

ENGINE MECHANICAL

SECTION EM

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

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

The Supplemental Restraint System such as "AIR BAG" and "SEAT BELT PRE-TENSIONER", used along with a seat belt, helps to reduce the risk or severity of injury to the driver and front passenger for certain types of collision. The Supplemental Restraint System consists of driver air bag module (located in the center of the steering wheel), front passenger air bag module (located on the instrument panel on passenger side), seat belt pre-tensioners, a diagnosis sensor unit, crash zone sensor, seat belt buckle switches, warning lamp, wiring harness and spiral cable.

Information necessary to service the system safely is included in the **RS section** of this Service Manual.

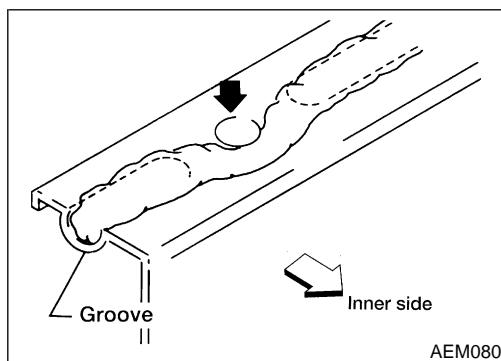
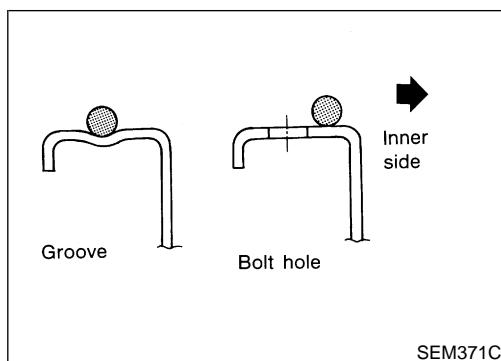
WARNING:

- 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 should be performed by an authorized NISSAN 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 RS 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 harness connectors.

Parts Requiring Angular Tightening

- NGEM0086
- Use an angle wrench for the final tightening of the following engine parts:
 - a) Cylinder head bolts
 - b) Connecting rod cap nuts
 - 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.

NGEM0087



Liquid Gasket Application Procedure

- 1) Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also completely clean any oil stains from these portions.
- 2) Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Silicone RTV or equivalent. Refer to GI-50, "Recommended Chemical Products and Sealants".)
 - Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) dia. (for oil pan).
 - Be sure liquid gasket is 2.0 to 3.0 mm (0.079 to 0.118 in) dia. (in areas except oil pan).
- 3) Apply liquid gasket to inner surface around hole perimeter area (unless otherwise specified).
- 4) Assembly should be done within 5 minutes after coating.
- 5) Wait at least 30 minutes before refilling engine oil and engine coolant.

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PREPARATION

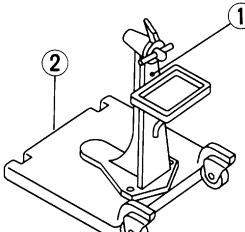
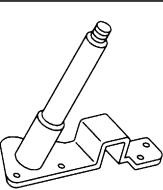
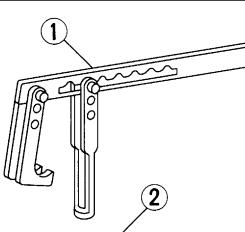
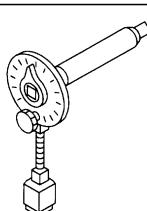
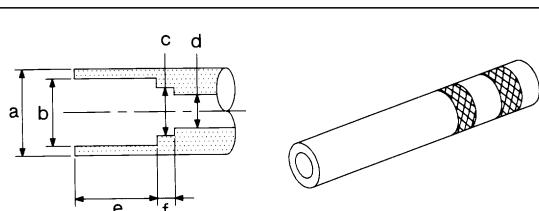
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Special Service Tools

Special Service Tools

NGEM0100

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	 <p>Disassembling and assembling</p> <p>NT042</p>
KV10105001 (—) Engine attachment	 <p>NT031</p>
KV101092S0 (J26336-B) Valve spring compressor 1 KV10109210 (—) Compressor 2 KV100109220 (—) Adapter	 <p>Disassembling and assembling valve components</p> <p>NT021</p>
KV10112100 (BT8653-A) Angle wrench	 <p>Tightening bearing cap, cylinder head bolts, etc.</p> <p>NT014</p>
KV10116300 (J-38955) Valve oil seal drift	 <p>Installing valve oil seal</p> <p>a: 25 (0.98) dia. b: 14.4 (0.567) dia. c: 11.8 (0.465) dia. d: 10 (0.39) dia. e: 11 (0.43) f: 9 (0.35)</p> <p>NT602</p>

PREPARATION

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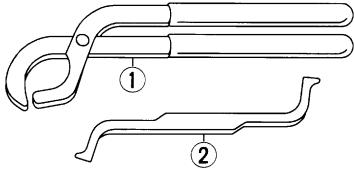
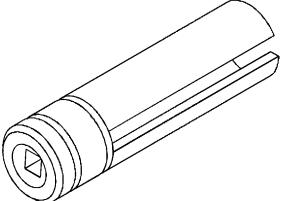
Special Service Tools (Cont'd)

Tool number (Kent-Moore No.) Tool name	Description	
KV10110300 (—) Piston pin press stand assembly 1 KV10110310 (—) Cap 2 KV10110330 (—) Spacer 3 ST13030020 (—) Press stand 4 ST13030030 (—) Spring 5 KV10110340 (—) Drift 6 KV10110320 (—) Center shaft	Disassembling and assembling piston with connecting rod	GI MA EM LC EC FE CL MT
		NT036
EM03470000 (J8037) Piston ring compressor		Installing piston assembly into cylinder bore AT TF
(J36467) Valve oil seal remover		Removing valve oil seal PD AX
ST16610001 (J23907) Pilot bushing puller		Removing crankshaft pilot bushing SU BR
KV10111100 (J37228) Seal cutter		Removing oil pan ST RS
WS39930000 (—) Tube presser		Pressing the tube of liquid gasket BT HA SC EL
	NT044	
	NT034	
	NT045	
	NT046	
	NT052	

PREPARATION

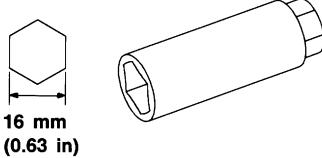
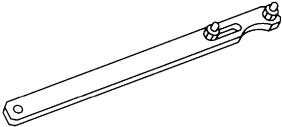
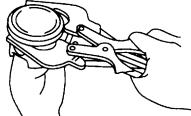
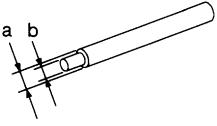
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Special Service Tools (Cont'd)

Tool number (Kent-Moore No.) Tool name	Description	
KV101151S0 (J38972) Lifter stopper set 1 KV10115110 (J38972-1) Camshaft pliers 2 KV10115120 (J38972-2) Lifter stopper	 NT041	Changing valve lifter shims
KV10117100 (J36471-A) Front heated oxygen sen- sor wrench	 NT379	Loosening or tightening heated oxygen sensor For 22 mm (0.87 in) hexagon nut

Commercial Service Tools

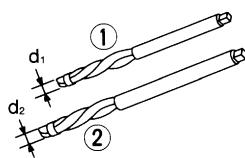
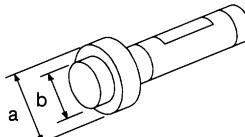
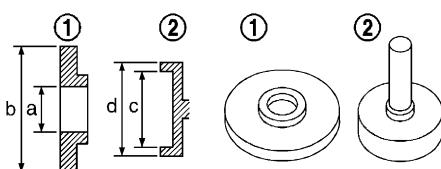
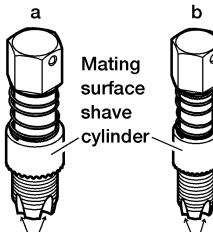
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Tool name (Kent Moore No.)	Description	
Spark plug wrench	 NT047	Removing and installing spark plug
Pulley holder	 NT035	Holding camshaft pulley while tightening or loosening camshaft bolt
Valve seat cutter set	 NT048	Finishing valve seat dimensions
Piston ring expander	 NT030	Removing and installing piston ring
Valve guide drift	 NT015	Removing and installing valve guide Intake & Exhaust: a = 10.5 mm (0.413 in) dia. b = 6.6 mm (0.260 in) dia.

PREPARATION

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Commercial Service Tools (Cont'd)

Tool name (Kent Moore No.)	Description
Valve guide reamer	 <p>NT016</p> <p>Reaming valve guide 1 or hole for oversize valve guide 2 Intake: $d_1 = 7.0 \text{ mm (0.276 in) dia.}$ $d_2 = 11.2 \text{ mm (0.441 in) dia.}$ Exhaust: $d_1 = 8.0 \text{ mm (0.315 in) dia.}$ $d_2 = 12.2 \text{ mm (0.480 in) dia.}$</p>
Front oil seal drift	 <p>NT049</p> <p>Installing front oil seal a: 52 mm (2.05 in) dia. b: 44 mm (1.73 in) dia.</p>
Rear oil seal drift	 <p>NT719</p> <p>Installing rear oil seal a: 46 mm (1.81 in) b: 110 mm (4.33 in) c: 84 mm (3.31 in) d: 96 mm (3.78 in)</p>
a: (J-43897-18) b: (J-43897-12) Thread repair tool for oxygen sensor	 <p>AEM488</p> <p>a: 18 mm (0.71 in) b: 12 mm (0.47 in)</p>
Anti-seize thread compound	 <p>AEM489</p> <p>For preventing corrosion, seizing, and galling on high temperature applications.</p>

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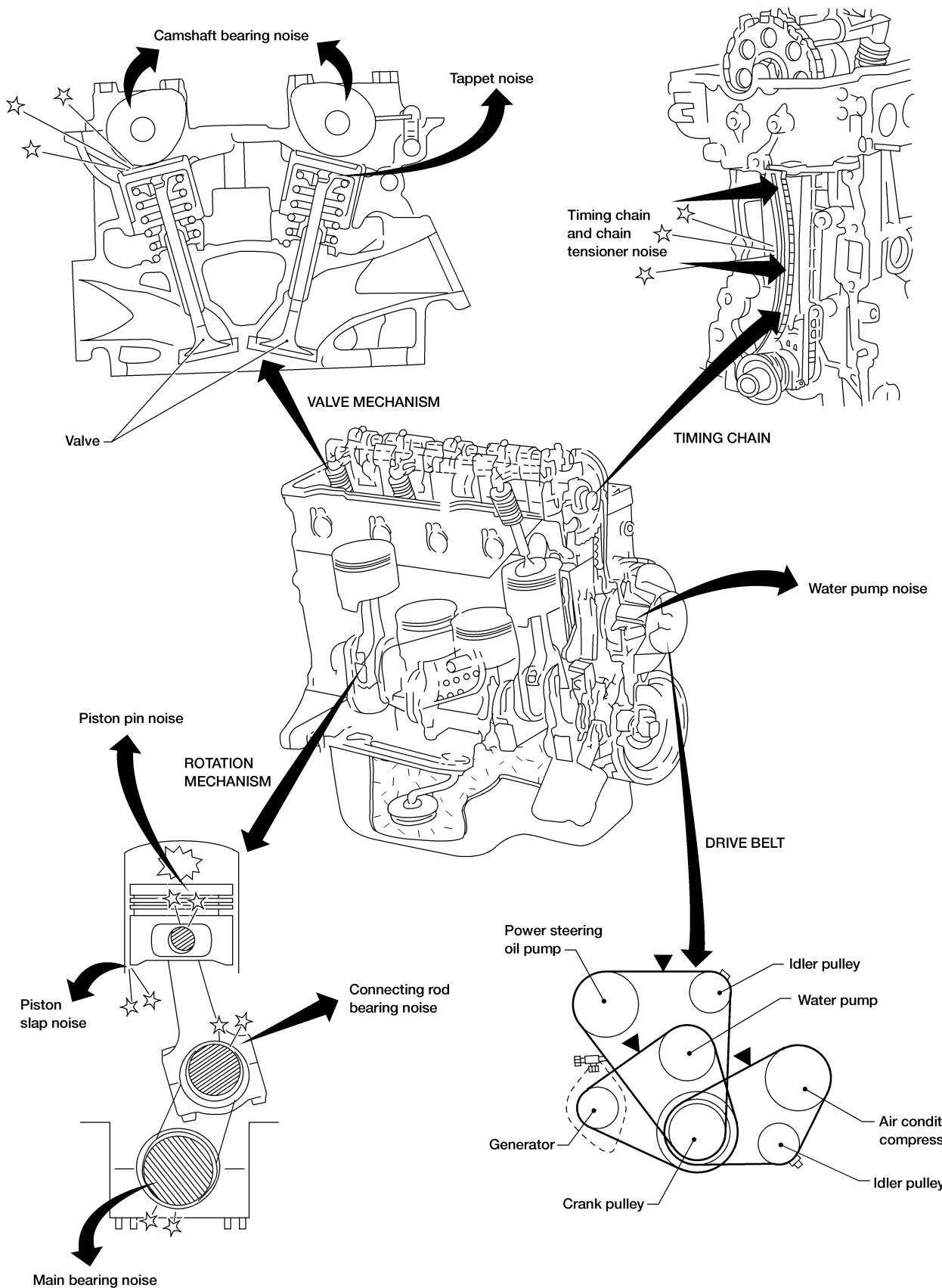
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NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

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NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

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NVH Troubleshooting Chart — Engine Noise

NVH Troubleshooting Chart — Engine Noise

NGEM0046S01

Use the chart below to help you find the cause of the symptom.

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

If necessary, repair or replace these parts.

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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 revving	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-38
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-32
Crankshaft pulley Cylinder block (upper side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance	EM-45, 51
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston ring side clearance Piston ring end gap Connecting rod bend and torsion Piston-to-bore clearance	EM-47, 46
	Knock	A	B	C	B	B	B	Connecting rod-bearing noise	Connecting rod bearing clearance (Big end) Connecting rod bushing clearance (Small end)	EM-50, 51
	Knock	A	B	—	A	B	C	Main bearing noise	Crankshaft runout Main bearing oil clearance	EM-48
Front of engine Timing chain cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear	EM-22
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Other drive belts (Sticking or slipping)	Drive belt deflection	MA-16, "Checking Drive Belts"
	Creaking	A	B	A	B	A	B	Other drive belts (Slipping)	Idler pulley bearing operation	
	Squall creak	A	B	—	B	A	B	Water pump noise	Water pump operation	LC-12, "Water Pump Inspection"

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

OUTER COMPONENT PARTS

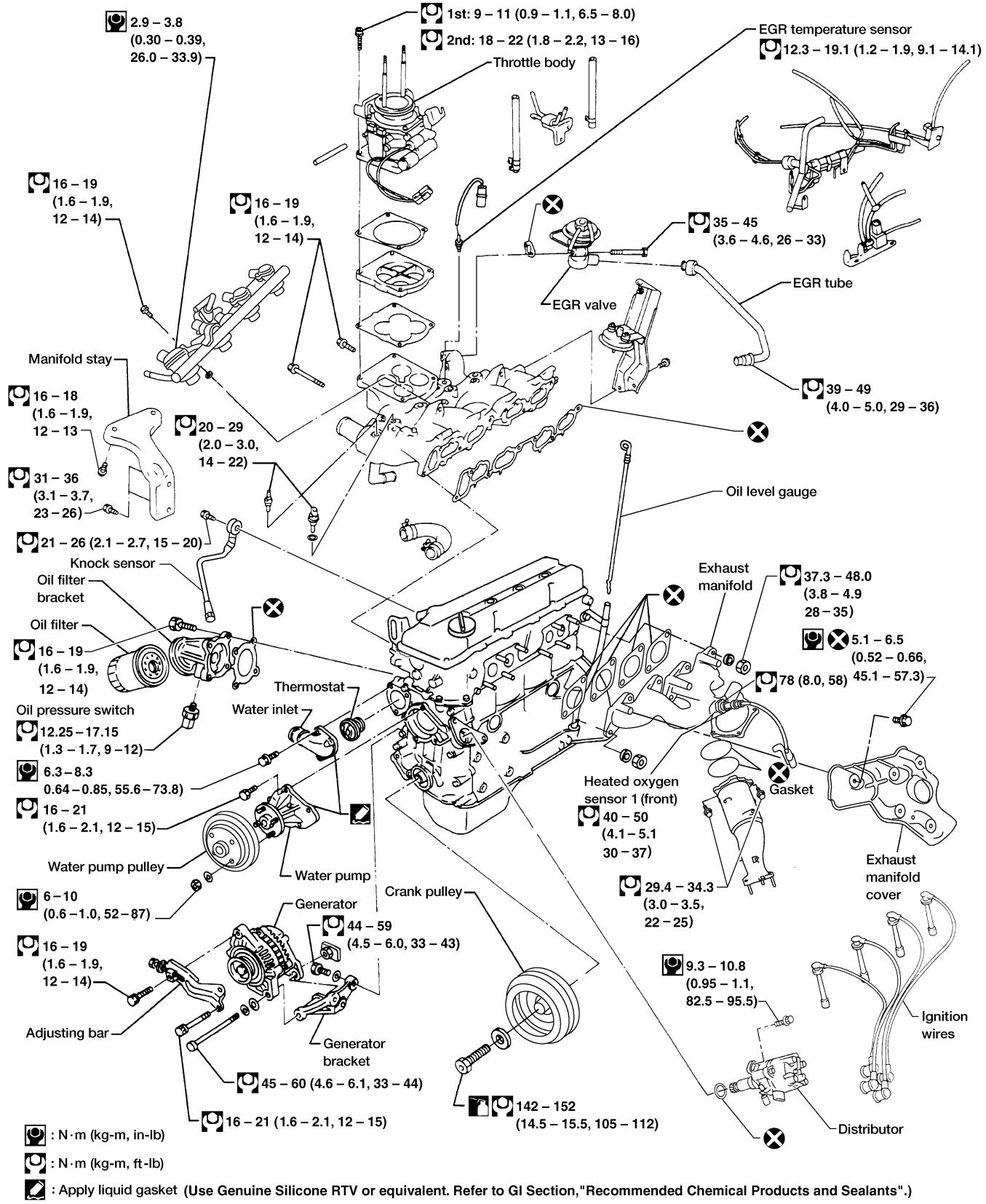
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Removal and Installation

Removal and Installation

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SEC. 120 • 140 • 147 • 150 • 163 • 164 • 210 • 220 • 221 • 230 • 231



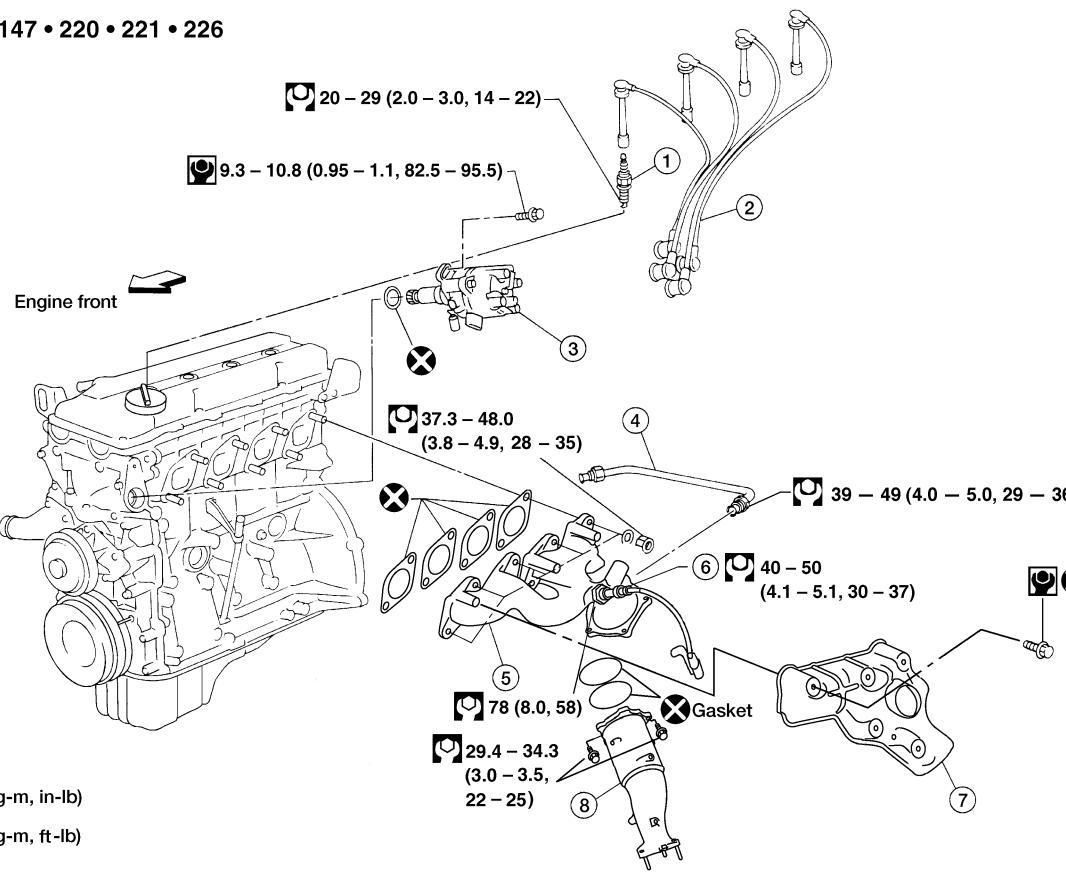
WEM132

OUTER COMPONENT PARTS

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Removal and Installation (Cont'd)

SEC. 140 • 147 • 220 • 221 • 226



P : N·m (kg-m, in-lb)

C : N·m (kg-m, ft-lb)

WEM073

1. Spark plug
2. Ignition wires
3. Camshaft position sensor built into distributor
4. EGR tube
5. Exhaust manifold
6. Heated oxygen sensor 1 (front)
7. Exhaust manifold cover
8. TWC (manifold)

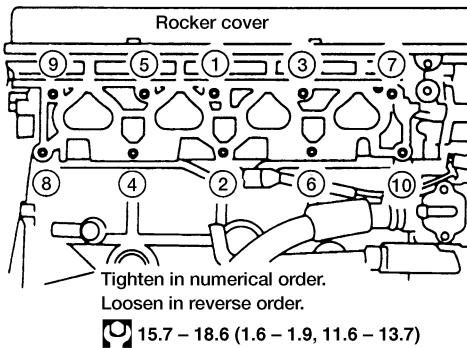
OUTER COMPONENT PARTS

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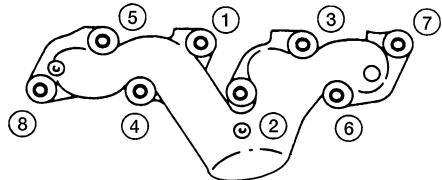
Removal and Installation (Cont'd)

Intake manifold

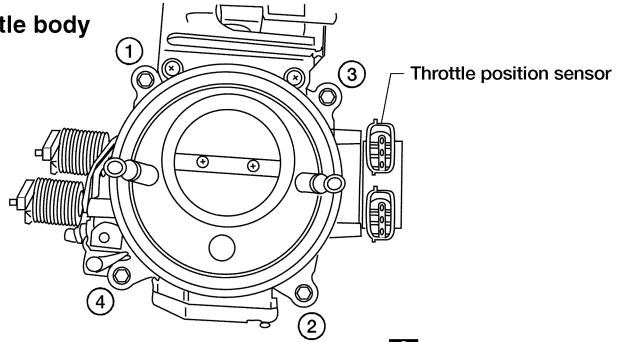
Engine front 



Exhaust manifold



Throttle body



 : N·m (kg·m, ft-lb)

AEM467

MEASUREMENT OF COMPRESSION PRESSURE

NGEM0048

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1. Warm up engine.
2. Turn ignition switch OFF.
3. Release fuel pressure.
Refer to **EC-57**, "Fuel Pressure Release".
4. Remove all spark plugs.
- **Clean area around plug with compressed air before removing the spark plug.**
5. Disconnect camshaft position sensor harness connector at the distributor.
6. Remove fuel injector fuse **3** on FUSE BLOCK (J/B) behind the instrument lower panel driver's side.
7. Attach a compression tester to No. 1 cylinder.
8. Depress accelerator pedal fully to keep throttle valve wide open.
9. Crank engine and record highest gauge indication.
10. Repeat the measurement on each cylinder as shown above.
- **Always use a fully-charged battery to obtain specified engine speed.**

Compression pressure: kPa (kg/cm², psi)/300 rpm

Standard

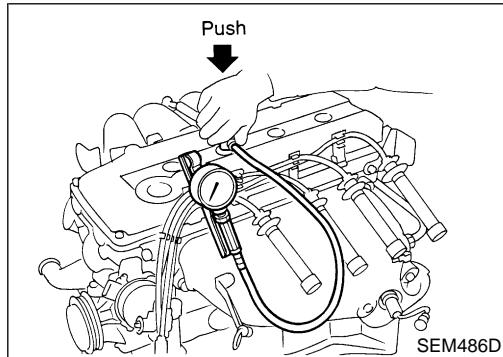
1,226 (12.5, 178)

Minimum

1,030 (10.5, 149)

Difference limit between cylinders

98 (1.0, 14)



11. If compression in one or more cylinders is low:
 - a. Pour a small amount of engine oil into cylinders through spark plug holes.
 - b. Retest compression.
- **If adding oil improves cylinder compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. Refer to "VALVE", EM-56 and "VALVE SEAT", EM-59. If valve or valve seat is damaged excessively, replace it.**
- **If compression in any two cylinders adjacent cylinders is low, and if adding oil does not improve compression, there is leakage past the gasket surface. If so, replace cylinder head gasket.**
12. Reinstall spark plugs, fuel injector fuse, fuel pump fuse, and reconnect camshaft position sensor harness connector at the distributor.
13. Erase the DTC stored in the ECM.

CAUTION:

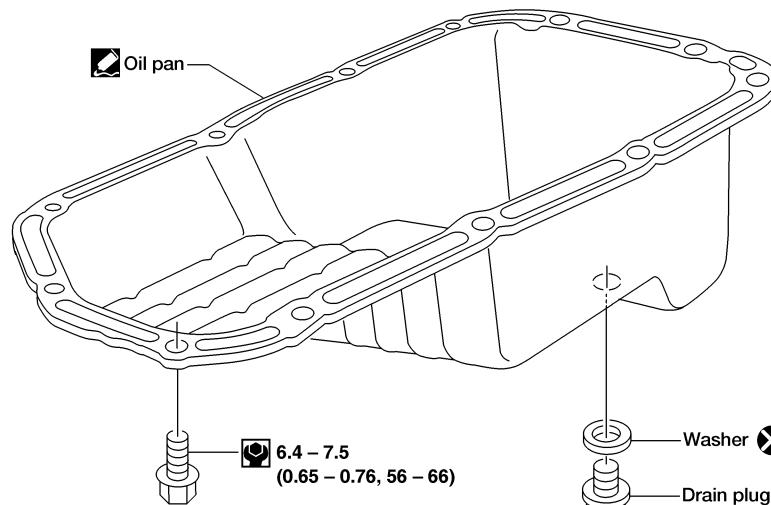
Always erase the DTC after checking compression. Refer to **EC-86**, "HOW TO ERASE EMISSION-RELATED DIAGNOSTIC INFORMATION".

Components

Components

NGEM0049

SEC. 110



: N·m (kg-m, in-lb)

: N·m (kg-m, ft-lb)

: Apply liquid gasket (Use Genuine Silicone RTV or equivalent. Refer to GI Section, "Recommended Chemical Products and Sealants".)

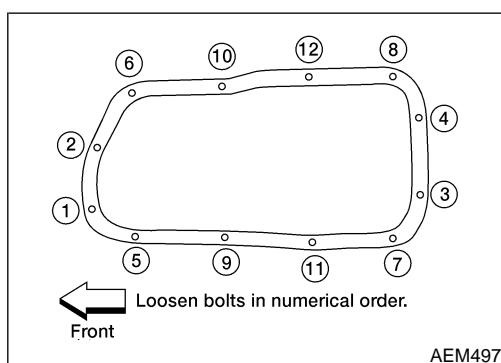
WEM133

Removal

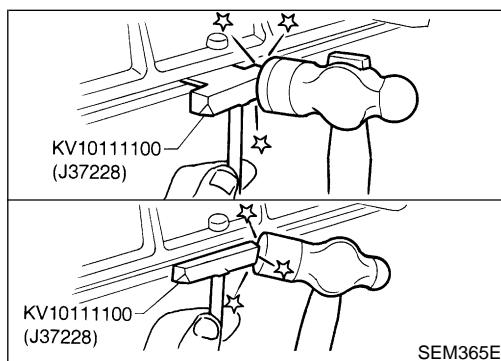
NGEM0050

1. Raise vehicle and support it with safety stands.
2. Remove engine under cover.
3. Drain engine oil.
4. Remove front suspension member.

5. Remove oil pan bolts.



6. Remove oil pan.
 - a. Insert Tool between cylinder block and oil pan.
 - Be careful not to damage aluminum mating surface.
 - Do not insert screwdriver, or oil pan flange will be damaged.
 - b. Slide Tool by tapping on the side of the Tool with a hammer.
7. Pull out oil pan from front side.



NGEM0051

GI

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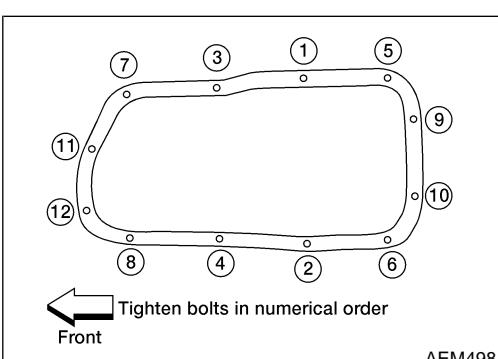
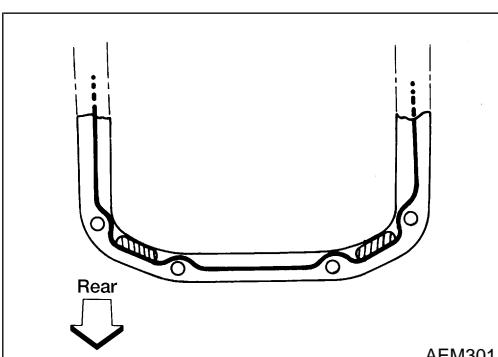
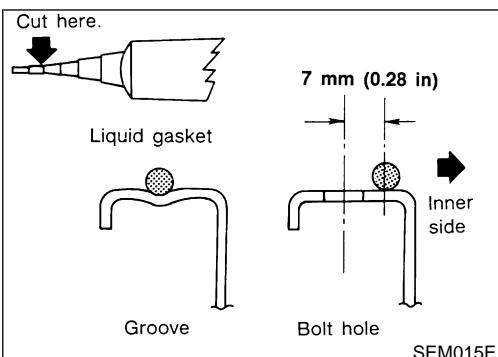
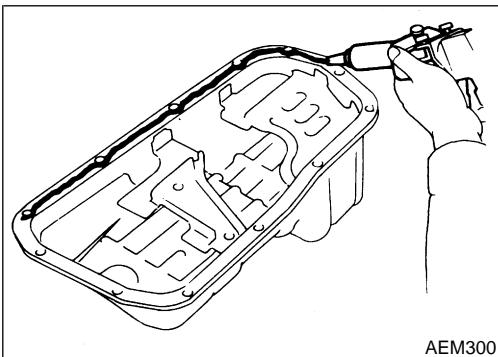
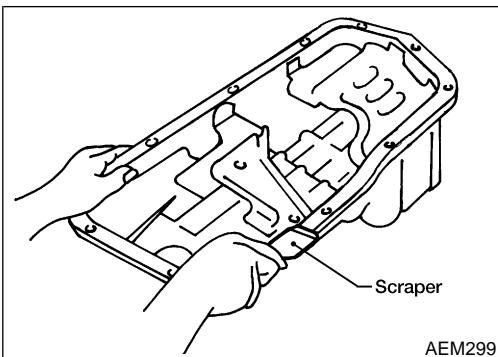
SC

EL

IDX

Installation

1. Use a scraper to remove old liquid gasket from mating surface of oil pan.
- **Also remove traces of liquid gasket from mating surface of cylinder block.**



2. Apply a continuous bead of liquid gasket to mating surface of oil pan.
- **Use Genuine Silicone RTV or equivalent. Refer to GI-50, "Recommended Chemical Products and Sealants".**
- **Apply to groove on mating surface.**
- **Allow 7 mm (0.28 in) clearance around bolt hole.**

- **Be sure liquid gasket diameter is 3.5 to 4.5 mm (0.138 to 0.177 in).**
- **Attaching should be done within 5 minutes after coating.**

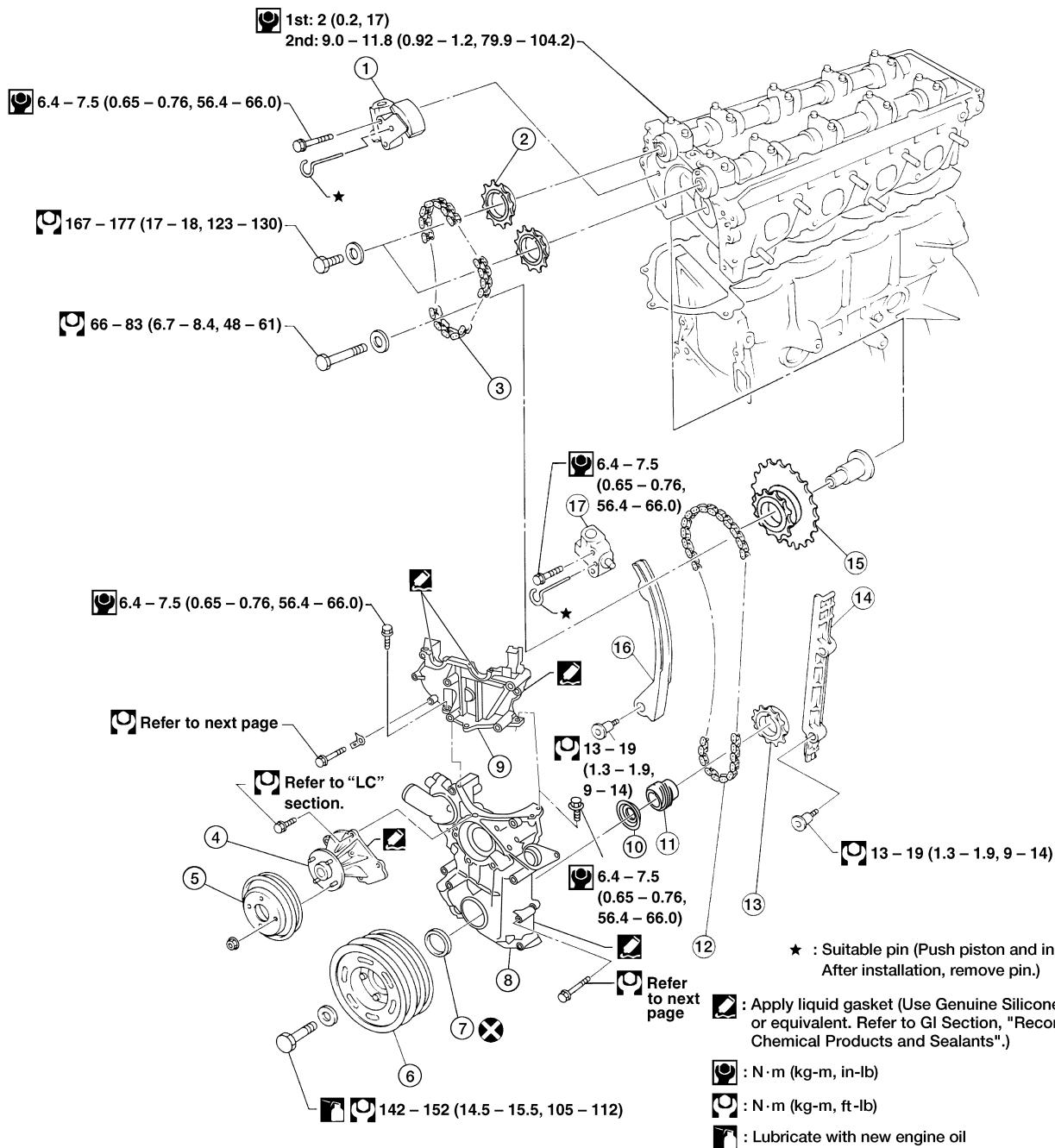
3. Install oil pan.
- **Tighten oil pan bolts in numerical order.**
Blue wrench icon : 6.4 - 7.5 N·m (0.65 - 0.76 kg-m, 56 - 66 in-lb)
- **Wait at least 30 minutes before refilling engine oil.**
4. Install parts in reverse order of removal.

Components

Components

NGEM0052

SEC. 120 • 130 • 135 • 210



WEM134

- | | | |
|---------------------------------|----------------------------|----------------------------------|
| 1. Upper timing chain tensioner | 7. Front oil seal | 13. Crankshaft sprocket |
| 2. Cam sprocket | 8. Front cover | 14. Chain guide |
| 3. Upper timing chain | 9. Camshaft sprocket cover | 15. Idler sprocket |
| 4. Water pump | 10. Oil slinger | 16. Chain tension arm |
| 5. Water pump pulley | 11. Oil pump drive gear | 17. Lower timing chain tensioner |
| 6. Crankshaft pulley | 12. Lower timing chain | |

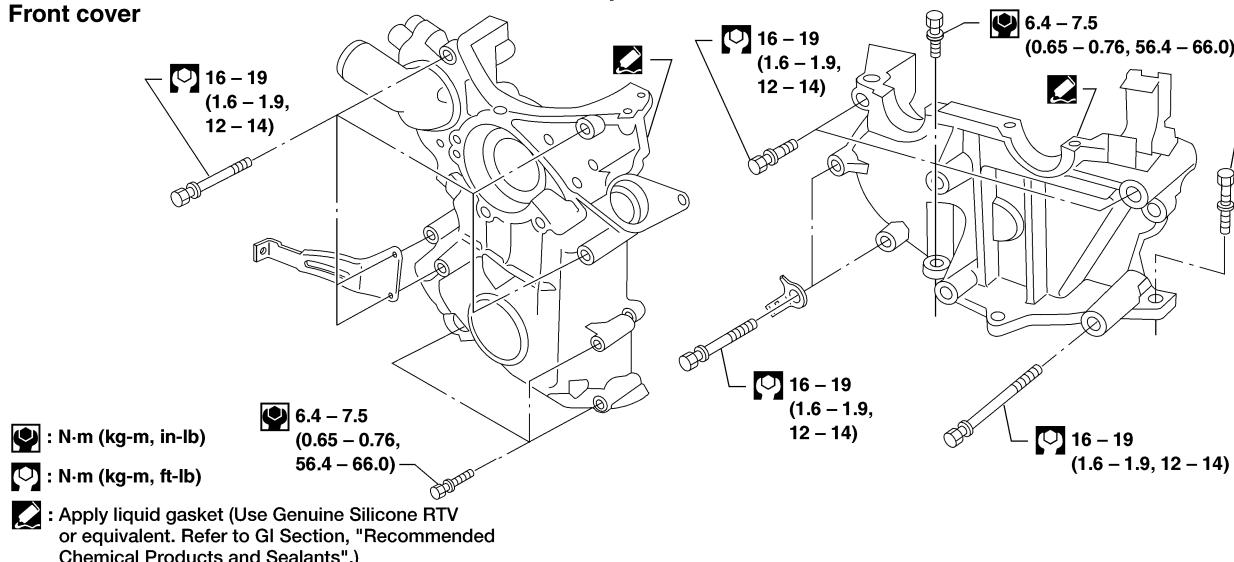
TIMING CHAIN

KA24DE

Components (Cont'd)

SEC. 135
Front cover

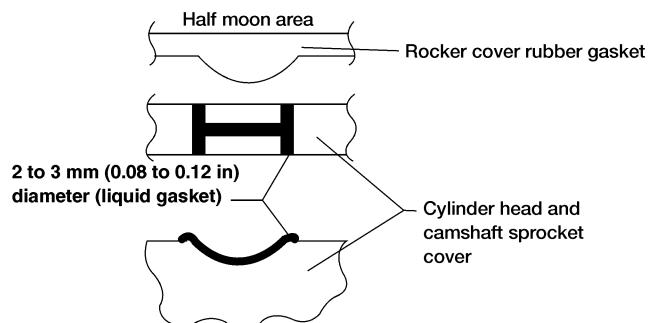
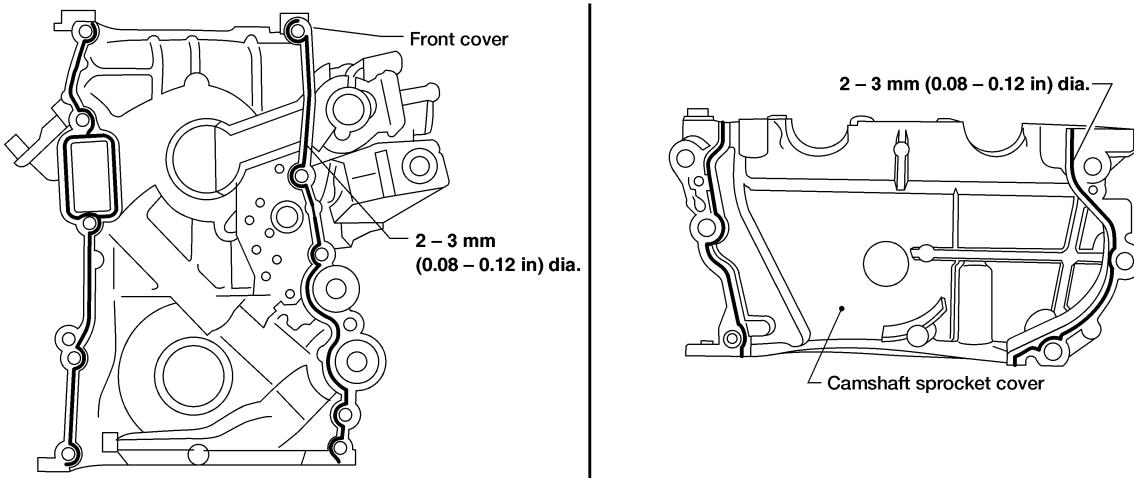
Camshaft sprocket cover



WEM135

LIQUID GASKET APPLICATION PLACES

NGEM0052S01



AEM479

Removal

Removal

NGEM0053

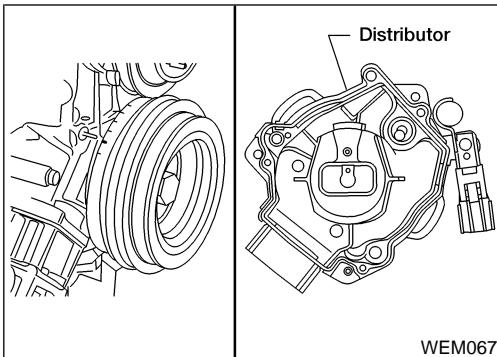
CAUTION:

- After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.
- When installing chain tensioners or other sliding parts, lubricate contacting surfaces with new engine oil.
- Apply new engine oil to bolt threads and seat surfaces when installing camshaft sprockets and crankshaft pulley.
- Do not spill engine coolant on drive belts.

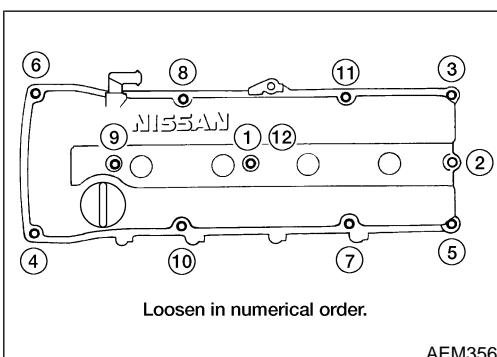
UPPER TIMING CHAIN

NGEM0053S01

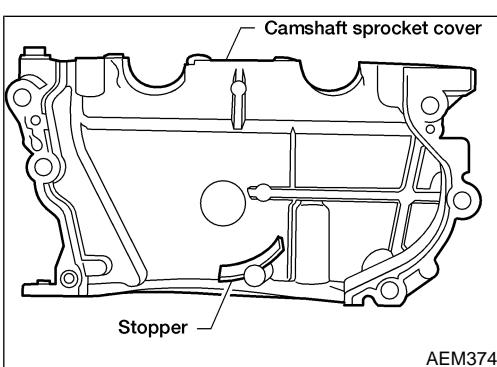
1. Remove the air cleaner assembly.
2. Remove the spark plug wires.



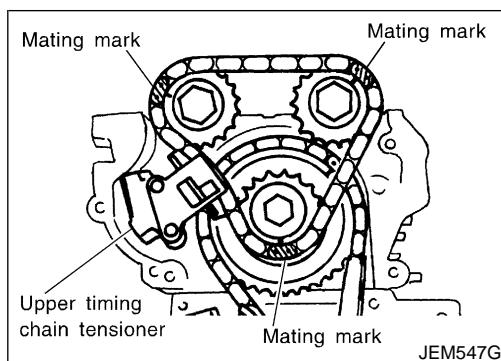
3. Set No.1 piston at TDC on its compression stroke.
4. Remove vacuum hoses, electrical harness connectors, and harness clamps.
5. Remove the power steering belt.
6. Remove the power steering pump and position it to one side. Remove the idler pulley and bracket as well.



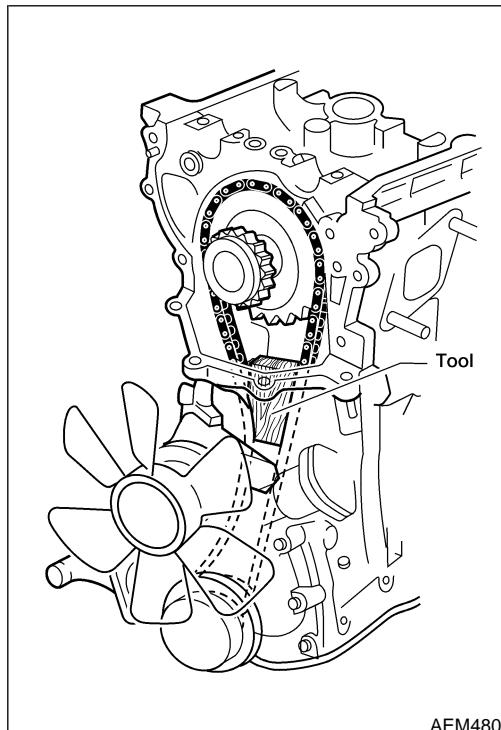
7. Remove the rocker cover.
- Loosen in numerical order as shown to remove the rocker cover bolts.



8. Remove the camshaft sprocket cover.



9. Wipe off the links of the timing chain next to the timing marks on the sprockets. Put paint marks on the timing chain, matching them with the timing marks on the cam sprockets and idler sprocket.
10. Remove cam sprocket bolts, cam sprockets and upper timing chain.



IDLER SPROCKET

NGEM0053S03

1. Remove upper timing chain.
Refer to "UPPER TIMING CHAIN", EM-20.
2. Support lower timing chain by using a suitable tool to prevent chain tensioner spring from coming out.

NOTE:

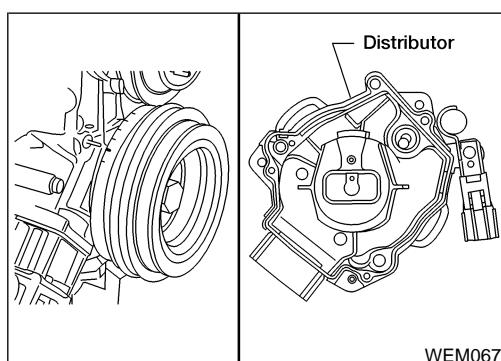
This step is only to be applied when the lower cover is not being removed.

3. Remove the idler sprocket.

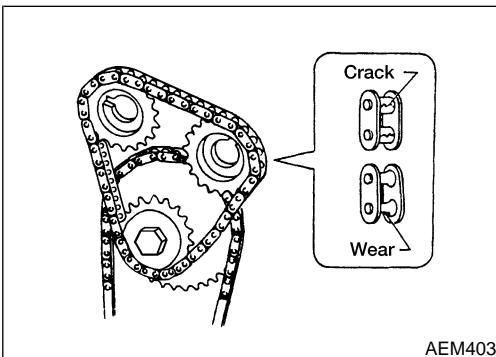
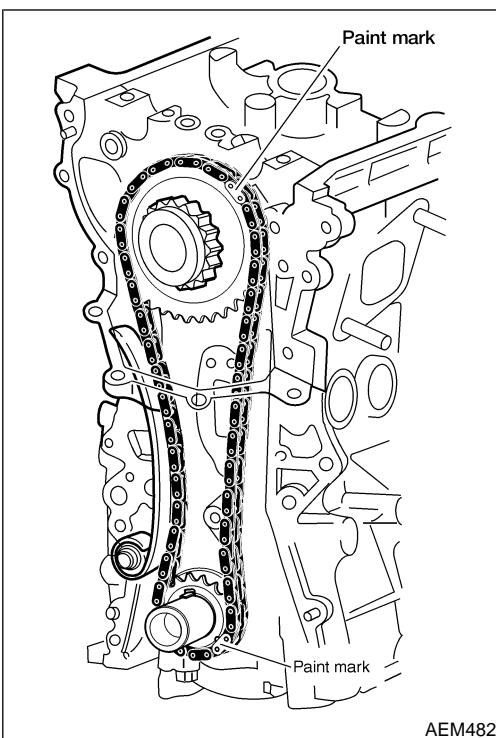
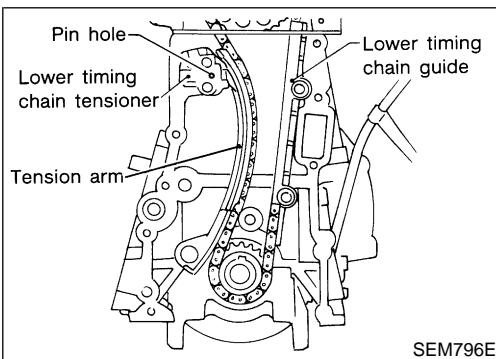
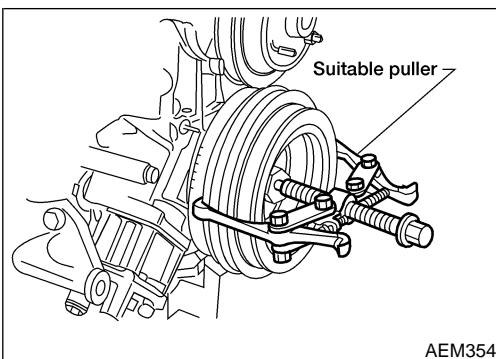
LOWER TIMING CHAIN

NGEM0053S02

1. Drain coolant by removing the cylinder block drain plug and opening the radiator drain cock. Refer to **MA-17**, "Changing Engine Coolant".
2. Drain engine oil from drain plug of oil pan.
3. Remove the following parts.
 - Alternator drive belt.
 - A/C compressor drive belt.
 - Cooling fan with coupling.
 - Radiator shroud.
4. Remove A/C compressor and position it to the side. Remove the idler pulley and bracket as well.
5. Set No. 1 piston to TDC on its compression stroke.
6. Remove the distributor.



Removal (Cont'd)



7. Remove the crankshaft pulley with suitable puller.
8. Remove oil pan.
Refer to "Removal", EM-16.
9. Remove the oil pump and distributor drive shaft, then the oil pickup strainer.
10. Remove the front cover.

CAUTION:**Be careful not to tear or damage the cylinder head gasket.**

11. Remove the following parts.
 - Lower timing chain tensioner (Push piston and insert a suitable pin into pin hole.)
 - Chain tension arm
 - Lower timing chain guide
12. Remove the upper timing chain and idler sprocket. **Refer to "UPPER TIMING CHAIN", EM-20 and "IDLER SPROCKET", EM-21.**
13. Wipe off the links of the timing chain next to the timing marks on the sprockets. Put paint marks on the timing chain, matching them with the timing marks on the crankshaft sprocket and idler sprocket.
14. Remove the lower timing chain and sprocket.

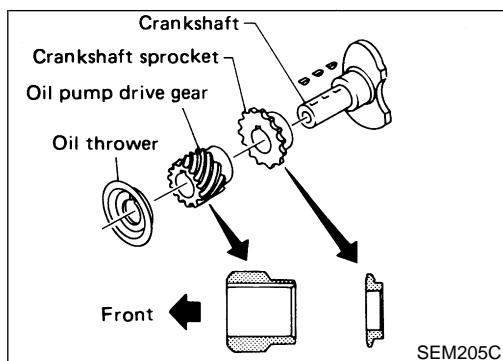
Inspection

NGEM0054
Check for cracks and excessive wear at roller links. Replace chain if necessary.

NGEM0055

NGEM0055S01

GI

**Installation****LOWER TIMING CHAIN**

1. Install crankshaft sprocket.
- **Make sure that mating marks of crankshaft sprocket face front of engine.**
2. Install the idler sprocket and lower timing chain using the mating marks and the paint marks made during the removal process.

CAUTION:**Be careful not to tear or damage the cylinder head gasket.**

3. Install chain guide and chain tension arm.
4. Install lower chain tensioner and remove the pin securing the piston into the tensioner body.

EM

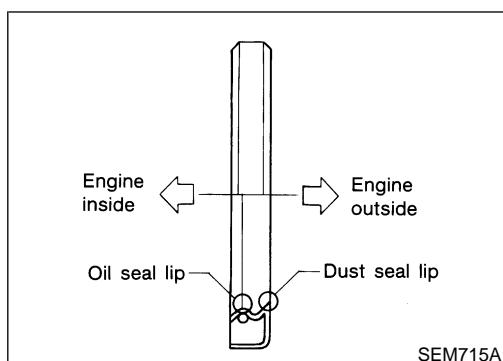
LC

EC

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MT

**5. Front cover installation:**

- Using a scraper or other suitable tool remove all traces of liquid gasket from the cylinder block and front cover mating surfaces.
- Install new crankshaft seal in front cover.
- **Apply a continuous bead of RTV sealant to the front cover. Refer to "LIQUID GASKET APPLICATION PLACES", EM-19.**

NOTE:

Use Genuine Silicone RTV or equivalent. Refer to GI-50, "Recommended Chemical Products and Sealants".

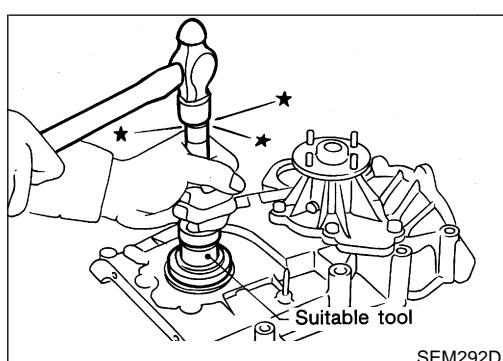
- **Be sure to install new front oil seal. Refer to "FRONT OIL SEAL", EM-26.**
- Also place RTV sealant on the head gasket surface.
- Install the front cover to the engine.
- 6. Install oil strainer and oil pan. Refer to "Installation", EM-17.

AT

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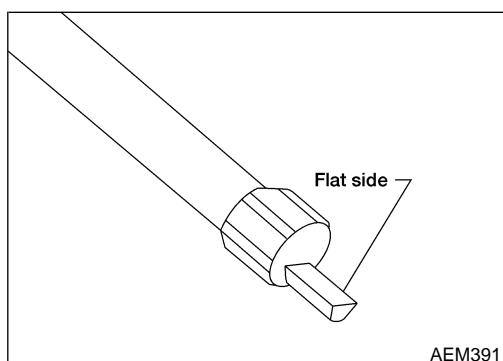
AX

**7. Install the oil pump and distributor drive shaft.****NOTE:**

Make sure the flat side of the distributor drive shaft is facing the engine. Failure to do so will result in the distributor being out of time.

8. Install the following parts:

- Crankshaft pulley.
- A/C compressor and idler pulley bracket.
- Radiator shroud and cooling fan with coupling.
- A/C compressor, alternator and power steering pump drive belts.



HA

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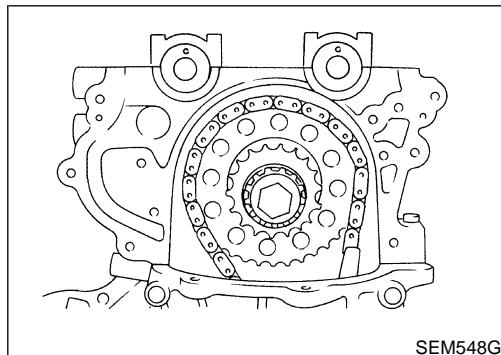
IDX

Installation (Cont'd)

- Air duct.

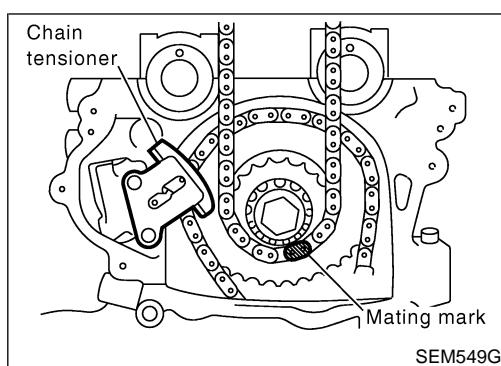
IDLER SPROCKET

- NGEM0055S03
1. Install lower timing chain. Refer to "LOWER TIMING CHAIN", EM-23.
 2. Install idler sprocket and bolt.



UPPER TIMING CHAIN

- NGEM0055S02
1. Install lower timing chain and idler sprocket. Refer to "LOWER TIMING CHAIN", EM-23 and "IDLER SPROCKET", EM-24.



2. Install upper timing chain and sprockets, referring to the painted marks made during removal.
3. Install chain tensioner. Remove the pin holding the tensioner piston in the bore of the tensioner.
4. Install camshaft sprocket cover:
 - Use a scraper to remove all traces of liquid gasket from mating surfaces of the engine block and camshaft sprocket cover.
 - Apply a continuous bead of RTV sealant to the cover. Refer to "LIQUID GASKET APPLICATION PLACES", EM-19.
 - Also place RTV sealant on the head gasket surface.

NOTE:

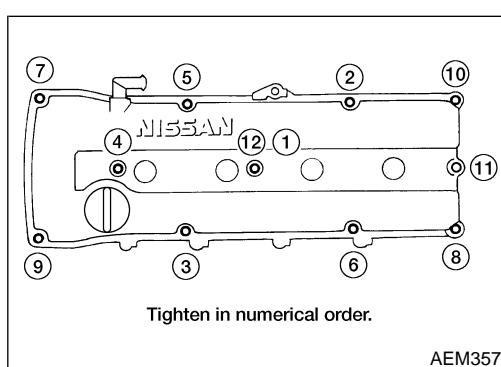
Use Genuine Silicone RTV or equivalent. Refer to **GI-50**, "Recommended Chemical Products and Sealants".

CAUTION:

- Be careful not to tear or damage the cylinder head gasket.
- Be careful upper timing chain does not slip or jump when installing camshaft sprocket cover.
- 5. Install rocker cover gasket to rocker cover.
- Apply a continuous bead of RTV sealant to the cylinder head camshaft sprocket cover. Refer to "LIQUID GASKET APPLICATION PLACES", EM-19.

6. Install rocker cover. Tighten bolts in numerical order.

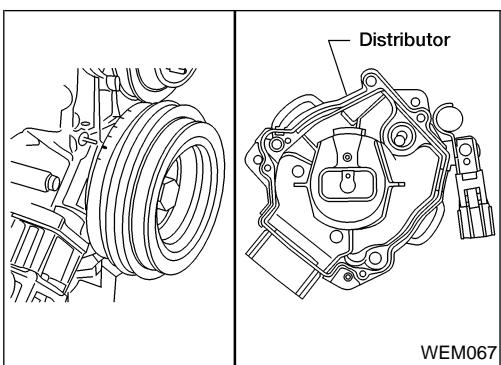
: 8 - 11 N·m (0.8 - 1.1 kg·m, 69 - 95 in-lb).



TIMING CHAIN

KA24DE

Installation (Cont'd)



7. Install distributor, aligning as shown.
8. Install vacuum hoses, electrical harnesses, connectors, and harness clamps.

GI

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Replacement

Replacement**VALVE OIL SEAL**

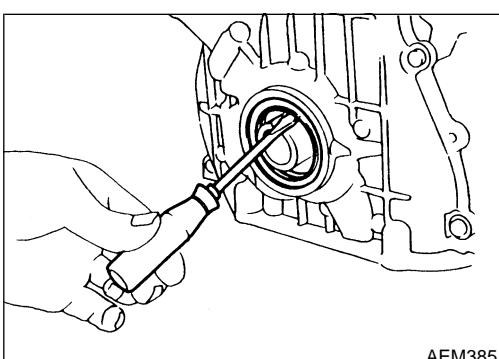
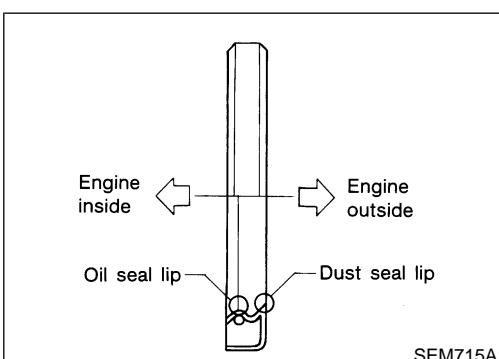
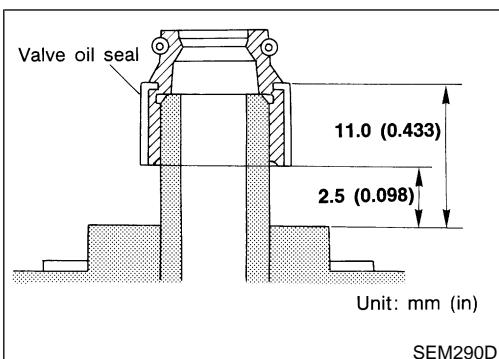
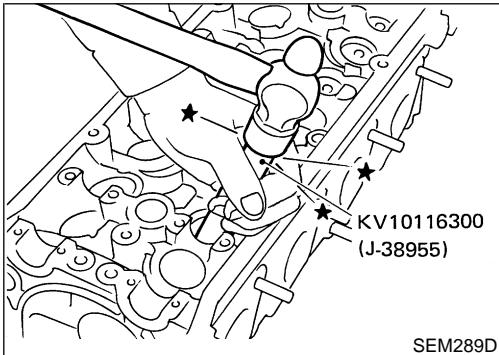
NGEM0056

NGEM0056S01

1. Remove rocker cover.
2. Remove camshaft. Refer to "TIMING CHAIN", EM-18.
3. Remove valve spring and valve oil seal with Tool or a suitable tool.

Piston concerned should be set at TDC to prevent valve from falling.

4. Apply engine oil to new valve oil seal and install it with Tool.

**OIL SEAL INSTALLING DIRECTION**

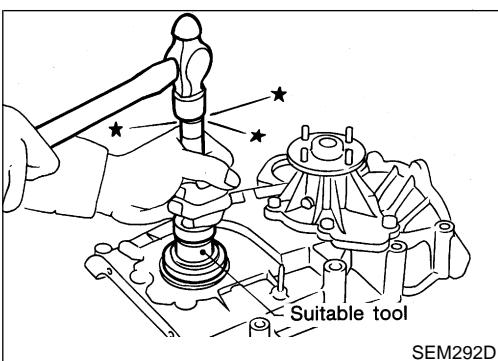
NGEM0056S02

- Install new oil seal in the direction shown.

FRONT OIL SEAL

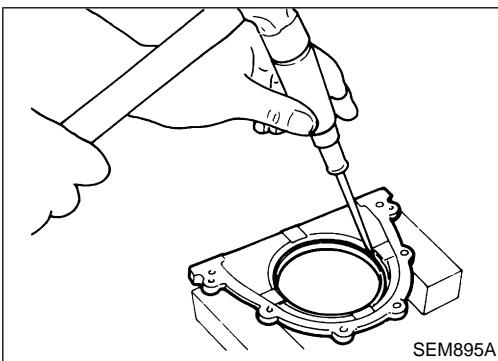
NGEM0056S03

1. Remove radiator shroud and crankshaft pulley.
 2. Remove front oil seal
- Be careful not to scratch front cover.



3. Apply engine oil to new oil seal and install it using a suitable tool.

GI



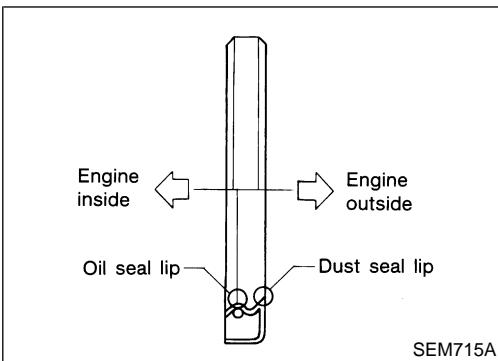
REAR OIL SEAL

NGEM0056S04

1. Remove flywheel.
2. Remove rear oil seal retainer.
3. Remove rear oil seal from retainer.
- Be careful not to scratch rear oil seal retainer.

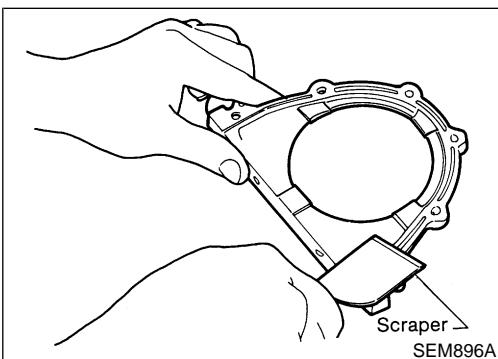
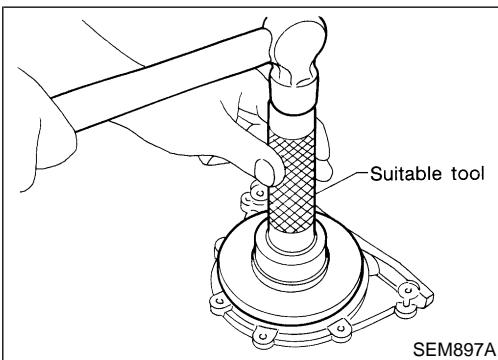
EC

FE



4. Apply engine oil to new oil seal and install it using suitable tool.
- Install new oil seal in the direction shown.

AT



5. Install rear oil seal retainer.
- a. Before installing rear oil seal retainer, remove all traces of liquid gasket from mating surface using a scraper.
- Also remove traces of liquid gasket from mating surface of cylinder block.

BT

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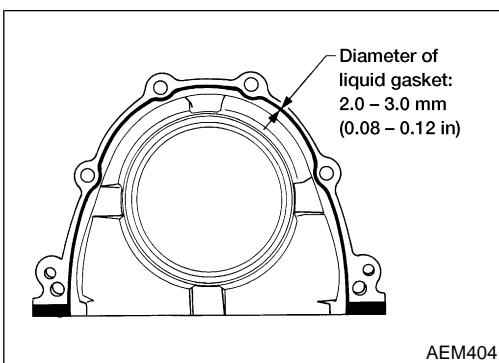
EL

IDX

OIL SEAL

KA24DE

Replacement (Cont'd)

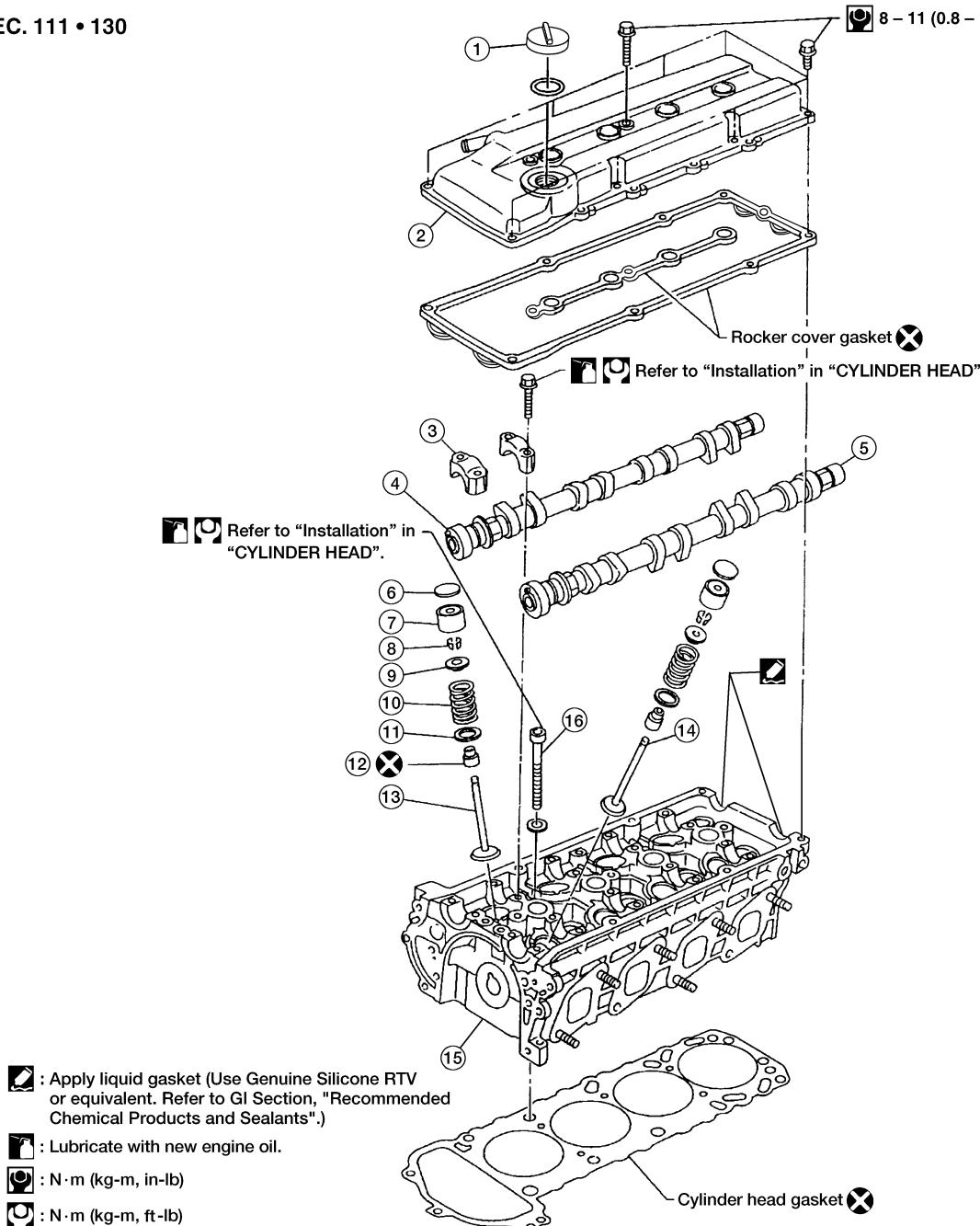


- b. Apply a continuous bead of liquid gasket to mating surface of rear oil seal retainer.
- Use Genuine Silicone RTV or equivalent. Refer to GI-50, "Recommended Chemical Products and Sealants".
- Apply around inner side of bolt holes.

Components

NGEM0057

SEC. 111 • 130



WEM136

RS

- | | | |
|---------------------|--------------------|------------------------|
| 1. Oil filler cap | 7. Valve lifter | 12. Valve oil seal |
| 2. Rocker cover | 8. Valve cotter | 13. Intake valve |
| 3. Camshaft bracket | 9. Spring retainer | 14. Exhaust valve |
| 4. Intake camshaft | 10. Valve spring | 15. Cylinder head |
| 5. Exhaust camshaft | 11. Spring seat | 16. Cylinder head bolt |
| 6. Shim | | |

BT

HA

SC

EL

IDX

Removal

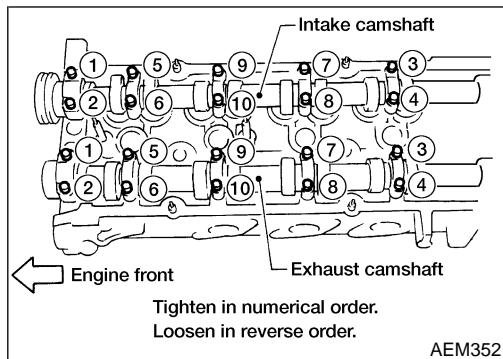
Removal

NGEM0058

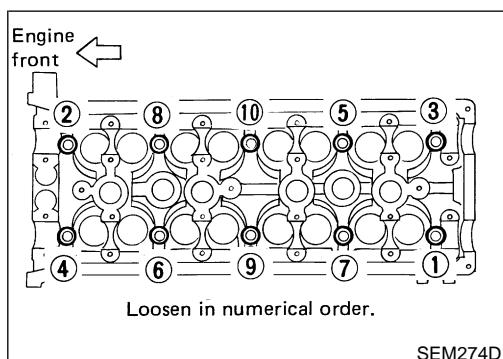
CAUTION:

- When installing camshafts, chain tensioners, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.
- Apply new engine oil to threads and seat surfaces when installing cylinder head, camshaft sprocket, crankshaft pulley, and camshaft bracket.
- Attach tags to valve lifters so as not to mix them up.

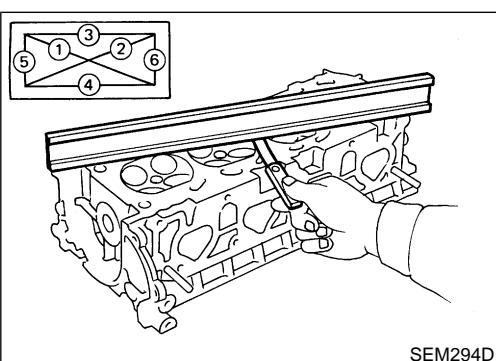
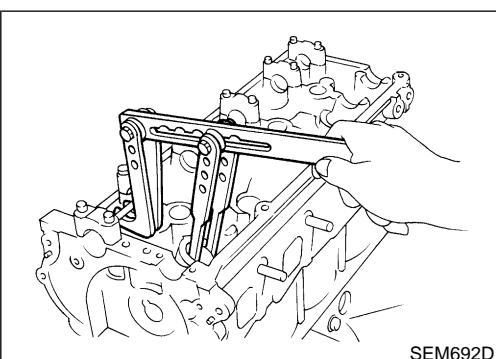
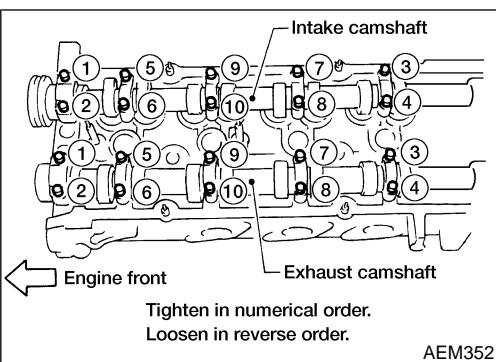
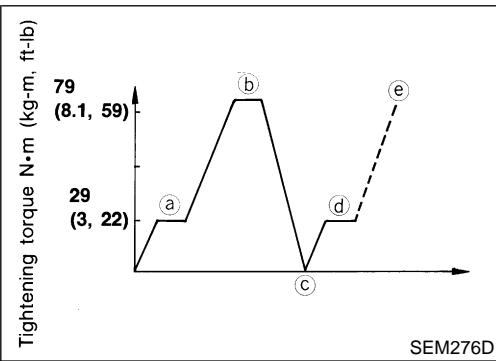
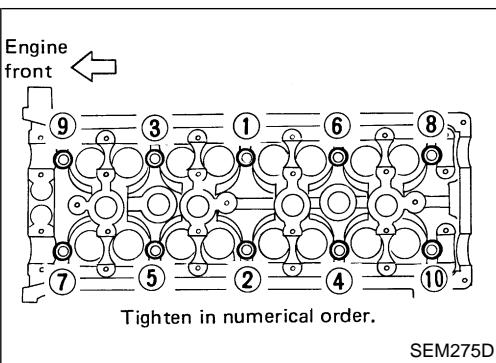
- Before removing camshaft and idler sprockets, apply paint marks to them for retiming.
- 1) Remove upper timing chain and idler sprocket.
- Refer to "UPPER TIMING CHAIN", EM-20 and "IDLER SPROCKET", EM-21.
- For retiming during cylinder head removal/installation, apply paint marks to camshaft sprockets, upper timing chain, lower timing chain, and idler sprocket.



- 2) Remove camshaft brackets and camshafts.
- **Mark these parts' original positions for reassembly.**



- 3) Remove cylinder head bolts in numerical order.
- **Removing bolts in incorrect order could result in a warped or cracked cylinder head.**
- **Loosen cylinder head bolts in two or three steps.**
- 4) Remove cylinder head and cylinder head gasket.



Installation

- NGEM0083
- 1) Tighten cylinder head bolts in numerical order using the following procedure:
 - a) Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
 - b) Tighten all bolts to 79 N·m (8.1 kg-m, 59 ft-lb).
 - c) Loosen all bolts completely.
 - d) Tighten all bolts to 25 to 34 N·m (2.5 to 3.5 kg-m, 18 to 25 ft-lb).
 - e) Turn all bolts 86 to 91 degrees clockwise. If angle wrench is not available, mark all cylinder head bolts on the side facing engine front. Then turn each cylinder head bolts 86 to 91 degrees clockwise.
 - 2) Install camshafts and camshaft brackets in the order shown using the following procedure:
 - a) Set camshafts and camshaft brackets.
 - Dowel pins of both intake and exhaust camshafts should be at 12 o'clock positions when installing the camshafts.
 - b) Tighten all bolts to 2 N·m (0.2 kg-m, 17 in-lb).
 - c) Tighten all bolts to 9.0 to 11.8 N·m (0.92 to 1.2 kg-m, 79.9 to 104.2 in-lb).
 - Apply new engine oil to bolt threads and seat surfaces.
 - 3) Install upper timing chain and idler sprocket.
 - Refer to "UPPER TIMING CHAIN", EM-24 and "IDLER SPROCKET", EM-24.

Disassembly

- 1) Remove intake manifold and exhaust manifold. Refer to "Removal and Installation", EM-12.
- 2) Remove valve components.
- 3) Remove valve oil seal with a suitable tool.

Inspection

CYLINDER HEAD DISTORTION

Clean surface of cylinder head.

Use a reliable straightedge and feeler gauge to check the flatness of cylinder head surface.

Check along six positions shown in the figure.

Head surface flatness:

Standard Less than 0.03 mm (0.0012 in)

Limit 0.1 mm (0.004 in)

NGEM0059

BR

ST

RS

BT

NGEM0060

NGEM0060S01

HA

SC

EL

IDX

Inspection (Cont'd)

If beyond the specified limit, replace it or resurface it.

Resurfacing limit:

The limit of cylinder head resurfacing is determined by the cylinder block resurfacing.

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit:

$$A + B = 0.2 \text{ mm (0.008 in)}$$

After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.

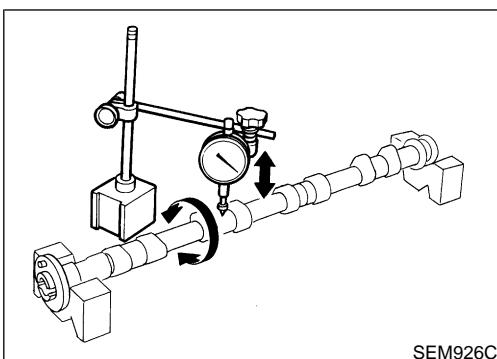
Nominal cylinder head height:

$$126.3 - 126.5 \text{ mm (4.972 - 4.980 in)}$$

CAMSHAFT VISUAL CHECK

NGEM0060S02

Check camshaft for scratches, seizure and wear.



CAMSHAFT RUNOUT

NGEM0060S03

- Measure camshaft runout at the center journal.

Runout (Total indicator reading):

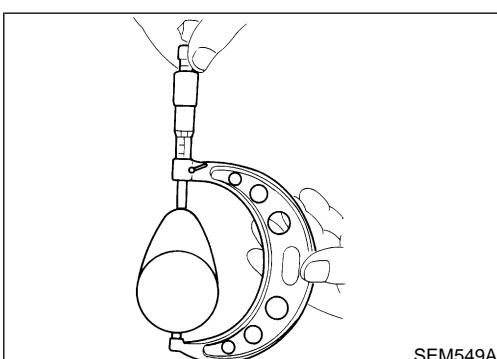
Standard:

Less than 0.02 mm (0.0008 in)

Limit:

0.04 mm (0.0016 in)

- If it exceeds the limit, replace camshaft.



CAMSHAFT CAM HEIGHT

NGEM0060S04

- Measure camshaft cam height.

Standard cam height:

Intake 41.755 - 41.945 mm (1.644 - 1.651 in)

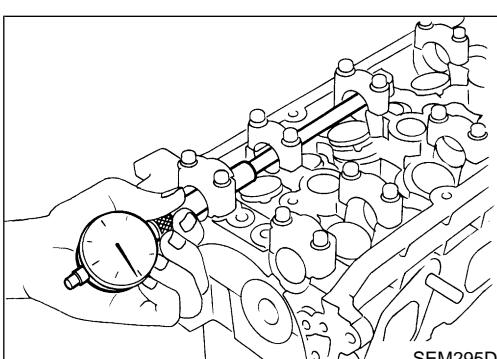
Exhaust 41.815 - 42.005 mm (1.646 - 1.654 in)

Cam height wear limit:

Intake & Exhaust

0.2 mm (0.008 in)

- If wear is beyond the limit, replace camshaft.



CAMSHAFT JOURNAL CLEARANCE

NGEM0060S05

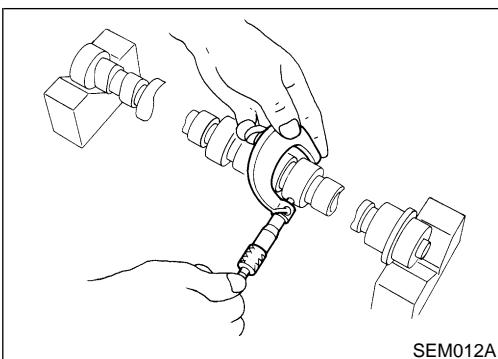
- Install camshaft bracket and tighten bolts to the specified torque.

- Measure inner diameter of camshaft bearing.

Standard inner diameter:

No. 1 to No. 5 journals

28.000 - 28.025 mm (1.1024 - 1.1033 in)



- Measure outer diameter of camshaft journal.

Standard outer diameter:

No. 1 to No. 5 journals

27.935 - 27.955 mm (1.0998 - 1.1006 in)

GI

- If clearance exceeds the limit, replace camshaft and/or cylinder head.

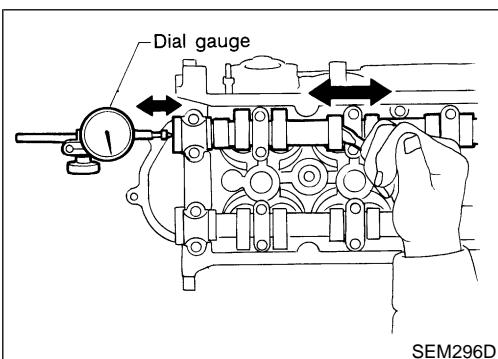
Camshaft journal clearance:

Standard 0.045 - 0.090 mm (0.0018 - 0.0035 in)

Limit 0.12 mm (0.0047 in)

MA

EM



CAMSHAFT END PLAY

NGEM0060S06

EC

- Install camshaft in cylinder head.
- Measure camshaft end play.

Camshaft end play:

Standard

0.070 - 0.148 mm (0.0028 - 0.0058 in)

Limit

0.2 mm (0.008 in)

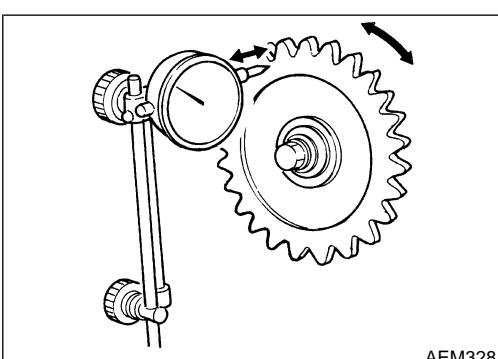
FE

CL

- If end play exceeds the limit, replace camshaft and remeasure camshaft end play.
- If end play still exceeds the limit after replacing camshaft, replace cylinder head.

MT

AT



CAMSHAFT SPROCKET RUNOUT

NGEM0060S07

SU

- Install sprocket on camshaft.
- Measure camshaft sprocket runout.

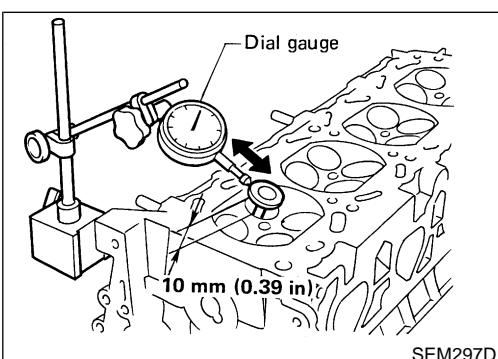
Runout (Total indicator reading):

Limit 0.15 mm (0.0059 in)

BR

- If it exceeds the limit, replace camshaft sprocket.

ST



VALVE GUIDE CLEARANCE

NGEM0060S08

BT

- Measure valve deflection as shown in figure. (Valve and valve guide mostly wear in this direction.)

Valve deflection limit (Dial gauge reading):

Intake & Exhaust

0.2 mm (0.008 in)

HA

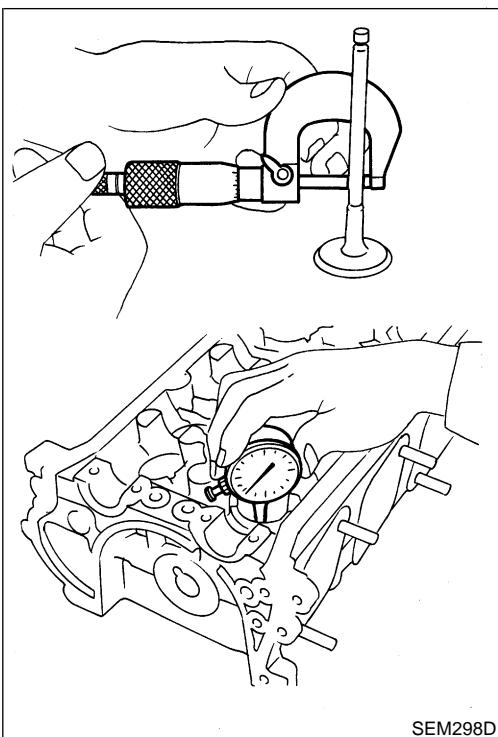
SC

10 mm (0.39 in)

EL

IDX

Inspection (Cont'd)



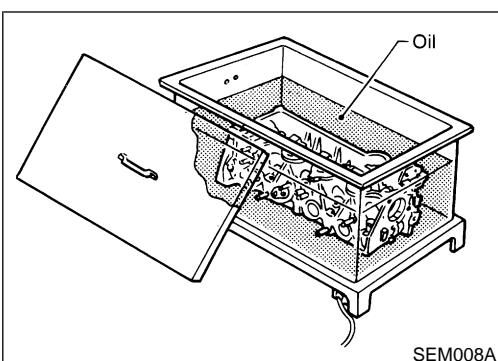
2. If it exceeds the limit, check valve to valve guide clearance.
 - a. Measure valve stem diameter and valve guide inner diameter.
 - b. Check that clearance is within specification.

Valve to valve guide clearance = Valve guide inner diameter - Valve stem diameter:

Unit: mm (in)

	Standard	Limit
Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)

- c. If it exceeds the limit, replace valve and remeasure clearance.
- If clearance still exceeds the limit after replacing valve, replace the valve guide.



VALVE GUIDE REPLACEMENT

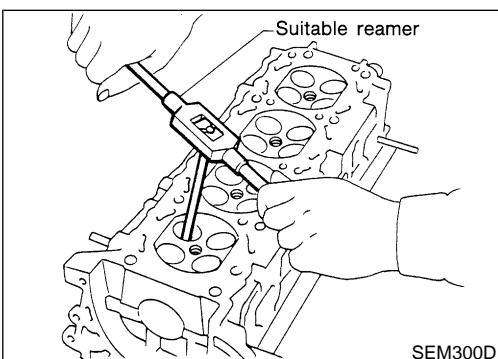
NGEM0060S09

1. To remove valve guide, heat cylinder head to 120 to 140°C (248 to 284°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 suitable tool.
3. Ream cylinder head valve guide hole.

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

Intake & Exhaust

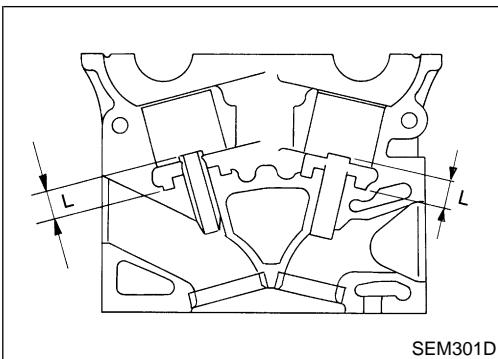
11.175 - 11.196 mm (0.4400 - 0.4408 in)



CYLINDER HEAD

KA24DE

Inspection (Cont'd)

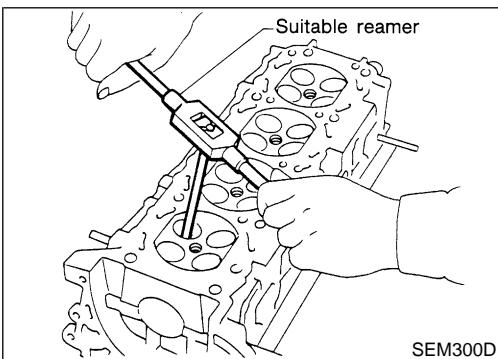


- Heat cylinder head to 120 to 140°C (248 to 284°F) and press service valve guide onto cylinder head.

Projection "L":

13.3 - 13.9 mm (0.524 - 0.547 in)

GI



- Ream valve guide.

Finished size:

Intake & Exhaust

7.000 - 7.018 mm (0.2756 - 0.2763 in)

MA

EM

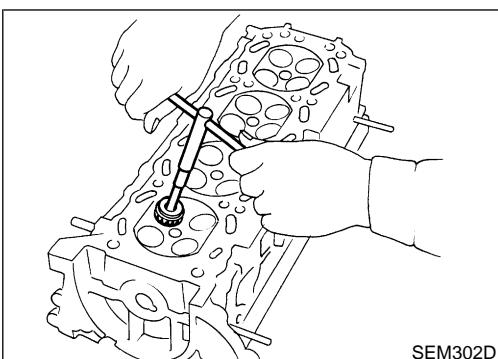
LC

EC

FE

CL

MT



VALVE SEATS

Check valve seats for pitting at contact surface. Resurface or replace if excessively worn.

NGEM0060S10

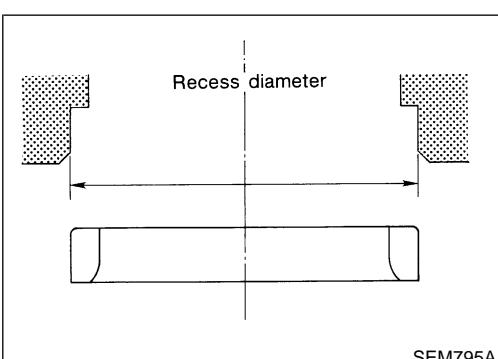
AT

- Before repairing valve seats, check valve and valve guide for wear. If they have worn, replace them. Then correct valve seat.
- Use both hands to cut uniformly.

TF

PD

AX



REPLACING VALVE SEAT FOR SERVICE PARTS

NGEM0060S11

SU

- 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.

BR

- Ream cylinder head recess.

Reaming bore for service valve seat

Oversize [0.5 mm (0.020 in)]:

Intake 38.000 - 38.016 mm (1.4961 - 1.4967 in)

Exhaust 32.700 - 32.716 mm (1.2874 - 1.2880 in)

ST

RS

Use the valve guide center for reaming to ensure valve seat will have the correct fit.

BT

HA

SC

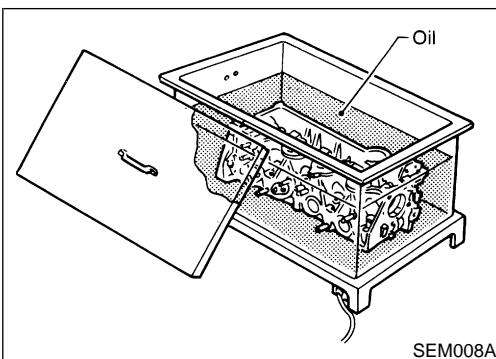
EL

IDX

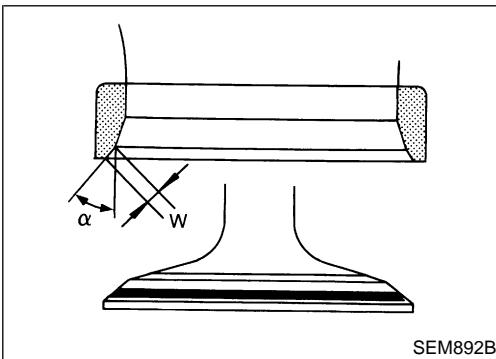
CYLINDER HEAD

KA24DE

Inspection (Cont'd)



3. Heat cylinder head to 120 to 140°C (248 to 284°F).
4. Press fit valve seat until it seats on the bottom.



5. Cut or grind valve seat using suitable tool to the specified dimensions. Refer to "VALVE", EM-56
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

Seat face angle "α":

45°15' - 45°45' deg.

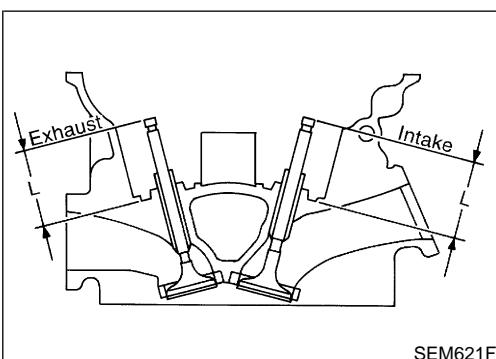
Contacting width "W":

Intake

1.48 - 1.63 mm (0.0583 - 0.0642 in)

Exhaust

1.8 - 2.0 mm (0.071 - 0.079 in)

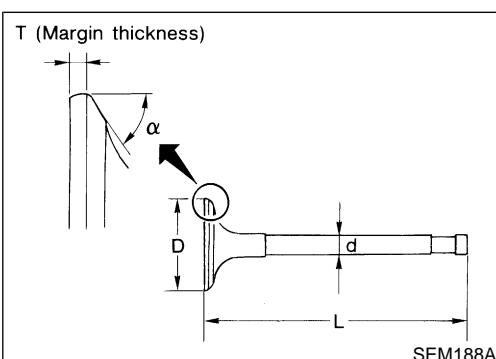


8. Use a depth gauge to measure the distance between the mounting surface of the cylinder head spring seat and the valve stem end. If the distance is shorter than specified, repeat step 5 above to adjust it. If it is longer, replace the valve seat with a new one.

Valve seat resurface limit "L":

Intake 42.02 - 42.52 mm (1.6543 - 1.6740 in)

Exhaust 42.03 - 42.53 mm (1.6547 - 1.6744 in)

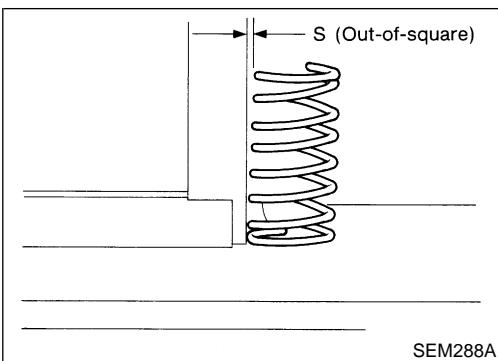


VALVE DIMENSIONS

Check dimensions of each valve. Refer to "Valve", EM-56. When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace valve.

Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.

NGEM0060S12

**VALVE SPRING****Squareness**

- Measure dimension "S".

Out-of-square "S":

Less than 2.2 mm (0.087 in)

- If it exceeds the limit, replace spring.

NGEM0060S13

NGEM0060S1301

GI

MA

EM

LC

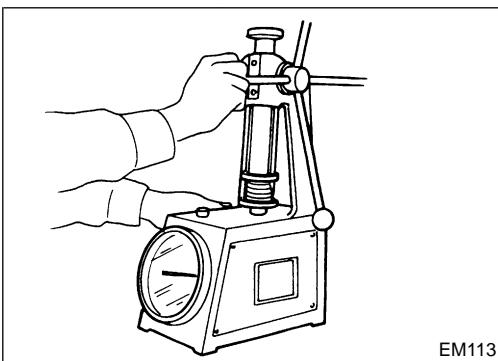
NGEM0060S1302

EC

FE

CL

MT

**Pressure**

Check valve spring pressure at specified spring height.

Pressure: N (kg, lb) at height mm (in)

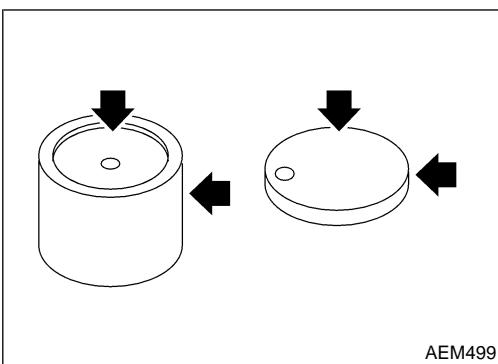
Standard

418.0 (42.6, 93.9) at 29.17 (1.1484)

Limit

393.0 (40.1, 88.4) at 29.17 (1.1484)

If not within specification, replace spring.

**VALVE LIFTER AND VALVE SHIM**

- Visually check contact and sliding surfaces for wear and scratches.

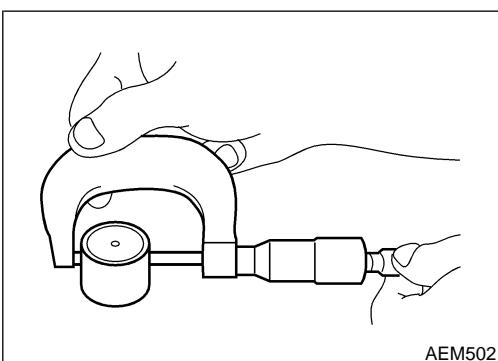
NGEM0060S14

AT

TF

PD

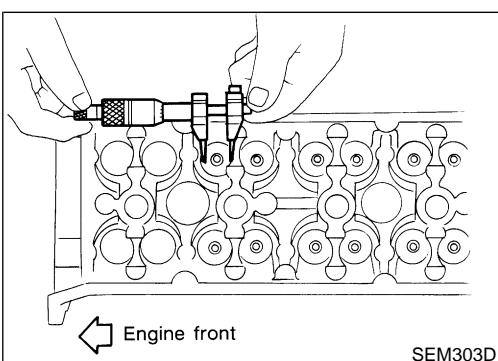
AX



- Check diameter of valve lifter and valve lifter guide bore.

Valve lifter outer diameter:

33.960 - 33.975 mm (1.3370 - 1.3376 in)



Lifter guide bore diameter:

34.000 - 34.021 mm (1.3386 - 1.3394 in)

Valve lifter to valve lifter guide clearance:

0.025 - 0.061 mm (0.0010 - 0.0024 in)

If it exceeds the standard diameter or clearance, replace valve lifter or cylinder head.

BT

HA

ST

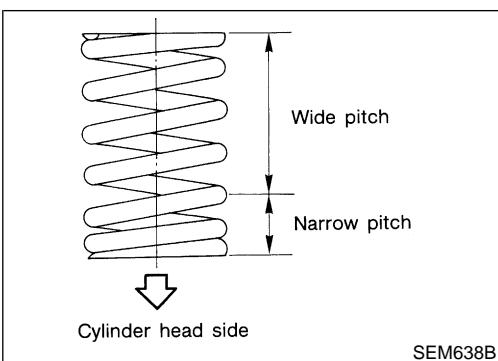
RS

SC

EL

IDX

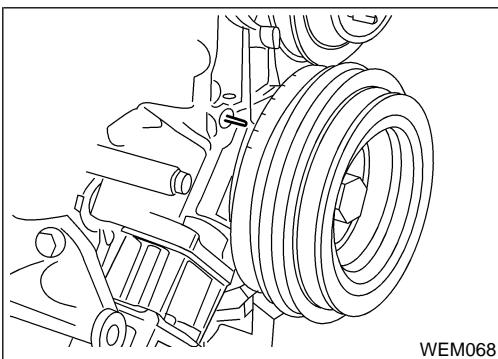
Assembly



Assembly

NGEM0061

1. Install valve component parts.
- Always use new valve oil seal. Refer to "Replacement", EM-26.
- Before installing valve oil seal, install valve spring seat.
- Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.
- After installing valve component parts, tap valve stem tip with plastic hammer to assure a proper fit.



Valve Clearance

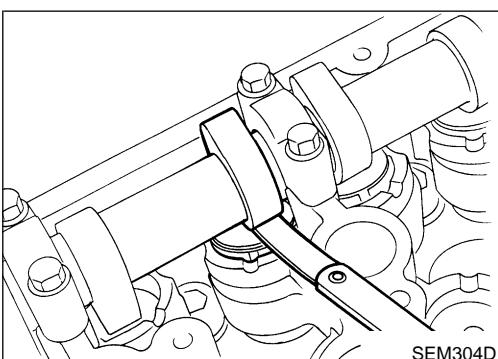
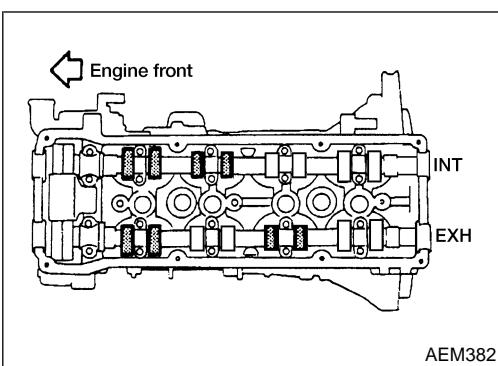
NGEM0062

CHECKING

NGEM0062S01

Check valve clearance while engine is warm but not running.

1. Remove rocker cover and all spark plugs.
2. Set No. 1 cylinder at TDC on its compression stroke.
 - Align pointer with TDC mark on crankshaft pulley.
 - Check that valve lifters on No. 1 cylinder are loose and valve lifters on No. 4 are tight.
If not, turn crankshaft one revolution (360°) and align as above.
3. Check only those valves shown in the figure.



4. Using a feeler gauge, measure clearance between valve lifter and camshaft.
- Record any valve clearance measurements which are out of specification. They will be used later to determine the required replacement adjusting shim.

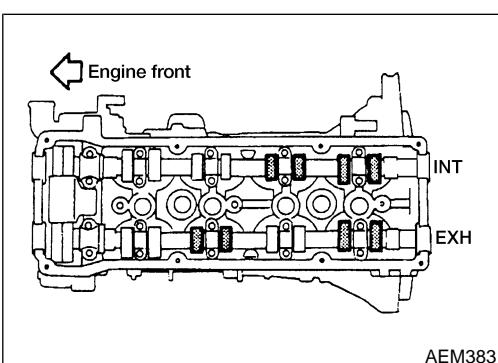
Valve clearance (Hot):

Intake

0.31 - 0.39 mm (0.012 - 0.015 in)

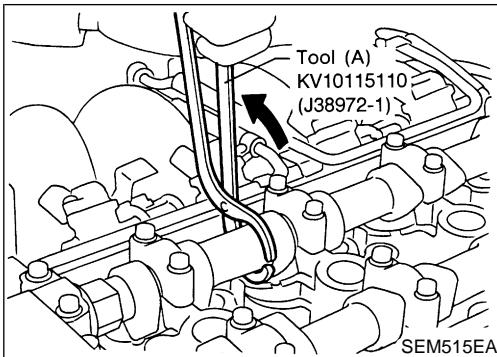
Exhaust

0.39 - 0.47 mm (0.015 - 0.019 in)

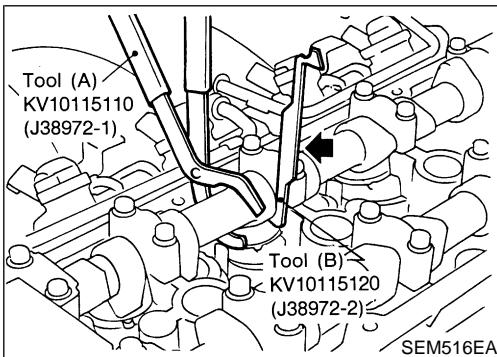


5. Turn crankshaft one revolution (360°) and align mark on crankshaft pulley with pointer.
6. Check those valves shown in the figure.
 - Use the same procedure as mentioned in step 4.
7. If all valve clearances are within specification, install the following parts.
 - Rocker cover
 - All spark plugs

NGEM0062S02

**ADJUSTING****Adjust valve clearance while engine is cold.**

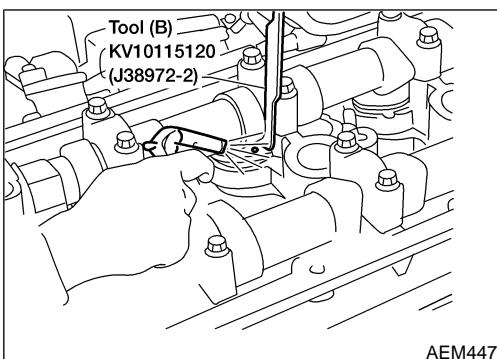
1. Turn crankshaft to position cam lobe on camshaft of valve that must be adjusted upward.
2. Place Tool (A) around camshaft as shown in figure.
3. Rotate Tool (A) so that lifter is pushed down.

**Before placing Tool (A), rotate notch toward center of cylinder head (See figure.), to simplify shim removal later.****CAUTION:****Be careful not to damage cam surface with Tool (A).**

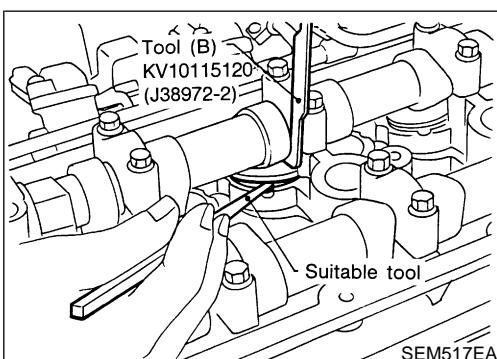
4. Place Tool (B) between camshaft and the edge of the valve lifter to retain valve lifter.

CAUTION:

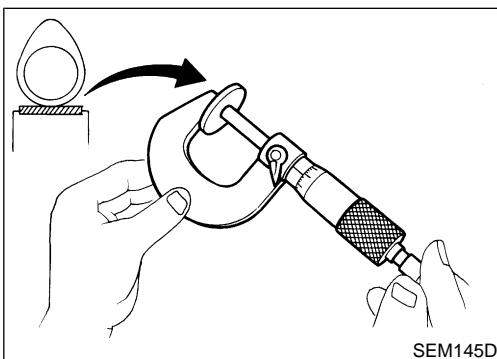
- Tool (B) must be placed as close to camshaft bracket as possible.
- Be careful not to damage cam surface with Tool (B).
- 5. Remove Tool (A).



6. Rotate adjusting shim until hole is visible. Blow air into the hole to separate adjusting shim from valve lifter.



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



8. Determine replacement adjusting shim size as follows.
 - a. Using a micrometer determine thickness of removed shim.
 - b. Calculate thickness of new adjusting shim so valve clearance comes within specified values.
- R = Thickness of removed shim
N = Thickness of new shim
M = Measured valve clearance

Intake & Exhaust:

$$N = R + [M - 0.37 \text{ mm (0.0146 in)}]$$

GI

MA

EM

LC

EC

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MT

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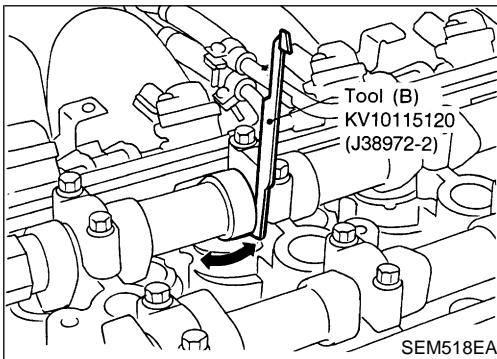
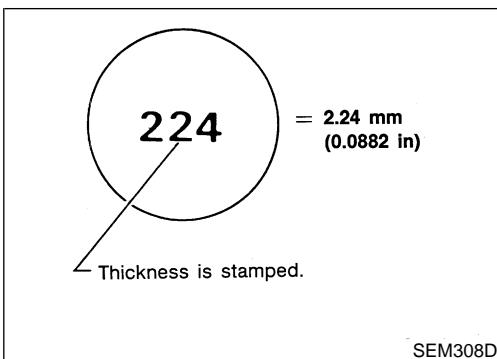
HA

SC

EL

IDX

Valve Clearance (Cont'd)



- Shims are available in thicknesses from 1.96 mm (0.0772 in) to 2.68 mm (0.1055 in), in steps of 0.02 mm (0.0008 in).
- c. Select new shim with thickness as close as possible to calculated value.
Refer to "AVAILABLE SHIMS", EM-58.

9. Install new shim using a suitable tool.
- **Install with the surface on which the thickness is stamped facing down.**
10. Place Tool (A) as mentioned in steps 2 and 3.
11. Remove Tool (B).
12. Remove Tool (A).
13. Recheck valve clearance.
Refer to "CHECKING", EM-38.

Removal and Installation

NGEM0063

SEC. 112

GI

MA

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LC

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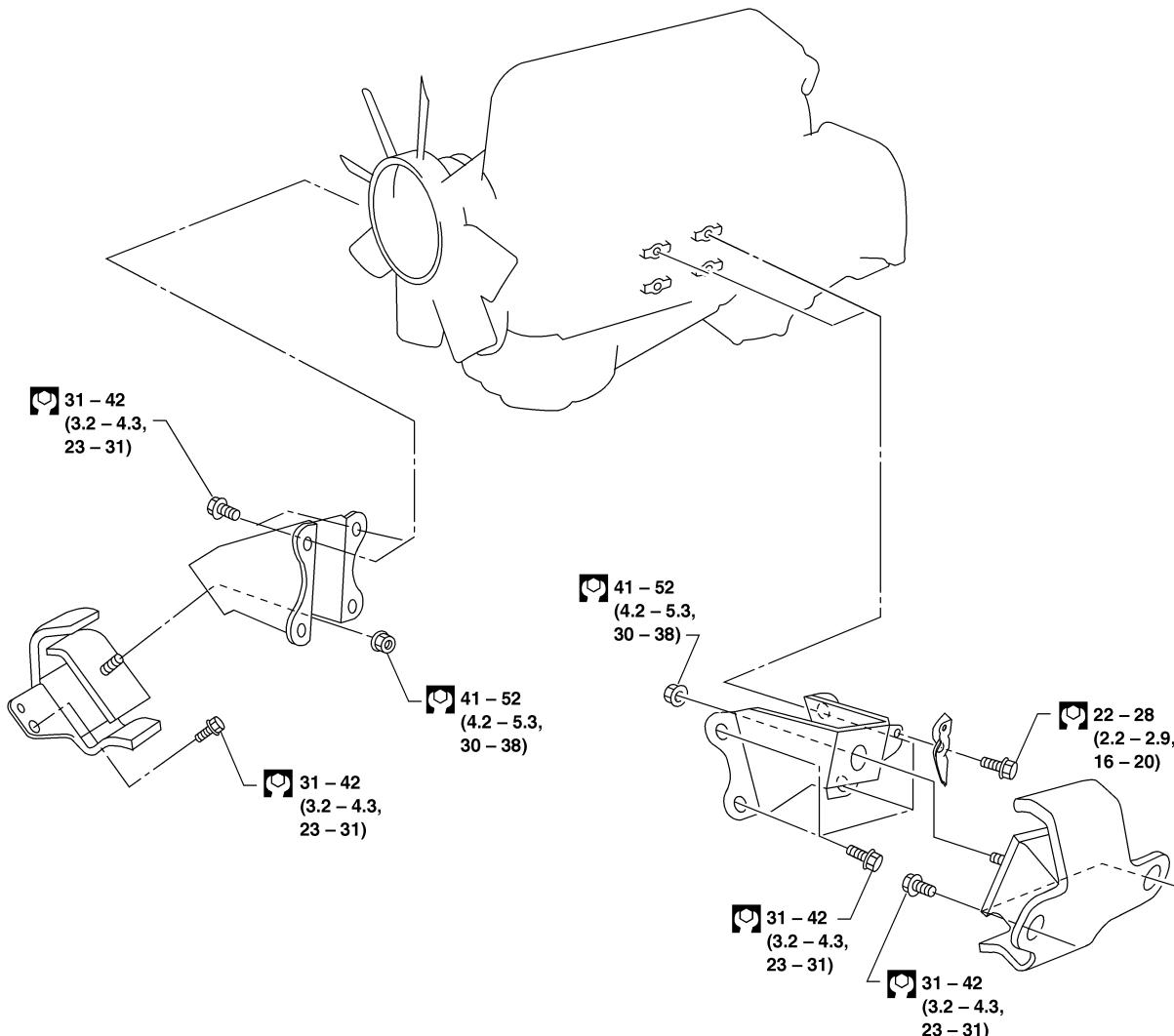
BT

HA

SC

EL

IDX



: N·m (kg-m, ft-lb)

WEM055

WARNING:

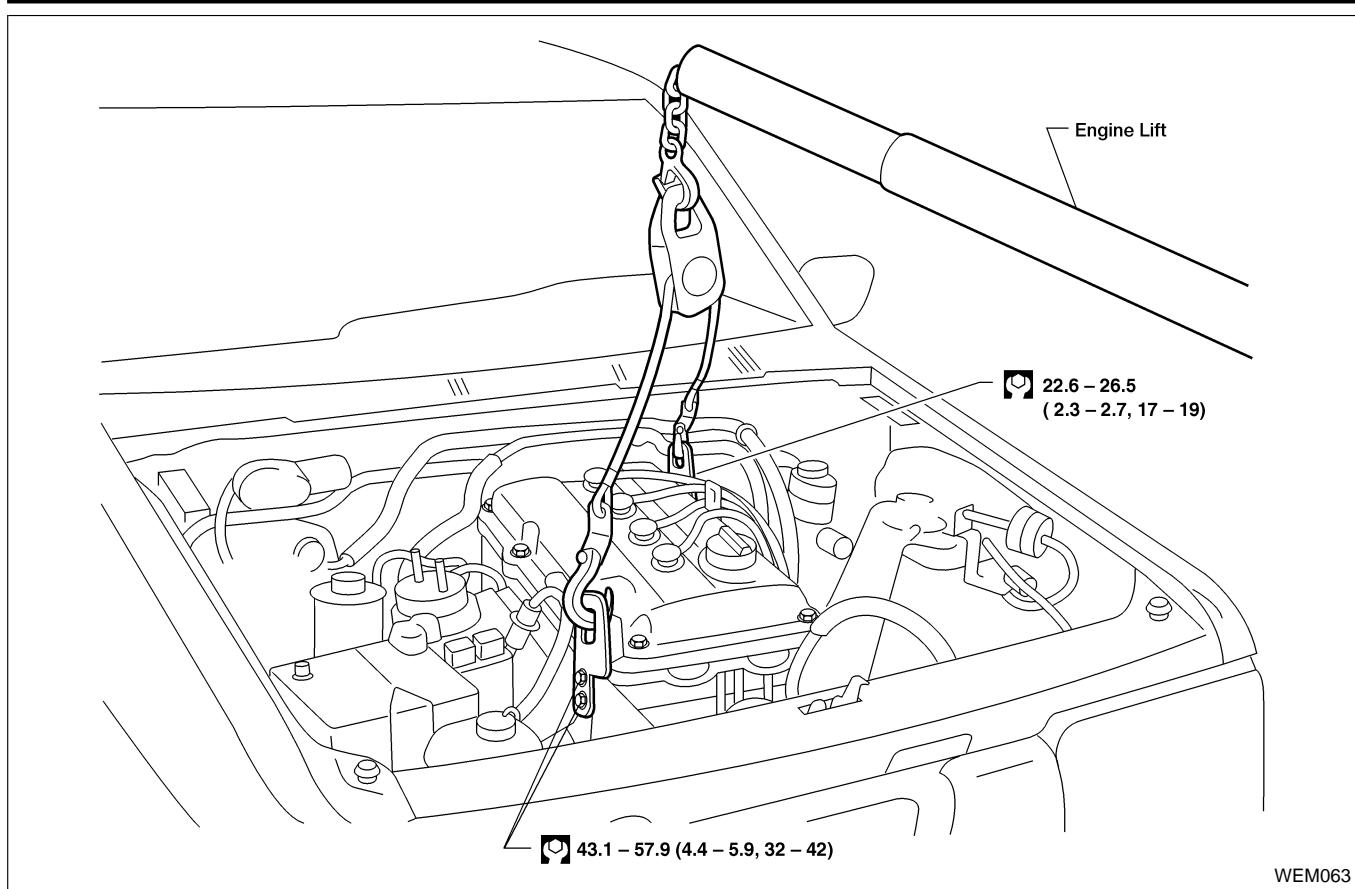
- Position vehicle on a flat and solid surface.
- Place chocks at front and back of rear wheels.
- Do not remove engine until exhaust system has completely cooled off. Otherwise, you may burn yourself and/or fire may break out in fuel line.
- Before disconnecting fuel hose, release fuel pressure. Refer to EC-57, "Fuel Pressure Release".
- Be sure to hoist engine and transmission in a safe manner.
- For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.

CAUTION:

- When lifting engine, be sure to clear surrounding parts. Take special care near accelerator wire casing, brake lines and brake master cylinder.
- In hoisting the engine, always use engine slingers in a safe manner.
- Before separating engine and transmission, remove the crankshaft position sensor (OBD) from the assembly.
- Always take extra care not to damage edge of crankshaft position sensor (OBD) or ring gear teeth.

REMOVAL

- NGEM0063S01
1. Drain coolant from engine block and radiator. Refer to **MA-17**, "Changing Engine Coolant".
 2. Release fuel pressure. Refer to **EC-57**, "Fuel Pressure Release".
 3. Remove negative battery cable.
 4. Remove hood. Refer to **BT-12**, "Removal and Installation".
 5. Remove air cleaner.
 6. Remove power steering drive belt, generator drive belt and A/C compressor drive belt.
 7. Remove radiator. Refer to **LC-14**, "Radiator".
 8. Remove exhaust manifold heat shield.
 9. Disconnect exhaust system at rear of TWC (manifold).
 10. Remove A/C compressor from bracket. Refer to **HA-70**, "Compressor Mounting".
 11. Disconnect accelerator wire, ASCD wire (if equipped), vacuum hoses, electrical connectors, heater hoses and vacuum booster hose.
 12. Remove four power steering pump bolts.
 13. Remove transmission. Refer to **MT-9**, "Removal".



14. Install engine slingers and connect engine lift.
15. Remove LH and RH engine mounts.
16. Remove engine.

INSTALLATION

- Install in reverse order of removal.

NGEM0063S02 AX

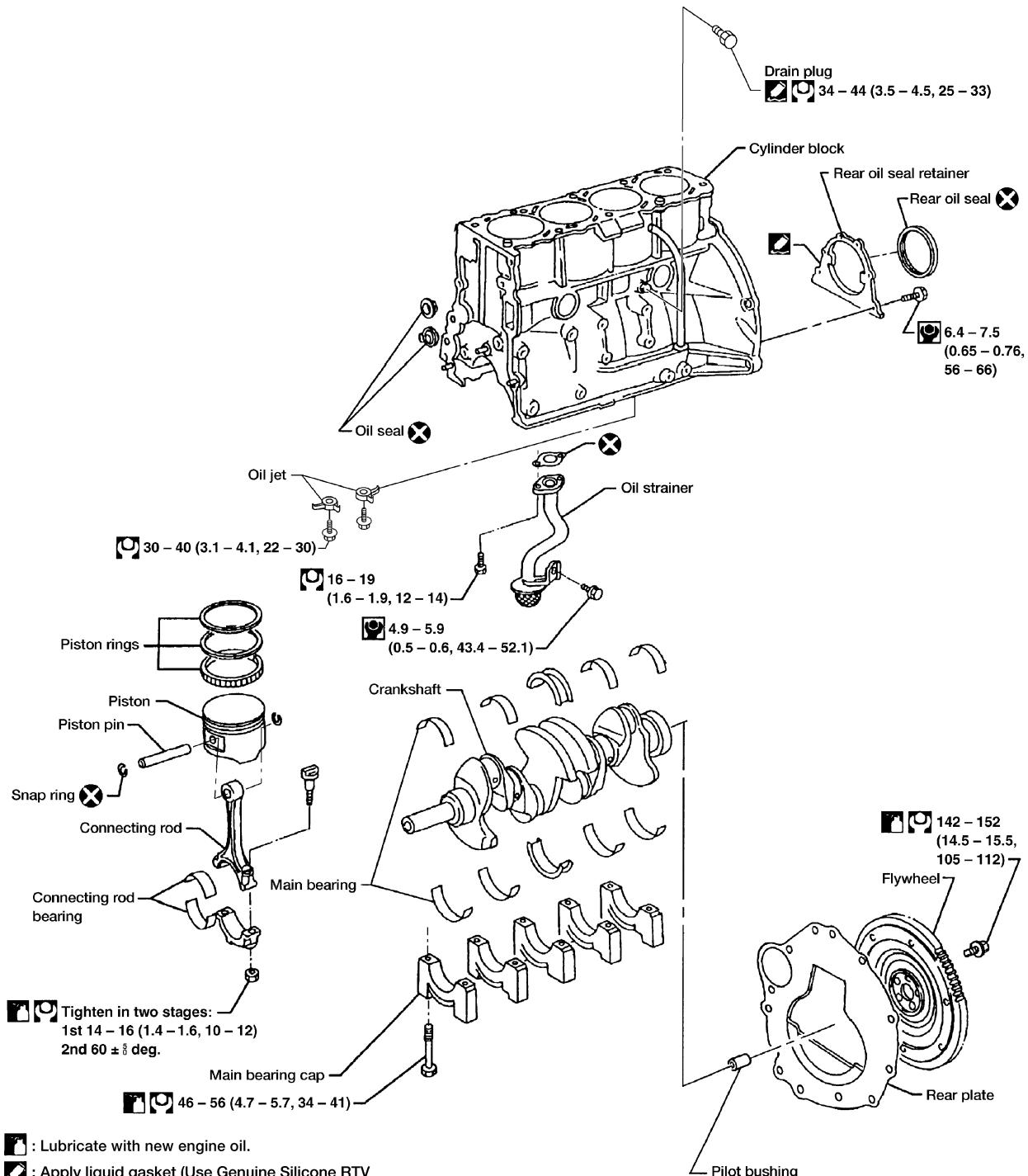
GI
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Components

Components

NGEM0064

SEC. 110 • 120 • 135 • 150 • 210



: Lubricate with new engine oil.

: Apply liquid gasket (Use Genuine Silicone RTV or equivalent. Refer to GI Section, "Recommended Chemical Products and Sealants".)

: N·m (kg·m, in·lb)

: N·m (kg·m, ft·lb)

NGEM0065

GI

Removal and Installation**CAUTION:**

- When installing sliding parts (bearings, pistons, etc.), lubricate contacting surfaces with new engine oil.
- Place removed parts such as bearings and bearing caps in their proper order and direction.
- When installing connecting rod nuts and main bearing cap bolts, apply new engine oil to threads and seating surfaces.
- Do not allow any magnetic materials to contact the ring gear teeth of flywheel or drive plate.

MA

EM

LC

NGEM0066

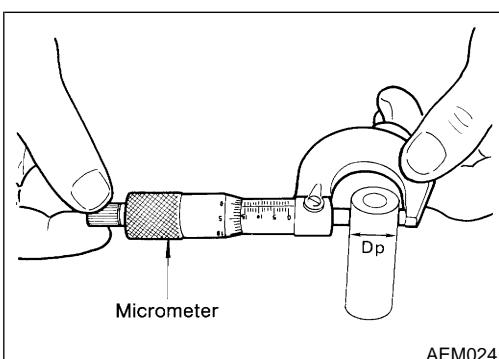
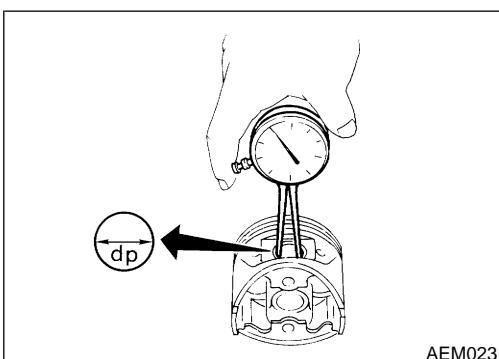
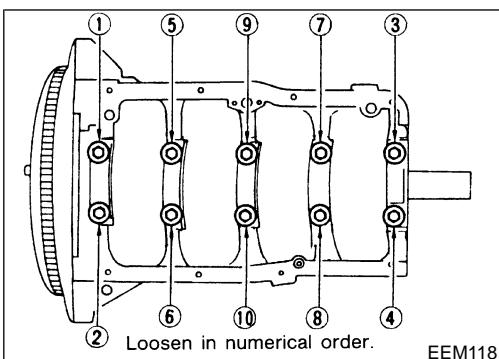
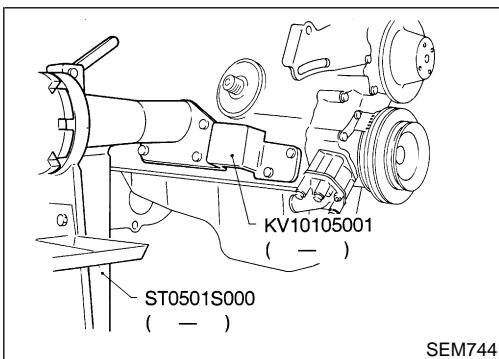
NGEM0066S01

EC

FE

CL

MT

**Disassembly****PISTON AND CRANKSHAFT**

- Place engine on a work stand.
 - Drain coolant and oil.
 - Remove oil pan.
 - Remove timing chain. Refer to "Removal", EM-20.
 - Remove water pump.
 - Remove cylinder head.
 - Remove pistons with connecting rods.
 - Remove bearing caps and crankshaft.
- Before removing bearing caps, measure crankshaft end play. Refer to "CRANKSHAFT", EM-53.**
 - Bolts should be loosened in two or three steps.**

AT

TF

PD

AX

Inspection**PISTON AND PISTON PIN CLEARANCE**

- Measure inner diameter of piston pin hole "dp".

Standard diameter "dp":**20.993 - 21.005 mm (0.8265 - 0.8270 in)**

NGEM0067

NGEM0067S01

BR

ST

RS

- Measure outer diameter of piston pin "Dp".

Standard diameter "Dp":**20.989 - 21.001 mm (0.8263 - 0.8268 in)**

- Calculate piston pin clearance.

 $dp - Dp = -0.002 - 0.01 \text{ mm } (-0.0001 - 0.0004 \text{ in})$

If it exceeds the above value, replace piston assembly with pin.

BT

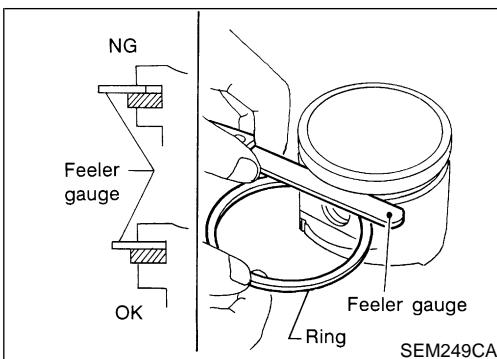
HA

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IDX

Inspection (Cont'd)



PISTON RING SIDE CLEARANCE

NGEM0067S02

Side clearance:

Top ring 0.04 - 0.08 mm (0.0016 - 0.0031 in)

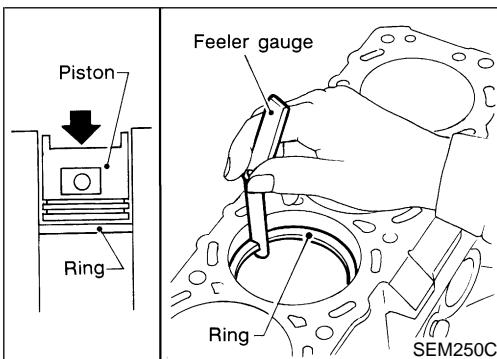
2nd ring 0.03 - 0.07 mm (0.0012 - 0.0028 in)

Max. limit of side clearance:

0.1 mm (0.004 in)

If out of specification, replace piston ring.

If clearance exceeds maximum limit with new ring, replace piston.



PISTON RING END GAP

NGEM0067S03

End gap:

Top ring

0.28 - 0.52 mm (0.0110 - 0.0205 in)

2nd ring

0.45 - 0.69 mm (0.0177 - 0.0272 in)

Oil ring

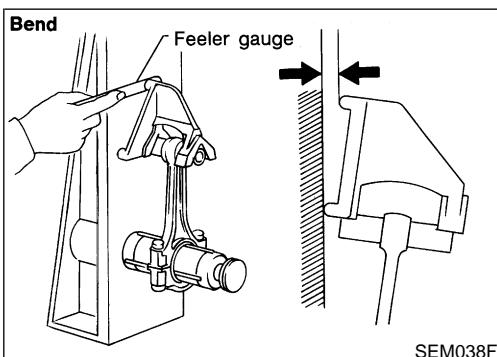
0.20 - 0.69 mm (0.0079 - 0.0272 in)

Max. limit of ring gap:

Refer to "PISTON RING", EM-62.

If out of specification, replace piston ring. If gap exceeds maximum limit with a new ring, rebore cylinder and use oversized piston and piston rings. Refer to "PISTON RING", EM-62.

- When replacing the piston, check cylinder block surface for scratches or seizure. If scratches or seizure are found, hone or replace the cylinder block.



CONNECTING ROD BEND AND TORSION

NGEM0067S04

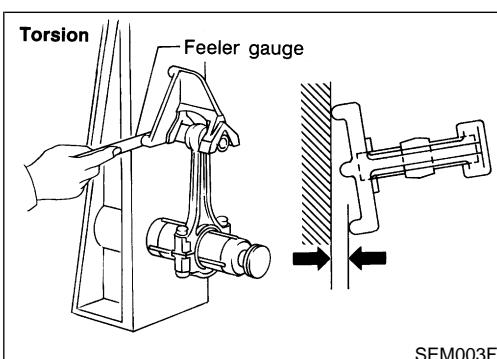
Bend:

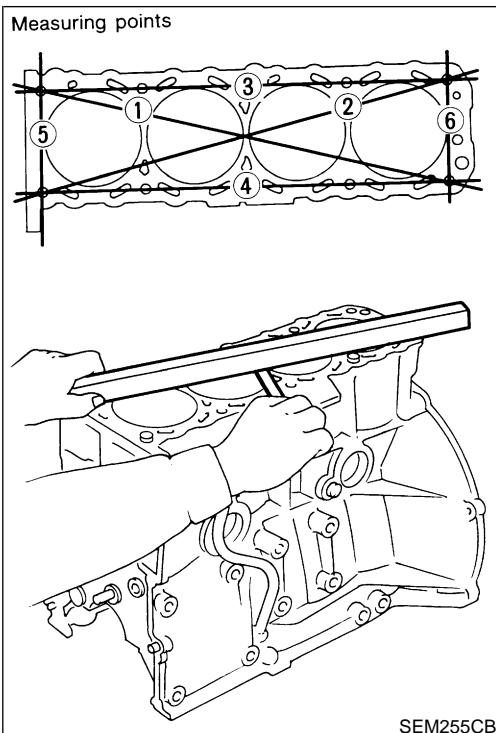
Limit 0.15 mm (0.0059 in)
per 100 mm (3.94 in) length

Torsion:

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

If it exceeds the limit, replace connecting rod assembly.



**CYLINDER BLOCK DISTORTION AND WEAR**

NGEM0067S05

1. Clean upper face of cylinder block.
Use a reliable straightedge and feeler gauge to check the flatness of cylinder block surface. Check along six positions shown in figure.

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

2. If out of specification, resurface it.
The limit for cylinder block resurfacing is determined by cylinder head resurfacing.

Amount of cylinder head resurfacing is "A"
Amount of cylinder block resurfacing is "B"

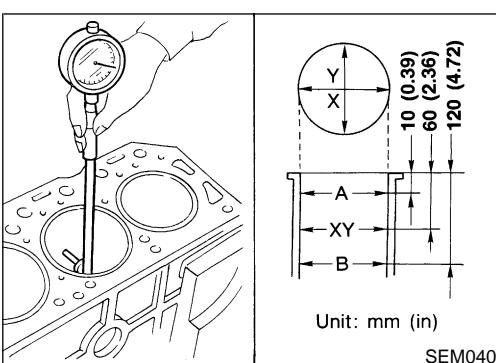
The maximum limit is as follows:

$$A + B = 0.2 \text{ mm (0.008 in)}$$

**Nominal cylinder block height
from crankshaft center:**

$$246.95 - 247.05 \text{ mm (9.7224 - 9.7264 in)}$$

3. If necessary, replace cylinder block.

**PISTON-TO-BORE CLEARANCE**

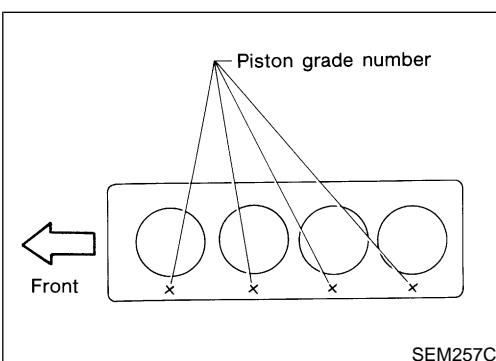
NGEM0067S06

1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.

Standard inner diameter:**Refer to "Cylinder Block", EM-60.****Wear limit: 0.2 mm (0.008 in)****Out-of-round (X - Y) standard: 0.015 mm (0.0006 in)****Taper (A - B) standard: 0.010 mm (0.0004 in)**

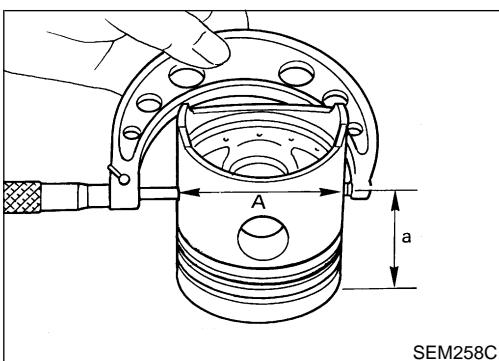
If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.

2. Check for scratches and seizure. If seizure is found, hone it.



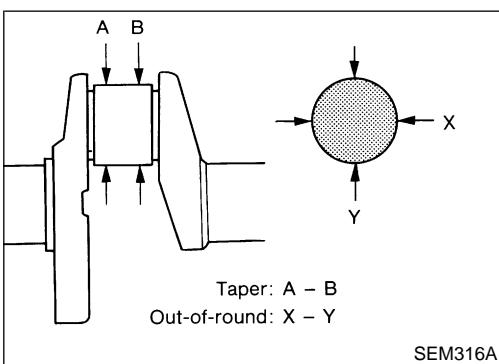
- If cylinder block and piston are replaced, match piston grade with grade number on cylinder block upper surface.

Inspection (Cont'd)



3. Measure piston skirt diameter.
Piston diameter "A":
Refer to "PISTON", EM-62.
Measuring point "a" (Distance from the top):
Approximately 48 mm (1.89 in)
4. Check that piston-to-bore clearance is within specification.
Piston-to-bore clearance "B":
0.020 - 0.040 mm (0.0008 - 0.0016 in)
5. Determine piston oversize according to amount of cylinder wear.
Oversize pistons are available for service. Refer to "Piston, Piston Ring and Piston Pin", EM-62.
6. 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
C: Honing allowance 0.02 mm (0.0008 in)
7. Install main bearing caps and tighten bolts to the specified torque. This will prevent distortion of cylinder bores.
8. Cut cylinder bores.
 - 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 at a time.
9. Hone cylinders to obtain specified piston-to-bore clearance.
10. Measure finished cylinder bore for out-of-round and taper.
 - Measurement should be done after cylinder bore cools down.



CRANKSHAFT

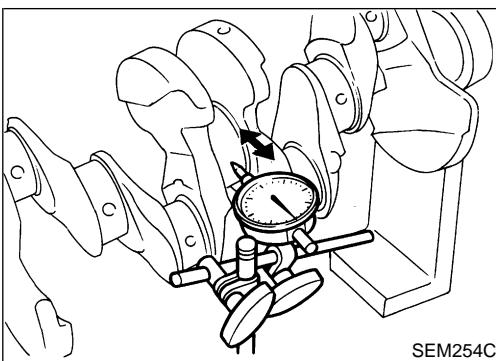
- NGEM0067S07
1. Check crankshaft main and pin journals for score, wear or cracks.
 2. With a micrometer, measure journals for taper and out-of-round.

Out-of-round (X - Y):

Main journal Less than 0.01 mm (0.0004 in)
Crank pin Less than 0.005 mm (0.0002 in)

Taper (A - B):

Main journal Less than 0.01 mm (0.0004 in)
Crank pin Less than 0.005 mm (0.0002 in)



- Measure crankshaft runout.

Runout (Total indicator reading):

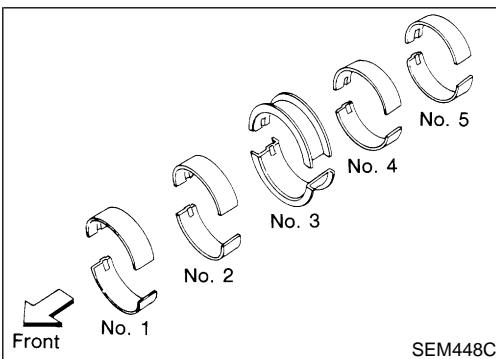
Less than 0.10 mm (0.0039 in)

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EM

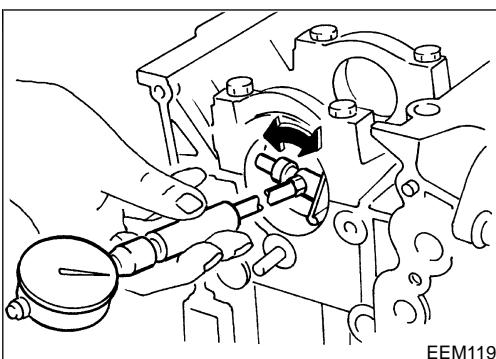
LC



BEARING CLEARANCE

- Use Method A or Method B. Method A is preferred because it is more accurate.

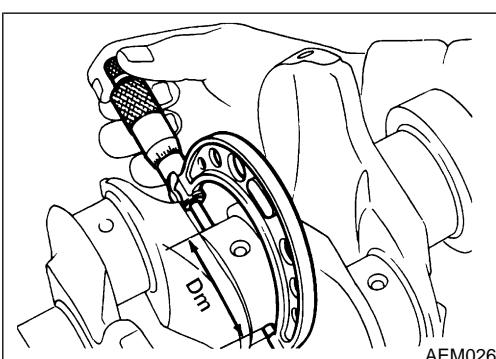
Method A (Using bore gauge and micrometer)



Main bearing

- Set main bearings in their proper positions on cylinder block and main bearing cap.

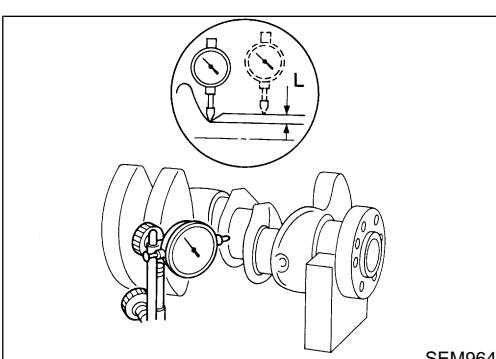
NGEM0067S0801



- Install main bearing cap to cylinder block.

- Tighten all bolts in correct order in two or three stages. Refer to "Components", EM-44 and "CRANKSHAFT", EM-53.**

- Measure inner diameter "A" of each main bearing.



- Measure outer diameter "Dm" of each crankshaft main journal.

- Calculate main bearing clearance.
Main bearing clearance = A - Dm

Standard:

0.020 - 0.047 mm (0.0008 - 0.0019 in)

Limit:

0.1 mm (0.004 in)

- If it exceeds the limit, replace bearing.

- If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.

- When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.**

"L": 0.1 mm (0.004 in)

- Grind crankshaft to use with available service parts. Refer to "Crankshaft", EM-63 and "Available Main Bearing", EM-64.**

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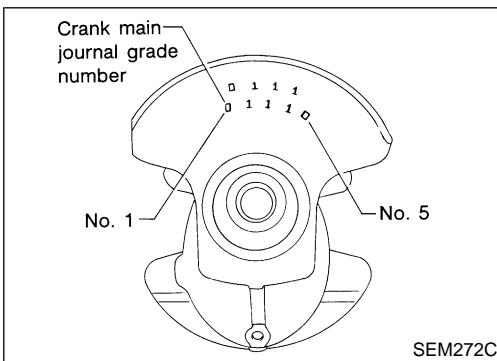
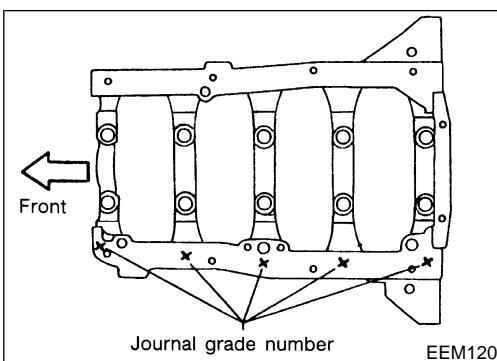
HA

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IDX

Inspection (Cont'd)



8. If crankshaft is reused, measure main bearing clearance and select thickness of main bearing.
If crankshaft or cylinder block is replaced, select thickness of main bearings as follows:
 - a. Grade number of each cylinder block main journal is punched on the respective cylinder block. These numbers are punched in either Arabic or Roman numerals.

- b. Grade number of each crankshaft main journal is punched on crankshaft. These numbers are punched in either Arabic or Roman numerals.
- c. Select main bearing with suitable thickness according to the following example or table.

For example:

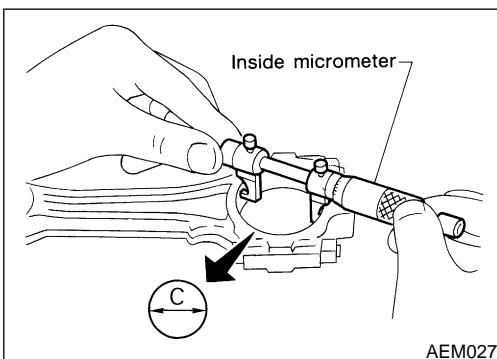
Main journal grade number: 1

Crankshaft journal grade number: 2

Main bearing grade number = 1 + 2 = 3 (Yellow)

Main bearing grade number and identification color:

		Main journal grade number		
		0	1	2
Crankshaft journal grade number	0	0 (Black)	1 (Brown)	2 (Green)
	1 or I	1 (Brown)	2 (Green)	3 (Yellow)
	2 or II	2 (Green)	3 (Yellow)	4 (Blue)



Connecting Rod Bearing (Big End)

NGEM0067S0802

1. Install connecting rod bearing to connecting rod and cap.
2. Install connecting rod cap to connecting rod.
- **Tighten bolts to the specified torque.**
3. Measure inner diameter "C" of each bearing.

4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.

Connecting rod bearing clearance = C - Dp:

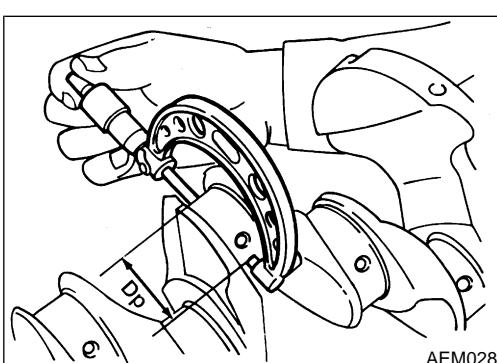
Standard

0.010 - 0.035 mm (0.0004 - 0.0014 in)

Limit

0.09 mm (0.0035 in)

6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.



Refer to step 5 of "BEARING CLEARANCE", EM-49.

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BT

NGEM0067S10

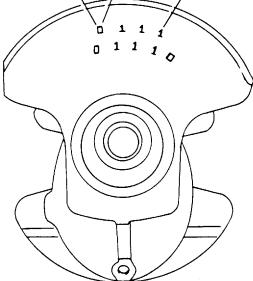
HA

SC

EL

IDX

Crank pin grade number
No. 1 No. 4



SEM567B

8. If crankshaft is replaced, select connecting rod bearing according to the following table.

Connecting rod bearing grade number:

These numbers are punched in either Arabic or Roman numerals.

Crank pin grade number	Connecting rod bearing grade number
0	0
1 or I	1
2 or II	2

Method B (Using plastigage)

CAUTION:

- Do not turn crankshaft or connecting rod while plastigage is being inserted.
- When bearing clearance exceeds the specified limit, ensure that the proper bearing has been installed. Then if excessive bearing clearance exists, use a thicker main bearing or undersized bearing so that the specified bearing clearance is obtained.

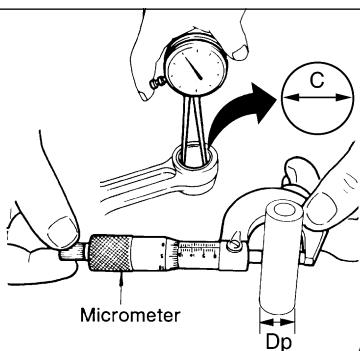
CONNECTING ROD BUSHING CLEARANCE (SMALL END)

- Measure inner diameter "C" of bushing.
- Measure outer diameter "Dp" of piston pin.
- Calculate connecting rod bushing clearance.

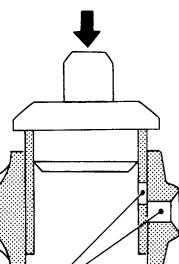
$$C - D_p =$$

0.005 - 0.017 mm (0.0002 - 0.0007 in) (Standard)
0.023 mm (0.0009 in) (Limit)

If out of specification, replace connecting rod assembly and/or piston set with pin.



AEM332



SEM062A

REPLACEMENT OF CONNECTING ROD BUSHING (SMALL END)

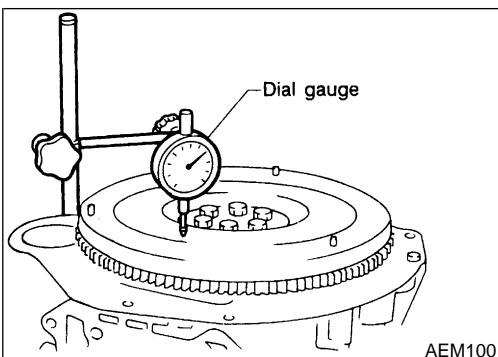
- Drive in small end bushing until it is flush with end surface of rod.

Be sure to align the oil holes.

- Ream the bushing until clearance with piston pin is within specification.

Clearance between connecting rod bushing and piston pin:
0.005 - 0.017 mm (0.0002 - 0.0007 in)

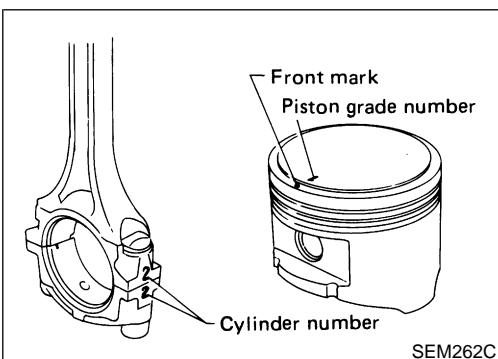
Inspection (Cont'd)

**FLYWHEEL RUNOUT**

NGEM0067S11

Runout (Total indicator reading):**Flywheel****Less than 0.15 mm (0.006 in)****CAUTION:**

- Be careful not to damage the ring gear teeth.
- Do not allow any magnetic materials to contact the ring gear teeth.
- Do not resurface the flywheel. Replace as necessary.

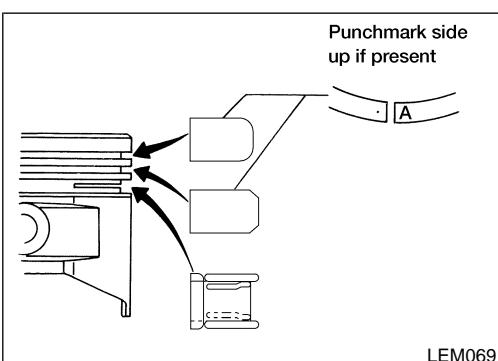
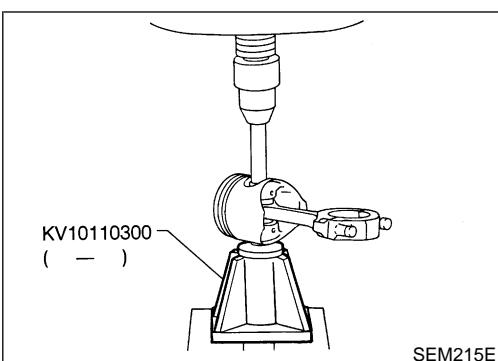
**Assembly**

NGEM0068

PISTON

NGEM0068S01

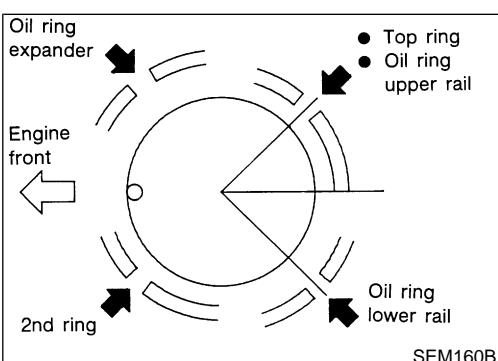
1. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin and connecting rod.
- Align the direction of piston and connecting rod.
- Numbers stamped on connecting rod and cap correspond to each cylinder.
- After assembly, make sure connecting rod swings smoothly.



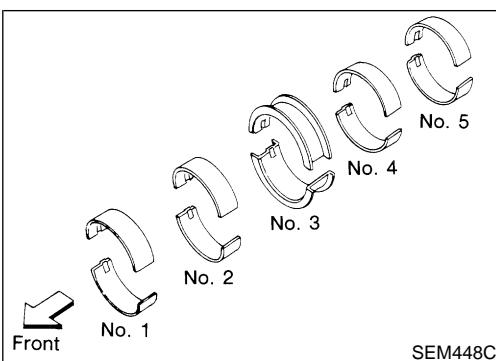
2. Set piston rings as shown.

CAUTION:

- When piston rings are not replaced, make sure that piston rings are mounted in their original positions.
- When piston rings are being replaced and no punchmark is present, piston rings can be mounted with either side up.



3. Align piston rings so that end gaps are positioned as shown.



CRANKSHAFT

- NGEM0068S02
- Set main bearings in their proper positions on cylinder block and main bearing caps.
 - Confirm that correct main bearings are used. Refer to "Bearing Clearance", EM-49.
 - Apply new engine oil to bearing surfaces.

GI

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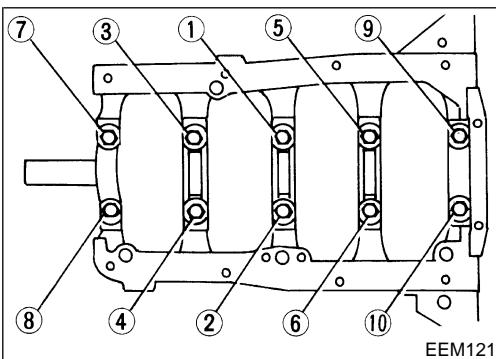
BT

HA

SC

EL

IDX



- Install crankshaft and main bearing caps and tighten bolts to the specified torque. Refer to "Components", EM-44.
- Apply new engine oil to the bolt threads and seat surface.
- Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting crankshaft in the axial direction.
- Tighten bearing cap bolts gradually in two or three stages. Start with center bearing and move outward as shown in figure.
- After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.

- Measure crankshaft end play.

Crankshaft end play:

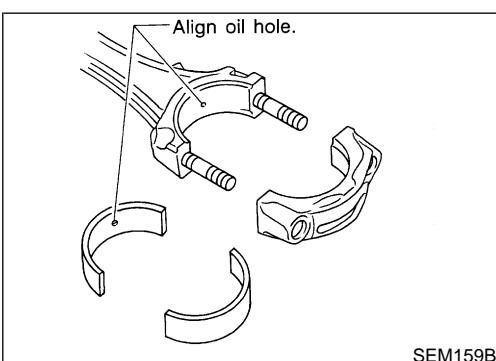
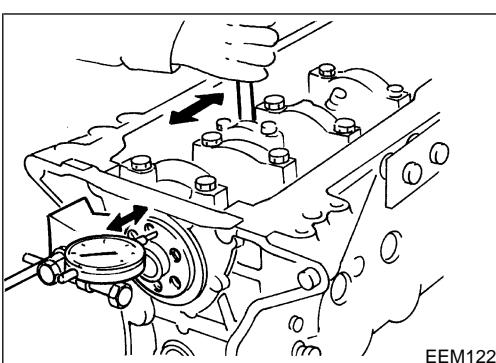
Standard

0.05 - 0.18 mm (0.0020 - 0.0071 in)

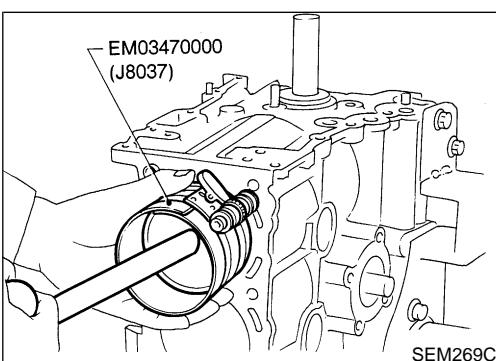
Limit

0.3 mm (0.012 in)

If beyond the limit, replace No. 3 bearing with a new one.

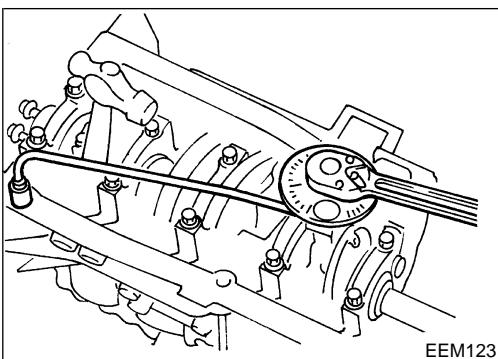


- Install connecting rod bearings in connecting rods and connecting rod caps.
- Confirm that correct bearings are used. Refer to "Connecting Rod Bearing (Big End)", EM-50.
- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.
- Apply new engine oil to bearing surfaces, bolt threads and seating surfaces.



- Install pistons with connecting rods.
- Install them into corresponding cylinders with Tool.
- Arrange so that front mark on piston head faces toward front of engine.
- Make sure connecting rod does not scratch cylinder wall.
- Make sure connecting rod bolts do not scratch crankshaft journals.
- Apply new engine oil to piston rings and sliding surface of piston.

Assembly (Cont'd)



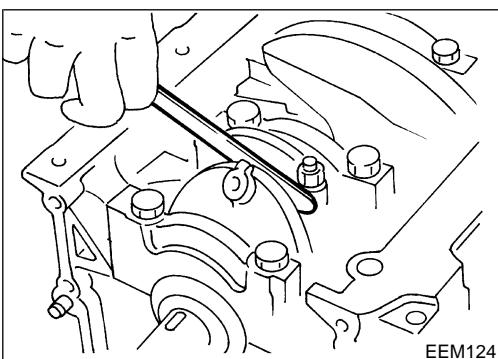
- b. Install connecting rod bearing caps.
Tighten connecting rod bearing cap nuts using the following procedure.

Connecting rod bearing nut:

(1) Tighten to 14 - 16 N·m
(1.4 - 1.6 kg-m, 10 - 12 ft-lb).

(2) Tighten nuts 60 to 65 degrees clockwise with an angle wrench.

If an angle wrench is not available, tighten them to 38 - 44 N·m (3.9 - 4.5 kg-m, 28 - 33 ft-lb).



6. Measure connecting rod side clearance.

Connecting rod side clearance:

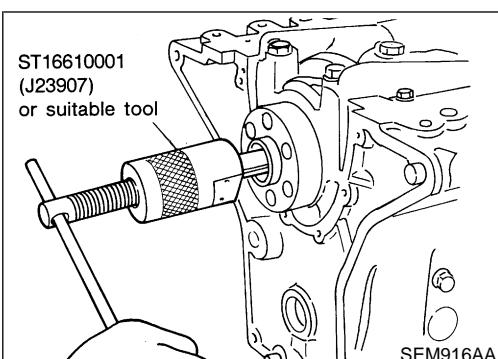
Standard

0.2 - 0.4 mm (0.008 - 0.016 in)

Limit

0.6 mm (0.024 in)

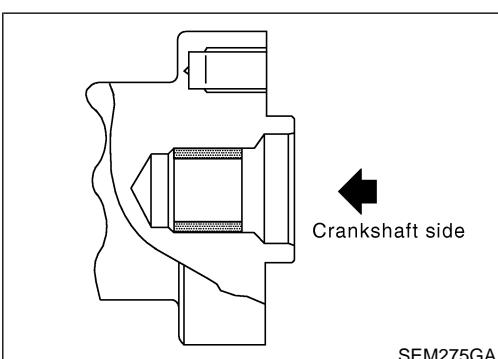
If beyond the limit, replace connecting rod and/or crankshaft.



REPLACING PILOT BUSHING

NGEM0068S03

1. Remove pilot bushing.



2. Install pilot bushing.

SERVICE DATA AND SPECIFICATIONS (SDS)

KA24DE

General Specifications

General Specifications

NGEM0069

Cylinder arrangement	In-line 4	GI
Displacement	2,389 cm ³ (145.78 cu in)	MA
Bore and stroke	89 x 96 mm (3.50 x 3.78 in)	
Valve arrangement	DOHC	EM
Firing order	1-3-4-2	
Number of piston rings	Compression Oil	LC
Number of main bearings	5	
Compression ratio	9.2	EC

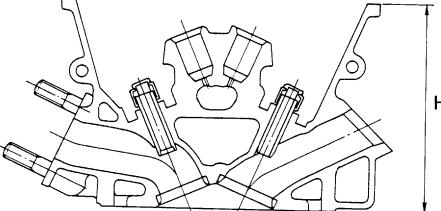
COMPRESSION PRESSURE

Unit: kPa (kg/cm², psi)/300 rpm ^{NGEM0069S01}

Standard	1,226 (12.5, 178)	FE
Minimum	1,030 (10.5, 149)	CL
Differential limit between cylinders	98 (1.0, 14)	MT

Cylinder Head

Unit: mm (in) ^{NGEM0070}

 <p>Nominal cylinder head height: H = 126.3 - 126.5 (4.972 - 4.980)</p> <p>SEM519E</p>	Standard	Limit	AT
	Head surface distortion	Less than 0.03 (0.0012)	TF PD AX SU BR ST RS BT HA SC EL IDX

SERVICE DATA AND SPECIFICATIONS (SDS)

KA24DE

Valve

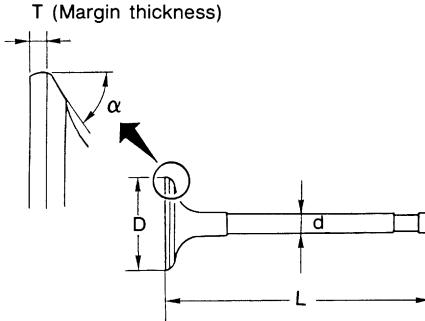
Valve

VALVE

NGEM0071

NGEM0071S01

Unit: mm (in)



SEM188

Valve head diameter "D"	Intake	36.5 - 36.7 (1.437 - 1.445)
	Exhaust	31.2 - 31.4 (1.228 - 1.236)
Valve length "L"	Intake	101.17 - 101.47 (3.9831 - 3.9949)
	Exhaust	98.67 - 98.97 (3.8846 - 3.8964)
Valve stem diameter "d"	Intake	6.965 - 6.980 (0.2742 - 0.2748)
	Exhaust	6.945 - 6.960 (0.2734 - 0.2740)
Valve seat angle "alpha"	Intake & Exhaust	45°15' - 45°45'
Valve margin "T"	Intake	0.95 - 1.25 (0.0374 - 0.0492)
	Exhaust	1.15 - 1.45 (0.0453 - 0.0571)
Valve margin "T" limit		More than 0.5 (0.020)
Valve stem end surface grinding limit		Less than 0.2 (0.008)

VALVE SPRING

NGEM0071S02

Free height mm (in)		50.3 (1.9831)
Pressure N (kg, lb) at height mm (in)	Standard	418.0 (42.6, 93.9) at 29.17 (1.1484)
	Limit	393.0 (40.1, 88.4) at 29.17 (1.1484)
Out-of-square mm (in)		Less than 2.2 (0.087)

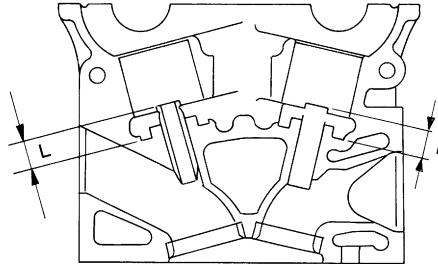
SERVICE DATA AND SPECIFICATIONS (SDS)

KA24DE

Valve (Cont'd)

VALVE GUIDE

NGEM0071S03
Unit: mm (in)



SEM301D

		Standard	Service
Valve guide Outer diameter	Intake	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
	Exhaust	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
Valve guide Inner diameter (Finished size)	Intake	7.000 - 7.018 (0.2756 - 0.2763)	
	Exhaust	7.000 - 7.018 (0.2756 - 0.2763)	
Cylinder head valve guide hole diameter	Intake	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
	Exhaust	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
		Standard	Limit
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
Valve deflection limit		0.2 (0.008)	
Projection length "L"		13.3 - 13.9 (0.524 - 0.547)	

VALVE LIFTER

NGEM0071S04
Unit: mm (in)

Valve lifter outer diameter	33.960 - 33.975 (1.3370 - 1.3376)
Lifter guide inner diameter	34.000 - 34.021 (1.3386 - 1.3394)
Clearance between lifter and filter guide	0.025 - 0.061 (0.0010 - 0.0024)

VALVE CLEARANCE ADJUSTMENT

NGEM0071S05
Unit: mm (in)

Valve clearance (Hot)	Intake	0.31 - 0.39 (0.012 - 0.015)
	Exhaust	0.39 - 0.47 (0.015 - 0.019)

SERVICE DATA AND SPECIFICATIONS (SDS)

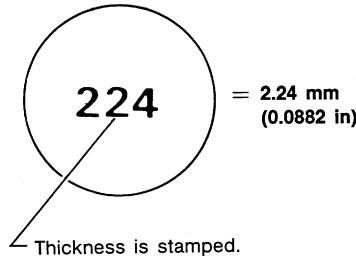
KA24DE

Valve (Cont'd)

AVAILABLE SHIMS

NGEM0071S06

Thickness mm (in)	Identification mark	Thickness mm (in)	Identification mark
—	—	1.90 (0.0748)	190
1.92 (0.0756)	192	1.94 (0.0764)	194
1.96 (0.0772)	196	1.98 (0.0780)	198
2.00 (0.0787)	200	2.02 (0.0795)	202
2.04 (0.0803)	204	2.06 (0.0811)	206
2.08 (0.819)	208	2.10 (0.0827)	210
2.12 (0.0835)	212	2.14 (0.0843)	214
2.16 (0.0850)	216	2.18 (0.0858)	218
2.20 (0.0866)	220	2.22 (0.0874)	222
2.24 (0.0882)	224	2.26 (0.0890)	226
2.28 (0.0898)	228	2.30 (0.0906)	230
2.32 (0.0913)	232	2.34 (0.0921)	234
2.36 (0.0929)	236	2.38 (0.0937)	238
2.40 (0.0945)	240	2.42 (0.0953)	242
2.44 (0.0961)	244	2.46 (0.0969)	246
2.48 (0.0976)	248	2.50 (0.0984)	250
2.52 (0.0992)	252	2.54 (0.1000)	254
2.56 (0.1008)	256	2.58 (0.1016)	258
2.60 (0.1024)	260	2.62 (0.1031)	262
2.64 (0.1039)	264	2.66 (0.1047)	266
2.68 (0.1055)	268	—	—



SEM308D

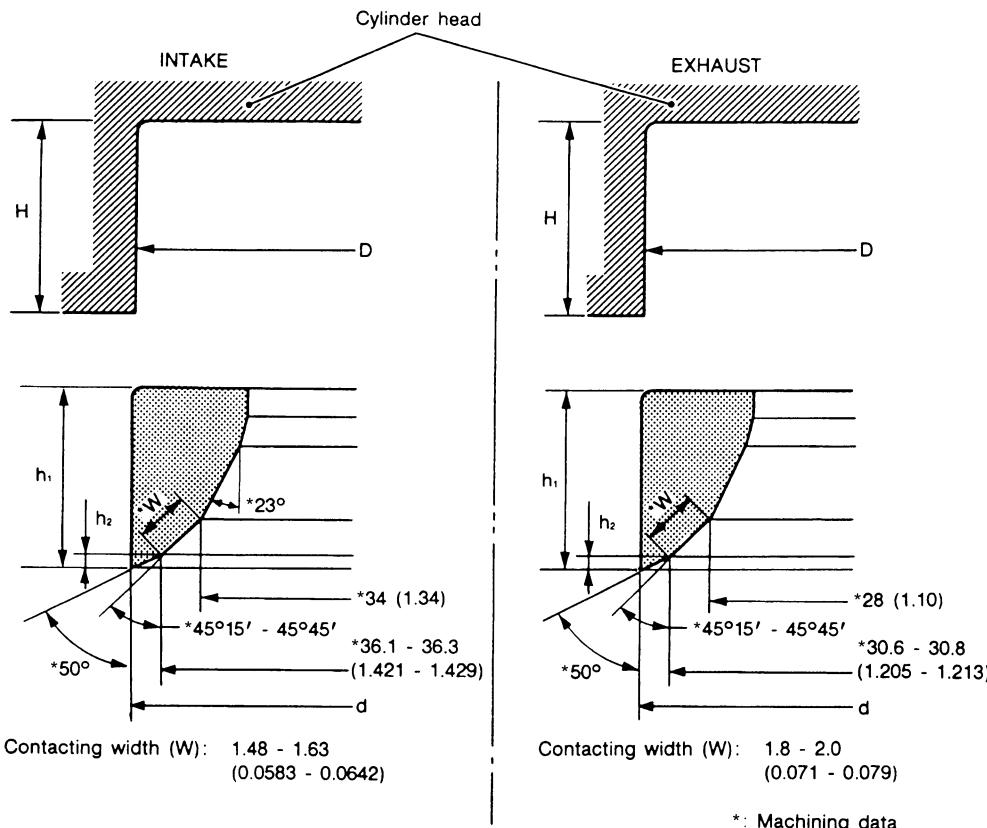
SERVICE DATA AND SPECIFICATIONS (SDS)

KA24DE

Valve (Cont'd)

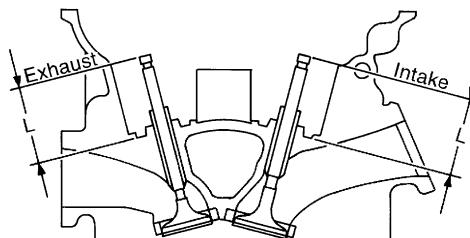
VALVE SEAT

NGEM0071S07
Unit: mm (in)



*: Machining data

AEM456



SEM621F

		Standard	Service
Cylinder head seat recess diameter (D)	Intake	37.500 - 37.516 (1.4764 - 1.4770)	38.000 - 38.016 (1.4961 - 1.4967)
	Exhaust	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)
Valve seat interference fit	Intake	0.064 - 0.096 (0.0025 - 0.0038)	
	Exhaust	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	Intake	37.580 - 37.596 (1.4795 - 1.4802)	38.080 - 38.096 (1.4992 - 1.4998)
	Exhaust	32.280 - 32.296 (1.2709 - 1.2715)	32.780 - 32.796 (1.2905 - 1.2912)
Depth (H)	Intake	6.1 - 6.3 (0.240 - 0.248)	
	Exhaust	6.1 - 6.3 (0.240 - 0.248)	
Height (h_1)	Intake	5.8 - 6.0 (0.228 - 0.236) 5.9 - 6.0 (0.232 - 0.236)	5.3 - 5.5 (0.209 - 0.217)
	Exhaust	5.9 - 6.0 (0.232 - 0.236)	5.32 - 5.42 (0.209 - 0.213)

SERVICE DATA AND SPECIFICATIONS (SDS)

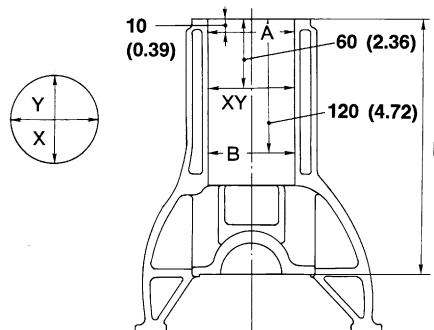
KA24DE

Valve (Cont'd)

Height (h_2)	Intake	0.24 - 0.64 (0.0094 - 0.0252) 0.34 - 0.64 (0.0134 - 0.0252)
	Exhaust	0.43 - 0.73 (0.0169 - 0.0287)
Depth (L)	Intake	42.02 - 42.52
	Exhaust	42.03 - 42.53

Cylinder Block

NGEM0072
Unit: mm (in)



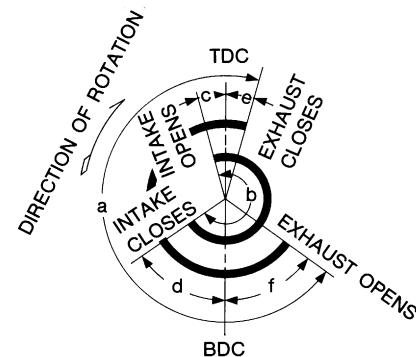
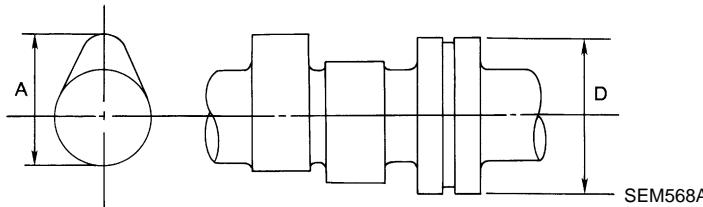
SEM400E

		Standard	Limit
Distortion		—	0.1 (0.004)
Cylinder bore	Inner diameter	Grade 1 89.000 - 89.010 (3.5039 - 3.5043)	0.2 (0.008)*
		Grade 2 89.010 - 89.020 (3.5043 - 3.5047)	
		Grade 3 89.020 - 89.030 (3.5047 - 3.5051)	
	Out-of-round (X - Y)		—
	Taper (A - B)		—
Difference in inner diameter between cylinders		Less than 0.015 (0.0006)	—
Piston-to-cylinder clearance		Less than 0.010 (0.0004)	—
Cylinder block height (From crankshaft center)		Less than 0.03 (0.0012)	0.2 (0.008)
		0.020 - 0.040 (0.0008 - 0.0016)	—
		246.95 - 247.05 (9.7224 - 9.7264)	0.2 (0.008)**

* Wear limit

** Total amount of cylinder head resurfacing and cylinder block resurfacing

Camshaft and Camshaft Bearing

NGEM0073
Unit: mm (in)

EM120

		Standard	Limit
Cam height (A)	Intake	41.755 - 41.945 (1.644 - 1.651)	—
	Exhaust	41.815 - 42.005 (1.646 - 1.654)	—
Wear limit of cam height		—	0.2 (0.008)
Camshaft journal to bearing clearance		0.045 - 0.090 (0.0018 - 0.0035)	0.12 (0.0047)
Inner diameter of camshaft bearing	#1 to #5 journals	28.000 - 28.025 (1.1024 - 1.1033)	—
Outer diameter of camshaft journal (D)	#1 to #5 journals	27.935 - 27.955 (1.0998 - 1.1006)	—
Camshaft runout*		Less than 0.02 (0.0008)	0.04 (0.0016)
Camshaft end play		0.070 - 0.148 (0.0028 - 0.0058)	0.2 (0.008)
Valve timing (Degree on crankshaft)	a	224	—
	b	224	—
	c	-1	—
	d	45	—
	e	7	—
	f	37	—

* Total indicator reading

SERVICE DATA AND SPECIFICATIONS (SDS)

KA24DE

Piston, Piston Ring and Piston Pin

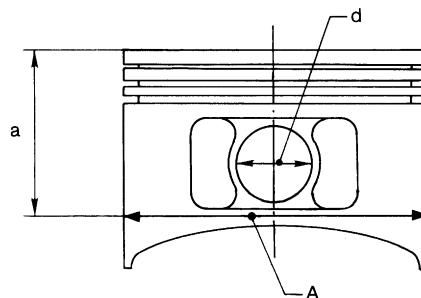
Piston, Piston Ring and Piston Pin

NGEM0074

PISTON

NGEM0074S01

Unit: mm (in)



SEM804E

Piston skirt diameter (A)	Standard	Grade No. 1	88.970 - 88.980 (3.5027 - 3.5031)	
		Grade No. 2	88.980 - 88.990 (3.5031 - 3.5035)	
		Grade No. 3	88.990 - 89.000 (3.5035 - 3.5039)	
	Service (Oversize)	0.5 (0.020)	89.470 - 89.500 (3.5224 - 3.5236)	
		1.0 (0.039)	89.970 - 90.000 (3.5421 - 3.5433)	
Dimension (a)		Approximately 48 (1.89)		
Piston pin hole diameter (d)		20.993 - 21.005 (0.8265 - 0.8270)		
Piston-to-cylinder bore clearance		0.020 - 0.040 (0.0008 - 0.0016)		

PISTON PIN

NGEM0074S02

Unit: mm (in)

	Standard	Limit
Piston pin outer diameter	20.989 - 21.001 (0.8263 - 0.8268)	—
Interference fit of piston pin to piston pin hole	-0.002 to 0.01 (-0.0001 to 0.0004)	—
Piston pin to connecting rod bearing clearance	0.005 - 0.017 (0.0002 - 0.0007)	0.023 (0.0009)

PISTON RING

NGEM0074S03

Unit: mm (in)

	Standard	Limit
Side clearance	Top	0.040 - 0.080 (0.0016 - 0.0031)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)
	Oil	0.065 - 0.135 (0.0026 - 0.0053)
Ring gap	Top	0.28 - 0.52 (0.0110 - 0.0205)
	2nd	0.45 - 0.69 (0.0177 - 0.0272)
	Oil (rail ring)	0.20 - 0.69 (0.0079 - 0.0272)

SERVICE DATA AND SPECIFICATIONS (SDS)

KA24DE

Connecting Rod

Connecting Rod

NGEM0075

Unit: mm (in)

GI

MA

EM

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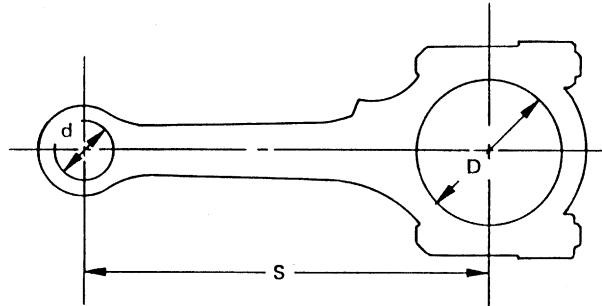
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SEM570A

	Standard	Limit
Center distance (S)	164.95 - 165.05 (6.4941 - 6.4980)	—
Bend [per 100 mm (3.94 in)]	—	0.15 (0.0059)
Torsion [per 100 mm (3.94 in)]	—	0.30 (0.0118)
Connecting rod small end inner diameter (d)*	23.970 - 24.000 (0.9437 - 0.9449)	—
Piston pin bushing inner diameter	21.000 - 21.012 (0.8268 - 0.8272)	—
Connecting rod big end inner diameter (D)*	53.000 - 53.013 (2.0866 - 2.0871)	—
Side clearance	0.2 - 0.4 (0.008 - 0.016)	0.6 (0.024)

* Without bearing

Crankshaft

NGEM0076

Unit: mm (in)

TF

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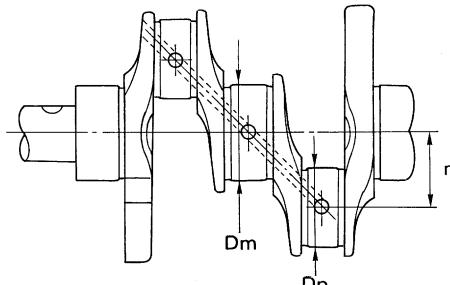
RS

BT

HA

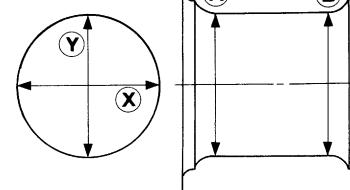
SC

EL



SEM394

Out-of-round
Taper $(X - Y) - (A - B)$



EM715

Main journal diameter (Dm)	Grade No. 0	59.967 - 59.975 (2.3609 - 2.3612)
	Grade No. 1	59.959 - 59.967 (2.3606 - 2.3609)
	Grade No. 2	59.951 - 59.959 (2.3603 - 2.3606)
Pin journal diameter (Dp)	Grade No. 0	49.968 - 49.974 (1.9672 - 1.9675)
	Grade No. 1	49.962 - 49.968 (1.9670 - 1.9672)
	Grade No. 2	49.956 - 49.962 (1.9668 - 1.9670)
Center distance (r)		47.95 - 48.05 (1.8878 - 1.8917)
	Standard	Limit
Taper of journal and pin [A - B]	Journal	—
	Pin	—
		0.01 (0.0004)
		0.005 (0.0002)

SERVICE DATA AND SPECIFICATIONS (SDS)

KA24DE

Crankshaft (Cont'd)

Out-of-round of journal and pin [X - Y]	Journal	—	0.01 (0.0004)
	Pin	—	0.005 (0.0002)
Runout [TIR]*		—	0.10 (0.0039)
Free end play		0.05 - 0.18 (0.0020 - 0.0071)	0.3 (0.012)
Fillet roll		More than 0.1 (0.004)	

* Total indicator reading

Bearing Clearance

NGEM0077
Unit: mm (in)

	Standard	Limit
Main bearing clearance	0.020 - 0.047 (0.0008 - 0.0019)	0.1 (0.004)
Connecting rod bearing clearance	0.010 - 0.035 (0.0004 - 0.0014)	0.09 (0.0035)

Available Main Bearing

NGEM0078

STANDARD

NGEM0078S01
Unit: mm (in)

Grade number	Thickness	Identification color
0	1.821 - 1.825 (0.0717 - 0.0719)	Black
1	1.825 - 1.829 (0.0719 - 0.0720)	Brown
2	1.829 - 1.833 (0.0720 - 0.0722)	Green
3	1.833 - 1.837 (0.0722 - 0.0723)	Yellow
4	1.837 - 1.841 (0.0723 - 0.0725)	Blue

UNDERSIZE (SERVICE)

NGEM0078S02
Unit: mm (in)

	Thickness	Main journal diameter "Dm"
0.25 (0.0098)	1.952 - 1.960 (0.0769 - 0.0772)	Grind so that bearing clearance is the specified value.

Available Connecting Rod Bearing

NGEM0079

STANDARD

NGEM0079S01
Unit: mm (in)

Grade number	Thickness	Identification color
0	1.505 - 1.508 (0.0593 - 0.0594)	—
1	1.508 - 1.511 (0.0594 - 0.0595)	Brown
2	1.511 - 1.514 (0.0595 - 0.0596)	Green

UNDERSIZE (SERVICE)

NGEM0079S02
Unit: mm (in)

	Thickness	Crank pin journal diameter "Dp"
0.08 (0.0031)	1.540 - 1.548 (0.0606 - 0.0609)	Grind so that bearing clearance is the specified value.
0.12 (0.0047)	1.560 - 1.568 (0.0614 - 0.0617)	
0.25 (0.0098)	1.625 - 1.633 (0.0640 - 0.0643)	

SERVICE DATA AND SPECIFICATIONS (SDS)**KA24DE**

Miscellaneous Components

Miscellaneous Components

NGEM0080

Unit: mm (in)

Camshaft sprocket runout [TIR]*	Less than 0.15 (0.0059)
Flywheel runout [TIR]*	Less than 0.15 (0.006)

* Total indicator reading

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

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

The Supplemental Restraint System such as "AIR BAG" and "SEAT BELT PRE-TENSIONER", used along with a seat belt, helps to reduce the risk or severity of injury to the driver and front passenger for certain types of collision. The Supplemental Restraint System consists of driver air bag module (located in the center of the steering wheel), front passenger air bag module (located on the instrument panel on passenger side), seat belt pre-tensioners, a diagnosis sensor unit, crash zone sensor, seat belt buckle switches, warning lamp, wiring harness and spiral cable.

Information necessary to service the system safely is included in the **RS section** of this Service Manual.

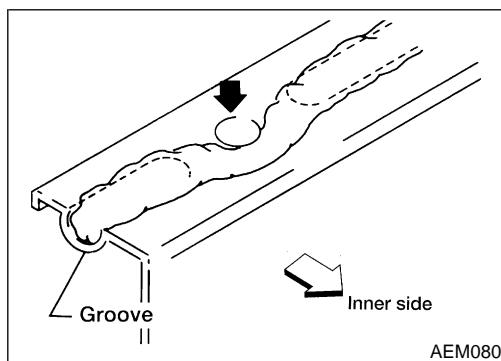
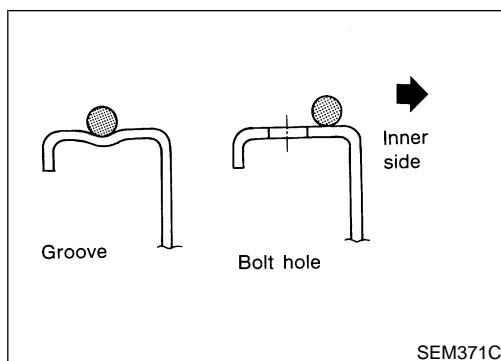
WARNING:

- 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 should be performed by an authorized NISSAN 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 RS 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 harness connectors.

Parts Requiring Angular Tightening

- NGEM0091
- Use an angle wrench for the final tightening of the following engine parts:
 - a) Cylinder head bolts
 - b) Connecting rod cap nuts
 - 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.

NGEM0092



Liquid Gasket Application Procedure

- 1) Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also completely clean any oil stains from these portions.
- 2) Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Silicone RTV or equivalent. Refer to GI-50, "Recommended Chemical Products and Sealants".)
 - Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) dia. (for oil pan).
 - Be sure liquid gasket is 2.0 to 3.0 mm (0.079 to 0.118 in) dia. (in areas except oil pan).
- 3) Apply liquid gasket to inner surface around hole perimeter area (unless otherwise specified).
- 4) Assembly should be done within 5 minutes after coating.
- 5) Wait at least 30 minutes before refilling engine oil and engine coolant.

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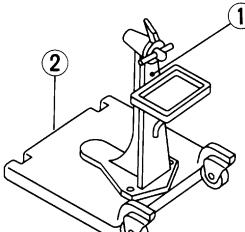
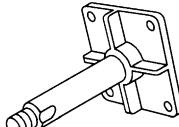
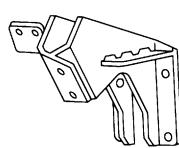
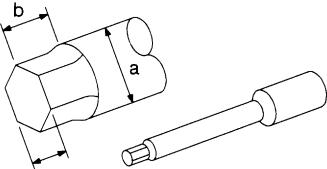
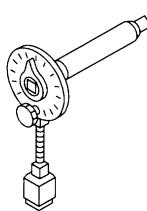
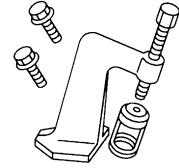
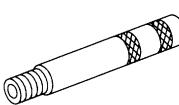
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Special Service Tools

Special Service Tools

NGEM0102

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	 <p>Disassembling and assembling</p> <p>NT042</p>
KV10106500 (—) Engine stand shaft	 <p>NT028</p>
KV10110001 (—) Engine sub-attachment	 <p>NT032</p>
ST10120000 (J24239-01) Cylinder head bolt wrench	 <p>Loosening and tightening cylinder head bolt a: 13 mm (0.51 in) dia. b: 12 mm (0.47 in) c: 10 mm (0.39 in)</p> <p>NT583</p>
KV10112100 (BT8653-A) Angle wrench	 <p>Tightening bearing cap, cylinder head bolts, etc.</p> <p>NT014</p>
KV10110600 (J33986) Valve spring compressor	 <p>Disassembling and assembling valve compo- nents</p> <p>NT033</p>
KV10107501 (—) Valve oil seal drift	 <p>Installing valve oil seal</p> <p>NT025</p>

PREPARATION

VG33E AND VG33ER

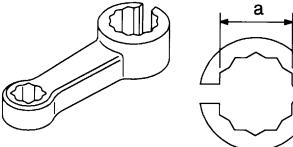
Special Service Tools (Cont'd)

Tool number (Kent-Moore No.) Tool name	Description	
KV10110300 (—) Piston pin press stand assembly 1 KV10110310 (—) Cap 2 KV10110330 (—) Spacer 3 ST13030020 (—) Press stand 4 ST13030030 (—) Spring 5 KV10110340 (—) Drift 6 KV10110320 (—) Center shaft	 NT036	Disassembling and assembling piston with connecting rod
EM03470000 (J8037) Piston ring compressor	 NT044	Installing piston assembly into cylinder bore
ST16610001 (J23907) Pilot bushing puller	 NT045	Removing crankshaft pilot bushing
KV10111100 (J37228) Seal cutter	 NT046	Removing oil pan
WS39930000 (—) Tube presser	 NT052	Pressing the tube of liquid gasket
KV10117100 (J36471-A) Front heated oxygen sensor wrench	 NT379	Loosening or tightening heated oxygen sensor For 22 mm (0.87 in) hexagon nut

PREPARATION

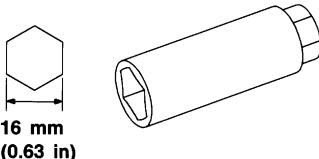
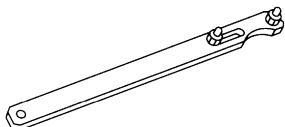
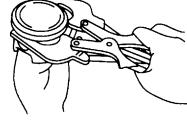
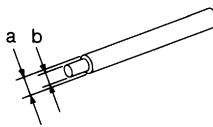
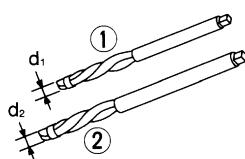
VG33E AND VG33ER

Special Service Tools (Cont'd)

Tool number (Kent-Moore No.)	Description
KV10114400 (J38365) Heated oxygen sensor wrench	 <p>NT636</p>

Commercial Service Tools

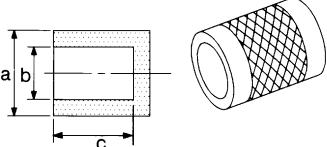
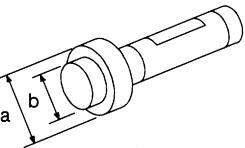
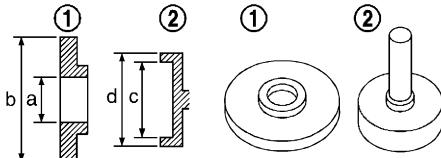
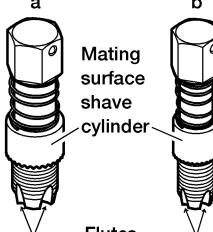
NGEM0103

Tool name (Kent Moore No.)	Description
Spark plug wrench	 <p>NT047</p>
Pulley holder	 <p>NT035</p>
Valve seat cutter set	 <p>NT048</p>
Piston ring expander	 <p>NT030</p>
Valve guide drift	 <p>NT015</p>
Valve guide reamer	 <p>NT016</p> <p>Reaming valve guide 1 or hole for oversize valve guide 2 Intake: $d_1 = 7.0 \text{ mm (0.276 in) dia.}$ $d_2 = 11.2 \text{ mm (0.441 in) dia.}$ Exhaust: $d_1 = 8.0 \text{ mm (0.315 in) dia.}$ $d_2 = 12.2 \text{ mm (0.480 in) dia.}$</p>

PREPARATION

VG33E AND VG33ER

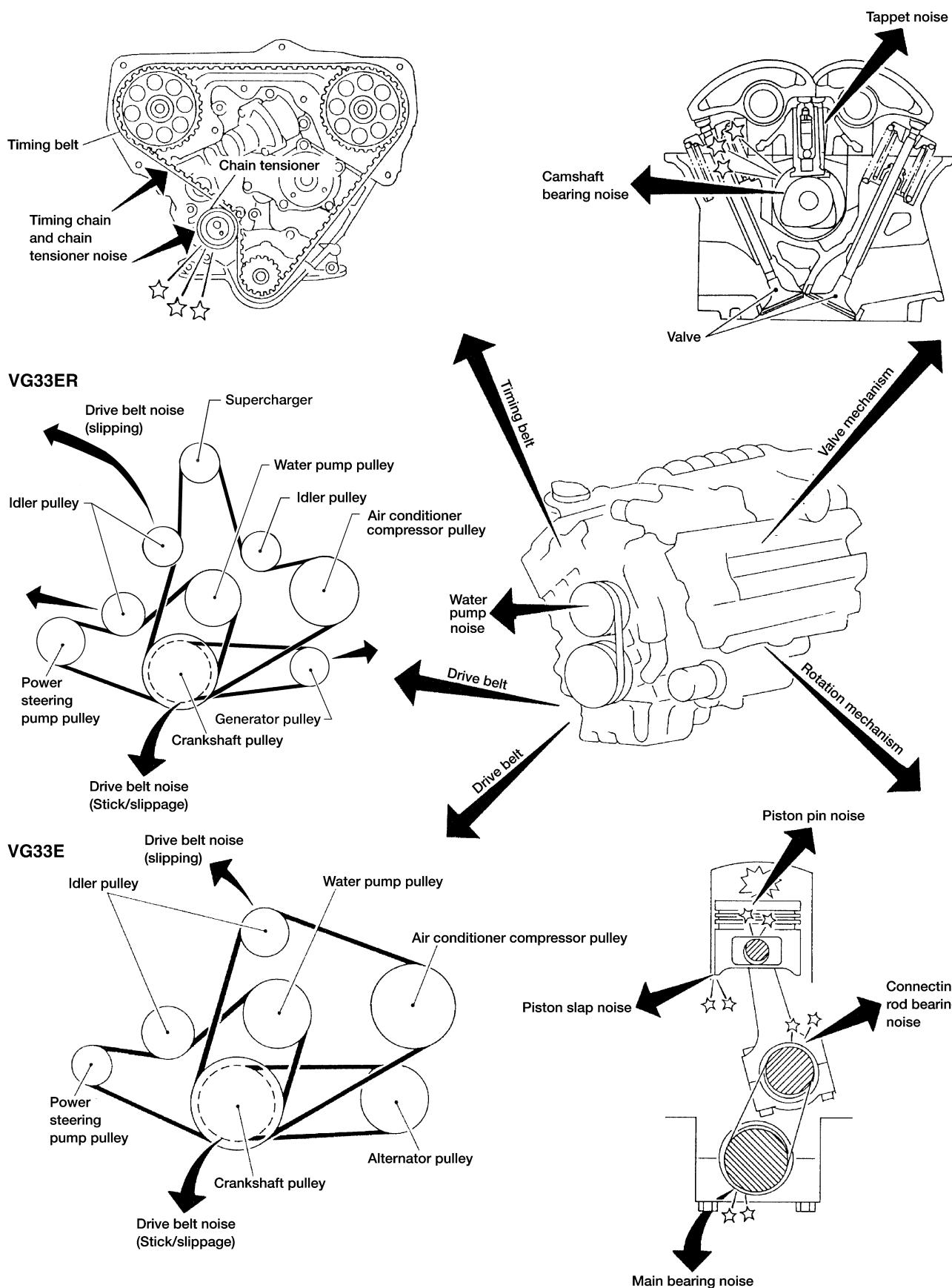
Commercial Service Tools (Cont'd)

Tool name (Kent Moore No.)	Description	
Camshaft oil seal drift	 NT613	GI Installing camshaft oil seal a: 60 mm (2.36 in) dia. b: 44.5 mm (1.752 in) dia. c: 75 mm (2.95 in)
Front oil seal drift	 NT049	MA EM Installing front oil seal a: 52 mm (2.05 in) dia. b: 44 mm (1.73 in) dia.
Rear oil seal drift	 NT719	LC EC FE CL MT AT TF PD AX SU BR ST RS BT HA SC EL Installing rear oil seal a: 46 mm (1.81 in) b: 110 mm (4.33 in) c: 84 mm (3.31 in) d: 96 mm (3.78 in)
a: (J-43897-18) b: (J-43897-12) Thread repair tool for oxygen sensor	 AEM488	a: 18 mm (0.71 in) b: 12 mm (0.47 in)
Anti-seize thread compound	 AEM489	For preventing corrosion, seizing, and galling on high temperature applications.

NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

NGEM0039

VG33E AND VG33ER



NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

VG33E AND VG33ER

NVH Troubleshooting Chart — Engine Noise

NVH Troubleshooting Chart — Engine Noise

NGEM0039S01

Use the chart below to help you find the cause of the symptom.

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

If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Hydraulic valve lifter	Step 19 in "Installation", EM-103
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-96, EM-96
Crank-shaft 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-117, EM-123
	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-119, EM-117, EM-118, EM-118
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing clearance (Small end) Connecting rod bearing clearance (Big end)	EM-123, EM-123
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-121, EM-120
Timing belt cover	Whine or hissing	C	A	—	A	A	—	Timing belt noise (too tight)	Loose timing belt Belt contacting case	EM-82
	Clatter	A	B	—	C	A	—	Timing belt noise (too loose)		
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Other drive belts (Sticking or slipping)	Drive belts deflection	MA-26, "Checking Drive Belts"
	Creaking	A	B	A	B	A	B	Other drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	LC-30, "Water Pump Inspection"

A: Closely related

B: Related

C: Sometimes related

—: Not related

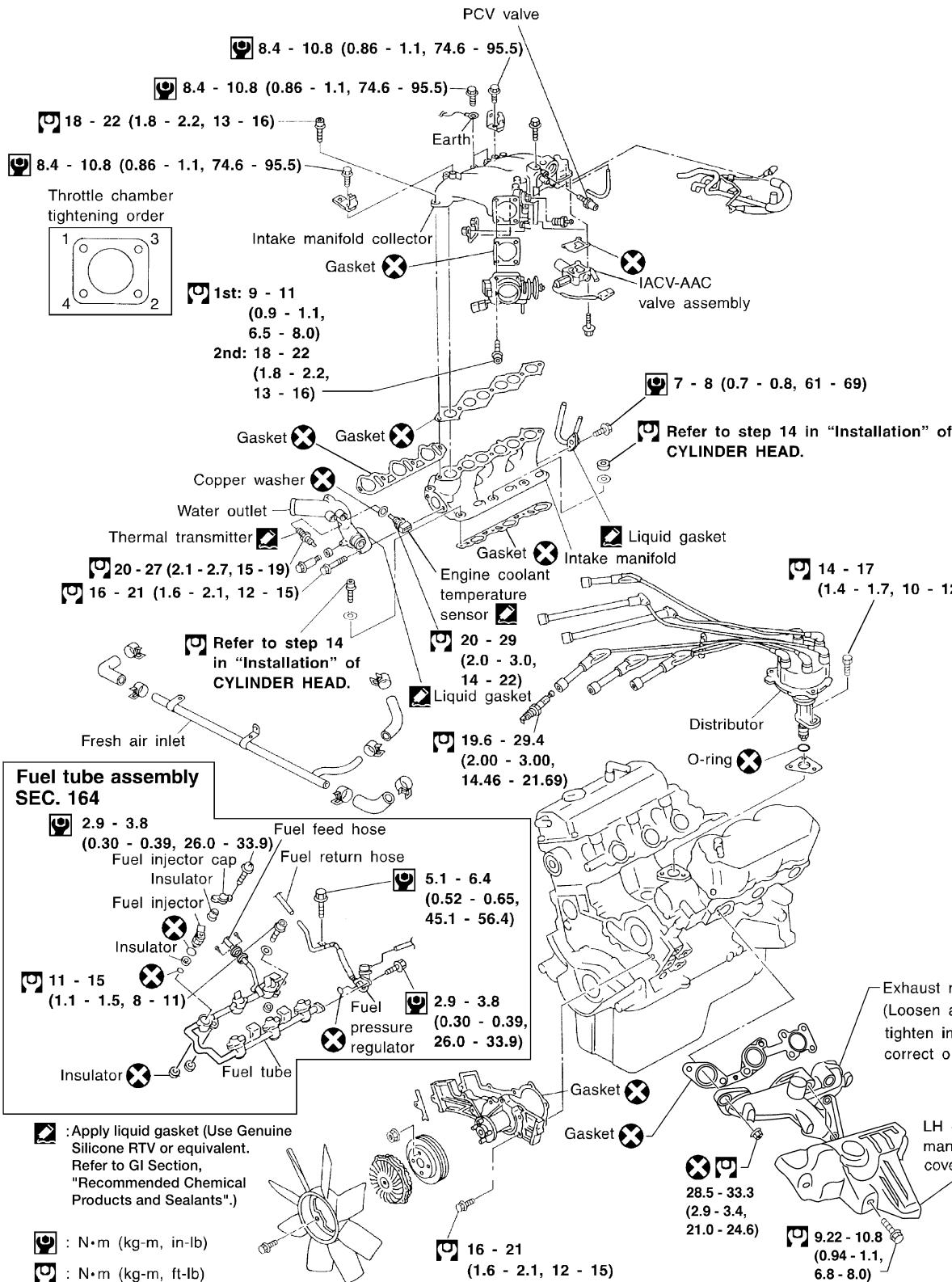
Removal and Installation

Removal and Installation

VG33E, VG33ER

NGEM0005

SEC. 140•147•148•163•164•173•210•221



VG33ER

SEC. 140 • 147 • 148 • 163 • 164 • 173 • 210 • 221

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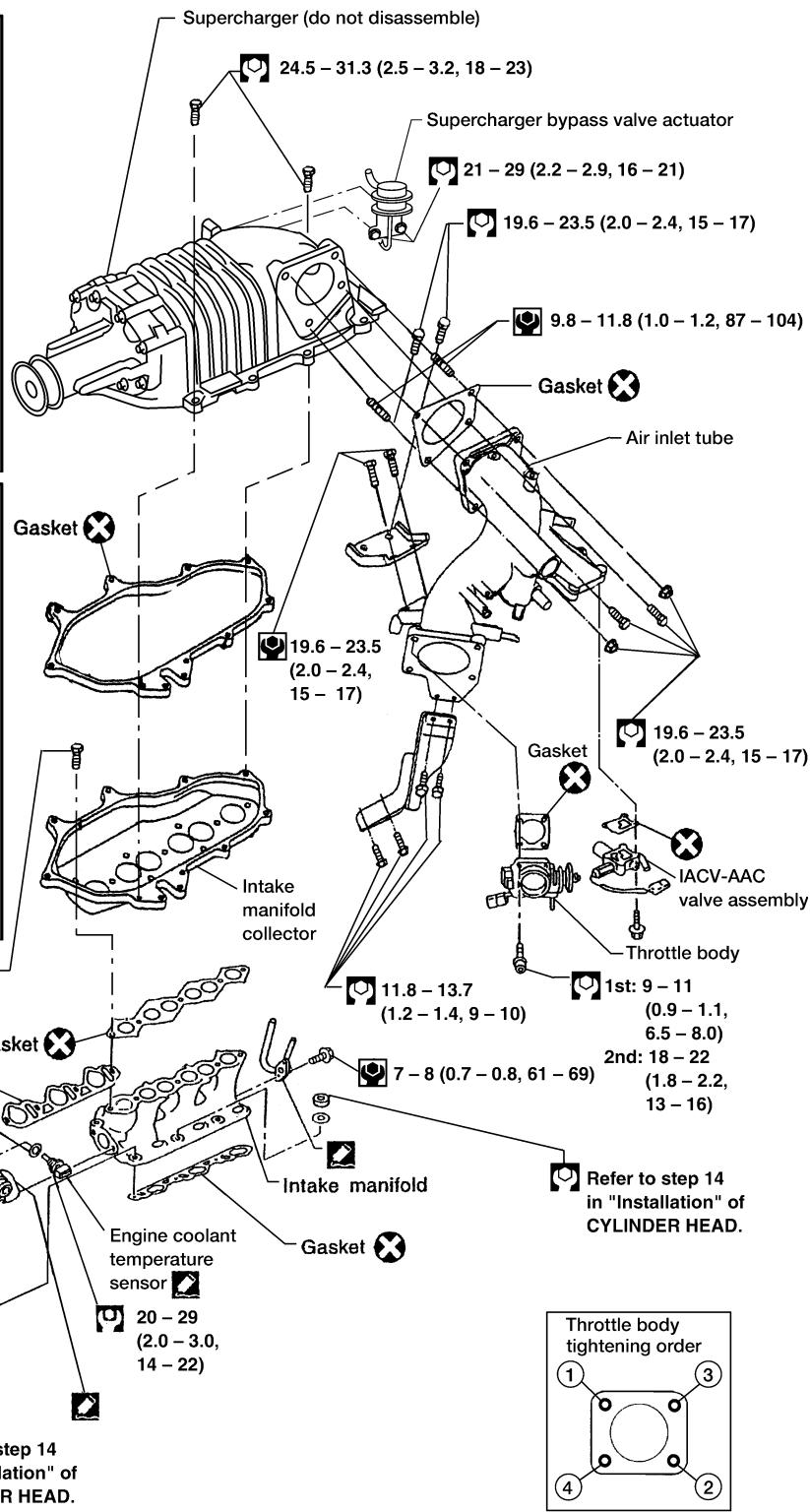
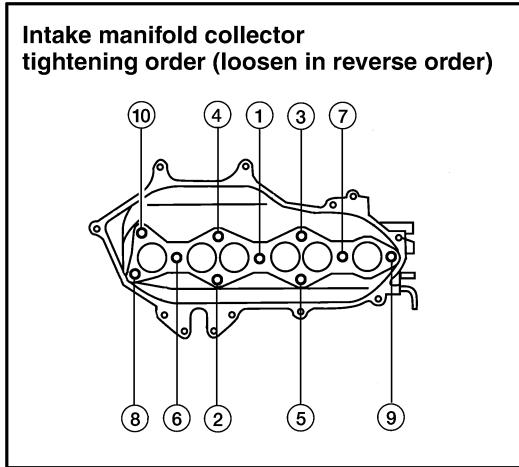
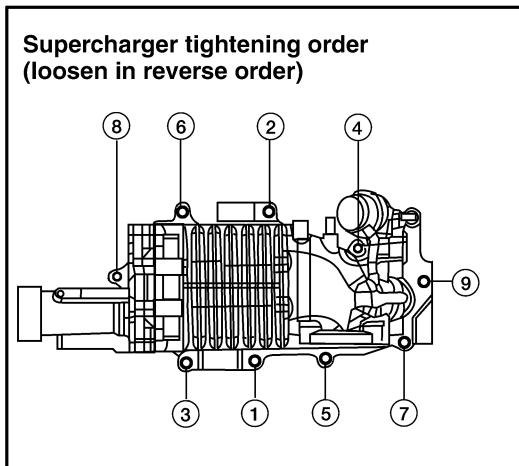
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: Apply liquid gasket (Use Genuine Silicone RTV or equivalent. Refer to GI Section, "Recommended Chemical Products and Sealants".)

: N·m (kg-m, in-lb)

: N·m (kg-m, ft-lb)

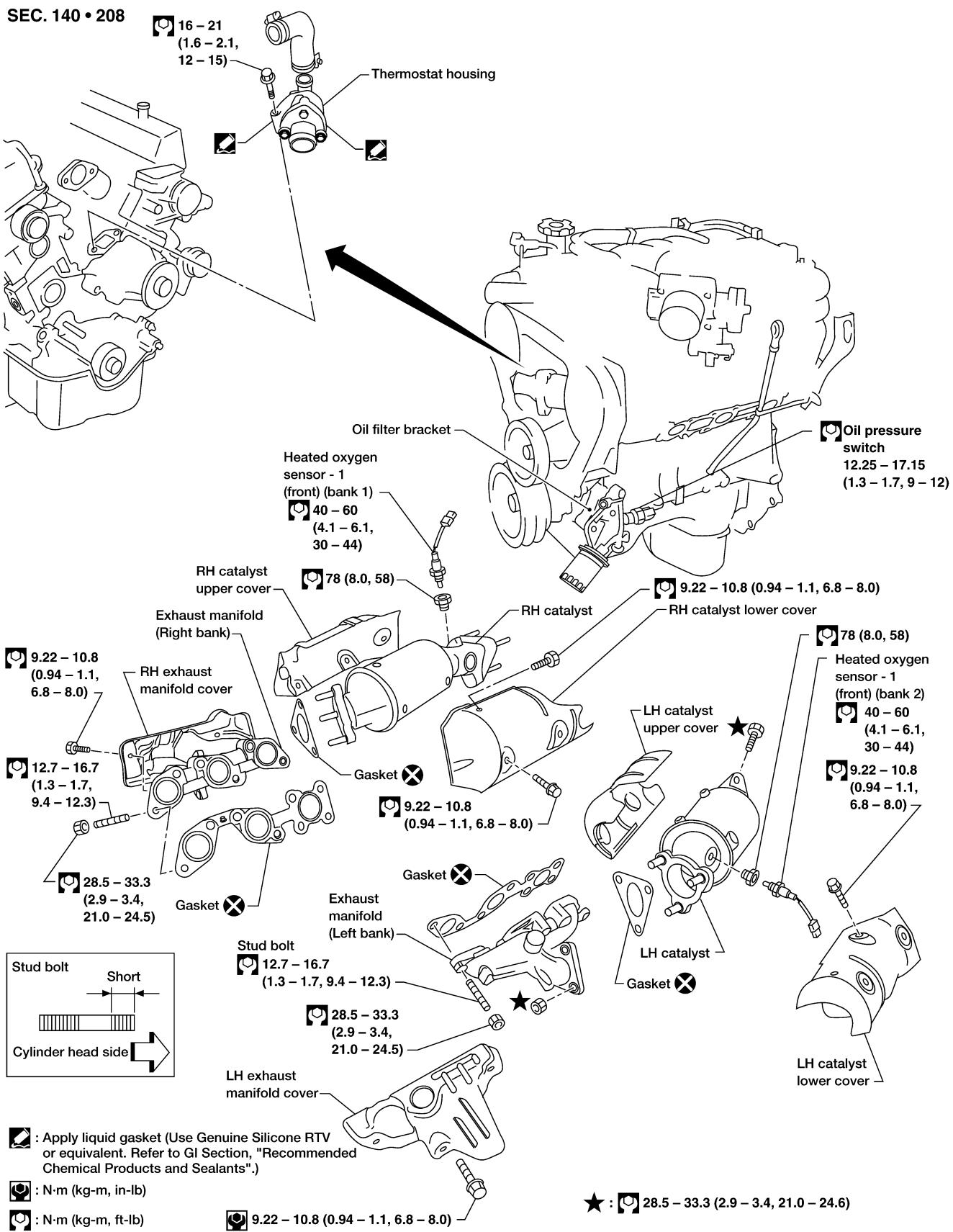
OUTER COMPONENT PARTS

VG33E AND VG33ER

Removal and Installation (Cont'd)

VG33E, VG33ER

SEC. 140 • 208



MEASUREMENT OF COMPRESSION PRESSURE

NGEM0006

VG33E AND VG33ER

1. Warm up engine.
2. Turn ignition switch OFF.
3. Release fuel pressure.
Refer to **EC-644**, "Fuel Pressure Release".
4. Remove all spark plugs.
- **Clean area around plug with compressed air before removing the spark plugs.**
5. Disconnect camshaft position sensor harness connector at the distributor.
6. Remove fuel injector fuse **3** on FUSE BLOCK (J/B) behind the instrument lower panel. Refer to "FUSE BLOCK — JUNCTION BOX (J/B)".

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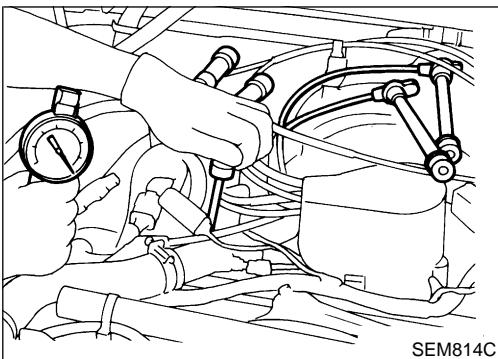
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7. Attach a compression tester to No. 1 cylinder.
8. Depress accelerator pedal fully to keep throttle valve wide open.
9. Crank engine and record highest gauge indication.
10. Repeat the measurement on each cylinder as shown above.
- **Always use a fully-charged battery to obtain specified engine speed.**

Compression pressure: kPa (kg/cm², psi)/300 rpm
Standard

1,196 (12.2, 173)

Minimum

883 (9.0, 128)

Difference limit between cylinders

98 (1.0, 14)

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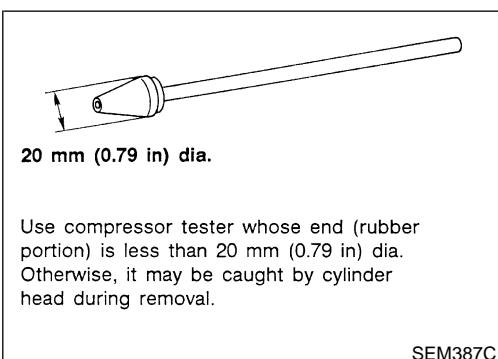
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11. If cylinder compression in one or more cylinders is low, pour a small amount of engine oil into cylinders through spark plug holes and retest compression.
- **If adding oil improves cylinder compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. Refer to "Valve Seat", EM-130. If valve or valve seat is damaged excessively, replace them.**
- **If compression in any two adjacent cylinders is low and if adding oil does not improve compression, there is leakage past the gasket surface. If so, replace cylinder head gasket.**
12. Reinstall spark plugs, fuel injector fuse, fuel pump fuse, and reconnect camshaft position sensor harness connector at the distributor.
13. Erase the DTC stored in the ECM.

MEASUREMENT OF COMPRESSION PRESSURE

VG33E AND VG33ER

CAUTION:

Always erase the DTC after checking compression.
Refer to *EC-673*, "HOW TO ERASE EMISSION-RELATED DIAGNOSTIC INFORMATION".

Removal

NGEM0007

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WARNING:

- Place vehicle on a flat and solid surface.
- Place chocks at front and rear of rear wheels.
- You should not remove oil pan until exhaust system and cooling system have completely cooled off. Otherwise, you may burn yourself and/or fire may break out in the fuel line.
- When removing front and/or rear engine mounting bolts or nuts, lift engine slightly to ensure safety.

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CAUTION:

- In lifting engine, be careful not to hit against adjacent parts, especially against accelerator wire casing end, brake tube and brake master cylinder.
 - For tightening torque, refer to AT-271, "Removal"; MT-41, "REMOVAL AND INSTALLATION"; and PD-8, "Removal and Installation".
1. Remove undercover.
 2. Drain engine oil.
 3. Remove stabilizer bracket bolts (RH & LH).
 4. Remove front propeller shaft from front differential carrier.
 5. Remove front drive shaft fixing bolts (RH & LH).
 6. Remove front differential carrier bleeder hose.
 7. Remove front suspension crossmember.
 8. Remove differential front mounting bolts (RH & LH) and rear mounting bolts.
 9. Remove front differential carrier.
 10. Remove front differential carrier mounting bracket.
 11. Remove starter motor.
 12. Remove transmission to rear engine mounting bracket nuts (RH & LH).
 13. Remove engine mounting bolts or nuts (RH & LH).
 14. Remove power steering mounting brackets (RH & LH).
 15. Lift up engine. If necessary, disconnect exhaust tube.
 16. Remove relay rod. It is not necessary to disconnect pitman arm.

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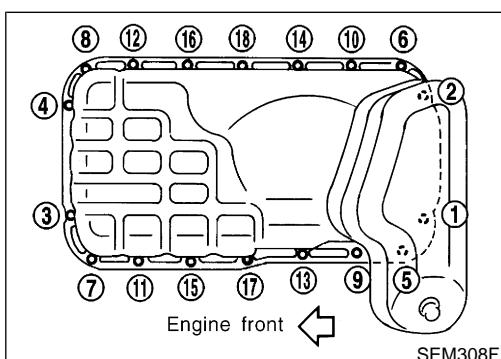
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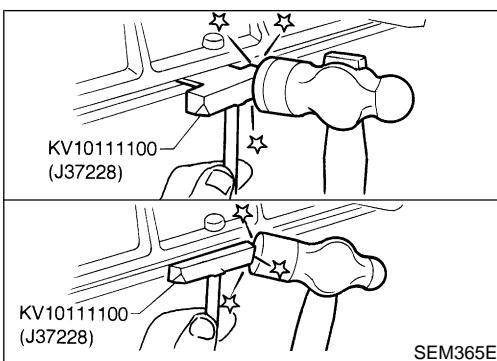
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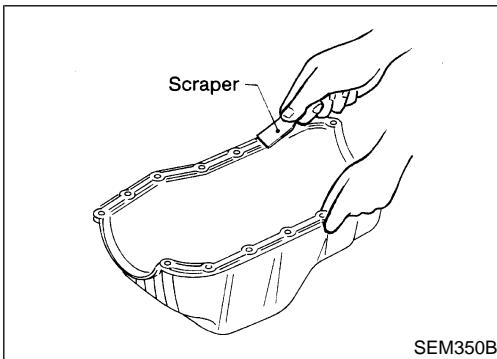
17. Remove oil pan bolts in numerical order.



Removal (Cont'd)



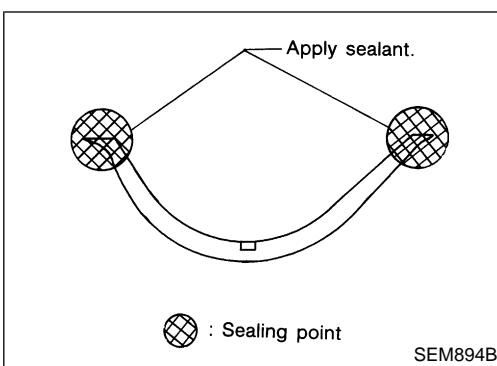
18. Remove oil pan.
 - a. Insert Tool between cylinder block and oil pan.
 - **Do not drive seal cutter into oil pump or rear oil seal retainer portion, or aluminum mating face will be damaged.**
 - **Do not insert screwdriver, or oil pan flange will be deformed.**
 - b. Slide Tool by tapping its side with a hammer, and remove oil pan.



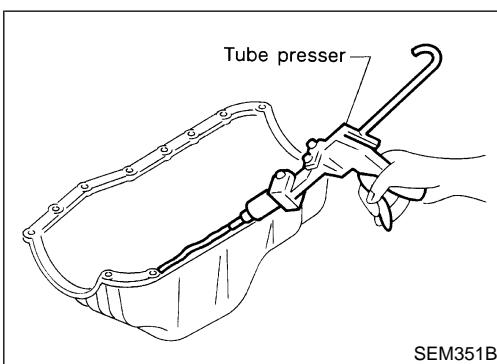
Installation

NGEM0008

1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
 - Also remove traces of liquid gasket from mating surface of cylinder block.



2. Apply sealant to oil pump gasket and rear oil seal retainer gasket.

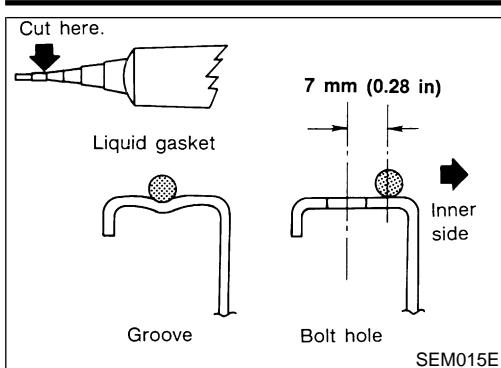


3. Apply a continuous bead of liquid gasket to mating surface of oil pan.
 - **(Use Genuine Silicone RTV or equivalent. Refer to GI-50, "Recommended Chemical Products and Sealants".)**

OIL PAN

VG33E AND VG33ER

Installation (Cont'd)



- Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.
- 4. Apply liquid gasket to inner sealing surface as shown in figure.
- Attaching should be done within 5 minutes after coating.
- 5. Install oil pan.
- Install bolts/nuts in the reverse order of removal.
- Wait at least 30 minutes before refilling engine oil.

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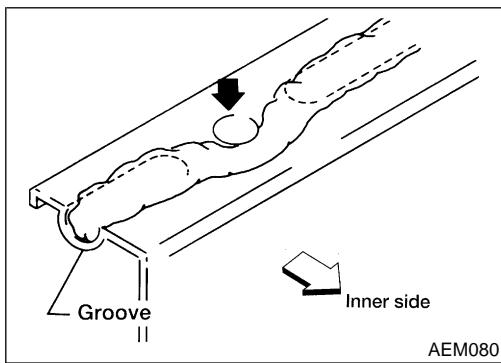
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Components

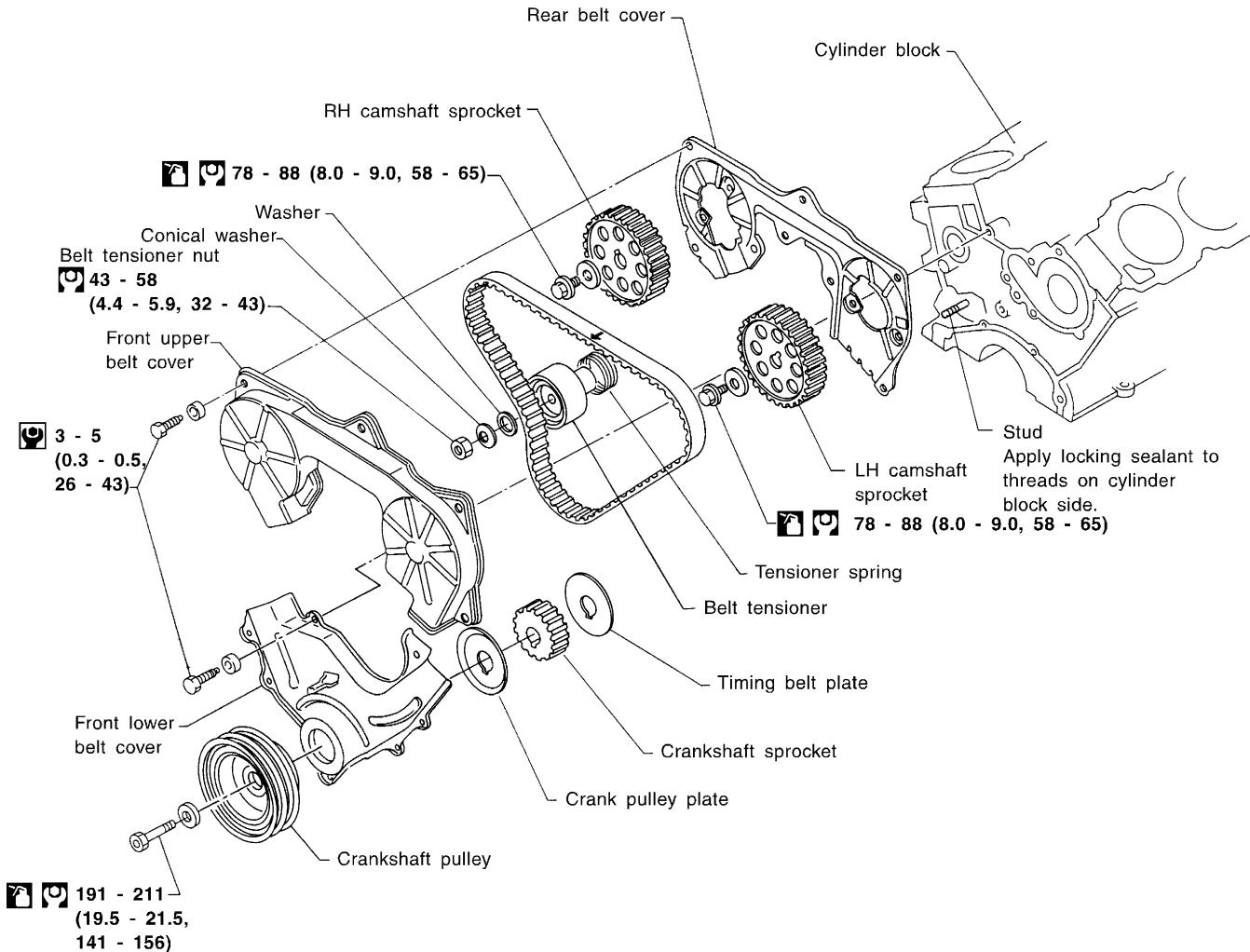
Components

NGEM0009

CAUTION:

- Do not bend or twist timing belt.
- After removing timing belt, do not turn crankshaft and camshaft separately because valves will strike piston heads.
- Make sure that timing belt, camshaft sprocket, crankshaft sprocket and belt tensioner are clean and free from oil and water.
- Installation should be carried out when engine is cold.

SEC. 120•130•135



: N·m (kg-m, in-lb)

: N·m (kg-m, ft-lb)

: Lubricate with new engine oil

SEM311FA

Removal

- NGEM0010
1. Remove engine under cover.
 2. Drain engine coolant from radiator. Refer to **MA-28**, "DRAINING ENGINE COOLANT".
 - Be careful not to spill coolant on drive belts.**
 3. Remove radiator. Refer to **LC-32**, "REMOVAL AND INSTALLATION".
 4. Remove engine cooling fan and water pump pulley.
 5. Remove the following belts.
 - Power steering pump drive belt
 - Compressor drive belt
 - Alternator drive belt
 - Supercharger (if equipped). Refer to "Removal", EM-109.
 6. Remove all spark plugs.
 7. Remove distributor protector.

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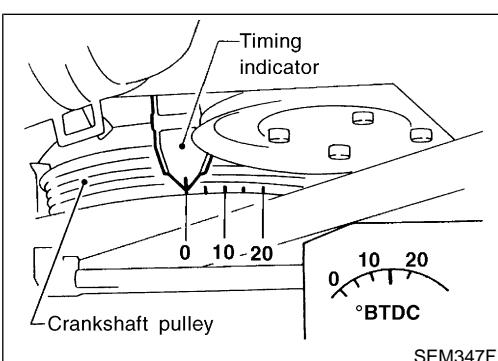
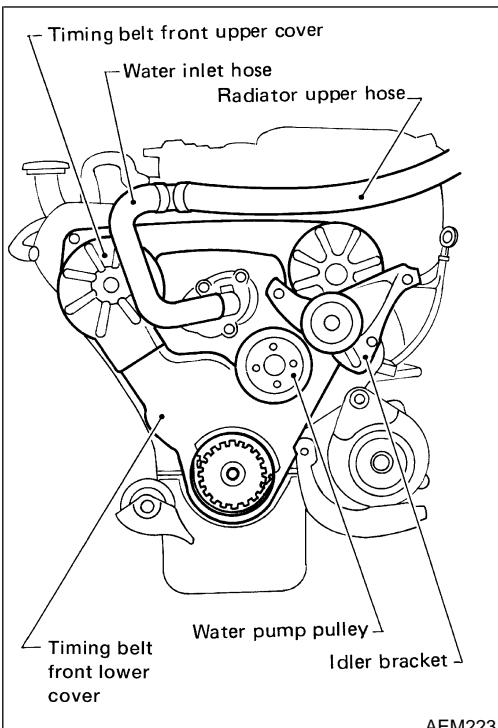
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8. Remove compressor drive belt idler bracket.
 9. Remove fresh-air intake tube for rocker cover.
 10. Remove water hose for thermostat housing.
-
11. Set No. 1 piston at TDC on its compression stroke by rotating crankshaft.
 12. Remove crankshaft pulley bolt.
 13. Remove crankshaft pulley using a suitable puller.
 14. Remove front upper and lower belt covers.

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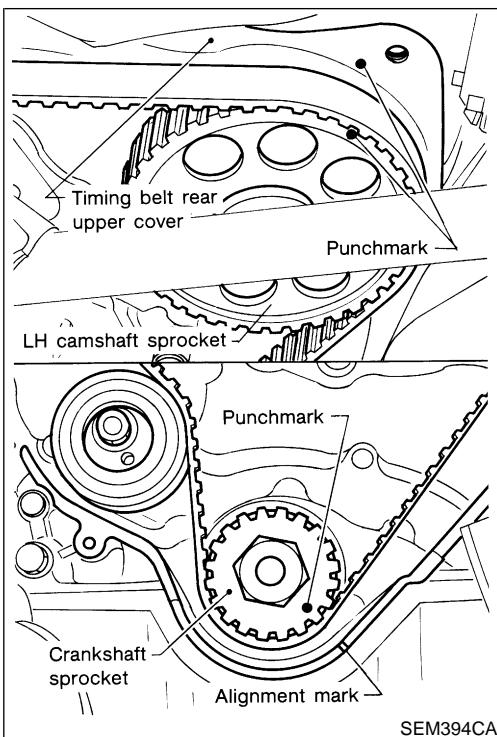
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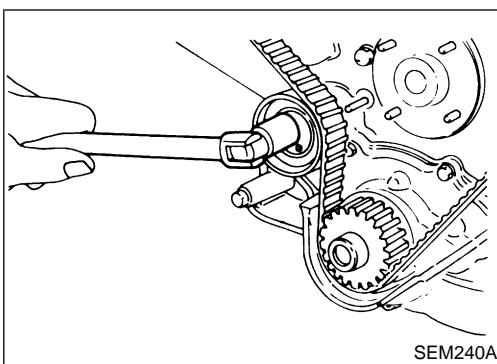
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Removal (Cont'd)



- Align punchmark on LH camshaft sprocket with punchmark on timing belt rear cover.
- Align punchmark on crankshaft sprocket with alignment mark on oil pump housing.
- Temporarily install crankshaft pulley bolt on crankshaft so the crankshaft can be rotated.

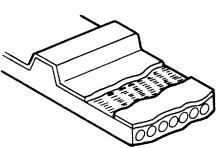
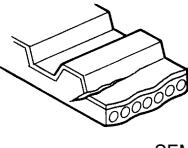
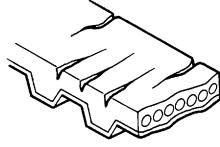


- Loosen timing belt tensioner nut, rotate tensioner, then remove timing belt.

Inspection

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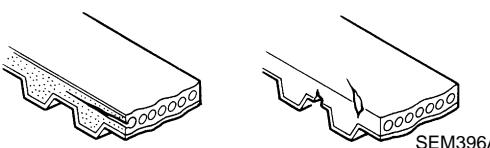
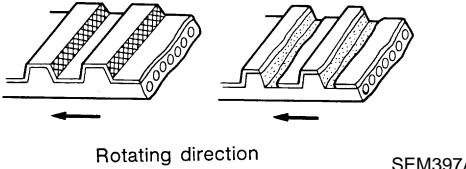
Visually check the condition of timing belt.
Replace if any abnormality is found.

Item to check	Problem	Cause
Tooth is broken/tooth root is cracked.	 	<ul style="list-style-type: none"> Camshaft jamming Distributor jamming Damaged camshaft/crankshaft oil seal
Back surface is cracked/worn.		<ul style="list-style-type: none"> Tensioner jamming Overheated engine Interference with belt cover

TIMING BELT

VG33E AND VG33ER

Inspection (Cont'd)

Item to check	Problem	Cause
Side surface is worn.	 • Belt corners are worn and round. • Wicks are frayed and coming out.	• Improper installation of belt • Malfunctioning crankshaft pulley plate/timing belt plate
Teeth are worn.	 Rotating direction SEM397A	• Poor belt cover sealing • Coolant leakage at water pump • Camshaft not functioning properly • Distributor not functioning properly • Excessive belt tension
Oil/Coolant or water is stuck to belt.	—	• Poor oil sealing of each oil seal • Coolant leakage at water pump • Poor belt cover sealing

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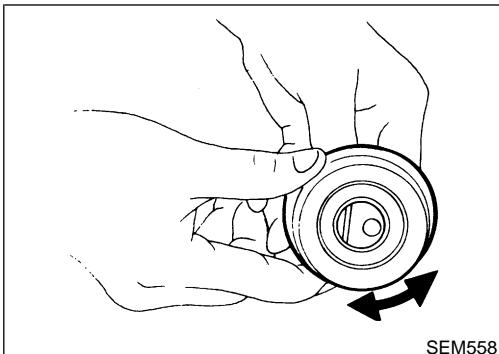
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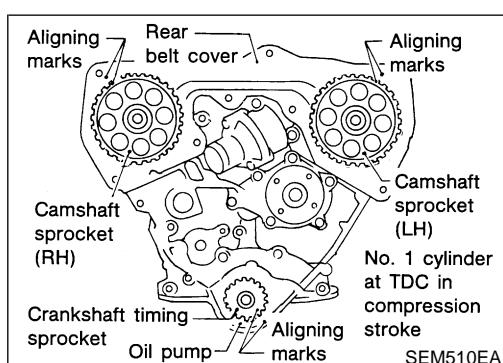
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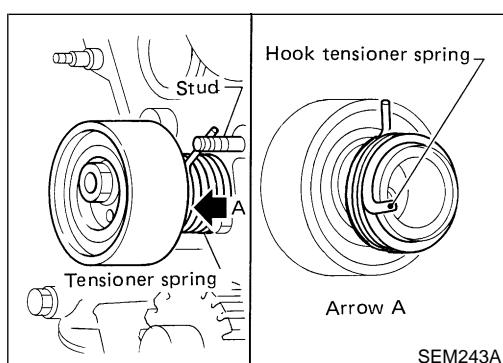
BELT TENSIONER AND TENSIONER SPRING

1. Check belt tensioner for smooth turning.
2. Check condition of tensioner spring.



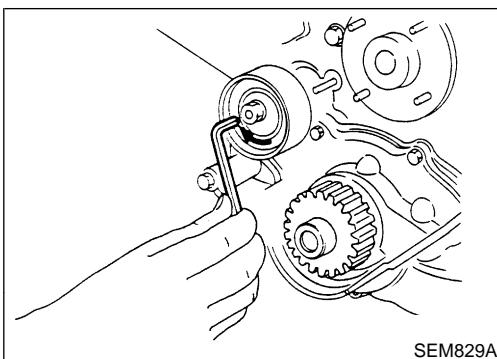
Installation

1. Confirm that No. 1 piston is set at TDC on its compression stroke.

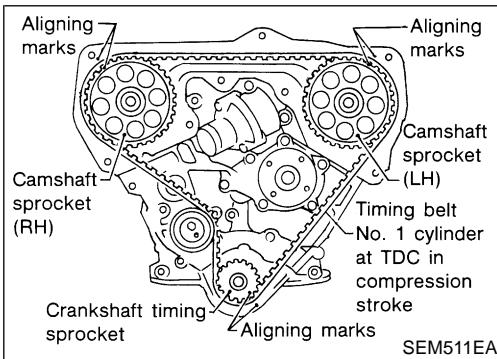


2. Install tensioner and tensioner spring.

Once stud is removed, apply locking sealant to threads of stud on cylinder block side before installing.

Installation (Cont'd)

- Turn tensioner fully outward with hexagon wrench, and temporarily tighten lock nut.

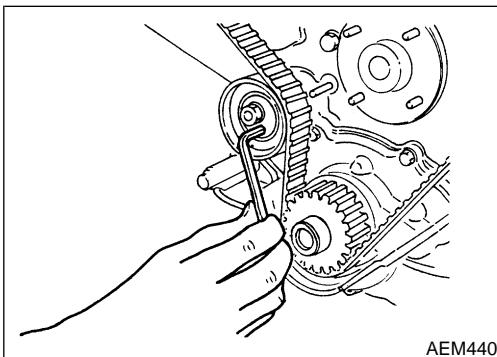


- Set timing belt when engine is cold.
- 1) Align white lines on timing belt with punchmarks on camshaft sprockets and crankshaft sprocket.
- 2) Point arrow on timing belt toward front belt cover.

Number of teeth (reference):

Number of timing belt teeth	133
Number of teeth between LH and RH camshaft sprockets	40
Between LH camshaft sprocket and crankshaft timing sprocket	43

- Install the remaining parts in the reverse order of removal.



Tension Adjustment AFTER BELT REPLACEMENT

NGEM0040

NGEM0040S01

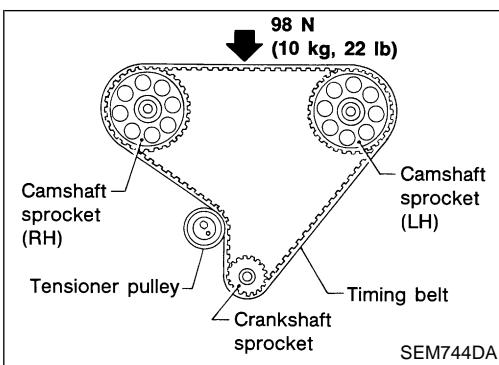
If the timing belt was replaced (or to adjust tension on a used belt), follow the steps below.

1. Loosen tensioner lock nut, then turn tensioner clockwise and counterclockwise with hexagon wrench at least 2 times.

TIMING BELT

VG33E AND VG33ER

Tension Adjustment (Cont'd)



2. Tighten tensioner lock nut.
3. Turn crankshaft clockwise at least 2 times, then slowly set No. 1 piston at TDC on its compression stroke.
4. Measure deflection of timing belt midway between camshaft pulleys while pushing with 98 N (10 kg, 22 lb) force.

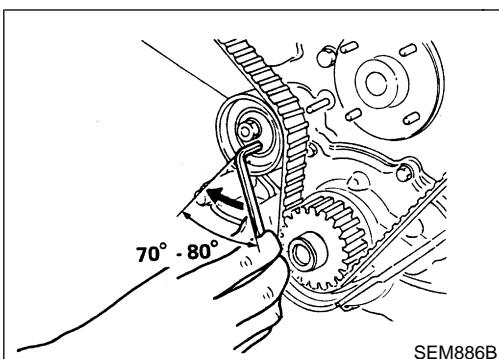
Belt deflection when engine is cold (Reference value):
13 - 15 mm (0.51 - 0.59 in)/98 N (10 kg, 22 lb)

5. If belt deflection is not within specification, return to step 1 and repeat procedure.

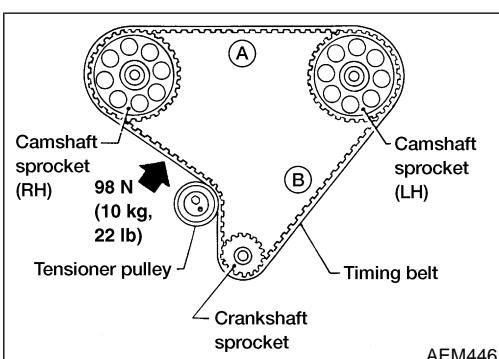
AFTER ENGINE OVERHAUL OR ENGINE REASSEMBLY (WITH ROCKER COVERS REMOVED)

If the engine was overhauled or previously disassembled (i.e. intake manifold and/or cylinder head were removed), follow the steps below.

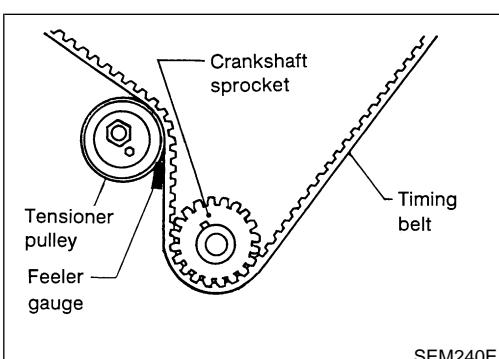
1. Loosen rocker shaft bolts to relieve belt tension caused by the cam shafts.



2. Loosen tensioner lock nut, keeping tensioner steady with hexagon wrench.
3. Turn tensioner 70 to 80 degrees clockwise with hexagon wrench to release belt tension, and temporarily tighten lock nut.
4. Turn crankshaft clockwise at least two times, then slowly set No. 1 piston at TDC on its compression stroke.



5. Push middle of timing belt between RH camshaft sprocket and tensioner pulley with force of 98 N (10 kg, 22 lb) to apply tensions on part A and part B.
6. Loosen tensioner lock nut, keeping tensioner steady with hexagon wrench.



7. Set feeler gauge as shown in figure which is 0.5 mm (0.0206 in) thick and 12.7 mm (0.500 in) wide.

GI

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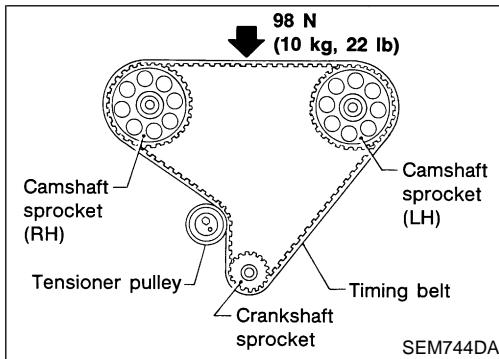
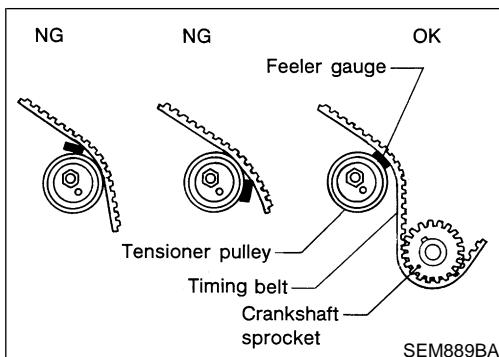
HA

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Tension Adjustment (Cont'd)



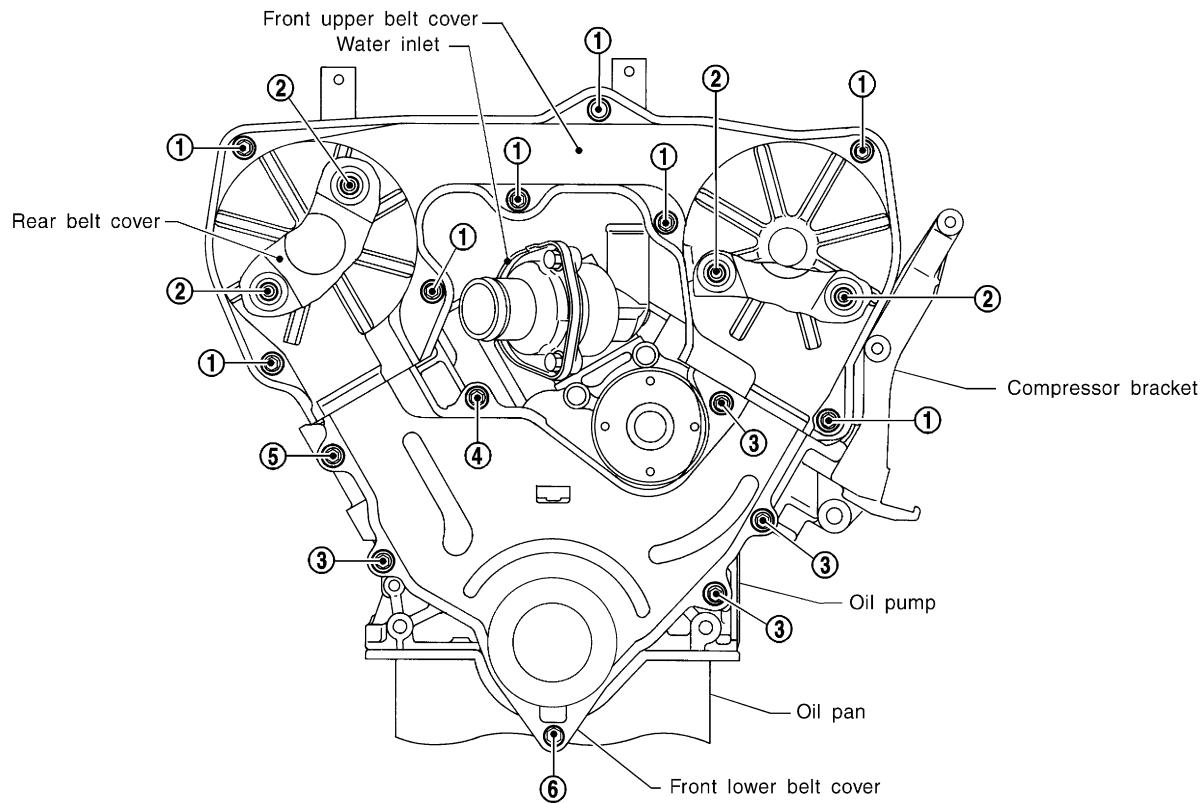
8. Turn crankshaft clockwise until feeler gauge is positioned as shown in figure.
 - Timing belt will move about 2.5 teeth.
9. Tighten tensioner lock nut, keeping tensioner steady with hexagon wrench.
10. Turn crankshaft clockwise or counterclockwise, and remove feeler gauge.
11. Turn crankshaft clockwise at least two times, then slowly set No. 1 piston at TDC on its compression stroke.
12. Measure deflection of timing belt midway between camshaft pulleys while pushing with 98 N (10 kg, 22 lb) force.

Belt deflection when engine is cold (Reference value):
13 - 15 mm (0.51 - 0.59 in)/98 N (10 kg, 22 lb)
13. If belt deflection is not within specification, return to step 1 and repeat procedure.
14. Install lower and upper belt covers.
15. Install the remaining components in the reverse order of removal.

TIMING BELT

VG33E AND VG33ER

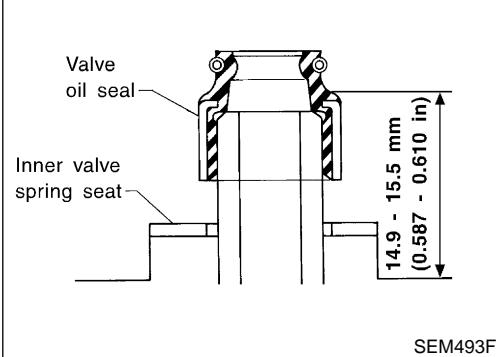
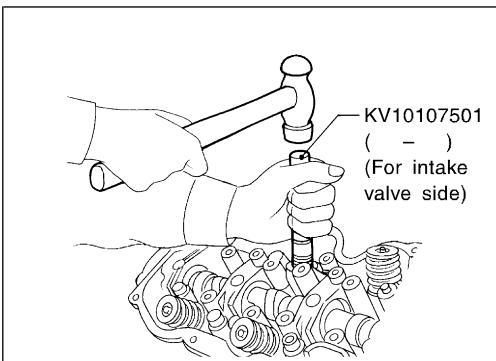
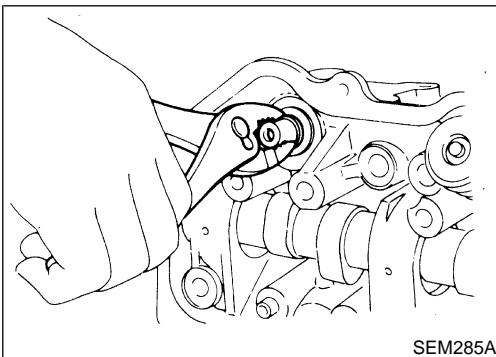
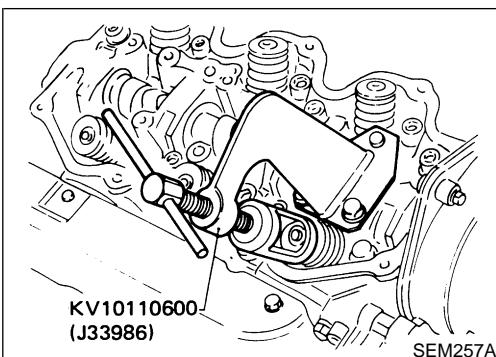
Tension Adjustment (Cont'd)



No.	Tightened parts	No.	Tightened parts
①	Bolt Rubber washer Front upper belt cover Welded nut	8 pcs.	④ Bolt Rubber washer Front lower belt cover 1 pc.
②	Hexagon bolt with washer Rear belt cover	4 pcs.	⑤ Bolt Rubber washer Front lower belt cover 1 pc.
③	Bolt Rubber washer Front lower belt cover	4 pcs.	⑥ Bolt Front lower belt cover Lock spring washer 1 pc.

SEM313F

Replacement



Replacement

VALVE OIL SEAL

NGEM0013

NGEM0013S01

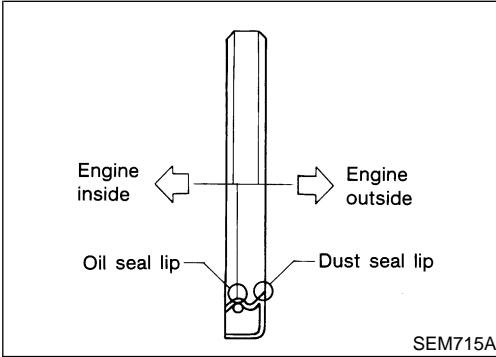
1. Remove rocker cover.
2. Remove rocker shaft assembly and valve lifters with valve lifter guide.
3. Remove valve springs and valve oil seal.
 - Piston concerned should be set at TDC to prevent valve from falling.
 - When removing intake side valve oil seal, use Tool or suitable tool.
 - When removing exhaust side valve oil seal, pull it out with suitable tool.

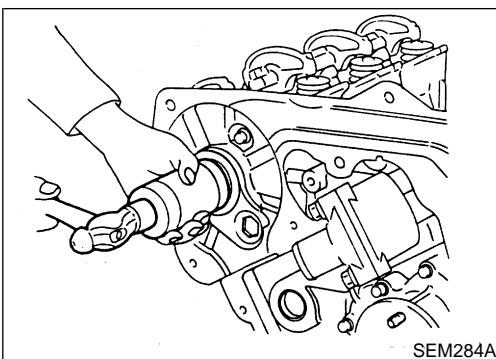
4. Apply engine oil to new valve oil seal and install it.
 - Before installing valve oil seal, install inner valve spring seat.
 - When installing intake side valve oil seal, use Tool.
 - When installing exhaust side valve oil seal, set it by hand.

OIL SEAL INSTALLING DIRECTION

NGEM0013S02

Install oil seal in direction shown.



**CAMSHAFT OIL SEAL**

1. Remove timing belt.
2. Remove camshaft sprocket.
3. Remove camshaft.
4. Remove camshaft oil seal.

Be careful not to scratch camshaft.

5. Apply engine oil to new camshaft oil seal.

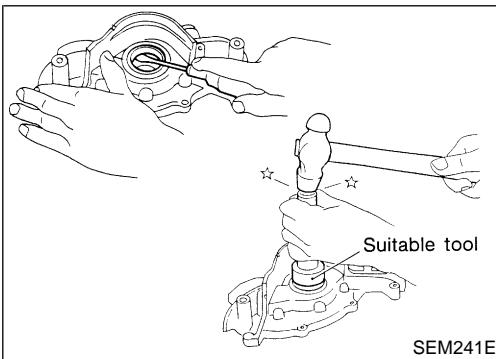
NGEM0013S03

GI

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**FRONT OIL SEAL**

1. Remove timing belt and crankshaft sprocket.
2. Remove oil pump assembly.
3. Remove front oil seal from oil pump body.
4. Apply engine oil to new oil seal and install it using suitable tool.

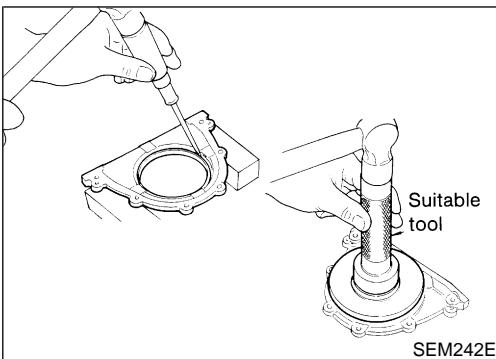
NGEM0013S04

EC

FE

CL

MT

**REAR OIL SEAL**

1. Remove drive plate.
2. Remove rear oil seal retainer.
3. Remove rear oil seal from retainer.
- Be careful not to scratch rear oil seal retainer.
4. Apply engine oil to new oil seal and install it using suitable tool.
5. Install rear oil seal retainer with a new gasket to cylinder block.
- Always use a new oil seal retainer to cylinder block gasket.

NGEM0013S05

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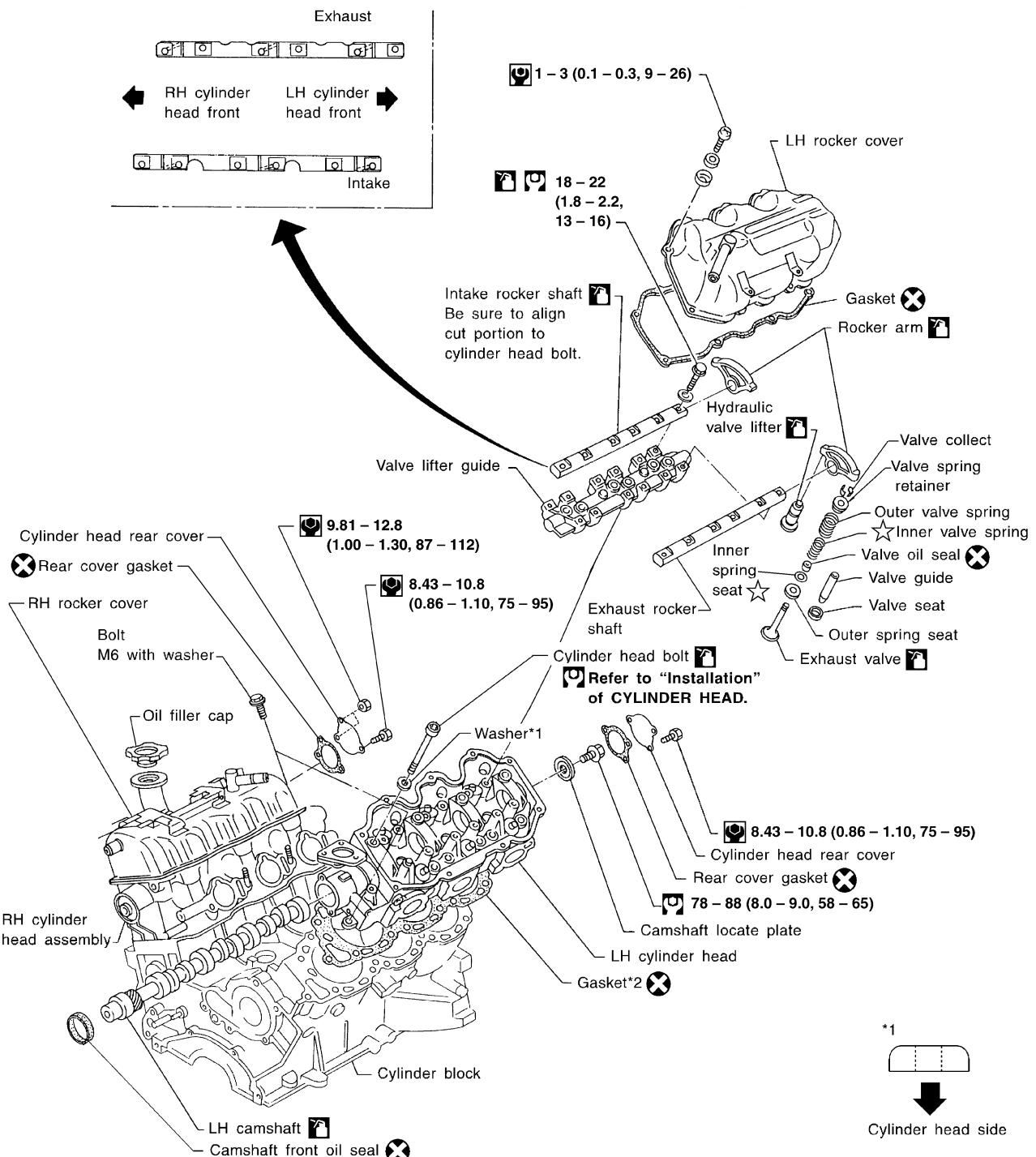
IDX

Components

Components

NGEM0014

SEC. 102•111•130



Ⓐ : N•m (kg-m, in-lb)

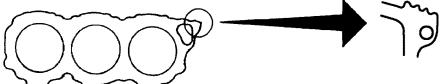
Ⓑ : N•m (kg-m, ft-lb)

Ⓒ : Lubricate with new engine oil

☆ : If equipped.

ⓧ : Always replace after every disassembly.

*2 Cylinder head gasket identification for VG33E



WEM155

Removal

NGEM0015

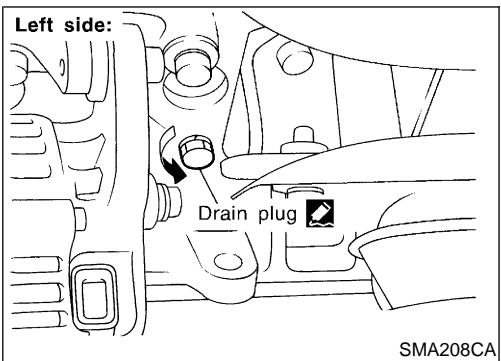
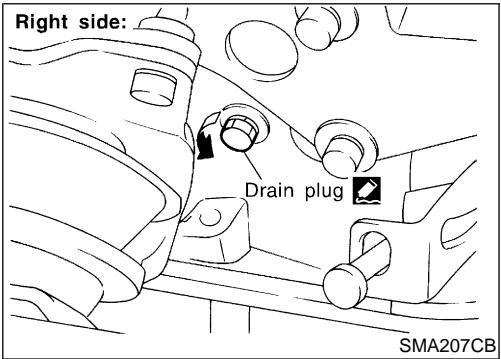
GI

1. Release fuel pressure.
Refer to **EC-644**, "Fuel Pressure Release".
2. Remove timing belt.
Refer to "Components", EM-82.

MA

EM

LC



3. Drain coolant by removing drain plugs from both sides of cylinder block.

EC

4. Separate ASCD and accelerator control wire from intake manifold collector (VG33E only).

FE

5. Remove intake manifold collector from engine (VG33E only).

FE

6. The following parts must be disconnected.

CL

- a. Harness connectors for:

MT

- IACV-AAC valve
- Throttle position sensor
- Throttle position switch
- Distributor (ignition coil)
- Distributor

AT

- b. Water hoses from collector

TF

- c. Heater hoses

PD

- d. PCV hose from RH/LH rocker cover

AX

- e. Vacuum hoses for:

SU

- Brake master cylinder

BR

- Pressure regulator

ST

- f. Purge hose from purge control valve

RS

- g. Spark plug wires

SC

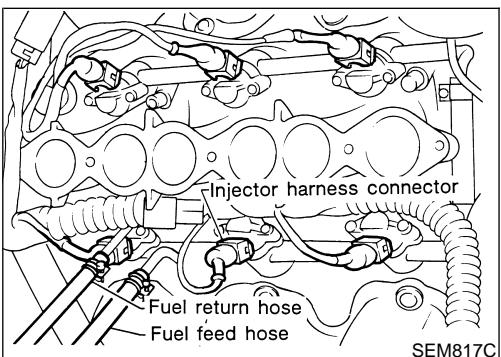
- h. Distributor assembly

EL

- i. 3 left/right bank injector connectors

IDX

- j. Ground harness



7. Remove fuel feed and fuel return hoses from injector fuel tube assembly.

BT

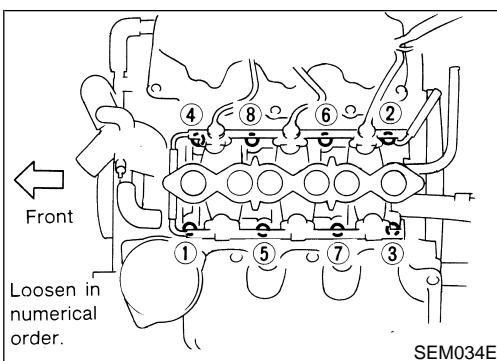
8. Disconnect the right injector harness connectors.

HA

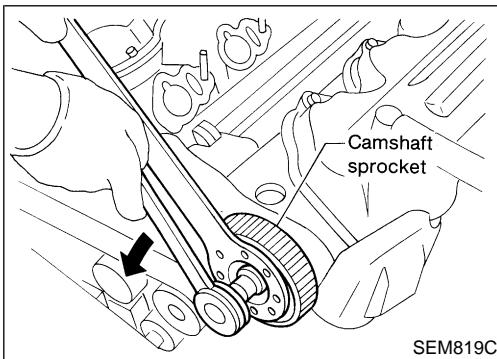
9. Remove injector fuel tube assembly.

SC

Removal (Cont'd)



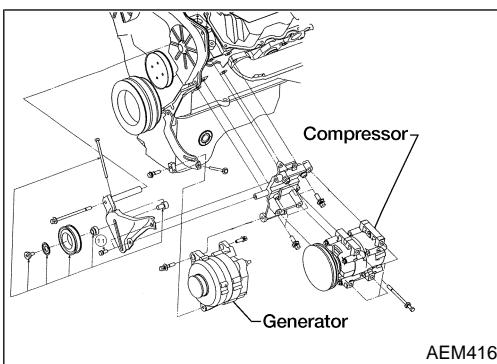
10. Remove intake manifold from engine. The following parts should be disconnected to remove intake manifold.
 - a. Engine coolant temperature switch harness connector
 - b. Thermal transmitter harness connector
 - c. Water hose from thermostat housing



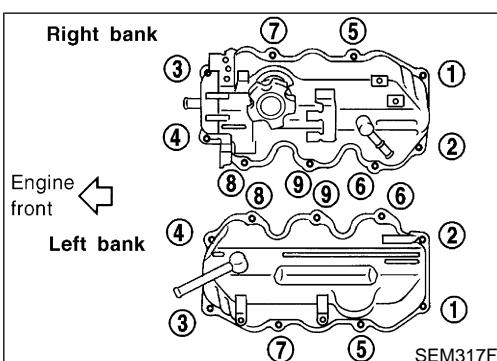
11. Remove both camshaft sprockets.
12. Remove rear timing belt cover.
13. Remove distributor and ignition wires.

After pulling out distributor from cylinder head, do not rotate distributor rotor.

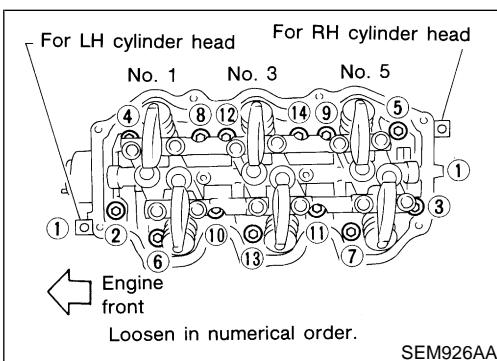
14. Remove harness clamp from RH rocker cover.
15. Remove exhaust tube from exhaust manifold.



16. Remove compressor and generator.
17. Remove power steering pump.
18. Remove the compressor, generator and power steering pump brackets.



19. Loosen and remove the bolts from both rocker covers in the order shown. Remove both rocker covers.



20. Remove cylinder head with exhaust manifold.
 - A warped or cracked cylinder head could result from removing in incorrect order.
 - Cylinder head bolts should be loosened in two or three steps.

NGEM0016

Disassembly**CAUTION:**

- When installing sliding parts such as rocker arms, cam-shaft and oil seal, be sure to apply new engine oil on their sliding surfaces.
- When tightening cylinder head bolts and rocker shaft bolts, apply new engine oil to thread portions and seat surfaces of bolts.

GI

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EC

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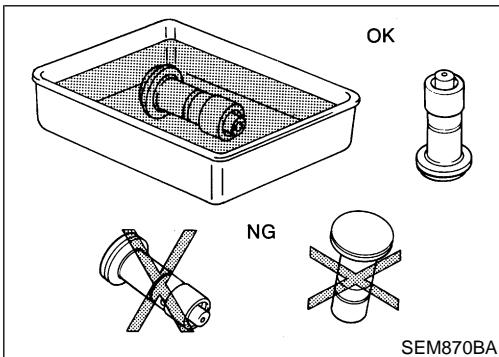
BT

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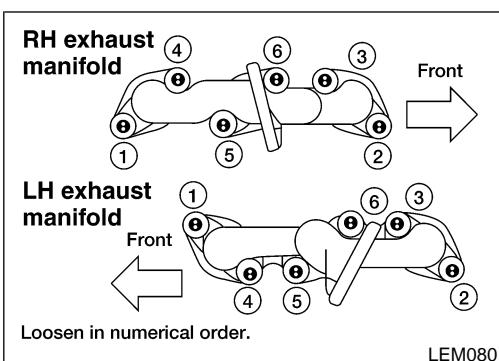
SC

EL

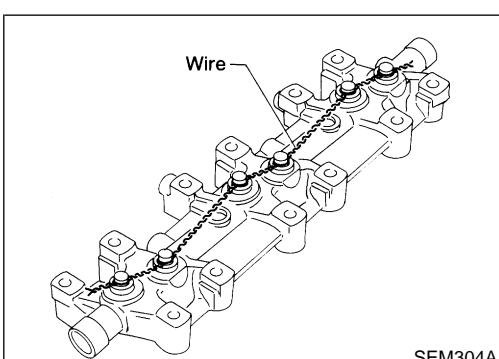
IDX



- If hydraulic valve lifter is kept on its side, there is a risk of air entering it. After removal, always set hydraulic valve lifter straight up, or when laying it on its side, have it soak in new engine oil.
- Do not disassemble hydraulic valve lifter.
- Attach tags to valve lifters so as not to mix them up.



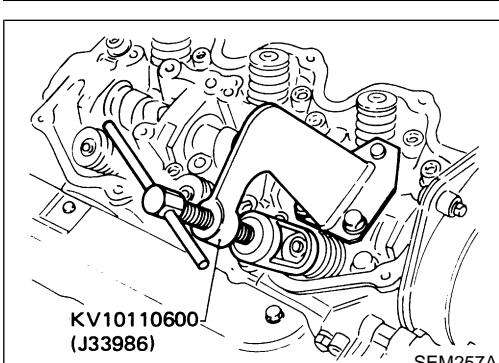
1. Remove exhaust manifolds from cylinder head.



2. Remove rocker shafts with rocker arms.

Bolts should be loosened in two or three steps.

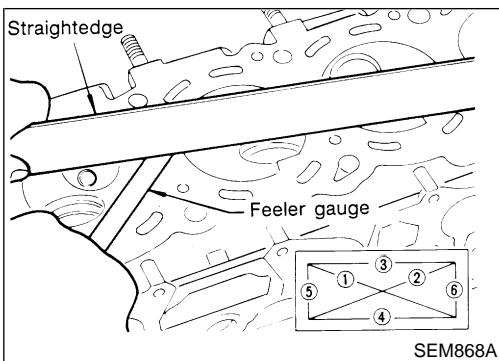
3. Remove hydraulic valve lifters and lifter guide.
- Hold hydraulic valve lifters with wire so that they will not drop from lifter guide.
4. Remove oil seal and camshaft.
- Before removing camshaft, measure camshaft end play.



5. Remove valve components with Tool.

6. Remove valve oil seals with Tool or suitable tool.

Inspection



Inspection

CYLINDER HEAD DISTORTION

NGEM0017

NGEM0017S01

Head surface flatness:

Less than 0.1 mm (0.004 in)

If beyond the specified limit, resurface it or replace it.

Resurfacing limit:

The resurfacing limit of cylinder head is determined by the cylinder block resurfacing in an engine.

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

 $A + B = 0.2 \text{ mm (0.008 in)}$

After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.

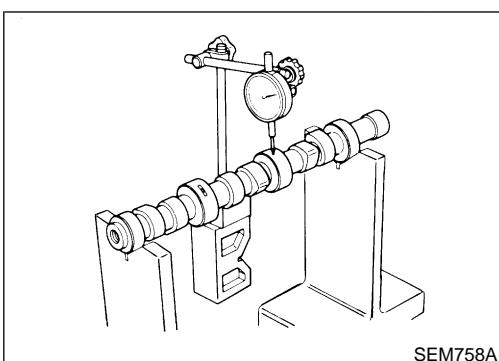
Nominal cylinder head height:

106.8 - 107.2 mm (4.205 - 4.220 in)

CAMSHAFT VISUAL CHECK

NGEM0017S02

Check camshaft for scratches, seizure and wear.



CAMSHAFT RUNOUT

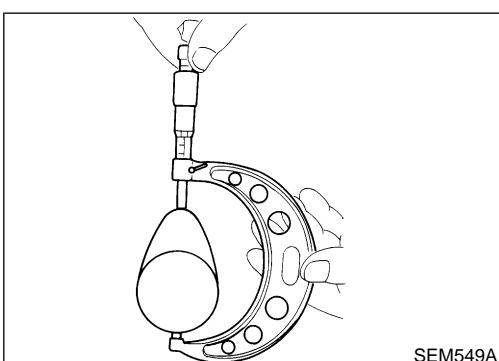
NGEM0017S03

- Measure camshaft runout at the center journal.

Runout (Total indicator reading):

Limit 0.1 mm (0.004 in)

- If it exceeds the limit, replace camshaft.



CAMSHAFT CAM HEIGHT

NGEM0017S04

- Measure camshaft cam height.

Standard cam height:

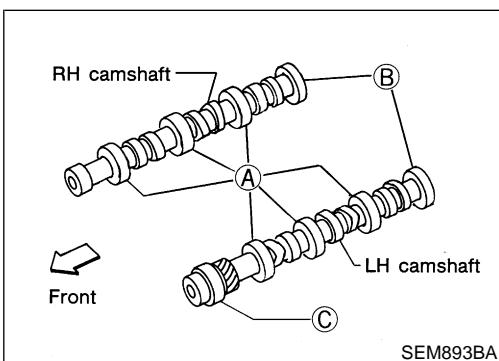
Intake and exhaust:

38.943 - 39.133 mm (1.5332 - 1.5407 in)

Cam wear limit:

0.15 mm (0.0059 in)

- If wear is beyond the limit, replace camshaft.



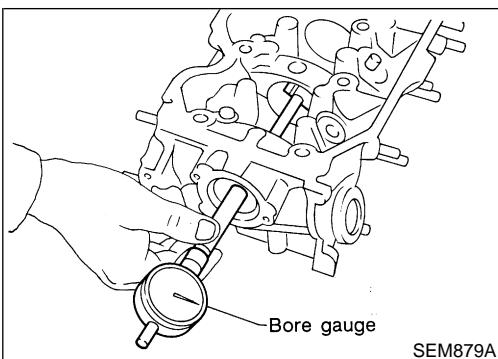
CAMSHAFT JOURNAL CLEARANCE

NGEM0017S05

- Measure outer diameter of camshaft journal.

Standard outer diameter:

A 46.920 - 46.940 mm (1.8472 - 1.8480 in)**B 42.420 - 42.440 mm (1.6701 - 1.6709 in)****C 47.920 - 47.940 mm (1.8866 - 1.8874 in)**



- Measure inner diameter of camshaft bearing.

Standard inner diameter:

A 47.000 - 47.025 mm (1.8504 - 1.8514 in) GI

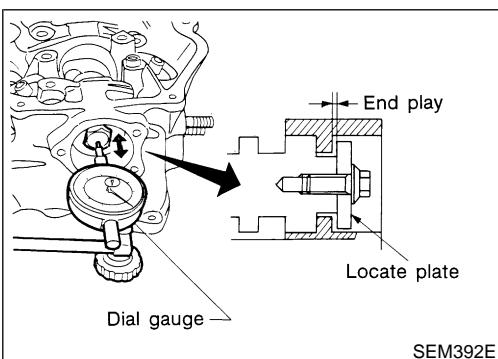
B 42.500 - 42.525 mm (1.6732 - 1.6742 in) MA

C 48.000 - 48.025 mm (1.8898 - 1.8907 in) EM

- If clearance exceeds the limit, replace camshaft and/or cylinder head.

Camshaft journal clearance limit:

0.15 mm (0.0059 in)



CAMSHAFT END PLAY

- Install camshaft and locate plate in cylinder head.

NGEM0017S06

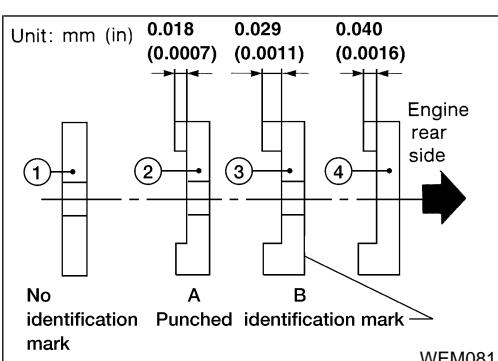
EC

- Measure camshaft end play.

Camshaft end play:

Standard:

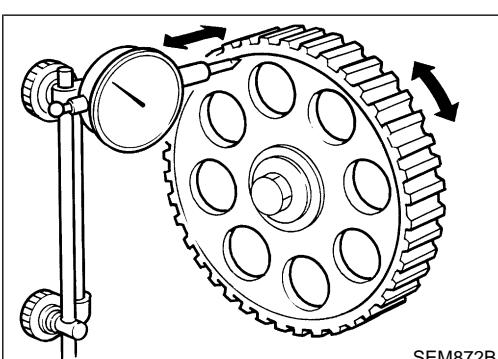
0.03 - 0.06 mm (0.0012 - 0.0024 in)



- If it is out of the specified range, select thickness of camshaft locate plate to obtain standard specified end play.

Example:

When camshaft end play is 0.08 mm (0.0031 in) with camshaft locate plate 1, replace camshaft locate plate 1 with camshaft locate plate 4 to set the end play at 0.04 mm (0.0016 in).



CAMSHAFT SPROCKET RUNOUT

NGEM0017S07

SU

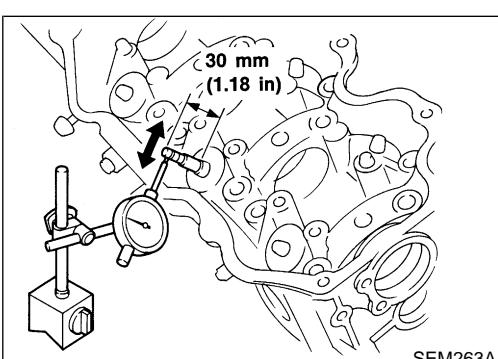
- Install sprocket on camshaft.
- Measure camshaft sprocket runout.

Runout (Total indicator reading):

Limit:

0.1 mm (0.004 in)

- If it exceeds the limit, replace camshaft sprocket.



VALVE GUIDE CLEARANCE

NGEM0017S08

BT

- Measure valve deflection in a right-angled direction with camshaft. (Valve and valve guide mostly wear in this direction.)

Valve deflection limit (Dial gauge reading):

0.20 mm (0.0079 in)

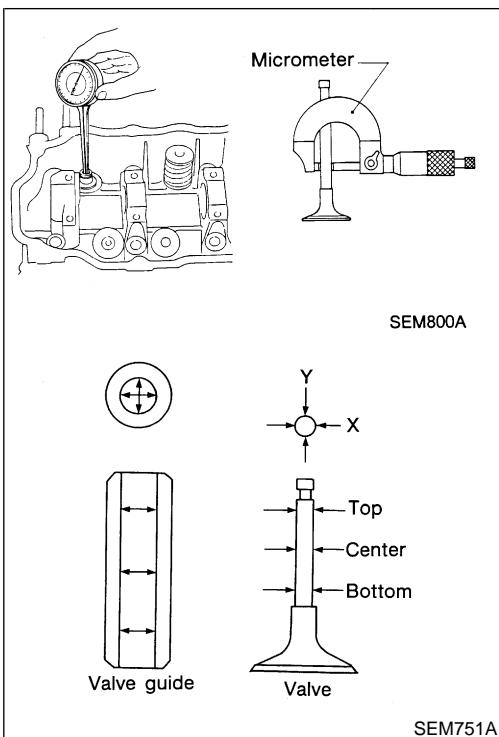
HA

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IDX

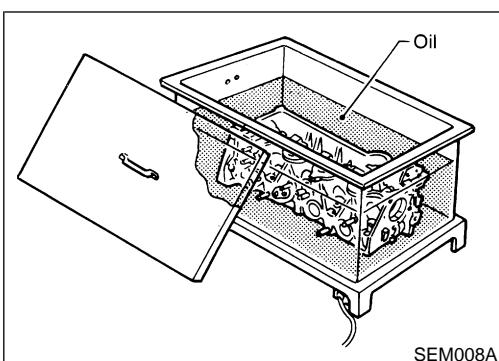
Inspection (Cont'd)



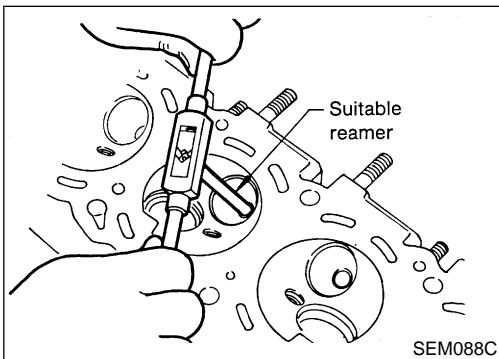
2. If it exceeds the limit, check valve to valve guide clearance.
 - a. Measure valve stem diameter and valve guide inner diameter.
 - b. Check that clearance is within specification.

Valve to valve guide clearance:**Intake:****0.020 - 0.053 mm (0.0008 - 0.0021 in)****Exhaust:****0.030 - 0.049 mm (0.0012 - 0.0019 in)****Limit:****0.10 mm (0.0039 in)**

- c. If it exceeds the limit, replace valve or valve guide.

**VALVE GUIDE REPLACEMENT**

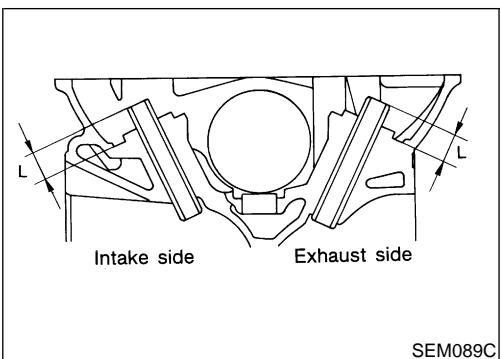
1. To remove valve guide, heat cylinder head to 150 to 160°C (302 to 320°F) by soaking in heated oil. NGEM0017S09
2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.
3. Ream cylinder head valve guide hole.

Valve guide hole diameter (for service parts):**Intake:****11.175 - 11.196 mm (0.4400 - 0.4408 in)****Exhaust:****12.175 - 12.196 mm (0.4793 - 0.4802 in)**

CYLINDER HEAD

VG33E AND VG33ER

Inspection (Cont'd)



4. Heat cylinder head to 150 to 160°C (302 to 320°F) and press service valve guide onto cylinder head.

Projection "L":

13.2 - 13.4 mm (0.520 - 0.528 in)

GI

5. Ream valve guide.

Finished size:

Intake:

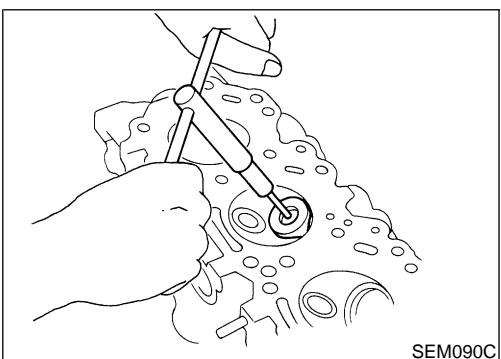
7.000 - 7.018 mm (0.2756 - 0.2763 in)

MA

Exhaust:

8.000 - 8.011 mm (0.3150 - 0.3154 in)

EM



VALVE SEATS

NGEM0017S10
Check valve seats for any evidence of pitting at valve contact surface, and reseat or replace if it has worn out excessively.

EC

- **Before repairing valve seats, check valve and valve guide for wear. If they have worn, replace them. Then correct valve seat.**

FE

- **Use both hands to cut uniformly.**

CL

MT

AT

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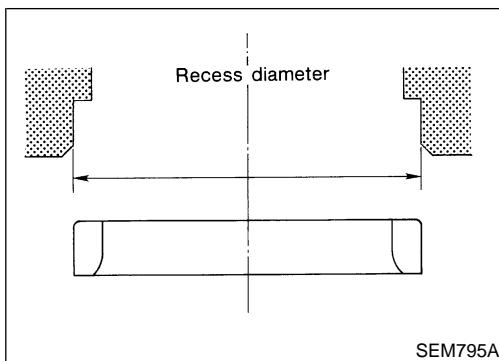
HA

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Inspection (Cont'd)

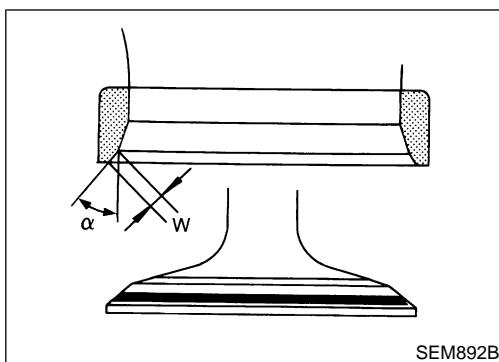
**REPLACING VALVE SEAT FOR SERVICE PARTS**=NGEM0017S11

1. Bore out old seat until it collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the seat recess in cylinder head.
2. Ream cylinder head recess.

Reaming bore for service valve seat:**Oversize [0.5 mm (0.020 in)]:****Intake:****44.500 - 44.516 mm (1.7520 - 1.7526 in)****Exhaust:****37.500 - 37.516 mm (1.4764 - 1.4770 in)**

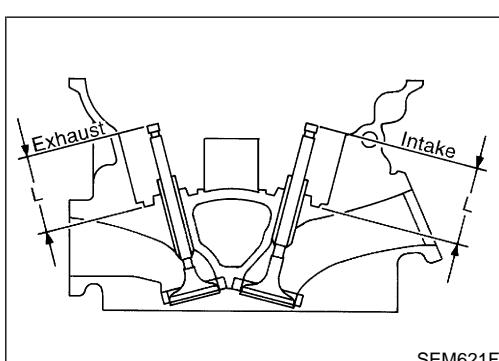
Reaming should be done in circles concentric to the valve guide center so that valve seat will have the correct fit.

3. Heat cylinder head to 150 to 160°C (302 to 320°F) by soaking in heated oil.
4. Press fit valve seat until it seats on the bottom.

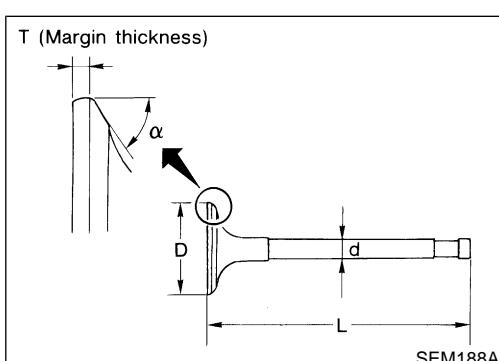


5. Cut or grind valve seat using suitable tool at the specified dimensions as shown. Refer to "VALVE", EM-128.
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

	Intake	Exhaust
Seat face angle "α" degree	45	45
Contacting width "W" mm (in)	1.75 (0.0689)	1.7 (0.067)

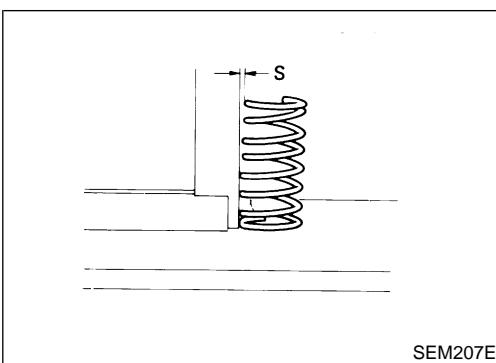


8. Use a depth gauge to measure the distance between the mounting surface of the cylinder head spring seat and the valve stem end. If the distance is shorter than specified, repeat step 5 above to adjust it. If it is longer, replace the valve seat with a new one.

Intake:**44.7 - 44.9 mm (1.760 - 1.768 in)****Exhaust:****45.4 - 45.6 mm (1.787 - 1.795 in)****VALVE DIMENSIONS**=NGEM0017S12

Check dimensions in each valve. Refer to "VALVE", EM-128. When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace valve.

Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.

**VALVE SPRING****Squareness**

- Measure "S" dimension.

NGEM0017S13

GI

Out-of-square (if equipped with two springs):**Outer:****Less than 2.2 mm (0.087 in)****Inner:****Less than 1.9 mm (0.075 in)****Out-of-square (if equipped with one spring):****Single:****Less than 2.0 mm (0.079 in)**

- If it exceeds the limit, replace spring.

NGEM0017S1301

MA

EM

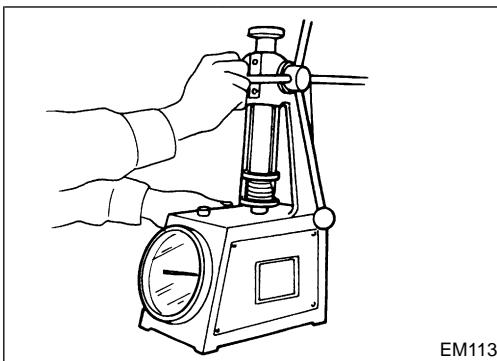
LC

EC

FE

CL

MT

**Pressure**

Check valve spring pressure.

NGEM0017S1302

AT

Standard pressure (if equipped with two springs): N (kg, lb) at height mm (in)**Outer:****523.7 (53.4, 117.7) at 30.0 (1.181)****Inner:****255.0 (26.0, 57.3) at 25.0 (0.984)****Standard pressure (if equipped with one spring) N (kg, lb) at height mm (in)****Single:****770 – 837 (78.5 – 85.4, 173.1 – 188.2) at 30.0 (1.181)****Limit pressure (if equipped with two springs): N (kg, lb) at height mm (in)****Outer:****More than 228.5 (23.3, 51.4) at 25.0 (0.984)****Inner:****More than 225.6 (23.0, 50.7) at 25.0 (0.984)****Limit pressure (if equipped with one spring): N (kg, lb) at height mm (in)****Single:****More than 733 (74.8, 164.8) at 30.0 (1.181)**

If not within specification, replace spring.

BR

ST

RS

BT

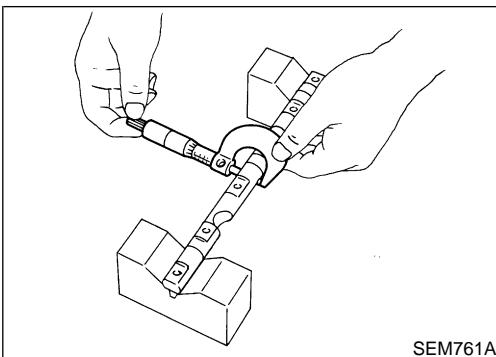
HA

SC

EL

IDX

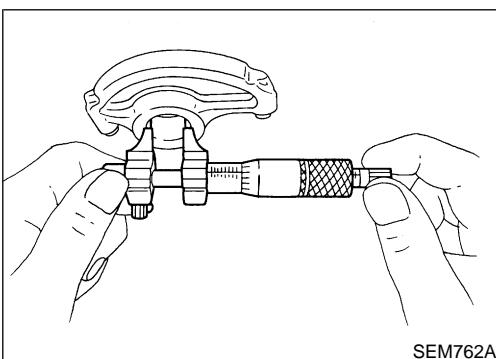
Inspection (Cont'd)



ROCKER SHAFT AND ROCKER ARM

NGEM0017S14

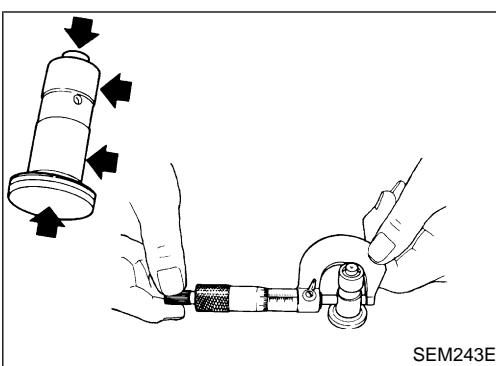
1. Check rocker shafts for scratches, seizure and wear.
2. Check outer diameter of rocker shaft.

Diameter:**17.979 - 18.000 mm (0.7078 - 0.7087 in)**

3. Check inner diameter of rocker arm.

Diameter:**18.007 - 18.028 mm (0.7089 - 0.7098 in)****Rocker arm to shaft clearance:****0.007 - 0.049 mm (0.0003 - 0.0019 in)**

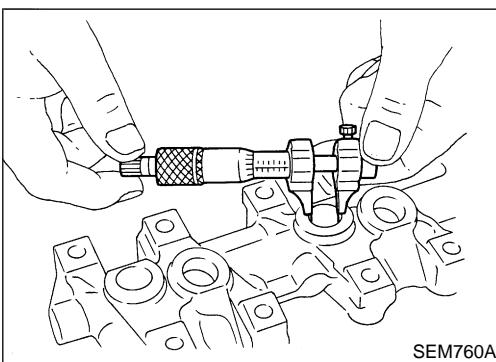
- Keep rocker arm with hydraulic valve lifter standing to prevent air from entering hydraulic valve lifter when checking.



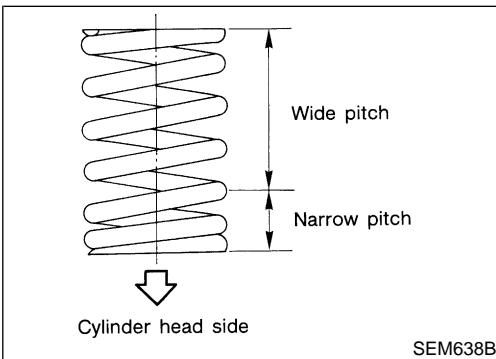
HYDRAULIC VALVE LIFTER

NGEM0017S15

1. Check contact and sliding surfaces for wear or scratches.
2. Check diameter of valve lifter.

Outer diameter:**15.947 - 15.957 mm (0.6278 - 0.6282 in)**

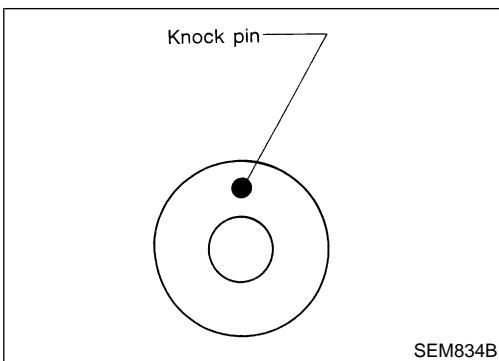
3. Check valve lifter guide inner diameter.

Inner diameter:**16.000 - 16.013 mm (0.6299 - 0.6304 in)****Standard clearance between valve lifter and lifter guide:****0.043 - 0.066 mm (0.0017 - 0.0026 in)**

Assembly

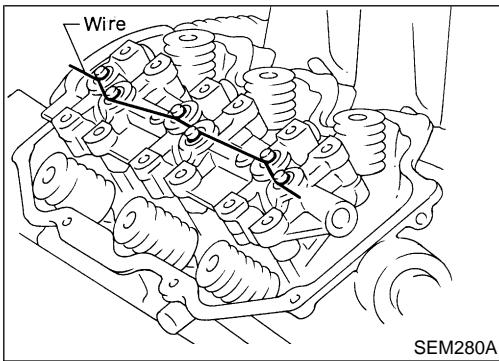
NGEM0018

1. Install valve component parts.
- Always use new valve oil seal. Refer to "VALVE OIL SEAL", EM-90.
- Before installing valve oil seal, install inner valve spring seat (if equipped).
- Install outer or single (if equipped) valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.
- After installing valve component parts, use plastic hammer to lightly tap valve stem tip to assure a proper fit.



2. Install camshafts, locate plates and cylinder head rear covers.
- Set knock pin of camshaft at the top.

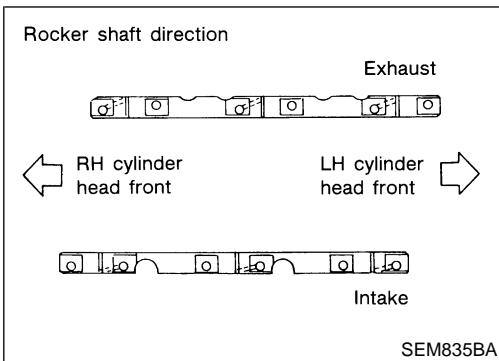
GI



3. Install valve lifters into valve lifter guide.
- Assemble valve lifters to their original position and hold all valve lifters with wire to prevent lifters from falling off.
- After installing, remove the wire.

EC

FE



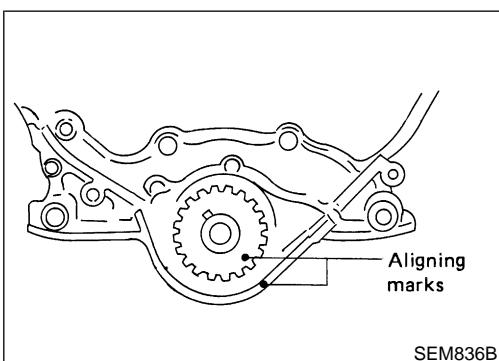
4. Install rocker shafts with rocker arms.
- Tighten bolts gradually in two or three stages.
- Before tightening, be sure to set camshaft the lobe at the position where lobe is not lifted.
- a. Set No. 1 piston at TDC on its compression stroke and tighten rocker shaft bolts for No. 2, No. 4 and No. 6 cylinders.
- b. Set No. 4 piston at TDC on its compression stroke and tighten rocker shaft bolts for No. 1, No. 3 and No. 5 cylinders.
5. Install exhaust manifold to cylinder head in reverse order of removal.

AT

TF

PD

AX



Installation

1. Set No. 1 piston at TDC on its compression stroke as follows:
- a. Align crankshaft sprocket aligning mark with mark on oil pump body.
- b. Confirm that knock pin on camshaft is set at the top.

NGEM0019

SU

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ST

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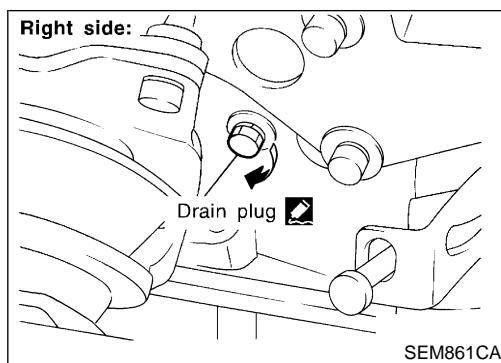
HA

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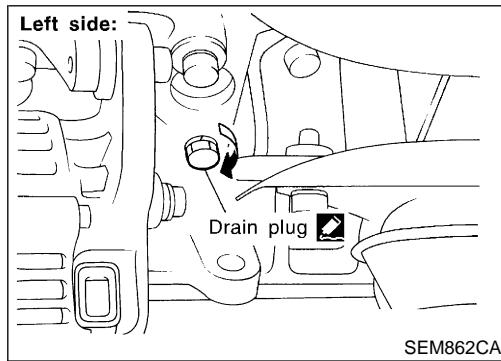
IDX

Installation (Cont'd)

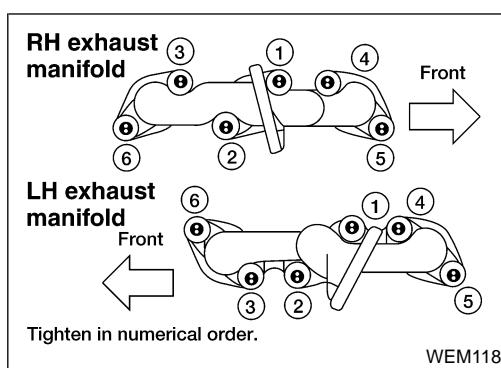


- Install both drain plugs.

- Use Genuine Silicone RTV or equivalent. Refer to **GI-50**, "Recommended Chemical Products and Sealants".

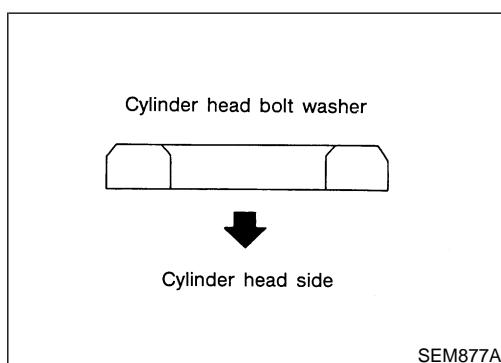


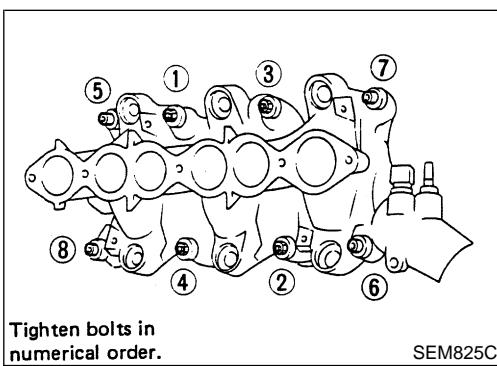
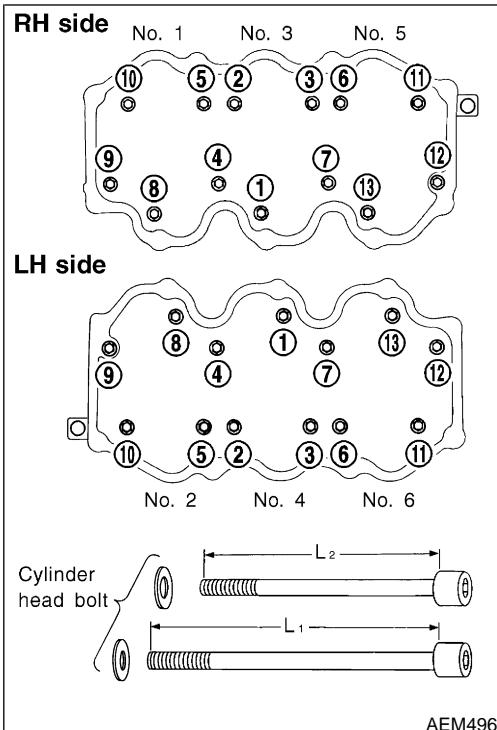
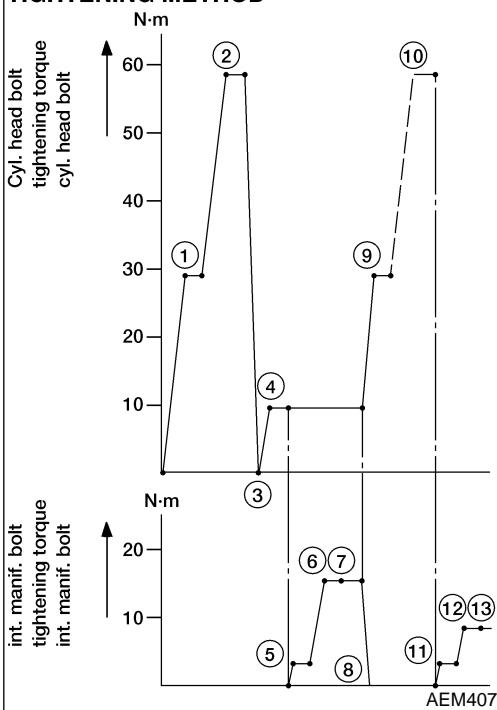
- Install exhaust manifolds to cylinder head.



- Install cylinder head with new gasket.

- Be sure to install washers between bolts and cylinder head.**
- Do not rotate crankshaft and camshaft separately, or valves will hit piston heads.**



TIGHTENING METHOD

5. Tighten cylinder head bolts in numerical order using angle wrench [ST10120000 (J24239-01)].

Apply engine oil to threads and seating surfaces of cylinder head bolts before installing them.

- Cylinder head bolts for 4, 7, 9 and 12 are longer (L1) than the others.

L₁: 127 mm (5.00 in) for 4, 7, 9 and 12

L₂: 106 mm (4.17 in) for others

- Install intake manifold and cylinder head at the same time using the following procedure:

- 1) Tighten cylinder head bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
- 2) Tighten cylinder head bolts to 59 N·m (6.0 kg-m, 43 ft-lb).
- 3) Loosen cylinder head bolts completely.
- 4) Tighten cylinder head bolts to 10 N·m (1.0 kg-m, 7 ft-lb).
- 5) Tighten intake manifold bolts and nuts to 4 N·m (0.4 kg-m, 2.9 ft-lb).
- 6) Tighten intake manifold bolts and nuts to 18 N·m (1.8 kg-m, 13 ft-lb).
- 7) Tighten intake manifold bolts and nuts to 16 to 20 N·m (1.6 to 2.0 kg-m, 12 to 14 ft-lb).
- 8) Loosen intake manifold bolts and nuts completely.
- 9) Tighten cylinder head bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
- 10) Turn cylinder head bolts to 60 to 65 degrees clockwise. If an angle wrench is not available, tighten cylinder head bolts to 54 to 64 N·m (5.5 to 6.5 kg-m, 40 to 47 ft-lb).
- 11) Tighten cylinder head sub-bolts to 9.0 to 11.8 N·m (0.92 to 1.20 kg-m, 6.7 to 8.7 ft-lb).
- 12) Tighten intake manifold bolts and nuts to 4 N·m (0.4 kg-m, 2.9 ft-lb).
- 13) Tighten intake manifold bolts and nuts to 9 N·m (0.9 kg-m, 6.5 ft-lb).
- 14) Tighten intake manifold bolts and nuts to 8 to 10 N·m (0.8 to 1.0 kg-m, 5.8 to 7 ft-lb).

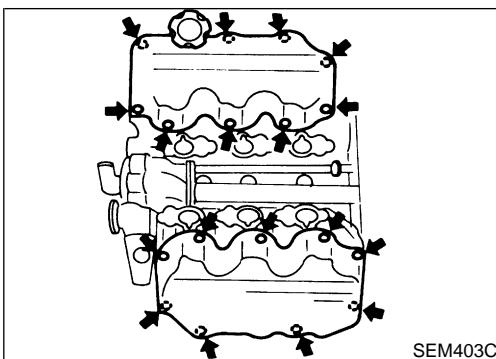
- If only intake manifold is removed and to be used again, install it using the following procedure:

- 1) Tighten all bolts and nuts to 4 N·m (0.4 kg-m, 2.9 ft-lb).
- 2) Tighten all bolts and nuts to 9 N·m (0.9 kg-m, 6.5 ft-lb).
- 3) Tighten all bolts and nuts to 8 to 10 N·m (0.8 to 1.0 kg-m, 5.8 to 7 ft-lb).

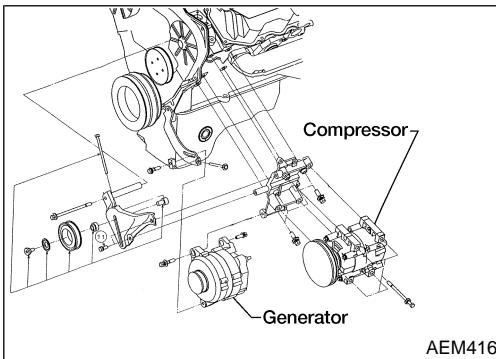
CAUTION:

If replacing intake manifold with a new one, cylinder head gasket must also be replaced with a new one. Refer to step 4.

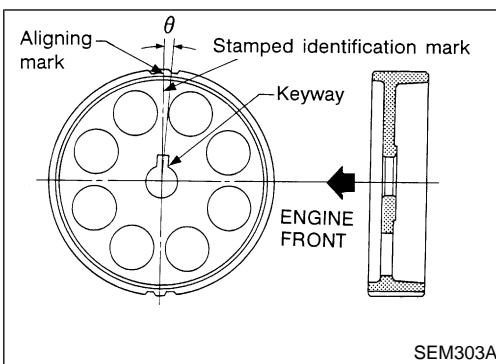
Installation (Cont'd)



6. Install both rocker covers.



7. Install compressor, generator and power steering pump brackets.
8. Install power steering pump.
9. Install compressor and generator.
10. Install exhaust front tube to exhaust manifold.



11. Install rear belt cover and camshaft sprocket.

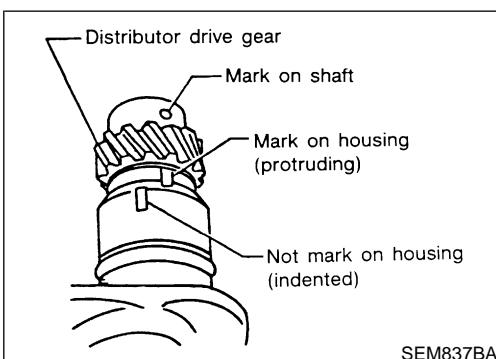
• RH camshaft sprocket and LH camshaft sprocket are different parts. Be sure to install them in the correct location.

	Identification mark	θ
RH camshaft sprocket	R3	$0^{\circ}53'$
LH camshaft sprocket	L3	$-3^{\circ}27'$

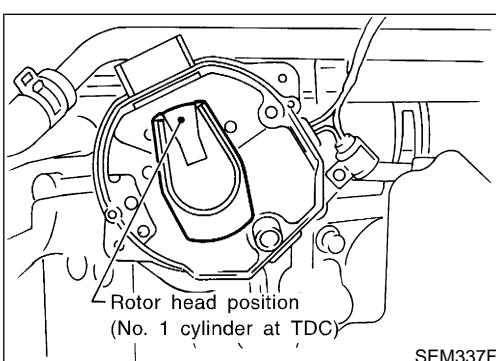
12. Install timing belt and adjust belt tension. Refer to "AFTER ENGINE OVERHAUL OR ENGINE REASSEMBLY (WITH ROCKER COVERS REMOVED)", EM-87.

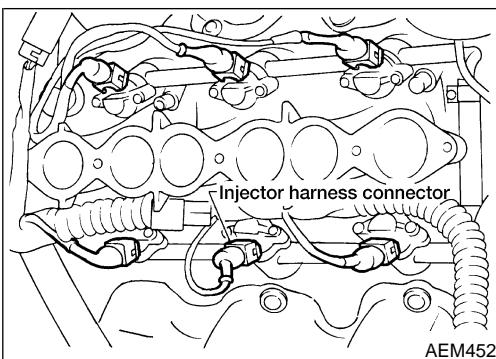
13. Install distributor.

- 1) Align mark on shaft with protruding mark on housing.



- 2) After installing, confirm that distributor rotor head is set as shown in figure.





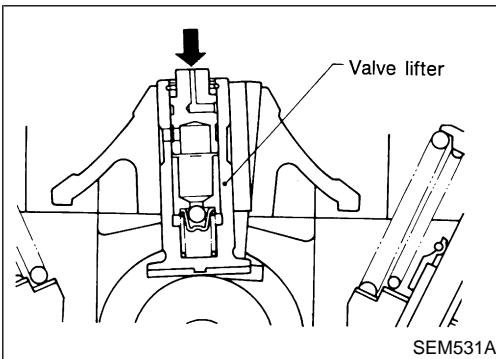
14. Install injector fuel tube assembly.
15. Connect all injector harness connectors.
16. Install fuel feed and fuel return hoses to injector fuel tube assembly.
17. Install intake manifold collector. Install all parts which were removed in Step 6, under "Removal", EM-93.
18. Install ASCD and accelerator control wire.

GI

MA

EM

LC



19. Check hydraulic valve lifter.
 - a. Push plunger forcefully with your finger.
 - **Be sure to check it with rocker arm in its free position (not on the lobe).**
 - b. If valve lifter moves more than 1 mm (0.04 in), air may be inside it.
 - c. Bleed air off by running engine at 1,000 rpm under no load for about 10 minutes.
 - d. If hydraulic valve lifters are still noisy, replace them and bleed air off again in the same manner as in Step 19 (c).
20. Install the remaining components in the reverse order of removal.

EC

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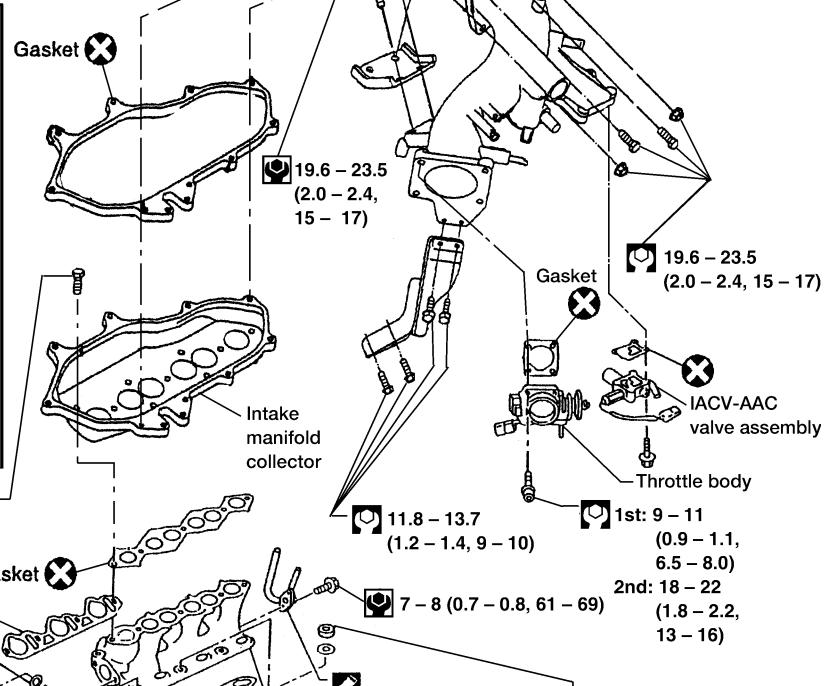
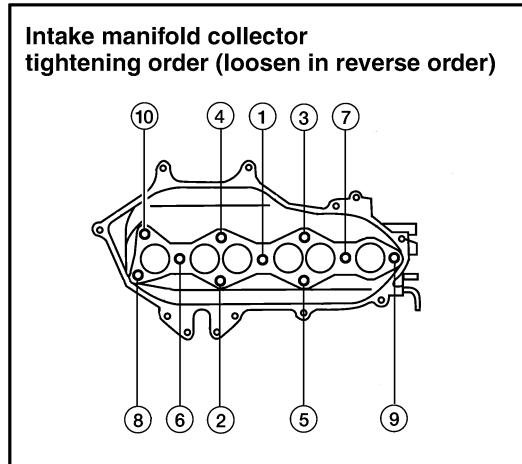
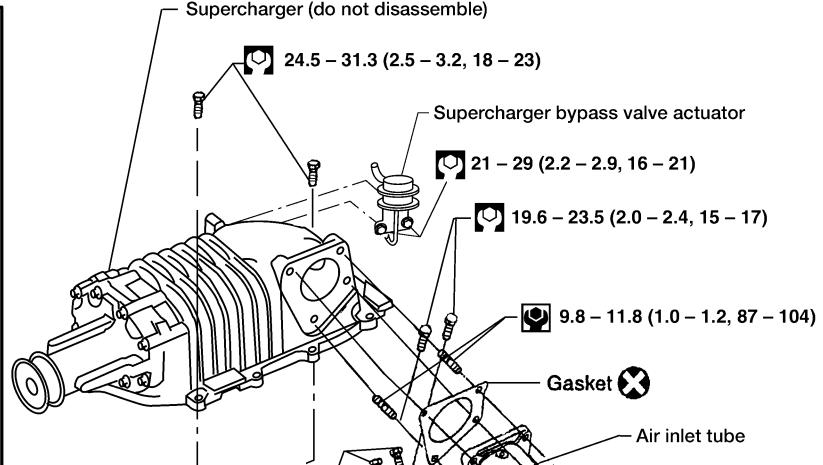
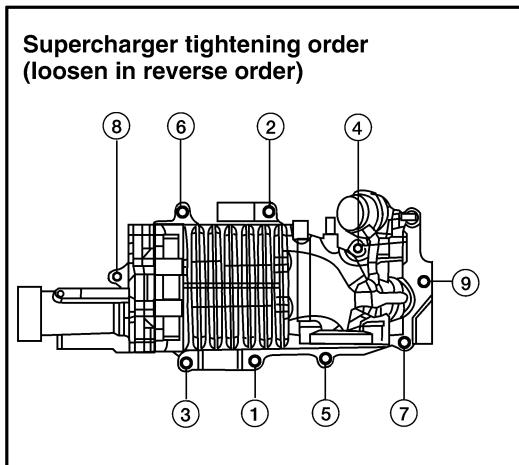
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Components

Components

NGEM0096

SEC. 140 • 147 • 148 • 163 • 164 • 173 • 210 • 221

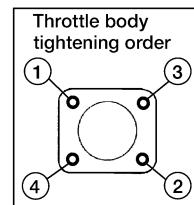


: Apply liquid gasket (Use Genuine Silicone RTV or equivalent. Refer to GI Section, "Recommended Chemical Products and Sealants".)

Refer to step 14 in "Installation" of CYLINDER HEAD.

: N·m (kg-m, in-lb)

: N·m (kg-m, ft-lb)



WEM141

Removal

NGEM0097

CAUTION:**Do not disassemble or adjust the supercharger.**

1. Disconnect the negative battery cable.

GI

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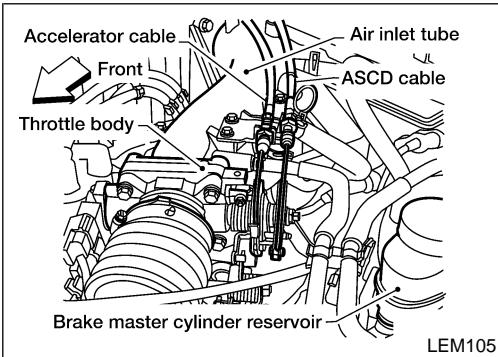
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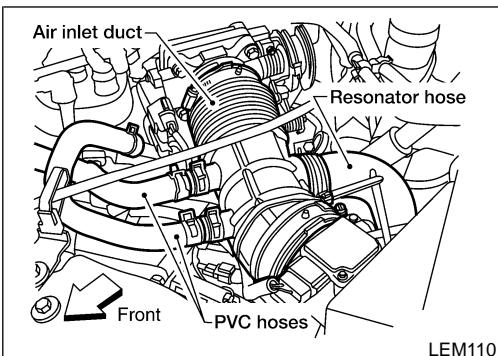
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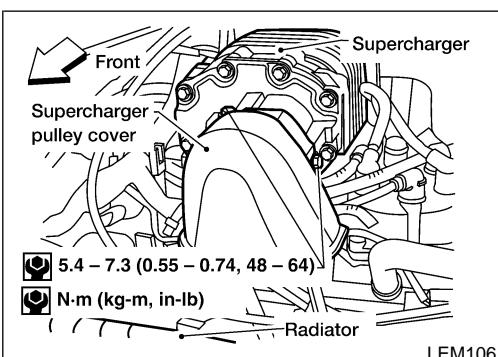
2. Disconnect the accelerator cable from the throttle body and the air inlet tube bracket.

3. Disconnect the ASCD cable from the throttle body and the air inlet tube bracket, if equipped.

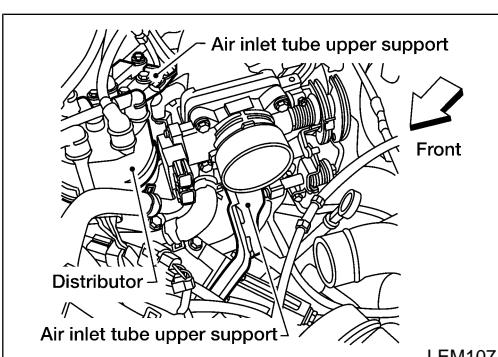


4. Remove the air inlet duct
 - Disconnect the PCV hoses.
 - Disconnect the resonator hose.

5. Partially drain the cooling system. Refer to **MA-17**, "Changing Engine Coolant".

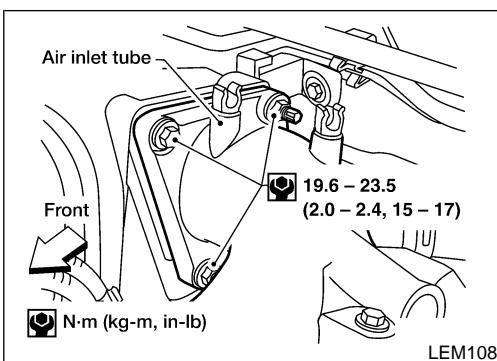


6. Remove the supercharger pulley cover and the supercharger/air conditioning drive belt. Refer to **MA-26**, "Checking Drive Belts".

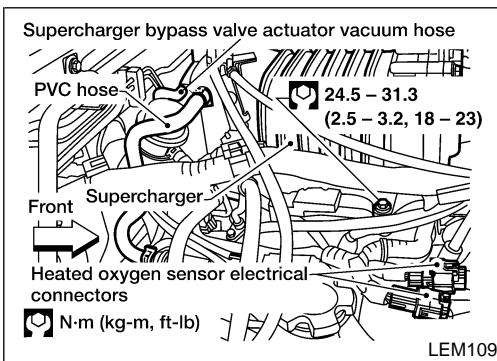


7. Remove the air inlet tube upper and lower supports.

Removal (Cont'd)



8. Remove the air inlet tube bolts, nuts, and studs. Position the air inlet tube aside.
- Disconnect the evaporative emission vacuum hose.
- Disconnect the brake booster vacuum hose.
- Disconnect the TPS sensor electrical connector.
- Disconnect the TPS switch electrical connector.



9. Remove the supercharger bolts and the supercharger assembly.
- Disconnect the boost control valve vacuum hose.
- Disconnect the PCV hose.

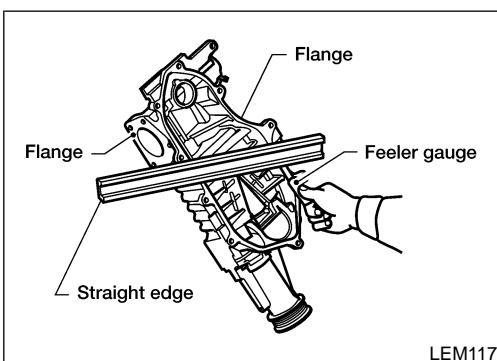
Inspection

SUPERCHARGER FLANGE

NGEM0098

NGEM0098S01

1. Clean the mating surface of the supercharger flange.



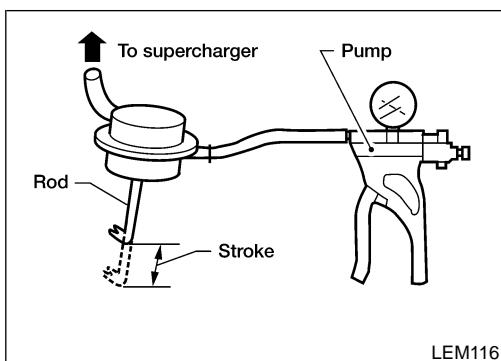
2. Check the flange surface for any deformation and flatness. Use a reliable straightedge and feeler gauge, or attach the supercharger flange to the intake collector mating flange, and check that the flatness is within specification.

Flange flatness limit: 0.12 mm (0.005 in)

ROTOR SYSTEM

NGEM0098S02

1. Check that the supercharger pulley rotates smoothly when turning it by hand in a clockwise direction. Rotating torque must not exceed specification.
- **Rotating torque: 0.5 N·m (0.05 kg·m, 4 in-lb)**
2. Check that both the left and right rotors are free from any cracks or contamination.

**SUPERCHARGER BYPASS VALVE ACTUATOR**

NGEM0098S03
1. Apply air pressure of less than 12 kPa (90 mmHg, 3.54 inHg) to the supercharger bypass valve actuator's lower side hose port and check for any leakage.

GI

2. Check the supercharger bypass valve actuator rod for smooth movement while maintaining the pressure at the specified levels below:

MA

Rod starts to extend at approximately: 12 Kpa (90 mmHg, 3.54 inHg)

EM

Rod is fully extended at approximately: 33.3 kPa (250 mmHg, 9.84 inHg)

LC

Rod full extended length: 20.83 — 22.71 mm (0.82 — 0.89 in)

EC

Installation

To install the supercharger, follow the removal steps in reverse order.

AT

- Replace all gaskets; make sure that all gasket surfaces are clean and undamaged.
- Follow all torque sequences for tightening.
- Refill the cooling system. Refer to **MA-17**, "Changing Engine Coolant".

TF

PD

AX

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RS

BT

HA

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IDX

Removal and Installation

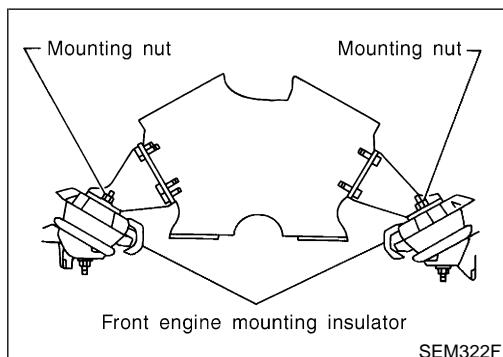
NGEM0020

WARNING:

- Situate vehicle on a flat and solid surface.
- Place chocks at front and back of rear wheels.
- Do not remove engine until exhaust system has completely cooled off. Otherwise, you may burn yourself and/or fire may break out in fuel line.
- For safety during subsequent steps, the tension of wires should be slackened against the engine.
- Before disconnecting fuel hose, release fuel pressure from fuel line.
Refer to EC-1197(VG33E), EC-1197(VG33ER), "Fuel Pressure Release".
- Before removing front axle from transmission, place safety stands under designated front supporting points. Refer to GI-45, "Lifting Points and Tow Truck Towing".
- Be sure to hoist engine and transmission in a safe manner.
- For engines not equipped with engine slingers, attach proper slingers and bolts described in the PARTS CATALOG.

CAUTION:

- When lifting engine, be careful not to strike adjacent parts, especially accelerator wire casing, brake lines, and brake master cylinder.
- In hoisting the engine, always use engine slingers in a safe manner.
- Before separating engine and transmission, remove crankshaft position sensor (OBD) from the assembly.
- Always take extra care not to damage edge of crankshaft position sensor (OBD), or ring gear teeth.



- Do not loosen front engine mounting insulator cover securing bolts.
- When cover is removed, damper oil flows out and mounting insulator will not function.
- Tighten to specifications. Refer to AT-271, "Removal" (automatic); MT-41, "REMOVAL AND INSTALLATION" (manual), and PD-8, "Removal and Installation" (drive shaft).

REMOVAL

Engine Mounting

NGEM0020S01

NGEM0020S0101

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SEC. 112

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LC

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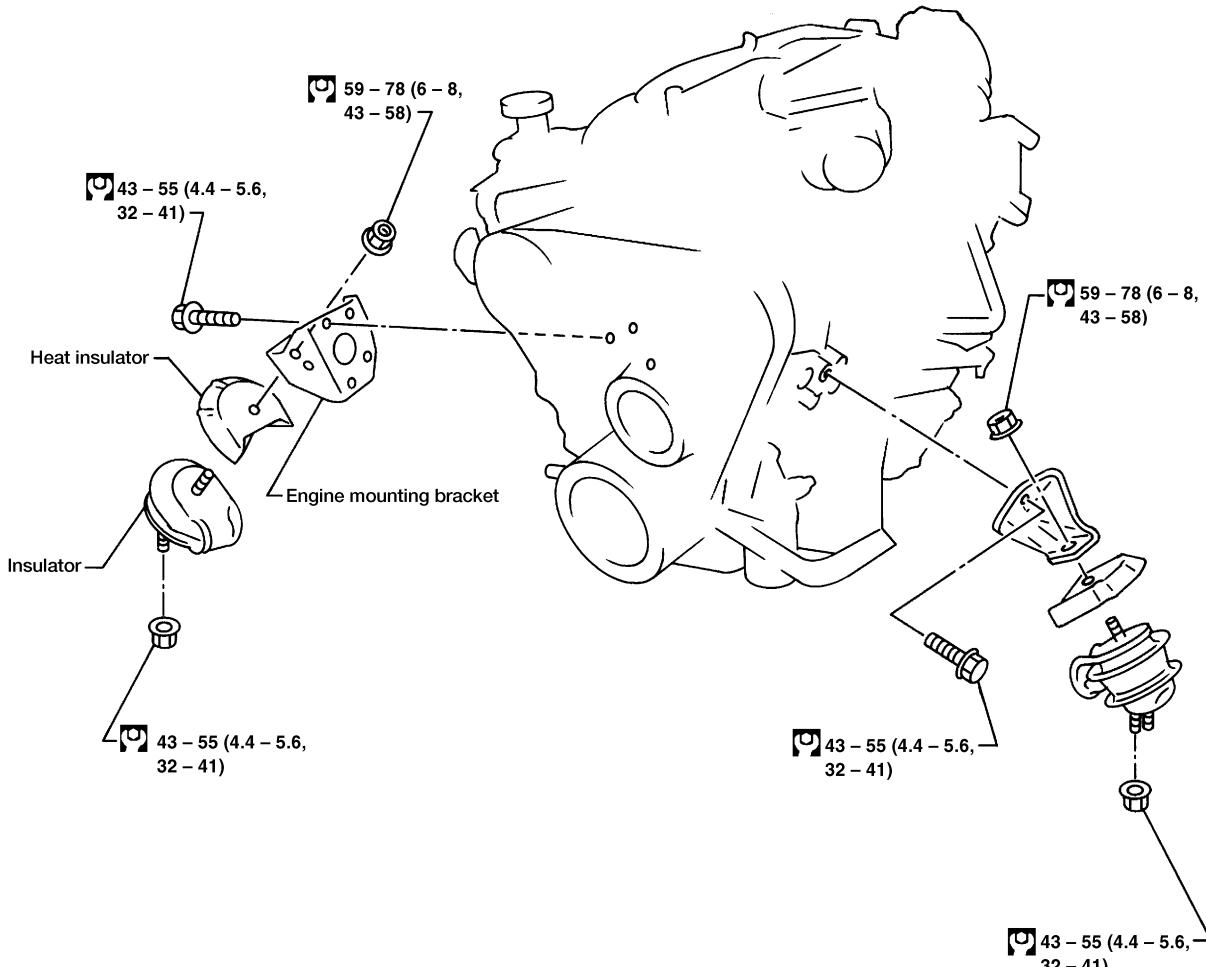
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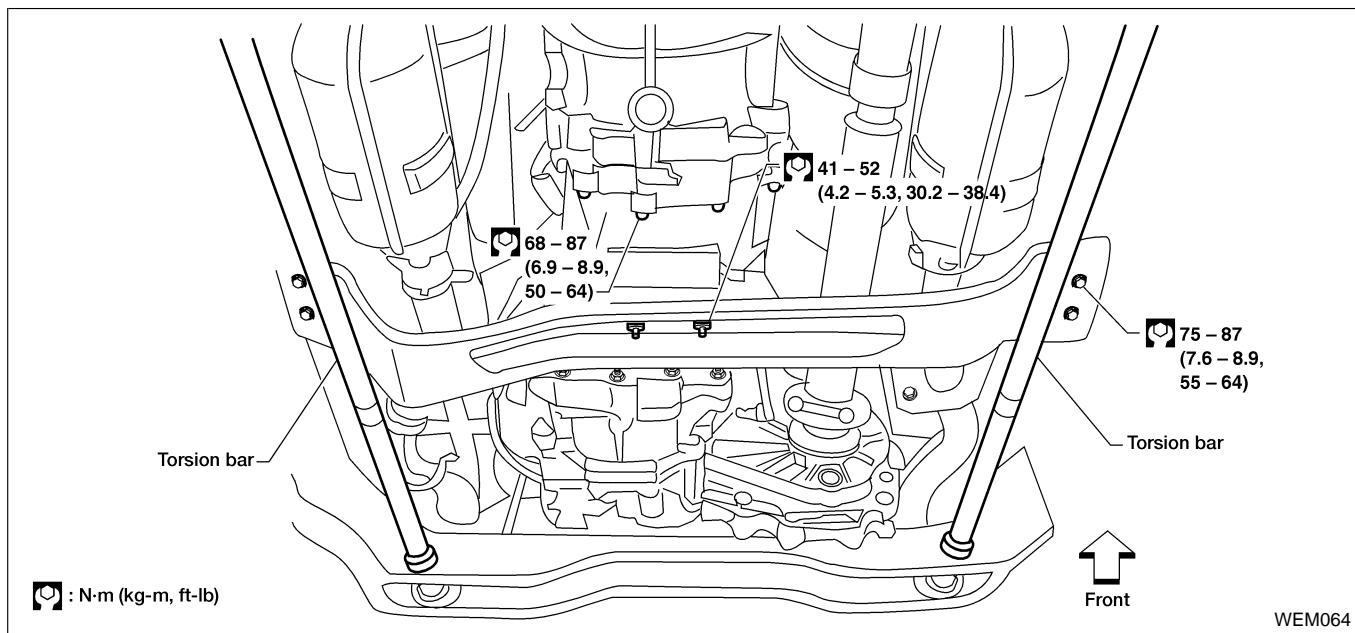


: N·m (kg·m, ft-lb)

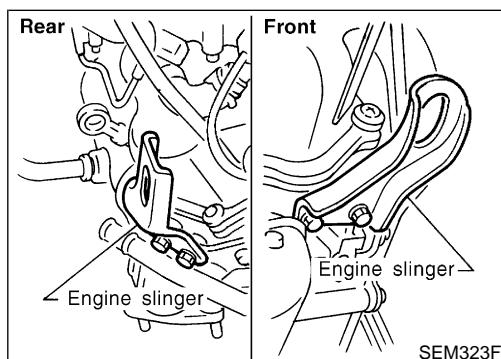
ENGINE ASSEMBLY

VG33E AND VG33ER

Removal and Installation (Cont'd)



1. Remove engine undercover and hood.
2. Drain coolant from cylinder block and radiator. Refer to **MA-28**, "Changing Engine Coolant".
3. Remove vacuum hoses, fuel tubes, wires, harnesses and connectors.
4. Before disconnecting fuel hose, release fuel pressure from fuel line. Refer to **EC-1197** (VG33E), **EC-1197** (VG33ER), "Fuel Pressure Release".
5. Remove radiator with shroud and cooling fan.
6. Remove drive belts.
7. Discharge refrigerant, refer to **HA-64**, "R-134a Service Procedure".
8. Remove A/C compressor manifold.
9. Remove power steering oil pump from engine.
10. Remove front exhaust tubes.
11. Remove transmission from vehicle. Refer to **AT-271**, "Removal" (automatic); or **MT-41**, "REMOVAL AND INSTALLATION" (manual).



12. Install engine slingers.
- Slinger bolts:**
Front: $20 - 26 \text{ N}\cdot\text{m} (2.1 - 2.7 \text{ kg}\cdot\text{m}, 15 - 20 \text{ ft}\cdot\text{lb})$
13. Hoist engine with engine slingers and remove engine mounting nuts from both sides.
14. Lift and remove engine from vehicle.

Components

NGEM0021

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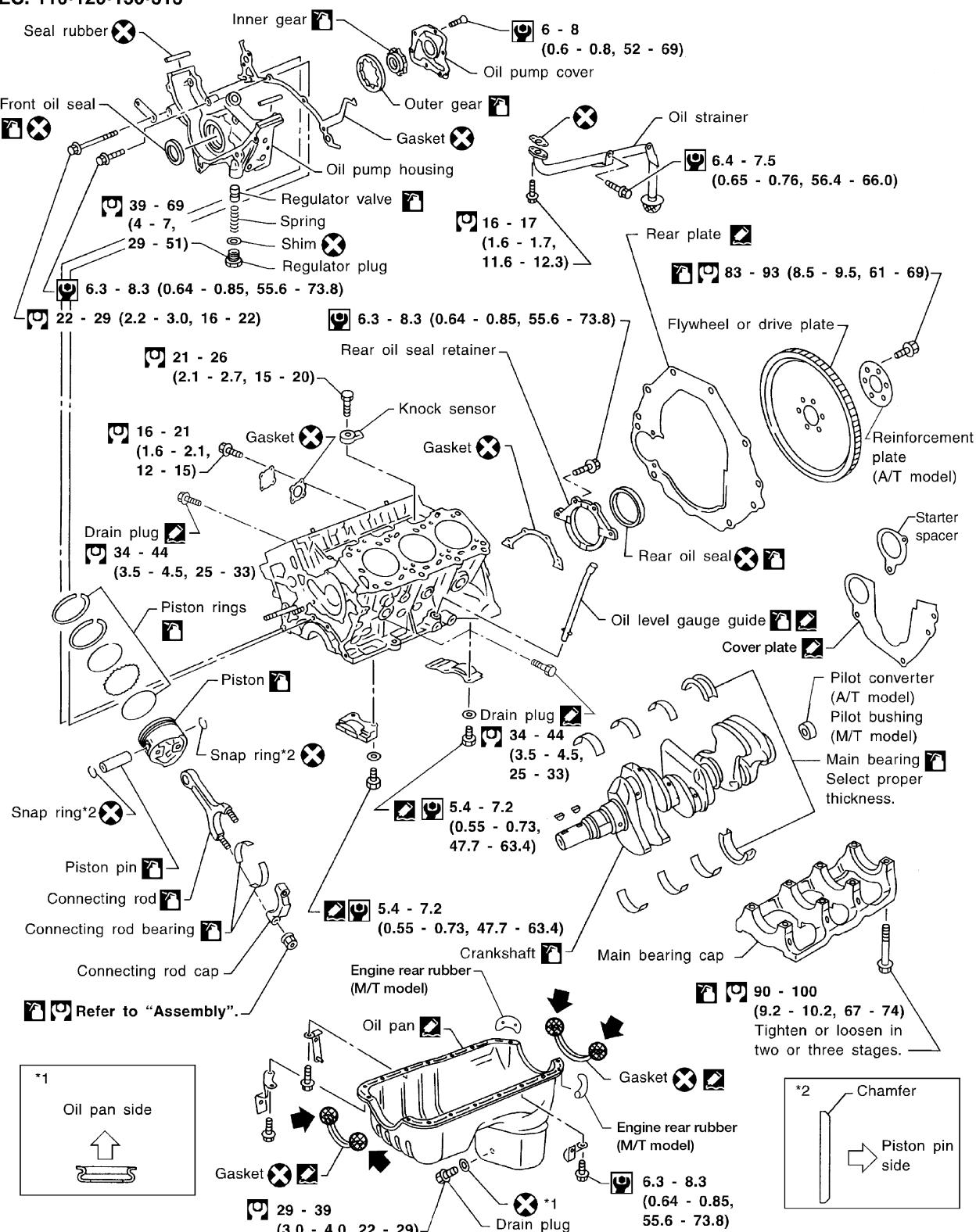
HA

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SEC. 110•120•150•313



Apply Genuine Silicone RTV or equivalent. Refer to GI Section.

N·m (kg-m, in-lb)

Apply sealant.

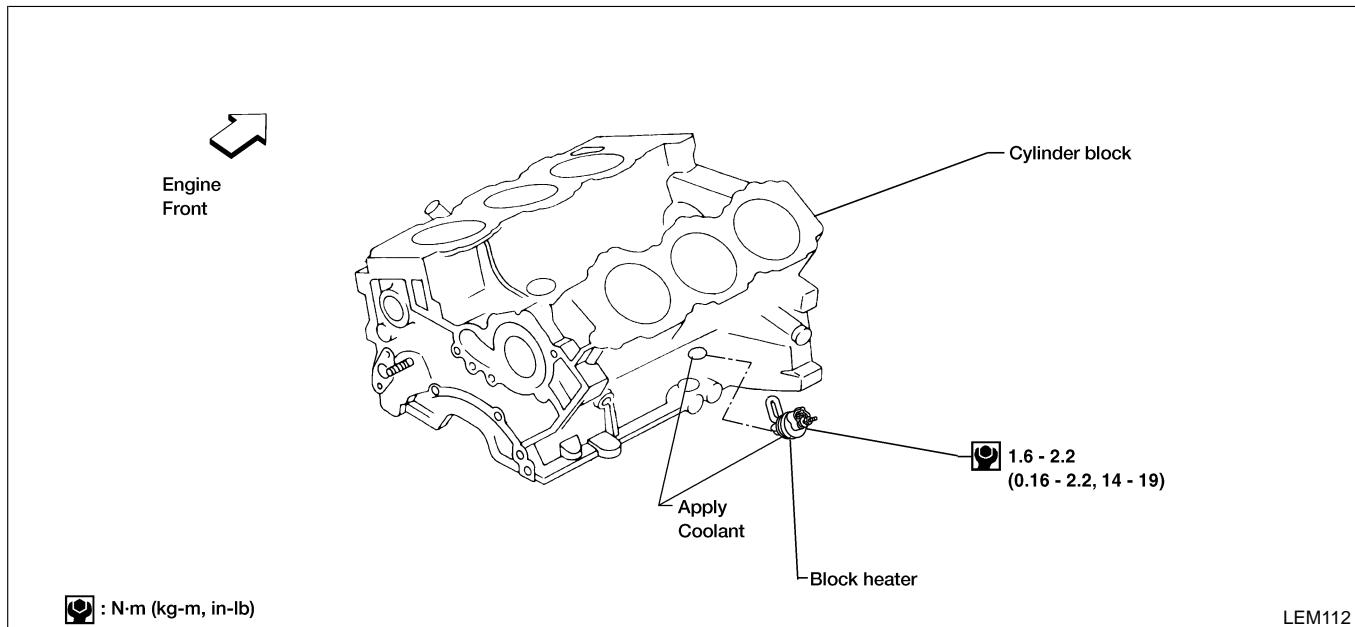
N·m (kg-m, ft-lb)

Lubricate with new engine oil.

Always replace after every disassembly.

Components (Cont'd)

Canada Models — Block Heater

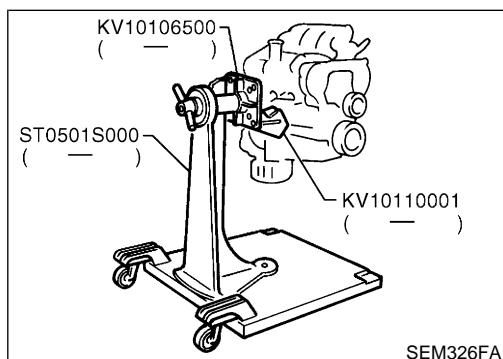


Removal and Installation

NGEM0022

CAUTION:

- When installing sliding parts such as bearings and pistons, be sure to apply engine oil on the sliding surfaces.
- Place removed parts such as bearings and bearing caps in their proper order and direction.
- When installing connecting rod bolts and main bearing cap bolts, apply new engine oil to threads and seating surfaces.
- Do not allow any magnetic materials to contact the ring gear teeth on drive plate and rear plate.



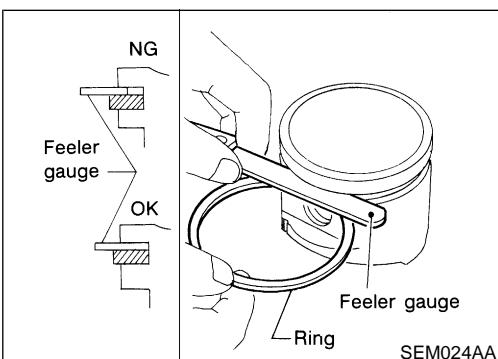
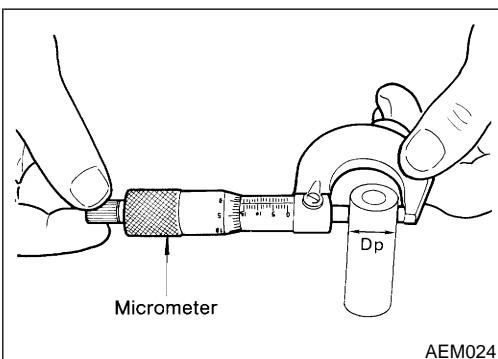
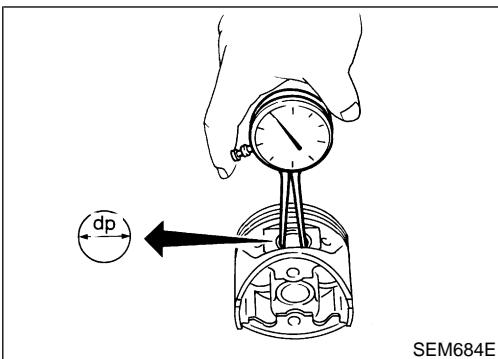
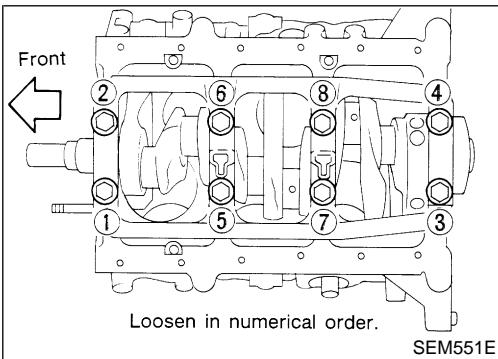
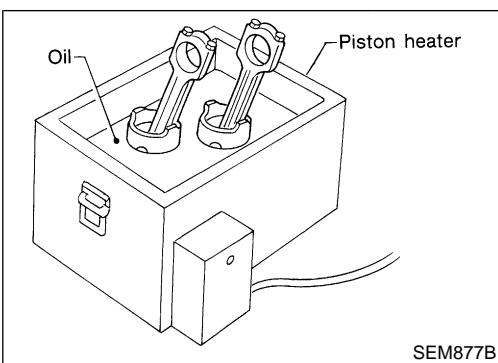
Disassembly

PISTON AND CRANKSHAFT

NGEM0023

NGEM0023S01

1. Place engine on a work stand.
2. Drain coolant and oil.
3. Remove timing belt.
4. Remove oil pan and oil pump.
5. Remove water pump.
6. Remove cylinder head.



7. Remove pistons with connecting rods.

- When disassembling piston and connecting rod, remove snap ring first, then heat piston to 60 to 70°C (140 to 158°F) or use piston pin press stand at room temperature.

GI

CAUTION:

- When piston rings are not replaced, make sure that piston rings are mounted in their original positions.
- When replacing piston rings, if there is no punchmark, install with either side up.

MA

EM

LC

EC

FE

CL

MT

8. Remove bearing cap and crankshaft.

- Before removing bearing cap, measure crankshaft end play.
- Bolts should be loosened in two or three steps.

FE

Inspection**PISTON AND PISTON PIN CLEARANCE**

1. Measure inner diameter of piston pin hole "dp".

Standard diameter "dp":**20.969 - 20.981 mm (0.8255 - 0.8260 in)**

NGEM0024

NGEM0024S01

AT

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PD

AX

2. Measure outer diameter of piston pin "Dp".

Standard diameter "Dp":**20.971 - 20.983 mm (0.8256 - 0.8261 in)**

3. Calculate piston pin clearance.

 $dp - Dp = 0 \text{ to } -0.004 \text{ mm (0 to } -0.0002 \text{ in)}$

If it exceeds the above value, replace piston assembly with pin.

SU

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RS

PISTON RING SIDE CLEARANCE**Side clearance:****Top ring: 0.040 - 0.080 mm (0.0016 - 0.0031 in)****2nd ring: 0.030 - 0.070 mm (0.0012 - 0.0028 in)****Oil ring: 0.015 - 0.185 mm (0.0006 - 0.0073 in)****Max. limit of side clearance:****Top ring: 0.11 mm (0.0043 in)****2nd ring: 0.1 mm (0.004 in)****Oil ring: —**

NGEM0024S02

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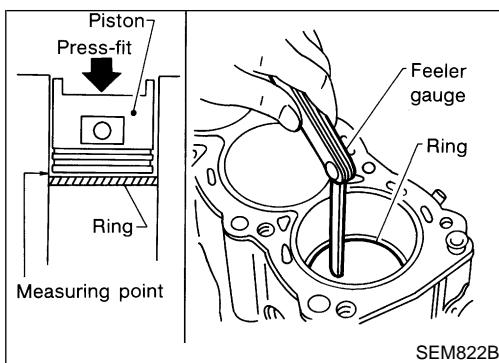
SC

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

Inspection (Cont'd)



PISTON RING END GAP

NGEM0024S03

End gap:

Top ring: 0.21 - 0.31 mm (0.0083 - 0.0122 in)

2nd ring: 0.50 - 0.60 mm (0.0197 - 0.0236 in)

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

Max. limit of ring gap:

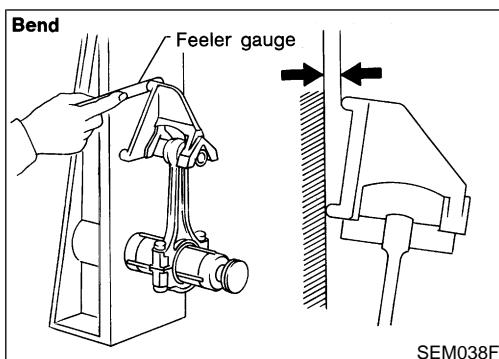
Top ring: 0.43 mm (0.0169 in)

2nd ring: 0.69 mm (0.0272 in)

Oil ring: 0.84 mm (0.0331 in)

If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, rebore cylinder and use oversized piston and piston rings. Refer to "Piston, Piston Ring and Piston Pin", EM-134.

- When replacing the piston, check the cylinder block surface for scratches or seizure. If scratches or seizure are found, hone or replace the cylinder block.



CONNECTING ROD BEND AND TORSION

NGEM0024S04

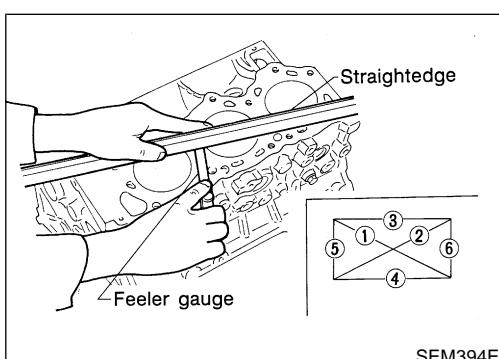
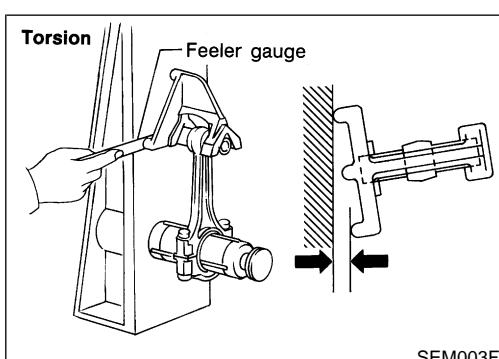
Bend:

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.



CYLINDER BLOCK DISTORTION AND WEAR

NGEM0024S05

- Clean upper face of cylinder block and measure the distortion.

Limit:

0.10 mm (0.0039 in)

2. If out of specification, resurface it.
The resurfacing limit is determined by cylinder head resurfacing in engine.

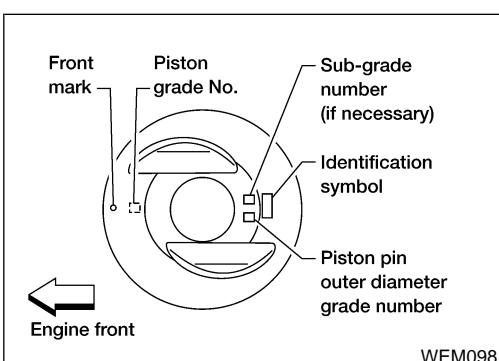
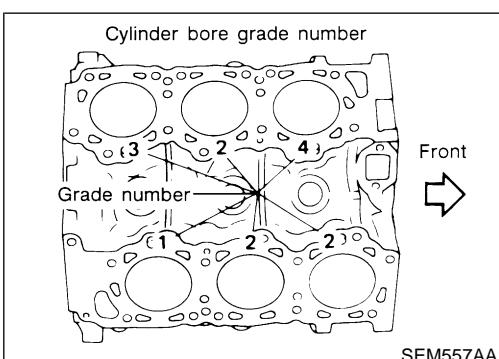
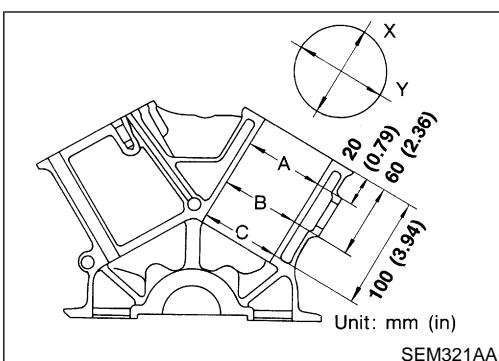
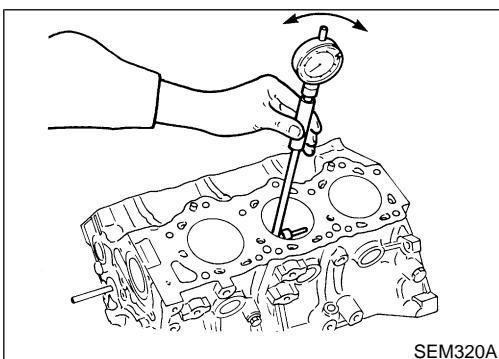
Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

$$A + B = 0.2 \text{ mm (0.008 in)}$$

Nominal cylinder block height from crankshaft center:
227.60 - 227.70 mm (8.9606 - 8.9645 in)

3. If necessary, replace cylinder block.



PISTON-TO-BORE CLEARANCE

1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.

Standard inner diameter:

$$91.500 - 91.530 \text{ mm (3.6024 - 3.6035 in)}$$

Refer to "Cylinder Block", EM-133.

Wear limit:

$$0.20 \text{ mm (0.0079 in)}$$

If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.

Out-of-round (X - Y) standard:

$$0.015 \text{ mm (0.0006 in)}$$

Taper (A - B or A - C) standard:

$$0.015 \text{ mm (0.0006 in)}$$

2. Check for scratches and seizure. If seizure is found, hone it.

- If both cylinder block and piston are replaced with new ones, select piston of the same grade number according to the following table. These numbers are punched on cylinder block and piston in either Arabic or Roman numerals.**

Combination of grade number for cylinder bore and piston

	For No. 3, 4 and 5 cylinders						For No. 1, 2 and 6 cylinders		
	1	2	3	4	5	6	1	2	3
Cylinder bore grade No.	1	2	3	4	5	6	1	2	3
Piston grade No.	2-1	3-2	3-3	4-4	4-5	5-6	1	2	3

GI

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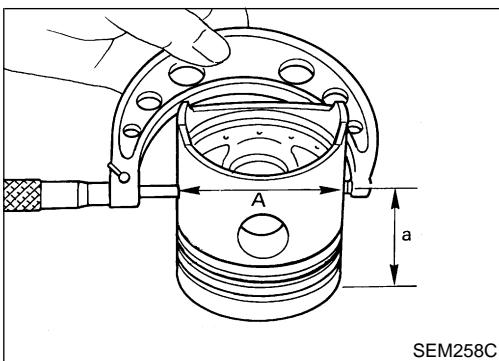
HA

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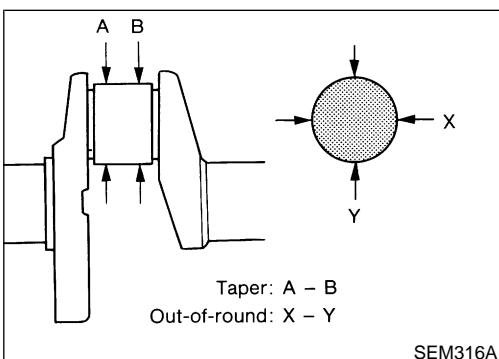
IDX

Inspection (Cont'd)



3. Measure piston skirt diameter.
Piston diameter "A":
 Refer to "AVAILABLE PISTON", EM-134.
Measuring point "a" (Distance from the top):
 49.0 mm (1.929 in)
4. Check that piston-to-bore clearance is within specification.
Piston-to-bore clearance "B":
 0.025 - 0.045 mm (0.0010 - 0.0018 in) for No. 1, 2, and 6 cylinders (and No. 5 cylinder for VG33ER only)
 0.015 - 0.025 mm (0.0006 - 0.0010 in) for No. 3 and 4 cylinders
 0.030 - 0.040 mm (0.0012 - 0.0016 in) for No. 5 cylinder (VG33E only)
5. Determine piston oversize according to amount of cylinder wear.
Oversize pistons are available for service. Refer to "Piston, Piston Ring and Piston Pin", EM-134.
6. 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
 C: Honing allowance 0.02 mm (0.0008 in)
7. Install main bearing caps, and tighten to the specified torque to prevent distortion of cylinder bores in final assembly.
8. Cut cylinder bores.
 - 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.
9. Hone cylinders to obtain specified piston-to-bore clearance.
10. Measure finished cylinder bore for out-of-round and taper.
 - Measurement should be done after cylinder bore cools down.



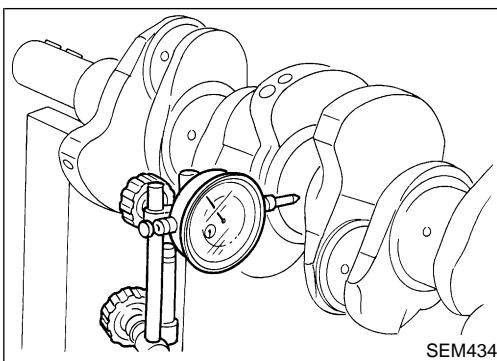
CRANKSHAFT

NGEM0024S07

1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.

Out-of-round (X - Y):
 Less than 0.005 mm (0.0002 in)

Taper (A - B):
 Less than 0.005 mm (0.0002 in)



3. Measure crankshaft runout.

Runout (Total indicator reading):

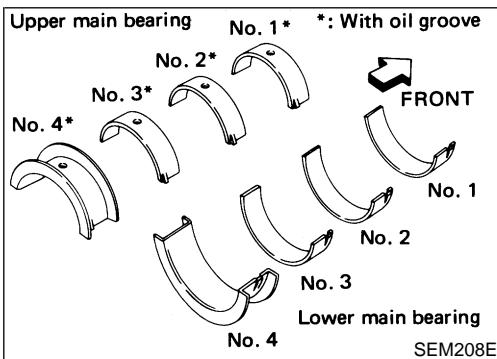
Less than 0.10 mm (0.0039 in)

GI

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BEARING CLEARANCE

- Either of the following two methods may be used, however, method A gives more reliable results and is preferable.

Method A (Using bore gauge & micrometer)

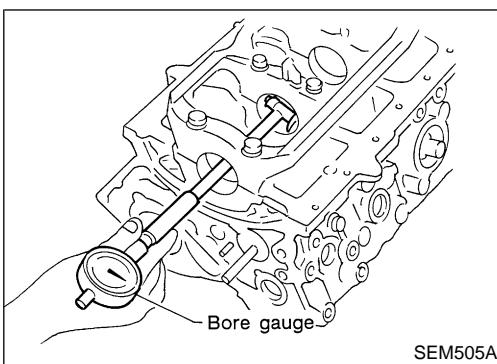
NGEM0024S08

EC

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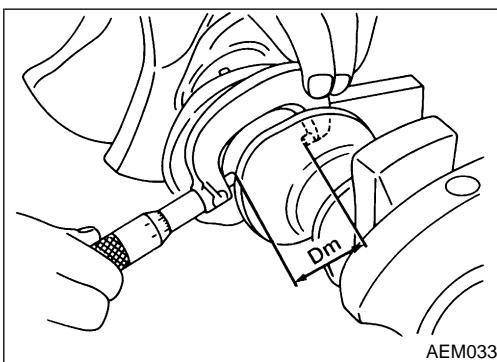
Main Bearing

- Set main bearings in their proper positions on cylinder block and main bearing cap.

NGEM0024S0801

CL

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- Install main bearing cap to cylinder block.

AT

Tighten all bolts in correct order in two or three stages.

TF

- Measure inner diameter "A" of each main bearing.

PD

AX

- Measure outer diameter "Dm" of each crankshaft main journal.
- Calculate main bearing clearance.

SU

BR

No. 1 Main bearing clearance (A - Dm):

Standard

0.030 - 0.048 mm (0.0012 - 0.0019 in)

Limit

0.060 mm (0.0024 in)

No. 2, 3, 4 Main bearing clearance (A - Dm):

Standard

0.038 - 0.065 mm (0.0015 - 0.0026 in)

Limit

0.080 mm (0.0031 in)

ST

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- If it exceeds the limit, replace bearing.
- If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.

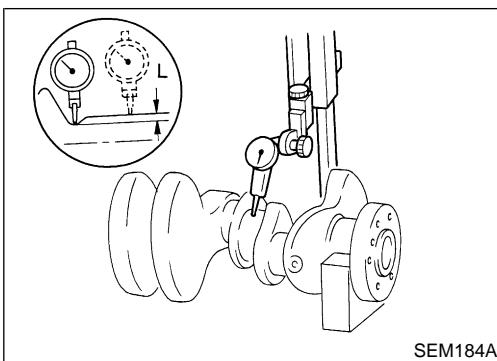
HA

SC

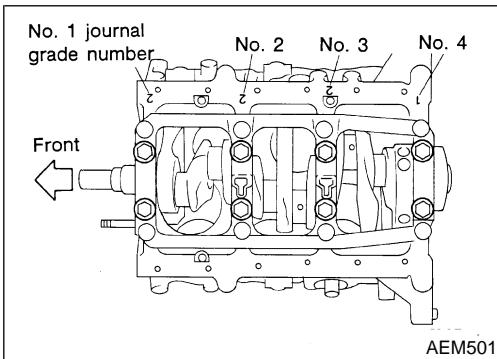
EL

IDX

Inspection (Cont'd)



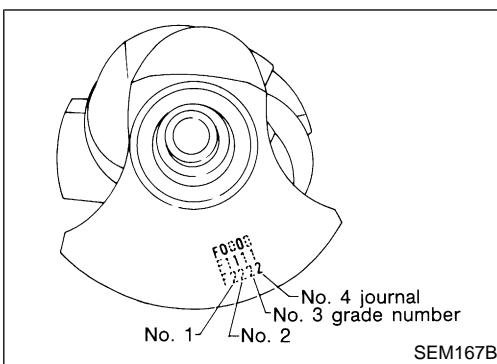
- a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.
"L": 0.1 mm (0.004 in)
- b. Grind the crankshaft to specification, and use available service parts. Refer to "Crankshaft", EM-135.



8. If crankshaft is reused, measure main bearing clearances and select thickness of main bearings.

If crankshaft is replaced with a new one, it is necessary to select thickness of main bearings as follows:

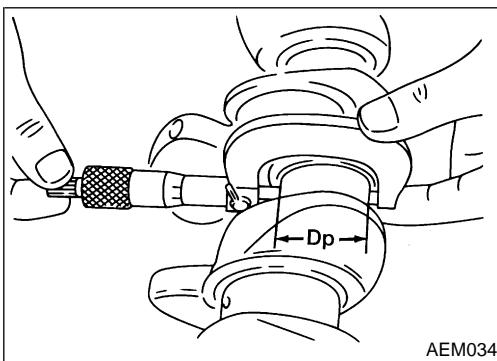
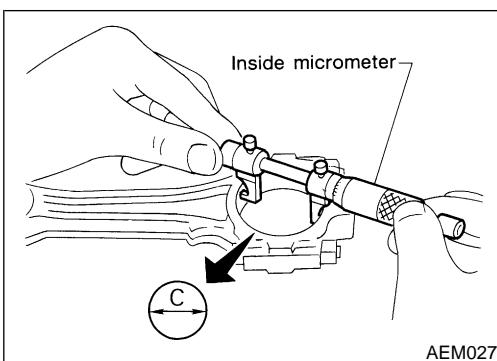
- a. Grade number of each cylinder block main journal is punched on the respective cylinder block. These numbers are punched in either Arabic or Roman numerals.
- b. Grade number of each crankshaft main journal is punched on the respective crankshaft. These numbers are punched in either Arabic or Roman numerals.
- c. Select main bearing with suitable thickness according to the following example or table.

**No. 1 main bearing grade number (Identification color):**

Crankshaft journal grade number	Main journal grade number			
	3	4	5	6
3	0 (Black)	1 (Brown)	2 (Green)	3 (Yellow)
4	1 (Brown)	2 (Green)	3 (Yellow)	4 (Blue)
5	2 (Green)	3 (Yellow)	4 (Blue)	5 (Pink)
6	3 (Yellow)	4 (Blue)	5 (Pink)	6 (Purple)

Except No. 1 main bearing grade number (Identification color):

Crankshaft journal grade number	Main journal grade number		
	0	1	2
0	0 (Black)	1 (Brown)	2 (Green)
1	1 (Brown)	2 (Green)	3 (Yellow)
2	2 (Green)	3 (Yellow)	4 (Blue)



Connecting Rod Bearing (Big end)

1. Install connecting rod bearing to connecting rod and cap.
2. Install connecting rod cap to connecting rod.

Tighten bolts to the specified torque.

3. Measure inner diameter "C" of each bearing.

NGEM0024S0802

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4. Measure outer diameter "Dp" of each crankshaft pin journal.

5. Calculate connecting rod bearing clearance.

Connecting rod bearing clearance (C - Dp):

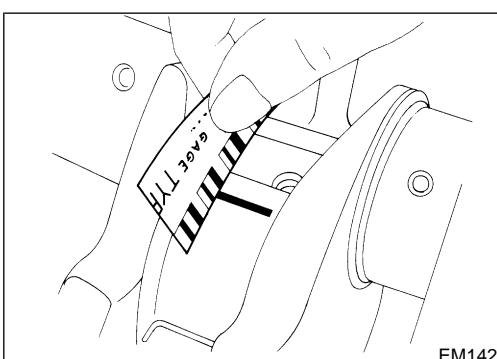
Standard

0.024 - 0.064 mm (0.0009 - 0.0025 in)

Limit

0.090 mm (0.0035 in)

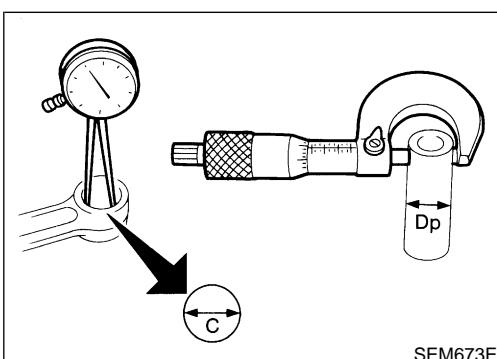
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to step 7 of "Available Main Bearing", EM-136.



Method B (Using plastigage)

CAUTION:

- Do not turn crankshaft or connecting rod while plastigage is being inserted.
- When bearing clearance exceeds the specified limit, ensure that the proper bearing has been installed. Then if excessive bearing clearance exists, use a thicker main bearing or undersized bearing so that the specified bearing clearance is obtained.



CONNECTING ROD BUSHING CLEARANCE (SMALL END)

1. Measure inner diameter "C" of bushing.
2. Measure outer diameter "Dp" of piston pin.
3. Calculate connecting rod bushing clearance.

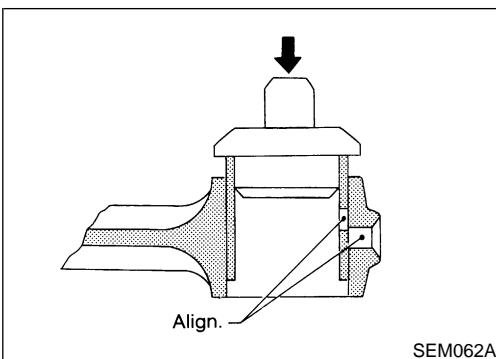
Connecting rod bushing clearance = C - Dp

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

Limit: 0.023 mm (0.0009 in)

If it exceeds the limit, replace connecting rod assembly or connecting rod bushing and/or piston set with pin.

Inspection (Cont'd)



REPLACEMENT OF CONNECTING ROD BUSHING (SMALL END)

NGEM0024S10

1. Drive in small end bushing until it is flush with end surface of rod.

Be sure to align the oil holes.

2. After driving in small end bushing, ream the bushing so that clearance between connecting rod bushing and piston pin is the specified value.

Clearance between connecting rod bushing and piston pin:

0.005 - 0.017 mm (0.0002 - 0.0007 in)

FLYWHEEL/DRIVE PLATE RUNOUT

NGEM0024S11

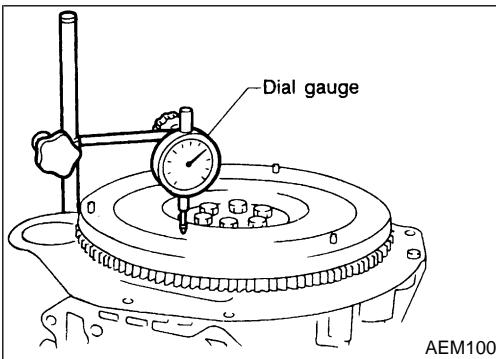
Runout (Total indicator reading):

Flywheel (M/T model)

Less than 0.15 mm (0.0059 in)

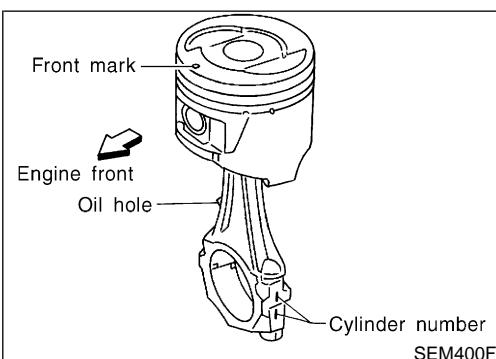
Drive plate (A/T model)

Less than 0.15 mm (0.0059 in)



CAUTION:

- Be careful not to damage the ring gear teeth.
- Check the drive plate for deformation or cracks.
- Do not allow any magnetic materials to contact the ring gear teeth.
- Do not surface flywheel or drive plate. Replace as necessary.



Assembly

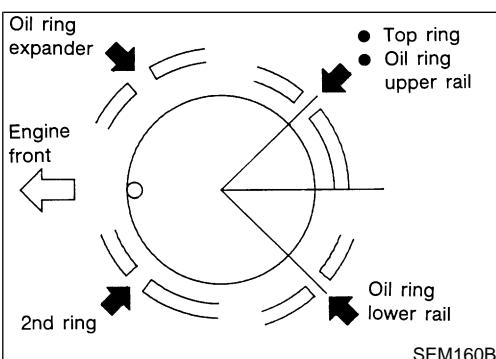
PISTON

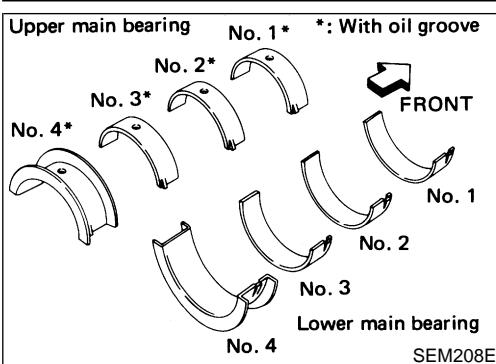
NGEM0025

NGEM0025S01

1. Install new snap ring on one side of piston pin hole.
2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.
- Align the direction of piston and connecting rod.
- Numbers stamped on connecting rod and cap correspond to each cylinder.
- After assembly, make sure connecting rod swings smoothly.

3. Set piston rings as shown.





CRANKSHAFT

- NGEM0025S02
- Set main bearings in their proper positions on cylinder block and main bearing cap.
 - Confirm that correct main bearings are used.**
 - Apply new engine oil to bearing surfaces.**
- Refer to "BEARING CLEARANCE", EM-121.

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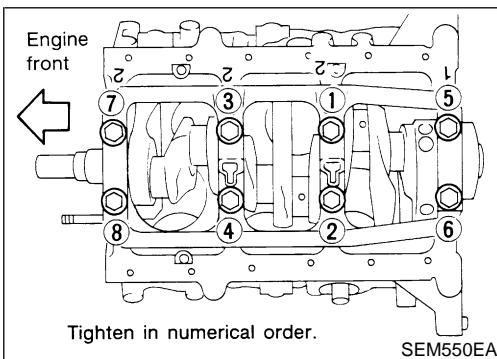
BT

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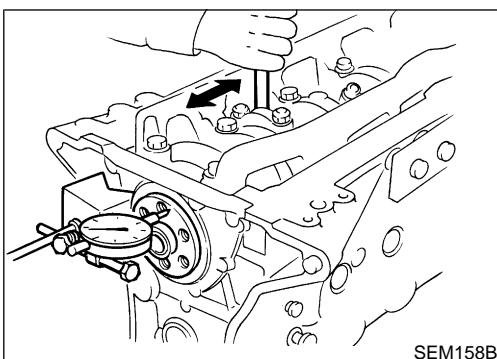


- Install crankshaft and main bearing caps and tighten bolts to the specified torque.
- Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting crankshaft in the axial direction.**
- Tighten bearing cap bolts gradually in two or three stages. Start with center bearing and move outward sequentially.**
- After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.**
- Lubricate threads and seat surfaces of the bolts with new engine oil.**

- Measure crankshaft end play.

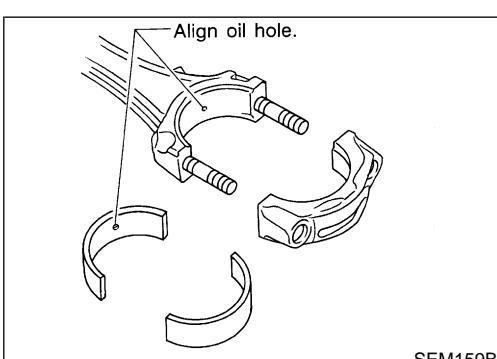
Crankshaft end play:**Standard****0.050 - 0.170 mm (0.0020 - 0.0067 in)****Limit****0.30 mm (0.0118 in)**

If beyond the limit, replace bearing with a new one.

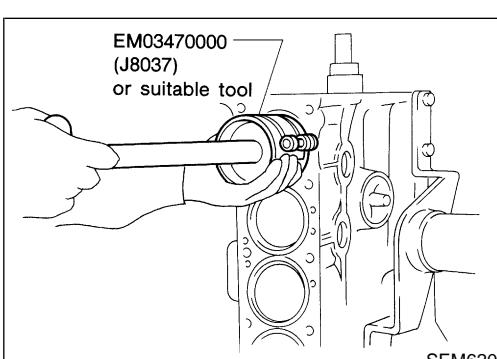


- Install connecting rod bearings in connecting rods and connecting rod caps.
 - Confirm that correct bearings are used.**
- Refer to "Connecting Rod Bearing (Big End)", EM-123.

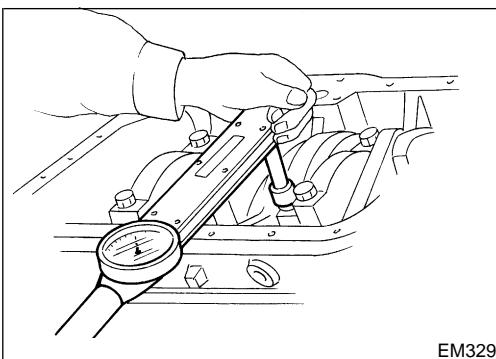
- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.



- Install pistons with connecting rods.
 - a. Install them into corresponding cylinders with Tool.
- Be careful not to scratch cylinder wall by connecting rod.**
 - Arrange so that front mark on piston head faces toward front of engine.**



Assembly (Cont'd)



- b. Install connecting rod bearing caps.
- Lubricate threads and seat surfaces with new engine oil. Tighten connecting rod bearing cap nuts to the specified torque.

: Connecting rod bearing nut

(1) Tighten to 14 to 16 N·m (1.4 to 1.6 kg·m, 10 to 12 ft-lb).

(2) Tighten nuts 60 to 65 degrees clockwise. If an angle wrench is not available, tighten nuts to 38 to 44 N·m (3.9 to 4.5 kg·m, 28 to 33 ft-lb).

6. Measure connecting rod side clearance.

Connecting rod side clearance:

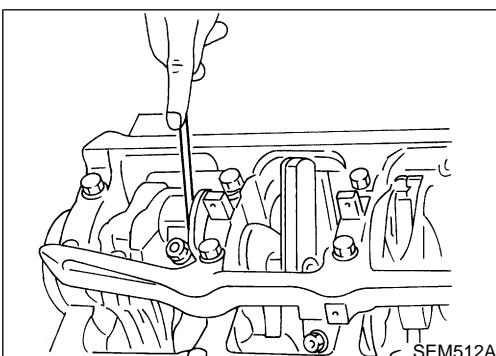
Standard

0.20 - 0.35 mm (0.0079 - 0.0138 in)

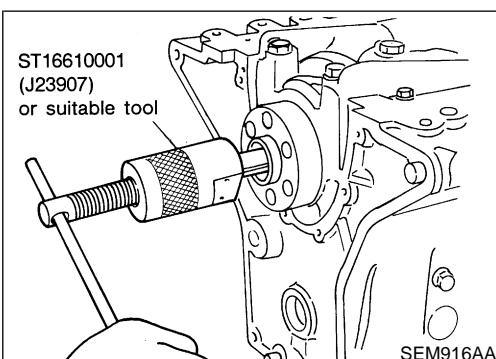
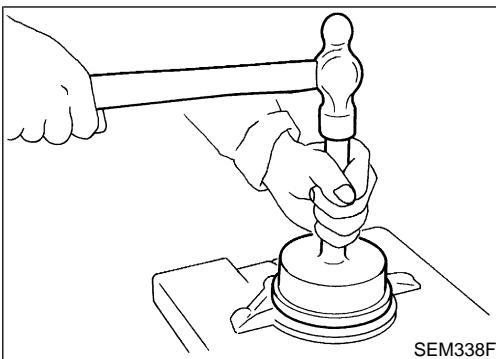
Limit

0.40 mm (0.0157 in)

If beyond the limit, replace connecting rod and/or crankshaft.



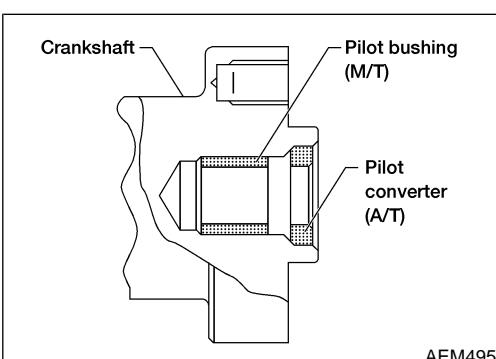
7. Install rear oil seal retainer.



REPLACING PILOT BUSHING (M/T) OR PILOT CONVERTER (A/T)

NGEM0025S03

1. Remove pilot bushing (M/T) or pilot converter (A/T).



2. Install pilot bushing (M/T) or pilot converter (A/T).

SERVICE DATA AND SPECIFICATIONS (SDS)

VG33E AND VG33ER

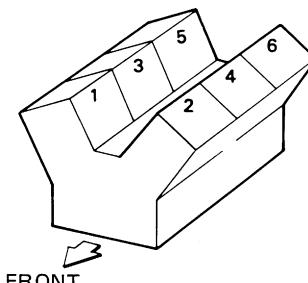
General Specifications

General Specifications

=NGEM0026

Cylinder arrangement	V-6	GI
Displacement	3,275 cm ³ (199.84 cu in)	MA
Bore and stroke	91.5 x 83 mm (3.602 x 3.27 in)	EM
Valve arrangement	OHC	LC
Firing order	1-2-3-4-5-6	FE
Number of piston rings	Compression 2 Oil 1	
Number of main bearings	4	CL
Compression ratio	VG33E 8.9:1 VG33ER 8.3:1	MT

Cylinder number



SEM713A

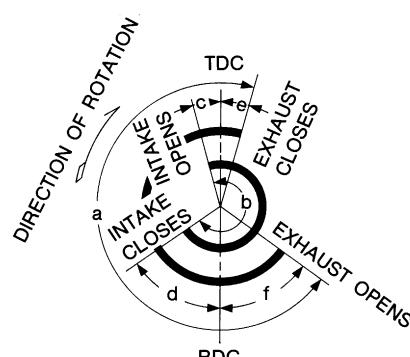
TF

Unit: kPa (kg/cm², psi)/300 rpm

Compression pressure	Standard	1,196 (12.2, 173)	PD
	Minimum	883 (9.0, 128)	AX
	Differential limit between cylinders	98 (1.0, 14)	SU

Unit: degree

Valve timing



EM120

HA

a
240

b
244

c
4

d
60

e
9

f
51

SC

EL

IDX

SERVICE DATA AND SPECIFICATIONS (SDS)

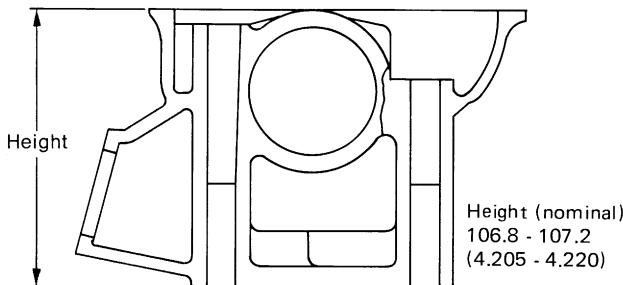
VG33E AND VG33ER

Cylinder Head

Cylinder Head

NGEM0027
Unit: mm (in)

	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)



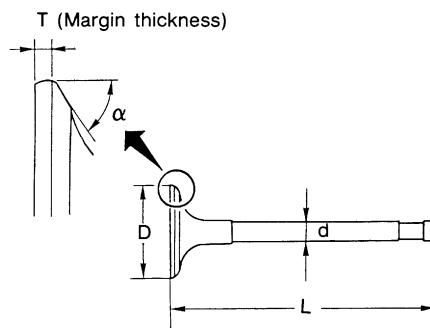
SEM082B

Valve

NGEM0028

VALVE

NGEM0028S01
Unit: mm (in)



SEM188

Valve head diameter "D"	Intake	42.0 - 42.2 (1.654 - 1.661)
	Exhaust	34.95 - 35.25 (1.376 - 1.388)
Valve length "L"	Intake	125.3 - 125.9 (4.933 - 4.957)
	Exhaust	124.2 - 124.8 (4.890 - 4.913)
Valve stem diameter "d"	Intake	6.965 - 6.980 (0.2742 - 0.2748)
	Exhaust	7.962 - 7.970 (0.3135 - 0.3138)
Valve seat angle " α "	Intake	$45^{\circ}15'$ - $45^{\circ}45'$
	Exhaust	
Valve margin "T"	Intake	1.15 - 1.45 (0.0453 - 0.0571)
	Exhaust	1.35 - 1.65 (0.0531 - 0.0650)
Valve margin "T" limit		More than 0.5 (0.020)
Valve stem end surface grinding limit		Less than 0.2 (0.008)
Valve clearance	Intake	0 (0)
	Exhaust	0 (0)

SERVICE DATA AND SPECIFICATIONS (SDS)

VG33E AND VG33ER

Valve (Cont'd)

VALVE SPRING

NGEM0028S02

Free height	Outer	51.2 mm (2.016 in)	GI
	Inner	44.1 mm (1.736 in)	MA
	Single	50.47 mm (1.987 in)	
Pressure	Outer	523.7 N (53.4 kg, 117.7 lb) at 30.0 mm (1.181 in)	EM
	Inner	255.0 N (26.0 kg, 57.3 lb) at 25.0 mm (0.984 in)	
	Single	770 - 837 N (78.5 - 85.4 kg, 173.1 - 188.2 lb) at 30.0 mm (1.181 in)	
Out-of-square	Outer	2.2 mm (0.087 in)	LC
	Inner	1.9 mm (0.075 in)	EC
	Single	2.0 mm (0.079 in)	

HYDRAULIC VALVE LIFTER

NGEM0028S03

Unit: mm (in)

Lifter outside diameter	15.947 - 15.957 (0.6278 - 0.6282)	FE
Lifter guide inside diameter	16.000 - 16.013 (0.6299 - 0.6304)	CL
Clearance between lifter and lifter guide	0.043 - 0.066 (0.0017 - 0.0026)	MT

VALVE GUIDE

NGEM0028S04

Unit: mm (in)

		Standard	Service	AT	
Valve guide	Outer diameter	Intake	11.023 - 11.034 (0.4340 - 0.4344)	TF	
		Exhaust	12.023 - 12.034 (0.4733 - 0.4738)	PD	
	Inner diameter (Finished size)	Intake	7.000 - 7.018 (0.2756 - 0.2763)		
		Exhaust	8.000 - 8.011 (0.3150 - 0.3154)		
Cylinder head valve guide hole diameter		Intake	10.975 - 10.996 (0.4321 - 0.4329)	AX	
		Exhaust	11.975 - 11.996 (0.4715 - 0.4723)		
Interference fit of valve guide		Intake	0.027 - 0.059 (0.0011 - 0.0023)		
		Exhaust			
		Standard	Max. tolerance	BR	
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.10 (0.0039)		
	Exhaust	0.030 - 0.049 (0.0012 - 0.0019)			
Valve deflection limit		—	0.20 (0.0079)	ST	

ROCKER SHAFT AND ROCKER ARM

NGEM0028S05

Unit: mm (in)

Rocker shaft	Outer diameter	17.979 - 18.000 (0.7078 - 0.7087)	RS
Rocker arm	Inner diameter	18.007 - 18.028 (0.7089 - 0.7098)	BT
Clearance between rocker arm and rocker shaft		0.007 - 0.049 (0.0003 - 0.0019)	HA

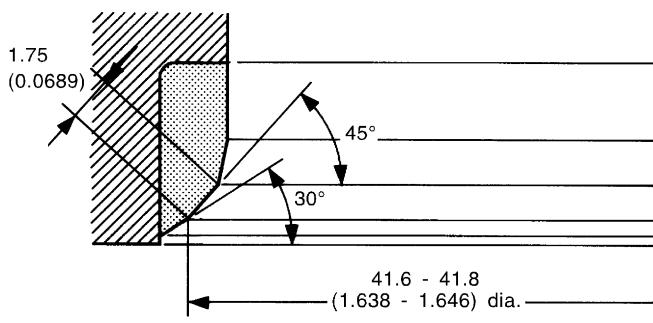
Valve Seat

Valve Seat

INTAKE VALVE SEAT

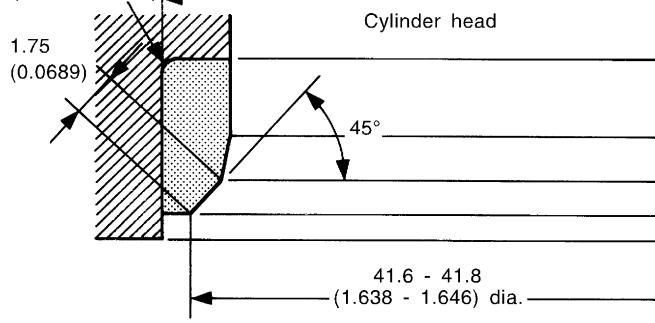
NGEM0029
NGEM0029S01

Standard

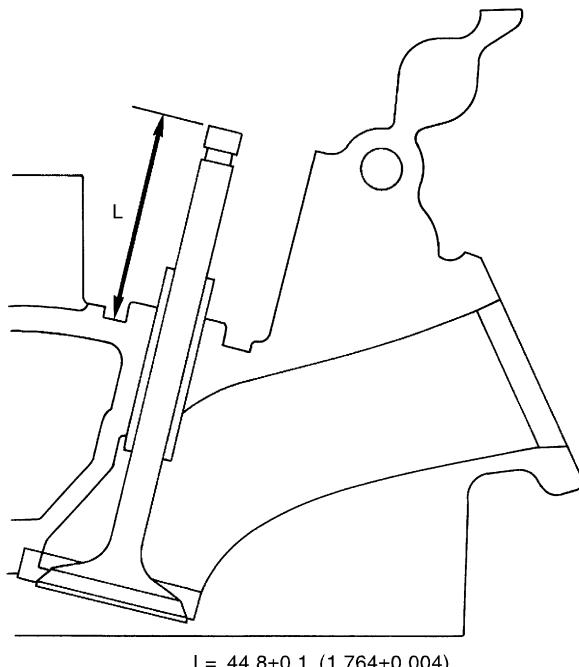


Oversize [0.5 (0.020)]

R0.3 - 0.5
(0.012 - 0.020) 44.500 - 44.516 (1.7520 - 1.7526) dia.



Unit: mm (in)



SEM639F

SERVICE DATA AND SPECIFICATIONS (SDS)

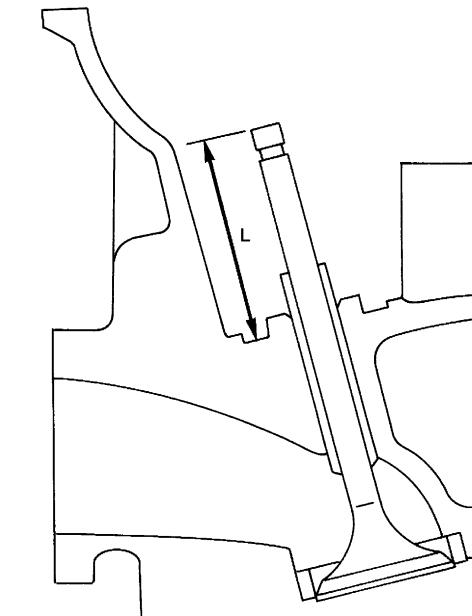
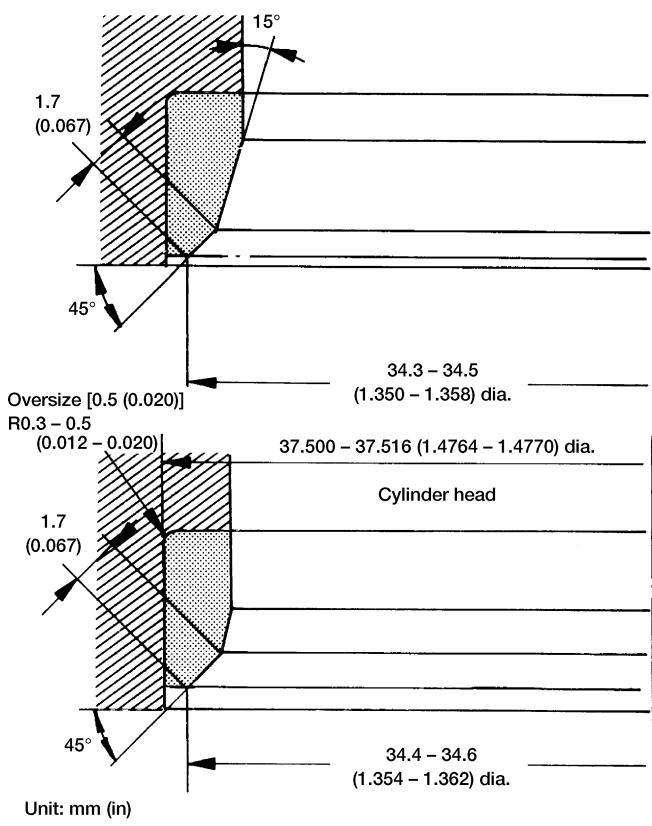
VG33E AND VG33ER

Valve Seat (Cont'd)

EXHAUST VALVE SEAT

NGEM0029S02

Standard



AEM455

GI

MA

EM

LC

EC

FE

CL

MT

AT

TF

PD

AX

SU

BR

ST

RS

BT

HA

SC

EL

IDX

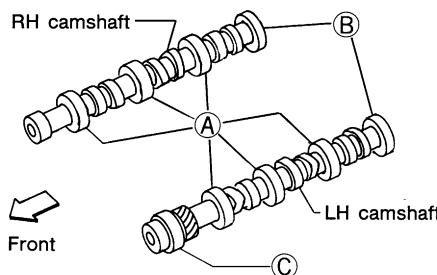
SERVICE DATA AND SPECIFICATIONS (SDS)

VG33E AND VG33ER

Camshaft and Camshaft Bearing

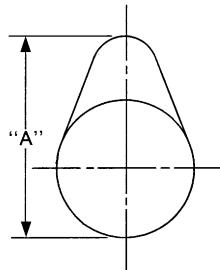
Camshaft and Camshaft Bearing

NGEM0030
Unit: mm (in)



SEM893BA

	Standard	Max. tolerance
Camshaft journal to bearing clearance	0.060 - 0.105 (0.0024 - 0.0041)	0.15 (0.0059)
Inner diameter of camshaft bearing	A: 47.000 - 47.025 (1.8504 - 1.8514) B: 42.500 - 42.525 (1.6732 - 1.6742) C: 48.000 - 48.025 (1.8898 - 1.8907)	—
Outer diameter of camshaft journal	A: 46.920 - 46.940 (1.8472 - 1.8480) B: 42.420 - 42.440 (1.6701 - 1.6709) C: 47.920 - 47.940 (1.8866 - 1.8874)	—
Camshaft runout [TIR*]	Less than 0.04 (0.0016)	0.1 (0.004)
Camshaft end play	0.03 - 0.06 (0.0012 - 0.0024)	—



EM671

Cam height "A"	Intake	38.943 - 39.133 (1.5332 - 1.5407)
	Exhaust	38.943 - 39.133 (1.5332 - 1.5407)
Wear limit of cam height		0.15 (0.0059)

*Total indicator reading

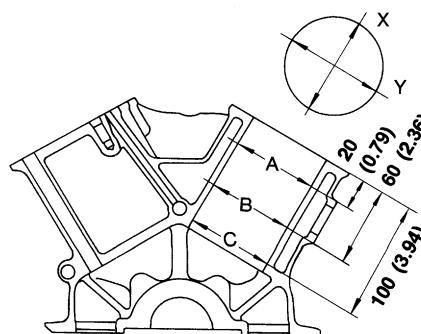
SERVICE DATA AND SPECIFICATIONS (SDS)

VG33E AND VG33ER

Cylinder Block

Cylinder Block

NGEM0031
Unit: mm (in)



SEM321A

Surface flatness		Standard	Less than 0.03 (0.0012)			
		Limit	0.10 (0.0039)			
Cylinder bore	Inner diameter	Standard (for No. 3 and 4 cylinders)	Grade No. 1	91.500 - 91.505 (3.6024 - 3.6026)		
			Grade No. 2	91.505 - 91.510 (3.6026 - 3.6027)		
			Grade No. 3	91.510 - 91.515 (3.6027 - 3.6029)		
			Grade No. 4	91.515 - 91.520 (3.6029 - 3.6031)		
			Grade No. 5	91.520 - 91.525 (3.6031 - 3.6033)		
			Grade No. 6	91.525 - 91.530 (3.6033 - 3.6035)		
		Standard (for No. 1, 2 and 6 cylinders)	Grade No. 1	91.500 - 91.510 (3.6024 - 3.6027)		
			Grade No. 2	91.510 - 91.520 (3.6027 - 3.6031)		
			Grade No. 3	91.520 - 91.530 (3.6031 - 3.6035)		
		Standard (for No. 5 cylinder)	Grade No. 1	91.515 - 91.520 (3.6029 - 3.6031)		
			Grade No. 2	91.520 - 91.525 (3.6031 - 3.6033)		
			Grade No. 3	91.525 - 91.530 (3.6033 - 3.6035)		
			Grade No. 4	91.530 - 91.535 (3.6035 - 3.6037)		
			Grade No. 5	91.535 - 91.540 (3.6037 - 3.6039)		
			Grade No. 6	91.540 - 91.545 (3.6039 - 3.6041)		
Wear limit			0.20 (0.0079)			
Out-of-round (X - Y)			Less than 0.015 (0.0006)			
Taper (A - B or A - C)			Less than 0.015 (0.0006)			
Main journal inner diameter		No. 1 main journal	Grade No.3	66.645 - 66.651 (2.6238 - 2.6240)		
			Grade No. 4	66.651 - 66.657 (2.6240 - 2.6243)		
			Grade No. 5	66.657 - 62.663 (2.6243 - 2.6245)		
			Grade No. 6	66.663 - 66.669 (2.6245 - 2.6248)		
		Except No. 1 main journal	Grade No. 0	66.645 - 66.654 (2.6238 - 2.6242)		
			Grade No. 1	66.654 - 66.663 (2.6242 - 2.6245)		
			Grade No. 2	66.663 - 66.672 (2.6245 - 2.6249)		
Difference in inner diameter between cylinders	Standard	Less than 0.05 (0.0020)				

SERVICE DATA AND SPECIFICATIONS (SDS)

VG33E AND VG33ER

Piston, Piston Ring and Piston Pin

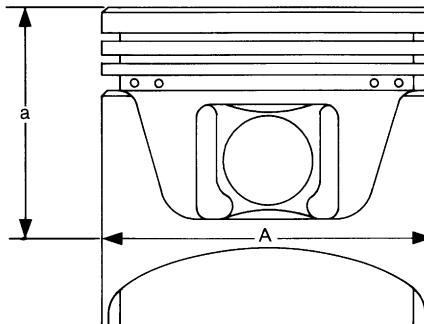
Piston, Piston Ring and Piston Pin

NGEM0032

AVAILABLE PISTON

NGEM0032S01

Unit: mm (in)



SEM882E

Piston skirt diameter "A"	Standard (for No. 3, 4 and 5 cylinders)	Grade No. 2-1	91.480 - 91.485 (3.6016 - 3.6018)
		Grade No. 3-2	91.485 - 91.490 (3.6018 - 3.6020)
		Grade No. 3-3	91.490 - 91.495 (3.6020 - 3.6022)
		Grade No. 4-4	91.495 - 91.500 (3.6022 - 3.6024)
		Grade No. 4-5	91.500 - 91.505 (3.6024 - 3.6026)
		Grade No. 5-6	91.505 - 91.510 (3.6026 - 3.6027)
	Standard (for No. 1, 2 and 6 cylinders)	Grade No. 1	91.465 - 91.475 (3.6010 - 3.6014)
		Grade No. 2	91.475 - 91.485 (3.6014 - 3.6018)
		Grade No. 3	91.485 - 91.495 (3.6018 - 3.6022)
	0.25 (0.0098) oversize (Service)		91.715 - 91.745 (3.6108 - 3.6120)
	0.50 (0.0197) oversize (Service)		91.965 - 91.995 (3.6207 - 3.6218)
"a" dimension			49.0 (1.929)
Piston pin hole diameter		Grade No. 0	20.969 - 20.975 (0.8255 - 0.8258)
		Grade No. 1	20.975 - 20.981 (0.8258 - 0.8260)
Piston clearance to cylinder block	Standard	For No. 3 and 4 cylinders	0.015 - 0.025 (0.0006 - 0.0010)
		For No. 1, 2 and 6 cylinders (No. 5 cylinder VG33ER only)	0.025 - 0.045 (0.0010 - 0.0018)
		For No. 5 cylinder (VG33E only)	0.030 - 0.040 (0.0012 - 0.0016)

PISTON RING

NGEM0032S02

Unit: mm (in)

		Standard	Limit
Side clearance	Top	0.040 - 0.080 (0.0016 - 0.0031)	0.11 (0.0043)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.10 (0.004)
	Oil	0.015 - 0.185 (0.0006 - 0.0073)	—
Ring gap	Top	0.21 - 0.31 (0.0083 - 0.0122)	0.43 (0.0169)
	2nd	0.50 - 0.60 (0.0197 - 0.0236)	0.69 (0.0272)
	Oil (rail ring)	0.20 - 0.60 (0.0079 - 0.0236)	0.84 (0.0331)

SERVICE DATA AND SPECIFICATIONS (SDS)

VG33E AND VG33ER

Piston, Piston Ring and Piston Pin (Cont'd)

PISTON PIN

NGEM0032S03
Unit: mm (in)

Piston pin outer diameter	20.971 - 20.983 (0.8256 - 0.8261)
Interference fit of piston pin to piston	0 to -0.004 (0 to -0.0002)
Piston pin to connecting rod bushing clearance	0.005 - 0.017 (0.0002 - 0.0007)

Values measured at ambient temperature of 20°C (68°F)

Connecting Rod

NGEM0033
Unit: mm (in)

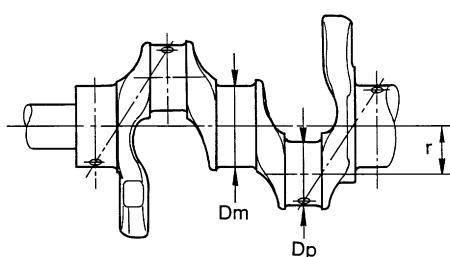
Center distance	154.1 - 154.2 (6.067 - 6.071)	
Bend, torsion [per 100 (3.94)]	Bend: 0.15 (0.0059) Torsion: 0.30 (0.0118)	
Piston pin bushing inner diameter*	20.982 - 20.994 (0.8261 - 0.8265)	
Connecting rod big end inner diameter	53.000 - 53.013 (2.0866 - 2.0871)	
Side clearance	Standard Limit	0.20 - 0.35 (0.0079 - 0.0138) 0.40 (0.0157)

*After installing in connecting rod

Crankshaft

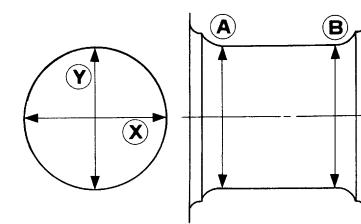
NGEM0034
Unit: mm (in)

Main journal dia. "Dm"	No. 1 main journal	Grade No. 3	62.696 - 62.975 (2.4683 - 2.4793)
		Grade No. 4	62.963 - 62.969 (2.4789 - 2.4791)
		Grade No. 5	62.957 - 62.963 (2.4786 - 2.4789)
		Grade No. 6	62.951 - 62.957 (2.4784 - 2.4786)
	Except No. 1 main journal	Grade No. 0	62.967 - 62.975 (2.4790 - 2.4793)
		Grade No. 1	62.959 - 62.967 (2.4787 - 2.4790)
		Grade No. 2	62.951 - 62.959 (2.4784 - 2.4787)
		Pin journal dia. "Dp"	49.955 - 49.974 (1.9667 - 1.9675)
Center distance "r"			41.5 (1.634)
Out-of-round (X - Y)	Standard		Less than 0.005 (0.0002)
Taper (A - B)	Standard		Less than 0.005 (0.0002)
Runout [TIR]	Standard		Less than 0.025 (0.0010)
	Limit		Less than 0.10 (0.0039)
Free end play	Standard		0.050 - 0.170 (0.0020 - 0.0067)
	Limit		0.30 (0.0118)



SEM645

Out-of-round
Taper
(X) - (Y)
(A) - (B)



EM715

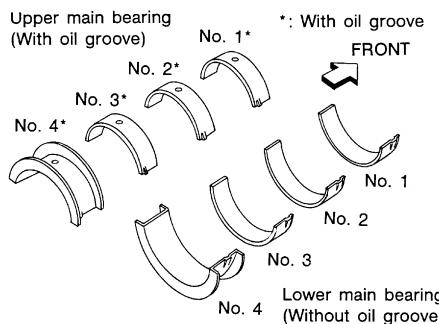
SERVICE DATA AND SPECIFICATIONS (SDS)

VG33E AND VG33ER

Available Main Bearing

Available Main Bearing

NGEM0084



SEM327A

NO. 1 MAIN BEARING

NGEM0084S01

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color(mark)
0	1.822 - 1.825 (0.0717 - 0.0719)	22.4 - 22.6 (0.882 - 0.890)	Black (A)
1	1.825 - 1.828 (0.0719 - 0.0720)		Brown (B)
2	1.828 - 1.831 (0.0720 - 0.0721)		Green (C)
3	1.831 - 1.834 (0.0721 - 0.0722)		Yellow (D)
4	1.834 - 1.837 (0.0722 - 0.0723)		Blue (E)
5	1.837 - 1.840 (0.0723 - 0.0724)		Pink (F)
6	1.840 - 1.843 (0.0724 - 0.0726)		Purple (G)

NO. 2 AND 3 MAIN BEARING

NGEM0084S02

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)	18.9 - 19.1 (0.744 - 0.752)	Black
1	1.821 - 1.825 (0.0717 - 0.0719)		Brown
2	1.825 - 1.829 (0.0719 - 0.0720)		Green
3	1.829 - 1.833 (0.0720 - 0.0722)		Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)		Blue

NO. 4 MAIN BEARING

NGEM0084S03

Grade number	Thickness "T" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)	Black
1	1.821 - 1.825 (0.0717 - 0.0719)	Brown
2	1.825 - 1.829 (0.0719 - 0.0720)	Green
3	1.829 - 1.833 (0.0720 - 0.0722)	Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)	Blue

UNDER SIZE

NGEM0084S04
Unit: mm (in)

		Thickness "T" mm (in)	Main journal diameter "Dm"
0.25 (0.0098)	No.1 main bearing	1.956 - 1.962 (0.0770 - 0.0772)	Grind so that bearing clearance is the specified value.
	No.2,3 and No.4 main bearing	1.948 - 1.956 (0.0767 - 0.0770)	

SERVICE DATA AND SPECIFICATIONS (SDS)

VG33E AND VG33ER

Available Connecting Rod Bearing

CONNECTING ROD BEARING UNDERSIZE

NGEM0036

Unit: mm (in)
GI

		Thickness	Crank pin journal diameter "Dp"
Standard		1.502 - 1.506 (0.0591 - 0.0593)	49.955 - 49.974 (1.9667 - 1.9675)
Undersize	0.08 (0.0031)	1.542 - 1.546 (0.0607 - 0.0609)	Grind so that bearing clearance is the specified value.
	0.12 (0.0047)	1.562 - 1.566 (0.0615 - 0.0617)	
	0.25 (0.0098)	1.627 - 1.631 (0.0641 - 0.0642)	

Miscellaneous Components

NGEM0037

Unit: mm (in)
EC

Drive plate runout [TIR]	Less than 0.15 (0.0059)
--------------------------	-------------------------

BEARING CLEARANCE

NGEM0037S01
Unit: mm (in)
FE

No. 1 Main bearing clearance	Standard	0.030 - 0.048 (0.0012 - 0.0019)
	Limit	0.060 (0.0024)
No. 2, 3, 4 Main bearing clearance	Standard	0.038 - 0.065 (0.0015 - 0.0026)
	Limit	0.080 (0.0031)
Connecting rod bearing clearance	Standard	0.024 - 0.064 (0.0009 - 0.0025)
	Limit	0.090 (0.0035)

NOTES