SECTION EM
ENGINE MECHANICAL

CONTENTS

VQ40DE

PRECAUTION

PRECAUTIONS

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

INFOID:0000000001281958

The Supplemental Restraint System such as “AIR BAG” and “SEAT BELT PRE-TENSIONER”, used along with a front seat belt, helps to reduce the risk or severity of injury to the driver and front passenger for certain types of collision. This system includes seat belt switch inputs and dual stage front air bag modules. The SRS system uses the seat belt switches to determine the front air bag deployment, and may only deploy one front air bag, depending on the severity of a collision and whether the front occupants are belted or unbelted. Information necessary to service the system safely is included in the SR and SB section of this Service Manual.

WARNING:

- **To avoid rendering the SRS inoperative, which could increase the risk of personal injury or death in the event of a collision which would result in air bag inflation, all maintenance must be performed by an authorized NISSAN/INFINITI dealer.**
- **Improper maintenance, including incorrect removal and installation of the SRS, can lead to personal injury caused by unintentional activation of the system. For removal of Spiral Cable and Air Bag Module, see the SR section.**
- **Do not use electrical test equipment on any circuit related to the SRS unless instructed to in this Service Manual. SRS wiring harnesses can be identified by yellow and/or orange harnesses or harness connectors.**

Precaution for Drain Engine Coolant

INFOID:0000000001281959

Drain engine coolant when engine is cooled.

Precaution for Disconnecting Fuel Piping

INFOID:0000000001281960

- 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.

Precaution for Removal and Disassembly

INFOID:0000000001281961

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

Precaution for Inspection, Repair and Replacement

INFOID:0000000001281962

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

Precaution for Assembly and Installation

INFOID:0000000001281963

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

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

Parts Requiring Angle Tightening

INFOID:0000000001281964

- 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.

Precaution for Liquid Gasket

INFOID:0000000001281965

REMOVAL OF LIQUID GASKET SEALING

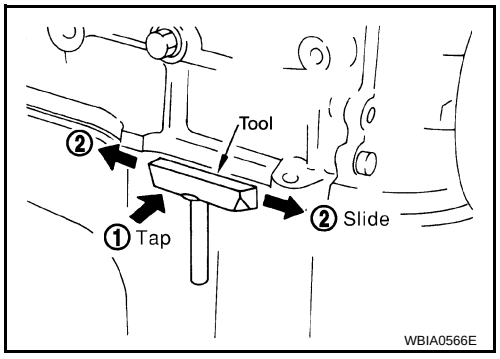
- After removing nuts and bolts, separate the mating surface and remove old liquid gasket sealing using Tool.

Tool number : KV10111100 (J-37228)

CAUTION:
Be careful not to damage the mating surfaces.

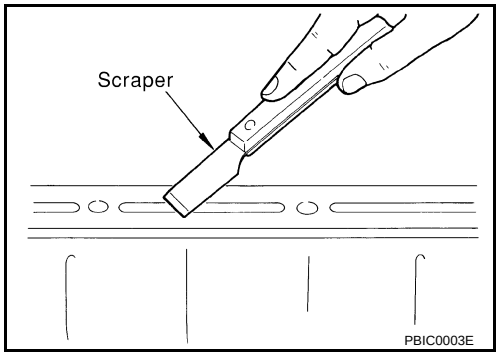
- Tap seal cutter to insert it (1), and then slide it by tapping on the side (2) as shown.
- In areas where Tool is difficult to use, use plastic hammer to lightly tap the parts, to remove it.

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



LIQUID GASKET APPLICATION PROCEDURE

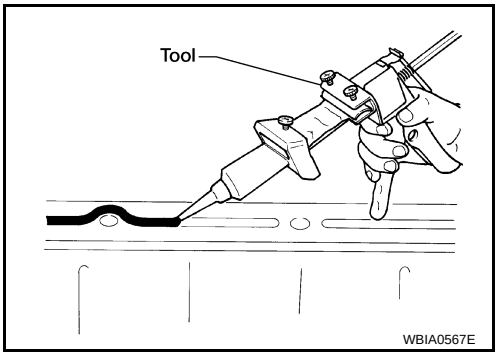
1. Remove the old liquid gasket adhering to the gasket application surface and the mating surface using suitable tool.
   - Remove liquid gasket completely from the groove of the gasket application surface, bolts, and bolt holes.
2. Thoroughly clean the mating surfaces and remove adhering moisture, grease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



3. Attach liquid gasket tube to the Tool.

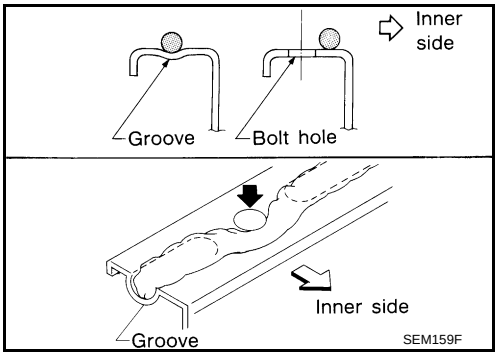
Tool number : WS39930000 (—)

Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".



4. Apply the liquid gasket without breaks to the specified location with the specified dimensions.

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



CAUTION:

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

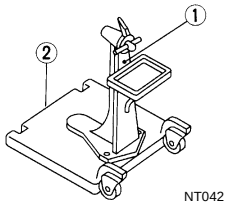
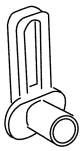
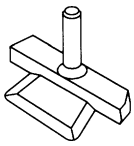
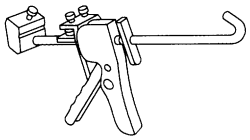
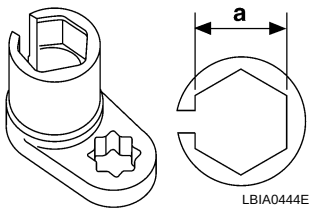
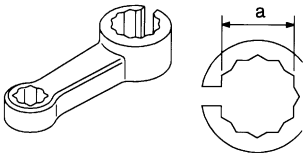
PREPARATION

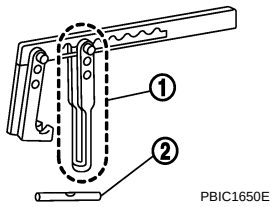
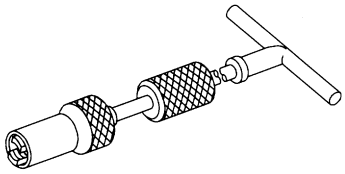
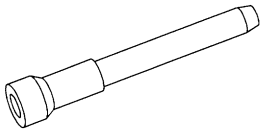
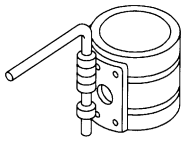
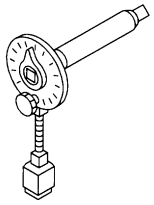
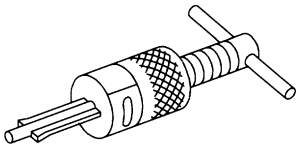
PREPARATION

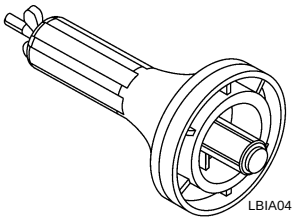
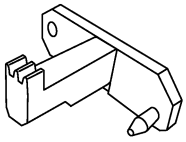
Special Service Tool

INFOID:0000000001281966

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

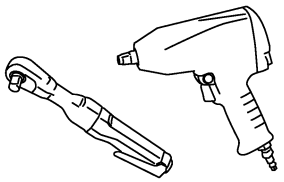
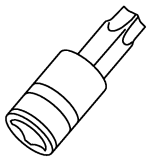
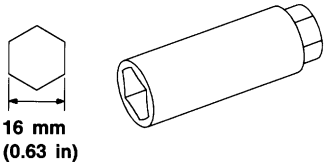
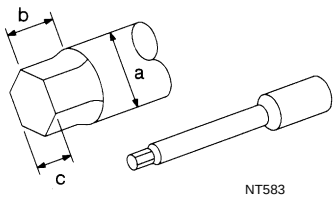
Tool number (Kent-Moore No.) Tool name	Description
ST0501S000 (—) Engine stand assembly 1. ST05011000 (—) Engine stand 2. ST05012000 (—) Base  NT042	Disassembling and assembling engine
— (J-45488) Quick connector release  PBIC0198E	Removing fuel tube quick connectors in engine room (Available in SEC. 164 of PARTS CATALOG: Part No. 16441 6N210)
KV10111100 (J-37228) Seal cutter  NT046	Removing oil pan (lower and upper), front and rear timing chain case, etc.
WS39930000 (—) Tube presser  NT052	Pressing the tube of liquid gasket
KV991J0050 (J-44626) Air fuel sensor Socket  LBIA0444E	Loosening or tightening air fuel ratio A/F sensor **a: 22 mm (0.87 in)**
KV10114400 (J-38365) Heated oxygen sensor wrench  NT636	Loosening or tightening heated oxygen sensor 1 **a: 22 mm (0.87 in)**

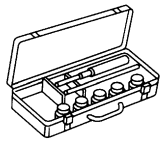
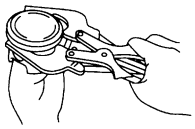
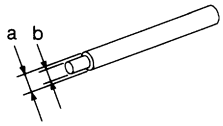
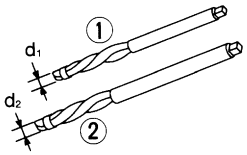
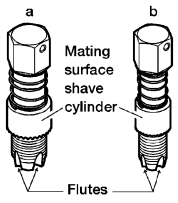
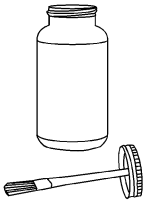
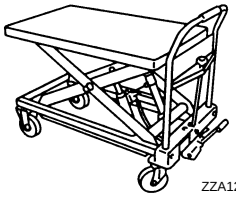
Tool number (Kent-Moore No.) Tool name	Description
KV10116200 (J-26336-A) Valve spring compressor 1. KV10115900 (J-26336-20) Attachment 2.KV10109220 (—) Adapter  PBIC1650E	Disassembling valve mechanism Part (1) is a component of KV10116200 (J-26336-A), but Part (2) is not so.
KV10107902 (J-38959) Valve oil seal puller  NT011	Replacing valve oil seal
— (J-39386) Valve oil seal drift  NT024	Installing valve oil seal
EM03470000 (J-8037) Piston ring compressor  NT044	Installing piston assembly into cylinder bore
KV10112100 (BT-8653-A) Angle wrench  NT014	Tightening bolts for bearing cap, cylinder head, etc. in angle
ST16610001 (J-23907) Pilot bushing puller  NT045	Removing pilot converter

Tool number (Kent-Moore No.) Tool name		Description
KV991J0120 (J-47128) Seal installer	 LBIA0452E	Installing rear main seal
KV10117700 (J-44716) Ring gear stopper	 NT822	Removing and installing crankshaft pulley

Commercial Service Tool

INFOID:0000000001281967

Tool number (Kent-Moore No.) Tool name		Description
(—) Power tool	 PBIC0190E	Loosening nuts and bolts
KV991J0100 (J-46531) TORX socket	 PBIC1113E	Removing and installing flywheel **Size: T55**
(—) Spark plug wrench	 16 mm (0.63 in) NT047	Removing and installing spark plug
(J-24239-01) Cylinder head bolt wrench	 NT583	Loosening and tightening cylinder head bolt, and used with angle wrench [SST: KV10112100 (BT8653-A)] **a: 13 (0.51) dia.** **b: 12 (0.47)** **c: 10 (0.39)** Unit: mm (in)

Tool number (Kent-Moore No.) Tool name	Description
(—) Valve seat cutter set  NT048	Finishing valve seat dimensions
(—) Piston ring expander  NT030	Removing and installing piston ring
(—) Valve guide drift  NT015	Removing and installing valve guide **Intake and Exhaust:** **a: 9.5 mm (0.374 in) dia.** **b: 5.5 mm (0.217 in) dia.**
(—) Valve guide reamer  NT016	(1): Reaming valve guide inner hole (2): Reaming hole for oversize valve guide **Intake and Exhaust:** **d_1: 6.0 mm (0.236 in) dia.** **d_2: 10.175 - 10.196 mm (0.4006 - 0.4014 in) dia.**
(J-43897-18) (J-43897-12) Oxygen sensor thread cleaner  AEM488	Reconditioning the exhaust system threads before installing a new heated oxygen sensor (Use with anti-seize lubricant shown below.) **a: J-43897-18 [18 mm (0.71 in) dia.] for zirconia heated oxygen sensor** **b: J-43897-12 [12 mm (0.47 in) dia.] for titania heated oxygen sensor**
(—) Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907)  AEM489	Lubricating oxygen sensor thread cleaning tool when reconditioning exhaust system threads
(—) Manual lift table caddy  ZZA1210D	Removing and installing engine

FUNCTION DIAGNOSIS

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

NVH Troubleshooting - Engine Noise

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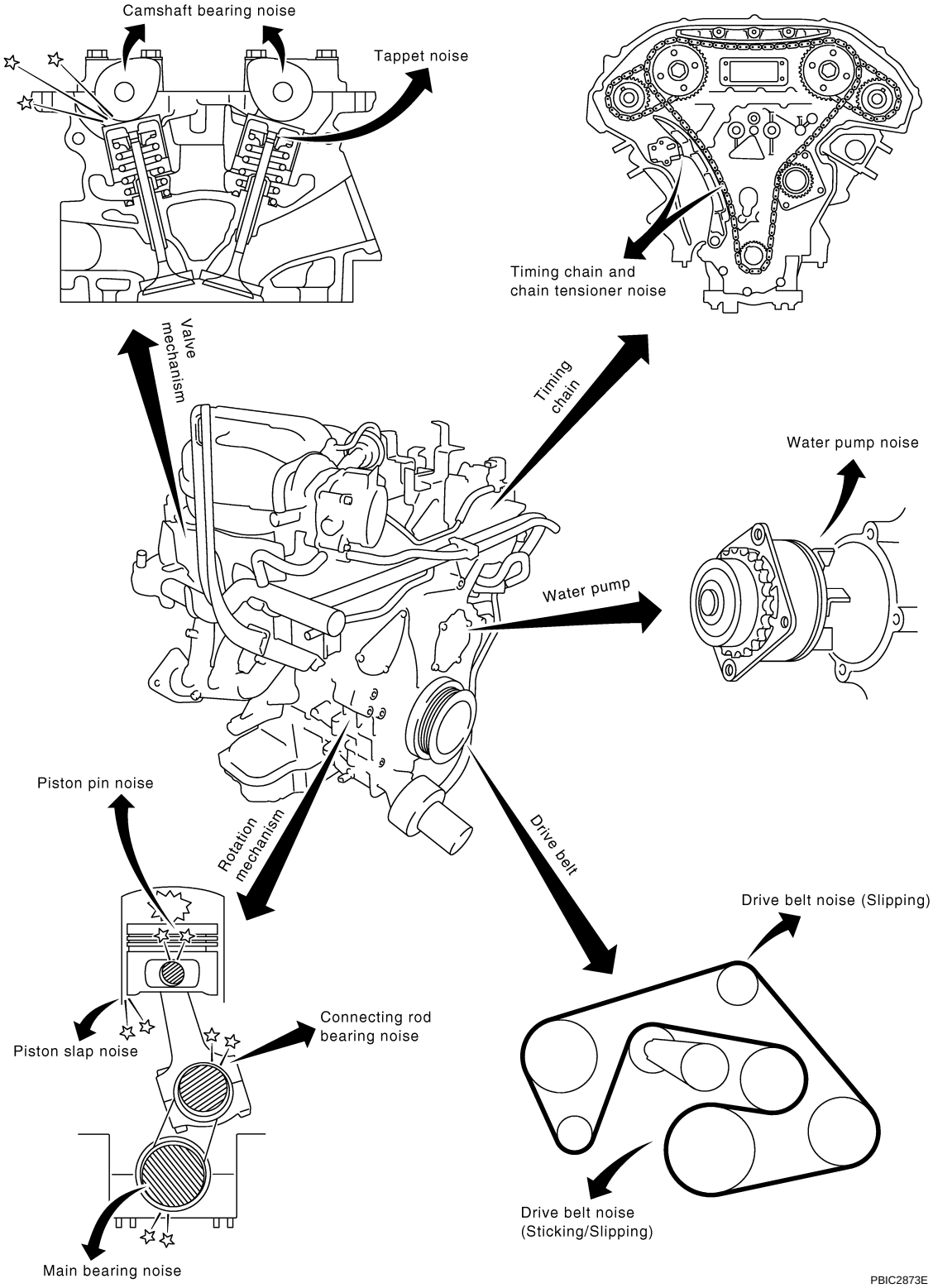

Use the Chart Below to Help You Find the Cause of the Symptom

INFOID:0000000001281969

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-18
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft runout Camshaft journal oil clearance	EM-81 EM-81
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-117 EM-117
	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-117 EM-117 EM-117 EM-117
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance Connecting rod bearing oil clearance	EM-117 EM-117
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-117 EM-117
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-61 EM-61
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-22
	Rattle	—	—	A	—	—	—	VTC	VTC lock pin clearance	EM-61

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

ON-VEHICLE MAINTENANCE

DRIVE BELTS

Checking Drive Belts

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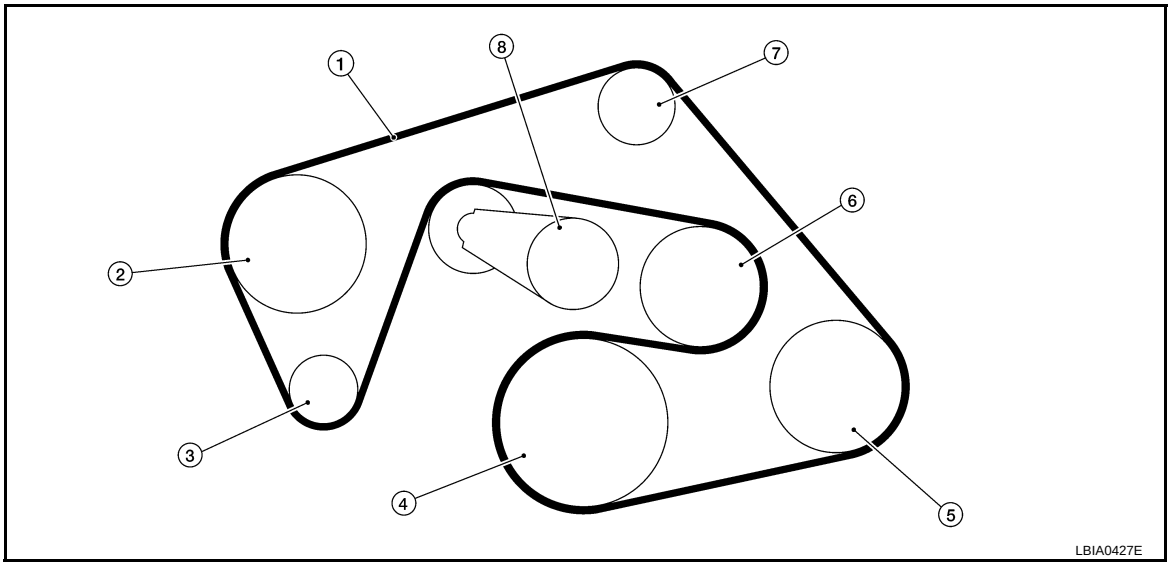


1. Drive belt
2. Power steering oil pump pulley
3. Generator pulley
4. Crankshaft pulley
5. A/C compressor
6. Cooling fan pulley
7. Idler pulley
8. Drive belt tensioner

WARNING:
Be sure to perform when the engine is stopped.

1. Remove air duct and resonator assembly when inspecting drive belt. Refer to EM-25, "Removal and Installation".
2. Visually check entire belt for wear, damage or cracks.

Tension Adjustment

INFOID:0000000001281972

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

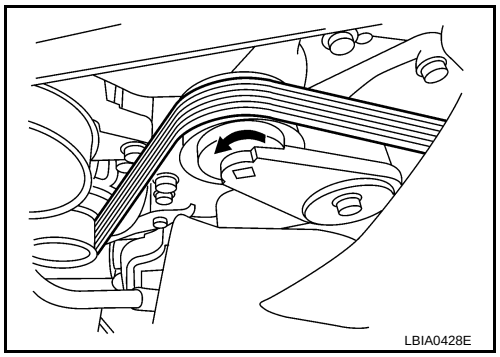
Removal and Installation

INFOID:0000000001281973

DRIVE BELT

Removal

1. Remove air duct and resonator assembly. Refer to EM-25, "Removal and Installation".
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.



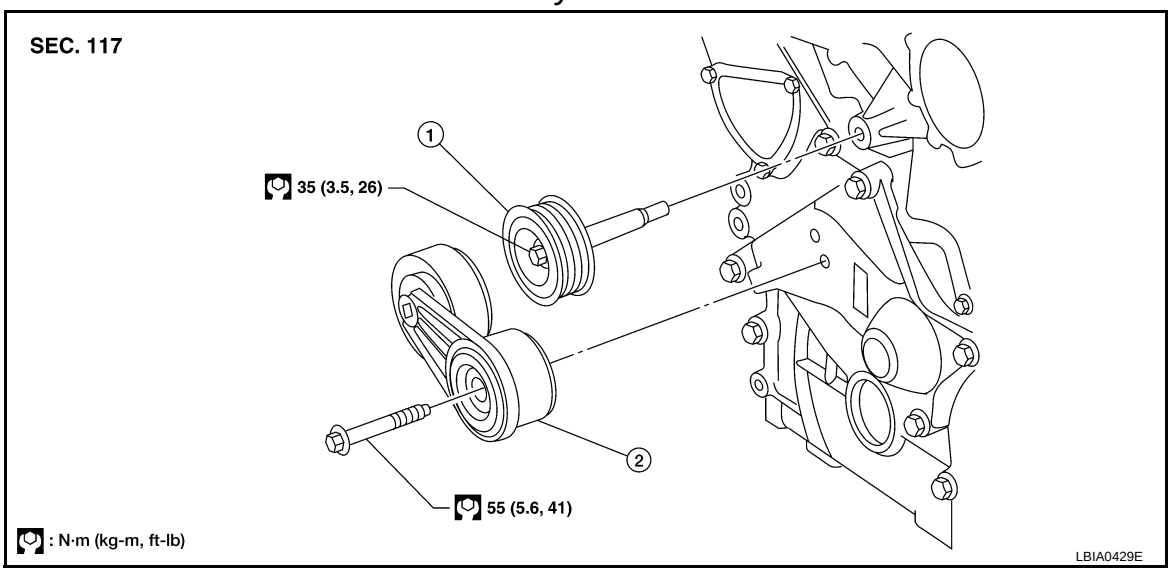
Installation

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

INFOID:0000000001281974



1. Idler pulley
2. Drive belt auto tensioner

REMOVAL

1. Remove air duct and resonator assembly. Refer to EM-25, "Removal and Installation".
2. Remove drive belt. Refer to EM-13, "Removal and Installation".
3. Remove engine cooling fan assembly (motor driven type). Refer to CO-20, "Removal and Installation (Motor driven type)".
4. Remove auto tensioner and idler pulley using power tool.

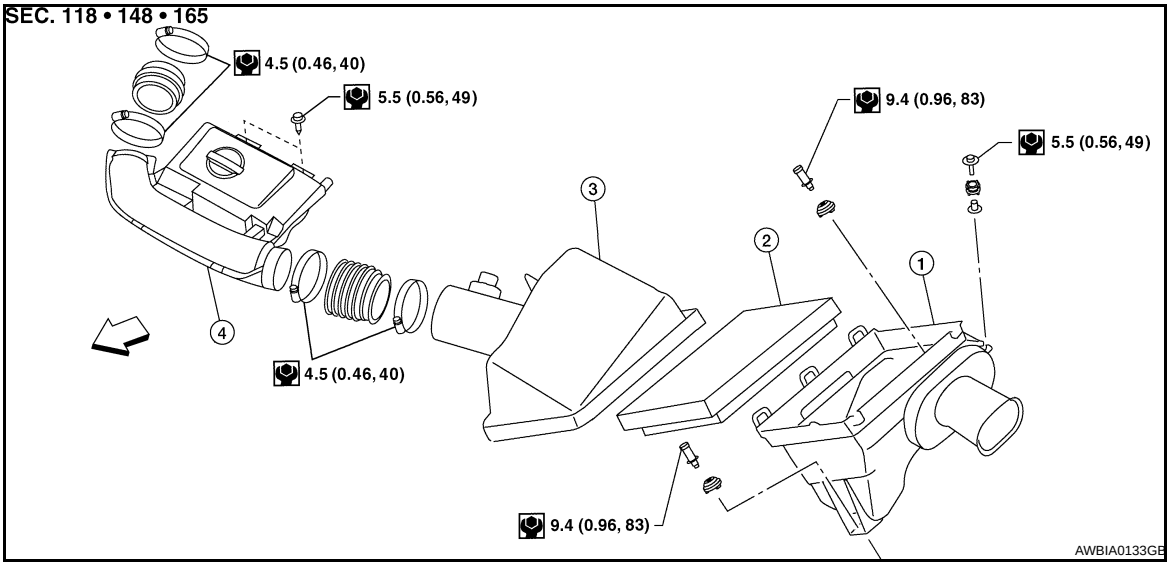
INSTALLATION

Installation is in the reverse order of removal.

AIR CLEANER FILTER

Changing Air Cleaner Filter

INFOID:0000000001281976



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

REMOVAL

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

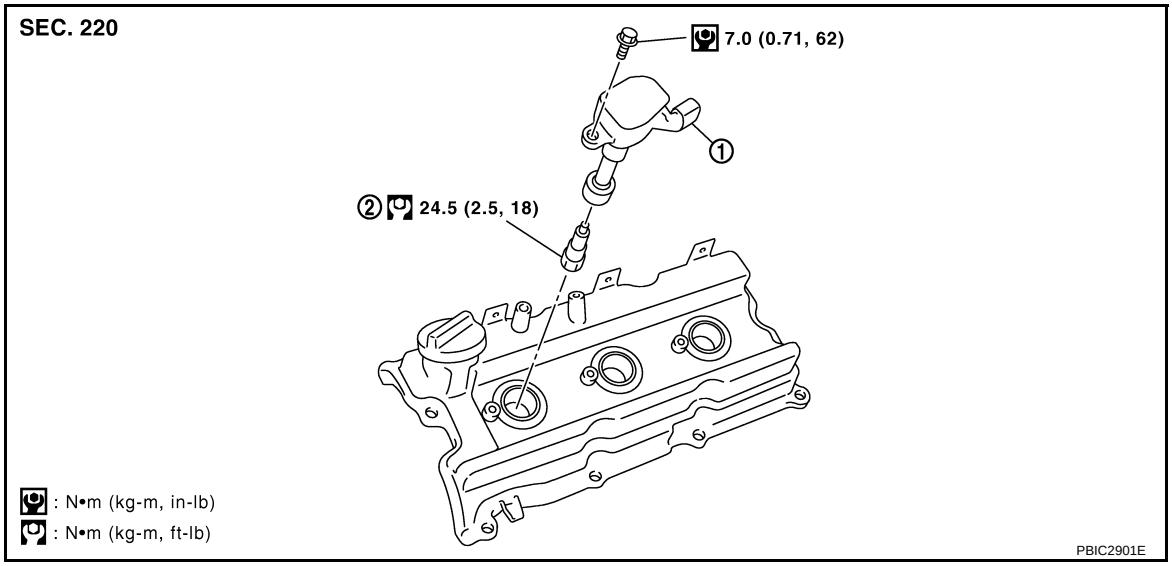
INSTALLATION

Installation is in the reverse order of removal.

SPARK PLUG

Changing Spark Plugs

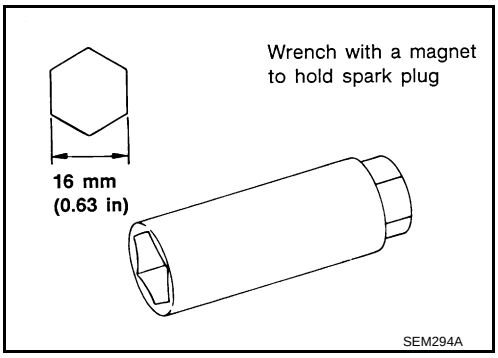
INFOID:0000000001281982



1. Ignition coil
2. Spark plug

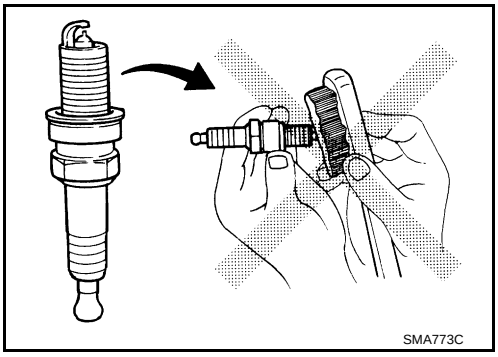
REMOVAL

1. Remove the ignition coil. Refer to EM-41, "Removal and Installation".
2. Remove the spark plug using a suitable tool.
   CAUTION:
   Do not drop or shock it.



INSPECTION AFTER REMOVAL

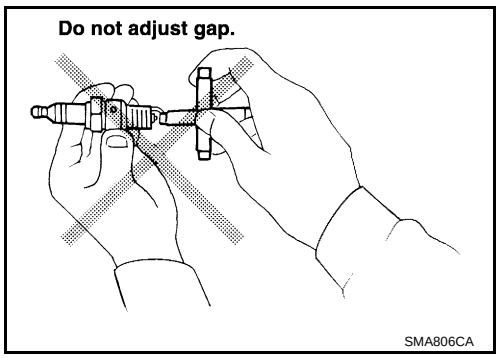
- Do not use a wire brush to clean the spark plug.



- If plug tip is covered with carbon, spark plug cleaner may be used.

Cleaner air pressure	**: Less than 588 kPa (5.9 bar, 6 kg/cm^2, 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.

CAUTION:

Do not drop or shock the spark plug.

Make	NGK
Standard type	DILFR5A-11
Gap (nominal)	1.1 mm (0.043 in)

CAMSHAFT VALVE CLEARANCE

Valve Clearance

INFOID:0000000001281988

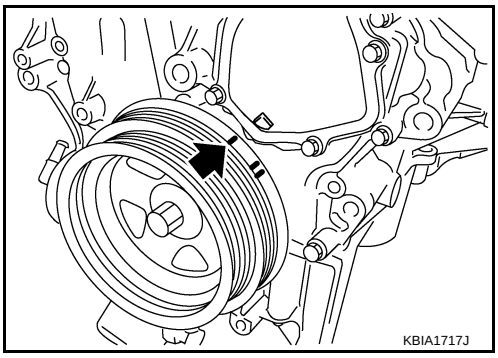
INSPECTION

NOTE:

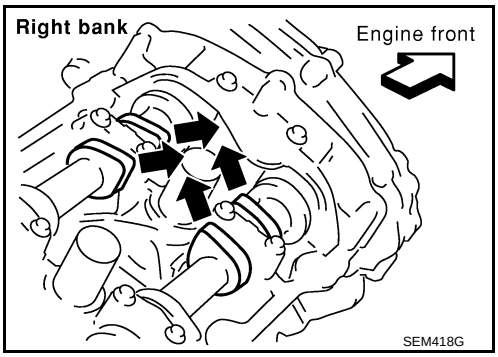
Perform the following inspection after removal, installation or replacement of camshaft or valve-related parts, or if there are unusual engine conditions due to changes in valve clearance over time (starting, idling, and/or noise).

1. Warm up the engine. Then stop the engine.
2. Remove rocker covers (right and left banks). Refer to EM-42, "Removal and Installation".
3. Measure the valve clearance as follows:

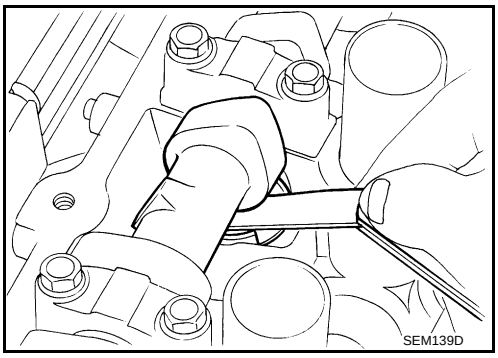
a. Set No. 1 cylinder at TDC of its compression stroke.
- Rotate crankshaft pulley clockwise to align timing mark (grooved line without color) with timing indicator.



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



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



Valve clearance:

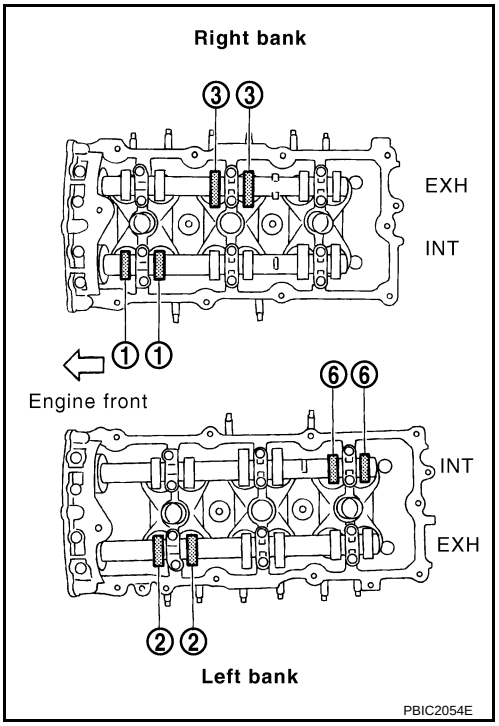
Unit: mm (in)

	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)

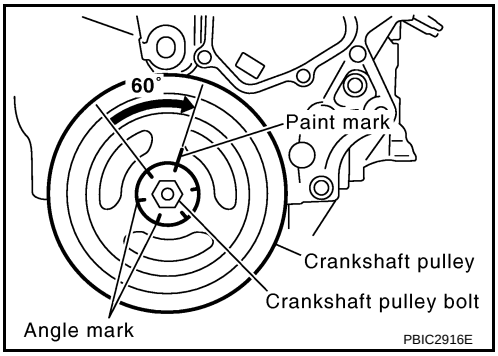
*: Approximately 80°C (176°F)

- Measure the valve clearances at locations marked "×" as shown in the table below (locations indicated in the illustration) with feeler gauge.
- No. 1 cylinder at compression TDC

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

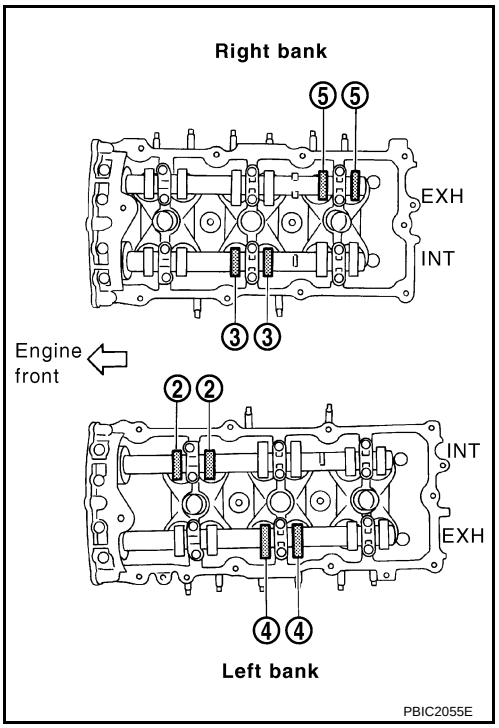


c. Rotate crankshaft by 240° clockwise (when viewed from engine front) to align No. 3 cylinder at TDC of its compression stroke.
NOTE:
Crankshaft pulley bolt flange has a stamped line every 60°. They can be used as a guide to rotation angle.

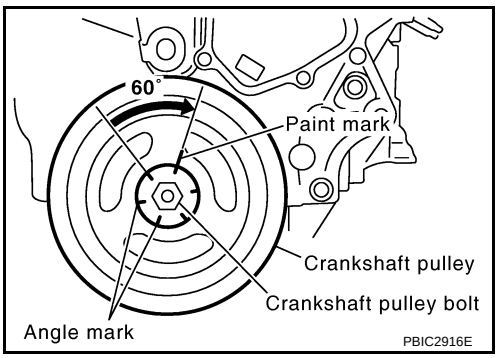


- Measure the valve clearances at locations marked "×" as shown in the table below (locations indicated in the illustration) with feeler gauge.
- No. 3 cylinder at compression TDC

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

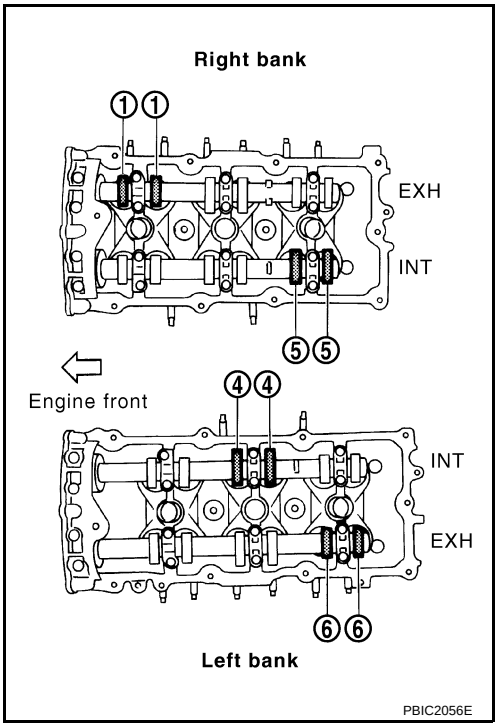


d. Rotate crankshaft by 240° clockwise (when viewed from engine front) to align No. 5 cylinder at TDC of compression stroke.



- Measure the valve clearances at locations marked "×" as shown in the table below (locations indicated in the illustration) with feeler gauge.
- No. 5 cylinder at compression TDC

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

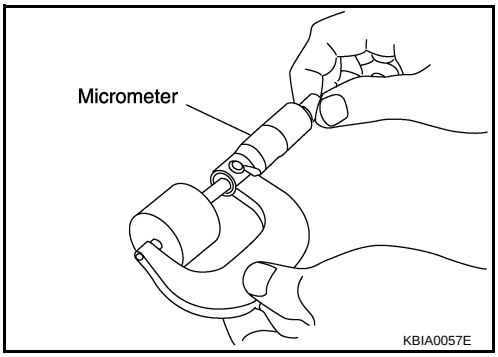


4. For the measured value out of the standard, perform adjustment.

ADJUSTMENT

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

1. Measure the valve clearance.
2. Remove camshaft. Refer to EM-81, "Removal and Installation".
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

t_1 = Removed valve lifter thickness

C_1 = Measured valve clearance

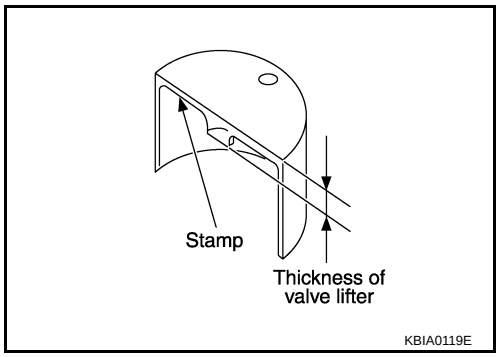
C_2 = Standard valve clearance:

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

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

***: Approximately 20°C (68°F)**

- 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-132, "Standard and Limit".

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-132, "Standard and Limit".

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-81, "Removal and 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.

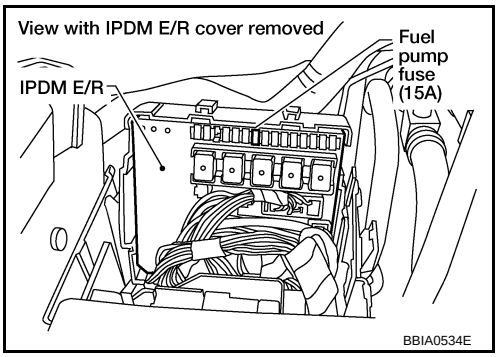
COMPRESSION PRESSURE

Compression Pressure

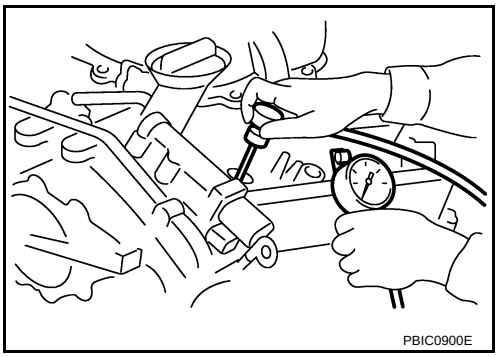
INFOID:0000000001301160

CHECKING COMPRESSION PRESSURE

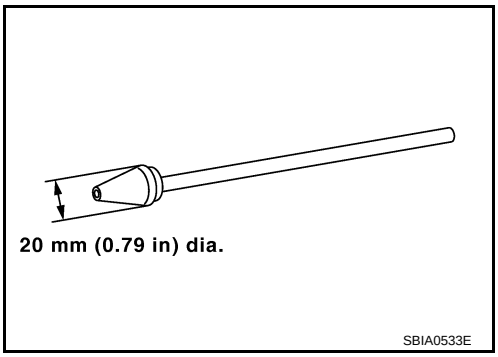
1. Warm up engine thoroughly.
2. Release fuel pressure. Refer to EC-481, "Fuel Pressure Check".
3. Disconnect fuel pump fuse to avoid fuel injection during measurement.



4. Remove intake manifold collector. Refer to EM-26, "Removal and Installation".
5. Remove spark plug from each cylinder. Refer to EM-16, "Changing Spark Plugs".
6. Connect engine tachometer (not required in use of CONSULT-III).
7. Install compression tester with adapter onto spark plug hole.



- Use compression gauge whose pick 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/cm^2, 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.

- 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-85, "Description".

ON-VEHICLE REPAIR

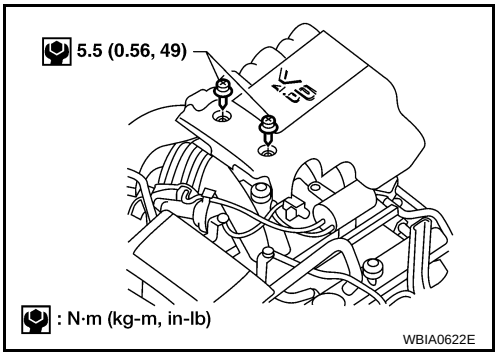
ENGINE ROOM COVER

Removal and Installation

INFOID:0000000001281970

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.



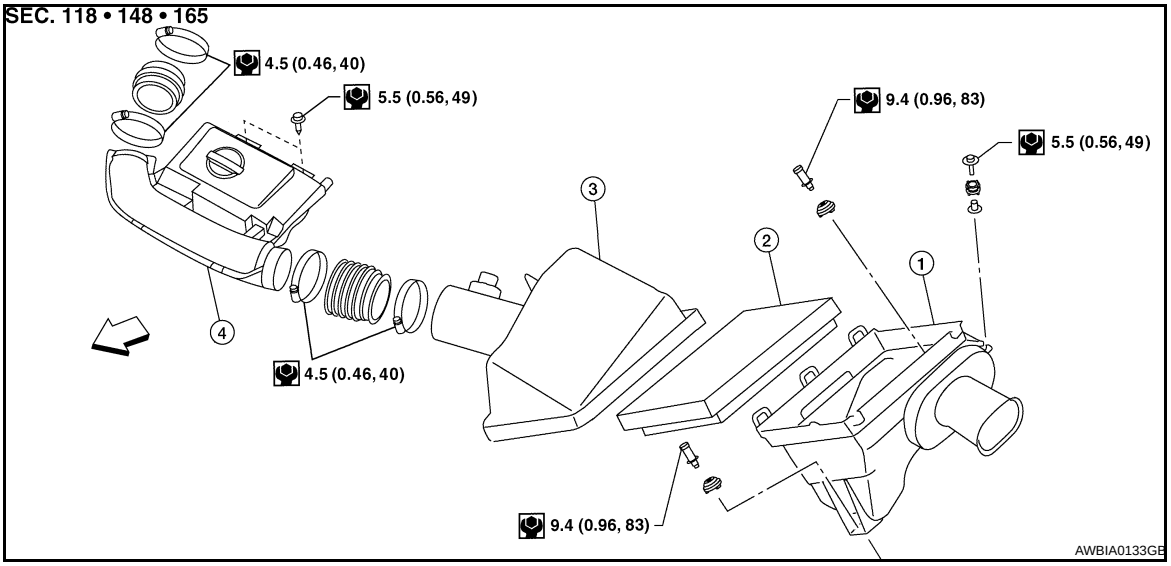
INSTALLATION

Installation is in the reverse order of removal.

AIR CLEANER AND AIR DUCT

Removal and Installation

INFOID:0000000001281975



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

REMOVAL

1. Remove the engine room cover using power tool. Refer to EM-164, "Removal and Installation".
2. Disconnect the harness connector from air cleaner case (upper).
3. Remove the air duct and resonator assembly and air cleaner case (upper).
4. Remove air cleaner filter and air cleaner case (lower).

• 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.

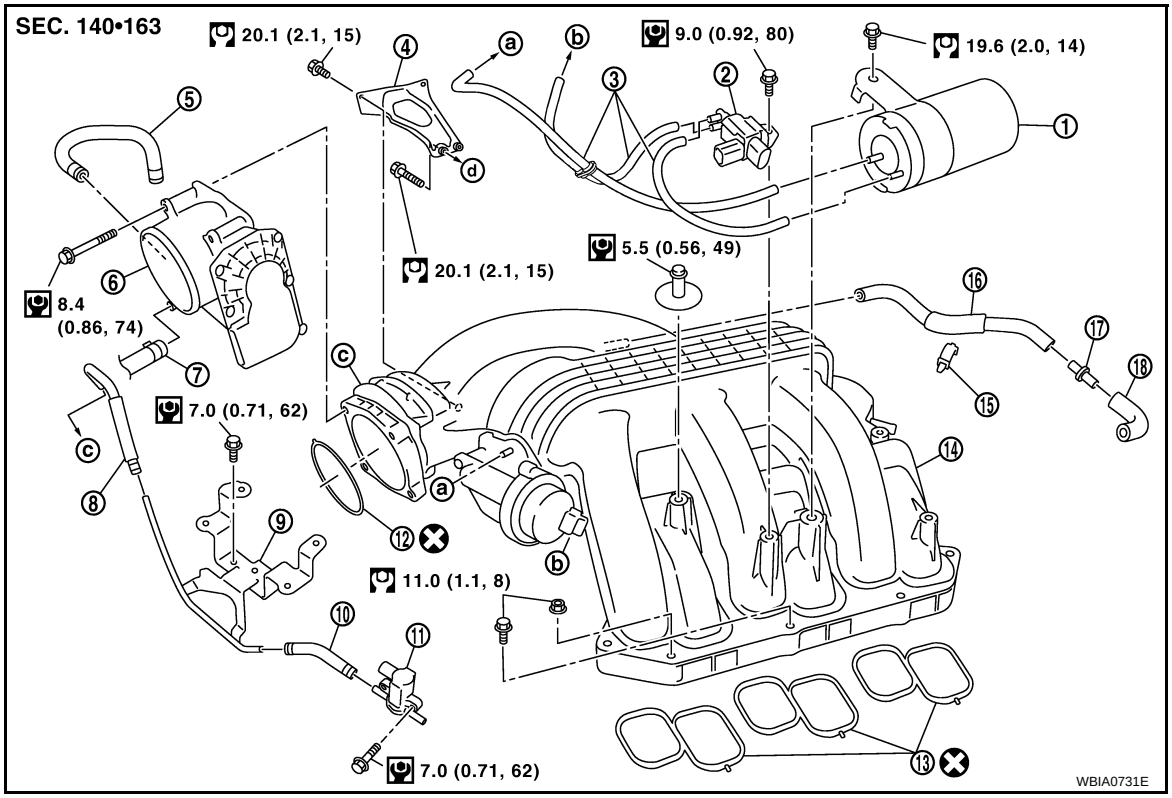
INSTALLATION

Installation is in the reverse order of removal.

INTAKE MANIFOLD COLLECTOR

Removal and Installation

INFOID:0000000001281977



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
a.	To intake manifold collector	b.	To power valve	c.	To throttle body
d.	To cylinder head (RH bank)				

REMOVAL

WARNING:

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

1. Remove engine cover. Refer to EM-24, "Removal and Installation".
2. Remove air cleaner case (upper) with mass air flow sensor and air duct assembly. Refer to EM-25, "Removal and Installation".
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 CO-12, "Changing Engine Coolant".

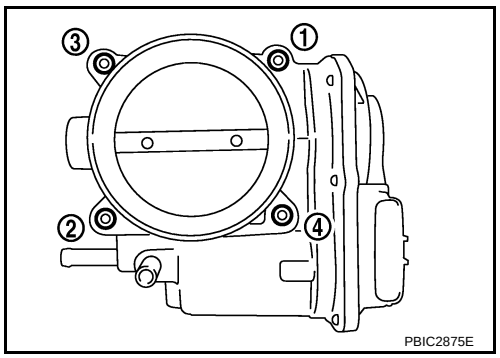
CAUTION:

- **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.

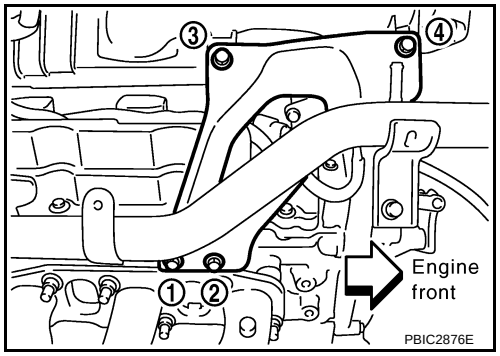
c. Disconnect harness connector.

d. Loosen bolts in reverse order as shown.
CAUTION:
- **Handle carefully to avoid any shock to electric throttle control actuator.**
- **Do not disassemble.**



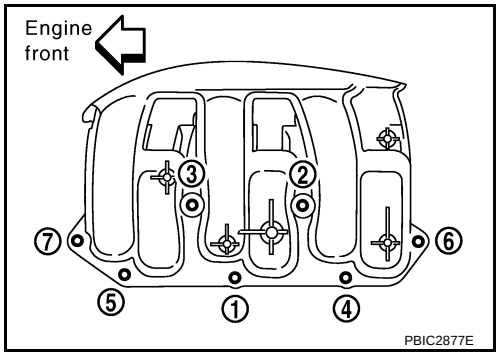
4. Remove the following parts:
- Vacuum hose (to brake booster)
- PCV hose

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.

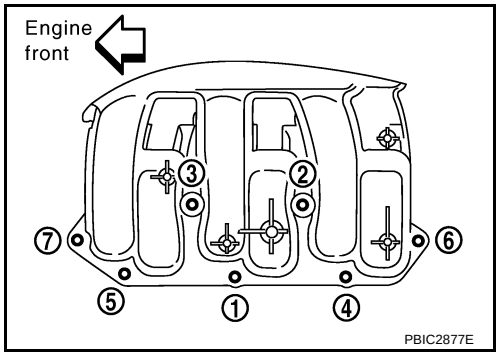
9. Loosen nuts and bolts in reverse order as shown with power tool, and remove intake manifold collector.
CAUTION:
Cover engine openings to avoid entry of foreign materials.



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.

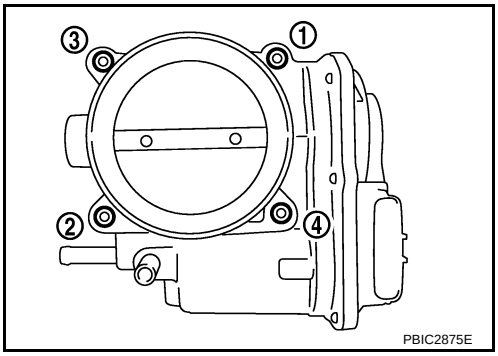


Intake manifold collector bolts and nuts : 11.0 N·m (1.1 kg-m, 8 ft-lb)

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

Electric Throttle Control Actuator

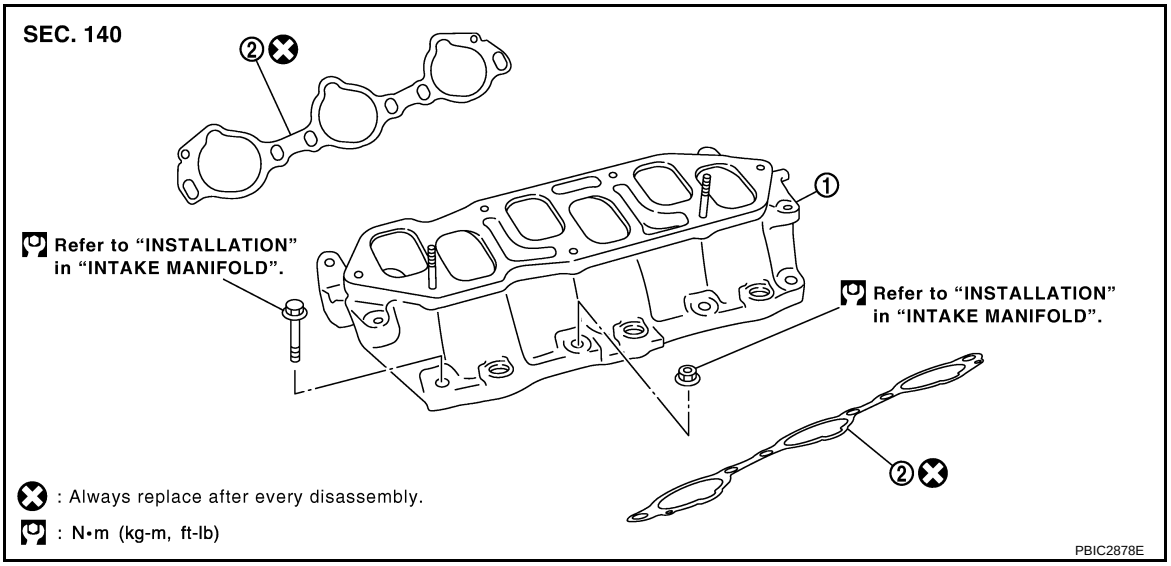
- Tighten bolts in numerical order as shown.
- Perform the “Throttle Valve Closed Position Learning” when harness connector of electric throttle control actuator is disconnected. Refer to EC-26, "Throttle Valve Closed Position Learning".
- Perform the “Idle Air Volume Learning” and “Throttle Valve Closed Position Learning” when electric throttle control actuator is replaced. Refer to EC-26, "Idle Air Volume Learning".



INTAKE MANIFOLD

Removal and Installation

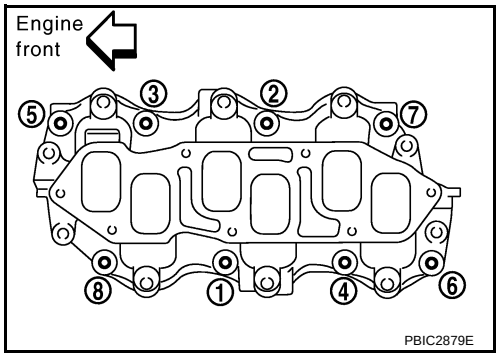
INFOID:0000000001281978



1. Intake manifold
2. Gasket

REMOVAL

1. Release fuel pressure. Refer to EC-481, "Fuel Pressure Check".
2. Remove intake manifold collector. Refer to EM-26, "Removal and Installation".
3. Remove fuel tube and fuel injector assembly. Refer to EM-47, "Removal and Installation".
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.

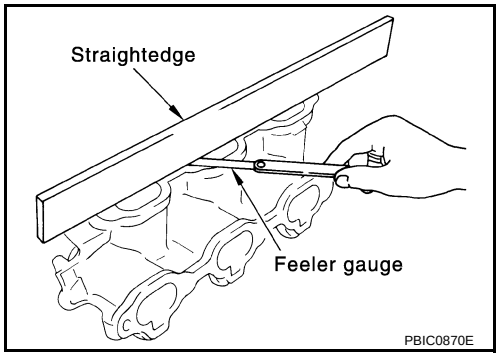
INSPECTION AFTER REMOVAL

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.



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.

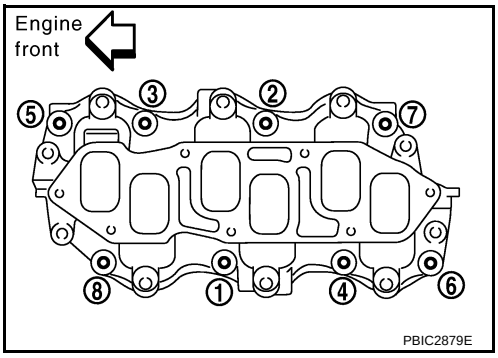
Intake manifold studs : 11.0 N·m (1.1kg-m, 8 ft-lb)

- 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, 65 in-lb)

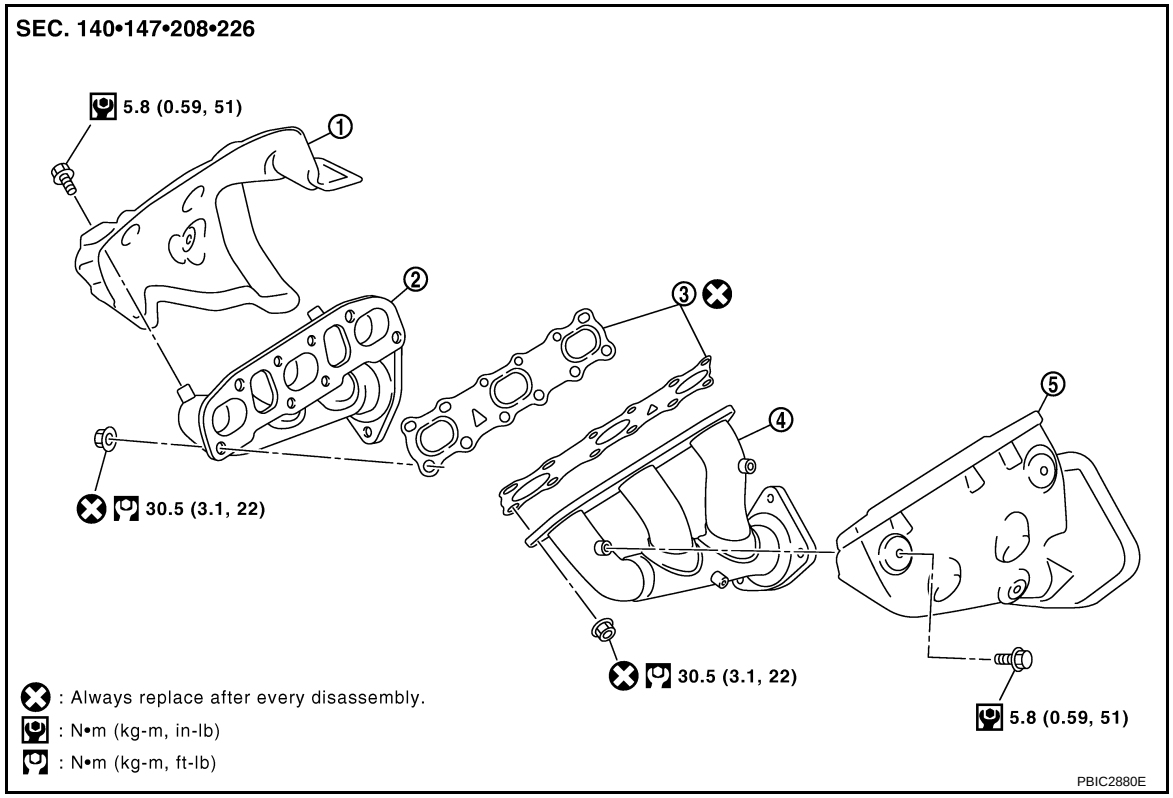
2nd step and after : 29.0 N·m (3.0 kg-m, 21 ft-lb)



EXHAUST MANIFOLD AND THREE WAY CATALYST

Removal and Installation

INFOID:0000000001281979



1. Exhaust manifold cover (RH)
2. Exhaust manifold (RH)
3. Gasket
4. Exhaust manifold (LH)
5. Exhaust manifold cover (LH)

REMOVAL (LH)

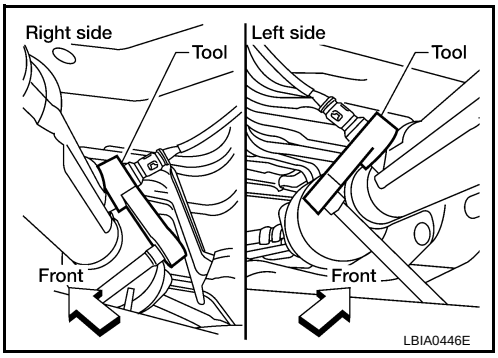
WARNING:

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

1. Remove air cleaner case and air duct. Refer to EM-25, "Removal and Installation".
2. Remove engine undercover using power tool.
3. Disconnect harness connector and remove LH and RH heated oxygen sensor 2 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 (19.70 in) onto a hard surface such as a concrete floor; replace with a new sensor.**

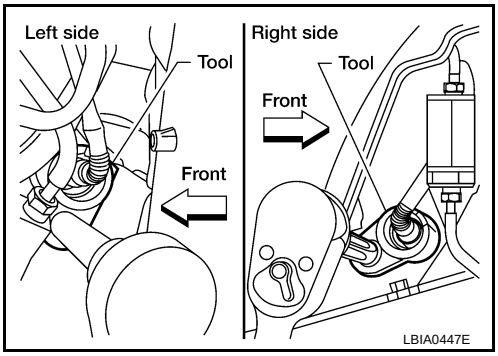


4. Remove center exhaust tube, main muffler and left front exhaust tube. Refer to EX-5, "Removal and Installation".
5. Remove exhaust manifold cover (LH).

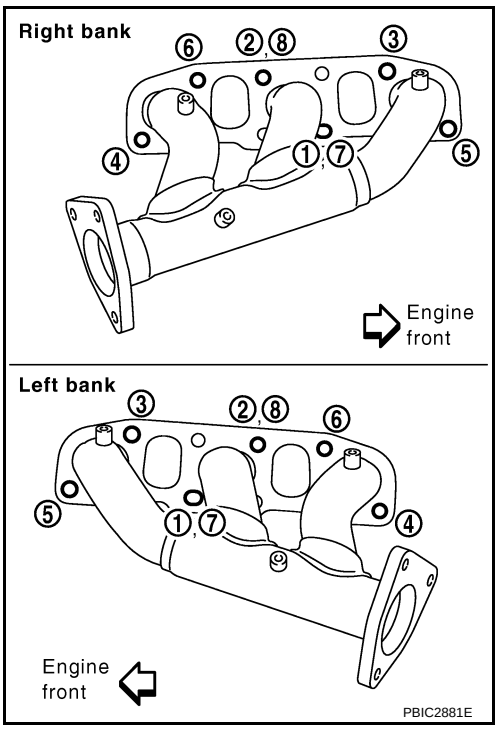
6. Disconnect harness connector and remove air fuel ratio sensor 1 (LH) using Tool.

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 LH).
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.

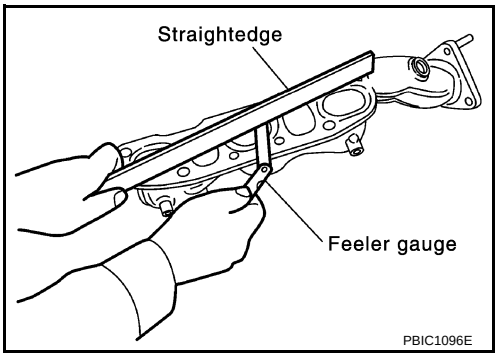
INSPECTION AFTER REMOVAL

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.

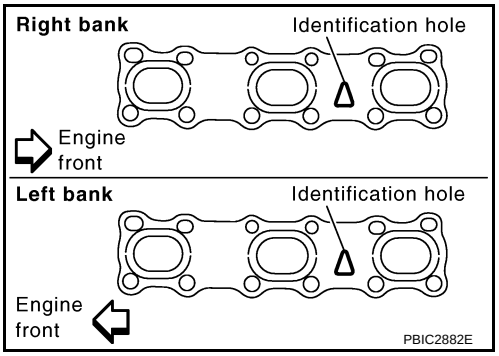


INSTALLATION (LH)

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

Exhaust Manifold Gasket

Install the exhaust manifold gaskets in direction as shown.



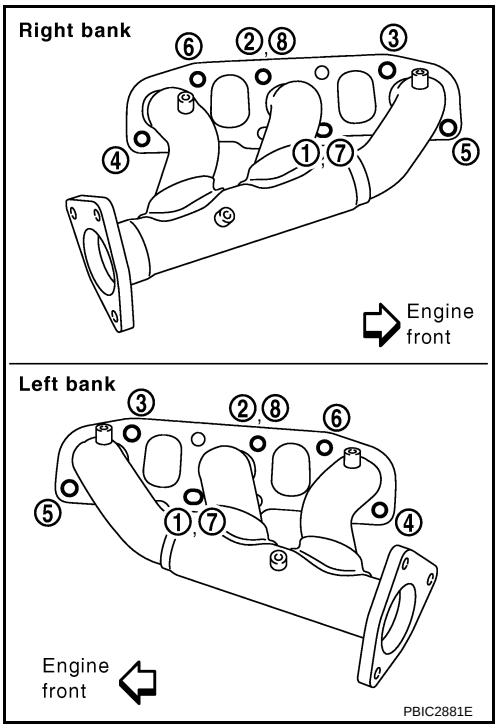
Exhaust Manifold

- 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.

CAUTION:
Use new exhaust manifold nuts for installation.
NOTE:
Tighten nuts No. 1 and 2 in two steps. The numerical order No. 7 and 8 show 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.**

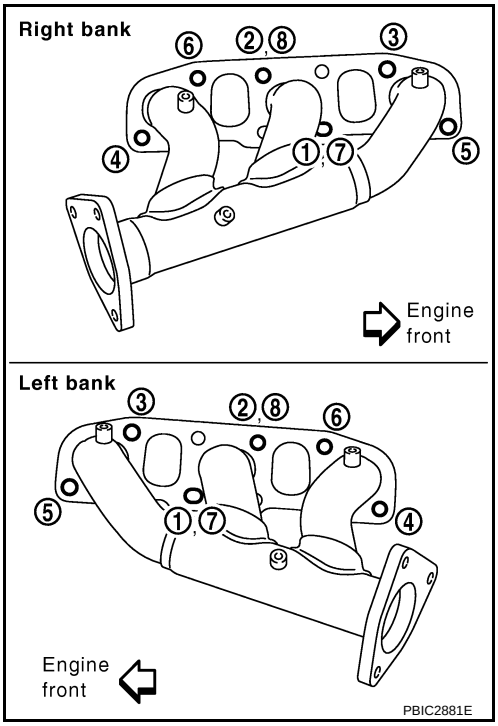
Tool number : — (J-43897-12)
: — (J-43897 18)

- **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.**

REMOVAL (RH)

1. Remove engine assembly. Refer to EM-103, "Removal and Installation".

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.

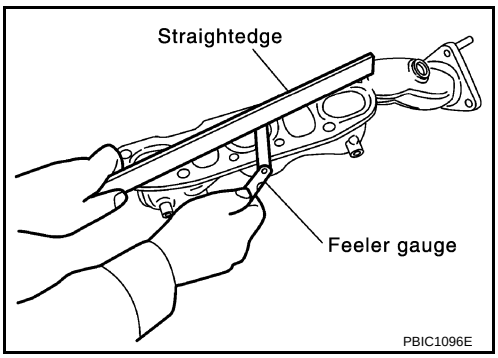
INSPECTION AFTER REMOVAL

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.

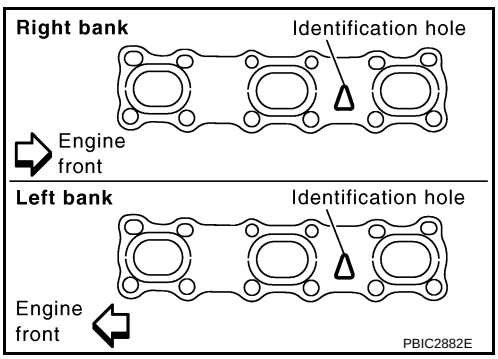


INSTALLATION (RH)

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

Exhaust Manifold Gasket

Install the exhaust manifold gaskets in direction as shown.



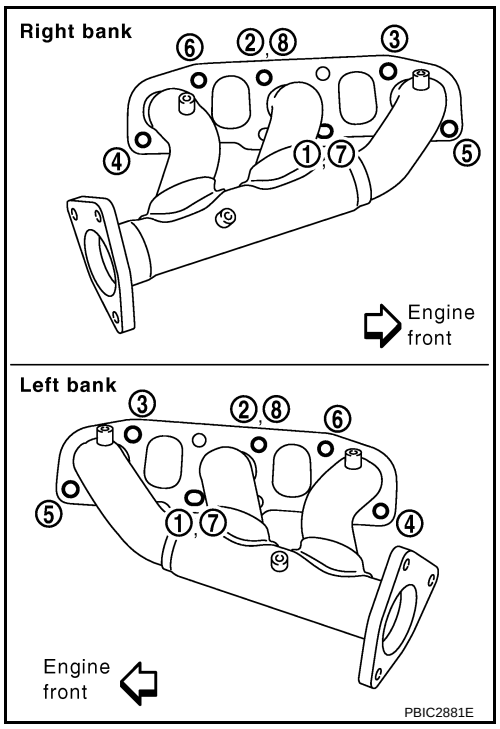
Exhaust Manifold

- 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.

CAUTION:
Use new exhaust manifold nuts for installation.
NOTE:
Tighten nuts No. 1 and 2 in two steps. The numerical order No. 7 and 8 show second step.



- 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.

Heated Oxygen Sensor

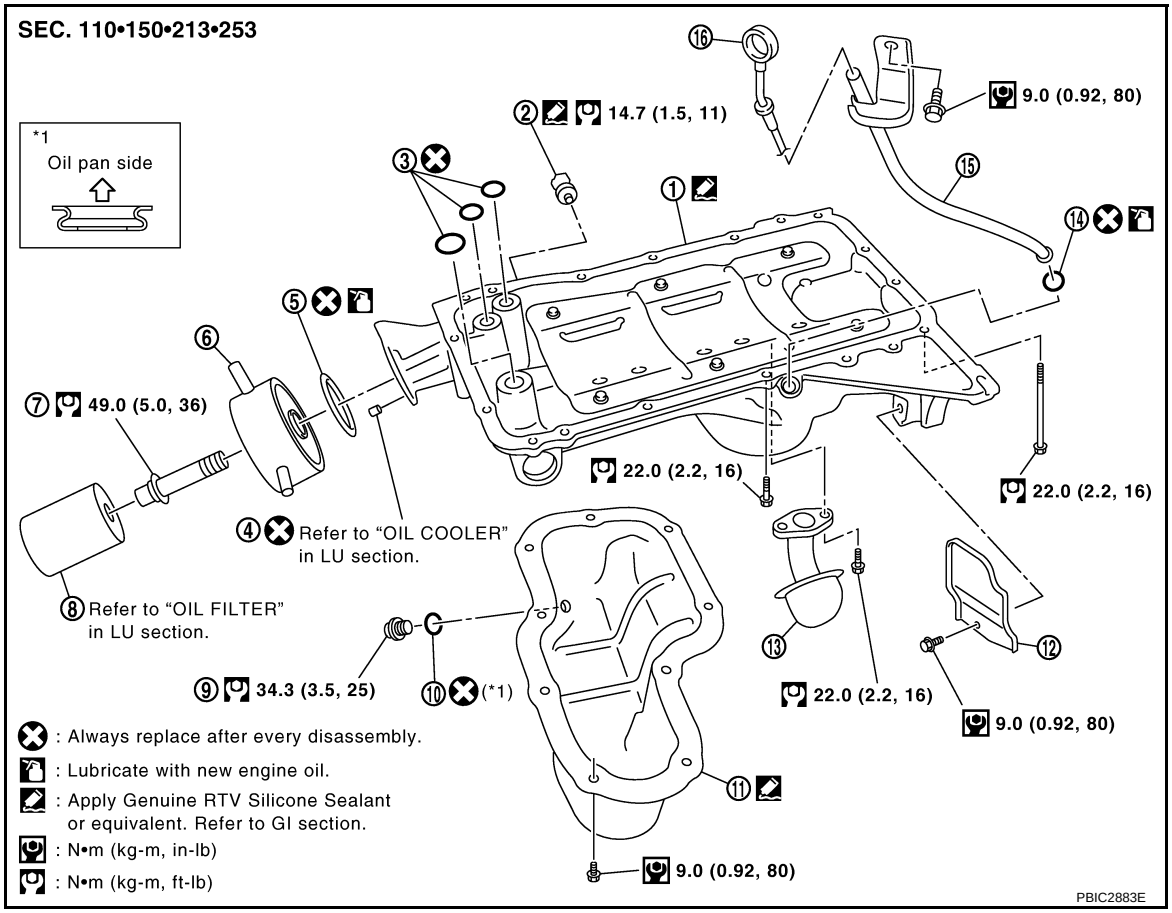
CAUTION:
- **Do not over tighten air fuel ratio sensor 1 and heated oxygen sensor 2. Doing so may cause damage to air fuel ratio sensor 1 and heated oxygen sensor 2, resulting in the "MIL" coming on.**
-

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

OIL PAN AND OIL STRAINER

Removal and Installation

INFOID:0000000001281980



1. Oil pan (upper)
2. Oil pressure switch
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

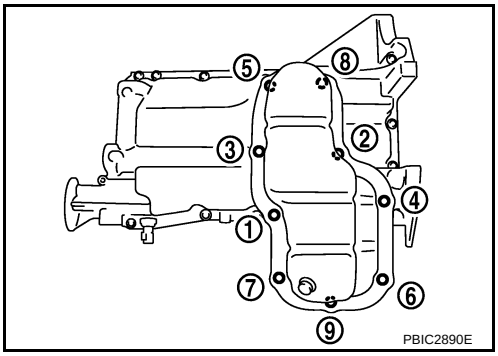
REMOVAL (Lower)

WARNING:

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

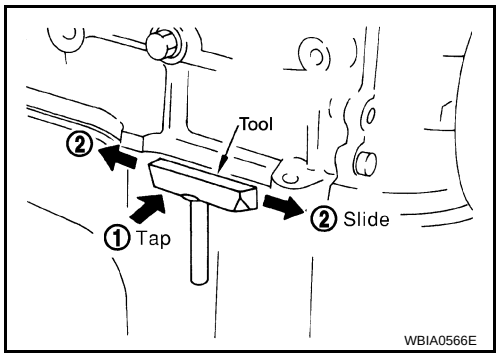
1. Drain engine oil. Refer to LU-9, "Changing Engine Oil".
2. Remove oil pan (lower) as follows:

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



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:
Tap seal cutter to insert it (1) and then slide it by tapping on the side (2) of the tool as shown.

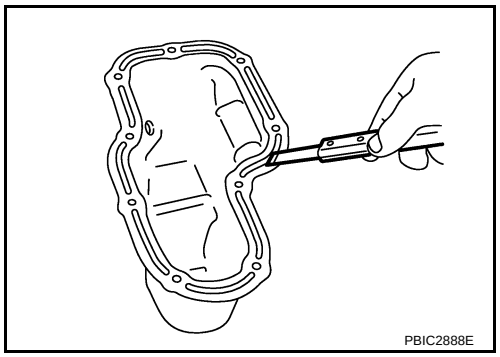
INSPECTION AFTER REMOVAL

Clean oil strainer if any object attached.

INSTALLATION (Lower)

1. Install oil pan (lower) as follows:

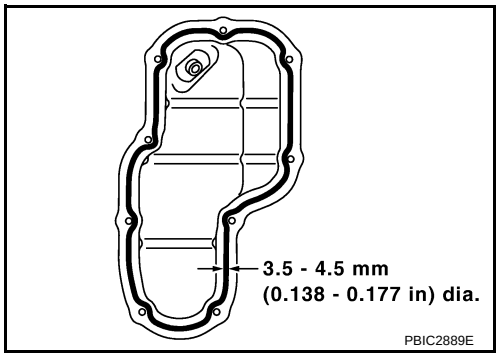
a. Use scraper to remove old liquid gasket from mating surfaces.
- Also remove old liquid gasket from mating surface of oil pan (upper).
- Remove old liquid gasket from the bolt holes and thread.



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.

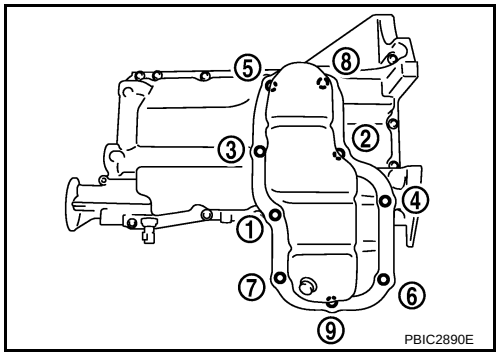
Tool number : WS39930000 (—)



Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "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-36, "Removal and Installation".
3. After 30 minutes fill with engine oil and inspect for leaks. Refer to LU-9, "Changing Engine Oil".

CAUTION:
Do not fill the engine with oil for at least 30 minutes after oil pan is installed.

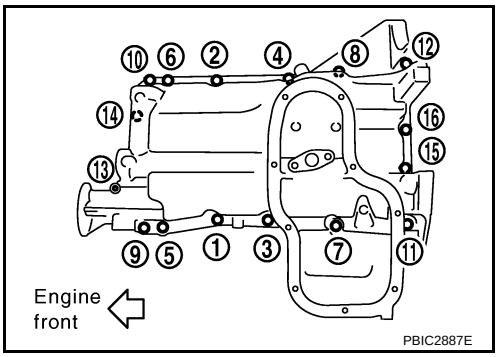
INSPECTION AFTER INSTALLATION

1. Check engine oil level and adjust engine oil. Refer to LU-8, "Inspection".
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-8, "Inspection".

REMOVAL (Upper)

WARNING:
To avoid the danger of being scalded, do not drain engine oil when engine is hot.
CAUTION:
- **Perform this procedure when engine is cold.**
- **Do not spill engine oil on drive belts.**
- **Do not spill engine coolant on drive belts.**

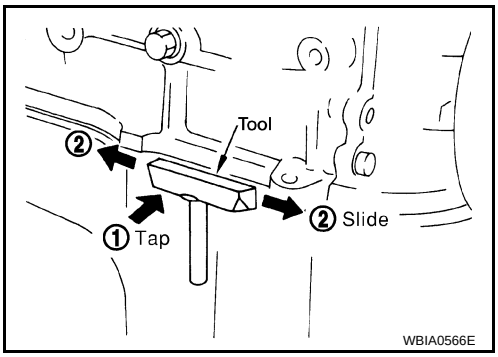
1. Remove engine cover with power tool. Refer to EM-24, "Removal and Installation".
2. Remove air duct. Refer to EM-25, "Removal and Installation".
3. Drain engine oil. Refer to LU-9, "Changing Engine Oil".
4. Drain engine coolant. Refer to CO-12, "Changing Engine Coolant".
5. Remove front final drive (4WD models). Refer to DLN-343, "Removal and Installation".
6. Disconnect steering gear lower joint shaft bolt and steering gear nuts and bolts, position out of the way. Refer to ST-22, "Removal and Installation".
7. Remove starter motor. Refer to STR-17, "Removal and Installation".
8. Disconnect A/T fluid cooler tube brackets and position out of the way. Refer to TM-224, "2WD : Exploded View" (2WD models), TM-228, "4WD : Exploded View" (4WD models).
9. Remove oil filter, as necessary. Refer to LU-11, "Removal and Installation".
10. Remove oil cooler. Refer to LU-12, "Removal and Installation".
11. Remove oil pan (lower). Refer to EM-36, "Removal and Installation".
12. Remove oil strainer.
13. Remove transmission joint bolts which pierce oil pan (upper). Refer to TM-224, "2WD : Exploded View" (2WD models), TM-228, "4WD : Exploded View" (4WD models).
14. Remove rear cover plate.
15. Loosen bolts with power tool in reverse order as shown.



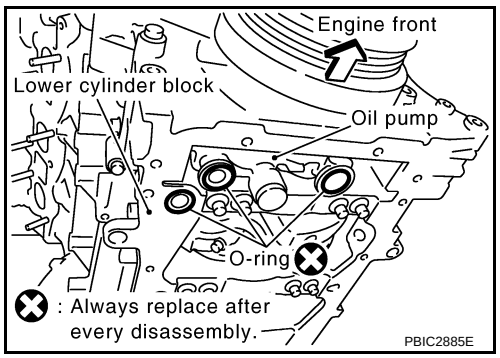
- Insert Tool between oil pan (upper) and lower cylinder block. Tap seal cutter to insert it (1) and then slide it by tapping on the side (2) as shown.

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

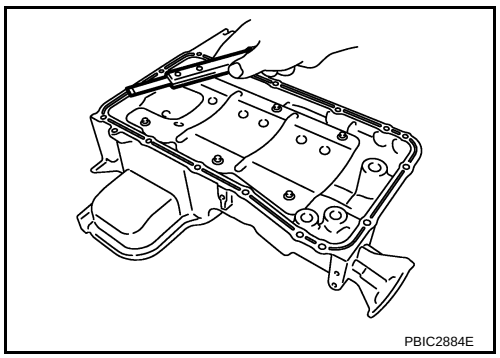
Clean oil strainer if any object attached.

INSTALLATION (Upper)

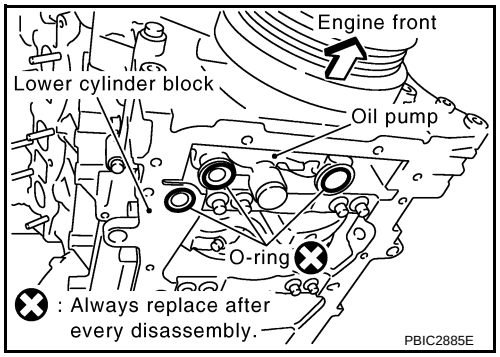
1. Install oil pan (upper) as follows:

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.

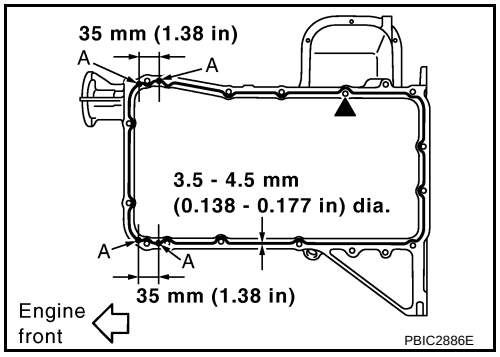


c. Apply a continuous bead of liquid gasket using Tool to the lower cylinder block mating surfaces of oil pan (upper) as shown.

Tool number : WS39930000 (—)

Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "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.**

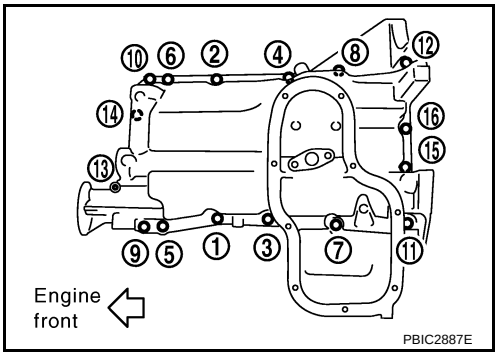


d. Install oil pan (upper).

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.

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 TM-224, "2WD : Exploded View" (2WD models), TM-228, "4WD : Exploded View" (4WD models).
2. Install oil strainer to oil pan (upper).
3. Installation of the remaining components is in the reverse order of removal.

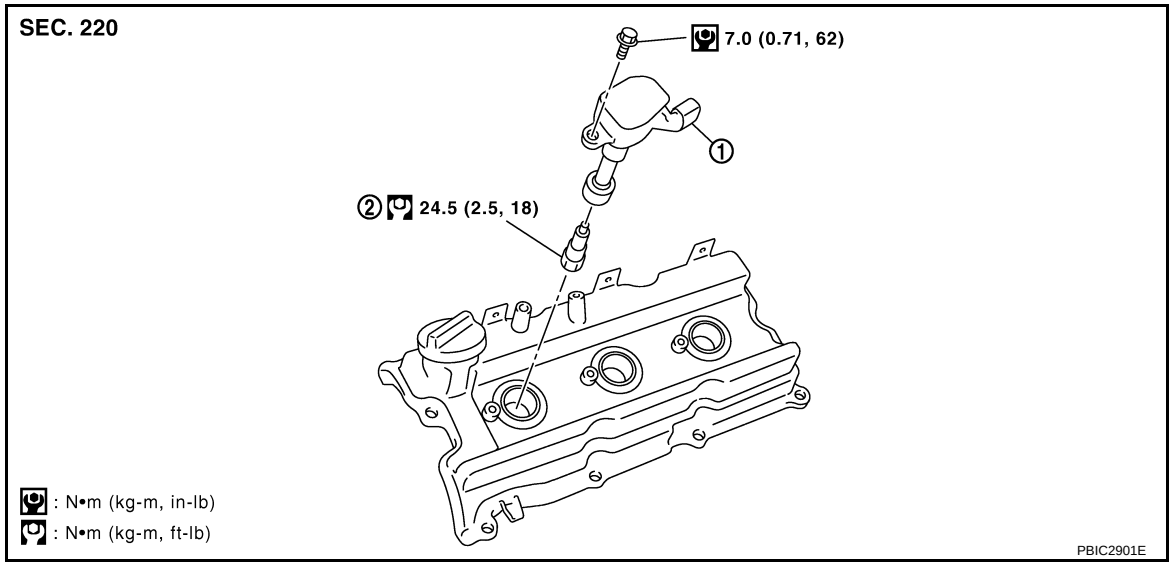
INSPECTION AFTER INSTALLATION

1. Check engine oil level and adjust engine oil. Refer to LU-8, "Inspection".
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-8, "Inspection".

IGNITION COIL

Removal and Installation

INFOID:0000000001281981



1. Ignition coil
2. Spark plug

REMOVAL (LH)

1. Remove engine cover with power tool. Refer to EM-24, "Removal and Installation".
2. Remove air cleaner case and air duct. Refer to EM-25, "Removal and Installation".
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 (LH)

Installation is in the reverse order of removal.

REMOVAL (RH)

1. Remove intake manifold collector with power tool. Refer to EM-26, "Removal and Installation".
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.

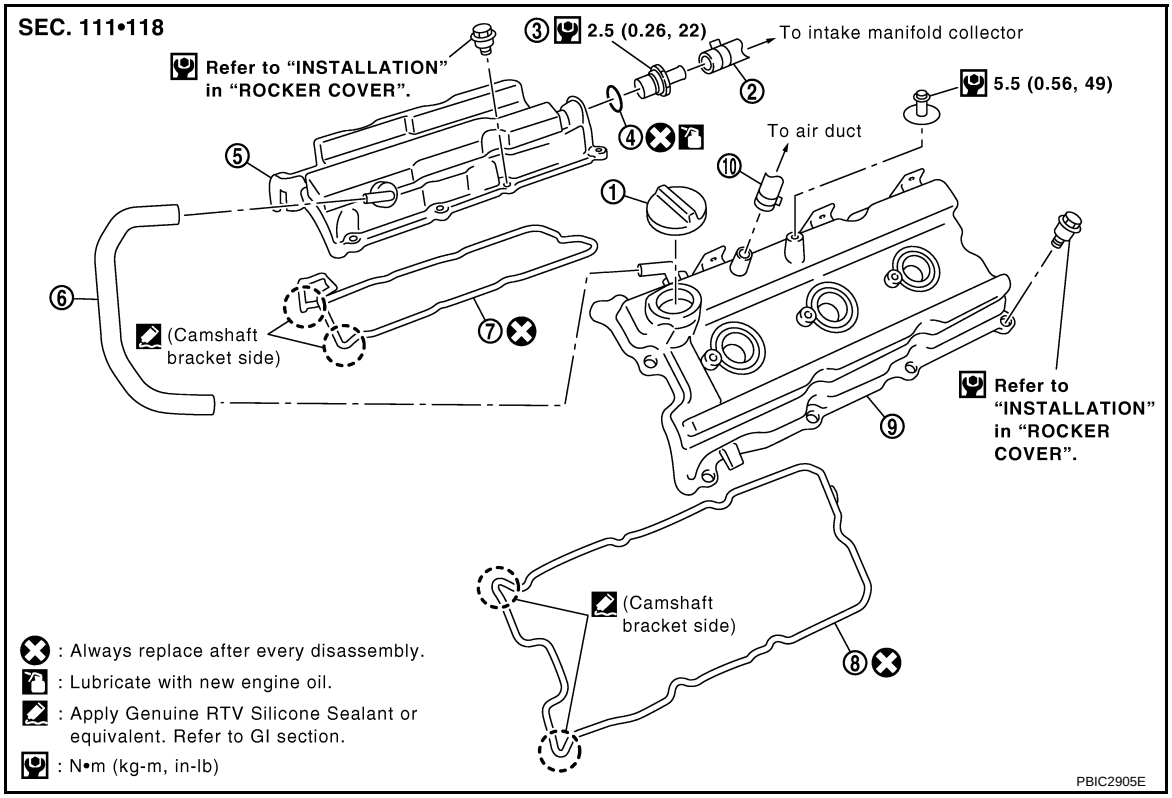
INSTALLATION (RH)

Installation is in the reverse order of removal.

ROCKER COVER

Removal and Installation

INFOID:0000000001281984

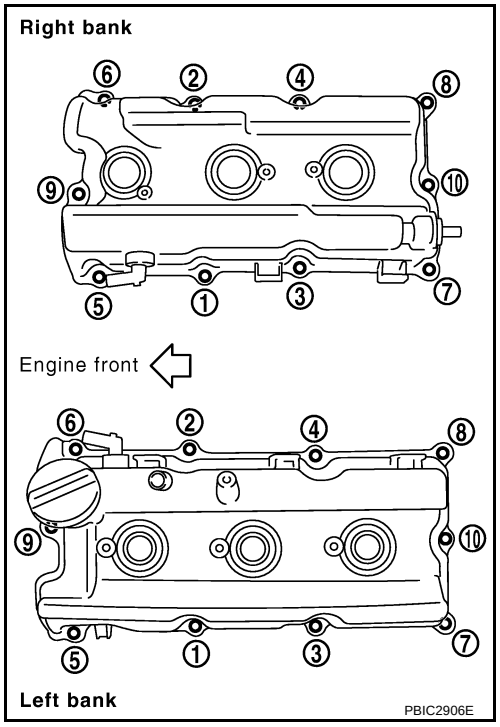


1. Oil filler cap
2. PCV hose
3. PCV valve
4. O-ring
5. Rocker cover (RH)
6. PCV hose
7. Rocker cover gasket (RH)
8. Rocker cover gasket (LH)
9. Rocker cover (LH)
10. PCV hose

REMOVAL (LH)

1. Remove engine cover. Refer to EM-24, "Removal and Installation".
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-41, "Removal and Installation".
5. Remove PCV hoses from rocker covers.
6. Remove oil filler cap from rocker cover (LH), if necessary.

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



8. Remove rocker cover gaskets from rocker covers.
9. 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.

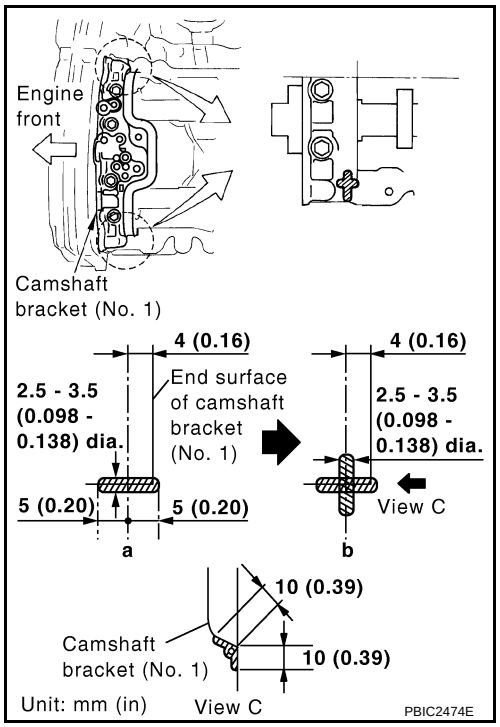
INSTALLATION (LH)

1. 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-26, "Recommended Chemical Products and Sealants".
NOTE:
The figure shows an example of LH side [zoomed in shows camshaft bracket (No. 1)].

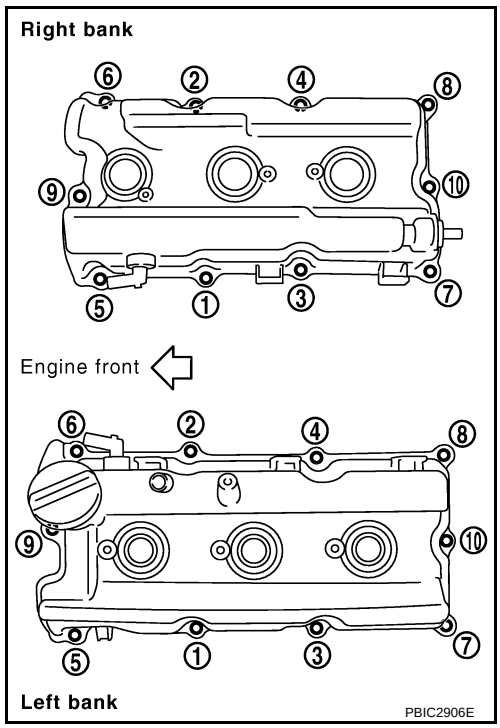
a. Apply liquid gasket to joint part of camshaft bracket "a" (No. 1) and cylinder head.
b. Apply liquid gasket "b" to the figure “a” squarely.



2. Install new rocker cover gasket to rocker cover.
3. Install rocker cover.
• Check to be sure rocker cover gasket is not dropped from installation groove of rocker cover.

4. Tighten bolts in two steps 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)**

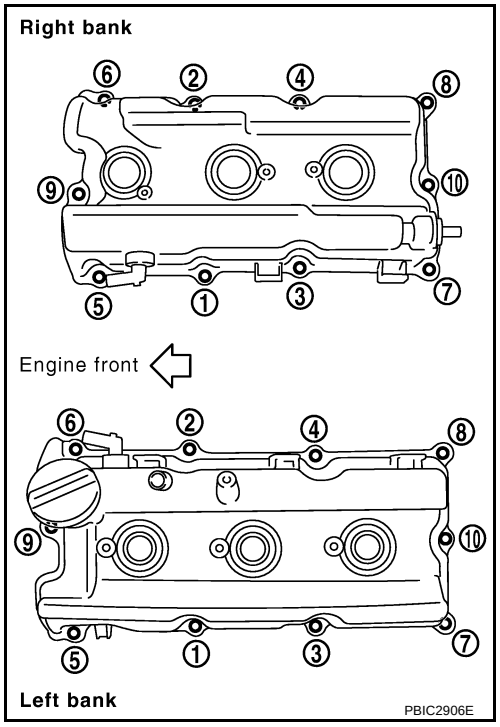


5. Install oil filer cap to rocker cover (left bank), if removed.
6. Install PCV hose.
   - Insert PCV hose by 25 to 30 mm (0.98 to 1.18 in) from connector end.
   - When installing, be careful not to twist or come in contact with other parts.
7. Installation of the remaining components is in the reverse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

REMOVAL (RH)

1. Remove intake manifold collector. Refer to EM-26, "Removal and Installation".
   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 (RH). Refer to EM-93, "Removal and Installation".
4. Remove ignition coil. Refer to EM-41, "Removal and Installation".
5. Remove PCV hoses from rocker cover.
6. Remove PCV valve and O-ring from rocker cover (RH), if necessary.

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



8. Remove rocker cover gaskets from rocker covers.
9. 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.

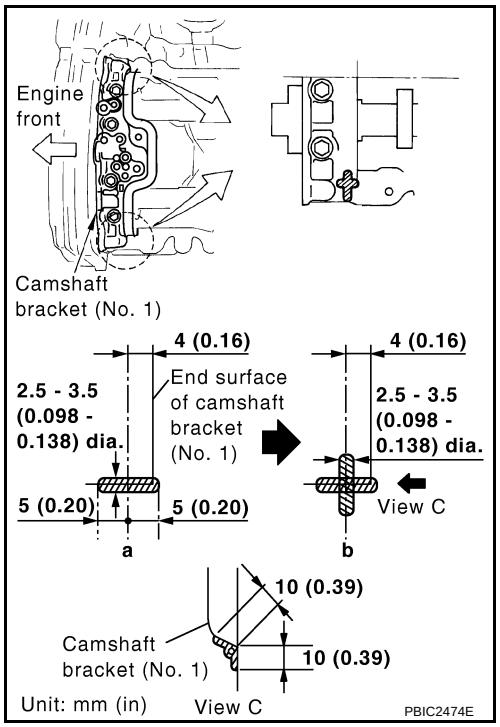
INSTALLATION (RH)

1. 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-26, "Recommended Chemical Products and Sealants".
NOTE:
The figure shows an example of LH side [zoomed in shows camshaft bracket (No. 1)].

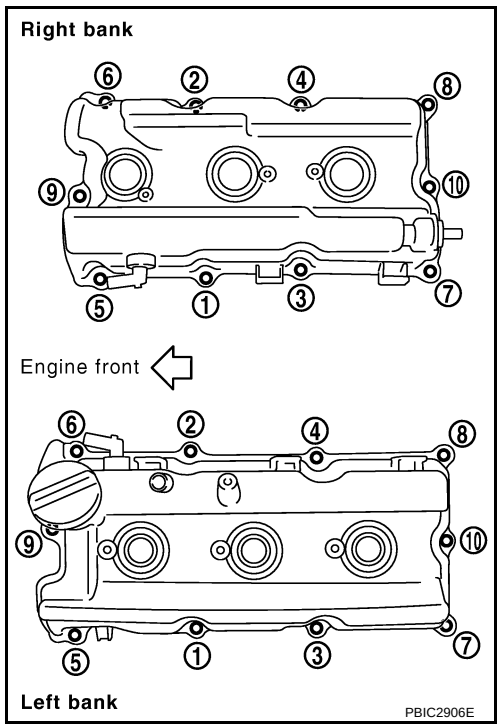
a. Apply liquid gasket to joint part of camshaft bracket "a" (No. 1) and cylinder head.
b. Apply liquid gasket "b" to the figure “a” squarely.



2. Install new rocker cover gasket to rocker cover.
3. Install rocker cover.
• Check to be sure rocker cover gasket is not dropped from installation groove of rocker cover.

4. Tighten bolts in two steps 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 (RH), 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.

FUEL INJECTOR AND FUEL TUBE

Removal and Installation

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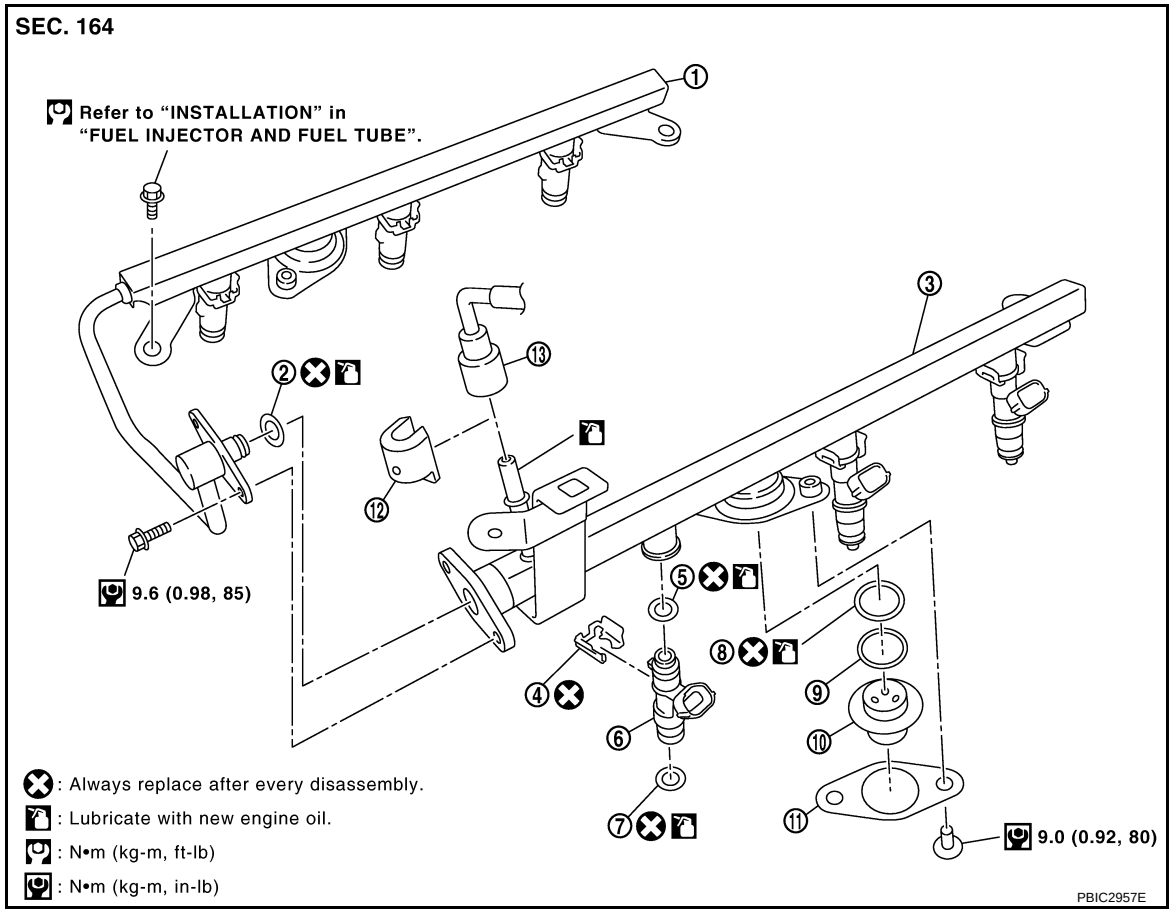


1. Fuel tube (RH)
2. O-ring
3. Fuel tube (LH)
4. Clip
5. O-ring (blue)
6. Fuel injector
7. O-ring (brown)
8. O-ring
9. Spacer
10. Fuel damper
11. Fuel damper cap
12. Quick connector cap
13. Fuel feed hose

REMOVAL

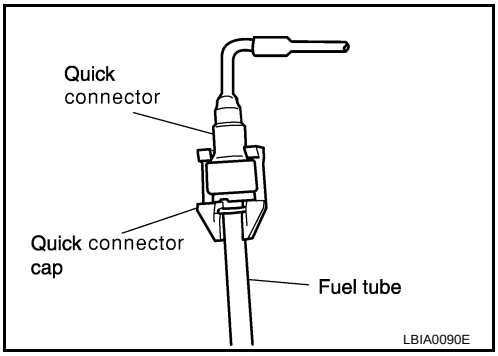
WARNING:

- **Put a "CAUTION FLAMMABLE" sign in the workshop.**
- **Be sure to work in a well ventilated area and furnish workshop with a CO_2 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-26, "Removal and Installation".
   CAUTION:
   Perform this step when engine is cold.

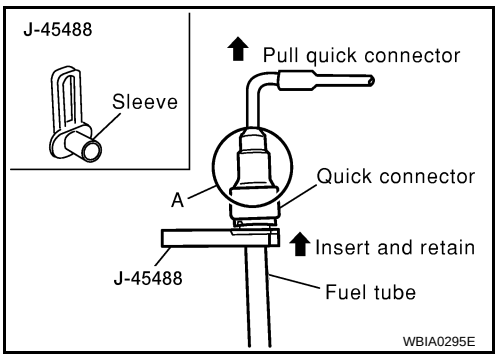
2. Disconnect the fuel quick connector on the engine side.

a. Remove quick connector cap.



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

Tool number : — (J-45488)



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

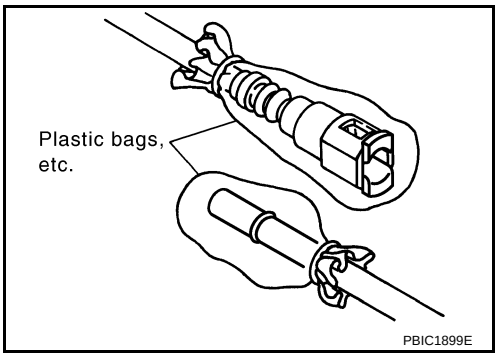
CAUTION:

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:

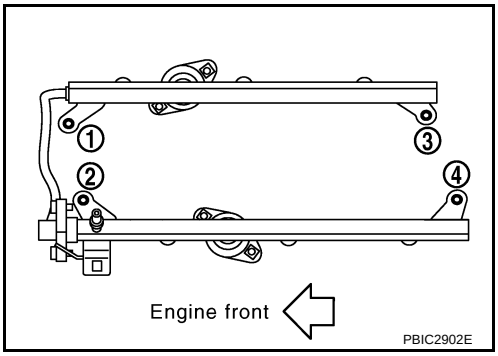
- **Pull quick connector holding it at the ″A″ position, as shown.**
- **Do not pull with lateral force applied. O-ring inside quick connector may be damaged.**
- **Prepare container and cloth beforehand as fuel will leak out.**
- **Avoid fire and sparks.**
- **Be sure to cover openings of disconnected 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.
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).

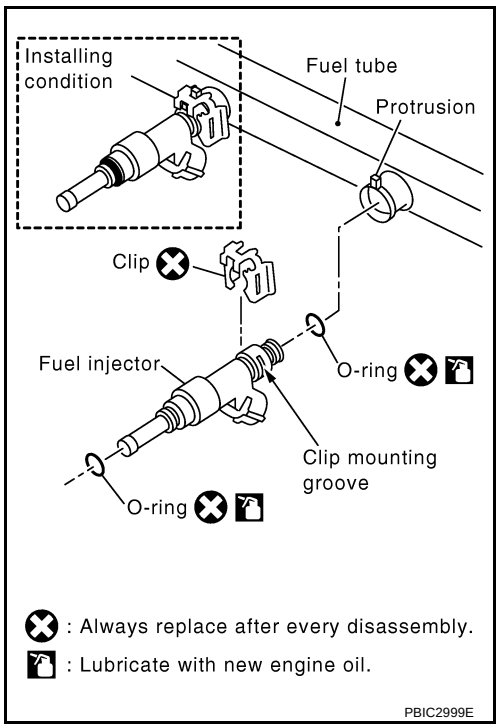
7. Remove fuel injector from fuel tube as follows:

a. Carefully open and remove clip.

b. Remove fuel injector from fuel tube by pulling straight.

CAUTION:

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



8. Disconnect fuel tube (RH) from fuel tube (LH).

9. Loosen bolts, to remove fuel damper cap and fuel damper, if necessary.

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. Never wear gloves.**
- **Lubricate new 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, do not 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, allow it to retract before inserting it into fuel tube.**
- **Insert new O-ring straight into fuel tube. Do not twist it.**

b. Install spacer to fuel damper.

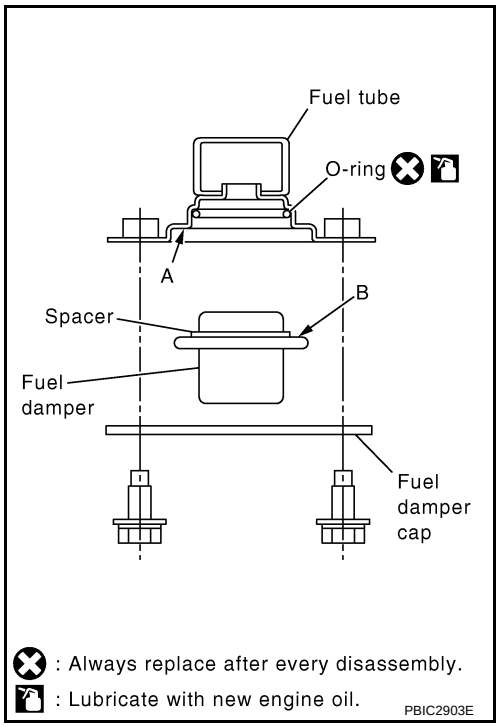
c. Insert fuel damper straight into fuel tube.

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 colors.**

Fuel tube side : Blue
Nozzle side : Brown

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

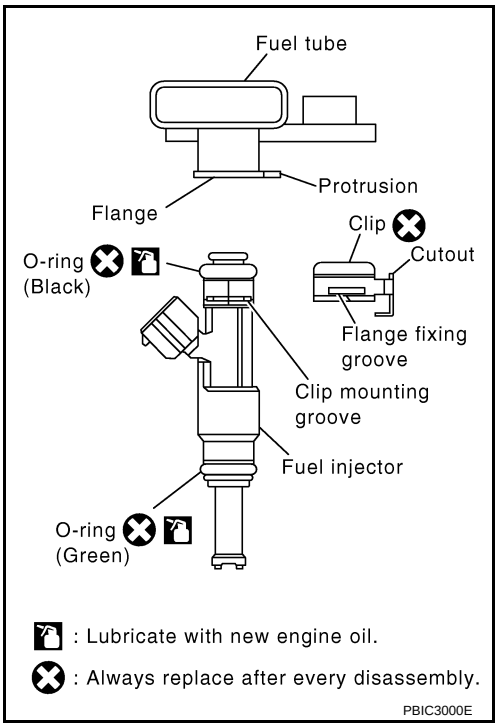
3. Install fuel injector to fuel tube as follows:

a. Insert clip into clip mounting groove on fuel injector.
- Insert clip so that protrusion of fuel injector matches cutout 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 of fuel tube matches cut-out 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, allow it to retract before inserting it 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.

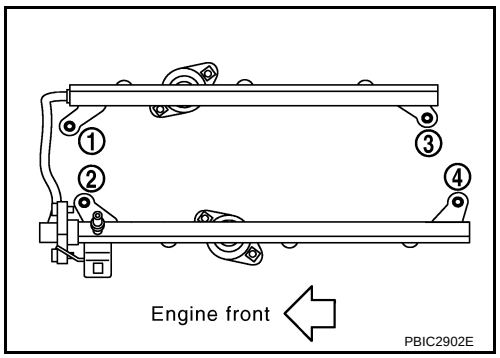
CAUTION:
Do not let the tip of the injector nozzle come in contact with other parts.

- 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-26, "Removal and Installation".
9. Installation of the remaining components is in the reverse order of removal.

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 stopping, as engine becomes extremely hot.

FRONT TIMING CHAIN CASE

Removal and Installation

INFOID:0000000001281985

NOTE:

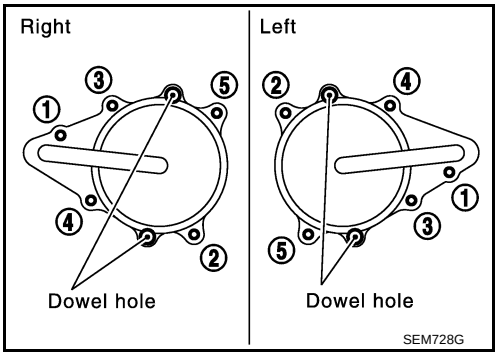
- This section describes removal/installation procedure of front timing chain case and timing chain related parts without removing oil pan (upper) on vehicle.
- When oil pan (upper) needs to be removed or installed, or when rear timing chain case is removed or installed, remove oil pans (upper and lower) 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-61.
- Refer to EM-61 for component parts location.

REMOVAL

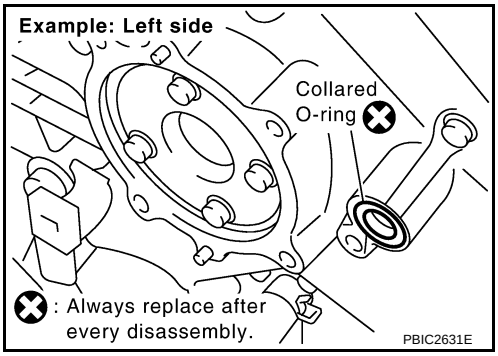
1. Remove engine cover with power tool. Refer to EM-24, "Removal and Installation".
2. Release the fuel pressure. Refer to EC-481, "Fuel Pressure Check".
3. Drain engine oil. Refer to LU-9, "Changing Engine Oil".
   CAUTION:
   - **Perform this step when engine is cold.**
   - **Do not spill engine oil on drive belts.**
4. Drain engine coolant from radiator. Refer to CO-12, "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-19, "Removal and Installation (Crankshaft driven type)".
6. Separate engine harnesses removing their brackets from front timing chain case.
7. Remove drive belts. Refer to EM-13, "Removal and Installation".
8. Remove power steering oil pump from bracket with piping connected, and temporarily secure it aside. Refer to ST-24, "Removal and Installation".
9. Remove power steering oil pump bracket. Refer to ST-24, "Removal and Installation".
10. Remove generator. Refer to CHG-21, "Removal and Installation".
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.



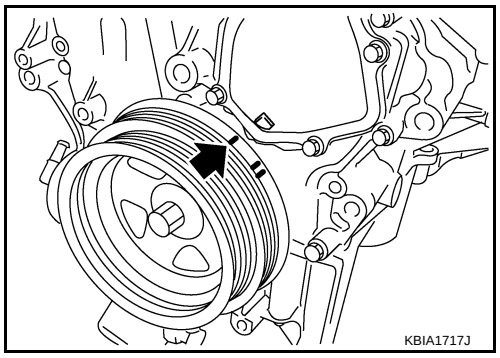
13. Remove collared O-rings from front timing chain case (left and right side).



14. Remove rocker covers (right and left banks). Refer to EM-42, "Removal and Installation".
NOTE:
When only timing chain (primary) is removed, rocker cover does not need to be removed.

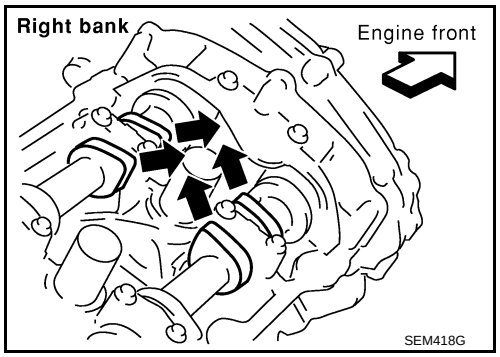
15. Obtain No. 1 cylinder at TDC of its compression stroke as follows:
NOTE:
When timing chain is not removed/installed, this step is not required.

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.

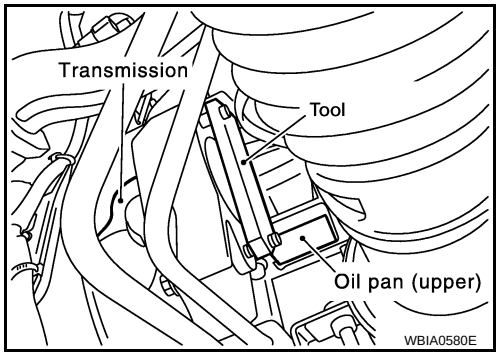
NOTE:
When only timing chain (primary) is removed, rocker cover does not need to be removed. To make sure that No. 1 cylinder is at its compression TDC, remove front timing chain case first. Then check mating marks on camshaft sprockets. Refer to EM-61, "Removal and Installation".



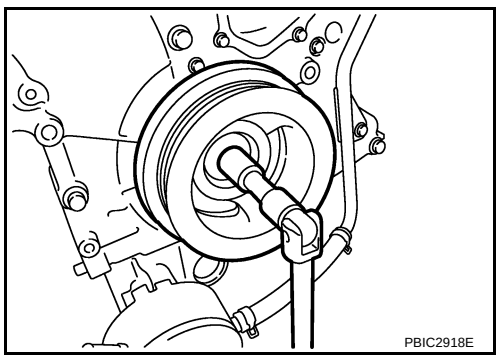
16. Remove crankshaft pulley as follows:

a. Remove starter motor and set Tool. Refer to STR-17, "Removal and Installation".

Tool number : KV10117700 (J-44716)

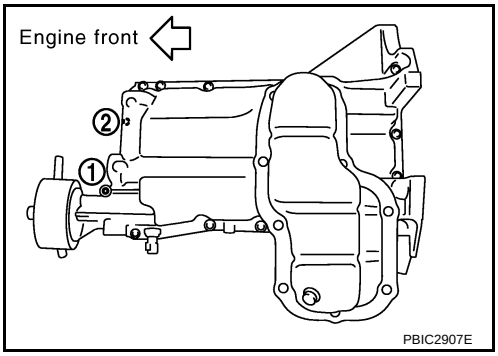


b. Loosen crankshaft pulley bolt and locate bolt seating surface as 10 mm (0.39 in) from its original position.
CAUTION:
Do not remove crankshaft pulley bolt. Keep loosened crankshaft pulley bolt in place to protect the crankshaft pulley from dropping.



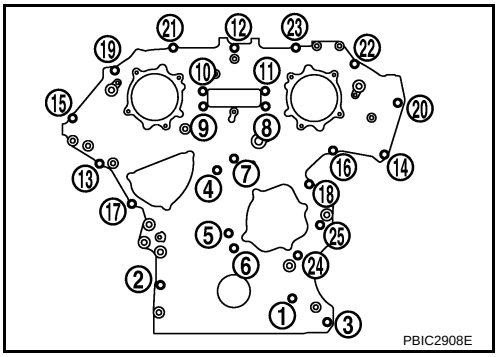
c. Pull crankshaft pulley with both hands to remove it.

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.

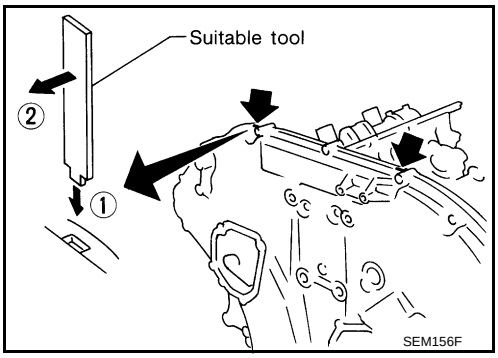


b. Insert suitable tool into the notch at the top of the front timing chain case as shown (1).

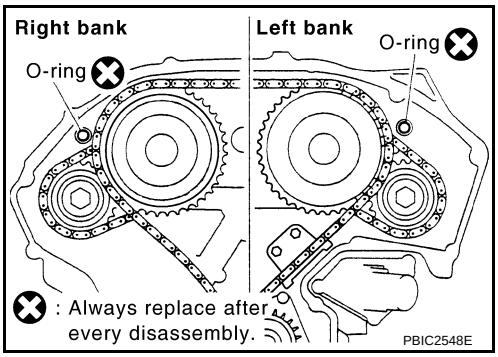
c. Pry off case by moving tool as shown (2).
- Cut liquid gasket for removal using Tool.

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 twist, bend, or warp under a load.**



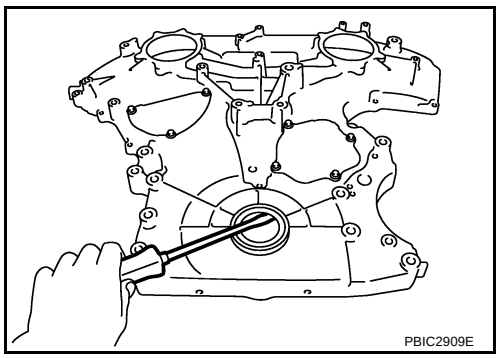
19. Remove O-rings from rear timing chain case.



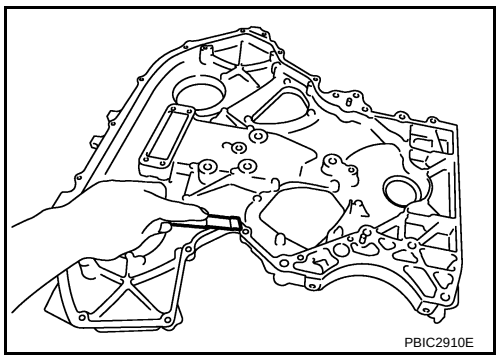
20. Remove water pump cover and chain tensioner cover from front timing chain case, if necessary.
- Cut liquid gasket for removal using Tool.

Tool number : KV10111100 (J-37228)

21. Remove front oil seal from front timing chain case using suitable tool.
CAUTION:
Be careful not to damage front timing chain case.


PBIC2909E

22. Remove timing chain and related parts. Refer to EM-61, "Removal and Installation".
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.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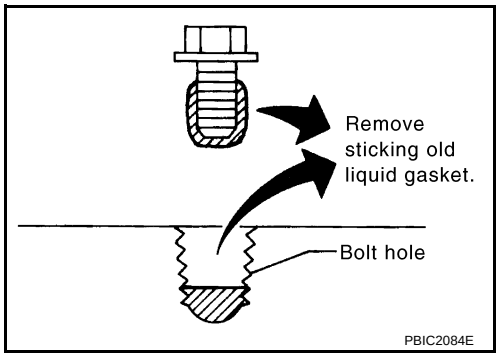
- Remove old liquid gasket from bolt hole and thread.



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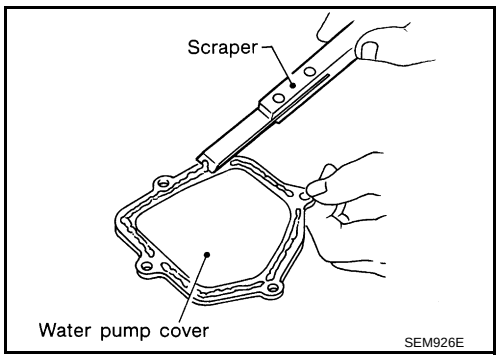
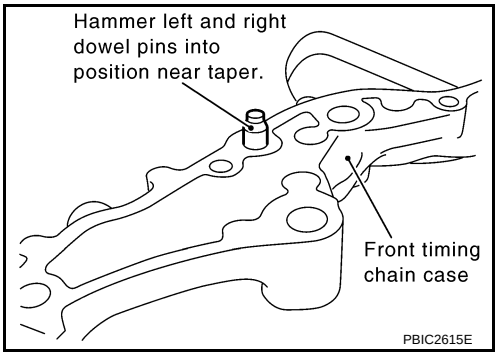
24. Use a scraper to remove all traces of old liquid gasket from water pump cover, chain tensioner cover and intake valve timing control covers.



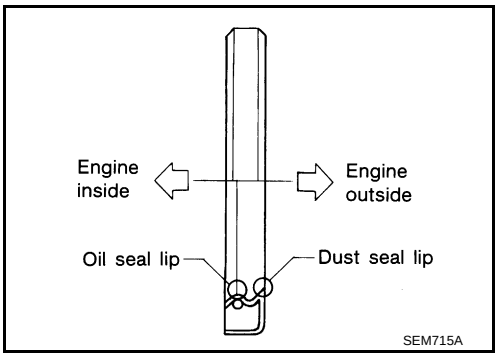
SEM926E

INSTALLATION

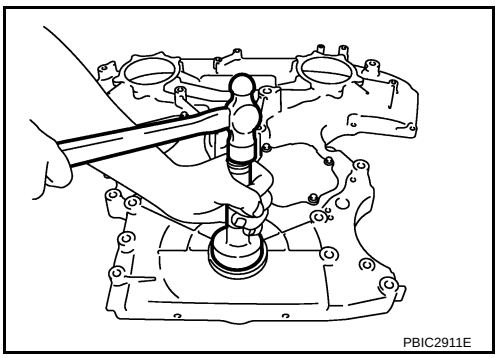
1. Hammer dowel pins (right and left) into front timing chain case up to a point close to taper in order to shorten protrusion length.



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.



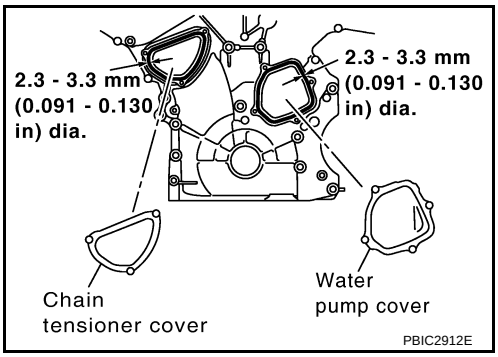
   - Press-fit oil seal until it becomes flush with front timing chain case end face using suitable drift [outer diameter: 60 mm (2.36 in)].
   - Make sure the garter spring is in position and seal lip is not inverted.



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 (—)

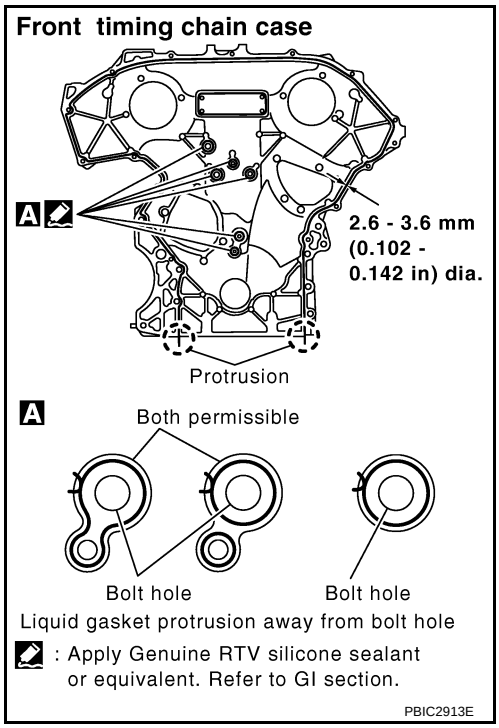
   Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".



4. Install front timing chain case as follows:

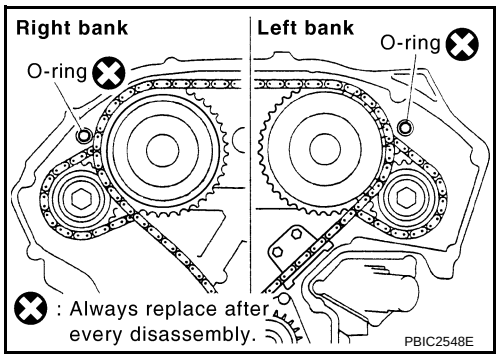
a. Apply a continuous bead of liquid gasket using Tool to front timing chain case back side as shown.

Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".

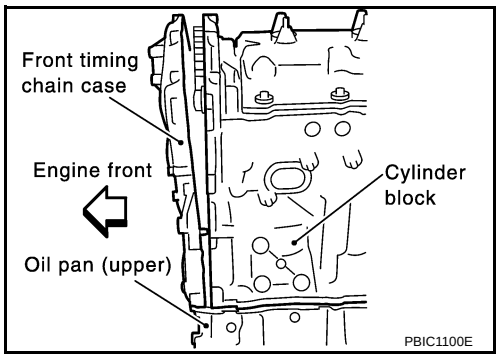


b. Install new O-rings on rear timing chain case.

c. Assemble front timing chain case as follows:

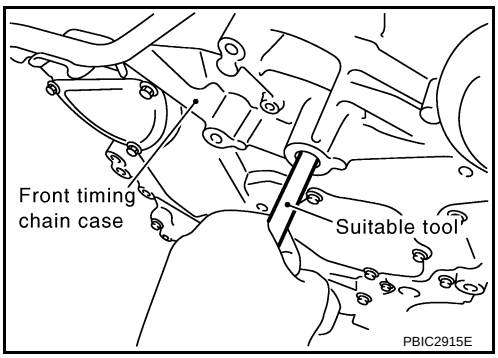


i. Fit lower end of front timing chain case tightly onto top face of oil pan (upper). From the fitting point, make entire front timing chain case contact rear timing chain case completely.



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.

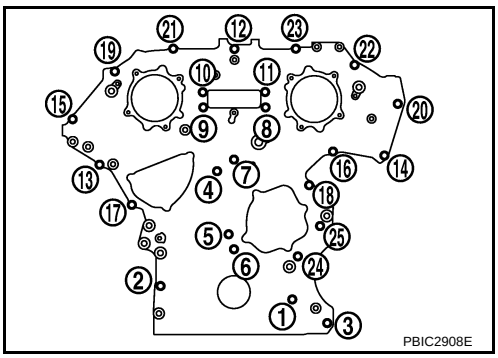


d. Tighten bolts to the specified torque in numerical order as shown.

e. After all bolts are tightened, retighten them to the specified torque in numerical order as shown.
• There are four type of bolts.

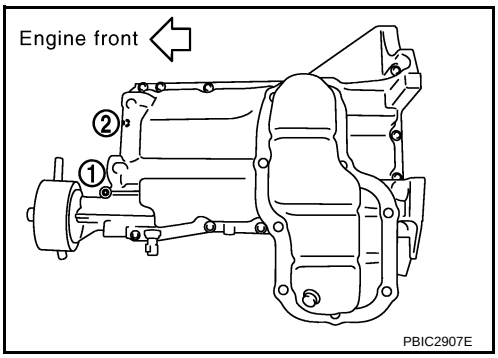
Bolt position	Bolt diameter
1 - 5	: 10 mm (0.39 in)
6 – 25	: 6 mm (0.24 in)

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)



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)



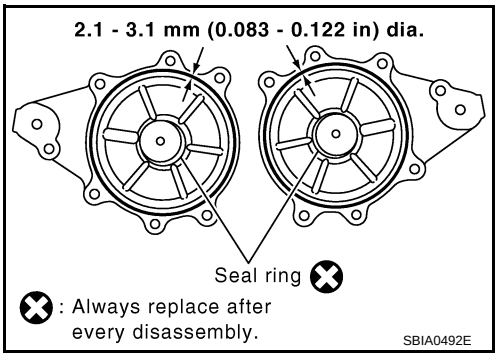
6. Install right and left intake valve timing control covers as follows:

a. Install new seal rings in shaft grooves.

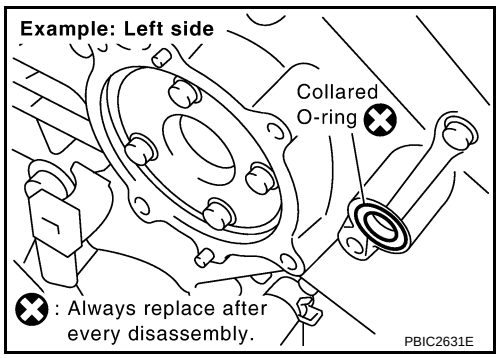
b. Apply a continuous bead of liquid gasket using Tool to intake valve timing control covers as shown.

Tool number : WS39930000 (—)

Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".

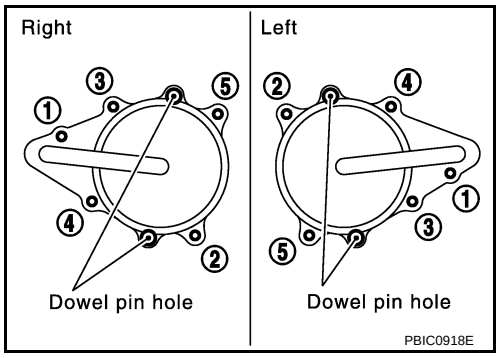


c. Install new collared O-rings in front timing chain case oil hole (left and right sides).



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:

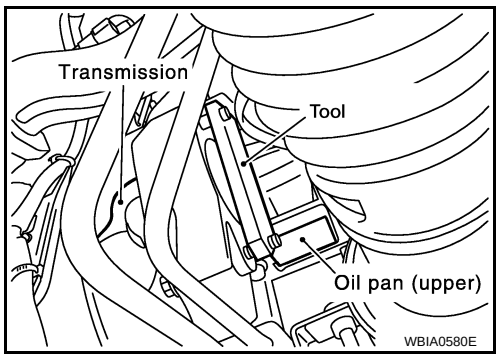
a. Install crankshaft pulley, taking care not to damage front oil seal.
- When press-fitting crankshaft pulley with plastic hammer, tap on its center portion (not circumference).

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 for Leaks

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-10, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.

- Run engine to check for unusual noise and vibration.
  NOTE:
  If hydraulic pressure inside 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.

TIMING CHAIN

Removal and Installation

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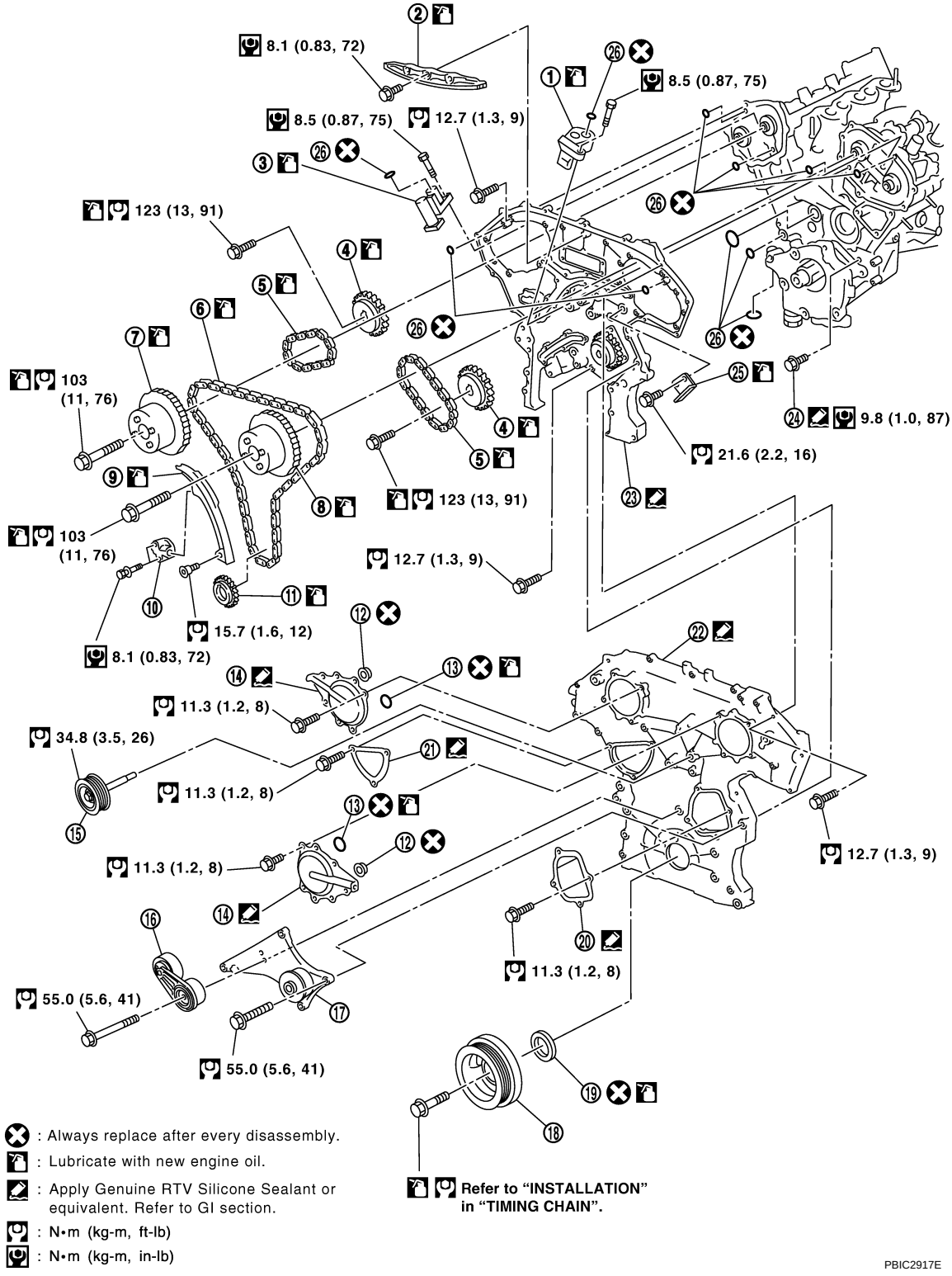
SEC. 120•130•150•210•275



PBIC2917E

1. Timing chain tensioner (secondary) (LH)
2. Internal chain guide
3. Timing chain tensioner (secondary) (RH)
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	

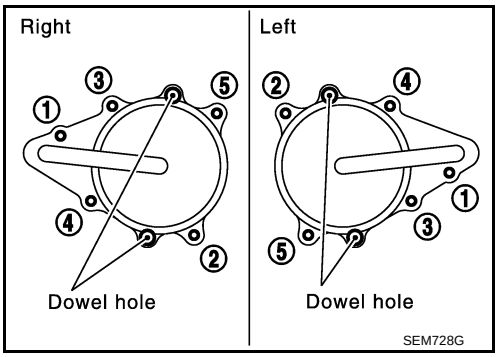
NOTE:
- This section describes procedures for removing/installing front timing chain case and timing chain related parts, and rear timing chain case, when oil pan (upper) needs to be removed/installed for engine overhaul, etc.
- To remove/install front timing chain case, timing chain, and its related parts without removing oil pan (upper), refer to EM-52.

REMOVAL

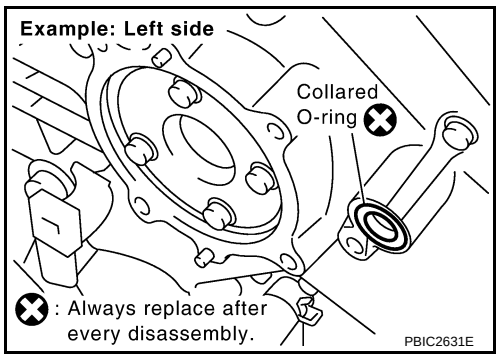
1. Remove engine cover with power tool. Refer to EM-24, "Removal and Installation".
2. Release the fuel pressure. Refer to EC-481, "Fuel Pressure Check".
3. Drain engine oil. Refer to LU-9, "Changing Engine Oil".
   CAUTION:
   - **Perform this step when engine is cold.**
   - **Do not spill engine oil on drive belts.**
4. Drain engine coolant from radiator. Refer to CO-12, "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-19, "Removal and Installation (Crankshaft driven type)".
6. Separate engine harnesses removing their brackets from front timing chain case.
7. Remove drive belts. Refer to EM-13, "Removal and Installation".
8. Remove power steering oil pump from bracket with piping connected, and temporarily secure it aside. Refer to ST-24, "Removal and Installation".
9. Remove power steering oil pump bracket. Refer to ST-24, "Removal and Installation".
10. Remove generator. Refer to CHG-21, "Removal and Installation".
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.

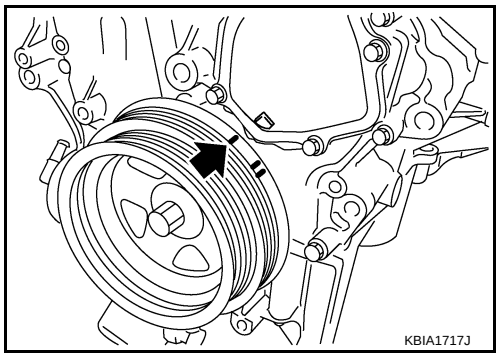


13. Remove collared O-rings from front timing chain case (left and right side).

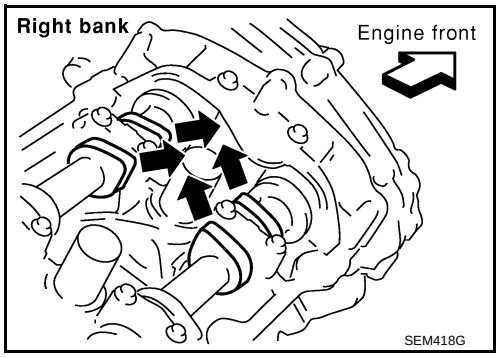


14. Remove rocker covers (right and left banks). Refer to EM-42, "Removal and Installation".
NOTE:
When only timing chain (primary) is removed, rocker cover does not need to be removed.
15. Obtain No. 1 cylinder at TDC of its compression stroke as follows:
NOTE:
When timing chain is not removed/installed, this step is not required.

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



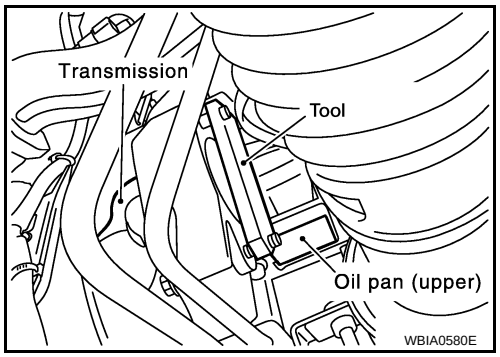
b. Make sure that intake and exhaust cam noses on No. 1 cylinder (engine front side of right bank) are located as shown.
• If not, turn crankshaft one revolution (360°) and align as shown.
NOTE:
When only timing chain (primary) is removed, rocker cover does not need to be removed. To make sure that No. 1 cylinder is at its compression TDC, remove front timing chain case first. Then check mating marks on camshaft sprockets. Refer to EM-81, "Removal and Installation".



16. Remove crankshaft pulley as follows:

a. Remove starter motor and set Tool. Refer to STR-17, "Removal and Installation".

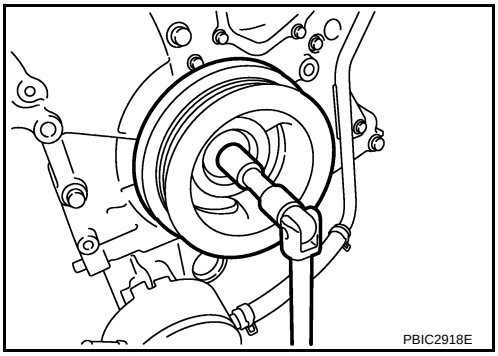
Tool number : KV10117700 (J-44716)



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

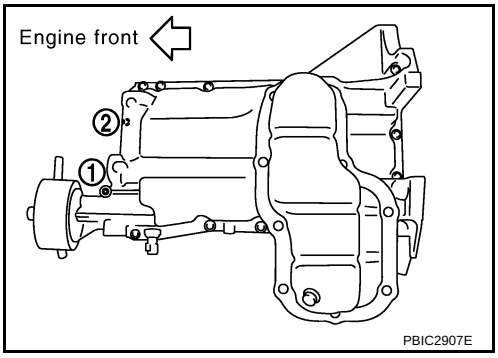
CAUTION:

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



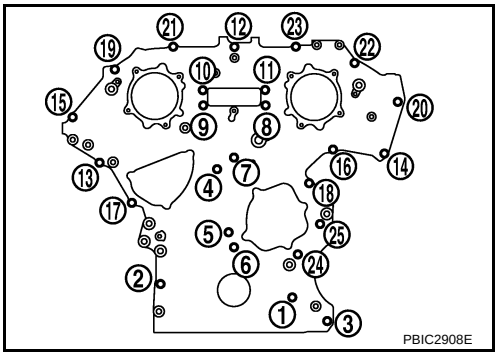
c. Pull crankshaft pulley with both hands to remove it.

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.

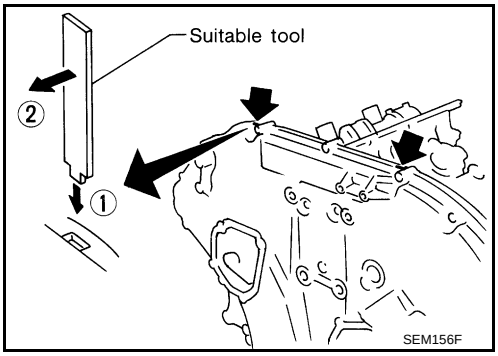


b. Insert suitable tool into the notch at the top of the front timing chain case as shown (1).

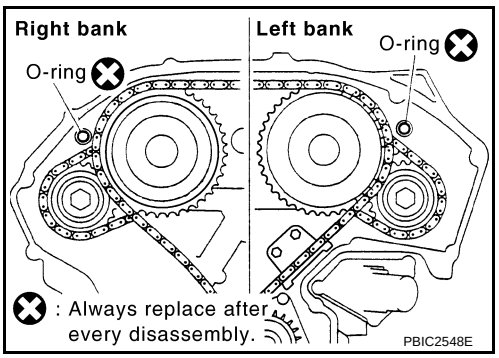
c. Pry off case by moving tool as shown (2).
- Cut liquid gasket for removal using Tool.

Tool number : KV10111100 (J-37228)

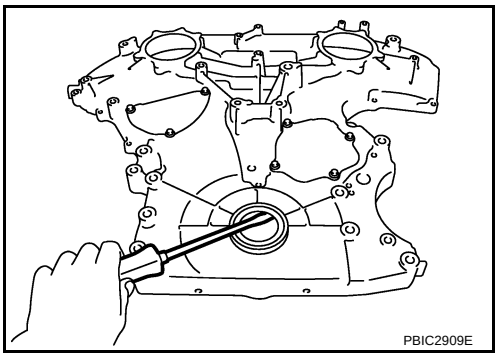
CAUTION:
- **Do not use screwdriver or something similar.**
- **After removal, handle front timing chain case carefully so it does not twist, bend, or warp under a load.**



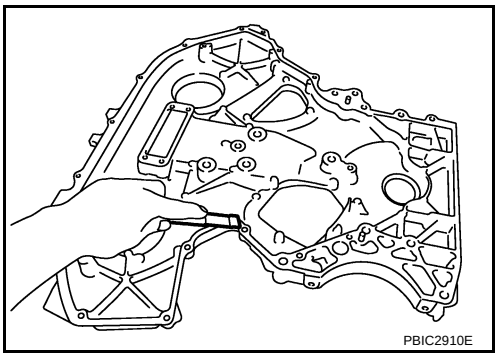
19. Remove O-rings from rear timing chain case.



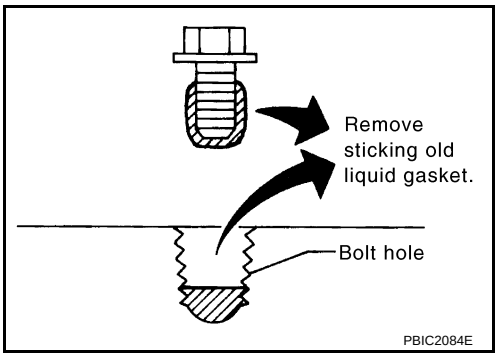
20. Remove water pump cover and chain tensioner cover from front timing chain case, if necessary.
    - Cut liquid gasket for removal using Tool.
21. Remove front oil seal from front timing chain case using suitable tool.
    CAUTION:
    Be careful not to damage front timing chain case.



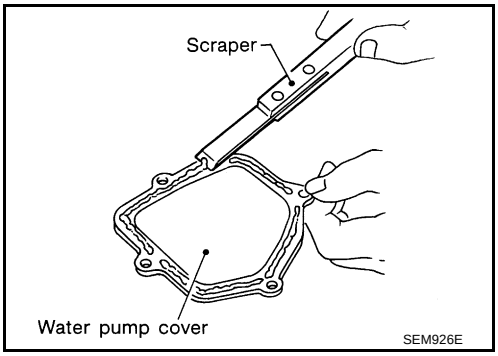
22. Use a scraper to remove all traces of old liquid gasket from front and rear timing chain cases and oil pan (upper), and liquid gasket mating surfaces.
    CAUTION:
    Be careful not to allow gasket fragments to enter oil pan.



    - Remove old liquid gasket from bolt hole and thread.



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.

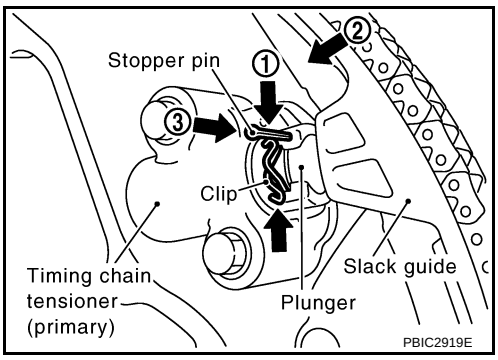


24. Remove timing chain tensioner (primary) as follows:

a. Loosen clip of timing chain tensioner (primary), and release plunger stopper (1).

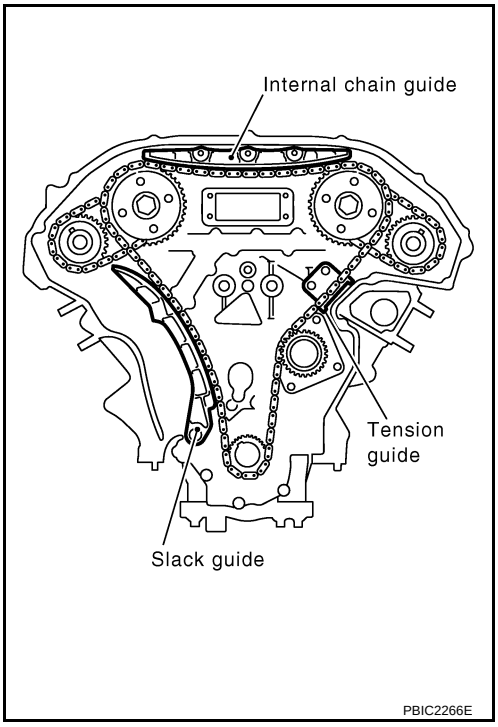
b. Insert plunger into tensioner body by pressing slack guide (2).

c. 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).

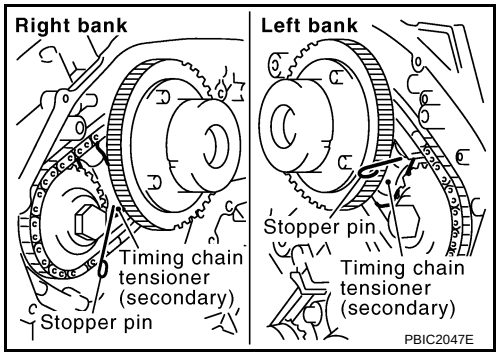
25. Remove internal chain guide, tension guide and slack guide.
NOTE:
Tension guide can be removed after removing timing chain (primary).



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.

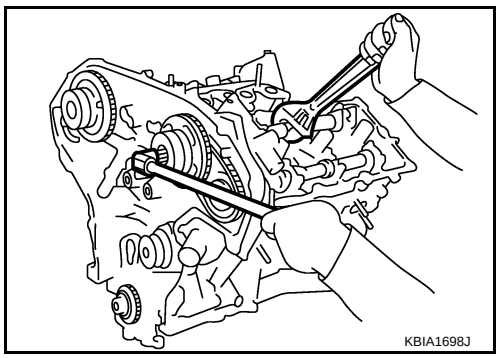
27. Remove timing chain (secondary) and camshaft sprockets as follows:

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-81. [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 by securing anything other than the camshaft hexagonal portion.

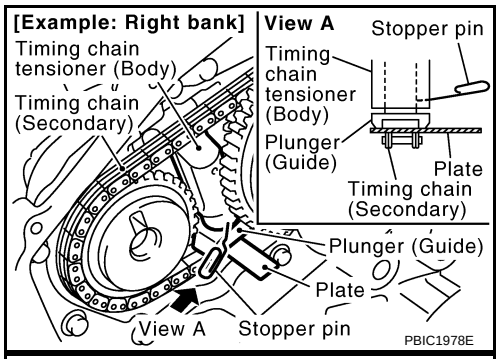


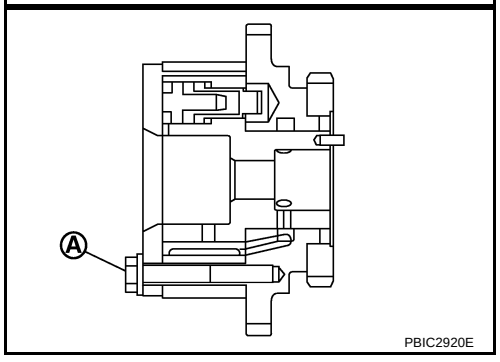
c. Remove timing chain (secondary) together with camshaft sprockets.
- Turn camshaft slightly to secure slackness of timing chain on timing chain tensioner (secondary) side.
- Insert 0.5 mm (0.020 in)-thick metal or resin plate between timing chain and timing chain tensioner plunger (guide). Remove timing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





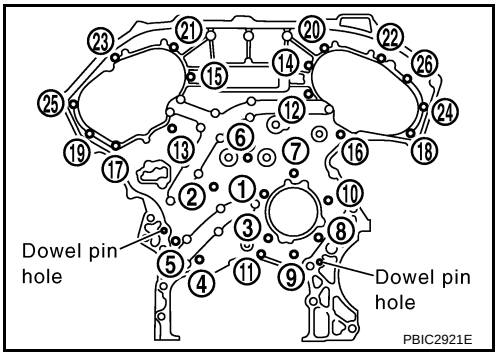
28. Remove water pump. Refer to CO-22, "Removal and Installation".

29. Remove rear timing chain case as follows:

a. Loosen and remove bolts using power tool in reverse order as shown.

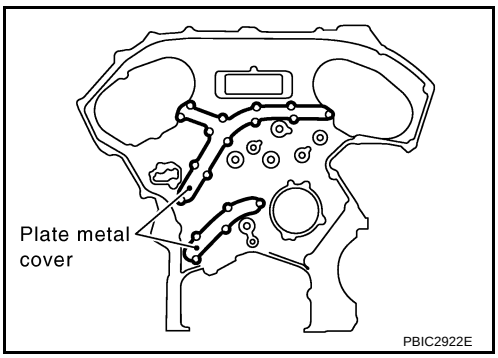
b. Cut liquid gasket using Tool and remove rear timing chain case.

Tool number : KV10111100 (J-37228)

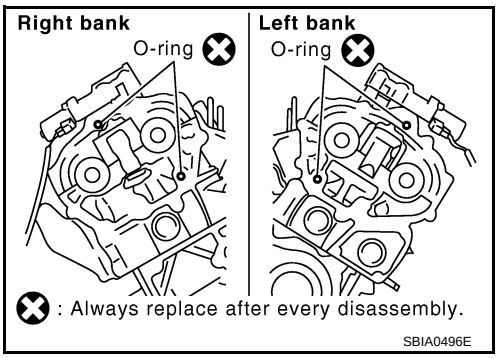


CAUTION:

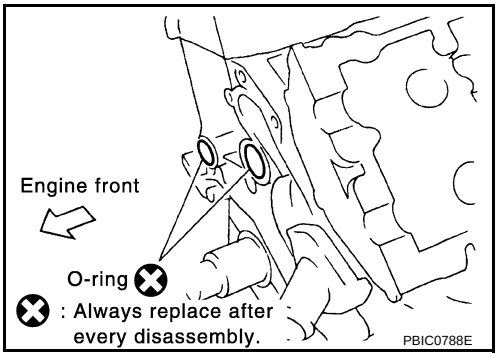
- **Do not remove plate metal cover of oil passage.**
- **After removal, handle rear timing chain case carefully so it does not twist, bend, or warp under a load.**



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



31. Remove O-rings from cylinder block.

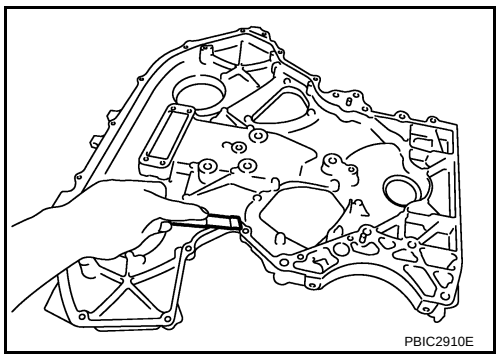


32. Remove timing chain tensioners (secondary) from cylinder head if necessary.

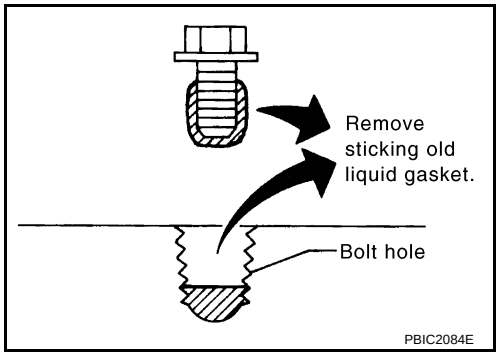
a. Remove camshaft brackets (No. 1). Refer to EM-81, "Removal and Installation".

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

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

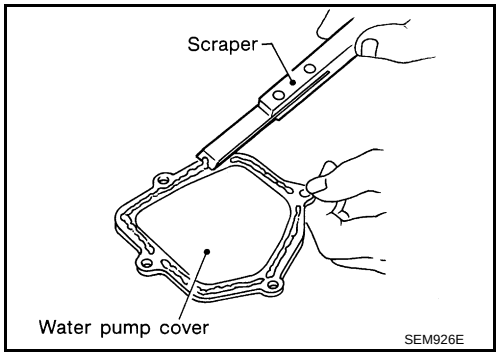

PBIC2910E

- Remove old liquid gasket from bolt hole and thread.



PBIC2084E

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

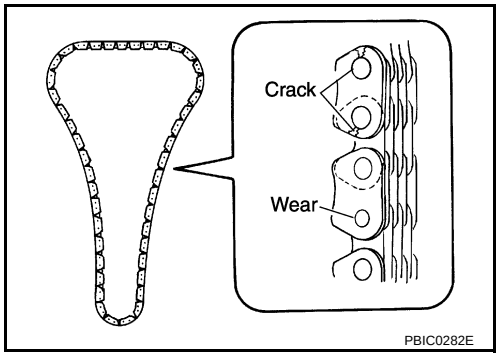


SEM926E

INSPECTION AFTER REMOVAL

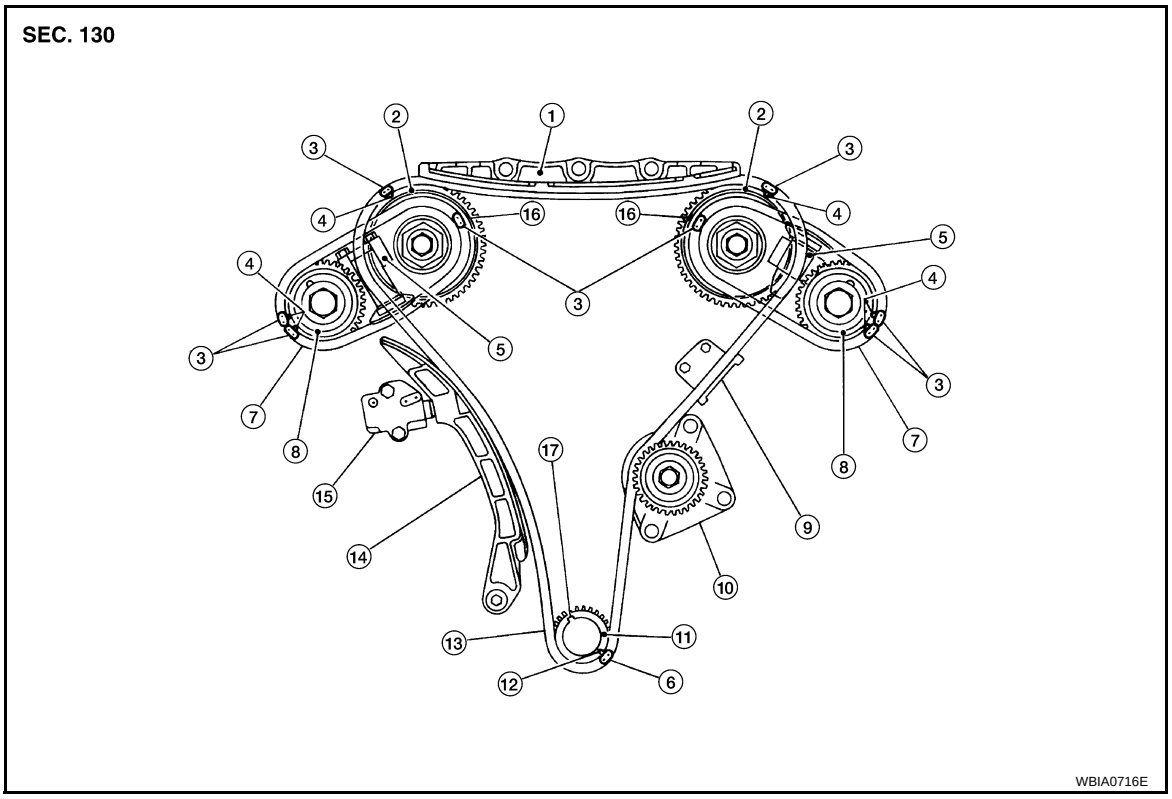
Check for cracks and any excessive wear at link plates. Replace chain if necessary.

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



PBIC0282E

INSTALLATION



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 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

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

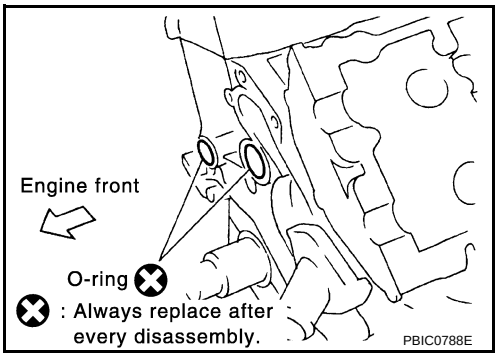
1. Install timing chain tensioners (secondary) to cylinder head if removed.

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

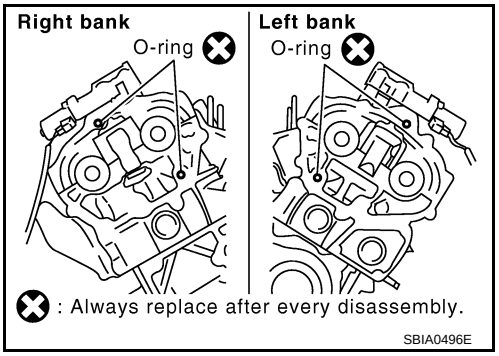
b. Install camshaft brackets (No. 1). Refer to EM-81, "Removal and Installation".

2. Install rear timing chain case as follows:

a. Install new O-rings onto cylinder block.



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



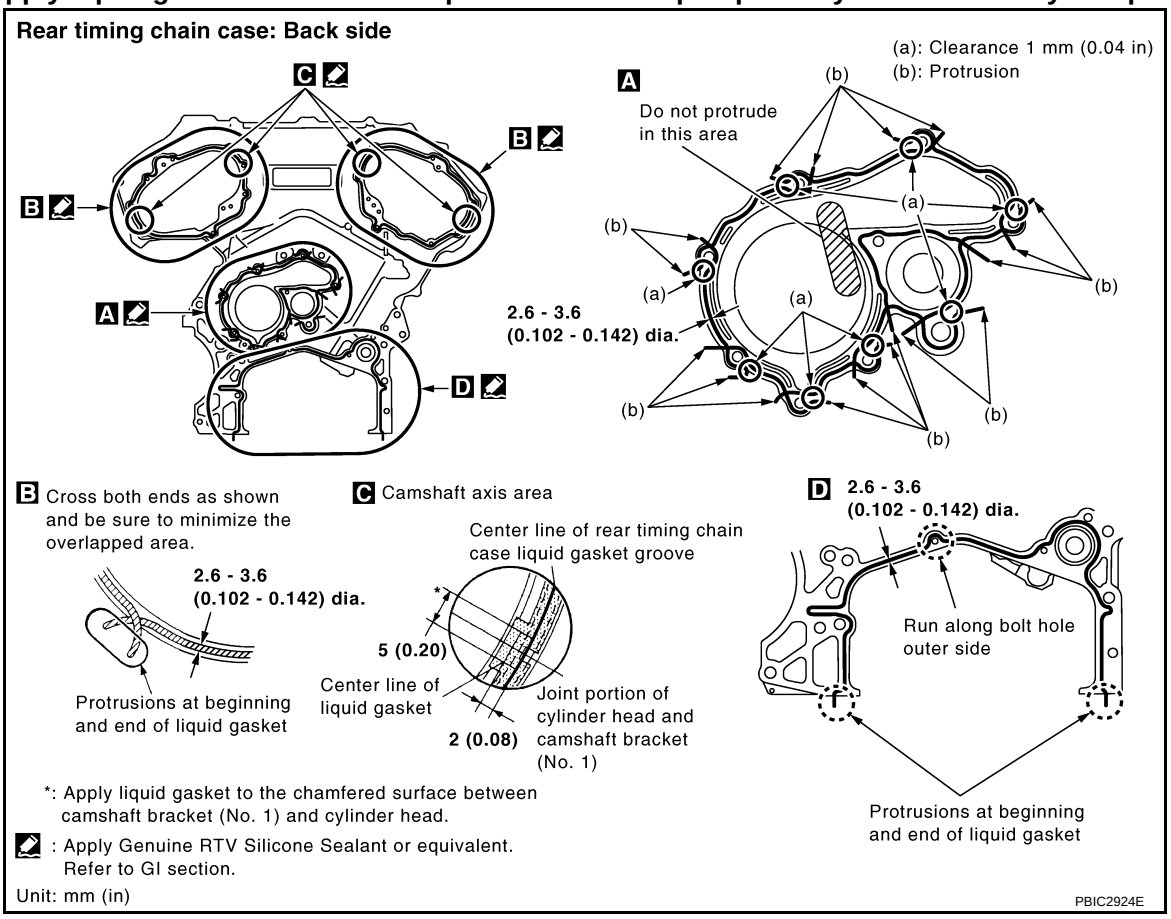
c. Apply liquid gasket using Tool to rear timing chain case back side as shown.

Tool number : WS39930000 (—)

Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".

CAUTION:

- **For "A", completely wipe off liquid gasket covering the area shown.**
- **Apply liquid gasket on installation position of water pump and cylinder head very completely.**



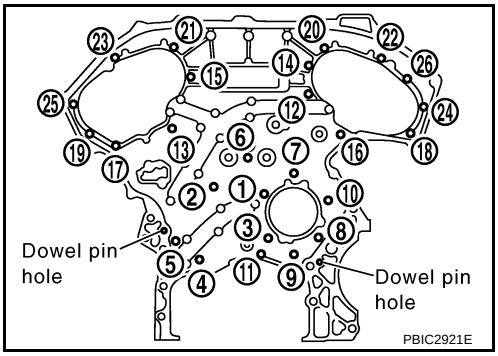
d. Align rear timing chain case with dowel pins (right and left) on cylinder block and install rear timing chain case.

- Make sure O-rings stay in place during installation to cylinder block, cylinder head and camshaft bracket (No. 1).

e. Tighten bolts in numerical order as shown.
- There are two type of 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 case bolt torque : 12.7 N·m (1.3 kg-m, 9 ft-lb)

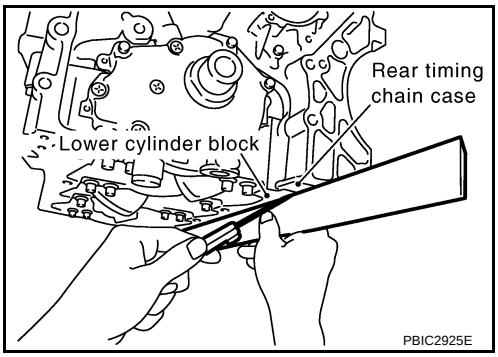


f. After all bolts are tightened, retighten them to the specified torque in numerical order as shown.
- If liquid gasket protrudes, wipe it off immediately.

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)

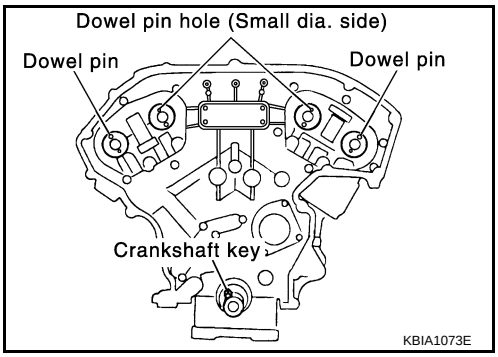
- If not within the standard, repeat the installation procedure.



3. Install water pump with new O-rings. Refer to CO-22, "Removal and 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.

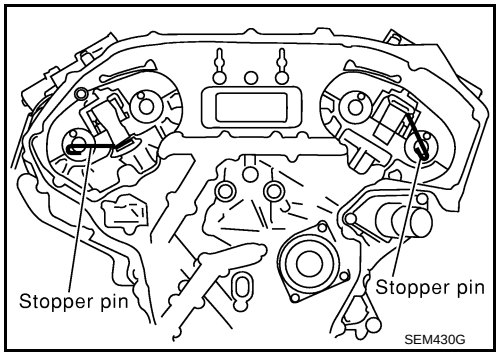
Camshaft dowel pin hole (intake side)
: At cylinder head upper face side in each bank.
Camshaft dowel pin (exhaust side)
: At cylinder head upper face side in each bank.
Crankshaft key
: At cylinder head side of right bank.



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

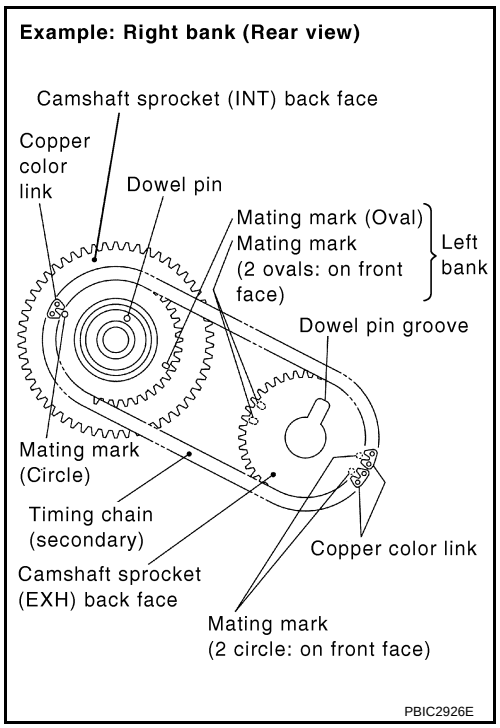
5. Install timing chains (secondary) and camshaft sprockets as follows:
CAUTION:
Mating marks between timing chain and sprockets slip easily. Confirm all mating mark positions repeatedly during the installation process.

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

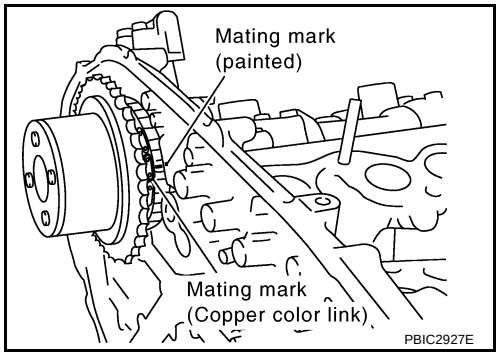


b. Install timing chains (secondary) and camshaft sprockets (INT and EXH).
- Align the mating marks on timing chain (secondary) (copper color link) with the ones on camshaft sprockets (INT and EXH) (punched), and install them.
  NOTE:
  - Mating marks for camshaft sprocket (INT) are on the back side 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.

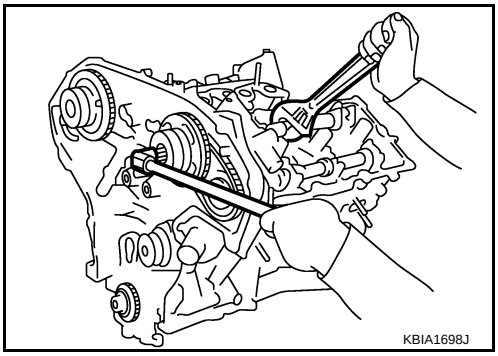
  Right bank : Use circle type.
  Left bank : Use oval type.



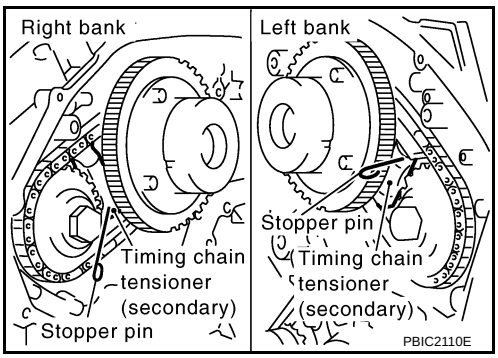
- Align dowel pin and pin hole on camshafts with the groove and dowel pin on sprockets, and install them.
- On the intake side, align pin hole on the small diameter side of the camshaft front end with dowel pin on the back side of camshaft sprocket, and install them.
- On the exhaust side, align dowel 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.



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

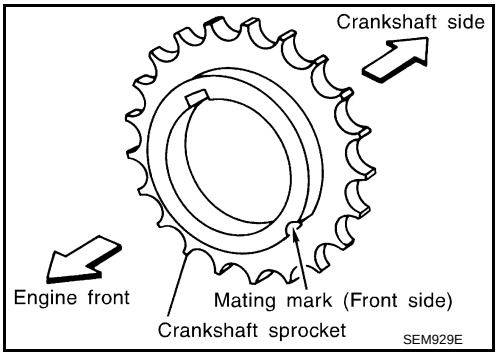


d. Pull stopper pins out from timing chain tensioners (secondary).

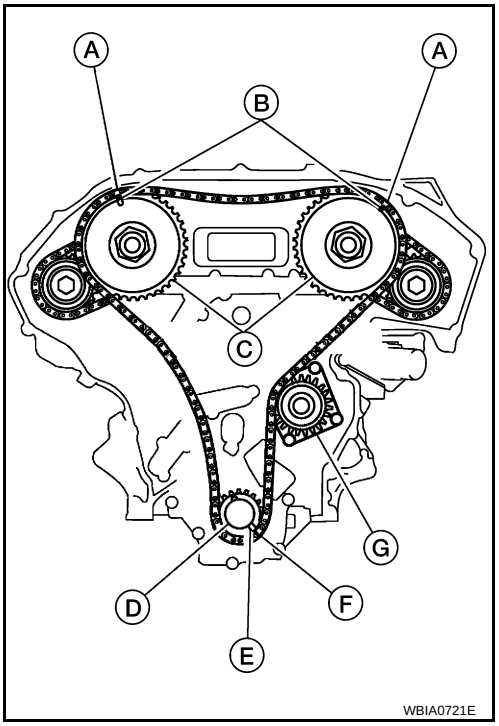


6. Install tension guide.
7. Install timing chain (primary) as follows:

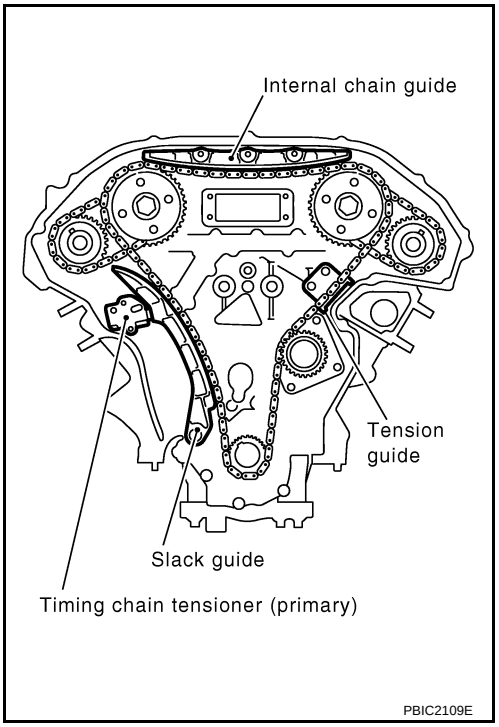
a. Install crankshaft sprocket.
   • Make sure the mating marks on crankshaft sprocket face the front of engine.



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.

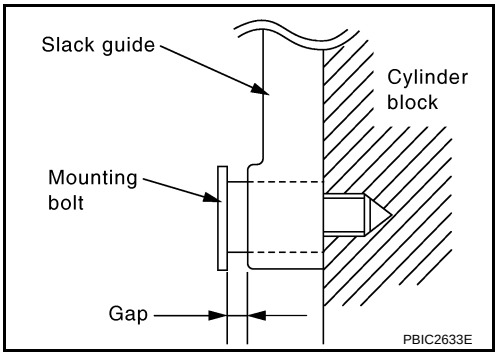


8. Install internal chain guide, slack guide and timing chain tensioner (primary).



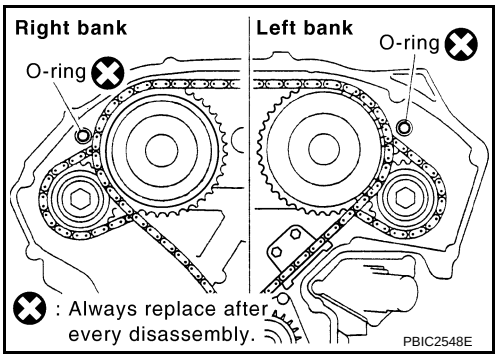
CAUTION:

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

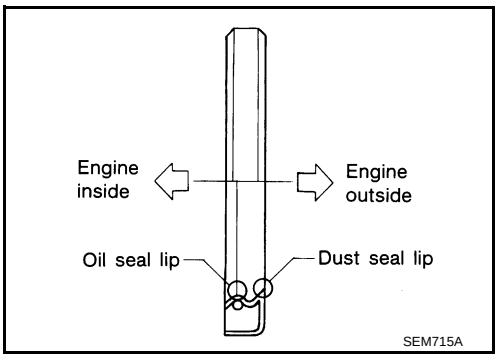


- When installing timing chain tensioner (primary), push in plunger and keep it pressed in with stopper pin.
- Remove any dirt and foreign materials completely from the back and the mounting surfaces of timing chain tensioner (primary).
- After installation, pull out stopper pin.

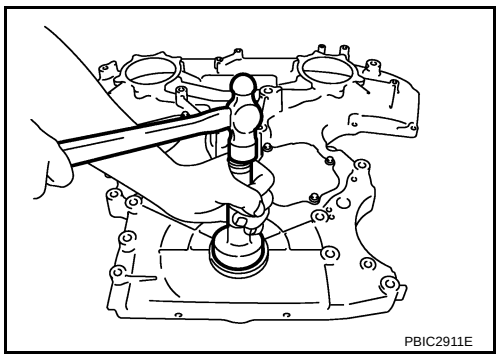
9. Make sure again that the mating marks on camshaft sprockets and timing chain have not slipped out of alignment.
10. Install new O-rings on rear timing chain case.



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.



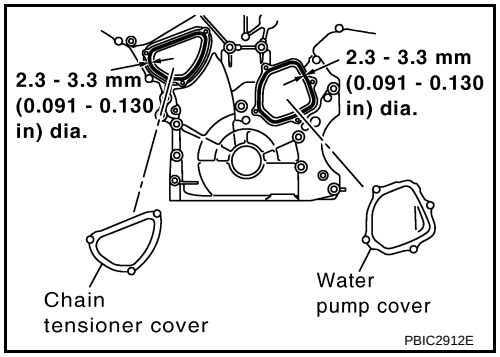
- Press-fit oil seal until it becomes flush with front timing chain case end face using suitable drift [outer diameter: 60 mm (2.36 in)].
- Make sure the garter spring is in position and seal lip is not inverted.


PBIC2911E

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-26, "Recommended Chemical Products and Sealants".



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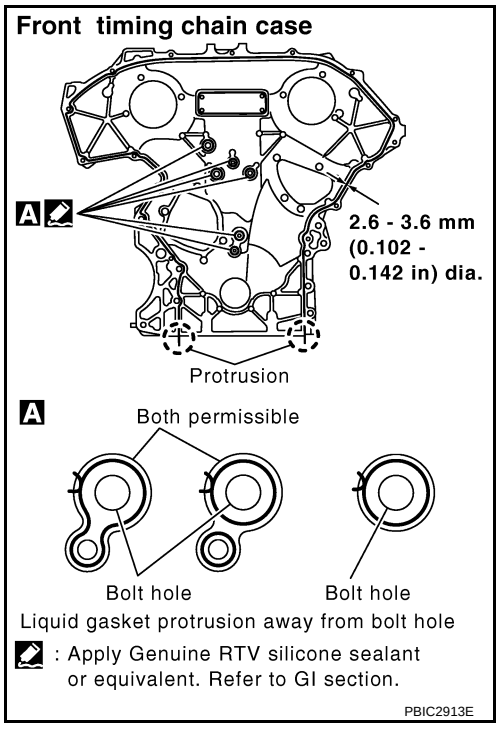
13. Install front timing chain case as follows:

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

Tool number : WS39930000 (—)

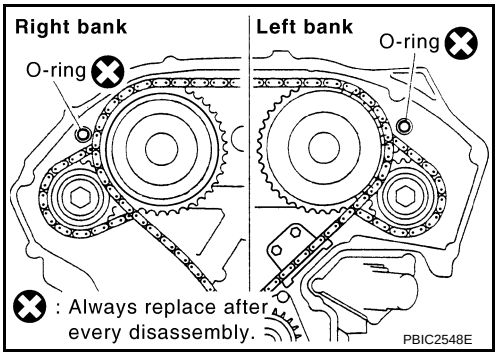
Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".



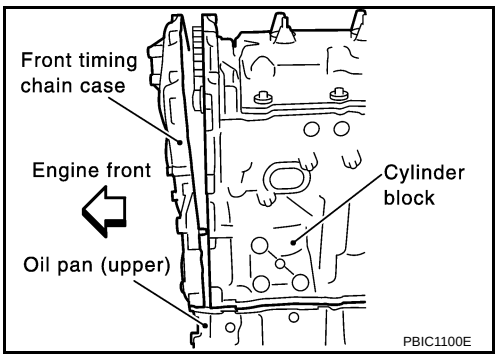
PBIC2913E

b. Install new O-rings on rear timing chain case.

c. Assemble front timing chain case as follows:

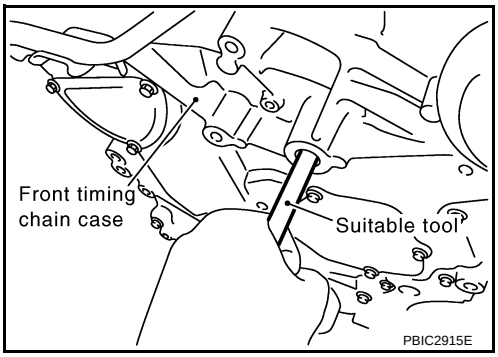


Fit lower end of front timing chain case tightly onto top face of oil pan (upper). From the fitting point, make entire front timing chain case contact rear timing chain case completely.



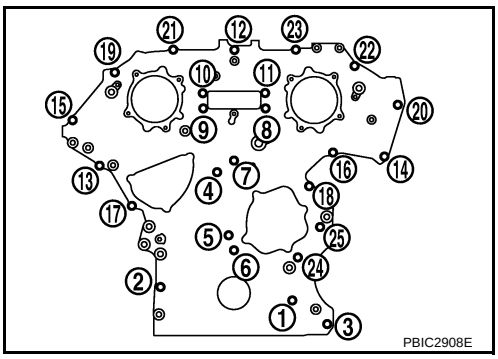
ii. Since front timing chain case is offset for difference of bolt holes, tighten bolts temporarily while holding front timing chain case from front and top as shown.

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.

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

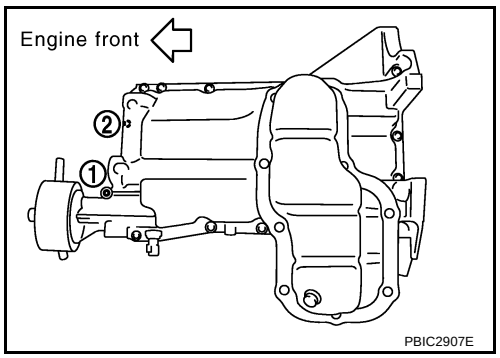


Bolt position	Bolt diameter
1 - 5	: 10 mm (0.39 in)
6 – 25	: 6 mm (0.24 in)

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)

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)



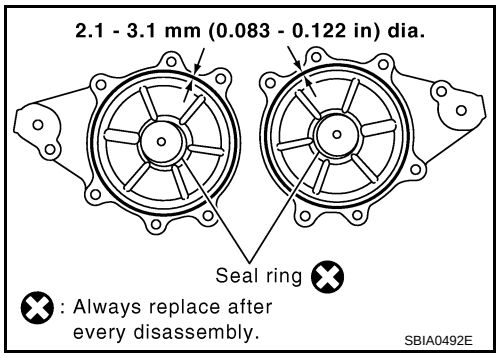
15. Install right and left intake valve timing control covers as follows:

a. Install new seal rings in shaft grooves.

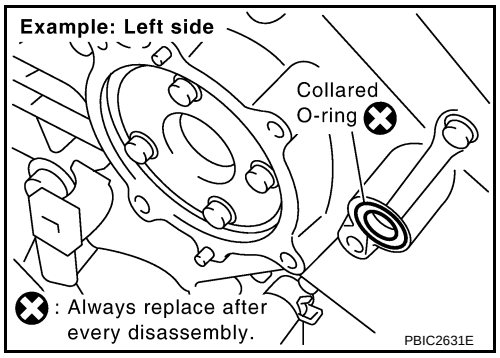
b. Apply a continuous bead of liquid gasket using Tool to intake valve timing control covers as shown.

Tool number : WS39930000 (—)

Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".

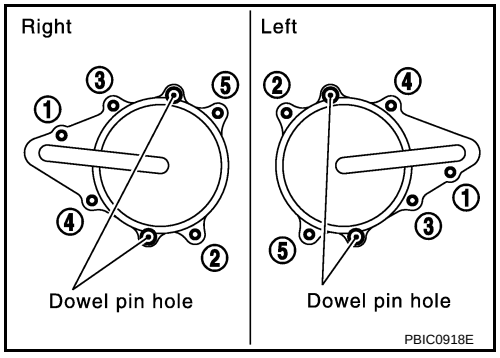


c. Install new collared O-rings in front timing chain case oil hole (left and right sides).



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.



16. Install crankshaft pulley as follows:

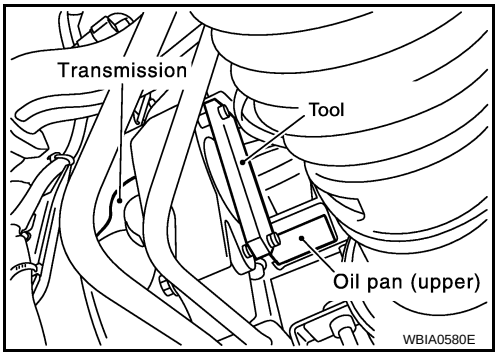
a. Install crankshaft pulley, taking care not to damage front oil seal.
- When press-fitting crankshaft pulley with plastic hammer, tap on its center portion (not circumference).

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)



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-36, "Removal and Installation".
19. Install rocker covers (right and left banks). Refer to EM-42, "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-10, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.

  NOTE:
  If hydraulic pressure inside 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 fluid, power steering fluid, brake fluid, etc.

CAMSHAFT

Removal and Installation

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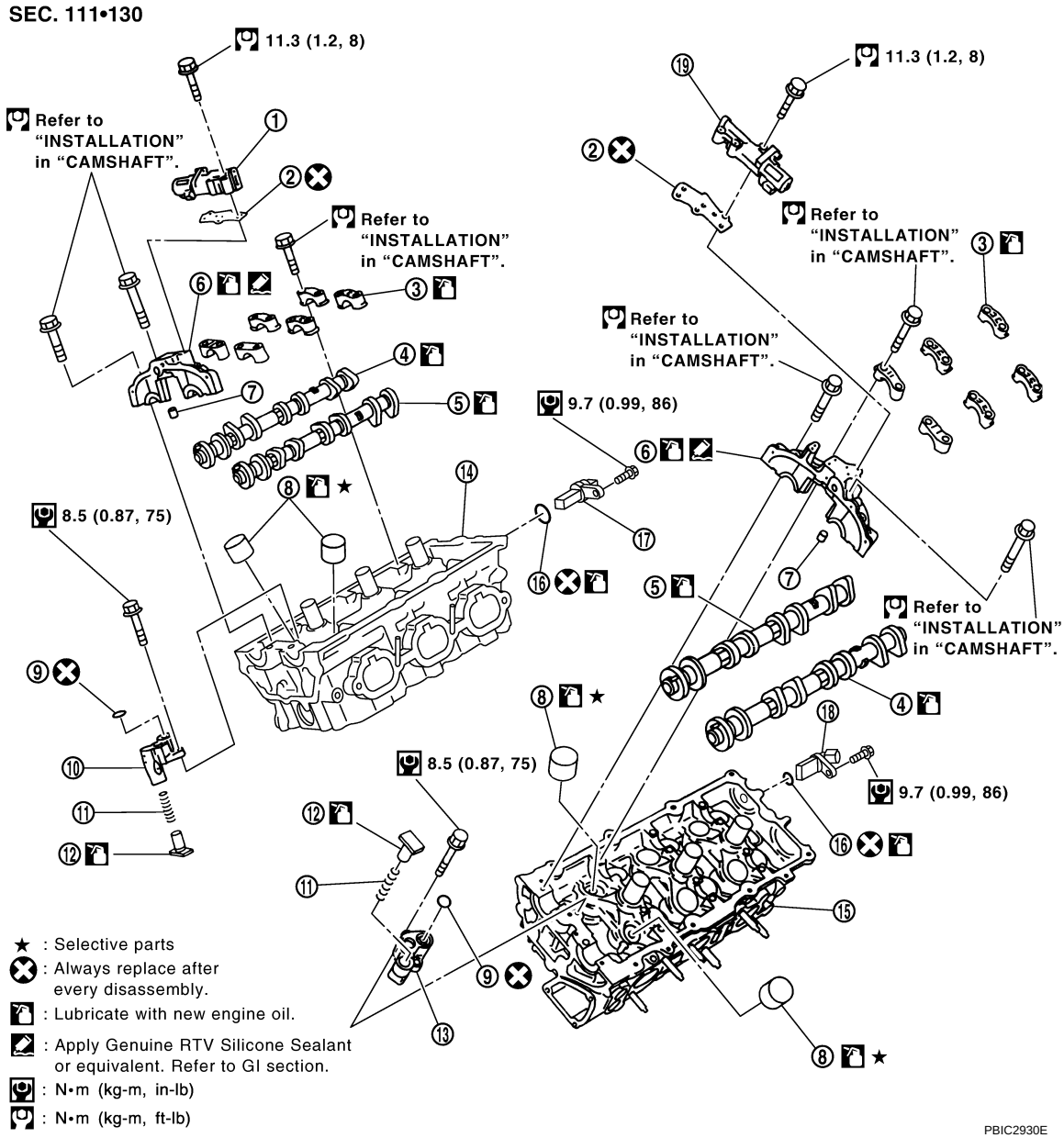
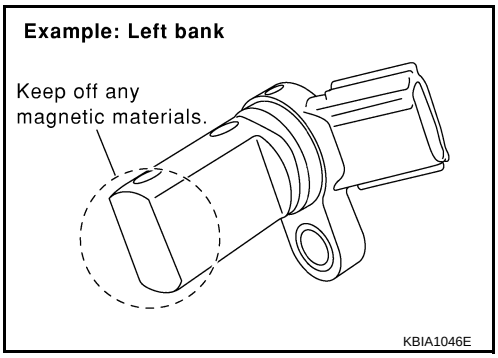


1.	Intake valve timing control solenoid valve (RH bank)	2.	Gasket	3.	Camshaft bracket (No. 2 to 4)
4.	Camshaft (EXH)	5.	Camshaft (INT)	6.	Camshaft bracket (No. 1)
7.	Dowel pin	8.	Valve lifter	9.	O-ring
10.	Timing chain tensioner (secondary) (RH bank)	11.	Spring	12.	Plunger
13.	Timing chain tensioner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

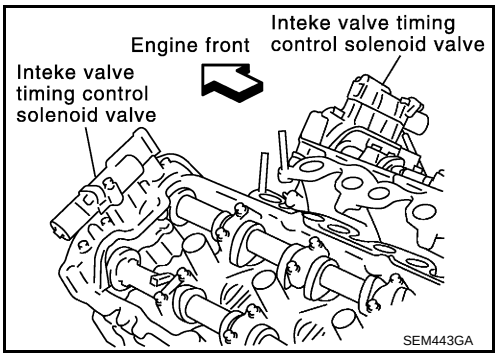
REMOVAL

1. Remove front timing chain case, camshaft sprocket, timing chain and rear timing chain case. Refer to EM-61, "Removal and Installation".
2. Remove camshaft position sensor (PHASE) (right and left banks) from cylinder head back side.

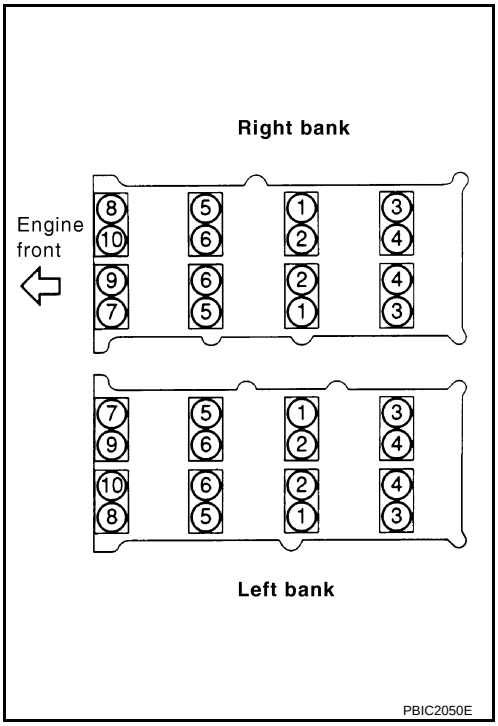
   CAUTION:
   - **Handle carefully to avoid dropping and shocks.**
   - **Do not disassemble.**
   - **Do not allow metal powder to adhere to magnetic part at sensor tip.**
   - **Do not place sensors in a location where they are exposed to magnetism.**



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

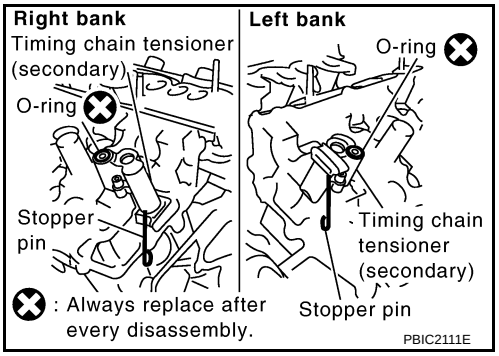


4. Remove camshaft brackets.
   - Mark camshafts, camshaft brackets and bolts so they are placed in the same position and direction for installation.
   - Equally loosen camshaft bracket bolts in several steps in reverse order as shown.



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

7. 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.

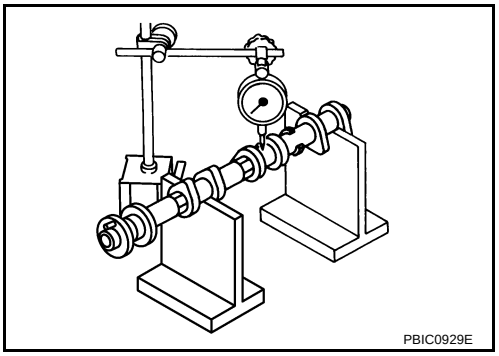


INSPECTION AFTER REMOVAL

Camshaft Runout

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.
2. Set dial indicator vertically to No. 3 journal.
3. 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)

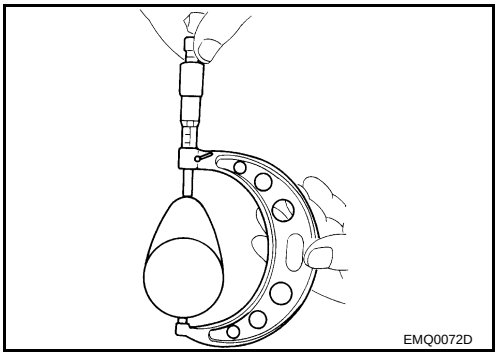


4. If it exceeds the limit, replace camshaft.

Camshaft Cam Height

1. 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)

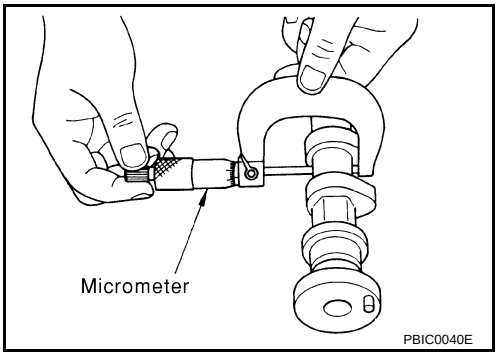


2. If wear exceeds the limit, replace camshaft.

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)



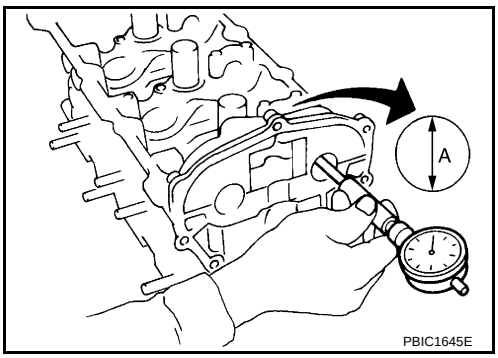
CAMSHAFT BRACKET INNER DIAMETER
• Tighten camshaft bracket bolt with the specified torque.

- 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:

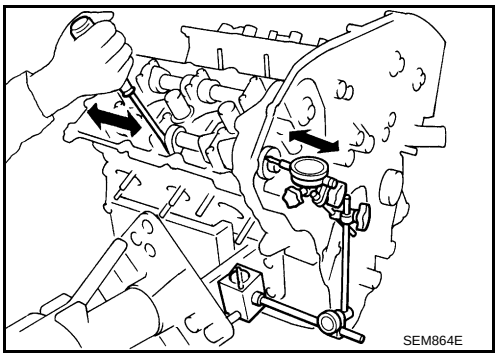
Camshaft bracket cannot be replaced as a single part, because it is machined together with cylinder head. Replace whole cylinder head assembly.

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.

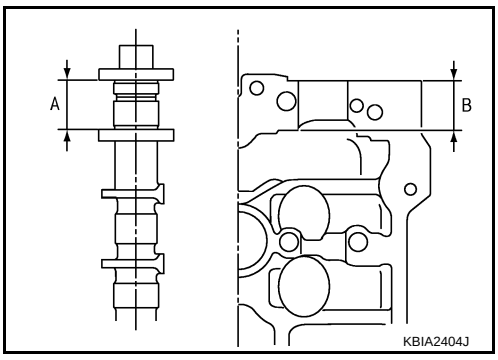
- Dimension “A” for camshaft No. 1 journal

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)

- Following the standards above, 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.

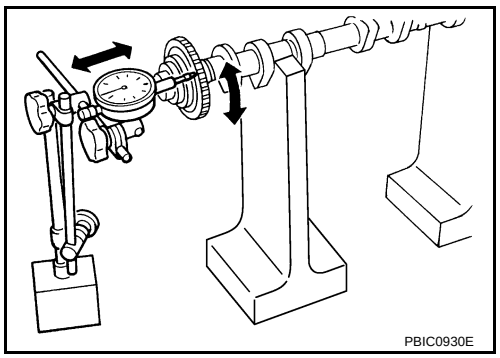
CAUTION:

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

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

Limit : 0.15 mm (0.0059 in)

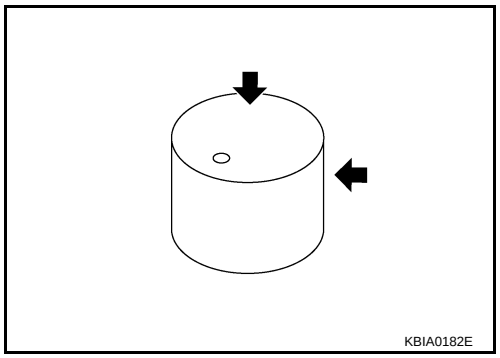
- If it exceeds the limit, replace camshaft sprocket.



Valve Lifter

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

- If anything above is found, replace valve lifter. Refer to EM-132, "Standard and Limit".

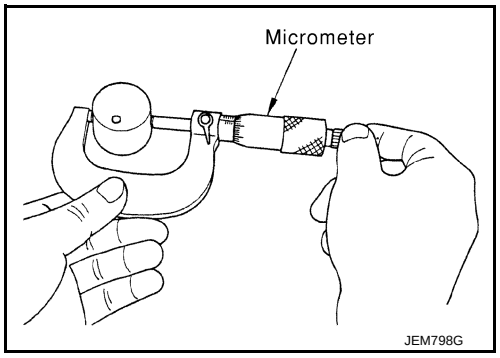


Valve Lifter Clearance

VALVE LIFTER OUTER DIAMETER

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

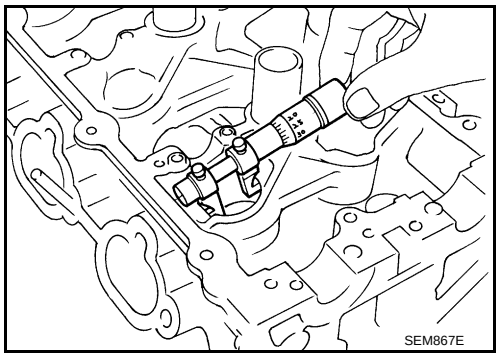
Standard (Intake and exhaust)
: 33.977 - 33.987 mm (1.3377 - 1.3381 in)



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

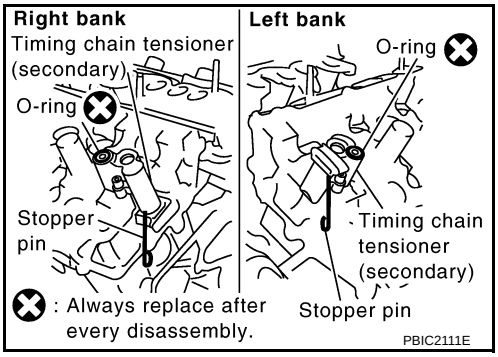
- (Valve lifter clearance) = (Valve lifter hole diameter) – (Valve lifter outer diameter), Refer to EM-18, "Valve Clearance".

Standard (Intake and exhaust)
: 0.013 - 0.039 mm (0.0005 - 0.0015 in)

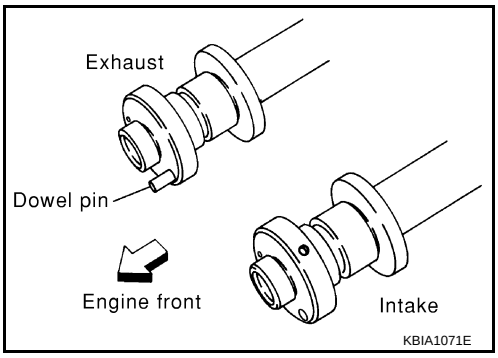
• If the calculated value is out of the standard, referring to each standard of valve lifter outer diameter and valve lifter hole diameter, replace either or both valve lifter and cylinder head.

INSTALLATION

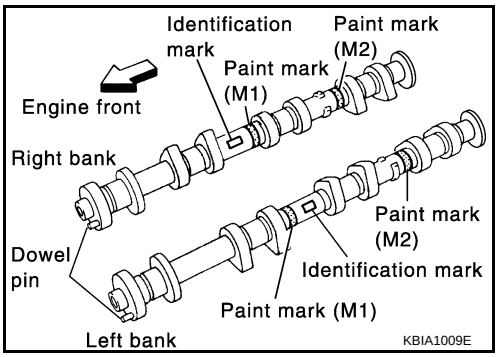
1. Install timing chain tensioners (secondary) on both sides of cylinder head.
   • Install timing chain tensioner with its stopper pin attached.
   • Install timing chain tensioner with sliding part facing downward on right-side cylinder head, and with sliding part facing upward on left-side cylinder 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.

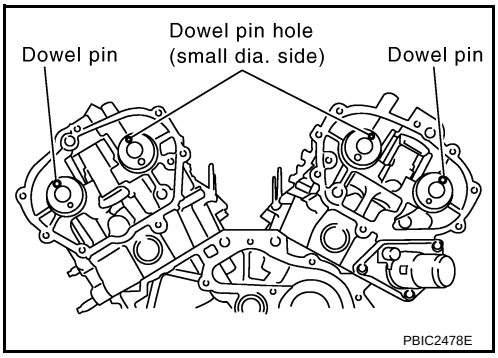


   • Follow your identification marks made during removal, or follow the identification marks that are present on new camshafts for proper placement and direction.

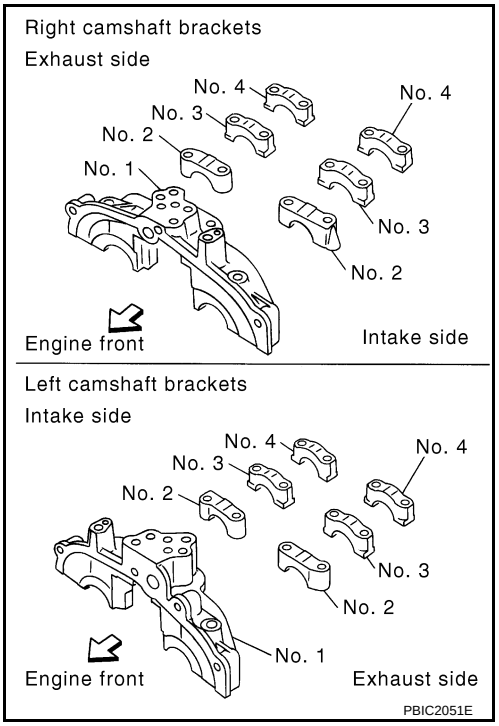


Bank	INT/EXH	Dowel pin	Paint marks		Identification mark
			M1	M2	
RH	INT	No	Green	No	RE
	EXH	Yes	No	White	RE
LH	INT	No	Green	No	LH
	EXH	Yes	No	White	LH

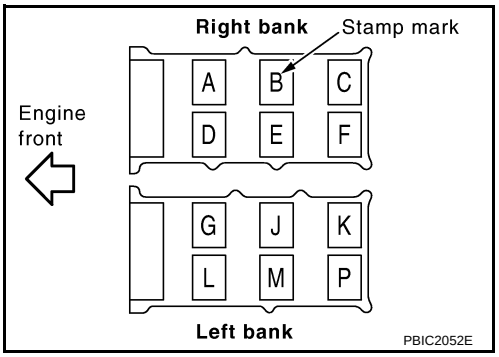
   • Install camshaft so that dowel pin hole and dowel pin on front end face are positioned as shown. (No. 1 cylinder TDC on its compression stroke)
   NOTE:
   • Large and small pin holes are located on front end face of camshaft (INT), at intervals of 180°. Face small dia. side pin hole upward (in cylinder 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.



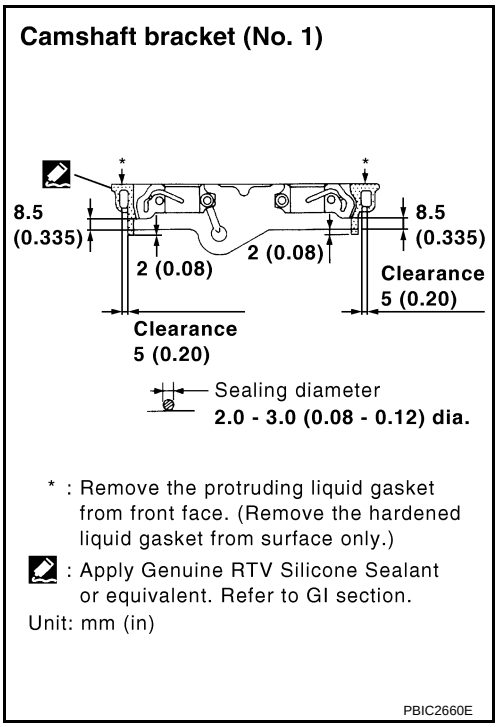
4. Install camshaft brackets.
   - Remove foreign material completely from camshaft bracket backside and from cylinder head installation face.
   - Install camshaft bracket in original position and direction as shown.



- 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).



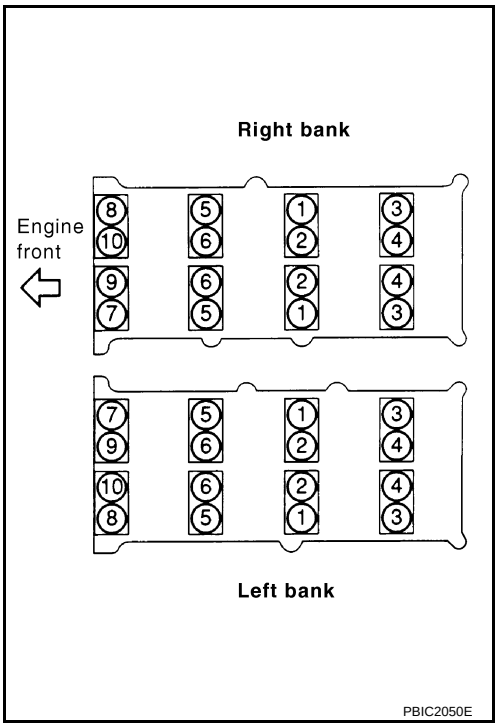
- Apply liquid gasket to mating surface of camshaft bracket (No. 1) as shown on right and left banks.
  Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".



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

Camshaft bracket bolts

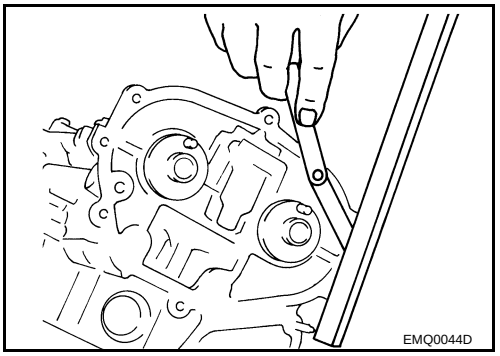
Step 1 (bolts 7 - 10)	**: 1.96 N·m (0.2 kg-m, 17 in-lb)**
Step 2 (bolts 1 - 6)	**: 1.96 N·m (0.2 kg-m, 17 in-lb)**
Step 3	**: 5.88 N·m (0.6 kg-m, 52 in-lb)**
Step 4	**: 10.4 N·m (1.1 kg-m, 92 in-lb)**



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-18, "Valve Clearance".
8. Installation of the remaining components is in the reverse order of removal.

INSPECTION AFTER INSTALLATION

Inspection of Camshaft Sprocket (INT) Oil Groove

CAUTION:

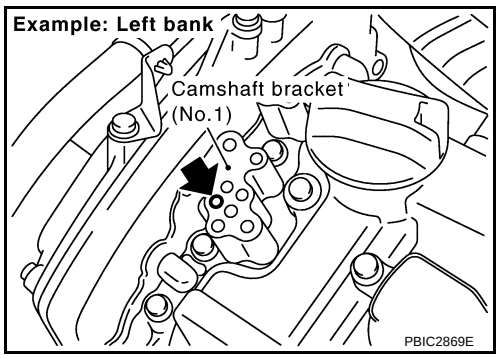
- **Perform this inspection only when DTC P0011 or P0021 are detected in self-diagnostic results of CONSULT-II and it is directed according to inspection procedure of EC section. Refer to EC-99, "DTC Confirmation Procedure".**
- **Check when engine is cold so as to prevent burns from any splashing engine oil.**

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

a. Release fuel pressure. Refer to EC-481, "Fuel Pressure Check".
b. Disconnect ignition coil and injector harness connectors.

3. Remove intake valve timing control solenoid valve. Refer to EM-52, "Removal and Installation".

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-7, "Lubrication Circuit", LU-7, "System Chart".

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-7, "Lubrication Circuit", LU-7, "System Chart".
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-10, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.

NOTE:
If hydraulic pressure inside 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 fluid, power steering fluid, brake fluid, etc.

OIL SEAL

Removal and Installation of Valve Oil Seal

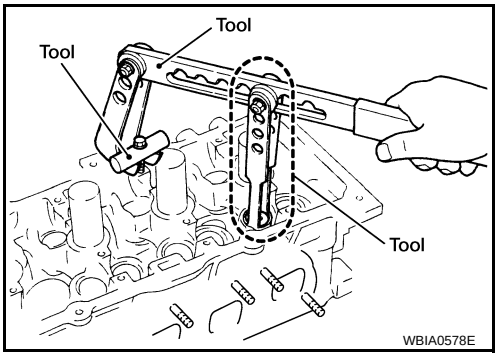
INFOID:0000000001281989

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-81, "Removal and Installation".
3. Remove valve lifters. Refer to EM-81, "Removal and Installation".
4. Remove valve collet, valve spring retainer and valve spring using Tool.
   CAUTION:
   When working, take care not to damage valve lifter holes.

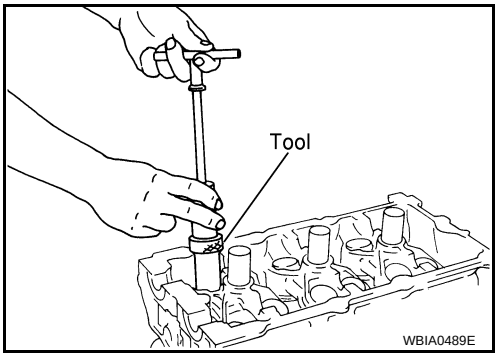
   Tool numbers : KV10116200 (J-26336-B)
   : KV10115900 (J-26336-20)
   : KV10109220 (—)

   - 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

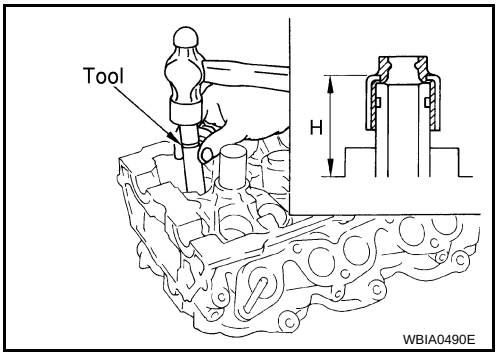
1. Apply new engine oil to new valve oil seal joint surface and seal lip.
2. Press in valve oil seal to specified height "H" using Tool.

   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.



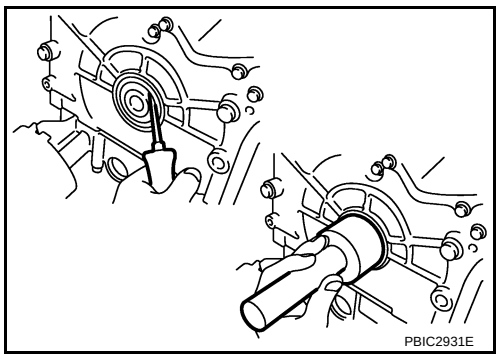
Removal and Installation of Front Oil Seal

INFOID:0000000001281990

REMOVAL

1. Remove engine undercover using power tools.
2. Remove drive belts. Refer to EM-13, "Removal and Installation".
3. Remove engine cooling fan assembly. Refer to CO-19, "Removal and Installation (Crankshaft driven type)".
4. Remove crankshaft pulley. Refer to EM-61, "Removal and Installation".

5. Remove front oil seal using suitable tool.
CAUTION:
Be careful not to damage front timing chain case and crankshaft.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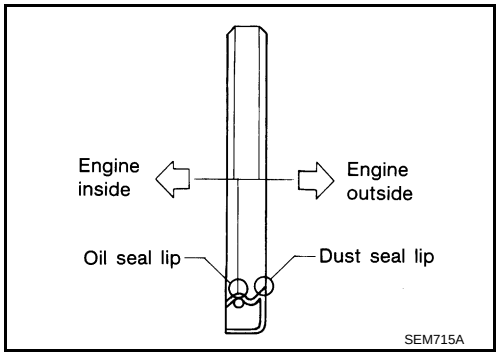
INSTALLATION

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.



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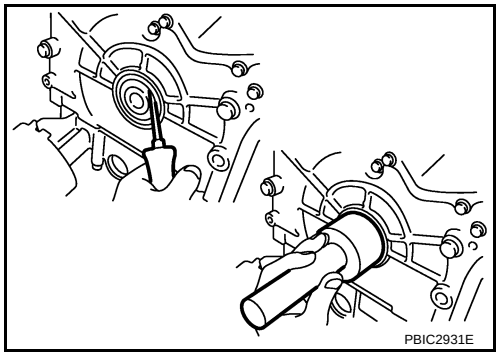
   - Press-fit until the height of front oil seal is level with the mounting surface using suitable tool.
   - Suitable drift: outer diameter 60 mm (2.36 in), inner diameter 50 mm (1.97 in).

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


PBIC2931E

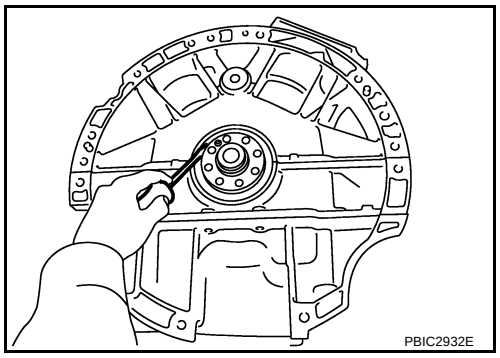
3. Installation is in the reverse order of removal after this step.

Removal and Installation of Rear Oil Seal

INFOID:0000000001281991

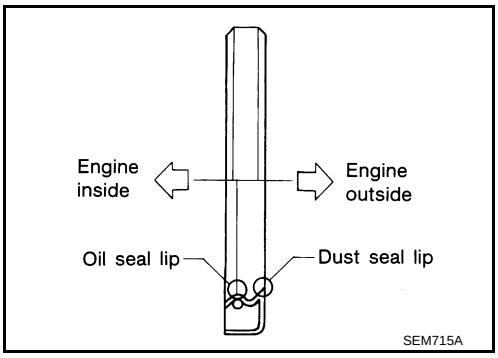
REMOVAL

1. Remove transmission assembly. Refer to TM-225, "2WD : Removal and Installation" (2WD models), TM-228, "4WD : Removal and Installation" (4WD models).
2. Remove rear oil seal with a suitable tool.
CAUTION:
Be careful not to damage crankshaft and cylinder block.


PBIC2932E

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.

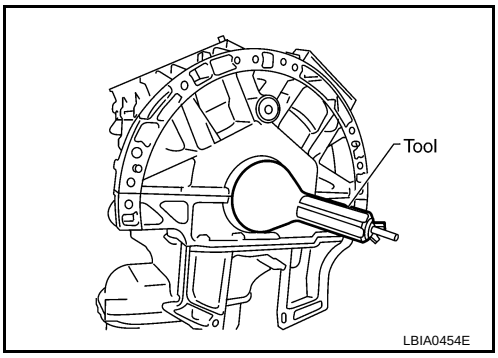


- Install new rear oil seal using Tool.

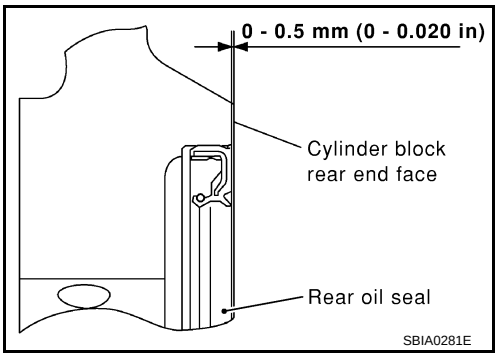
Tool number : KV991J0120 (J-47128)

CAUSTION:

- **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.**



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

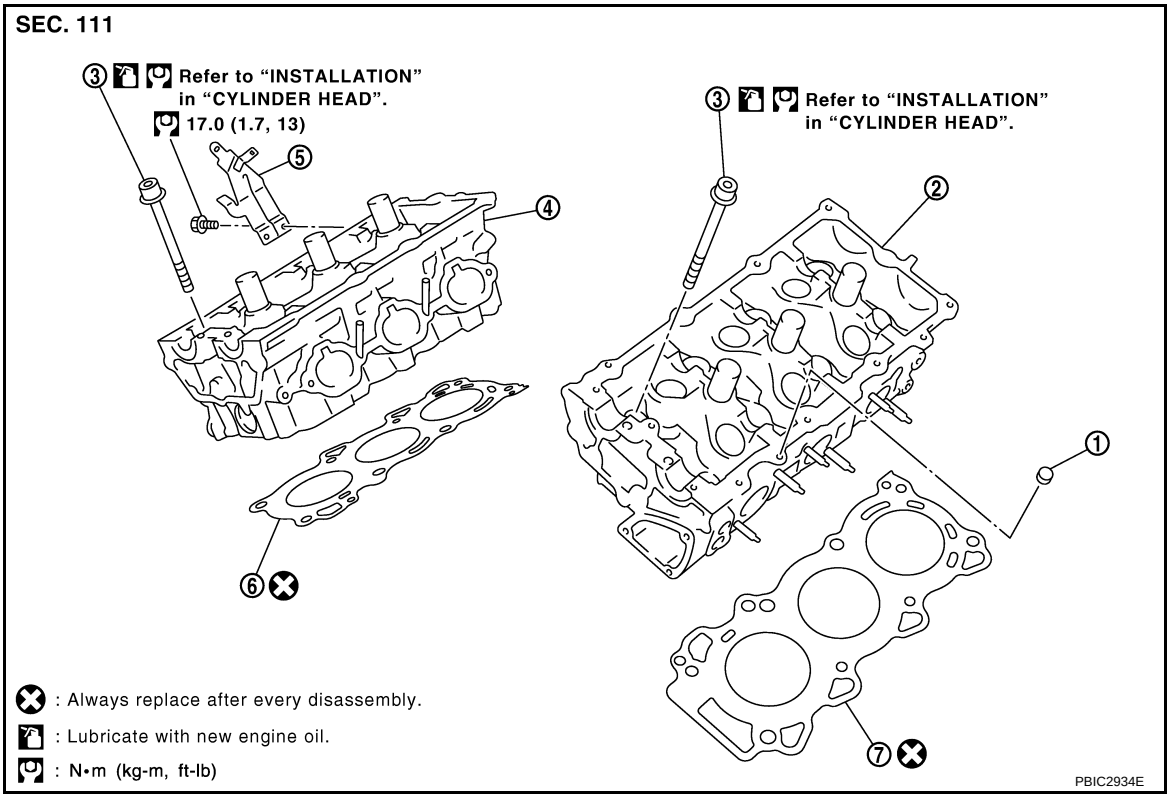


3. Installation of the remaining components is in the reverse order of removal.

CYLINDER HEAD

Removal and Installation

INFOID:0000000001281993



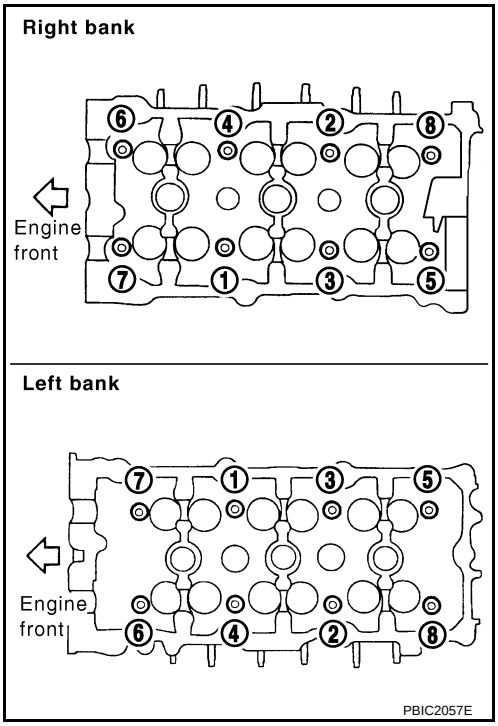
1. Rubber plug
2. Cylinder head (left bank)
3. Cylinder head bolt
4. Cylinder head (right bank)
5. Harness bracket
6. Cylinder head gasket (right bank)
7. Cylinder head gasket (left bank)

REMOVAL

1. Remove camshaft. Refer to EM-81, "Removal and Installation".
2. Remove intake manifold. Refer to EM-29, "Removal and Installation".
3. Remove exhaust manifold. Refer to EM-31, "Removal and Installation".
4. Remove water inlet and thermostat assembly. Refer to CO-26, "Removal and Installation".
5. Remove water outlet, water pipe and heater pipe. Refer to CO-28, "Removal and Installation".

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.

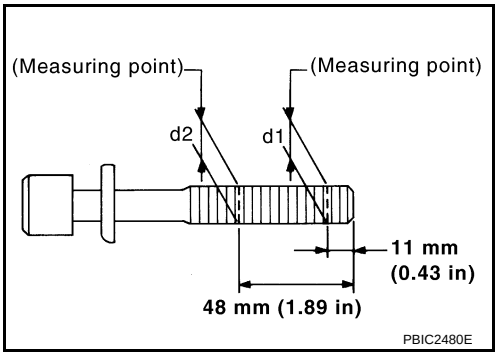
INSPECTION AFTER REMOVAL

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 the bolt with a 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

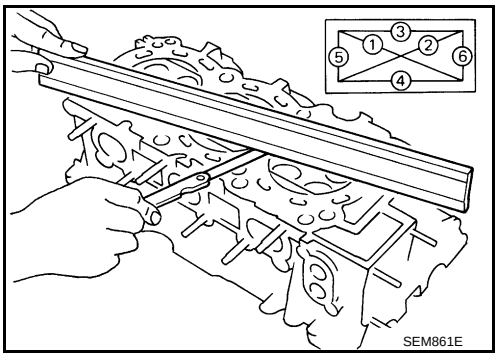
NOTE:

When performing this inspection, cylinder block distortion should be also checked. Refer to EM-117, "Inspection After Disassembly".

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.

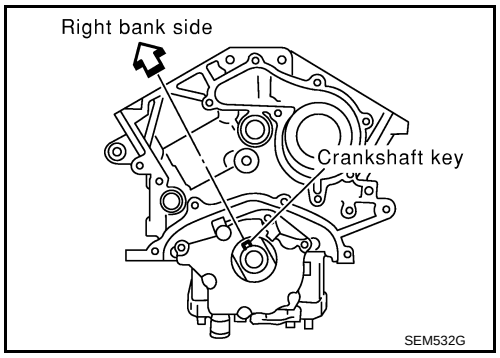
Limit : 0.1 mm (0.004 in)

- If it exceeds the limit, replace cylinder head.



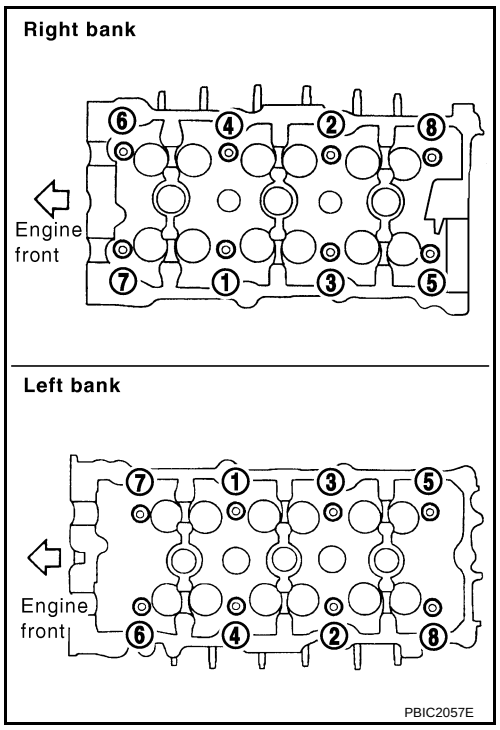
INSTALLATION

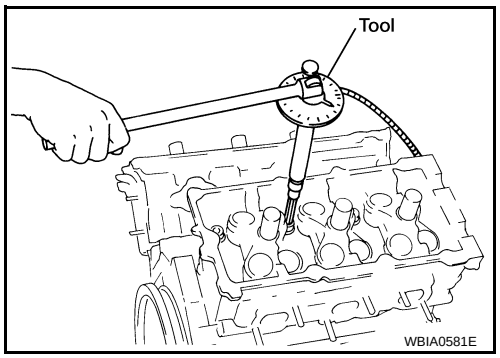
1. Install new cylinder head gasket.
2. Turn crankshaft until No. 1 piston is set at TDC.
   - Crankshaft key should line up with the right bank cylinder center line as shown.



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, "Removal and Installation" (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

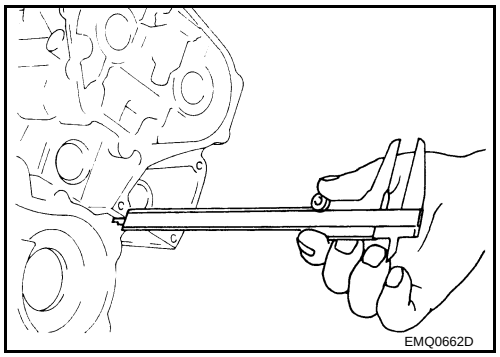




4. After installing cylinder head, measure distance between front end faces of cylinder block and cylinder head (left and right banks).

   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-10, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- 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, power steering fluid, brake fluid, etc.

Disassembly and Assembly

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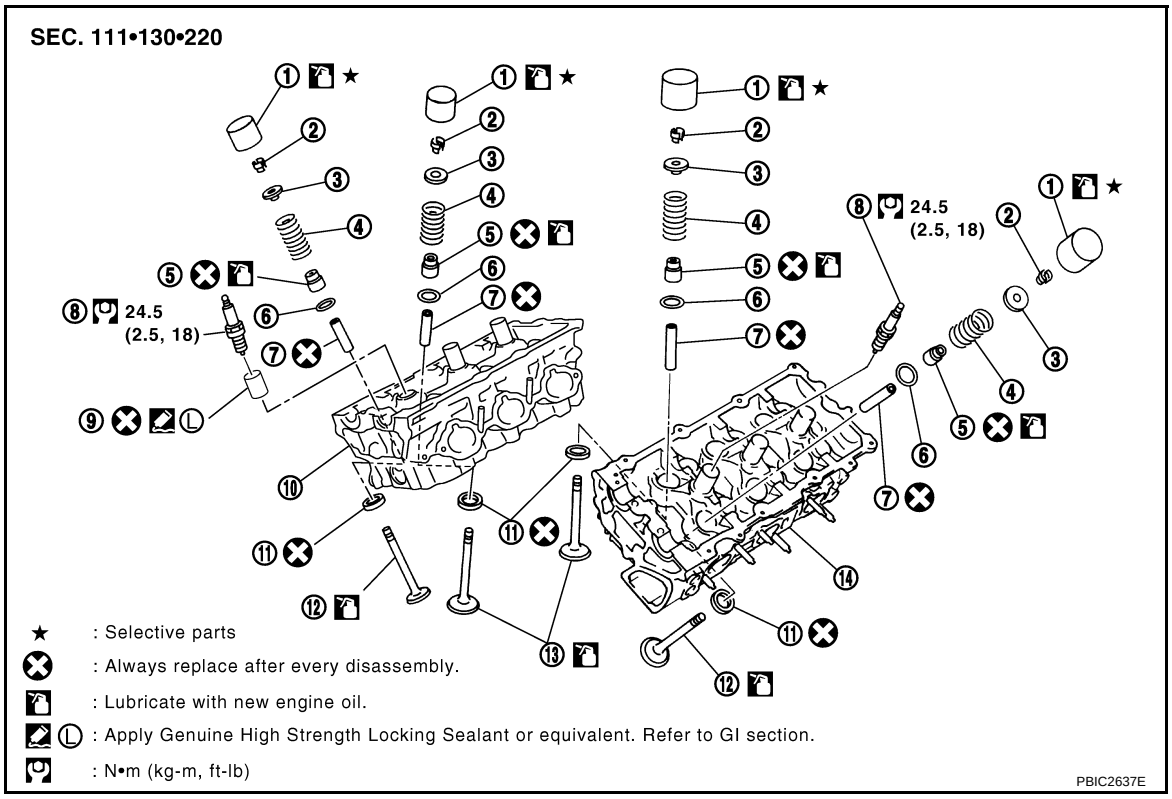


1. Valve lifter
2. Valve collet
3. Valve spring retainer
4. Valve spring
5. Valve oil seal
6. Valve spring seat

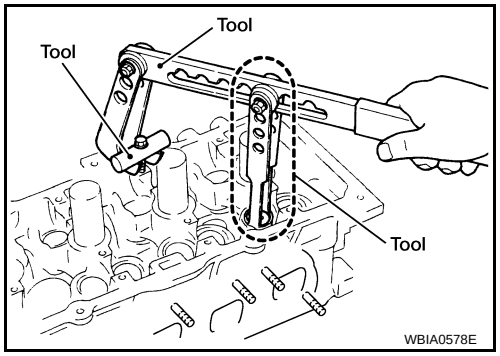
7. Valve guide
8. Spark plug
9. Spark plug tube
10. Cylinder head (right bank)
11. Valve seat
12. Valve (EXH)
13. Valve (INT)
14. Cylinder head (left bank)

DISASSEMBLY

1. Remove spark plug.
2. Remove valve lifter.
   • Identify installation positions, and store them without mixing them up.
3. Remove valve collet.
   • Compress valve spring and remove valve collet with magnet hand using Tool.

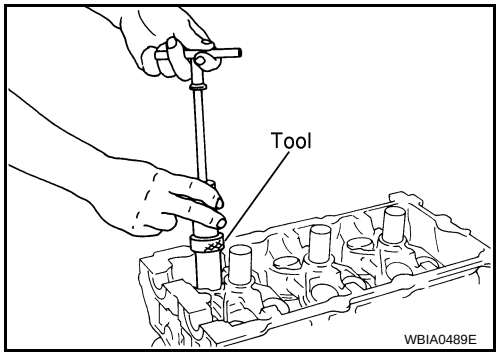
   CAUTION:
   When working, take care not to damage valve lifter holes.

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



4. Remove valve spring retainer, valve spring and valve spring seat.
5. Push valve stem to combustion chamber side, and remove valve.
   • Identify installation positions, and store them without mixing them up.
6. Remove valve oil seals using Tool.

   Tool number : KV10107902 (J-38959)



7. If valve seat must be replaced, refer to EM-98, "Inspection After Disassembly".
8. If valve guide must be replaced, refer to EM-98, "Inspection After Disassembly".
9. Remove spark plug tube, as necessary.
   • Using pair of pliers, pull spark plug tube out of cylinder head.

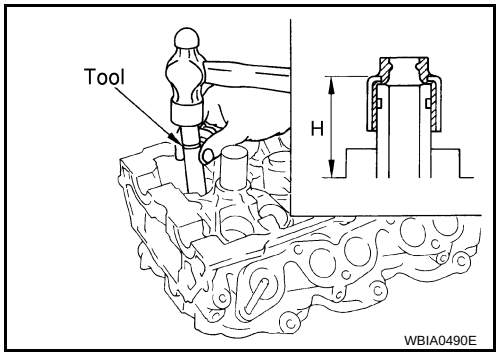
   CAUTION:
   • **Take care not to damage cylinder head.**
   • **Once removed, spark plug tube will be deformed and cannot be reused. Do not remove it unless absolutely necessary.**

ASSEMBLY

1. When valve guide is removed, install it. Refer to EM-98, "Inspection After Disassembly".
2. When valve seat is removed, install it. Refer to EM-98, "Inspection After Disassembly".
3. Install valve oil seals using Tool.

   Tool number : — (J-39386)

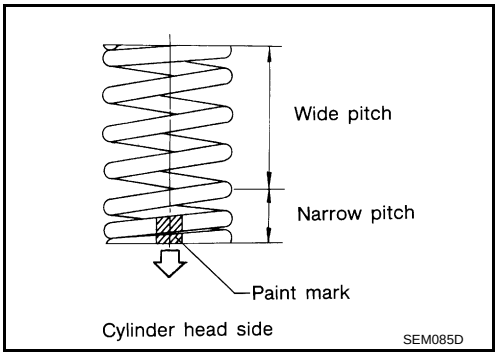
   Height "H" (Without valve spring seat installed)
   Intake and exhaust : 14.3 - 14.9 mm (0.563 - 0.587 in)



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

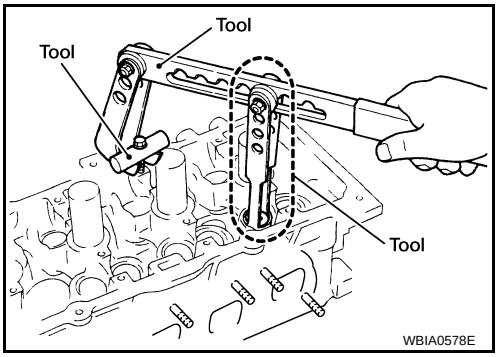
NOTE:
Larger diameter valves are for intake side.

6. Install valve spring (uneven pitch type).
   • Install 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)

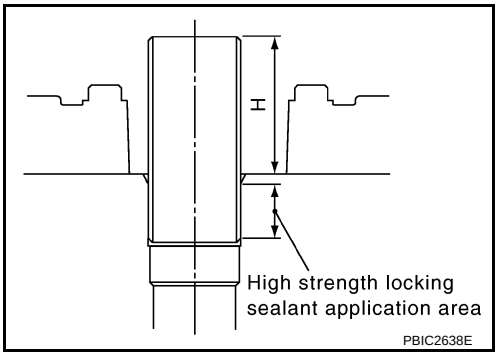


CAUTION:
When working, take care not to damage valve lifter holes or valve stems.
   • Tap valve stem edge lightly with plastic hammer after installation to check its installed condition.

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

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-26, "Recommended Chemical Products and Sealants".
c. Press-fit spark plug tube so that its height “H” is as specified 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.

Inspection After Disassembly

INFOID:0000000001281995

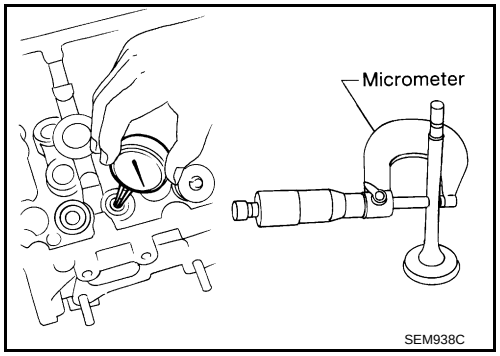
VALVE DIMENSIONS

• Check dimensions of each valve. For dimensions, refer to EM-132, "Standard and Limit".
• If dimensions are out of the standard, replace valve and check the valve seat contact. Follow the "VALVE SEAT CONTACT" procedure.

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)

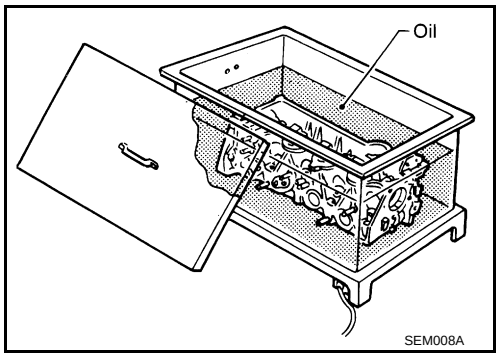
Exhaust : 0.09 mm (0.004 in)

- If the calculated value exceeds the limit, replace valve and/or valve guide. When valve guide must be replaced, follow the "VALVE GUIDE REPLACEMENT" procedure.

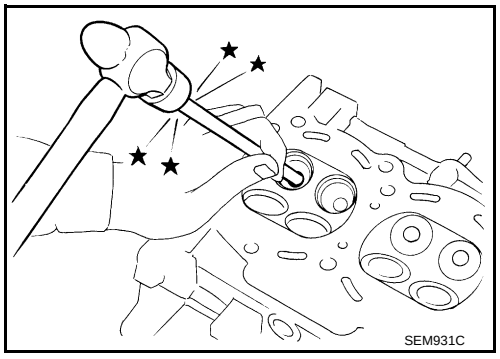
VALVE GUIDE REPLACEMENT

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

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

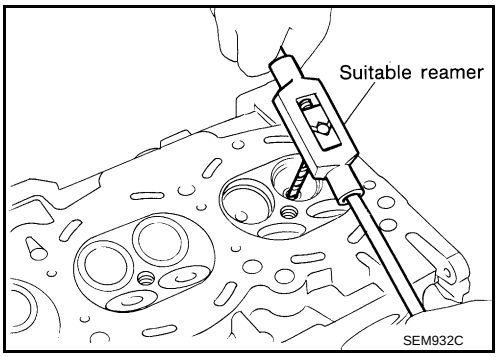


2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and valve guide drift (commercial service tool).
   CAUTION:
   Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.

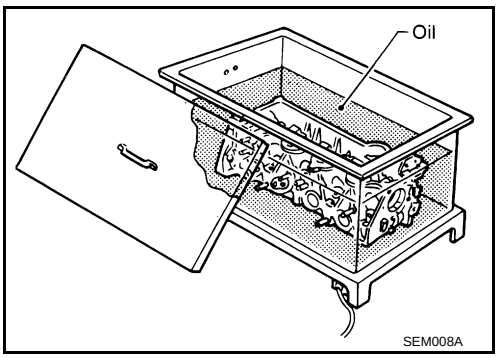


3. Ream cylinder head valve guide hole; using suitable reamer.

Valve guide hole diameter (for service parts):
Intake and exhaust
: 10.175 - 10.196 mm (0.4006 - 0.4014 in)



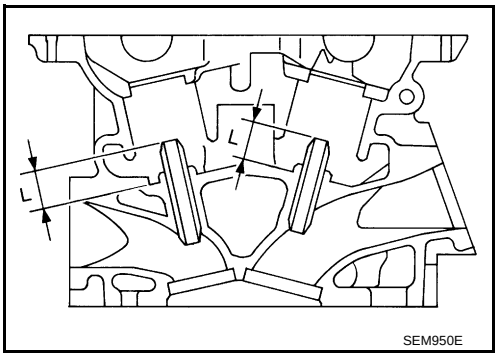
4. Heat cylinder head to 110° to 130°C (230° to 266°F) by soaking in heated oil.



5. Press valve guide from camshaft side to the dimensions as shown using suitable tool.

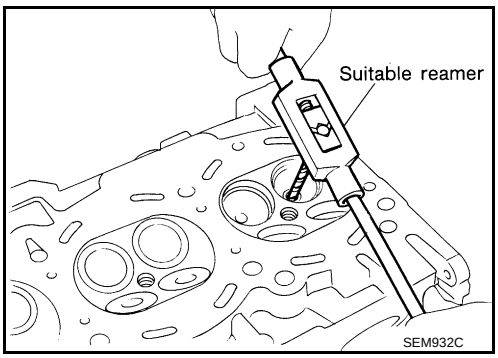
Projection "L"
Intake and exhaust
: 12.6 - 12.8 mm (0.496 - 0.504 in)

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



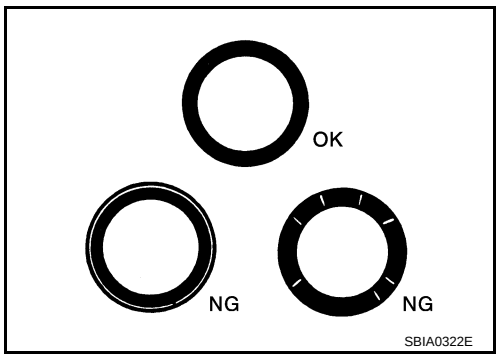
6. Apply reamer finish to valve guide using suitable reamer.

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. Follow the "VALVE SEAT REPLACEMENT" procedure.



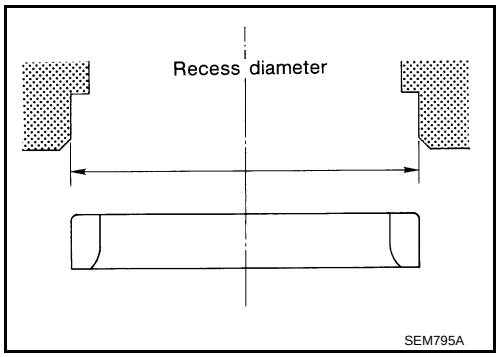
VALVE SEAT REPLACEMENT

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

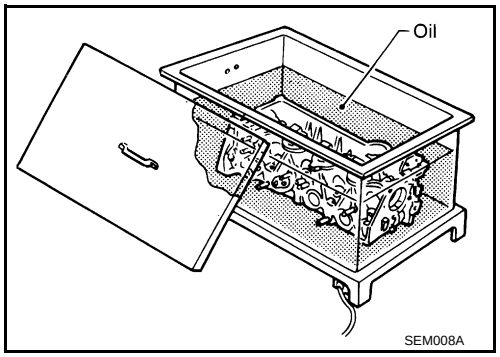
1. Bore out old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in cylinder head. Set the machine depth stop to ensure this. Refer to EM-132, "Standard and Limit".
   CAUTION:
   Prevent to scratch cylinder head by excessive boring.
2. Ream cylinder head 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)

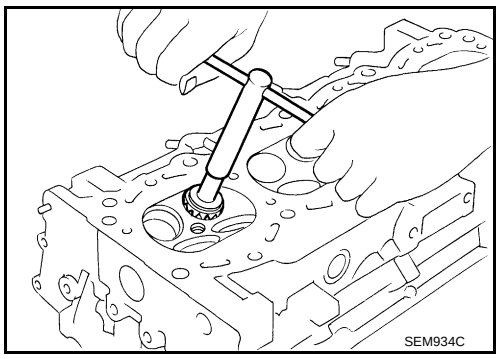
   - Be sure to ream in circles concentric to valve guide center. This will enable valve to fit correctly.



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 contains heat. When working, wear protective equipment to avoid getting burned.**
5. Finish seat to the specified dimensions using suitable tool. Refer to EM-132, "Standard and Limit".
   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.

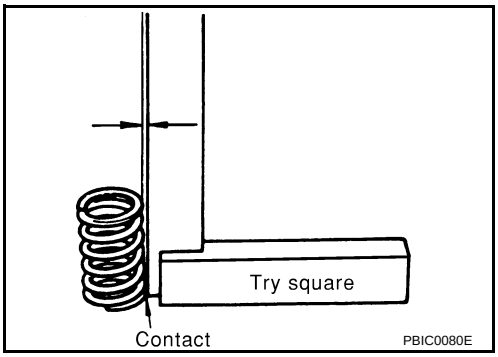
7. Check again for normal contact. Follow the "VALVE SEAT CONTACT" procedure.

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.

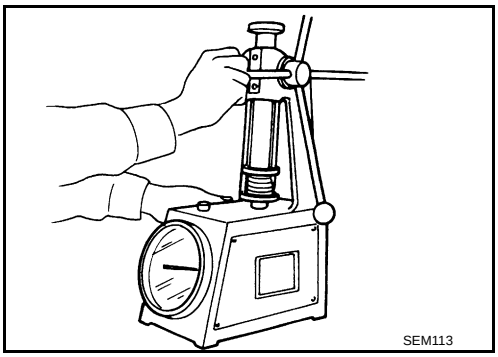
Limit : 2.1 mm (0.083 in)

- 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.

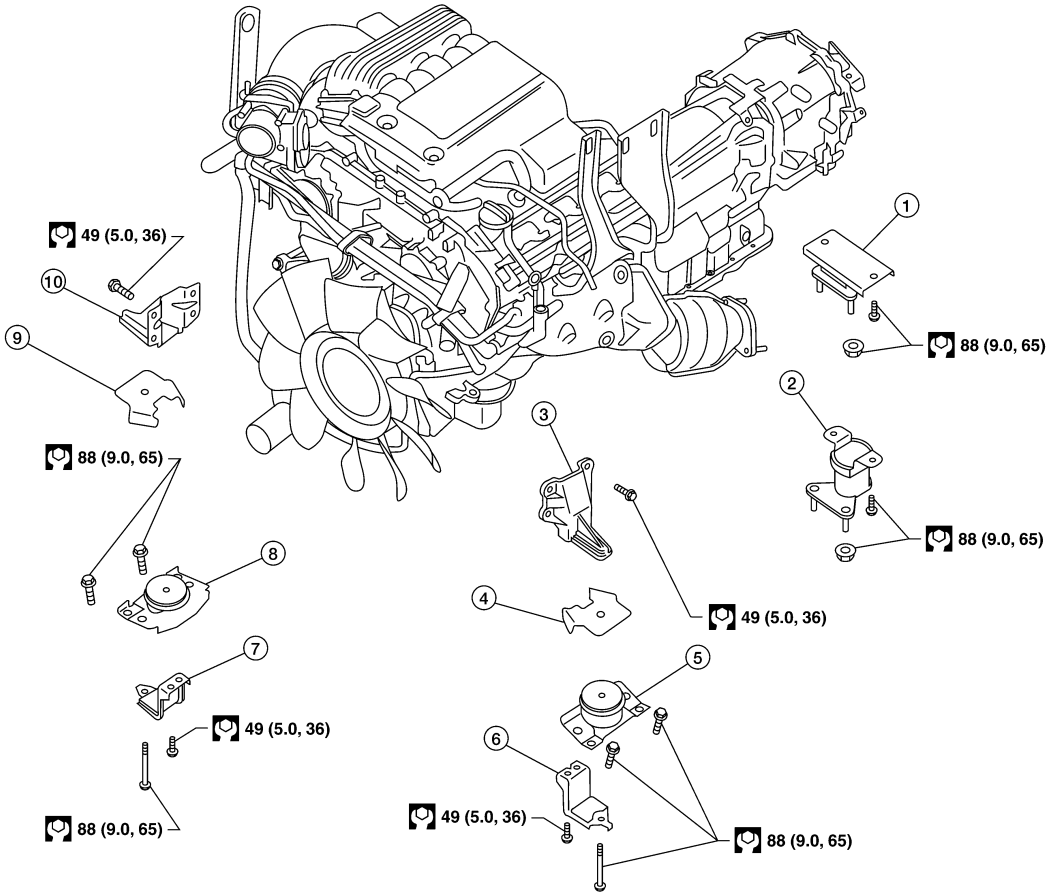
REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

Removal and Installation

INFOID:0000000001281996

SEC. 112



: N·m (kg-m, ft-lb)

LBIA0432E

1. Rear engine mounting insulator 4WD
2. Rear engine mounting insulator 2WD
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
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.**

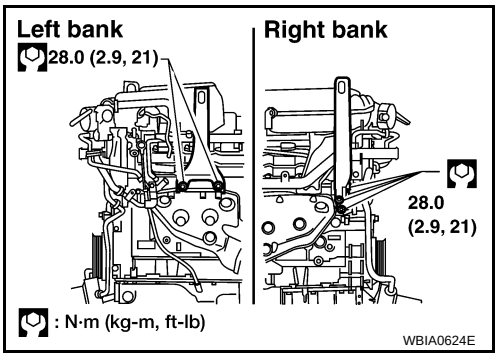
- **Do not start working until exhaust system and engine coolant are cooled sufficiently.**
- **If items or work required are not covered by the engine section, follow the procedures in the applicable sections.**
- **Always use the support point specified for lifting.**
- **Use either 2-point lift type 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-43, "Garage Jack and Safety Stand".**

REMOVAL

Preparation

1. Drain engine coolant. Refer to CO-12, "Changing Engine Coolant".
2. Partially drain A/T fluid. Refer to TM-182, "Changing the A/T Fluid (ATF)".
3. Release fuel pressure. Refer to EC-481, "Fuel Pressure Check".
4. Remove the engine hood. Refer to DLK-182, "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-25, "Removal and Installation".
7. Disconnect vacuum hose between vehicle and engine and set it aside.
8. Remove the radiator assembly and hoses. Refer to CO-16, "Removal and Installation".
9. Remove the drive belts. Refer to EM-13, "Removal and Installation".
10. Remove the engine cooling fan. Refer to CO-19, "Removal and Installation (Crankshaft driven type)".
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 ST-24, "Removal and Installation".
15. Remove the A/C compressor bolts and set aside. Refer to HA-40, "Removal and Installation for Compressor".
16. Disconnect brake booster vacuum line.
17. Disconnect EVAP line.
18. Disconnect the fuel hose at the engine side connection. Refer to EM-47, "Removal and Installation".
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 (4WD models). Refer to DLN-343, "Removal and Installation".
22. Remove three way catalyst. Refer to EM-31, "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)



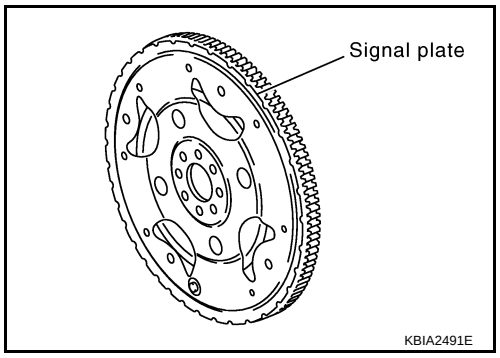
24. Remove transmission. Refer to TM-225, "2WD : Removal and Installation" (2WD models) or TM-228, "4WD : Removal and Installation" (4WD models).
25. Lift with hoist and secure the engine in position.
26. Remove engine assembly from vehicle, avoiding interference with vehicle body.
    CAUTION:
    - **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 a engine holding the surface, to which transmission is installed.

a. Remove drive plate.

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

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-47, "Removal and Installation".
- Remove intake manifold. Refer to EM-29, "Removal and Installation".
- Remove rocker cover. Refer to EM-42, "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 generator. Refer to CHG-21, "Removal and Installation".
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 fluid, power steering fluid, brake fluid, etc.

DISASSEMBLY AND ASSEMBLY

ENGINE UNIT

Disassembly and Assembly

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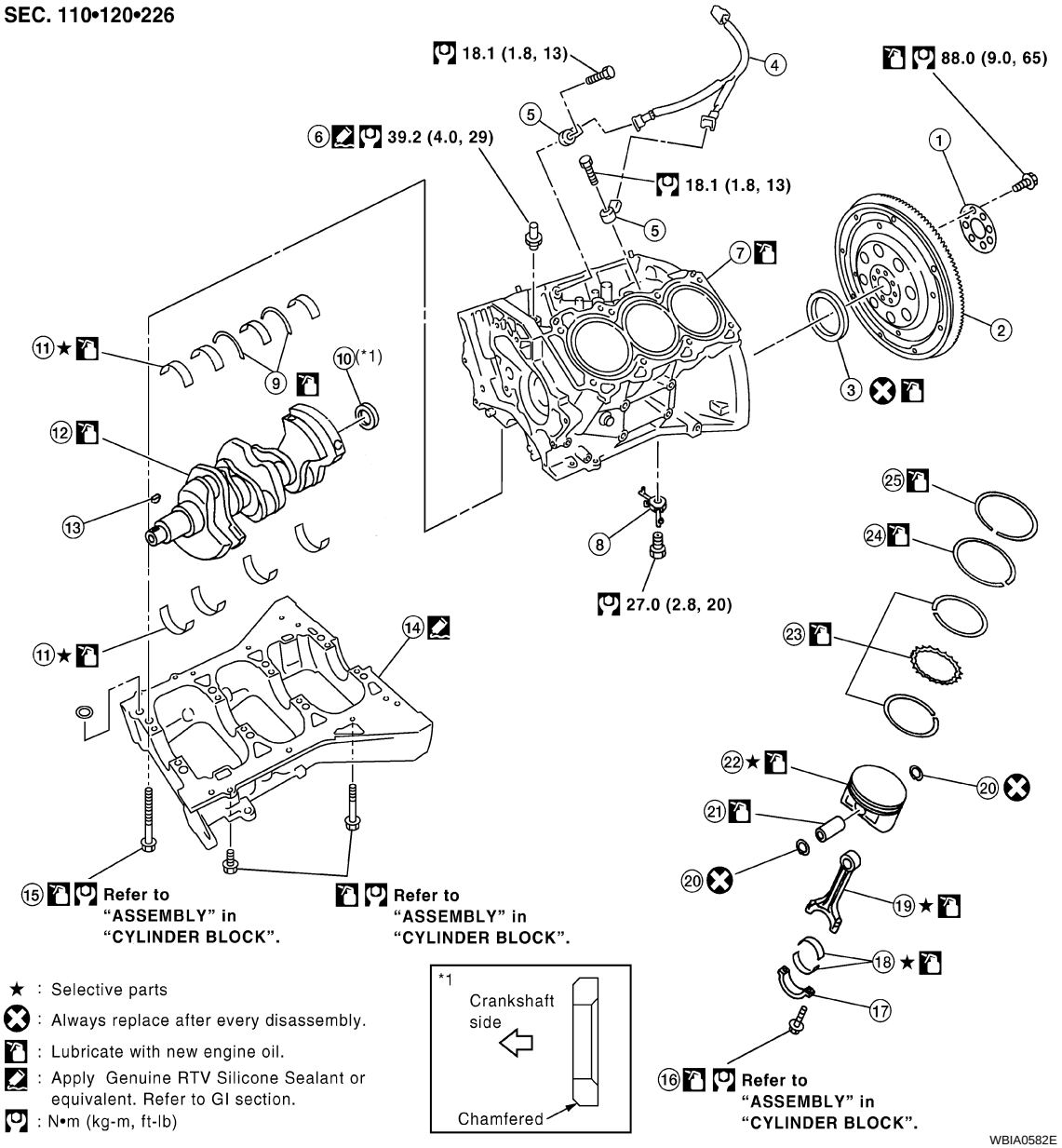
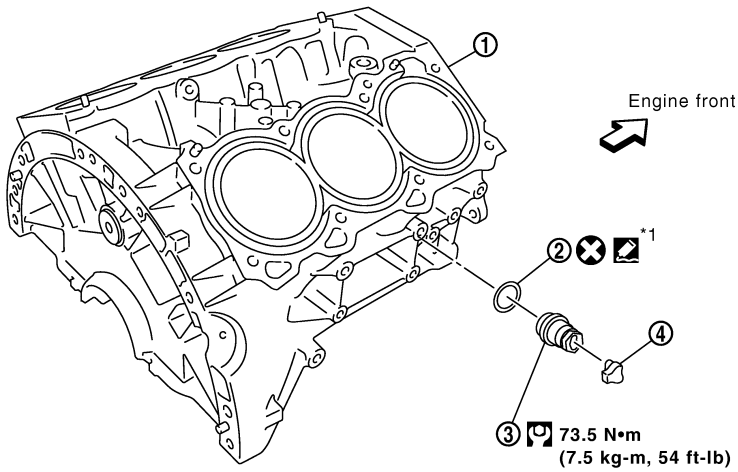
SEC. 110•120•226



1. Reinforcement plate
2. Drive plate
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
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

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.

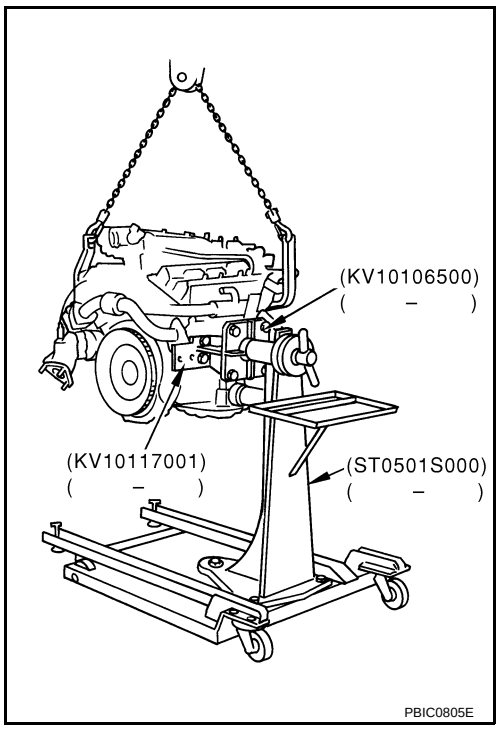
PBIC2936E

1. Cylinder block
2. Gasket
3. Cylinder block heater
4. Connector protector cap

DISASSEMBLY

NOTE:
Explained here is how to disassemble with engine stand supporting transmission surface. When using different type of engine stand, some steps may be different.

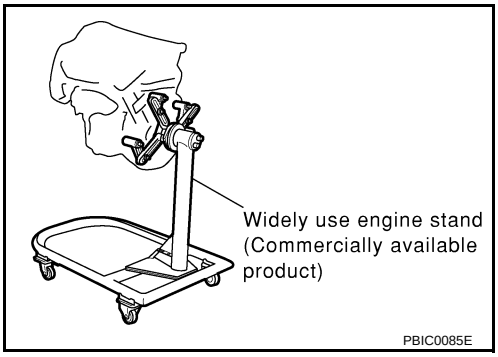
1. Remove engine assembly from vehicle. Refer to EM-103, "Removal and Installation".
2. Remove both exhaust manifolds. Refer to EM-31, "Removal and Installation".
3. Lift engine, and mount to engine stand.
   CAUTION:
   Before removing the hanging chains, make sure engine stand is stable and there is no risk of overturning.



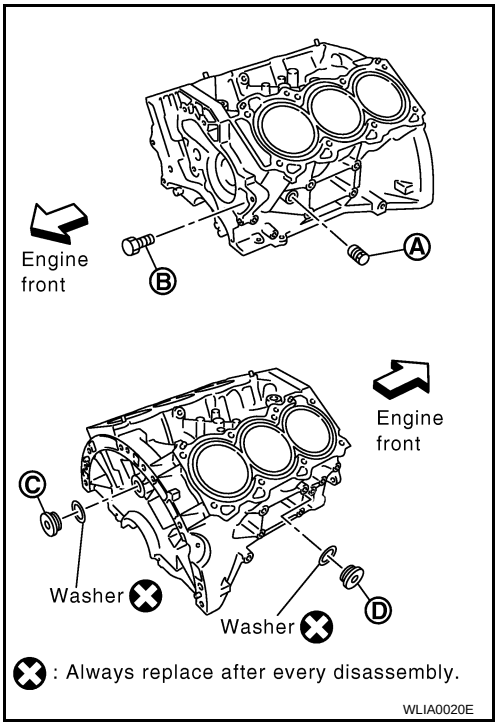
PBIC0805E

- 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-9, "Changing Engine Oil".
5. Drain engine coolant by removing the cylinder block drain plugs "A", "B", "C" and "D" from cylinder block as shown.
NOTE:
For Canada, “D” is not plug but block heater.

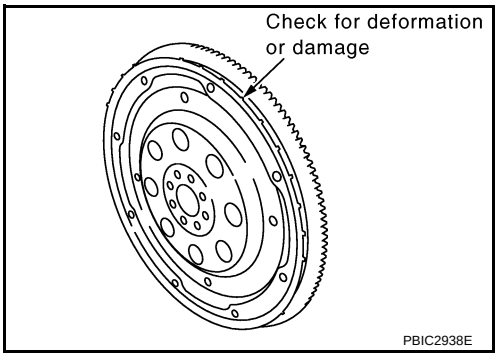


6. Remove drive plate using Tool.

Tool number : KV10117700 (J-44716)

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

CAUTION:
- **Do not disassemble drive plate.**
- **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.**

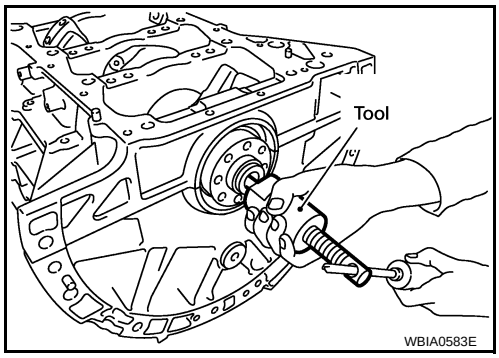


7. Remove cylinder head. Refer to EM-93, "Removal and Installation".
8. Remove sub harness, and remove knock sensors.

CAUTION:
Carefully handle sensor avoiding shocks.

9. Remove pilot converter using Tool as necessary.

Tool number : ST16610001 (J-23907)

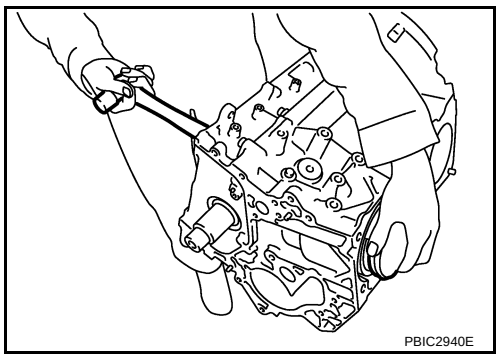


10. Remove piston and connecting rod assembly as follows:
    - Before removing piston and connecting rod assembly, check the connecting rod side clearance. Refer to EM-117, "Inspection After Disassembly".

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.

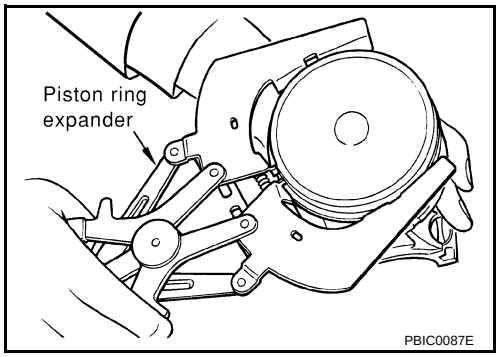


14. Remove connecting rod bearings from connecting rod and connecting rod bearing cap.

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

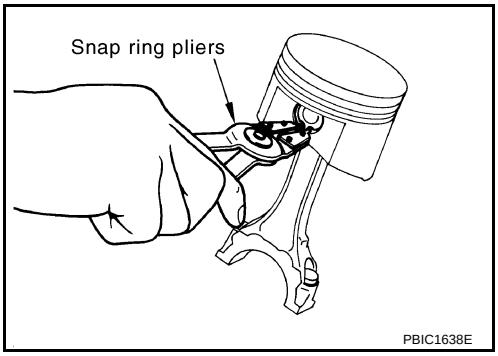
15. Remove piston rings form piston.
    - Before removing piston rings, check the piston ring side clearance. Refer to EM-117, "Inspection After Disassembly".
    - Remove piston rings using piston ring expander or suitable tool.

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

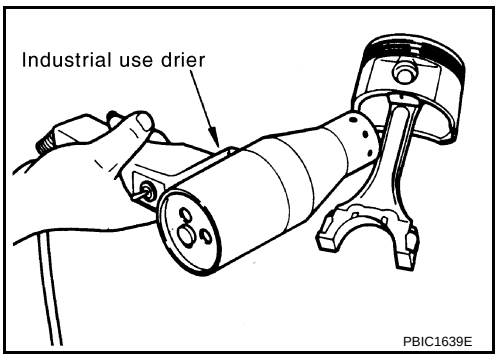


16. Remove piston from connecting rod as follows:

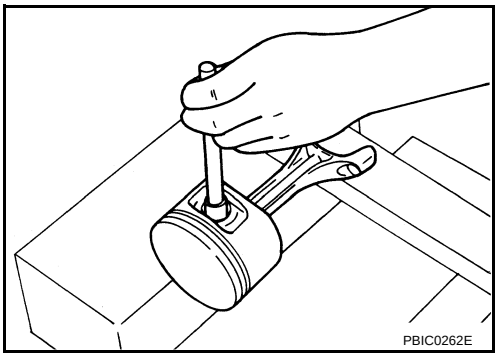
a. Remove snap ring using snap ring pliers.



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

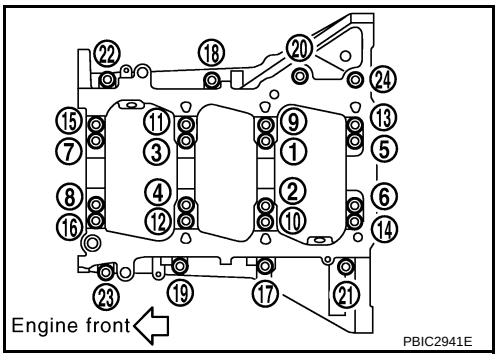


c. Push out piston pin with stick of outer diameter approximately 20 mm (0.79 in).



17. Remove lower cylinder block bolts.
    - Before loosening lower cylinder block bolts, measure the crankshaft end play. Refer to EM-117, "Inspection After Disassembly".
    - 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, "Precaution for Liquid Gasket".

    Tool number : KV10111100 (J-37228)

    CAUTION:
    Be careful not to damage the mounting surfaces.
19. Remove crankshaft.
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.

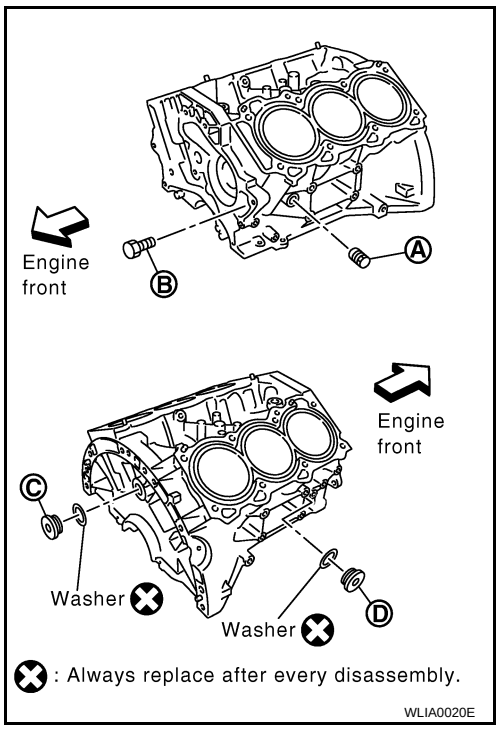
21. Remove main bearings and thrust bearings from cylinder block and lower cylinder block.
CAUTION:
- **Be careful not to drop main bearing, and to scratch the surface.**
- **Identify installation positions, and store them without mixing them up.**

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-26, "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-26, "Recommended Chemical Products and Sealants".
- Apply sealant to the thread of plug “D”.
Use Anaerobic Liquid Gasket or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".
NOTE:
For Canada, “D” is not plug but block heater. Refer to EM-106, "Disassembly and Assembly".
- Replace washers with new one.



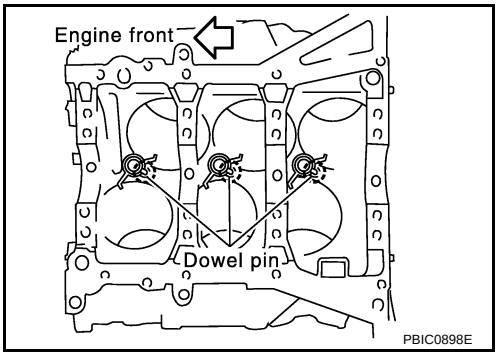
- Tighten each plug as specified below.

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	No	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	Yes	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.

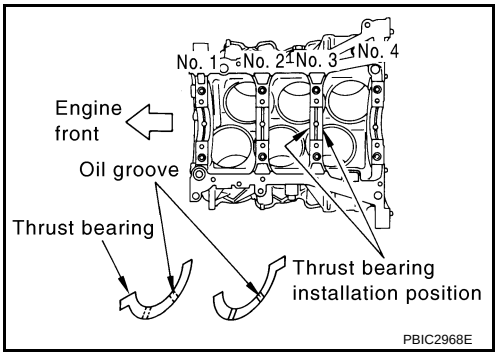
- Insert oil jet dowel pin into cylinder block dowel pin hole, and tighten bolts.



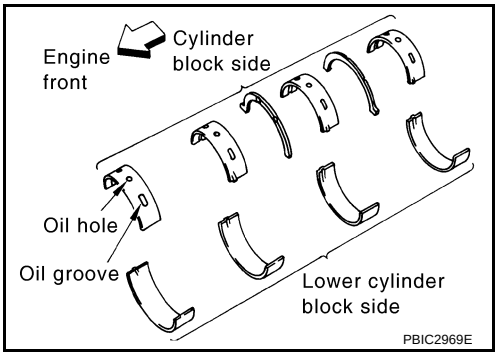
4. Install main bearings and thrust bearings as follows:

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

b. 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-117, "Inspection After Disassembly".

7. Install lower cylinder block as follows:

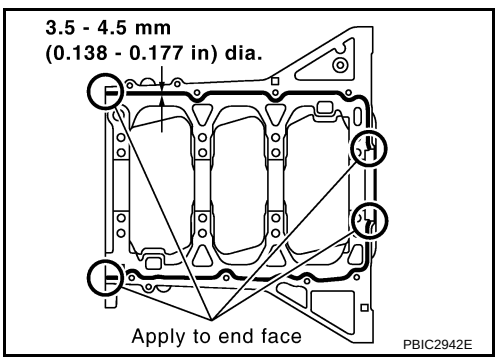
NOTE:
Lower cylinder block cannot be replaced as a single part, because it is machined together with cylinder block.

a. 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-26, "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.



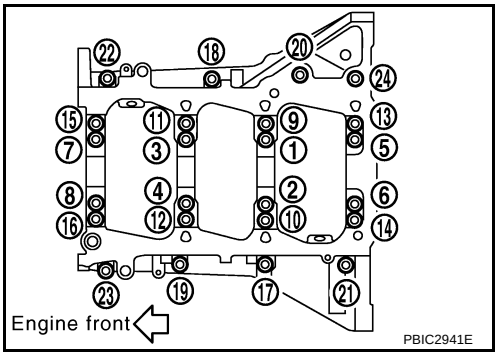
b. Tighten lower cylinder block as follows:

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.

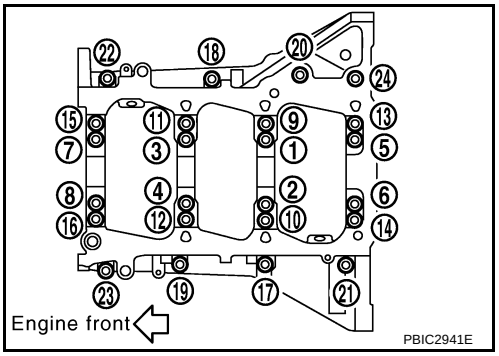


c. Install rear oil seal. Refer to EM-91, "Removal and Installation of Rear Oil Seal".

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).

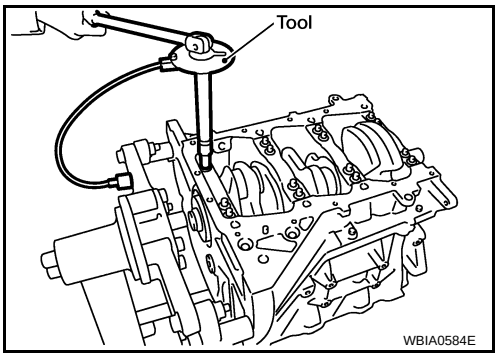
Bolts 1 - 16 : 35.3 N·m (3.6 kg-m, 26 ft-lb)



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.



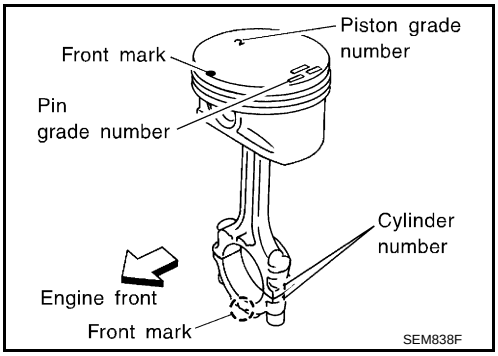
- After installing the bolts, make sure that crankshaft can be rotated smoothly by hand.
- Wipe off completely any protruding liquid gasket on front side of the engine.
- Check the crankshaft end play. Refer to EM-117, "Inspection After Disassembly".

8. Inspect the outer diameter of connecting rod bolt. Refer to EM-117, "Inspection After Disassembly".
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.

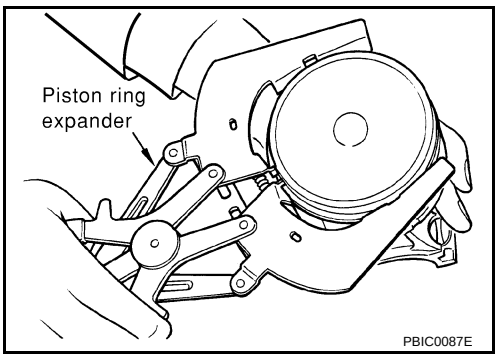
- Assemble so that the front mark on the piston head and the cylinder number on connecting rod are positioned as shown.



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 expending them excessively.**

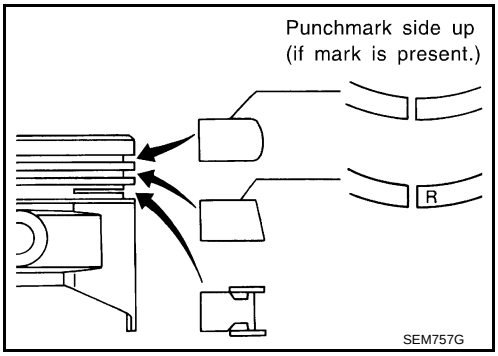


- If there is stamped mark on ring, mount it with marked side up.

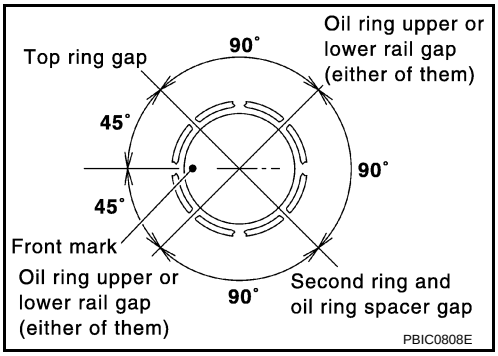
NOTE:
If there is no stamp on ring, no specific orientation is required for installation.

Stamped mark:

Top ring	**: —**
Second ring	**: R**



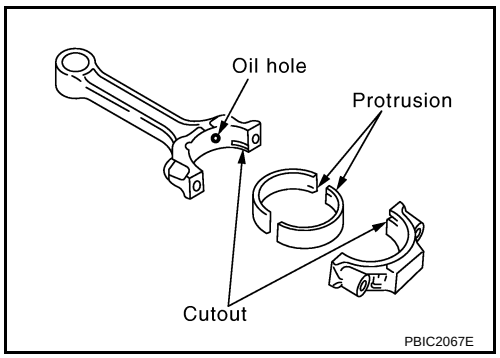
- Position each ring with the gap as shown referring to the piston front mark.



- Check the piston ring side clearance. Refer to EM-117, "Inspection After Disassembly".

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.

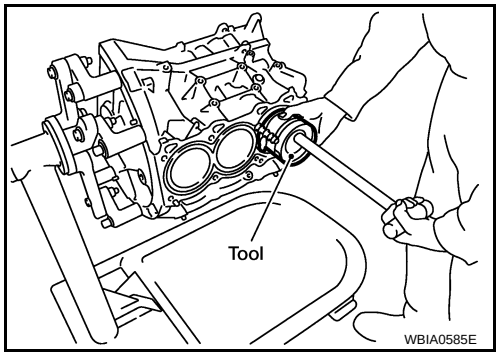
- When installing, align connecting rod bearing stopper protrusion with cutout of connecting rods and connecting rod bearing caps to install.
- Ensure the oil hole on connecting rod and that on the corresponding bearing are aligned.



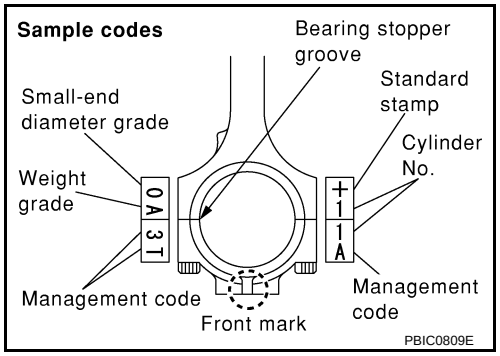
12. Install piston and connecting rod assembly to crankshaft.
13. Position crankshaft pin corresponding to connecting rod to be installed onto the bottom dead center.
14. Apply engine oil sufficiently to the cylinder bore, piston and crankshaft pin journal.
15. Match the cylinder position with the cylinder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

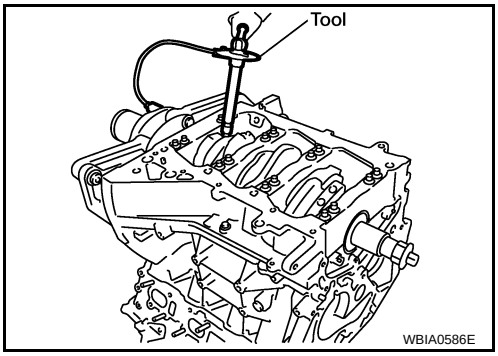
c. Then tighten all connecting rod bolts 90° clockwise.

CAUTION:

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

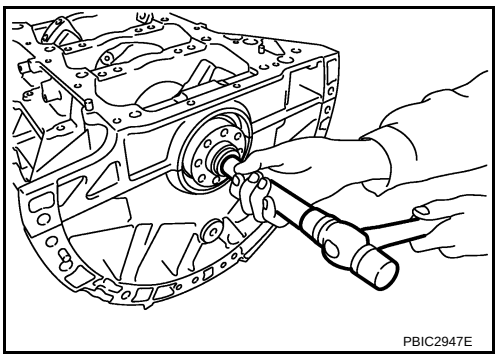
Tool number : KV10112100 (BT-8653-A)

- After tightening connecting rod bolts, make sure that crankshaft rotates smoothly.
- Check the connecting rod side clearance. Refer to EM-117, "Inspection After Disassembly".

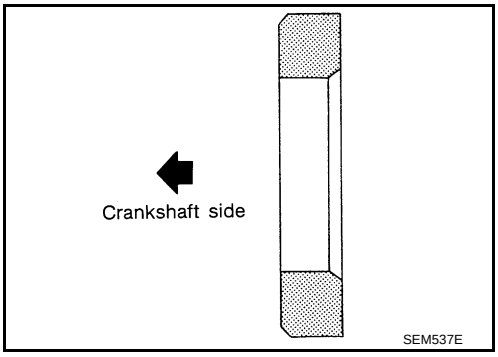


19. Install pilot converter.
    - With drift of the following outer diameter, press-fit as far as it will go.

Pilot converter : Approx. 33 mm (1.30 in)



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



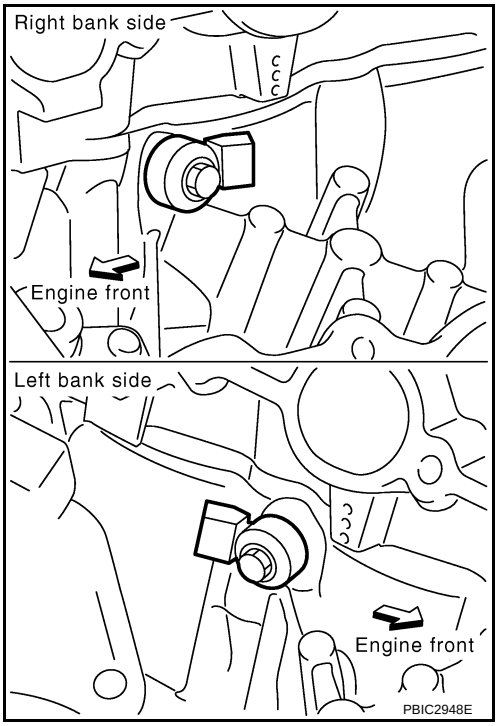
20. Install knock sensors.
    - Install knock sensor so that connector faces rear of engine.
    - After installing knock sensor, connect harness connector, and lay it out to rear of engine.

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.

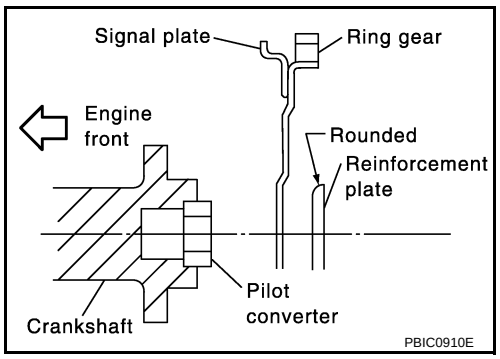


21. Assemble in the reverse order of disassembly after this step.

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

Tool number : KV10117700 (J-44716)

- Tighten bolts crosswise over several times.



Inspection After Disassembly

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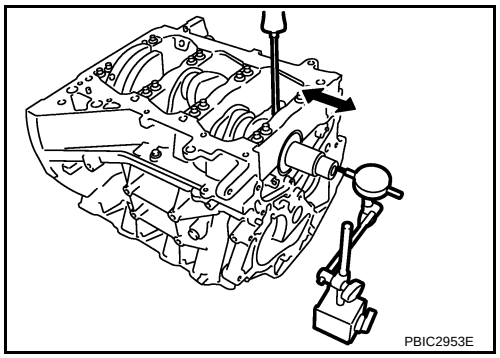
CRANKSHAFT END PLAY

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

Standard : 0.10 - 0.25 mm (0.0039 - 0.0098 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.

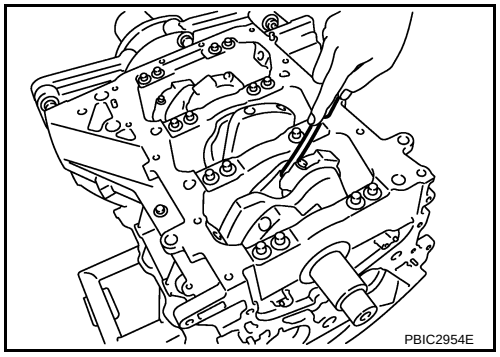


CONNECTING ROD SIDE CLEARANCE

- 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.

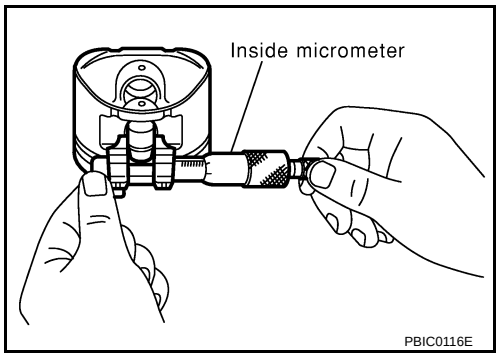


PISTON TO PISTON PIN CLEARANCE

Piston Pin Hole Diameter

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

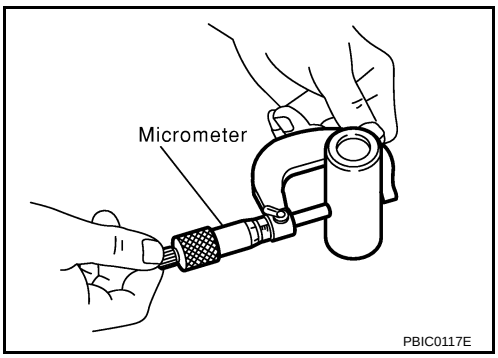
Standard : 21.993 - 22.005 mm (0.8659 - 0.8663 in)



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)

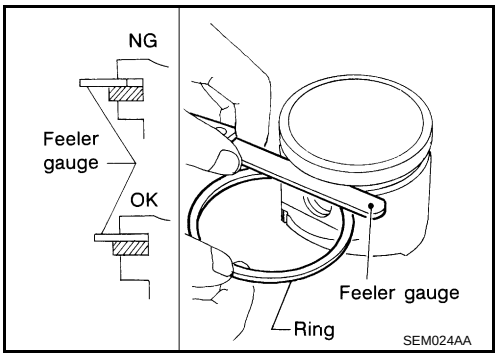
- If the calculated value is out of the standard, replace piston and piston pin assembly.
- When replacing piston and piston pin assembly, refer to EM-127, "How to Select Piston and Bearing".

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)**

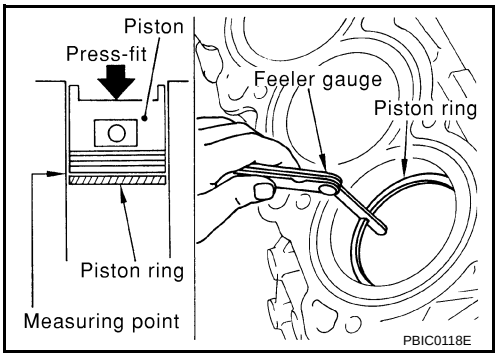
Limit:

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. Follow the "Cylinder Bore Inner Diameter" procedure.
- 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.

CONNECTING ROD BEND AND TORSION

- Check with connecting rod aligner.

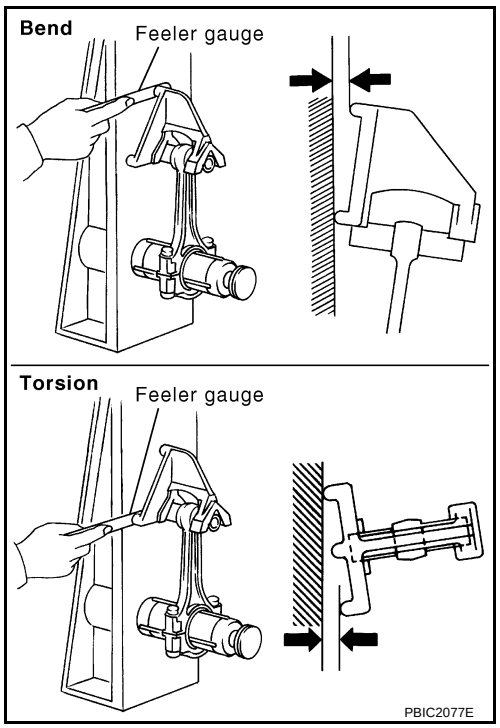
Bend:

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.

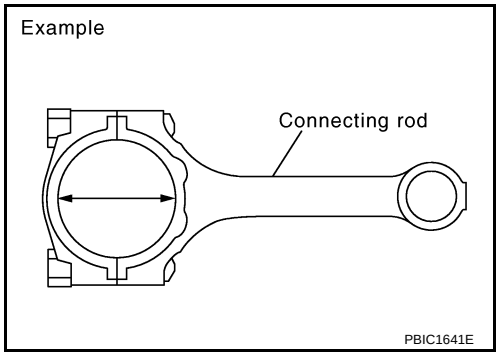


CONNECTING ROD DIAMETER (BIG END)

- Install connecting rod bearing cap without installing connecting rod bearing, and tightening connecting rod bolts to the specified torque. Refer to EM-106, "Disassembly and 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.

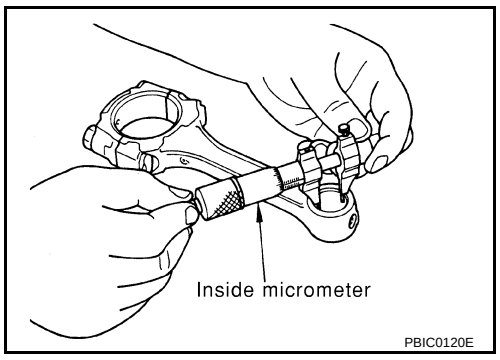


CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)

Connecting Rod Bushing Inside Diameter (Small End)

Measure inside diameter of connecting rod bushing using suitable tool.

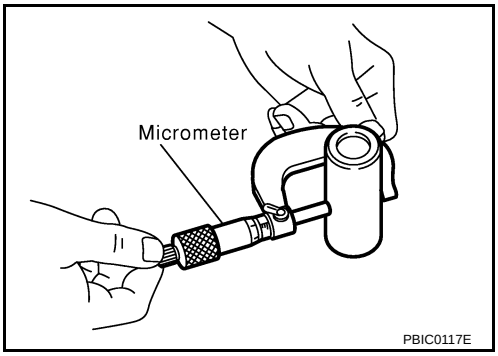
Standard : 22.000 - 22.012 mm (0.8661 - 0.8666 in)



Piston Pin Diameter

Measure diameter of piston pin using suitable tool.

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



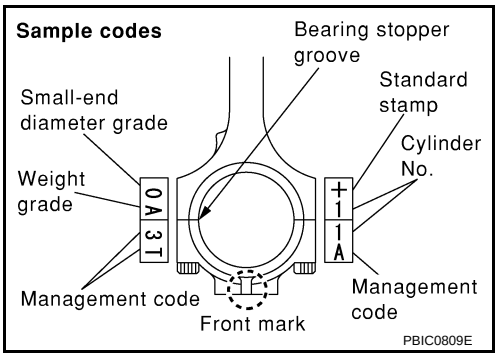
Connecting Rod Bushing Oil Clearance (Small End)

(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-127, "How to Select Piston and Bearing".
- If replacing connecting rod assembly, follow the "CONNECTING ROD BEARING OIL CLEARANCE" procedure to select the connecting rod bearing.



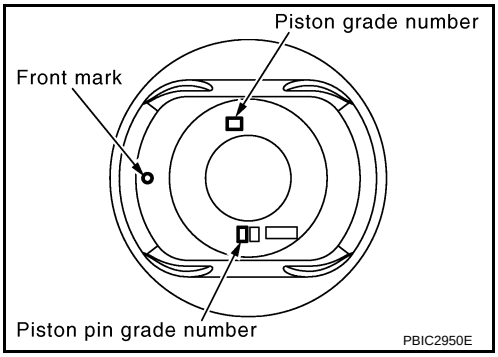
Factory installed parts grading:

- Only grade “0”.

Unit: mm (in)

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

*: After installing in connecting rod



CYLINDER BLOCK DISTORTION

- Remove any oil, scale, gasket, sealant and carbon deposits from the cylinder block surface.

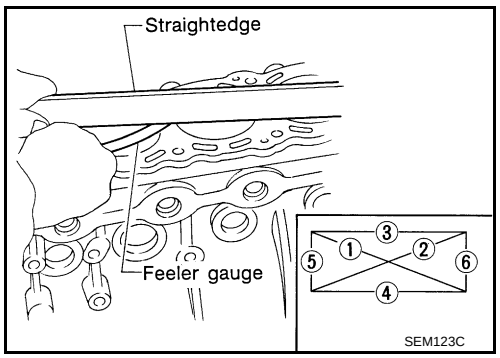
CAUTION:

Do not allow any debris to enter engine oil or engine coolant passages.

- 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.



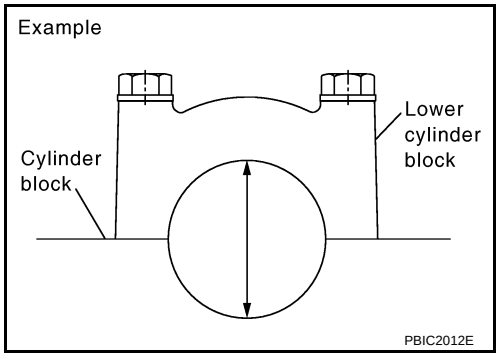
MAIN BEARING HOUSING INNER DIAMETER

- Install lower cylinder block without installing main bearings, and tighten lower cylinder block bolts to the specified torque. Refer to EM-106, "Disassembly and 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.

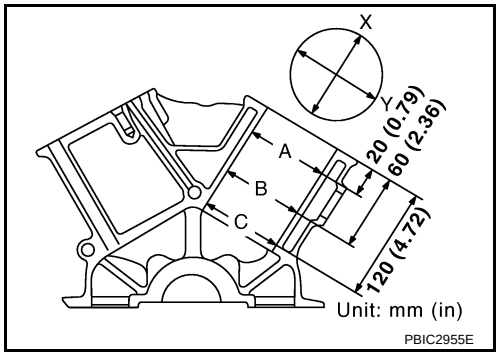


PISTON TO CYLINDER BORE CLEARANCE

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)

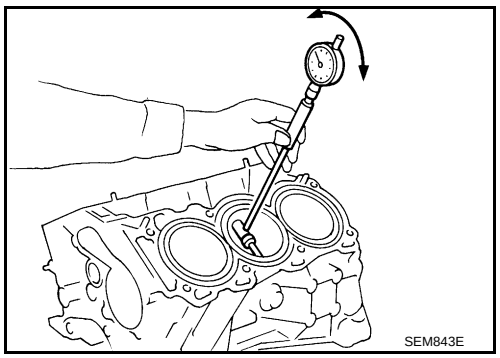
Standard inner diameter:
95.500 - 95.530 mm (3.7598 - 3.7610 in)
Out-of-round (Difference between “X” and “Y”):
0.015 mm (0.0006 in)
Taper limit (Difference between “A” and “C”):
0.01 mm (0.0004 in)



- 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.

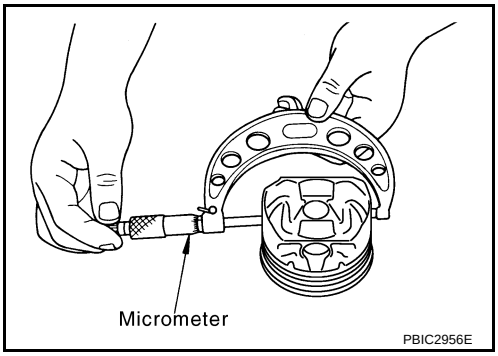
Oversize (OS) : 0.2 mm (0.008 in)



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-127, "How to Select Piston and Bearing".

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.

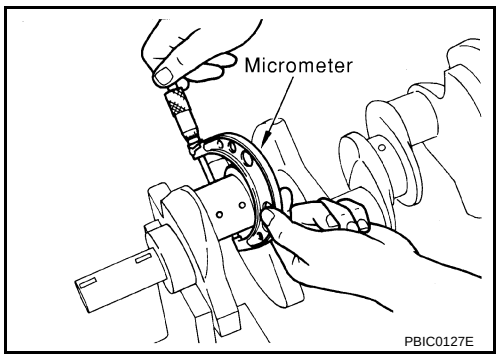
Standard : 69.951 - 69.975 mm (2.7540 - 2.7549 in) dia.

- If out of the standard, measure the main bearing oil clearance. Then use undersize bearing. Follow the "MAIN BEARING OIL CLEARANCE" procedure.

CRANKSHAFT PIN JOURNAL DIAMETER

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

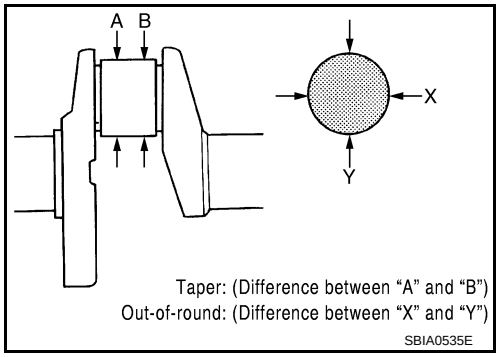
Standard : 53.956 - 53.974 mm (2.1242 - 2.1250 in) dia.



- If out of the standard, measure the connecting rod bearing oil clearance. Then use undersize bearing. Follow the "CONNECTING ROD BEARING OIL CLEARANCE" procedure.

OUT-OF-ROUND AND TAPER OF CRANKSHAFT

- Measure the dimensions at four different points as shown 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)

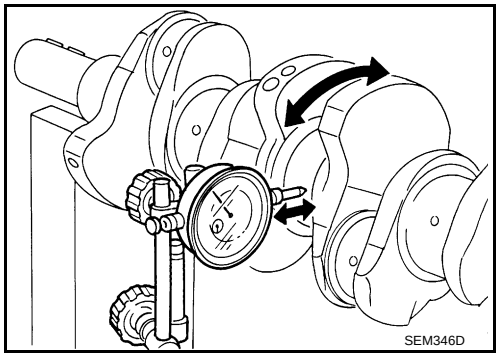
- If the measured value exceeds the limit, correct or replace crankshaft.
- If corrected, measure the bearing oil clearance of the corrected main journal and/or pin journal. Then select the main bearing and/or connecting rod bearing. Follow the "MAIN BEARING OIL CLEARANCE" and/or "CONNECTING ROD BEARING OIL CLEARANCE" procedures.

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 (0.002 in)

Limit : 0.10 mm (0.0039 in)



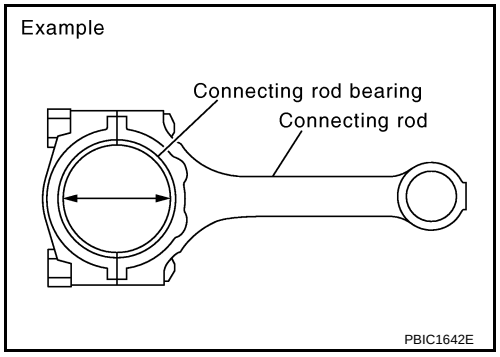
- If it exceeds the limit, replace crankshaft.

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-106, "Disassembly and 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)

- 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-127, "How to Select Piston and Bearing".

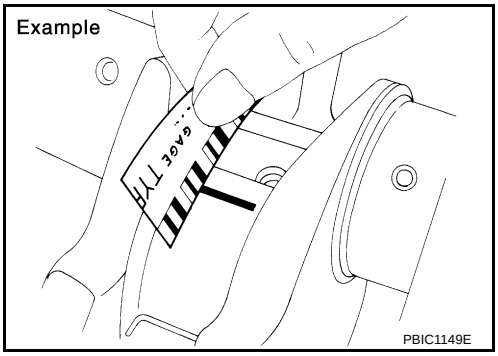
Method of Using Plastigage

- 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-106, "Disassembly and 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”.

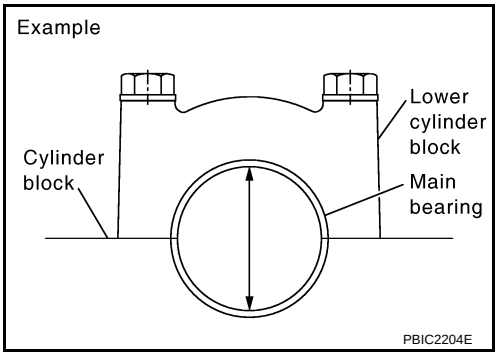


MAIN BEARING OIL CLEARANCE

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-106, "Disassembly and 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-127, "How to Select Piston and Bearing".

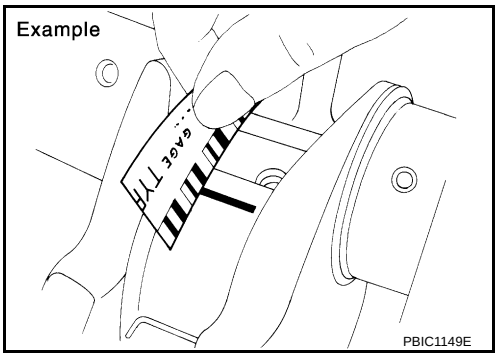
Method of Using Plastigage

- 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-106, "Disassembly and Assembly" for the tightening procedure.

CAUTION:
Do not rotate crankshaft.

- 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”.

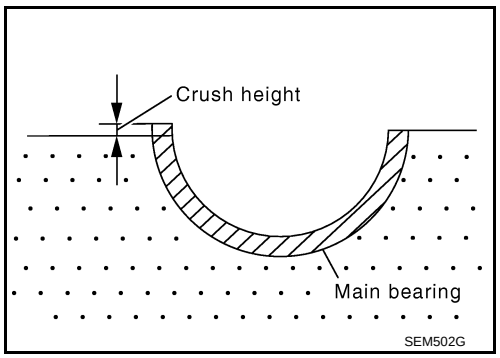


CRUSH HEIGHT OF MAIN BEARING

- 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-106, "Disassembly and Assembly" for the tightening procedure.

Standard : There must be crush height.

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

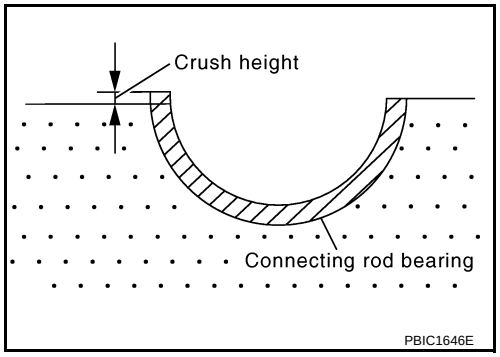


CRUSH HEIGHT OF CONNECTING ROD BEARING

- 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-106, "Disassembly and Assembly" for the tightening procedure.

Standard : There must be crush height.

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

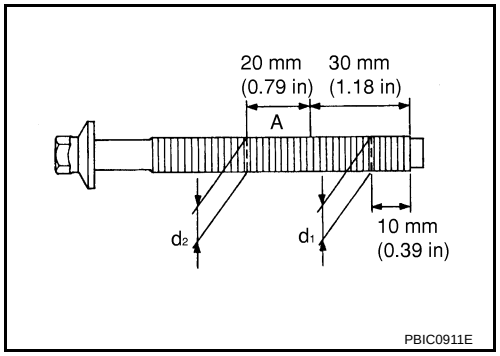


LOWER CYLINDER BLOCK BOLT OUTER DIAMETER

- Measure the outer diameters (“d_1”, “d_2”) at two positions as shown.
- If reduction appears in “A” range, regard it as “d_2”.

Limit (“d_1” – “d_2”) : 0.11 mm (0.0051 in)

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

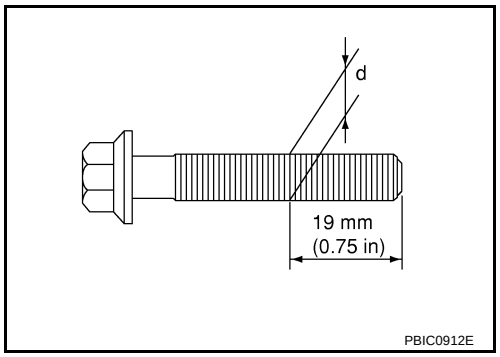


CONNECTING ROD BOLT OUTER DIAMETER

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

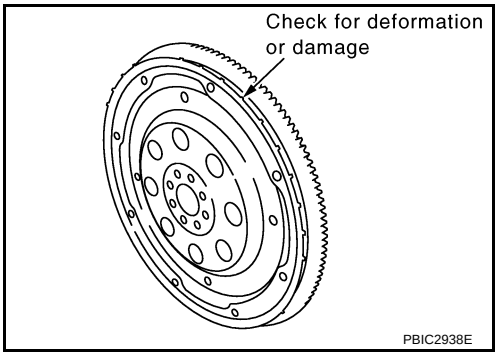
Limit : 7.75 mm (0.3051 in)

- 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.

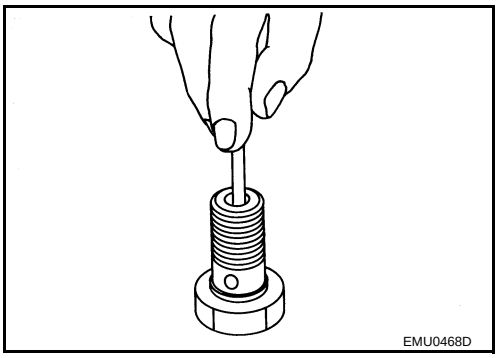


OIL JET

- 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.



HOW TO SELECT PISTON AND BEARING

How to Select Piston and Bearing

INFOID:0000000001281998

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, follow the applicable procedures.

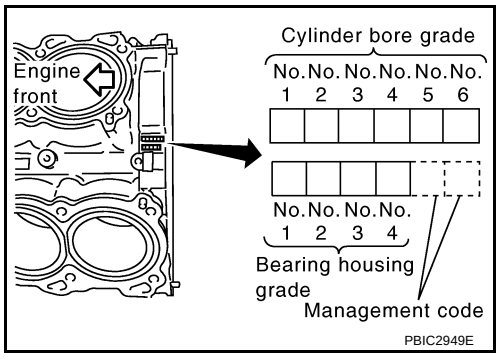
HOW TO SELECT PISTON

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.

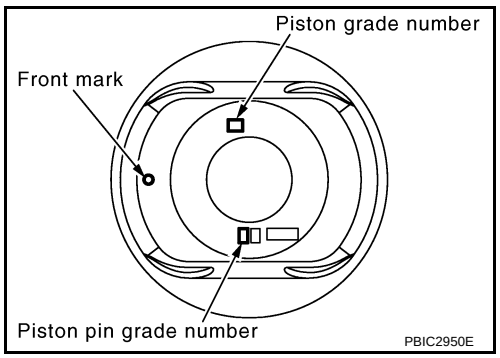
NOTE:

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-117, "Inspection After Disassembly".
2. Determine the bore grade by comparing the measurement with the values under the cylinder bore inner diameter of the “Piston Selection Table”.



3. 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.

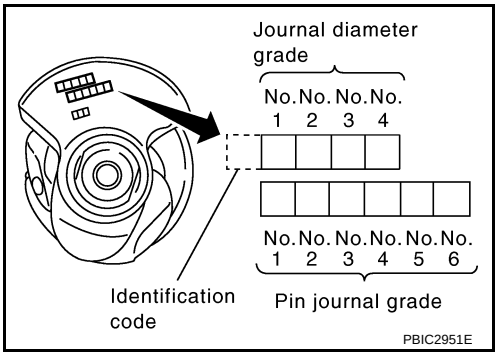
HOW TO SELECT CONNECTING ROD BEARING

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

1. Measure the connecting rod big end diameter. Refer to EM-117, "Inspection After Disassembly".
2. Make sure that the connecting rod big end diameter is within the standard value.
3. Measure the crankshaft pin journal diameter. Refer to EM-117, "Inspection After Disassembly".
4. 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”.
5. 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)

Unit: mm (in)

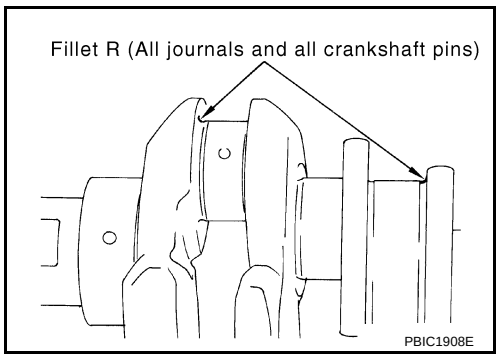
Crankshaft		Connecting rod bearing		
Crankshaft pin journal diameter	Grade (Mark)	Dimension (Bearing thickness range)	Bearing grade No.	Color
53.968 - 53.974 (2.1247 - 2.1250)	0	1.500 - 1.503 (0.0591 - 0.0592)	STD 0	Black
53.962 - 53.968 (2.1245 - 2.1247)	1	1.503 - 1.506 (0.0592 - 0.0593)	STD 1	Brown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

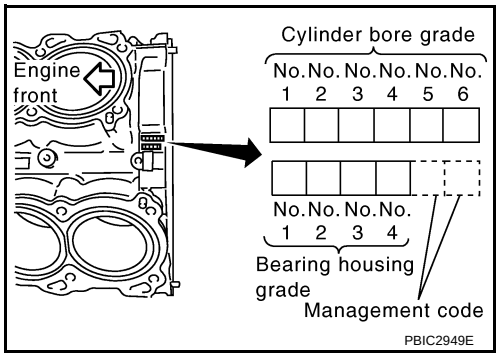
Unit: mm (in)

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

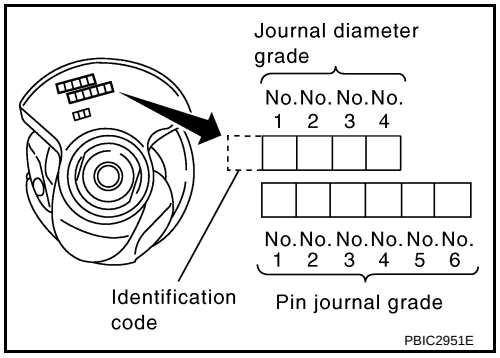
HOW TO SELECT MAIN BEARING

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.



3. 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

1. Measure cylinder block main bearing housing inner diameter and crankshaft main journal diameter. Refer to EM-117, "Inspection After Disassembly" and EM-117, "Inspection After Disassembly".
2. Correspond the measured dimension in “Cylinder block main bearing housing inner diameter” row of “Main Bearing Selection Table”.
3. Correspond the measured dimension in “Crankshaft main journal diameter” column of “Main Bearing Selection Table”.
4. Select main bearing grade at the point where selected row and column meet in following selection table.

Main Bearing Selection Table

Cylinder block main bearing housing inner diameter Unit: mm (in) / Crankshaft main journal diameter Unit: mm (in)		Mark	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	4	7
		Hole diameter	74.993 - 74.994 (2.9525 - 2.9525)	74.994 - 74.995 (2.9525 - 2.9526)	74.995 - 74.996 (2.9526 - 2.9526)	74.996 - 74.997 (2.9526 - 2.9526)	74.997 - 74.998 (2.9526 - 2.9527)	74.998 - 74.999 (2.9527 - 2.9527)	74.999 - 75.000 (2.9527 - 2.9528)	75.000 - 75.001 (2.9528 - 2.9528)	75.001 - 75.002 (2.9528 - 2.9528)	75.002 - 75.003 (2.9528 - 2.9529)	75.003 - 75.004 (2.9529 - 2.9529)	75.004 - 75.005 (2.9529 - 2.9529)	75.005 - 75.006 (2.9529 - 2.9530)	75.006 - 75.007 (2.9530 - 2.9530)	75.007 - 75.008 (2.9530 - 2.9531)	75.008 - 75.009 (2.9531 - 2.9531)	75.009 - 75.010 (2.9531 - 2.9531)	75.010 - 75.011 (2.9531 - 2.9532)	75.011 - 75.012 (2.9532 - 2.9532)	75.012 - 75.013 (2.9532 - 2.9533)	75.013 - 75.014 (2.9533 - 2.9533)	75.014 - 75.015 (2.9533 - 2.9533)	75.015 - 75.016 (2.9533 - 2.9534)	75.016 - 75.017 (2.9534 - 2.9534)
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	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	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	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4
E	69.971 - 69.970 (2.7548 - 2.7547)		01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45
F	69.970 - 69.969 (2.7547 - 2.7547)		01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45
G	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	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	45	45	45	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	45	45	45	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	45	45	45	5	5	5
L	69.965 - 69.964 (2.7545 - 2.7545)		12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56
M	69.964 - 69.963 (2.7545 - 2.7544)		12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56
N	69.963 - 69.962 (2.7544 - 2.7544)		2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56
P	69.962 - 69.961 (2.7544 - 2.7544)		2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6
R	69.961 - 69.960 (2.7544 - 2.7543)		2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6
S	69.960 - 69.959 (2.7543 - 2.7543)		23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6
T	69.959 - 69.958 (2.7543 - 2.7542)		23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67
U	69.958 - 69.957 (2.7542 - 2.7542)		23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67
V	69.957 - 69.956 (2.7542 - 2.7542)		3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67
W	69.956 - 69.955 (2.7542 - 2.7541)		3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7
X	69.955 - 69.954 (2.7541 - 2.7541)		3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7
Y	69.954 - 69.953 (2.7541 - 2.7540)		34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7
4	69.953 - 69.952 (2.7540 - 2.7540)		34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	X
7	69.952 - 69.951 (2.7540 - 2.7540)		34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	X	X

WBIA0625E

Main Bearing Grade Table (All Journals)

Grade number	Thickness Unit: mm (in)	Width Unit: mm (in)	Identification color	Remarks

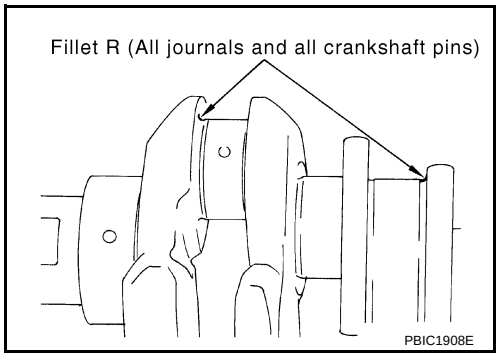
0		2.500 - 2.503 (0.0984 - 0.0985)	19.9 - 20.1 (0.783 - 0.791)	Black	Grade is the same for upper and lower bearings.
1		2.503 - 2.506 (0.0985 - 0.0987)		Brown	
2		2.506 - 2.509 (0.0987 - 0.0988)		Green	
3		2.509 - 2.512 (0.0988 - 0.0989)		Yellow	
4		2.512 - 2.515 (0.0989 - 0.0990)		Blue	
5		2.515 - 2.518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

Undersize Bearing Usage Guide

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

CAUTION:

In grinding crankshaft main journal to use undersize bearings, keep the fillet R [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)

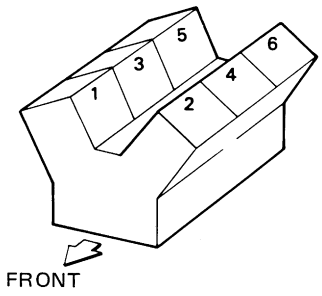
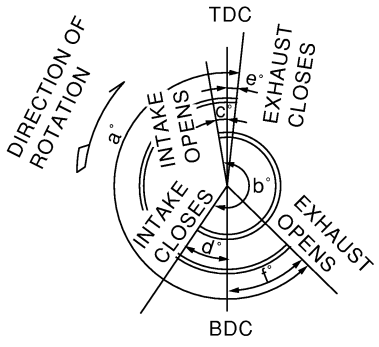
SERVICE DATA AND SPECIFICATIONS (SDS)

SERVICE DATA AND SPECIFICATIONS (SDS)

Standard and Limit

INFOID:0000000001282000

GENERAL SPECIFICATIONS

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

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)

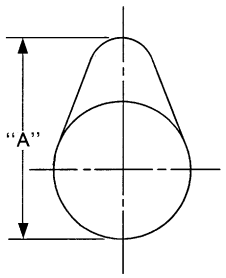
SPARK PLUG

Make	NGK
Standard type	DILFR5A-11
Gap (nominal)	1.1 mm (0.043 in)

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 - 1.7974)	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 (0.0008)	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)

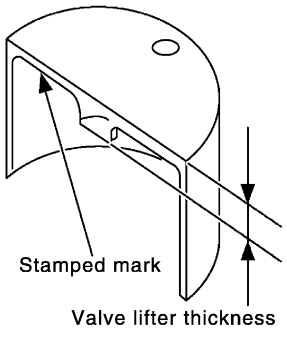
*: Approximately 80°C (176°F)

Available Valve Lifter

VQ40DE

Unit: mm (in)

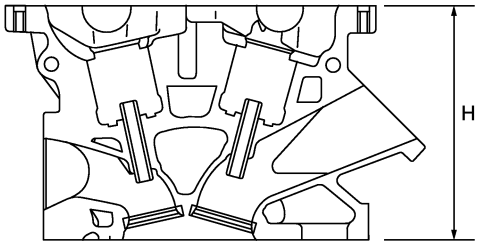
Identification (stamped) mark		Thickness
Intake	Exhaust	
788U	N788	7.88 (0.3102)
790U	N790	7.90 (0.3110)
792U	N792	7.92 (0.3118)
794U	N794	7.94 (0.3126)
796U	N796	7.96 (0.3134)
798U	N798	7.98 (0.3142)
800U	N800	8.00 (0.3150)
802U	N802	8.02 (0.3157)
804U	N804	8.04 (0.3165)
806U	N806	8.06 (0.3173)
808U	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)



CYLINDER HEAD

Unit: mm (in)

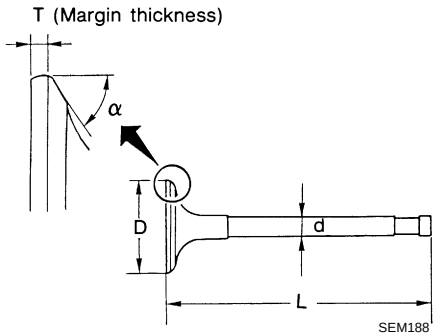
Items	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)
Normal cylinder head height “H”	126.3 - 126.5 (4.972 - 4.980)	—



PBIC0924E

Valve Dimensions

Unit: mm (in)

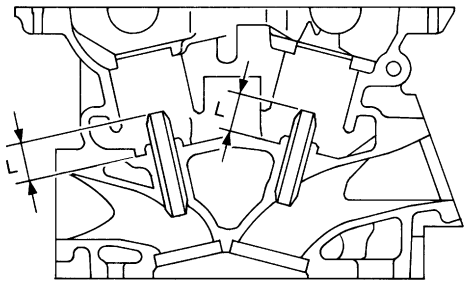


SEM188

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)

Valve Guide

Unit: mm (in)

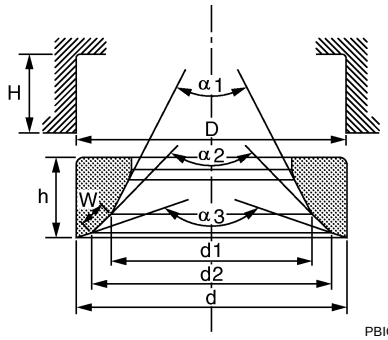


SEM950E

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 (0.020)] (Service)
Cylinder head seat recess diameter “D”	Intake	38.000 - 38.016 (1.4961 - 1.4967)	38.500 - 38.516 (1.5157 - 1.5164)
	Exhaust	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)
Valve seat 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′	

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”

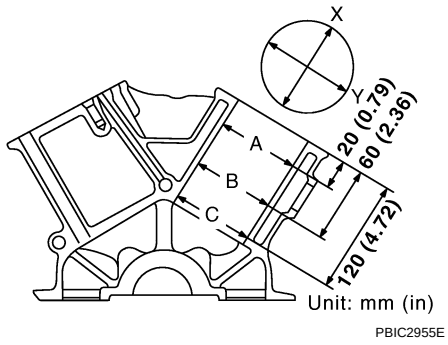
*3: Machining data

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)

CYLINDER BLOCK

Unit: mm (in)



PBIC2955E

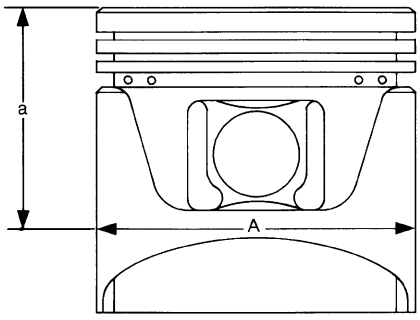
Surface flatness		Standard		Less than 0.03 (0.0012)
		Limit		0.1 (0.004)
Main bearing housing inner diameter		Standard		74.993 - 75.017 (2.9525 - 2.9534)
Cylinder bore	Inner diameter	Standard	Grade No. 1	95.500 - 95.510 (3.7598 - 3.7602)
			Grade No. 2	95.510 - 95.520 (3.7602 - 3.7606)
			Grade No. 3	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)

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)

CONNECTING ROD

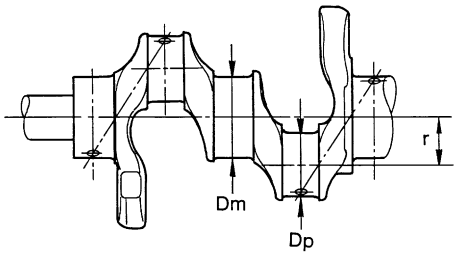
Unit: mm (in)

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)	: 40 mm (0.0157)

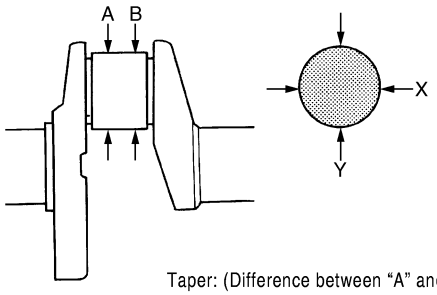
*: After installing in connecting rod

CRANKSHAFT

Unit: mm (in)



SEM645



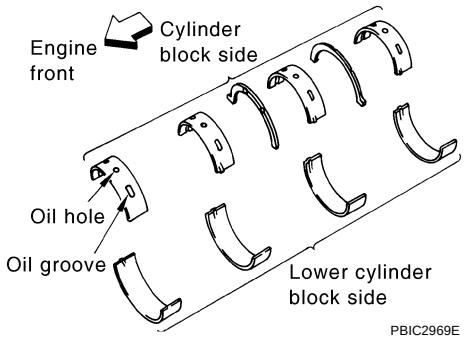
Taper: (Difference between “A” and “B”)
Out-of-round: (Difference between “X” and “Y”)

SBIA0535E

Main journal diameter. “Dm” grade	Standard	Grade No. A	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

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	
01	UPR	2.503 - 2.506 (0.0985 - 0.0987)		Brown	Grade is different for upper and lower bearings.
	LWR	2.500 - 2.503 (0.0984 - 0.0985)		Black	
12	UPR	2.506 - 2.509 (0.0987 - 0.0988)		Green	
	LWR	2.503 - 2.506 (0.0985 - 0.0987)		Brown	
23	UPR	2.509 - 2.512 (0.0988 - 0.0989)		Yellow	
	LWR	2.506 - 2.509 (0.0987 - 0.0988)		Green	
34	UPR	2.512 - 2.515 (0.0989 - 0.0990)		Blue	
	LWR	2.509 - 2.512 (0.0988 - 0.0989)		Yellow	
45	UPR	2.515 - 2.518 (0.0990 - 0.0991)		Pink	
	LWR	2.512 - 2.515 (0.0989 - 0.0990)		Blue	
56	UPR	2.518 - 2.521 (0.0991 - 0.0993)		Purple	
	LWR	2.515 - 2.518 (0.0990 - 0.0991)		Pink	
67	UPR	2.521 - 2.524 (0.0993 - 0.0994)		White	
	LWR	2.518 - 2.521 (0.0991 - 0.0993)		Purple	

Undersize

Unit: mm (in)

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

Main Bearing Oil Clearance

Unit: mm (in)

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

*: Actual clearance

CONNECTING ROD BEARING

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

PRECAUTION

PRECAUTIONS

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

INFOID:0000000001282001

The Supplemental Restraint System such as “AIR BAG” and “SEAT BELT PRE-TENSIONER”, used along with a front seat belt, helps to reduce the risk or severity of injury to the driver and front passenger for certain types of collision. This system includes seat belt switch inputs and dual stage front air bag modules. The SRS system uses the seat belt switches to determine the front air bag deployment, and may only deploy one front air bag, depending on the severity of a collision and whether the front occupants are belted or unbelted. Information necessary to service the system safely is included in the SR and SB section of this Service Manual.

WARNING:

- **To avoid rendering the SRS inoperative, which could increase the risk of personal injury or death in the event of a collision which would result in air bag inflation, all maintenance must be performed by an authorized NISSAN/INFINITI dealer.**
- **Improper maintenance, including incorrect removal and installation of the SRS, can lead to personal injury caused by unintentional activation of the system. For removal of Spiral Cable and Air Bag Module, see the SR section.**
- **Do not use electrical test equipment on any circuit related to the SRS unless instructed to in this Service Manual. SRS wiring harnesses can be identified by yellow and/or orange harnesses or harness connectors.**

Precaution for Drain Engine Coolant

INFOID:0000000001282002

Drain engine coolant when engine is cooled.

Precaution for Disconnecting Fuel Piping

INFOID:0000000001282003

- 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.

Precaution for Removal and Disassembly

INFOID:0000000001282004

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

Precaution for Inspection, Repair and Replacement

INFOID:0000000001282005

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

Precaution for Assembly and Installation

INFOID:0000000001282006

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

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

Parts Requiring Angular Tightening

INFOID:0000000001282007

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

Tool number : KV10112100 (BT-8653-A)

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

Precaution for Liquid Gasket

INFOID:0000000001282008

REMOVAL OF LIQUID GASKET SEALING

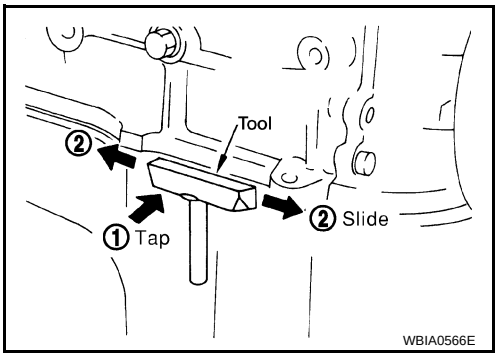
- After removing nuts and bolts, separate the mating surface and remove old liquid gasket sealing using Tool.

Tool number : KV10111100 (J-37228)

CAUTION:
Be careful not to damage the mating surfaces.

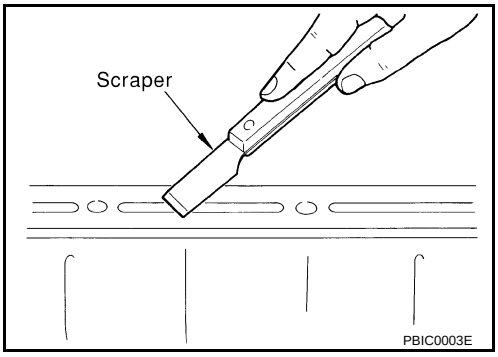
- Tap seal cutter to insert it (1), and then slide it by tapping on the side (2) as shown.
- In areas where Tool is difficult to use, use plastic hammer to lightly tap the parts, to remove it.

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



LIQUID GASKET APPLICATION PROCEDURE

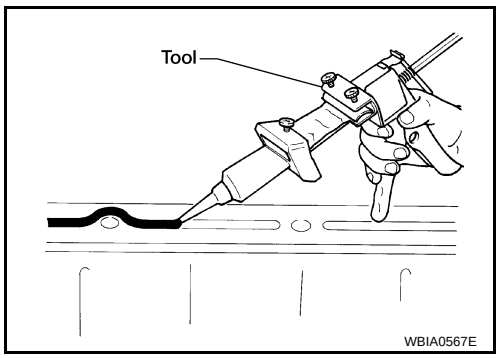
1. Remove the old liquid gasket adhering to the gasket application surface and the mating surface using suitable tool.
   - Remove the liquid gasket completely from the groove of the liquid gasket application surface, bolts, and bolt holes.
2. Thoroughly clean the mating surfaces and remove adhering moisture, grease and foreign material.



3. Attach the liquid gasket tube to the Tool.

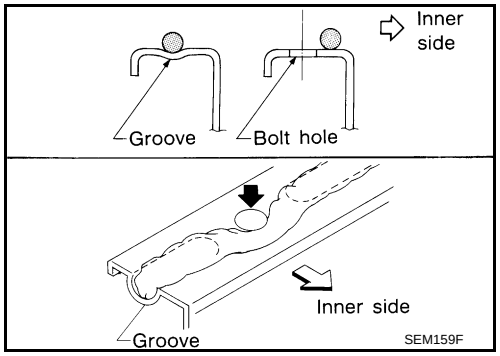
Tool number : WS39930000 (—)

Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".



4. Apply the liquid gasket without breaks to the specified location with the specified dimensions.

- If there is a groove for the liquid gasket application, apply the liquid gasket to the groove.
- As for the bolt holes, normally apply the liquid gasket inside the holes. If specified in the procedure, it should also be applied outside the holes.
- Within five minutes of liquid gasket application, install the mating component.
- If the liquid gasket protrudes, wipe it off immediately.
- Do not retighten nuts or bolts after the installation.
- Wait 30 minutes or more after installation before refilling the engine with engine oil and engine coolant.



CAUTION:

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

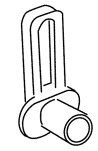
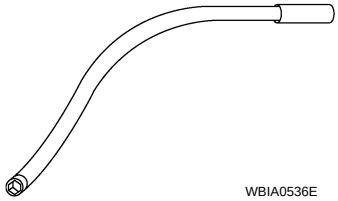
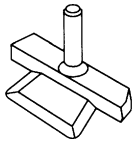
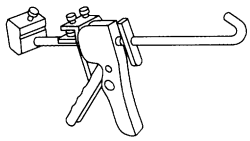
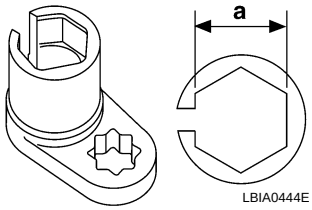
PREPARATION

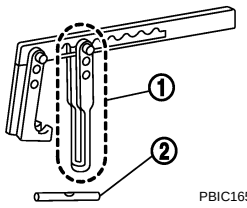
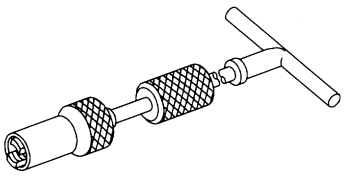
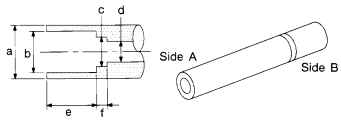
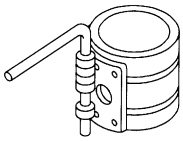
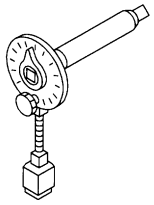
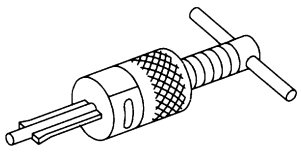
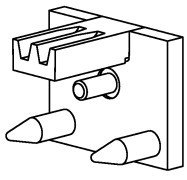
PREPARATION

Special Service Tool

INFOID:0000000001282009

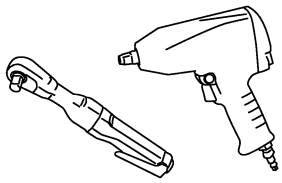
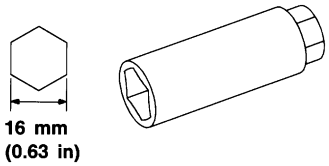
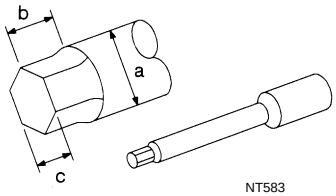
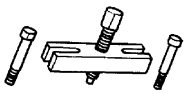
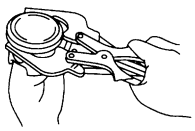
The actual shapes of Kent-Moore tools may differ from those of special service tools illustrated here.

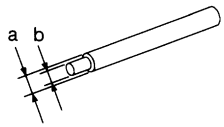
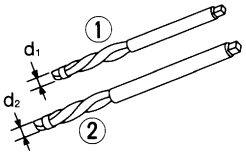
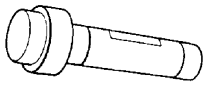
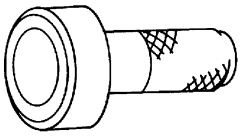
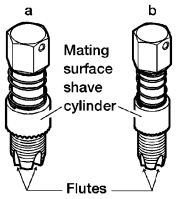
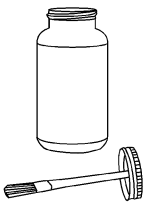
Tool number (Kent-Moore No.) Tool name	Description
16441 6N210 (J-45488) Quick connector release  PBIC0198E	Removing fuel tube quick connectors in engine room (Available in SEC. 164 of PARTS CATALOG: Part No. 16441 6N210)
— (J-46535) Drive belt tension releaser  WBIA0536E	Releasing drive belt tension
KV10111100 (J-37228) Seal cutter  S-NT046	Removing steel oil pan and rear timing chain case
WS39930000 (—) Tube presser  S-NT052	Pressing the tube of liquid gasket
— (J-44626) Air fuel sensor Socket  LBIA0444E	Loosening or tightening air fuel ratio A/F sensor **a: 22 mm (0.87 in)**
EG15050500 (J-45402) Compression gauge adapter  ZZA1225D	Inspecting compression pressure

Tool number (Kent-Moore No.) Tool name		Description
KV10116200 (J-26336-A) Valve spring compressor 1. KV10115900 (J-26336-20) Attachment 2. KV10109220 (—) Adapter	 PBIC1650E	Disassembling valve mechanism Part (1) is a component of KV10116200 (J-26336-A), but part (2) is not.
KV10107902 (J-38959) Valve oil seal puller	 S-NT011	Removing valve oil seal
KV10115600 (J-38958) Valve oil seal drift	 S-NT603	Installing valve oil seal **Use side A.** **a: 20 (0.79) dia.** **d: 8 (0.31) dia.** **b: 13 (0.51) dia.** **e: 10.7 (0.421) dia.** **c: 10.3 (0.406) dia.** **f: 5 (0.20) dia.** Unit: mm (in)
EM03470000 (J-8037) Piston ring compressor	 S-NT044	Installing piston assembly into cylinder bore
KV10112100 (BT-8653-A) Angle wrench	 S-NT014	Tightening bolts for cylinder head, main bearing cap and connecting rod cap
ST16610001 (J-23907) Pilot bushing puller	 S-NT045	Removing crankshaft pilot bushing
— (J-45476) Ring gear stopper	 PBIC1655E	Removing and installing crankshaft pulley

Commercial Service Tool

INFOID:0000000001282010

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

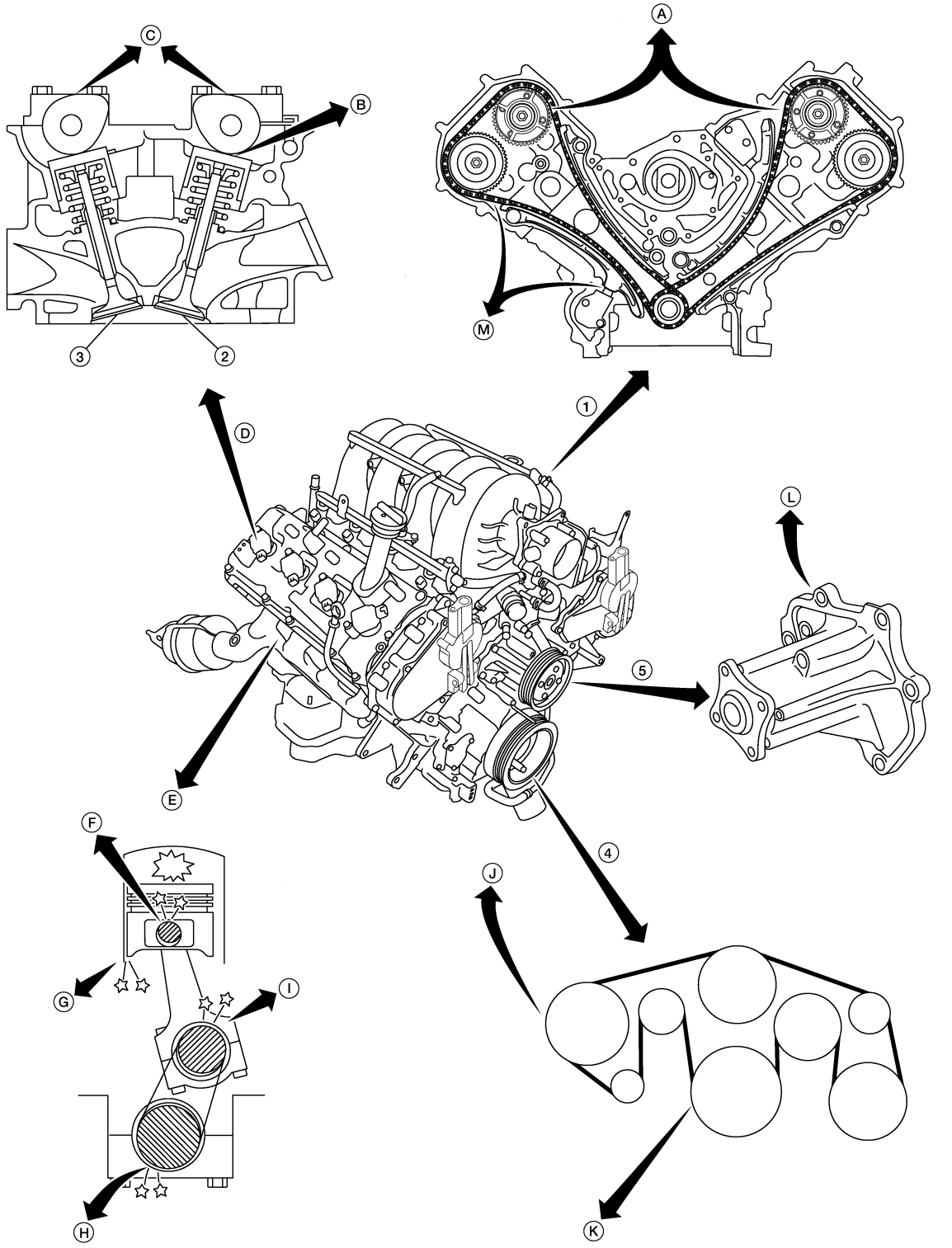
(Kent-Moore No.) Tool name	Description
Valve guide drift  S-NT015	Removing and installing valve guide **Intake & Exhaust:** **a: 9.5 mm (0.374 in) dia.** **b: 5.5 mm (0.217 in) dia.**
Valve guide reamer  S-NT016	1: Reaming valve guide hole 2: Reaming hole for oversize valve guide **Intake & Exhaust:** **d_1 : 6.0 mm (0.236 in) dia.** **d_2 : 10.175 - 10.196 mm (0.4006 - 0.4014 in) dia.**
Front oil seal drift  ZZA0012D	Installing front oil seal
Rear oil seal drift  ZZA0025D	Installing rear oil seal
(J-43897-18) (J-43897-12) Oxygen sensor thread cleaner  AEM488	Reconditioning the exhaust system threads before installing a new Air Fuel Ratio sensor and heated oxygen sensor (Use with anti-seize lubricant shown below.) **a: J-43897-18 (18 mm dia.) (0.71 in)** **b: J-43897-12 (12 mm dia.) (0.55 in)**
Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907)  AEM489	Lubricating A/F sensors and heated oxygen sensor thread cleaning tool when reconditioning exhaust system threads

FUNCTION DIAGNOSIS

NOISE, VIBRATION, AND HARSHNESS (NVH) TROUBLESHOOTING

NVH Troubleshooting - Engine Noise

INFOID:0000000001282011



AWBIA0149ZZ

1. Timing chain
2. Intake valve
3. Exhaust valve
4. Drive belt
5. Water pump
A. VTC noise
B. Tappet noise
C. Camshaft bearing noise
D. Valve mechanism
E. Rotation mechanism
F. Piston pin noise
G. Piston slap noise
H. Main bearing noise
I. Connecting rod bearing noise
J. Drive belt noise (slipping)
K. Drive belt noise (stick/slipping)
L. Water pump noise
M. Timing chain and chain tensioner noise

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

INFOID:0000000001282012

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-212
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-202 EM-202
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance	EM-230 EM-230
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston-to-bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-230 EM-230 EM-230 EM-230
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing oil clearance (Small end) Connecting rod bearing clearance (Big end)	EM-230 EM-230
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-230 EM-230
Front of engine Chain case cover Front cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation	EM-185 EM-185

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			
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	EM-153
	Creaking	A	B	A	B	A	B	Drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creaking	A	B	—	B	A	B	Water pump noise	Water pump operation	CO-49
	Rattle	—	—	A	—	—	—	VTC	VTC lock pin clearance	EM-202

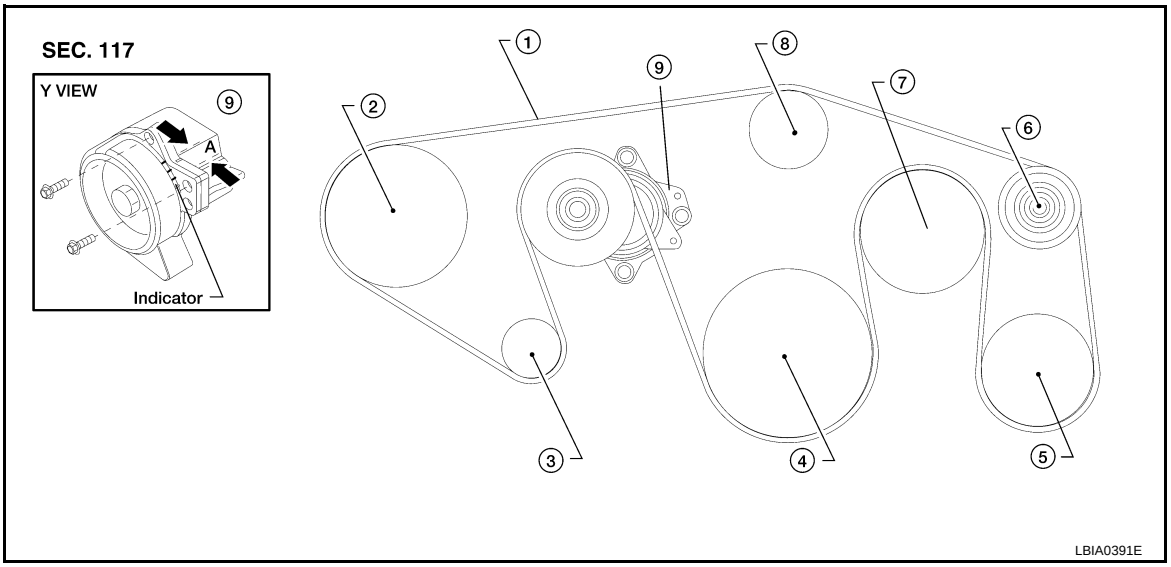
A: Closely related B: Related C: Sometimes related —: Not related

ON-VEHICLE MAINTENANCE

DRIVE BELTS

Checking Drive Belts

INFOID:0000000001282014



1. Drive belt
2. Power steering pump pulley
3. Generator pulley
4. Crankshaft pulley
5. A/C compressor
6. Idler pulley
7. Cooling fan pulley
8. Water pump pulley
9. Drive belt auto tensioner
A. Allowable working range

WARNING:
Be sure to perform when the engine is stopped.

1. Remove air duct and resonator assembly when inspecting drive belt.
2. Make sure that indicator (single line notch) of each auto tensioner is within the allowable working range “A” (between three line notches) as shown.
   NOTE:
   • Check the drive belt auto tensioner indication when the engine is cold.
   • The indicator notch is located on the moving side of the drive belt auto tensioner.
3. Visually check entire belt for wear, damage or cracks.
4. If the indicator is out of allowable working range or belt is damaged, replace the belt. Refer to EM-153, "Removal and Installation".

DRIVE BELT TENSION

There is no manual drive belt tension adjustment. The drive belt tension is automatically adjusted by the drive belt auto tensioner.

Removal and Installation

INFOID:0000000001282015

REMOVAL

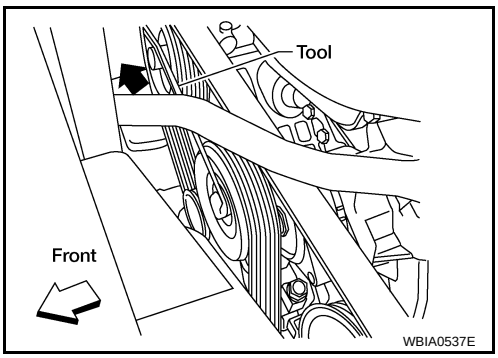
1. Remove the air duct and resonator assembly. Refer to EM-165, "Removal and Installation".

2. Install Tool on drive belt auto tensioner pulley bolt, move in the direction of arrow (loosening direction of tensioner) as shown.

Tool number : — (J-46535)

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

3. Remove the drive belt.



INSTALLATION

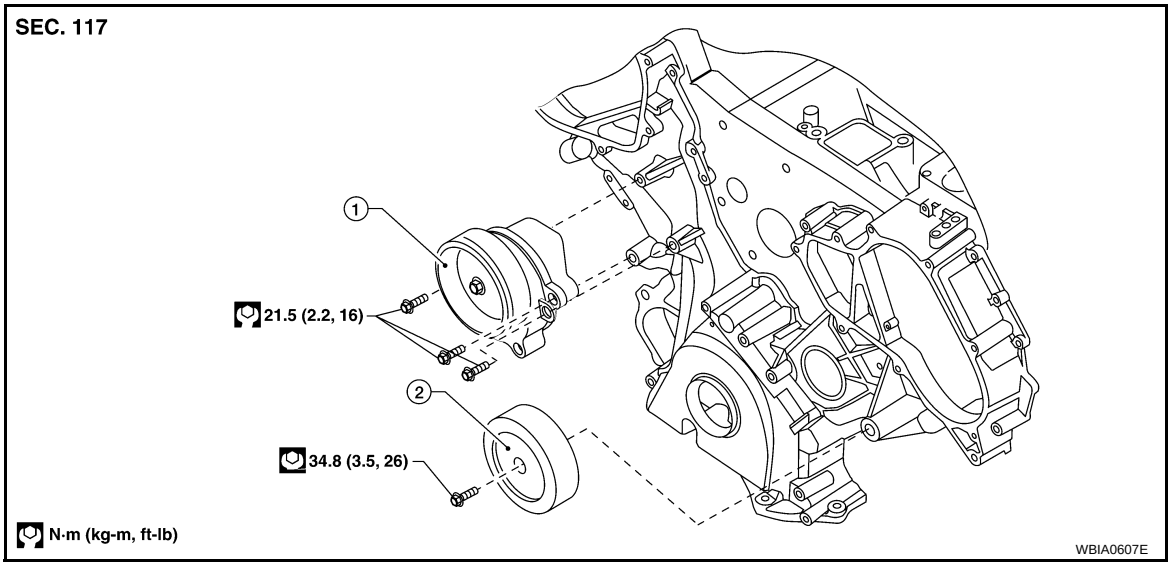
Installation is in the reverse order of removal.

CAUTION:
Make sure belt is securely installed around all pulleys.

- Rotate the crankshaft pulley several turns clockwise to equalize belt tension between pulleys.
- Make sure belt tension is within the allowable working range, using the indicator notch on the drive belt auto tensioner. Refer to EM-153, "Checking Drive Belts".

Drive Belt Auto Tensioner and Idler Pulley

INFOID:0000000001282016



1. Drive belt auto tensioner
2. Idler pulley

REMOVAL

1. Remove the air duct and resonator assembly. Refer to EM-165, "Removal and Installation".
2. Remove the drive belt. Refer to EM-153, "Removal and Installation".
3. Remove the drive belt auto tensioner and idler pulley using power tool.

INSTALLATION

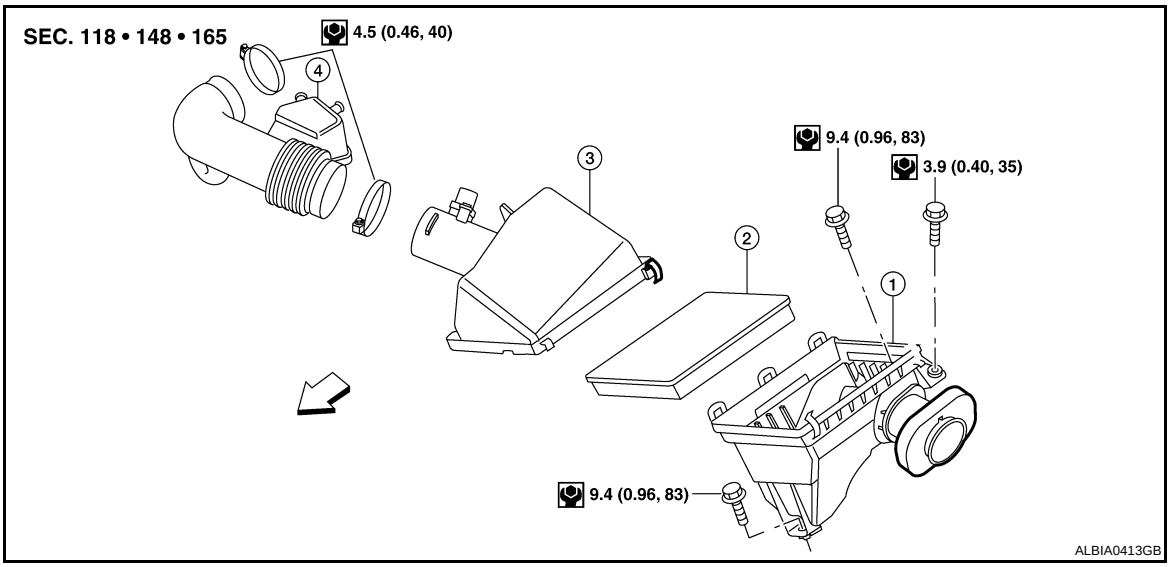
Installation is in the reverse order of removal.

AIR CLEANER FILTER

Removal and Installation

INFOID:0000000001468877

REMOVAL



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

NOTE:
- The viscous paper type filter does not need cleaning between replacement intervals.
- Replace the air filter as necessary for periodic maintenance. Refer to MA-6, "Introduction of Periodic Maintenance".

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

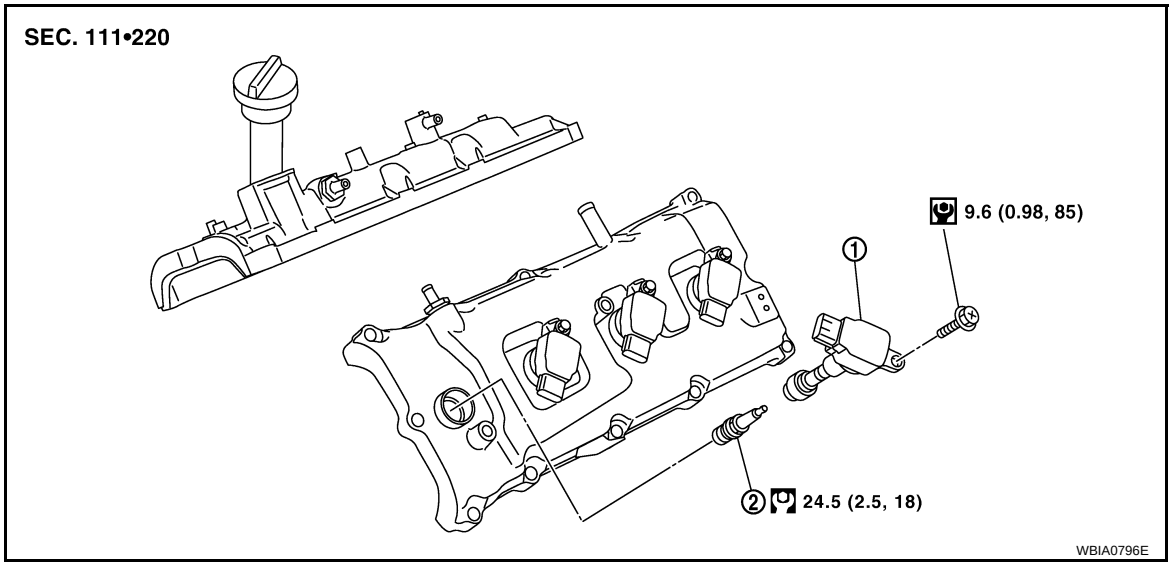
INSTALLATION

1. Installation is in the reverse order of removal.

SPARK PLUG

Removal and Installation

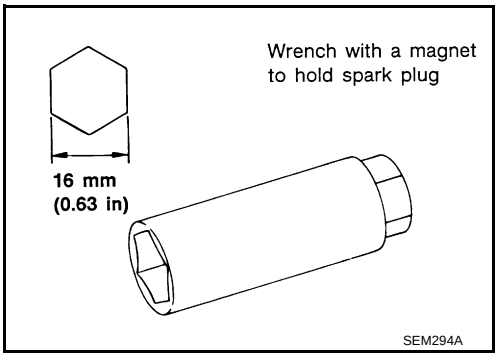
INFOID:0000000001282023



1. Ignition coil
2. Spark plug

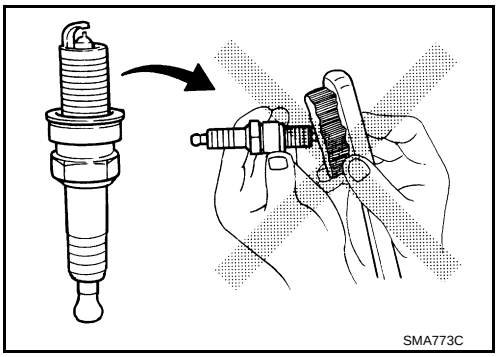
REMOVAL

1. Remove the ignition coil. Refer to EM-177, "Removal and Installation".
2. Remove the spark plug using suitable tool.
   CAUTION:
   Do not drop or shock it.



INSPECTION AFTER REMOVAL

- Do not use a wire brush for cleaning.

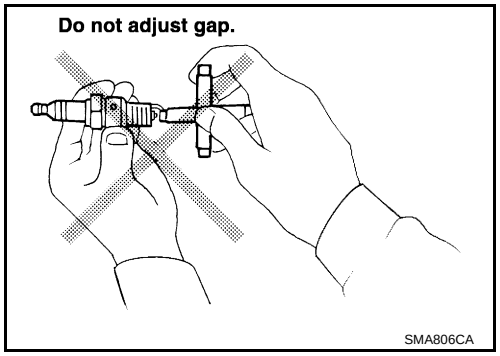


- If the spark plug tip is covered with carbon, a spark plug cleaner may be used.

Cleaner air pressure : **Less than 588 kPa (5.9 bar, 6 kg/cm^2, 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.

CAUTION:

Do not drop or shock spark plug.

Make	NGK
Standard type	DILFR5A-11
Gap (Nominal)	1.1 mm (0.043 in)

CAMSHAFT VALVE CLEARANCE

Valve Clearance

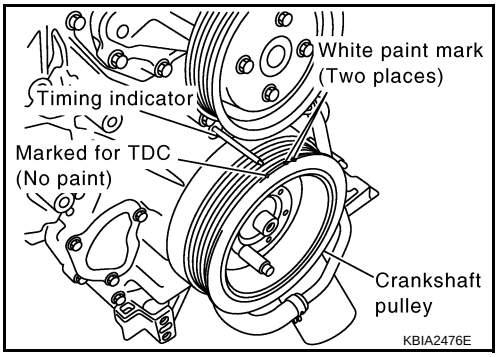
INFOID:0000000001282029

INSPECTION

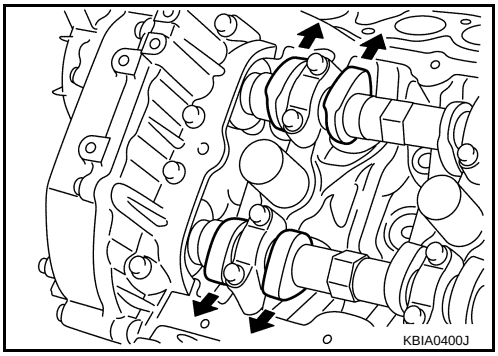
NOTE:

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

1. Warm up the engine. Then stop the engine.
2. Remove the RH bank and LH bank rocker covers using power tool. Refer to EM-178, "Removal and Installation".
3. Turn the crankshaft pulley in the normal direction (clockwise when viewed from engine front) to align TDC identification notch (without paint mark) with timing indicator.

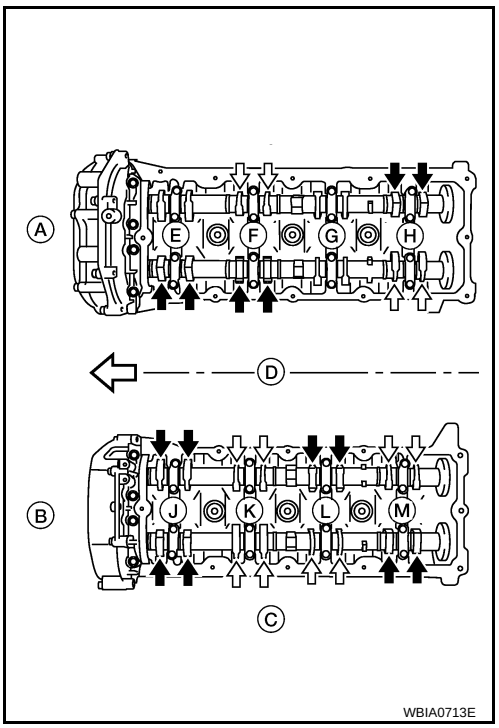


4. At this time, make sure both the intake and exhaust cam noses of No. 1 cylinder (top front on LH bank) face outside.
   - If they do not face outside, turn crankshaft pulley once more.



5. Measure valve clearances at the locations marked "×" as shown in the table below (locations indicated with black arrow).
   - ⇐: Engine front
   - ⇐ (black): Measurable at No.1 cylinder compression top dead center
   - ⇐ (white): Measurable at No. 3 cylinder compression top dead center
   - A: RH
   - B: LH
   - C: Exhaust
   - D: Intake

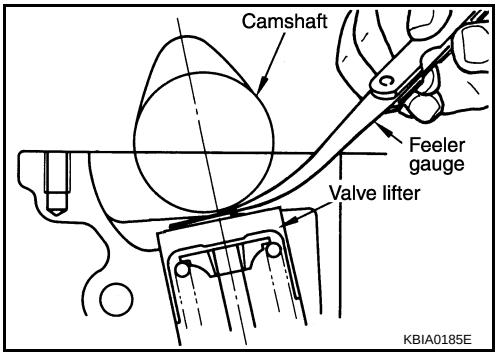
   NOTE:
   Firing order 1-8-7-3-6-5-4-2
   - No. 1 cylinder compression TDC



Measuring position (RH bank)		No. 2 cyl (E)	No. 4 cyl (F)	No. 6 cyl (G)	No. 8 cyl (H)
No. 1 cylinder at TDC	EXH				×
	INT	×	×		
Measuring position (LH bank)		No. 1 cyl (J)	No. 3 cyl (K)	No. 5 cyl (L)	No. 7 cyl (M)
No. 1 cylinder at TDC	INT	×		×	
	EXH	×			×

   - Measure valve clearance using suitable tool.

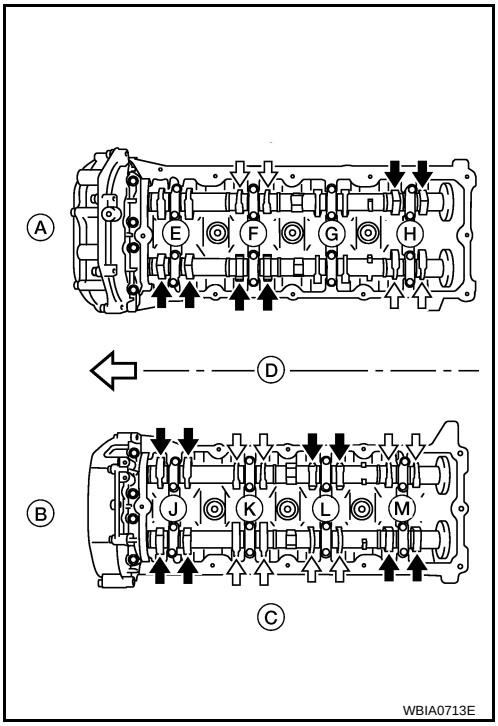
   CAUTION:
   If the inspection was carried out with a cold engine, make sure the values with a fully warmed up engine are still within specifications.



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

7. Measure valve clearances at the locations marked "×" as shown in the table below (locations indicated with white arrow).
   - ⇐: Engine front
   - ⇐ (black): Measurable at No.1 cylinder compression top dead center
   - ⇐ (white): Measurable at No. 3 cylinder compression top dead center
   - A: RH
   - B: LH
   - C: Exhaust
   - D: Intake

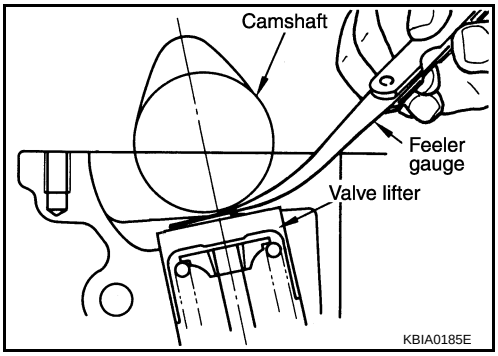
   NOTE:
   Firing order 1-8-7-2-3-6-5-4-2
   - No. 3 cylinder compression TDC



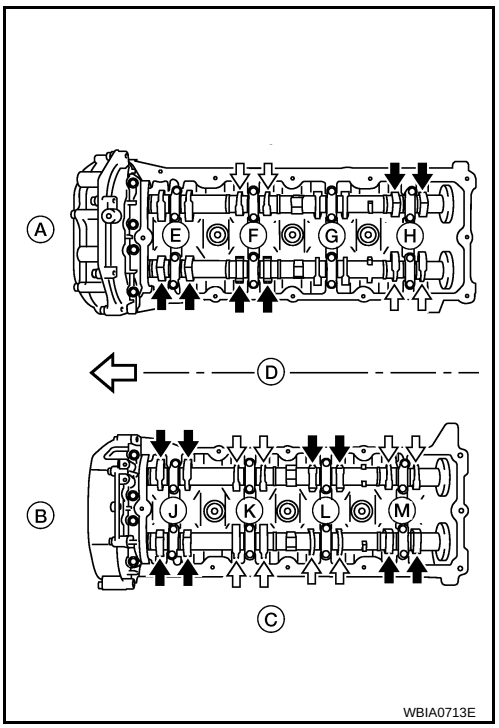
Measuring position (RH bank)		No. 2 cyl (E)	No. 4 cyl (F)	No. 6 cyl (G)	No. 8 cyl (H)
No. 3 cylinder at TDC	EXH		×		
	INT				×
Measuring position (LH bank)		No. 1 cyl (J)	No. 3 cyl (K)	No. 5 cyl (L)	No. 7 cyl (M)
No. 3 cylinder at TDC	INT		×		×
	EXH		×	×	

   - Measure valve clearance using suitable tool.

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



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



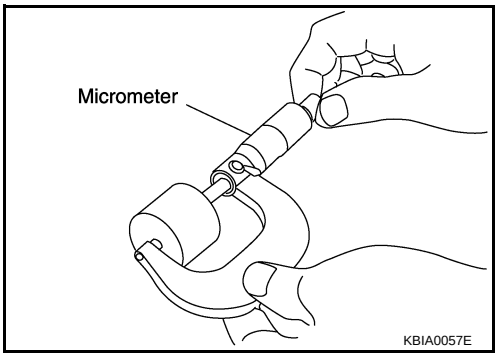
9. If out of specifications, adjust as necessary.

ADJUSTMENT

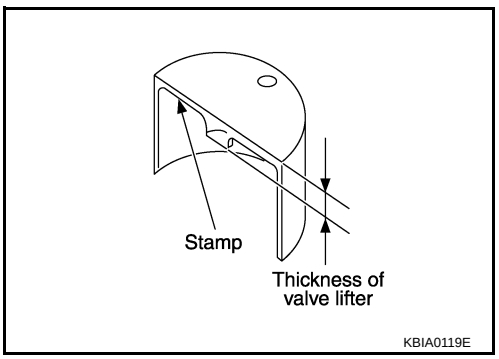
NOTE:

- Perform adjustment depending on the selected head thickness of the valve lifter.
- The specified valve lifter thickness is the dimension at normal temperatures. Ignore dimensional differences caused by temperature. Use the specifications for hot engine condition to adjust.

1. Remove the camshaft. Refer to EM-193, "Removal and Installation".
2. Remove the valve lifters at the locations that are out of specification.
3. Measure the center thickness of the removed valve lifters using suitable tool.
4. Use the equation below to calculate the valve lifter thickness for replacement.
   - Valve lifter thickness calculation:
     Thickness of replacement valve lifter = t1+ (C1 - C2)
     t1 = Thickness of removed valve lifter
     C1 = Measured valve clearance
     C2= Standard valve clearance:



   - Thickness of a new valve lifter can be identified by stamp marks on the reverse side (inside the cylinder).
     Stamp mark N788 indicates 7.88 mm (0.3102 in) in thickness.
   - Available thickness of valve lifter: 25 sizes with range 7.88 to 8.36 mm (0.3102 to 0.3291 in) in steps of 0.02 mm (0.0008 in) (when manufactured at factory). Refer to EM-248, "Standard and Limit".



5. Install the selected valve lifter.

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

COMPRESSION PRESSURE

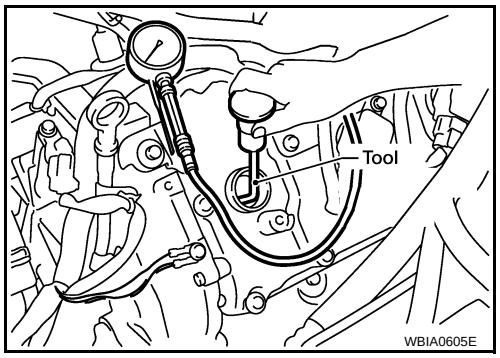
Compression Pressure

INFOID:0000000001301161

CHECKING COMPRESSION PRESSURE

1. Warm up the engine thoroughly. Then stop the engine.
2. Release the fuel pressure. Refer to EC-948, "Fuel Pressure Check".
   CAUTION:
   If CONSULT-III is not used to release fuel pressure leave the fuel pump fuse disconnected until step 7.
3. Remove the spark plug from the cylinder to be checked. Refer to EM-156, "Removal and Installation".
4. Connect the engine tachometer (not required in use of CONSULT-III).
5. Install the compression tester with Tool into the spark plug hole.

   Tool number : EG15050500 (J-45402)



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

Unit: kPa (kg/cm^2, psi) /rpm

Standard	Minimum	Deference limit between cylinders
1,520 (15.5, 220) / 200	1,324 (13.5, 192) / 200	98 (1.0, 14) / 200

CAUTION:
Always use a fully charged battery to obtain specified engine speed.
- If the engine speed is out of the specified range, check the battery liquid for proper gravity. Check the engine speed again with normal battery gravity.
- If the compression pressure is below the minimum value, check the valve clearances and parts associated with the combustion chamber (valve, valve seat, piston, piston ring, cylinder bore, cylinder head, cylinder head gasket). After checking, measure the compression pressure again.
- If some cylinders have low compression pressure, pour a small amount of engine oil into the spark plug hole of the cylinder to re-check it for compression.
  - If the added engine oil improves the compression, the piston rings may be worn out or damaged. Check the piston rings and replace if necessary.
  - If the compression pressure remains at a low level despite the addition of engine oil, the valves may be malfunctioning. Check the valves for damage. Replace the valve or valve seat accordingly.
- If two adjacent cylinders have respectively low compression pressure and their compression remains low even after the addition of engine oil, the gaskets may be leaking, or a valve in adjacent cylinders may be damaged. Inspect and repair as required.

7. Install the components in the reverse order of removal.
8. Start the engine and confirm that it runs smoothly.
9. Perform trouble diagnosis. If DTC appears, erase it. Refer to EC-554, "Description".

ON-VEHICLE REPAIR

ENGINE ROOM COVER

Removal and Installation

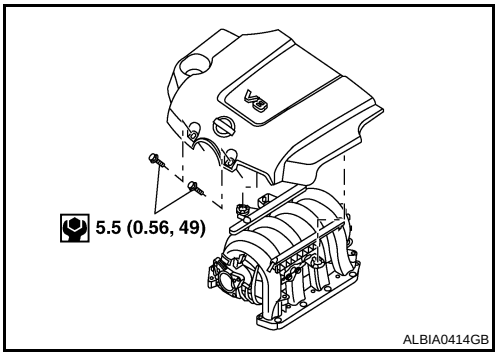
INFOID:0000000001282013

REMOVAL

- Remove the engine cover bolts and cover.

CAUTION:

Do not damage or scratch cover when installing or removing.



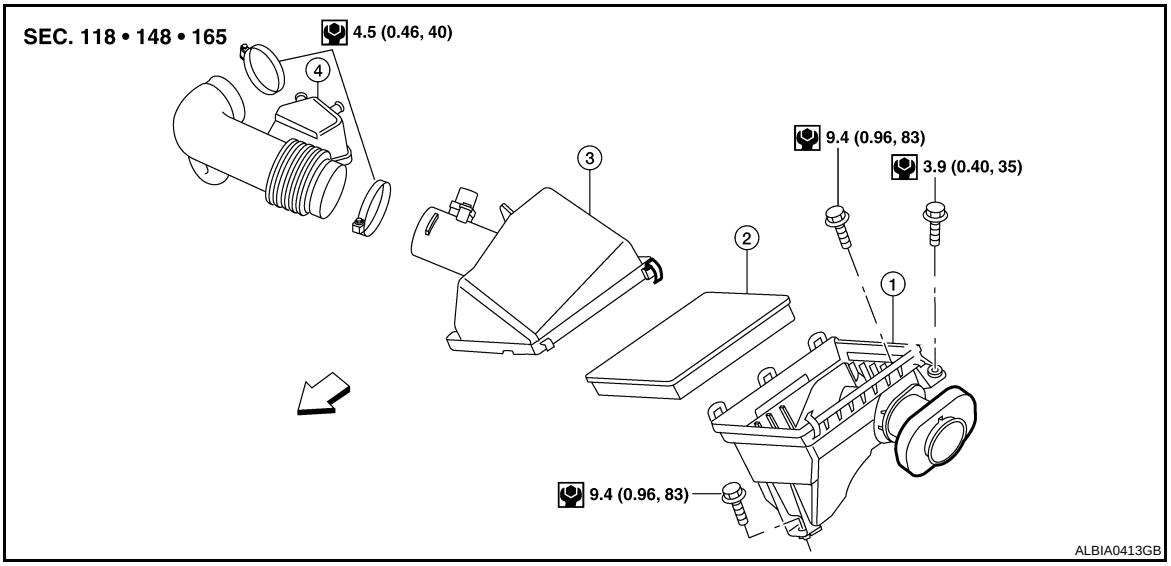
INSTALLATION

Installation is in the reverse order of removal.

AIR CLEANER AND AIR DUCT

Removal and Installation

INFOID:0000000001282017



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

REMOVAL

1. Remove the engine room cover using power tool. Refer to EM-164, "Removal and Installation".
2. Disconnect the harness connector from air cleaner case (upper).
3. Remove the air duct and resonator assembly and air cleaner case (upper).
4. Remove air cleaner filter and air cleaner case (lower).

• 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.

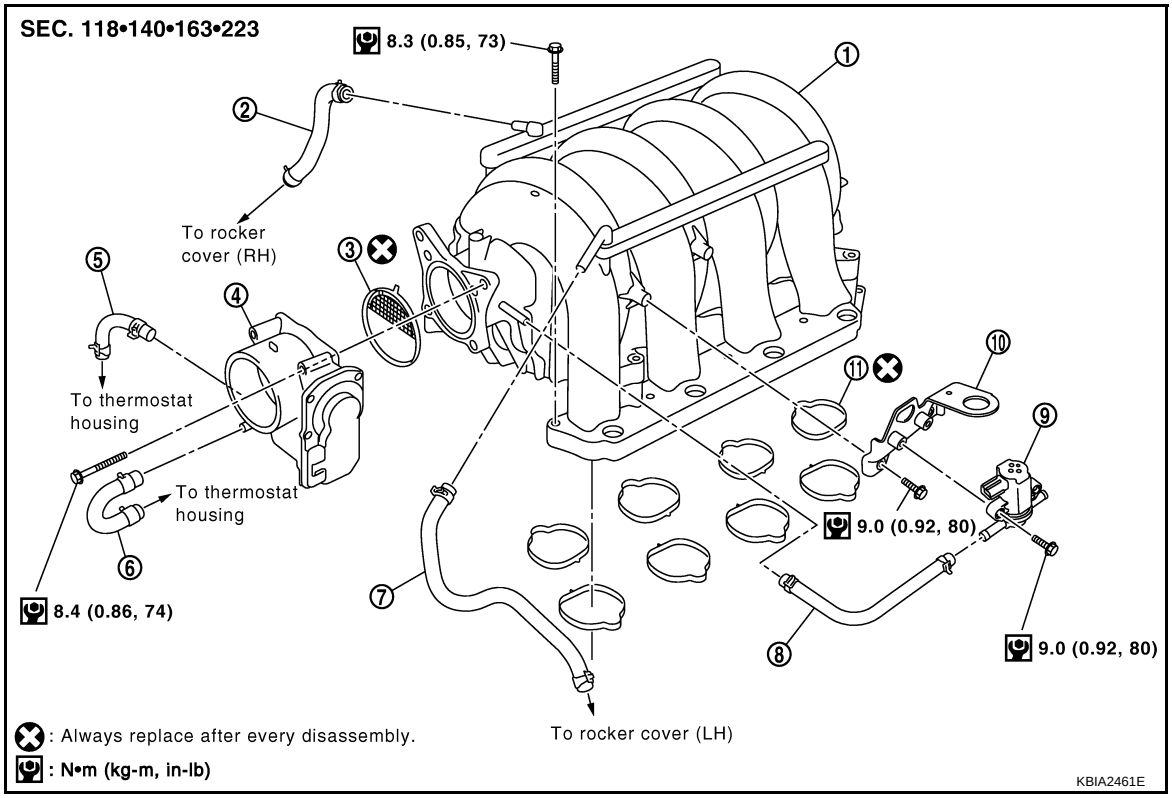
INSTALLATION

Installation is in the reverse order of removal.

INTAKE MANIFOLD

Removal and Installation

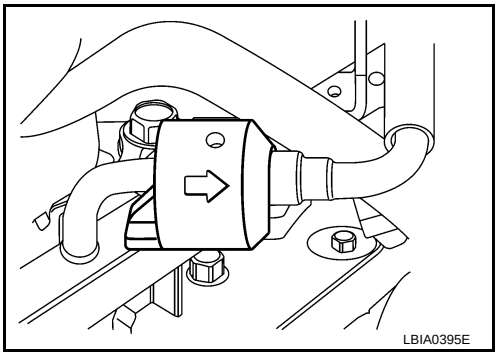
INFOID:0000000001282019



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

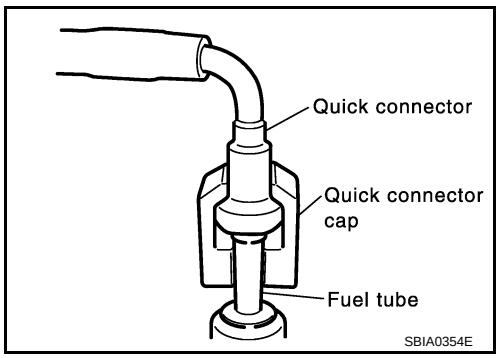
REMOVAL

1. Remove the air dam using power tool.
2. Remove the engine undercover using power tool.
3. Partially drain the engine coolant. Refer to CO-39, "Changing Engine Coolant".
   WARNING:
   To avoid the danger of being scalded, never drain the engine coolant when the engine is hot.
4. Remove the engine room cover using power tool. Refer to EM-164, "Removal and Installation".
5. Release the fuel pressure. Refer to EC-948, "Fuel Pressure Check".
6. Remove the air duct and resonator assembly. Refer to EM-165, "Removal and Installation".
7. Disconnect the fuel tube quick connector on the engine side.



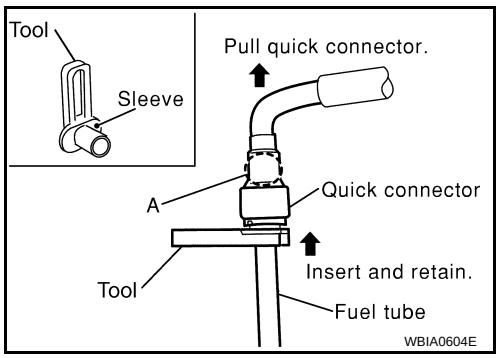
- Perform the following steps to disconnect the quick connector using Tool.

a. Remove quick connector cap (engine side only).



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

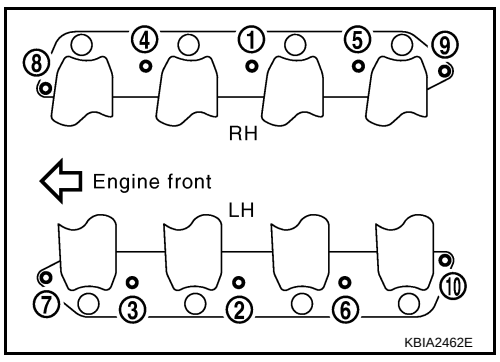
Tool number : 16441 6N210 (J-45488)



c. Insert Tool into quick connector until sleeve contacts and goes no further. Hold the Tool in that position.
CAUTION:
Inserting the Tool hard will not disconnect quick connector. Hold Tool where it contacts and goes no further.

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

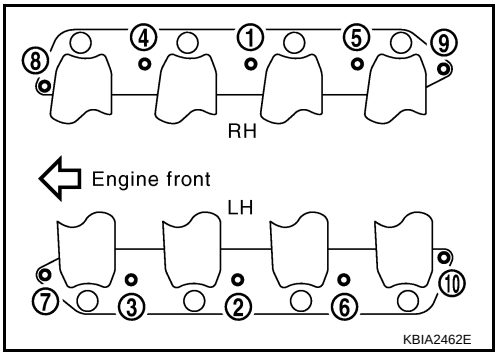
8. Remove or disconnect harnesses, brackets, vacuum hose, vacuum gallery and PCV hose and tube from intake manifold.
9. Remove electric throttle control actuator by loosening bolts diagonally.
CAUTION:
- **Handle carefully to avoid any damage to the electric throttle control actuator.**
- **Do not disassemble.**
10. Remove the fuel injectors and fuel tube assembly. Refer to EM-180, "Removal and Installation".
11. Loosen the bolts in reverse order shown using power tool.
12. Remove the intake manifold.
CAUTION:
Cover engine openings to avoid entry of foreign materials.
- Clean all gasket mating surfaces, do not reuse gaskets.



INSTALLATION

Installation is in the reverse order of removal.

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

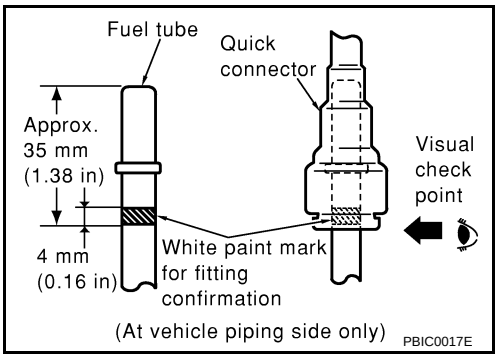


- Install the EVAP canister purge control solenoid valve connector with it facing front of engine.
- Tighten the electronic throttle control actuator bolts of the electric throttle control actuator equally and diagonally in several steps.
- After installation perform procedure in "INSPECTION AFTER INSTALLATION".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

Connecting Quick Connector of Fuel Tube

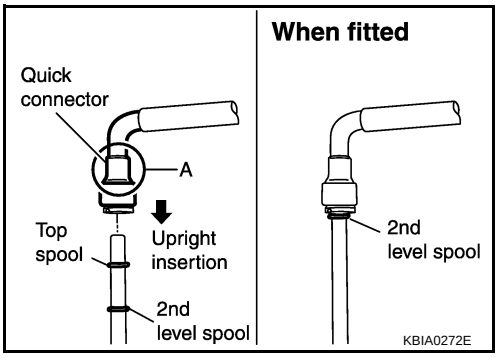
Install quick connector as follows (the steps are the same for quick connectors on both engine side and vehicle side except for the quick connector cap).

1. Make sure no foreign substances are deposited in and around tube and quick connector, and they are not damaged.
2. Thinly apply new engine oil around the fuel tube from tip end to the spool end.
3. Align center to insert quick connector straight into fuel tube.
   - Insert until the paint mark for engagement identification (white) goes completely inside quick connector so that you cannot see it from the straight side of the connected part. Use a mirror to check this where it is not possible to view directly from the straight side, such as quick connector on vehicle side.



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

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

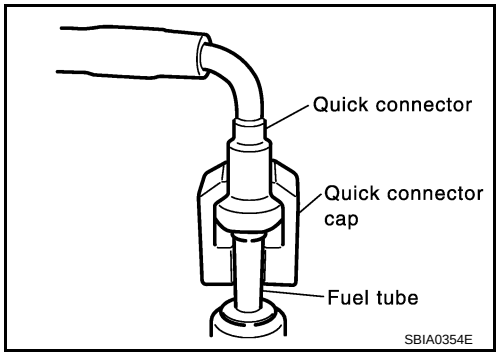


4. Pull quick connector by hand holding "A" position. Make sure it is completely engaged (connected) so that it does not come out from fuel tube.

   NOTE:

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

5. Install the quick connector cap on the quick connector joint (on engine side only).
6. Install the fuel hose and tube to hose clamps.
7. Refill the engine coolant. Refer to CO-39, "Changing Engine Coolant".



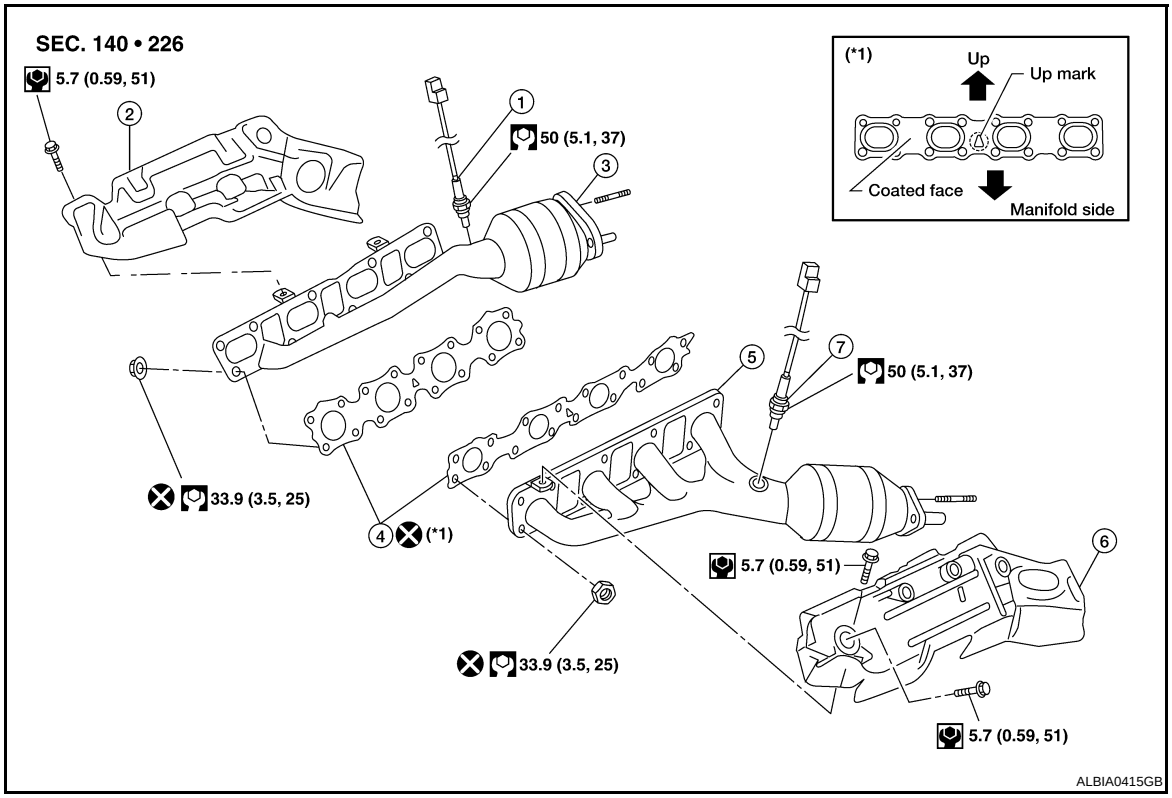
INSPECTION AFTER INSTALLATION

- After installing fuel tubes, make sure there is no fuel leakage at connections in the following steps.
- Apply fuel pressure to fuel lines by turning ignition switch ON (with engine stopped). Then check for fuel leaks at connections.
- Start the engine and rev it up and check for fuel leaks at the connections.
- Perform procedures for “Throttle Valve Closed Position Learning” after finishing repairs. Refer to EC-497, "Throttle Valve Closed Position Learning".
- If electric throttle control actuator is replaced, perform procedures for “Idle Air Volume Learning” after finishing repairs. Refer to EC-497, "Idle Air Volume Learning".

EXHAUST MANIFOLD AND THREE WAY CATALYST

Removal and Installation

INFOID:0000000001282020



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

REMOVAL

WARNING:

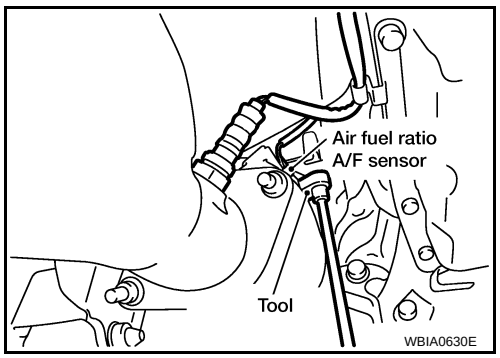
Perform the work when the exhaust and cooling system have cooled sufficiently.

1. Remove the air dam using power tool.
2. Remove the engine undercover using power tool.
3. Remove front final drive assembly (4WD models). Refer to DLN-376, "Removal and Installation".
4. Remove the main muffler assembly and center exhaust tube. Refer to EX-5, "Removal and Installation".
5. Remove the front exhaust tubes. Refer to EX-5, "Removal and Installation".
6. Remove front tires.
7. Remove fender protectors. Refer to EXT-20, "Removal and Installation of Front Fender Protector".
8. Remove the LH and RH air fuel ratio A/F sensors.
   - Follow steps below to remove each air fuel ratio A/F sensor.

a. Remove the harness connector of each air fuel ratio A/F sensor, and harness from bracket and middle clamp.

b. Remove the air fuel ratio A/F sensors from both LH and RH exhaust manifolds using Tool.

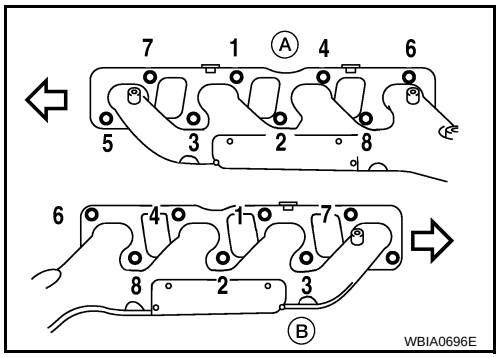
Tool number : — (J-44626)



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

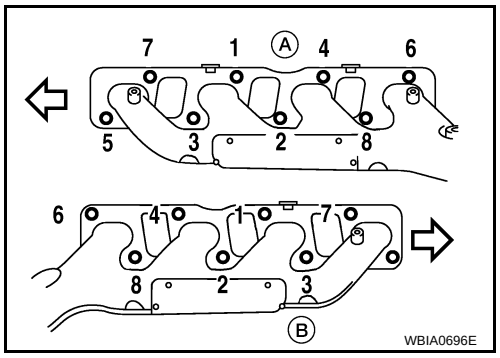
9. Support the engine using a suitable tool.
10. Remove the exhaust manifold (LH) (A) following the steps below.

a. Remove the engine mounting insulator. Refer to EM-218, "Removal and Installation".
b. Remove the exhaust manifold cover.
c. Remove the engine mounting bracket. Refer to EM-218, "Removal and Installation".
d. Loosen the nuts in reverse order as shown using power tool.
e. Remove the exhaust manifold (LH).



11. Remove the exhaust manifold (RH) (B) following the steps below.

a. Remove the engine mounting insulator. Refer to EM-218, "Removal and Installation".
b. Remove the exhaust manifold cover.
c. Remove the engine mounting bracket. Refer to EM-218, "Removal and Installation".
d. Remove the oil level gauge guide. Refer to EM-173, "Removal and Installation".
e. Loosen the nuts in reverse order as shown using power tool.
f. Remove the exhaust manifold (RH).

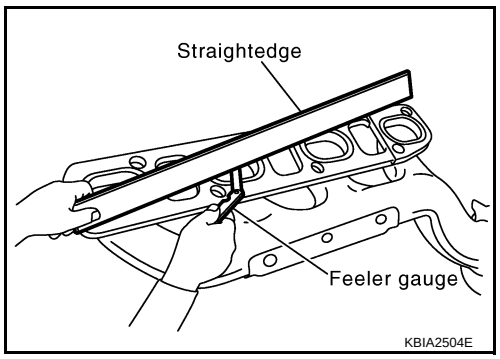


INSPECTION AFTER REMOVAL

Surface Distortion

- Check the flatness of each exhaust manifold flange surface using suitable tools.

Flatness limit : 0.3 mm (0.012 in)



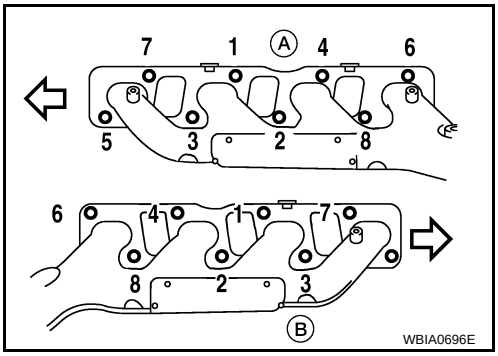
- If measurement exceeds the limit, replace the exhaust manifold.

INSTALLATION

Installation is in the reverse order of removal.

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

- Tighten the exhaust manifold nuts LH (A) and RH (B) in the numerical order shown. Then recheck the torque of the nuts.



- Before installing new air fuel ration A/F sensors, clean the exhaust system threads using Tool and apply anti-seize lubricant.

Heated Oxygen Sensor

CAUTION:

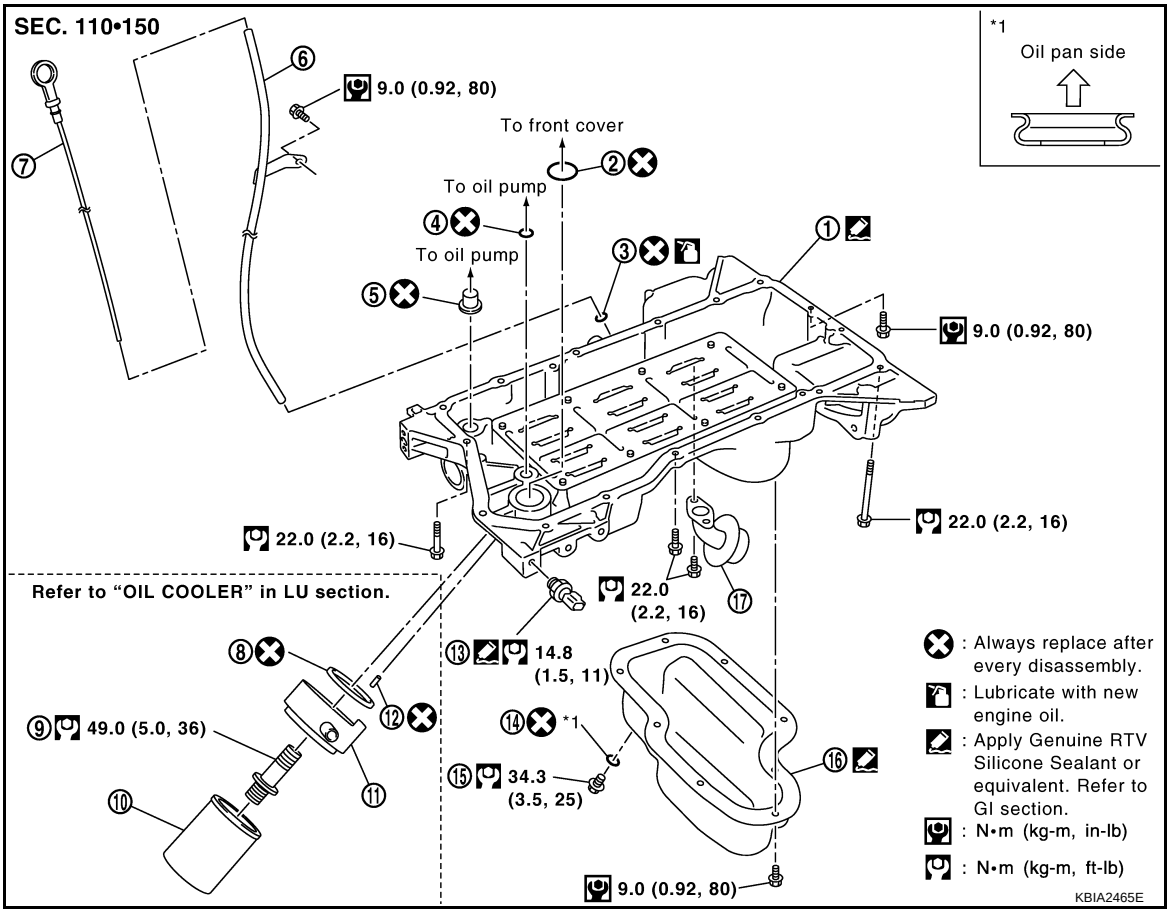
- **Do not over tighten the air fuel ratio A/F sensors. Doing so may cause damage to the sensor, resulting in the MIL coming on.**

Tool number : — (J-43879-12)
: — (J-43897-18)

OIL PAN AND OIL STRAINER

Removal and Installation

INFOID:0000000001282021



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

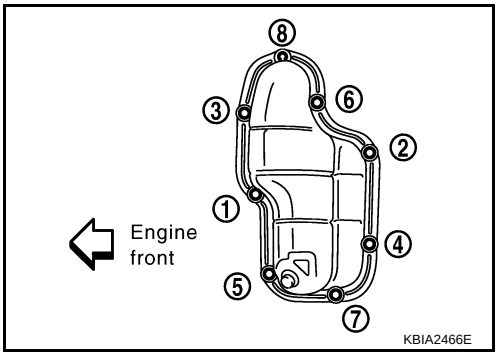
REMOVAL

WARNING:

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

1. Remove the engine. Refer to EM-218, "Removal and Installation".
2. Remove the oil pan (lower) using the following steps.

a. Remove the oil pan (lower) bolts using power tool.

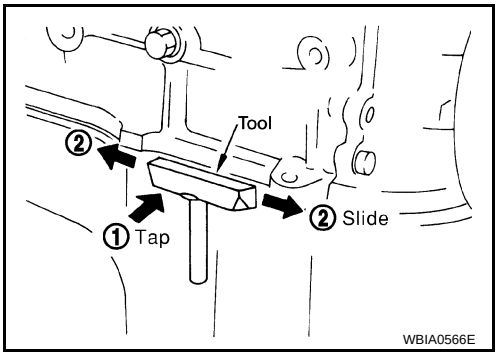


b. Insert Tool between the lower oil pan and the upper oil pan.

Tool number : KV10111100 (J-37228)

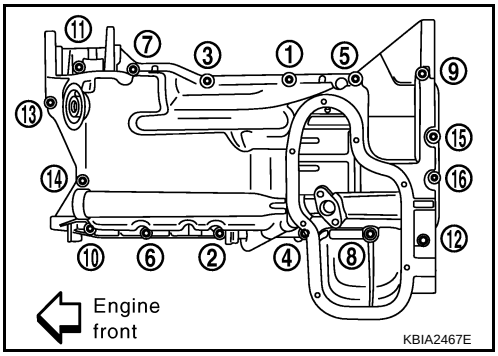
CAUTION:
- **Be careful not to damage the mating surface.**
- **Do not insert a screwdriver, this will damage the mating surfaces.**

c. Tap seal cutter to insert it (1) and then slide it by tapping on the side (2) of the tool as shown.



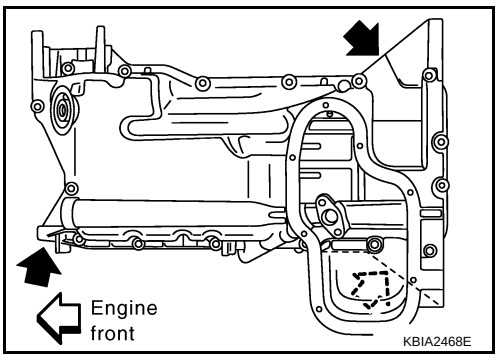
3. Remove the oil cooler assembly. Refer to LU-28, "Removal and Installation".
4. Remove the oil strainer from the oil pan (upper).
5. Remove the oil pan (upper) using the following steps.

a. Remove the oil pan (upper) bolts as shown.



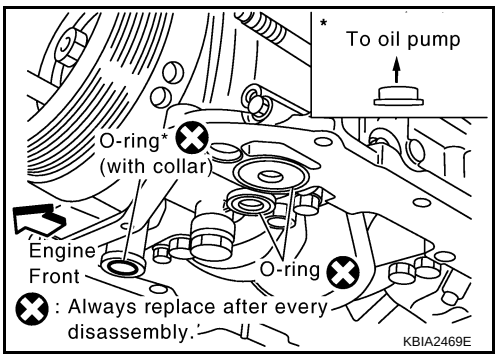
b. Remove the oil pan (upper) from the cylinder block by prying it at the points shown, using suitable tool.

CAUTION:
Do not damage mating surface.



6. Remove the O-rings from the oil pump and front cover.

NOTE:
Do not reuse O-rings.



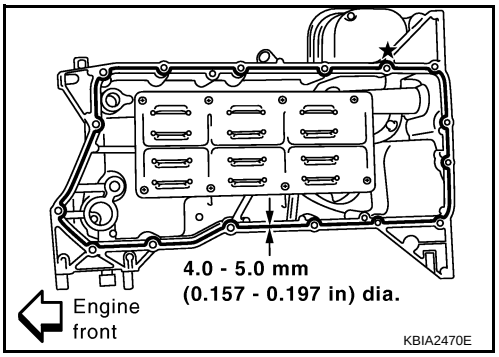
INSPECTION AFTER REMOVAL

Clean the oil strainer.

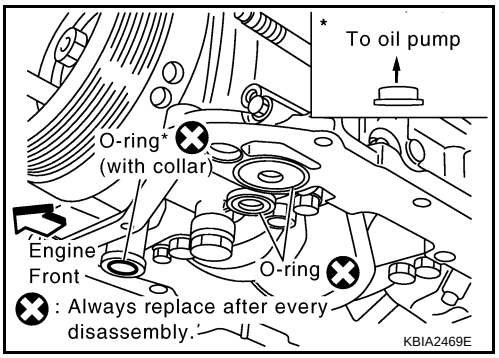
INSTALLATION

1. Install the oil pan (upper) using the following steps.

a. Apply liquid gasket thoroughly as shown.
Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".
CAUTION:
Apply liquid gasket to outside of bolt hole for the hole shown by ★.

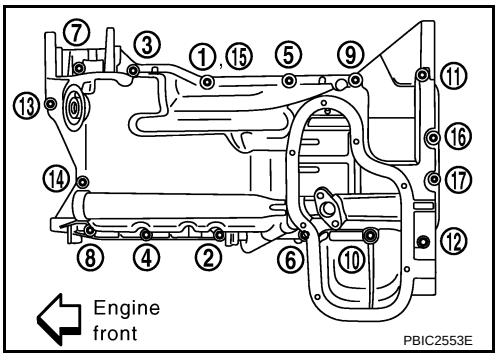


b. Install new O-rings to the oil pump and front cover side.



c. Tighten the bolts in numerical order as shown.

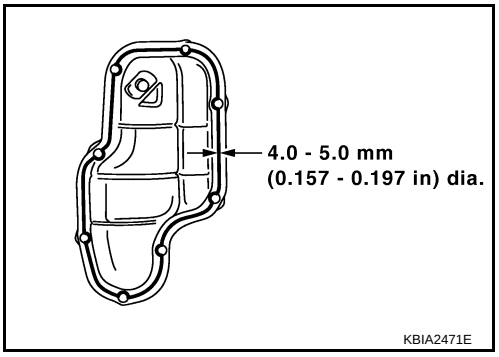
M6 × 30 mm (1.18 in) : No. 15, 16
M8 × 25 mm (0.98in) : No. 1, 3, 5, 7, 11, 13
M8 × 45 mm (1.77 in) : No. 2, 4, 6, 8, 10, 14
M8 × 123 mm (4.84in) : No. 9, 12



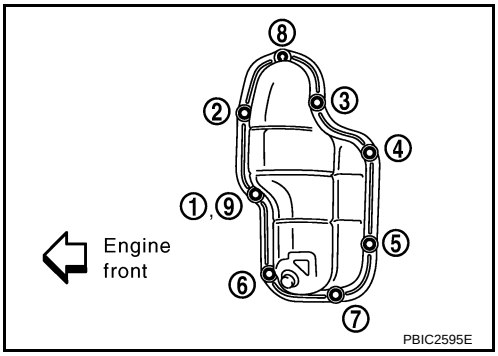
2. Install the oil strainer to the oil pan (upper).

3. Install the oil pan (lower).

a. Apply liquid gasket thoroughly as shown.
Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants"
CAUTION:
Attaching should be done within 5 minutes after coating.



b. Tighten the oil pan (lower) bolts in numerical order as shown.



4. Install the oil pan drain plug.
5. Install engine assembly. Refer to EM-218, "Removal and Installation".
   - Do not fill the engine with oil for at least 30 minutes after oil pan is installed.

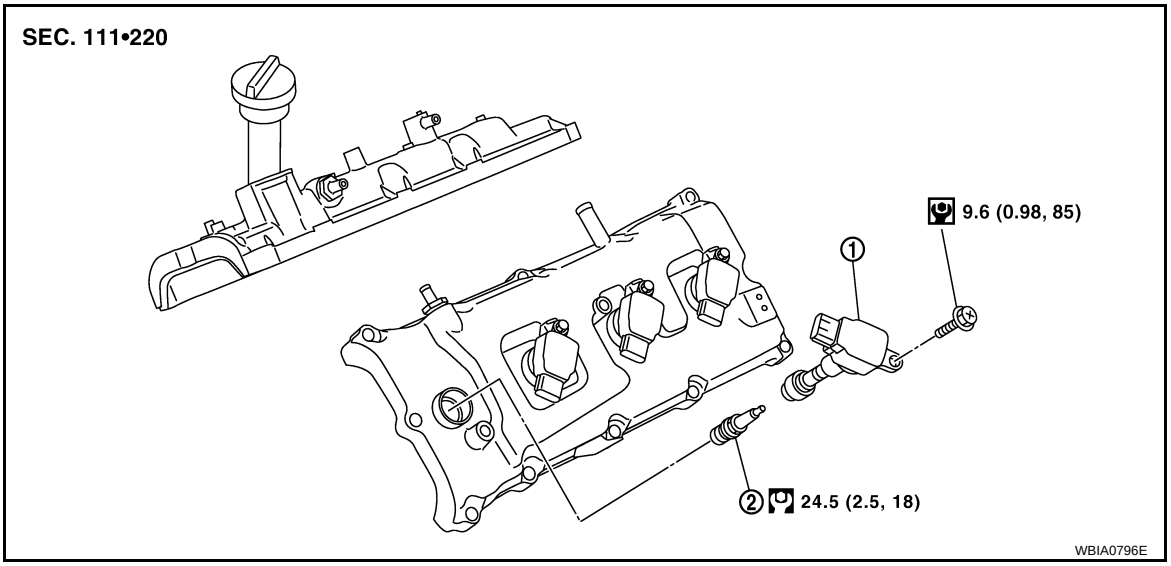
INSPECTION AFTER INSTALLATION

1. Check engine oil level and add engine oil if necessary. Refer to LU-24, "Inspection".
2. Start the engine, and check for leaks of engine oil.
3. Stop engine and wait for 10 minutes.
4. Check engine oil level again.

IGNITION COIL

Removal and Installation

INFOID:0000000001282022



1. Ignition coil
2. Spark plug

REMOVAL

1. Remove the engine room cover using power tool. Refer to EM-164, "Removal and Installation".
2. Remove the air duct and resonator assembly. Refer to EM-165, "Removal and Installation".
3. Disconnect the harness connector from the ignition coil.
4. Remove the ignition coil.
   CAUTION:
   Do not shock ignition coil.

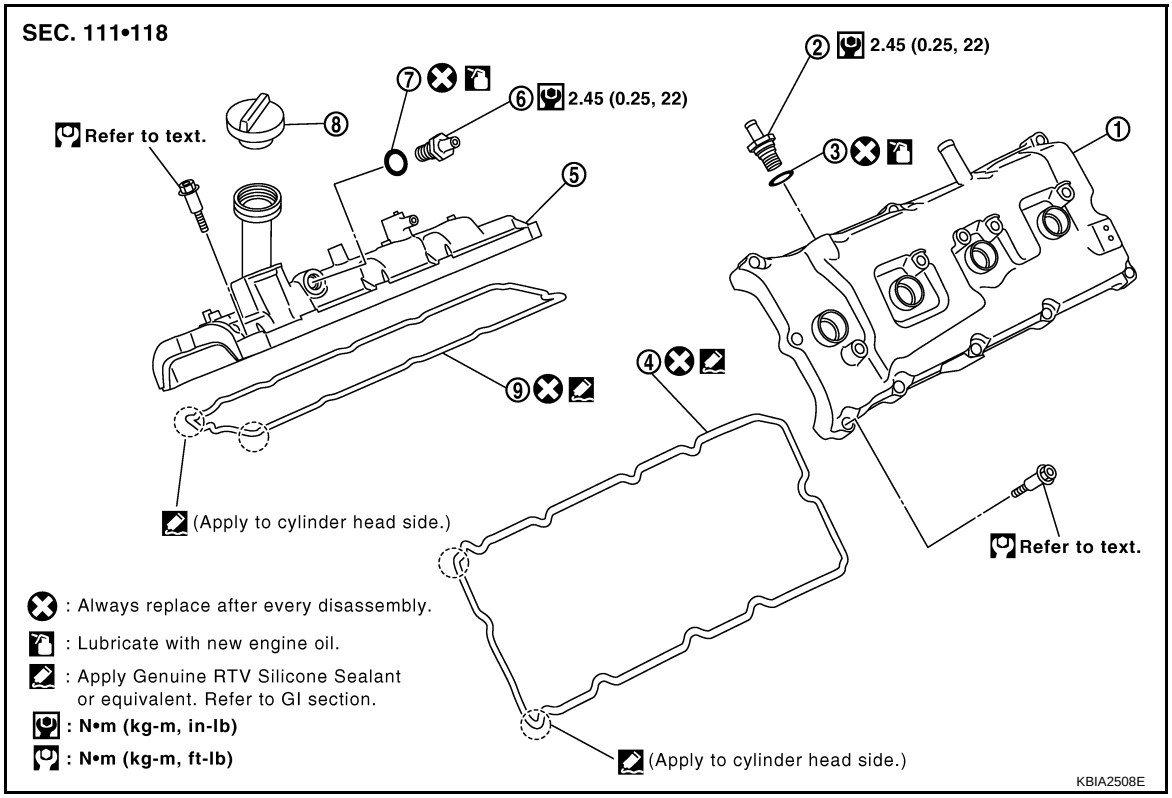
INSTALLATION

Installation is in the reverse order of removal.

ROCKER COVER

Removal and Installation

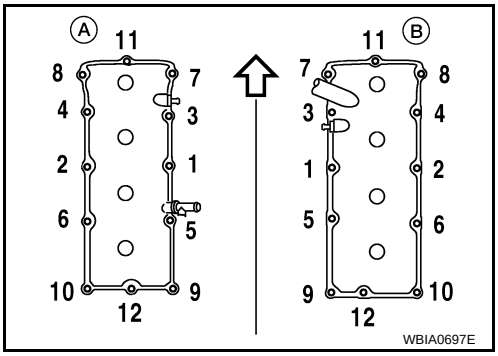
INFOID:0000000001282025



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

REMOVAL

1. Remove the engine room cover using power tool. Refer to EM-164, "Removal and Installation".
2. Remove the air duct and resonator assembly. Refer to EM-165, "Removal and Installation".
3. Move the harness on the upper rocker cover and its peripheral aside.
4. Remove the ignition coils. Refer to EM-177, "Removal and Installation".
5. Remove the PCV hose from the PCV control valves.
   • ⇐: Engine front
6. Loosen the bolts in reverse order shown using power tool for rocker cover (LH) (A) or (RH) (B).
   CAUTION:
   Do not hold the rocker cover (RH) (B) by the oil filler neck.

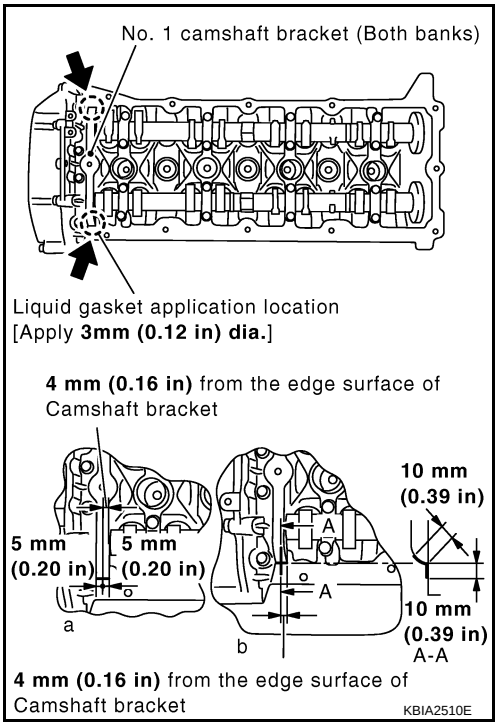


INSTALLATION

1. Apply liquid gasket to the joint part of the cylinder head and camshaft bracket following the steps below.
NOTE:
Illustration shows an example of (LH) side (zoomed in shows No.1 camshaft bracket).

a. Apply liquid gasket to the joint part of No.1 camshaft bracket and cylinder head "a".

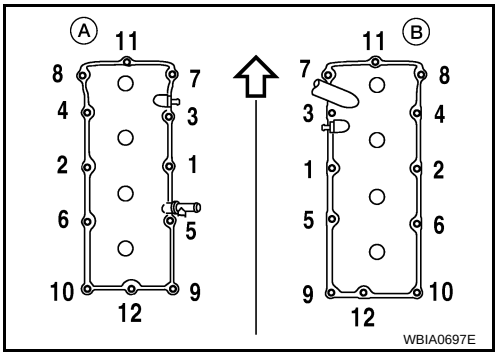
b. Apply liquid gasket 90° "b" to illustration ″a″.
Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".



2. Install the rocker cover (LH) (A) or (RH) (B).
- Make sure the new rocker cover gasket is installed in the groove of the rocker cover (LH) (A) or (RH) (B).
- Tighten the bolts in two steps in the numerical order shown.

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

CAUTION:
Do not hold the rocker cover (RH) (B) by the oil filler neck.



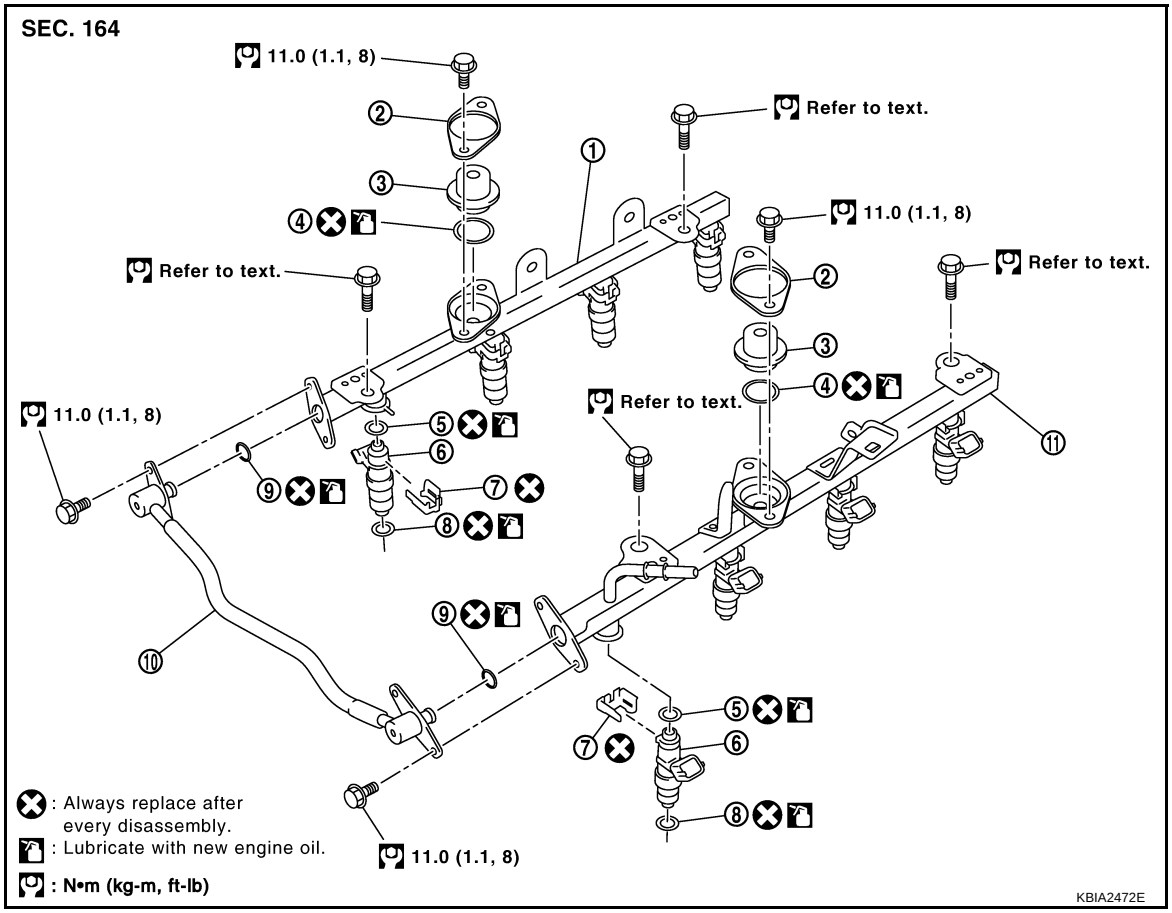
3. Install the PCV hoses.
NOTE:
- Remove foreign materials from inside the hose using compressed air.
- The inserted length is within 25 - 30 mm (0.98 - 1.18 in) [Target: 25 mm (0.98 in)].

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

FUEL INJECTOR AND FUEL TUBE

Removal and Installation

INFOID:0000000001282024



1. Fuel tube (RH)
2. Cap
3. Fuel damper
4. O-ring
5. O-ring (blue)
6. Fuel injector
7. Clip
8. O-ring (brown)
9. O-ring
10. Fuel hose assembly
11. Fuel tube (LH)

CAUTION:
Do not remove or disassemble parts unless instructed as shown.

REMOVAL

WARNING:
- **Put a “CAUTION FLAMMABLE” sign in the workshop.**
- **Be sure to work in a well ventilated area and furnish workshop with a CO_2 fire extinguisher.**
- **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.**

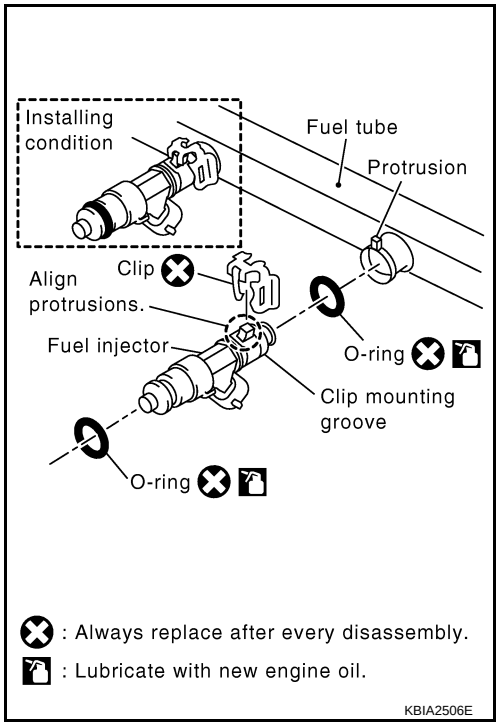
1. Disconnect the negative battery terminal.
2. Remove the engine room cover using power tool. Refer to EM-164, "Removal and Installation".
3. Release the fuel pressure. Refer to EC-948, "Fuel Pressure Check".
4. Remove the air duct and resonator assembly. Refer to EM-165, "Removal and Installation".
5. Disconnect the fuel injector harness connectors.
6. Disconnect the fuel hose assembly from the fuel tubes (RH and LH).
   CAUTION:
   - **While hoses are disconnected, plug them to prevent fuel from draining.**
   - **Do not separate the fuel connector and fuel hose.**
7. Remove the fuel injectors with the fuel tube assembly.

8. Remove the fuel injector from the fuel tube using the following steps.

a. Spread open and remove the clip.

b. Remove the fuel injector from the fuel tube by pulling straight out.

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



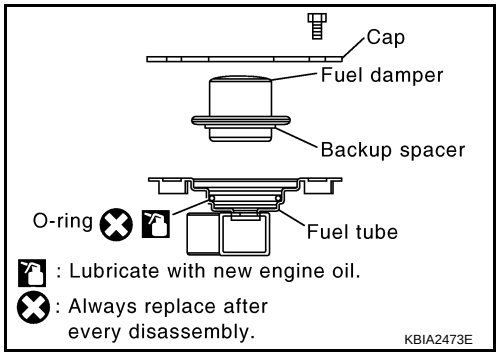
9. Remove the fuel damper from each fuel tube.

INSTALLATION

1. Install the fuel damper to each fuel tube using the following steps.

a. Apply engine oil to the new O-ring and set it into the cup of the fuel tube.

CAUTION:
- **Handle O-ring with bare hands. Never wear gloves.**
- **Lubricate new 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, do not scratch it with tool or fingernails.**
- **Do not twist or stretch the O-ring.**



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

NOTE:
The backup spacer is part of the fuel damper assembly.

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

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

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

d. Install the cap, and then tighten the bolts evenly.
- After tightening the bolts, make sure that there is no gap between the cap and fuel tube.

2. Install new O-rings to the fuel injector paying attention to the items below.

CAUTION:
- **Upper and lower O-rings are different colors.**

Fuel tube side : Blue
Nozzle side : Brown

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

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

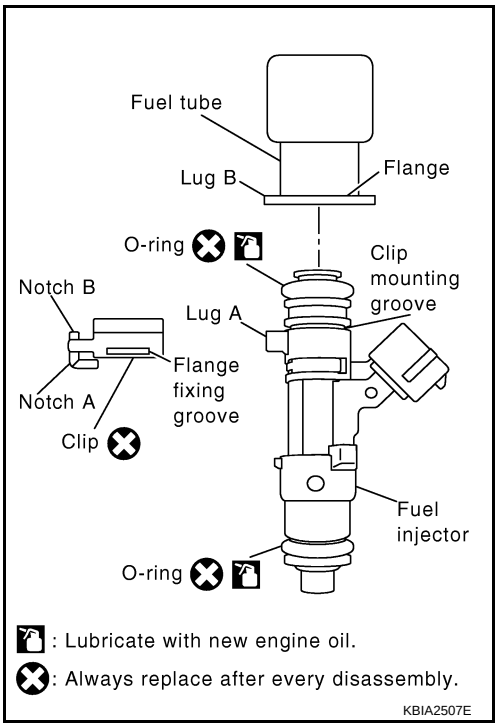
3. Install the fuel injector to the fuel tube using the following steps.

a. Insert new clip into clip mounting groove on the fuel injector.
- Insert clip so that lug ″A″ of fuel injector matches notch ″A″ of the clip.

CAUTION:
- **Do not reuse clip. Replace it with a new one.**
- **Do not allow the clip to interfere with the O-ring. If interference occurs, replace the O-ring.**

b. Insert the fuel injector into the fuel tube with the clip attached.
- Insert it while matching it to the axial center.
- Insert fuel injector so that lug ″B″ of fuel tube matches notch ″B″ of the clip.
- Make sure that the fuel tube flange is securely seated in the flange fixing groove on the clip.

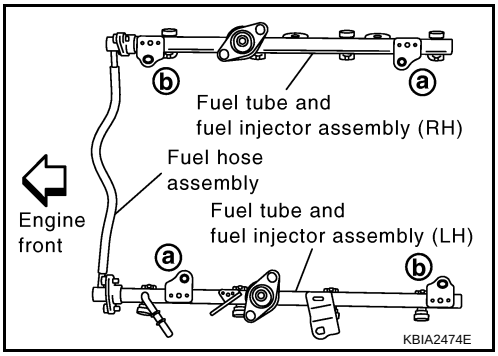
c. Make sure that installation is complete by checking that the fuel injector does not rotate or come off.
- Make sure that the protrusions of the fuel injectors are aligned with the cutouts of the clips after installation.



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

CAUTION:
Do not let the tip of the injector nozzle come in contact with other parts.
- Tighten fuel tube assembly bolts ″a″ to ″b″ in illustration in two steps.

1st step : 12.8 N·m (1.3 kg-m, 9 ft-lb)
2nd step : 24.5 N·m (2.5 kg-m, 18 ft-lb)



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

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.**

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

INSPECTION AFTER INSTALLATION

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

1. Apply fuel pressure to the fuel lines by turning ignition switch ON (with engine stopped). Then check for fuel leaks at the connections.
   NOTE:
   Use mirrors for checking on hidden points.
2. Start the engine and rev it up and check for fuel leaks at the connections.
   CAUTION:
   Do not touch the engine immediately after stopping, as engine becomes extremely hot.

TIMING CHAIN

Components

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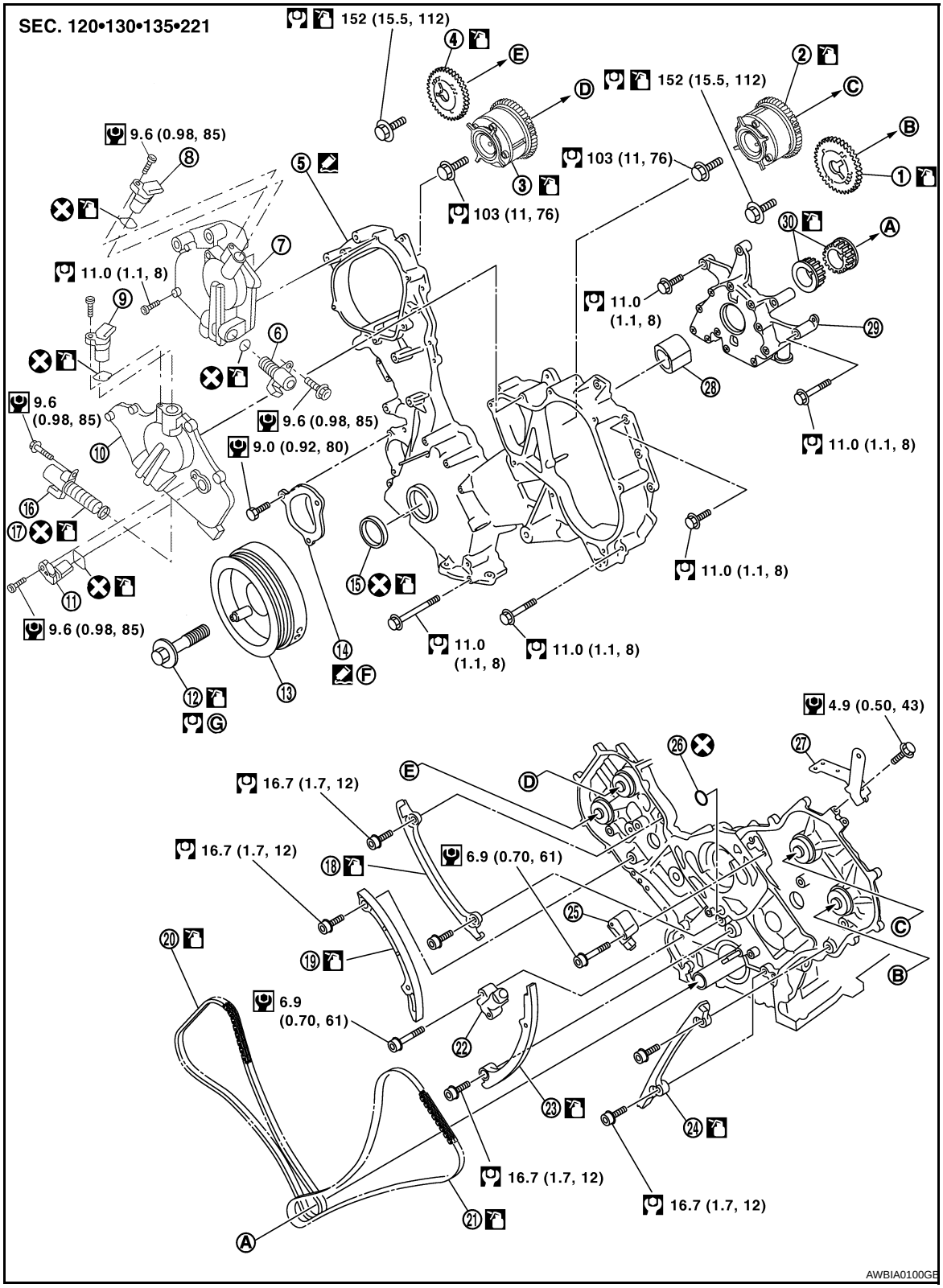

1. Camshaft sprocket LH bank EXH	2. Camshaft sprocket LH bank INT (VTC)	3. Camshaft sprocket RH bank INT (VTC)
4. Camshaft sprocket RH bank EXH	5. Front cover	6. Intake valve control solenoid valve (LH)
7. Intake valve control solenoid valve cover (LH)	8. Intake valve timing control position sensor (LH)	9. Intake valve timing control position sensor (RH)
10. Intake valve control solenoid valve cover (RH)	11. Camshaft position sensor (PHASE)	12 Crankshaft pulley bolt
13. Crankshaft pulley	14. Chain tensioner cover	15. Front oil seal
16. Intake valve control solenoid valve (RH)	17. O-ring	18. Timing chain tension guide RH bank
19. Timing chain slack guide (RH)	20. Timing chain LH bank	21. Timing chain (RH)
22. Chain tensioner (RH)	23. Timing chain slack guide LH bank	24. Timing chain tension guide LH bank
25. Chain tensioner (LH)	26. O-ring	27. Bracket
28. Oil pump drive spacer	29. Oil pump assembly	30. Crankshaft sprocket
A. To crankshaft	B. To camshaft LH bank EXH	C. To camshaft LH bank INT (VTC)
D. To camshaft RH bank INT (VTC)	E. To camshaft RH bank EXH	F. Apply sealant to mating side
G. Refer to EM-185		

Removal and Installation

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NOTE:
- To remove timing chain and associated parts, start with those on the LH bank. The procedure for removing parts on the RH bank is omitted because it is the same as that for removal on the LH bank.
- To install timing chain and associated parts, start with those on the RH bank. The procedure for installing parts on the LH bank is omitted because it is the same as that for installation on the RH bank.

REMOVAL

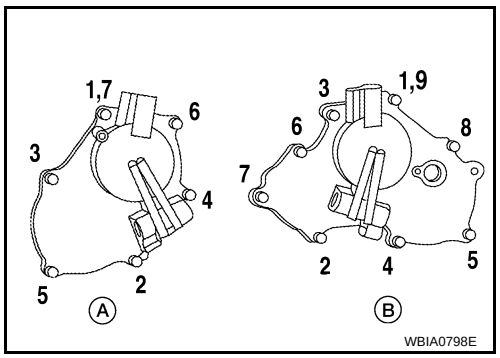
1. Remove the engine assembly from the vehicle. Refer to EM-218, "Removal and Installation".
2. Remove the following components and related parts:
   - Drive belt auto tensioner and idler pulley. Refer to EM-154, "Drive Belt Auto Tensioner and Idler Pulley".
   - Thermostat housing and water hose. Refer to CO-51, "Removal and Installation".
   - Power steering oil pump bracket. Refer to ST-24, "Removal and Installation".
   - Oil pan (lower), (upper) and oil strainer. Refer to EM-173, "Removal and Installation".
   - Ignition coil. Refer to EM-177, "Removal and Installation".
   - Rocker cover. Refer to EM-178, "Removal and Installation".
3. Remove the Intake valve control solenoid valve cover (RH) (A) and Intake valve control solenoid valve cover (LH) (B) as follows:

a. Loosen and remove the bolts as shown.

b. Cut the liquid gasket and remove the covers using Tool.

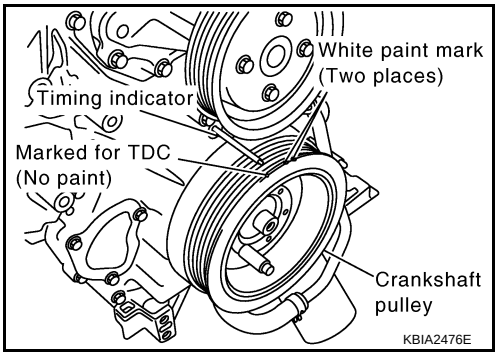
Tool number : KV10111100 (J-37228)

CAUTION:
Do not damage mating surfaces.

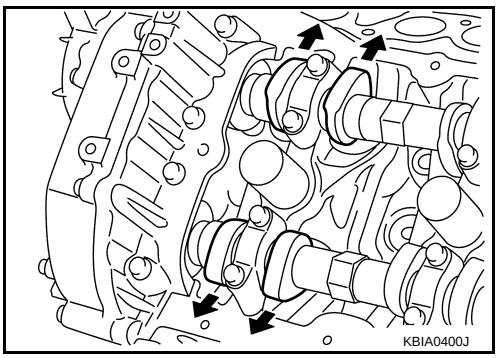


4. Obtain compression TDC of No. 1 cylinder as follows:

a. Turn the crankshaft pulley clockwise to align the TDC identification notch (without paint mark) with the timing indicator on the front cover.

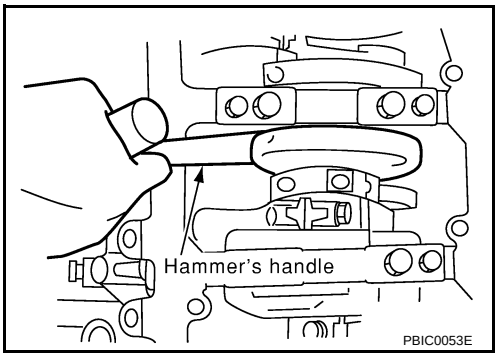


b. At this time, make sure both intake and exhaust cam lobes of No. 1 cylinder (top front on LH bank) point outside.
- If they do not point outside, turn crankshaft pulley once more.



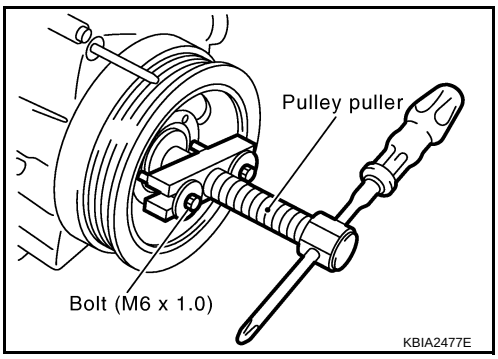
5. Remove the crankshaft pulley.

a. Loosen the crankshaft pulley bolts using a hammer handle to secure the crankshaft.



b. Remove the crankshaft pulley from the crankshaft using tool.
- Remove the crankshaft pulley using suitable tool. Set the bolts in the two bolt holes [M6 x 1.0 mm (0.04 in)] on the front surface.

NOTE:
The dimension between the centers of the two bolt holes is 61 mm (2.40 in).



6. Remove the front cover.

a. Loosen and remove the bolts in the reverse of order shown.

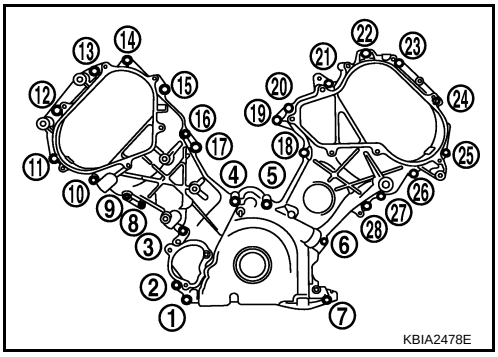
b. Cut the liquid gasket and remove the covers using Tool.

Tool number : KV10111100 (J-37228)

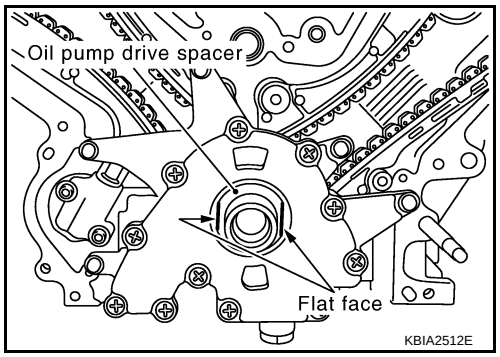
CAUTION:
Do not damage mating surfaces.

7. Remove the front oil seal using suitable tool.

CAUTION:
Do not damage front cover.

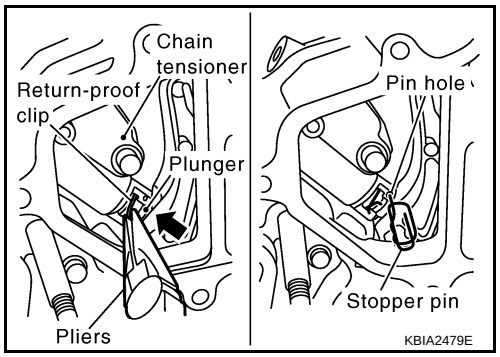


8. Remove the oil pump drive spacer.
   • Hold and remove the flat space of the oil pump drive spacer by pulling it forward.



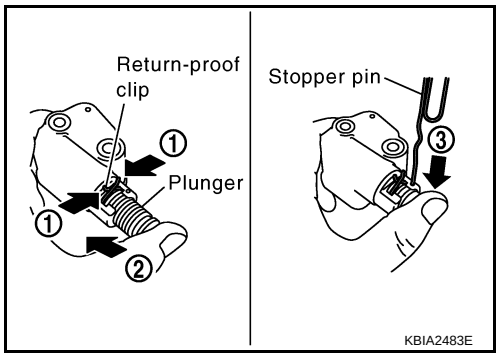
9. Remove the oil pump. Refer to LU-30, "Removal and Installation".
10. Remove the chain tensioner on the LH bank using the following steps.
    NOTE:
    To remove the timing chain and associated parts, start with those on the LH bank. The procedure for removing parts on the RH bank is omitted because it is the same as that for the LH bank.

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

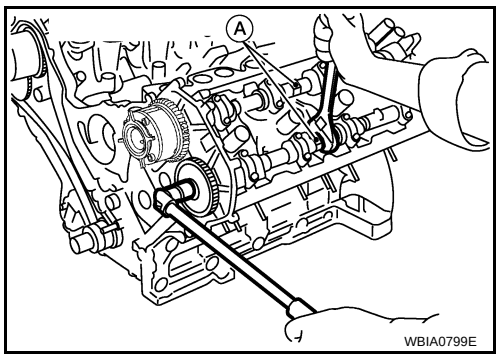


WARNING:
Plunger, spring, and spring seat pop out when (squeezing) return-proof clip without holding plunger head. It may cause serious injuries. Always hold plunger head when removing.

NOTE:
• Stop the plunger in the fully extended position by using the return-proof clip (1) if the stopper pin is removed.
• Push the plunger (2) into the tensioner body while squeezing the return-proof clip (1). Secure it using stopper pin (3).



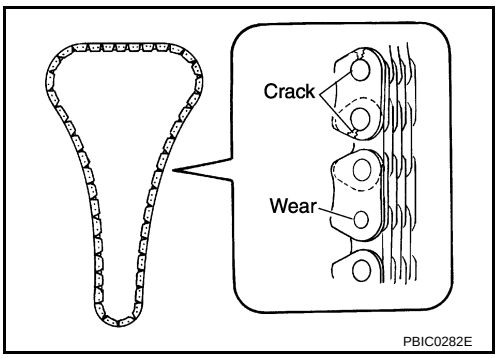
11. Remove the timing chain tension guide and timing chain slack guide.
12. Remove the timing chain and crankshaft sprocket.
13. Loosen the camshaft sprocket bolts as shown and remove the camshaft sprocket.
    CAUTION:
    To avoid interference between valves and pistons, do not turn crankshaft or camshaft when timing chain is disconnected.
14. Repeat the same procedure to remove the RH timing chain and associated parts.



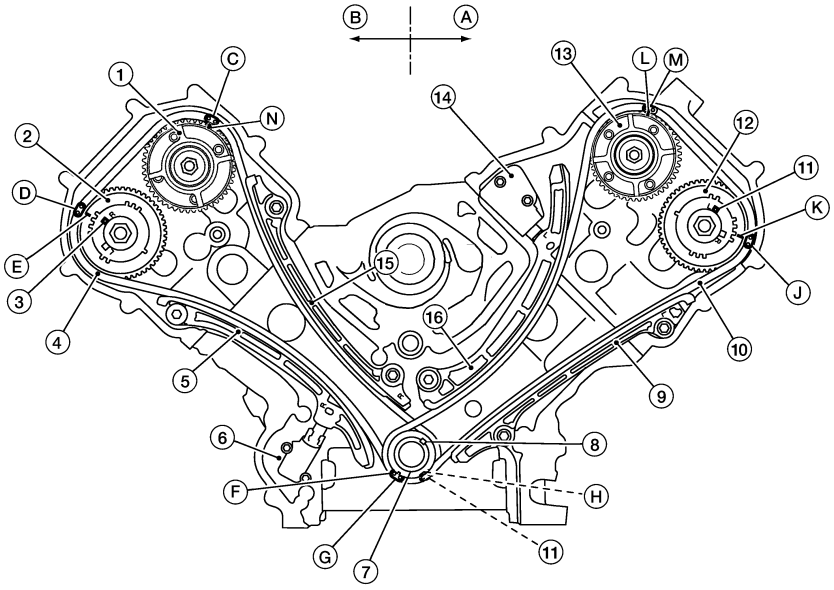
INSPECTION AFTER REMOVAL

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

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



INSTALLATION

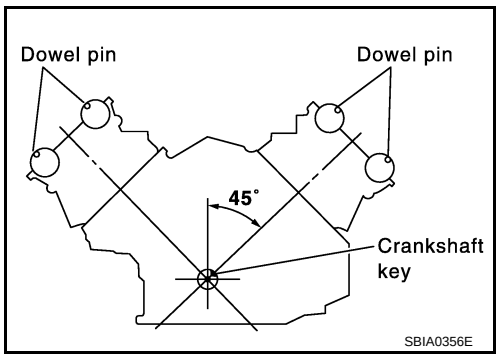


1.	RH bank Camshaft sprocket (INT) (VTC)	2.	RH bank Camshaft sprocket (EXH)	3.	RH bank camshaft dowel pin
4.	Timing chain	5.	RH bank Timing chain slack guide	6.	Primary timing chain tensioner
7.	Crankshaft sprocket	8.	Crankshaft key	9.	LH Timing chain tension guide
10.	Timing chain	11.	LH Camshaft dowel pin	12.	LH bank Camshaft sprocket (EXH)
13.	LH bank Camshaft sprocket (INT) (VTC)	14.	Secondary timing chain tensioner	15.	RH bank timing chain tension guide
16.	LH timing chain slack guide	A.	LH bank	B.	RH bank
C.	Alignment mark (Link color: copper)	D.	Alignment mark (Link color: copper)	E.	Alignment mark (Identification mark)
F.	Alignment mark for LH bank (Notch)	G.	Alignment mark for LH bank (Link color: Yellow)	H.	Alignment mark for RH bank (Link color: Yellow)
J.	Alignment mark (Link color: copper)	K.	Alignment mark (Identification mark)	L.	Alignment mark (Identification mark)
M	Alignment mark (Link color: copper)	N.	Alignment mark (Identification mark)		

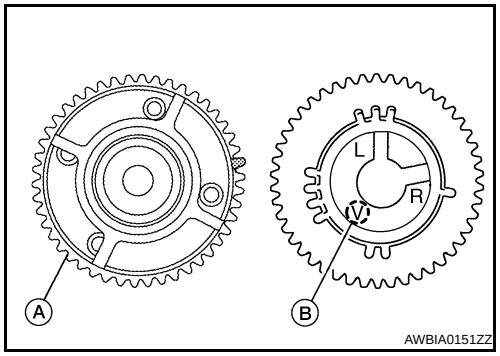
NOTE:

- The above figure shows the relationship between the mating mark on each timing chain and that of the corresponding sprocket, with the components installed.
- To install the timing chain and associated parts, start with those on the RH bank. The procedure for installing parts on the LH bank is omitted because it is the same as that for installation on the RH bank.

1. Make sure the crankshaft key and RH bank camshaft dowel pin and LH bank camshaft dowel pin are facing in the direction shown.

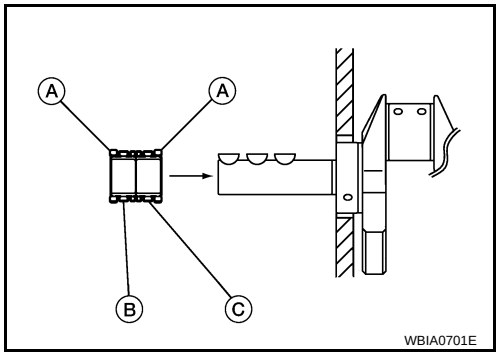


2. Install the camshaft sprockets.
   - Install the intake camshaft sprocket (VTC) (A) and exhaust camshaft sprockets (B) by selectively using the groove of the dowel pin according to the bank. (Common part used for both exhaust banks.)
   - Lock the hexagonal part of the camshaft in the same way as for removal, and tighten the bolts.
   - A : Intake
   - B = V: Exhaust



3. Install the crankshaft sprockets for both banks.
   - Install LH bank crankshaft sprocket (B) and RH bank crankshaft sprocket (C) so that their flange side (A) (the larger diameter side without teeth) faces in the direction shown.

   NOTE:
   The same parts are used but facing directions are different.

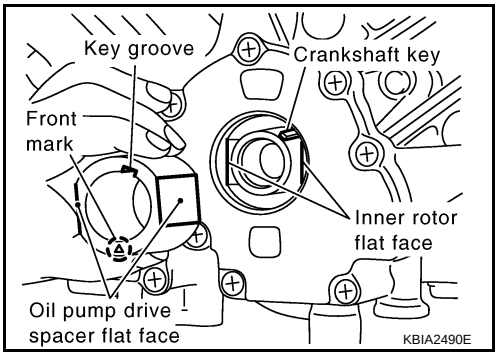


4. Install the timing chains and associated parts.
   - Align the alignment mark on each sprocket and the timing chain for installation.

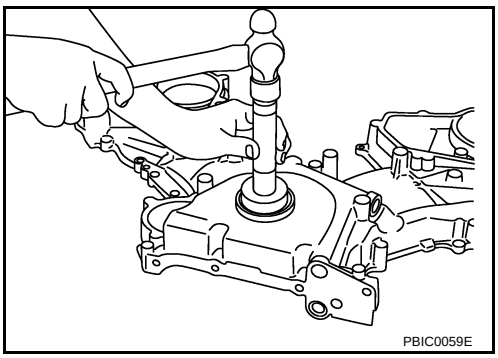
   CAUTION:
   - **Before installing timing chain tensioner, it is possible to change the position of alignment mark on timing chain and each sprocket. After the alignment marks are aligned, keep them aligned by holding them by hand.**
   - Install the slack guides and tension guides onto the correct side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

   CAUTION:
   - **Before and after the installation of the timing chain tensioner, make sure that the alignment mark on the timing chain is not out of alignment.**
   - **After installing the timing chain tensioner, remove the stopper pin to release the tensioner. Make sure the tensioner is released.**
   - **To avoid chain-link skipping of the timing chain, do not move crankshaft or camshafts until the front cover is installed.**
5. In the same way as for the RH bank, install the timing chain and associated parts on the LH bank.
6. Install the oil pump.

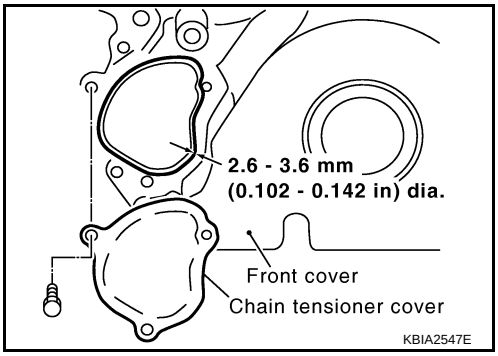
7. Install the oil pump drive spacer as follows:
   - Install so that the front mark on the front edge of the oil pump drive spacer faces the front of the engine.
   - Insert the oil pump drive spacer according to the directions of the crankshaft key and the two flat surfaces of the oil pump inner rotor.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



8. Install the front oil seal using suitable tool.
   CAUTION:
   Do not scratch or make burrs on the circumference of the oil seal.

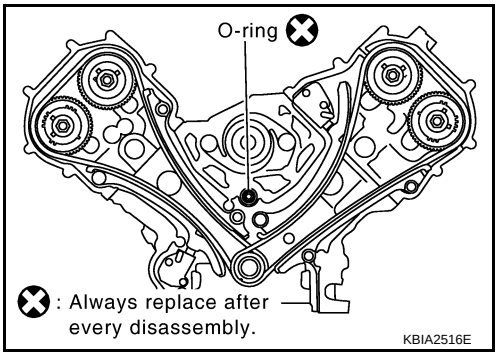


9. Install the chain tensioner cover.
   - Apply liquid gasket as shown.
     Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".



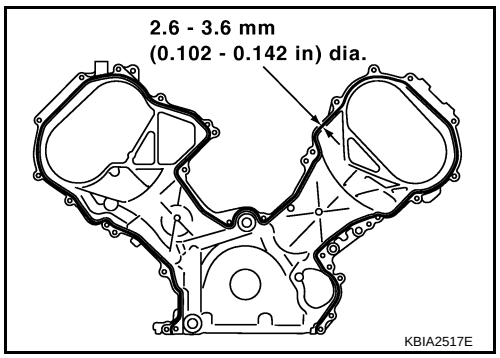
10. Install the front cover as follows:

a. Install a new O-ring on the cylinder block.



b. Apply liquid gasket as shown.
Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".

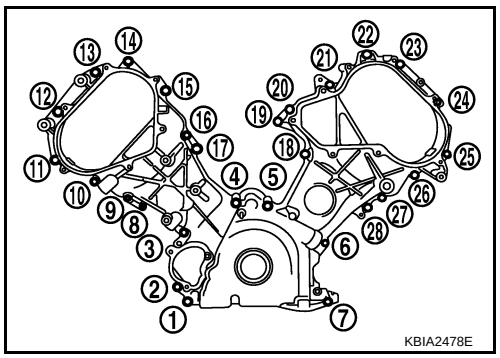
c. Check again that the timing alignment marks on the timing chain and on each sprocket are aligned. Then install the front cover.



d. Install the bolts in the numerical order shown.

M6 × 50 mm (1.97 in) : No. 1, 20, 25, 26, 27
M6 × 80 mm (3.15 in) : No. 4, 5, 7
M6 × 20 mm (0.79 in) : Except the above

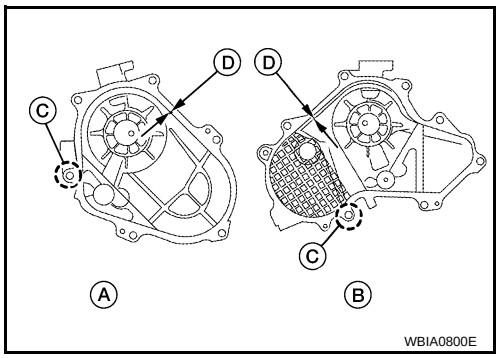
e. After tightening, re-tighten to the specified torque.
CAUTION:
Be sure to wipe off any excessive liquid gasket leaking onto surface mating with oil pan.



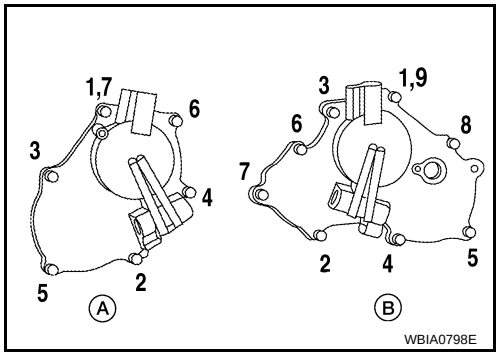
11. Install the Intake valve control solenoid valve cover (RH) (A) and Intake valve control solenoid valve cover (LH) (B) as follows:
• *: Cross mark (C) that can not be seen after assembly

D : 2.6 - 3.6 mm (0.102 - 0.142 in) dia.

a. Apply liquid gasket (D) as shown.
Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".
CAUTION:
The start and end of the application of the liquid gasket should be crossed at a position that cannot be seen after attaching the Intake valve control solenoid valve cover.



b. Install the bolts in the numerical order shown.

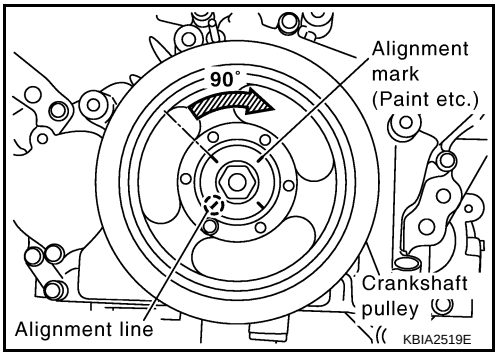


12. Install the crankshaft pulley.
• Install the key of the crankshaft.
• Insert the pulley by lightly tapping it.
CAUTION:
Do not tap pulley on the side surface where the belt is installed (outer circumference).

13. Tighten the crankshaft pulley bolt.
• Lock the crankshaft using suitable tool, then tighten the bolt.
• Perform the following steps for angular tightening:

a. Apply engine oil onto the threaded parts of the bolt and seating area.

b. Select the one most visible notch of the four on the bolt flange. Corresponding to the selected notch, put a alignment mark (such as paint) on the crankshaft pulley.



Crankshaft pulley bolt torque

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

Step 2 : additional 90° (angle tightening)

14. Rotate the crankshaft pulley in normal direction (clockwise when viewed from engine front) to check for parts interference.
15. Installation of the remaining components is in the reverse of 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-10, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.

  NOTE:

  If hydraulic pressure inside 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 fluid, power steering fluid, brake fluid, etc.

CAMSHAFT

Components

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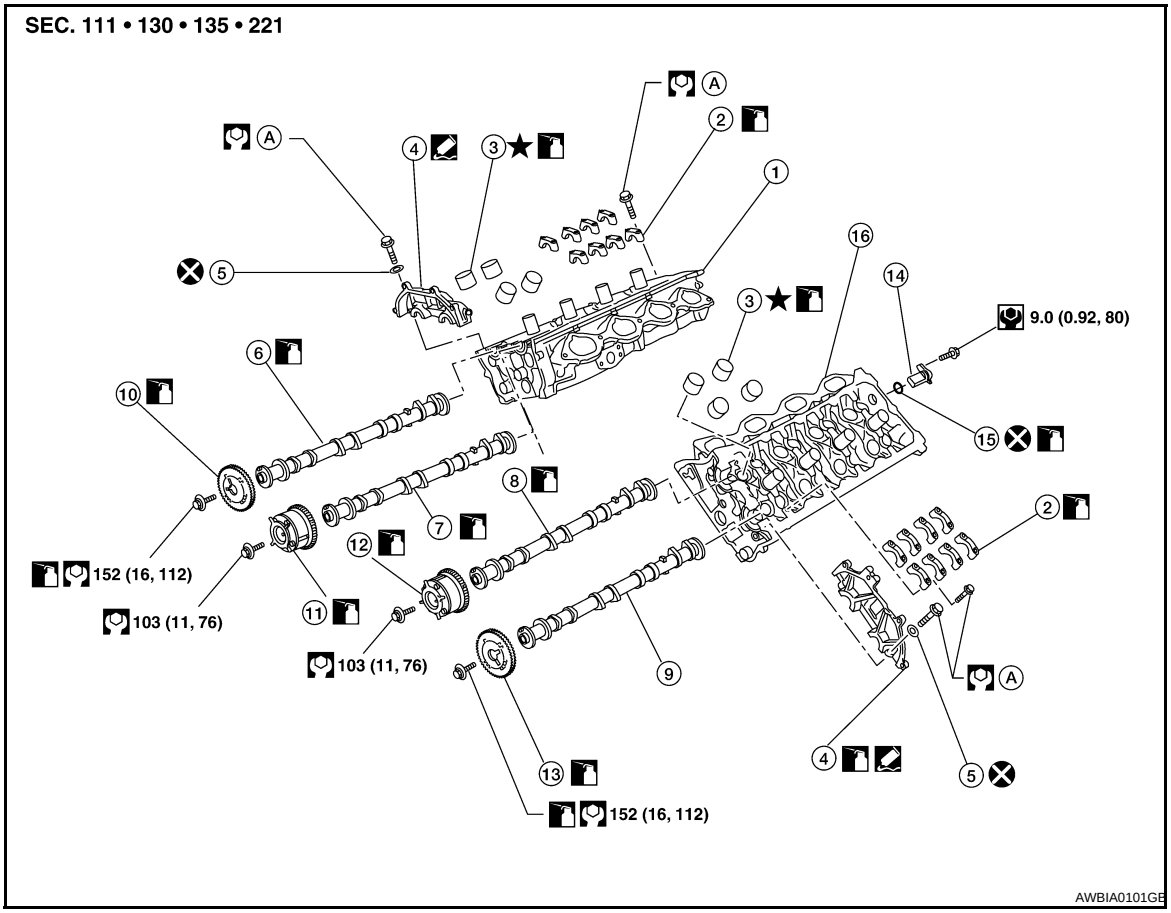

1. Cylinder head RH bank	2. Camshaft bracket (No. 2, 3, 4, 5)	3. Valve lifter
4. Camshaft bracket (No. 1)	5. Seal washer	6. Camshaft RH bank (EXH)
7. Camshaft RH bank (INT)	8. Camshaft LH bank (INT)	9. Camshaft LH bank (EXH)
10. Camshaft sprocket RH bank (EXH)	11. Camshaft sprocket RH bank (INT) (VTC)	12. Camshaft sprocket LH bank (INT) (VTC)
13. Camshaft sprocket LH bank (EXH)	14. Camshaft position sensor (PHASE)	15. O-ring
16. Cylinder head LH bank	A. Refer to EM-193	

Removal and Installation

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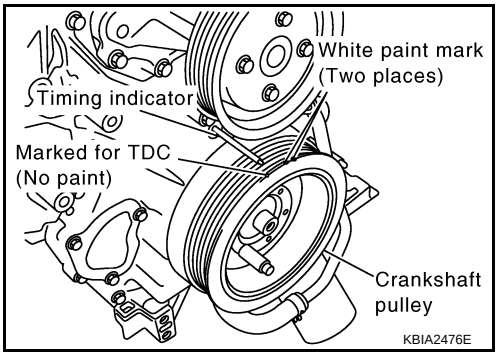
NOTE:
Do not remove the engine assembly to perform this procedure.

REMOVAL

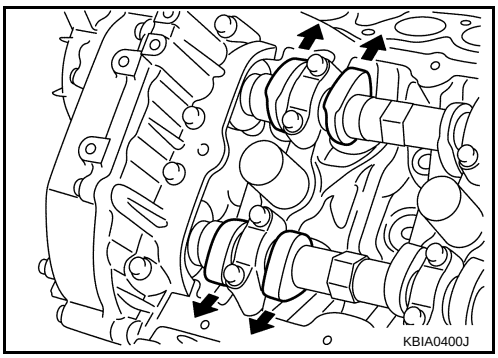
1. Remove the RH bank and LH bank rocker covers. Refer to EM-178, "Removal and Installation".

2. Obtain compression TDC of No. 1 cylinder as follows:

a. Turn the crankshaft pulley clockwise to align the TDC identification notch (without paint mark) with the timing indicator on the front cover.



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



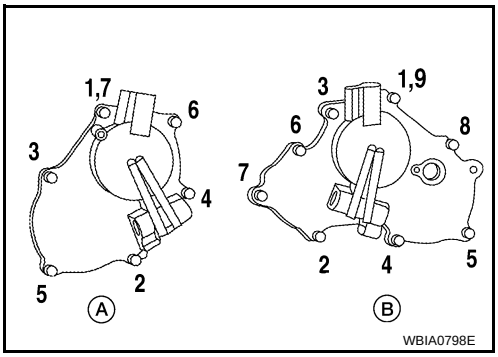
3. Remove the intake valve control solenoid cover RH bank (A) and intake valve control solenoid cover LH bank (B) as follows:

a. Loosen and remove the bolts as shown.

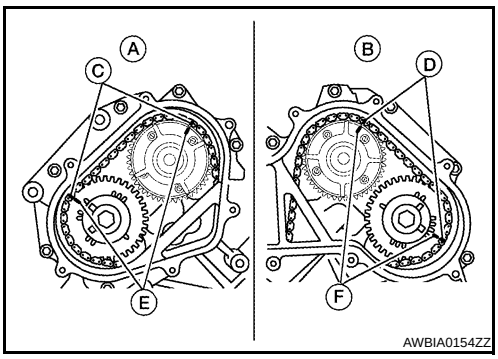
b. Cut the liquid gasket and remove the covers using Tool.

Tool number : KV10111100 (J-37228)

CAUTION:
Do not damage mating surfaces.



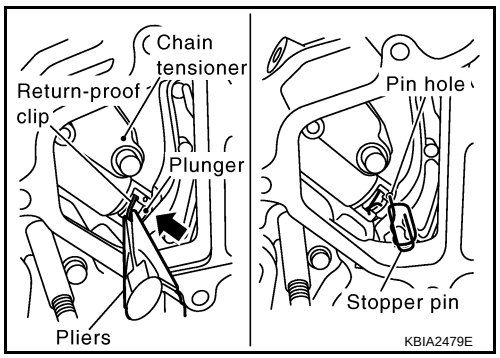
4. Paint alignment marks on the RH bank (A) timing chain links (C) and LH bank (B) timing chain links (D) and align with the camshaft sprocket alignment marks (E) and (F).



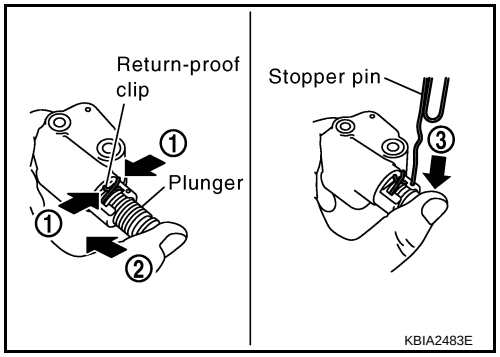
5. Remove the LH bank timing chain tensioner using the following steps.

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

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



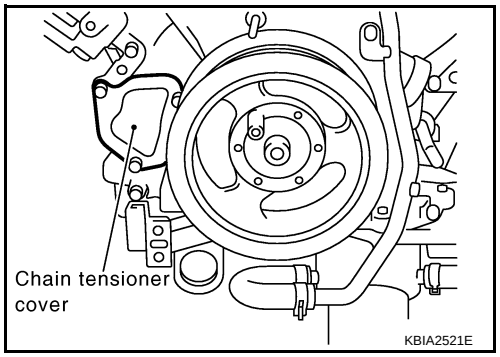
NOTE:
- Stop plunger in the fully extended position using return-proof clip (1) if stopper pin is removed.
- Push the plunger (2) into the tensioner body while squeezing the return-proof clip (1). Secure it using stopper pin (3).



6. Remove the RH bank timing chain tensioner cover from the front cover using Tool.

Tool number : KV10111100 (J-37228)

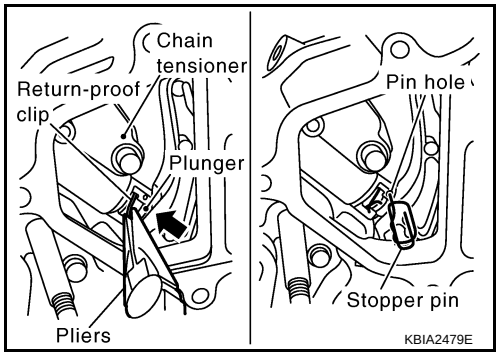
CAUTION:
Do not damage mating surfaces.



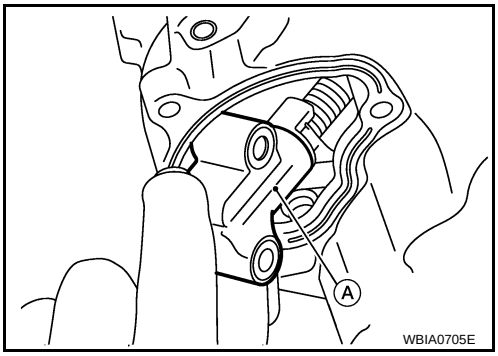
7. Remove the RH bank timing chain tensioner using the following steps.

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

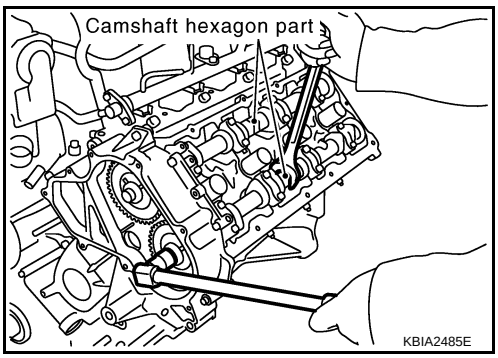
a. Squeeze return-proof clip ends using suitable tool and push the plunger into the tensioner body.
b. Secure plunger using stopper pin.
   • Stopper pin is made from hard wire approximately 1 mm (0.04 in) in diameter.



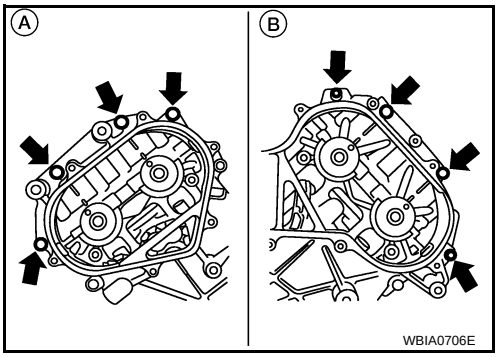
c. Remove the bolts and the RH bank timing chain tensioner (A).
NOTE:
If it is difficult to push plunger on RH bank timing chain tensioner (A), remove the plunger under extended condition.



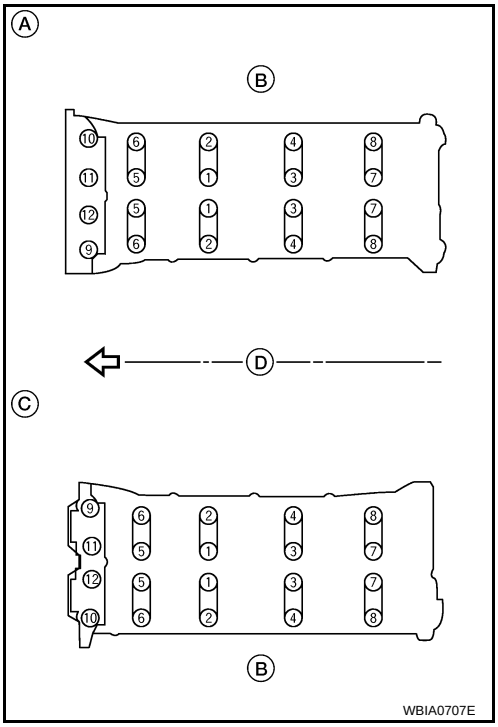
8. Loosen camshaft sprocket bolts as shown and remove camshaft sprockets.
CAUTION:
To avoid interference between valves and pistons, do not turn crankshaft or camshaft with timing chain disconnected.



9. Remove the RH (A) front cover bolts and LH (B) front cover bolts.



10. Remove RH (A) camshaft bracket bolts and LH (C) camshaft bracket bolts in the reverse of order shown to remove camshaft brackets.
- Remove No. 1 camshaft bracket.
NOTE:
The bottom and front surface of bracket will be stuck because of liquid gasket.
- ⇐: Engine front
- B: Exhaust side
- D: Intake side



11. Remove the camshaft.
12. Remove the valve lifters if necessary.
    - Correctly identify location where each part is removed from. Keep parts organized to avoid mixing them up.

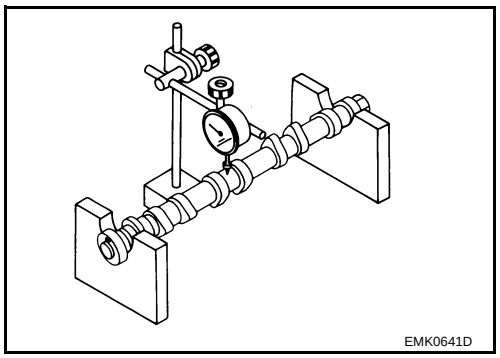
INSPECTION AFTER REMOVAL

Camshaft Runout

1. Put V block on precise flat work bench, and support No. 1 and No. 5 journals of the camshaft.
2. Set dial indicator vertically to No. 3 journal.
3. Turn the camshaft to one direction, and measure the camshaft runout on dial indicator (total indicator reading).

Camshaft runout : Less than 0.02 mm (0.0008 in)

- If measurement exceeds specification, replace the camshaft.

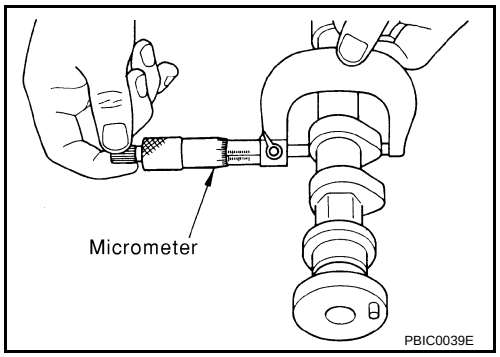

EMK0641D

Camshaft Cam Height

- Measure the camshaft cam height.

Standard cam height (intake)	**: 44.865 - 45.055 mm (1.7663 - 1.7738 in)**
Standard cam height (exhaust)	**: 45.075 - 45.265 mm (1.7746 - 1.7821 in)**
Cam wear limit (intake & exhaust)	**: 0.02 mm (0.0008 in)**

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



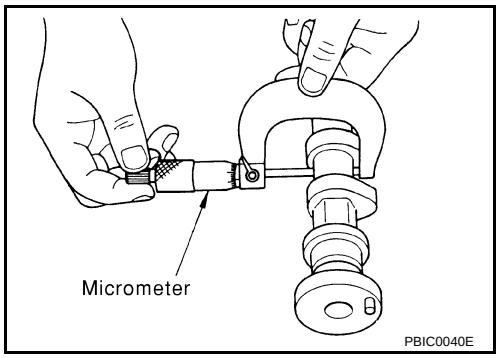
PBIC0039E

Camshaft Journal Clearance

Camshaft Journal Diameter

- Measure the diameter of the camshaft journal.

Standard diameter : 25.950 - 25.970 mm (1.0217 - 1.0224 in)



PBIC0040E

Camshaft Bracket Inner Diameter

- Tighten the camshaft bracket bolt to the specified torque.
- Measure the inner diameter (A) of the camshaft bracket.

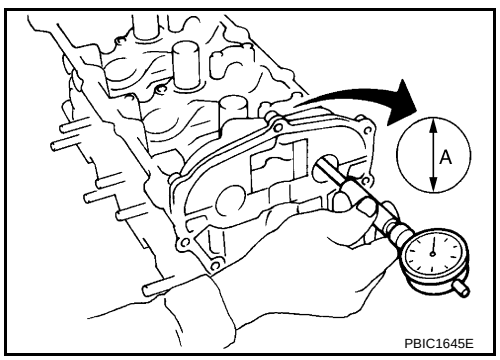
Standard : 26.000 - 26.021 mm (1.0236 - 1.0244 in)

Calculation of Camshaft Journal Clearance

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

Standard : 0.030 - 0.071 mm (0.0012 - 0.0028 in)

- If measurement is not within specification, replace either or both camshaft and cylinder head.



PBIC1645E

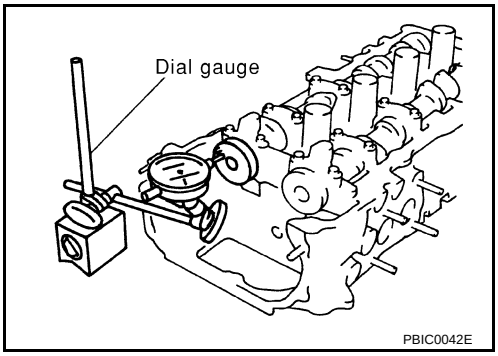
NOTE:
The inner diameter of the camshaft bracket is manufactured together with the cylinder head. Replace the whole cylinder head as an assembly.

Camshaft End Play

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

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

- If measurement is out of the specified range, replace the camshaft and measure again.
- If measurement is still out of the specified range, replace the cylinder head.



- Measure the following parts if end play is outside the specified value.

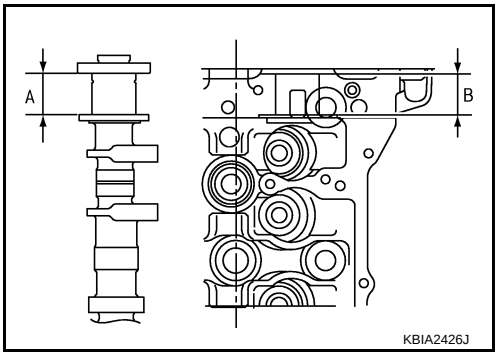
- Dimension ″A″ for camshaft No. 1 journal

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

- Dimension ″B″ for cylinder head No. 1 journal

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

- If measurements are not within specification, replace the camshaft and/or cylinder head.

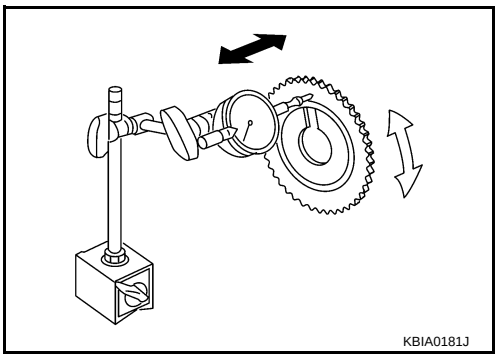


Camshaft Sprocket Runout

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

Runout : Less than 0.15 mm (0.0059 in)

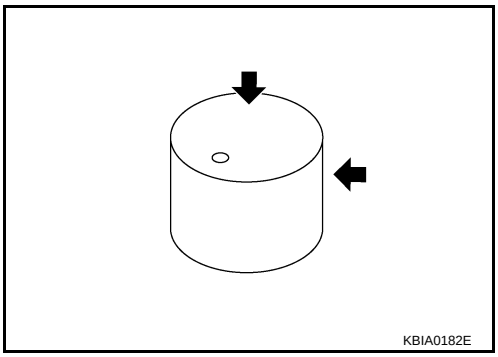
- If measurement exceeds the specification, replace the camshaft sprocket.



Valve Lifter

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

- If any damage is found, replace the valve lifter.
- Select the thickness of the head so that the valve clearance is within the standard when replacing. Refer to EM-202, "Inspection after Installation".

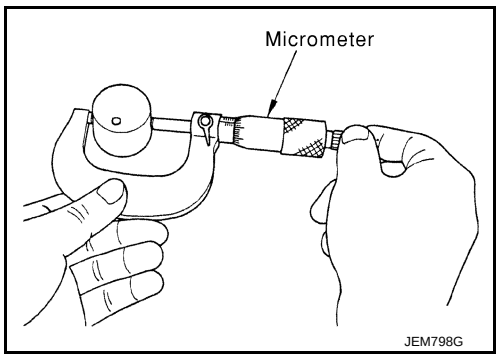


Valve Lifter Clearance

Valve Lifter Diameter

- Measure the diameter of the valve lifter.

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



Valve Lifter Hole Diameter

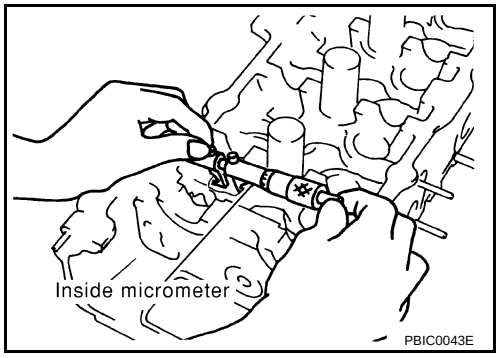
- Measure the diameter of the valve lifter hole of the cylinder head, using suitable tool.

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

Calculation of Valve Lifter Clearance

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

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

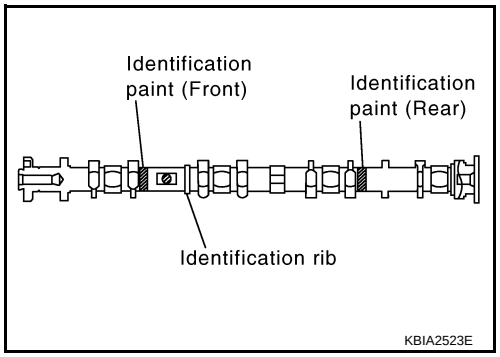


- If the measurement is not within specification, referring to each specification of the valve lifter diameter and hole diameter, replace either or both the valve lifter and cylinder head.

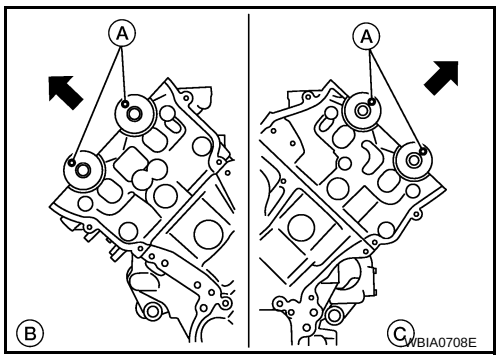
INSTALLATION

1. Install the valve lifters if removed.
   - Install removed parts in their original locations.
2. Install the camshafts. Use the table below for identification of the RH and LH, and intake and exhaust.

Bank	INT EXH	Identification paint (front)	Identification paint (rear)	Identification rib
RH	INT	Pink	—	Yes
	EXH	—	Orange	Yes
LH	INT	Pink	—	No
	EXH	—	Orange	No

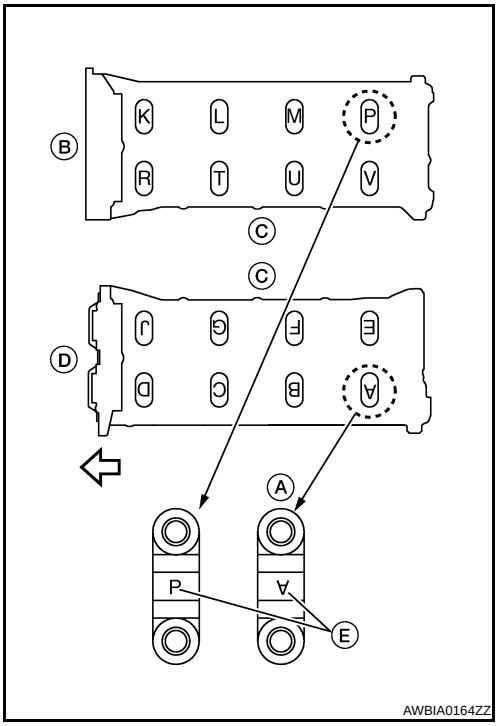


- Install so that the RH bank (B) dowel pins (A) and LH bank (C) dowel pins (A) at the front of the camshaft face are in the direction shown.



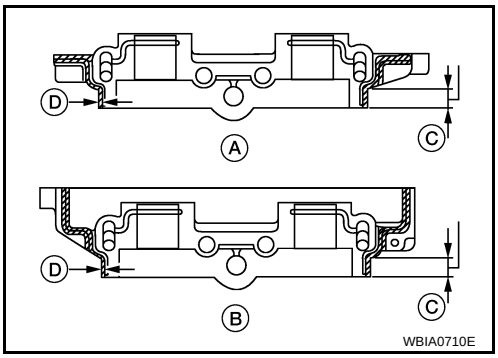
3. Install the RH bank (B) and LH bank (D) camshaft brackets (A).
   - Install by referring to the installation location mark (E) on the upper surface.
   - Install so that the installation location mark (E) can be correctly read when viewed from the intake manifold side (C).

   ⇐ : **Front**

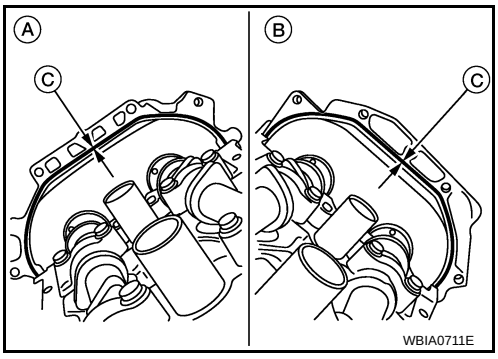


- Install No. 1 camshaft bracket using the following procedure:
- C:11 mm (0.43 in)
- D: 2.0 - 3.0 mm (0.079 - 0.118 in) dia.

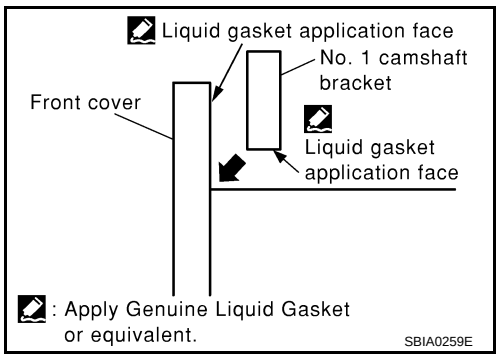
- Apply liquid gasket to No. 1 camshaft bracket (A) and (B) as shown.
  Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".
  CAUTION:
  - **After installation, be sure to wipe off any excessive liquid gasket outside of application (C) and (D) both on RH and LH sides.**
  - **Remove completely any excess of liquid gasket inside bracket.**



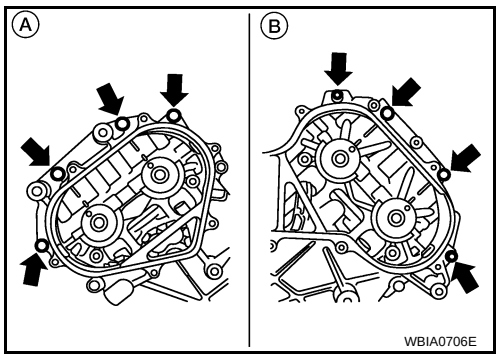
- Apply liquid gasket (C) to the back side of the LH (A) bank front cover and RH (B) bank front cover as shown.
  Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".
- C: 2.6 - 3.6 mm (0.102 - 0.142 in) dia.



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



- Temporarily tighten the RH (A) and LH (B) front cover bolts (4 for each bank) as shown.

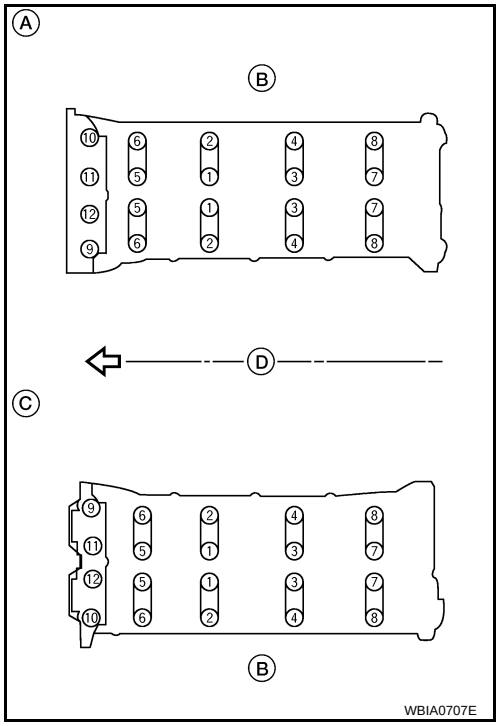


4. Tighten the camshaft bracket bolts as follows:

Camshaft bracket bolts

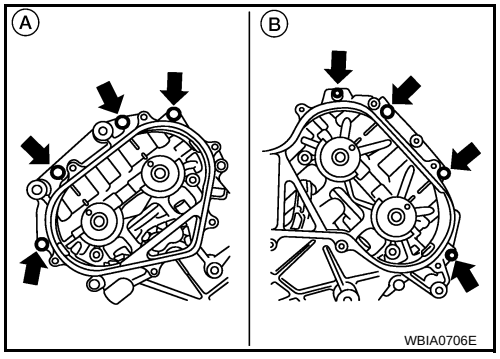
Step 1 (bolts 9 - 12)	**: 2.0 N·m (0.2 kg-m, 17 in-lb)**
Step 2 (bolts 1 - 8)	**: 2.0 N·m (0.2 kg-m, 17 in-lb)**
Step 3 (all bolts)	**: 5.9 N·m (0.6 kg-m, 52 in-lb)**
Step 4 (all bolts)	**: 10.4 N·m (1.1 kg-m, 92 in-lb)**

CAUTION:
After tightening the camshaft bracket bolts, be sure to wipe off excessive liquid gasket from the parts listed below.
- **Mating surface of rocker cover**
- **Mating surface of front cover**
- A: RH bank
- B: Exhaust side
- C: LH bank
- D: Intake side
- ⇐: Front



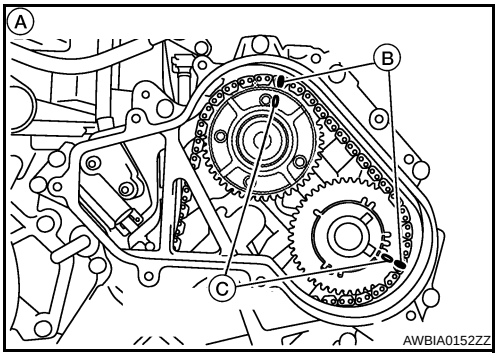
a. Tighten the RH (A) and LH (B) front cover bolts (4 for each bank) as shown to the specified torque.

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



5. Install the camshaft sprockets using the following procedure:
   - A: LH bank shown

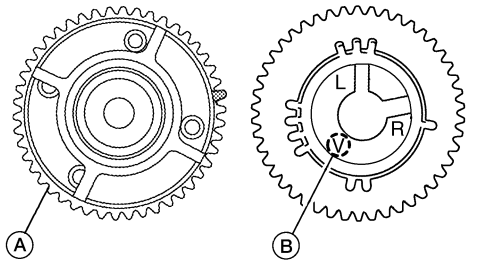
a. Install the camshaft sprockets aligning them with the matching marks painted on the timing chain (B) and the camshaft sprockets (C) before removal. Align the camshaft sprocket key groove with the dowel pin on the camshaft front edge at the same time. Then temporarily tighten camshaft sprocket bolts.



   - Install the intake VTC (A) and exhaust (B) side camshaft sprockets by selectively using the groove of the dowel pin according to the bank for the exhaust (B) side camshaft sprockets. (Common part used for both exhaust banks.)
   - A: Intake (VTC)
   - B: Exhaust
   - R: for RH bank
   - L: for LH bank

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

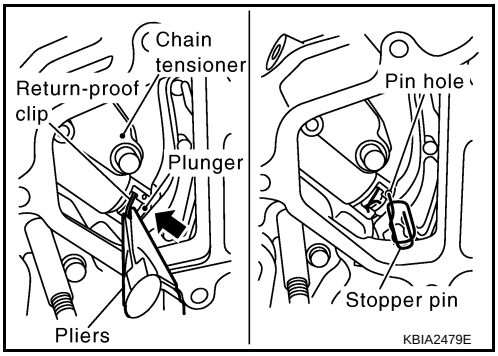
c. Check again that the timing alignment mark on the timing chain and on each sprocket are aligned.



6. Install the chain tensioner using the following procedure:
   NOTE:
   LH is shown.

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

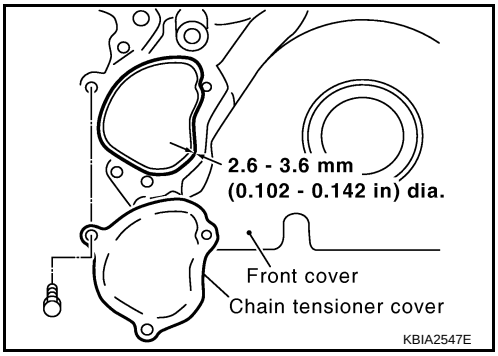
Chain tensioner bolts : 6.9 N·m (0.70 kg-m, 61 in-lb)



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

c. Install the RH bank timing chain tensioner cover onto the front cover.
   - Apply liquid gasket as shown.
     Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".

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



7. Check and adjust valve clearances. Refer to EM-202, "Inspection after Installation".

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

Inspection after Installation

INFOID:0000000001683807

INSPECTION OF CAMSHAFT SPROCKET (INT) OIL GROOVE

CAUTION:

- **Perform this inspection only when DTC P0011 is detected in self-diagnostic results of CONSULT III and it is directed according to inspection procedure of EC section. Refer to EC-573, "Component Inspection".**
- **Check when engine is cold so as to prevent burns from any splashing engine oil.**

1. Check engine oil level. Refer to LU-24, "Inspection".
2. Perform the following procedure so as to prevent the engine from being unintentionally started while checking.

a. Release fuel pressure. Refer to EC-948, "Fuel Pressure Check".
b. Disconnect ignition coil and injector harness connectors if practical.

3. Remove IVT control solenoid valve.
4. Crank engine, and then make sure that engine oil comes out from IVT control cover oil hole. End cranking after checking.

WARNING:
Be careful not to touch rotating parts (drive belts, idler pulley, and crankshaft pulley, etc.).
CAUTION:
- **Engine oil may squirt from IVT control solenoid valve installation hole during cranking. Use a shop cloth to prevent engine oil from splashing on worker, engine components and vehicle.**
- **Do not allow engine oil to get on rubber components such as drive belts or engine mount insulators. Immediately wipe off any splashed engine oil.**

5. Clean oil groove between oil strainer and IVT control solenoid valve if engine oil does not come out from IVT control valve cover oil hole. Refer to LU-23, "System Chart".
6. Remove components between IVT control solenoid valve and camshaft sprocket (INT), and then check each oil groove for clogging.
   - Clean oil groove if necessary.
7. After inspection, installation of the remaining components is in the reverse order of removal.

OIL SEAL

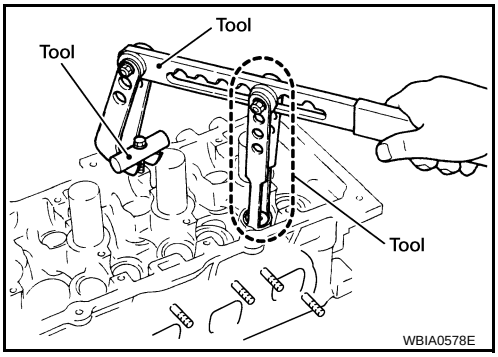
Removal and Installation of Valve Oil Seal

INFOID:0000000001282030

REMOVAL

1. Remove the camshaft relating to the valve oil seal to be removed. Refer to EM-193, "Removal and Installation".
2. Remove the valve lifters. Refer to EM-193, "Components".
   - Correctly identify the location where each part is removed from. Keep parts organized to avoid mixing them up.
3. Turn the crankshaft until the cylinder requiring new oil seals is at TDC. This will prevent the valve from dropping into the cylinder.
4. Remove the valve collet using Tool.

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



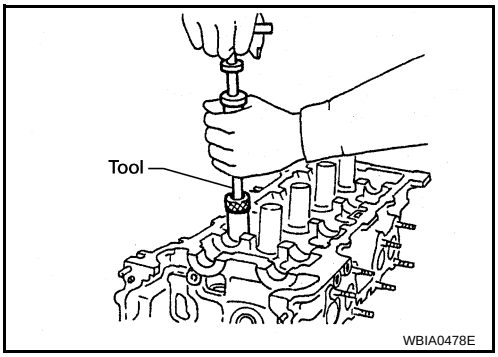
CAUTION:
Do not damage the valve lifter holes.

5. Remove the valve spring retainer and valve spring.

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

6. Remove the valve oil seal using Tool.

Tool number : KV10107902 (J-38959)



INSTALLATION

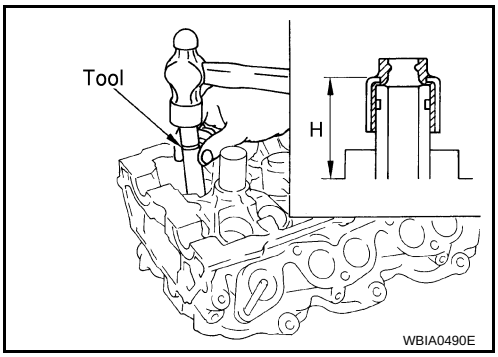
Installation is in the reverse order of removal.

- Install the valve oil seal using Tool.

Tool number : KV10115600 (J-38958)

- Apply new engine oil on the new valve oil seal joint and seal lip.
- Install the valve oil seal to the specified height "H".

Height "H" (without valve spring installed)
Intake and exhaust : 14.3 - 14.9 mm (0.563 - 0.587 in)



Removal and Installation of Front Oil Seal

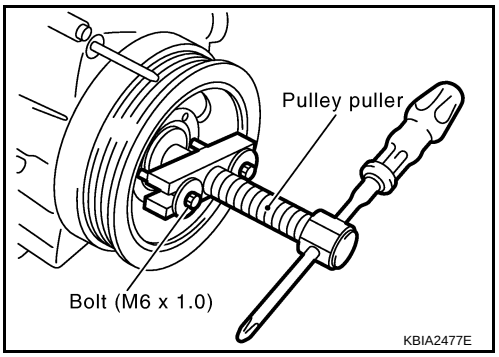
INFOID:0000000001282031

REMOVAL

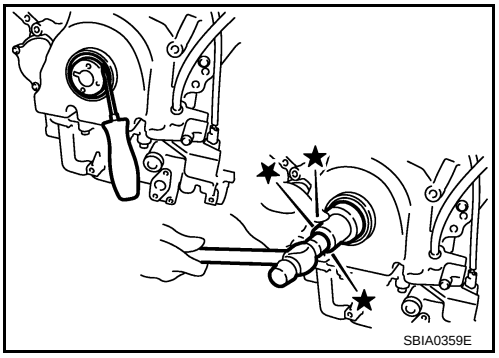
1. Remove the air dam using power tool.
2. Remove the engine undercover using power tool.
3. Remove the air duct and resonator assembly and the air cleaner case (upper). Refer to EM-165, "Removal and Installation".

4. Remove the radiator assembly. Refer to CO-43, "Removal and Installation".
5. Remove the cooling fan (crankshaft driven type). Refer to CO-46, "Removal and Installation (Crankshaft Driven Type)".
6. Remove the crankshaft pulley.

a. Remove the crankshaft pulley from the crankshaft using suitable tool.
   - Set the bolts in the two bolt holes [M6 x 1.0 mm (0.04 in)] on the front surface.
   NOTE:
   The dimension between the centers of the two bolt holes is 61 mm (2.40 in).

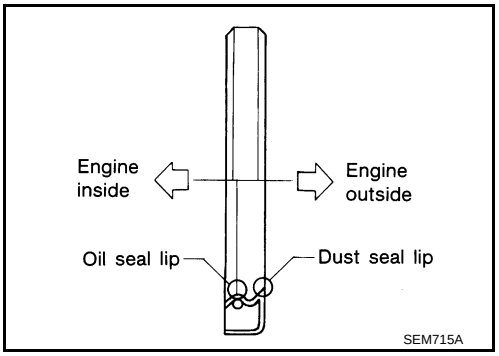


7. Remove the front oil seal using suitable tool.
   CAUTION:
   Do not damage front cover and oil pump drive spacer.

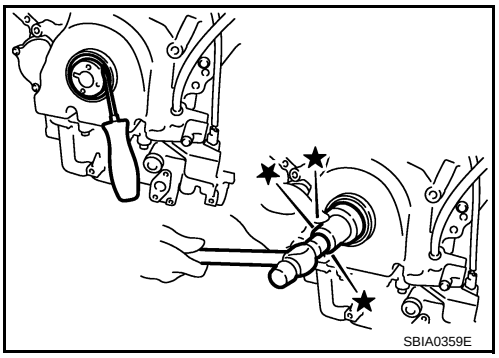


INSTALLATION

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



   - Press-fit until the front oil seal is level with the front cover using suitable tool.
   CAUTION:
   - **Do not damage front cover and crankshaft.**
   - **Press-fit straight and avoid causing burrs or tilting oil seal.**



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

Removal and Installation of Rear Oil Seal

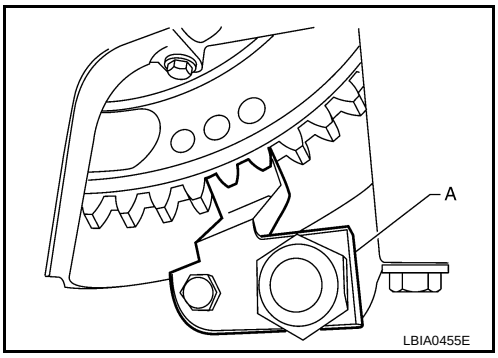
INFOID:0000000001282032

REMOVAL

1. Remove the transmission assembly. Refer to TM-225, "2WD : Removal and Installation" (2WD models) or TM-228, "4WD : Removal and Installation" (4WD models).
2. Lock the drive plate using Tool A.

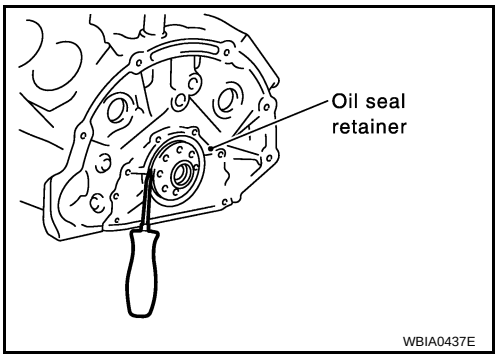
Tool number : — (J-47245)

CAUTION:
- **Do not damage the drive plate. Especially, avoid deforming and damaging the signal plate teeth (circumference position).**
- **Keep magnetic materials away from signal plate.**



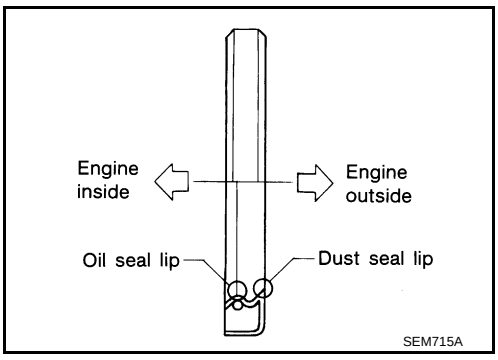
3. Remove the drive plate.
CAUTION:
Place the drive plate with the signal plate surface facing upward.
NOTE:
Remove the bolts diagonally.

4. Remove the rear oil seal using suitable tool.
CAUTION:
Do not damage crankshaft or oil seal retainer surface.

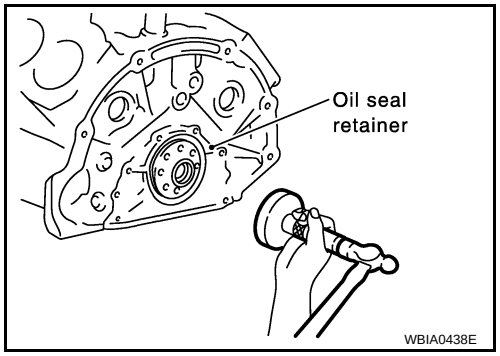


INSTALLATION

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



- Press-fit the rear oil seal using suitable tool.
  CAUTION:
  - **Do not damage the crankshaft or oil seal retainer.**
  - **Press-fit the oil seal straight to avoid causing burrs or tilting.**
  - **Do not touch grease applied onto the oil seal lip.**
  - **Do not damage or scratch the outer circumference of the rear oil seal.**
- Tap until flush with the front edge of the oil seal retainer.

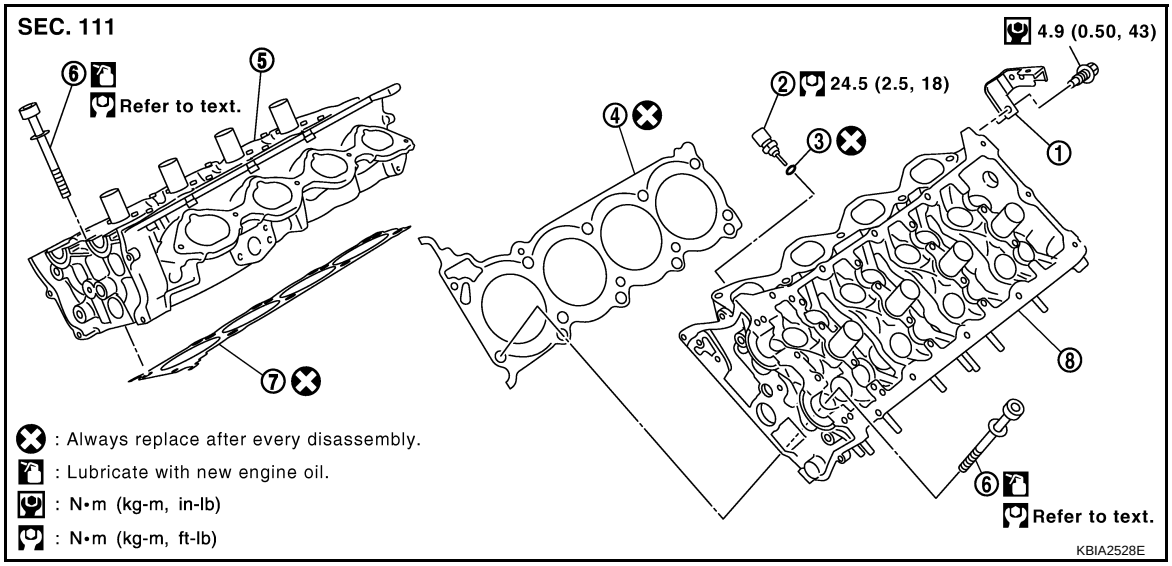


3. Installation of the remaining components is in the reverse order of removal.

CYLINDER HEAD

Removal and Installation

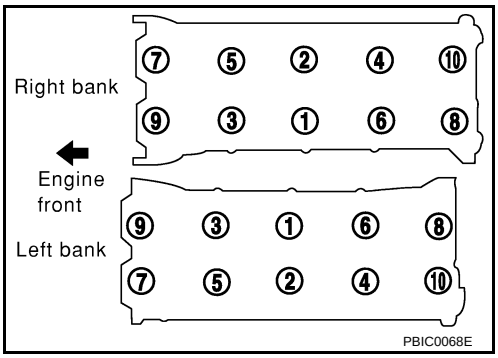
INFOID:0000000001282034



1. Harness bracket
2. Engine coolant temperature sensor
3. Washer
4. Cylinder head gasket (LH)
5. Cylinder head (RH)
6. Cylinder head bolt
7. Cylinder head gasket (RH)
8. Cylinder head (LH)

REMOVAL

1. Remove the engine assembly from the vehicle. Refer to EM-218, "Removal and Installation".
2. Remove the following components and related parts:
   - Drive belt auto tensioner drive belts and idler pulley. Refer to EM-153, "Removal and Installation"
   - Thermostat housing and water piping. Refer to CO-51, "Removal and Installation".
   - Fuel tube and fuel injector assembly. Refer to EM-180, "Removal and Installation".
   - Starter. Refer to STR-17, "Removal and Installation".
   - Rocker cover. Refer to EM-178, "Removal and Installation".
   - Generator and generator bracket. Refer to CHG-21, "Removal and Installation".
   - Oil pan and oil strainer. Refer to EM-173, "Removal and Installation".
3. Remove the crankshaft pulley, front cover, oil pump, and timing chain. Refer to EM-185, "Removal and Installation".
4. Remove the camshaft sprockets and camshafts. Refer to EM-193, "Removal and Installation".
5. Remove the cylinder head bolts in reverse of order shown.



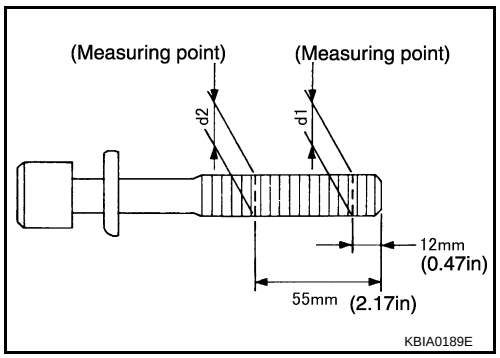
INSPECTION AFTER REMOVAL

Cylinder Head Bolts Diameter

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

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

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



INSTALLATION

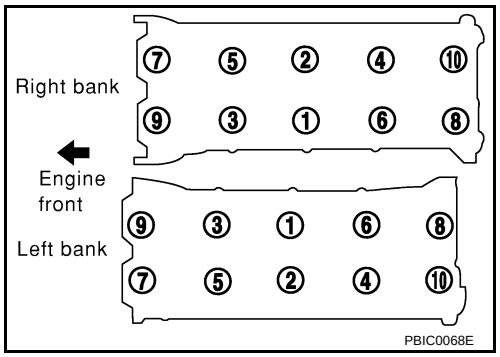
1. Install a new cylinder head gasket.
2. Install the cylinder head. Follow the steps below to tighten the bolts in the numerical order shown.

CAUTION:

- **If cylinder head bolts are re-used, check their diameters before installation. Follow the "Cylinder Head Bolts Diameter" procedure.**

a. Apply engine oil to threads and seating surface of the bolts.

Step a : 98.1 N·m (10 kg-m, 72 ft-lb)
Step b :Loosen in the reverse order of tightening.
Step c : 44.1 N·m (4.5 kg-m, 33 ft-lb)

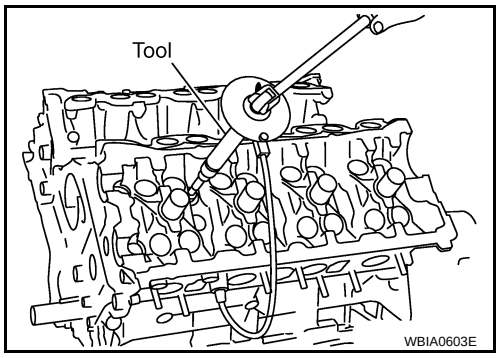


b. Measure the tightening angle using Tool.

Tool number : KV10112100 (BT-8653-A)

CAUTION:
Measure the tightening angle using Tool. Do not measure visually.

Step d : 60° clockwise
Step e : 60° clockwise



3. Installation of the remaining components 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-10, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.
- Turn ignition switch “ON” (with engine stopped). With fuel pressure applied to fuel piping, check for fuel leakage at connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- 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 fluid, power steering fluid, brake fluid, etc.

Disassembly and Assembly

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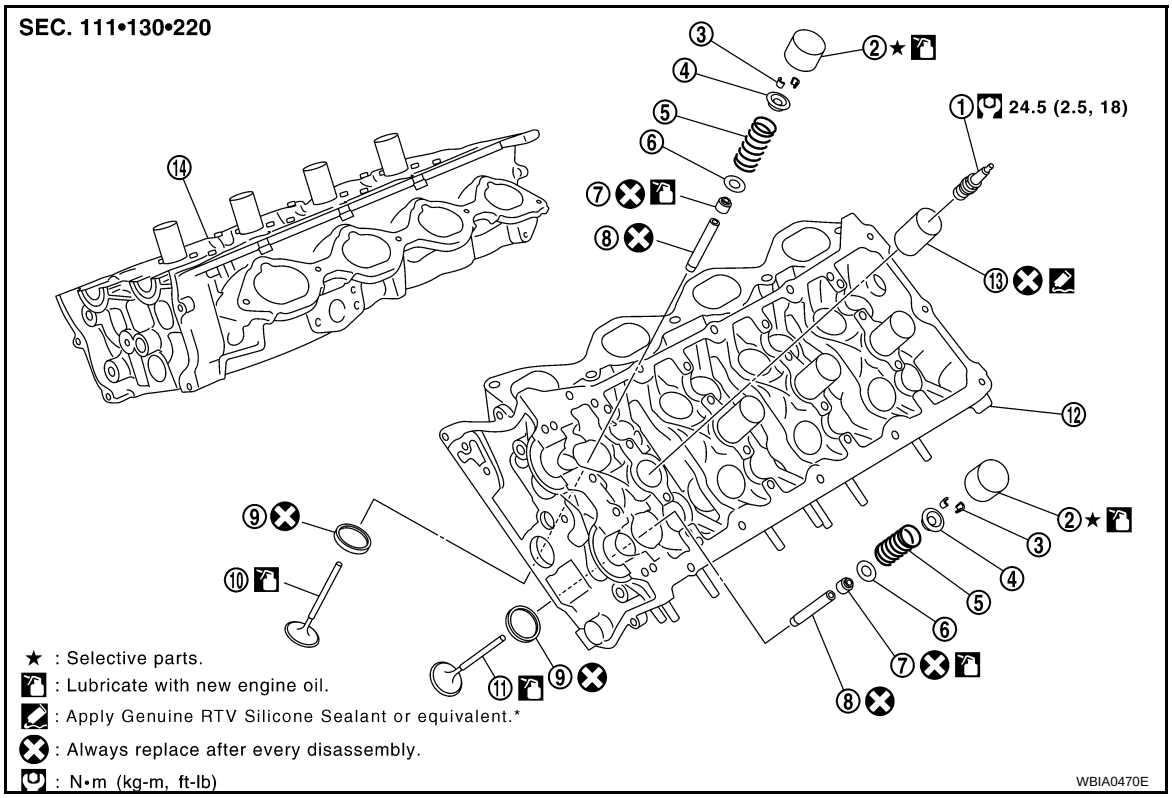
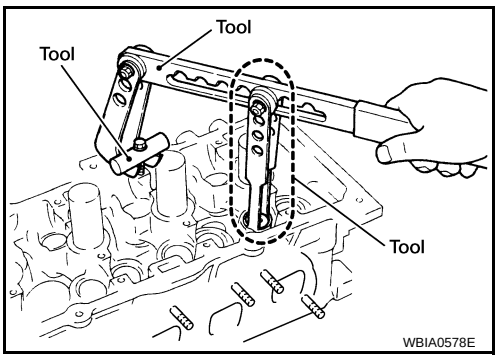


1. Spark plug
2. Valve lifter
3. Valve collet
4. Valve spring retainer
5. Valve spring
6. Valve spring seat
7. Valve oil seal
8. Valve guide
9. Valve seat
10. Valve (INT)
11. Valve (EXH)
12. Cylinder head (LH bank)
13. Spark plug tube
14. Cylinder head (RH bank)

DISASSEMBLY

1. Remove the spark plug. Refer to EM-156, "Removal and Installation".
2. Remove the valve lifter.
   • Identify the installation positions, and store them without mixing them up.
3. Remove the valve collet using Tool.

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

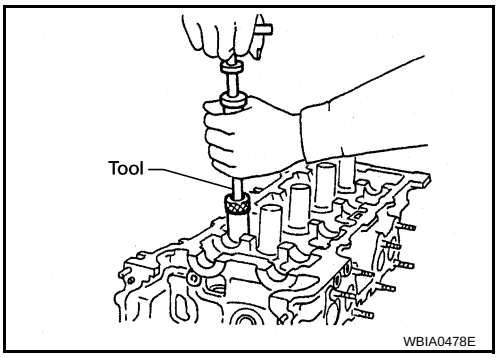


CAUTION:
When working, take care not to damage valve lifter holes.

4. Remove the valve spring retainer, valve spring and valve spring seat.
5. Inspect the valve guide clearance. Refer to EM-212, "Inspection After Disassembly".

6. Push the valve stem to the combustion chamber side, and remove the valve.
   • Identify the installation positions, and store them without mixing them up.
7. Remove the valve oil seal using Tool.

Tool number : KV10107902 (J-38959)



8. Replace the valve seat if necessary. Refer to EM-212, "Inspection After Disassembly".
9. Replace the valve guide if necessary. Refer to EM-212, "Inspection After Disassembly".
10. Remove the spark plug tube, as necessary.
    • Remove the spark plug tube out of the cylinder head using suitable tool.
    CAUTION:
    • **Do not damage the cylinder head.**
    • **Do not remove the spark plug tube unless absolutely necessary. Once removed, the spark plug tube will be deformed and cannot be reused.**

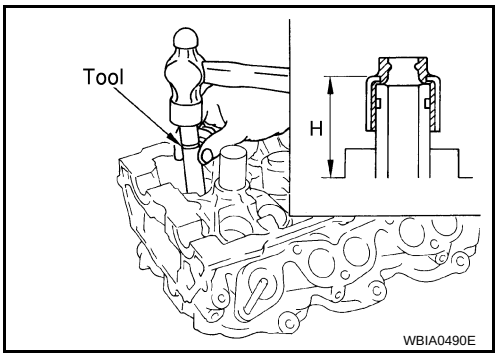
ASSEMBLY

1. Install the valve guide if necessary. Refer to EM-212, "Inspection After Disassembly".
2. Install the valve seat if necessary. Refer to EM-212, "Inspection After Disassembly".
3. Install the valve oil seal using Tool.

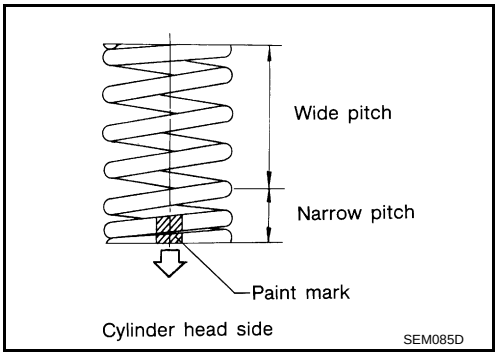
Tool number : KV10115600 (J-38958)

• Apply new engine oil on the new valve oil seal joint and seal lip.
• Install the valve oil seal to the specified height "H".

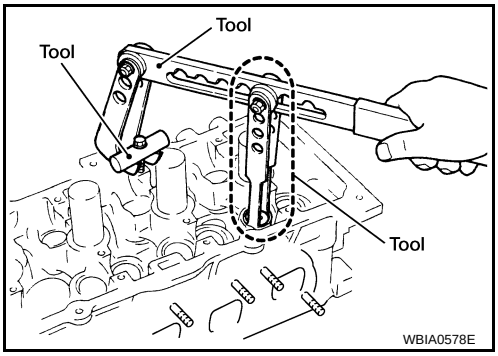
Height "H" (without valve spring installed)
Intake and exhaust : 14.3 - 14.9 mm (0.563 - 0.587 in)



4. Install the valves in their original position.
5. Install the valve spring seats.
6. Install the valve springs.
   • Install the narrow pitch end (paint mark side) to the cylinder head side.
7. Install the valve spring retainers.



8. Install the valve collet using Tool.



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

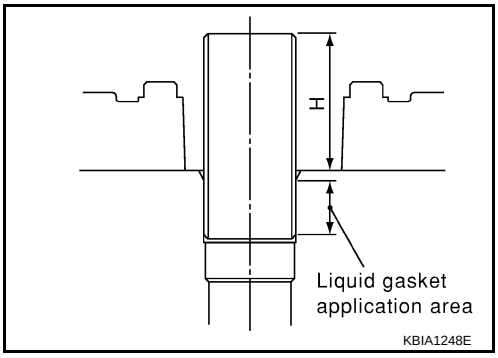
CAUTION:
When working, take care not to damage valve lifter holes.

9. Install the valve lifters.
   - Install the removed parts in their original locations.
   - If installing new lifters, select the correct size lifter for proper valve clearance. Refer to EM-212, "Inspection After Disassembly".
10. Install the spark plug tube if necessary, following the procedure below.

a. Remove any old liquid gasket adhering to the cylinder-head spark plug tube hole.

b. Apply liquid gasket to area within approximately 12 mm (0.47 in) from the edge of the spark plug tube press-fit side.
Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".

c. Press-fit the spark plug tube to the specified height “H” using suitable tool.



Standard press-fit height “H” :38.4 - 39.4 mm (1.512 - 1.551 in)

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

11. Install the spark plugs.

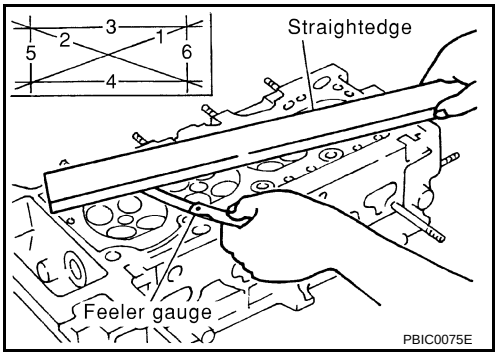
Inspection After Disassembly

INFOID:0000000001282036

CYLINDER HEAD DISTORTION

1. Remove any oil, scale, gasket, sealant and carbon deposits from the cylinder head surface.
CAUTION:
Do not allow any debris to enter the oil or coolant passages.

2. Measure the bottom surface of the cylinder head for distortion in six directions as shown, using suitable tools.

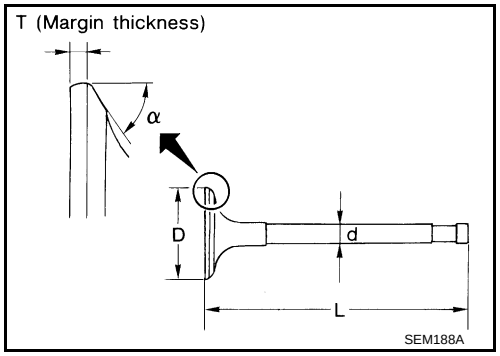


Standard : 0.03 mm (0.0012 in)
Limit : 0.1mm (0.004 in)

- If measurement exceeds the limit, replace the cylinder head.

VALVE DIMENSIONS

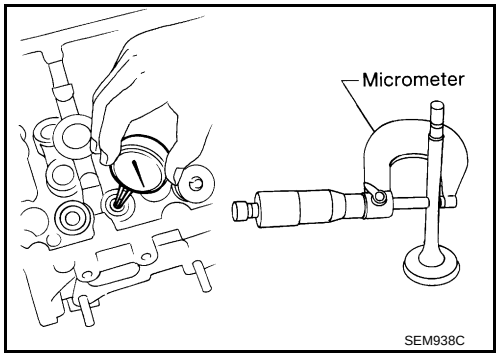
- Check the dimensions of each valve. Refer to EM-248, "Standard and Limit".
- If the dimensions are out of the standard, replace the valve.



VALVE GUIDE CLEARANCE

Valve Stem Diameter

Measure the diameter of the valve stem using suitable tool.



Standard

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

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

Valve Guide Inside Diameter

Measure the inside diameter of the valve guide using suitable tool.

Standard

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

Valve Guide Clearance

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

Valve guide clearance:

Standard

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

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

Limit

Intake : 0.08 mm (0.0031 in)

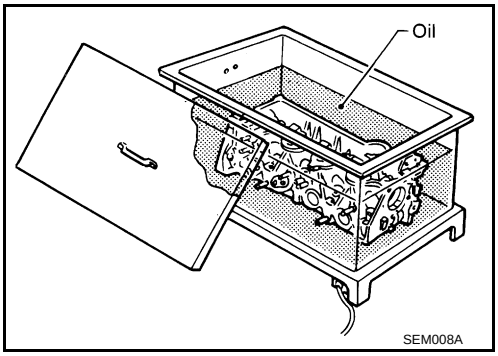
Exhaust : 0.09 mm (0.0035 in)

- If the calculated value exceeds the limit, replace valve and/or valve guide. When the valve guide must be replaced, Follow the "VALVE GUIDE REPLACEMENT" procedure.

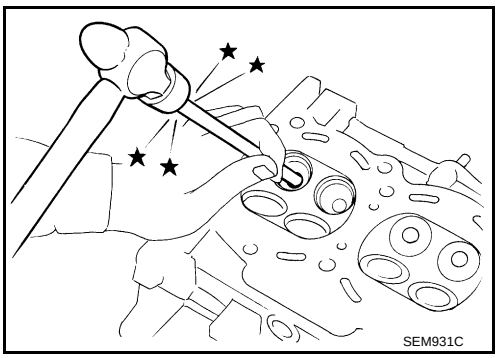
VALVE GUIDE REPLACEMENT

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

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



2. Remove the valve guide using suitable tool.
CAUTION:
Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.



3. Ream the cylinder head valve guide hole using suitable tool.

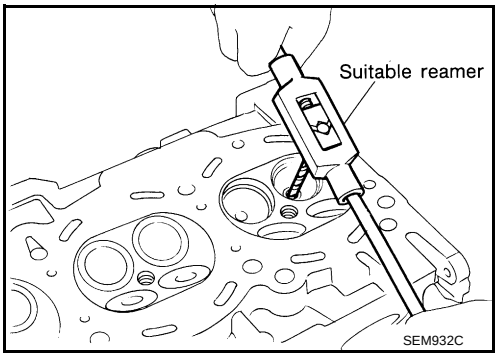
Valve guide hole diameter:

Standard

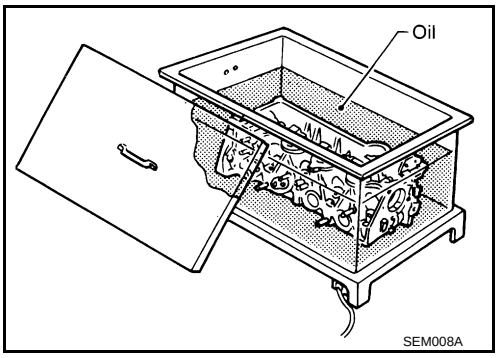
Intake and exhaust : 9.975 - 9.996 mm (0.3927 - 0.3935 in)

Oversize (service)

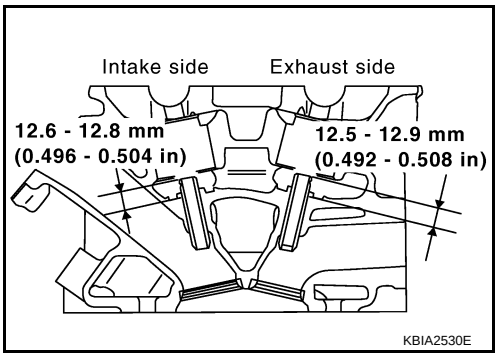
Intake and exhaust : 10.175 - 10.196 mm (0.4006 - 0.4014 in)



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



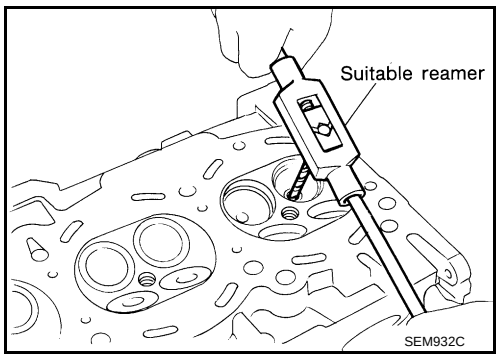
5. Press the valve guide from the camshaft side to the dimensions as shown.
CAUTION:
Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.



6. Ream the cylinder head valve guide using suitable tool.

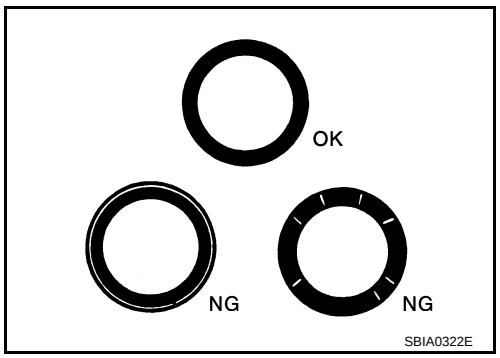
Valve guide hole diameter:

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



VALVE SEAT CONTACT

- After confirming that the dimensions of the valve guides and valves are within specifications, perform this procedure.
- Apply prussian blue (or white lead) onto the contacting surface of the 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 the valve fit and check again. If the contacting surface still has NG conditions even after the re-check, replace the valve seat.



VALVE SEAT REPLACEMENT

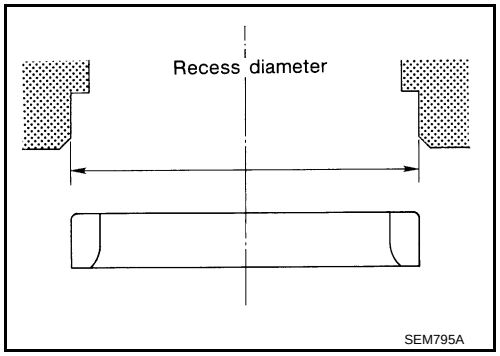
When the valve seat is removed, replace it with oversized (0.5 mm, 0.020 in) valve seat.

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

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

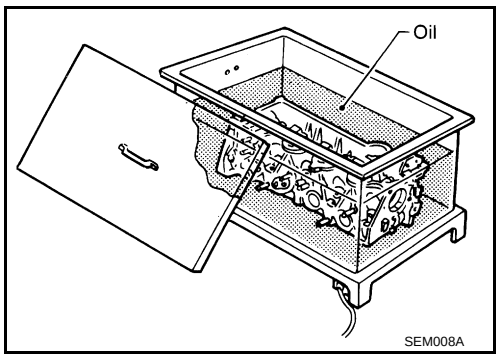
Intake : 38.500 - 38.516 mm (1.5157 - 1.5164 in)

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



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

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

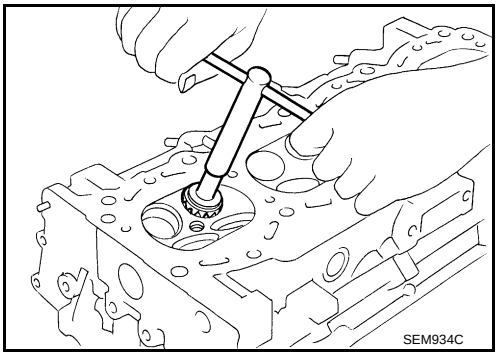


4. Cool the valve seats well with dry ice. Force fit the valve seat into the cylinder head.

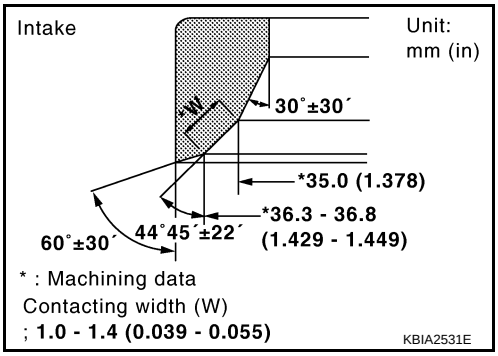
CAUTION:

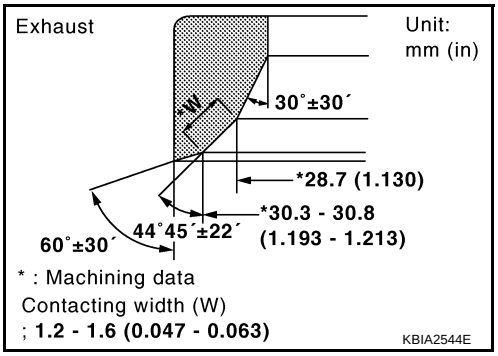
- **Avoid directly touching cold valve seats.**
- **Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.**

5. Finish the seat to the specified dimensions using suitable tool. Follow the "VALVE SEAT CONTACT" procedure.
CAUTION:
When using valve seat cutter, firmly grip the cutter handle with both hands. Then, press on the contacting surface all around the circumference to cut in a single drive. Improper pressure on the cutter or cutting many different times may result in stage valve seat.



6. Grind to obtain the dimensions indicated as shown.
• Using compound, grind to adjust valve fitting.





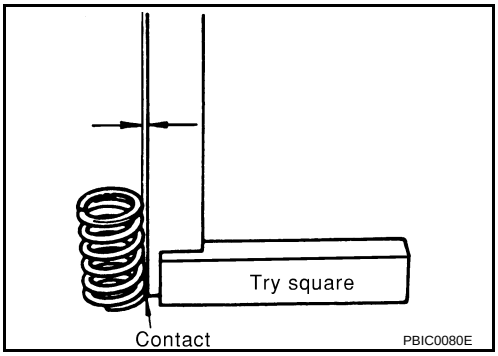
7. Check again for normal contact. Follow the "VALVE SEAT CONTACT" procedure.

VALVE SPRING SQUARENESS

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

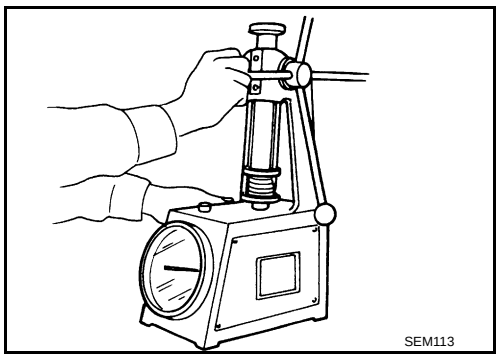
Limit : Less than 2.2 mm (0.087 in)

• If measurement is not within specifications, replace the valve spring.



VALVE SPRING DIMENSIONS AND VALVE SPRING PRESSURE LOAD

- Check the valve spring pressure at the specified spring height.



Standard:

Intake and exhaust

Free height:	**50.58 mm (1.9913 in)**
Installation height:	**37.0 mm (1.457 in)**
Installation pressure:	**165.8 - 187.0 N (16.9 - 19.1 kg, 37- 42 lb)**
Height during valve open:	**28.2 mm (1.110 in)**
Load with valve open:	**314.8 - 355.0 N (32.1 - 36.2 kg, 71 - 80 lb)**

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

REMOVAL AND INSTALLATION

ENGINE ASSEMBLY

Removal and Installation

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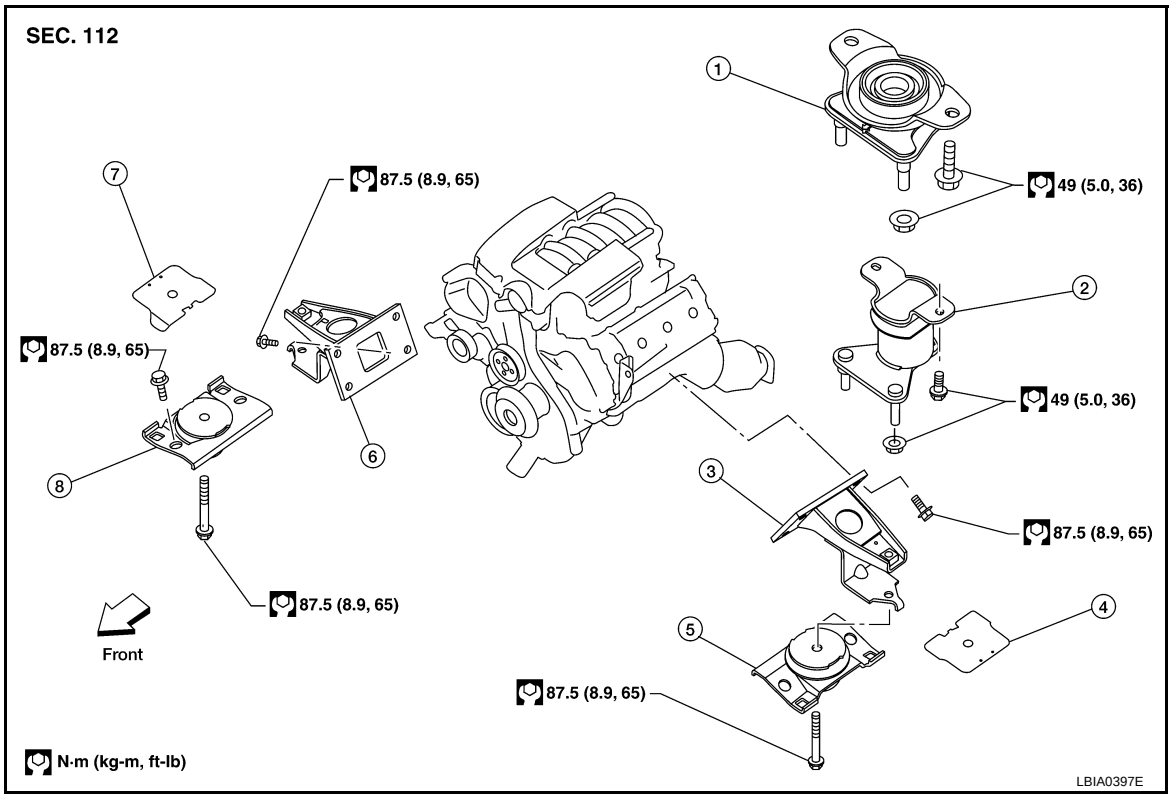


1. Rear engine mounting insulator 4WD
2. Rear engine mounting insulator 2WD
3. LH engine mounting bracket
4. LH heat shield plate
5. LH engine mounting insulator
6. RH engine mounting bracket
7. RH heat shield plate
8. RH engine mounting insulator

WARNING:

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

CAUTION:

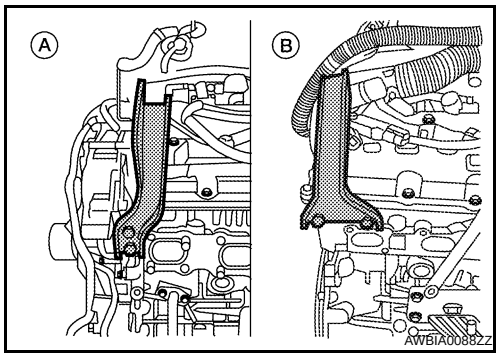
- **Always be careful to work safely, avoid forceful or uninstructed operations.**
- **Do not start working until exhaust system and engine coolant are cooled sufficiently.**
- **If items or work required are not covered by the engine section, follow the applicable sections.**
- **Always use the support 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-43, "Garage Jack and Safety Stand".**

REMOVAL

Preparation

1. Remove air dam using power tool.
2. Remove engine undercover using power tool.
3. Drain the engine coolant. Refer to CO-39, "Changing Engine Coolant".

4. Partially drain the A/T fluid. Refer to TM-182, "Changing the A/T Fluid (ATF)".
5. Drain the transfer fluid (4WD models). Refer to DLN-132, "Replacement" or DLN-269, "Replacement".
6. Remove the engine hood. Refer to DLK-182, "Removal and Installation of Hood Assembly".
7. Release the fuel pressure. Refer to EC-948, "Fuel Pressure Check".
8. Remove the engine room cover using power tool. Refer to EM-164, "Removal and Installation".
9. Remove the air duct and air cleaner case assembly. Refer to EM-165, "Removal and Installation".
10. Disconnect the vacuum hose between the vehicle and engine and set it aside.
11. Remove the radiator assembly and hoses. Refer to CO-43, "Removal and Installation".
12. Remove the drive belts. Refer to EM-153, "Removal and Installation".
13. Remove the fan blade. Refer to CO-46, "Removal and Installation (Crankshaft Driven Type)".
14. Disconnect the engine room harness from the fuse box and set it aside.
15. Disconnect the ECM.
16. Disconnect the engine room harness from the engine side and set it aside.
17. Disconnect the engine harness grounds.
18. Disconnect the power steering reservoir tank from the engine and move it aside.
19. Disconnect the power steering oil pump from the engine. Move it aside and secure it using suitable wire or rope. Refer to ST-24, "Removal and Installation".
20. Remove the A/C compressor bolts and set the compressor aside. Refer to HA-40, "Removal and Installation for Compressor".
21. Disconnect the brake booster vacuum line.
22. Disconnect the EVAP line.
23. Disconnect the fuel hose at the engine side connection. Refer to EM-180, "Removal and Installation".
24. Disconnect the heater hoses at the cowl, and install plugs to avoid leakage of engine coolant.
25. Remove the A/T oil level indicator and indicator tube upper bolts.
26. Remove the front final drive assembly (4WD models). Refer to DLN-376, "Removal and Installation".
27. Remove the exhaust manifolds. Refer to EM-170, "Removal and Installation".
28. Remove the A/T. Refer to TM-225, "2WD : Removal and Installation" (2WD models) or TM-228, "4WD : Removal and Installation" (4WD models).
29. Install the engine slingers into the left bank cylinder head (A) and right bank cylinder head (B).



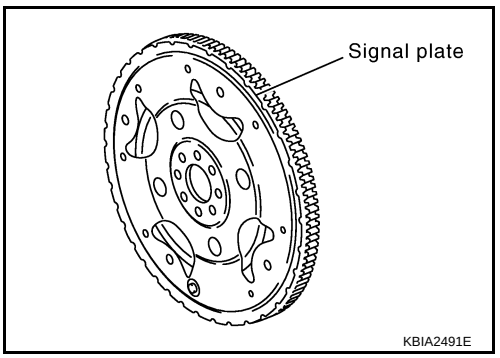
Engine slinger torque: 45.0 N·m (4.6 kg-m, 33 ft-lb)

30. Lift using a hoist and secure the engine in position.
31. Remove engine mounting insulator bolts.
32. Remove the engine assembly from the vehicle, avoid interference with the vehicle body.
    CAUTION:
    - **Before and during lifting, always check if any harnesses are left connected.**
33. Remove the parts that may restrict installation of the engine to the engine stand.
    NOTE:
    This procedure is described assuming that you use an engine stand mounting to the surface to which the transmission mounts.

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

CAUTION:

- **Be careful not to damage the drive plate. Especially avoid deforming and damaging of the signal plate teeth (circumference position).**
- **Place the drive plate with the signal plate surface facing other than downward.**
- **Keep magnetic materials away from the 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 the fuel tube and fuel injector assembly. Refer to EM-180, "Removal and Installation".**
- **Remove the intake manifold. Refer to EM-166, "Removal and Installation".**
- **Remove the ignition coil. Refer to EM-177, "Removal and Installation".**
- **Remove the rocker cover. Refer to EM-178, "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.

34. Remove the generator. Refer to CHG-21, "Removal and Installation".
35. Remove the engine mounting insulator and bracket using power tool.

INSTALLATION

Installation is in the reverse order of removal.

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

INSPECTION AFTER INSTALLATION

- Before starting the engine, check oil/fluid levels including engine coolant and engine oil. If the levels are lower than required quantity, fill to the specified level. Refer to MA-10, "Fluids and Lubricants".
- Use procedure below to check for fuel leakage.
- Turn ignition switch ON (with engine stopped). With fuel pressure applied to the fuel piping, check for fuel leakage at the connection points.
- Start engine. With engine speed increased, check again for fuel leakage at connection points.
- Run engine to check for unusual noise and vibration.
- Warm up engine thoroughly to make sure there is no leakage of fuel, exhaust gas, or any oils/fluids including engine oil and engine coolant.
- Bleed air from passages in lines and hoses, such as in cooling system.
- After cooling down the engine, again check oil/fluid levels including engine oil and engine coolant. Refill to specified level if necessary.
- Summary of the inspection items:

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

*Transmission fluid, power steering fluid, brake fluid, etc.

DISASSEMBLY AND ASSEMBLY

ENGINE UNIT

Disassembly and Assembly

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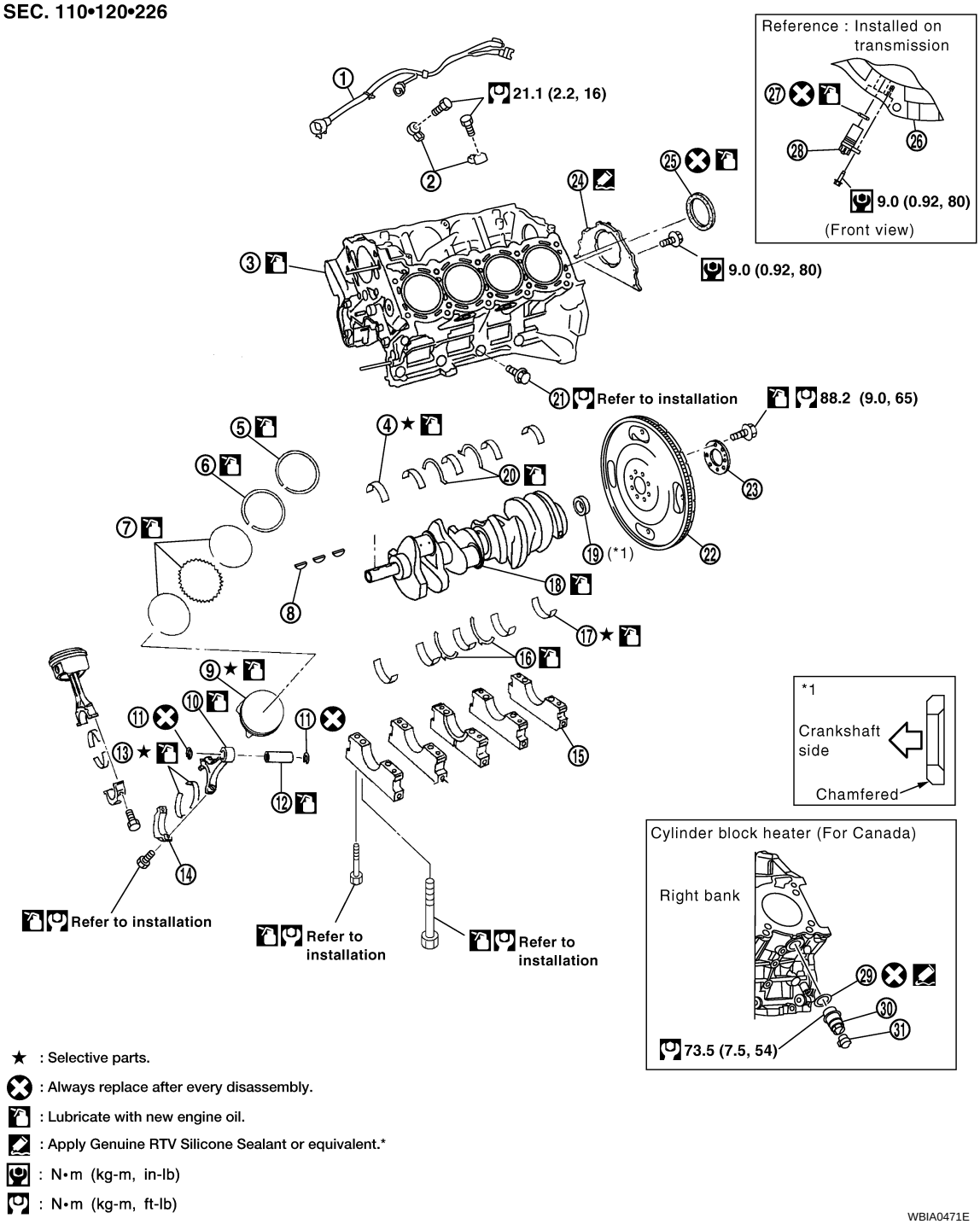


WBIA0471E

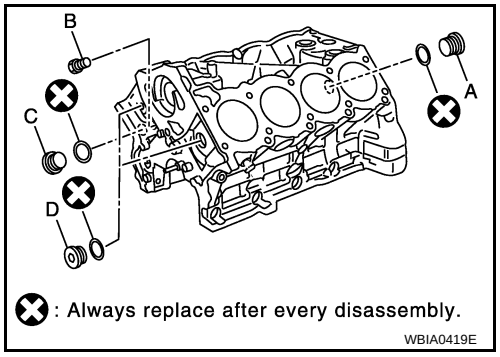
1. Knock sensor sub-harness
2. Knock sensor
3. Cylinder block
4. Main bearing upper
5. Top ring
6. Second ring
7. Oil ring
8. Crankshaft key
9. Piston
10. Connecting rod
11. Snap ring
12. Piston pin
13. Connecting rod bearing
14. Connecting rod bearing cap
15. Main bearing cap

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

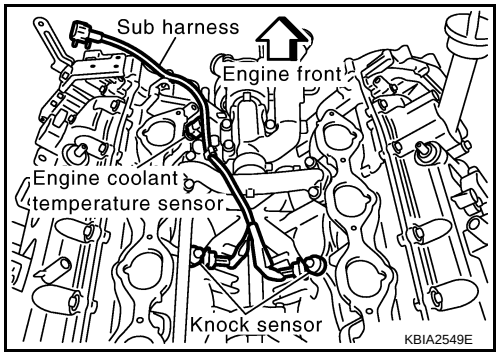
DISASSEMBLY

NOTE:
Explained here is how to disassemble with engine stand supporting transmission surface. When using different type of engine stand, some steps may be different.

1. Remove engine assembly from vehicle and mount to engine stand. Refer to EM-218, "Removal and Installation".
   CAUTION:
   Before removing the hanging chains, make sure engine stand is stable and there is no risk of overturning.
2. Drain engine oil. Refer to LU-25, "Changing Engine Oil".
3. Drain engine coolant by removing the cylinder block drain plugs (A)", ("B)", ("C) and ("D) as shown.



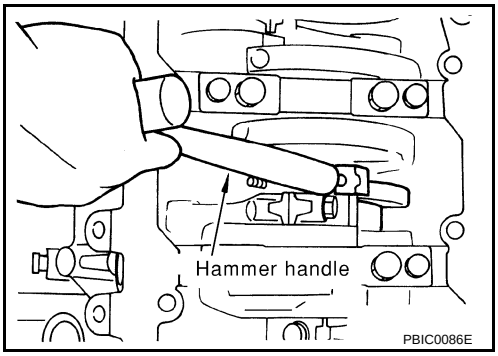
4. Remove the following components and associated parts (the parts referred to in step 1 are not included here).
   - Oil pan (upper and lower) and oil strainer. Refer to EM-173, "Removal and Installation".
   - Crankshaft pulley, front cover and timing chain. Refer to EM-185, "Removal and Installation".
   - Camshaft. Refer to EM-193, "Removal and Installation".
   - Cylinder head. Refer to EM-208, "Removal and Installation".
5. Remove knock sensor and sub harness.
   CAUTION:
   Carefully handle sensor, avoiding shocks.



6. Check connecting rod side clearance. Refer to EM-230, "Inspection After Disassembly".
7. Remove piston and connecting rod assembly as follows.

a. Position the crankshaft pin corresponding to the connecting rod to be removed onto bottom dead center.
b. Remove connecting rod cap.

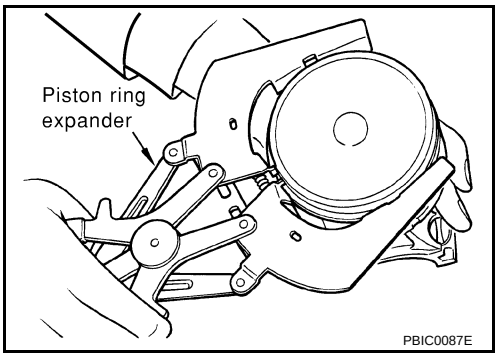
c. Push the piston and connecting rod assembly out to the cylinder head side using suitable tool.



8. Remove connecting rod bearings.
CAUTION:
When removing them, note the installation position. Keep them in the correct order.

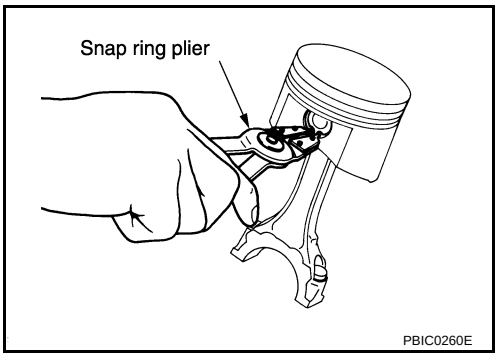
9. Check piston ring side clearance. Refer to EM-230, "Inspection After Disassembly".

10. Remove piston rings from piston using suitable tool.
CAUTION:
- **Do not damage piston.**
- **Do not damage piston rings by expanding them excessively.**

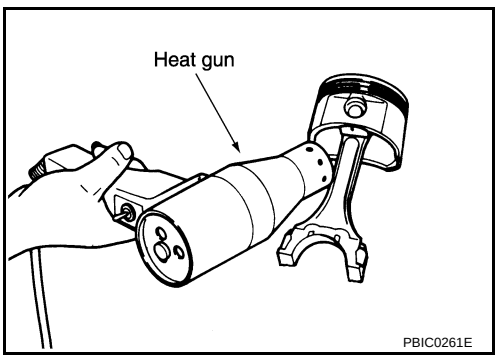


11. Remove piston from connecting rod as follows.

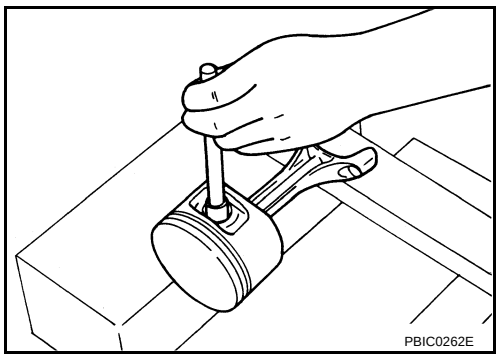
a. Remove snap ring using suitable tool.



b. Heat piston to 60° to 70°C (140° to 158°F) using suitable tool.



c. Push out piston pin using suitable tool.



12. Separate and remove rear oil seal retainer from cylinder block.
CAUTION:
Do not damage mating surface.

13. Remove rear oil seal from rear oil seal retainer.

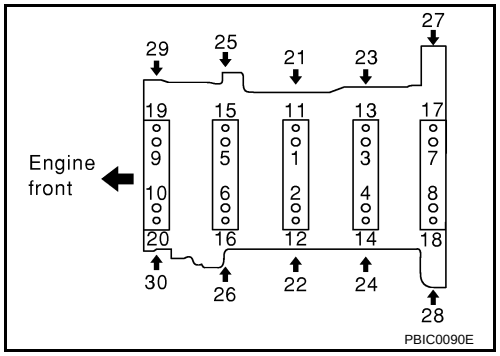
14. Measure the crankshaft side clearance. Refer to EM-230, "Inspection After Disassembly".

15. Remove main bearing caps as follows:
- Loosen bolts in reverse order as shown in several different steps.

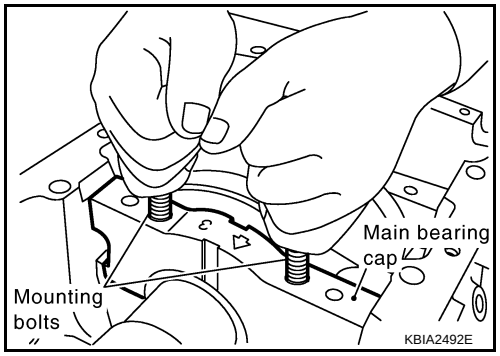
a. Loosen side bolts (M10) starting from 30 to 21 to remove.

b. Loosen main bearing cap sub bolts (M9) starting from 20 to 11 to remove.

c. Loosen main bearing cap bolts (M12) starting from 10 to 1 to remove.



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

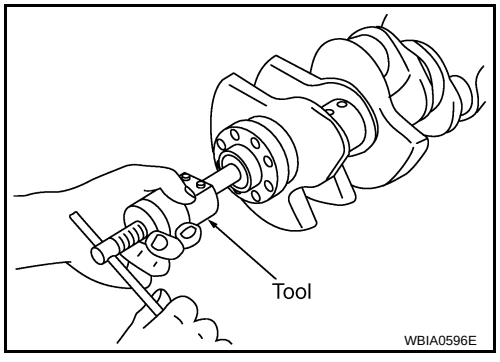


16. Remove crankshaft.

17. Remove the main bearings and thrust bearings from the cylinder block and main bearing caps.
- When removing them, note the installation position. Keep them in the correct order.

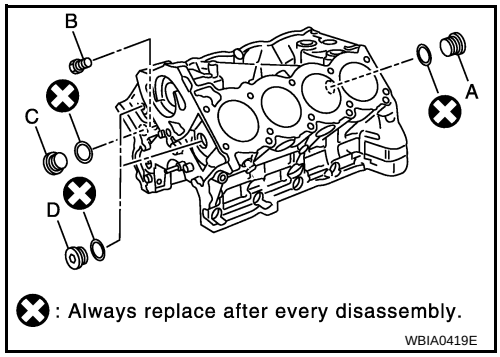
18. Remove pilot converter using Tool if necessary.

Tool number : ST16610001 (J-23907)



ASSEMBLY

1. Fully air-blow the coolant and oil passages in the cylinder block, cylinder bore, and crankcase to remove any foreign material.
   CAUTION:
   Use goggles to protect your eyes.
2. Install each plug to the cylinder block (only screw-type plugs are shown).
   - Apply liquid gasket.
     Use Genuine Thread Sealant or equivalent. Refer to GI-26, "Recommended Chemical Products and Sealants".
   - Replace copper washers with new ones.
   - Tighten each plug as specified below.

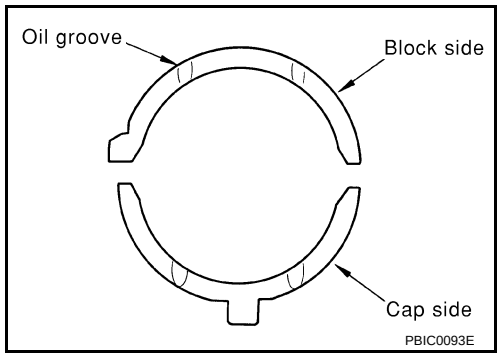


Part	Washer	Tightening torque
A	Yes	53.9 N·m (5.5 kg-m, 40 ft-lb)
B	No	19.6 N·m (2.0 kg-m, 15 ft-lb)
C	Yes	62.7 N·m (6.4 kg-m, 46 ft-lb)
D	Yes	62.7 N·m (6.4 kg-m, 46 ft-lb)

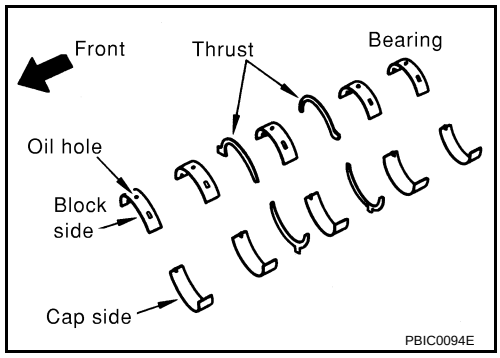
3. Install main bearings and thrust bearings.

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

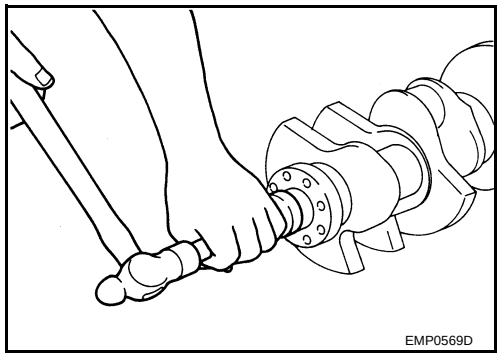
b. Install thrust bearings to both sides of the No. 3 journal housing on the cylinder block and main bearing caps
   - Install thrust bearings with the oil groove facing the crankshaft arm (outside).
   - Install thrust bearings with a protrusion in the center on the main bearing caps.



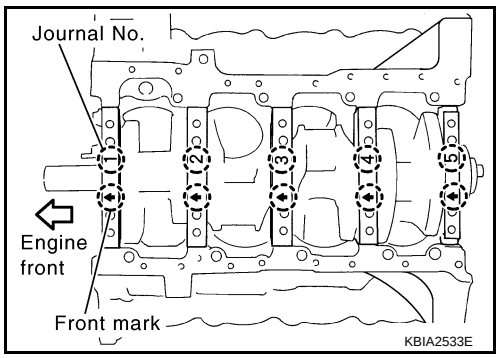
c. Install main bearings paying attention to the direction.
   - Install the one with oil holes onto the cylinder block and the one without oil holes onto the main bearing cap.
   - Before installing bearings, apply engine oil to bearing surface (inside). Do not apply oil to the back surface, but thoroughly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



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



6. Install main bearing caps.
   - Align the identification number to the journal position to install.
   - Install it with the front mark (indicated by the arrow) facing the front of engine.
   - Tap caps lightly to seat them in the installation position.

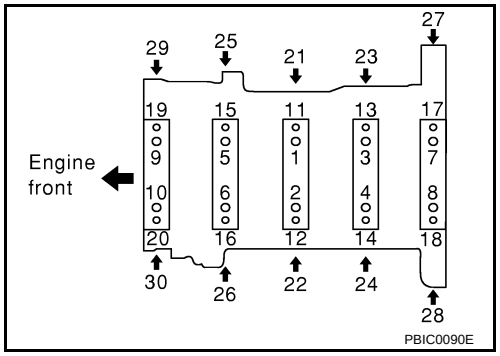


7. Follow the steps below to tighten each main bearing cap bolt.

a. Apply engine oil to threads and seating surfaces of bolts, and tighten all bolts temporarily.

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

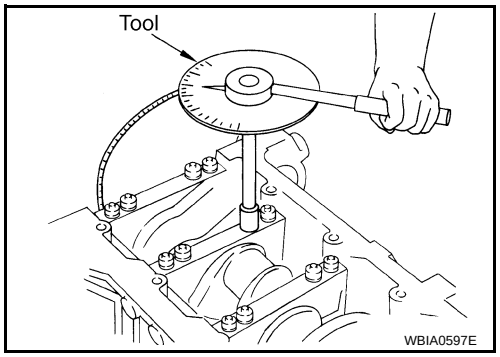
Main bearing cap sub bolts in order of 11 to 20 : **29.4 N·m (3.0 kg-m, 22 ft-lb)**



b. Measure tightening angle using Tool.

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

CAUTION:
Measure tightening angle using Tool. Do not measure visually.



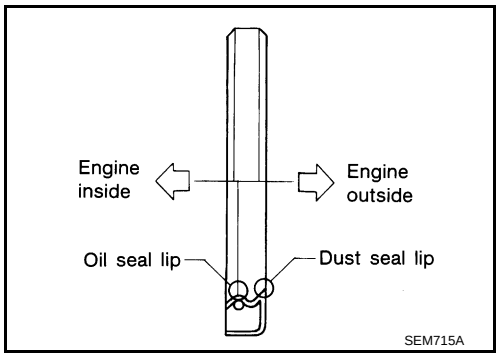
Main bearing cap bolts in order of 1 to 10 : **40°**

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

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

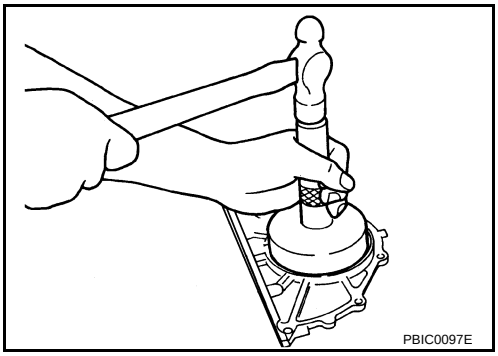
- Rotate crankshaft by hand after bolts are tightened. Check if it rotates smoothly.
- Check crankshaft side clearance. Refer to EM-230, "Inspection After Disassembly".

8. Install rear oil seal to rear oil seal retainer.
   - Install new rear oil seal in the direction shown.

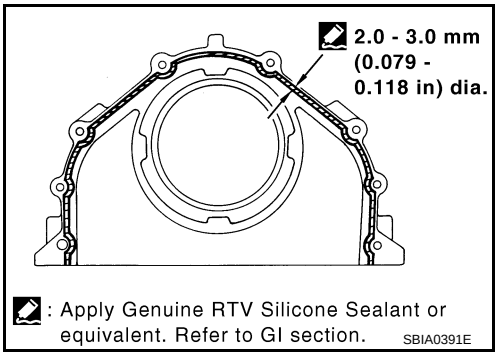


- Tap the rear oil seal until it is level with the rear end surface of rear oil seal retainer.

CAUTION:
Do not damage or scratch outer circumference of oil seal.



9. Install rear oil seal retainer.
   - Apply liquid gasket thoroughly to rear oil seal retainer as shown.
     Use Genuine RTV Silicone Sealant or equivalent. Refer to **GI-26, "Recommended Chemical Products and Sealants"**.
   - Apply new engine oil on the lips of rear oil seal. Do not touch.

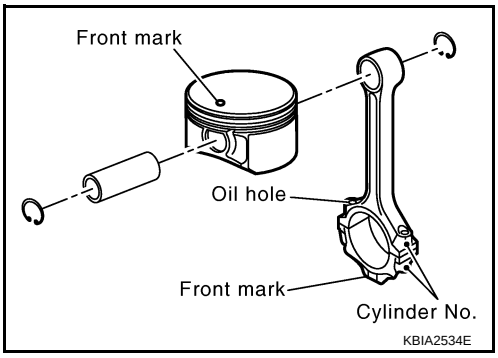


10. Install the piston to the connecting rod.

a. Install the snap ring to the grooves of the piston rear side.
   - Insert it fully into the groove to install.

b. Install the piston to the connecting rod.
   - 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 the piston pin into the piston and the connecting rod.
   - Assemble so that the front mark on the piston crown and the oil holes and cylinder No. on the connecting rod are positioned as shown.

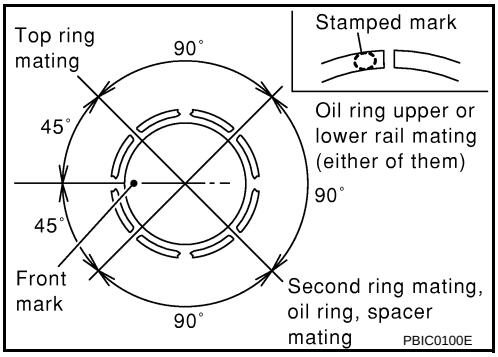
c. Install the snap ring to the grooves of the piston front side.
   - Insert it fully into the groove to install.
   - After installing, make sure connecting rod moves smoothly.



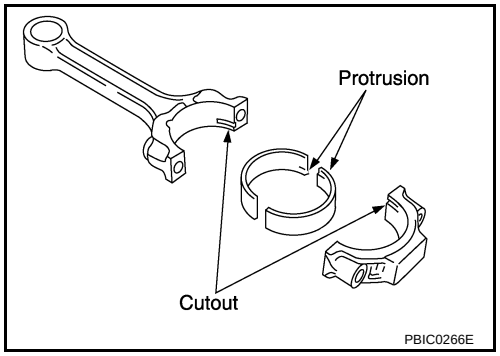
11. Install piston rings.

CAUTION:
Do not damage piston.
- Position each ring with the gap as shown, referring to the piston front mark.
- Install the second ring with the stamped surface facing upward.

Stamped mark Second ring : 2N



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

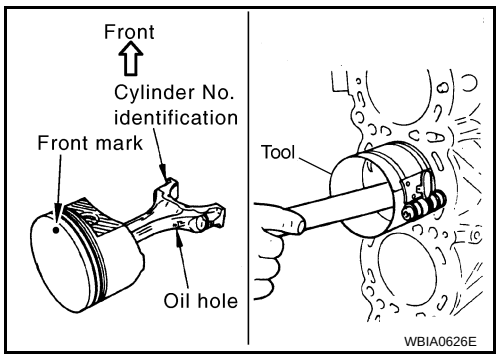


13. Install the piston and connecting rod assembly to the crankshaft using Tool.

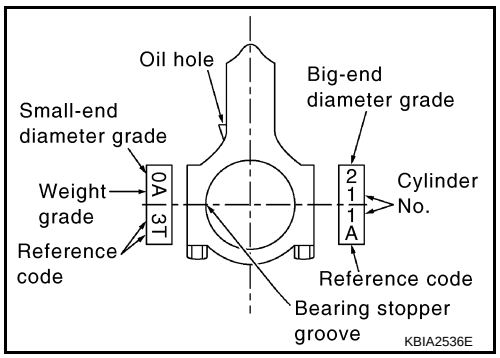
    Tool number : EM03470000 (J-8037)

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

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



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



15. Tighten connecting rod bolts using Tool.

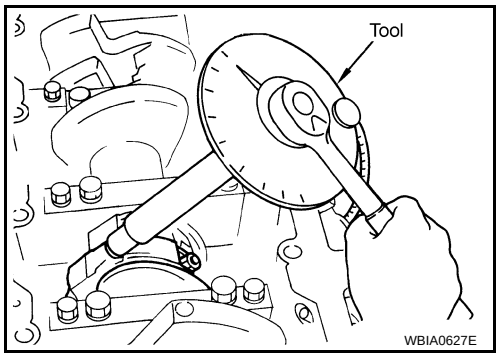
    Tool number : KV10112100 (BT-8653-A)

    Connecting rod bolts

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

    Step 2 : 90° clockwise

    - Apply engine oil to threads and seats of connecting rod bolts.
    - After tightening bolts, make sure the crankshaft rotates smoothly.
    - Check connecting rod side clearance. Refer to EM-230, "Inspection After Disassembly".

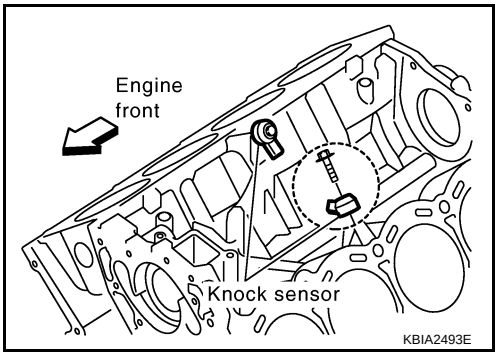


16. Install knock sensors.

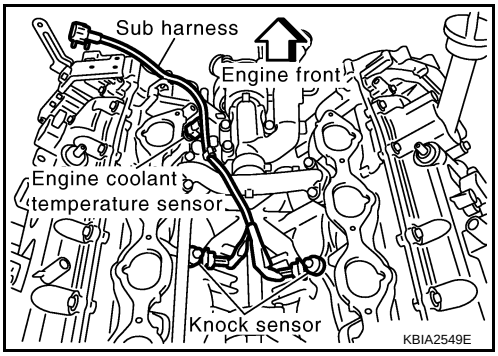
CAUTION:

If knock sensor is dropped, replace it with a new one.

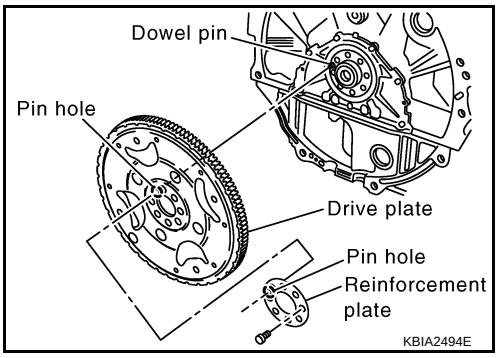
- Make sure that there is no foreign material on the cylinder block mating surface and the back surface of knock sensor.
- Install it with its connector facing the center of the cylinder block side.
- Do not tighten knock sensor bolts while holding connector.
- Make sure knock sensor does not interfere with other parts.



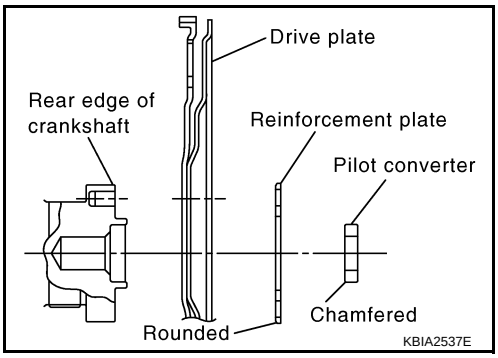
- Position the sub-harness as shown before installing intake manifold.



17. Installation of the remaining components is in the reverse order of removal.
18. Remove engine assembly from engine stand.
19. Install drive plate.
    - Align dowel pin of crankshaft rear end with pin holes of each part to install.



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



Inspection After Disassembly

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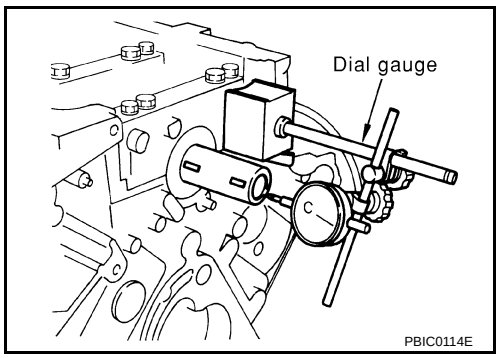
CRANKSHAFT END PLAY

- Move the crankshaft fully forward and backward and measure the clearance between the thrust bearings and crankshaft arm using suitable tool.

Standard : 0.10 - 0.26 mm (0.0039 - 0.0102 in)
Limit : 0.30 mm (0.0118 in)

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

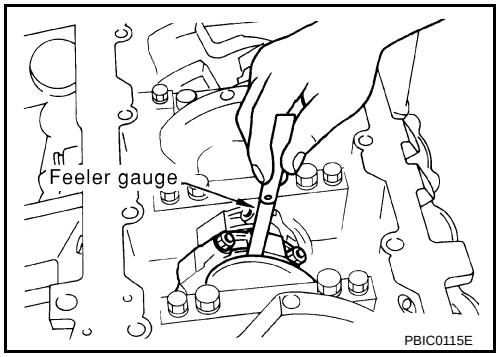


CONNECTING ROD SIDE CLEARANCE

- Measure side clearance between the connecting rod and crankshaft arm using suitable tool.

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

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

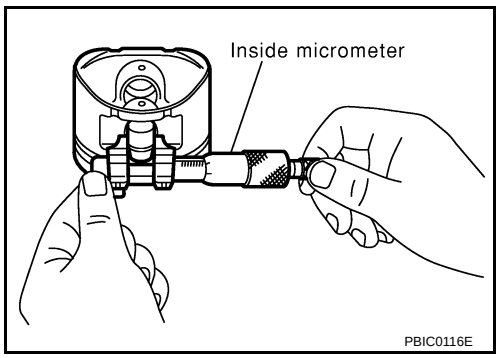


PISTON AND PISTON PIN CLEARANCE

Piston Pin Hole Diameter

- Measure diameter of piston pin hole using suitable tool.

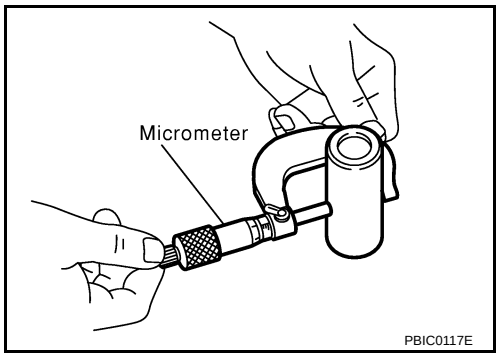
Standard : 21.993 - 21.999 mm (0.8659 - 0.8661 in)



Piston Pin Outer Diameter

- Measure diameter of piston pin using suitable tool.

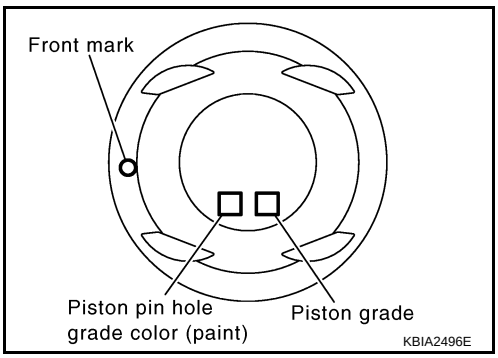
Standard : 21.989 - 21.995 mm (0.8657 - 0.8659 in)



Piston to Piston Pin Clearance

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

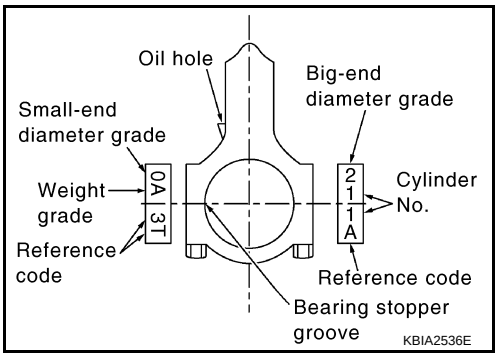
Standard : 0.002 - 0.006 mm (0.0001 - 0.0002 in)



- If clearance exceeds specification, replace either or both the piston/piston pin assembly and the connecting rod assembly with reference to the specification of each part.
- Use the piston selection table to replace piston/piston pin assembly. Refer to EM-241, "How to Select Piston and Bearing".
- Use the connecting rod bearing selection table to replace connecting rod. Refer to EM-241, "How to Select Piston and Bearing".

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

- Follow the "CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)" procedure for the values for each grade at the plant.



PISTON RING SIDE CLEARANCE

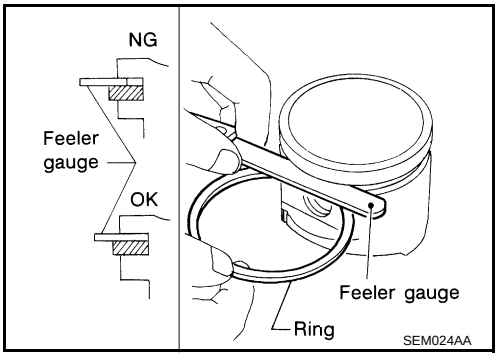
- Measure side clearance of the piston ring and piston ring groove using suitable tool.

Standard:

Top ring	**: 0.035 - 0.085 mm (0.0014 - 0.0033 in)**
2nd ring	**: 0.030 - 0.070 mm (0.0012 - 0.0028 in)**
Oil ring	**: 0.015 - 0.050 mm (0.0006 - 0.0020 in)**

Limit:

Top ring	**: 0.11 mm (0.0043 in)**
2nd ring	**: 0.10 mm (0.0039 in)**



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

PISTON RING END GAP

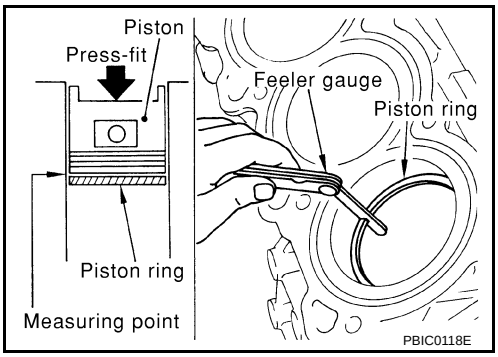
- Check if the diameter of the cylinder bore is within specification. Follow the "Piston to Cylinder Bore Clearance" procedure.
- Insert the piston ring into the middle of the cylinder using the piston, and measure the gap.

Standard

Top ring	**: 0.23 - 0.33 mm (0.0091 - 0.0130 in)**
2nd ring	**: 0.25 - 0.40 mm (0.0098 - 0.0157 in)**
Oil ring	**: 0.20 - 0.60 mm (0.0079 - 0.0236 in)**

Limit:

Top ring	**: 0.56 mm (0.0220 in)**
2nd ring	**: 0.52 mm (0.0205 in)**
Oil ring	**: 0.96 mm (0.0378 in)**



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

CONNECTING ROD BEND AND TORSION

- Check connecting rod alignment using suitable tool.

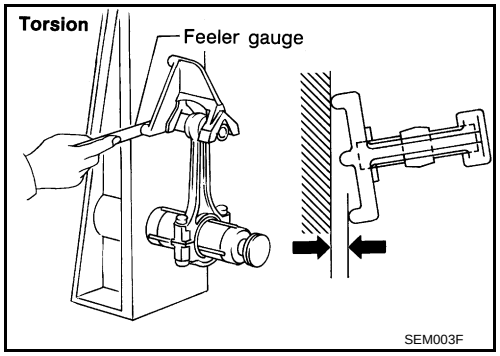
Limit:

Bend

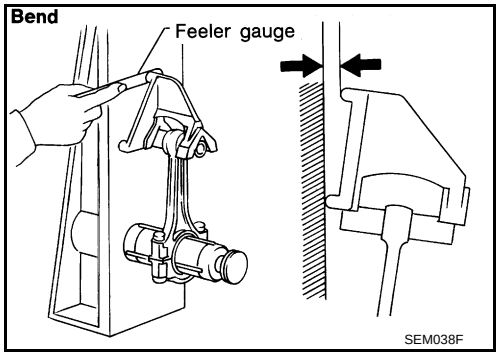
: 0.15 mm (0.0059 in) per 100 mm (3.94 in) length

Torsion

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



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

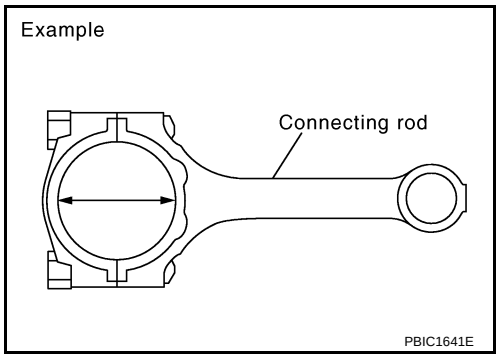


CONNECTING ROD DIAMETER (BIG END)

- Install the connecting rod cap without the connecting rod bearing installed. After tightening the connecting rod bolt to the specified torque, measure the connecting rod large end inside diameter. Refer to EM-222, "Disassembly and Assembly".

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

- If measurement exceeds the standard, replace connecting rod.

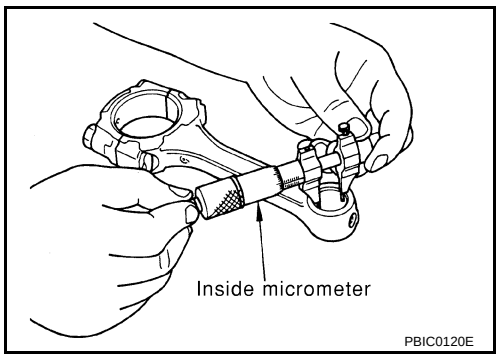


CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)

Connecting Rod Inside Diameter (Small End)

- Measure inside diameter of connecting rod bushing using suitable tool.

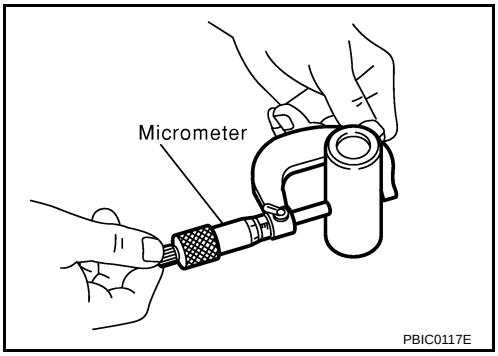
Standard : 22.000 - 22.006 mm (0.8661 - 0.8664 in)



Piston Pin Diameter

- Measure diameter of piston pin using suitable tool.

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

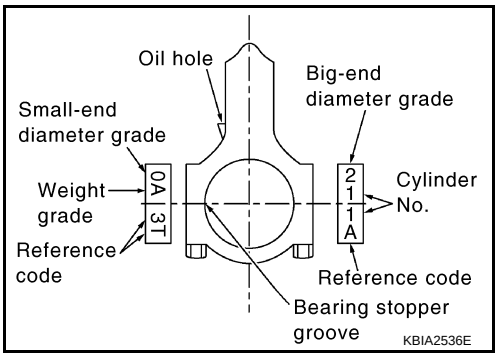


Connecting Rod Bushing Oil Clearance (Small End)

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

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

- If measured value exceeds the standard, replace the connecting rod assembly and/or piston and piston pin assembly.
- If replacing the piston and piston pin assembly, use the Table for Selective Fitting for Piston to select the piston corresponding to the applicable bore grade of the cylinder block to be used. Refer to EM-241, "How to Select Piston and Bearing".

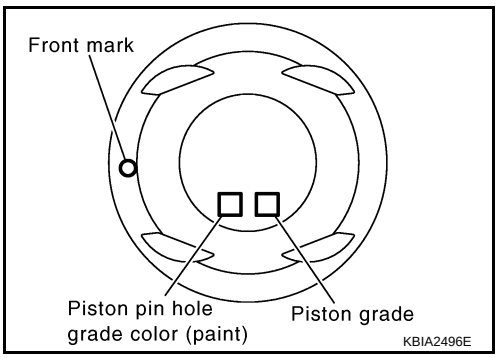


Factory installed parts grading:

- Only grade 0 is available.

Unit: mm (in)

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



CYLINDER BLOCK DISTORTION

- Remove any oil, scale, gasket, sealant and carbon deposits from the cylinder block surface.

CAUTION:

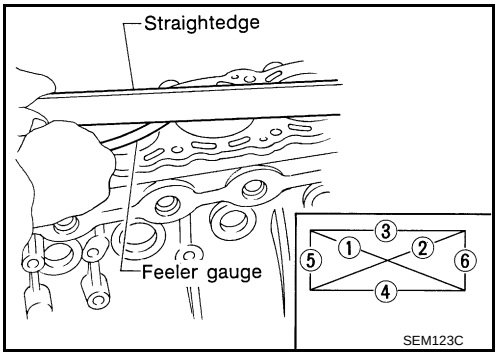
Do not allow any debris to enter the engine oil or engine coolant passages.

- Measure block upper face for distortion in six directions as shown.

Standard : 0.03 mm (0.0012 in)

Limit : 0.1 mm (0.004 in)

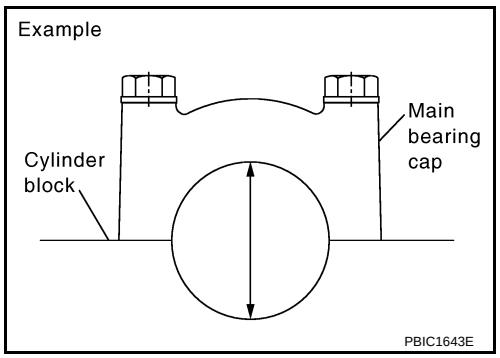
- If measurement exceeds the limit, replace cylinder block.



MAIN BEARING HOUSING INSIDE DIAMETER

- Install the main bearing caps with the main bearings removed, and tighten the bolts to the specified torque. Refer to EM-222, "Disassembly and Assembly".
- Measure inside diameter of main bearing housing.

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



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

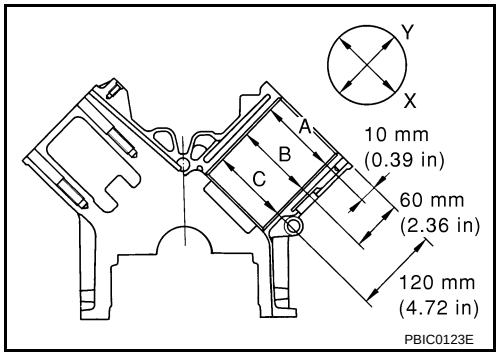
NOTE:
These components must be replaced as a single unit, because they were processed together.

PISTON TO CYLINDER BORE CLEARANCE

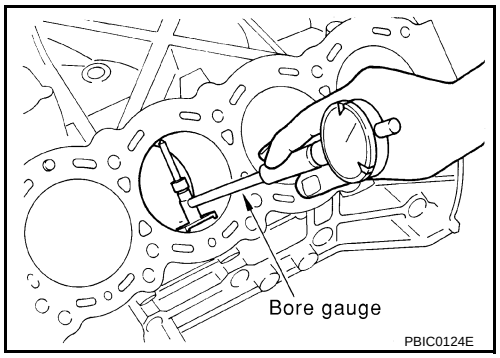
Cylinder Bore Diameter

- Measure the 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″).

NOTE:
When determining cylinder bore grade, measure cylinder bore at "B" position.



Standard diameter:
98.000 - 98.030 mm (3.8583 - 3.8594 in)
Wear limit:
0.20 mm (0.0079 in)
Out-of-round (Difference between ″X″ and ″Y″):
Limit: 0.015 mm (0.0006 in)
Taper limit (Difference between ″A″ and ″C″):
Limit: 0.010 mm (0.0004 in)



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

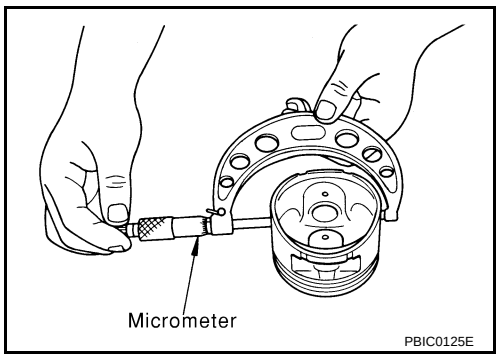
Piston oversize Grade No. 0 (Service) : 0.20 mm (0.0079 in)

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

Piston Skirt Diameter

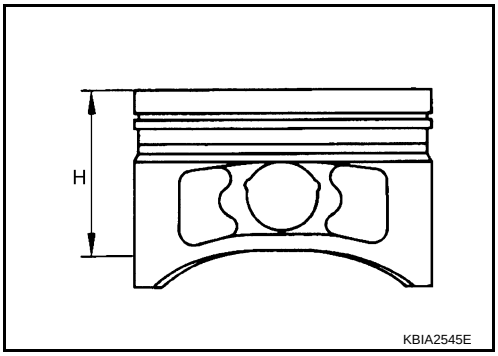
- Measure piston skirt diameter using suitable tool.

Standard : 97. 980 - 98. 010 mm (3.8575 - 3.8587 in)



- Measure point "H".

Distance from the top : 39 mm (1.54 in)



Piston to Cylinder Bore Clearance

- Calculate by using diameter of the piston skirt and the cylinder bore diameter (direction X, position B).
  (Clearance) = (Cylinder bore diameter) – (piston skirt diameter)

Standard : 0.010 - 0.030 mm (0.0004 - 0.0012 in)
Limit : 0.08 mm (0.0031 in)

- If calculation exceeds the limit, replace piston/piston pin assembly.

Reboring Cylinder Bore

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

Rebored size calculation: D = A +B - C
where,
D: Bored diameter
A: Piston diameter as measured
B: Piston - to - bore clearance (standard value)
C: Honing allowance 0.02 mm (0.0008 in)

2. Install main bearing caps, and tighten them to the specified torque. Otherwise, cylinder bores may be distorted in final assembly.
3. Cut the 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 one 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-bore clearance.
5. Measure finished cylinder bore for out-of-round and taper.
   NOTE:
   Measurement should be done after cylinder bore cools down.

CRANKSHAFT MAIN JOURNAL DIAMETER

- Measure diameter of crankshaft journals.

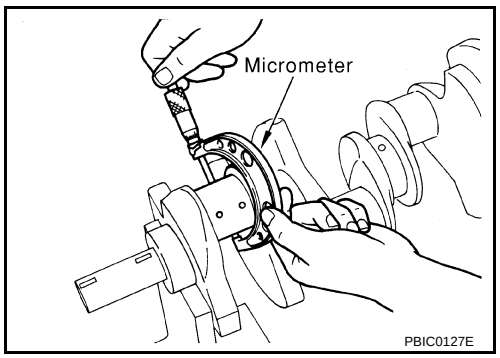
Standard : 63.940 - 63.964 mm (2.5173 - 2.5183 in)

- If measurement is out of standard, measure the main bearing oil clearance. Then use the undersize bearing. Follow the "MAIN BEARING OIL CLEARANCE" procedure.

CRANKSHAFT PIN JOURNAL DIAMETER

- Measure diameter of crankshaft pin using suitable tool.

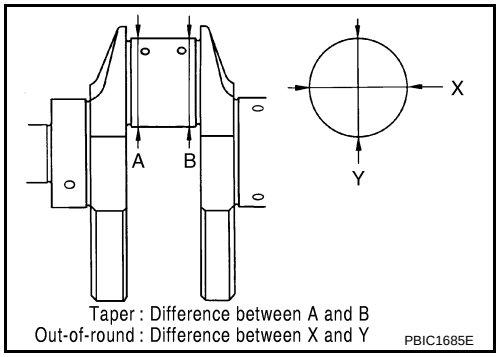
Standard : 53.956 - 53.974 mm (2.1243 - 2.1250 in)



- If measurement is out of standard, measure connecting rod bearing oil clearance. Then use undersize bearing. Follow the " CONNECTING ROD BEARING OIL CLEARANCE" procedure.

OUT-OF-ROUND AND TAPER OF CRANKSHAFT

- Measure dimensions at four different points as shown on each journal and pin.
- Out-of-roundness is indicated by the difference in dimension between ″X″ and ″Y″ at ″A″ and ″B″.
- Taper is indicated by the difference in dimension between ″A″ and ″B″ at ″X″ and ″Y″.



Limit

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

: 0.002 mm (0.0001 in)

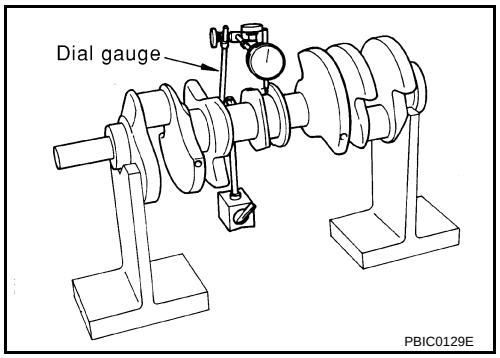
Taper (Difference between ″A″ and ″B″)

: 0.002 mm (0.0001 in)

- If measured value exceeds the standard, correct or replace crankshaft.
- If corrected, measure the bearing oil clearance of the corrected journal or pin. Then select the main bearing or connecting rod bearing. Follow the "MAIN BEARING OIL CLEARANCE" or "CONNECTING ROD BEARING OIL CLEARANCE" procedures.

CRANKSHAFT RUNOUT

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



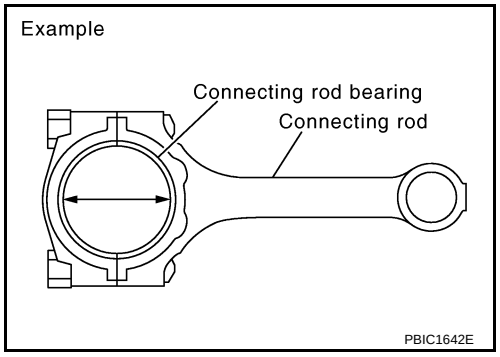
Limit : Less than 0.05 mm (0.002 in)

- If measurement exceeds the limit, replace crankshaft.

CONNECTING ROD BEARING OIL CLEARANCE

Method of Measurement

- Install connecting rod bearings to the connecting rod and cap. Tighten connecting rod bolts to the specified torque. Refer to EM-222, "Disassembly and Assembly".
  Measure inside diameter of connecting rod bearing.
  (Oil clearance) = (Inside diameter of connecting rod bearing) – (Crankshaft pin diameter)



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

Limit : 0.055 mm (0.0022 in)

- If clearance cannot be adjusted within the standard, grind crankshaft pin and use undersized bearing. Refer to EM-241, "How to Select Piston and Bearing".

Method of Using Plastigage

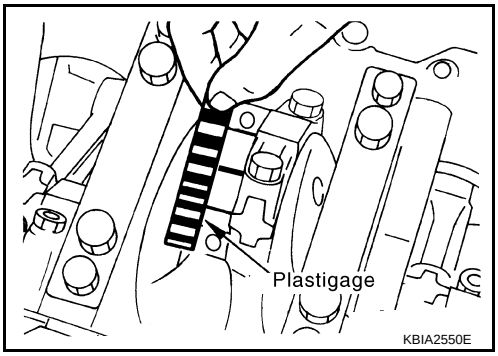
- Remove oil and dust on the crankshaft pin and surfaces of each bearing completely.
- Cut a plastigage slightly shorter than the bearing width, and place it in the crankshaft axial direction, avoiding oil holes.
- Install the connecting rod bearings to the connecting rod and connecting rod bearing cap, and tighten the connecting rod bolts to the specified torque.

  CAUTION:

  Do not rotate crankshaft with plastigage installed.
- Remove the connecting rod bearing cap and bearings. Measure the plastigage width using the scale on the plastigage bag.

  NOTE:

  The procedure when the measured value exceeds the repair limit is the same as that described in “Method of Measurement”.

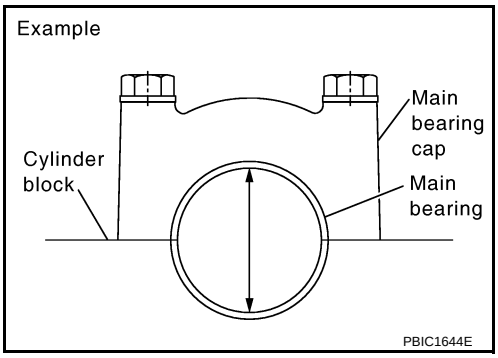


MAIN BEARING OIL CLEARANCE

Method of Measurement

- Install the main bearings to the cylinder block and main bearing cap. Measure the main bearing inside diameter with the bearing cap bolts tightened to the specified torque. Refer to EM-222, "Disassembly and Assembly".

  (Oil clearance) = (Inside diameter of main bearing) – (Crankshaft journal diameter)



Standard:

No. 1 and 5 journals

: 0.001 - 0.011 mm (0.00004 - 0.0004 in)

No. 2, 3 and 4 journals

: 0.007 - 0.017 mm (0.0003 - 0.0007 in)

Limit:

No.1 and 5 journals

: 0.021 mm (0.0008 in)

No. 2, 3 and 4 journals

: 0.027 mm (0.0011 in)

- If measured value exceeds the repair limit, select main bearings referring to the main bearing inside diameter and crankshaft journal diameter, so that the oil clearance satisfies the standard. Refer to EM-241, "How to Select Piston and Bearing".

Method of Using Plastigage

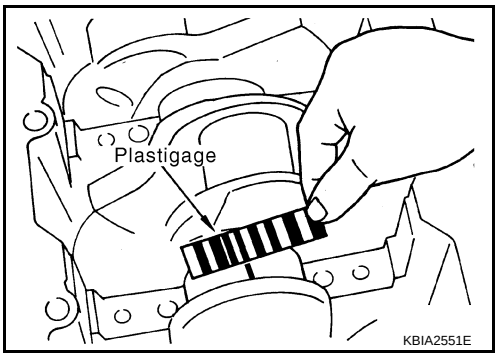
- Remove oil and dust on the crankshaft journal and surfaces of each bearing completely.
- Cut a plastigage slightly shorter than the bearing width, and place it in crankshaft axial direction, avoiding oil holes.
- Install the main bearings to the cylinder block and main bearing cap, and tighten the main bearing bolts to the specified torque.

  CAUTION:

  Do not rotate crankshaft with plastigage installed.
- Remove bearing cap and bearings. Measure plastigage width using the scale on the plastigage bag.

  NOTE:

  The procedure when the measured value exceeds the repair limit is the same as that described in “Method of Measurement”.

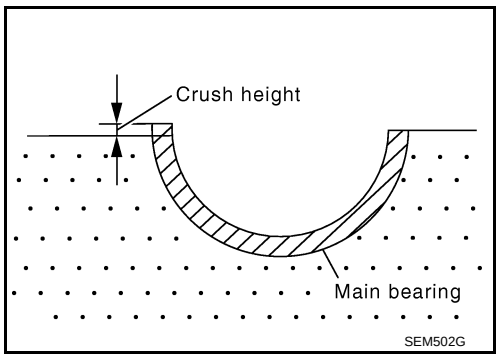


CRUSH HEIGHT OF MAIN BEARING

- When the bearing cap is removed after being tightened to the specified torque with main bearings installed, the tip end of the bearing must protrude. Refer to EM-222, "Disassembly and Assembly" for the tightening procedure.

Standard : There must be crush height

- If standard is not met, replace main bearings.

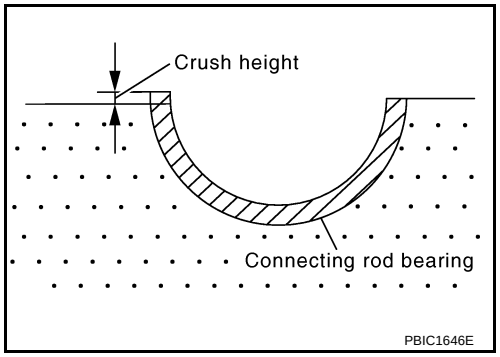


CRUSH HEIGHT OF CONNECTING ROD BEARING

- When connecting rod bearing cap is removed after being tightened to the specified torque with the connecting rod bearings installed, the tip end of the bearing must protrude. Refer to EM-222, "Disassembly and Assembly" for tightening procedure.

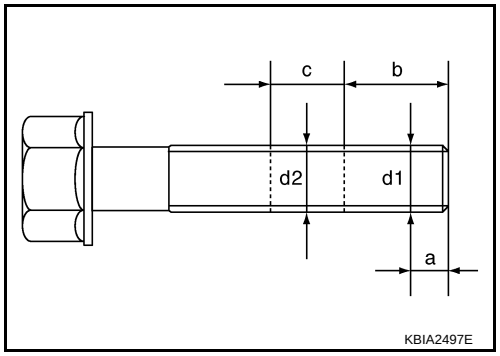
Standard : There must be crush height.

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



MAIN BEARING CAP BOLT DIAMETER

- Check for bolts (M9 and M12) installed from lower side using the following procedure.
  NOTE:
  - Side bolt (M10) is outside the target.
  - Figure shows M12 bolt.
- Measure bolt diameter ″d1″ from tip of the bolt to dimension "a".
- Measure bolt diameter ″d2″ from the dimension between tip of the bolt and dimension ″b″ as base station to dimension ″c″.
  NOTE:
  If a narrower part in the threads is determined by visual check, measure ″d2″ at that point.
- Calculate the difference between ″d1″ and ″d2″.



M9 bolt

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

M12 bolt

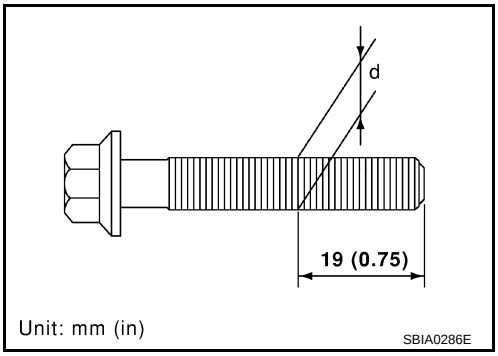
Dimension “a” : 12 mm (0.47 in)
Dimension “b” : 55 mm (2.17 in)
Dimension “c” : 20 mm (0.79 in)
Limit : 0.15 mm (0.0059 in)

- Replace applicable bolts if outside the limit.

CONNECTING ROD BOLT DIAMETER

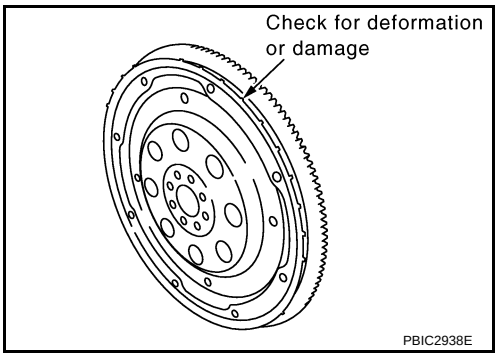
- Measure diameter "d" at position shown.
- When "d" is out of specifications (when it becomes thinner), replace bolt with a new one.

Limit : 7.75 mm (0.3051 in) or less.



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.



HOW TO SELECT PISTON AND BEARING

How to Select Piston and Bearing

INFOID:0000000001282039

DESCRIPTION

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

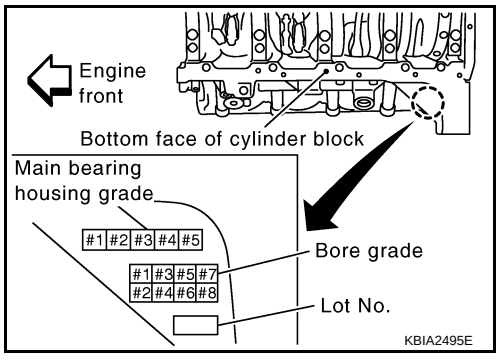
*For the service parts, the grade for fitting cannot be selected between a piston pin and a connecting rod. (Only 0 grade is available.) The information at the shipment from the plant is described as a reference.

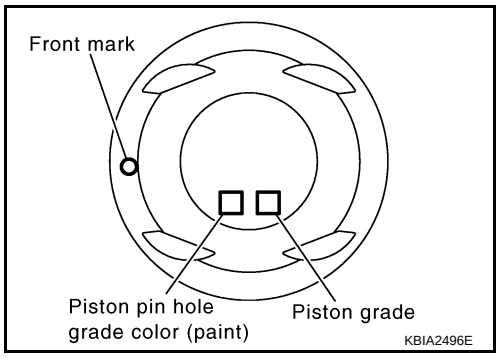
- The identification grade stamped on each part is the grade for the dimension measured in new condition. This grade cannot apply to reused parts.
- For reused or repaired parts, measure the dimension accurately. Determine the grade by comparing the measurement with the values of each selection table.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

HOW TO SELECT PISTON

Piston Selective Fitting When New Cylinder Block is Used:

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





When Cylinder Block is Reused

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

Piston Selection Table

Unit: mm (in)

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

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

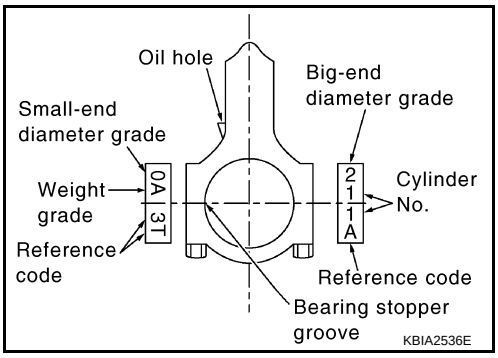
Piston oversize (Service) : 0.20 mm (0.0079 in)

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

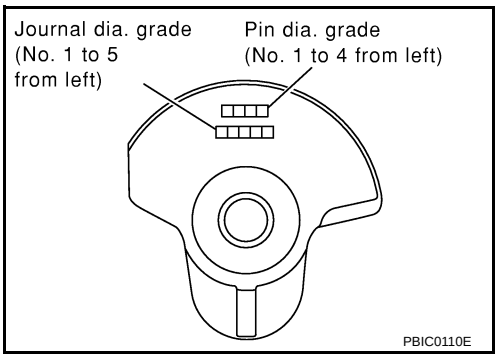
HOW TO SELECT CONNECTING ROD BEARING

When New Connecting Rod and Crankshaft are Used

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



2. Apply the pin diameter grade stamped on the crankshaft front side to the column in the “Connecting Rod Bearing Selection Table”.
3. Read the symbol at the cross point of the selected row and column in the “Connecting Rod Bearing Selection Table”.
4. Apply the symbol obtained to the "Connecting Rod Bearing Grade Table" to select.



When Crankshaft and Connecting Rod are Reused

1. Measure dimensions of the big end inside diameter of the connecting rod and diameter of the crankshaft pin individually.
2. Apply the measured dimension to the “Connecting Rod Bearing Selection Table”.
3. The following steps are the same as in “When New Connecting Rod and Crankshaft are Used”. Follow the "HOW TO SELECT CONNECTING ROD BEARING" procedure.

Connecting Rod Bearing Selection Table

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

KBIA2538E

Connecting Rod Bearing Grade Table.

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

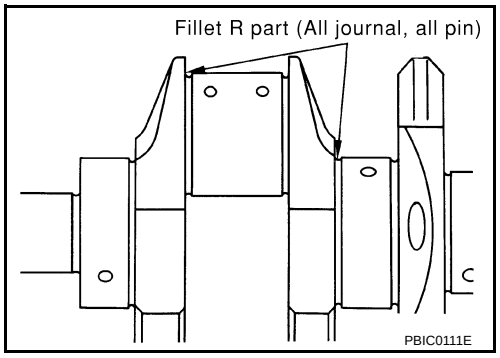
Undersize Bearings Usage Guide

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

Bearing undersize table

Unit: mm (in)

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



CAUTION:

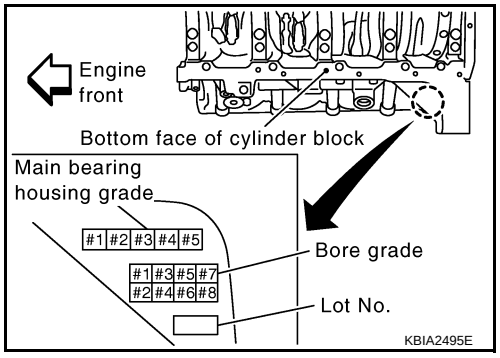
In grinding the crankshaft pin to use undersize bearings, keep the fillet R (All crankshaft pins).

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

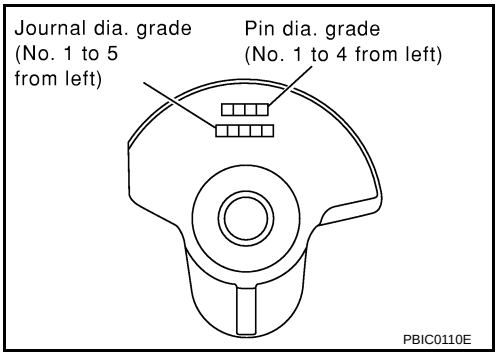
HOW TO SELECT MAIN BEARING

When New Cylinder Block and Crankshaft are Used

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



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



3. Read the symbol at the cross point of the selected row and column in the "Main Bearings Selection Table".
   CAUTION:
   - **Initial clearance for No. 1, 5 journal and No. 2, 3, 4 journal is different. Use two different selection lists for each part.**
   - **No. 1, 5 journal and No. 2, 3, 4 journal have the same signs but different measures. Do not confuse them.**

4. Apply the symbol to the "Main Bearings Grade Table" to select.
   NOTE:
   - Grade list applies to all journals.
   - Service parts are available as a set of both upper and lower.

When Cylinder Block and Crankshaft are Reused

1. Measure the inside diameter of the cylinder block main bearings housing and the outside diameter of the crankshaft journal.
2. Apply measurement in above step 1 to "Main Bearings Selection Table".
3. The following steps are same as in “When New Cylinder Block and Crankshaft are Used”. Follow the "HOW TO SELECT MAIN BEARING" procedure.

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

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

WBIA0608E

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

Crankshaft journal outer diameter / Cylinder block main bearing housing inner diameter		I.D. mark	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	4	7
		Inner diameter Unit: mm (in)	68.944 – 68.945 (2.7143 – 2.7144)	68.945 – 68.946 (2.7144 – 2.7144)	68.946 – 68.947 (2.7144 – 2.7144)	68.947 – 68.948 (2.7144 – 2.7145)	68.948 – 68.949 (2.7145 – 2.7145)	68.949 – 68.950 (2.7145 – 2.7146)	68.950 – 68.951 (2.7146 – 2.7146)	68.951 – 68.952 (2.7146 – 2.7146)	68.952 – 68.953 (2.7146 – 2.7147)	68.953 – 68.954 (2.7147 – 2.7147)	68.954 – 68.955 (2.7147 – 2.7148)	68.955 – 68.956 (2.7148 – 2.7148)	68.956 – 68.957 (2.7148 – 2.7148)	68.957 – 68.958 (2.7148 – 2.7149)	68.958 – 68.959 (2.7149 – 2.7149)	68.959 – 68.960 (2.7149 – 2.7150)	68.960 – 68.961 (2.7150 – 2.7150)	68.961 – 68.962 (2.7150 – 2.7150)	68.962 – 68.963 (2.7150 – 2.7151)	68.963 – 68.964 (2.7151 – 2.7151)	68.964 – 68.965 (2.7151 – 2.7152)	68.965 – 68.966 (2.7152 – 2.7152)	68.966 – 68.967 (2.7152 – 2.7152)	68.967 – 68.968 (2.7152 – 2.7153)
I.D. mark	Outer diameter Unit: mm (in)																									
A	63.964 – 63.963 (2.5183 – 2.5182)		0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4
B	63.963 – 63.962 (2.5182 – 2.5182)		0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4
C	63.962 – 63.961 (2.5182 – 2.5181)		01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4
D	63.961 – 63.960 (2.5181 – 2.5181)		01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45
E	63.960 – 63.959 (2.5181 – 2.5181)		01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45
F	63.959 – 63.958 (2.5181 – 2.5180)		1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45
G	63.958 – 63.957 (2.5180 – 2.5180)		1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5
H	63.957 – 63.956 (2.5180 – 2.5179)		1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5
J	63.956 – 63.955 (2.5179 – 2.5179)		12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5
K	63.955 – 63.954 (2.5179 – 2.5179)		12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56
L	63.954 – 63.953 (2.5179 – 2.5178)		12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56
M	63.953 – 63.952 (2.5178 – 2.5178)		2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56
N	63.952 – 63.951 (2.5178 – 2.5178)		2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6
P	63.951 – 63.950 (2.5178 – 2.5177)		2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6
R	63.950 – 63.949 (2.5177 – 2.5177)		23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6
S	63.949 – 63.948 (2.5177 – 2.5176)		23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67
T	63.948 – 63.947 (2.5176 – 2.5176)		23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67
U	63.947 – 63.946 (2.5176 – 2.5176)		3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67
V	63.946 – 63.945 (2.5176 – 2.5175)		3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7
W	63.945 – 63.944 (2.5175 – 2.5175)		3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7
X	63.944 – 63.943 (2.5175 – 2.5174)		34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7
Y	63.943 – 63.942 (2.5174 – 2.5174)		34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78
1	63.942 – 63.941 (2.5174 – 2.5174)		34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78
2	63.941 – 63.940 (2.5174 – 2.5173)		4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	78	78	78

WBIA0609E

Main Bearings Grade Table (All Journals)

Unit: mm (in)

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

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

Use Undersize Bearing Usage Guide

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

Bearing undersize table

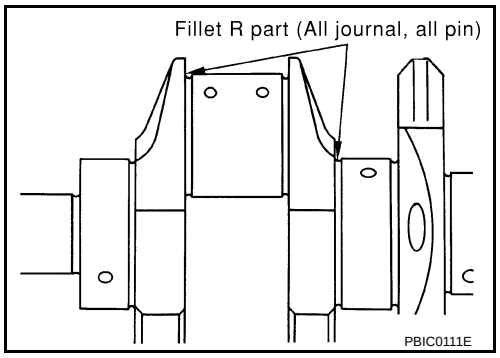
Unit: mm (in)

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

CAUTION:

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

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



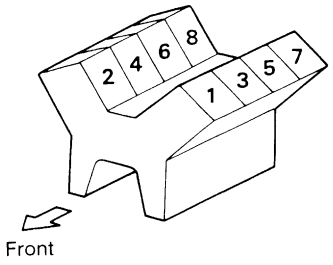
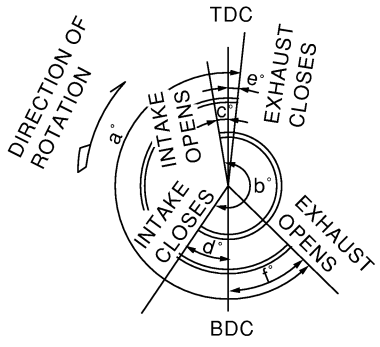
SERVICE DATA AND SPECIFICATIONS (SDS)

SERVICE DATA AND SPECIFICATIONS (SDS)

Standard and Limit

INFOID:0000000001282041

GENERAL SPECIFICATIONS

Cylinder arrangement		V-8
Displacement cm^3 (in^3)		5,552 (338.80)
Bore and stroke mm (in)		98 x 92 (3.86 x 3.62)
Valve arrangement		DOHC
Firing order		1-8-7-3-6-5-4-2
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		5
Compression ratio		9.8:1
Compression pressure kPa (kg/cm^2, psi)/rpm	Standard	1,520 (15.5, 220)/200
	Minimum	1,324 (13.5, 192)/200
	Differential limit between cylinders	98 (1.0, 14)/200
Cylinder number	 SEM957C	
Valve timing	 PBIC0187E	

Unit: degree

a	b	c	d	e	f
244°	232°	8°	60°	10°	54°

DRIVE BELTS

Tension of drive belts	Auto adjustment by auto tensioner

EXHAUST MANIFOLD

Unit: mm (in)

Items		Limit
Surface distortion	Exhaust manifold	0.3 (0.012)

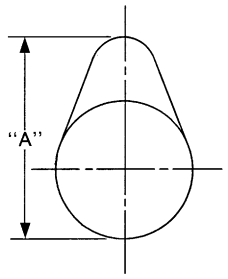
SPARK PLUG

Make	NGK
Standard type	DILFR5A-11
Gap (nominal)	1.1 mm (0.043 in)

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

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



SEM671

Camshaft cam height "A"	Intake	44.865 - 45.055 (1.7663 - 1.7738)
	Exhaust	45.075 - 45.265 (1.7746 - 1.7821)
	Cam wear limit	0.02 (0.0008)
Outside diameter of camshaft journal		25.950 - 25.970 (1.0217 - 1.0224)
Camshaft bracket inside diameter		26.000 - 26.021 (1.0236 - 1.0244)
Camshaft journal clearance		0.030 - 0.071 (0.0012 - 0.0028)
Camshaft end play		0.115 - 0.188 (0.0045 - 0.0074)
Camshaft sprocket runout [TIR*]		Less than 0.15 (0.0059)

*: Total indicator reading

Valve Lifter

Unit: mm (in)

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

Valve Clearance

Unit: mm (in)

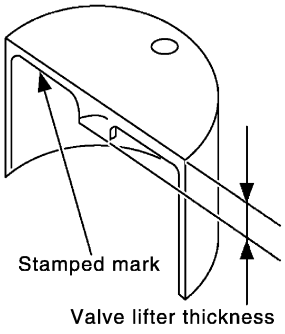
Items	Hot*	Cold
Intake	0.304 - 0.416 (0.012 - 0.016)	0.26 - 0.34 (0.010 - 0.013)
Exhaust	0.308 - 0.432 (0.012 - 0.017)	0.29 - 0.37 (0.011 - 0.015)

*: Approximately 80°C (176°F)

Available Valve Lifter

Unit: mm (in)

Identification (stamped) Mark	Thickness



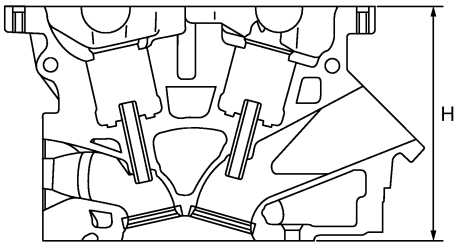
N788	7.88 (0.3102)
N790	7.90 (0.3110)
N792	7.92 (0.3118)
N794	7.94 (0.3126)
N796	7.96 (0.3134)
N798	7.98 (0.3142)
N800	8.00 (0.3150)
N802	8.02 (03.157)
N804	8.04 (0.3165)
N806	8.06 (0.3173)
N808	8.08 (0.3181)
N810	8.10 (0.3189)
N812	8.12 (0.3197)
N814	8.14 (0.3205)
N816	8.16 (0.3213)
N818	8.18 (0.3220)
N820	8.20 (0.3228)
N822	8.22 (0.3236)
N824	8.24 (0.3244)
N826	8.26 (0.3252)
N828	8.28 (0.3260)
N830	8.30 (0.3268)
N832	8.32 (0.3276)
N834	8.34 (0.3283)
N836	8.36 (0.3291)

CYLINDER HEAD

Unit: mm (in)

Items	Standard	Limit
Head surface distortion	0.03 (0.0012)	0.1 (0.004)

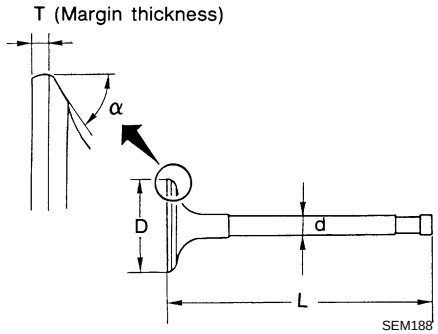
Items	Standard	Limit
Nominal cylinder head height “H”	126.3 (4.97)	



KBIA2554E

Valve Dimensions

Unit: mm (in)

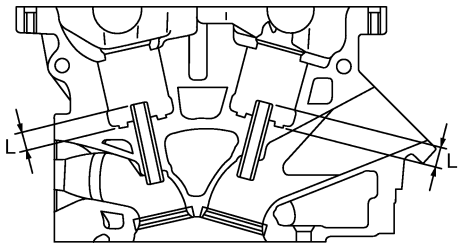


SEM188

Valve head diameter “D”	Intake	37.0 - 37.3 (1.457 - 1.469)
	Exhaust	31.2 - 31.5 (1.228 - 1.240)
Valve length “L”	Intake	96.21- 96.71 (3.7878 - 3.8075)
	Exhaust	93.74 - 94.24 (3.6905 - 3.7102)
Valve stem diameter “d”	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.955 - 5.970 (0.2344 - 0.2350)
Valve seat angle “α”	Intake	45°15′ - 45°45′
	Exhaust	
Valve margin “T”	Intake	1.1 (0.043)
	Exhaust	1.3 (0.051)

Valve Guide

Unit: mm (in)



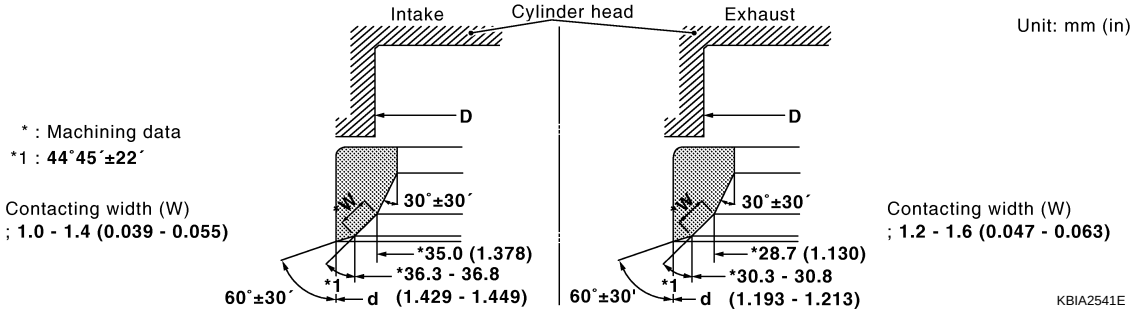
KBIA2555E

Items	Standard	Oversize [0.2 (0.008)] (service)

Valve guide	Outside diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
	Inside diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	—
Cylinder head valve guide hole diameter		9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
Items		Standard	Limit
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
	Exhaust	0.030 - 0.063 (0.0012 - 0.0025)	0.09 (0.0035)
Projection length “L”	Intake	12.6 - 12.8 (0.496 - 0.504)	
	Exhaust	12.5 - 12.9 (0.492 - 0.508)	

Valve Seat

Unit: mm (in)



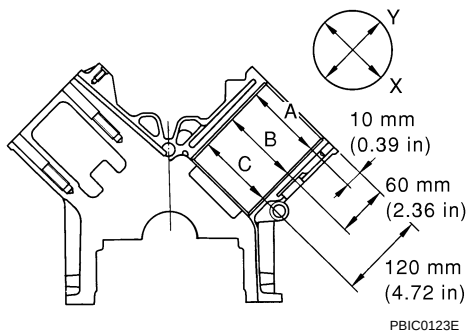
Items		Standard	Oversize [0.5 (0.020)] (Service)
Cylinder head seat recess diameter ″D″	Intake	38.000 - 38.016 (1.4961 - 1.4967)	38.500 - 38.516 (1.5157 - 1.5164)
	Exhaust	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)
Valve seat interference fit	Intake	0.081 - 0.113 (0.0032 - 0.0044)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

Valve Spring

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

CYLINDER BLOCK

Unit: mm (in)

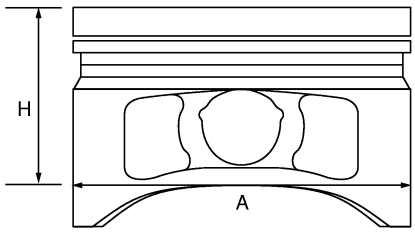


Surface flatness	Standard		0.03 (0.0012)
	LImit		0.1 (0.004)
Main bearing housing inside diameter	Standard		68.944 - 68.968 (2.7143 - 2.7153)
Cylinder bore diameter	Standard	Grade No. 1	98.000 - 98.010 (3.8583 - 3.8587)
		Grade No. 2	98.010 - 98.020 (3.8587 - 3.8590)
		Grade No. 3	98.020 - 98.030 (3.8590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

PISTON, PISTON RING AND PISTON PIN

Available Piston

Unit: mm (in)



PBIC0188E

Items		Standard	Limit
Piston skirt diameter “A”	Grade No. 1	97.980 - 97.990 (3.8575 - 3.8579)	—
	Grade No. 2	97.990 - 98.000 (3.8579 - 3.8583)	—
	Grade No. 3	98.000 - 98.010 (3.8583 - 3.8587)	—
	Grade No. 0 (Service)	98.180 - 98.210 (3.8653 - 3.8665)	0.20 (0.0079)

"H" dimension		39 (1.54)	—
Piston pin hole diameter	Grade No. 0	21.993 - 21.999 (0.8659 - 0.8661)	—
Piston to cylinder bore clearance		0.010 - 0.030 (0.0004 - 0.0012)	0.08 (0.0031)

Piston Ring

Unit: mm (in)

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

Piston Pin

Unit: mm (in)

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

CONNECTING ROD

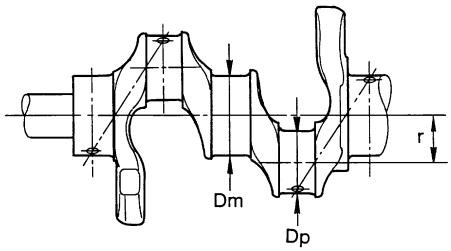
Unit: mm (in)

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

*: After installing in connecting rod

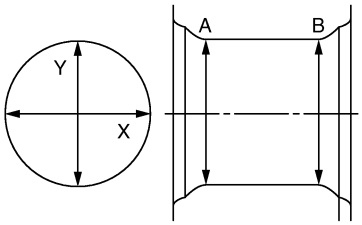
CRANKSHAFT

Unit: mm (in)



SEM645

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



PBIC1686E

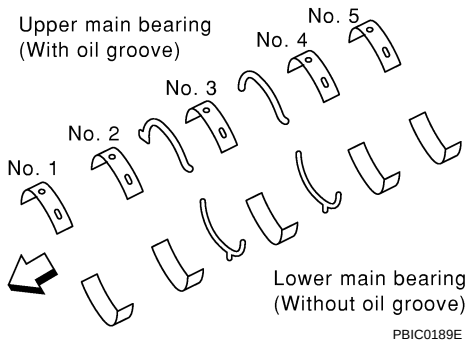
Main journal dia. “Dm” grade (No. 1 and 5)	Standard	Grade No. G	63.963 - 63.964 (2.5182 - 2.5183)
		Grade No. H	63.962 - 63.963 (2.5182 - 2.5182)
		Grade No. J	63.961 - 63.962 (2.5181 - 2.5182)
		Grade No. K	63.960 - 63.961 (2.5181 - 2.5181)
		Grade No. L	63.959 - 63.960 (2.5181 - 2.5181)
		Grade No.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

Pin journal dia. “Dp”	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 (2.1243 - 2.1245)
Center distance “r”			45.96 - 46.04 (1.8094 - 1.8126)
Out-of-round (Difference between ″X″ and ″Y″)	Limit		0.002 (0.0001)
Taper (Difference between ″A″ and ″B″)			0.002 (0.0001)
Runout [TIR*]			Less than 0.05 (0.002)
Crankshaft end play	Standard		0.10 - 0.26 (0.0039 - 0.0102)
	Limit		0.30 (0.0118)

*: Total indicator reading

MAIN BEARING

Unit: mm (in)



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

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

Undersize

Unit: mm (in)

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

Main Bearing Oil Clearance

Unit: mm (in)

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

Connecting Rod Bearing

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

Undersize

Unit: mm (in)

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

Connecting Rod Bearing Oil Clearance

Unit: mm (in)

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