

ENGINE MECHANICAL

SECTION **EM**

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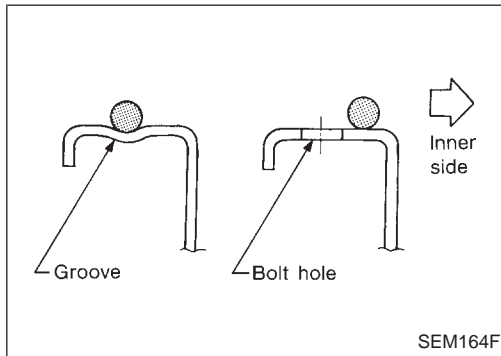
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PRECAUTIONS

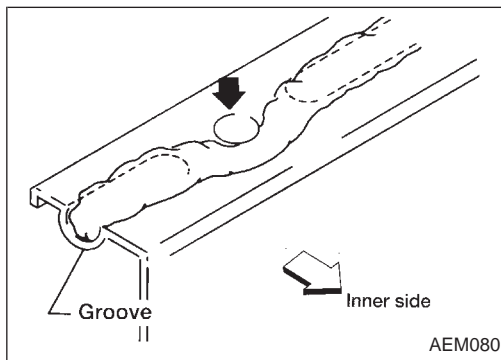
Parts Requiring Angular Tightening

- Use an angle wrench for the final tightening of the following engine parts:
 - (1) Cylinder head bolts
 - (2) Main bearing cap bolts
 - (3) 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.



Liquid Gasket Application Procedure

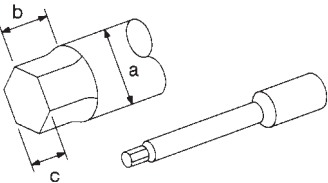
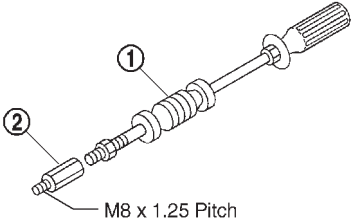
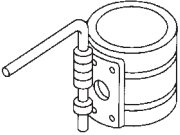
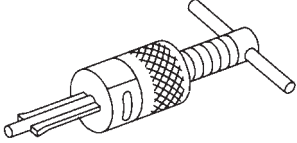
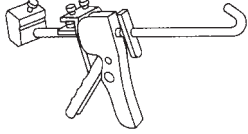
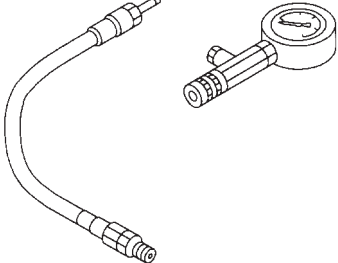
- a. Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also, completely clean any oil from these areas.
- b. Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent.)
 - Be sure liquid gasket diameter is as specified.
- c. Apply liquid gasket around the inner side of bolt holes (unless otherwise specified).
- d. Assembly should be done within 5 minutes after coating.
- e. Wait at least 30 minutes before refilling engine oil and engine coolant.



PREPARATION

Special Service Tools

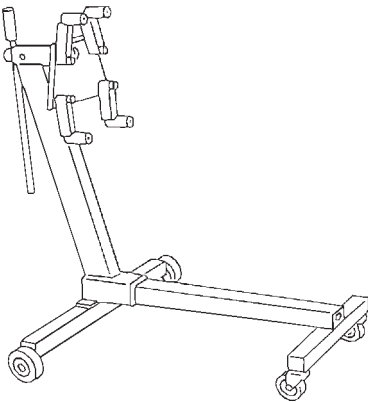
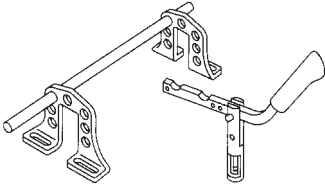
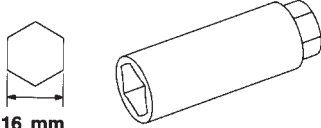
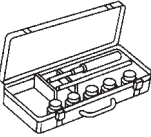
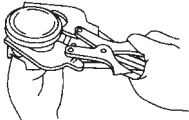
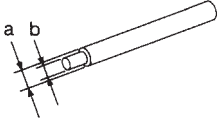
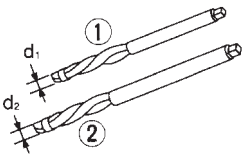
The actual shapes of Kent-Moore tools may differ from those of special service tools illustrated here.

Tool number (Kent-Moore No.) Tool name	Description	
ST10120000 (J24239-01) Cylinder head bolt wrench	 <p>NT583</p> <p>a: 13 mm (0.51 in) dia. b: 12 mm (0.47 in) c: 10 mm (0.39 in)</p>	GI MA EM
① (J6125-1B) Slide hammer ② (J38139-1) Slide hammer adapter	 <p>NT377</p> <p>M8 x 1.25 Pitch</p>	LC EC FE
EM03470000 (J8037) Piston ring compressor	 <p>NT044</p>	AT PD
ST16610001 (J23907) Pilot bushing puller	 <p>NT045</p>	FA RA
WS39930000 (—) Tube presser	 <p>NT052</p>	BR ST
EG15060000 (—) Compression gauge and adapter	 <p>NT238</p>	RS BT HA EL

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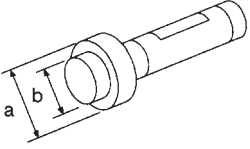
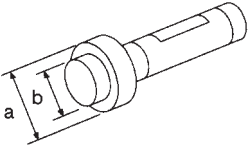
PREPARATION

Commercial Service Tools

Tool name	Description
Engine stand assembly	<p data-bbox="1032 247 1349 275">Disassembling and assembling</p>  <p data-bbox="475 646 537 667">NT388</p>
Valve spring compressor	<p data-bbox="1032 693 1466 747">Disassembling and assembling valve components</p>  <p data-bbox="475 873 537 894">NT103</p>
Spark plug wrench	<p data-bbox="1032 917 1390 945">Removing and installing spark plug</p>  <p data-bbox="565 1037 643 1083">16 mm (0.63 in)</p> <p data-bbox="475 1094 537 1115">NT047</p>
Valve seat cutter set	<p data-bbox="1032 1134 1357 1161">Finishing valve seat dimensions</p>  <p data-bbox="475 1283 537 1304">NT048</p>
Piston ring expander	<p data-bbox="1032 1323 1390 1350">Removing and installing piston ring</p>  <p data-bbox="475 1472 537 1493">NT030</p>
Valve guide drift	<p data-bbox="1032 1512 1401 1539">Removing and installing valve guide</p>  <p data-bbox="475 1667 537 1688">NT015</p> <p data-bbox="1032 1604 1417 1692"> Intake: a = 11.5 mm (0.453 in) dia. b = 6.5 mm (0.256 in) dia. Exhaust: a = 12.5 mm (0.492 in) dia. b = 7.5 mm (0.295 in) dia. </p>
Valve guide reamer	<p data-bbox="1032 1701 1455 1766">Reaming valve guide ① or hole for over-size valve guide ②</p>  <p data-bbox="475 1881 537 1902">NT016</p> <p data-bbox="1032 1818 1466 1915"> Intake: d₁ = 7.000 mm (0.2756 in) dia. Exhaust: d₁ = 8.000 mm (0.3150 in) dia. Intake: d₂ = 11.175 mm (0.4400 in) dia. Exhaust: d₂ = 12.175 mm (0.4793 in) dia. </p>

PREPARATION

Commercial Service Tools (Cont'd)

Tool name	Description
Front oil seal drift	<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: center;">  <p>NT049</p> </div> <div style="text-align: right;"> <p>Installing front oil seal</p> <p>a = 65 mm (2.56 in) dia. b = 45 mm (1.77 in) dia.</p> </div> </div>
Rear oil seal drift	<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: center;">  <p>NT049</p> </div> <div style="text-align: right;"> <p>Installing rear oil seal</p> <p>a = 100 mm (3.94 in) dia. b = 80 mm (3.15 in) dia.</p> </div> </div>

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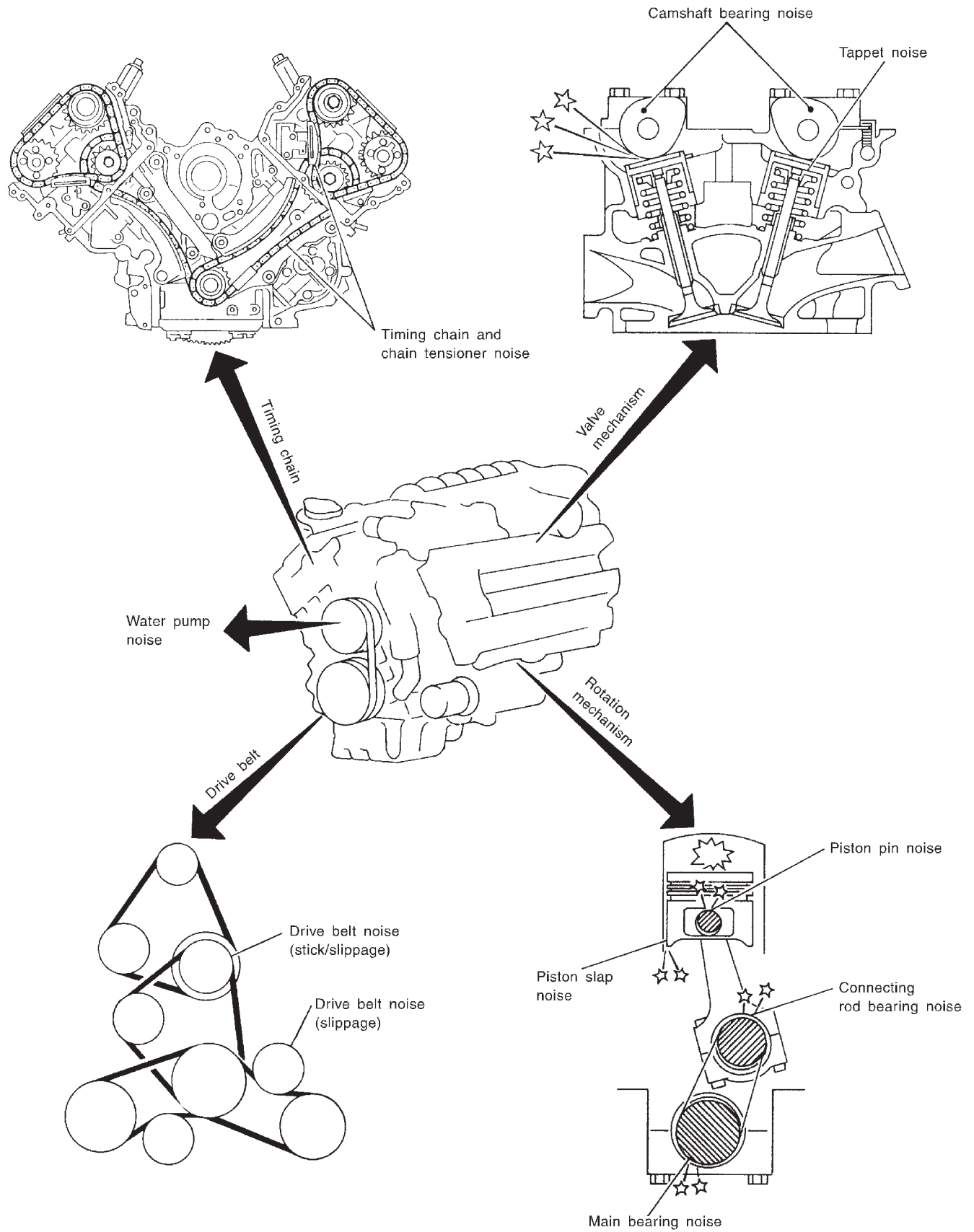
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NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING



NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

NVH Troubleshooting — Engine Noise

Use the table 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.

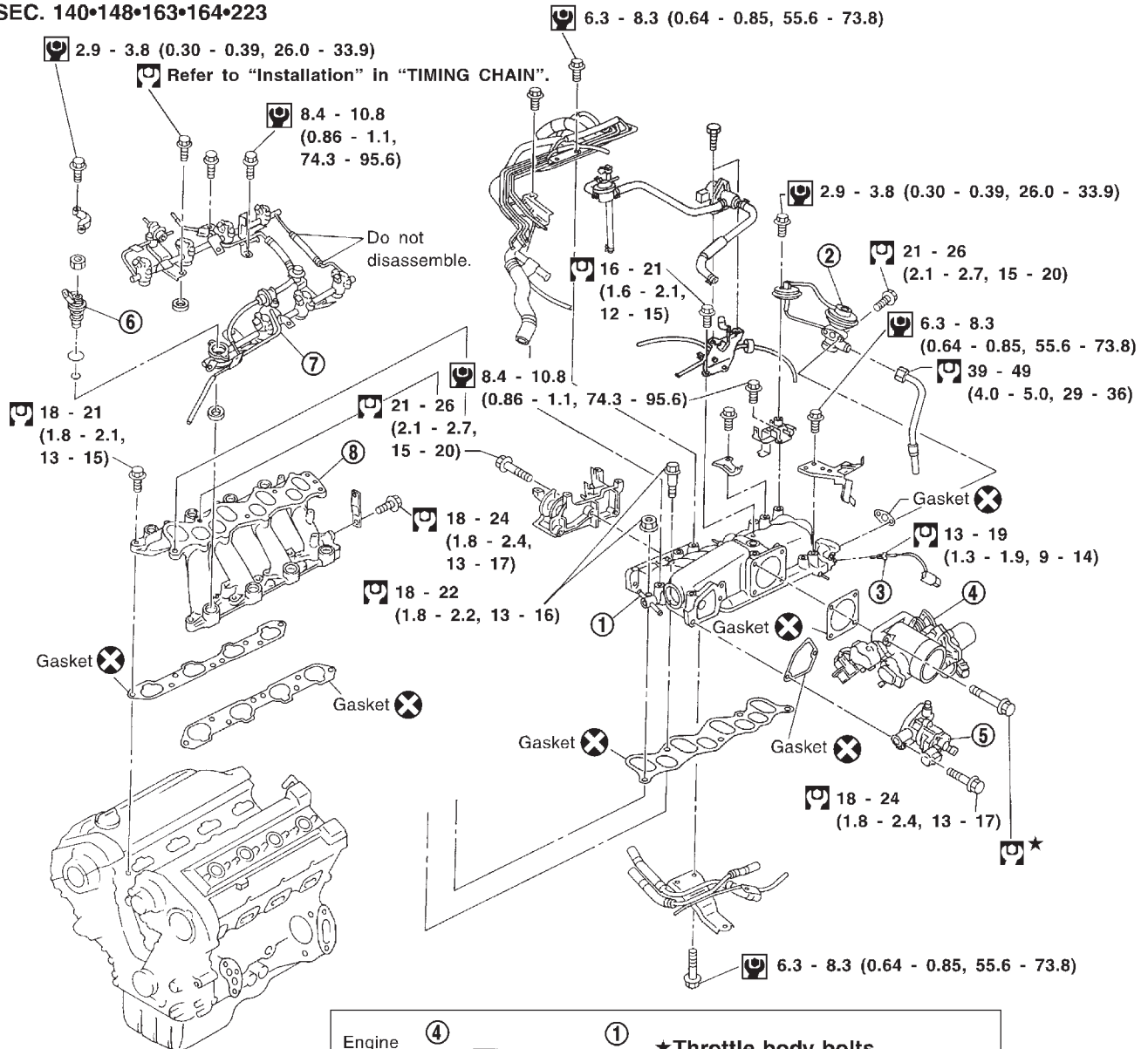
If necessary, repair or replace these parts.

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 lash adjuster	EM-39
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-35, 36
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance	EM-47, 52
	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-48, 47
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing clearance (Small end) Connecting rod bearing clearance (Big end)	EM-52, 51
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-49, 50
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-18
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Other drive belts (Sticking or slipping)	Drive belt deflection	MA section ("Checking Drive Belts", "ENGINE MAINTENANCE")
	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 section ("Water Pump Inspection", "ENGINE COOLING SYSTEM")

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

OUTER COMPONENT PARTS

SEC. 140•148•163•164•223



: N·m (kg-m, in-lb)

: N·m (kg-m, ft-lb)

★Throttle body bolts

Tightening procedure

- 1) Tighten all bolts to 9 to 11 N·m (0.9 to 1.1 kg-m, 6.5 to 8.0 ft-lb).
- 2) Tighten all bolts to 18 to 22 N·m (1.8 to 2.2 kg-m, 13 to 16 ft-lb).

SEM622FA

- ① Intake manifold collector
- ② EGR valve
- ③ EGR temperature sensor

- ④ Throttle body
- ⑤ IACV-AAC valve
- ⑥ Injector

- ⑦ Fuel tube assembly
- ⑧ Intake manifold

OUTER COMPONENT PARTS

SEC. 140•147•150•220•226•223

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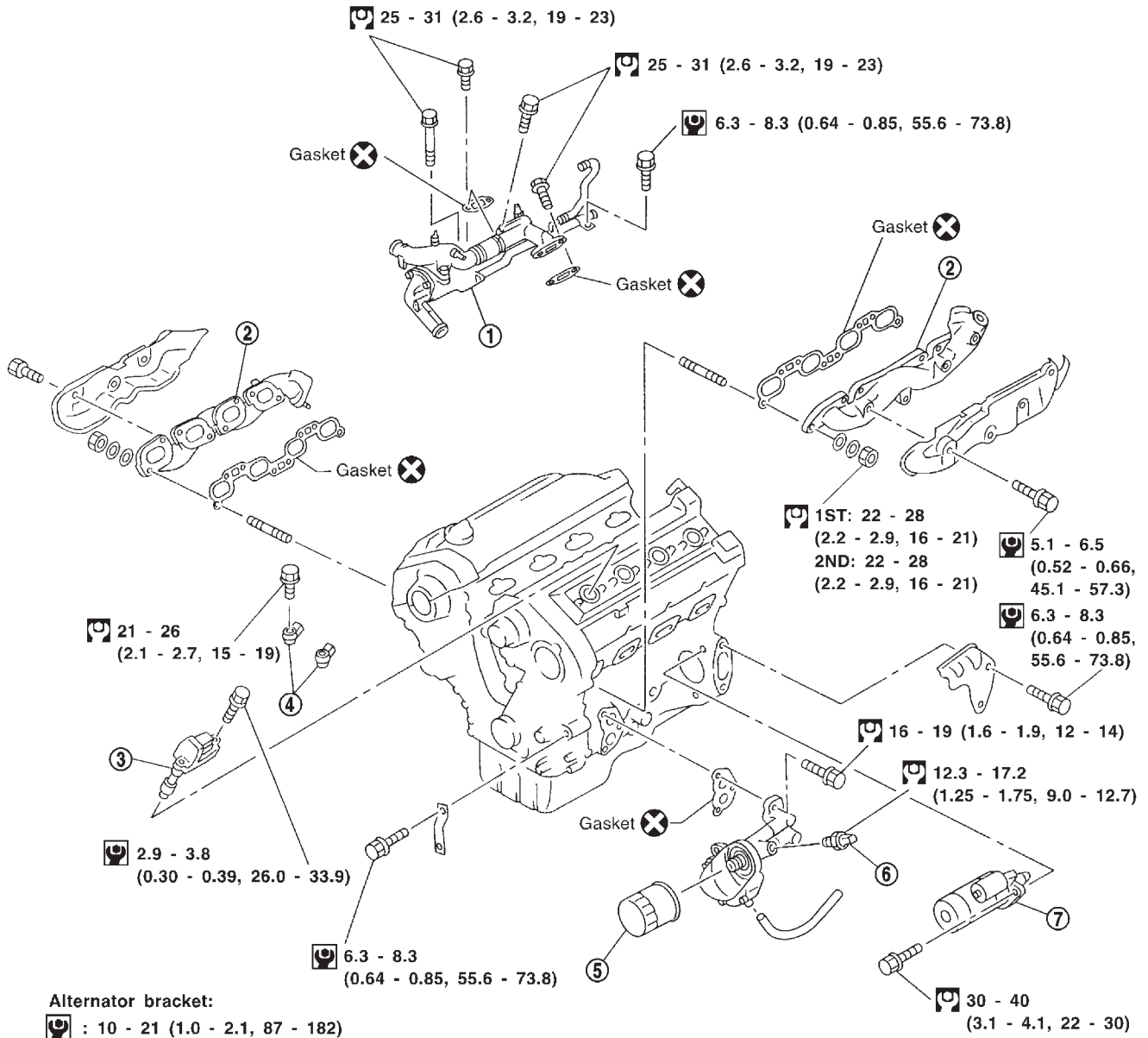
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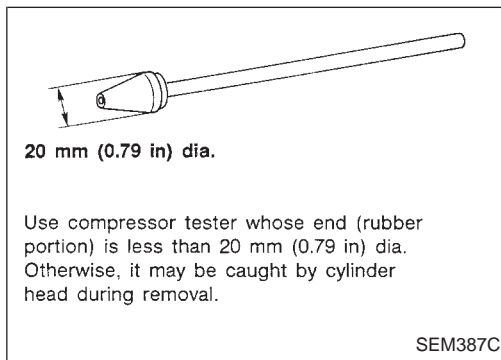
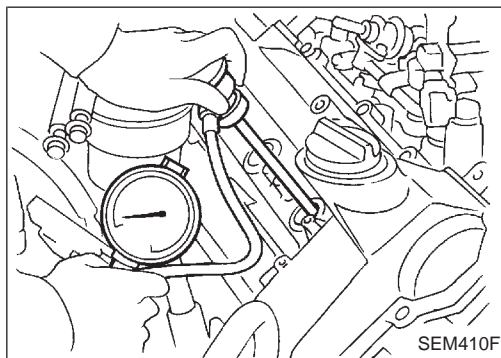
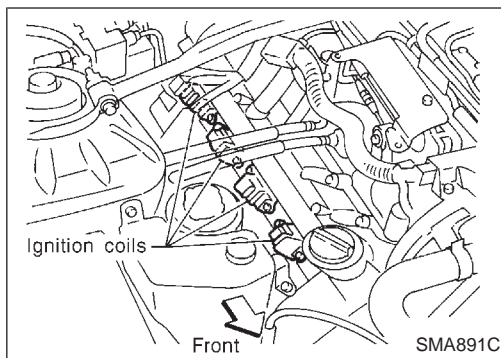
- ① Water inlet and outlet
- ② Exhaust manifold
- ③ Ignition coil with power transistor

- ④ Knock sensor
- ⑤ Oil filter

- ⑥ Oil pressure switch
- ⑦ Starter motor

SEM623FA

COMPRESSION PRESSURE



Measurement of Compression Pressure

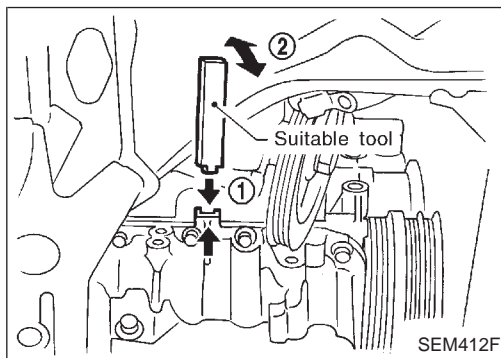
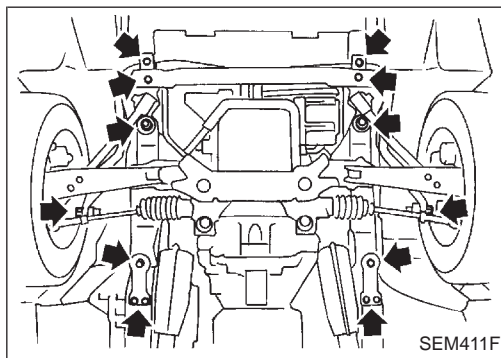
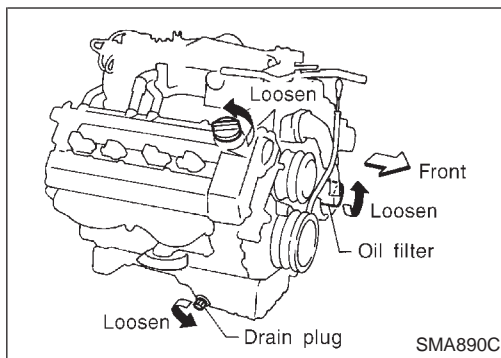
1. Warm up engine.
 2. Turn ignition switch off.
 3. Release fuel pressure.
Refer to "Releasing Fuel Pressure" in EC section.
 4. Disconnect ignition coil with power transistor harness connectors, then remove ignition coils.
 5. Remove all spark plugs.
 6. Attach a compression tester to No. 1 cylinder.
 7. Depress accelerator pedal fully to keep throttle valve wide open.
 8. Crank engine and record highest gauge indication.
 9. Repeat the measurement on each cylinder as shown above.
- **Always use a fully-charged battery to obtain specified engine speed.**

Unit: kPa (kg/cm², psi)/rpm

Standard	Minimum	Difference limit between cylinders
1,285 (13.1, 186)/300	991 (10.1, 144)/300	98 (1.0, 14)/300

10. 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 helps 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 SDS, EM-57.) If valve or valve seat is damaged excessively, replace them.**
 - **If compression stays low in two cylinders that are next to each other:**
 - a. The cylinder head gasket may be leaking, or
 - b. Both cylinders may have valve component damage. Inspect and repair as necessary.

OIL PAN



Removal

1. Raise vehicle and support it with safety stands.
2. Drain engine oil.
3. Install engine slingers to cylinder head. Refer to "ENGINE REMOVAL" (EM-43).
4. Set a suitable hoist on engine slinger and hold the engine.

5. Remove the following parts.
 - Fan coupling with fan
 - Power steering oil pump
 - Drive belts
 - Front stabilizer bar securing bolts and nuts from side member.
 - Both left and right side engine mounting bolts. Refer to "ENGINE REMOVAL" (EM-43).
6. Disconnect steering shaft lower joint.

7. Remove power steering tube bracket securing bolts at front suspension member.
8. Remove front suspension member securing nuts while supporting with a jack.
9. Lower front suspension member.
10. Remove air conditioner compressor and bracket.

11. Remove oil pan.
 - a. Remove oil pan and oil pan-to-transmission bolts.
 - b. Insert an appropriate size tool into the notch of oil pan as shown in the figure.
 - **Be careful not to damage aluminum mating surface.**
 - **Do not insert screwdriver, or oil pan flange will be deformed.**
 - c. Pry off oil pan by moving the tool up and down.
 - d. Remove oil pan.

12. Pull out oil pan from the front while lowering the front suspension member.

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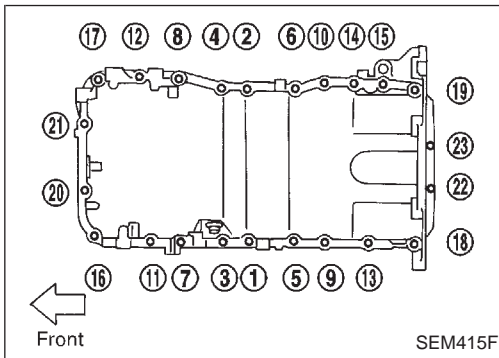
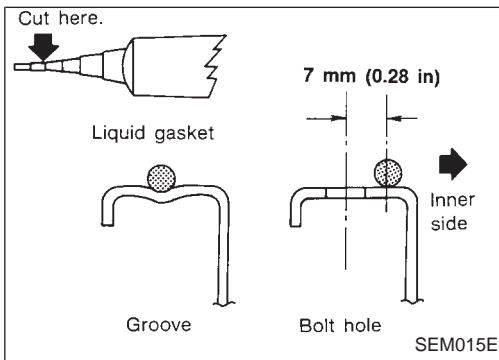
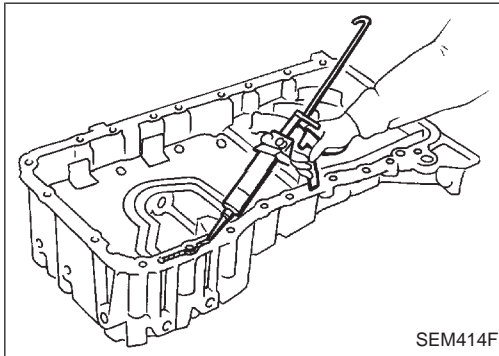
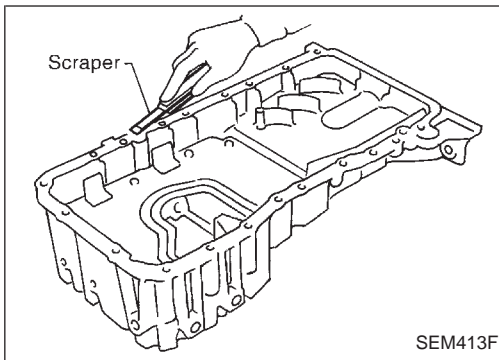
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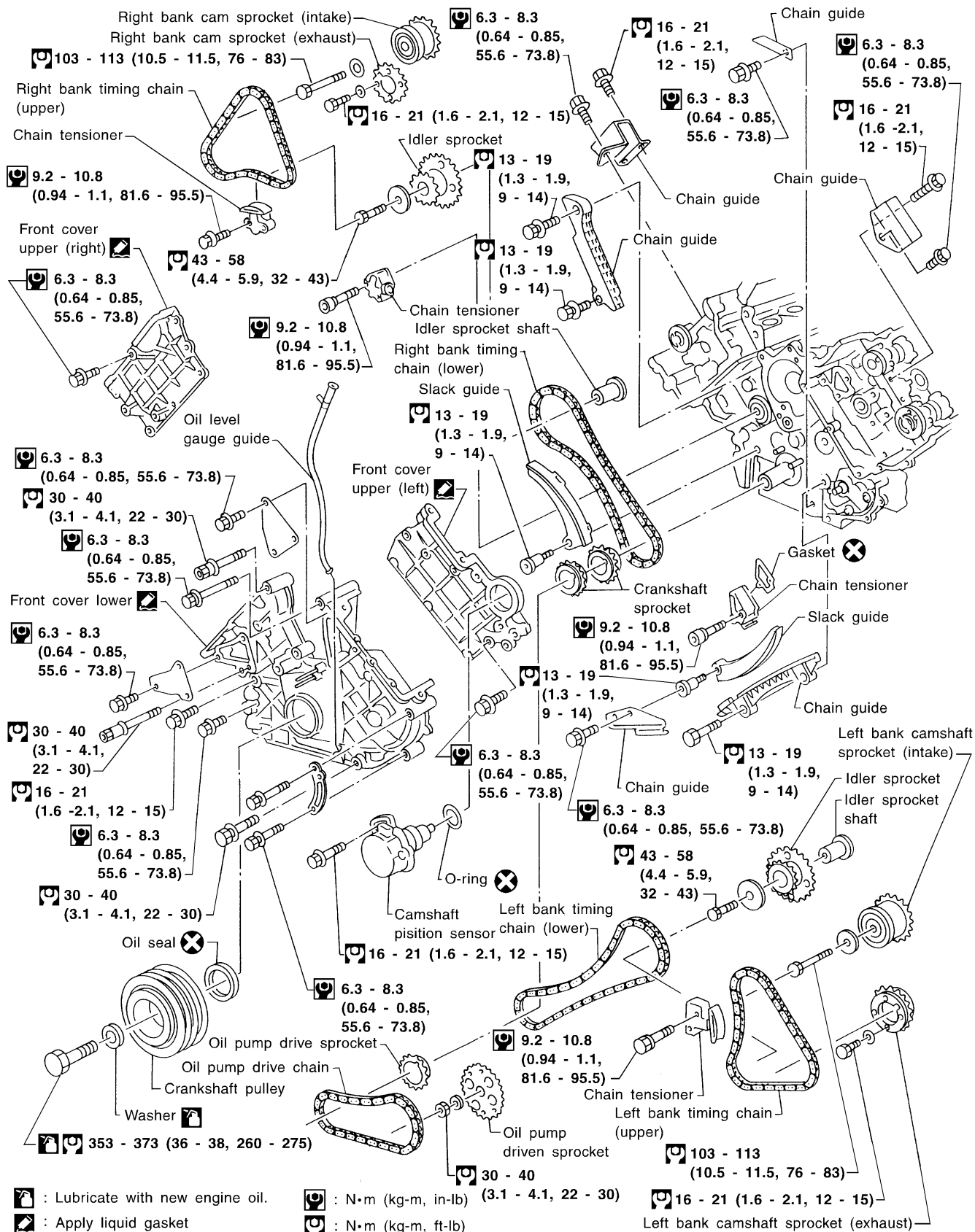
OIL PAN



Installation

1. Use a scraper to remove all traces of liquid gasket from mating surfaces.
 - Also remove traces of liquid gasket from mating surface of cylinder block.
 - **Remove old liquid gasket from the bolt hole and thread.**
2. Apply a continuous bead of liquid gasket to mating surface of oil pan.
 - **Use Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent.**
3. Apply liquid gasket to inner sealing surface as shown in the figure.
 - **Be sure liquid gasket diameter is 2.5 to 3.5 mm (0.098 to 0.138 in).**
 - **Attaching should be done within 5 minutes after coating.**
4. Install oil pan.
 - **Wait at least 30 minutes before refilling engine oil.**
 - **Tighten bolts in numerical order as shown in the figure.**
 - a. Tighten bolts (① - ⑳) to 16 to 19 N·m (1.6 to 1.9 kg-m, 12 to 14 ft-lb).
 - b. Tighten bolts (㉑ - ㉓) to 6.4 to 7.4 N·m (0.65 to 0.75 kg-m, 56.4 to 65.1 in-lb).

TIMING CHAIN



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: Lubricate with new engine oil.
 : Apply liquid gasket (Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent).

: N·m (kg-m, in-lb)
 : N·m (kg-m, ft-lb)

16 - 21 (1.6 - 2.1, 12 - 15)

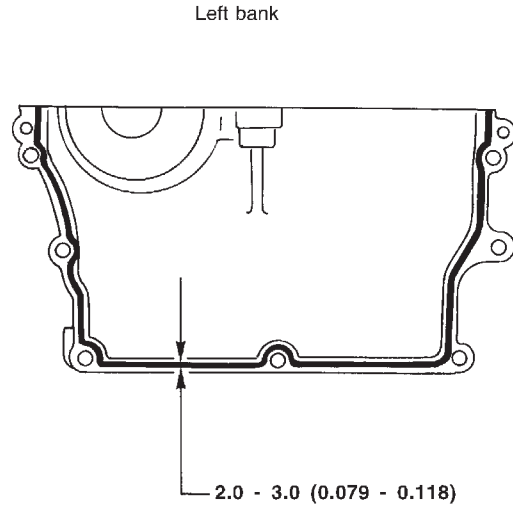
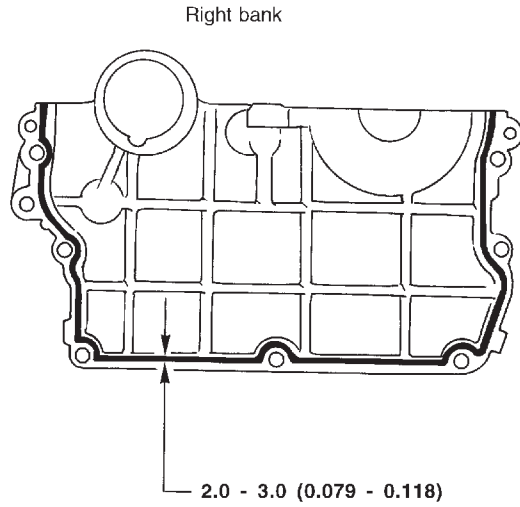
TIMING CHAIN

POSITION FOR APPLYING LIQUID GASKET

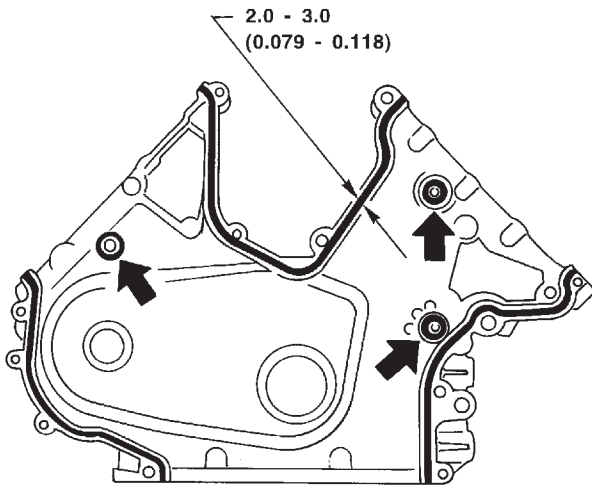
Refer to "Installation" in "OIL PAN" for installing oil pan (EM-12).

- Before installation, wipe off the protruding sealant.

Front cover upper

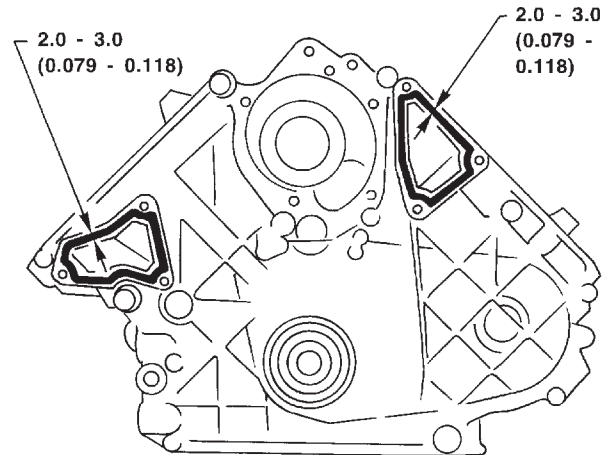


Front cover



Unit: mm (in)

Tensioner cover



SEM417F

TIMING CHAIN

CAUTION:

- After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.
- When installing camshafts, chain tensioners, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.
- Apply new engine oil to bolt threads and seat surfaces when installing cylinder head, camshaft sprockets, crankshaft pulley, and camshaft brackets.
- Before disconnecting fuel hose, release fuel pressure. Refer to EC section (“Fuel Pressure Release”, “BASIC SERVICE PROCEDURE”).
- Do not spill engine coolant on drive belts.

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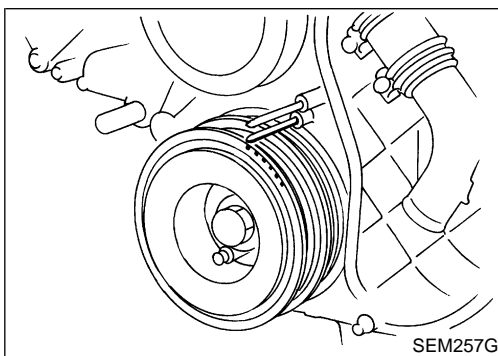
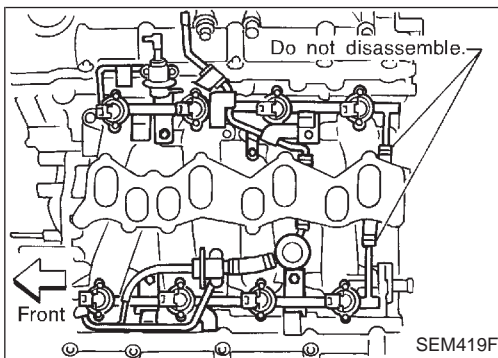
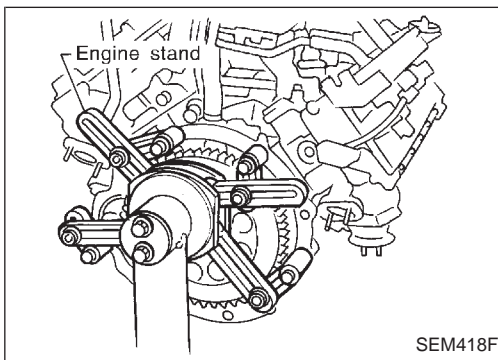
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Removal

1. Remove engine assembly from vehicle. Refer to “ENGINE REMOVAL” (EM-43).
2. Remove the following parts.
 - Engine mounts
 - Alternator
 - Air conditioner compressor
 - Exhaust manifold
3. Place engine assembly on stand.
4. Remove intake manifold collector.
5. Disconnect injector harness connector and remove fuel tube assembly with injector.
 - **Do not disassemble fuel hose.**
6. Remove intake manifold.
7. Remove rocker cover. Refer to “CYLINDER HEAD” (EM-30).
8. Set No. 1 piston at TDC on its compression stroke. Align the timing mark on crankshaft pulley with timing indicator on front cover.

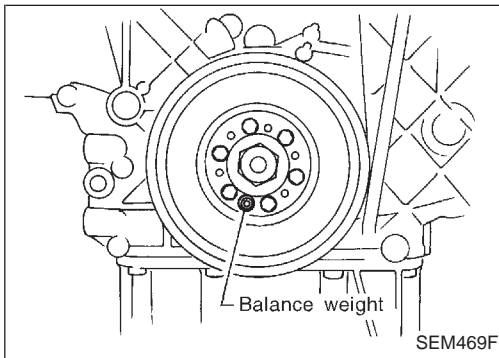
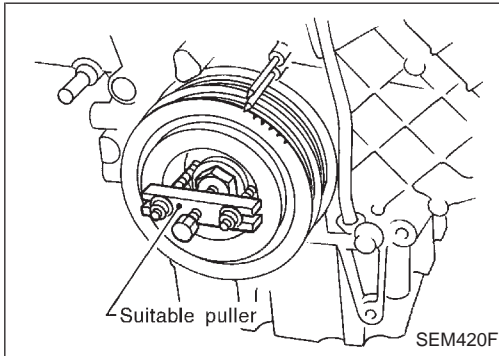
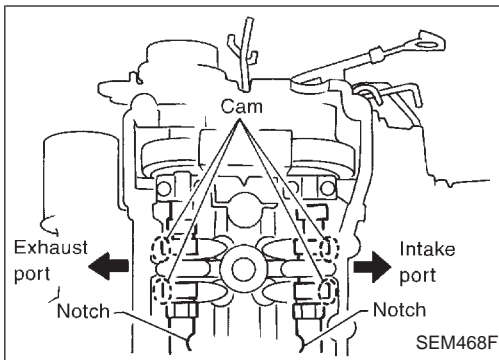
TIMING CHAIN

Removal (Cont'd)

Make sure the intake camshaft lobe for the No. 1 cylinder faces the intake port and the exhaust lobe faces the exhaust port.

Reference:

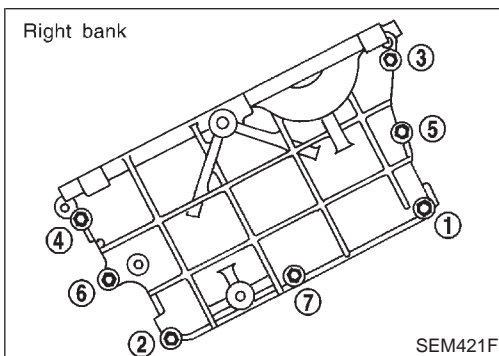
It is possible to confirm camshaft positions by checking notch positions on the camshaft when No. 1 piston is at TDC of the compression stroke. This is the position where cylinder head bolts can be removed.



9. Remove crankshaft pulley.

- Do not remove the crankshaft pulley balance weight.
- Do not disassemble the crankshaft pulley.

10. Remove camshaft position sensor assembly.
Do not disassemble camshaft position sensor unit.

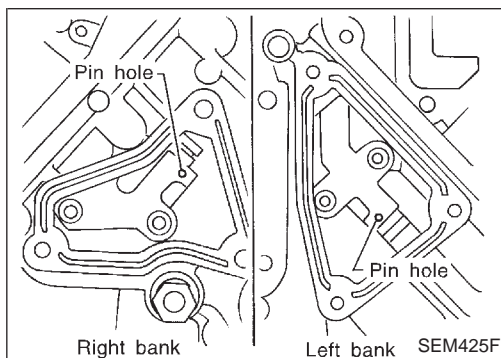
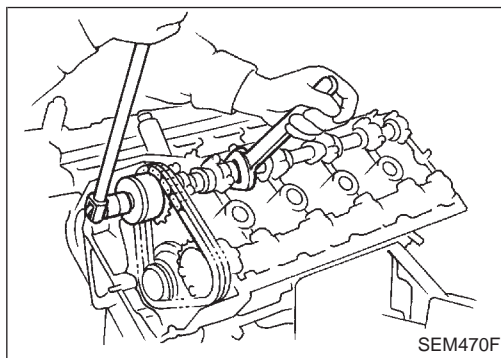
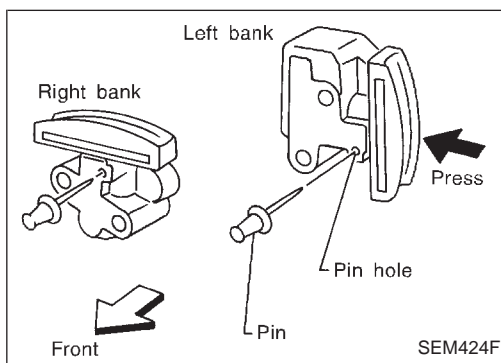
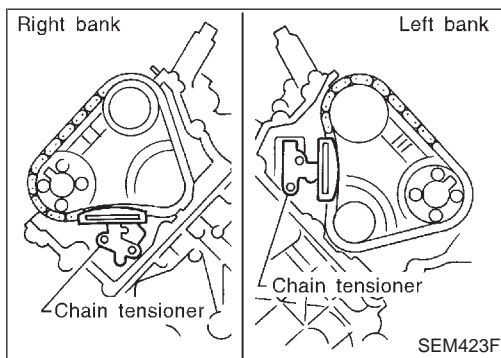
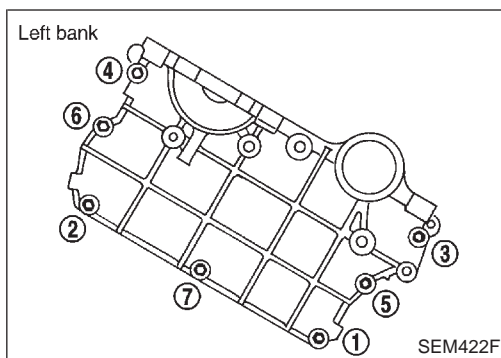


11. Remove front cover upper.

- Loosen bolts and nuts in the numerical order shown in the figure and then remove them.

TIMING CHAIN

Removal (Cont'd)



12. Remove upper chain tensioner.

- Press tensioner in and insert 1 mm (0.04 in) diameter pin in pin hole. After securing tensioner, remove bolts.

13. Remove camshaft sprocket bolt while holding the hexagonal part of camshaft with wrench. Remove camshaft sprockets.

- **Apply paint to upper timing chain and camshaft sprockets for alignment during installation.**

14. Remove right and left tensioner covers from front covers.

- Press tensioner in and insert 1 mm (0.04 in) diameter pin in pin hole.

15. Remove idler sprocket bolts.

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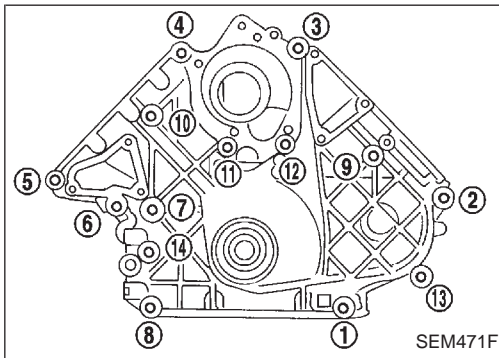
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TIMING CHAIN

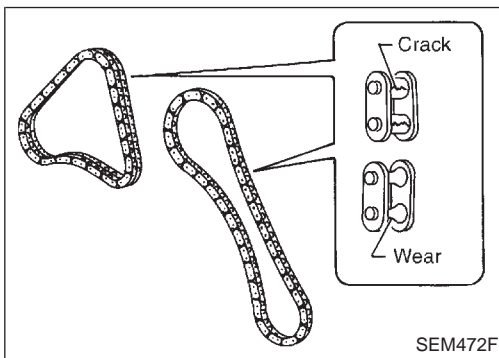
Removal (Cont'd)

16. Remove chain guide between No. 1 camshaft bracket.
17. Remove cylinder head assembly. Refer to "CYLINDER HEAD" (EM-32).
18. Remove upper timing chain.
19. Remove idler sprocket.
- **Apply paint to lower timing chain and idler sprocket for alignment during installation.**
20. Remove oil pan. Refer to "OIL PAN" (EM-11).



21. Remove front cover.
Loosen bolts in the numerical order shown in the figure and then remove them.

22. Remove lower chain tensioner.
23. Remove oil pump drive chain.
24. Remove slack guide and chain guide.
25. Remove lower timing chain together with crankshaft sprocket.



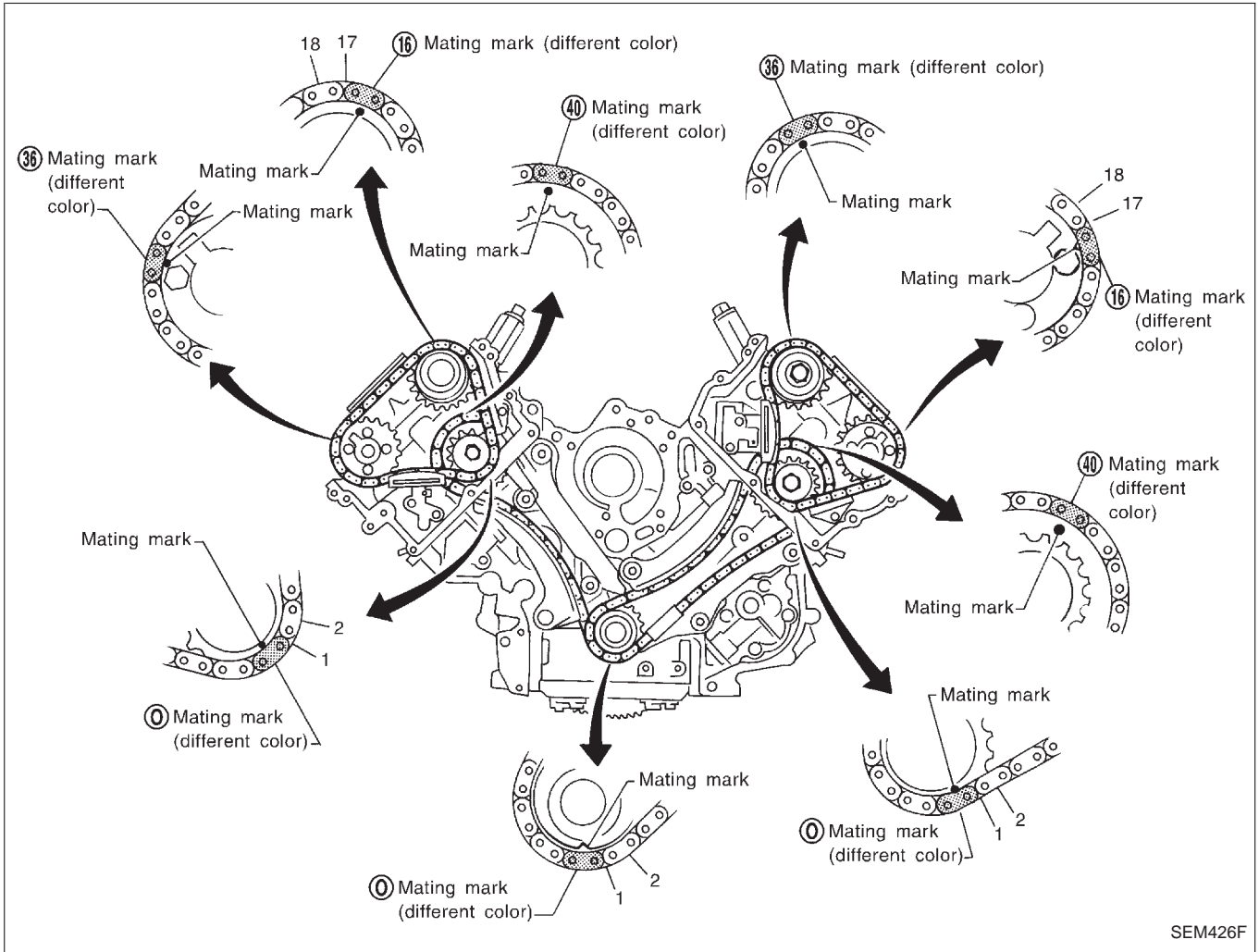
Inspection

TIMING CHAIN

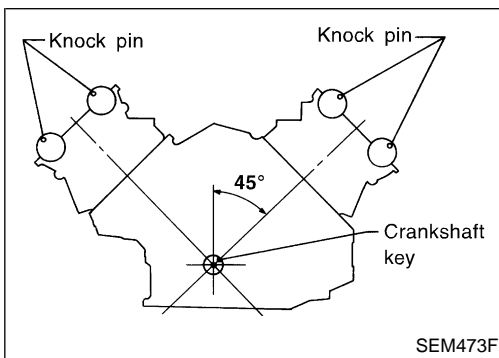
Check for cracks and excessive wear at roller links. Replace if necessary.

TIMING CHAIN

Installation



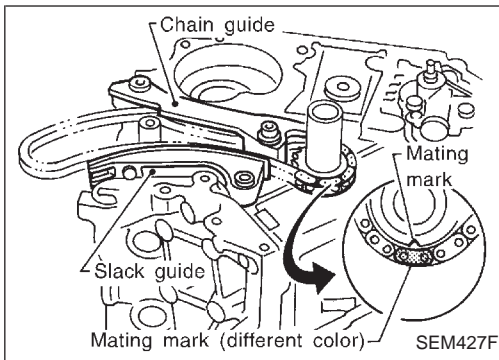
- Refer to the figure and align the mating marks on each sprocket and timing chain.



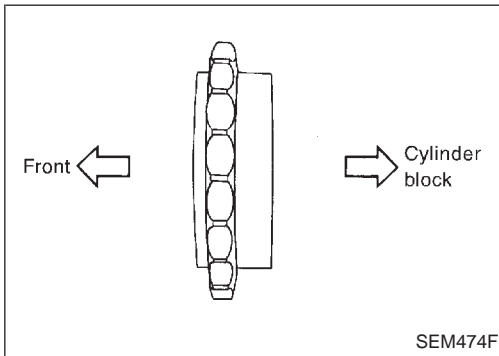
1. Check that crankshaft key faces upward at 45° angle in direction of left bank axis when viewed from the front.

TIMING CHAIN

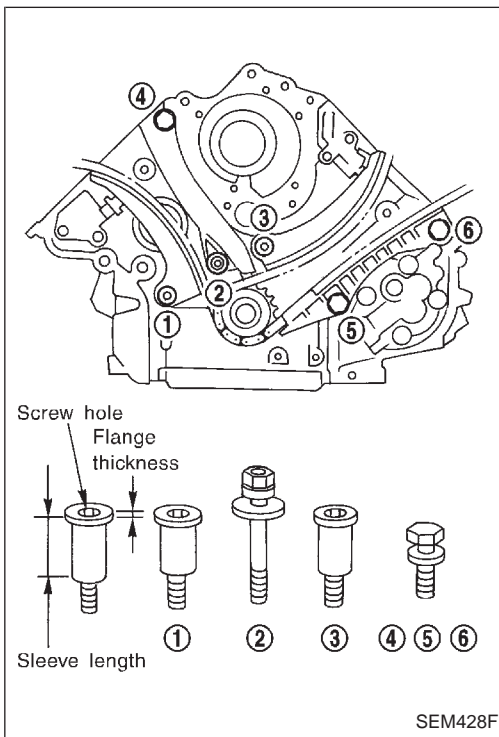
Installation (Cont'd)



2. Install lower timing chain on right bank. Align the mating marks on timing chain and crankshaft sprocket and install on crankshaft.



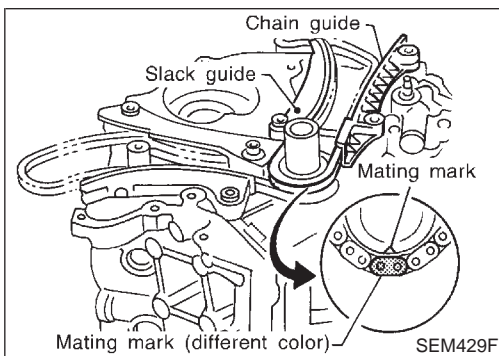
3. Install crankshaft sprocket so thick boss faces cylinder block.



4. Install slack guide and chain guide. Refer to figure and check that bolt assembly is correctly positioned.

Item	Position	①	②	③	④, ⑤, ⑥
Flange thickness	mm (in)	2.5 (0.098)	—	2.5 (0.098)	—
Sleeve length	mm (in)	23.5 (0.925)	—	23.5 (0.925)	—
Hexagonal hole screw hole presence		No	—	Yes	—

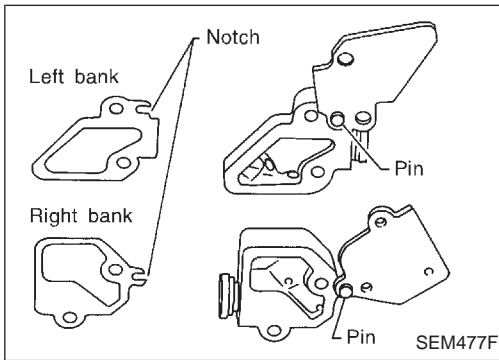
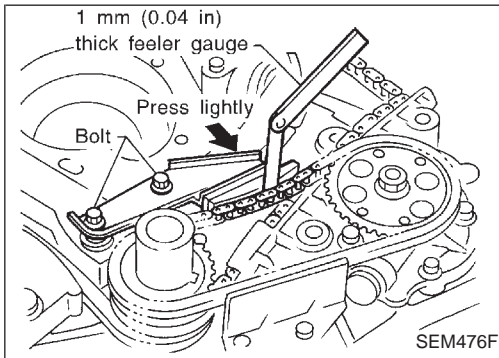
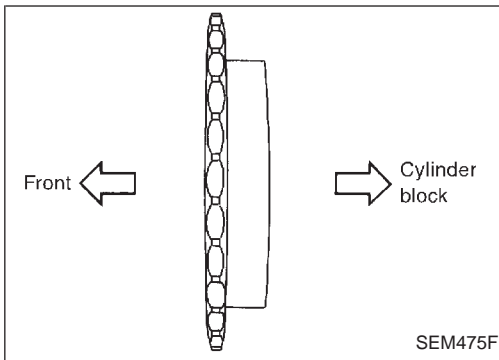
: 13 - 19 N·m (1.3 - 1.9 kg·m, 9 - 14 ft·lb)



5. Install lower timing chain on left bank. Align the mating marks on timing chain and crankshaft sprocket and install on crankshaft. Install crankshaft with boss side facing engine. (Install in same manner as right bank.)
6. Install left bank slack guide and chain guide. Refer to figure and make sure bolts are installed correctly.

TIMING CHAIN

Installation (Cont'd)



7. Install oil pump drive chain.
 - Install oil pump drive sprocket on crankshaft side with boss side facing cylinder block.


8. Install the upper and lower oil pump drive chain guides. Install the upper guide as follows.
 - a. Install the lower side.
 - b. Loosely tighten bolts on upper side.
 - c. Insert 1 mm (0.04 in) feeler gauge between guide and chain. Press the guide lightly on the chain side with the same force as the guide weight and tighten installation bolts.

 : 6.3 - 8.3 N·m (0.64 - 0.85 kg-m, 55.6 - 73.8 in-lb)

9. Install chain tensioner.
 - Always replace gasket with new part.
 - Install gasket by pressing the notch on pin connecting chain tensioner to plate.

Be careful not to bend gasket during installation.

- Install with pins inserted. Tighten bolts to specified tightening torque.

 : 9.2 - 10.8 N·m (0.94 - 1.1 kg-m, 81.6 - 95.5 in-lb)

- Lubricate timing chain and sliding parts with engine oil.

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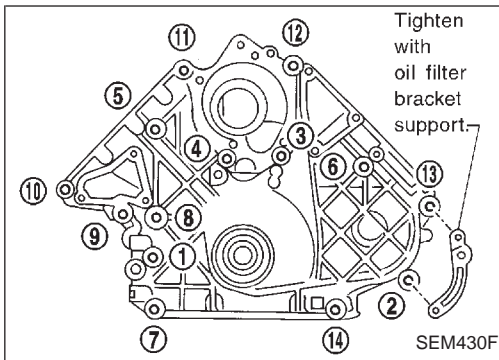
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TIMING CHAIN

Installation (Cont'd)



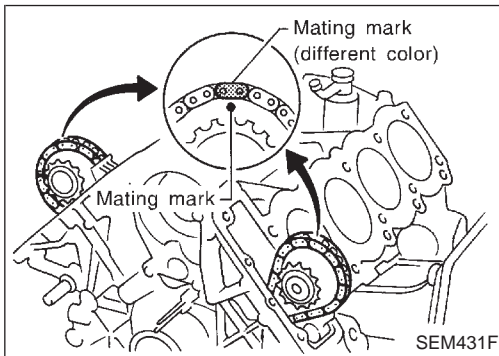
10. Install front cover.

- Apply liquid gasket to front cover. Refer to "POSITION FOR APPLYING LIQUID GASKET" (EM-14).
- Tighten bolts in the numbered order shown in the figure.
- The bolt dimensions and tightening torque vary depending on the position. Refer to the following table for the correct procedure.

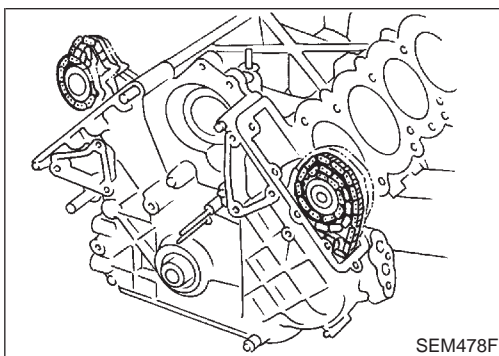
Position	Bolt dimensions	Tightening torque
①, ③, ⑤, ⑦	M6 x 45	6.3 - 8.3 N·m (0.64 - 0.85 kg·m, 55.6 - 73.8 in·lb)
②	M6 x 47	
⑥, ⑩	M6 x 65	
⑬	M6 x 67	
⑫	M6 x 84	16 - 21 N·m (1.6 - 2.1 kg·m, 12 - 15 ft·lb)
④, ⑧	M8 x 50	
⑨	M10 x 52	30 - 40 N·m (3.1 - 4.1 kg·m, 22 - 30 ft·lb)
⑭	M10 x 60	
⑪	M10 x 62	

Before installing front cover, make sure crankshaft sprocket and timing chain mating marks have not become misaligned.

11. Coat idler shaft with engine oil and install on idler sprocket.



12. Align the mating marks on the lower timing chains with idler sprocket mating marks and install.



13. Set upper timing chains on idler sprockets and rotate them.

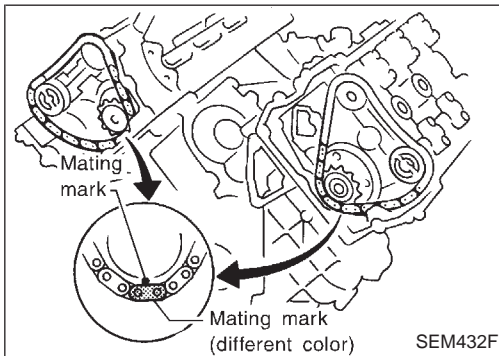
Note:

It is not necessary to align the positions of the upper chain and idler sprocket at this time because the mating mark can be aligned after the cylinder head is installed.

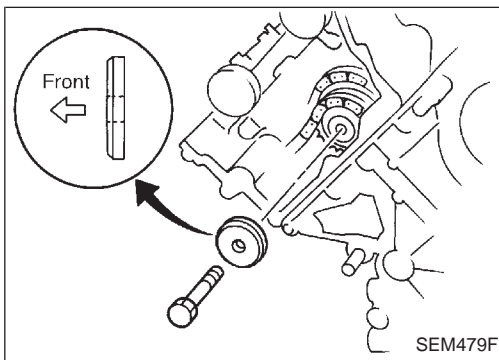
TIMING CHAIN

Installation (Cont'd)

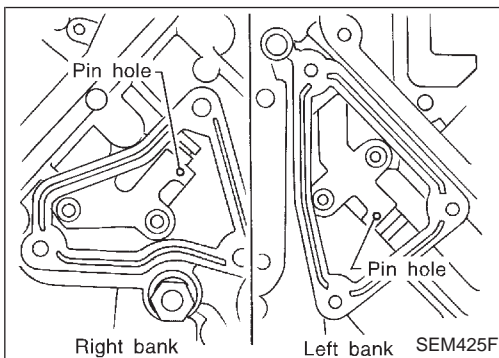
14. Install cylinder head gasket and cylinder head assembly. Refer to "CYLINDER HEAD" (EM-40).



15. Align mating marks on idler sprocket and upper timing chain. Install on camshaft without changing positioning.



16. Install idler shaft bolts.
 - Torque: **43 - 58 N·m (4.4 - 5.9 kg-m, 32 - 43 ft-lb)**
 - Install washer so chamfered side faces front of engine.



17. Remove lower chain tensioner pin from tensioner cover holes on front cover.
18. Install tensioner cover.
 - Apply liquid gasket to front cover. Refer to "POSITION FOR APPLYING LIQUID GASKET" (EM-14).

19. Install chain guide between No. 1 camshaft bracket.

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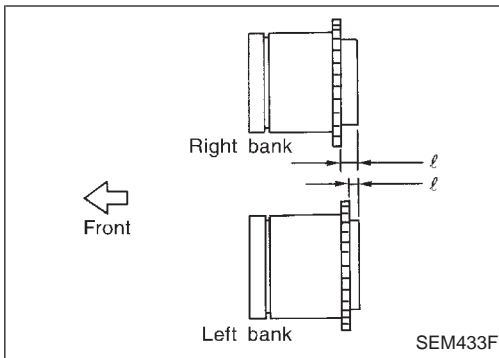
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TIMING CHAIN

Installation (Cont'd)



20. Install camshaft sprockets.

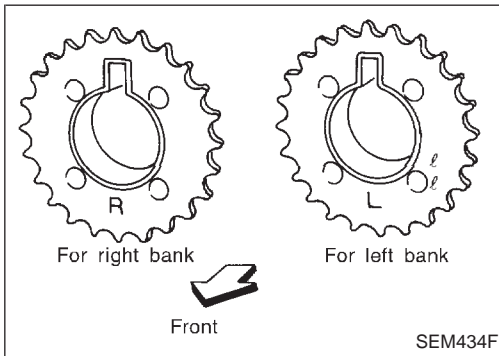
a. Identify the camshaft sprocket type.

The intake side camshaft sprockets can be identified by the difference in the “*l*” dimension shown in the figure.

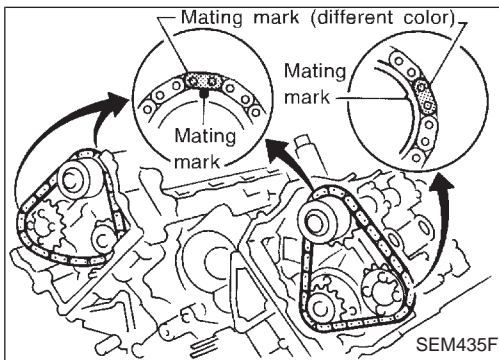
“*l*” dimension:

Right bank 15.2 mm (0.598 in)

Left bank 10.2 mm (0.402 in)



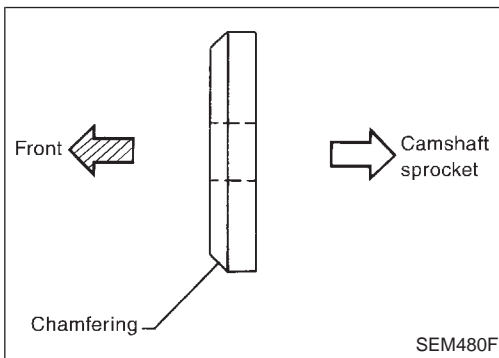
- The same type of cam sprockets are used for both left and right banks. Only the positioning direction changes. When installing, position camshaft sprockets on both right and left banks facing the side with “R” / “L” punchmarks toward front of engine, respectively.



b. Align the upper timing chain mating marks with sprocket mating marks (The notch is only used as a mating mark for the left bank exhaust side. Punchmarks are used in the other positions.) and install on camshaft.

If the sprocket does not fit on camshaft dowel pin, turn the hexagonal part of the camshaft with a wrench to align.

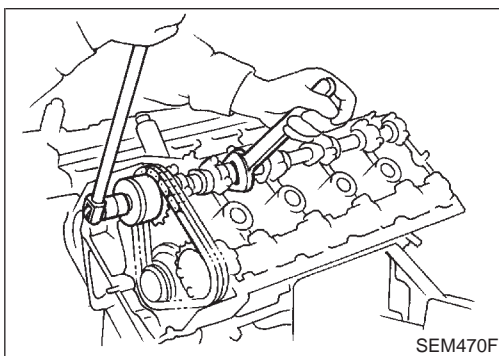
- **Make sure the timing chain and idler sprocket mating marks do not become misaligned during the installation operation.**



c. Install camshaft sprocket bolts.

Position the washers for the intake and exhaust so chamfered side forward.

Lubricate the thread of exhaust bolt and seating surface with engine oil.



d. Tighten camshaft sprocket bolts.

Tighten sprocket bolts to specified torque while holding the hexagonal part of camshaft.

Intake:

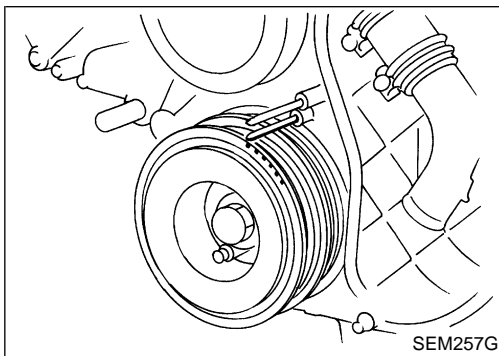
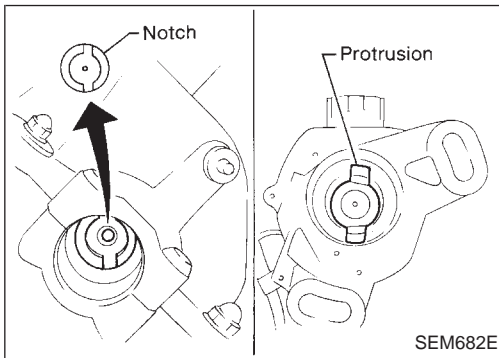
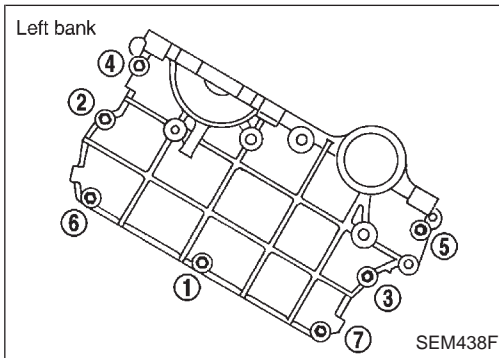
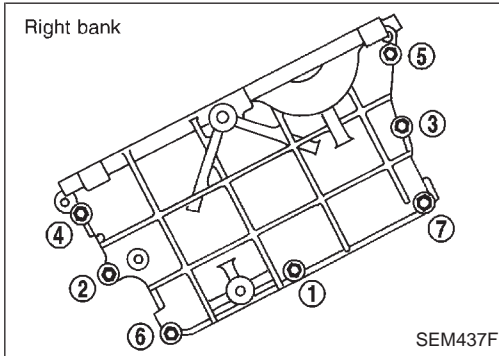
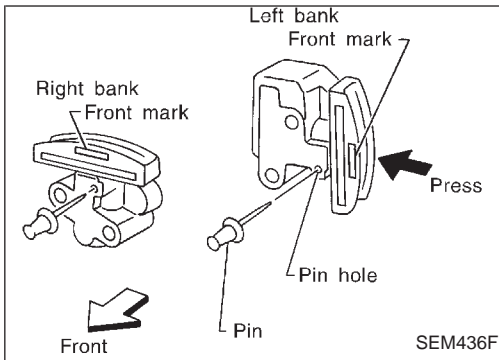
: 103 - 113 N·m (10.5 - 11.5 kg-m, 76 - 83 ft-lb)

Exhaust:

: 16 - 21 N·m (1.6 - 2.1 kg-m, 12 - 15 ft-lb)

TIMING CHAIN

Installation (Cont'd)



21. Install chain tensioner.

- Press chain tensioner in and insert 1 mm (0.04 in) diameter pin in pin hole to secure tensioner and then install tensioner. Reference: Reuse the accessory pin when replacing the chain tensioner with a new part.

Tighten bolts to specified torque.

: 9.2 - 10.8 N·m (0.94 - 1.1 kg-m, 81.6 - 95.5 in-lb)

Remove pin after installation is completed.

- **Install chain tensioner guide in the direction shown in the figure.**

22. Lubricate timing chain and chain sliding parts with new engine oil.

23. Install front cover upper.

- Apply liquid gasket to front cover upper. Refer to "POSITION FOR APPLYING LIQUID GASKET" (EM-14).

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

: 6.3 - 8.3 N·m (0.64 - 0.85 kg-m, 55.6 - 73.8 in-lb)

Before installing cover, check that timing chain and sprocket mating marks are aligned correctly.

- Install chain guide bolt on front cover upper.

24. Install camshaft position sensor.

Note:

Notch on exhaust camshaft on left bank is off-centered so that camshaft position sensor can be installed properly.

25. Install crankshaft pulley.

26. Set No. 1 piston at TDC on its compression stroke.

Align the timing mark on crankshaft pulley with timing indicator on front cover.

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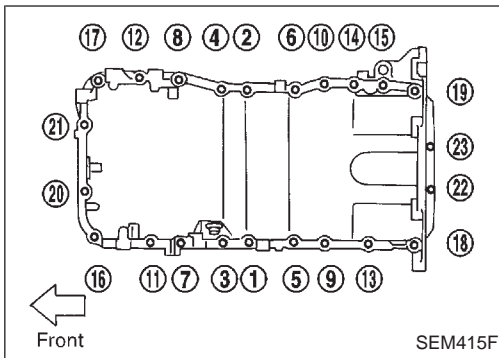
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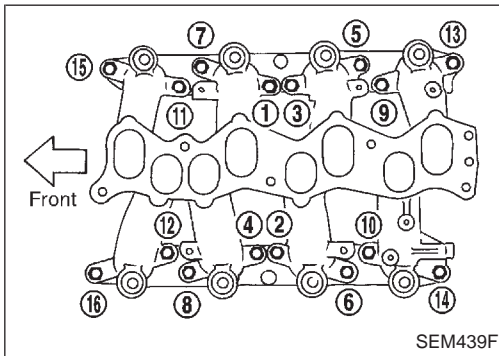
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TIMING CHAIN

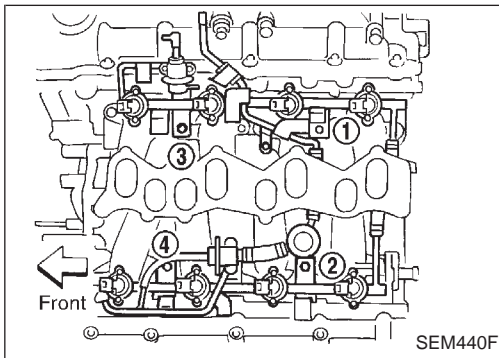
Installation (Cont'd)



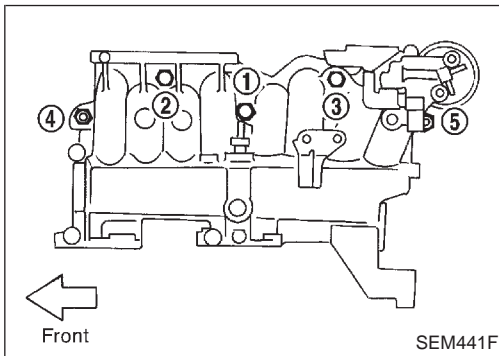
27. Install oil pan. Refer to "Installation" in "OIL PAN" (EM-12).
28. Install rocker cover. Refer to "CYLINDER HEAD" (EM-40).



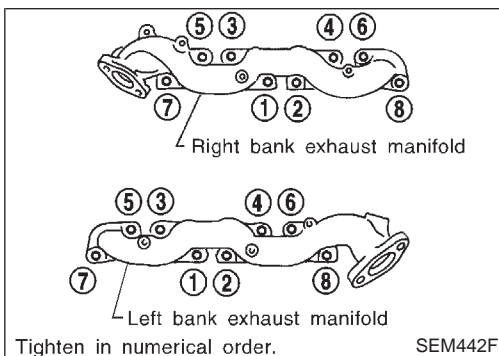
29. Install intake manifold.
 - Tighten bolts in numerical order as shown in the figure.



30. Install fuel tube assembly.
 - Tighten in numerical order as shown in the figure.
 - a. Tighten all bolts to 9.3 to 10.8 N·m (0.95 to 1.1 kg-m, 6.9 to 8.0 ft-lb).
 - b. Tighten all bolts to 21 to 26 N·m (2.1 to 2.7 kg-m, 15 to 20 ft-lb).



31. Install intake manifold collector.
 - Tighten in numerical order as shown in the figure.



32. Install exhaust manifolds.

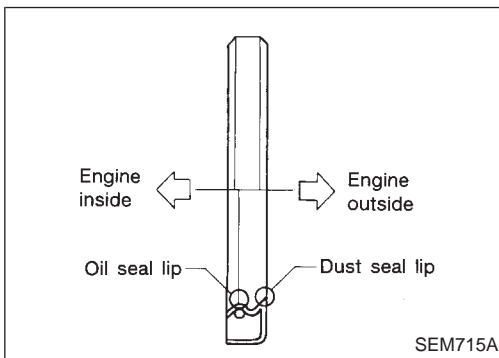
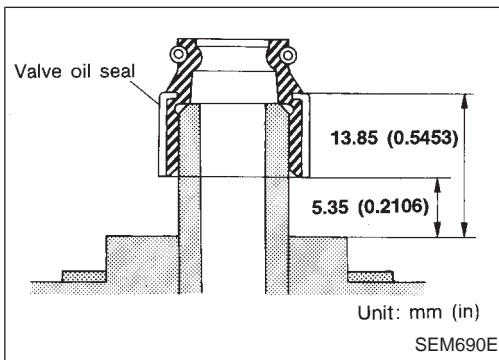
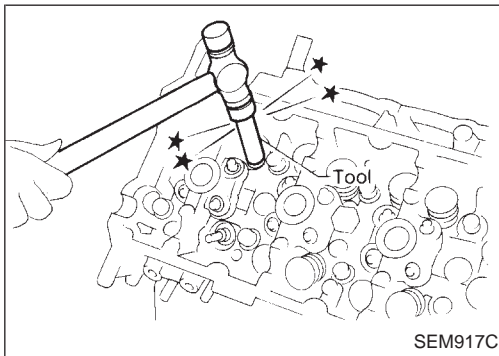
OIL SEAL REPLACEMENT

VALVE OIL SEAL

1. Remove rocker cover. Refer to "Removal" in "CYLINDER HEAD" (EM-30).
2. Remove camshaft.
3. Remove rocker arm.
4. Remove valve spring and valve oil seal with suitable tool.

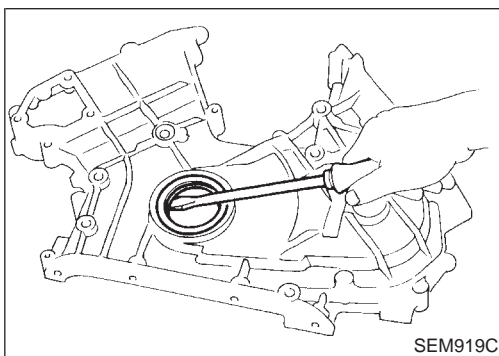
Piston concerned should be set at TDC to prevent valves from falling.

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



OIL SEAL INSTALLING DIRECTION

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



FRONT OIL SEAL

1. Remove the following parts.
 - Engine under cover
 - Cooling fan
 - Drive belts
 - Crankshaft pulley
2. Remove front oil seal.

Be careful not to scratch front cover.

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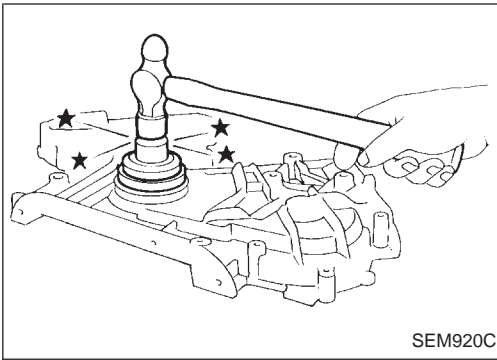
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OIL SEAL REPLACEMENT



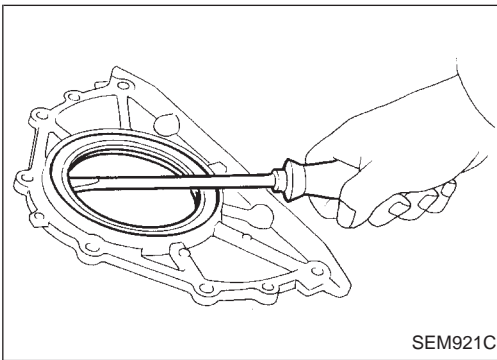
3. Apply engine oil to new oil seal and install it using suitable tool.

REAR OIL SEAL

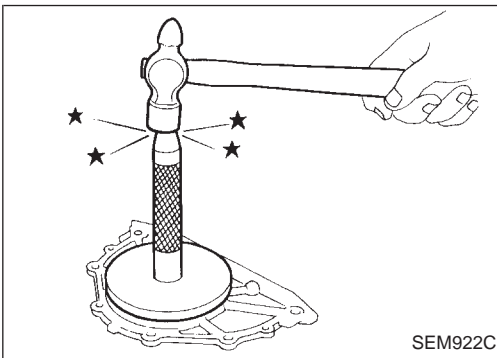
1. Remove transmission.

Refer to AT section.

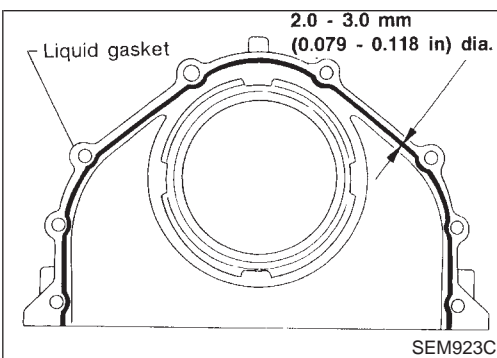
2. Remove drive plate.
3. Remove rear oil seal retainer.
4. Remove traces of liquid gasket using scraper.



5. Remove rear oil seal from rear oil seal retainer.



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



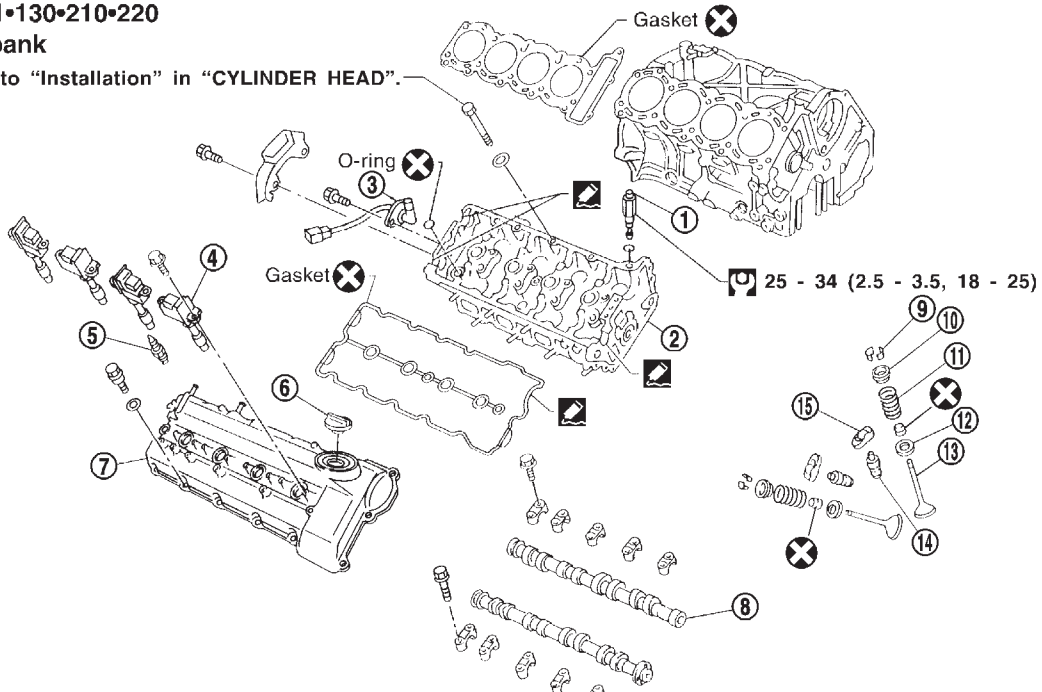
7. Apply a continuous bead of liquid gasket to rear oil seal retainer.

CYLINDER HEAD

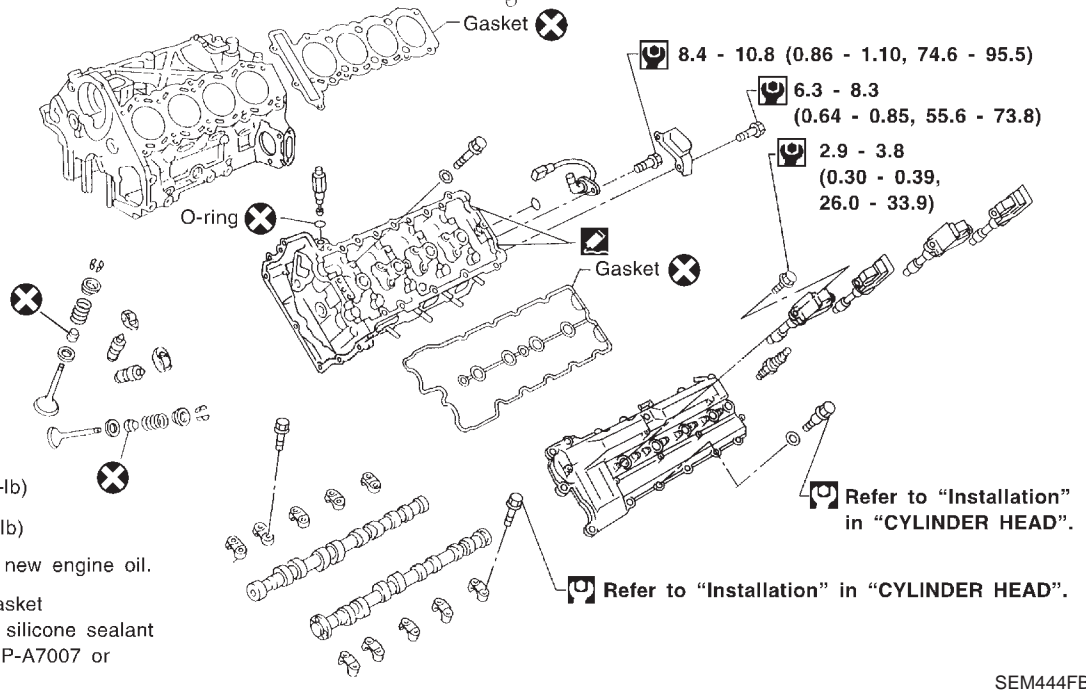
SEC. 110•111•130•210•220

Right-side bank

Refer to "Installation" in "CYLINDER HEAD".



Left-side bank



: N·m (kg-m, in-lb)

: N·m (kg-m, ft-lb)

: Lubricate with new engine oil.

: Apply liquid gasket
(Genuine RTV silicone sealant
part No. 999MP-A7007 or
equivalent).

- ① Intake valve timing control solenoid valve
- ② Cylinder head
- ③ Intake valve timing control position sensor
- ④ Ignition coil with power transistor

- ⑤ Spark plug
- ⑥ Oil filler cap
- ⑦ Rocker cover
- ⑧ Camshaft
- ⑨ Valve collet
- ⑩ Valve spring retainer

- ⑪ Valve spring
- ⑫ Valve spring seat
- ⑬ Valve
- ⑭ Hydraulic lash adjuster
- ⑮ Roller rocker arm

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CYLINDER HEAD

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.

Removal

Note:

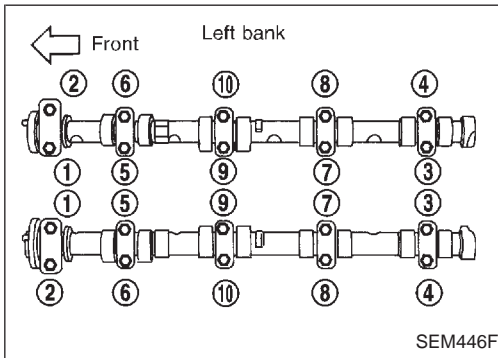
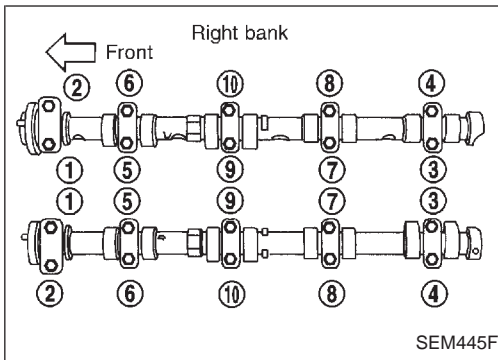
The cylinder head assembly removal and installation should be performed after removing the engine assembly. This section describes the removal of the camshaft, rocker arms and hydraulic lash adjusters.

Camshaft Removal

- Release fuel pressure. Refer to “Fuel Pressure Release”, “BASIC SERVICE PROCEDURE” in EC section.
 - Remove ornament cover.
 - Remove under cover.
 - Remove radiator.
 - Remove cooling fan.
 - Remove water inlet and outlet.
 - Remove alternator belt.
 - Remove alternator belt idler bracket.
 - Remove air duct.
 - Remove intake manifold collector.
 - Remove intake valve timing control solenoid valve.
1. Remove left rocker cover.
 - a. Remove vacuum pipe.
 - b. Remove main harness from bracket and move where it will not interfere with camshaft removal.
 - c. Remove all ignition coils and spark plugs.
 - d. Remove blowby hoses from rocker covers.
 - e. Remove rocker cover bolts.
 2. Remove right rocker cover.
 - a. Remove power steering oil reservoir tank bolts so tank is loose.
 - b. Separate fuel pipes.
 - c. Remove engine slinger.
 - d. Separate blowby hoses from rocker covers.
 - e. Remove all ignition coils and spark plugs.
 - f. Remove rocker cover bolts.
 3. Remove camshaft.
 - a. Set No. 1 piston to TDC on compression stroke.
 - b. Remove camshaft position sensor.
 - c. Remove front cover upper.
 - d. Mark the timing chain links so they correspond to the camshaft sprocket and idler sprocket mating marks.
 - e. Remove chain tensioner.
 - f. Remove camshaft sprocket.
- Refer to “TIMING CHAIN” (EM-15) for procedures (a) to (f).

CYLINDER HEAD

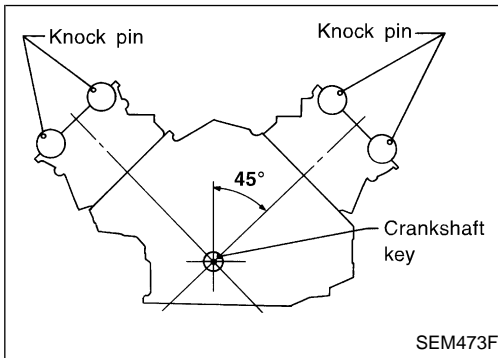
Camshaft Removal (Cont'd)



- g. Remove camshaft.
Loosen and remove the camshaft bolts following the order shown in the figure.

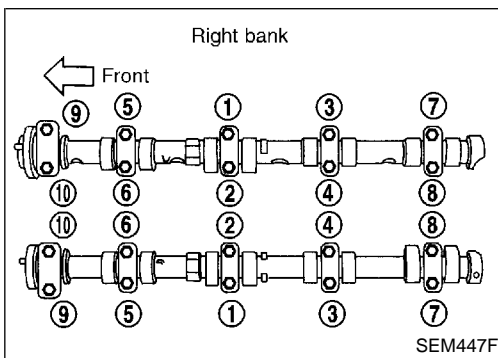
Be sure to mark the camshaft bracket installation position before removing the camshaft.

4. Remove rocker arms.
5. Remove hydraulic lash adjusters. Refer to "Disassembly" in "CYLINDER HEAD" (EM-33).



Camshaft Installation

- Install in reverse order of removal. Refer to "Installation" in "CYLINDER HEAD" (EM-40).
- Install camshaft knock pins in the positions shown in the figure.



• Tightening procedure

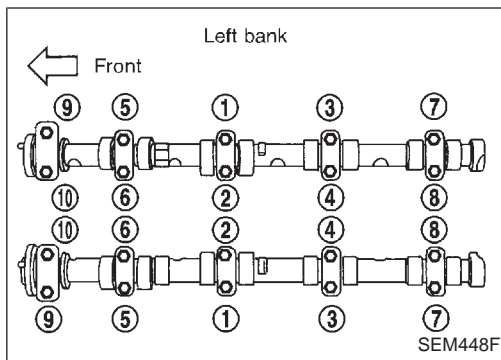
Tighten the camshaft brackets in the following steps.

Step	Tightening torque	Tightening order
1	2 N·m (0.2 kg·m, 17 in-lb)	Tighten in the order of ⑨ to ⑩, then tighten ① to ⑧.
2	6 N·m (0.6 kg·m, 52 in-lb)	Tighten in the numerical order.
3	11.8 - 13.7 N·m (1.20 - 1.40 kg·m, 104.2 - 121.5 in-lb)	Tighten in the numerical order.

- Tighten in numerical order shown in the figure.

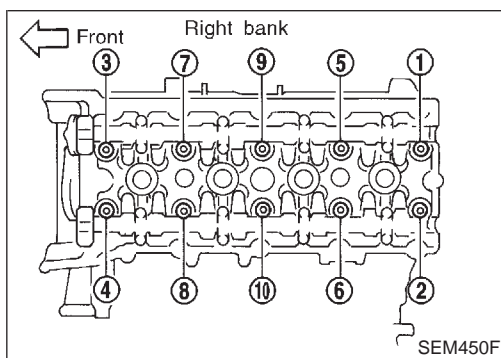
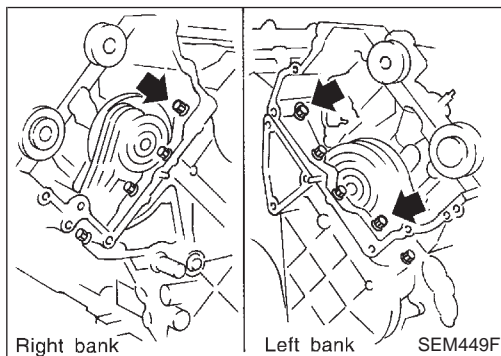
CYLINDER HEAD

Camshaft Installation (Cont'd)



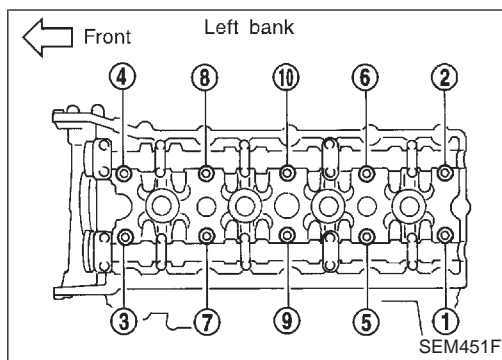
Cylinder Head Assembly Removal

1. Remove engine assembly from vehicle. Refer to "ENGINE REMOVAL" (EM-43).
2. Remove exhaust manifold.
3. Drain all coolant from drain plugs on left and right side of cylinder block.
4. Remove the following parts.
 - Intake manifold collector.
 - Ignition coil sub-harness.
 - Ignition coils.
 - Spark plugs.
5. Remove fuel tube assembly.
6. Remove intake manifold.
7. Remove rocker cover.
8. Set No. 1 position at TDC on compression stroke.
9. Remove camshaft position sensor.
10. Remove front cover upper.
11. Remove chain tensioner.
12. Remove camshaft sprocket.
13. Remove idler sprocket bolt. Refer to "TIMING CHAIN" (EM-15) for procedures 5 to 13.
 - **Apply paint to camshaft and idler sprockets for alignment during installation.**
14. Remove cylinder head sub-bolts.
Be careful during installation because the bolt (indicated by the arrow) dimensions is different from others.
15. Loosen cylinder head bolts following the order shown in the figure and remove cylinder head.

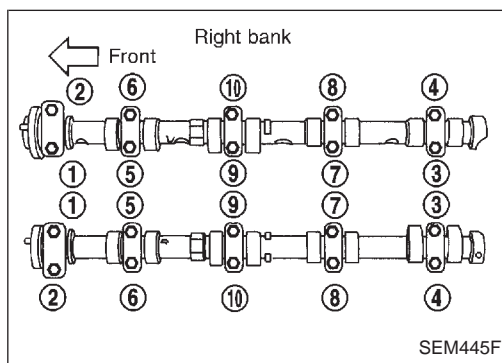


CYLINDER HEAD

Cylinder Head Assembly Removal (Cont'd)



16. Remove cylinder head gaskets.



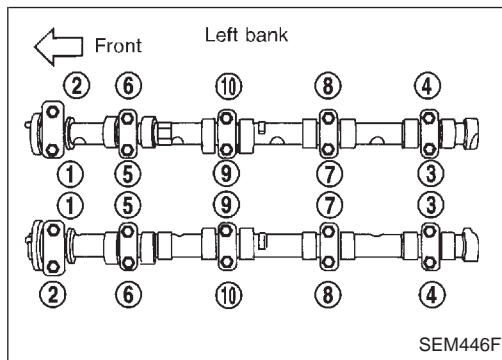
Disassembly

1. Remove camshaft bracket.

Loosen and remove bolts following the order shown in the figure.

Mark the installation position before removing camshaft bracket.

Inspect camshaft end play before loosening camshaft bracket bolts.



2. Remove camshaft.
3. Remove rocker arm.

GI

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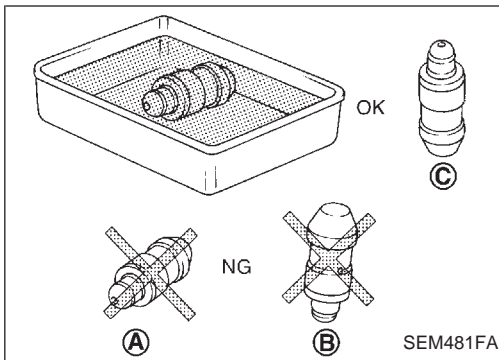
HA

EL

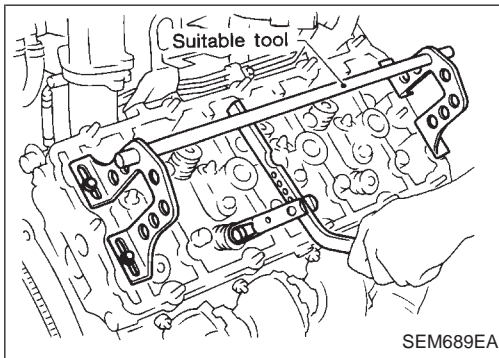
IDX

CYLINDER HEAD

Disassembly (Cont'd)

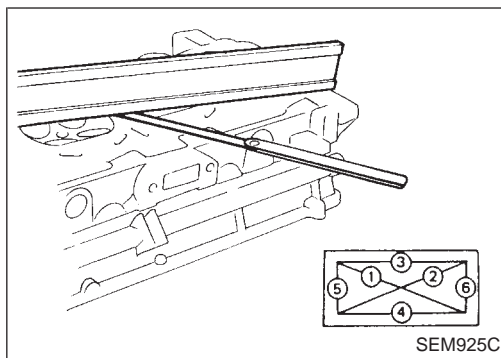


4. Remove hydraulic lash adjuster.
If hydraulic lash adjuster is kept on its side, there is a risk of air entering it. After removal, always set hydraulic lash adjuster in upright position. Otherwise, place it in a container of engine oil when laying it on its side.
- Do not disassemble hydraulic lash adjuster.
 - Attach tags to valve lifters so as not to mix them up.



5. Remove valve collets.
Use valve spring compressor (suitable tool) and remove valve collets.
6. Remove valve spring retainers, valve springs and valve spring seats.
 7. Remove valves.
Before removing valves, inspect gap between valve guides and check valve stem protrusion distance.

CYLINDER HEAD



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)

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

Resurfacing limit:

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

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

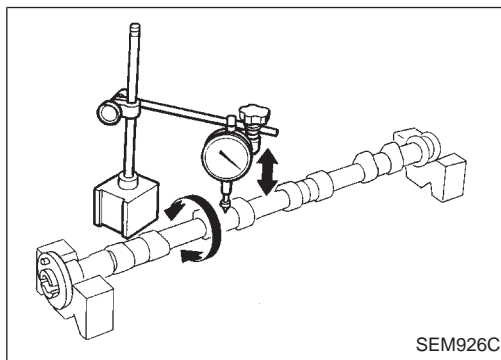
The maximum limit is as follows:

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

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

Nominal cylinder head height:

130.7 - 130.9 mm (5.146 - 5.154 in)



CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.

CAMSHAFT RUNOUT

1. Measure camshaft runout at the center journal.

Runout (Total indicator reading):

Standard

Less than 0.02 mm (0.0008 in)

Limit

0.05 mm (0.0020 in)

2. If it exceeds the limit, replace camshaft.

CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height.

Standard cam height:

Intake

37.858 - 38.048 mm (1.4905 - 1.4979 in)

Exhaust

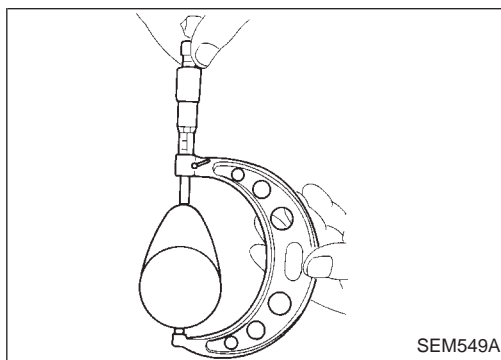
34.969 - 35.159 mm (1.3767 - 1.3842 in)

Cam wear limit:

Intake & Exhaust

0.05 mm (0.0020 in)

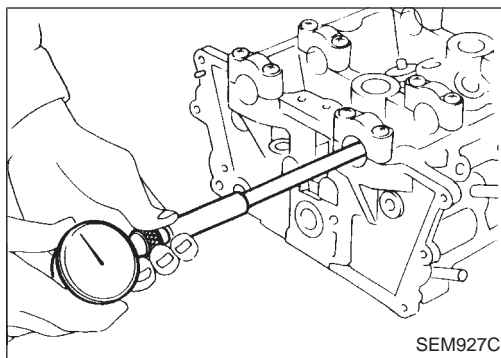
2. If wear is beyond the limit, replace camshaft.



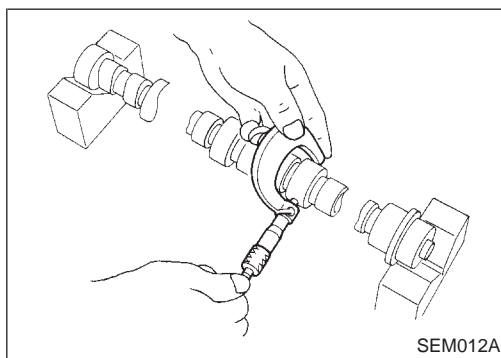
CYLINDER HEAD

Inspection (Cont'd)

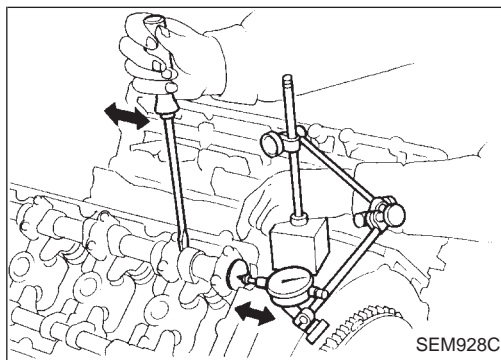
CAMSHAFT JOURNAL CLEARANCE



1. Install camshaft bracket and tighten bolts to the specified torque.
2. Measure inner diameter of camshaft bearing.
Standard inner diameter:
26.000 - 26.021 mm (1.0236 - 1.0244 in)

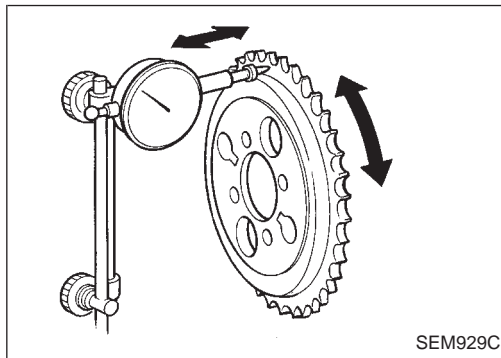


3. Measure outer diameter of camshaft journal.
Standard outer diameter:
25.935 - 25.955 mm (1.0211 - 1.0218 in)
4. If clearance exceeds the limit, replace camshaft and/or cylinder head.
Camshaft journal clearance:
Standard
0.045 - 0.086 mm (0.0018 - 0.0034 in)
Limit
0.15 mm (0.0059 in)



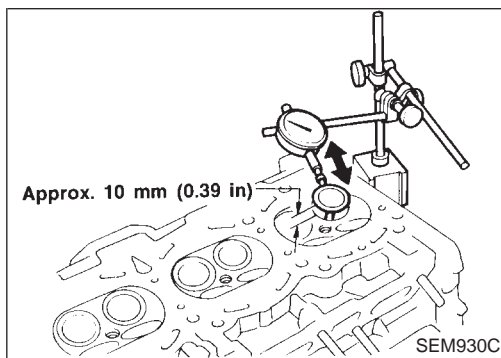
CAMSHAFT END PLAY

1. Install camshaft in cylinder head.
2. Measure camshaft end play.
Camshaft end play:
Standard
0.070 - 0.148 mm (0.0028 - 0.0058 in)
Limit
0.20 mm (0.0079 in)



CAMSHAFT SPROCKET RUNOUT

1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.
Runout (Total indicator reading):
Less than 0.25 mm (0.0098 in)
3. If it exceeds the limit, replace camshaft sprocket.

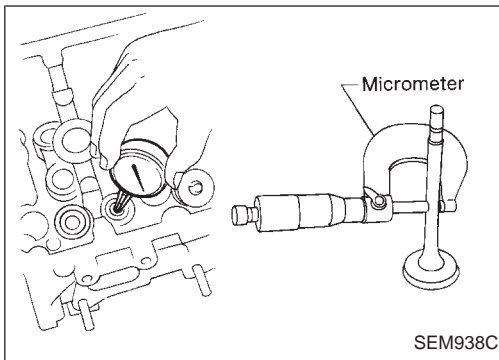


VALVE GUIDE CLEARANCE

1. Measure valve deflection in a parallel direction with rocker arm. (Valve and valve guide mostly wear in this direction.)
Valve deflection limit (Dial gauge reading):
Intake & Exhaust
0.15 mm (0.0059 in)

CYLINDER HEAD

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:

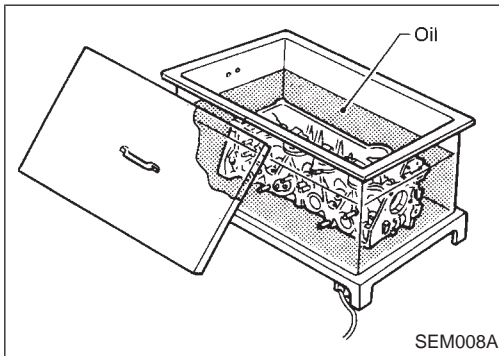
Unit: mm (in)

	Standard	Limit
Intake	0.029 - 0.052 (0.0011 - 0.0020)	0.086 (0.0034)
Exhaust	0.035 - 0.051 (0.0014 - 0.0020)	0.092 (0.0036)

GI

MA

EM



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

LC

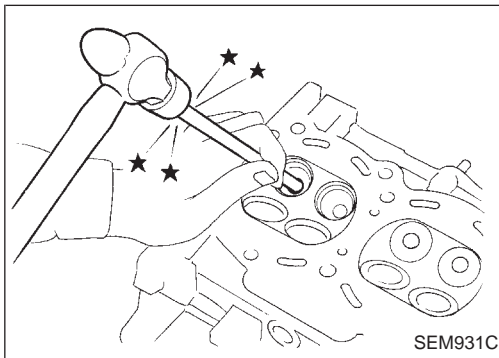
VALVE GUIDE REPLACEMENT

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

EC

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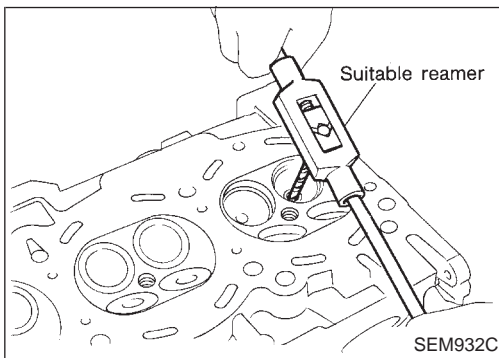
2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.

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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

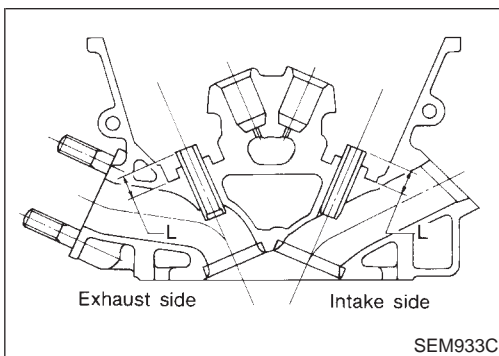
12.175 - 12.196 mm (0.4793 - 0.4802 in)

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4. Heat cylinder head to 110 to 130°C (230 to 266°F) and press service valve guide onto cylinder head.

Projection "L":

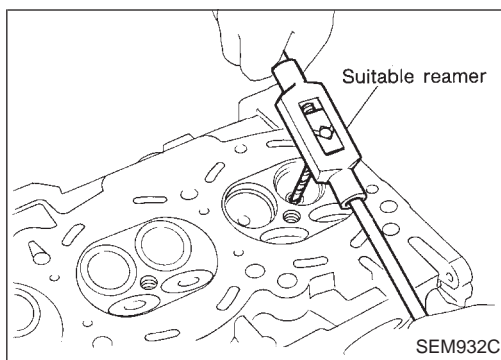
17.15 - 17.35 mm (0.6725 - 0.6831 in)

EL

IDX

CYLINDER HEAD

Inspection (Cont'd)



5. Ream valve guide.

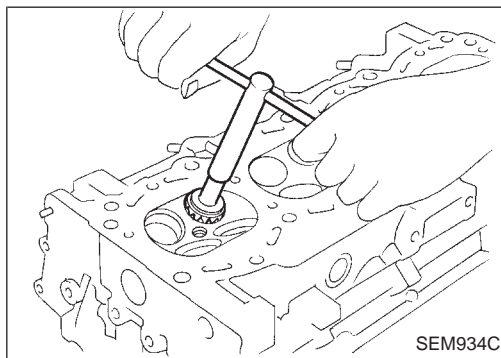
Finished size:

Intake

7.000 - 7.018 mm (0.2756 - 0.2763 in)

Exhaust

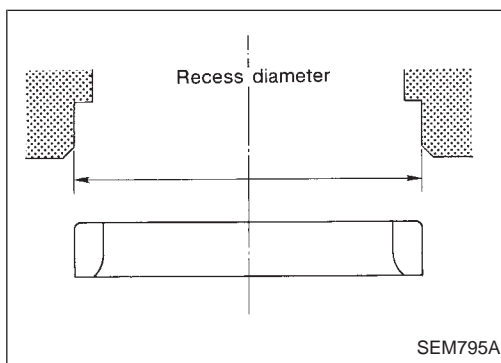
8.000 - 8.011 mm (0.3150 - 0.3154 in)



VALVE SEATS

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

- 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 valve seat uniformly.



REPLACING VALVE SEAT FOR SERVICE PARTS

1. Bore out old seat until it collapses. Set machine depth stop so that boring cannot contact bottom face of seat recess in cylinder head.
2. Ream cylinder head recess.

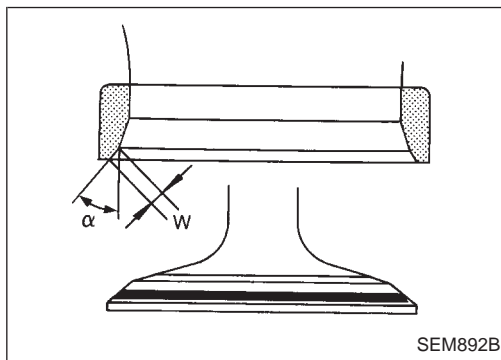
Reaming bore for service valve seat

Oversize [0.5 mm (0.020 in)]:

Intake 39.500 - 39.516 mm (1.5551 - 1.5557 in)

Exhaust 34.500 - 34.516 mm (1.3583 - 1.3589 in)

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



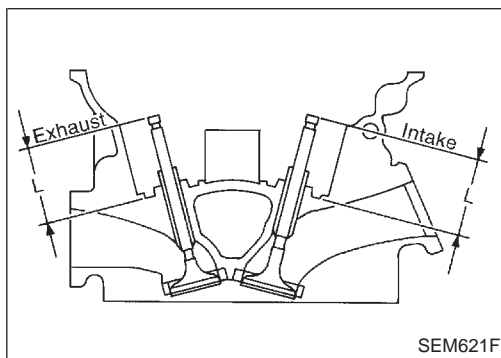
3. Heat cylinder head to 110 to 130°C (230 to 266°F).
4. Press fit valve seat until it seats on the bottom.
5. Cut or grind valve seat using suitable tool at the specified dimensions as shown in SDS (EM-58).
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

Seat face angle "α": 44°53' - 45°07' deg.

Contacting width "W":

Intake 1.05 - 1.35 mm (0.0413 - 0.0531 in)

Exhaust 1.25 - 1.55 mm (0.0492 - 0.0610 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 46.25 - 46.95 mm (1.8209 - 1.8484 in)

Exhaust 46.21 - 46.91 mm (1.8193 - 1.8468 in)

CYLINDER HEAD

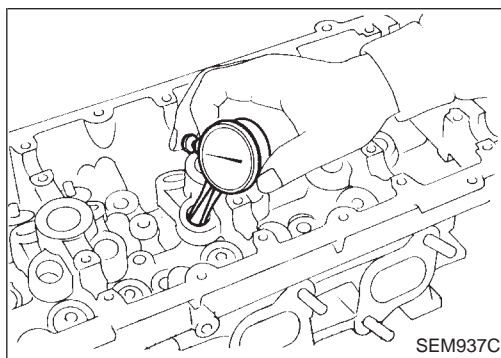
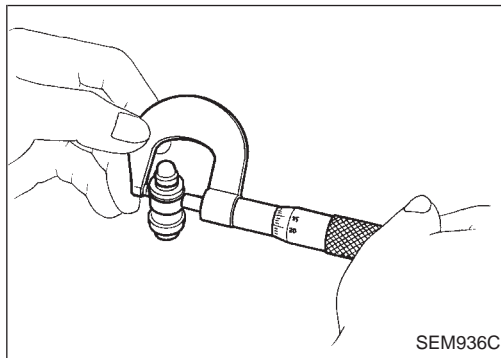
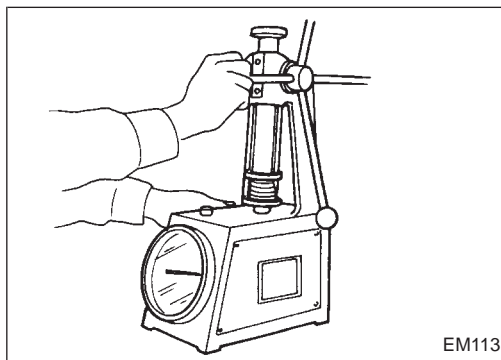
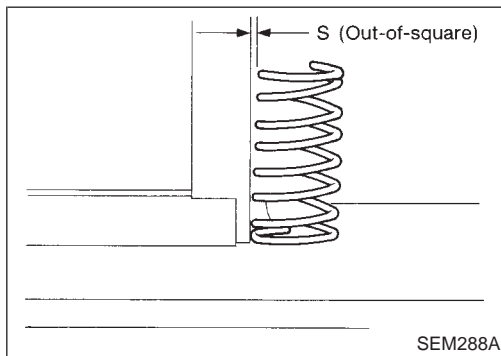
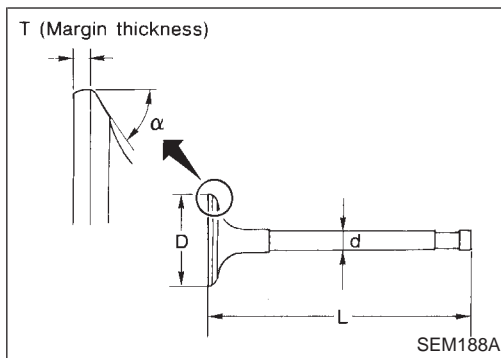
Inspection (Cont'd)

VALVE DIMENSIONS

Check dimensions in each valve. For dimensions, refer to SDS (EM-57).

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

1. Measure dimension "S".

Out-of-square "S":

Less than 2.0 mm (0.079 in)

2. If it exceeds the limit, replace spring.

Pressure

Check valve spring pressure at specified spring height.

Pressure:

Standard

**535.5 N (54.6 kg, 120.4 lb)
at height 26.8 mm (1.055 in)**

Limit

**More than 477.6 N (48.7 kg, 107.4 lb)
at height 26.8 mm (1.055 in)**

If it exceeds the limit, replace spring.

HYDRAULIC LASH ADJUSTER

1. Check contact and sliding surfaces for wear or scratches.
2. Check diameter of lash adjuster.

Outer diameter:

16.980 - 16.993 mm (0.6685 - 0.6690 in)

3. Check lash adjuster guide inner diameter.

Inner diameter:

17.000 - 17.020 mm (0.6693 - 0.6701 in)

**Standard clearance between lash adjuster and
adjuster guide:**

0.007 - 0.040 mm (0.0003 - 0.0016 in)

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CYLINDER HEAD

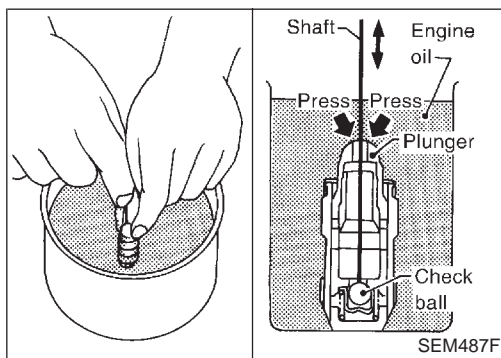
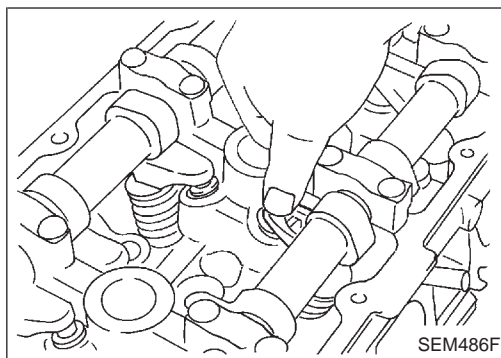
Inspection (Cont'd)

Inspection of air entering

- Check if air has entered inside of hydraulic lash adjuster when it is installed or if abnormal sound occurs when engine is running.
- Press rocker arm pivot firmly around the cam base circle as shown in figure.

Depression limit: 1.0 mm (0.039 in)

- If depression dimension is greater than 1.0 mm (0.039 in), air may have entered the high-pressure chamber of hydraulic lash adjuster. Perform the following procedures to bleed air from the adjuster.



Air bleeding

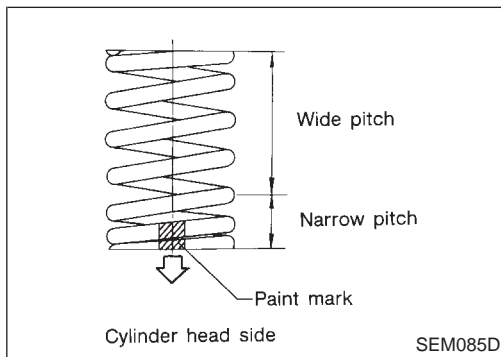
- Remove hydraulic lash adjuster. Place adjuster in container of engine oil. While pressing plunger down as shown in the figure, lightly press check ball with a narrow rod.
- Air bleeding is accomplished when the plunger is pressed and does not spring back.

CAUTION:

- **Be especially careful not to damage the check ball.**
- **If air bleeding does not remove air, replace the hydraulic lash adjuster assembly.**
- **Do not disassemble hydraulic lash adjuster.**

Assembly

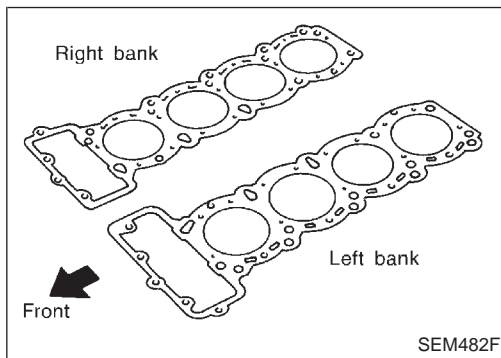
1. Install valve component parts.
 - **Always use new valve oil seal. Refer to OIL SEAL REPLACEMENT (EM-27).**
 - **Before installing valve oil seal, install valve spring seat.**
 - **Install valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side (Paint mark).**
 - **After installing valve components, tap valve stem tip with a plastic hammer to assure a proper fit.**



Installation

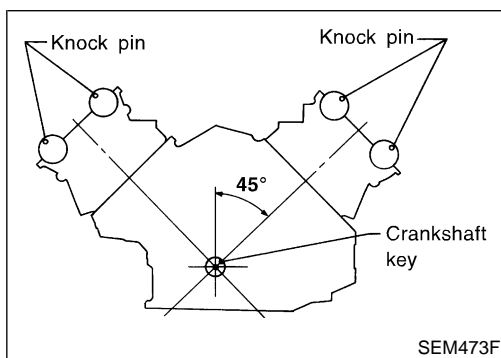
1. Install cylinder head gaskets.

Remove all oil and debris from the cylinder head and block mating surfaces.
Always use new gaskets.
Refer to the figure to determine the difference between left and right gaskets.



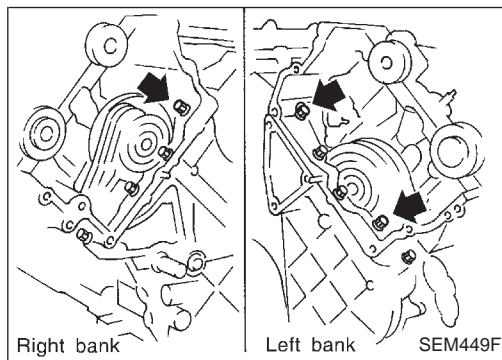
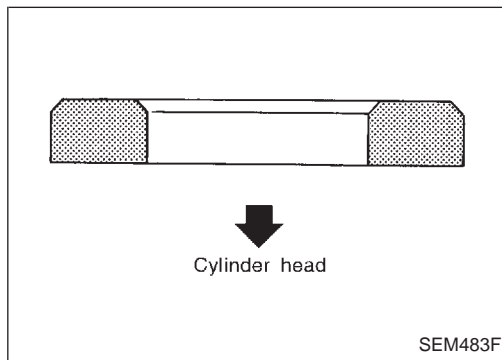
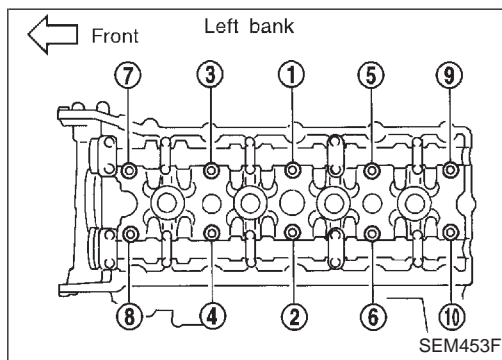
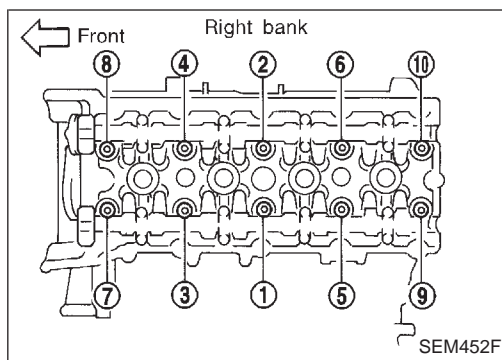
2. Install cylinder heads.

Check that camshaft key and camshaft knock pins are located in positions shown in the figure. Install cylinder heads on block.
Be careful not to damage or scratch cylinder head gaskets during installation.



CYLINDER HEAD

Installation (Cont'd)



3. Tighten cylinder head bolts.
 - Lubricate threads and seat surfaces of the bolts with new engine oil.
 - Tightening procedure
 - (a) Tighten bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
 - (b) Tighten bolts to 93 N·m (9.5 kg-m, 69 ft-lb).
 - (c) Loosen bolts completely.
 - (d) Tighten bolts to 25 to 34 N·m (2.5 to 3.5 kg-m, 18 to 25 ft-lb).
 - (e) Turn bolts 90 to 95 degrees clockwise.

- Install the washer with non-chamfered side facing the cylinder head.

4. Install cylinder head sub-bolts.
 - : 6.3 - 8.3 N·m (0.64 - 0.85 kg-m, 55.6 - 73.8 in-lb)
 The bolts indicated by arrow marks in the figure have different dimensions [$\ell = 35$ mm (1.38 in)] than the other bolts [$\ell = 23$ mm (0.91 in)]. Make sure bolt length and location correspond.

5. Install idler sprocket bolts.
6. Install camshaft sprocket.
7. Install chain tensioner.
8. Install front cover upper. Refer to "TIMING CHAIN" for explanation of above procedures.

GI

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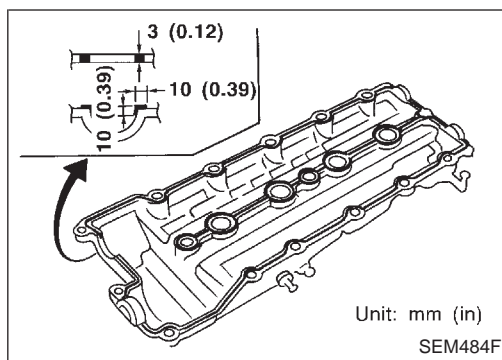
HA

EL

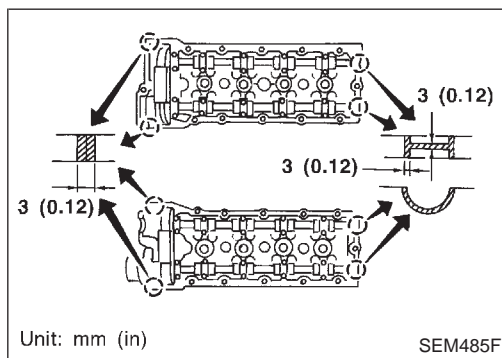
IDX

CYLINDER HEAD

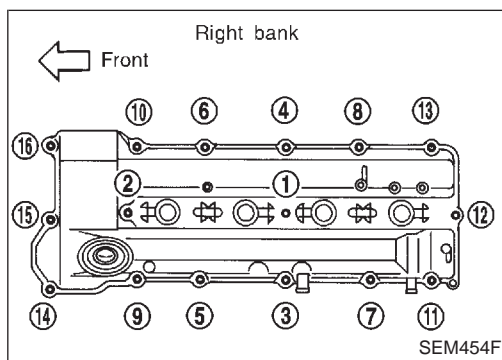
Installation (Cont'd)



9. Install rocker cover gasket in rocker cover groove. Always use a new gasket.
 - a. Remove all oil and debris from the gasket and cylinder head mating surfaces.
 - b. Apply a continuous bead of liquid gasket to gasket arch in the dimensions shown in the figure.
 - **Use Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent.**



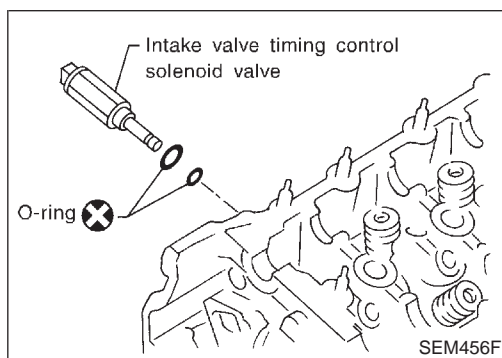
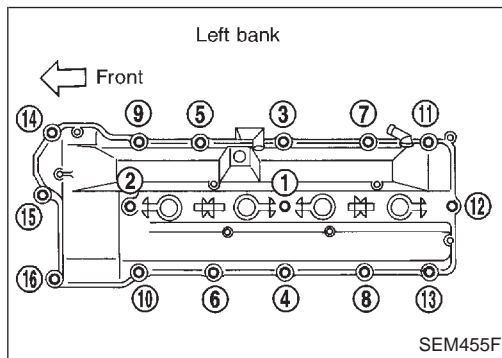
- c. Apply a continuous bead of liquid gasket to where rubber plugs are inserted in cylinder head and mating surfaces of front cover and cylinder head as shown in figure.
 - **Use Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent.**



10. Install RH and LH rocker covers.

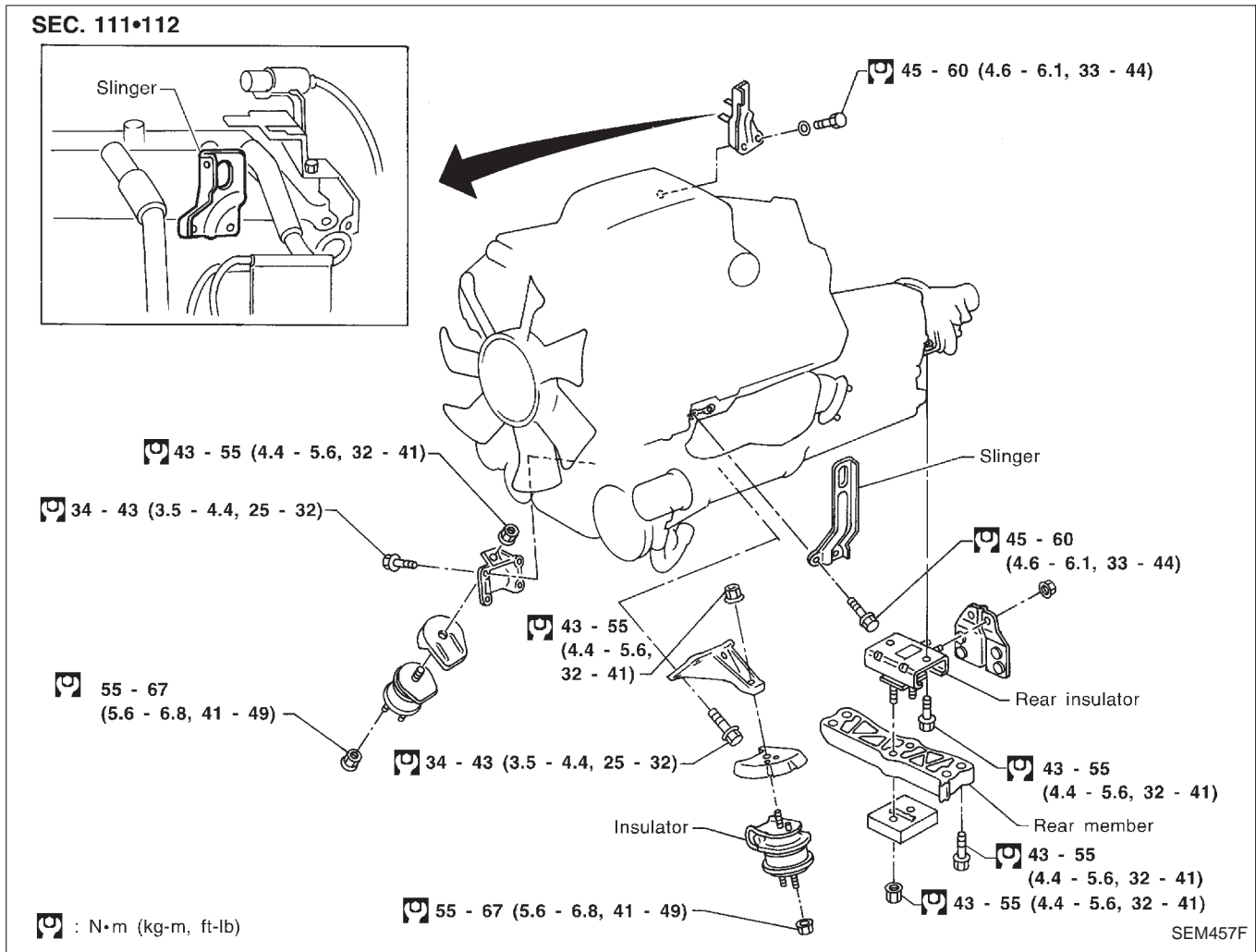
Rocker cover tightening procedure:

- **Tighten in numerical order as shown in the figure.**
 - a. Tighten bolts ① to ⑯ in that order to 4 to 6 N·m (0.4 to 0.6 kg-m, 35 to 52 in-lb).
 - b. Tighten bolts ① to ⑯ as indicated in figure to 7 to 9 N·m (0.7 to 0.9 kg-m, 61 to 78 in-lb).
 - c. Tighten bolts ① and ② to 7 to 9 N·m (0.7 to 0.9 kg-m, 61 to 78 in-lb).



11. Install intake valve timing control solenoid valve. Always replace the two O-rings with new parts. Check that there is no debris or foreign matter in the end of the intake valve timing control solenoid valve. Coat the O-rings with engine oil.
 - **25 - 34 N·m (2.5 - 3.5 kg-m, 18 - 25 ft-lb)**
12. Install in the reverse order of removal thereafter.

ENGINE REMOVAL



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.
- Before disconnecting fuel hose, release fuel pressure from fuel line. Refer to EC section (“Fuel Pressure Release”, “BASIC SERVICE PROCEDURE”).
- 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 careful not to strike adjacent parts, especially the following: 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.

ENGINE REMOVAL

Removal

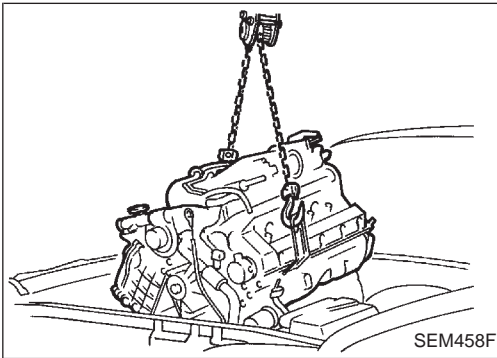
1. Remove transmission.

Refer to AT section.

2. Remove engine under cover and hood.
3. Drain coolant from both cylinder block drain plug, and radiator drain cock.
4. Drain engine oil from drain plug of oil pan.
5. Remove vacuum hoses, fuel tubes, wires, harness and connectors and so on.
6. Remove front exhaust tubes.
7. Remove radiator and shroud.
8. Remove drive belts.
9. Remove power steering oil pump from engine.
10. Discharge refrigerant.

Refer to HA section.

11. Remove A/C piping.
12. Install engine slingers to cylinder head.
13. Set a suitable hoist on engine slinger.
14. Remove engine mounting bolts from both sides and then slowly raise engine.



15. Remove engine as shown.

CYLINDER BLOCK

SEC. 110•120•150

GI

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EM

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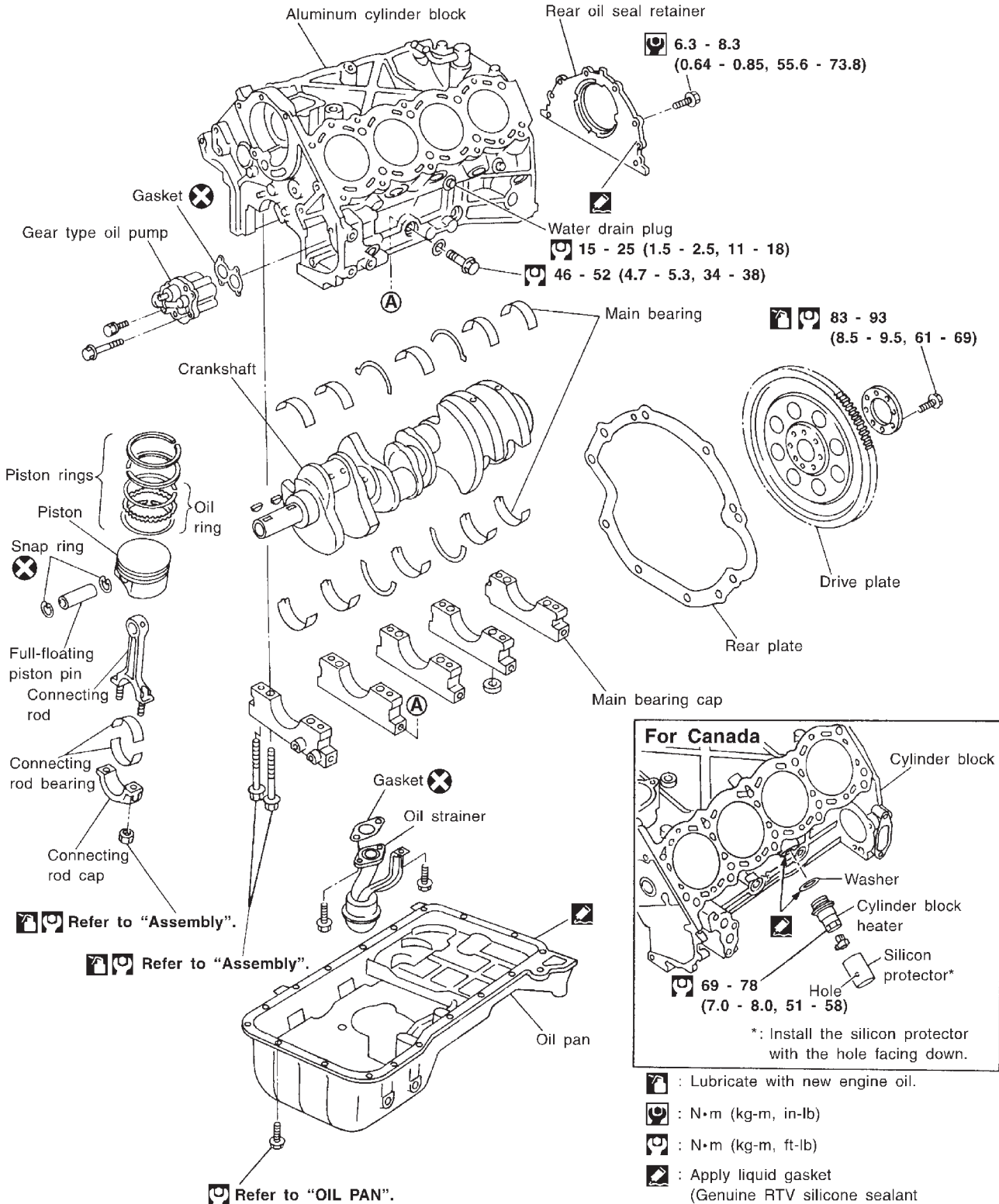
RS

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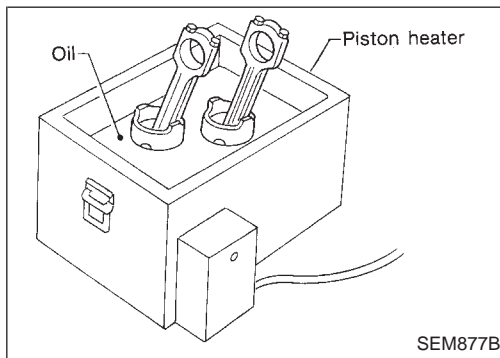


- : Lubricate with new engine oil.
- : N•m (kg-m, in-lb)
- : N•m (kg-m, ft-lb)
- : Apply liquid gasket (Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent).

CYLINDER BLOCK

CAUTION:

- When installing bearings, pistons, or other sliding parts, 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.



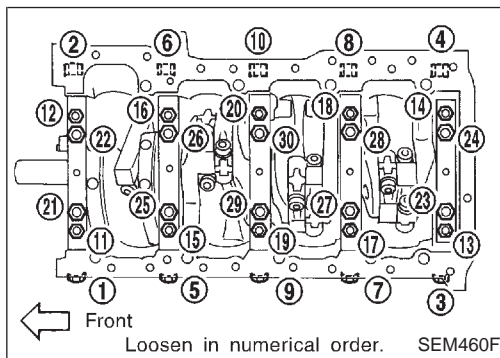
Disassembly

PISTON AND CRANKSHAFT

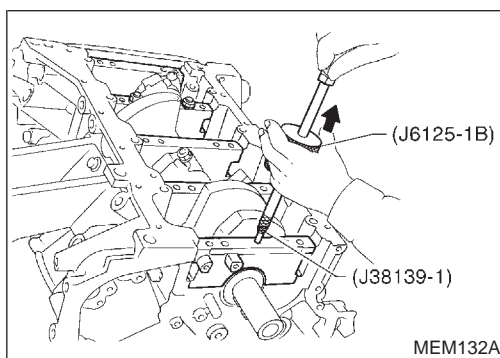
1. Remove timing chain.
Refer to "Removal" in "TIMING CHAIN" (EM-15).
2. Remove pistons with connecting rods.
 - When disassembling piston and connecting rod, remove snap ring first. Then heat piston to 60 to 70°C (140 to 158°F), or use piston pin press stand at room temperature.
3. Remove rear oil seal retainer.

CAUTION:

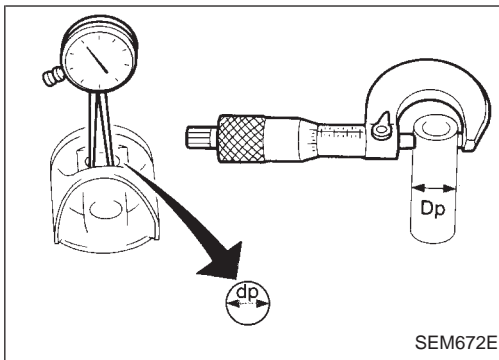
- When piston rings are not replaced, make sure that piston rings are mounted in their original positions.
- When replacing piston rings, if there is no punchmark, install with either side up.



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



CYLINDER BLOCK

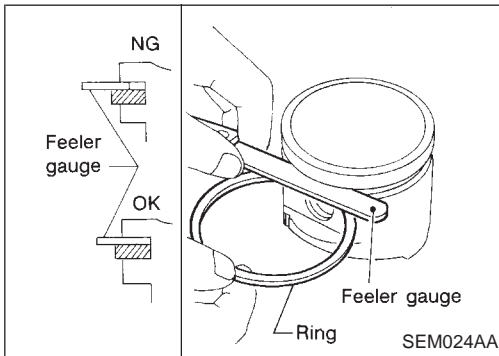


Inspection

PISTON AND PISTON PIN CLEARANCE

1. Measure inner diameter of piston pin hole "dp".
Standard diameter "dp":
 21.987 - 21.999 mm (0.8656 - 0.8661 in)
2. Measure outer diameter of piston pin "Dp".
Standard diameter "Dp":
 21.989 - 22.001 mm (0.8657 - 0.8662 in)
3. Calculate piston pin clearance.
 $dp - Dp = -0.004 \text{ to } 0 \text{ mm } (-0.0002 \text{ to } 0 \text{ in})$

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



PISTON RING SIDE CLEARANCE

Side clearance:

Top ring

0.040 - 0.080 mm (0.0016 - 0.0031 in)

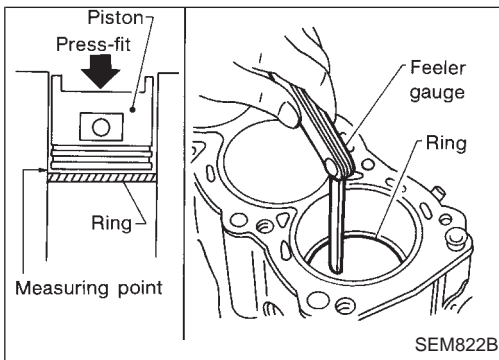
2nd ring

0.030 - 0.070 mm (0.0012 - 0.0028 in)

Max. limit of side clearance:

0.1 mm (0.004 in)

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



PISTON RING END GAP

End gap:

Top ring 0.27 - 0.46 mm (0.0106 - 0.0181 in)

2nd ring 0.39 - 0.63 mm (0.0154 - 0.0248 in)

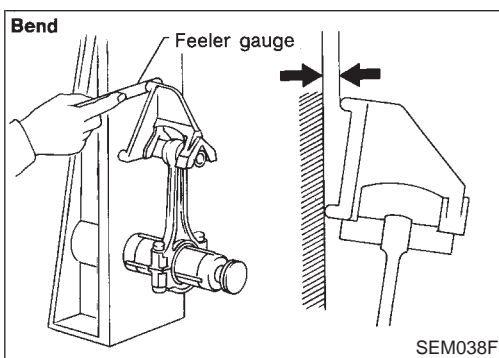
Oil ring 0.20 - 0.69 mm (0.0079 - 0.0272 in)

Max. limit of ring gap: 1.0 mm (0.039 in)

If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, do the following. Rebore cylinder and use oversized piston and piston rings.

Refer to SDS (EM-60).

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



CONNECTING ROD BEND AND TORSION

Bend: Limit 0.15 mm (0.0059 in)

per 100 mm (3.94 in) length

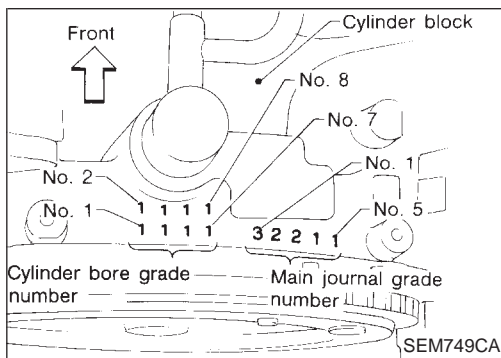
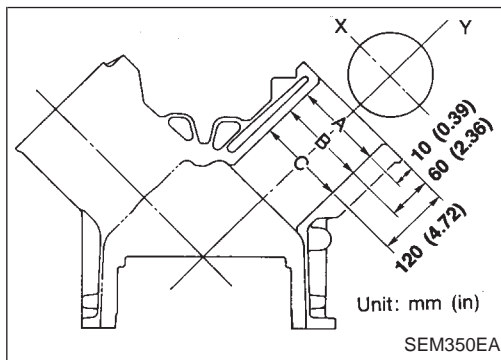
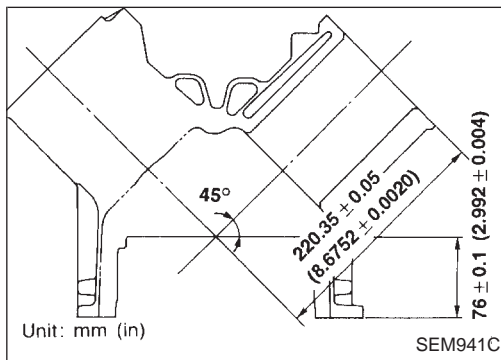
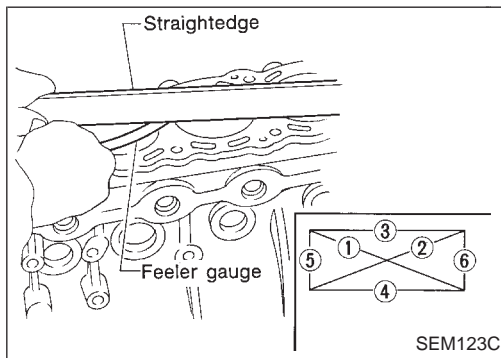
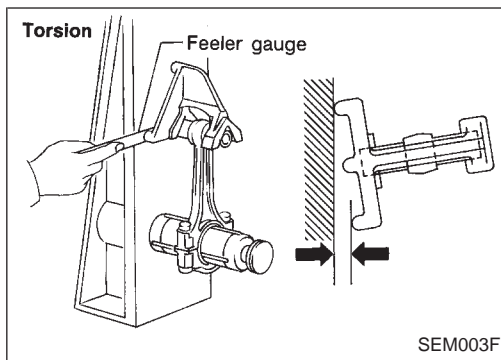
Torsion: Limit 0.30 mm (0.0118 in)

per 100 mm (3.94 in) length

If it exceeds the limit, replace connecting rod assembly.

CYLINDER BLOCK

Inspection (Cont'd)



CYLINDER BLOCK DISTORTION AND WEAR

- Clean upper surface of cylinder block. Use a reliable straightedge and feeler gauge to check the flatness of cylinder block surface. Check along six positions shown in the figure.
Standard: Less than 0.03 mm (0.0012 in)
Limit: 0.10 mm (0.0039 in)
- If out of specification, resurface it. The limit for cylinder block resurfacing is determined by cylinder head resurfacing in engine.

Resurfacing limit:

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:

$$220.30 - 220.40 \text{ mm (8.6732 - 8.6771 in)}$$

Refer to SDS (EM-59).

- If necessary, replace cylinder block.

PISTON-TO-BORE CLEARANCE AND BORING

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

Standard inner diameter:

$$93.000 - 93.030 \text{ mm (3.6614 - 3.6626 in)}$$

Wear limit: 0.20 mm (0.0079 in)

Out-of-round (X - Y) limit: 0.015 mm (0.0006 in)

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

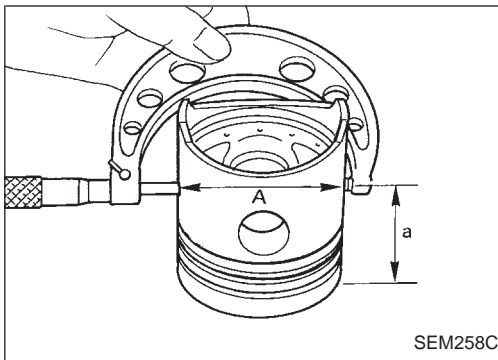
If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.

2. Check for scratches and seizure. If necessary, hone it.

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

CYLINDER BLOCK

Inspection (Cont'd)



3. Measure piston skirt diameter.
Piston diameter "A":
Refer to SDS (EM-60).
Measuring point "a" (Distance from the top):
54 mm (2.13 in)
4. Check that piston-to-bore clearance is within specification.
Piston-to-bore clearance "B":
0.010 - 0.030 mm (0.0004 - 0.0012 in)
5. Determine piston oversize according to amount of cylinder wear.

Upsize pistons are available for service. Refer to SDS (EM-60).

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

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

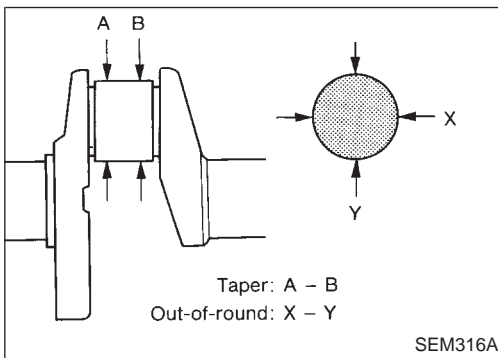
where, **D: Bored diameter**

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. Otherwise, cylinder bores may be distorted 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

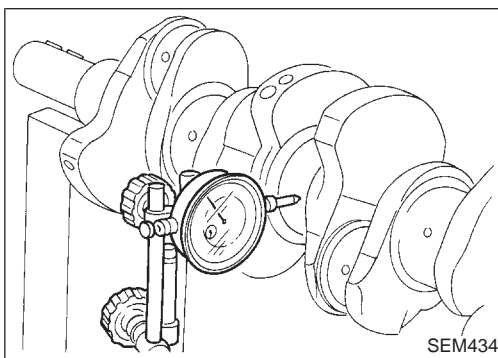
1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.

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 limit (Total indicator reading):
0.1 mm (0.004 in)

CYLINDER BLOCK

Inspection (Cont'd)

BEARING CLEARANCE

- Use either of the following two methods, however, method "A" gives more reliable results and is preferable.

Method A (Using bore gauge & micrometer)

Main bearing

1. Set main bearings in their proper positions on cylinder block and main bearing cap.
2. Install main bearing cap to cylinder block.

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

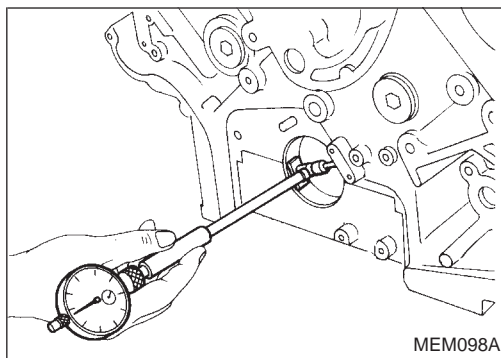
3. Measure inner diameter "A" of each main bearing.
4. Measure outer diameter "Dm" of each crankshaft main journal.
5. Calculate main bearing clearance.

$$\text{Main bearing clearance} = A - Dm$$

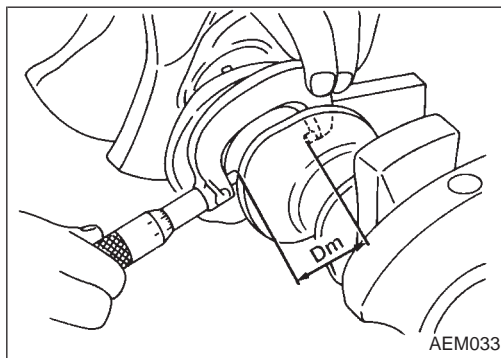
Standard: 0.006 - 0.020 mm (0.0002 - 0.0008 in)

Limit: 0.030 mm (0.0012 in)

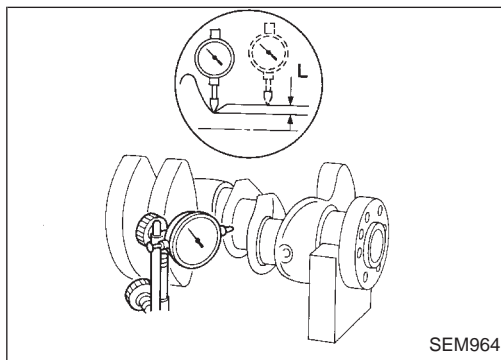
- If it exceeds the limit, replace bearing.
- If clearance cannot be adjusted within the standard, grind crankshaft journal and use undersized bearing.



MEM098A



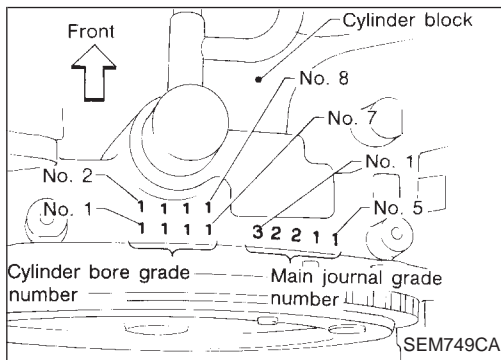
AEM033



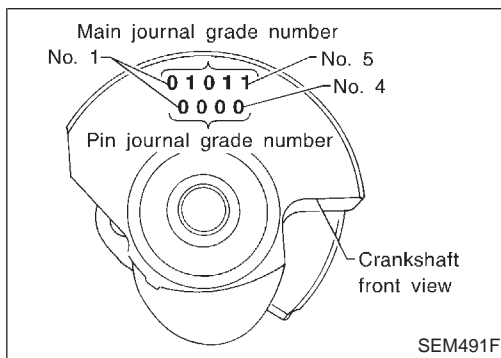
SEM964

CAUTION:

- When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.
"L": 0.1 mm (0.004 in)
- Refer to SDS for grinding crankshaft and available service parts.



SEM749CA



SEM491F

6. 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 calculation or table.

Example of calculation:

Cylinder block main journal grade number: 1

Crankshaft main journal grade number: 2

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

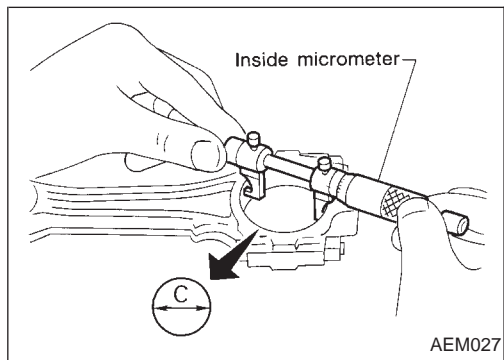
CYLINDER BLOCK

Inspection (Cont'd)

Main bearing grade number (Identification color):

These numbers are punched in either Arabic or Roman numerals.

		Cylinder block main journal grade number					
		"0"	"1"	"2"	"3"	"4"	"5"
Crankshaft main journal grade number	"0"	0 (Black)	1 (Brown)	2 (Green)	3 (Yellow)	4 (Blue)	5 (Pink)
	"1"	1 (Brown)	2 (Green)	3 (Yellow)	4 (Blue)	5 (Pink)	6 (No color)
	"2"	2 (Green)	3 (Yellow)	4 (Blue)	5 (Pink)	6 (No color)	7 (White)
	"3"	3 (Yellow)	4 (Blue)	5 (Pink)	6 (No color)	7 (White)	8 (Red)
	"4"	4 (Blue)	5 (Pink)	6 (No color)	7 (White)	8 (Red)	9 (Black/Black)
	"5"	5 (Pink)	6 (No color)	7 (White)	8 (Red)	9 (Black/Black)	10 (Yellow/Yellow)

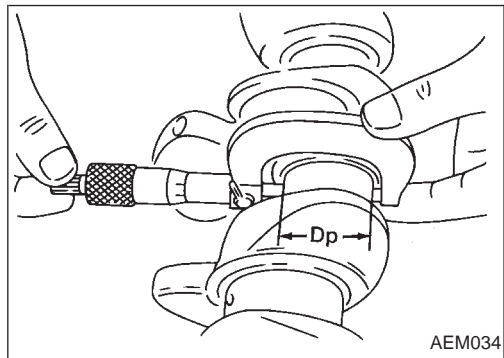


Connecting rod bearing (Big end)

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.



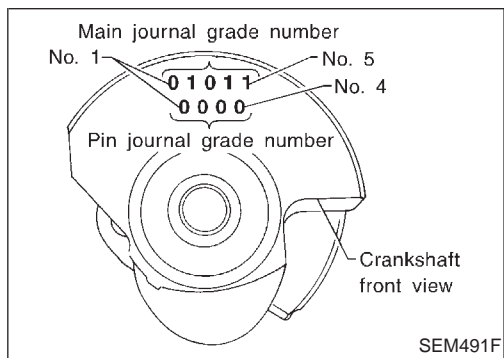
4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.

$$\text{Connecting rod bearing clearance} = C - Dp$$

Standard: 0.020 - 0.045 mm (0.0008 - 0.0018 in)

Limit: 0.055 mm (0.0022 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 "BEARING CLEARANCE — Main bearing" (EM-50).



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

Connecting rod bearing grade number (Identification color):

These numbers are punched in either Arabic or Roman numerals.

Crankshaft pin journal grade number	Connecting rod bearing grade number
0	0 (No color)
1	1 (Brown)
2	2 (Green)

GI

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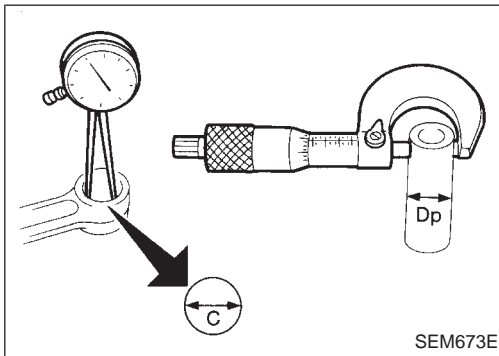
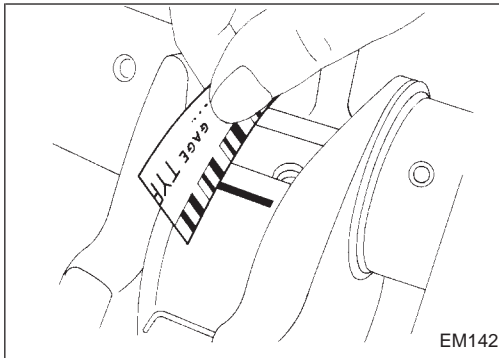
CYLINDER BLOCK

Inspection (Cont'd)

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. If incorrect bearing clearance exists, use a thicker or undersized main bearing to ensure specified clearance.



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

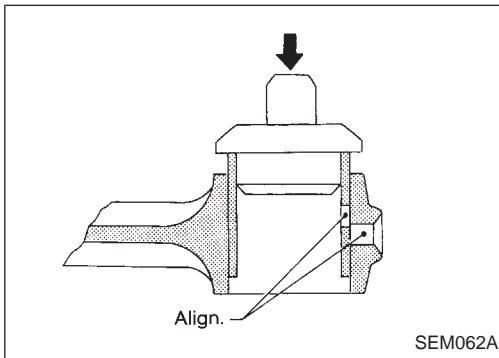
Standard:

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.



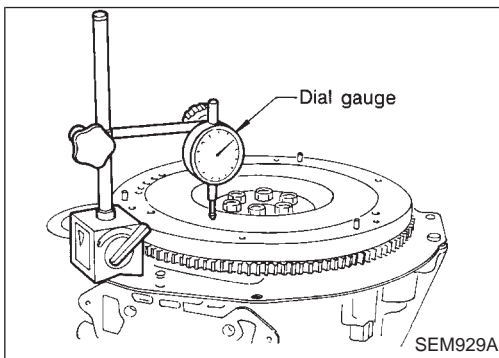
REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

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. This is to ensure the 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)



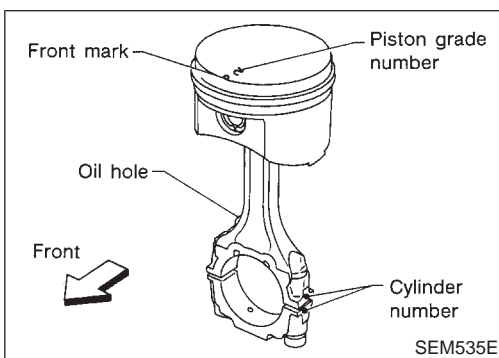
DRIVE PLATE RUNOUT

Drive plate runout (Total indicator reading):

Less than 0.20 mm (0.0079 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.



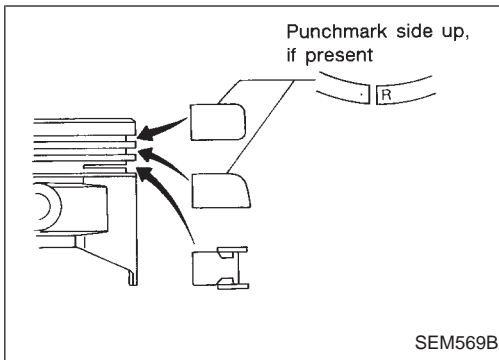
Assembly

PISTON

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.

CYLINDER BLOCK

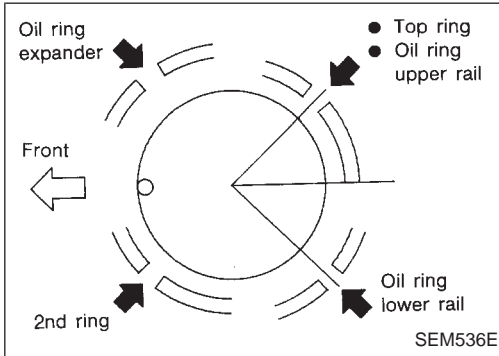
Assembly (Cont'd)



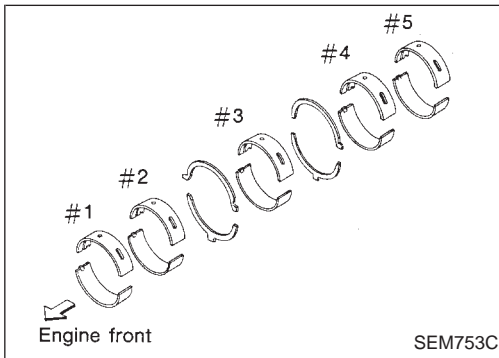
3. Set piston rings as shown.

CAUTION:

- When piston rings are not replaced, make sure that piston rings are mounted in their original positions.
- When replacing piston rings, these without punchmarks, present, piston rings can be mounted with either side up.



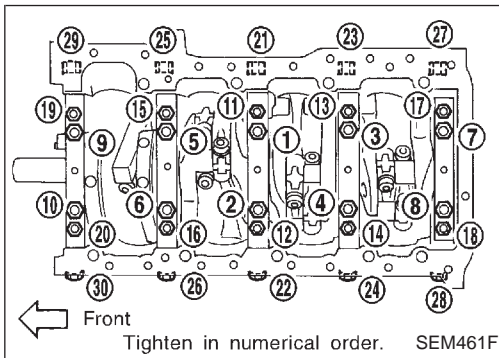
- Align piston rings so that end gaps are positioned as shown in the figure.



CRANKSHAFT

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

- Confirm that correct main bearings are used. Refer to "Inspection" of this section.
- Apply engine oil to bearing surface.



2. Install crankshaft, main bearing caps and beam and tighten bolts to the specified torque.

- Lubricate threads and seat surfaces of the bolts with new engine oil.
- Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting in the axial direction.
- Tightening procedure
 - 1) Tighten bolts (1 - 20) to a.
 - 2) Turn bolts (1 - 20) b degrees clockwise with angle wrench.
 - 3) Tighten all bolts (21 - 30) to c.

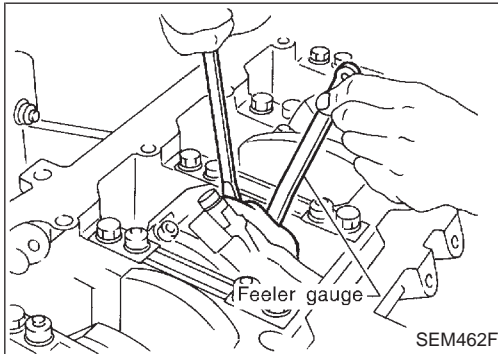
Unit: N·m (kg·m, ft·lb)

	Bolts (1 - 10)	Bolts (11 - 20)	Bolts (21 - 30)
a	36 - 42 (3.7 - 4.3, 27 - 31)	26 - 32 (2.7 - 3.3, 20 - 24)	—
b	40 ⁺⁵ ₀ degrees	35 ⁺⁵ ₀ degrees	—
c	—	—	46 - 52 (4.7 - 5.3, 34 - 38)

CYLINDER BLOCK

Assembly (Cont'd)

- After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.



3. Measure crankshaft end play.

Crankshaft end play:

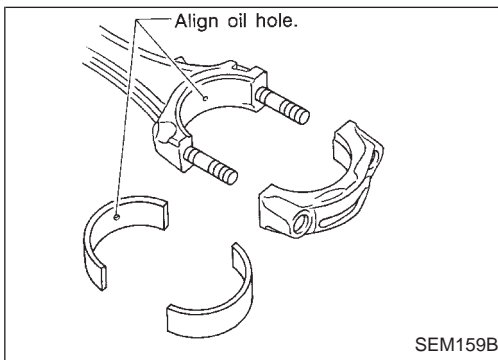
Standard

0.10 - 0.26 mm (0.0039 - 0.0102 in)

Limit

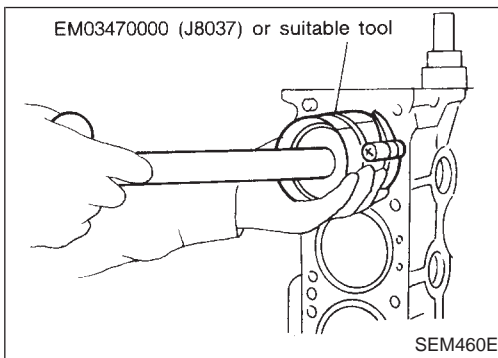
0.30 mm (0.0118 in)

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



4. Install connecting rod bearings in connecting rods and connecting rod caps.

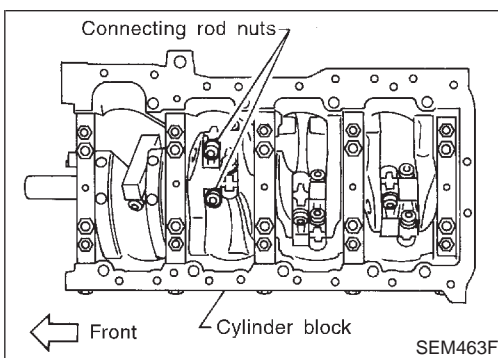
- Confirm that correct bearings are used. Refer to "Inspection".
- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.



5. Install pistons with connecting rods.

- a. Install them into corresponding cylinders with Tool.

- Be careful not to scratch cylinder wall with the connecting rod.
- Arrange so that front mark on piston head faces toward front of engine.
- Apply engine oil to piston rings and sliding surface of piston.



- b. Install connecting rod caps.

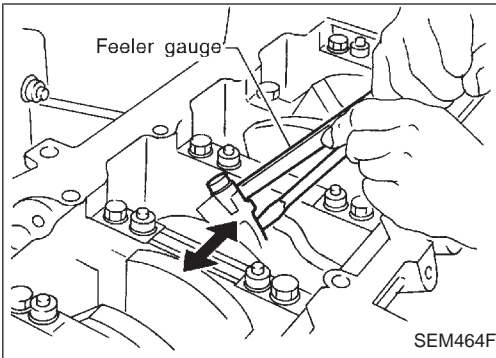
- Apply engine oil to bolt threads and bearing surface. Tighten connecting rod bearing cap nuts to the specified torque.

Tightening procedure:

- 1) Tighten nuts to 14 to 16 N·m (1.4 to 1.6 kg·m, 10 to 12 ft·lb).
- 2) Turn nuts 60 to 65 degrees clockwise with angle wrench.

CYLINDER BLOCK

Assembly (Cont'd)



6. Measure connecting rod side clearance.

Connecting rod side clearance:

Standard

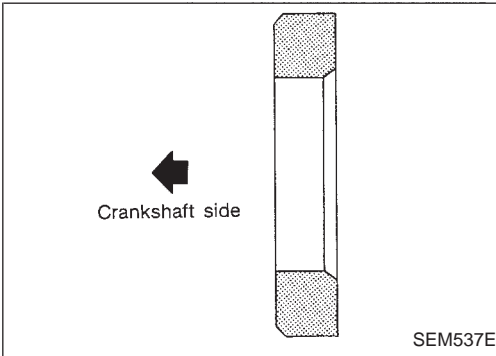
0.20 - 0.35 mm (0.0079 - 0.0138 in)

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 CONVERTER

1. Remove pilot converter.
2. Install pilot converter.

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SERVICE DATA AND SPECIFICATIONS (SDS)

General Specifications

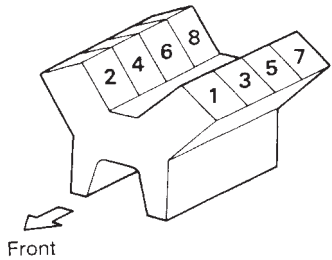
Cylinder arrangement	V-8	
Displacement	cm ³ (cu in)	4,130 (252.01)
Bore and stroke	mm (in)	93 x 76 (3.66 x 2.99)
Valve arrangement	DOHC	
Firing order	1-8-7-3-6-5-4-2	
Number of piston rings		
Compression	2	
Oil	1	
Number of main bearings	5	
Compression ratio	10.5	

COMPRESSION PRESSURE

Unit: kPa (kg/cm², psi)/300 rpm

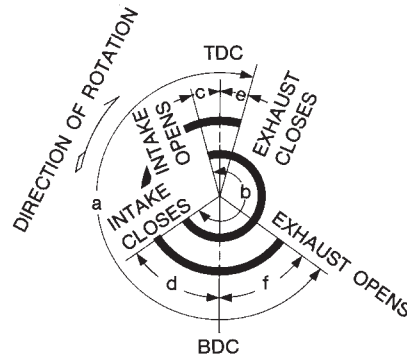
Compression pressure		
Standard	1,285 (13.1, 186)	
Minimum	991 (10.1, 144)	
Differential limit between cylinders	98 (1.0, 14)	

Cylinder number



SEM957C

Valve timing



EM120
Unit: degree

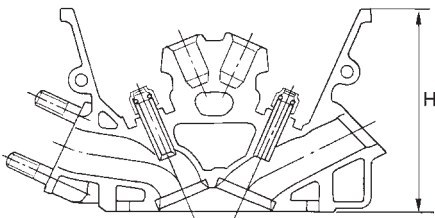
		a	b	c	d	e	f
Intake valve timing control solenoid valve	ON	232	232	15	37	5	47
	OFF	232	232	-5	57	5	47

Inspection and Adjustment

CYLINDER HEAD

Unit: mm (in)

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



SEM956C

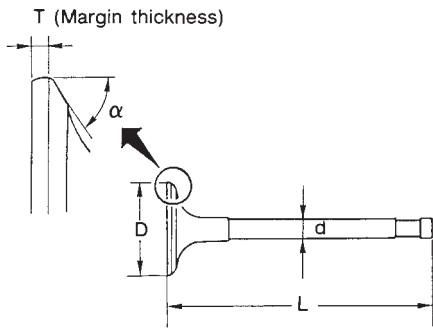
Nominal cylinder head height:
H = 130.7 - 130.9 mm (5.146 - 5.154 in)

SERVICE DATA AND SPECIFICATIONS (SDS)

Inspection and Adjustment (Cont'd)

VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	
Intake	38.0 - 38.3 (1.496 - 1.508)
Exhaust	33.0 - 33.2 (1.299 - 1.307)
Valve length "L"	
Intake	101.70 - 102.30 (4.0039 - 4.0276)
Exhaust	102.12 - 102.72 (4.0205 - 4.0441)
Valve stem diameter "d"	
Intake	6.966 - 6.971 (0.2743 - 0.2744)
Exhaust	7.960 - 7.965 (0.3134 - 0.3136)
Valve seat angle "α"	
Intake	45°15' - 45°45'
Exhaust	
Valve margin "T"	
Intake	1.15 - 1.45 (0.0453 - 0.0571)
Exhaust	1.45 - 1.75 (0.0571 - 0.0689)
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)

Valve spring

Free height	mm (in)	49.42 (1.9457)	
Pressure N (kg, lb) at height mm (in)	Standard	535.5 (54.6, 120.4) at 26.8 (1.055)	
		Limit	477.6 (48.7, 107.4) at 26.8 (1.055)
		Out-of-square	mm (in)

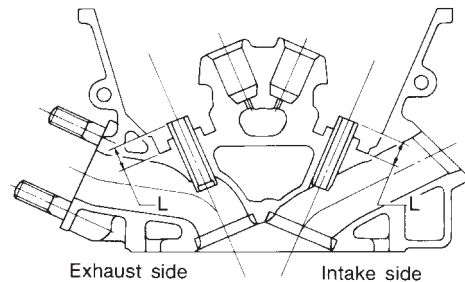
Hydraulic lash adjuster (HLA)

Unit: mm (in)

HLA outer diameter	16.980 - 16.993 (0.6685 - 0.6690)
HLA guide inner diameter	17.000 - 17.020 (0.6693 - 0.6701)
Clearance between HLA and HLA guide	0.007 - 0.040 (0.0003 - 0.0016)

Valve guide

Unit: mm (in)



SEM933C

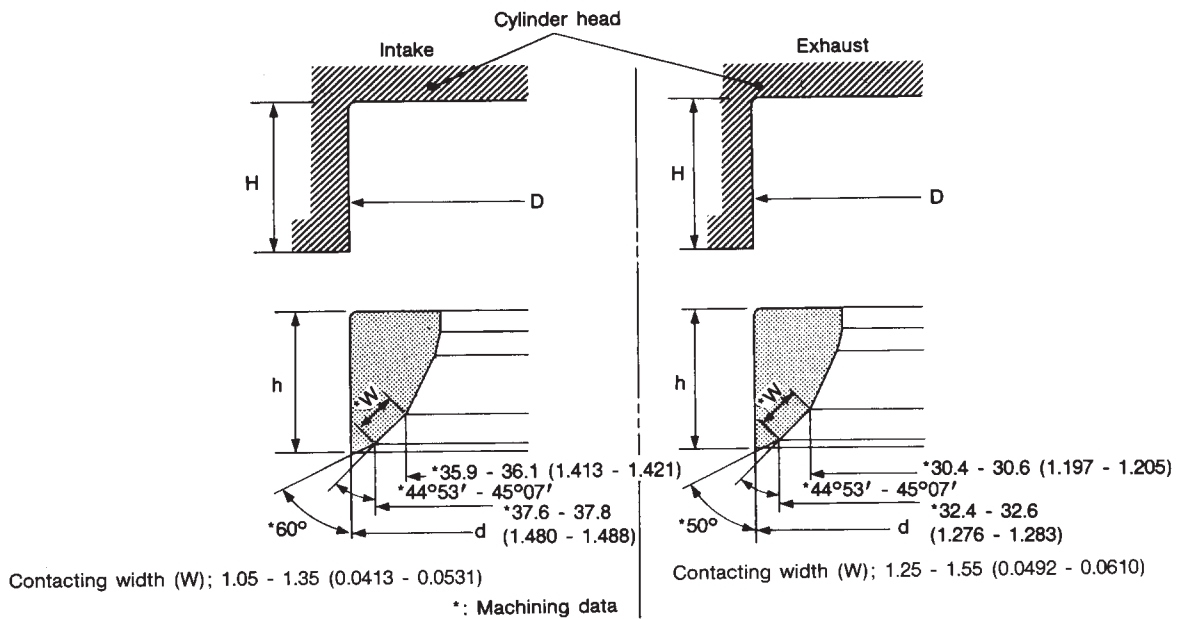
		Standard	Service
Valve guide	Outer diameter	Intake	11.023 - 11.034 (0.4340 - 0.4344)
		Exhaust	12.023 - 12.034 (0.4733 - 0.4738)
Valve guide	Inner diameter (Finished size)	Intake	7.000 - 7.018 (0.2756 - 0.2763)
		Exhaust	8.000 - 8.011 (0.3150 - 0.3154)
Cylinder head valve guide hole diameter	Intake	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
	Exhaust	11.975 - 11.996 (0.4715 - 0.4723)	12.175 - 12.196 (0.4793 - 0.4802)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
Stem to guide clearance	Intake	Standard	0.029 - 0.052 (0.0011 - 0.0020)
		Limit	0.086 (0.0034)
Stem to guide clearance	Exhaust	Standard	0.035 - 0.051 (0.0014 - 0.0020)
		Limit	0.092 (0.0036)
Valve deflection limit		—	0.15 (0.0059)
Projection length "L"		17.15 - 17.35 (0.6752 - 0.6831)	

SERVICE DATA AND SPECIFICATIONS (SDS)

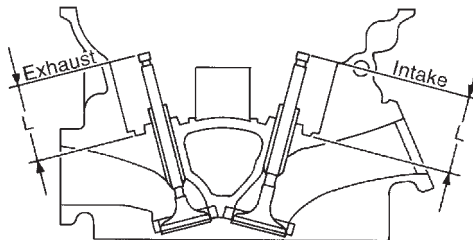
Inspection and Adjustment (Cont'd)

VALVE SEAT

Unit: mm (in)



SEM687EA



SEM621F

		Standard	Service
Cylinder head seat recess diameter (D)	In.	39.000 - 39.016 (1.5354 - 1.5361)	39.500 - 39.516 (1.5551 - 1.5557)
	Ex.	34.000 - 34.016 (1.3386 - 1.3392)	34.500 - 34.516 (1.3583 - 1.3589)
Valve seat interference fit	In.	0.081 - 0.113 (0.0032 - 0.0044)	
	Ex.	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	In.	39.097 - 39.113 (1.5392 - 1.5399)	39.597 - 39.613 (1.5589 - 1.5596)
	Ex.	34.080 - 34.096 (1.3417 - 1.3424)	34.580 - 34.596 (1.3614 - 1.3620)
Depth (H)	In.	6.32 - 6.52 (0.2488 - 0.2567)	
	Ex.	6.15 - 6.35 (0.2421 - 0.2500)	
Height (h)		6.2 - 6.3 (0.244 - 0.248)	
Depth (L)	In.	46.25 - 46.95 (1.8209 - 1.8484)	
	Ex.	46.21 - 46.91 (1.8193 - 1.8468)	

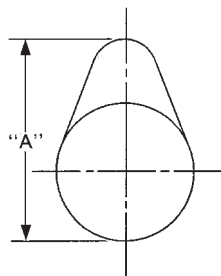
SERVICE DATA AND SPECIFICATIONS (SDS)

Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

	Standard	Limit
Camshaft journal to bearing clearance	0.045 - 0.086 (0.0018 - 0.0034)	0.15 (0.0059)
Inner diameter of camshaft bearing	26.000 - 26.021 (1.0236 - 1.0244)	—
Outer diameter of camshaft journal	25.935 - 25.955 (1.0211 - 1.0218)	—
Camshaft runout [TIR*]	Less than 0.02 (0.0008)	0.05 (0.0020)
Camshaft sprocket runout [TIR*]	Less than 0.25 (0.0098)	—
Camshaft end play	0.070 - 0.148 (0.0028 - 0.0058)	0.20 (0.0079)



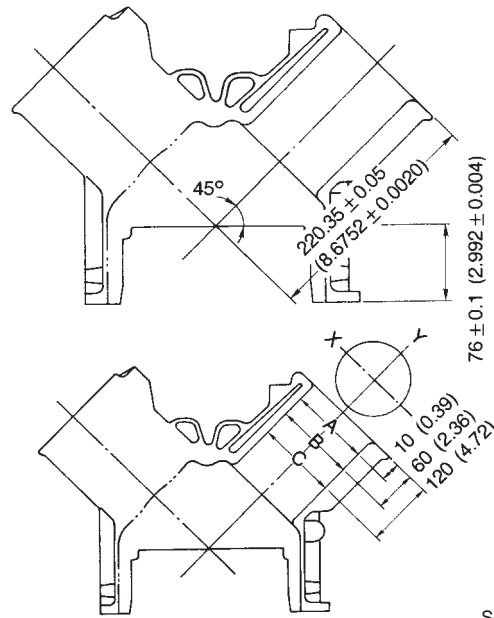
EM671

Cam height "A"	
Intake	37.858 - 38.048 (1.4905 - 1.4979)
Exhaust	34.969 - 35.159 (1.3767 - 1.3842)
Wear limit of cam height	0.05 (0.0020)

*Total indicator reading

CYLINDER BLOCK

Unit: mm (in)



SEM955CB

Surface flatness

Standard	Less than 0.03 (0.0012)
Limit	0.10 (0.0039)

Cylinder bore

Inner diameter

Standard	
Grade No. 1	93.000 - 93.010 (3.6614 - 3.6618)
Grade No. 2	93.010 - 93.020 (3.6618 - 3.6622)
Grade No. 3	93.020 - 93.030 (3.6622 - 3.6626)
Wear limit	0.20 (0.0079)

Out-of-round (X - Y)	Less than 0.015 (0.0006)
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Taper (A - B - C)	Less than 0.010 (0.0004)
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Difference in inner diameter between cylinders

Limit	Less than 0.03 (0.0012)
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Main journal inner diameter

Grade No. 0	68.944 - 68.948 (2.7143 - 2.7145)
Grade No. 1	68.948 - 68.952 (2.7145 - 2.7146)
Grade No. 2	68.952 - 68.956 (2.7146 - 2.7148)
Grade No. 3	68.956 - 68.960 (2.7148 - 2.7150)
Grade No. 4	68.960 - 68.964 (2.7150 - 2.7151)
Grade No. 5	68.964 - 68.968 (2.7151 - 2.7153)

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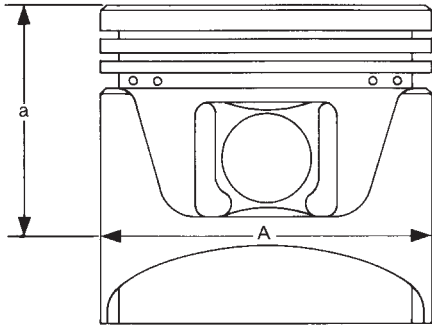
SERVICE DATA AND SPECIFICATIONS (SDS)

Inspection and Adjustment (Cont'd)

PISTON, PISTON RING AND PISTON PIN

Available piston

Unit: mm (in)



SEM882E

Piston skirt diameter "A"	
Standard	
Grade No. 1	92.980 - 92.990 (3.6606 - 3.6610)
Grade No. 2	92.990 - 93.000 (3.6610 - 3.6614)
Grade No. 3	93.000 - 93.010 (3.6614 - 3.6618)
0.20 (0.0079) over-size (Service)	93.180 - 93.210 (3.6685 - 3.6697)
"a" dimension	54 (2.13)
Piston clearance to cylinder block	0.010 - 0.030 (0.0004 - 0.0012)
Piston pin hole diameter	21.987 - 21.999 (0.8656 - 0.8661)

Piston ring

Unit: mm (in)

	Standard	Limit
Side clearance		
Top	0.040 - 0.080 (0.0016 - 0.0031)	0.1 (0.004)
2nd	0.030 - 0.070 (0.0012 - 0.0028)	
End gap		
Top	0.27 - 0.46 (0.0106 - 0.0181)	1.0 (0.039)
2nd	0.39 - 0.63 (0.0154 - 0.0248)	
Oil (rail ring)	0.20 - 0.69 (0.0079 - 0.0272)	

Piston pin

Unit: mm (in)

Piston pin outer diameter	21.989 - 22.001 (0.8657 - 0.8662)
Interference fit of piston pin to piston	-0.004 to 0 (-0.0002 to 0)
Piston pin to connecting rod bushing clearance	
Standard	0.005 - 0.017 (0.0002 - 0.0007)
Limit	0.023 (0.0009)

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

CONNECTING ROD

Unit: mm (in)

Center distance	146.95 - 147.05 (5.7854 - 5.7894)
Bend, torsion [per 100 (3.94)]	
Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	
Limit	0.3 (0.012)
Connecting rod small end inner diameter	24.980 - 25.000 (0.9835 - 0.9843)
Piston pin bushing inner diameter*	22.000 - 22.012 (0.8661 - 0.8666)
Connecting rod big end inner diameter	55.000 - 55.013 (2.1654 - 2.1659)
Side clearance	
Standard	0.20 - 0.35 (0.0079 - 0.0138)
Limit	0.40 (0.0157)

*After installing in connecting rod

SERVICE DATA AND SPECIFICATIONS (SDS)

Inspection and Adjustment (Cont'd)

CRANKSHAFT

Unit: mm (in)

Main journal dia. "Dm"

Grade No. 0	63.960 - 63.964 (2.5181 - 2.5183)
Grade No. 1	63.956 - 63.960 (2.5179 - 2.5181)
Grade No. 2	63.952 - 63.956 (2.5178 - 2.5179)
Grade No. 3	63.948 - 63.952 (2.5176 - 2.5178)
Grade No. 4	63.944 - 63.948 (2.5175 - 2.5176)
Grade No. 5	63.940 - 63.944 (2.5173 - 2.5175)

Pin journal dia. "Dp"

Grade No. 0	51.968 - 51.974 (2.0460 - 2.0462)
Grade No. 1	51.962 - 51.968 (2.0457 - 2.0460)
Grade No. 2	51.956 - 51.962 (2.0455 - 2.0457)

Center distance "r"

37.996 - 38.004 (1.4959 - 1.4962)

Out-of-round (X - Y)

Standard	Less than 0.005 (0.0002)
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Taper (A - B)

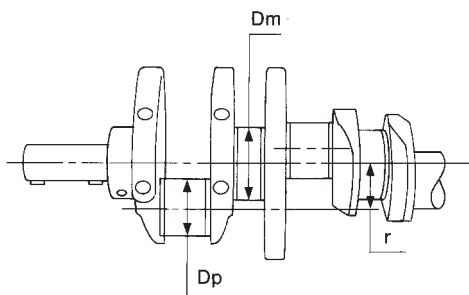
Standard	Less than 0.005 (0.0002)
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Runout [TIR]

Standard	Less than 0.05 (0.0020)
Limit	0.1 (0.004)

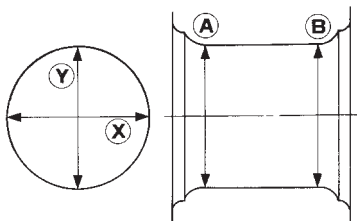
Free end play

Standard	0.10 - 0.26 (0.0039 - 0.0102)
Limit	0.30 (0.0118)



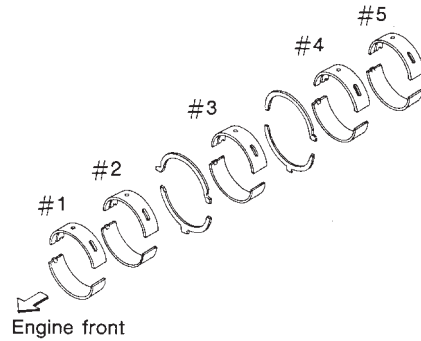
SEM954C

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



EM715

AVAILABLE MAIN BEARING



Engine front

SEM753C

Standard size

Unit: mm (in)

Grade number	Thickness "T"	Identification color (mark)
0	2.484 - 2.487 (0.0978 - 0.0979)	Black (A)
1	2.486 - 2.489 (0.0979 - 0.0980)	Brown (B)
2	2.488 - 2.491 (0.0980 - 0.0981)	Green (C)
3	2.490 - 2.493 (0.0980 - 0.0981)	Yellow (D)
4	2.492 - 2.495 (0.0981 - 0.0982)	Blue (E)
5	2.494 - 2.497 (0.0982 - 0.0983)	Pink (F)
6	2.496 - 2.499 (0.0983 - 0.0984)	No color (G)
7	2.498 - 2.501 (0.0983 - 0.0985)	White (H)
8	2.500 - 2.503 (0.0984 - 0.0985)	Red (I)
9	2.502 - 2.505 (0.0985 - 0.0986)	Black/Black (J)
10	2.504 - 2.507 (0.0986 - 0.987)	Yellow/Yellow (K)

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SERVICE DATA AND SPECIFICATIONS (SDS)

Inspection and Adjustment (Cont'd)

Undersize

Unit: mm (in)

	Thickness	Main journal diameter "Dm"
0.25 (0.0098)	2.617 - 2.625 (0.1030 - 0.1033)	Grind so that bearing clearance is the specified value.

Bearing clearance

Unit: mm (in)

Main bearing clearance	
Standard	0.006 - 0.020 (0.0002 - 0.0008)
Limit	0.030 (0.0012)
Connecting rod bearing clearance	
Standard	0.020 - 0.045 (0.0008 - 0.0018)
Limit	0.055 (0.0022)

AVAILABLE CONNECTING ROD BEARING

Connecting rod bearing

Standard size

Unit: mm (in)

Grade number	Thickness "T"	Identification color (mark)
0	1.500 - 1.503 (0.0591 - 0.0592)	No color (A)
1	1.503 - 1.506 (0.0592 - 0.0593)	Brown (B)
2	1.506 - 1.509 (0.0593 - 0.0594)	Green (C)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Drive plate	
Runout [TIR]*	Less than 0.20 (0.0079)

*Total indicator reading

Undersize

Unit: mm (in)

	Thickness	Crank pin journal diameter "Dp"
0.08 (0.0031)	1.541 - 1.549 (0.0607 - 0.0610)	Grind so that bearing clearance is the specified value.
0.12 (0.0047)	1.561 - 1.569 (0.0615 - 0.0618)	
0.25 (0.0098)	1.626 - 1.634 (0.0640 - 0.0643)	