

SECTION **EM**

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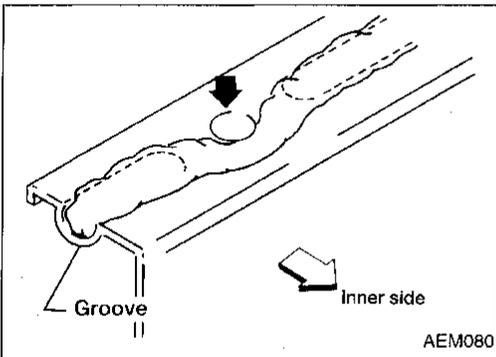
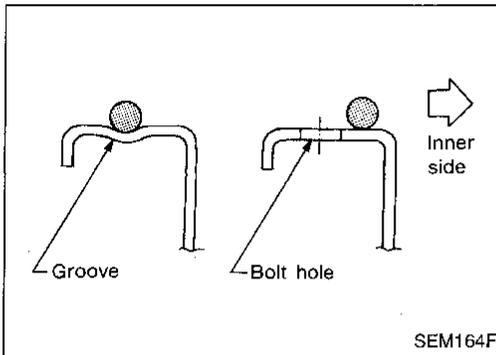
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PRECAUTIONS

Parts Requiring Angular Tightening

- Use an angle wrench for the final tightening of the following engine parts:
 - (1) Cylinder head bolts
 - (2) Main bearing cap bolts
 - (3) Connecting rod cap nuts
- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread and seat surfaces are clean and coated with engine oil.



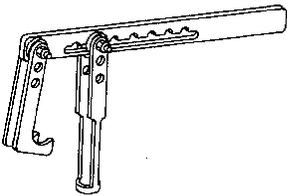
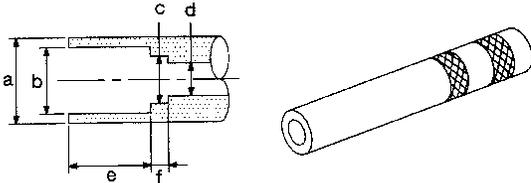
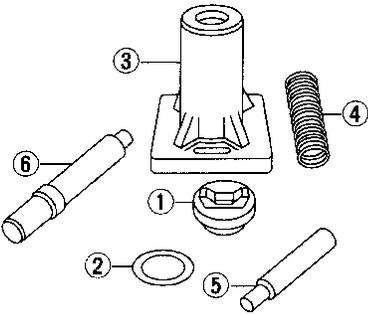
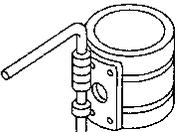
Liquid Gasket Application Procedure

- Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also, completely clean any oil from these areas.
- Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Liquid Gasket or equivalent.)
 - Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide (for oil pan.)
 - 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 around the inner side of bolt holes (unless otherwise specified).
- Assembly should be done within 5 minutes after coating.
- Wait at least 30 minutes before refilling engine oil and engine coolant.

PREPARATION

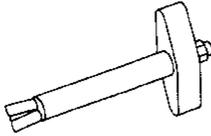
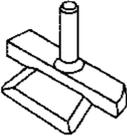
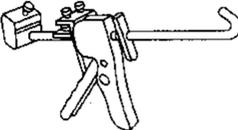
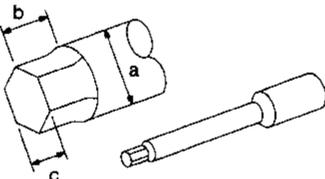
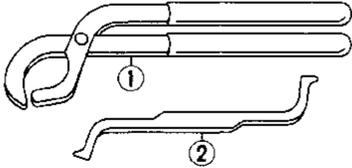
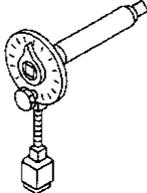
Special Service Tools

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

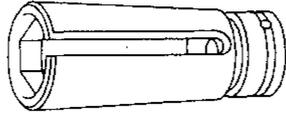
Tool number (Kent-Moore No.) Tool name	Description	
KV101092S0 (J26336-B or J39773) Valve spring compressor	Disassembling and assembling valve components  NT382	GI MA EM LC EC FE
KV10116300 (J-38955) Valve oil seal drift	Installing valve oil seal  NT602	CL MT AT Unit: mm (in)
KV10110300 (—) Piston pin press stand assembly ① KV10110310 (—) Cap ② KV10110330 (—) Spacer ③ ST13030020 (—) Press stand ④ ST13030030 (—) Spring ⑤ KV10110340 (—) Drift ⑥ KV10110320 (—) Center shaft	Disassembling and assembling piston with connecting rod  NT036	PD FA RA BR ST RS BT HA
EM03470000 (J8037) Piston ring compressor	Installing piston assembly into cylinder bore  NT044	EL IDX

PREPARATION

Special Service Tools (Cont'd)

Tool number (Kent-Moore No.) Tool name	Description
(J36467) Valve oil seal remover	<div style="text-align: right;">Displacement valve oil seal</div> <div style="text-align: center;">  </div> <p style="text-align: center;">NT034</p>
KV10111100 (J37228) Seal cutter	<div style="text-align: right;">Removing oil pan</div> <div style="text-align: center;">  </div> <p style="text-align: center;">NT046</p>
WS39930000 (—) Tube presser	<div style="text-align: right;">Pressing the tube of liquid gasket</div> <div style="text-align: center;">  </div> <p style="text-align: center;">NT052</p>
ST16610001 (J23907) Pilot bushing puller	<div style="text-align: right;">Removing crankshaft pilot pushing</div> <div style="text-align: center;">  </div> <p style="text-align: center;">NT045</p>
ST10120000 (J24239-01) Cylinder head bolt wrench	<div style="text-align: right;">Loosening and tightening cylinder head bolt</div> <div style="text-align: center;">  </div> <p style="text-align: center;">NT583</p> <div style="text-align: right;"> <p>a: 13 (0.51) dia.</p> <p>b: 12 (0.47)</p> <p>c: 10 (0.39)</p> <p>Unit: mm (in)</p> </div>
KV101151S0 (J38972) Lifter stopper set ① KV10115110 (J38972-1) Camshaft pliers ② KV10115120 (J38972-2) Lifter stopper	<div style="text-align: right;">Changing valve lifter shims</div> <div style="text-align: center;">  </div> <p style="text-align: center;">NT041</p>
KV10112100 (BT8653-A) Angle wrench	<div style="text-align: right;">Tightening bolts for bearing cap, cylinder head, etc.</div> <div style="text-align: center;">  </div> <p style="text-align: center;">NT014</p>

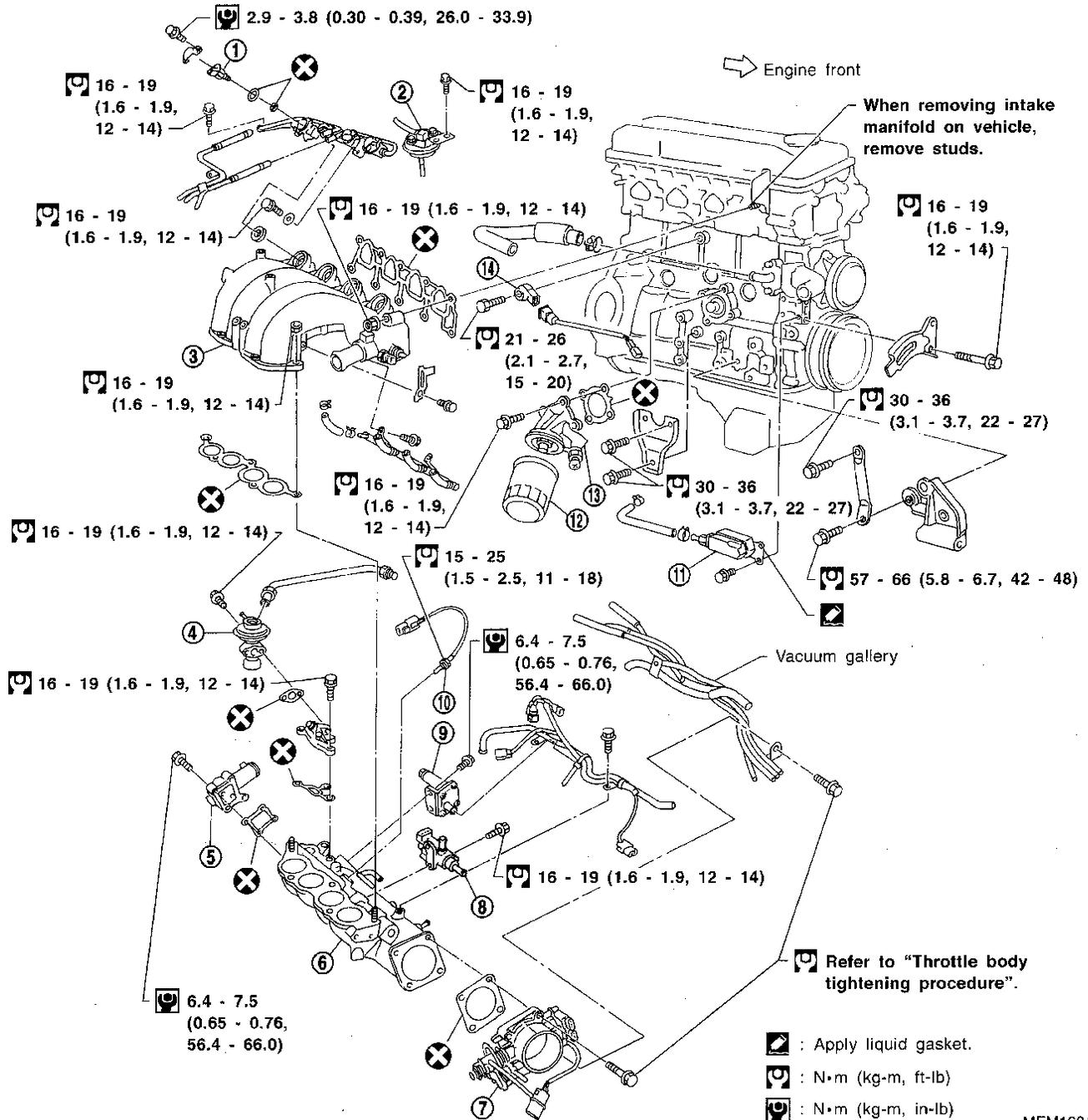
PREPARATION
Special Service Tools (Cont'd)

Tool number (Kent-Moore No.) Tool name	Description
KV10117100 (J36471-A) Front heated oxygen sensor wrench	<div style="display: flex; align-items: center; justify-content: center;">  <div style="margin-left: 20px;"> <p>Removing and installing front heated oxygen sensor [22 mm (0.87 in) type]</p> </div> </div> <p style="margin-top: 10px;">NT630</p>

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OUTER COMPONENT PARTS

SEC. 118•140•147•148•150•163•164•223•226



- ① Fuel injector
- ② EGRC-BPT valve
- ③ Intake manifold
- ④ EGR valve
- ⑤ IAA unit

- ⑥ Intake manifold collector
- ⑦ Throttle body
- ⑧ EVAP canister purge volume control valve
- ⑨ IACV-air regulator

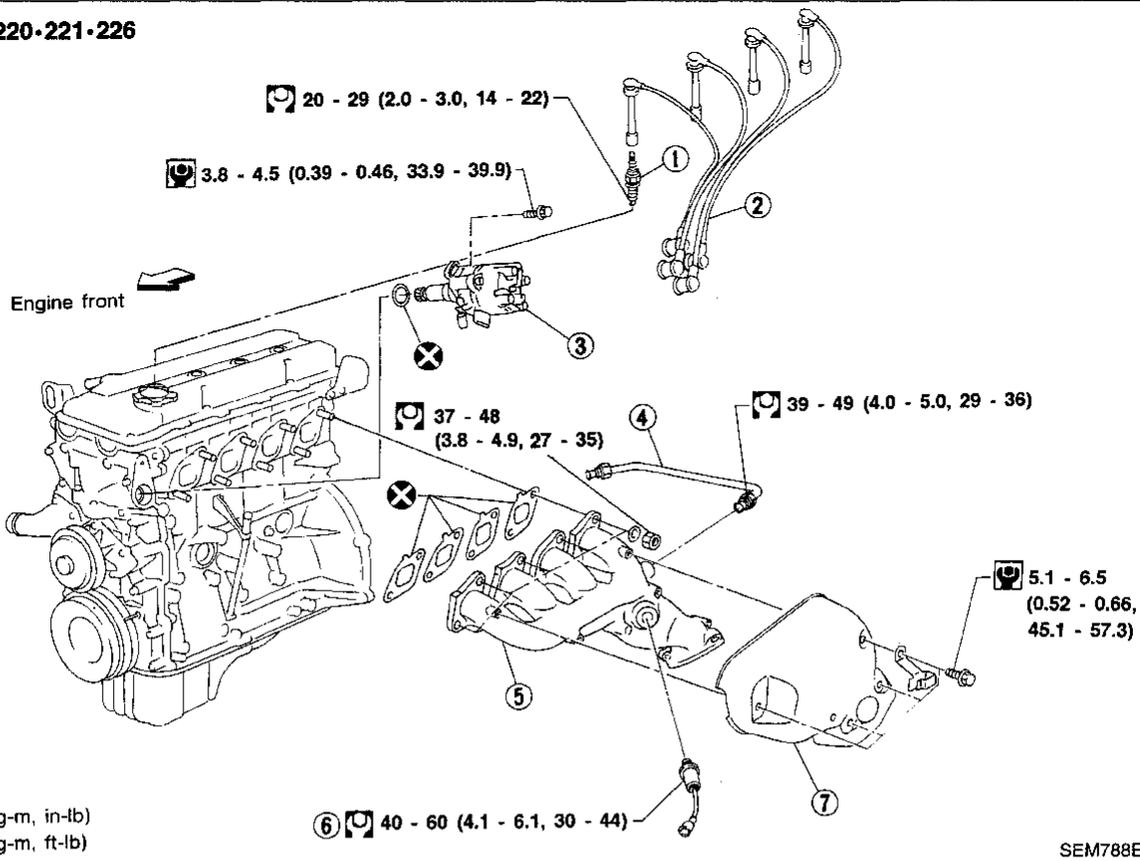
- ⑩ EGR temperature sensor
- ⑪ Breather separator
- ⑫ Oil filter
- ⑬ Oil filter bracket
- ⑭ Knock sensor

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OUTER COMPONENT PARTS

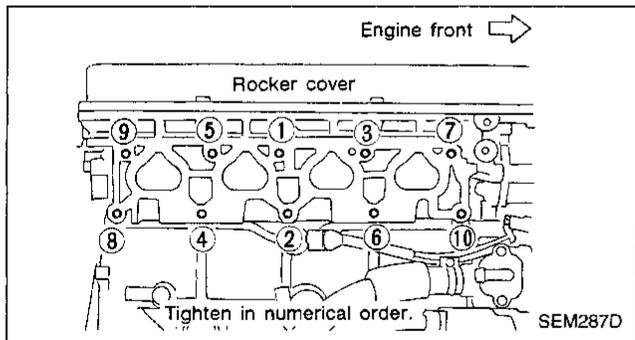
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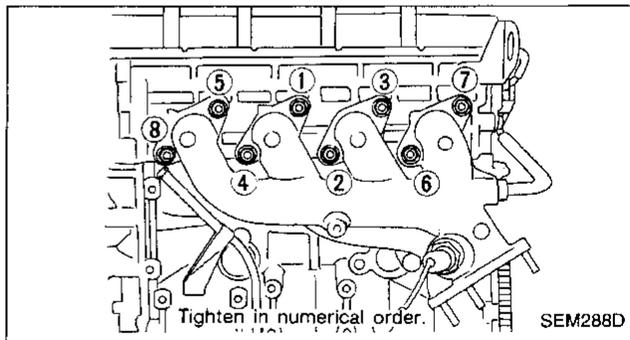
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|---|--------------------|------------------------------|
| ① Spark plug | ④ EGR tube | ⑥ Front heated oxygen sensor |
| ② Ignition wire | ⑤ Exhaust manifold | ⑦ Exhaust manifold cover |
| ③ Camshaft position sensor built into distributor | | |

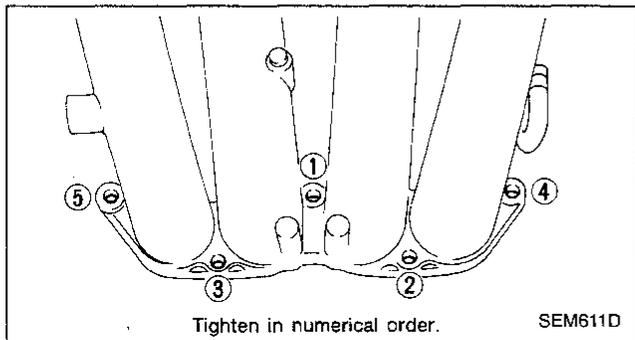
Intake manifold tightening procedure



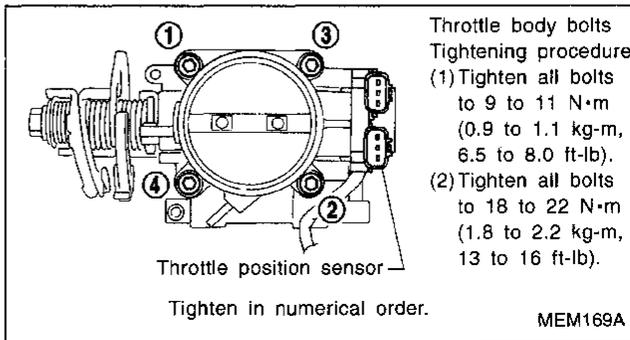
Exhaust manifold tightening procedure



Intake manifold collector tightening procedure



Throttle body tightening procedure



COMPRESSION PRESSURE

Measurement of Compression Pressure

1. Warm up engine.
2. Turn ignition switch off.
3. Release fuel pressure.
Refer to EC section ("Fuel Pressure Release", "BASIC SERVICE PROCEDURE").
4. Remove all spark plugs.
5. Disconnect distributor center cable.

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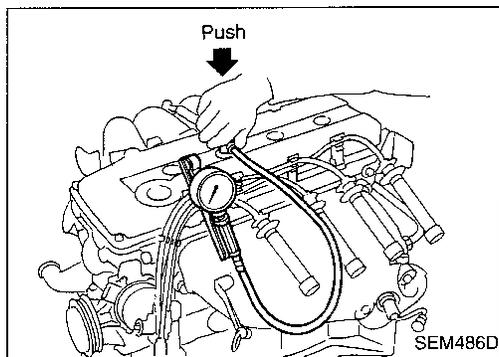
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6. Attach a compression tester to No. 1 cylinder.
 7. Depress accelerator pedal fully to keep throttle valve wide open.
 8. Crank engine and record highest gauge indication.
 9. Repeat the measurement on each cylinder as shown above.
- **Always use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

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

Standard

1,236 (12.6, 179)/300

Minimum

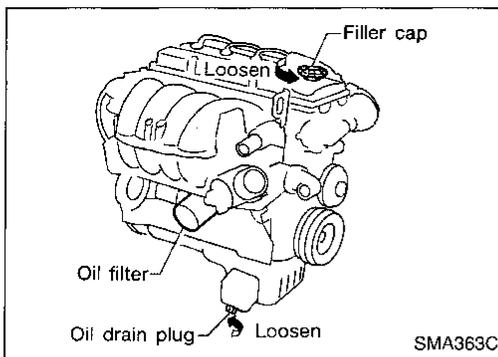
1,040 (10.6, 151)/300

Difference limit between cylinders

98 (1.0, 14)/300

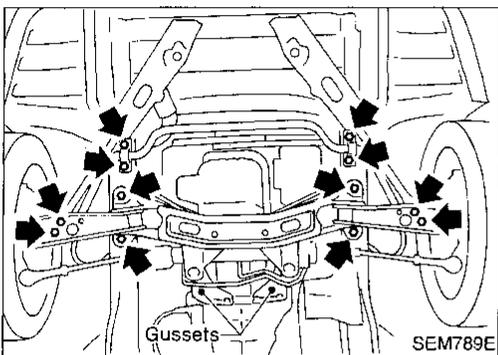
10. If compression in one or more cylinders is low:
 - a. Pour a small amount of engine oil into cylinders through spark plug holes.
 - b. Retest compression.
- **If adding oil improves cylinder compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
 - **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. (Refer to SDS, EM-47 and EM-49.) If valve or valve seat is damaged excessively, replace them.**
 - **If compression stays low in two cylinders that are next to each other:
 - a. The cylinder head gasket may be leaking, or
 - b. Both cylinders may have valve component damage. Inspect and repair as necessary.**

OIL PAN

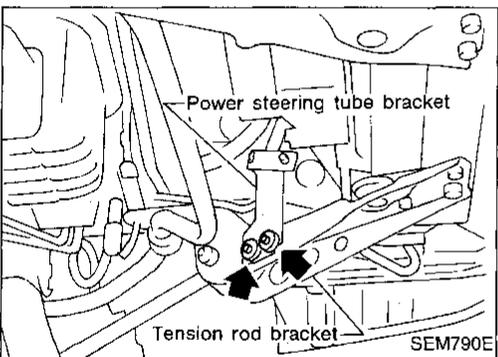


Removal

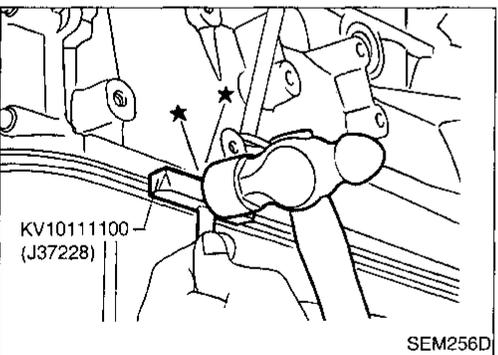
1. Raise vehicle and support it with safety stands.
2. Drain engine oil.
3. Install engine slingers to cylinder head. Refer to "ENGINE REMOVAL" (EM-33).
4. Set a suitable hoist on engine slinger and hold the engine.



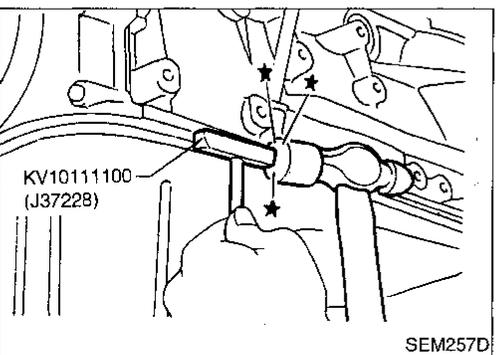
5. Remove the following parts.
 - Tension rod bolts at transverse links
 - Front stabilizer bar securing bolts and nuts from side member.
 - Both left and right side engine mounting bolts. Refer to "ENGINE REMOVAL" (EM-33).
 - Gussets
6. Disconnect steering shaft lower joint.



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 damaged.**

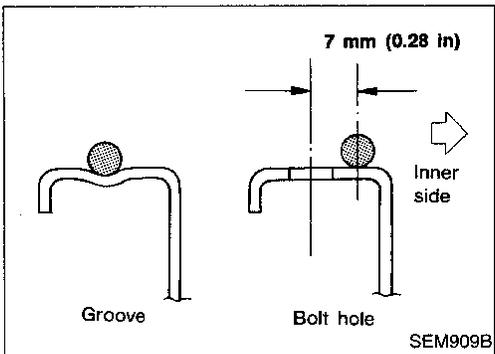
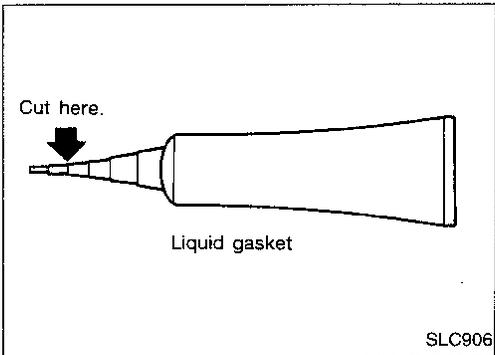
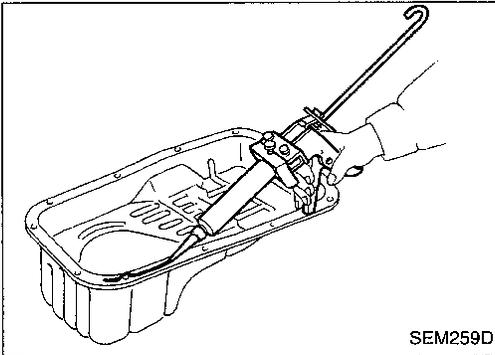
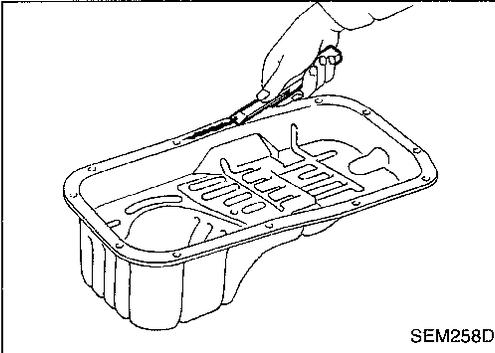
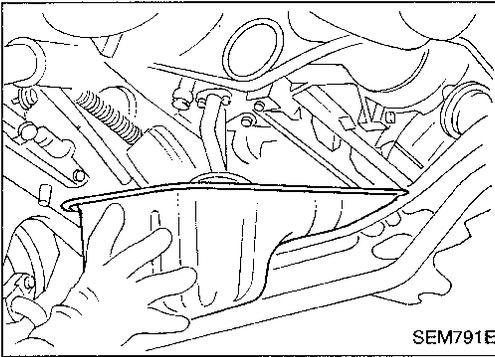


- b. Slide Tool by tapping on the side of the Tool with a hammer.
- c. Remove oil pan.

OIL PAN

Removal (Cont'd)

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



Installation

1. Use a scraper to remove all traces of liquid gasket from mating surfaces.
 - Also remove traces of liquid gasket from mating surface of cylinder block.

2. Apply a continuous bead of liquid gasket to mating surface of oil pan.
 - Use **Genuine Liquid Gasket or equivalent.**

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

- Apply liquid gasket to groove on mating surface.
 - Allow a 7 mm (0.28 in) clearance around bolt hole.
 - **Attaching should be done within 5 minutes after coating.**
3. Install oil pan.
 - **Wait at least 30 minutes before refilling engine oil.**

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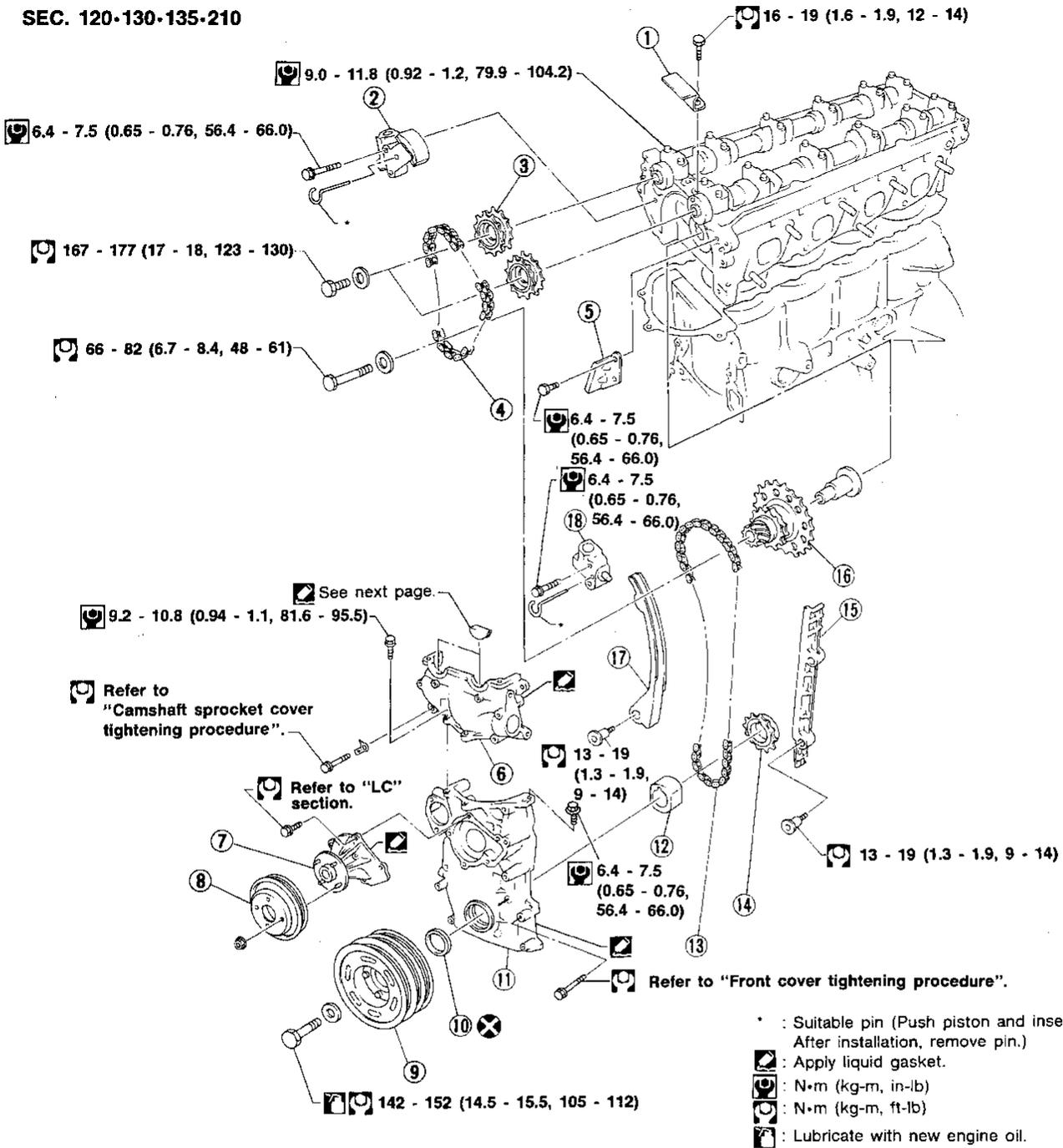
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TIMING CHAIN

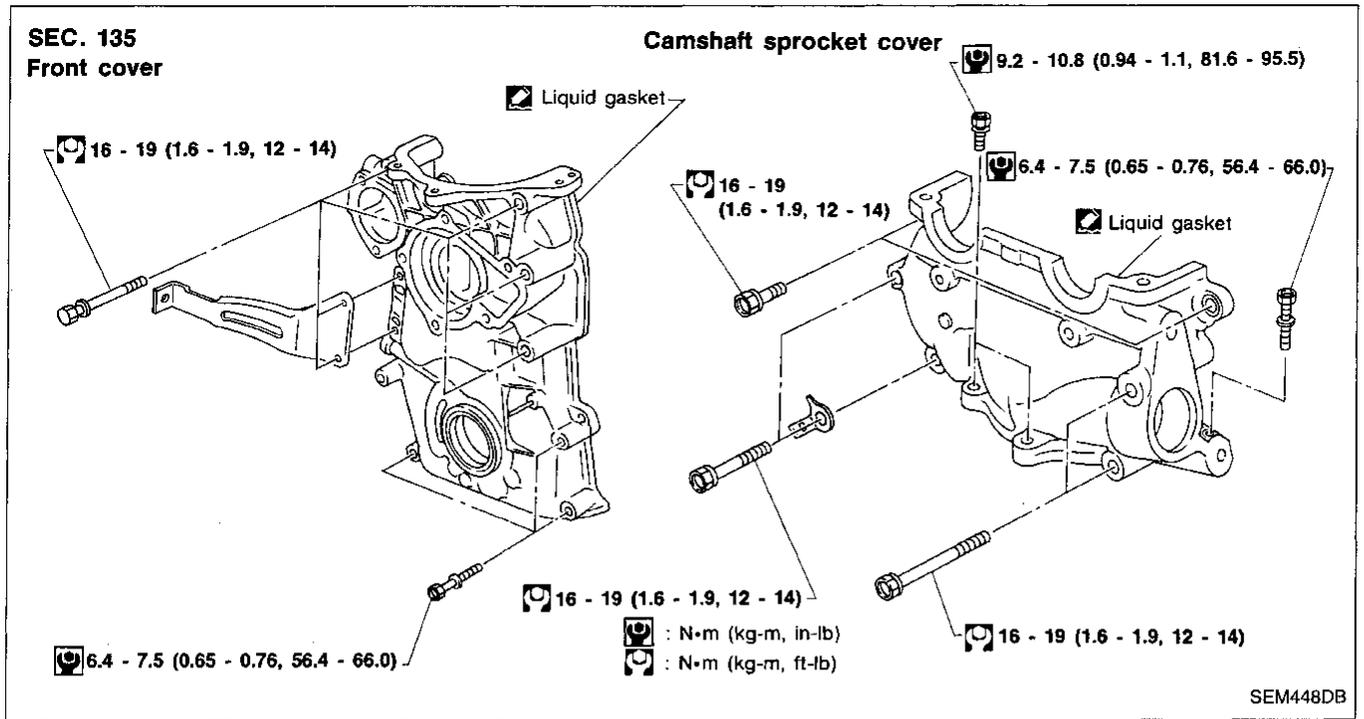
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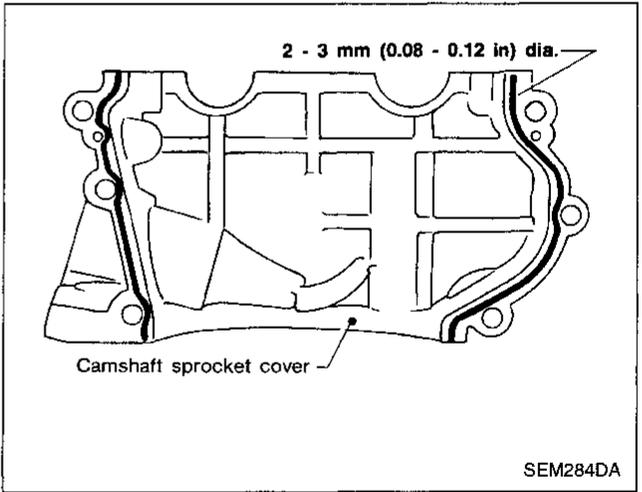
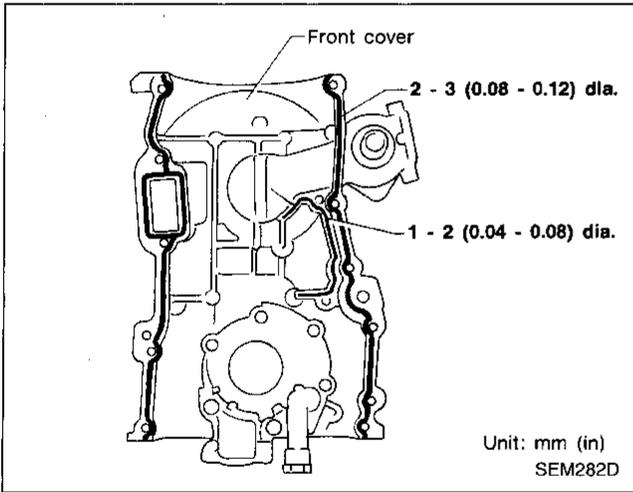
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| ① Chain guide | ⑦ Water pump | ⑬ Lower timing chain |
| ② Upper timing chain tensioner | ⑧ Water pump pulley | ⑭ Crankshaft sprocket |
| ③ Cam sprocket | ⑨ Crankshaft pulley | ⑮ Chain guide |
| ④ Upper timing chain | ⑩ Front oil seal | ⑯ Idler sprocket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

TIMING CHAIN

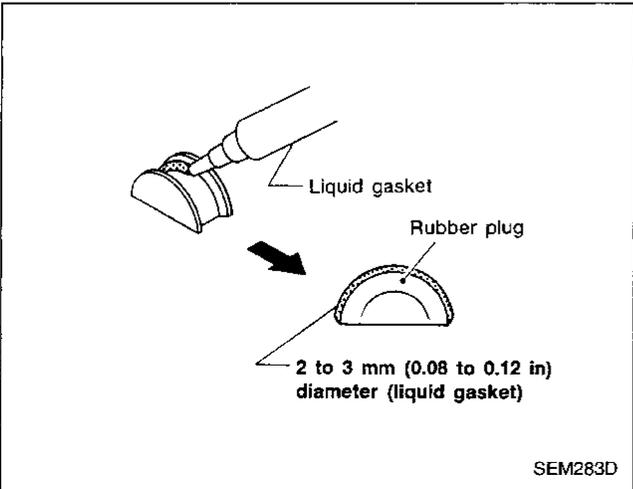


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Liquid gasket application places



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TIMING CHAIN

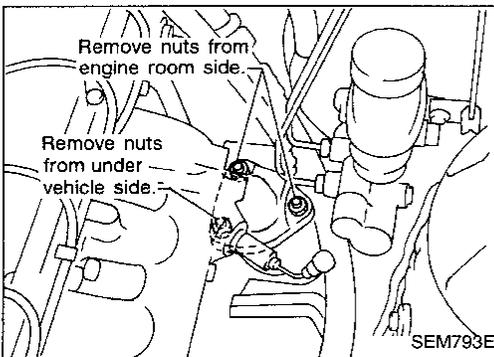
CAUTION:

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

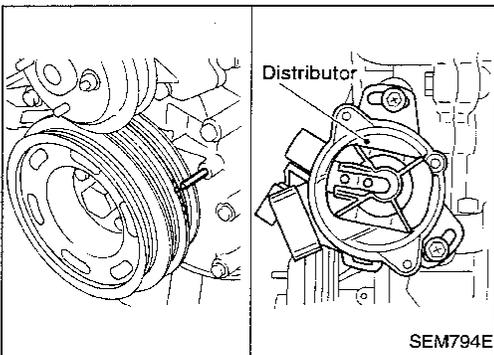
Removal

UPPER TIMING CHAIN

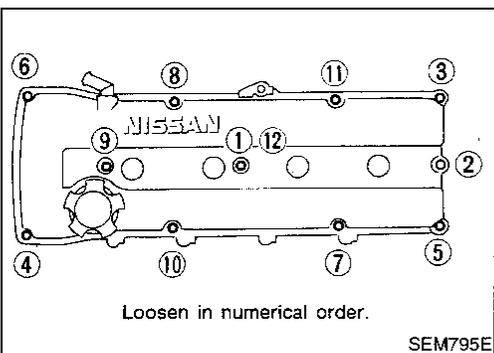
1. Drain coolant from both cylinder block drain plug and radiator drain cock. Refer to MA section.
2. Drain engine oil from drain plug of oil pan.
3. Remove vacuum hoses, fuel tubes, wires, harness and connectors and so on.



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.



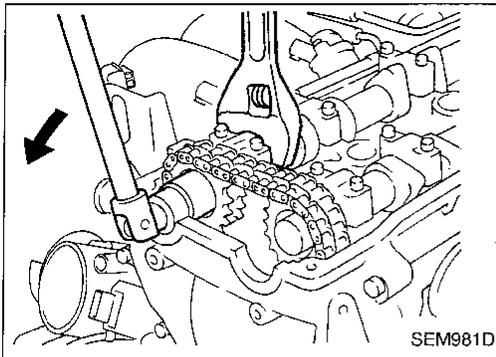
8. Set No. 1 piston at TDC on its compression stroke.



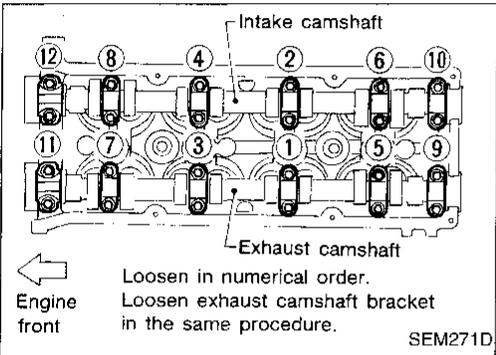
9. Remove rocker cover.
10. Remove distributor.

TIMING CHAIN

Removal (Cont'd)

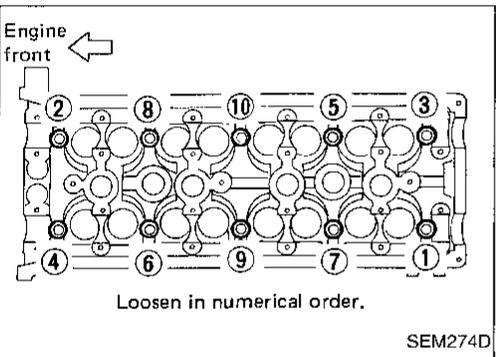


11. Remove cam sprocket.



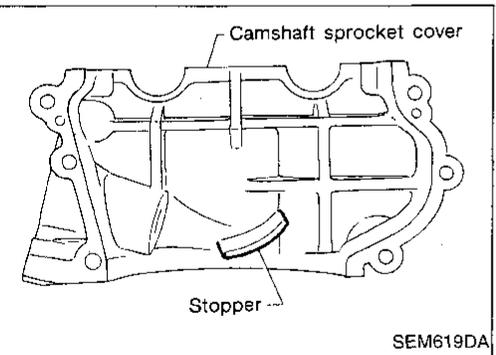
12. Remove cam brackets and camshafts.

- 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 camshaft sprocket cover

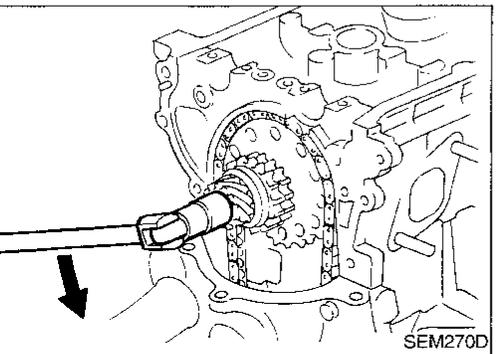
- Upper timing chain will not be disengaged from idler sprocket. For this reason, a stopper need not be used.

Cast portion of camshaft 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.

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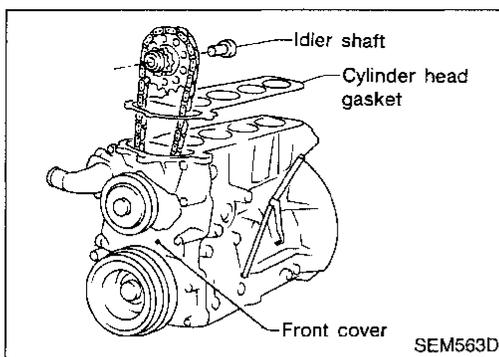
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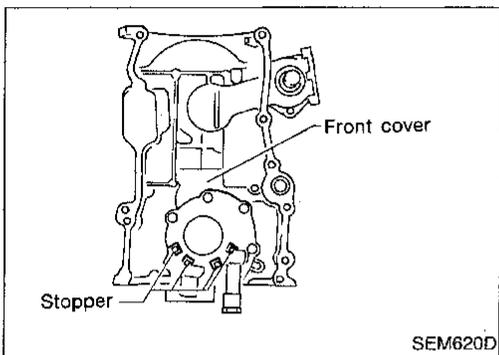
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TIMING CHAIN

Removal (Cont'd)

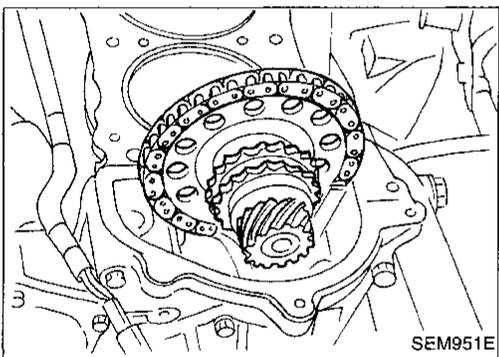


19. Remove cylinder head with intake manifold, intake manifold collector and exhaust manifold assembly.
20. Remove cylinder head gasket.



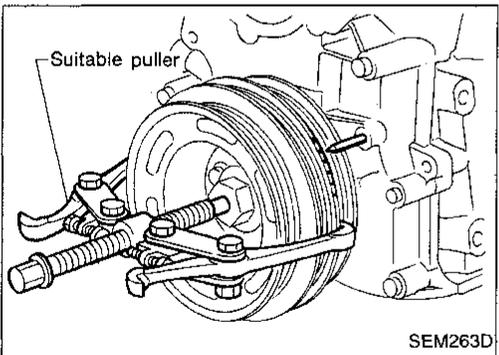
- Lower timing chain will not be disengaged from crankshaft sprocket. For this reason, a stopper need not be used.

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

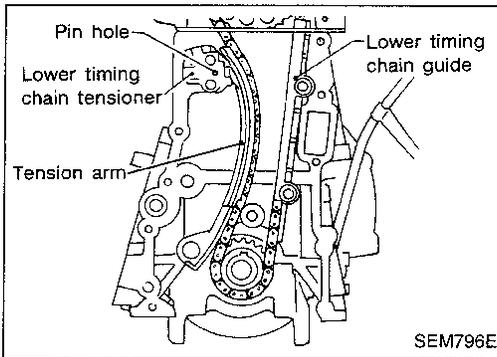
1. Remove upper timing chain.
Refer to "UPPER TIMING CHAIN" in "Removal" (EM-14).



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.
 - Inspect for oil leakage at front oil seal. Replace seal if oil leak is present.

TIMING CHAIN

Removal (Cont'd)



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.

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Inspection

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

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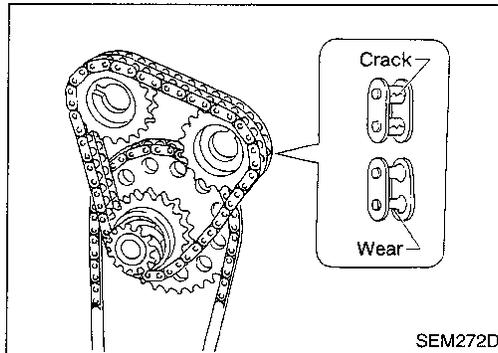
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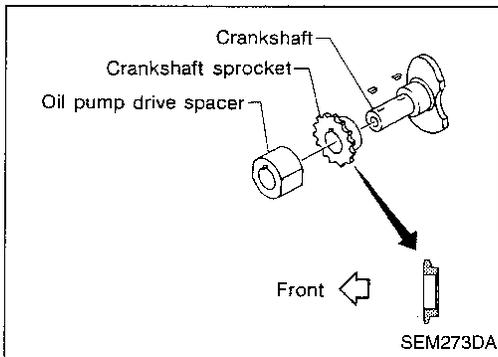
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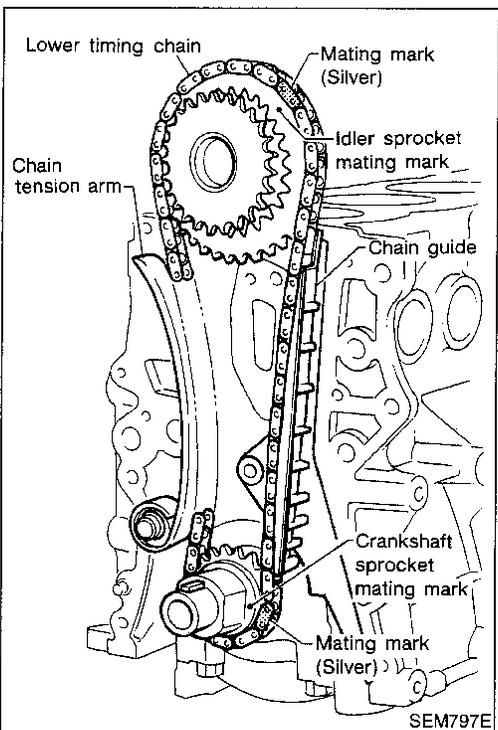


Installation

LOWER TIMING CHAIN



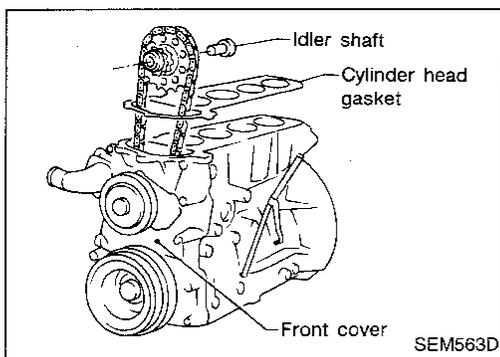
1. Install crankshaft sprocket.
 - **Make sure that mating marks of crankshaft sprocket face front of engine.**
2. Position crankshaft so that No. 1 piston is set at TDC.



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.**

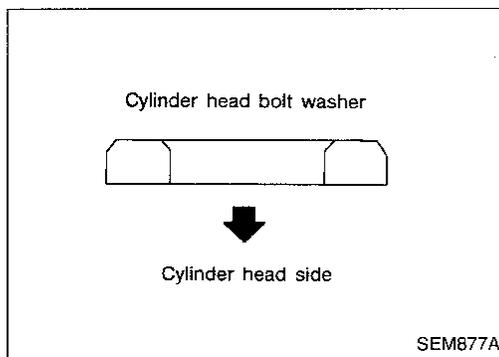
TIMING CHAIN

Installation (Cont'd)



6. Install front cover.
 - Use a scraper to remove all traces of liquid gasket from mating surface.
 - Also remove traces of liquid gasket from mating surface of cylinder block.
 - **Apply a continuous bead of liquid gasket to front cover (Refer to EM-13).**
 - **Use Genuine Liquid Gasket or equivalent.**
 - **Be careful not to damage cylinder head gasket.**
 - **Be sure to install new front oil seal. Refer to EM-21.**

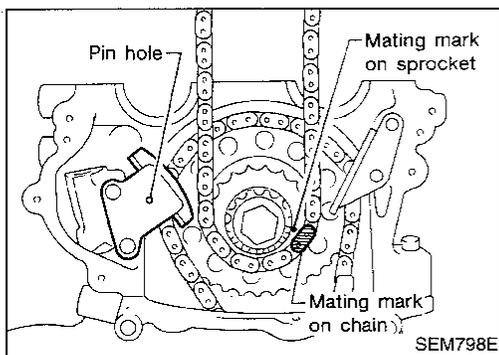
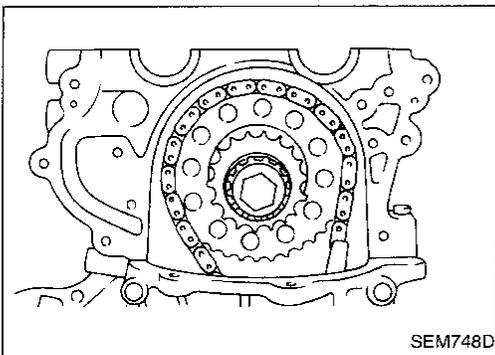
7. Install the following parts:
 - Crankshaft pulley
 - Oil strainer and oil pan
 - Component parts below the engine
 - Air compressor idler pulley
 - New cylinder head gasket
 - Idler shaft



8. Install cylinder head and temporarily tighten cylinder head bolts when installing front cover.
 - **Apply new engine oil to bolt threads and seat surfaces.**
 - **Temporarily tighten cylinder head bolts. This is necessary to avoid damaging cylinder head gasket.**
 - **Be sure to install washers between bolts and cylinder head.**

UPPER TIMING CHAIN

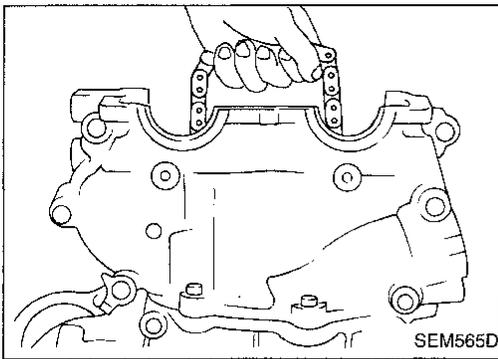
1. Install lower timing chain.
Refer to "LOWER TIMING CHAIN" in "Installation" (EM-17).



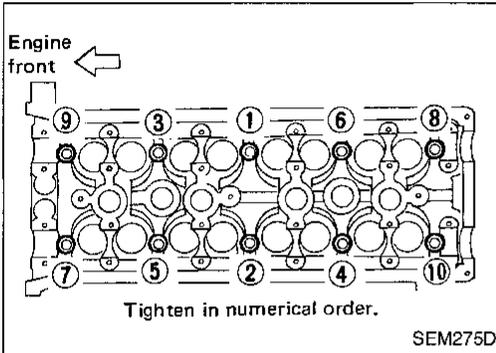
2. Install upper timing chain, chain tensioner and chain guide.
 - **Set upper timing chain on the idler sprockets, aligning mating marks.**
 - **When installing chain tensioner, insert a suitable pin into pin hole to stop piston.**
 - **After installation remove the pin to release piston.**

TIMING CHAIN

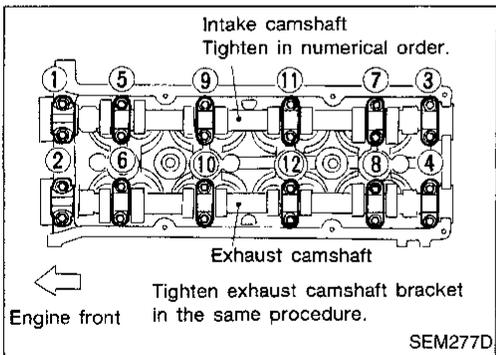
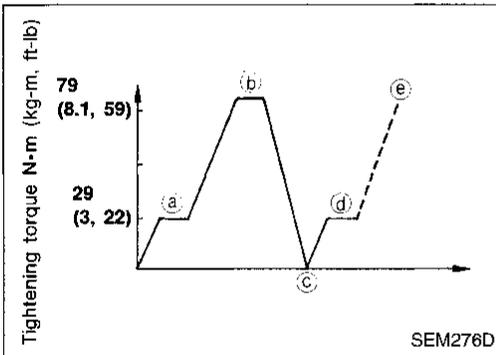
Installation (Cont'd)



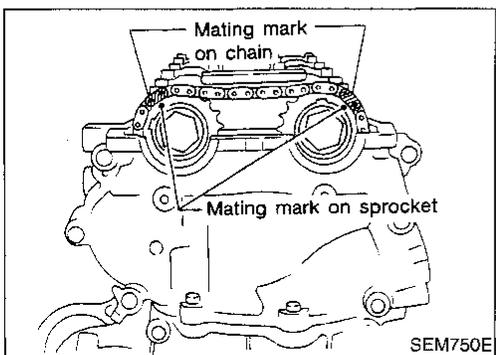
3. Install camshaft sprocket cover.
 - Use a scraper to remove all traces of liquid gasket from mating surface.
 - Also remove traces of liquid gasket from mating surface of cylinder block.
 - **Apply a continuous bead of liquid gasket to camshaft sprocket cover (Refer to EM-13).**
 - **Use Genuine Liquid Gasket or equivalent.**
 - **Be careful not to damage cylinder head gasket.**
 - **Be careful upper timing chain does not slip or jump when installing camshaft 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_{-0}^{+5} 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).**



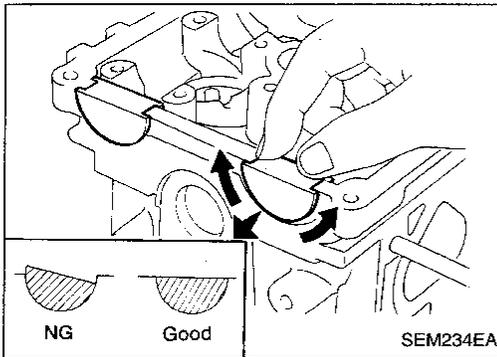
5. Install camshafts and camshaft brackets.
 - **Tightening procedure**
 - a. **Tighten all bolts to 2 N·m (0.2 kg-m, 17 in-lb).**
 - b. **Tighten all bolts to 9.0 to 11.8 N·m (0.92 to 1.2 kg-m, 79.9 - 104.2 in-lb).**



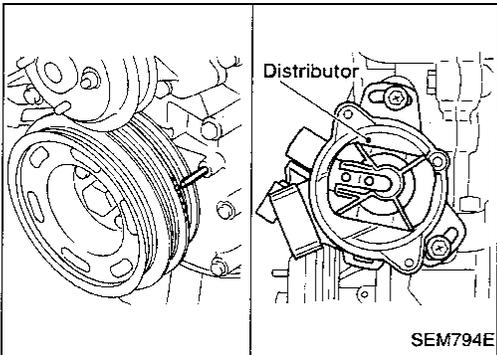
6. Install camshaft sprockets.
7. Install chain guide between both camshaft sprockets.

TIMING CHAIN

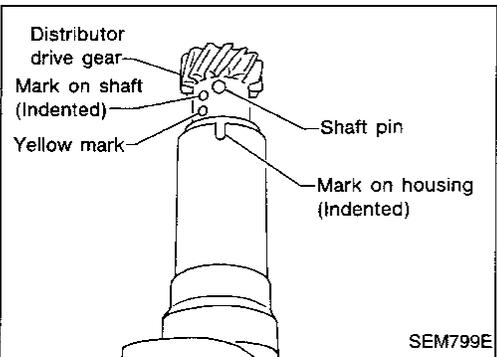
Installation (Cont'd)



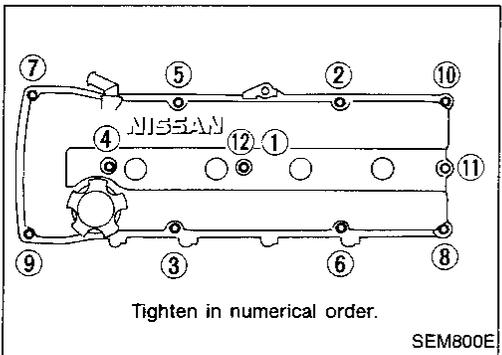
8. Install rubber plugs as follows.
 - (1) Apply liquid gasket to rubber plugs.
 - (2) Install rubber plugs, then move them by hand to uniformly spread the gasket on cam sprocket cover surface.
 - Rubber plugs should be installed flush with the cylinder head surface.
9. Install chain guide between both 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.



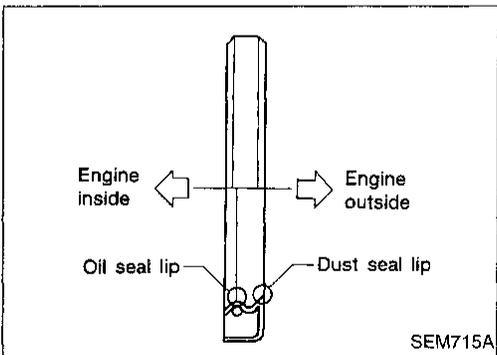
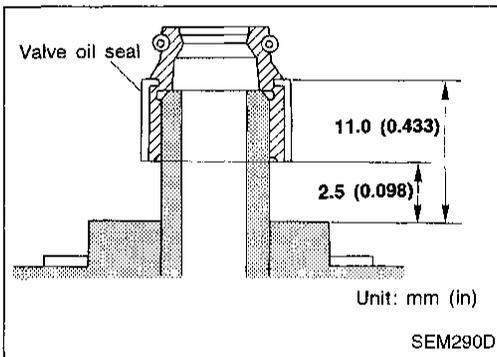
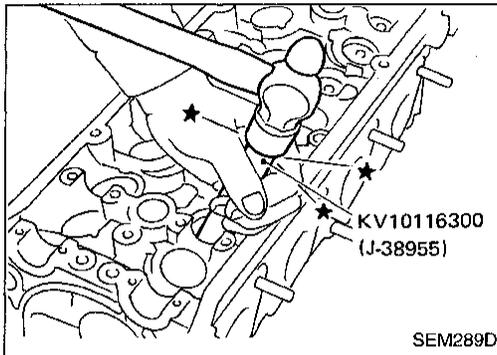
11. Install rocker cover.
12. Install all spark plugs with high-tension cords.
13. Connect injector harness connector and replace injector tube assembly with injectors.
14. Install the following parts.
 - Radiator shroud
 - Cooling fan with coupling
 - Air duct
15. Install vacuum hoses, fuel tubes, wires,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

OIL SEAL REPLACEMENT

VALVE OIL SEAL

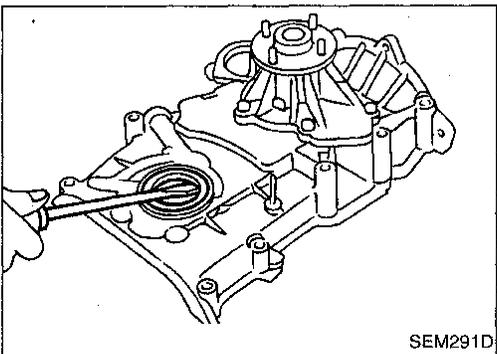
1. Remove rocker cover.
2. Remove camshaft. Refer to "TIMING CHAIN" (EM-12).
3. Remove valve spring and valve oil seal with Tool or a suitable tool.

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



OIL SEAL INSTALLING DIRECTION

- Install new oil seal in the direction shown.



FRONT OIL SEAL

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

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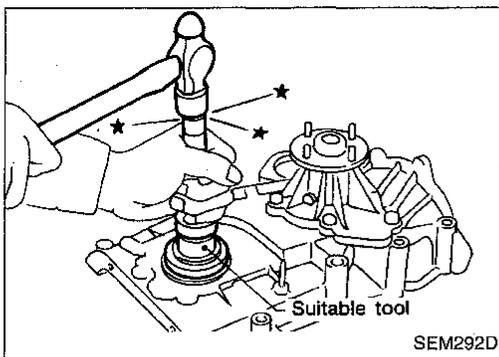
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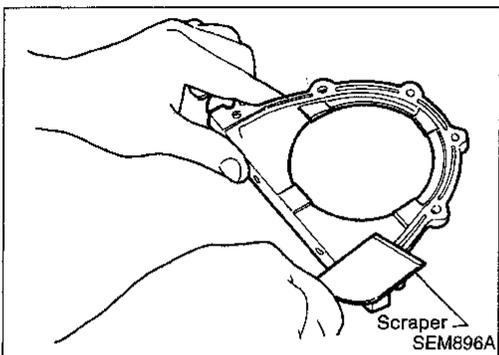
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OIL SEAL REPLACEMENT



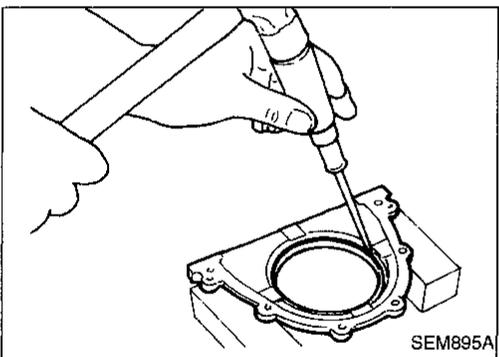
3. Apply engine oil to new oil seal and install it using a suitable tool.



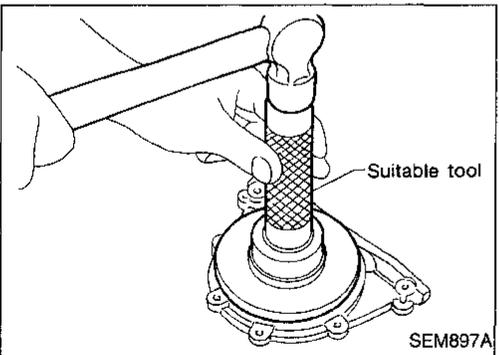
REAR OIL SEAL

1. Remove drive plate or flywheel.
2. Remove rear oil seal retainer.
3. Use a scraper to remove all traces of liquid gasket from mating surface.

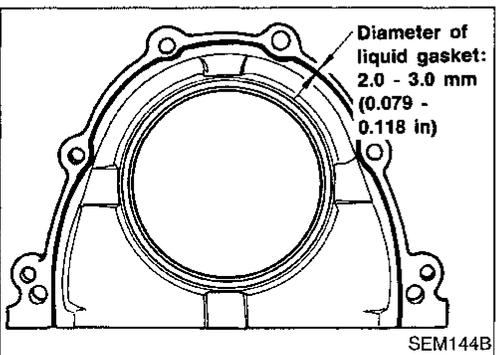
- **Remove old liquid gasket from the bolt holes and threads.**



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.

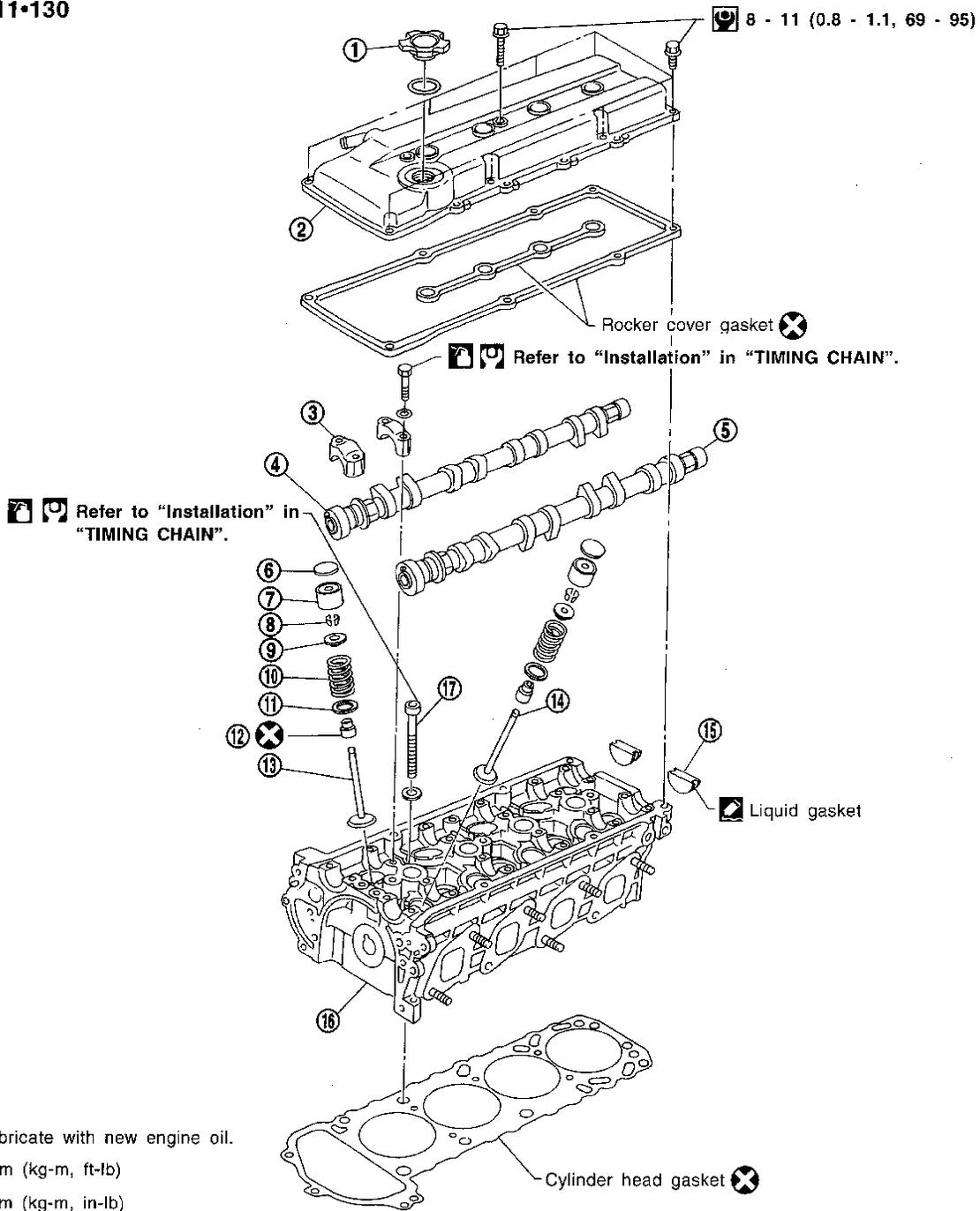


6. Apply a continuous bead of liquid gasket to rear oil seal retainer.

- **Use Genuine Liquid Gasket or equivalent.**
- Apply a continuous bead of liquid gasket around inner side of bolt holes.

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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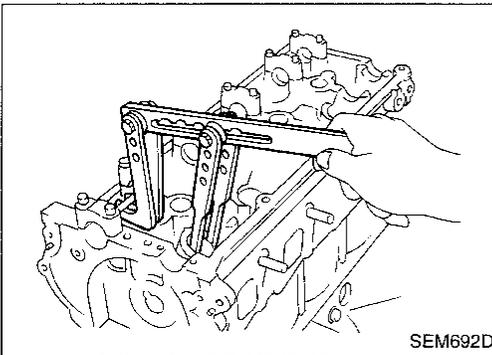
CYLINDER HEAD

CAUTION:

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

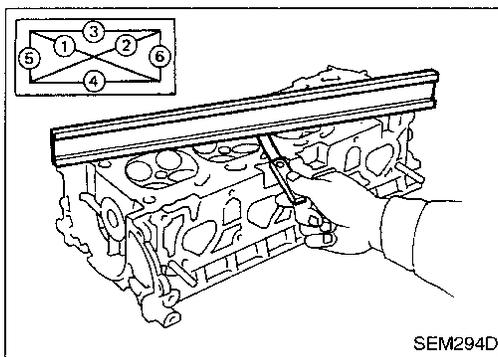
Removal and Installation

- 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

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

Check along six positions shown in the figure.

Head surface flatness:

Standard Less than 0.03 mm (0.0012 in)

Limit 0.1 mm (0.004 in)

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

Resurfacing limit:

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

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit:

A + B = 0.2 mm (0.008 in)

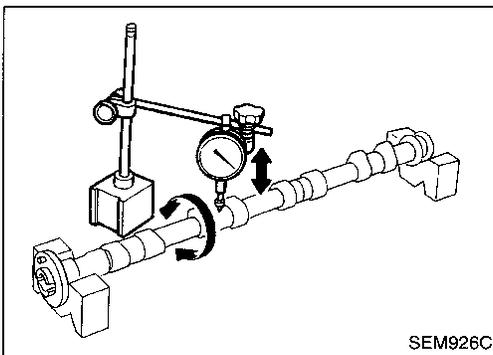
After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.

Nominal cylinder head height:

126.3 - 126.5 mm (4.972 - 4.980 in)

CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.



CAMSHAFT RUNOUT

1. Measure camshaft runout at the center journal.

Runout (Total indicator reading):

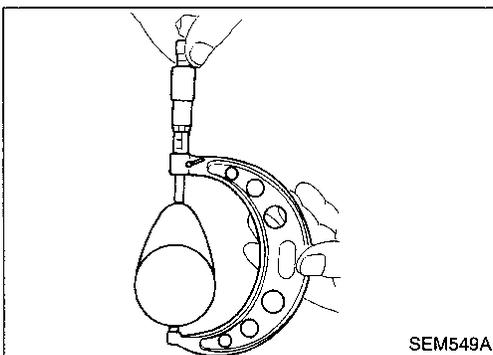
Standard:

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 height wear limit:

Intake & Exhaust

0.2 mm (0.008 in)

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

CYLINDER HEAD

Inspection (Cont'd)

CAMSHAFT JOURNAL CLEARANCE

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

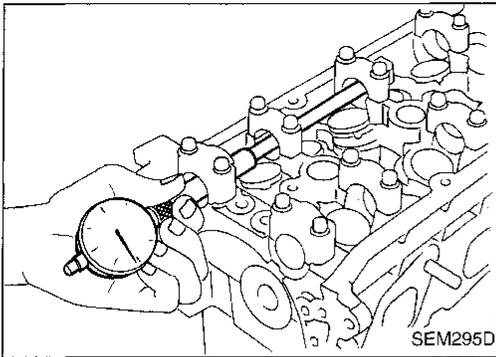
Standard inner diameter:

#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

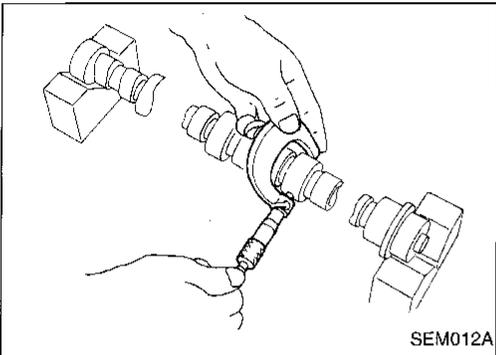
23.935 - 23.955 mm (0.9423 - 0.9431 in)

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 in cylinder head.
2. Measure camshaft end play.

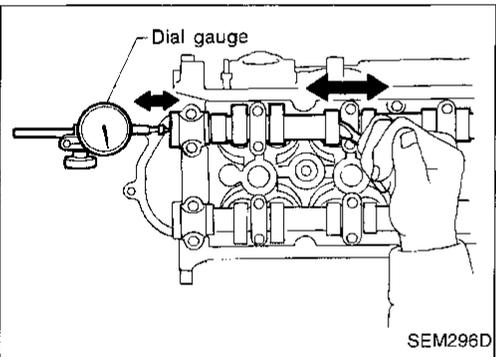
Camshaft end play:

Standard

0.070 - 0.148 mm (0.0028 - 0.0058 in)

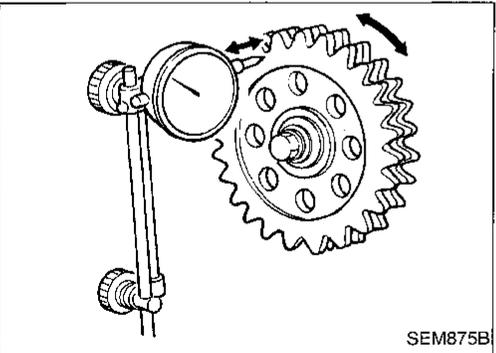
Limit

0.2 mm (0.008 in)



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.



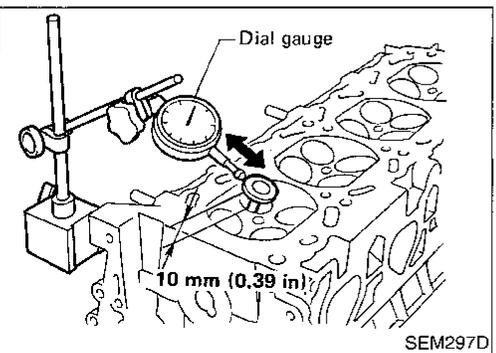
VALVE GUIDE CLEARANCE

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

Valve deflection limit (Dial gauge reading):

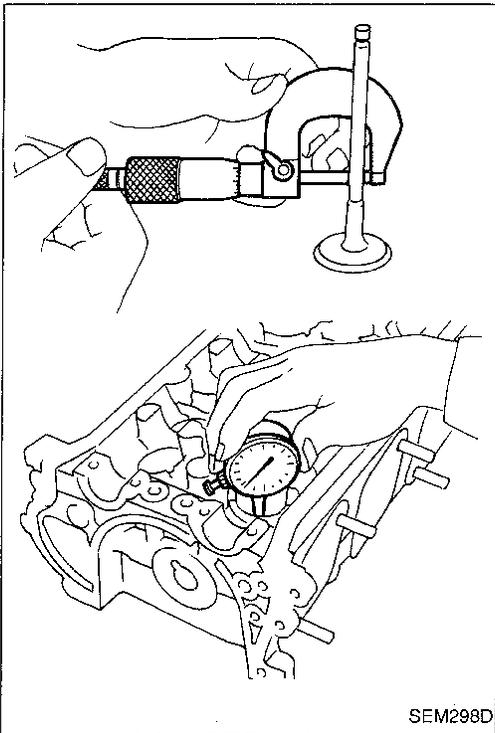
Intake & Exhaust

0.2 mm (0.008 in)



CYLINDER HEAD

Inspection (Cont'd)

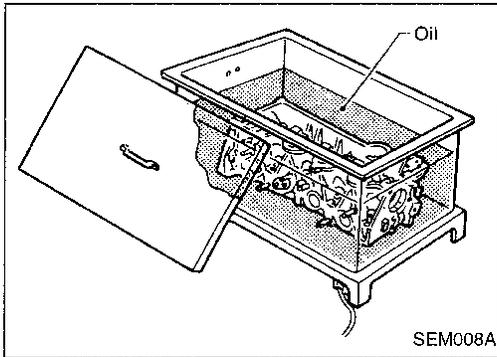


2. If it exceeds the limit, check valve to valve guide clearance.
 - a. Measure valve stem diameter and valve guide inner diameter.
 - b. Check that clearance is within specification.

Valve to valve guide clearance:

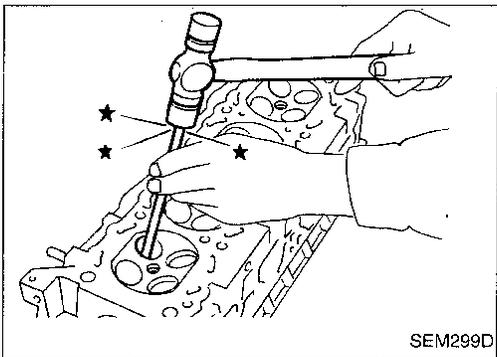
Unit: mm (in)		
	Standard	Limit
Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)

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

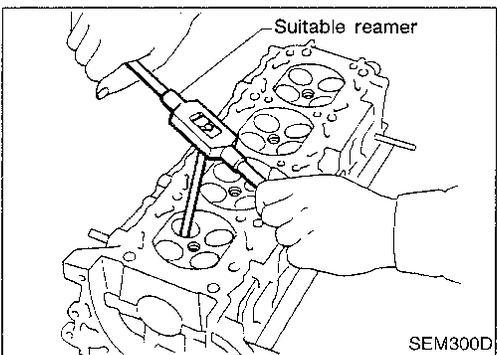


VALVE GUIDE REPLACEMENT

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



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



3. Ream cylinder head valve guide hole.

Valve guide hole diameter (for service parts):

Intake

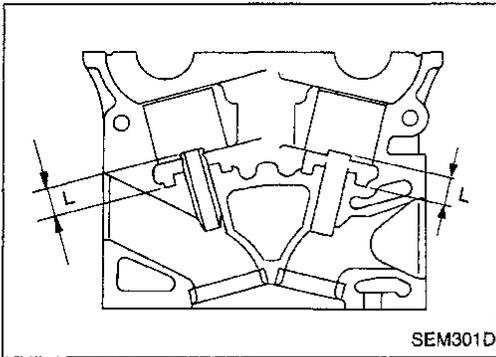
11.175 - 11.196 mm (0.4400 - 0.4408 in)

Exhaust

11.175 - 11.196 mm (0.4400 - 0.4408 in)

CYLINDER HEAD

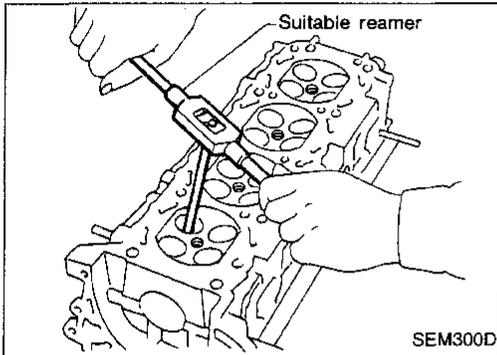
Inspection (Cont'd)



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

Projection "L":

13.3 - 13.9 mm (0.524 - 0.547 in)

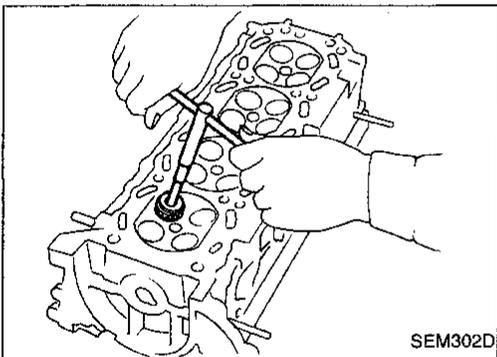


- Ream valve guide.

Finished size:

Intake & Exhaust

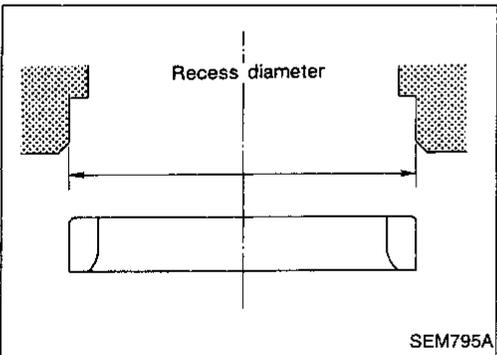
7.000 - 7.018 mm (0.2756 - 0.2763 in)



VALVE SEATS

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

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



REPLACING VALVE SEAT FOR SERVICE PARTS

- 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.
- Ream cylinder head recess.

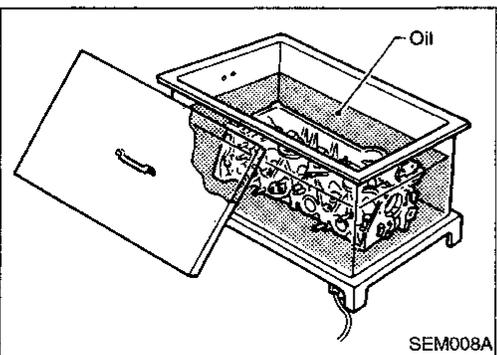
Reaming bore for service valve seat

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)

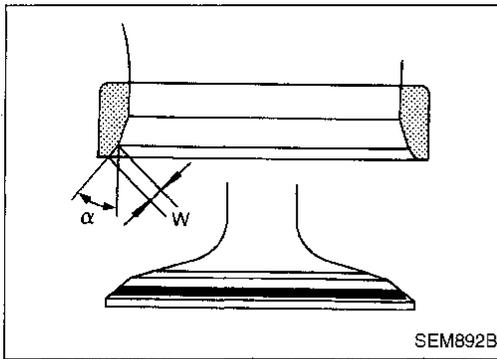
Use the valve guide center for reaming to ensure valve seat will have the correct fit.



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

CYLINDER HEAD

Inspection (Cont'd)



5. Cut or grind valve seat using suitable tool to 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)

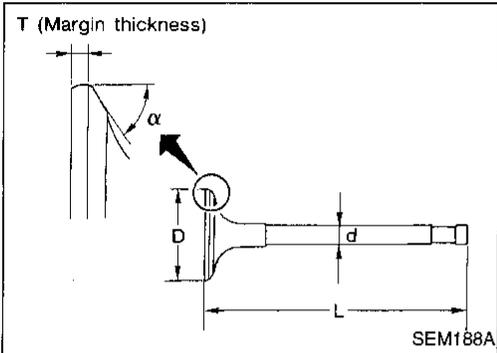
Exhaust

1.8 - 2.0 mm (0.071 - 0.079 in)

GI

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EM



VALVE DIMENSIONS

Check dimensions of each valve. For dimensions, refer to SDS (EM-47).

When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace valve.

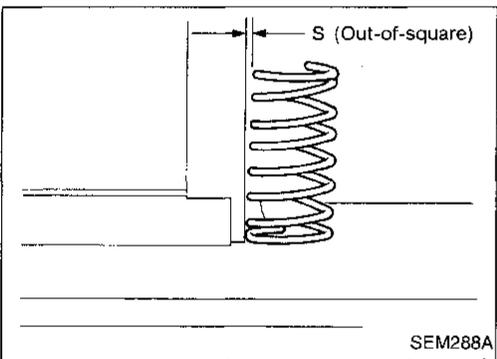
Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.

LC

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VALVE SPRING

Squareness

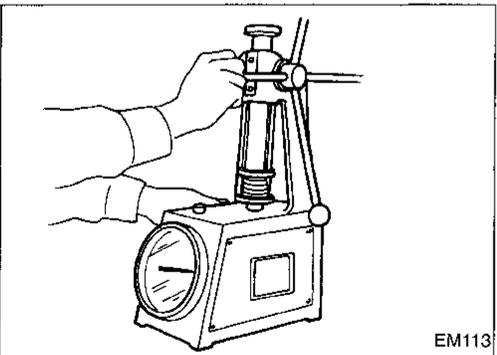
1. Measure dimension " S ".
Out-of-square " S ":
Less than 1.9 mm (0.075 in)
2. If it exceeds the limit, replace spring.

MT

AT

PD

FA



Pressure

Check valve spring pressure at specified spring height.

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)

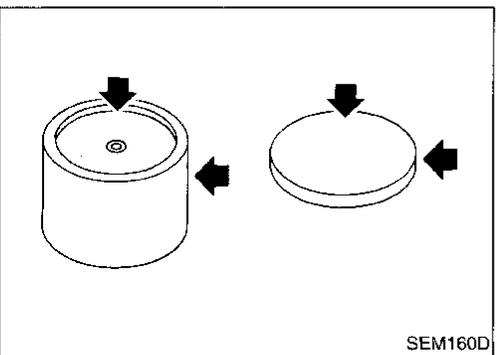
If it exceeds the limit, replace spring.

RA

BR

ST

RS



VALVE LIFTER AND VALVE SHIM

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

BT

HA

EL

IDX

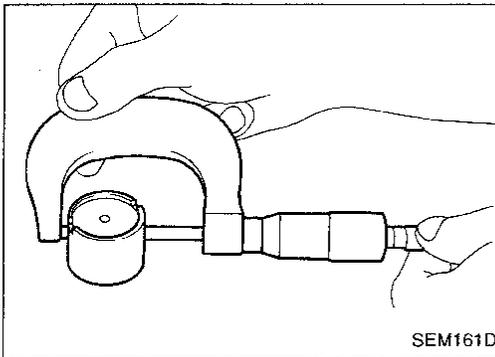
CYLINDER HEAD

Inspection (Cont'd)

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

Valve lifter diameter:

33.960 - 33.975 mm (1.3370 - 1.3376 in)

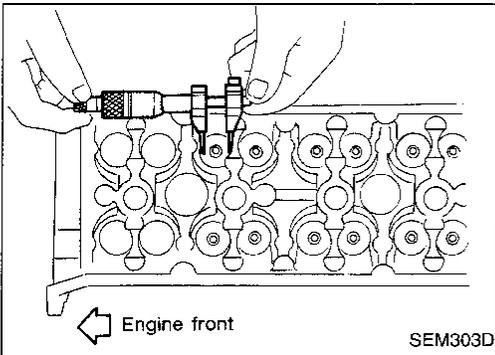


Lifter guide bore diameter:

34.000 - 34.021 mm (1.3386 - 1.3394 in)

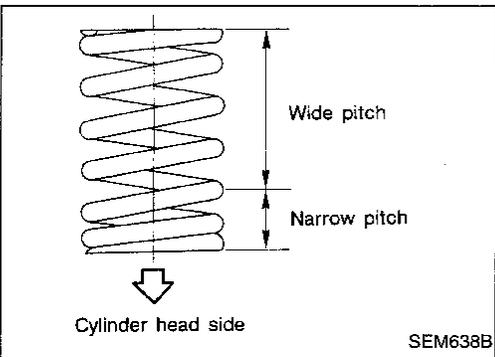
Valve lifter to valve lifter guide clearance:

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.**

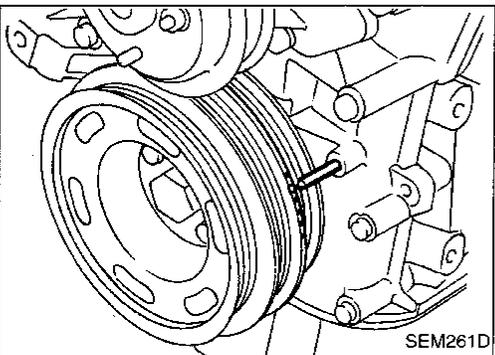


Valve Clearance

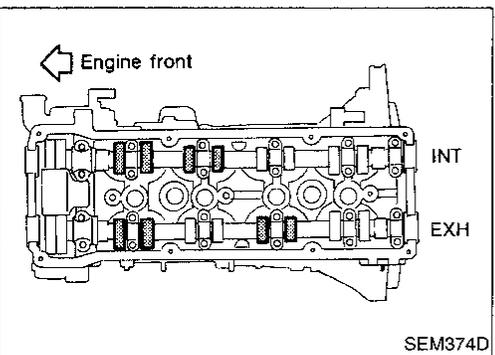
CHECKING

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.

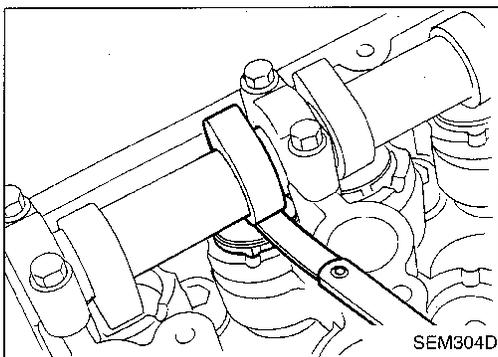


3. Check only those valves shown in the figure.



CYLINDER HEAD

Valve Clearance (Cont'd)

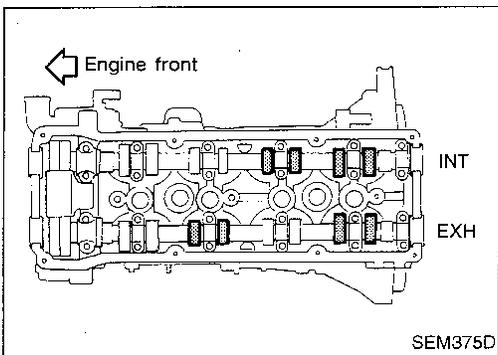


- Using a feeler gauge, measure clearance between valve lifter and camshaft.
- Record any valve clearance measurements which are out of specification. They will be used later to determine the required replacement adjusting shim.

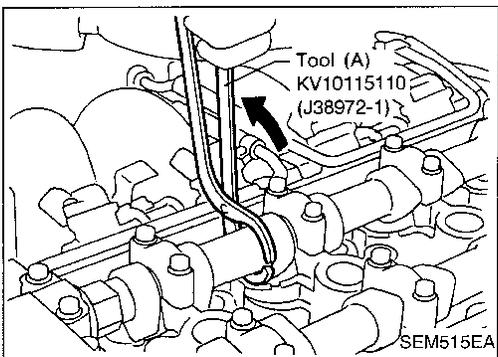
Valve clearance (Hot):

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

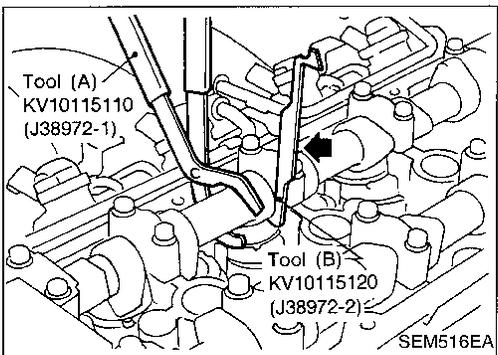
Adjust valve clearance while engine is cold.

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).

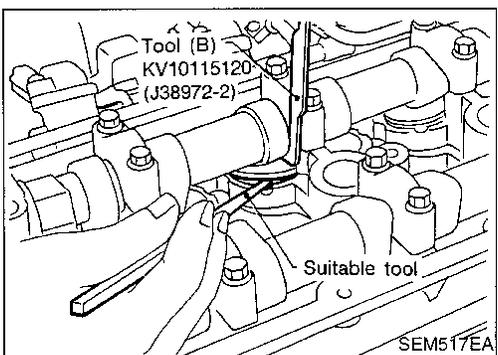


4. Place Tool (B) between camshaft and the edge of the valve lifter to retain valve lifter.

CAUTION:

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

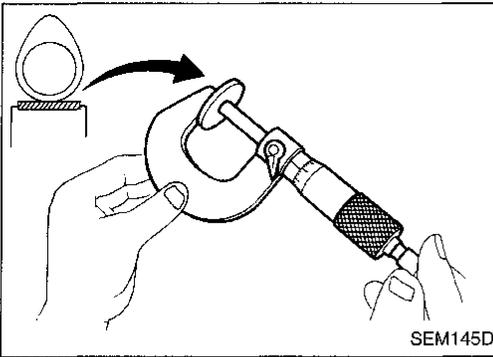
5. Remove Tool (A).



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

CYLINDER HEAD

Valve Clearance (Cont'd)



7. Determine replacement adjusting shim size following formula.
 - a. Using a micrometer determine thickness of removed shim.
 - b. Calculate thickness of new adjusting shim so valve clearance comes within specified values.

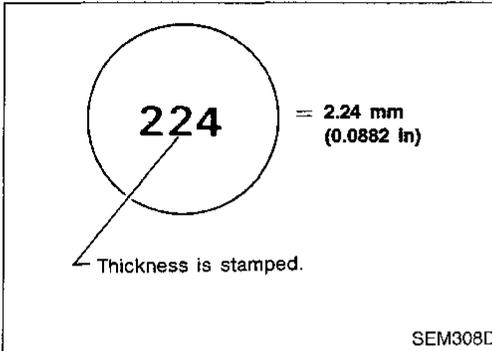
R = Thickness of removed shim

N = Thickness of new shim

M = Measured valve clearance

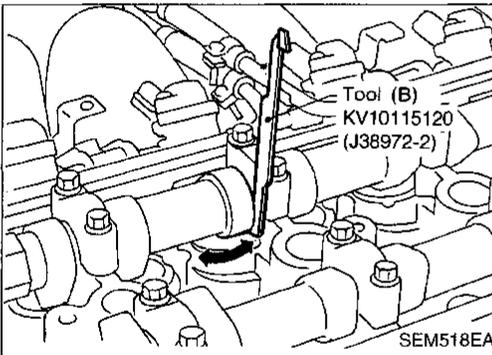
Intake & Exhaust:

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



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

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



8. Install new shim using a suitable tool.

- **Install with the surface on which the thickness is stamped facing down.**

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

10. Remove Tool (B).

11. Remove Tool (A).

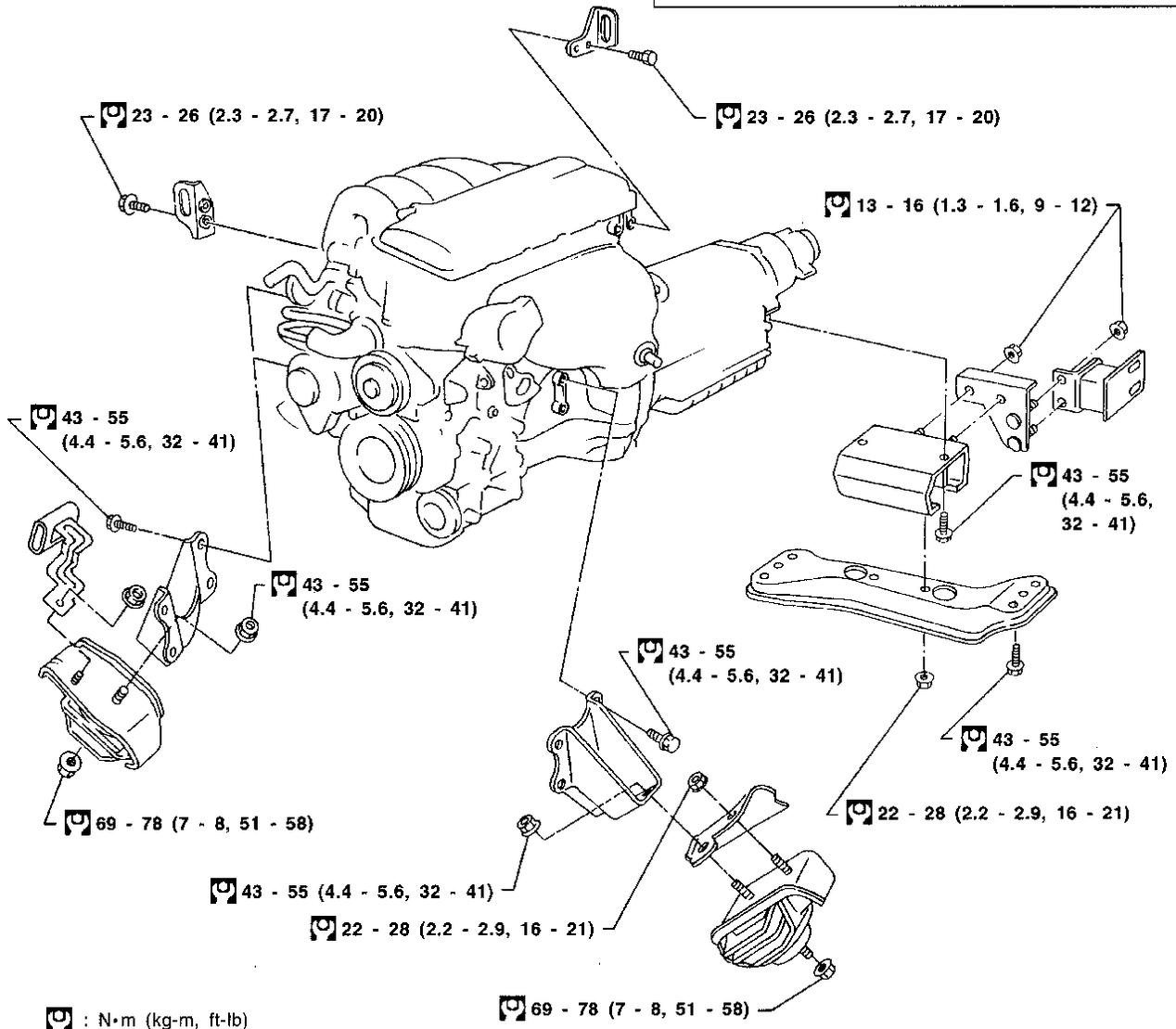
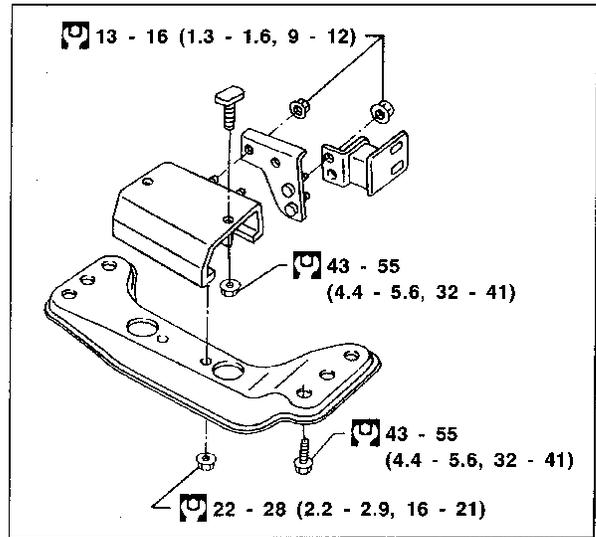
12. Recheck valve clearance.

Refer to "CHECKING" (EM-30).

ENGINE REMOVAL

SEC. 112•111

M/T model



: N•m (kg-m, ft-lb)

69 - 78 (7 - 8, 51 - 58)

GI

MA

EM

LC

EC

FE

CL

MT

AT

PD

FA

RA

BR

ST

RS

BT

HA

EL

IDX

ENGINE REMOVAL

WARNING:

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

CAUTION:

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

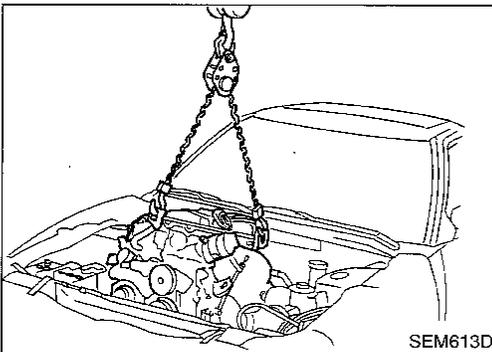
Removal

1. Remove transmission.

Refer to AT or MT section.

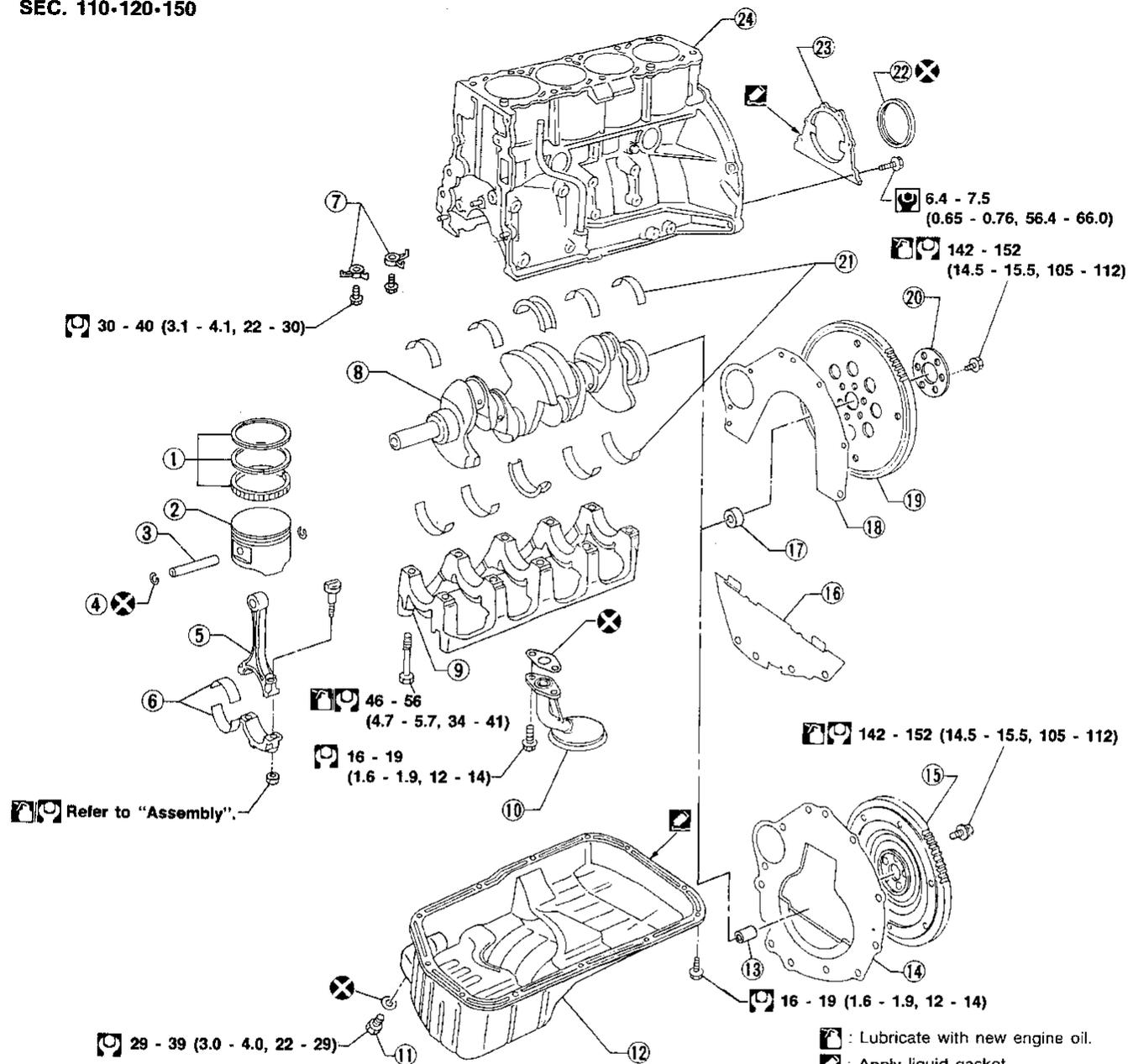
2. Remove engine under cover and hood.
3. Drain coolant from both cylinder block drain plug, and radiator drain cock.
4. Drain engine oil from drain plug of oil pan.
5. Remove vacuum hoses, fuel tubes, wires, harness and connectors and so on.
6. Remove front exhaust tubes.
7. Remove radiator and shroud.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



- : Lubricate with new engine oil.
- : Apply liquid gasket.
- : N·m (kg-m, in-lb)
- : N·m (kg-m, ft-lb)

SEM803EA

- ① Piston rings
- ② Piston
- ③ Piston pin
- ④ Snap ring
- ⑤ Connecting rod
- ⑥ Connecting rod bearing
- ⑦ Oil jet
- ⑧ Crankshaft

- ⑨ Main bearing cap
- ⑩ Oil strainer
- ⑪ Drain plug
- ⑫ Oil pan
- ⑬ Pilot bushing (M/T)
- ⑭ Rear plate (M/T)
- ⑮ Flywheel (M/T)
- ⑯ Dust cover (A/T)

- ⑰ Pilot converter (A/T)
- ⑱ Rear plate (A/T)
- ⑲ Drive plate (A/T)
- ⑳ Drive plate reinforcement
- ㉑ Main bearing
- ㉒ Rear oil seal
- ㉓ Rear oil seal retainer
- ㉔ Cylinder block

GI

MA

EM

LC

EC

FE

CL

MT

AT

PD

FA

RA

BR

ST

RS

BT

HA

EL

IDX

CYLINDER BLOCK

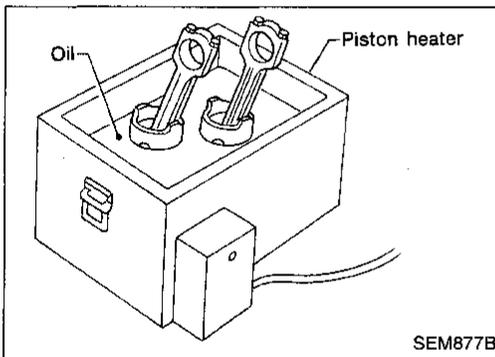
CAUTION:

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

Disassembly

PISTON AND CRANKSHAFT

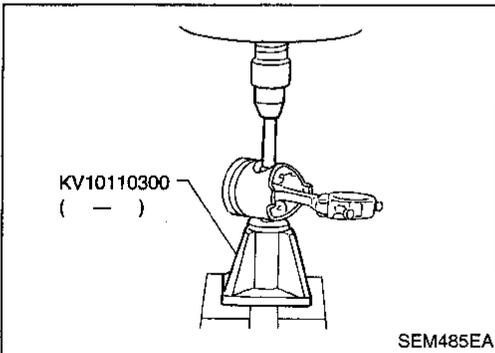
1. Place engine on a work stand.
2. Remove timing chain.
Refer to "Removal" in "TIMING CHAIN" (EM-14).



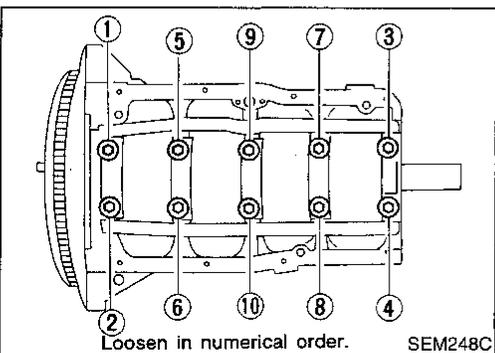
3. Remove pistons with connecting rods.
 - To disassemble piston and connecting rod, first remove snap rings. Heat piston to 60 to 70°C (140 to 158°F) then use piston pin press to remove pin.

CAUTION:

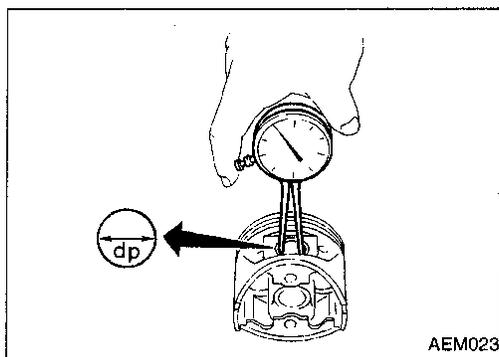
- When piston rings are not replaced, make sure that piston rings are mounted in their original positions.
- When replacing piston rings, if there is no punchmark, install with either side up.



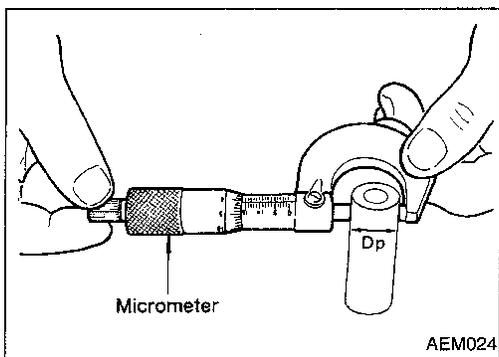
4. Remove main bearing beam and crankshaft.
 - Before removing main bearing beam, measure crankshaft end play. Refer to EM-44.
 - Bolts should be loosened in two or three steps.



CYLINDER BLOCK



AEM023



AEM024

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 piston pin clearance.
dp - Dp = 0 - 0.004 mm (0 - 0.0002 in)
 If it exceeds the above value, replace piston assembly with pin.

GI

MA

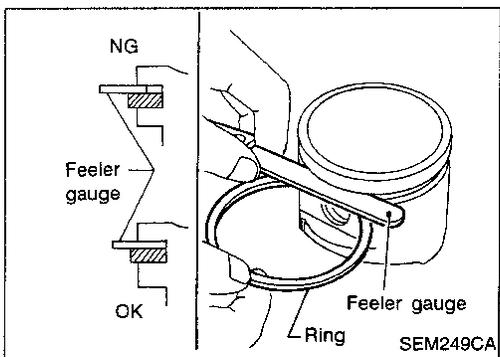
EM

LC

EC

FE

CL



SEM249CA

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)

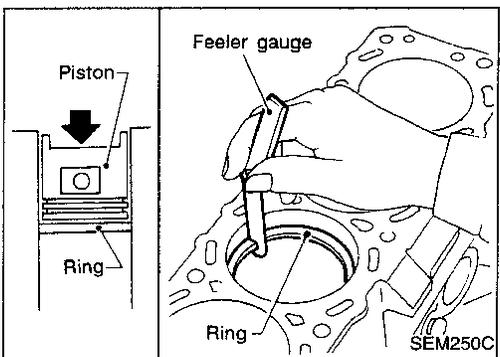
If out of specification, replace piston ring. If clearance exceeds maximum limit with new ring, replace piston.

MT

AT

PD

FA



SEM250C

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 oversized piston and piston rings.

Refer to SDS (EM-52).

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

RA

BR

ST

RS

BT

HA

EL

IDX

CYLINDER BLOCK

Inspection (Cont'd)

CONNECTING ROD BEND AND TORSION

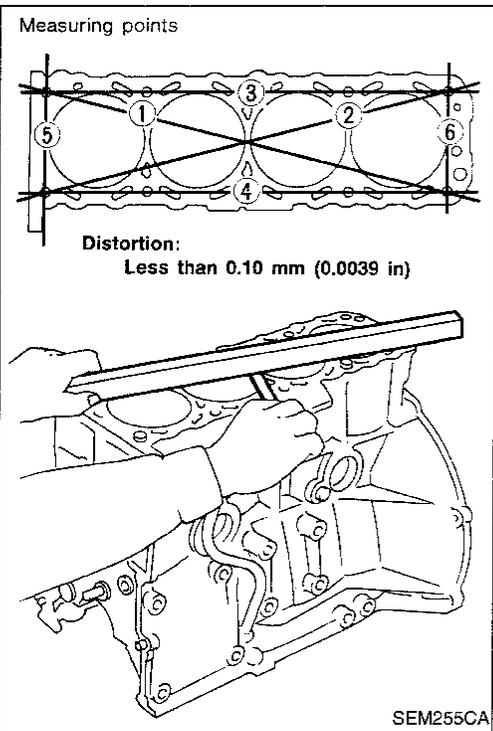
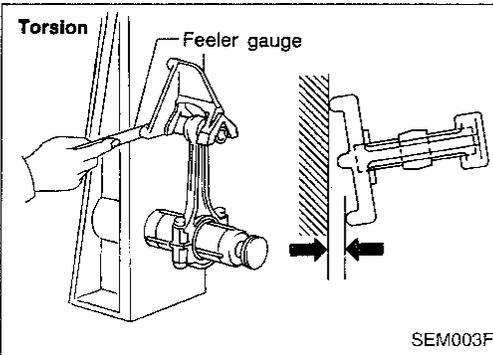
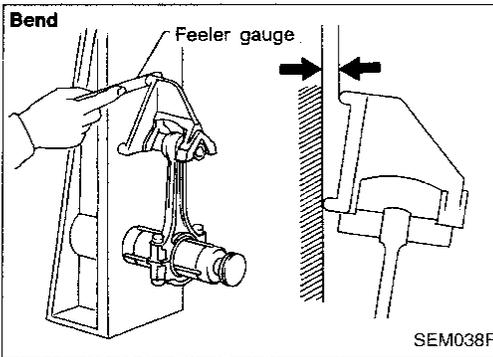
Bend:

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

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

Distortion limit: 0.10 mm (0.0039 in)

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

Resurfacing limit:

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

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

Nominal cylinder block height
from crankshaft center:

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

- If necessary, replace cylinder block.

PISTON-TO-BORE CLEARANCE

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

Standard inner diameter:

Refer to SDS, EM-50.

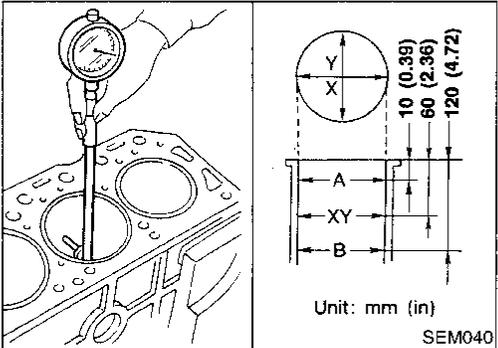
Wear limit:

0.2 mm (0.008 in)

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

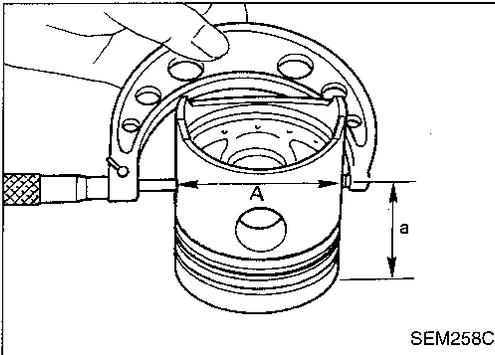
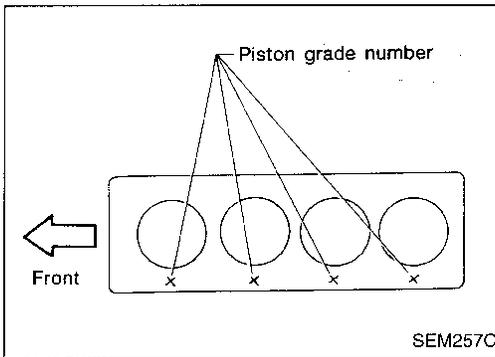
Out-of-round (X - Y) standard:

0.015 mm (0.0006 in)



CYLINDER BLOCK

Inspection (Cont'd)



Taper (A - B) standard:

0.01 mm (0.0004 in)

2. Check for scratches and seizure. If seizure is found, hone it.
 - If both cylinder block and pistons are replaced with new ones, select pistons of the same grade numbers as those punched on cylinder block upper surface.

3. Measure piston skirt diameter.

Piston diameter "A":

Refer to SDS (EM-52).

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-52).

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

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

D: Bored diameter

A: Piston diameter as measured

B: Piston-to-bore clearance

C: Honing allowance 0.02 mm (0.0008 in)

7. Install main bearing caps, and tighten bolts to the specified torque. This will prevent distortion of cylinder bores.

- Otherwise, cylinder bores may be distorted in final assembly.

8. Cut cylinder bores.

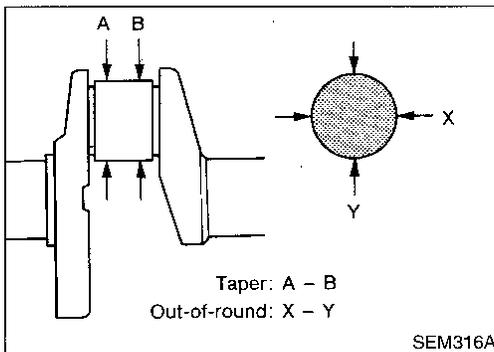
- **When any cylinder needs boring, all other cylinders must also be bored.**

- **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.**



Taper: A - B

Out-of-round: X - Y

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):

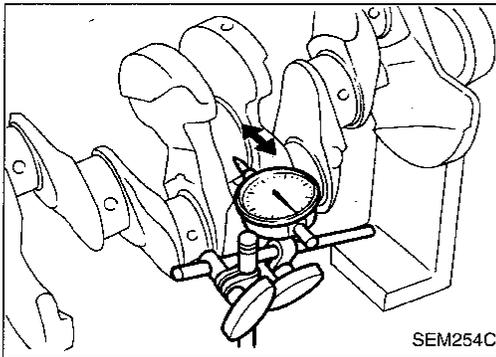
Less than 0.005 mm (0.0002 in)

Taper (A - B):

Less than 0.002 mm (0.0001 in)

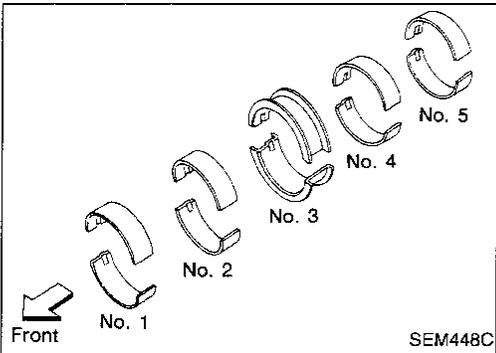
CYLINDER BLOCK

Inspection (Cont'd)



3. Measure crankshaft runout.

Runout (Total indicator reading):
Less than 0.04 mm (0.0016 in)



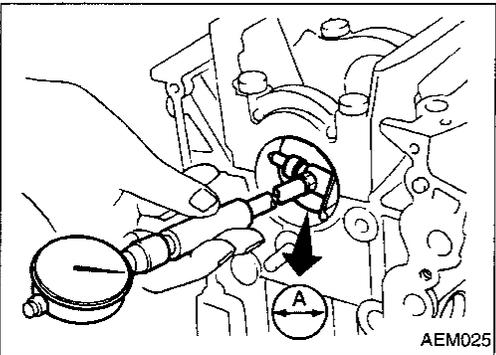
BEARING CLEARANCE

- 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

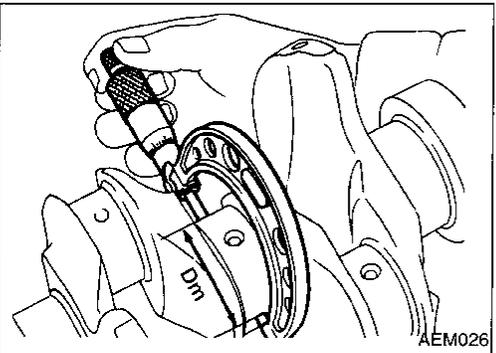
1. Set main bearings in their proper positions on cylinder block and main bearing cap.



2. Install main bearing cap to cylinder block.

Tighten all bolts in correct order in two or three stages. Refer to "Assembly" (EM-43).

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



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

5. Calculate main bearing clearance.

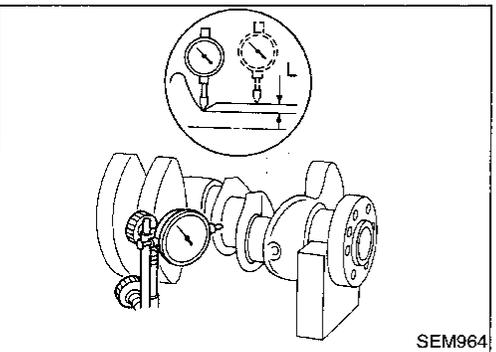
Main bearing clearance = A - Dm

Standard:

0.020 - 0.047 mm (0.0008 - 0.0019 in)

Limit: 0.1 mm (0.004 in)

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



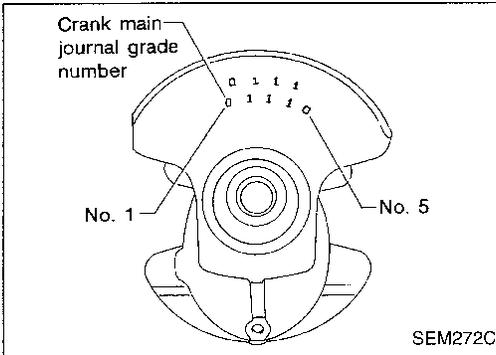
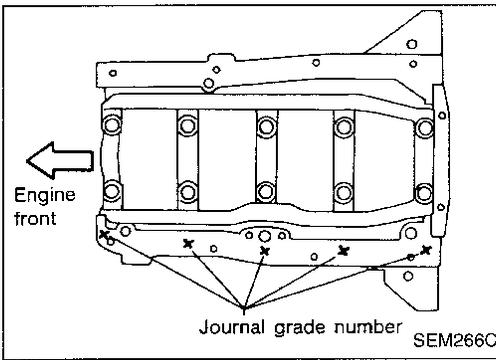
- a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.

"L": 0.1 mm (0.004 in)

- b. Refer to SDS (EM-53) for grinding crankshaft and avail ableservice parts.

CYLINDER BLOCK

Inspection (Cont'd)



6. 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:

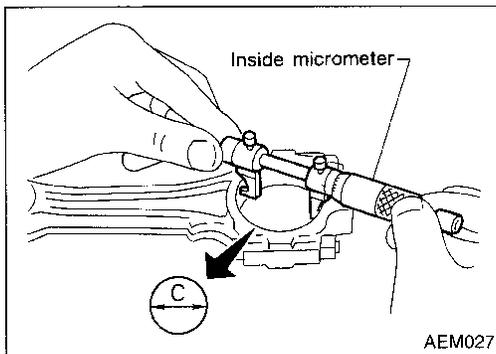
		Cylinder block main journal grade number		
		0	1	2
Crankshaft main journal grade number	0	0 (Black)	1 (Brown)	2 (Green)
	1	1 (Brown)	2 (Green)	3 (Yellow)
	2	2 (Green)	3 (Yellow)	4 (Blue)

For example:

Cylinder block main journal grade number: 1

Crankshaft main journal grade number: 2

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

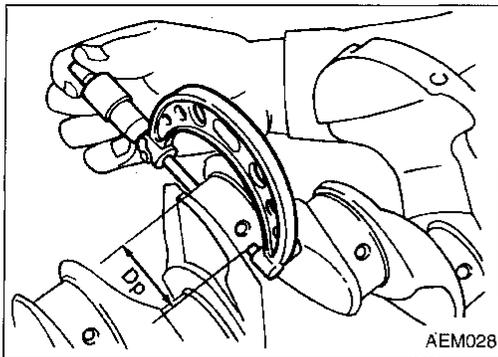


Connecting rod bearing (Big end)

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

CYLINDER BLOCK

Inspection (Cont'd)

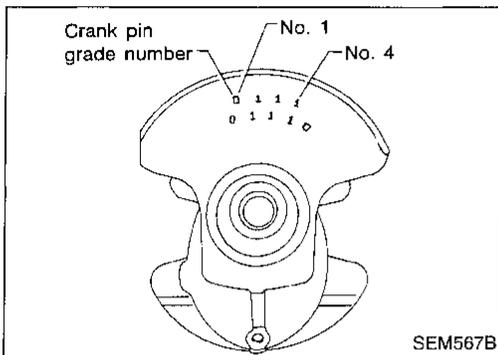


4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.

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

Standard: 0.010 - 0.035 mm (0.0004 - 0.0014 in)
Limit: 0.09 mm (0.0035 in)

- If it exceeds the limit, replace bearing.
- If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to step 5 of "BEARING CLEARANCE — Main bearing" (EM-40).



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

Connecting rod bearing grade number:

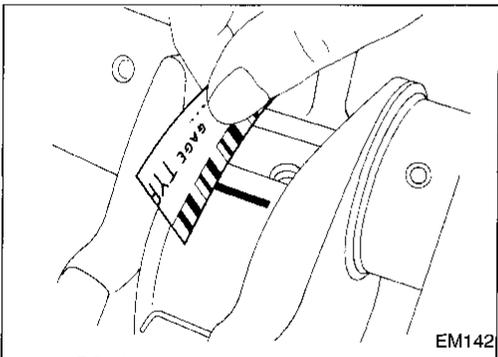
These numbers are punched in either Arabic or Roman numerals.

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

Method B (Using plastigage)

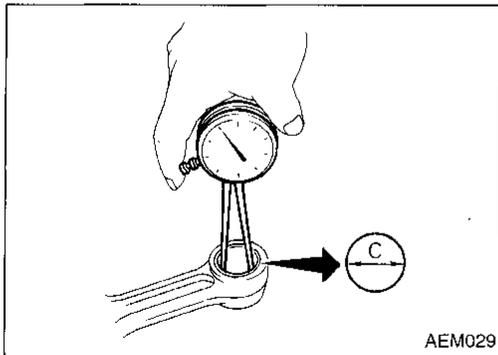
CAUTION:

- Do not turn crankshaft or connecting rod while plastigage is being inserted.
- If incorrect bearing clearance exists, use a thicker or undersized main bearing to ensure specified clearance.



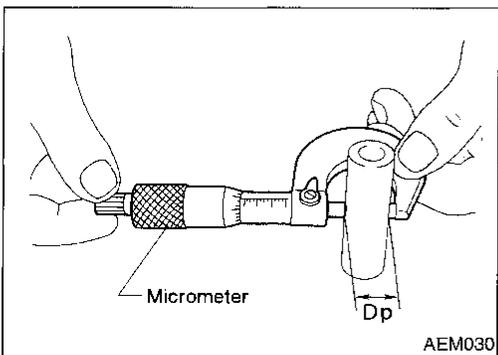
CONNECTING ROD BUSHING CLEARANCE (Small end)

1. Measure inner diameter "C" of bushing.



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



CYLINDER BLOCK

Inspection (Cont'd)

REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

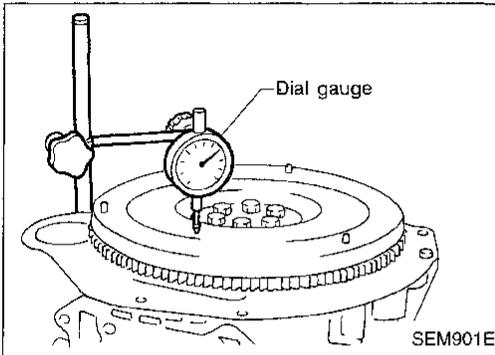
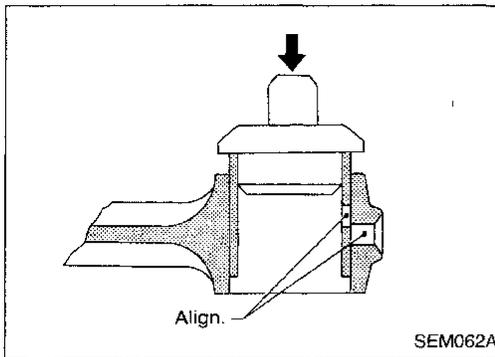
1. Drive in small end bushing until it is flush with end surface of rod.

Be sure to align the oil holes.

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

Clearance between connecting rod bushing and piston pin:

0.005 - 0.017 mm (0.0002 - 0.0007 in)



FLYWHEEL/DRIVE PLATE RUNOUT

Runout (Total indicator reading):

Flywheel (M/T model)

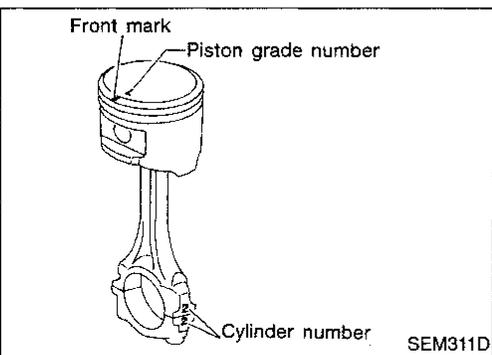
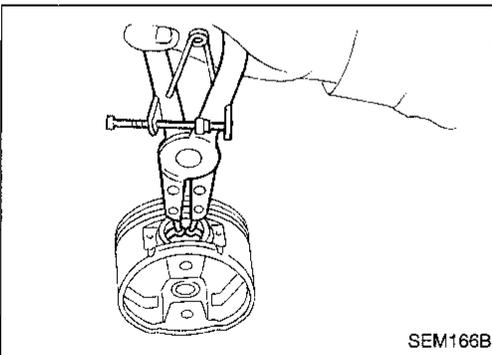
Less than 0.15 mm (0.0059 in)

Drive plate (A/T model)

Less than 0.5 mm (0.020 in)

CAUTION:

- The signal plate is built into the flywheel assembly. Be careful not to damage the signal plate, especially the teeth.
- Check the drive plate for deformation or cracks.
- Never place the flywheel assembly with the signal plate facing down.
- Keep any magnetized objects away from the signal plate.
- Do not allow any magnetic materials to contact the signal plate teeth.
- Do not surface flywheel. Replace as necessary.



Assembly

PISTON

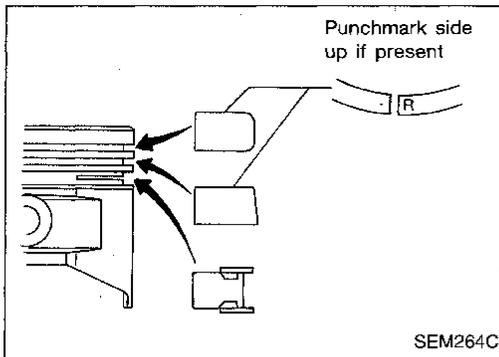
1. Install new snap ring on one side of piston pin hole.

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

- **Align the direction of piston and connecting rod.**
- **Numbers stamped on connecting rod and cap correspond to each cylinder.**
- **After assembly, make sure connecting rod swings smoothly.**

CYLINDER BLOCK

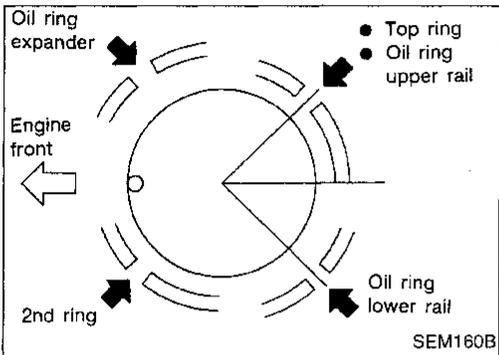
Assembly (Cont'd)



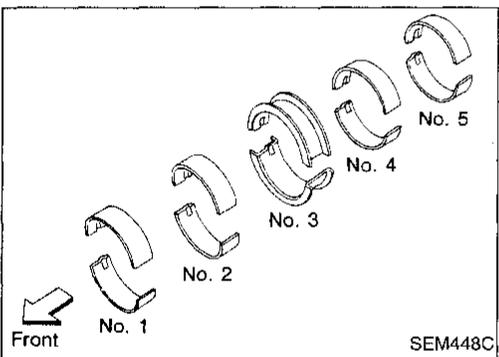
3. Set piston rings as shown.

CAUTION:

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



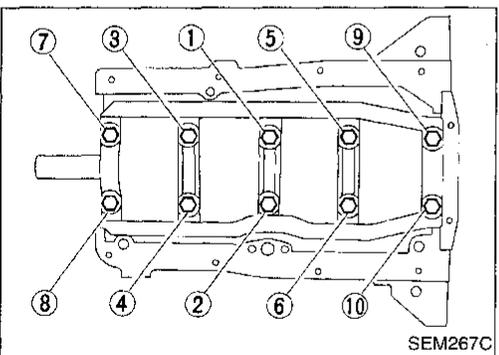
- Align piston rings so that end gaps are positioned as shown in the figure.



CRANKSHAFT

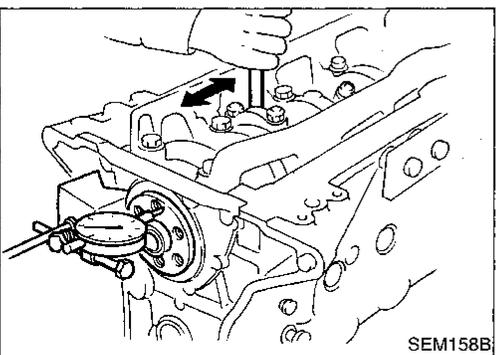
1. Set main bearings in their proper positions on cylinder block and main bearing beam.

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



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

- Lubricate threads and seat surfaces of the bolts with new engine oil.
- Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting in the axial direction.
- 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)

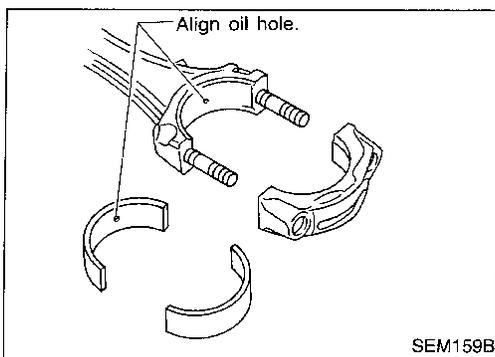
Limit

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.
 - Apply engine oil to bolt threads and bearing surfaces.

GI

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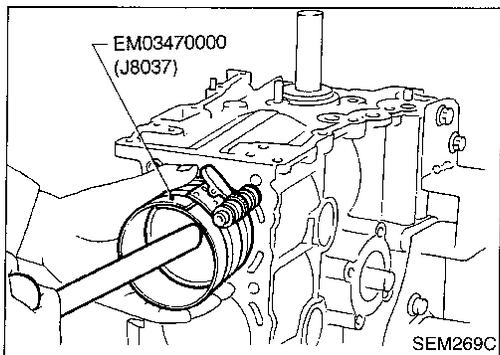
RS

BT

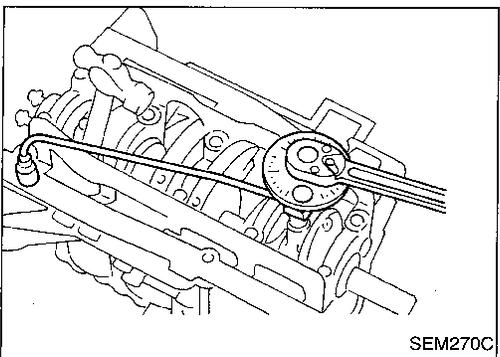
HA

EL

IDX



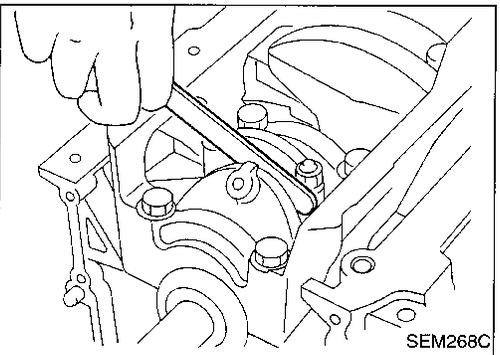
5. Install pistons with connecting rods.
 - a. Install them into corresponding cylinders with Tool.
 - Be careful not to scratch cylinder wall with the connecting rod.
 - Arrange so that front mark on piston head faces toward engine front.
 - Apply engine oil to piston rings and sliding surface of piston.



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

Connecting rod bearing nut:

- (1) Tighten to 14 to 16 N·m (1.4 to 1.6 kg·m, 10 to 12 ft·lb).
- (2) Tighten bolts 60⁺⁵ 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:

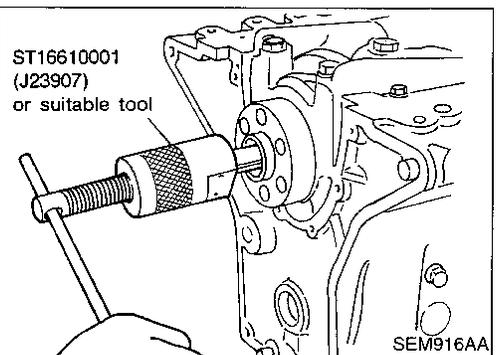
Standard

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.



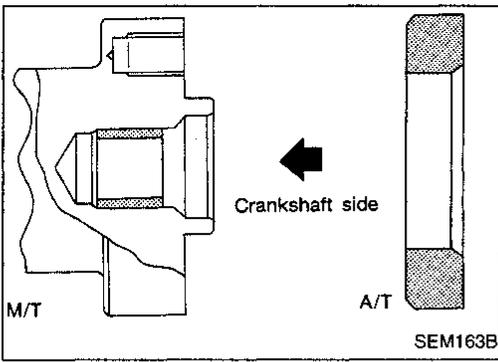
REPLACING PILOT BUSHING

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).



SERVICE DATA AND SPECIFICATIONS (SDS)

General Specifications

Cylinder arrangement	In-line 4	
Displacement	cm ³ (cu in)	2,389 (145.78)
Bore and stroke	mm (in)	89 x 96 (3.50 x 3.78)
Valve arrangement	DOHC	
Firing order	1-3-4-2	
Number of piston rings		
Compression	2	
Oil	1	
Number of main bearings	5	
Compression ratio	9.5	

COMPRESSION PRESSURE

Unit: kPa (kg/cm², psi)/300 rpm

Compression pressure	
Standard	1,236 (12.6, 179)
Minimum	1,040 (10.6, 151)
Differential limit between cylinders	98 (1.0, 14)

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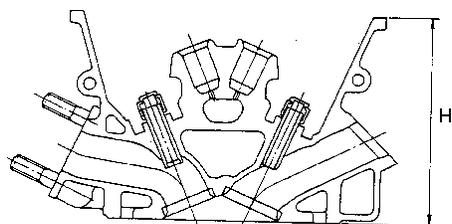
IDX

Inspection and Adjustment VALVE

CYLINDER HEAD

Unit: mm (in)

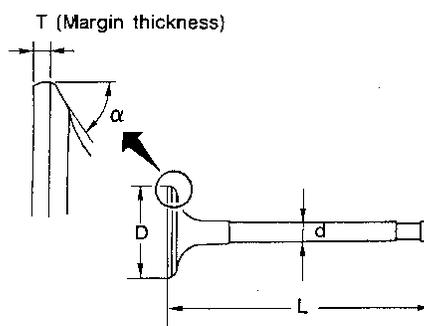
	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)



Nominal cylinder head height:
H = 126.3 - 126.5 (4.972 - 4.980)

SEM519E

Unit: mm (in)



SEM188

Valve head diameter "D"

Intake	36.5 - 36.7 (1.437 - 1.445)
Exhaust	31.2 - 31.4 (1.228 - 1.236)

Valve length "L"

Intake	101.02 - 101.62 (3.9772 - 4.0008)
Exhaust	98.52 - 99.72 (3.8787 - 3.9260)

Valve stem diameter "d"

Intake	6.965 - 6.980 (0.2742 - 0.2748)
Exhaust	6.945 - 6.960 (0.2734 - 0.2740)

Valve seat angle "α"

Intake & Exhaust	45°15' - 45°45'
------------------	-----------------

Valve margin "T"

Intake	0.95 - 1.25 (0.0374 - 0.0492)
Exhaust	1.15 - 1.45 (0.0453 - 0.0571)

Valve margin "T" limit

More than 0.5 (0.020)

Valve stem end surface grinding limit

Less than 0.2 (0.008)

SERVICE DATA AND SPECIFICATIONS (SDS)

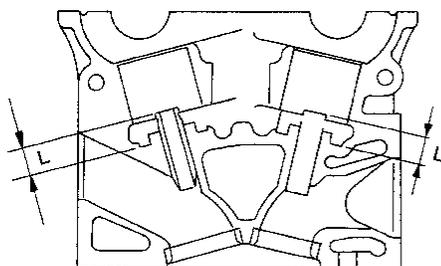
Inspection and Adjustment (Cont'd)

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)		
		Standard	Limit
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
Valve deflection limit	0.2 (0.008)		
Projection length "L"	13.3 - 13.9 (0.524 - 0.547)		

Valve lifter

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

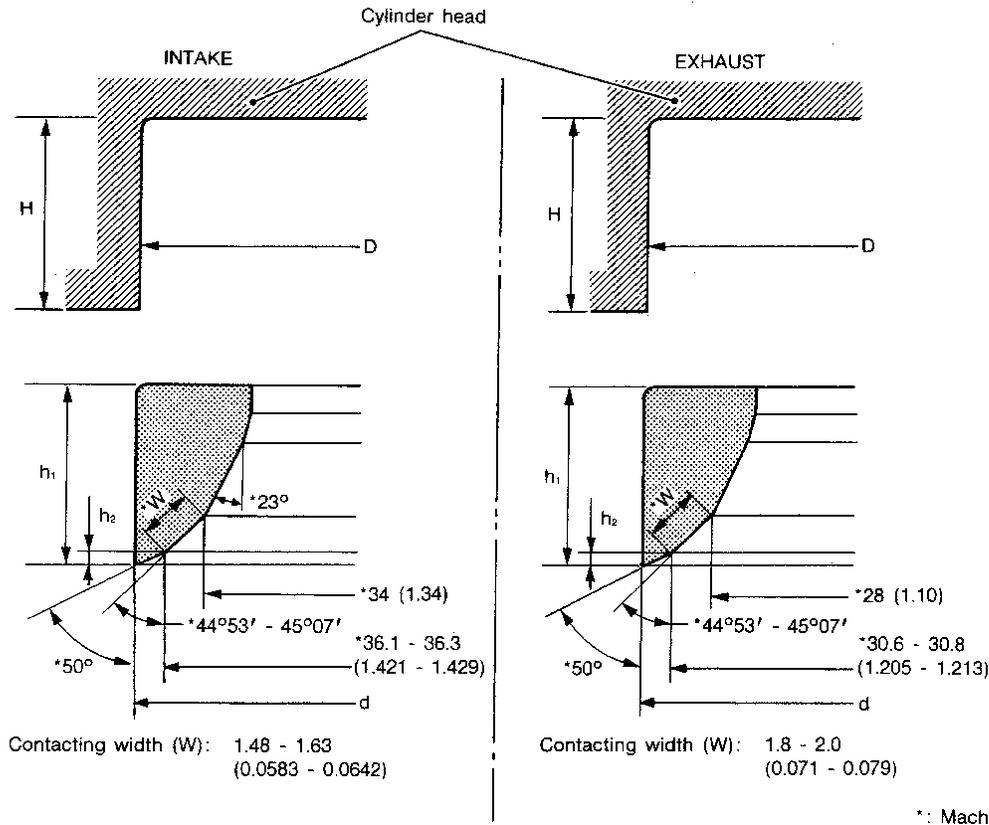
Thickness mm (in)	Identification mark
1.96 (0.0772)	196
1.98 (0.0780)	198
2.00 (0.0787)	200
2.02 (0.0795)	202
2.04 (0.0803)	204
2.06 (0.0811)	206
2.08 (0.0819)	208
2.10 (0.0827)	210
2.12 (0.0835)	212
2.14 (0.0843)	214
2.16 (0.0850)	216
2.18 (0.0858)	218
2.20 (0.0866)	220
2.22 (0.0874)	222
2.24 (0.0882)	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)



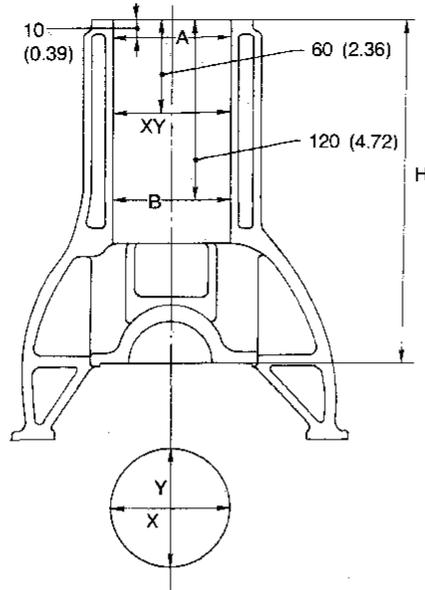
SEM952E

		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)

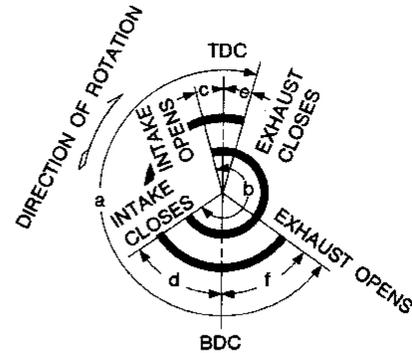
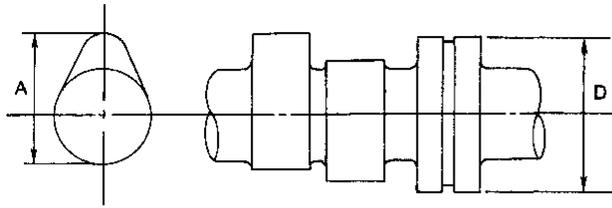
		Standard	Limit
Distortion		Less than 0.03 (0.0012)	0.1 (0.004)
Cylinder bore	Inner diameter	Grade 1	89.000 - 89.010 (3.5039 - 3.5043)
		Grade 2	89.010 - 89.020 (3.5043 - 3.5047)
		Grade 3	89.020 - 89.030 (3.5047 - 3.5051)
	Out-of-round (X - Y)		Less than 0.015 (0.0006)
Taper (A - B)		Less than 0.010 (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

GI

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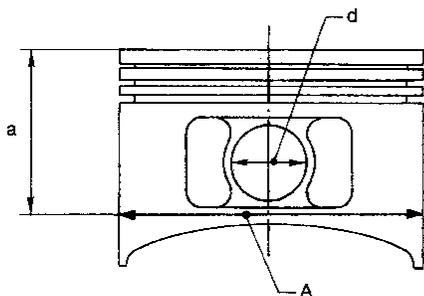
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SERVICE DATA AND SPECIFICATIONS (SDS)

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

Piston pin

Unit: mm (in)

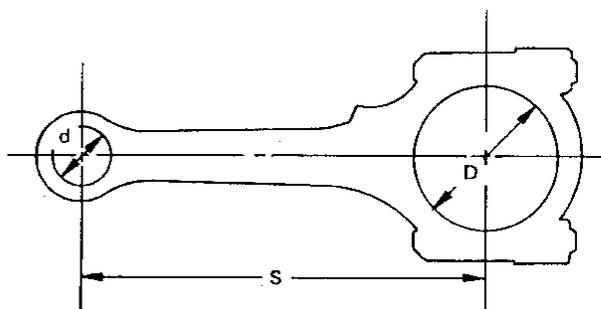
	Standard	Limit
Piston pin outer diameter	20.989 - 21.001 (0.8263 - 0.8268)	—
Interference fit of piston pin to piston pin hole	0 - 0.004 (0 - 0.0002)	—
Piston pin to connecting rod bearing clearance	0.005 - 0.017 (0.0002 - 0.0007)	0.023 (0.0009)

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)

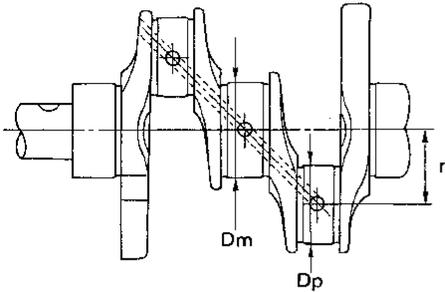
	Standard	Limit
Center distance (S)	164.95 - 165.05 (6.4941 - 6.4980)	—
Bend [per 100 mm (3.94 in)]	—	0.15 (0.0059)
Torsion [per 100 mm (3.94 in)]	—	0.30 (0.0118)
Piston pin bushing inner diameter (d)*	21.000 - 21.012 (0.8268 - 0.8272)	—
Connecting rod big end inner diameter (D)*	53.000 - 53.013 (2.0866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

* Without bearing

SERVICE DATA AND SPECIFICATIONS (SDS)

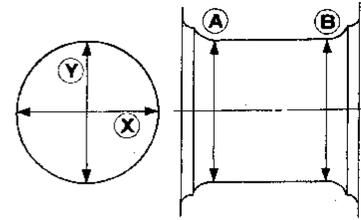
Inspection and Adjustment (Cont'd)

CRANKSHAFT



SEM394

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



EM715

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)
Taper of journal and pin [(A) - (B)]		Standard	Limit
		—	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 roll		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