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SECTION **EM**

ENGINE MECHANICAL

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PRECAUTIONS

PRECAUTIONS

PFP:00001

Precautions for Drain Engine Coolant

EBS00NJ6

Drain engine coolant when engine is cooled.

Precautions for Disconnecting Fuel Piping

EBS00NJ7

- 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

EBS00NJ8

- When instructed to use SST, use specified tools. Always be careful to work safely, avoid forceful or uninstructed operations.
- Exercise maximum care to avoid damage to mating or sliding surfaces.
- Cover openings of engine system with tape or 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 in the step.

Precautions for Inspection, Repair and Replacement

EBS00NJ9

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

Precautions for Assembly and Installation

EBS00NJA

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

Parts Requiring Angle Tightening

EBS00NJB

- For the final tightening of the following engine parts use Tool:

Tool number : KV10112100 (BT-8653-A)

- Cylinder head bolts
- Lower cylinder block bolts
- Connecting rod cap bolts
- Crankshaft pulley bolt (No angle wrench is required as bolt flange is provided with notches for angle 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

EBS00NJC

Precautions for Liquid Gasket REMOVAL OF LIQUID GASKET SEALING

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

Tool number : KV10111100 (J-37228)

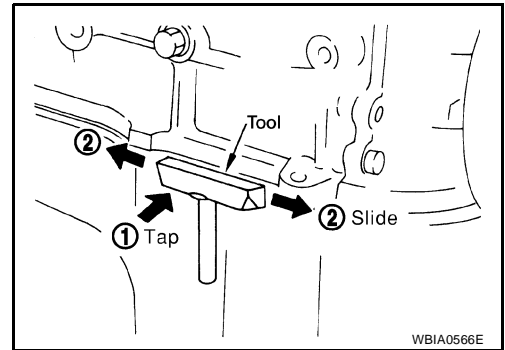
CAUTION:

Be careful not to damage the mating surfaces.

- Tap seal cutter to insert it, and then slide it by tapping on the side as shown.
- In areas where Tool is difficult to use, use plastic hammer to lightly tap the parts, to remove it.

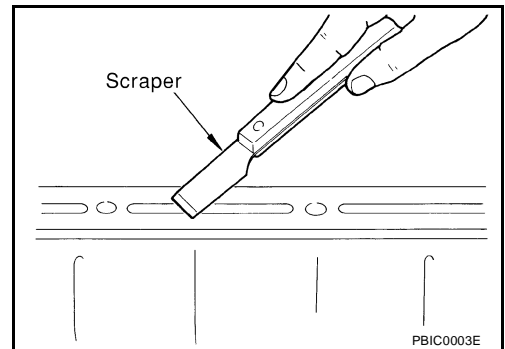
CAUTION:

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



LIQUID GASKET APPLICATION PROCEDURE

- Using scraper, remove old liquid gasket adhering to the gasket application surface and the mating surface.
 - Remove liquid gasket completely from the groove of the gasket application surface, bolts, and bolt holes.
- Thoroughly clean the mating surfaces and remove adhering moisture, grease and foreign materials.

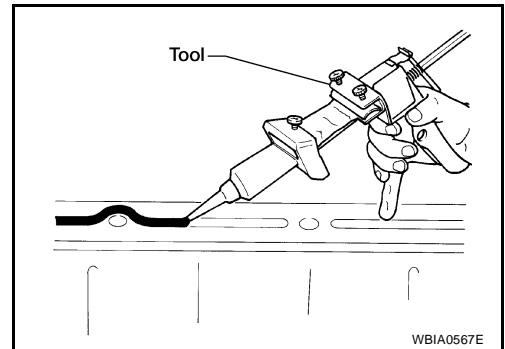


- Attach liquid gasket tube to Tool.

Tool number : WS39930000 (—)

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

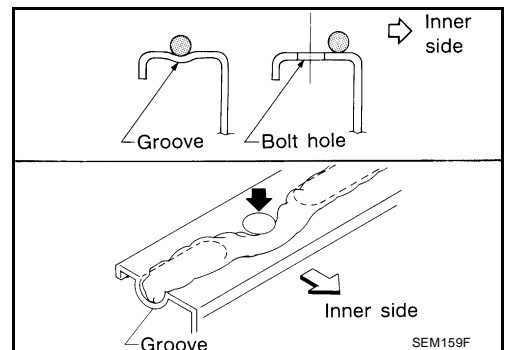
- Apply liquid gasket without breaks to the specified location with the specified dimensions.
 - If there is a groove for liquid gasket application, apply liquid gasket to the groove.



- As for bolt holes, normally apply 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 liquid gasket protrudes, wipe it off immediately.
- Do not retighten nuts or bolts after the installation.
- After 30 minutes or more have passed from the installation, fill engine oil and engine coolant.

CAUTION:

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



PREPARATION

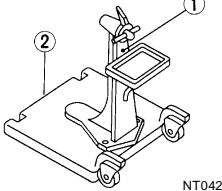
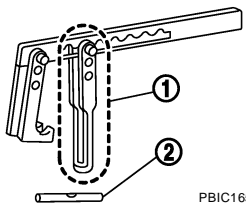
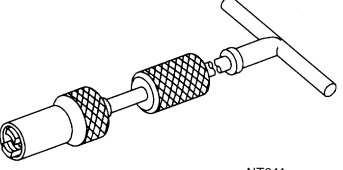
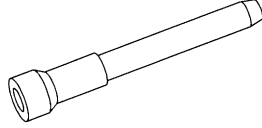
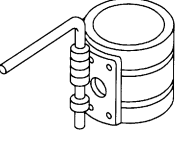
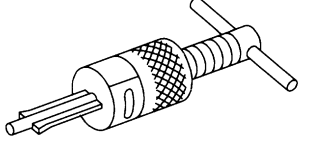
PREPARATION

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Special Service Tools

EBS000B5

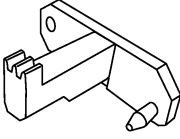

The actual shapes of Kent-Moore tools may differ from those of special service tools illustrated here.

Tool number (Kent-Moore No.) Tool name	Description
ST0501S000 (—) Engine stand assembly 1. ST05011000 (—) Engine stand 2. ST05012000 (—) Base	Disassembling and assembling engine  <p style="text-align: right; font-size: small;">NT042</p>
KV10116200 (J-26336-A) Valve spring compressor 1. KV10115900 (J-26336-20) Attachment 2. KV10109220 (—) Adapter	Disassembling valve mechanism Part (1) is a component of KV10116200 (J-26336-A), but Part (2) is not so.  <p style="text-align: right; font-size: small;">PBIC1650E</p>
KV10107902 (J-38959) Valve oil seal puller	Replacing valve oil seal  <p style="text-align: right; font-size: small;">NT011</p>
— (J-39386) Valve oil seal drift	Installing valve oil seal  <p style="text-align: right; font-size: small;">NT024</p>
EM03470000 (J-8037) Piston ring compressor	Installing piston assembly into cylinder bore  <p style="text-align: right; font-size: small;">NT044</p>
ST16610001 (J-23907) Pilot bushing puller	Removing pilot converter (A/T models)  <p style="text-align: right; font-size: small;">NT045</p>

PREPARATION

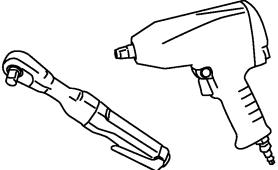
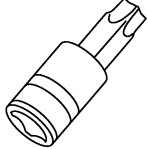
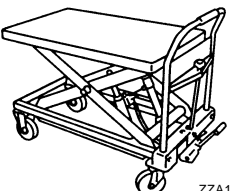
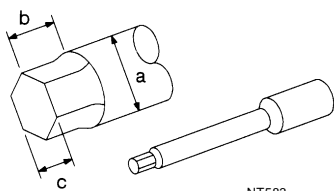
Tool number (Kent-Moore No.) Tool name	Description	
KV991J0120 (J-47128) Seal installer	Installing rear main seal	A EM C
KV10111100 (J-37228) Seal cutter	Removing oil pan (lower and upper), front and rear timing chain case, etc.	D E
WS39930000 (—) Tube presser	Pressing the tube of liquid gasket	F G H
KV10112100 (BT-8653-A) Angle wrench	Tightening bolts for bearing cap, cylinder head, etc. in angle	I J
KV991J0050 (J-44626) Air fuel sensor Socket	Loosening or tightening air fuel ratio A/F sensor a: 22 mm (0.87 in)	K L
KV10114400 (J-38365) Heated oxygen sensor wrench	Loosening or tightening heated oxygen sensor 1 a: 22 mm (0.87 in)	M

PREPARATION

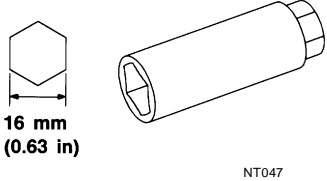
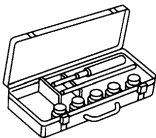
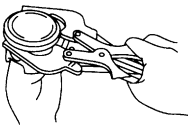
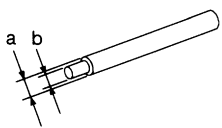
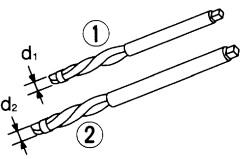
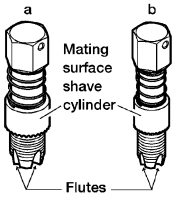

Tool number (Kent-Moore No.) Tool name	Description
KV10117700 (J-44716) Ring gear stopper	Removing and installing crankshaft pulley
 NT822	
— (J-45488) Quick connector release	Removing fuel tube quick connectors in engine room (Available in SEC. 164 of PARTS CATALOG: Part No. 16441 6N210)
 PBIC0198E	

Commercial Service Tools

EBS00QB3

(Kent-Moore No.) Tool name	Description
(—) Power tool	Loosening nuts and bolts
 PBIC0190E	
KV991J0100 (J-46531) TORX socket	Removing and installing flywheel Size: T55
 PBIC1113E	
(—) Manual lift table caddy	Removing and installing engine
 ZZA1210D	
(J-24239-01) Cylinder head bolt wrench	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)
 NT583	

PREPARATION

(Kent-Moore No.) Tool name	Description	A
(—) Spark plug wrench	 <p style="text-align: center;">16 mm (0.63 in)</p> <p style="text-align: center;">NT047</p>	EM
(—) Valve seat cutter set	 <p style="text-align: center;">NT048</p>	C D E
(—) Piston ring expander	 <p style="text-align: center;">NT030</p>	F G
(—) Valve guide drift	 <p style="text-align: center;">NT015</p>	H I
(—) Valve guide reamer	 <p style="text-align: center;">NT016</p>	J K L
(J-43897-18) (J-43897-12) Oxygen sensor thread cleaner	 <p style="text-align: center;">AEM488</p>	M
(—) Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specifica- tion MIL-A-907)	 <p style="text-align: center;">AEM489</p>	

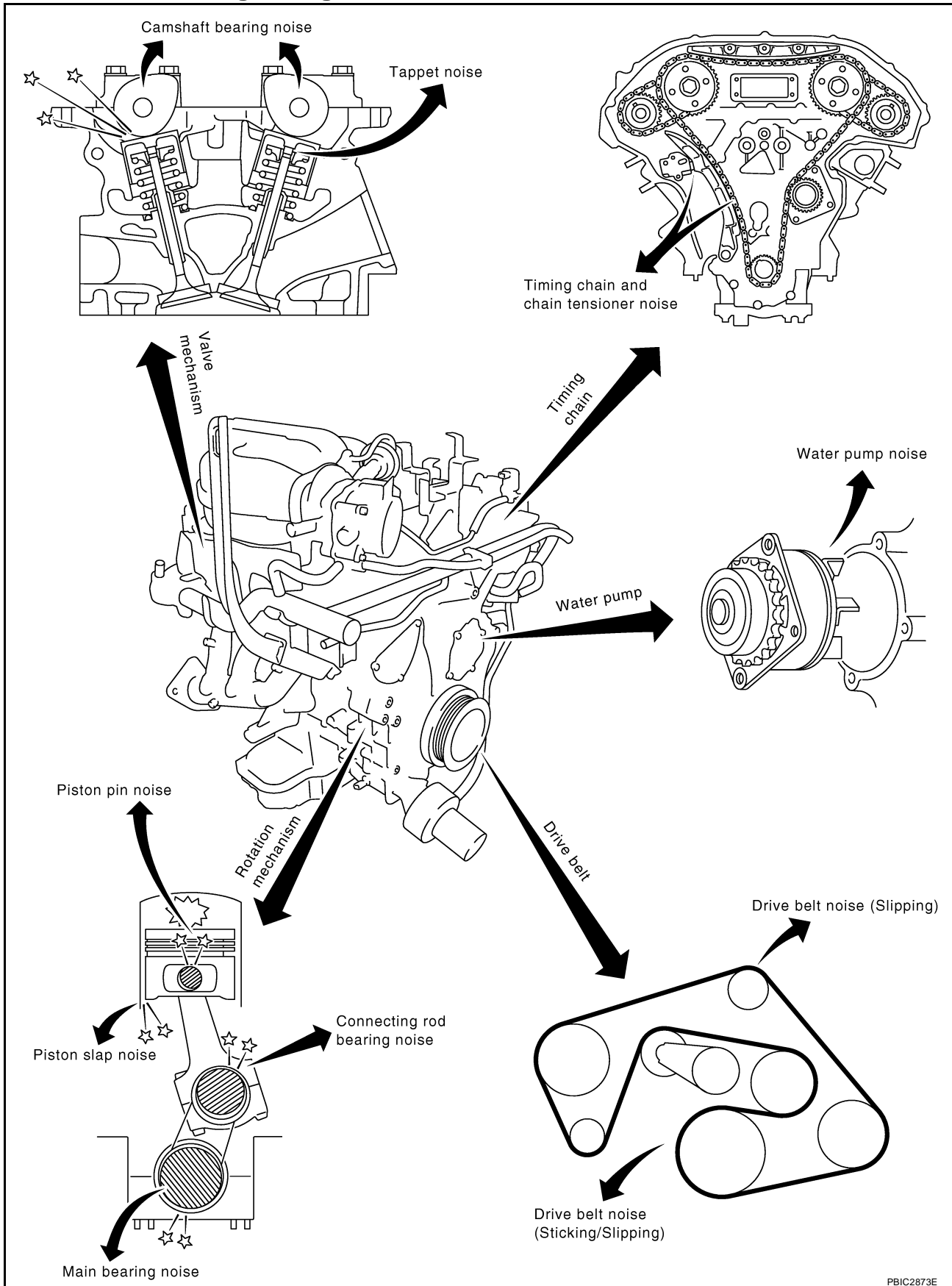
NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

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NVH Troubleshooting —Engine Noise

EBS00NJF



NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

EBS00NJG

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-83
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft runout Camshaft journal oil clearance	EM-76 EM-76
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston to piston pin oil clearance Connecting rod bushing oil clearance	EM-121 EM-123
	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-125 EM-122 EM-122 EM-123
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing oil clearance	EM-123 EM-127
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-128 EM-127
Front of engine Timing chain case	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation	EM-62 EM-54
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	EM-13
	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-16

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

ENGINE ROOM COVER

ENGINE ROOM COVER

PF14049

Removal and Installation

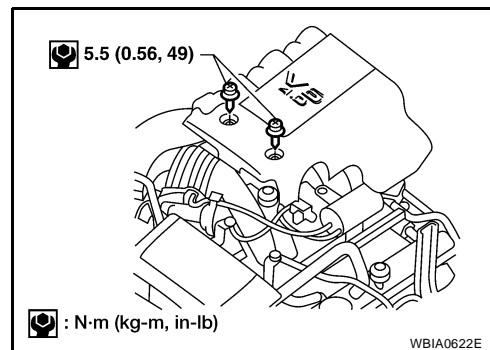
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REMOVAL

1. Remove bolts using power tool.
2. Lift up on engine cover firmly to dislodge snap fit mounts.

CAUTION:

Do not damage or scratch cover when installing or removing.



INSTALLATION

Installation is in the reverse order of removal.

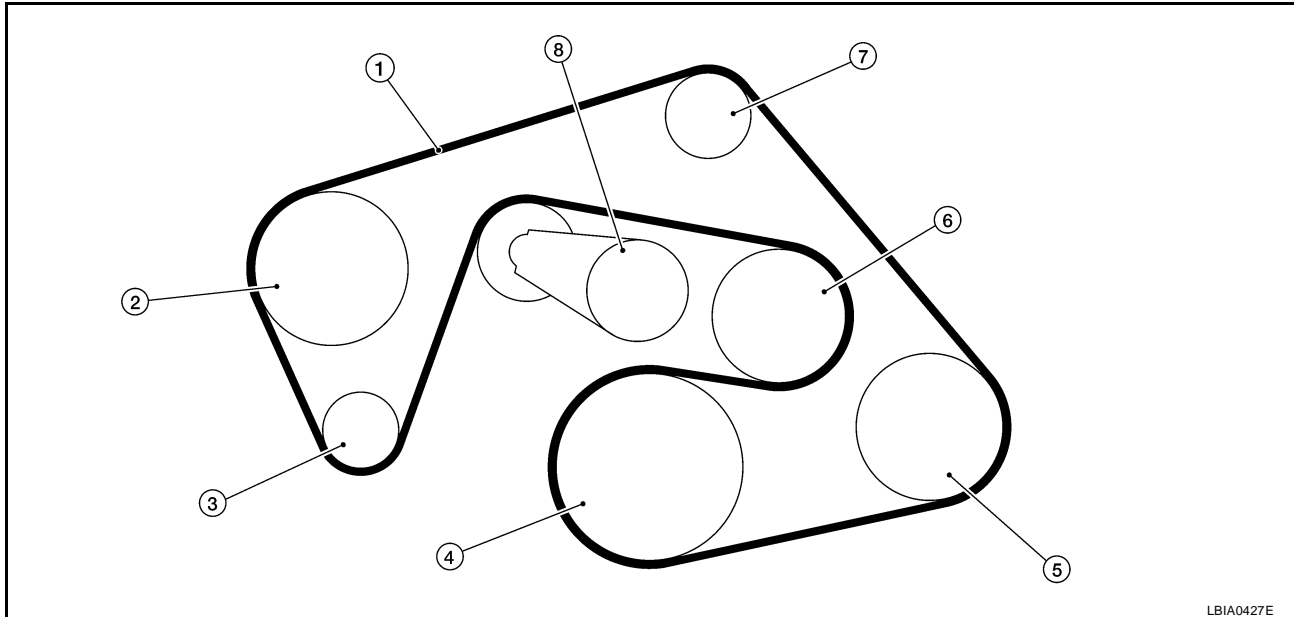
DRIVE BELTS

DRIVE BELTS

PPF:02117

Checking Drive Belts

EBS00NJI



LBIA0427E

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

WARNING:

Be sure to perform when the engine is stopped.

1. Remove air duct and resonator assembly (inlet) when inspecting drive belt. Refer to [EM-15, "REMOVAL"](#).
2. Visually check entire belt for wear, damage or cracks.

Tension Adjustment

EBS00NJJ

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

Removal and Installation

EBS00NJK

DRIVE BELT

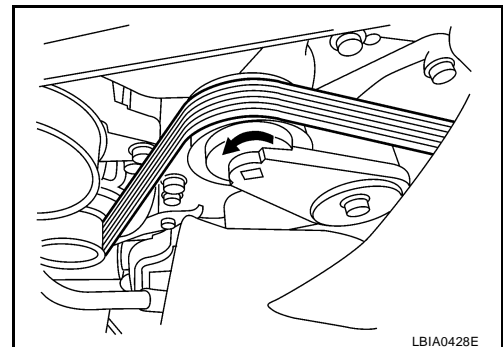
Removal

1. Remove air duct and resonator assembly (inlet). Refer to [EM-15, "REMOVAL"](#).
2. Rotate the drive belt auto tensioner in the direction of arrow (loosening direction of tensioner) as shown, using suitable tool.

CAUTION:

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

3. Remove the drive belt.



LBIA0428E

DRIVE BELTS

INSTALLATION

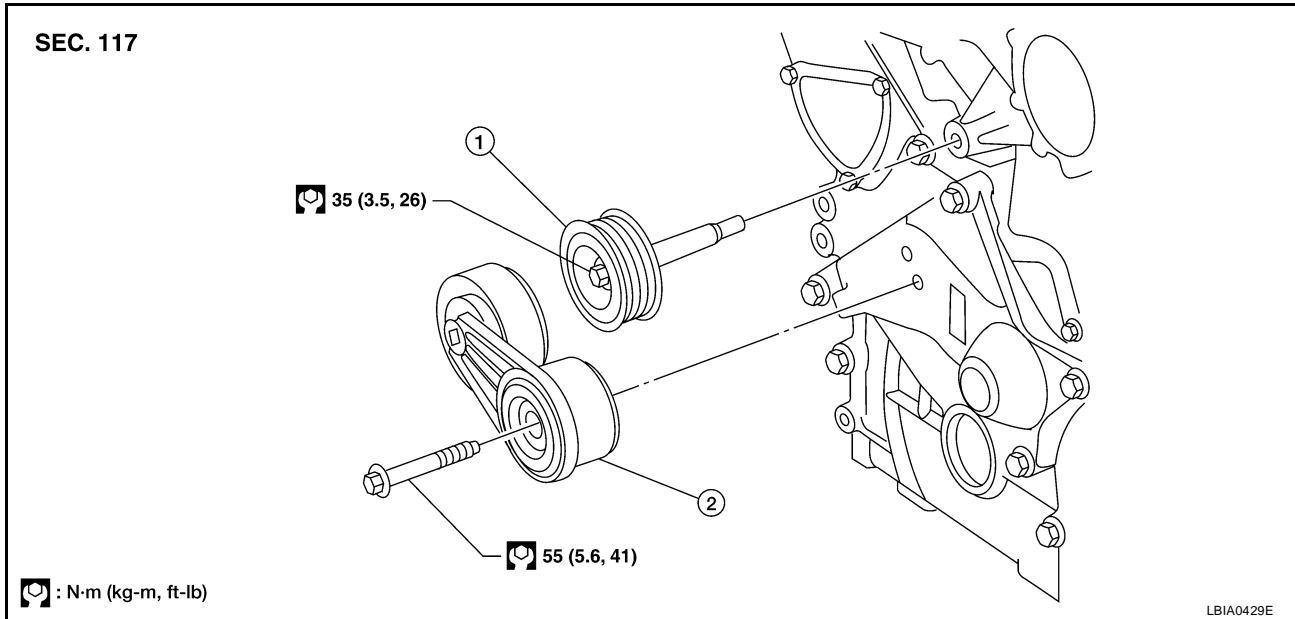
Installation is in the reverse order of removal.

CAUTION:

Make sure belt is securely installed around all pulleys.

Drive Belt Auto Tensioner and Idler Pulley

EBS00NJL



1. Idler pulley

2. Drive belt auto tensioner

REMOVAL

1. Remove air duct and resonator assembly (inlet). Refer to [EM-15, "REMOVAL"](#) .
2. Remove drive belt. Refer to [EM-13, "Removal"](#) .
3. Remove radiator cooling fan assembly. Refer to [CO-14, "REMOVAL"](#) .
4. Remove auto tensioner and idler pulley using power tool.

INSTALLATION

Installation is in the reverse order of removal.

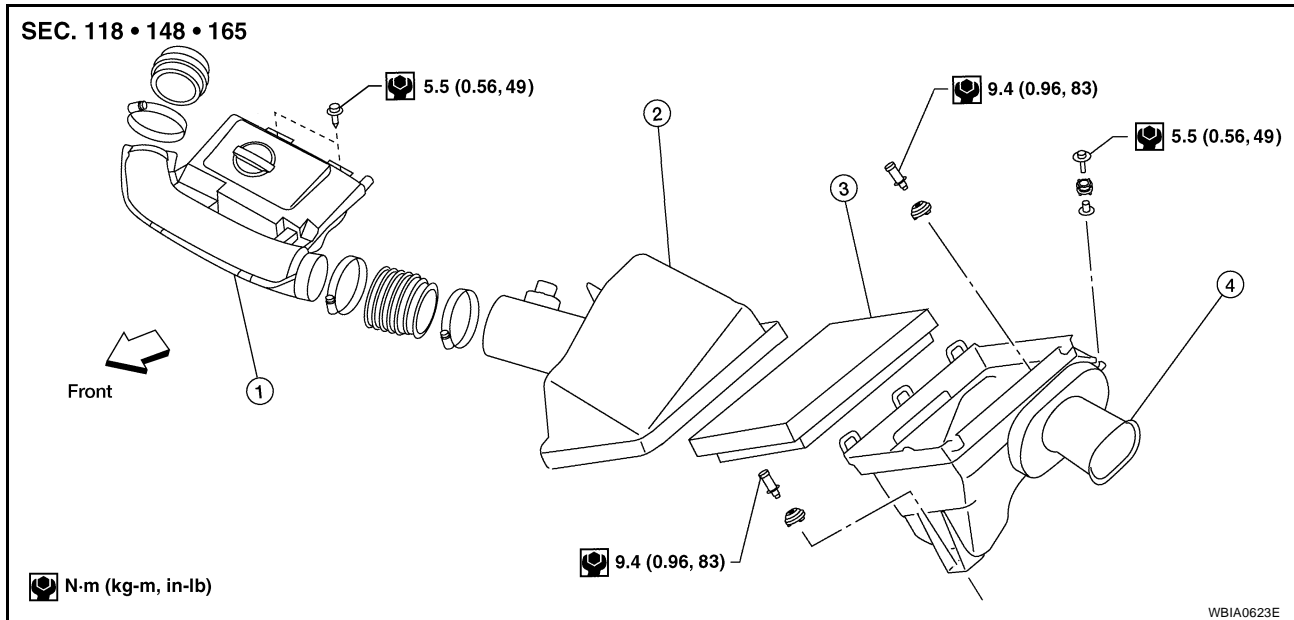
AIR CLEANER AND AIR DUCT

PF16500

AIR CLEANER AND AIR DUCT

Removal and Installation

EBS00NJM



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

REMOVAL

1. Disconnect harness connector from mass air flow sensor.
2. Disconnect PCV hose.
3. Remove air cleaner case/mass air flow sensor assembly and air duct assembly disconnecting their joints.
 - Add marks as necessary for easier installation.

CAUTION:

Handle mass air flow sensor with care.

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

INSPECTION AFTER REMOVAL

Inspect air duct for crack or tear.

- If anything found, replace air duct.

INSTALLATION

Installation is in the reverse order of removal.

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

Changing Air Cleaner Filter

REMOVAL

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

INSTALLATION

Installation is in the reverse order of removal.

EBS00NJN

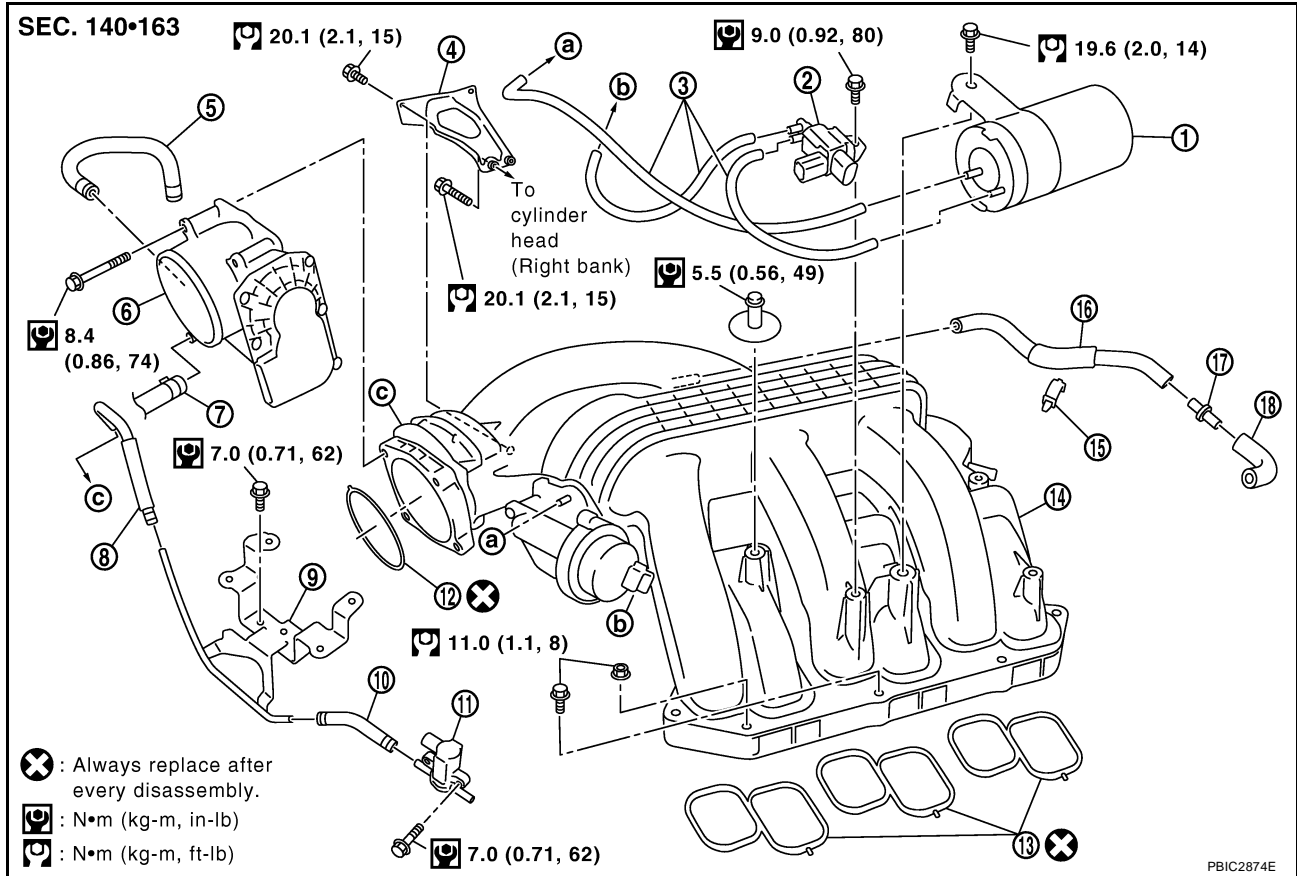
INTAKE MANIFOLD COLLECTOR

PF14003

EBS00NJO

INTAKE MANIFOLD COLLECTOR

Removal and Installation



- | | | |
|--------------------------------------|---|---------------------------------------|
| 1. Vacuum tank | 2. VIAS control solenoid valve | 3. Vacuum hose |
| 4. Intake manifold collector support | 5. Water hose | 6. Electric throttle control actuator |
| 7. Water hose | 8. EVAP hose | 9. Bracket |
| 10. EVAP hose | 11. EVAP canister purge volume control solenoid valve | 12. Gasket |
| 13. Gasket | 14. Intake manifold collector | 15. Clip |
| 16. PCV hose | 17. Connector | 18. PCV hose |

INTAKE MANIFOLD COLLECTOR

REMOVAL

WARNING:

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

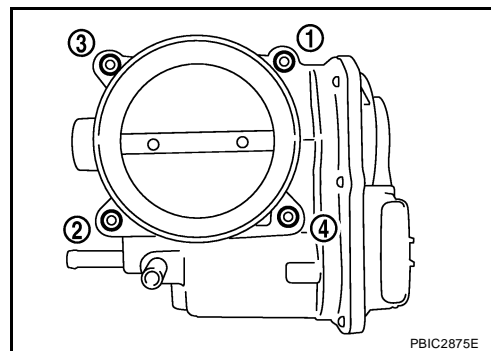
1. Remove engine cover. Refer to [EM-12, "REMOVAL"](#).
2. Remove air cleaner case (upper) with mass air flow sensor and air duct assembly. Refer to [EM-15, "REMOVAL"](#).
3. Remove electric throttle control actuator as follows:
 - a. Drain engine coolant, or when water hoses are disconnected, attach plug to prevent engine coolant leakage. Refer to [MA-13, "Changing Engine Coolant"](#).

CAUTION:

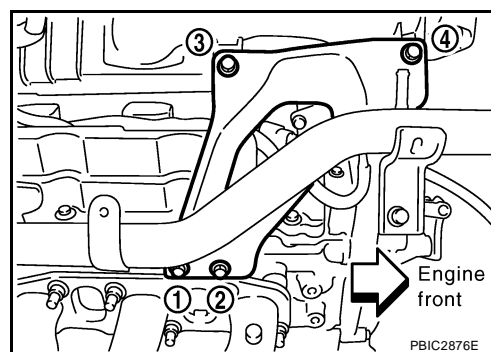
- Perform when engine is cold.
 - Do not spill engine coolant on drive belt.
- b. Disconnect water hoses from electric throttle control actuator.
 - When engine coolant is not drained from radiator, attach plug to water hoses to prevent engine coolant leakage.
 - c. Disconnect harness connector.
 - d. Loosen bolts in reverse order as shown.

CAUTION:

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



4. Remove the following parts:
 - Vacuum hose (to brake booster)
 - PCV hose
5. Loosen bolts in reverse order as shown to remove intake manifold collector support.



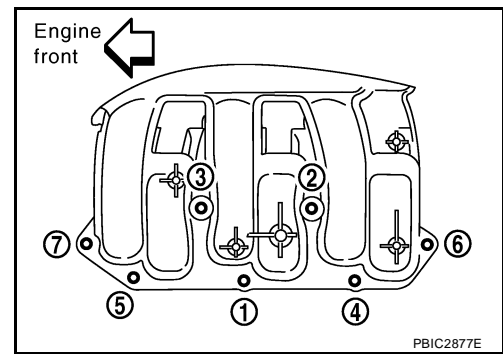
6. Disconnect EVAP hoses and harness connector from EVAP canister purge volume control solenoid valve.
7. Remove EVAP canister purge volume control solenoid valve.
8. Remove VIAS control solenoid valve and vacuum tank.
 - Add mating marks as necessary for easier installation.

INTAKE MANIFOLD COLLECTOR

- Loosen nuts and bolts in reverse order as shown with power tool, and remove intake manifold collector.

CAUTION:

Cover engine openings to avoid entry of foreign materials.



INSTALLATION

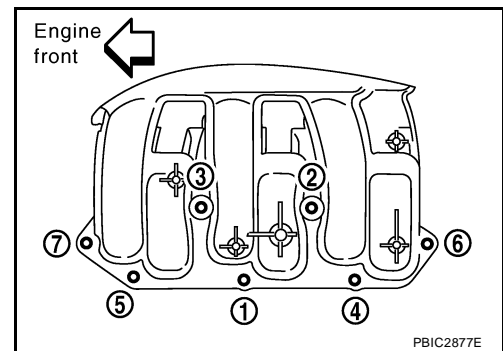
Installation is in the reverse order of removal. Note the following:

Intake Manifold Collector

- If stud bolts were removed from intake manifold, install them and tighten to the specified torque.
- Tighten nuts and bolts in numerical order as shown.

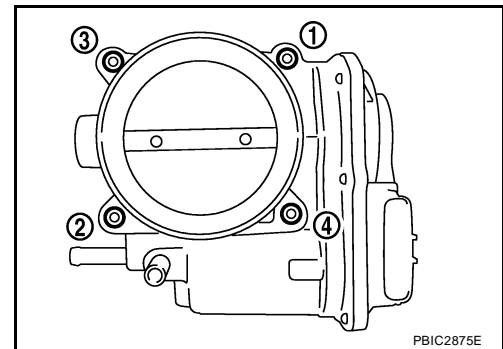
Intake manifold collector : 11.0 N·m (1.1 kg·m, 8 ft·lb)
bolts and nuts

Stud bolts : 6.9 N·m (7.0kg·m, 61 in·lb)



Electric Throttle Control Actuator

- Tighten bolts in numerical order as shown.
- Perform the “Throttle Valve Closed Position Learning” when harness connector of electric throttle control actuator is disconnected. Refer to [EC-88, "Throttle Valve Closed Position Learning"](#).
- Perform the “Idle Air Volume Learning” and “Throttle Valve Closed Position Learning” when electric throttle control actuator is replaced. Refer to [EC-89, "Idle Air Volume Learning"](#).



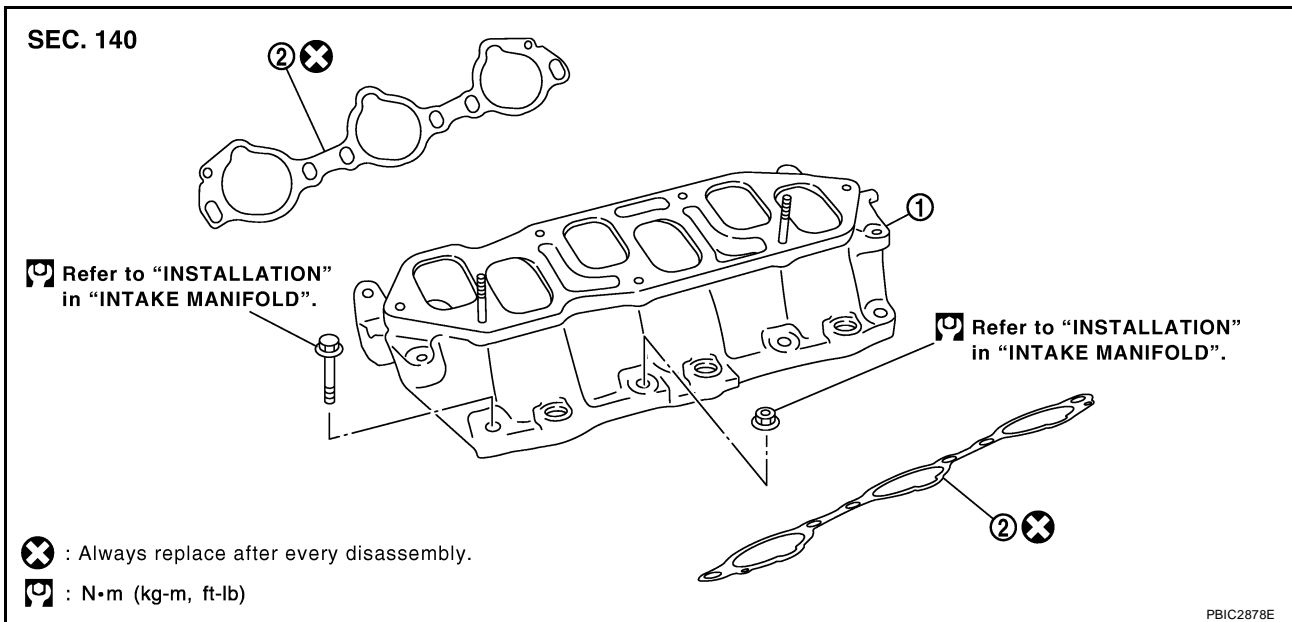
INTAKE MANIFOLD

PFP:14003

EBS00NJP

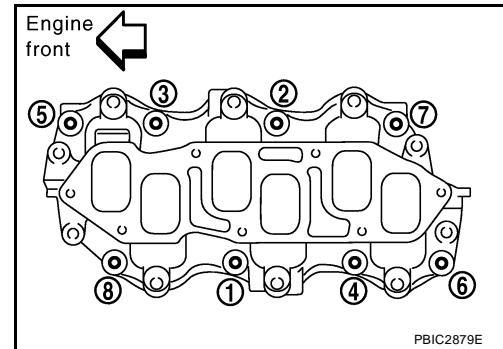
INTAKE MANIFOLD

Removal and Installation



REMOVAL

1. Release fuel pressure. Refer to [EC-91, "FUEL PRESSURE RELEASE"](#).
2. Remove intake manifold collector. Refer to [EM-17, "REMOVAL"](#).
3. Remove fuel tube and fuel injector assembly. Refer to [EM-34, "REMOVAL"](#).
4. Loosen nuts and bolts with power tool in reverse order as shown to remove intake manifold.



5. Remove gaskets.

CAUTION:

Cover engine openings to avoid entry of foreign materials.

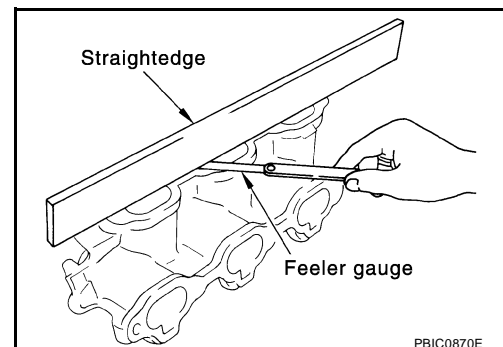
INSPECTION AFTER REMOVAL

Surface Distortion

- Check the surface distortion of the intake manifold mating surface with straightedge and feeler gauge.

Limit : 0.1 mm (0.004 in)

- If it exceeds the limit, replace intake manifold.



INTAKE MANIFOLD

INSTALLATION

Installation is in the reverse order of removal. Note the following:

Intake Manifold

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

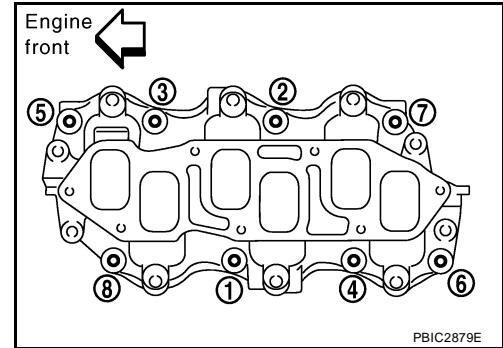
Intake manifold studs : 11.0 N·m (1.1kg-m, 8 ft-lb)

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

Intake manifold bolt and nuts

1st step : 7.4 N·m (0.75 kg-m, 5 ft-lb)

2nd step and after : 29.0 N·m (3.0 kg-m, 21 ft-lb)



EXHAUST MANIFOLD AND THREE WAY CATALYST

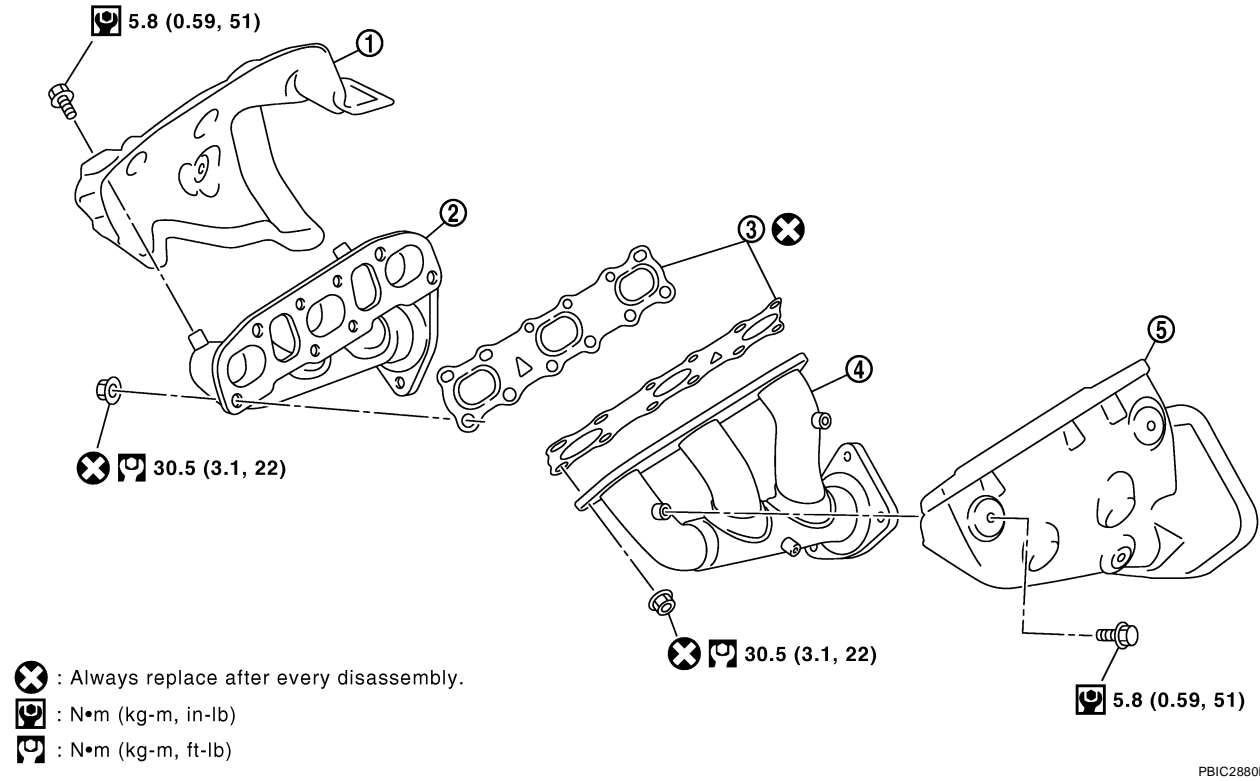
PF14004

EBS00NJQ

EXHAUST MANIFOLD AND THREE WAY CATALYST

Removal and Installation

SEC. 140•147•208•226



- | | | |
|--|----------------------------------|-----------|
| 1. Exhaust manifold cover (right bank) | 2. Exhaust manifold (right bank) | 3. Gasket |
| 4. Exhaust manifold cover (left bank) | 5. Exhaust manifold (left bank) | |

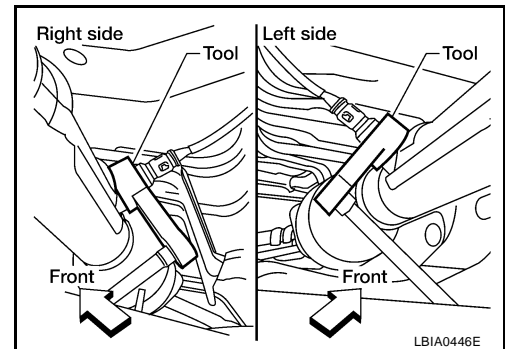
REMOVAL (LEFT BANK)

1. Remove air cleaner case and air duct. Refer to [EM-15, "REMOVAL"](#).
2. Remove engine undercover with power tool.
3. Disconnect harness connector and remove heated oxygen sensor 2 on both banks using Tool.

Tool number : KV10114400 (J-38365)

CAUTION:

- Be careful not to damage heated oxygen sensor 2.
- Discard any heated oxygen sensor 2 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; replace with a new sensor.



4. Remove center exhaust tube, main muffler and left front exhaust tube. Refer to [EX-4, "REMOVAL"](#).
5. Remove exhaust manifold cover (left bank).

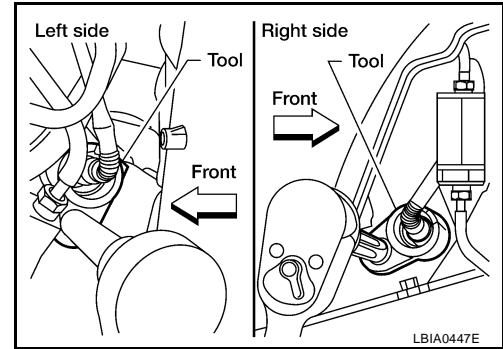
EXHAUST MANIFOLD AND THREE WAY CATALYST

6. Disconnect harness connector and remove air fuel ratio sensor 1 (left bank) using Tool.

Tool number : KV991J0050 (J-44626)

CAUTION:

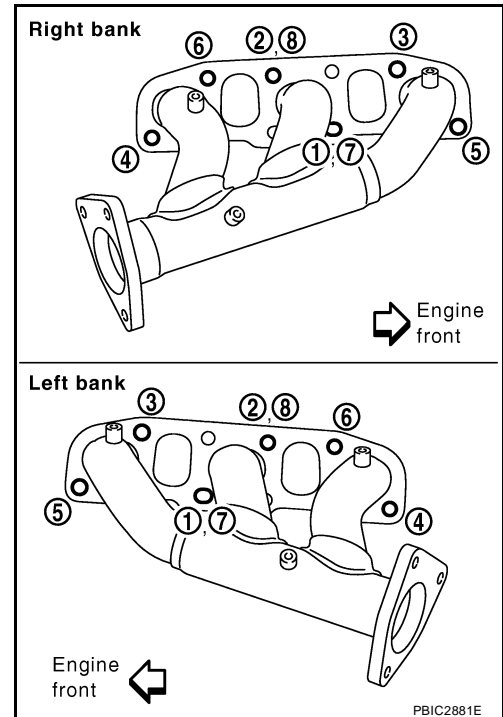
- Be careful not to damage air fuel ratio sensor 1.
- Discard any air fuel ratio sensor 1 which has been dropped from a height of more than 0.5 m (19.7 in) onto a hard surface such as a concrete floor; replace with a new sensor.



7. Remove three way catalyst (left bank).
8. Loosen nuts with power tool in reverse order as shown.

NOTE:

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



9. Remove gaskets.

CAUTION:

Cover engine openings to avoid entry of foreign materials.

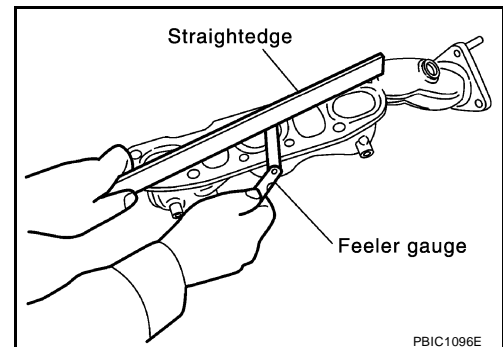
INSPECTION AFTER REMOVAL

Surface Distortion

- Check the surface distortion of the exhaust manifold mating surface with straightedge and feeler gauge.

Limit : 0.3 mm (0.012 in)

- If it exceeds the limit, replace exhaust manifold.



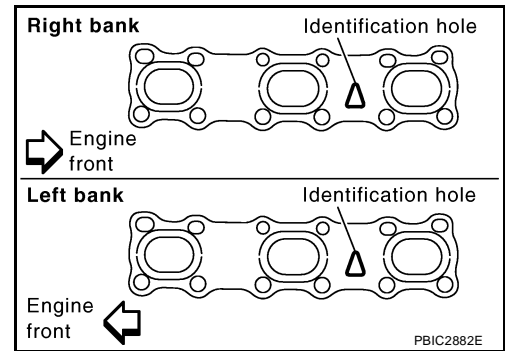
EXHAUST MANIFOLD AND THREE WAY CATALYST

INSTALLATION (LEFT BANK)

Installation of the remaining components is in the reverse order of removal. Note the following:

Exhaust Manifold Gasket

Install in direction as shown.



Exhaust Manifold

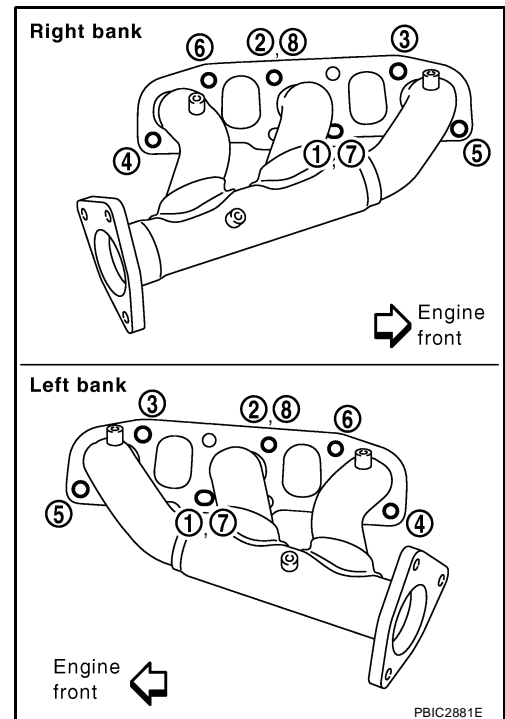
- If stud bolts were removed, install them and tighten to the specified torque.

Exhaust manifold stud torque : 14.7 N-m (1.5 kg-m, 11 ft-lb)

- Install exhaust manifold and tighten nuts in numerical order as shown.

NOTE:

Tighten nuts No. 1 and 2 in two steps. The numerical order No. 7 and 8 shown second step.



Heated Oxygen Sensor

CAUTION:

- Before installing a new air fuel ratio sensor 1 and heated oxygen sensor 2, clean exhaust system threads using oxygen sensor thread cleaner and apply anti-seize lubricant.

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

- Do not over torque air fuel ratio sensor 1 and heated oxygen sensor 2. Doing so may cause damage to air fuel ratio sensor 1 and heated oxygen sensor 2, resulting in the "MIL" coming on.

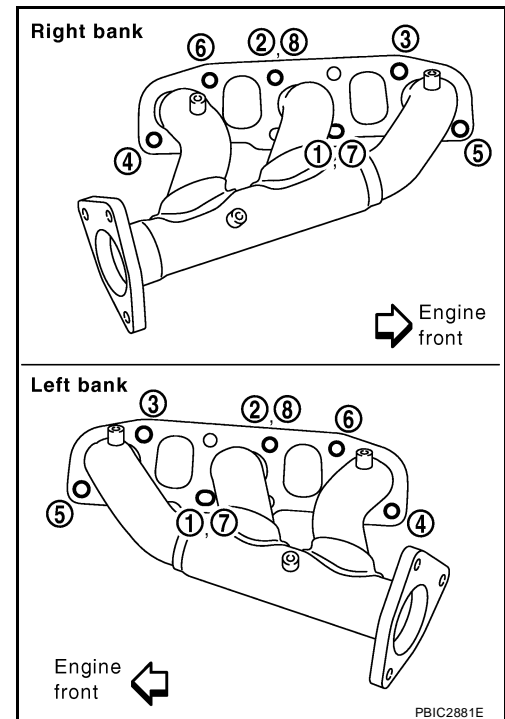
EXHAUST MANIFOLD AND THREE WAY CATALYST

REMOVAL (RIGHT BANK)

1. Remove engine assembly. Refer to [EM-103, "REMOVAL"](#) .
2. Loosen nuts with power tool in reverse order as shown.

NOTE:

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



3. Remove gaskets.

CAUTION:

Cover engine openings to avoid entry of foreign materials.

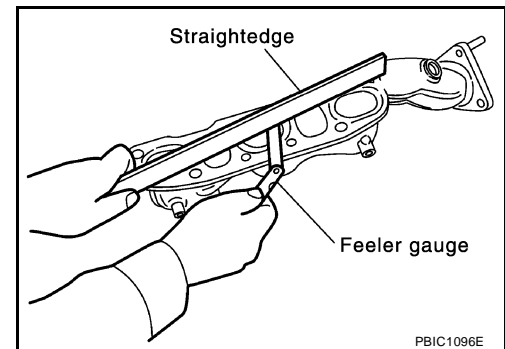
INSPECTION AFTER REMOVAL

Surface Distortion

- Check the surface distortion of the exhaust manifold mating surface with straightedge and feeler gauge.

Limit : 0.3 mm (0.012 in)

- If it exceeds the limit, replace exhaust manifold.



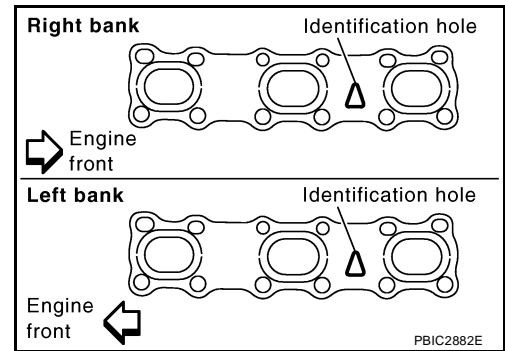
EXHAUST MANIFOLD AND THREE WAY CATALYST

INSTALLATION (RIGHT BANK)

Installation of the remaining components is in the reverse order of removal. Note the following:

Exhaust Manifold Gasket

Install in direction as shown.



Exhaust Manifold

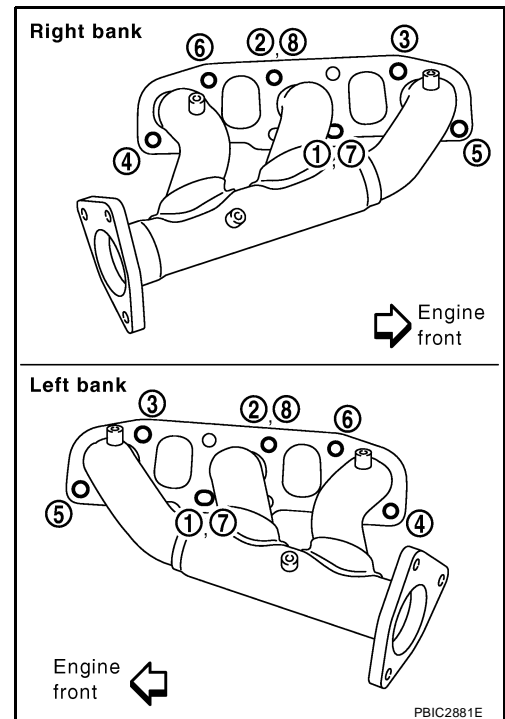
- If stud bolts were removed, install them and tighten to the specified torque.

Exhaust manifold stud torque : 14.7 N-m (1.5 kg-m, 11 ft-lb)

- Install exhaust manifold and tighten nuts in numerical order as shown.

NOTE:

Tighten nuts No. 1 and 2 in two steps. The numerical order No. 7 and 8 shown second step.



Heated Oxygen Sensor

CAUTION:

- Before installing a new air fuel ratio sensor 1 and heated oxygen sensor 2, clean exhaust system threads using oxygen sensor thread cleaner and apply anti-seize lubricant.

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

- Do not over torque air fuel ratio sensor 1 and heated oxygen sensor 2. Doing so may cause damage to air fuel ratio sensor 1 and heated oxygen sensor 2, resulting in the "MIL" coming on.

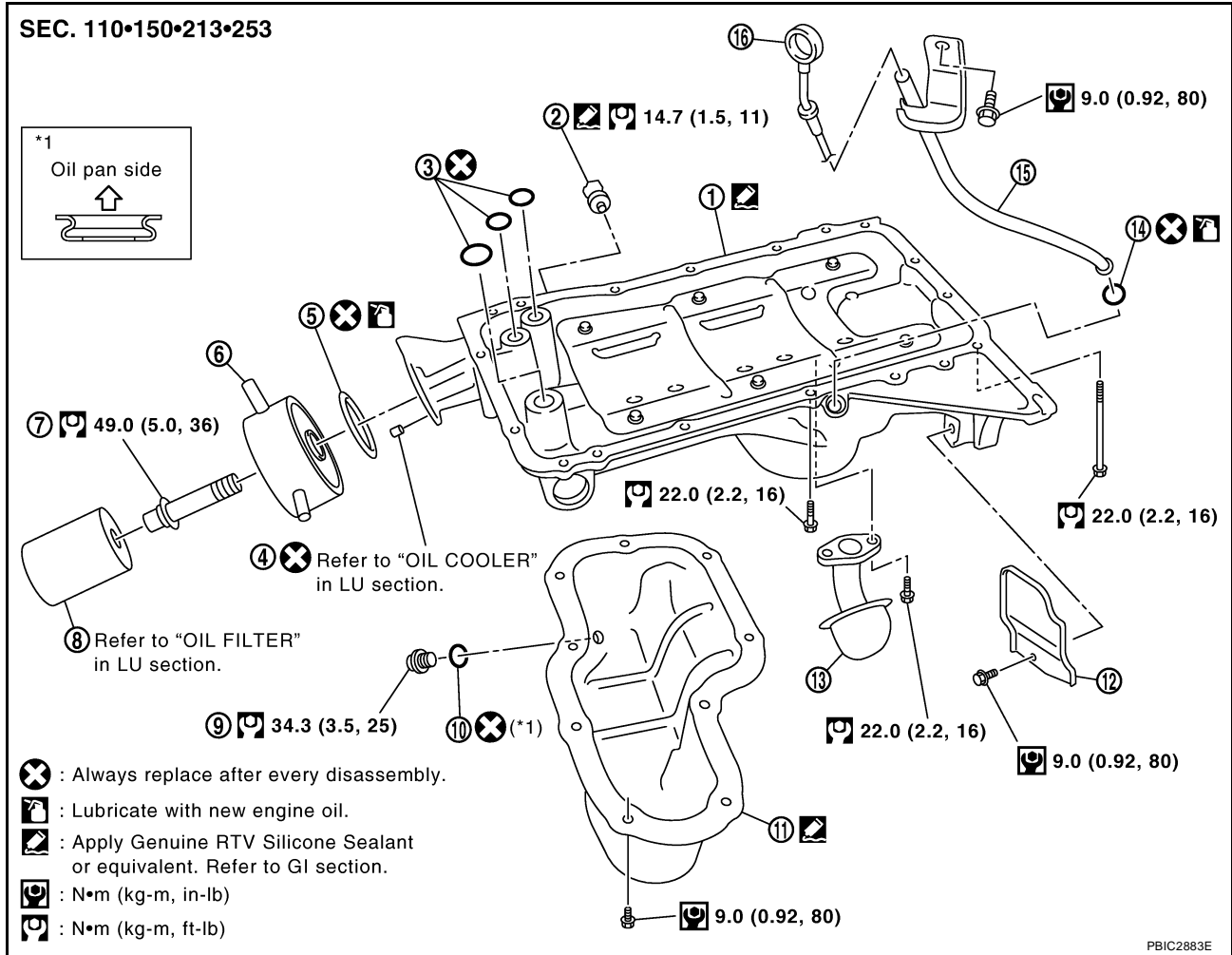
OIL PAN AND OIL STRAINER

PFP:11110

EBS00NJR

OIL PAN AND OIL STRAINER

Removal and Installation



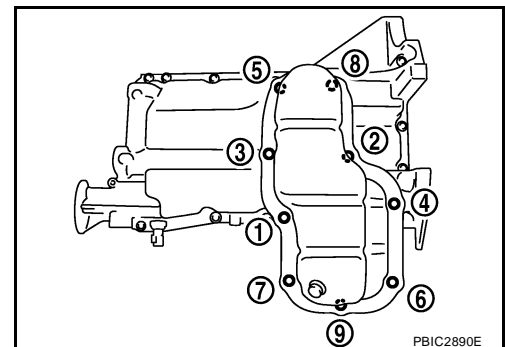
- | | | |
|-----------------------|------------------------|---------------------------|
| 1. Oil pan (upper) | 2. Oil pressure sensor | 3. O-ring |
| 4. Relief valve | 5. O-ring | 6. Oil cooler |
| 7. Connector bolt | 8. Oil filter | 9. Drain plug |
| 10. Drain plug washer | 11. Oil pan (lower) | 12.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

REMOVAL (LOWER)

WARNING:

To avoid the danger of being scalded, do not drain engine oil when engine is hot.

1. Drain engine oil. Refer to [MA-17, "Changing Engine Oil"](#).
2. Remove oil pan (lower) as follows:
 - a. Loosen bolts with power tool in reverse order as shown to remove.



OIL PAN AND OIL STRAINER

- b. Remove oil pan (lower) using Tool.

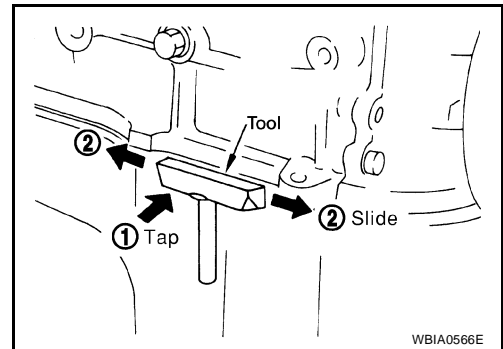
Tool number : KV10111100 (J-37228)

CAUTION:

- Be careful not to damage the mating surfaces.
- Do not insert screwdriver, this will damage the mating surfaces.

NOTE:

Slide seal cutter (1) by tapping on the side (2) of the tool with hammer.



INSPECTION AFTER REMOVAL

Clean oil strainer if any object attached.

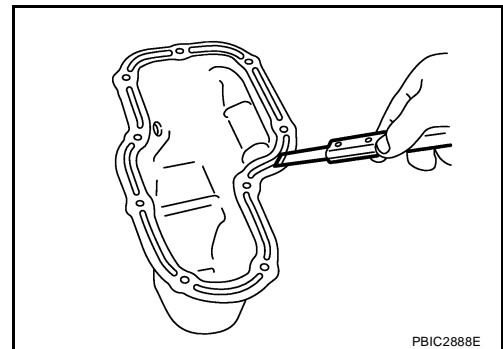
INSTALLATION (LOWER)

1. Install oil pan (lower) as follows:

- a. Use scraper to remove old liquid gasket from mating surfaces.
- Also remove old liquid gasket from mating surface of oil pan (upper).
 - Remove old liquid gasket from the bolt holes and thread.

CAUTION:

Do not scratch or damage the mating surfaces when cleaning off old liquid gasket.



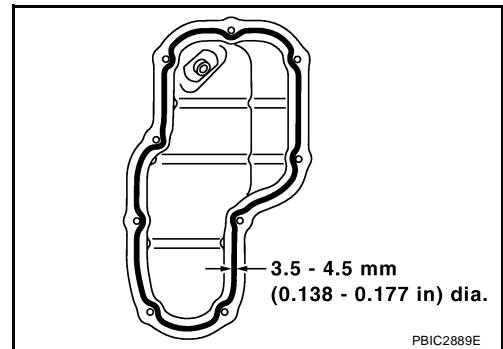
- b. Apply a continuous bead of liquid gasket using Tool to the oil pan (lower) as shown.

Tool number : WS39930000 (—)

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

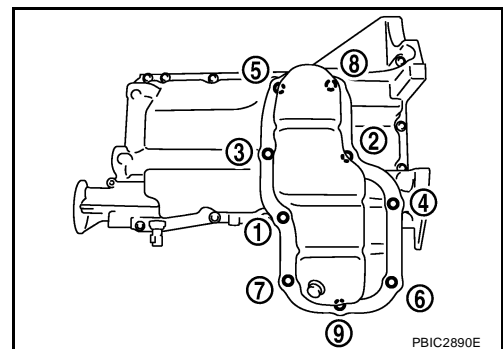
CAUTION:

Attaching should be done within 5 minutes after coating.



- c. Install oil pan (lower).

- Tighten bolts in numerical order as shown.



2. Install oil pan drain plug. Refer to [EM-26, "Removal and Installation"](#).
3. Installation is in the reverse order of removal.

NOTE:

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

OIL PAN AND OIL STRAINER

INSPECTION AFTER INSTALLATION

1. Check engine oil level and adjust engine oil. Refer to [LU-6, "ENGINE OIL"](#) .
2. Start engine, and check there is no leak of engine oil.
3. Stop engine and wait for 10 minutes.
4. Check engine oil level again. Refer to [LU-6, "ENGINE OIL"](#) .

REMOVAL (UPPER)

WARNING:

To avoid the danger of being scalded, do not drain engine oil when engine is hot.

1. Remove engine cover with power tool. Refer to [EM-12, "REMOVAL"](#) .
2. Remove air duct. Refer to [EM-15, "REMOVAL"](#) .
3. Drain engine oil. Refer to [LU-8, "Changing Engine Oil"](#) .

CAUTION:

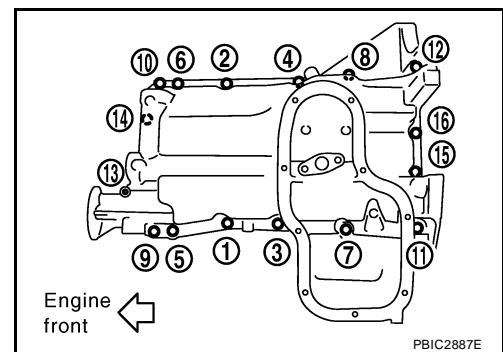
- Perform this step when engine is cold.
- Do not spill engine oil on drive belts.

4. Drain engine coolant. Refer to [MA-13, "Changing Engine Coolant"](#) .

CAUTION:

- Perform this step when engine is cold.
- Do not spill engine coolant on drive belts.

5. Remove front final drive (4X4). Refer to [FFD-14, "REMOVAL"](#) .
6. Disconnect steering gear lower joint shaft bolt and steering gear mounting nuts and bolts, position out of the way. Refer to [PS-15, "REMOVAL"](#) .
7. Remove starter motor. Refer to [SC-17, "REMOVAL"](#) .
8. Disconnect A/T fluid cooler tube brackets and position out of the way. Refer to [AT-245, "TRANSMISSION ASSEMBLY"](#) .
9. Remove oil filter, as necessary. Refer to [LU-9, "REMOVAL"](#) .
10. Remove oil cooler. Refer to [LU-10, "REMOVAL"](#) .
11. Remove oil pan (lower). Refer to [EM-26, "REMOVAL \(Lower\)"](#) .
12. Remove oil strainer.
13. Remove transmission joint bolts which pierce oil pan (upper). Refer to [AT-245, "TRANSMISSION ASSEMBLY"](#) .
14. Remove rear cover plate.
15. Loosen bolts with power tool in reverse order as shown to remove.



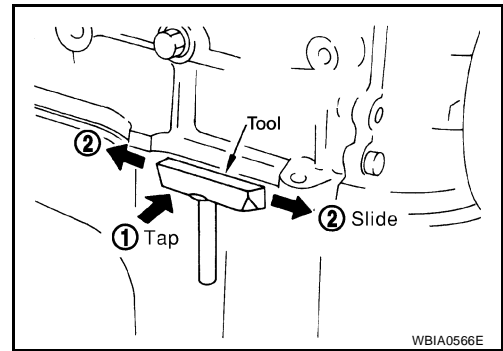
OIL PAN AND OIL STRAINER

- Insert Tool between oil pan (upper) and lower cylinder block.
- Slide Tool by tapping on the side of Tool with hammer.
- Remove oil pan (upper).

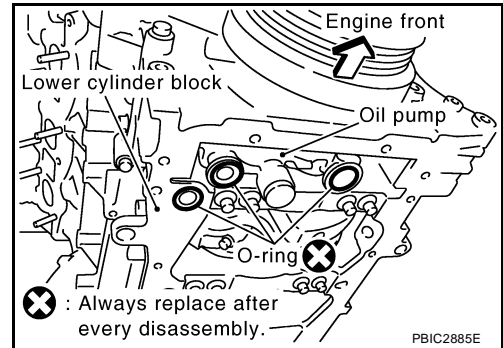
Tool number : KV10111100 (J-37228)

CAUTION:

Be careful not to damage mating surfaces.



16. Remove O-rings from bottom of lower cylinder block and oil pump.



INSPECTION AFTER REMOVAL

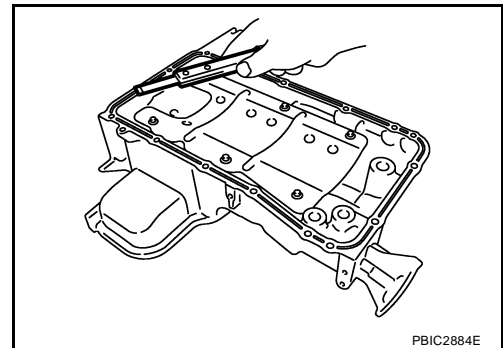
Clean oil strainer if any object attached.

INSTALLATION (UPPER)

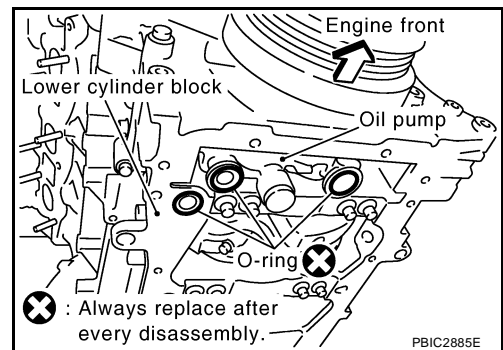
1. Install oil pan (upper) as follows:
 - a. Use scraper to remove old liquid gasket from mating surfaces.
 - Also remove the old liquid gasket from mating surface of lower cylinder block.
 - Remove old liquid gasket from the bolt holes and threads.

CAUTION:

Do not scratch or damage the mating surfaces when cleaning off old liquid gasket.



- b. Install new O-rings on the bottom of lower cylinder block and oil pump.



OIL PAN AND OIL STRAINER

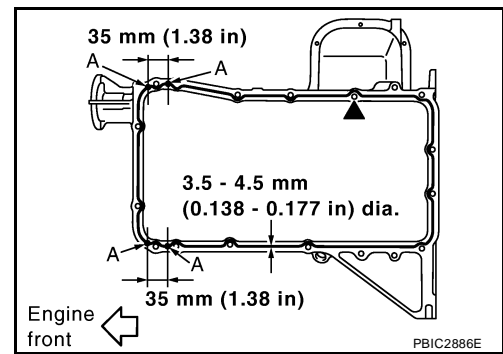
- c. Apply a continuous bead of liquid gasket using Tool to the lower cylinder block mating surfaces of oil pan (upper) to a limited portion as shown.

Tool number : WS39930000 (—)

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

CAUTION:

- For bolt holes with ▲ mark, apply liquid gasket outside the hole.
- Apply a bead of 4.5 to 5.5 mm (0.177 to 0.217 in) in diameter to area "A".
- Attaching should be done within 5 minutes after coating.



- d. Install oil pan (upper).

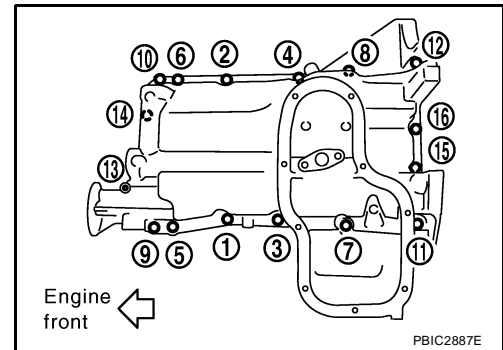
CAUTION:

Install avoiding misalignment of both oil pan gaskets and O-rings.

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

M8 × 100 mm (3.97 in) : 7, 11, 12, 13

M8 × 25 mm (0.98 in) : Except the above



- e. Tighten transmission joint bolts. Refer to [AT-245, "TRANSMISSION ASSEMBLY"](#) .
2. Install oil strainer to oil pan (upper).
 3. Installation of the remaining components is in the reverse order of removal.

INSPECTION AFTER INSTALLATION

1. Check engine oil level and adjust engine oil. Refer to [LU-6, "ENGINE OIL"](#) .
2. Start engine, and check there is no leak of engine oil.
3. Stop engine and wait for 10 minutes.
4. Check engine oil level again. Refer to [LU-6, "ENGINE OIL"](#) .

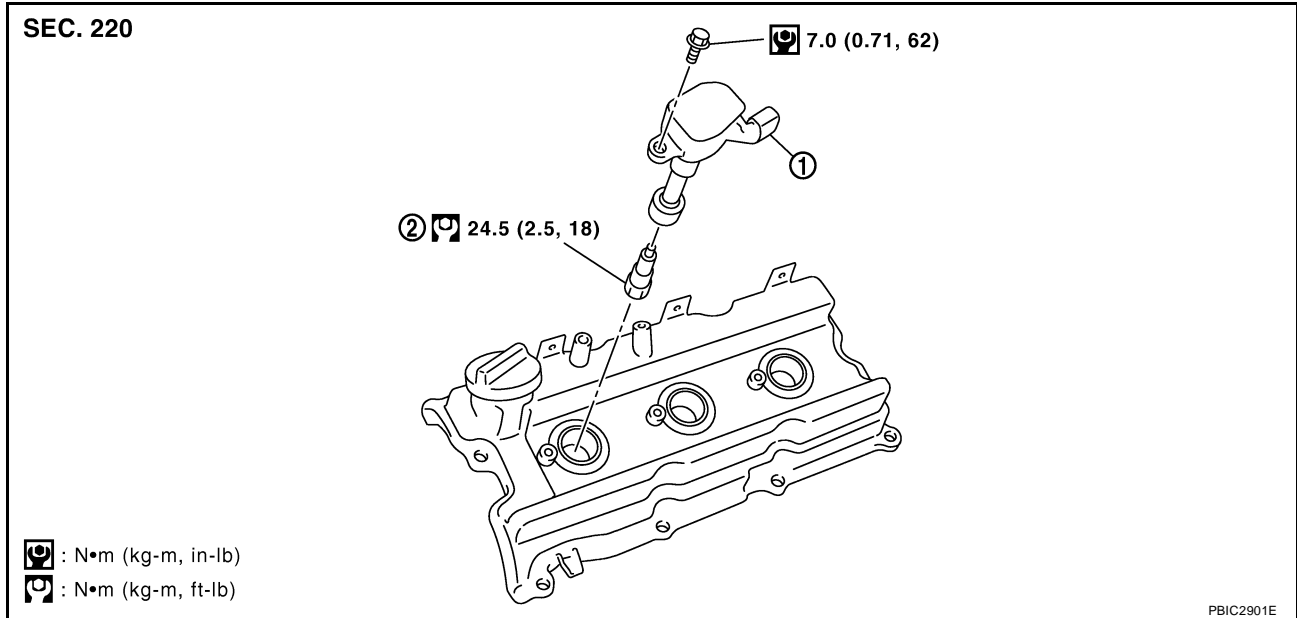
IGNITION COIL

PF22448

IGNITION COIL

Removal and Installation

EBS00NJS



REMOVAL (LEFT BANK)

1. Remove engine cover with power tool. Refer to [EM-12, "REMOVAL"](#).
2. Remove air cleaner case and air duct. (At the left bank side, remove ignition coil) Refer to [EM-15, "REMOVAL"](#).
3. Move aside harness, harness bracket, and hoses located above ignition coil.
4. Disconnect harness connector from ignition coil.
5. Remove ignition coil.

CAUTION:

Do not shock it.

INSTALLATION (LEFT BANK)

Installation is in the reverse order of removal.

REMOVAL (RIGHT BANK)

1. Remove intake manifold collector with power tool. Refer to [EM-17, "REMOVAL"](#).
2. Move aside harness, harness bracket, and hoses located above ignition coil.
3. Disconnect harness connector from ignition coil.
4. Remove ignition coil.

CAUTION:

Do not shock it.

INSTALLATION (RIGHT BANK)

Installation is in the reverse order of removal.

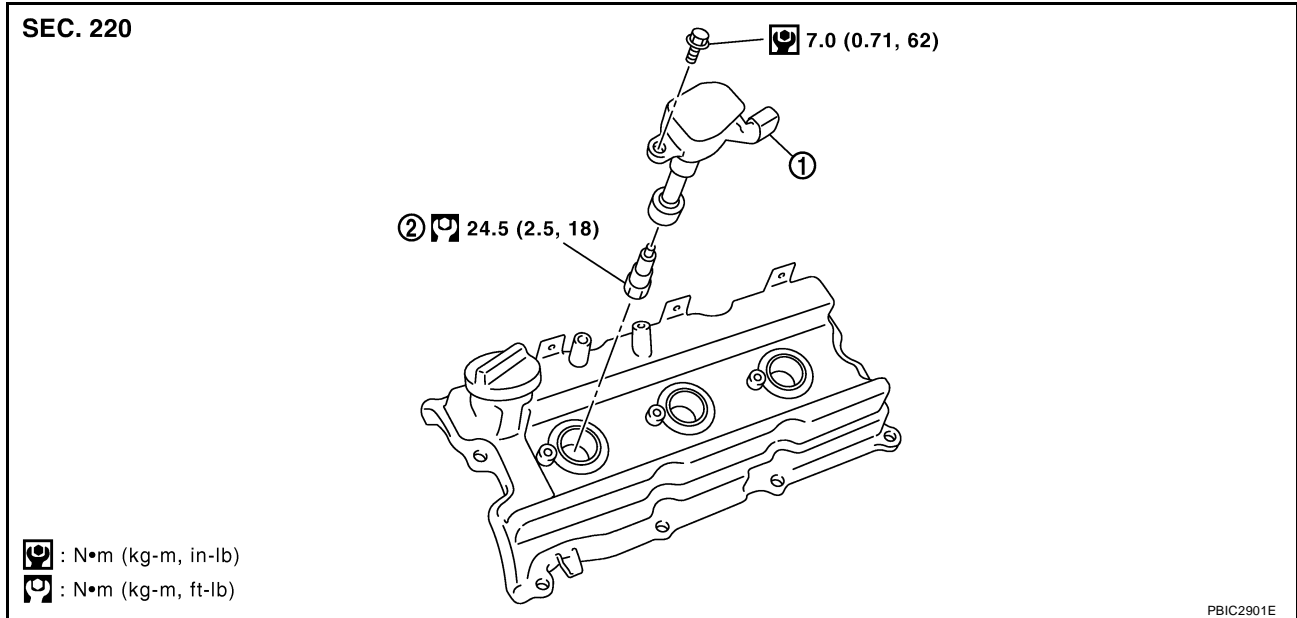
SPARK PLUG (PLATINUM-TIPPED TYPE)

SPARK PLUG (PLATINUM-TIPPED TYPE)

PFM:22401

Removal and Installation

EBS00NJT



1. Ignition coil

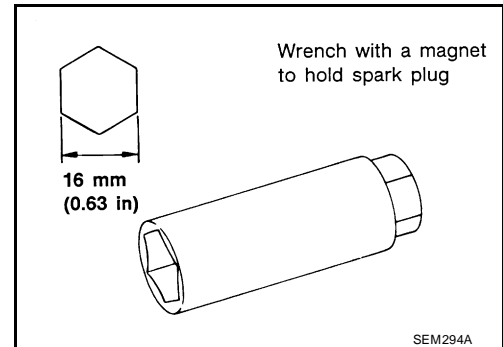
2. Spark plug

REMOVAL

1. Remove ignition coil. Refer to [EM-31, "Removal and Installation"](#).
2. Remove spark plug using spark plug wrench (commercial service tool).

CAUTION:

Do not drop or shock it.



INSPECTION AFTER REMOVAL

Use standard type spark plug for normal condition.

Hot type spark plug is suitable when fouling occurs with standard type spark plug under conditions such as:

- Frequent engine starts
- Low ambient temperatures

Cold type spark plug is suitable when spark plug knock occurs with standard type spark plug under conditions such as:

- Extended highway driving
- Frequent high engine revolution

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

Gap (Nominal) : 1.1 mm (0.043 in)

CAUTION:

- Do not drop or shock spark plug.

SPARK PLUG (PLATINUM-TIPPED TYPE)

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

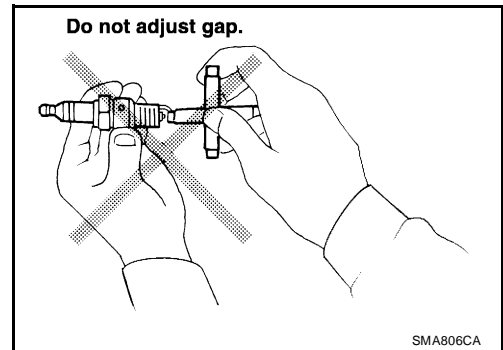
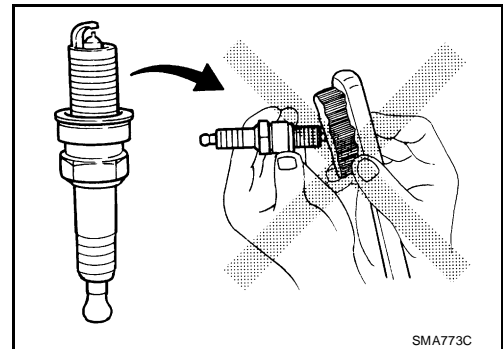
Cleaner air pressure:

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

Installation is in the reverse order of removal.

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FUEL INJECTOR AND FUEL TUBE

PF16600

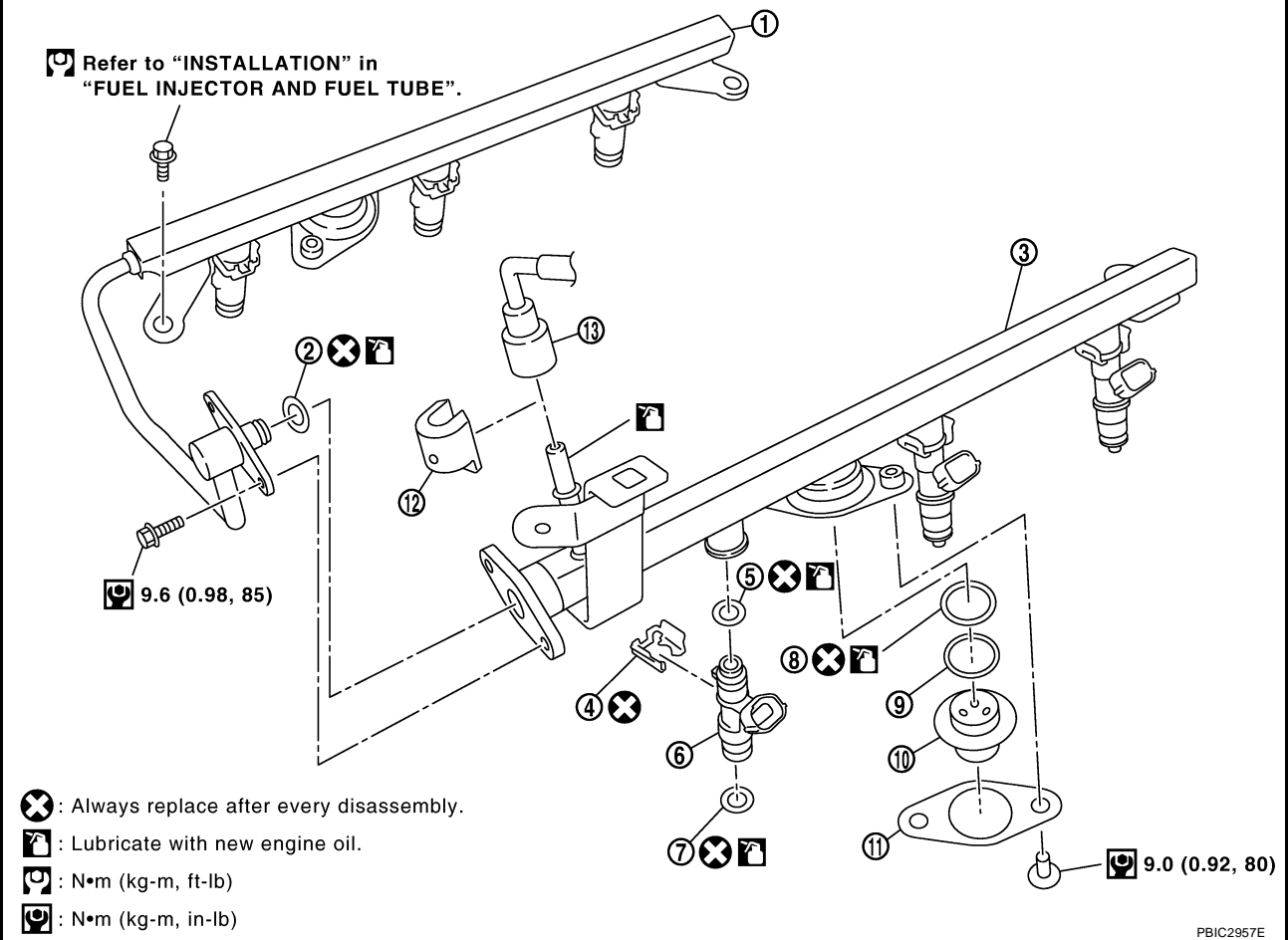
FUEL INJECTOR AND FUEL TUBE

Removal and Installation

EBS00NJU

SEC. 164

Refer to "INSTALLATION" in "FUEL INJECTOR AND FUEL TUBE".



PBIC2957E

- | | | |
|--------------------|---------------------|-------------------------|
| 1. Fuel tube (RH) | 2. O-ring | 3. Fuel tube (LH) |
| 4. Clip | 5. O-ring (blue) | 6. Fuel injector |
| 7. O-ring (brown) | 8. O-ring | 9. Spacer |
| 10. Fuel damper | 11. Fuel damper cap | 12. Quick connector cap |
| 13. Fuel feed hose | | |

REMOVAL

WARNING:

- Put a "CAUTION INFLAMMABLE" sign in the workshop.
- Be sure to work in a well ventilated area and furnish workshop with a CO₂ fire extinguisher.
- Do not smoke while servicing fuel system. Keep open flames and sparks away from the work area.
- To avoid the danger of being scalded, do not drain engine coolant when engine is hot.

1. Remove intake manifold collector. Refer to [EM-17, "REMOVAL"](#).

CAUTION:

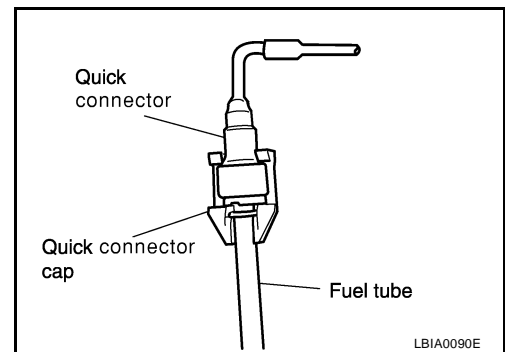
Perform this step when engine is cold.

2. Disconnect the fuel quick connector on the engine side.
 - Using Tool perform the following steps to disconnect the quick connector.

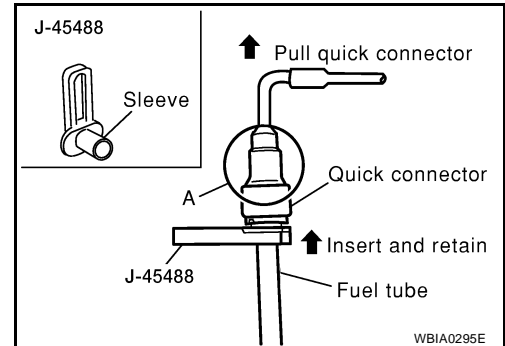
Tool number : — (J-45488)

FUEL INJECTOR AND FUEL TUBE

- a. Remove quick connector cap.



- b. With the sleeve side of Tool facing quick connector, install Tool onto fuel tube.



- c. Insert Tool into quick connector until sleeve contacts and goes no further. Hold the Tool on that position.

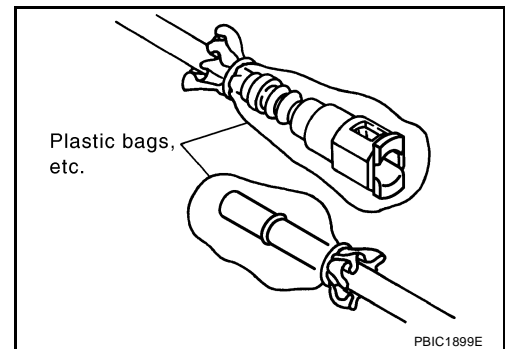
CAUTION:

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

- d. Pull the quick connector straight out from the fuel tube.

CAUTION:

- Pull quick connector holding it at the "A" position, as shown.
- 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.



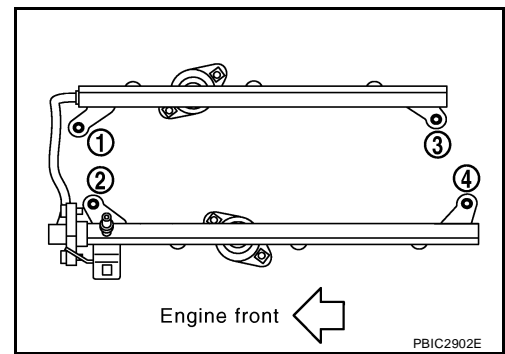
3. Remove PCV hose between rocker covers (right and left banks).
4. Disconnect harness connector from fuel injector.

FUEL INJECTOR AND FUEL TUBE

5. Loosen bolts in reverse order as shown, and remove fuel tube and fuel injector assembly.

CAUTION:

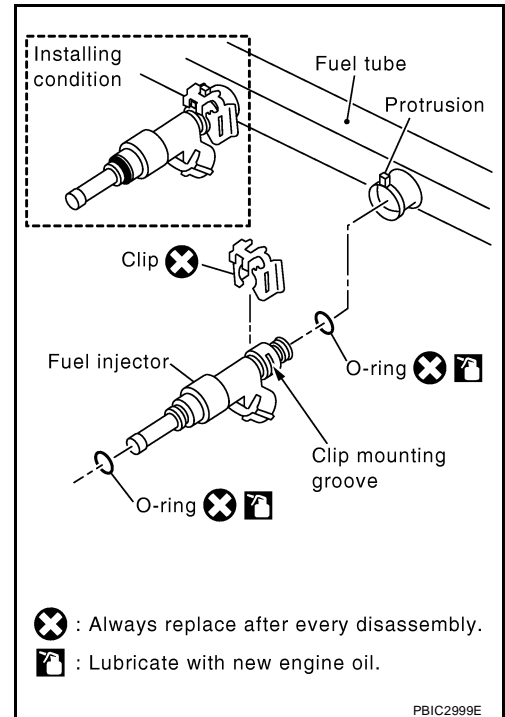
Do not tilt it, or remaining fuel in pipes may flow out from pipes.



6. Remove bolts which connects fuel tube (RH) and fuel tube (LH).
7. Remove fuel injector from fuel tube as follows:
a. Carefully open and remove clip.
b. Remove fuel injector from fuel tube by pulling straight.

CAUTION:

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



8. Disconnect fuel tube (RH) from fuel tube (LH).
9. Loosen bolts, to remove fuel damper cap and fuel damper, if necessary.

FUEL INJECTOR AND FUEL TUBE

INSTALLATION

1. Install fuel damper as follows:

a. Install new O-ring to fuel tube as shown.

- When handling new O-rings, be careful of the following caution:

CAUTION:

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

b. Install spacer to fuel damper.

c. Insert fuel damper straight into fuel tube.

CAUTION:

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

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

- Insert fuel damper until "B" is touching "A" of fuel tube.

d. Tighten bolts evenly in turn.

- After tightening bolts, make sure that there is no gap between fuel damper cap and fuel tube.

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

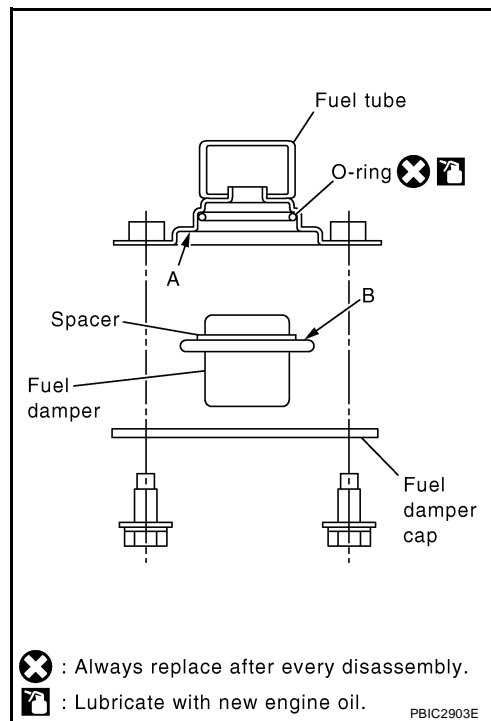
CAUTION:

- Upper and lower O-ring are different. Be careful not to confuse them.

Fuel tube side : Blue

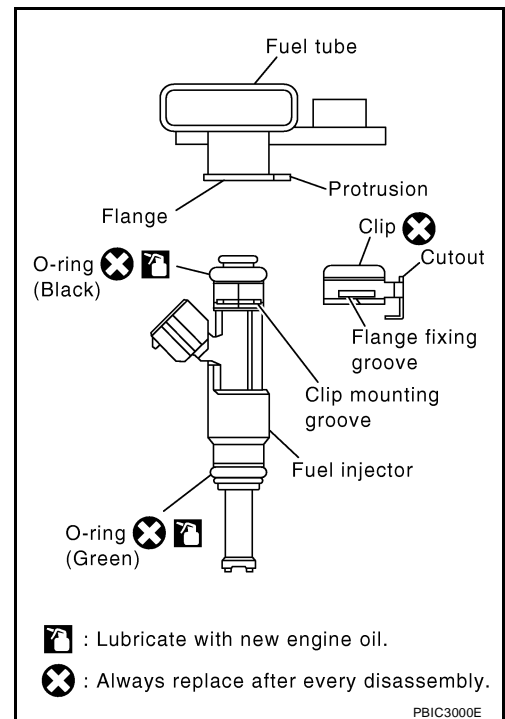
Nozzle side : Brown

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



FUEL INJECTOR AND FUEL TUBE

3. Install fuel injector to fuel tube as follows:
 - a. Insert clip into clip mounting groove on fuel injector.
 - Insert clip so that protrusion "A" of fuel injector matches cutout "A" of clip.
 - CAUTION:**
 - Do not reuse clip. Replace it with a new one.
 - Be careful to keep clip from interfering with O-ring. If interference occurs, replace O-ring.
 - b. Insert fuel injector into fuel tube with clip attached.
 - Insert it while matching it to the axial center.
 - Insert fuel injector so that protrusion "B" of fuel tube matches cutout "B" of clip.
 - Make sure that fuel tube flange is securely fixed in flange fixing groove on clip.
 - c. Make sure that installation is complete by checking that fuel injector does not rotate or come off.
 - Make sure that protrusions of fuel injectors are aligned with cutouts of clips after installation.



4. Connect fuel tube (RH) to fuel tube (LH), and tighten bolts temporarily.
 - Tighten bolts with the specified torque after installing fuel tube and fuel injector assembly.
- CAUTION:**
 - Handle O-ring with bare hands. Do not wear gloves.
 - Lubricate O-ring with new engine oil.
 - Do not clean O-ring with solvent.
 - Make sure that O-ring and its mating part are free of foreign material.
 - When installing O-ring, be careful not to scratch it with tool or fingernails. Also be careful not to twist or stretch O-ring. If O-ring was stretched while it was being attached, do not insert it quickly into fuel tube.
 - Insert new O-ring straight into fuel tube. Do not twist it.
5. Install fuel tube and fuel injector assembly to intake manifold.

CAUTION:

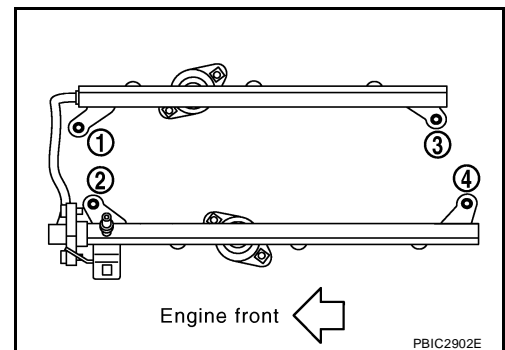
Be careful not to let tip of injector nozzle come in contact with other parts.

- Tighten bolts in two steps in numerical order as shown.

Fuel injector tube assembly bolts

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

2nd step : 22.0 N·m (2.2 kg-m, 16 ft-lb)



6. Tighten bolts which connects fuel tube (RH) and fuel tube (LH) with the specified torque.
7. Connect fuel injector harness connector.
8. Install intake manifold collector. Refer to [EM-18, "INSTALLATION"](#).
9. Installation of the remaining components is in the reverse order of removal.

FUEL INJECTOR AND FUEL TUBE

INSPECTION AFTER INSTALLATION

Check on Fuel Leakage

1. Turn ignition switch "ON" (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.

NOTE:

Use mirrors for checking at points out of clear sight.

2. Start engine. With engine speed increased, check again for fuel leakage at connection points.

CAUTION:

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

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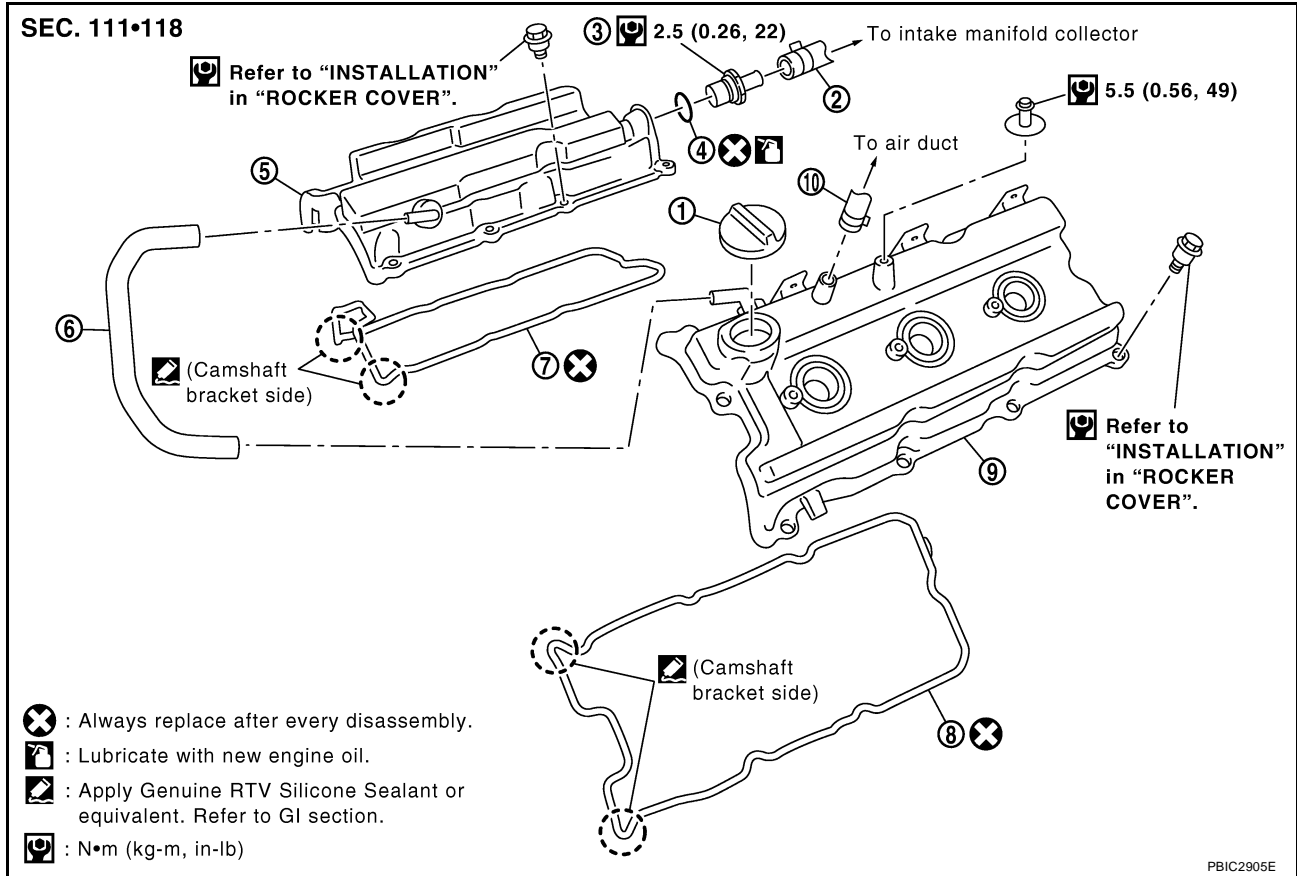
ROCKER COVER

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EBS00NJV

ROCKER COVER

Removal and Installation



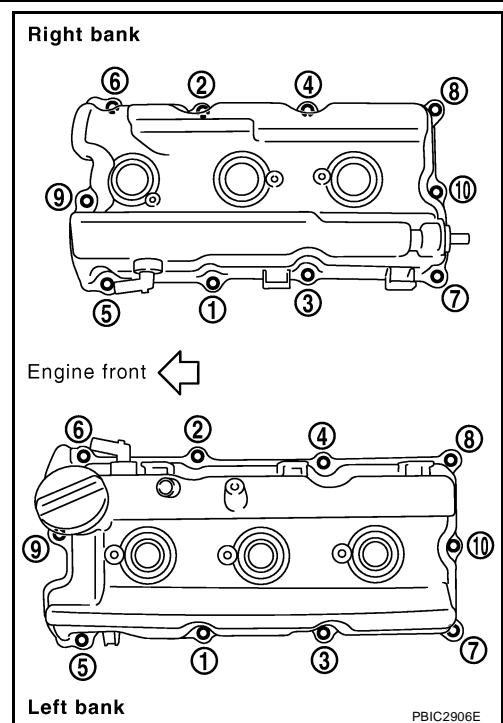
- | | | |
|-------------------------------------|------------------------------------|-----------------------------|
| 1. Oil filler cap | 2. PCV hose | 3. PCV valve |
| 4. O-ring | 5. Rocker cover (right bank) | 6. PCV hose |
| 7. Rocker cover gasket (right bank) | 8. Rocker cover gasket (left bank)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

REMOVAL (LEFT BANK)

1. Remove engine cover. Refer to [EM-12, "REMOVAL"](#).
2. Separate engine harness removing their brackets from rocker covers.
3. Remove harness bracket from cylinder head, if necessary.
4. Remove ignition coil. Refer to [EM-31, "Removal and Installation"](#).
5. Remove PCV hoses from rocker covers.
6. Remove oil filler cap from rocker cover (left bank), if necessary.

ROCKER COVER

- Loosen bolts with power tool in reverse order as shown.



- Remove rocker cover gaskets from rocker covers.
- Use scraper to remove all traces of liquid gasket from cylinder head and camshaft bracket (No. 1).

CAUTION:

Do not scratch or damage the mating surface when cleaning off old liquid gasket.

INSTALLATION (LEFT BANK)

- Apply liquid gasket using Tool to joint part among rocker cover, cylinder head and camshaft bracket (No. 1) as follows:

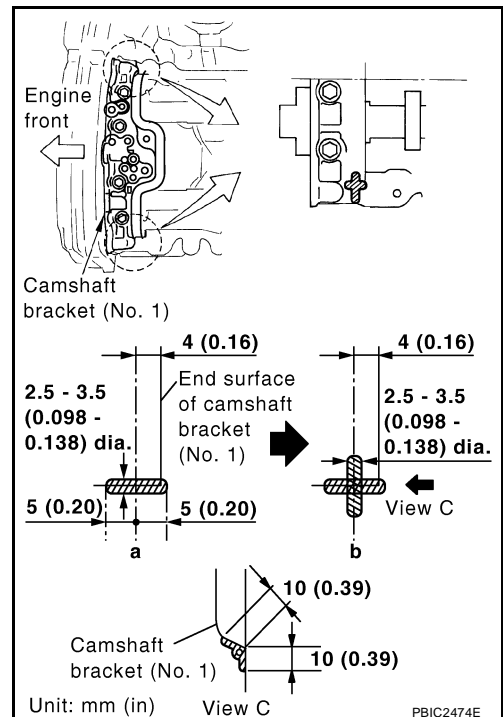
Tool number : WS39930000 (—)

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

NOTE:

The figure shows an example of left bank side [zoomed in shows camshaft bracket (No. 1)].

- Refer to the figure "a" to apply liquid gasket to joint part of camshaft bracket (No. 1) and cylinder head.
- Refer to the figure "b" to apply liquid gasket to the figure "a" squarely.

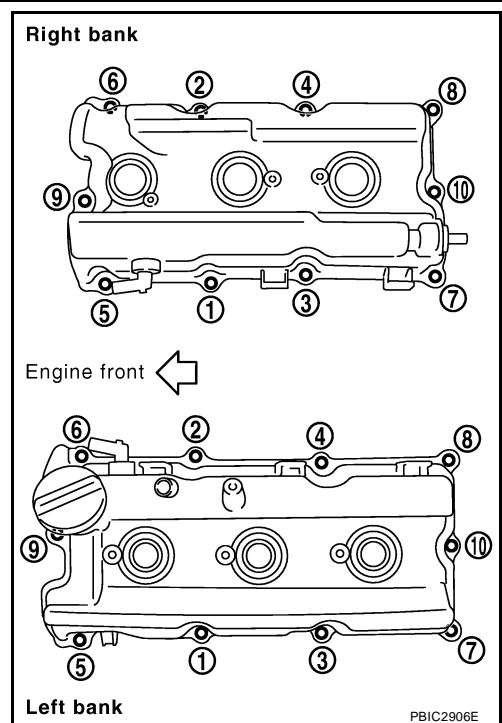


- Install new rocker cover gasket to rocker cover.
- Install rocker cover.
 - Check if rocker cover gasket is not dropped from installation groove of rocker cover.

ROCKER COVER

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

1st step : 1.96 N·m (0.20 kg-m, 17 in-lb)
2nd step : 8.33 N·m (0.85 kg-m, 74 in-lb)



5. Install oil filler cap to rocker cover (left bank), if removed.
6. Install PCV hose.
 - Insert PCV hose by 25 to 30 mm (0.98 to 1.18 in) from connector end.
 - When installing, be careful not to twist or come in contact with other parts.7. Installation of the remaining components is in the reverse order of removal.

REMOVAL (RIGHT BANK)

1. Remove intake manifold collector. Refer to [EM-17, "REMOVAL"](#).

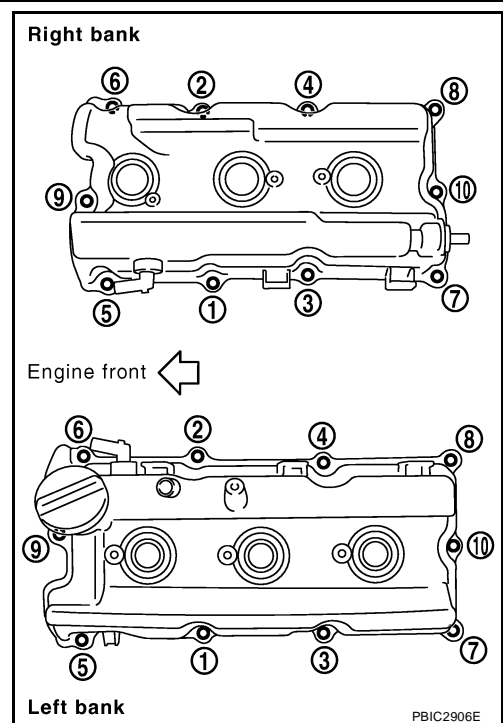
CAUTION:

Perform this step when engine is cold.

2. Separate engine harness removing their brackets from rocker covers.
3. Remove harness bracket from cylinder head (right bank). Refer to [EM-91, "CYLINDER HEAD"](#).
4. Remove ignition coil. Refer to [EM-31, "Removal and Installation"](#).
5. Remove PCV hoses from rocker cover.
6. Remove PCV valve and O-ring from rocker cover (right bank), if necessary.

ROCKER COVER

- Loosen bolts with power tool in reverse order as shown.



- Remove rocker cover gaskets from rocker covers.
- Use scraper to remove all traces of liquid gasket from cylinder head and camshaft bracket (No. 1).

CAUTION:

Do not scratch or damage the mating surface when cleaning off old liquid gasket.

INSTALLATION (RIGHT BANK)

- Apply liquid gasket using Tool to joint part among rocker cover, cylinder head and camshaft bracket (No. 1) as follows:

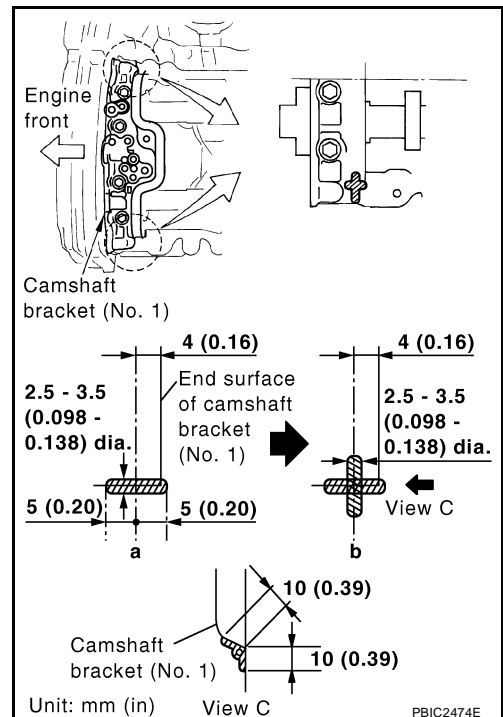
Tool number : WS39930000 (—)

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

NOTE:

The figure shows an example of left bank side [zoomed in shows camshaft bracket (No. 1)].

- Refer to the figure "a" to apply liquid gasket to joint part of camshaft bracket (No. 1) and cylinder head.
- Refer to the figure "b" to apply liquid gasket to the figure "a" squarely.



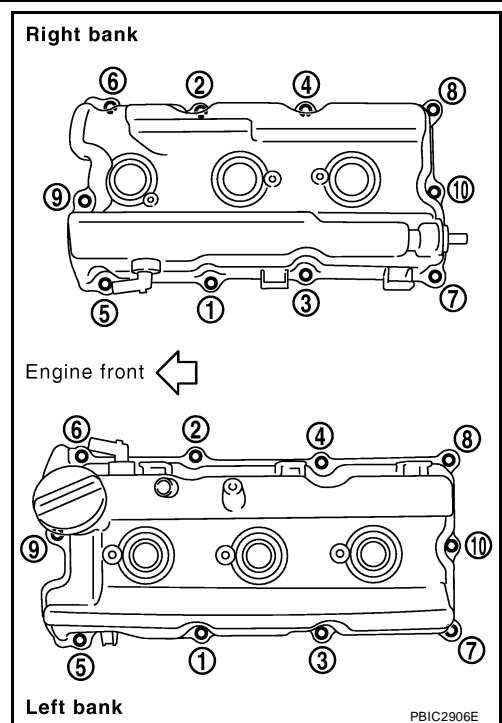
- Install new rocker cover gasket to rocker cover.
- Install rocker cover.
 - Check if rocker cover gasket is not dropped from installation groove of rocker cover.

ROCKER COVER

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

1st step : 1.96 N-m (0.20 kg-m, 17 in-lb)

2nd step : 8.33 N-m (0.85 kg-m, 74 in-lb)



5. Install new O-ring and PCV valve to rocker cover (right bank), if removed.
6. Install PCV hose.
- Insert PCV hose by 25 to 30 mm (0.98 to 1.18 in) from connector end.
 - When installing, be careful not to twist or come in contact with other parts.
7. Installation of the remaining components is in the reverse order of removal.

FRONT TIMING CHAIN CASE

PF13599

FRONT TIMING CHAIN CASE

Removal and Installation

EBS00NJW

NOTE:

- This section describes removal/installation procedure of front timing chain case and timing chain related parts without removing oil pan (upper) on vehicle.
- When oil pan (upper) needs to be removed or installed, or when rear timing chain case is removed or installed, remove oil pans (upper and lower) first. Then remove front timing chain case, timing chain related parts, and rear timing chain case in this order, and installation is in the reverse order of removal. Refer to [EM-54, "TIMING CHAIN"](#).
- Refer to [EM-54, "TIMING CHAIN"](#) for component parts location.

REMOVAL

1. Remove engine cover with power tool. Refer to [EM-12, "REMOVAL"](#).
2. Release the fuel pressure. Refer to [EC-91, "FUEL PRESSURE RELEASE"](#).
3. Drain engine oil. Refer to [LU-8, "Changing Engine Oil"](#).

CAUTION:

- Perform this step when engine is cold.
 - Do not spill engine oil on drive belts.
4. Drain engine coolant from radiator. Refer to [MA-13, "Changing Engine Coolant"](#).

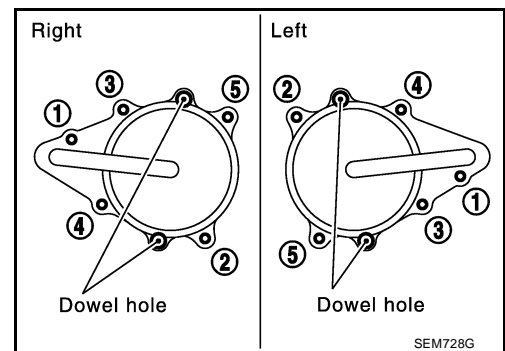
CAUTION:

- Perform this step when engine is cold.
 - Do not spill engine coolant on drive belts.
5. Remove radiator cooling fan assembly. Refer to [CO-14, "ENGINE COOLING FAN"](#).
 6. Separate engine harnesses removing their brackets from front timing chain case.
 7. Remove drive belts. Refer to [EM-13, "Removal"](#).
 8. Remove power steering oil pump from bracket with piping connected, and temporarily secure it aside. Refer to [PS-20, "REMOVAL"](#).
 9. Remove power steering oil pump bracket. Refer to [PS-20, "REMOVAL"](#).
 10. Remove alternator. Refer to [SC-30, "REMOVAL"](#).
 11. Remove water bypass hose, water hose clamp and idler pulley bracket from front timing chain case.
 12. Remove right and left intake valve timing control covers.
 - Loosen bolts in reverse order as shown.
 - Cut liquid gasket for removal using Tool.

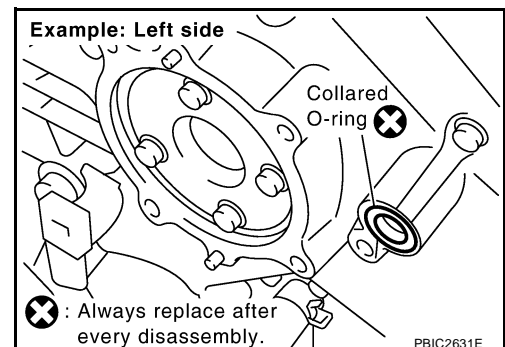
Tool number : KV10111100 (J-37228)

CAUTION:

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



13. Remove collared O-rings from front timing chain case (left and right side).



FRONT TIMING CHAIN CASE

14. Remove rocker covers (right and left banks). Refer to [EM-40, "Removal and Installation"](#).

NOTE:

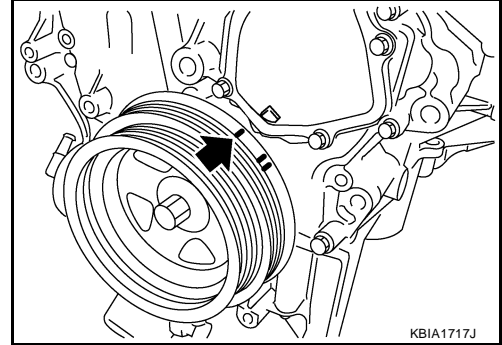
When only timing chain (primary) is removed, rocker cover does not need to be removed.

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

NOTE:

When timing chain is not removed/installed, this step is not required.

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

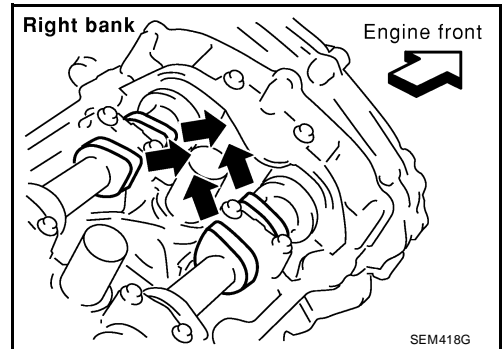


- b. Make sure that intake and exhaust cam noses on No. 1 cylinder (engine front side of right bank) are located as shown.

- If not, turn crankshaft one revolution (360°) and align as shown.

NOTE:

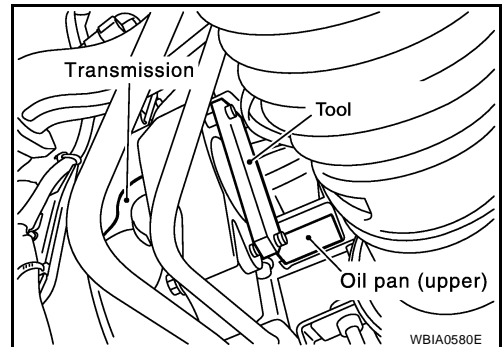
When only timing chain (primary) is removed, rocker cover does not need to be removed. To make sure that No. 1 cylinder is at its compression TDC, remove front timing chain case first. Then check mating marks on camshaft sprockets. Refer to [EM-63, "INSTALLATION"](#).



16. Remove crankshaft pulley as follows:

- a. Remove starter motor and set Tool. Refer to [SC-17, "REMOVAL"](#).

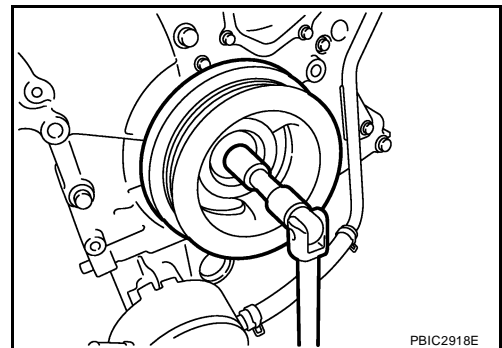
Tool number : KV10117700 (J-44716)



- b. Loosen crankshaft pulley bolt and locate bolt seating surface as 10 mm (0.39 in) from its original position.

CAUTION:

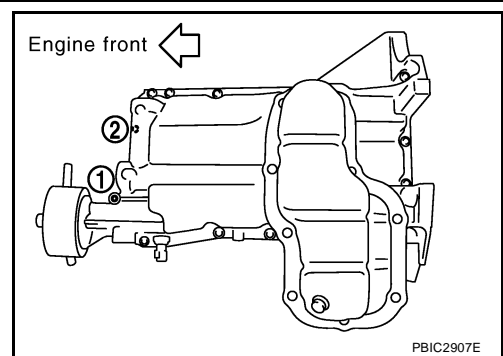
Do not remove crankshaft pulley bolt. Keep loosened crankshaft pulley bolt in place to protect the crankshaft pulley from dropping.



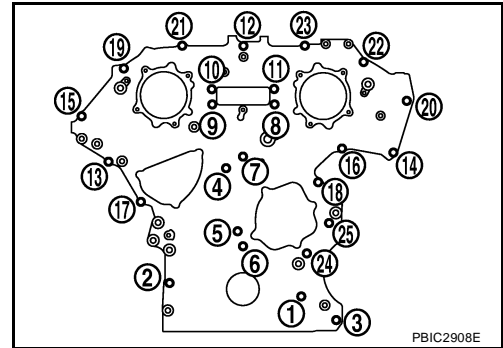
- c. Pull crankshaft pulley with both hands to remove it.

FRONT TIMING CHAIN CASE

17. Loosen two bolts in front of oil pan (upper) in reverse order as shown.



18. Remove front timing chain case as follows:
 a. Loosen bolts with power tool in reverse order as shown.

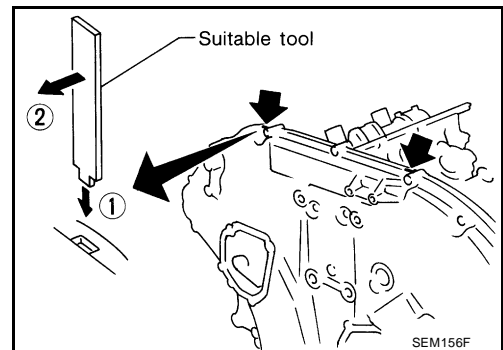


- b. Insert suitable tool into the notch at the top of the front timing chain case as shown (1).
 c. Pry off case by moving tool as shown (2).
 ● Cut liquid gasket for removal using Tool.

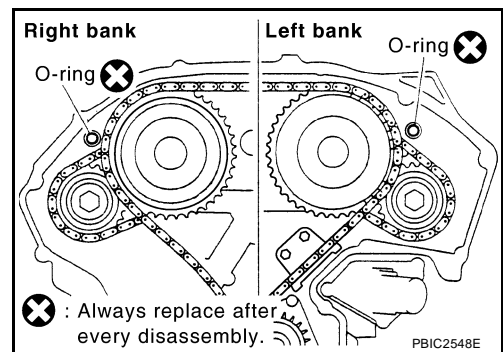
Tool number : KV10111100 (J-37228)

CAUTION:

- Do not use screwdriver or something similar.
- After removal, handle front timing chain case carefully so it does not tilt, cant, or warp under a load.



19. Remove O-rings from rear timing chain case.



20. Remove water pump cover and chain tensioner cover from front timing chain case, if necessary.
 ● Cut liquid gasket for removal using Tool.

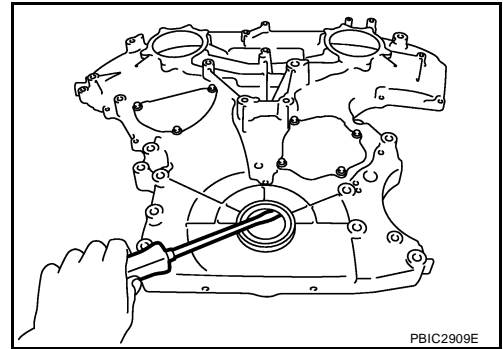
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FRONT TIMING CHAIN CASE

21. Remove front oil seal from front timing chain case using suitable tool.

CAUTION:

Be careful not to damage front timing chain case.

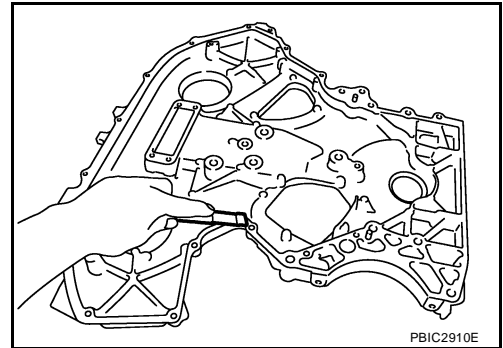


22. Remove timing chain and related parts. Refer to [EM-55, "REMOVAL"](#).

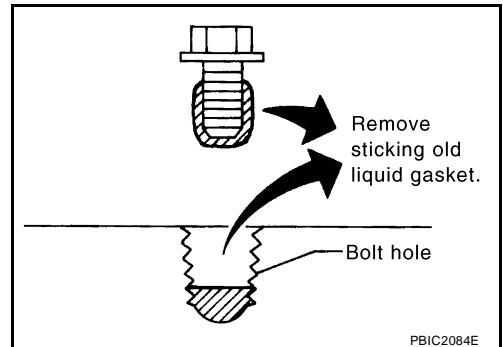
23. Use a scraper to remove all traces of old liquid gasket from front and rear timing chain cases and oil pan (upper), and liquid gasket mating surfaces.

CAUTION:

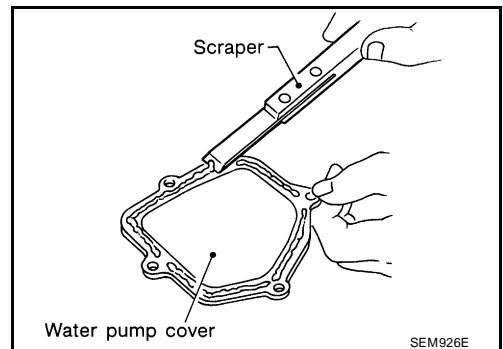
Be careful not to allow gasket fragments to enter oil pan.



- Remove old liquid gasket from bolt hole and thread.



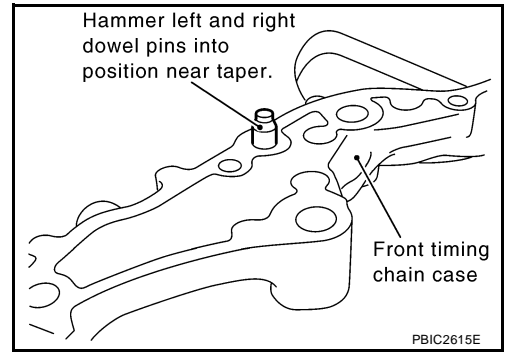
24. Use a scraper to remove all traces of old liquid gasket from water pump cover, chain tensioner cover and intake valve timing control covers.



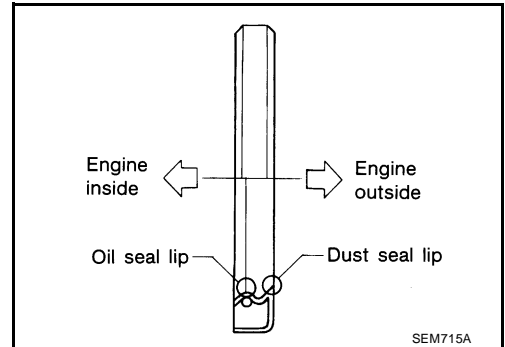
FRONT TIMING CHAIN CASE

INSTALLATION

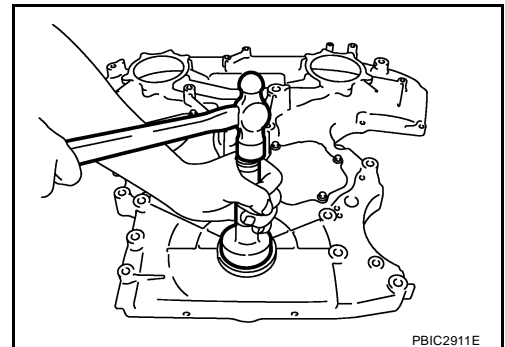
1. Hammer dowel pins (right and left) into front timing chain case up to a point close to taper in order to shorten protrusion length.



2. Install new front oil seal on the front timing chain case.
 - Apply new engine oil to both oil seal lip and dust seal lip.
 - Install it so that each seal lip is oriented as shown.



- Press-fit oil seal until it becomes flush with front timing chain case end face using suitable drift [outer diameter: 60 mm (2.36 in)].
- Make sure the garter spring is in position and seal lip is not inverted.

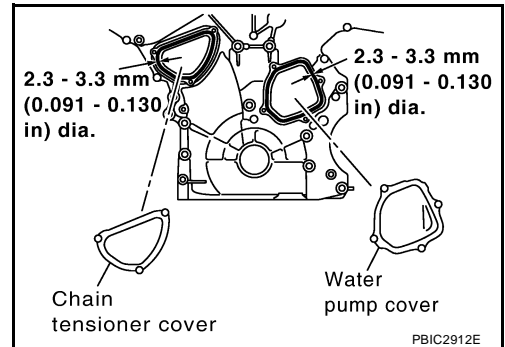


3. Install water pump cover and chain tensioner cover to front timing chain case, if removed.

- Apply a continuous bead of liquid gasket using Tool to front timing chain case as shown.

Tool number : WS39930000 (—)

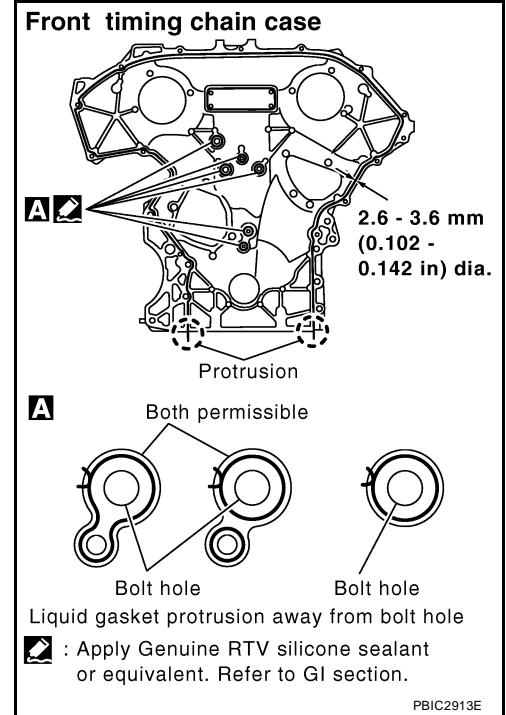
Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#)



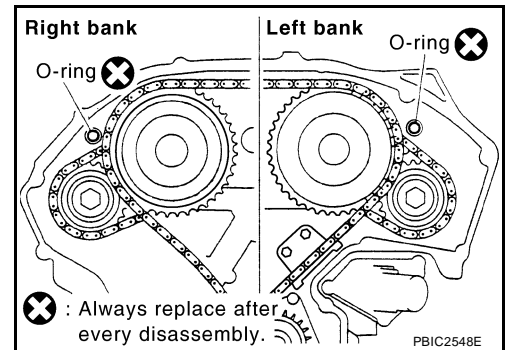
FRONT TIMING CHAIN CASE

4. Install front timing chain case as follows:
 - a. Apply a continuous bead of liquid gasket using Tool to front timing chain case back side as shown.

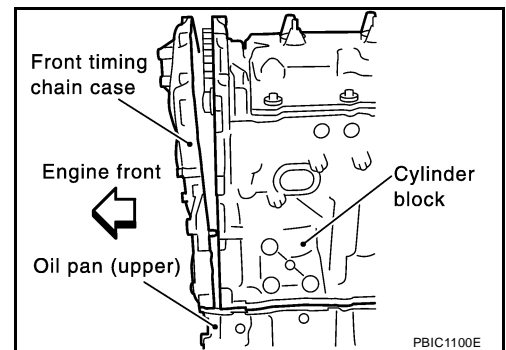
Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#).



- b. Install new O-rings on rear timing chain case.
 - c. Assemble front timing chain case as follows:

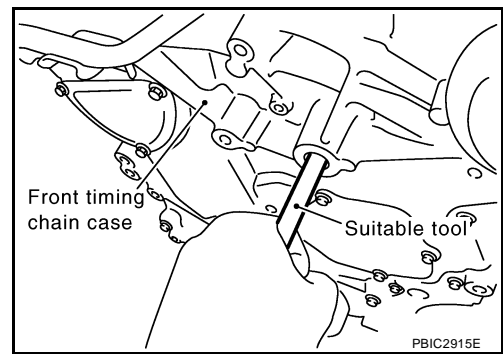


Fit lower end of front timing chain case tightly onto top face of oil pan (upper). From the fitting point, make entire front timing chain case contact rear timing chain case completely.



FRONT TIMING CHAIN CASE

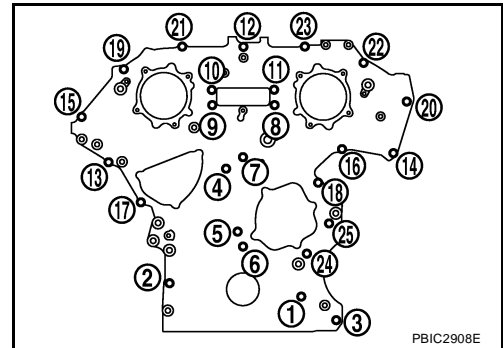
- ii. Since front timing chain case is offset for difference of bolt holes, tighten bolts temporarily while holding front timing chain case from front and top as shown.
- iii. Same as the previous step, insert dowel pin while holding front timing chain case from front and top completely.



- d. Tighten bolts to the specified torque in numerical order as shown.
 - There are four type of bolts. Refer to the following for locating bolts.

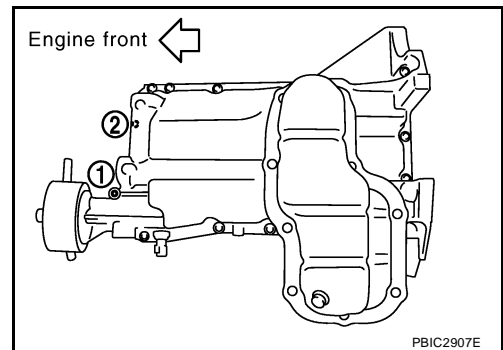
Bolt position	Bolt diameter
1 - 5	: 10 mm (0.39 in)
6 - 25	: 6 mm (0.24 in)

Bolt position	Tightening specification
1 - 5	: 55.0 N-m (5.6 kg-m, 41 ft-lb)
6 - 25	: 12.7 N-m (1.3 kg-m, 9 ft-lb)



- e. After all bolts tightened, retighten them to the specified torque in numerical order as shown.
5. Install two bolts in front of oil pan (upper) in numerical order as shown.

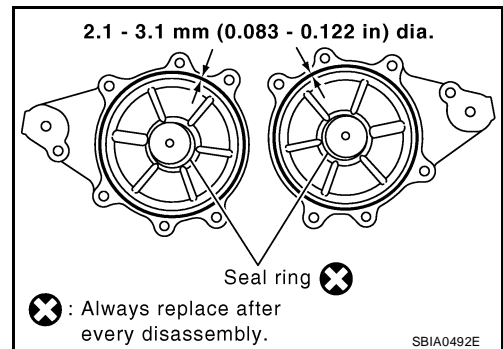
Front oil pan bolt torque : 22.0 N-m (2.2 kg-m, 16 ft-lb)



6. Install right and left intake valve timing control covers as follows:
 - a. Install new seal rings in shaft grooves.
 - b. Apply a continuous bead of liquid gasket using Tool to intake valve timing control covers as shown.

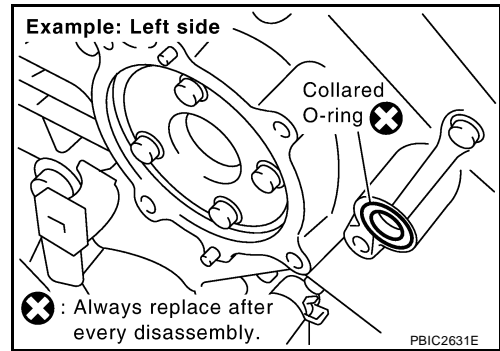
Tool number : WS39930000 (—)

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

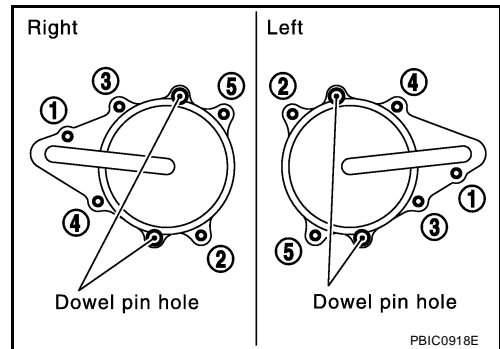


FRONT TIMING CHAIN CASE

- c. Install new collared O-rings in front timing chain case oil hole (left and right sides).



- d. Being careful not to move seal ring from the installation groove, align dowel pins on front timing chain case with the holes to install intake valve timing control covers.
- e. Tighten bolts in numerical order as shown.



7. Install crankshaft pulley as follows:

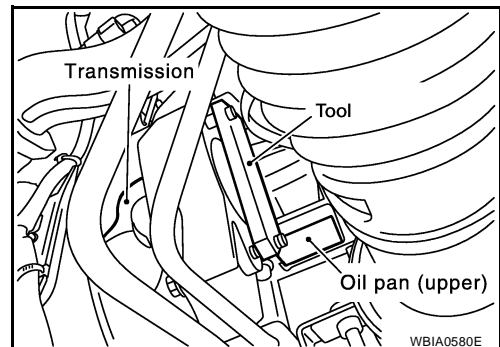
- a. Install crankshaft pulley, taking care not to damage front oil seal.
- When press-fitting crankshaft pulley with plastic hammer, tap on its center portion (not circumference).
- b. Tighten crankshaft pulley bolt in two steps.

Step 1 : 44.1 N·m (4.5 kg-m, 33 ft-lb)

Step 2 : 84° - 90° degrees clockwise

- c. Remove Tool.

Tool number : KV10117700 (J-44716)



8. Rotate crankshaft pulley in normal direction (clockwise when viewed from front) to confirm it turns smoothly.
9. Installation of the remaining components is in the reverse order of removal after this step.

INSPECTION AFTER INSTALLATION

Inspection for Leaks

The following are procedures for checking fluid leaks, lubricant leaks and exhaust gases leaks.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to [MA-11, "RECOMMENDED FLUIDS AND LUBRICANTS"](#).
- Use procedure below to check for fuel leakage.
- Turn ignition switch "ON" (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.

FRONT TIMING CHAIN CASE

- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.

NOTE:

If hydraulic pressure inside timing chain tensioner drops after removal/installation, slack in the guide may generate a pounding noise during and just after engine start. However, this is normal. Noise will stop after hydraulic pressure rises.

- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

Summary of the inspection items:

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level
Other oils and fluid*	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage

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

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TIMING CHAIN

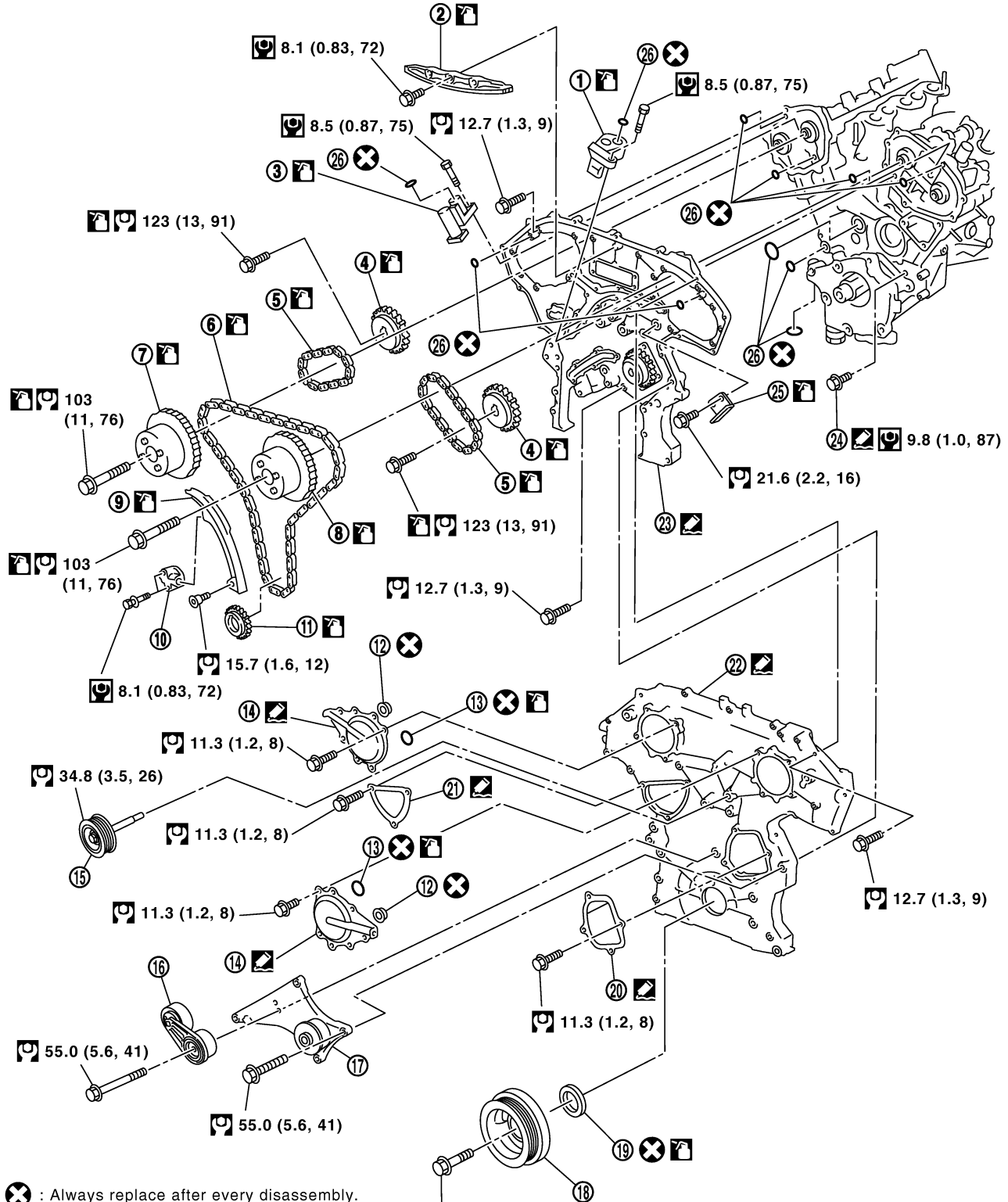
PF1:13028

EBS00NJX

TIMING CHAIN

Removal and Installation

SEC. 120•130•150•210•275



⊗ : Always replace after every disassembly.

🛢️ : Lubricate with new engine oil.

🔧 : Apply Genuine RTV Silicone Sealant or equivalent. Refer to GI section.

🔧 : N·m (kg-m, ft-lb)

🔧 : N·m (kg-m, in-lb)

🔧🔧 Refer to "INSTALLATION" in "TIMING CHAIN".

PBIC2917E

TIMING CHAIN

- | | | |
|---|---------------------------------------|--|
| 1. Timing chain tensioner (secondary) (left bank) | 2. Internal chain guide | 3. Timing chain tensioner (secondary) (right bank) |
| 4. Camshaft sprocket (EXH) | 5. Timing chain (secondary) | 6. Timing chain (primary) |
| 7. Camshaft sprocket (INT) | 8. Camshaft sprocket (INT) | 9. Slack guide |
| 10. Timing chain tensioner (primary) | 11. Crankshaft sprocket | 12. Collared O-ring |
| 13. O-ring | 14. Intake valve timing control cover | 15. Idler pulley |
| 16. Drive belt auto tensioner | 17. Cooling fan bracket | 18. Crankshaft pulley |
| 19. Front oil seal | 20. Water pump cover | 21. Chain tensioner cover |
| 22. Front timing chain case | 23. Rear timing chain case | 24. Water drain plug (front) |
| 25. Tension guide | 26. O-ring | |

NOTE:

- This section describes procedures for removing/installing front timing chain case and timing chain related parts, and rear timing chain case, when oil pan (upper) needs to be removed/installed for engine overhaul, etc.
- To remove/install front timing chain case, timing chain, and its related parts without removing oil pan (upper), refer to [EM-45, "FRONT TIMING CHAIN CASE"](#).

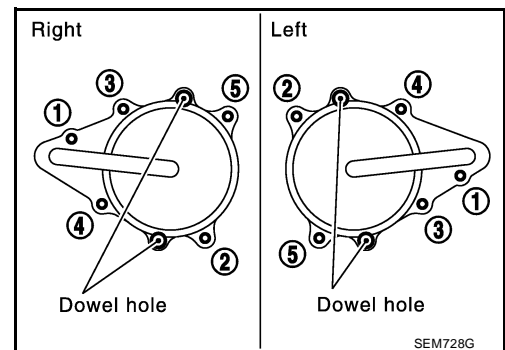
REMOVAL

1. Remove engine cover with power tool. Refer to [EM-12, "REMOVAL"](#).
2. Release the fuel pressure. Refer to [EC-91, "FUEL PRESSURE RELEASE"](#).
3. Drain engine oil. Refer to [LU-8, "Changing Engine Oil"](#).
 - CAUTION:**
 - Perform this step when engine is cold.
 - Do not spill engine oil on drive belts.
4. Drain engine coolant from radiator. Refer to [MA-13, "Changing Engine Coolant"](#).
 - CAUTION:**
 - Perform this step when engine is cold.
 - Do not spill engine coolant on drive belts.
5. Remove radiator cooling fan assembly. Refer to [CO-14, "ENGINE COOLING FAN"](#).
6. Separate engine harnesses removing their brackets from front timing chain case.
7. Remove drive belts. Refer to [EM-13, "Removal"](#).
8. Remove power steering oil pump from bracket with piping connected, and temporarily secure it aside. Refer to [PS-20, "REMOVAL"](#).
9. Remove power steering oil pump bracket. Refer to [PS-20, "REMOVAL"](#).
10. Remove alternator. Refer to [SC-30, "REMOVAL"](#).
11. Remove water bypass hose, water hose clamp and idler pulley bracket from front timing chain case.
12. Remove right and left intake valve timing control covers.
 - Loosen bolts in reverse order as shown.
 - Cut liquid gasket for removal using Tool.

Tool number : KV1011100 (J-37228)

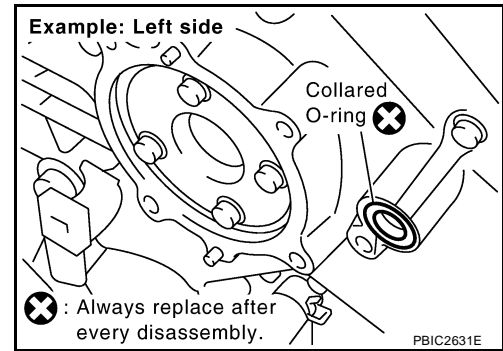
CAUTION:

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



TIMING CHAIN

13. Remove collared O-rings from front timing chain case (left and right side).



14. Remove rocker covers (right and left banks). Refer to [EM-40, "Removal and Installation"](#).

NOTE:

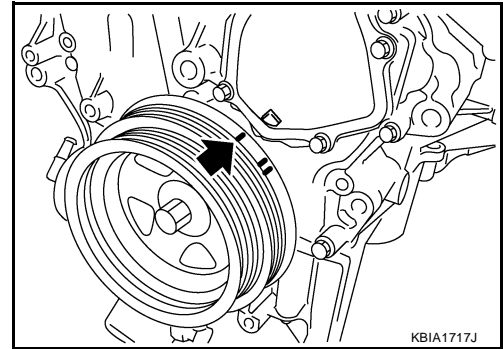
When only timing chain (primary) is removed, rocker cover does not need to be removed.

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

NOTE:

When timing chain is not removed/installed, this step is not required.

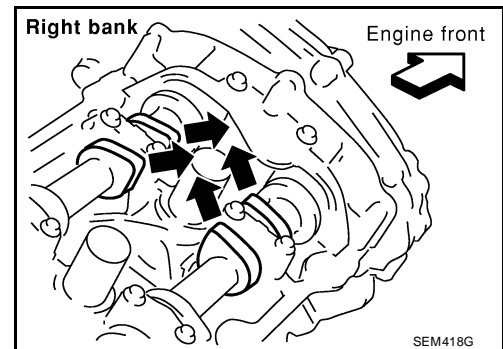
- a. Rotate crankshaft pulley clockwise to align timing mark (grooved line without color) with timing indicator.



- b. Make sure that intake and exhaust cam noses on No. 1 cylinder (engine front side of right bank) are located as shown.
- If not, turn crankshaft one revolution (360°) and align as shown.

NOTE:

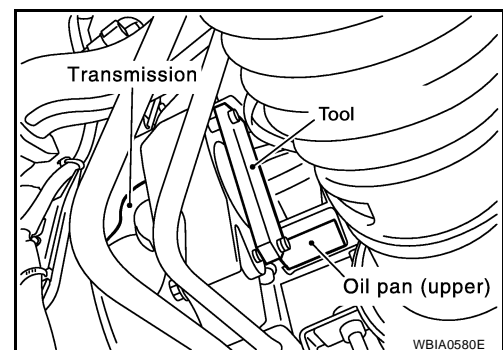
When only timing chain (primary) is removed, rocker cover does not need to be removed. To make sure that No. 1 cylinder is at its compression TDC, remove front timing chain case first. Then check mating marks on camshaft sprockets. Refer to [EM-63, "INSTALLATION"](#).



16. Remove crankshaft pulley as follows:

- a. Remove starter motor and set Tool. Refer to [SC-17, "REMOVAL"](#).

Tool number : KV10117700 (J-44716)

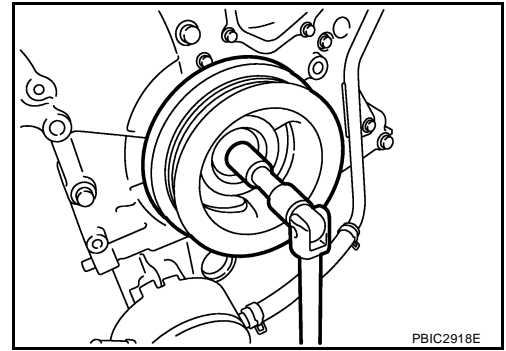


TIMING CHAIN

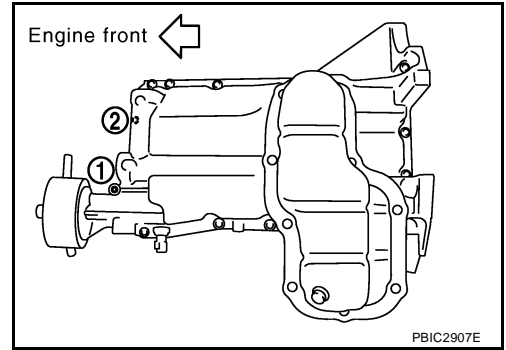
- b. Loosen crankshaft pulley bolt and locate bolt seating surface as 10 mm (0.39 in) from its original position.

CAUTION:

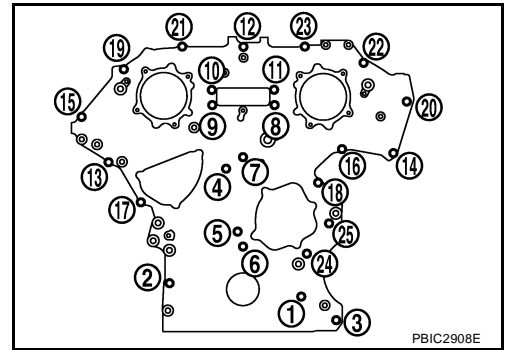
Do not remove crankshaft pulley bolt. Keep loosened crankshaft pulley bolt in place protect removed crankshaft pulley from dropping.



- c. Pull crankshaft pulley with both hands to remove it.
17. Loosen two bolts in front of oil pan (upper) in reverse order as shown.



18. Remove front timing chain case as follows:
- a. Loosen bolts with power tool in reverse order as shown.

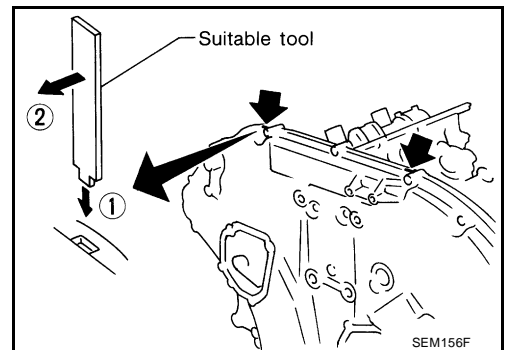


- b. Insert suitable tool into the notch at the top of the front timing chain case as shown (1).
- c. Pry off case by moving tool as shown (2).
- Cut liquid gasket for removal using Tool.

Tool number : KV10111100 (J-37228)

CAUTION:

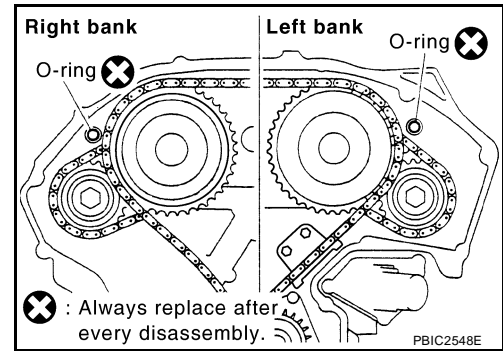
- Do not use screwdriver or something similar.
- After removal, handle front timing chain case carefully so it does not tilt, cant, or warp under a load.



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TIMING CHAIN

19. Remove O-rings from rear timing chain case.



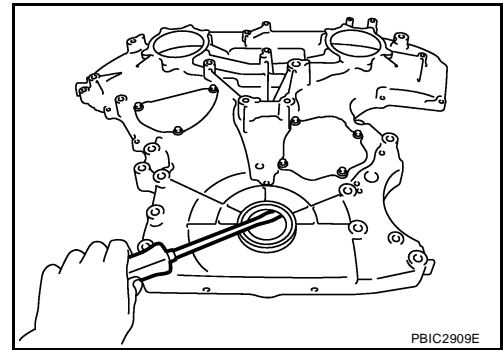
20. Remove water pump cover and chain tensioner cover from front timing chain case, if necessary.

- Cut liquid gasket for removal using Tool.

21. Remove front oil seal from front timing chain case using suitable tool.

CAUTION:

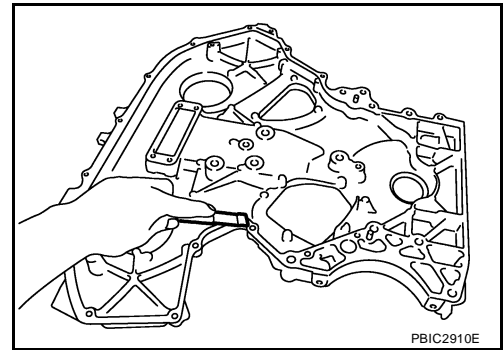
Be careful not to damage front timing chain case.



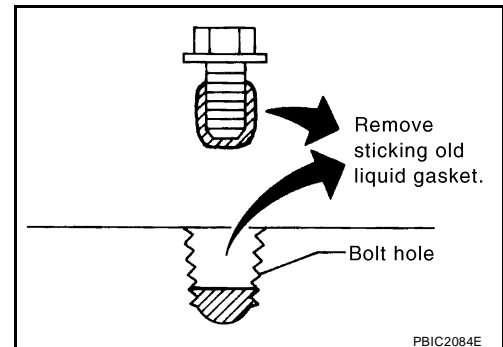
22. Use a scraper to remove all traces of old liquid gasket from front and rear timing chain cases and oil pan (upper), and liquid gasket mating surfaces.

CAUTION:

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

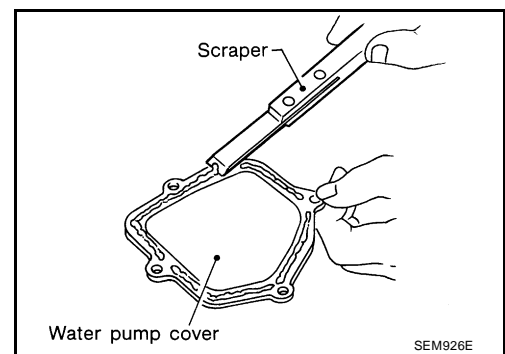


- Remove old liquid gasket from bolt hole and thread.

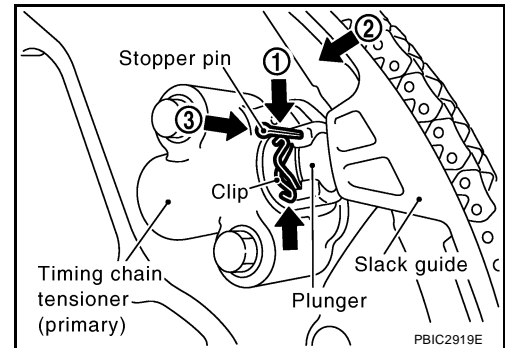


TIMING CHAIN

23. Use a scraper to remove all traces of old liquid gasket from water pump cover, chain tensioner cover and intake valve timing control covers.



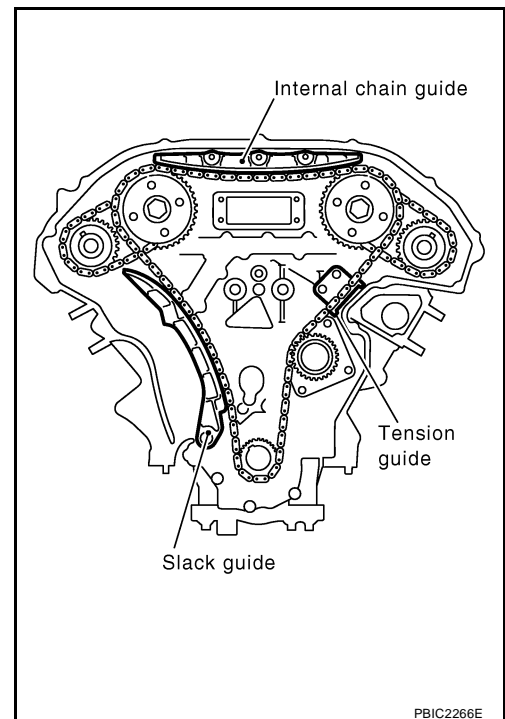
24. Remove timing chain tensioner (primary) as follows:
- Loosen clip of timing chain tensioner (primary), and release plunger stopper. (1)
 - Insert plunger into tensioner body by pressing slack guide. (2)
 - Keep slack guide pressed and hold plunger in by pushing stopper pin through the tensioner body hole and plunger groove. (3)



- d. Remove bolts and remove timing chain tensioner (primary).
25. Remove internal chain guide, tension guide and slack guide.

NOTE:

Tension guide can be removed after removing timing chain (primary).



26. Remove timing chain (primary) and crankshaft sprocket.

CAUTION:

After removing timing chain (primary), do not turn crankshaft and camshaft separately, or valves will strike the piston heads.

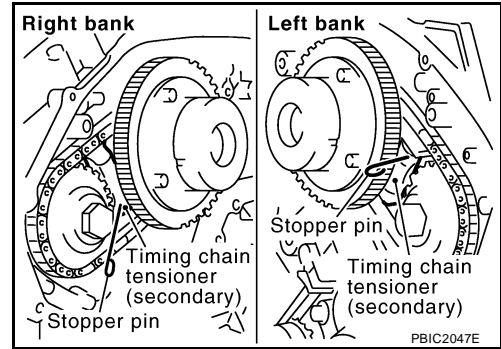
27. Remove timing chain (secondary) and camshaft sprockets as follows:

TIMING CHAIN

- a. Attach suitable stopper pin to the right and left timing chain tensioners (secondary).

NOTE:

- Use approximately 0.5 mm (0.02 in) dia. hard metal pin as a stopper pin.
- For removal of timing chain tensioner (secondary), refer to [EM-74, "CAMSHAFT"](#) . [Removing camshaft bracket (No. 1) is required.]

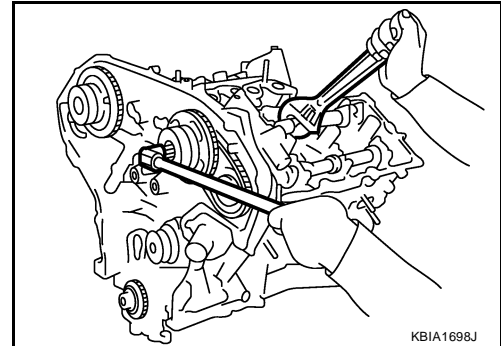


- b. Remove camshaft sprocket (INT and EXH) bolts.

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

CAUTION:

Do not loosen bolts with securing anything other than the camshaft hexagonal portion or with tensioning the timing chain.



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

- Turn camshaft slightly to secure slackness of timing chain on timing chain tensioner (secondary) side.
- Insert 0.5 mm (0.020 in)-thick metal or resin plate between timing chain and timing chain tensioner plunger (guide). Remove timing chain (secondary) together with camshaft sprockets with timing chain loose from guide groove.

CAUTION:

Be careful of plunger coming off when removing timing chain (secondary). This is because plunger of timing chain tensioner (secondary) moves during operation, leading to coming off of fixed stopper pin.

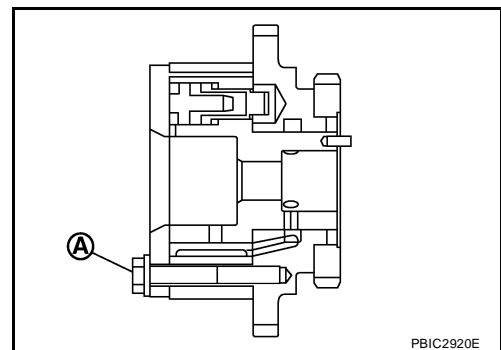
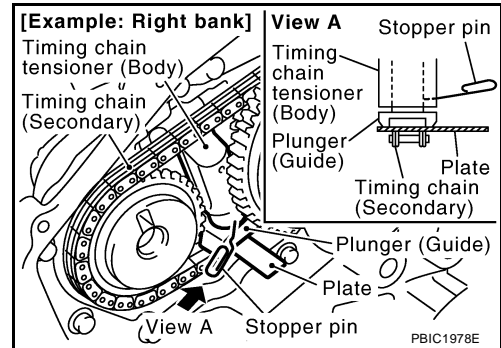
NOTE:

Camshaft sprocket (INT) is a one piece integrated design sprockets for timing chain (primary) and for timing chain (secondary).

- When handling camshaft sprocket (INT), be careful of the following:

CAUTION:

- Handle carefully to avoid any shock to camshaft sprocket.
- Do not disassemble. (Do not loosen bolts "A" as shown).



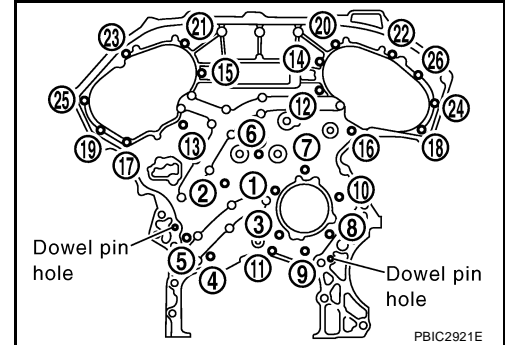
28. Remove water pump. Refer to [CO-16, "REMOVAL"](#) .

TIMING CHAIN

29. Remove rear timing chain case as follows:

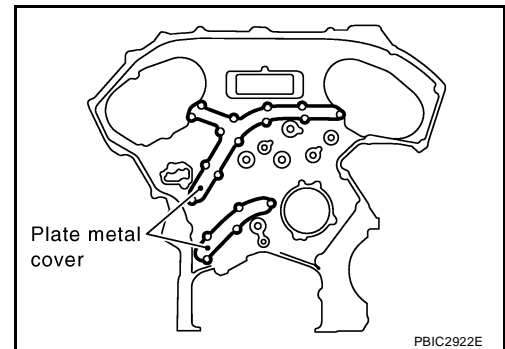
Tool number : KV10111100 (J-37228)

- Loosen and remove bolts with power tool in reverse order as shown.
- Cut liquid gasket using Tool and remove rear timing chain case.

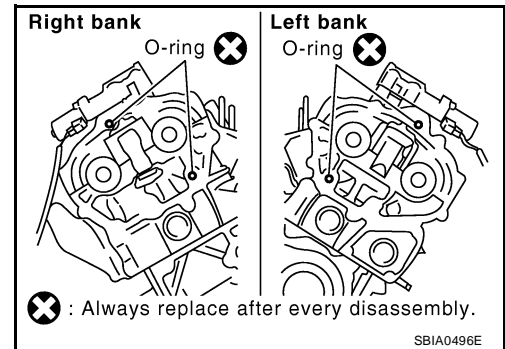


CAUTION:

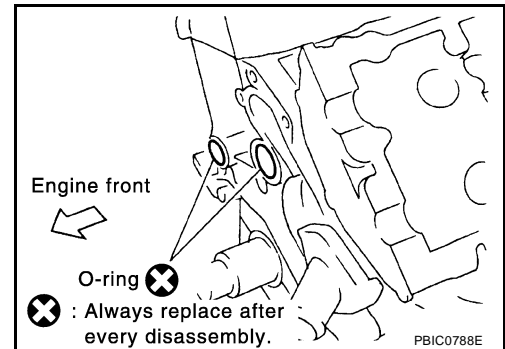
- Do not remove plate metal cover of oil passage.
- After removal, handle rear timing chain case carefully so it does not tilt, cant, or warp under a load.



30. Remove O-rings from cylinder head and camshaft bracket (No. 1).



31. Remove O-rings from cylinder block.



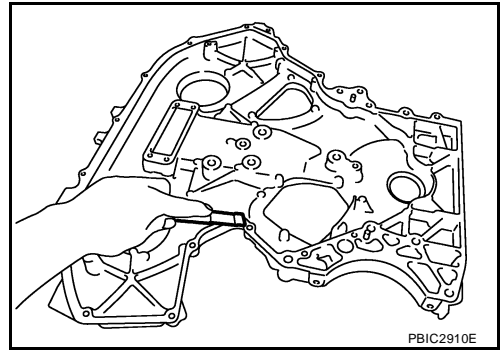
32. Remove timing chain tensioners (secondary) from cylinder head if necessary.

- Remove camshaft brackets (No. 1). Refer to [EM-75, "REMOVAL"](#).
- Remove timing chain tensioners (secondary) with stopper pin attached.

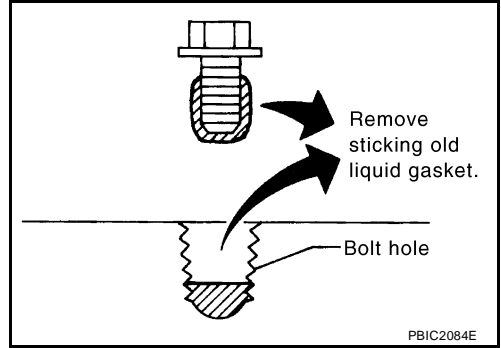
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TIMING CHAIN

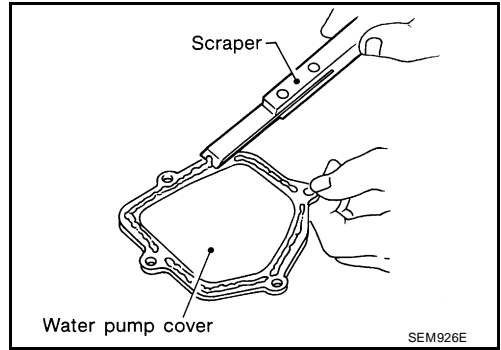
33. Use scraper to remove all traces of old liquid gasket from front and rear timing chain cases, and opposite mating surfaces.



- Remove old liquid gasket from bolt hole and thread.



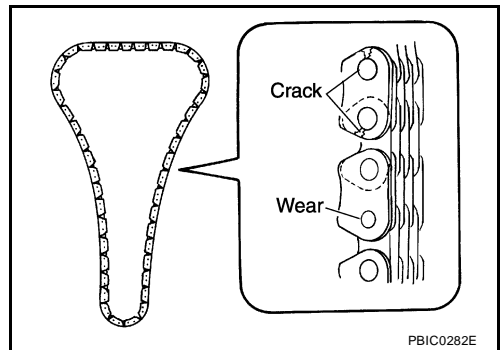
34. Use scraper to remove all traces of liquid gasket from water pump cover, chain tensioner cover and intake valve timing control covers.



INSPECTION AFTER REMOVAL

Timing Chain

Check for cracks and any excessive wear at link plates and roller links of timing chain. Replace timing chain as necessary.

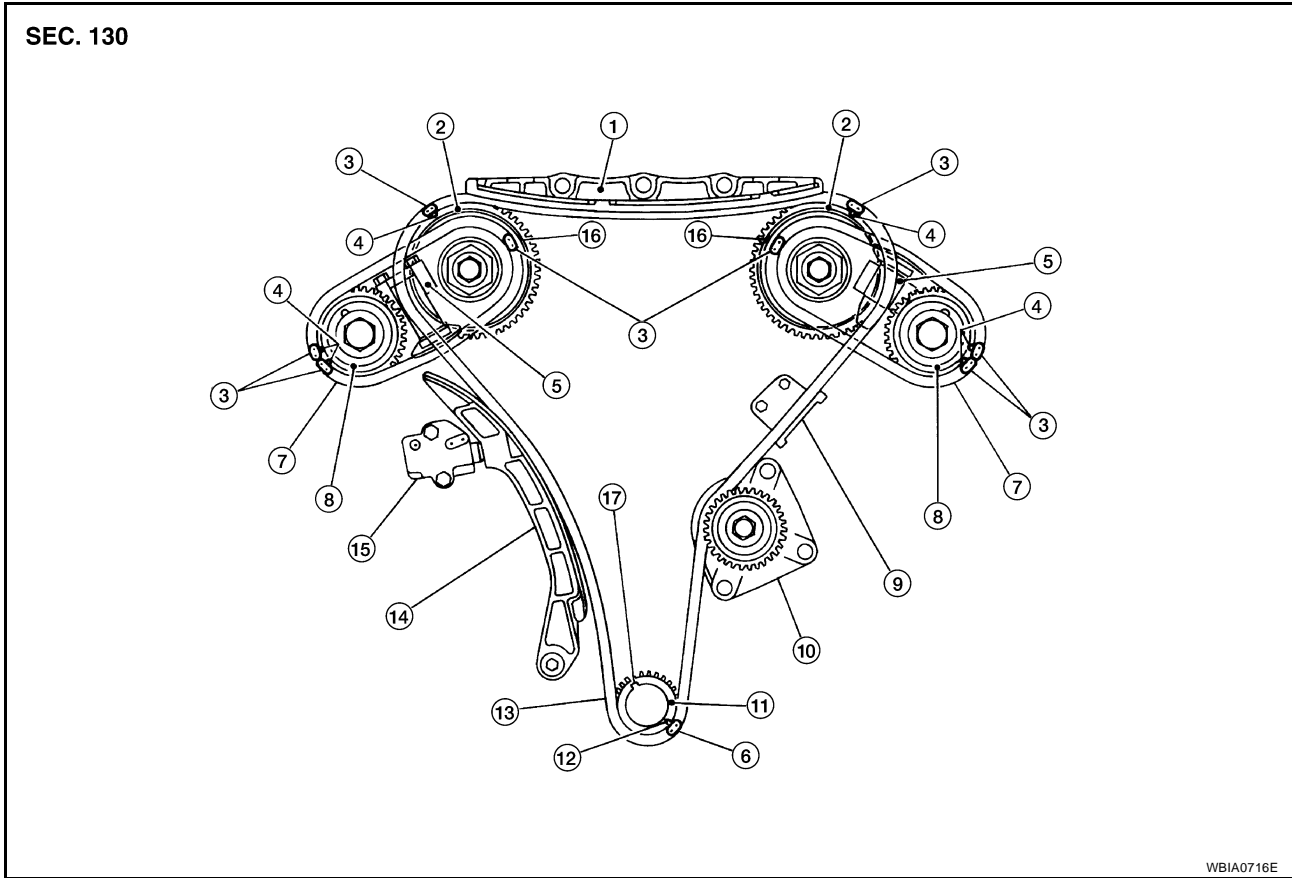


TIMING CHAIN

INSTALLATION

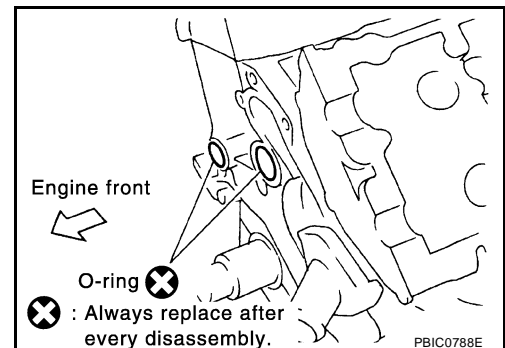
NOTE:

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



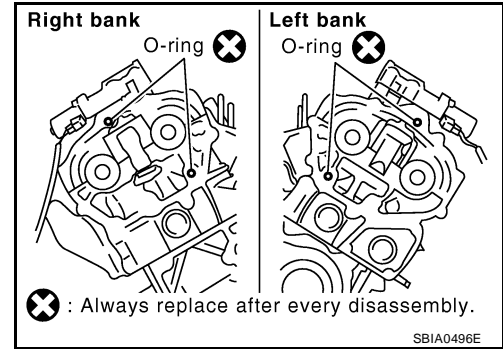
- | | | |
|-----------------------------|-------------------------------------|--------------------------------------|
| 1. Internal chain guide | 2. Camshaft sprocket (intake) | 3. Mating mark (copper link) |
| 4. Mating mark (punched) | 5. Secondary timing chain tensioner | 6. Mating mark (yellow or gold link) |
| 7. Secondary timing chain | 8. Camshaft sprocket (exhaust) | 9. Tensioner guide |
| 10. Water pump | 11. Crankshaft sprocket | 12. Mating mark (notched) |
| 13. Primary timing chain | 14. Slack guide | 15. Primary timing chain tensioner |
| 16. Mating mark (back side) | 17. Crankshaft key | |

1. Install timing chain tensioners (secondary) to cylinder head if removed. Refer to [EM-63, "INSTALLATION"](#).
 - a. Install timing chain tensioners (secondary) with stopper pin attached and new O-ring.
 - b. Install camshaft brackets (No. 1). Refer to [EM-79, "INSTALLATION"](#).
2. Install rear timing chain case as follows:
 - a. Install new O-rings onto cylinder block.



TIMING CHAIN

- b. Install new O-rings to cylinder head and camshaft bracket (No. 1).



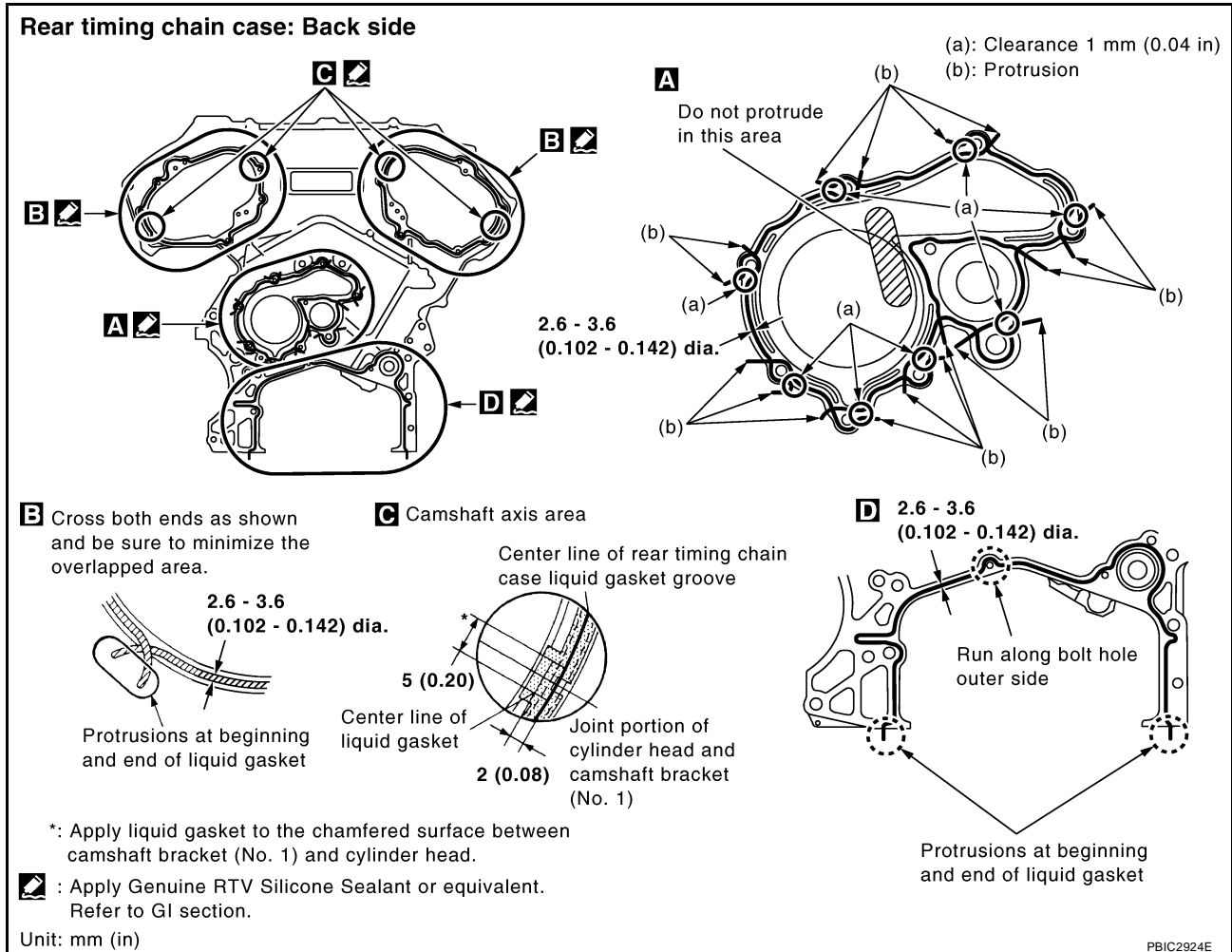
- c. Apply liquid gasket using Tool to rear timing chain case back side as shown.

Tool number : WS39930000 (—)

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

CAUTION:

- For "A" in the figure, completely wipe out liquid gasket extended on a portion touching at engine coolant.
- Apply liquid gasket on installation position of water pump and cylinder head very completely.



- d. Align rear timing chain case with dowel pins (right and left) on cylinder block and install rear timing chain case.
- Make sure O-rings stay in place during installation to cylinder block, cylinder head and camshaft bracket (No. 1).

TIMING CHAIN

e. Tighten bolts in numerical order as shown.

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

Bolt length:	Bolt position
20 mm (0.79 in)	: 1, 2, 3, 6, 7, 8, 9, 10
16 mm (0.63 in)	: Except the above

Rear timing chain case torque : 12.7 N-m (1.3 kg-m, 9 ft-lb)

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

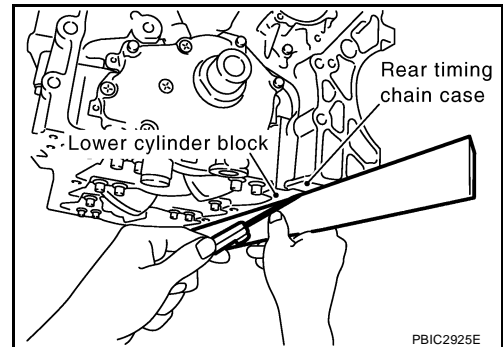
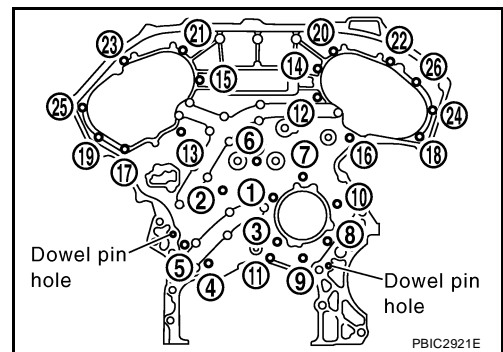
- If liquid gasket protrudes, wipe it off immediately.

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

Standard

Rear timing chain case to lower cylinder block:
-0.24 to 0.14 mm (-0.0094 to 0.0055 in)

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



3. Install water pump with new O-rings. Refer to [CO-18. "INSTALLATION"](#) .

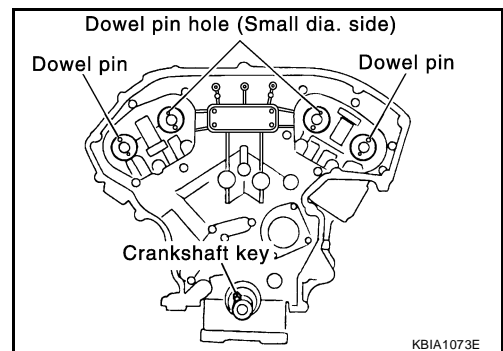
4. Make sure that dowel pin hole, dowel pin of camshaft and crankshaft key are located as shown. (No. 1 cylinder at compression TDC)

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

Camshaft dowel pin hole (intake side)
: At cylinder head upper face side in each bank.

Camshaft dowel pin (exhaust side)
: At cylinder head upper face side in each bank.

Crankshaft key
: At cylinder head side of right bank.



CAUTION:

Hole on small dia. side must be used for intake side dowel pin hole. Do not misidentify (ignore big dia. side).

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

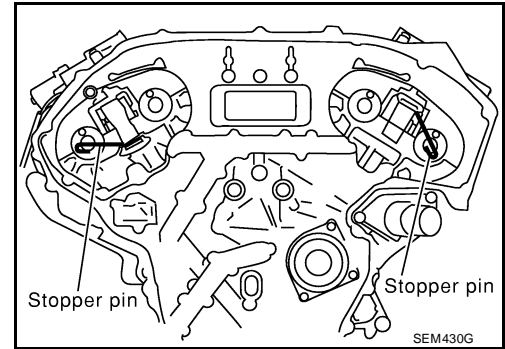
CAUTION:

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

A
EM
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D
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J
K
L
M

TIMING CHAIN

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



- b. Install timing chains (secondary) and camshaft sprockets (INT and EXH).

- Align the mating marks on timing chain (secondary) (copper color link) with the ones on camshaft sprockets (INT and EXH) (punched), and install them.

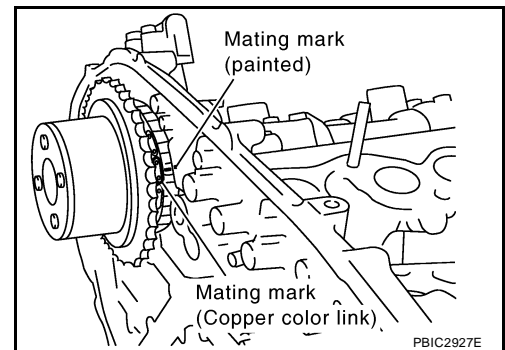
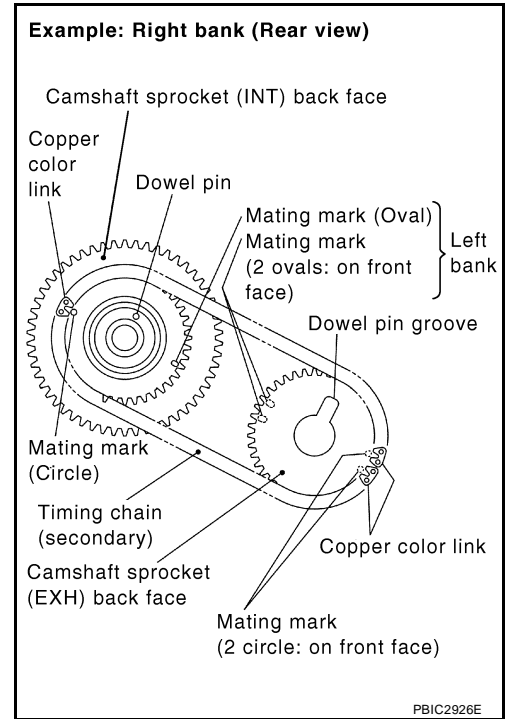
NOTE:

- Mating marks for camshaft sprocket (INT) are on the back side of camshaft sprocket (secondary).
- There are two types of mating marks, circle and oval types. They should be used for the right and left banks, respectively.

Right bank : Use circle type.

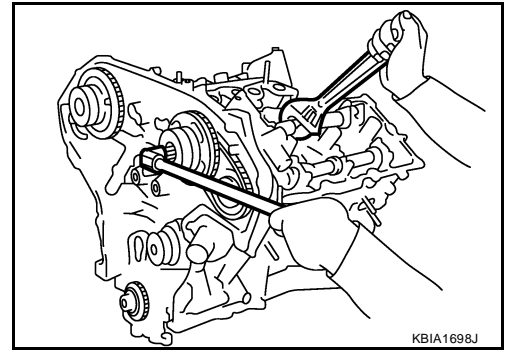
Left bank : Use oval type.

- Align dowel pin and pin hole on camshafts with the groove and dowel pin on sprockets, and install them.
- On the intake side, align pin hole on the small diameter side of the camshaft front end with dowel pin on the back side of camshaft sprocket, and install them.
- On the exhaust side, align dowel pin on camshaft front end with pin groove on camshaft sprocket, and install them.
- In case that positions of each mating mark and each dowel pin are not fit on mating parts, make fine adjustment to the position holding the hexagonal portion on camshaft with wrench or equivalent.
- Bolts for camshaft sprockets must be tightened in the next step. Tightening them by hand is enough to prevent the dislocation of dowel pins.
- It may be difficult to visually check the dislocation of mating marks during and after installation. To make the matching easier, make a mating mark on the top of sprocket teeth and its extended line in advance with paint.

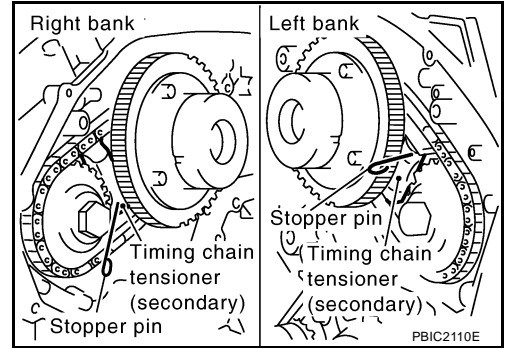


TIMING CHAIN

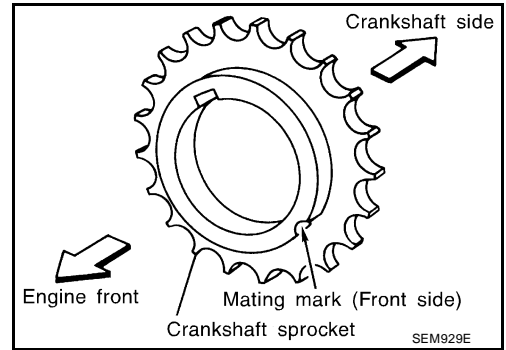
- c. After confirming the mating marks are aligned, tighten camshaft sprocket bolts.
- Secure camshaft using wrench at the hexagonal portion to tighten bolts.



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



6. Install tension guide.
7. Install timing chain (primary) as follows:
- a. Install crankshaft sprocket.
- Make sure the mating marks on crankshaft sprocket face the front of engine.

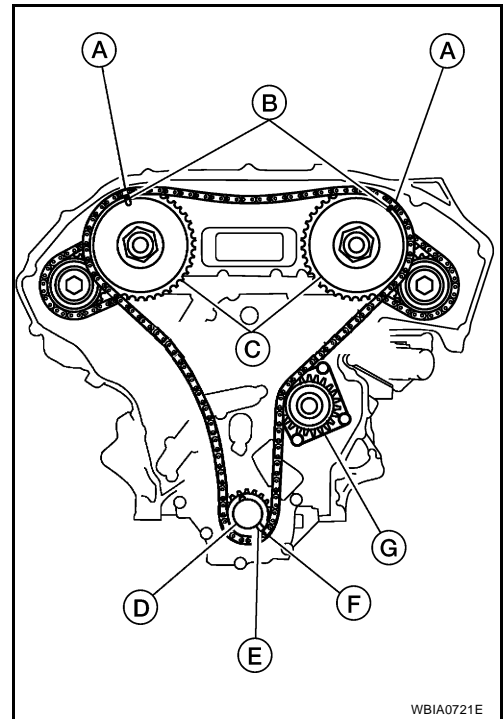


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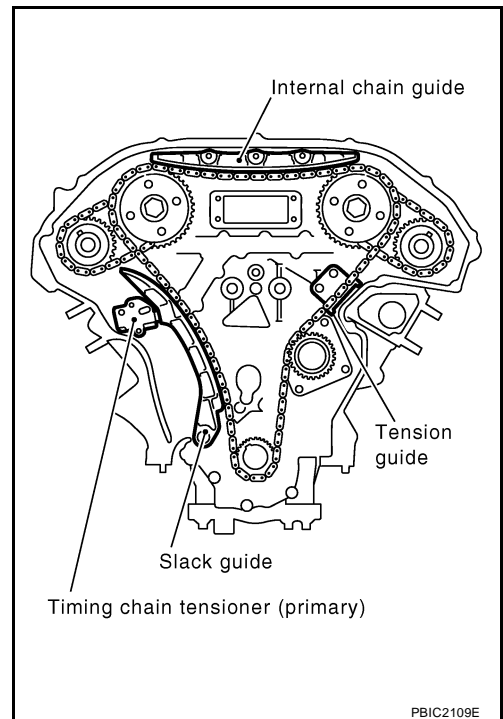
TIMING CHAIN

b. Install the primary timing chain.

- Water pump (G).
- Install primary timing chain so the mating mark punched (B) on camshaft sprocket is aligned with the copper link (A) on the timing chain, while the mating mark notched (E) on the crankshaft sprocket (D) is aligned with the yellow link (F) on the timing chain, as shown.
- When it is difficult to align mating marks (A) with (B) and (E) with (F) of the primary timing chain with each sprocket, gradually turn the camshaft using a wrench on the hexagonal portion to align it with the mating marks.
- During alignment, be careful to prevent dislocation of mating mark alignments of the secondary timing chains.



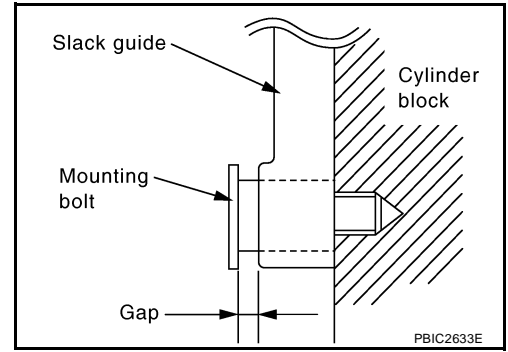
8. Install internal chain guide, slack guide and timing chain tensioner (primary).



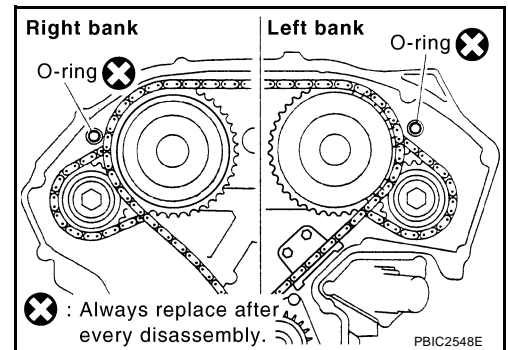
TIMING CHAIN

CAUTION:

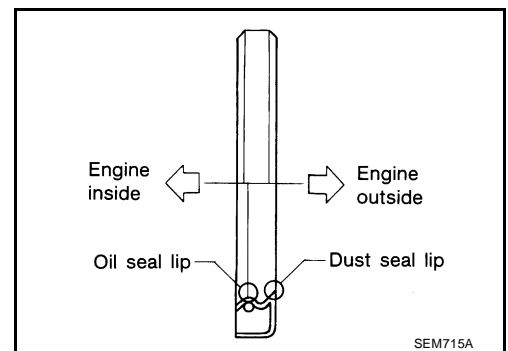
Do not overtighten slack guide bolts. It is normal for a gap to exist under the bolt seats when bolts are tightened to specification.



- When installing timing chain tensioner (primary), push in plunger and keep it pressed in with stopper pin.
 - Remove any dirt and foreign materials completely from the back and the mounting surfaces of timing chain tensioner (primary).
 - After installation, pull out stopper pin by pressing slack guide.
9. Make sure again that the mating marks on camshaft sprockets and timing chain have not slipped out of alignment.
10. Install new O-rings on rear timing chain case.

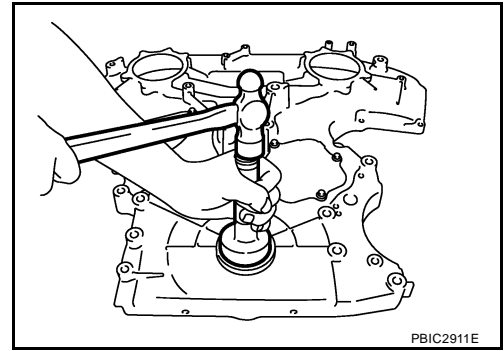


11. Install new front oil seal on front timing chain case.
- Apply new engine oil to both oil seal lip and dust seal lip.
 - Install it so that each seal lip is oriented as shown.



TIMING CHAIN

- Press-fit oil seal until it becomes flush with front timing chain case end face using suitable drift [outer diameter: 60 mm (2.36 in)].
- Make sure the garter spring is in position and seal lip is not inverted.

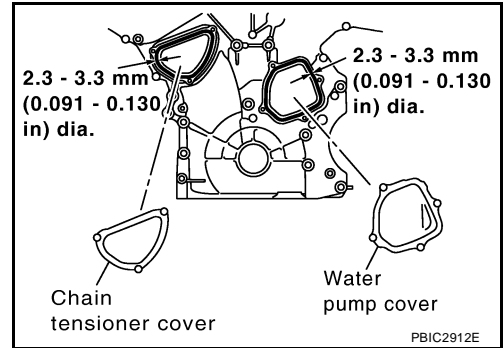


12. Install water pump cover and chain tensioner cover to front timing chain case.

- Apply a continuous bead of liquid gasket using Tool to front timing chain case as shown.

Tool number : WS39930000 (—)

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

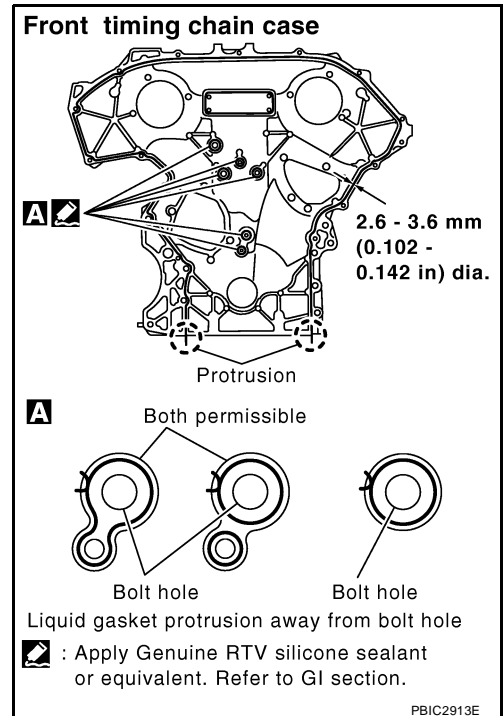


13. Install front timing chain case as follows:

- a. Apply a continuous bead of liquid gasket using Tool to front timing chain case back side as shown.

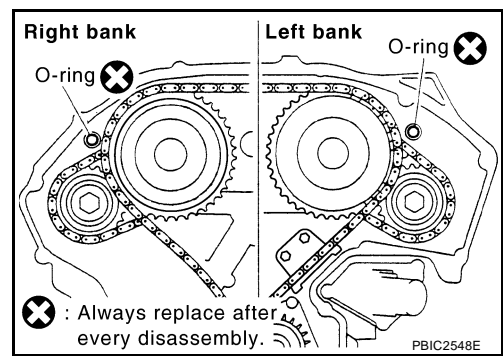
Tool number : WS39930000 (—)

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

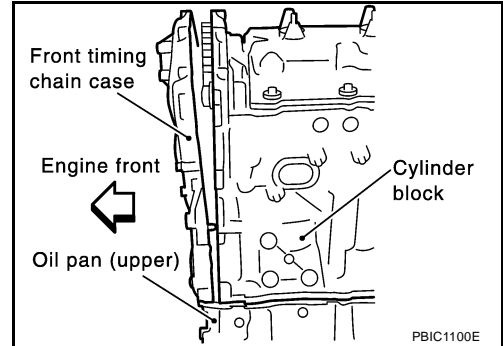


TIMING CHAIN

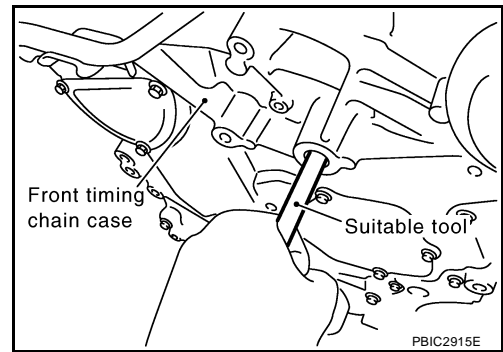
- b. Install new O-rings on rear timing chain case.
- c. Assemble front timing chain case as follows:



Fit lower end of front timing chain case tightly onto top face of oil pan (upper). From the fitting point, make entire front timing chain case contact rear timing chain case completely.



- ii. Since front timing chain case is offset for difference of bolt holes, tighten bolts temporarily while holding front timing chain case from front and top as shown.
- iii. Same as the previous step, insert dowel pin while holding front timing chain case from front and top completely.

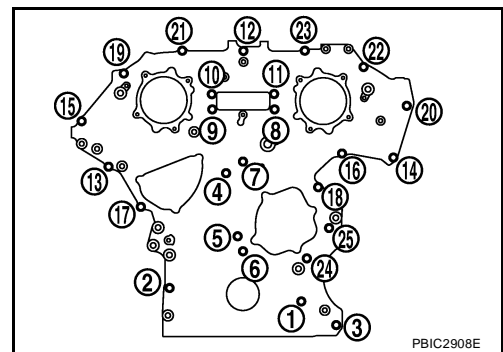


- d. Tighten bolts to the specified torque in numerical order as shown.

- There are four type of bolts. Refer to the following for locating bolts.

Bolt position	Bolt diameter
1 - 5	: 10 mm (0.39 in)
6 - 25	: 6 mm (0.24 in)

Bolt position	Tightening specification
1 - 5	: 55.0 N·m (5.6 kg-m, 41 ft-lb)
6 - 25	: 12.7 N·m (1.3 kg-m, 9 ft-lb)

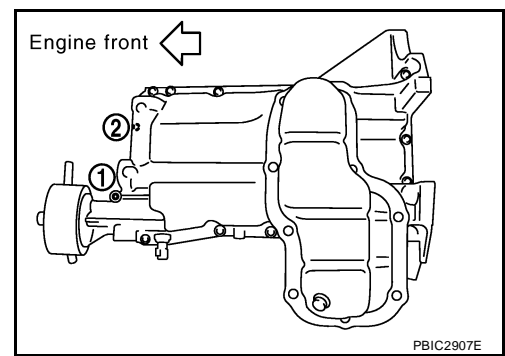


- e. After all bolts tightened, retighten them to the specified torque in numerical order as shown.

TIMING CHAIN

14. Install two bolts in front of oil pan (upper) in numerical order as shown.

Front oil pan bolt torque : 22.0 N-m (2.2 kg-m, 16 ft-lb)

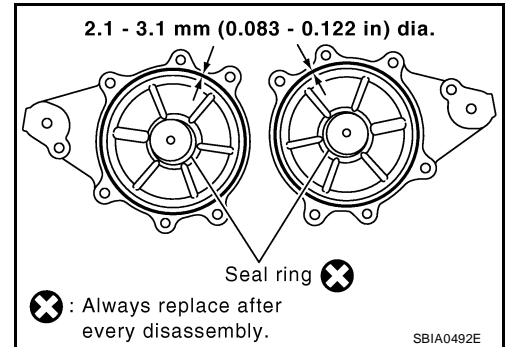


15. Install right and left intake valve timing control covers as follows:

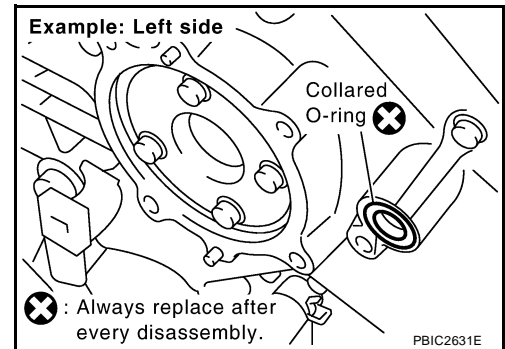
- Install new seal rings in shaft grooves.
- Apply a continuous bead of liquid gasket using Tool to intake valve timing control covers as shown.

Tool number : WS39930000 (—)

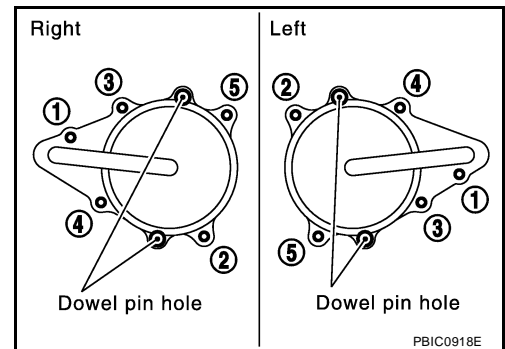
Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#) .



- Install new collared O-rings in front timing chain case oil hole (left and right sides).



- Being careful not to move seal ring from the installation groove, align dowel pins on front timing chain case with the holes to install intake valve timing control covers.
- Tighten bolts in numerical order as shown.



16. Install crankshaft pulley as follows:

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

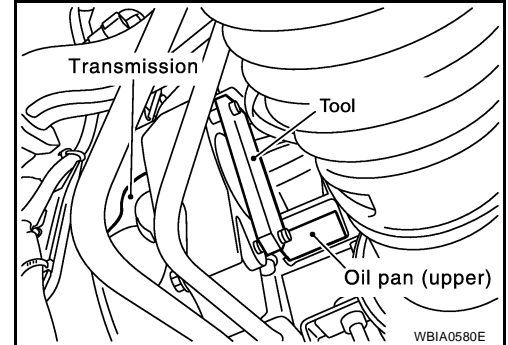
TIMING CHAIN

Step 1 : 44.1 N-m (4.5 kg-m, 33 ft-lb)

Step 2 :84° - 90° degrees clockwise

c. Remove Tool.

Tool number : KV10117700 (J-44716)



17. Rotate crankshaft pulley in normal direction (clockwise when viewed from front) to confirm it turns smoothly.
18. Install oil pans (upper and lower). Refer to [EM-26, "Removal and Installation"](#) .
19. Install rocker covers (right and left banks). Refer to [EM-40, "Removal and Installation"](#) .
20. Installation of the remaining components is in the reverse order of removal after this step.

INSPECTION AFTER INSTALLATION

Inspection for Leaks

The following are procedures for checking fluid leaks, lubricant leaks and exhaust gases leaks.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to [MA-11, "RECOMMENDED FLUIDS AND LUBRICANTS"](#) .
- Use procedure below to check for fuel leakage.
- Turn ignition switch "ON" (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.

NOTE:

If hydraulic pressure inside timing chain tensioner drops after removal/installation, slack in the guide may generate a pounding noise during and just after engine start. However, this is normal. Noise will stop after hydraulic pressure rises.

- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

Summary of the inspection items:

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level
Other oils and fluid*	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage

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

CAMSHAFT

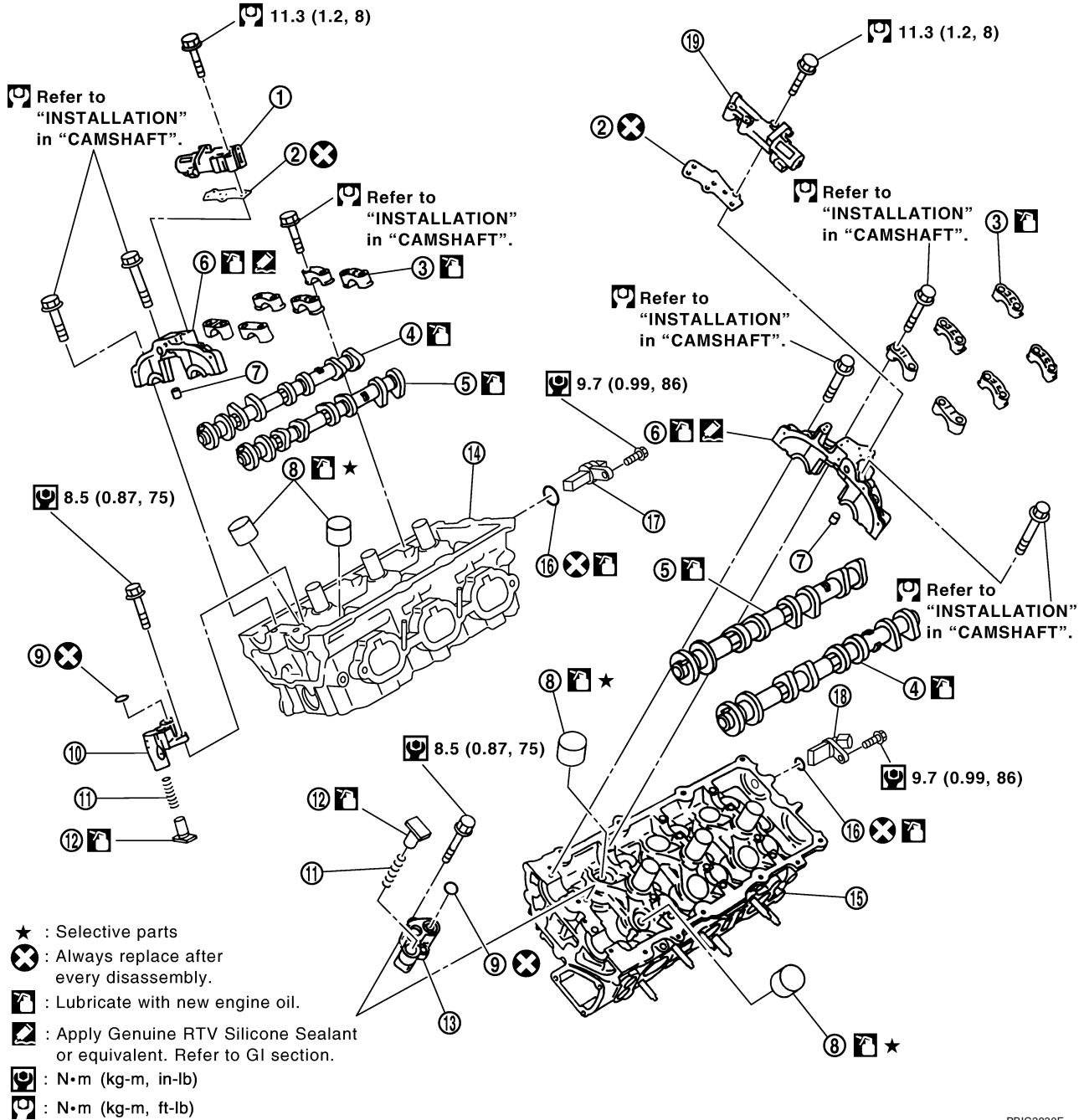
PFP:13001

EBS00NJY

CAMSHAFT

Removal and Installation

SEC. 111•130



PBIC2930E

- | | | |
|--|---|--|
| 1. Intake valve timing control valve (right bank) | 2. Gasket | 3. Camshaft bracket (No. 2 to 4) |
| 4. Camshaft (EXH) | 5. Camshaft (INT) | 6. Camshaft bracket (No. 1) |
| 7. Dowel pin | 8. Valve lifter | 9. O-ring |
| 10. Timing chain tensioner (secondary) (right bank) | 11. Spring | 12. Plunger |
| 13. Timing chain tensioner (secondary) (left bank) | 14. Cylinder head (right bank) | 15. Cylinder head (left bank) |
| 16. O-ring | 17. Camshaft position sensor (PHASE) (right bank) | 18. Camshaft position sensor (PHASE) (left bank) |
| 19. Intake valve timing control solenoid valve (left bank) | | |

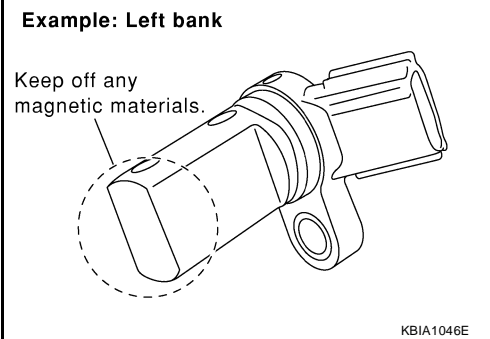
CAMSHAFT

REMOVAL

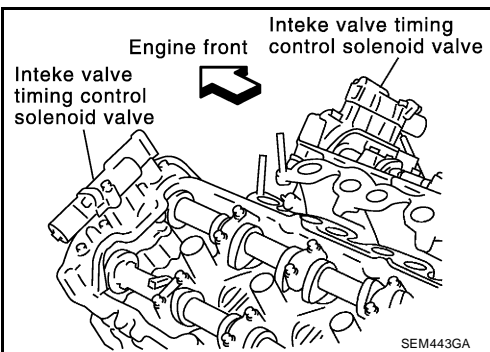
1. Remove front timing chain case, camshaft sprocket, timing chain and rear timing chain case. Refer to [EM-55, "REMOVAL"](#).
2. Remove camshaft position sensor (PHASE) (right and left banks) from cylinder head back side.

CAUTION:

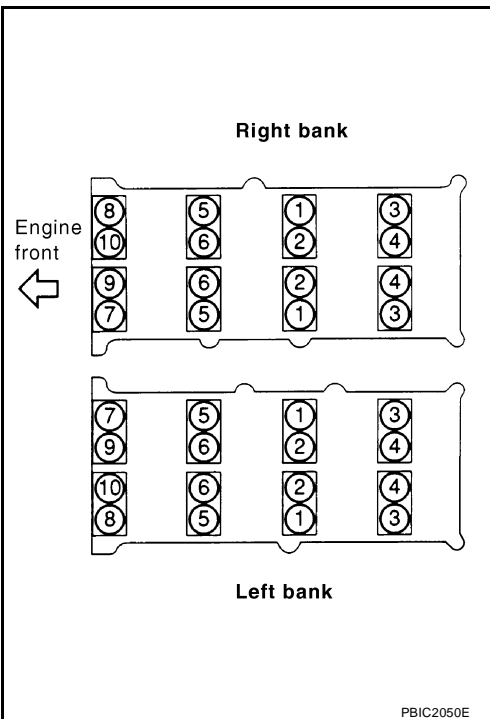
- Handle carefully to avoid dropping and shocks.
- Do not disassemble.
- Do not allow metal powder to adhere to magnetic part at sensor tip.
- Do not place sensors in a location where they are exposed to magnetism.



3. Remove intake valve timing control solenoid valves.
 - Discard intake valve timing control solenoid valve gaskets and use new gaskets for installation.



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



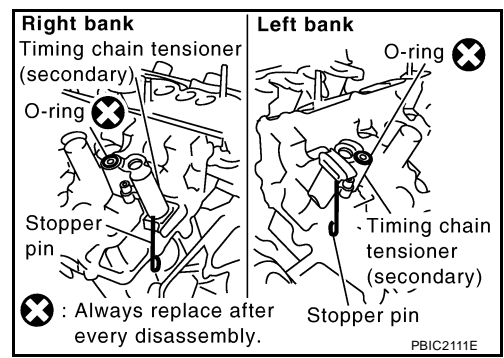
5. Remove camshafts.
6. Remove valve lifters.
 - Identify installation positions, and store them without mixing them up.

CAMSHAFT

- Remove timing chain tensioner (secondary) from cylinder head.
 - Remove timing chain tensioner (secondary) with its stopper pin attached.

NOTE:

Stopper pin was attached when timing chain (secondary) was removed.



INSPECTION AFTER REMOVAL

Camshaft Runout

- Put V-block on precise flat table, and support No. 2 and 4 journal of camshaft.

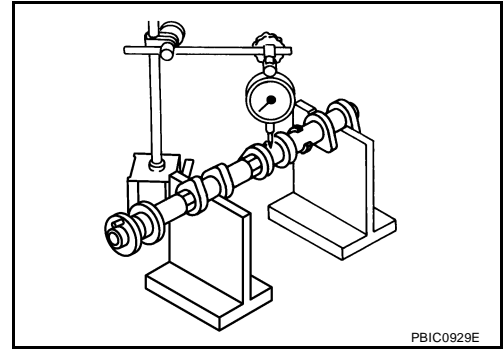
CAUTION:

Do not support journal No. 1 (on the side of camshaft sprocket) because it has a different diameter from the other three locations.

- Set dial indicator vertically to No. 3 journal.
- Turn camshaft to one direction with hands, and measure the camshaft runout on dial indicator. (Total indicator reading)

Standard : Less than 0.02 mm (0.0008 in)
Limit : 0.05 mm (0.0020 in)

- If it exceeds the limit, replace camshaft.



Camshaft Cam Height

- Measure the camshaft cam height with micrometer.

Standard:

Intake : 45.465 - 45.655 mm (1.7900 - 1.7974 in)

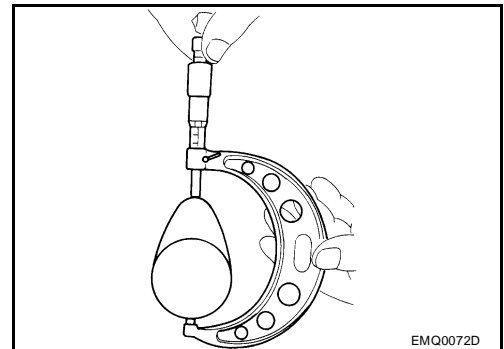
Exhaust : 45.075 - 45.265 mm (1.7746 - 1.7821 in)

Limit:

Intake : 45.265 mm (1.7821 in)

Exhaust : 44.875 mm (1.7667 in)

- If wear exceeds the limit, replace camshaft.



Camshaft Journal Oil Clearance

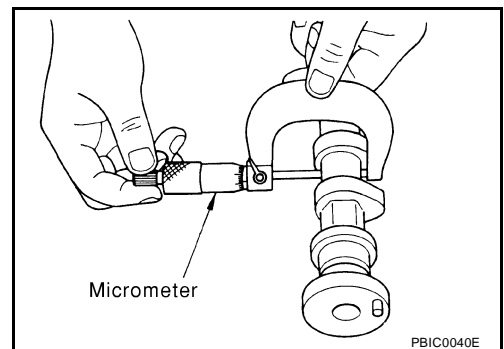
CAMSHAFT JOURNAL DIAMETER

- Measure the outer diameter of camshaft journal with micrometer.

Standard:

No. 1 : 25.935 - 25.955 mm (1.0211 - 1.0218 in)

No. 2, 3, 4 : 23.445 - 23.465 mm (0.9230 - 0.9238 in)



CAMSHAFT BRACKET INNER DIAMETER

- Tighten camshaft bracket bolt with the specified torque. Refer to [EM-79, "INSTALLATION"](#) for the tightening procedure.

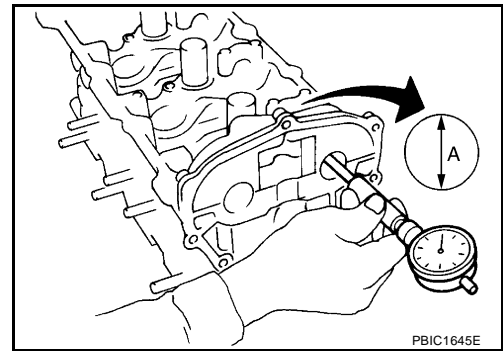
CAMSHAFT

- Measure the inner diameter “A” of camshaft bracket with bore gauge.

Standard:

No. 1 : 26.000 - 26.021 mm (1.0236 - 1.0244 in)

No. 2, 3, 4 : 23.500 - 23.521 mm (0.9252 - 0.9260 in)



CAMSHAFT JOURNAL OIL CLEARANCE

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

Standard:

No. 1 : 0.045 - 0.086 mm (0.0018 - 0.0034 in)

No. 2, 3, 4 : 0.035 - 0.076 mm (0.0014 - 0.0030 in)

Limit : 0.15 mm (0.0059 in)

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

NOTE:

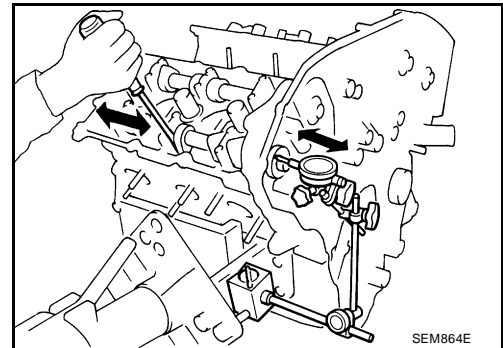
Camshaft bracket cannot be replaced as a single part, because it is machined together with cylinder head. Replace whole cylinder head assembly.

Camshaft End Play

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

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

Limit : 0.24 mm (0.0094 in)



- Measure the following parts if out of the limit.

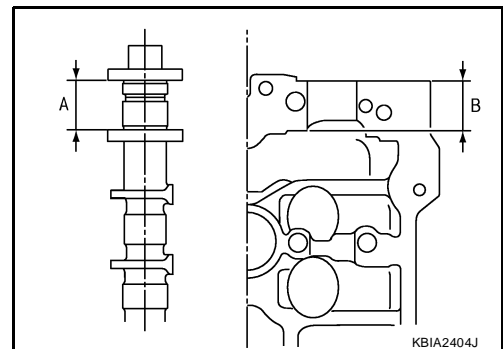
- Dimension “A” for camshaft No. 1 journal

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

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

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

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



Camshaft Sprocket Runout

1. Put V-block on precise flat table, and support No. 2 and 4 journal of camshaft.

CAUTION:

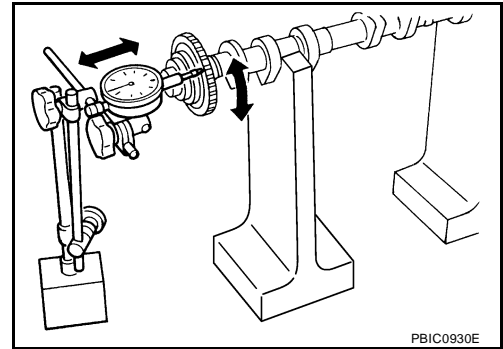
Do not support journal No. 1 (on the side of camshaft sprocket) because it has a different diameter from the other three locations.

CAMSHAFT

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

Limit : 0.15 mm (0.0059 in)

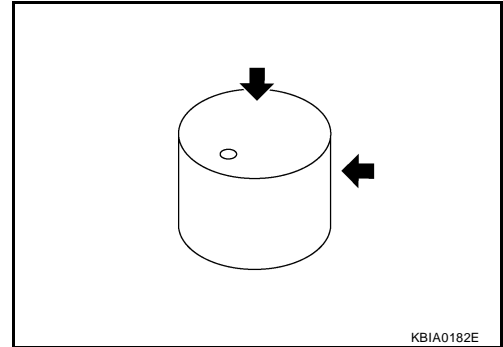
- If it exceeds the limit, replace camshaft sprocket.



Valve Lifter

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

- If anything above is found, replace valve lifter. Refer to [EM-134, "Available Valve Lifter"](#).



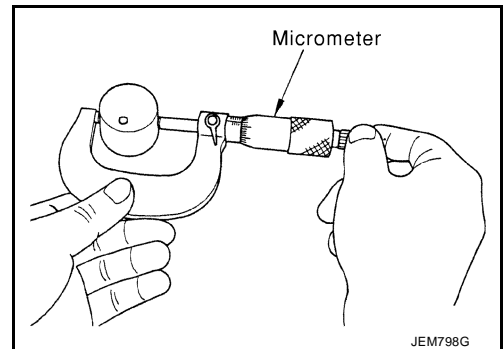
Valve Lifter Clearance

VALVE LIFTER OUTER DIAMETER

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

Standard (Intake and exhaust)

: 33.977 - 33.987 mm (1.3377 - 1.3381 in)

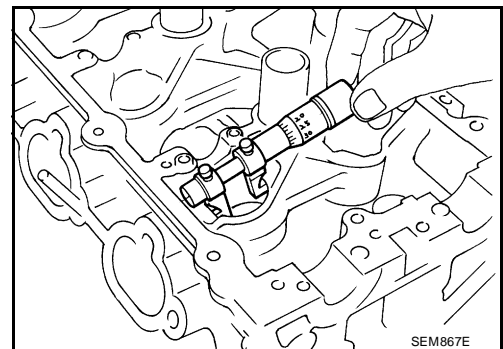


VALVE LIFTER HOLE DIAMETER

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

Standard (Intake and exhaust)

: 34.000 - 34.016 mm (1.3386 - 1.3392 in)



VALVE LIFTER CLEARANCE

- (Valve lifter clearance) = (Valve lifter hole diameter) – (Valve lifter outer diameter), Refer to [EM-83, "Valve Clearance"](#).

Standard (Intake and exhaust)

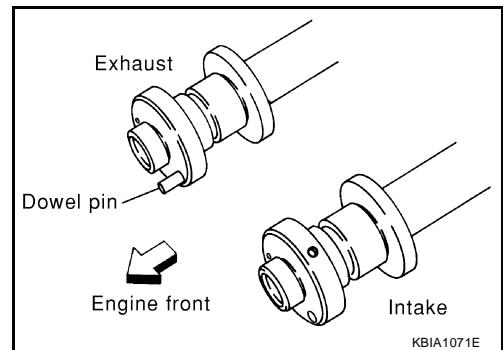
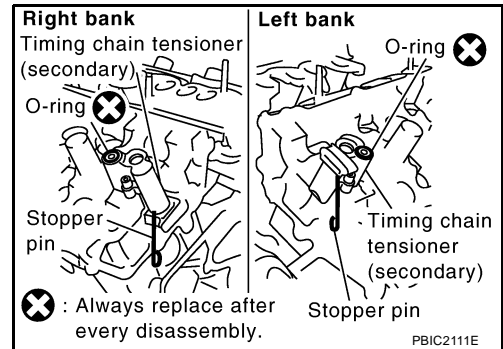
: 0.013 - 0.039 mm (0.0005 - 0.0015 in)

CAMSHAFT

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

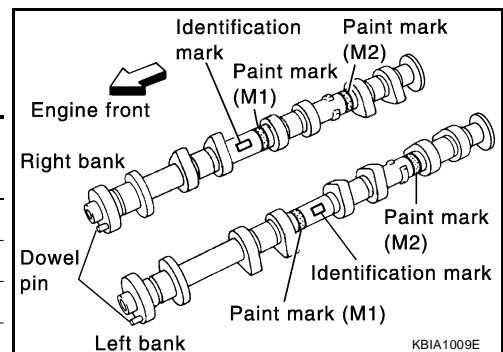
INSTALLATION

1. Install timing chain tensioners (secondary) on both sides of cylinder head.
 - Install timing chain tensioner with its stopper pin attached.
 - Install timing chain tensioner with sliding part facing downward on right-side cylinder head, and with sliding part facing upward on left-side cylinder head.
 - Install new O-rings as shown.
2. Install valve lifters.
 - Install it in the original position.
3. Install camshafts.
 - Install camshaft with dowel pin attached to its front end face on the exhaust side.



- Follow your identification marks made during removal, or follow the identification marks that are present on new camshafts for proper placement and direction.

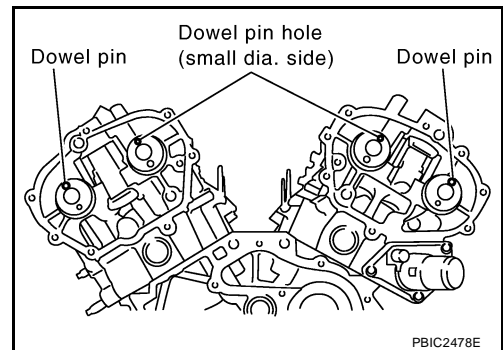
Bank	INT/EXH	Dowel pin	Paint marks		Identification mark
			M1	M2	
RH	INT	No	Green	No	RE
	EXH	Yes	No	White	RE
LH	INT	No	Green	No	LH
	EXH	Yes	No	White	LH



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

NOTE:

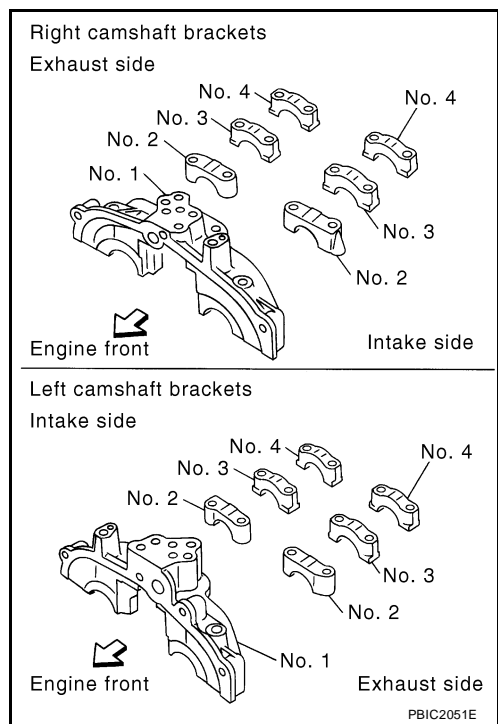
- Large and small pin holes are located on front end face of camshaft (INT), at intervals of 180°. Face small dia. side pin hole upward (in cylinder head upper face direction).
- Though camshaft does not stop at the portion as shown, for the placement of cam nose, it is generally accepted camshaft is placed for the same direction as shown.



CAMSHAFT

4. Install camshaft brackets.

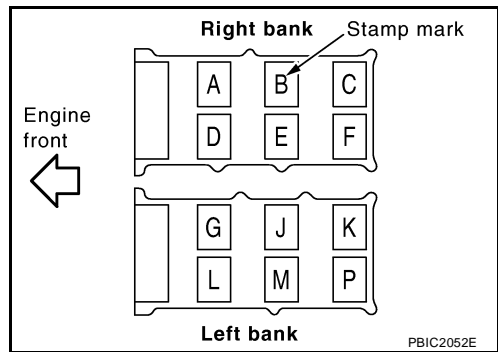
- Remove foreign material completely from camshaft bracket backside and from cylinder head installation face.
- Install camshaft bracket in original position and direction as shown.



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

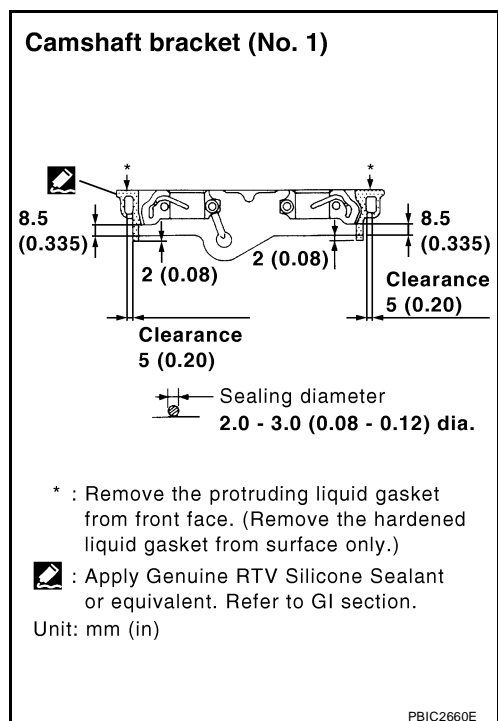
NOTE:

There are no identification marks indicating left and right for camshaft bracket (No. 1).



- Apply liquid gasket to mating surface of camshaft bracket (No. 1) as shown on right and left banks.

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



CAMSHAFT

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

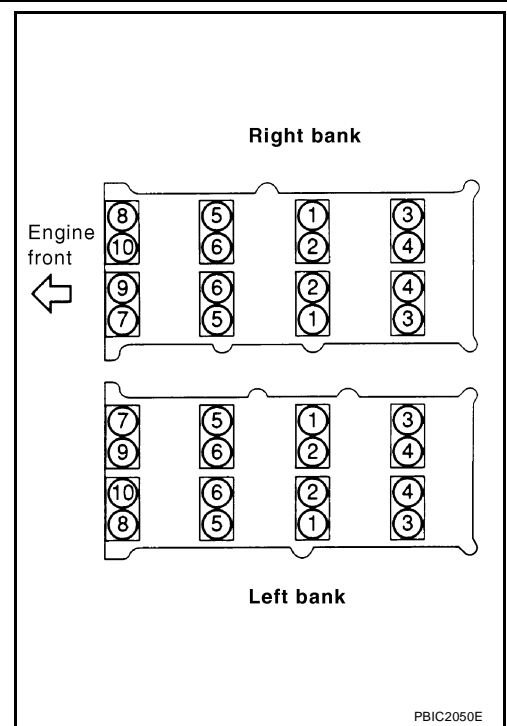
Camshaft bracket bolts

Step 1 (bolts 7 - 10) : 1.96 N·m (0.2 kg-m, 17 in-lb)

Step 2 (bolts 1 - 6) : 1.96 N·m (0.2 kg-m, 17 in-lb)

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

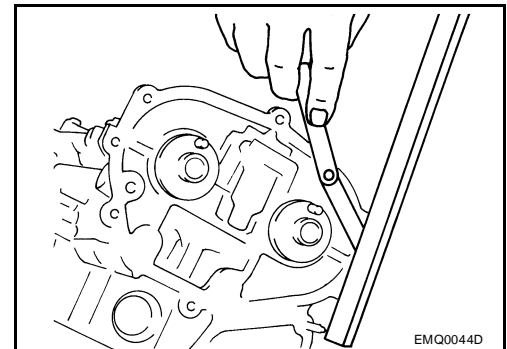
Step 4 : 10.4 N·m (1.1 kg-m, 92 in-lb)



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

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

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



7. Check and adjust the valve clearance. Refer to [EM-83, "Valve Clearance"](#).
8. Installation of the remaining components is in the reverse order of removal.

CAMSHAFT

INSPECTION AFTER INSTALLATION

Inspection of Camshaft Sprocket (INT) Oil Groove

CAUTION:

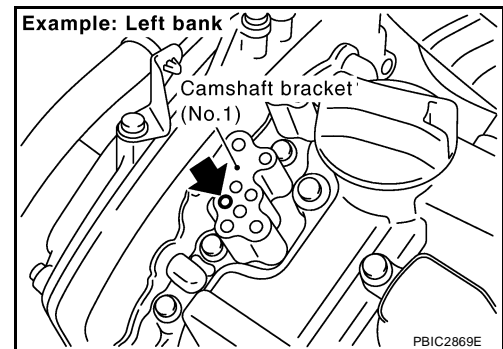
- Perform this inspection only when DTC P0011 or P0021 are detected in self-diagnostic results of CONSULT-II and it is directed according to inspection procedure of EC section. Refer to [EC-129, "SELF-DIAG RESULTS MODE"](#) .
 - Check when engine is cold so as to prevent burns from any splashing engine oil.
1. Check the engine oil level. Refer to [LU-6, "ENGINE OIL"](#) .
 2. Perform the following procedure so as to prevent the engine from being unintentionally started while checking.
 - a. Release fuel pressure. Refer to [EC-91, "FUEL PRESSURE RELEASE"](#) .
 - b. Disconnect ignition coil and injector harness connectors.
 3. Remove intake valve timing control solenoid valve. Refer to [EM-75, "REMOVAL"](#) .
 4. Crank the engine, and then make sure that engine oil comes out from camshaft bracket (No. 1) oil hole. End crank after checking.

WARNING:

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

CAUTION:

Engine oil may squirt from intake valve timing control solenoid valve installation hole during cranking. Use a shop cloth to prevent the engine components and the vehicle. Do not allow engine oil to get on rubber components such as drive belt or engine mount insulators. Immediately wipe off any splashed engine oil.



- Clean oil groove between oil strainer and intake valve timing control solenoid valve if engine oil does not come out from camshaft bracket (No. 1) oil hole. Refer to [LU-4, "LUBRICATION SYSTEM"](#) .
5. Remove components between intake valve timing control solenoid valve and camshaft sprocket (INT), and then check each oil groove for clogging.
 - Clean oil groove if necessary. Refer to [LU-4, "LUBRICATION SYSTEM"](#) .
 6. After inspection, install removed parts.

Inspection for Leaks

The following are procedures for checking fluid leaks, lubricant leaks and exhaust gases leaks.

- Before starting engine, check oil/fluid levels including engine coolant and engine oil. If less than required quantity, fill to the specified level. Refer to [MA-11, "RECOMMENDED FLUIDS AND LUBRICANTS"](#) .
- Use procedure below to check for fuel leakage.
 - Turn ignition switch "ON" (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
 - Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.

NOTE:

If hydraulic pressure inside timing chain tensioner drops after removal/installation, slack in the guide may generate a pounding noise during and just after engine start. However, this is normal. Noise will stop after hydraulic pressure rises.

- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gases, or any oil/fluids including engine oil and engine coolant.
- Bleed air from lines and hoses of applicable lines, such as in cooling system.
- After cooling down engine, again check oil/fluid levels including engine oil and engine coolant. Refill to the specified level, if necessary.

CAMSHAFT

Summary of the inspection items:

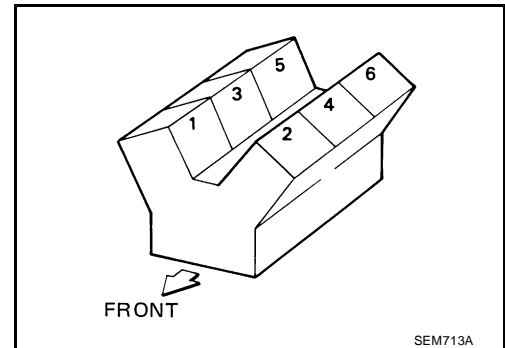
Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level
Other oils and fluid*	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage

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

Valve Clearance INSPECTION

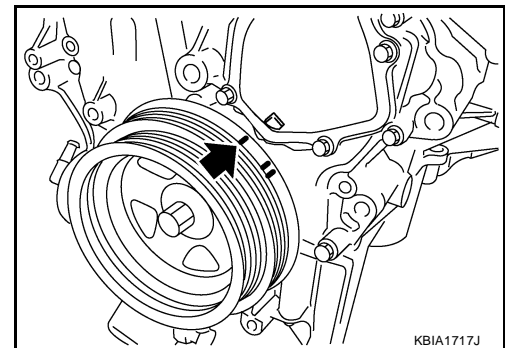
EBS00NJZ

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

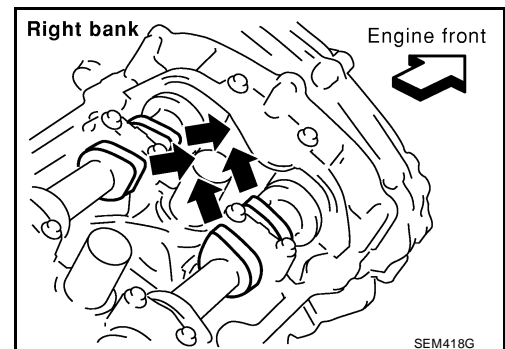


1. Remove rocker covers (right and left banks). Refer to [EM-40, "Removal and Installation"](#).
2. Measure the valve clearance as follows:
 - a. Set No. 1 cylinder at TDC of its compression stroke.

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

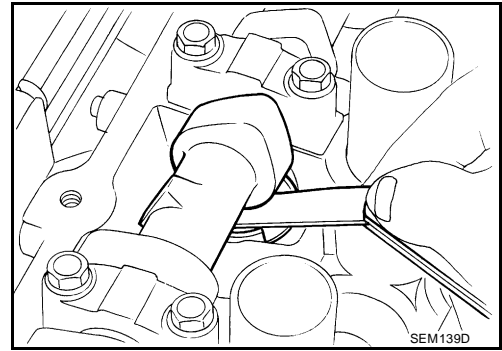


- Make sure that intake and exhaust cam noses on No. 1 cylinder (engine front side of right bank) are located as shown.
- If not, rotate crankshaft one revolution (360°) and align as shown.



CAMSHAFT

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



Valve clearance:

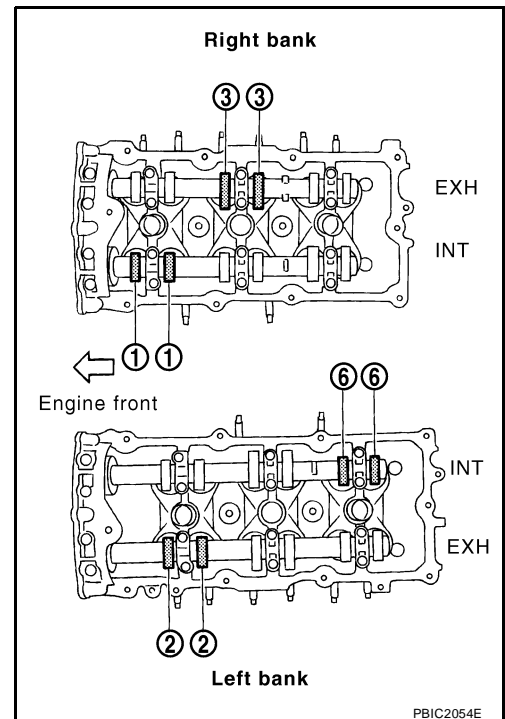
Unit: mm (in)

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

*: Approximately 80°C (176°F)

- By referring to the figure, measure the valve clearances at locations marked "x" as shown (locations indicated in the figure) with feeler gauge.
- No. 1 cylinder at compression TDC

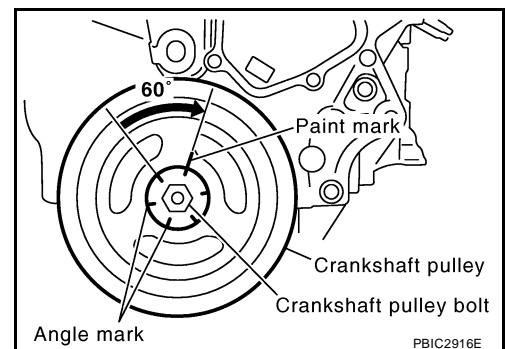
Measuring position (right bank)		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.
No. 1 cylinder at compression TDC	EXH		x	
	INT	x		
Measuring position (left bank)		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.
No. 1 cylinder at compression TDC	INT			x
	EXH	x		



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

NOTE:

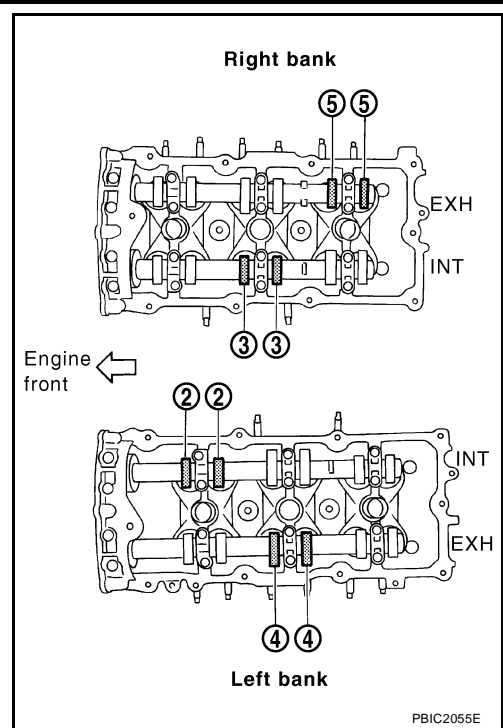
Crankshaft pulley bolt flange has a stamped line every 60°. They can be used as a guide to rotation angle.



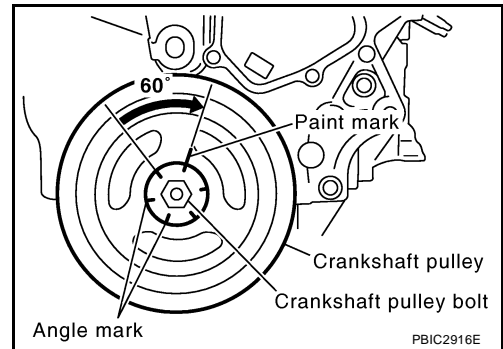
CAMSHAFT

- By referring to the figure, measure the valve clearances at locations marked “x” as shown in the table below (locations indicated in the figure) with feeler gauge.
- No. 3 cylinder at compression TDC

Measuring position (right bank)		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.
No. 3 cylinder at compression TDC	EXH			x
	INT		x	
Measuring position (left bank)		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.
No. 3 cylinder at compression TDC	INT	x		
	EXH		x	

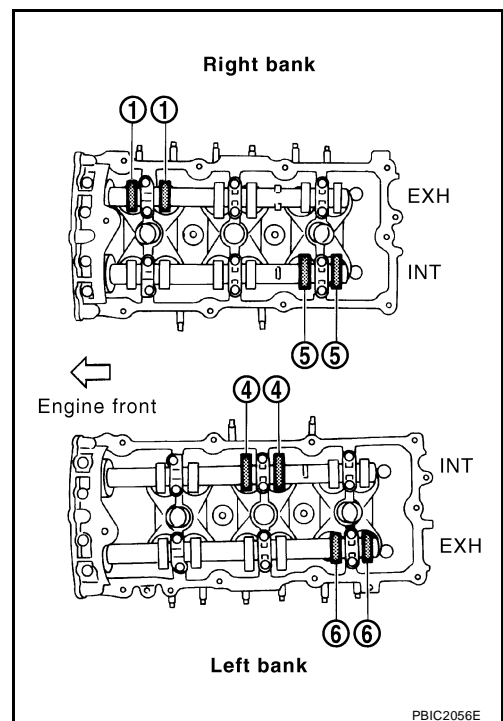


- d. Rotate crankshaft by 240° clockwise (when viewed from engine front) to align No. 5 cylinder at TDC of compression stroke.



- By referring to the figure, measure the valve clearances at locations marked “x” as shown in the table below (locations indicated in the figure) with feeler gauge.
- No. 5 cylinder at compression TDC

Measuring position (right bank)		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.
No. 5 cylinder at compression TDC	EXH	x		
	INT			x
Measuring position (left bank)		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.
No. 5 cylinder at compression TDC	INT		x	
	EXH			x

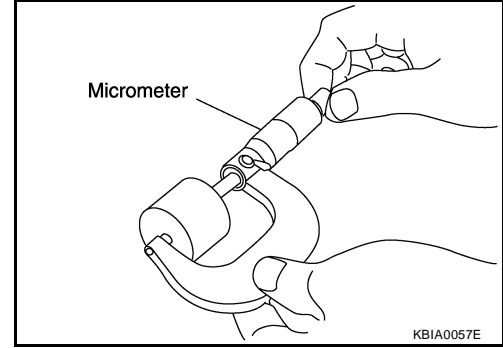


CAMSHAFT

3. For the measured value out of the standard, perform adjustment. Refer to [EM-86, "ADJUSTMENT"](#) .

ADJUSTMENT

- Perform adjustment depending on selected head thickness of valve lifter.
- 1. Measure the valve clearance. Refer to [EM-83, "INSPECTION"](#) .
- 2. Remove camshaft. Refer to [EM-75, "REMOVAL"](#) .
- 3. Remove valve lifters at the locations that are out of the standard.
- 4. Measure the center thickness of removed valve lifters with micrometer.



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

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

t = Valve lifter thickness to be replaced

t₁ = Removed valve lifter thickness

C₁ = Measured valve clearance

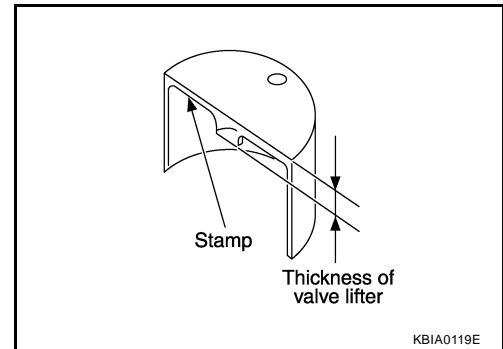
C₂ = Standard valve clearance:

Intake : 0.30 mm (0.012 in)*

Exhaust : 0.33 mm (0.013 in)*

***: Approximately 20°C (68°F)**

- Thickness of new valve lifter can be identified by stamp marks on the reverse side (inside the cylinder).



Intake

Stamp mark	Thickness
788U	7.88 mm (0.3102 in)
790U	7.90 mm (0.3110 in)
.	.
.	.
840U	8.40 mm (0.3307 in)

Available thickness of valve lifter: 27 sizes with range 7.88 to 8.40 mm (0.3102 to 0.3307 in) in steps of 0.02 mm (0.0008 in) (when manufactured at factory). Refer to [EM-134, "Available Valve Lifter"](#) .

CAMSHAFT

Exhaust	
Stamp mark	Thickness
N788	7.88 mm (0.3102 in)
N790	7.90 mm (0.3110 in)
.	.
.	.
N836	8.36 mm (0.3291 in)

Available thickness of valve lifter: 25 sizes with range 7.88 to 8.36 mm (0.3102 to 0.3291 in) in steps of 0.02 mm (0.0008 in) (when manufactured at factory). Refer to [EM-134, "Available Valve Lifter"](#).

CAUTION:

Install identification letter at the end and top, "U" and "N", at each of proper positions. (Be careful of mis-installation between intake and exhaust.)

6. Install selected valve lifter.
7. Install camshaft. Refer to [EM-79, "INSTALLATION"](#).
8. Manually turn crankshaft pulley a few turns.
9. Make sure that the valve clearances for cold engine are within the specifications by referring to the specified values.
10. Installation of the remaining components is in the reverse order of removal.
11. Start the engine, and check for unusual noise and vibration.

OIL SEAL

Removal and Installation of Valve Oil Seal REMOVAL

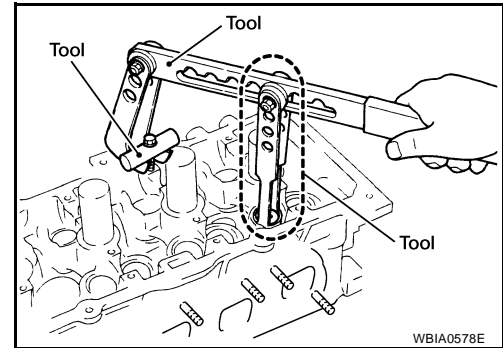
1. Turn crankshaft until the cylinder requiring new oil seals is at TDC. This will prevent valve from dropping into cylinder.
2. Remove camshaft relating to valve oil seal to be removed. Refer to [EM-75, "REMOVAL"](#).
3. Remove valve lifters. Refer to [EM-75, "REMOVAL"](#).
4. Remove valve collet, valve spring retainer and valve spring using Tool.

CAUTION:

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

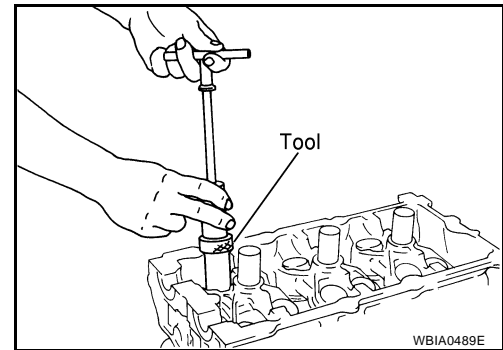
Tool numbers : KV10116200 (J-26336-B)
: KV10115900 (J-26336-20)
: KV10109220 (—)

- Compress valve spring using Tool attachment, adapter. Remove valve collet with magnet hand.



5. Remove valve oil seal using Tool.

Tool number : KV10107902 (J-38959)



INSTALLATION

1. Apply new engine oil to new valve oil seal joint surface and seal lip.
2. Press in valve oil seal to height "H" using Tool to specified height.

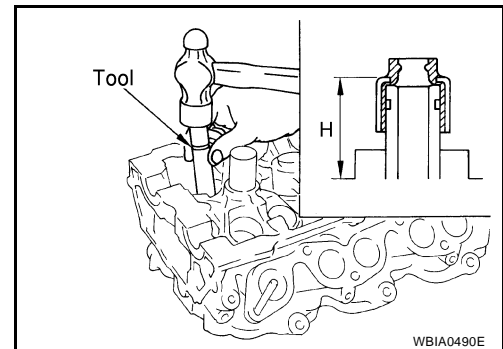
Tool number : — (J-39386)

NOTE:

Dimension "H": height measured before valve spring seat installation.

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

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



OIL SEAL

EBS00NK1

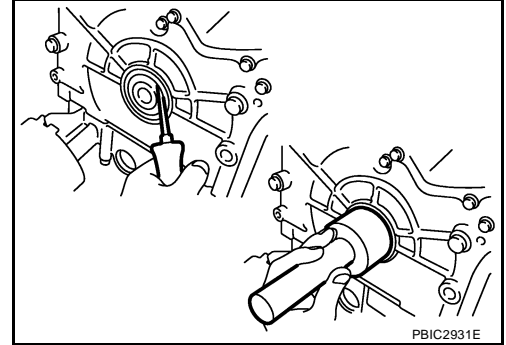
Removal and Installation of Front Oil Seal

REMOVAL

1. Remove engine undercover using power tools.
2. Remove drive belts. Refer to [EM-13, "Removal"](#).
3. Remove engine cooling fan assembly. Refer to [CO-14, "ENGINE COOLING FAN"](#).
4. Remove crankshaft pulley. Refer to [EM-55, "REMOVAL"](#).
5. Remove front oil seal using suitable tool.

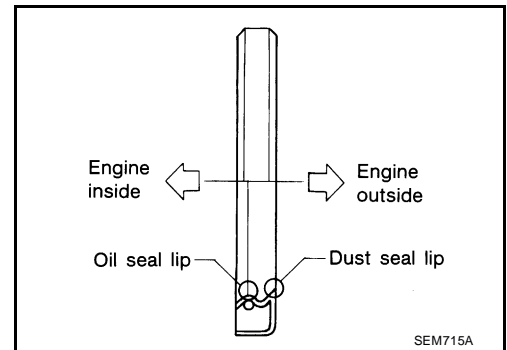
CAUTION:

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



INSTALLATION

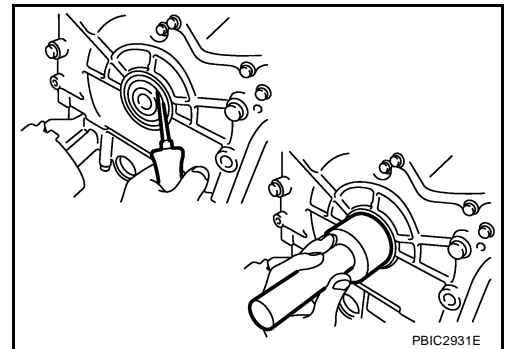
1. Apply new engine oil to both oil seal lip and dust seal lip of new front oil seal.
2. Install front oil seal.
 - Install front oil seal so that each seal lip is oriented as shown.



- Press-fit until the height of front oil seal is level with the mounting surface using suitable tool.
- Suitable drift: outer diameter 60 mm (2.36 in), inner diameter 50 mm (1.97 in).

CAUTION:

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



3. Installation is in the reverse order of removal after this step.

OIL SEAL

EBS00QB6

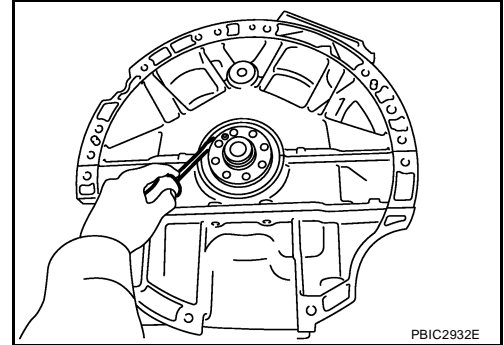
Removal and Installation of Rear Oil Seal

REMOVAL

1. Remove transmission assembly. Refer to [AT-245, "TRANSMISSION ASSEMBLY"](#).
2. Remove rear oil seal with a suitable tool.

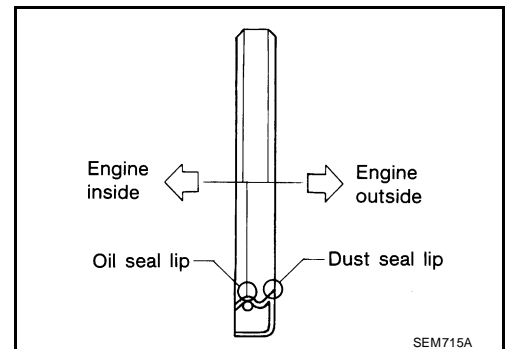
CAUTION:

Be careful not to damage crankshaft and cylinder block.

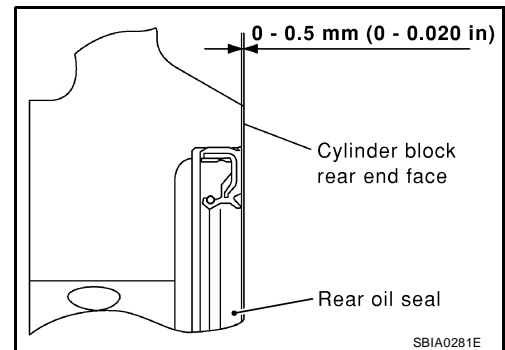


INSTALLATION

1. Apply new engine oil to new rear oil seal joint surface and seal lip.
2. Install rear oil seal so that each seal lip is oriented as shown.



- Press in rear oil seal to the position as shown.

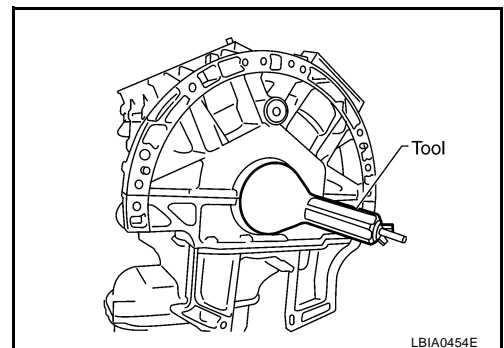


- Install new rear oil seal using Tool.

Tool number : KV991J0120 (J-47128)

CAUTION:

- Be careful not to damage crankshaft and cylinder block.
- Press-fit oil seal straight to avoid causing burrs or tilting.
- Do not touch grease applied onto oil seal lip.



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

CYLINDER HEAD

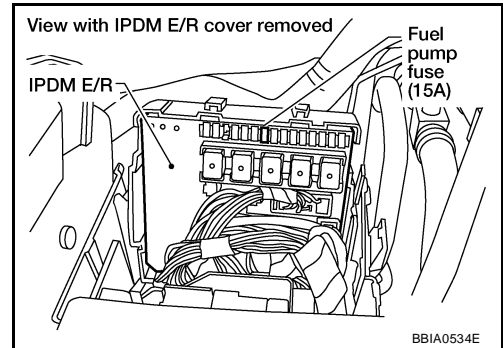
CYLINDER HEAD

PFP:11041

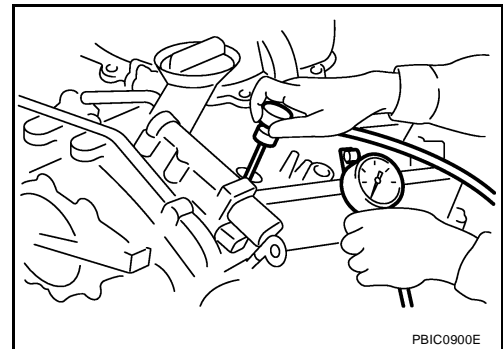
EBS00NK3

On-Vehicle Service CHECKING COMPRESSION PRESSURE

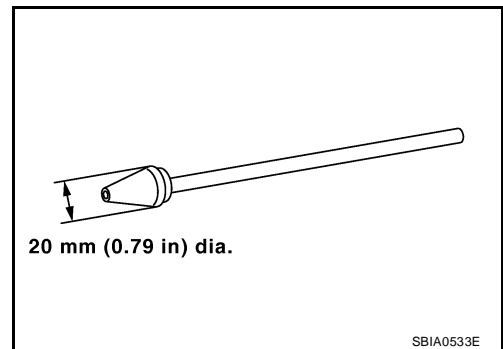
1. Warm up engine thoroughly. Then, stop it.
2. Release fuel pressure. Refer to [EC-91, "FUEL PRESSURE RELEASE"](#).
3. Disconnect fuel pump fuse to avoid fuel injection during measurement.



4. Remove intake manifold collector. Refer to [EM-17, "REMOVAL"](#).
5. Remove spark plug from each cylinder. Refer to [EM-32, "REMOVAL"](#).
6. Connect engine tachometer (not required in use of CONSULT-II).
7. Install compression tester with adapter onto spark plug hole.



- 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.



8. 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	Differential limit between cylinders
1,275 (13.0, 185) / 300	981 (10.0, 142) / 300	98 (1.0, 14) / 300

CAUTION:

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

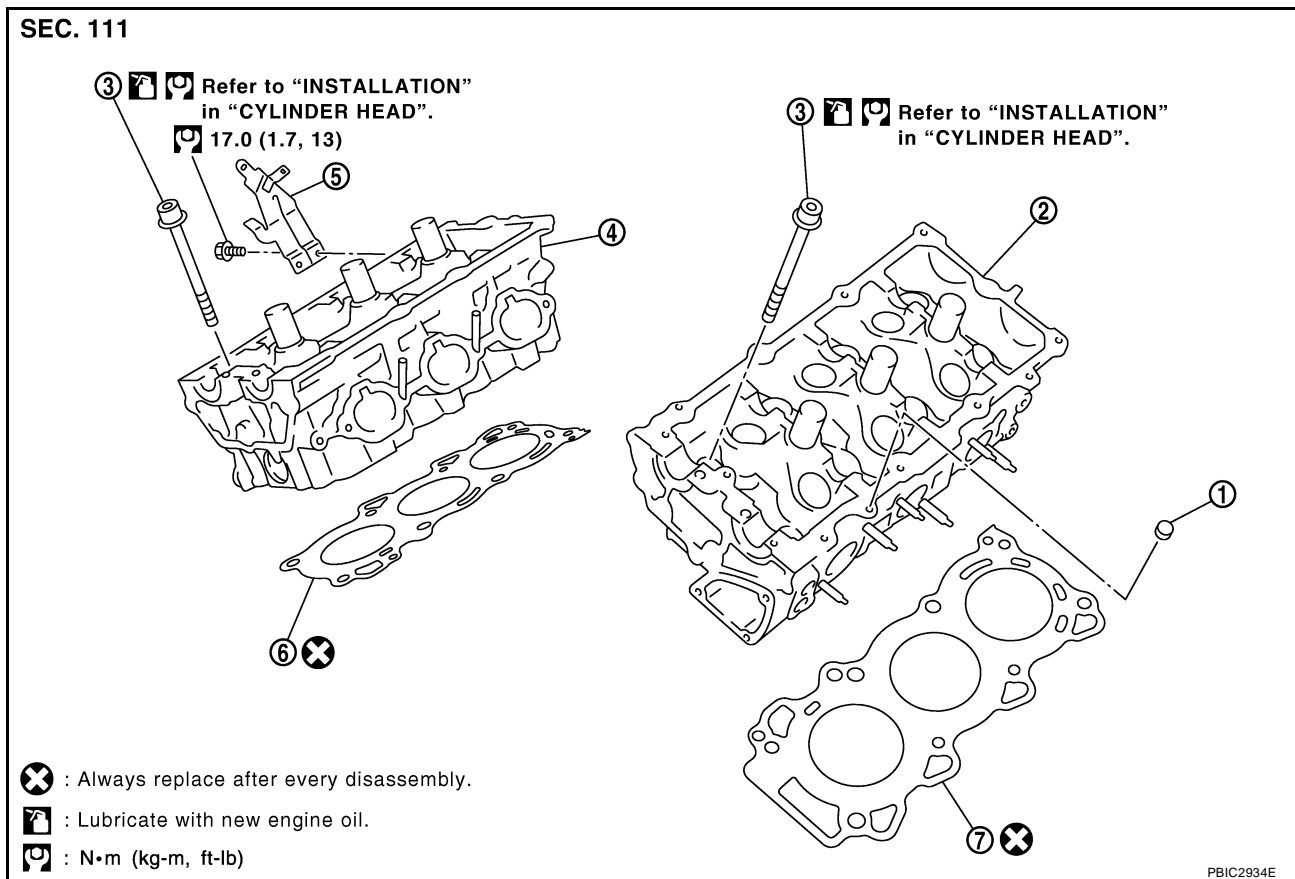
- If the engine speed is out of specified range, check battery liquid for proper gravity. Check engine speed again with normal battery gravity.

CYLINDER HEAD

- 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, 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, valves may be malfunctioning. Check valves for damage. Replace valve or valve seat accordingly.
 - If two adjacent cylinders have respectively low compression pressure and their compression remains low even after the addition of engine oil, cylinder head gaskets are leaking. In such a case, replace cylinder head gaskets.
9. After inspection is completed, install removed parts.
10. Start engine, and make sure that engine runs smoothly.
11. Perform trouble diagnosis. If DTC appears, erase it. Refer to [EC-93, "TROUBLE DIAGNOSIS"](#).

Removal and Installation

EBS00NK4



- | | | |
|-------------------------------------|------------------------------|--------------------------------------|
| 1. Rubber plug | 2. Cylinder head (left bank) | 3. Cylinder head bolt |
| 4. Cylinder head (right bank) | 5. Harness bracket | 6. Cylinder head gasket (right bank) |
| 7. Cylinder head gasket (left bank) | | |

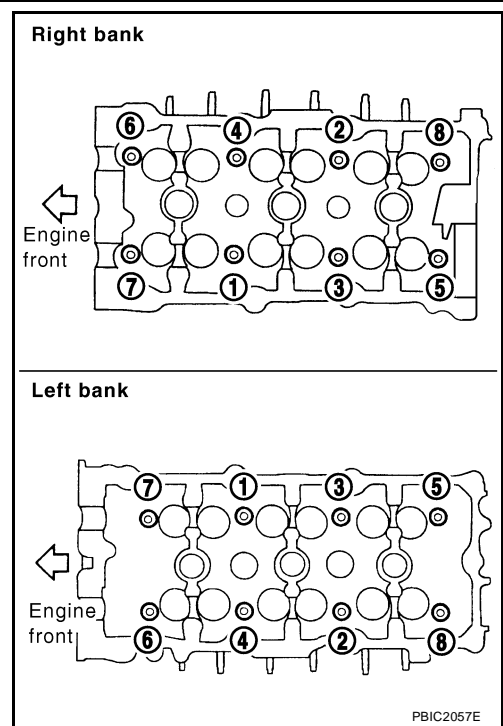
REMOVAL

1. Remove camshaft. Refer to [EM-75, "REMOVAL"](#).
2. Remove intake manifold. Refer to [EM-19, "REMOVAL"](#).
3. Remove exhaust manifold. Refer to [EM-21, "Removal and Installation"](#).
4. Remove water inlet and thermostat assembly. Refer to [CO-21, "REMOVAL"](#).
5. Remove water outlet, water pipe and heater pipe. Refer to [CO-23, "REMOVAL"](#).

CYLINDER HEAD

6. Remove cylinder head bolts in reverse order as shown using commercial service tool and power tool to remove cylinder heads (right and left banks).

Tool number : (J-24239-01)



7. Remove cylinder head gaskets.

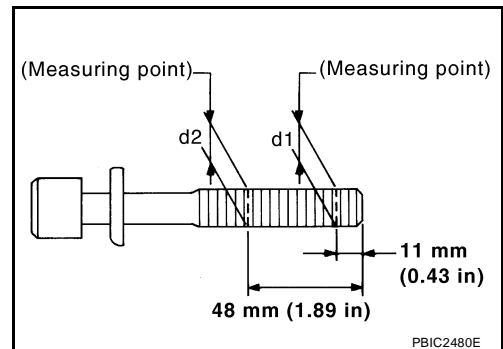
INSPECTION AFTER REMOVAL

Cylinder Head Bolts Outer Diameter

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

Limit (“d1” – “d2”) : 0.11 mm (0.0043 in)

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



Cylinder Head Distortion

NOTE:

When performing this inspection, cylinder block distortion should be also checked. Refer to [EM-124, "CYLINDER BLOCK DISTORTION"](#).

1. Using suitable tool, wipe off oil, scale, gasket, sealant and carbon deposits from surface of cylinder head.

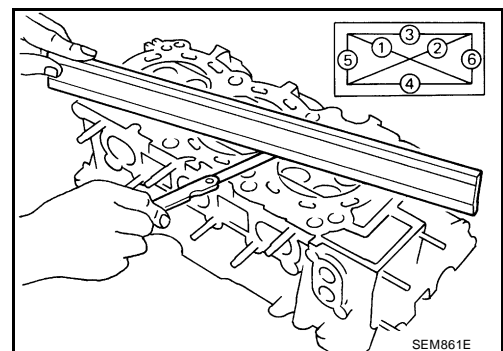
CAUTION:

Do not allow gasket fragments to enter engine oil or engine coolant passages.

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

Limit : 0.1 mm (0.004 in)

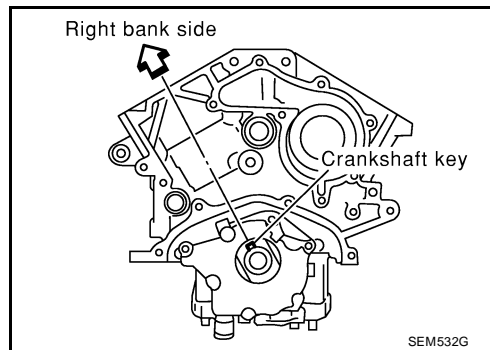
- If it exceeds the limit, replace cylinder head.



CYLINDER HEAD

INSTALLATION

1. Install new cylinder head gasket.
2. Turn crankshaft until No. 1 piston is set at TDC.
 - Crankshaft key should line up with the right bank cylinder center line as shown.



3. Install cylinder head follow the steps below to tighten cylinder head bolts in numerical order as shown.

CAUTION:

If cylinder head bolts re-used, check their outer diameters before installation. Refer to [EM-93, "Cylinder Head Bolts Outer Diameter"](#) .

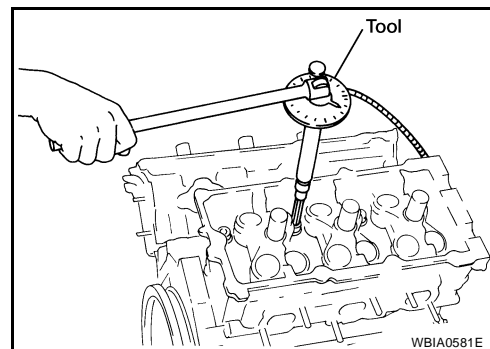
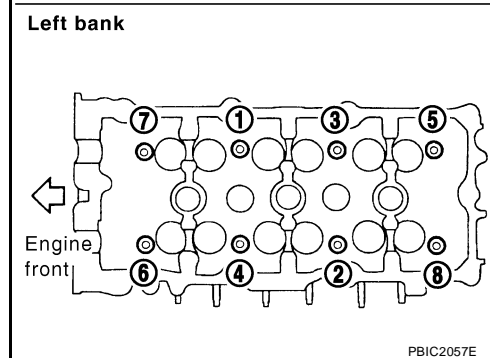
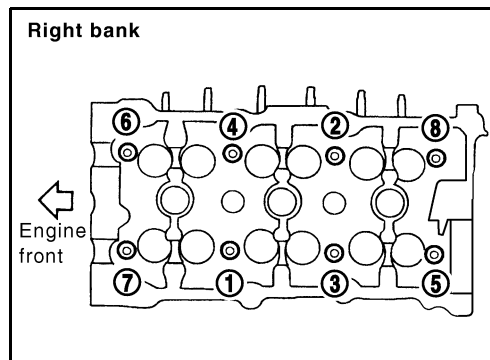
Step a : 98 N·m (10 kg·m, 72 ft·lb)

Step b : Loosen to 0 N·m in the reverse order of tightening.

Step c : 39.2 N·m (4.0 kg·m, 29 ft·lb)

Step d : 90° clockwise

Step e : 90° clockwise

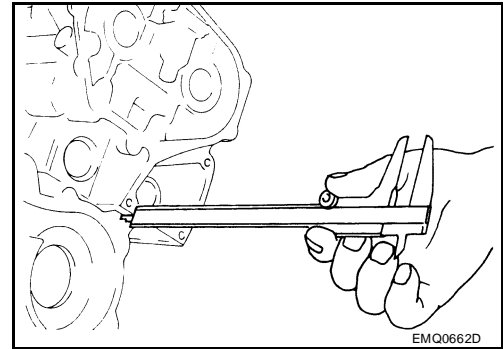


CYLINDER HEAD

4. After installing cylinder head, measure distance between front end faces of cylinder block and cylinder head (left and right banks).

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

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



5. Installation of the remaining parts is in the reverse order of removal.

INSPECTION AFTER INSTALLATION

Inspection for Leaks

The following are procedures for checking fluid leaks, lubricant leaks and exhaust gases leaks.

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

Summary of the inspection items:

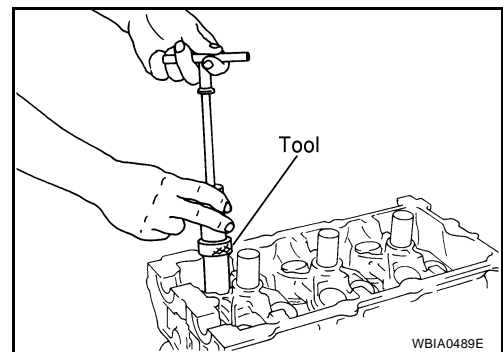
Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level
Other oils and fluid*	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage
Exhaust gases	—	Leakage	—

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

CYLINDER HEAD

6. Remove valve oil seals using Tool.

Tool number : KV10107902 (J-38959)



7. If valve seat must be replaced, refer to [EM-100, "VALVE SEAT REPLACEMENT"](#) .
8. If valve guide must be replaced, refer to [EM-98, "VALVE GUIDE REPLACEMENT"](#) .
9. Remove spark plug tube, as necessary.

CAUTION:

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

ASSEMBLY

1. When valve guide is removed, install it. Refer to [EM-98, "VALVE GUIDE REPLACEMENT"](#) .
2. When valve seat is removed, install it. Refer to [EM-100, "VALVE SEAT REPLACEMENT"](#) .
3. Install valve oil seals using Tool.

Tool number : — (J-39386)

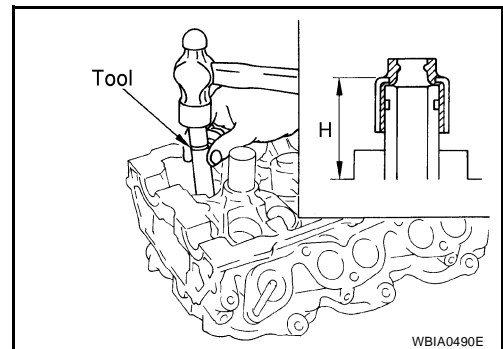
Height "H" (Without valve spring seat installed)

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

4. Install valve spring seat.
5. Install valves.
● Install it in the original position.

NOTE:

Larger diameter valves are for intake side.



6. Install valve spring narrow pitch end (paint mark) to cylinder head side (valve spring seat side).
7. Install valve spring retainer.
8. Install valve collet.

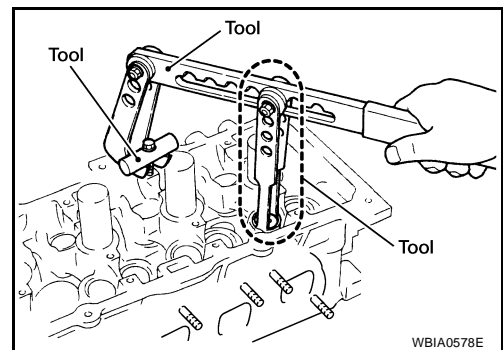
- Compress valve spring using Tool, attachment and adapter using Tool. Install valve collet with magnet hand.

Tool numbers : KV10109220 (—)
: KV10116200 (J-26336-A)
: KV10115900 (J-26336-20)

CAUTION:

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

- Tap valve stem edge lightly with plastic hammer after installation to check its installed condition.



9. Install valve lifter.
● Install it in the original position.
10. Install spark plug tube.
● Press-fit spark plug tube as follows:

CYLINDER HEAD

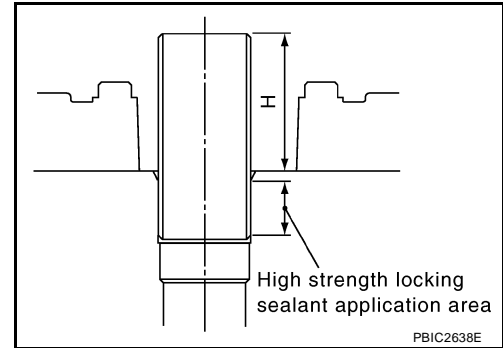
- a. Remove old liquid gasket adhering to cylinder head mounting hole.
- b. Apply sealant to area within approximately 12 mm (0.47 in) from edge of spark plug tube press-fit side. **Use Genuine High Strength Locking Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#).**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

Standard press-fit height "H"
: 38.1 - 39.1 mm (1.500 - 1.539 in)

CAUTION:

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

11. Install spark plug.



EBS00NK6

Inspection After Disassembly

VALVE DIMENSIONS

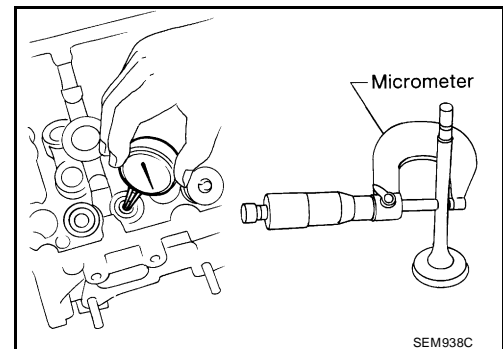
- Check dimensions of each valve. For dimensions, refer to [EM-98, "VALVE DIMENSIONS"](#).
- If dimensions are out of the standard, replace valve and check the valve seat contact. Refer to [EM-100, "VALVE SEAT CONTACT"](#).

VALVE GUIDE CLEARANCE

Valve Stem Diameter

Measure the diameter of valve stem with micrometer.

Standard
Intake : 5.965 - 5.980 mm (0.2348 - 0.2354 in)
Exhaust : 5.955 - 5.970 mm (0.2344 - 0.2350 in)



Valve Guide Inner Diameter

Measure the inner diameter of valve guide with inside micrometer.

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

Valve Guide Clearance

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

Valve guide clearance:

Standard
Intake : 0.020 - 0.053 mm (0.0008 - 0.0021 in)
Exhaust : 0.030 - 0.063 mm (0.0012 - 0.0025 in)

Limit

Intake : 0.08 mm (0.003 in)
Exhaust : 0.09 mm (0.004 in)

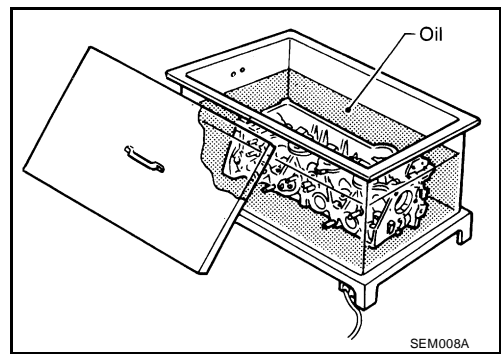
- If the calculated value exceeds the limit, replace valve and/or valve guide. When valve guide must be replaced, refer to [EM-98, "VALVE GUIDE REPLACEMENT"](#).

VALVE GUIDE REPLACEMENT

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

CYLINDER HEAD

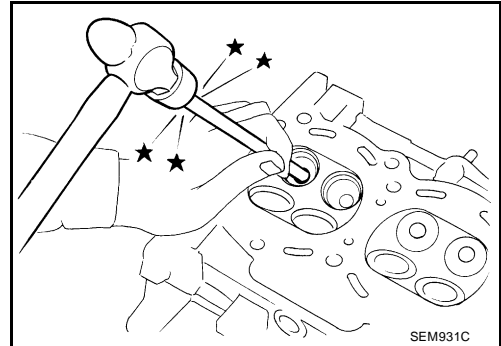
1. To remove valve guide, heat cylinder head to 110° to 130°C (230° to 266°F) by soaking in heated oil.



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 valve guide drift (commercial service tool).

CAUTION:

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

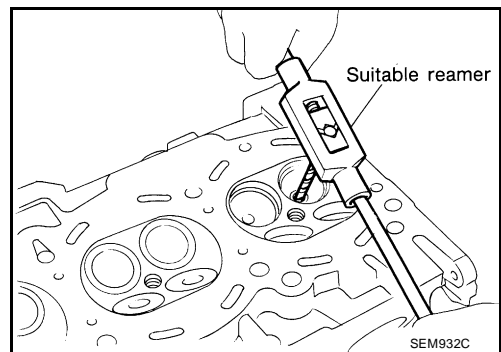


3. Ream cylinder head valve guide hole; using suitable reamer.

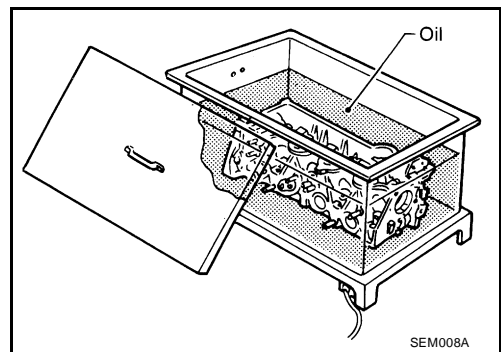
Valve guide hole diameter (for service parts):

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 the dimensions as shown using suitable tool.

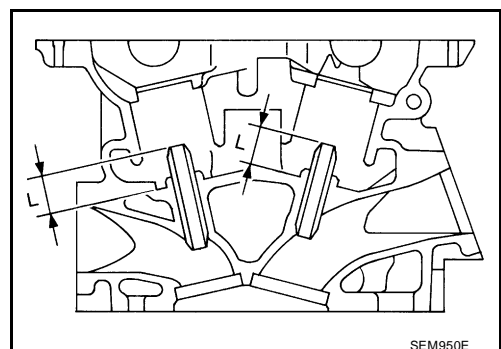
Projection "L"

Intake and exhaust

: 12.6 - 12.8 mm (0.496 - 0.504 in)

CAUTION:

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



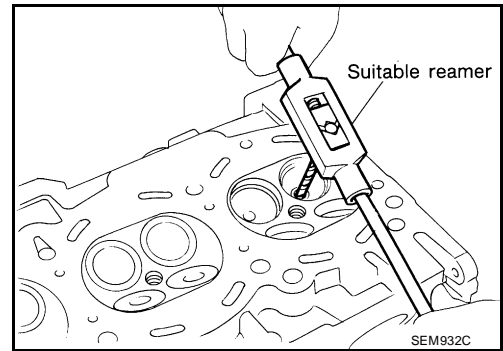
CYLINDER HEAD

6. Apply reamer finish to valve guide using suitable reamer.

Standard:

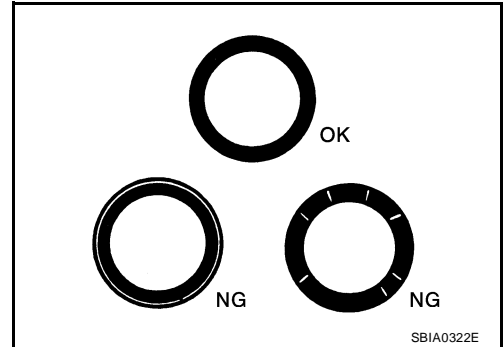
Intake and exhaust

: 6.000 - 6.018 mm (0.2362 - 0.2369 in)



VALVE SEAT CONTACT

- After confirming that the dimensions of valve guides and valves are within the specifications, perform this procedure.
- Apply prussian blue (or white lead) onto contacting surface of valve seat to check the condition of the valve contact on the surface.
- Check if the contact area band is continuous all around the circumference.
- If not, grind to adjust valve fitting and check again. If the contacting surface still has "NG" conditions even after the re-check, replace valve seat. Refer to [EM-100, "VALVE SEAT REPLACEMENT"](#).



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. Refer to [EM-136, "Valve Seat"](#).

CAUTION:

Prevent to scratch cylinder head by excessive boring.

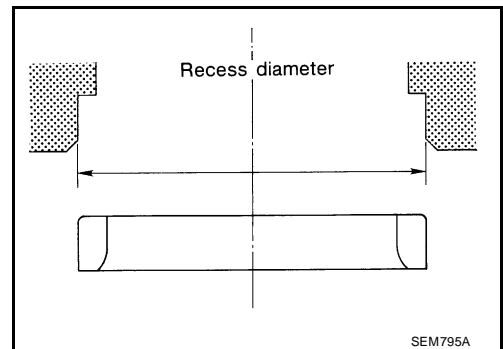
2. Ream cylinder head recess diameter for service valve seat.

Oversize [0.5 mm (0.020 in)]

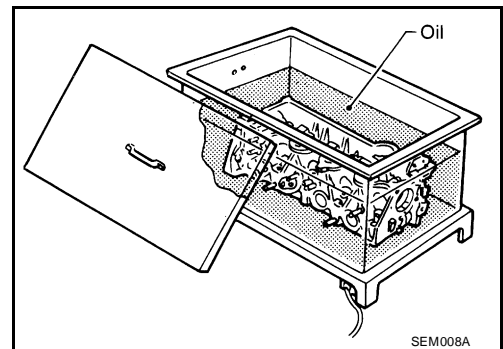
Intake : 38.500 - 38.516 mm (1.5157 - 1.5164 in)

Exhaust : 32.700 - 32.716 mm (1.2874 - 1.2880 in)

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

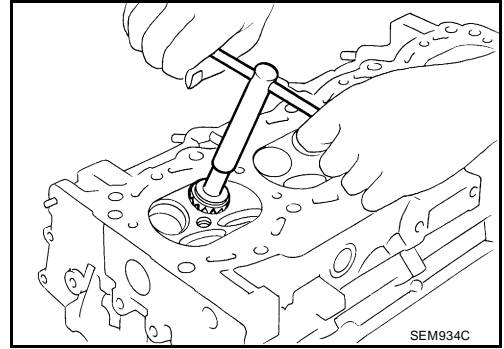
CYLINDER HEAD

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

5. Finish seat to the specified dimensions using suitable tool. Refer to [EM-136, "Valve Seat"](#).

CAUTION:

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



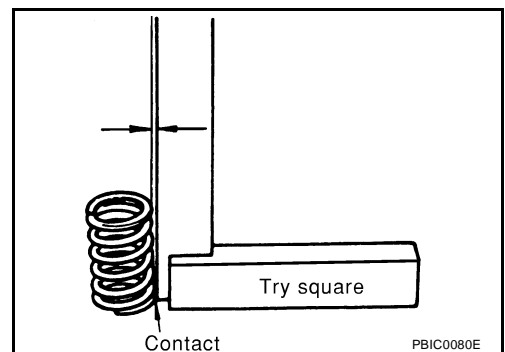
6. Using compound, grind to adjust valve fitting.
7. Check again for normal contact. Refer to [EM-100, "VALVE SEAT CONTACT"](#).

VALVE SPRING SQUARENESS

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

Limit : 2.1 mm (0.083 in)

- If it exceeds the limit, replace valve spring.



VALVE SPRING DIMENSIONS AND VALVE SPRING PRESSURE LOAD

- Check valve spring pressure at the specified spring height.

Standard:

Intake and exhaust

Free height

: 47.07 mm (1.8531 in)

Installation height

: 37.00 mm (1.4567 in)

Installation load

: 166 - 188 N (16.9 - 19.2 kg, 37 - 42 lb)

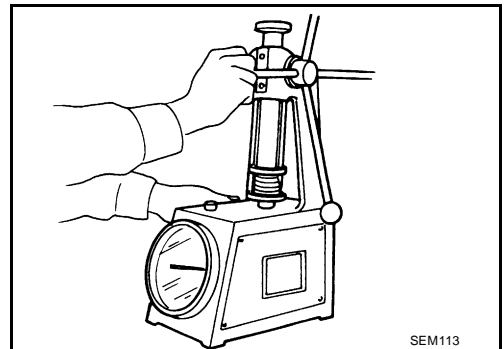
Height during valve open

: 27.20 mm (1.0709 in)

Load with valve open

: 373 - 421 N (38.0 - 42.9 kg, 84 - 95 lb)

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



ENGINE ASSEMBLY

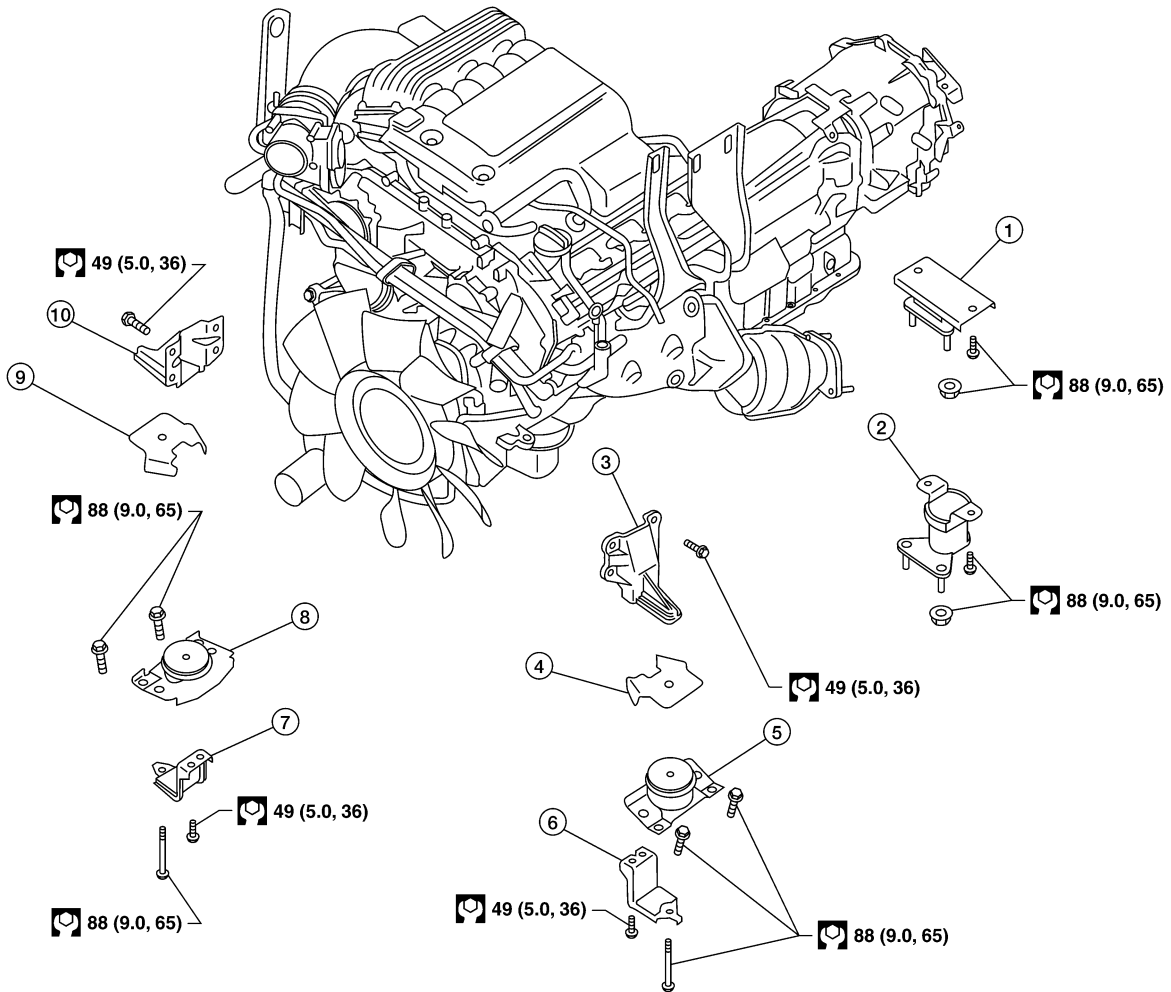
ENGINE ASSEMBLY


PF1:10001

Removal and Installation

EBS00NK7

SEC. 112



 : N·m (kg-m, ft-lb)

LBI/A0432E

- | | | |
|--|---|---------------------------------------|
| 1. Rear engine mounting insulator 4x4 | 2. Rear engine mounting insulator 4x2 | 3. LH engine mounting bracket (upper) |
| 4. LH heat shield plate | 5. LH engine mounting insulator | 6. LH engine mounting bracket (lower) |
| 7. RH engine mounting bracket (lower) | 8. RH engine mounting insulator (upper) | 9. RH heat shield plate |
| 10. RH engine mounting bracket (upper) | | |

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.

ENGINE ASSEMBLY

- Do not start working until exhaust system and engine coolant are cooled sufficiently.
- If items or work required are not covered by the engine section, refer to the applicable sections.
- Always use the support point specified for lifting.
- Use either 2-point lift type or separate type lift. If board-on type is used for unavoidable reasons, support at the rear axle jacking point with transmission jack or similar tool before starting work, in preparation for the backward shift of center of gravity.
- For supporting points for lifting and jacking point at rear axle, refer to [GI-40, "Garage Jack and Safety Stand"](#).

REMOVAL

Preparation

1. Drain engine coolant. Refer to [MA-13, "DRAINING ENGINE COOLANT"](#).
2. Partially drain A/T fluid. Refer to [MA-24, "Changing the Automatic Transmission Fluid \(ATF\)"](#).
3. Release fuel pressure. Refer to [EC-91, "FUEL PRESSURE RELEASE"](#).
4. Remove the engine hood. Refer to [BL-13, "Removal and Installation of Hood Assembly"](#).
5. Remove engine room cover using power tools.
6. Remove the air duct and air cleaner case assembly. Refer to [EM-15, "REMOVAL"](#).
7. Disconnect vacuum hose between vehicle and engine and set it aside.
8. Remove the radiator assembly and hoses. Refer to [CO-11, "REMOVAL"](#).
9. Remove the drive belts. Refer to [EM-13, "Removal"](#).
10. Remove the engine cooling fan. Refer to [CO-14, "ENGINE COOLING FAN"](#).
11. Disconnect the engine room harness from the engine side and set it aside for easier work.
12. Disconnect the engine harness grounds.
13. Disconnect the reservoir tank for power steering from engine and move it aside for easier work.
14. Disconnect power steering oil pump from engine. Move it from its location and secure with a rope for easier work. Refer to [PS-20, "REMOVAL"](#).
15. Remove the A/C compressor bolts and set aside. Refer to [ATC-158, "REMOVAL"](#) (ATC) or [MTC-101, "REMOVAL"](#) (MTC).
16. Disconnect brake booster vacuum line.
17. Disconnect EVAP line.
18. Disconnect the fuel hose at the engine side connection. Refer to [EM-34, "REMOVAL"](#).
19. Disconnect the heater hoses at cowl, and install plugs to avoid leakage of engine coolant.
20. Remove the A/T oil level indicator and indicator tube.
21. Remove front final drive assembly (4x4 only). Refer to [FFD-14, "REMOVAL"](#).
22. Remove three way catalyst. Refer to [EM-21, "Removal and Installation"](#).
23. Install engine slingers into left bank and right bank.

Engine slinger torque: 28.0 N·m (2.9 kg-m, 21 ft-lb)

24. Remove transmission. Refer to [AT-245, "Removal and Installation \(4x2\)"](#) or [AT-248, "Removal and Installation \(4x4\)"](#).
25. Lift with hoist and secure the engine in position.
26. Remove engine assembly from vehicle, avoiding interference with vehicle body.

CAUTION:

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

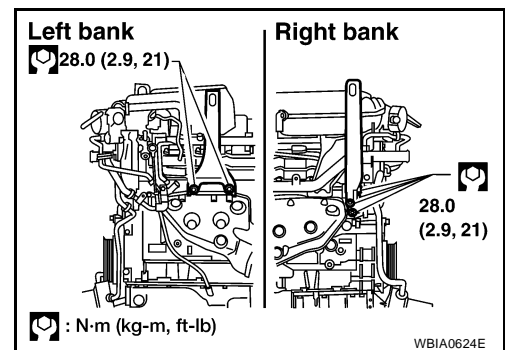
27. Remove the parts that may restrict installation of engine to engine stand.

NOTE:

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

- a. Remove drive plate.

- Holding crankshaft pulley bolts, lock crankshaft to remove drive plate bolts.

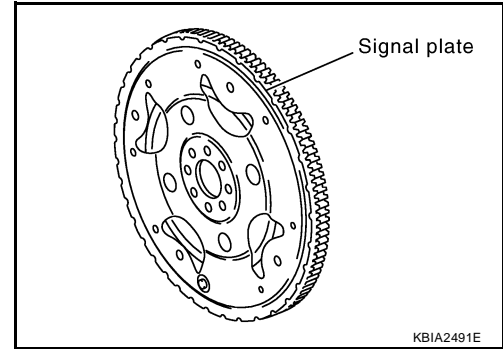


ENGINE ASSEMBLY

- Loosen bolts diagonally.

CAUTION:

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



CAUTION:

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

- If the load capacity of the stand is not adequate, remove the following parts beforehand to reduce the potential risk of overturning the stand.
 - Remove fuel tube and fuel injector assembly. Refer to [EM-34, "REMOVAL"](#) .
 - Remove intake manifold. Refer to [EM-19, "REMOVAL"](#) .
 - Remove rocker cover. Refer to [EM-40, "Removal and Installation"](#) .
 - Other removable brackets.

CAUTION:

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

28. Remove alternator. Refer to [SC-30, "REMOVAL"](#) .
29. Remove engine mounting insulator bracket (upper) with power tool.

INSTALLATION

Installation is in the reverse order of removal.

INSPECTION AFTER INSTALLATION

- Before starting engine, check the levels of engine coolant, engine oil and working fluid. If less than required quantity, fill to the specified level.
- Use procedure below to check for fuel leakage.
- Turn ignition switch ON (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of engine coolant, engine oil, working fluid, fuel and exhaust gas.
- Bleed air from passages in pipes and tubes of applicable lines, such as in cooling system.
- After cooling down engine, again check amounts of engine coolant, engine oil and working fluid. Refill to specified level, if necessary.
- Summary of the inspection items:

Item	Before starting engine	Engine running	After engine stopped
Engine coolant	Level	Leakage	Level
Engine oil	Level	Leakage	Level
Working fluid	Level	Leakage	Level
Fuel	Leakage	Leakage	Leakage
Exhaust gas	—	Leakage	—

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

CYLINDER BLOCK

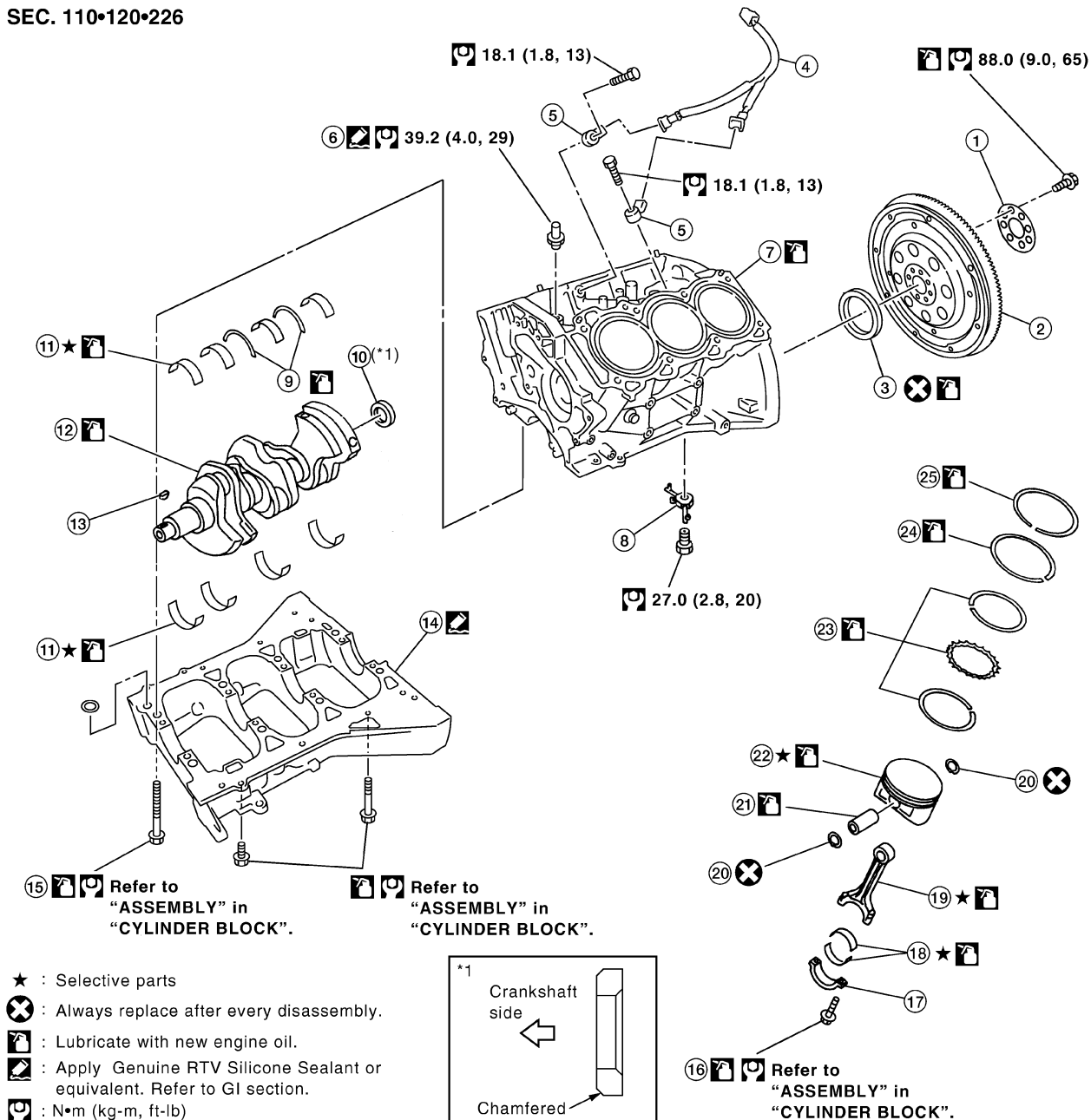
PFP:11010

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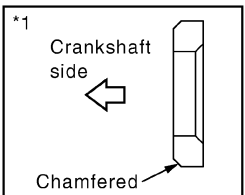
CYLINDER BLOCK

Disassembly and Assembly

SEC. 110•120•226



- ★ : Selective parts
- ⊗ : Always replace after every disassembly.
- 🛢️ : Lubricate with new engine oil.
- 🖌️ : Apply Genuine RTV Silicone Sealant or equivalent. Refer to GI section.
- 🔧 : N•m (kg-m, ft-lb)

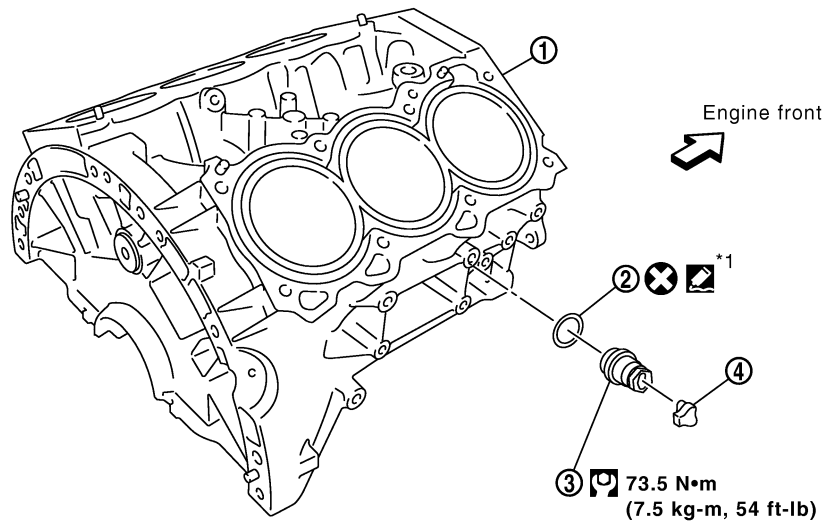


- | | | |
|----------------------------------|--------------------------------|-------------------------------|
| 1. Reinforcement plate | 2. Drive plate (A/T models) | 3. Rear oil seal |
| 4. Sub harness | 5. Knock sensor | 6. Water connector |
| 7. Cylinder block | 8. Oil jet | 9. Thrust bearing |
| 10. Pilot converter (A/T models) | 11. Main bearing | 12. Crankshaft |
| 13. Crankshaft key | 14. Lower cylinder block | 15. Lower cylinder block bolt |
| 16. Connecting rod bolt | 17. Connecting rod bearing cap | 18. Connecting rod bearing |
| 19. Connecting rod | 20. Snap ring | 21. Piston pin |
| 22. Piston | 23. Oil ring | 24. Second ring |
| 25. Top ring | | |

WBIA0582E

CYLINDER BLOCK

For Canada
SEC. 110



- Install cylinder block heater with heater part downward as shown in the figure.
- Remove liquid gasket completely after removing cylinder block heater.

: Apply Anaerobic Liquid Gasket or equivalent. Refer to GI section.

*1 Sealing point : Front and reverse side.

: Always replace after every disassembly.

PBIC2936E

1. Cylinder block

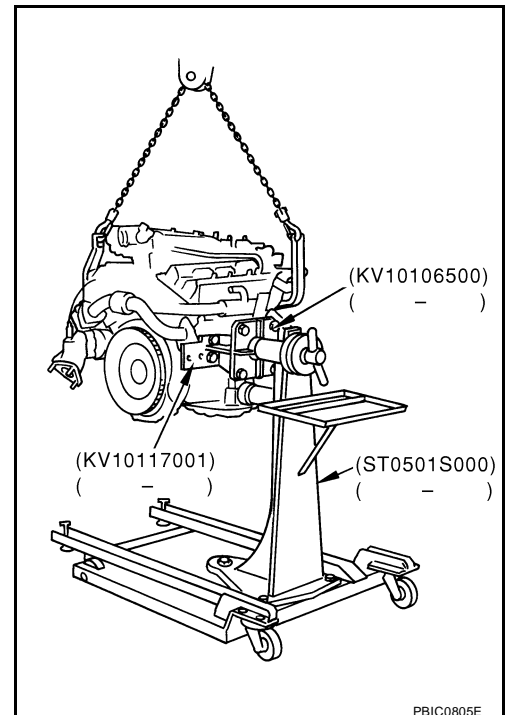
2. Gasket

3. Cylinder block heater

4. Connector protector cap

DISASSEMBLY

1. Remove engine assembly from vehicle. Refer to [EM-103, "REMOVAL"](#) .
2. Remove both exhaust manifolds. Refer to [EM-21, "Removal and Installation"](#) .
3. Lift engine, and mount it onto engine stand.



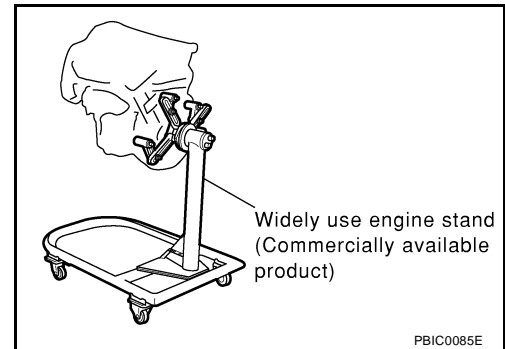
PBIC0805E

CYLINDER BLOCK

- A widely use engine stand can be used.

CAUTION:

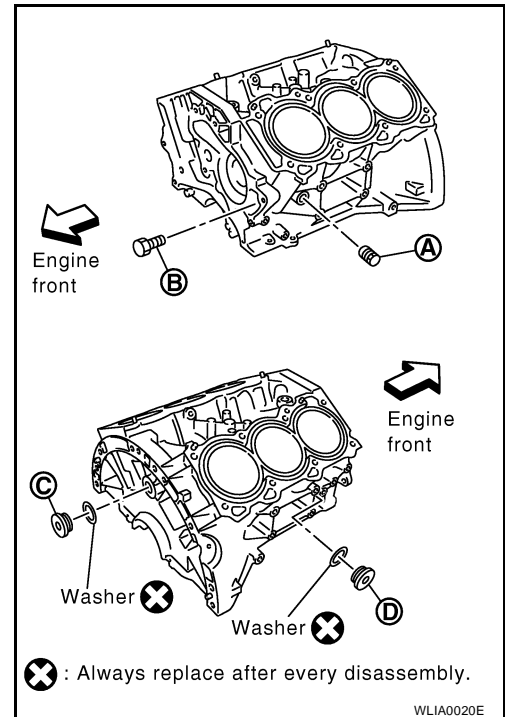
Use engine stand that has a load capacity [approximately 220 kg (441 lb) or more] large enough for supporting the engine weight.



4. Drain engine oil. Refer to [LU-8, "Changing Engine Oil"](#) .
5. Drain engine coolant by removing water drain plugs from cylinder block left side at "A" and cylinder block front side at "B" as shown in the figure.

NOTE:

For Canada, "D" in the figure is not plug but block heater.



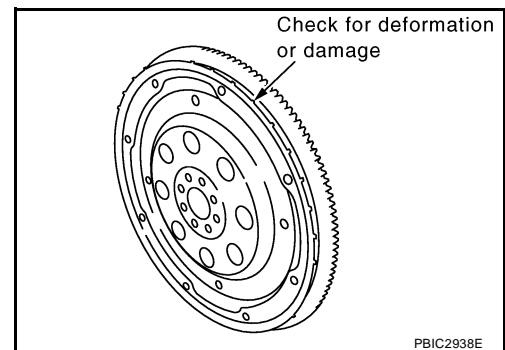
6. Remove drive plate (A/T models); using Tool.

Tool number : KV10117700 (J-44716)

- Loosen bolts in diagonal order.
- Use TORX socket for drive plate bolts.

CAUTION:

- Do not disassemble drive plate (A/T models).
- Do not place drive plate (A/T models) with signal plate facing down.
- When handling signal plate, take care not to damage or scratch it.
- Handle signal plate in a manner that prevents it from becoming magnetized.



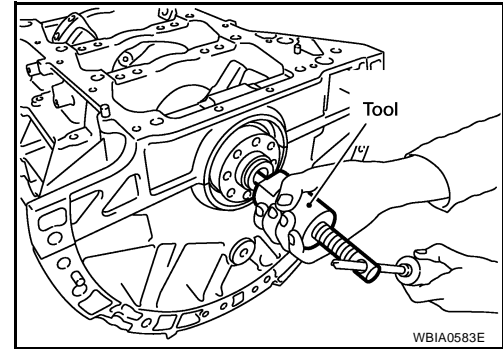
7. Remove cylinder head. Refer to [EM-92, "REMOVAL"](#) .
8. Remove sub harness, and remove knock sensors.

CYLINDER BLOCK

CAUTION:
Carefully handle sensor avoiding shocks.

9. Remove pilot converter (A/T models) using Tool as necessary.

Tool number : ST16610001 (J-23907)



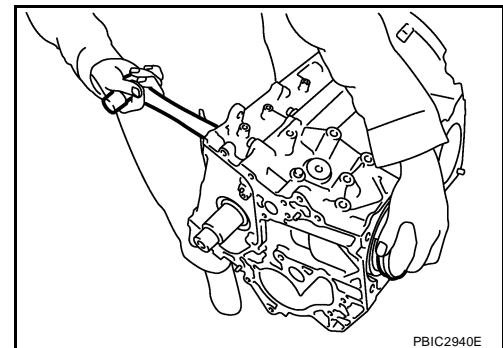
10. Remove piston and connecting rod assembly as follows:

- Before removing piston and connecting rod assembly, check the connecting rod side clearance. Refer to [EM-121, "CONNECTING ROD SIDE CLEARANCE"](#).

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

11. Position crankshaft pin corresponding to connecting rod to be removed onto the bottom dead center.
12. Remove connecting rod bearing cap.
13. Push piston and connecting rod assembly out to the cylinder head side using suitable tool.

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



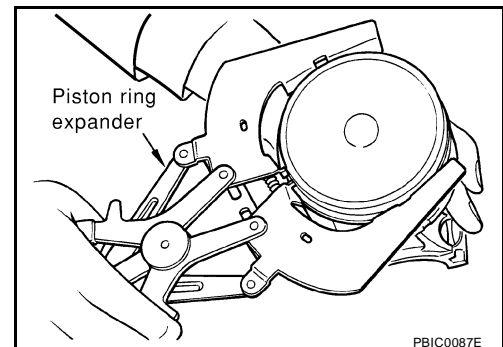
14. Remove connecting rod bearings from connecting rod and connecting rod bearing cap.

CAUTION:
Identify installation position, and store them without mixing them up.

15. Remove piston rings from piston.

- Before removing piston rings, check the piston ring side clearance. Refer to [EM-122, "PISTON RING SIDE CLEARANCE"](#).
- Remove piston rings using piston ring expander or suitable tool.

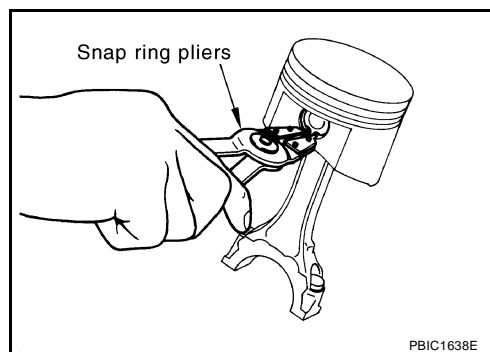
CAUTION:
● When removing piston rings, be careful not to damage piston.
● Be careful not to damage piston rings by expanding them excessively.



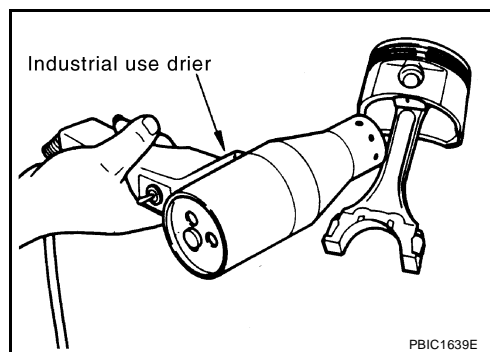
16. Remove piston from connecting rod as follows:

CYLINDER BLOCK

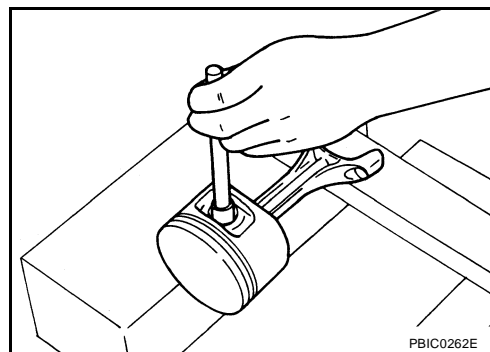
- a. Remove snap ring using snap ring pliers.



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



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

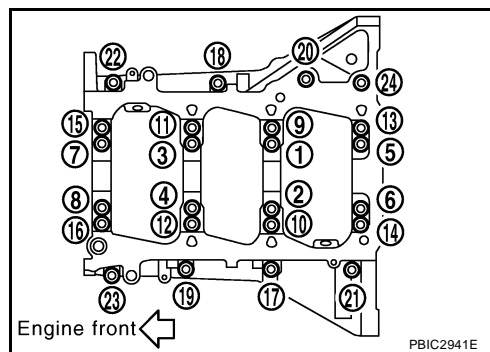


17. Remove lower cylinder block bolts.

- Before loosening lower cylinder block bolts, measure the crankshaft end play. Refer to [EM-121, "CRANKSHAFT END PLAY"](#).
- Loosen lower cylinder block bolts in reverse order as shown in several different steps.

NOTE:

Use TORX socket (size E14) for bolts No. 1 to 16 (M10 bolt).



18. Remove lower cylinder block.

- Cut liquid gasket for removal. Refer to [EM-5, "REMOVAL OF LIQUID GASKET SEALING"](#).

Tool number : KV10111100 (J-37228)

CAUTION:

Be careful not to damage the mounting surfaces.

19. Remove crankshaft.

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CYLINDER BLOCK

20. Pull rear oil seal out from rear end of crankshaft.

NOTE:

When replacing rear oil seal without removing lower cylinder block, use a suitable to pull the rear oil seal installed between crankshaft and cylinder block out.

CAUTION:

Be careful not to damage crankshaft and cylinder block.

21. Remove main bearings and thrust bearings from cylinder block and lower cylinder block.

CAUTION:

- Be careful not to drop main bearing, and to scratch the surface.
- Identify installation positions, and store them without mixing them up.

22. Remove oil jet.

ASSEMBLY

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

CAUTION:

Use a goggles to protect your eye.

2. Install each plug to cylinder block as shown.

- Apply sealant to the thread of water drain plugs "A" and "B".
Use Genuine RTV Silicone Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#)

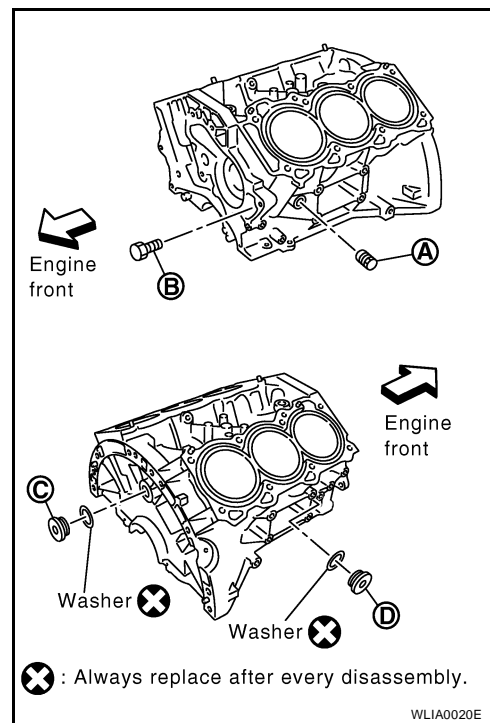
- Apply sealant to the thread of plugs "C".
Use Genuine High Strength Thread Locking Sealant or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#)

- Apply sealant to the thread of plug "D".
Use Anaerobic Liquid Gasket or equivalent. Refer to [GI-45, "Recommended Chemical Products and Sealants"](#)

NOTE:

For Canada, "D" in the figure is not plug but block heater. Refer to [EM-105, "Disassembly and Assembly"](#)

- Replace washers with new one.



- Tighten each plug as specified below.

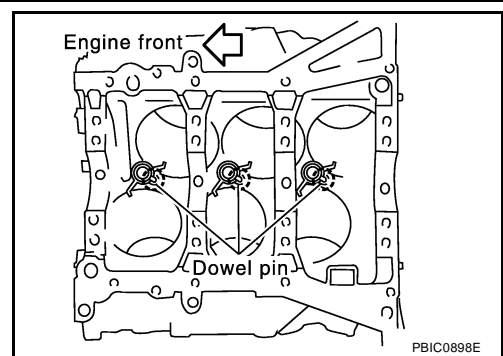
Block Plug and Block Heater Installation

Part	Washer	Tightening Torque
A	No	19.6 N·m (2.0 kg-m, 14 ft-lb)
B	Reuse	9.8 N·m (1.0 kg-m, 87 in-lb)
	New	6.0 N·m (0.61 kg-m, 53 in-lb)
C	Yes	116 N·m (11.8 kg-m, 85 ft-lb)
D	Plug	62 N·m (6.3 kg-m, 46 ft-lb)
	Block heater	73.5 N·m (7.5 kg-m, 54 ft-lb)

3. Install oil jet.

CYLINDER BLOCK

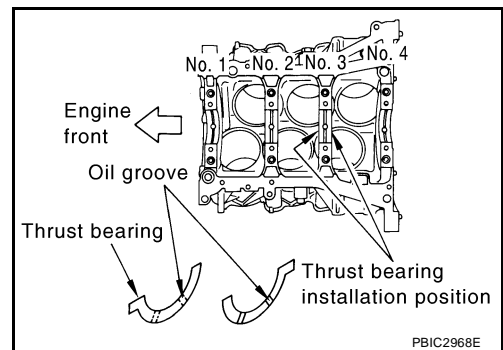
- Insert oil jet dowel pin into cylinder block dowel pin hole, and tighten bolts.



4. Install main bearings and thrust bearings as follows:

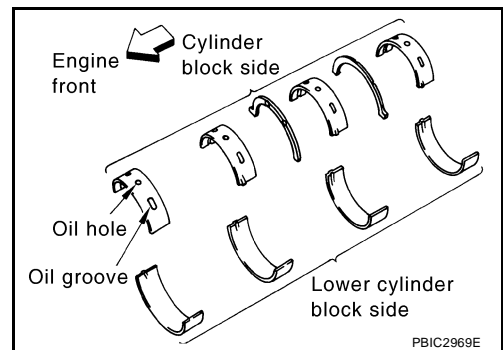
- Remove dust, dirt, and engine oil on bearing mating surfaces of cylinder block and main bearing caps.
- Install thrust bearings to the both sides of the No. 3 journal housing on cylinder block.

- Install thrust bearings with the oil groove facing crankshaft arm (outside).
- Install thrust bearing with a projection on one end on cylinder block, Align projection with mating notch.



c. Install main bearings paying attention to the direction.

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



5. Install crankshaft to cylinder block.

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

6. Inspect the outer diameter of lower cylinder block bolt. Refer to [EM-129, "LOWER CYLINDER BLOCK BOLT OUTER DIAMETER"](#).

7. Install lower cylinder block as follows:

NOTE:

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

- Apply a continuous bead of liquid gasket using Tool to lower cylinder block as shown.

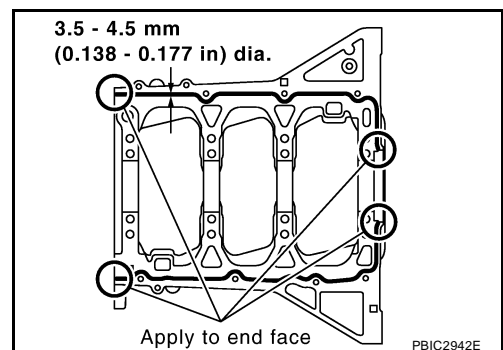
Tool number : WS39930000 (—)

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

CAUTION:

After liquid gasket is applied, rear oil seal installation must be finished within 5 minutes. Therefore, the following procedure must be performed quickly.

- Tighten lower cylinder block as follows:



CYLINDER BLOCK

- i. Apply new engine oil to threads and seat surfaces of the bolts.
- ii. Tighten M8 bolts in numerical order as shown from No. 17 to 24.

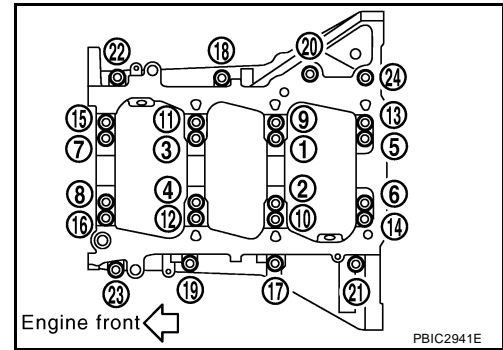
Bolts 17 - 24 : 22.1 N-m (2.3 kg-m, 16 ft-lb)

CAUTION:

Wipe off completely any protruding liquid gasket on rear oil seal installation surface.

NOTE:

There are more processes to complete the tightening bolts. However stop procedure here to install rear oil seal.

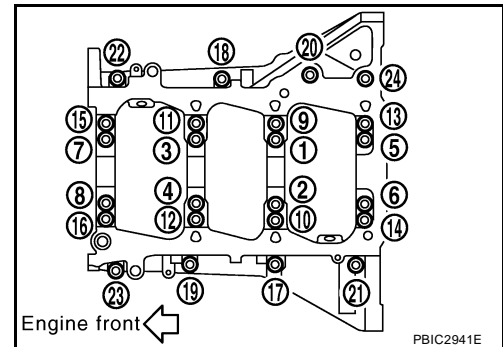


- c. Install rear oil seal. Refer to [EM-90, "INSTALLATION"](#).
- d. Restart tightening of lower cylinder block bolts as follows:
- i. Tighten M10 bolts in numerical order as shown from No. 1 to 16.

NOTE:

Use TORX socket (size E14) for bolts No. 1 to 16 (M10 bolt).

Bolts 1 - 16 : 35.3 N-m (3.6 kg-m, 26 ft-lb)

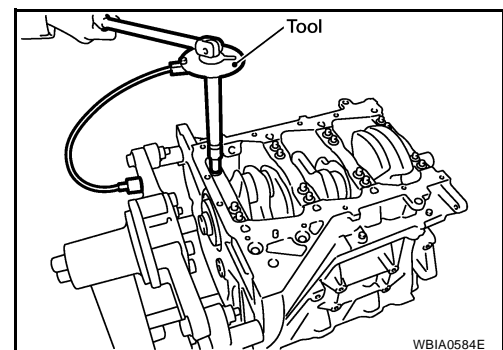


- ii. Turn M10 bolts 90° clockwise in numerical order from No. 1 to 16 using Tool.

Tool number : KV10112100 (BT-8653-A)

CAUTION:

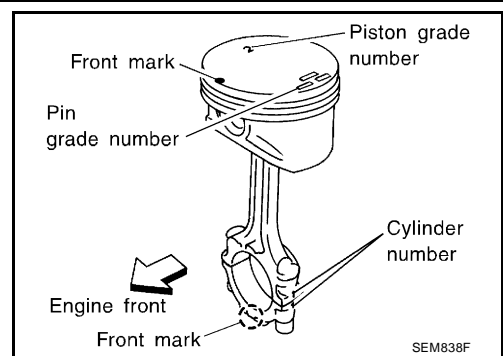
Use angle wrench Tool to check tightening angle. Do not make judgement by visual inspection.



- After installing the bolts, make sure that crankshaft can be rotated smoothly by hand.
 - Wipe off completely any protruding liquid gasket on front side of the engine.
 - Check the crankshaft end play. Refer to [EM-121, "CRANKSHAFT END PLAY"](#).
8. Inspect the outer diameter of connecting rod bolt. Refer to [EM-130, "CONNECTING ROD BOLT OUTER DIAMETER"](#).
 9. Install piston to connecting rod as follows:
 - a. Install new snap ring to the groove of piston rear side using suitable tool.
 - Insert it fully into groove to install.
 - b. Install piston to connecting rod.
 - Using industrial use drier or similar tool, heat piston until 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 piston pin into piston and connecting rod.

CYLINDER BLOCK

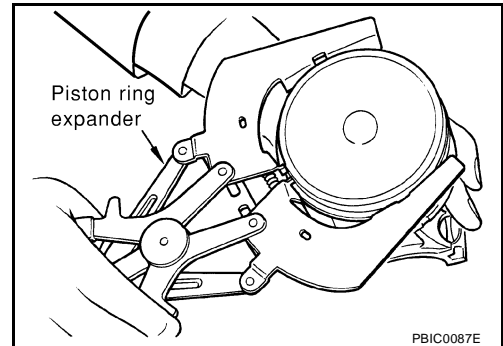
- Assemble so that the front mark on the piston head and the cylinder number on connecting rod are positioned as shown.
- c. Install new snap ring to the groove of the piston front side.
- Insert it fully into groove to install.
 - After installing, make sure that connecting rod moves smoothly.



10. Install piston rings using piston ring expander or suitable tool.

CAUTION:

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



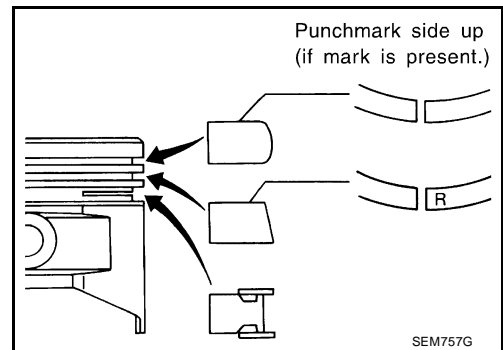
- If there is stamped mark on ring, mount it with marked side up.

NOTE:

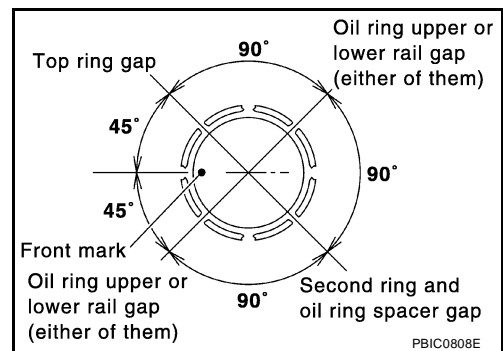
If there is no stamp on ring, no specific orientation is required for installation.

Stamped mark:

- Top ring : —
- Second ring : R



- Position each ring with the gap as shown referring to the piston front mark.



- Check the piston ring side clearance. Refer to [EM-122, "PISTON RING SIDE CLEARANCE"](#) .

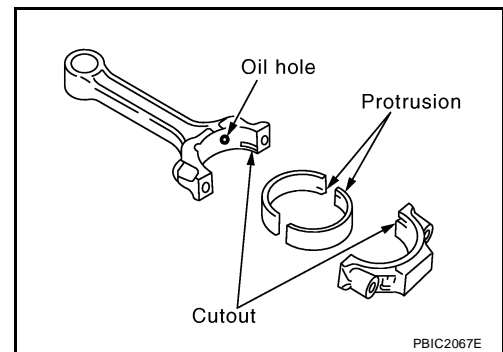
11. Install connecting rod bearings to connecting rod and connecting rod bearing cap.

- Before installing connecting rod bearings, apply engine oil to the bearing surface (inside). Do not apply engine oil to the back surface, but thoroughly clean it.

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CYLINDER BLOCK

- When installing, align connecting rod bearing stopper protrusion with cutout of connecting rods and connecting rod bearing caps to install.
- Ensure the oil hole on connecting rod and that on the corresponding bearing are aligned.



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

NOTE:

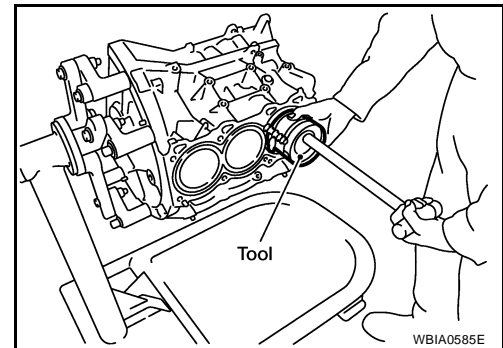
Be sure that front mark on piston head is facing front of engine.

16. Install piston with the front mark on the piston head facing the front of engine using Tool.

Tool number : EM03470000 (J-8037)

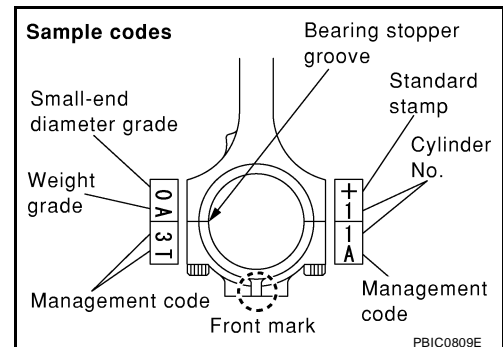
CAUTION:

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



17. Install connecting rod bearing cap.

- Match the stamped cylinder number marks on connecting rod with those on connecting rod bearing cap to install.
- Be sure that front mark on connecting rod bearing cap is facing front of engine.



18. Tighten connecting rod bolts as follows:
 - a. Apply engine oil to the threads and seats of connecting rod bolts.
 - b. Tighten connecting rod bolts.

Connecting rod bolt : 19.6 N-m (2.0 kg-m, 14 ft-lb)

CYLINDER BLOCK

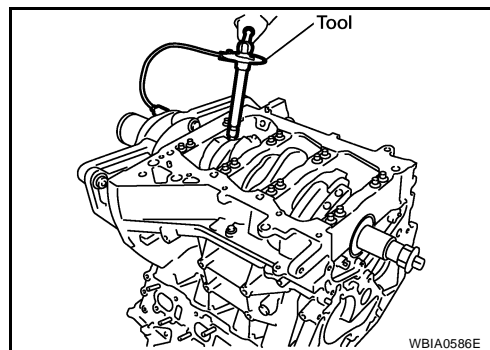
c. Then tighten all connecting rod bolts 90° clockwise.

CAUTION:

Always use Tool. Avoid tightening based on visual check alone.

Tool number : KV10112100 (BT-8653-A)

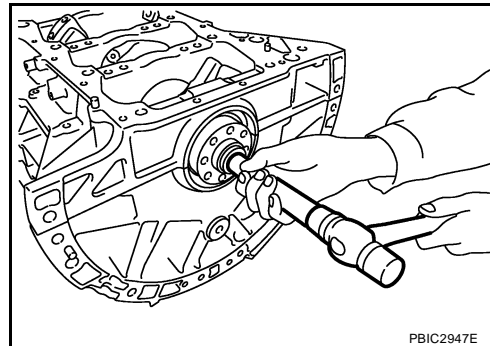
- After tightening connecting rod bolts, make sure that crankshaft rotates smoothly.
- Check the connecting rod side clearance. Refer to [EM-121, "CONNECTING ROD SIDE CLEARANCE"](#).



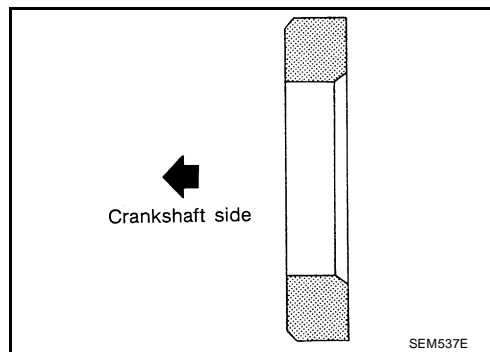
19. Install pilot converter (A/T models).

- With drift of the following outer diameter, press-fit as far as it will go.

Pilot converter : Approx. 33 mm (1.30 in)



- Press-fit pilot converter with its chamfer facing crankshaft as shown. (A/T models)



20. Install knock sensors.

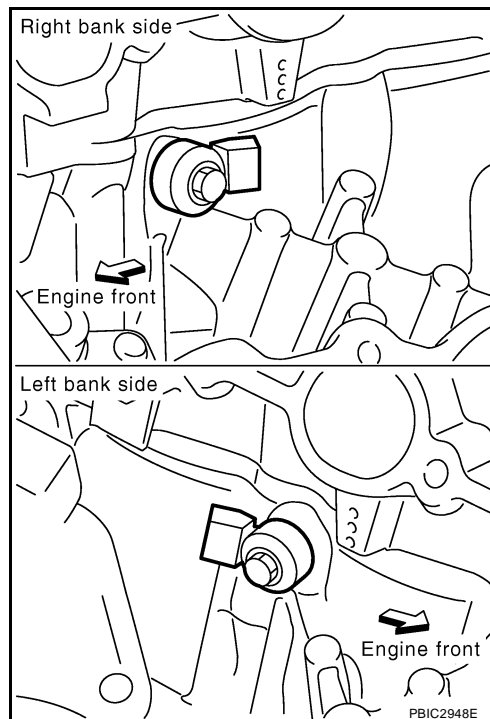
- Install knock sensor so that connector faces rear of engine.
- After installing knock sensor, connect harness connector, and lay it out to rear of engine.

CAUTION:

- **Do not tighten bolts while holding connector.**
- **If any impact by dropping is applied to knock sensor, replace it with new one.**

NOTE:

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



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CYLINDER BLOCK

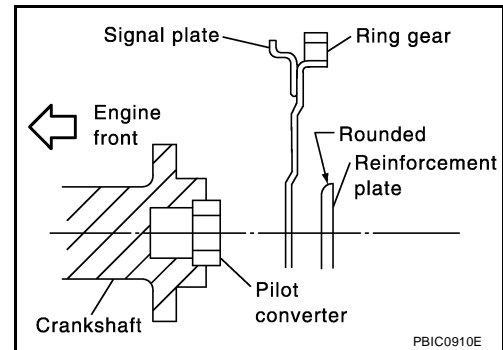
21. Assemble in the reverse order of disassembly after this step.

Drive plate (A/T models)

- Install drive plate and reinforcement plate as shown.
- Holding ring gear using Tool.

Tool number : KV10117700 (J-44716)

- Tighten bolts crosswise over several times.



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How to Select Piston and Bearing DESCRIPTION

Selection points	Selection parts	Selection items	Selection methods
Between cylinder block and crankshaft	Main bearing	Main bearing grade (bearing thickness)	Determined by match of cylinder block bearing housing grade (inner diameter of housing) and crankshaft journal grade (outer diameter of journal)
Between crankshaft and connecting rod	Connecting rod bearing	Connecting rod bearing grade (bearing thickness)	Combining service grades for connecting rod big end diameter and crankshaft pin outer diameter determine connecting rod bearing selection.
Between cylinder block and piston	Piston and piston pin assembly (Piston is available together with piston pin as assembly.)	Piston grade (piston skirt diameter)	Piston grade = cylinder bore grade (inner diameter of bore)
Between piston and connecting rod*	—	—	—

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

- The identification grade stamped on each part is the grade for the dimension measured in new condition. This grade cannot apply to reused parts.
- For reused or repaired parts, measure the dimension accurately. Determine the grade by comparing the measurement with the values of each selection table.
- For details of the measurement method of each part, the reuse standards and the selection method of the selective fitting parts, refer to the text.

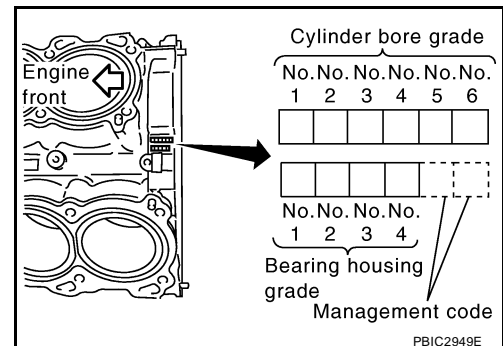
HOW TO SELECT PISTON

When New Cylinder Block is Used

Check the cylinder bore grade ("1", "2", or "3") on rear side of cylinder block, and select piston of the same grade.

NOTE:

Piston is available with piston pin as a set for the service part. (Only "0" grade piston pin is available.)

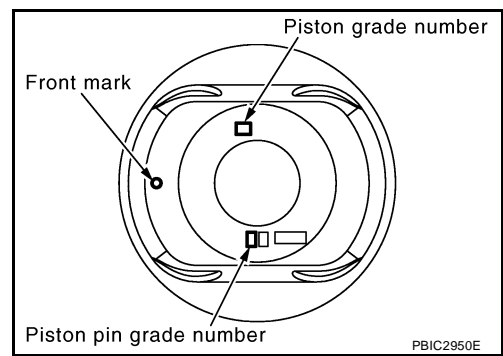


When Cylinder Block is Reused

1. Measure the cylinder bore inner diameter. Refer to [EM-125, "Cylinder Bore Inner Diameter"](#) .

CYLINDER BLOCK

- Determine the bore grade by comparing the measurement with the values under the cylinder bore inner diameter of the "Piston Selection Table".



- Select piston of the same grade.

Piston Selection Table

Unit: mm (in)

Grade	1	2 (or no mark)	3
Cylinder bore inner diameter	95.500 - 95.510 (3.7598 - 3.7602)	95.510 - 95.520 (3.7602 - 3.7606)	95.520 - 95.530 (3.7606 - 3.7610)
Piston skirt diameter	95.480 - 95.490 (3.7590 - 3.7594)	95.490 - 95.500 (3.7594 - 3.7598)	95.500 - 95.510 (3.7598 - 3.7602)

NOTE:

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

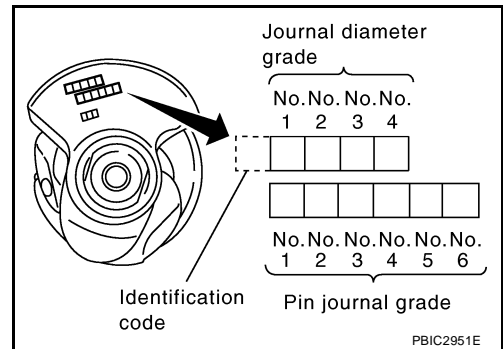
HOW TO SELECT CONNECTING ROD BEARING

When New Connecting Rod and Crankshaft are Used

Check pin journal grade ("0", "1", or "2") on front of crankshaft, and select connecting rod bearing of the same grade.

NOTE:

There is no grading for connecting rod big end diameter.



When Crankshaft and Connecting Rod are Reused

- Measure the connecting rod big end diameter. Refer to [EM-123, "CONNECTING ROD BIG END DIAMETER"](#).
- Make sure that the connecting rod big end diameter is within the standard value.
- Measure the crankshaft pin journal diameter. Refer to [EM-127, "CRANKSHAFT PIN JOURNAL DIAMETER"](#).
- Determine the grade of crankshaft pin journal grade by corresponding to the measured dimension in "Crankshaft pin journal diameter" column of "Connecting Rod Bearing Selection Table".
- Select connecting rod bearing of the same grade.

Connecting Rod Bearing Selection Table

Unit: mm (in)

Connecting rod big end diameter	57.000 - 57.013 (2.2441 - 2.2446)
---------------------------------	-----------------------------------

CYLINDER BLOCK

Unit: mm (in)

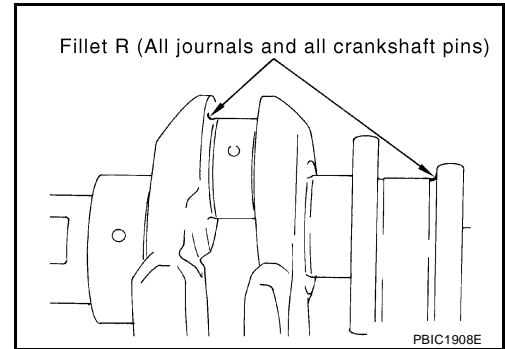
Crankshaft		Connecting rod bearing		
Crankshaft pin journal diameter	Grade (Mark)	Dimension (Bearing thickness range)	Bearing grade No.	Color
53.968 - 53.974 (2.1247 - 2.1250)	0	1.500 - 1.503 (0.0591 - 0.0592)	STD 0	Black
53.962 - 53.968 (2.1245 - 2.1247)	1	1.503 - 1.506 (0.0592 - 0.0593)	STD 1	Brown
53.956 - 53.962 (2.1242 - 2.1245)	2	1.506 - 1.509 (0.0593 - 0.0594)	STD 2	Green

Undersize Bearings Usage Guide

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

CAUTION:

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



Bearing undersize table

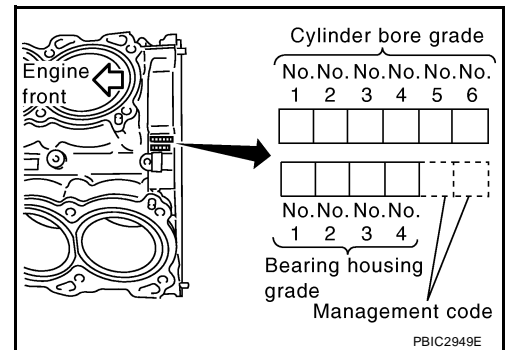
Unit: mm (in)

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

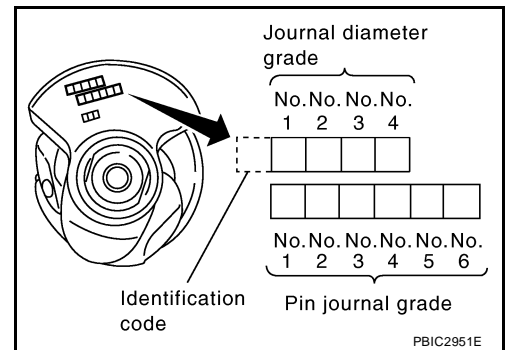
HOW TO SELECT MAIN BEARING

When New Cylinder Block and Crankshaft are Used

1. "Main Bearing Selection Table" rows correspond to bearing housing grade on rear left side of cylinder block.



2. "Main Bearing Selection Table" columns correspond to journal diameter grade on front side of crankshaft.



CYLINDER BLOCK

- Select main bearing grade at the point where selected row and column meet in "Main Bearing Selection Table".

When Cylinder Block and Crankshaft are Reused

- Measure cylinder block main bearing housing inner diameter and crankshaft main journal diameter. Refer to [EM-125, "MAIN BEARING HOUSING INNER DIAMETER"](#) and [EM-126, "CRANKSHAFT MAIN JOURNAL DIAMETER"](#).
- Correspond the measured dimension in "Cylinder block main bearing housing inner diameter" row of "Main Bearing Selection Table".
- Correspond the measured dimension in "Crankshaft main journal diameter" column of "Main Bearing Selection Table".
- Select main bearing grade at the point where selected row and column meet in following selection table.

Main Bearing Selection Table

<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p style="text-align: center;">Cylinder block main bearing housing inner diameter Unit: mm (in)</p> </div> <div style="width: 45%; border-left: 1px solid black;"> <p style="text-align: center;">Hole diameter</p> </div> </div>		Mark																													
		A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	4	7						
Mark	Axle diameter																														
A	69.975 - 69.974 (2.7549 - 2.7549)	0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34						
B	69.974 - 69.973 (2.7549 - 2.7548)	0	0	01	01	01	1	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4					
C	69.973 - 69.972 (2.7548 - 2.7548)	0	01	01	01	1	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4					
D	69.972 - 69.971 (2.7548 - 2.7548)	01	01	01	1	1	1	1	12	12	12	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4					
E	69.971 - 69.970 (2.7548 - 2.7547)	01	01	1	1	1	1	12	12	12	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	45					
F	69.970 - 69.969 (2.7547 - 2.7547)	01	1	1	1	1	12	12	12	2	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45				
G	69.969 - 69.968 (2.7547 - 2.7546)	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	4	45	45	45				
H	69.968 - 69.967 (2.7546 - 2.7546)	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5				
J	69.967 - 69.966 (2.7546 - 2.7546)	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5				
K	69.966 - 69.965 (2.7546 - 2.7545)	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	5				
L	69.965 - 69.964 (2.7545 - 2.7545)	12	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				
M	69.964 - 69.963 (2.7545 - 2.7544)	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				
N	69.963 - 69.962 (2.7544 - 2.7544)	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	56				
P	69.962 - 69.961 (2.7544 - 2.7544)	2	2	23	23	23	3	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	6				
R	69.961 - 69.960 (2.7544 - 2.7543)	2	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6				
S	69.960 - 69.959 (2.7543 - 2.7543)	23	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6				
T	69.959 - 69.958 (2.7543 - 2.7542)	23	23	3	3	3	34	34	34	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6	67				
U	69.958 - 69.957 (2.7542 - 2.7542)	23	3	3	3	34	34	34	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6	67	67			
V	69.957 - 69.956 (2.7542 - 2.7542)	3	3	3	34	34	34	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6	67	67			
W	69.956 - 69.955 (2.7542 - 2.7541)	3	3	34	34	34	4	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6	67	67	7		
X	69.955 - 69.954 (2.7541 - 2.7541)	3	34	34	34	4	4	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6	67	67	7	7	
Y	69.954 - 69.953 (2.7541 - 2.7540)	34	34	34	4	4	4	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6	67	67	7	7	
4	69.953 - 69.952 (2.7540 - 2.7540)	34	34	4	4	4	4	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6	67	67	7	X	
7	69.952 - 69.951 (2.7540 - 2.7540)	34	4	4	4	4	4	4	4	4	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	6	67	67	7	X	X

WBIA0625E

CYLINDER BLOCK

Main Bearing Grade Table (All Journals)

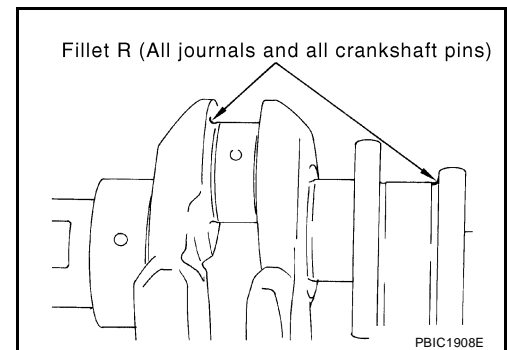
Grade number		Thickness Unit: mm (in)	Width Unit: mm (in)	Identification color	Remarks
0		2.500 - 2.503 (0.0984 - 0.0985)	19.9 - 20.1 (0.783 - 0.791)	Black	Grade is the same for upper and lower bearings.
1		2.503 - 2.506 (0.0985 - 0.0987)		Brown	
2		2.506 - 2.509 (0.0987 - 0.0988)		Green	
3		2.509 - 2.512 (0.0988 - 0.0989)		Yellow	
4		2.512 - 2.515 (0.0989 - 0.0990)		Blue	
5		2.515 - 2.518 (0.0990 - 0.0991)		Pink	
6		2.518 - 2.521 (0.0991 - 0.0993)		Purple	
7		2.521 - 2.524 (0.0993 - 0.0994)		White	Grade is different for upper and lower bearings.
01	UPR	2.503 - 2.506 (0.0985 - 0.0987)		Brown	
	LWR	2.500 - 2.503 (0.0984 - 0.0985)		Black	
12	UPR	2.506 - 2.509 (0.0987 - 0.0988)		Green	
	LWR	2.503 - 2.506 (0.0985 - 0.0987)		Brown	
23	UPR	2.509 - 2.512 (0.0988 - 0.0989)		Yellow	
	LWR	2.506 - 2.509 (0.0987 - 0.0988)		Green	
34	UPR	2.512 - 2.515 (0.0989 - 0.0990)	Blue		
	LWR	2.509 - 2.512 (0.0988 - 0.0989)	Yellow		
45	UPR	2.515 - 2.518 (0.0990 - 0.0991)	Pink		
	LWR	2.512 - 2.515 (0.0989 - 0.0990)	Blue		
56	UPR	2.518 - 2.521 (0.0991 - 0.0993)	Purple		
	LWR	2.515 - 2.518 (0.0990 - 0.0991)	Pink		
67	UPR	2.521 - 2.524 (0.0993 - 0.0994)	White		
	LWR	2.518 - 2.521 (0.0991 - 0.0993)	Purple		

Undersize Bearing Usage Guide

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

CAUTION:

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



Bearing undersize table

Unit: mm (in)

Size	Thickness
US 0.25 (0.0098)	2.633 - 2.641 (0.1037 - 0.1040)

CYLINDER BLOCK

EBS00NKA

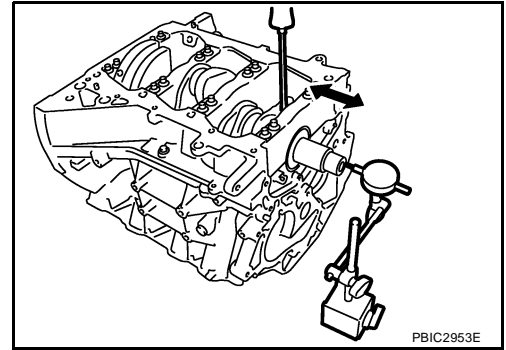
Inspection After Disassembly CRANKSHAFT END PLAY

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

Standard : 0.14 - 0.22 mm (0.0055 - 0.0087 in)

Limit : 0.30 mm (0.0118 in)

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



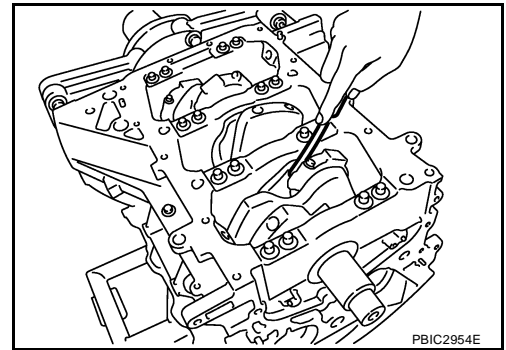
CONNECTING ROD SIDE CLEARANCE

- Measure the side clearance between connecting rod and crankshaft arm with 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 limit, replace connecting rod, and measure again. If it still exceeds the limit, replace crankshaft also.

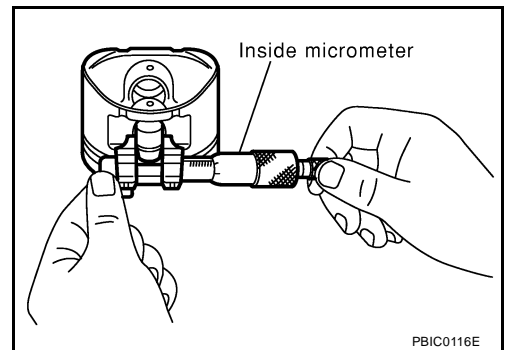


PISTON TO PISTON PIN OIL CLEARANCE

Piston Pin Hole Diameter

Measure the inner diameter of piston pin hole with inside micrometer.

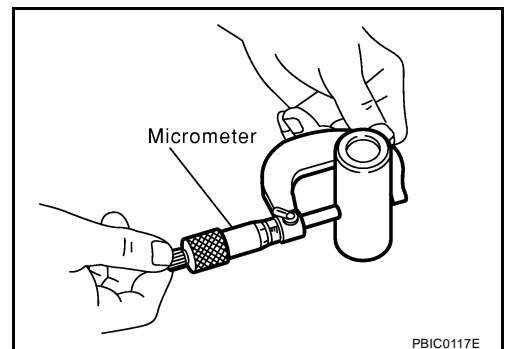
Standard : 21.993 - 22.005 mm (0.8659 - 0.8663 in)



Piston Pin Outer Diameter

Measure the outer diameter of piston pin with micrometer.

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



Piston to Piston Pin Oil Clearance

(Piston to piston pin oil clearance) = (Piston pin hole diameter) – (Piston pin outer diameter)

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

- If the calculated value is out of the standard, replace piston and piston pin assembly.

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

CYLINDER BLOCK

- When replacing piston and piston pin assembly, refer to [EM-116, "HOW TO SELECT PISTON"](#).

NOTE:

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

PISTON RING SIDE CLEARANCE

- Measure 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)

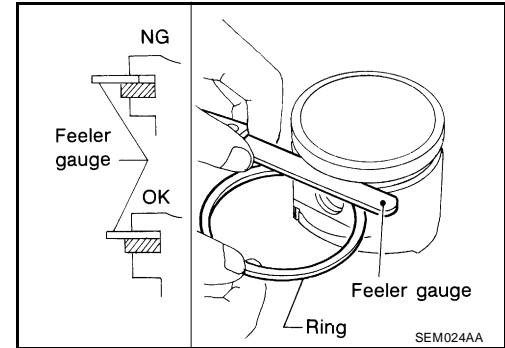
2nd ring : 0.030 - 0.070 mm (0.0012 - 0.0028 in)

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

PISTON RING END GAP

- Make sure that the cylinder bore inner diameter is within the specification. Refer to [EM-125, "Cylinder Bore Inner Diameter"](#).
- Lubricate with new engine oil to piston and piston ring, and then insert piston ring until middle of cylinder with piston, and measure the piston ring end gap with feeler gauge.

Standard:

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

2nd ring : 0.33 - 0.48 mm (0.0130 - 0.0189 in)

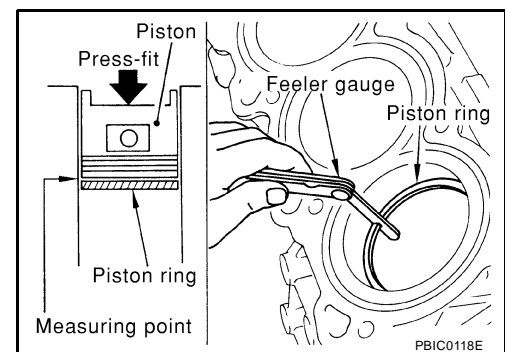
Oil ring : 0.20 - 0.50 mm (0.0079 - 0.0197 in)

Limit:

Top ring : 0.56 mm (0.0220 in)

2nd ring : 0.68 mm (0.0268 in)

Oil ring : 0.85 mm (0.0335 in)

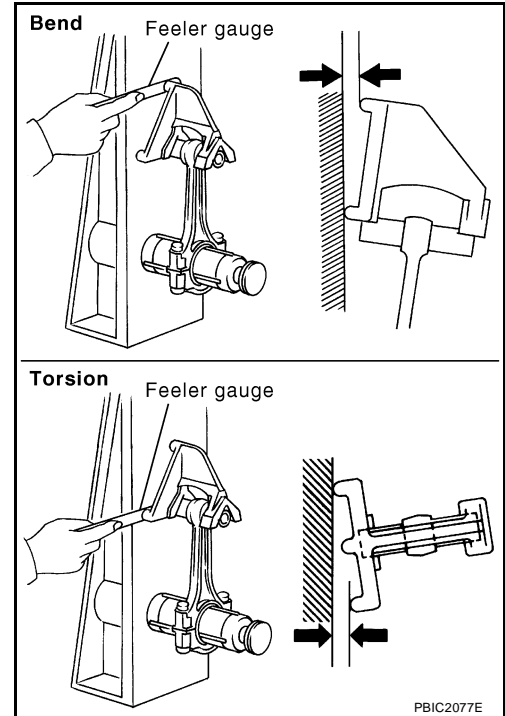


- If the measured value exceeds the limit, replace piston ring, and measure again. If it still exceeds the limit, re-bore cylinder and use oversize piston and piston rings.

CYLINDER BLOCK

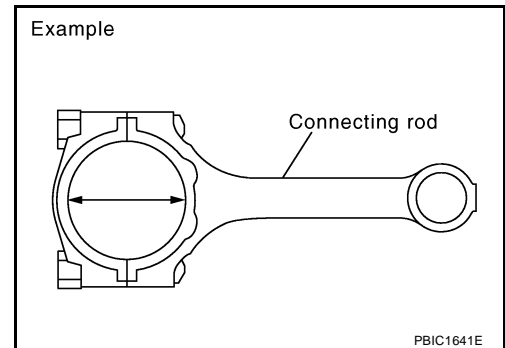
CONNECTING ROD BEND AND TORSION

- 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 BIG END DIAMETER

- Install connecting rod bearing cap without installing connecting rod bearing, and tightening connecting rod bolts to the specified torque. Refer to [EM-110, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of connecting rod big end with inside micrometer.
 - Standard : 57.000 - 57.013 mm (2.2441 - 2.2446 in)**
- If out of the standard, replace connecting rod assembly.

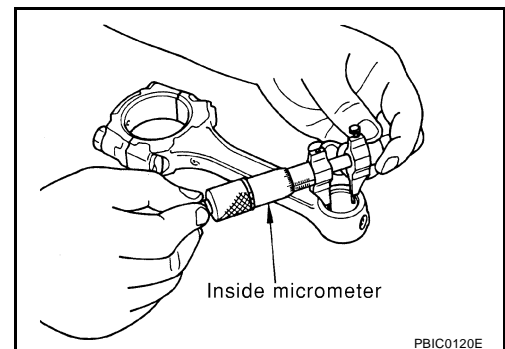


CONNECTING ROD BUSHING OIL CLEARANCE

Connecting Rod Bushing Inner Diameter

Measure the inner diameter of connecting rod bushing with inside micrometer.

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

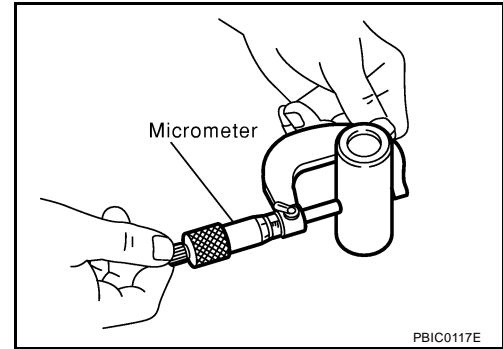


CYLINDER BLOCK

Piston Pin Outer Diameter

Measure the outer diameter of piston pin with micrometer.

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



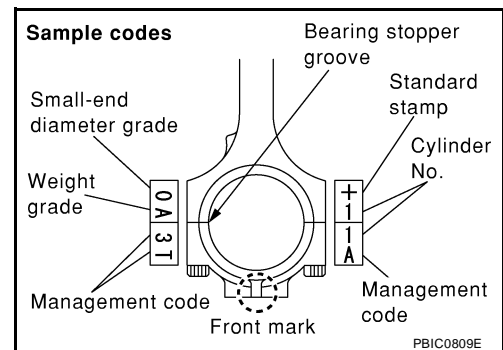
Connecting Rod Bushing Oil Clearance

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

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

Limit : 0.030 mm (0.0012 in)

- If the calculated value exceeds the limit, replace connecting rod assembly and/or piston and piston pin assembly.
- If replacing piston and piston pin assembly, refer to [EM-116, "HOW TO SELECT PISTON"](#) .
- If replacing connecting rod assembly, refer to [EM-127, "CONNECTING ROD BEARING OIL CLEARANCE"](#) to select the connecting rod bearing.

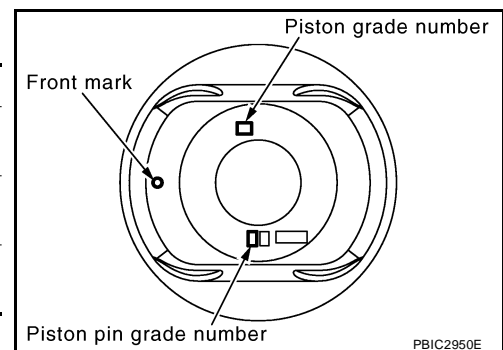


Factory installed parts grading:

- Service parts apply only to grade "0".

Grade	Unit: mm (in)	
	0	1
Connecting rod bushing inner diameter *	22.000 - 22.006 (0.8661 - 0.8664)	22.006 - 22.012 (0.8664 - 0.8666)
Piston pin hole diameter	21.993 - 21.999 (0.8659 - 0.8661)	21.999 - 22.005 (0.8661 - 0.8663)
Piston pin outer diameter	21.989 - 21.995 (0.8657 - 0.8659)	21.995 - 22.001 (0.8659 - 0.8662)

*: After installing in connecting rod



CYLINDER BLOCK DISTORTION

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

CAUTION:

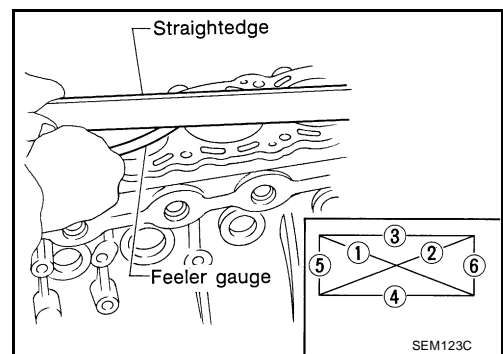
Be careful not to allow gasket flakes to enter engine oil or engine coolant passages.

CYLINDER BLOCK

- Measure the distortion on the cylinder block upper face at some different points in six directions with straightedge and feeler gauge.

Limit : 0.1 mm (0.004 in)

- If it exceeds the limit, replace cylinder block.



MAIN BEARING HOUSING INNER DIAMETER

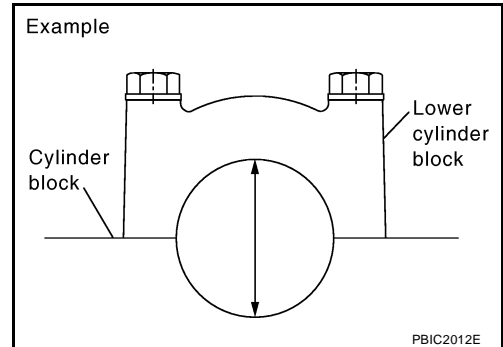
- Install lower cylinder block without installing main bearings, and tighten lower cylinder block bolts to the specified torque. Refer to [EM-110, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of main bearing housing with bore gauge.

Standard : 74.993 - 75.017 mm (2.9525 - 2.9534 in)

- If out of the standard, replace cylinder block and lower cylinder block as assembly.

NOTE:

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



PISTON TO CYLINDER BORE CLEARANCE

Cylinder Bore Inner Diameter

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

Standard inner diameter:

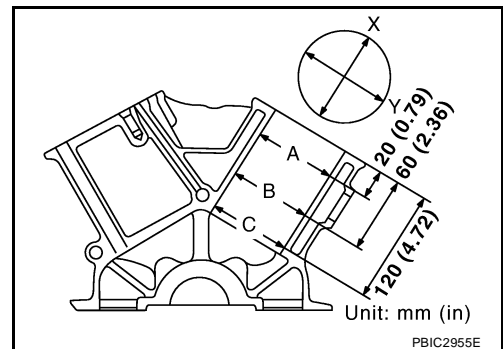
95.500 - 95.530 mm (3.7598 - 3.7610 in)

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

0.015 mm (0.0006 in)

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

0.01 mm (0.0004 in)

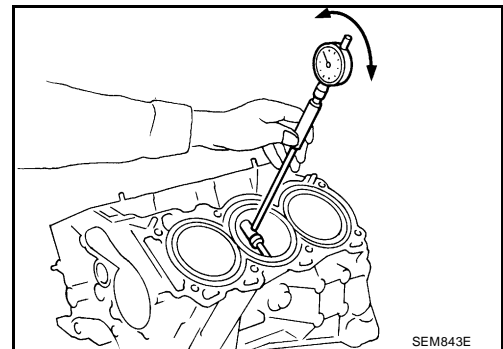


- If the measured value exceeds the limit, or if there are scratches and/or seizure on the cylinder inner wall, hone or re-bore the inner wall.
- Oversize piston is provided. When using oversize piston, re-bore cylinder so that the clearance of the piston-to-cylinder bore satisfies the standard.

CAUTION:

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

Oversize (OS) : 0.2 mm (0.008 in)



CYLINDER BLOCK

Piston Skirt Diameter

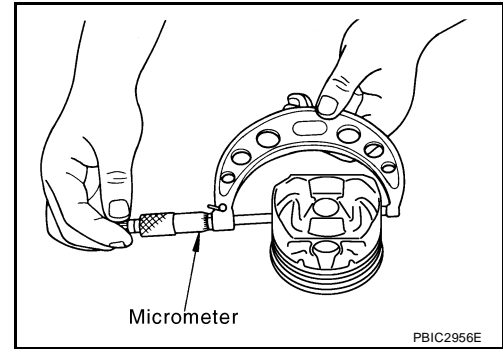
Measure the outer diameter of piston skirt with micrometer.

Measure point

: Distance from the top 43.03 mm (1.6941 in)

Standard

: 95.480 - 95.510 mm (3.7590 - 3.7602 in)



Piston to Cylinder Bore Clearance

Calculate by piston skirt diameter and cylinder bore inner diameter (direction "X", position "B").
(Clearance) = (Cylinder bore inner diameter) – (Piston skirt diameter).

Standard : 0.010 - 0.030 mm (0.0004 - 0.0012 in)

Limit : 0.08 mm (0.0031 in)

- If the calculated value exceeds the limit, replace piston and piston pin assembly. Refer to [EM-116, "HOW TO SELECT PISTON"](#).

Re-boring Cylinder Bore

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

Re-bored size calculation: $D = A + B - C$

where,

D: Bored diameter

A: Piston skirt diameter as measured

B: Piston to cylinder bore clearance (standard value)

C: Honing allowance 0.02 mm (0.0008 in)

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

NOTE:

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

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

NOTE:

Measurement should be done after cylinder bore cools down.

CRANKSHAFT MAIN JOURNAL DIAMETER

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

Standard : 69.951 - 69.975 mm (2.7540 - 2.7549 in) dia.

- If out of the standard, measure the main bearing oil clearance. Then use undersize bearing. Refer to [EM-128, "MAIN BEARING OIL CLEARANCE"](#).

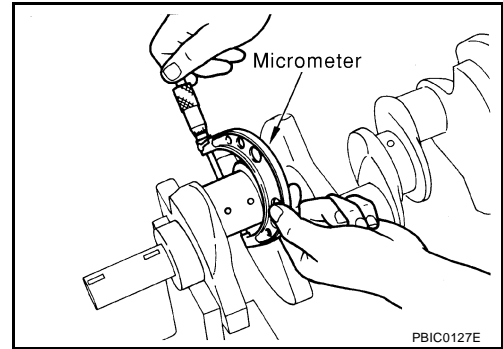
CYLINDER BLOCK

CRANKSHAFT PIN JOURNAL DIAMETER

- Measure the outer diameter of crankshaft pin journal with micrometer.

Standard : 53.956 - 53.974 mm (2.1242 - 2.1250 in) dia.

- If out of the standard, measure the connecting rod bearing oil clearance. Then use undersize bearing. Refer to [EM-127, "CONNECTING ROD BEARING OIL CLEARANCE"](#).



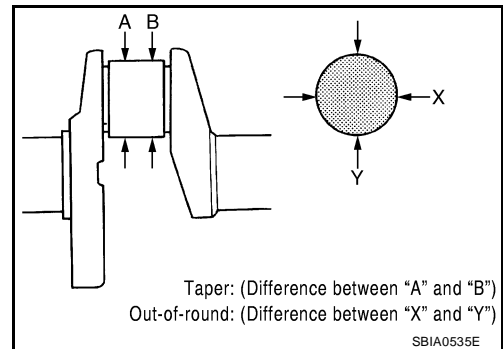
CRANKSHAFT OUT-OF-ROUND AND TAPER

- Measure the dimensions at four different points as shown in the figure on each main journal and pin journal with micrometer.
- Out-of-round is indicated by the difference in the dimensions between "X" and "Y" at "A" and "B".
- Taper is indicated by the difference in the dimensions between "A" and "B" at "X" and "Y".

Limit:

**Out-of-round (Difference between "X" and "Y")
: 0.002 mm (0.0001 in)**

**Taper (Difference between "A" and "B")
: 0.002 mm (0.0001 in)**



- If the measured value exceeds the limit, correct or replace crankshaft.
- If corrected, measure the bearing oil clearance of the corrected main journal and/or pin journal. Then select the main bearing and/or connecting rod bearing. Refer to [EM-128, "MAIN BEARING OIL CLEARANCE"](#) and/or [EM-127, "CONNECTING ROD BEARING OIL CLEARANCE"](#).

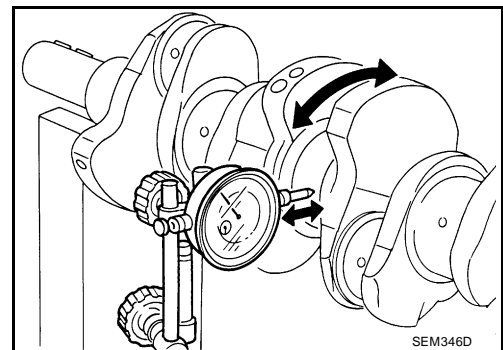
CRANKSHAFT RUNOUT

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

Standard : Less than 0.05 mm (0.0020 in)

Limit : 0.10 mm (0.0039 in)

- If it exceeds the limit, replace crankshaft.



CONNECTING ROD BEARING OIL CLEARANCE

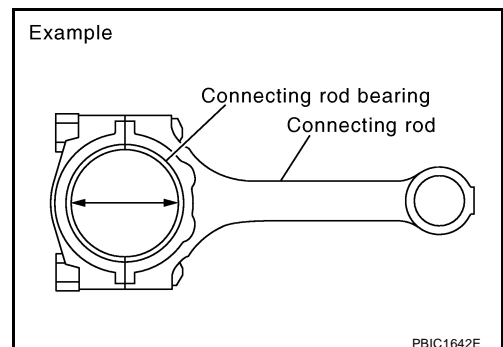
Method by Calculation

- Install connecting rod bearings to connecting rod and cap, and tighten connecting rod bolts to the specified torque. Refer to [EM-110, "ASSEMBLY"](#) for the tightening procedure.
- Measure the inner diameter of connecting rod bearing with inside micrometer.

(Bearing oil clearance) = (Connecting rod bearing inner diameter) – (Crankshaft pin journal diameter)

**Standard : 0.034 - 0.059 mm (0.0013 - 0.0023 in)
(actual clearance)**

Limit : 0.070 mm (0.0028 in)



CYLINDER BLOCK

- If the calculated value exceeds the limit, select proper connecting rod bearing according to connecting rod big end diameter and crankshaft pin journal diameter to obtain the specified bearing oil clearance. Refer to [EM-117, "HOW TO SELECT CONNECTING ROD BEARING"](#) .

Method of Using Plastigage

- Remove oil and dust on crankshaft pin journal and the surfaces of each bearing completely.
- Cut plastigage slightly shorter than the bearing width, and place it in crankshaft axial direction, avoiding oil holes.
- Install connecting rod bearings to connecting rod and cap, and tighten connecting rod bolts to the specified torque. Refer to [EM-110, "ASSEMBLY"](#) for the tightening procedure.

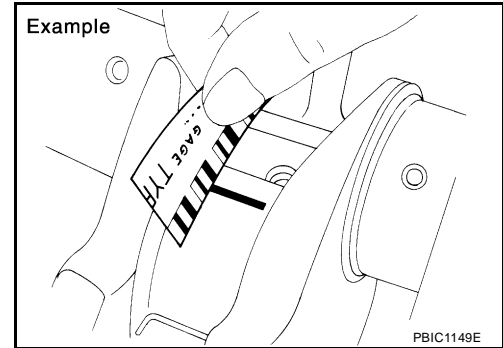
CAUTION:

Do not rotate crankshaft.

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

NOTE:

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



MAIN BEARING OIL CLEARANCE

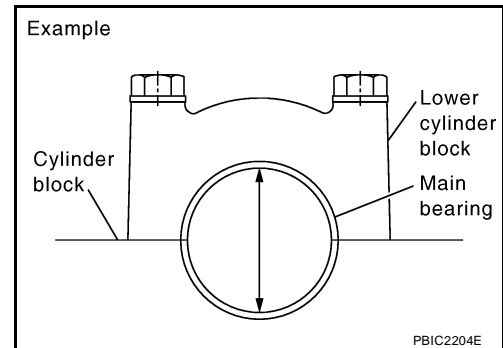
Method by Calculation

- Install main bearings to cylinder block and lower cylinder block, and tighten lower cylinder block bolts to the specified torque. Refer to [EM-110, "ASSEMBLY"](#) for the tightening procedure.
 - Measure the inner diameter of main bearing with bore gauge.
- (Bearing clearance) = (Main bearing inner diameter) – (Crankshaft main journal diameter)

Standard : 0.035 - 0.045 mm (0.0014 - 0.0018 in)
(actual clearance)

Limit : 0.065 mm (0.0026 in)

- If the calculated value exceeds the limit, select proper main bearing according to main bearing inner diameter and crankshaft main journal diameter to obtain specified bearing oil clearance. Refer to [EM-118, "HOW TO SELECT MAIN BEARING"](#) .



Method of Using Plastigage

- Remove engine oil and dust on crankshaft main journal and the surfaces of each bearing completely.
- Cut plastigage slightly shorter than the bearing width, and place it in crankshaft axial direction, avoiding oil holes.
- Install main bearings to cylinder block and lower cylinder block, and tighten lower cylinder block bolts to the specified torque. Refer to [EM-110, "ASSEMBLY"](#) for the tightening procedure.

CAUTION:

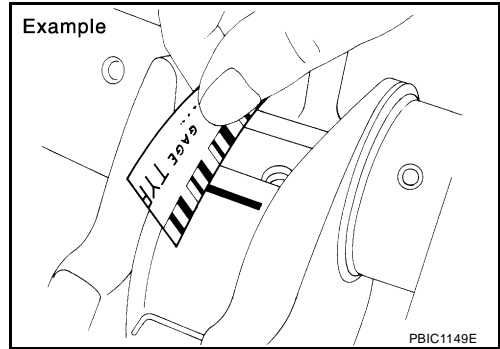
Do not rotate crankshaft.

CYLINDER BLOCK

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

NOTE:

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

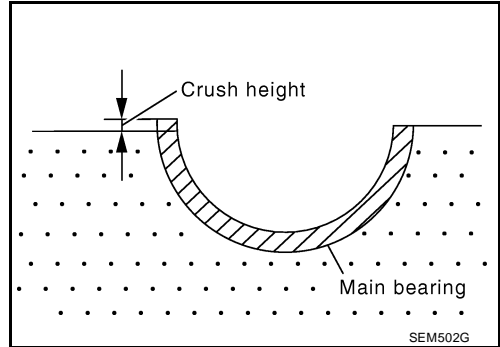


CRUSH HEIGHT OF MAIN BEARING

- When lower cylinder block is removed after being tightened to the specified torque with main bearings installed, the tip end of bearing must protrude. Refer to [EM-110, "ASSEMBLY"](#) for the tightening procedure.

Standard : There must be crush height.

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

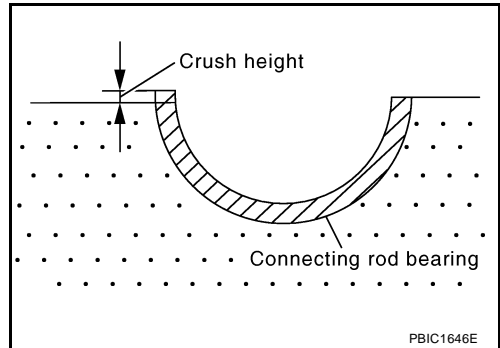


CRUSH HEIGHT OF CONNECTING ROD BEARING

- When connecting rod bearing cap is removed after being tightened to the specified torque with connecting rod bearings installed, the tip end of bearing must protrude. Refer to [EM-110, "ASSEMBLY"](#) for the tightening procedure.

Standard : There must be crush height.

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

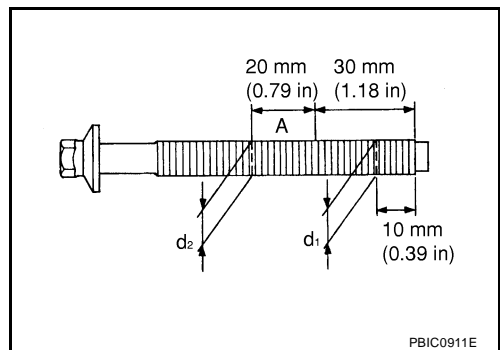


LOWER CYLINDER BLOCK BOLT OUTER DIAMETER

- Measure the outer diameters ("d1", "d2") at two positions as shown.
- If reduction appears in "A" range, regard it as "d2".

Limit ("d1" - "d2") : 0.11 mm (0.0051 in)

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



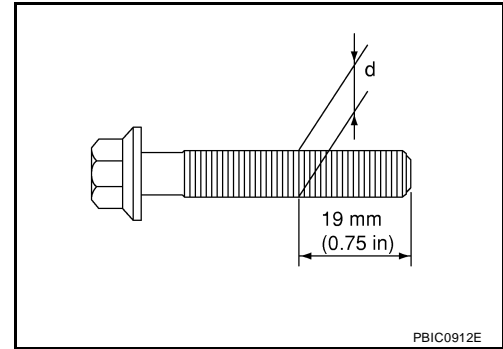
CYLINDER BLOCK

CONNECTING ROD BOLT OUTER DIAMETER

- Measure the outer diameter “d” at position shown.
- If the reduction appears in a position other than “d”, regard it as “d”.

Limit : 7.75 mm (0.3051 in)

- When “d” exceeds the limit (when it becomes thinner), replace connecting rod bolt with new one.

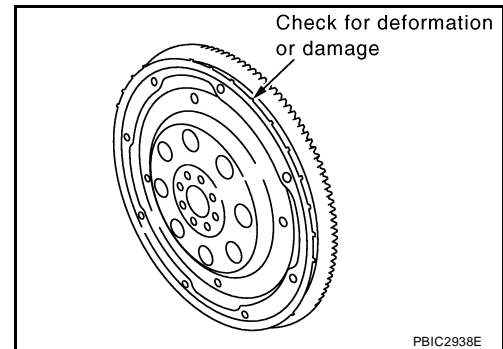


DRIVE PLATE

- Check drive plate and signal plate for deformation or cracks.

CAUTION:

- Do not disassemble drive plate.
- Do not place drive plate with signal plate facing down.
- When handling signal plate, take care not to damage or scratch it.
- Handle signal plate in a manner that prevents it from becoming magnetized.
- If anything is found, replace drive plate.

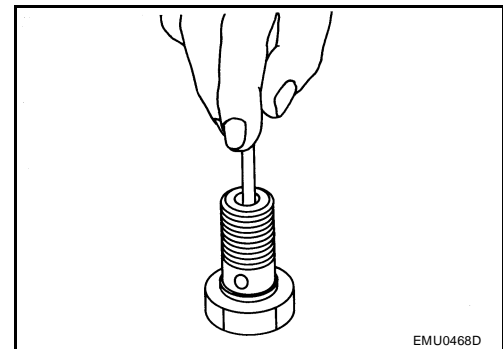


OIL JET

- Check nozzle for deformation and damage.
- Blow compressed air from nozzle, and check for clogs.
- If it is not satisfied, clean or replace oil jet.

OIL JET RELIEF VALVE

- Using clean plastic stick, press check valve in oil jet relief valve. Make sure that valve moves smoothly with proper reaction force.
- If it is not satisfied, replace oil jet relief valve.



SERVICE DATA AND SPECIFICATIONS (SDS)

SERVICE DATA AND SPECIFICATIONS (SDS)

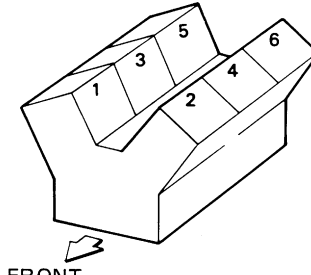
PF0:00100

Standard and Limit GENERAL SPECIFICATIONS

EBS00NKB

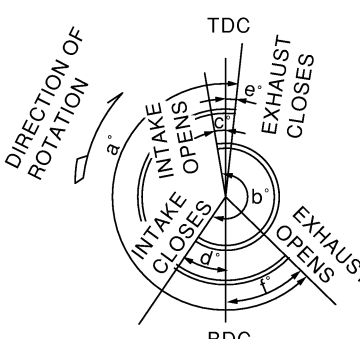
Cylinder arrangement		V-6
Displacement cm ³ (cu in)		3,954 (241.30)
Bore and stroke mm (in)		95.5 × 92.0 (3.76 × 3.622)
Valve arrangement		DOHC
Firing order		1-2-3-4-5-6
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		4
Compression ratio		9.7
Compression pressure kPa (kg/cm ² , psi)/300 rpm	Standard	1,275 (13.0, 185)
	Minimum	981 (10.0, 142)
	Differential limit between cylinders	98 (1.0, 14)

Cylinder number



SEM713A

Valve timing
(Intake valve timing control - "OFF")



PBIC0187E

Unit: degree

a	b	c	d	e	f
244	240	-4	64	6	58

SERVICE DATA AND SPECIFICATIONS (SDS)

DRIVE BELT

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

INTAKE MANIFOLD COLLECTOR, INTAKE MANIFOLD AND EXHAUST MANIFOLD

Unit: mm (in)

Items		Limit
Surface distortion	Intake manifold	0.1 (0.004)
	Exhaust manifold	0.3 (0.012)

SPARK PLUG

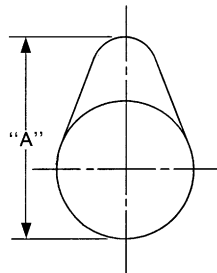
Make	NGK
Standard type	PLFR5A-11
Hot type	PLFR4A-11
Cold type	PLFR6A-11
Gap (nominal)	1.1 mm (0.043 in)

SERVICE DATA AND SPECIFICATIONS (SDS)

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

Items		Standard	Limit
Camshaft journal oil clearance	No. 1	0.045 - 0.086 (0.0018 - 0.0034)	0.15 (0.0059)
	No. 2, 3, 4	0.035 - 0.076 (0.0014 - 0.0030)	
Camshaft bracket inner diameter	No. 1	26.000 - 26.021 (1.0236 - 1.0244)	—
	No. 2, 3, 4	23.500 - 23.521 (0.9252 - 0.9260)	—
Camshaft journal diameter	No. 1	25.935 - 25.955 (1.0211 - 1.0218)	—
	No. 2, 3, 4	23.445 - 23.465 (0.9230 - 0.9238)	—
Camshaft end play		0.115 - 0.188 (0.0045 - 0.0074)	0.24 (0.0094)
Camshaft cam height "A"	Intake	45.465 - 45.655 (1.7900 - 1.7921)	45.265 (1.7821)
	Exhaust	45.075 - 45.265 (1.7746 - 1.7821)	44.875 (1.7667)
Camshaft runout [TIR* ¹]		Less than 0.02 mm (0.001)	0.05 (0.002)
Camshaft sprocket runout [TIR* ²]		—	0.15 (0.0059)



SEM671

*¹ : Total indicator reading

Valve Lifter

Unit: mm (in)

Items	Standard
Valve lifter outer diameter	33.977 - 33.987 (1.3377 - 1.3381)
Valve lifter hole diameter	34.000 - 34.016 (1.3386 - 1.3392)
Valve lifter clearance	0.013 - 0.039 (0.0005 - 0.0015)

Valve Clearance

Unit: mm (in)

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

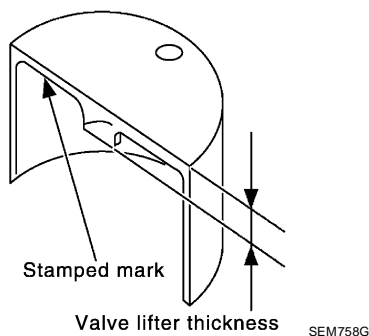
*: Approximately 80°C (176°F)

SERVICE DATA AND SPECIFICATIONS (SDS)

Available Valve Lifter VQ40DE

Unit: mm (in)

Identification (stamped) mark		Thickness
Intake	Exhaust	
788U	N788	7.88 (0.3102)
790U	N790	7.90 (0.3110)
792U	N792	7.92 (0.3118)
794U	N794	7.94 (0.3126)
796U	N796	7.96 (0.3134)
798U	N798	7.98 (0.3142)
800U	N800	8.00 (0.3150)
802U	N802	8.02 (0.3157)
804U	N804	8.04 (0.3165)
806U	N806	8.06 (0.3173)
808U	N808	8.08 (0.3181)
810U	N810	8.10 (0.3189)
812U	N812	8.12 (0.3197)
814U	N814	8.14 (0.3205)
816U	N816	8.16 (0.3213)
818U	N818	8.18 (0.3220)
820U	N820	8.20 (0.3228)
822U	N822	8.22 (0.3236)
824U	N824	8.24 (0.3244)
826U	N826	8.26 (0.3252)
828U	N828	8.28 (0.3260)
830U	N830	8.30 (0.3268)
832U	N832	8.32 (0.3276)
834U	N834	8.34 (0.3283)
836U	N836	8.36 (0.3291)
838U	—	8.38 (0.3299)
840U	—	8.40 (0.3307)

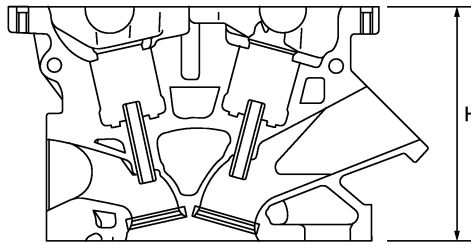


SERVICE DATA AND SPECIFICATIONS (SDS)

CYLINDER HEAD

Unit: mm (in)

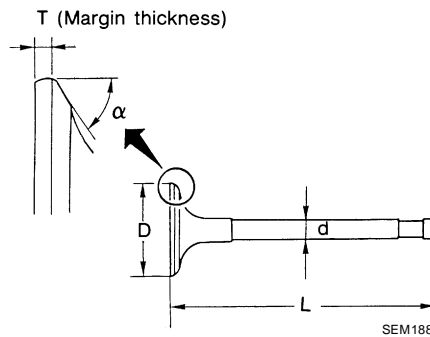
Items	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)
Normal cylinder head height "H"	126.3 - 126.5 (4.972 - 4.980)	—



PBIC0924E

Valve Dimensions

Unit: mm (in)

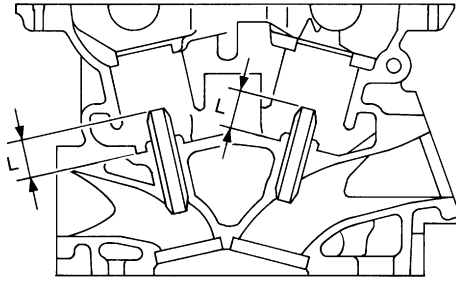


Valve head diameter "D"	Intake	37.0 - 37.3 (1.4567 - 1.4685)
	Exhaust	31.2 - 31.5 (1.228 - 1.240)
Valve length "L"	Intake	96.46 (3.7976)
	Exhaust	93.99 (3.7004)
Valve stem diameter "d"	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.955 - 5.970 (0.2344 - 0.2350)
Valve seat angle " α "	Intake	45°15' - 45°45'
	Exhaust	
Valve margin "T"	Intake	1.1 (0.043)
	Exhaust	1.3 (0.051)

SERVICE DATA AND SPECIFICATIONS (SDS)

Valve Guide

Unit: mm (in)

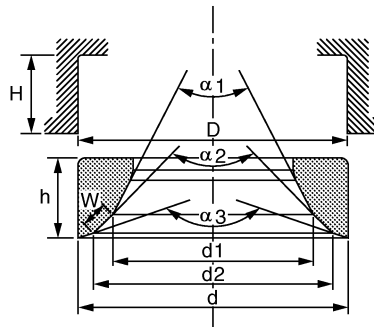


SEM950E

Items		Standard	0.2 (0.008) oversize (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)	
Items		Standard	Limit
Valve guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.003)
	Exhaust	0.030 - 0.063 (0.0012 - 0.0025)	0.09 (0.004)
Projection length "L"		12.6 - 12.8 (0.496 - 0.504)	

Valve Seat

Unit: mm (in)



PBIC2745E

Items		Standard	Oversize [0.5 (0.02)] (Service)
Cylinder head seat recess diameter "D"	Intake	38.000 - 38.016 (1.4961 - 1.4967)	38.500 - 38.516 (1.5157 - 1.5164)
	Exhaust	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)
Valve seat outer diameter "d"	Intake	38.097 - 38.113 (1.4999 - 1.5005)	38.597 - 38.613 (1.5196 - 1.5202)
	Exhaust	32.280 - 32.296 (1.2709 - 1.2715)	32.780 - 32.796 (1.2905 - 1.2912)
Valve seat interference fit	Intake	0.081 - 0.113 (0.0032 - 0.0044)	
	Exhaust	0.064 - 0.096 (0.0025 - 0.0038)	
Diameter "d1"*1	Intake	35 (1.38)	
	Exhaust	28.7 (1.130)	
Diameter "d2"*2	Intake	36.3 - 36.8 (1.429 - 1.449)	
	Exhaust	30.3 - 30.8 (1.193 - 1.213)	
Angle "α1"	Intake	60°	
	Exhaust	60°	
Angle "α2"	Intake	88°45' - 90°15'	
	Exhaust	88°45' - 90°15'	

SERVICE DATA AND SPECIFICATIONS (SDS)

Angle "α3"	Intake	120°	
	Exhaust	120°	
Contacting width "W" ^{*3}	Intake	1.0 - 1.4 (0.039-0.055)	
	Exhaust	1.2 - 1.6 (0.047-0.063)	
Height "h"	Intake	5.9 - 6.0 (0.232 - 0.236)	5.05 - 5.15 (0.1988 - 0.2028)
	Exhaust	5.9 - 6.0 (0.232 - 0.236)	4.95 - 5.05 (0.1949 - 0.1988)
Depth "H"	6.0 (0.236)		

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

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

*3: Machining data

Valve Spring

Free height	mm (in)	47.07 (1.8531)	
Pressure	N (kg, lb) at height mm (in)	Installation	166 - 188 (16.9 - 19.2, 37 - 42) at 37.00 (1.4567)
		Valve open	373 - 421 (38.0 - 42.9, 84 - 95) at 27.20 (1.0709)
squareness	mm (in)	Limit	2.1 (0.083)

A

EM

C

D

E

F

G

H

I

J

K

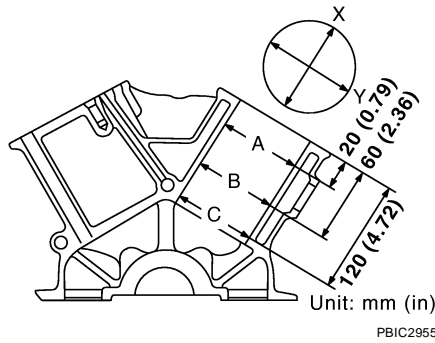
L

M

SERVICE DATA AND SPECIFICATIONS (SDS)

CYLINDER BLOCK

Unit: mm (in)



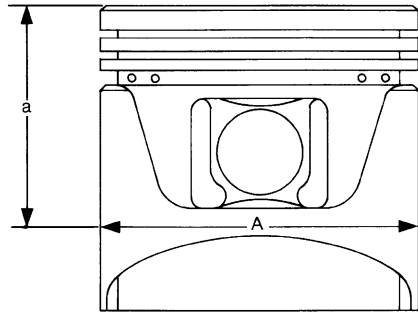
Surface flatness		Standard		Less than 0.03 (0.0012)
		Limit		0.1 (0.004)
Main bearing housing inner diameter		Standard		74.993 - 75.017 (2.9525 - 2.9534)
Cylinder bore	Inner diameter	Standard	Grade No. 1	95.500 - 95.510 (3.7598 - 3.7602)
			Grade No. 2	95.510 - 95.520 (3.7602 - 3.7606)
			Grade No. 3	95.520 - 95.530 (3.7606 - 3.7610)
Out-of-round (Difference between "X" and "Y")		Limit		0.015 (0.0006)
Taper (Difference between "A" and "C")				0.01 (0.0004)
Main bearing housing inner diameter (Without bearing)		Grade No. A		74.993 - 74.994 (2.9525 - 2.9525)
		Grade No. B		74.994 - 74.995 (2.9525 - 2.9526)
		Grade No. C		74.995 - 74.996 (2.9526 - 2.9526)
		Grade No. D		74.996 - 74.997 (2.9526 - 2.9526)
		Grade No. E		74.997 - 74.998 (2.9526 - 2.9527)
		Grade No. F		74.998 - 74.999 (2.9527 - 2.9527)
		Grade No. G		74.999 - 75.000 (2.9527 - 2.9528)
		Grade No. H		75.000 - 75.001 (2.9528 - 2.9528)
		Grade No. J		75.001 - 75.002 (2.9528 - 2.9528)
		Grade No. K		75.002 - 75.003 (2.9528 - 2.9529)
		Grade No. L		75.003 - 75.004 (2.9529 - 2.9529)
		Grade No. M		75.004 - 75.005 (2.9529 - 2.9529)
		Grade No. N		75.005 - 75.006 (2.9529 - 2.9530)
		Grade No. P		75.006 - 75.007 (2.9530 - 2.9530)
		Grade No. R		75.007 - 75.008 (2.9530 - 2.9531)
		Grade No. S		75.008 - 75.009 (2.9530 - 2.9531)
		Grade No. T		75.009 - 75.010 (2.9531 - 2.9531)
Grade No. U		75.010 - 75.011 (2.9531 - 2.9532)		
Grade No. V		75.011 - 75.012 (2.9532 - 2.9532)		
Grade No. W		75.012 - 75.013 (2.9532 - 2.9533)		
Grade No. X		75.013 - 75.014 (2.9533 - 2.9533)		
Grade No. Y		75.014 - 75.015 (2.9533 - 2.9533)		
Grade No. 4		75.015 - 75.016 (2.9533 - 2.9534)		
Grade No. 7		75.016 - 75.017 (2.9534 - 2.9534)		
Difference in inner diameter between cylinders		Standard		Less than 0.03 (0.0012)

SERVICE DATA AND SPECIFICATIONS (SDS)

PISTON, PISTON RING AND PISTON PIN

Available Piston

Unit: mm (in)



SEM882E

Items		Standard	0.20 (0.0079) oversize
Piston skirt diameter "A"	Grade No. 1	95.480 - 95.490 (3.7590 - 3.7594)	—
	Grade No. 2	95.490 - 95.500 (3.7594 - 3.7598)	—
	Grade No. 3	95.500 - 95.510 (3.7598 - 3.7602)	—
	Service	—	95.680 - 95.710 (3.7669 - 3.7681)
Items		Standard	Limit
"a" dimension		43.03 (1.6941)	—
Piston pin hole diameter	Grade No. 0	21.993 - 21.999 (0.8659 - 0.8661)	—
	Grade No. 1	21.999 - 22.005 (0.8661 - 0.8663)	—
Piston to cylinder bore clearance		0.010 - 0.030 (0.0004 - 0.0012)	0.08 (0.0031)

Piston Ring

Unit: mm (in)

Items		Standard	Limit
Side clearance	Top	0.045 - 0.080 (0.0018 - 0.0031)	0.11 (0.0043)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.10 (0.0039)
	Oil ring	0.065 - 0.135 (0.0026 - 0.0053)	—
End gap	Top	0.23 - 0.33 (0.0091 - 0.0130)	0.56 (0.0220)
	2nd	0.33 - 0.48 (0.0130 - 0.0189)	0.68 (0.0268)
	Oil (rail ring)	0.20 - 0.50 (0.0079 - 0.0197)	0.85 (0.0335)

Piston Pin

Unit: mm (in)

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

SERVICE DATA AND SPECIFICATIONS (SDS)

CONNECTING ROD

Unit: mm (in)

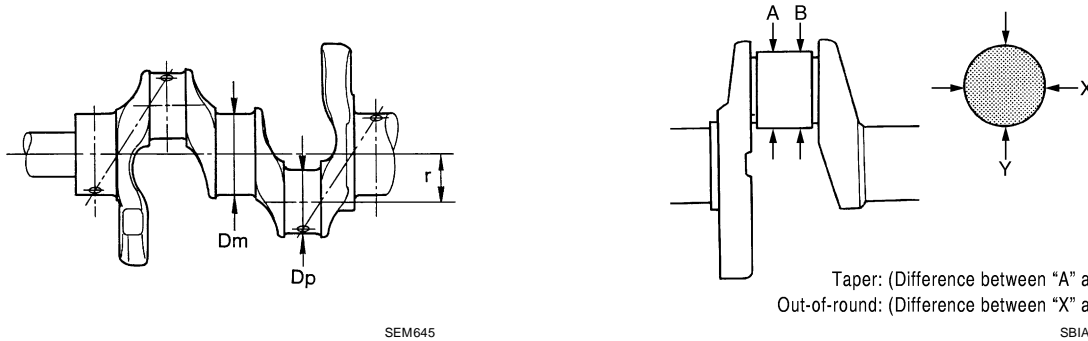
Items	Standard	Limit
Center distance	165.82 - 165.92 (6.5283 - 6.5323)	—
Bend [per 100 (3.94)]	—	0.15 (0.0059)
Torsion [per 100 (3.94)]	—	0.30 (0.0118)
Connecting rod bushing inner diameter*	Grade No. 0	22.000 - 22.006 (0.8661 - 0.8664)
	Grade No. 1	22.006 - 22.012 (0.8664 - 0.8666)
Connecting rod big end diameter (Without bearing)	57.000 - 57.013 (2.2441 - 2.2446)	—
Side clearance	0.20 - 0.35 (0.0079 - 0.0138)	—

*: After installing in connecting rod

SERVICE DATA AND SPECIFICATIONS (SDS)

CRANKSHAFT

Unit: mm (in)

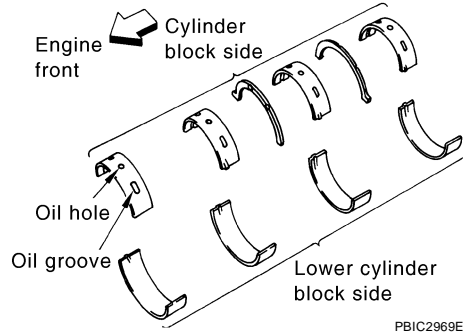


Main journal diameter. "Dm" grade	Standard	Grade No. A	69.975 - 69.974 (2.7549 - 2.7549)
		Grade No. B	69.974 - 69.973 (2.7549 - 2.7548)
		Grade No. C	69.973 - 69.972 (2.7548 - 2.7548)
		Grade No. D	69.972 - 69.971 (2.7548 - 2.7548)
		Grade No. E	69.971 - 69.970 (2.7548 - 2.7547)
		Grade No. F	69.970 - 69.969 (2.7547 - 2.7547)
		Grade No. G	69.969 - 69.968 (2.7547 - 2.7546)
		Grade No. H	69.968 - 69.967 (2.7546 - 2.7546)
		Grade No. J	69.967 - 69.966 (2.7546 - 2.7546)
		Grade No. K	69.966 - 69.965 (2.7546 - 2.7545)
		Grade No. L	69.965 - 69.964 (2.7545 - 2.7545)
		Grade No. M	69.964 - 69.963 (2.7545 - 2.7544)
		Grade No. N	69.963 - 69.962 (2.7544 - 2.7544)
		Grade No. P	69.962 - 69.961 (2.7544 - 2.7544)
		Grade No. R	69.961 - 69.960 (2.7544 - 2.7543)
		Grade No. S	69.960 - 69.959 (2.7543 - 2.7543)
		Grade No. T	69.959 - 69.958 (2.7543 - 2.7542)
		Grade No. U	69.958 - 69.957 (2.7542 - 2.7542)
		Grade No. V	69.957 - 69.956 (2.7542 - 2.7542)
Grade No. W	69.956 - 69.955 (2.7542 - 2.7541)		
Grade No. X	69.955 - 69.954 (2.7541 - 2.7541)		
Grade No. Y	69.954 - 69.953 (2.7541 - 2.7540)		
Grade No. 4	69.953 - 69.952 (2.7540 - 2.7540)		
Grade No. 7	69.952 - 69.951 (2.7540 - 2.7540)		
Pin journal diameter. "Dp" grade	Standard	Grade No. 0	53.968 - 53.974 (2.1247 - 2.1250)
		Grade No. 1	53.962 - 53.968 (2.1245 - 2.1247)
		Grade No. 2	53.956 - 53.962 (2.1242 - 2.1245)
Center distance "r"			45.96 - 46.04 (1.8094 - 1.8126)
Taper (Difference between "A" and "B")	Limit		0.002 (0.0001)
Out-of-round (Difference between "X" and "Y")			0.002 (0.0001)
Crankshaft runout [TIR*]	Standard		Less than 0.05 (0.002)
	Limit		0.10 (0.0039)
Crankshaft end play	Standard		0.10 - 0.25 (0.0039 - 0.0098)
	Limit		0.30 (0.0118)

*: Total indicator reading

SERVICE DATA AND SPECIFICATIONS (SDS)

MAIN BEARING



Grade number	UPR/LWR	Thickness mm (in)	Width mm (in)	Identification color	Remarks
0	—	2.500 - 2.503 (0.0984 - 0.0985)	19.9 - 20.1 (0.783 - 0.791)	Black	Grade is the same for upper and lower bearings.
1	—	2.503 - 2.506 (0.0985 - 0.0987)		Brown	
2	—	2.506 - 2.509 (0.0987 - 0.0988)		Green	
3	—	2.509 - 2.512 (0.0988 - 0.0989)		Yellow	
4	—	2.512 - 2.515 (0.0989 - 0.0990)		Blue	
5	—	2.515 - 2.518 (0.0990 - 0.0991)		Pink	
6	—	2.518 - 2.521 (0.0991 - 0.0993)		Purple	
7	—	2.521 - 2.524 (0.0993 - 0.0994)		White	Grade is different for upper and lower bearings.
01	UPR	2.503 - 2.506 (0.0985 - 0.0987)		Brown	
	LWR	2.500 - 2.503 (0.0984 - 0.0985)		Black	
12	UPR	2.506 - 2.509 (0.0987 - 0.0988)		Green	
	LWR	2.503 - 2.506 (0.0985 - 0.0987)		Brown	
23	UPR	2.509 - 2.512 (0.0988 - 0.0989)		Yellow	
	LWR	2.506 - 2.509 (0.0987 - 0.0988)		Green	
34	UPR	2.512 - 2.515 (0.0989 - 0.0990)	Blue		
	LWR	2.509 - 2.512 (0.0988 - 0.0989)	Yellow		
45	UPR	2.515 - 2.518 (0.0990 - 0.0991)	Pink		
	LWR	2.512 - 2.515 (0.0989 - 0.0990)	Blue		
56	UPR	2.518 - 2.521 (0.0991 - 0.0993)	Purple		
	LWR	2.515 - 2.518 (0.0990 - 0.0991)	Pink		
67	UPR	2.521 - 2.524 (0.0993 - 0.0994)	White		
	LWR	2.518 - 2.521 (0.0991 - 0.0993)	Purple		

Undersize

Unit: mm (in)

Items	Thickness	Main journal diameter
0.25 (0.0098)	2.633 - 2.641 (0.1037 - 0.1040)	Grind so that bearing clearance is the specified value.

Main Bearing Oil Clearance

Unit: mm (in)

Items	Standard	Limit
Main bearing oil clearance	0.035 - 0.045 (0.0014 - 0.0018)*	0.065 (0.0026)

*: Actual clearance

SERVICE DATA AND SPECIFICATIONS (SDS)

CONNECTING ROD BEARING

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

Undersize

Unit: mm (in)

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

Connecting Rod Bearing Oil Clearance

Unit: mm (in)

Items	Standard	Limit
Connecting rod bearing oil clearance	0.034 - 0.059 (0.0013 - 0.0023)*	0.070 (0.0028)

*: Actual clearance

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

SERVICE DATA AND SPECIFICATIONS (SDS)
