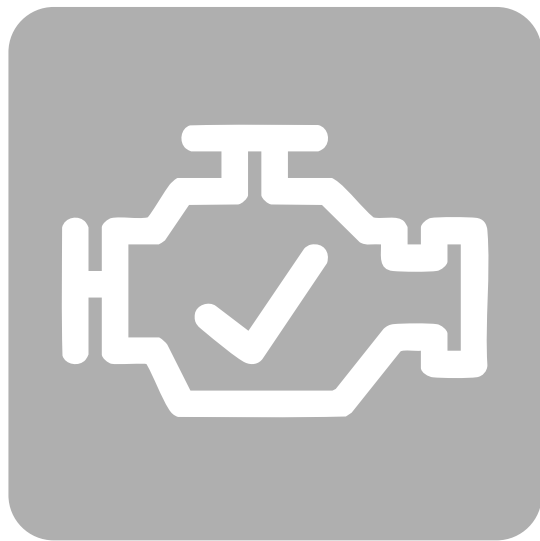


# HARBORFRONT

## ENGINE MECHANICAL



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## PRECAUTIONS

### Supplemental Restraint System (SRS) "AIR BAG"

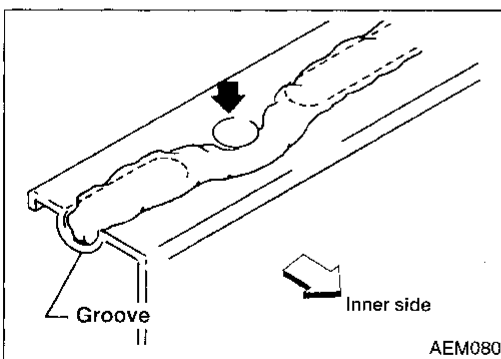
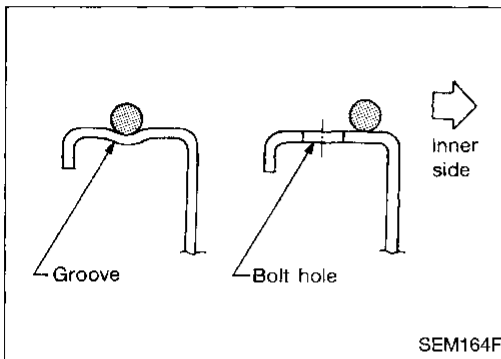
The Supplemental Restraint System "Air Bag", used along with a seat belt, helps to reduce the risk or severity of injury to the driver in a frontal collision. The Supplemental Restraint System consists of an air bag module (located in the center of the steering wheel), a diagnosis sensor unit, warning lamp, wiring harness, a crash zone sensor (4WD models) and spiral cable. Information necessary to service the system safely is included in the **RS section** of this Service Manual.

#### WARNING:

- To avoid rendering the SRS inoperative, which could increase the risk of personal injury or death in the event of a collision which would result in air bag inflation, all maintenance must be performed by an authorized NISSAN dealer.
- Improper maintenance, including incorrect removal and installation of the SRS, can lead to personal injury caused by unintentional activation of the system.
- Do not use electrical test equipment on any circuit related to the SRS unless instructed to in this Service Manual. SRS wiring harnesses are covered with yellow insulation either just before the harness connectors or for the complete harness, for easy identification.

#### Parts Requiring Angular Tightening

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



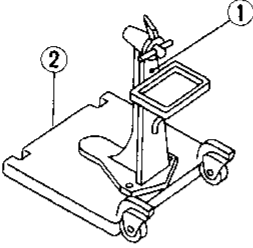
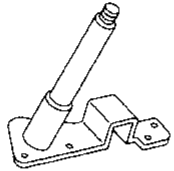
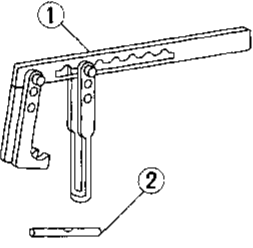
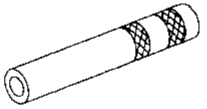
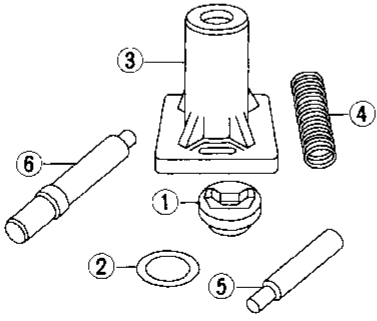
#### Liquid Gasket Application Procedure

- Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also, completely clean any oil from these areas.
- Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Liquid Gasket or equivalent.)
  - For oil pan, be sure liquid gasket diameter is 3.5 to 4.5 mm (0.138 to 0.177 in).
  - For areas except oil pan, be sure liquid gasket diameter is 2.0 to 3.0 mm (0.079 to 0.118 in).
- 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
ST0501S000 ( — ) Engine stand assembly ① ST05011000 ( — ) Engine stand ② ST05012000 ( — ) Base	Disassembling and assembling  NT042
KV10105001 ( — ) Engine attachment	 NT031
KV10109250 (J26336-B) Valve spring compressor ① KV10109210 ( — ) Compressor ② KV10109220 ( — ) Adapter	Disassembling and assembling valve components  NT021
KV109B0010 ( — ) Valve oil seal drift	Installing valve oil seal  NT027
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

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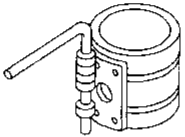
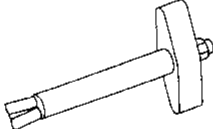
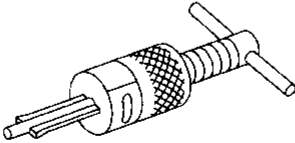
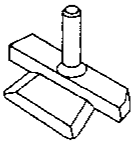
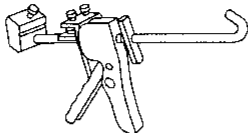
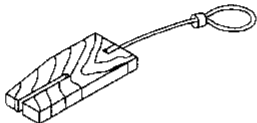
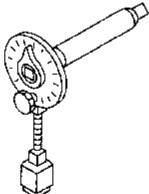
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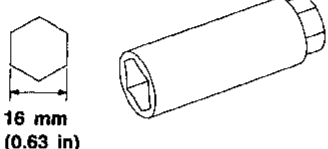
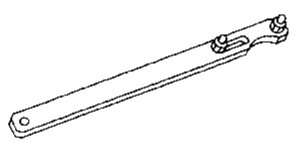

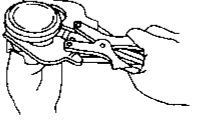
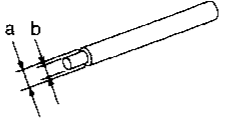
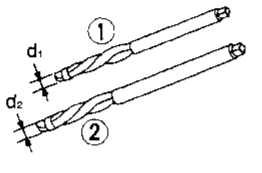
## PREPARATION

### Special Service Tools (Cont'd)

Tool number (Kent-Moore No.) Tool name	Description
EM03470000 (J8037) Piston ring compressor	<div style="display: flex; justify-content: space-between;"> <div>NT044</div> <div>  </div> <div>Installing piston assembly into cylinder bore</div> </div>
(J36467) Valve oil seal remover	<div style="display: flex; justify-content: space-between;"> <div>NT034</div> <div>  </div> <div>Displacement valve oil seal</div> </div>
ST16610001 (J23907) Pilot bushing puller	<div style="display: flex; justify-content: space-between;"> <div>NT045</div> <div>  </div> <div>Removing crankshaft pilot bushing</div> </div>
KV10111100 (J37228) Seal cutter	<div style="display: flex; justify-content: space-between;"> <div>NT046</div> <div>  </div> <div>Removing oil pan</div> </div>
WS39930000 ( — ) Tube presser	<div style="display: flex; justify-content: space-between;"> <div>NT052</div> <div>  </div> <div>Pressing the tube of liquid gasket</div> </div>
KV10105800 (J25660-C) Chain stopper	<div style="display: flex; justify-content: space-between;"> <div>NT010</div> <div>  </div> <div>Holding the timing chain</div> </div>
KV10112100 (BT8653-A) Angle wrench	<div style="display: flex; justify-content: space-between;"> <div>NT014</div> <div>  </div> <div>Tightening bolts for bearing cap, cylinder head, etc.</div> </div>

# PREPARATION

## Commercial Service Tools

Tool name	Description											
Spark plug wrench	 <p>16 mm (0.63 in)</p> <p>NT047</p> <p>Removing and installing spark plug</p>											
Pulley holder	 <p>NT035</p> <p>Holding camshaft pulley while tightening or loosening camshaft bolt</p>											
Valve seat cutter set	 <p>NT048</p> <p>Finishing valve seat dimensions</p>											
Piston ring expander	 <p>NT030</p> <p>Removing and installing piston ring</p>											
Valve guide drift	 <p>NT015</p> <p>Removing and installing valve guide</p> <table border="1"> <thead> <tr> <th rowspan="2">Diameter</th> <th colspan="2">mm (in)</th> </tr> <tr> <th>Intake</th> <th>Exhaust</th> </tr> </thead> <tbody> <tr> <td>a</td> <td>10.5 (0.413)</td> <td>11.5 (0.453)</td> </tr> <tr> <td>b</td> <td>6.6 (0.260)</td> <td>7.6 (0.299)</td> </tr> </tbody> </table>	Diameter	mm (in)		Intake	Exhaust	a	10.5 (0.413)	11.5 (0.453)	b	6.6 (0.260)	7.6 (0.299)
Diameter	mm (in)											
	Intake	Exhaust										
a	10.5 (0.413)	11.5 (0.453)										
b	6.6 (0.260)	7.6 (0.299)										
Valve guide reamer	 <p>NT016</p> <p>Reaming valve guide ① or hole for oversize valve guide ②</p> <p><b>Intake:</b>  <math>d_1 = 7.0 \text{ mm (0.276 in) dia.}</math>  <math>d_2 = 11.2 \text{ mm (0.441 in) dia.}</math></p> <p><b>Exhaust:</b>  <math>d_1 = 8.0 \text{ mm (0.315 in) dia.}</math>  <math>d_2 = 12.2 \text{ mm (0.480 in) dia.}</math></p>											

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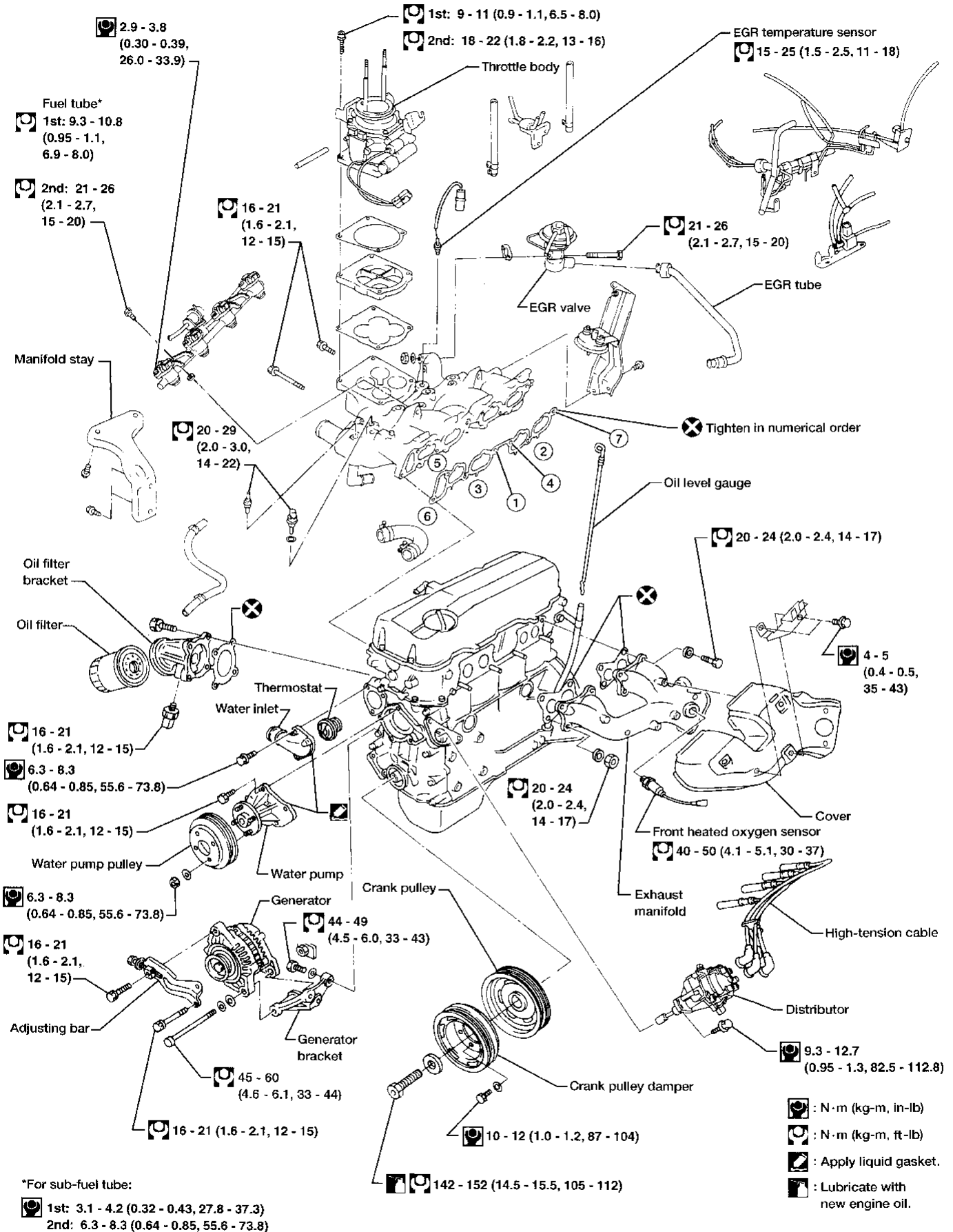
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# OUTER COMPONENT PARTS

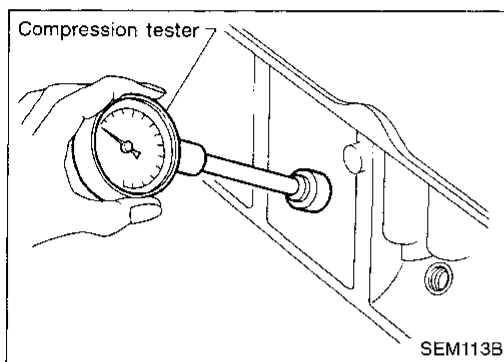
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AEM254

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

**Compression pressure:**

**kPa (kg/cm<sup>2</sup>, psi)/rpm**

**Standard**

**1,324 (13.5, 192)/300**

**Minimum**

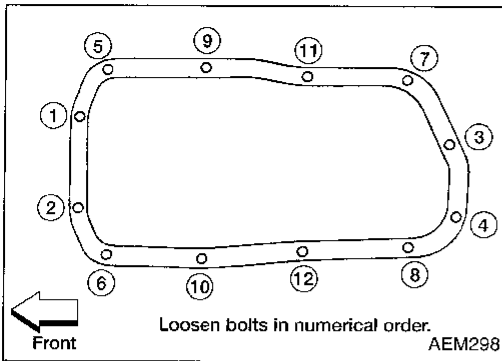
**981 (10, 142)/300**

**Difference limit between cylinders**

**98 (1.0, 14)/300**

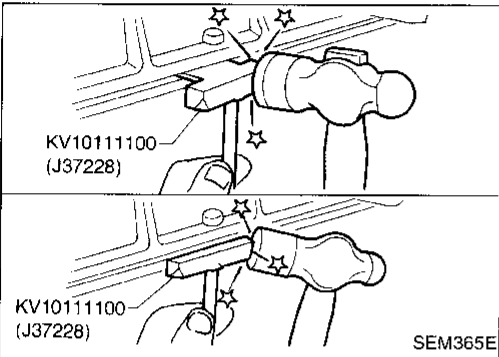
10. If compression in one or more cylinders is low:
  - a. Pour a small amount of engine oil into cylinders through spark plug holes.
  - b. Retest compression.
  - **If adding oil helps compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
  - **If pressure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

# OIL PAN

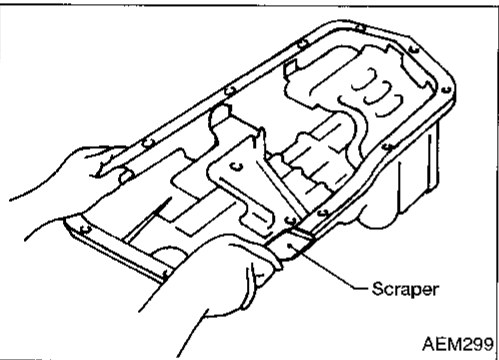


## Removal

1. Raise vehicle and support it with safety stands.
2. Drain engine oil.
3. Remove front stabilizer bar securing bolts and nuts from side member.
4. Lift engine.
5. Remove oil pan bolts.

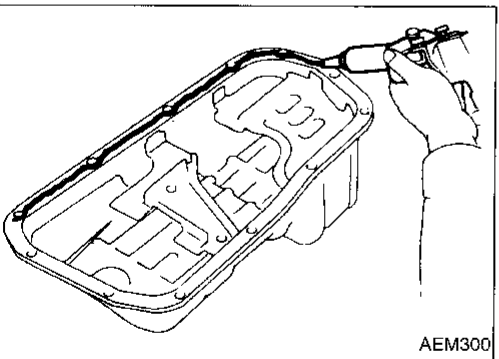


6. Remove oil pan.
  - a. Insert Tool between cylinder block and oil pan.
    - **Be careful not to damage aluminum mating surface.**
    - **Do not insert screwdriver, or oil pan flange will be damaged.**
  - b. Slide Tool by tapping on the side of the Tool with a hammer.
7. Pull out oil pan from front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

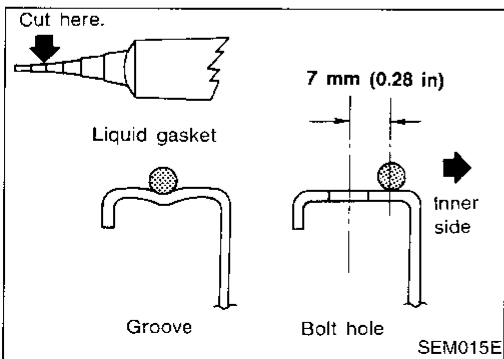


## Installation

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

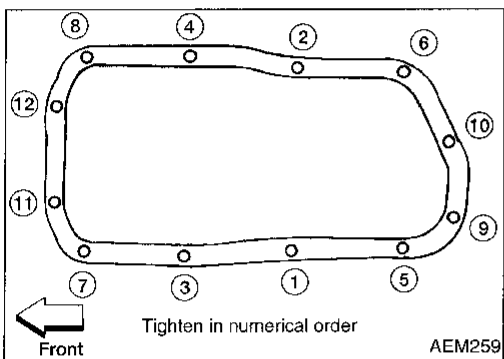
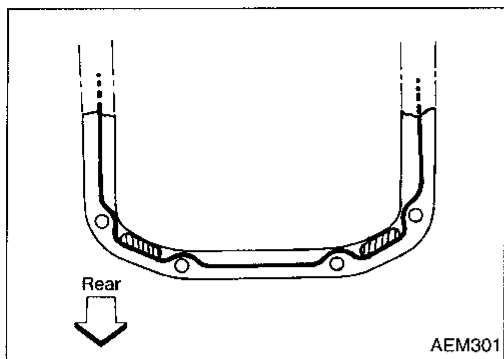


2. Apply a continuous bead of liquid gasket to mating surface of oil pan.
  - **Use Genuine Liquid Gasket or equivalent.**
  - **Apply to groove on mating surface.**
  - **Allow 7 mm (0.28 in) clearance around bolt hole.**



# OIL PAN

## Installation (Cont'd)



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

3. Install oil pan.
- **Tighten oil pan bolts in numerical order.**  
⚙️: 6.3 - 8.3 N·m (0.64 - 0.85 kg-m, 55.6 - 73.8 in-lb)
- **Wait at least 30 minutes before refilling engine oil.**
4. Install parts in reverse order of removal.

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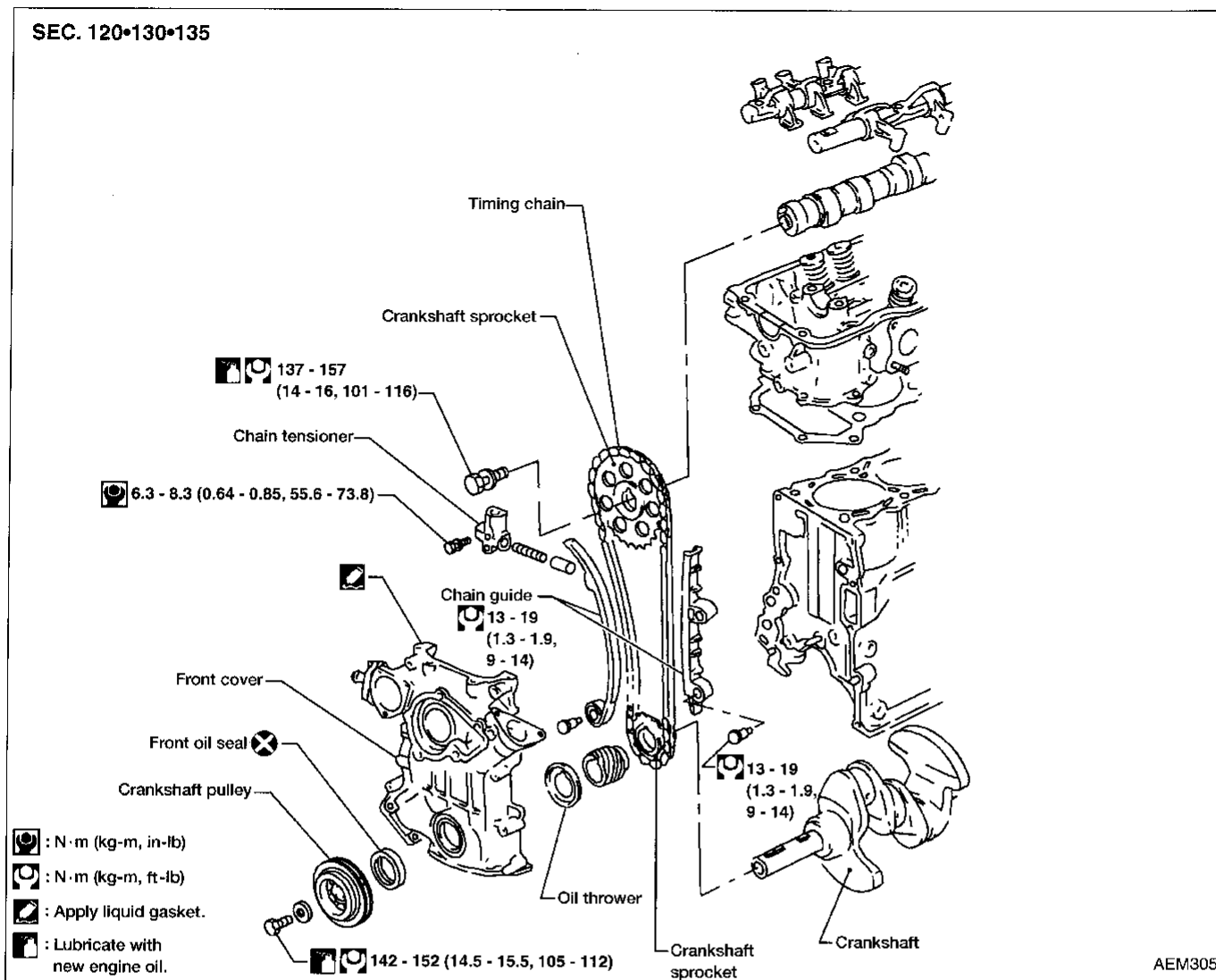
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# TIMING CHAIN

SEC. 120•130•135



## CAUTION:

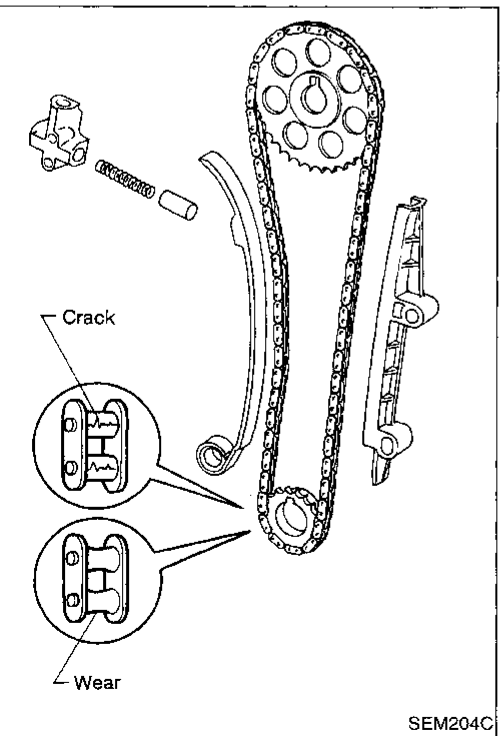
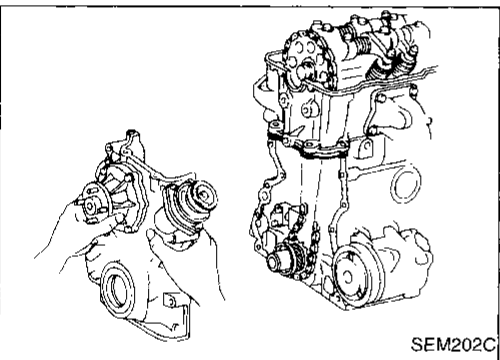
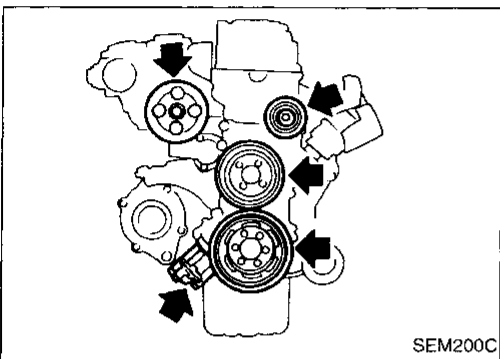
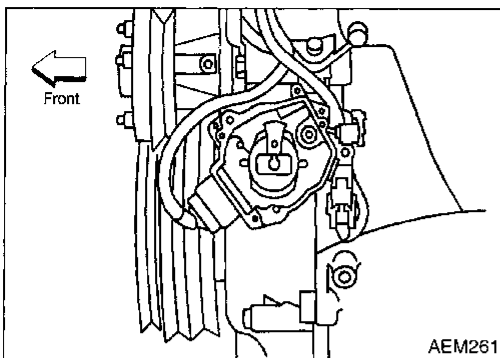
- After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.
- When installing rocker arms, camshafts, chain tensioner, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.
- Apply new engine oil to bolt threads and seat surfaces when installing cylinder head, camshaft sprockets, crankshaft pulley, and camshaft brackets.

## Removal

1. Disconnect battery terminal.
2. Drain coolant from radiator.
3. Remove radiator shroud and cooling fan.
4. Remove the following belts.
  - Power steering drive belt
  - Compressor drive belt
  - Generator drive belt

## TIMING CHAIN

### Removal (Cont'd)



5. Remove all spark plugs.
6. Set No. 1 piston at TDC on its compression stroke.

7. Remove the following parts.
  - Power steering pump, idler pulley and power steering pump brackets
  - Compressor idler pulley
  - Crankshaft pulley with a suitable puller
  - Oil pump with pump drive spindle
  - Rocker cover

8. Remove oil pan. (Refer to OIL PAN, EM-9.)
9. Remove front cover.
  - Inspect for oil leakage at front oil seal. Replace seal if oil leak is present.

10. Remove the following parts.
  - **For retiming during cylinder head removal/installation, apply paint mark to timing chain at mating mark of camshaft sprocket.**
  - Chain tensioner
  - Chain guides
  - Timing chain and camshaft sprocket
  - Oil thrower, oil pump drive gear and crankshaft sprocket

### Inspection

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

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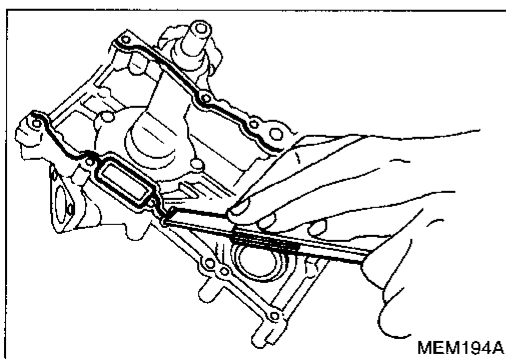
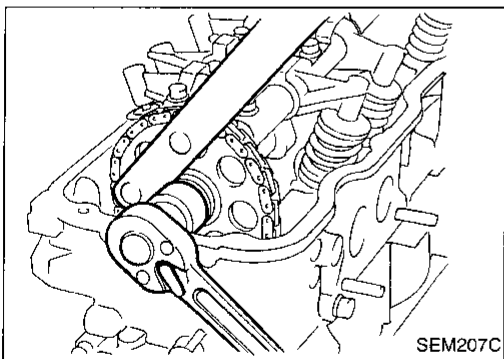
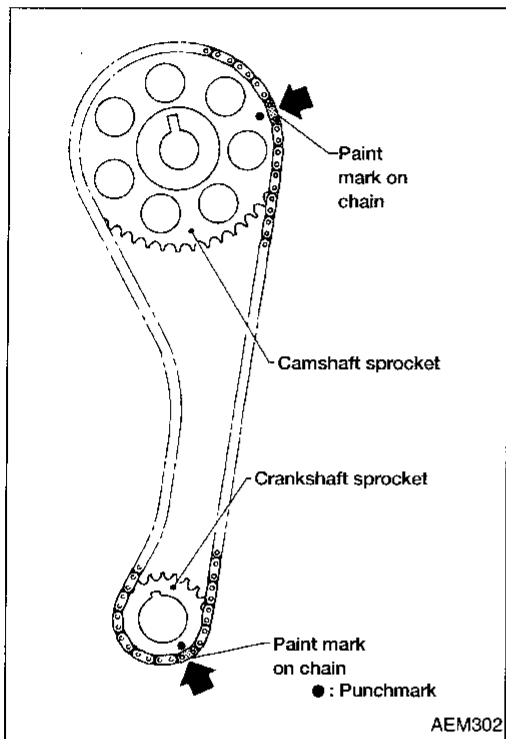
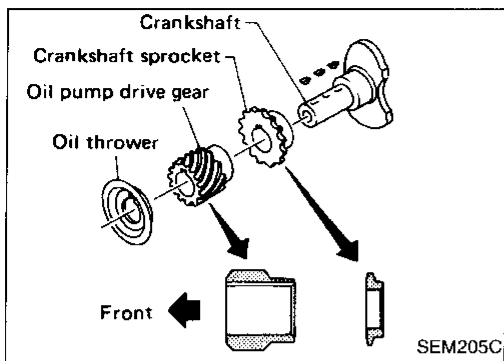
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## TIMING CHAIN



### Installation

1. Install crankshaft sprocket, oil pump drive gear and oil thrower.

- **Make sure that mating marks on crankshaft sprocket face front of engine.**

2. Install camshaft sprocket.

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

4. Install timing chain.

- **Set timing chain by aligning paint marks with mating marks of crankshaft sprocket and camshaft sprocket.**

5. Tighten camshaft sprocket bolt.

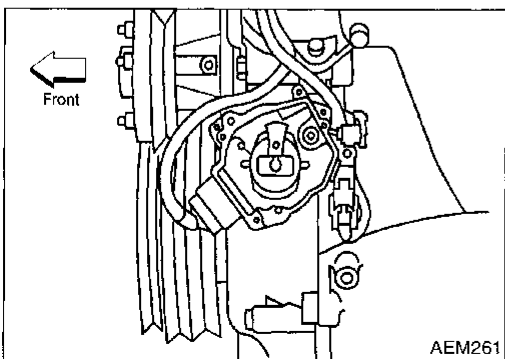
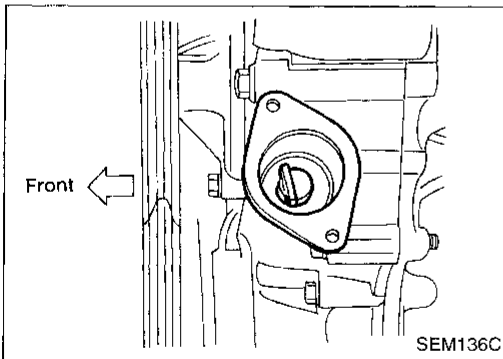
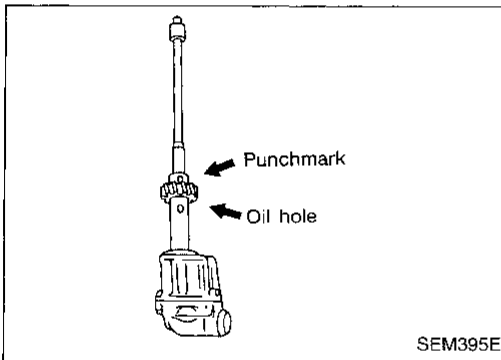
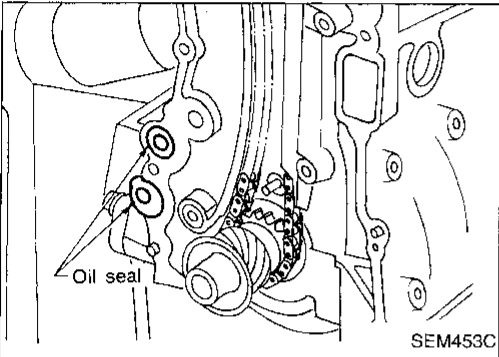
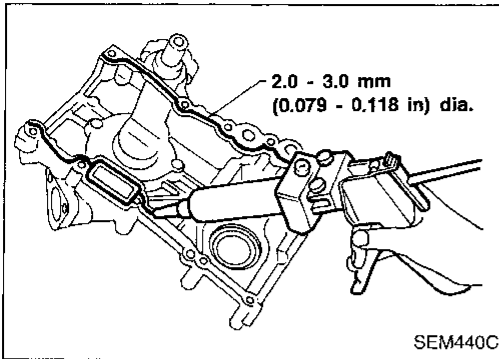
6. Install chain guide and chain tensioner.

7. Use a scraper to remove old liquid gasket from mating surface of front cover.

- **Also remove traces of liquid gasket from mating surface of cylinder block.**

# TIMING CHAIN

## Installation (Cont'd)



8. Apply a continuous bead of liquid gasket to front cover.
  - Use Genuine Liquid Gasket or equivalent.
  - Be sure to install new front oil seal in the right direction. Refer to EM-14.
9. Apply lithium grease to sealing lip of crankshaft oil seal.

10. Install front cover.
  - Be careful not to damage cylinder head gasket.
  - Be careful not to damage front oil seal when installing front cover.
11. Install new rubber plug. (Refer to "Installation", CYLINDER HEAD, EM-27.)
12. Install oil pan. (Refer to OIL PAN, EM-9.)

13. Install oil pump and distributor driving spindle with new gasket in front cover.
  - a. Assemble oil pump and driving spindle, aligning punchmark on driving spindle with oil hole.

- b. Make sure that driving spindle is set as shown in figure.

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

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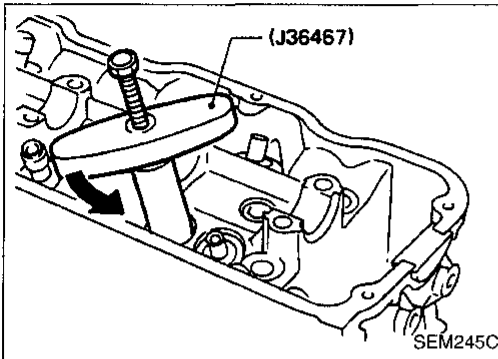
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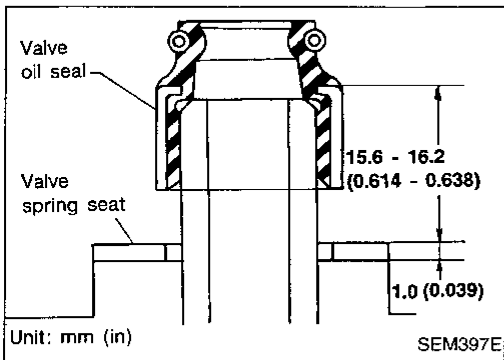
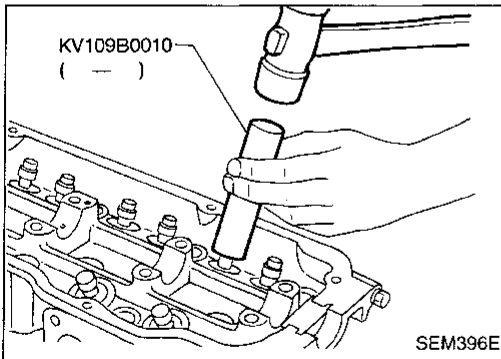
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# OIL SEAL REPLACEMENT



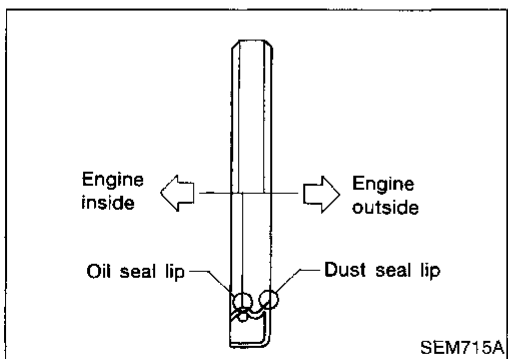
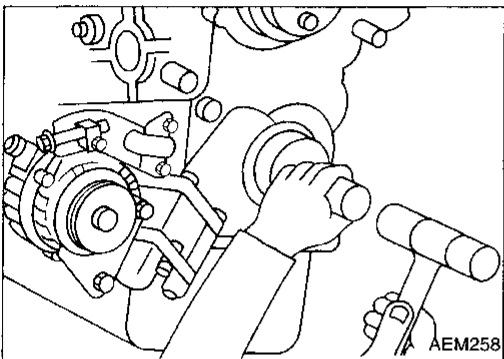
## Valve Oil Seal

1. Remove rocker cover.
2. Remove rocker shaft assembly. (Refer to "Disassembly", CYLINDER HEAD, EM-19.)
3. Remove valve spring and valve oil seal with Tool or 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.
  - **Before installing valve oil seal, install valve spring seat.**

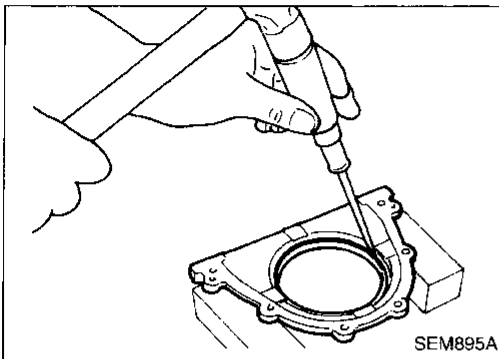


## Front Oil Seal

1. Remove radiator shroud and crankshaft pulley.
2. Remove front oil seal.
  - **Be careful not to scratch front cover.**
3. Apply engine oil to new oil seal and install it using suitable tool.
  - **Install new oil seal in the direction shown.**

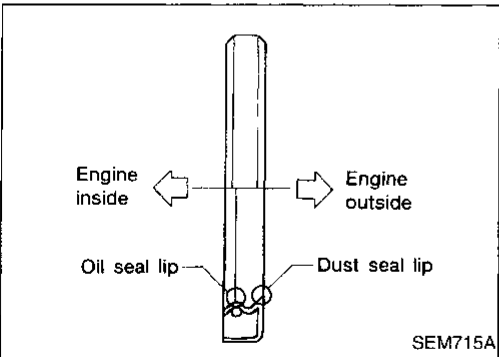


# OIL SEAL REPLACEMENT

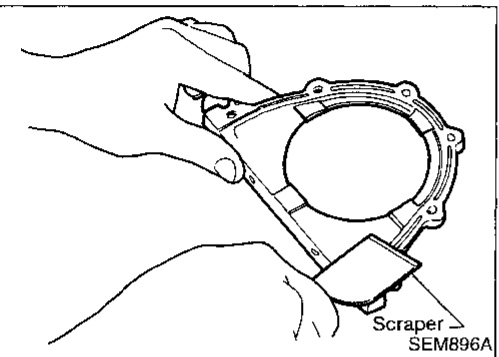
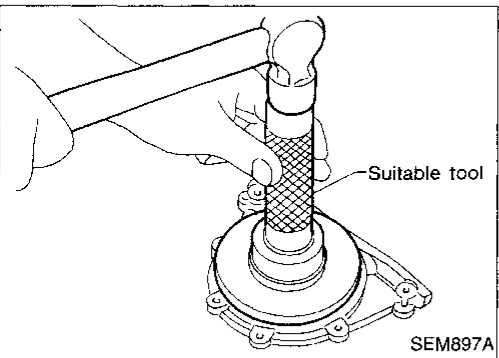


## Rear Oil Seal

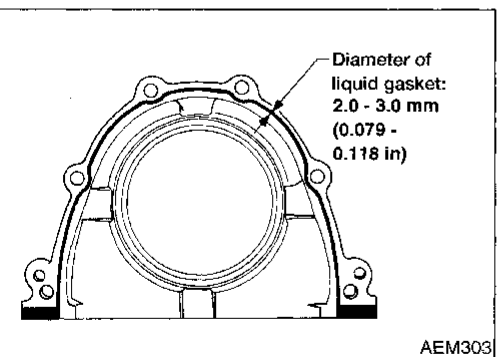
1. Remove flywheel or drive plate.
  2. Remove rear oil seal retainer.
  3. Remove rear oil seal from retainer.
- **Be careful not to scratch rear oil seal retainer.**



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



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



- b. Apply a continuous bead of liquid gasket to mating surface of rear oil seal retainer.
- **Use Genuine Liquid Gasket or equivalent.**
  - **Apply around inner side of bolt holes.**

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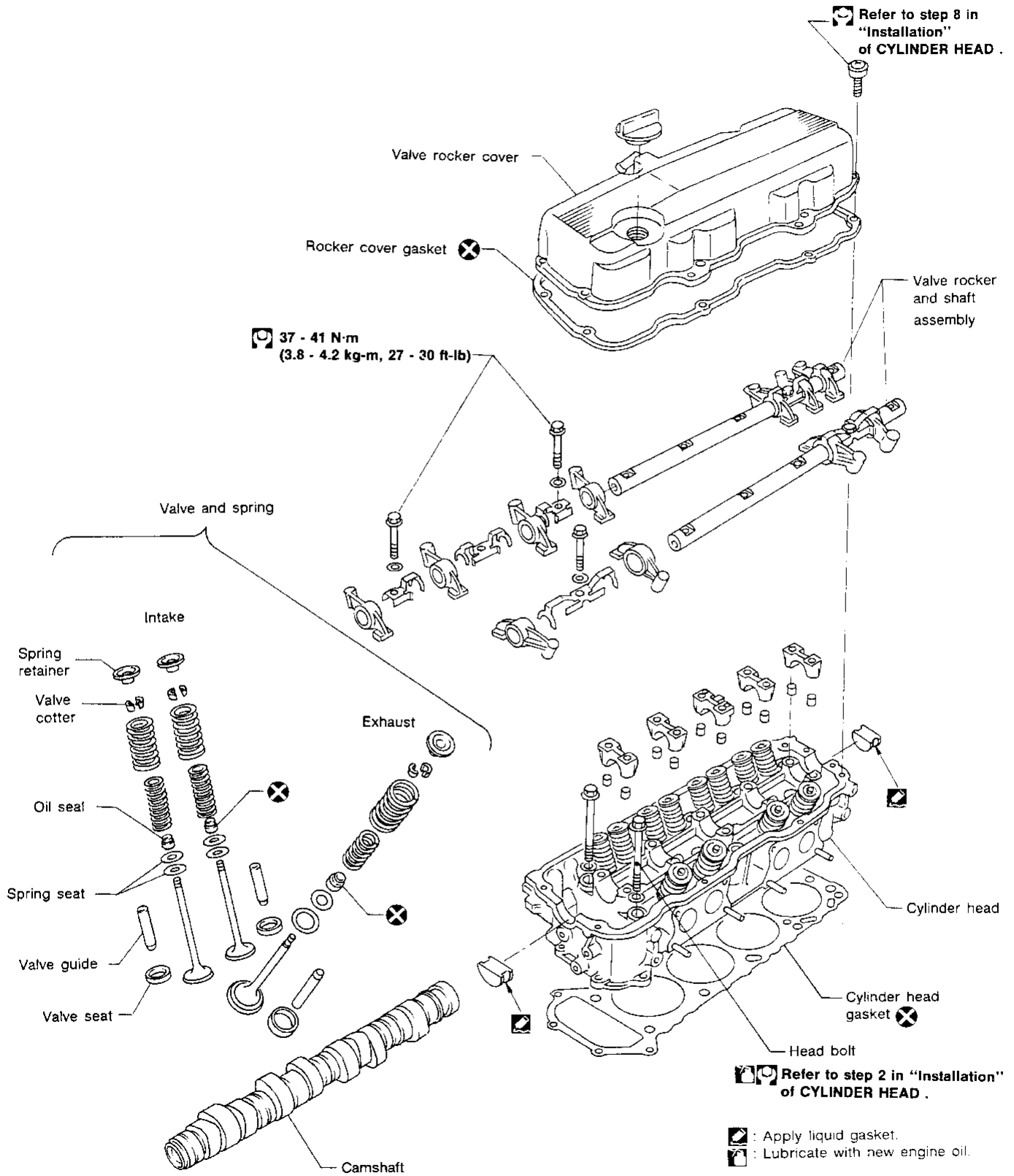
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# CYLINDER HEAD

SEC. 111-130



# CYLINDER HEAD

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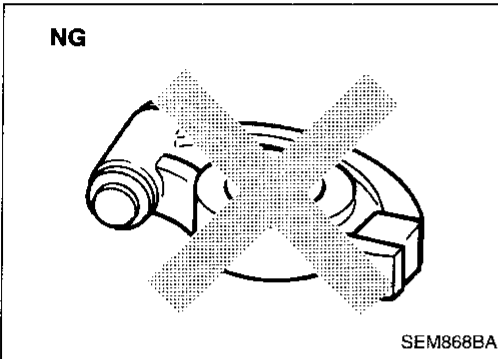
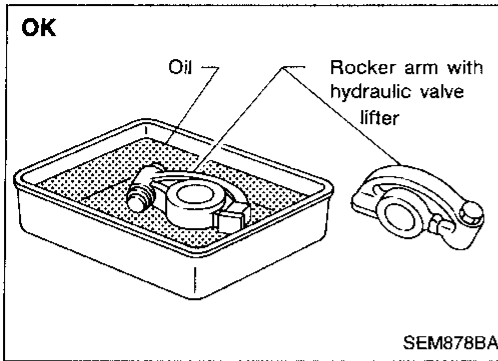
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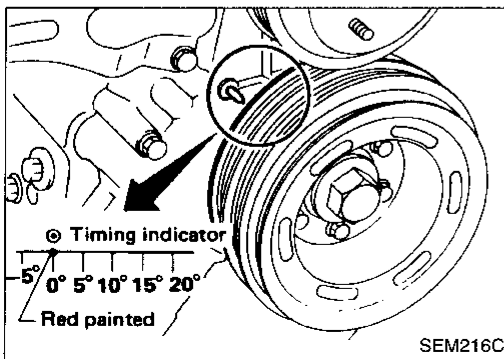


## CAUTION:

- When installing rocker arms, camshaft and oil seal, lubricate contacting surfaces with new engine oil.
- When tightening cylinder head bolts and rocker shaft bolts, lubricate bolt threads and seat surfaces with new engine oil.
- Hydraulic valve lifters are installed in each rocker arm. If hydraulic valve lifter is kept on its side, even when installed in rocker arm, there is a risk of air entering it. When rocker arms are removed, stand them straight up or soak them in new engine oil.
- Do not disassemble hydraulic valve lifter.
- Attach tags to valve lifters so as not to mix them up.

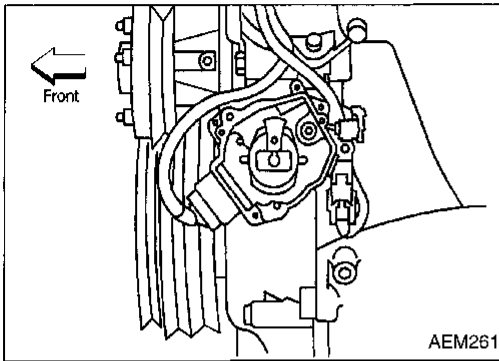
## Removal

1. Release fuel pressure. Refer to EC section ("Fuel Pressure Release", "BASIC SERVICE PROCEDURE").
2. Drain coolant from radiator and drain plug of block.
3. Remove the following parts.
  - Power steering drive belt
  - Power steering pump, idler pulley and power steering brackets
  - Vacuum hoses of swirl control valve and pressure control solenoid valve
  - Accelerator wire bracket
4. Disconnect EGR tube from exhaust manifold.
5. Remove bolts which hold intake manifold collector to intake manifold.
6. Remove bolts which hold intake manifold to cylinder head while raising collector upwards.
7. Remove rocker cover.
  - When removing rocker cover, do not hit rocker cover against rocker arm.
8. Set No. 1 piston at TDC on its compression stroke.

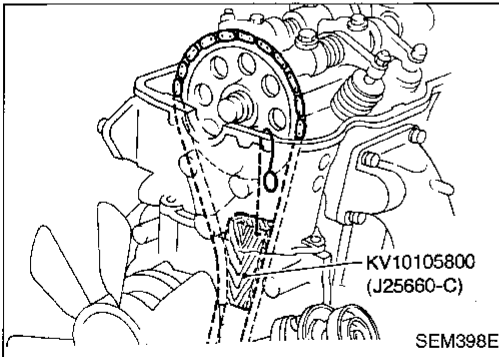


## CYLINDER HEAD

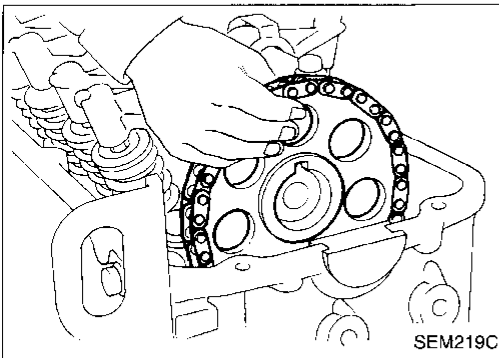
### Removal (Cont'd)



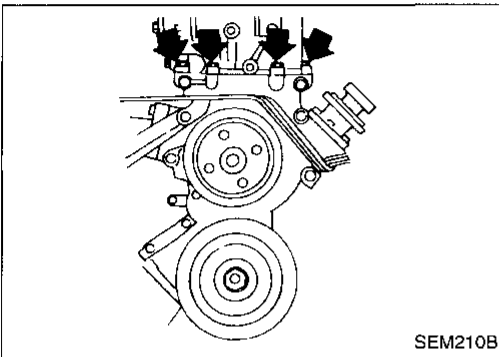
- Make sure No. 1 cylinder is at TDC by looking at the distributor rotor position.



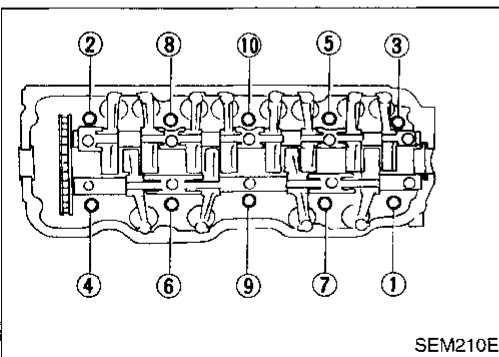
9. Loosen camshaft sprocket bolt.
- Support timing chain by using Tool as shown in figure.



10. Remove camshaft sprocket.
- For retiming during installation, apply paint marks to timing chain at mating marks of crankshaft sprocket and camshaft sprocket.

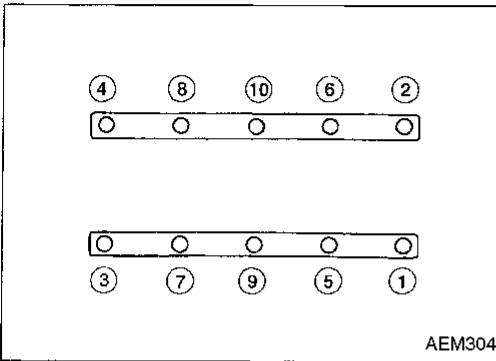


11. Remove front timing cover to cylinder head bolts.



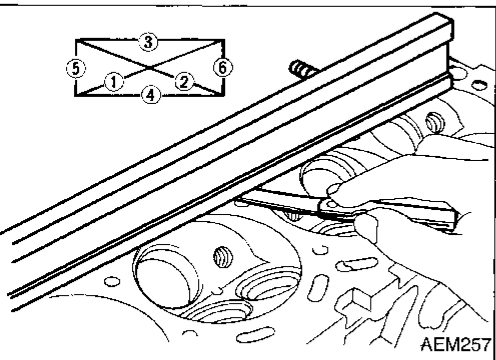
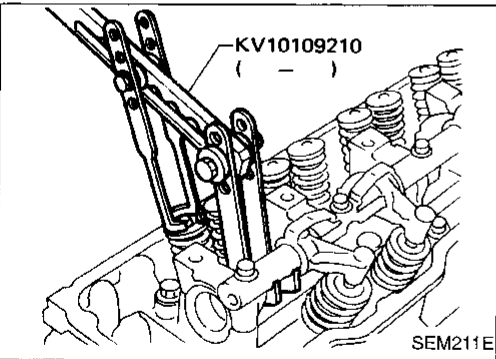
12. Remove cylinder head.
- Loosen in numerical order.
  - A warped or cracked cylinder head could result from removing in incorrect order.
  - Loosen cylinder head bolts in two or three steps.

# CYLINDER HEAD



## Disassembly

1. Remove rocker shaft assembly.
  - a. **When loosening bolts, evenly loosen as shown in figure at left.**
  - b. **Bolts should be loosened in two or three steps.**
2. Remove camshaft.
  - **Before removing camshaft, measure camshaft end play. (Refer to "Inspection".)**
3. Remove valve components with Tool.
4. Remove valve oil seals. (Refer to OIL SEAL REPLACEMENT, EM-14.)



## 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 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 or resurface.

#### Resurfacing limit:

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

**Amount of cylinder head resurfacing is "A"**

**Amount of cylinder block resurfacing is "B"**

**The maximum limit is as follows:**

**A + B = 0.2 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:**

**98.8 - 99.0 mm (3.890 - 3.898 in)**

### CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.

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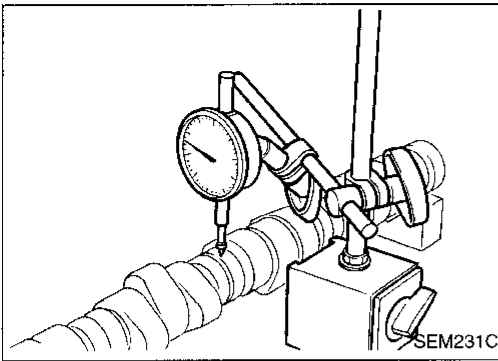
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## CYLINDER HEAD

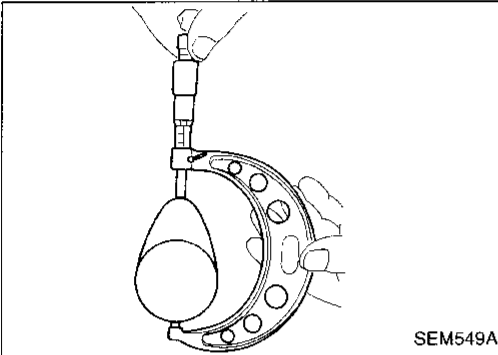
### Inspection (Cont'd)

#### CAMSHAFT RUNOUT



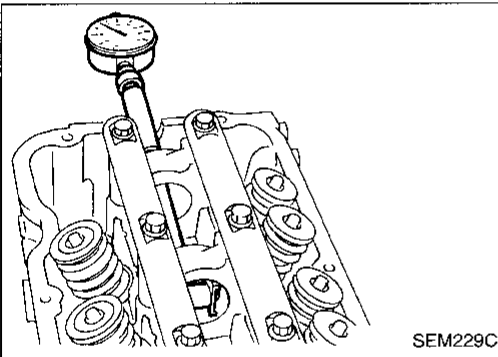
1. Measure camshaft runout at the center journal.  
**Runout (Total indicator reading):**  
**0 - 0.02 mm (0 - 0.0008 in)**
2. If it exceeds the limit, replace camshaft.

#### CAMSHAFT CAM HEIGHT

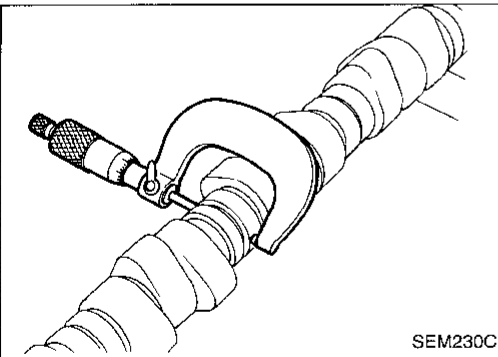


1. Measure camshaft cam height.  
**Standard cam height:**  
**44.43 - 44.58 mm (1.7492 - 1.7551 in)**  
**Cam height wear limit:**  
**0.2 mm (0.008 in)**
2. If wear is beyond the limit, replace camshaft.

#### CAMSHAFT JOURNAL CLEARANCE

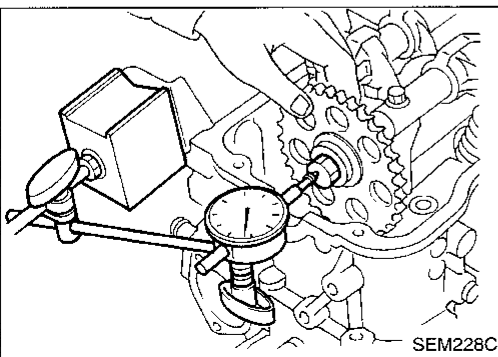


1. Install camshaft bracket and rocker shaft and tighten bolts to the specified torque.
2. Measure inner diameter of camshaft bearing.  
**Standard inner diameter:**  
**33.000 - 33.025 mm (1.2992 - 1.3002 in)**



3. Measure outer diameter of camshaft journal.  
**Standard outer diameter:**  
**32.935 - 32.955 mm (1.2967 - 1.2974 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

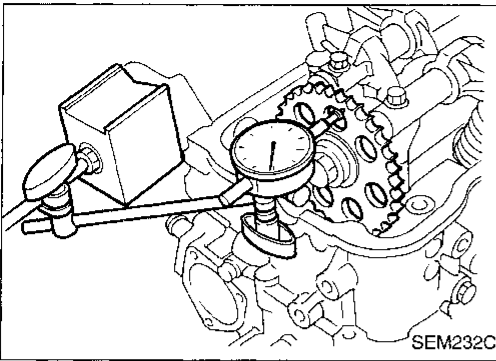


1. Install camshaft in cylinder head.
2. Measure camshaft end play.  
**Camshaft end play:**  
**Standard**  
**0.07 - 0.15 mm (0.0028 - 0.0059 in)**  
**Limit**  
**0.2 mm (0.008 in)**
3. If end play exceeds the limit, replace camshaft and remeasure camshaft end play.
  - If end play still exceeds the limit after replacing camshaft, replace cylinder head.

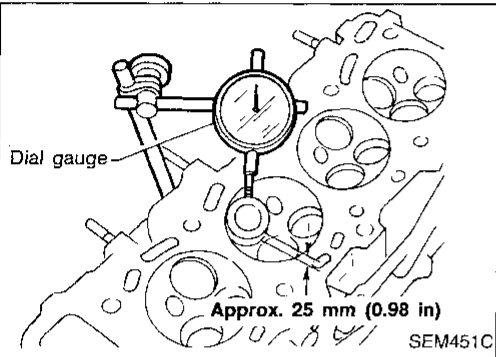
## CYLINDER HEAD

### Inspection (Cont'd)

#### CAMSHAFT SPROCKET RUNOUT

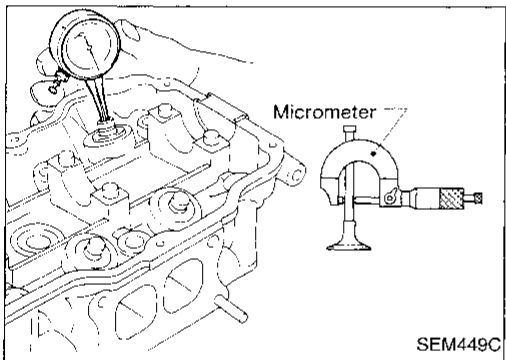


1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.  
**Runout (Total indicator reading):  
Limit 0.12 mm (0.0047 in)**
3. If it exceeds the limit, replace camshaft sprocket.



#### VALVE GUIDE CLEARANCE

1. Measure valve deflection as shown in illustration. (Valve and valve guide wear the most in this direction.)  
**Valve deflection limit (Dial gauge reading):  
0.15 mm (0.0059 in)**

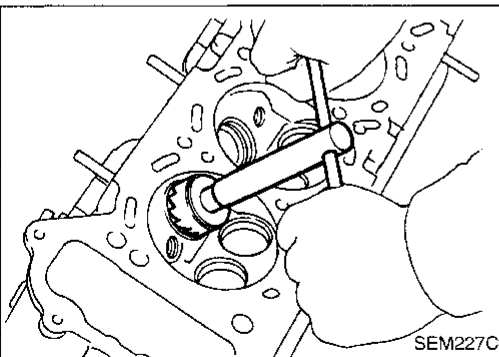
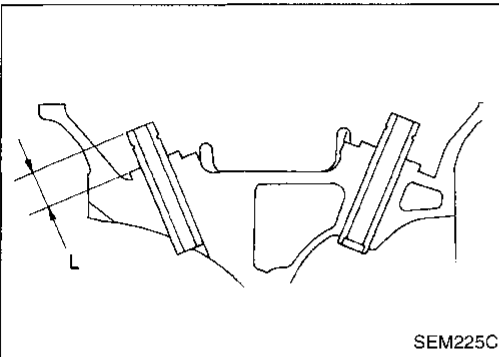
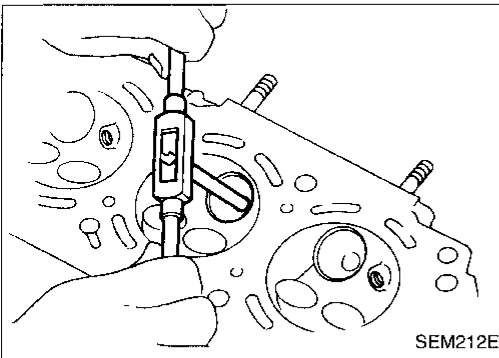
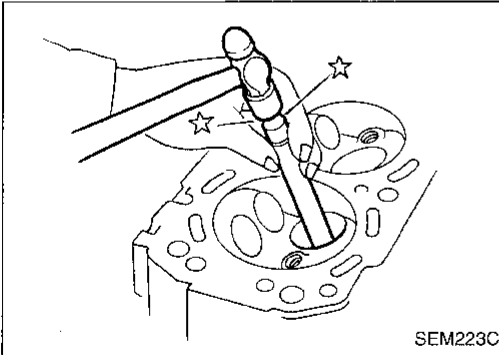
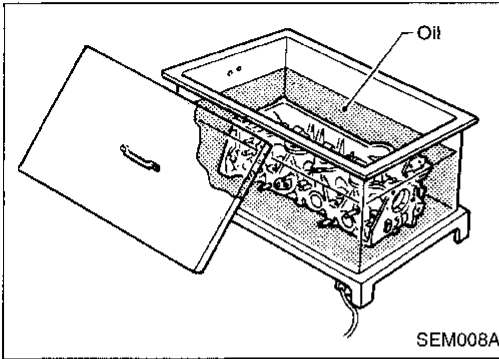


2. If it exceeds the limit, check valve to valve guide clearance.
  - a. Measure valve stem diameter and valve guide inner diameter.
  - b. Check that clearance is within specification.  
**Valve to valve guide clearance = valve guide inner diameter – valve stem diameter:**  
**Standard**  
**Intake**  
**0.020 - 0.053 mm (0.0008 - 0.0021 in)**  
**Exhaust**  
**0.040 - 0.070 mm (0.0016 - 0.0028 in)**  
**Limit 0.1 mm (0.004 in)**
- c. If it exceeds the limit, replace valve and remeasure clearance.
  - If clearance still exceeds the limit after replacing valve, replace the valve guide.

## CYLINDER HEAD

### Inspection (Cont'd)

#### VALVE GUIDE REPLACEMENT



1. To remove valve guide, heat cylinder head to 150 to 160°C (302 to 320°F).

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

3. Ream cylinder head valve guide hole.

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

**Intake**

11.175 - 11.196 mm (0.4400 - 0.4408 in)

**Exhaust**

12.175 - 12.196 mm (0.4793 - 0.4802 in)

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

**Projection "L":**

14.9 - 15.1 mm (0.587 - 0.594 in)

5. Ream valve guide.

**Finished size:**

**Intake**

7.000 - 7.018 mm (0.2756 - 0.2763 in)

**Exhaust**

8.000 - 8.018 mm (0.3150 - 0.3157 in)

#### VALVE SEATS

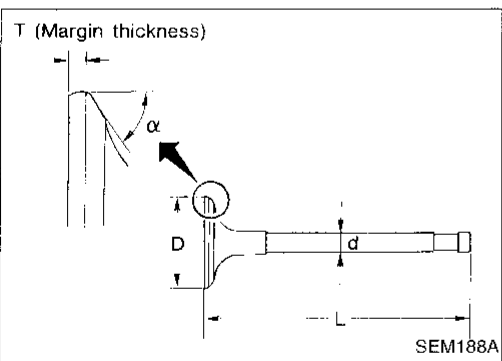
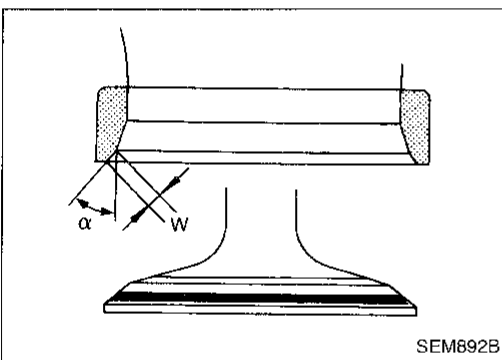
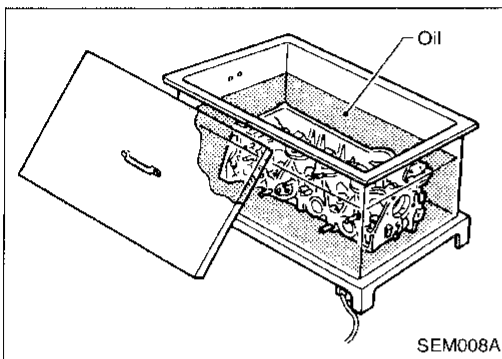
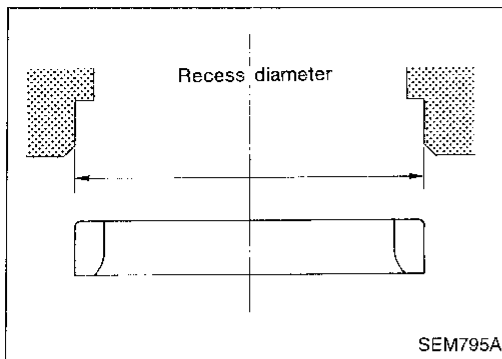
Check valve seats for pitting at contact surface. Resurface or replace if excessively worn.

- 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.

# CYLINDER HEAD

## Inspection (Cont'd)

### REPLACING VALVE SEAT FOR SERVICE PARTS



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

2. Ream cylinder head recess.

**Reaming bore for service valve seat**

**Oversize [0.5 mm (0.020 in)]:**

**Intake 36.500 - 36.516 mm (1.4370 - 1.4376 in)**

**Exhaust 42.500 - 42.516 mm (1.6732 - 1.6739 in)**

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

3. Heat cylinder head to 150 to 160°C (302 to 320°F).

4. Press fit valve seat until it seats on the bottom.

5. Cut or grind valve seat using suitable tool of the specified dimensions. Refer to SDS, EM-43.

6. After cutting, lap valve seat with abrasive compound.

7. Check valve seating condition.

**Seat face angle " $\alpha$ ":**

**45 deg.**

**Contacting width "W":**

**Intake**

**1.6 - 1.7 mm (0.063 - 0.067 in)**

**Exhaust**

**1.7 - 2.1 mm (0.067 - 0.083 in)**

### VALVE DIMENSIONS

Check dimensions of each valve. Refer to SDS, EM-44.

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.**

## CYLINDER HEAD

### Inspection (Cont'd)

#### VALVE SPRING

##### Squareness

1. Measure dimension "S".

##### Out-of-square "S":

###### Outer

Intake Less than 2.5 mm (0.098 in)

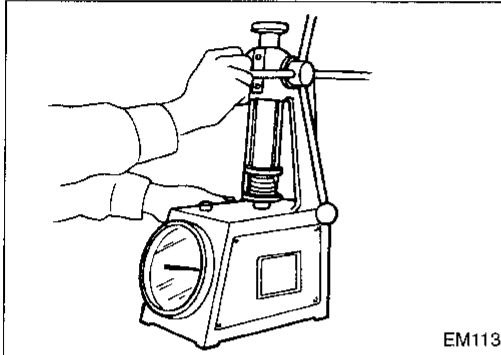
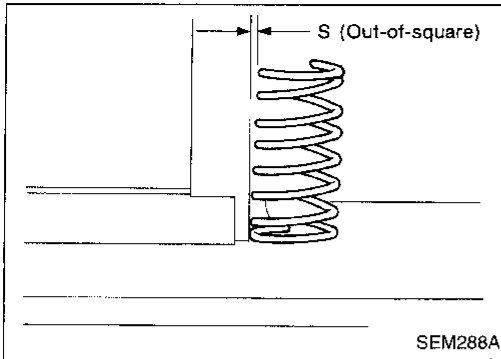
Exhaust Less than 2.3 mm (0.091 in)

###### Inner

Intake Less than 2.3 mm (0.091 in)

Exhaust Less than 2.1 mm (0.083 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

###### Outer

Intake 604.1 (61.6, 135.8) at 37.6 (1.480)

Exhaust 640.4 (65.3, 144.0) at 34.1 (1.343)

###### Inner

Intake 284.4 (29.0, 63.9) at 32.6 (1.283)

Exhaust 328.5 (33.5, 73.9) at 29.1 (1.146)

###### Limit

###### Outer

Intake 567.8 (57.9, 127.7) at 37.6 (1.480)

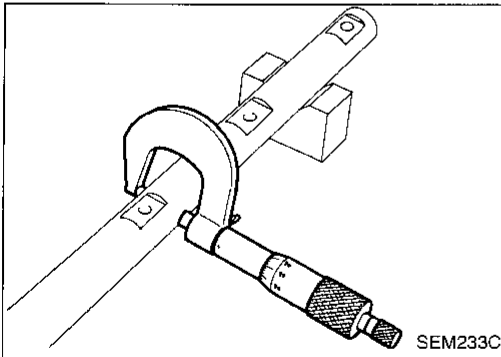
Exhaust 620.8 (63.3, 139.6) at 34.1 (1.343)

###### Inner

Intake 266.8 (27.2, 60.0) at 32.6 (1.283)

Exhaust 318.7 (32.5, 71.7) at 29.1 (1.146)

If it exceeds the limit, replace spring.

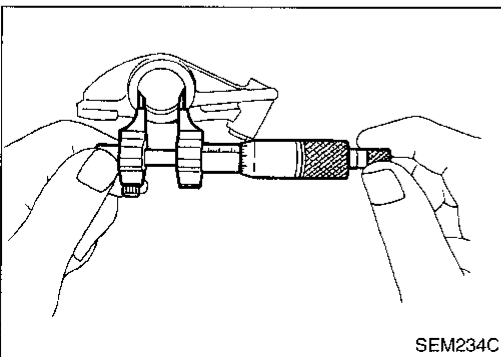


#### ROCKER SHAFT AND ROCKER ARM

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

##### Diameter:

21.979 - 22.000 mm (0.8653 - 0.8661 in)



3. Check inner diameter of rocker arm.

##### Diameter:

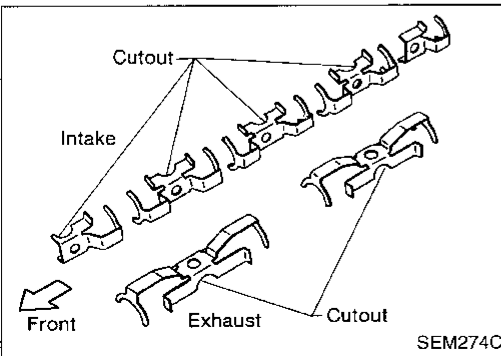
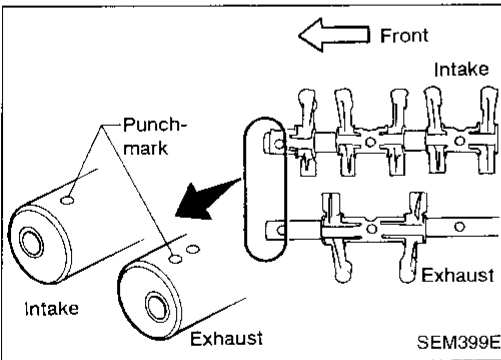
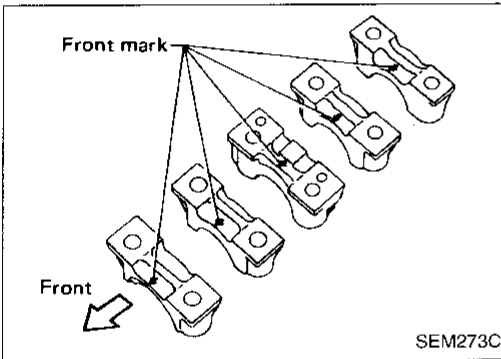
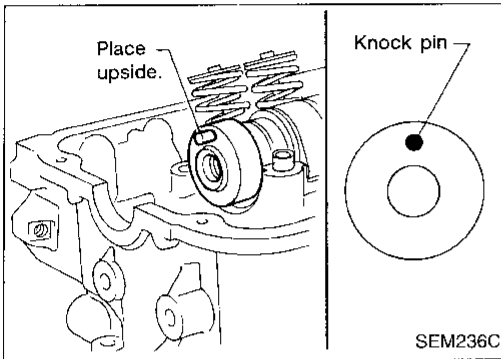
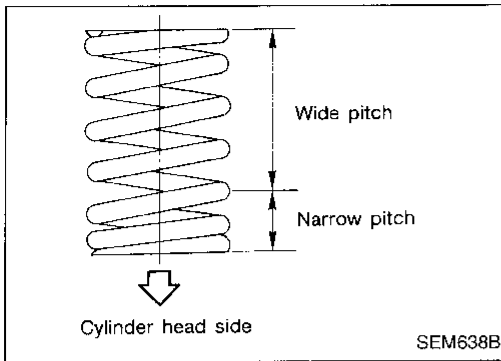
22.012 - 22.029 mm (0.8666 - 0.8673 in)

##### Rocker arm to shaft clearance:

0.012 - 0.050 mm (0.0005 - 0.0020 in)

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

# CYLINDER HEAD



## Assembly

1. Install valve component parts.
  - **Always use new valve oil seal. Refer to OIL SEAL REPLACEMENT.**
  - **Before installing valve oil seal, install inner valve spring seat.**
  - **Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.**
  - **After installing valve component parts, use plastic hammer to lightly tap valve stem tip to assure a proper fit.**
2. Install camshaft, placing knock pin towards front of engine and in the top position.
  - **Apply engine oil to camshaft when mounting onto cylinder head.**
3. Install camshaft brackets.
  - **Front mark is punched on the camshaft brackets.**
4. Install rocker shaft with rocker arms.
  - **Install retainer with cutout facing direction shown in figure at left.**

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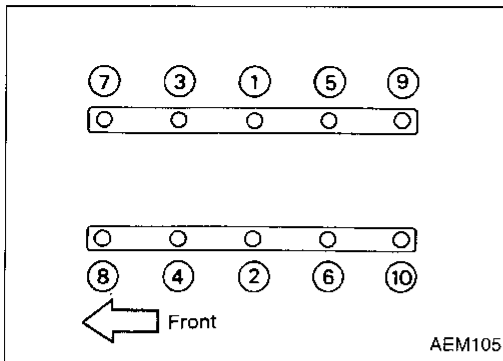
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## CYLINDER HEAD

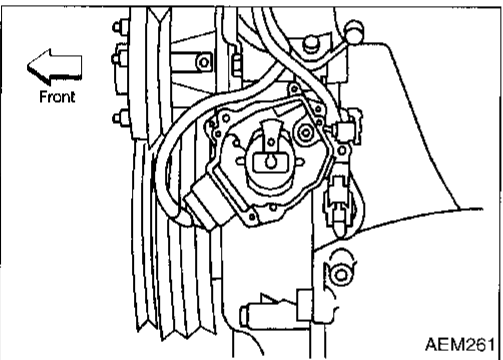
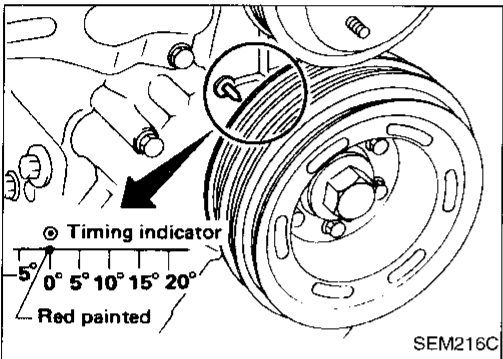
### Assembly (Cont'd)

5. Tighten bolts as shown in figure at left.

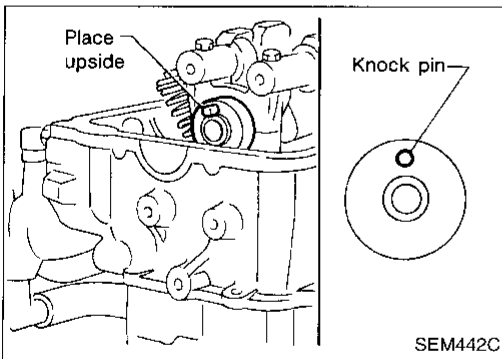


### Installation

1. Set No. 1 piston at TDC on its compression stroke as follows:
  - a. Align mark on crankshaft pulley with "0" position and confirm that distributor rotor head is set as shown in figure.



- b. Confirm that knock pin on camshaft is set at the top.

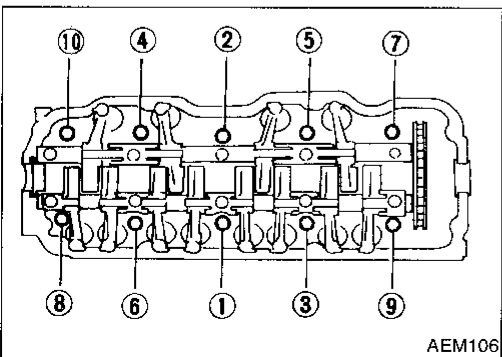


2. Install cylinder head with new gasket and tighten cylinder head bolts in numerical order.

- Do not rotate crankshaft and camshaft separately, or valves will hit piston heads.

- Tightening procedure

- a. Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
- b. Tighten all bolts to 78 N·m (8.0 kg-m, 58 ft-lb).
- c. Loosen all bolts completely.
- d. Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
- e. Turn all bolts  $80^{+5}_{-0}$  degrees clockwise with an angle wrench. If an angle wrench is not available, tighten all bolts to 74 to 83 N·m (7.5 to 8.5 kg-m, 54 to 61 ft-lb).



# CYLINDER HEAD

## Installation (Cont'd)

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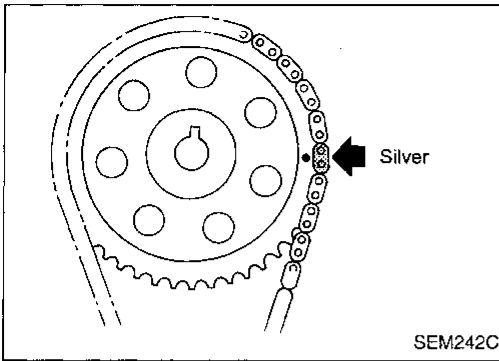
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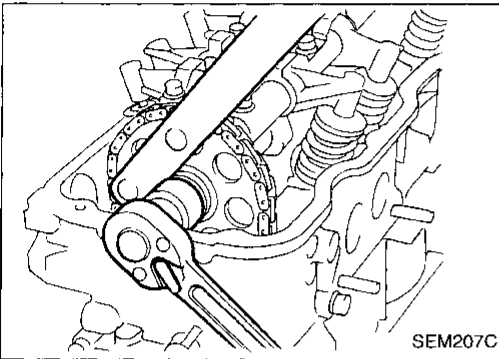
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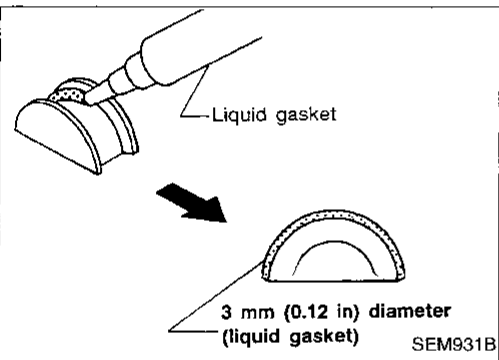
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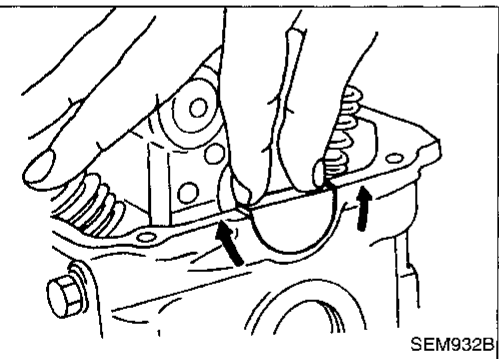
3. Set chain on camshaft sprocket by aligning each mating mark. Then install camshaft sprocket to camshaft.



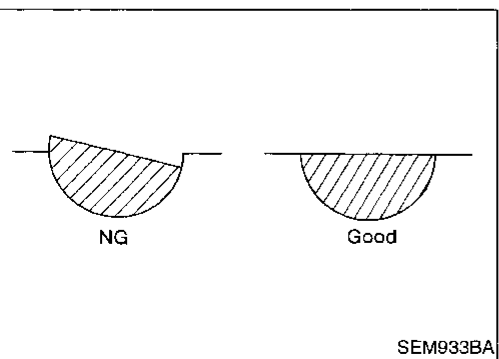
4. Tighten camshaft sprocket bolt.



5. Install rubber plugs as follows:
- a. Apply liquid gasket to rubber plugs.
    - Rubber plugs should be replaced with new ones.
    - Rubber plugs should be installed within 5 minutes of applying liquid gasket.

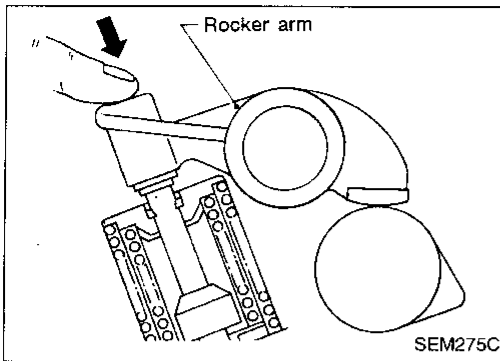


- b. Install rubber plugs, then move them with your fingers to uniformly spread the gasket on cylinder head surface.
  - Rubber plugs should be installed flush with the surface.
  - Do not start the engine for 30 minutes after installing rocker cover.
  - Wipe away excessive liquid gasket from cylinder head top surface.

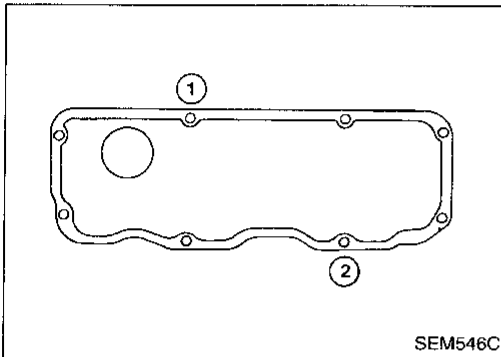


## CYLINDER HEAD

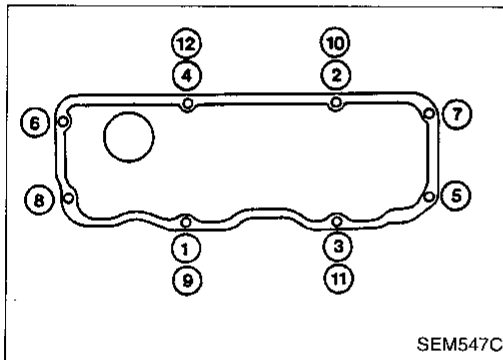
### Installation (Cont'd)



6. Check hydraulic valve lifter.
  - a. Push hydraulic valve lifter forcefully with your finger.
    - **Be sure to check it with rocker arm in its free position.**
  - b. If valve lifter moves more than 1 mm (0.04 in), air may be inside of it.
  - c. Bleed air off by running engine at 1,000 rpm under no load for about 20 minutes.
  - d. If hydraulic valve lifters are still noisy, replace them and bleed air off again in the same manner as in step c.



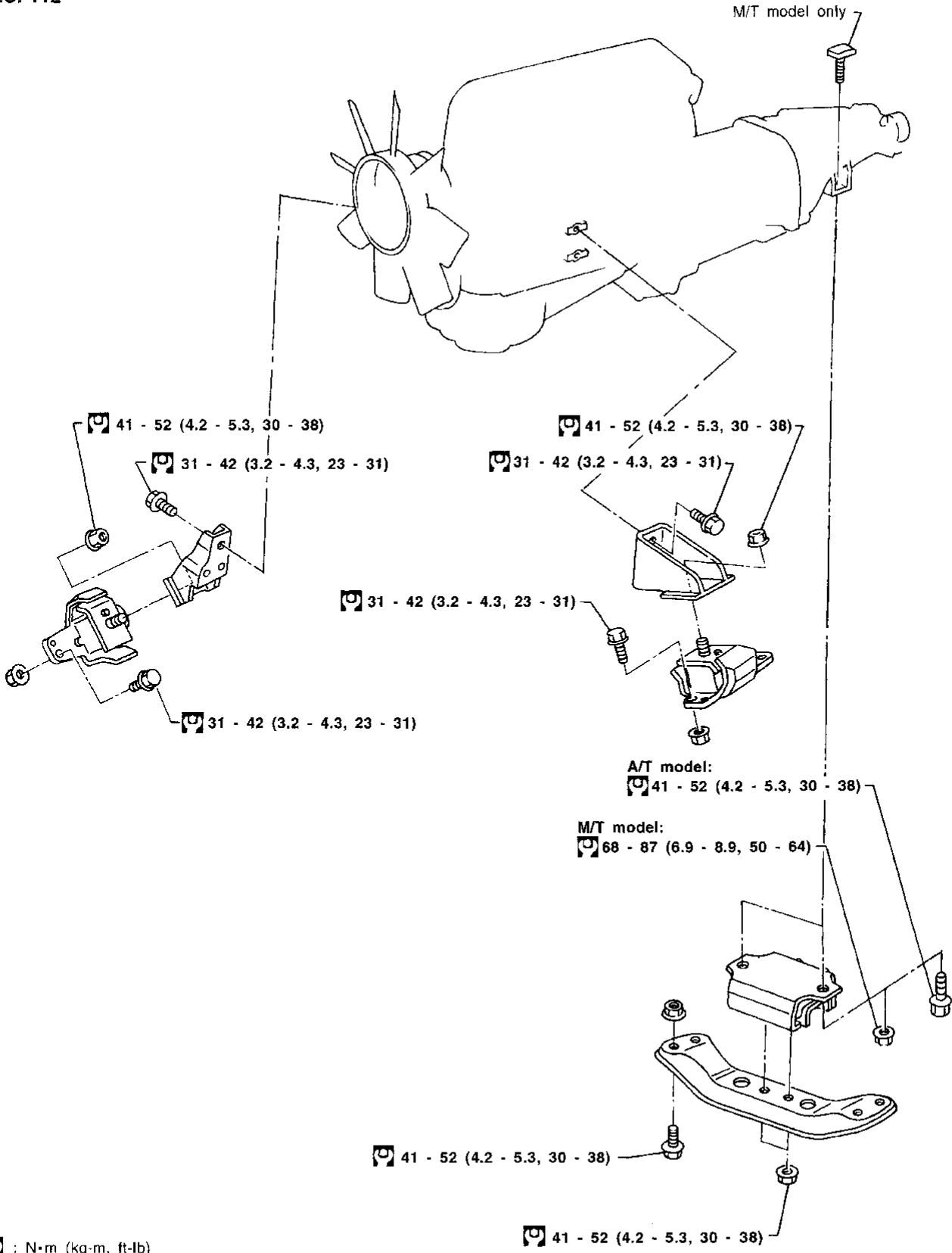
7. Install rocker cover.
  - **Be sure to avoid interference between rocker cover and rocker arm.**
8. Tighten bolts as follows:
  - a. Tighten two bolts to 3 N·m (0.3 kg-m, 26 in-lb) temporarily in order shown in figure.





- b. Then tighten bolts to 7 to 11 N·m (0.7 to 1.1 kg-m, 61 to 95 in-lb) in order shown in figure.
  9. Install any parts removed.

# ENGINE REMOVAL

SEC. 112



 : N·m (kg-m, ft-lb)

 41 - 52 (4.2 - 5.3, 30 - 38)

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## ENGINE REMOVAL

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### WARNING:

- Position vehicle on a flat and solid surface.
- Place chocks at front and back of rear wheels.
- Do not remove engine until exhaust system has completely cooled off.  
Otherwise, you may burn yourself and/or fire may break out in fuel line.
- Before disconnecting fuel hose, release fuel pressure. Refer to EC 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 sure to clear surrounding parts. Take special care near accelerator wire casing, brake lines and brake master cylinder.
- In hoisting the engine, always use engine slingers in a safe manner.
- Before separating engine and transmission, remove the crankshaft position sensor (OBD) from the assembly.
- Always take extra care not to damage edge of crankshaft position sensor (OBD) or ring gear teeth.

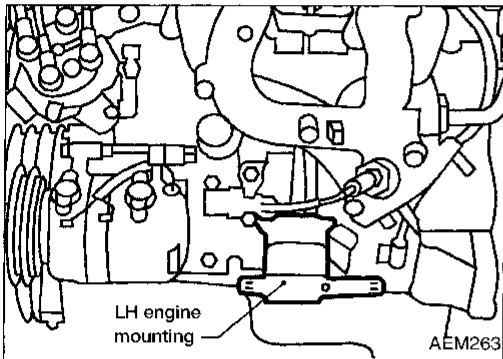
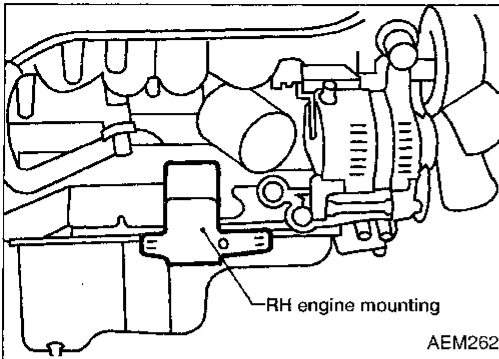
### Removal

1. Drain coolant from engine block and radiator. Refer to MA section ("Changing Engine Coolant", "ENGINE MAINTENANCE").
2. Release fuel pressure. Refer to EC section ("Fuel Pressure Release", "BASIC SERVICE PROCEDURE").
3. Remove negative battery cable.
4. Remove hood. Refer to BT section.
5. Remove power steering drive belt, generator drive belt and A/C compressor drive belt.
6. Remove radiator. Refer to LC section ("Radiator", "ENGINE COOLING SYSTEM").
7. Remove exhaust manifold heat shield.
8. Disconnect exhaust system from exhaust manifold.
9. Discharge refrigerant. Refer to HA section ("R-134a Service Procedure", "SERVICE PROCEDURES").
10. Disconnect refrigerant lines. Refer to HA section ("Refrigerant Lines", "SERVICE PROCEDURES").
11. Disconnect accelerator wire, vacuum hoses, electrical connectors, heater hoses and vacuum booster hose.

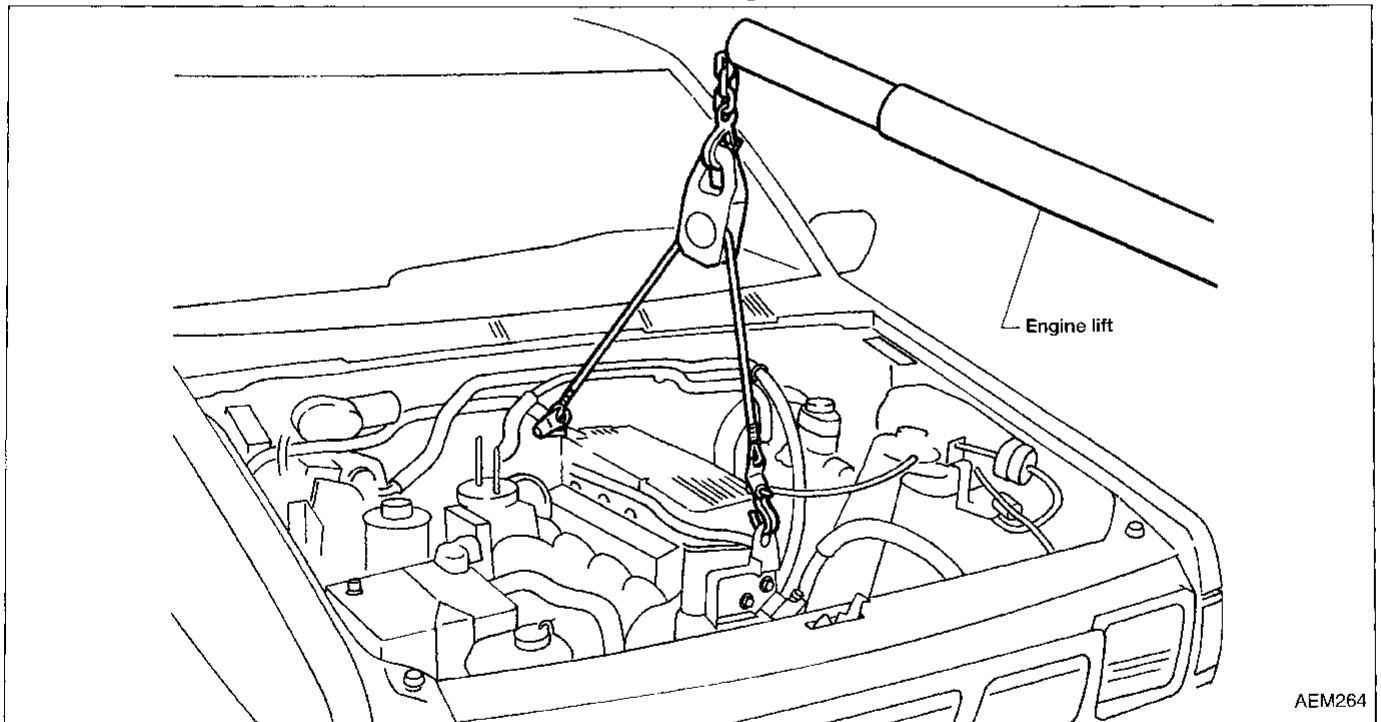
## ENGINE REMOVAL

### Removal (Cont'd)

12. Remove four power steering pump bolts.
13. Disconnect A/T dipstick tube and A/T throttle wire. (A/T models only)
14. Remove transmission Refer to MT or AT section ("Removal", "REMOVAL AND INSTALLATION").
15. Remove LH and RH engine mounts.



16. Remove engine.



### Installation

- Install in reverse order of removal.

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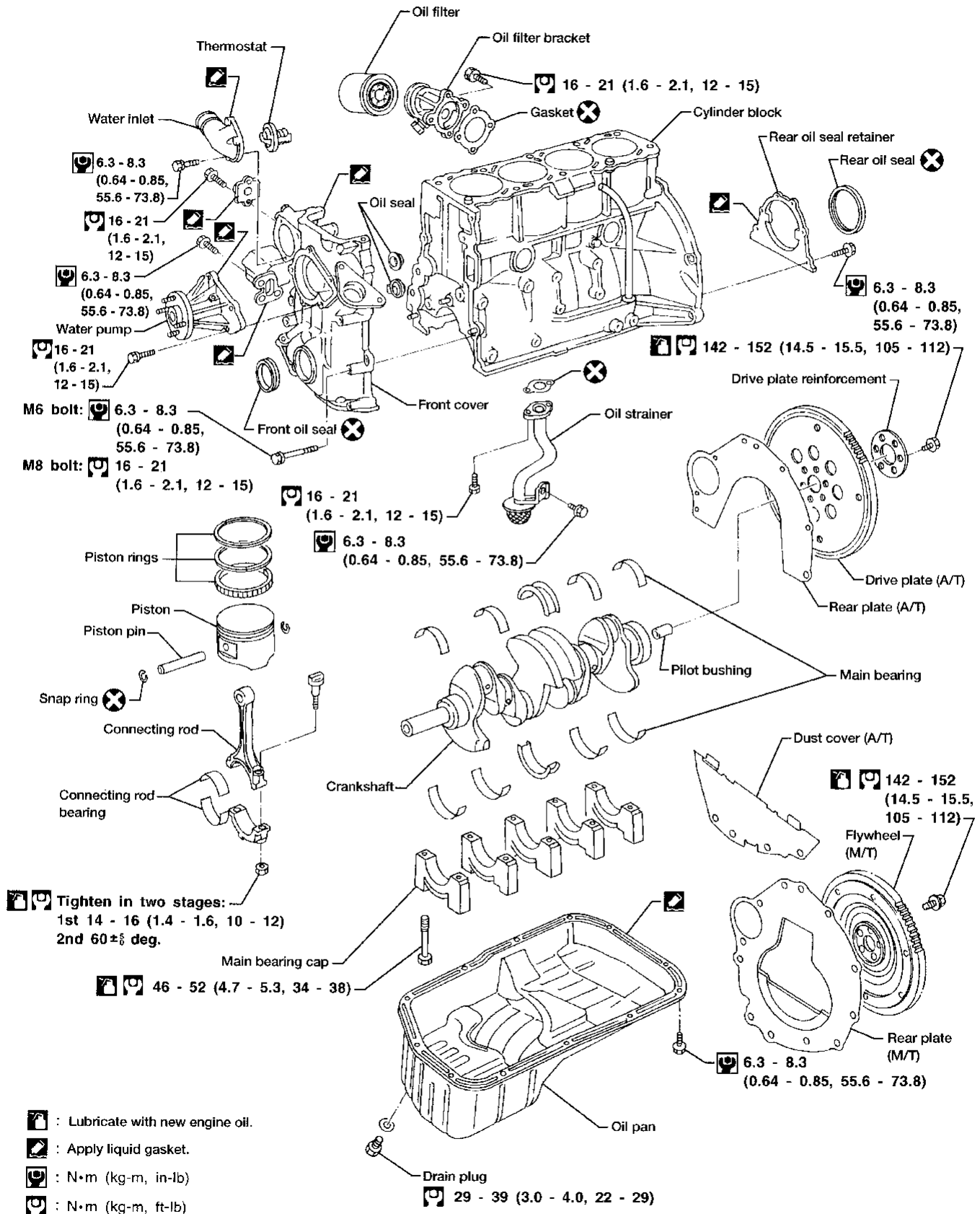
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# CYLINDER BLOCK

SEC. 110•120•135•150•210



AEM256

## CAUTION:

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

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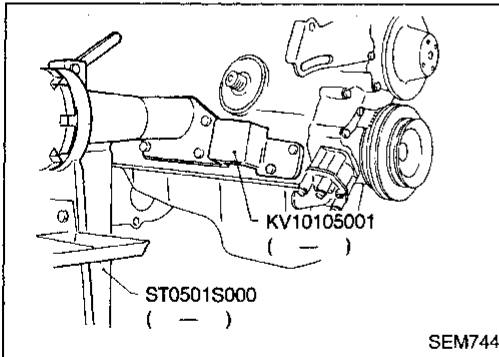
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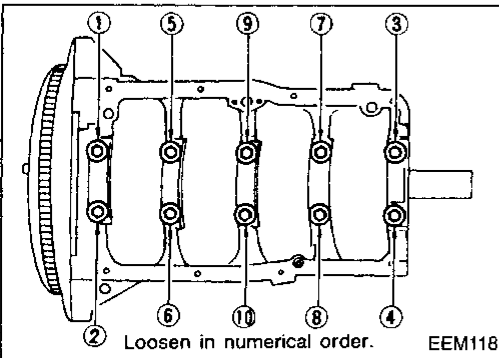
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## Disassembly

### PISTON AND CRANKSHAFT

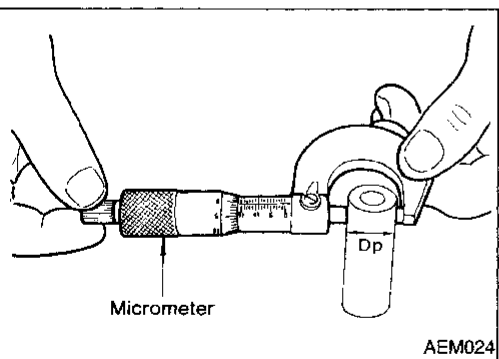
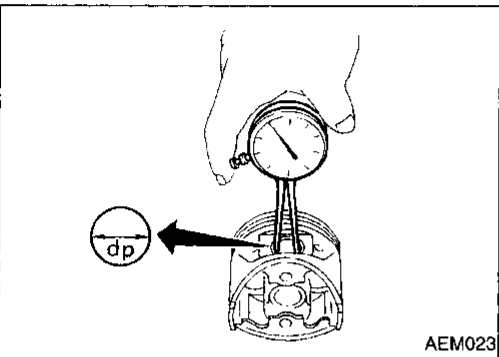
1. Place engine on a work stand.
  2. Drain coolant and oil.
  3. Remove oil pan.
  4. Remove timing chain.
  5. Remove water pump.
  6. Remove cylinder head.
  7. Remove pistons with connecting rod.
  8. Remove bearing caps and crankshaft.
- Before removing bearing caps, measure crankshaft end play. Refer to EM-40.
  - Bolts should be loosened in two or three steps.



## Inspection

### PISTON AND PISTON PIN CLEARANCE

1. Measure inner diameter of piston pin hole "dp".  
Standard diameter "dp":  
21.002 - 21.008 mm (0.8268 - 0.8271 in)
2. Measure outer diameter of piston pin "Dp".  
Standard diameter "Dp":  
20.994 - 20.996 mm (0.8265 - 0.8266 in)
3. Calculate piston pin clearance.  
 $dp - Dp = 0.008 - 0.012 \text{ mm (0.0003 - 0.0005 in)}$   
If it exceeds the above value, replace piston assembly with pin.



## CYLINDER BLOCK

### Inspection (Cont'd)

#### PISTON RING SIDE CLEARANCE

##### Side clearance:

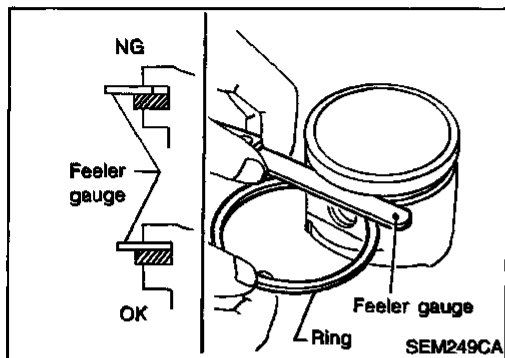
- Top ring 0.04 - 0.08 mm (0.0016 - 0.0031 in)
- 2nd ring 0.03 - 0.07 mm (0.0012 - 0.0028 in)
- Oil ring 0.065 - 0.135 mm (0.0026 - 0.0053 in)

##### 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)

(R or T is punched on the ring.)

0.55 - 0.70 mm (0.0217 - 0.0276 in)

(N is punched on the ring.)

##### Oil ring

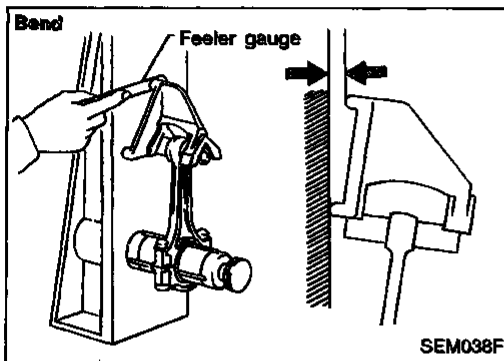
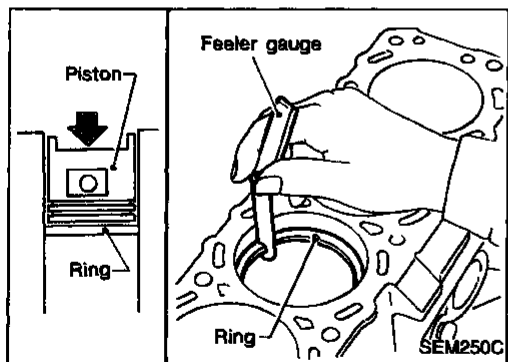
0.20 - 0.69 mm (0.0079 - 0.0272 in)

##### Max. limit of ring gap:

0.5 mm (0.020 in)

If out of specification, replace piston ring. If gap exceeds maximum limit with a new ring, rebore cylinder and use oversized piston and piston rings. Refer to SDS, EM-46.

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



#### CONNECTING ROD BEND AND TORSION

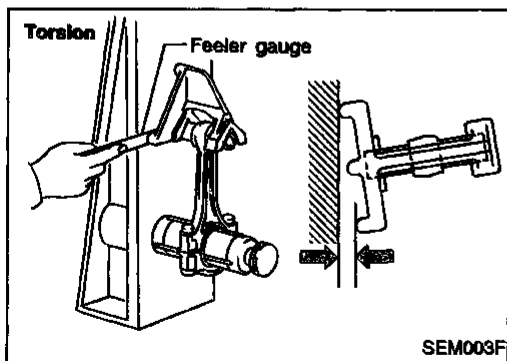
##### Bend:

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

##### Torsion:

Limit 0.3 mm (0.012 in)  
per 100 mm (3.94 in) length

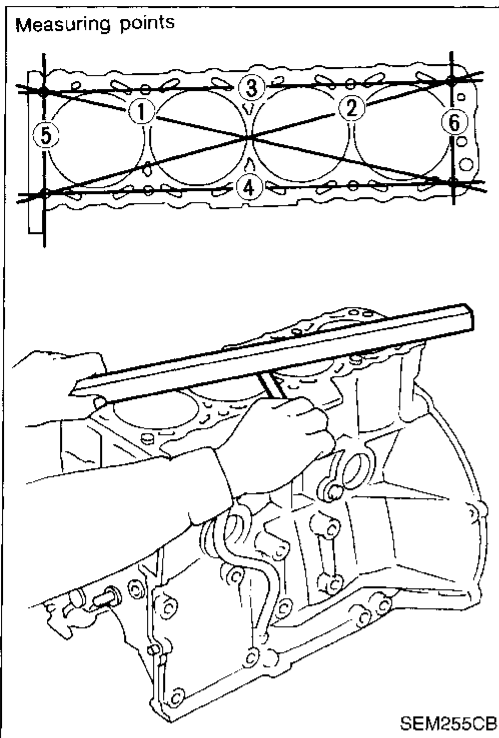
If it exceeds the limit, replace connecting rod assembly.



# CYLINDER BLOCK

## Inspection (Cont'd)

### CYLINDER BLOCK DISTORTION AND WEAR



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

**Limit:**

**0.1 mm (0.004 in)**

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

**Amount of cylinder head resurfacing is "A"**

**Amount of cylinder block resurfacing is "B"**

**The maximum limit is as follows:**

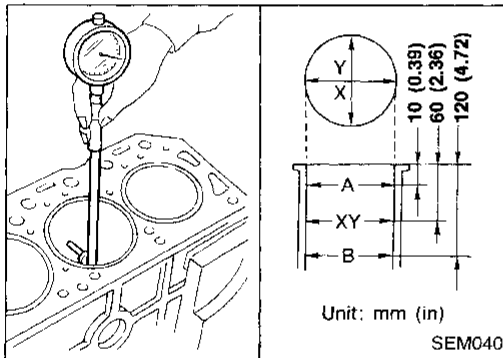
**A + B = 0.2 mm (0.008 in)**

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

**246.95 - 247.05 mm (9.7224 - 9.7264 in)**

3. If necessary, replace cylinder block.

### PISTON-TO-BORE CLEARANCE



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

**Standard inner diameter:**

**Refer to SDS, EM-42.**

**Wear limit: 0.2 mm (0.008 in)**

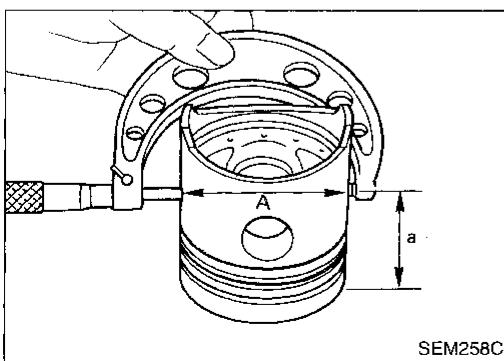
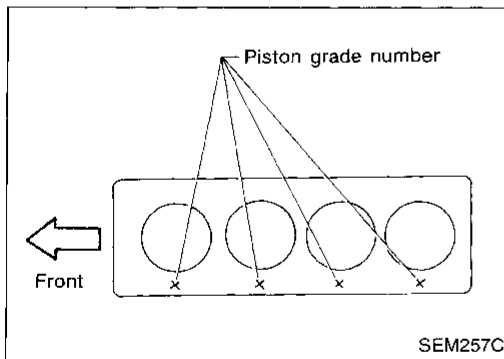
**Out-of-round (X - Y) standard: 0.015 mm (0.0006 in)**

**Taper (A - B) standard: 0.015 mm (0.0006 in)**

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

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

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



3. Measure piston skirt diameter.

**Piston diameter "A":**

**Refer to SDS, EM-46.**

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

**Approximately 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-46.**

# CYLINDER BLOCK

## Inspection (Cont'd)

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

Rebored size calculation:

$$D = A + B - C$$

where,

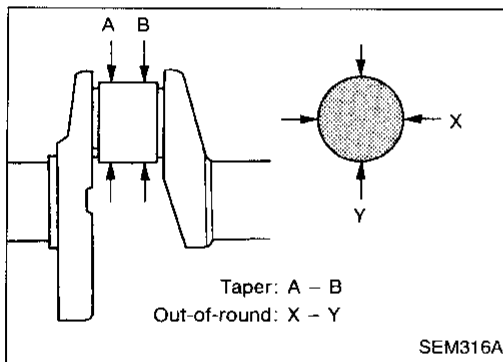
**D: Bored diameter**

**A: Piston diameter as measured**

**B: Piston-to-bore clearance**

**C: Honing allowance 0.02 mm (0.0008 in)**

7. Install main bearing caps and tighten bolts to the specified torque. This will prevent distortion of cylinder bores.
8. Cut cylinder bores.
  - **When any cylinder needs boring, all other cylinders must also be bored.**
  - **Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so at a time.**
9. Hone cylinders to obtain specified piston-to-bore clearance.
10. Measure finished cylinder bore for out-of-round and taper.
  - **Measurement should be done after cylinder bore cools down.**



## CRANKSHAFT

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

Out-of-round (X - Y):

Main journal Less than 0.01 mm (0.0004 in)

Crank pin Less than 0.005 mm (0.0002 in)

Taper (A - B):

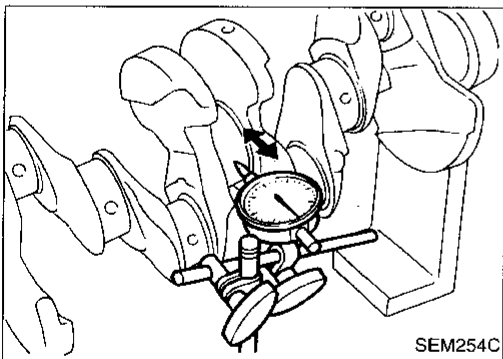
Main journal Less than 0.01 mm (0.0004 in)

Crank pin Less than 0.005 mm (0.0002 in)

3. Measure crankshaft runout.

Runout (Total indicator reading):

Less than 0.10 mm (0.0039 in)



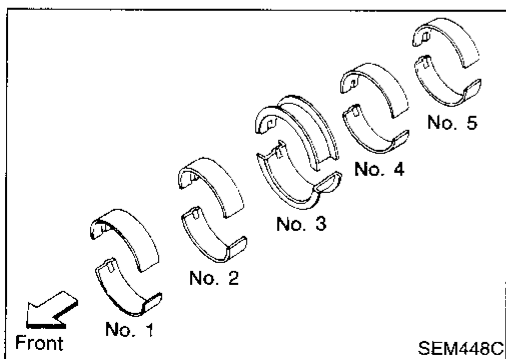
## BEARING CLEARANCE

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

**Method A (Using bore gauge and micrometer)**

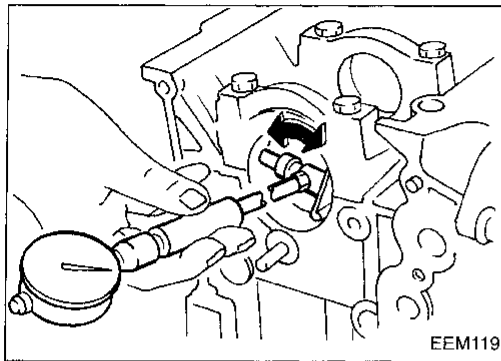
### Main bearing

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

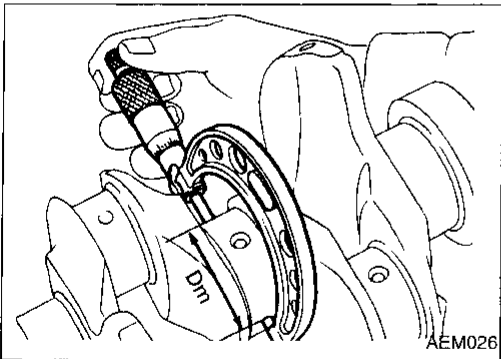


# CYLINDER BLOCK

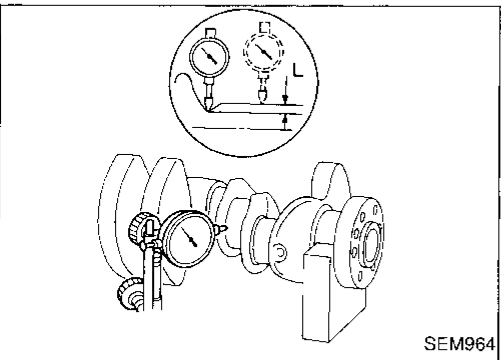
## Inspection (Cont'd)



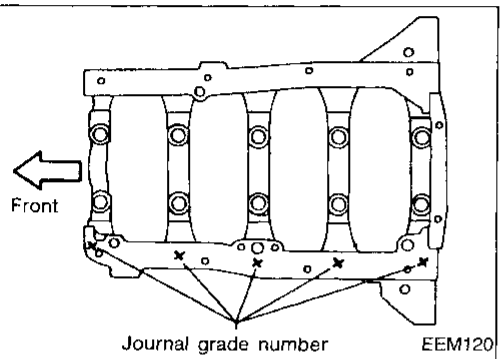
2. Install main bearing cap to cylinder block.
  - **Tighten all bolts in correct order in two or three stages.**
3. Measure inner diameter "A" of each main bearing.



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

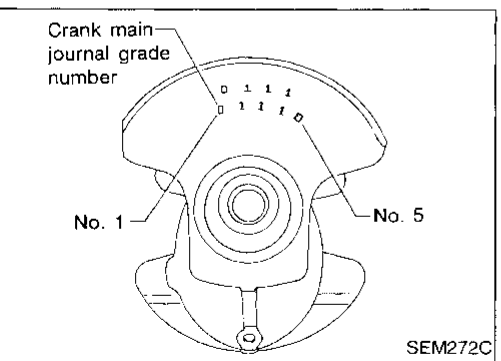


- a. **When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.**  
"L": 0.1 mm (0.004 in)
- b. **Refer to SDS for grinding crankshaft and available service parts.**



8. If crankshaft is reused, measure main bearing clearance and select thickness of main bearing.  
If crankshaft or cylinder block is replaced, select thickness of main bearings as follows:

- a. Grade number of each cylinder block main journal is punched on the respective cylinder block. These numbers are punched in either Arabic or Roman numerals.



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

For example:

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

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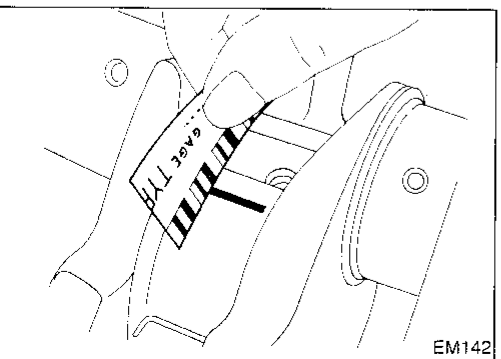
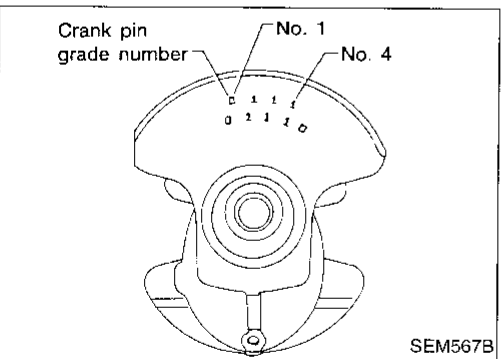
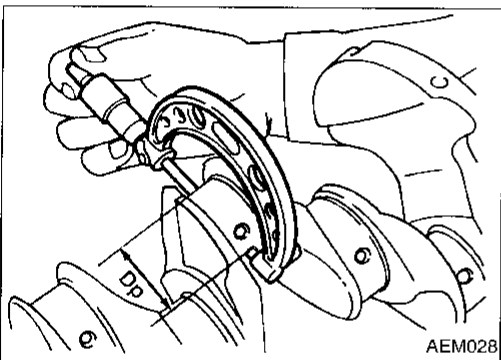
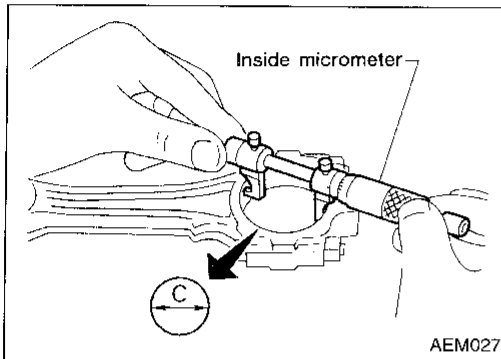
IDX

# CYLINDER BLOCK

## Inspection (Cont'd)

Main bearing grade number and identification color:

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



### Connecting rod bearing (Big end)

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

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

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

### Connecting rod bearing grade number:

These numbers are punched in either Arabic or Roman numerals.

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

### Method B (Using plastigage)

#### CAUTION:

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

# CYLINDER BLOCK

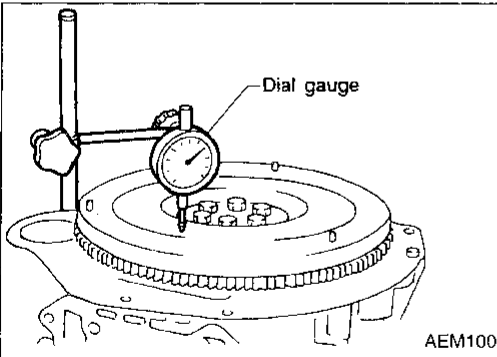
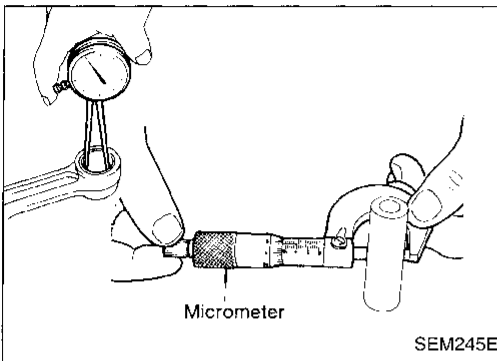
## Inspection (Cont'd)

### 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.

$$C - Dp = -0.015 \text{ to } -0.033 \text{ mm } (-0.0006 \text{ to } -0.0013 \text{ in (Standard)})$$

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



### FLYWHEEL/DRIVE PLATE RUNOUT

Runout (Total indicator reading):

- Flywheel (M/T model)  
Less than 0.1 mm (0.004 in)
- Drive plate (A/T model)  
Less than 0.1 mm (0.004 in)

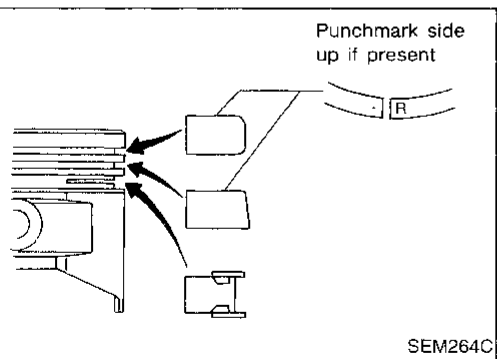
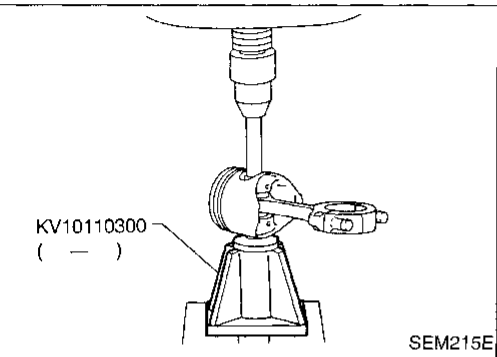
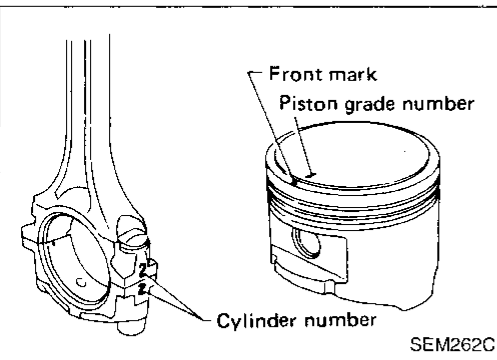
#### CAUTION:

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

## Assembly

### PISTON

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



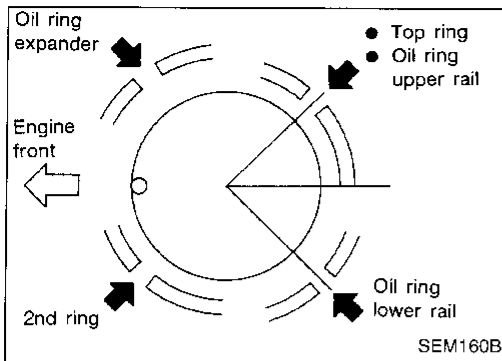
2. Set piston rings as shown.

#### CAUTION:

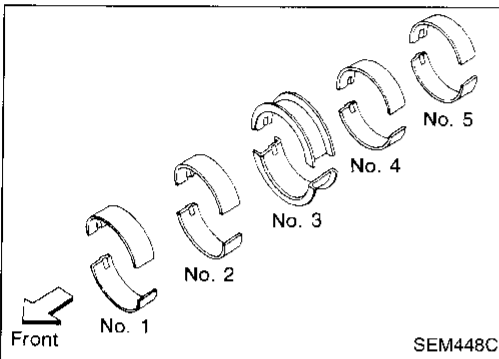
- When piston rings are not replaced, make sure that piston rings are mounted in their original positions.
- When piston rings are being replaced and no punchmark is present, piston rings can be mounted with either side up.

# CYLINDER BLOCK

## Assembly (Cont'd)



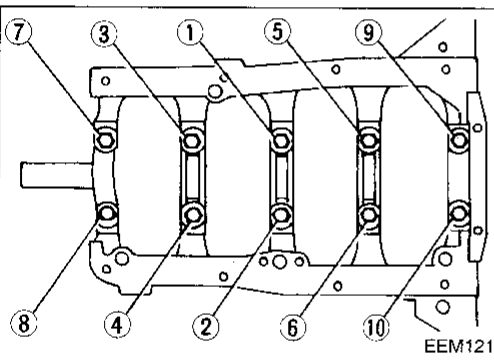
3. Align piston rings so that end gaps are positioned as shown.



## CRANKSHAFT

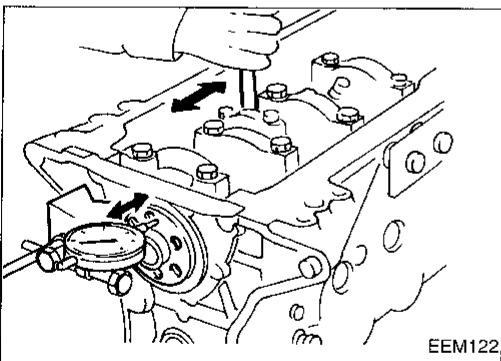
1. Set main bearings in their proper positions on cylinder block and main bearing beam.

- Confirm that correct main bearings are used. Refer to EM-36.
- Apply new engine oil to bearing surfaces.



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

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



3. Measure crankshaft end play.

### Crankshaft end play:

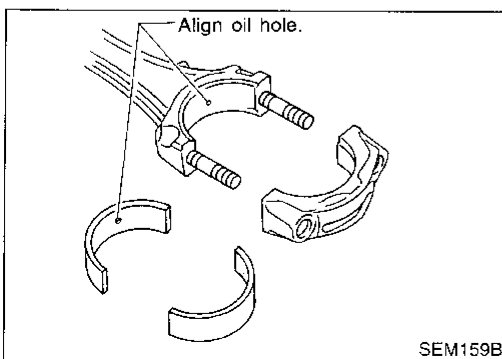
#### Standard

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.

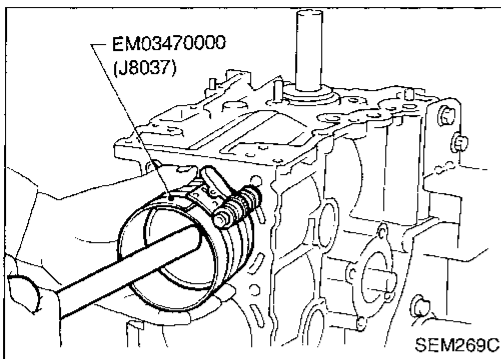


4. Install connecting rod bearings in connecting rods and connecting rod caps.

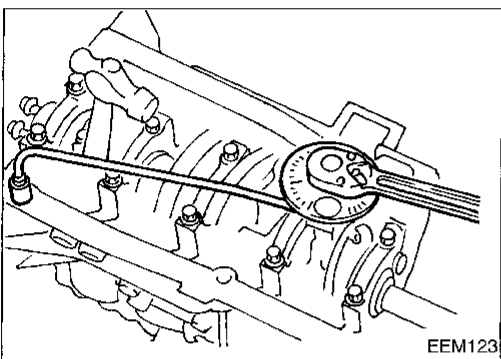
- Confirm that correct bearings are used. Refer to EM-38.
- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.
- Apply new engine oil to bearing surfaces, bolt threads and seating surfaces.

# CYLINDER BLOCK

## Assembly (Cont'd)



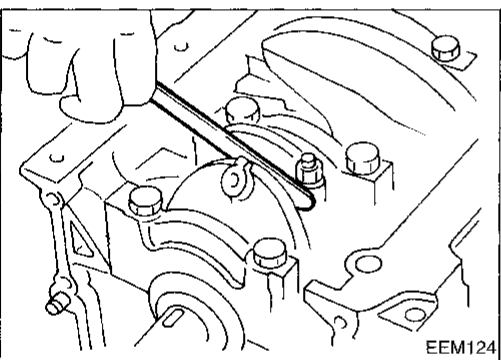
5. Install pistons with connecting rods.
  - a. Install them into corresponding cylinders with Tool.
    - Arrange so that front mark on piston head faces toward front of engine.
    - Make sure connecting rod does not scratch cylinder wall.
    - Make sure connecting rod bolts do not scratch crankshaft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



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

### 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  $60^{+5}_0$  degrees clockwise with an angle wrench.  
If an angle wrench is not available, tighten them to 38 to 44 N·m (3.9 to 4.5 kg-m, 28 to 33 ft-lb).

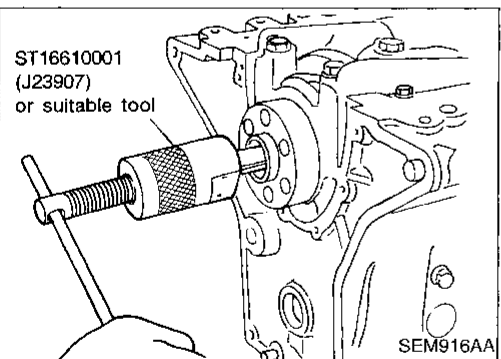


6. Measure connecting rod side clearance.

### Connecting rod side clearance:

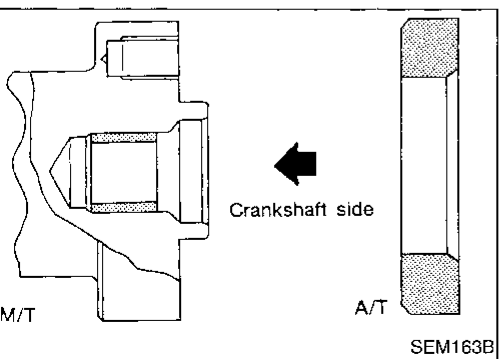
- Standard**  
0.2 - 0.4 mm (0.008 - 0.016 in)
- Limit**  
0.6 mm (0.024 in)

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



## REPLACING PILOT BUSHING

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



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

# SERVICE DATA AND SPECIFICATIONS (SDS)

## General Specifications

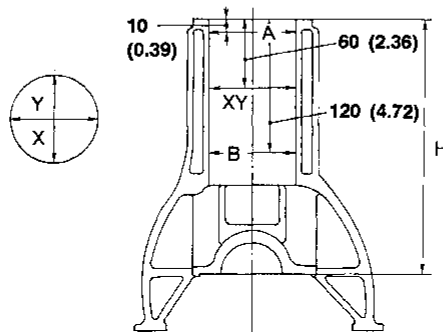
Cylinder arrangement	4, in-line	
Displacement	cm <sup>3</sup> (cu in)	2,389 (145.78)
Bore x stroke	mm (in)	89 x 96 (3.50 x 3.78)
Valve arrangement	OHC	
Firing order	1-3-4-2	
Number of piston rings		
Compression	2	
Oil	1	
Number of main bearings	5	
Compression ratio	8.6	

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

Compression pressure	
Standard	1,324 (13.5, 192)/300
Minimum	981 (10, 142)/300
Differential limit between cylinders	98 (1.0, 14)/300

## Inspection and Adjustment

### CYLINDER BLOCK



SEM400E

Unit: mm (in)

			Standard	Limit
Distortion			—	0.1 (0.004)
Cylinder bore	Inner diameter	Grade 1	89.000 - 89.010 (3.5039 - 3.5043)	0.2 (0.008)*
		Grade 2	89.010 - 89.020 (3.5043 - 3.5047)	
		Grade 3	89.020 - 89.030 (3.5047 - 3.5051)	
	Out-of-round (X - Y)		Less than 0.015 (0.0006)	—
Taper (A - B)		Less than 0.015 (0.0006)	—	
Difference in inner diameter between cylinders			Less than 0.05 (0.0020)	0.2 (0.008)
Piston-to-cylinder clearance			0.020 - 0.040 (0.0008 - 0.0016)	—
Cylinder block height (From crankshaft center)			246.95 - 247.05 (9.7224 - 9.7264)	0.2 (0.008)**

\* Wear limit

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

### CYLINDER HEAD

Unit: mm (in)

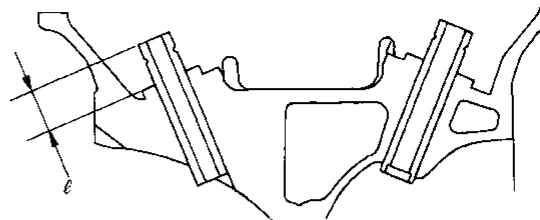
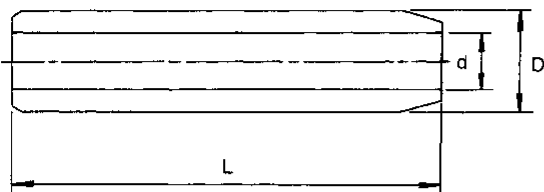
	Standard	Limit
Height (H)	98.8 - 99.0 (3.890 - 3.898)	0.2 (0.008)*
Surface distortion	0.03 (0.0012)	0.1 (0.004)

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

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Inspection and Adjustment (Cont'd)

### VALVE GUIDE



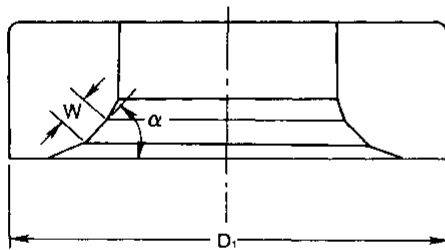
SEM401E

Unit: mm (in)

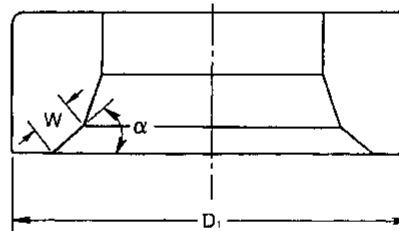
	Standard		Service		Limit
	Intake	Exhaust	Intake	Exhaust	
Length (L)	52.6 (2.071)	56.0 (2.205)	52.6 (2.071)	56.0 (2.205)	—
Outer diameter (D)	11.023 - 11.034 (0.4340 - 0.4344)	12.023 - 12.034 (0.4733 - 0.4738)	11.223 - 11.234 (0.4418 - 0.4423)	12.223 - 12.234 (0.4812 - 0.4817)	—
Inner diameter (d) (Finished size)	7.000 - 7.018 (0.2756 - 0.2763)	8.000 - 8.018 (0.3150 - 0.3157)	7.000 - 7.018 (0.2756 - 0.2763)	8.000 - 8.018 (0.3150 - 0.3157)	—
Cylinder head hole diameter	10.975 - 10.996 (0.4321 - 0.4329)	11.975 - 11.996 (0.4715 - 0.4723)	11.175 - 11.196 (0.4400 - 0.4408)	12.175 - 12.196 (0.4793 - 0.4802)	—
Interference fit	0.027 - 0.059 (0.0011 - 0.0023)				—
Stem to guide clearance	0.020 - 0.053 (0.0008 - 0.0021)	0.040 - 0.070 (0.0016 - 0.0028)	0.020 - 0.053 (0.0008 - 0.0021)	0.040 - 0.070 (0.0016 - 0.0028)	0.1 (0.004)
Tapping length (f)	14.9 - 15.1 (0.587 - 0.594)				—

### VALVE SEAT

Standard



Service



SEM402E

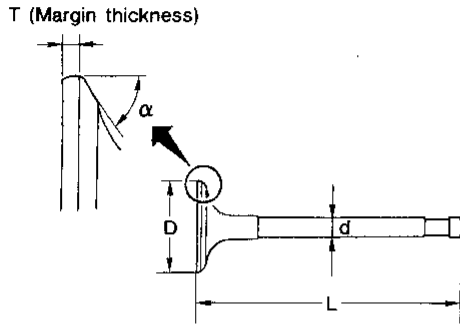
Unit: mm (in)

	Standard		Service	
	Intake	Exhaust	Intake	Exhaust
Cylinder head seat recess diameter	36.000 - 36.016 (1.4173 - 1.4179)	42.000 - 42.016 (1.6535 - 1.6542)	36.500 - 36.516 (1.4370 - 1.4376)	42.500 - 42.516 (1.6732 - 1.6739)
Valve seat outer diameter (Di)	36.080 - 36.096 (1.4205 - 1.4211)	42.080 - 42.096 (1.6567 - 1.6573)	36.580 - 36.596 (1.4402 - 1.4408)	42.580 - 42.596 (1.6764 - 1.6770)
Face angle (α)	45°	45°	45°	45°
Contacting width (W)	1.6 - 1.7 (0.063 - 0.067)	1.7 - 2.1 (0.067 - 0.083)	1.6 - 1.7 (0.063 - 0.067)	1.7 - 2.1 (0.067 - 0.083)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Inspection and Adjustment (Cont'd)

### VALVE



SEM188A

Unit: mm (in)

		Standard	Limit
Valve head diameter (D)	In.	33.95 - 34.25 (1.3366 - 1.3484)	—
	Ex.	40.0 - 40.2 (1.575 - 1.583)	—
Valve length (L)	In.	119.9 - 120.2 (4.720 - 4.732)	—
	Ex.	120.67 - 120.97 (4.7508 - 4.7626)	—
Valve stem diameter (d)	In.	6.965 - 6.980 (0.2742 - 0.2748)	—
	Ex.	7.948 - 7.960 (0.3129 - 0.3134)	—
Valve face angle (α)	In.	45°30'	—
	Ex.	45°30'	—
Valve head margin (T)	In.	1.15 - 1.45 (0.0453 - 0.0571)	0.5 (0.020)
	Ex.	1.35 - 1.65 (0.0531 - 0.0650)	
Valve clearance		0 (0)	

### VALVE SPRING

Unit: mm (in)

		Standard		Limit	
		Intake	Exhaust	Intake	Exhaust
Free height (H)	Outer	57.44 (2.2614)	53.21 (2.0949)	—	—
	Inner	53.34 (2.1000)	47.95 (1.8878)	—	—
Pressure N (kg, lb) at height	Outer	604.1 (61.6, 135.8) at 37.6 (1.480)	640.4 (65.3, 144.0) at 34.1 (1.343)	567.8 (57.9, 127.7) at 37.6 (1.480)	620.8 (63.3, 139.6) at 34.1 (1.343)
	Inner	284.4 (29.0, 63.9) at 32.6 (1.283)	328.5 (33.5, 73.9) at 29.1 (1.146)	266.8 (27.2, 60.0) at 32.6 (1.283)	318.7 (32.5, 71.7) at 29.1 (1.146)
Out-of-square	Outer	—	—	2.5 (0.098)	2.3 (0.091)
	Inner	—	—	2.3 (0.091)	2.1 (0.083)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Inspection and Adjustment (Cont'd)

### CAMSHAFT AND CAMSHAFT BEARING

GI

MA

EM

LC

EC

FE

CL

MT

AT

TF

PD

FA

RA

BR

ST

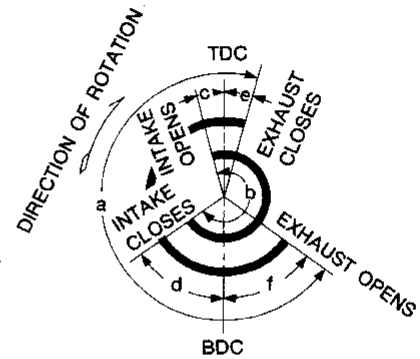
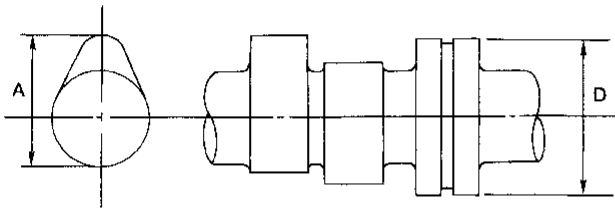
RS

BT

HA

EL

IDX



SEM568A

EM120

Unit: mm (in)

	Standard	Limit
Cam height (A)	44.43 - 44.58 (1.7492 - 1.7551)	—
Valve lift (h)	9.7 (0.382)	—
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	33.000 - 33.025 (1.2992 - 1.3002)	—
Outer diameter of camshaft journal (D)	32.935 - 32.955 (1.2967 - 1.2974)	—
Camshaft runout	0 - 0.02 (0 - 0.0008)	—
Camshaft end play	0.07 - 0.15 (0.0028 - 0.0059)	0.2 (0.008)
Valve timing (Degree on crankshaft)	a	232
	b	232
	c	-5
	d	57
	e	11
	f	41

### ROCKER ARM AND ROCKER SHAFT

Unit: mm (in)

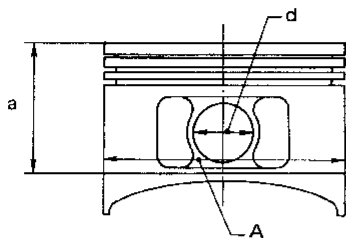
Rocker arm to shaft clearance	0.012 - 0.050 (0.0005 - 0.0020)
Rocker shaft diameter	21.979 - 22.000 (0.8653 - 0.8661)
Rocker arm rocker shaft hole diameter	22.012 - 22.029 (0.8666 - 0.8673)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Inspection and Adjustment (Cont'd)

### PISTON, PISTON RING AND PISTON PIN

#### Piston



SEM444C

Unit: mm (in)

Piston skirt diameter (A)	Standard	Grade No. 1	88.970 - 88.980 (3.5027 - 3.5031)
		Grade No. 2	88.980 - 88.990 (3.5031 - 3.5035)
Grade No. 3		88.990 - 89.000 (3.5035 - 3.5039)	
Service (Oversize)	0.5 (0.020)	89.470 - 89.500 (3.5224 - 3.5236)	
	1.0 (0.039)	89.970 - 90.000 (3.5421 - 3.5433)	
Dimension (a)	Approximately 52 (2.05)		
Piston pin hole diameter (d)	21.002 - 21.008 (0.8268 - 0.8271)		
Piston-to-cylinder bore clearance	0.020 - 0.040 (0.0008 - 0.0016)		

#### Piston pin

Unit: mm (in)

	Standard
Piston pin outer diameter	20.994 - 20.996 (0.8265 - 0.8266)
Pin to piston pin hole clearance	0.008 - 0.012 (0.0003 - 0.0005)
Piston pin to connecting rod clearance	-0.015 to -0.033 (-0.0006 to -0.0013)

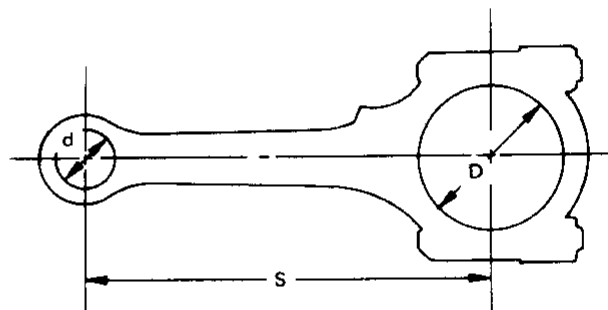
#### Piston ring

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)
	Oil	0.065 - 0.135 (0.0026 - 0.0053)*	0.1 (0.004)
Ring gap	Top	0.28 - 0.52 (0.0110 - 0.0205)	0.5 (0.020)
	2nd	0.45 - 0.69 (0.0177 - 0.0272)	0.5 (0.020)
	Oil (rail ring)	0.20 - 0.69 (0.0079 - 0.0272)	0.5 (0.020)

\*: Riken-make

#### CONNECTING ROD



SEM216E

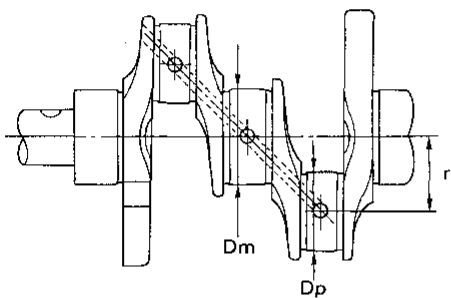
Unit: mm (in)

	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)]	—	0.3 (0.012)
Small end inner diameter (d)	20.948 - 20.978 (0.8247 - 0.8259)	—
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)

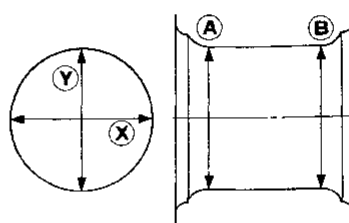
# SERVICE DATA AND SPECIFICATIONS (SDS)

## Inspection and Adjustment (Cont'd)

### CRANKSHAFT



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



SEM394

EM715

Unit: mm (in)

Main journal diameter (Dm)	No. 0	59.967 - 59.975 (2.3609 - 2.3612)	
	Grade No. 1	59.959 - 59.967 (2.3606 - 2.3609)	
	No. 2	59.951 - 59.959 (2.3603 - 2.3606)	
Pin journal diameter (Dp)	No. 0	49.968 - 49.974 (1.9672 - 1.9675)	
	Grade No. 1	49.962 - 49.968 (1.9670 - 1.9672)	
	No. 2	49.956 - 49.962 (1.9668 - 1.9670)	
Center distance (r)		47.95 - 48.05 (1.8878 - 1.8917)	
Taper of journal and pin [(A) - (B)]	Journal	Standard	Limit
	Pin	—	0.01 (0.0004)
Out-of-round of journal and pin [(X) - (Y)]	Journal	—	0.005 (0.0002)
	Pin	—	0.01 (0.0004)
Runout [TIR]*		—	0.005 (0.0002)
Free end play		0.05 - 0.18 (0.0020 - 0.0071)	0.10 (0.0039)
Fillet roil		More than 0.1 (0.004)	

\* Total indicator reading

### BEARING CLEARANCE

Unit: mm (in)

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

## SERVICE DATA AND SPECIFICATIONS (SDS)

### Inspection and Adjustment (Cont'd)

#### 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

##### 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 0.12 (0.0047)
Flywheel runout [TIR]*	Less than 0.1 (0.004)
Drive plate runout [TIR]*	Less than 0.1 (0.004)

\* Total indicator reading