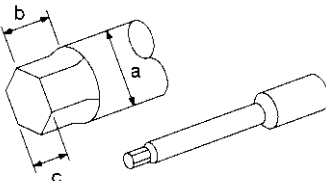
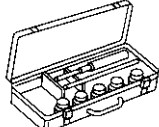
S-NT052

PREPARATION

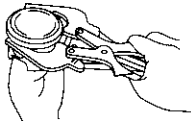
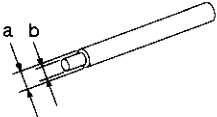
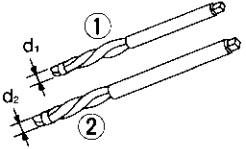
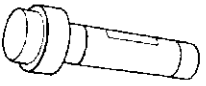
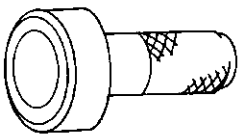
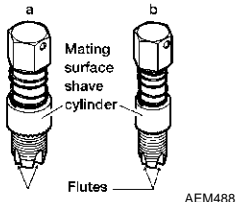

Tool number (Kent-Moore No.) Tool name		Description	
— (J- 45476) Ring gear stopper	 PBIC1655E	Removing and installing crankshaft pulley	A EM C
— (J-45488) Quick connector release	 PBIC0198E	Removing fuel tube quick connectors in engine room (Available in SEC. 164 of PARTS CATALOG: Part No. 16441 6N210)	D E

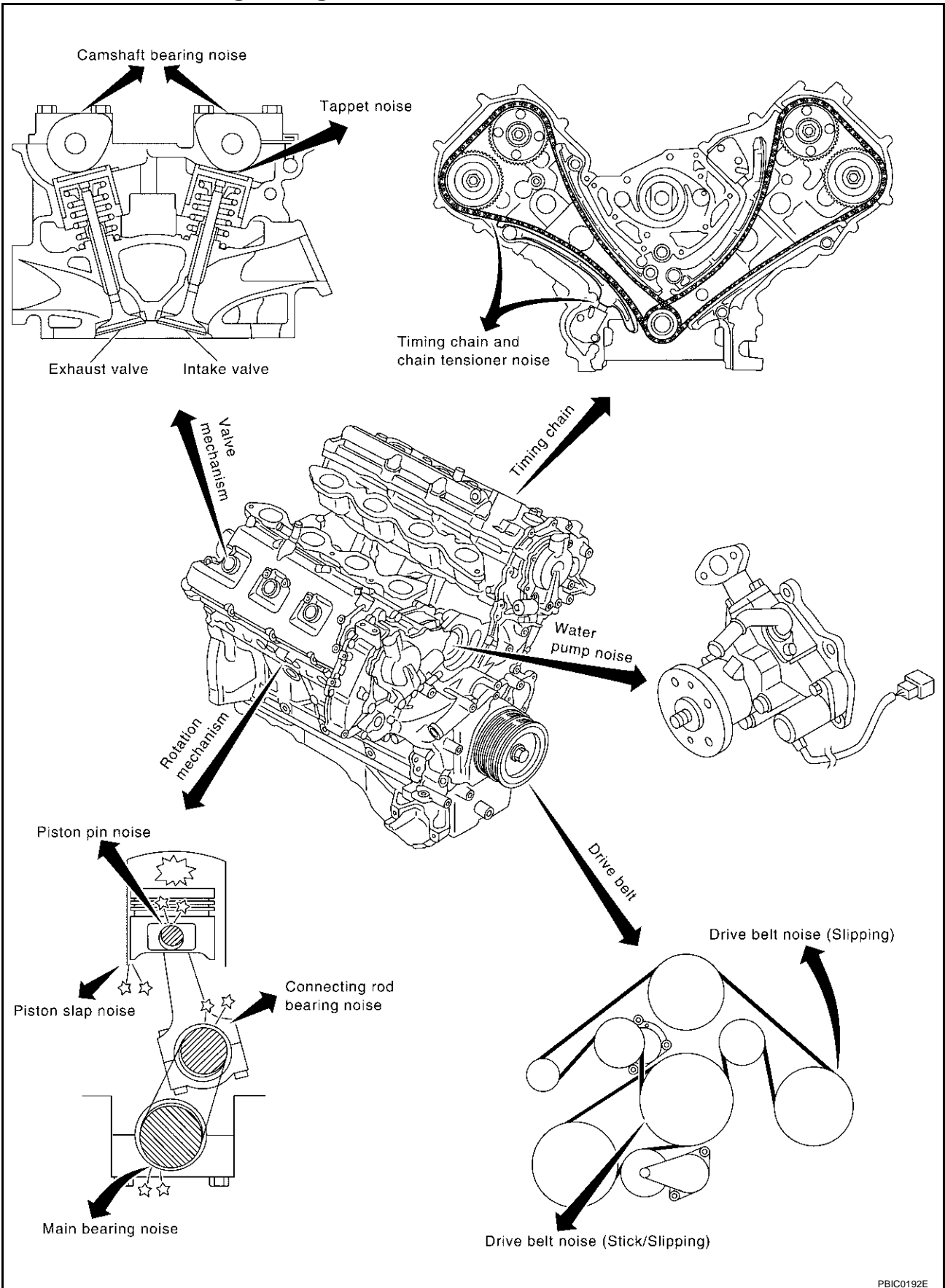
Commercial Service Tools

EBS001L6

(Kent-Moore No.) Tool name		Description	
Power tool	 PBIC0190E	Loosening bolts and nuts	G H I
Spark plug wrench	 16 mm (0.63 in) S-NT047	Removing and installing spark plug	J K
(J24239-01) Cylinder head bolt wrench	 NT583	Loosening and tightening cylinder head bolt, and used with angle wrench [SST: KV10112100 (BT8653-A)] a: 13 (0.51) dia. b: 12 (0.47) c: 10 (0.39) Unit: mm (in)	L M
Valve seat cutter set	 S-NT048	Finishing valve seat dimensions	

PREPARATION

(Kent-Moore No.) Tool name	Description
Piston ring expander  S-NT030	Removing and installing piston ring
Valve guide drift  S-NT015	Removing and installing valve guide Intake & Exhaust: a: 9.5 mm (0.374 in) dia. b: 5.5 mm (0.217 in) dia.
Valve guide reamer  S-NT016	1: Reaming valve guide inner hole 2: Reaming hole for oversize valve guide Intake & Exhaust: d1 : 6.0 mm (0.236 in) dia. d2 : 10.2 mm (0.402 in) dia.
Front oil seal drift  ZZA0012D	Installing front oil seal when front cover is removed
Rear oil seal drift  ZZA0025D	Installing rear oil seal
(J-43897-18) (J-43897-12) Oxygen sensor thread cleaner  AEM488	Reconditioning the exhaust system threads before installing a new heated oxygen sensor (Use with anti-seize lubricant shown below.) a: J-43897-18 (18 mm dia.) for zirconia heated oxygen sensor b: J-43897-12 (12 mm dia.) for titania heated oxygen sensor
Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907)  AEM489	Lubricating heated oxygen sensor thread cleaning tool when reconditioning exhaust system threads



NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

EBS002MH

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	EM-52
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-50 EM-49
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 oil clearance (Small end)	EM-88 EM-90
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston to cylinder bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-92 EM-89 EM-89 EM-90
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance (Small end) Connecting rod bearing (Big end)	EM-90 EM-90
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-95 EM-94
Front of engine Timing chain cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation	EM-39 EM-35
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	EM-12
	Creaking	A	B	A	B	A	B	Drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	CO-22

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

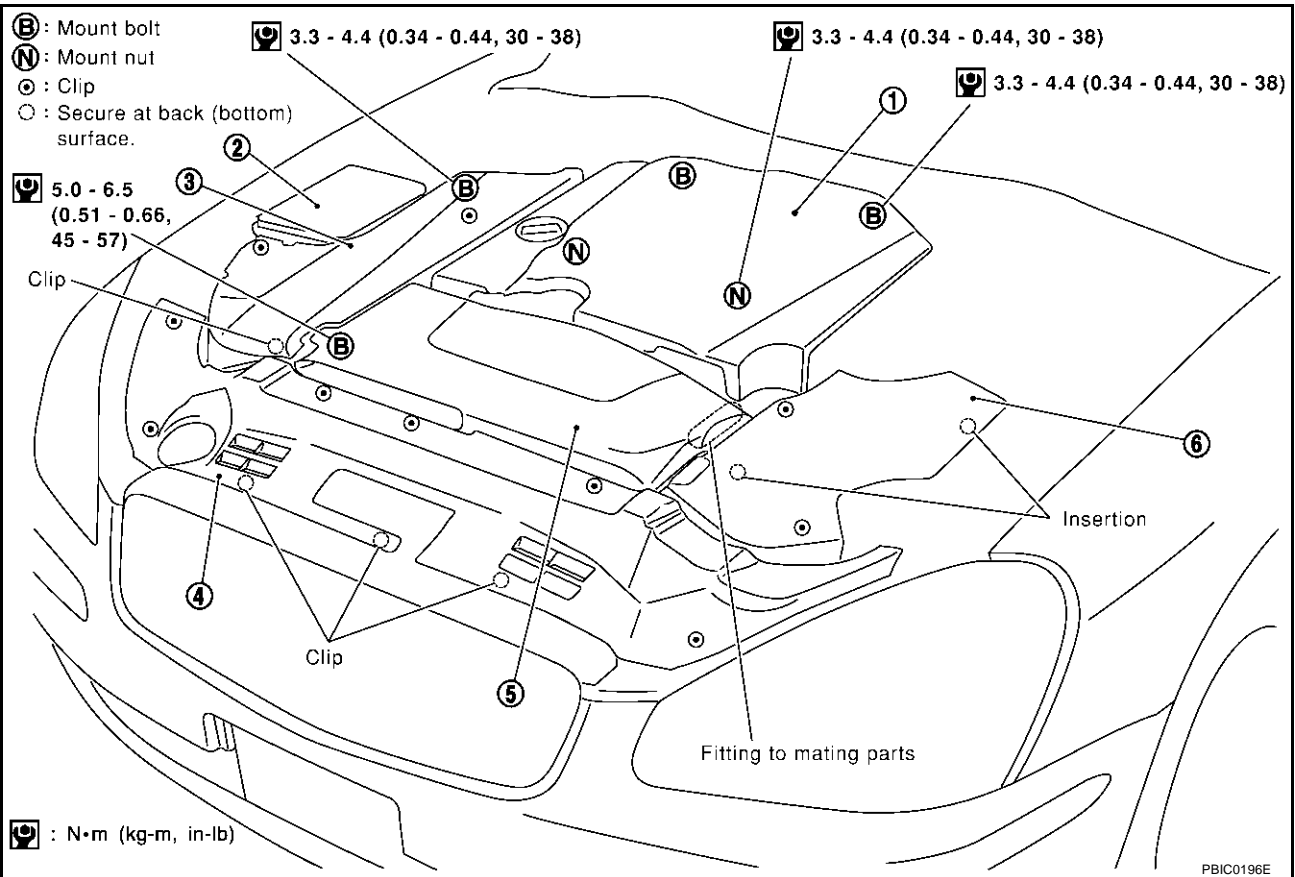
ENGINE ROOM COVER

PFP:14049

ENGINE ROOM COVER

Removal and Installation

EBS001ZC



- | | | |
|--------------------|---------------------|----------------------|
| 1. Engine cover | 2. Relay box | 3. Battery cover |
| 4. Front air guide | 5. Air duct (inlet) | 6. Air cleaner cover |

REMOVAL

- Remove clips on back with clip driver.

CAUTION:

Do not damage or scratch cover when installing or removing.

- Major parts and inspection points under each cover are as follows; (numbered as in illustration)
 - Upper side of engine assembly, power steering reservoir tank, cooling fan reservoir tank
 - Relay
 - Battery, relay box
 - Cooling fan fluid cooler, power steering fluid cooling tube
 - Engine assembly front side, drive belts, cooling fan
 - Mass air flow sensor, air cleaner case

INSTALLATION

Install in the reverse order of removal.

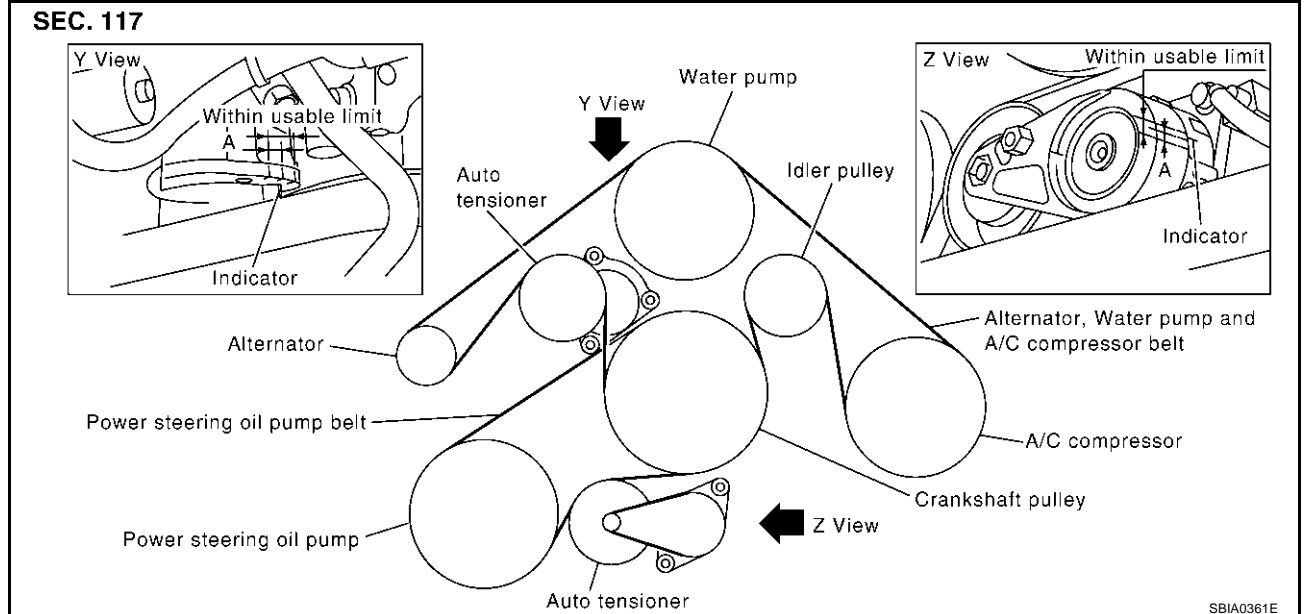
DRIVE BELTS

DRIVE BELTS

PFP:02117

Checking Drive Belts

EBS001JT



WARNING:

Be sure to perform when the engine is stopped.

- Remove air duct (inlet) when inspecting drive belt for alternator, water pump and A/C compressor.
- Remove engine undercover (with power tool) when inspecting power steering oil pump belt.
- Make sure that indicator (single line notch) of each auto tensioner is within the allowable working range (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 A.
- The indicator notch is located on the moving side of the auto tensioner for alternator, water pump and A/C compressor belt, while it is found on the fixed side for power steering oil pump belt.
- Visually check entire belt for wear, damage or cracks.
- If the indicator is out of allowable working range or belt is damaged, replace the belt.

Tension Adjustment

EBS002MI

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

DRIVE BELTS

EBS002MJ

Removal and Installation

REMOVAL

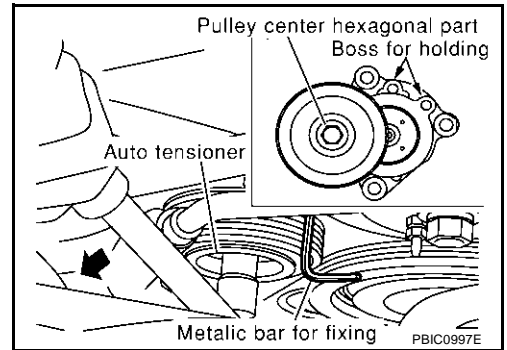
Alternator, Water Pump and A/C Compressor Belt

1. Remove air duct (inlet).
2. With box wrench, and while securely holding the hexagonal part in pulley center of auto tensioner, move the wrench handle in the direction of arrow (loosening direction of tensioner).

CAUTION:

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

3. Under the above condition, insert a metal bar of approximately 6 mm (0.24 in) in diameter (hexagonal bar wrench shown as example in the figure) through the holding boss to lock auto tensioner pulley arm.
 - Leave auto tensioner pulley arm locked until belt is installed again.
4. Remove alternator, water pump and A/C compressor belt.



Power Steering Oil Pump Belt

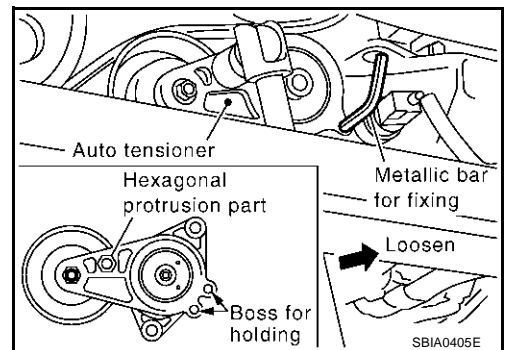
1. Remove air duct (inlet) and engine undercover (with power tool).
2. Remove alternator, water pump and A/C compressor belt. Refer to [EM-13. "Alternator, Water Pump and A/C Compressor Belt"](#).

3. While securely holding the hexagonal protrusion part of auto tensioner pulley center with box wrench, move the wrench handle in the direction of arrow (loosening direction of tensioner).

CAUTION:

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

4. Under the above condition, insert a metal bar of approximately 6 mm (0.24 in) in diameter (hexagonal bar wrench shown as example in the figure) through the holding boss to lock auto tensioner pulley arm.
 - Leave auto tensioner pulley arm locked until belt is installed again.
5. Remove power steering oil pump belt.



INSTALLATION

Power Steering Oil Pump Belt

Install in the reverse order of removal paying attention to the following.

CAUTION:

Make sure belt is securely installed around all pulleys.

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

Alternator, Water Pump and A/C Compressor Belt

Install in the reverse order of removal paying attention to the following.

CAUTION:

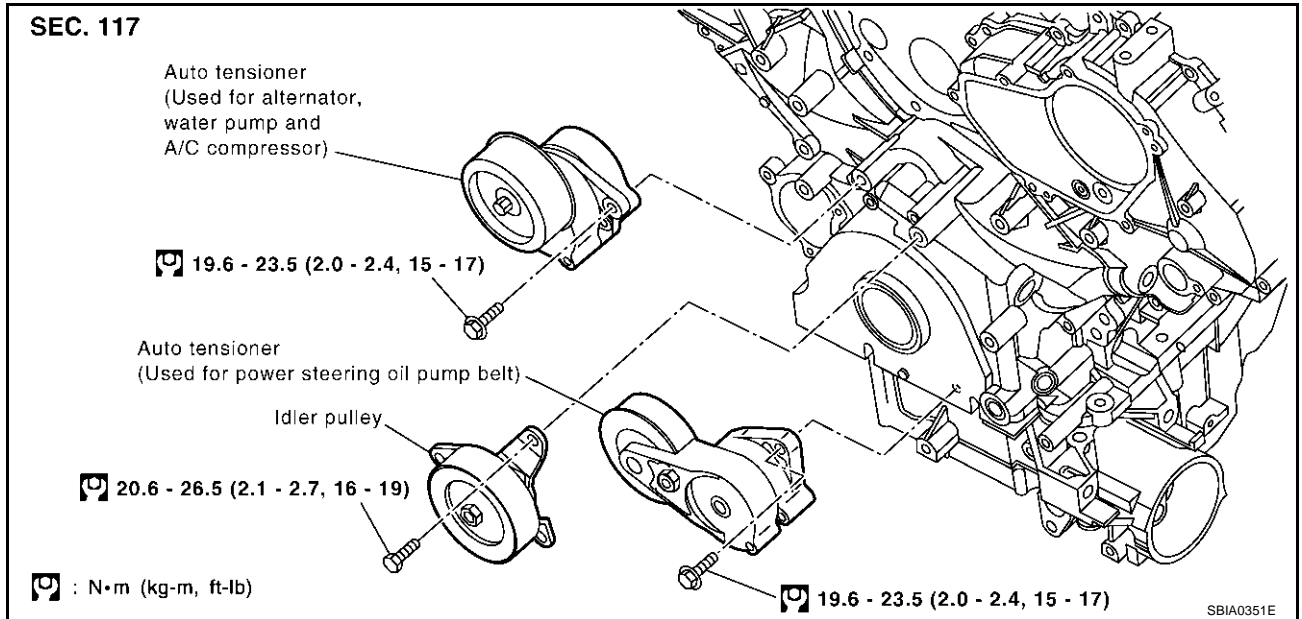
Confirm belts are completely set to pulleys.

- Release auto tensioner, and apply auto tensions to belt.
- Turn crankshaft pulley clockwise several times to equalize tension between each pulley.
- Confirm tensions of belt at indicator is within the allowable working range. Refer to [EM-12. "Checking Drive Belts"](#).

DRIVE BELTS

Drive Belt Auto Tensioner and Idler Pulley

EBS002MK



REMOVAL

1. Remove air duct (inlet) and engine undercover (with power tool).
2. Remove drive belts. Refer to [EM-13, "Removal and Installation"](#).
 - Keep auto tensioner pulley arm locked after belt is removed.
3. Remove auto tensioner and idler pulley with power tool.
 - Keep auto tensioner pulley arm locked to install or remove auto tensioner.

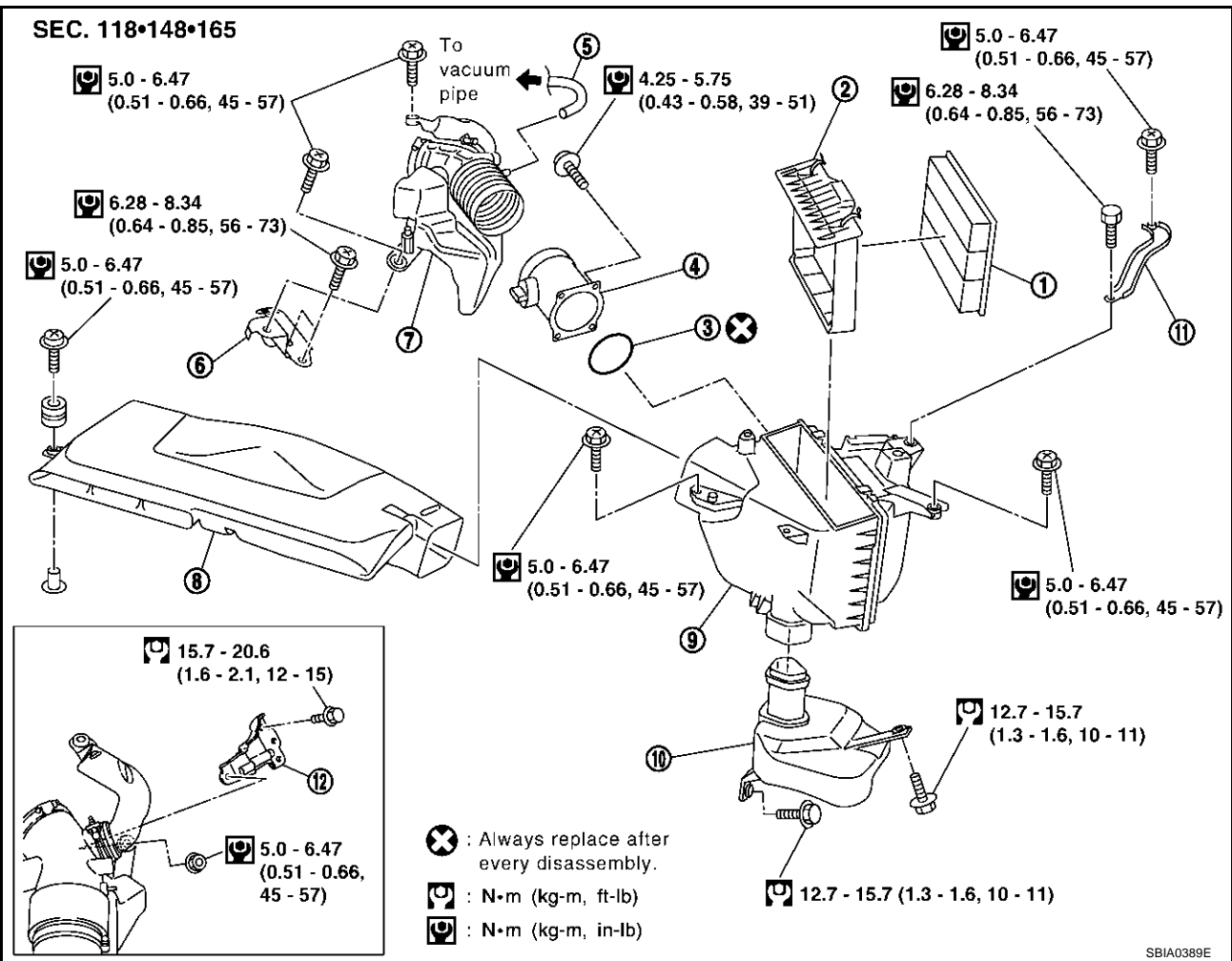
INSTALLATION

Install in the reverse order of removal.

AIR CLEANER AND AIR DUCT

Removal and Installation

EBS001JW



- | | | |
|-------------------------|---------------------|---------------------|
| 1. Air cleaner filter | 2. Holder | 3. O-ring |
| 4. Mass air flow sensor | 5. Vacuum hose | 6. Bracket |
| 7. Air duct | 8. Air duct (inlet) | 9. Air cleaner case |
| 10. Resonator | 11. Bracket | 12. Bracket |

REMOVAL

1. Remove engine cover and air cleaner cover. Refer to [EM-11, "Removal and Installation"](#).
2. Remove harness connector from mass air flow sensor.
3. Remove air duct (inlet), air cleaner case/mass air flow sensor assembly and air duct/resonator assembly disconnecting their joints.

- Add marks as necessary for easier installation.

4. Remove mass air flow sensor from air cleaner case.

CAUTION:

Handle mass air flow sensor with following cares.

- Do not shock it.
- Do not disassemble it.
- Do not touch its sensor.

5. Remove resonator in fender lifting left fender protector.

INSTALLATION

Installation in the reverse order of removal paying attention to the following.

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

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AIR CLEANER AND AIR DUCT

CHANGING AIR CLEANER FILTER

1. Remove air cleaner cover.
Refer to [EM-11, "Removal and Installation"](#) .
2. Remove two clips and lift up air cleaner filter along with holder.
3. Remove air cleaner filter from holder.

INTAKE MANIFOLD

PFP:14003

A

INTAKE MANIFOLD

Removal and Installation

EBS001L9

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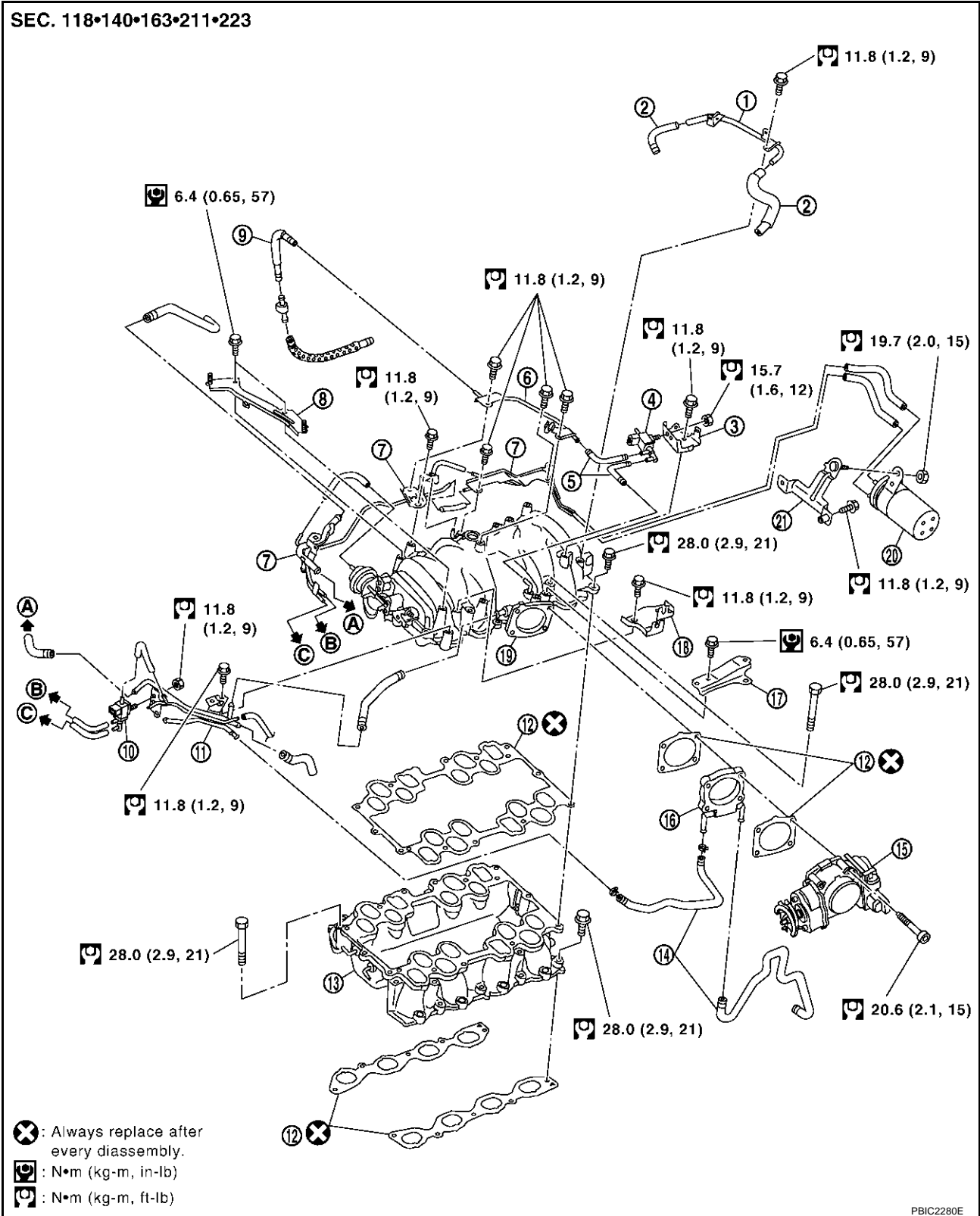
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- | | | |
|---|-------------------------------|---|
| 1. PCV tube | 2. PCV hose | 3. EVAP canister purge control solenoid valve bracket |
| 4. EVAP canister purge control solenoid valve | 5. EVAP hose | 6. EVAP tube |
| 7. Vacuum gallery | 8. Engine cover front bracket | 9. EVAP hose |

INTAKE MANIFOLD

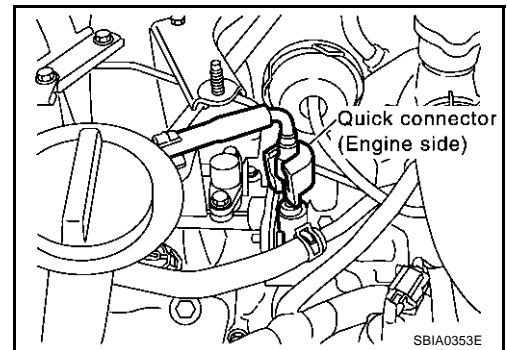
- | | | |
|---------------------------------|-------------------------------|--|
| 10. VIAS control solenoid valve | 11. Water gallery | 12. Gasket |
| 13. Intake manifold lower | 14. Water hose | 15. Electric throttle control actuator |
| 16. Intake manifold adapter | 17. Engine cover rear bracket | 18. Accelerator wire bracket |
| 19. Intake manifold upper | 20. Vacuum tank | 21. Vacuum tank bracket |

REMOVAL

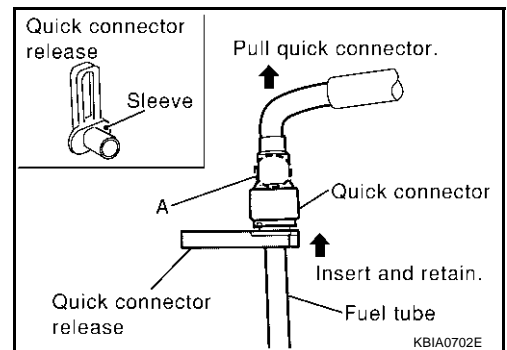
WARNING:

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

1. Remove engine cover (with power tool), air cleaner cover and battery cover. Refer to [EM-11, "Removal and Installation"](#).
2. Release fuel pressure. Refer to [EC-48, "FUEL PRESSURE RELEASE"](#).
3. Remove air cleaner case and air duct assembly. Refer to [EM-15, "Removal and Installation"](#).
4. Drain engine coolant when engine is cooled. Refer to [CO-9, "Changing Engine Coolant"](#).
5. Disconnect fuel tube quick connector on engine side only.



- Using tool of quick connector release [SST:J-45488], perform the following steps to disconnect quick connector.



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

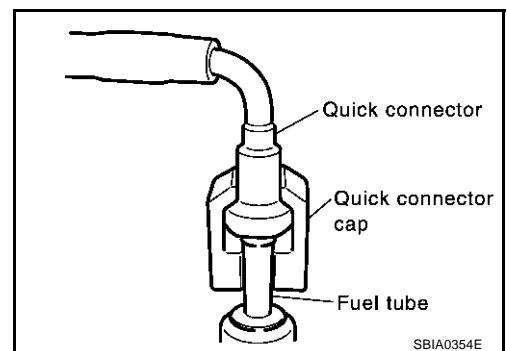
CAUTION:

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

- d. 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.



INTAKE MANIFOLD

6. Move cooling fan fluid reservoir tank.
7. Remove or disconnect intake manifold upper, wiring harnesses, brackets, vacuum hose, vacuum gallery and PCV hose and tube.

CAUTION:

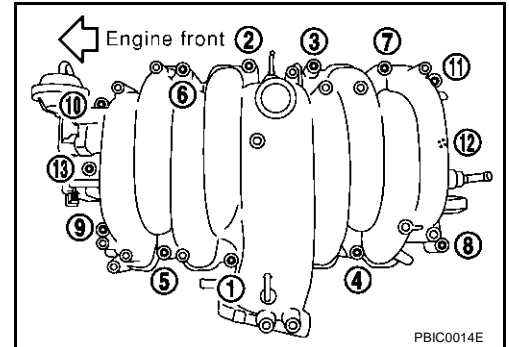
Cover engine openings to avoid entry of foreign materials.

8. Disconnect water hoses.
9. Remove electric throttle control actuator loosening fixing bolts diagonally.

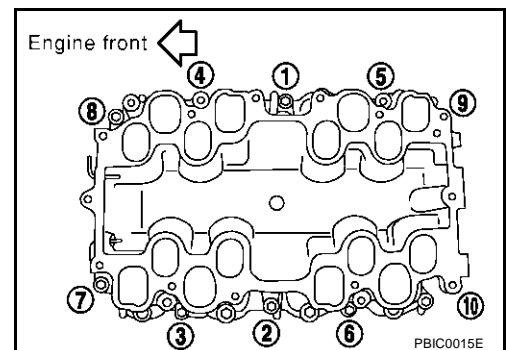
CAUTION:

Handle carefully to avoid any shock.

10. Loosen bolts in reverse order of illustration to remove intake manifold upper assembly with power tool.



11. Loosen bolts in reverse order of illustration to remove intake manifold lower assembly with power tool.

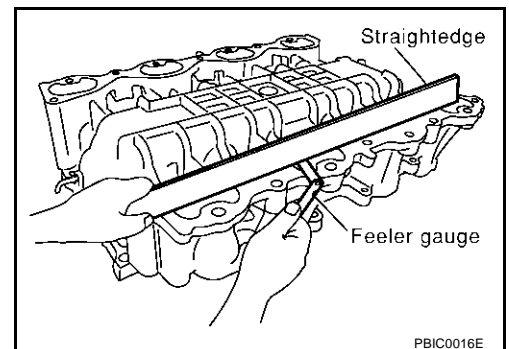


INSPECTION AFTER REMOVAL

Surface Distortion

Using straightedge and feeler gauge, inspect surface distortion of intake manifold lower and intake manifold upper.

Limit : 0.1 mm (0.004 in)



INSTALLATION

Install in the reverse order of removal paying attention to the following.

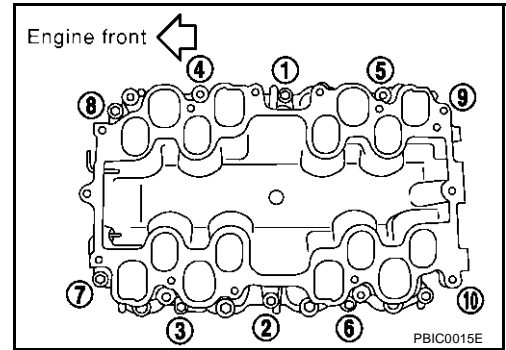
INTAKE MANIFOLD

Tightening Intake Manifold Lower Bolts

Tighten in numerical order as shown in the figure.

NOTE:

No.7 and 8 have longer bolt length than others.

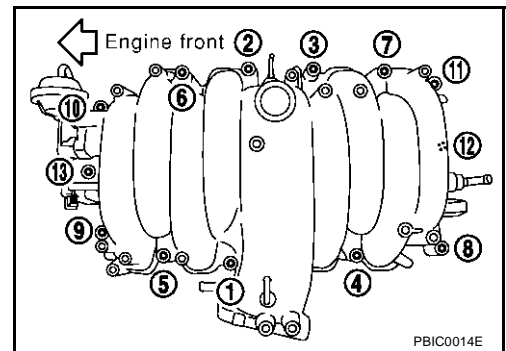


Tightening Intake Manifold Upper Bolts

Tighten in numerical order as shown in the figure.

NOTE:

No.1 to 4 have longer bolt length than others.



Installation of Electric Throttle Control Actuator

- Install intake manifold adapter gasket and electric throttle control actuator gasket so that three protrusions for installation identification do not face downward.
- Tighten fixing bolts of electric throttle control actuator equally and diagonally in several steps.
- After installation perform procedure in [EM-21, "INSPECTION AFTER INSTALLATION"](#).

Connecting Water Hose

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 Vacuum Hose

Refer to [EC-24, "Vacuum Hose Drawing"](#).

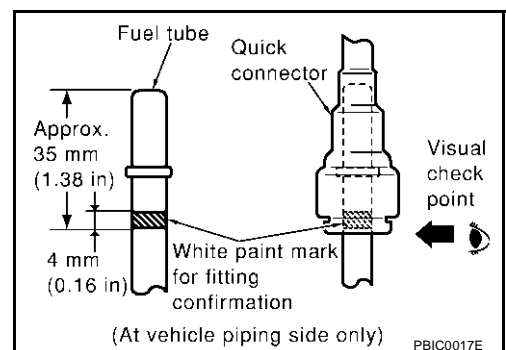
Connecting Quick Connector of Fuel Tube

Install quick connector as follows on engine side only.

1. Make sure no foreign substances are deposited in and around tube and quick connector, and no damage on 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 straightly into fuel tube.
 - Insert fuel tube into quick connector until edge side spool is completely inside quick connector, and 2nd spool exposes right below quick connector.

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.



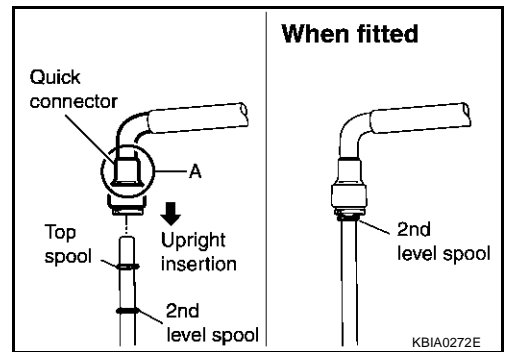
INTAKE MANIFOLD

- To avoid misidentification of engagement with a similar sound, be sure to perform the next step.

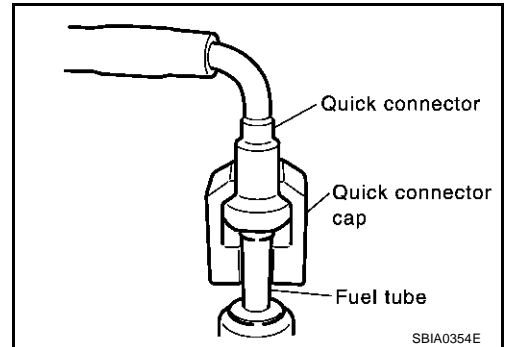
4. Pull quick connector by hand holding A position. Make sure it is completely engaged (connected) so that it does not come out from fuel tube.

NOTE:

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



5. Install quick connector cap on quick connector joint (on engine side only).
6. Install fuel hose and fuel tube to hose clamps.



INSPECTION AFTER INSTALLATION

- After installing fuel tubes, make sure there is no fuel leakage at connections in the following steps.
 - a) Apply fuel pressure to fuel lines with turning ignition switch ON (with engine stopped). Then check for fuel leaks at connections.
 - b) 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-46, "Throttle Valve Closed Position Learning"](#) .
- If electric throttle control actuator is replaced, perform procedures for "Idle Air Volume Learning" after finishing repairs. Refer to [EC-46, "Idle Air Volume Learning"](#) .

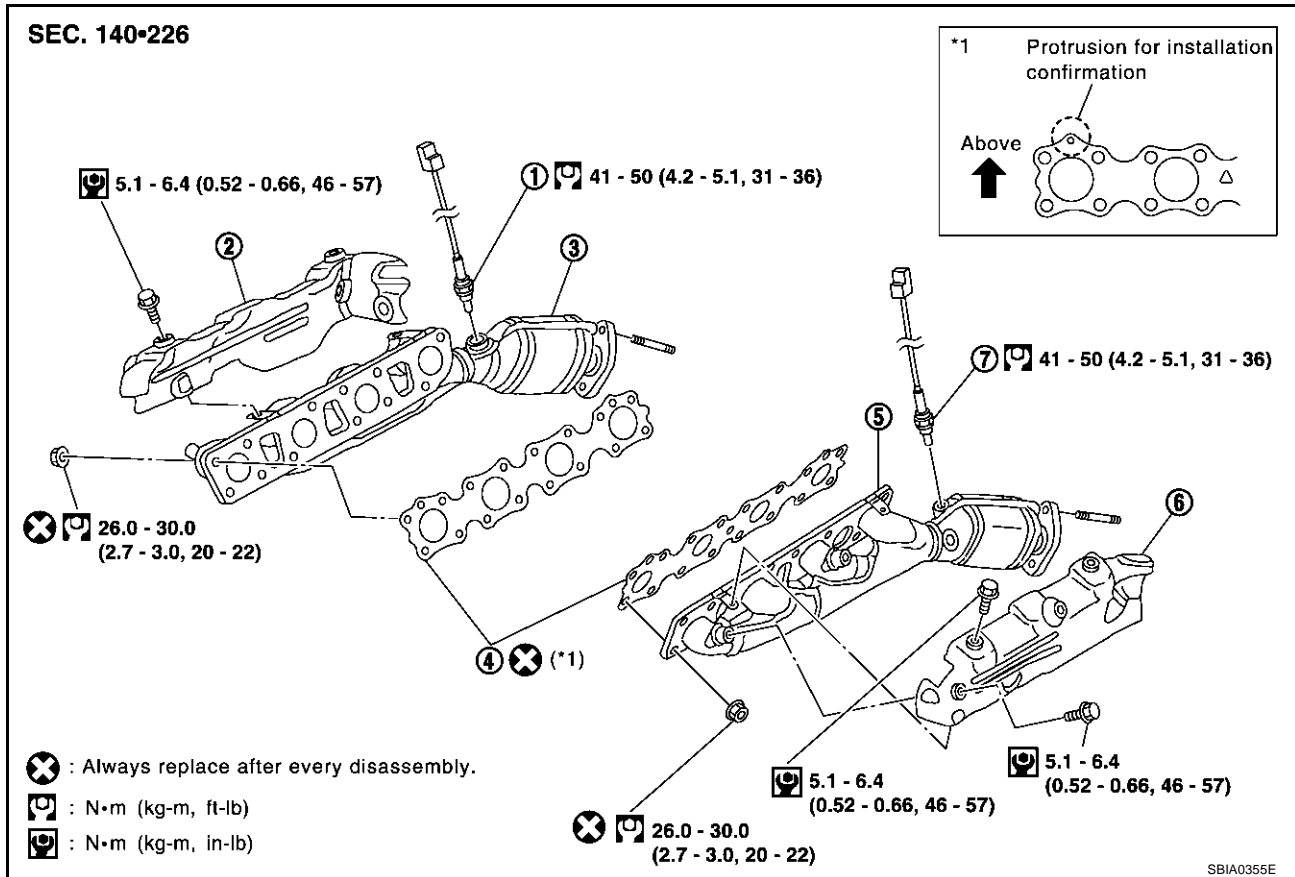
EXHAUST MANIFOLD AND THREE WAY CATALYST

EXHAUST MANIFOLD AND THREE WAY CATALYST

PFP:14004

Removal and Installation

EBS00NBE



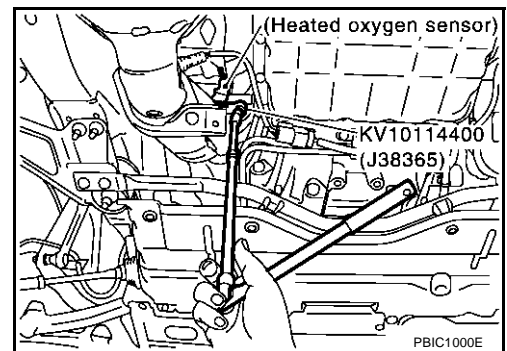
1. Heated oxygen sensor 1 (bank 2)
2. Exhaust manifold cover (right bank)
3. Exhaust manifold and three way catalyst (right bank)
4. Gasket
5. Exhaust manifold and three way catalyst (left bank)
6. Exhaust manifold cover (left bank)
7. Heated oxygen sensor 1 (bank1)

REMOVAL

1. Remove heated oxygen sensors.
 - Follow below steps to remove each heated oxygen sensor.
 - a. Remove engine undercover and engine cover with power tool.
 - b. Remove harness connector of each heated oxygen sensor, and harness from bracket and middle clamp.
 - c. Using heated oxygen sensor wrench, remove both left and right heated oxygen sensors.

CAUTION:

- Be careful not to damage heated oxygen sensor.
 - Discard any heated oxygen sensor which has been dropped from a height of more than 0.5 m (19.7 in) onto a hard surface such as a concrete floor; use a new one.
2. Remove exhaust manifold and three way catalyst (left bank) in below steps.
 - a. Remove A/C compressor with power tool and put aside with piping connected. Refer to [ATC-144, "Compressor"](#).
 - b. Remove exhaust front tube with power tool. Refer to [EX-3, "Removal and Installation"](#).
 - c. Remove steering lower joint to enable steering shaft to move freely.
 - d. Support and lift up bottom of engine with transmission jack. Remove left engine mount insulator along with left engine mount brackets.



EXHAUST MANIFOLD AND THREE WAY CATALYST

- e. Remove exhaust manifold cover.
- f. Loosen nuts in reverse order of illustration to remove exhaust manifold and three way catalyst.

CAUTION:
Disregard the numerical order No.9 to 12 in removal.

3. Remove exhaust manifold and three way catalyst (right bank) loosening nuts in reverse order in the figure.

a. Remove drive belt and alternator with power tool. Refer to [SC-19, "Removal and Installation"](#) .

b. Remove exhaust front tube with power tool. Refer to [EX-3, "Removal and Installation"](#) .

c. Remove nuts on bottom of right engine mounting insulator, and lift up right side of engine approximately 3 cm (1.18 in) with transmission jack.

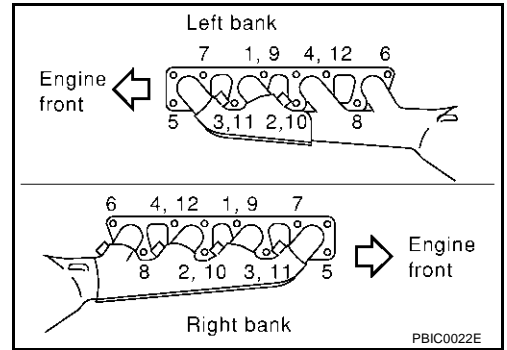
d. Remove starter motor with power tool. Refer to [SC-28, "Removal and Installation"](#) .

e. Support and lift up bottom of engine with transmission jack. Remove right engine mount insulator along with right engine mount brackets.

f. Remove exhaust manifold cover.

g. Loosen nuts in reverse order of illustration to remove exhaust manifold and three way catalyst with power tool.

CAUTION:
Disregard the numerical order No.9 to 12 in removal.

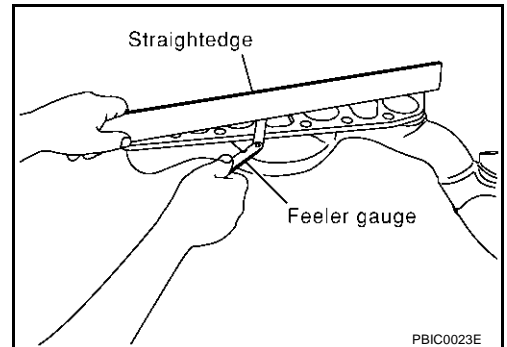


INSPECTION AFTER REMOVAL

Surface Distortion

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

Limit : 0.3mm (0.012in)



INSTALLATION

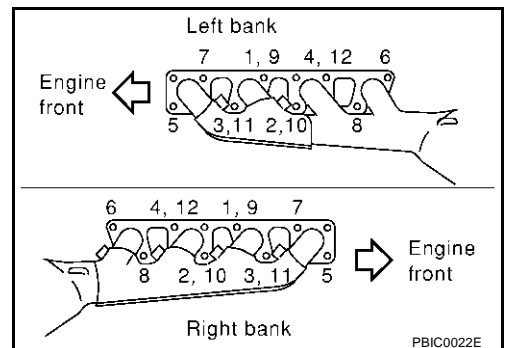
Install in the reverse order of removal paying attention to the following.

Exhaust Manifold Gasket

Install exhaust manifold gasket with its directional protrusion set upward. Refer to illustration of components on former page.

Tightening Exhaust Manifold Nuts

- Install exhaust manifold and three way catalyst in the numerical order shown in the figure.
- Tighten nuts No.1 to No.4 in two steps. Order No.9 to 12 shows second step.



EXHAUST MANIFOLD AND THREE WAY CATALYST

Installation of Heated Oxygen Sensor

CAUTION:

- When using heated oxygen sensor wrench (KV10114400), tighten to the middle of specified torque because length of tool may induce slight indication increase. (Do not tighten to the maximum specified torque)
- Before installing a new heated oxygen sensor, clean exhaust system threads using oxygen sensor thread cleaner tool, J-43897-18 or J-43897-12, and apply anti-seize lubricant.
- Do not over torque the heated oxygen sensor. Doing so may cause damage to the heated oxygen sensor, resulting in the MIL coming on.

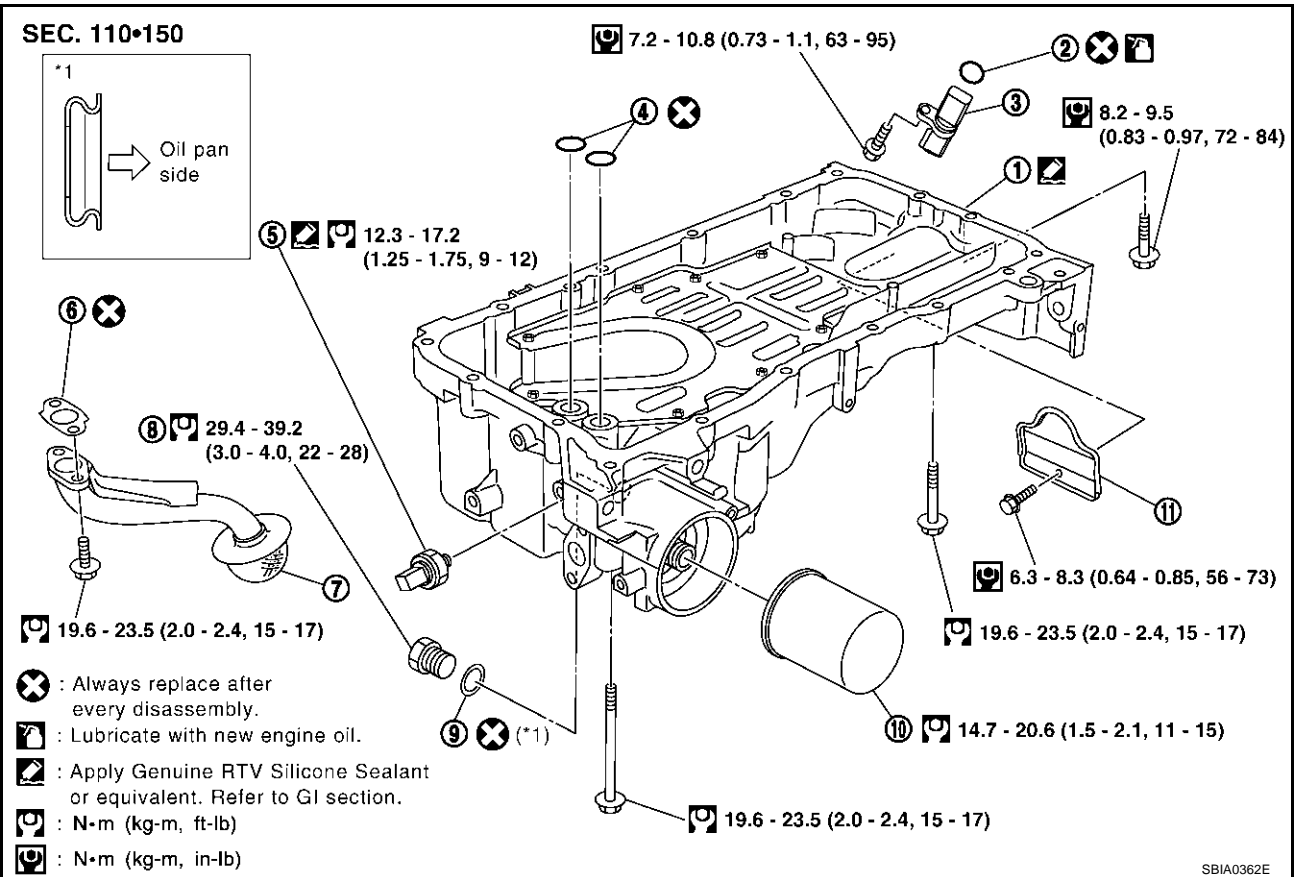
OIL PAN AND OIL STRAINER

OIL PAN AND OIL STRAINER

PPF:11110

Removal and Installation

EBS001LC



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|-----------------|------------------------|-------------------------------------|
| 1. Oil pan | 2. O-ring | 3. Crankshaft position sensor (POS) |
| 4. O-ring | 5. Oil pressure switch | 6. Gasket |
| 7. Oil strainer | 8. Drain plug | 9. Washer |
| 10. Oil filter | 11. Rear plate cover | |

REMOVAL

WARNING:

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

- Remove front tire.
- Remove hood assembly. Refer to [BL-15, "Removal and Installation of Hood Assembly"](#).
- Remove engine undercover and engine cover with power tool.
- Drain engine oil. Refer to [LU-7, "Changing Engine Oil"](#).
- Remove drive belts. Refer to [EM-13, "Removal and Installation"](#).
- Remove auto tensioner of power steering oil pump belt. Refer to [EM-14, "Drive Belt Auto Tensioner and Idler Pulley"](#).
- Move power steering oil pump and remove power steering oil pump bracket.
- Remove oil filter. Refer to [LU-8, "Removal and Installation"](#).
- Remove A/C compressor fitting bolts, and install A/C compressor temporarily on vehicle side with ropes or equivalent.
- Disconnect harness and wires of lower side of oil pan from oil pan.
- Remove crankshaft position sensor (POS) from transmission.

CAUTION:

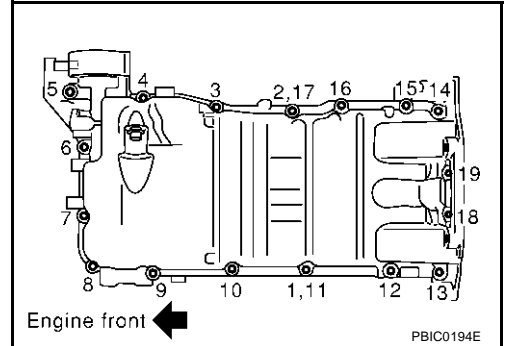
- Do not drop or shock it.
- Do not disassemble it.

OIL PAN AND OIL STRAINER

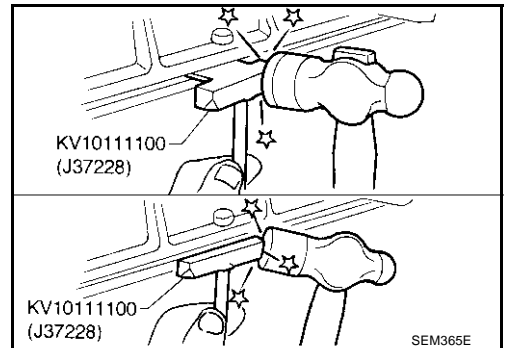
- Do not let steel powders contact magnetic parts of sensor tips.
 - Do not leave where magnetically effected.
12. Install engine slinger and hang engine assembly to secure position. Refer to [EM-70, "Removal and Installation"](#).
 13. Remove front suspension member. Refer to [FSU-15, "FRONT SUSPENSION MEMBER"](#).
 14. Remove oil pan in the order shown below.
 - a. Remove rear plate cover.
 - b. Remove transmission joint bolts (M12: 4 bolts) which pierce oil pan.
 - c. Loosen oil pan bolts with power tool in reverse order of illustration to remove.

NOTE:

Exclude No.11 and No.17 in removal.



- d. Insert seal cutter between oil pan and cylinder block. Slide seal cutter by tapping on side of the seal cutter with a hammer. Remove oil pan.
15. Remove oil strainer.

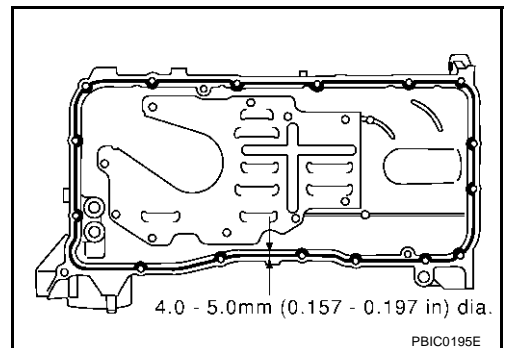


INSPECTION AFTER REMOVAL

Clean oil strainer if any object attached.

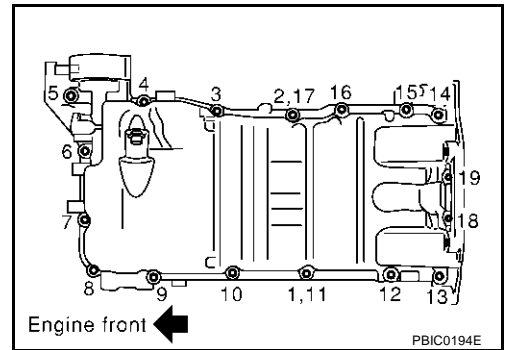
INSTALLATION

1. Install oil strainer.
2. Install oil pan in the order below.
 - a. Apply liquid gasket thoroughly as in illustration. **Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-46, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**
 - b. Install new O-ring to oil pump and timing chain case side.



OIL PAN AND OIL STRAINER

- c. Tighten bolts in numerical order as shown.
- No.11 and 17 indicate double tightening of bolts 1 and 2.
- NOTE:**
Refer to the below for locating bolts.
- d. M6 × 30 mm (1.18 in): No.18, 19
M8 × 100 mm (3.97 in): No.5, 9
M8 × 45 mm (1.77 in): Except the above
- e. Tighten transmission joint bolts. Refer to [AT-297, "TRANSMISSION ASSEMBLY"](#).
- f. Install rear plate cover.
3. Install oil pan drain plug. Refer to illustration of components of former page for installation direction of washer.
4. Install in the reverse order of removal after this step.
- Pour engine oil at least 30 minutes after oil pan is installed.



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INSPECTION AFTER INSTALLATION

- Check engine oil level. Refer to [LU-6, "ENGINE OIL LEVEL"](#).
- Check for leakage of engine oil when engine is warmed.

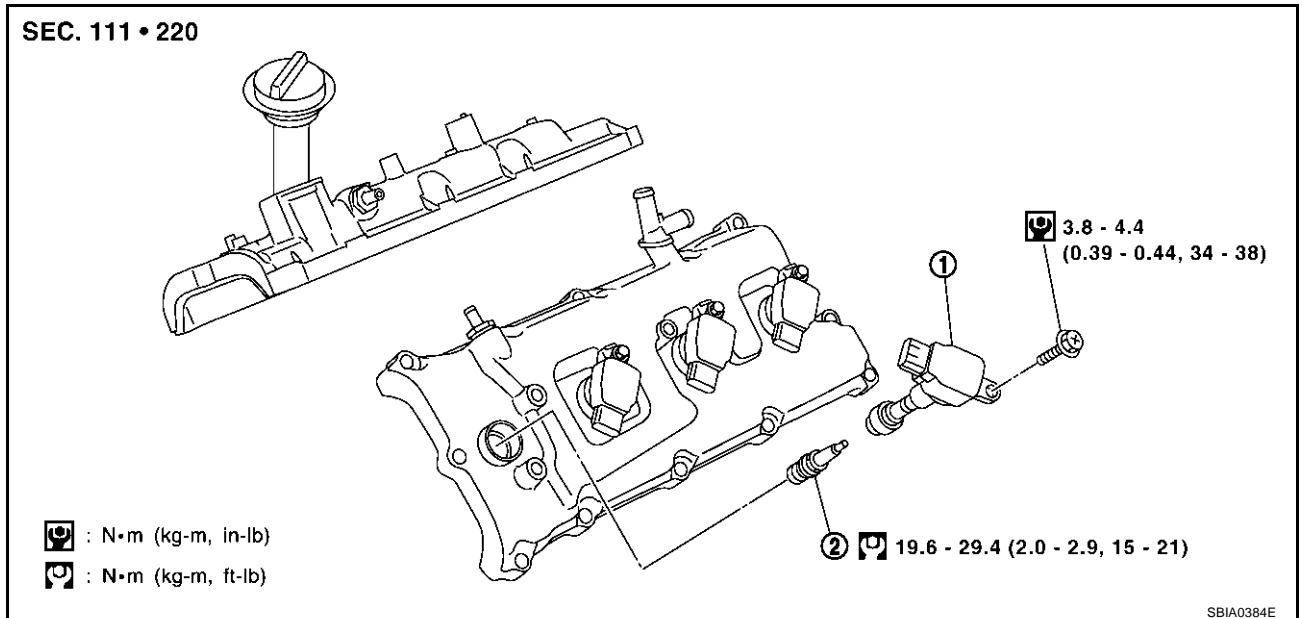
IGNITION COIL

IGNITION COIL

PFP:22448

Removal and Installation

EBS001LD



1. Ignition coil

2. Spark plug

REMOVAL

1. Remove engine cover (with power tool), air cleaner cover and battery cover. Refer to [EM-11, "Removal and Installation"](#).
2. Move heater hose and its peripheral parts aside. (No.7 cylinder)
3. Disconnect harness connector from ignition coil.
4. Remove ignition coil.

CAUTION:

Do not shock it.

INSTALLATION

Install in the reverse order of removal.

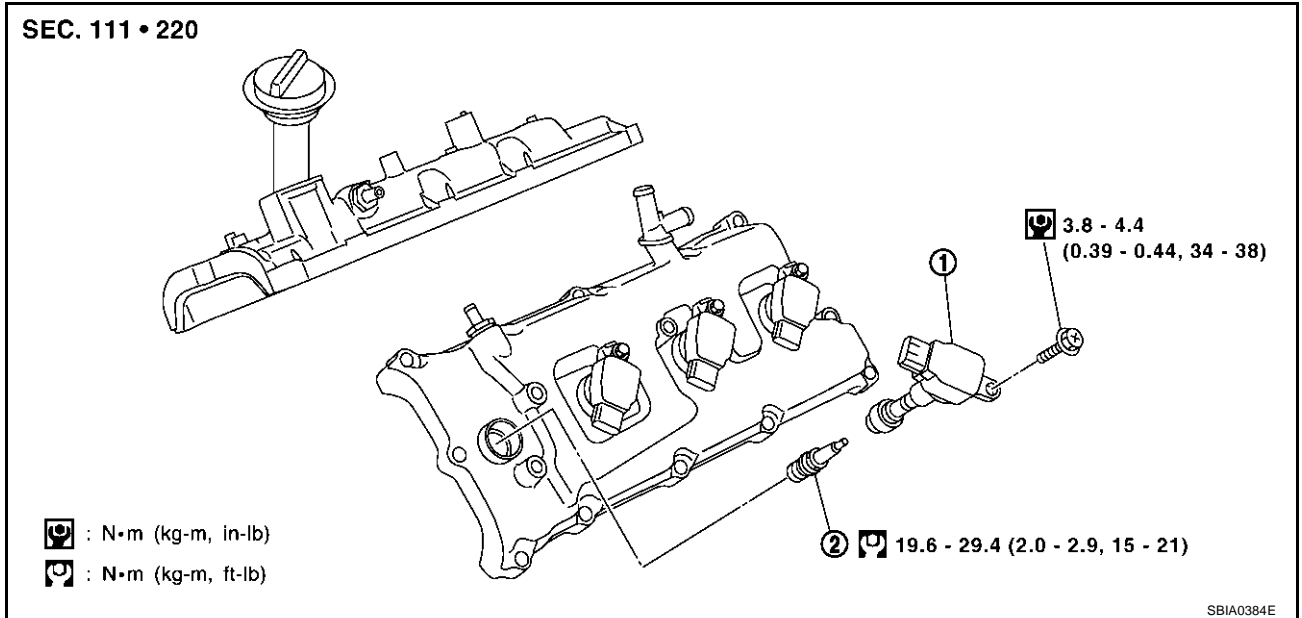
SPARK PLUG (PLATINUM-TIPPED TYPE)

PFP:22401

SPARK PLUG (PLATINUM-TIPPED TYPE)

Removal and Installation

EBS001LE

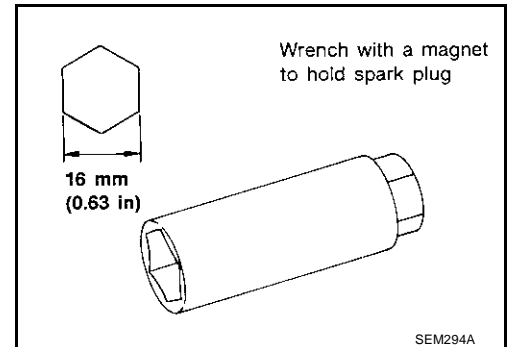


1. Ignition coil

2. Spark plug

REMOVAL

1. Remove engine cover with power tool. Refer to [EM-11, "ENGINE ROOM COVER"](#).
2. Remove ignition coil. Refer to [EM-28, "IGNITION COIL"](#).
3. Remove spark plug with spark plug wrench (commercial service tool).



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

Spark plug (Platinum-tipped type):

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

Gap (Nominal) : 1.1 mm (0.043 in)

SPARK PLUG (PLATINUM-TIPPED TYPE)

CAUTION:

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

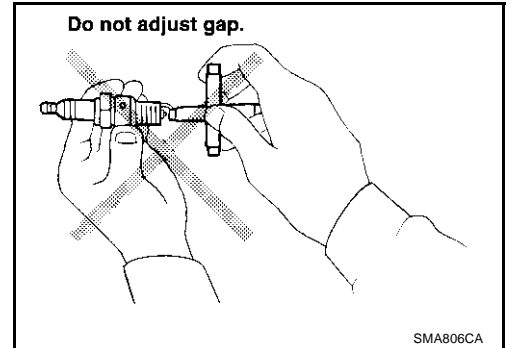
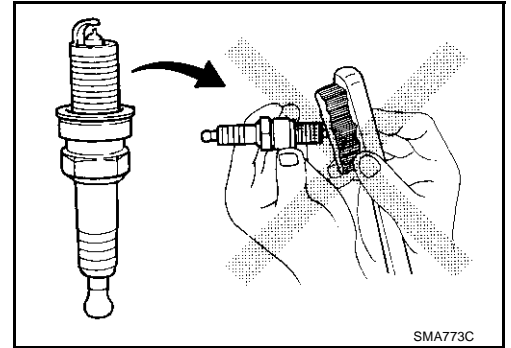
Cleaner air pressure:

Less than 588 kPa (6 kg/cm² , 85 psi)

Cleaning time:

Less than 20 seconds

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



INSTALLATION

Install in the reverse order of removal.

Spark plug:

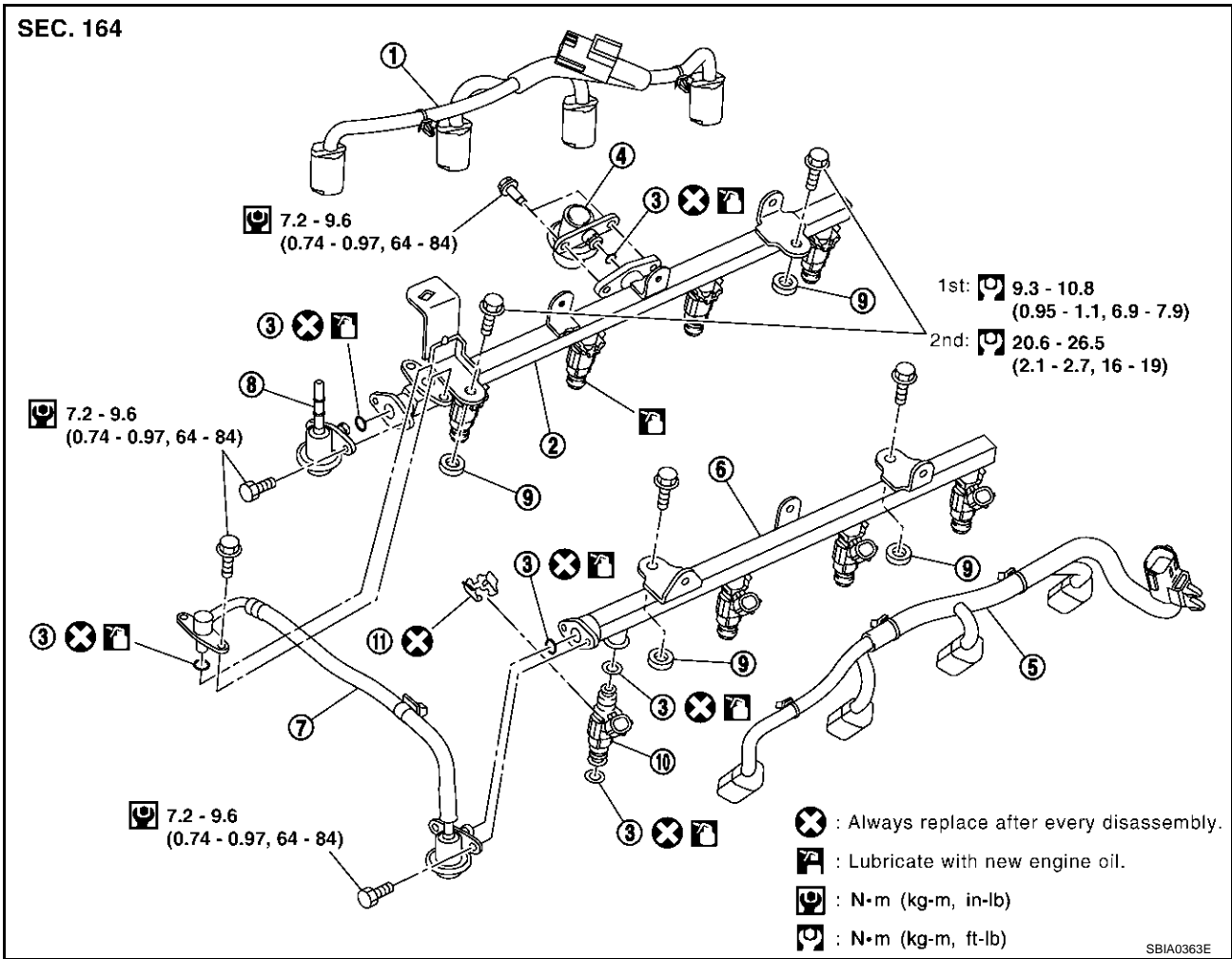
 : 19.6 - 29.4 N·m (2.0 - 2.9 kg-m, 15 - 21 ft-lb)

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FUEL INJECTOR AND FUEL TUBE

Removal and Installation

EBS001LF



- | | | |
|------------------------------------|-----------------------------------|----------------------------|
| 1. Fuel injector sub harness (RH) | 2. Fuel tube assembly (RH) | 3. O-ring |
| 4. Fuel damper assembly (RH) | 5. Fuel injector sub harness (LH) | 6. Fuel tube assembly (LH) |
| 7. Fuel damper assembly, with hose | 8. Fuel feed damper assembly | 9. Insulator |
| 10. Fuel injector | 11. Clip | |

CAUTION:

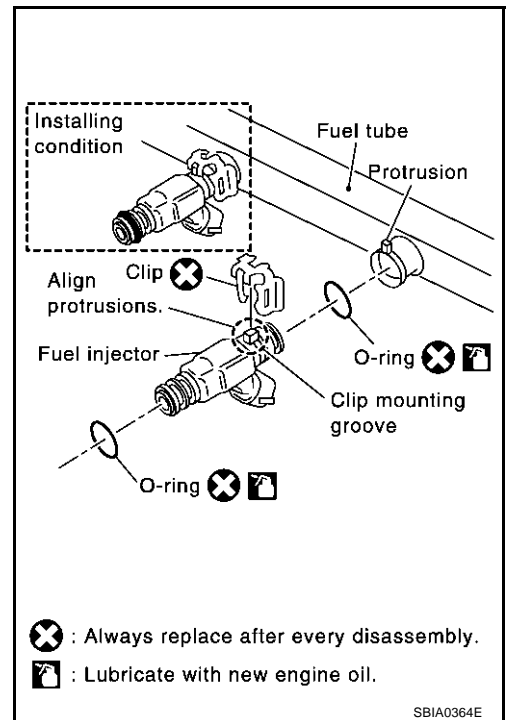
- Apply new engine oil when installing the parts that specified to do so in the figure.
- Do not remove or disassemble parts unless instructed as shown in the figure.

REMOVAL

1. Release fuel pressure. Refer to [EC-48, "FUEL PRESSURE RELEASE"](#) .
2. Remove intake manifold upper with power tool. Refer to [EM-17, "Removal and Installation"](#) .
3. Disconnect fuel injector sub harness connectors.
4. Disconnect fuel damper assembly with hose from fuel tube RH and LH.
5. Remove fuel injectors with fuel tube assembly.

FUEL INJECTOR AND FUEL TUBE

6. Expand and remove clips securing fuel injectors.
7. Extract fuel injectors straight from fuel tubes.
 - **Be careful not to damage injector nozzles during removal.**
 - **Do not bump or drop fuel injectors.**



INSTALLATION

1. Carefully install O-rings, including the one used the fuel damper.
 - **Lubricate O-rings by smearing new engine oil.**
 - **Be careful not to damage O-rings and surfaces for O-ring sealing with service tools, finger nails or clips. Do not expand or twist O-rings.**
 - **Discard old clips; replace with new ones.**
2. Position clips in grooves on fuel injectors.
 - **Make sure that protrusions of fuel injectors are aligned with cutouts of clips after installation.**
3. Align protrusions of fuel tubes with those of fuel injectors.
4. After properly inserting fuel injectors, check to make sure that fuel tube protrusions are engaged with those of fuel injectors, and that flanges of fuel tubes are engaged with clips.
5. Tighten fuel tube assembly mounting bolts "a" to "c" in illustration and in two steps.

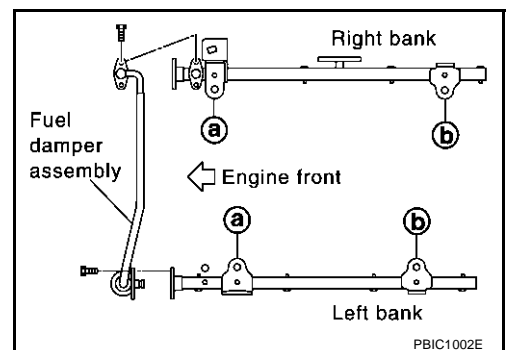
1st step

🔧 : 9.3 - 10.8 N·m (0.95 - 1.1 kg·m, 6.2 - 7.9 ft·lb)

2nd step

🔧 : 20.6 - 26.5 N·m (2.1 - 2.7 kg·m, 16 - 19 ft·lb)

6. Install all removed parts in the reverse order of removal.



INSPECTION AFTER INSTALLATION

Check on Fuel Leakage

- After installing fuel tubes, make sure there is no fuel leakage at connections in the following steps.
 - a) Apply fuel pressure to fuel lines with turning ignition switch ON (with engine stopped). Then check for fuel leaks at connections.
 - b) Start the engine and rev it up and check for fuel leaks at connections.

NOTE:

Use mirrors for checking on invisible points.

CAUTION:

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

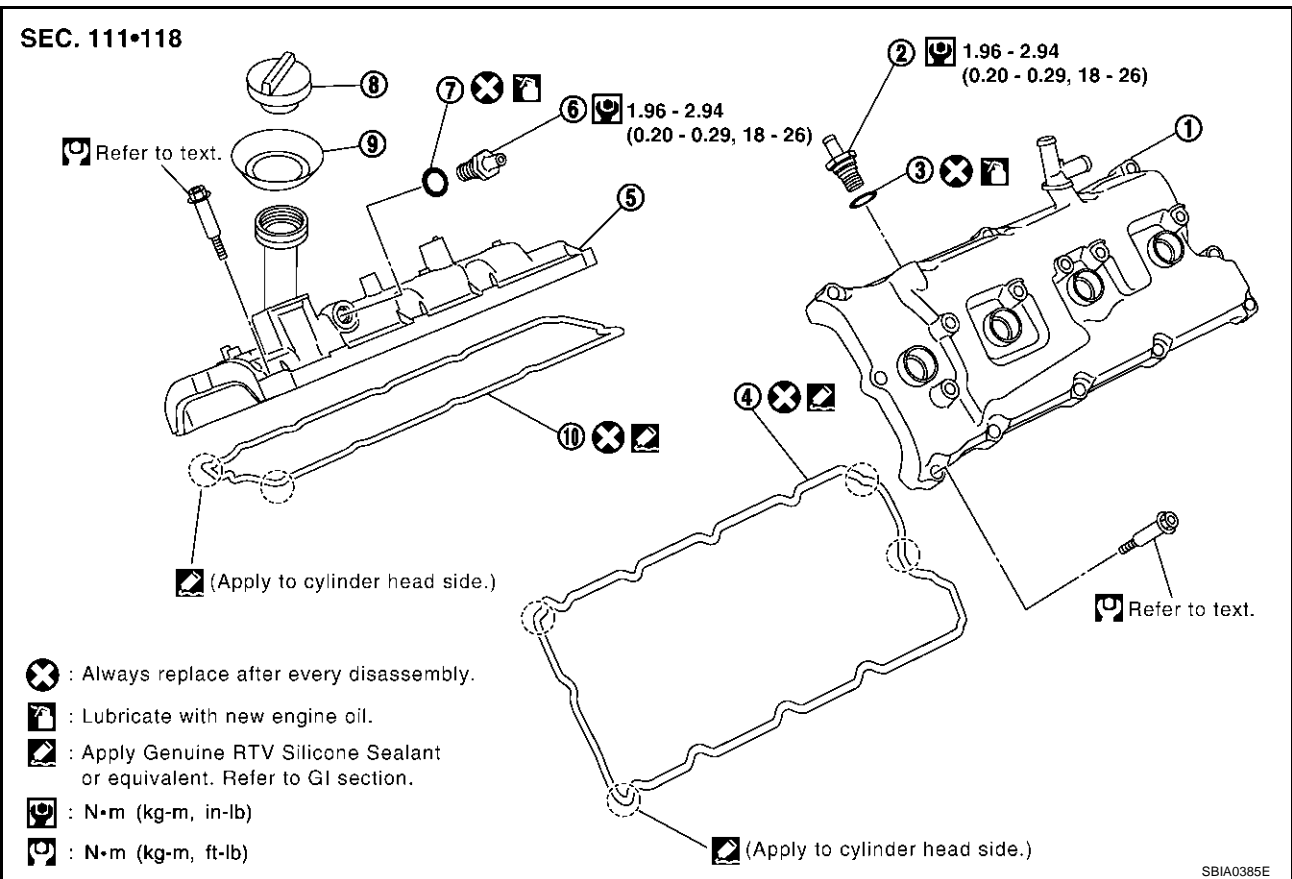
ROCKER COVER

PFP:13264

ROCKER COVER

Removal and Installation

EBS001LG



- | | | |
|--------------------------------------|------------------------------|----------------|
| 1. Rocker cover (left bank) | 2. PCV valve | 3. O-ring |
| 4. Rocker cover gasket (left bank) | 5. Rocker cover (right bank) | 6. PCV valve |
| 7. O-ring | 8. Oil filler cap | 9. Oil catcher |
| 10. Rocker cover gasket (right bank) | | |

REMOVAL

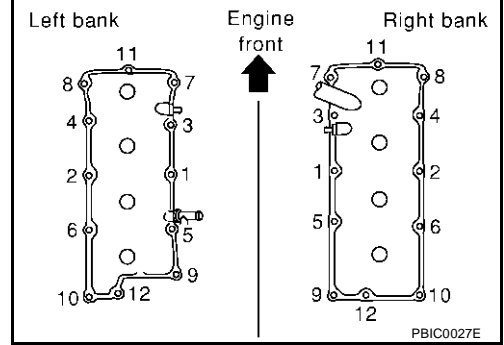
1. Refer to the followings for removal works related to left-bank.
 - a. Remove engine cover (with power tool) and air cleaner cover. Refer to [EM-11, "Removal and Installation"](#).
 - b. Remove air duct and air cleaner case assembly. Refer to [EM-15, "Removal and Installation"](#).
 - c. Remove bracket (installation parts for No.6 camshaft bracket).
 - d. Move harness on upper rocker cover and its peripheral aside.
 - e. Remove ignition coil. Refer to [EM-28, "Removal and Installation"](#).
 - f. Remove PCV valve hose from PCV valve.
2. Refer to the followings for removal works related to right-bank.
 - a. Remove engine cover (with power tool) and battery cover. Refer to [EM-11, "Removal and Installation"](#).
 - b. Move harness on upper rocker cover and its peripheral aside.
 - c. Remove ignition coil [EM-28, "Removal and Installation"](#).
 - d. Remove PCV valve hose from PCV valve.

ROCKER COVER

- Loosen bolts in reverse order shown in the figure (with power tool).

CAUTION:

Do not hold oil filler neck (right bank) not to damage it.



INSTALLATION

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

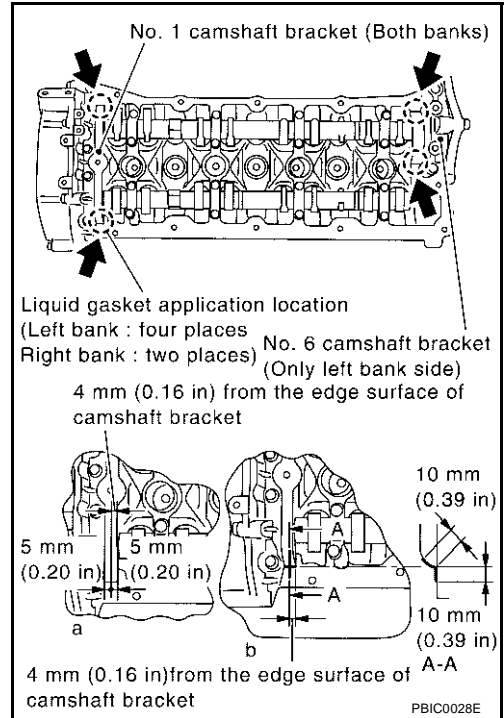
NOTE:

Illustration shows an example of left-bank side (zoomed in shows No.1 camshaft bracket). Apply only to No.1 camshaft bracket for right-bank side.

- Refer to illustration "a" to apply liquid gasket to joint part of No.1 and No.6 camshaft bracket and cylinder head.
- Refer to illustration "b" to apply liquid gasket in 90° to illustration "a".

Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-46, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).

- Install rocker cover.
 - Check if rocker cover gasket is not dropped from installation groove of rocker cover.



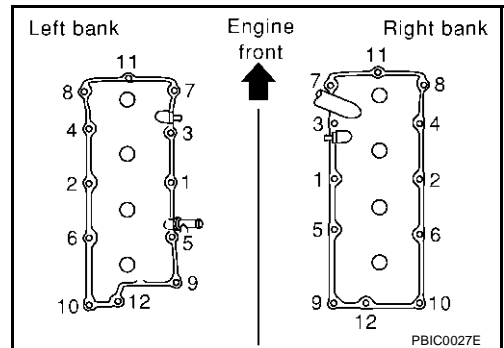
- Tighten bolts in two steps separately in order numbers in illustration.

1st step

: 1.0 - 3.0 N·m (0.1 - 0.31 kg·m, 9 - 26 in·lb)

2nd step

: 7.4 - 9.3 N·m (0.75 - 0.95 kg·m, 66 - 82 in·lb)



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

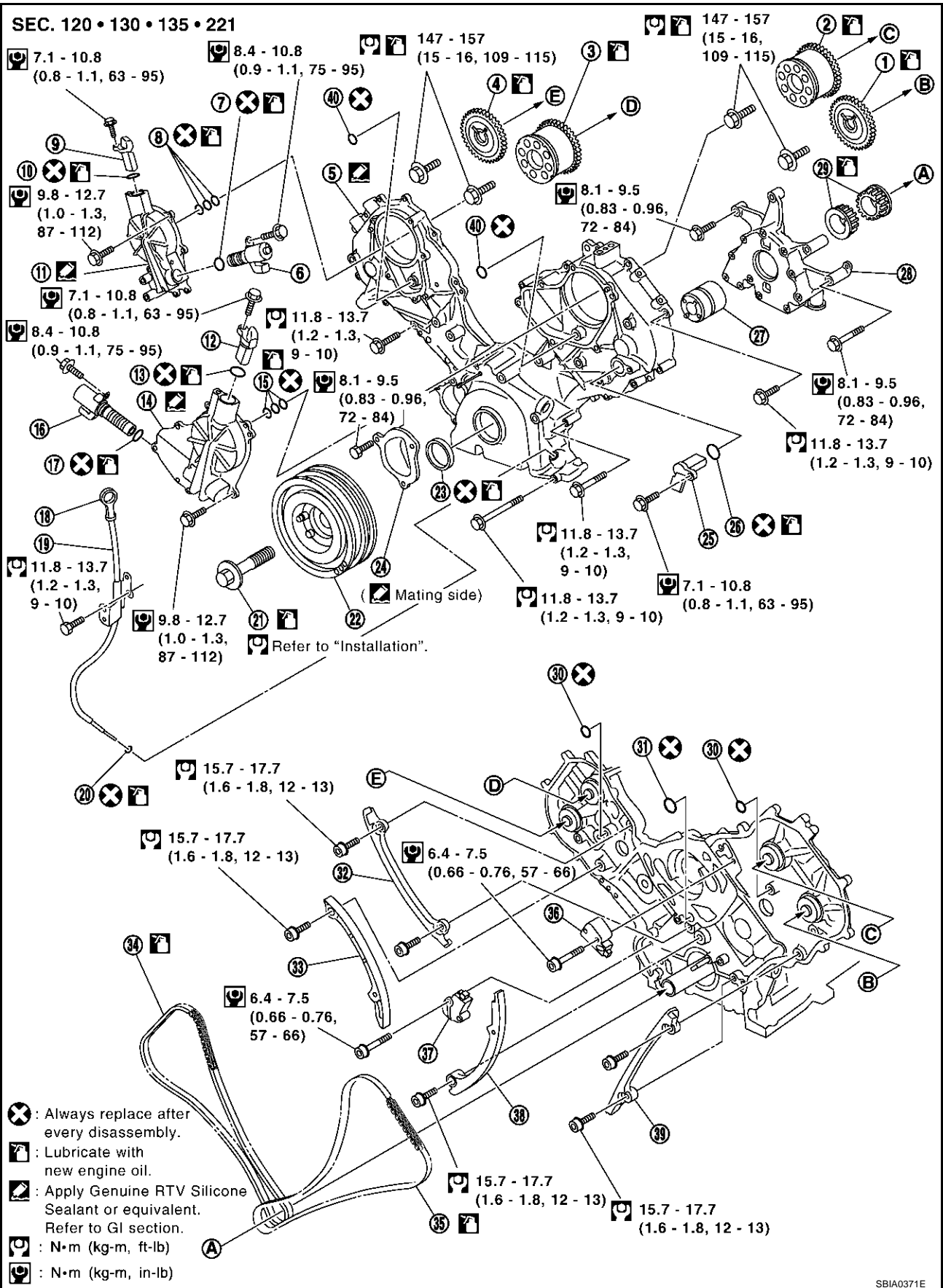
TIMING CHAIN

PF13028

EBS00JX6

TIMING CHAIN

Removal and Installation



SBI0371E

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. Intake valve timing control solenoid valve (right bank) |
| 7. O-ring | 8. Seal ring | 9. Intake valve timing control position sensor (right bank) |
| 10. O-ring | 11. Intake valve timing control cover (right bank) | 12. Intake valve timing control position sensor (left bank) |
| 13. O-ring | 14. Intake valve timing control cover (left bank) | 15. Seal ring |
| 16. Intake valve timing control solenoid valve (left bank) | 17. O-ring | 18. Oil level gauge |
| 19. Oil level gauge guide | 20. O-ring | 21. Crankshaft pulley bolt |
| 22. Crankshaft pulley | 23. Front oil seal | 24. Chain tensioner cover |
| 25. Camshaft position sensor (PHASE) | 26. O-ring | 27. Oil pump drive spacer |
| 28. Oil pump assembly | 29. Crankshaft sprocket | 30. O-ring |
| 31. O-ring | 32. Timing chain tension guide (right bank) | 33. Timing chain slack guide (right bank) |
| 34. Timing chain (right bank) | 35. Timing chain (left bank) | 36. Chain tensioner (left bank) |
| 37. Chain tensioner (right bank) | 38. Timing chain slack guide (left bank) | 39. Timing chain tension guide (right bank) |
| 40. O-ring | | |

CAUTION:

Apply new engine oil to parts marked in illustration before installation.

REMOVAL

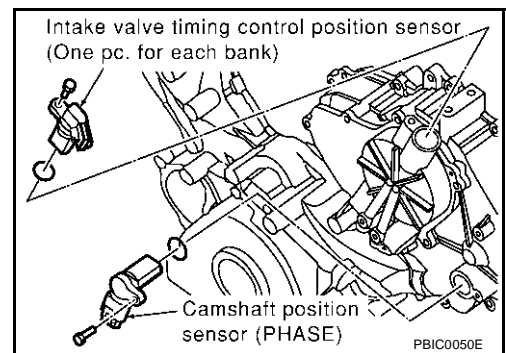
1. Remove engine assembly from vehicle. Refer to [EM-70, "Removal and Installation"](#) .
2. Remove the following components and related parts:
 - Drive belt auto tensioner and idler pulley. Refer to [EM-14, "Drive Belt Auto Tensioner and Idler Pulley"](#) .
 - Thermostat housing and hose. Refer to [CO-24, "Removal and Installation"](#) .
 - Oil pan and oil strainer. Refer to [EM-25, "Removal and Installation"](#) .
 - Ignition coil (When camshaft sprocket is removed). Refer to [EM-28, "Removal and Installation"](#) .
 - Rocker cover (When camshaft sprocket is removed). Refer to [EM-33, "Removal and Installation"](#) .
3. If necessary, remove intake valve timing control position sensor (right and left) and camshaft position sensor (PHASE) from intake valve timing control cover and front cover.

CAUTION:

- Handle components and parts carefully to avoid dropping and shocks.
 - Do not disassemble.
4. If necessary, remove intake valve timing control solenoid valve from intake valve timing control cover.

CAUTION:

- Handle components and parts carefully to avoid dropping and shocks.
- Do not disassemble.

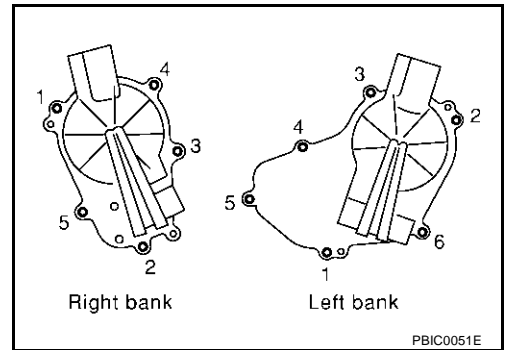


TIMING CHAIN

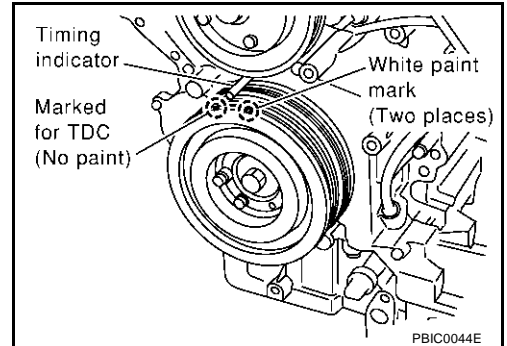
5. Remove intake valve timing control cover as follows:
 - a. Loosen and remove fixing bolts in the reverse order of that shown in figure.
 - b. Use seal cutter or the equivalent to cut liquid gasket for removal.

CAUTION:

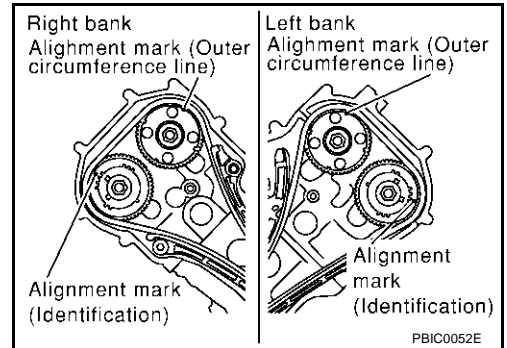
- Exercise care not to damage mating surfaces.
- Pull out cover keeping levelness without an angle, as inner part of cover is engaged with the center of intake cam sprocket.



6. 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.



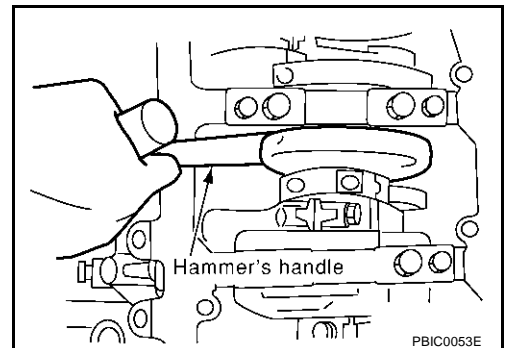
- b. At this time, check that the mating mark on camshaft sprocket is in the position as shown in the figure.
 - If the mating mark does not come in the position shown, turn crankshaft pulley once more to bring the mark in the position.



7. Remove crankshaft pulley as follows:
 - a. Lock crankshaft with a hammer handle or similar tool to loosen fixing bolts.
 - b. Pull crankshaft pulley with both hands to remove it.

CAUTION:

- Do not remove fixing bolts. Keep loosened fixing bolts in place to protect removed crankshaft pulley from dropping.
- Do not remove balance weight (inner hexagon bolt) at the front of crankshaft pulley.



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TIMING CHAIN

8. Remove front cover as follows:

- a. Loosen and remove fixing bolts in the reverse order of that shown in figure.
- b. Use seal cutter or the equivalent to cut liquid gasket for removal.

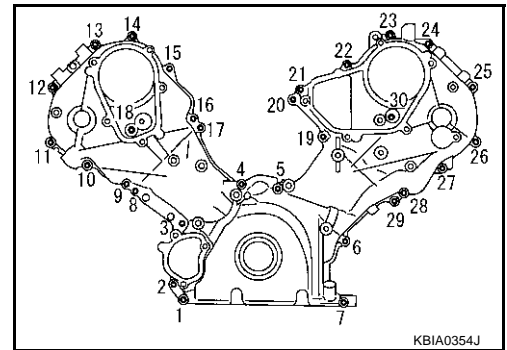
CAUTION:

Exercise care not to damage mating surfaces.

9. If replacement of front oil seal is necessary, lift the seal with a screwdriver for removal.

CAUTION:

Exercise care not to damage front cover.



10. Remove oil pump drive spacer.

- Install bolts into two bolt holes [M6 x pitch 1.0 mm (0.04 in)] on front surface. Using a small puller, pull spacer off from crankshaft.

NOTE:

The center-to-center dimension between the two bolt holes is 33 mm (1.30 in).

11. Remove oil pump. Refer to [LU-9, "OIL PUMP"](#).

12. 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.

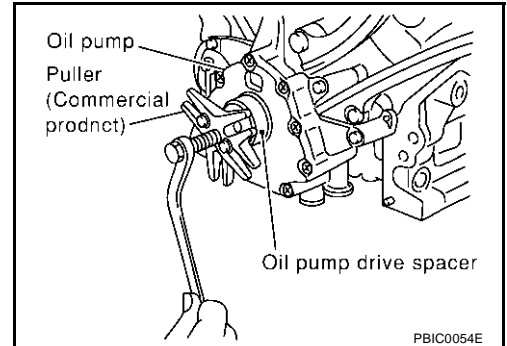
- a. Press tab in the direction of arrow (or turn lever in the direction of arrow) to unlock the locking with the groove that stops tensioner plunger from returning.

- Lightly press tensioner plunger to release the tension of spring for this operation.

- b. Push in tensioner plunger to align the hole on lever and that on pump main body.

- Pushing in tensioner too far does not allow the holes to align. Therefore, push in plunger to the degree at which the start of stopper groove and tab engages.

- c. Insert a stopper pin [hard wire with approx. 0.5 mm (0.020 in) diameter or a similar tool] to fix plunger. With plunger fixed, remove chain tensioner.



13. Remove chain tensioner guide and slack guide.

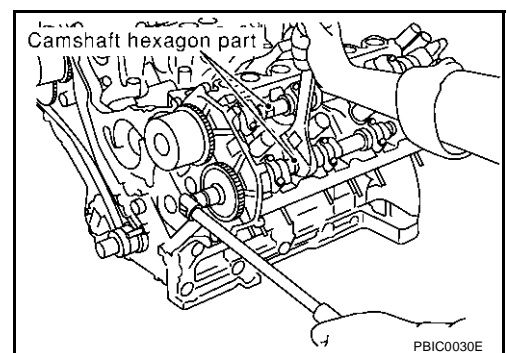
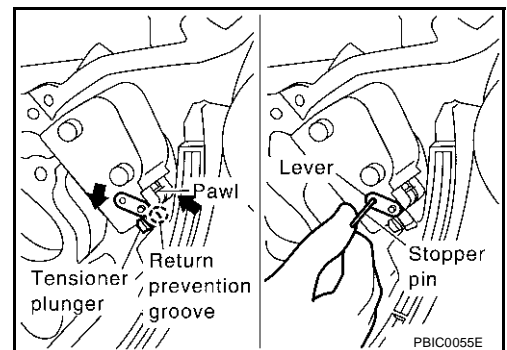
14. Remove timing chain and crankshaft sprocket.

15. 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 is disconnected.

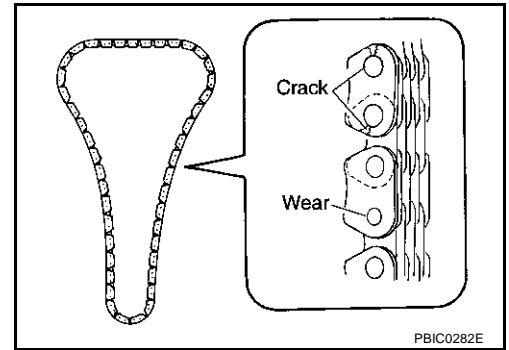
16. Using the same procedure as for left bank, remove timing chain and associated parts on right side.



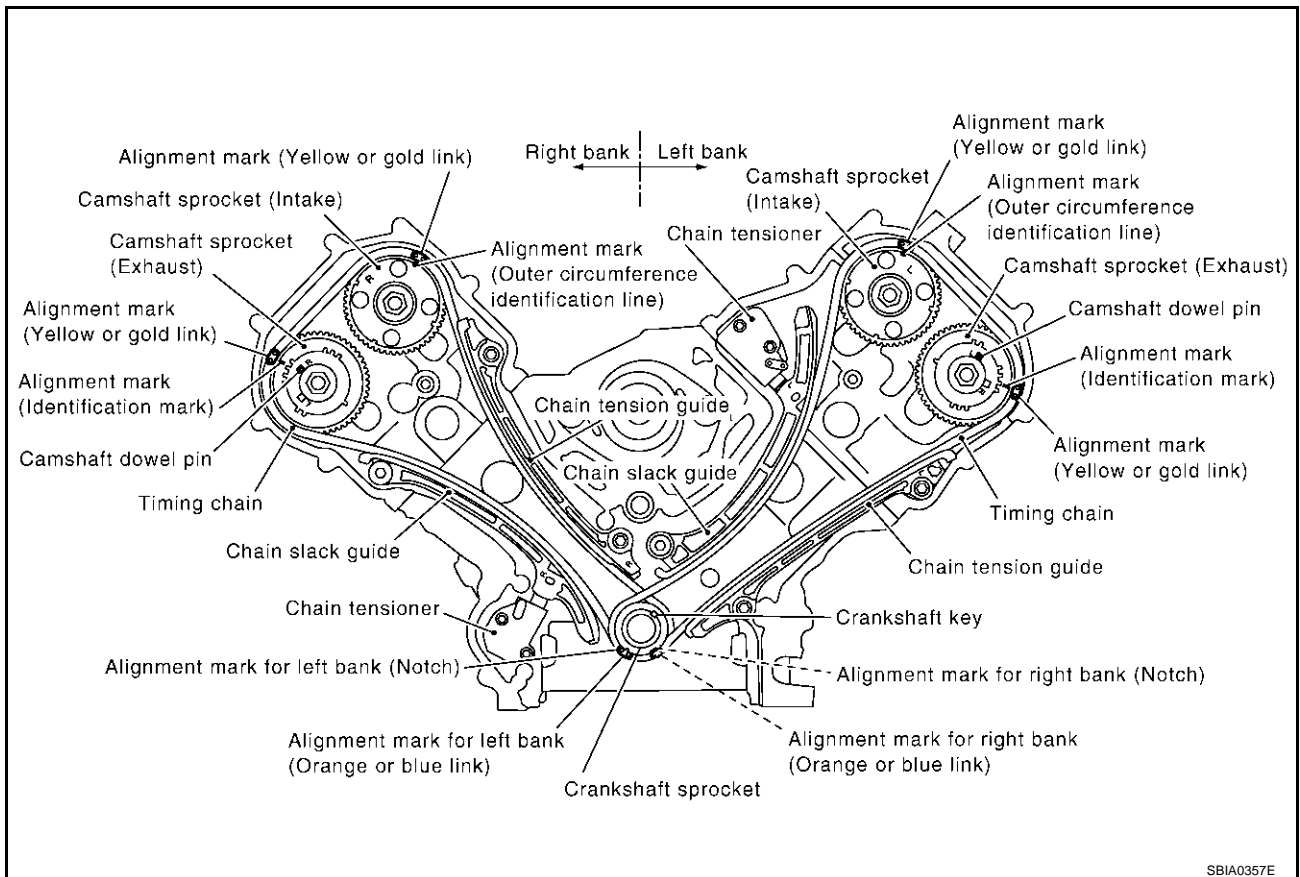
TIMING CHAIN

INSPECTION AFTER REMOVAL

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



INSTALLATION



NOTE:

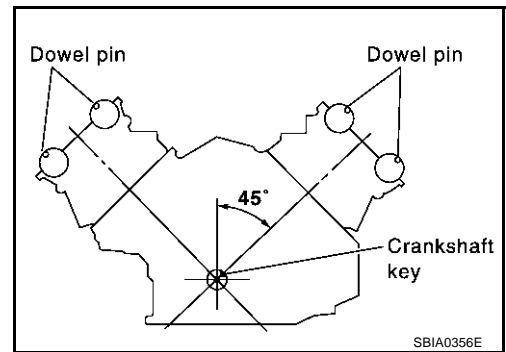
- The above figure shows the relationship between the mating mark on each timing chain and that on the corresponding sprocket, with the components installed.
- Parts with an identification mark (R or L) should be installed on the corresponding bank according to the mark.

Parts with an identification mark:

- Intake camshaft sprocket
- Dowel pin groove of exhaust camshaft sprocket (camshaft sprocket is same part both banks)
- Chain tension guide
- Chain slack guide
- Because of parallel manufacture, there are two types of mark (link colors) for timing chain.
- 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.

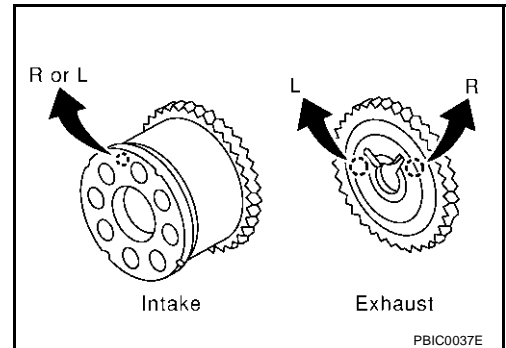
TIMING CHAIN

1. Check that the crankshaft key and dowel pin of each camshaft are facing in the direction indicated.



2. Install camshaft sprockets.

- Install onto correct side by checking with identification mark on surface
- Install exhaust-side 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 fixing bolts.

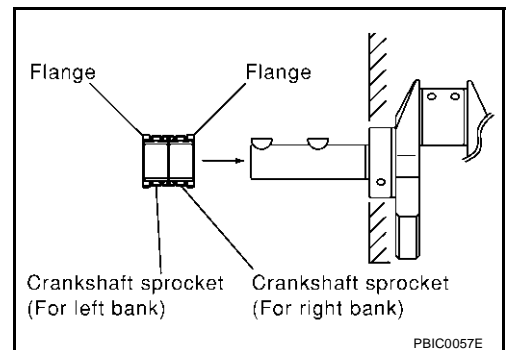


3. Install crankshaft sprockets for both banks.

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

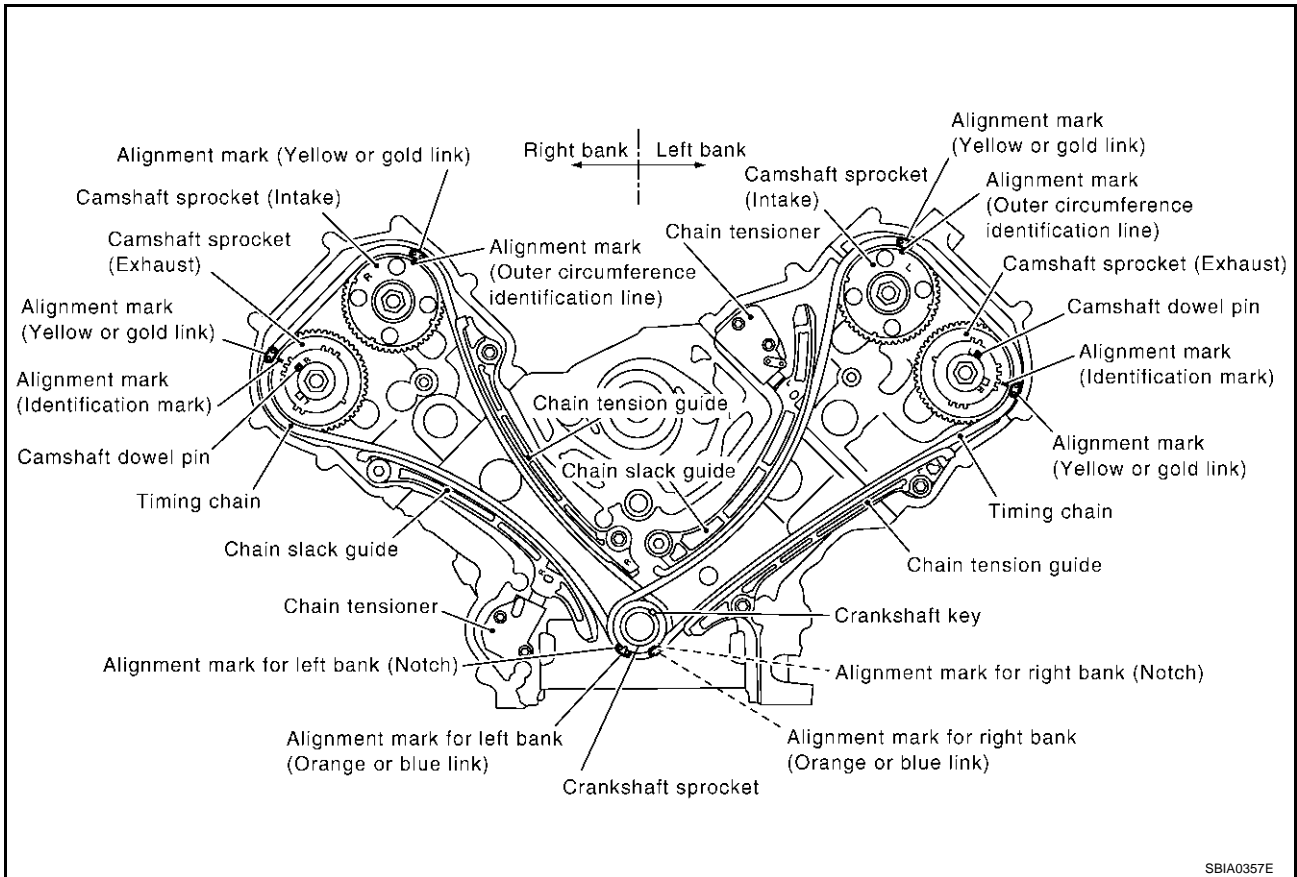
NOTE:

The same parts are used but facing directions are different.



TIMING CHAIN

4. Install timing chains and associated parts.



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

NOTE:

Before installing chain tensioner, it is possible to change the position of mating mark on timing chain for that on each sprocket for alignment.

CAUTION:

For the above reason, after the mating marks are aligned, keep them aligned by holding them with a hand.

- Install slack guides and tension guides onto correct side by checking with identification mark on surface.
- Install chain tensioner with plunger fixed as described in its removal.

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. Check that tensioner is released.
- To avoid chain-link skipping of timing chain, never move crankshaft or camshafts until front cover is installed.

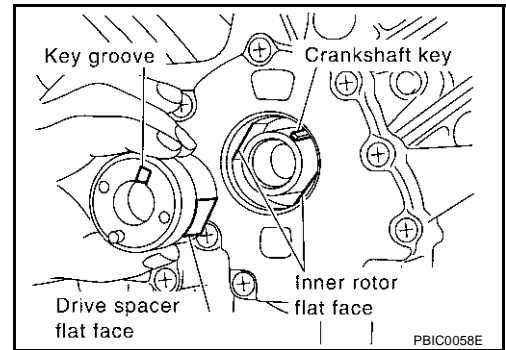
5. In the same way as for right bank, install timing chain and associated parts on left side.

6. Install oil pump.

TIMING CHAIN

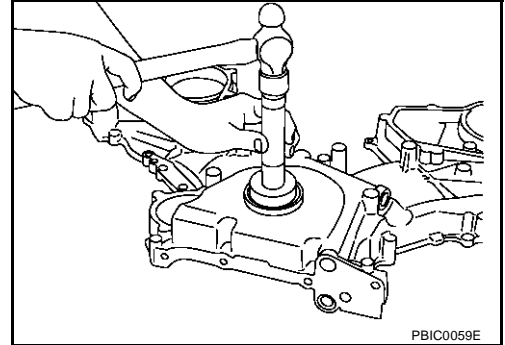
7. Install oil pump drive spacer as follows:

- a. 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 spacer.
- b. After confirming that the position of each part is in correct condition to allow for the spacer, force fit the spacer by lightly tapping with a plastic hammer until it contacts and does not go further.



8. Install front oil seal onto front cover.

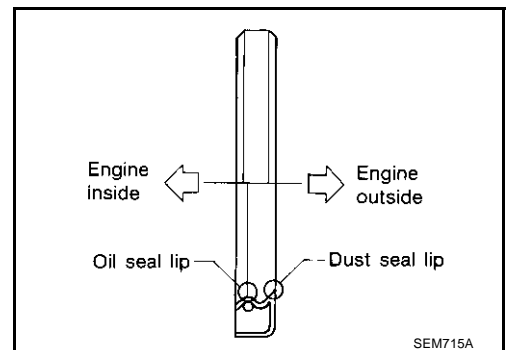
- Using oil seal drift or drift with 54 mm (2.13 in) diameter, force fit the seal until it levels with the front end surface of front cover.



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

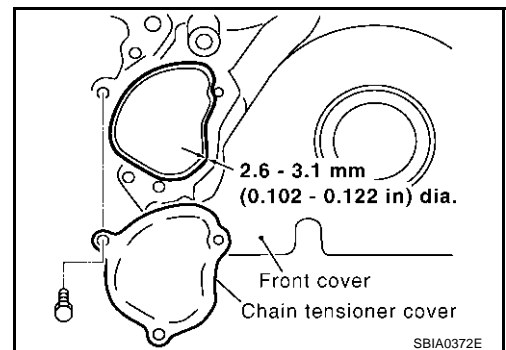
CAUTION:

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



9. Install chain tensioner cover onto front cover.

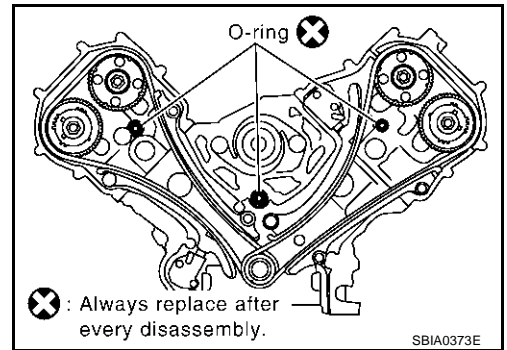
- Apply liquid gasket as shown in the figure.
Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-46, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).



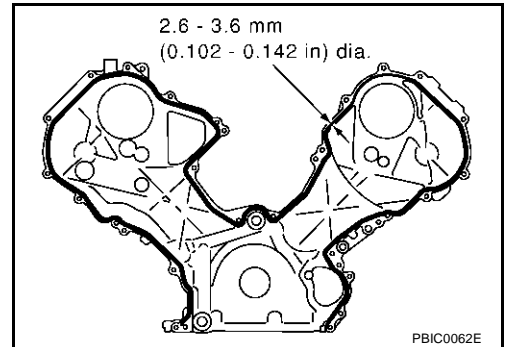
TIMING CHAIN

10. Install front cover as follows:

- a. Install new O-rings onto RH and LH cylinder heads and cylinder block.



- b. Apply liquid gasket as shown in the figure. **Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-46, "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.

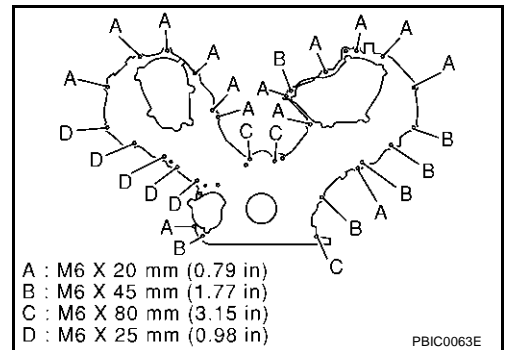
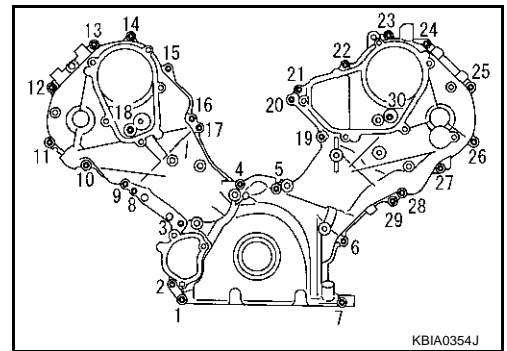
CAUTION:

Be careful to avoid interference with the front end of oil pump drive spacer. Such interference may damage front oil seal.

- d. Tighten fixing bolts in the order shown in 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.



11. Install intake valve timing control cover as follows:

- a. At the back of intake valve timing control cover, install new seal rings (three for each) to the area to be inserted into intake camshaft sprocket.

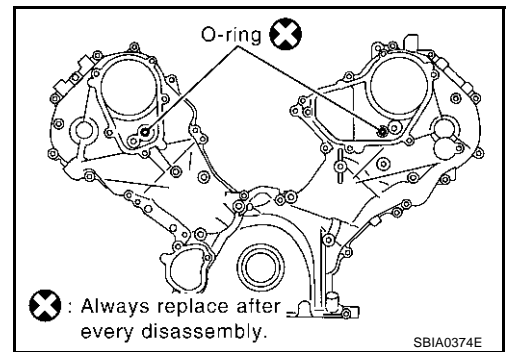
CAUTION:

Do not spread seal ring excessively to avoid breaks and deformation.

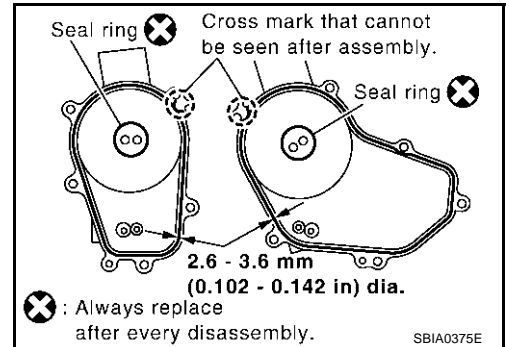
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TIMING CHAIN

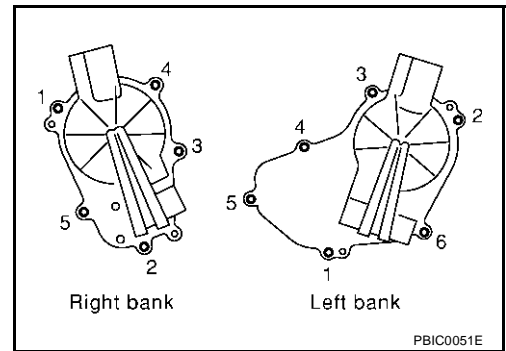
- b. On the side of front cover, install new O-ring (one for each bank).



- c. Apply liquid gasket as shown in the figure.
Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-46, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).



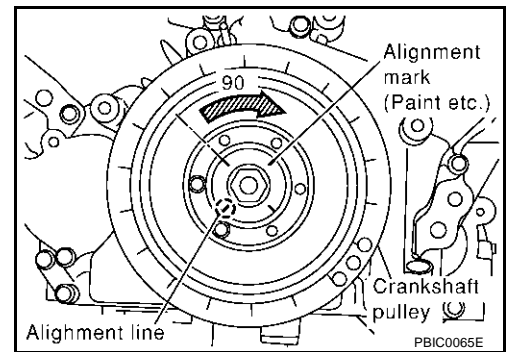
- d. Tighten fixing bolts in the order shown in figure.



12. Install intake valve timing control position sensor, intake valve timing control solenoid valve and camshaft position sensor (PHASE) to intake valve timing control cover and front cover.
- Be sure to tighten bolts with flanges completely seated.
13. Install crankshaft pulley.
- Install according to the dowel pin of oil pump drive spacer.
 - Lightly tapping its center with plastic hammer, insert pulley.
- CAUTION:**
Do not tap pulley on the side surface where belt is installed (outer circumference).
14. Tighten fixing bolts of crankshaft pulley.
- Lock crankshaft with a hammer handle or similar tool to tighten fixing bolts.
 - Perform the following steps for angular tightening:
- a. Apply engine oil onto threaded parts of bolts and seating areas.
- b. Tighten bolt 88.2 to 98.0 N·m (9.0 to 9.9 kg·m, 65 to 72 ft·lb).

TIMING CHAIN

- c. 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.
- d. Tighten further by 90° to 96° [target: 90°].
 - Check the tightening angle by referencing to the notches. The angle between two notches is 90° .



15. Rotate crankshaft pulley in normal direction (clockwise when viewed from FRONT) to check for interference among parts.
16. For the following operations, perform steps in the reverse order of removal.

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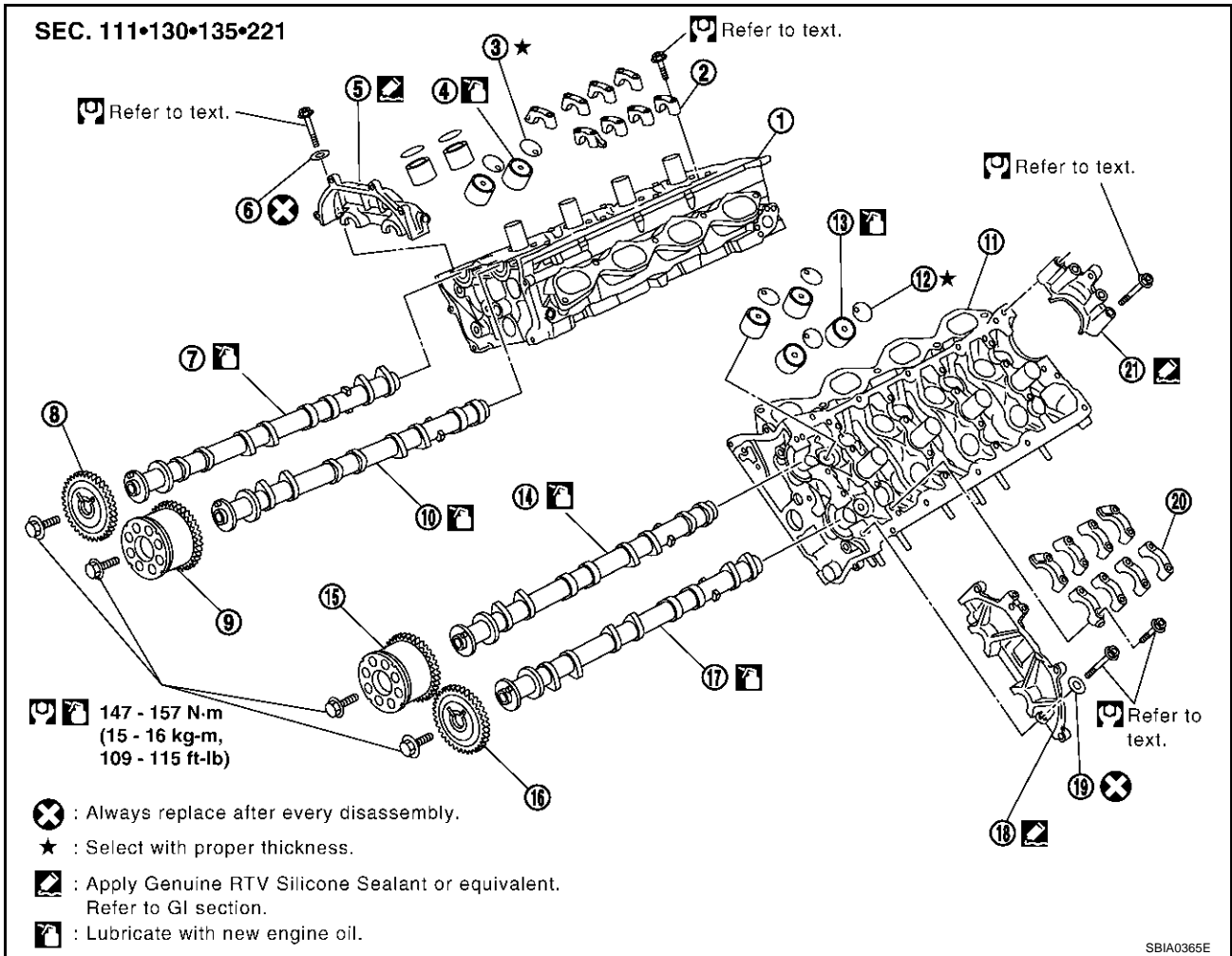
CAMSHAFT

PFP:13001

CAMSHAFT

Removal and Installation

EBS001JZ



- | | | |
|---------------------------------|--------------------------------------|-------------------------------------|
| 1. Cylinder head (right bank) | 2. Camshaft bracket (No.2, 3, 4, 5) | 3. Adjusting shim |
| 4. Valve lifter | 5. Camshaft bracket (No.1) | 6. Washer |
| 7. Camshaft (exhaust) | 8. Camshaft sprocket (exhaust) | 9. Camshaft sprocket (intake) |
| 10. Camshaft (intake) | 11. Cylinder head (left bank) | 12. Adjusting shim |
| 13. Valve lifter | 14. Camshaft (intake) | 15. Camshaft sprocket (intake) |
| 16. Camshaft sprocket (exhaust) | 17. Camshaft (exhaust) | 18. Camshaft bracket (No.1) |
| 19. Washer | 20. Camshaft bracket (No.2, 3, 4, 5) | 21. Camshaft bracket (intake, No.6) |

CAUTION:

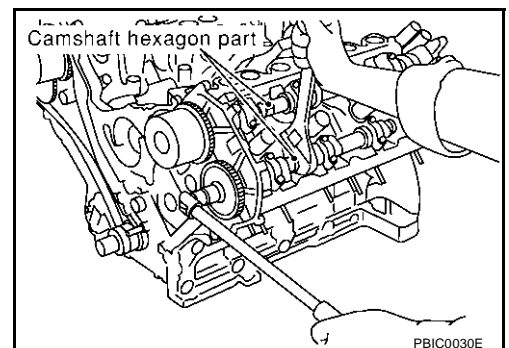
Apply new engine oil to parts marked in illustration before installation.

REMOVAL

1. Remove timing chain. Refer to [EM-35, "Removal and Installation"](#).
2. With hexagonal part of camshaft locked with wrench, loosen bolts securing camshaft sprocket to remove camshaft sprocket.

CAUTION:

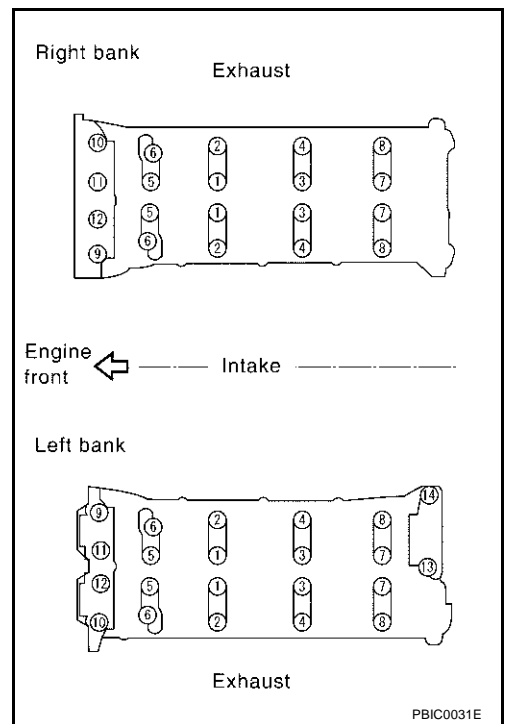
To avoid interference between valves and pistons, do not turn crankshaft or camshaft with timing chain disconnected.



CAMSHAFT

3. Loosen fixing bolts in the reverse order of that shown in figure to remove camshaft brackets.
 - Lightly tapping with plastic hammer, remove No. 1 camshaft bracket and No. 6 camshaft bracket.

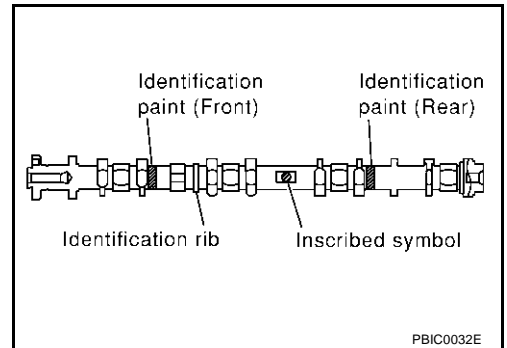
NOTE:
The bottom surface of each bracket will be stuck to cylinder head because of liquid gasket.
4. Remove camshaft.
5. Remove adjusting shims and valve lifters if necessary.
 - Correctly identify location where each part is installed. Keep parts in an organized way to avoid mixing them up.



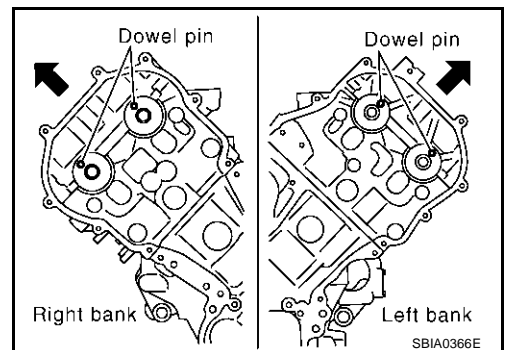
INSTALLATION

1. Install adjusting shims and valve lifters if necessary.
 - Install removed parts in the same locations as before.
2. Install camshafts. Refer to the table below for identification of right and left bank, and intake and exhaust.

Bank	IN/EX	Identification paint (front)	Identification paint (rear)	Identification rib	Identification symbol
LH	IN	Blue	—	No.	LH
	EXH	—	Orange	No.	LH
RH	INT	Blue	—	Yes.	RH
	EXH	—	Orange	Yes.	RH



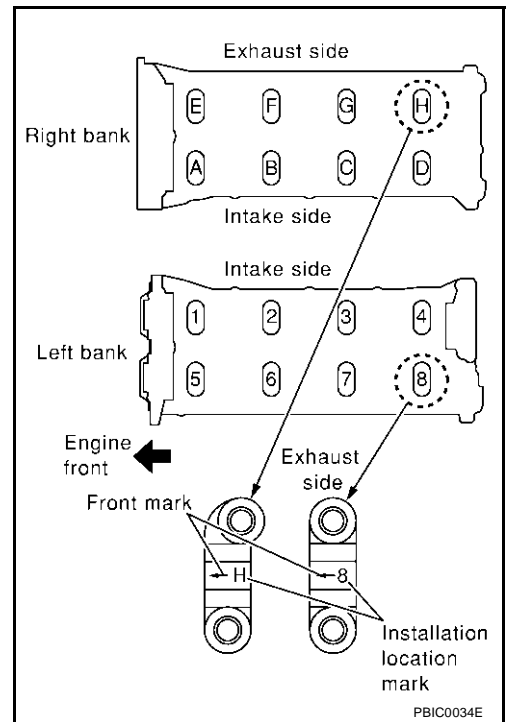
- Install so that dowel pin at the front of camshaft face is in the direction shown in the figure.



CAMSHAFT

3. Install camshaft brackets.

- Install by referring to identification mark on upper surface and front mark.
- Install so that identification mark can be correctly read when viewed from the side of left exhaust bank.



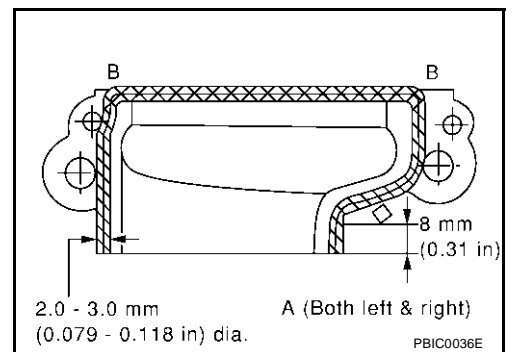
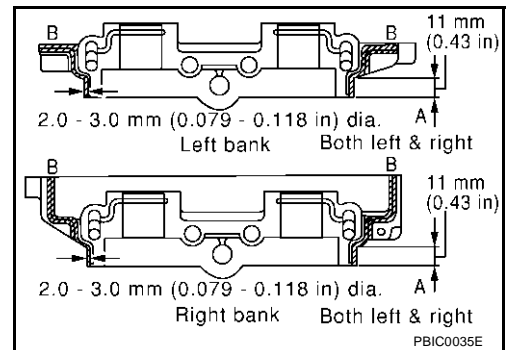
- Install No. 1 camshaft bracket as follow:
 - Apply liquid gasket to No.1 camshaft bracket as in illustration. **Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-46, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).**

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 No.6 camshaft bracket on left bank intake as in illustration.

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.



CAMSHAFT

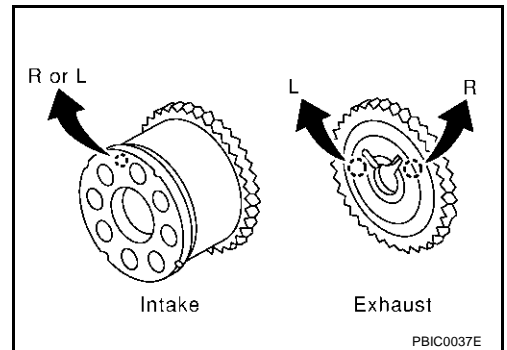
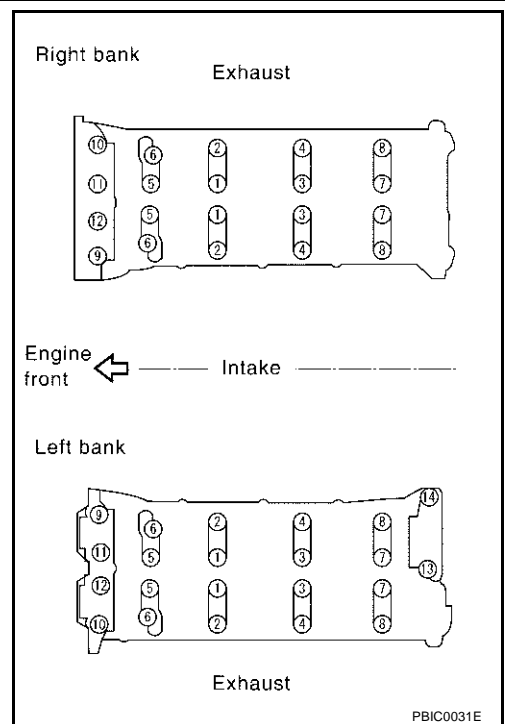
4. Tighten fixing bolts of camshaft brackets as follows:
 - a. Tighten in the order from 9 to 12 with tightening torque 1.96 N·m (0.2 kg·m, 17 in·lb).
 - b. Tighten in the order from 1 to 8 with tightening torque 1.96 N·m (0.2 kg·m, 17 in·lb).
 - c. Tighten in the order from 13 to 14 with tightening torque 1.96 N·m (0.2 kg·m, 17 in·lb) (Left bank only).
 - d. Tighten all bolts in the specified order with tightening torque 5.88 N·m (0.6 kg·m, 52 in·lb)
 - e. Tighten in the order from 1 to 12 with tightening torque 9.02 to 11.8N·m (0.92 to 1.2 kg·m, 80 to 104 in·lb).
 - f. Tighten in the order from 13 to 14 with tightening torque 29.4 to 33.3 N·m (3.0 to 3.3 kg·m, 22 to 24 ft·lb) (left bank only).

CAUTION:

After tightening fixing bolts of 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

5. Install camshaft sprockets.
 - Install by checking with identification mark on surface.
 - Install exhaust-side 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 fixing bolts.
6. For the following operations, perform steps in the reverse order of removal.
7. Check and adjust valve clearances.
Refer to [EM-52, "Valve Clearance"](#).



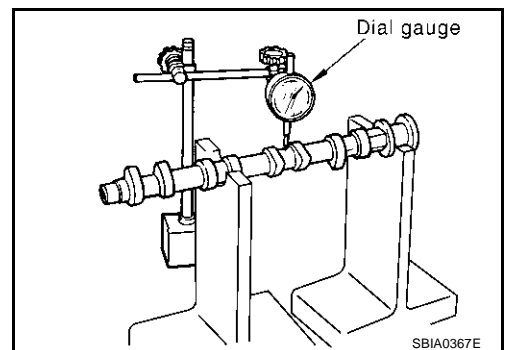
INSPECTION AFTER REMOVAL

Camshaft Runout

1. Put V block on precise flat bed, and support No.2 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)

4. If it exceeds the specification, replace camshaft.



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CAMSHAFT

Camshaft Cam Height

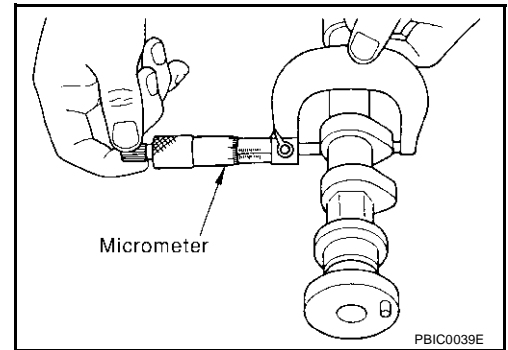
1. Measure camshaft cam height.

Standard cam height:

Intake: 44.865 - 45.055 mm (1.7663 - 1.7738 in)

Exhaust: 43.925 - 44.115 mm (1.7293 - 1.7368 in)

2. If wear is beyond the specifications, replace camshaft.



Camshaft Journal Clearance

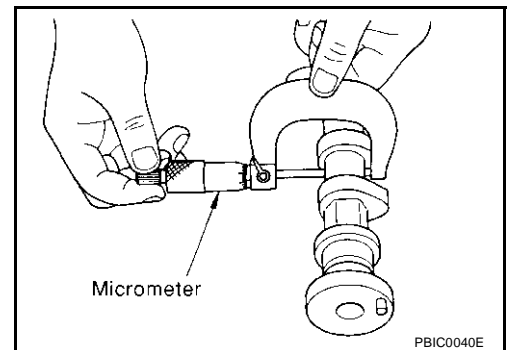
Outer Diameter of Camshaft Journal

Measure outer diameter of camshaft journal.

Standard outer diameter:

No.1: 25.938 - 25.955 mm (1.0212 - 1.0218 in)

No.2, 3, 4, 5: 25.953 - 25.970 mm (1.0218 - 1.0224 in)



Inner Diameter of Camshaft Bracket

- 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) = (inner diameter of camshaft bracket) – (outer diameter of camshaft journal)

Standard:

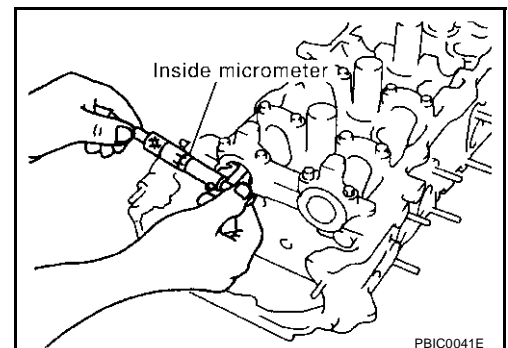
No.1 : 0.045 - 0.083 mm (0.0018 - 0.0033 in)

No.2, 3, 4, 5 : 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.

NOTICE:

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



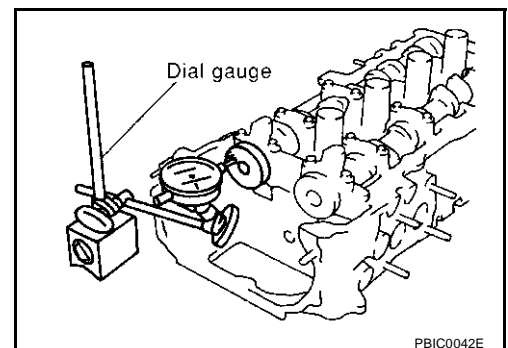
Camshaft End Play

- 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.



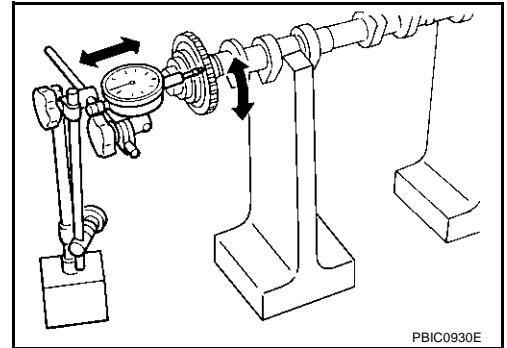
CAMSHAFT

Camshaft Sprocket Runout

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

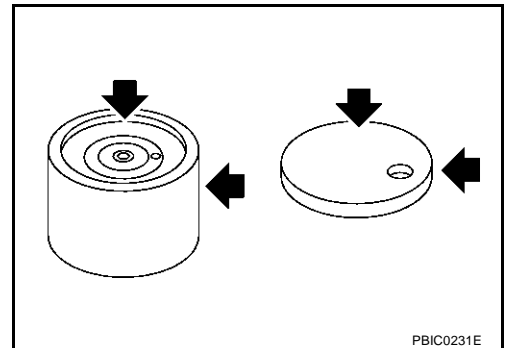
Runout : Less than 0.15 mm (0.0059 in)

4. If it exceeds the specifications, replace camshaft sprocket.



Valve Lifter and Adjusting Shim

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

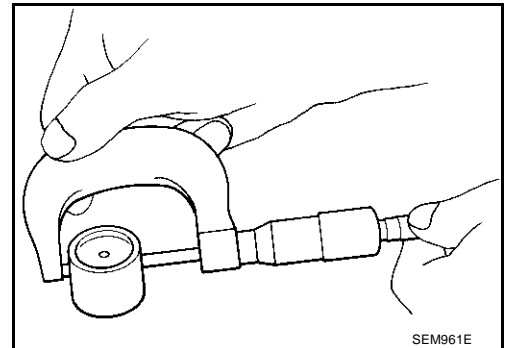


Valve Lifter Clearance

Outer Diameter of Valve Lifter

Measure outer diameter of valve lifter.

Standard: 33.965 - 33.975 mm (1.3372 - 1.3376 in)



Valve Lifter Hole Diameter

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

Standard:

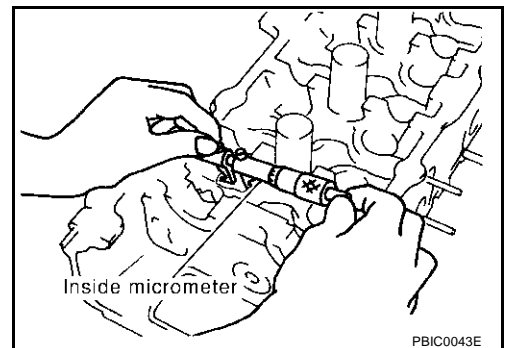
34.000 - 34.016 mm (1.3386 - 1.3392 in)

Calculation of Valve Lifter Clearance

(Valve lifter clearance) = (hole diameter of valve lifter) – (outer diameter of valve lifter)

Standard:

0.025 - 0.051 mm (0.0010 - 0.0020 in)



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

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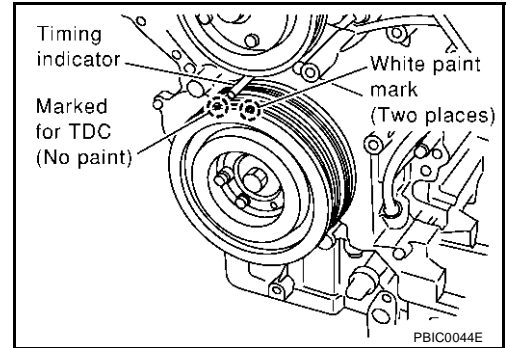
CAMSHAFT

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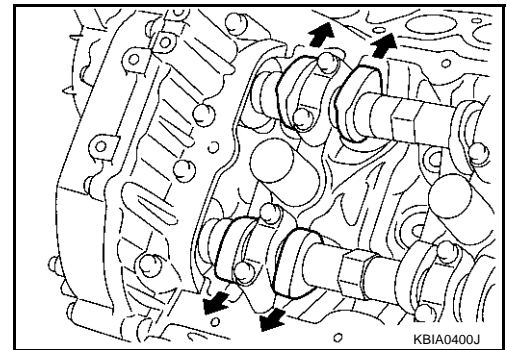
Valve Clearance INSPECTION

Perform inspection as follows after removal, installation or replacement of camshaft or valve-related parts, or if there is 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 and engine room covers (RH and LH) with power tool and air duct (inlet). Refer to [EM-11, "Removal and Installation"](#) .
3. Remove RH and LH rocker covers with power tool. Refer to [EM-33, "Removal and Installation"](#) .
4. Turn crankshaft pulley in normal direction (clockwise when viewed from FRONT) to align TDC identification notch (without paint mark) with timing indicator.



5. At this time, check that the both 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.



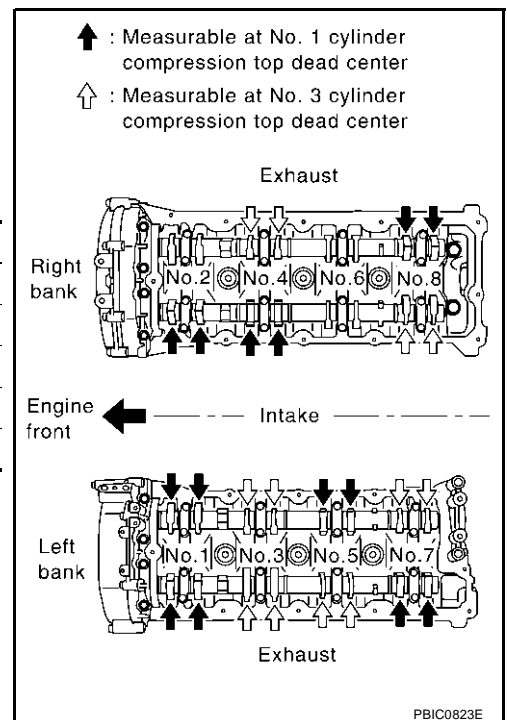
6. By referring to the figure, measure valve clearances at locations marked X as shown in the table below (locations indicated with black arrow in figure) with a thickness gauge.

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				×
	INT	×	×		
Measuring position (LH bank)		No.1 CYL	No. 3 CYL	No. 5 CYL	No. 7 CYL
No. 1 cylinder at TDC	INT	×		×	
	EXH	×			×



CAMSHAFT

- Use a fine thickness gauge.

Valve clearance standard:

Hot	Intake	: 0.32 - 0.40 mm (0.013 - 0.016 in)
	Exhaust	: 0.33 - 0.41 mm (0.013 - 0.016 in)
Cold*	Intake	: 0.26 - 0.34 mm (0.010 - 0.013 in)
	Exhaust	: 0.29 - 0.37 mm (0.011 - 0.015 in)

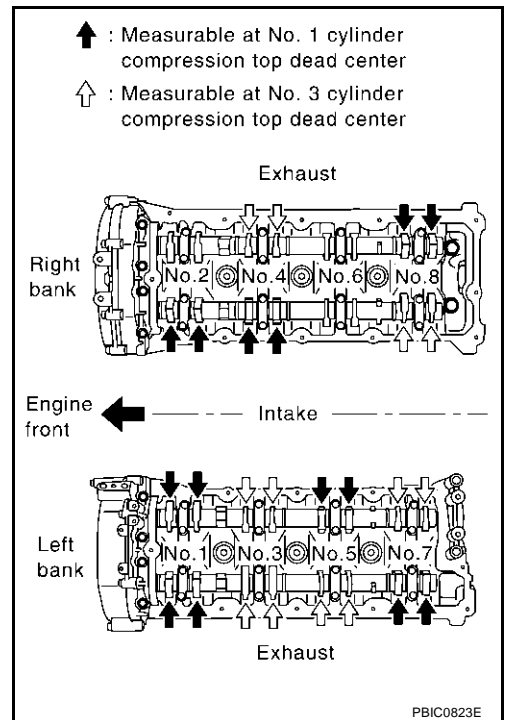
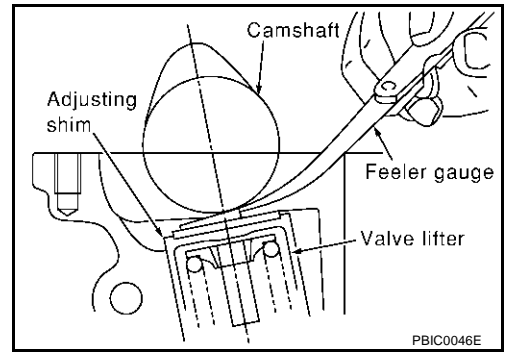
*Approximately 20°C (68°F)

CAUTION:

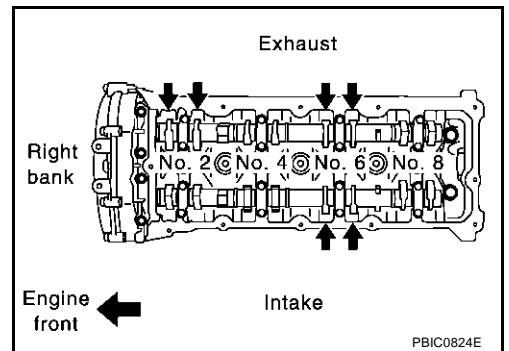
If inspection was carried out with cold engine, check that values with fully warmed up engine are still within specifications.

- Turn crankshaft pulley clockwise by 270° from the position of No. 1 cylinder compression TDC to obtain No. 3 cylinder compression TDC.
- By referring to the figure, measure valve clearances at locations marked X as shown in the table below (locations indicated with white arrow in figure)
 - 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		×		
	INT				×
Measuring position (LH bank)		No.1 CYL	No. 3 CYL	No. 5 CYL	No. 7 CYL
No. 3 cylinder at TDC	INT		×		×
	EXH		×	×	



- Turn crankshaft pulley clockwise by 90° from the position of No. 3 cylinder compression TDC (clockwise by 360° 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.



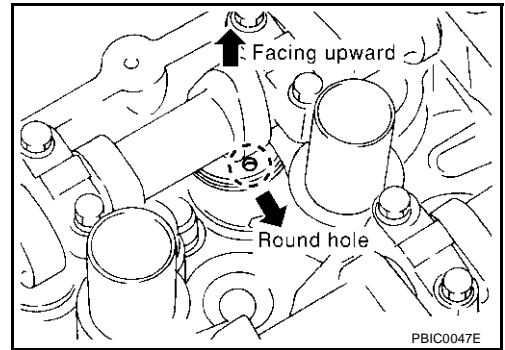
- If out of specifications, adjust as follows:

CAMSHAFT

ADJUSTMENT

Adjust valve clearance while engine is cold.

1. Turn crankshaft, to position cam lobe on camshaft of valve that must be adjusted upward.
2. Thoroughly wipe off engine oil around adjusting shim using a rag.
3. Using a extra-fine screwdriver, turn the round hole of the adjusting shim in the direction of the arrow.

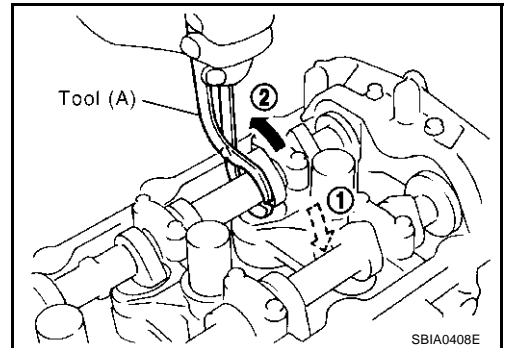


4. Place Tool (A) around camshaft as shown in figure.
 - Before placing Tool (A), rotate cam lobe toward center of cylinder head (See (1) in figure.) to simplify shim removal later.

CAUTION:

Be careful not to damage cam surface with Tool (A).

5. Rotate Tool (A) (See (2) in figure.) so that valve lifter is pushed down.



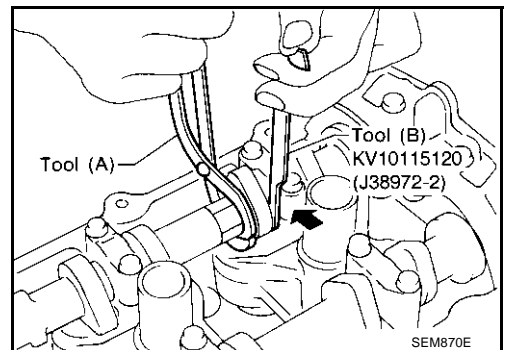
6. Place Tool (B) between camshaft and the edge of the valve lifter to retain valve lifter.

CAUTION:

● **Tool (B) must be placed as close to camshaft bracket as possible.**

● **Be careful not to damage cam surface with Tool (B).**

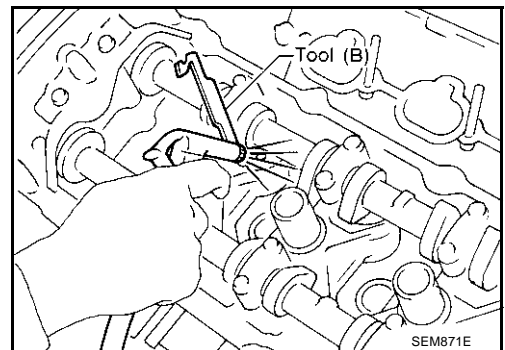
7. Remove Tool (A).



8. Blow air into the hole to separate adjusting shim from valve lifter.

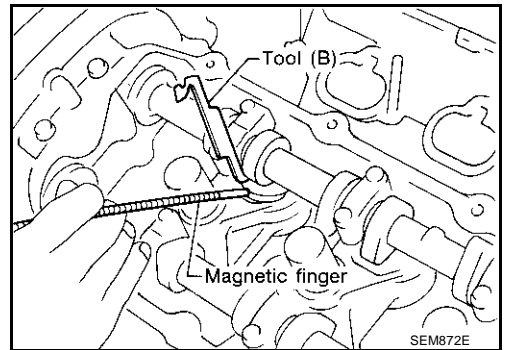
CAUTION:

When blowing, use goggles to protect your eye.



CAMSHAFT

9. Remove adjusting shim using a small screwdriver and a magnetic finger.



10. Determine replacement adjusting shim size following formula.

- Using a micrometer determine thickness of removed shim with measured at center.
- Calculate thickness of new adjusting shim so valve clearance comes within specified values (Cold value).
 R = Thickness of removed shim
 N = Thickness of new shim
 M = Measured valve clearance

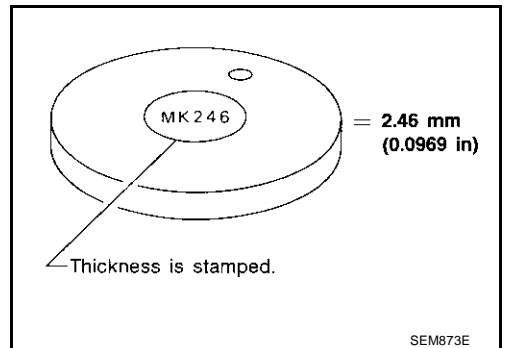
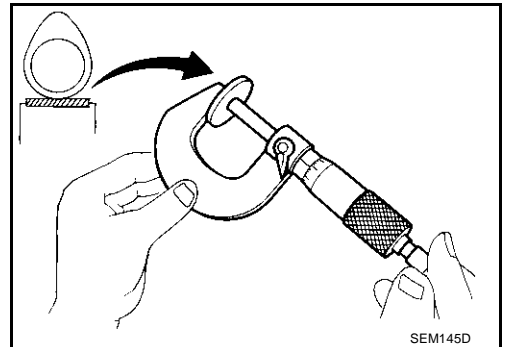
Intake : $N = R + [M - 0.30 \text{ mm (0.0118 in)}]^*$

Exhaust : $N = R + [M - 0.33 \text{ mm (0.0130 in)}]^*$

*: Approximately 20° C (68° F)

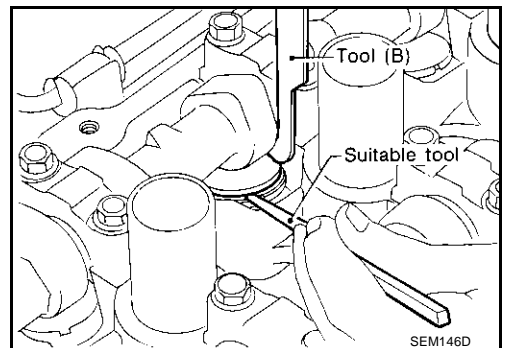
Shims are available in 64 sizes from 2.32 mm (0.0913 in) to 2.95 mm (0.1161 in) in steps of 0.01 mm (0.0004 in).

- Select new shim with thickness as close as possible to calculated value.



11. Install new shim using a suitable tool.

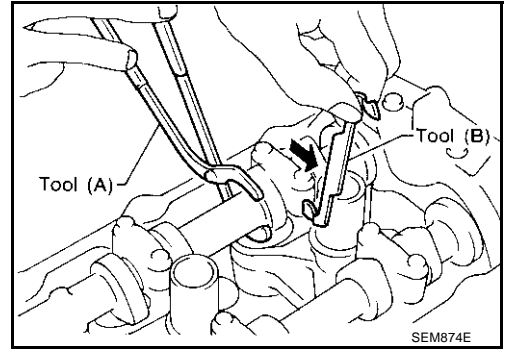
- **Install with the surface on which the thickness is stamped facing down.**



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12. Place Tool (A) as mentioned in steps 4 and 5.
13. Remove Tool (B).
14. Remove Tool (A).
15. Recheck valve clearance. (Cold value)
16. Finally check valve clearance with warmed up engine. (Hot value)



Valve clearance:

Unit: mm (in)

	Cold* (reference data)	Hot
Intake	0.26 - 0.34 (0.010 - 0.013)	0.32 - 0.40 (0.013 - 0.016)
Exhaust	0.29 - 0.37 (0.011 - 0.015)	0.33 - 0.41 (0.013 - 0.016)

*: Approximately 20°C (68°F)

OIL SEAL

OIL SEAL

PF0:00100

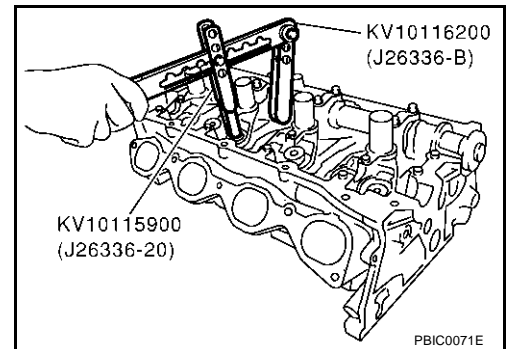
Removal and Installation of Valve Oil Seal REMOVAL

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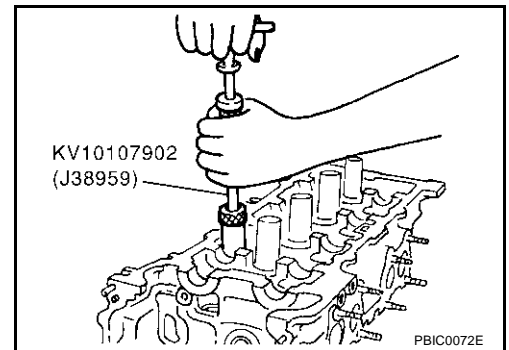
1. Remove camshaft relating to valve oil seal to be removed. Refer to [EM-46, "CAMSHAFT"](#) .
2. Remove adjusting shims and valve lifters. Refer to [EM-46, "CAMSHAFT"](#) .
 - Correctly identify location where each part is installed. Keep parts in an organized way to avoid mixing them up.
3. Turn crankshaft until the cylinder requiring new oil seals is at TDC. This will prevent the valve from dropping into the cylinder.
4. Remove valve collet.
 - Compress valve spring with valve spring compressor. Remove valve collet with magnet driver.
5. Remove valve spring retainer and valve spring.

CAUTION:

Do not remove valve spring seat from valve spring.

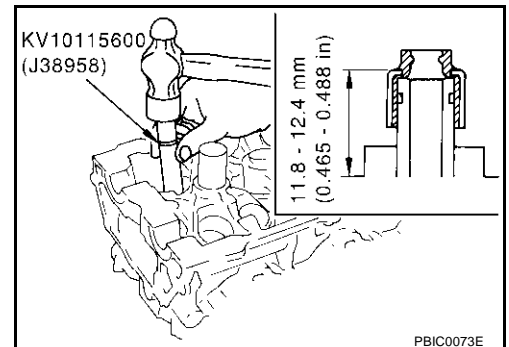


6. Remove valve oil seal using valve oil seal puller (special service tool).



INSTALLATION

1. Apply engine oil on new valve oil seal joint and seal lip.
2. Install valve oil seal.
 - Install with valve oil seal drift to match dimension in illustration.
3. Perform steps in the reverse order of removal for the following operations.

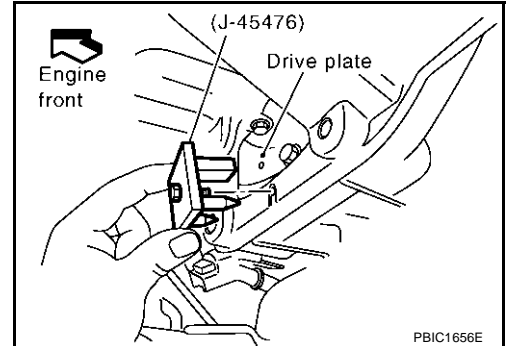


OIL SEAL

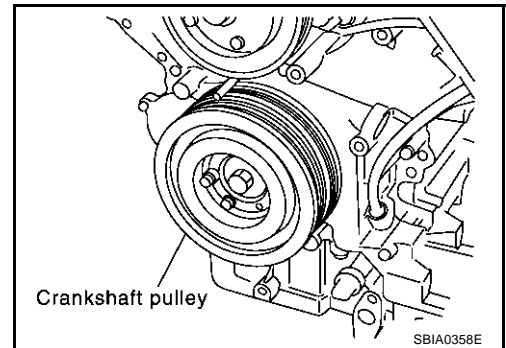
EBS00JX8

Removal and Installation of Front Oil Seal REMOVAL

1. Remove the following parts:
 - Undercover
 - Drive belt; Refer to [EM-12, "DRIVE BELTS"](#) .
 - Cooling fan; Refer to [CO-18, "COOLING FAN"](#) .
2. Set ring gear stopper (SST).



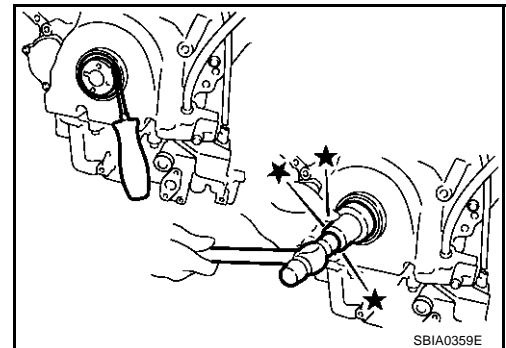
3. Remove crankshaft pulley.



4. Remove front oil seal using a suitable tool.

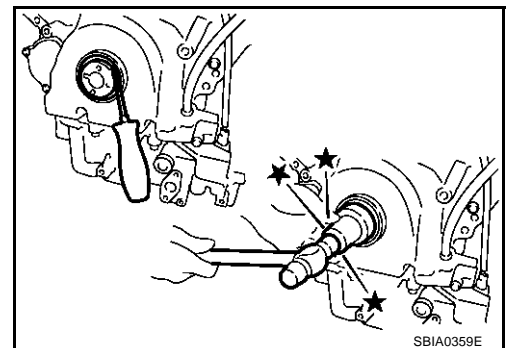
CAUTION:

Be careful not to damage front timing chain case and crankshaft.



INSTALLATION

1. Install front oil seal onto front cover.
 - Apply engine oil on new front oil seal.
 - Using oil seal drift or drift with 54 mm (2.13 in) diameter, force fit the seal until it levels with the front end surface of front cover.



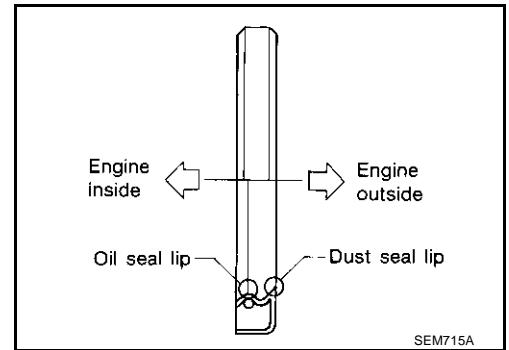
OIL SEAL

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

CAUTION:

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

2. For the following operations, perform steps in the reverse order of removal.
3. Perform steps in the reverse order of removal for the following operations.



A

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OIL SEAL

EBS00JX9

Removal and Installation of Rear Oil Seal

REMOVAL

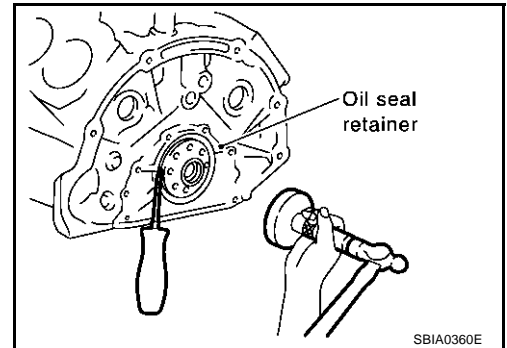
1. Remove transmission assembly. Refer to [AT-297, "TRANSMISSION ASSEMBLY"](#) .
 - a. Remove drive plate.
 - Holding crankshaft pulley mounting bolts, lock crankshaft to remove bolts fixing drive plate.
 - Loosen fixing bolts diagonally.

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.
2. Remove rear oil seal using a suitable tool.

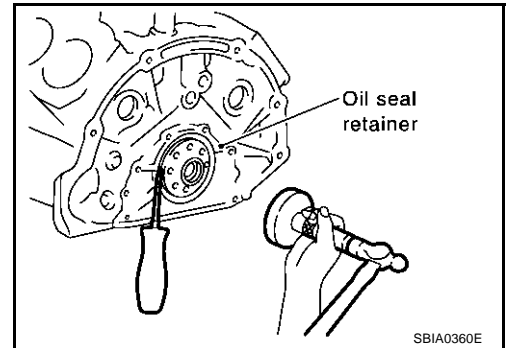
CAUTION:

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



INSTALLATION

1. Install rear oil seal to oil seal retainer.
 - Tap until flattened with front edge of oil seal retainer. Do not damage or scratch outer circumference of oil seal.

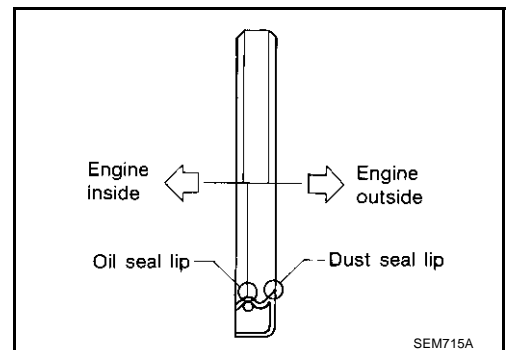


- Install new oil seal in the direction shown in the figure.

CAUTION:

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

2. Perform steps in the reverse order of removal for the following operations.



CYLINDER HEAD

CYLINDER HEAD

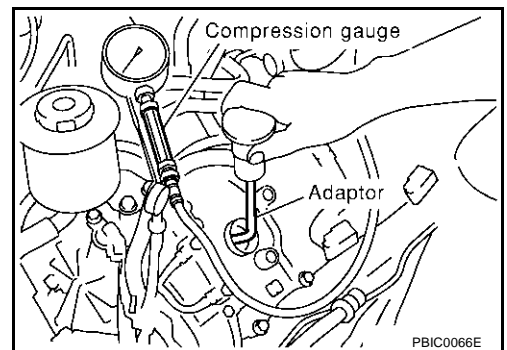
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On-Vehicle Service

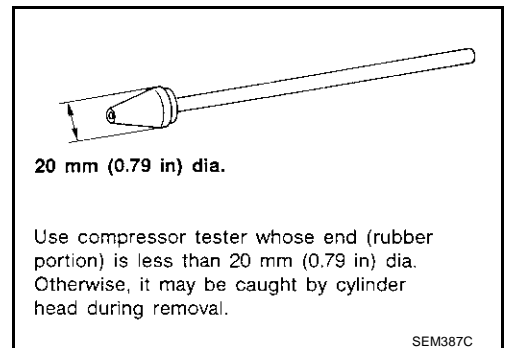
EBS001K1

CHECKING COMPRESSION PRESSURE

1. Remove engine cover with power tool, air cleaner cover and battery cover. Refer to [EM-11, "Removal and Installation"](#).
2. Warm up engine thoroughly. Then, stop it.
3. Release fuel pressure.
 - a. Remove fuel pump fuse, and start engine. Refer to [EC-48, "FUEL PRESSURE RELEASE"](#) for fuel pump fuse location.
 - b. After engine stalls, crank it two or three times to release all fuel pressure.
 - Let fuel pump fuse removed until the end of step 7.
4. Remove ignition coil and spark plug from each cylinder. Refer to [EM-28, "Removal and Installation"](#) and [EM-29, "Removal and Installation"](#).
5. Connect engine tachometer (not required in use of CONSULT-II).
6. Install compression gauge with adaptor onto spark plug hole.
 - Use compression gauge adapter which is required on No.7 and No.8 cylinders.



- Use compression gauge whose picking up end inserted to spark plug hole is smaller than 20 mm (0.79 in) in diameter. Otherwise, it may be caught by cylinder head during removal.
7. 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.



Compression pressure

Unit: kPa (kg/cm², psi) /rpm

Standard	Minimum	Deference limit between cylinders
1,320 (13.5, 191) / 300	1,130 (11.5, 164) / 300	98 (1.03, 14) / 300

CAUTION:

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

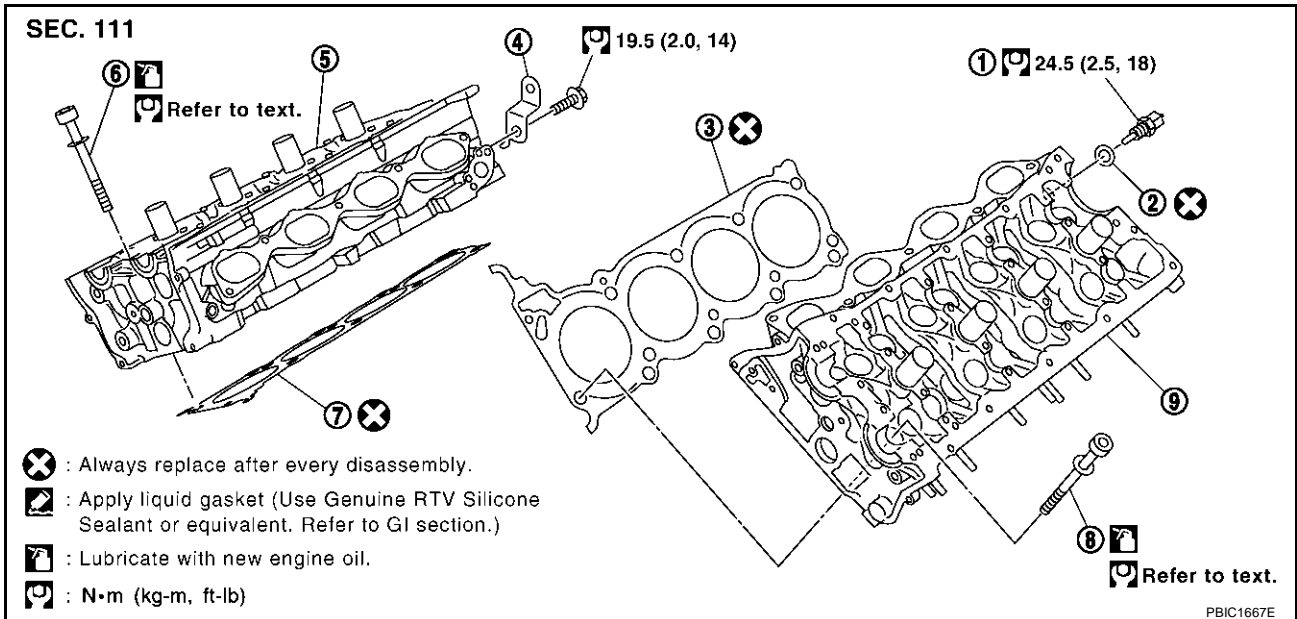
- If the engine speed is out of specified range, check battery liquid for proper gravity. Check engine speed again with normal battery gravity.
- If compression pressure is below minimum value, check valve clearances and parts associated with combustion chamber (Valve, valve seat, piston, piston ring, 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.

CYLINDER HEAD

- If two adjacent cylinders have respectively low compression pressure and their compression remains low even after the addition of engine oil, the gaskets are leaking. In such a case, replace the cylinder head gaskets.
8. Install removed parts in the reverse order of removal.
 9. Start engine, and confirm that engine runs smoothly.
 10. Perform trouble diagnosis. If DTC appears, erase it. Refer to [EC-74, "TROUBLE DIAGNOSIS"](#).

Removal and Installation

EBS00NBD



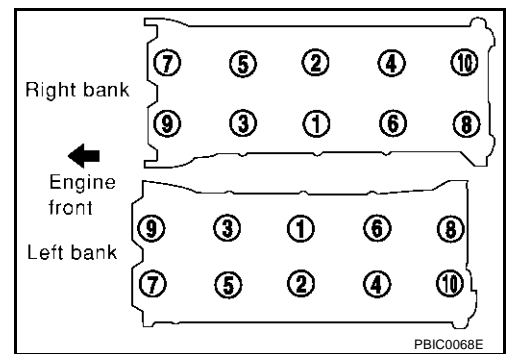
- | | | |
|--------------------------------------|-------------------------------|-------------------------------------|
| 1. Engine coolant temperature sensor | 2. Washer | 3. Cylinder head gasket (left bank) |
| 4. Harness bracket | 5. Cylinder head (right bank) | 6. Cylinder head bolt |
| 7. Cylinder head gasket (right bank) | 8. Cylinder head bolt | 9. Cylinder head (left bank) |

REMOVAL

1. Remove engine assembly from vehicle. Refer to [EM-70, "Removal and Installation"](#).
2. Remove the following components and related parts:
 - Auto tensioner of drive belts and idler pulley. Refer to [EM-14, "Drive Belt Auto Tensioner and Idler Pulley"](#).
 - Thermostat housing and hose. Refer to [CO-24, "Removal and Installation"](#).
 - Oil pan and oil strainer. Refer to [EM-25, "Removal and Installation"](#).
 - Intake manifold upper and intake manifold lower. Refer to [EM-17, "Removal and Installation"](#).
 - Fuel tube and fuel injector assembly. Refer to [EM-31, "Removal and Installation"](#).
 - Ignition coil. Refer to [EM-28, "Removal and Installation"](#).
 - Rocker cover. Refer to [EM-33, "Removal and Installation"](#).
 - Exhaust manifold and three way catalyst. Refer to [EM-22, "Removal and Installation"](#).
3. Remove crankshaft pulley, front cover, oil pump, and timing chain. Refer to [EM-35, "Removal and Installation"](#).
4. Remove camshaft sprockets and camshafts. Refer to [EM-46, "Removal and Installation"](#).

CYLINDER HEAD

- Remove cylinder head loosening bolts in reverse order shown in the figure and using cylinder head bolt wrench (Commercial service tool).



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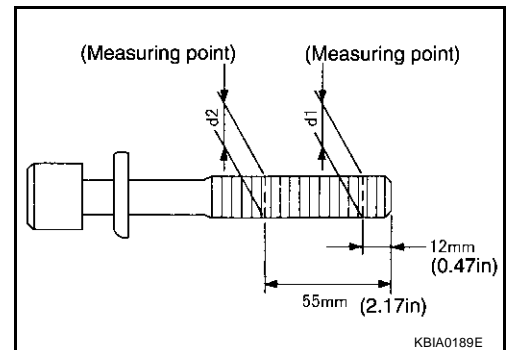
INSPECTION AFTER REMOVAL

Outer Diameter of Cylinder Head Bolts

- Cylinder head bolts are tightened by plastic zone tightening method. Whenever the size difference between d_1 and d_2 exceeds the limit, replace them with new one.

Limit ($d_1 - d_2$) : More than 0.18 mm (0.0071 in)

- If reduction of outer diameter appears in a position other than d_2 , use it as d_2 point.



D
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INSTALLATION

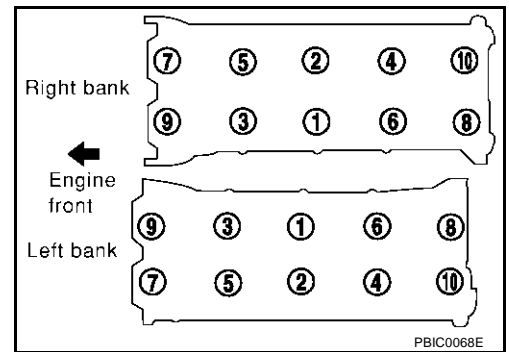
- Install cylinder head gasket.
- Follow the steps below to tighten fixing bolts in the order shown in figure to install cylinder head.

CAUTION:

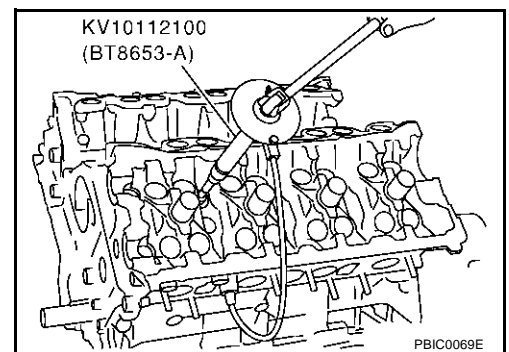
- If cylinder head bolts are re-used, check their outer diameters before installation. Refer to above [EM-63, "Outer Diameter of Cylinder Head Bolts"](#).
 - In step "c", loosen bolts in the reverse order of that indicated in figure.
- Apply engine oil to threads and seating surface of bolts.
 - Tighten all bolts to 98.1 N·m (10 kg·m, 72 ft·lb).
 - Completely loosen all bolts.
 - Tighten all bolts to 39.2 to 49.0 N·m (4.0 to 5.0 kg·m, 29 to 36 ft·lb).
 - Turn all bolts 60 to 65 (target: 60) degrees clockwise.
 - Turn all bolts 60 to 65 (target: 60) degrees clockwise again.

CAUTION:

Check and confirm the tightening angle by using angle wrench (SST) and cylinder head bolt wrench (commercial service tool). Avoid judgment by visual inspection without the SST.



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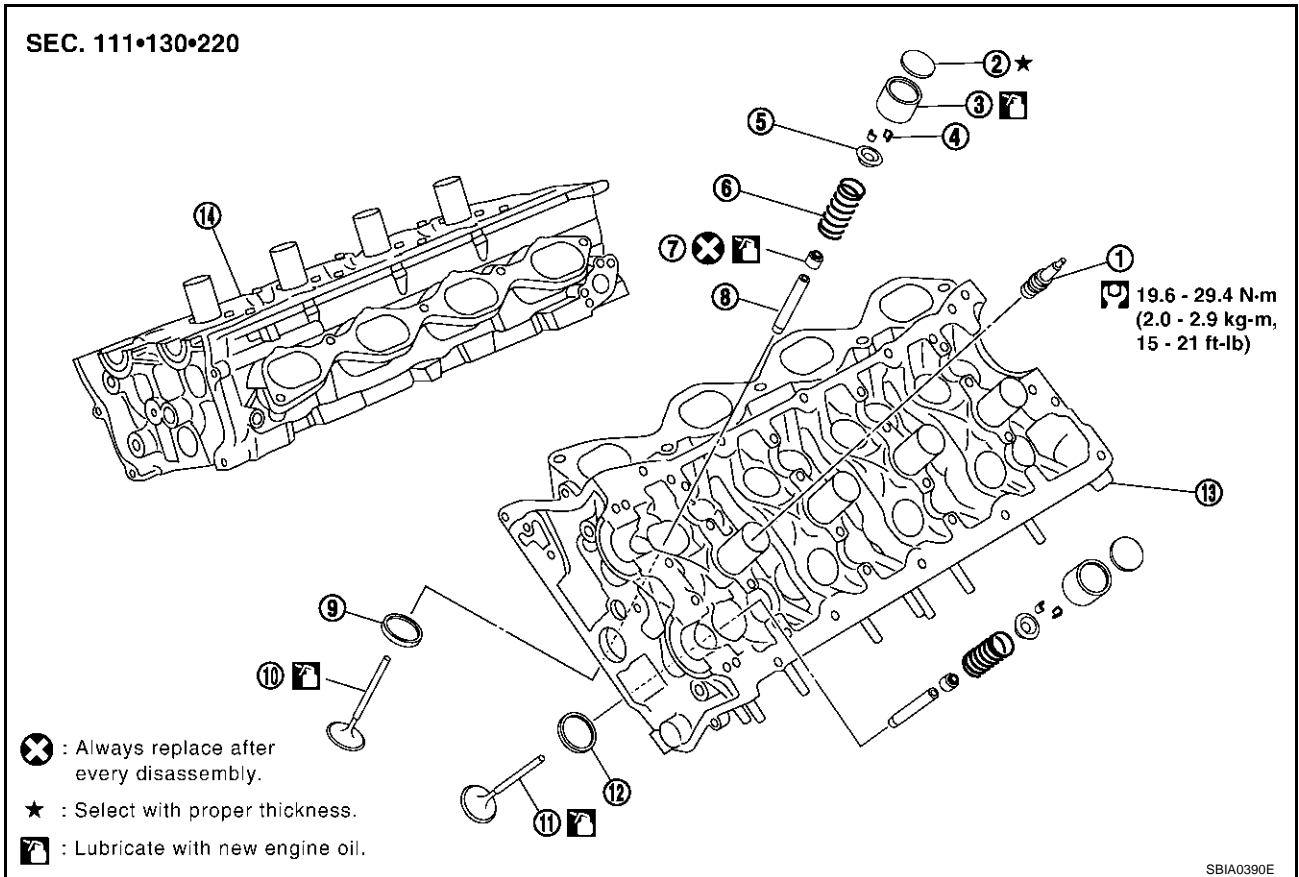


- Install followings in reverse order of removal.

CYLINDER HEAD

Disassembly and Assembly

EBS002MT



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

DISASSEMBLY

- Remove spark plug with spark plug wrench.
- Remove spark plug tube, as necessary.
 - Using a pair of pliers, pull spark plug tube out of cylinder head.
- Remove adjusting shim and valve lifter.
 - Confirm installation point. Keep parts in an organized way to avoid.
- Remove valve collet.
 - Compress valve spring with valve spring compressor. Remove valve collet with magnet driver.
- Remove valve spring retainer and valve spring.

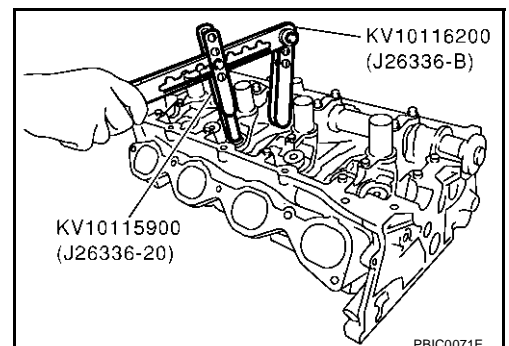
CAUTION:

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

CAUTION:

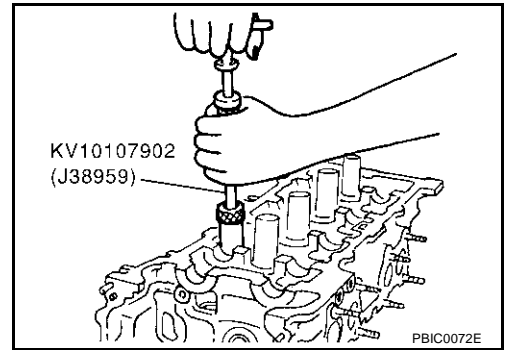
Do not remove valve spring seat from valve spring.

- Push valve stem to combustion chamber side, and remove valve.
 - Inspect valve guide clearance before removal. Refer to [EM-66, "VALVE GUIDE CLEARANCE"](#).



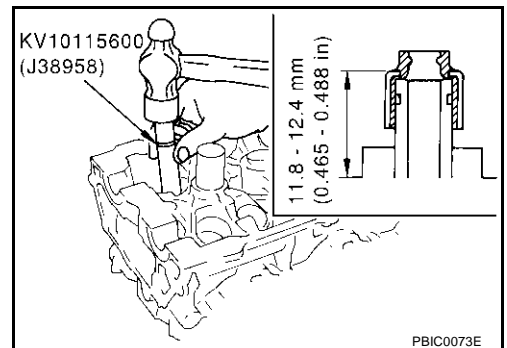
CYLINDER HEAD

- Confirm installation point. Keep parts in an organized way to avoid.
7. Remove valve oil seal with valve oil seal puller.
 8. When valve seat must be replaced, refer to [EM-68, "VALVE SEAT REPLACEMENT"](#).
 9. When valve guide must be replaced, refer to [EM-66, "VALVE GUIDE REPLACEMENT"](#).

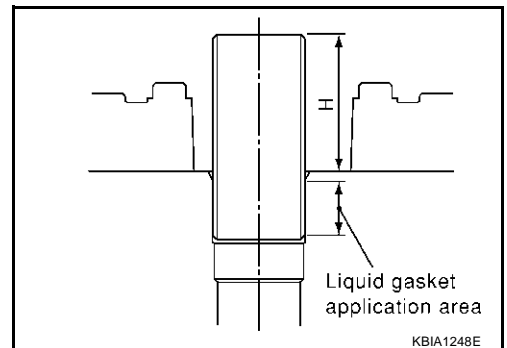
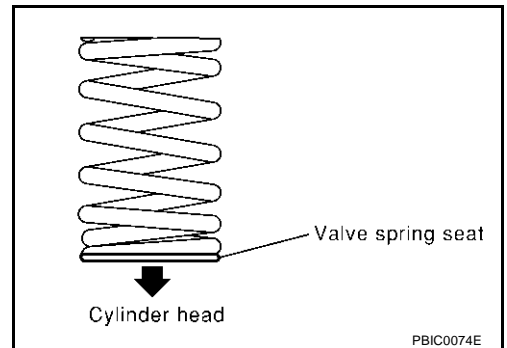


ASSEMBLY

1. Install valve guide. Refer to [EM-66, "VALVE GUIDE REPLACEMENT"](#).
2. Install valve seat. Refer to [EM-68, "VALVE SEAT REPLACEMENT"](#).
3. Install valve oil seal.
 - Install with valve oil seal drift to match dimension in illustration.
4. Install valve.
 - Install larger diameter to intake side.



5. Install valve spring.
 - Install smaller pitch (valve spring seat side) to cylinder head side.
6. Install valve spring retainer.
7. Install valve collet.
 - Compress valve spring with valve spring compressor. Install valve collet with magnet hand.
 - Tap stem edge lightly with plastic hammer after installation to check its installed condition.
8. Install valve lifter.
9. 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 liquid gasket or equivalent.
- c. Using a drift, press-fit spark plug tube so that its height "H" in the figure is as specified.



Standard press-fit height "H":

38.4 - 39.4 mm (1.512 - 1.551 in)

CAUTION:

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

CYLINDER HEAD

EBS003MN

Inspection After Disassembly CYLINDER HEAD DISTORTION

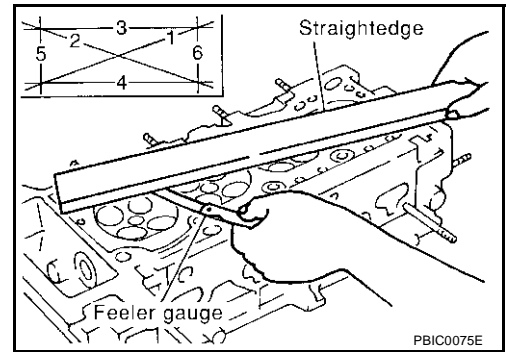
1. Wipe off oil and remove water scale (like deposit), gasket, sealer, carbon, etc. with scraper.

CAUTION:

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

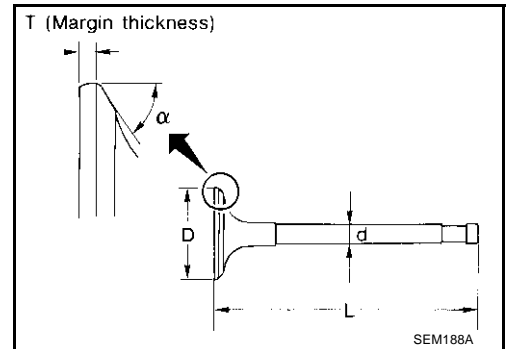
2. At each of several locations on bottom surface of cylinder head, measure distortion in six directions.

Limit : 0.1mm (0.004 in)



VALVE DIMENSIONS

- Check dimensions of each valve. For dimensions, refer to [EM-98, "Valve Dimensions"](#).



VALVE GUIDE CLEARANCE

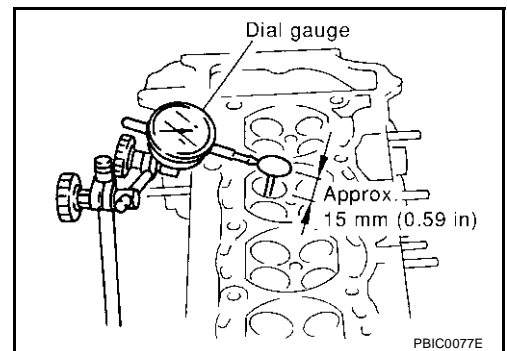
Perform this inspection before removing valve guide.

1. Make sure that the valve stem diameter is within the specification.
2. Push the valve out by approx. 15 mm (0.59 in) toward the combustion chamber side to measure the valve's run-out volume (in the direction of dial gauge) with dial gauge.
3. The half of the run-out volume accounts for the valve guide clearance.

Standard

Intake : 0.020 - 0.046 mm (0.0008 - 0.0018 in)

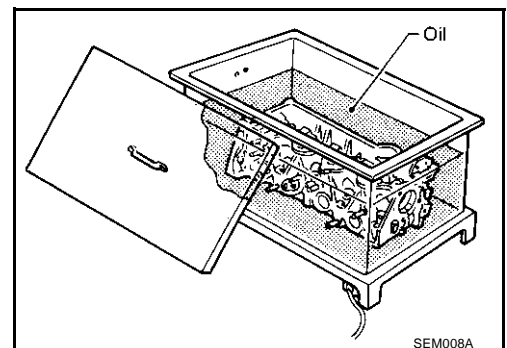
Exhaust : 0.030 - 0.056 mm (0.0012 - 0.0022 in)



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.

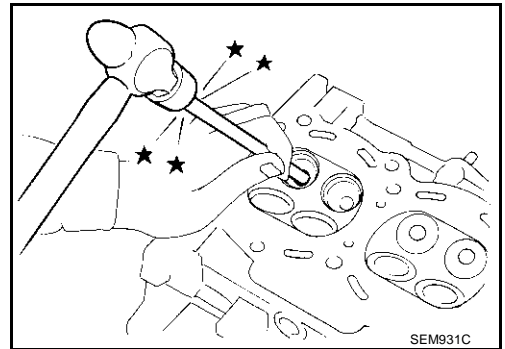


CYLINDER HEAD

2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.

CAUTION:

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



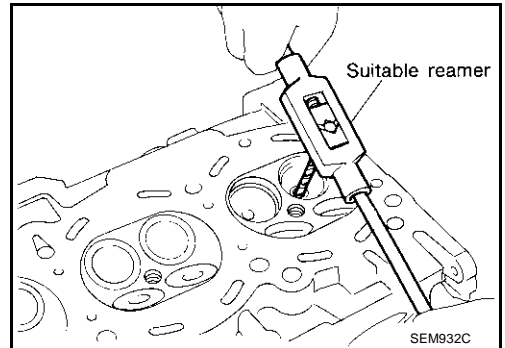
3. Ream cylinder head valve guide hole.

Valve guide hole diameter (for service parts)

Intake and exhaust:

10.175 - 10.196 mm (0.4006 - 0.4014 in)

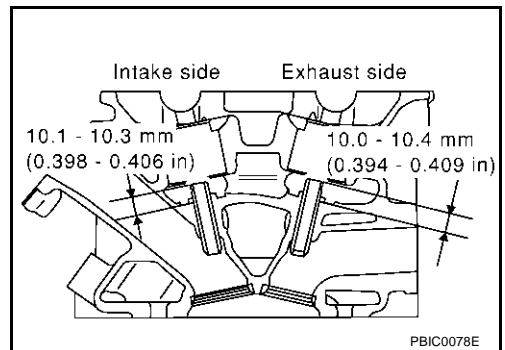
4. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.



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.

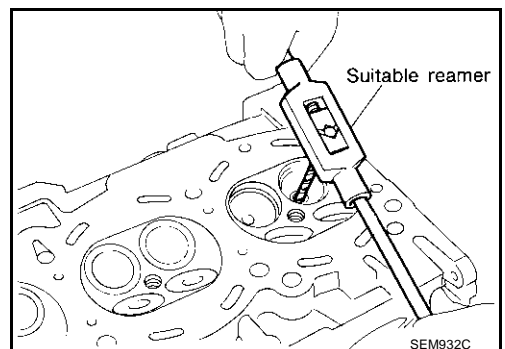


6. Using valve guide reamer, apply reamer finish to valve guide.

Standard

Intake and exhaust:

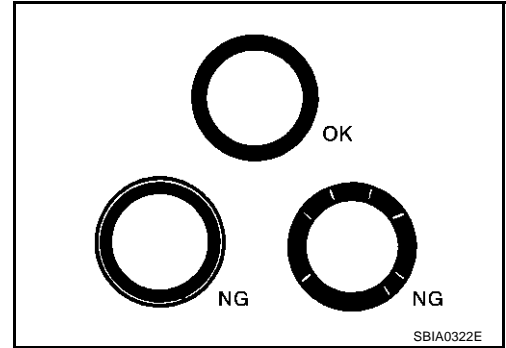
6.000 - 6.018 mm (0.2362 - 0.2369 in)



CYLINDER HEAD

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 N.G conditions even after the re-check, replace valve seat.



VALVE SEAT REPLACEMENT

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

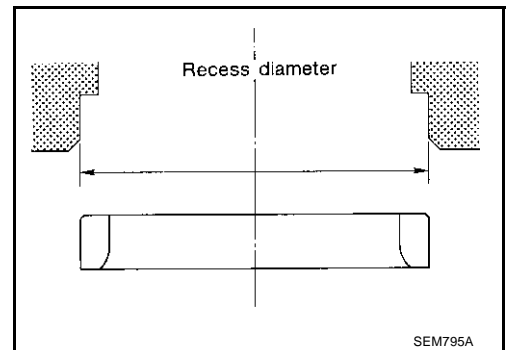
1. Bore out old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in cylinder head. Set the machine depth stop to ensure this.
2. Ream cylinder head recess diameter for service valve seat.

Oversize [0.5 mm (0.020 in)]:

Intake 37.500 - 37.516 mm (1.4764 - 1.4770 in)

Exhaust 32.700 - 32.716 mm (1.2874 - 1.2880 in)

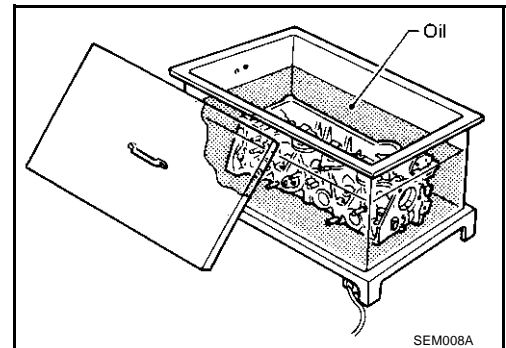
- Be sure to ream in circles concentric to the valve guide center.
- This will enable valve seat to fit correctly.



3. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.
4. Provide valve seats cooled well with dry ice. Force fit valve seat into cylinder head.

CAUTION:

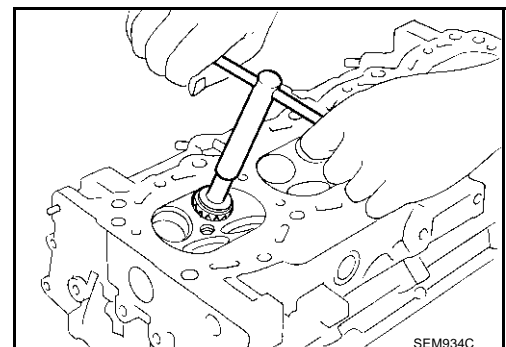
- Avoid directly touching cold valve seats.
- Cylinder head contains heat, when working wear protective equipment to avoid getting burned.



5. Using valve seat cutter set and valve seat grinder, finish the seat to the specified dimensions.

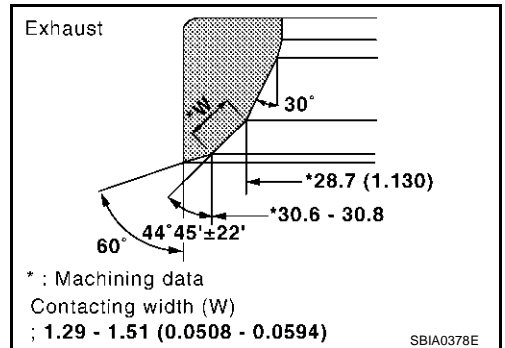
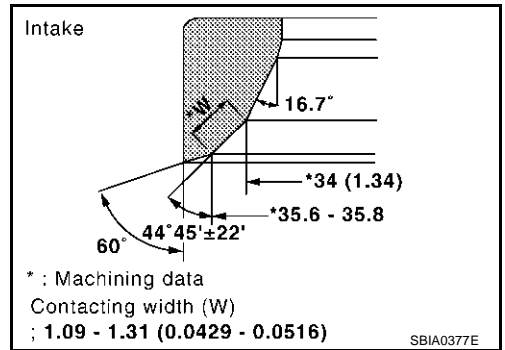
CAUTION:

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.



CYLINDER HEAD

- Grind to obtain the dimensions indicated in figure.



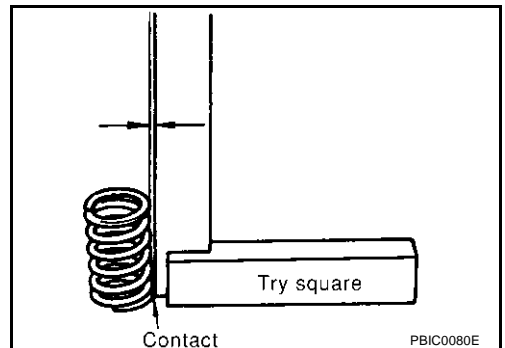
- Using compound, grind to adjust valve fitting.
- Check again for normal contact.

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 : 2.0 mm (0.079 in)

- If it exceeds the limit, replace valve spring.



VALVE SPRING DIMENSIONS AND VALVE SPRING PRESSURE LOAD

Check valve spring pressure at specified spring height.

CAUTION:

Do not remove valve spring seat from valve spring (parts for assy).

Standard:

Free height 46.35 - 46.85 mm (1.8247 - 1.8444 in)

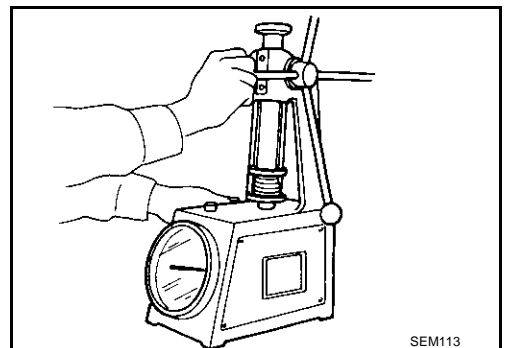
Installation height 33.8 mm (1.331 in)

Installation load 165- 189 N (16.8 - 19.3 kg, 37- 42 lb)

Height during valve open 24.4 mm (0.961 in)

Load with valve open 290- 330 N (29.6- 33.7 kg, 65 - 74 lb)

- If the dimensions exceed the standard, replace the valve spring.



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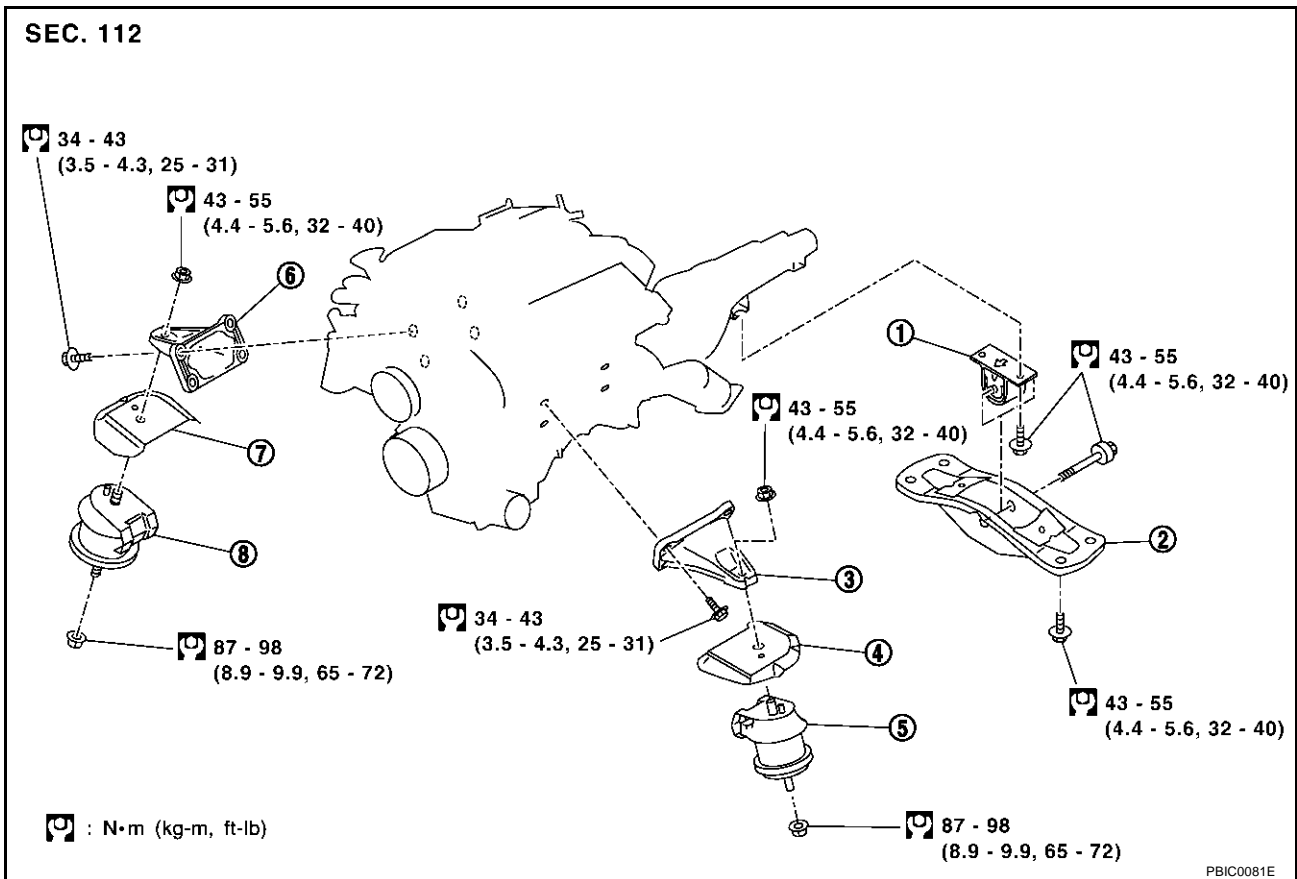
ENGINE ASSEMBLY

PFP:10001

ENGINE ASSEMBLY

Removal and Installation

EBS001K5



- | | | |
|-----------------------------------|---------------------------------|-------------------------------|
| 1. Rear engine mounting insulator | 2. Rear member | 3. LH engine mounting bracket |
| 4. Heat insulator | 5. LH engine mounting insulator | 6. RH engine mounting bracket |
| 7. Heat insulator | 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 cool enough.
- If items or work required are not covered by the engine section, refer to the applicable sections.
- Always use the support point specified for lifting.
- Use either 2-point lift type or separate type lift as best you can. 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

Outline

After removal of transmission, lift up engine assembly to remove it from vehicle.

Preparation

1. Release fuel pressure. Refer to [EC-48. "FUEL PRESSURE RELEASE"](#).
2. Remove engine cover and engine undercover with power tool.

ENGINE ASSEMBLY

3. Drain engine coolant from radiator drain plug. Refer to [CO-9, "Changing Engine Coolant"](#) .
4. Remove the following parts:
 - Engine hood
 - Front tower bar
 - Battery
 - Air duct (inlet)
 - Air duct and air cleaner case assembly
 - Drive belts (Refer to [EM-13, "REMOVAL"](#) .)
 - Power valve vacuum tank
 - Cooling fan and tubes
 - Radiator assembly and hoses (Refer to [CO-12, "RADIATOR"](#) .)
 - Water suction pipe

Engine room LH

5. Disconnect engine room harness from the engine side and set it aside for easier work.
6. Disconnect heater hoses, and install plugs to avoid leakage of engine coolant.
7. Disconnect wire bonding exhaust manifold cover to vehicle.
8. Disconnect vacuum hose between vehicle and engine and set it aside.
9. Remove reservoir tank for cooling fan.
10. Remove A/C compressor from brackets, and install A/C compressor temporarily with ropes or equivalent to avoid applying any pressures on piping or disturbing installation or removal of any vehicle parts. Refer to [ATC-144, "Compressor"](#) .

Engine room RH

11. Disconnect fuel hose at the engine side connection.
 - For disconnection/connection of quick connector, refer to [EM-31, "Removal and Installation"](#) .
12. Disconnect engine room harness from the engine side and set it aside for easier work.
13. Disconnect wire bonding exhaust manifold cover to vehicle.
14. Disconnect vacuum hose between vehicle and engine and set it aside.
15. Disconnect reservoir tank for power steering from engine and move it aside for easier work.
16. Move away relay case.


Vehicle underbody

17. Disconnect power steering oil pump from engine. Move it from its location and secure with a rope for easier work. Refer to [PS-23, "POWER STEERING OIL PUMP"](#) .
18. Remove pipe of cooler for automatic transmission.
19. Remove exhaust front tube.
20. Disconnect steering lower joint, and release steering shaft. Refer to [PS-15, "POWER STEERING GEAR AND LINKAGE"](#) .
21. Disconnect propeller shaft. Refer to [PR-3, "REAR PROPELLER SHAFT"](#) .
 - After disconnection, plug the opening on transmission side.

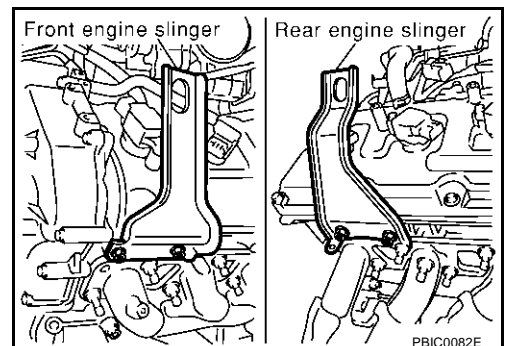
Removal

22. Remove transmission assembly. Refer to [AT-297, "TRANSMISSION ASSEMBLY"](#) .
23. Install engine slingers into front of left bank cylinder head and rear of right bank cylinder head.

Slinger bolts:

: **30.4 - 36.3 N·m (3.1 - 3.7 kg·m, 23 - 26 ft·lb)**

24. Lift with hoist and secure the engine in position.
25. Remove engine mounting nuts on bottom surface.
26. Carefully lift up engine assembly, avoiding interference with vehicle body, move it away and upward.

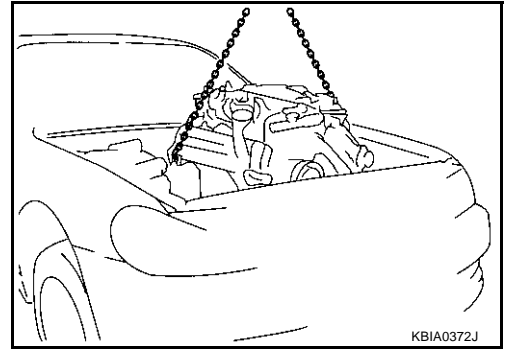


ENGINE ASSEMBLY

27. With engine assembly lifted up, remove rear end of exhaust manifold to avoid contact with vehicle.
28. Remove engine assembly from vehicle.

CAUTION:

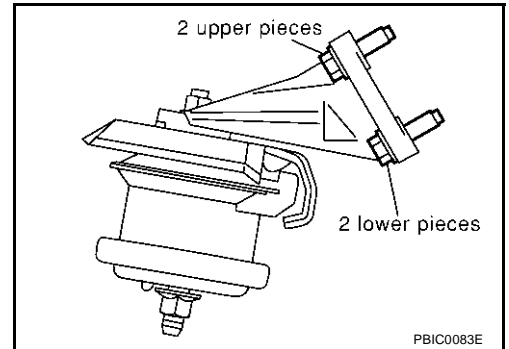
- Before and during this lifting, always check if any harnesses are left connected.
- Avoid damage to oil/grease smearing or spills onto engine mount insulator.



INSTALLATION

Install in the reverse order of removal.

- Where positioning pin is used, be sure to securely insert it into the hole of mating part.
- When installing front engine mount bracket to cylinder block, first tighten two bolts on upper side. Then, tighten two bolts on lower side. (The same applies to both right and left.)



INSPECTION AFTER INSTALLATION

- Before starting engine, check the levels of engine coolant, lubrications, working oils.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of engine coolant, lubricants, working oil, fuel, and exhaust gas.
- Bleed air from passages in pipes and tubes of applicable lines.

CYLINDER BLOCK

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, "ENGINE ASSEMBLY"](#) .
2. Remove the parts that may restrict installation of engine to general-purpose engine stand.

NOTE:

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

- a. Remove drive plate.
 - Holding crankshaft pulley mounting bolts, lock crankshaft to remove bolts fixing drive plate.
 - Loosen fixing 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.
3. Lift the engine with hoist to install it onto the general-purpose engine stand.

CAUTION:

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

- If the load capacity of the stand is not adequate, remove the following parts beforehand to reduce the potential risk of overturning the stand.
 - Remove intake manifold upper and intake manifold lower. Refer to [EM-17, "INTAKE MANIFOLD"](#) .
 - Remove exhaust manifold and three way catalyst. Refer to [EM-22, "EXHAUST MANIFOLD AND THREE WAY CATALYST"](#) .
 - Remove fuel injector and fuel tube. Refer to [EM-31, "FUEL INJECTOR AND FUEL TUBE"](#) .
 - Remove starter motor. Refer to [SC-28, "Removal and Installation"](#) .
 - Remove ignition coil. Refer to [EM-28, "IGNITION COIL"](#) .
 - Remove rocker cover. Refer to [EM-33, "ROCKER COVER"](#) .
 - Other removable brackets.

NOTE:

The figure shows an example of general-purpose engine stand that can hold mating surface of transmission with drive plate and rear plate removed.

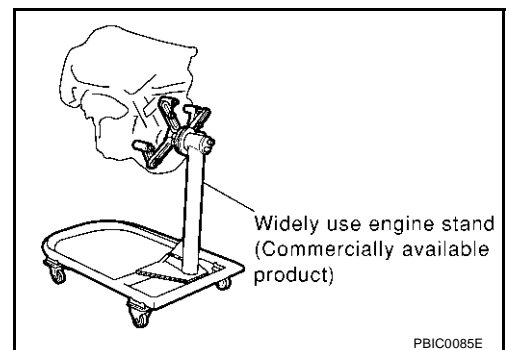
CAUTION:

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

4. Drain engine oil and engine coolant from inside of engine.
5. 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-25, "OIL PAN AND OIL STRAINER"](#) .
 - Crankshaft pulley, front cover and timing chain: Refer to [EM-35, "TIMING CHAIN"](#) .
 - Camshaft: Refer to [EM-46, "CAMSHAFT"](#) .
 - Cylinder head: Refer to [EM-61, "CYLINDER HEAD"](#) .
6. Remove knock sensor.

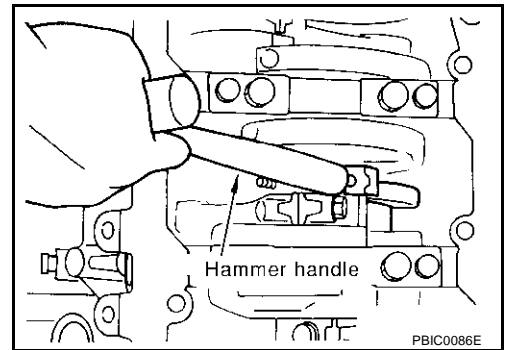
CAUTION:

Carefully handle the sensor, avoiding shocks.



CYLINDER BLOCK

7. Remove the piston and connecting rod assembly.
 - 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 hammer handle or similar tool, push the piston and connecting rod assembly out to the cylinder head side.
 - Before removing the piston and connecting rod assembly, check the connecting rod side clearance. Refer to [EM-88, "CONNECTING ROD SIDE CLEARANCE"](#) .
8. Remove the connecting rod bearings.



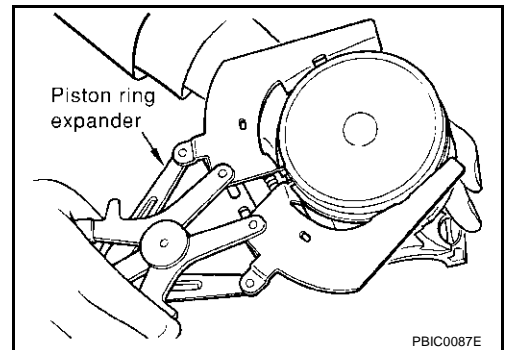
CAUTION:

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

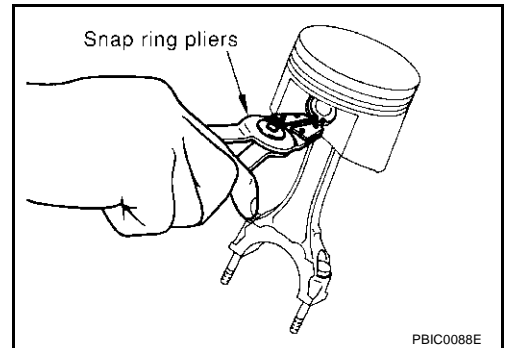
9. Remove the piston rings from the piston.
 - Use a piston ring expander.

CAUTION:

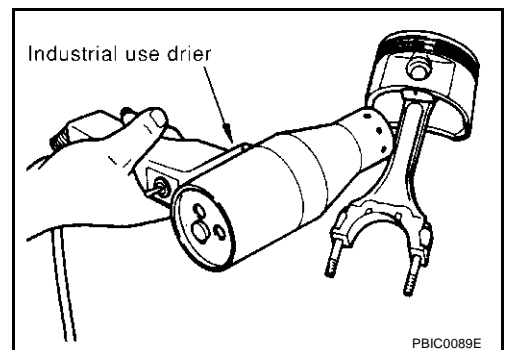
- When removing the piston rings, be careful not to damage the piston.
- Be careful not to damage piston rings by expanding them excessively.
- Before removing the piston rings, check the piston ring side clearance. Refer to [EM-89, "PISTON RING SIDE CLEARANCE"](#) .



10. Remove the piston from the connecting rod as follows.
 - a. Using a snap ring pliers, remove the snap ring.



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



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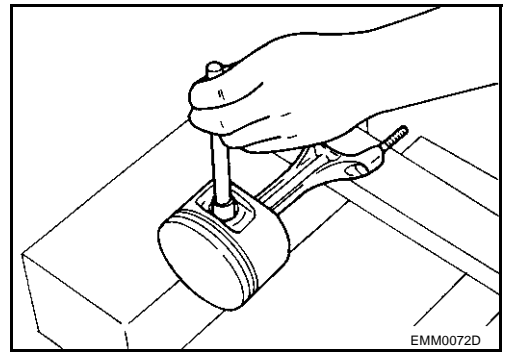
CYLINDER BLOCK

- c. Push out piston pin with stick of outer diameter approximately 20 mm (0.8 in).
- 11. Remove the rear oil seal retainer from the cylinder block.
 - Insert a minus-head screwdriver or similar tool between the rear end of the crankshaft counter weight and rear oil seal retainer, and separate the liquid gasket to remove.

CAUTION:

Be careful not to damage the mating surface.

- 12. Using a minus-head screwdriver or similar tool, and lever off the rear oil seal from the rear oil seal retainer.

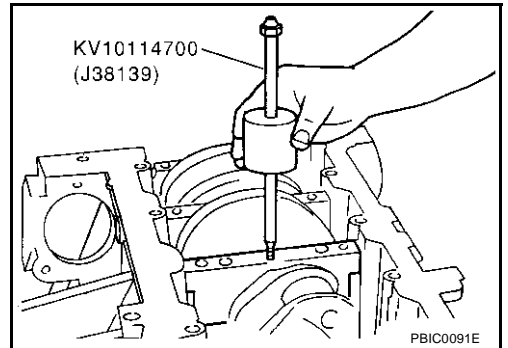
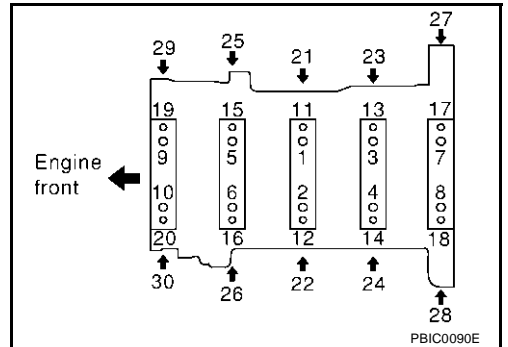


- 13. Remove the main bearing cap as follows:
 - Before loosening the main bearing cap bolts, measure the crankshaft end play. Refer to [EM-87, "CRANKSHAFT END PLAY"](#).
 - Loosen bolts in several different steps.
- a. Remove the cover attached to the rear right side of the cylinder block (next to the starter motor housing).

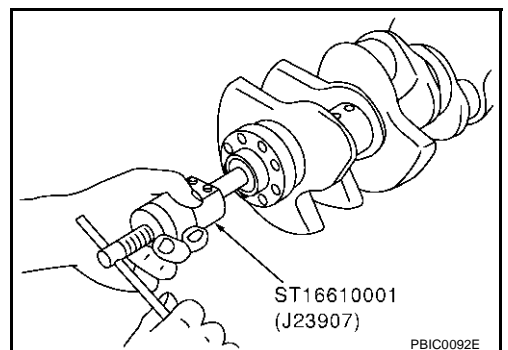
NOTE:

Bolts (No. 28 shown in the figure) are installed on the inside of the cover.

- b. Loosen the side bolts (M10) starting from 30 to 21 to remove.
- c. Loosen the main bearing cap sub bolts (M9) starting from 20 to 11 to remove.
- d. Loosen the main bearing cap bolts (M12) starting from 10 to 1 to remove.
- e. Using a main bearing cap remover, remove the main bearing cap.



- 14. Remove the crankshaft.
- 15. 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.
- 16. If the pilot converter must be removed, remove it from the rear end of the crankshaft using a pilot bearing puller.
 - Removal and installation without the engine stand is possible.



CYLINDER BLOCK

ASSEMBLY

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

CAUTION:

Use a goggles to protect your eye.

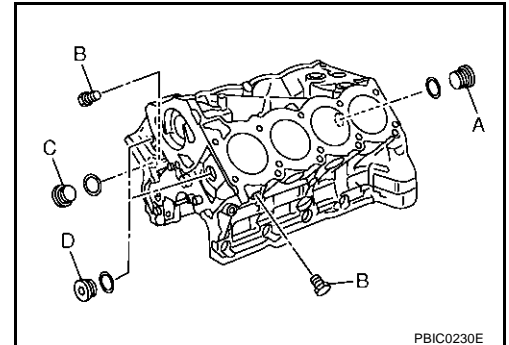
2. Install each plug to the cylinder block. (Only screwed-type plugs are shown in the figure.)

- Apply liquid gasket.

Use Genuine Thread Sealant or equivalent. Refer to [GL-46, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS"](#).

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

Part	Washer	Tightening torque
A	Yes.	49.0 - 58.8 N·m (5.0 - 6.0 kg·m, 37 - 43 ft·lb)
B	No.	14.7 - 24.5 N·m (1.5 - 2.5 kg·m, 11 - 18 ft·lb)
C	Yes.	57.8 - 67.6 N·m (5.9 - 6.9 kg·m, 43 - 49 ft·lb)
D	Yes.	57.8 - 67.6 N·m (5.9 - 6.9 kg·m, 43 - 49 ft·lb)

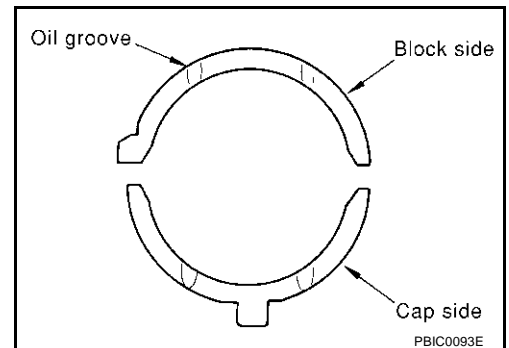


3. Install the main bearings and the thrust bearings.

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

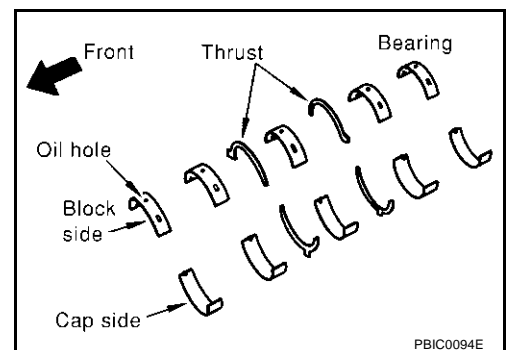
- b. Install the thrust bearings to the both sides of the No. 3 journal housing on the cylinder block and main bearing caps

- Install the thrust bearings with the engine 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 engine 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.

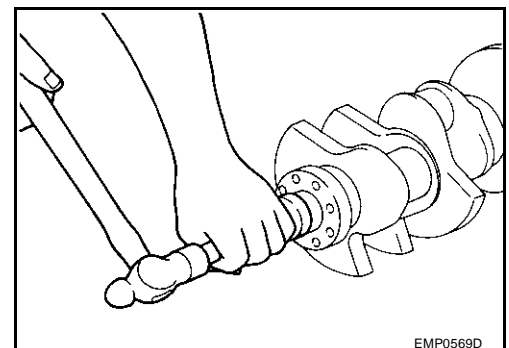


4. Install the pilot converter to the crankshaft.

- Using a drift approximately 35 mm (1.38 in) in outer diameter, drive the pilot converter until its front end contacts the crankshaft.
- Press-fit the pilot converter with its chamfering side facing the crankshaft. (Refer to "Component parts illustration on former page".)
- It is acceptable to install it without the engine stand.

5. Install the crankshaft to the cylinder block.

- While turning the crankshaft by hand, check that it turns smoothly.

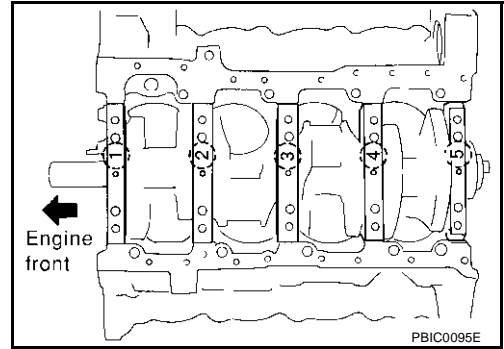


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CYLINDER BLOCK

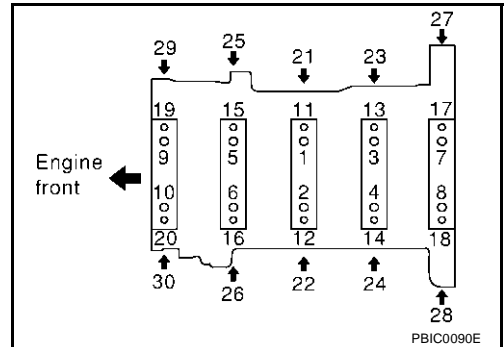
6. Install the main bearing caps.

- Align the identification number to the journal position to install.
- Install the upper side of the identification number facing the front of the engine. (The number shall be read correctly from the rear of the engine.)
- Using a plastic hammer or similar tool, tap them lightly to seat them on the installation position.



7. Follow the below steps to tighten each main bearing cap bolts.

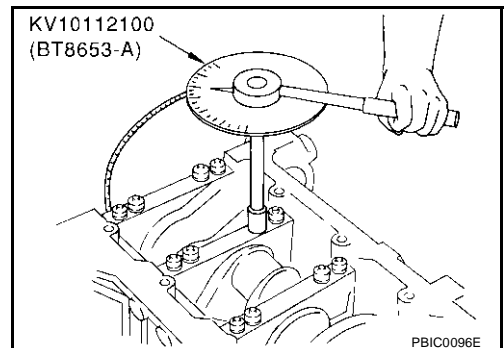
- Apply engine oil to threads and seating surface of bolts, and tighten all bolts temporarily.
- Tighten main bearing cap bolt (M12) to 36.3 to 42.1 N·m (3.7 to 4.3 kg-m, 27 to 31 ft-lb) in order of 1 to 10.
- Tighten main bearing cap sub bolt (M9) to 26.5 to 32.3 N·m (2.7 to 3.3 kg-m, 20 to 23 ft-lb) in order of 11 to 20.
- Tighten main bearing cap bolt (M12) to 40 to 45° degrees (ideal 40 degrees) in order of 1 to 10.
- Tighten main bearing cap sub bolt (M9) to 30 to 35° degrees (ideal 30 degrees) in order of 11 to 20.
- Tighten side bolt (M10) to 46.1 to 51.9 N·m (4.7 to 5.3 kg-m, 34 to 38 ft-lb) in order of 21 to 30.
- Install cover of cylinder block right-rear side (next to starter motor housing).



CAUTION:

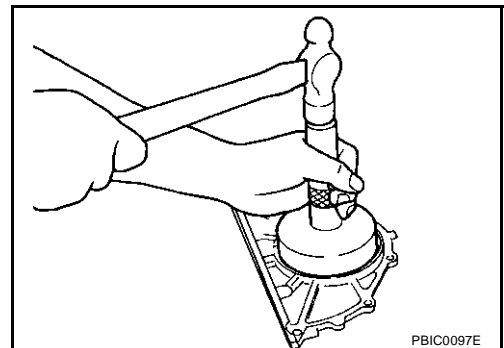
Measure tighten angle in step “d” and “e” with angle wrench. Do not measure visually.

- Rotate crankshaft by hands after bolts are tightened. Check if it rotates smoothly.
- Check the crankshaft end play. Refer to [EM-87, "CRANK-SHAFT END PLAY"](#).



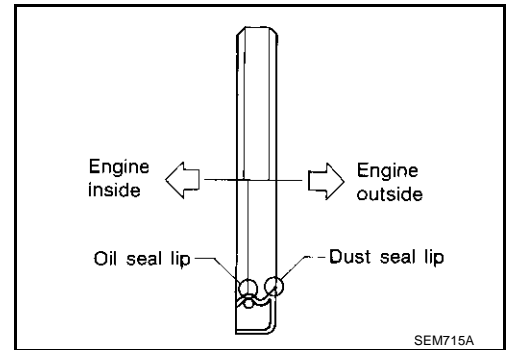
8. Install rear oil seal to oil seal retainer.

- Tap until flattened with front edge of oil seal retainer. Do not damage or scratch outer circumference of oil seal.



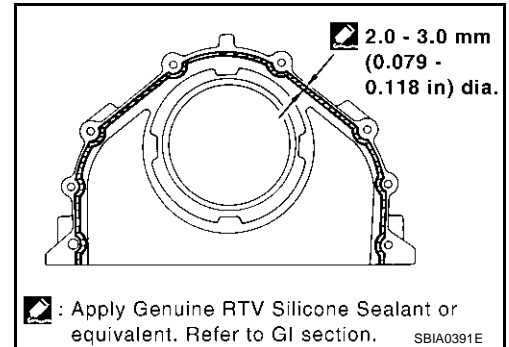
CYLINDER BLOCK

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



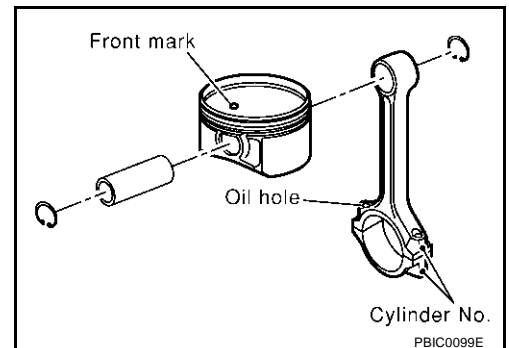
9. Install rear oil seal retainer.

- Apply liquid gasket thoroughly to rear oil seal retainer. **Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-46, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS".**
- Apply new engine oil on lips of oil seal. Do not touch.



10. Install the piston to the connecting rod.

- Using a snap ring pliers, install the snap ring to the grooves of the piston rear side.
 - Insert it fully into groove to install.
- Install the piston to the connecting rod.
 - Using an industrial drier or similar 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.
- Install the snap rings to the front of the piston.
 - After installing, check that the connecting rod moves smoothly.

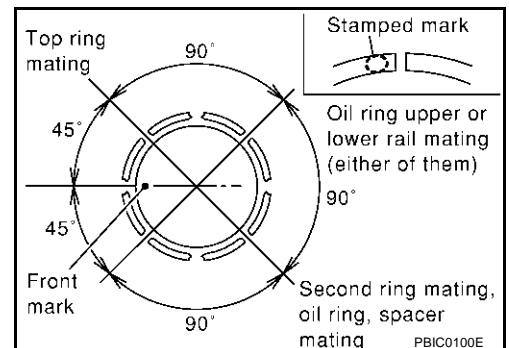


11. Using a piston ring expander, install the piston rings.

CAUTION:
Be careful not to damage the piston.

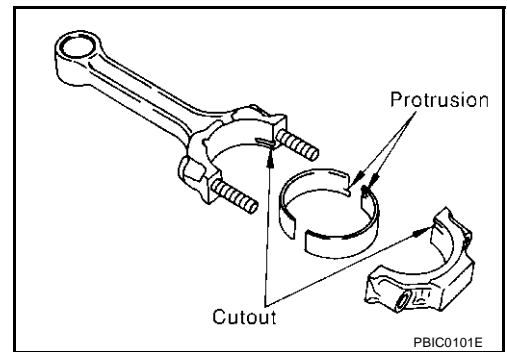
- Position each ring with the gap as shown in the figure, referring to the piston front mark.
- Install the top ring and the second ring with the stamped surface facing upward.

Stamped mark : R (top ring)
: 2R (second ring)

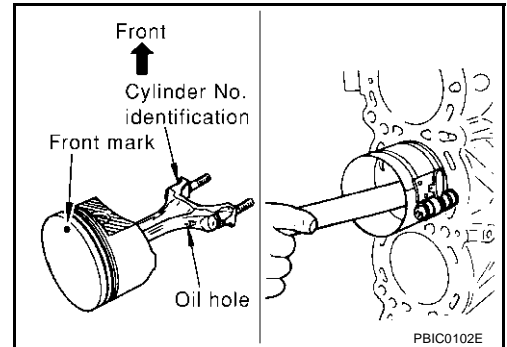


CYLINDER BLOCK

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 engine oil to the back surface, but thoroughly clean it.
 - When installing, align the connecting rod bearing stopper protrusion with the notch of the connecting rod to install.
 - Check the oil holes on the connecting rod and those on the corresponding bearing are aligned.



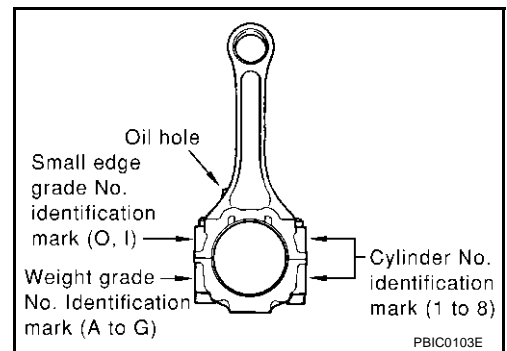
13. Install the piston and connecting rod assembly to the crankshaft.
- Position the crankshaft pin corresponding to the connecting rod to be installed onto the bottom dead center.
 - Apply engine oil sufficiently to the cylinder bore, piston, and crankshaft pin.
 - Match the cylinder position with the cylinder No. on the connecting rod to install.
 - Using a piston ring compressor, 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.

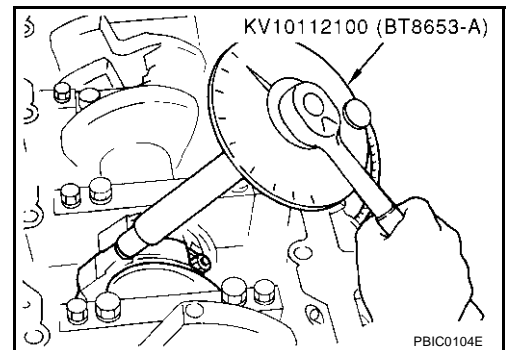


15. Tighten the connecting rod nuts as follows:
- Apply engine oil to the threads and seats of the connecting rod bolts and nuts.
 - Tighten nuts to 13.7 to 15.7 N·m (1.4 to 1.6 kg·m, 10 to 12 ft·lb).
 - Put mating (with paint) on each nut and connecting rod cap, all in the same direction (when using a protractor).
 - Then all nuts 60 to 65 degrees clockwise [target: 60 degrees] (angle tightening).

CAUTION:

Always use either an angle wrench or protractor. Avoid tightening based on visual check alone.

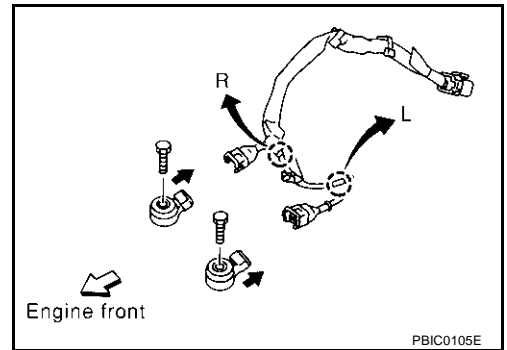
- After tightening the nuts, make sure that the crankshaft rotates smoothly.
- Check the connecting rod side clearance. Refer to [EM-88, "CONNECTING ROD SIDE CLEARANCE"](#).



CYLINDER BLOCK

16. Install knock sensor.

- 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 rear side.
- Do not tighten the mounting bolts while holding the connector.
- Make sure that the knock sensor does not interfere with other parts.
- Install the sub-harness with its shorter branch line to the RH bank.



CAUTION:

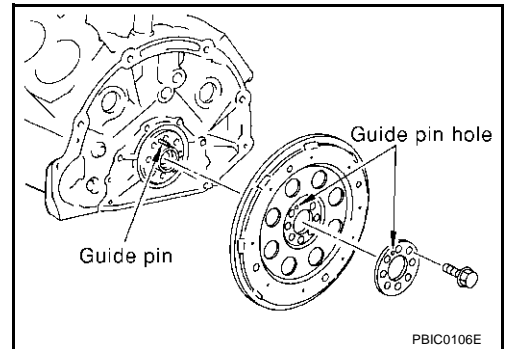
If any impact by dropping is applied to the knock sensor, replace it with new one.

17. Install followings in reverse order of removal.

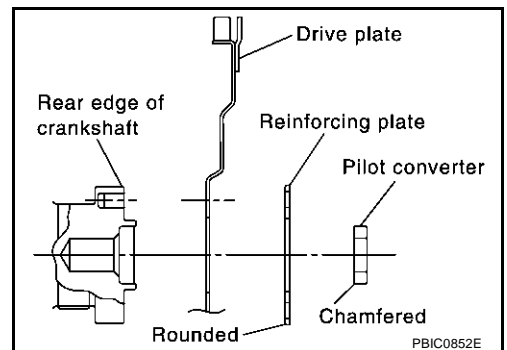
18. Remove engine assembly from engine stand.

19. Install drive plate.

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



- Install drive plate, reinforcement plate and pilot converter (if not installed in step 4) as shown in figure.
- Using drift of 33 mm (1.30 in) dia, push pilot converter into the end.
- Face chamfered or rounded edge side to crankshaft.



How to Select Piston and Bearing DESCRIPTION

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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 (inner diameter of housing) and crankshaft journal grade (outer diameter of journal)
Between crankshaft to connecting rod	Connecting rod bearing	Connecting rod bearing grade (bearing thickness)	Connecting rod bearing grade = crankshaft pin grade (outer diameter of pin). No grade exists for inner 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 outer diameter)	Piston grade = cylinder bore grade (inner diameter of bore)
*Between piston to connecting rod	—	—	—

CYLINDER BLOCK

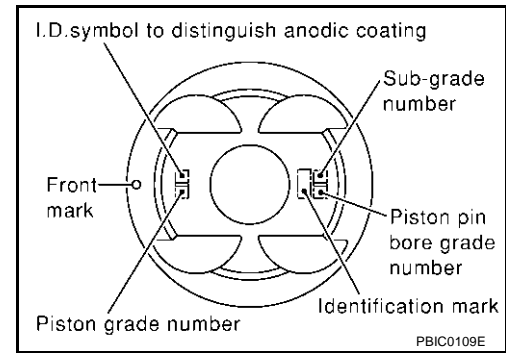
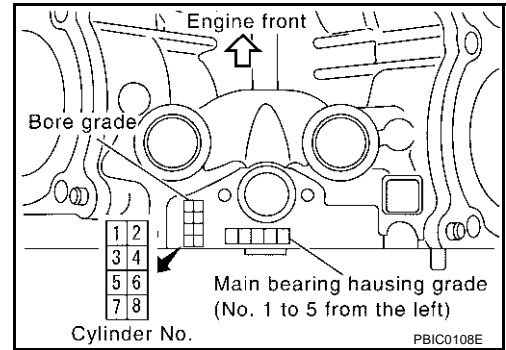
*For the service parts, the grade for fitting cannot be selected between a piston pin and a connecting rod. (Only 0 grade is available.) The information at the shipment from the plant is described as a reference.

- 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 rear upper side between cylinder block banks, and select the piston of the same grade.



When Cylinder Block is Reused:

1. Measure the cylinder block bore inner diameter.
2. Determine the bore grade by comparing the measurement with the values under the "Cylinder bore inner diameter" of the piston selection table. Select the piston of the same grade.

Piston Selection Table

Unit: mm (in)

Grade number (Mark)	1	2	3
Inner diameter of cylinder bore	93.000-93.010 (3.6614-3.6618)	93.010-93.020 (3.6618-3.6622)	93.020-93.030 (3.6622-3.6626)
Outer diameter of piston	92.980-92.990 (3.6606-3.6610)	92.990-93.000 (3.6610-3.6614)	93.000-93.010 (3.6614-3.6618)

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.).

CYLINDER BLOCK

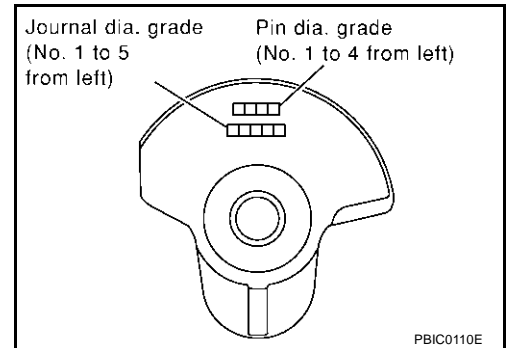
HOW TO SELECT CONNECTING ROD BEARING

When New Connecting Rod and Crankshaft are Used:

Compare the pin diameter grade of the crankshaft front surface with the values of the selection table of connecting rod bearing.

NOTE:

There is no grading for connecting rod big end.



When Crankshaft and Connecting Rod are Reused:

1. Measure the pin outer diameter of the crankshaft.
2. Compare the measurement with the values of the selection table of connecting rod bearing.

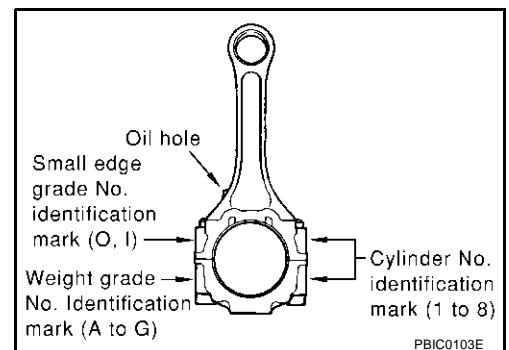
Selection Table of Connecting Rod Bearing

Unit: mm (in)

Connecting rod big end inner diameter		55.000 - 55.013 (2.1654 - 2.1659)
Crankshaft pin outer diameter	Grade (Mark)	—(No grade)
51.968 - 51.974 (2.0460 - 2.0462)	0	Bearing grade No. 0 Bearing thickness range: 1.500 - 1.503 (0.00591 - 0.0592) Color: No color
51.962 - 51.968 (2.0457 - 2.0460)	1	Bearing grade No. 1 Bearing thickness range: 1.503 - 1.506 (0.0592 - 0.0593) Color: Brown
51.956 - 51.962 (2.0455 - 2.0457)	2	Bearing grade No. 2 Bearing thickness range: 1.506 - 1.509 (0.0593 - 0.0594) Color: Green

NOTE:

(At shipment from the plant) For an engine, all the connecting rod assemblies are in the same weight class. For service parts, no weight grades can be selected.



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 bearings, measure the bearing inner diameters with bearings installed, and grind the crankshaft pin so that the oil clearance satisfies the standard.

CYLINDER BLOCK

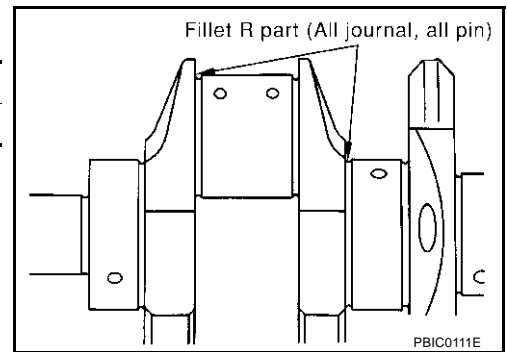
Bearing undersize table

Unit: mm (in)

Undersize		Thickness
US	0.25 (0.0098)	1.626 - 1.634 (0.0640 - 0.0643)

CAUTION:

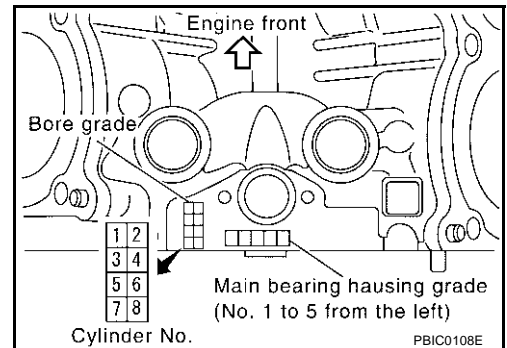
In grinding the crankshaft pin to use undersize bearings, do not damage the fillet R (All crankshaft pins).



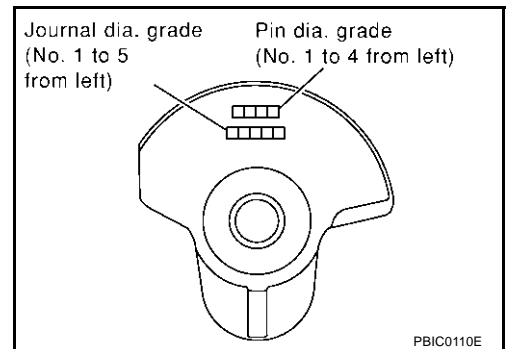
HOW TO SELECT MAIN BEARING

When New Cylinder Block and Crankshaft are Used:

1. Apply main bearing housing grade on upper rear side between cylinder block banks to row in main bearing selection table.



2. Apply journal diameter grade on crankshaft front to column in main bearing selection table.



3. Find sign at crossing of row and column in main bearing selection table.

CAUTION:

- Initial clearance for No.1, 5 journal and No. 2, 3, 4 journal is different. Use two different selection 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 bearing grade table.

NOTE:

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

When Cylinder Block and Crankshaft are Reused:

1. Measure inner diameter of cylinder block main bearing housing and outer diameter of crankshaft journal.
2. Apply measurement in above step 1 to main bearing selection table.
3. Follow step 3 and later in "When new cylinder block and crankshaft are used".

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		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	1	2			
G	63.964 - 63.963 (2.5183 - 2.5182)			1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	
H	63.963 - 63.962 (2.5182 - 2.5182)			1	12	12	12	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5
J	63.962 - 63.961 (2.5182 - 2.5181)			12	12	12	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	
K	63.961 - 63.960 (2.5181 - 2.5181)			12	12	2	2	2	2	23	23	23	3	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	56	
L	63.960 - 63.959 (2.5181 - 2.5181)			12	2	2	2	23	23	23	3	3	3	3	34	34	34	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	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	
N	63.958 - 63.957 (2.5180 - 2.5180)			2	2	23	23	23	3	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	5	56	56	
P	63.957 - 63.956 (2.5180 - 2.5179)			2	23	23	23	3	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	5	56	56	56	
R	63.956 - 63.955 (2.5179 - 2.5179)			23	23	23	3	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	5	56	56	56	56	
S	63.955 - 63.954 (2.5179 - 2.5179)			23	23	3	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	56	56	56	
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	5	56	56	56	56	56	56	56	56	
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	5	56	56	56	56	56	56	56	56	56	
V	63.952 - 63.951 (2.5178 - 2.5178)			3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	56	56	56	56	56	56	56	
W	63.951 - 63.950 (2.5178 - 2.5177)			3	34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	56	56	56	56	56	56	56	56	
X	63.950 - 63.949 (2.5177 - 2.5177)			34	34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	56	56	56	56	56	56	56	56	56	
Y	63.949 - 63.948 (2.5177 - 2.5176)			34	34	4	4	4	4	45	45	45	5	5	5	5	56	56	56	56	56	56	56	56	56	56	56	56	56	
1	63.948 - 63.947 (2.5176 - 2.5176)			34	4	4	4	45	45	45	5	5	5	5	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	
2	63.947 - 63.946 (2.5176 - 2.5176)			4	4	4	45	45	45	5	5	5	5	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	
3	63.946 - 63.945 (2.5176 - 2.5175)			4	4	45	45	45	5	5	5	5	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	
4	63.945 - 63.944 (2.5175 - 2.5175)			4	45	45	45	5	5	5	5	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	
5	63.944 - 63.943 (2.5175 - 2.5174)			45	45	45	5	5	5	5	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	
6	63.943 - 63.942 (2.5174 - 2.5174)			45	45	5	5	5	5	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	
7	63.942 - 63.941 (2.5174 - 2.5174)			45	5	5	5	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	
9	63.941 - 63.940 (2.5174 - 2.5173)			5	5	5	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	

PBIC0112E

CYLINDER BLOCK

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

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

PBIC0113E

Main Bearings Grade Table (All Journals)

Unit: mm (in)

Grade number	Thickness	Identification color (UPR/LWR)	Remarks
0	2.483 - 2.486 (0.0978 - 0.0979)	Black	Grade and color are 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	

CYLINDER BLOCK

01	UPR	2.483 - 2.486 (0.0978 - 0.0979)	Black/Brown	Grade and color are different for upper and lower bearings.
	LWR	2.486 - 2.489 (0.0979 - 0.0980)		
12	UPR	2.486 - 2.489 (0.0979 - 0.0980)	Brown/Green	
	LWR	2.489 - 2.492 (0.0980 - 0.0981)		
23	UPR	2.489 - 2.492 (0.0980 - 0.0981)	Green/Yellow	
	LWR	2.492 - 2.495 (0.0981 - 0.0982)		
34	UPR	2.492 - 2.495 (0.0981 - 0.0982)	Yellow/Blue	
	LWR	2.495 - 2.498 (0.0982 - 0.0983)		
45	UPR	2.495 - 2.498 (0.0982 - 0.0983)	Blue/Pink	
	LWR	2.498 - 2.501 (0.0983 - 0.0985)		
56	UPR	2.498 - 2.501 (0.0983 - 0.0985)	Pink/Purple	
	LWR	2.501 - 2.504 (0.0985 - 0.0986)		
67	UPR	2.501 - 2.504 (0.0985 - 0.0986)	Purple/White	
	LWR	2.504 - 2.507 (0.0986 - 0.0987)		
78	UPR	2.504 - 2.507 (0.0986 - 0.0987)	White/Red	
	LWR	2.507 - 2.510 (0.0987 - 0.0988)		

A
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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 inner diameter of bearing installed and grind journal until oil clearance falls within specification.

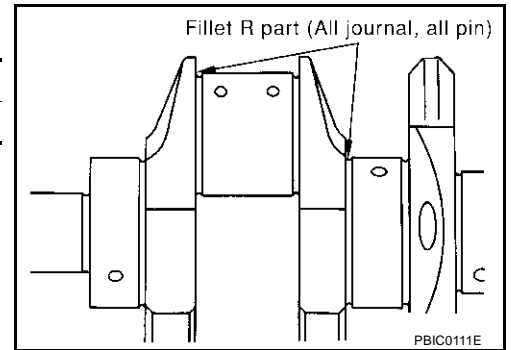
Bearing undersize table

Unit: mm (in)

	Size	Thickness
US	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).



EBS002MX

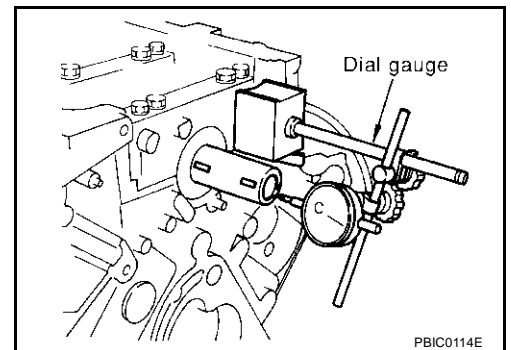
Inspection After Disassembly CRANKSHAFT END PLAY

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

Standard : 0.10 - 0.25 mm (0.0039 - 0.0098 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.



CYLINDER BLOCK

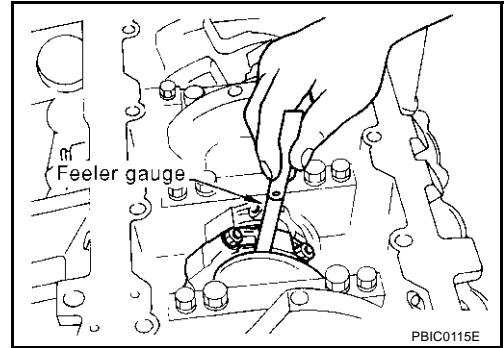
CONNECTING ROD SIDE CLEARANCE

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

Standard : 0.20 - 0.35 mm (0.0079 - 0.0138 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.

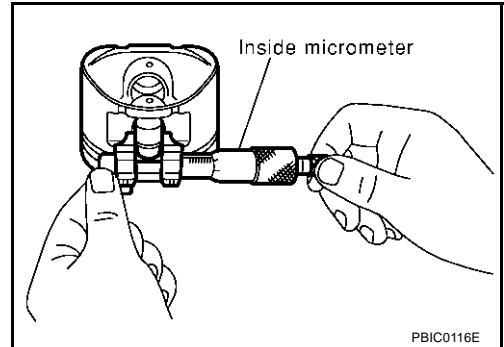


PISTON AND PISTON PIN CLEARANCE

Inner Diameter of Piston Pin

Measure the inner diameter of piston pin bore with an inside micrometer.

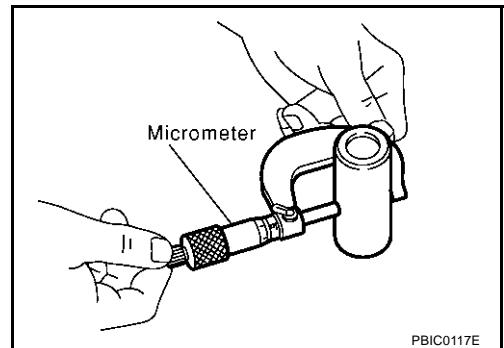
Standard : 21.993 - 22.005 mm (0.8659 - 0.8663 in)



Outer Diameter of Piston Pin

Measure outer diameter of piston pin with a micrometer.

Standard : 21.989 - 22.001 mm (0.8657 - 0.8662 in)

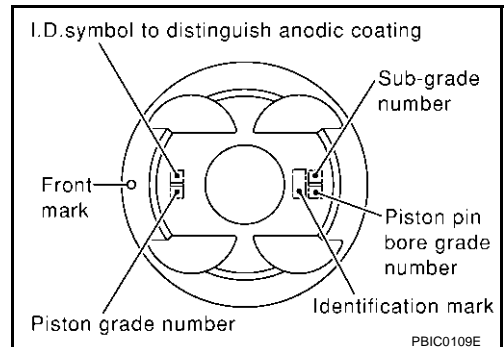


Piston and Piston Pin Clearance

(Piston pin clearance) = (Piston pin bore diameter) – (Outer diameter of piston pin)

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

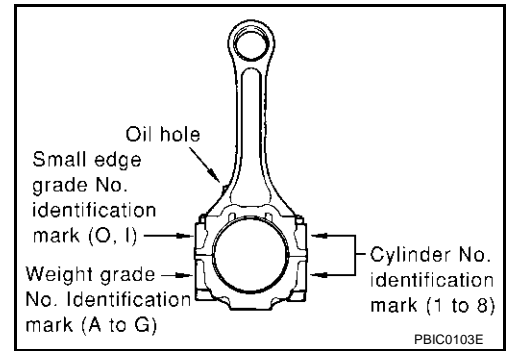
- If clearance exceeds specification, replace either or both of piston/piston pin assembly and connecting rod assembly with reference to specification of each part.
- Refer to piston selection table to replace piston/piston pin assembly. Refer to [EM-82, "HOW TO SELECT PISTON"](#).
- Refer to connecting rod bearing selection table to replace connecting rod. Refer to [EM-83, "HOW TO SELECT CONNECTING ROD BEARING"](#).



CYLINDER BLOCK

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-91, "Connecting Rod Bushing Oil Clearance \(Small End\)"](#) for the values for each grade at the plant.



PISTON RING SIDE CLEARANCE

- Measure side clearance of piston ring and piston ring groove with feeler gauge.

Standard:

Top ring 0.045 - 0.080 mm (0.0018 - 0.0031 in)

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

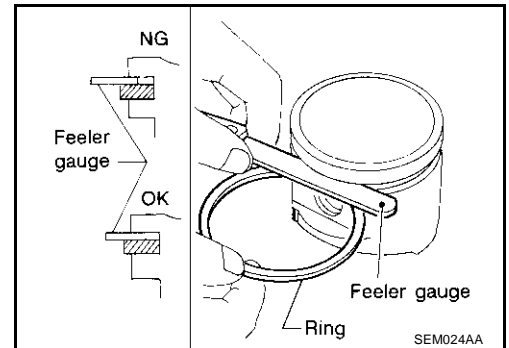
Oil ring 0.065 - 0.135 mm (0.0026 - 0.0053 in)

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 inner diameter of cylinder bore is within specification. Refer to [EM-93, "Piston to Cylinder Bore Clearance"](#).
- Insert piston ring until middle of cylinder with piston, and measure gap.

Standard:

Top ring 0.22 - 0.32 mm (0.0087 - 0.0126 in)

2nd ring 0.22 - 0.32 mm (0.0087 - 0.0126 in)

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

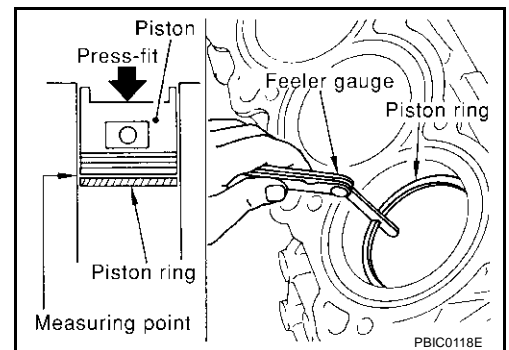
Limit:

Top ring 0.56 mm (0.0220 in)

2nd ring 0.52 mm (0.0205 in)

Oil ring 0.96 mm (0.0378 in)

- 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.



CYLINDER BLOCK

CONNECTING ROD BEND AND TORSION

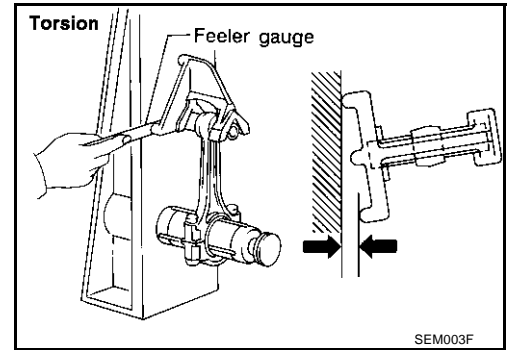
- Check with connecting rod aligner.

Bend:

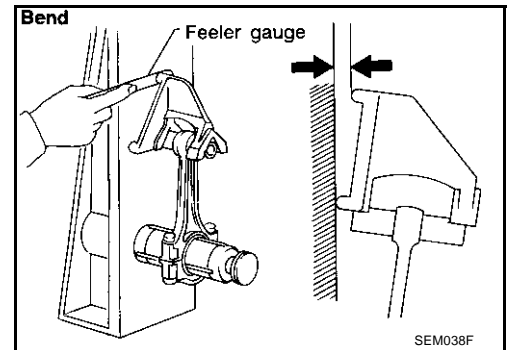
Limit 0.15 mm (0.0059 in) per 100 mm (3.94 in) length

Torsion:

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



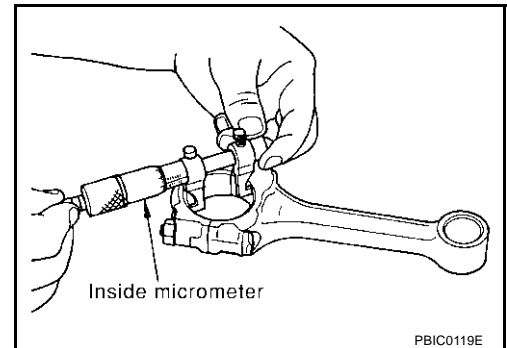
- If it exceeds the limit, replace connecting rod assembly.



CONNECTING ROD BEARING (BIG END)

Install the connecting rod cap without the connecting rod bearing installed. After tightening the connecting rod nut to the specified torque, measure the connecting rod large end inner diameter using an inside micrometer.

Standard : 55.000 - 55.013 mm (2.1654 - 2.1659 in)

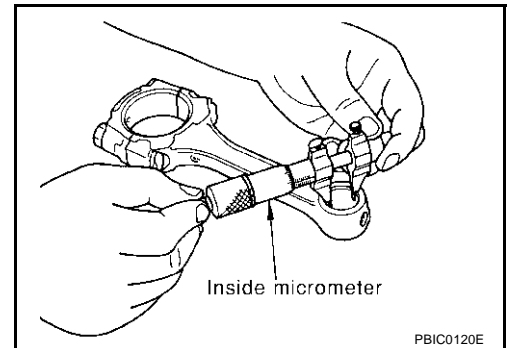


CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)

Inner Diameter of Connecting Rod (Small End)

Measure inner diameter of bushing.

Standard : 22.000 - 22.012 mm (0.8661 - 0.8666 in)

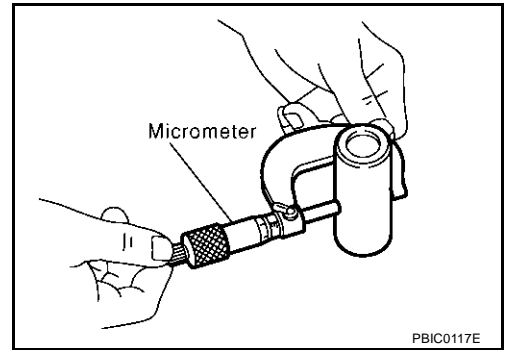


CYLINDER BLOCK

Outer Diameter of Piston Pin

Measure outer diameter of piston pin.

Standard : 21.989 - 22.001 mm (0.8657 - 0.8662 in)

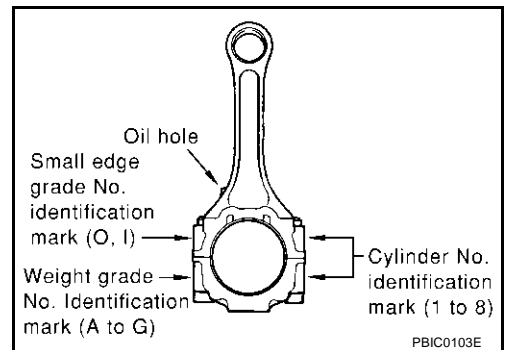


Connecting Rod Bushing Oil Clearance (Small End)

(Connecting rod small end oil clearance) = (Inner diameter of connecting rod small end) – (Outer diameter of piston pin)

Standard : 0.005 - 0.017 mm (0.0002 - 0.007 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-82, "HOW TO SELECT PISTON"](#) .

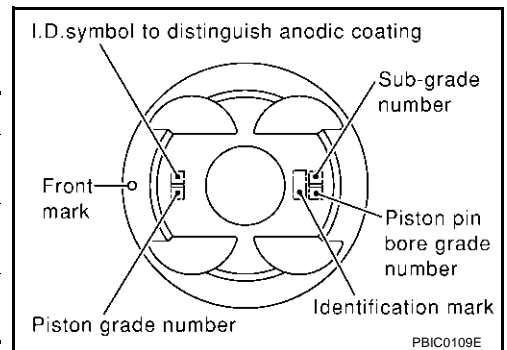


Factory installed parts grading:

Service parts apply only to grade 0.

Unit: mm (in)

Grade	0	1
Connecting rod small end inner diameter	22.000 - 22.006 (0.8661 - 0.8664)	22.006 - 22.012 (0.8664 - 0.8666)
Piston pin outer diameter	21.989 - 21.995 (0.8657 - 0.8659)	21.995 - 22.001 (0.8659 - 0.8662)
Piston pin bore diameter	21.993 - 21.999 (0.8659 - 0.8661)	21.999 - 22.005 (0.8661 - 0.8663)



CYLINDER BLOCK DISTORTION

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

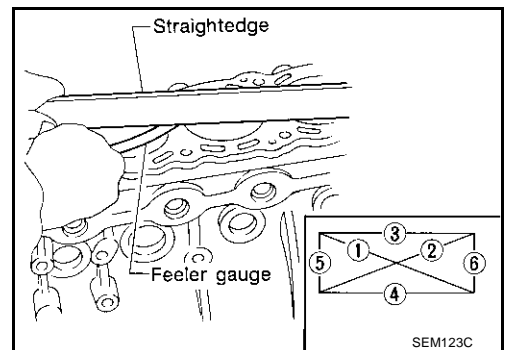
CAUTION:

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

- Measure the distortion on the block upper face at some different points in 6 directions.

Limit : 0.1 mm (0.004 in)

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



CYLINDER BLOCK

INNER DIAMETER OF MAIN BEARING HOUSING

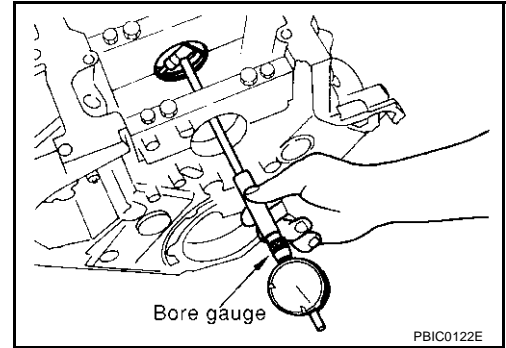
- Install the main bearing caps with the main bearings removed, and tighten the mounting bolts to the specified torque.
- Using a bore gauge, measure the inner diameter of the main bearing housing.

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 cannot be replaced as a single unit, because they were processed together.



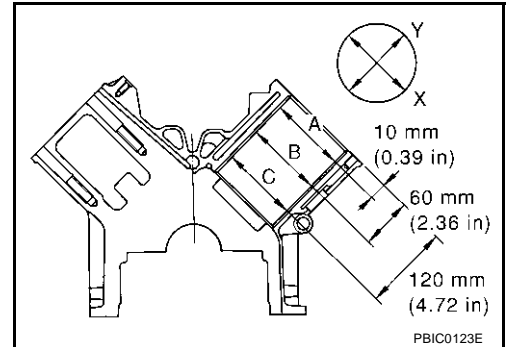
PISTON TO CYLINDER BORE CLEARANCE

Inner Diameter of Cylinder Bore

- Using a bore gauge, 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 inner diameter:

93.000 - 93.030 mm (3.6614 - 3.6626 in)

Wear limit:

0.20 mm (0.0079 in)

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

Less than 0.015 mm (0.0006 in)

Taper limit (Difference between A and C):

Less than 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.

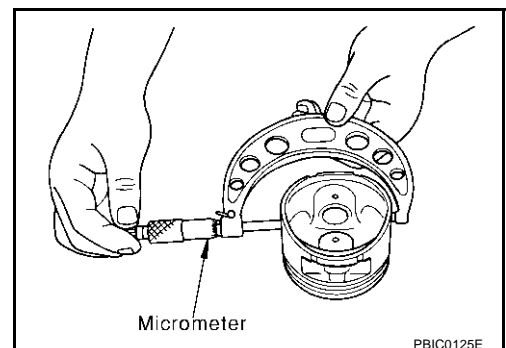
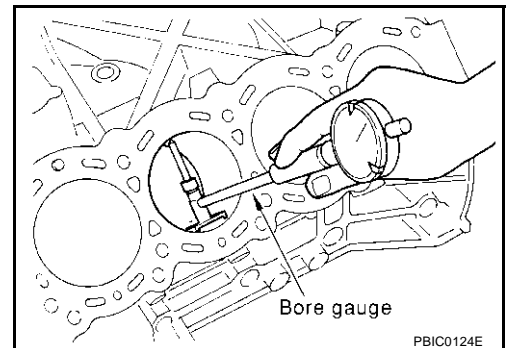
Oversize (OS) : 0.2 mm (0.008 in)

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

Outer Diameter of Piston

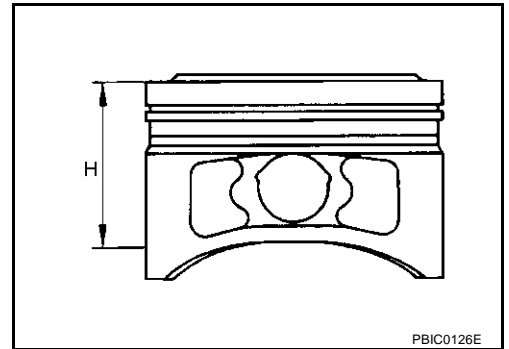
- Measure piston skirt diameter.

Standard : 92.980 - 93.010 mm (3.6606 - 3.6618 in)



CYLINDER BLOCK

- Measure point “H”(Distance from the top): 42 mm (1.65 in)



Piston to Cylinder Bore Clearance

- Calculate by outer diameter of piston skirt and inner diameter of cylinder (direction X, position B).
(Clearance) = (Inner diameter of cylinder) – (Outer diameter of piston skirt)

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

1. 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)

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

NOTE:

- When any cylinder needs boring, all other cylinders must also be bored.
- Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.

4. Hone cylinders to obtain specified piston-to-bore clearance.
5. Measure finished cylinder bore for out-of-round and taper.

NOTE:

Measurement should be done after cylinder bore cools down.

OUTER DIAMETER OF CRANKSHAFT JOURNAL

Measure outer diameter of crankshaft journals.

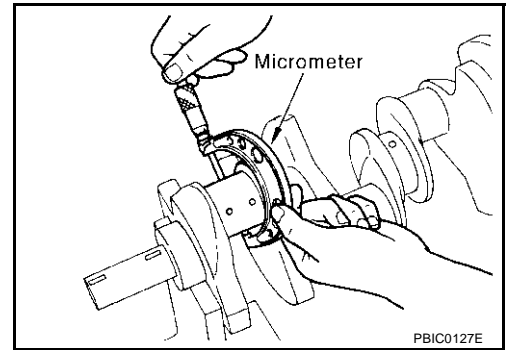
Standard : 63.940 - 63.964 mm (2.5173 - 2.5183 in)

CYLINDER BLOCK

OUTER DIAMETER OF CRANKSHAFT PIN

Measure outer diameter of crankshaft pin.

Standard : 51.956 - 51.974 mm (2.0455-2.0462 in)



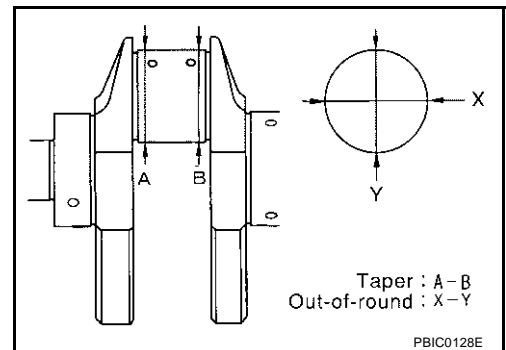
OUT-OF-ROUND AND TAPER OF CRANKSHAFT

- Using a micrometer, 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 (X-Y) : 0.015 mm (0.0006 in)

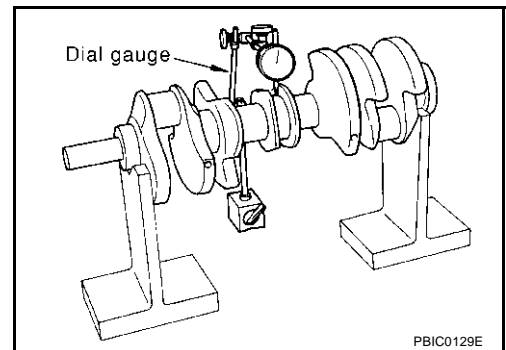
Taper (A-B) : 0.010 mm (0.0004 in)



CRANKSHAFT RUNOUT

- Place a V-block on a precise flat table to support the journals on the both end of the crankshaft.
- Place a dial gauge 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: : 0.05 mm (0.002 in)



OIL CLEARANCE OF CONNECTING ROD BEARING

Method of Measurement

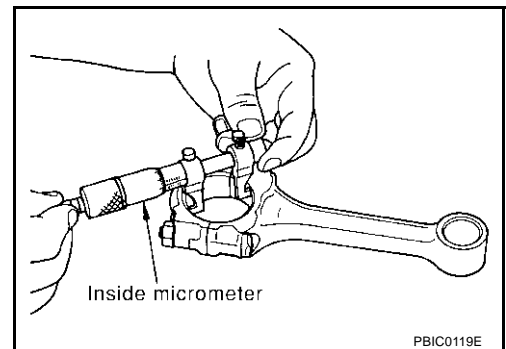
- Install the connecting rod bearings to the connecting rod and the cap, and tighten the connecting rod nut to the specified torque. Using an inside micrometer measure the inner diameter of connecting rod bearing.

(Oil clearance) = (Inner diameter of connecting rod bearing) – (Outer diameter of crankshaft pin)

Standard : 0.020 - 0.045 mm (0.0008 - 0.0018 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-83, "HOW TO SELECT CONNECTING ROD BEARING"](#).



CYLINDER BLOCK

Method of Using Plastigauge

- 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 the connecting rod bearing cap, and tighten the connecting rod nut to the specified torque.

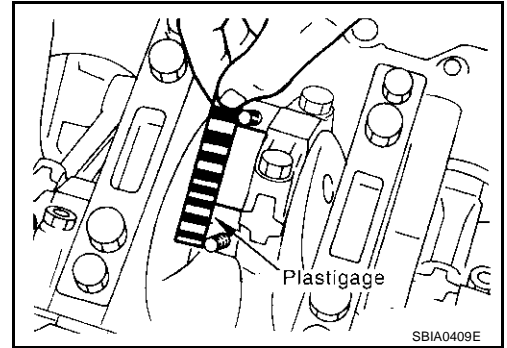
CAUTION:

Never rotate the crankshaft.

- Remove the connecting rod 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".



OIL CLEARANCE OF MAIN BEARING

Method of Measurement

- Install the main bearings to the cylinder block and main bearing cap. Measure the main bearing inner diameter with the bearing cap bolt tightened to the specified torque. Refer to [EM-77, "ASSEMBLY"](#).

(Oil clearance) = (Inner diameter of main bearing) – (Outer diameter of crankshaft journal)

Standard:

No. 1 and 5 journals : 0.001 - 0.011 mm (0.0004 - 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 inner diameter and crankshaft journal outer diameter, so that the oil clearance satisfies the standard. Refer to [EM-84, "HOW TO SELECT MAIN BEARING"](#).

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.

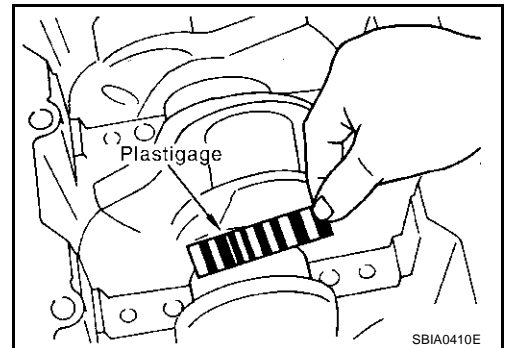
CAUTION:

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".



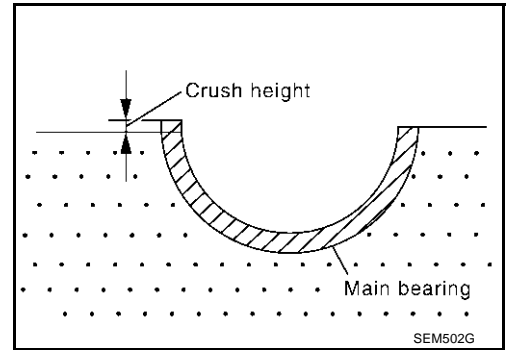
CYLINDER BLOCK

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.

Standard : There must be crush height

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



SERVICE DATA AND SPECIFICATIONS (SDS)

SERVICE DATA AND SPECIFICATIONS (SDS)

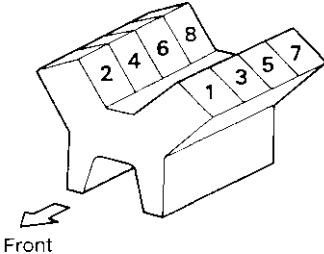
PFP:00030

Standard and Limit GENERAL SPECIFICATIONS

EBS003P5

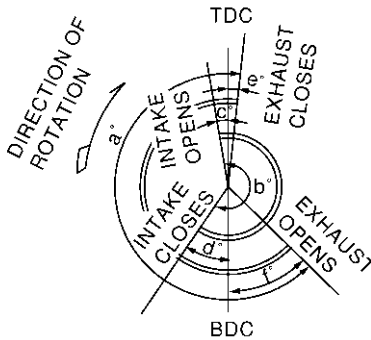
Cylinder arrangement		V-8
Displacement cm ³ (cu in)		4,494 (274.22)
Bore and stroke mm (in)		93 x 82.7 (3.66 x 3.256)
Valve arrangement		DOHC
Firing order		1-8-7-3-6-5-4-2
Number of piston rings	Compression	2
	engine oil	1
Number of main bearings		5
Compression ratio		10.5
Compression pressure kPa (kg/cm ² , psi)/300 rpm	Standard	1,320 (13.5, 191)
	Minimum	1,130 (11.5, 164)
	Differential limit between cylinders	98 (1.0, 14)

Cylinder number



SEM957C

Valve timing



PBIC0187E

Unit: degree

a	b	c	d	e	f
228	240	0	60	0	48

DRIVE BELTS

Tension of drive belts	Auto adjustment by auto tensioner
------------------------	-----------------------------------

INTAKE MANIFOLD AND EXHAUST MANIFOLD

Unit: mm (in)

Item		Limit
Surface distortion	Intake manifold upper	0.1 (0.004)
	Intake manifold lower	0.1 (0.004)
	Exhaust manifold	0.3 (0.012)

SERVICE DATA AND SPECIFICATIONS (SDS)

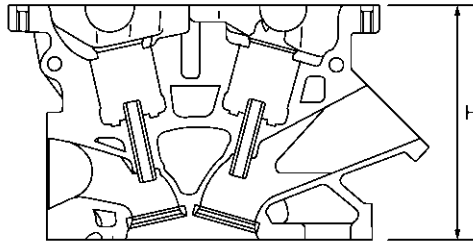
SPARK PLUG (PLATINUM-TIPPED TYPE)

Make		NGK
Type	Standard	PLFR5A-11
	Hot	PLFR4A-11
	Cold	PLFR6A-11
	Plug gap (Nominal)	1.1 mm (0.043 in)

CYLINDER HEAD

Unit: mm (in)

Items	Limit
Head surface distortion	0.1 (0.004)



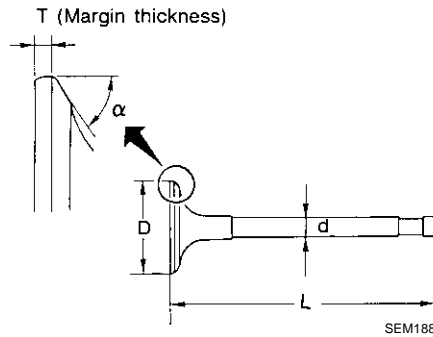
Nominal cylinder head height:
H = 126.4 mm (4.98 in)

PBIC0183E

VALVE

Valve Dimensions

Unit: mm (in)



Valve head diameter "D"	Intake	36.0 - 36.3 (1.417 - 1.429)
	Exhaust	31.2 - 31.5 (1.228 - 1.240)
Valve length "L"	Intake	96.57 (3.8020)
	Exhaust	94.50 (3.720)
Valve stem diameter "d"	Intake	5.972 - 5.980 (0.2351 - 0.2354)
	Exhaust	5.962 - 5.970 (0.2347 - 0.2350)
Valve seat angle "α"	Intake	45°15' - 45°45'
	Exhaust	
Valve margin "T"	Intake	0.95 - 1.25 (0.0374 - 0.0492)
	Exhaust	1.15 - 1.45 (0.0453 - 0.0571)

SERVICE DATA AND SPECIFICATIONS (SDS)

Valve Clearance

Unit: mm (in)

Items	Cold* (reference data)	Hot
Intake	0.26 - 0.34 (0.010 - 0.013)	0.32 - 0.40 (0.013 - 0.016)
Exhaust	0.29 - 0.37 (0.011 - 0.015)	0.33 - 0.41 (0.013 - 0.016)

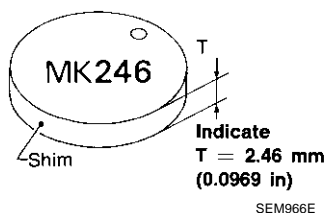
*: Approximately 20°C (68 °F)

Available Shims

Thickness mm (in)	Identification mark
2.32 (0.0913)	232
2.33 (0.0917)	233
2.34 (0.0921)	234
2.35 (0.0925)	235
2.36 (0.0929)	236
2.37 (0.0933)	237
2.38 (0.0937)	238
2.39 (0.0941)	239
2.40 (0.0945)	240
2.41 (0.0949)	241
2.42 (0.0953)	242
2.43 (0.0957)	243
2.44 (0.0961)	244
2.45 (0.0965)	245
2.46 (0.0969)	246
2.47 (0.0972)	247
2.48 (0.0976)	248
2.49 (0.0980)	249
2.50 (0.0984)	250
2.51 (0.0988)	251
2.52 (0.0992)	252
2.53 (0.0996)	253
2.54 (0.1000)	254
2.55 (0.1004)	255
2.56 (0.1008)	256
2.57 (0.1012)	257
2.58 (0.1016)	258
2.59 (0.1020)	259
2.60 (0.1024)	260
2.61 (0.1028)	261
2.62 (0.1031)	262
2.63 (0.1035)	263
2.64 (0.1039)	264
2.65 (0.1043)	265
2.66 (0.1047)	266
2.67 (0.1051)	267
2.68 (0.1055)	268

SERVICE DATA AND SPECIFICATIONS (SDS)

Thickness mm (in)	Identification mark
2.69 (0.1059)	269
2.70 (0.1063)	270
2.71 (0.1067)	271
2.72 (0.1071)	272
2.73 (0.1075)	273
2.74 (0.1079)	274
2.75 (0.1083)	275
2.76 (0.1087)	276
2.77 (0.1091)	277
2.78 (0.1094)	278
2.79 (0.1098)	279
2.80 (0.1102)	280
2.81 (0.1106)	281
2.82 (0.1110)	282
2.83 (0.1114)	283
2.84 (0.1118)	284
2.85 (0.1122)	285
2.86 (0.1126)	286
2.87 (0.1130)	287
2.88 (0.1134)	288
2.89 (0.1138)	289
2.90 (0.1142)	290
2.91 (0.1146)	291
2.92 (0.1150)	292
2.93 (0.1154)	293
2.94 (0.1157)	294
2.95 (0.1161)	295



Valve Spring

Free height mm (in)		46.35 - 46.85 (1.8247 - 1.8444)
Pressure N (kg, lb) at height mm (in)	Installation	165 - 189 (16.8 - 19.3, 37 - 42) at 33.8 (1.331)
	Valve open	290 - 330 (29.6 - 33.7, 65 - 74) at 24.4 (0.961)
Out-of-square mm (in)	Limit	2.0 (0.079)

Valve Lifter

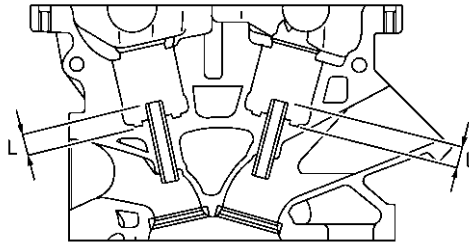
Unit: mm (in)

Items	Standard
Valve lifter outer diameter	33.965 - 33.975 (1.3372 - 1.3776)
Lifter guide inner diameter	34.000 - 34.016 (1.3386 - 1.3392)
Clearance between lifter and lifter guide	0.025 - 0.051 (0.0010 - 0.0020)

SERVICE DATA AND SPECIFICATIONS (SDS)

Valve Guide

Unit: mm (in)

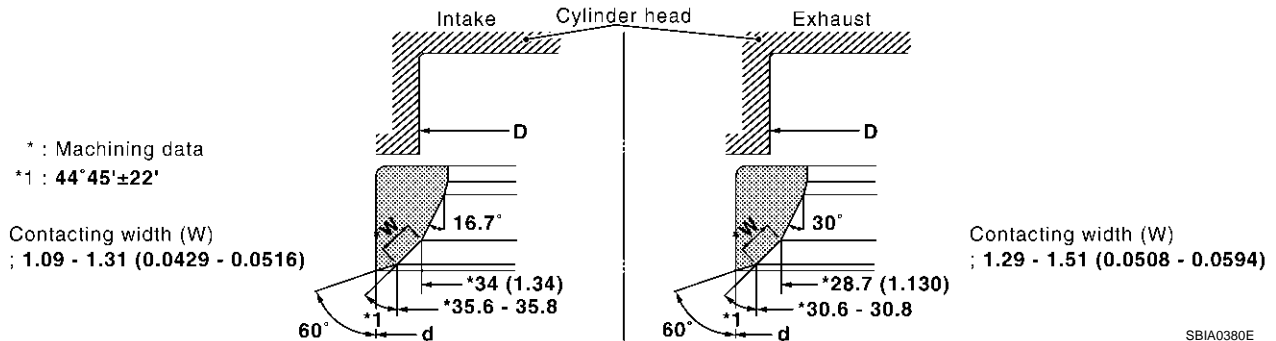


PBIC0184E

Items		Standard	Service
Valve guide	Outer diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
	Inner diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter		9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
Standard			
Stem to guide clearance	Intake	0.020 - 0.046 (0.0008 - 0.0018)	
	Exhaust	0.030 - 0.056 (0.0012 - 0.0022)	
Projection length "L"	Intake	10.1 - 10.3 (0.398 - 0.406)	
	Exhaust	10.0 - 10.4 (0.394 - 0.409)	

Valve Seat

Unit: mm (in)



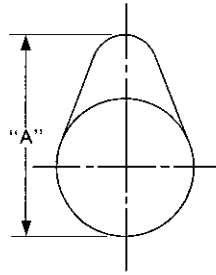
Items		Standard	Service
Cylinder head seat recess diameter (D)	Intake	37.000 - 37.016 (1.4567 - 1.4573)	37.500 - 37.516 (1.4764 - 1.4770)
	Exhaust	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)
Valve seat interference fit	Intake	0.081 - 0.113 (0.0032 - 0.0044)	
	Exhaust	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	Intake	37.097 - 37.113 (1.4605 - 1.4611)	37.597 - 37.613 (1.4802 - 1.4808)
	Exhaust	32.280 - 32.296 (1.2709 - 1.2715)	32.780 - 32.796 (1.2905 - 1.2912)

SERVICE DATA AND SPECIFICATIONS (SDS)

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

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



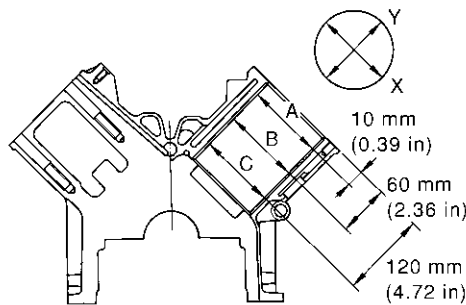
SEM671

Cam height "A"	Intake	44.865 - 45.055 (1.7663 - 1.7738)
	Exhaust	43.925 - 44.115 (1.7293 - 1.7368)
Outer diameter of camshaft journal	No.1	25.938 - 25.955 (1.0212 - 1.0218)
	No.2, 3, 4, 5	25.953 - 25.970 (1.0218 - 1.0224)
Inner diameter of camshaft bracket		26.000 - 26.021 (1.0236 - 1.0244)
Camshaft journal clearance	No.1	0.045 - 0.083 (0.0018 - 0.0033)
	No.2, 3, 4, 5	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

CYLINDER BLOCK

Unit: mm (in)



PBIC0123E

Surface flatness	Limit	0.1 (0.004)	
Cylinder bore	Inner diameter	Standard	
		Grade No. 1	93.000 - 93.010 (3.6614 - 3.6618)
		Grade No. 2	93.010 - 93.020 (3.6618 - 3.6622)
	Grade No. 3	93.020 - 93.030 (3.6622 - 3.6626)	
	Wear limit	0.20 (0.008)	
Out-of-round (Difference between X and Y)		Less than 0.015 (0.0006)	
Taper (Difference between A and C)		Less than 0.010 (0.0004)	

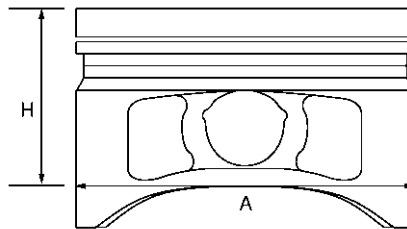
SERVICE DATA AND SPECIFICATIONS (SDS)

Main journal inner diameter grade (Without bearing)	Grade No. A	68.944 - 68.945 (2.7143 - 2.7144)
	Grade No. B	68.945 - 68.946 (2.7144 - 2.7144)
	Grade No. C	68.946 - 68.947 (2.7144 - 2.7144)
	Grade No. D	68.947 - 68.948 (2.7144 - 2.7145)
	Grade No. E	68.948 - 68.949 (2.7145 - 2.7145)
	Grade No. F	68.949 - 68.950 (2.7145 - 2.7146)
	Grade No. G	68.950 - 68.951 (2.7146 - 2.7146)
	Grade No. H	68.951 - 68.952 (2.7146 - 2.7146)
	Grade No. J	68.952 - 68.953 (2.7146 - 2.7147)
	Grade No. K	68.953 - 68.954 (2.7147 - 2.7147)
	Grade No. L	68.954 - 68.955 (2.7147 - 2.7148)
	Grade No. M	68.955 - 68.956 (2.7148 - 2.7148)
	Grade No. N	68.956 - 68.957 (2.7148 - 2.7148)
	Grade No. P	68.957 - 68.958 (2.7148 - 2.7149)
	Grade No. R	68.958 - 68.959 (2.7149 - 2.7149)
	Grade No. S	68.959 - 68.960 (2.7149 - 2.7150)
	Grade No. T	68.960 - 68.961 (2.7150 - 2.7150)
	Grade No. U	68.961 - 68.962 (2.7150 - 2.7150)
	Grade No. V	68.962 - 68.963 (2.7150 - 2.7151)
Grade No. W	68.963 - 68.964 (2.7151 - 2.7151)	
Grade No. X	68.964 - 68.965 (2.7151 - 2.7152)	
Grade No. Y	68.965 - 68.966 (2.7152 - 2.7152)	
Grade No. 1	68.966 - 68.967 (2.7152 - 2.7152)	
Grade No. 2	68.967 - 68.968 (2.7152 - 2.7153)	
Difference in inner diameter between cylinders	Standard	Less than 0.03 (0.0012)

PISTON, PISTON RING AND PISTON PIN

Available Piston

Unit: mm (in)



PBIC0188E

Piston skirt diameter "A"	Standard	Grade No. 1	92.980 - 92.990 (3.6606 - 3.6609)
		Grade No. 2	92.990 - 93.000 (3.6609 - 3.6614)
		Grade No. 3	93.000 - 93.010 (3.6614 - 3.6618)
		0.20 (0.0079) oversize (Service)	93.180 - 93.210 (3.6685 - 3.6697)
"H" dimension			42 (1.65)
Piston pin bore diameter		Grade No.0	21.993 - 21.999 (0.8659 - 0.8661)
		Grade No.1	21.999 - 22.005 (0.8661 - 0.8663)
Piston clearance to cylinder block		Standard	0.010 - 0.030 (0.0004 - 0.0012)
		Limit	0.08 (0.0031)

SERVICE DATA AND SPECIFICATIONS (SDS)

Piston Ring

Unit: mm (in)

Items		Standard	Limit
Side clearance	Top	0.045 - 0.080 (0.0018 - 0.0031)	0.11 (0.0043)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.10 (0.004)
	Oil ring	0.065 - 0.135 (0.0026 - 0.0053)	—
End gap	Top	0.22 - 0.32 (0.0087 - 0.0126)	0.56 (0.0220)
	2nd	0.22 - 0.32 (0.0087 - 0.0126)	0.52 (0.0205)
	Oil (rail ring)	0.20 - 0.60 (0.0079 - 0.0236)	0.96 (0.0378)

Piston Pin

Unit: mm (in)

Piston pin outer diameter	Grade No.0	21.989 - 21.995 (0.8657 - 0.8659)
	Grade No.1	21.995 - 22.001 (0.8659 - 0.8662)
Interference fit of piston pin to piston	Standard	0.002 - 0.006 (0.0001 - 0.0002)
Piston pin to connecting rod bushing clearance	Standard	0.005 - 0.017 (0.0002 - 0.0007)

CONNECTING ROD

Unit: mm (in)

Center distance		146.95 - 147.05 (5.79 - 5.79)
Bend [per 100 (3.94)]	Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	Limit	0.30 (0.0118)
Connecting rod small end inner diameter		24.980 - 25.000 (0.9835 - 0.9843)
Piston pin bushing inner diameter*	Grade No. 0	22.000 - 22.006 (0.8661 - 0.8664)
	Grade No. 1	22.006 - 22.012 (0.8664 - 0.8666)
Connecting rod big end inner diameter		55.000 - 55.013 (2.1654 - 2.1659)
Side clearance	Standard	0.20 - 0.35 (0.0079 - 0.0138)
	Limit	0.40 (0.0157)

*: After installing in connecting rod

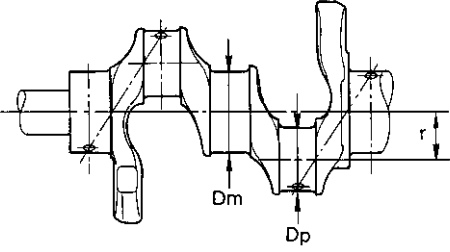
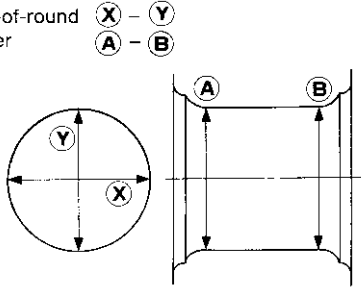
SERVICE DATA AND SPECIFICATIONS (SDS)

CRANKSHAFT

Unit: mm (in)

Main journal dia. "Dm" grade (No.1 and 5)	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)
	Main journal dia. "Dm" grade (No.2, 3 and 4)	Grade No. A
Grade No. B		63.962 - 63.963 (2.5182 - 2.5182)
Grade No. C		63.961 - 63.962 (2.5181 - 2.5182)
Grade No. D		63.960 - 63.961 (2.5181 - 2.5181)
Grade No. E		63.959 - 63.960 (2.5181 - 2.5181)
Grade No. F		63.958 - 63.959 (2.5180 - 2.5181)
Grade No. G		63.957 - 63.958 (2.5180 - 2.5180)
Grade No. H		63.956 - 63.957 (2.5179 - 2.5180)
Grade No. J		63.955 - 63.956 (2.5179 - 2.5179)
Grade No. K		63.954 - 63.955 (2.5179 - 2.5179)
Grade No. L		63.953 - 63.954 (2.5178 - 2.5179)
Grade No. M		63.952 - 63.953 (2.5178 - 2.5178)
Grade No. N		63.951 - 63.952 (2.5178 - 2.5178)
Grade No. P		63.950 - 63.951 (2.5177 - 2.5178)
Grade No. R		63.949 - 63.950 (2.5177 - 2.5177)
Grade No. S		63.948 - 63.949 (2.5176 - 2.5177)
Grade No. T		63.947 - 63.948 (2.5176 - 2.5176)
Grade No. U		63.946 - 63.947 (2.5176 - 2.5176)
Grade No. V		63.945 - 63.946 (2.5175 - 2.5176)
Grade No. W	63.944 - 63.945 (2.5175 - 2.5175)	
Grade No. X	63.943 - 63.944 (2.5174 - 2.5175)	
Grade No. Y	63.942 - 63.943 (2.5174 - 2.5174)	
Grade No. 1	63.941 - 63.942 (2.5174 - 2.5174)	
Grade No. 2	63.940 - 63.941 (2.5173 - 2.5174)	
Pin journal dia. "Dp"	Grade No. 0	51.968 - 51.974 (2.0460 - 2.0462)
	Grade No. 1	51.962 - 51.968 (2.0457 - 2.0460)
	Grade No. 2	51.956 - 51.962 (2.0455 - 2.0457)
Center distance "r"		41.31 - 41.39 (1.6264 - 1.6295)
Out-of-round (X - Y)	Limit	0.015 (0.0006)
Taper (A - B)	Limit	0.010 (0.0004)
Runout [TIR*]	Limit	0.05 (0.0020)

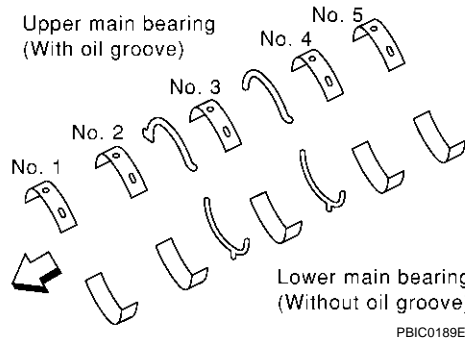
SERVICE DATA AND SPECIFICATIONS (SDS)

Free end play	Standard	0.10 - 0.25 (0.0039 - 0.0098)
	Limit	0.30 (0.0118)
 SEM645		<p>Out-of-round $\textcircled{X} - \textcircled{Y}$ Taper $\textcircled{A} - \textcircled{B}$</p>  SEM715

*: Total indicator reading

MAIN BEARING

Unit: mm (in)



Grade number	Thickness	Identification color (UPR/LWR)	Remarks
0	2.483 - 2.486 (0.0978 - 0.0979)	Black	Grade and color are 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	

SERVICE DATA AND SPECIFICATIONS (SDS)

01	UPR	2.483 - 2.486 (0.0978 - 0.0979)	Black/Brown	Grade and color are different for upper and lower bearings.
	LWR	2.486 - 2.489 (0.0979 - 0.0980)		
12	UPR	2.486 - 2.489 (0.0979 - 0.0980)	Brown/Green	
	LWR	2.489 - 2.492 (0.0980 - 0.0981)		
23	UPR	2.489 - 2.492 (0.0980 - 0.0981)	Green/Yellow	
	LWR	2.492 - 2.495 (0.0981 - 0.0982)		
34	UPR	2.492 - 2.495 (0.0981 - 0.0982)	Yellow/Blue	
	LWR	2.495 - 2.498 (0.0982 - 0.0983)		
45	UPR	2.495 - 2.498 (0.0982 - 0.0983)	Blue/Pink	
	LWR	2.498 - 2.501 (0.0983 - 0.0985)		
56	UPR	2.498 - 2.501 (0.0983 - 0.0985)	Pink/Purple	
	LWR	2.501 - 2.504 (0.0985 - 0.0986)		
67	UPR	2.501 - 2.504 (0.0985 - 0.0986)	Purple/White	
	LWR	2.504 - 2.507 (0.0986 - 0.0987)		
78	UPR	2.504 - 2.507 (0.0986 - 0.0987)	White/Red	
	LWR	2.507 - 2.510 (0.0987 - 0.0988)		

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.

Bearing Clearance

Unit: mm (in)

Main bearing clearance	Standard	No.1 and 5	0.001 - 0.011 (0.0004 - 0.0004)
		No.2, 3 and 4	0.007 - 0.017 (0.0003 - 0.0007)
	Limit	No.1 and 5	0.021 (0.0008)
		No.2, 3 and 4	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)	No color
1	1.503 - 1.506 (0.0592 - 0.0593)	Brown
2	1.506 - 1.509 (0.0593 - 0.0594)	Green

Undersize

Unit: mm (in)

Undersize	Thickness	Crank pin journal diameter "Dp"
0.25 (0.0098)	1.626 - 1.634 (0.0640 - 0.0643)	Grind so that bearing clearance is the specified value.

Bearing Clearance

Unit: mm (in)

Connecting rod bearing clearance	Standard	0.020 - 0.045 (0.0008 - 0.0018)
	Limit	0.055 (0.0022)

SERVICE DATA AND SPECIFICATIONS (SDS)

EBS003P6

Tightening Torque

*1: Parts to be tightened in particular orders.

1)-: Order of tightening when tightening two or more times separately.

Unit: N·m (kg·m, ft·lb)

Unit: N·m (kg·m, in·lb)*2

Engine cover and battery cover		3.3 - 4.4 (0.34 - 0.45, 30 - 38)*2
Air duct (inlet)		5.0 - 6.5 (0.51 - 0.66, 45 - 57)*2
Auto tensioner (Used for alternator, water pump and A/C compressor)		19.6 - 23.5 (2.0 - 2.4, 15 - 17)
Auto tensioner (Used for power steering pump belt)		19.6 - 23.5 (2.0 - 2.4, 15 - 17)
Idler pulley		20.6 - 26.5 (2.1 - 2.7, 16 - 19)
Mass air flow sensor		4.25 - 5.75 (0.43 - 0.58, 39 - 51)*2
Electric throttle control actuator		20.6 (2.1, 15)
EVAP canister purge control solenoid valve		15.7 (1.6, 12)
EVAP canister purge control solenoid valve bracket		11.8 (1.2, 9)
*1 Intake manifold upper		28.0 (2.9, 21)
*1 Intake manifold lower		28.0 (2.9, 21)
PCV tube		11.8 (1.2, 9)
*1 Exhaust manifold		26 - 30 (2.6 - 3.1, 19 - 22)
Exhaust manifold cover		5.1 - 6.4 (0.52 - 0.66, 46 - 57)*2
Heated oxygen sensor		41 - 50 (4.1 - 5.1, 30 - 36)
*1 Oil pan	M6 bolt	8.2 - 9.5 (0.83 - 0.97, 72 - 84)*2
	M8 bolt	19.6 - 23.5 (2.0 - 2.4, 15 - 17)
Oil pan drain plug		29.4 - 39.2 (3.0 - 4.0, 22 - 28)
Oil pressure switch		12.3 - 17.2 (1.25 - 1.75, 9 - 12)
Oil strainer		19.6 - 23.5 (2.0 - 2.4, 15 - 17)
Oil filter		14.7 - 20.6 (1.5 - 2.1, 11 - 15)
Rear plate cover		6.3 - 8.3 (0.64 - 0.85, 56 - 73)*2
Ignition coil		3.8 - 4.4 (0.39 - 0.44, 34 - 38)*2
Spark plug		19.6 - 29.4 (2.0 - 2.9, 15 - 21)
Fuel damper assembly (RH)		7.2 - 9.6 (0.74 - 0.97, 64 - 84)*2
Fuel feed damper assembly		7.2 - 9.6 (0.74 - 0.97, 64 - 84)*2
Fuel damper assembly, with hose		7.2 - 9.6 (0.74 - 0.97, 64 - 84)*2
Fuel tube assembly		1) 9.3 - 10.8 (0.95 - 1.1, 6.2 - 7.9) 2) 20.6 - 26.5 (2.1 - 2.7, 16 - 19)
*1 Rocker cover		1) 1.0 - 3.0 (0.1 - 0.31, 9 - 26)*2 2) 7.4 - 9.3 (0.75 - 0.95, 66 - 82)*2
PCV valve		1.96 - 2.94 (0.20 - 0.29, 18 - 26)*2
*1 Camshaft bracket	M6 and M8 bolts M6 and M8 bolts M6 bolt M8 bolt	1) 1.96 (0.2, 17)*2 2) 5.88 (0.6, 52)*2 3) 9.02 - 11.8 (0.92 - 1.2, 80 - 104)*2 4) 29.4 - 33.3 (3.0 - 3.4, 22 - 24)
Camshaft sprocket		147 - 157 (15.0 - 16.0, 109 - 115)
*1 Front cover		11.8 - 13.7 (1.2 - 1.3, 9 - 10)
Crankshaft pulley		1) 88.2 - 98.0 (9.0 - 9.9, 65 - 72) 2) 90° - 96° (angle tightening)

SERVICE DATA AND SPECIFICATIONS (SDS)

Oil pump		8.1 - 9.5 (0.83 - 0.96, 72 - 84)* ²	A
Oil level gauge guide		11.8 - 13.7 (1.2 - 1.3, 9 - 10)	
Timing chain slack guide		15.7 - 17.7 (1.6 - 1.8, 12 - 13)	
Timing chain tension guide		15.7 - 17.7 (1.6 - 1.8, 12 - 13)	EM
Chain tensioner		6.4 - 7.5 (0.66 - 0.76, 57 - 66)* ²	
Chain tensioner cover		8.1 - 9.5 (0.83 - 0.96, 72 - 84)* ²	C
Intake valve timing control cover		9.8 - 12.7 (1.0 - 1.3, 87 - 112)* ²	
Intake valve timing control solenoid valve		8.4 - 10.8 (0.9 - 1.1, 75 - 95)* ²	D
Camshaft position sensor (PHASE)		7.1 - 10.8 (0.8 - 1.1, 63 - 95)* ²	
Intake valve timing control position sensor		7.1 - 10.8 (0.8 - 1.1, 63 - 95)* ²	
*1 Cylinder head		1) 98.1 (10.0, 72) 2) 0 (0.0, 0) 3) 39.2 - 49.0 (4.0 - 5.0, 29 - 36) 4) 60° - 65° (angle tightening) 5) 60° - 65° (angle tightening)	E F
Engine coolant temperature sensor		20 - 29 (2.0 - 3.0, 15 - 21)	G
Engine slinger (front and rear)		30.4 - 36.3 (3.1 - 3.7, 23 - 26)	
*1 Main bearing cap	M12 bolt	1) 36.3 - 42.1 (3.7 - 4.3, 27 - 31)	H
	M9 bolt	2) 26.5 - 32.3 (2.7 - 3.3, 20 - 23)	
	M12 bolt	3) 40° - 45° (angle tightening)	
	M9 bolt	4) 30° - 35° (angle tightening)	I
	M10 side bolt	5) 46.1 - 51.9 (4.7 - 5.3, 34 - 38)	
Connecting rod cap		1) 13.7 - 15.7 (1.4 - 1.6, 10 - 12) 2) 60° - 65° (angle tightening)	J
Rear oil seal retainer		6.3 - 8.3 (0.85 - 0.95, 56 - 73)* ²	
Drive plate		84 - 93 (8.5 - 9.5, 62 - 68)	K
Crankshaft position sensor (POS)		7.1 - 10.8 (0.8 - 1.1, 63 - 95)* ²	
Knock sensor		16 - 26 (1.6 - 2.7, 12 - 19)	
Cylinder block heater (For Canada)		69 - 78 (7.1 - 7.9, 51 - 57)	L

M

SERVICE DATA AND SPECIFICATIONS (SDS)
