

# ENGINE MECHANICAL

## SECTION **EM**

GI

MA

EM

LC

EC

FE

CL

MT

AT

FA

RA

BR

ST

RS

BT

HA

EL

IDX

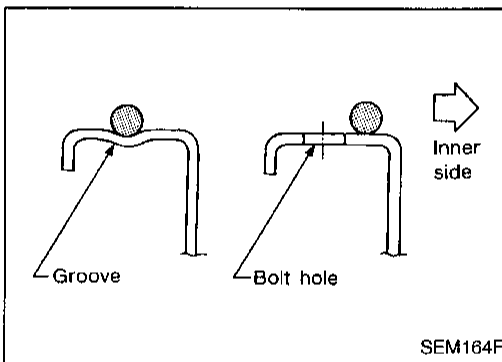
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# PRECAUTIONS

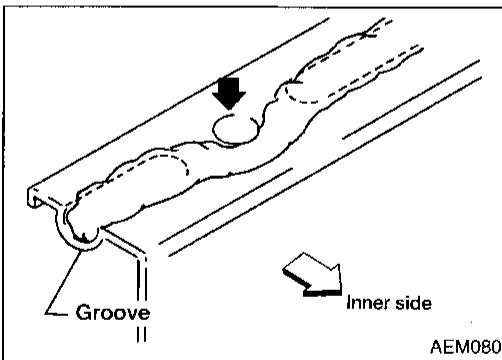
## Parts Requiring Angular Tightening

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



## Liquid Gasket Application Procedure

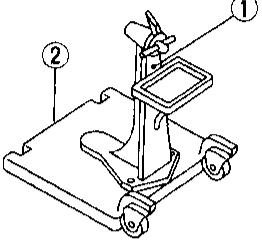
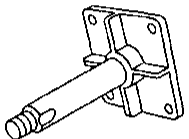
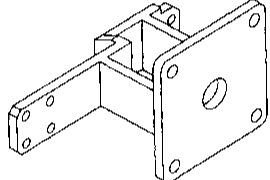
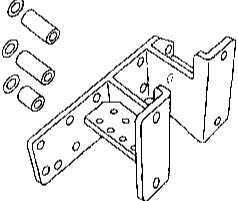
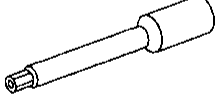
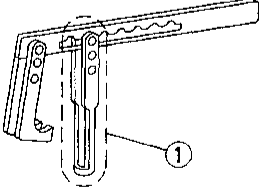
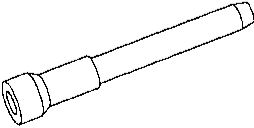
- Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also, completely clean any oil from these areas.
- Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine RTV silicone sealant Part No. 999MP-A7007 or equivalent.)
  - Be sure liquid gasket diameter is as specified.
- 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

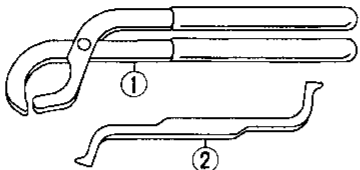
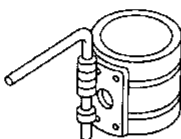
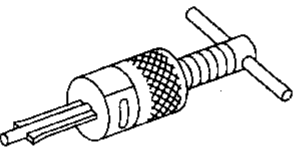
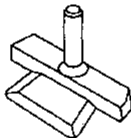
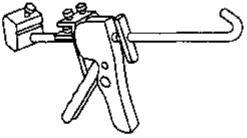
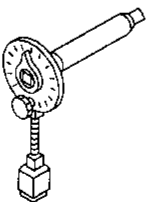
## Special Service Tools

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	 NT042	GI MA <b>EM</b> LC
KV10106500 ( — ) Engine stand shaft	 NT028	EC FE
KV10117000 (J41262) Engine sub-attachment	 NT373	CL MT AT
KV10117001 ( — ) Engine sub-attachment	 NT372	FA RA BR
ST10120000 (J24239-01) Cylinder head bolt wrench	 NT019	ST RS
KV10116200 (J26336-A) Valve spring compressor ① KV10115900 (J26336-20) Attachment	 NT022	BT HA EL
(J39386) Valve oil seal drift	 NT024	IDX


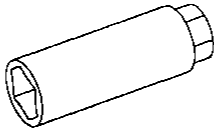
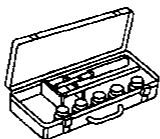
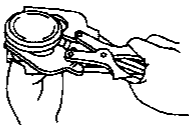
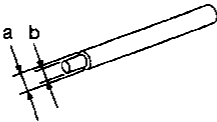
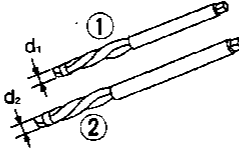
## PREPARATION

### Special Service Tools (Cont'd)

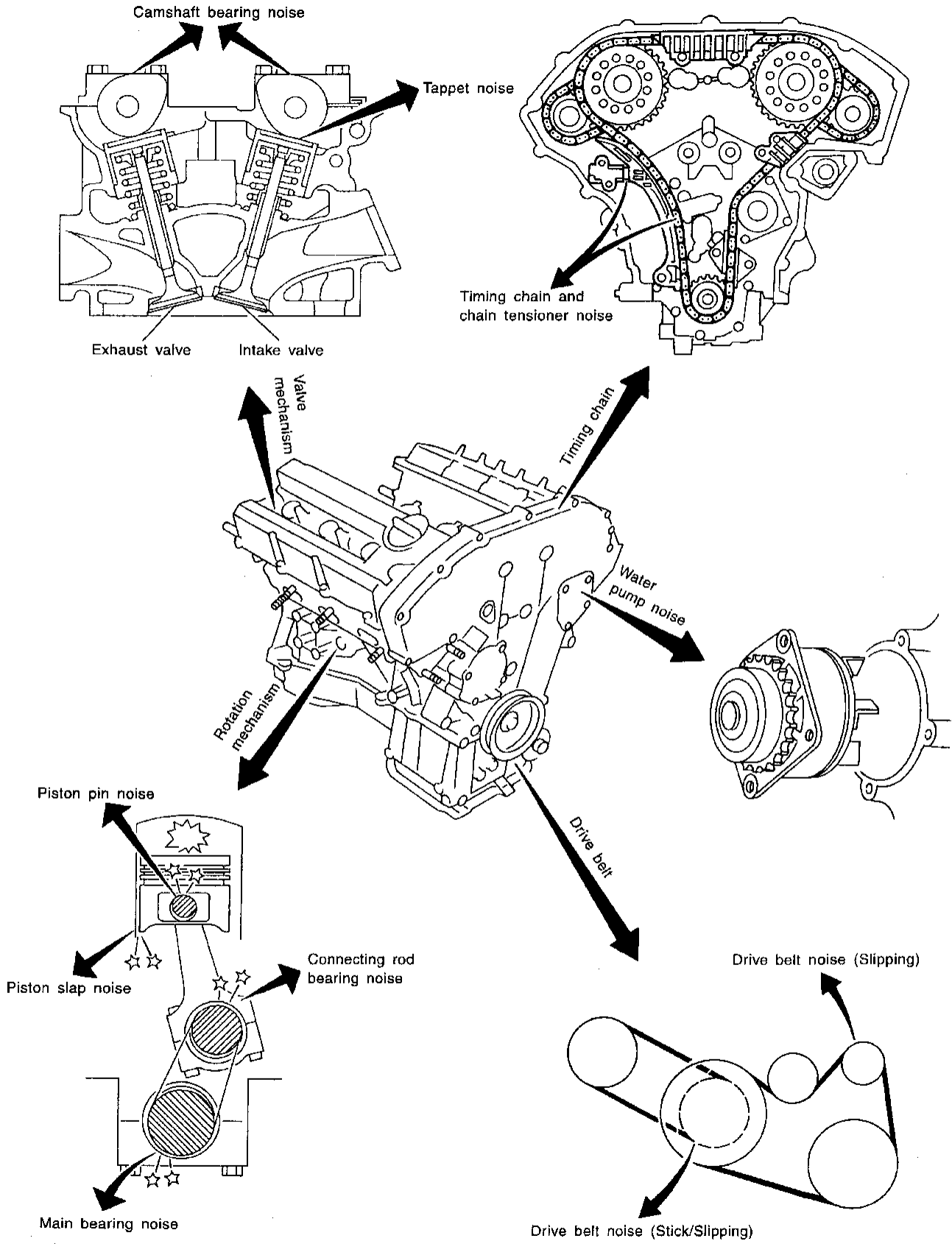
Tool number (Kent-Moore No.) Tool name	Description
KV101151S0 (J38972) Lifter stopper set ① KV10115110 (J38972-1) Camshaft pliers ② KV10115120 (J38972-2) Lifter stopper	<div style="text-align: right;">Changing shims</div> <div style="text-align: center;">  </div> <div style="text-align: left;">NT041</div>
EM03470000 (J8037) Piston ring compressor	<div style="text-align: right;">Installing piston assembly into cylinder bore</div> <div style="text-align: center;">  </div> <div style="text-align: left;">NT044</div>
ST16610001 (J23907) Pilot bushing puller	<div style="text-align: right;">Removing crankshaft pilot bushing</div> <div style="text-align: center;">  </div> <div style="text-align: left;">NT045</div>
KV10111100 (J37228) Seal cutter	<div style="text-align: right;">Removing steel oil pan and rear timing chain case</div> <div style="text-align: center;">  </div> <div style="text-align: left;">NT046</div>
WS39930000 ( — ) Tube presser	<div style="text-align: right;">Pressing the tube of liquid gasket</div> <div style="text-align: center;">  </div> <div style="text-align: left;">NT052</div>
KV10112100 (BT8653-A) Angle wrench	<div style="text-align: right;">Tightening bolts for bearing cap, cylinder head, etc.</div> <div style="text-align: center;">  </div> <div style="text-align: left;">NT014</div>

# PREPARATION

## Commercial Service Tools

Tool name	Description	GI
Spark plug wrench	<div style="display: flex; justify-content: space-between;"> <div data-bbox="493 302 667 449">  <p>16 mm (0.63 in)</p> </div> <div data-bbox="699 281 911 407">  </div> </div> <p>NT047</p>	Removing and installing spark plug
Valve seat cutter set	 <p>NT048</p>	MA
Piston ring expander	 <p>NT030</p>	EM
Valve guide drift	 <p>NT015</p>	LC
Valve guide reamer	 <p>NT016</p>	EC
	<p><b>Intake &amp; Exhaust:</b>  a = 9.5 mm (0.374 in) dia.  b = 5.5 mm (0.217 in) dia.</p>	FE
	<p>Reaming valve guide ① or hole for oversize valve guide ②</p>	CL
	<p><b>Intake &amp; Exhaust:</b>  d<sub>1</sub> = 6.0 mm (0.236 in) dia.  d<sub>2</sub> = 10.2 mm (0.402 in) dia.</p>	MT
		AT
		FA
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		BR
		ST
		RS
		BT
		HA
		EL
		IDX

# NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING



# NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

## NVH Troubleshooting — Engine Noise

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

1. Locate the area where noise occurs.
2. Confirm the type of noise.
3. Specify the operating condition of engine.
4. Check specified noise source.

If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-53
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-40, 41
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance	EM-58, 64
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston-to-bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-59, 59, 59, 60
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing clearance (Small end) Connecting rod bearing clearance (Big end)	EM-64, 63
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-62, 62
Front of engine Timing chain cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation	EM-29, 20
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Other drive belts (Sticking or slipping)	Drive belts deflection	MA section ("Checking Drive Belts", "ENGINE MAINTENANCE")
	Creaking	A	B	A	B	A	B	Other drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	LC section ("Water Pump Inspection", "ENGINE COOLING SYSTEM")

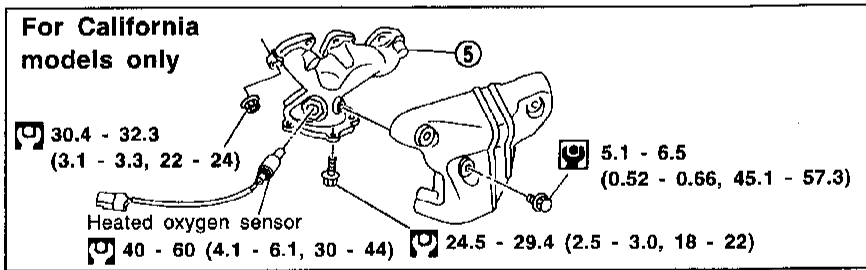
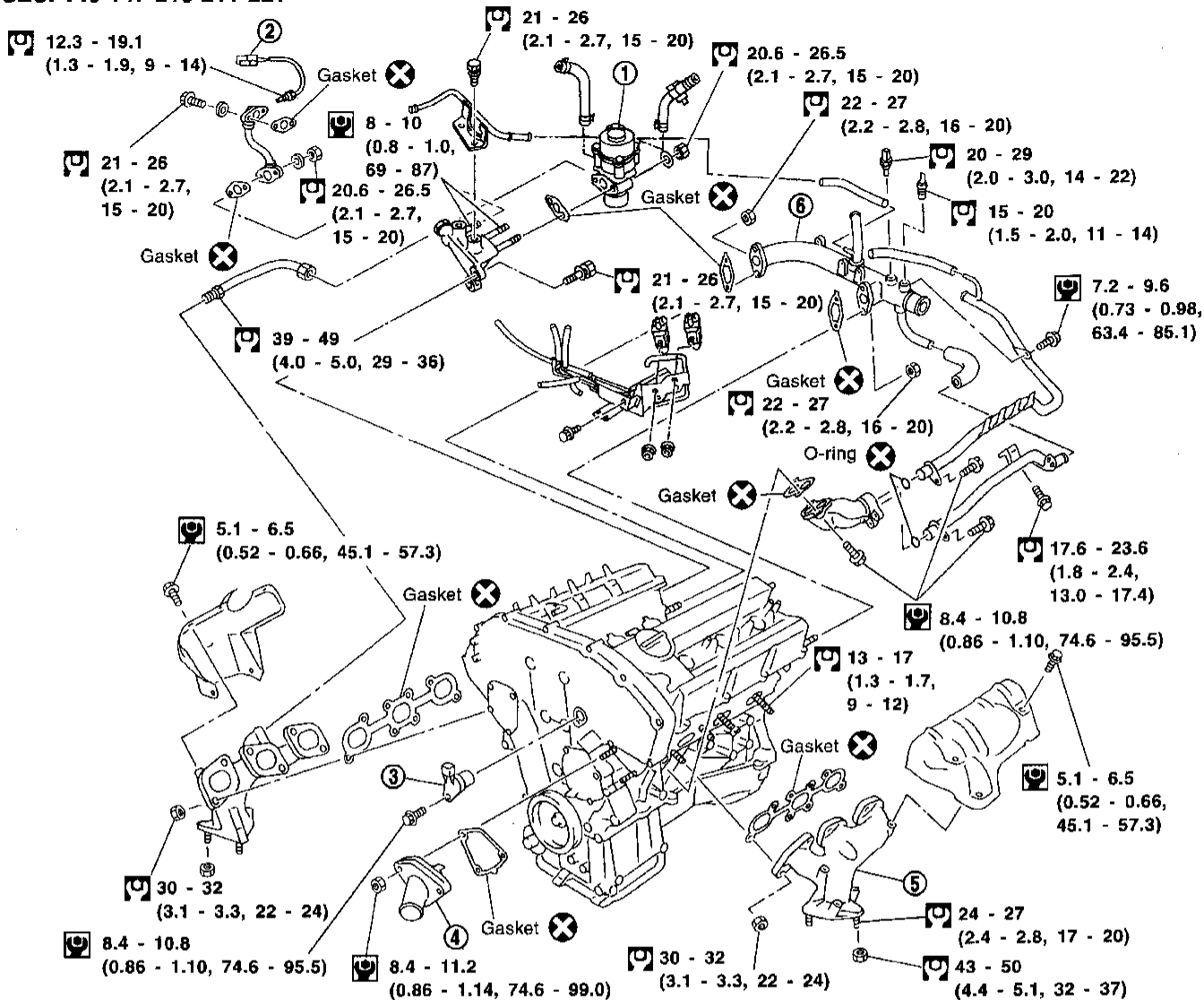
A: Closely related B: Related C: Sometimes related —: Not related





# OUTER COMPONENT PARTS

SEC. 140•147•210•211•221

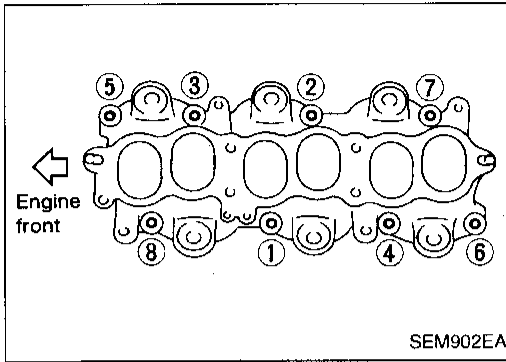


: N•m (kg-m, ft-lb)  
 : N•m (kg-m, in-lb)

- ① EGR valve
- ② EGR temperature sensor
- ③ Camshaft position sensor (PHASE)
- ④ Thermostat with water inlet
- ⑤ Exhaust manifold
- ⑥ Water outlet

SEM832F

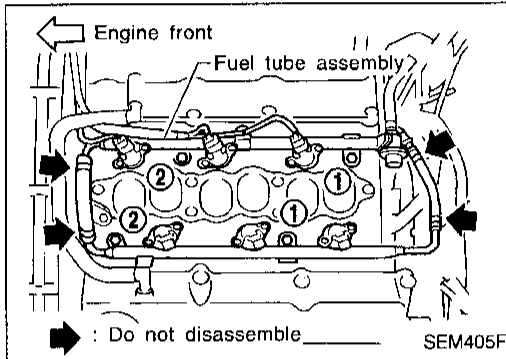
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## TIGHTENING PROCEDURES

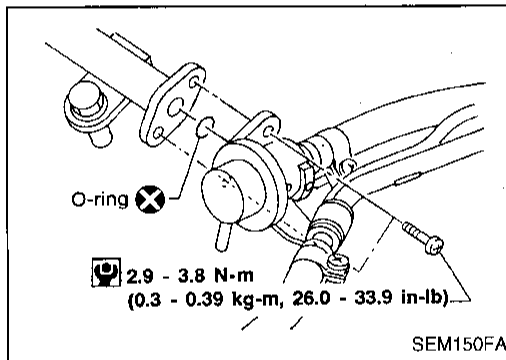
### Intake manifold

- Tighten in numerical order shown in the figure.
- 1. Tighten all bolts and nuts to 5 to 10 N·m (0.5 to 1.0 kg-m, 3.6 to 7.2 ft-lb).
- 2. Tighten all bolts and nuts to 26 to 31 N·m (2.7 to 3.2 kg-m, 20 to 23 ft-lb).
- 3. Repeat step 2 at least five times to have all bolts and nuts tightened at a torque of 26 to 31 N·m (2.7 to 3.2 kg-m, 20 to 23 ft-lb).



### Fuel tube

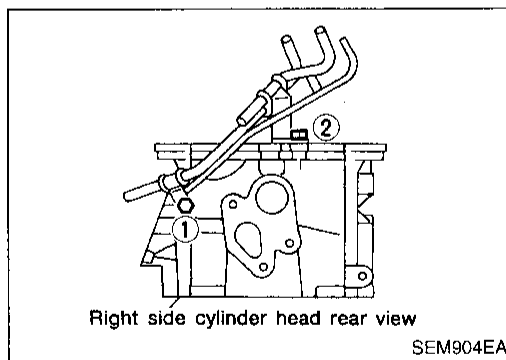
- Tighten in numerical order shown in the figure.
- 1. Tighten all bolts to 9.3 to 10.8 N·m (0.95 to 1.1 kg-m, 6.9 to 8.0 ft-lb).
- 2. Tighten all bolts to 21 to 26 N·m (2.1 to 2.7 kg-m, 15 to 20 ft-lb).
- Do not disassemble fuel tube assembly.



### Fuel pressure regulator

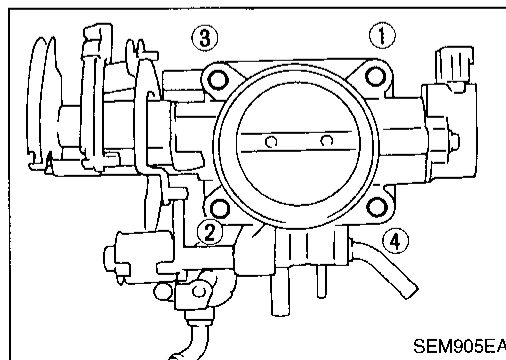
Tighten fuel pressure regulator to 2.9 to 3.8 N·m (0.3 to 0.39 kg-m, 26.0 to 33.9 in-lb).

- Tighten screws evenly several times to have the fuel pressure regulator tightened at the specified torque.
- Always replace O-ring with new ones.
- Lubricate O-ring with new engine oil.



### Sub-fuel tube

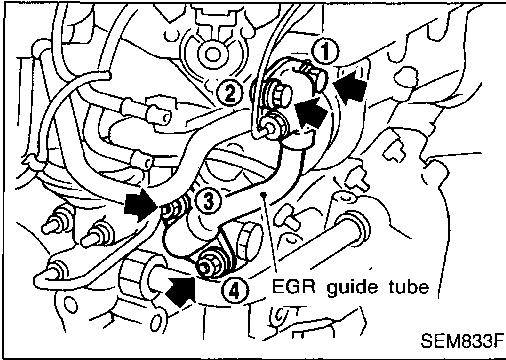
1. Temporarily tighten bolt ②.
2. Tighten bolt ① to 20.6 to 26.5 N·m (2.10 to 2.70 kg-m, 15.19 to 19.55 ft-lb).
3. Tighten bolt ② to 8.5 to 10.8 N·m (0.87 to 1.10 kg-m, 75.5 to 95.5 in-lb).



### Throttle body

- Tighten in numerical order shown in the figure.
- 1. Tighten all bolts to 8.8 to 10.8 N·m (0.9 to 1.1 kg-m, 6.5 to 8.0 ft-lb).
- 2. Tighten all bolts to 17.7 to 21.6 N·m (1.8 to 2.2 kg-m, 13 to 16 ft-lb).

# OUTER COMPONENT PARTS



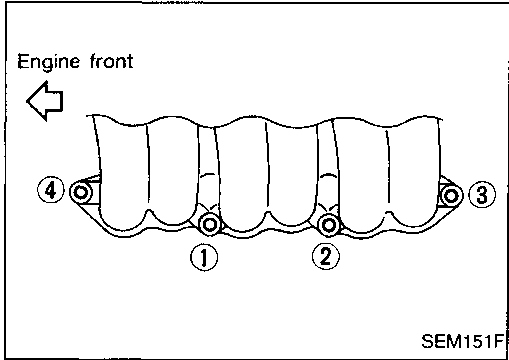
## EGR guide tube

1. Tighten all bolts to 9 to 10 N·m (0.9 to 1.0 kg·m, 6.5 to 7.2 ft·lb).
  2. Tighten all bolts to 21 to 26 N·m (2.1 to 2.7 kg·m, 15 to 20 ft·lb).
- Before installing EGR guide tube, tighten intake manifold collector and collector bracket.

GI

MA

EM



## Intake manifold collector

Tighten bolts and nuts to 18 to 22 N·m (1.8 to 2.2 kg·m, 13 to 16 ft·lb) in numerical order shown in the figure.

LC

EC

FE

CL

MT

AT

FA

RA

BR

ST

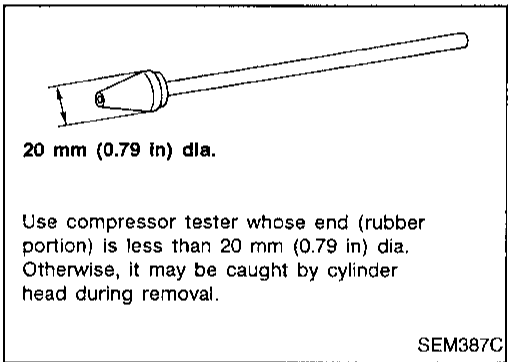
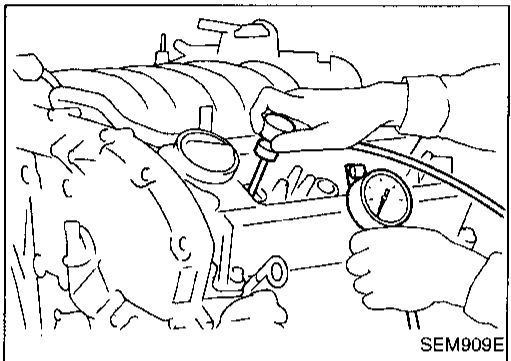
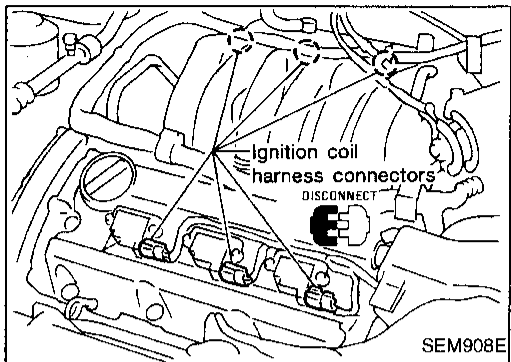
RS

BT

HA

EL

IDX



## Measurement of Compression Pressure

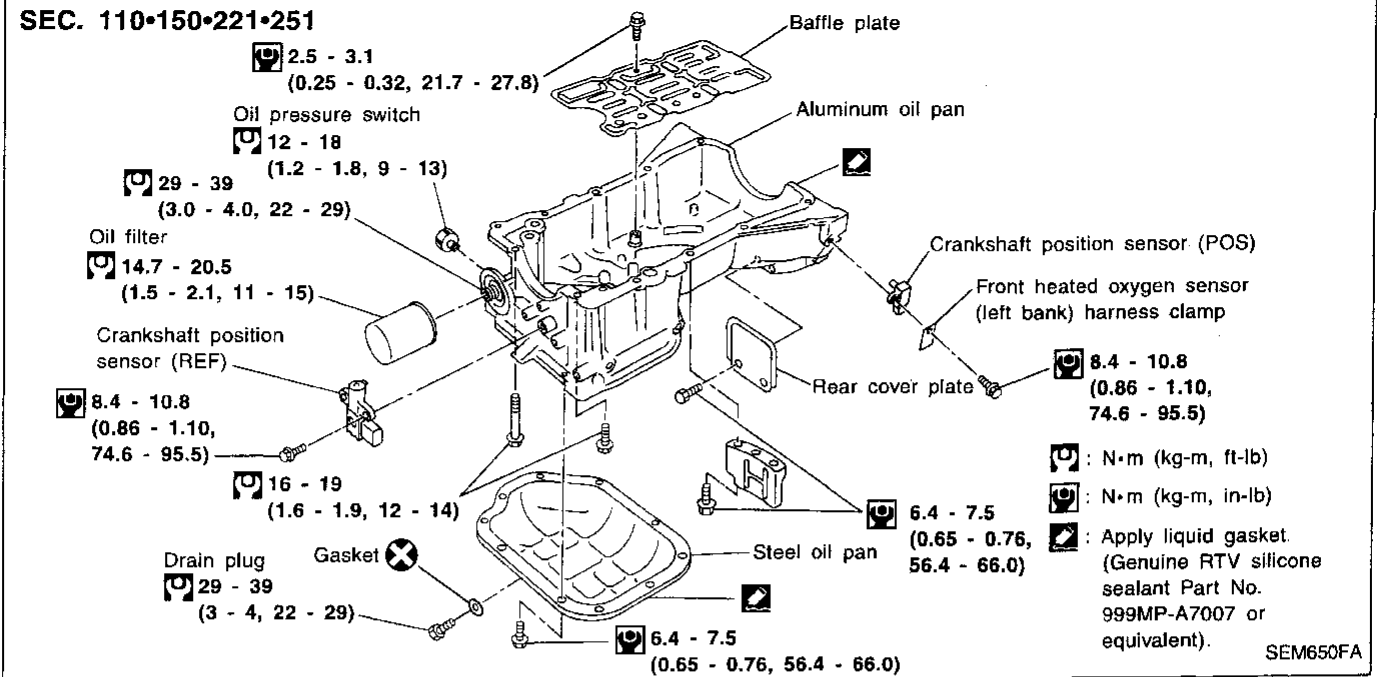
1. Warm up engine.
  2. Turn ignition switch OFF.
  3. Release fuel pressure.  
Refer to "Releasing Fuel Pressure" in EC section.
  4. Disconnect ignition coil with power transistor harness connectors, then remove ignition coils.
  5. Remove all spark plugs.
  6. Disconnect all injector harness connectors.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

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

Standard	Minimum	Difference limit between cylinders
1,275 (13.0, 185)/300	981 (10.0, 142)/300	98 (1.0, 14)/300

11. If compression in one or more cylinders is low:
    - a. Pour a small amount of engine oil into cylinders through spark plug holes.
    - b. Retest compression.
- **If adding oil helps compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
  - **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. (Refer to SDS, EM-68 and EM-71.) 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

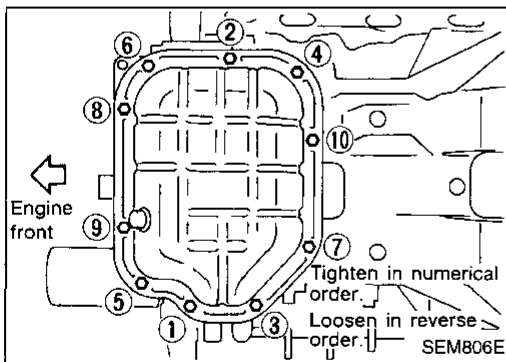
### CAUTION:

When removing the aluminum oil pan from engine, first remove the crankshaft position sensors (POS and REF) from the assembly.

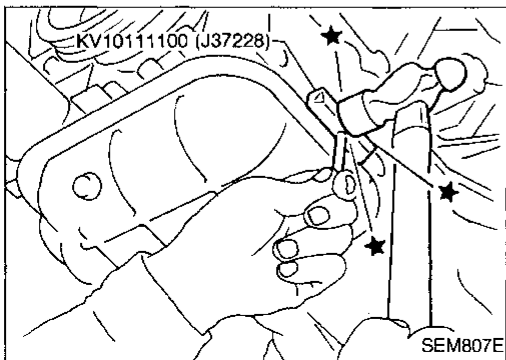
Be careful not to damage sensor edges and signal plate teeth.

1. Remove engine undercover.
2. Drain engine oil.

3. Remove steel oil pan bolts.

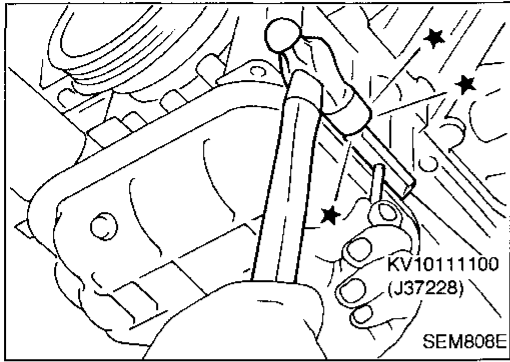


4. Remove steel oil pan.
  - a. Insert Tool between aluminum oil pan and steel oil pan.
    - Be careful not to damage aluminum mating surface.
    - Do not insert screwdriver, or oil pan flange will be deformed.

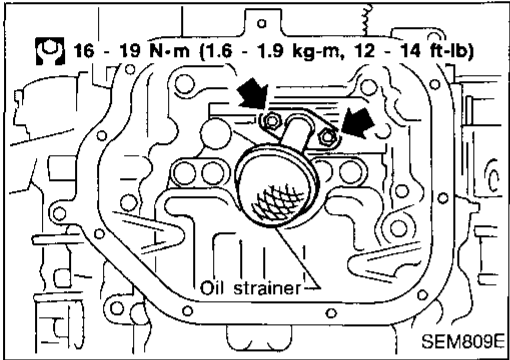


## OIL PAN

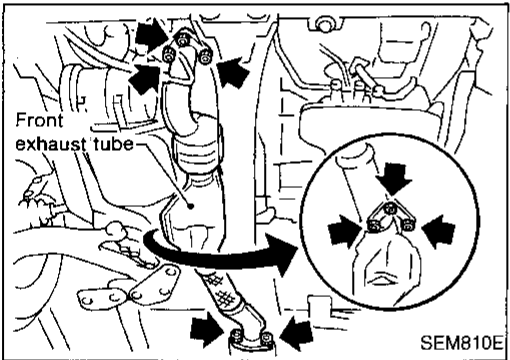
### Removal (Cont'd)



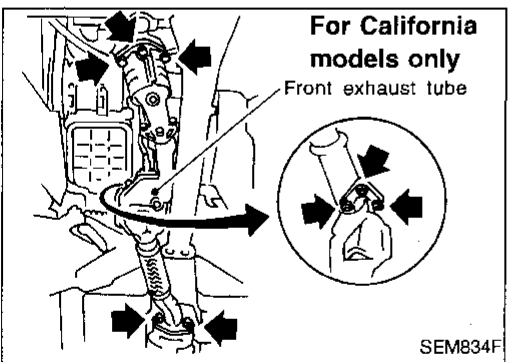
- b. Slide Tool by tapping on the side of the Tool with a hammer.
- c. Remove steel oil pan.



- 5. Remove oil strainer.

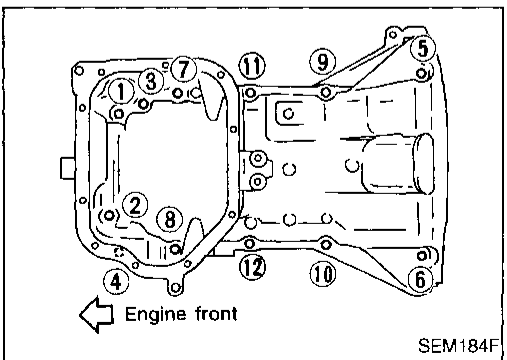
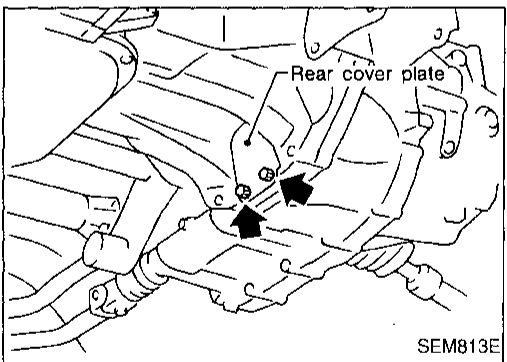
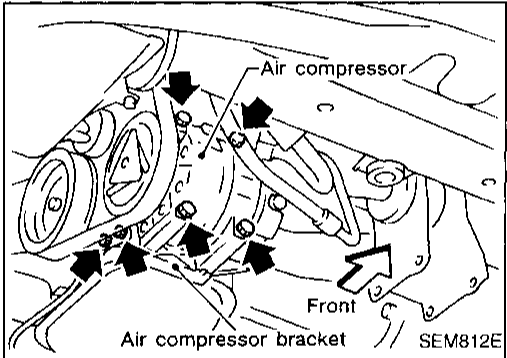
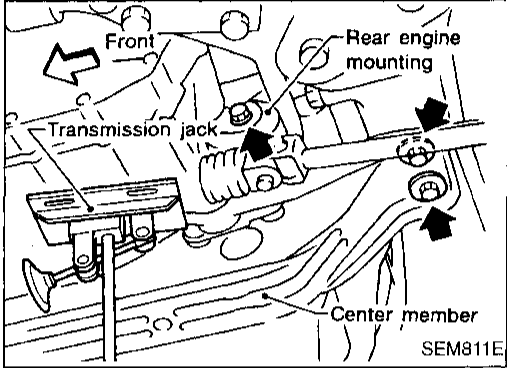
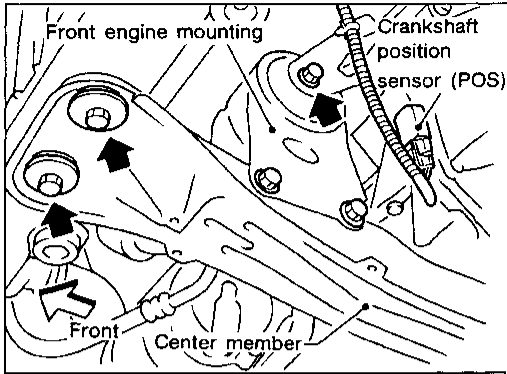


- 6. Remove front exhaust tube and its support.



# OIL PAN

## Removal (Cont'd)



7. Set a suitable transmission jack under transaxle and hoist engine with engine slinger.
8. Remove crankshaft position sensors (POS and REF) from oil pan.
9. Remove front and rear engine mounting nuts and bolts.
10. Remove center member.

11. Remove drive belts.
12. Remove air compressor and bracket.

13. Remove rear cover plate.

14. Remove aluminum oil pan bolts.

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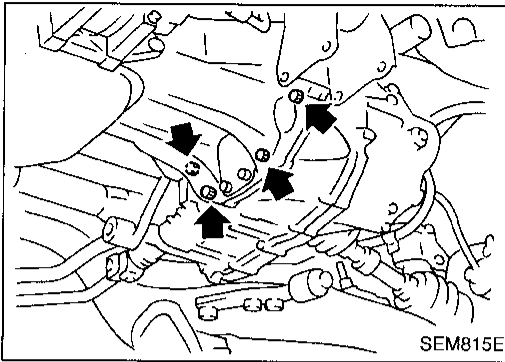
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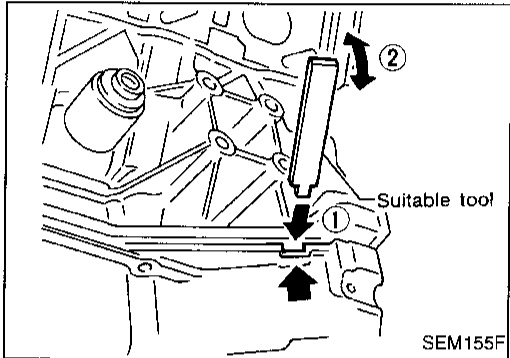
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## OIL PAN

### Removal (Cont'd)



15. Remove transaxle bolts.



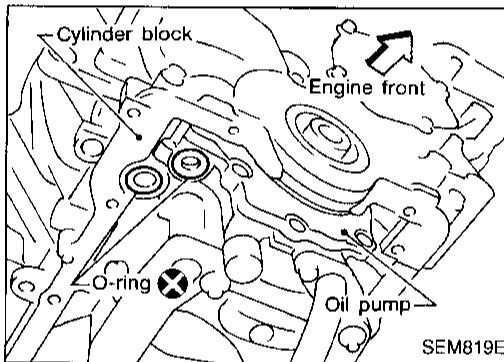
16. Remove aluminum oil pan.

a. Insert an appropriate size tool into the notch of aluminum oil pan as shown in the figure.

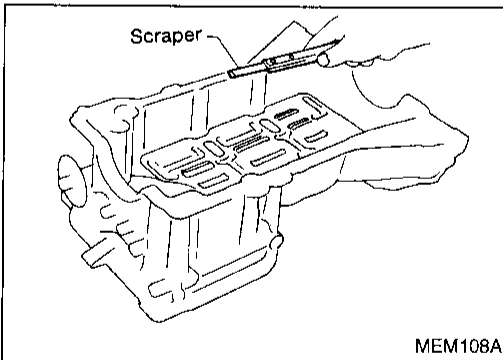
- Be careful not to damage aluminum mating surface.
- Do not insert screwdriver, or oil pan flange will be deformed.

b. Pry off aluminum oil pan by moving the tool up and down.

c. Remove aluminum oil pan.



17. Remove O-rings from cylinder block and oil pump body.



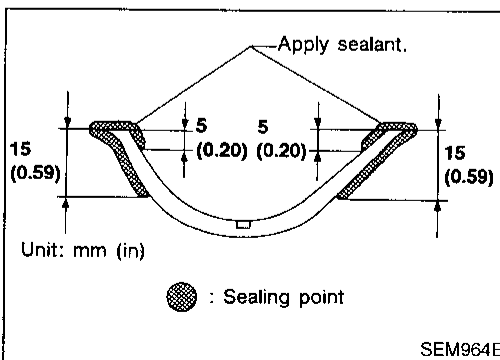
### Installation

1. Install aluminum oil pan.

a. Use a scraper to remove all traces of liquid gasket from mating surfaces.

- Also remove traces of liquid gasket from mating surface of cylinder block, front cover and steel oil pan.
- Remove old liquid gasket from the bolt hole and thread.

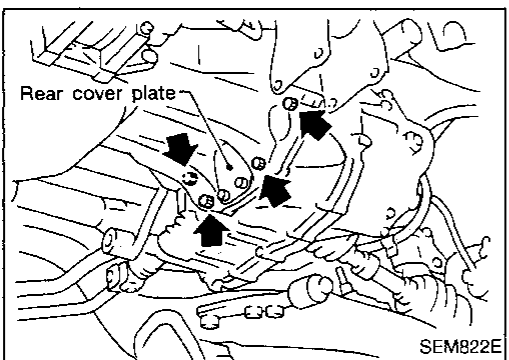
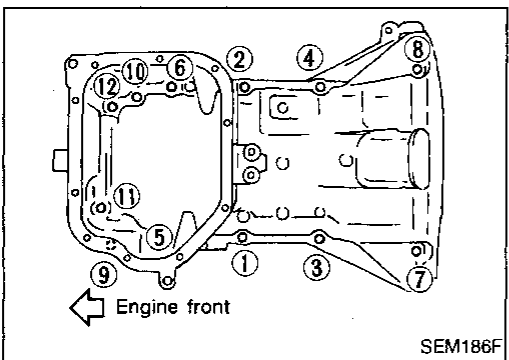
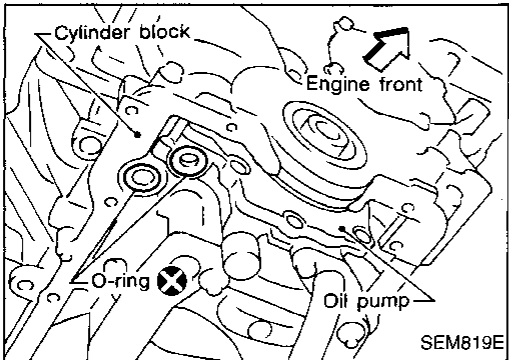
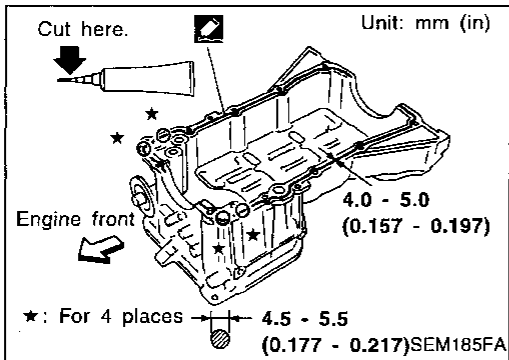
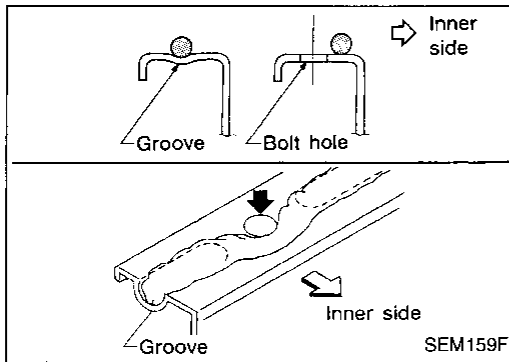
b. Apply sealant to front cover gasket and rear oil seal retainer gasket.





# OIL PAN

## Installation (Cont'd)



- c. Apply a continuous bead of liquid gasket to mating surface of aluminum oil pan.
- Use Genuine RTV silicone sealant Part No. 999MP-A7007 or equivalent.

- d. Apply liquid gasket to inner sealing surface as shown in figure.
- Be sure liquid gasket is 4.0 to 5.0 mm (0.157 to 0.197 in) or 4.5 to 5.5 mm (0.177 to 0.217 in) wide.
  - Attaching should be done within 5 minutes after coating.

- e. Install O-rings, cylinder block and oil pump body.

- f. Install aluminum oil pan.
- Tighten bolts in numerical order.
  - Wait at least 30 minutes before refilling engine oil.

2. Install the transaxle bolts.
3. Install rear cover plate.

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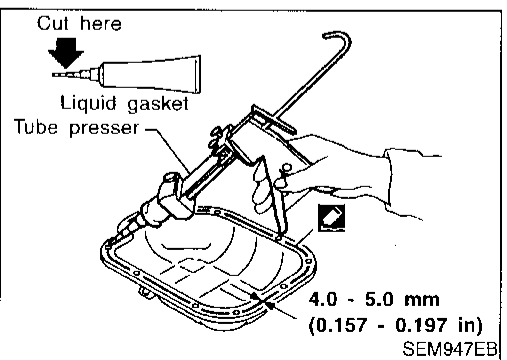
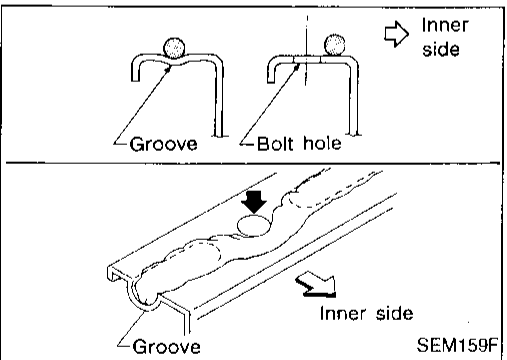
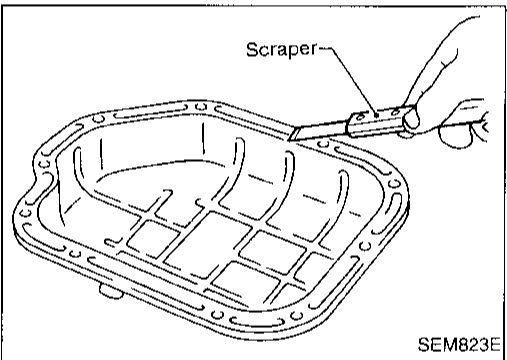
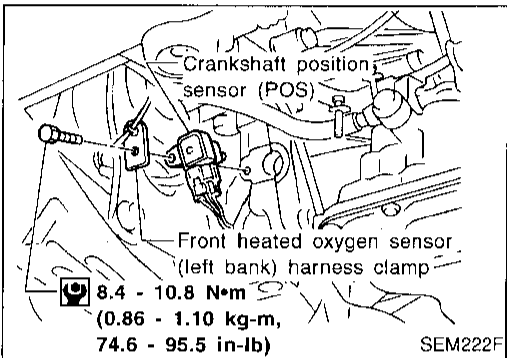
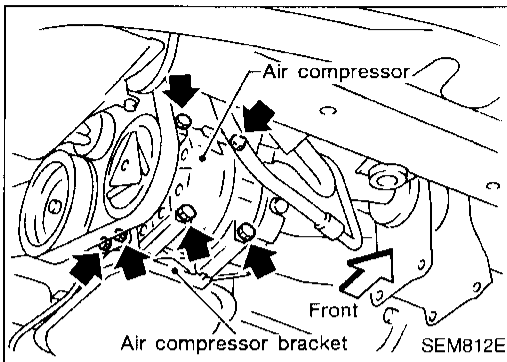
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## OIL PAN

### Installation (Cont'd)



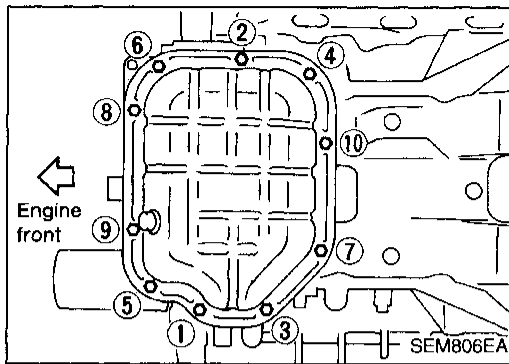
4. Install air compressor and bracket.
5. Install drive belts.
6. Install center member.
7. Install front and rear engine mounting insulator nuts and bolts.

8. Install crankshaft position sensors (POS and REF) and front heated oxygen sensor (left bank) harness clamp.
  - **Make sure that crankshaft position sensor (POS) and front heated oxygen sensor (left bank) harness clamp are installed correctly as shown in figure.**
9. Install front exhaust tube and its support.
10. Install oil strainer.

11. Install steel oil pan.
  - a. Use a scraper to remove all traces of liquid gasket from mating surfaces.
    - Also remove traces of liquid gasket from mating surface of aluminum oil pan.
  - b. Apply a continuous bead of liquid gasket to mating surface of steel oil pan.
    - Use **Genuine RTV silicone sealant Part No. 999MP-A7007 or equivalent.**
    - **Be sure liquid gasket is 4.0 to 5.0 mm (0.157 to 0.197 in) wide.**
    - **Attaching should be done within 5 minutes after coating.**

## OIL PAN

### Installation (Cont'd)



c. Install steel oil pan.

- Tighten in numerical order shown in the figure.
- Wait at least 30 minutes before refilling engine oil.

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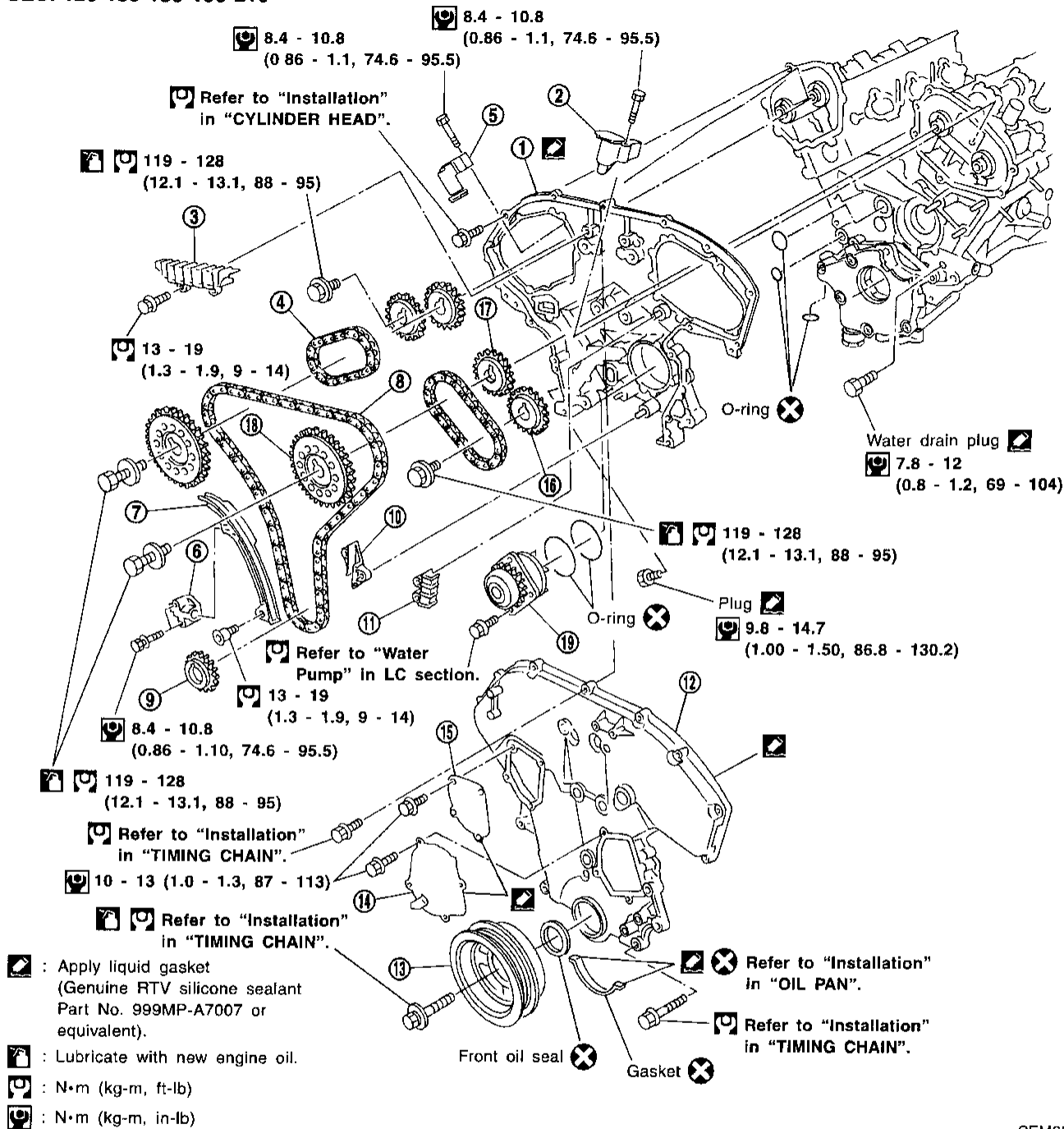
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# TIMING CHAIN

SEC. 120•130•135•150•210



SEM651FA

- |                                  |                           |                                 |
|----------------------------------|---------------------------|---------------------------------|
| ① Rear timing chain case         | ⑧ Timing chain            | ⑭ Water pump cover              |
| ② Left camshaft chain tensioner  | ⑨ Crankshaft sprocket     | ⑮ Chain tensioner cover         |
| ③ Internal chain guide           | ⑩ Lower chain guide       | ⑯ Exhaust camshaft sprocket 2ND |
| ④ Camshaft chain                 | ⑪ Upper chain guide       | ⑰ Intake camshaft sprocket 2ND  |
| ⑤ Right camshaft chain tensioner | ⑫ Front timing chain case | ⑱ Camshaft sprocket 1ST         |
| ⑥ Timing chain tensioner         | ⑬ Crankshaft pulley       | ⑲ Water pump                    |
| ⑦ Slack side chain guide         |                           |                                 |

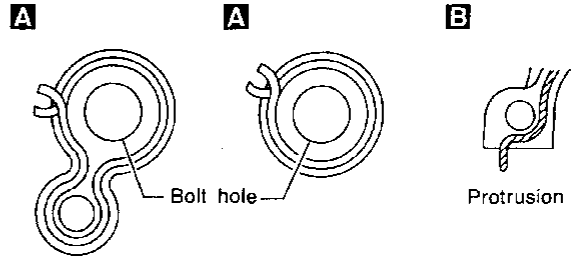
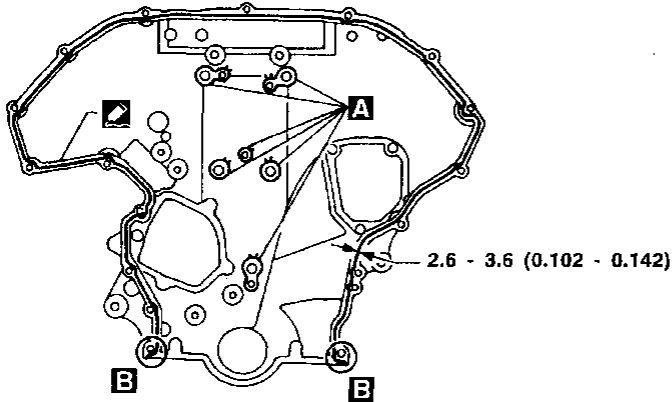
# TIMING CHAIN

## POSITION FOR APPLYING LIQUID GASKET

Refer to "Installation" in "OIL PAN" for installing oil pan (EM-16).

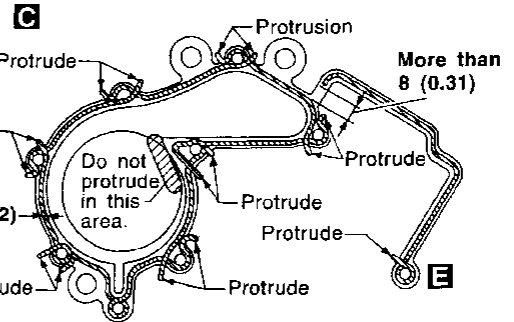
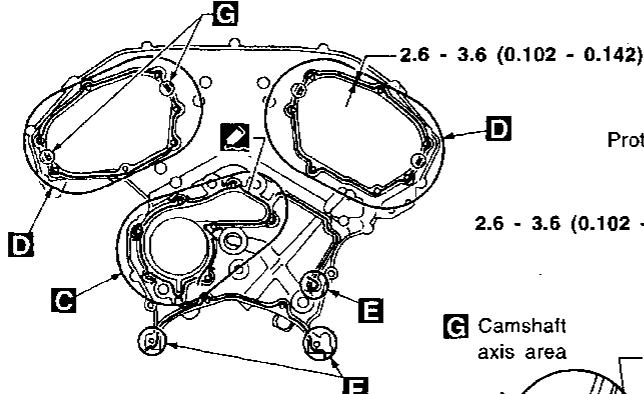
- Before installation, wipe off the protruding sealant.

### Front timing chain case

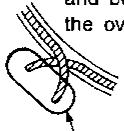


Sealant protrusion away from bolt hole

### Rear timing chain case



**D** Cross both ends as shown and be sure to minimize the overlapped area.



Protrusions at beginning and end of liquid gasket

**G** Camshaft axis area

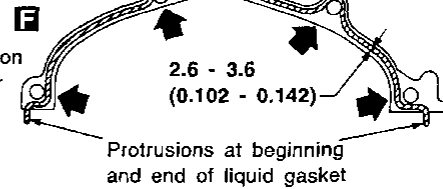
Center line of liquid gasket

\*1

Joint portion of cylinder head and camshaft bracket

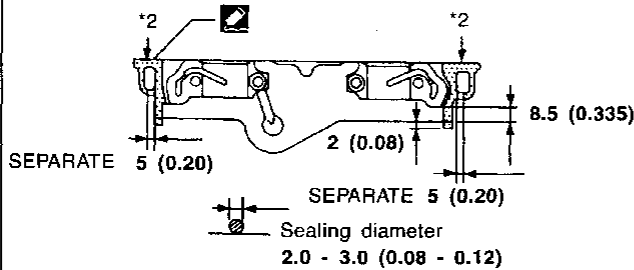
Center line of rear timing chain case sealant groove

← : Run along bolt hole outer side.



\*1 : Apply liquid gasket to the chamfered surface between camshaft bracket and cylinder head.

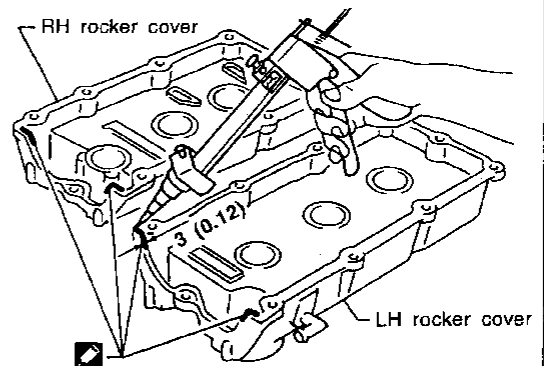
### Camshaft bracket



\*2 : Remove the protruding sealant from front face.  
(Remove the hardened sealant from surface only.)

Unit: mm (in)

### Rocker cover



SEM443FA

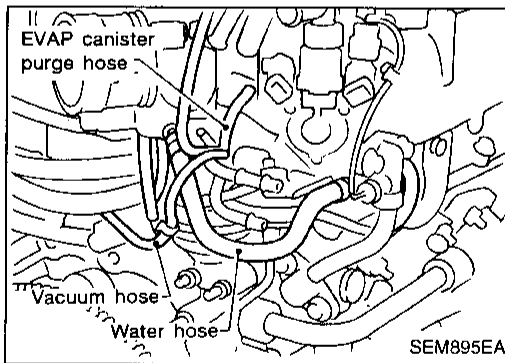
# TIMING CHAIN

## CAUTION:

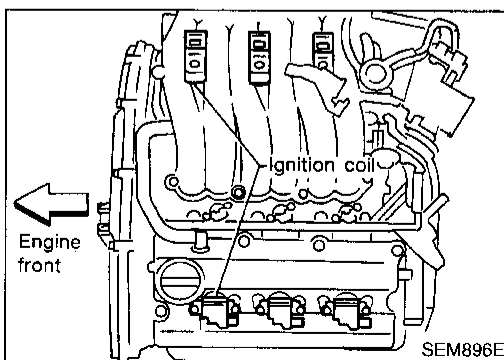
- After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.
- When installing camshafts, chain tensioners, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.
- Apply new engine oil to bolt threads and seat surfaces when installing cylinder head, camshaft sprockets, crankshaft pulley, and camshaft brackets.
- Before disconnecting fuel hose, release fuel pressure. Refer to EC section ("Fuel Pressure Release", "BASIC SERVICE PROCEDURE").
- When removing the oil pans, oil pump assembly and timing chain from engine, first remove the camshaft position sensor (PHASE) and the crankshaft position sensors (REF)/(POS) from the assembly.  
Be careful not to damage sensor edges.
- Do not spill engine coolant on drive belts.

## Removal

1. Drain engine oil.
2. Release fuel pressure.  
Refer to "Fuel Pressure Release" in EC section.
3. Drain coolant by removing cylinder block drain plugs (refer to "Water pump" in LC section) and radiator drain cock.
4. Remove left side ornament cover.
5. Remove air duct to intake manifold, collector, blow-by hose, vacuum hoses, fuel hoses, wires, harness, connectors and so on.



6. Remove the following.
  - Vacuum hoses
  - Water hoses
  - EVAP canister purge hose
  - Blow-by hose

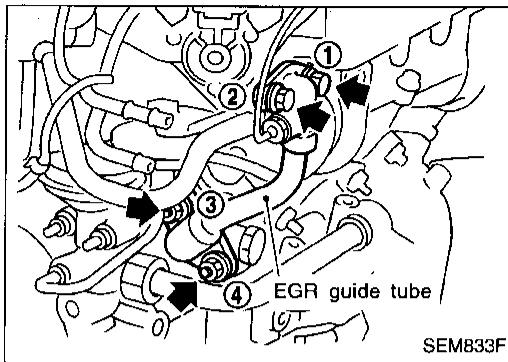


7. Remove RH and LH ignition coils.

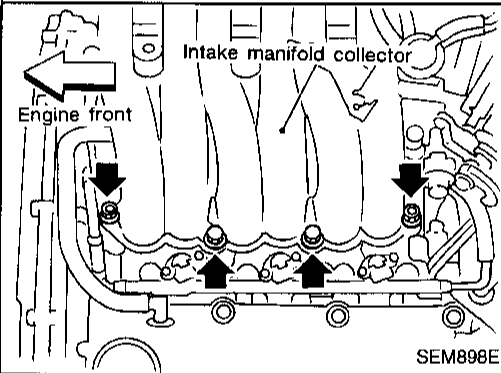
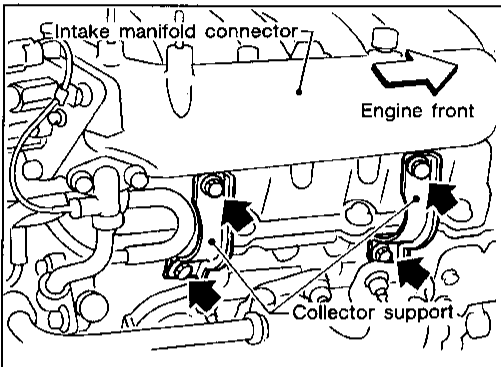
# TIMING CHAIN

## Removal (Cont'd)

8. Remove EGR guide tube.

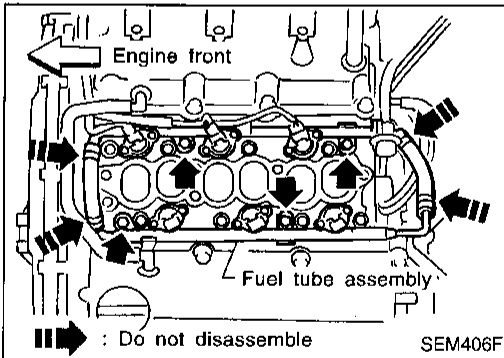


9. Remove intake manifold collector supports and intake manifold collector (RH cylinder head only).

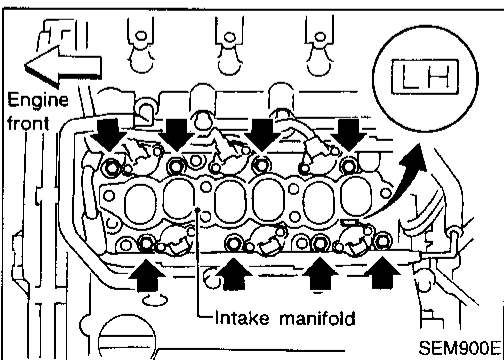


10. Remove fuel tube assembly.

- Do not disassemble fuel tube assembly.



11. Remove intake manifold in reverse order of installation. Refer to "TIGHTENING PROCEDURES" in "OUTER COMPONENT PARTS" (EM-10).



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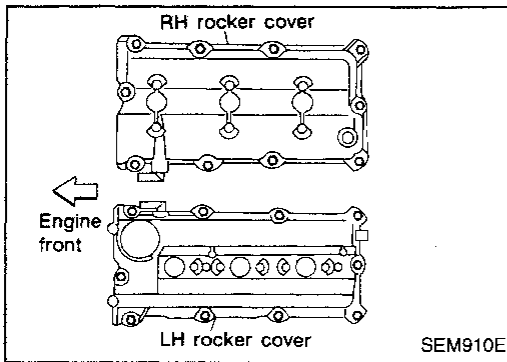
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## TIMING CHAIN

### Removal (Cont'd)

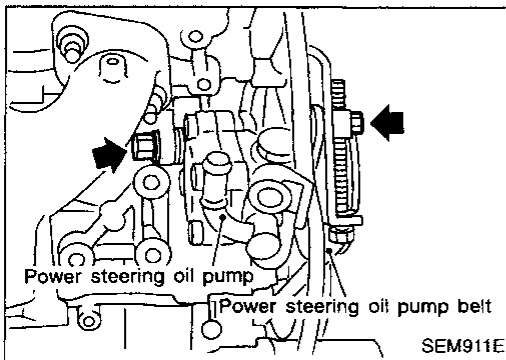


12. Remove RH and LH rocker covers from cylinder head.

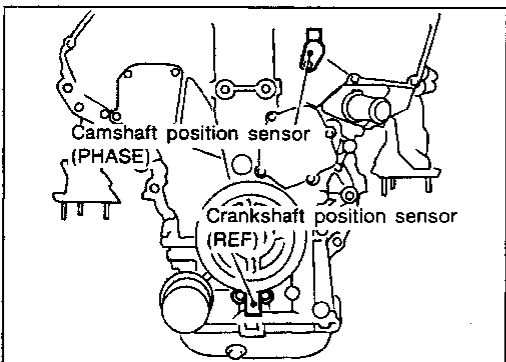
13. Remove engine undercover.

14. Remove front RH wheel and engine side cover.

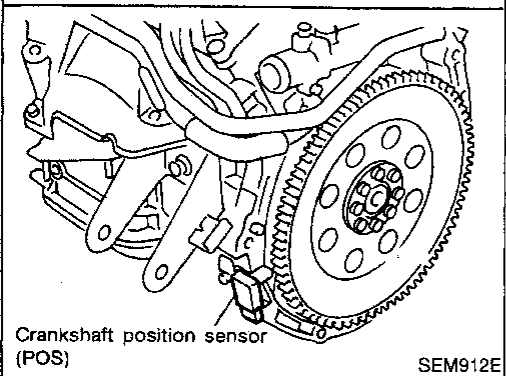
15. Remove drive belts and idler pulley bracket.



16. Remove power steering oil pump belt and power steering oil pump assembly.



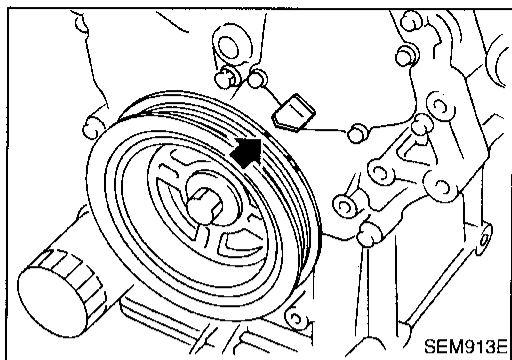
17. Remove camshaft position sensor (PHASE) and crankshaft position sensors (REF)/(POS).



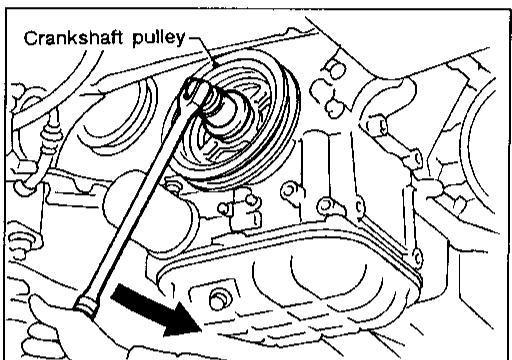


## TIMING CHAIN

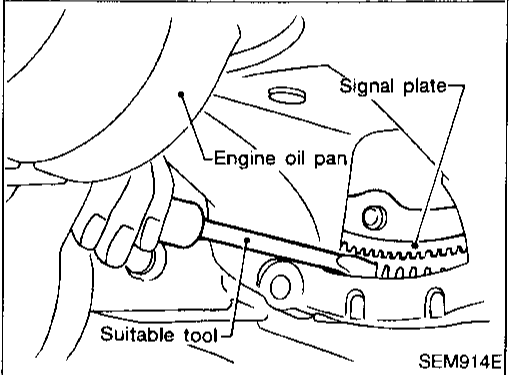
### Removal (Cont'd)



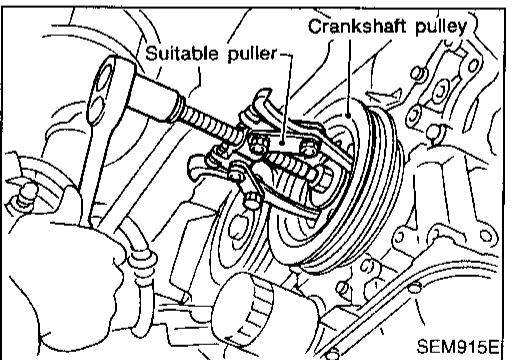
18. Set No. 1 piston at TDC on the compression stroke by rotating crankshaft.



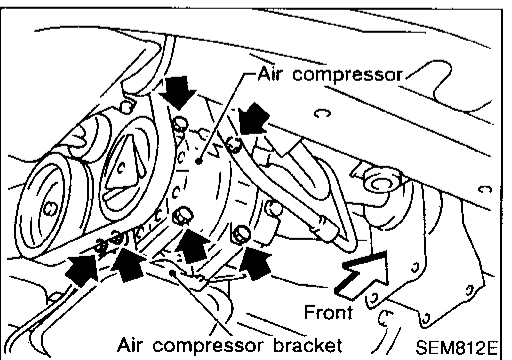
19. Loosen crankshaft pulley bolt. (At this time remove oil pan rear cover plate and set a suitable tool to ring gear so that crankshaft cannot rotate.)



- Be careful not to damage the signal plate teeth.



20. Remove crankshaft pulley with a suitable puller.



21. Remove air compressor and bracket.  
22. Remove front exhaust tube and its support.  
23. Hang engine at right and left side engine slingers with a suitable hoist.  
24. Remove right side engine mounting, mounting bracket and nuts.  
25. Remove center member assembly.  
26. Remove upper and lower oil pans.
- For procedures described in steps 21 through 26, refer to "Removal" in "OIL PAN" (EM-13).

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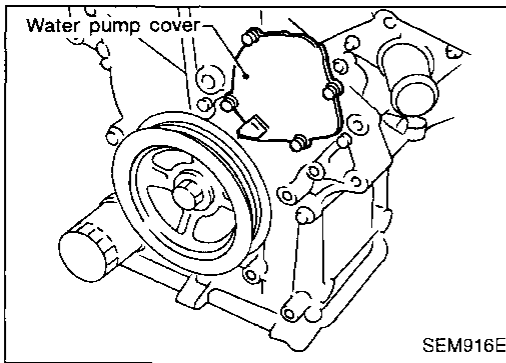
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## TIMING CHAIN

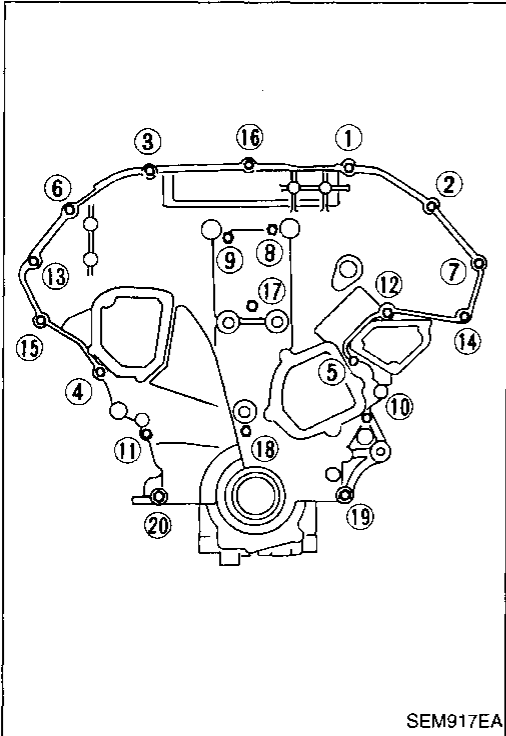
### Removal (Cont'd)

27. Remove water pump cover.



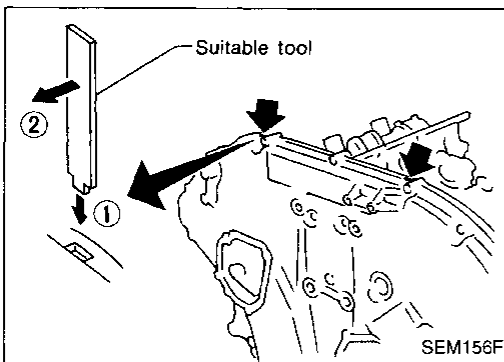
28. Remove front timing chain case bolts.

- Loosen bolts in numerical order as shown in the figure.



29. Remove front timing chain case.

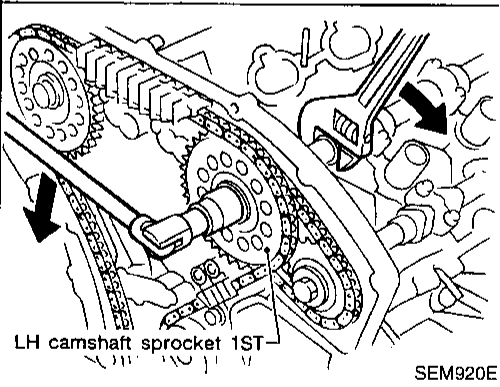
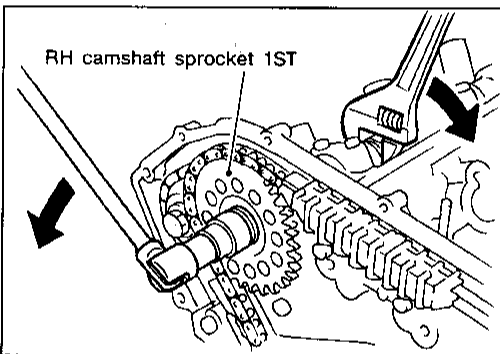
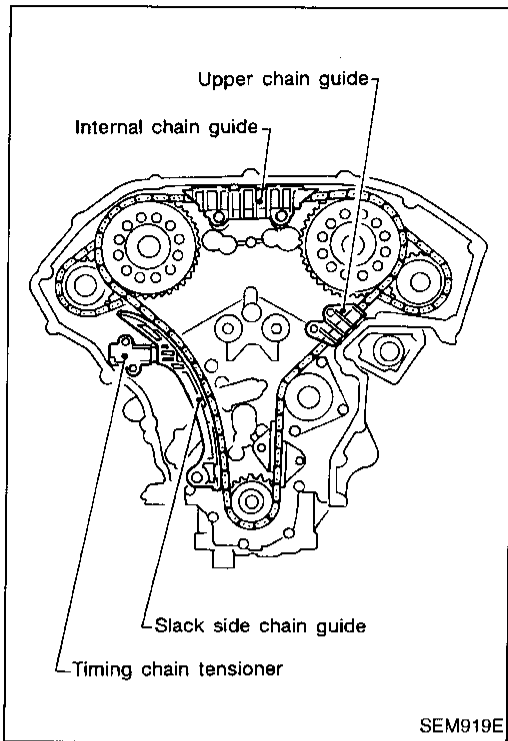
- Do not scratch sealing surfaces.



## TIMING CHAIN

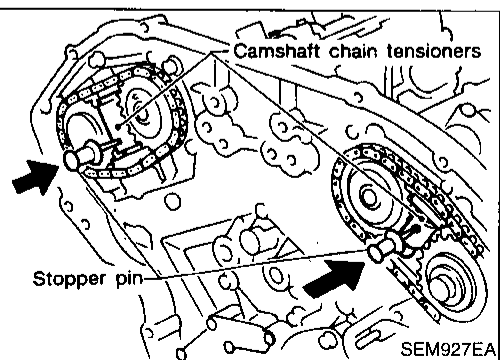
### Removal (Cont'd)

30. Remove internal timing chain guide.
31. Remove upper chain guide.
32. Remove timing chain tensioner and slack side chain guide.



33. Remove RH & LH camshaft sprocket 1ST bolts.
34. Remove camshaft sprockets 1ST on both sides, crankshaft sprocket and timing chain.

- **Apply paint to timing chain and camshaft sprockets 1ST for alignment during installation.**



35. Attach a suitable stopper pin to RH and LH camshaft chain tensioners.

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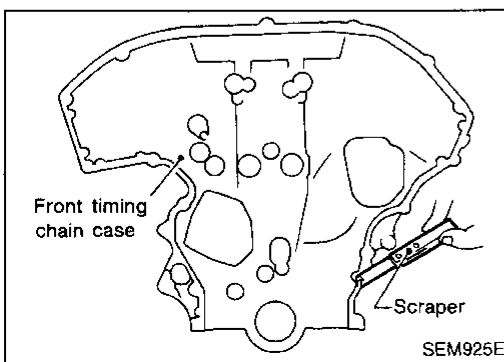
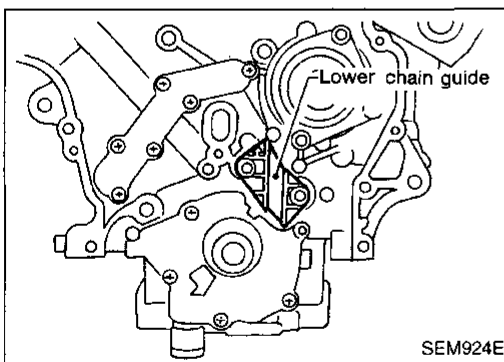
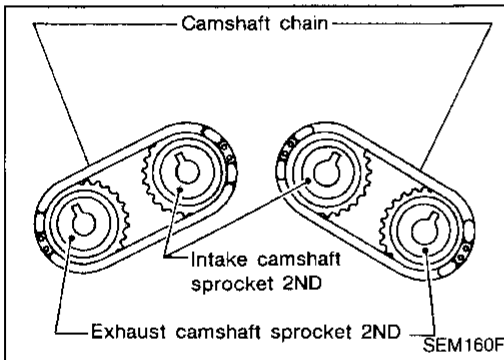
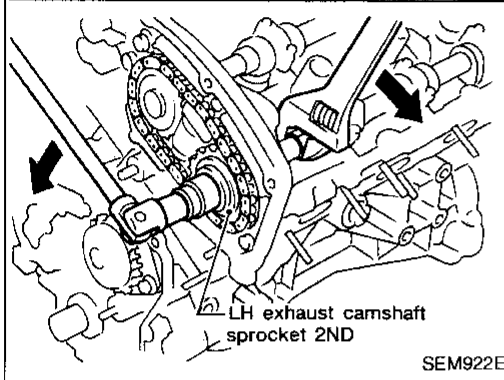
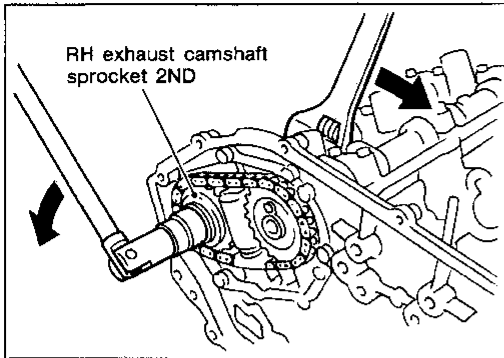
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## TIMING CHAIN

### Removal (Cont'd)



36. Remove exhaust camshaft sprocket 2ND bolts on both sides.

- Apply paint to timing chain and camshaft sprockets 2ND for alignment during installation.

37. Remove exhaust camshaft sprockets 2ND, intake camshaft sprockets 2ND and camshaft chains on both sides.

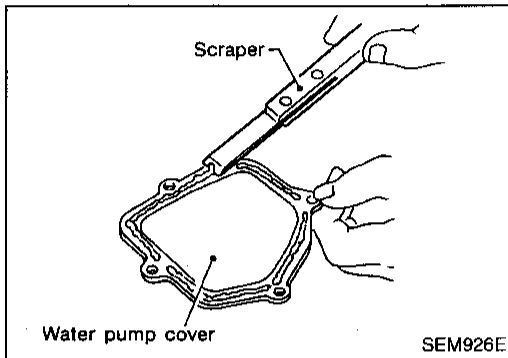
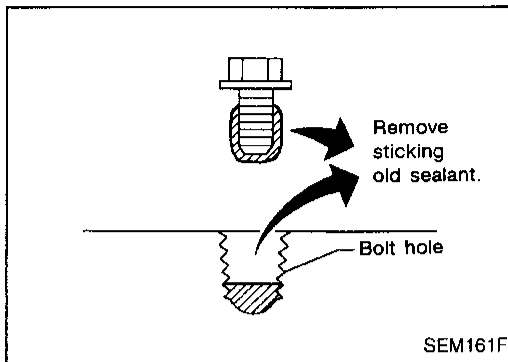
38. Remove lower chain guide.

39. Use a scraper to remove all traces of liquid gasket from front timing chain case.

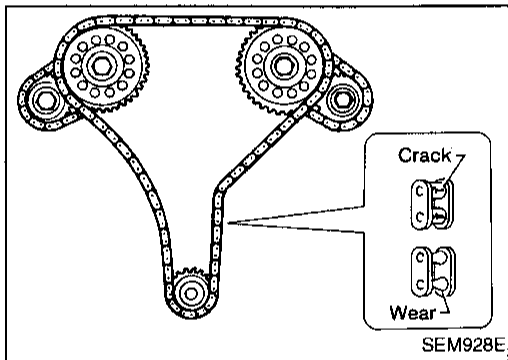
# TIMING CHAIN

## Removal (Cont'd)

- Remove old liquid gasket from the bolt hole and thread.

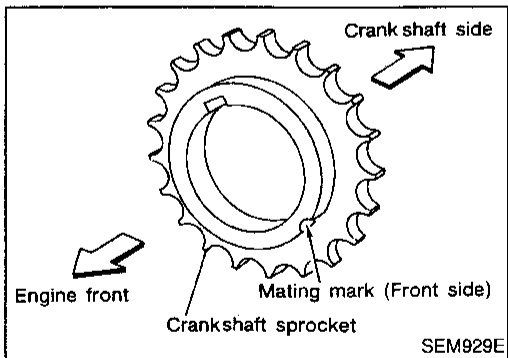


40. Use a scraper to remove all traces of liquid gasket from water pump cover.



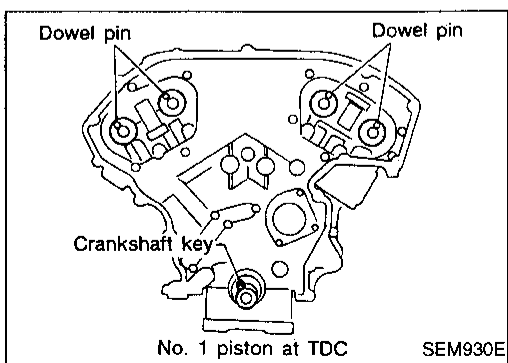
## Inspection

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



## Installation

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



2. Position crankshaft so that No. 1 piston is set at TDC on compression stroke.

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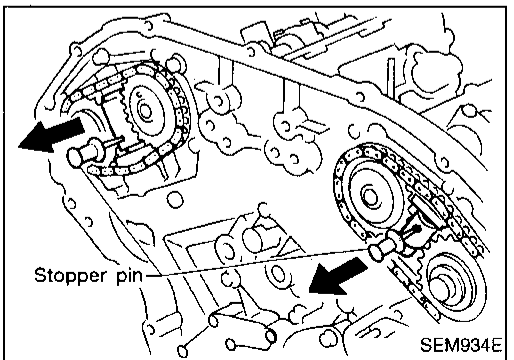
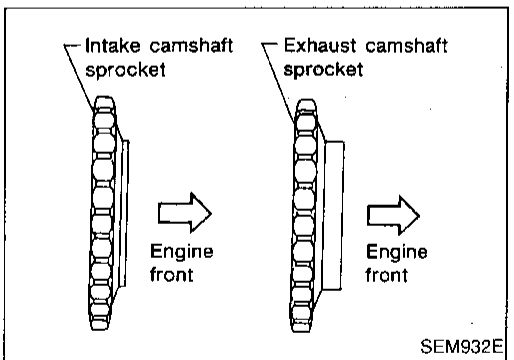
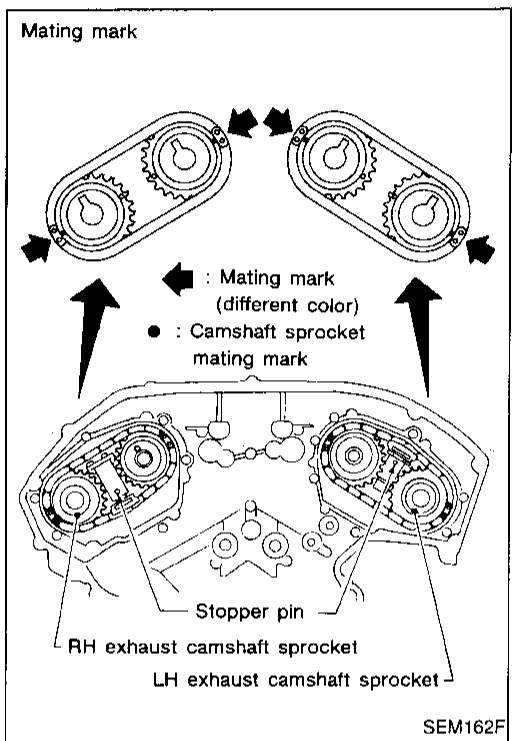
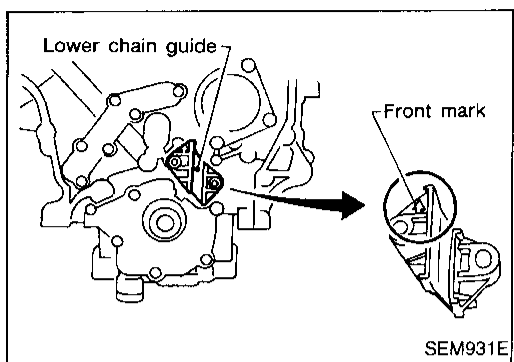
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## TIMING CHAIN

### Installation (Cont'd)



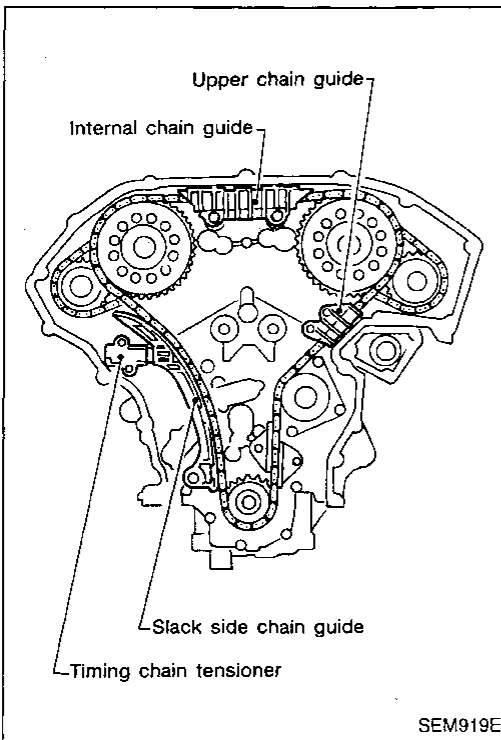
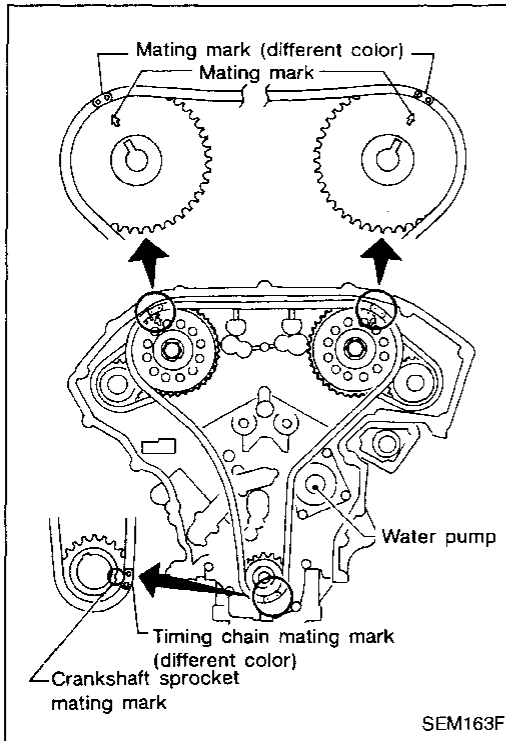
3. Install lower chain guide on dowel pin, with front mark on the guide facing upside.
  4. Align the marks on RH and LH intake camshaft sprockets 2ND, exhaust camshaft sprockets 2ND and camshaft chain, as shown.
  5. Put LH camshaft dowel pin into camshaft sprocket dowel groove and install these on camshaft. Tighten LH exhaust camshaft sprocket 2ND bolt.
  6. Put RH camshaft dowel pin in camshaft sprocket dowel groove and install sprocket on camshaft.
  7. Tighten RH exhaust camshaft sprocket 2ND bolt.
- **Make sure that the timing marks on RH and LH intake camshaft sprockets 2ND are aligned with the camshaft chain mark.**
  - **Lubricate threads and seat surfaces of camshaft sprocket bolts with new engine oil.**

- **Be careful not to confuse intake and exhaust camshaft sprockets 2ND (their thicknesses are different).**

8. Remove RH and LH camshaft chain tensioner stopper pins.

## TIMING CHAIN

### Installation (Cont'd)



9. Align mating mark on crankshaft sprocket with matchmark on chain as shown.
  10. Attach lower timing chain on the water pump sprocket.
  11. Install RH and LH camshaft sprockets 1ST onto camshafts by matching sprocket dowel grooves with camshaft.
  12. Tighten RH and LH camshaft sprocket 1ST bolts.
- **Lubricate threads and seat surfaces of the bolts with new engine oil.**
13. Install timing chain. Make sure that mating marks on crankshaft sprocket and RH and LH camshaft sprockets are aligned with matchmarks on timing chain.

14. Install internal chain guide.
  15. Install upper chain guide.
  16. Install timing chain tensioner and slack side chain guide.
  17. Apply liquid gasket to front timing chain case.
- Refer to "POSITION FOR APPLYING LIQUID GASKET" (EM-21).
  - **Before installation, wipe off the protruding sealant.**

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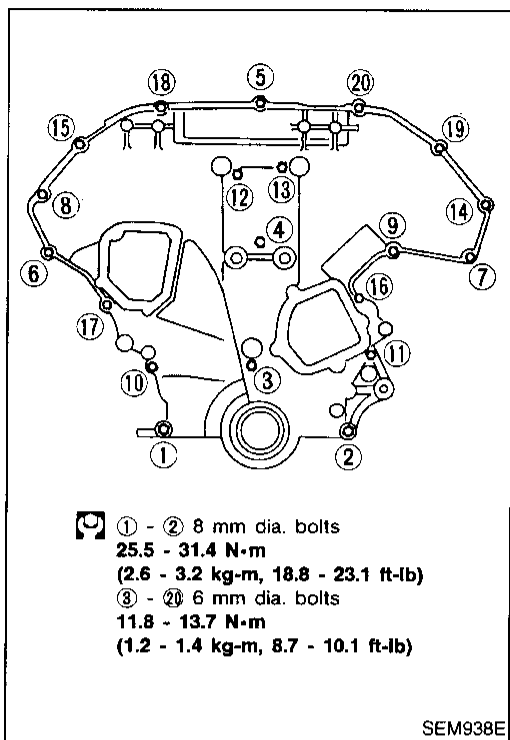
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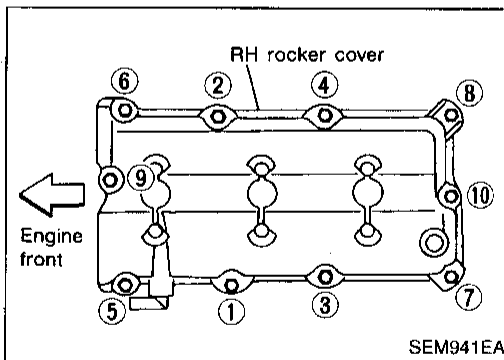
## TIMING CHAIN

### Installation (Cont'd)



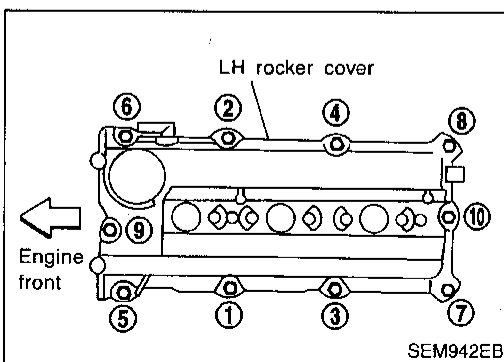
18. Install rear case pin into dowel pin hole on front timing chain case.
19. Tighten bolts to the specified torque in order shown in the figure.
  - Leave the bolts unattended for 30 minutes or more after tightening.

20. Apply liquid gasket to water pump cover.
  - Apply a continuous bead of liquid gasket to mating surface of water pump cover. Refer to LC section ("Water Pump Installation").
21. Install water pump cover.
22. Apply liquid gasket to RH and LH rocker covers.
  - Use genuine liquid gasket or equivalent.
  - Refer to "POSITION FOR APPLYING LIQUID GASKET" (EM-21).



23. Install RH and LH rocker covers.
- Rocker cover tightening procedure:**

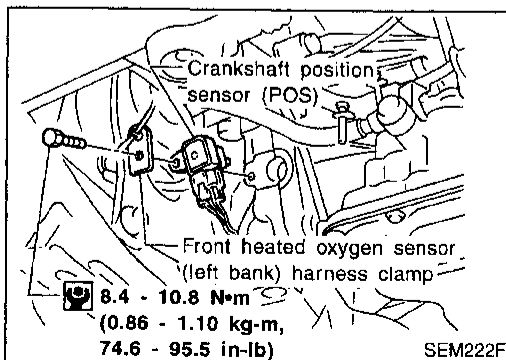
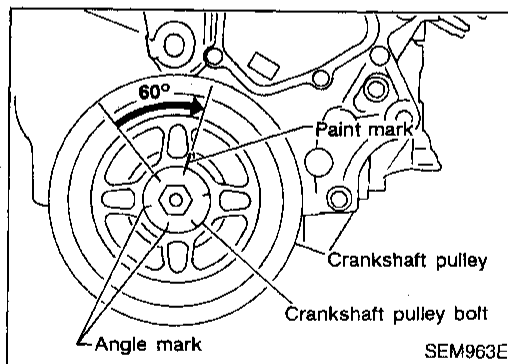
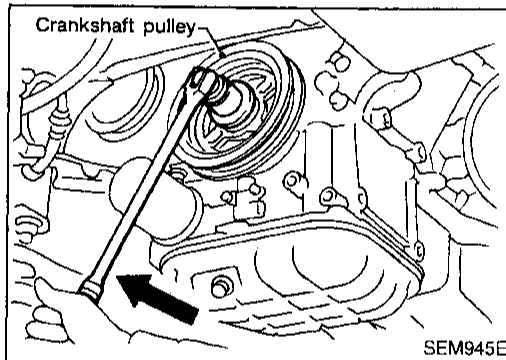
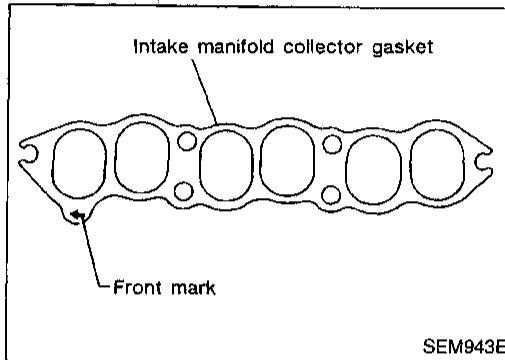
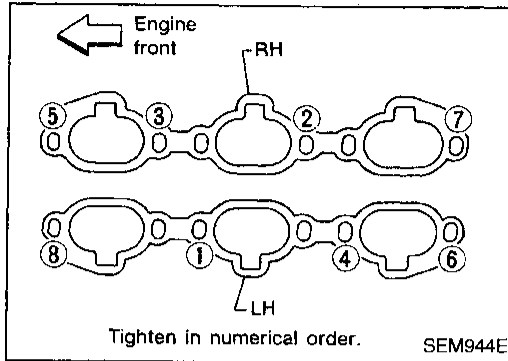
- Tighten in numerical order as shown in the figure.
  - a. Tighten bolts ① to ⑩ in that order to 1 to 3 N·m (0.1 to 0.3 kg-m, 9 to 26 in-lb).
  - b. Tighten bolts ① to ⑩ as indicated in figure to 5.4 to 7.4 N·m (0.55 to 0.75 kg-m, 47.7 to 65.1 in-lb).





## TIMING CHAIN

### Installation (Cont'd)



24. Install intake manifold. Tighten intake manifold nuts and bolts. Refer to "TIGHTENING PROCEDURES" in "OUTER COMPONENT PARTS" (EM-10).

25. Install fuel tube assembly.

26. Install intake manifold collector gasket, with its front mark facing forwards.

27. Install intake manifold collector, supports and intake manifold collector bolt.

28. Install EGR guide tube.

Refer to "TIGHTENING PROCEDURES" in "OUTER COMPONENT PARTS" (EM-10).

29. Install RH and LH ignition coils.

30. Install rocker cover ornament on left side.

31. Install crankshaft pulley to crankshaft.

- Lubricate thread and seat surface of the bolt with new engine oil.

a. Tighten to 39 to 49 N·m (4.0 to 5.0 kg-m, 29 to 36 ft-lb).

b. Put a paint mark on the crankshaft pulley.

c. Again tighten by turning 60° to 66°, about the angle from one hexagon bolt head corner to another.

32. Install camshaft position sensor (PHASE), crankshaft position sensors (REF)/(POS) and front heated oxygen sensor (left bank) harness clamp.

- Make sure that crankshaft position sensor (POS) and front heated oxygen sensor (left bank) harness clamp are installed correctly as shown in figure.

33. Reinstall removed parts in reverse order of removal.

- When installing fuel tube assembly, refer to "Injector Removal and Installation" in EC section.

- After installing the tensioner, race the engine at about 3,000 rpm under no load to purge air from the high-pressure chamber. The engine may produce a rattling noise. This indicates that air still remains in the chamber and is not a matter of concern.

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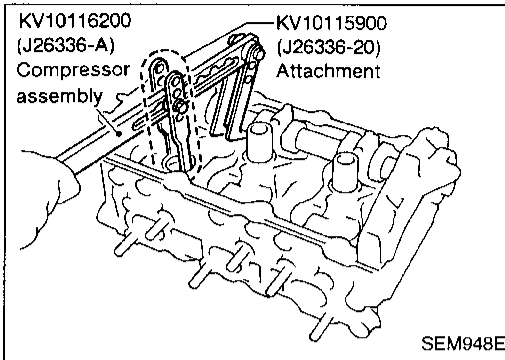
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# OIL SEAL REPLACEMENT



## CAUTION:

When removing the oil pans, oil pump assembly and timing chain from engine, first remove the camshaft position sensor (PHASE) and the crankshaft position sensors (REF)/(POS) from the assembly.

Be careful not to damage sensor edges.

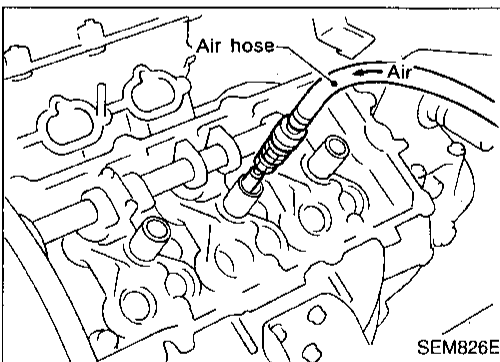
## VALVE OIL SEAL

1. Remove LH ornament cover.
2. Remove RH and LH ignition coils.
3. Remove EGR guide tube.
4. Remove intake manifold collector supports and intake manifold collector (RH cylinder head only).
5. Remove RH and LH rocker covers from cylinder head.
6. Remove camshaft position sensor (PHASE) and crankshaft position sensors (REF)/(POS).
7. Remove oil pan. (Refer to "Removal" in "OIL PAN", EM-13.)
8. Remove timing chain. (Refer to "Removal" in "TIMING CHAIN", EM-22.)
9. Remove camshaft brackets and camshaft. (Refer to "Disassembly" in "CYLINDER HEAD", EM-38.)
10. Remove valve lifters and shims.
11. Remove valve spring with Tool.
12. Reinstall any parts removed in reverse order of removal.

Before removing valve spring, fix valve as follows.

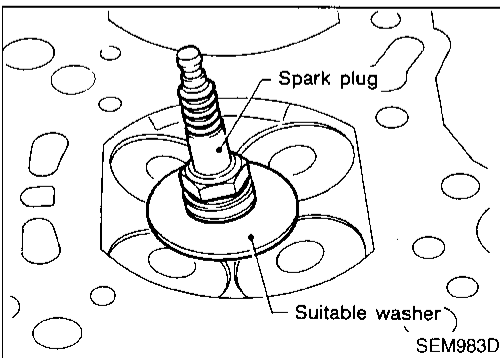
### Method A:

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



### Method B:

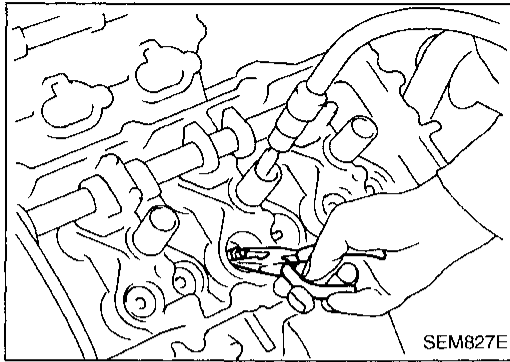
Remove spark plug, then install air hose adapter into spark plug hole and apply air pressure to hold valves in place. Apply a pressure of 490 kPa (5 kg/cm<sup>2</sup>, 71 psi).



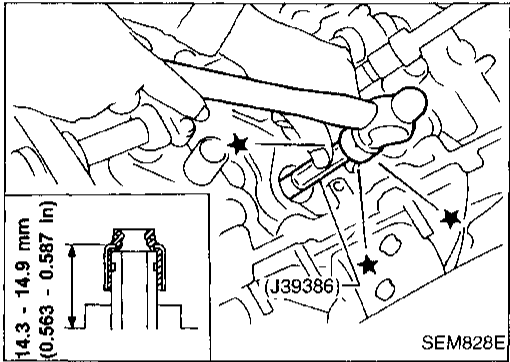
### Method C:

Install spark plug with suitable washer into spark plug hole from combustion chamber side.

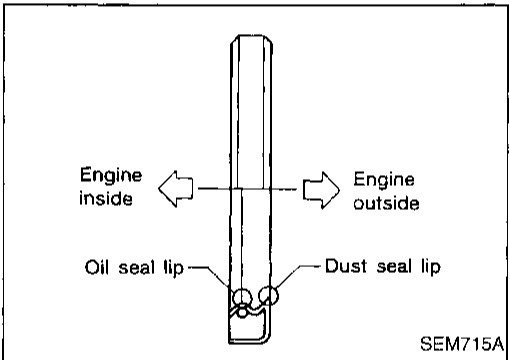
# OIL SEAL REPLACEMENT



13. Remove valve oil seal.



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



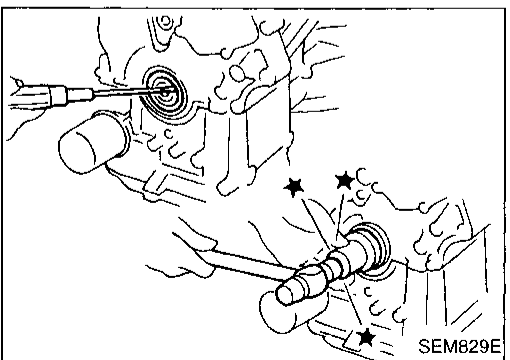
## OIL SEAL INSTALLATION DIRECTION

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

## FRONT OIL SEAL

1. Remove the following parts:
  - Engine undercover
  - Front RH wheel and engine side cover
  - Drive belts
  - Crankshaft position sensor (REF)
  - Crankshaft pulley

**Be careful not to damage sensor edge.**

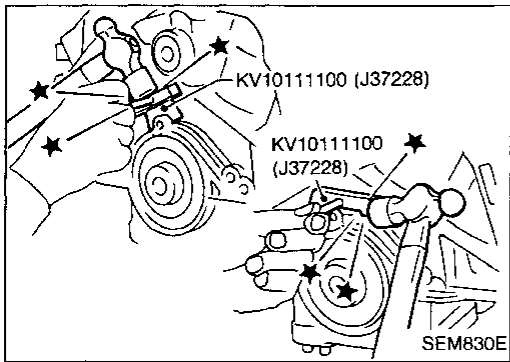


2. Remove front oil seal using a suitable tool.

**Be careful not to scratch front cover.**

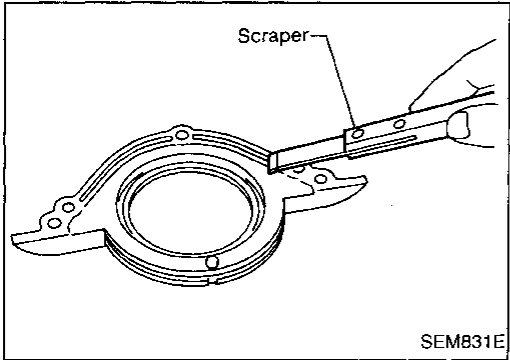
3. Apply engine oil to new oil seal and install it using a suitable tool.

# OIL SEAL REPLACEMENT

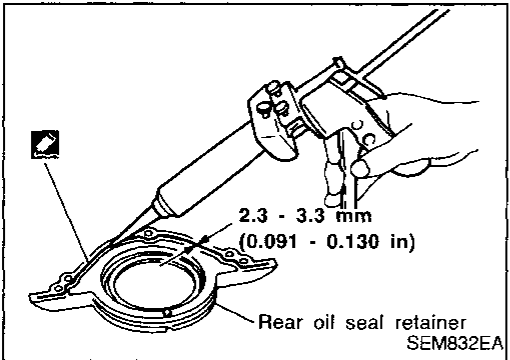


## REAR OIL SEAL

1. Remove transaxle. (Refer to MT or AT section.)
2. Remove flywheel or drive plate.
3. Remove oil pan. (Refer to OIL PAN.)
4. Remove rear oil seal retainer.



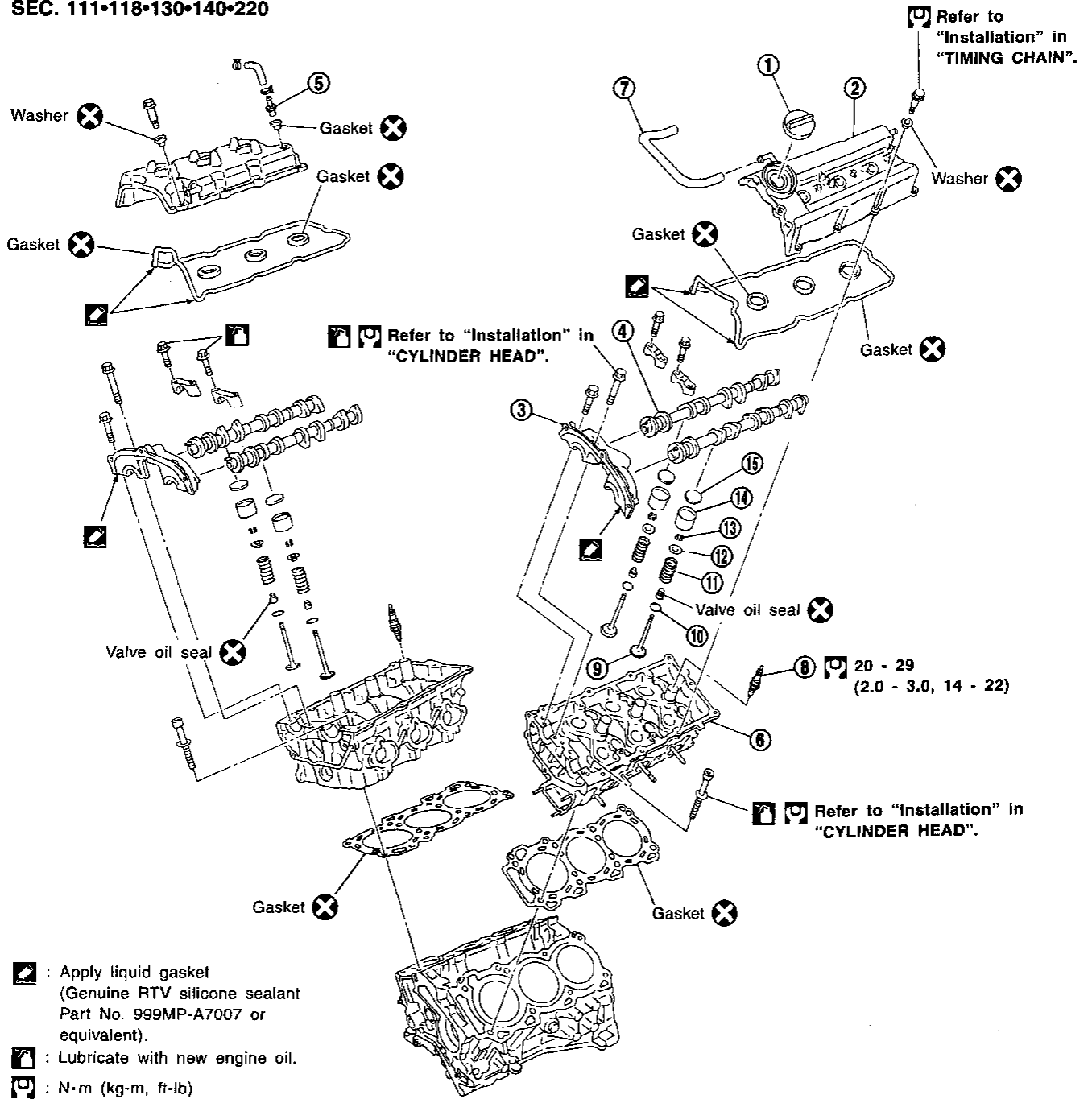
5. Remove traces of liquid gasket using scraper.
  - Remove old liquid gasket from the bolt hole and thread.



6. Apply liquid gasket to rear oil seal retainer.

# CYLINDER HEAD

SEC. 111•118•130•140•220



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

- ① Oil filler cap
- ② Rocker cover
- ③ Camshaft bracket
- ④ Camshaft
- ⑤ PCV valve

- ⑥ Cylinder head
- ⑦ Blow-by hose
- ⑧ Spark plug
- ⑨ Valve
- ⑩ Valve spring seat

- ⑪ Valve spring
- ⑫ Valve spring retainer
- ⑬ Valve collet
- ⑭ Valve lifter
- ⑮ Shim

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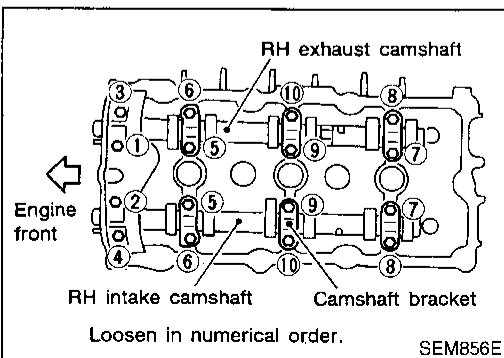
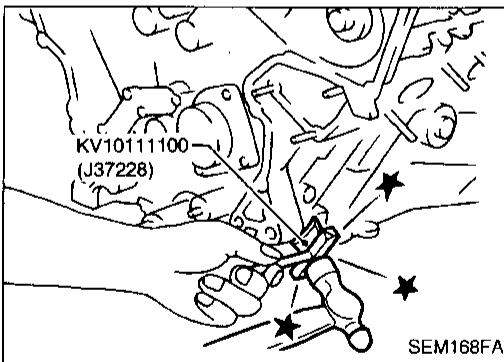
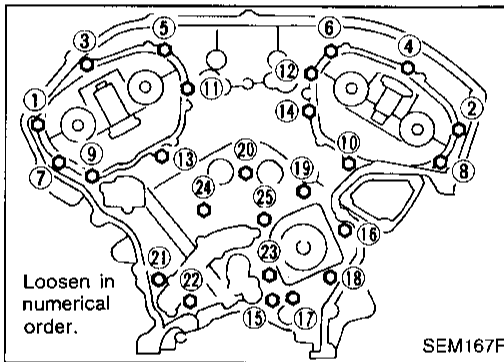
# CYLINDER HEAD

## CAUTION:

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

## Removal

- This removal is the same procedure as that for timing chain. Refer to "Removal" in "TIMING CHAIN" (EM-22).
- Apply paint to camshaft sprockets for alignment during installation.



## Disassembly

1. Remove rear timing chain case bolts.

2. Remove rear timing chain case.

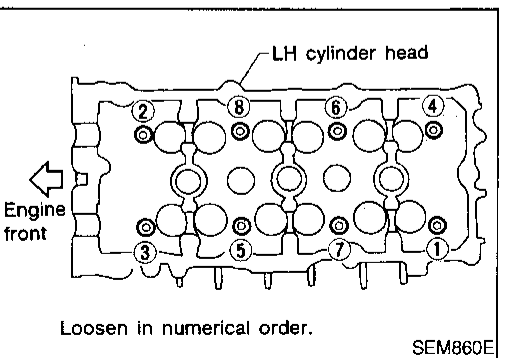
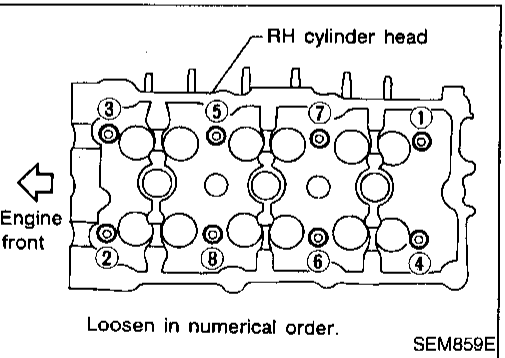
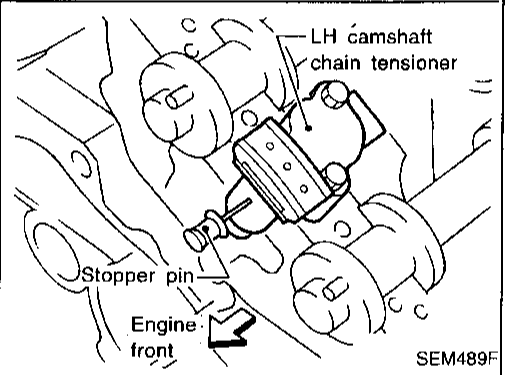
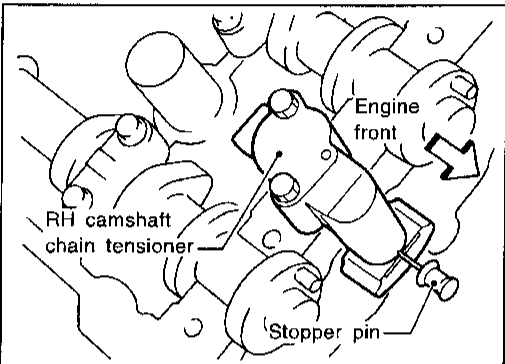
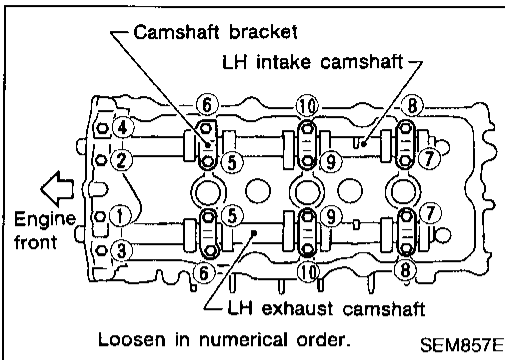
3. Remove intake and exhaust camshafts and camshaft brackets.
  - Equally loosen camshaft bracket bolts in several steps in the numerical order shown in the figure.

**For reinstallation, be sure to put marks on camshaft bracket before removal.**

4. Remove valve component parts.  
Refer to "VALVE OIL SEAL" in "OIL SEAL REPLACEMENT" (EM-34).

# CYLINDER HEAD

## Disassembly (Cont'd)



5. Remove RH and LH camshaft chain tensioners from cylinder head.

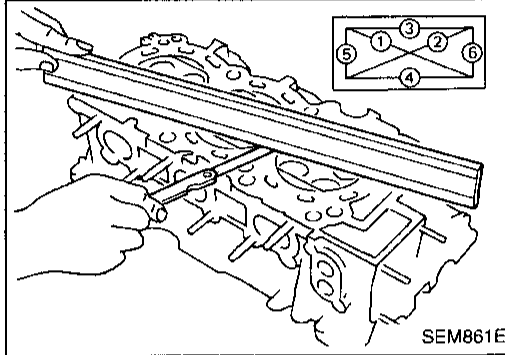
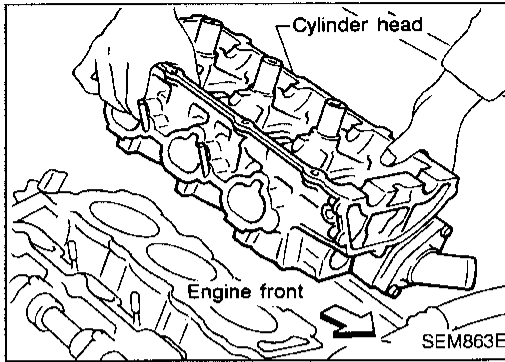
6. Remove cylinder head bolts.
  - **Cylinder head bolts should be loosened in two or three steps.**
  - **A warped or cracked cylinder head could result from removing in incorrect order.**

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## CYLINDER HEAD

### Disassembly (Cont'd)

7. Remove cylinder head.



### Inspection

#### CYLINDER HEAD DISTORTION

Clean surface of cylinder head.

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

Check along six positions shown in the figure.

**Head surface flatness: Limit 0.1 mm (0.004 in)**

If beyond the specified limit, resurface or replace it.

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

#### Resurfacing limit:

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

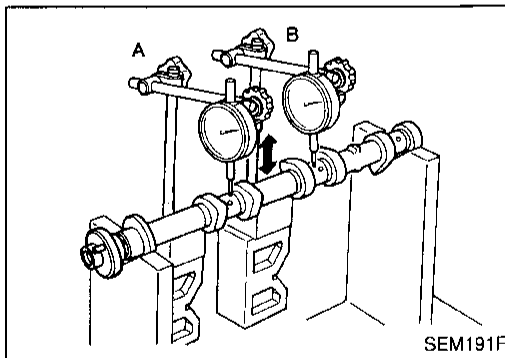
**Amount of cylinder block resurfacing is "B".**

**The maximum limit :  $A + B = 0.2 \text{ mm (0.008 in)}$**

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

**Nominal cylinder head height:**

**126.3 - 126.5 mm (4.972 - 4.980 in)**



#### CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.

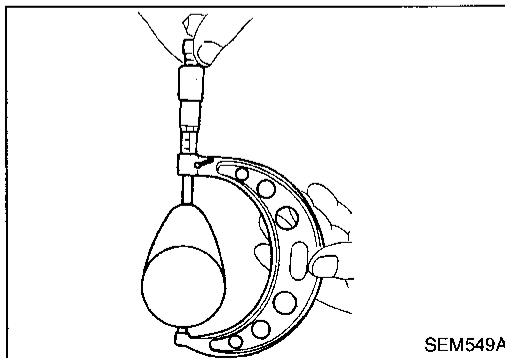
#### CAMSHAFT RUNOUT

1. Measure camshaft runout at A and B as shown in the figure.

**Runout (Total indicator reading):**

**Limit 0.05 mm (0.0020 in)**

2. If it exceeds the limit, replace camshaft.



#### CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height.

**Standard cam height:**

**43.940 - 44.130 mm (1.7299 - 1.7374 in)**

**Cam wear limit:**

**0.2 mm (0.008 in)**

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



## CYLINDER HEAD

### Inspection (Cont'd)

#### CAMSHAFT JOURNAL CLEARANCE

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

##### Standard inner diameter:

No. 1: 26.000 - 26.021 mm (1.0236 - 1.0244 in)

No. 2, 3, 4: 23.500 - 23.521 mm (0.9252 - 0.9260 in)

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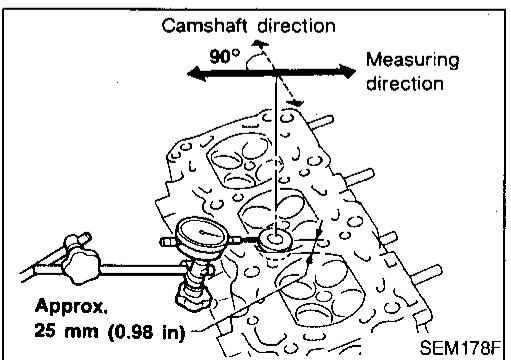
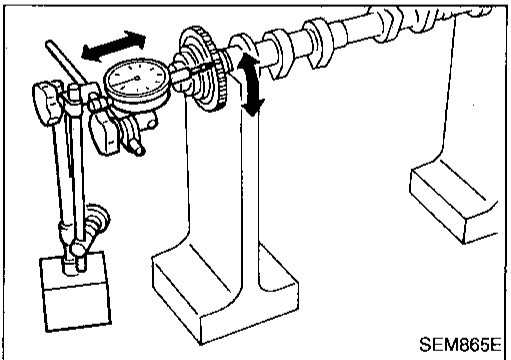
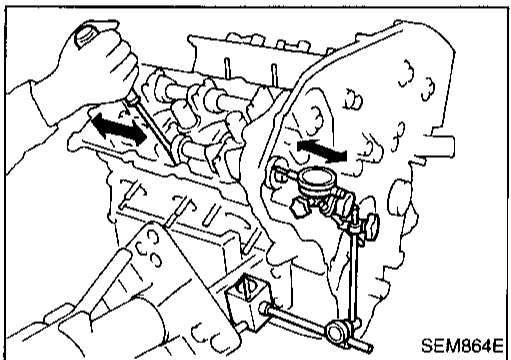
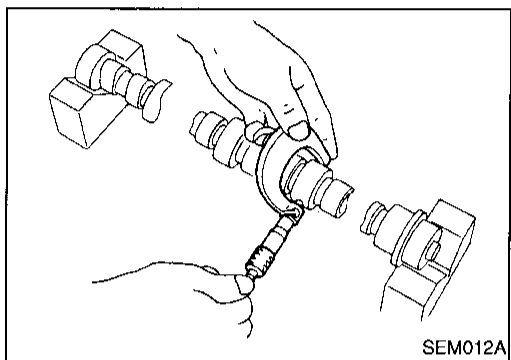
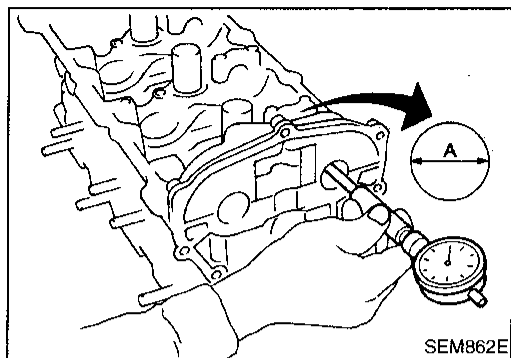
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3. Measure outer diameter of camshaft journal.

##### Standard outer diameter:

No. 1: 25.935 - 25.955 mm (1.0211 - 1.0218 in)

No. 2, 3, 4: 23.445 - 23.465 mm (0.9230 - 0.9238 in)

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

##### Camshaft journal clearance:

###### Standard

No. 1: 0.045 - 0.086 mm (0.0018 - 0.0034 in)

No. 2, 3, 4: 0.035 - 0.076 mm (0.0014 - 0.0030 in)

###### Limit

0.15 mm (0.0059 in)

#### CAMSHAFT END PLAY

1. Install camshaft in cylinder head.
2. Measure camshaft end play.

##### Camshaft end play:

###### Standard

0.115 - 0.188 mm (0.0045 - 0.0074 in)

###### Limit

0.24 mm (0.0094 in)

#### CAMSHAFT SPROCKET RUNOUT

1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.  
**Runout (Total indicator reading):**  
Less than 0.15 mm (0.0059 in)
3. If it exceeds the limit, replace camshaft sprocket.

#### VALVE GUIDE CLEARANCE

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

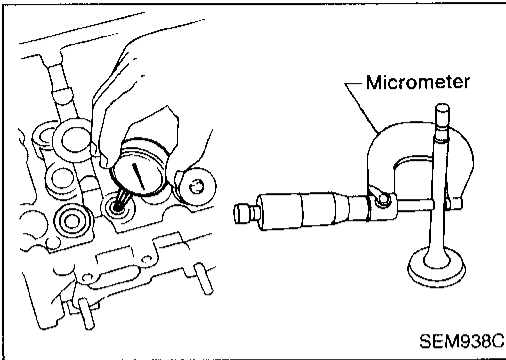
##### Valve deflection limit (Dial gauge reading):

Intake 0.24 mm (0.0094 in)

Exhaust 0.28 mm (0.0110 in)

## CYLINDER HEAD

### Inspection (Cont'd)



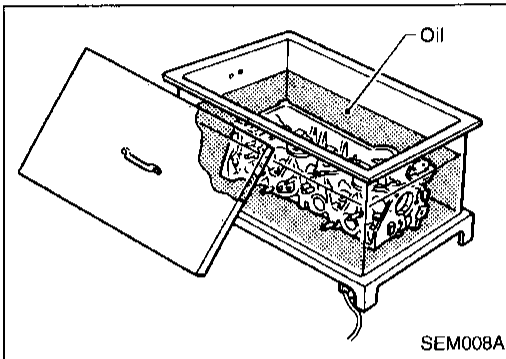
2. If it exceeds the limit, check valve to valve guide clearance.
  - a. Measure valve stem diameter and valve guide inner diameter.
  - b. Check that clearance is within specification.

#### Valve to valve guide clearance limit:

Intake 0.08 mm (0.0031 in)

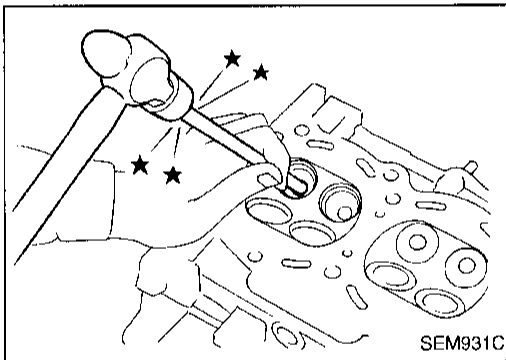
Exhaust 0.1 mm (0.004 in)

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

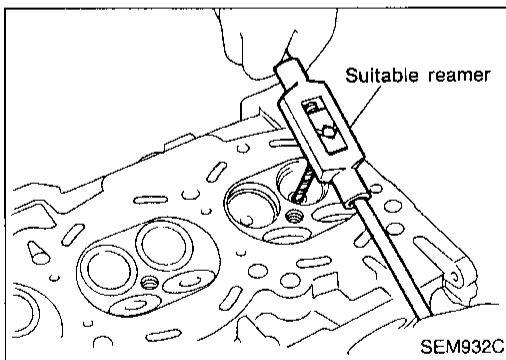


### VALVE GUIDE REPLACEMENT

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



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

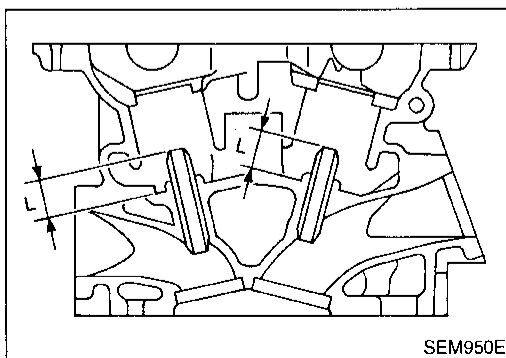


3. Ream cylinder head valve guide hole.

#### Valve guide hole diameter

(for service parts):

10.175 - 10.196 mm (0.4006 - 0.4014 in)



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

#### Projection "L":

12.6 - 12.8 mm (0.496 - 0.504 in)

5. Ream valve guide.

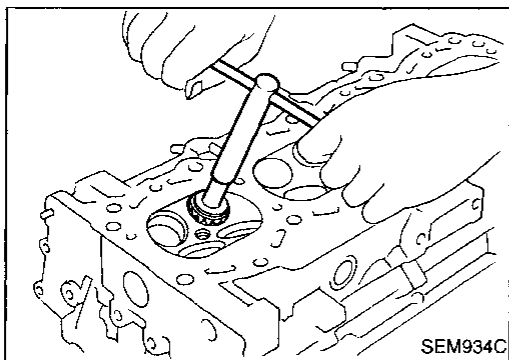
#### Finished size:

6.000 - 6.018 mm (0.2362 - 0.2369 in)

# CYLINDER HEAD

## Inspection (Cont'd)

### VALVE SEATS



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

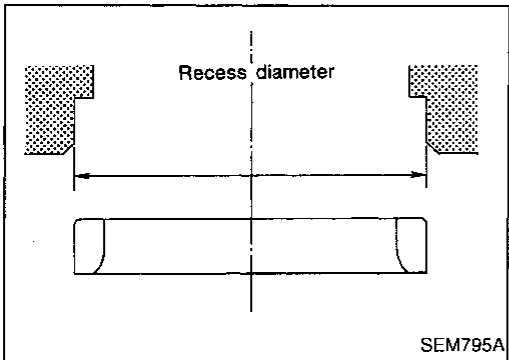
- Before repairing valve seats, check valve and valve guide for wear. If they have worn, replace them. Then correct valve seat.
- Use both hands to cut uniformly.

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### REPLACING VALVE SEAT FOR SERVICE PARTS



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

LC

2. Ream cylinder head recess for service valve seat.

EC

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

**Intake 37.500 - 37.516 mm (1.4764 - 1.4770 in)**

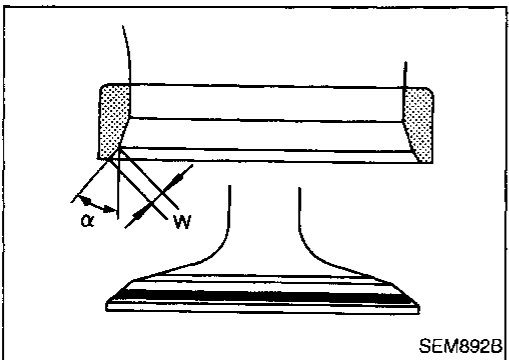
FE

**Exhaust 32.700 - 32.716 mm (1.2874 - 1.2880 in)**

**Be sure to ream in circles concentric to the valve guide center.**

CL

**This will enable valve seat to fit correctly.**



3. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.

MT

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

5. Cut or grind valve seat using suitable tool to the specified dimensions as shown in SDS (EM-71).

AT

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

FA

7. Check valve seating condition.

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

**Contacting width "W":**

**Intake: 1.09 - 1.31 mm (0.0429 - 0.0516 in)**

RA

**Exhaust: 1.29 - 1.51 mm (0.0508 - 0.0594 in)**

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

BR

ST

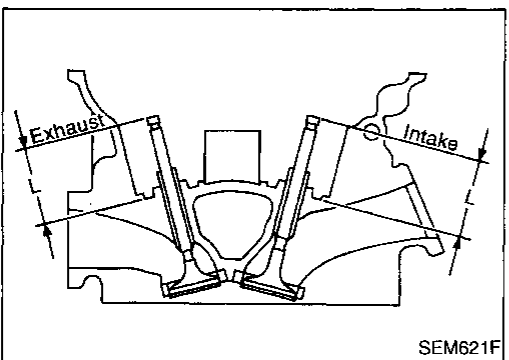
**Valve seat resurface limit "L":**

**Intake: 41.07 - 41.67 mm (1.6169 - 1.6405 in)**

RS

**Exhaust: 41.00 - 41.60 mm (1.6142 - 1.6378 in)**

BT



### VALVE DIMENSIONS

Check dimensions of each valve. For dimensions, refer to SDS (EM-68).

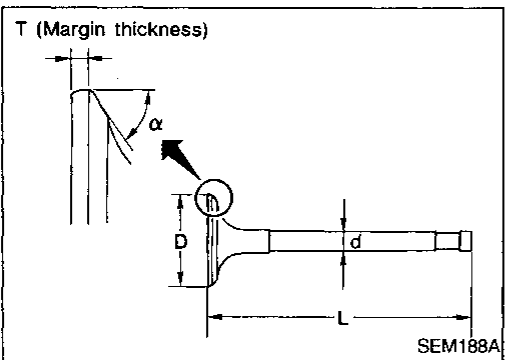
When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace valve.

HA

EL

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

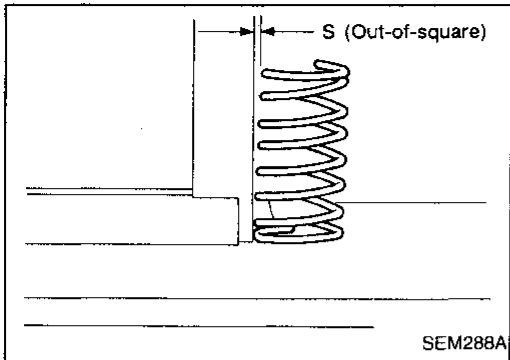
IDX



## CYLINDER HEAD

### Inspection (Cont'd)

#### VALVE SPRING



#### Squareness

1. Measure dimension "S".  
**Out-of-square "S":**  
**Less than 2.0 mm (0.079 in)**
2. If it exceeds the limit, replace spring.

#### Pressure

Check valve spring pressure at specified spring height.

#### Pressure:

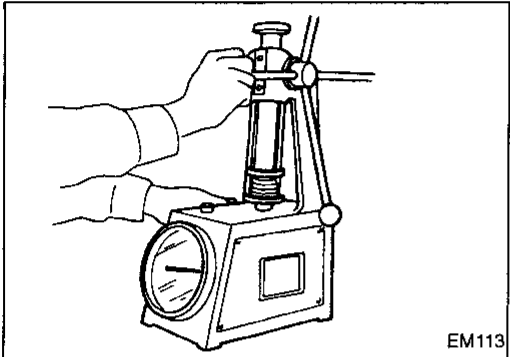
##### Standard

**454 N (46.3 kg, 102.1 lb)**  
**at height 27.55 mm (1.0846 in)**

##### Limit

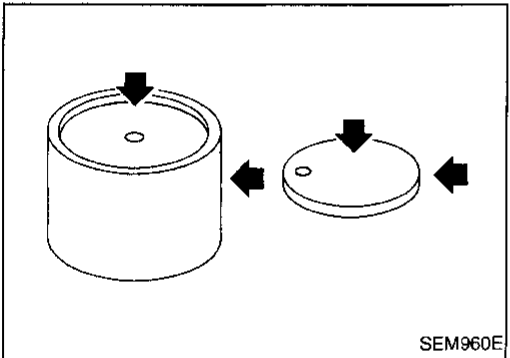
**More than 427 N (43.6 kg, 96.0 lb)**  
**at height 27.55 mm (1.0846 in)**

If it exceeds the limit, replace spring.



#### VALVE LIFTER

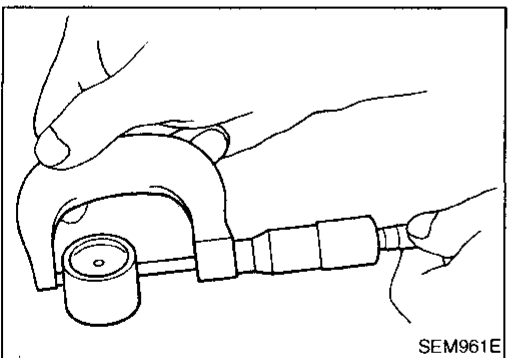
1. Check contact and sliding surfaces for wear or scratches.



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

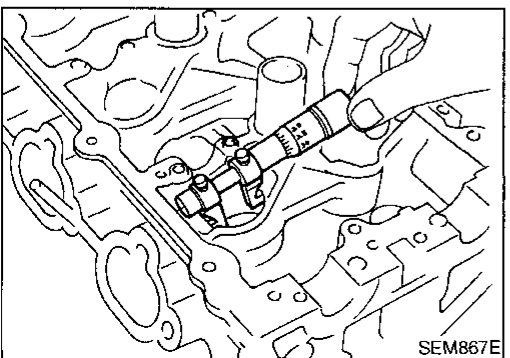
#### Valve lifter outer diameter:

**34.960 - 34.975 mm (1.3764 - 1.3770 in)**

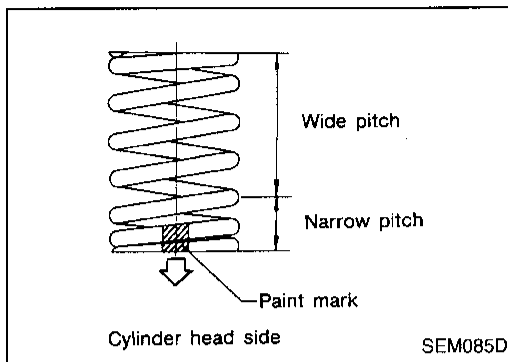


#### Lifter guide bore diameter:

**35.000 - 35.021 mm (1.3780 - 1.3788 in)**



# CYLINDER HEAD



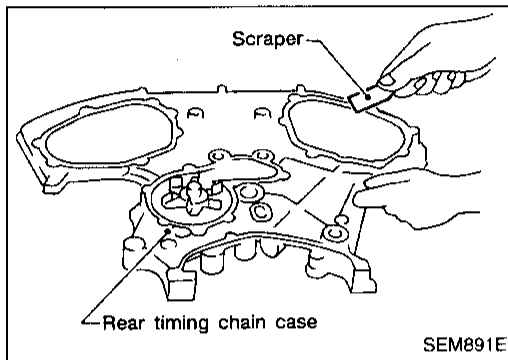
## Assembly

1. Install valve component parts.
  - **Always use new valve oil seal. Refer to OIL SEAL REPLACEMENT (EM-34).**
  - **Before installing valve oil seal, install valve spring seat.**
  - **Install valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side (paint mark).**
  - After installing valve component parts, tap valve stem tip with plastic hammer to assure a proper fit.

GI

MA

EM



## Installation

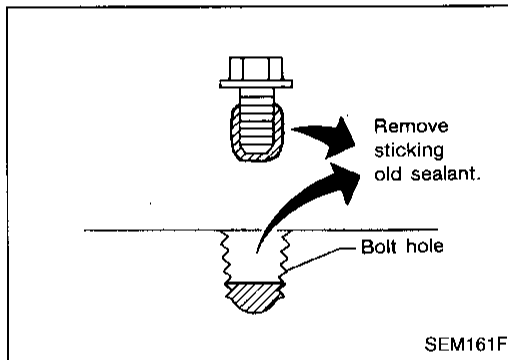
1. Before installing rear timing chain case, remove all traces of liquid gasket from mating surface using a scraper.
- Also remove traces of liquid gasket from mating surface of cylinder block.

LC

EC

FE

CL



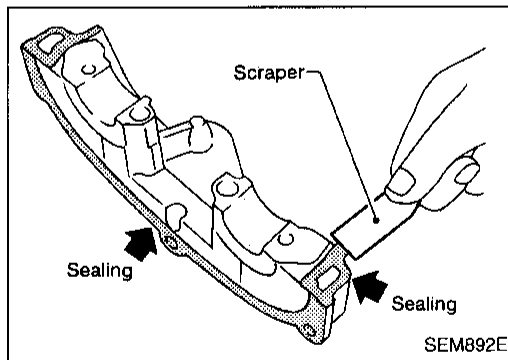
- **Remove old liquid gasket from the bolt hole and thread.**

MT

AT

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RA



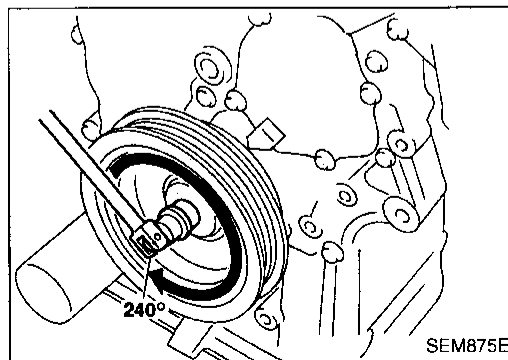
2. Before installing cam bracket, remove all traces of liquid gasket from mating surface using a scraper.
3. Remove O-rings from cylinder block.

BR

ST

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BT



4. Turn crankshaft until No. 1 piston is set at approximately 240° before TDC on compression stroke to prevent interference of valves and pistons.

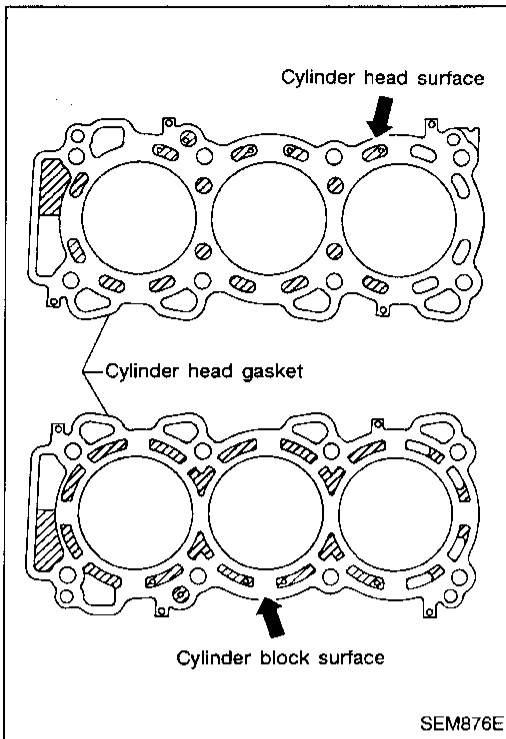
HA

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IDX

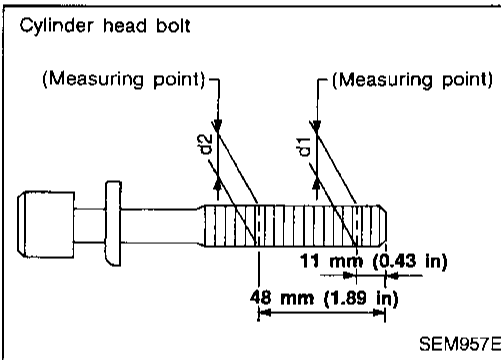
## CYLINDER HEAD

### Installation (Cont'd)



5. Install cylinder heads with new gaskets.

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



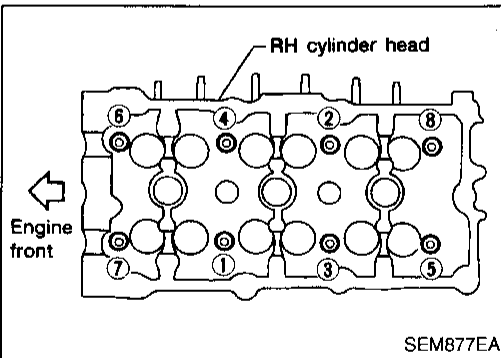
#### CAUTION:

Cylinder head bolts are tightened by plastic zone tightening method. Whenever the size difference between d1 and d2 exceeds the limit, replace them with new ones.

Limit (d1 - d2):

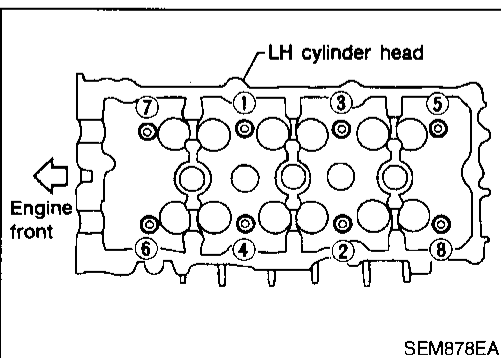
0.11 mm (0.0043 in)

- Lubricate threads and seat surfaces of the bolts with new engine oil.



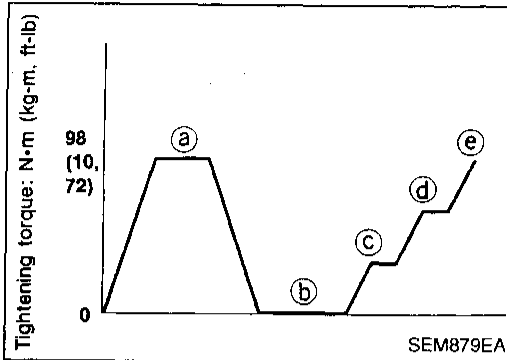
- Tightening procedure:

- Tighten all bolts to 98 N·m (10 kg-m, 72 ft-lb).
  - Completely loosen all bolts.
  - Tighten all bolts to 34 to 44 N·m (3.5 to 4.5 kg-m, 25 to 33 ft-lb).
  - Turn all bolts 90 to 95 degrees clockwise.
  - Turn all bolts 90 to 95 degrees clockwise.
- Tighten in numerical order shown in the figure.

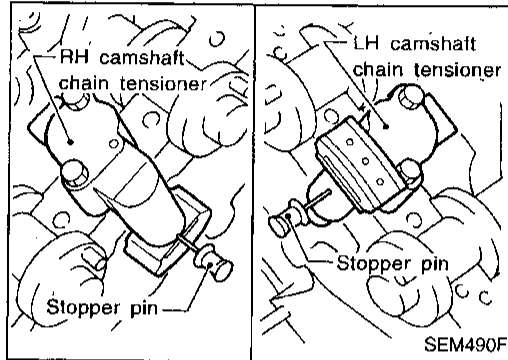


# CYLINDER HEAD

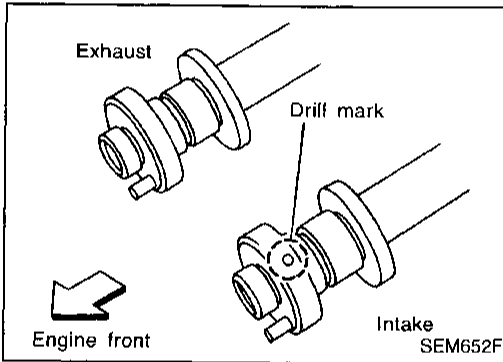
## Installation (Cont'd)



6. Install cylinder head outside bolts.

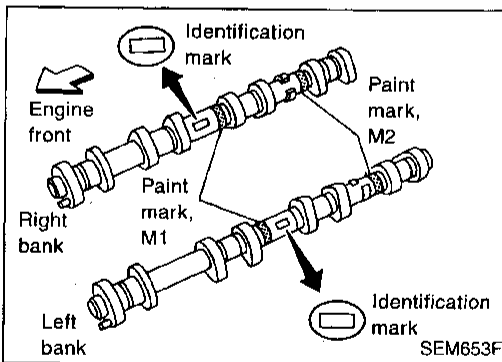


7. Install camshaft chain tensioners on both sides of cylinder head.



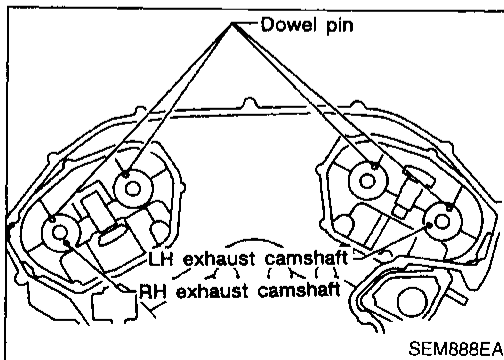
8. Install exhaust and intake camshafts and camshaft brackets.

- Intake camshaft has a drill mark on camshaft sprocket mounting flange. Install it on the intake side.



● Identification marks are present on camshafts.

Bank	INT/EXH	ID mark	Drill mark	Paint mark	
				M1	M2
RH	INT	R3	Yes	Yes	No
	EXH	R3	No	No	Yes
LH	INT	L3	Yes	Yes	No
	EXH	L3	No	No	Yes

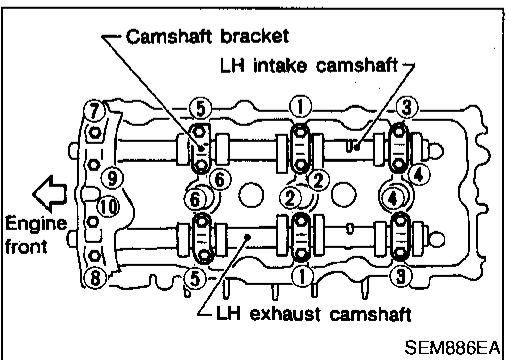
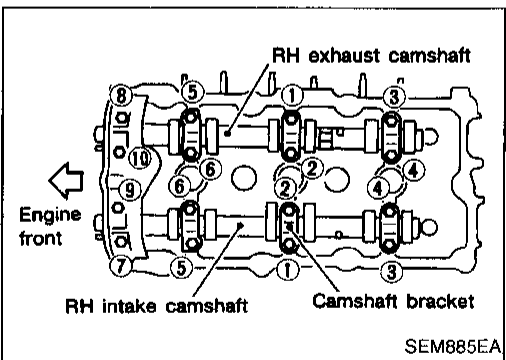
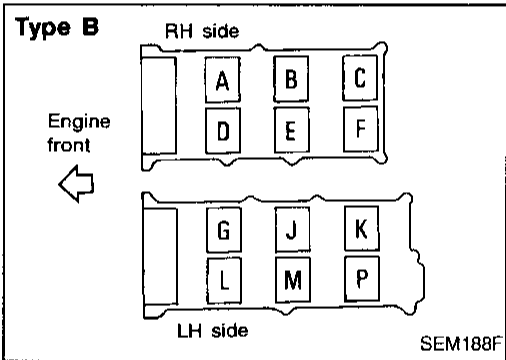
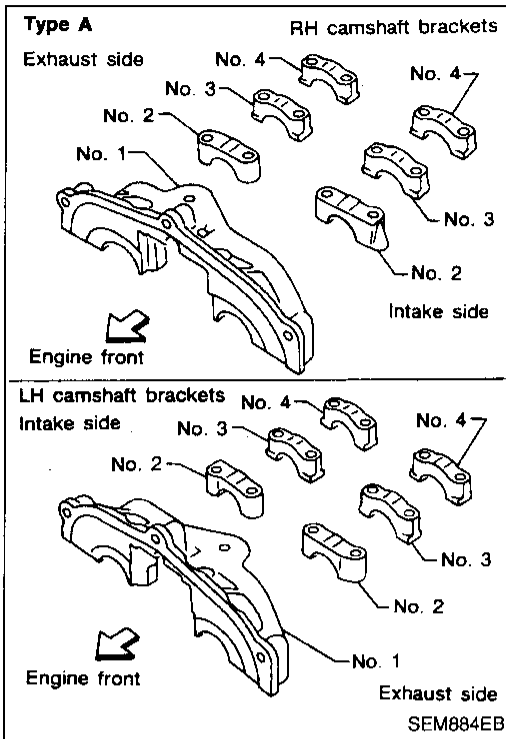


● Position camshaft  
 RH exhaust camshaft dowel pin at about 10 o'clock  
 LH exhaust camshaft dowel pin at about 2 o'clock

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 BT  
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 EL  
 IDX

# CYLINDER HEAD

## Installation (Cont'd)



9. Before installing camshaft brackets, apply sealant to mating surface of No. 1 journal head.
  - Use Genuine RTV silicone sealant Part No. 999MP-A7007 or equivalent.
  - Refer to "POSITION FOR APPLYING LIQUID GASKET" (EM-21).
  - Install camshaft brackets in their original positions.
  - Tighten camshaft bracket bolts gradually in two or three stages.
  - If any part of valve assembly or camshaft is replaced, check valve clearance according to reference data. After completing assembly check valve clearance. Refer to "Checking" and "Adjusting" in "VALVE CLEARANCE" (EM-50 and 51).

Reference data valve clearance (Cold):

Intake

0.26 - 0.34 mm (0.010 - 0.013 in)

Exhaust

0.29 - 0.37 mm (0.011 - 0.015 in)

- Lubricate threads and seat surfaces of camshaft bracket bolts with new engine oil before installing them.
- Align stamp mark as shown in the figure.

### Tightening procedure

Tighten the camshaft brackets in the following steps.

Step	Tightening torque	Tightening order
1	1.96 N·m (0.2 kg-m, 17 in-lb)	Tighten in the order of ⑦ to ⑩, then tighten ① to ⑥.
2	6 N·m (0.6 kg-m, 52 in-lb)	Tighten in the numerical order.
3	9.02 - 11.8 N·m (0.92 - 1.20 kg-m, 79.9 - 104.2 in-lb)	Tighten in the numerical order.

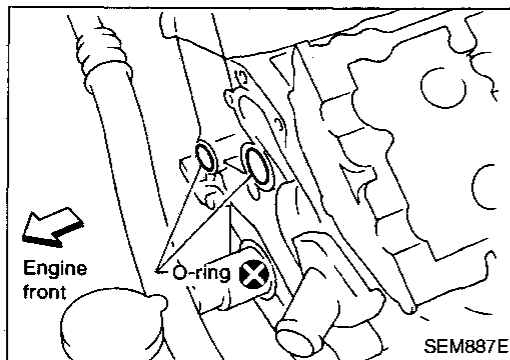
- Tighten in numerical order shown in the figure.



## CYLINDER HEAD

### Installation (Cont'd)

10. Install O-rings to cylinder block.



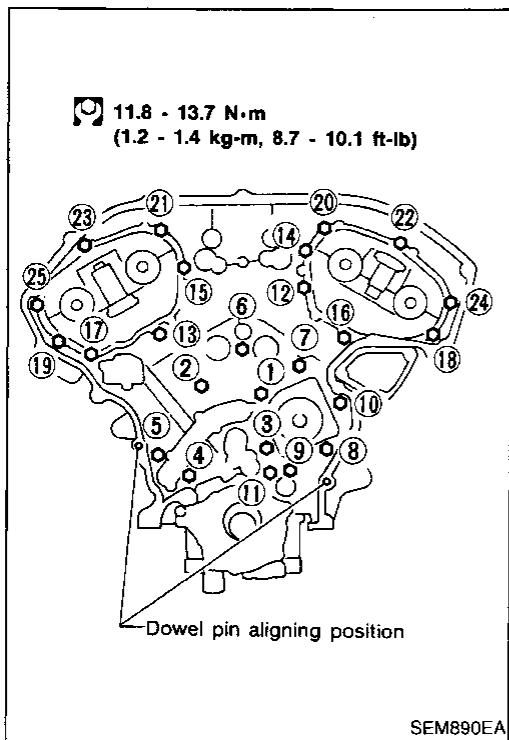
11. Apply sealant to the hatched portion of rear timing chain case.
- Apply continuous bead of liquid gasket to mating surface of rear timing chain case. Refer to "POSITION FOR APPLYING LIQUID GASKET" (EM-21).
  - **Before installation, wipe off the protruding sealant.**

12. Align rear timing chain case with dowel pins, then install on cylinder head and block.

13. Tighten rear chain case bolts.

- (1) Tighten bolts in numerical order shown in the figure.  
(2) Repeat above step (1).

- This installation is the same procedure as that for timing chain. Refer to "Installation" in "TIMING CHAIN" (EM-29).



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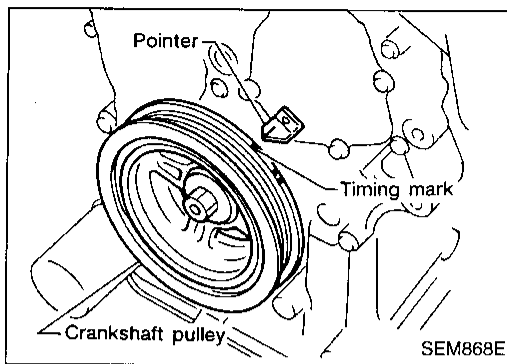
BT

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# VALVE CLEARANCE

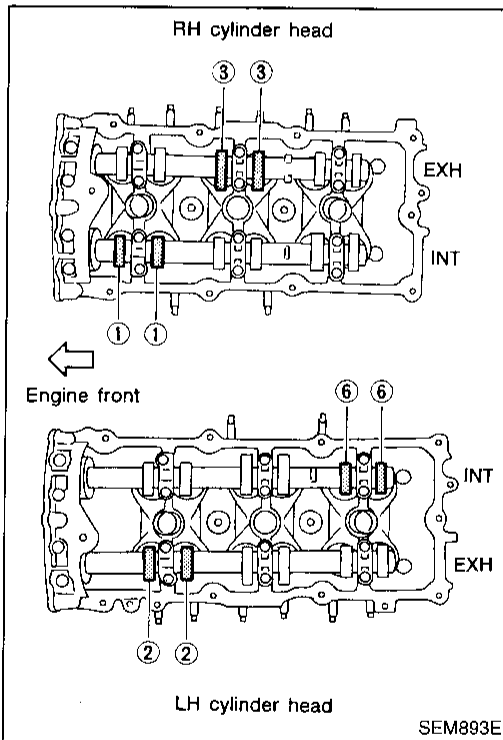


## Checking

Check valve clearance while engine is cold and not running.

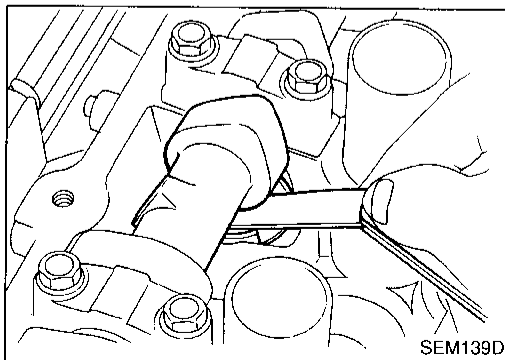
1. Remove intake manifold collector.
2. Remove rocker ornament covers.
3. Remove RH and LH rocker covers.
4. Remove all spark plugs.
5. Set No. 1 cylinder at TDC on its compression stroke.
  - Align pointer with TDC mark on crankshaft pulley.
  - Check that valve lifters on No. 1 cylinder are loose and valve lifters on No. 4 are tight.

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



6. Check only those valves shown in the figure.

Valve Crank position	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6	
	INT	EXH	INT	EXH	INT	EXH	INT	EXH	INT	EXH	INT	EXH
No. 1 TDC	○			○		○						○



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

**Valve clearance for checking (Cold):**

**Intake**

0.26 - 0.34 mm (0.010 - 0.013 in)

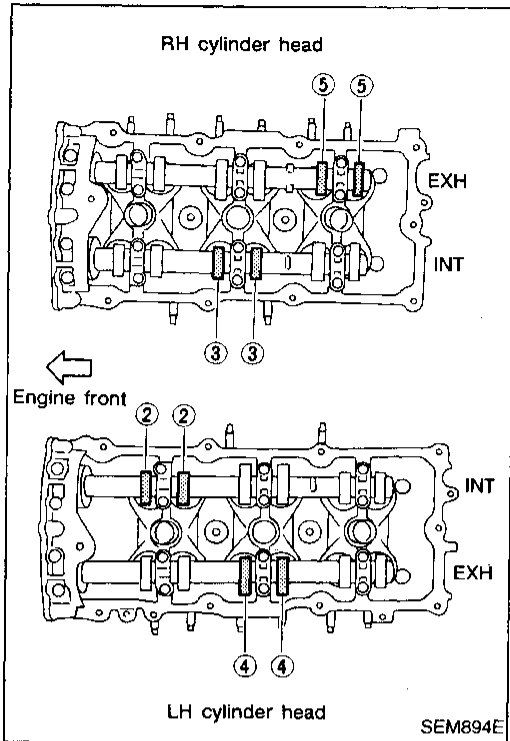
**Exhaust**

0.29 - 0.37 mm (0.011 - 0.015 in)

# VALVE CLEARANCE

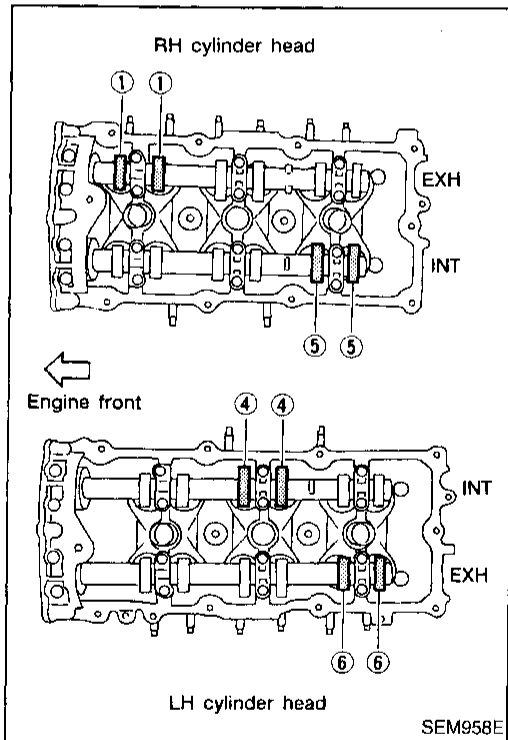
## Checking (Cont'd)

7. Turn crankshaft 240° and align as above.
8. Set No. 3 cylinder at TDC on its compression stroke.
9. Check only those valves shown in the figure.



Valve	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6	
	INT	EXH	INT	EXH	INT	EXH	INT	EXH	INT	EXH	INT	EXH
No. 3 TDC			○		○			○		○		

10. Turn crankshaft 240° and align as above.
11. Set No. 5 cylinder at TDC on its compression stroke.
12. Check only those valves shown in the figure.



Valve	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6	
	INT	EXH	INT	EXH	INT	EXH	INT	EXH	INT	EXH	INT	EXH
No. 5 TDC		○					○		○			○

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

- Intake manifold collector
- RH and LH rocker covers
- All spark plugs
- Rocker cover ornament

## Adjusting

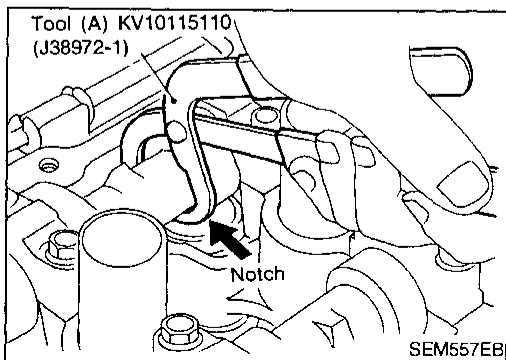
Adjust valve clearance while engine is cold.

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

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

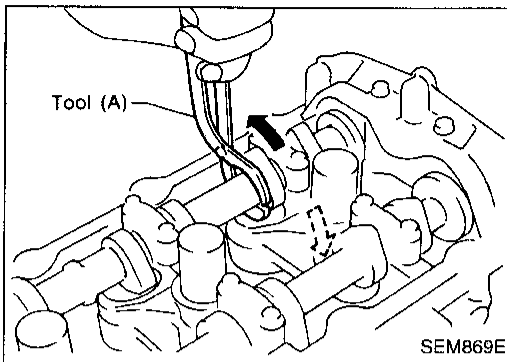
### CAUTION:

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

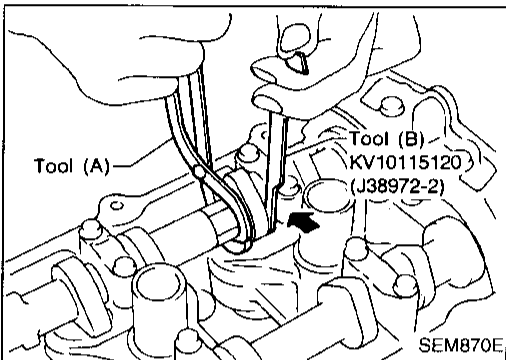


## VALVE CLEARANCE

### Adjusting (Cont'd)



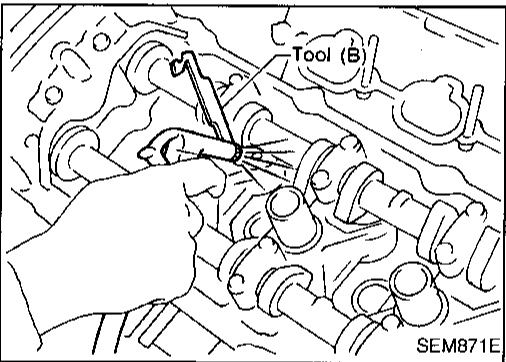
3. Rotate Tool (A) (See figure.) so that valve lifter is pushed down.



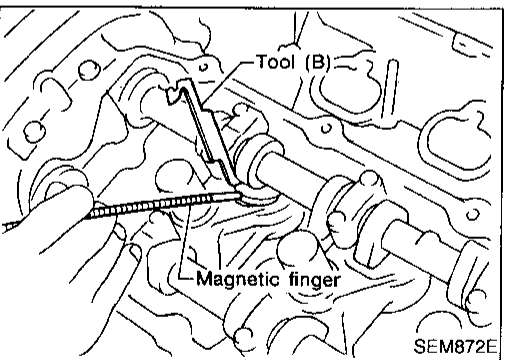
4. Place Tool (B) between camshaft and the edge of the valve lifter to retain valve lifter.

#### CAUTION:

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



6. Blow air into the hole to separate adjusting shim from valve lifter.



7. Remove adjusting shim using a small screwdriver and a magnetic finger.
  8. Determine replacement adjusting shim size following formula.
- Using a micrometer determine thickness of removed shim.
  - Calculate thickness of new adjusting shim so valve clearance comes within specified values.

R = Thickness of removed shim

N = Thickness of new shim

M = Measured valve clearance

#### Intake:

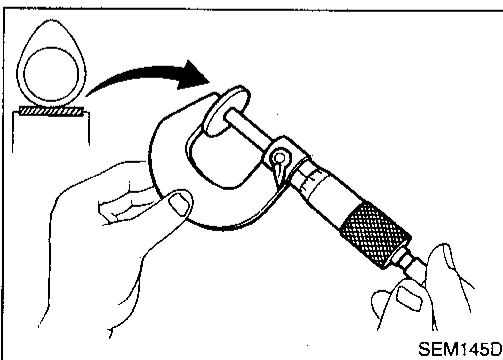
$$N = R + [M - 0.30 \text{ mm (0.0118 in)}]$$

#### Exhaust:

$$N = R + [M - 0.33 \text{ mm (0.0130 in)}]$$

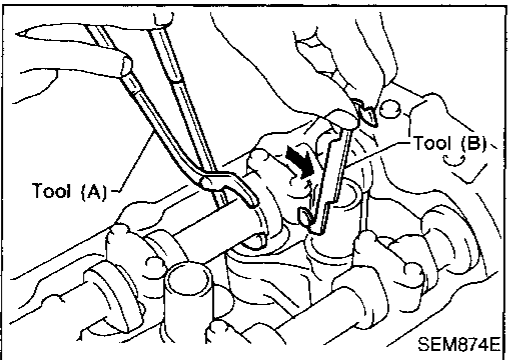
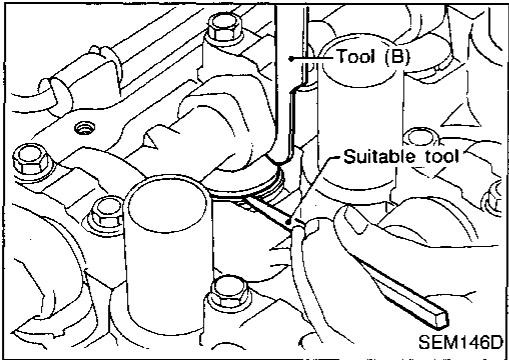
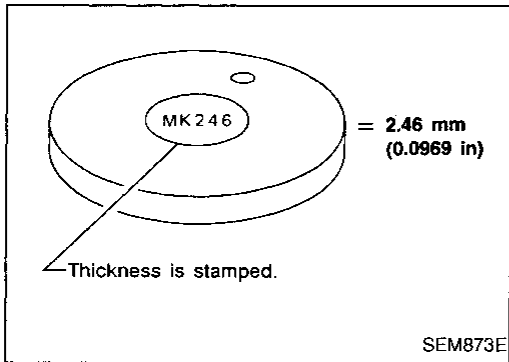
Shims are available in 64 sizes from 2.32 mm (0.0913 in) to 2.95 mm (0.1161 in), in steps of 0.01 mm (0.0004 in).

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



# VALVE CLEARANCE

## Adjusting (Cont'd)



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

10. Place Tool (A) as mentioned in steps 2 and 3.
11. Remove Tool (B).
12. Remove Tool (A).
13. Recheck valve clearance.

### Valve clearance:

Unit: mm (in)

	Cold	Hot* (reference data)
Intake	0.26 - 0.34 (0.010 - 0.013)	0.304 - 0.416 (0.012 - 0.016)
Exhaust	0.29 - 0.37 (0.011 - 0.015)	0.308 - 0.432 (0.012 - 0.017)

\*: Approximately 80°C (176°F)

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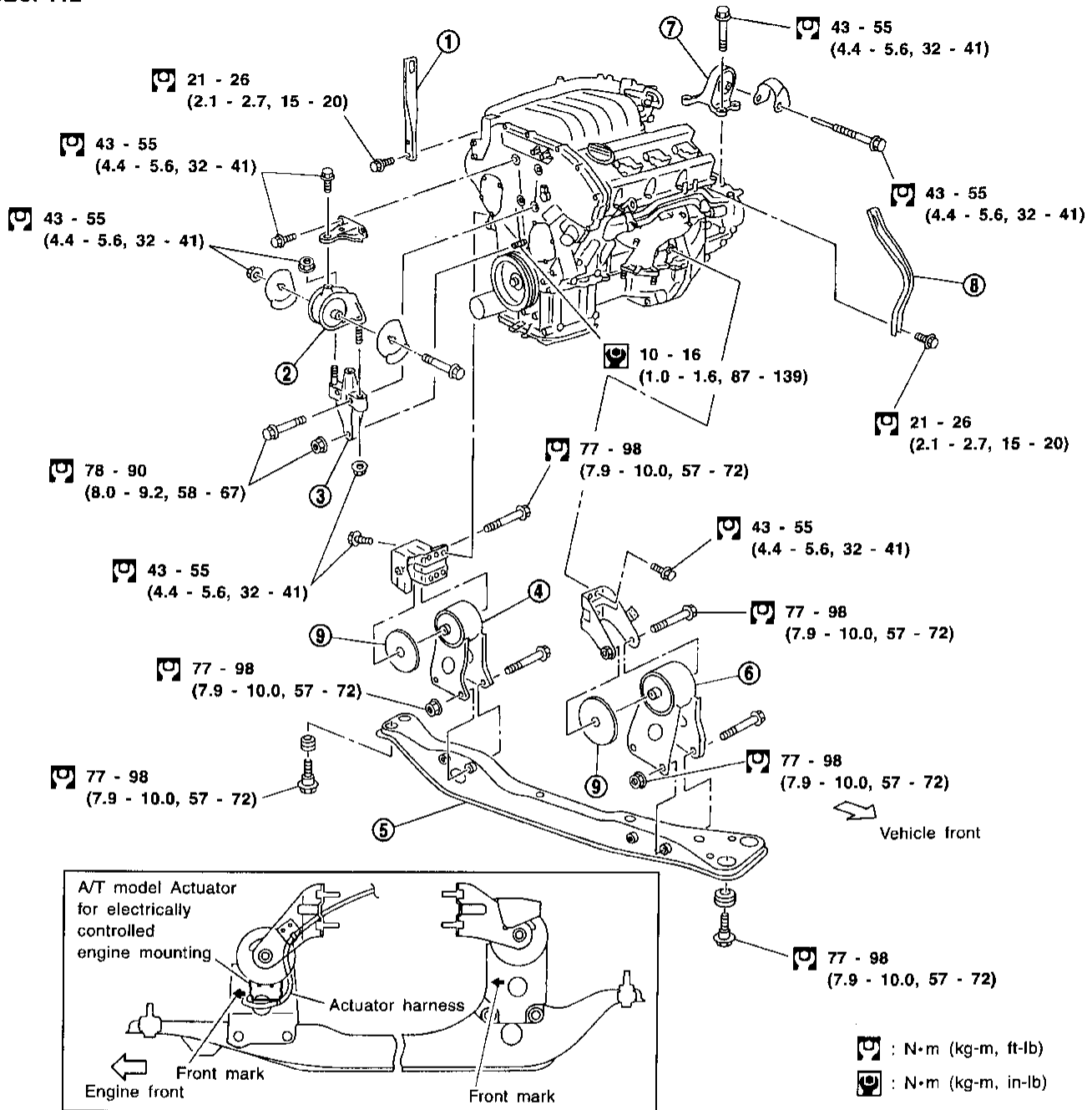
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# ENGINE REMOVAL

## SEC. 112



SEM837F

- |                              |                                      |                       |
|------------------------------|--------------------------------------|-----------------------|
| ① Front upper engine slinger | ④ Rear engine mounting (Fluid type)  | ⑦ LH engine mounting  |
| ② RH engine mounting         | ⑤ Center member                      | ⑧ Rear engine slinger |
| ③ Mounting bracket           | ⑥ Front engine mounting (Fluid type) | ⑨ Insulator           |

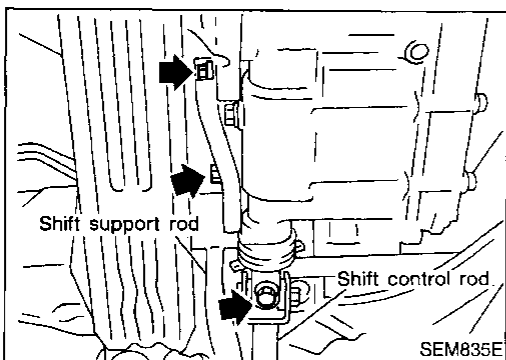
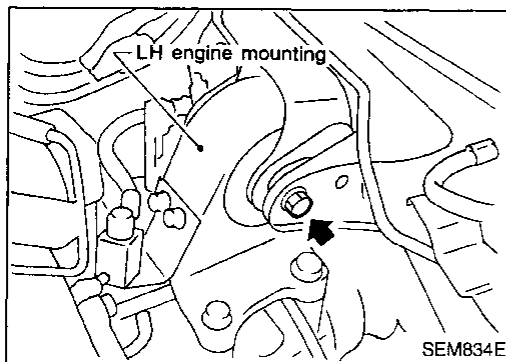
# ENGINE REMOVAL

## WARNING:

- Situate vehicle on a flat and solid surface.
- Place chocks at front and back of rear wheels.
- Do not remove engine until exhaust system has completely cooled off. Otherwise, you may burn yourself and/or fire may break out in fuel line.
- For safety during subsequent steps, the tension of wires should be slackened against the engine.
- Before disconnecting fuel hose, release fuel pressure from fuel line. Refer to "Fuel Pressure Release", "BASIC SERVICE PROCEDURE" in EC section.
- Before removing front axle from transaxle, place safety stands under designated front supporting points. Refer to GI section for lifting points and towing.
- Be sure to hoist engine and transaxle in a safe manner.
- For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.

## CAUTION:

- When lifting engine, be careful not to strike adjacent parts, especially the following: Accelerator wire casing, brake lines, and brake master cylinder.
- In hoisting the engine, always use engine slingers in a safe manner.
- In removing drive shaft, be careful not to damage grease seal of transaxle.

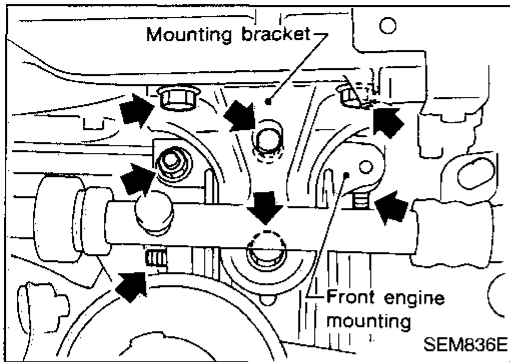


## Removal

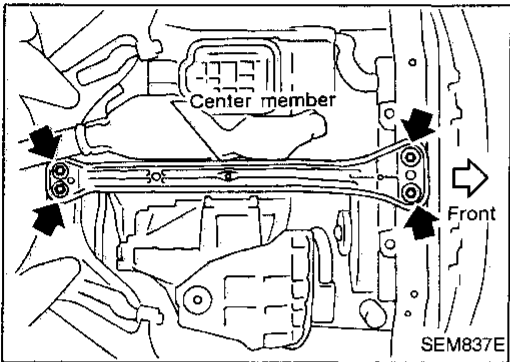
1. Remove engine undercover and hood.
2. Drain coolant from both cylinder block and radiator.
3. Remove vacuum hoses, fuel hoses, wires, harnesses, connectors and so on.
4. Remove front exhaust tubes, ball joints and drive shafts.
5. Remove radiator and fans.
6. Remove drive belts.
7. Remove alternator, compressor and power steering oil pump from engine.
8. Set a suitable transmission jack under transaxle. Hoist engine with engine slinger.
9. Remove rear engine mounting.
10. Disconnect control rod and support rod from transaxle (M/T model).
11. Disconnect control cable from transaxle (A/T model).

## ENGINE REMOVAL

### Removal (Cont'd)

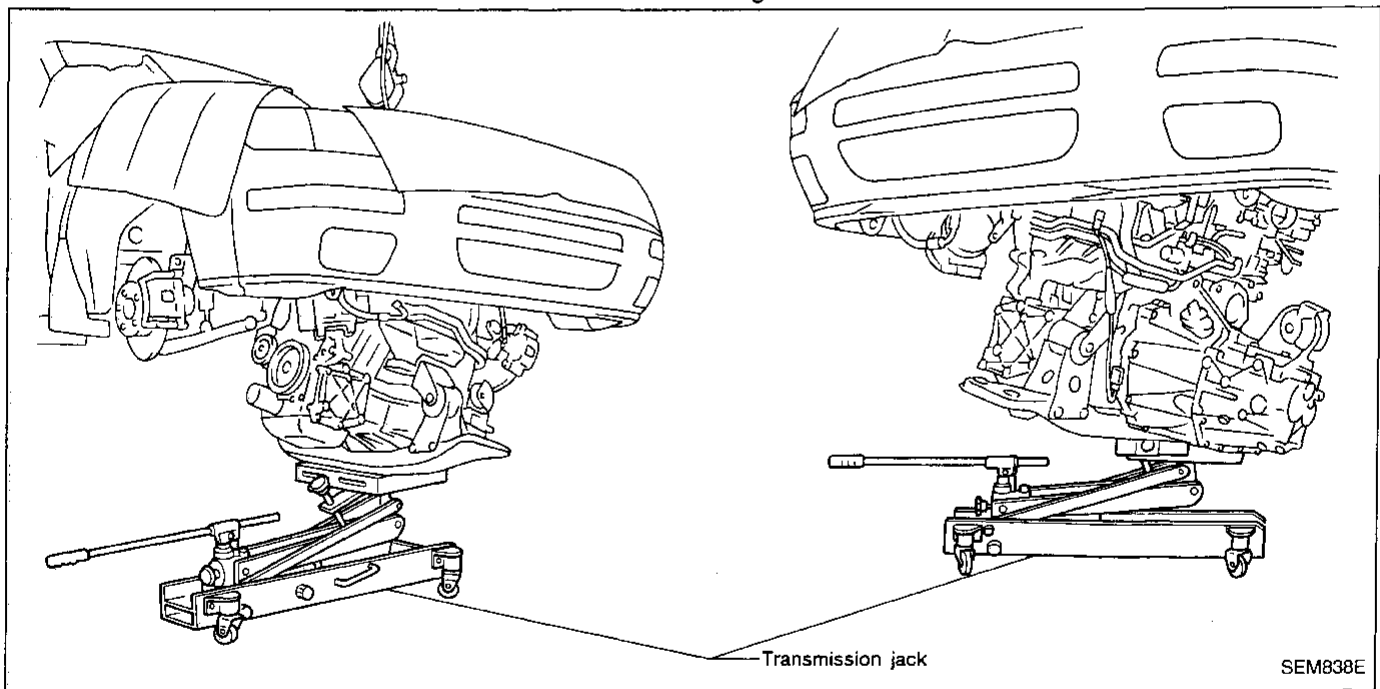


12. Remove front engine mounting.



13. Remove center member and then slowly lower transmission jack.

14. Remove engine with transaxle as shown.



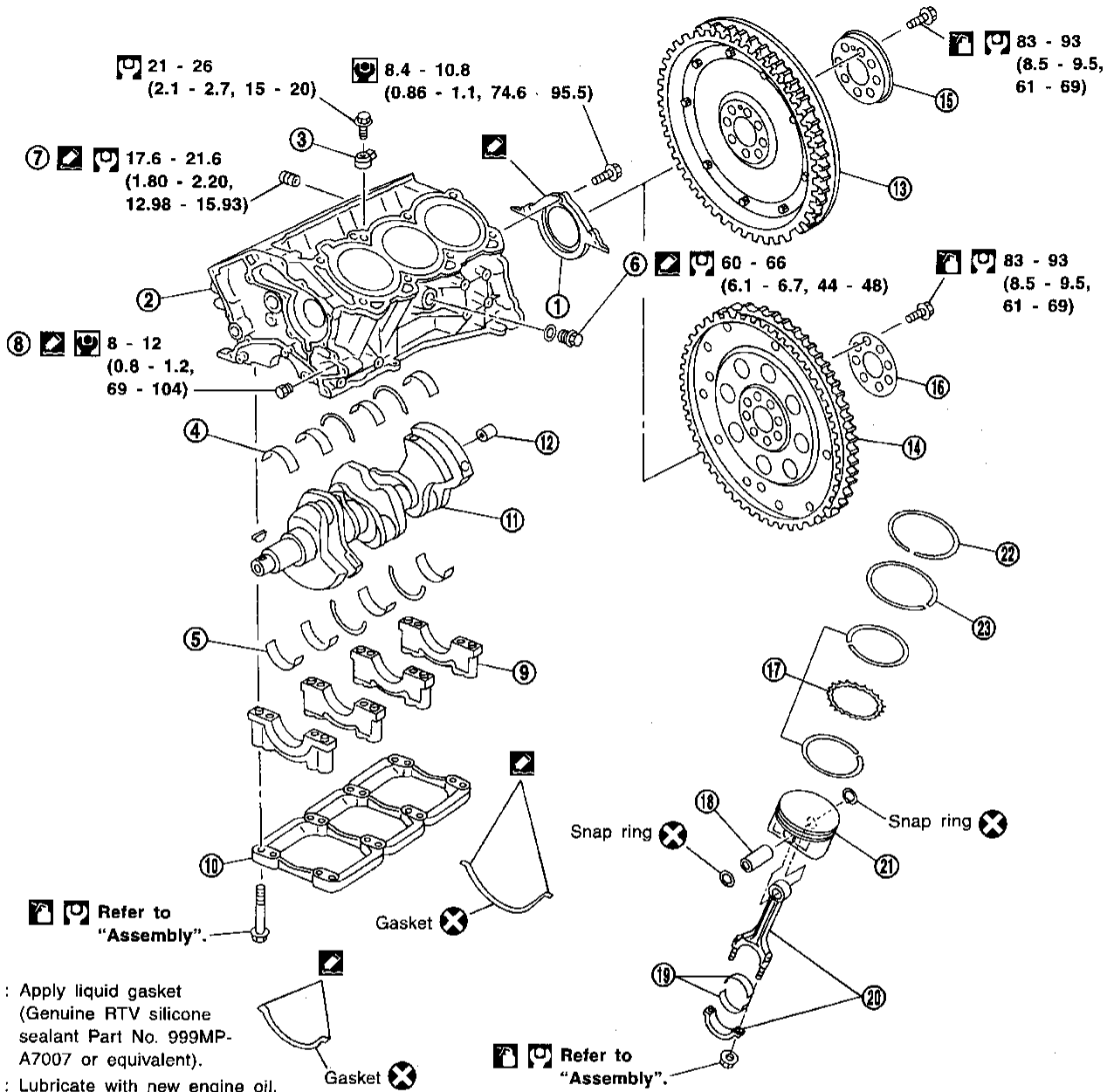
### Installation

1. Installation is in the reverse order of removal.



# CYLINDER BLOCK

SEC. 110•120•226



- ① Rear oil seal retainer
- ② Cylinder block
- ③ Knock sensor
- ④ Upper main bearing
- ⑤ Lower main bearing
- ⑥ Water drain plug (LH side)
- ⑦ Water drain plug (RH side)
- ⑧ Water drain plug (Water pump side)

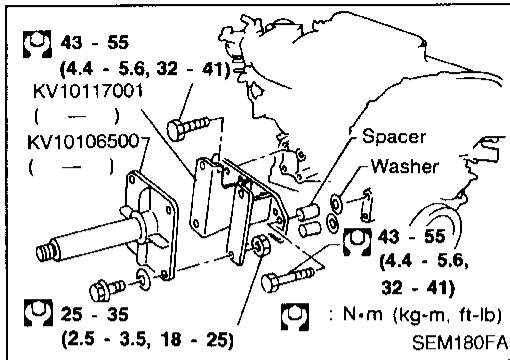
- ⑨ Main bearing cap
- ⑩ Main bearing beam
- ⑪ Crankshaft
- ⑫ Pilot bushing or pilot converter
- ⑬ Flywheel with signal plate (M/T models)
- ⑭ Drive plate with signal plate (A/T model)
- ⑮ Flywheel reinforcement

- ⑯ Drive plate reinforcement
- ⑰ Oil ring
- ⑱ Piston pin
- ⑲ Connecting rod bearing
- ⑳ Connecting rod
- ㉑ Piston
- ㉒ Top ring
- ㉓ 2nd ring

GI  
MA  
EM  
LC  
EC  
FE  
CL  
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SEM654FA

# CYLINDER BLOCK

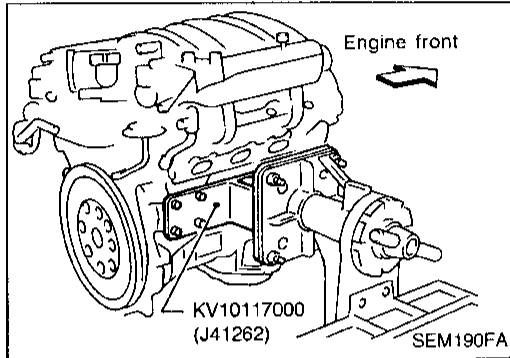


## CAUTION:

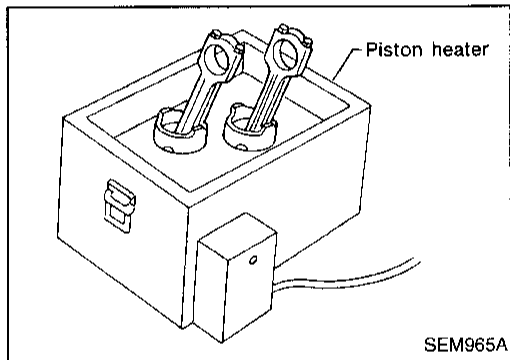
- When installing bearings, pistons, or other sliding parts, lubricate contacting surfaces with new engine oil.
- Place removed parts such as bearings and bearing caps in their proper order and direction.
- When installing connecting rod nuts, and main bearing cap bolts, apply new engine oil to threads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

## Disassembly

### PISTON AND CRANKSHAFT

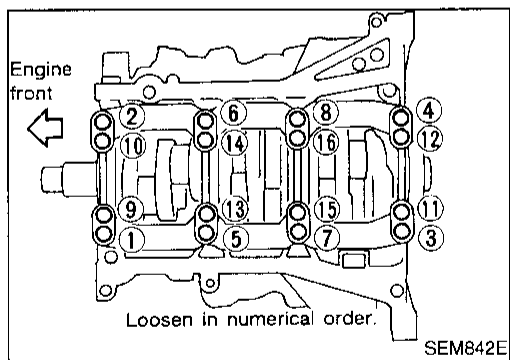


1. Remove engine. Refer to "ENGINE REMOVAL" (EM-54).
2. Place engine on a work stand.
3. Drain coolant and oil.
4. Remove oil pan. Refer to "Removal" in "OIL PAN" (EM-13).
5. Remove timing chain. Refer to "Removal" in "TIMING CHAIN" (EM-22).
6. Remove cylinder head. Refer to "Removal" in "TIMING CHAIN" (EM-22).
7. Remove pistons with connecting rods.
  - When disassembling piston and connecting rod, remove snap ring first, then heat piston to 60 to 70°C (140 to 158°F).
8. Remove rear oil seal retainer.



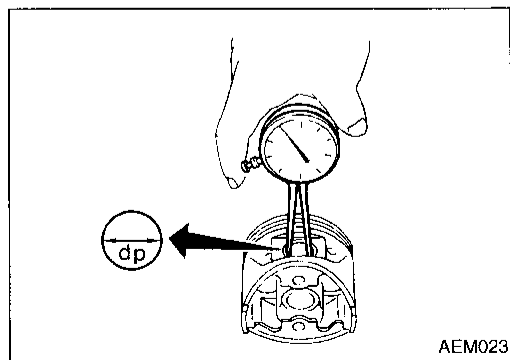
## CAUTION:

- When piston rings are not replaced, make sure that piston rings are mounted in their original positions.
  - When replacing piston rings, if there is no punchmark, install with either side up.
9. Remove main bearing beam, cap and crankshaft.
    - Before removing bearing beam and bearing cap, measure crankshaft end play. Refer to EM-66.
    - Bolts should be loosened in two or three steps.



## Inspection

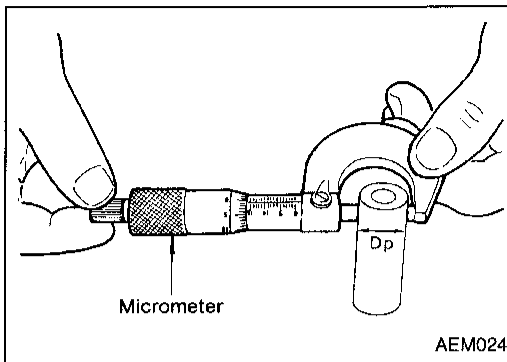
### PISTON AND PISTON PIN CLEARANCE



1. Measure inner diameter of piston pin hole "dp".  
 Standard diameter "dp":  
 21.993 - 22.005 mm (0.8659 - 0.8663 in)

# CYLINDER BLOCK

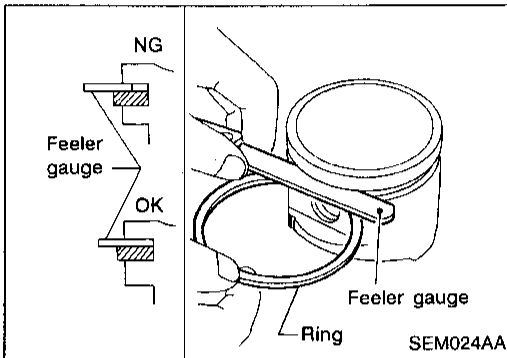
## Inspection (Cont'd)



2. Measure outer diameter of piston pin "Dp".  
**Standard diameter "Dp":**  
 21.989 - 22.001 mm (0.8657 - 0.8662 in)
3. Calculate piston pin clearance.  
**Dp - dp = 0.002 - 0.010 mm (0.0001 - 0.0004 in)**  
 If it exceeds the above value, replace piston assembly with pin.

GI  
MA  
EM

## PISTON RING SIDE CLEARANCE



**Side clearance:**

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

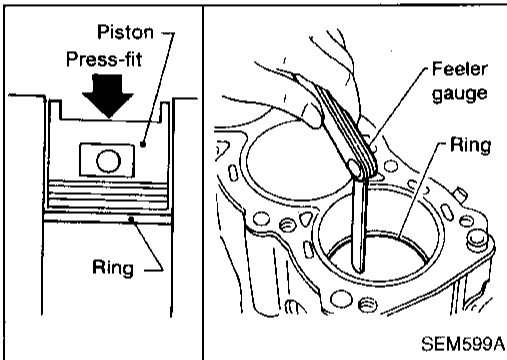
**Max. limit of side clearance:**

- Top ring** 0.11 mm (0.0043 in)
- 2nd ring** 0.1 mm (0.004 in)

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

LC  
EC  
FE  
CL

## PISTON RING END GAP



**End gap:**

- Top ring** 0.22 - 0.32 mm (0.0087 - 0.0126 in)
- 2nd ring** 0.32 - 0.47 mm (0.0126 - 0.0185 in)
- Oil ring** 0.20 - 0.60 mm (0.0079 - 0.0236 in)

**Max. limit of ring gap:**

- Top ring** 0.55 mm (0.0217 in)
- 2nd ring** 0.85 mm (0.0335 in)
- Oil ring** 0.95 mm (0.0374 in)

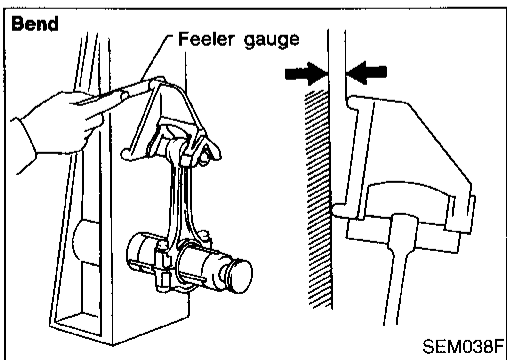
If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, do the following. Rebore cylinder and use oversized piston and piston rings.

**Refer to SDS (EM-73).**

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

MT  
AT  
FA  
RA  
BR

## CONNECTING ROD BEND AND TORSION



**Bend:**

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

**Torsion:**

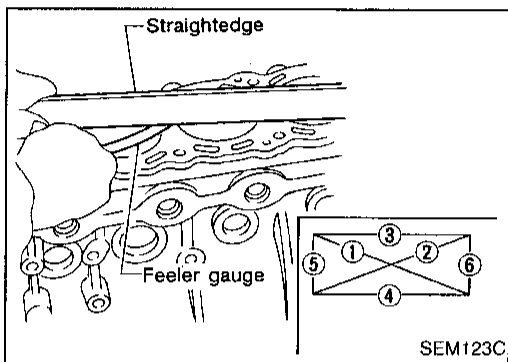
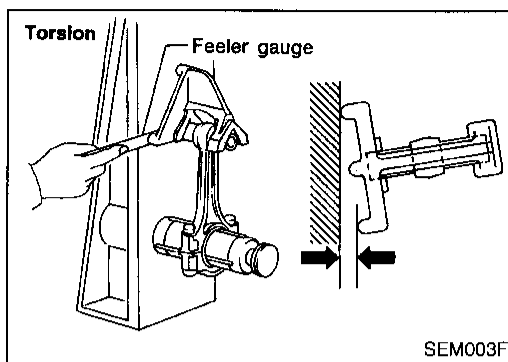
- Limit 0.30 mm (0.0118 in)  
per 100 mm (3.94 in) length

If it exceeds the limit, replace connecting rod assembly.

ST  
RS  
BT  
HA  
EL  
IDX

# CYLINDER BLOCK

## Inspection (Cont'd)



### CYLINDER BLOCK DISTORTION AND WEAR

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

**Distortion limit: 0.10 mm (0.0039 in)**

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

#### Resurfacing limit:

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

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

**The maximum limit is as follows:**

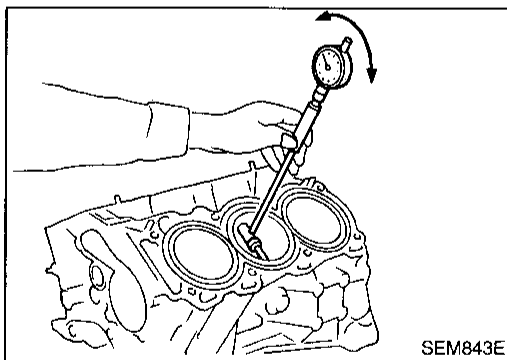
$$A + B = 0.2 \text{ mm (0.008 in)}$$

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

$$214.95 - 215.05 \text{ mm (8.4626 - 8.4665 in)}$$

**Refer to SDS (EM-72).**

- If necessary, replace cylinder block.



### PISTON-TO-BORE CLEARANCE

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

#### Cylinder bore inner diameter

Grade No.	Standard inner diameter	Wear limit
No. 1	93.000 - 93.010 mm (3.6614 - 3.6618 in)	0.20 mm (0.0079 in)
No. 2	93.011 - 93.020 mm (3.6618 - 3.6622 in)	
No. 3	93.021 - 93.030 mm (3.6622 - 3.6626 in)	

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

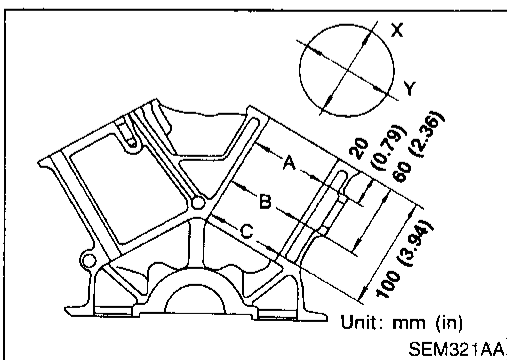
#### Out-of-round (X - Y):

**Limit 0.015 mm (0.0006 in)**

#### Taper (A - B - C):

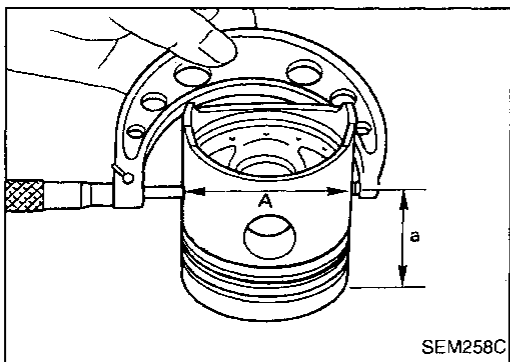
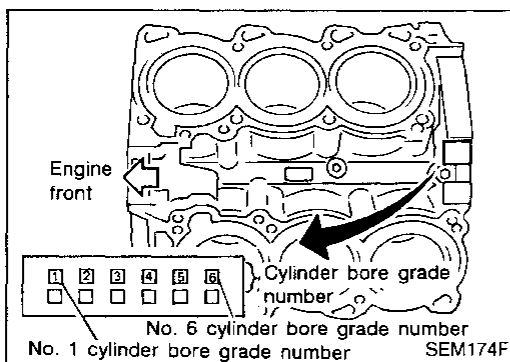
**Limit 0.015 mm (0.0006 in)**

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



## CYLINDER BLOCK

### Inspection (Cont'd)



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

3. Measure piston skirt diameter.  
**Piston diameter "A": Refer to SDS (EM-73).**  
**Measuring point "a" (Distance from the top):**  
45.4 mm (1.787 in)
4. Check that piston-to-bore clearance is within specification.  
**Piston-to-bore clearance "B":**  
0.010 - 0.030 mm (0.0004 - 0.0012 in)
5. Determine piston oversize according to amount of cylinder wear.

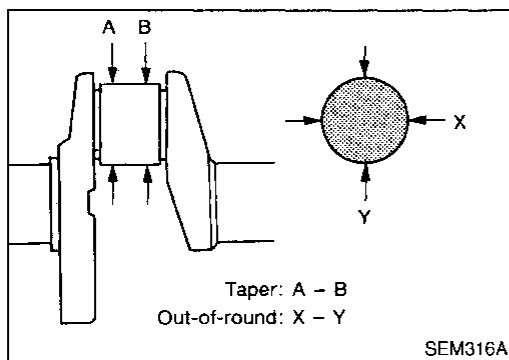
**Oversize pistons are available for service.**  
**Refer to SDS (EM-73).**

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

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

**D:** Bored diameter  
**A:** Piston diameter as measured  
**B:** Piston-to-bore clearance  
**C:** Honing allowance 0.02 mm (0.0008 in)

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



### CRANKSHAFT

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

**Out-of-round (X - Y):**  
**Standard**  
0.002 mm (0.0001 in)

**Taper (A - B):**  
**Standard**  
0.002 mm (0.0001 in)

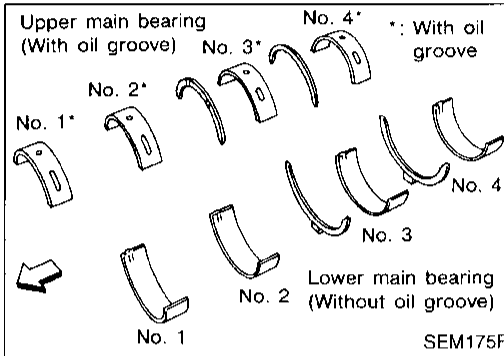
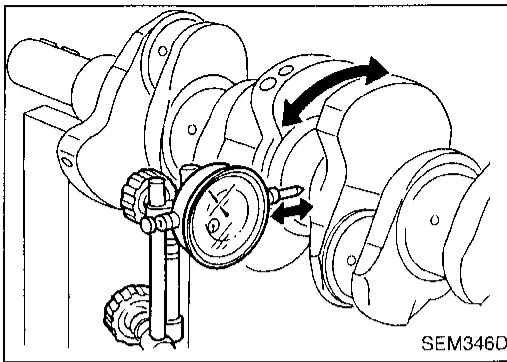
# CYLINDER BLOCK

## Inspection (Cont'd)

3. Measure crankshaft runout.

**Runout (Total indicator reading):**

**Limit: 0.10 mm (0.0039 in)**



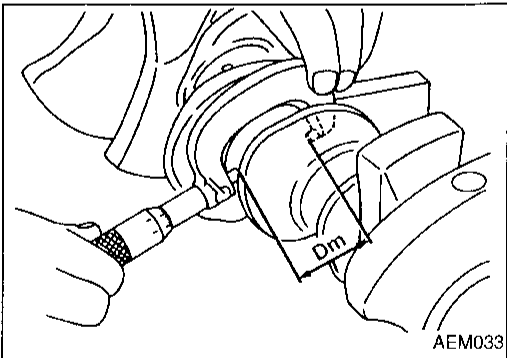
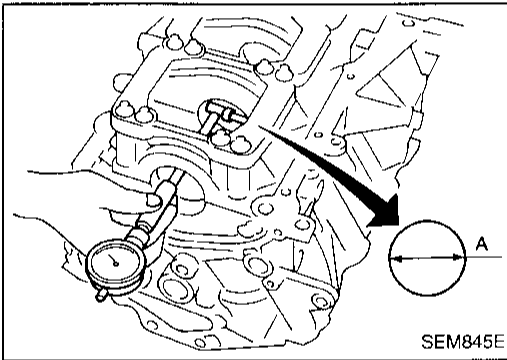
## BEARING CLEARANCE

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

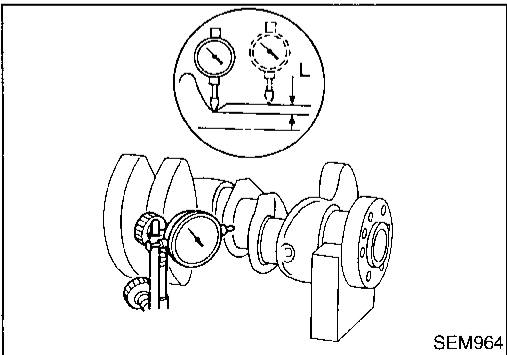
### Method A (Using bore gauge & micrometer)

#### Main bearing

1. Set main bearings in their proper positions on cylinder block and main bearing cap.
  2. Install main bearing cap and bearing beam to cylinder block.
- Tighten all bolts in correct order.**
3. Measure inner diameters "A" of each main bearing.



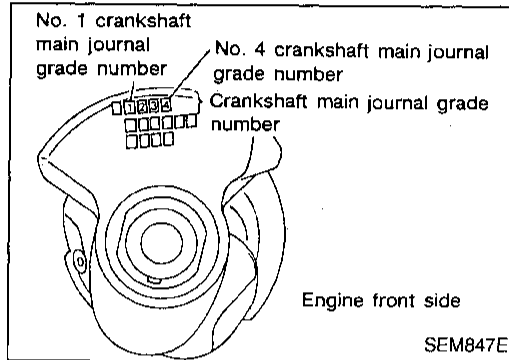
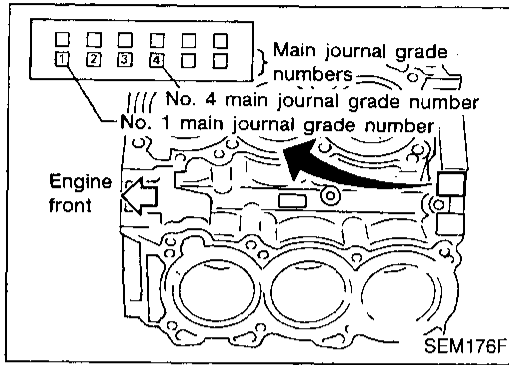
4. Measure outer diameters "Dm" of each crankshaft main journal.
  5. Calculate main bearing clearance.  
Main bearing clearance = A - Dm  
**Standard: 0.012 - 0.030 mm (0.0005 - 0.0012 in)**  
**Limit: 0.065 mm (0.0026 in)**
- If it exceeds the limit, replace bearing.
  - If clearance cannot be adjusted using any standard bearing grade, grind crankshaft journal and use undersized bearing.



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

# CYLINDER BLOCK

## Inspection (Cont'd)



6. If crankshaft is reused, measure main bearing clearances and select thickness of main bearings. If crankshaft is replaced with a new one, select thickness of main bearings as follows:

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

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

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

Example of calculation:

Cylinder block main journal grade number: 1

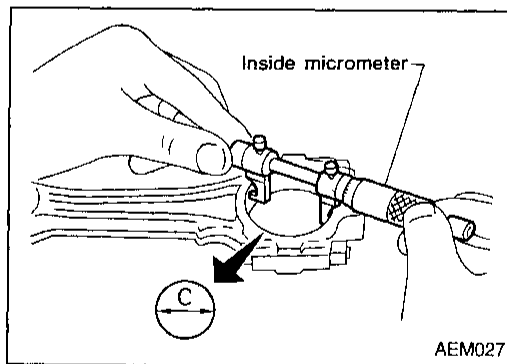
Crankshaft main journal grade number: 2

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

### Main bearing grade number (Identification color):

These numbers are punched in either Arabic or Roman numerals.

		Cylinder block main journal grade number			
		"0"	"1"	"2"	"3"
Crankshaft main journal grade number	"0"	0 (Black)	1 (Brown)	2 (Green)	3 (Yellow)
	"1"	1 (Brown)	2 (Green)	3 (Yellow)	4 (Blue)
	"2"	2 (Green)	3 (Yellow)	4 (Blue)	5 (Pink)
	"3"	3 (Yellow)	4 (Blue)	5 (Pink)	6 (Purple)

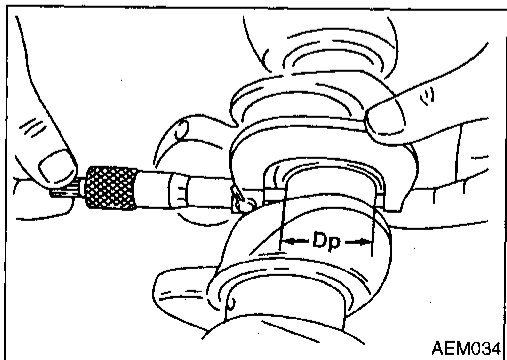


### Connecting rod bearing (Big end)

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 connecting rod.



4. Measure outer diameter "Dp" of each crankshaft pin journal.

5. Calculate connecting rod bearing clearance.

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

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

**Limit: 0.070 mm (0.0028 in)**

6. If it exceeds the limit, replace bearing.

7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to "BEARING CLEARANCE — Main bearing" (EM-62).

## CYLINDER BLOCK

### Inspection (Cont'd)

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

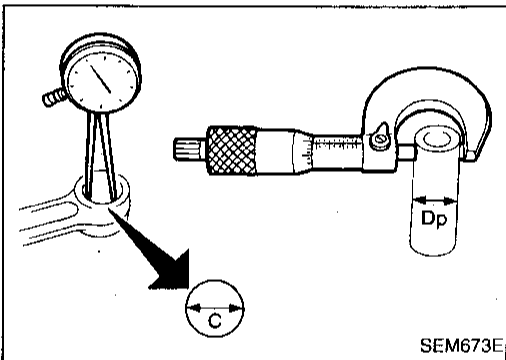
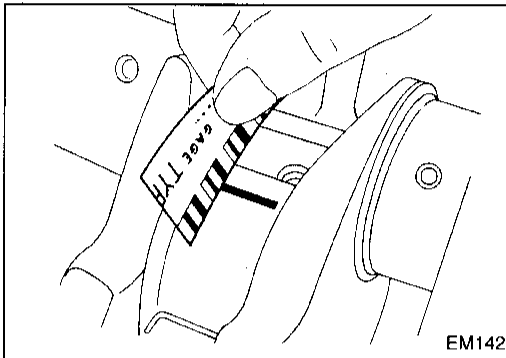
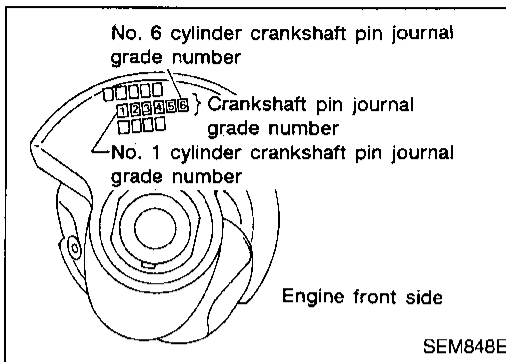
**Connecting rod bearing grade number (Identification color):**  
These numbers are punched in either Arabic or Roman numerals.

Crankshaft pin journal grade number	Connecting rod bearing grade number
0	0 (Black)
1	1 (Brown)
2	2 (Green)

### Method B (Using plastigage)

#### CAUTION:

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



### CONNECTING ROD BUSHING CLEARANCE (Small end)

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

Connecting rod bushing clearance = C - Dp

**Standard: 0.005 - 0.017 mm (0.0002 - 0.0007 in)**

**Limit: 0.030 mm (0.0012 in)**

If it exceeds the limit, replace connecting rod assembly or connecting rod bushing and/or piston set with pin.

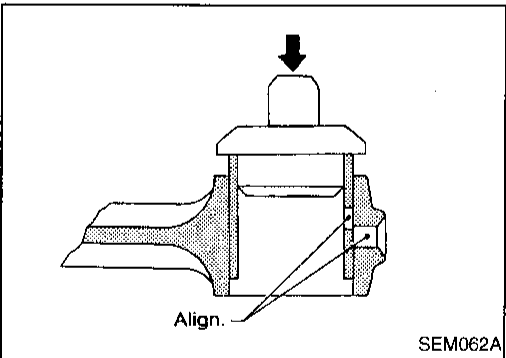
### REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

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

**Be sure to align the oil holes.**

2. After driving in small end bushing, ream the bushing. This is to ensure the clearance between connecting rod bushing and piston pin is the specified value.

**Clearance between connecting rod bushing and piston pin: 0.005 - 0.017 mm (0.0002 - 0.0007 in)**





# CYLINDER BLOCK

## Inspection (Cont'd)

### FLYWHEEL/DRIVE PLATE RUNOUT

Runout (Total indicator reading):

Flywheel (M/T model)★

Less than 0.15 mm (0.0059 in)

Drive plate (A/T model)

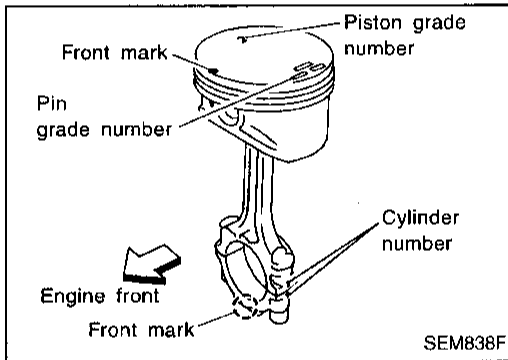
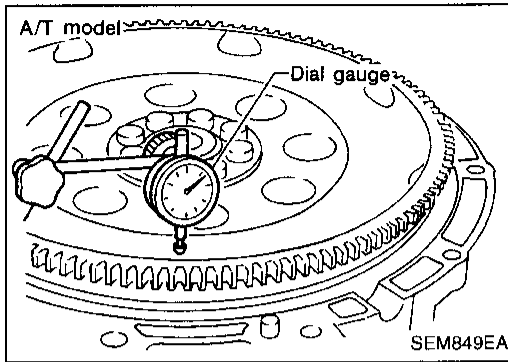
Less than 0.15 mm (0.0059 in)

★ Measurement position:

Approximately 145 mm (5.71 in) from the crankshaft center

#### CAUTION:

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



## Assembly

### PISTON

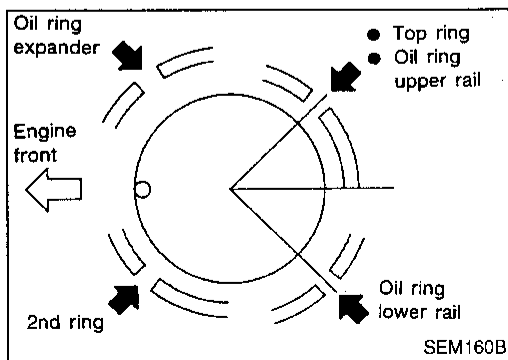
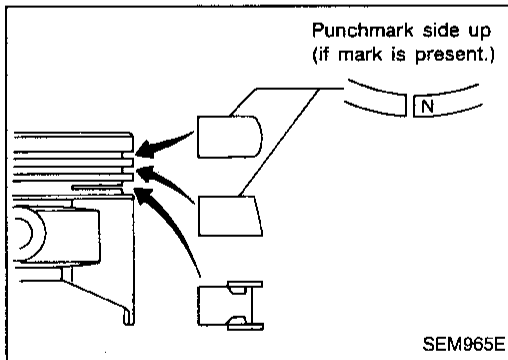
1. Install new snap ring on one side of piston pin hole.
2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.

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

3. Set piston rings as shown.

#### CAUTION:

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



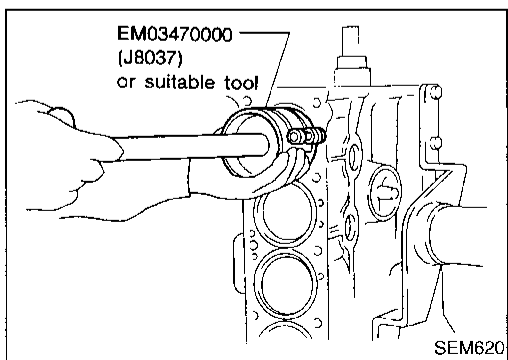
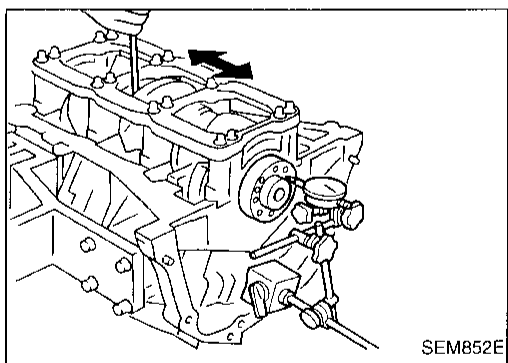
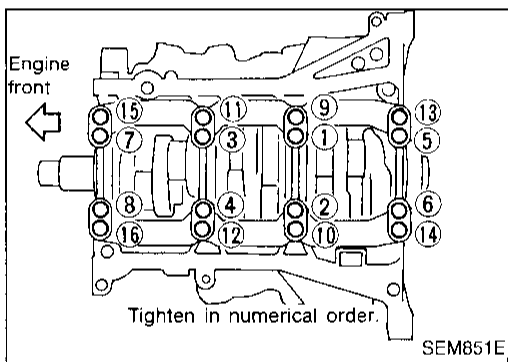
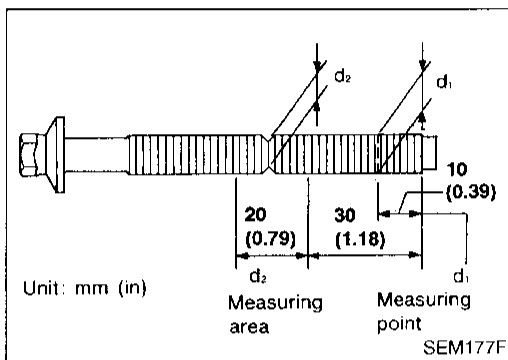
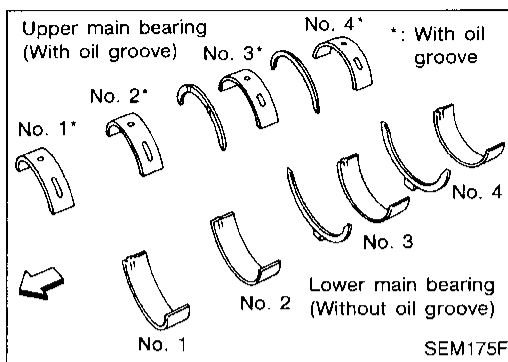
- Align piston rings so that end gaps are positioned as shown in the figure.

GI  
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EL  
IDX

# CYLINDER BLOCK

## Assembly (Cont'd)

### CRANKSHAFT



1. Set main bearings in their proper positions on cylinder block and main bearing beam.
  - Confirm that correct main bearings are used. Refer to "Inspection" of this section.

2. Instructions for re-use of main bearing cap bolts.
  - A plastic zone tightening method is used for tightening main bearing cap bolts. Measure  $d_1$  and  $d_2$  as shown in the figure.
    - $d_2$ : Select minimum diameter in the measuring area.
    - If the difference between  $d_1$  and  $d_2$  exceeds the limit, replace the bolts with new ones.
    - Limit ( $d_1 - d_2$ ): 0.11 mm (0.0043 in)

3. After installing crankshaft, main bearing cap, main bearing beam and bearing cap bolts, tighten bearing cap bolts in numerical order.

- **Tightening procedure**
- (1) Tighten all bolts to 32 to 38 N·m (3.3 to 3.9 kg-m, 24 to 28 ft-lb).
- (2) Turn all bolts 90 to 95 degrees clockwise with angle wrench.

- Prior to tightening bearing cap bolts, place bearing beam in its proper position by shifting crankshaft in the axial direction.
- After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.
- Lubricate threads and seat surfaces of the bolts with new engine oil.

4. Measure crankshaft end play.
  - Crankshaft end play:**
  - Standard: 0.10 - 0.25 mm (0.0039 - 0.0098 in)**
  - Limit: 0.30 mm (0.0118 in)**

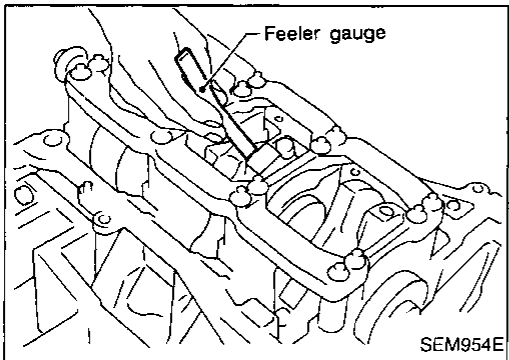
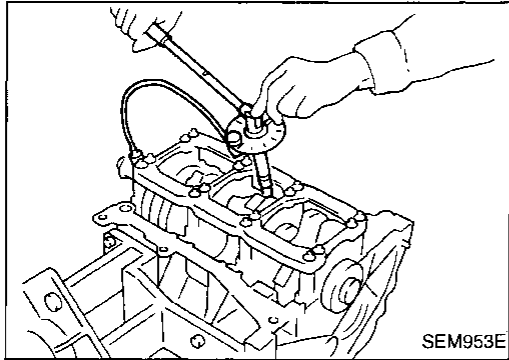
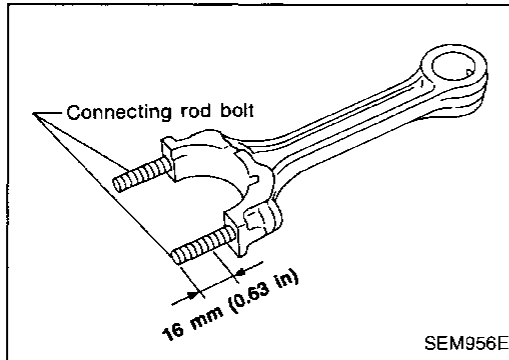
If beyond the limit, replace bearing with a new one.

5. Install connecting rod bearings in connecting rods and connecting rod caps.
  - Confirm that correct bearings are used.

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

# CYLINDER BLOCK

## Assembly (Cont'd)



b. A plastic zone tightening method is used for tightening connecting rod bolts and nuts. Check the old bolts for deformation before re-using them.

- Ensure that the connecting rod nut can be screwed smoothly as far as the bolt thread end.
- If this is not possible, use slide calipers to measure the outside diameter of the narrowest thread part of the bolt at 16 mm (0.63 in) from the thread end. Replace the connecting rod bolt and nut, if under the limit.  
Standard: 7.90 - 8.00 mm (0.3110 - 0.3150 in)  
Limit: 7.75 mm (0.3051 in)

c. Install connecting rod caps.

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

Connecting rod bearing nut:

- (1) Tighten nuts to 19 to 21 N·m (1.9 to 2.1 kg-m, 14 to 15 ft-lb).
- (2) Turn nuts 90 to 95 degrees clockwise with angle wrench.

7. Measure connecting rod side clearance.

Connecting rod side clearance:

Standard

0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit

0.40 mm (0.0157 in)

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

8. Install rear oil seal retainer.

GI

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# SERVICE DATA AND SPECIFICATIONS (SDS)

## General Specifications

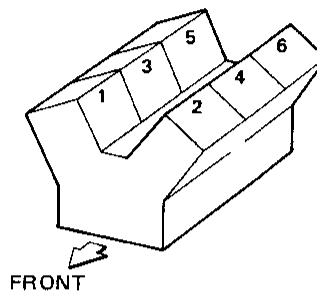
Cylinder arrangement	V-6	
Displacement	cm <sup>3</sup> (cu in)	2,988 (182.33)
Bore and stroke	mm (in)	93 x 73.3 (3.66 x 2.886)
Valve arrangement	DOHC	
Firing order	1-2-3-4-5-6	
Number of piston rings		
Compression	2	
Oil	1	
Number of main bearings	4	
Compression ratio	10.0	

## COMPRESSION PRESSURE

Unit: kPa (kg/cm<sup>2</sup>, psi)/300 rpm

Compression pressure	
Standard	1,275 (13.0, 185)
Minimum	981 (10.0, 142)
Differential limit between cylinders	98 (1.0, 14)

Cylinder number



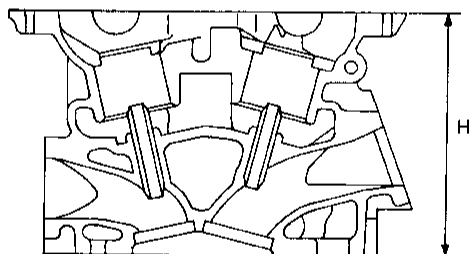
SEM713A

## Inspection and Adjustment

### CYLINDER HEAD

Unit: mm (in)

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

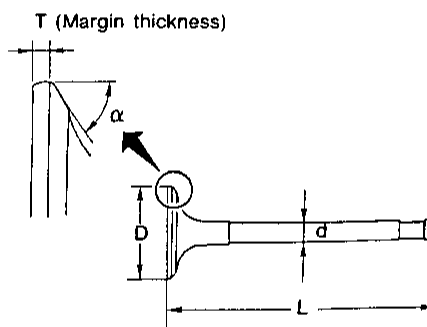


**Nominal cylinder head height:**  
H = 126.3 - 126.5 mm (4.972 - 4.980 in)

SEM949E

### VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	
Intake	36.0 - 36.3 (1.417 - 1.429)
Exhaust	31.2 - 31.5 (1.228 - 1.240)
Valve length "L"	
Intake	97.32 - 97.82 (3.8315 - 3.8512)
Exhaust	94.85 - 95.35 (3.7342 - 3.7539)
Valve stem diameter "d"	
Intake	5.965 - 5.980 (0.2348 - 0.2354)
Exhaust	5.945 - 5.960 (0.2341 - 0.2346)
Valve seat angle "α"	
Intake	45°15' - 45°45'
Exhaust	45°15' - 45°45'
Valve margin "T"	
Intake	0.95 - 1.25 (0.0374 - 0.0492)
Exhaust	1.15 - 1.45 (0.0453 - 0.0571)
Valve margin "T" limit	More than 0.5 (0.020)
Valve stem end surface grinding limit	Less than 0.2 (0.008)
Valve clearance (Cold)	
Intake	0.26 - 0.34 (0.010 - 0.013)
Exhaust	0.29 - 0.37 (0.011 - 0.015)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Inspection and Adjustment (Cont'd)

### Valve clearance

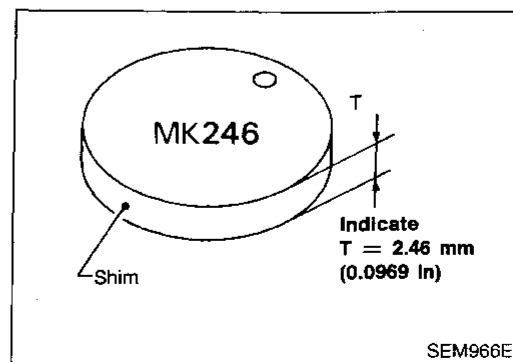
Unit: mm (in)		
	Cold	Hot* (reference data)
Intake	0.26 - 0.34 (0.010 - 0.013)	0.304 - 0.416 (0.012 - 0.016)
Exhaust	0.29 - 0.37 (0.011 - 0.015)	0.308 - 0.432 (0.012 - 0.017)

\*: Approximately 80°C (176°F)

### Available shims

Thickness mm (in)	Identification mark
2.32 (0.0913)	232
2.33 (0.0917)	233
2.34 (0.0921)	234
2.35 (0.0925)	235
2.36 (0.0929)	236
2.37 (0.0933)	237
2.38 (0.0937)	238
2.39 (0.0941)	239
2.40 (0.0945)	240
2.41 (0.0949)	241
2.42 (0.0953)	242
2.43 (0.0957)	243
2.44 (0.0961)	244
2.45 (0.0965)	245
2.46 (0.0969)	246
2.47 (0.0972)	247
2.48 (0.0976)	248
2.49 (0.0980)	249
2.50 (0.0984)	250
2.51 (0.0988)	251
2.52 (0.0992)	252
2.53 (0.0996)	253
2.54 (0.1000)	254
2.55 (0.1004)	255
2.56 (0.1008)	256
2.57 (0.1012)	257
2.58 (0.1016)	258
2.59 (0.1020)	259
2.60 (0.1024)	260
2.61 (0.1028)	261
2.62 (0.1031)	262
2.63 (0.1035)	263
2.64 (0.1039)	264

Thickness mm (in)	Identification mark
2.65 (0.1043)	265
2.66 (0.1047)	266
2.67 (0.1051)	267
2.68 (0.1055)	268
2.69 (0.1059)	269
2.70 (0.1063)	270
2.71 (0.1067)	271
2.72 (0.1071)	272
2.73 (0.1075)	273
2.74 (0.1079)	274
2.75 (0.1083)	275
2.76 (0.1087)	276
2.77 (0.1091)	277
2.78 (0.1094)	278
2.79 (0.1098)	279
2.80 (0.1102)	280
2.81 (0.1106)	281
2.82 (0.1110)	282
2.83 (0.1114)	283
2.84 (0.1118)	284
2.85 (0.1122)	285
2.86 (0.1126)	286
2.87 (0.1130)	287
2.88 (0.1134)	288
2.89 (0.1138)	289
2.90 (0.1142)	290
2.91 (0.1146)	291
2.92 (0.1150)	292
2.93 (0.1154)	293
2.94 (0.1157)	294
2.95 (0.1161)	295



GI  
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# SERVICE DATA AND SPECIFICATIONS (SDS)

## Inspection and Adjustment (Cont'd)

### Valve spring

Free height	mm (in)	46.93 (1.8476)
Pressure N (kg, lb) at height mm (in)		454 (46.3, 102.1) at 27.55 (1.0846)
		427 (43.6, 96.0) at 27.55 (1.0846)
Out-of-square	mm (in)	Less than 2.0 (0.079)

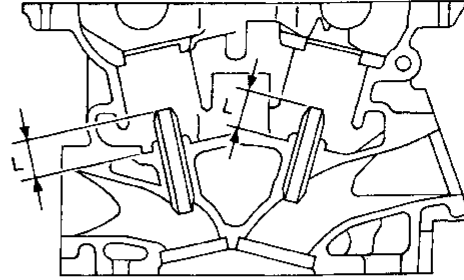
### Valve lifter

Unit: mm (in)

Valve lifter outer diameter	34.960 - 34.975 (1.3764 - 1.3770)
Lifter guide inner diameter	35.000 - 35.021 (1.3780 - 1.3788)
Clearance between lifter and lifter guide	0.025 - 0.061 (0.0010 - 0.0024)

### Valve guide

Unit: mm (in)



SEM950E

	Standard	Service
Valve guide		
Outer diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
Valve guide		
Inner diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter	9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide	0.027 - 0.059 (0.0011 - 0.0023)	
	Standard	Max. tolerance
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)
Valve deflection limit	Intake	—
	Exhaust	—
Projection length "L"	12.6 - 12.8 (0.496 - 0.504)	



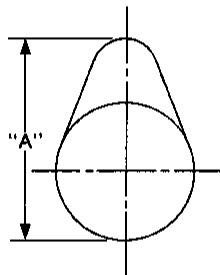
# SERVICE DATA AND SPECIFICATIONS (SDS)

## Inspection and Adjustment (Cont'd)

### CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

	Standard	Limit
Camshaft journal to bearing clearance	No. 1 0.045 - 0.086 (0.0018 - 0.0034)	0.15 (0.0059)
	No. 2, 3, 4 0.035 - 0.076 (0.0014 - 0.0030)	
Inner diameter of camshaft bearing	No. 1 26.000 - 26.021 (1.0236 - 1.0244)	—
	No. 2, 3, 4 23.500 - 23.521 (0.9252 - 0.9260)	
Outer diameter of camshaft journal	No. 1 25.935 - 25.955 (1.0211 - 1.0218)	—
	No. 2, 3, 4 23.445 - 23.465 (0.9230 - 0.9238)	
Camshaft runout [TIR*]	Less than 0.02 (0.0008)	0.05 (0.0020)
Camshaft sprocket runout [TIR*]	Less than 0.15 (0.0059)	—
Camshaft end play	0.115 - 0.188 (0.0045 - 0.0074)	0.24 (0.0094)

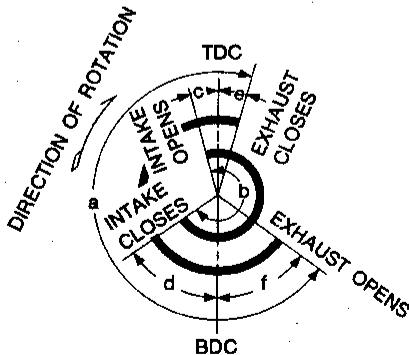


EM671

Cam height "A"	
Intake & Exhaust	43.940 - 44.130 (1.7299 - 1.7374)
Wear limit of cam height	0.2 (0.008)

\*Total indicator reading

### Valve timing

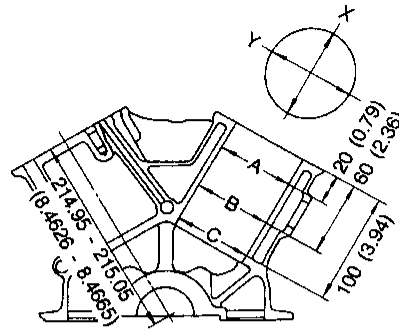


EM120  
Unit: degree

a	b	c	d	e	f
232	232	3	49	3	49

### CYLINDER BLOCK

Unit: mm (in)



SEM022EA

#### Surface flatness

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

#### Cylinder bore

##### Inner diameter

Standard	
Grade No. 1	93.000 - 93.010 (3.6614 - 3.6618)
Grade No. 2	93.011 - 93.020 (3.6618 - 3.6622)
Grade No. 3	93.021 - 93.030 (3.6622 - 3.6626)
Wear limit	0.20 (0.0079)

Out-of-round (X - Y)	Less than 0.015 (0.0006)
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Taper (A - B - C)	Less than 0.015 (0.0006)
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#### Main journal inner diameter

Grade No. A	63.993 - 63.994 (2.5194 - 2.5194)
Grade No. B	63.994 - 63.995 (2.5194 - 2.5195)
Grade No. C	63.995 - 63.996 (2.5195 - 2.5195)
Grade No. D	63.996 - 63.997 (2.5195 - 2.5196)
Grade No. E	63.997 - 63.998 (2.5196 - 2.5196)
Grade No. F	63.998 - 63.999 (2.5196 - 2.5196)
Grade No. G	63.999 - 64.000 (2.5196 - 2.5197)
Grade No. H	64.000 - 64.001 (2.5197 - 2.5197)
Grade No. J	64.001 - 64.002 (2.5197 - 2.5198)
Grade No. K	64.002 - 64.003 (2.5198 - 2.5198)
Grade No. L	64.003 - 64.004 (2.5198 - 2.5198)
Grade No. M	64.004 - 64.005 (2.5198 - 2.5199)
Grade No. N	64.005 - 64.006 (2.5199 - 2.5199)
Grade No. P	64.006 - 64.007 (2.5199 - 2.5200)
Grade No. R	64.007 - 64.008 (2.5200 - 2.5200)
Grade No. S	64.008 - 64.009 (2.5200 - 2.5200)
Grade No. T	64.009 - 64.010 (2.5200 - 2.5201)
Grade No. U	64.010 - 64.011 (2.5201 - 2.5201)
Grade No. V	64.011 - 64.012 (2.5201 - 2.5202)
Grade No. W	64.012 - 64.013 (2.5202 - 2.5202)
Grade No. X	64.013 - 64.014 (2.5202 - 2.5202)
Grade No. Y	64.014 - 64.015 (2.5202 - 2.5203)
Grade No. 4	64.015 - 64.016 (2.5203 - 2.5203)
Grade No. 7	64.016 - 64.017 (2.5203 - 2.5203)

#### Difference in inner diameter between cylinders

Standard	Less than 0.03 (0.0012)
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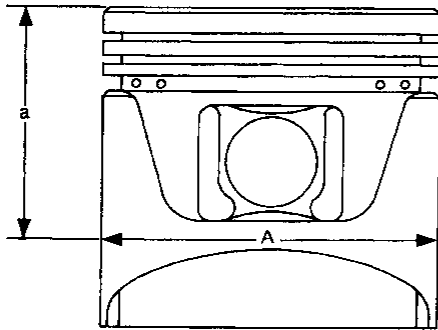
# SERVICE DATA AND SPECIFICATIONS (SDS)

## Inspection and Adjustment (Cont'd)

### PISTON, PISTON RING AND PISTON PIN

#### Available piston

Unit: mm (in)



SEM882E

#### Piston skirt diameter "A"

##### Standard

Grade No. 1	92.979 - 92.988 (3.6606 - 3.6609)
Grade No. 2	92.988 - 93.000 (3.6609 - 3.6614)
Grade No. 3	93.000 - 93.009 (3.6614 - 3.6618)
0.20 (0.0079) oversize (Service)	93.180 - 93.210 (3.6685 - 3.6697)
"a" dimension	45.4 (1.787)
Piston pin hole diameter	21.993 - 22.005 (0.8659 - 0.8663)
Piston clearance to cylinder block	0.010 - 0.030 (0.0004 - 0.0012)

#### Piston ring

Unit: mm (in)

	Standard	Limit
Side clearance		
Top	0.040 - 0.080 (0.0016 - 0.0031)	0.11 (0.0043)
2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.1 (0.004)
End gap		
Top	0.22 - 0.32 (0.0087 - 0.0126)	0.55 (0.0217)
2nd	0.32 - 0.47 (0.0126 - 0.0185)	0.85 (0.0335)
Oil (rail ring)	0.20 - 0.60 (0.0079 - 0.0236)	0.95 (0.0374)

#### Piston pin

Unit: mm (in)

Piston pin outer diameter	21.989 - 22.001 (0.8657 - 0.8662)
Interference fit of piston pin to piston	0.002 - 0.010 (0.0001 - 0.0004)
Piston pin to connecting rod bushing clearance	0.005 - 0.017 (0.0002 - 0.0007)

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

#### CONNECTING ROD

Unit: mm (in)

Center distance	147.60 - 147.70 (5.8110 - 5.8149)
Bend [per 100 (3.94)]	
Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	
Limit	0.30 (0.0118)
Connecting rod small end inner diameter	23.980 - 24.000 (0.9441 - 0.9449)
Piston pin bushing inner diameter*	22.000 - 22.012 (0.8661 - 0.8666)
Connecting rod big end inner diameter	48.000 - 48.013 (1.8898 - 1.8903)
Side clearance	
Standard	0.20 - 0.35 (0.0079 - 0.0138)
Limit	0.40 (0.0157)

\*After installing in connecting rod

# SERVICE DATA AND SPECIFICATIONS (SDS)

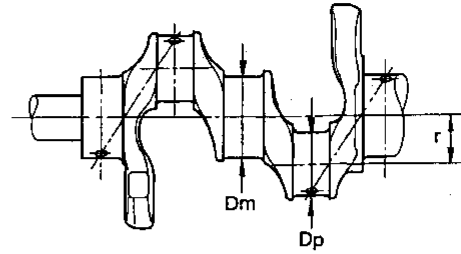
## Inspection and Adjustment (Cont'd)

### CRANKSHAFT

Unit: mm (in)

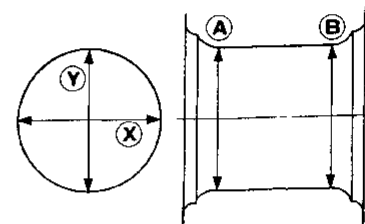
#### Main journal dia. "Dm"

Grade No. A	59.974 - 59.975 (2.3612 - 2.3612)
Grade No. B	59.973 - 59.974 (2.3611 - 2.3612)
Grade No. C	59.972 - 59.973 (2.3611 - 2.3611)
Grade No. D	59.971 - 59.972 (2.3611 - 2.3611)
Grade No. E	59.970 - 59.971 (2.3610 - 2.3611)
Grade No. F	59.969 - 59.970 (2.3610 - 2.3610)
Grade No. G	59.968 - 59.969 (2.3609 - 2.3610)
Grade No. H	59.967 - 59.968 (2.3609 - 2.3609)
Grade No. J	59.966 - 59.967 (2.3609 - 2.3609)
Grade No. K	59.965 - 59.966 (2.3608 - 2.3609)
Grade No. L	59.964 - 59.965 (2.3608 - 2.3608)
Grade No. M	59.963 - 59.964 (2.3607 - 2.3608)
Grade No. N	59.962 - 59.963 (2.3607 - 2.3607)
Grade No. P	59.961 - 59.962 (2.3607 - 2.3607)
Grade No. R	59.960 - 59.961 (2.3606 - 2.3607)
Grade No. S	59.959 - 59.960 (2.3606 - 2.3606)
Grade No. T	59.958 - 59.959 (2.3605 - 2.3606)
Grade No. U	59.957 - 59.958 (2.3605 - 2.3605)
Grade No. V	59.956 - 59.957 (2.3605 - 2.3605)
Grade No. W	59.955 - 59.956 (2.3604 - 2.3605)
Grade No. X	59.954 - 59.955 (2.3604 - 2.3604)
Grade No. Y	59.953 - 59.954 (2.3603 - 2.3604)
Grade No. 4	59.952 - 59.953 (2.3603 - 2.3603)
Grade No. 7	59.951 - 59.952 (2.3603 - 2.3603)



SEM645

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



EM715

#### Pin journal dia. "Dp"

Grade No. 0	44.968 - 44.974 (1.7704 - 1.7706)
Grade No. 1	44.962 - 44.968 (1.7702 - 1.7704)
Grade No. 2	44.956 - 44.962 (1.7699 - 1.7702)

Center distance "r" 36.61 - 36.69 (1.4413 - 1.4445)

#### Out-of-round (X - Y)

Standard Less than 0.002 (0.0001)

#### Taper (A - B)

Standard Less than 0.002 (0.0001)

#### Runout [TIR]

Limit Less than 0.10 (0.0039)

#### Free end play

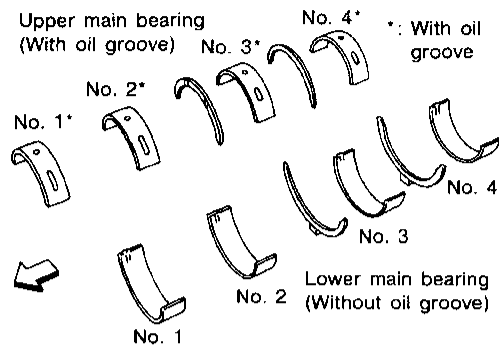
Standard 0.10 - 0.25 (0.0039 - 0.0098)

Limit 0.30 (0.0118)

# SERVICE DATA AND SPECIFICATIONS (SDS)

## Inspection and Adjustment (Cont'd)

### AVAILABLE MAIN BEARING



SEM175F

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color
0	2.000 - 2.003 (0.0787 - 0.0789)	19.9 - 20.1 (0.783 - 0.791)	Black
1	2.003 - 2.006 (0.0789 - 0.0790)		Brown
2	2.006 - 2.009 (0.0790 - 0.0791)		Green
3	2.009 - 2.012 (0.0791 - 0.0792)		Yellow
4	2.012 - 2.015 (0.0792 - 0.0793)		Blue
5	2.015 - 2.018 (0.0793 - 0.0794)		Pink
6	2.018 - 2.021 (0.0794 - 0.0796)		Purple

### Undersize

Unit: mm (in)

	Thickness	Main journal diameter "Dm"
0.25 (0.0098)	2.132 - 2.140 (0.0839 - 0.0843)	Grind so that bearing clearance is the specified value.

### AVAILABLE CONNECTING ROD BEARING

#### Connecting rod bearing

Grade number	Thickness "T" mm (in)	Identification color (mark)
0	1.500 - 1.503 (0.0591 - 0.0592)	Black
1	1.503 - 1.506 (0.0592 - 0.0593)	Brown
2	1.506 - 1.509 (0.0593 - 0.0594)	Green

### Undersize

Unit: mm (in)

	Thickness	Crank pin journal diameter "Dp"
0.25 (0.0098)	1.626 - 1.634 (0.0640 - 0.0643)	Grind so that bearing clearance is the specified value.

### MISCELLANEOUS COMPONENTS

Unit: mm (in)

Flywheel runout [TIR]\* Less than 0.15 (0.0059)

Drive plate runout [TIR]\* Less than 0.15 (0.0059)

\*Total indicator reading

### Bearing clearance

Unit: mm (in)

#### Main bearing clearance

Standard 0.012 - 0.030 (0.0005 - 0.0012)

Limit 0.065 (0.0026)

#### Connecting rod bearing clearance

Standard 0.020 - 0.045 (0.0008 - 0.0018)

Limit 0.070 (0.0028)