

## SECTION **EM**

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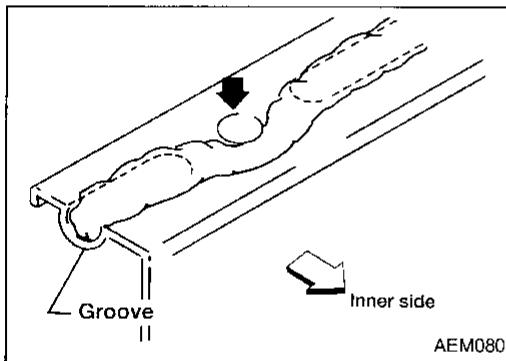
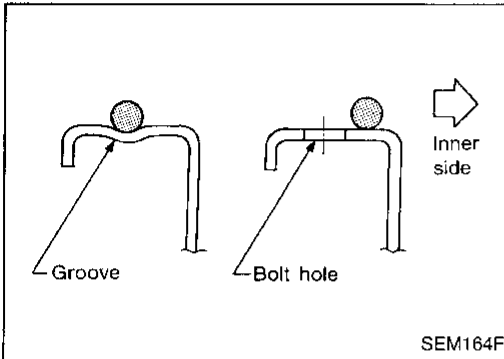
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## PRECAUTIONS

### 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.



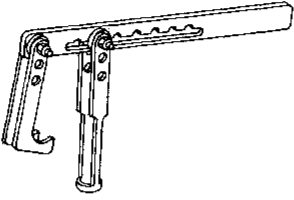
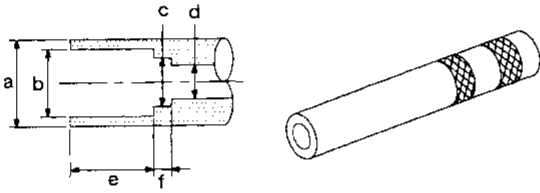
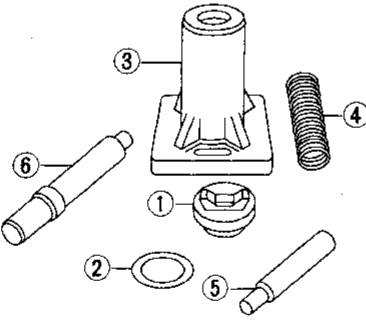
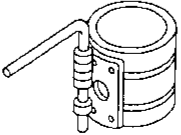
### Liquid Gasket Application Procedure

- 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 RTV silicone sealant Part No. 999 MP-A7007, Three Bond TB1207D 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

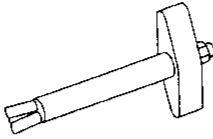
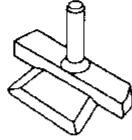
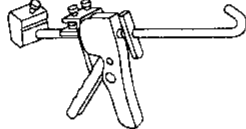
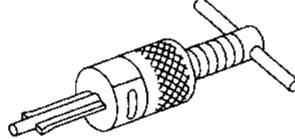
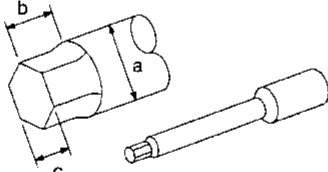
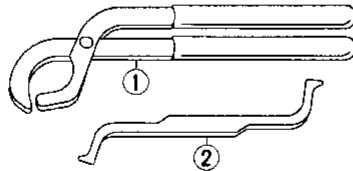
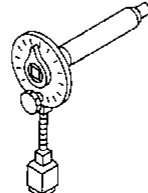
## Special Service Tools

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 <b>EM</b> LC EC FE
KV10116300 (J-38955) Valve oil seal drift	Installing valve oil seal    NT602	CL MT AT
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

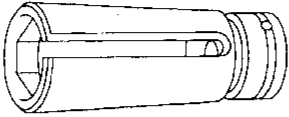
## PREPARATION

### Special Service Tools (Cont'd)

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

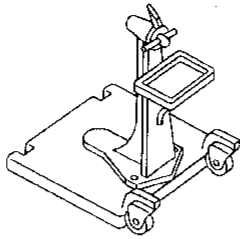
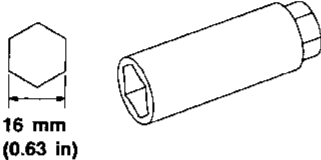

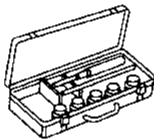
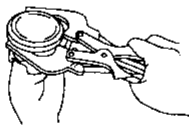
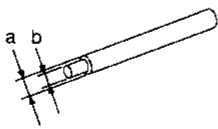
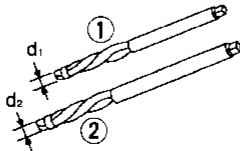
# PREPARATION

## Special Service Tools (Cont'd)

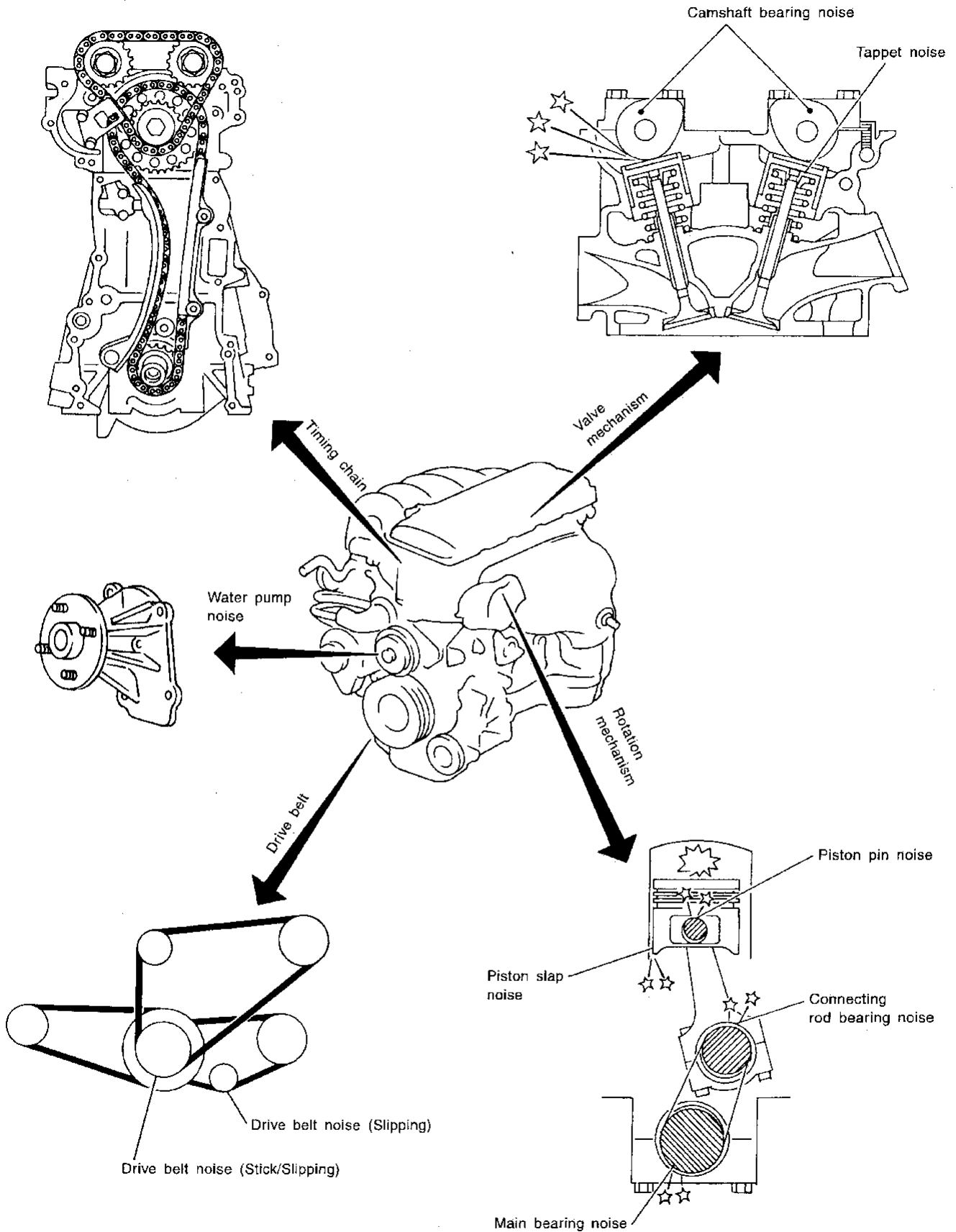
Tool number (Kent-Moore No.) Tool name	Description		
KV10117100 (J36471-A) Front heated oxygen sensor wrench	<div style="text-align: center;">  </div>	Removing and installing front heated oxygen sensor [22 mm (0.87 in) type]	GI  MA  <b>EM</b>
	NT630		LC  EC  FE  CL  MT  AT  PD  FA  RA  BR  ST  RS  BT  HA  EL  IDX

# PREPARATION

## Commercial Service Tools

Tool name	Description									
Engine stand assembly	 NT381	Disassembling and assembling								
Spark plug wrench	 NT047	Removing and installing spark plug								
Pulley holder	 NT035	Holding camshaft pulley while tightening or loosening camshaft bolt								
Valve seat cutter set	 NT048	Finishing valve seat dimensions								
Piston ring expander	 NT030	Removing and installing piston ring								
Valve guide drift	 NT015	Removing and installing valve guide  <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 60%;">Diameter:</th> <th style="width: 40%;">mm (in)</th> </tr> </thead> <tbody> <tr> <td></td> <td style="text-align: center;">Intake &amp; Exhaust</td> </tr> <tr> <td style="text-align: center;">a</td> <td style="text-align: center;">10.5 (0.413)</td> </tr> <tr> <td style="text-align: center;">b</td> <td style="text-align: center;">6.6 (0.260)</td> </tr> </tbody> </table>	Diameter:	mm (in)		Intake & Exhaust	a	10.5 (0.413)	b	6.6 (0.260)
Diameter:	mm (in)									
	Intake & Exhaust									
a	10.5 (0.413)									
b	6.6 (0.260)									
Valve guide reamer	 NT016	Reaming valve guide (①) or hole for over-size valve guide (②)  <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 60%;">Diameter:</th> <th style="width: 40%;">mm (in)</th> </tr> </thead> <tbody> <tr> <td></td> <td style="text-align: center;">Intake &amp; Exhaust</td> </tr> <tr> <td style="text-align: center;">d<sub>1</sub></td> <td style="text-align: center;">7 (0.28)</td> </tr> <tr> <td style="text-align: center;">d<sub>2</sub></td> <td style="text-align: center;">11.175 (0.4400)</td> </tr> </tbody> </table>	Diameter:	mm (in)		Intake & Exhaust	d <sub>1</sub>	7 (0.28)	d <sub>2</sub>	11.175 (0.4400)
Diameter:	mm (in)									
	Intake & Exhaust									
d <sub>1</sub>	7 (0.28)									
d <sub>2</sub>	11.175 (0.4400)									

# NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING



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# NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

## NVH Troubleshooting Chart — Engine Noise

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

1. Locate the area where noise occurs.
  2. Confirm the type of noise.
  3. Specify the operating condition of the engine.
  4. Check the specified noise source.
- If necessary, repair or replace these parts.

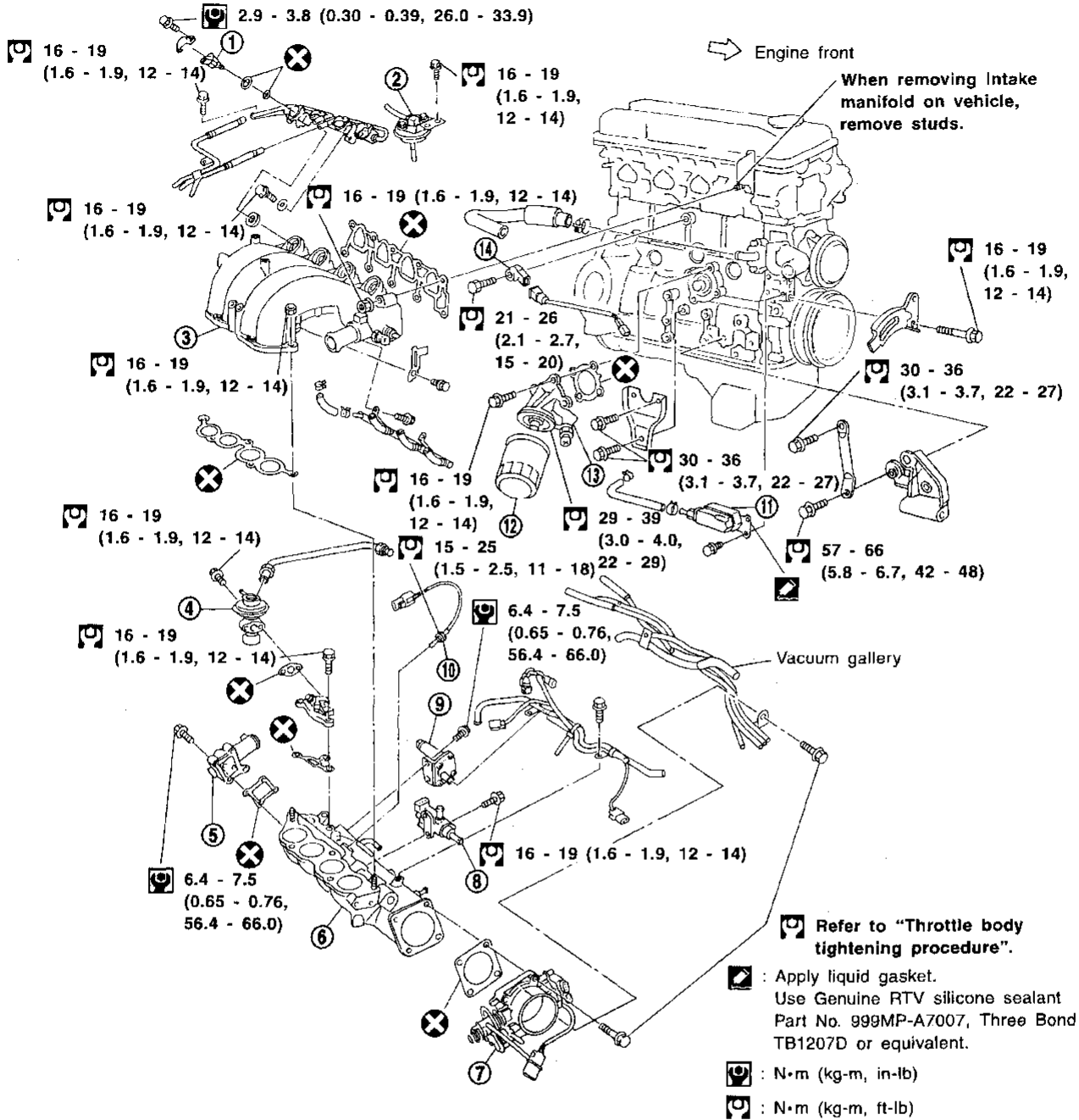
Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-33
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-27, 28
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance	EM-39, 44
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston-to-bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-40, 39
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing clearance (Small end) Connecting rod bearing clearance (Big end)	EM-44, 43
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-42
Front of engine Timing chain cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear	EM-19
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Other drive belts (Sticking or slipping)	Drive belt deflection	MA section ("Checking Drive Belts", "ENGINE MAINTENANCE")
	Creaking	A	B	A	B	A	B	Other drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	LC section ("Water Pump Inspection", "ENGINE COOLING SYSTEM")

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



# OUTER COMPONENT PARTS

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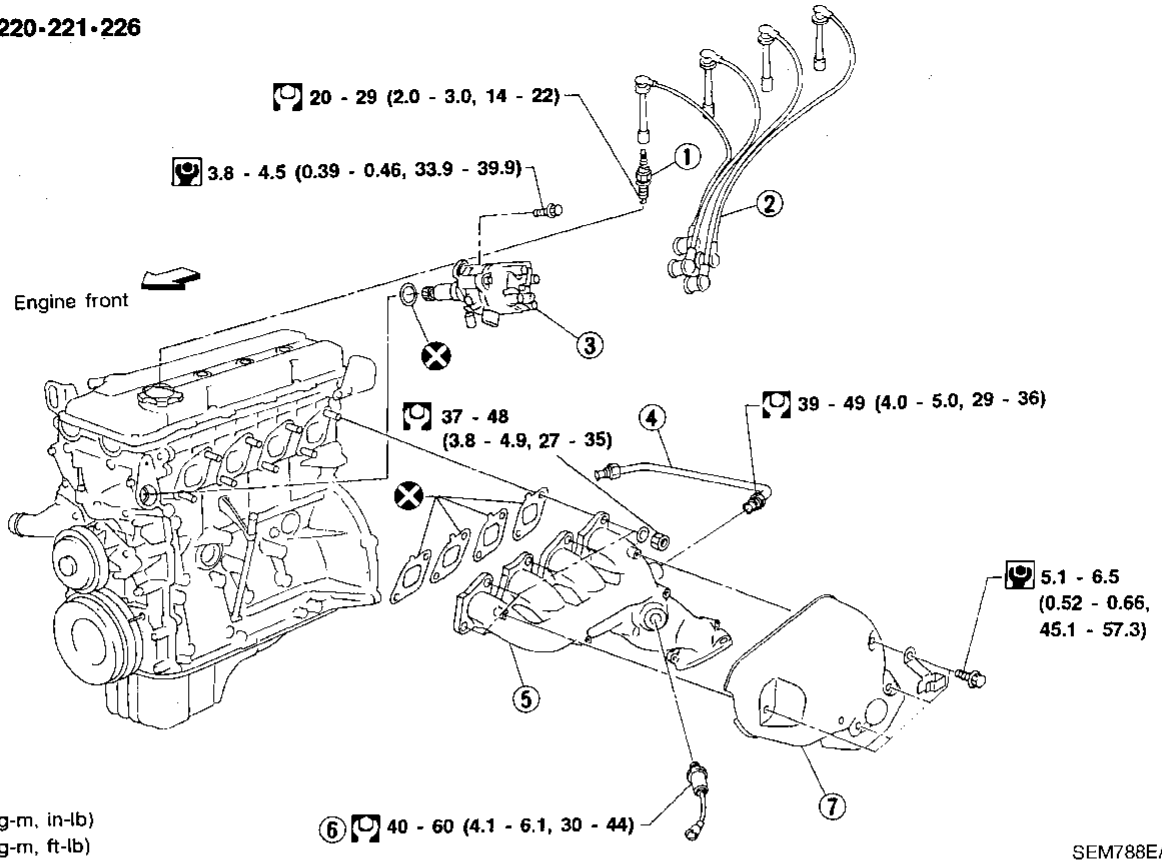
- |                   |  |                          |
|-------------------|--|--------------------------|
| ① Fuel injector   | ⑥ Intake manifold collector                | ⑩ EGR temperature sensor |
| ② EGRC-BPT valve  | ⑦ Throttle body                            | ⑪ Breather separator     |
| ③ Intake manifold | ⑧ EVAP canister purge volume control valve | ⑫ Oil filter             |
| ④ EGR valve       | ⑨ IACV-air regulator                       | ⑬ Oil filter bracket     |
| ⑤ IAA unit        |  | ⑭ Knock sensor           |

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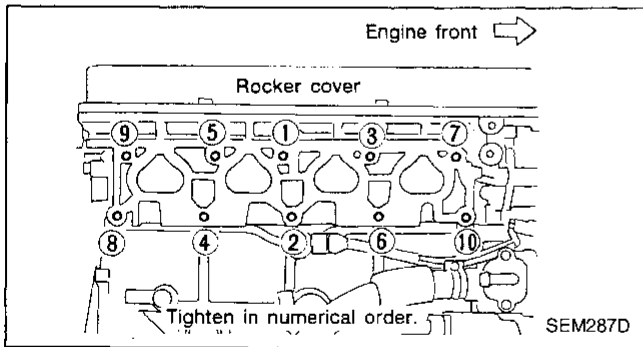
# OUTER COMPONENT PARTS

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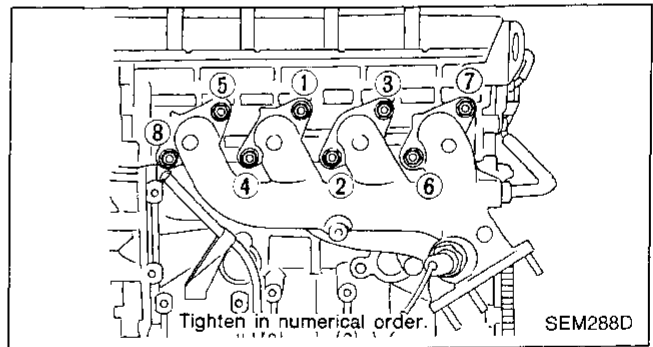


- ① Spark plug
- ② Ignition wire
- ③ Camshaft position sensor built into distributor
- ④ EGR tube
- ⑤ Exhaust manifold
- ⑥ Front heated oxygen sensor
- ⑦ Exhaust manifold cover

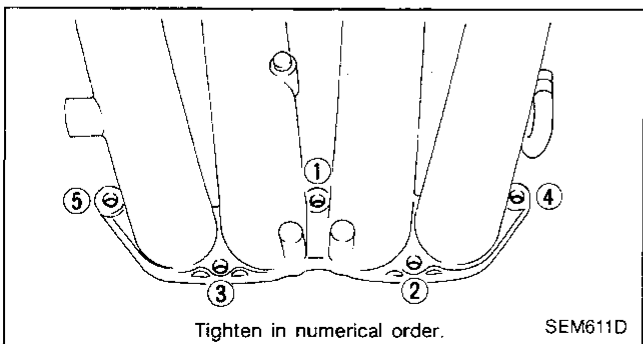
## Intake manifold tightening procedure



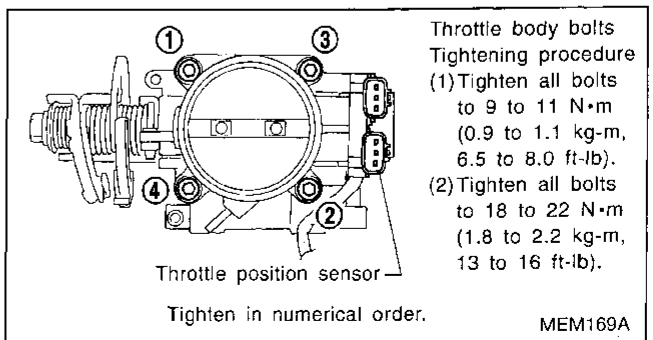
## Exhaust manifold tightening procedure



## Intake manifold collector tightening procedure



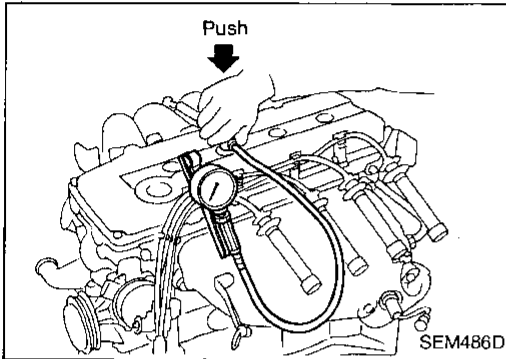
## Throttle body tightening procedure



# 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.



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/cm<sup>2</sup>, 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-48 and EM-50.) 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.**

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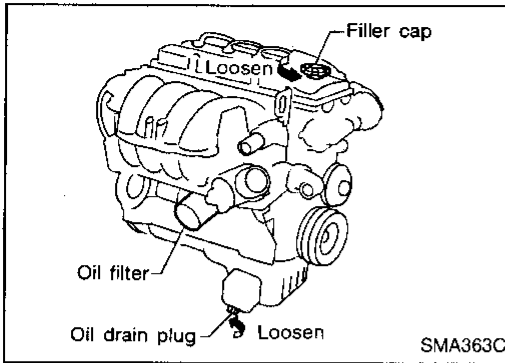
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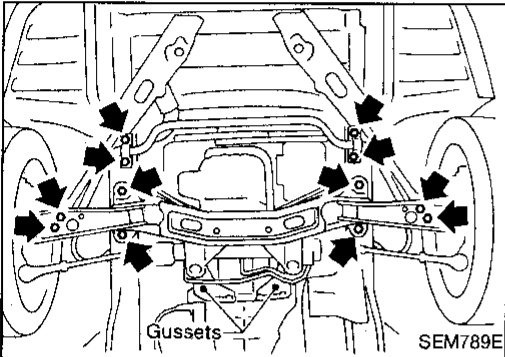
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# OIL PAN

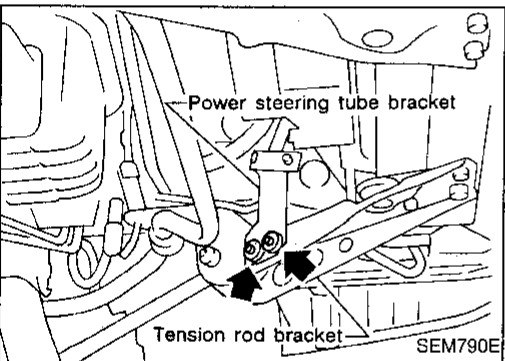


## Removal

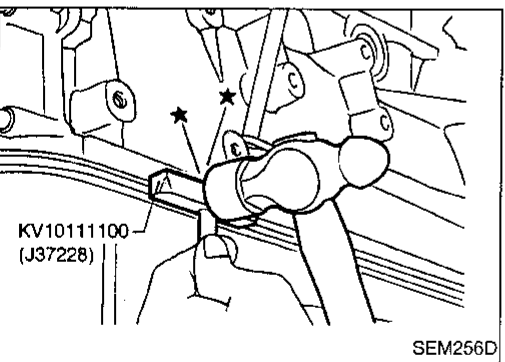
1. Raise vehicle and support it with safety stands.
2. Drain engine oil.
3. Install engine slingers to cylinder head. Refer to "ENGINE REMOVAL" (EM-35).
4. Set a suitable hoist on engine slinger and hold the engine.



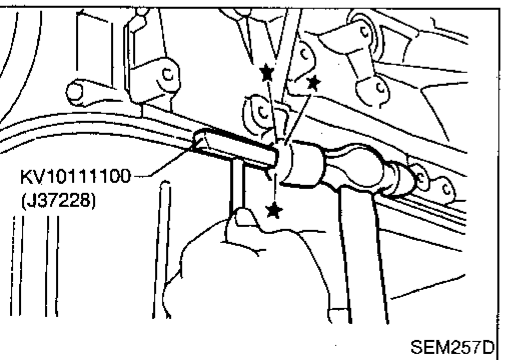
5. Remove the following parts.
  - Tension rod bolts at transverse links
  - Front stabilizer bar securing bolts and nuts from side member.
  - Both left and right side engine mounting bolts. Refer to "ENGINE REMOVAL" (EM-35).
  - Gussets
6. Disconnect steering shaft lower joint.



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.**

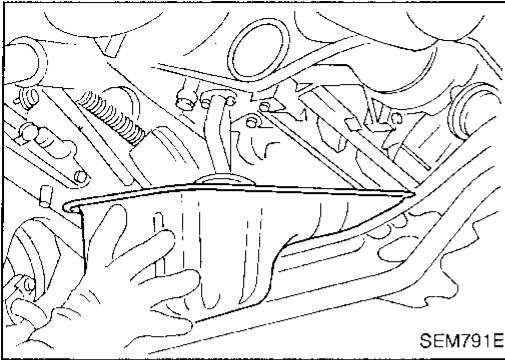


- b. Slide Tool by tapping on the side of the Tool with a hammer.
  - c. Remove oil pan.

# OIL PAN

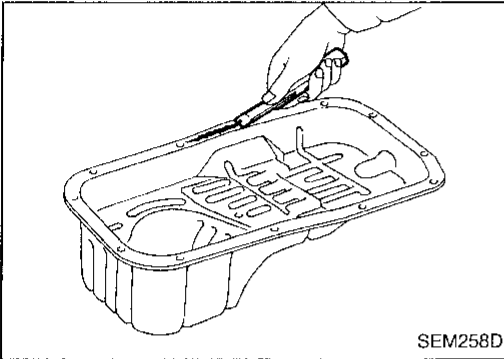
## Removal (Cont'd)

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

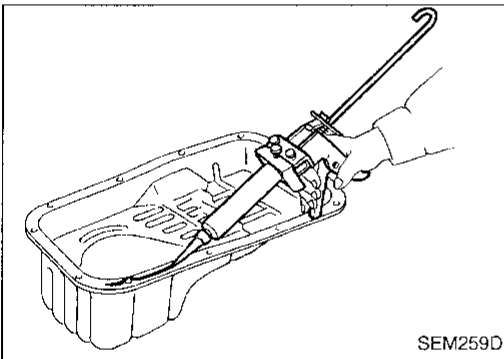


## Installation

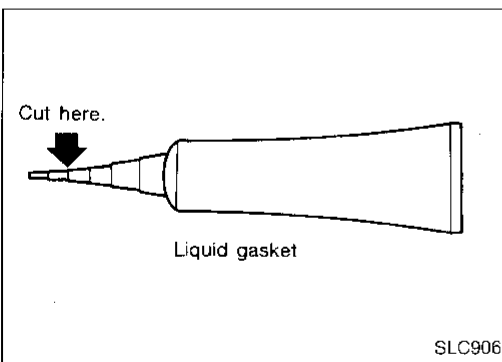
1. Use a scraper to remove all traces of liquid gasket from mating surfaces.
  - Also remove traces of liquid gasket from mating surface of cylinder block.



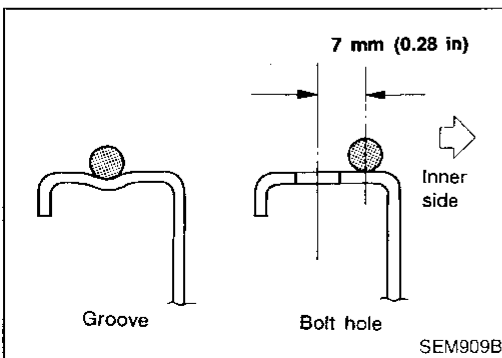
2. Apply a continuous bead of liquid gasket to mating surface of oil pan.
  - Use **Genuine RTV silicone sealant Part No. 999MP-A7007, Three Bond TB1207D or equivalent.**



- 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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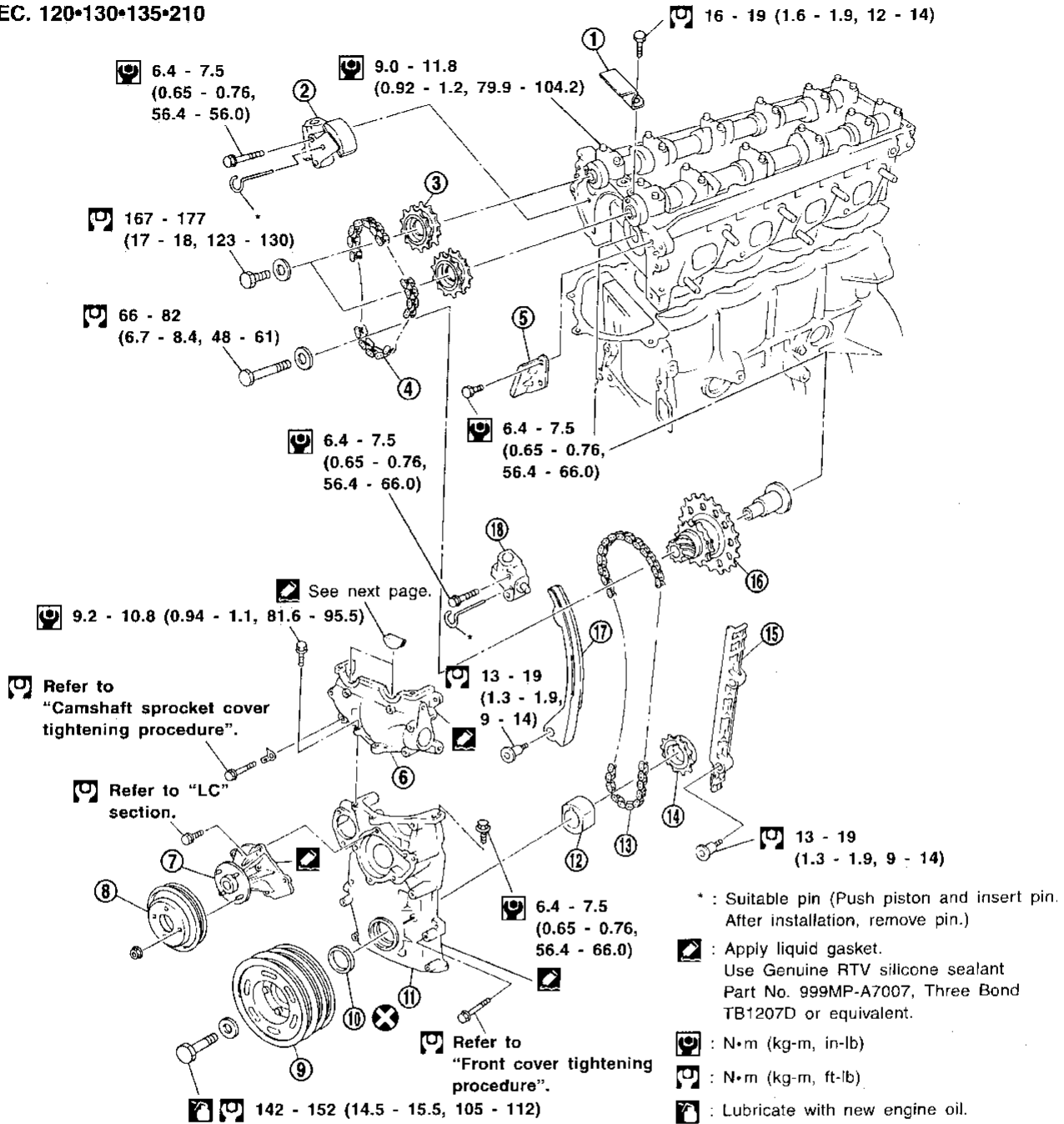
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# TIMING CHAIN

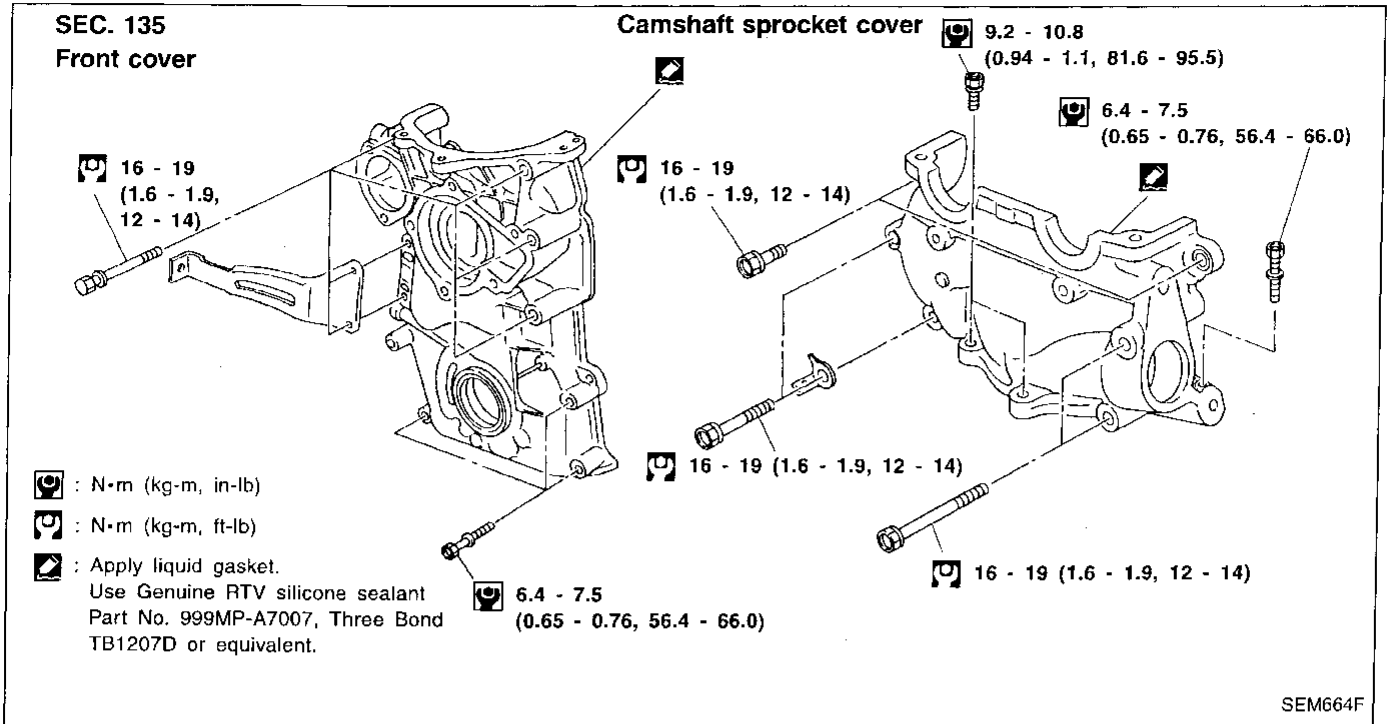
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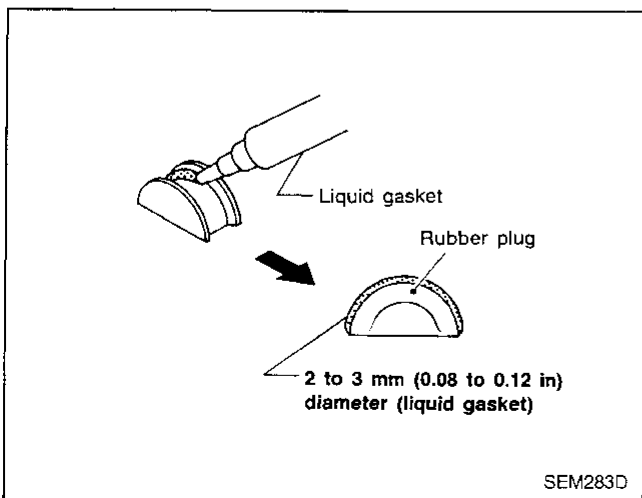
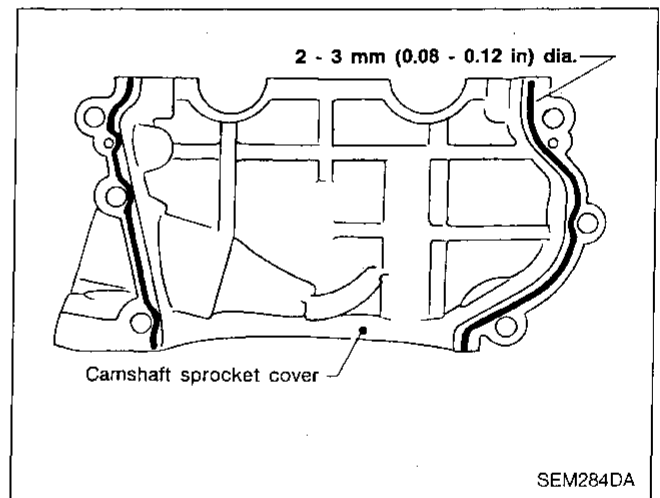
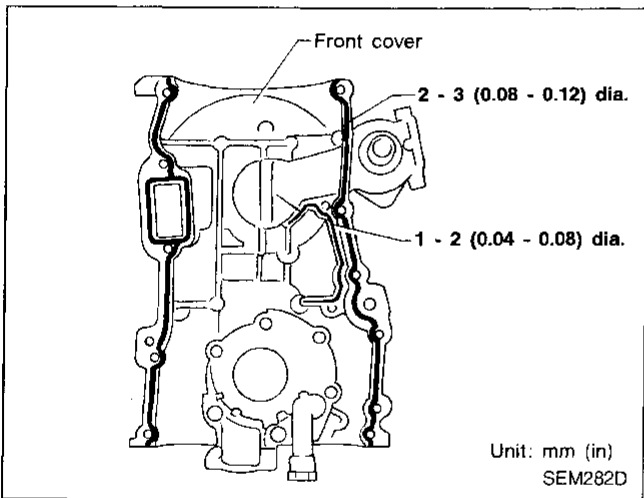
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- |                                |                         |                                |
|--------------------------------|-------------------------|--------------------------------|
| ① Chain guide                  | ⑦ Water pump            | 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



## Liquid gasket application places



## TIMING CHAIN

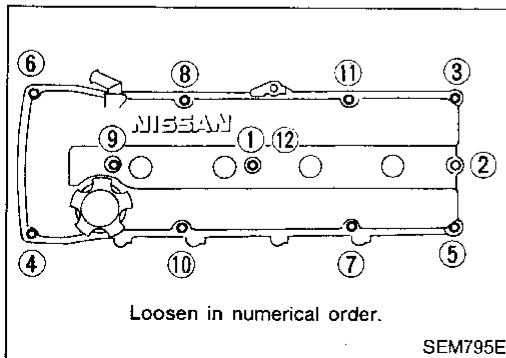
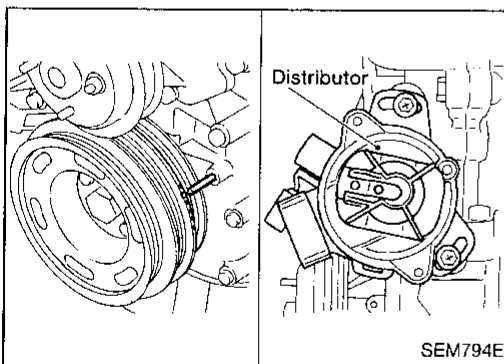
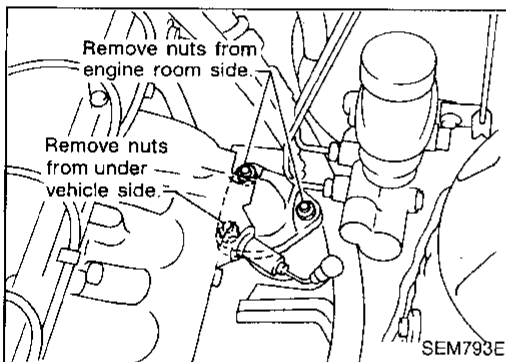
### CAUTION:

- 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

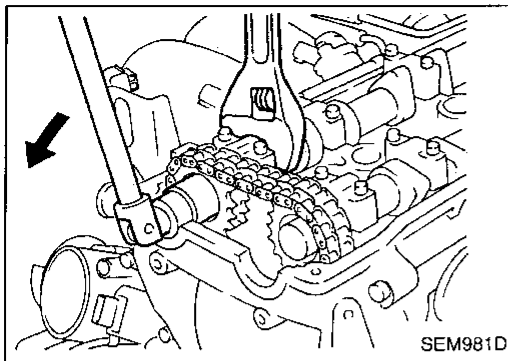
1. Drain coolant from both cylinder block drain plug and radiator drain cock. Refer to MA section.
2. Drain engine oil from drain plug of oil pan.
3. Remove vacuum hoses, fuel tubes, wires, harness and connectors and so on.
4. Remove exhaust manifold cover and front exhaust tube.
5. Remove the following 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.





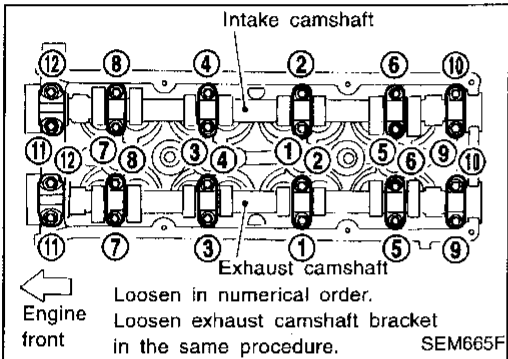
## TIMING CHAIN

### Removal (Cont'd)



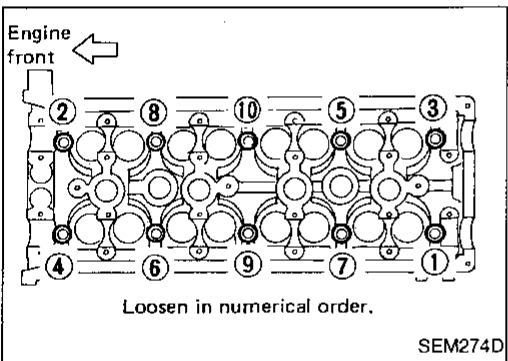
11. Remove cam sprocket.

- For retiming in cylinder head removal, apply paint marks to timing chain matched with mating marks of cam sprockets.



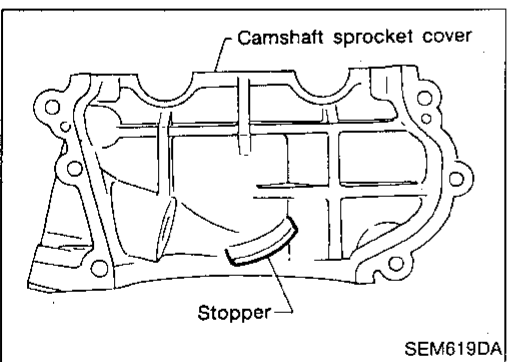
12. Remove cam brackets and camshafts.

- 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.

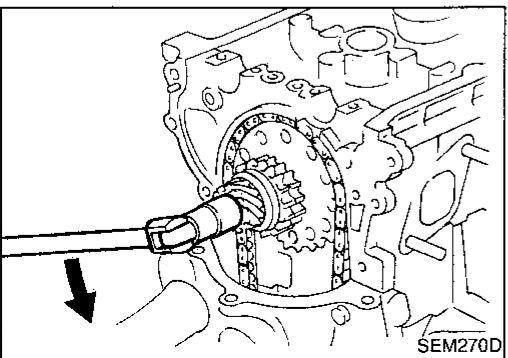
- Upper timing chain will not be disengaged from idler sprocket. For this reason, a stopper need not be used.

**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.

- For retiming in cylinder head removal, apply paint marks to timing chain matched with mating mark of idler sprocket.

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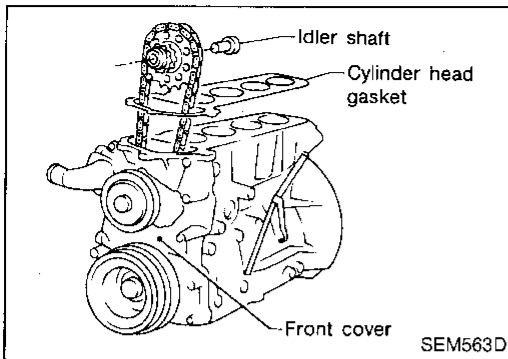
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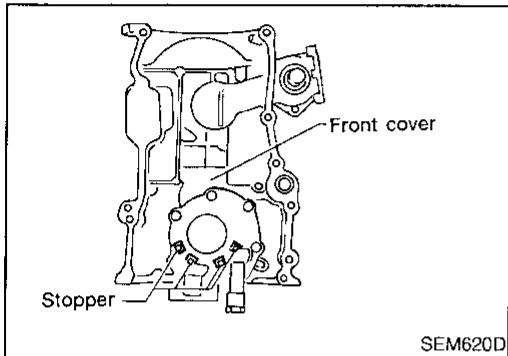
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## TIMING CHAIN

### Removal (Cont'd)

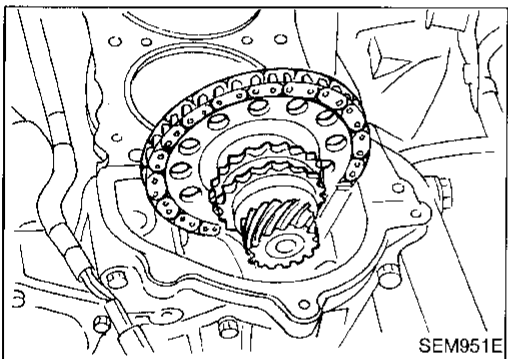


19. Remove cylinder head with intake manifold, intake manifold collector and exhaust manifold assembly.
20. Remove cylinder head gasket.



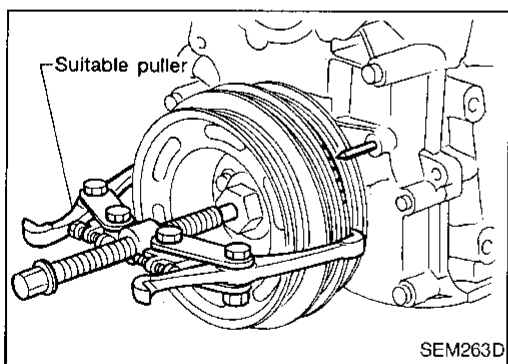
- Lower timing chain will not be disengaged from crankshaft sprocket. For this reason, a stopper need not be used.

**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

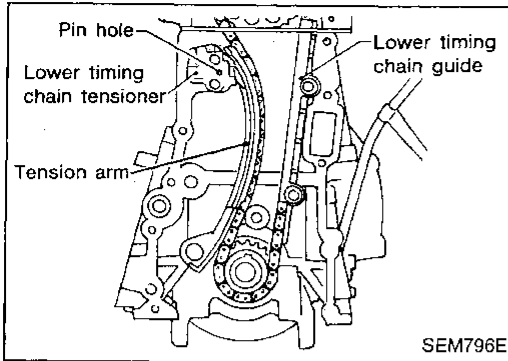
1. Remove upper timing chain.  
**Refer to "UPPER TIMING CHAIN" in "Removal" (EM-16).**



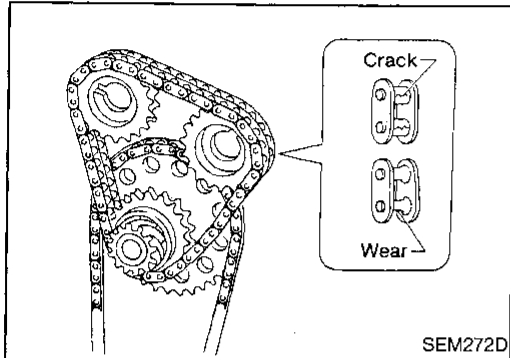
2. Remove oil pan.  
**Refer to "Removal" in "OIL PAN" (EM-12).**
3. Remove oil strainer.
4. Remove the following parts.
  - Power steering drive belt
  - Alternator drive belt
  - Air compressor drive belt
  - Air compressor idler pulley
5. Remove crankshaft pulley.
6. Remove front cover.
  - Inspect for oil leakage at front oil seal. Replace seal if oil leak is present.

## TIMING CHAIN

### Removal (Cont'd)

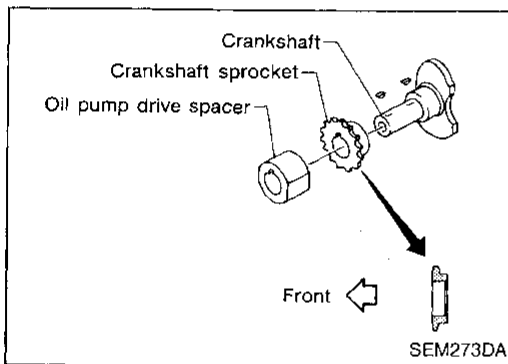


7. Remove the following parts.
  - Lower timing chain tensioner (Push piston and insert a suitable pin into pin hole.)
  - Chain tension arm
  - Lower timing chain guide
8. Remove lower timing chain and idler sprocket.



### Inspection

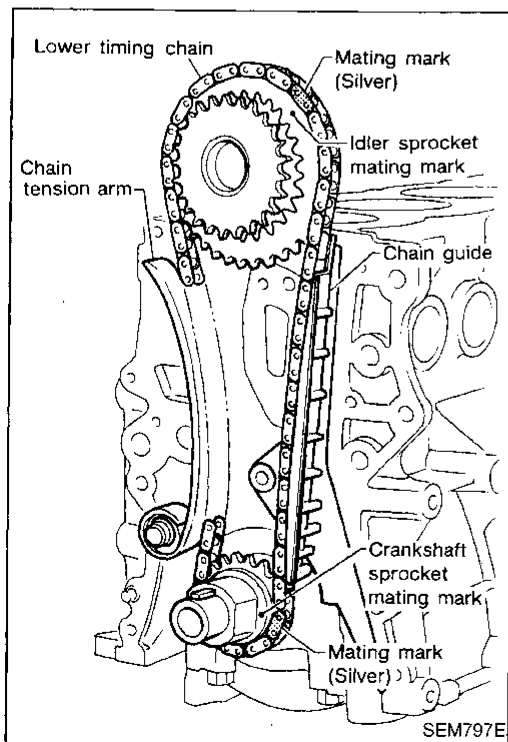
Check for cracks and excessive wear at roller links. Replace chain if necessary.



### Installation

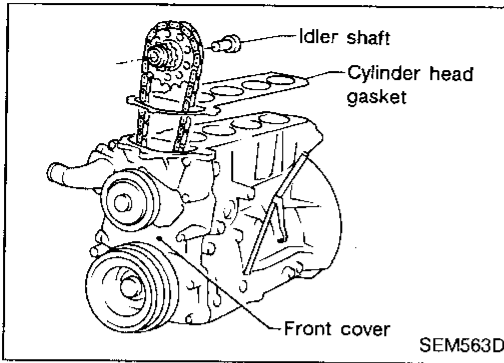
#### LOWER TIMING CHAIN

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.**



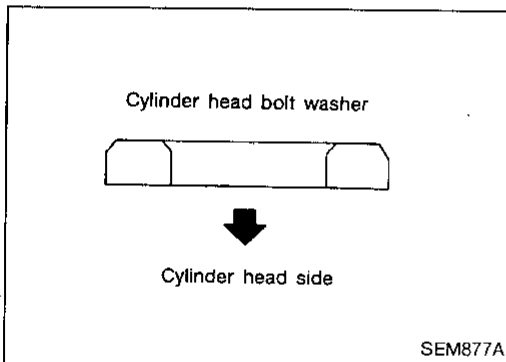
## TIMING CHAIN

### 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-15).**
  - **Use Genuine RTV silicone sealant Part No. 999MP-A7007, Three Bond TB1207D or equivalent.**
  - **Be careful not to damage cylinder head gasket.**
  - **Be sure to install new front oil seal. Refer to EM-23.**

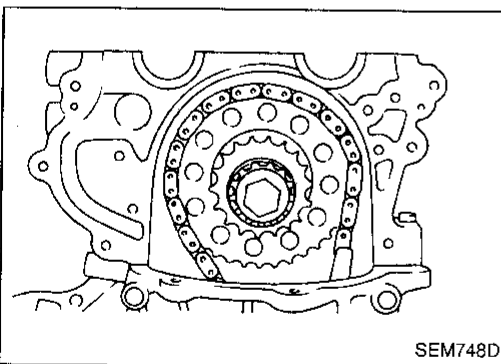
7. Install the following parts:
  - Crankshaft pulley
  - Oil strainer and oil pan
  - Component parts below the engine
  - Air compressor idler pulley
  - New cylinder head gasket
  - Idler shaft



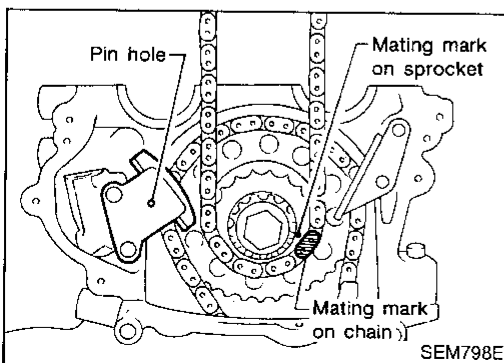
8. Install cylinder head and temporarily tighten cylinder head bolts when installing front cover.
  - **Apply new engine oil to bolt threads and seat surfaces.**
  - **Temporarily tighten cylinder head bolts. This is necessary to avoid damaging cylinder head gasket.**
  - **Be sure to install washers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

### UPPER TIMING CHAIN

1. Install lower timing chain.  
Refer to "LOWER TIMING CHAIN" in "Installation" (EM-19).

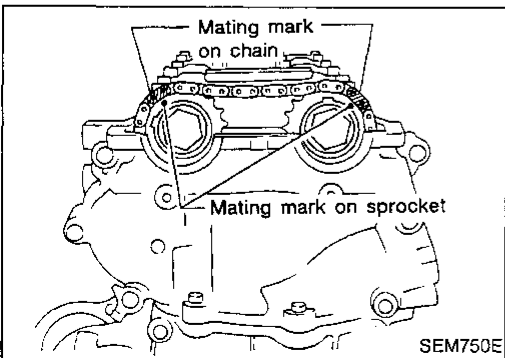
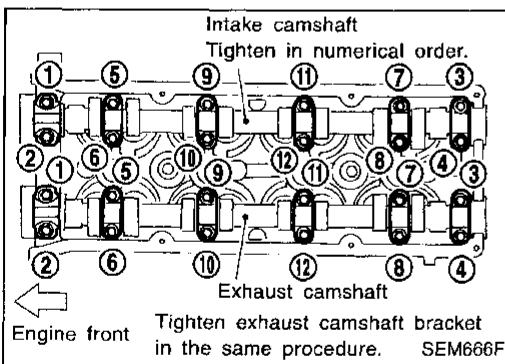
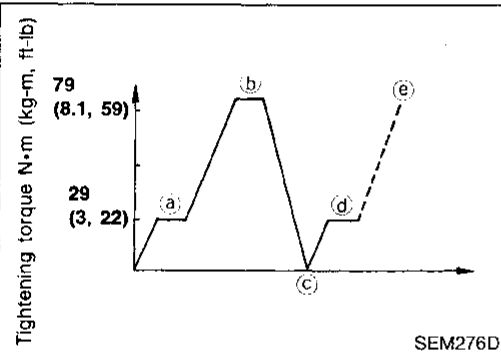
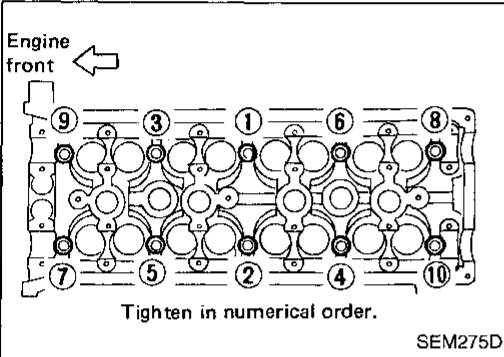
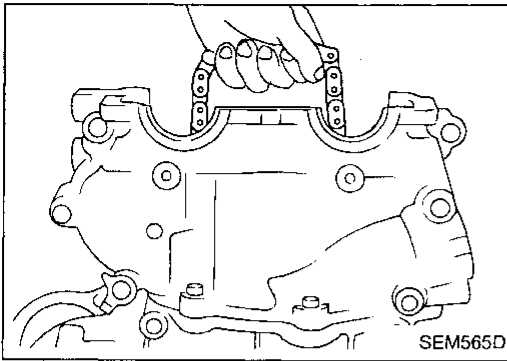


2. Install upper timing chain, chain tensioner and chain guide.
  - **Set upper timing chain on the idler sprockets, aligning mating marks.**
  - **When installing chain tensioner, insert a suitable pin into pin hole to stop piston.**
  - **After installation remove the pin to release piston.**



## 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-15).**
  - **Use Genuine RTV silicone sealant Part No. 999MP-A7007, Three Bond TB1207D 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 to 104.2 in-lb).
6. Install camshaft sprockets.
7. Install chain guide between both camshaft sprockets.

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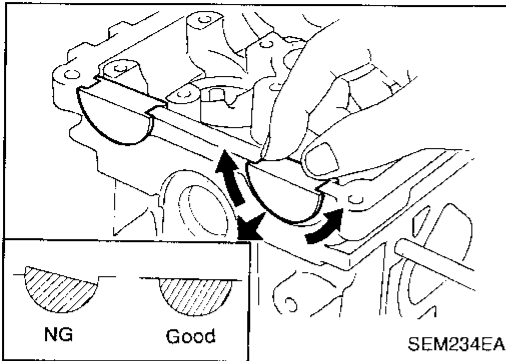
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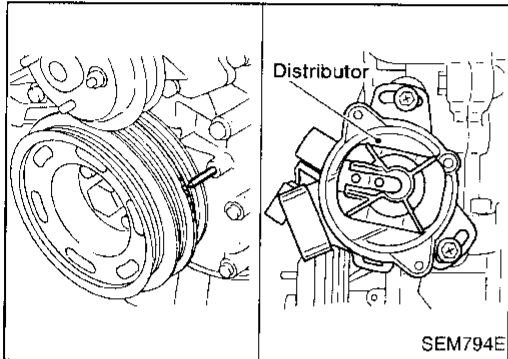
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## TIMING CHAIN

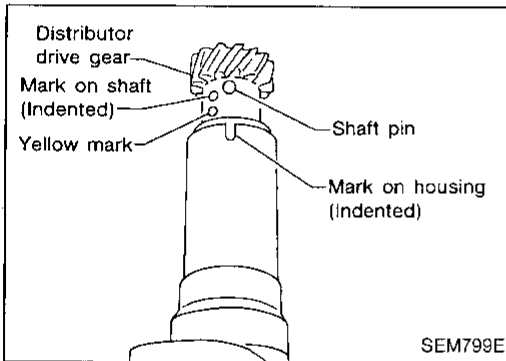
### Installation (Cont'd)



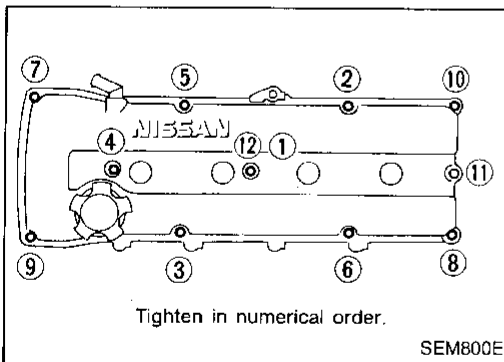
8. Install rubber plugs as follows.
  - (1) Apply liquid gasket to rubber plugs.
  - (2) Install rubber plugs, then move them by hand to uniformly spread the gasket on cam sprocket cover surface.
  - Rubber plugs should be installed flush with the cylinder head surface.
9. Install chain guide between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

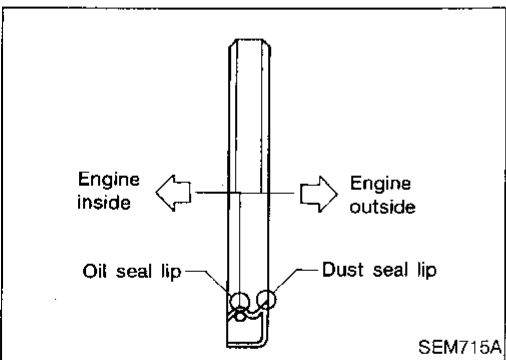
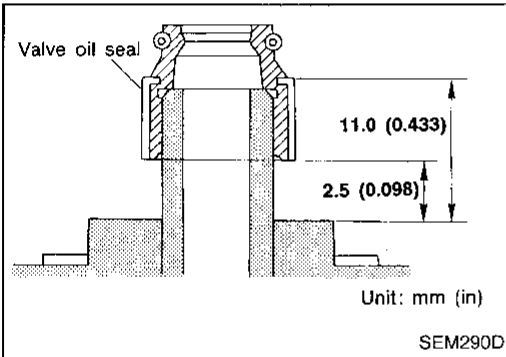
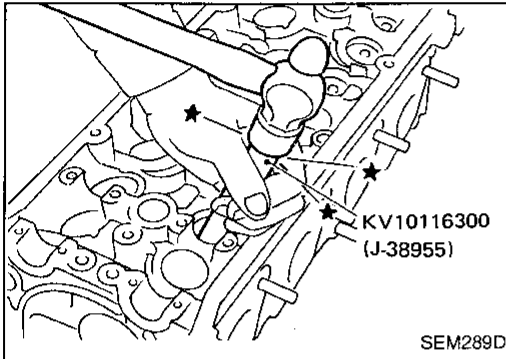
# OIL SEAL REPLACEMENT

## VALVE OIL SEAL

1. Remove rocker cover.
2. Remove camshaft. Refer to "TIMING CHAIN" (EM-14).
3. Remove valve spring and valve oil seal with Tool or a suitable tool.

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

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



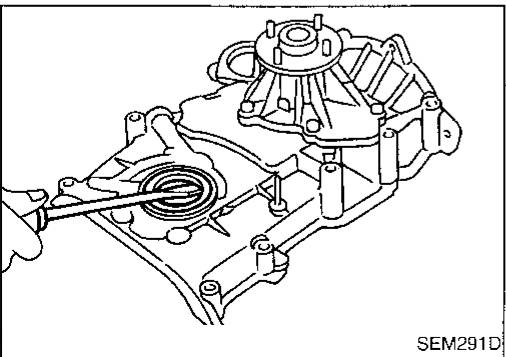
## OIL SEAL INSTALLING DIRECTION

- 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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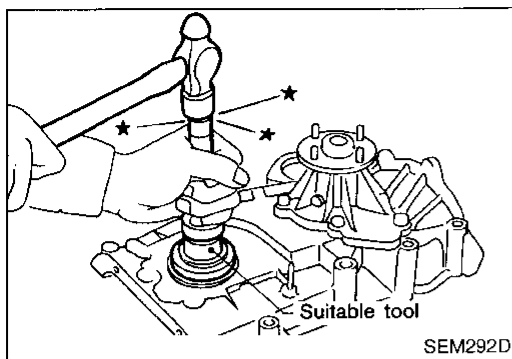
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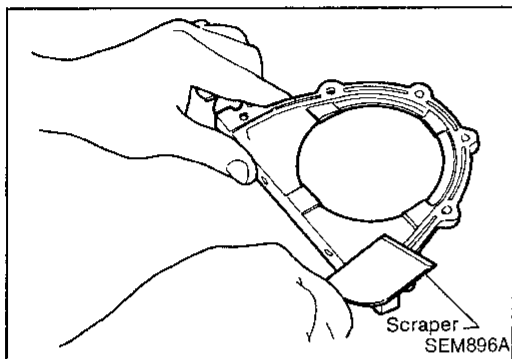
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## OIL SEAL REPLACEMENT

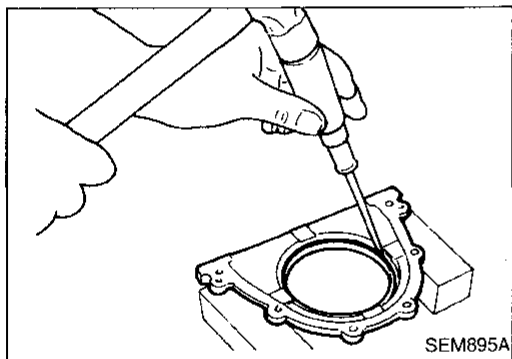


3. Apply engine oil to new oil seal and install it using a suitable tool.

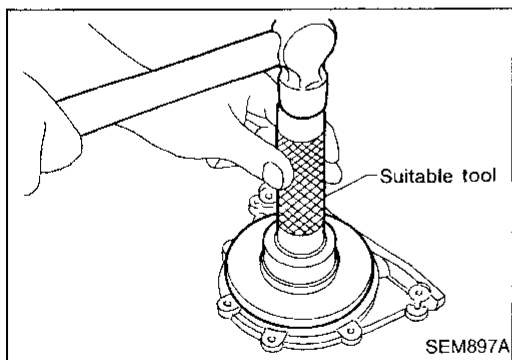


### REAR OIL SEAL

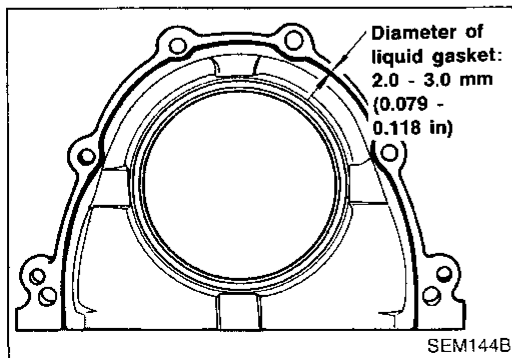
1. Remove drive plate or flywheel.
  2. Remove rear oil seal retainer.
  3. Use a scraper to remove all traces of liquid gasket from mating surface.
- **Remove old liquid gasket from the bolt holes and threads.**



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.

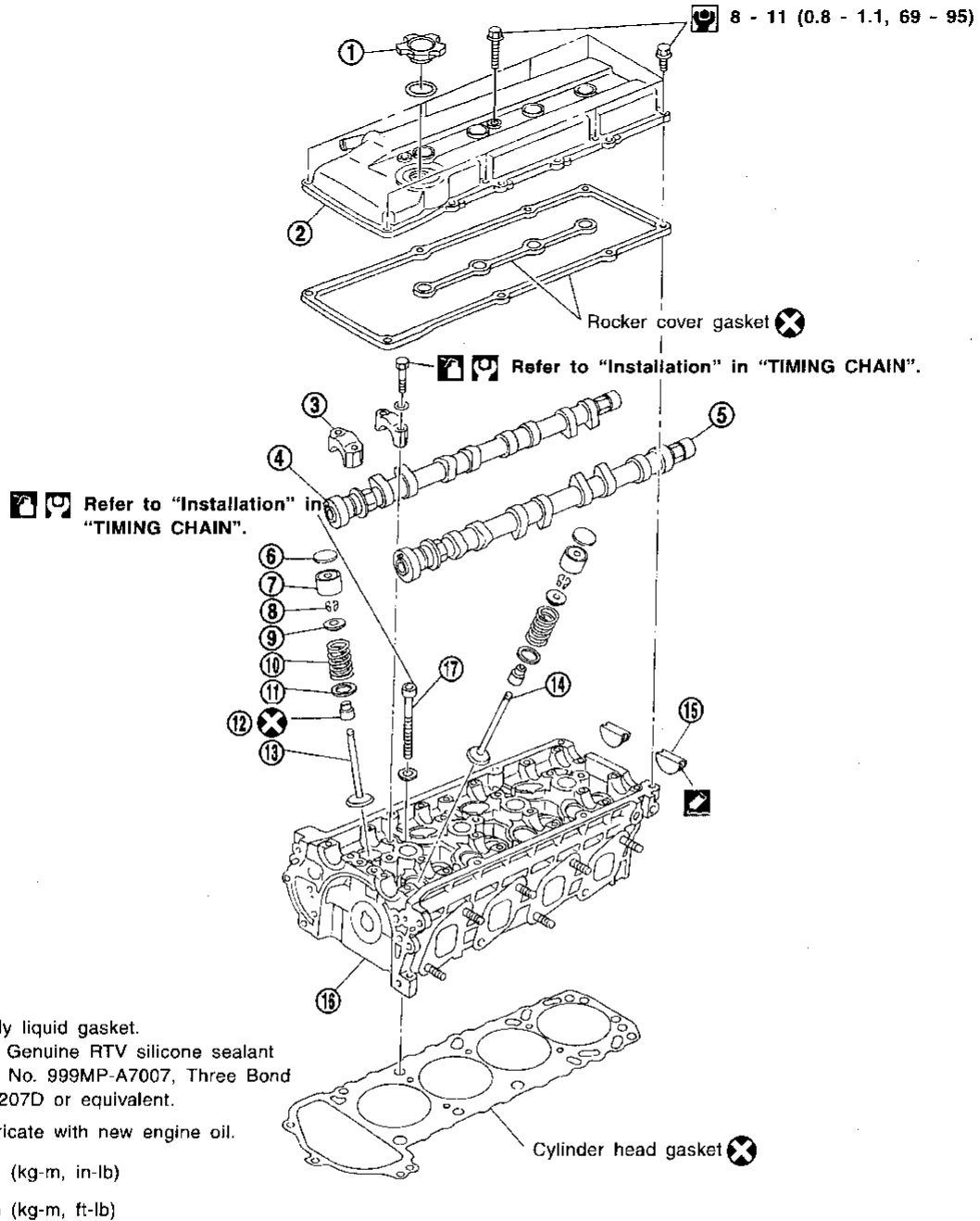


6. Apply a continuous bead of liquid gasket to rear oil seal retainer.
- **Use Genuine RTV silicone sealant Part No. 999MP-A7007, Three Bond TB1207D or equivalent.**
  - Apply a continuous bead of liquid gasket around inner side of bolt holes.



# 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

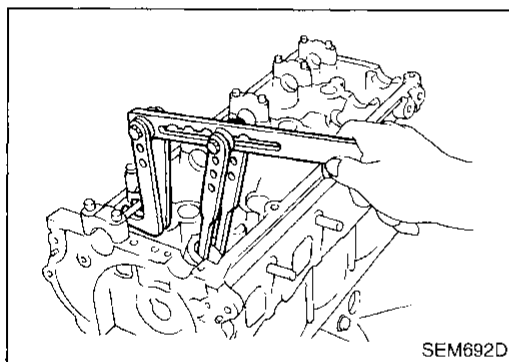
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### CAUTION:

- 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

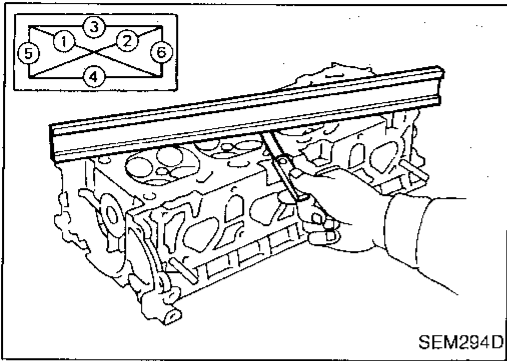
- Removal and installation procedures are the same as those for timing chain. Refer to "Removal" and "Installation" in "TIMING CHAIN" (EM-16, EM-19).
- Before removing camshaft and idler sprockets, apply paint marks to them for retiming.



### Disassembly

1. Remove intake manifold, collector assembly and exhaust manifold. Refer to "OUTER COMPONENT PARTS" (EM-9).
2. Remove valve components with Tool.
3. Remove valve oil seal with a suitable tool.

# CYLINDER HEAD



## Inspection

### CYLINDER HEAD DISTORTION

Clean surface of cylinder head.

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

Check along six positions shown in the figure.

**Head surface flatness:**

**Standard** Less than 0.03 mm (0.0012 in)

**Limit** 0.1 mm (0.004 in)

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

**Resurfacing limit:**

The limit 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)**

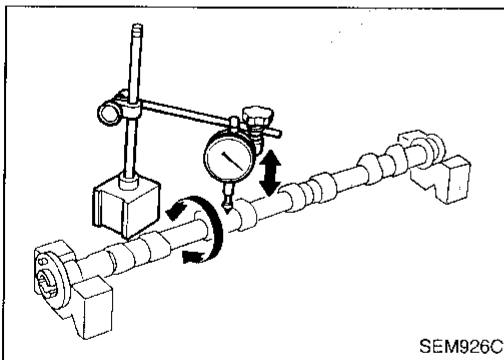
After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.

**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

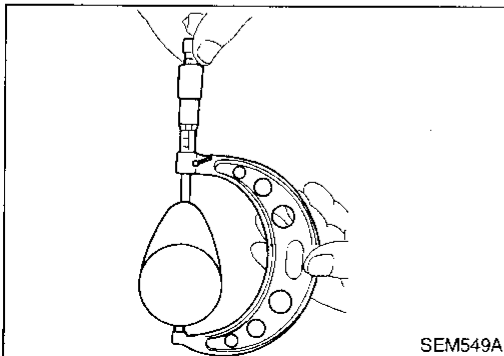
1. Measure camshaft runout at the center journal.

**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)

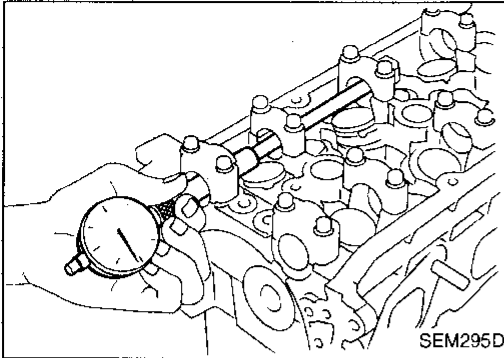
#### CAMSHAFT JOURNAL CLEARANCE

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

**Standard inner diameter:**

**#1 to #6 journals**

**28.000 - 28.025 mm (1.1024 - 1.1033 in)**



3. Measure outer diameter of camshaft journal.

**Standard outer diameter:**

**#1 to #6 journals**

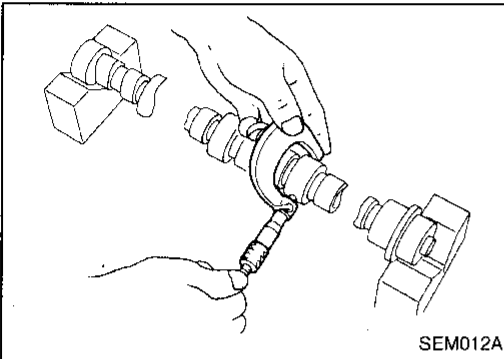
**27.935 - 27.955 mm (1.0998 - 1.1006 in)**

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.

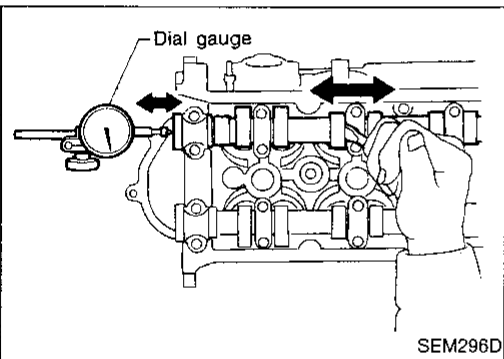
**Camshaft end play:**

**Standard**

**0.070 - 0.148 mm (0.0028 - 0.0058 in)**

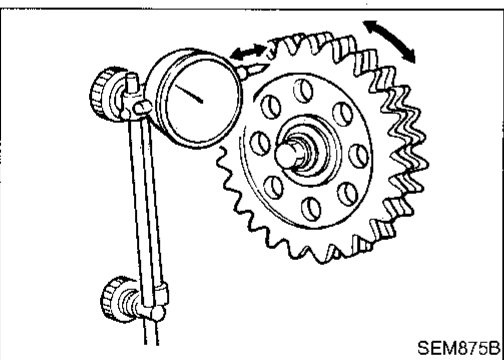
**Limit**

**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.

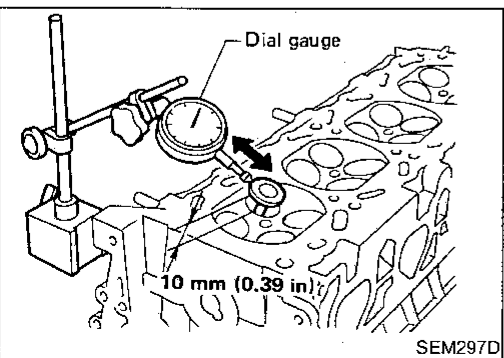


#### VALVE GUIDE CLEARANCE

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)

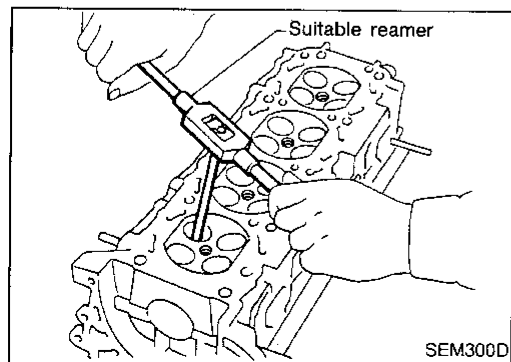
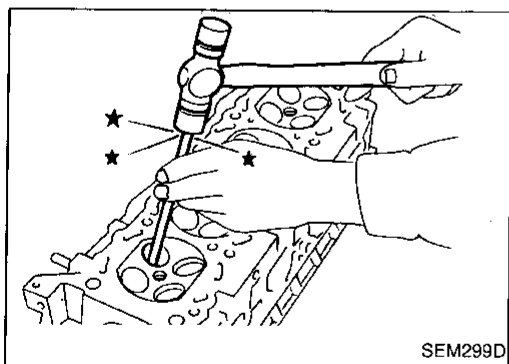
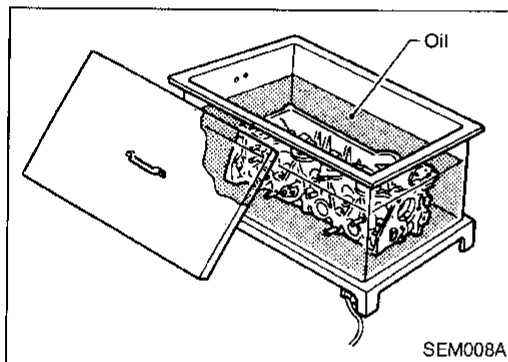
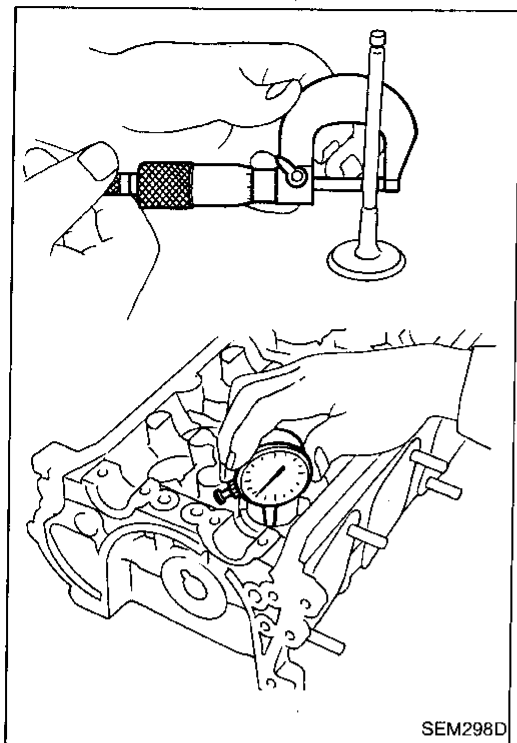
2. If it exceeds the limit, check valve to valve guide clearance.
  - a. Measure valve stem diameter and valve guide inner diameter.
  - b. Check that clearance is within specification.

#### 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.
 

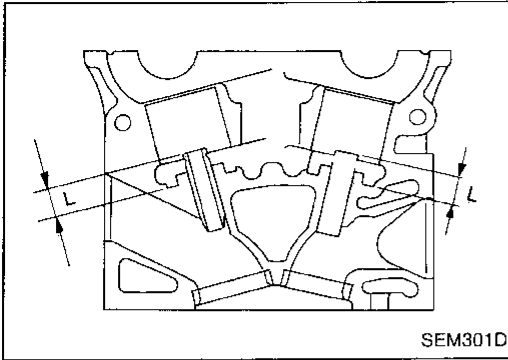
**Valve guide hole diameter (for service parts):**

Intake  
11.175 - 11.196 mm (0.4400 - 0.4408 in)

Exhaust  
11.175 - 11.196 mm (0.4400 - 0.4408 in)

## CYLINDER HEAD

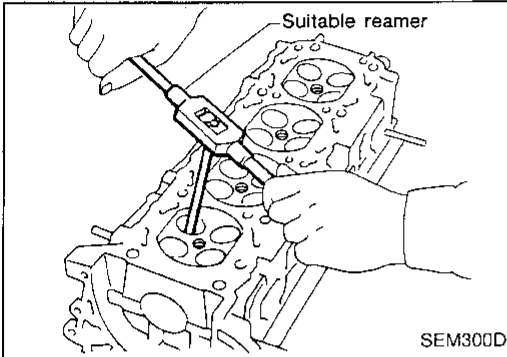
### Inspection (Cont'd)



- 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)**

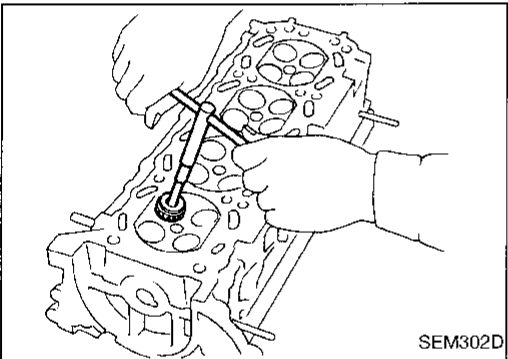


- Ream valve guide.

**Finished size:**

**Intake & Exhaust**

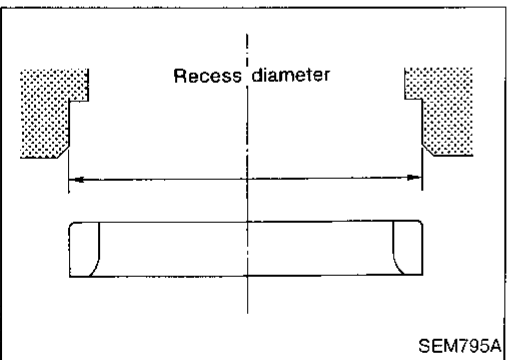
**7.000 - 7.018 mm (0.2756 - 0.2763 in)**



### 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.

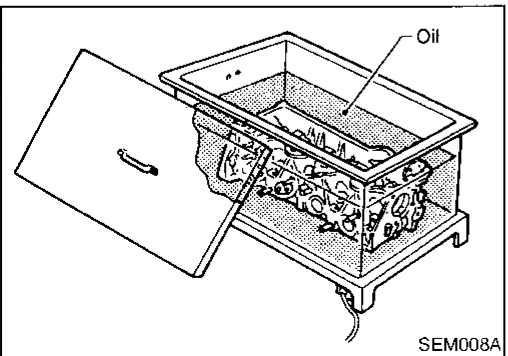
**Reaming bore for service valve seat**

**Override [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)**

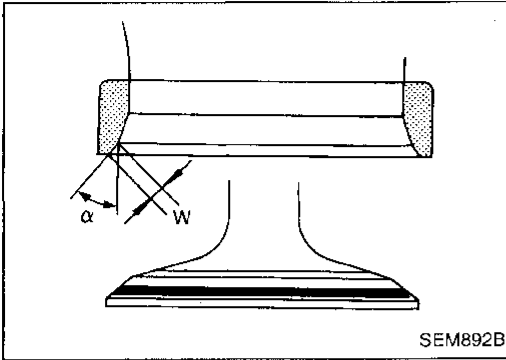
**Use the valve guide center for reaming to ensure valve seat will have the correct fit.**



- 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.

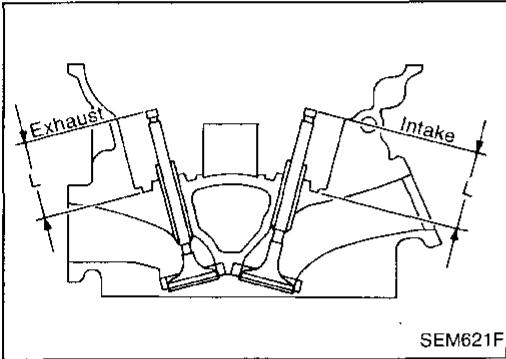
**Seat face angle "α":**

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)

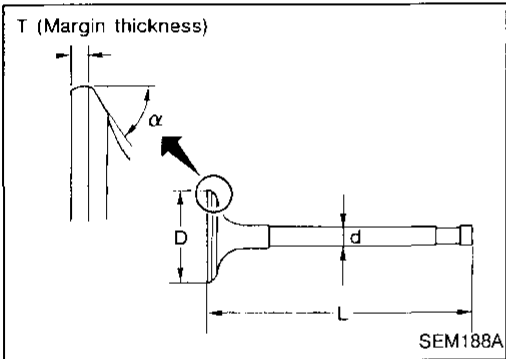


8. Use a depth gauge to measure the distance between the mounting surface of the cylinder head spring seat and the valve stem end. If the distance is shorter than specified, repeat step 5 above to adjust it. If it is longer, replace the valve seat with a new one.

**Valve seat resurface limit "L":**

Intake 46.03 - 46.53 mm (1.8122 - 1.8319 in)

Exhaust 40.72 - 41.22 mm (1.6031 - 1.6228 in)

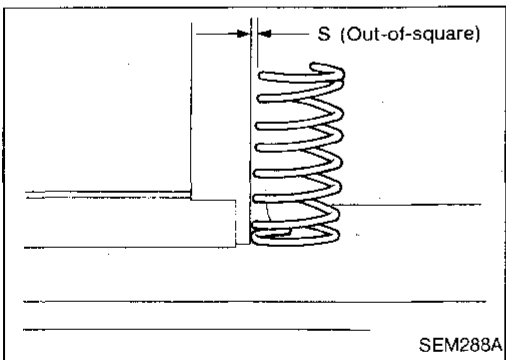


## VALVE DIMENSIONS

Check dimensions of each valve. For dimensions, refer to SDS (EM-48).

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

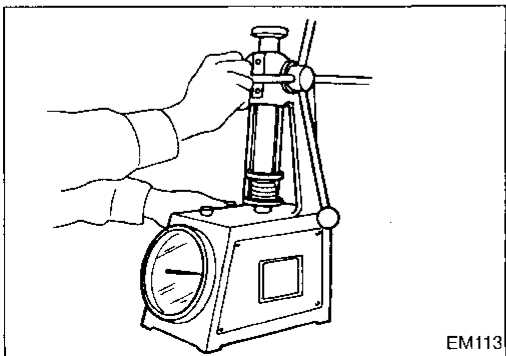
**Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.**



## VALVE SPRING

### Squareness

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



### 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.

GI

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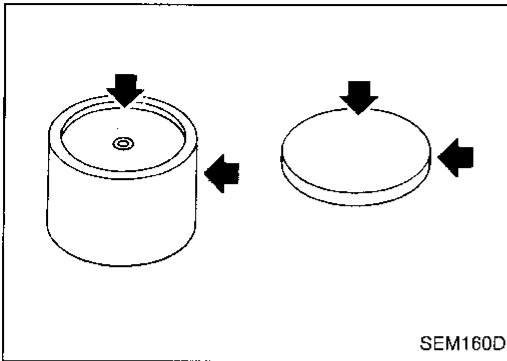
IDX

## CYLINDER HEAD

### Inspection (Cont'd)

#### VALVE LIFTER AND VALVE SHIM

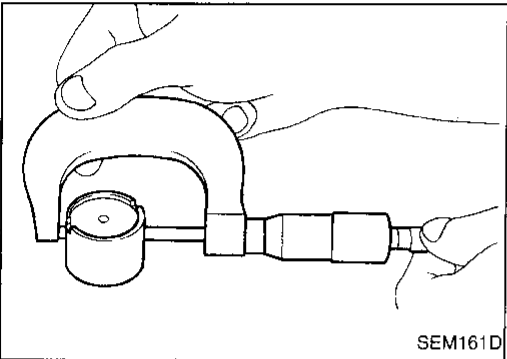
1. Visually check contact and sliding surfaces for wear or scratches.



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

**Valve lifter diameter:**

**33.960 - 33.975 mm (1.3370 - 1.3376 in)**

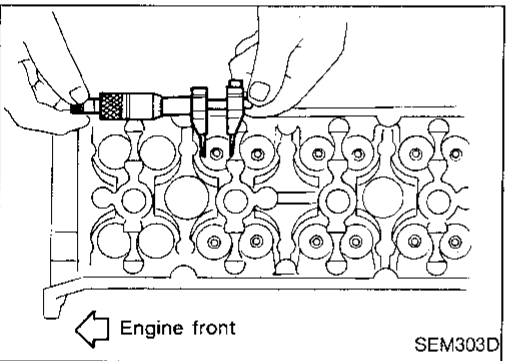


**Lifter guide bore diameter:**

**34.000 - 34.021 mm (1.3386 - 1.3394 in)**

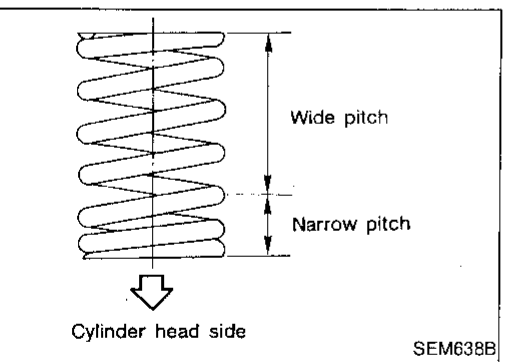
**Valve lifter to valve lifter guide clearance:**

**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-23).**
  - **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.**

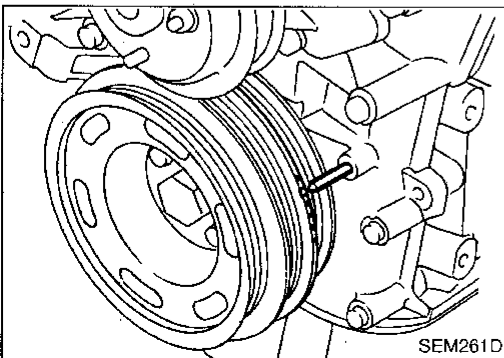


### Valve Clearance

#### CHECKING

**Check valve clearance while engine is warm but not running.**

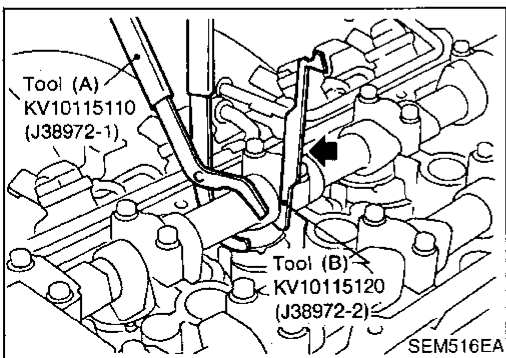
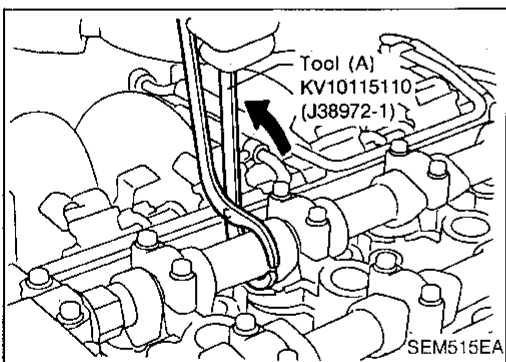
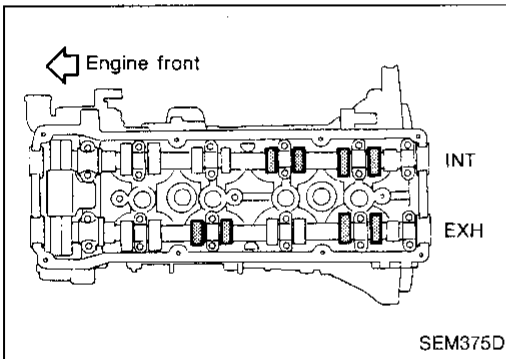
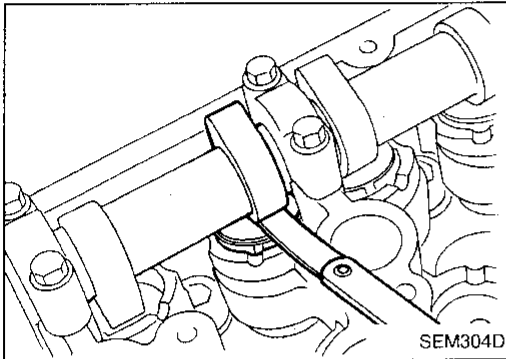
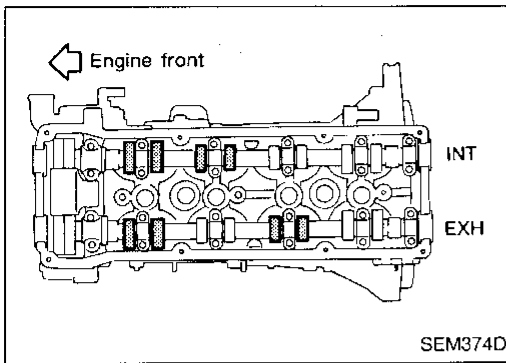
1. Remove rocker cover and all spark plugs.
  2. Set No. 1 cylinder at TDC on its compression stroke.
    - Align pointer with TDC mark on crankshaft pulley.
    - Check that valve lifters on No. 1 cylinder are loose and valve lifters on No. 4 are tight.
- If not, turn crankshaft one revolution (360°)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





## CYLINDER HEAD

### Valve Clearance (Cont'd)



3. Check only those valves shown in the figure.

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

#### Valve clearance (Hot):

##### Intake & Exhaust

0.33 - 0.41 mm (0.013 - 0.016 in)

4. Turn crankshaft one revolution (360°) and align mark on crankshaft pulley with pointer.
5. Check those valves shown in the figure.
  - Use the same procedure as mentioned in step 4.
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).

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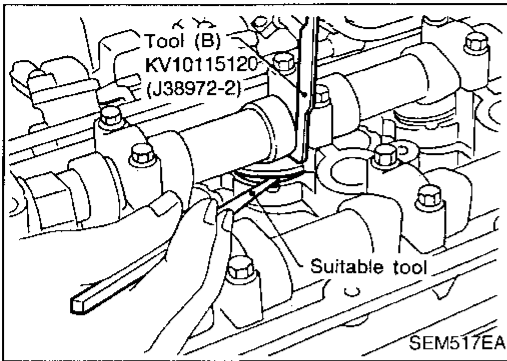
HA

EL

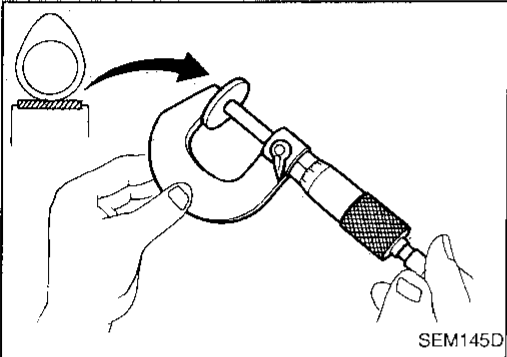
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## CYLINDER HEAD

### Valve Clearance (Cont'd)



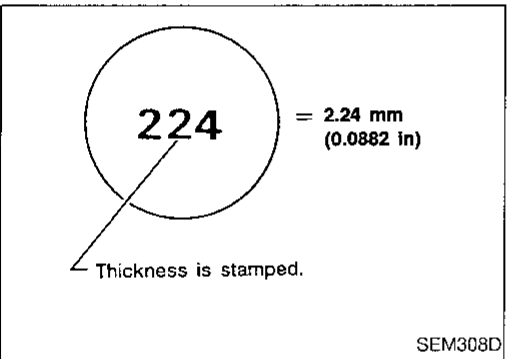
6. Remove adjusting shim using a small screwdriver and a magnetic finger.



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

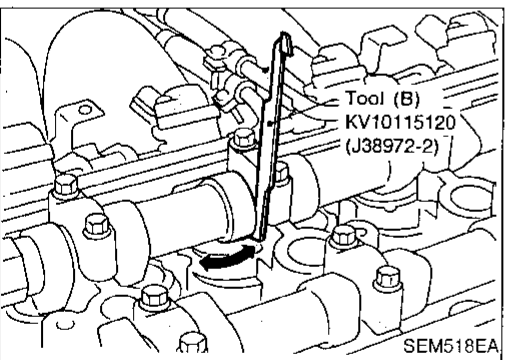
**Intake & Exhaust:**

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



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.

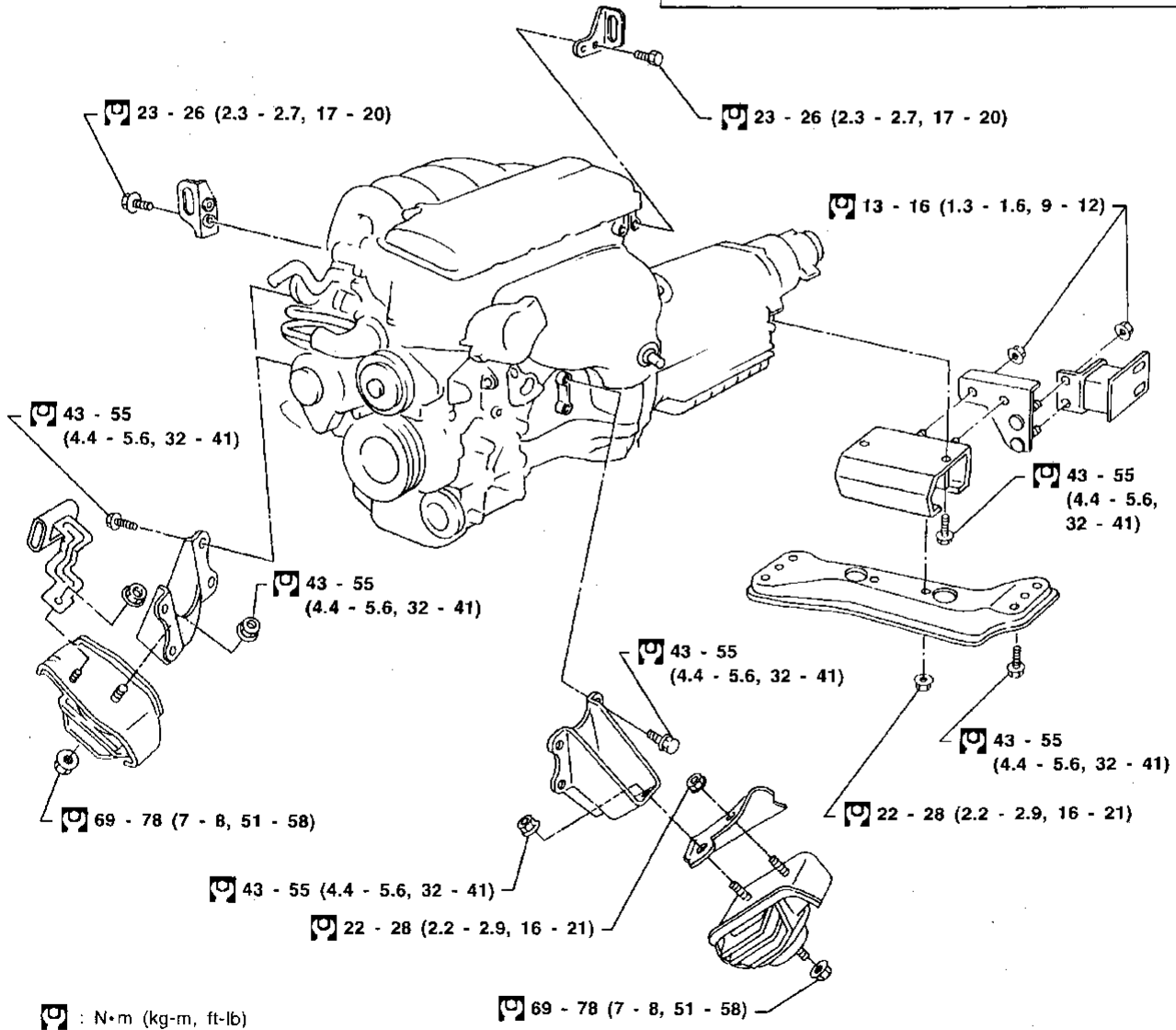
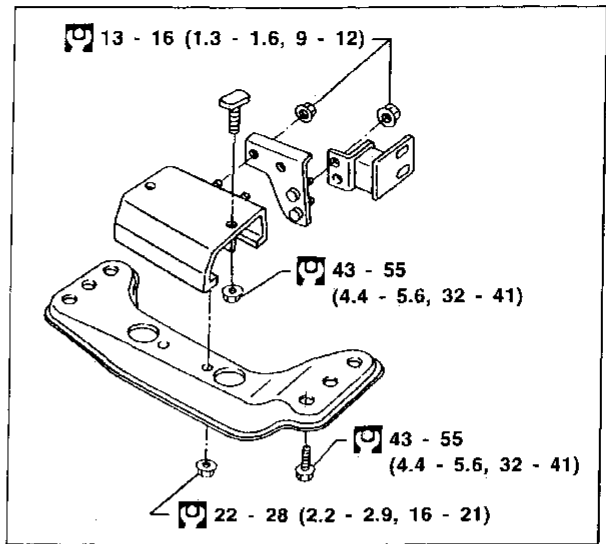


8. Install new shim using a suitable tool.
  - **Install with the surface on which the thickness is stamped facing down.**
9. Place Tool (A) as mentioned in steps 2 and 3.
10. Remove Tool (B).
11. Remove Tool (A).
12. Recheck valve clearance.  
Refer to "CHECKING" (EM-32).

# ENGINE REMOVAL

SEC. 111•112

M/T model



□ : N·m (kg-m, ft-lb)

□ 69 - 78 (7 - 8, 51 - 58)

GI  
MA  
**EM**  
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IDX

MEM171A

# 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.

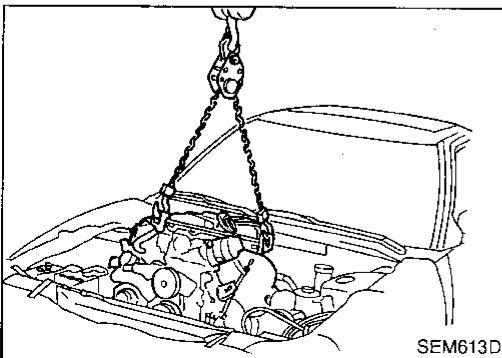
## Removal

1. Remove transmission.

Refer to AT or MT section.

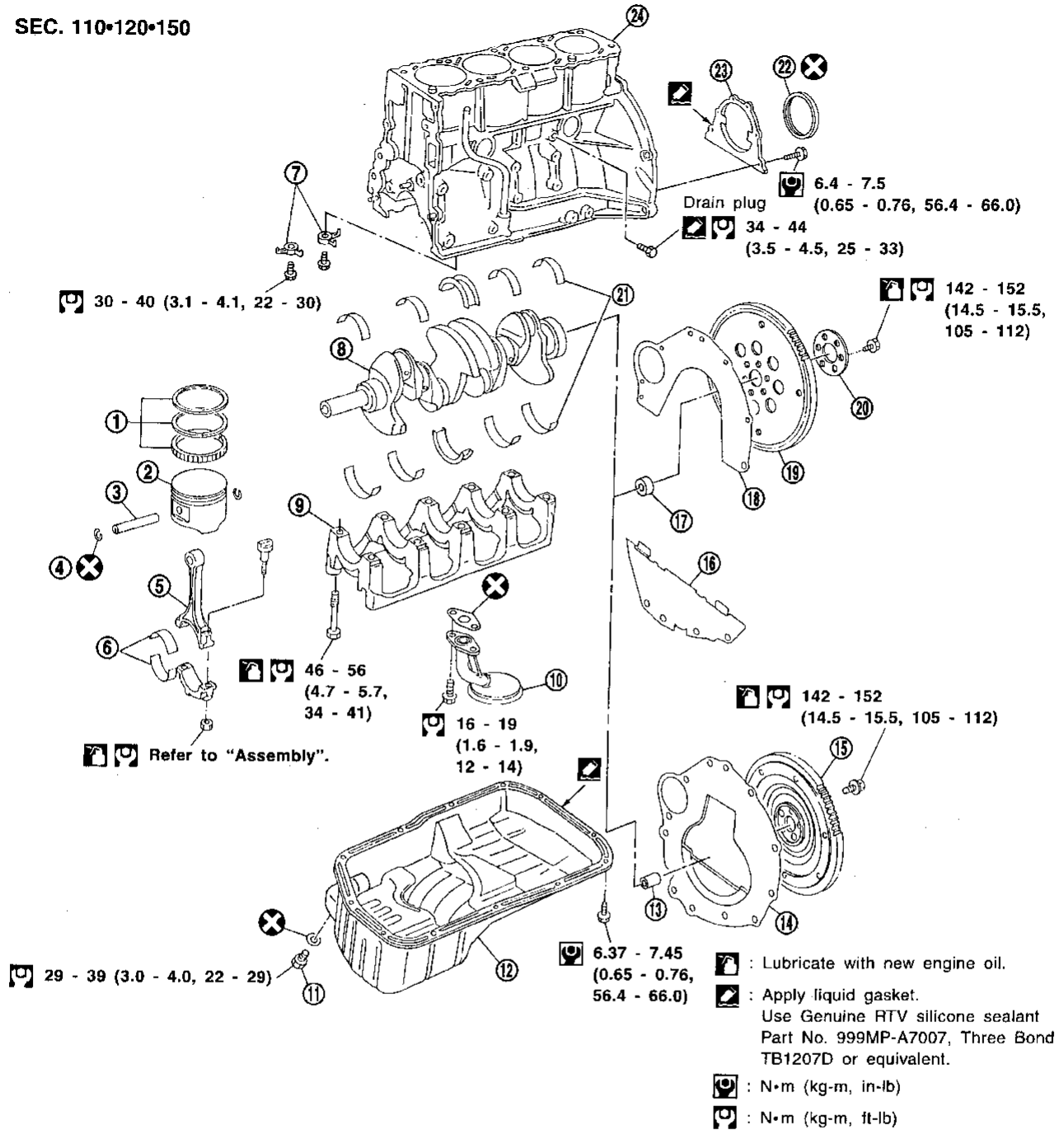
2. Remove engine under cover and hood.
3. Drain coolant from both cylinder block drain plug, and radiator drain cock.
4. Drain engine oil from drain plug of oil pan.
5. Remove vacuum hoses, fuel tubes, wires, harness and connectors and so on.
6. Remove front exhaust tubes.
7. Remove radiator and shroud.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



- 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

SEM688F

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# CYLINDER BLOCK

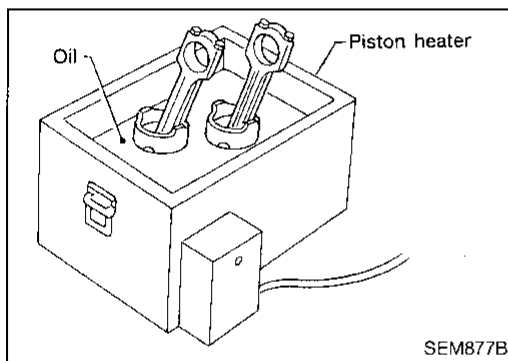
## CAUTION:

- 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

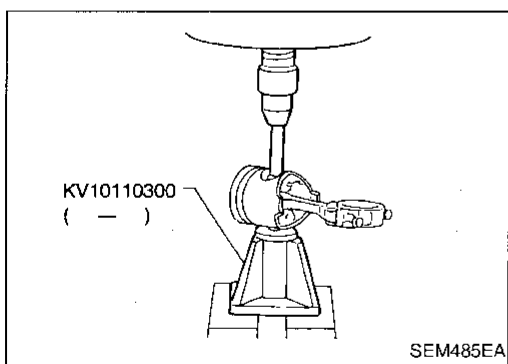
1. Place engine on a work stand.
2. Remove timing chain.  
Refer to "Removal" in "TIMING CHAIN" (EM-16).



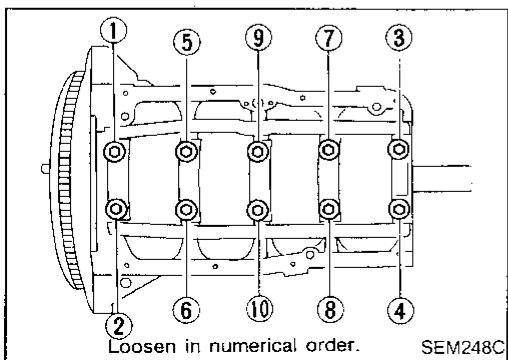
3. Remove pistons with connecting rods.
  - To disassemble piston and connecting rod, first remove snap rings. Heat piston to 60 to 70°C (140 to 158°F) then use piston pin press to remove pin.

## CAUTION:

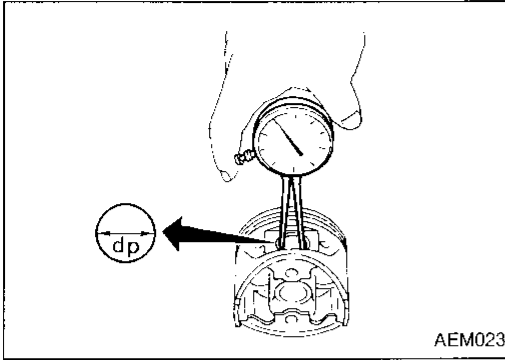
- When piston rings are not replaced, make sure that piston rings are mounted in their original positions.
- When replacing piston rings, if there is no punchmark, install with either side up.



4. Remove main bearing beam and crankshaft.
  - Before removing main bearing beam, measure crankshaft end play. Refer to EM-46.
  - Bolts should be loosened in two or three steps.



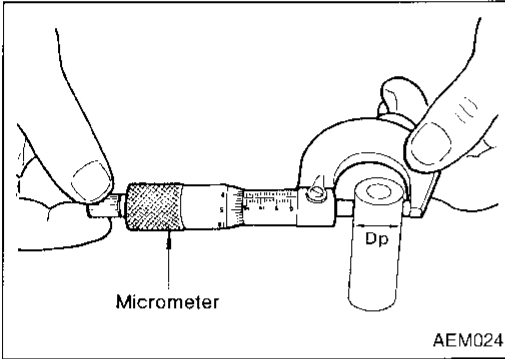
# CYLINDER BLOCK



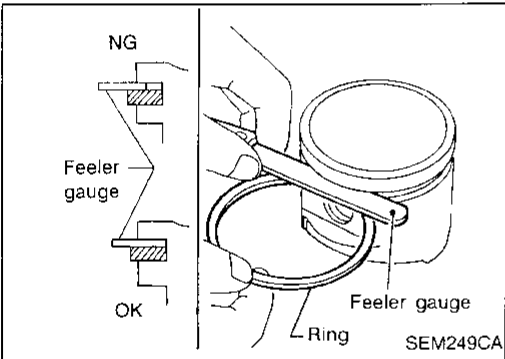
## Inspection

### PISTON AND PISTON PIN CLEARANCE

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



2. Measure outer diameter of piston pin "Dp".  
**Standard diameter "Dp":**  
**20.989 - 21.001 mm (0.8263 - 0.8268 in)**
3. Calculate piston pin clearance.  
**dp - Dp = -0.004 to 0 mm (-0.0002 to 0 in)**  
 If it exceeds the above value, replace piston assembly with pin.



### PISTON RING SIDE CLEARANCE

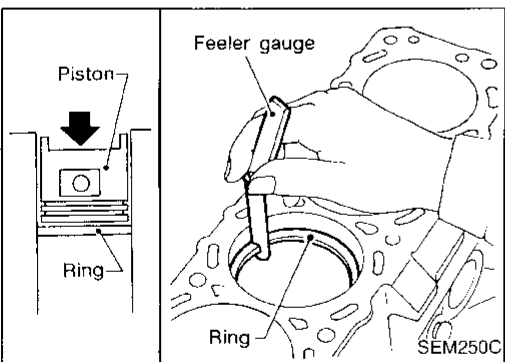
Side clearance:

- Top ring  
0.040 - 0.080 mm (0.0016 - 0.0031 in)
- 2nd ring  
0.030 - 0.070 mm (0.0012 - 0.0028 in)

Max. limit of side clearance:

0.1 mm (0.004 in)

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



### 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-53).

- 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.

GI

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## CYLINDER BLOCK

### Inspection (Cont'd)

#### CONNECTING ROD BEND AND TORSION

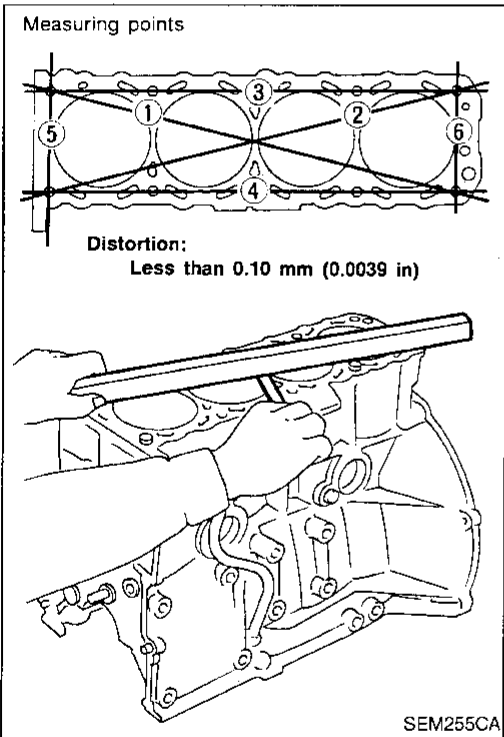
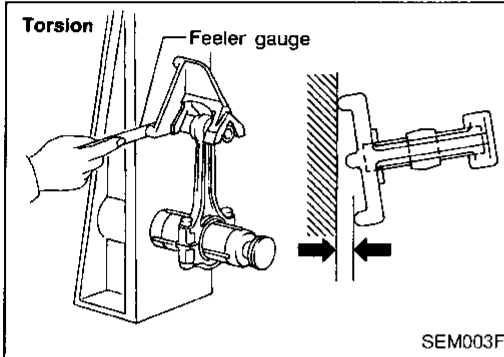
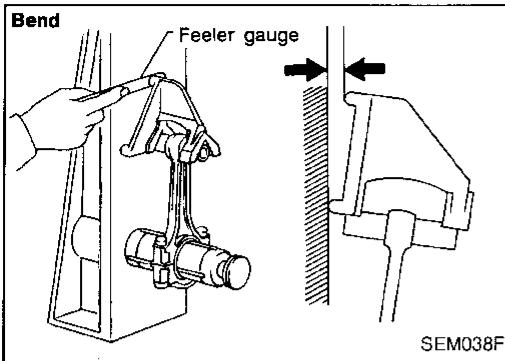
##### Bend:

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

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

**Standard inner diameter:**

Refer to SDS, EM-51.

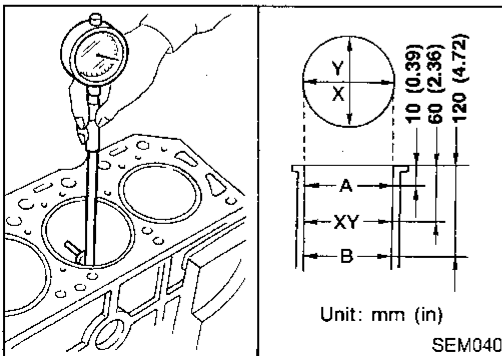
**Wear limit:**

**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:**

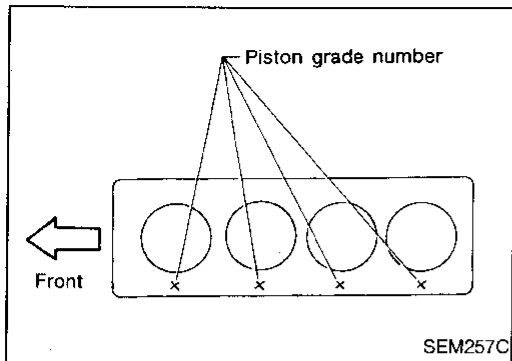
**0.015 mm (0.0006 in)**





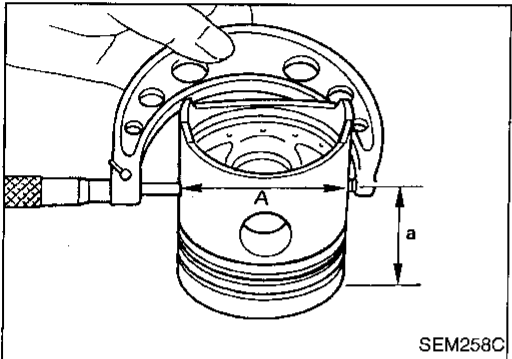
# CYLINDER BLOCK

## 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-53).  
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-53).**

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

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

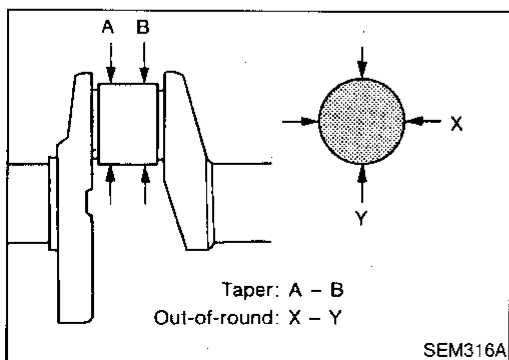
**D: Bored diameter**

**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.



## 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):**

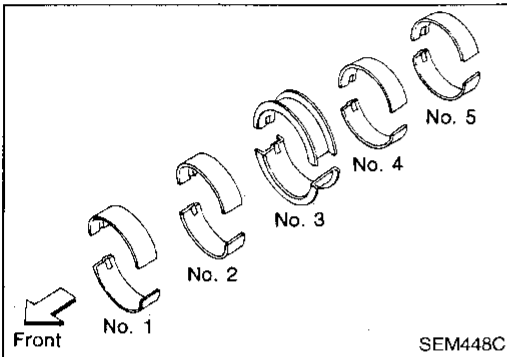
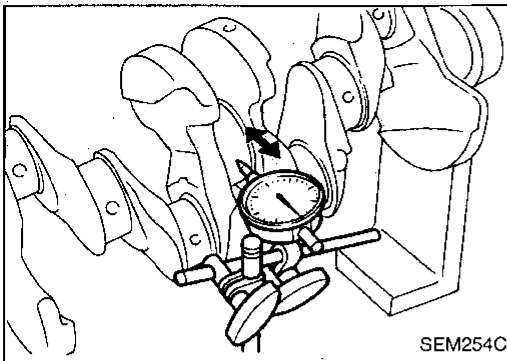
**Less than 0.002 mm (0.0001 in)**

## CYLINDER BLOCK

### Inspection (Cont'd)

3. Measure crankshaft runout.

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



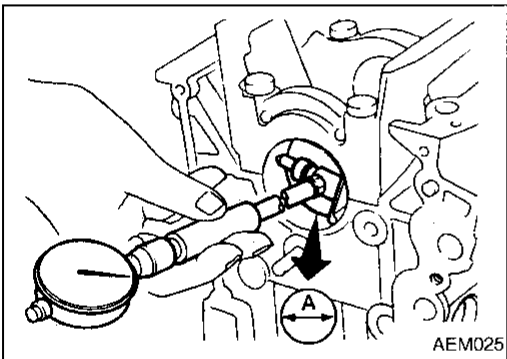
### BEARING CLEARANCE

- 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

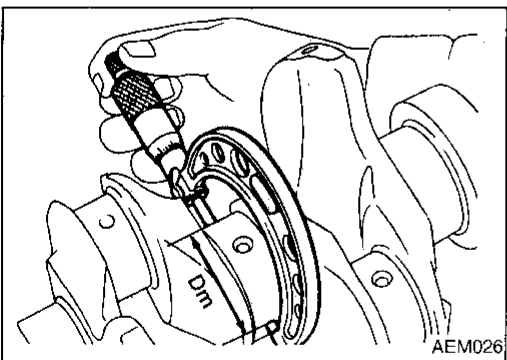
1. Set main bearings in their proper positions on cylinder block and main bearing cap.



2. Install main bearing cap to cylinder block.

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

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



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

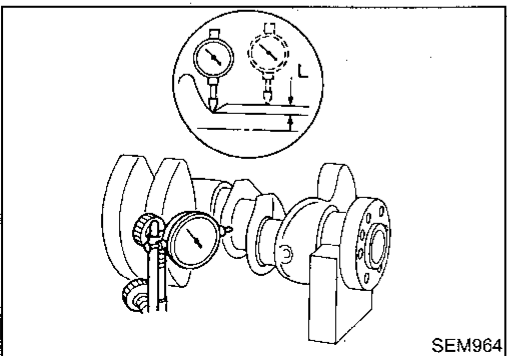
Main bearing clearance = A - Dm

##### 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.



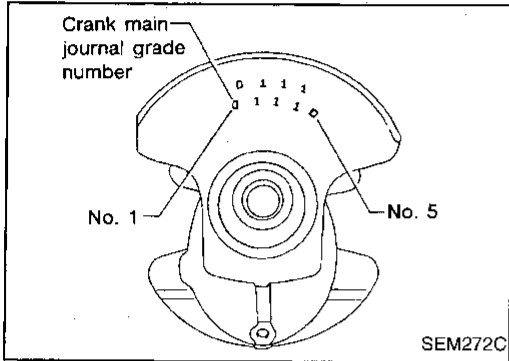
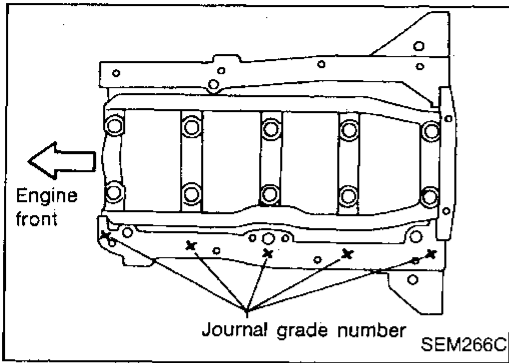
- a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.

"L": 0.1 mm (0.004 in)

- b. Refer to SDS (EM-54) 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:

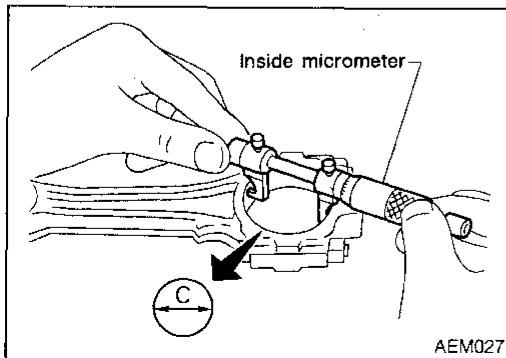
		Cylinder block main journal grade number		
		0	1	2
Crankshaft main journal grade number	0	0 (Black)	1 (Brown)	2 (Green)
	1	1 (Brown)	2 (Green)	3 (Yellow)
	2	2 (Green)	3 (Yellow)	4 (Blue)

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)

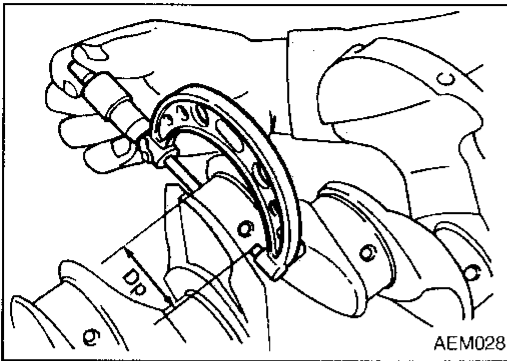
1. Install connecting rod bearing to connecting rod and cap.
2. Install connecting rod cap to connecting rod.

### Tighten bolts to the specified torque.

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

## CYLINDER BLOCK

### Inspection (Cont'd)



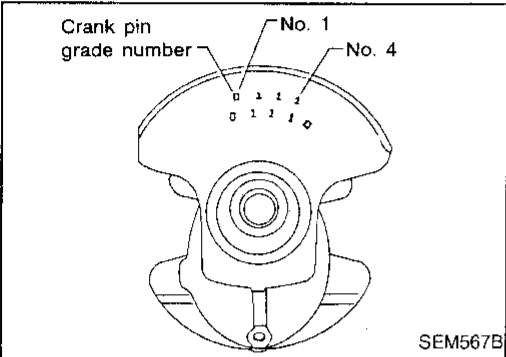
4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.

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

**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-42).

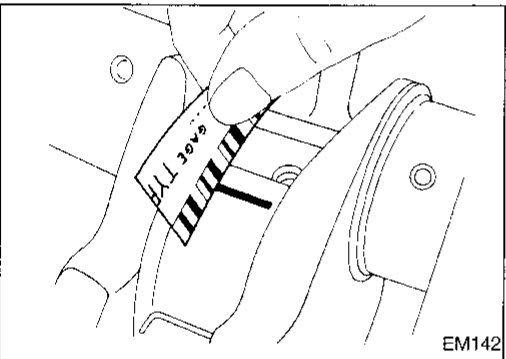


6. If crankshaft is replaced with a new one, select connecting rod bearing according to the following table.

#### Connecting rod bearing grade number:

These numbers are punched in either Arabic or Roman numerals.

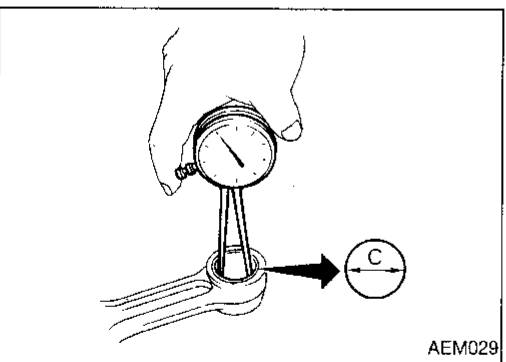
Crank pin journal grade number	Connecting rod bearing grade number
0	0 (No color)
1	1 (Brown)
2	2 (Green)



#### Method B (Using plastigage)

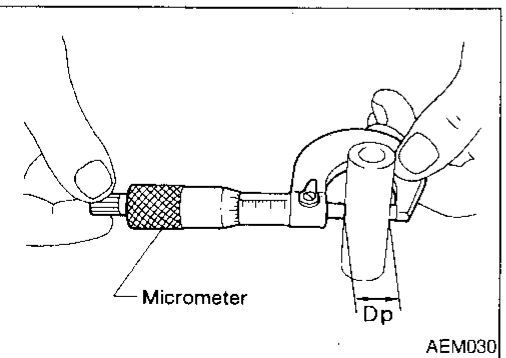
##### CAUTION:

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

**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)

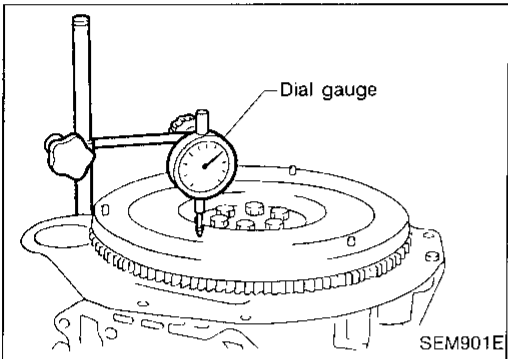
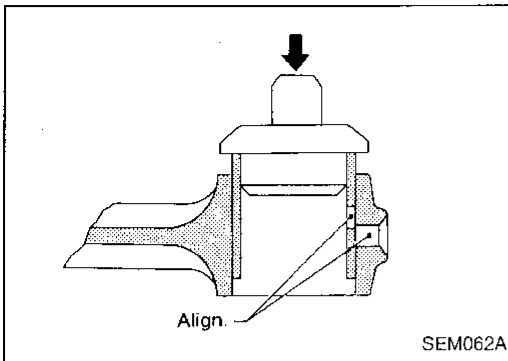
1. Drive in small end bushing until it is flush with end surface of rod.

**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)

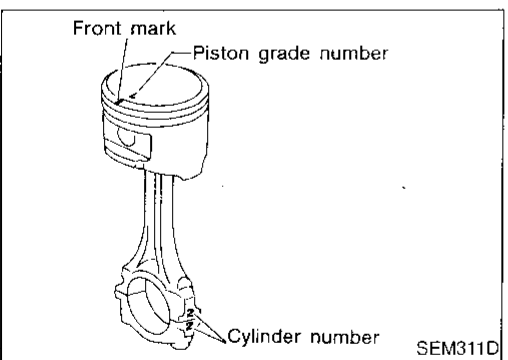
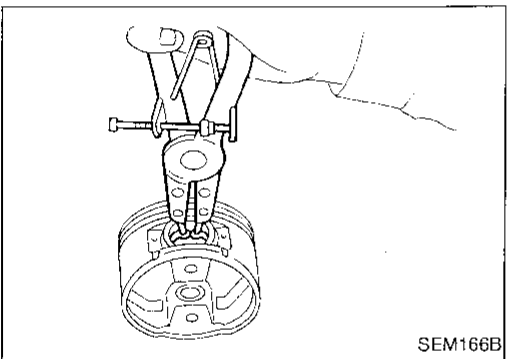
#### CAUTION:

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

## Assembly

### PISTON

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



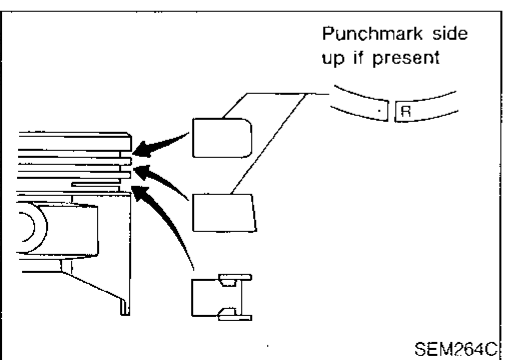
2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.

- **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.**

3. Set piston rings as shown.

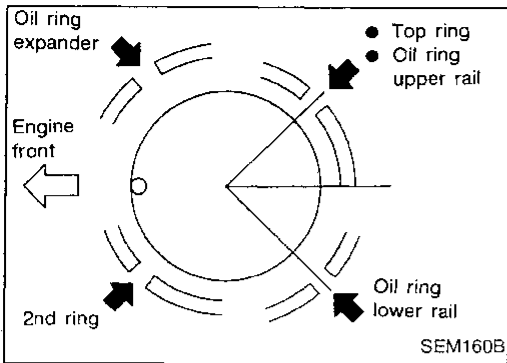
#### CAUTION:

- **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.**

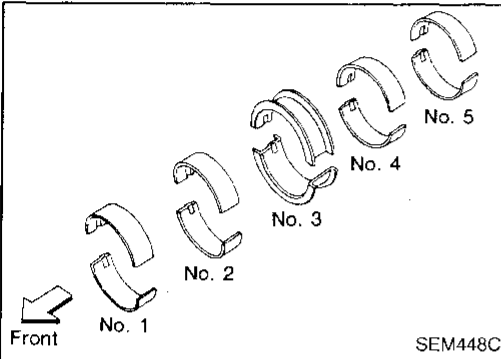


## CYLINDER BLOCK

### Assembly (Cont'd)

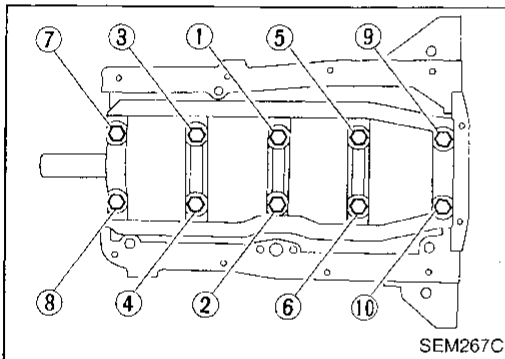


- Align piston rings so that end gaps are positioned as shown in the figure.

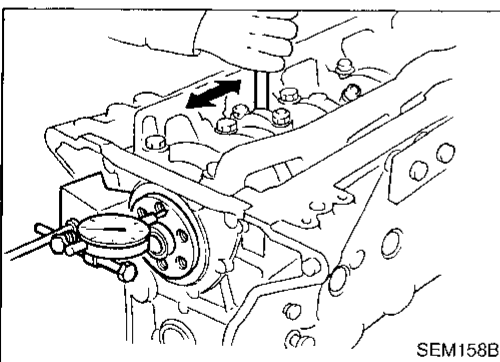


### CRANKSHAFT

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-41).
  - 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:

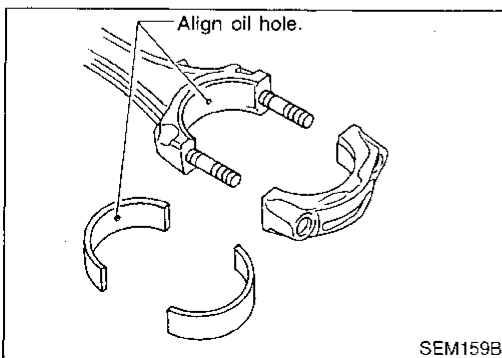
##### Standard

0.05 - 0.18 mm (0.0020 - 0.0071 in)

##### Limit

0.3 mm (0.012 in)

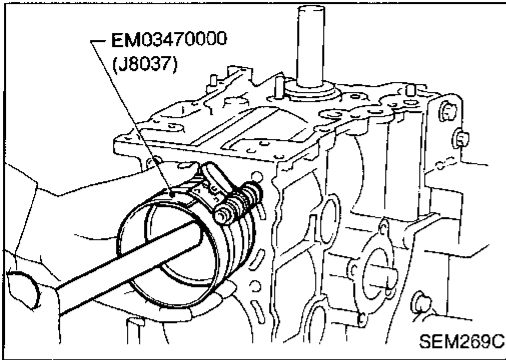
If beyond the limit, replace bearing with a new one.



4. Install connecting rod bearings in connecting rods and connecting rod caps.
  - Confirm that correct bearings are used. Refer to "Inspection" (EM-43).
  - Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.
  - Apply engine oil to bolt threads and bearing surfaces.

# CYLINDER BLOCK

## Assembly (Cont'd)

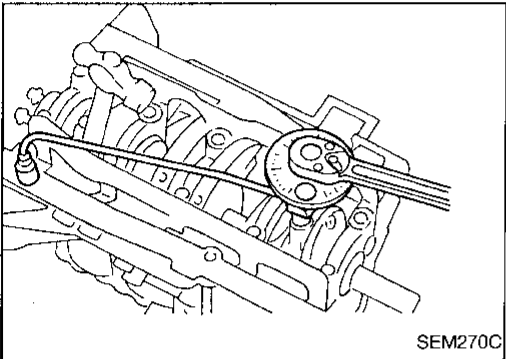


5. Install pistons with connecting rods.
  - a. Install them into corresponding cylinders with Tool.
    - **Be careful not to scratch cylinder wall with the connecting rod.**
    - **Arrange so that front mark on piston head faces toward engine front.**
    - **Apply engine oil to piston rings and sliding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

GI

MA

EM



- 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.

LC

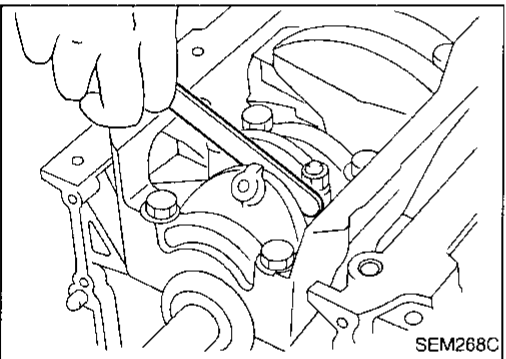
EC

### 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  $60_{-5}^{+5}$  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).

FE

CL



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.

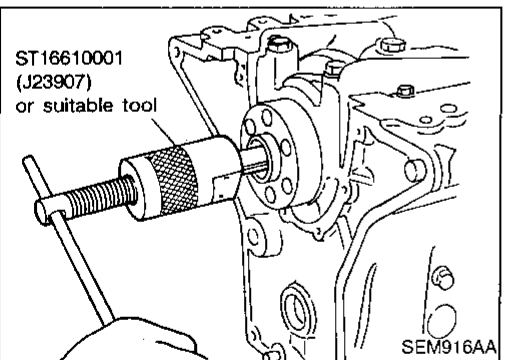
MT

AT

PD

FA

## REPLACING PILOT BUSHING



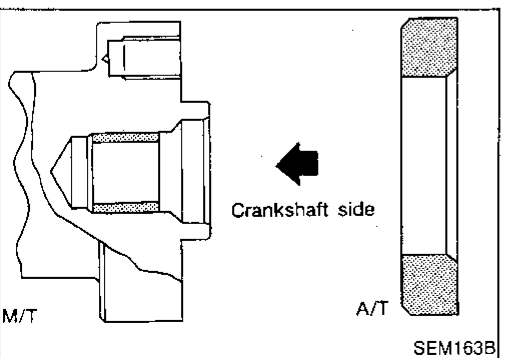
1. Remove pilot bushing (M/T) or pilot converter (A/T).

RA

BR

ST

RS



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

BT

HA

EL

IDX

# SERVICE DATA AND SPECIFICATIONS (SDS)

## General Specifications

Cylinder arrangement	In-line 4	
Displacement	cm <sup>3</sup> (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	

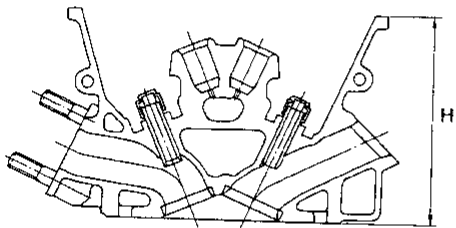
## COMPRESSION PRESSURE

		Unit: kPa (kg/cm <sup>2</sup> , 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)	

## Inspection and Adjustment

### CYLINDER HEAD

	Unit: mm (in)	
	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)

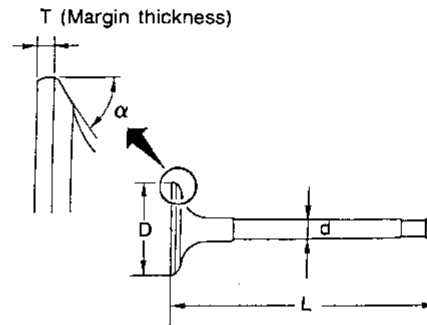


Nominal cylinder head height:  
H = 126.3 - 126.5 (4.972 - 4.980)

SEM519E

### VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"		
Intake	36.5 - 36.7 (1.437 - 1.445)	
Exhaust	31.2 - 31.4 (1.228 - 1.236)	
Valve length "L"		
Intake	101.17 - 101.47 (3.9831 - 3.9949)	
Exhaust	98.67 - 98.97 (3.8846 - 3.8964)	
Valve stem diameter "d"		
Intake	6.965 - 6.980 (0.2742 - 0.2748)	
Exhaust	6.945 - 6.960 (0.2734 - 0.2740)	
Valve seat angle "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)

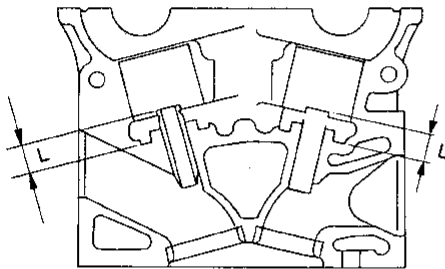
## Inspection and Adjustment (Cont'd)

### 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)
		Exhaust	11.023 - 11.034 (0.4340 - 0.4344)
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

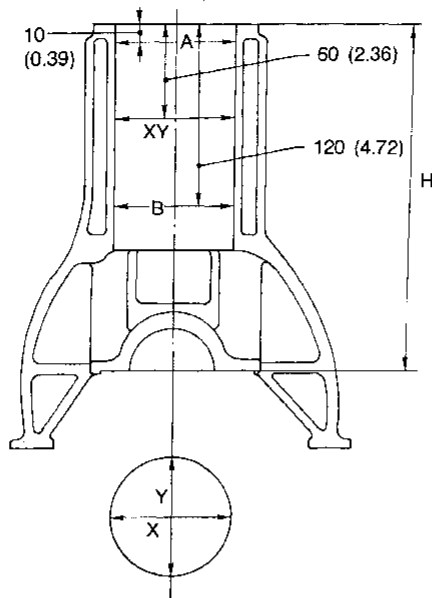
Thickness mm (in)	Identification mark
1.96 (0.0772)	196
1.98 (0.0780)	198
2.00 (0.0787)	200
2.02 (0.0795)	202
2.04 (0.0803)	204
2.06 (0.0811)	206
2.08 (0.0819)	208
2.10 (0.0827)	210
2.12 (0.0835)	212
2.14 (0.0843)	214
2.16 (0.0850)	216
2.18 (0.0858)	218
2.20 (0.0866)	220
2.22 (0.0874)	222
2.24 (0.0882)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

### 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)	0.2 (0.008)
		Grade 2	89.010 - 89.020 (3.5043 - 3.5047)	
		Grade 3	89.020 - 89.030 (3.5047 - 3.5051)	
	Out-of-round (X - Y)		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

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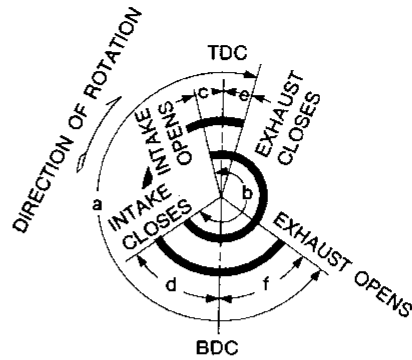
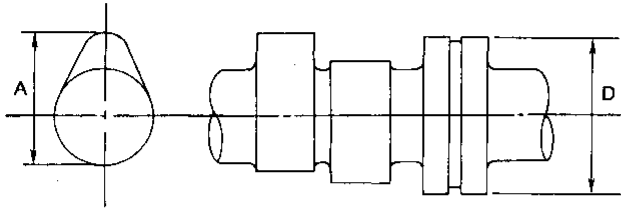
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# SERVICE DATA AND SPECIFICATIONS (SDS)

## 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 to #6 journals	28.000 - 28.025 (1.1024 - 1.1033)	—
Outer diameter of camshaft journal (D)	#1 to #6 journals	27.935 - 27.955 (1.0998 - 1.1006)	—
Camshaft runout*		Less than 0.02 (0.0008)	0.04 (0.0016)
Camshaft end play		0.070 - 0.148 (0.0028 - 0.0058)	0.2 (0.008)
Valve timing (Degree on crankshaft)	a	232	—
	b	232	—
	c	-1	—
	d	53	—
	e	4	—
	f	48	—

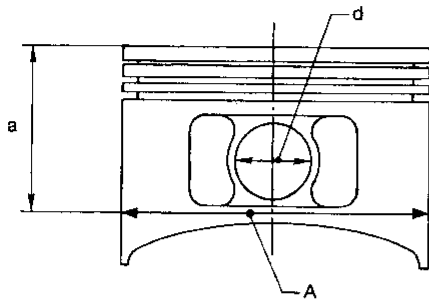
\* Total indicator reading

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Inspection and Adjustment (Cont'd)

### PISTON, PISTON RING AND PISTON PIN

#### Piston



SEM804E

Unit: mm (in)

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

#### Piston pin

Unit: mm (in)

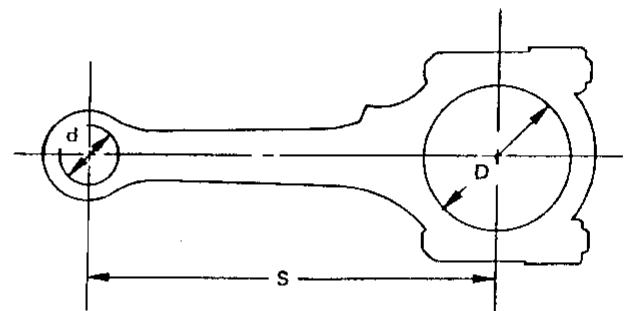
	Standard	Limit
Piston pin outer diameter	20.989 - 21.001 (0.8263 - 0.8268)	—
Interference fit of piston pin to piston pin hole	-0.004 to 0 (-0.0002 to 0)	—
Piston pin to connecting rod bearing clearance	0.005 - 0.017 (0.0002 - 0.0007)	0.023 (0.0009)

#### 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)

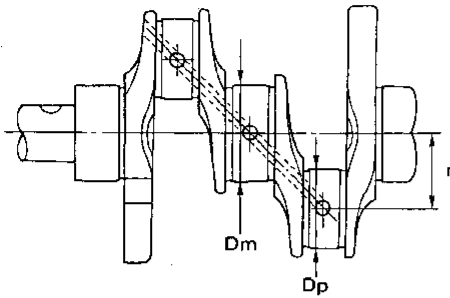
	Standard	Limit
Center distance (S)	164.95 - 165.05 (6.4941 - 6.4980)	—
Bend [per 100 mm (3.94 in)]	—	0.15 (0.0059)
Torsion [per 100 mm (3.94 in)]	—	0.30 (0.0118)
Connecting rod small end inner diameter (d)*	23.987 - 24.000 (0.9444 - 0.9449)	—
Piston pin bushing inner diameter	21.000 - 21.012 (0.8268 - 0.8272)	—
Connecting rod big end inner diameter (D)*	53.000 - 53.013 (2.0866 - 2.0871)	—
Side clearance	0.2 - 0.4 (0.008 - 0.016)	0.6 (0.024)

\* Without bearing

# SERVICE DATA AND SPECIFICATIONS (SDS)

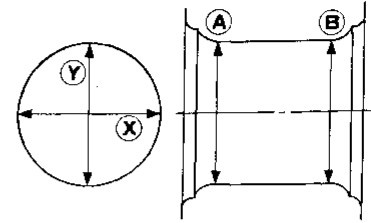
## Inspection and Adjustment (Cont'd)

### 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)	
		Standard	Limit
Taper of journal and pin (A) - (B)		—	0.002 (0.0001)
Out-of-round of journal and pin (X) - (Y)		—	0.005 (0.0002)
Runout [TIR]*		—	0.04 (0.0016)
Free end play		0.05 - 0.18 (0.0020 - 0.0071)	0.3 (0.012)
Fillet 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

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