

ENGINE MECHANICAL

SECTION **EM**

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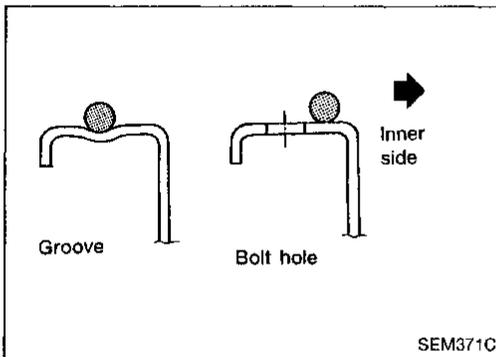
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PRECAUTIONS

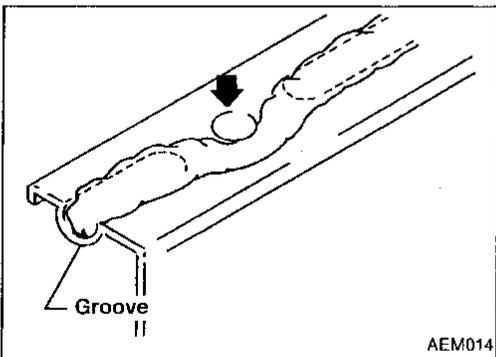
Parts Requiring Angular Tightening

- Tighten the following engine parts in an angular-tightening method, not in a torque-setting method. Otherwise, with the latter method, the dispersal of tightening force (axial bolt force) would be greater (two or three times).
- The bolts and nuts which require the angular-tightening method are as follows:
 - (1) Cylinder head bolts
 - (2) Main bearing cap bolts
 - (3) Connecting rod cap nuts
- The torque-setting values in this manual are for reference only. They are equivalent to those used when bolts and nuts are tightened with an angular-tightening method.
- Before tightening bolts and nuts, ensure thread and seat surfaces are clean and coated with engine oil.



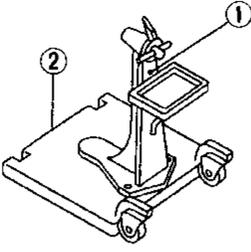
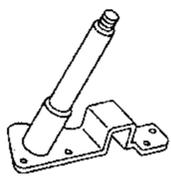
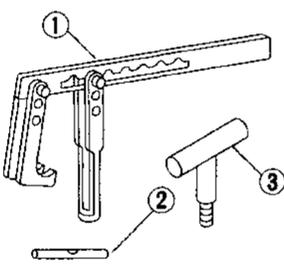
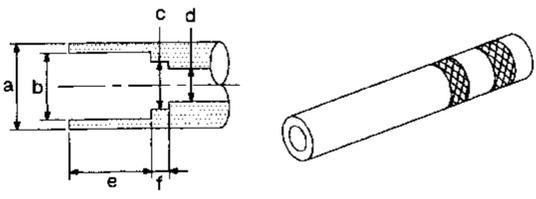
Liquid Gasket Application Procedure

- Remove all traces of old liquid gasket from mating surfaces and grooves using a scraper. Then completely clean any oil stains from these portions.
- Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Liquid Gasket or equivalent.)
 - 1) Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide (for oil pan).
 - 2) Be sure liquid gasket is 2.0 to 3.0 mm (0.079 to 0.118 in) wide (in areas except oil pan).
- Apply liquid gasket to inner surface around hole perimeter area. (Assembly should be done within 5 minutes after coating.)
- Wait at least 30 minutes before refilling engine oil and engine coolant.



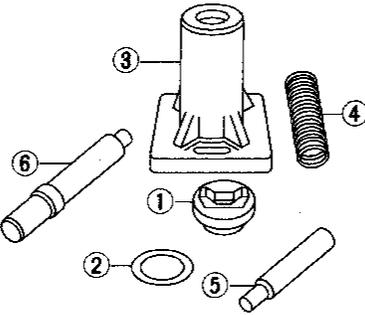
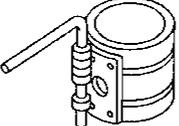
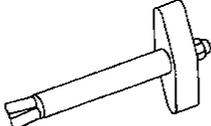
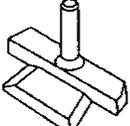
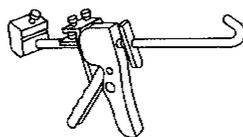
PREPARATION

Special Service Tools

Tool number (Kent-Moore No.) Tool name	Description	
ST0501S000 (—) Engine stand assembly ① ST05011000 (—) Engine stand ② ST05012000 (—) Base		Disassembling and assembling GI MA EM LC EC
KV10105001 (—) Engine attachment		When overhauling engine FE CL
KV101092S0 (—) Valve spring compressor ① KV10109210 (—) Compressor ② KV10109220 (—) Adapter ③ KV10111200 (—) Adapter		Disassembling and assembling valve components MT AT PD FA RA
KV10116300 (J-38955) Valve oil seal drift		Installing valve oil seal BR ST BF

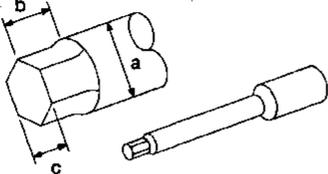
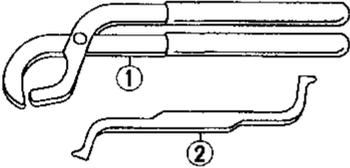
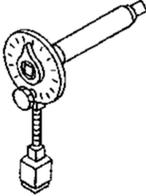
PREPARATION

Special Service Tools (Cont'd)

Tool number (Kent-Moore No.) Tool name	Description
KV10110300 (—) Piston pin press stand assembly ① KV10110310 (—) Cap ② KV10110330 (—) Spacer ③ ST13030020 (—) Press stand ④ ST13030030 (—) Spring ⑤ KV10110340 (—) Drift ⑥ KV10110320 (—) Center shaft	<div style="text-align: right;">Disassembling and assembling piston with connecting rod</div> <div style="text-align: center;">  </div> <div style="text-align: left;">NT036</div>
EM03470000 (J8037) Piston ring compressor	<div style="text-align: right;">Installing piston assembly into cylinder bore</div> <div style="text-align: center;">  </div> <div style="text-align: left;">NT044</div>
(J36467) Valve oil seal remover	<div style="text-align: right;">Displacement valve oil seal</div> <div style="text-align: center;">  </div> <div style="text-align: left;">NT034</div>
KV10111100 (J37228) Seal cutter	<div style="text-align: right;">Removing oil pan</div> <div style="text-align: center;">  </div> <div style="text-align: left;">NT046</div>
WS39930000 (—) Tube presser	<div style="text-align: right;">Pressing the tube of liquid gasket</div> <div style="text-align: center;">  </div> <div style="text-align: left;">NT052</div>

PREPARATION

Special Service Tools (Cont'd)

Tool number (Kent-Moore No.) Tool name	Description	GI
ST16610001 (J23907) Pilot bushing puller	Removing crankshaft pilot pushing  NT045	MA
ST10120000 (J-24239-01) Cylinder head bolt wrench	Loosening and tightening cylinder head bolt  NT583 a: 13 (0.51) dia. b: 12 (0.47) c: 10 (0.39) Unit: mm (in)	EM
KV101151S0 (J38972) Lifter stopper set ① KV10115110 (J38972-1) Camshaft pliers ② KV10115120 (J38972-2) Lifter stopper	Changing valve lifter shims  NT041	FE
KV10112100 Angle wrench	Tightening bolts for bearing cap, cylinder head, etc.  NT014	CL

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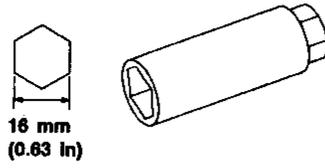
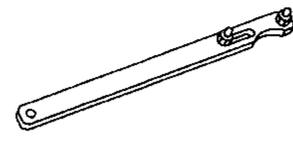
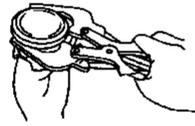
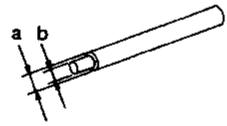
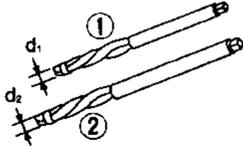
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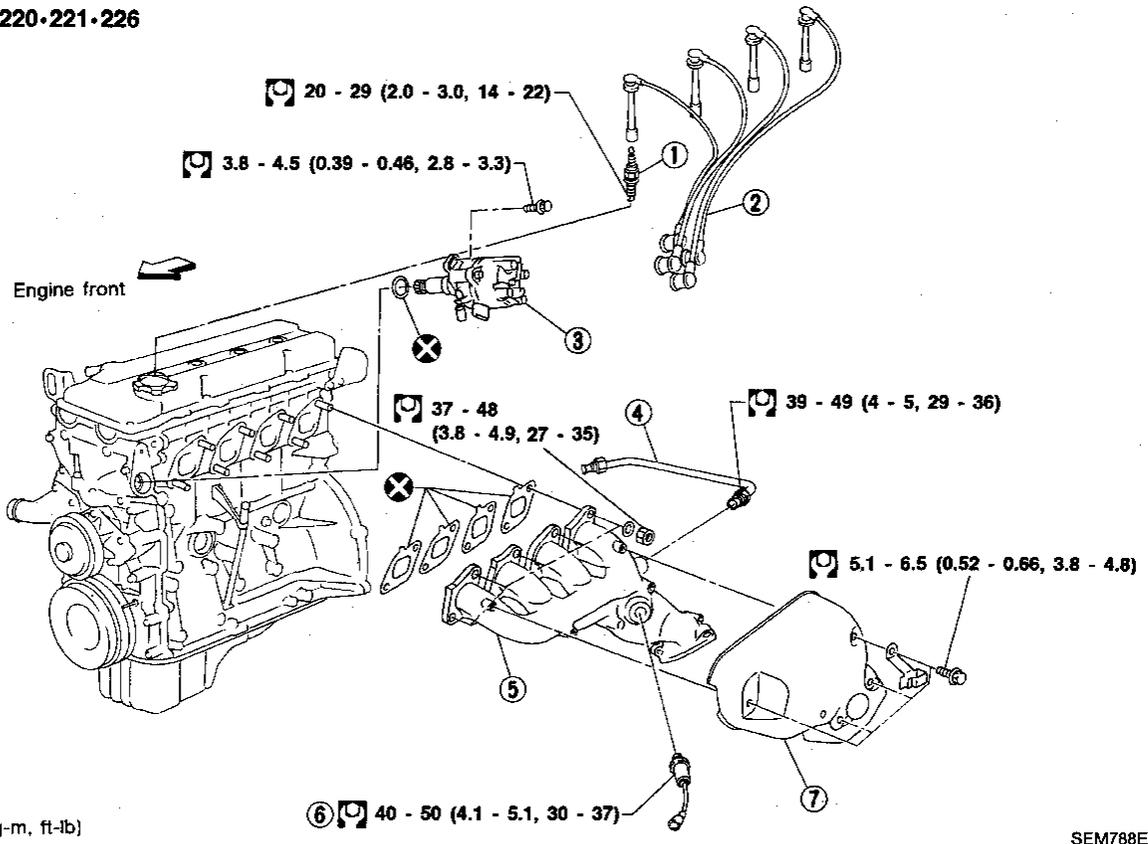
PREPARATION

Commercial Service Tools

Tool name	Description													
Spark plug wrench	 <p style="text-align: center;">NT047</p>	Removing and installing spark plug												
Pulley holder	 <p style="text-align: center;">NT035</p>	Holding camshaft pulley while tightening or loosening camshaft bolt												
Valve seat cutter set	 <p style="text-align: center;">NT048</p>	Finishing valve seat dimensions												
Piston ring expander	 <p style="text-align: center;">NT030</p>	Removing and installing piston ring												
Valve guide drift	 <p style="text-align: center;">NT015</p>	Removing and installing valve guide <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: left;">Diameter:</th> <th style="text-align: right;">mm (in)</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td style="text-align: center;">Intake & Exhaust</td> </tr> <tr> <td style="text-align: center;">a</td> <td></td> <td style="text-align: center;">10.5 (0.413)</td> </tr> <tr> <td style="text-align: center;">b</td> <td></td> <td style="text-align: center;">6.6 (0.260)</td> </tr> </tbody> </table>	Diameter:		mm (in)			Intake & Exhaust	a		10.5 (0.413)	b		6.6 (0.260)
Diameter:		mm (in)												
		Intake & Exhaust												
a		10.5 (0.413)												
b		6.6 (0.260)												
Valve guide reamer	 <p style="text-align: center;">NT016</p>	Reaming valve guide (①) or hole for oversize valve guide (②) <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: left;">Diameter:</th> <th style="text-align: right;">mm (in)</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td style="text-align: center;">Intake & Exhaust</td> </tr> <tr> <td style="text-align: center;">d_1</td> <td></td> <td style="text-align: center;">7 (0.28)</td> </tr> <tr> <td style="text-align: center;">d_2</td> <td></td> <td style="text-align: center;">11.175 (0.4400)</td> </tr> </tbody> </table>	Diameter:		mm (in)			Intake & Exhaust	d_1		7 (0.28)	d_2		11.175 (0.4400)
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		Intake & Exhaust												
d_1		7 (0.28)												
d_2		11.175 (0.4400)												

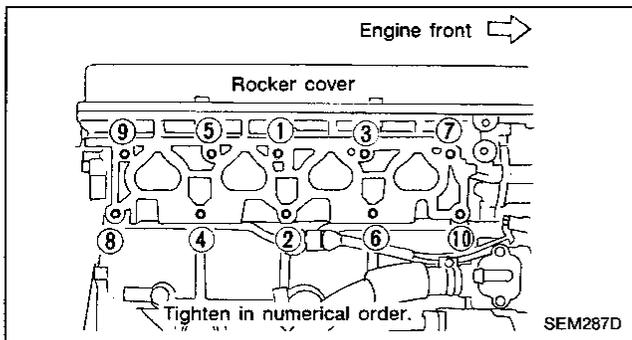
OUTER COMPONENT PARTS

SEC. 140-147-220-221-226

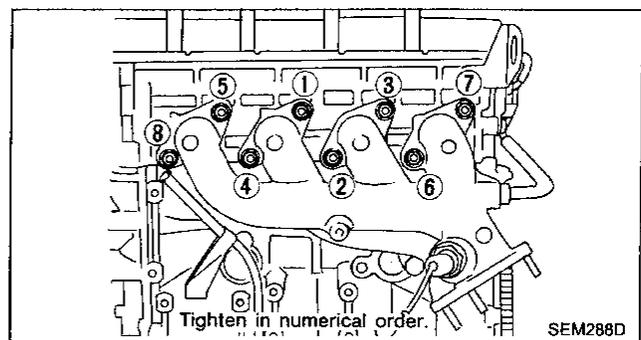


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| ① Spark plug | ③ Camshaft position sensor built into distributor | ⑤ Exhaust manifold |
| ② Ignition wire | ④ EGR tube | ⑥ Oxygen sensor |
| | | ⑦ Exhaust manifold cover |

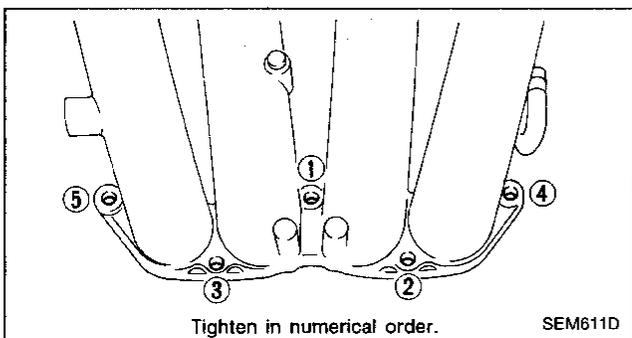
Intake manifold tightening procedure



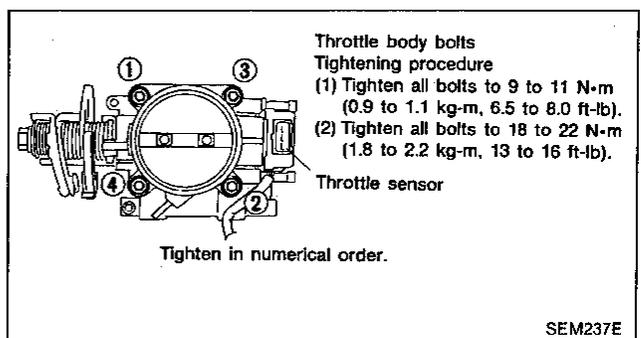
Exhaust manifold tightening procedure



Intake manifold collector tightening procedure



Throttle body tightening procedure



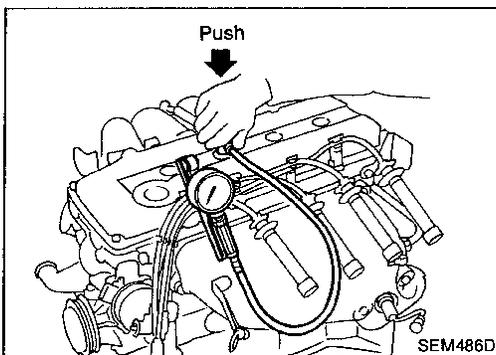
Measurement of Compression Pressure

1. Warm up engine.
2. Turn ignition switch off.
3. Release fuel pressure.
Refer to "Releasing Fuel Pressure" in EC section.
4. Remove all spark plugs.
5. Disconnect distributor center cable.

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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.

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

FE

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

Standard

1,236 (12.6, 179)/300

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Minimum

1,040 (10.6, 151)/300

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Difference limit between cylinders

98 (1.0, 14)/300

10. If cylinder compression in one or more cylinders is low, do the following:
Pour a small amount of engine oil into cylinders through spark plug holes. Then retest compression.
- **If adding oil improves cylinder compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. (Refer to SDS) If valve or valve seat is damaged excessively, replace them.**
- **There is leakage past the gasket surface if the following is observed. Compression in two adjacent cylinders is low and adding oil does not improve compression. If so, replace cylinder head gasket.**

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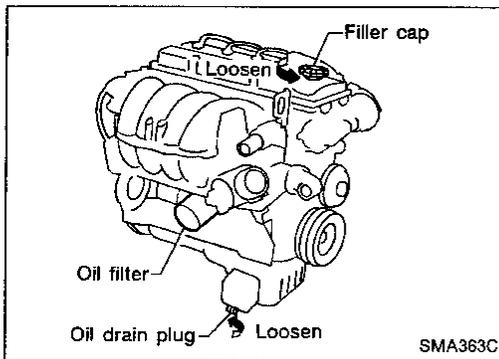
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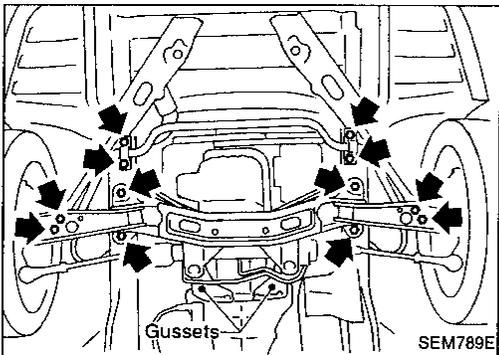
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OIL PAN

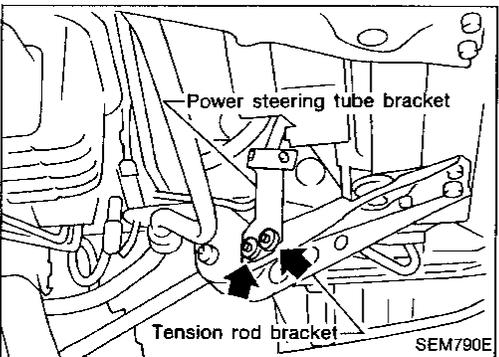


Removal

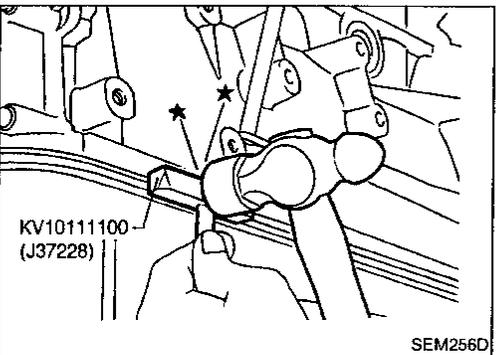
1. Raise vehicle and support it with safety stands.
2. Drain engine oil.
3. Install engine slingers to cylinder head. Refer to "ENGINE REMOVAL" (EM-32).
4. Set a suitable hoist on engine slinger and hold the engine.



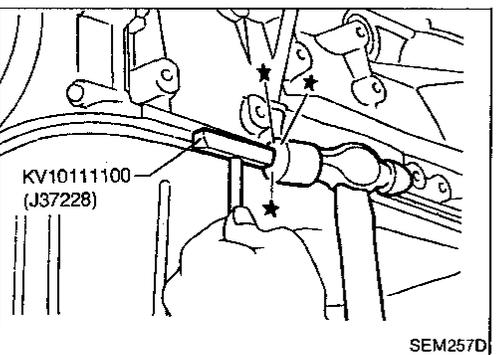
5. Remove the following parts.
 - Tension rod bolts at transverse links
 - Front stabilizer bar securing bolts and nuts from side member.
 - Both left and right side engine mounting bolts. Refer to "ENGINE REMOVAL" (EM-32).
 - Gussets
6. Disconnect steering shaft lower joint.



7. Remove power steering tube bracket securing bolts at left tension rod bracket.
8. Remove front suspension member securing bolts while supporting with a jack.
9. Lower front suspension member by around 60 mm (2.36 in).



10. Remove oil pan.
 - a. Insert Tool between cylinder block and oil pan.
 - **Do not drive seal cutter into oil pump or rear oil seal retainer portion, or aluminum mating face will be damaged.**
 - **Do not insert screwdriver, or oil pan flange will be deformed.**

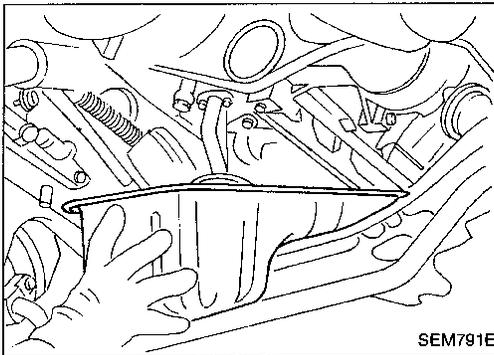


- b. Slide Tool by tapping its side with a hammer, and remove oil pan.

OIL PAN

Removal (Cont'd)

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



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Installation

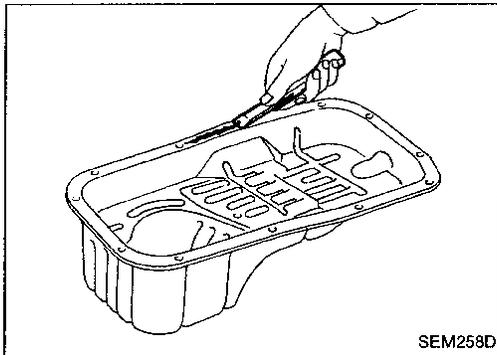
1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
 - Also remove traces of liquid gasket from mating surface of cylinder block.

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2. Apply a continuous bead of liquid gasket to mating surface of oil pan.

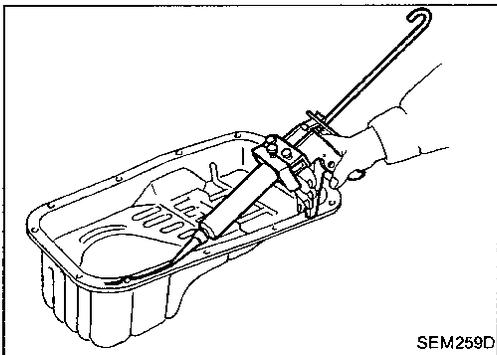
- Use Genuine Liquid Gasket or equivalent.

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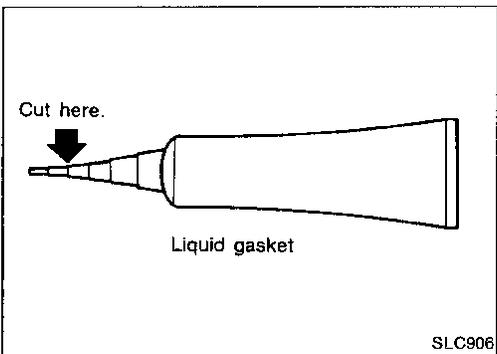
- Be sure liquid gasket bead is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.

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3. Apply liquid gasket to inner sealing surface as shown in figure.

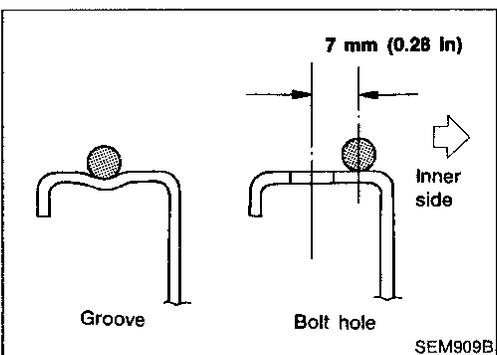
- Attaching should be done within 5 minutes after coating.

4. Install oil pan.

- Wait at least 30 minutes before refilling engine oil.

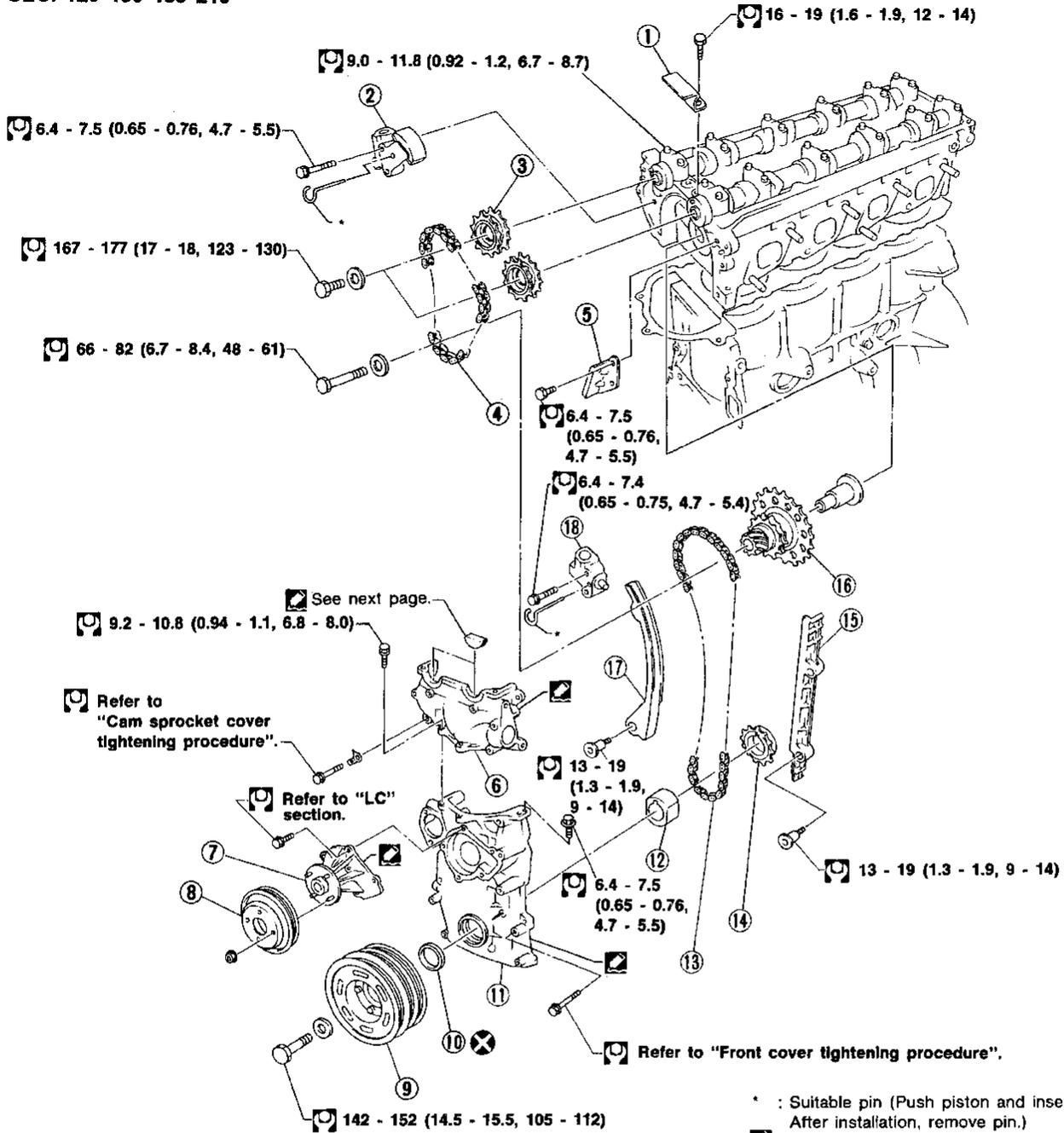
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TIMING CHAIN

SEC. 120-130-135-210



* : Suitable pin (Push piston and insert pin. After installation, remove pin.)

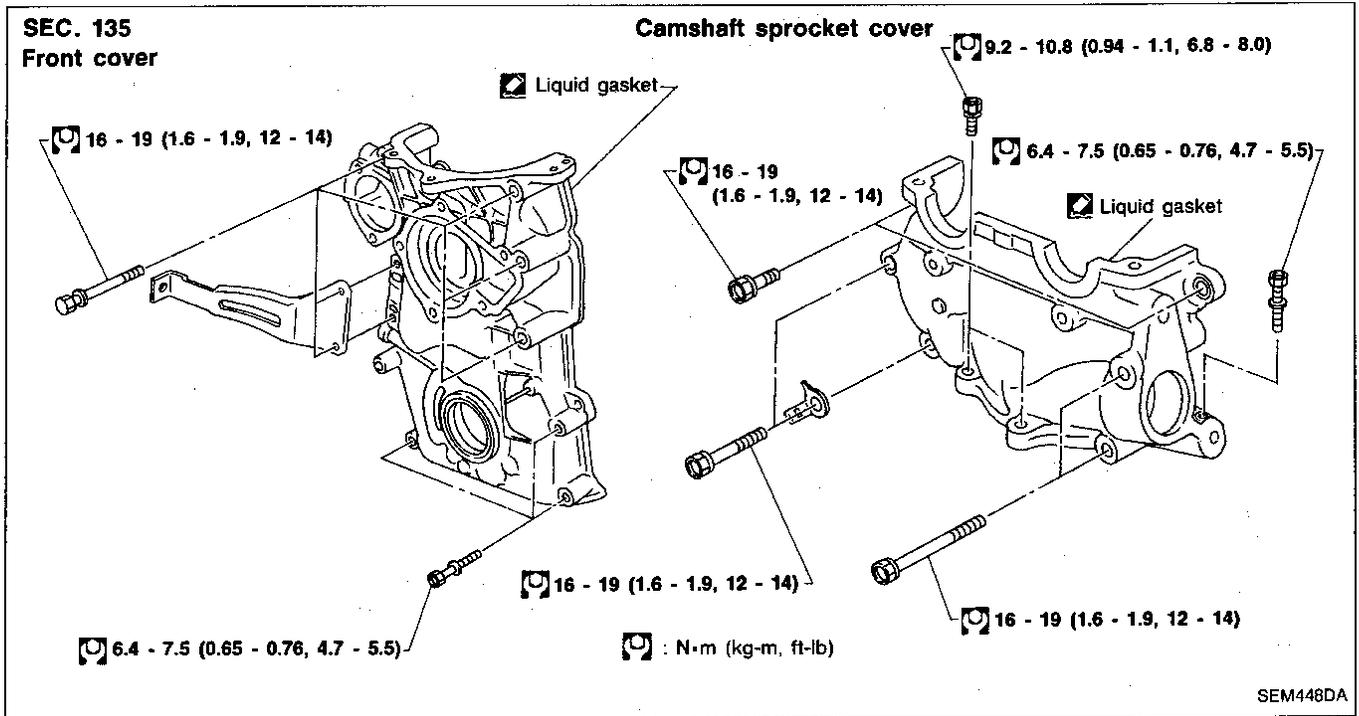
☑ : Apply liquid gasket.

Ⓜ : N·m (kg-m, ft-lb)

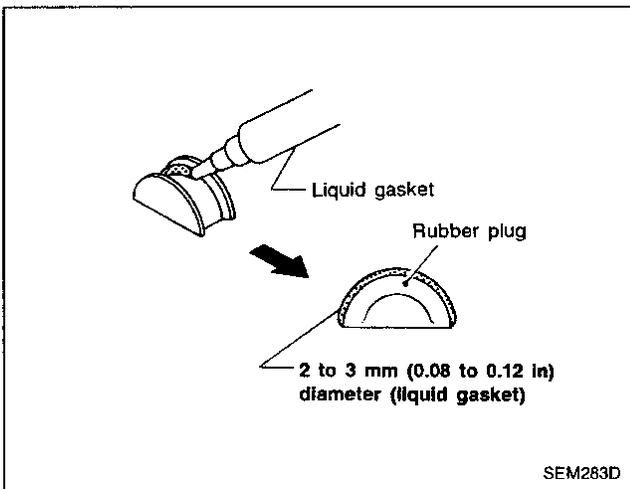
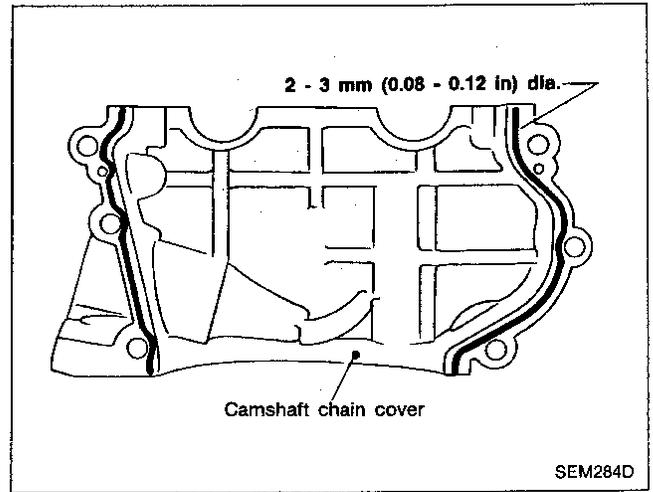
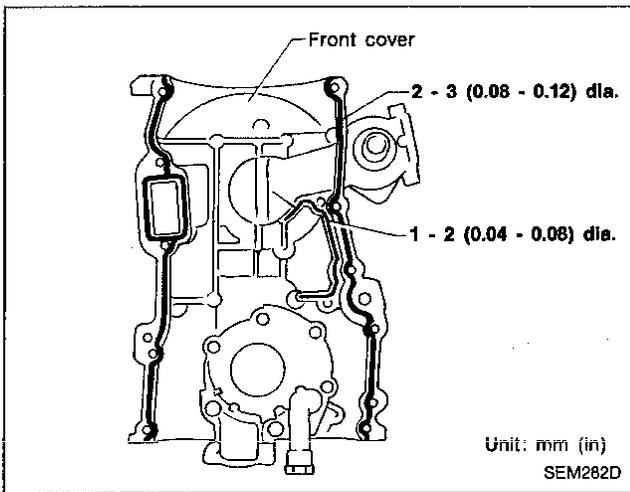
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|--------------------------------|-------------------------|--------------------------------|
| ① Chain guide | ⑦ Water pump | ⑬ Lower timing chain |
| ② Upper timing chain tensioner | ⑧ Water pump pulley | ⑭ Crankshaft sprocket |
| ③ Cam sprocket | ⑨ Crankshaft pulley | ⑮ Chain guide |
| ④ Upper timing chain | ⑩ Front oil seal | ⑯ Idrler sprocket |
| ⑤ Chain guide | ⑪ Front cover | ⑰ Chain tension arm |
| ⑥ Upper front cover | ⑫ Oil pump drive spacer | ⑱ Lower timing chain tensioner |

TIMING CHAIN



Liquid gasket application places



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TIMING CHAIN

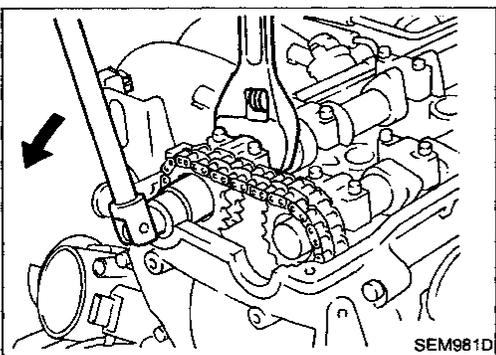
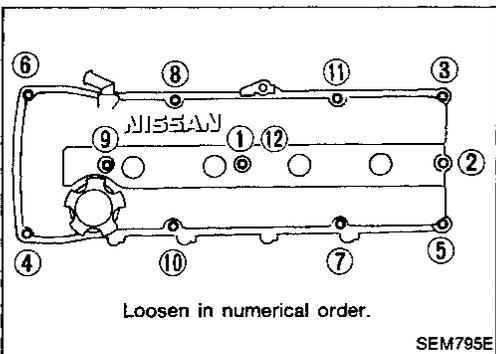
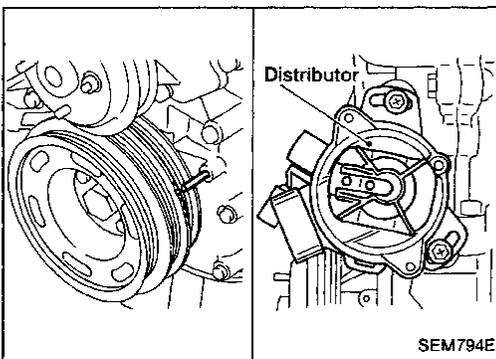
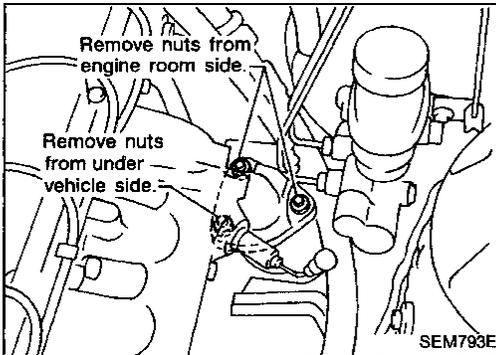
CAUTION:

- After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.

Removal

UPPER TIMING CHAIN

1. Drain coolant from both cylinder block drain plug and radiator drain cock. Refer to MA section.
2. Drain engine oil from drain plug of oil pan.
3. Remove vacuum hoses, fuel tubes, wires, harness and connectors and so on.
4. Remove exhaust manifold cover and front exhaust tube .
5. Remove the following parts.
 - Air duct
 - Cooling fan with coupling
 - Radiator shroud
6. Disconnect injector harness connector and remove injector tube assembly with injectors.
7. Remove all spark plugs with high-tension cords.



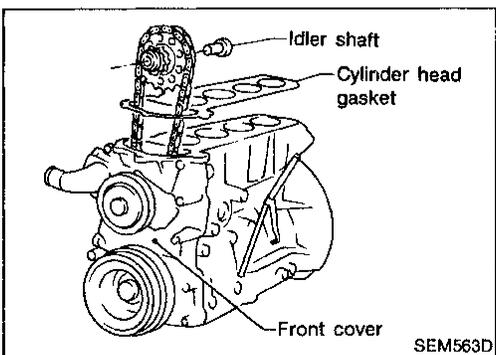
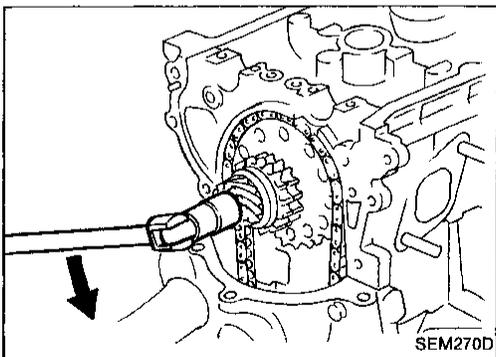
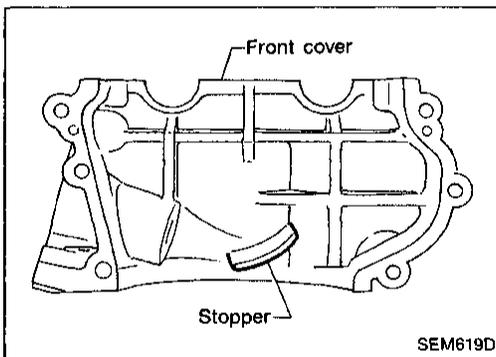
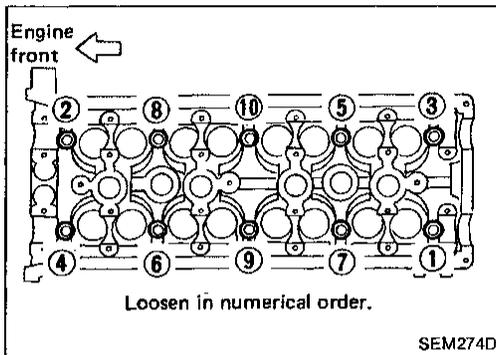
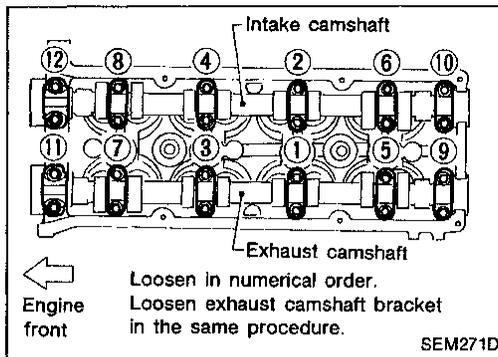
8. Set No. 1 piston at TDC on its compression stroke.

9. Remove rocker cover.
10. Remove distributor.

11. Remove cam sprocket.

TIMING CHAIN

Removal (Cont'd)



12. Remove cam brackets and camshafts.

- These parts should be reassembled in their original positions.

13. Loosen cylinder head bolts.

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

14. Remove cam sprocket cover

- Upper timing chain will not be disengaged from idler sprocket. For this reason, a stopper need not be used.

Cast portion of cam sprocket cover is located on lower side of idler sprocket so upper timing chain need not be disengaged from idler sprocket.

15. Remove upper chain tensioner.

(Push piston and insert a suitable pin into pin hole.)

16. Remove upper chain guides.

17. Remove upper timing chain.

18. Remove idler sprocket bolt.

19. Remove cylinder head with intake manifold, intake manifold collector and exhaust manifold assembly.

20. Remove cylinder head gasket.

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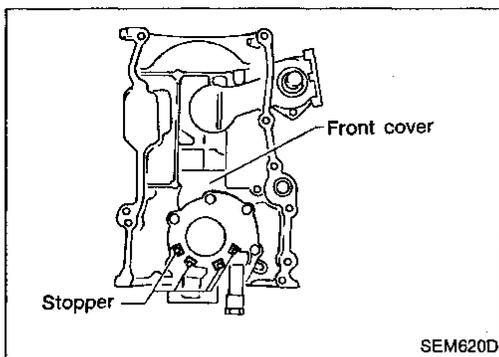
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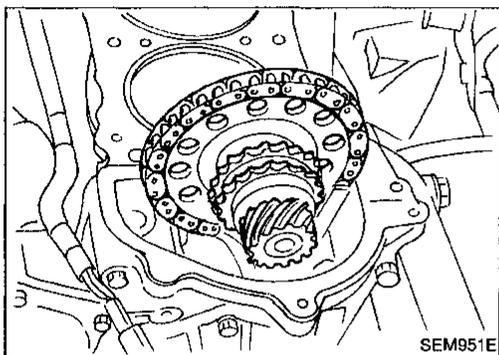
TIMING CHAIN

Removal (Cont'd)



- Lower timing chain will not be disengaged from crankshaft sprocket. For this reason, a stopper need not be used.

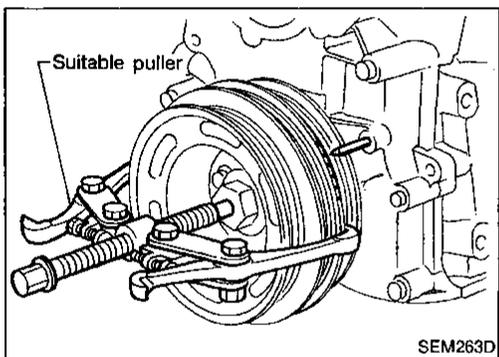
Cast portion of front cover is located on lower side of crankshaft sprocket so lower timing chain need not be disengaged from idler sprocket.



LOWER TIMING CHAIN

1. Remove upper timing chain.

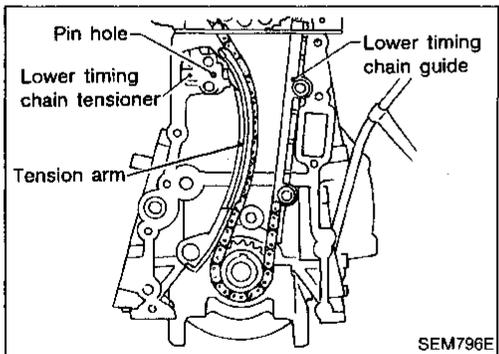
Refer to "UPPER TIMING CHAIN" in "Removal" (EM-14).



2. Remove oil pan.

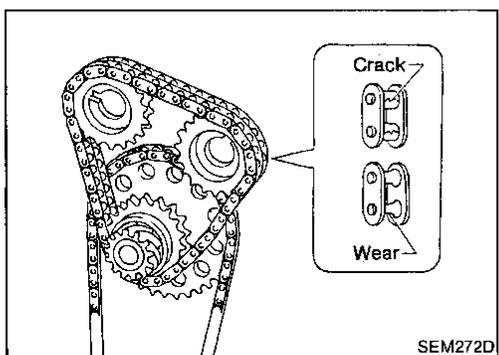
Refer to "Removal" in "OIL PAN" (EM-10).

3. Remove oil strainer.
4. Remove the following parts.
 - Power steering drive belt
 - Alternator drive belt
 - Air compressor drive belt
 - Air compressor idler pulley
5. Remove crankshaft pulley.
6. Remove front cover.



7. Remove the following parts.

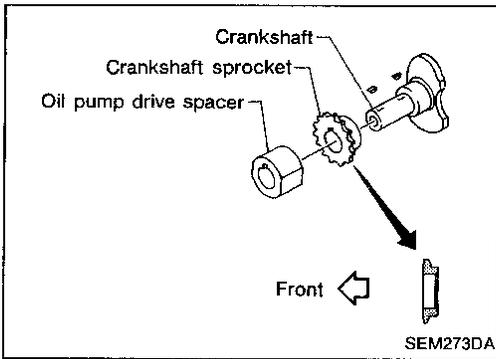
- Lower timing chain tensioner (Push piston and insert a suitable pin into pin hole.)
 - Chain tension arm
 - Lower timing chain guide
8. Remove lower timing chain and idler sprocket.



Inspection

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

TIMING CHAIN



Installation

LOWER TIMING CHAIN

1. Install crankshaft sprocket.
 - **Make sure that mating marks of crankshaft sprocket face front of engine.**
2. Position crankshaft so that No. 1 piston is set at TDC.

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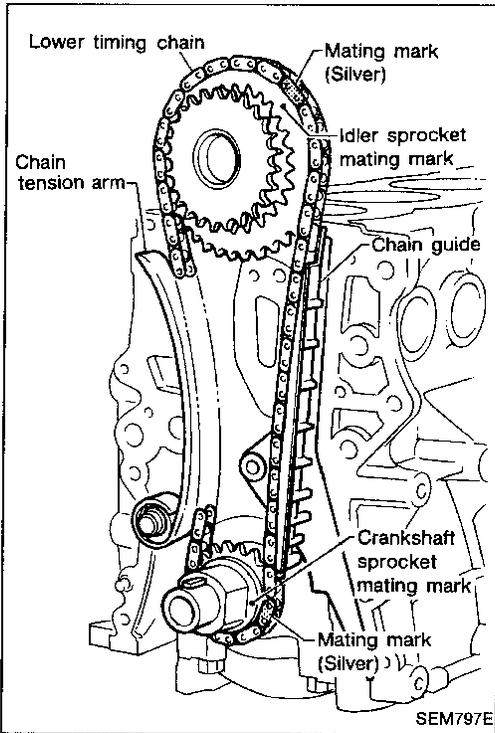
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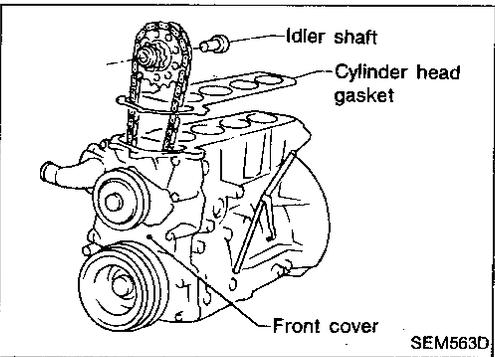
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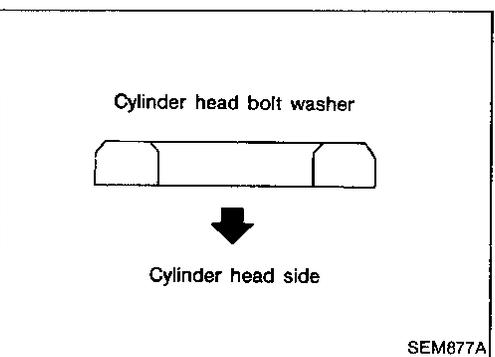
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3. Install idler sprocket and lower timing chain.
 - **Set lower timing chain on the sprockets, aligning mating marks.**
 - **Be careful not to damage cylinder head gasket when installing lower timing chain.**
4. Install chain tension arm and chain guide.
5. Install lower timing chain tensioner.
 - **When installing, insert a suitable pin into pin hole to stop piston.**
 - **After installation remove the pin to release piston.**



6. Install front cover.
 - **Apply a continuous bead of liquid gasket to front cover.**
 - **Be careful not to damage cylinder head gasket.**
 - **Be sure to install oil seal.**
7. Install the following parts:
 - Crankshaft pulley
 - Oil strainer and oil pan
 - Component parts below the engine
 - Air compressor idler pulley
 - New cylinder head gasket
 - Idler shaft

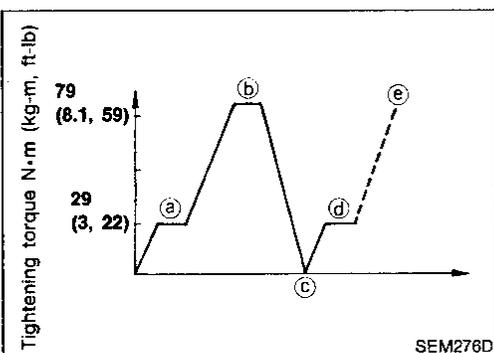
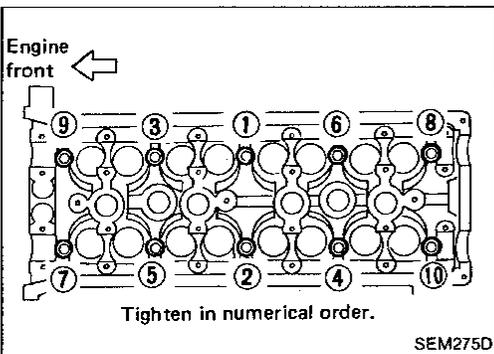
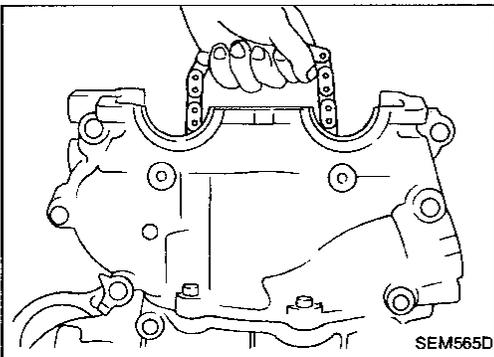
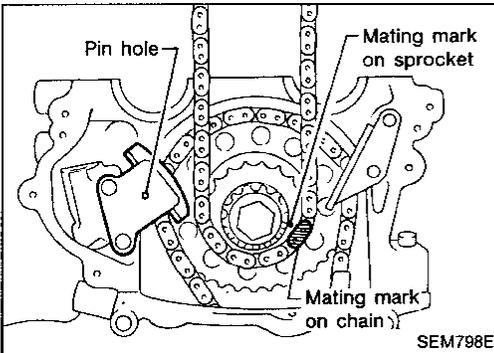
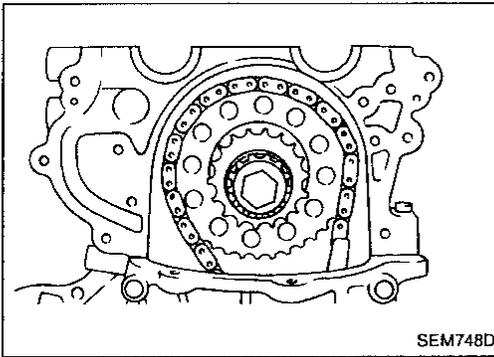


8. Install cylinder head and temporarily tighten cylinder head bolts when installing front cover.
 - **Temporarily tighten cylinder head bolts. This is necessary to avoid damaging cylinder head gasket.**
 - **Be sure to install washers between bolts and cylinder head.**

TIMING CHAIN

Installation (Cont'd)

UPPER TIMING CHAIN



1. Install lower timing chain.
Refer to "LOWER TIMING CHAIN" in "Installation" (EM-16).

2. Install upper timing chain, chain tensioner and chain guide.

- Set upper timing chain on the idler sprockets, aligning mating marks.
- When installing chain tensioner, insert a suitable pin into pin hole to stop piston.
- After installation remove the pin to release piston.

3. Install cam sprocket cover.

- Apply a continuous bead of liquid gasket to front cover.
- Be careful not to damage cylinder head gasket.
- Be careful upper timing chain does not slip or jump when installing cam sprocket cover.

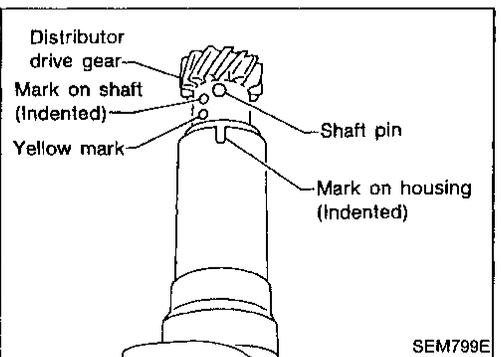
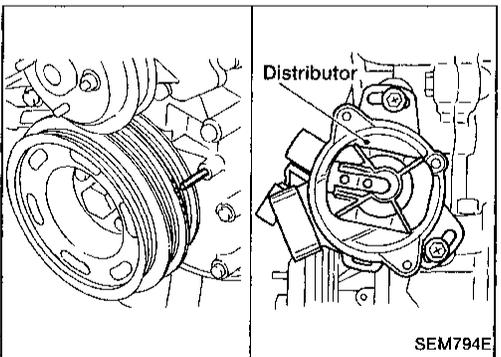
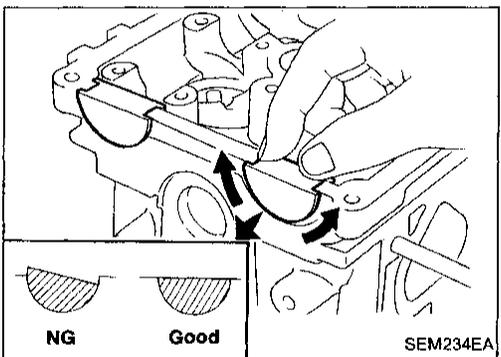
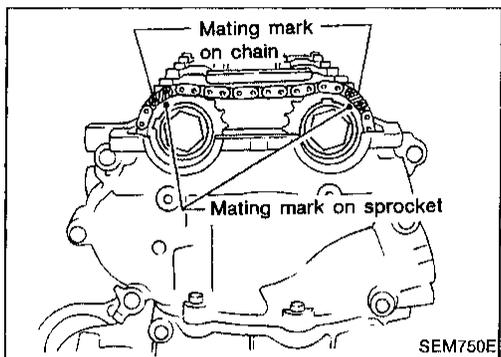
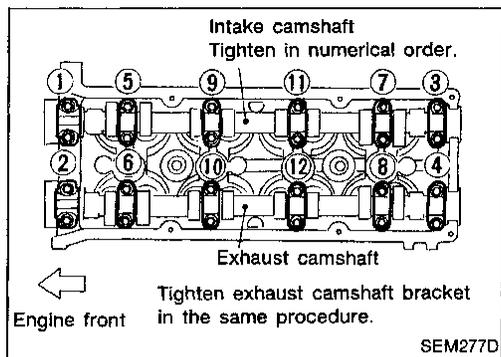
4. Tighten cylinder head bolts.

- Tightening procedure

- a Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
- b Tighten all bolts to 79 N·m (8.1 kg-m, 59 ft-lb).
- c Loosen all bolts completely
- d Tighten all bolts to 25 to 34 N·m (2.5 to 3.5 kg-m, 18 to 25 ft-lb).
- e Turn all bolts 86 to 91 degrees clockwise, or if an angle wrench is not available, tighten bolts to 75 to 84 N·m (7.6 to 8.6 kg-m, 55 to 62 ft-lb).

TIMING CHAIN

Installation (Cont'd)



5. Install camshafts and camshaft brackets.

- **Tightening procedure**

a. Tighten all bolts to 2 N·m (0.2 kg-m, 1.4 ft-lb).

b. Tighten all bolts to 9.0 to 11.8 N·m (0.92 to 1.2 kg-m, 6.7 to 8.7 ft-lb).

6. Install camshaft sprockets.

7. Install chain guide between both camshaft sprockets.

8. Install rubber plugs as follows.

(1) Apply liquid gasket to rubber plugs.

(2) Install rubber plugs, then move them by hand to uniformly spread the gasket on cam sprocket cover surface.

- Rubber plugs should be installed flush with the cylinder head surface.

9. Install chain guide between both camshaft sprockets.

10. Install distributor.

- Make sure that No. 1 piston is set at TDC and that distributor rotor is set at No. 1 cylinder spark position.

- When installing distributor, align marks on shaft with indented mark on housing as shown.

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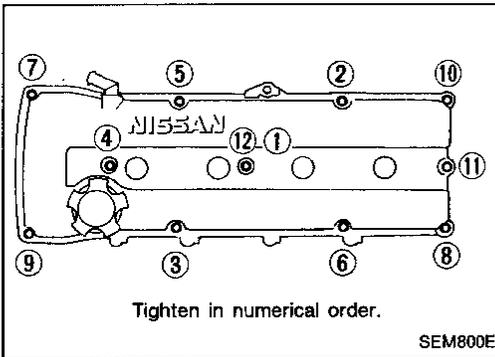
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TIMING CHAIN

Installation (Cont'd)



11. Install rocker cover.
12. Install all spark plugs with high-tension cords.
13. Connect injector harness connector and replace injector tube assembly with injectors.
14. Install the following parts.
 - Radiator shroud
 - Cooling fan with coupling
 - Air duct
15. Install vacuum hoses, fuel tubes, wires, harness and connectors and so on.

OIL SEAL REPLACEMENT

VALVE OIL SEAL

1. Remove rocker cover.
2. Remove camshaft. Refer to "TIMING CHAIN" (EM-12).
3. Remove valve spring and valve oil seal with Tool or a suitable tool.

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

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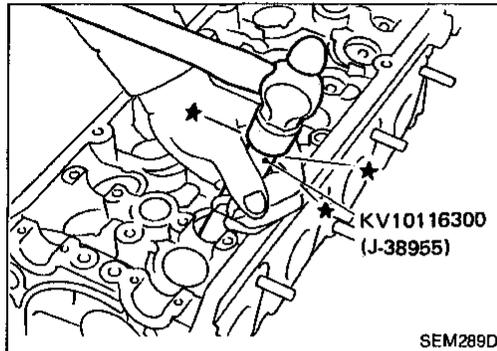
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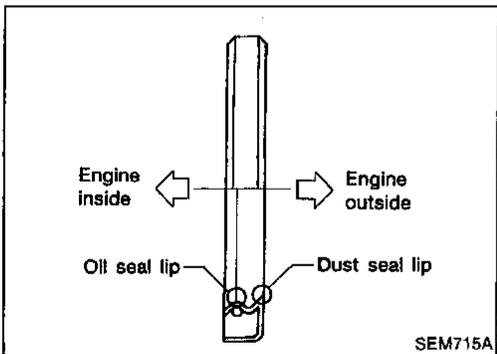
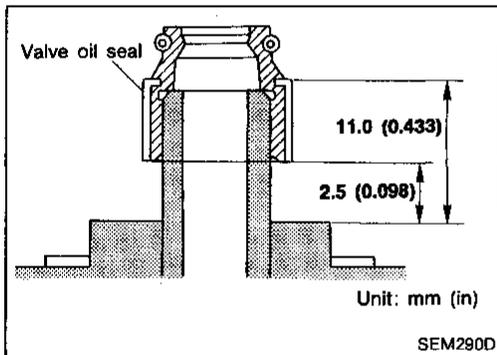
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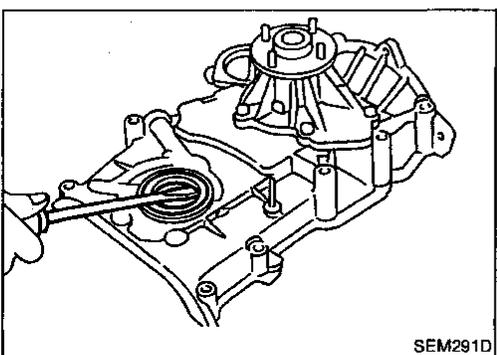
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4. Apply engine oil to new valve oil seal and install it with Tool.



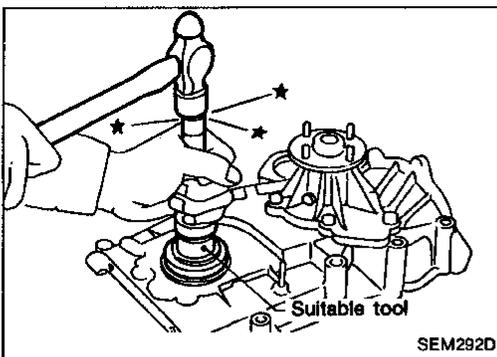
OIL SEAL INSTALLING DIRECTION



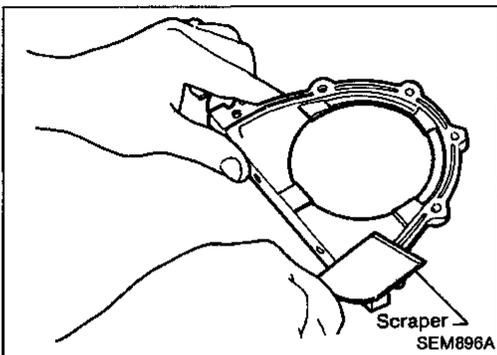
FRONT OIL SEAL

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

OIL SEAL REPLACEMENT

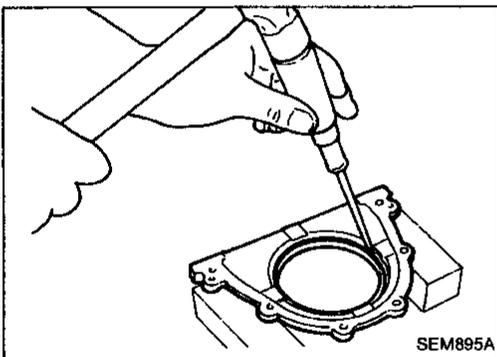


3. Apply engine oil to new oil seal and install it using a suitable tool.

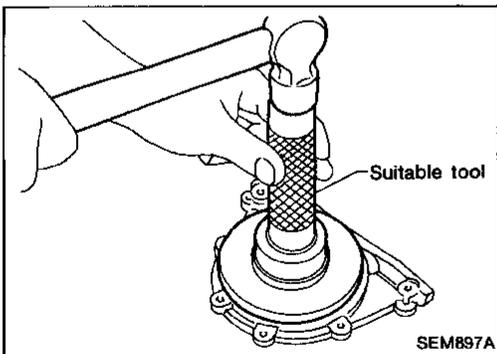


REAR OIL SEAL

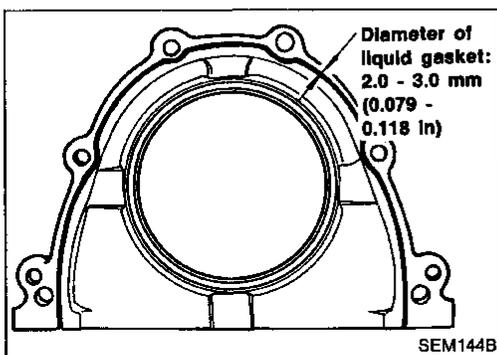
1. Remove drive plate or flywheel.
2. Remove rear oil seal retainer.
3. Remove traces of liquid gasket using scraper.



4. Remove rear oil seal from rear oil seal retainer.



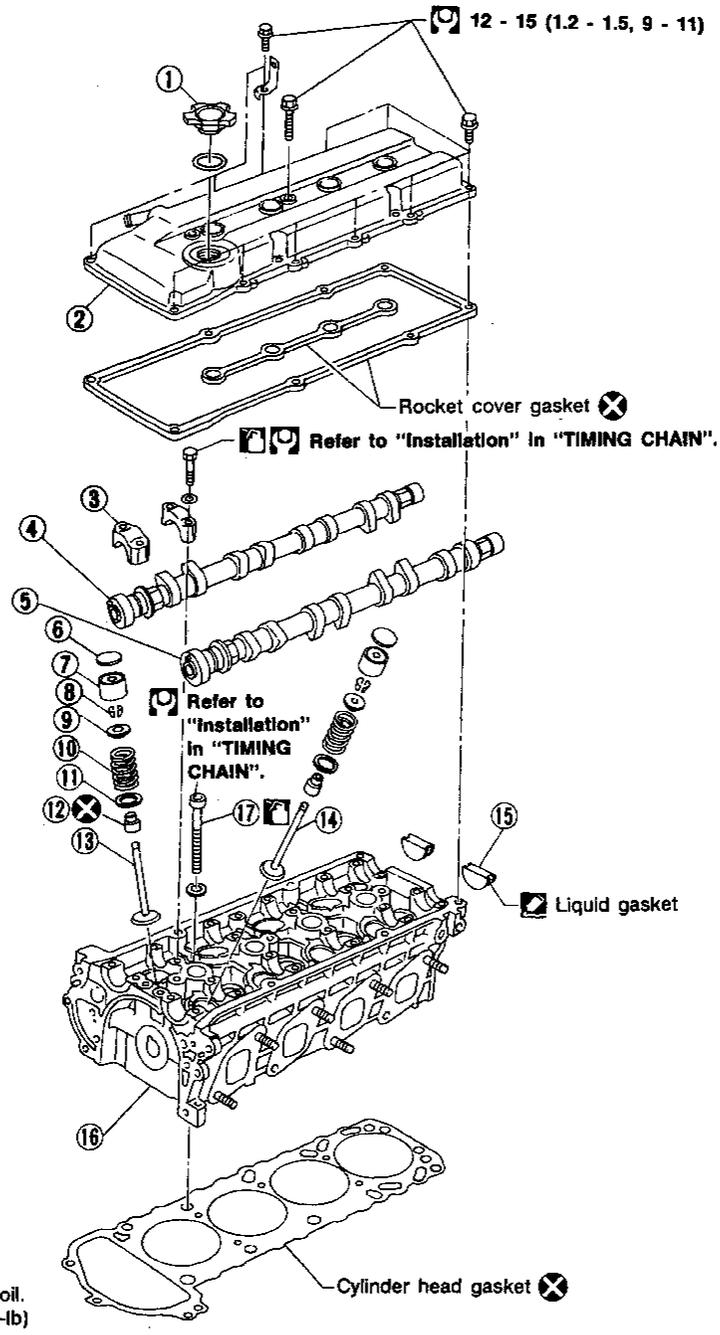
5. Apply engine oil to new oil seal and install it using a suitable tool.



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

CYLINDER HEAD

SEC. 111-130



- ① Oil filler cap
- ② Rocker cover
- ③ Camshaft bracket
- ④ Intake camshaft
- ⑤ Exhaust camshaft
- ⑥ Shim

- ⑦ Valve lifter
- ⑧ Valve cotter
- ⑨ Spring retainer
- ⑩ Valve spring
- ⑪ Spring seat
- ⑫ Valve oil seal

- ⑬ Intake valve
- ⑭ Exhaust valve
- ⑮ Rubber plug
- ⑯ Cylinder head
- ⑰ Cylinder head bolt

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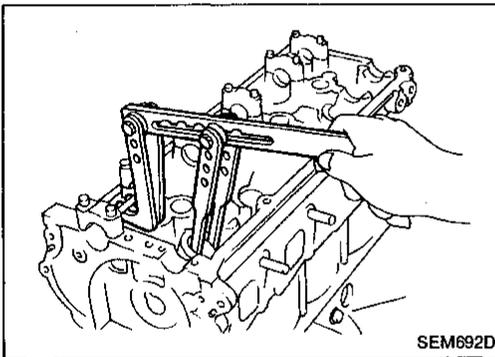
CYLINDER HEAD

CAUTION:

- Apply new engine oil to the sliding surfaces when installing sliding parts. Sliding parts include rocker arms, camshafts, oil seal, etc.
- Apply new engine oil to bolt thread and seat surfaces when tightening the following: Cylinder head bolts, camshaft sprocket bolts, crankshaft bracket bolts.
- Attach tags to valve lifters so as not to mix them up.

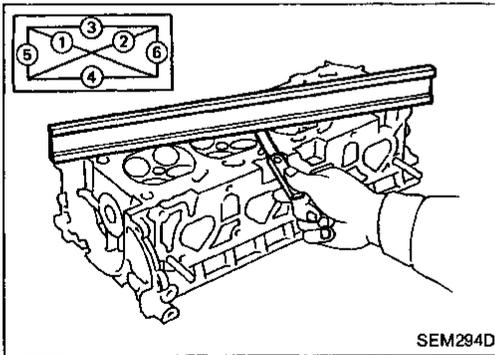
Removal and Installation

- Removal and installation procedures are the same as those for timing chain. Refer to "Removal" and "Installation" in "TIMING CHAIN" (EM-14, EM-17).



Disassembly

1. Remove intake manifold, collector assembly and exhaust manifold. Refer to "Outer Component Parts" (EM-7).
2. Remove valve components with Tool.
3. Remove valve oil seal with a suitable tool.



Inspection

CYLINDER HEAD DISTORTION

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

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

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

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

Nominal cylinder head height:

126.3 - 126.5 mm (4.972 - 4.980 in)

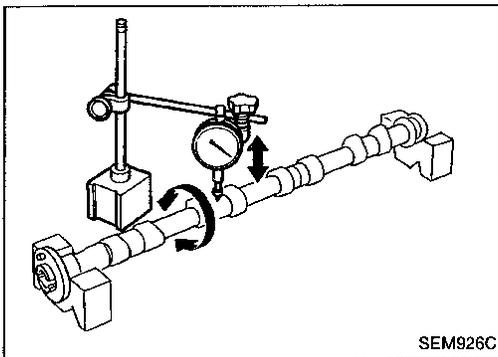
CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.

CYLINDER HEAD

Inspection (Cont'd)

CAMSHAFT RUNOUT



1. Measure camshaft runout at the center journal.

Runout (Total indicator reading):

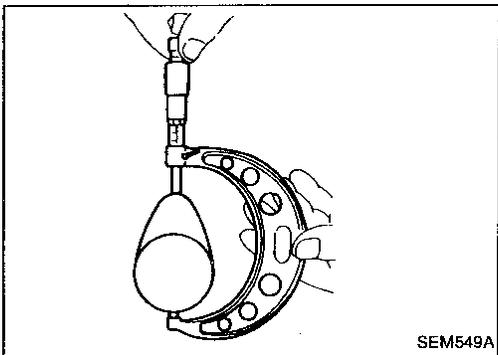
Standard:

Less than 0.02 mm (0.0008 in)

Limit:

0.04 mm (0.0016 in)

2. If it exceeds the limit, replace camshaft.



CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height.

Standard cam height:

Intake & Exhaust

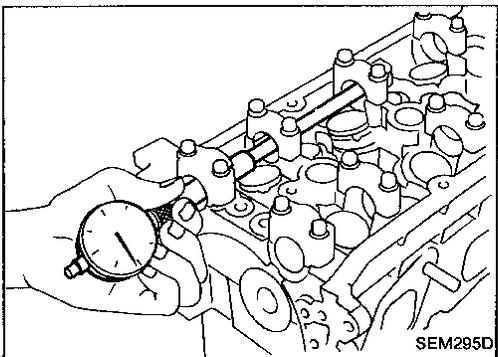
42.415 - 42.605 mm (1.6699 - 1.6774 in)

Cam wear limit:

Intake & Exhaust

0.2 mm (0.008 in)

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



CAMSHAFT JOURNAL CLEARANCE

1. Install camshaft bracket and tighten bolts to the specified torque.
2. Measure inner diameter of camshaft bearing.

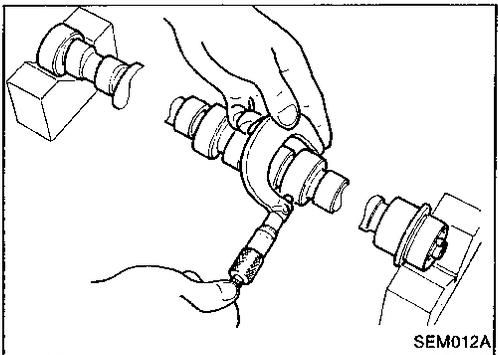
Standard inner diameter:

#1 journal

28.000 - 28.025 mm (1.1024 - 1.1033 in)

#2 to #5 journals

24.000 - 24.025 mm (0.9449 - 0.9459 in)



3. Measure outer diameter of camshaft journal.

Standard outer diameter:

#1 journal

27.935 - 27.955 mm (1.0998 - 1.1006 in)

#2 to #5 journals

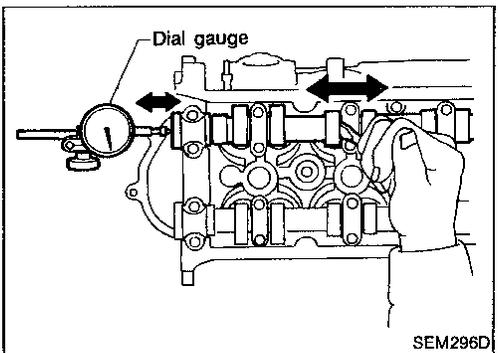
23.935 - 23.955 mm (0.9423 - 0.9431 in)

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

Camshaft journal clearance:

Standard 0.045 - 0.090 mm (0.0018 - 0.0035 in)

Limit 0.12 mm (0.0047 in)



CAMSHAFT END PLAY

1. Install camshaft and thermostat housing in cylinder head.
2. Measure camshaft end play.

Camshaft end play:

Standard

0.070 - 0.148 mm (0.0028 - 0.0058 in)

Limit

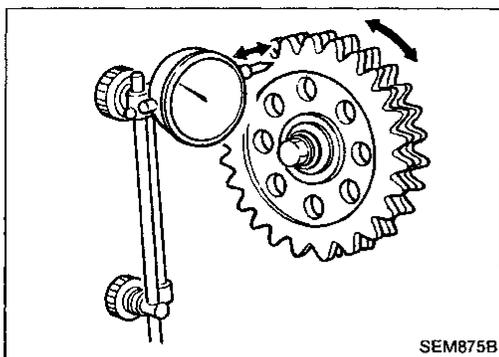
0.2 mm (0.008 in)

CYLINDER HEAD

Inspection (Cont'd)

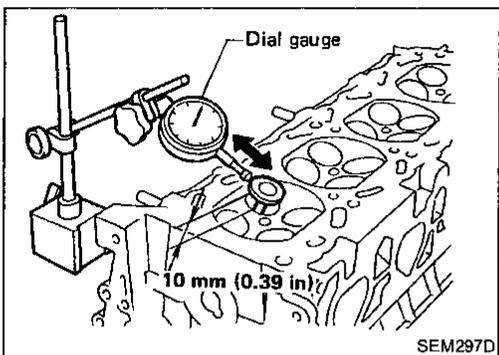
CAMSHAFT SPROCKET RUNOUT

1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.
Runout (Total indicator reading):
Limit 0.15 mm (0.0059 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
0.2 mm (0.008 in)



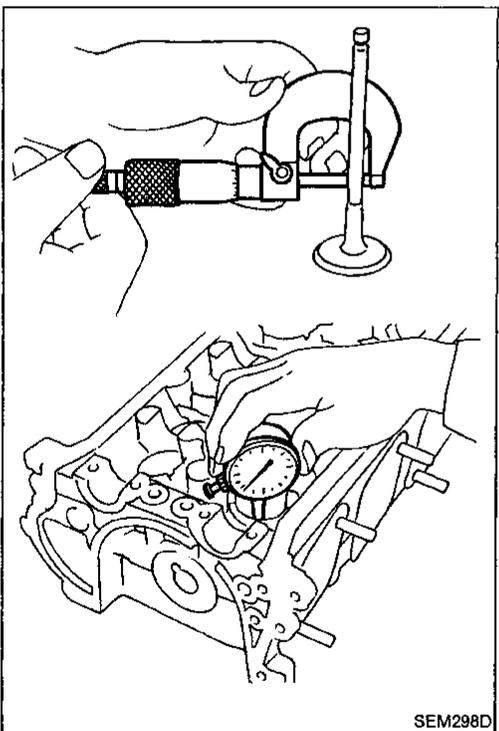
2. If it exceeds the limit, check valve to valve guide clearance.
 - a. Measure valve stem diameter and valve guide inner diameter.
 - b. Check that clearance is within specification.

Valve to valve guide clearance:

Unit: mm (in)

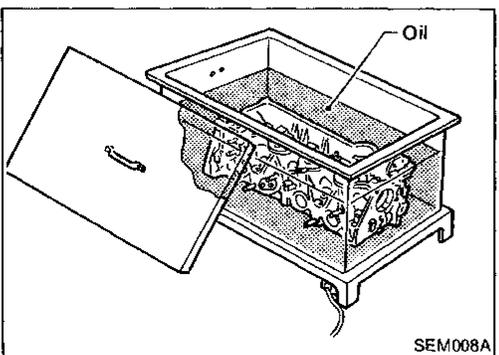
	Standard	Limit
Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)

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



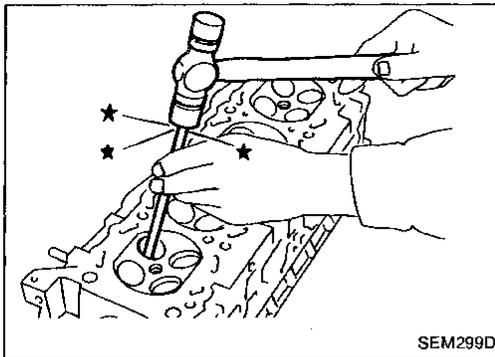
VALVE GUIDE REPLACEMENT

1. To remove valve guide, heat cylinder head to 120 to 140°C (248 to 284°F).



CYLINDER HEAD

Inspection (Cont'd)



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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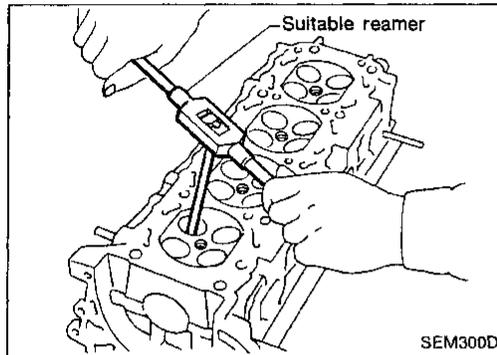
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3. Ream cylinder head valve guide hole.

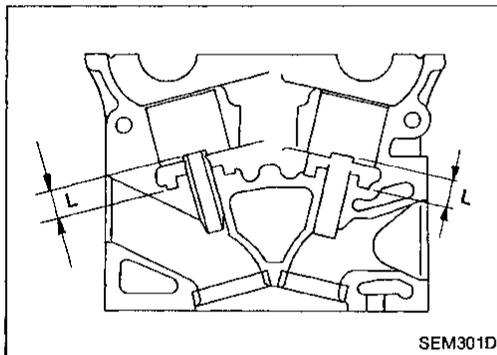
**Valve guide hole diameter
(for service parts):**

Intake

11.175 - 11.196 mm (0.4400 - 0.4408 in)

Exhaust

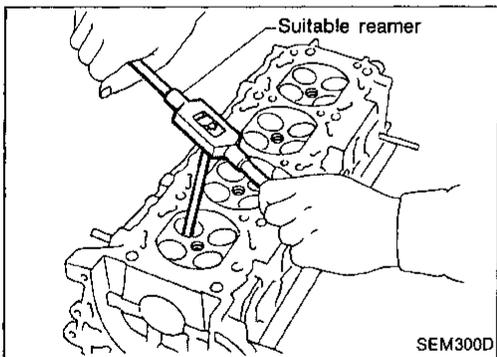
11.175 - 11.196 mm (0.4400 - 0.4408 in)



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

Projection "L":

13.3 - 13.9 mm (0.524 - 0.547 in)

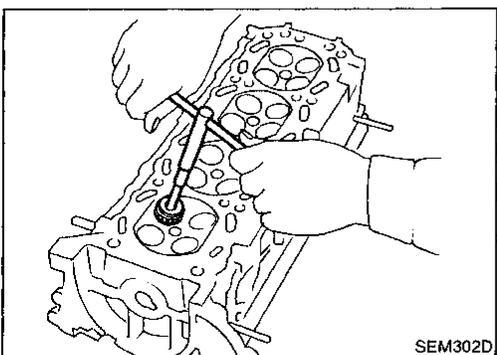


5. Ream valve guide.

Finished size:

Intake & Exhaust

7.000 - 7.018 mm (0.2756 - 0.2763 in)



VALVE SEATS

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

- **Before repairing valve seats, check valve and valve guide for wear. If they have worn, replace them. Then correct valve seat.**
- **Cut with both hands to uniform the cutting surface.**

CYLINDER HEAD

Inspection (Cont'd)

REPLACING VALVE SEAT FOR SERVICE PARTS

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

Reaming bore for service valve seat

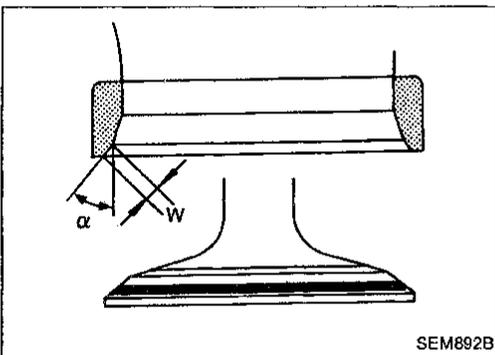
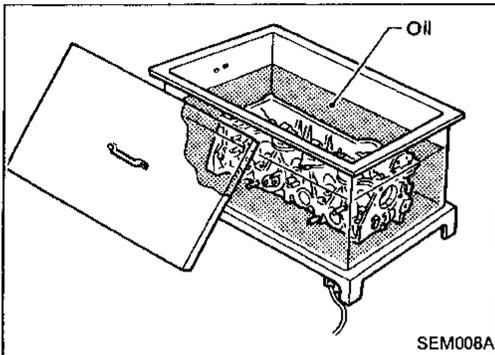
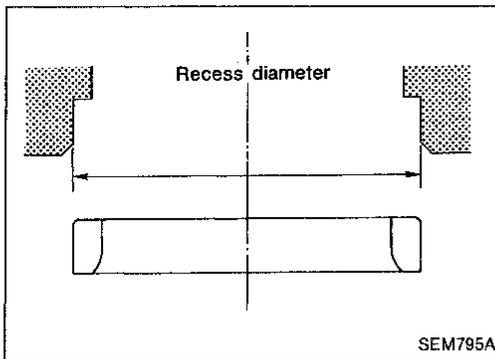
Oversize [0.5 mm (0.020 in)]:

Intake 38.000 - 38.016 mm (1.4961 - 1.4967 in)

Exhaust 32.700 - 32.716 mm (1.2874 - 1.2880 in)

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

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



5. Cut or grind valve seat using suitable tool at the specified dimensions as shown in SDS.
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

Seat face angle " α ":

44°53' - 45°07' deg.

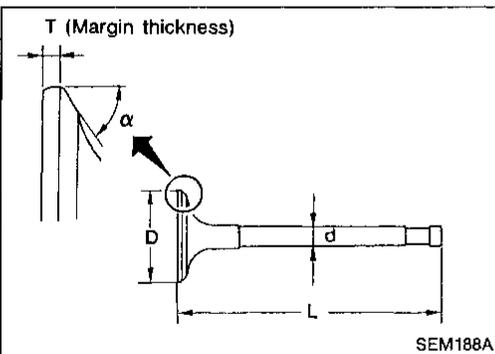
Contacting width "W":

Intake

1.48 - 1.63 mm (0.0583 - 0.0642 in)

Exhaust

1.8 - 2.0 mm (0.071 - 0.079 in)

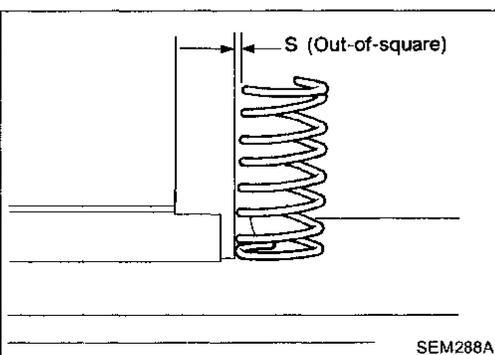


VALVE DIMENSIONS

Check dimensions in each valve. For dimensions, refer to SDS (EM-46).

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 "S" dimension.

Out-of-square:

Less than 1.9 mm (0.075 in)

2. If it exceeds the limit, replace spring.

CYLINDER HEAD

Inspection (Cont'd)

Pressure

Check valve spring pressure.

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

Standard

548.70 (55.95, 123.37) at 26.0 (1.024)

Limit

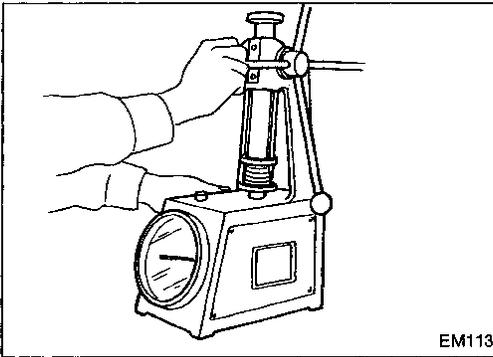
More than 489.4 (49.9, 110.0) at 26.0 (1.024)

If it exceeds the limit, replace spring.

GI

MA

EM



VALVE LIFTER AND VALVE SHIM

1. Visually check contact and sliding surfaces for wear or scratches.

LC

EC

FE

CL

MT

AT

PD

FA

RA

BR

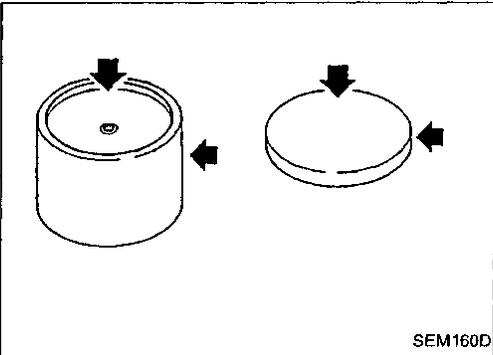
ST

BF

HA

EL

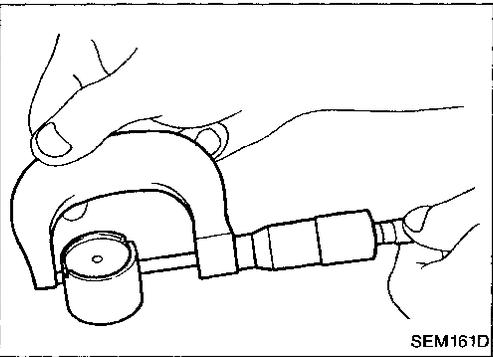
IDX



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

Valve lifter diameter:

33.960 - 33.975 mm (1.3370 - 1.3376 in)

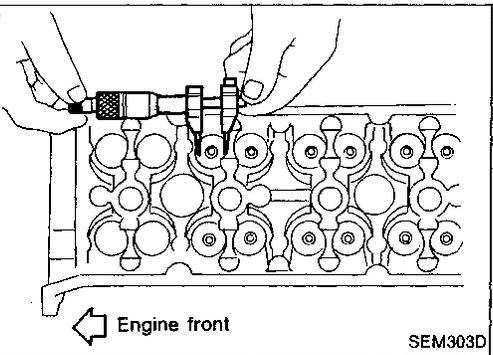


Lifter guide bore diameter:

34.000 - 34.021 mm (1.3386 - 1.3394 in)

Valve lifter to valve lifter guide clearance:

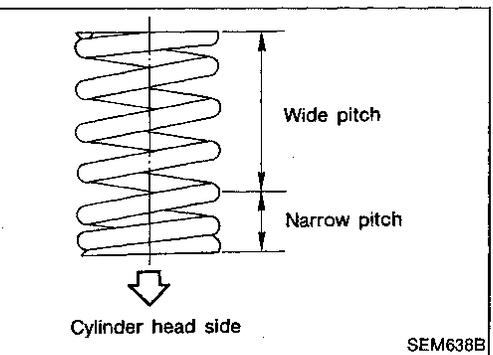
0.025 - 0.061 mm (0.0010 - 0.0024 in)



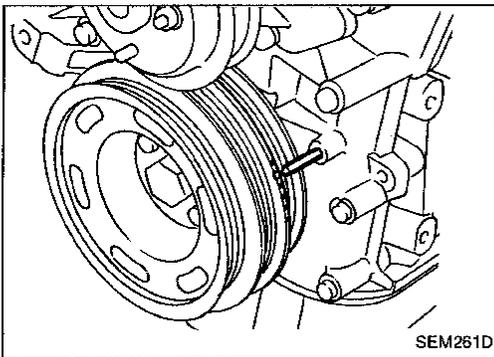
Assembly

1. Install valve component parts.

- Always use new valve oil seal. Refer to OIL SEAL REPLACEMENT (EM-21).
- Before installing valve oil seal, install valve spring seat.
- Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.
- After installing valve component parts, tap valve stem tip with plastic hammer to assure a proper fit.



CYLINDER HEAD



Valve Clearance

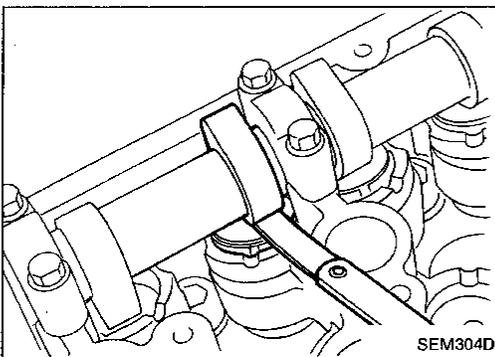
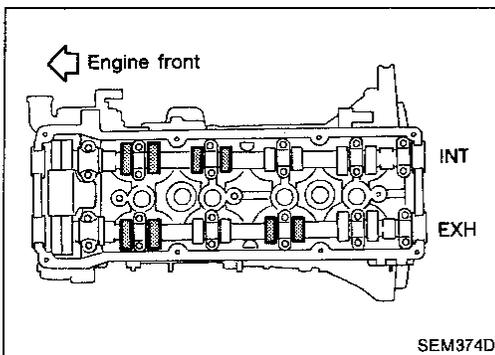
CHECKING

Check valve clearance while engine is warm but not running.

1. Remove rocker cover and all spark plugs.
2. Set No. 1 cylinder at TDC on its compression stroke.
 - Align pointer with TDC mark on crankshaft pulley.
 - Check that valve lifters on No. 1 cylinder are loose and valve lifters on No. 4 are tight.

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

3. Check only those valves shown in the figure.



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

Valve clearance (Hot):

Intake & Exhaust

0.33 - 0.41 mm (0.013 - 0.016 in)

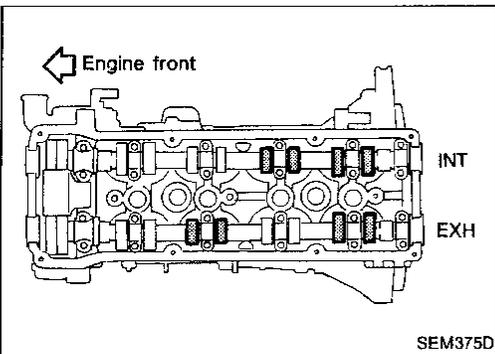
4. Turn crankshaft one revolution (360°) and align mark on crankshaft pulley with pointer.

5. Check those valves shown in the figure.

- Use the same procedure as mentioned in step 3.

6. If all valve clearances are within specification, install the following parts.

- Rocker cover
- All spark plugs



ADJUSTING

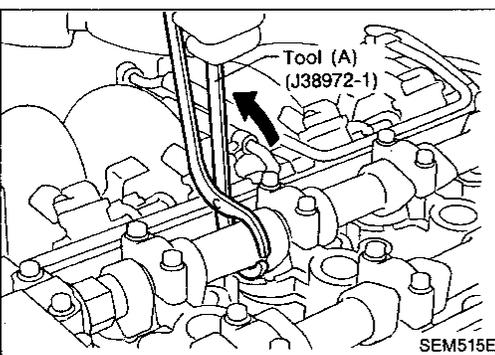
Adjust valve clearance while engine is cold.

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

Before placing Tool (A), rotate notch toward center of cylinder head (See figure.), to simplify shim removal later.

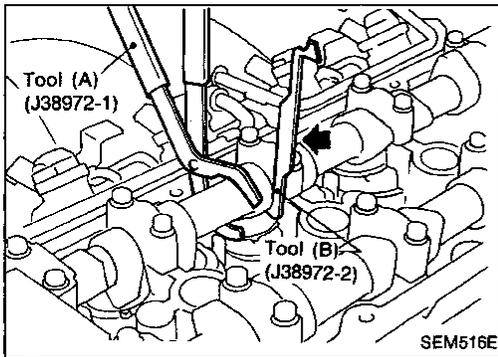
CAUTION:

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



CYLINDER HEAD

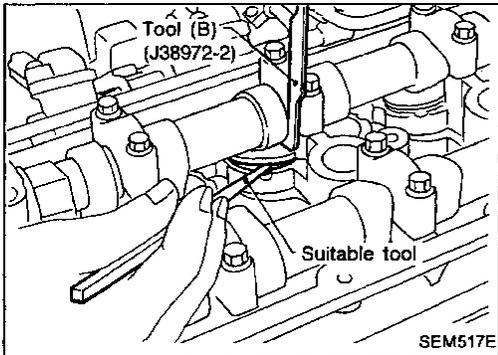
Valve Clearance (Cont'd)



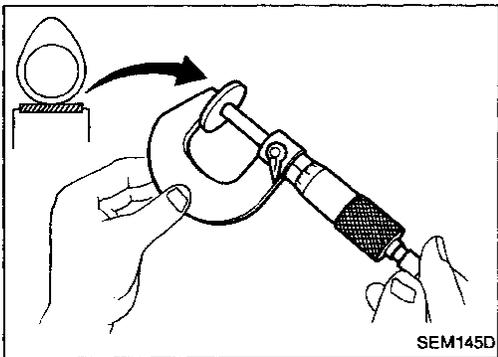
- Place Tool (B) between camshaft and valve lifter to retain valve lifter.

CAUTION:

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



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



- Determine replacement adjusting shim size following formula.

- Using a micrometer determine thickness of removed shim.
- Calculate thickness of new adjusting shim so valve clearance comes within specified values.

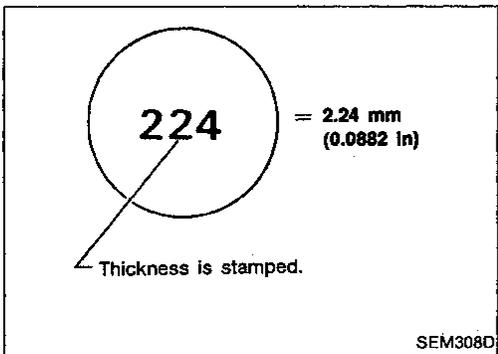
R = Thickness of removed shim

N = Thickness of new shim

M = Measured valve clearance

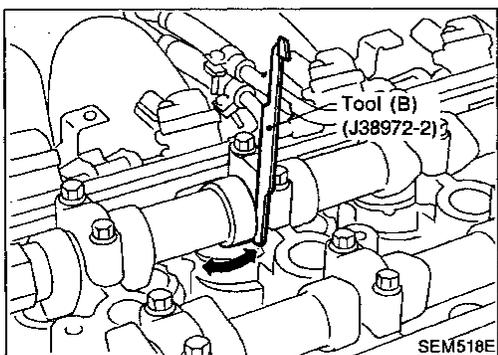
Intake & Exhaust:

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



Shims are available in different thicknesses from 1.96 mm (0.0772 in) to 2.68 mm (0.1055 in) in increments of 0.02 mm (0.0008 in).

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



- Install new shim using a suitable tool.
- Install with the surface on which the thickness is stamped facing down.

- Place Tool (A) as mentioned in steps 2 and 3.

- Remove Tool (B).

- Remove Tool (A).

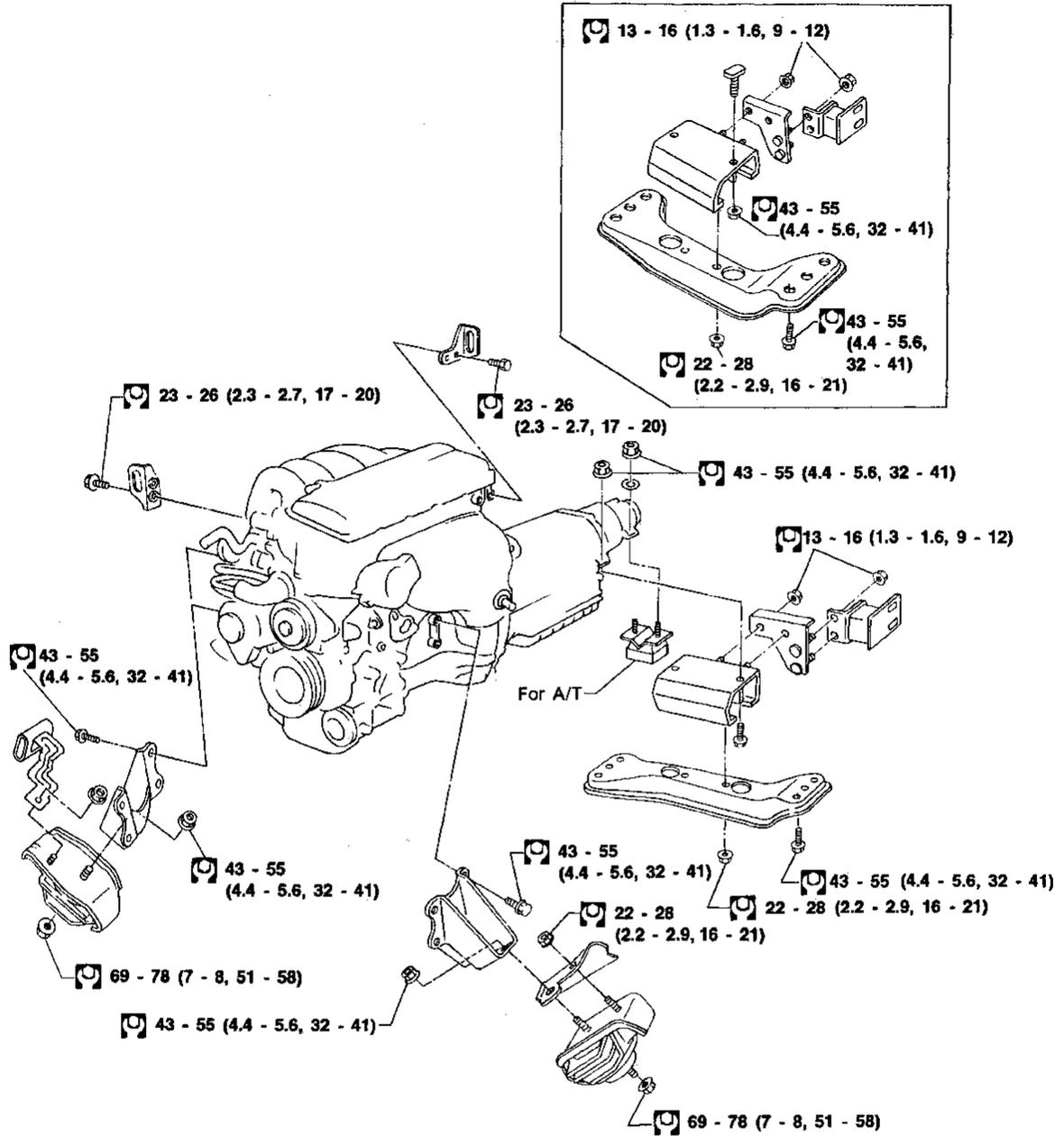
- Recheck valve clearance.

Refer to "CHECKING" (EM-30).

ENGINE REMOVAL

SEC. 112-111

M/T model



: N·m (kg-m, ft-lb)

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.
- For safety during subsequent steps, the tension of wires should be slackened against the engine.
- Before disconnecting fuel hose, release fuel pressure from fuel line.
Refer to "Releasing Fuel Pressure" in EC section.
- 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:

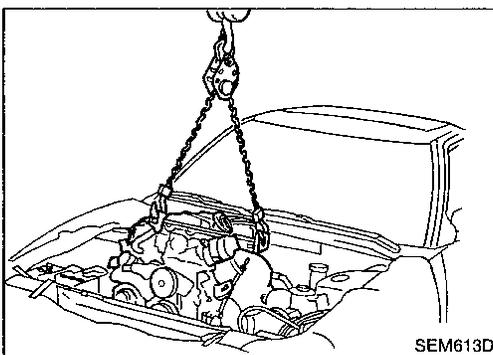
- When lifting engine, be careful not to strike adjacent parts, especially the following: Accelerator wire casing, brake lines, and brake master cylinder.
- In hoisting the engine, always use engine slingers in a safe manner.
- When removing the transmission assembly from engine, first remove the crankshaft position sensor (OBD) from the assembly.
Be careful not to damage sensor edge and ring gear teeth.

Removal

1. Remove transmission.

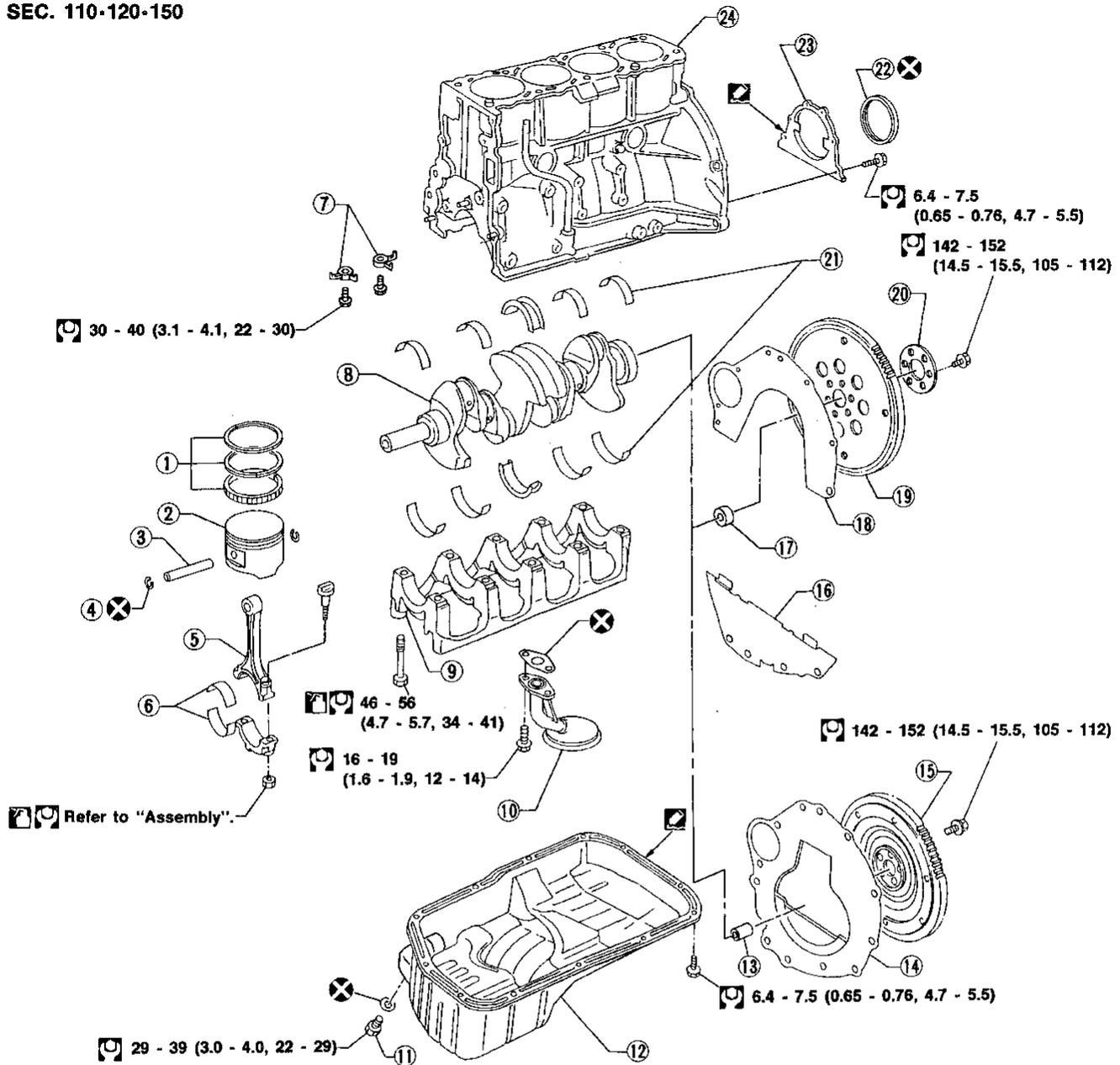
Refer to AT or MT section.

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 A/C compressor and power steering oil pump from engine.
10. Install engine slingers to cylinder head.
11. Set a suitable hoist on engine slinger.
12. Remove engine mounting bolts from both sides and then slowly raise engine.
13. Remove engine as shown.



CYLINDER BLOCK

SEC. 110-120-150



- : Apply engine oil.
- : Apply liquid gasket.
- : N-m (kg-m, ft-lb)

SEM803E

- | | | |
|--------------------------|-----------------------|-----------------------------|
| ① Piston rings | ⑨ Main bearing cap | ⑰ Pilot converter (A/T) |
| ② Piston | ⑩ Oil strainer | ⑱ Rear plate (A/T) |
| ③ Piston pin | ⑪ Drain plug | ⑲ Drive plate (A/T) |
| ④ Snap ring | ⑫ Oil pan | ⑳ Drive plate reinforcement |
| ⑤ Connecting rod | ⑬ Pilot bushing (M/T) | ㉑ Main bearing |
| ⑥ Connecting rod bearing | ⑭ Rear plate (M/T) | ㉒ Rear oil seal |
| ⑦ Oil jet | ⑮ Flywheel (M/T) | ㉓ Rear oil seal retainer |
| ⑧ Crankshaft | ⑯ Dust cover (A/T) | ㉔ Cylinder block |

CYLINDER BLOCK

CAUTION:

- When installing sliding parts (bearings, pistons, etc.), apply new engine oil to the sliding surfaces.
- Place removed parts such as bearings and bearing caps in their proper order and direction.
- Apply new engine oil to bolt thread and seat surfaces when tightening the following: connecting rod bolts and main bearing cap bolts.
- Do not allow any magnetic materials to contact the ring gear teeth of the flywheel/drive plate.

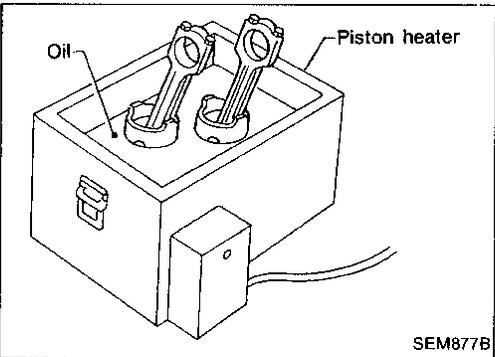
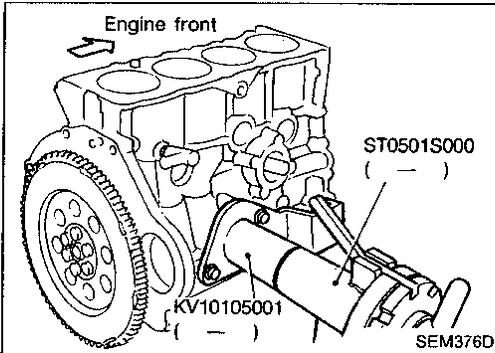
GI
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Disassembly

PISTON AND CRANKSHAFT

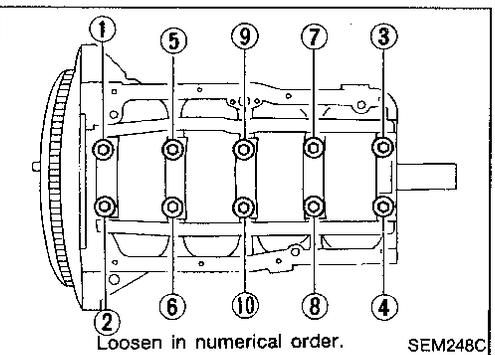
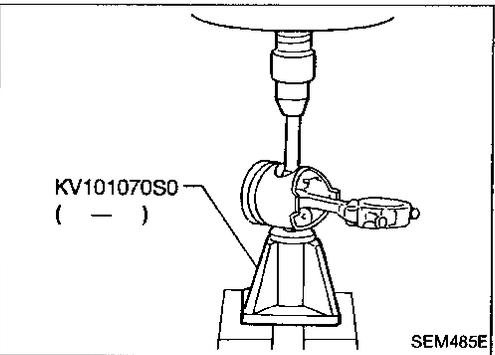
1. Place engine on a work stand.
2. Remove timing chain.
Refer to "Removal" in "TIMING CHAIN" (EM-14).



3. Remove pistons with connecting rods.
 - When disassembling piston and connecting rod, remove snap rings. Then heat piston to 60 to 70°C (140 to 158°F), or use piston pin press stand at room temperature.

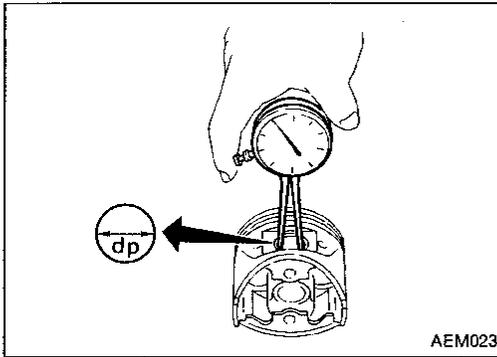
CAUTION:

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



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

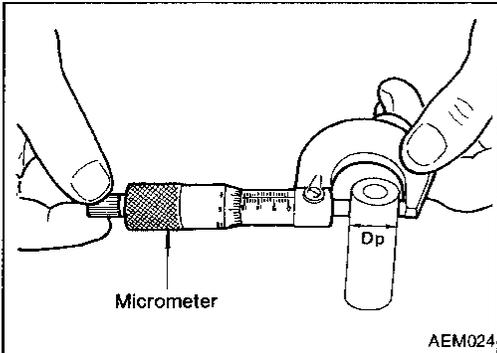
CYLINDER BLOCK



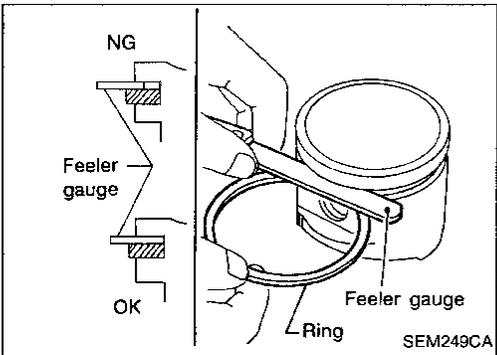
Inspection

PISTON AND PISTON PIN CLEARANCE

1. Measure inner diameter of piston pin hole "dp".
Standard diameter "dp":
20.987 - 20.999 mm (0.8263 - 0.8267 in)



2. Measure outer diameter of piston pin "Dp".
Standard diameter "Dp":
20.989 - 21.001 mm (0.8263 - 0.8268 in)
3. Calculate interference fit of piston pin to piston.
 $dp - Dp = 0 - 0.004 \text{ mm (0 - 0.0002 in)}$
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)

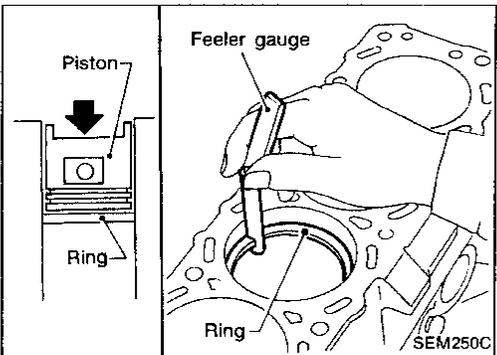
2nd ring

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

0.28 - 0.52 mm (0.0110 - 0.0205 in)

2nd ring

0.45 - 0.69 mm (0.0177 - 0.0272 in)

Oil ring

0.20 - 0.69 mm (0.0079 - 0.0272 in)

Max. limit of ring gap:

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 over-sized piston and piston rings.

Refer to SDS (EM-51).

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

CYLINDER BLOCK

Inspection (Cont'd)

CONNECTING ROD BEND AND TORSION

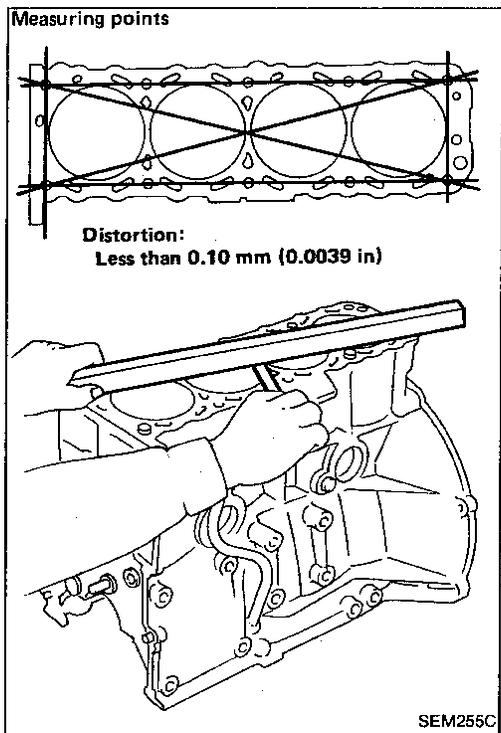
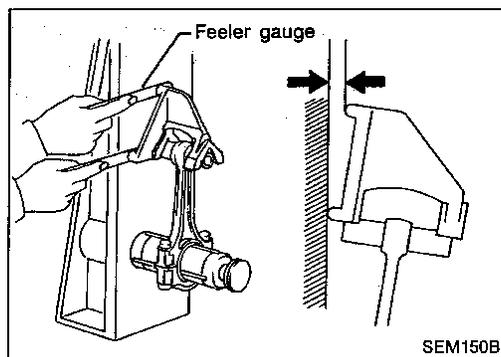
Bend:

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 DISTORTION AND WEAR

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

Limit:

0.10 mm (0.0039 in)

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

Amount of cylinder head resurfacing is "A"

Amount of cylinder block resurfacing is "B"

The maximum limit is as follows:

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

Nominal cylinder block height
from crankshaft center:

246.95 - 247.05 mm (9.7224 - 9.7264 in)

3. If necessary, replace cylinder block.

PISTON-TO-BORE CLEARANCE

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

Standard inner diameter:

89.000 - 89.030 mm (3.5039 - 3.5051 in)

Wear limit:

0.2 mm (0.008 in)

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

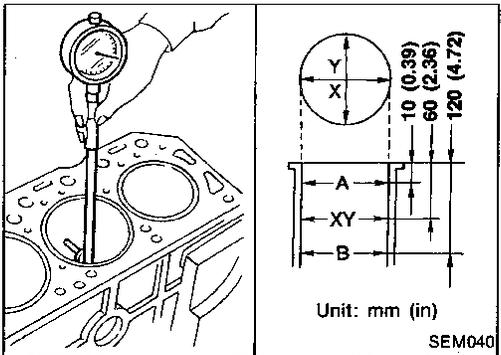
Out-of-round (X - Y) standard:

0.015 mm (0.0006 in)

Taper (A - B) standard:

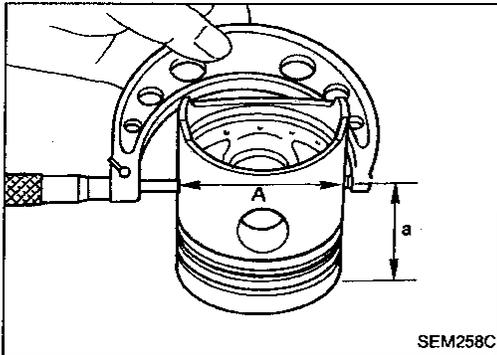
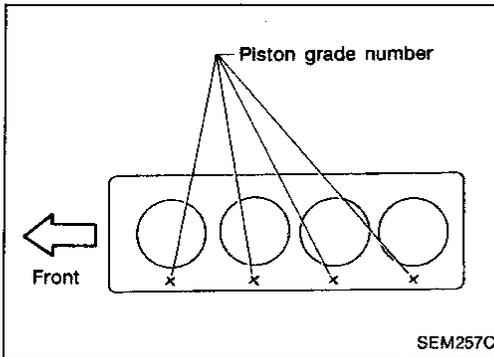
0.01 mm (0.0004 in)

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



CYLINDER BLOCK

Inspection (Cont'd)



- When replacing both cylinder block and piston with new ones, select piston making sure of grade numbers. Piston grade number should be the same as the grade number punched on cylinder block upper surface.

3. Measure piston skirt diameter.

Piston diameter "A":

Refer to SDS (EM-51).

Measuring point "a" (Distance from the top):

52 mm (2.05 in)

4. Check that piston-to-bore clearance is within specification.

Piston-to-bore clearance "B":

0.020 - 0.040 mm (0.0008 - 0.0016 in)

5. Determine piston oversize according to amount of cylinder wear.

Oversize pistons are available for service. Refer to SDS (EM-51).

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.

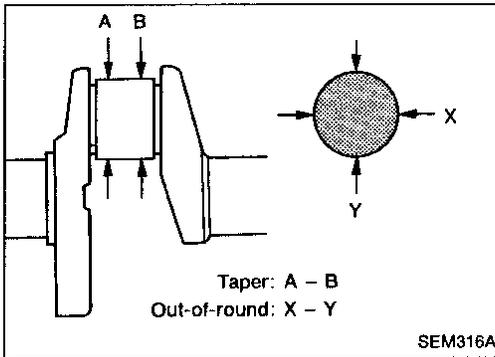
10. Measure finished cylinder bore for out-of-round and taper.

- **Measurement should be done after cylinder bore cools down.**

CYLINDER BLOCK

Inspection (Cont'd)

CRANKSHAFT



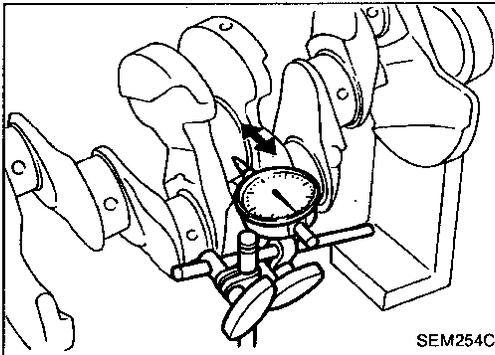
1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.

Out-of-round (X - Y):

Less than 0.005 mm (0.0002 in)

Taper (A - B):

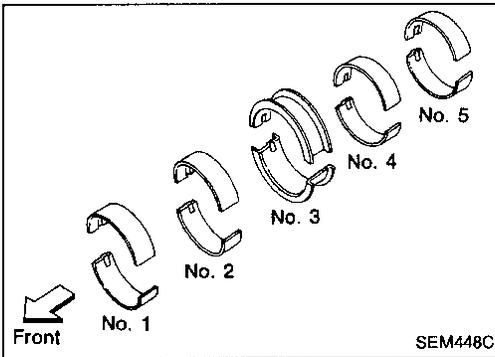
Less than 0.002 mm (0.0001 in)



3. Measure crankshaft runout.

Runout (Total indicator reading):

Less than 0.04 mm (0.0016 in)



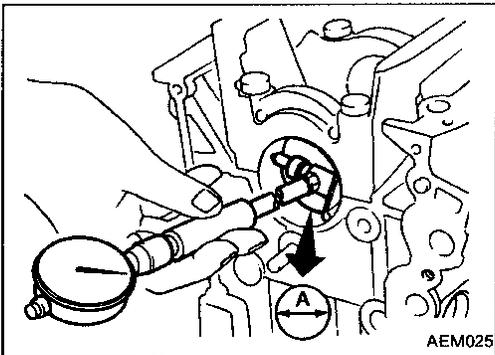
BEARING CLEARANCE

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

Method A (Using bore gauge & micrometer)

Main bearing

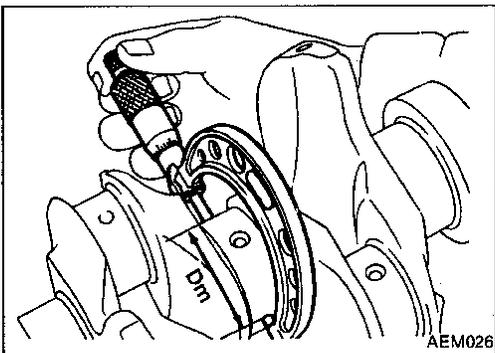
1. Set main bearings in their proper positions on cylinder block and main bearing cap.



2. Install main bearing cap to cylinder block.

Tighten all bolts in correct order in two or three stages. Refer to "Assembly" (EM-42).

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



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

5. Calculate main bearing clearance.

Main bearing clearance = A - Dm

Standard:

0.020 - 0.047 mm (0.0008 - 0.0019 in)

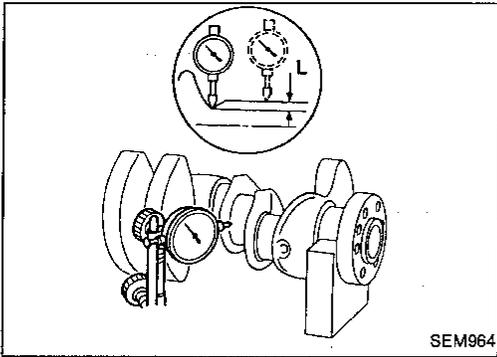
Limit: 0.1 mm (0.004 in)

6. If it exceeds the limit, replace bearing.

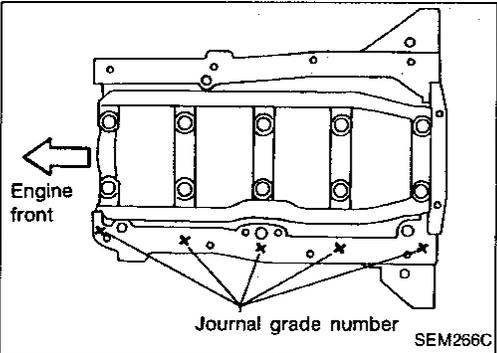
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.

CYLINDER BLOCK

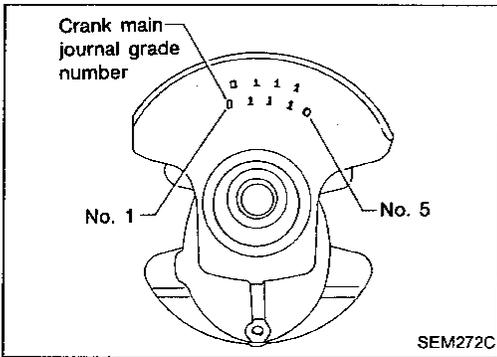
Inspection (Cont'd)



SEM964



SEM266C



SEM272C

- a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.
"L": 0.1 mm (0.004 in)
- b. Refer to SDS (EM-52) for grinding crankshaft and available service parts.

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

- b. Grade number of each crankshaft main journal is punched on crankshaft. These numbers are punched in either Arabic or Roman numerals.

- c. Select main bearing with suitable thickness according to the following table.

Main bearing grade number:

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

For example:

Main journal grade number: 1

Crankshaft journal grade number: 2

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

CYLINDER BLOCK

Inspection (Cont'd)

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.

GI

MA

EM

LC

EC

FE

CL

MT

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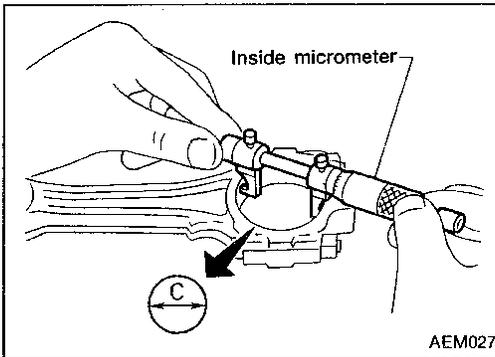
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BF

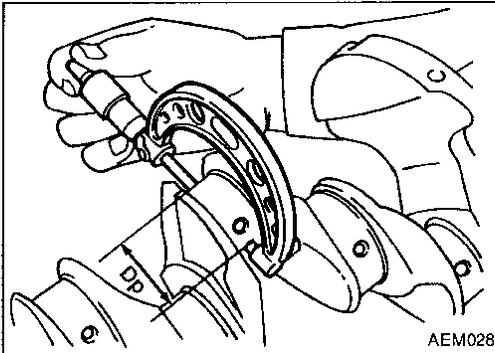
HA

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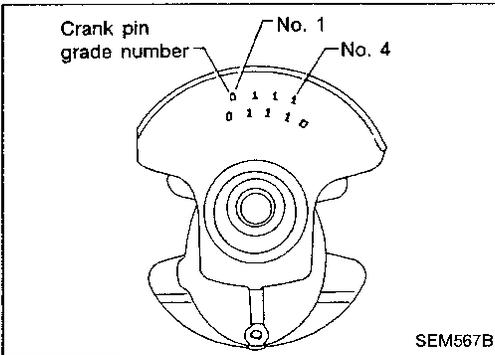
IDX



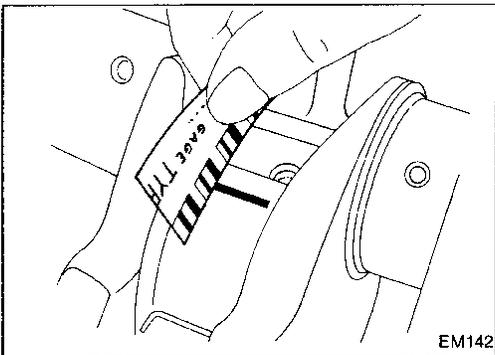
AEM027



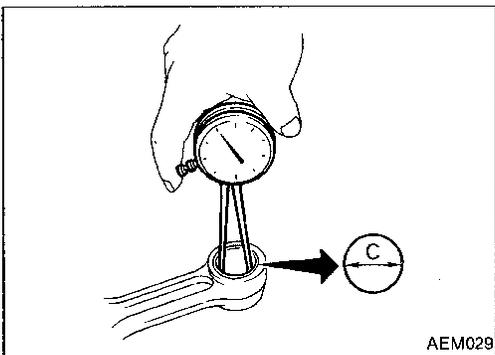
AEM028



SEM567B



EM142



AEM029

4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.
Connecting rod bearing clearance = C - Dp
Standard: 0.010 - 0.035 mm (0.0004 - 0.0014 in)
Limit: 0.09 mm (0.0035 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to step 7 of "BEARING CLEARANCE — Main bearing" (EM-39).

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

Connecting rod bearing grade number:

These numbers are punched in either Arabic or Roman numerals.

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

Method B (Using plastigage)

CAUTION:

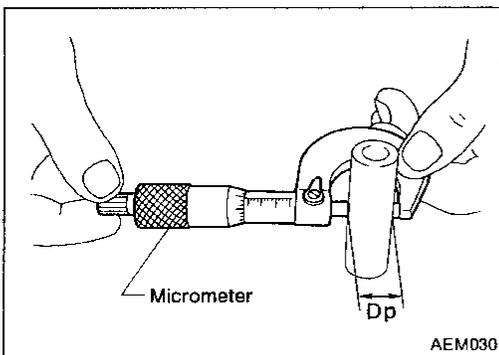
- Do not turn crankshaft or connecting rod while plastigage is being inserted.
- When bearing clearance exceeds the specified limit, ensure that the proper bearing has been installed. If incorrect bearing clearance exists, use a thicker or undersized main bearing to ensure specified clearance.

CONNECTING ROD BUSHING CLEARANCE (Small end)

1. Measure inner diameter "C" of bushing.

CYLINDER BLOCK

Inspection (Cont'd)



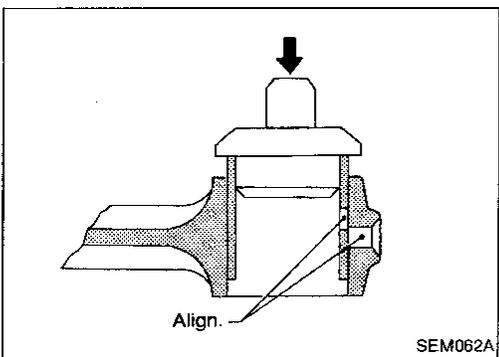
2. Measure outer diameter "Dp" of piston pin.
3. Calculate connecting rod bushing clearance.

$$C - Dp =$$

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

If it exceeds the limit, replace connecting rod assembly 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 ensure that clearance between connecting rod bushing and piston pin is the specified value.

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

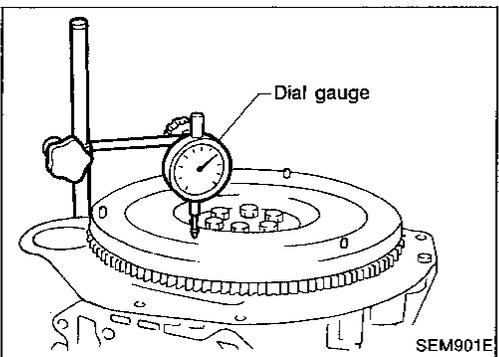
FLYWHEEL/DRIVE PLATE RUNOUT

Runout (Total indicator reading):

- Flywheel (M/T model)
Less than 0.15 mm (0.0059 in)
- Drive plate (A/T model)
Less than 0.5 mm (0.020 in)

CAUTION:

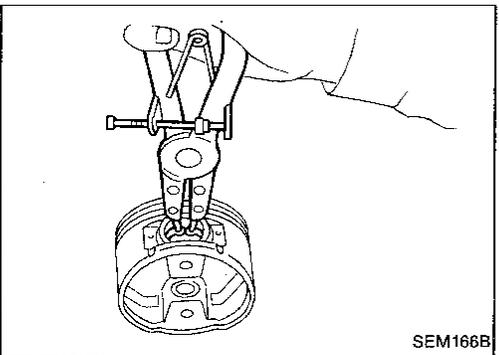
Do not allow any magnetic materials to contact the ring gear teeth.



Assembly

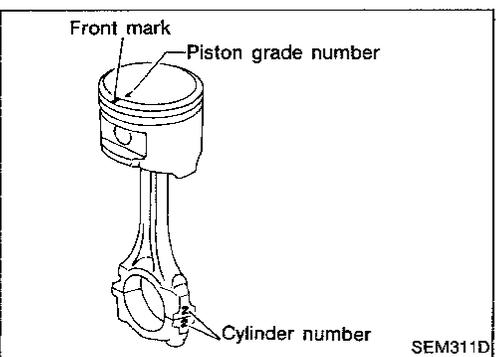
PISTON

1. Install new snap ring on one side of piston pin hole.



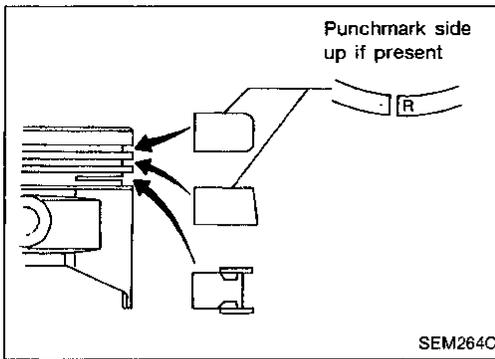
2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.

- **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 being replaced, make sure that piston rings are mounted in their original positions.
- When replacing piston rings, those without punchmarks can be mounted with either side up.

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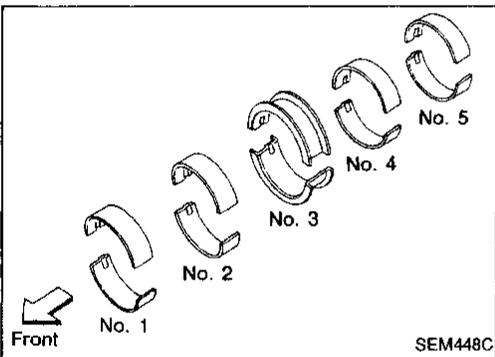
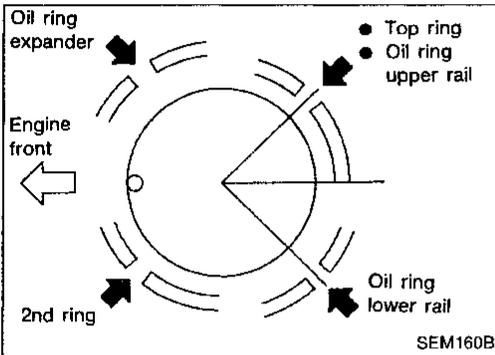
ST

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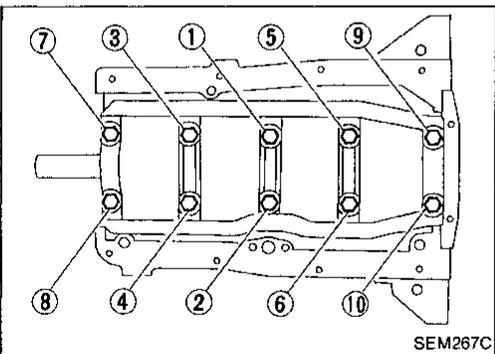
IDX



CRANKSHAFT

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

- Confirm that correct main bearings are used. Refer to "Inspection" of this section (EM-39).



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

- Prior to tightening bearing cap bolts, place bearing cap in its proper position. This is done by shifting crankshaft in the axial direction.
- Tighten bearing cap bolts gradually in two or three stages. Start with center bearing and move outward sequentially.
- After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.

3. Measure crankshaft end play.

Crankshaft end play:

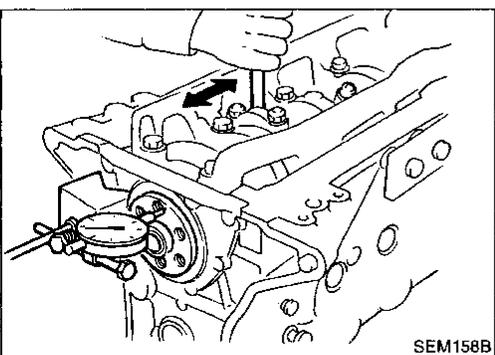
Standard

0.05 - 0.18 mm (0.0020 - 0.0071 in)

Limit

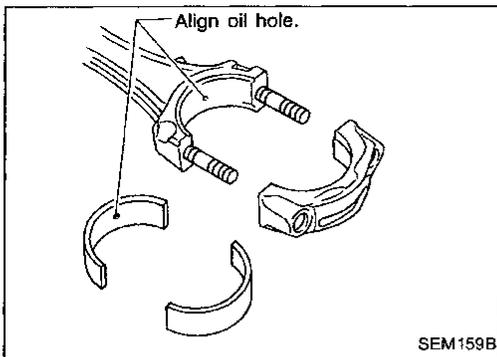
0.3 mm (0.012 in)

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

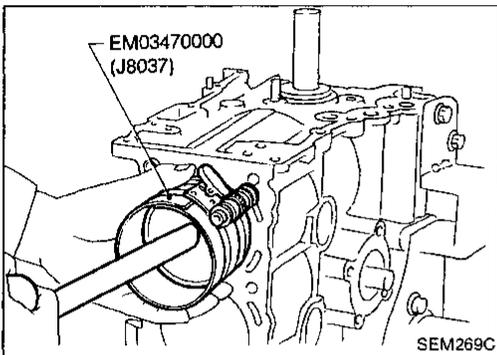


CYLINDER BLOCK

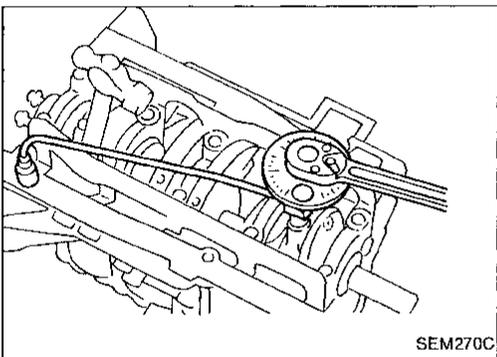
Assembly (Cont'd)



4. Install connecting rod bearings in connecting rods and connecting rod caps.
 - Confirm that correct bearings are used. Refer to "Inspection" (EM-41).
 - Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.



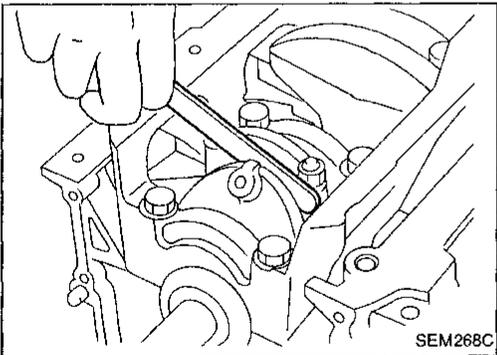
5. Install pistons with connecting rods.
 - a. Install them into corresponding cylinders with Tool.
 - **Be careful not to scratch cylinder wall by connecting rod.**
 - **Arrange so that front mark on piston head faces toward front of engine.**



- b. Install connecting rod bearing caps. Tighten connecting rod bearing cap nuts to the specified torque.

Connecting rod bearing nut:

- (1) Tighten to 14 to 16 N·m
(1.4 to 1.6 kg·m, 10 to 12 ft·lb).
- (2) Tighten bolts 60 to 65 degrees clockwise with an angle wrench, or if an angle wrench is not available, tighten them to 38 to 44 N·m (3.9 to 4.5 kg·m, 28 to 33 ft·lb).



6. Measure connecting rod side clearance.

Connecting rod side clearance:

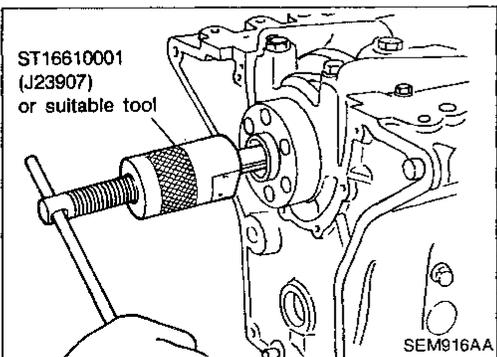
Standard

0.2 - 0.4 mm (0.008 - 0.016 in)

Limit

0.6 mm (0.024 in)

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



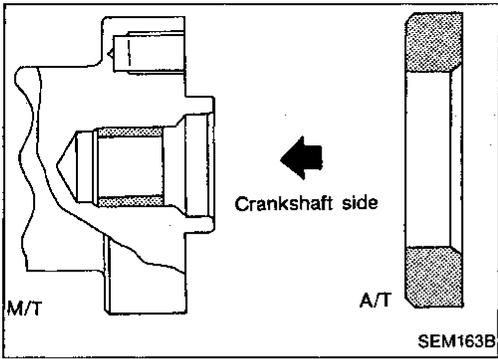
REPLACING PILOT BUSHING

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

CYLINDER BLOCK

Assembly (Cont'd)

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



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SERVICE DATA AND SPECIFICATIONS (SDS)

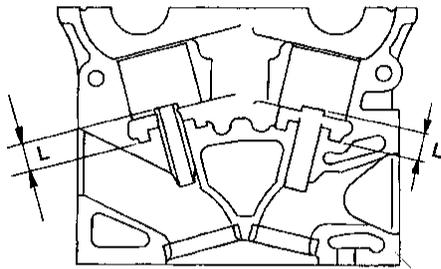
Inspection and Adjustment (Cont'd)

Valve spring

Free height	mm (in)	44.6 (1.756)	
Pressure N (kg, lb) at height mm (in)		548.70 (55.95, 123.37) at 26.0 (1.024)	
			Standard
			Limit
Out-of-square	mm (in)	Less than 1.9 (0.075)	

Valve guide

Unit: mm (in)



SEM301D

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

Valve lifter

Unit: mm (in)

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

Valve clearance adjustment

Unit: mm (in)

Valve clearance (Hot)	
Intake & Exhaust	0.33 - 0.41 (0.013 - 0.016)

Available shims

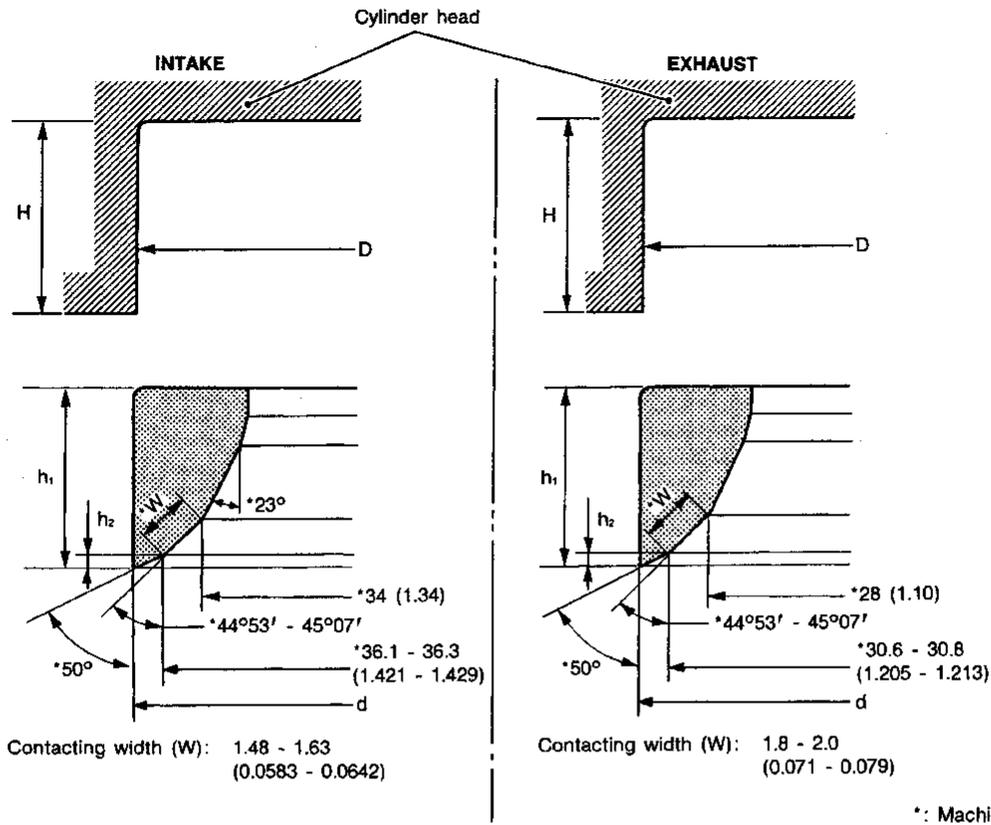
Thickness mm (in)	Identification mark
1.96 (0.0772)	196
1.98 (0.0780)	198
2.00 (0.0787)	200
2.02 (0.0795)	202
2.04 (0.0803)	204
2.06 (0.0811)	206
2.08 (0.0819)	208
2.10 (0.0827)	210
2.12 (0.0835)	212
2.14 (0.0843)	214
2.16 (0.0850)	216
2.18 (0.0858)	218
2.20 (0.0866)	220
2.22 (0.0874)	222
2.24 (0.0882)	224
2.26 (0.0890)	226
2.28 (0.0898)	228
2.30 (0.0906)	230
2.32 (0.0913)	232
2.34 (0.0921)	234
2.36 (0.0929)	236
2.38 (0.0937)	238
2.40 (0.0945)	240
2.42 (0.0953)	242
2.44 (0.0961)	244
2.46 (0.0969)	246
2.48 (0.0976)	248
2.50 (0.0984)	250
2.52 (0.0992)	252
2.54 (0.1000)	254
2.56 (0.1008)	256
2.58 (0.1016)	258
2.60 (0.1024)	260
2.62 (0.1031)	262
2.64 (0.1039)	264
2.66 (0.1047)	266
2.68 (0.1055)	268

SERVICE DATA AND SPECIFICATIONS (SDS)

Inspection and Adjustment (Cont'd)

Valve seat

Unit: mm (in)



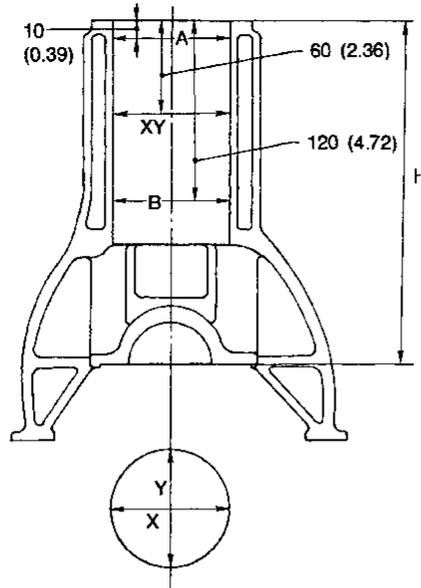
SEM952E

		Standard	Service
Cylinder head seat recess diameter (D)	In.	37.500 - 37.516 (1.4764 - 1.4770)	38.000 - 38.016 (1.4961 - 1.4967)
	Ex.	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)
Valve seat interference fit	In.	0.064 - 0.096 (0.0025 - 0.0038)	
	Ex.	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	In.	37.580 - 37.596 (1.4795 - 1.4802)	38.080 - 38.096 (1.4992 - 1.4998)
	Ex.	32.280 - 32.296 (1.2709 - 1.2715)	32.780 - 32.796 (1.2905 - 1.2912)
Depth (H)	In.	6.1 - 6.3 (0.240 - 0.248)	
	Ex.	6.1 - 6.3 (0.240 - 0.248)	
Height (h ₁)		5.9 - 6.0 (0.232 - 0.236)	
Height (h ₂)	In.	0.44 - 0.64 (0.0173 - 0.0252)	
	Ex.	0.53 - 0.73 (0.0209 - 0.0287)	

SERVICE DATA AND SPECIFICATIONS (SDS)

Inspection and Adjustment (Cont'd)

CYLINDER BLOCK



SEM447C

Unit: mm (in)

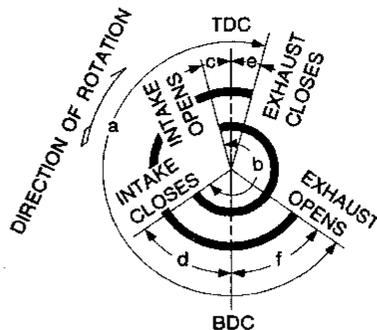
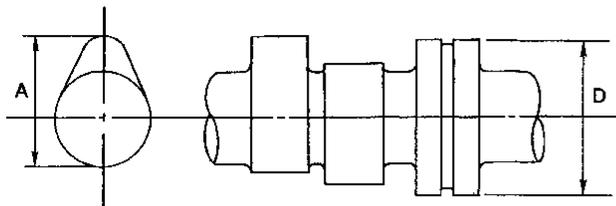
		Standard	Limit
Distortion		Less than 0.03 (0.0012)	0.1 (0.004)
Cylinder bore	Inner diameter	Grade 1	89.000 - 89.010 (3.5039 - 3.5043)
		Grade 2	89.010 - 89.020 (3.5043 - 3.5047)
		Grade 3	89.020 - 89.030 (3.5047 - 3.5051)
	Out-of-round (X - Y)	Less than 0.015 (0.0006)	—
Taper (A - B)		Less than 0.010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

* Total amount of cylinder head resurfacing and cylinder block resurfacing

SERVICE DATA AND SPECIFICATIONS (SDS)

Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BEARING



SEM568A

EM120

Unit: mm (in)

		Standard	Limit
Cam height (A)	Intake	42.415 - 42.605 (1.6699 - 1.6774)	—
	Exhaust	42.415 - 42.605 (1.6699 - 1.6774)	—
Wear limit of cam height		—	0.2 (0.008)
Camshaft journal to bearing clearance		0.045 - 0.090 (0.0018 - 0.0035)	0.12 (0.0047)
Inner diameter of camshaft bearing	#1 journal	28.000 - 28.025 (1.1024 - 1.1033)	—
	#2 to #5 journal	24.000 - 24.025 (0.9449 - 0.9459)	
Outer diameter of camshaft journal (D)	#1 journal	27.935 - 27.955 (1.0998 - 1.1006)	—
	#2 to #5 journal	23.935 - 23.955 (0.9423 - 0.9431)	
Camshaft runout*		Less than 0.02 (0.0008)	0.04 (0.0016)
Camshaft end play		0.070 - 0.148 (0.0028 - 0.0058)	0.2 (0.008)
Valve timing (Degree on crankshaft)	a	232	—
	b	232	—
	c	-1	—
	d	53	—
	e	4	—
	f	48	—

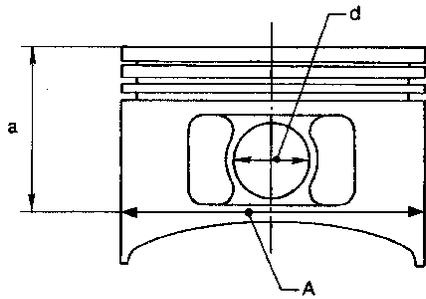
* Total indicator reading

SERVICE DATA AND SPECIFICATIONS (SDS)

Inspection and Adjustment (Cont'd)

PISTON, PISTON RING AND PISTON PIN

Piston



SEM804E

Unit: mm (in)

Piston skirt diameter (A)	Standard	Grade No. 1	88.970 - 88.980 (3.5027 - 3.5031)
		Grade No. 2	88.980 - 88.990 (3.5031 - 3.5035)
Grade No. 3		88.990 - 89.000 (3.5035 - 3.5039)	
Service (Oversize)	0.5 (0.020)	89.470 - 89.500 (3.5224 - 3.5236)	
	1.0 (0.039)	89.970 - 90.000 (3.5421 - 3.5433)	
Dimension (a)	Approximately 52 (2.05)		
Piston pin hole diameter (d)	20.987 - 20.999 (0.8263 - 0.8267)		
Piston-to-cylinder bore clearance	0.020 - 0.040 (0.0008 - 0.0016)		

Piston pin

Unit: mm (in)

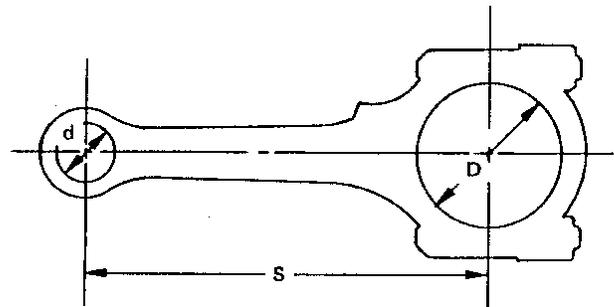
	Standard	Limit
Piston pin outer diameter	20.989 - 21.001 (0.8263 - 0.8268)	—
Interference fit of piston pin to piston pin hole	0 - 0.004 (0 - 0.0002)	—
Piston pin to connecting rod bearing clearance	0.005 - 0.017 (0.0002 - 0.0007)	0.023 (0.0009)

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)	0.1 (0.004)
Ring gap	Top	0.28 - 0.52 (0.0110 - 0.0205)	1.0 (0.039)
	2nd	0.45 - 0.69 (0.0177 - 0.0272)	1.0 (0.039)
	Oil (rail ring)	0.20 - 0.69 (0.0079 - 0.0272)	1.0 (0.039)

CONNECTING ROD



SEM570A

Unit: mm (in)

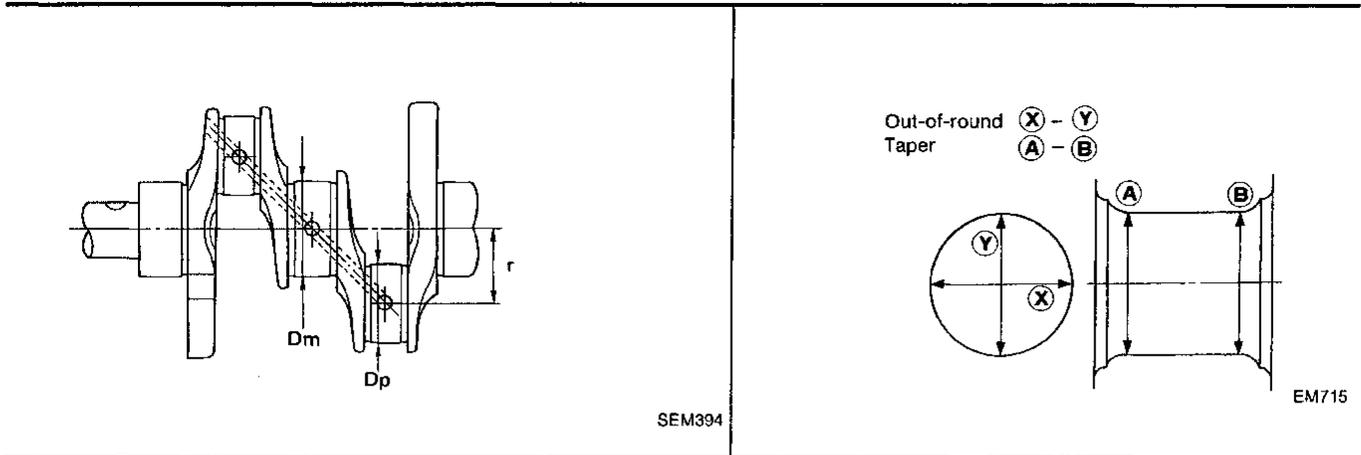
	Standard	Limit
Center distance (S)	164.95 - 165.05 (6.4941 - 6.4980)	—
Bend [per 100 mm (3.94 in)]	—	0.15 (0.0059)
Torsion [per 100 mm (3.94 in)]	—	0.30 (0.0118)
Piston pin bushing inner diameter (d)*	21.000 - 21.012 (0.8268 - 0.8272)	—
Connecting rod big end inner diameter (D)*	53.000 - 53.013 (2.0866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

* Without bearing

SERVICE DATA AND SPECIFICATIONS (SDS)

Inspection and Adjustment (Cont'd)

CRANKSHAFT



Unit: mm (in)

Main journal diameter (Dm)	Grade	No. 0	59.967 - 59.975 (2.3609 - 2.3612)
		No. 1	59.959 - 59.967 (2.3606 - 2.3609)
		No. 2	59.951 - 59.959 (2.3603 - 2.3606)
Pin journal diameter (Dp)	Grade	No. 0	49.968 - 49.974 (1.9672 - 1.9675)
		No. 1	49.962 - 49.968 (1.9670 - 1.9672)
		No. 2	49.956 - 49.962 (1.9668 - 1.9670)
Center distance (r)			47.95 - 48.05 (1.8878 - 1.8917)
		Standard	Limit
Taper of journal and pin [(A) - (B)]		—	0.002 (0.0001)
Out-of-round of journal and pin [(X) - (Y)]		—	0.005 (0.0002)
Runout [TIR]*		—	0.04 (0.0016)
Free end play		0.05 - 0.18 (0.0020 - 0.0071)	0.3 (0.012)
Fillet roil		More than 0.1 (0.004)	

* Total indicator reading

BEARING CLEARANCE

Unit: mm (in)

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

AVAILABLE MAIN BEARING

Standard

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

SERVICE DATA AND SPECIFICATIONS (SDS)

Inspection and Adjustment (Cont'd)

Undersize (service)

Unit: mm (in)

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

AVAILABLE CONNECTING ROD BEARING

Standard

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

Undersize (service)

Unit: mm (in)

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

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Camshaft sprocket runout [TIR]*	Less than 0.15 (0.0059)
Flywheel runout [TIR]*	Less than 0.15 (0.0059)
Drive plate runout [TIR]*	Less than 0.5 (0.020)

* Total indicator reading

GI

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