

# ENGINE MECHANICAL

## SECTION **EM**

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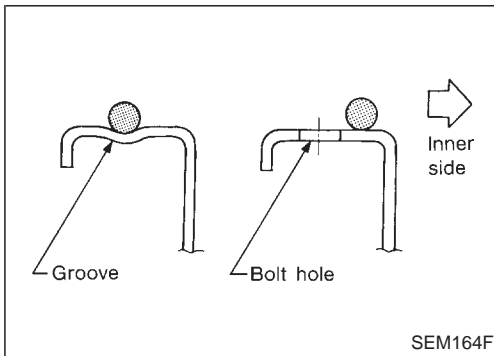
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## PRECAUTIONS

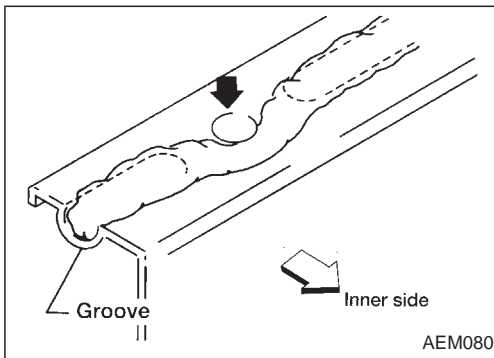
### Parts Requiring Angular Tightening

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



### Liquid Gasket Application Procedure

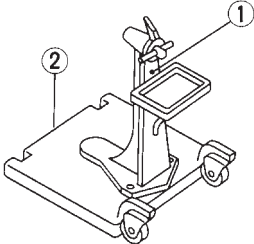
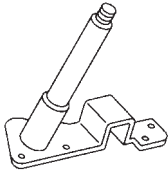
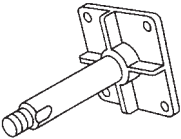
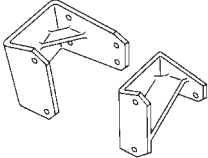
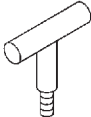
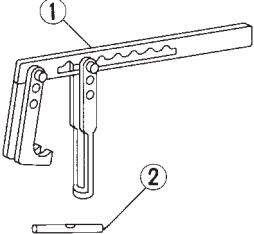
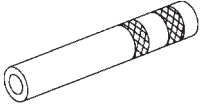
- Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also, completely clean any oil from these areas.
- Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Liquid Gasket or equivalent.)
  - For oil pan, be sure liquid gasket diameter is 3.5 to 4.5 mm (0.138 to 0.177 in) for gasoline engines.
  - For areas except oil pan, be sure liquid gasket diameter is 2.0 to 3.0 mm (0.079 to 0.118 in) for gasoline engines and 2.5 to 3.5 mm (0.098 to 0.138 in) for diesel engines.
- 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

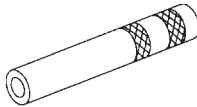
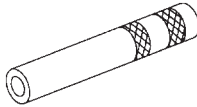
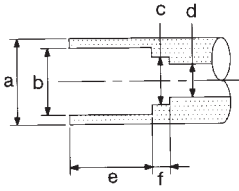
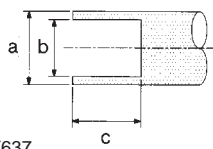
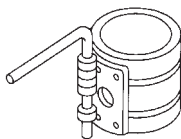
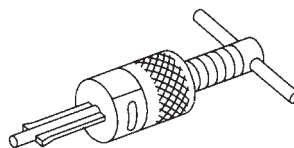
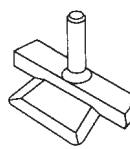
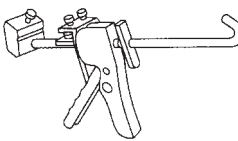
## SPECIAL SERVICE TOOLS

\*: Special tool or commercial equivalent

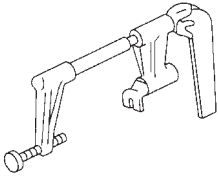
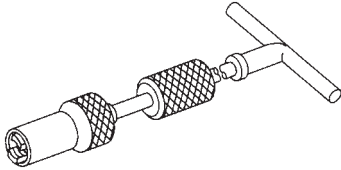
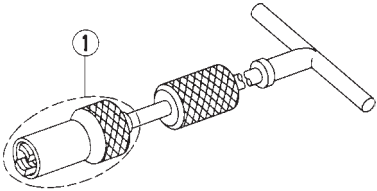
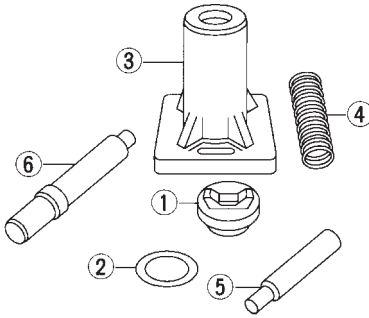
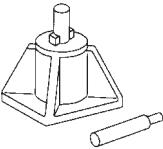
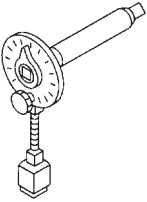
Tool number Tool name	Description	Engine application				
		KA	NA	Z	QD	TD
ST0501S000* Engine stand assembly ① ST05011000 Engine stand ② ST05012000 Base	 NT042					
KV10105001* Engine attachment	 NT031					
KV10106500* Engine attachment	 NT028					
KV11103200* Engine sub-attachment	 NT246					
KV10111200* Adapter	 NT687					
KV101092S0* Valve spring compressor ① KV10109210 Compressor ② KV10109220 Adapter	 NT021					
KV109B0010 Valve oil seal drift	 NT027					

GI  
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IDX

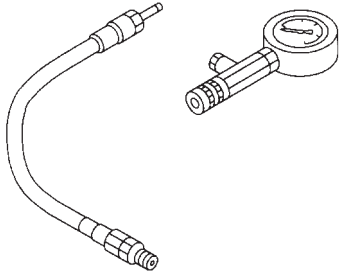
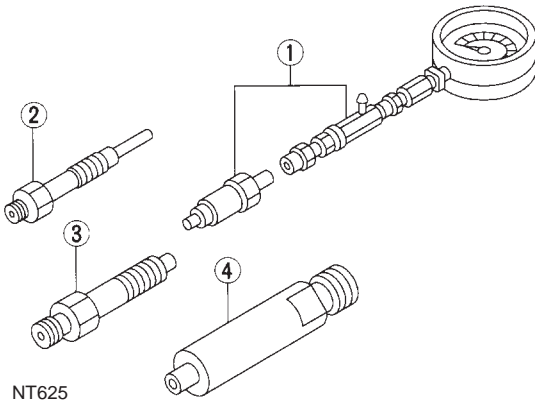
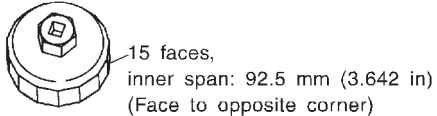
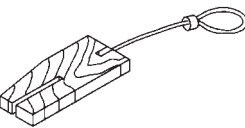
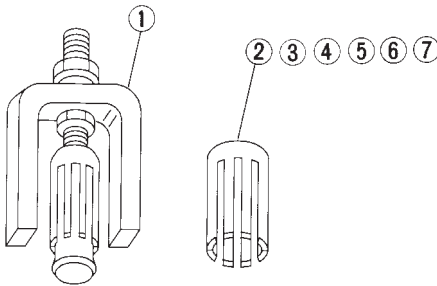
# PREPARATION

Tool number Tool name	Description	Engine application				
		KA	NA	Z	QD	TD
KV10113000 Valve oil seal drift	 NT027	Installing valve oil seal				
		—	X	—	—	—
KV10107501 Valve oil seal drift	 NT027	Installing valve oil seal				
		—	—	X	—	—
KV11105300 Valve oil seal drift	 NT602	Installing valve oil seal				
		—	—	—	X	X
		<b>a: 20 (0.79) dia.</b> <b>b: 14.6 (0.575) dia.</b> <b>c: 13.3 (0.524) dia.</b> <b>d: 8.5 (0.335) dia.</b> <b>e: 17.5 (0.689)</b> <b>f: 4.5 (0.177)</b> Unit: mm (in)				
KV11105400* Valve guide drift	 NT637	Installing valve guide				
		—	—	—	X	X
		<b>a: 20 (0.79) dia.</b> <b>b: 12.2 (0.480) dia.</b> <b>c: 16 (0.63)</b> Unit: mm (in)				
EM03470000* Piston ring compressor	 NT044	Installing piston assembly into cylinder bore				
		X	X	X	X	X
ST16610001* Pilot bushing puller	 NT045	Removing crankshaft pilot bushing				
		X	X	X	X	X
KV10111100 Seal cutter	 NT046	Removing oil pan				
		X	X	X	X	X
WS39930000* Tube presser	 NT052	Pressing the tube of liquid gasket				
		X	X	X	X	X

# PREPARATION

Tool number Tool name	Description	Engine application					
		KA	NA	Z	QD	TD	
ST12070000* Valve lifter	NT241 	—	X	X	—	—	GI MA EM
KV10107900* Valve lip seal puller	NT011 	—	X	X	—	—	LC EC FE
KV10107902* Valve oil seal puller ① KV10116100 Valve oil seal puller adapter	NT605  Disassembling valve oil seal	—	—	—	X	X	CL MT TF
KV10110300 Piston pin press stand assembly ① KV10110310 Cap ② KV10110330 Spacer ③ ST13030020 Press stand ④ ST13030030 Spring ⑤ KV10110340 Drift ⑥ KV10110320 Center shaft	NT036  Disassembling and assembling piston with connecting rod	X	—	—	—	—	PD FA RA BR ST
ST13030001 Piston pin press stand	NT242 	—	X	X	—	—	RS BT
KV10112100 Angle wrench	NT014  Tightening bolts for bearing cap, cylinder head, etc.	X	X	X	X	X	HA EL IDX

# PREPARATION

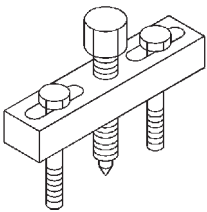
Tool number Tool name	Description	Engine application				
		KA	NA	Z	QD	TD
EG15060000 Compression gauge and adapter	 NT238	X	X	X	—	—
① ED19601000 Compression gauge ② ED19600600 Compression gauge adapter (for glow plug hole) ③ ED19600700 Compression gauge adapter (for injector hole) ④ ED19600800 Compression gauge adapter (Useless)	 NT625	Checking compression pressure				
KV10106001* Oil filter wrench	 NT690	Removing oil filter				
KV10105800* Chain stopper	 NT010	X	X	X	—	—
① KV11101110 Valve seat remover ② KV11103510 Adapter (Intake) ③ KV11103520 Adapter (Exhaust) ④ KV11104910 Adapter (Intake) ⑤ KV11104920 Adapter (Exhaust) ⑥ KV11103610 Adapter (Intake) ⑦ KV11103620 Adapter (Exhaust)	 NT251	Removing valve seat				

# PREPARATION

Tool number Tool name	Description	Engine application					
		KA	NA	Z	QD	TD	
① KV11101110 Valve seat drift ② KV11104910 Adapter (Intake) ③ KV11104920 Adapter (Exhaust) ④ KV11103810 Adapter (Intake) ⑤ KV11103820 Adapter (Exhaust)	Installing valve seat  NT252				X	X	GI
					—	—	MA
					—	—	EM
					X	X	LC
					X	X	
① KV11104010 Cylinder liner tool ② KV11104020 Adapter for removing ③ KV11104700 Adapter for removing ④ KV11104110 Adapter for removing ⑤ KV11104030 Adapter for installing	Removing and installing cylinder liner  NT681				—	X	EC
					—	—	FE
					—	—	CL
					—	X	MT
					—	X	TF
							PD
KV111033S0 Engine stopper ① KV11103310 Stopper plate ② KV10105630 Stopper gear	Preventing crankshaft from rotating  NT616 a: 3 (0.12) b: 6.4 (0.252) c: 2.8 (0.110) d: 6.6 (0.260) e: 119 (4.69) f: 12 (0.47) g: 18 (0.71) Unit: mm (in)				X	X	FA
							RA
							BR
							ST
KV111045S0 Cam bushing replacer set ① KV11104510 Replacer bar ② KV11104520 Guide plate ③ KV11104530 Adapter (1st bushing) ④ ST15243000 Drift	Removing cam bushing or installing cam bushing  NT610				X	X	RS
							BT
							HA
							EL
KV10109300* Pulley holder	Preventing drive gear from rotating  NT628 a: 68 mm (2.68 in) b: 8 mm (0.31 in) dia.				X	X	IDX

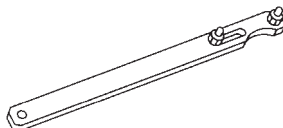
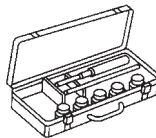
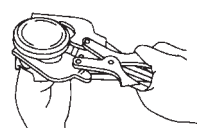
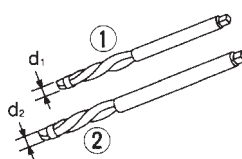
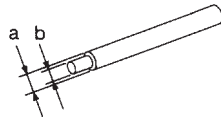
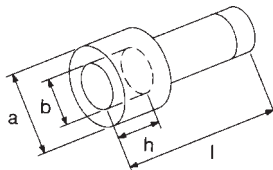


## PREPARATION

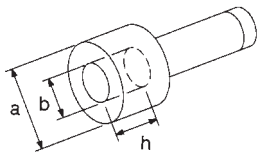
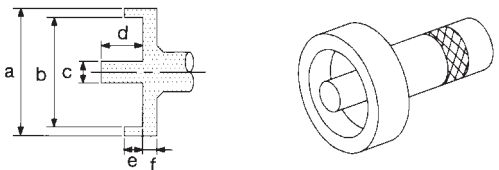
Tool number Tool name	Description	Engine application				
		KA	NA	Z	QD	TD
KV11103000* Injection pump drive gear puller	<div style="text-align: right;">Removing drive gear</div> <div style="text-align: center;">  </div> <div>NT676</div>	—	—	—	X	X

# PREPARATION


## COMMERCIAL SERVICE TOOLS

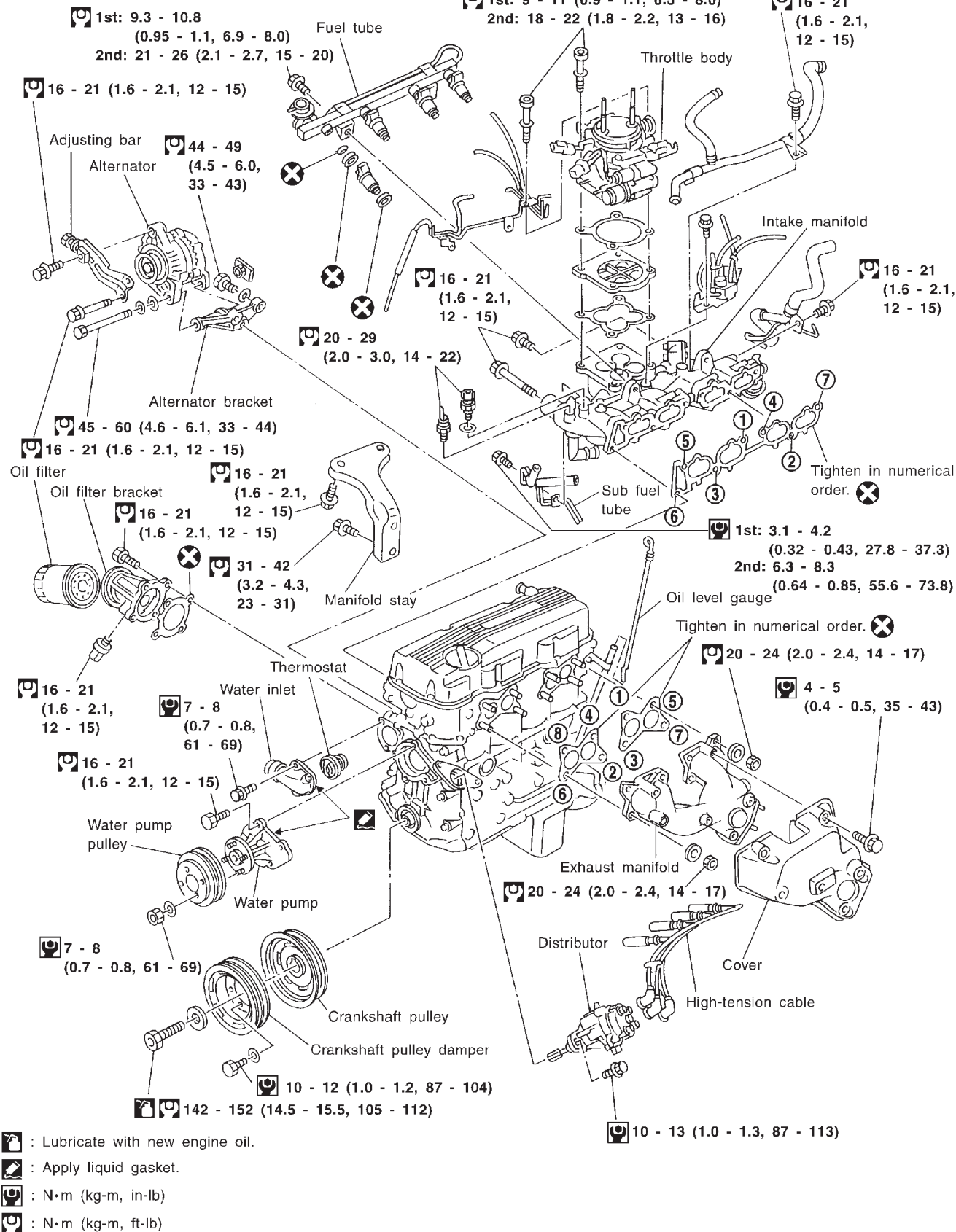
Tool name	Description	Engine application					GI	
		KA	NA	Z	QD	TD		
Pulley holder	<div>NT035</div> 	Holding camshaft pulley while tightening or loosening camshaft bolt	X	X	—	—	—	MA
Valve seat cutter set	<div>NT048</div> 	Finishing valve seat dimensions	X	X	X	X	X	LC
Piston ring expander	<div>NT030</div> 	Removing and installing piston ring	X	X	X	X	X	EC
Valve guide reamer	<div>NT016</div> 	Reaming valve guide inner ① or hole for oversize valve guide②  Diameter (Intake/Exhaust) KA24E d <sub>1</sub> : 7.000 - 7.018 (0.2756 - 0.2763)/ 8.000 - 8.018 (0.3150 - 0.3157) d <sub>2</sub> : 11.175 - 11.196 (0.4400 - 0.4408)/ 12.175 - 12.196 (0.4793 - 0.4802) NA20S and Z24S d <sub>1</sub> : 8.000 - 8.018 (0.3150 - 0.3157) d <sub>2</sub> : 12.175 - 12.196 (0.4793 - 0.4802) QD32 and TD27 d <sub>1</sub> : 8.000 - 8.015 (0.3150 - 0.3156) d <sub>2</sub> : — Unit: mm (in)	X	X	X	X	X	FE
Valve guide drift	<div>NT015</div> 	Removing and installing valve guide  Diameter (Intake/Exhaust) KA24E a: 10.5 (0.413)/11.5 (0.453) b: 6.6 (0.260)/7.6 (0.299) NA20S a: 11.5 (0.453) b: 6.5 (0.256) Z24S, QD32 and TD25 a: 11.5 (0.453) b: 7.6 (0.299) Unit: mm (in)	X	X	X	X	X	CL
Front oil seal drift	<div>NT243</div> 	Installing front oil seal  a = 70 mm (2.76 in) dia. b = 55 mm (2.17 in) dia. h = 15 mm (0.59 in) l = 50 mm (1.97 in)	—	X	—	—	—	MT

# PREPARATION

Tool name	Description	Engine application				
		KA	NA	Z	QD	TD
Rear oil seal drift	 <p>NT244</p> <p>Installing rear oil seal</p> <p>a = 109 mm (4.29 in) dia. b = 80 mm (3.15 in) dia. h = 15 mm (0.59 in)</p>	—	X	—	—	—
Rear oil seal drift	 <p>NT608</p> <p>Installing rear oil seal</p> <p>a: 98 (3.86) dia. b: 86 (3.39) dia. c: 15.9 (0.626) dia. d: 33 (1.30) e: 14.5 (0.571) f: 10.5 (0.413) Unit: mm (in)</p>	X	—	X	—	—

**1st: 9 - 11 (0.9 - 1.1, 6.5 - 8.0)**  
**2nd: 18 - 22 (1.8 - 2.2, 13 - 16)**

 16 - 21  
(1.6 - 2.1,  
12 - 15)



GI

MA

EM

LC

EC

FE

CL

MT

TF

PD

FA

RA

BR

ST

RS

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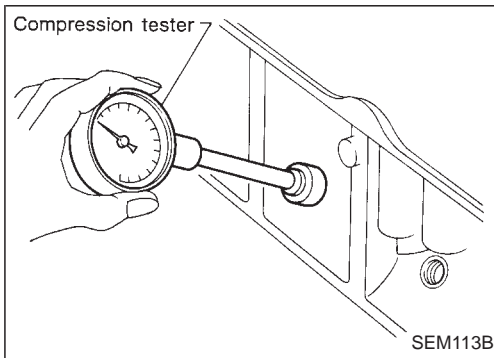
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## Measurement of Compression Pressure

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



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

### Compression pressure:

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

#### Standard

**1,324 (13.24, 13.5, 192)/300**

#### Minimum

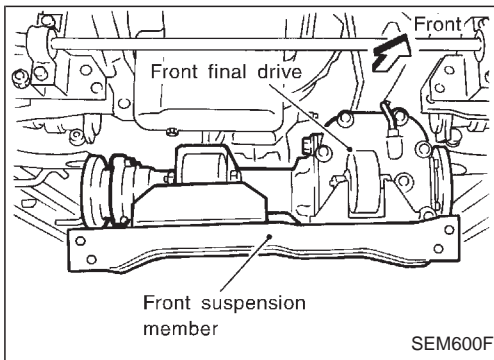
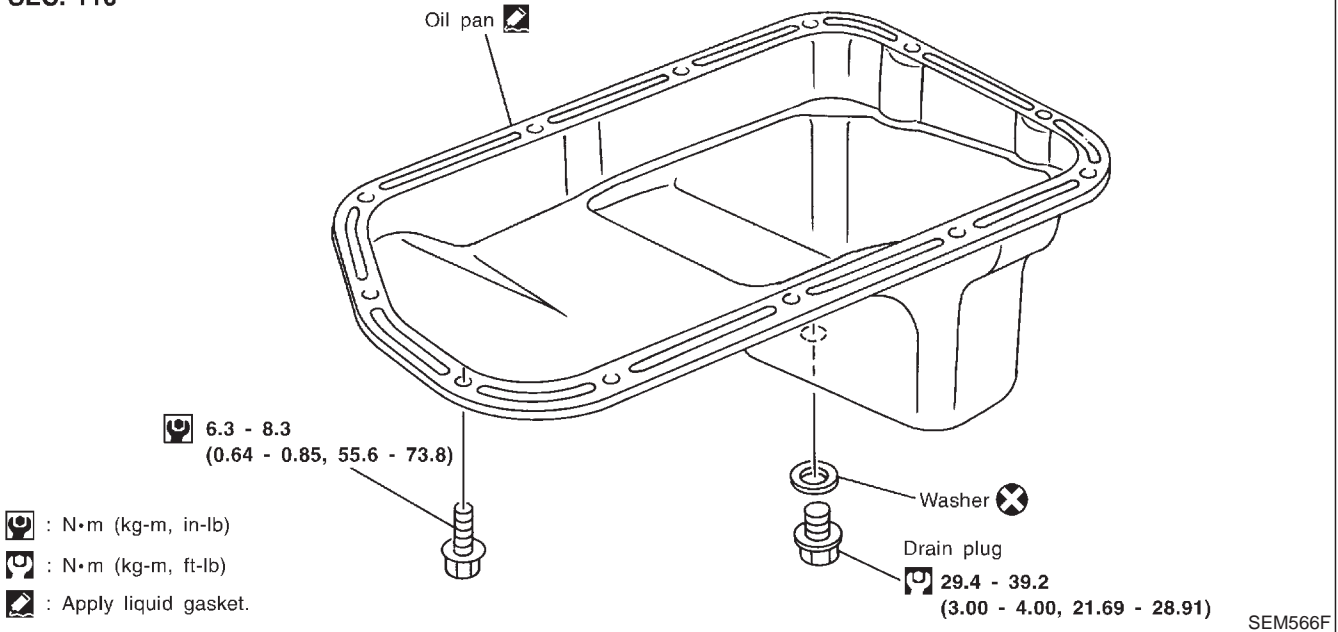
**981 (9.8, 10, 142)/300**

#### Difference limit between cylinders

**98 (0.98, 1.0, 14)/300**

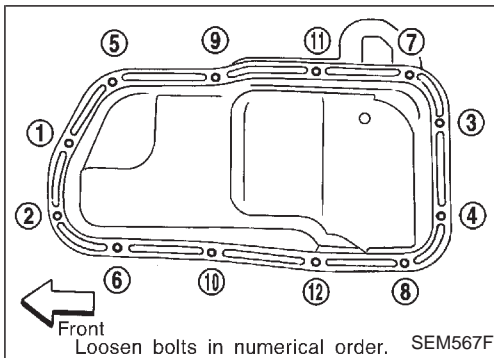
10. If compression in one or more cylinders is low:
  - a. Pour a small amount of engine oil into cylinders through spark plug holes.
  - b. Retest compression.
- **If adding oil helps compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure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

## SEC. 110

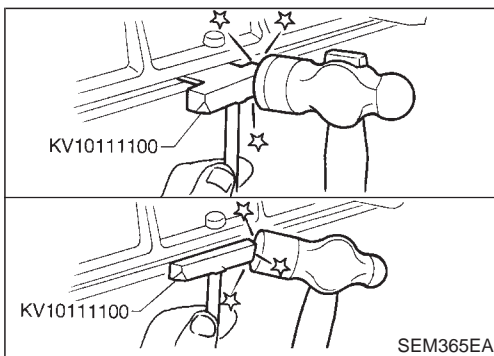


## Removal

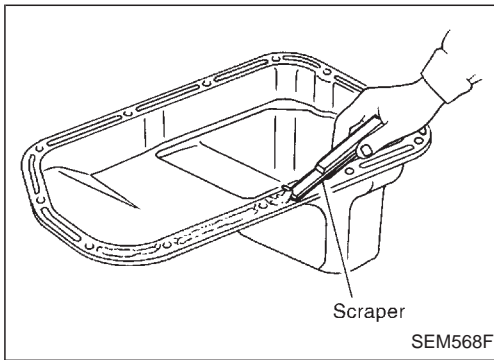
1. Raise vehicle and support it with safety stands.
2. Remove engine under cover.
3. Drain engine oil.
4. Remove front final drive together with differential mounting member. Refer to PD section ("Removal and Installation", "Front final drive") — 4WD models only.
5. Remove front suspension member bolt (RH & LH).



6. Remove oil pan bolts.

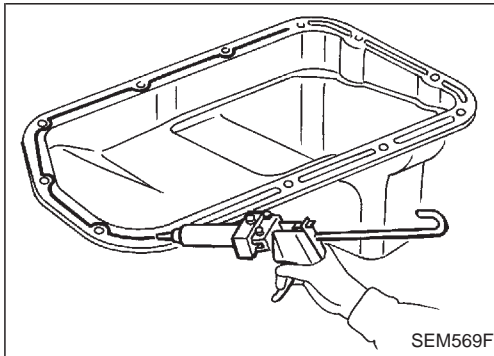


7. Remove oil pan.
  - a. Insert Tool between cylinder block and oil pan.
    - **Be careful not to damage aluminum mating surface.**
    - **Do not insert screwdriver, or oil pan flange will be damaged.**
  - b. Slide Tool by tapping on the side of the Tool with a hammer.
8. Pull out oil pan from front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

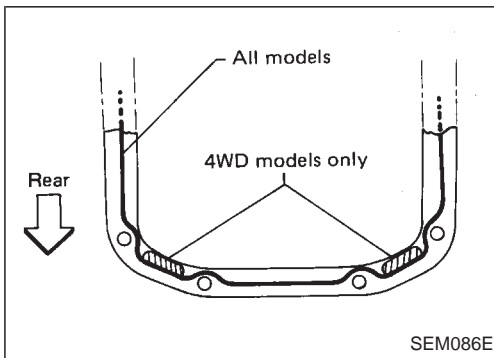
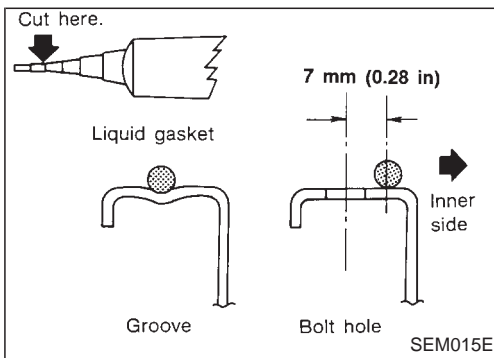


## Installation

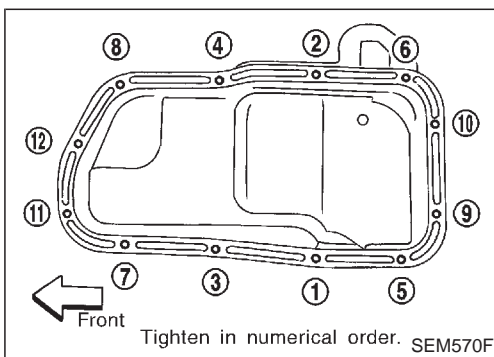
1. Use a scraper to remove old liquid gasket from mating surface of oil pan.
  - Also remove traces of liquid gasket from mating surface of cylinder block.



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



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



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

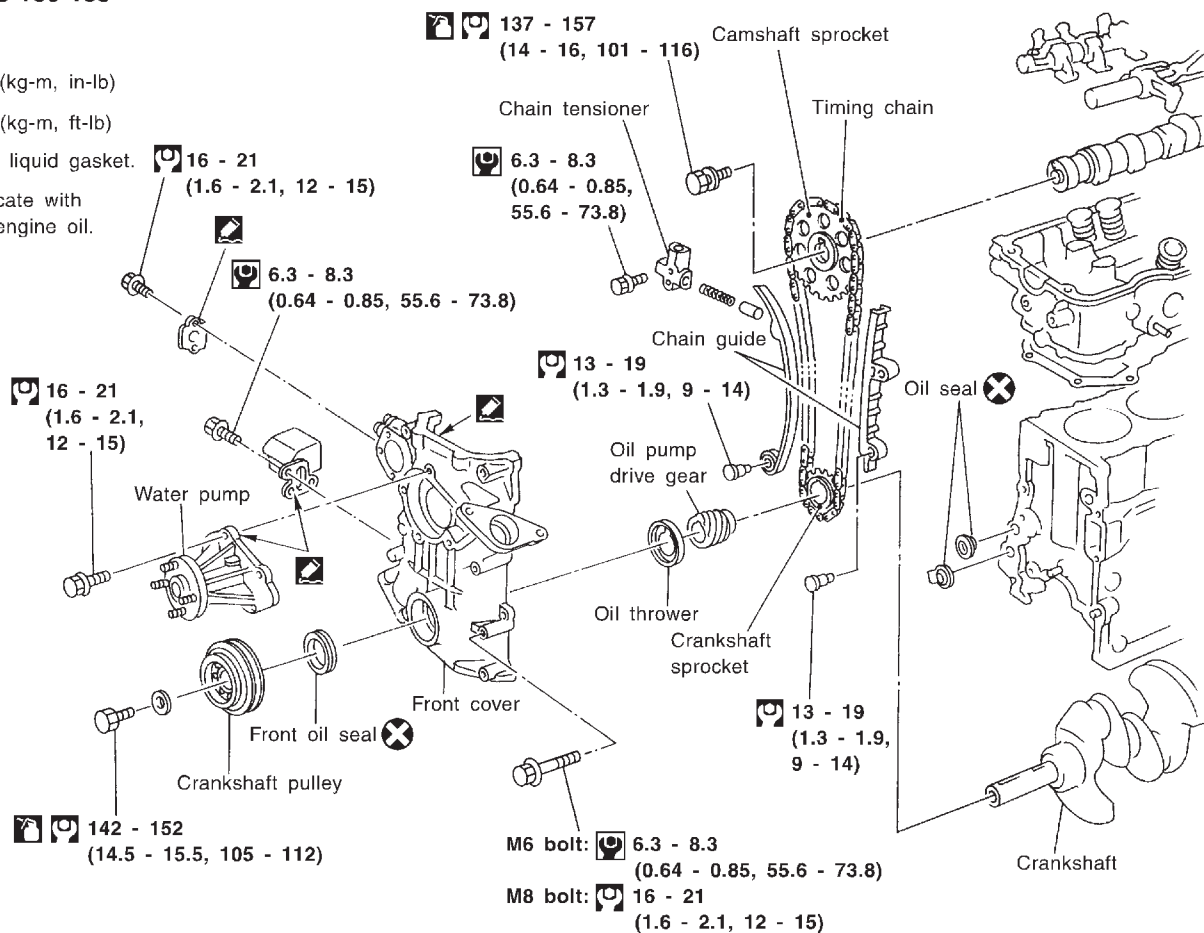
## SEC. 120•130•135

: N•m (kg-m, in-lb)

: N•m (kg-m, ft-lb)

: Apply liquid gasket.

: Lubricate with new engine oil.



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**CAUTION:**

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

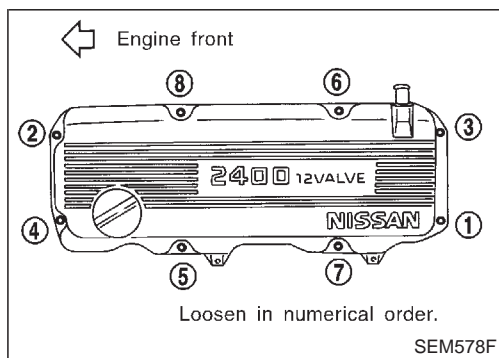
**Removal**

1. Disconnect battery terminal.
2. Remove air cleaner and air intake duct.
3. Drain coolant by removing cylinder block drain plug and radiator drain cock.
4. Remove heater hose and radiator hoses.
5. Remove radiator with shroud and cooling fan.
6. Remove the following belts.
  - Power steering drive belt
  - Compressor drive belt
  - Alternator drive belt
7. Remove accel control wire.
8. Disconnect exhaust manifold from exhaust front tube.
9. Remove PCV hoses from rocker cover.

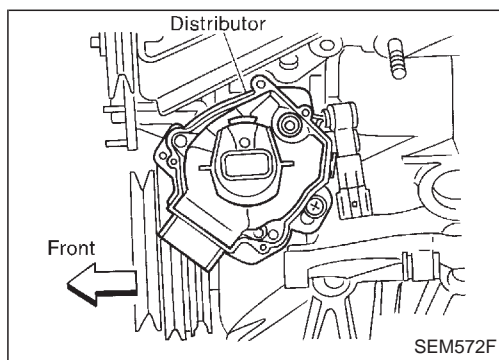


**Removal (Cont'd)**

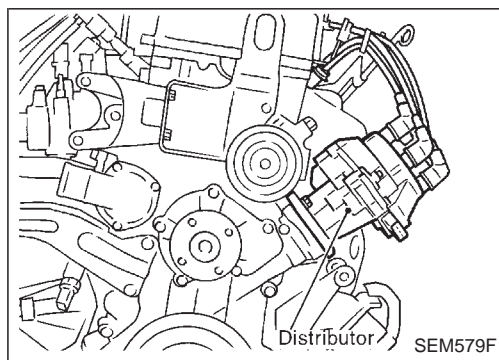
10. Remove alternator and bracket.
11. Remove power steering oil pump and bracket from engine.
12. Remove vacuum hoses, fuel hoses, wires, harness, connectors and so on.
13. Remove all high tension wires.



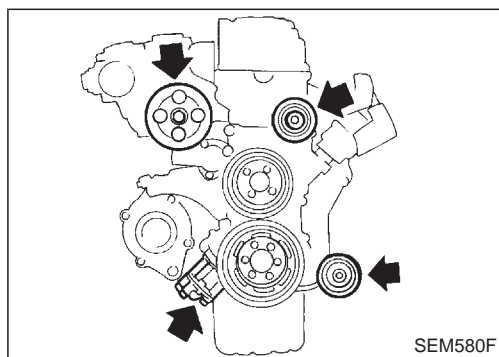
14. Remove rocker cover.
  - Loosen bolts in numerical order as shown in figure.



15. Remove all spark plugs.
16. Set No. 1 piston at TDC on its compression stroke.



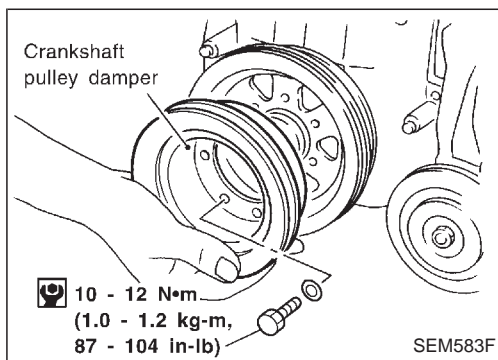
17. Remove distributor.
  - **Do not turn rotor with distributor removed.**



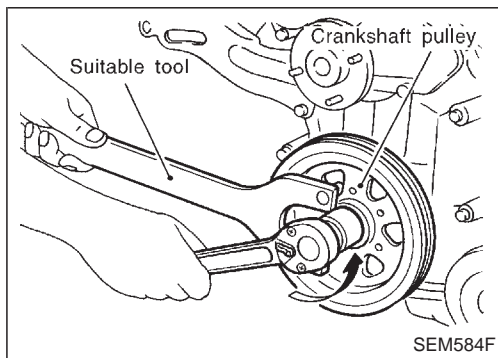
18. Remove the following parts.
  - Power steering pump, idler pulley and power steering pump brackets
  - Compressor idler pulley
  - Oil pump with pump drive spindle

## Removal (Cont'd)

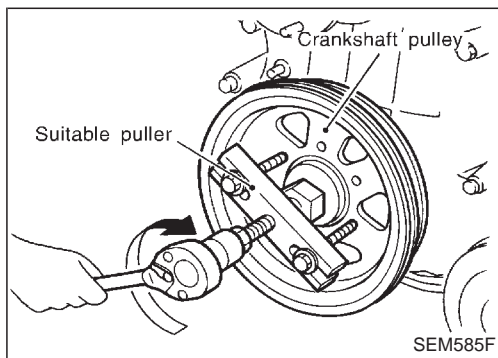
19. Remove crankshaft pulley damper.



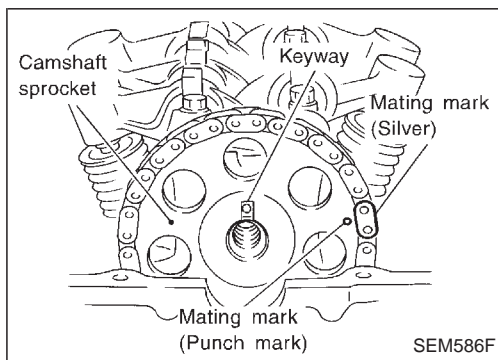
20. Loosen crankshaft pulley bolt.



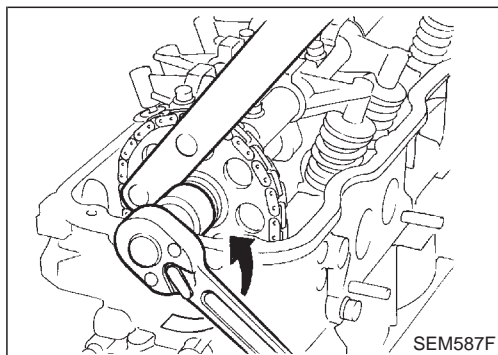
21. Remove crankshaft pulley with a suitable puller.



- Rotate crankshaft until key way on camshaft sprocket is in top position.



22. Remove camshaft sprockets bolt.



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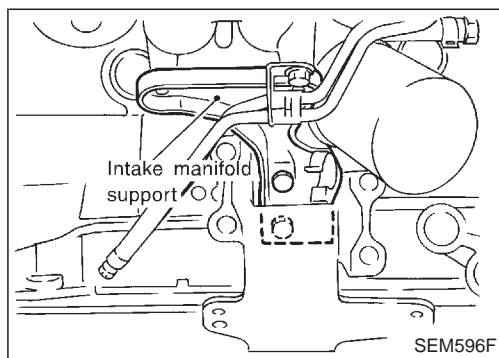
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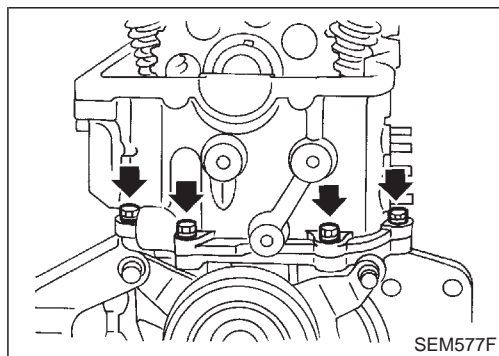
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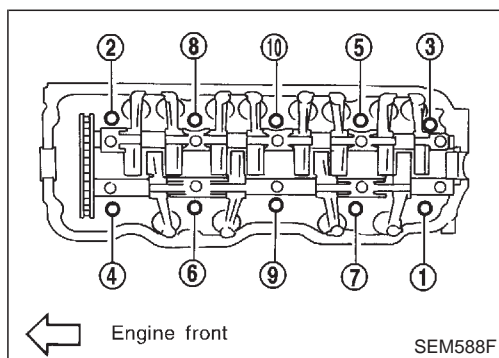
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**Removal (Cont'd)**

23. Remove the bolt securing intake manifold to intake manifold support.



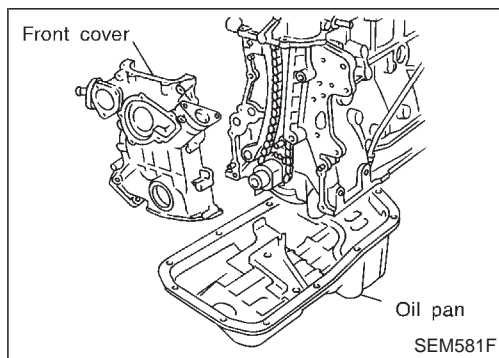
24. Remove front timing cover to cylinder head bolts.



25. Remove cylinder head bolts.

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

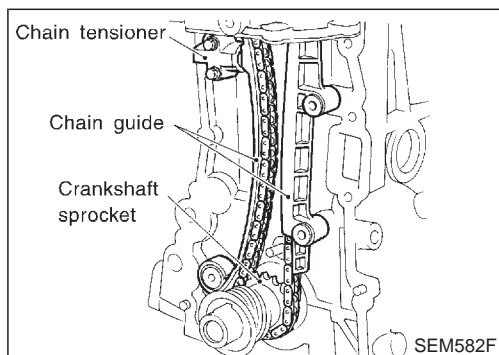
26. Remove cylinder head with intake and exhaust manifolds.



27. Remove oil pan. (Refer to OIL PAN, EM-13.)

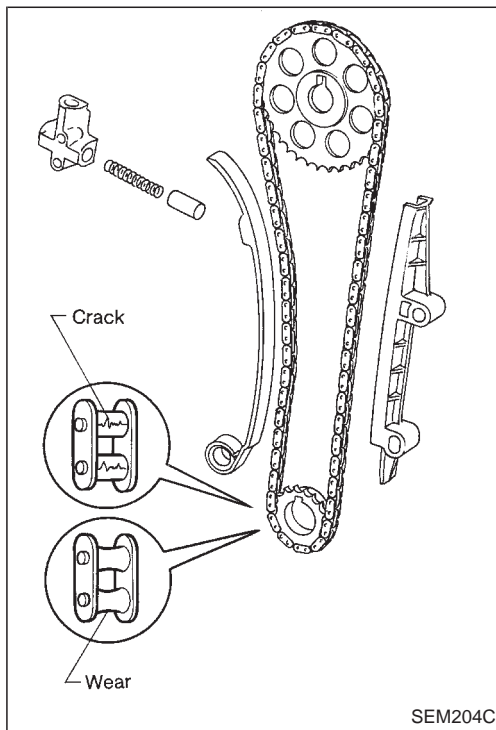
28. Remove front cover.

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



29. Remove the following parts.

- Chain tensioner
- Chain guides
- Timing chain and camshaft sprocket
- Oil thrower, oil pump drive gear and crankshaft sprocket



## Inspection

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

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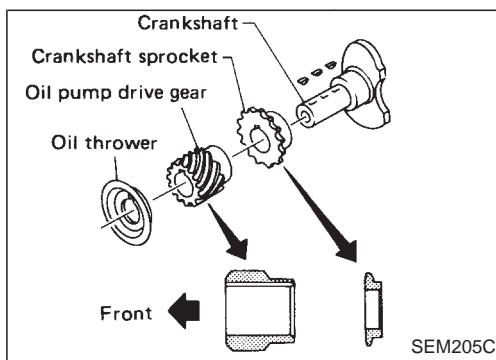
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## Installation

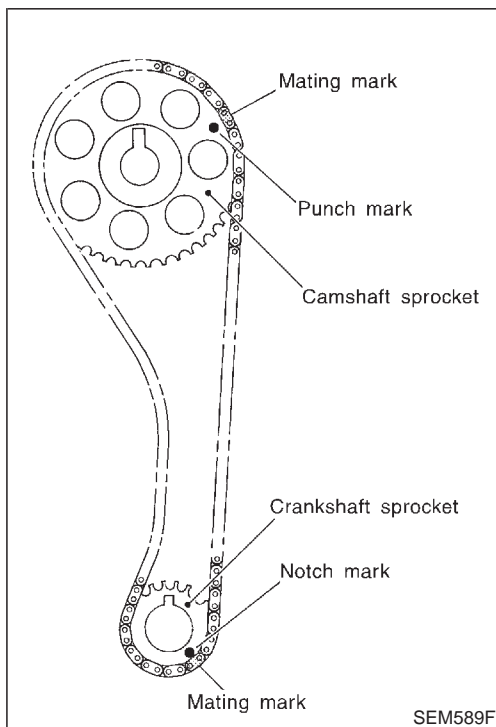
- Install crankshaft sprocket, oil pump drive gear and oil thrower.
  - Make sure that mating marks on crankshaft sprocket face front of engine.

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- Position crankshaft so that No. 1 piston is set at TDC (Keyway at 12 o'clock) fit timing chain to crankshaft sprocket so that mating mark is in line with mating mark on crankshaft sprocket.
- Temporarily install cylinder head with new gasket. Position camshaft so that keyway is set at 12 o'clock.
- Set timing chain by aligning its mating marks with those of crankshaft sprocket and camshaft sprocket.

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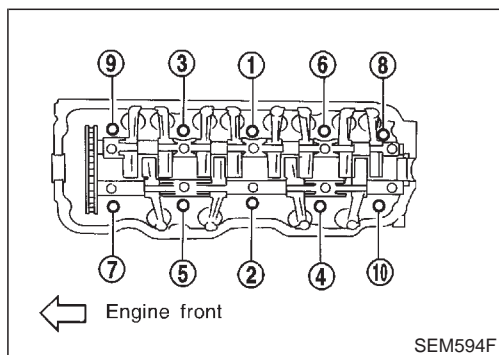
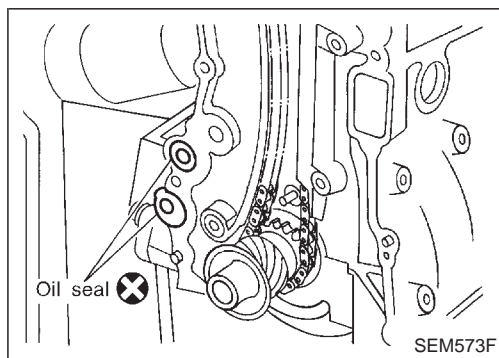
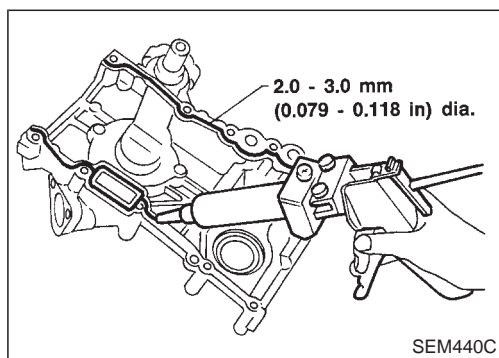
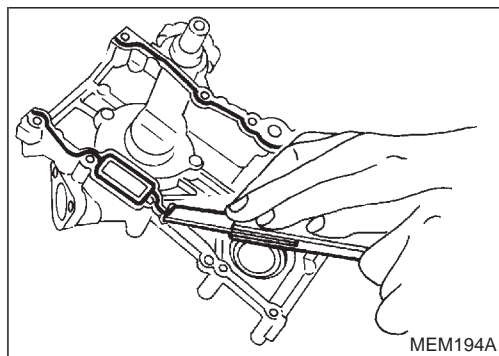
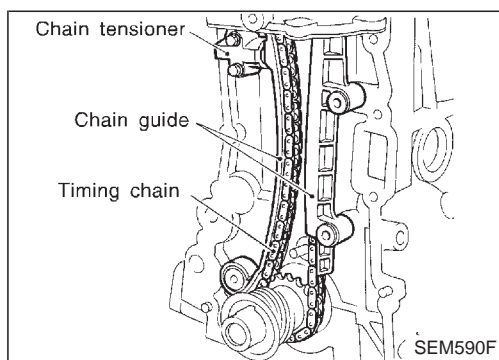
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## TIMING CHAIN

## Installation (Cont'd)



4. Install timing chain and timing chain guides and chain tensioner.

5. Before installing front cover, remove all traces of liquid gasket from mating surface using a scraper.

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

6. Apply a continuous bead of liquid gasket to front cover.

- **Use Genuine Liquid Gasket or equivalent.**
- **Be sure to install new front oil seal in the right direction. Refer to EM-24.**

7. Apply lithium grease to sealing lip of crankshaft oil seal.

8. Install front cover.

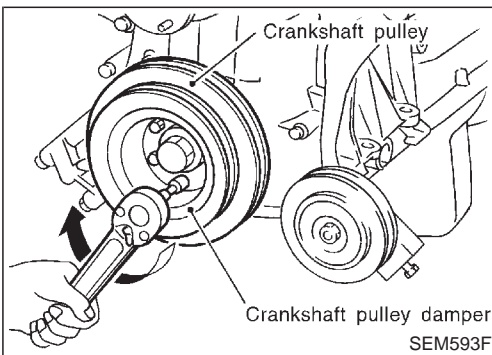
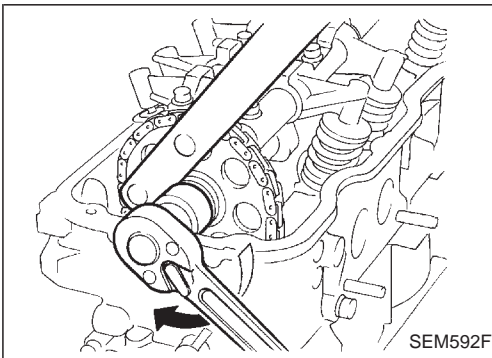
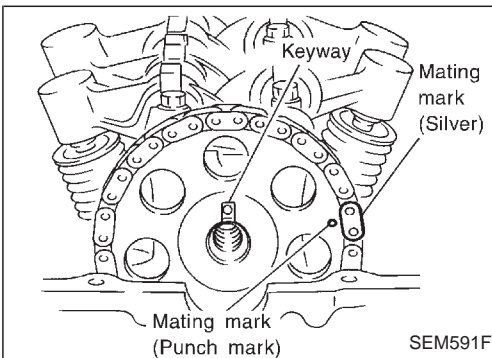
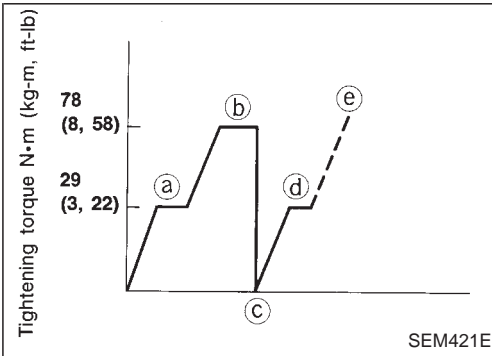
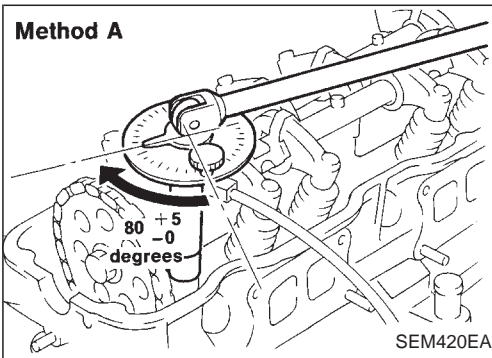
- **Be careful not to damage cylinder head gasket.**
- **Be careful not to damage front oil seal when installing front cover.**

9. Install oil pan. (Refer to OIL PAN, EM-13.)

10. Tighten cylinder head bolts.

- Tighten all bolts to 29 N·m (3 kg-m, 22 ft-lb).**
- Tighten all bolts to 78 N·m (8 kg-m, 58 ft-lb).**
- Loosen all bolts completely.**
- Tighten all bolts to 25 to 34 N·m (2.5 to 3.5 kg-m, 18 to 25 ft-lb).**

Method A



## Installation (Cont'd)

⑤ Method A: Turn all bolts  $80^{+5}_{-0}$  degrees clockwise with an angle wrench.

Method B: If an angle wrench is not available, tighten all bolts to 74 to 83 N·m (7.5 to 8.5 kg-m, 54 to 61 ft-lb).

	Tightening torque N·m (kg-m, ft-lb)
(a)	29 (3, 22)
(b)	78 (8, 58)
(c)	0 (0, 0)
(d)	29±5 (3±0.5, 21.7±3.6)
(e)	80 $^{+5}_{-0}$ degrees or 78±5 (8.0±0.5, 57.9±3.6)

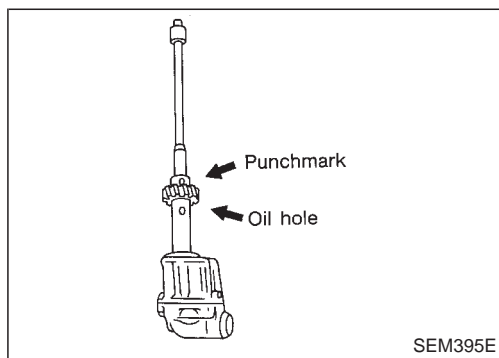
11. Install camshaft sprockets.

Line up mating mark on timing chain with mating mark on camshaft sprocket.

- Lock camshafts as shown in figure and tighten to specified torque.

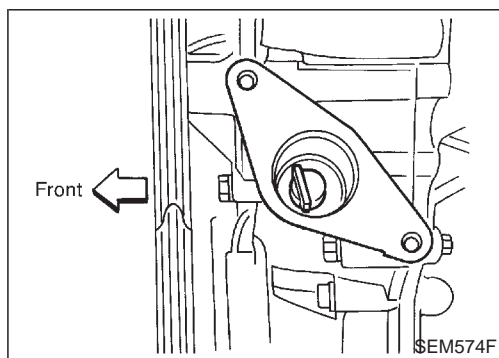
: 137 - 157 N·m (14.0 - 16.0 kg-m, 101 - 116 ft-lb)

12. Install crankshaft pulley and crankshaft pulley damper.

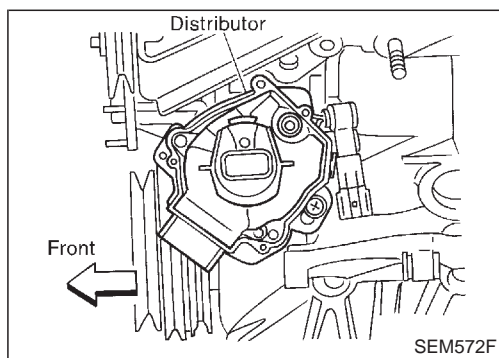
**Installation (Cont'd)**

13. Install oil pump and distributor driving spindle with new gasket in front cover.

- a. Assemble oil pump and driving spindle, aligning punchmark on driving spindle with oil hole.

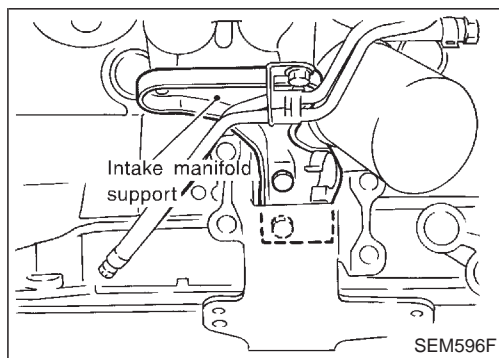


- b. Make sure that driving spindle is set as shown in figure.



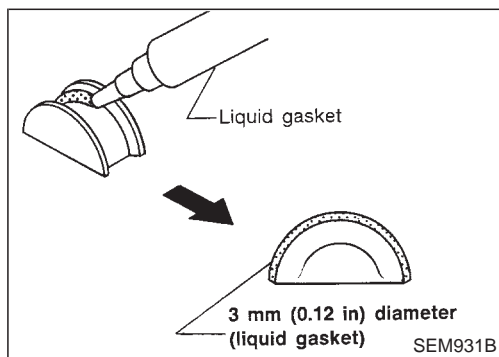
14. Install distributor.

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



16. Install cylinder head outside bolts.

17. Install intake manifold support.



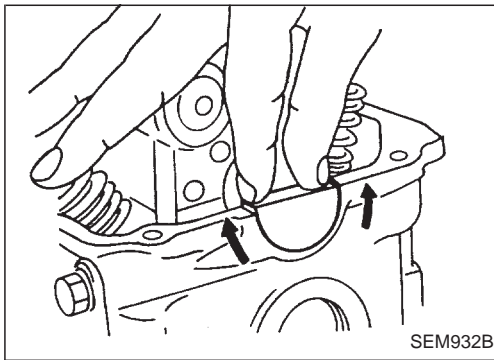
18. Install rubber plugs as follows:

- a. Apply liquid gasket to rubber plugs.

- Rubber plugs should be replaced with new ones.
- Rubber plugs should be installed within 5 minutes of applying liquid gasket.

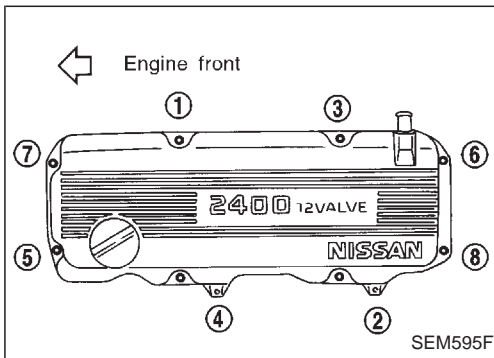
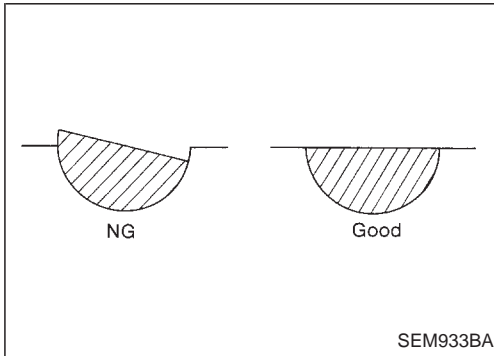


## Installation (Cont'd)



b. Install rubber plugs, then move them with your fingers to uniformly spread the gasket on cylinder head surface.

- Rubber plugs should be installed flush with the surface.
- Do not start the engine for 30 minutes after installing rocker cover.
- Wipe clean excessive liquid gasket from cylinder head top surface.



19. Install rocker cover.

## Rocker cover tightening procedure:

- (1) Tighten bolts ① - ② in that order to 3 N·m (0.3 kg-m, 26 in-lb).
- (2) Tighten nuts ④ - ③ - ② - ① - ⑧ - ⑦ - ⑥ - ⑤ - ④ - ③ - ② - ① in that order to 7 to 11 N·m (0.7 to 1.1 kg-m, 61 to 95 in-lb).

20. Install parts in the reverse order of removal.

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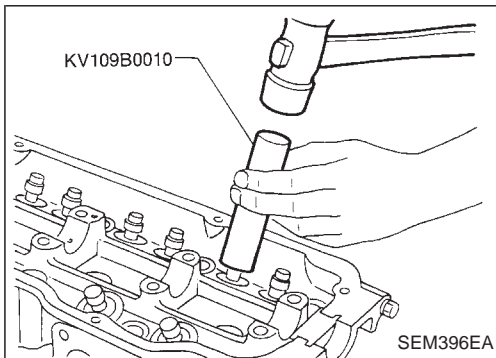
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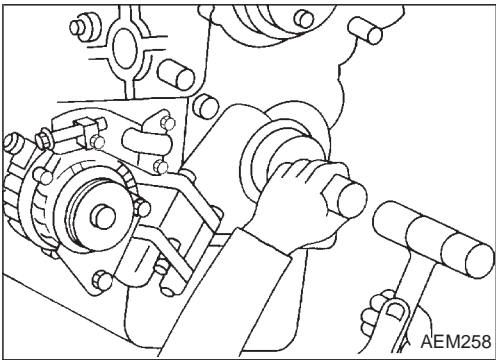
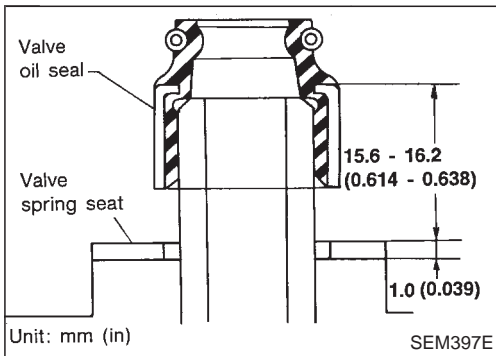


### Valve Oil Seal

1. Remove rocker cover.
  2. Remove rocker shaft assembly. (Refer to "Disassembly", "CYLINDER HEAD", EM-29.)
  3. Remove valve spring and valve oil seal with Tool or suitable tool.
- **Piston concerned should be set at TDC to prevent valve from falling.**

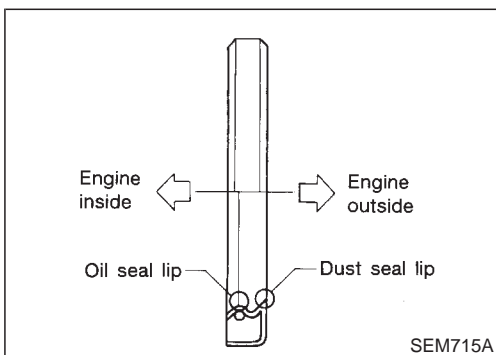


4. Apply engine oil to new valve oil seal and install it with Tool.
- **Before installing valve oil seal, install valve spring seat.**

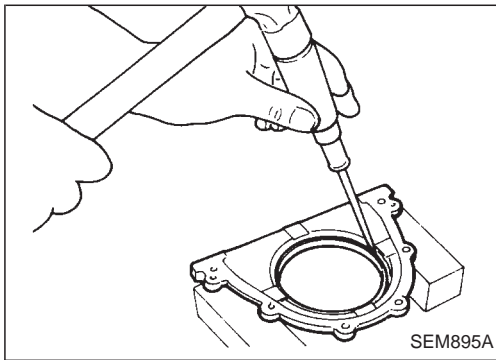


### Front Oil Seal

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

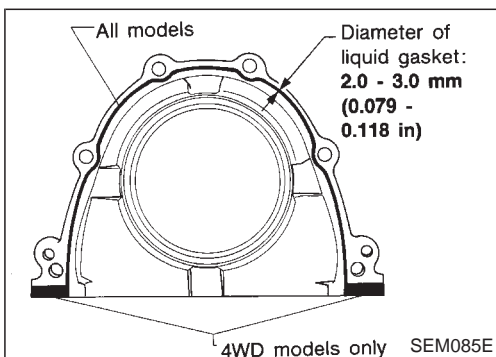
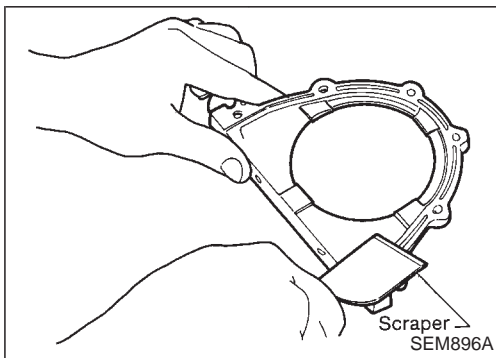
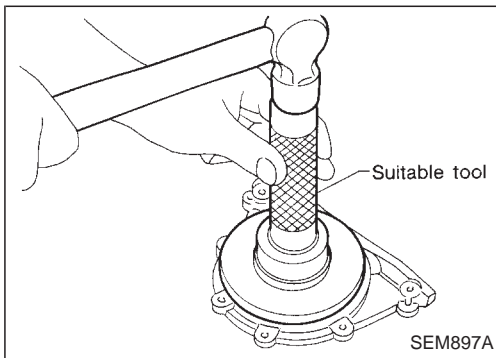
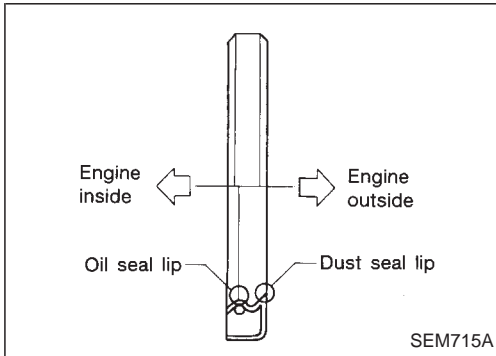


3. Apply engine oil to new oil seal and install it using suitable tool.
- **Install new oil seal in the direction shown.**



## Rear Oil Seal

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



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

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

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

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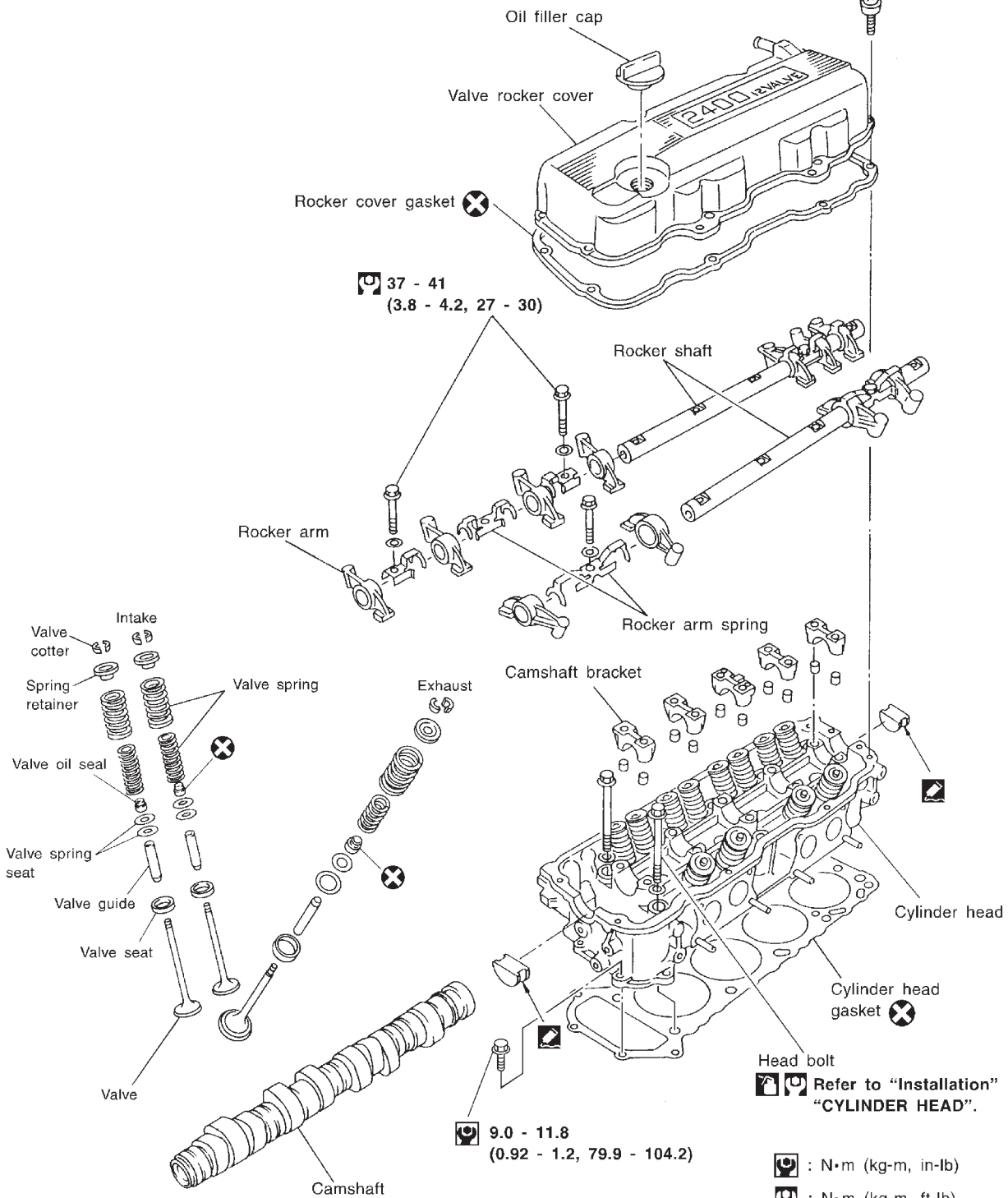
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## SEC. 111•130

 Refer to "Installation" in "TIMING CHAIN".

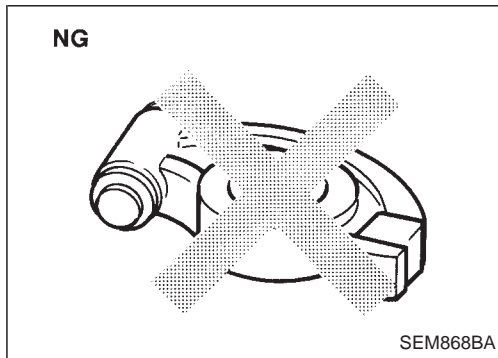
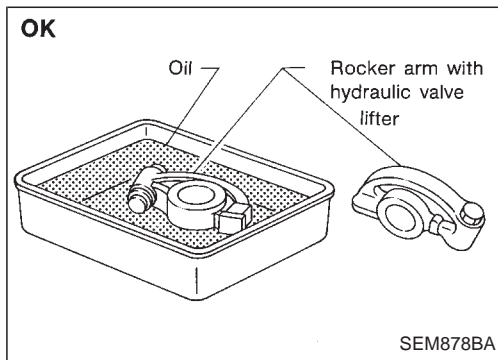


 : N•m (kg-m, in-lb)

 : N•m (kg-m, ft-lb)

 : Apply liquid gasket.

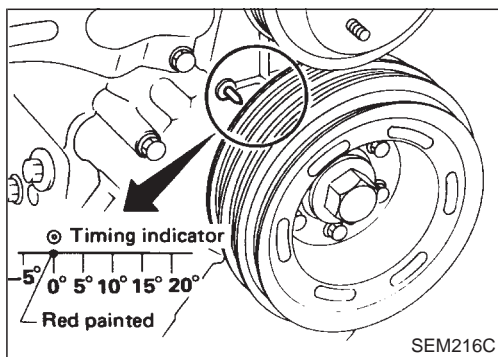
 : Lubricate with new engine oil.

**CAUTION:**

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

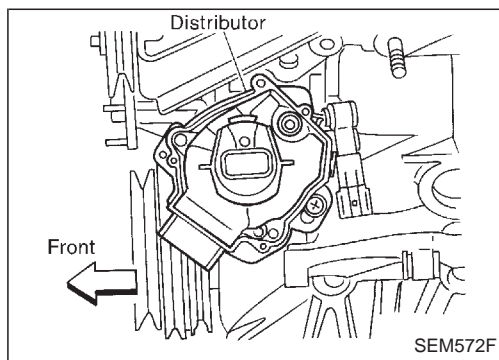
**Removal**

1. Release fuel pressure. Refer to EC section ("Fuel Pressure Release").
2. Drain coolant from radiator and drain plug of block.
3. Remove the following parts.
  - Power steering drive belt
  - Power steering pump, idler pulley and power steering brackets
  - Vacuum hoses of swirl control valve and pressure control solenoid valve
  - Accelerator wire bracket
4. Remove bolts which hold intake manifold collector to intake manifold.
5. Remove bolts which hold intake manifold to cylinder head while raising collector upwards.
6. Remove exhaust manifold cover and exhaust manifold.
7. Remove rocker cover.
  - **When removing rocker cover, do not hit rocker cover against rocker arm.**

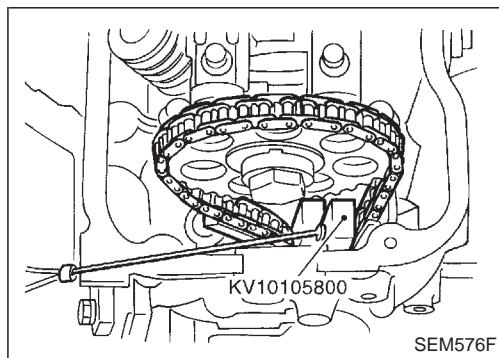


8. Set No. 1 piston at TDC on its compression stroke.

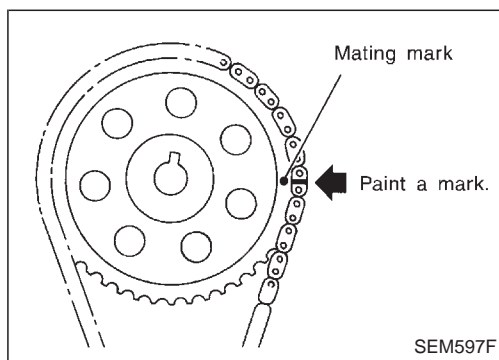
## Removal (Cont'd)



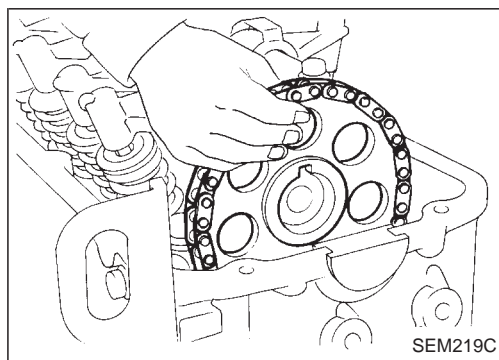
- Make sure No. 1 cylinder is at TDC by looking at the distributor rotor position.



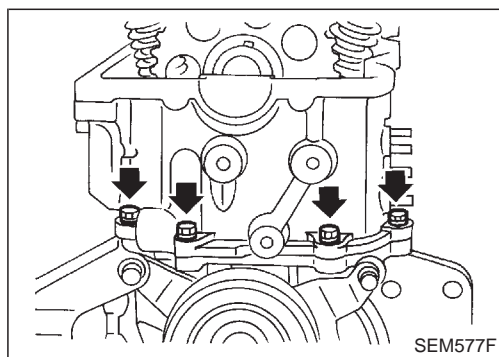
9. Loosen camshaft sprocket bolt.
- Support timing chain by using Tool as shown in figure.



10. Apply paint marks to timing chain matched with mating marks of camshaft sprockets.



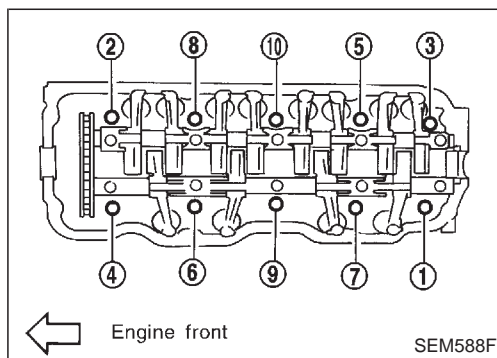
11. Remove camshaft sprocket.



12. Remove front timing cover to cylinder head bolts.

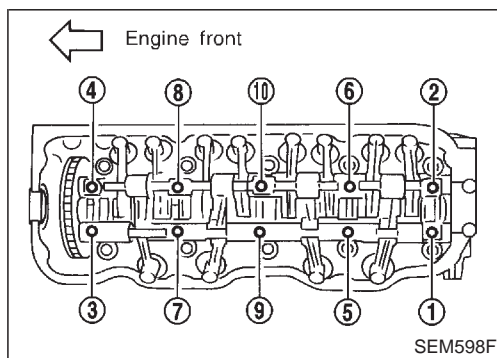
## CYLINDER HEAD

## Removal (Cont'd)



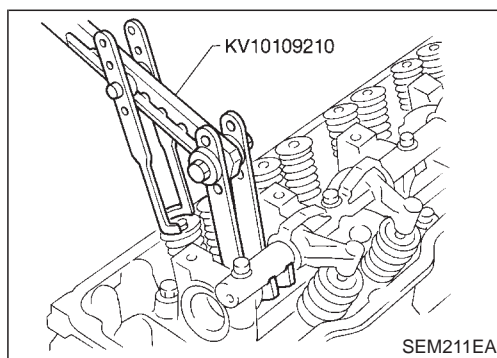
13. Remove cylinder head.

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

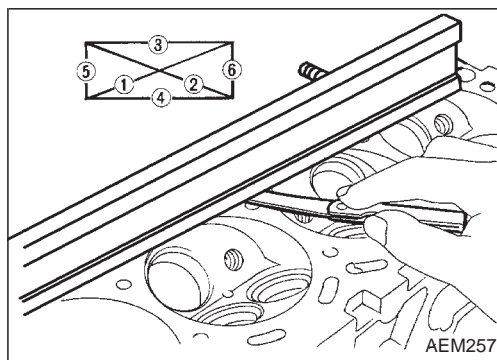


## Disassembly

1. Remove rocker shaft assembly.
  - a. When loosening bolts, evenly loosen from outside in sequence.
  - b. Bolts should be loosened in two or three steps.
2. Remove camshaft.
  - Before removing camshaft, measure camshaft end play. (Refer to "Inspection".)



3. Remove valve components with Tool.
4. Remove valve oil seals. (Refer to "OIL SEAL REPLACEMENT", EM-24.)



## Inspection

## CYLINDER HEAD DISTORTION

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

Head surface flatness: mm (in)

Standard

Less than 0.03 (0.0012)

Limit

0.1 (0.004)

If beyond the specified limit, replace or resurface.

**Resurfacing limit:**

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

Amount of cylinder head resurfacing is "A"

Amount of cylinder block resurfacing is "B"

The maximum limit is as follows:

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

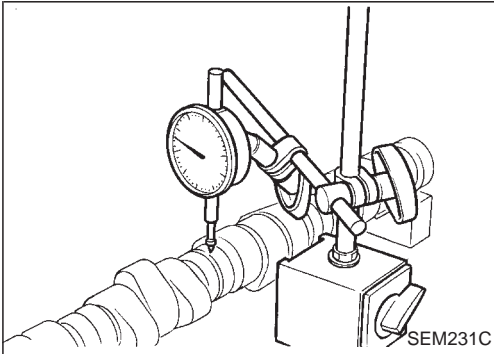
After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.

**Nominal cylinder head height:**

98.8 - 99.0 mm (3.890 - 3.898 in)

**Inspection (Cont'd)****CAMSHAFT VISUAL CHECK**

Check camshaft for scratches, seizure and wear.

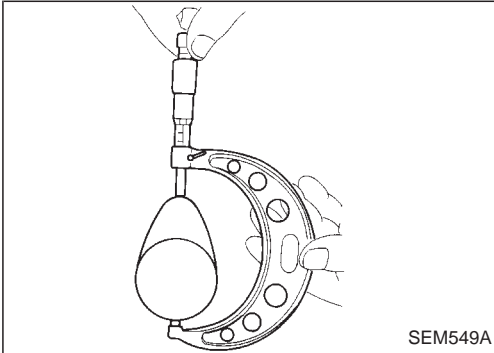
**CAMSHAFT RUNOUT**

1. Measure camshaft runout at the center journal.

**Runout (Total indicator reading):**

**0 - 0.02 mm (0 - 0.0008 in)**

2. If it exceeds the limit, replace camshaft.

**CAMSHAFT CAM HEIGHT**

1. Measure camshaft cam height.

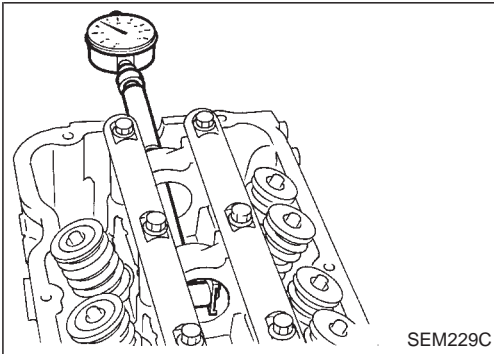
**Standard cam height:**

**44.43 - 44.58 mm (1.7492 - 1.7551 in)**

**Cam height wear limit:**

**0.2 mm (0.008 in)**

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

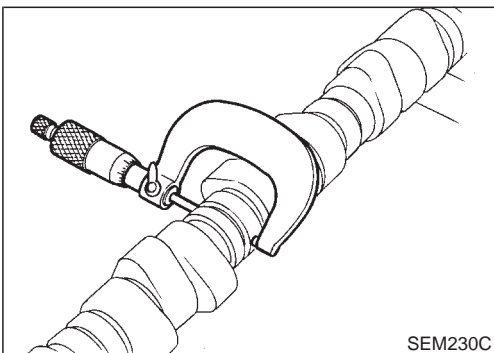
**CAMSHAFT JOURNAL CLEARANCE**

1. Install camshaft bracket and rocker shaft and tighten bolts to the specified torque.

2. Measure inner diameter of camshaft bearing.

**Standard inner diameter:**

**33.000 - 33.025 mm (1.2992 - 1.3002 in)**



3. Measure outer diameter of camshaft journal.

**Standard outer diameter:**

**32.935 - 32.955 mm (1.2967 - 1.2974 in)**

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

**Camshaft journal clearance: mm (in)**

**Standard**

**0.045 - 0.090 (0.0018 - 0.0035)**

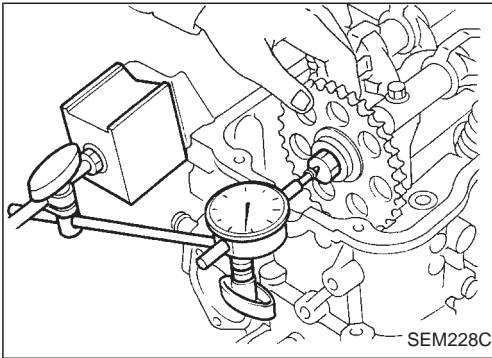
**Limit**

**0.12 (0.0047)**



## Inspection (Cont'd)

## CAMSHAFT END PLAY



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

**Camshaft end play: mm (in)**

**Standard**

**0.07 - 0.15 (0.0028 - 0.0059)**

**Limit**

**0.2 (0.008)**

3. If end play exceeds the limit, replace camshaft and remeasure camshaft end play.
- If end play still exceeds the limit after replacing camshaft, replace cylinder head.

GI

MA

EM

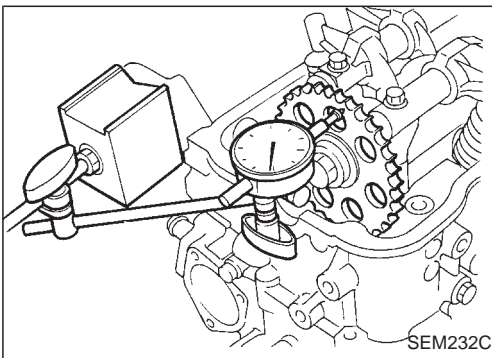
LC

EC

FE

CL

MT



## CAMSHAFT SPROCKET RUNOUT

1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.

**Runout (Total indicator reading):**

**Limit 0.12 mm (0.0047 in)**

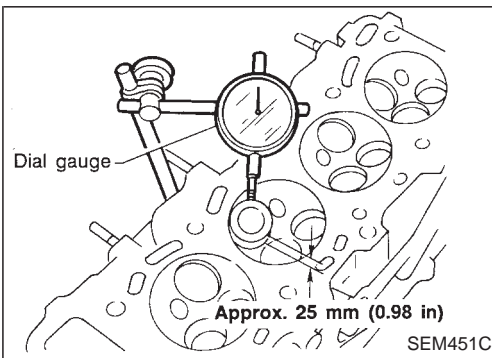
3. If it exceeds the limit, replace camshaft sprocket.

TF

PD

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RA



## VALVE GUIDE CLEARANCE

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

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

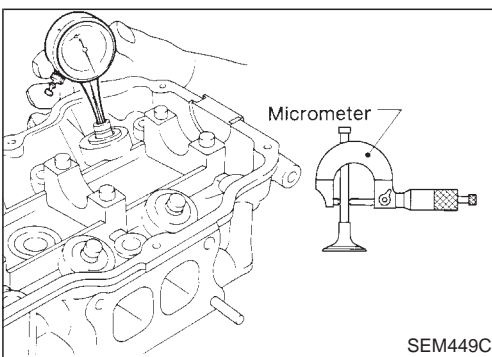
**0.15 mm (0.0059 in)**

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

**Valve to valve guide clearance = valve guide inner diameter - valve stem diameter: mm (in)**

**Standard**

**Intake**

**0.020 - 0.053 (0.0008 - 0.0021)**

**Exhaust**

**0.040 - 0.070 (0.0016 - 0.0028)**

**Limit 0.1 (0.004)**

- c. If it exceeds the limit, replace valve and remeasure clearance.

HA

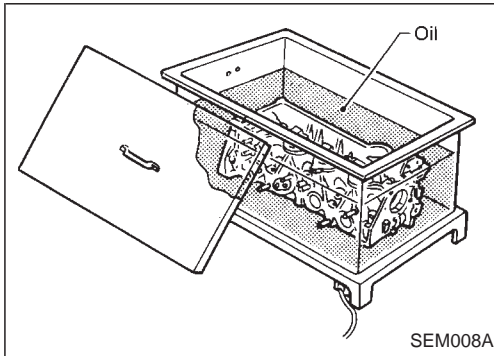
EL

IDX

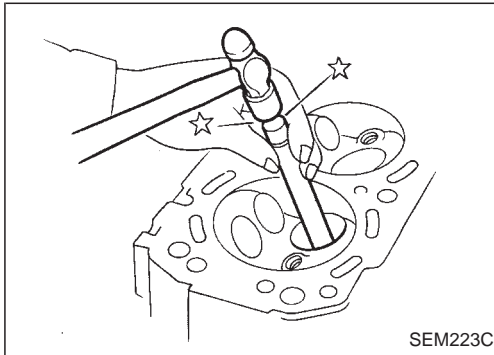


**Inspection (Cont'd)**

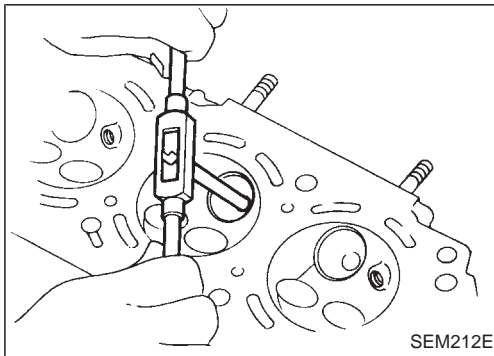
- If clearance still exceeds the limit after replacing valve, replace the valve guide.

**VALVE GUIDE REPLACEMENT**

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



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



3. Ream cylinder head valve guide hole.

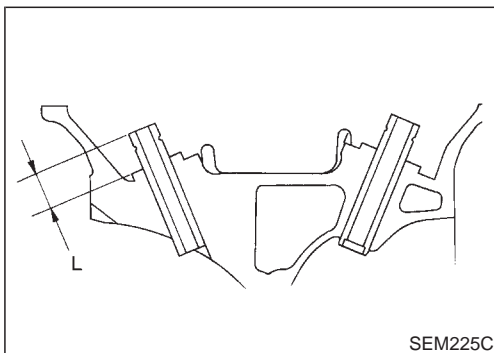
**Valve guide hole diameter  
(for service parts): mm (in)**

**Intake**

**11.175 - 11.196 (0.4400 - 0.4408)**

**Exhaust**

**12.175 - 12.196 (0.4793 - 0.4802)**



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

**Projection "L":**

**14.9 - 15.1 mm (0.587 - 0.594 in)**

5. Ream valve guide.

**Finished size: mm (in)**

**Intake**

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

**Exhaust**

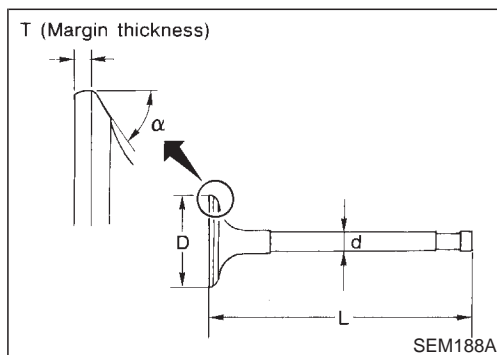
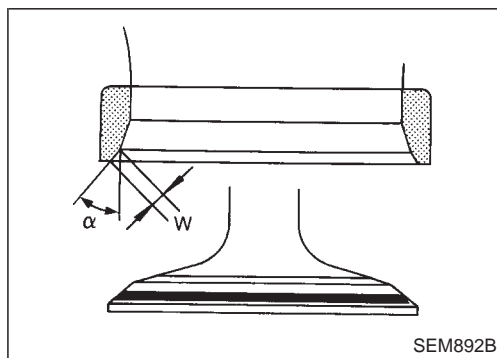
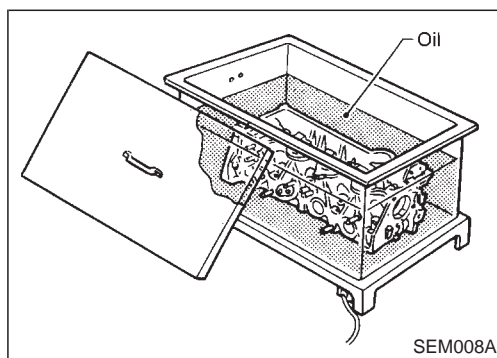
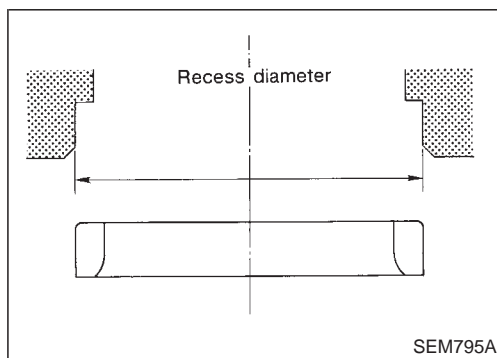
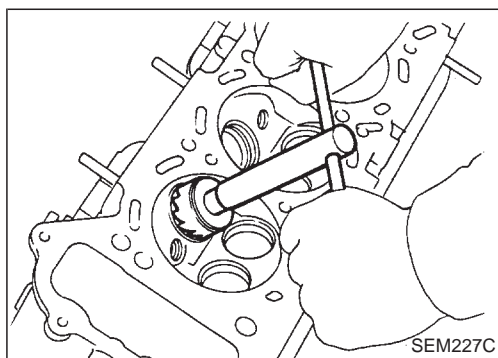
**8.000 - 8.018 (0.3150 - 0.3157)**

## Inspection (Cont'd)

## VALVE SEATS

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

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



## REPLACING VALVE SEAT FOR SERVICE PARTS

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

2. Ream cylinder head recess.

**Reaming bore for service valve seat**

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

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

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

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

3. Heat cylinder head to 110 to 130°C (230 to 266°F).
4. Press fit valve seat until it seats on the bottom.

5. Cut or grind valve seat using suitable tool of the specified dimensions. Refer to SDS, EM-178.
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

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

**45 deg.**

**Contacting width "W": mm (in)**

**Intake**

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

**Exhaust**

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

## VALVE DIMENSIONS

Check dimensions of each valve. Refer to SDS, EM-179.

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

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

## CYLINDER HEAD

### Inspection (Cont'd)

#### VALVE SPRING

##### Squareness

1. Measure dimension "S".

**Out-of-square "S": mm (in)**

##### Outer

**Intake Less than 2.5 (0.098)**

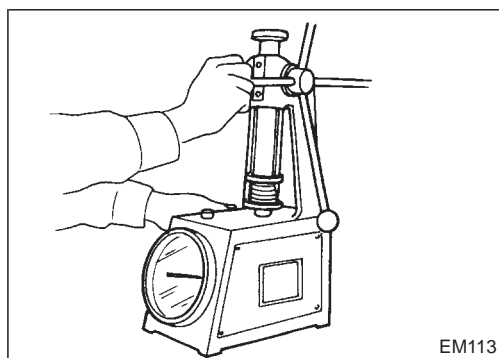
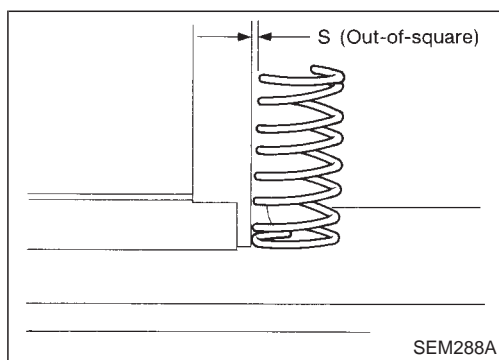
**Exhaust Less than 2.3 (0.091)**

##### Inner

**Intake Less than 2.3 (0.091)**

**Exhaust Less than 2.1 (0.083)**

2. If it exceeds the limit, replace spring.



##### Pressure

Check valve spring pressure at specified spring height.

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

##### Standard

##### Outer

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

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

##### Inner

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

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

##### Limit

##### Outer

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

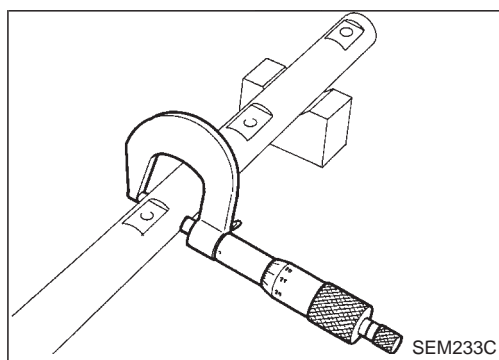
**Exhaust 620.8 (63.3, 139.6) at 34.1 (1.343)**

##### Inner

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

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

If it exceeds the limit, replace spring.

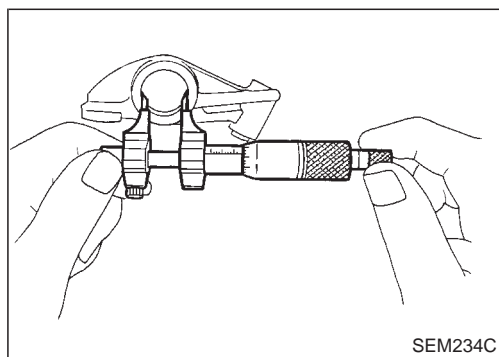


#### ROCKER SHAFT AND ROCKER ARM

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

**Diameter:**

**21.979 - 22.000 mm (0.8653 - 0.8661 in)**



3. Check inner diameter of rocker arm.

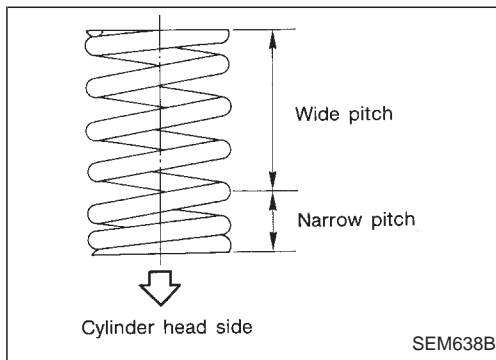
**Diameter:**

**22.012 - 22.029 mm (0.8666 - 0.8673 in)**

**Rocker arm to shaft clearance:**

**0.012 - 0.050 mm (0.0005 - 0.0020 in)**

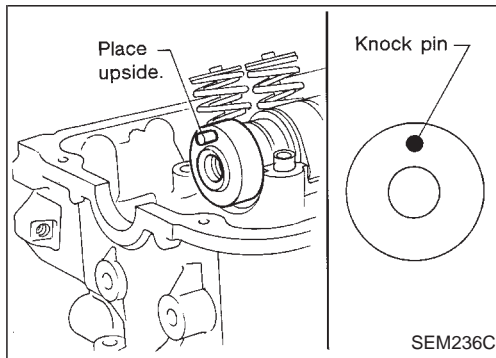
- Keep rocker arm with hydraulic valve lifter standing to prevent air from entering hydraulic valve lifter when checking.



## Assembly

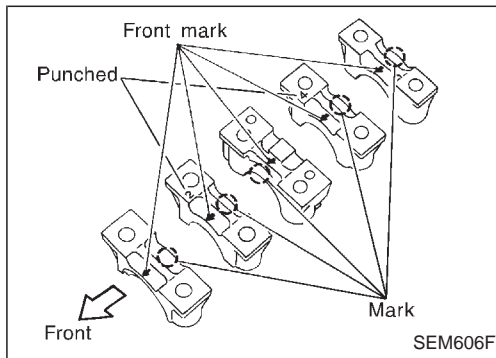
1. Install valve component parts.

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



2. Install camshaft, placing knock pin towards front of engine and in the top position.

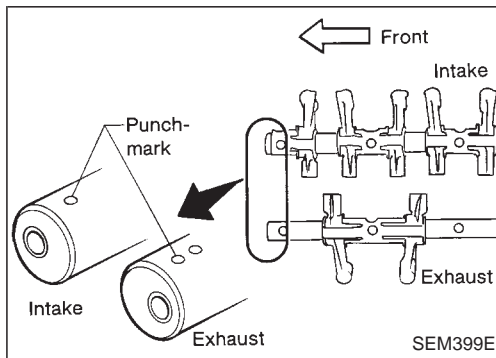
- **Apply engine oil to camshaft when mounting onto cylinder head.**



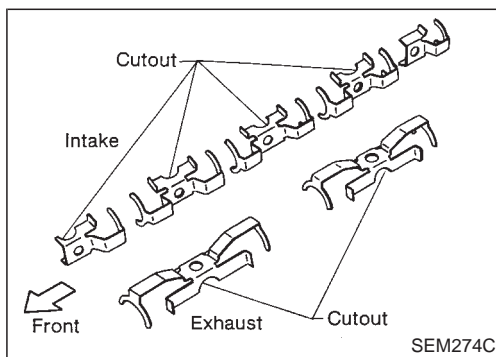
3. Install camshaft brackets.

- **Front mark is punched on the camshaft bracket.**

Location (from front side)	Identification	
	Mark	Punched
No. 1	51	—
No. 2	52	2
No. 3	53	—
No. 4	52	4
No. 5	55	—



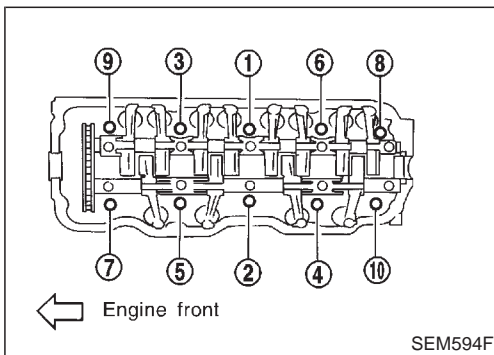
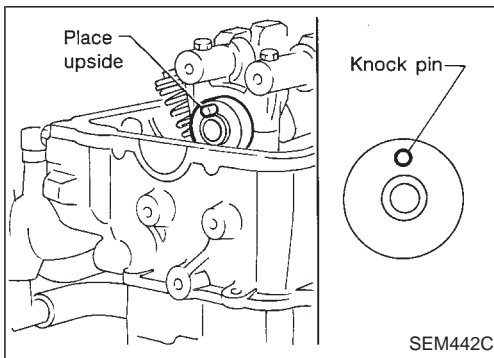
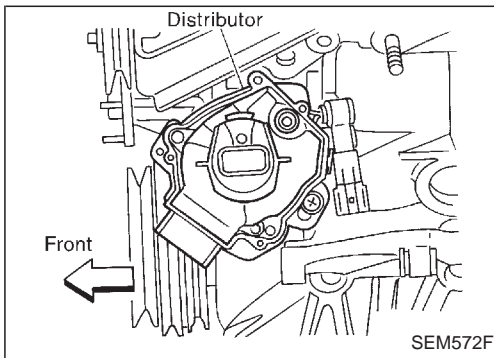
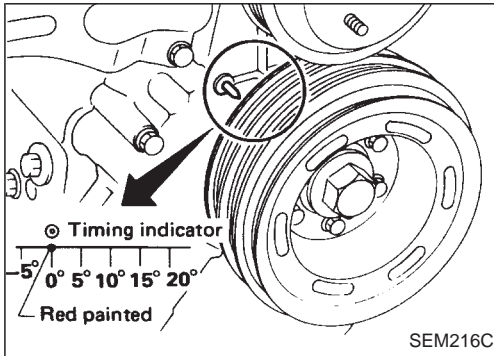
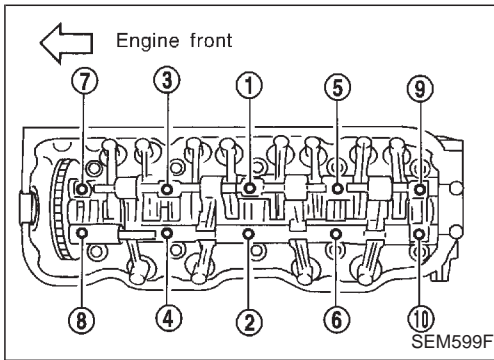
4. Install rocker shaft with rocker arms.



- **Install retainer with cutout facing direction shown in figure at left.**

## Assembly (Cont'd)

5. Tighten bolts as shown in figure at left.



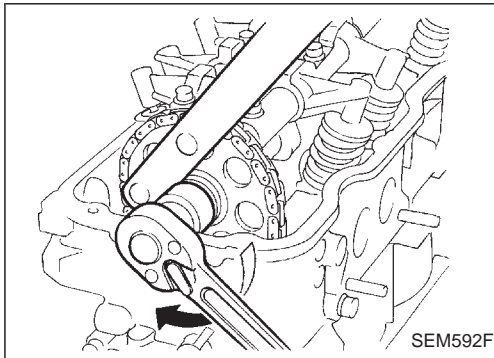
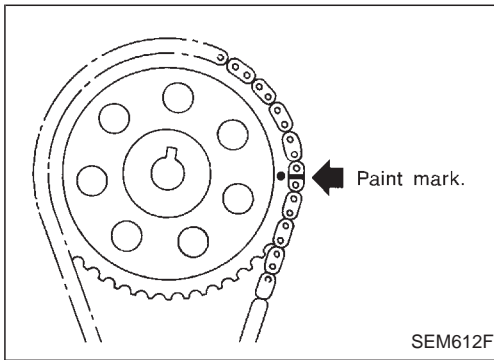
## Installation

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

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

2. Install cylinder head with new gasket and tighten cylinder head bolts in numerical order.
  - Do not rotate crankshaft and camshaft separately, or valves will hit piston heads.
  - Tightening procedure
    - a. Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
    - b. Tighten all bolts to 78 N·m (8.0 kg-m, 58 ft-lb).
    - c. Loosen all bolts completely.
    - d. Tighten all bolts to 25 to 34 N·m (2.5 to 3.5 kg-m, 18 to 25 ft-lb).
    - e. Turn all bolts  $80^{+5}_0$  degrees clockwise with an angle wrench. If an angle wrench is not available, tighten all bolts to 74 to 83 N·m (7.5 to 8.5 kg-m, 54 to 61 ft-lb).

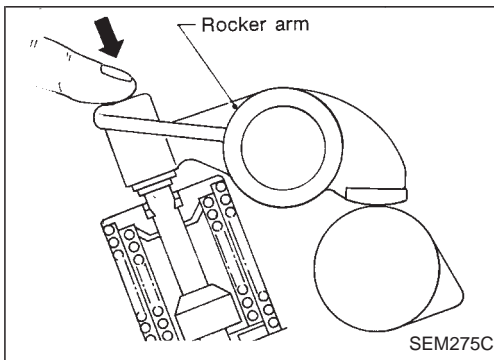
## Installation (Cont'd)



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

4. Tighten camshaft sprocket bolt.

5. Install rubber plugs. Refer to TIMING CHAIN, EM-23.



6. Check hydraulic valve lifter.
  - a. Push hydraulic valve lifter forcefully with your finger.
    - **Be sure to check it with rocker arm in its free position.**
  - b. If valve lifter moves more than 1 mm (0.04 in), air may be inside of it.
  - c. Bleed air off by running engine at 1,000 rpm under no-load for about 20 minutes.
  - d. If hydraulic valve lifters are still noisy, replace them and bleed air off again in the same manner as in step c.
7. Install rocker cover. Refer to TIMING CHAIN, EM-23.
  - **Be sure to avoid interference between rocker cover and rocker arm.**
8. Install intake and exhaust manifolds. Refer to "OUTER COMPONENT PARTS", EM-11.

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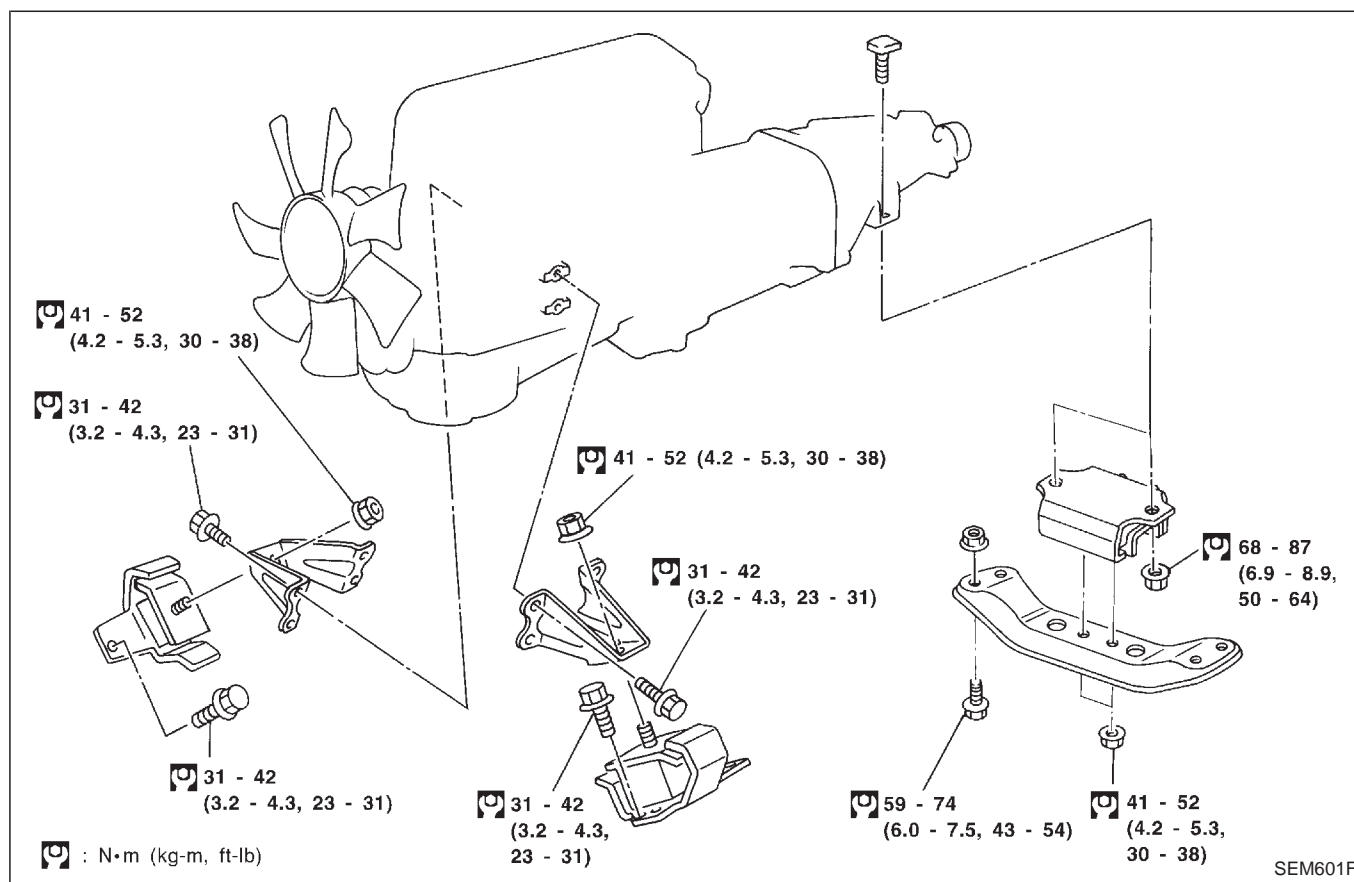
RS

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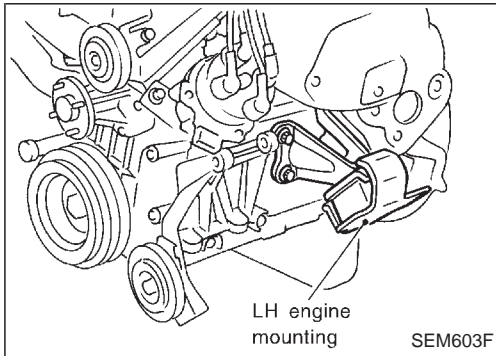
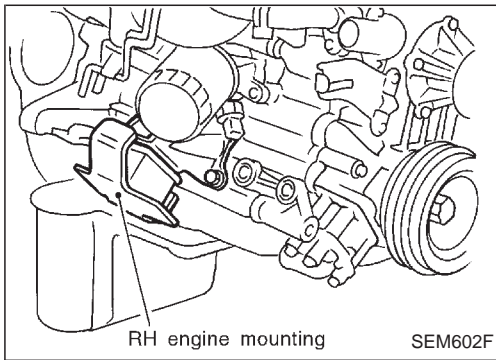
**WARNING:**

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

**CAUTION:**

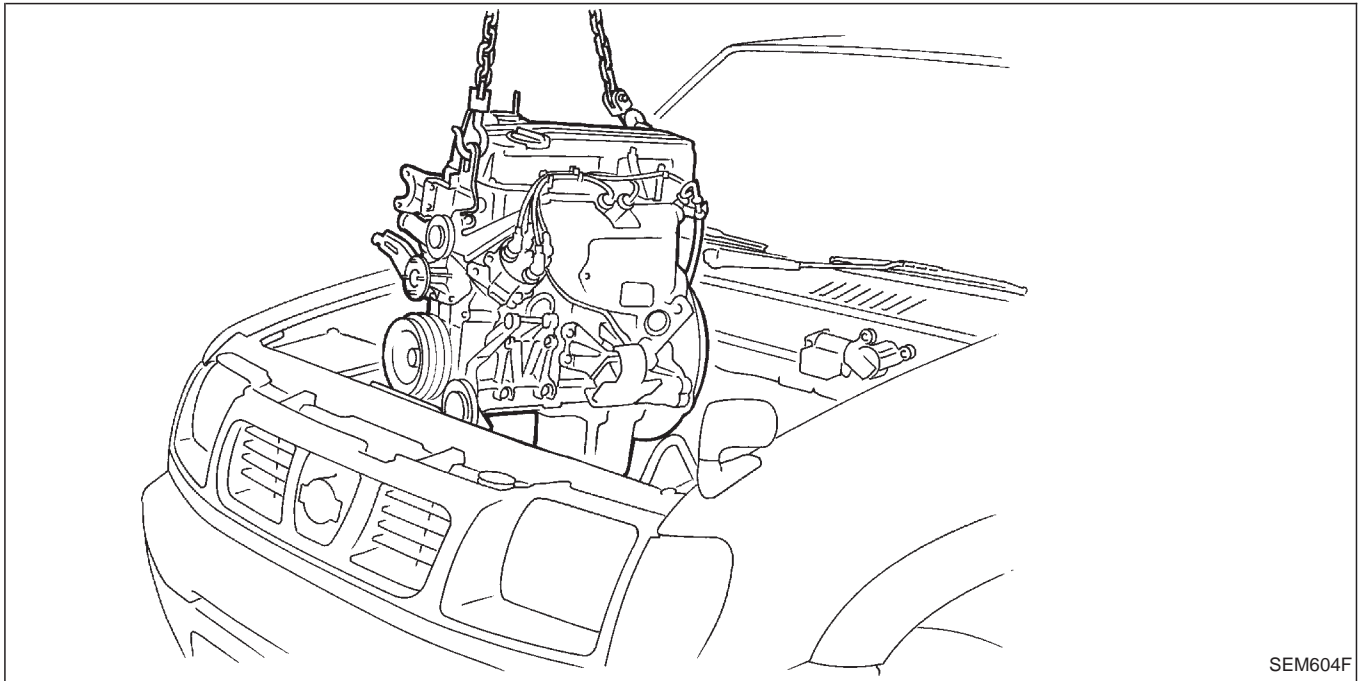
- When lifting engine, be sure to clear surrounding parts. Take special care near accelerator wire casing, brake lines and brake master cylinder.
- In lifting the engine, always use engine slingers in a safe manner.
- For 4WD models, apply sealant between engine and transmission. Refer to MT section ("Removal and Installation").





## Removal

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

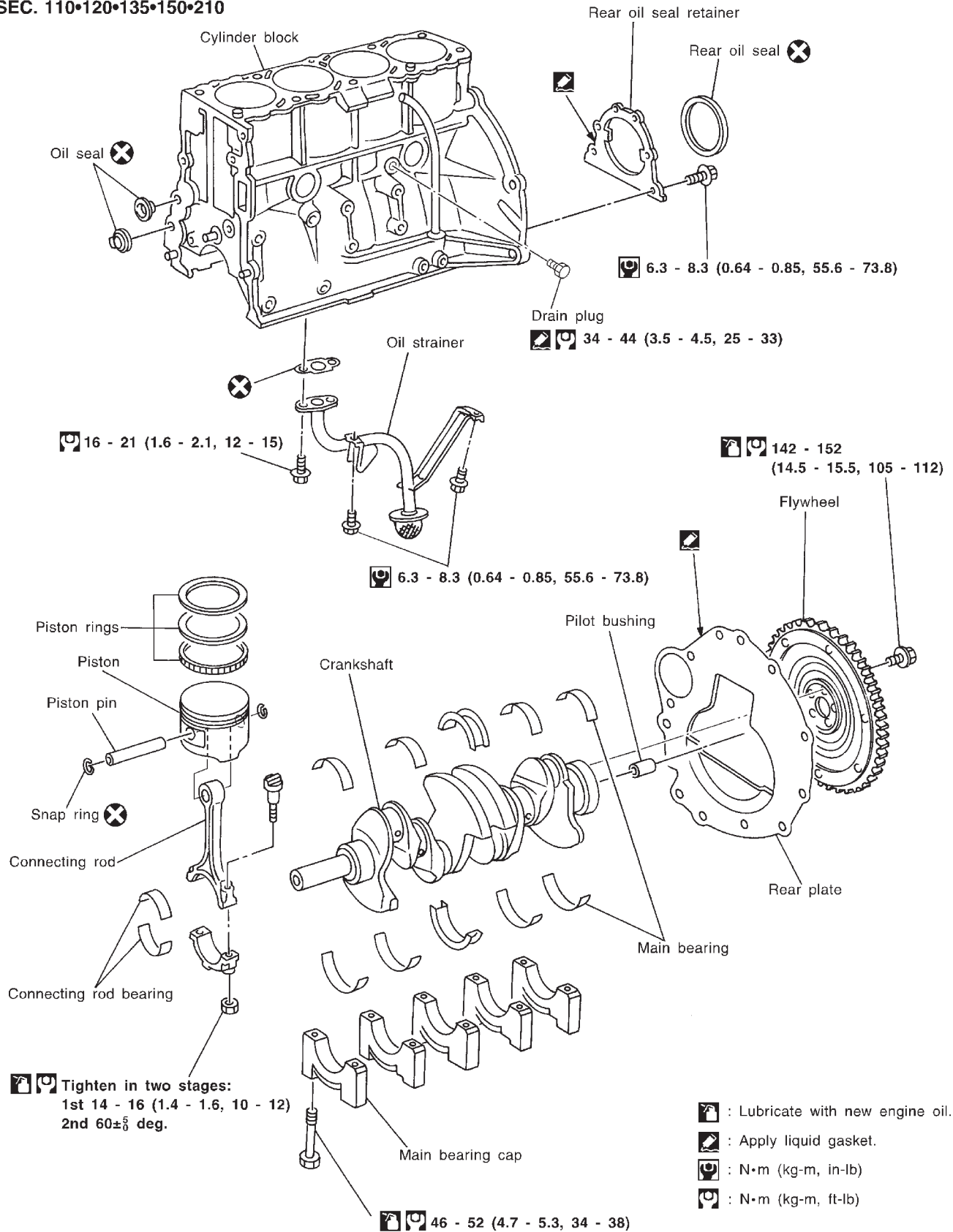


## Installation

- Install in reverse order of removal.

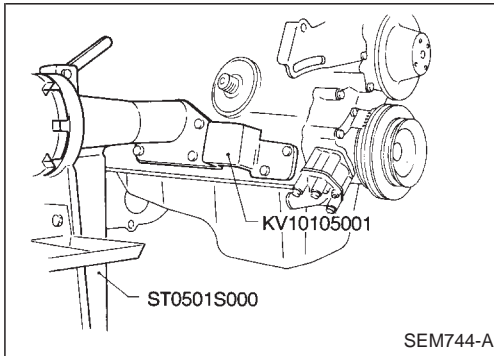


## SEC. 110•120•135•150•210

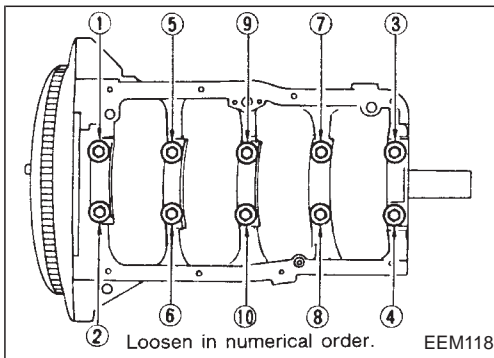


**CAUTION:**

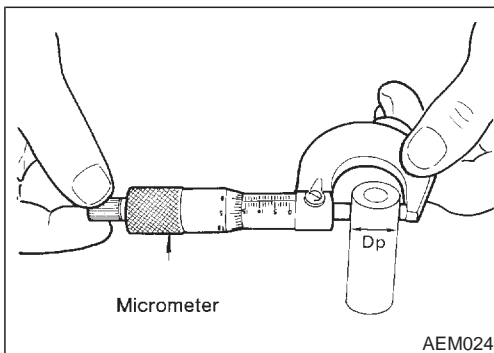
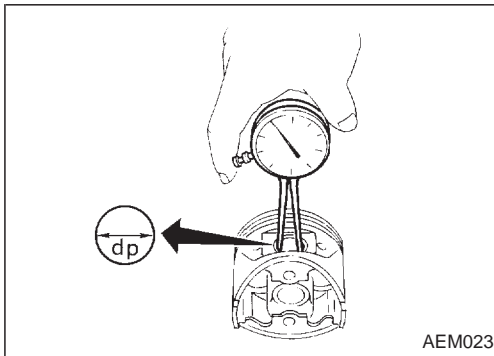
- When installing sliding parts (bearings, pistons, etc.), lubricate contacting surfaces with new engine oil.
- Place removed parts such as bearings and bearing caps in their proper order and direction.
- When installing connecting rod nuts and main bearing cap bolts, apply new engine oil to threads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

**Disassembly****PISTON AND CRANKSHAFT**

1. Remove intake manifold.
  2. Place engine on a work stand.
  3. Drain coolant and oil.
  4. Remove oil pan.
  5. Remove water pump.
  6. Remove timing chain.
  7. Remove cylinder head.
  8. Remove pistons with connecting rod.
  9. Remove bearing caps and crankshaft.
- **Before removing bearing caps, measure crankshaft end play. Refer to EM-48.**
  - **Bolts should be loosened in two or three steps.**

**Inspection****PISTON AND PISTON PIN CLEARANCE**

1. Measure inner diameter of piston pin hole "dp".  
**Standard diameter "dp":**  
**21.002 - 21.008 mm (0.8268 - 0.8271 in)**
2. Measure outer diameter of piston pin "Dp".  
**Standard diameter "Dp":**  
**20.993 - 20.998 mm (0.8265 - 0.8267 in)**
3. Calculate piston pin clearance.  
**dp - Dp = 0.008 - 0.012 mm (0.0003 - 0.0005 in)**  
 If it exceeds the above value, replace piston assembly with pin.



## CYLINDER BLOCK

### Inspection (Cont'd)

#### PISTON RING SIDE CLEARANCE

Side clearance: mm (in)

Top ring 0.01 - 0.03 (0.0004 - 0.0012)

2nd ring 0.03 - 0.07 (0.0012 - 0.0028)

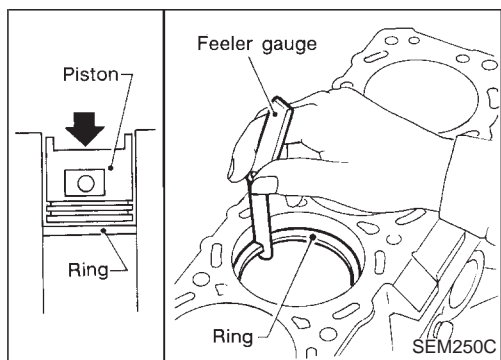
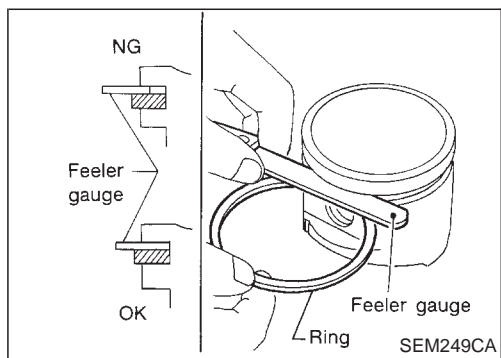
Oil ring 0.085 - 0.115 (0.0033 - 0.0045)

Max. limit of side clearance:

0.1 mm (0.004 in)

If out of specification, replace piston ring.

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



#### PISTON RING END GAP

End gap: mm (in)

Top ring

0.28 - 0.43 (0.0110 - 0.0169)

2nd ring

0.45 - 0.60 (0.0177 - 0.0236)

(R or T is punched on the ring.)

0.55 - 0.70 (0.0217 - 0.0276)

(N is punched on the ring.)

Oil ring

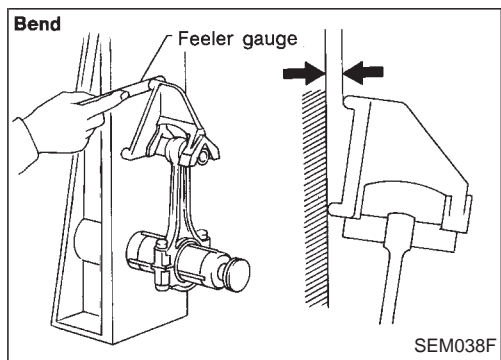
0.20 - 0.60 (0.0079 - 0.0236)

Max. limit of ring gap:

0.5 mm (0.020 in)

If out of specification, replace piston ring. If gap exceeds maximum limit with a new ring, rebore cylinder and use oversized piston and piston rings. Refer to SDS, EM-181.

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



#### CONNECTING ROD BEND AND TORSION

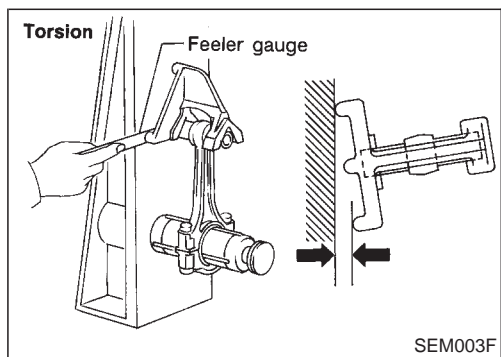
Bend: mm (in)

Limit 0.15 (0.0059) per 100 (3.94) length

Torsion: mm (in)

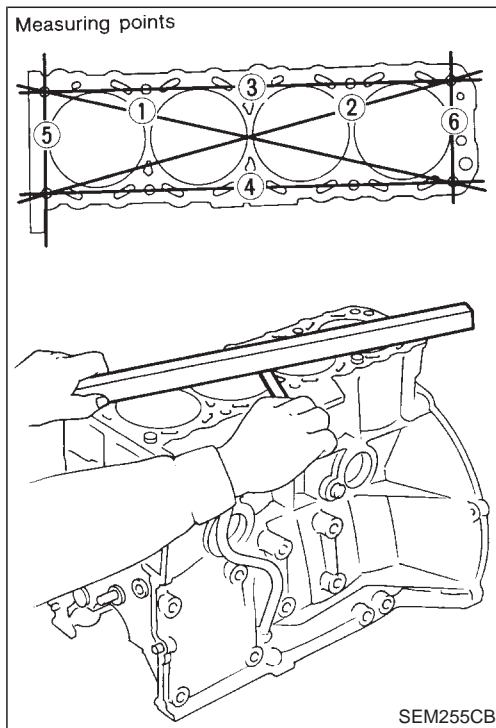
Limit 0.3 (0.012) per 100 (3.94) length

If it exceeds the limit, replace connecting rod assembly.



## Inspection (Cont'd)

## CYLINDER BLOCK DISTORTION AND WEAR



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

Limit:

**0.1 mm (0.004 in)**

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

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

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

The maximum limit is as follows:

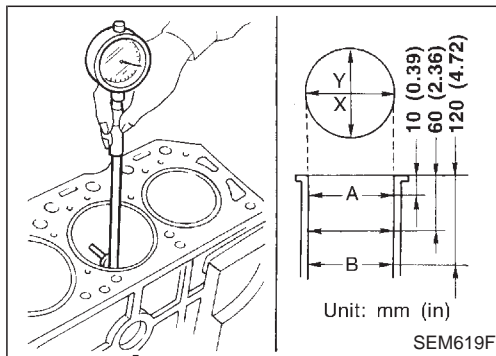
**A + B = 0.2 mm (0.008 in)**

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

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

3. If necessary, replace cylinder block.

## PISTON-TO-BORE CLEARANCE



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

**Standard inner diameter:**

**Refer to SDS, EM-177.**

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

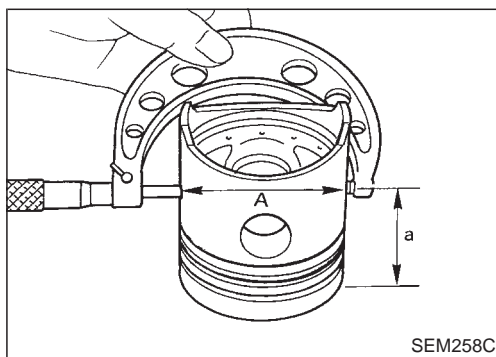
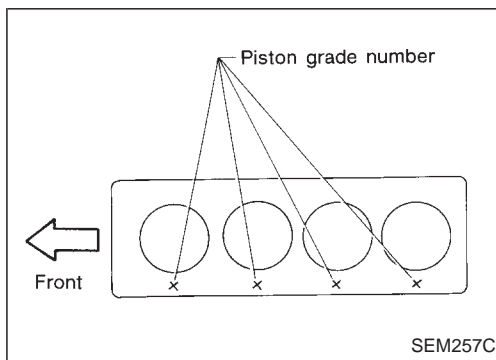
**Out-of-round (X - Y) standard: 0.015 mm (0.0006 in)**

**Taper (A - B) standard: 0.010 mm (0.0004 in)**

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

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

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



3. Measure piston skirt diameter.

**Piston diameter "A":**

**Refer to SDS, EM-181.**

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

**Approximately 52 mm (2.05 in)**

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

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

**0.020 - 0.040 mm (0.0008 - 0.0016 in)**

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

**Oversize pistons are available for service. Refer to SDS, EM-181.**

## Inspection (Cont'd)

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

**Rebored size calculation:**

$$D = A + B - C$$

where,

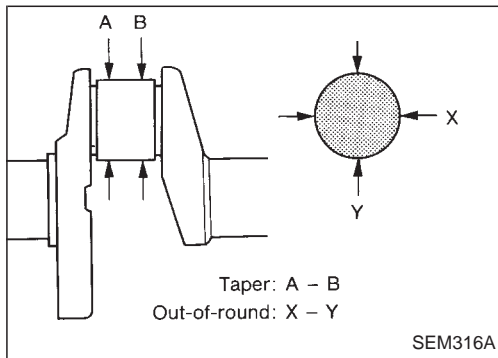
**D: Bored diameter**

**A: Piston diameter as measured**

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

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

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



## CRANKSHAFT

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

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

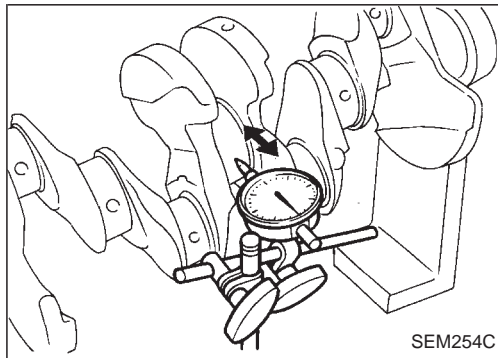
**Main journal Less than 0.01 (0.0004)**

**Crank pin Less than 0.005 (0.0002)**

**Taper (A - B): mm (in)**

**Main journal Less than 0.01 (0.0004)**

**Crank pin Less than 0.005 (0.0002)**



3. Measure crankshaft runout.

**Runout (Total indicator reading):**

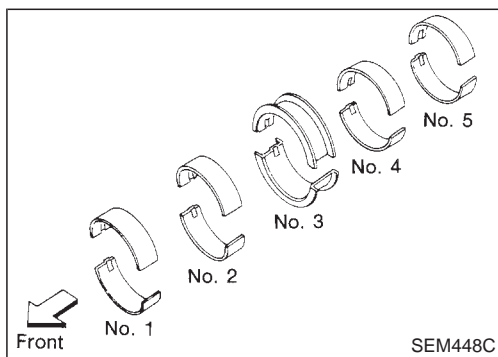
**Less than 0.10 mm (0.0039 in)**

## BEARING CLEARANCE

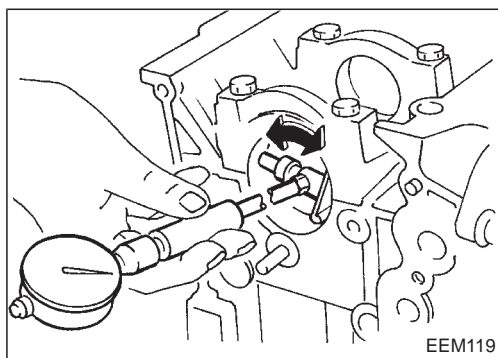
- Use Method A or Method B. Method A is preferred because it is more accurate.

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

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

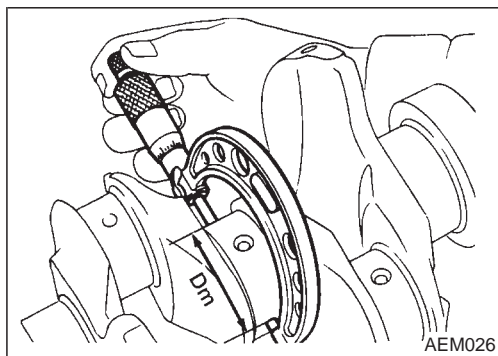


## Inspection (Cont'd)



2. Install main bearing cap to cylinder block.

- **Tighten all bolts in correct order in two or three stages.**
3. Measure inner diameter "A" of each main bearing.



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

Main bearing clearance = A – Dm

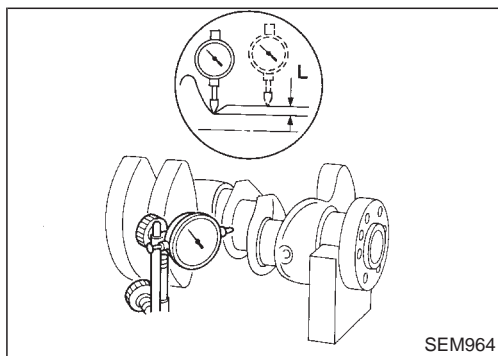
**Standard:**

**0.020 - 0.047 mm (0.0008 - 0.0019 in)**

**Limit:**

**0.1 mm (0.004 in)**

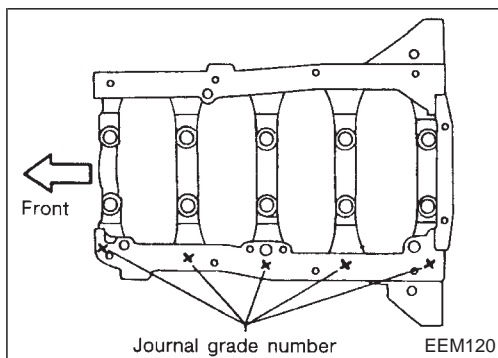
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.



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

**"L": 0.1 mm (0.004 in)**

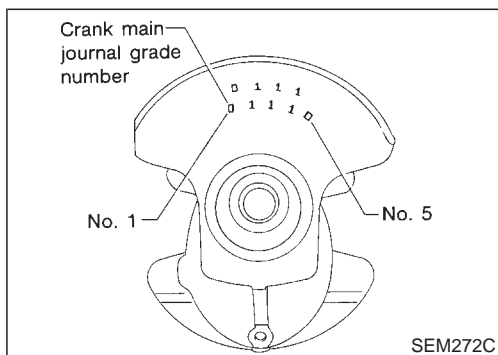
- b. **Refer to SDS for grinding crankshaft and available service parts.**



8. If crankshaft is reused, measure main bearing clearance and select thickness of main bearing.

If crankshaft or cylinder block is replaced, select thickness of main bearings as follows:

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



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

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

For example:

Main journal grade number: 1

Crankshaft journal grade number: 2

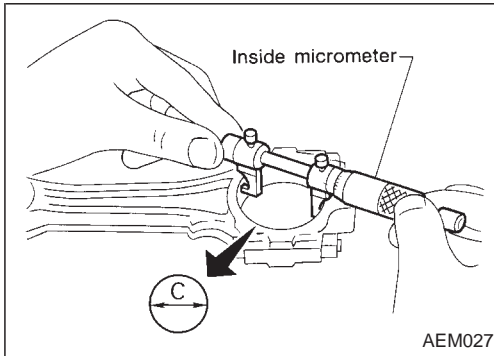
Main bearing grade number = 1 + 2  
= 3 (Yellow)



## Inspection (Cont'd)

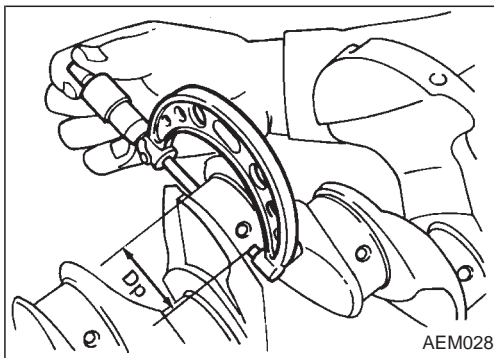
Main bearing grade number and identification color:

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



## Connecting rod bearing (Big end)

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



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

Connecting rod bearing clearance

$$= C - Dp: \text{mm (in)}$$

Standard

0.010 - 0.035 (0.0004 - 0.0014)

Limit

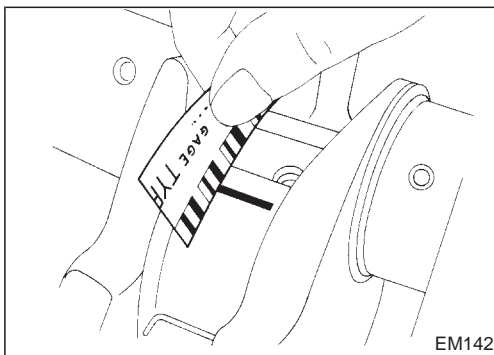
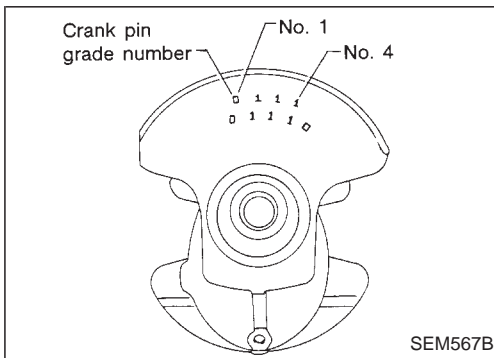
0.09 (0.0035)

6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to step 7 of "BEARING CLEARANCE — Main bearing".
8. If crankshaft is replaced, select connecting rod bearing according to the following table.

## Connecting rod bearing grade number:

These numbers are punched in either Arabic or Roman numerals.

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



## Method B (Using plastigage)

## CAUTION:

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

## Inspection (Cont'd)

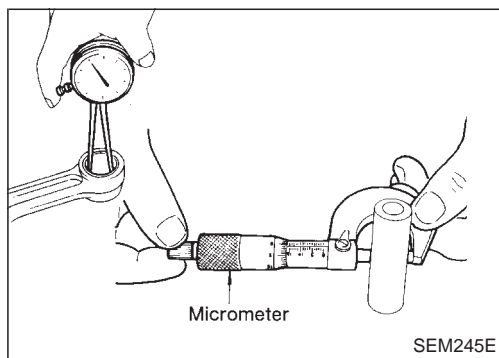
## CONNECTING ROD BUSHING CLEARANCE (Small end)

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

$$C - Dp =$$

-0.015 to -0.033 mm (-0.0006 to -0.0013 in) (Standard)

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



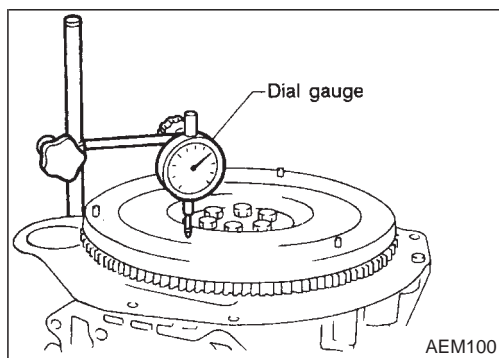
## FLYWHEEL RUNOUT

Runout (Total indicator reading):

Flywheel Less than 0.1 mm (0.004 in)

**CAUTION:**

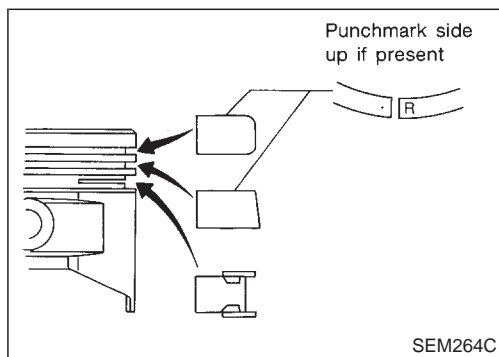
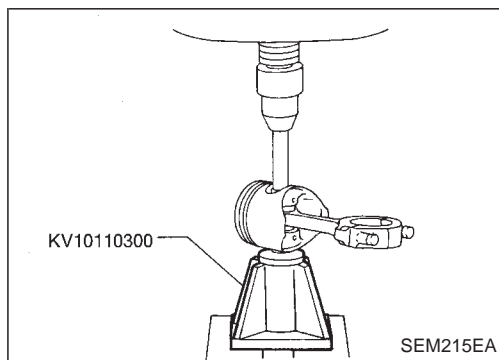
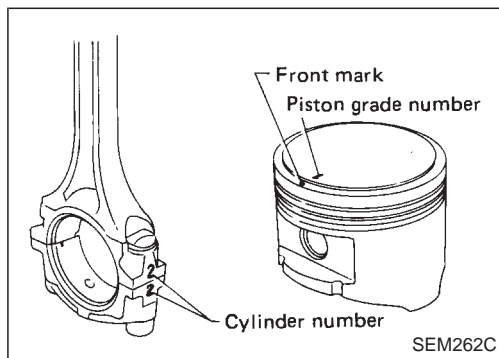
Do not allow any magnetic materials to contact the ring gear teeth.



## Assembly

## PISTON

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



2. Set piston rings as shown.

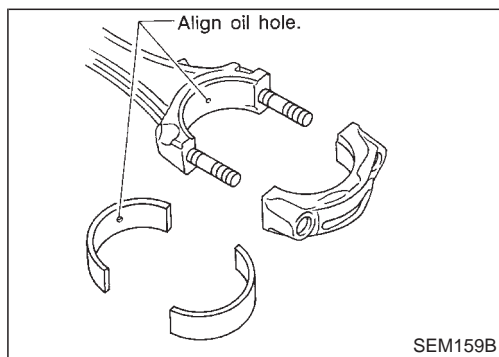
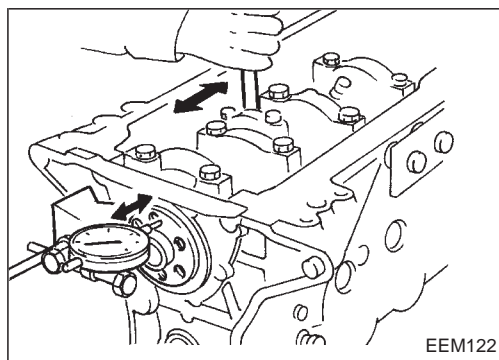
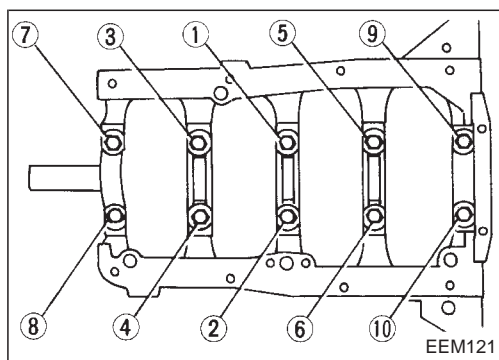
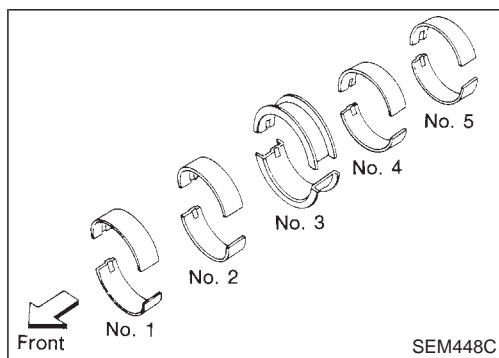
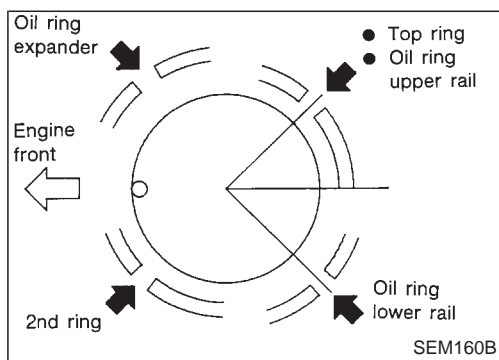
**CAUTION:**

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



## Assembly (Cont'd)

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



## CRANKSHAFT

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

- Confirm that correct main bearings are used. Refer to EM-44.
- Apply new engine oil to bearing surfaces.

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

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

3. Measure crankshaft end play.

Crankshaft end play: mm (in)

Standard

0.05 - 0.18 (0.0020 - 0.0071)

Limit

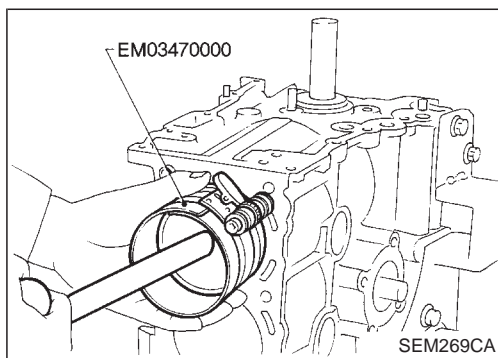
0.3 (0.012)

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

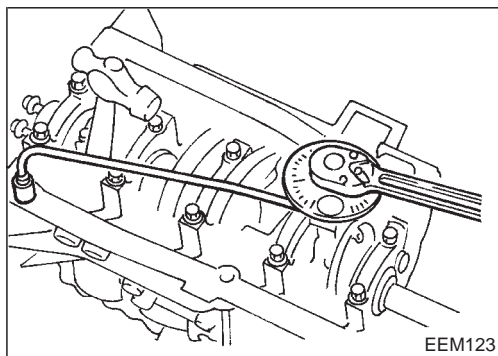
4. Install connecting rod bearings in connecting rods and connecting rod caps.

- Confirm that correct bearings are used. Refer to EM-46.
- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.
- Apply new engine oil to bearing surfaces, bolt threads and seating surfaces.

## Assembly (Cont'd)



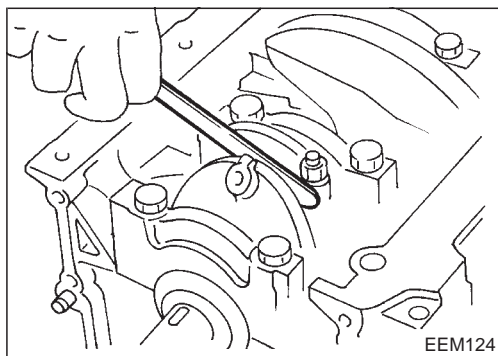
5. Install pistons with connecting rods.
  - a. Install them into corresponding cylinders with Tool.
    - Arrange so that front mark on piston head faces toward front of engine.
    - Make sure connecting rod does not scratch cylinder wall.
    - Make sure connecting rod bolts do not scratch crankshaft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



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

## Connecting rod bearing nut:

- (1) Tighten to 14 to 16 N·m (1.4 to 1.6 kg-m, 10 to 12 ft-lb).
- (2) Tighten bolts  $60^{+5}_0$  degrees clockwise with an angle wrench. If an angle wrench is not available, tighten them to 38 to 44 N·m (3.9 to 4.5 kg-m, 28 to 33 ft-lb).



6. Measure connecting rod side clearance.

## Connecting rod side clearance: mm (in)

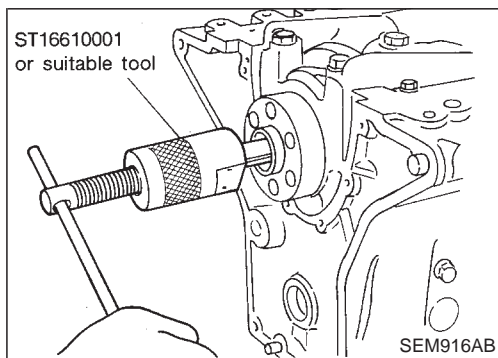
## Standard

0.2 - 0.4 (0.008 - 0.016)

## Limit

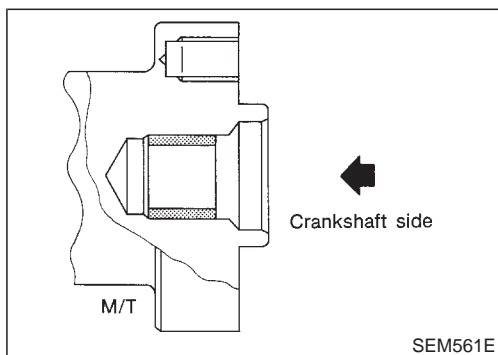
0.6 (0.024)

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

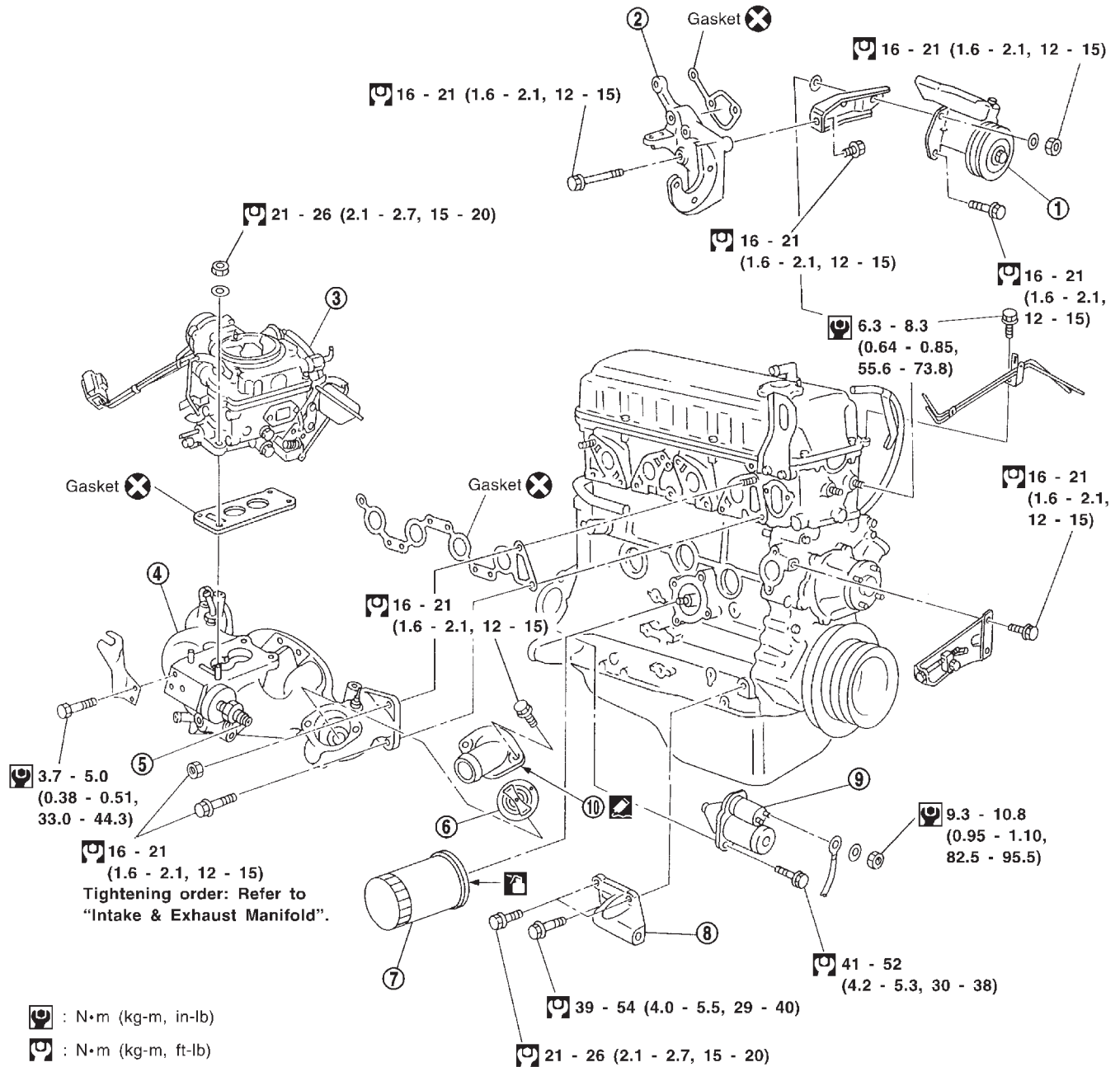


## REPLACING PILOT BUSHING

1. Remove pilot bushing.



2. Install pilot bushing.



SEM540F

- |                               |              |                      |
|-------------------------------|--------------|----------------------|
| ① Power steering idler pulley | ⑤ BCV valve  | ⑧ Alternator bracket |
| ② Power steering pump bracket | ⑥ Thermostat | ⑨ Starter motor      |
| ③ Carburetor                  | ⑦ Oil filter | ⑩ Water outlet       |
| ④ Intake manifold             |              |                      |

GI

MA

EM

LC

EC

FE

CL

MT

TF

PD

FA

RA

BR

ST

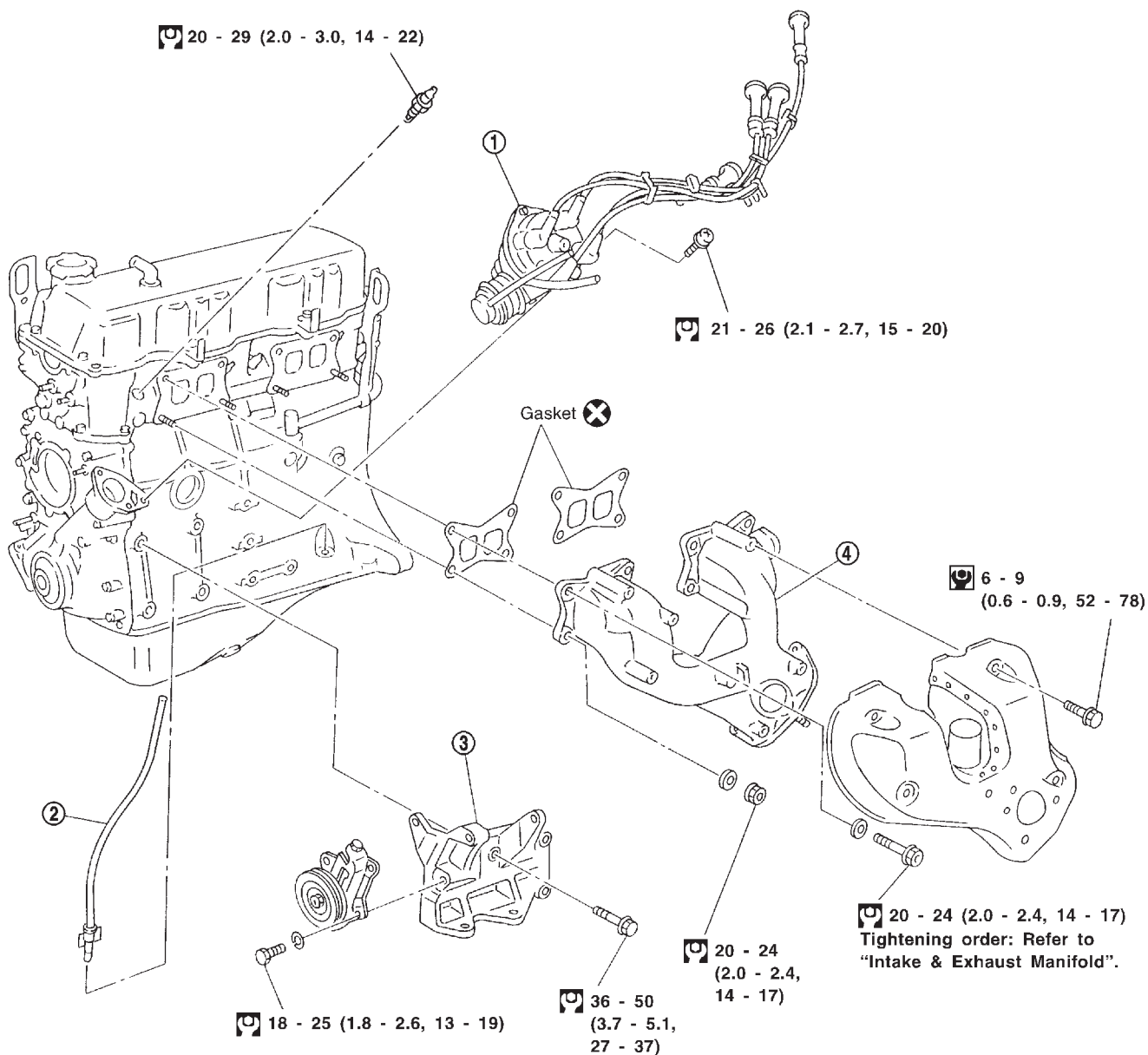
RS

BT

HA

EL

IDX



: N·m (kg-m, in-lb)

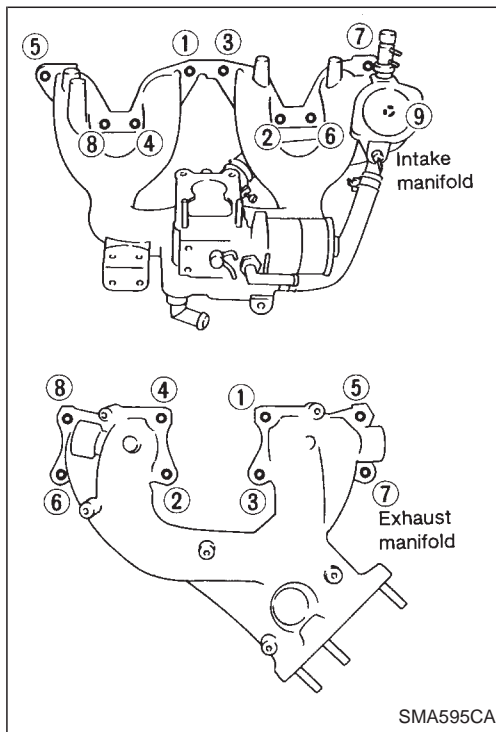
: N·m (kg-m, ft-lb)

SEM541F

- ① Distributor
- ② Oil level gauge

- ③ A/C compressor bracket

- ④ Exhaust manifold



## Intake & Exhaust Manifold

- Tighten in numerical order as shown.
- Checking should be performed while engine is cold.

Manifold bolts and nuts:

Intake manifold

: 16 - 21 N·m  
(1.6 - 2.1 kg-m, 12 - 15 ft-lb)

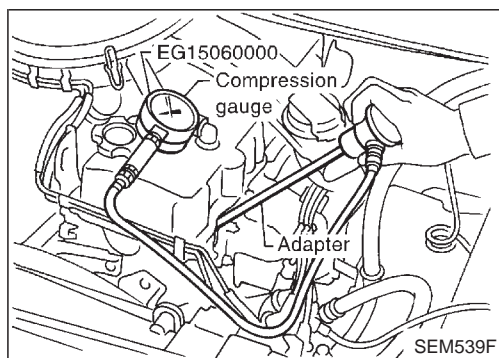
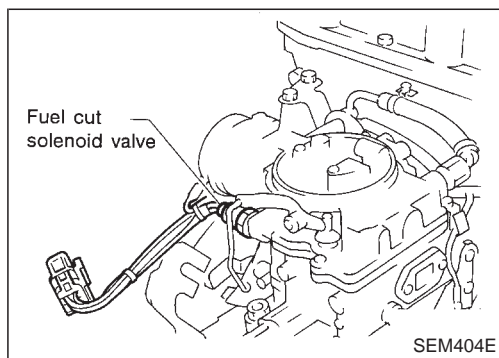
Exhaust manifold

: 20 - 24 N·m  
(2.0 - 2.4 kg-m, 14 - 17 ft-lb)

Exhaust tube nuts:

: 51 - 65 N·m  
(5.2 - 6.6 kg-m, 38 - 48 ft-lb)

- Removal is in the reverse order of installation.



## Measurement of Compression Pressure

1. Warm up engine.
2. Turn ignition switch off.
3. Disconnect fuel cut solenoid valve connector.
4. Remove all spark plugs.
5. Disconnect distributor center cable.
6. Attach a compression tester to No. 1 cylinder.
7. Depress accelerator pedal fully to keep throttle valve wide open.
8. Crank engine and record highest gauge indication.
9. Repeat the measurement on each cylinder as shown above.
- **Always use a fully-charged battery to obtain specified engine speed.**

**Compression pressure: kPa (bar, kg/cm<sup>2</sup>, psi)/rpm**  
**Standard 1,187 (11.87, 12.1, 172)/350**  
**Minimum 991 (9.91, 10.1, 144)/350**  
**Difference limit between cylinders:**  
**98 (0.98, 1.0, 14)/350**
10. If cylinder 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-191. If valve or valve seat is damaged excessively, replace them.**
  - **If compression stays low in two cylinders that are next to each other:**
    - a. The cylinder head gasket may be leaking, or
    - b. Both cylinders may have valve component damage. Inspect and repair as necessary.

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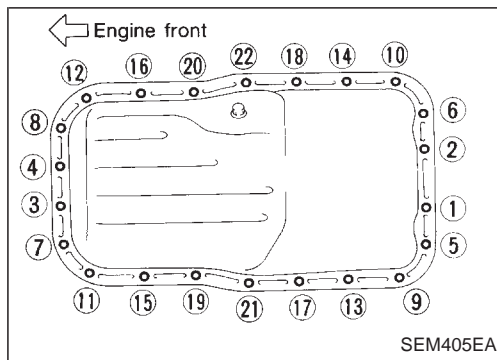
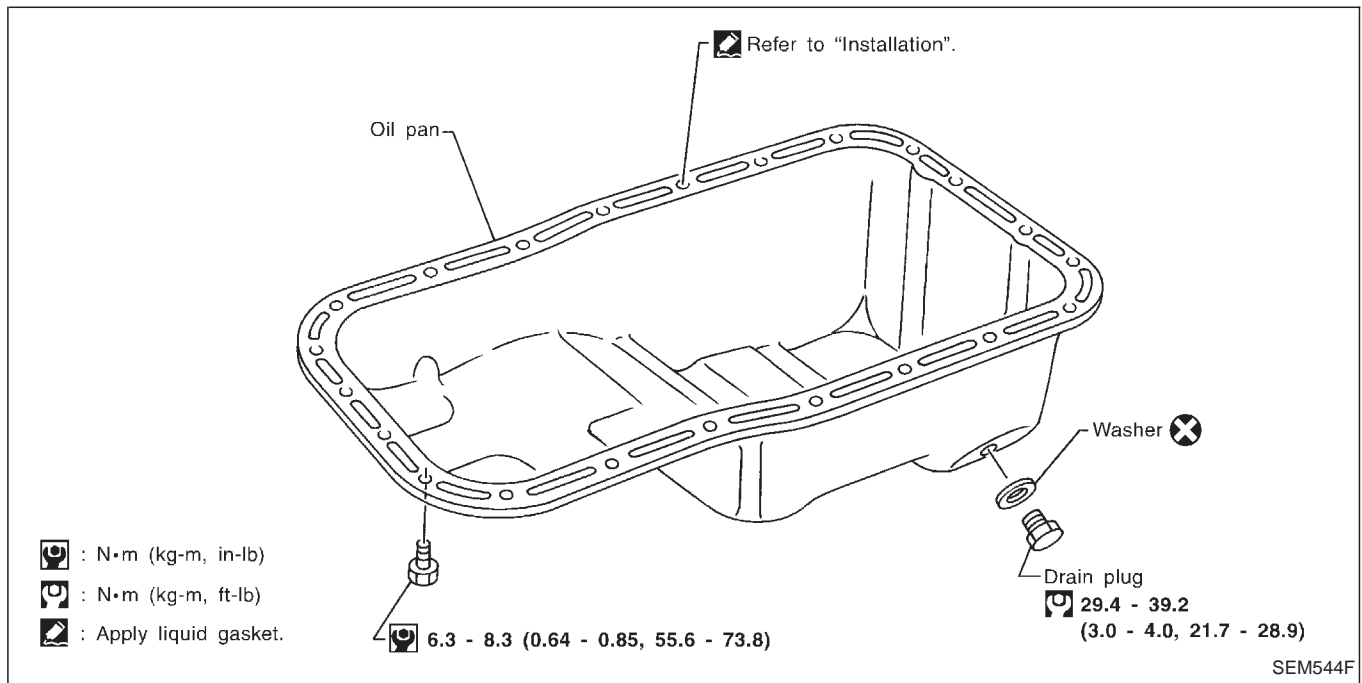
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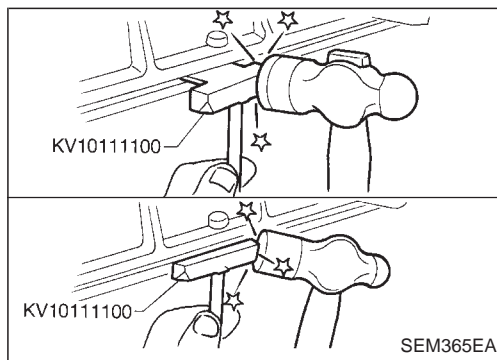
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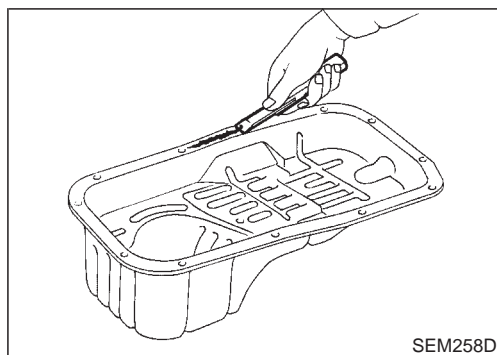


## Removal

1. Drain engine oil.
2. Remove suspension member.
3. Remove oil pan bolts.
  - Loosen in numerical order as shown.



4. Remove oil pan.
  - a. Insert Tool between cylinder block and oil pan.
    - Do not insert screwdriver, or oil pan flange will be deformed.
  - b. Slide Tool by tapping on the side of the Tool with a hammer.

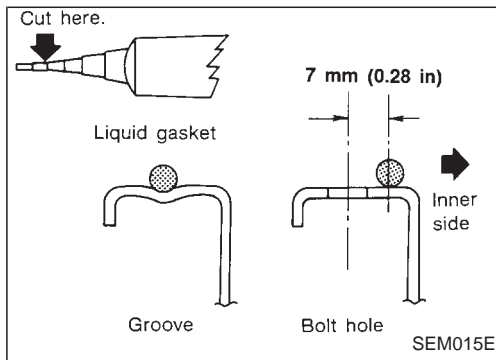


## Installation

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

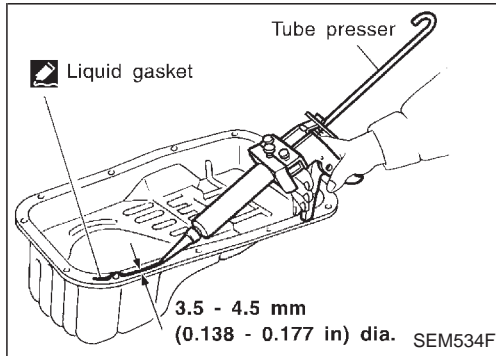


## Installation (Cont'd)

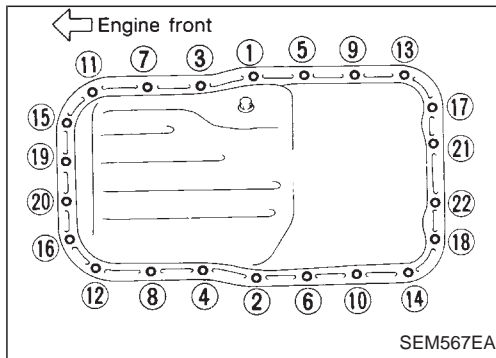


2. Apply a continuous bead of liquid gasket to mating surface of oil pan.

- Use Genuine Liquid Gasket or equivalent.
- Apply to groove on mating surface.
- Allow 7 mm (0.28 in) clearance around bolt hole.

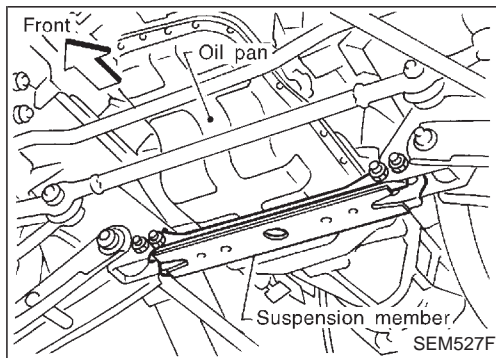


- Be sure liquid gasket diameter is 3.5 to 4.5 mm (0.138 to 0.177 in).
- Attaching should be done within 5 minutes after coating.



3. Tighten bolts in numerical order as shown.

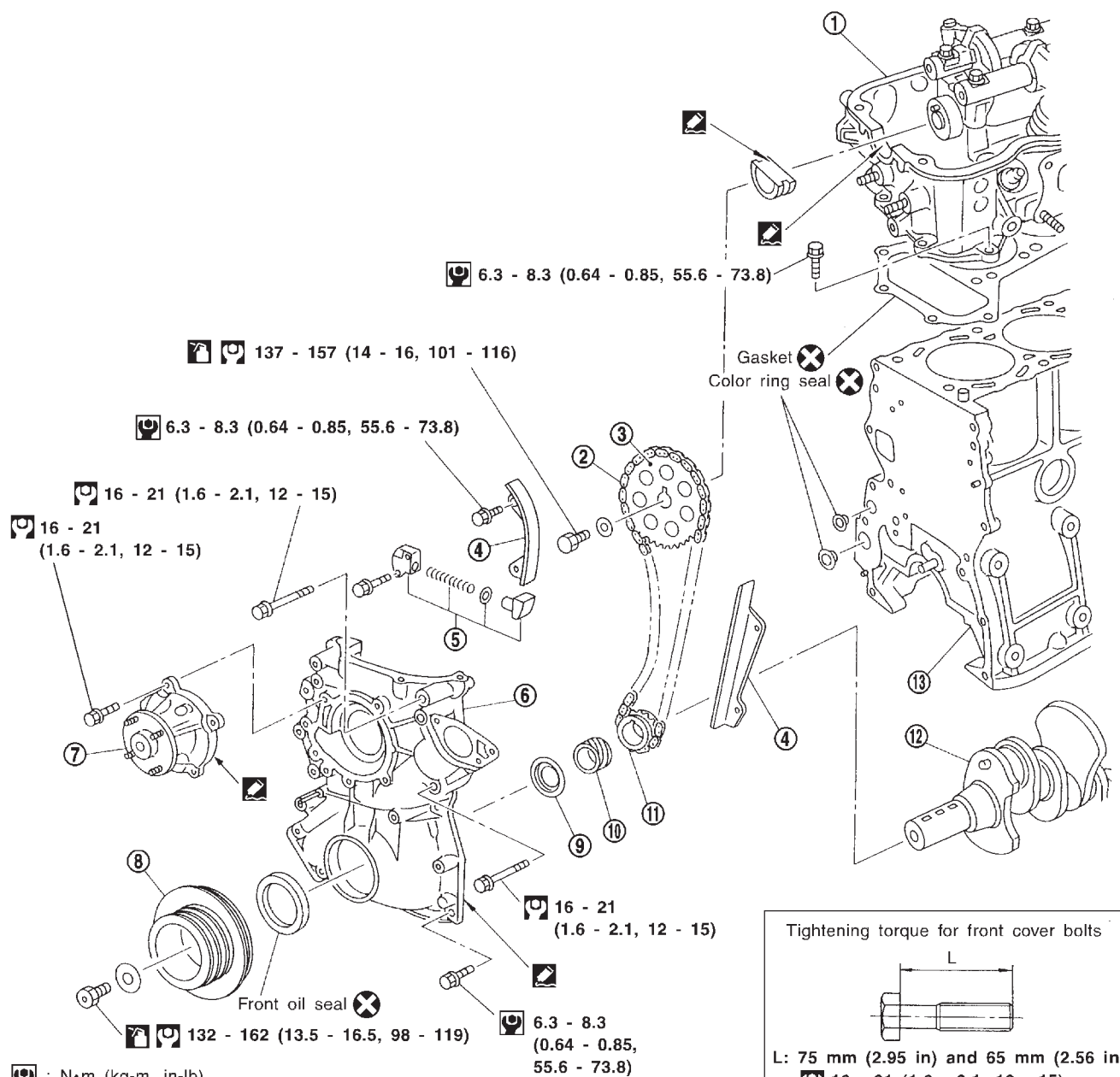
- Wait at least 30 minutes before refilling engine oil.



4. Install suspension member.

: 78 - 98 N·m (8.0 - 10.0 kg-m, 58 - 72 ft-lb)





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

- ① Cylinder head
- ② Timing chain
- ③ Camshaft sprocket
- ④ Chain guide
- ⑤ Chain tensioner
- ⑥ Front cover
- ⑦ Water pump
- ⑧ Crankshaft pulley
- ⑨ Oil thrower
- ⑩ Oil pump drive gear

- ⑪ Crankshaft sprocket
- ⑫ Crankshaft
- ⑬ Cylinder block

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**CAUTION:**

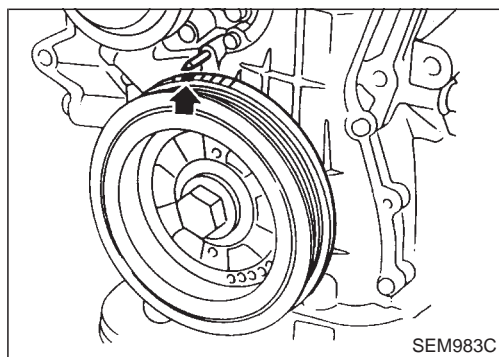
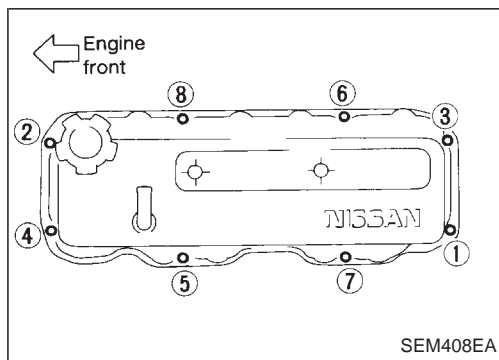
- After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.
- When installing sliding parts such as rocker arms, camshafts, chain tensioner and oil seal, be sure to apply new engine oil on their sliding surfaces.
- Apply new engine oil to bolt threads and seat surfaces when installing cylinder head, camshaft sprockets, crankshaft pulley, and camshaft brackets.

**Removal**

1. Disconnect battery terminal.
2. Remove engine undercovers.
3. Drain engine oil.
4. Remove oil pan. Refer to EM-54.
5. Drain coolant from radiator and cylinder block. Refer to MA section.
6. Remove exhaust front tube.
7. Remove radiator shroud, radiator, cooling fan and water pump pulley.
8. Remove the following belts. Refer to MA section.
  - Power steering drive belt
  - A/C compressor drive belt
  - Alternator drive belt
9. Remove air cleaner and air intake duct.
10. Remove radiator hose and heater hose.
11. Remove the following parts:
  - Idler pulley bracket
  - A/C compressor
  - Power steering oil pump
12. Disconnect the following parts:
  - Vacuum hoses
  - Fuel hoses
  - Wires
  - Harness
  - Connectors
13. Remove all high tension wires and spark plugs.

14. Remove rocker cover.

- Loosen bolts in numerical order as shown.

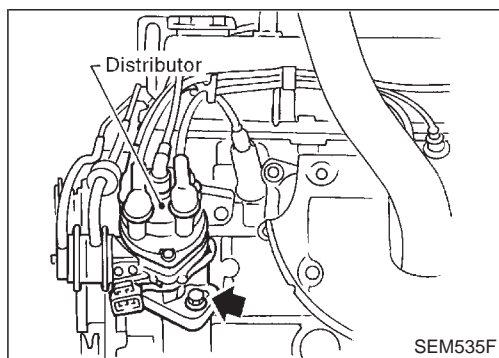
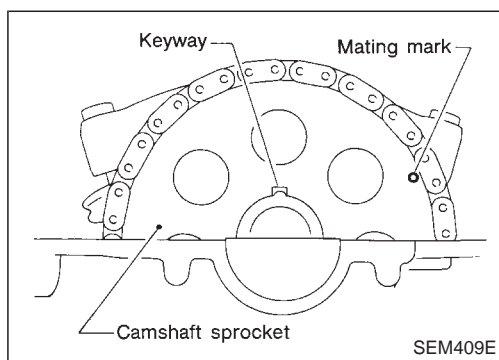


15. Set No. 1 piston at TDC on the compression stroke by rotating crankshaft.

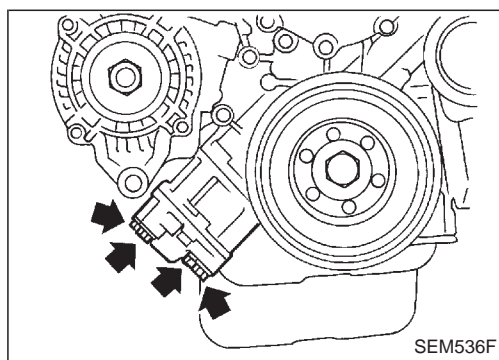
## TIMING CHAIN

### Removal (Cont'd)

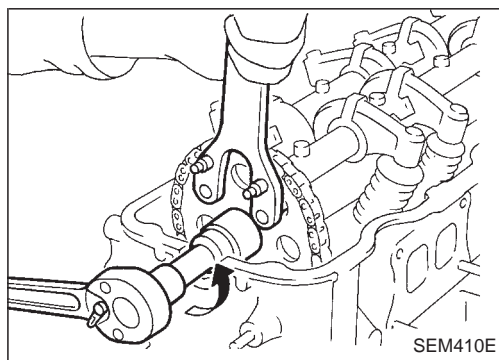
- Rotate crankshaft until key way on camshaft sprocket is in top position.
- Apply paint marks to timing chain matched with mating marks of camshaft sprockets.



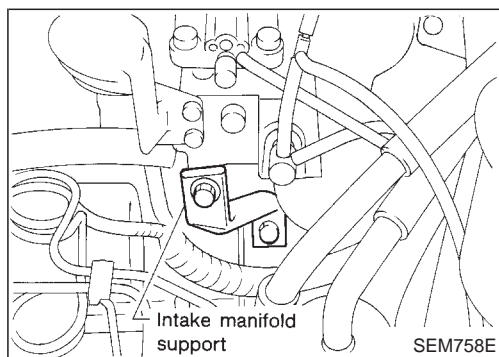
16. Remove distributor.  
Do not turn rotor with distributor removed.



17. Remove oil pump.



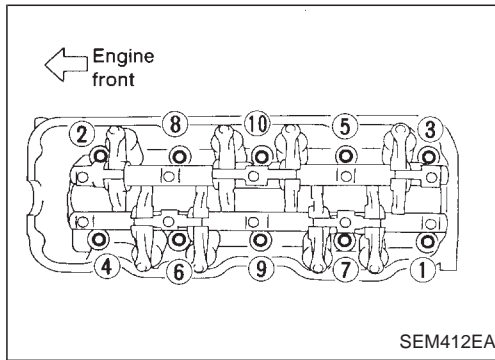
18. Remove camshaft sprockets.
- For retiming in cylinder head removal, apply paint mark to timing chain matched with mating marks of camshaft sprockets.



19. Remove the bolt securing intake manifold to intake manifold support.

## TIMING CHAIN

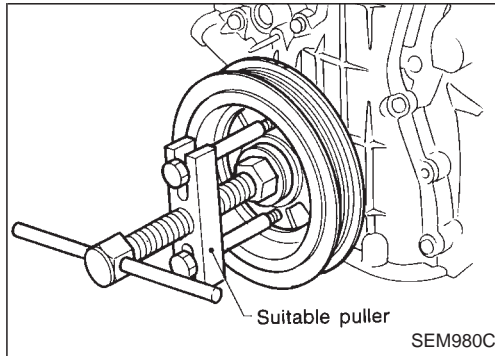
### Removal (Cont'd)



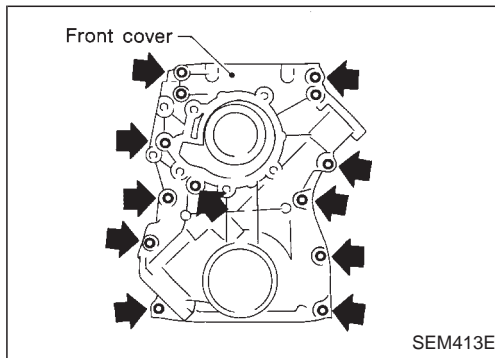
20. Remove cylinder head bolts.

- Loosen in numerical order as shown.
- Removing bolts in incorrect order could result in a warped or cracked cylinder head.
- Loosen cylinder head bolts in two or three steps.

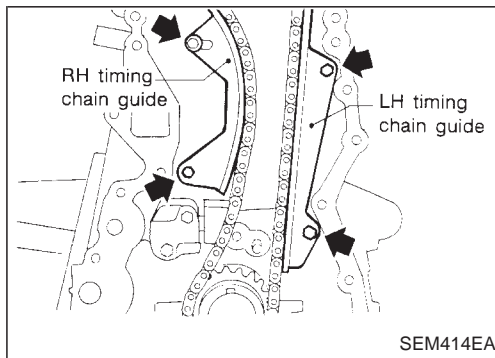
21. Remove cylinder head with intake and exhaust manifolds.



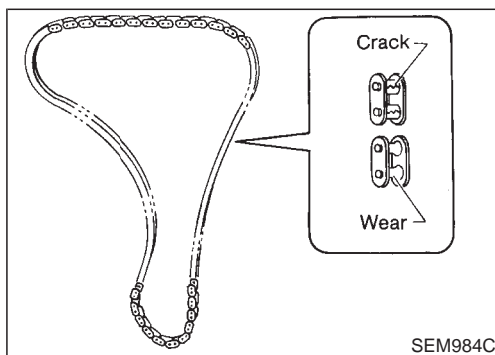
22. Remove starter motor and set ring gear stopper, then remove crankshaft pulley.



23. Remove front cover.

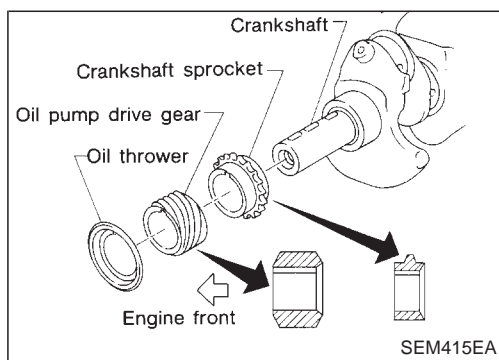


24. Remove timing chain guides and timing chain.



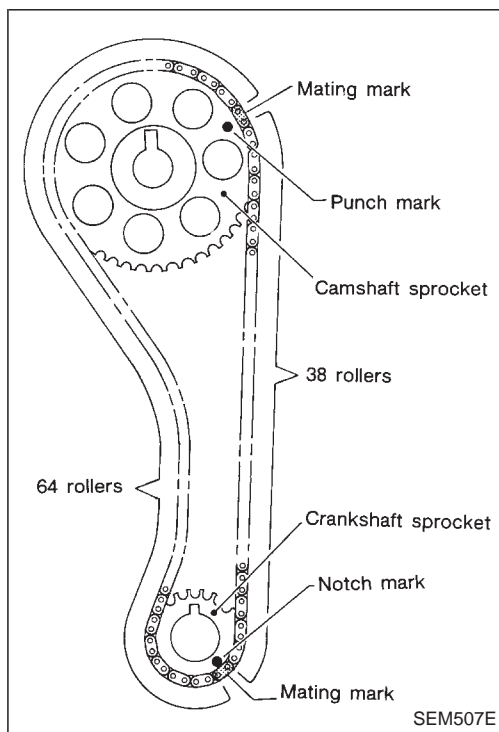
### Inspection

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

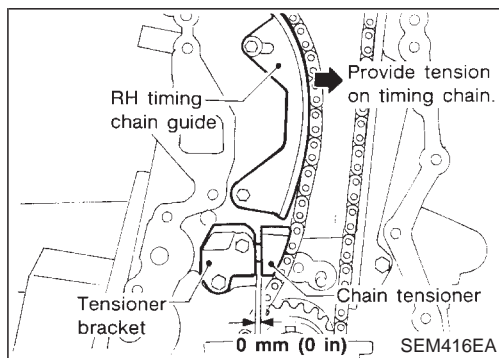


## Installation

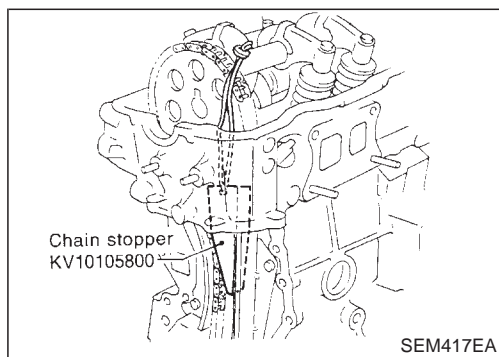
1. Install crankshaft sprocket on crankshaft.



2. Position crankshaft so that No. 1 piston is set at TDC (Keyway at 12 o'clock) fit timing chain to crankshaft sprocket so that mating mark is in line with mating mark on crankshaft sprocket.
3. Temporarily install cylinder head with new gasket. Position camshaft so that keyway is set at 12 o'clock.
4. Install camshaft sprocket with mating mark on timing chain.

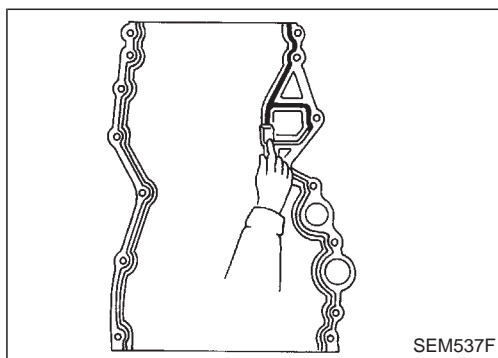


5. Install timing chain and timing chain guides, and chain tensioner.
  - When installing RH timing chain guide, provide tension on timing chain by pulling it inside. Make sure gap between tensioner and tensioner bracket is 0 mm (0 in).



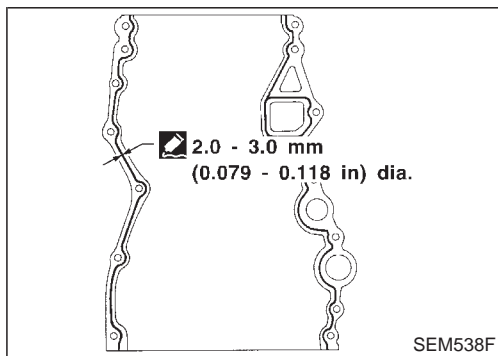
6. Remove camshaft sprocket, then loosen cylinder head bolts.
  - Insert chain stopper before removing camshaft sprocket so that chain tensioner holds its position.
7. Before installing front cover, remove all traces of liquid gasket from mating surface using a scraper.
  - Also remove traces of liquid gasket from mating surface of cylinder block.
8. Apply a continuous bead of liquid gasket to mating surface of front cover.
  - Use Genuine Liquid Gasket or equivalent.

## Installation (Cont'd)



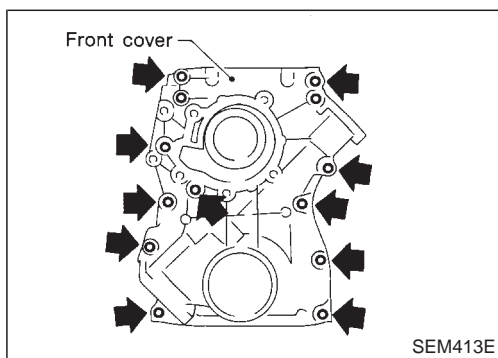
9. Use a scraper to remove old liquid gasket from mating surface of front cover.

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

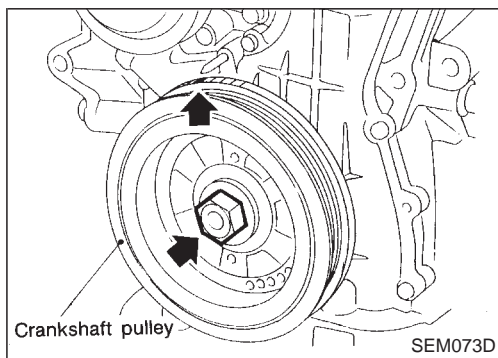


10. Apply a continuous bead of liquid gasket to front cover.

- Use Genuine Liquid Gasket or equivalent.
- Be sure to install new front oil seal in the right direction. Refer to EM-65.



11. Install front cover.



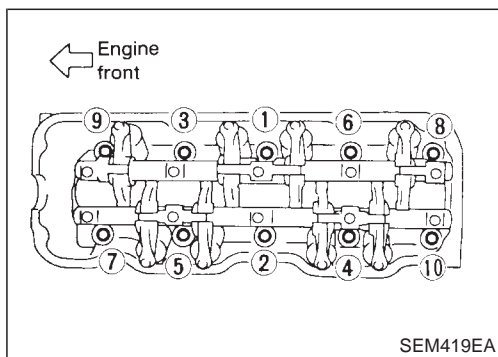
12. Install crankshaft pulley.

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

14. Install starter motor.

15. Install exhaust front tube.

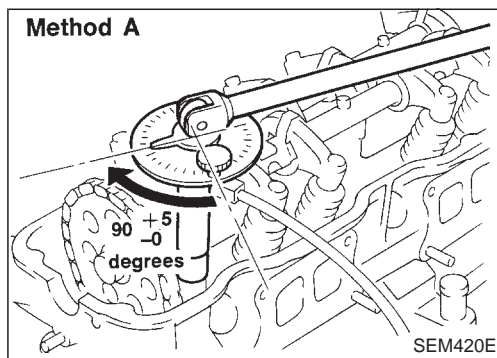
16. Install oil pan. Refer to EM-54.



17. Tighten cylinder head bolts.

- Tighten in numerical order as shown.
- Apply engine oil to threads and seating surfaces of cylinder head bolts before installing them.
- Be sure to install washers between bolts and cylinder head.
- Ⓐ Tighten all bolts to 29 N·m (3 kg-m, 22 ft-lb).
- Ⓑ Tighten all bolts to 78 N·m (8 kg-m, 58 ft-lb).
- Ⓒ Loosen all bolts completely.
- Ⓓ Tighten all bolts to 25 to 34 N·m (2.5 to 3.5 kg-m, 18 to 25 ft-lb).

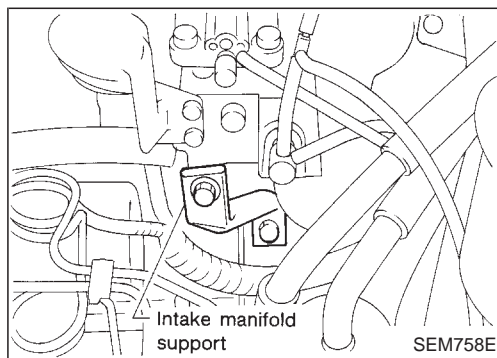
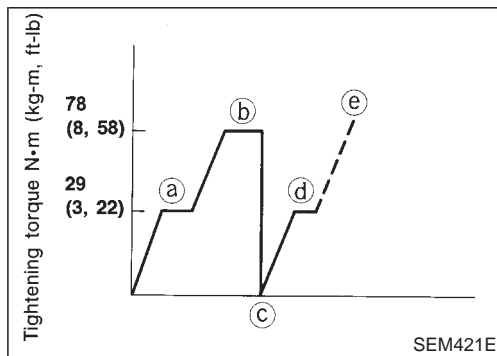
## Installation (Cont'd)



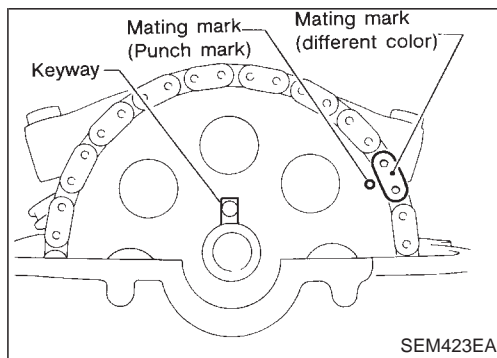
- ⑤ **Method A:** Turn all bolts 90 to 95 degrees clockwise with Tool or suitable angle wrench.

**Method B:** If angle wrench is not available, tighten all bolts to 74 to 83 N·m (7.5 to 8.5 kg-m, 54 to 61 ft-lb).

	Tightening torque N·m (kg-m, ft-lb)
a	29 (3, 22)
b	78 (8, 58)
c	0 (0, 0)
d	29±5 (3±0.5, 21.7±3.6)
e	90 <sup>+5</sup> <sub>-0</sub> degrees or 78±5 (8.0±0.5, 57.9±3.6)

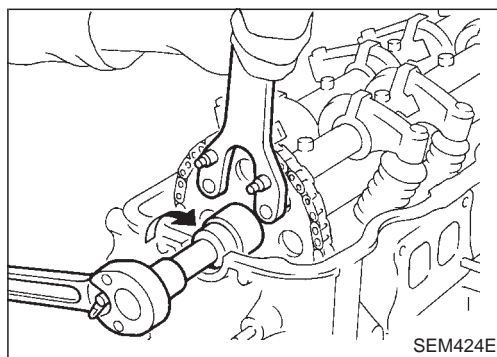


18. Install cylinder head outside bolts.  
19. Install intake manifold support.



20. Install camshaft sprockets.

- Set timing chain by aligning mating mark with camshaft sprocket.

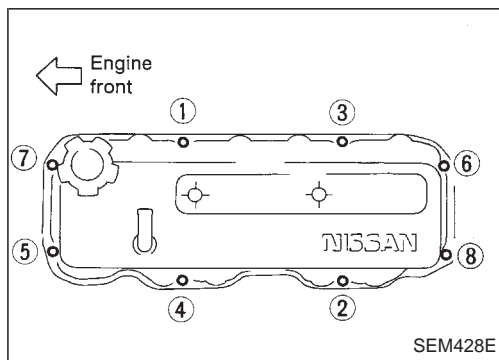
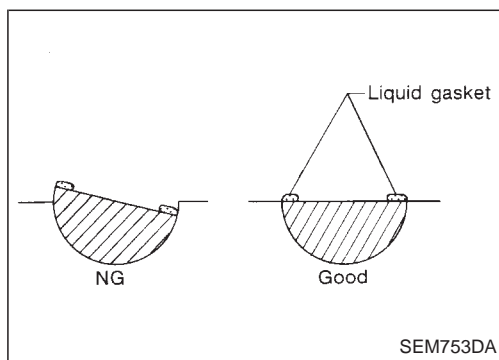
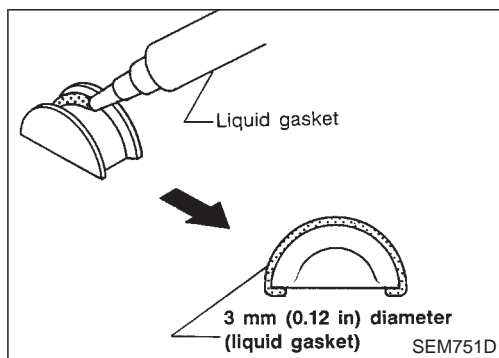


- Lock camshafts as shown in figure and tighten to specified torque.  
Ⓜ: 137 - 157 N·m (14.0 - 16.0 kg-m, 101 - 116 ft-lb)
- Apply new engine oil to threads and seating surfaces of camshaft sprocket bolts before installing them.



## Installation (Cont'd)

21. Install oil pump and distributor.  
Refer to LC section ("Oil Pump").



22. Install rubber plugs as follows:

- a. Apply liquid gasket to rubber plugs.

- Rubber plugs should be replaced with rocker cover gasket.
- Rubber plugs should be installed within 5 minutes of applying liquid gasket.

- b. Install rubber plugs, then move them with your fingers to uniformly spread the gasket on cylinder head surface.

- Rubber plugs should be installed flush with the surface.
- Do not start the engine for 30 minutes after installing rocker cover.

23. Install rocker cover.

## Rocker cover tightening procedure:

- a. Tighten bolts ① - ② in that order to 3 N·m (0.3 kg-m, 26 in-lb).

- b. Tighten nuts ④ - ③ - ② - ① - ⑧ - ⑦ - ⑥ - ⑤ - ④ - ③ - ② - ① in that order to 7 to 11 N·m (0.7 to 1.1 kg-m, 61 to 95 in-lb).

24. Install the following parts:

- Spark plugs and wire
  - Power steering oil pump
  - A/C compressor
  - Idler pulley bracket
  - Water pump pulley and drive belts
- For adjusting drive belt deflection, refer to MA section ("Checking Drive Belts", "ENGINE MAINTENANCE").
- Radiator
- Refit hoses and refill with coolant. Refer to MA section ("REFILLING ENGINE COOLANT", "Changing Engine Coolant").
- Oil pump
- Refer to LC section ("Oil Pump", "ENGINE LUBRICATION SYSTEM").
- Engine undercovers

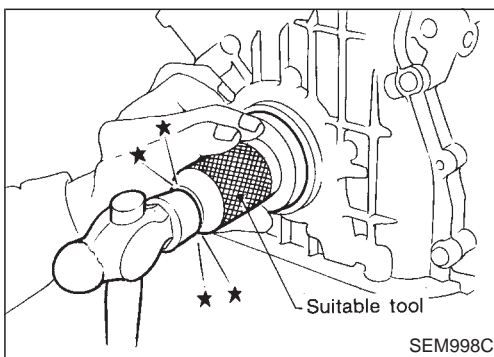
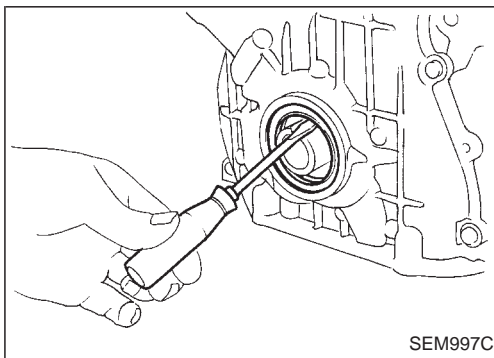
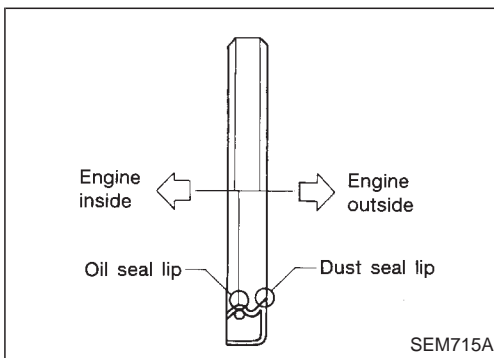
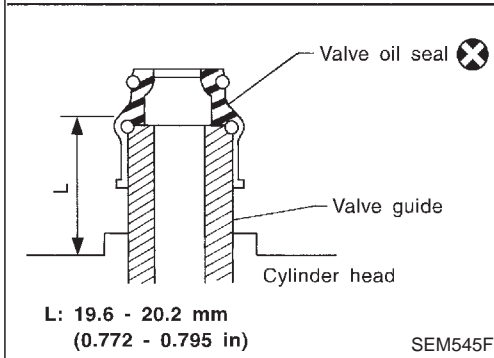
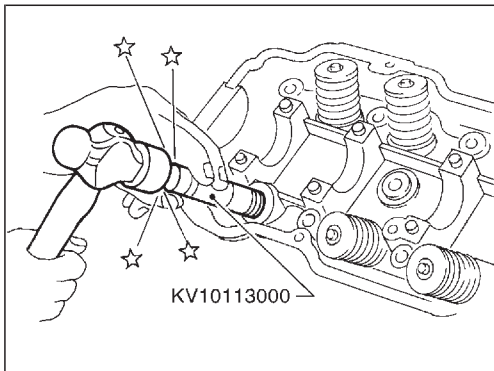


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**Installation (Cont'd)**

25. Connect the following:

- Vacuum hoses
- Fuel hoses
- Wire harnesses and connectors
- Air duct to intake manifold



### VALVE OIL SEAL

1. Remove rocker cover.
2. Remove rocker shaft assembly.
3. Remove valve spring and valve oil seal with suitable tool.  
**Piston concerned should be set at TDC to prevent valve from falling.**
4. Apply engine oil to new valve oil seal and install it with Tool.

### OIL SEAL INSTALLATION DIRECTION

### FRONT OIL SEAL

1. Remove the following parts:
  - Cooling fan and fan coupling
  - Drive belts
  - Crankshaft pulley
2. Remove front oil seal.  
**Be careful not to scratch front cover.**

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

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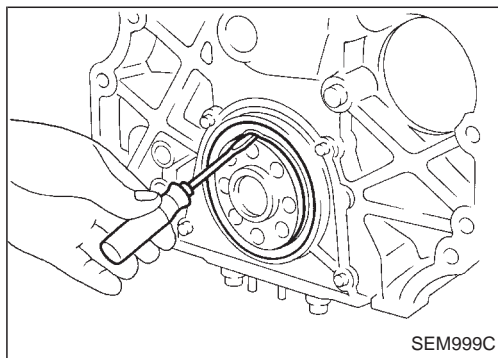
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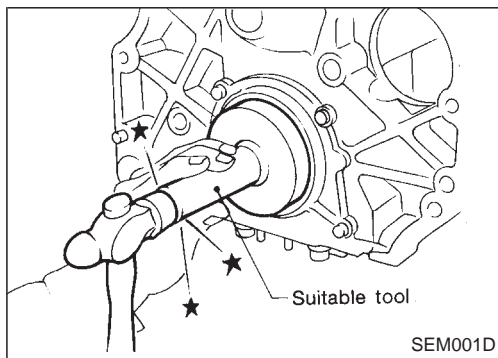
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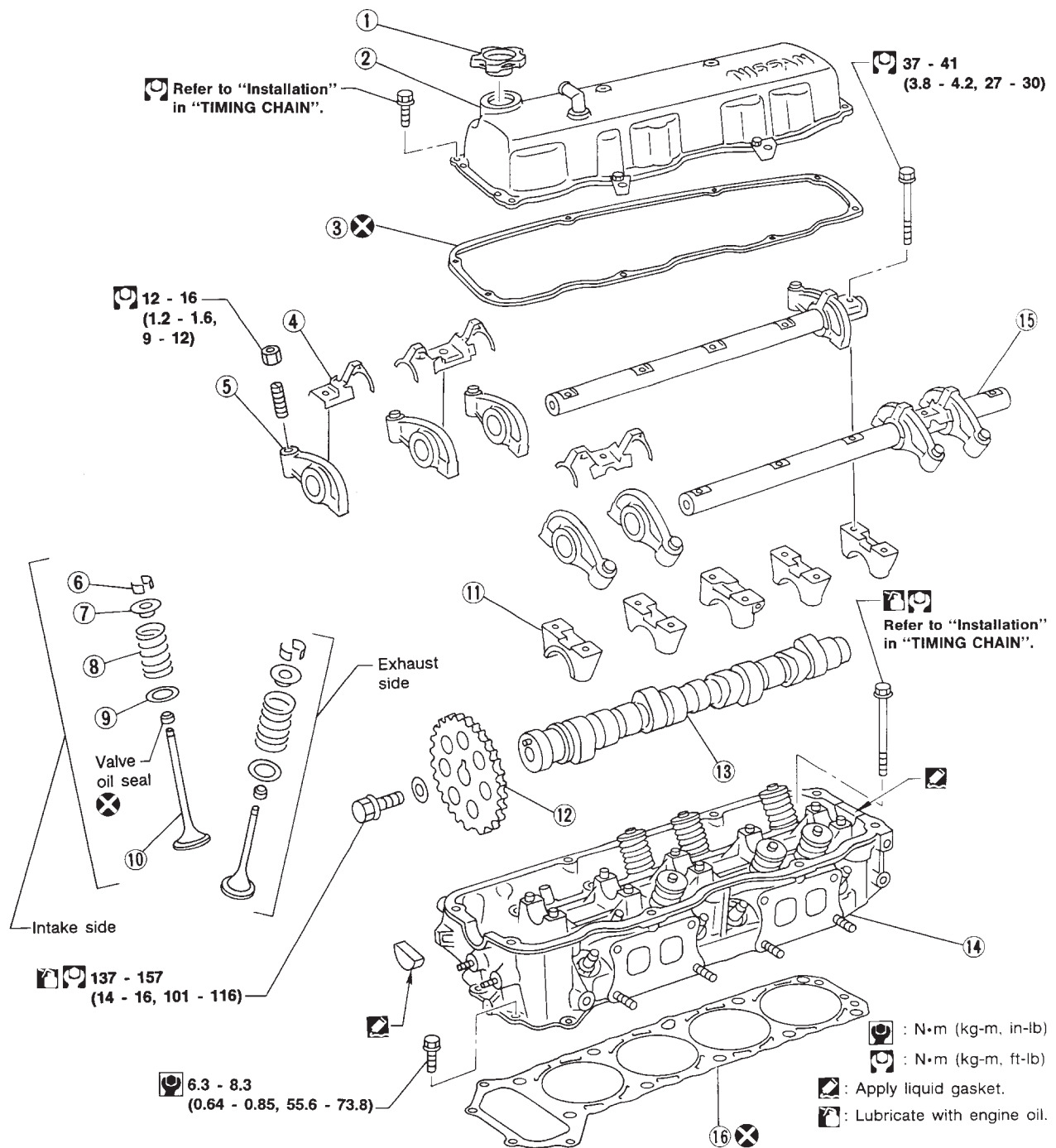
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**REAR OIL SEAL**

1. Remove transmission. Refer to MT section.
  2. Remove flywheel.
  3. Remove rear oil seal.
- Be careful not to scratch rear oil seal retainer.**



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



- ① Oil filler cap
- ② Rocker cover
- ③ Rocker cover gasket
- ④ Rocker arm spring
- ⑤ Rocker arm
- ⑥ Valve collet

- ⑦ Valve spring retainer
- ⑧ Valve spring
- ⑨ Valve spring seat
- ⑩ Valve
- ⑪ Camshaft bracket
- ⑫ Camshaft sprocket

- ⑬ Camshaft
- ⑭ Cylinder head
- ⑮ Rocker shaft
- ⑯ Cylinder head gasket

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**CAUTION:**

- When installing rocker arms, camshaft and oil seal, lubricate contacting surfaces with new engine oil.
- When tightening cylinder head bolts, camshaft sprocket bolts and camshaft bracket bolts, lubricate bolt threads and seat surfaces with new engine oil.

**Removal**

Remove cylinder head with intake and exhaust manifolds.

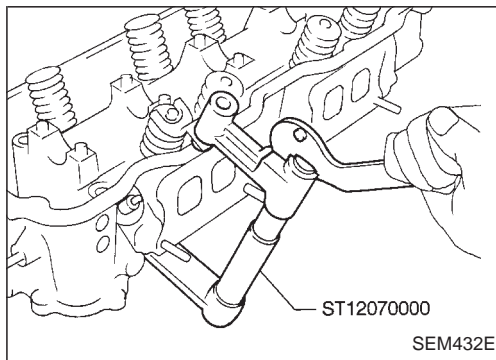
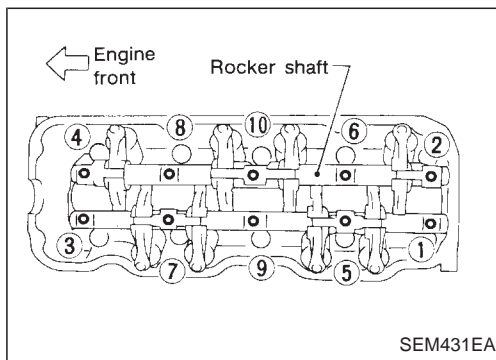
This removal is the same procedure as that for timing chain. Refer to "Removal", "TIMING CHAIN", EM-57.

**Disassembly**

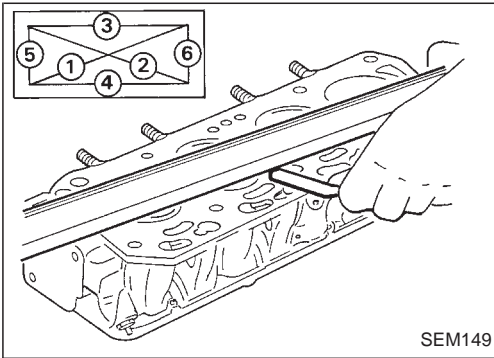
1. Remove manifolds from cylinder head.  
Refer to "Intake & Exhaust Manifold", "OUTER COMPONENT PARTS", EM-52.
2. Remove rocker shafts with rocker arms and camshaft.
  - **Loosen in numerical order as shown.**
  - **Bolts should be loosened in two or three steps.**

**CAUTION:**

Keep parts in order so they can be installed in their original positions during assembly.



3. Remove valve components with Tool.
4. Remove valve oil seal with a suitable tool.  
Refer to "VALVE OIL SEAL", EM-65.



## Inspection

### CYLINDER HEAD DISTORTION

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

#### Head surface flatness:

**Less than 0.1 mm (0.004 in)**

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

#### Resurfacing limit:

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

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

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

**The maximum limit is as follows:**

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

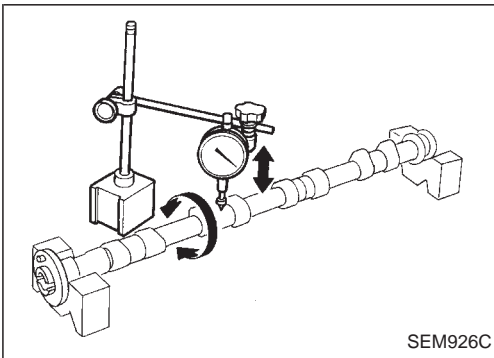
After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.

#### Nominal cylinder head height:

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

### CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.



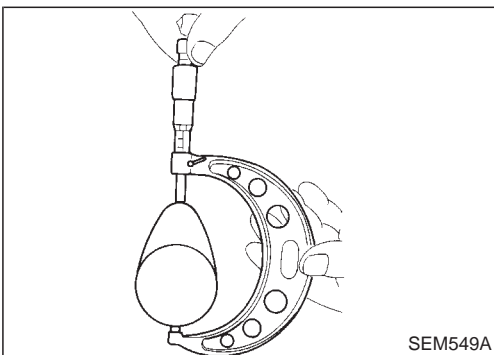
### CAMSHAFT RUNOUT

1. Measure camshaft runout at the center journal.

**Runout (Total indicator reading):**

**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:**

**Intake & Exhaust**

**44.572 - 44.762 mm (1.7548 - 1.7623 in)**

**Cam wear limit:**

**Intake & Exhaust**

**0.25 mm (0.0098 in)**

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

## CYLINDER HEAD

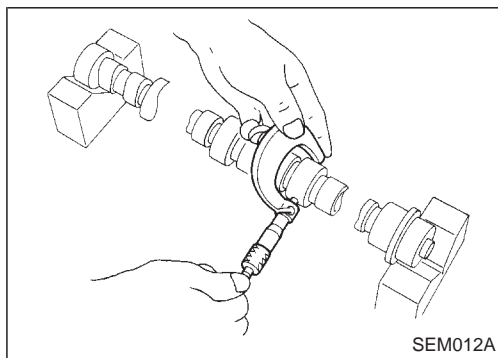
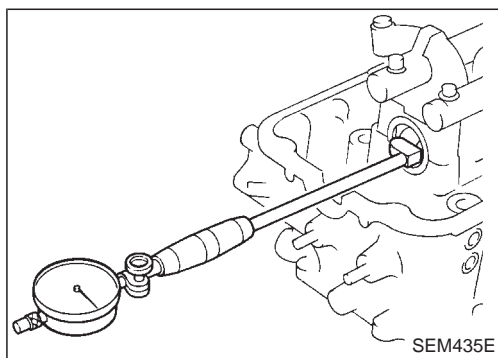
### Inspection (Cont'd)

#### CAMSHAFT JOURNAL CLEARANCE

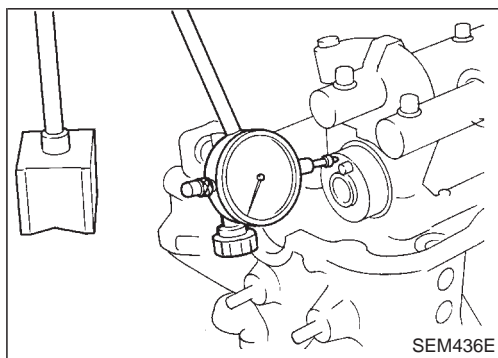
1. Install camshaft bracket and tighten bolts. Refer to EM-74.
2. Measure inner diameter of camshaft bearing.

**Standard inner diameter:**

**33.000 - 33.025 mm (1.2992 - 1.3002 in)**



3. Measure outer diameter of camshaft journal.  
**Standard outer diameter:**  
**32.935 - 32.955 mm (1.2967 - 1.2974 in)**
4. Calculate camshaft journal clearance.  
**Camshaft journal clearance = standard inner diameter - standard outer diameter: mm (in)**  
**Standard**  
**0.045 - 0.090 (0.0018 - 0.0035)**  
**Limit**  
**0.12 (0.0047)**
5. If clearance exceeds the limit, replace camshaft and remeasure camshaft journal clearance.
  - If clearance still exceeds the limit after replacing camshaft, replace cylinder head.



#### CAMSHAFT END PLAY

1. Install camshaft in cylinder head. Refer to EM-74.
2. Measure camshaft end play.

**Camshaft end play: mm (in)**

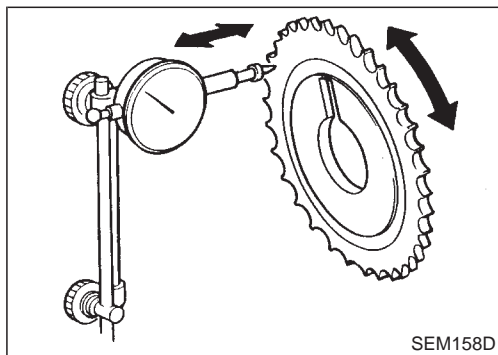
**Standard**

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

**Limit**

**0.2 (0.008)**

3. If end play exceeds the limit, replace camshaft and remeasure camshaft end play.
  - If end play still exceeds the limit after replacing camshaft, replace cylinder head.



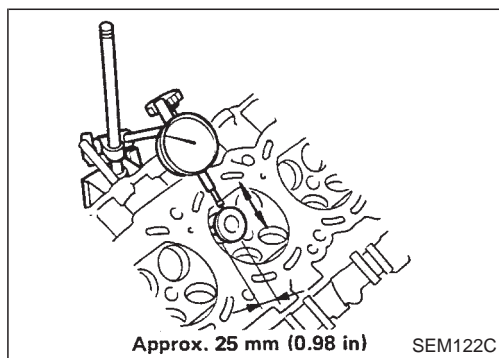
#### CAMSHAFT SPROCKET RUNOUT

1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.  
**Runout (Total indicator reading):**  
**Limit 0.25 mm (0.0098 in)**
3. If it exceeds the limit, replace camshaft sprocket.

## CYLINDER HEAD

## Inspection (Cont'd)

## VALVE GUIDE CLEARANCE

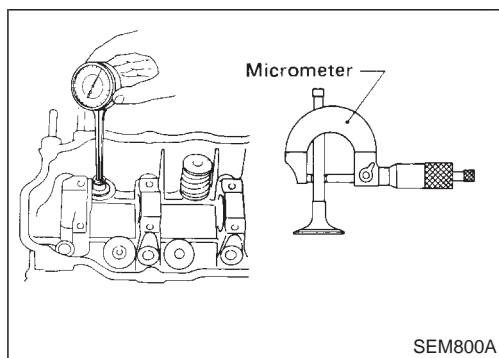


1. Measure valve deflection as shown in illustration. (Valve and valve guide mostly wear in this direction.)

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

**Intake & Exhaust**

**0.12 mm (0.0047 in)**



2. If it exceeds the limit, check valve to valve guide clearance.
  - a. Measure valve stem diameter and valve guide inner diameter.
  - b. Calculate valve to valve guide clearance.

**Valve to valve guide clearance = valve guide inner diameter – valve stem diameter: mm (in)**

**Standard**

**Intake 0.020 - 0.053 (0.0008 - 0.0021)**

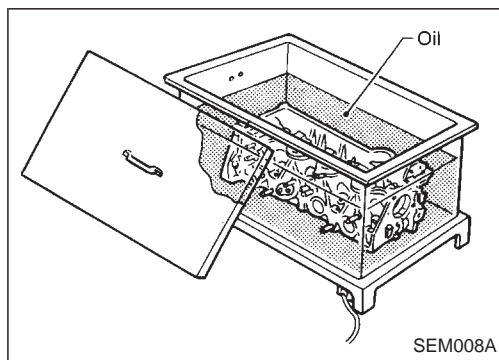
**Exhaust 0.040 - 0.073 (0.0016 - 0.0029)**

**Limit**

**Intake 0.1 (0.004)**

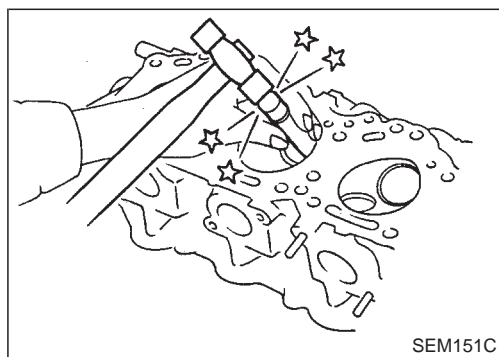
**Exhaust 0.1 (0.004)**

- c. If it exceeds the limit, replace valve and remeasure clearance.
  - If clearance still exceeds the limit after replacing valve, replace valve guide.



## VALVE GUIDE REPLACEMENT

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

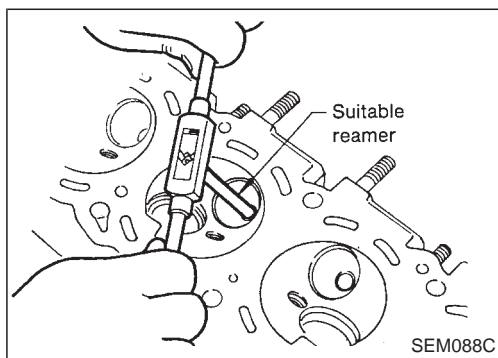


2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.



## CYLINDER HEAD

### Inspection (Cont'd)



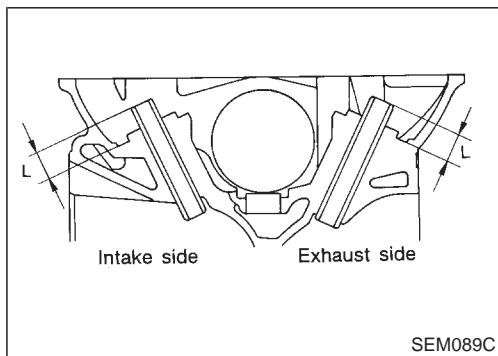
3. Ream cylinder head valve guide hole.

**Valve guide hole diameter**

**(for service parts):**

**Intake & Exhaust**

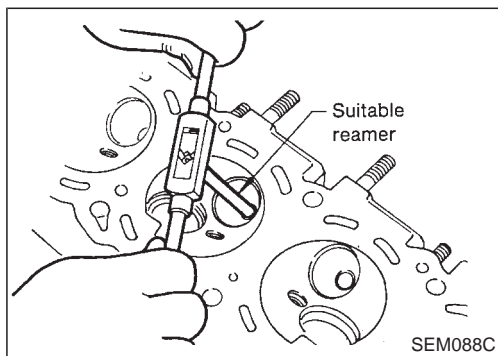
**12.175 - 12.196 mm (0.4793 - 0.4802 in)**



4. Heat cylinder head to 110 to 120°C (230 to 248°F) and press service valve guide onto cylinder head.

**Projection "L":**

**17.9 - 18.1 mm (0.705 - 0.713 in)**

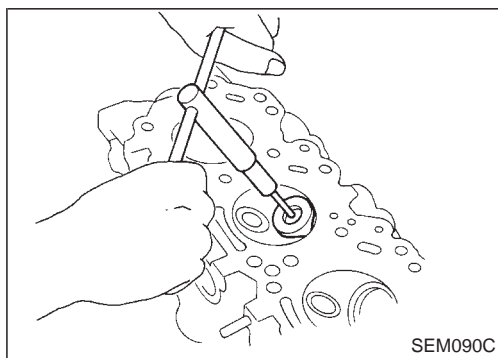


5. Ream valve guide.

**Finished size:**

**Intake & Exhaust**

**8.000 - 8.018 mm (0.3150 - 0.3157 in)**



### VALVE SEATS

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

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

### REPLACING VALVE SEAT FOR SERVICE PARTS

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

2. Ream cylinder head recess.

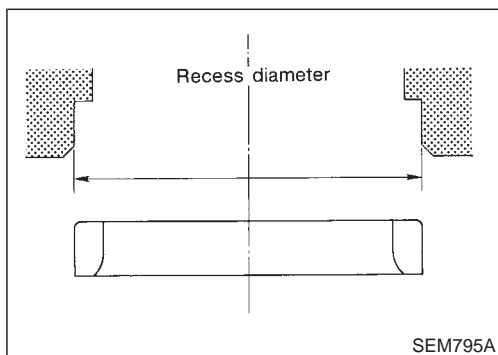
**Reaming bore for service valve seat**

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

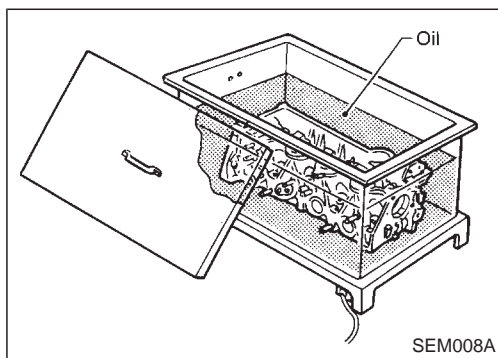
**Intake 41.500 - 41.516 (1.6339 - 1.6345)**

**Exhaust 36.500 - 36.516 (1.4370 - 1.4376)**

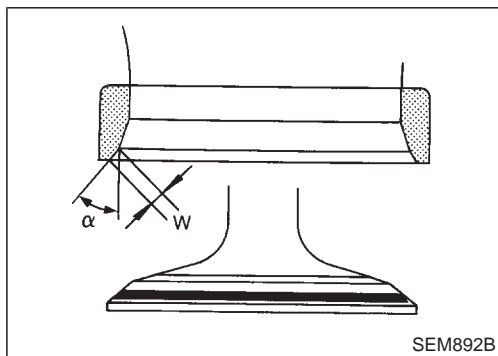
**Use the valve guide center for reaming to ensure valve seat will have the correct fit.**



## Inspection (Cont'd)



3. Heat cylinder head to 110 to 130°C (230 to 266°F).
4. Press fit valve seat until it seats on the bottom.



5. Cut or grind valve seat using suitable tool at the specified dimensions as shown in SDS, EM-191.
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

**Seat face angle "α":**

**45 deg.**

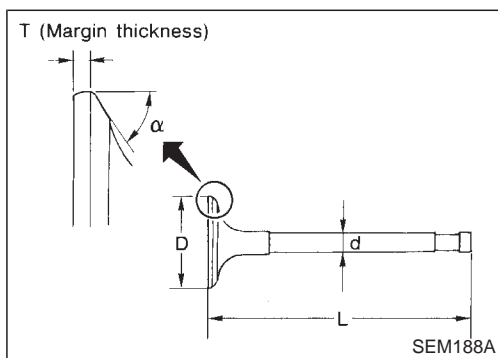
**Contacting width "W": mm (in)**

**Intake**

**1.41 - 1.56 (0.0555 - 0.0614)**

**Exhaust**

**1.9 - 2.1 (0.075 - 0.083)**

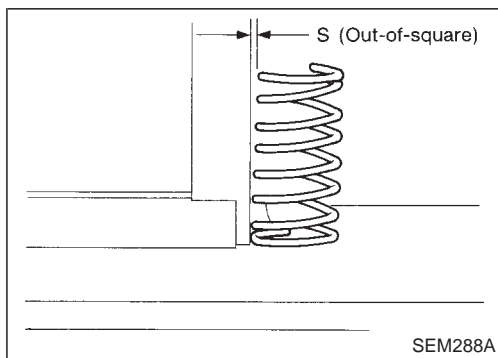


## VALVE DIMENSIONS

Check dimensions in each valve. For dimensions, refer to SDS, EM-184.

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

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



## VALVE SPRING

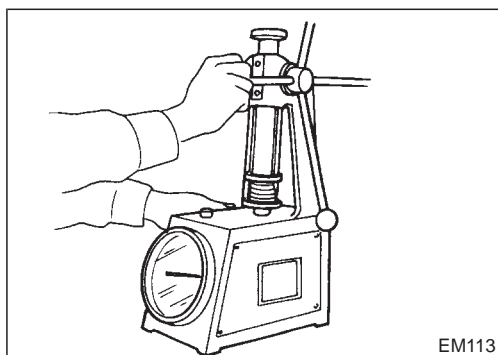
## Squareness

1. Measure "S" dimension.

**Out-of-square:**

**Less than 2.3 mm (0.091 in)**

2. If it exceeds the limit, replace spring.



## Pressure

Check valve spring pressure at specified spring height.

**Pressure:**

**Standard**

**665.0 - 749.0 N (67.81 - 76.37 kg,  
149.52 - 168.40 lb) at 35 mm (1.38 in)**

**Limit**

**More than 631.37 N (64.38 kg, 141.96 lb)  
at 35 mm (1.38 in)**

If it exceeds the limit, replace spring.

## CYLINDER HEAD

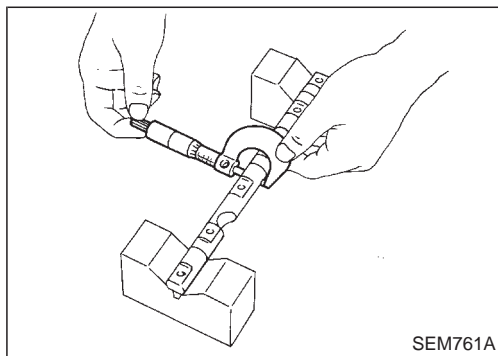
### Inspection (Cont'd)

#### ROCKER SHAFT AND ROCKER ARM

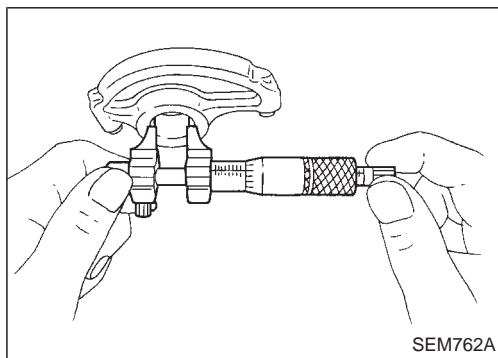
1. Check rocker shafts for scratches, seizure and wear.
2. Check outer diameter of rocker shaft.

**Diameter:**

**21.988 - 22.000 mm (0.8657 - 0.8661 in)**



SEM761A



SEM762A

3. Check inner diameter of rocker arm.

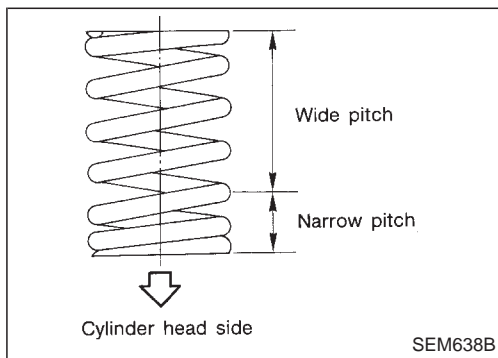
**Diameter:**

**22.023 - 22.041 mm (0.8670 - 0.8678 in)**

**Rocker arm to shaft clearance:**

**0.023 - 0.053 mm (0.0009 - 0.0021 in)**

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

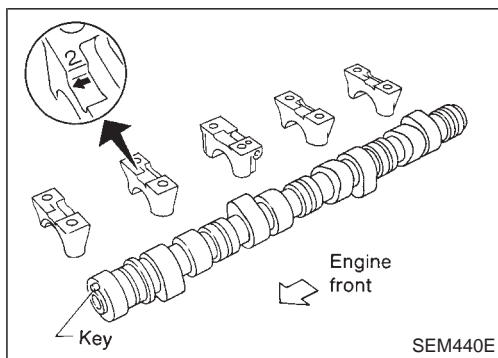


SEM638B

### Assembly

1. Install valve component parts.

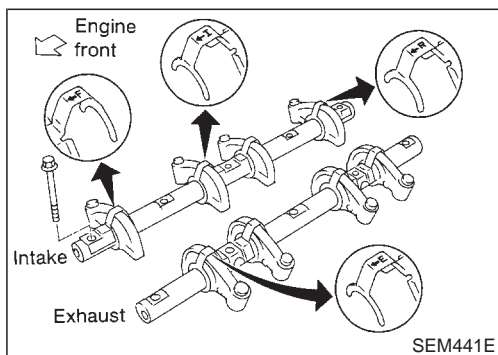
- Always use new valve oil seal. Refer to "OIL SEAL REPLACEMENT", EM-65.
- Before installing valve oil seal, install valve spring seat.
- Install valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.
- After installing valve components, use plastic hammer to lightly tap valve stem tip to assure a proper fit.



SEM440E

2. Install camshafts and camshaft brackets.

- Set key on camshaft at the top.
- Apply new engine oil to bearing and cam surfaces of camshafts before installing them.




SEM441E

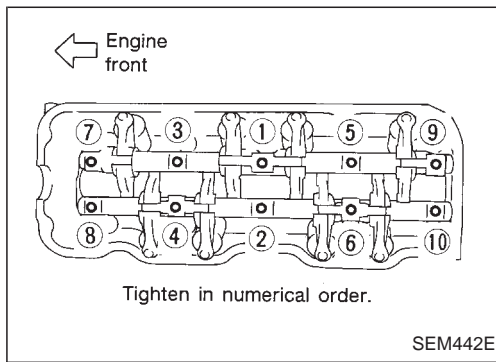
3. Install rocker shafts with rocker arms.

- Apply new engine oil to threads and seating surfaces of camshaft bracket bolts before installing them.

**Assembly (Cont'd)**

**Tighten rocker shaft securing bolts in two or three stages.**  
Set No. 1 piston at TDC on its compression stroke and tighten rocker shaft bolts.

: 37 - 41 N·m (3.8 - 4.2 kg-m, 27 - 30 ft-lb)

**Installation**

- This installation is the same procedure as that for timing chain. Refer to "Installation", "TIMING CHAIN", EM-60.
- Install intake and exhaust manifolds with new gaskets. Refer to "Intake & Exhaust Manifold", "OUTER COMPONENT PARTS", EM-52.

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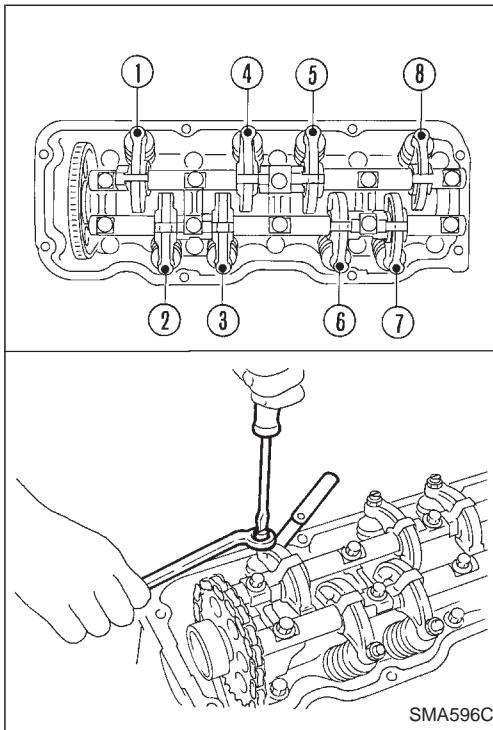
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## Adjusting Intake and Exhaust Valve Clearance

- Adjustment should be made while engine is warm but not running.
- Adjust valve clearance.
  - (1) Set No. 1 cylinder at top dead center on its compression stroke, and adjust valve clearances ①, ②, ④, and ⑥.
  - (2) Set No. 4 cylinder at top dead center on its compression stroke, and adjust valve clearances ③, ⑤, ⑦, and ⑧.

Unit: mm (in)

	COLD	HOT
Intake ①, ④, ⑤, ⑧	0.21 (0.008)	0.3 (0.012)
Exhaust ②, ③, ⑥, ⑦	0.23 (0.009)	0.3 (0.012)

### Adjusting screw lock nuts:

: 12 - 16 N·m (1.2 - 1.6 kg-m, 9 - 12 ft-lb)

- Whenever valve clearances are adjusted to cold specifications, check that the clearances satisfy hot specifications and adjust again if necessary.



- ③ Rear engine mounting member
- ④ Front engine slinger

- **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.**

**Be sure to hoist engine and transmission in a safe manner. For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.**

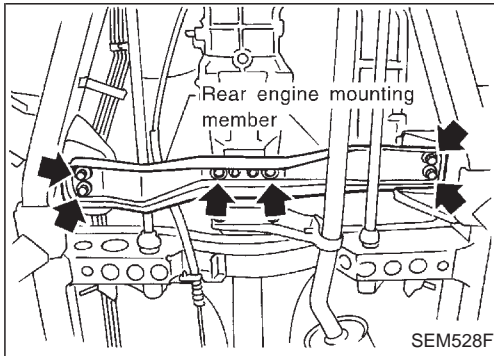
- When lifting engine, be careful not to strike adjacent parts, especially the following: Accelerator wire casing, brake lines, and brake master cylinder.
- In hoisting the engine, always use engine slingers in a safe manner.

1. Remove engine undercover and hood.
2. Drain coolant from both cylinder block and radiator.
3. Remove vacuum hoses, fuel hoses, radiator hoses, heater hose, wires, harnesses, connectors and so on.
4. Remove air duct and air cleaner assembly.
5. Remove radiator and fans.
6. Remove front seat fixing bolt, kicking plate, then peel off the floor carpet.
7. Remove shift lever boot finisher.

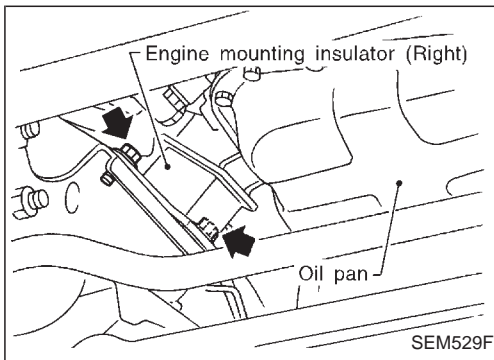
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**Removal (Cont'd)**

8. Remove shift lever assembly.
9. Remove alternator.
10. Remove starter motor assembly.
11. Remove clutch operating cylinder.
12. Remove exhaust front tube assembly.
13. Remove propeller shaft.
14. Set a suitable transmission jack under transmission. Hoist engine with engine slinger.



15. Remove rear engine mounting member.



16. Remove transmission assembly.
17. Remove engine mounting insulator (Right).
18. Remove engine mounting insulator (Left).

19. Remove engine assembly.

**Installation**

Installation is in the reverse order of removal.



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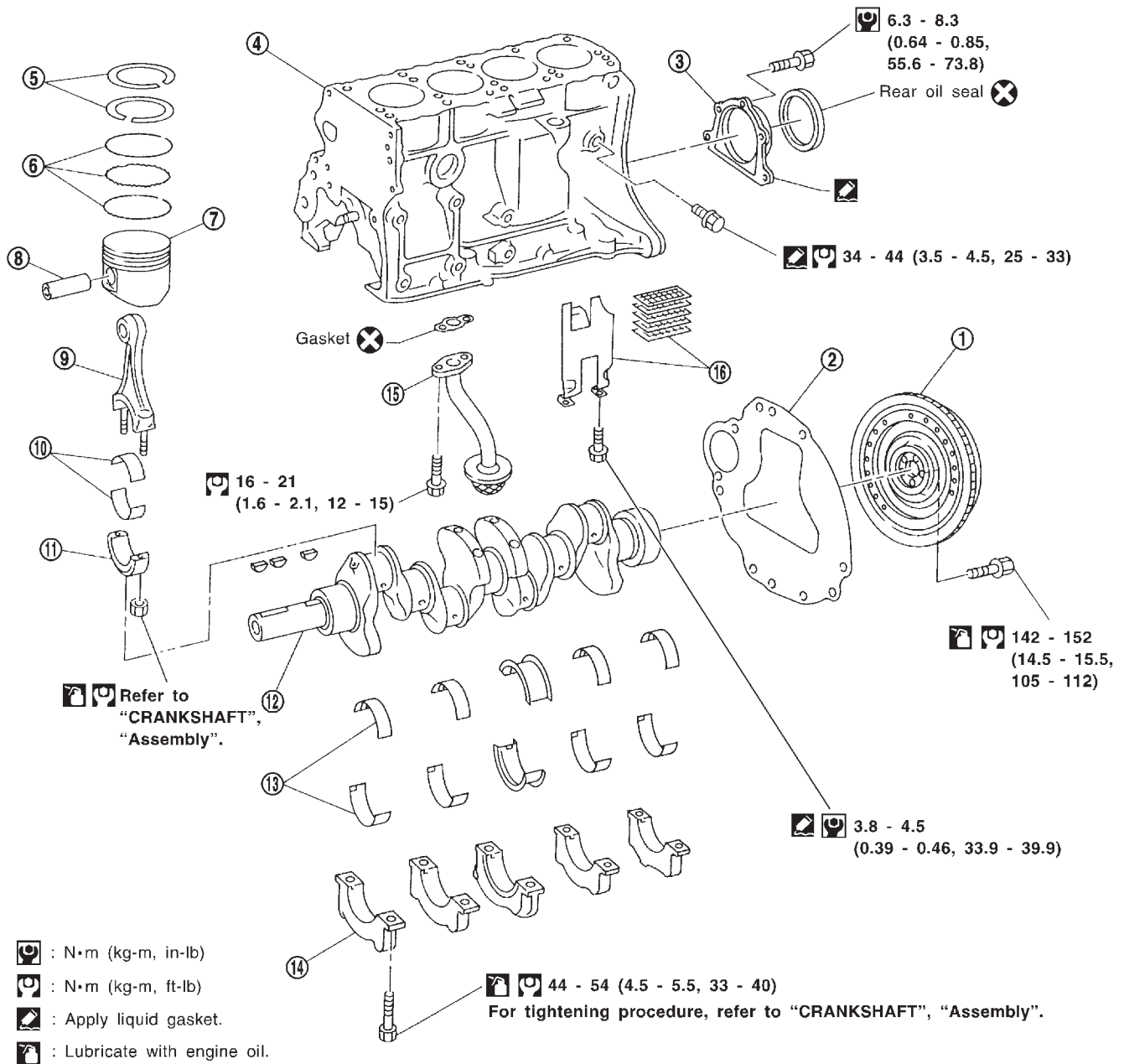
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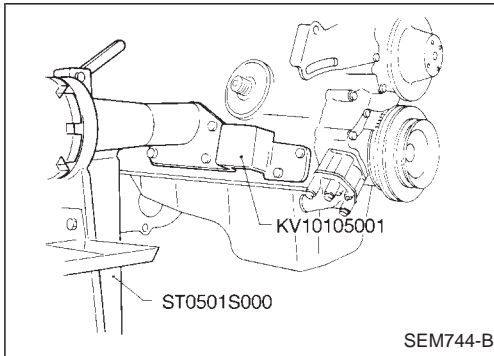
- ① Flywheel
- ② Rear plate
- ③ Rear oil seal retainer
- ④ Cylinder block
- ⑤ Piston rings
- ⑥ Oil rings

- ⑦ Piston
- ⑧ Piston pin
- ⑨ Connecting rod
- ⑩ Connecting rod bearing
- ⑪ Connecting rod cap
- ⑫ Crankshaft

- ⑬ Main bearing
- ⑭ Main bearing cap
- ⑮ Oil strainer
- ⑯ Baffle plate and net

**CAUTION:**

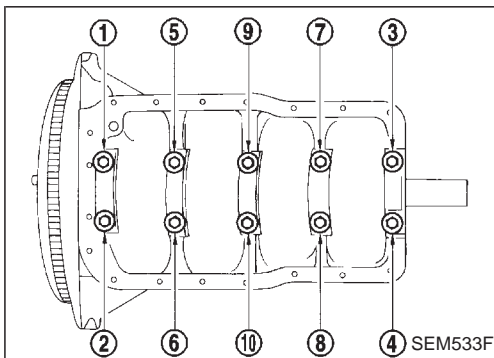
- When installing sliding parts (bearings, pistons, etc.), lubricate contacting surfaces with new engine oil.
- Place removed parts such as bearings and bearing caps in their proper order and direction.
- When installing connecting rod nuts and main bearing cap bolts, apply new engine oil to threads and seating surfaces.

**Disassembly****PISTON AND CRANKSHAFT**

1. Place engine on engine stand (ST0501S000).
  2. Drain coolant and oil.
  3. Remove oil pan.  
Refer to "Removal", "OIL PAN", EM-54.
  4. Remove timing chain.  
Refer to "Removal", "TIMING CHAIN", EM-57.
  5. Remove pistons with connecting rod.
- Confirm that the piston pin can be pushed into the piston pin hole with your finger at room temperature.

**CAUTION:**

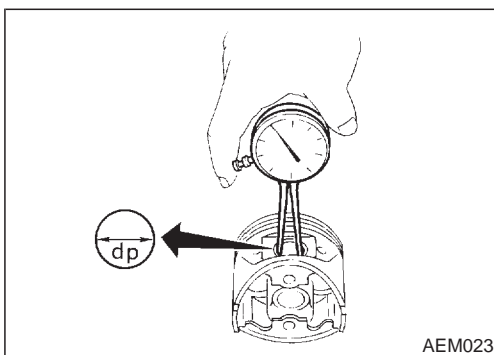
- When piston rings are not replaced, make sure that piston rings are mounted in their original positions.
  - When replacing piston rings, if there is no punchmark, install with either side up.
6. Remove rear oil seal retainer.

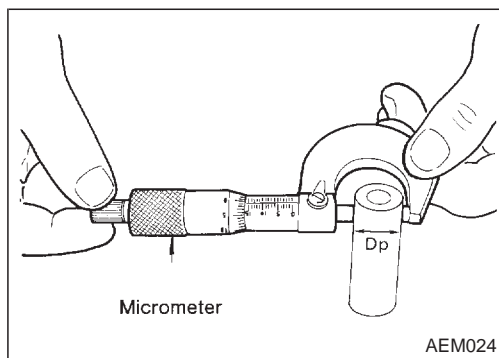


7. Remove bearing cap and crankshaft.
- Loosen in numerical order as shown.
  - Before removing bearing cap, measure crankshaft end play. Refer to EM-87.
  - Bolts should be loosened in two or three steps.

**Inspection****PISTON AND PISTON PIN CLEARANCE**

1. Measure inner diameter of piston pin hole "dp".  
Standard diameter "dp":  
21.001 - 21.008 mm (0.8268 - 0.8271 in)



**Inspection (Cont'd)**

2. Measure outer diameter of piston pin "Dp".

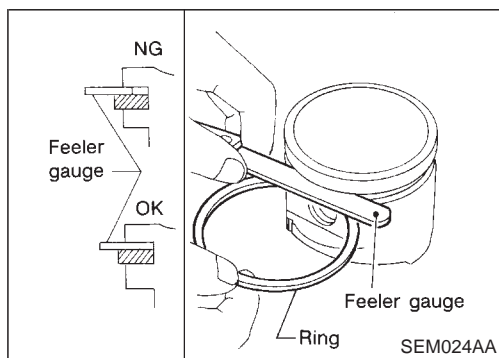
**Standard diameter "Dp":**

**20.993 - 20.998 mm (0.8265 - 0.8267 in)**

3. Calculate piston pin clearance.

**dp - Dp = 0.008 - 0.012 mm (0.0003 - 0.0005 in)**

If it exceeds the above value, replace piston assembly with pin.

**PISTON RING SIDE CLEARANCE**

**Side clearance: mm (in)**

**Top ring**

**0.040 - 0.075 (0.0016 - 0.0030)**

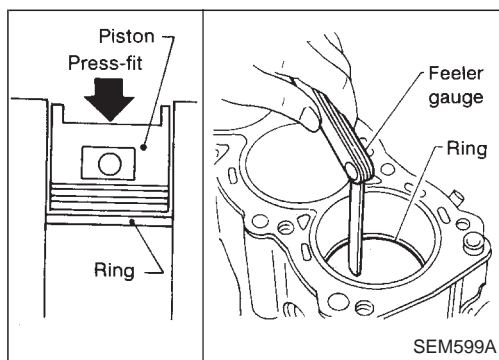
**2nd ring**

**0.030 - 0.063 (0.0012 - 0.0025)**

**Max. limit of side clearance:**

**0.1 mm (0.004 in)**

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

**PISTON RING END GAP**

**End gap: mm (in)**

**Top ring 0.24 - 0.43 (0.0094 - 0.0169)**

**2nd ring 0.42 - 0.66 (0.0165 - 0.0260)**

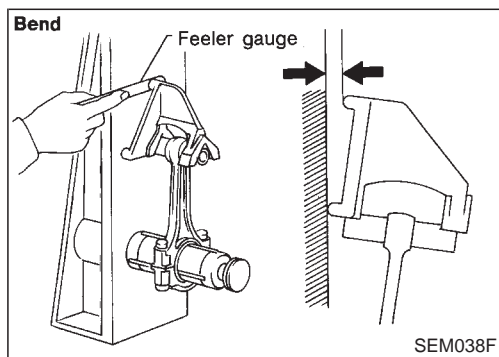
**Oil ring 0.20 - 0.69 (0.0079 - 0.0272)**

**Max. limit of ring gap:**

**1.0 mm (0.039 in)**

If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, rebore cylinder and use oversized piston and piston rings. Refer to SDS, EM-187.

- 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.

**CONNECTING ROD BEND AND TORSION**

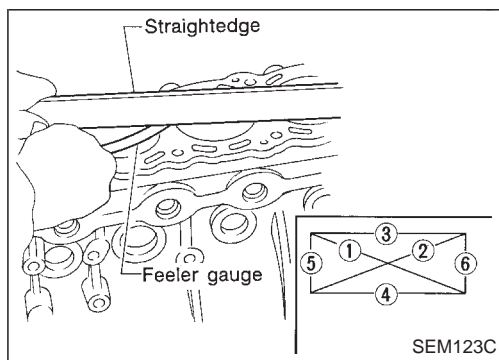
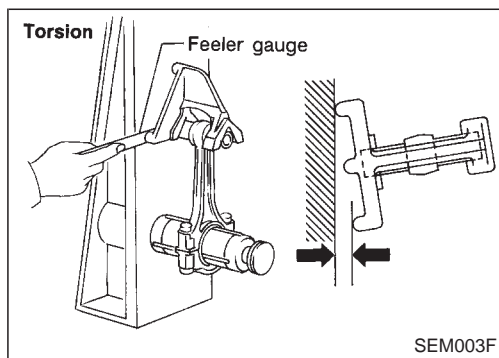
**Bend: mm (in)**

**Limit 0.15 (0.0059) per 100 (3.94) length**

**Torsion: mm (in)**

**Limit 0.3 (0.012) per 100 (3.94) length**

If it exceeds the limit, replace connecting rod assembly.



### CYLINDER BLOCK DISTORTION AND WEAR

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

**Block surface flatness: mm (in)**

**Standard Less than 0.03 (0.0012)**

**Limit 0.10 (0.0039)**

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

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

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

**The maximum limit is as follows:**

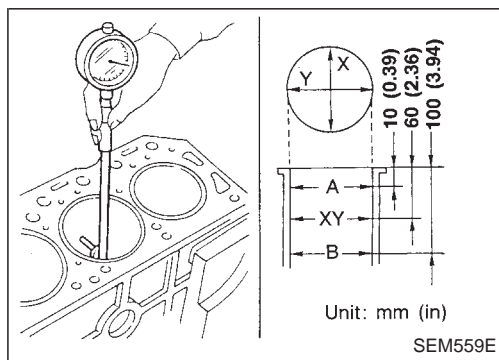
**$A + B = 0.2 \text{ mm (0.008 in)}$**

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

**227.40 - 227.50 mm (8.9527 - 8.9567 in)**

**Refer to SDS, EM-184.**

3. If necessary, replace cylinder block.



### PISTON-TO-BORE CLEARANCE

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

**Standard inner diameter:**

**86.000 - 86.030 mm (3.3858 - 3.3870 in)**

**Wear limit:**

**0.2 mm (0.008 in)**

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

**0.015 mm (0.0006 in)**

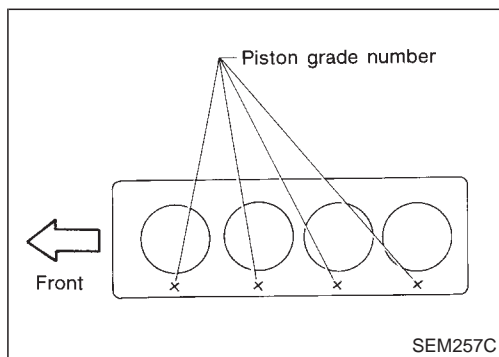
**Taper (A - B) standard:**

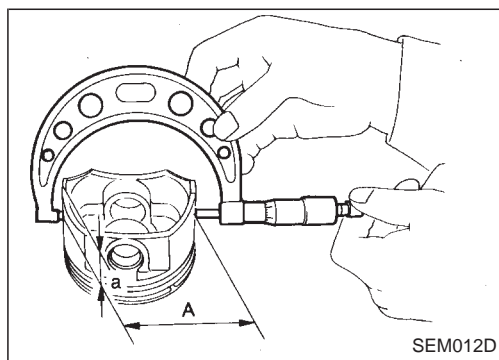
**0.010 mm (0.0004 in)**

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

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

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





### Inspection (Cont'd)

3. Measure piston skirt diameter.

**Piston diameter "A":**

**Refer to SDS, EM-187.**

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

**14 mm (0.55 in)**

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

**Piston-to-bore clearance = bore measurement "B"**

**- piston diameter "A":**

**0.025 - 0.045 mm (0.0010 - 0.0018 in)**

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

**Oversize pistons are available for service. Refer to SDS, EM-187.**

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

**Rebored size calculation:**

$$D = A + B - C$$

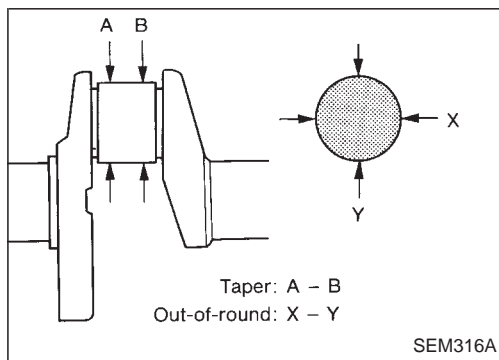
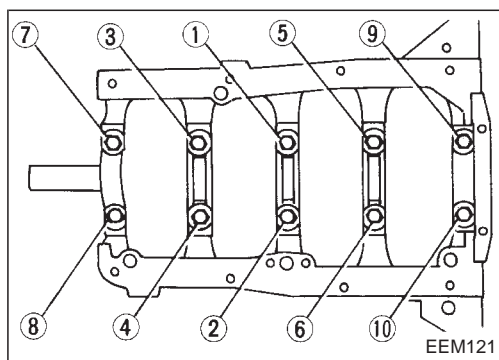
**where,**

**D: Bored diameter**

**A: Piston diameter as measured**

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

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



7. Install main bearing caps and tighten bolts to 44 to 54 N·m (4.5 to 5.5 kg-m, 33 to 40 ft-lb) as shown. This will prevent distortion of cylinder bores, otherwise cylinder bores may be distorted in final assembly.

8. Cut cylinder bores.

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

• **Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.**

9. Hone cylinders to obtain specified piston-to-bore clearance.

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

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

### CRANKSHAFT

1. Check crankshaft main and pin journals for score, wear or cracks.

2. With a micrometer, measure journals for taper and out-of-round.

**Main journal: mm (in)**

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

**Less than 0.03 (0.0012)**

**Taper (A - B)**

**Less than 0.03 (0.0012)**

**Pin journal: mm (in)**

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

**Less than 0.03 (0.0012)**

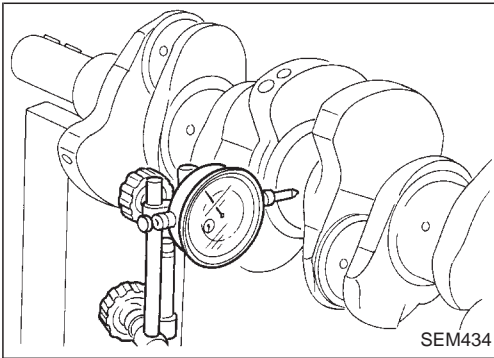
**Taper (A - B)**

**Less than 0.03 (0.0012)**

**Inspection (Cont'd)**

3. Measure crankshaft runout.

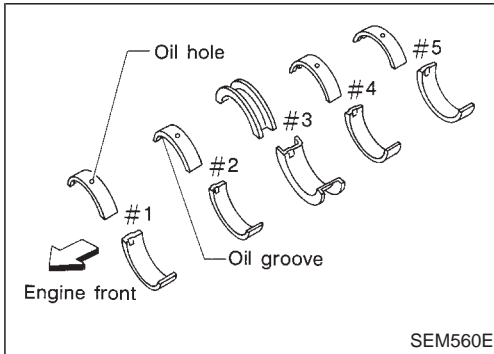
**Runout (Total indicator reading):**  
**Less than 0.05 mm (0.0020 in)**

**BEARING CLEARANCE**

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

**Method A (Using bore gauge & micrometer)****Main bearing**

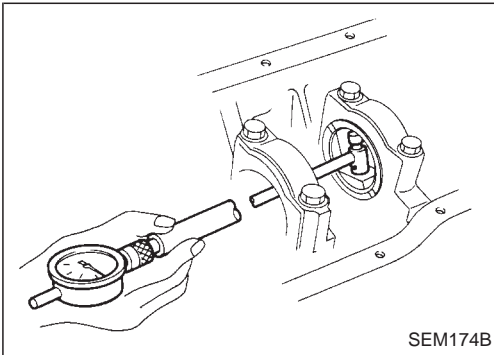
1. Set main bearings in their proper positions on cylinder block and main bearing cap.



2. Install main bearing cap to cylinder block.

**Tighten all bolts in correct order in two or three stages. Refer to EM-87.**

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**

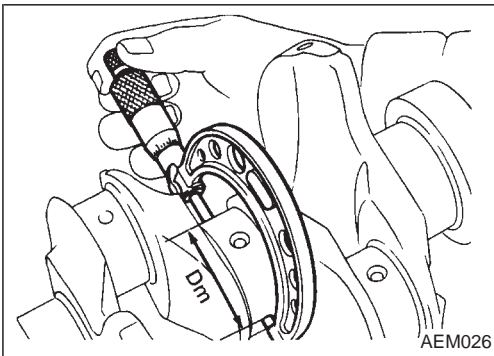
**Standard:**

**0.024 - 0.056 mm (0.0009 - 0.0022 in)**

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

If it exceeds the limit, replace bearing.

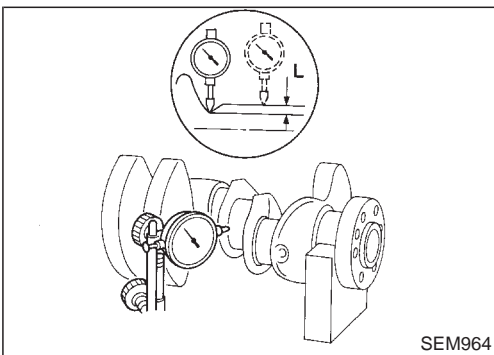
- If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.



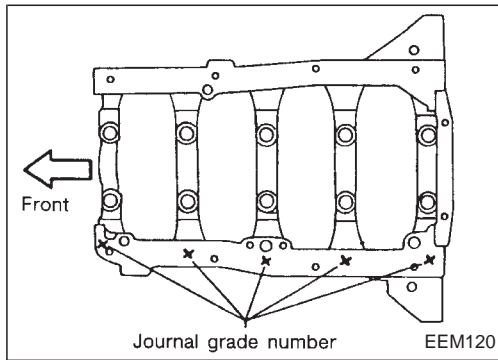
- When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.

**"L": 0.1 mm (0.0039 in)**

- Refer to SDS, EM-188, for grinding crankshaft and available service parts.







### Inspection (Cont'd)

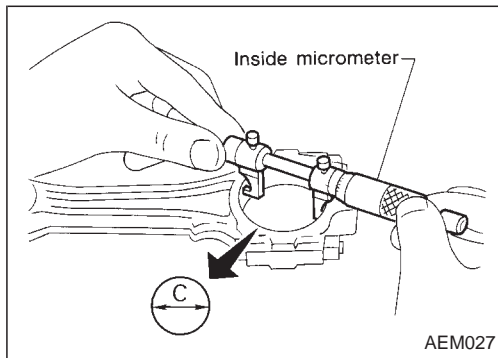
- If crankshaft is replaced, select thickness of main bearings as follows:
  - a. Grade number of each cylinder block main journal is punched on the respective cylinder block. These numbers are punched in either Arabic or Roman numerals.

- b. Grade number of each crankshaft main journal is punched on 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.

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

These numbers are punched in either Arabic or Roman numerals.

Main journal grade number	"0"	"1"	"2"
Main bearing grade number (Identification color):	0 (Green)	1 (Yellow)	2 (Blue)

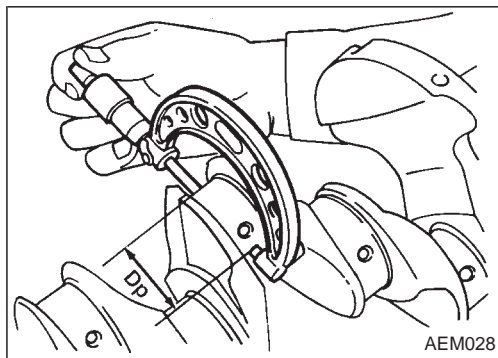


#### Connecting rod bearing (Big end)

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

**Tighten bolts to the specified torque. Refer to EM-88.**

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



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

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

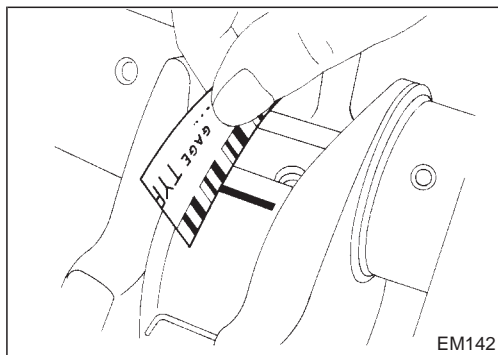
**Standard:**

$$0.024 - 0.056 \text{ mm (0.0009 - 0.0022 in)}$$

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

If it exceeds the limit, replace bearing.

- If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to step 5 of "BEARING CLEARANCE — Main bearing", EM-84.



#### Method B (Using plastigage)

##### CAUTION:

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



## CYLINDER BLOCK

## Inspection (Cont'd)

## FLYWHEEL RUNOUT

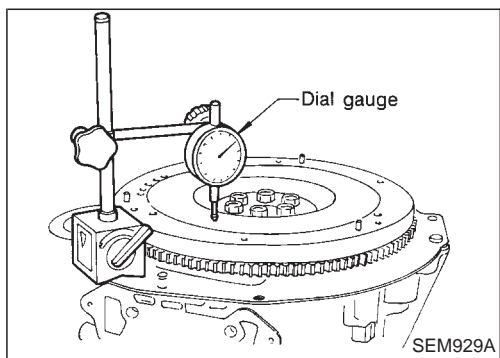
Runout (Total indicator reading):

Flywheel

Less than 0.15 mm (0.0059 in)

**CAUTION:**

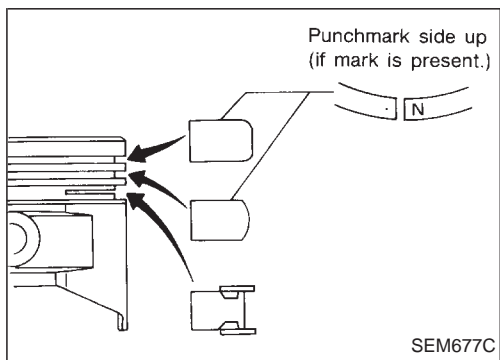
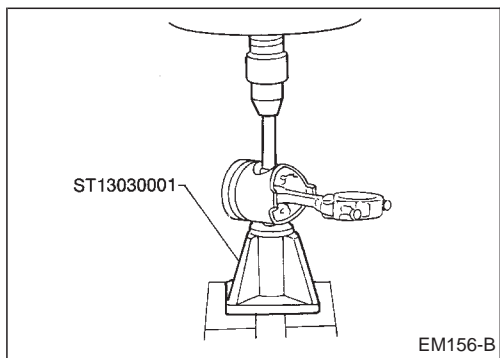
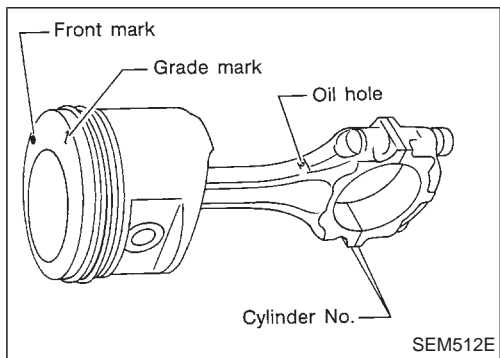
- Be careful not to damage the ring gear teeth.
- Check the drive plate for deformation or cracks.
- Do not resurface flywheel. Replace as necessary.



## Assembly

## PISTON

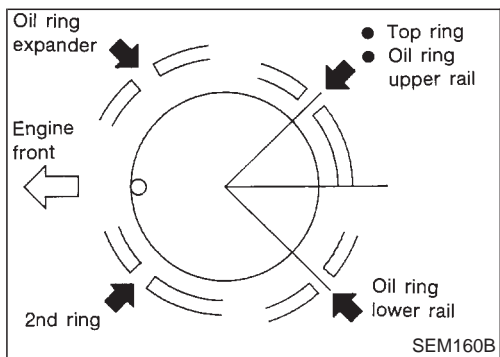
1. Assemble connecting rod and piston.
  - Align the direction of piston and connecting rod.
  - Numbers stamped on connecting rod and cap correspond to each cylinder.
  - After assembly, make sure connecting rod swings smoothly.



2. Set piston rings as shown.

**CAUTION:**

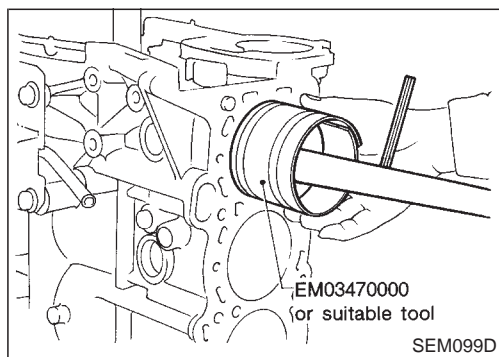
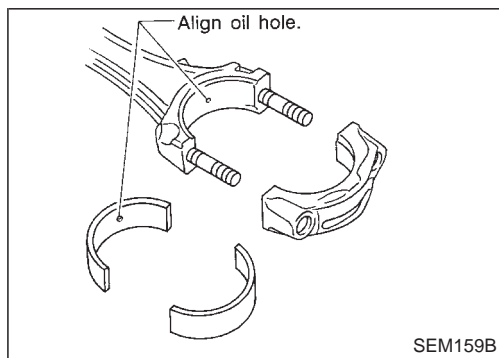
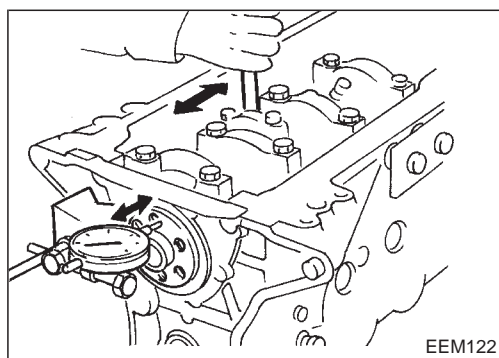
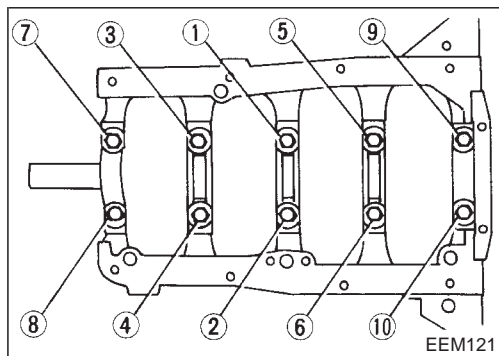
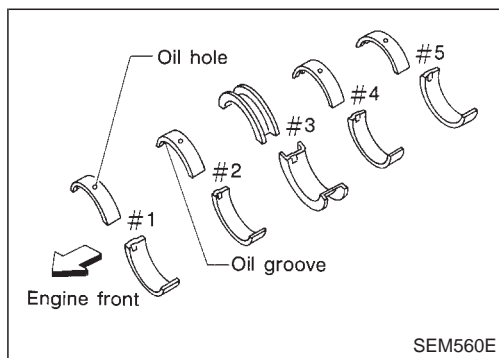
- When piston rings are not replaced, make sure that piston rings are mounted in their original positions.
- Install new piston rings either side up if there is no punch mark.



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

## Assembly (Cont'd)

## CRANKSHAFT



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

- Confirm that correct main bearings are selected by using Method A or Method B. Refer to EM-84.
- Apply new engine oil to bearing surfaces.

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

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

Tightening torque:

44 - 54 N·m (4.5 - 5.5 kg-m, 33 - 40 ft-lb)

3. Measure crankshaft end play.

Crankshaft end play: mm (in)

Standard

0.050 - 0.150 (0.0020 - 0.0059)

Limit

0.3 (0.012)

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

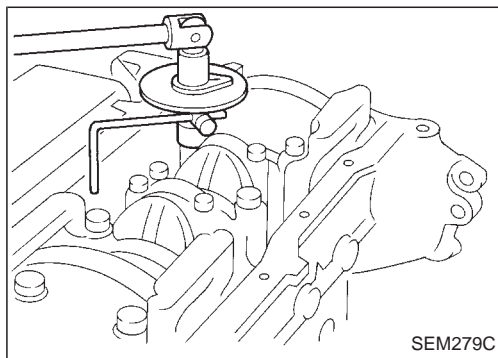
4. Install connecting rod bearings in connecting rods and connecting rod caps.

- Confirm that correct bearings are used. Refer to EM-85.
- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.
- Apply new engine oil to bolt threads and bearing surfaces.

5. Install pistons with connecting rods.

a. Install them into corresponding cylinders with Tool.

- Make sure connecting rod does not scratch cylinder wall.
- Make sure connecting rod bolts do not scratch crankshaft pin journals.
- Arrange so that front mark on piston head faces engine front.
- Apply new engine oil to piston rings and sliding surface of piston.

**Assembly (Cont'd)**

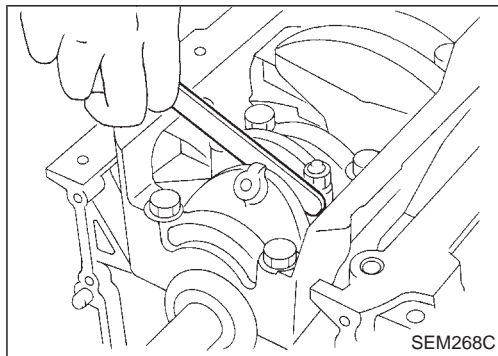
b. Install connecting rod caps.

- **Apply new engine oil to threads and seat surfaces.**

Tighten connecting rod bearing cap nuts to the specified torque.

**Connecting rod bearing nut:**

- (1) Tighten to 14 to 16 N·m  
(1.4 to 1.6 kg-m, 10 to 12 ft-lb).
- (2) Turn nuts 60 to 65 degrees clockwise.  
If an angle wrench is not available, tighten nuts to 48.5 to 53.4 N·m (4.95 to 5.45 kg-m, 35.8 to 39.4 ft-lb).



6. Measure connecting rod side clearance.

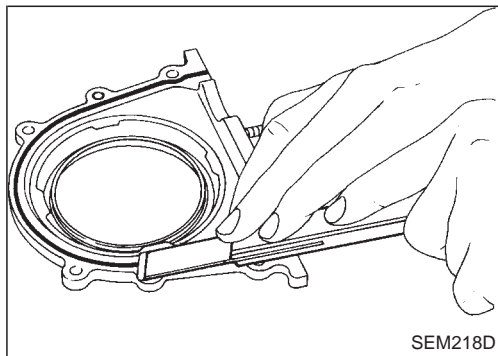
**Connecting rod side clearance: mm (in)****Standard**

**0.20 - 0.30 (0.0079 - 0.0118)**

**Limit**

**0.30 (0.0118)**

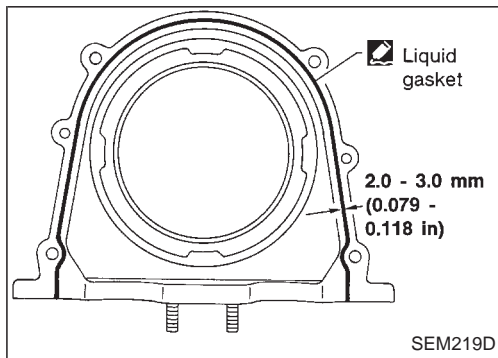
If beyond the limit, replace connecting rod and/or crankshaft.



7. Install rear oil seal retainer.

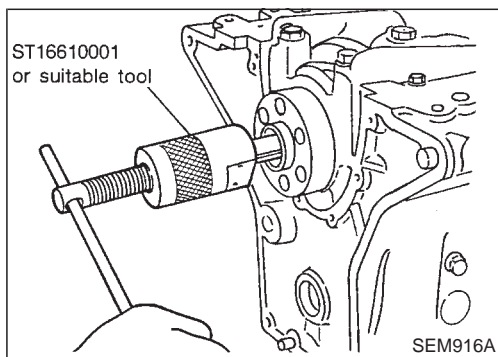
- (1) Before installing rear oil seal retainer, remove all traces of liquid gasket from mating surface using a scraper.

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



- (2) Apply a continuous bead of liquid gasket to mating surface of rear oil seal retainer.

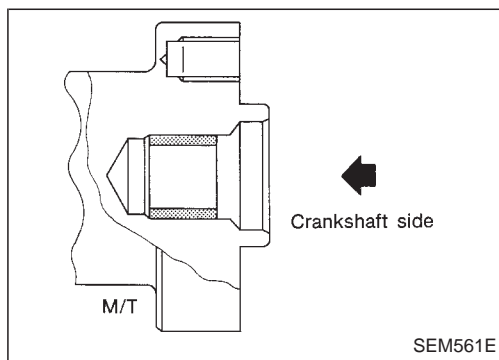
- Use Genuine Liquid Gasket or equivalent.
- Apply around inner side of bolt holes.
- Always replace oil seal with new ones. Refer to "REAR OIL SEAL", EM-66.

**REPLACING PILOT BUSHING**

1. Remove pilot bushing.

**Assembly (Cont'd)**

2. Install pilot bushing.



GI

MA

**EM**

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EC

FE

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FA

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BR

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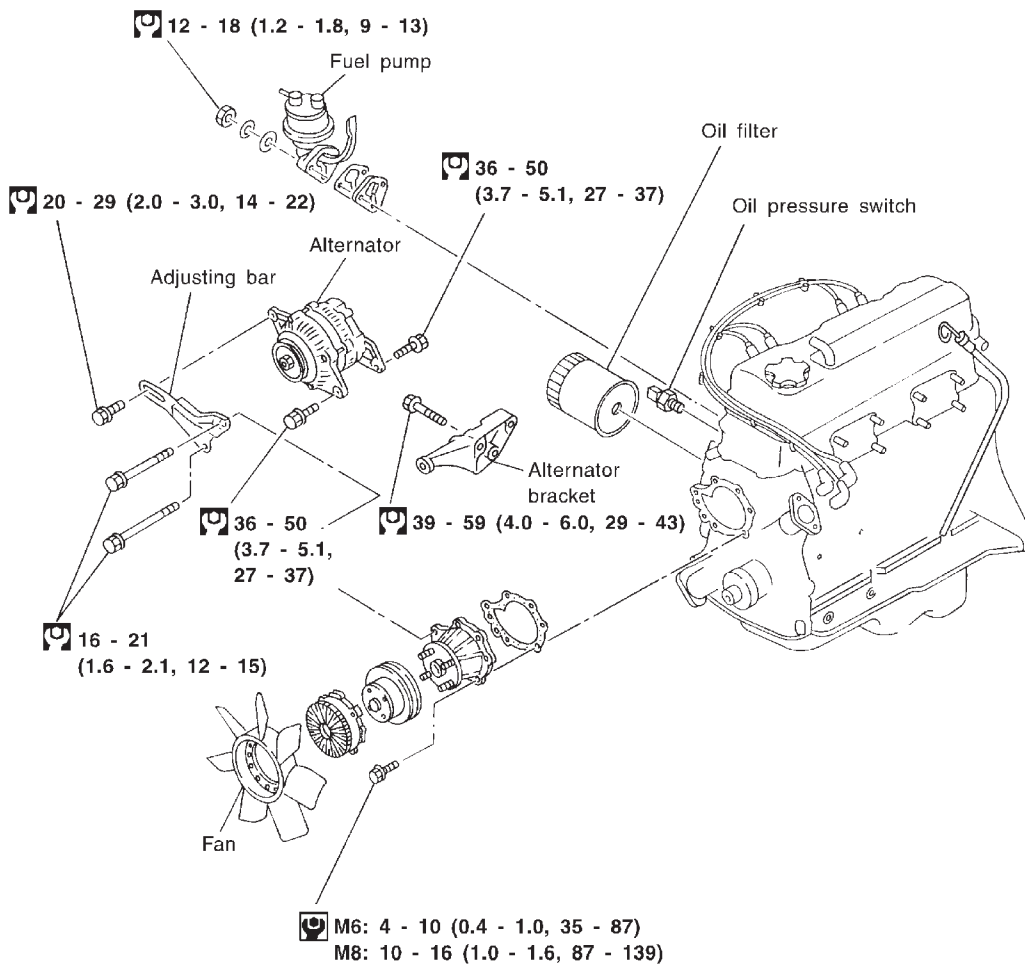
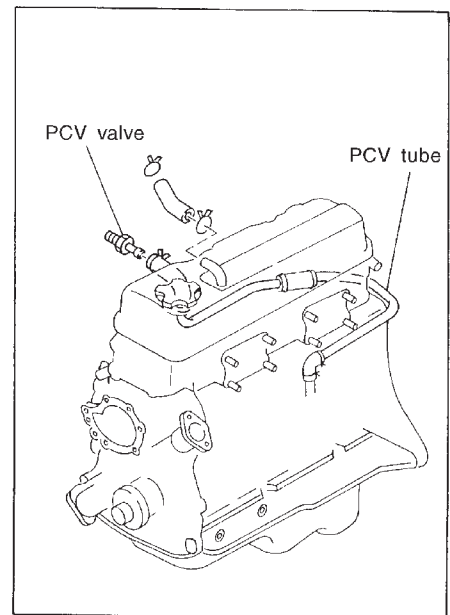
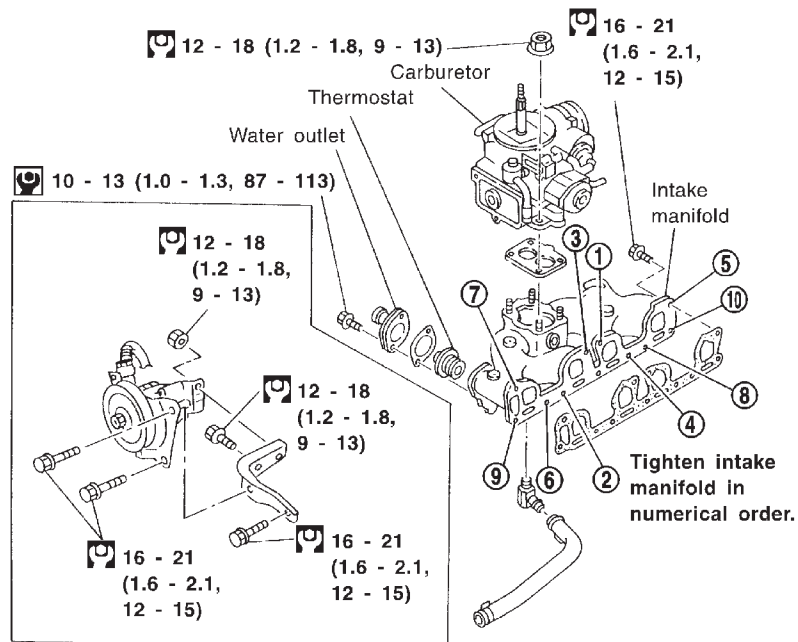
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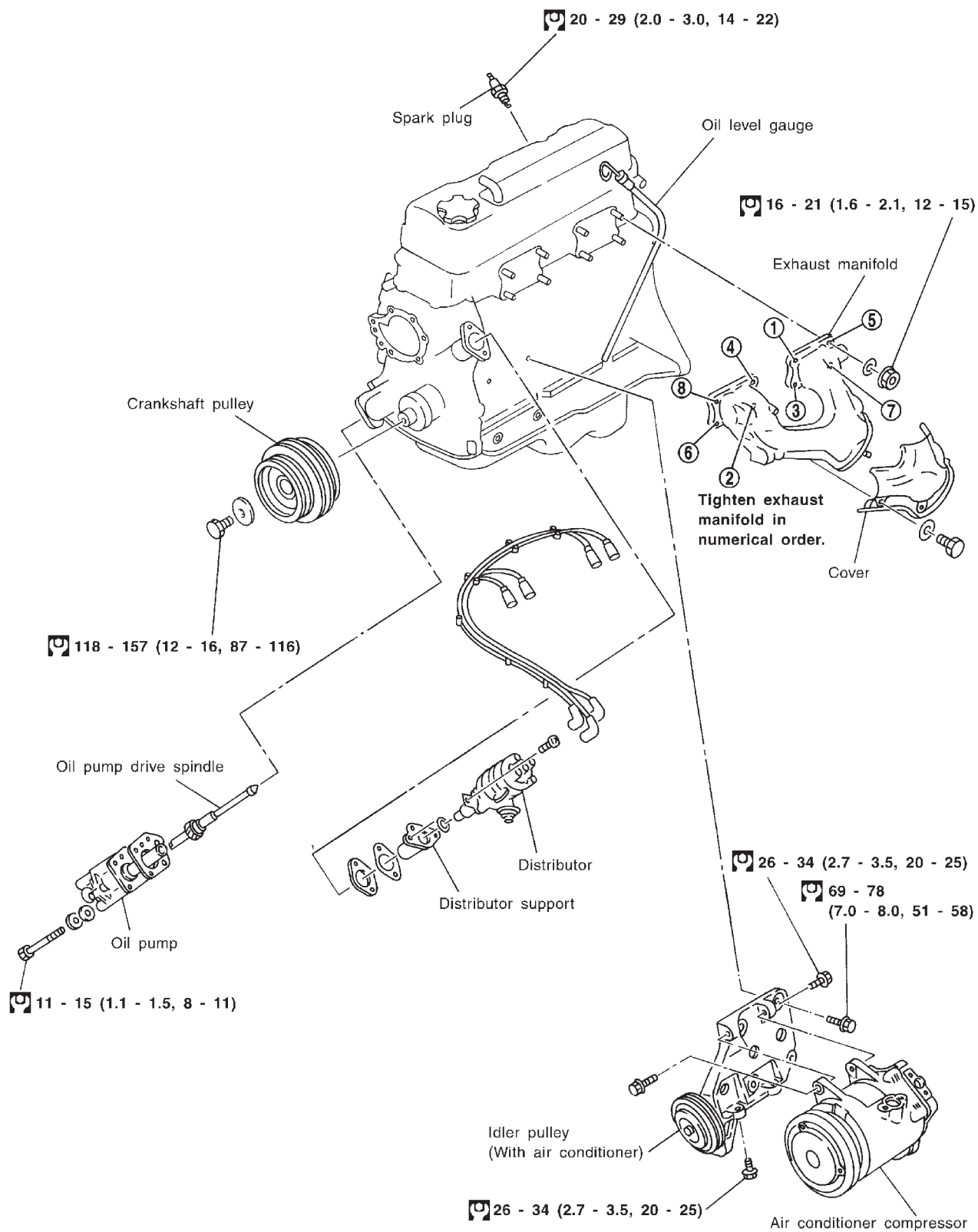
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IDX



: N•m (kg-m, in-lb)

: N•m (kg-m, ft-lb)



: N·m (kg-m, ft-lb)

GI

MA

EM

LC

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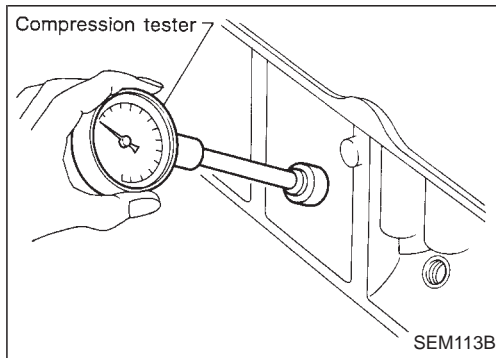
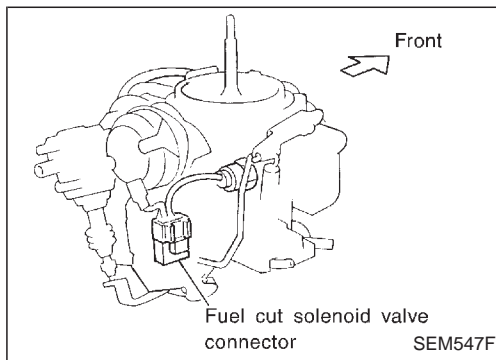
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## Measurement of Compression Pressure


1. Warm up engine.
2. Turn ignition switch off.
3. Disconnect fuel cut solenoid valve connector.
4. Remove all spark plugs.
5. Disconnect distributor center cable.
6. Attach a compression tester to No. 1 cylinder.
7. Depress accelerator pedal fully to keep throttle valve wide open.
8. Crank engine and record highest gauge indication.
9. Repeat the measurement on each cylinder as shown above.
- **Always use a fully-charged battery to obtain specified engine speed.**
  - Compression pressure: kPa (bar, kg/cm<sup>2</sup>, psi)/rpm**
  - Standard**
  - 1,196 (11.96, 12.2, 173)/350**
  - Minimum**
  - 902 (9.02, 9.2, 131)/350**
  - Difference limit between cylinders:**
  - 98 (0.98, 1.0, 14)/350**
10. If cylinder 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-190. 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.**












## Removal (Cont'd)

 : N·m (kg-m, in-lb)

 : N·m (kg-m, ft-lb)

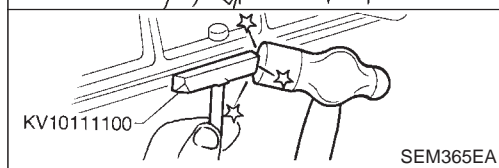
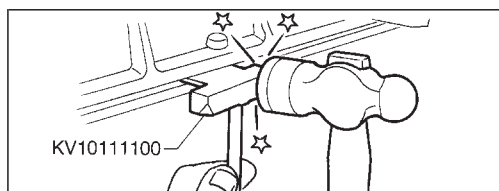
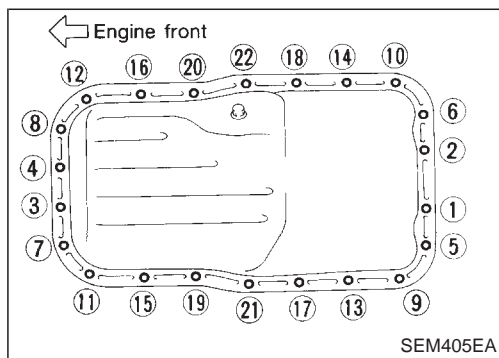
Removal order and points	2WD model	4WD model	Remarks
1 Remove undercover.	O	O	 3 - 4 (0.3 - 0.4, 26 - 35)
2 Drain engine oil.	O	O	 20 - 29 (2.0 - 3.0, 14 - 22)*
3 Remove front drive shaft fixing bolts (RH & LH).	—	—	 34 - 44 (3.5 - 4.5, 25 - 33)
4 Remove front differential carrier member bolt (RH & LH).	—	O	 54 - 64 (5.5 - 6.5, 40 - 47)
5 Disconnect front propeller shaft from front differential carrier.	—	O	 39 - 44 (4.0 - 4.5, 29 - 33)
6 Set a transmission jack under the front differential carrier.	—	O	—
7 Remove front suspension crossmember.	O	—	 54 - 64 (5.5 - 6.5, 40 - 47)
8 Remove front differential carrier with members.	—	O	—
9 Remove oil pan.	O	O	 7 - 10 (0.7 - 1.0, 61 - 87)

\* Refer to next page.

## Removal (Cont'd)

Remove oil pan.

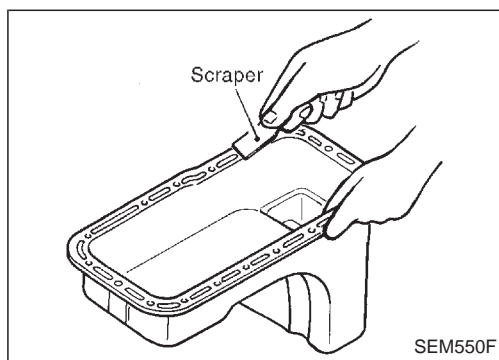
- Loosen in numerical order as shown.



- Insert seal cutter (Special Service Tool) between cylinder block and oil pan.

- **Do not insert screwdriver, or oil pan flange will be deformed.**

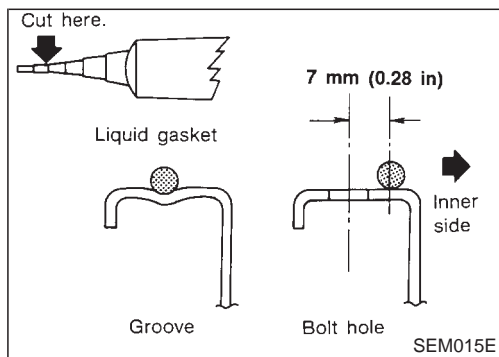
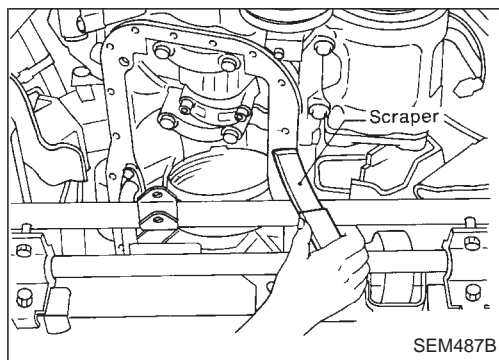
  - Slide seal cutter by tapping its side with a hammer.



## Installation

- Before installing oil pan, remove all traces of liquid gasket from mating surface by using a scraper.

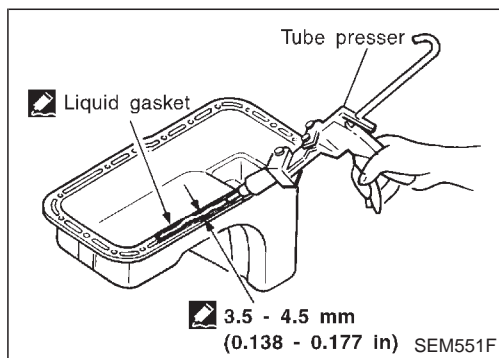
- **Also remove old liquid gasket from mating surfaces of cylinder block and front cover.**



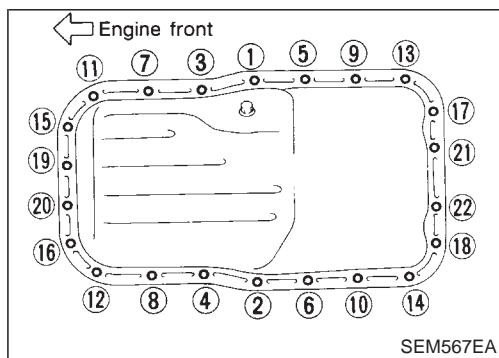
- Apply a continuous bead of liquid gasket to mating surface of oil pan.

- **Use Genuine Liquid Gasket or equivalent.**
- **Apply to groove on mating surface.**
- **Allow 7 mm (0.28 in) clearance around bolt hole.**

## Installation (Cont'd)

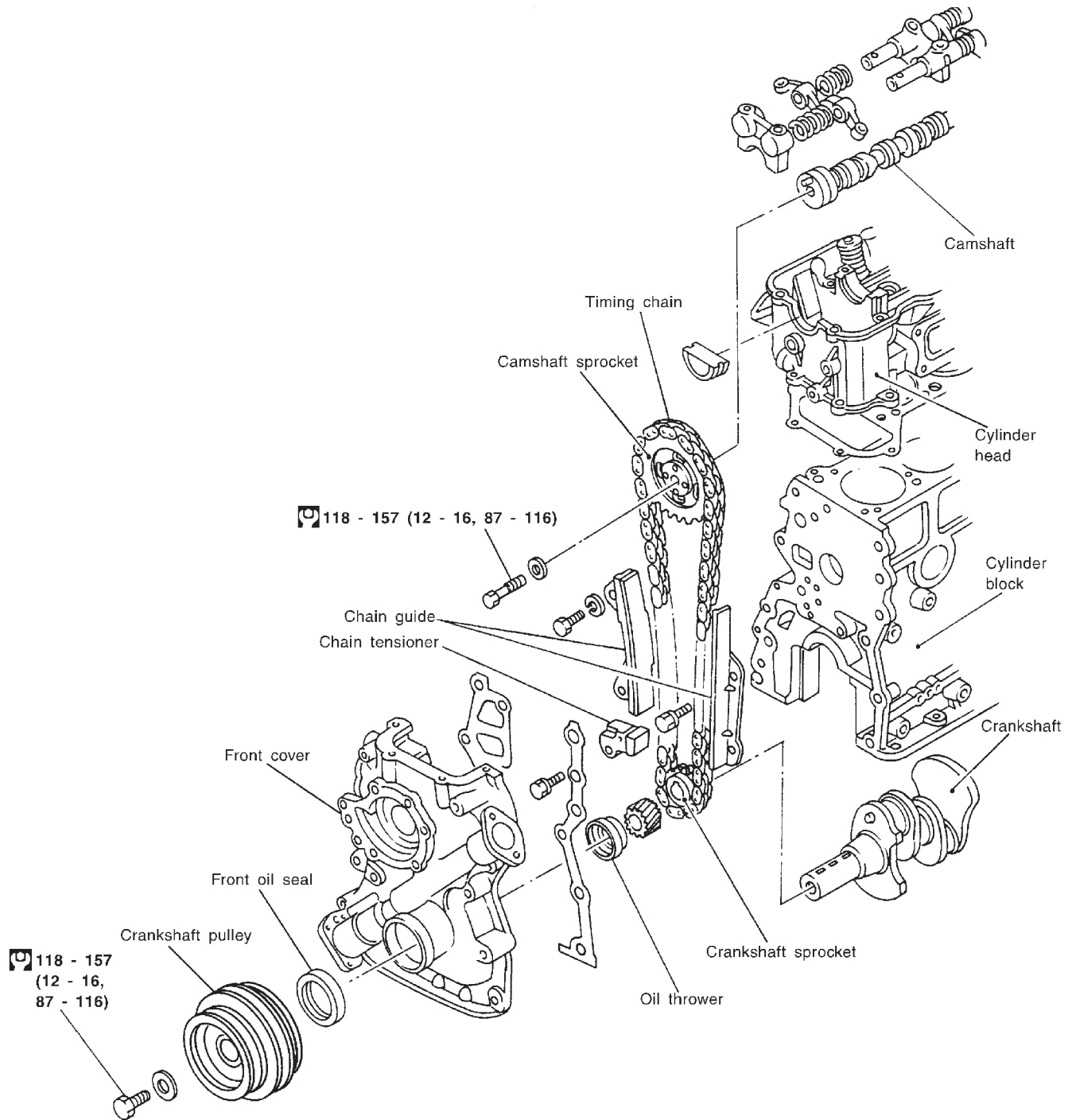


- Be sure liquid gasket diameter is 3.5 to 4.5 mm (0.138 to 0.177 in).
- Attaching should be done within 5 minutes after coating.



3. Install oil pan.
  - Tighten in numerical order as shown.

4. Install in reverse order of removal.



: N·m (kg-m, ft-lb)

GI

MA

EM

LC

EC

FE

CL

MT

TF

PD

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RS

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**CAUTION:**

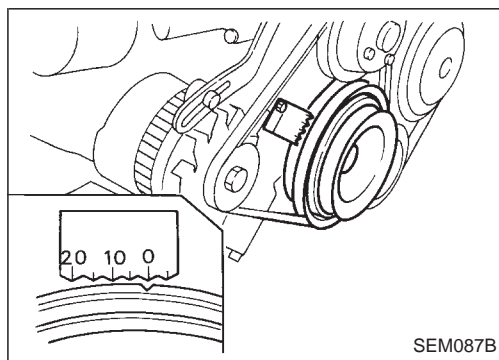
- Before installing timing chain, confirm that No. 1 cylinder is set at TDC on compression stroke.
- Align silver color on timing chain sprocket and crankshaft sprocket.
- After removing timing chain, do not rotate crankshaft and camshaft separately because valves will hit piston head.

**Removal**

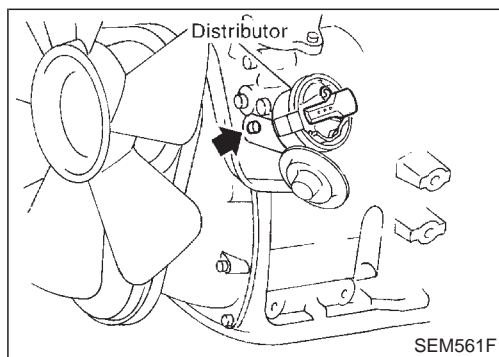
1. Remove engine undercover.
2. Drain engine oil.
3. Drain coolant from radiator.
- **Be careful not to spill coolant on drive belts.**
4. Remove radiator hose and heater hose.

**Refer to LC section.**

5. Remove radiator.
6. Remove cooling fan.
7. Remove the following parts:
  - Air cleaner and air intake duct
8. Remove the following belts. Refer to MA section ("Checking Drive Belt").
  - Power steering drive belt
  - Compressor drive belt
  - Alternator drive belt
9. Disconnect the following parts:
  - Vacuum hoses
  - Fuel hoses
  - Wires
  - Harness
  - Connectors
10. Remove all spark plugs.

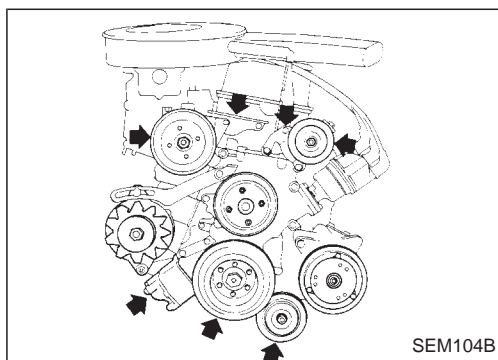


11. Set No. 1 cylinder at TDC on its compression stroke, as the distributor rotor points in the direction shown in the figure.



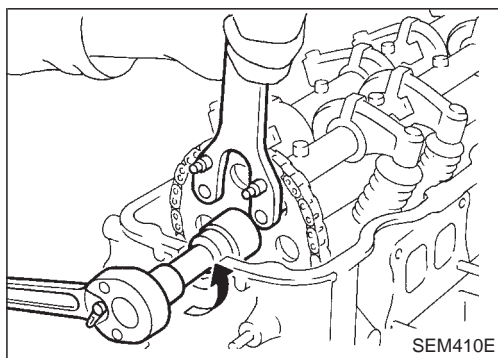
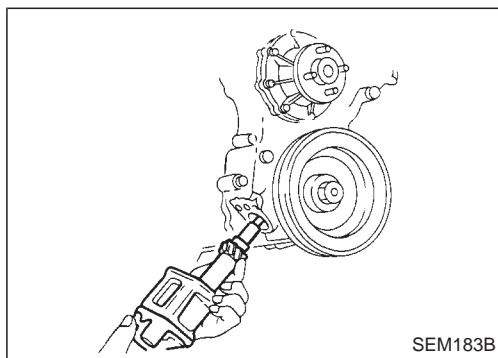
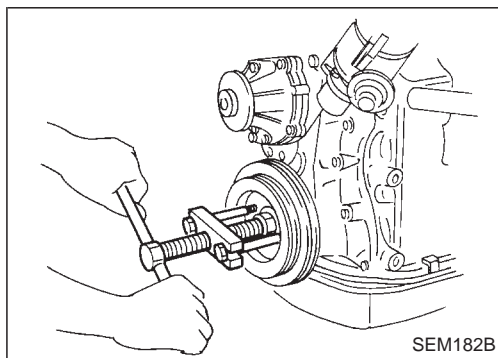
12. Remove distributor.

## Removal (Cont'd)



13. Remove the following parts:

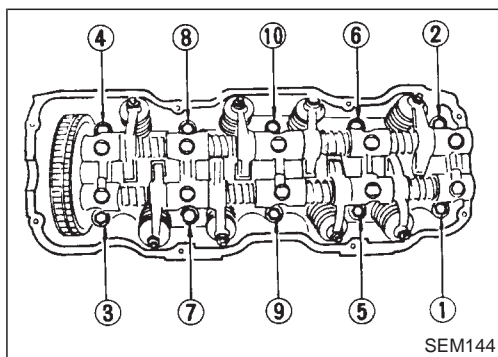
- Power steering pump, idler pulley and power steering brackets
- Compressor idler pulley
- Starter motor
- Crankshaft pulley
- Oil pump with pump drive spindle
- Rocker cover
- Exhaust front tube



14. Remove oil pan. Refer to "Removal", "OIL PAN", EM-93.

15. Remove camshaft sprockets.

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



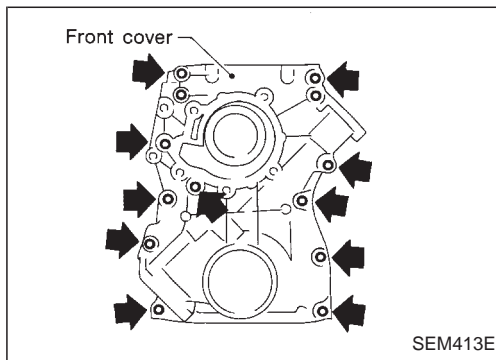
16. Remove cylinder head to front cover securing bolts.

17. Remove cylinder head bolts.

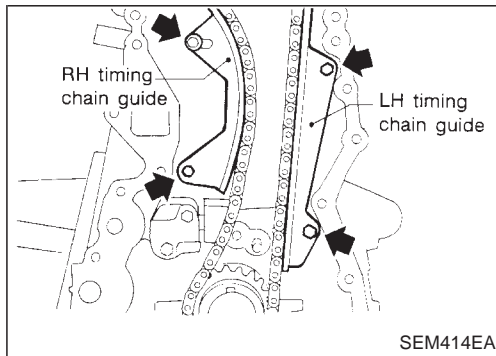
- **Loosen in numerical order as shown.**
- **Loosen cylinder head bolts in two or three steps.**
- **Removing bolts in incorrect order could result in a warped or cracked cylinder head.**

## Removal (Cont'd)

18. Remove front cover.

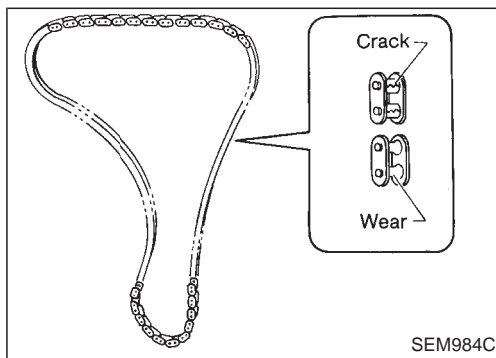


19. Remove timing chain guides and timing chain.



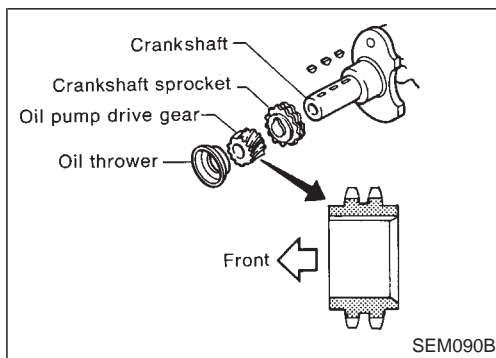
## Inspection

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

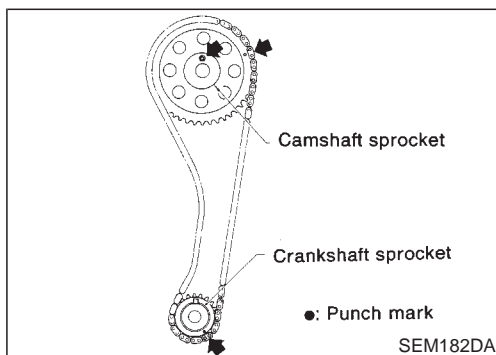


## Installation

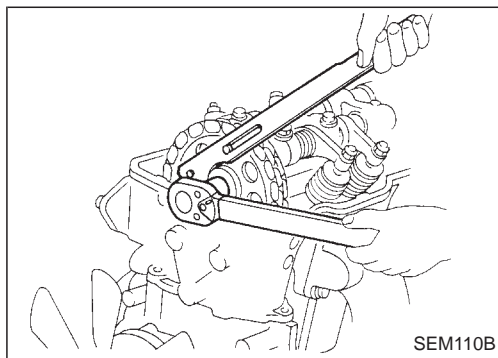
1. Install crankshaft sprocket, oil pump drive gear and oil thrower.
  - a. Make sure that the mating marks of crankshaft sprocket face the engine front.
  - b. Install oil pump drive gear so that large chamfered inner faces rearward.



2. Temporarily install cylinder head with new gasket.
3. Install camshaft sprocket and timing chain.
  - Set timing chain by aligning its mating marks with those of crankshaft sprocket and camshaft sprocket.



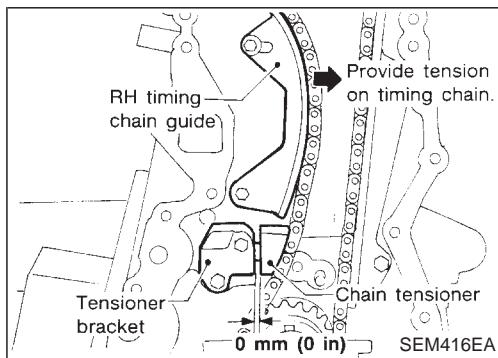
## Installation (Cont'd)



4. Tighten camshaft sprocket bolt.

**Camshaft sprocket bolt:**

: 118 - 157 N·m (12 - 16 kg-m, 87 - 116 ft-lb)

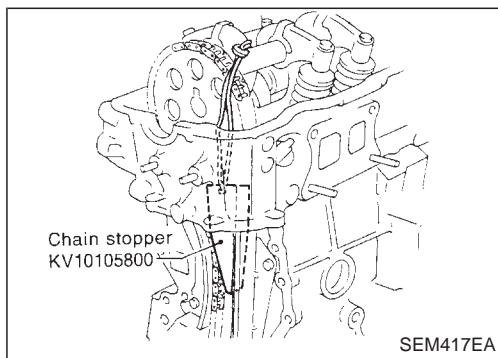


5. Install timing chain, timing chain guides and chain tensioner.

**Chain guide and chain tensioner bolt:**

: 6 - 10 N·m (0.6 - 1.0 kg-m, 52 - 87 in-lb)

- When installing RH timing chain guide, provide tension on timing chain by pulling it inside. Make sure gap between tensioner and tensioner bracket is 0 mm (0 in).



6. Remove camshaft sprocket, then loosen cylinder head bolts.

- Insert chain stopper before removing camshaft sprocket so that chain tensioner holds its position.

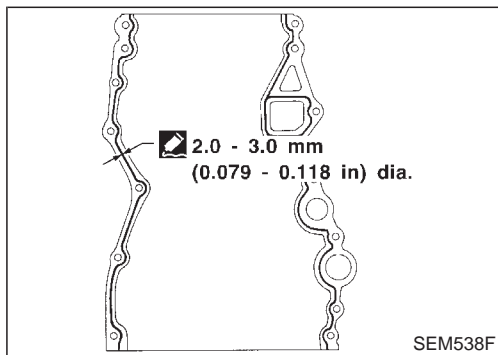
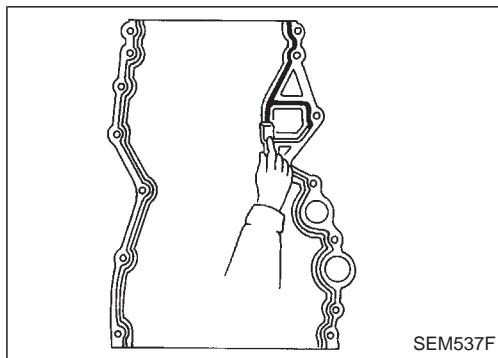
7. Use a scraper to remove old liquid gasket from mating surface of front cover.

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

8. Apply a continuous bead of liquid gasket to front cover.

- Use Genuine Liquid Gasket or equivalent.**

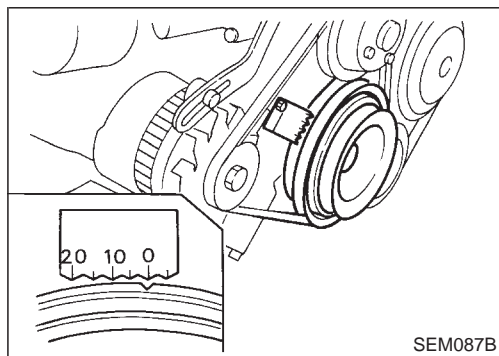
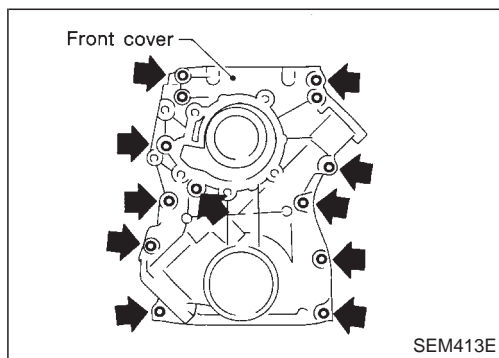
- Be sure to install new front oil seal in the right direction. Refer to EM-105.**





## Installation (Cont'd)

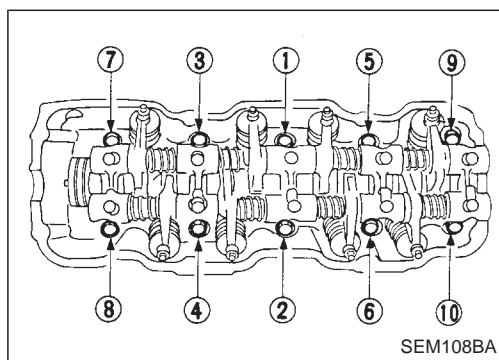
9. Install front cover.



10. Install crankshaft pulley.

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

12. Install starter motor.

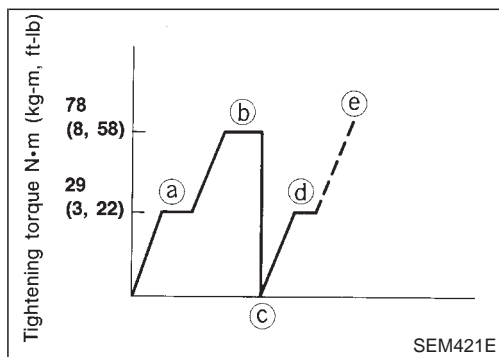
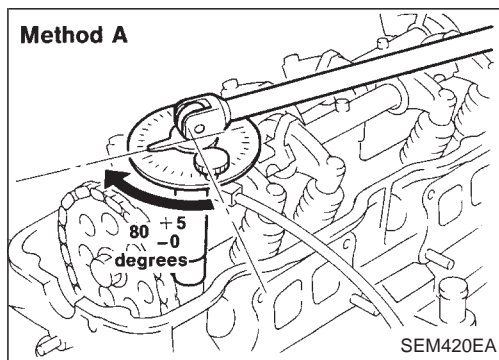


13. Install oil pan. Refer to EM-93.

14. Tighten cylinder head bolts.

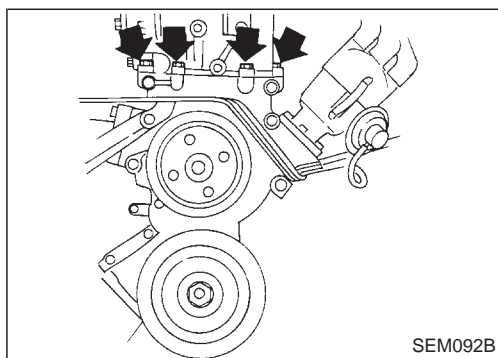
- Tighten in numerical order as shown.
- Apply engine oil to threads and seating surfaces of cylinder head bolts before installing them.
- Be sure to install washers between bolts and cylinder head.

- a Tighten all bolts to 29 N·m (3 kg-m, 22 ft-lb).
- b Tighten all bolts to 78 N·m (8 kg-m, 58 ft-lb).
- c Loosen all bolts completely.
- d Tighten all bolts to 25 to 34 N·m (2.5 to 3.5 kg-m, 18 to 25 ft-lb).
- e Method A: Turn all bolts 90 to 95 degrees clockwise with Tool or suitable angle wrench.  
Method B: If angle wrench is not available, tighten all bolts to 74 to 83 N·m (7.5 to 8.5 kg-m, 54 to 61 ft-lb).



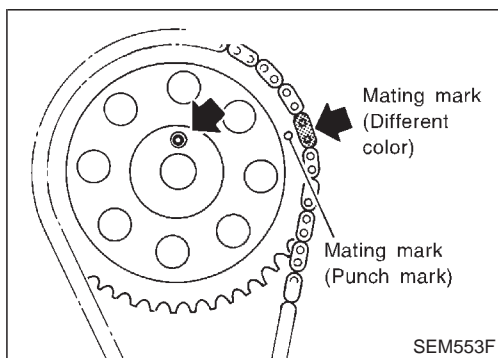
	Tightening torque N·m (kg-m, ft-lb)
a	29 (3, 22)
b	78 (8, 58)
c	0 (0, 0)
d	29±5 (3±0.5, 21.7±3.6)
e	90 <sup>+5</sup> <sub>-0</sub> degrees or 78±5 (8.0±0.5, 57.9±3.6)

## Installation (Cont'd)



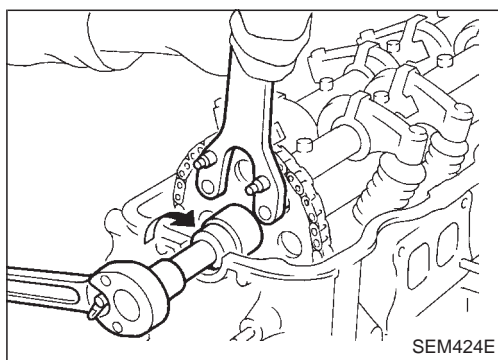
15. Install cylinder head to front cover securing bolts.

: 6 - 10 N·m (0.6 - 1.0 kg-m, 52 - 87 in-lb)



16. Install camshaft sprockets.

- Set timing chain by aligning mating mark with camshaft sprocket.

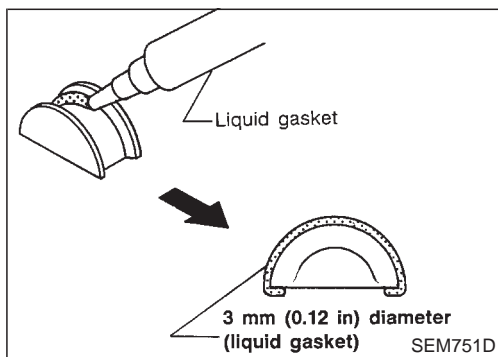


- Lock camshafts as shown in figure and tighten to specified torque.

: 137 - 157 N·m (14.0 - 16.0 kg-m, 101 - 116 ft-lb)

Apply new engine oil to threads and seating surfaces of camshaft sprocket bolts before installing them.

17. Install oil pump and distributor.  
Refer to LC section ("Oil Pump").



18. Install rubber plugs as follows:

a. Apply liquid gasket to rubber plugs.

- Rubber plugs should be replaced with rocker cover gasket.
- Rubber plugs should be installed within 5 minutes of applying liquid gasket.

GI

MA

EM

LC

EC

FE

CL

MT

TF

PD

FA

RA

BR

ST

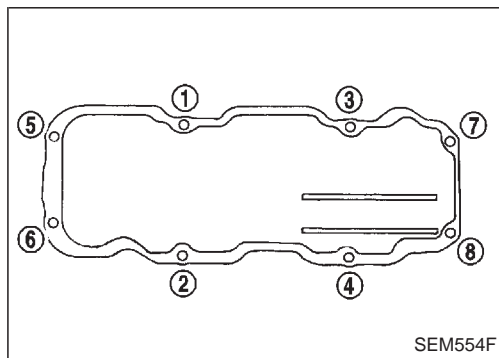
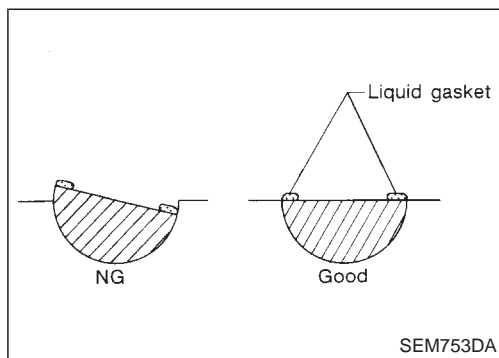
RS

BT

HA

EL

IDX



## Installation (Cont'd)

b. Install rubber plugs, then move them with your fingers to uniformly spread the gasket on cylinder head surface.

- **Rubber plugs should be installed flush with the surface.**
- **Do not start the engine for 30 minutes after installing rocker cover.**

19. Install rocker cover.

a. Tighten bolts to specified torque.

**Bolts should be tightened in the order shown in the figure.**

**Rocker cover bolts:**

: 6 - 10 N·m (0.6 - 1.0 kg-m, 52 - 87 in-lb)

b. Loosen bolts one full turn.

c. Retighten bolts to specified torque.

**Rocker cover bolts:**

: 6 - 10 N·m (0.6 - 1.0 kg-m, 52 - 87 in-lb)

**Do not start the engine for 30 minutes after installing rocker cover.**

20. Install the following parts:

- Spark plugs and ignition wire
- Power steering oil pump
- Compressor idler pulley
- Idler pulley bracket
- Water pump pulley and drive belts

For adjusting drive belt deflection, refer to MA section ("Checking Drive Belts", "ENGINE MAINTENANCE").

- Cooling fan
- Exhaust front tube
- Radiator

Refit hoses and refill with coolant.

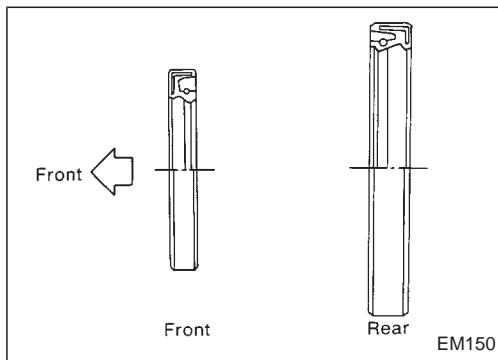
Refer to MA section ("REFILLING ENGINE COOLANT", "Changing Engine Coolant").

- Engine undercovers

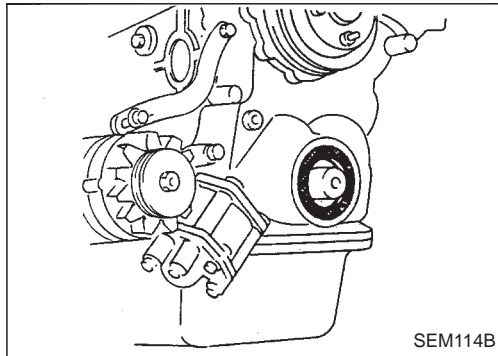
21. Install air cleaner and air intake duct.

22. Connect the following:

- Vacuum hoses
- Fuel hoses
- Wire harnesses and connectors

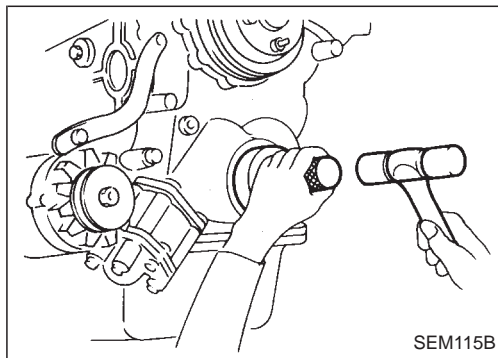


## OIL SEAL INSTALLING DIRECTION

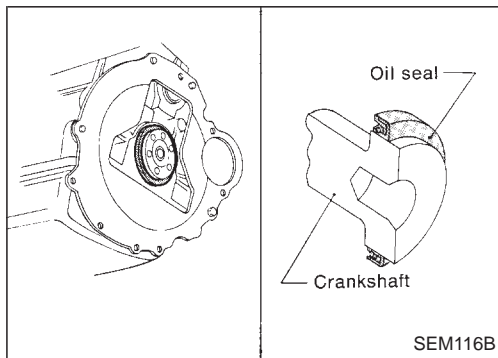


## FRONT OIL SEAL

1. Remove the following parts:
  - Cooling fan
  - Radiator shroud
  - Crankshaft pulley
2. Remove oil seal. Be careful not to damage surface of crankshaft.

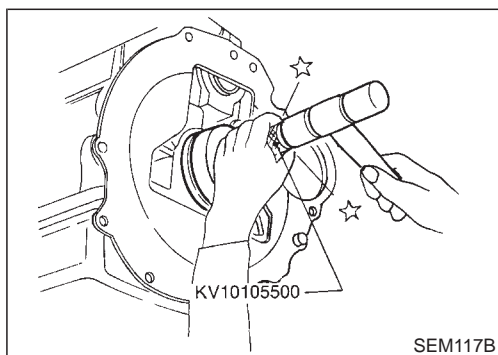


3. Apply engine oil to oil seal and install it in place using suitable tool.
4. Install the following parts:
  - Crankshaft pulley
  - Cooling fan
  - Radiator shroud



## REAR OIL SEAL

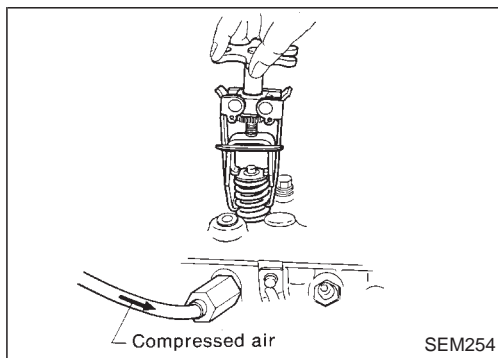
1. Remove transmission. Refer to MT section.
2. Remove flywheel. Remove oil seal using a suitable tool. Be careful not to damage surface of crankshaft.



3. Apply engine oil to oil seal and install it in place using suitable tool.
4. Install transmission. Refer to MT section.

## VALVE OIL SEAL

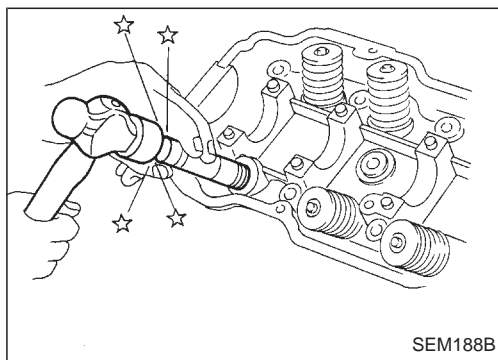
1. Remove rocker cover.
2. Remove rocker arm and rocker shaft assembly.
3. Remove all spark plugs.



4. Install air hose adapter into spark plug hole and apply air pressure to hold valves in place [Apply pressure of 490 kPa (4.9 bar, 5 kg/cm<sup>2</sup>, 71 psi)].

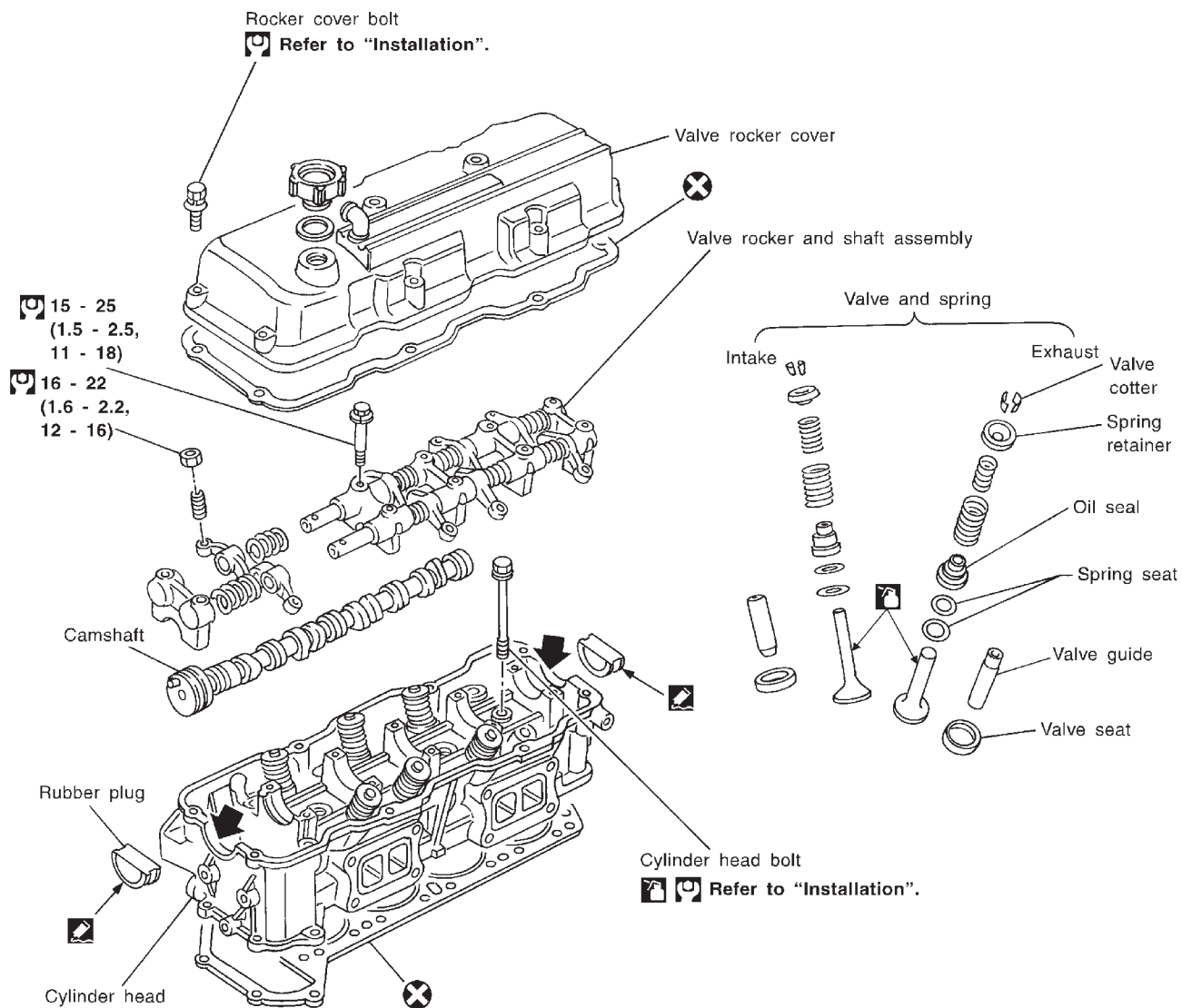
**When performing this operation piston should be set at TDC.**

5. Remove valve spring and valve oil seal.



6. Apply engine oil to valve oil seal and install it in place.  
**Before installing valve oil seal, install inner valve spring seat.**

7. Install parts in the reverse order of removal.



: N•m (kg-m, ft-lb)

: Apply liquid gasket.

: Lubricate with engine oil.

**CAUTION:**

- When installing rocker arms, camshaft and oil seal, lubricate contacting surfaces with new engine oil.
- When tightening cylinder head bolts, camshaft sprocket bolts and camshaft bracket bolts, lubricate bolt threads and seat surfaces with new engine oil.
- When installing sliding parts such as bearings, be sure to apply engine oil on the sliding surfaces.
- Use new gasket and oil seals.
- Be careful not to damage oil seal.

**Removal**

- Before removing camshaft and idler sprockets, apply paint marks to them for retiming.

1. Drain coolant from radiator.

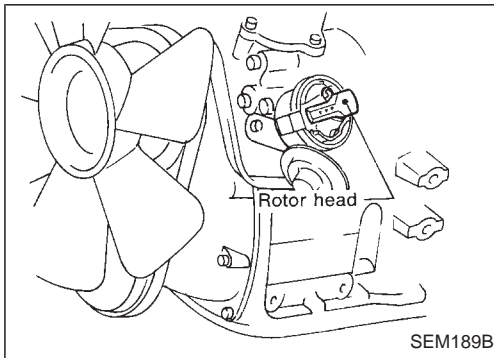
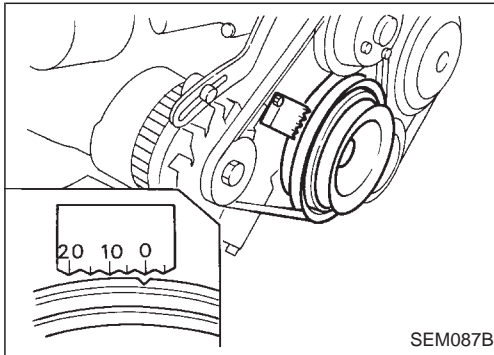
**Be careful not to spill coolant on drive belts.**

2. Remove the following parts:

- Power steering pump drive belt
  - Power steering pump, idler pulley and power steering brackets
3. Disconnect front exhaust tube from exhaust manifold.

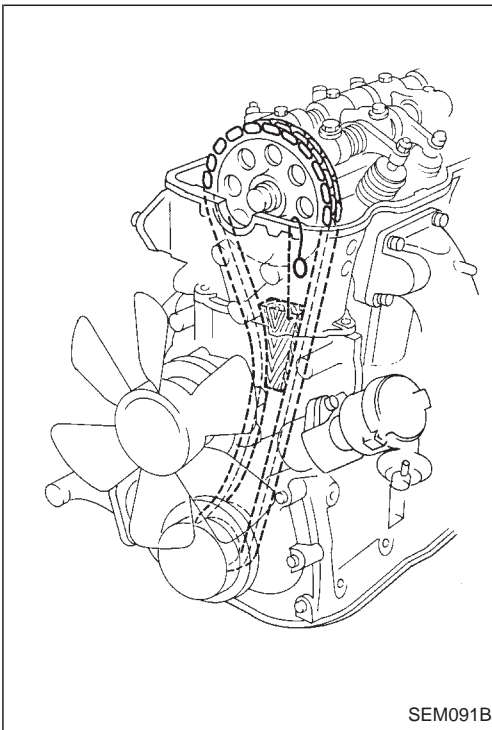
4. Remove rocker cover.

5. Set No. 1 cylinder at TDC on its compression stroke as the distributor rotor points in the direction shown in the figure.

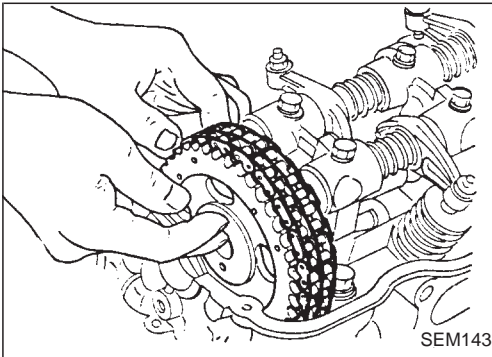


## Removal (Cont'd)

6. Loosen camshaft sprocket bolt.
7. Support timing chain by using Tool between timing chain.

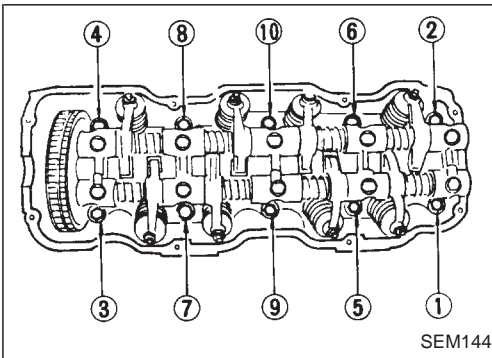


SEM091B



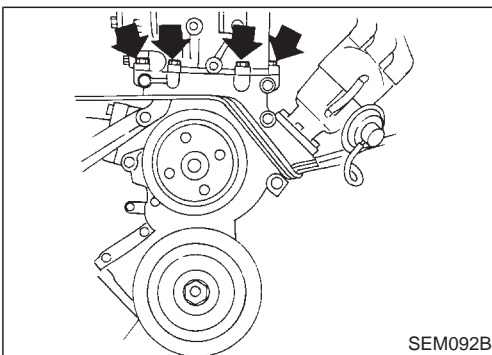
SEM143

8. Remove camshaft sprocket.



SEM144

9. Loosen cylinder head bolts in the sequence shown.  
**Head warpage or cracking could result from removing them in incorrect order.**

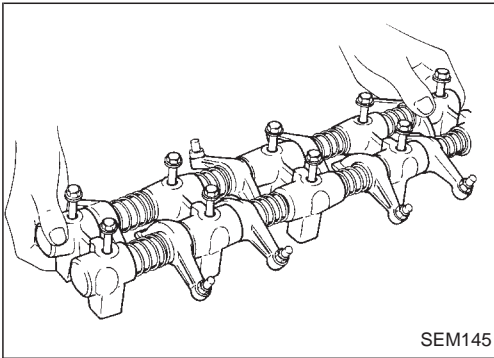


SEM092B

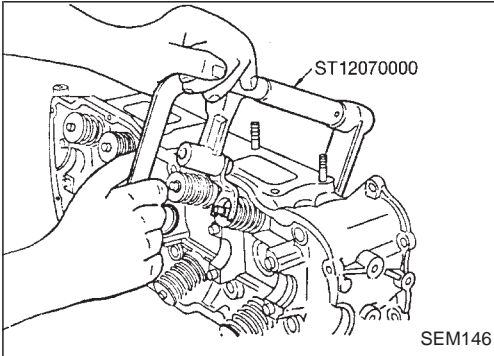
10. Remove cylinder head to front cover securing bolts.  
⚙ : 6 - 10 N·m (0.6 - 1.0 kg-m, 52 - 87 in-lb)
11. Remove cylinder head with intake and exhaust manifolds.

GI  
MA  
EM  
LC  
EC  
FE  
CL  
MT  
TF  
PD  
FA  
RA  
BR  
ST  
RS  
BT  
HA  
EL  
IDX

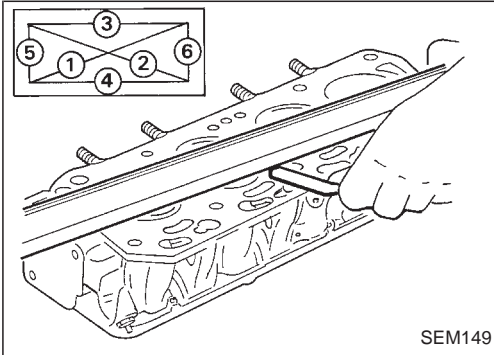




SEM145



SEM146



SEM149

## Disassembly

1. Remove intake manifold with carburetor and exhaust manifold.
2. Remove rocker shaft assembly together with securing bolts.
  - a. **Do not remove bolts at No. 1 and No. 5 brackets since rocker shaft bracket and rocker will spring out.**
  - b. **When loosening bolts, evenly loosen from outside in sequence.**

3. Remove camshaft.
4. Remove valves, valve springs and relating parts using Tool. **Keep the disassembled parts in order.**

## Inspection

### CYLINDER HEAD DISTORTION

Cylinder head distortion:

**Less than 0.1 mm (0.004 in)**

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

**Resurfacing limit:**

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

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

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

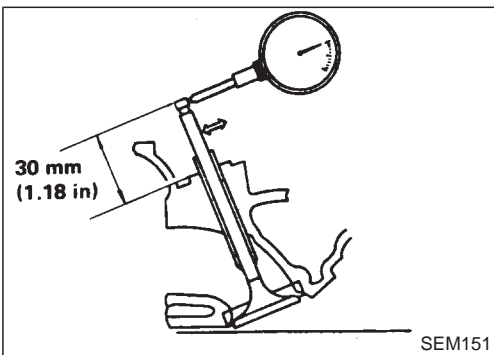
**The maximum limit is as follows:**

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

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

**Cylinder head height (Nominal):**

**98.9±0.1 mm (3.894±0.004 in)**



SEM151

### VALVE GUIDE CLEARANCE

- Valve guide clearance should be measured parallel with rocker arm. (Generally, a large amount of wear occurs in this direction.)

**Stem to guide clearance: mm (in)**

**Maximum limit**

**0.10 (0.0039)**

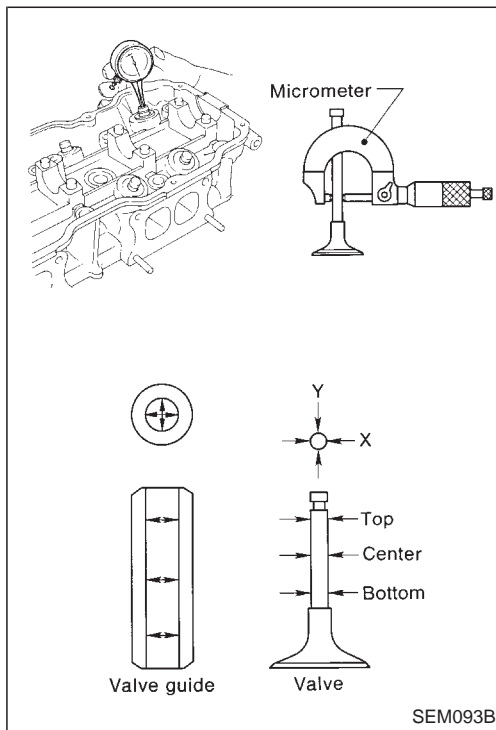
**Maximum allowable deflection**

**(Dial indicator reading)**

**0.2 (0.008)**

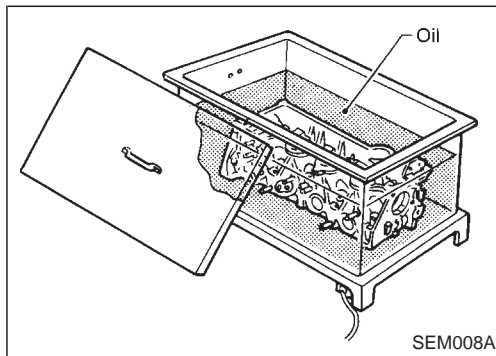
## Inspection (Cont'd)

- To determine the correct replacement part, measure valve stem diameter and valve guide bore.
- For dimensions, refer to SDS, EM-190, 192.

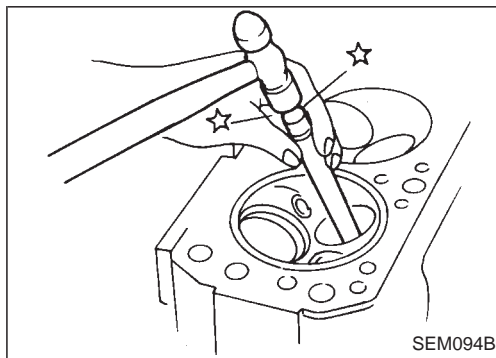


## VALVE GUIDE REPLACEMENT

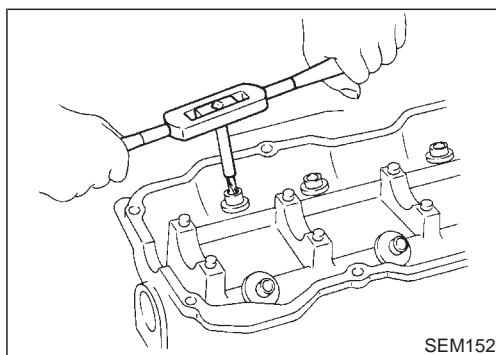
- To remove valve guide heat cylinder head to 150 to 160°C (302 to 320°F).

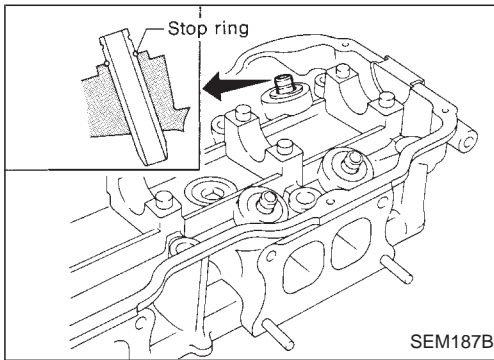


- Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer, and suitable tool.

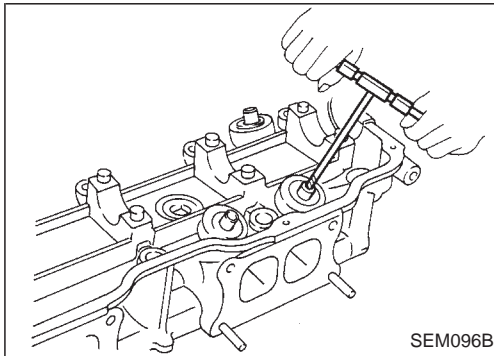


- Ream cylinder head valve guide hole.  
**Valve guide hole inner diameter**  
**(For service parts):**  
**12.175 - 12.196 mm (0.4793 - 0.4802 in)**



**Inspection (Cont'd)**

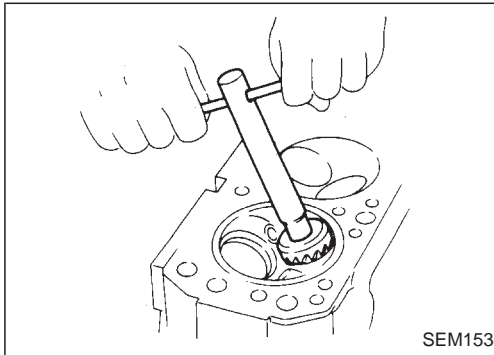
4. Heat cylinder head to 150 to 160°C (302 to 320°F) and press service valve guide onto cylinder head.



5. Ream valve guide.

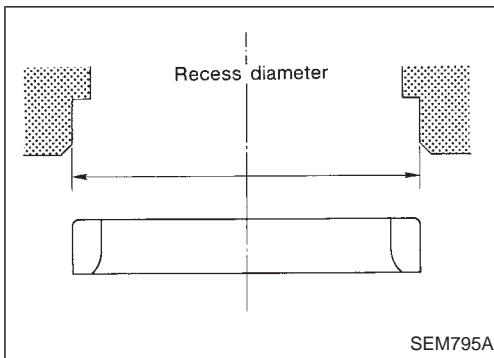
**Finished size:**

**8.000 - 8.018 mm (0.3150 - 0.3157 in)**

**VALVE SEATS**

Check valve for any evidence of pitting at valve contact surface, and reseal or replace if worn out excessively.

- **When repairing valve seats, check valve and valve guide for wear beforehand. If worn, replace them. Then correct valve seat.**
- **The cutting should be done with both hands for uniform cutting.**

**REPLACING VALVE SEAT FOR SERVICE PARTS**

1. Bore out old seat until it collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the seat recess in cylinder head.
2. Ream cylinder head recess.

**Reaming bore for service valve seat**

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

**Intake**

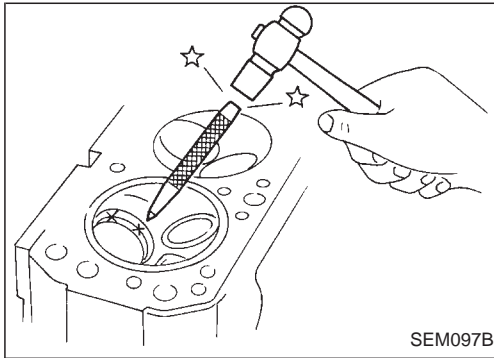
**45.500 - 45.516 (1.7913 - 1.7920)**

**Exhaust**

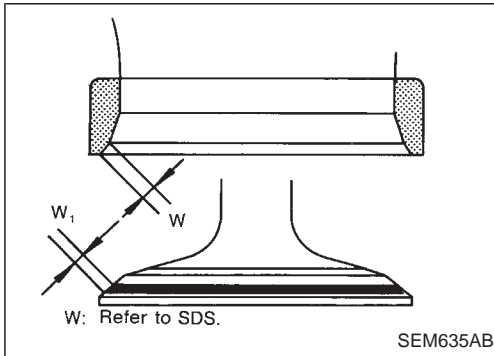
**40.500 - 40.516 (1.5945 - 1.5951)**

Reaming should be done to the concentric circles to valve guide center so that valve seat will have the correct fit.

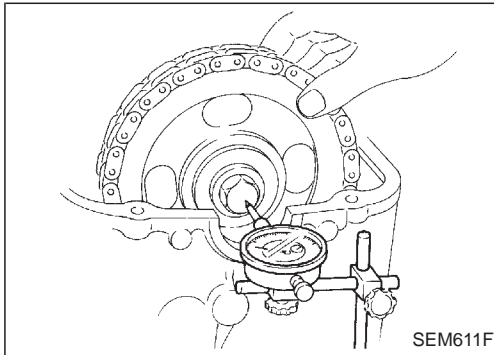
## Inspection (Cont'd)



3. Heat cylinder head to a temperature of 150 to 160°C (302 to 320°F).
4. Press fit insert until it seats on the bottom, and caulk more than 4 points.



5. Cut or grind valve seat using suitable tool at the specified dimensions as shown in SDS, EM-191.
6. After cutting, lap valve seat with a lapping compound.
7. Check contact condition of valve seat.



## CAMSHAFT VISUAL CHECK

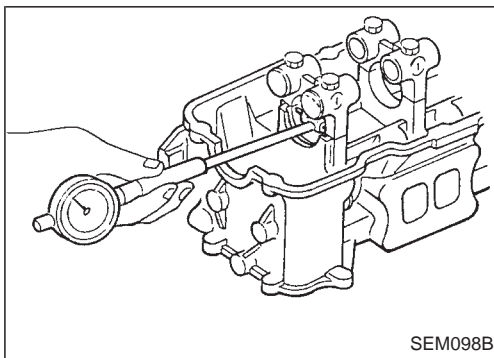
Check camshaft for scratches, seizure and wear.

## CAMSHAFT END PLAY

1. Install camshaft and locate plate in cylinder head.
2. Measure camshaft end play.

**Camshaft end play:**

**Limit 0.2 mm (0.008 in)**

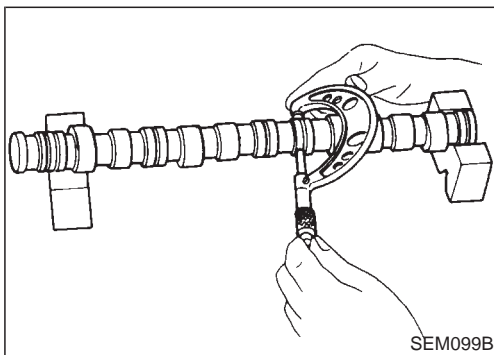


## CAMSHAFT JOURNAL CLEARANCE

1. Measure the inside diameter of camshaft bearing.

**Standard inner diameter:**

**33.000 - 33.025 mm (1.2992 - 1.3002 in)**



2. Measure the outside diameter of camshaft journal.

**Standard outer diameter:**

**32.920 - 32.940 mm (1.2961 - 1.2968 in)**

If the clearance is greater than the maximum, replace camshaft and/or cylinder head.

**Maximum clearance:**

**0.12 mm (0.0047 in)**

## CYLINDER HEAD

### Inspection (Cont'd)

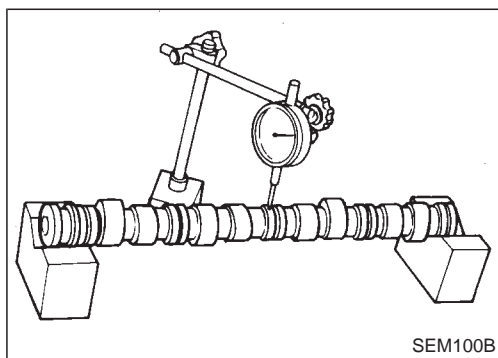
#### CAMSHAFT RUNOUT

Runout [TIR (Total Indicator Reading)]:

Limit 0.02 mm (0.0008 in)

at the center journal

If beyond the limit, replace.



SEM100B

#### CAMSHAFT CAM HEIGHT

Standard cam height: mm (in)

Intake

38.477 - 38.527 (1.5148 - 1.5168)

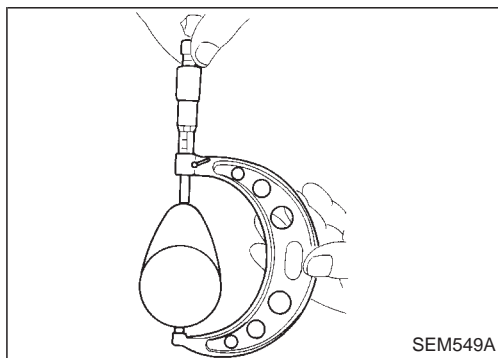
Exhaust

38.481 - 38.531 (1.5150 - 1.5170)

Cam wear:

Limit 0.25 mm (0.0098 in)

If wear is beyond the limit, replace.



SEM549A

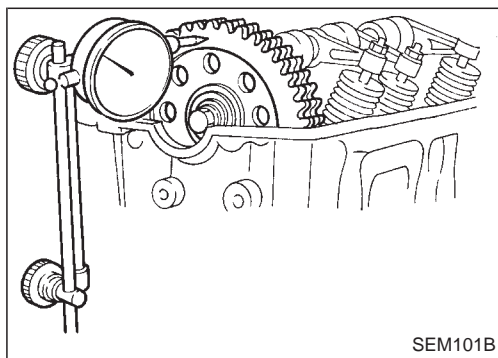
#### CAMSHAFT SPROCKET RUNOUT

Install sprocket on camshaft and check for runout.

If runout exceeds the specified limit, replace camshaft sprocket.

Runout (Total indicator reading):

Limit 0.1 mm (0.004 in)



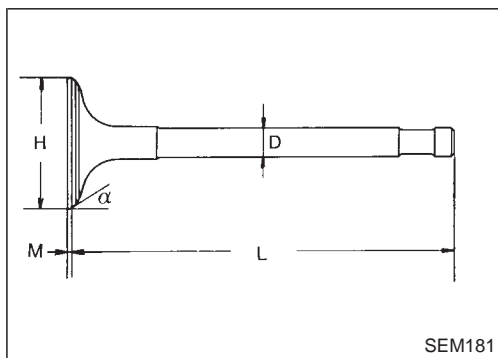
SEM101B

#### VALVE DIMENSIONS

Check dimensions in each valve. For dimensions, refer to SDS.

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

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



SEM181

#### VALVE SPRING SQUARENESS

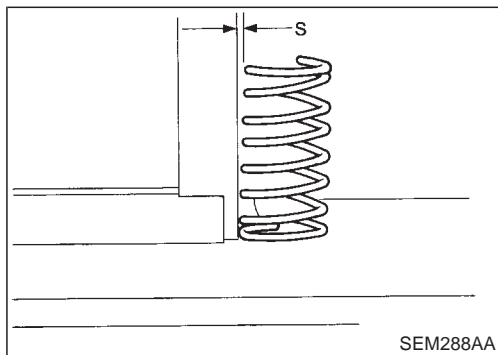
Out-of-square: mm (in)

Outer

Less than 2.2 (0.087)

Inner

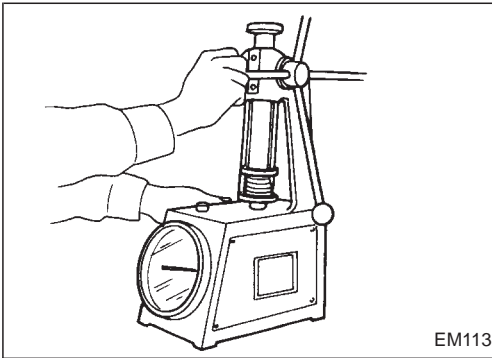
Less than 1.9 (0.075)



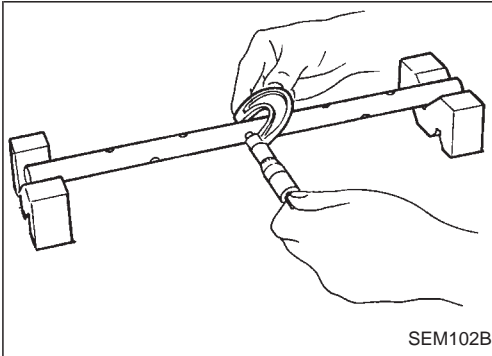
SEM288AA

**Inspection (Cont'd)****VALVE SPRING PRESSURE LOAD**

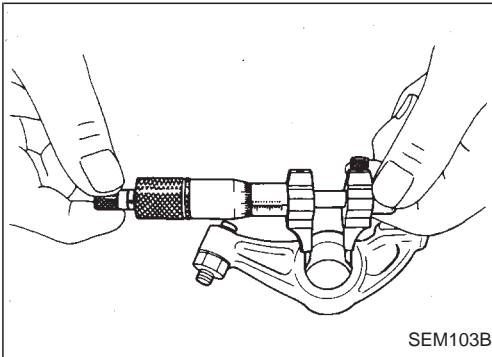
Refer to SDS, EM-191.



EM113



SEM102B



SEM103B

**ROCKER SHAFT AND ROCKER ARM**

1. Check rocker shafts and rocker arms for scratches, seizure and wear.

2. Check outer diameter of rocker shaft.

**Diameter:**

**19.979 - 20.000 mm (0.7866 - 0.7874 in)**

3. Check inner diameter of rocker arm.

**Diameter:**

**20.007 - 20.028 mm (0.7877 - 0.7885 in)**

**Rocker arm to shaft clearance:**

**0.007 - 0.049 mm (0.0003 - 0.0019 in)**

**Assembly**

- Discard old oil seal and install new one.
- Apply a coat of engine oil to sealing lips of oil seal and frictional surfaces of moving parts.

GI

MA

EM

LC

EC

FE

CL

MT

TF

PD

FA

RA

BR

ST

RS

BT

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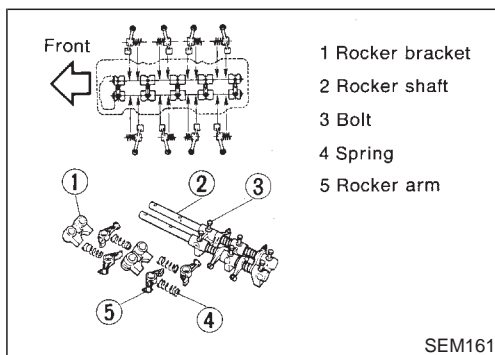
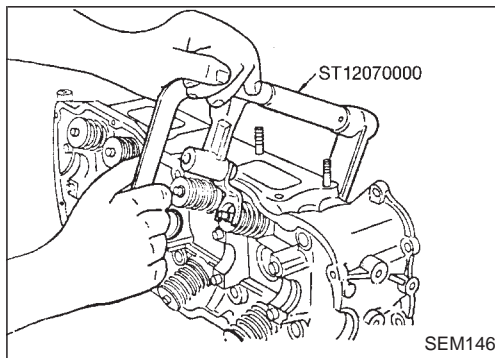
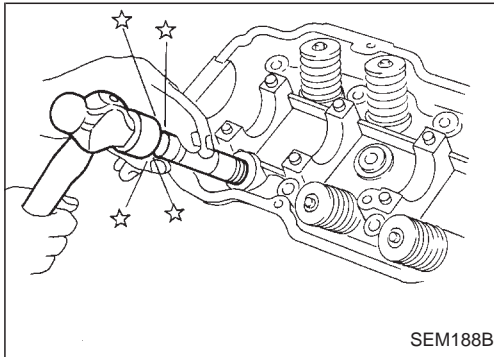
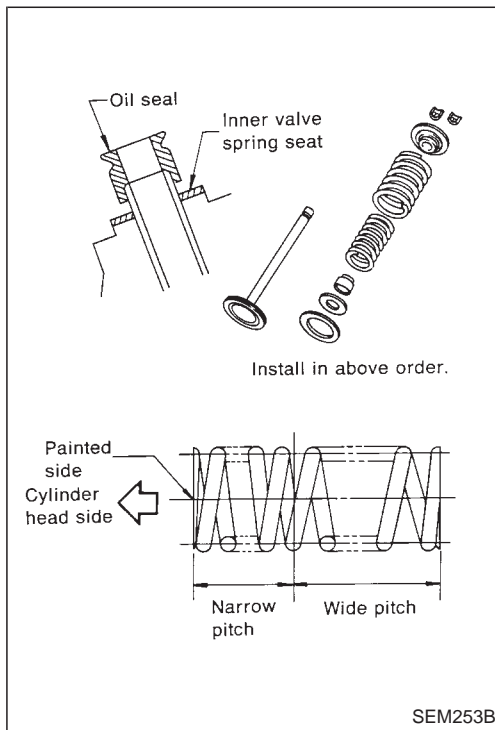
EL

IDX

## Assembly (Cont'd)

1. Install valve component parts.

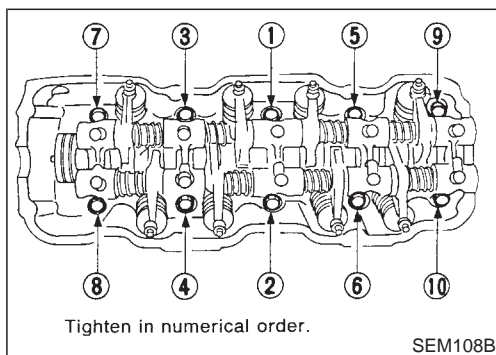
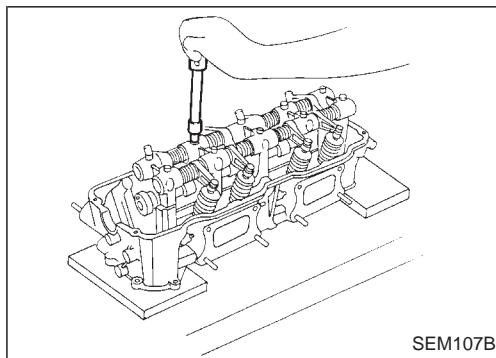
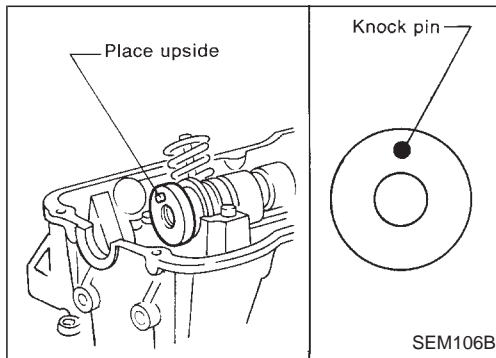
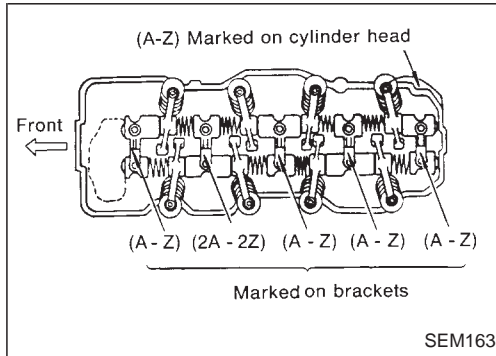
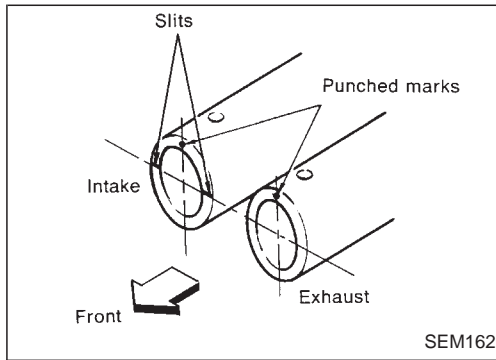
- Before installing valve oil seal, install inner valve spring seat.
- Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.



2. Install rocker shaft bracket, valve rocker, and spring on valve rocker shaft, observing the following.



## Assembly (Cont'd)



- (1) Intake rocker shaft has identification mark (slit on front surface), but exhaust rocker shaft does not.
- (2) Both rocker shafts should be assembled so that punched marks on front surfaces come to upside. Marks are used to identify oil hole direction.

- (3) Valve rocker is the same as for intake and exhaust and also No. 1 and No. 3 cylinder, and provides identification mark "1". Similarly, the one for No. 2 and No. 4 cylinder provides mark "2".
- (4) Be careful not to miss original location of rocker shaft brackets. For this purpose, the same alphabetical identification marks are provided on each bracket and cylinder head.

**To prevent rocker shaft brackets from slipping out of rocker shafts, insert bracket bolts (any bolt will do) into bolt holes of No. 1 and No. 5 rocker shaft bracket.**

3. Mount camshaft onto cylinder head, placing knock pin at front end to top position.

4. Mount valve rocker shaft assembly on cylinder head by accommodating to knock pin of the head. Then, tighten to the specified torque.

**Rocker shaft bracket bolt:**

: 15 - 25 N·m (1.5 - 2.5 kg-m, 11 - 18 ft-lb)

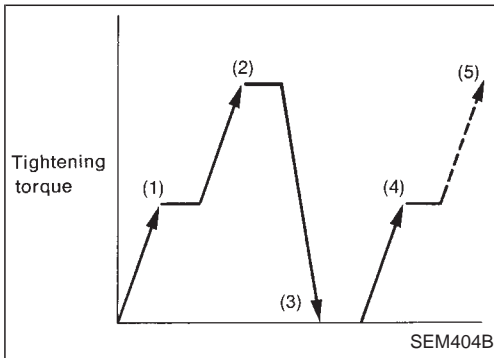
- Tighten bolts gradually, in two to three stages outwardly from center bracket.
- When tightening bolts, make space under cylinder head since some valves will open and interfered.

## Installation

1. Install cylinder head with new gasket and tighten cylinder head bolts.



## Installation (Cont'd)



- Tightening procedure

1st Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).

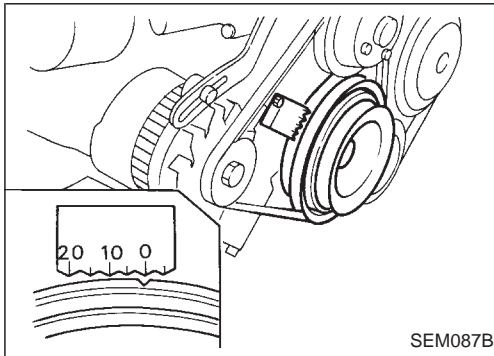
2nd Tighten all bolts to 78 N·m (8.0 kg-m, 58 ft-lb).

3rd Loosen all bolts completely.

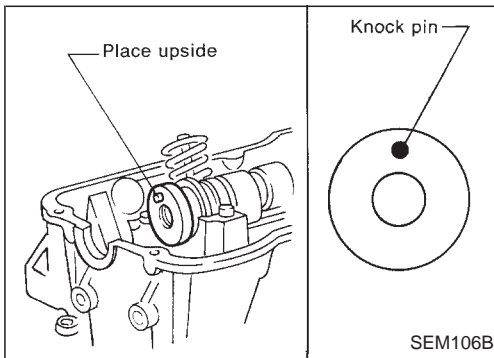
4th Tighten all bolts to 25 to 34 N·m (2.5 to 3.5 kg-m, 18 to 25 ft-lb).

5th Turn all bolts 90 to 95 degrees clockwise.

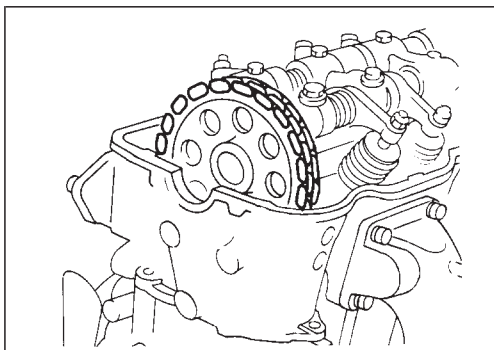
If angle wrench is not available, tighten all bolts to 74 to 83 N·m (7.5 to 8.5 kg-m, 54 to 61 ft-lb).



2. Confirm that No. 1 cylinder is set at TDC on its compression stroke.

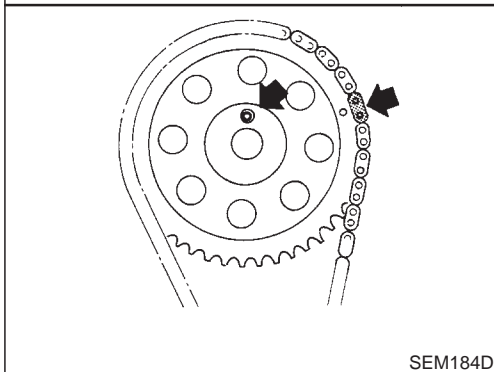


3. Ensure that front knock pin is positioned at upper surface of camshaft.




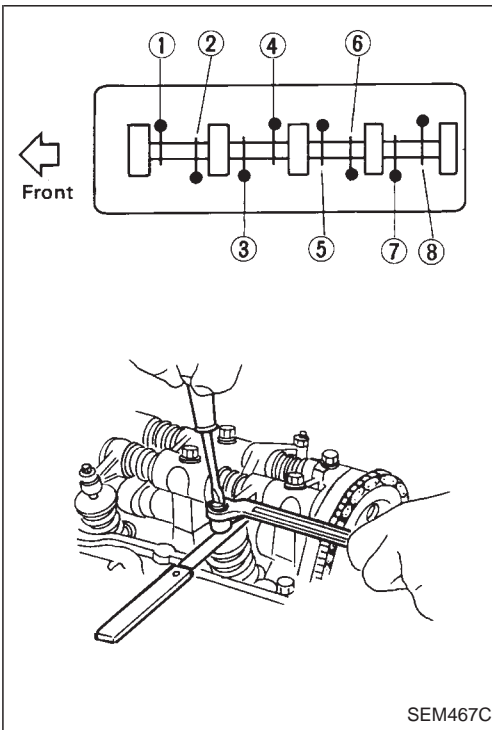
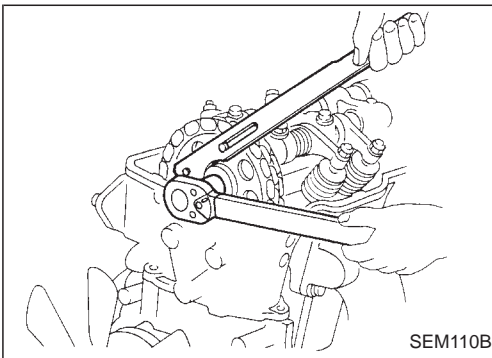
4. Set chain on camshaft sprocket by aligning each mating mark. Then install camshaft sprocket to camshaft.

- **Camshaft sprocket should be installed by fitting the knock pin of camshaft into its No. 2 hole. And No. 2 timing mark must also be used.**



## Installation (Cont'd)

Camshaft sprocket bolt:

: 118 - 157 N·m (12 - 16 kg-m, 87 - 116 ft-lb)


5. Adjust valve clearance.

- (1) Set No. 1 cylinder to top dead center on its compression stroke, and adjust valve clearance ①, ②, ④ and ⑥.
- (2) Again, rotate crankshaft one turn so that No. 4 cylinder is at top dead center of its compression stroke, and adjust valve clearance ③, ⑤, ⑦ and ⑧.


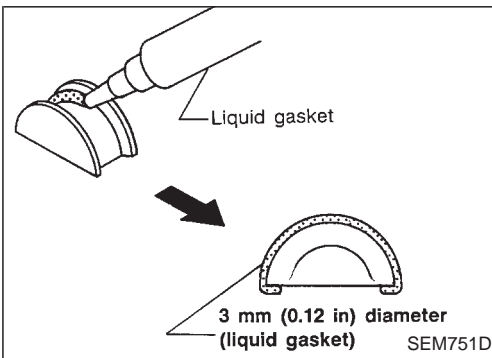
Valve clearance:

Unit: mm (in)		
	COLD*	HOT
Intake	0.25 (0.010)	0.3 (0.012)
Exhaust	0.27 (0.011)	0.3 (0.012)

\*: At temperature 20°C (68°F)

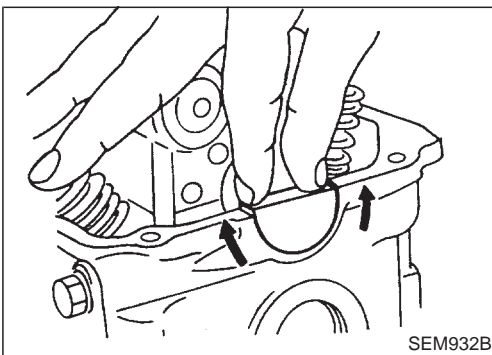
- **Whenever valve clearances are adjusted to cold specifications, check that clearances satisfy hot specifications and adjust again if necessary.**

Adjusting screw lock nuts:

: 16 - 22 N·m (1.6 - 2.2 kg-m, 12 - 16 ft-lb)


6. Apply liquid gasket to rubber plugs.

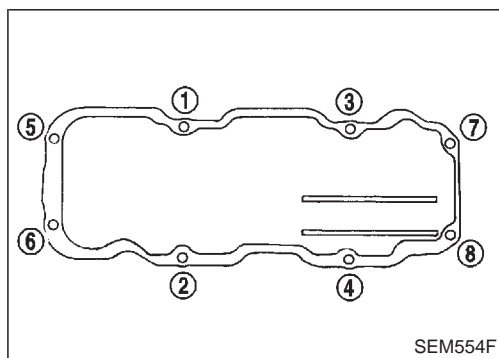
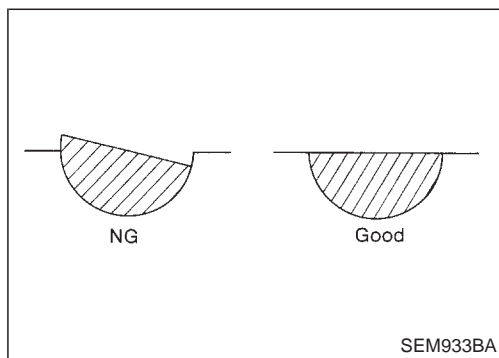
- **Rubber plug should be replaced with rocker cover gasket.**
- **Rubber plugs should be installed within 5 minutes of applying liquid gasket.**



7. Install rubber plugs, then move them with your fingers to uniformly spread the gasket on cylinder head surface.

**Rubber plugs should be installed flush with the surface.**

## Installation (Cont'd)



8. Place new gasket and rocker cover on cylinder head.

a. Tighten bolts to specified torque.

**Bolts should be tightened in the order shown in the figure.**

**Rocker cover bolts:**

 : 6 - 10 N·m (0.6 - 1.0 kg-m, 52 - 87 in-lb)

b. Loosen bolts one full turn.

c. Retighten bolts to specified torque.

**Rocker cover bolts:**

 : 6 - 10 N·m (0.6 - 1.0 kg-m, 52 - 87 in-lb)

**Do not start the engine for 30 minutes after installing rocker cover.**

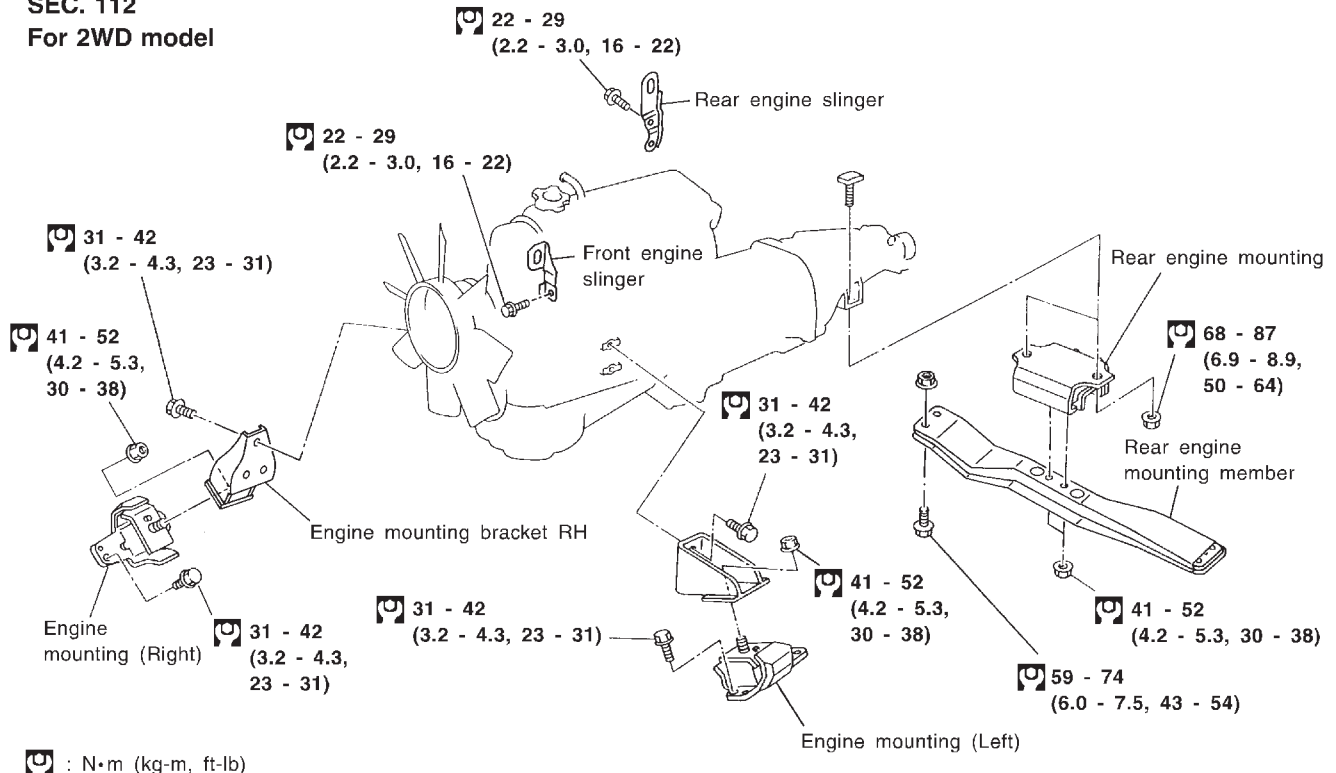
9. Install the following parts.

- Power steering pump, idler pulley and brackets
- Power steering pump drive belt

10. Connect exhaust manifold and exhaust tube.

## SEC. 112

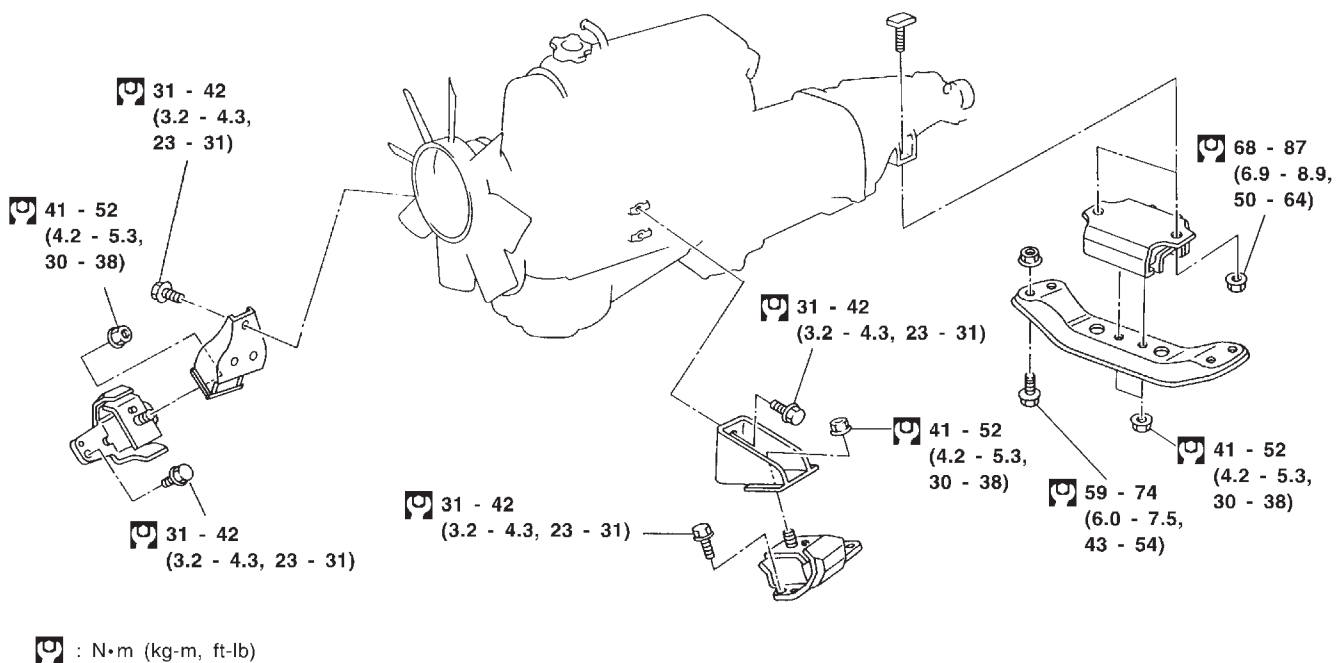
For 2WD model



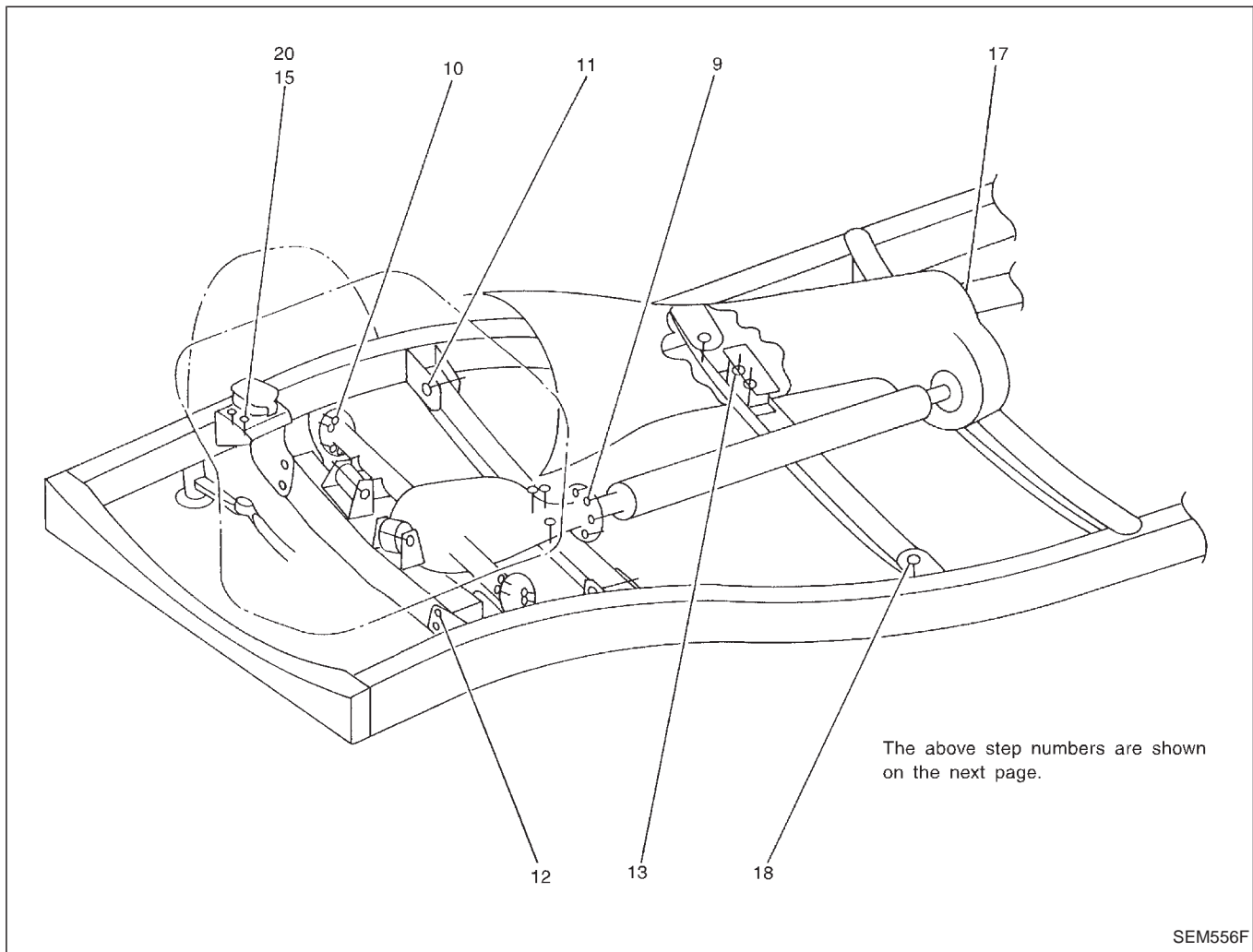
SEM562F

## SEC. 112

For 4WD model




SEM555F

**WARNING:**


















- Place vehicle on a flat and solid surface.
- Place chocks at front and rear of rear wheels.
- You should not remove engine until exhaust system and cooling system have completely cooled off. Otherwise, you may burn yourself and/or fire may break out in the fuel line.
- When removing front and/or rear engine mounting bolts or nuts, lift up slightly engine for safety work.
- Be sure to hoist engine and transmission in a safe manner.
- For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.

**CAUTION:**

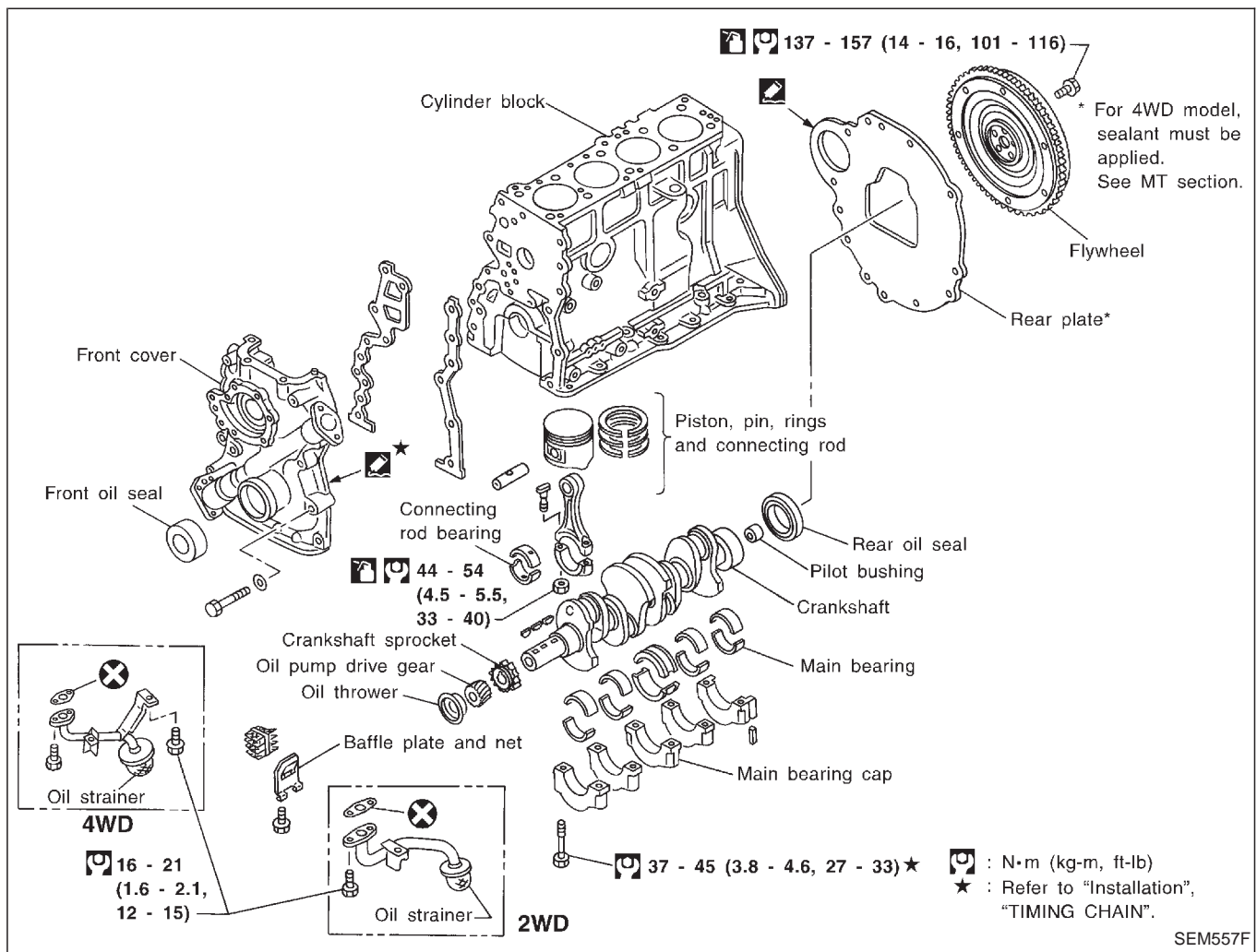
- In lifting engine, be careful not to hit it against adjacent parts, especially against accelerator wire casing end, brake tube and brake master cylinder.
- Do not loosen front engine mounting insulator cover securing nuts.  
When cover is removed, damper oil flows out and mounting insulator will not function.
- For tightening torque, refer to MT and PD sections.
- For 4WD model, sealant should be applied between engine and transmission.  
Refer to MT section.

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

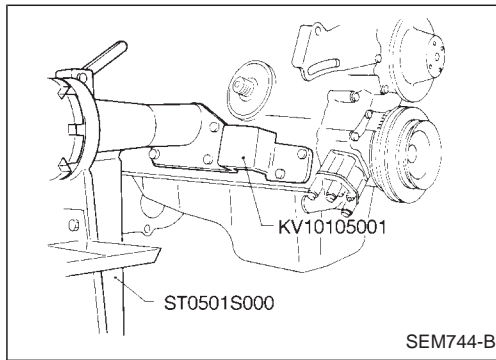
 : N-m (kg-m, ft-lb)

Removal order and points	2WD model	4WD model	Remarks
1 Drain engine oil and coolant.	O	O	 29 - 39 (3.0 - 4.0, 22 - 29)
2 Remove radiator with shroud and cooling fan.	O	O	 Radiator 3 - 4 (0.3 - 0.4, 26 - 35) Cooling fan 6 - 10 (0.6 - 1.0, 52 - 87)
3 Remove undercover.	O	O	 3 - 4 (0.3 - 0.4, 26 - 35)
4 Remove A/C compressor and P/S pump.	O	O	 31 - 42 (3.2 - 4.3, 23 - 31)
5 Remove starter motor.	—	O	 29 - 39 (3.0 - 4.0, 22 - 29)
6 Disconnect harness from starter motor.	O	—	—
7 Disconnect exhaust manifold from exhaust front tube.	O	O	 26 - 36 (2.7 - 3.7, 20 - 27)
8 Remove front exhaust tube.	O	O	 31 - 42 (3.2 - 4.3, 23 - 31)
9 Disconnect front propeller shaft from front differential carrier.	—	O	 39 - 44 (4.0 - 4.5, 29 - 33)
10 Remove front drive shaft fixing bolts (RH & LH).	—	O	 34 - 44 (3.5 - 4.5, 25 - 33)
11 Remove front differential carrier member.	—	O	 54 - 64 (5.5 - 6.5, 40 - 47)
12 Remove suspension member bolts.	—	O	 68 - 87 (6.9 - 8.9, 50 - 64)
13 Remove transmission to rear engine mounting bracket nuts.	—	—	 68 - 87 (6.9 - 8.9, 50 - 64)
14 Remove front differential carrier with members.	—	O	—
15 Remove front engine mounting bolts (RH & LH).	—	O	 31 - 42 (3.2 - 4.3, 23 - 31)
16 Lift up engine.	—	O	—
17 Disconnect rear propeller shaft from transmission.	O	—	 34 - 44 (3.5 - 4.5, 25 - 33)
18 Remove transmission member.	O	—	 41 - 52 (4.2 - 5.3, 30 - 38)
19 Remove engine to transmission fixing bolts.	—	O	 Bolt length 16 or 25 mm 29 - 39 (3.0 - 4.0, 22 - 29) Others 39 - 49 (4.0 - 5.0, 29 - 36)
20 Remove front engine mounting bolts (RH & LH).	O	—	 31 - 42 (3.2 - 4.3, 23 - 31)
21 Hang on and carry out engine.	O	O	—

Install engine in reverse order of removal.

**CAUTION:**

- When installing sliding parts (bearings, pistons, etc.), lubricate contacting surfaces with new engine oil.
- Place removed parts such as bearings and bearing caps in their proper order and direction.
- When installing connecting rod nuts and main bearing cap bolts, apply new engine oil to threads and seating surfaces.

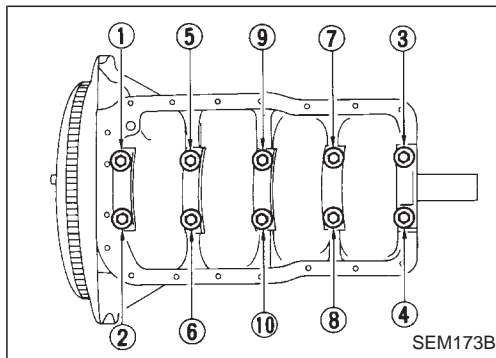


## Disassembly

### PISTON AND CRANKSHAFT

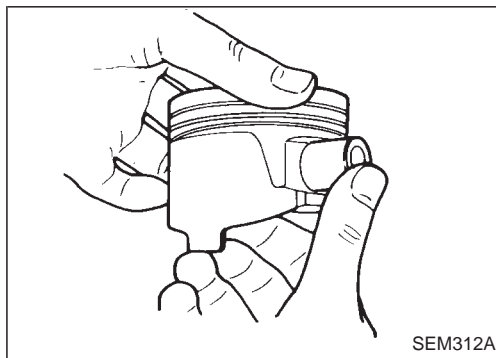
1. Place engine on work stand.

2. Remove timing chain. Refer to "Removal", "TIMING CHAIN", EM-98.
3. Drain coolant and oil.
4. Remove water pump.
5. Remove oil pan and oil pump. Refer to "Removal", "OIL PAN", EM-93.
6. Remove cylinder heads.
7. Remove pistons.



8. Remove bearing cap and crankshaft.

- Place the bearings and caps in their proper order.



## Inspection

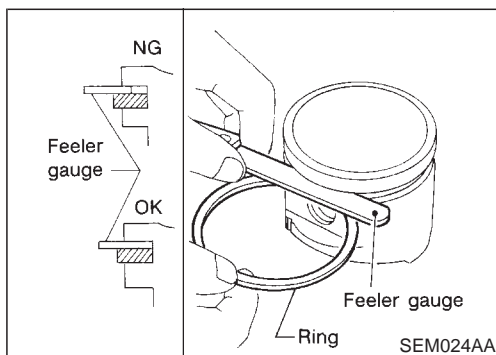
### PISTON AND PISTON PIN CLEARANCE

- Confirm the fitting of piston pin into piston pin hole to such an extent that it can be pressed smoothly by finger at room temperature.

Piston pin to piston clearance:

0.008 - 0.012 mm (0.0003 - 0.0005 in)

Apply engine oil to piston pin.



### PISTON RING SIDE CLEARANCE

Side clearance: mm (in)

Top ring

0.040 - 0.073 (0.0016 - 0.0029)

2nd ring

0.030 - 0.063 (0.0012 - 0.0025)

Max. limit of side clearance (Top and 2nd rings):

0.1 mm (0.004 in)

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



**Inspection (Cont'd)****PISTON RING GAP**

Standard ring gap: mm (in)

Top ring

0.25 - 0.40 (0.0098 - 0.0157)

2nd ring

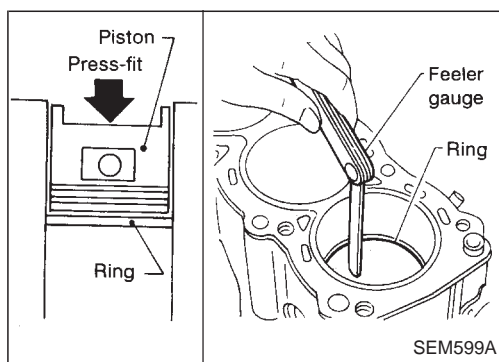
0.15 - 0.30 (0.0059 - 0.0118)

Oil ring

0.30 - 0.90 (0.0118 - 0.0354)

Max. limit of ring gap:

1.0 mm (0.039 in)

**BEARING CLEARANCE**

- Either of the following two methods may be used, however, method "A" gives more reliable results and is preferable.

Bearing clearance: mm (in)

Main bearing

0.020 - 0.062 (0.0008 - 0.0024)

Limit 0.12 (0.0047)

Connecting rod bearing

0.012 - 0.054 (0.0005 - 0.0021)

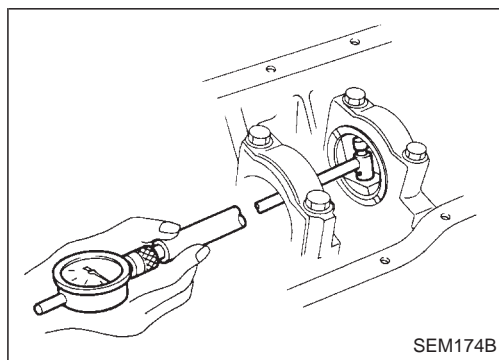
Limit 0.12 (0.0047)

**Method A (Using dial gauge & micrometer)****Main bearing**

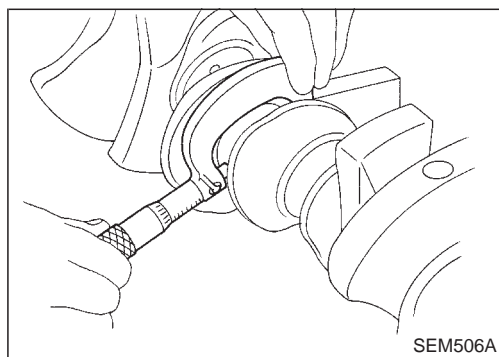
1. Install main bearings to cylinder block and main bearing cap.
2. Install main bearing cap to cylinder block.

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

: 44 - 54 N·m (4.5 - 5.5 kg-m, 33 - 40 ft-lb)



3. Measure inside diameter "A" of main journal.



4. Measure outside diameter "Dm" of main journal in crankshaft.

## Inspection (Cont'd)

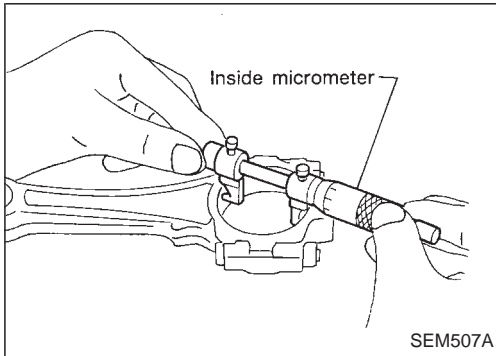
- Calculate main bearing clearance.  
Main bearing clearance =  $A - Dm$

## Connecting rod bearing

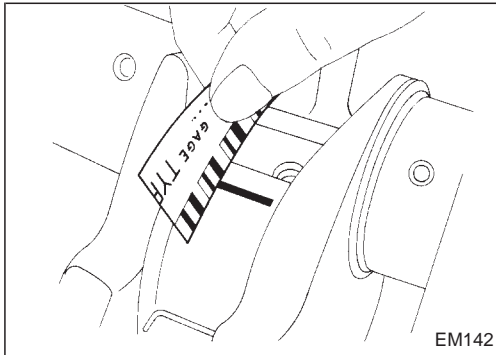
- Install connecting rod bearing to connecting rod and cap.
- Install connecting rod cap to connecting rod.

Apply oil to the thread portion of bolts and seating surface of nuts.

: 37 - 45 N·m (3.8 - 4.6 kg·m, 27 - 33 ft·lb)



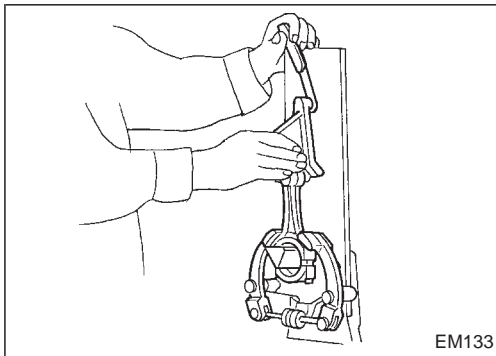
- Measure inside diameter "C" of bearing.
- Measure outside diameter "Dp" of pin journal in crankshaft.
- Calculate connecting rod bearing clearance.  
Connecting rod bearing clearance =  $C - Dp$



## Method B (Using plastigage)

**CAUTION:**

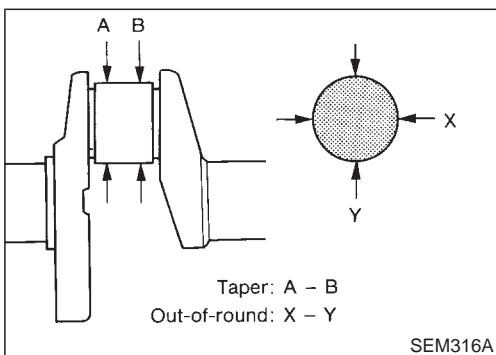
- Do not turn crankshaft or connecting rod while the plastigage is being inserted.
- When bearing clearance exceeds the specified limit, ensure that the proper bearing has been installed. Then if excessive bearing clearance exists, use thicker main bearing or undersized bearing so that the specified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



## CONNECTING ROD BEND AND TORSION

Bend and torsion: mm (in)

Limit 0.5 (0.0020) per 100 (3.94) length



## CRANKSHAFT

- Check crankshaft journals for score, bias, wear or cracks. If faults are minor, correct with fine crocus cloth.
- Check journals with a micrometer for taper and out-of-round.

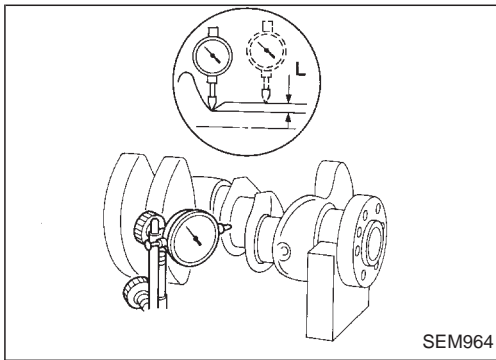
Out-of-round ( $X - Y$ ):

Less than 0.01 mm (0.0004 in)

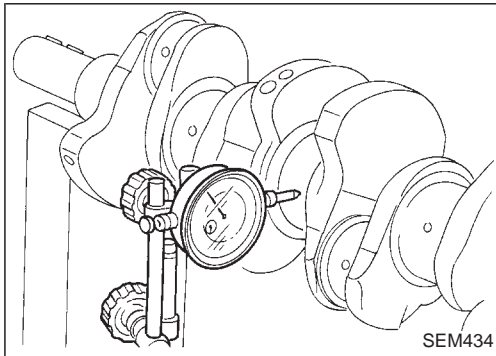
Taper ( $A - B$ ):

Less than 0.01 mm (0.0004 in)

## Inspection (Cont'd)

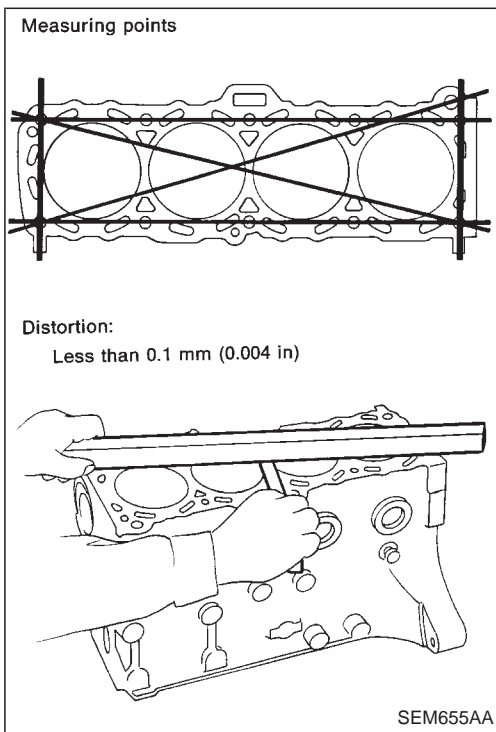


- When regrounding crank pin and crank journal, measure "L" dimension in fillet roll. Make sure the measurements exceed the specified limit. If the measurements are within the specified limit, do not regrind.  
L: More than 0.1 mm (0.004 in)
- Do not grind off fillet roll.
- Refer to SDS for regrounding crankshaft and available service parts.



- Check crankshaft runout.

**Runout [TIR (Total Indicator Reading)]:**  
Less than 0.05 mm (0.0020 in)



## CYLINDER BLOCK DIMENSION AND WEAR

- If beyond the specified limit, resurface it.

**Resurfacing limit:**

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

Amount of cylinder head resurfacing is "A".

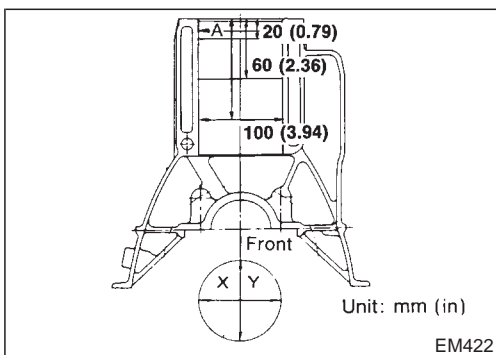
Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

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

Nominal cylinder block height from crankshaft center:

$$247.00 \pm 0.05 \text{ mm (9.7244} \pm 0.0020 \text{ in)}$$



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

**Standard inner diameter:**

$$89.000 - 89.050 \text{ mm (3.5039 - 3.5059 in)}$$

Refer to SDS.

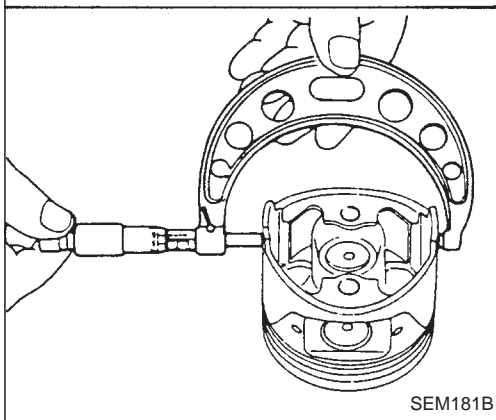
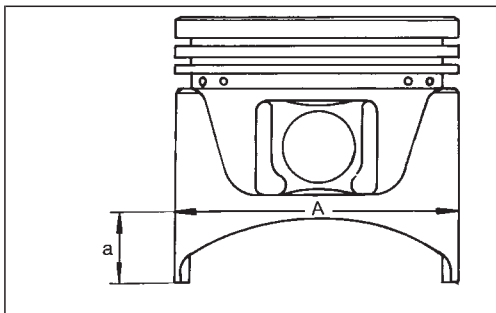
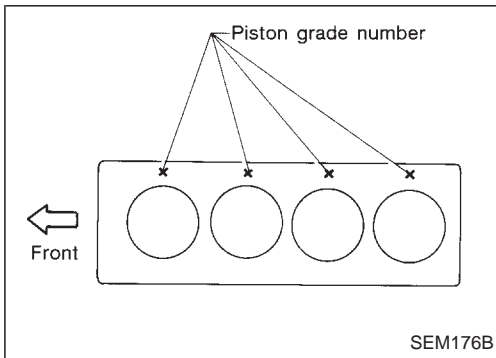
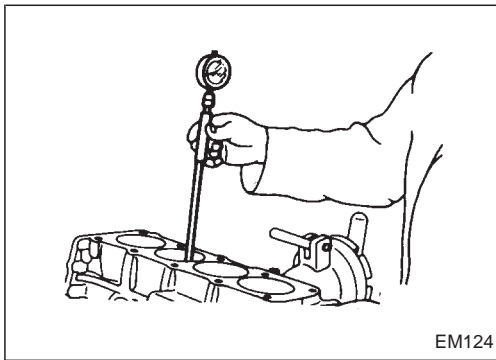
**Out-of-round (X - Y):**

$$\text{Limit } 0.015 \text{ mm (0.0006 in)}$$

**Taper (A - B):**

$$\text{Limit } 0.010 \text{ mm (0.0004 in)}$$

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



- If either cylinder block or piston is replaced with new one, select the same piston as piston grade number punched on cylinder block upper surfaces.

### CYLINDER BORING

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

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

Oversize pistons are available for service.

Refer to SDS, EM-194.

2. The size to which cylinders must be honed is determined by adding piston-to-cylinder clearance to the piston skirt diameter "A".

Dimension "a":

About 20 mm (0.79 in)

Rebored size calculation:

$$D = A + B - C = A + [0.005 \text{ to } 0.025 \text{ mm} (0.0002 \text{ to } 0.0010 \text{ in})]$$

where,

D: Bored diameter

A: Skirt diameter as measured

B: Piston-to-wall clearance

C: Honing allowance 0.02 mm (0.0008 in)

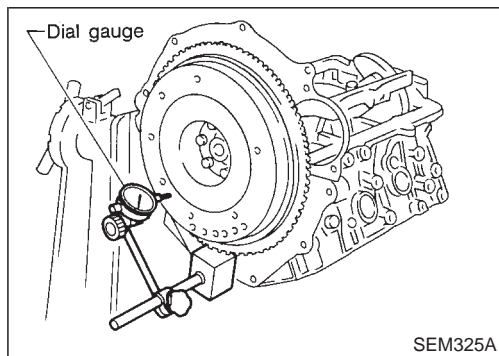
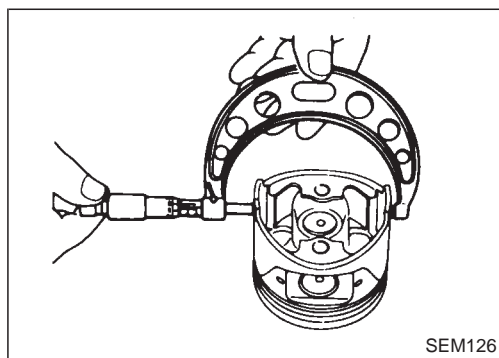
3. Install main bearing caps in place, and tighten to the specified torque to prevent distortion of the cylinder bores in final assembly.
4. Cut cylinder bores.
  - Do not cut too much out of the cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.
- 5.hone the cylinders to the required size referring to SDS.
6. Measure the finished cylinder bore for out-of-round and taper.
  - Measurement of a just machined cylinder bore requires utmost care since it is expanded by cutting heat.

## Inspection (Cont'd)

## PISTON-TO-BORE CLEARANCE

## Using micrometer

1. Measure piston and cylinder bore diameter.  
**Piston diameter "A":**  
Refer to SDS, EM-194.  
**Measuring point "a":**  
20 mm (0.79 in)
2. Check that piston clearance is within the specification.  
**Piston clearance:**  
0.025 - 0.045 mm (0.0010 - 0.0018 in)



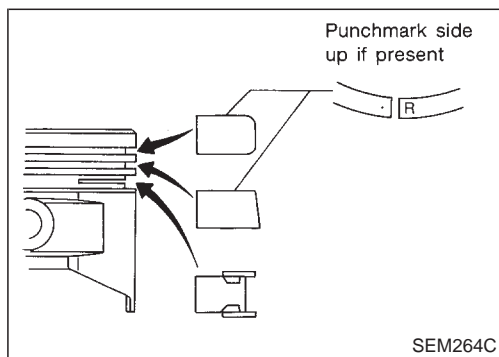
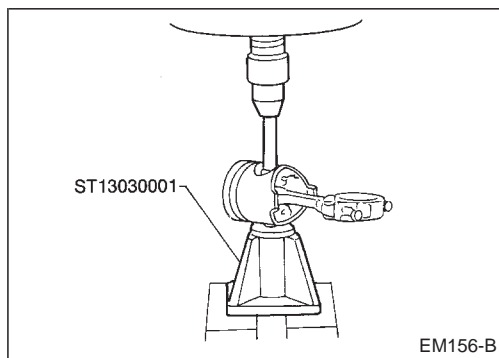
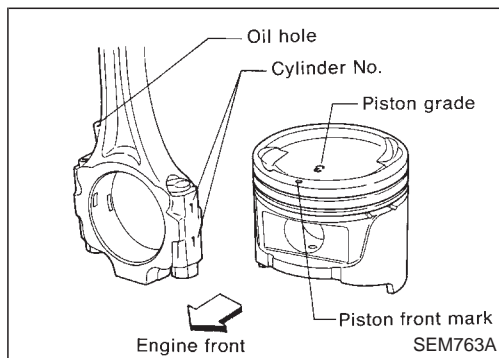
## FLYWHEEL RUNOUT

**Runout (Total indicator reading):**  
Less than 0.10 mm (0.0039 in)

## Assembly

## PISTON

- a. Numbers are stamped on the connecting rod and cap corresponding to each cylinder. Care should be taken to avoid a wrong combination including bearing.
- b. When pressing piston pin in connecting rod, apply engine oil to pin and small end of connecting rod.
- c. After assembling, ascertain that piston swings smoothly.



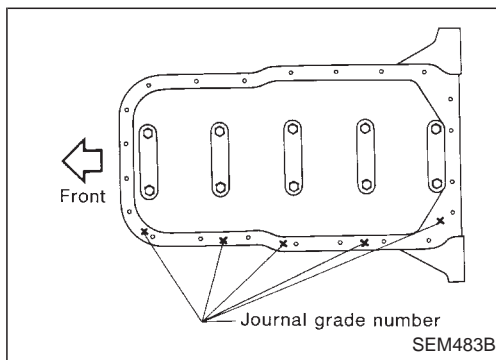
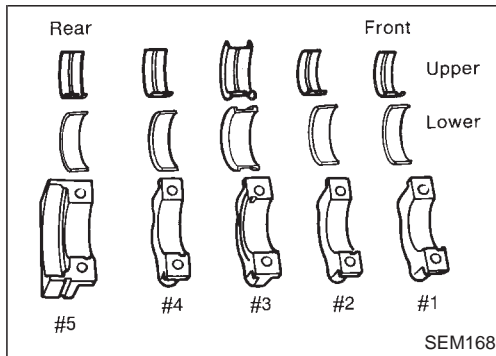
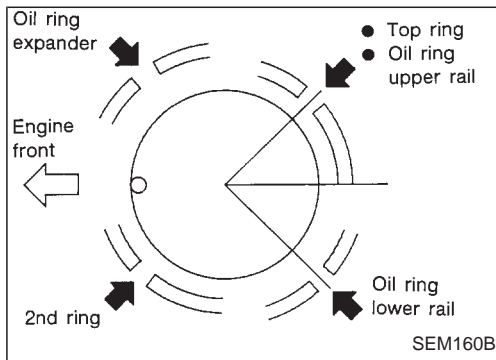
Install piston assembly.

**CAUTION:**

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

# CYLINDER BLOCK Assembly (Cont'd)

Z



## CRANKSHAFT

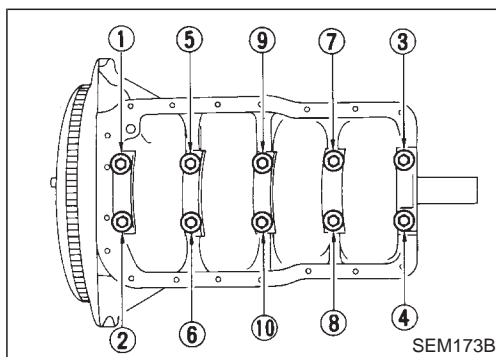
1. Set main bearings in the proper piston on cylinder block. If either crankshaft, cylinder block or main bearing is reused again, it is necessary to measure main bearing clearance.
  - a. Only center bearing (No. 3) is a flanged type.
  - b. All inter-bearings (No. 2 and No. 4) are the same type.
  - c. Front bearing (No. 1) is also the same type as rear bearing (No. 5).
  - d. Upper and lower bearings are not interchangeable. Upper ones have oil groove.

If all of crankshaft, cylinder block and main bearing are replaced with new ones, it is necessary to select thickness of main bearing as follows:

- a. Grade number of all cylinder block main journals is punched on the respective cylinder block.

- b. Select suitable thickness of main bearing according to the following table.

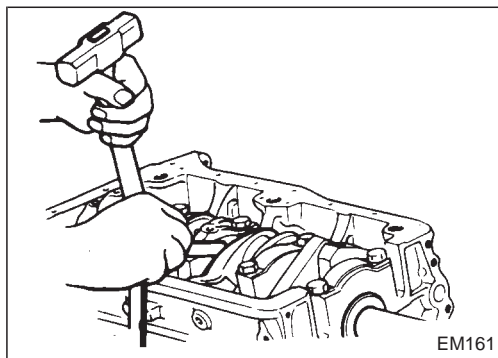
No. 1, 2, 3, 4, 5 main journal grade number	1	Select standard bearing
	2	



2. Apply engine oil to main bearing surfaces on both sides of cylinder block and cap.
3. Install crankshaft and main bearing caps and tighten bolts to the specified torque.

: 44 - 54 N·m (4.5 - 5.5 kg-m, 33 - 40 ft-lb)

- Tighten in two or three stages.
- After securing bearing cap bolts, ascertain that crankshaft turns smoothly by hand.

**Assembly (Cont'd)**

4. Make sure that there exists proper end play of crankshaft at center bearing.

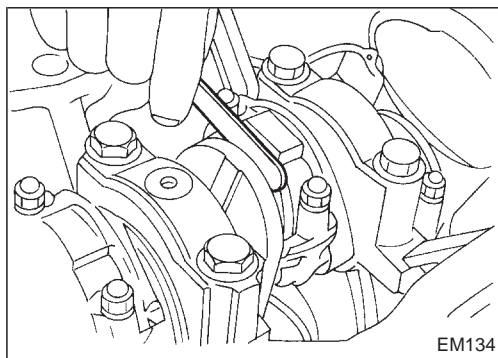
**Crankshaft free end play: mm (in)**

**Standard**

**0.05 - 0.18 (0.0020 - 0.0071)**

**Limit**

**0.30 (0.0118)**



5. Measure connecting rod side clearance.

**Connecting rod side clearance: mm (in)**

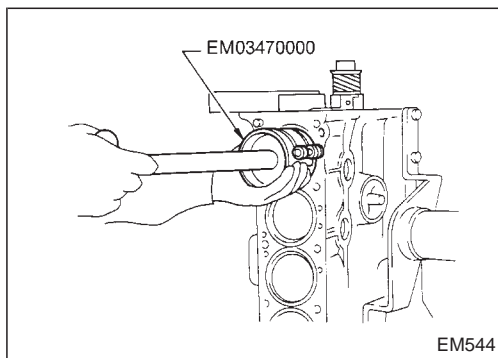
**Standard**

**0.20 - 0.30 (0.0079 - 0.0118)**

**Limit**

**0.60 (0.0236)**

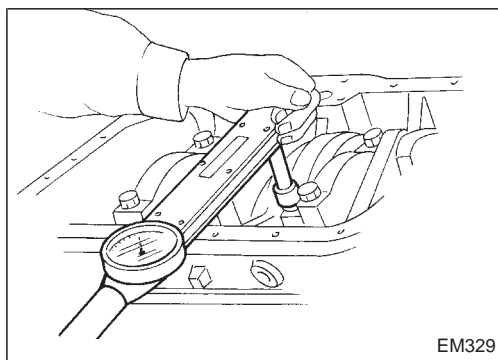
**If beyond the limit, replace connecting rod and/or crankshaft.**



6. Install pistons with connecting rods.

(1) Install them into corresponding cylinder using Tool.

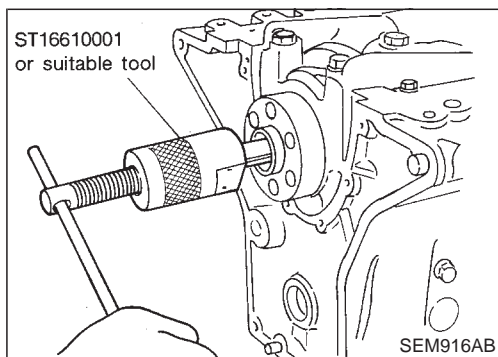
- **Be careful not to scratch cylinder wall with connecting rod.**
- **Apply engine oil to cylinder wall, piston and bearing.**
- **Arrange so that the front mark on piston head faces to the front of engine.**



- (2) Install connecting rod bearing caps.

**Connecting rod bearing nut:**

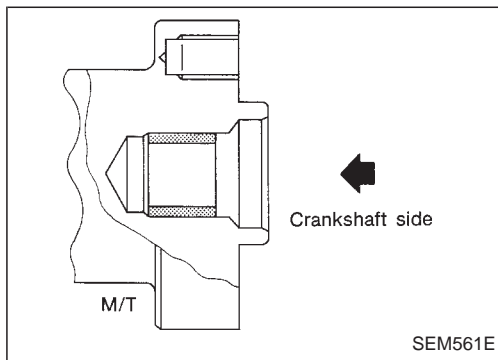
**⌚: 37 - 45 N·m (3.8 - 4.6 kg-m, 27 - 33 ft-lb)**

**REPLACING PILOT BUSHING**

1. Remove pilot bushing.

## Assembly (Cont'd)

2. Install pilot bushing.



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LC

EC

FE

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MT

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FA

RA

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ST

RS

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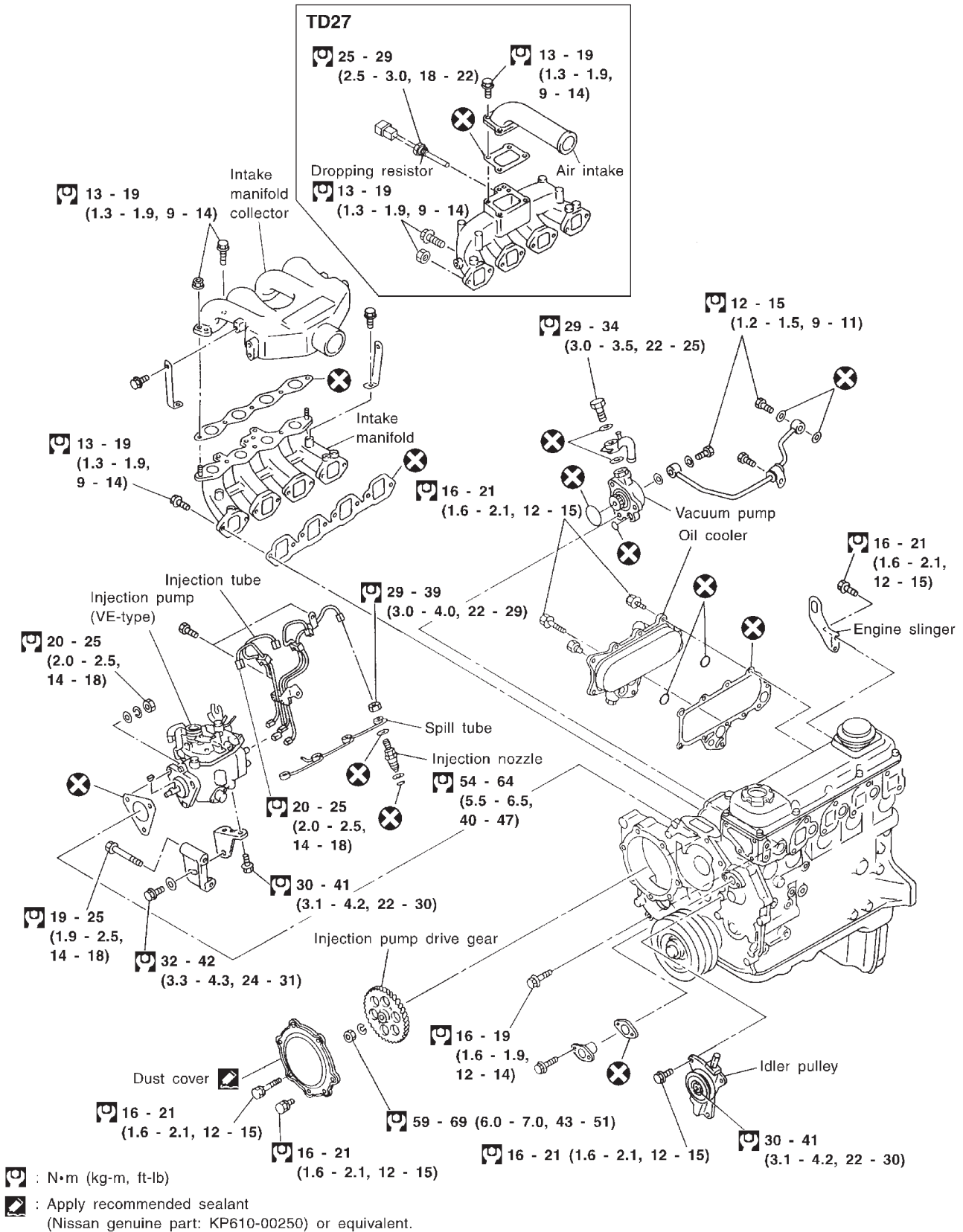
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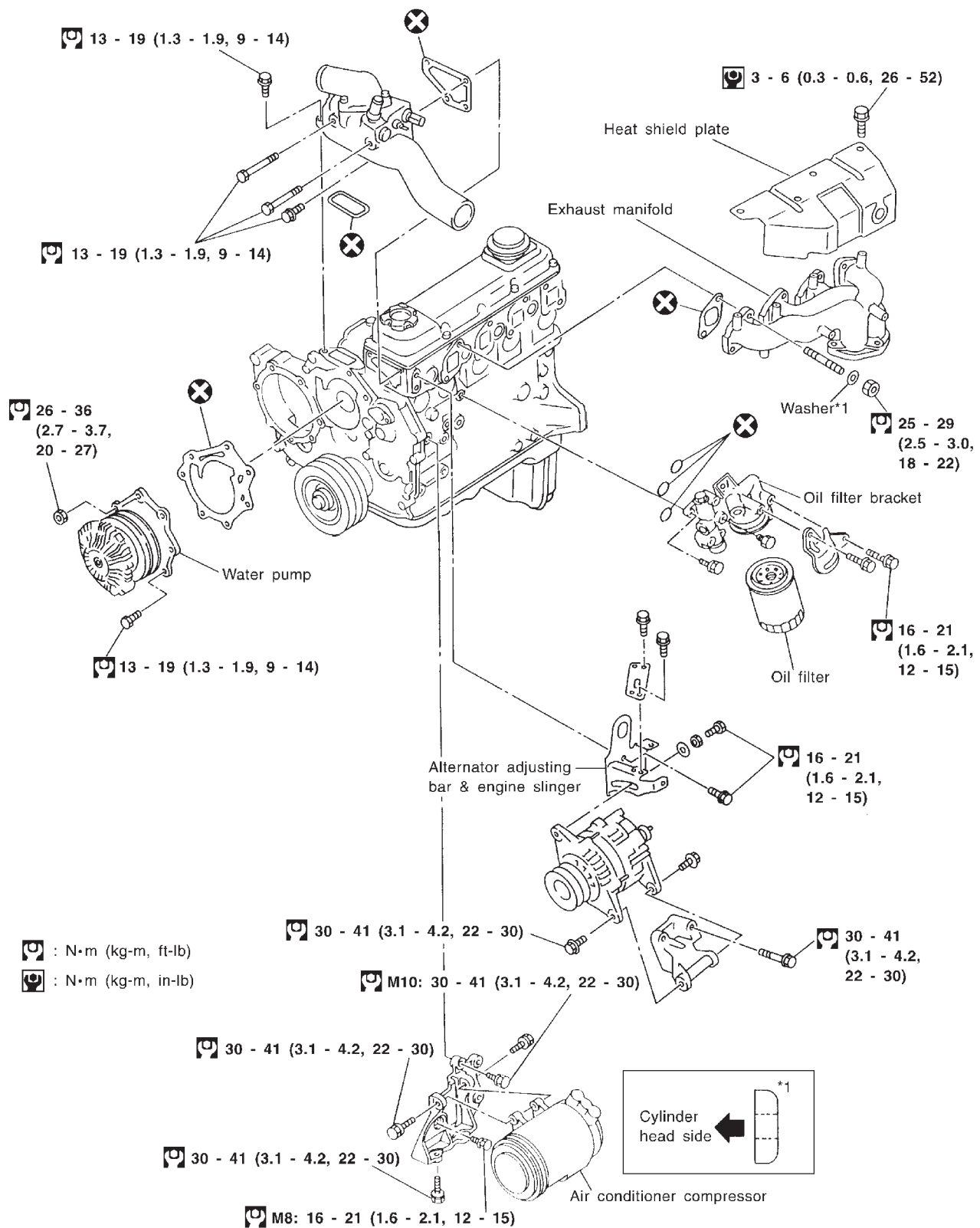


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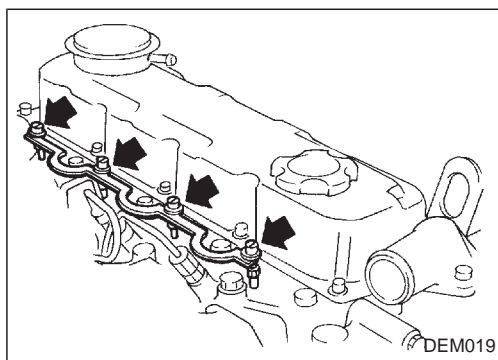


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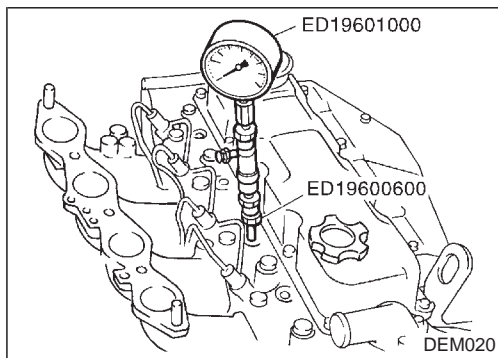


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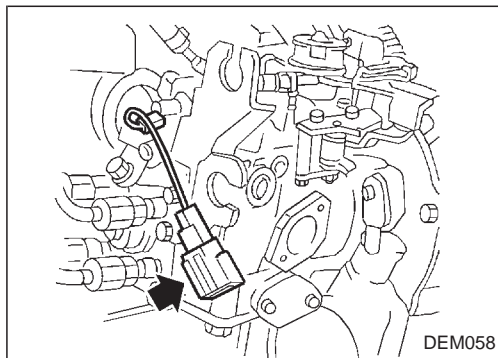


## Measurement of Compression Pressure

1. Warm up engine.
2. Stop engine. Remove glow plate and glow plugs.



3. Fit compression gauge adapter to cylinder head.  
**Compression gauge adapter:**  
⌚: 15 - 20 N·m (1.5 - 2.0 kg-m, 11 - 14 ft-lb)



4. Disconnect fuel cut solenoid wire connector.
5. Crank engine, then read gauge indication.
  - **Engine compression measurement should be made as quickly as possible.**

### Compression pressure:

Unit: kPa (bar, kg/cm<sup>2</sup>, psi)/200 rpm

Standard	2,942 (29.4, 30, 427)
Minimum	2,452 (24.5, 25, 356)
Differential limit between cylinders	294 (2.9, 3, 43)

6. If cylinder compression in one or more cylinders is low, pour a small quantity of engine oil into cylinders through the glow holes and retest compression.
  - **If adding oil helps the compression pressure, chances are that piston rings are worn or damaged.**
  - **If pressure stays low, valve may be sticking or seating improperly.**
  - **If cylinder compression in any two adjacent cylinders is low, and if adding oil does not help the compression, there is leakage past the gasketed surface.**  
Oil and water in combustion chambers can result from this problem.

## Removal

Removal order and points		Applied model	
		2WD	4WD
1	Remove undercover.	○	○
2	Drain engine oil.	○	○
3	Remove front propeller shaft from front differential carrier.	—	○
4	Remove front drive shaft fixing bolts (RH & LH).	—	○
5	Remove front suspension crossmember.	○	○
6	Remove differential front mounting bolts (RH & LH) and rear mounting bolts.	—	○
7	Remove front differential carrier.	—	○

Removal order and points		Applied model	
		2WD	4WD
8	Remove front differential carrier mounting bracket.	—	○
9	Remove transmission to rear engine mounting bracket nuts (RH & LH).	○	○
10	Remove engine mounting bolts or nuts (RH & LH).	○	○
11	Lift up engine. If necessary, disconnect exhaust tube.	○	○
12	Remove oil pan.	○	○

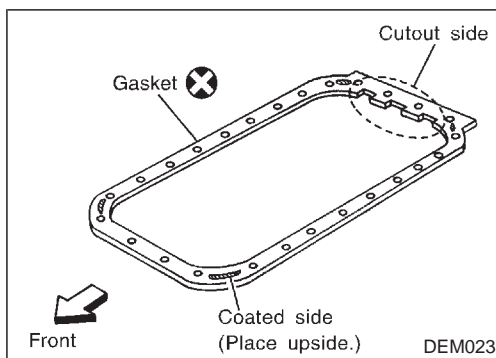
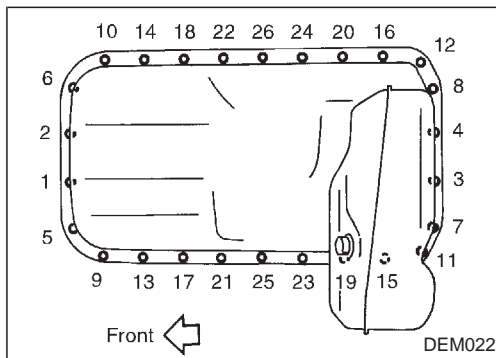
**WARNING:**

- Place vehicle on a flat and solid surface.
- Place chocks at front and rear of rear wheels.
- You should not remove oil pan until exhaust system and cooling system have completely cooled off. Otherwise, you may burn yourself and/or fire may break out in the fuel line.
- When removing front and/or rear engine mounting bolts or nuts, lift up slightly engine for safety work.

**CAUTION:**

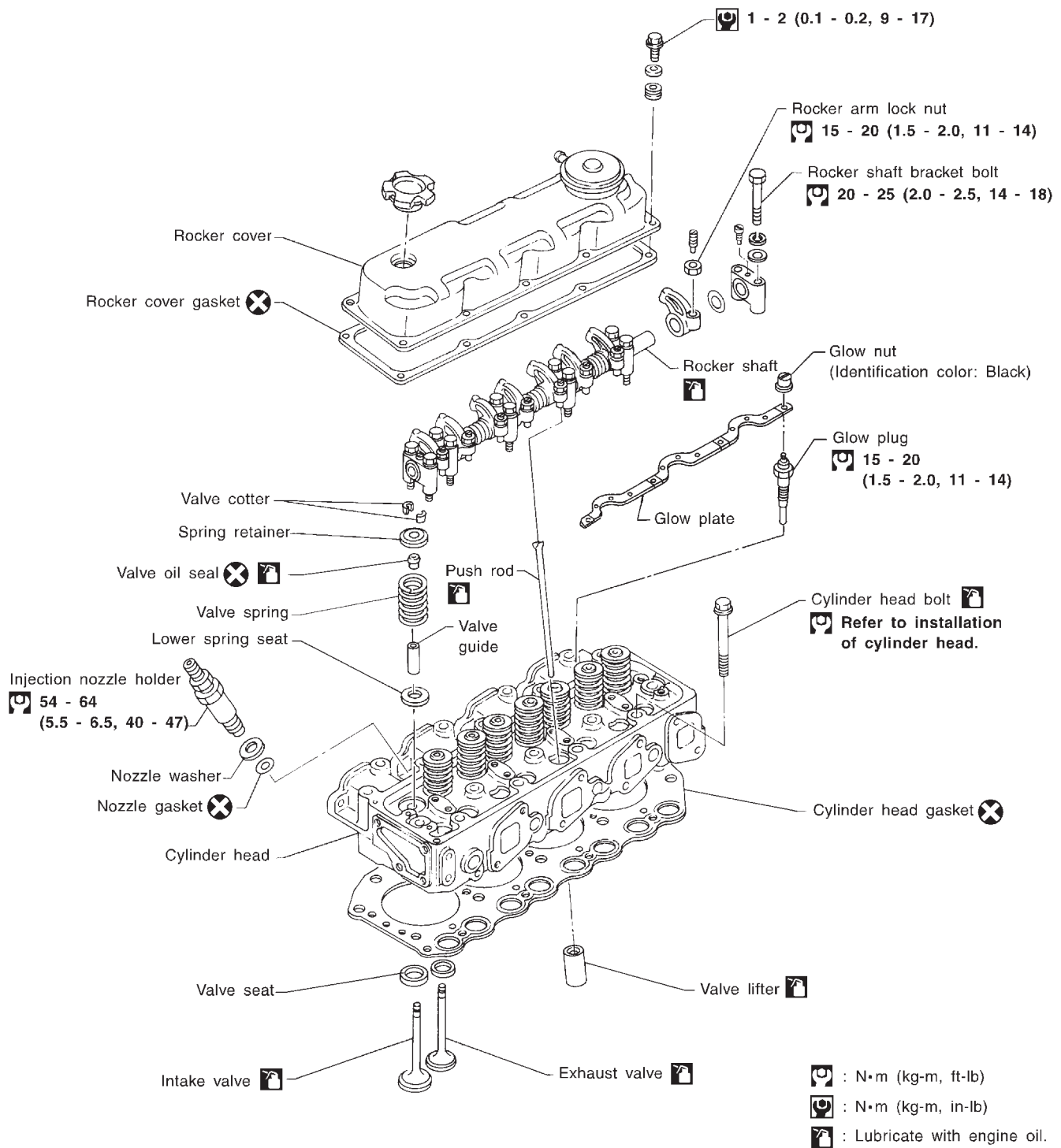
- In lifting engine, be careful not to hit against adjacent parts, especially against accelerator wire casing end, brake tube and brake master cylinder.
- For tightening torque, refer to EM-157, MT and PD sections.

Remove oil pan bolts in order shown.



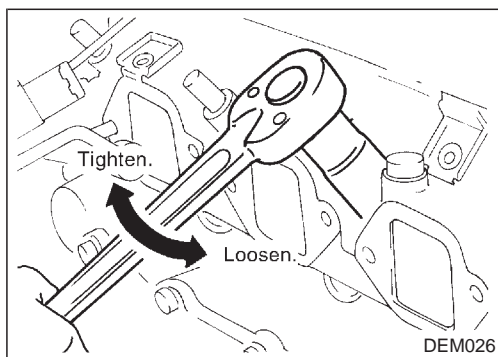
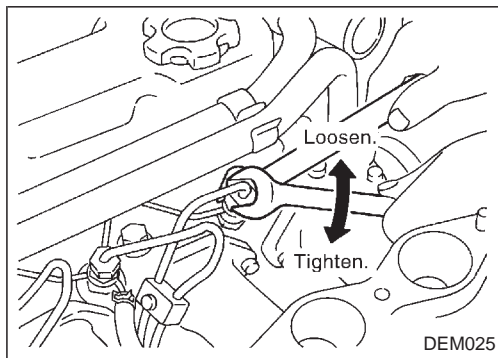
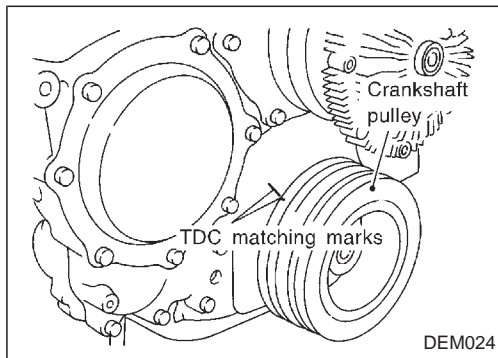
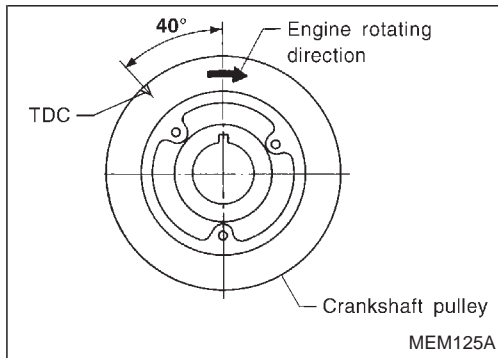
## Installation

1. Install the oil pan gasket with the coated surface facing the cylinder block and the notch facing the rear of the engine.
2. Tighten all bolts in reverse order of removal.



**CAUTION:**

- When installing sliding parts such as rocker arms, camshaft and oil seal, be sure to apply new engine oil on their sliding surfaces.
- When tightening cylinder head bolts and rocker shaft bolts, apply new engine oil to thread portions and seat surfaces of bolts.

**Removal**

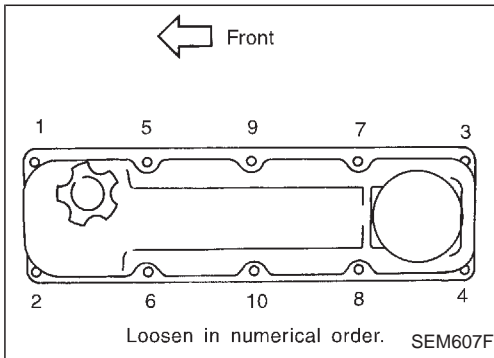
1. Set No. 1 cylinder at TDC (top dead center) on its compression stroke.
2. Drain engine coolant from drain plugs on cylinder block and radiator.
3. Remove air cleaner and/or air duct.
4. Remove alternator adjusting bolt.
5. Disconnect exhaust manifold from front exhaust tube.
6. Disconnect radiator outlet hose and thermostat housing water inlet hose.
7. Remove intake manifold collector (QD32) and air intake housing (TD27).

8. Remove fuel injection tube assembly and spill tube.

9. Remove injection nozzle holder and top nozzle gasket using deep socket wrench.

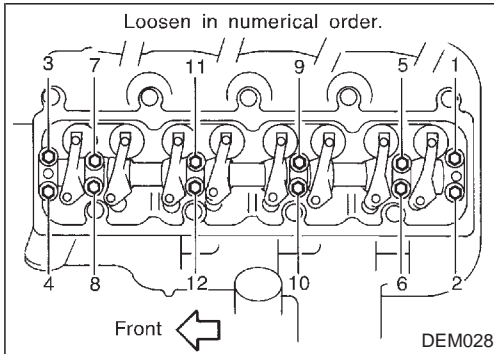
## Removal (Cont'd)

10. Remove rocker cover.



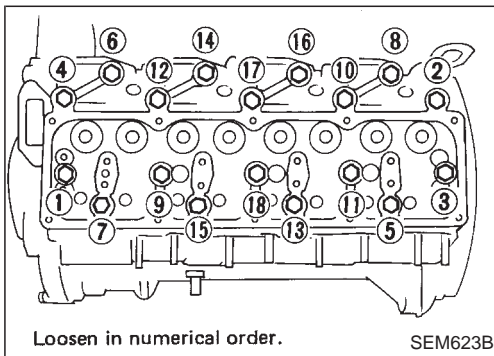
11. Remove rocker shaft with rocker arms.

12. Remove push rods.



13. Remove cylinder head bolts in numerical order and remove cylinder head.

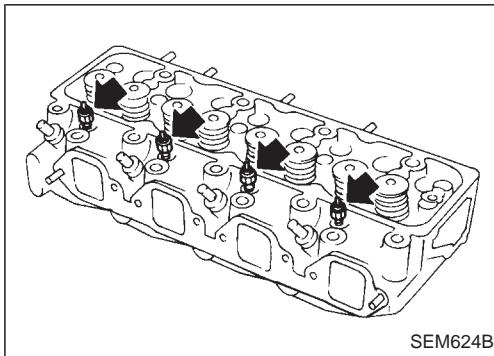
**Head warpage or cracking could result from removing in incorrect order.**



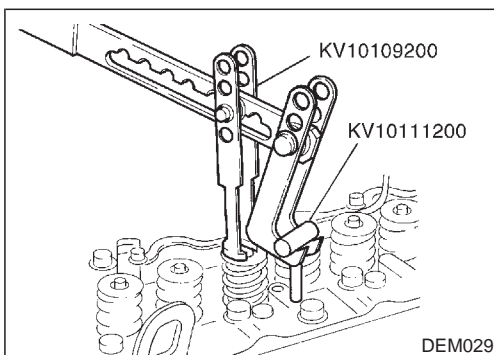
## Disassembly

1. Remove following parts:

- Intake manifold
- Exhaust manifold
- Thermostat housing
- Alternator adjusting bar & engine slinger
- Glow plate and glow plugs



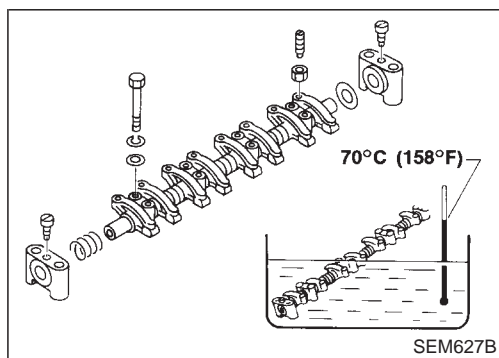
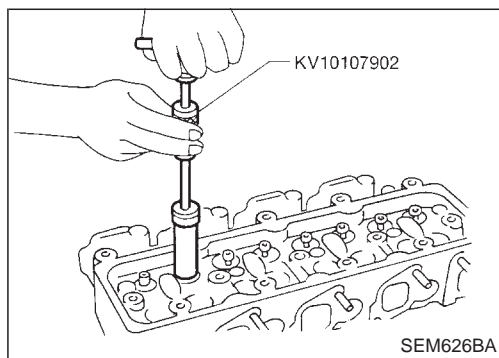
2. Remove valve component parts with Tool.





## Disassembly (Cont'd)

3. Remove valve oil seals with Tool.

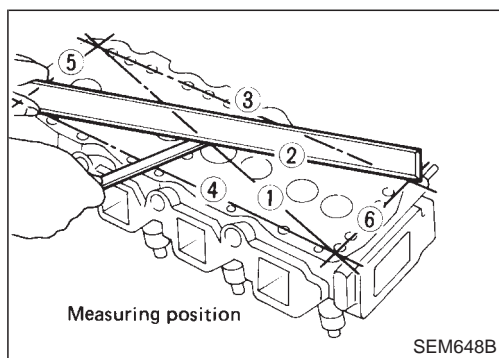


4. Disassemble rocker shaft assembly.

a. Remove rocker shaft lock bolt.

b. Remove valve rocker and rocker shaft bracket.

**If it is difficult to remove rocker shaft bracket, immerse rocker shaft assembly in oil of 70°C (158°F) for a few minutes and then remove bracket.**



## Inspection

## CYLINDER HEAD DISTORTION

Cylinder head distortion: mm (in)

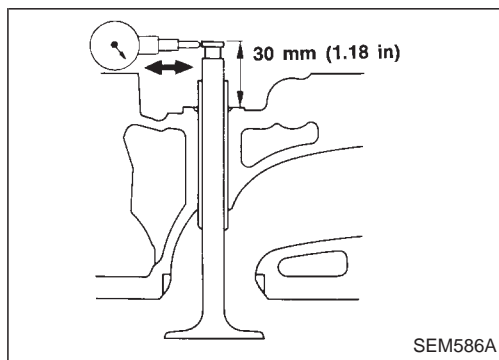
Standard

Less than 0.07 (0.0028)

Limit

0.2 (0.008)

If beyond the specified limit, correct with a surface grinder. Cylinder head height should be greater than 89.7 mm (3.531 in) after surface has been ground.



## VALVE GUIDE CLEARANCE

- Valve guide clearance should be measured parallel with rocker arm. (Generally, a large amount of wear occurs in this direction.)

Stem to guide clearance: mm (in)

Limit

Intake 0.15 (0.0059)

Exhaust 0.20 (0.0079)

Maximum allowable deflection  
(Dial indicator reading)

Intake 0.30 (0.0118)

Exhaust 0.40 (0.0157)

- To determine the correct replacement part, measure valve stem diameter and valve guide inner diameter.

Valve stem diameter: mm (in)

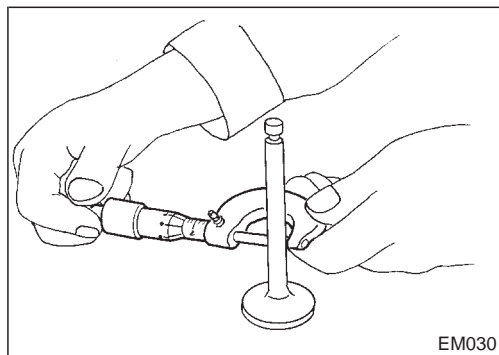
Standard

Intake

7.962 - 7.977 (0.3135 - 0.3141)

Exhaust

7.945 - 7.960 (0.3128 - 0.3134)



GI

MA

EM

LC

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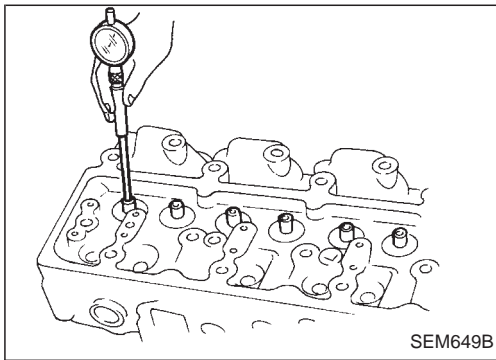
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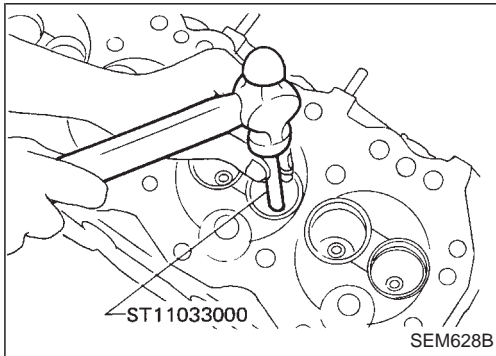
## Inspection (Cont'd)

Valve guide inner diameter:  
8.000 - 8.015 mm (0.3150 - 0.3156 in)

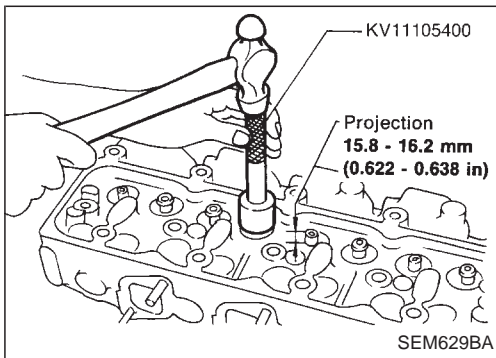


## VALVE GUIDE REPLACEMENT

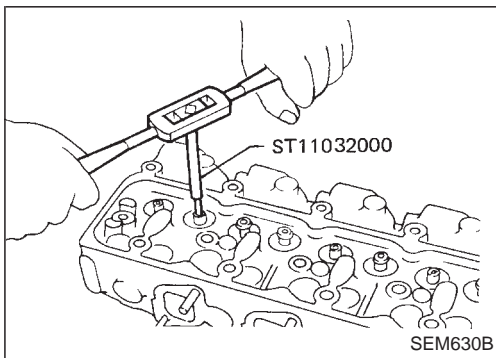
1. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer, and suitable tool.



2. Press service valve guide onto cylinder head using suitable tool until the guide projects out 15.8 to 16.2 mm (0.622 to 0.638 in).



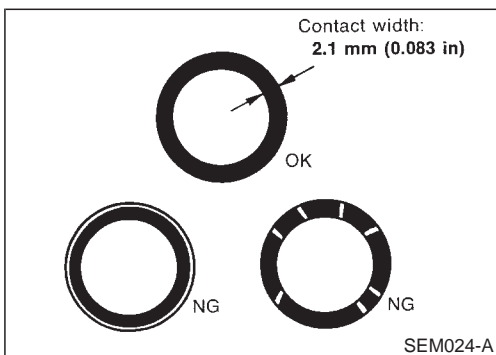
3. Ream valve guide.  
**Finished size:**  
8.000 - 8.015 mm (0.3150 - 0.3156 in)



## VALVE SEATS

Check valve for any evidence of pitting at valve contact surface, and reseal or replace if worn out excessively.

- When repairing valve seats, check valve and valve guide for wear beforehand. If worn, replace them. Then correct valve seat.
- The cutting should be done with both hands for uniform cutting.

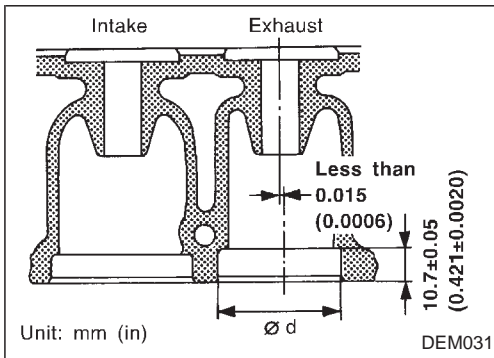
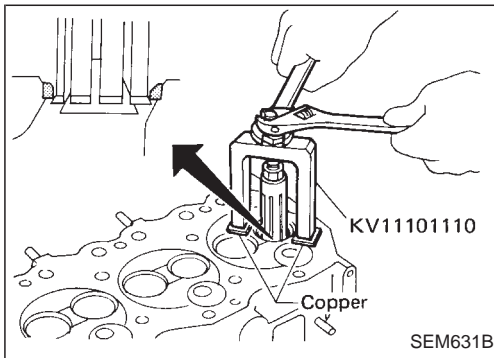


## Inspection (Cont'd)

## REPLACING VALVE SEAT FOR SERVICE PARTS

1. Bore out old seat until it collapses or remove valve seats with Tool.

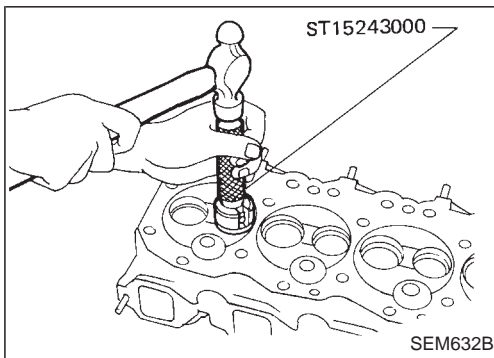
Place a copper seat between contact surface of Tool and cylinder head.



2. If the valve seat for the exhaust side is oversized, machine its mating area (on the cylinder head side) to the dimensions indicated in the table below. Refer to the figure at the left for machining procedures.

Unit: mm (in)

Oversized valve seat	Bore diameter "d"	
	QD32	TD27
0.2 (0.008)	40.695 - 40.710 (1.6022 - 1.6028)	39.695 - 39.710 (1.5628 - 1.5634)
0.4 (0.016)	40.895 - 40.910 (1.6100 - 1.6106)	39.895 - 39.910 (1.5707 - 1.5713)

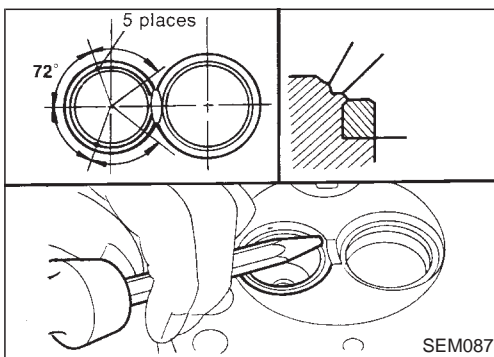


3. Place new valve seats on dry ice and allow them to cool for five minutes.

**WARNING:**

**Do not touch cooled valve seats with bare hand.**

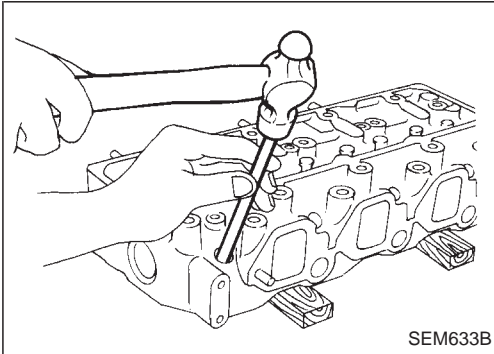
4. Heat cylinder head to 80°C (176°F).
5. Install cooled valve seats on cylinder head with Tool.



6. Stake exhaust valve seat at five places with punch.  
**When staking valve seat, select different places than those staked before.**

**Inspection (Cont'd)**

7. Cut or grind valve seat using suitable tool at the specified dimensions as shown in SDS, EM-198.
8. After cutting, lap valve seat with a lapping compound.
9. Check contact condition of valve seat.

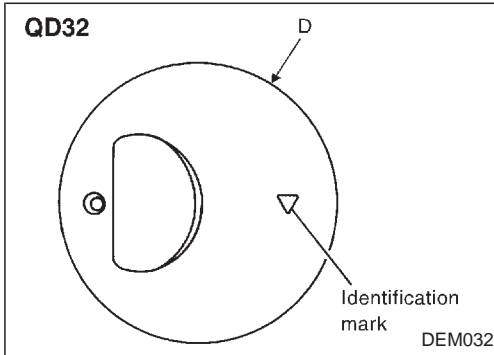
**COMBUSTION CHAMBER**

Check combustion chamber for cracks and other damage. If necessary, replace.

**REPLACING COMBUSTION CHAMBER**

**Usually combustion chamber should not be removed.**

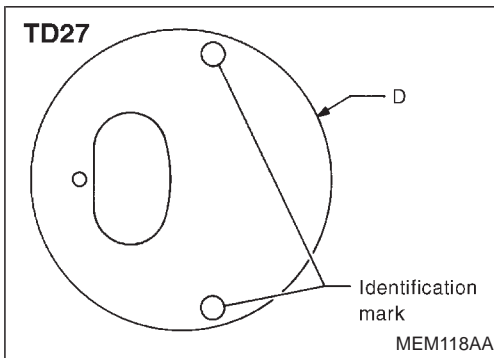
1. Remove combustion chamber so that cylinder head cannot be damaged.



2. Install combustion chamber.

**Identification of combustion chambers**

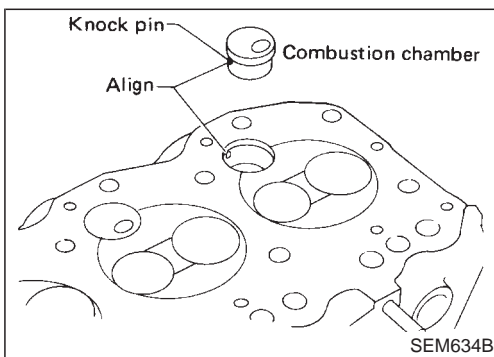
Identification mark (on combustion chamber)	Outer diameter "D" mm (in)	Engine
1 place	37 (1.46)	QD32
2 places		TD27



- (1) Cool combustion chamber with dry ice for approximately 5 to 10 minutes.

**WARNING:**

**Do not touch cooled combustion chamber with bare hand.**



- (2) Align combustion chamber knock pin with cylinder head notch, and drive in combustion chamber with a soft hammer.
3. Check amount of protrusion of combustion chamber.

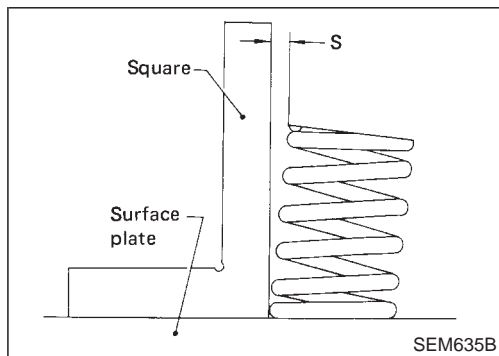
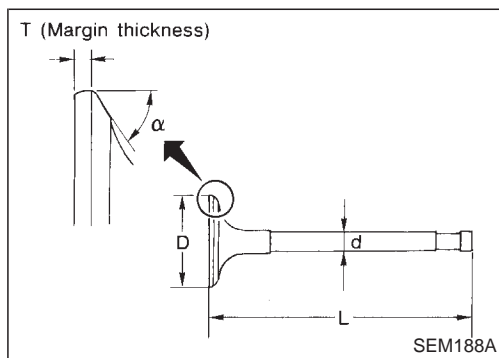
**Protrusion:****Standard**

**-0.05 to 0.10 mm (-0.0020 to 0.0039 in)**

## Inspection (Cont'd)

## VALVE DIMENSIONS

Check dimensions in each valve. For dimensions, refer to SDS. When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace the valve. Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.

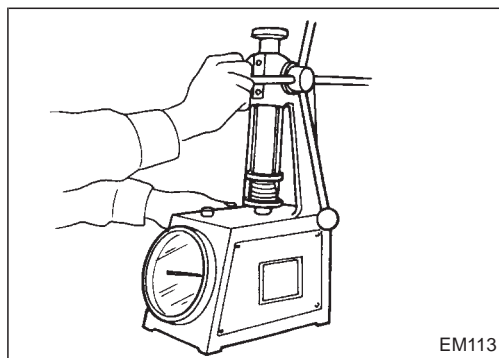


## VALVE SPRING SQUARENESS

Align the valve spring with a square. Rotate the spring to measure any gap between the top of the spring and the square.

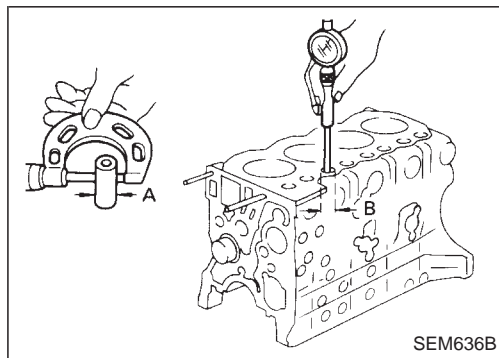
Out-of-square "S":

Less than 2.3 mm (0.091 in)



## VALVE SPRING PRESSURE LOAD

Refer to SDS, EM-197.



## VALVE LIFTER AND PUSH ROD

## Valve lifter

1. Check valve lifters for excessive wear on the face.
2. Replace with new ones if worn beyond repair.

- a. Valve lifter end should be smooth.
- b. Valve lifter to lifter hole clearance: mm (in)

Standard

0.030 - 0.073 (0.0012 - 0.0029)

Limit

Less than 0.20 (0.0079)

Valve lifter outer diameter "A":

Standard

25.960 - 25.970 mm (1.0220 - 1.0224 in)

Cylinder block valve lifter hole diameter "B":

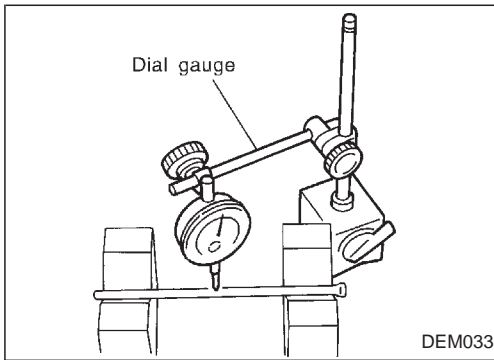
Standard

26.000 - 26.033 mm (1.0236 - 1.0249 in)

## Inspection (Cont'd)

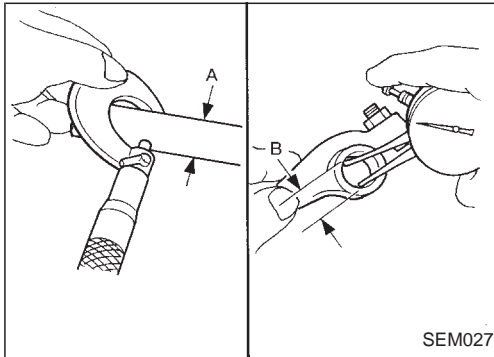
## Push rod

1. Inspect push rod for excessive wear on the face.
2. Replace if worn or damaged beyond repair.
3. Check push rod for bend using a dial gauge.

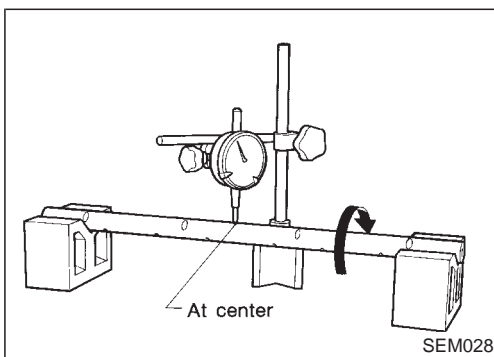
**Maximum allowable bend****(Total indicator reading):****Less than 0.5 mm (0.020 in)**

## ROCKER SHAFT AND ROCKER ARM

1. Check valve rockers, brackets and rocker shafts for scoring, wear or distortion. Replace if necessary.



2. Check clearance between valve rockers and rocker shaft. If specified clearance is exceeded, replace affected valve rockers or shafts.

**Specified clearance: mm (in)****Standard****0.014 - 0.056 (0.0006 - 0.0022)****Limit****Less than 0.15 (0.0059)****Rocker shaft outer diameter "A":****Standard****19.979 - 20.000 mm (0.7866 - 0.7874 in)****Rocker arm inner diameter "B":****Standard****20.014 - 20.035 mm (0.7880 - 0.7888 in)**

3. Check rocker shaft bend at its center. If bend is within specified limit, straighten it; and if it is greater than specified limit, replace rocker shaft.

**Rocker shaft bend****(Total indicator reading):****Limit****Less than 0.3 mm (0.012 in)**

## Inspection (Cont'd)

## MEASURING CYLINDER HEAD TO VALVE DISTANCE

Measure distance from cylinder head surface to intake and exhaust valves. If specified distance is exceeded, replace valve(s) or valve seat(s).

**Specified distance: mm (in)**

**Standard**

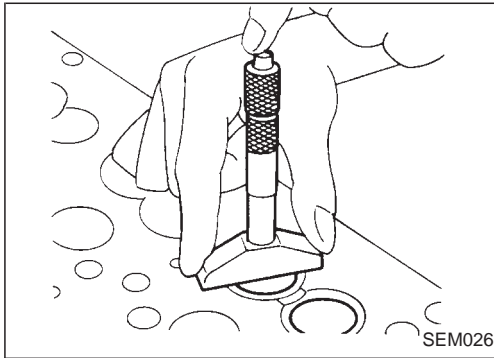
**Intake and Exhaust**

**0.7 - 1.3 (0.028 - 0.051)**

**Limit**

**Less than 1.7 (0.067)**

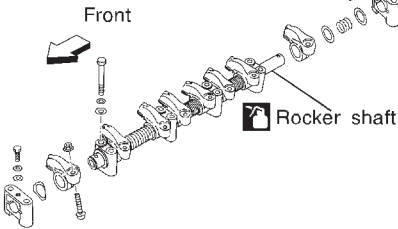
**for intake and exhaust valves**



SEM026

## SEC. 130

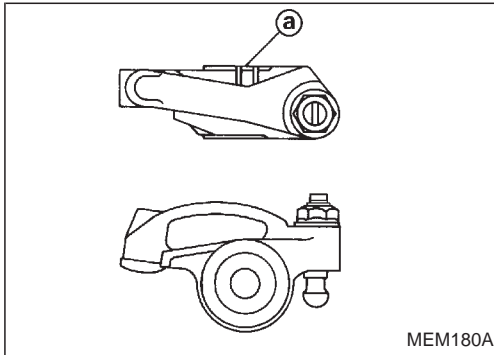
**2.9 - 4.9 N•m**  
(0.3 - 0.5 kg-m,  
26 - 43 in-lb)



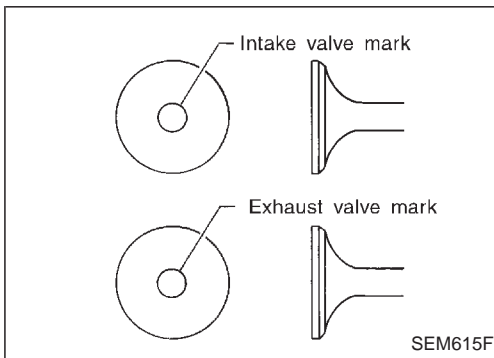
**Rocker shaft**

: Lubricate with new engine oil.

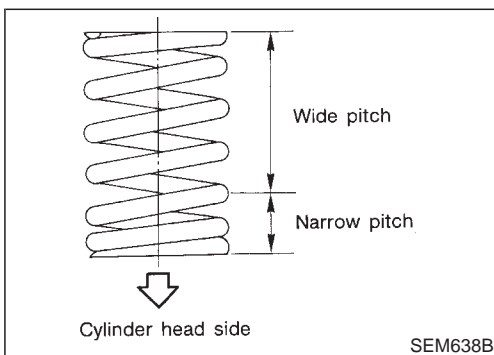
DEM034



MEM180A



SEM615F



SEM638B

## Assembly

1. Assemble rocker shaft component parts.

## Identification of rocker arms

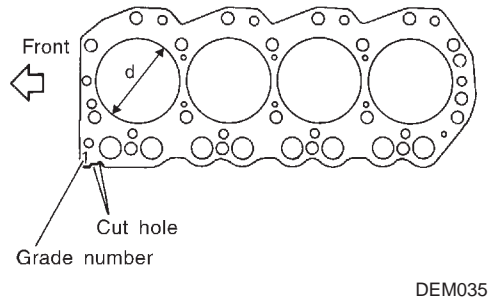
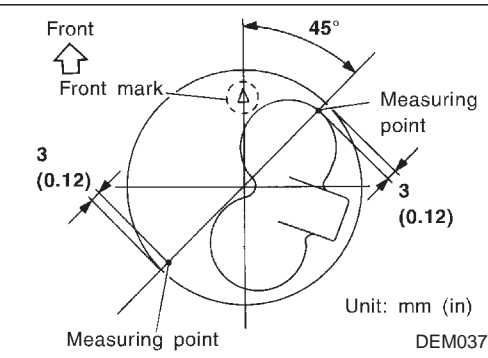
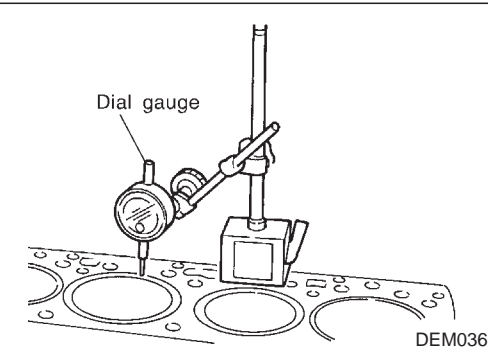
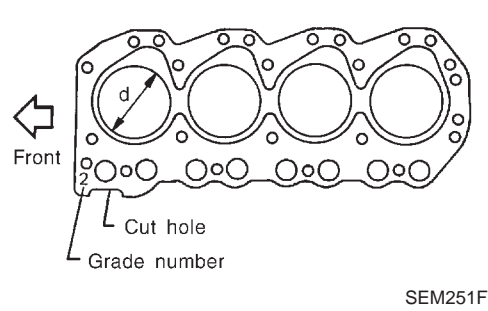
Identification mark (At area (a) on rocker arm)	For use with
Two ridges	Intake
No ridge	Exhaust

2. Install valve component parts.

## Identification of valves

Identification mark (on intake and exhaust valve)		Engine
Intake valve	Exhaust valve	
4	J	QD32
3	C	TD27

- Always use new valve oil seal. (Refer to EM-153.)
- Install valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.

**QD32****TD27****Installation**

1. Install cylinder head gasket.

**Identification of cylinder head gaskets**

Identification cut hole (on cylinder head gas- ket)	Inner diameter "d" mm (in)	Engine
2	100.4 (3.953)	QD32
1	97.5 (3.839)	TD27

- When replacing only cylinder head gasket, install same grade gasket as the one formerly used.
- When replacing or repairing cylinder block, cylinder head, piston, connecting rod and crankshaft, select gasket as follows:

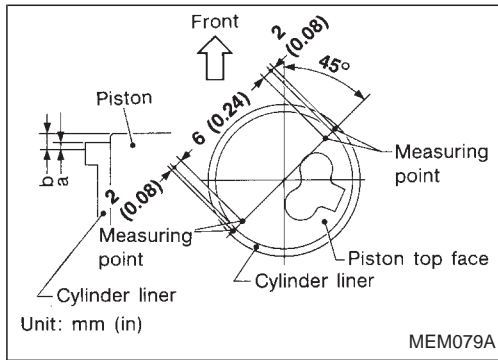
- Selecting gasket thickness (QD32 engine)**

- Measure piston projection from cylinder block surface.
  - Measure the projection (piston height above cylinder block) at two points, when the piston is at the top dead center position.
  - Average the two projections (piston height above cylinder block) for each cylinder  $H_L$ .
- Select suitable cylinder head gasket which conforms to the largest amount of projection of the four pistons.

Unit: mm (in)

Average values piston projections $H_L$	Gasket thickness		Gasket grade number
	New parts	In assembly	
Less than 0.168 (0.0066)	1.35 (0.0531)	1.20 (0.0472)	1
0.168 - 0.218 (0.0066 - 0.0086)	1.40 (0.0551)	1.25 (0.0492)	2
More than 0.218 (0.0086)	1.45 (0.0571)	1.30 (0.0512)	3

**Make sure that No. 1 piston is at TDC on its compression stroke.**



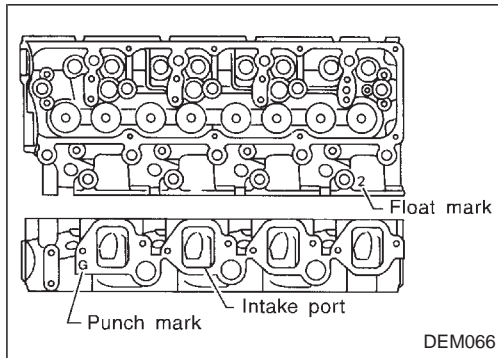
### ● Selecting gasket thickness (TD27 engine)

- (1) Measure piston projection from cylinder block surface.
  - a. Measure the projection a and a' (cylinder liner height above cylinder block) at two points in each cylinder.
  - b. Measure the projection b and b' (piston height above cylinder block) at two points, when the piston is at the top dead center position.
  - c. Calculate the piston height projection above cylinder liner  $b - a$  ( $b' - a'$ ).
  - d. Average the two projections (piston height above cylinder liner) for each cylinder  $H_L$ .
- (2) Select suitable cylinder head gasket which conforms to the largest amount of projection of the four pistons.

Unit: mm (in)

Average values piston projections $H_L$	Gasket thickness		Gasket grade number
	New parts	In assembly	
Less than 0.168 (0.0066)	1.35 (0.0531)	1.20 (0.0472)	2
0.168 - 0.218 (0.0066 - 0.0086)	1.40 (0.0551)	1.25 (0.0492)	3
More than 0.218 (0.0086)	1.45 (0.0571)	1.30 (0.0512)	4

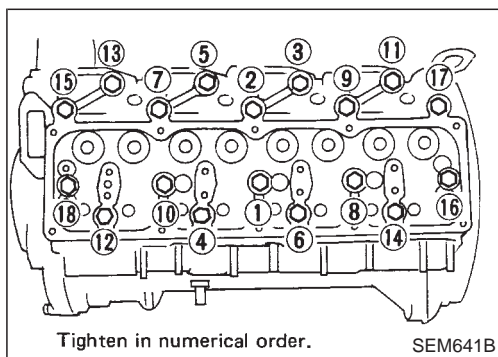
**Make sure that No. 1 piston is at TDC on its compression stroke.**



### 2. Install cylinder head.

#### Cylinder head identification mark

Identification number (on cylinder head)		Engine
Float mark	Punch mark	
5	—	QD32
2	G	TD27



3. Apply oil to the thread portion and seat surface of bolts and tighten cylinder head bolts using Tool.

### CAUTION:

#### ● Tightening procedure

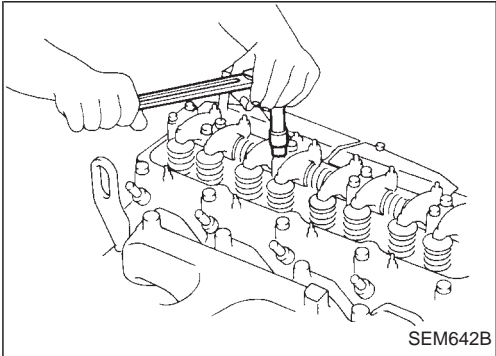
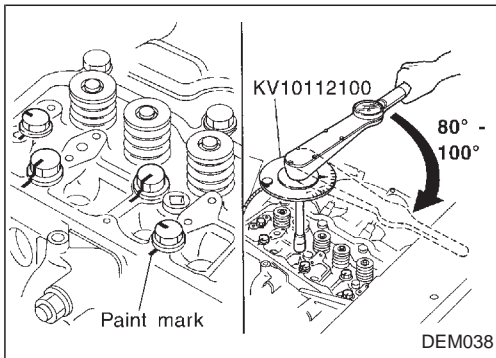
- 1st: Tighten bolts to 39 - 44 N·m  
(4.0 - 4.5 kg-m, 29 - 33 ft-lb).
- 2nd: Tighten bolts to 59 - 64 N·m  
(6.0 - 6.5 kg-m, 43 - 47 ft-lb).



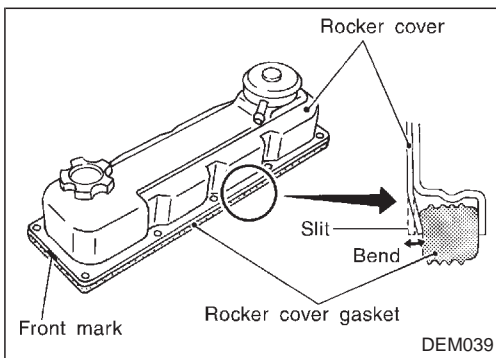
## Installation (Cont'd)

3rd:

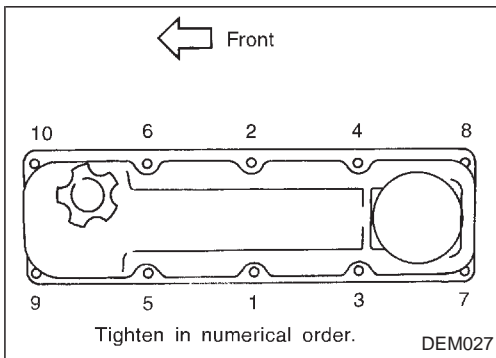
- (1) Mark exhaust side of cylinder head and cylinder head bolts with paint as shown.
  - (2) Turn all bolts  $90 \pm 10$  degrees clockwise.
  - (3) Check that the paint mark of each bolt is facing the front of the vehicle.
- Always check the bolt tightening angle with an angle wrench or protractor. Do not check visually.



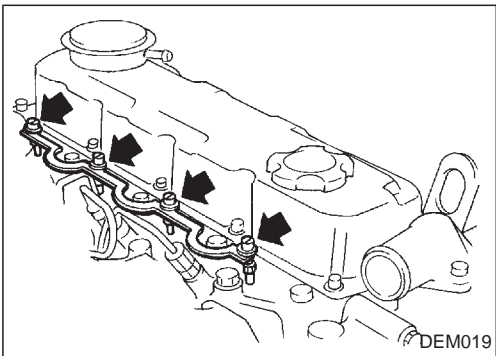
4. Apply engine oil and install push rods.
5. Install rocker shaft assembly.  
Adjust intake and exhaust valve clearance tentatively.  
Refer to "Adjusting Intake and Exhaust Valve Clearance", "ENGINE MAINTENANCE" in MA section.



6. Install rocker cover.
  - Be sure the "F" mark on rocker cover plate faces upward and is at the front end.
  - When replacing rocker cover gasket, bend slit of rocker cover baffle plate a little to hold the gasket. Do not twist gasket.
  - Tighten all bolts in numerical sequence (as shown in the figure at left) to the specified torque.

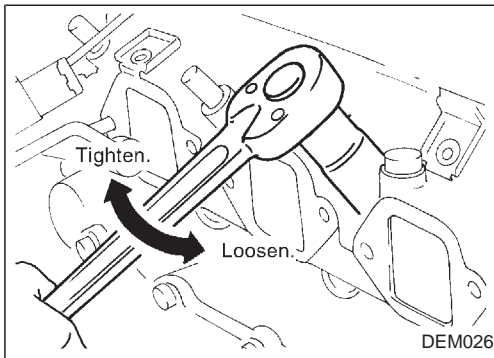


7. Install glow plugs and glow plate.

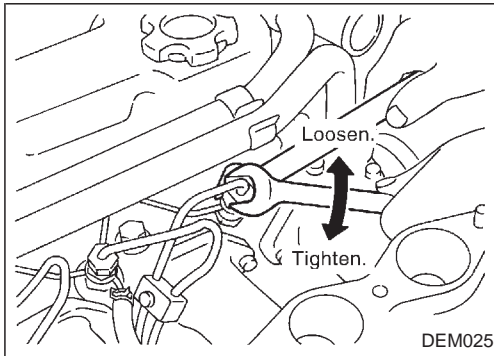


**Installation (Cont'd)**

8. Install new top nozzle gasket and injection nozzle.



9. Install spill tube and injection tube.



10. Connect thermostat housing water inlet hose and radiator hose.  
11. After assembling all disassembled parts, fill radiator and engine with new coolant up to filler opening.

GI

MA

**EM**

LC

EC

FE

CL

MT

TF

PD

FA

RA

BR

ST

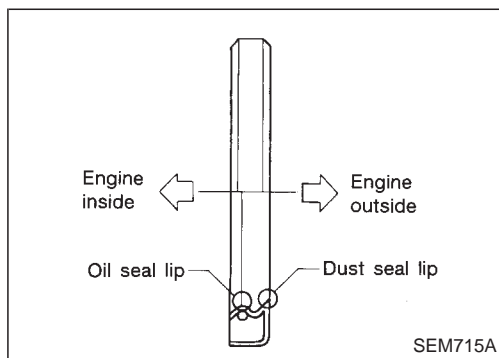
RS

BT

HA

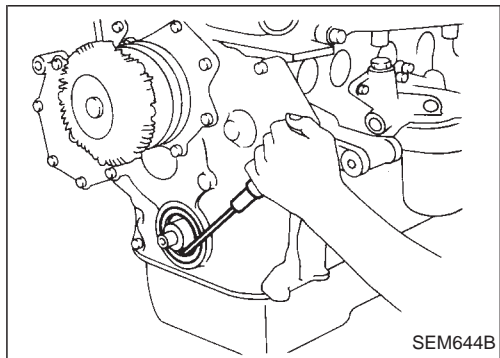
EL

IDX



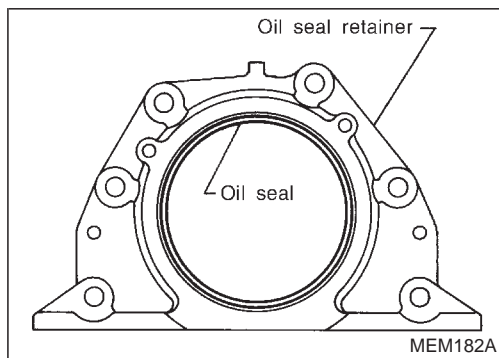
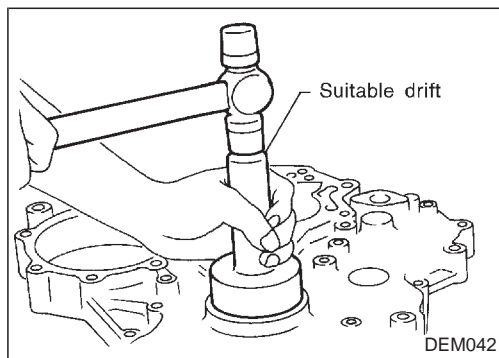
### OIL SEAL INSTALLING DIRECTION

- When installing a new front or rear seal, make sure its mounting direction is correct.



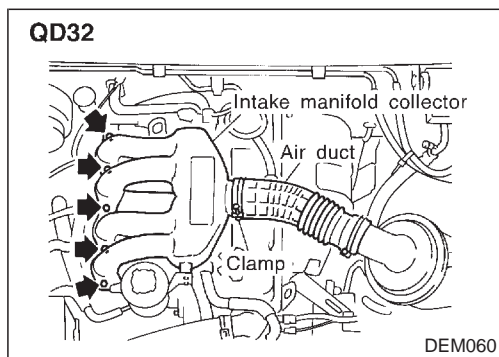
### CRANKSHAFT FRONT OIL SEAL

- Remove radiator shroud.
  - Remove cooling fan.
  - Remove drive belts.
  - Remove crankshaft pulley.
  - Remove crankshaft oil seal.
- Be careful not to damage sealing surfaces of crankshaft.
  - Coat new oil seal with engine oil and install it in place.
  - Press the oil seal until it contacts with the front cover.



### CRANKSHAFT REAR OIL SEAL

- Dismount transmission.
  - Remove clutch cover assembly.
  - Remove flywheel and rear plate.
  - Remove oil pan and oil pan gasket.
  - Remove oil seal retainer assembly and retainer gasket.
- Replace oil seal and retainer assembly as a single unit (mono-block type combined with oil seal).**
  - Coat oil seal with engine oil and install new oil seal retainer assembly in place.



### VALVE STEM OIL SEAL

- Remove following parts.
- Intake manifold collector and air duct (QD32)

GI

MA

EM

LC

EC

FE

CL

MT

TF

PD

FA

RA

BR

ST

RS

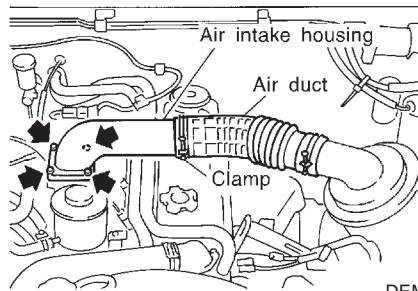
BT

HA

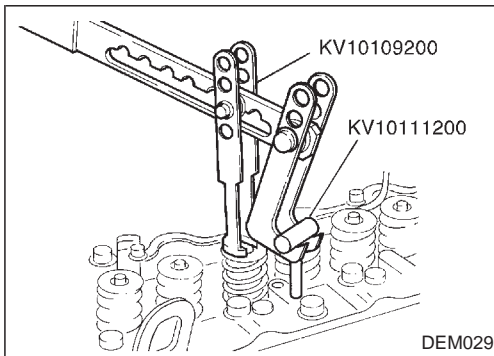
EL

IDX

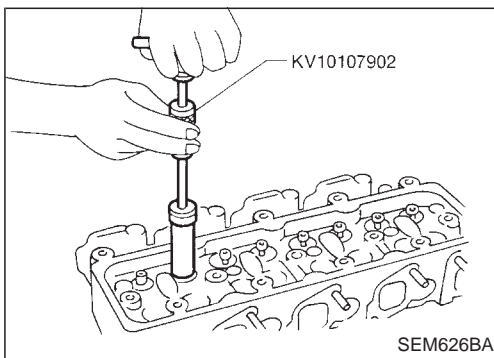
## TD27



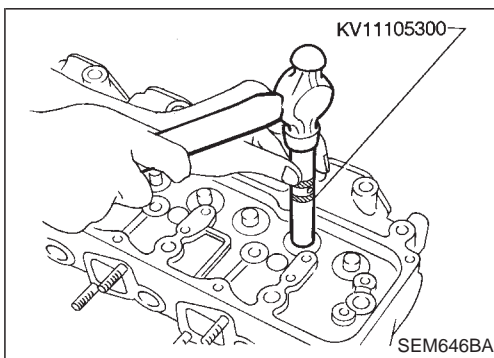
- Air intake housing and air duct (TD27)



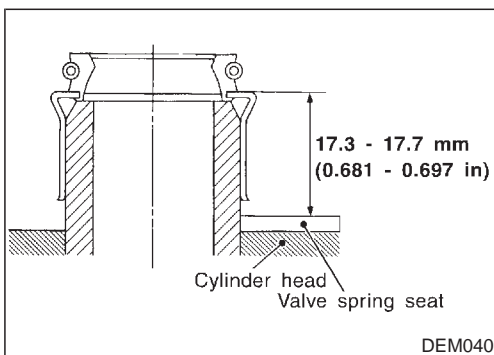
2. Remove rocker cover.
3. Remove rocker shaft assembly.
4. Remove valve spring.

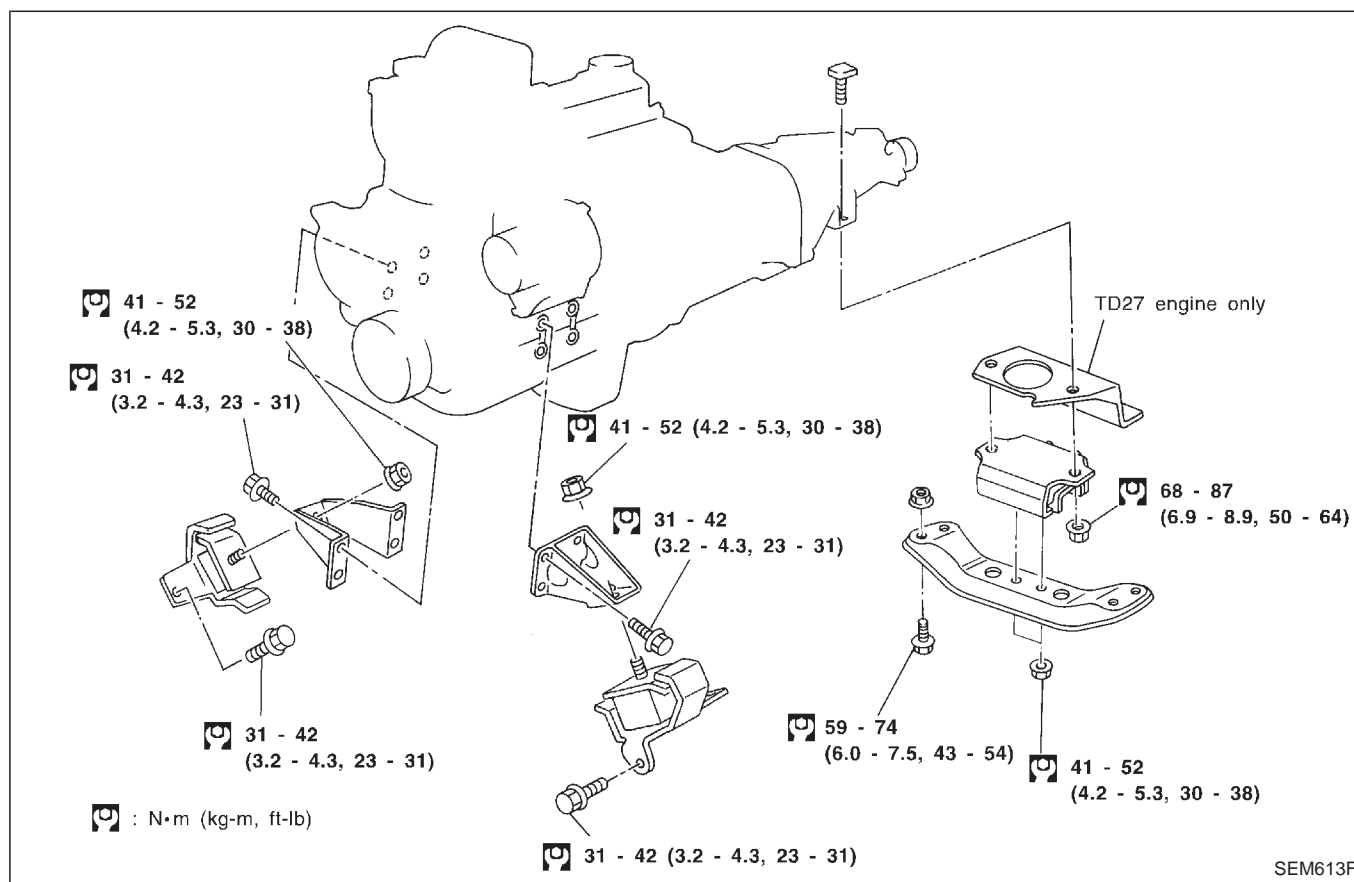


5. Remove valve oil seals.



6. Apply engine oil to valve oil seal and install it in place.

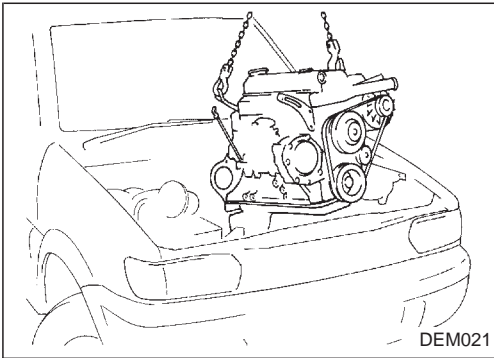


**WARNING:**

- Position vehicle on a flat and solid surface.
- Place chocks at front and back of rear wheels.
- Do not remove engine until exhaust system has completely cooled off.  
Otherwise, you may burn yourself and/or fire may break out in fuel line.
- Be sure to hoist engine and transmission in a safe manner.
- For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.

**CAUTION:**

- When lifting engine, be sure to clear surrounding parts. Take special care near accelerator wire casing, brake lines and brake master cylinder.
- In lifting the engine, always use engine slingers in a safe manner.
- For 4WD models, apply sealant between engine and transmission. Refer to MT section ("Removal and Installation").



## Removal

1. Remove engine undercover and hood.
2. Drain engine coolant.
3. Remove vacuum hoses, fuel tubes, wires, harnesses and connectors and so on.
4. Remove radiator, shroud and cooling fan.
5. Remove drive belts.
6. Remove power steering oil pump and air conditioner compressor.
7. Remove front exhaust tube.
8. Remove transmission from vehicle.

### Refer to MT section.

9. Install engine slingers.
10. Hoist engine with engine slingers and remove engine mounting bolts from both sides.
11. Remove engine from vehicle.

## Installation

- Install in reverse order of removal.

GI

MA

EM

LC

EC

FE

CL

MT

TF

PD

FA

RA

BR

ST

RS

BT

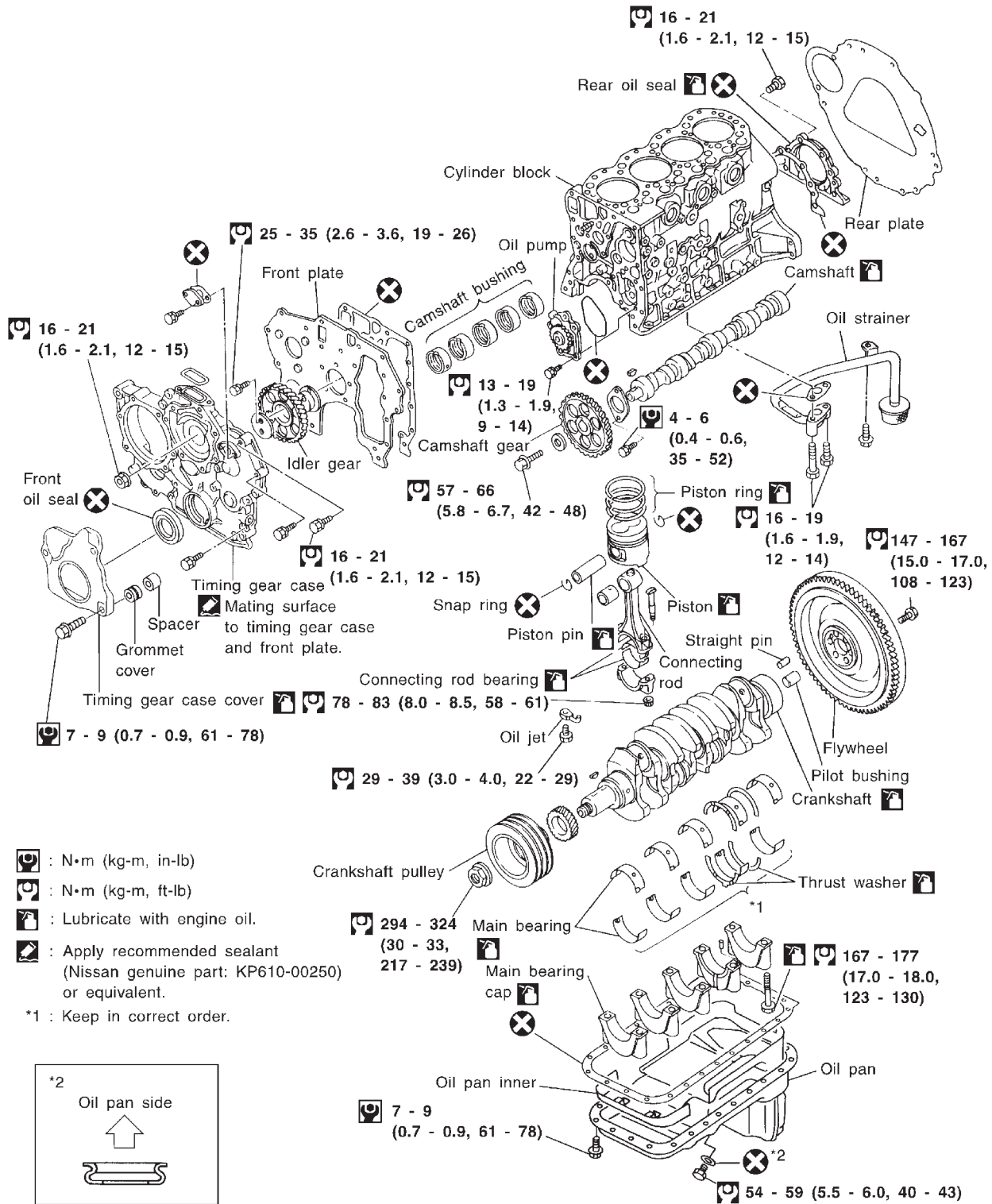
HA

EL

IDX

QD32

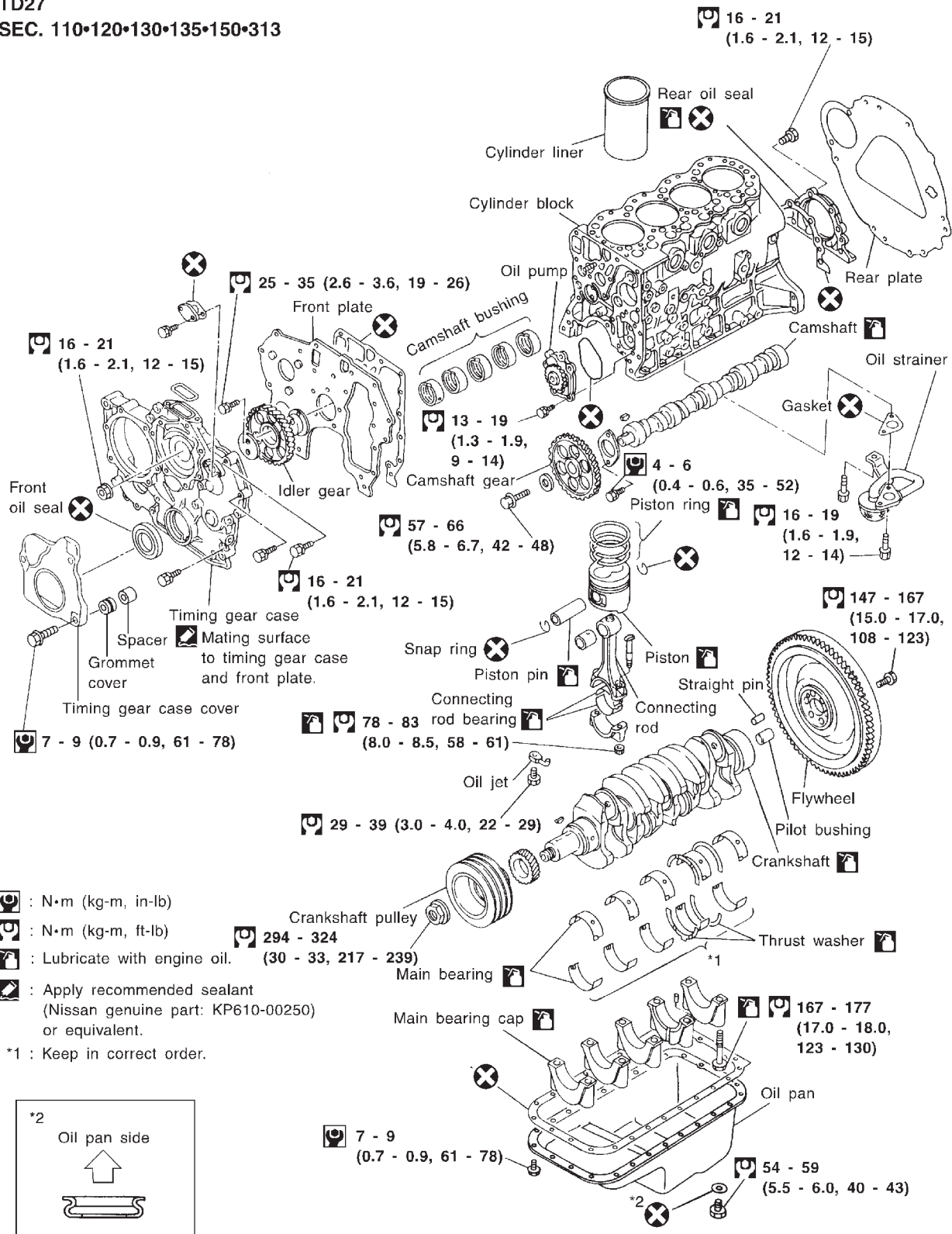
SEC. 110•120•130•135•150•313





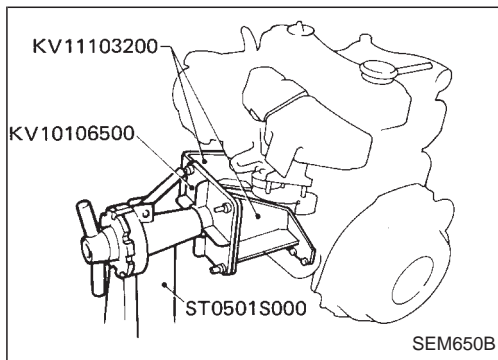
TD27

SEC. 110•120•130•135•150•313



GI  
MA  
EM  
LC  
EC  
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CL  
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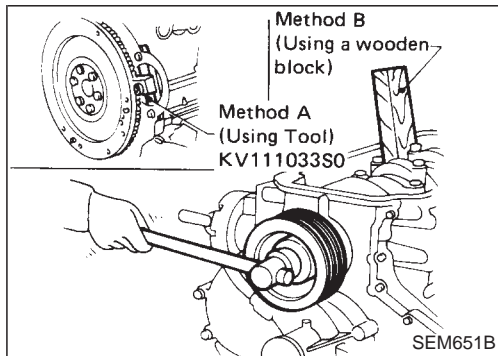




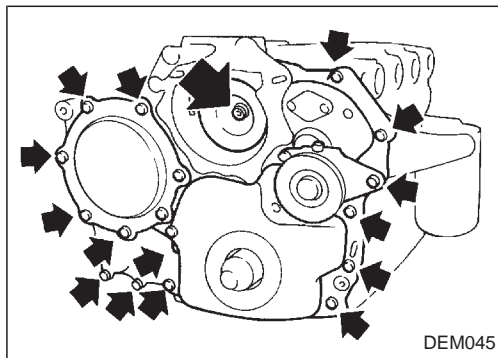
## Disassembly

### PISTON AND CRANKSHAFT

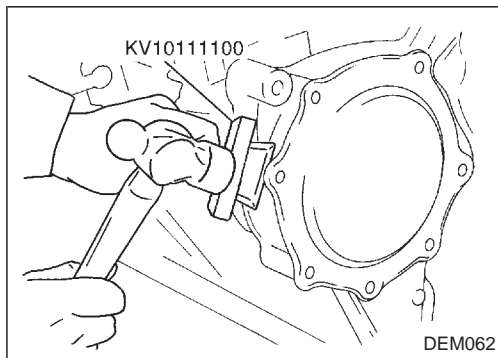
1. Remove oil filter.
2. Place engine on work stand.
3. Drain coolant and oil.
4. Remove drive belts.
5. Remove cylinder head.
6. Remove oil pan.



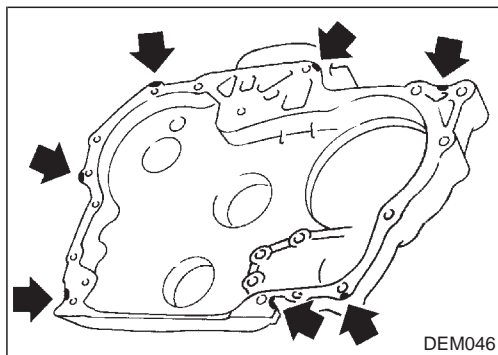
7. Remove crankshaft pulley.



8. Remove water pump.
9. Remove timing gear case.



- Remove dust cover with a seal cutter.

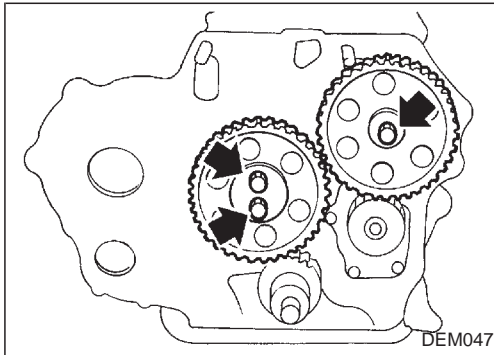
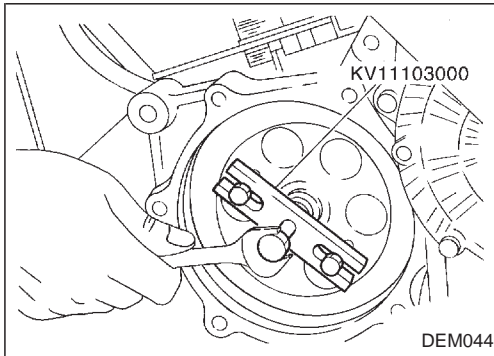
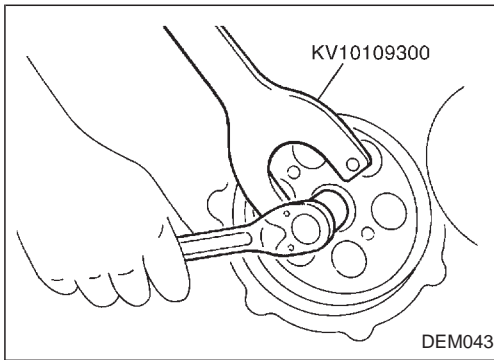


- If the timing case is hard to remove due to liquid gasket, pry it off with a suitable tool at the cutout section.

**Disassembly (Cont'd)**

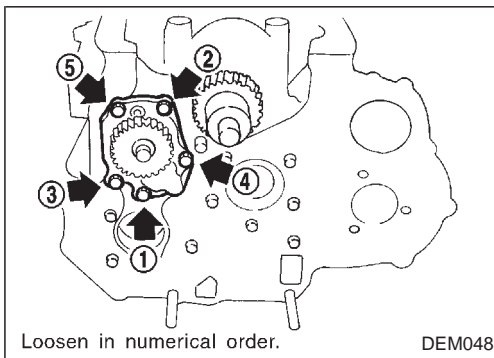
10. Remove injection pump gear.

- Be careful not to lose the woodruff key during injection pump removal.



11. Remove idler gear and idler gear shaft.

12. Remove camshaft gear, camshaft and valve lifters.



13. Remove oil pump assembly.

14. Remove crankshaft gear.

15. Remove flywheel and rear plate.

16. Remove connecting rod caps.

17. Remove pistons.

- Remove the connecting rod in such a way that it does not interfere with oil jet.

GI

MA

EM

LC

EC

FE

CL

MT

TF

PD

FA

RA

BR

ST

RS

BT

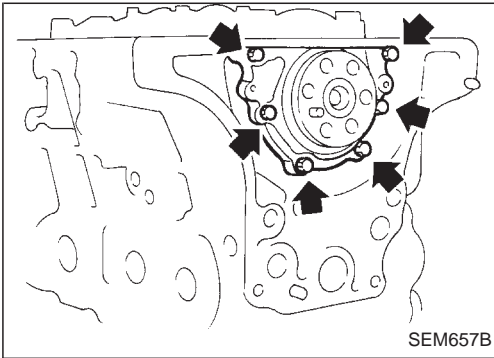
HA

EL

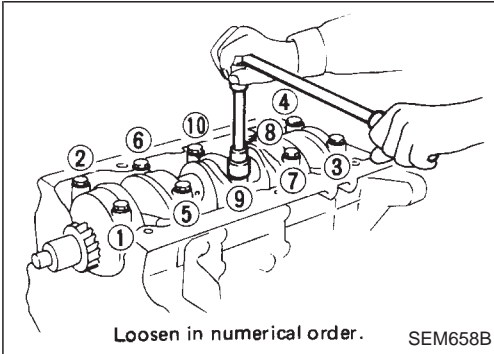
IDX

**Disassembly (Cont'd)**

18. Remove rear oil seal retainer assembly.



19. Remove bearing cap and crankshaft.  
**Place the bearings and caps in their proper order.**

**Inspection and Replacement****CYLINDER BLOCK DISTORTION**

If beyond the specified limit, replace it.

**Cylinder block distortion: mm (in)**

**Standard**

**Less than 0.05 (0.0020)**

**Limit**

**0.2 (0.008)**

- Remove all traces of gasket from the cylinder block. Do not allow pieces of the gasket to enter the oil and cooling water passages during gasket removal.

**CYLINDER BORE WEAR (QD32 engine)**

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

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

**Standard inside diameter:**

**99.200 - 99.230 mm (3.9055 - 3.9067 in)**

**Refer to SDS, EM-200.**

**Wear limit:**

**0.20 mm (0.0079 in)**

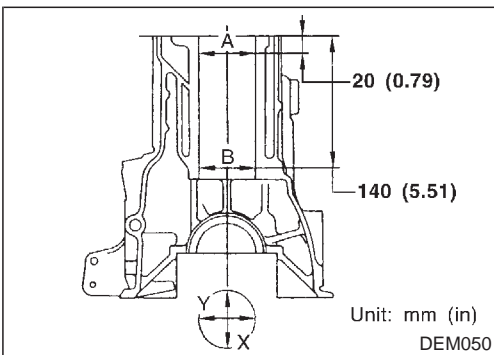
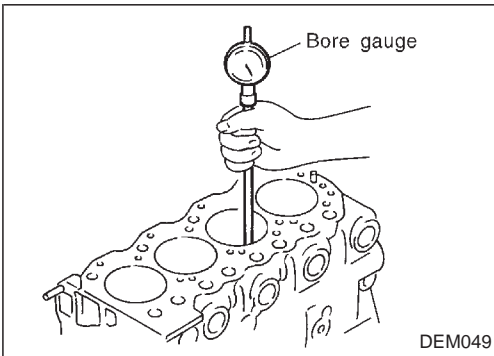
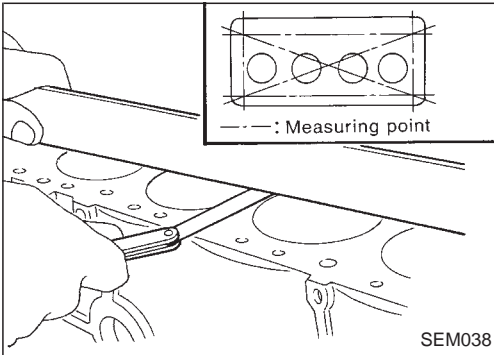
**Out-of-round (X - Y) standard:**

**0.020 mm (0.0008 in)**

**Taper (A - B) standard:**

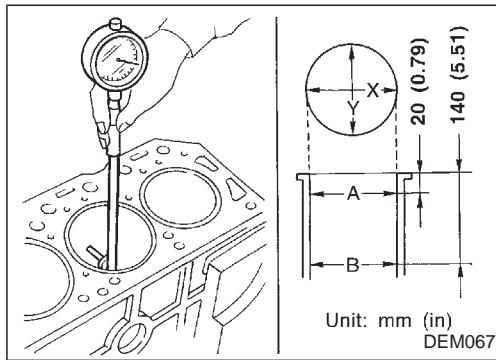
**0.020 mm (0.0008 in)**

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



## Inspection and Replacement (Cont'd)

## CYLINDER LINER WEAR (TD27 engine)



1. Measure cylinder liner bore for out-of-round and taper with a bore gauge. If beyond the limit, replace cylinder liner.

**Standard inside diameter:**

**96.000 - 96.030 mm (3.7795 - 3.7807 in)**

**Refer to SDS, EM-200.**

**Wear limit:**

**0.20 mm (0.0079 in)**

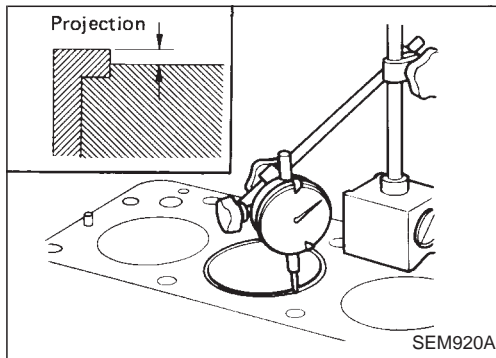
**Out-of-round (X - Y) standard:**

**0.020 mm (0.0008 in)**

**Taper (A - B) standard:**

**0.020 mm (0.0008 in)**

2. Check for scratches or seizure. If seizure is found, replace cylinder liner.



3. Check amount of projection of cylinder liner.

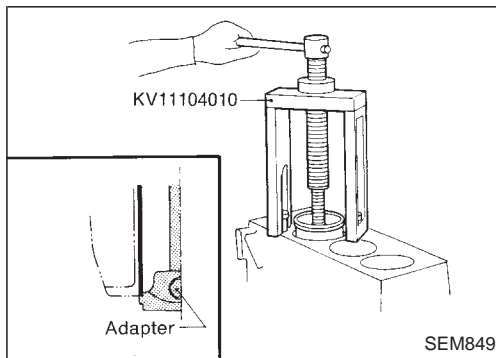
**Cylinder liner projection:**

**Standard**

**0.02 - 0.09 mm (0.0008 - 0.0035 in)**

**Deviation of each cylinder:**

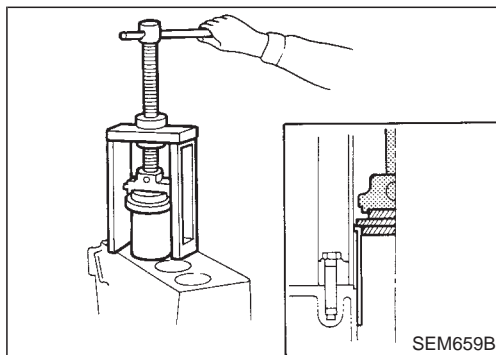
**Less than 0.05 mm (0.0020 in)**



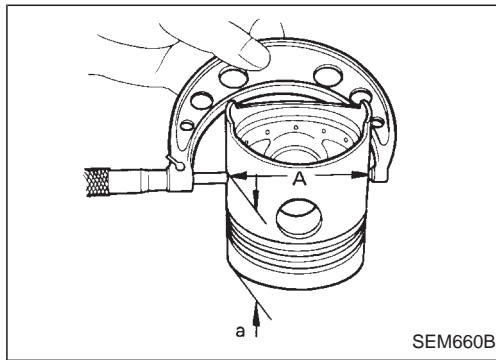
## CYLINDER LINER (TD27 engine)

## Replacement

1. Remove cylinder liner with Tool.



2. Install cylinder liner with Tool.
3. Check amount of projection of cylinder liner.



## Inspection and Replacement (Cont'd)

### PISTON TO CYLINDER WALL CLEARANCE

1. Measure piston and cylinder bore diameter.

**Piston diameter "A":**

Refer to SDS, EM-201.

**Measuring point "a"**

(Distance from the top): mm (in)

QD32

54.8 (2.157)

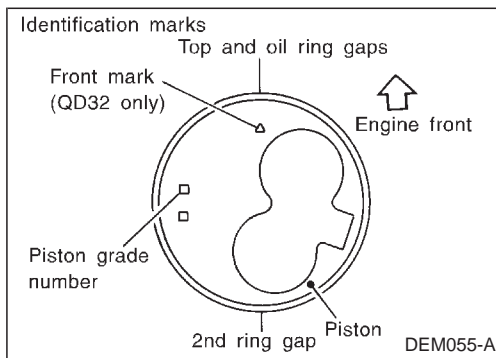
TD27

70 (2.76)

2. Check that piston clearance is within the specification.

**Piston clearance:**

0.05 - 0.07 mm (0.0020 - 0.0028 in)

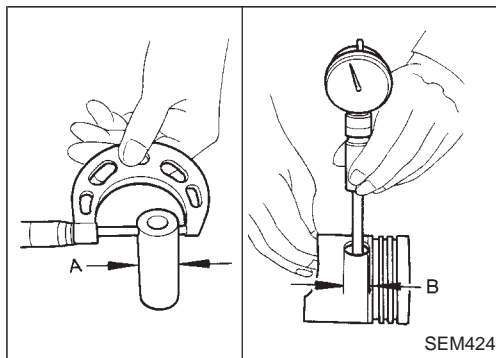


### Combination of piston and cylinder bore

Use the same piston grade in one engine.

Cylinder bore grade number	Piston grade number		
	1	2	3
1	OK	NG	NG
2	Possible	OK	NG
3	Possible	Possible	OK

Refer to SDS, EM-200, for finding cylinder bore grade number.



### PISTON AND PISTON PIN CLEARANCE

Check clearance between pistons and piston pins.

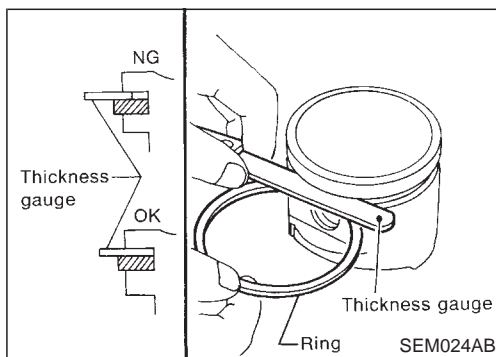
**Clearance (A - B): mm (in)**

**Standard**

-0.003 to 0.012 (-0.0001 to 0.0005)

**Limit**

Less than 0.10 (0.0039)



### PISTON RING SIDE CLEARANCE

**Side clearance: mm (in)**

**Top ring**

0.06 - 0.10 (0.0024 - 0.0039)

**2nd ring**

0.04 - 0.08 (0.0016 - 0.0031)

**Oil ring**

0.02 - 0.06 (0.0008 - 0.0024)

**Max. limit of side clearance: mm (in)**

**Top ring** 0.50 (0.0197)

**2nd ring** 0.30 (0.0118)

**Oil ring** 0.15 (0.0059)

## Inspection and Replacement (Cont'd)

## PISTON RING GAP

Standard ring gap: mm (in)

Top ring

0.30 - 0.45 (0.0118 - 0.0177)

2nd ring

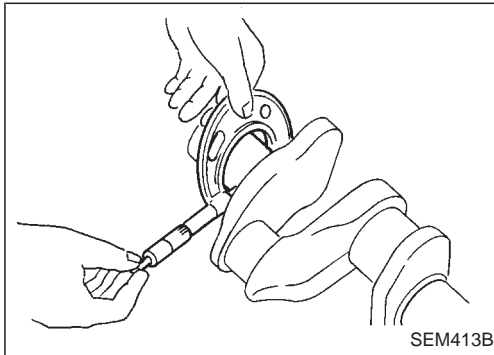
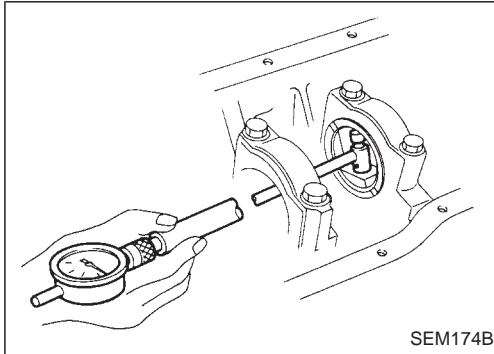
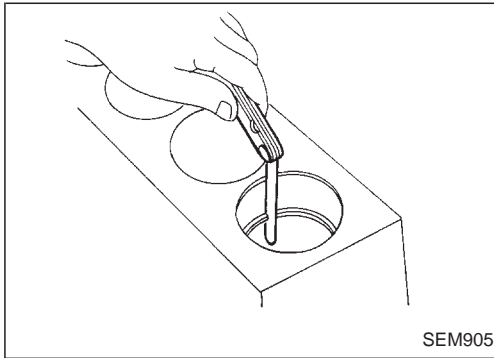
0.50 - 0.65 (0.0197 - 0.0256)

Oil ring

0.30 - 0.50 (0.0118 - 0.0197)

Max. limit of ring gap:

1.5 mm (0.059 in)



## MAIN BEARING CLEARANCE

1. Install main bearings to cylinder block and main bearing cap.
2. Install main bearing cap to cylinder block.
  - Apply engine oil to the thread portion and seating surface of bolts.
  - Tighten all bolts with specified torque in correct order and in two or three stages. Refer to EM-174.
3. Measure inside diameter "A" of main bearing.

4. Measure outside diameter "Dm" of main journal in crankshaft.
5. Calculate main bearing clearance.

Main bearing clearance = A - Dm

Standard:

0.035 - 0.087 mm (0.0014 - 0.0034 in)

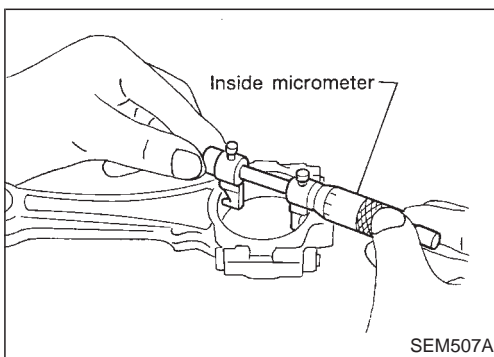
Limit:

Less than 0.15 mm (0.0059 in)

## CONNECTING ROD BEARING CLEARANCE

1. Install connecting rod bearing to connecting rod and cap.
2. Install connecting rod cap to connecting rod and tighten with specified torque.

Apply engine oil to the thread portion of bolts and seating surface of nuts.



3. Measure inside diameter "A" of bearing.
4. Measure outside diameter "Dp" of pin journal in crankshaft.
5. Calculate connecting rod bearing clearance.

Connecting rod bearing clearance = A - Dp

Standard:

0.035 - 0.081 mm (0.0014 - 0.0032 in)

Limit:

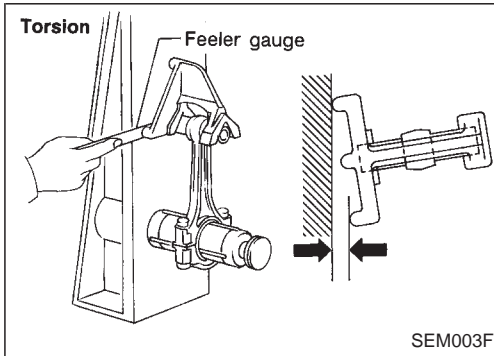
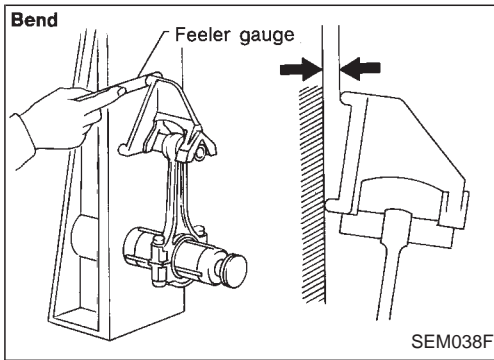
Less than 0.15 mm (0.0059 in)

**Inspection and Replacement (Cont'd)****CONNECTING ROD BEND AND TORSION**

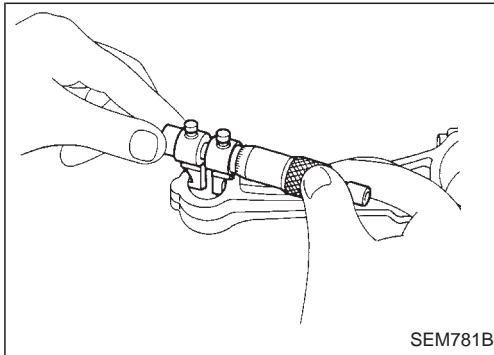
Bend and torsion: mm (in)

Limit

0.075 (0.0030) per 100 (3.94) length

**CONNECTING ROD SMALL END BUSHING CLEARANCE**

1. Measure inside diameter "A" of connecting rod small end bushings.



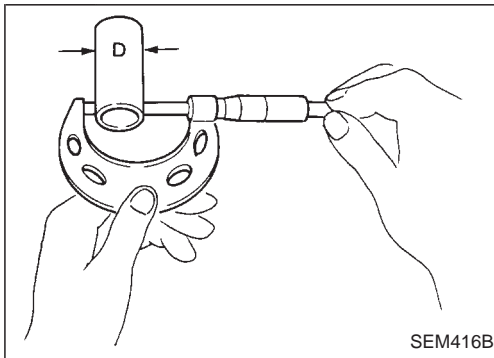
2. Measure outside diameter "D" of piston pin.
3. Calculate connecting rod small end bushing clearance.  
Connecting rod small end bushing clearance = A - D

**Standard:**

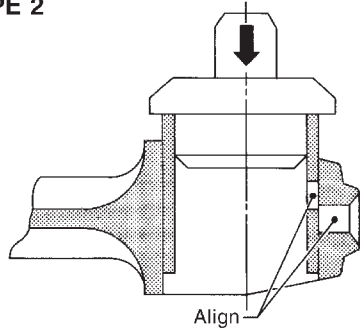
0.025 - 0.045 mm (0.0010 - 0.0018 in)

**Limit:**

0.15 mm (0.0059 in)



TYPE 2



## Inspection and Replacement (Cont'd)

### REPLACEMENT OF CONNECTING ROD SMALL END BUSHING

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

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

2. After driving in the small end bushing, ream the bushing.

**Small end bushing inside diameter: mm (in)**

**Finished size**

**QD32**

**33.025 - 33.038 (1.3002 - 1.3007)**

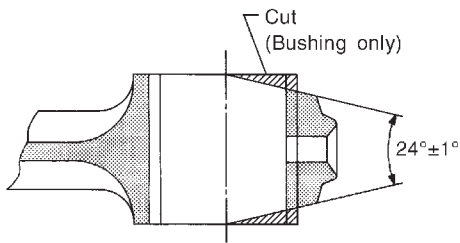
**TD27**

**30.025 - 30.038 (1.1821 - 1.1826)**

3. Machine the bushing to match the tapered surface of the connecting rod small end.

4. Remove burrs from the machined bushing.

TYPE 2



## CRANKSHAFT

1. Check crankshaft journals and pins for score, bias, wear or cracks. If faults are minor, correct with fine crocus cloth.
2. Check journals and pins with a micrometer for taper and out-of-round.

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

**Standard**

**Less than 0.01 (0.0004)**

**Limit**

**0.02 (0.0008)**

**Taper (A - B): mm (in)**

**Standard**

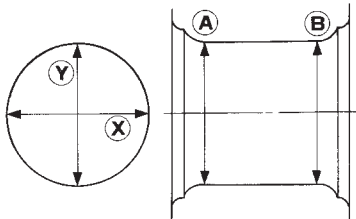
**Less than 0.01 (0.0004)**

**Limit**

**0.02 (0.0008)**

Out-of-round  
Taper

(X) - (Y)  
(A) - (B)



3. Check crankshaft runout.

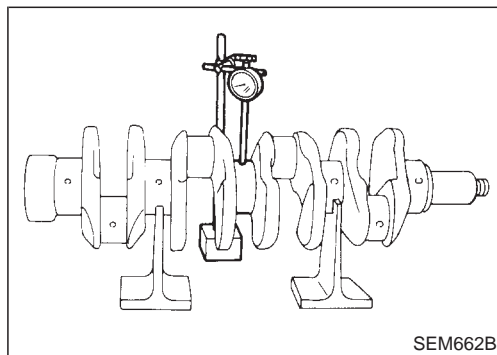
**Runout [TIR (Total Indicator Reading)]: mm (in)**

**Standard**

**0 - 0.03 (0 - 0.0012)**

**Limit**

**0.10 (0.0039)**





## Inspection and Replacement (Cont'd)

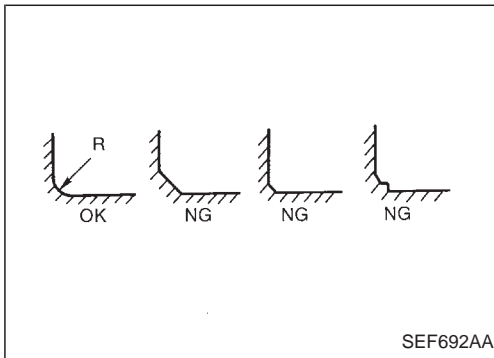
### RESURFACING OF CRANKSHAFT JOURNAL AND CRANK PIN

When using undersize main bearings and connecting rod bearings, the crankshaft journals or crank pins must be finished to match the bearings.

R: Crank journal 3.0 mm (0.118 in)  
Crank pin 3.5 mm (0.138 in)

#### CAUTION:

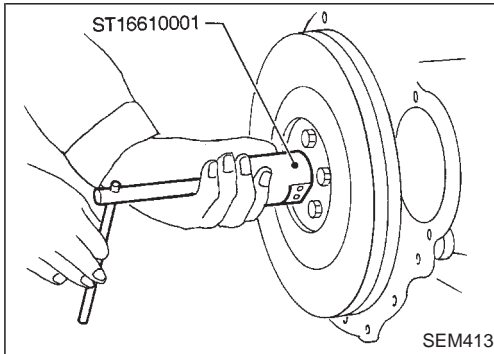
- At the same time make sure that the surface width does not increase.
- Do not attempt to cut counterweight of crankshaft.



### CRANKSHAFT PILOT BUSHING

#### Replacement

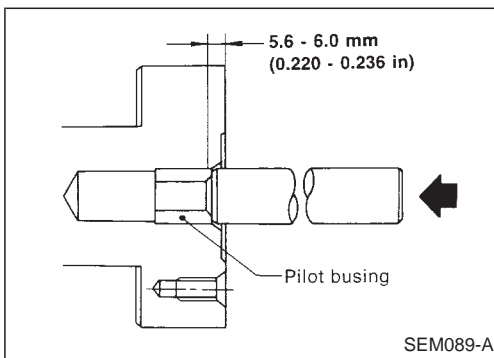
- Pull out bushing with Tool.



- Insert pilot bushing until distance between flange end and bushing is specified value.

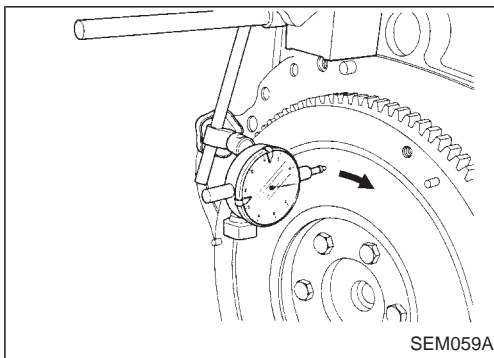
#### Distance:

Approx. 5.6 - 6.0 mm (0.220 - 0.236 in)



### FLYWHEEL RUNOUT

Runout (Total indicator reading):  
Less than 0.15 mm (0.0059 in)

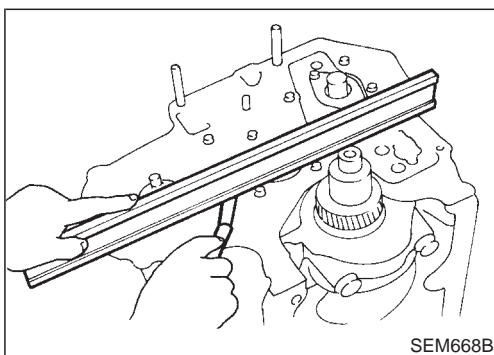


### FRONT PLATE

Check front plate for warpage. If not within the limit, make flat or replace front plate.

#### Warpage limit:

0.2 mm (0.008 in)



## Inspection and Replacement (Cont'd)

## GEAR TRAIN

**Camshaft drive gear, injection pump drive gear, oil pump gear, idler gear and crankshaft gear**

1. If gear tooth and key have scratches or are excessively worn, replace gear and key.
2. Check gear train backlash before disassembling and after assembling.

Method A (Using dial gauge)

Method B (Using fuse wire)

If beyond the limit, replace gear.

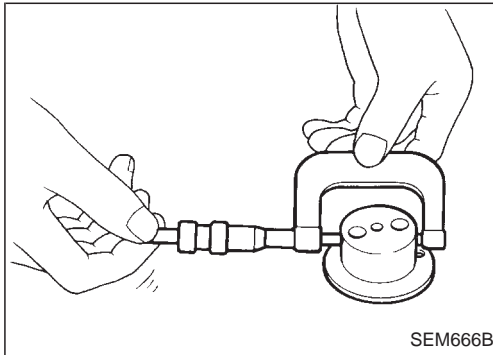
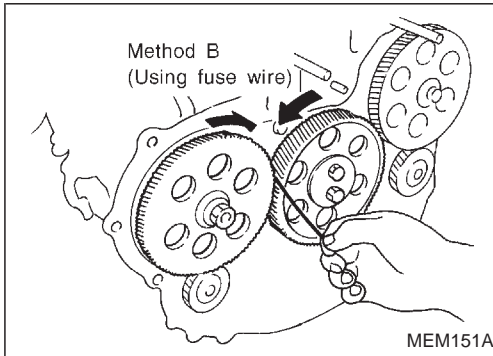
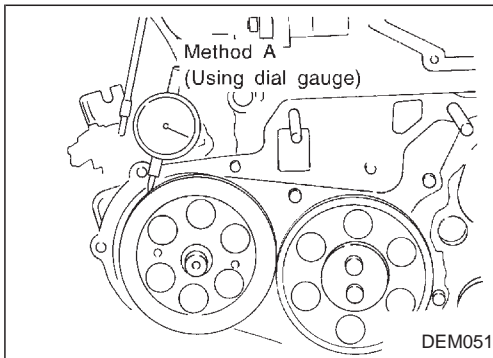
**Backlash: mm (in)**

**Standard**

**0.07 - 0.11 (0.0028 - 0.0043)**

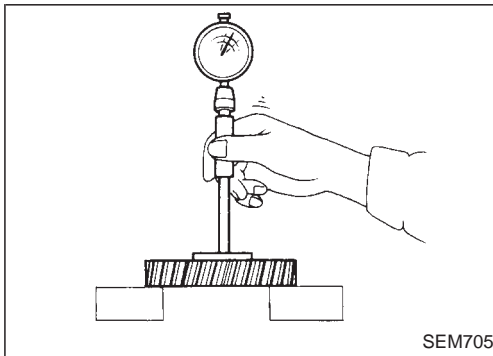
**Limit**

**0.20 (0.0079)**



## IDLER GEAR BUSHING CLEARANCE

1. Measure idler gear shaft outer diameter.



2. Measure idler gear bushing inner diameter.
3. Calculate idler gear bushing clearance.

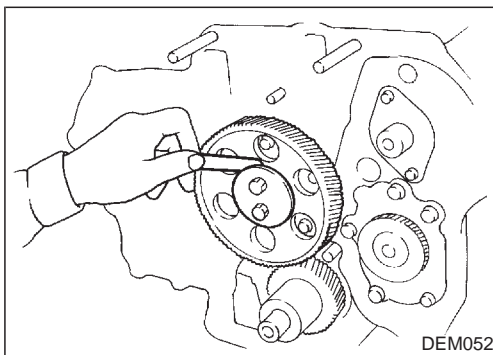
**Bushing clearance: mm (in)**

**Standard**

**0.025 - 0.061 (0.0010 - 0.0024)**

**Limit**

**0.20 (0.0079)**



## IDLER GEAR END PLAY

Measure idler gear end play between gear plate and gear.

**Idler gear end play: mm (in)**

**Standard**

**0.03 - 0.14 (0.0012 - 0.0055)**

**Limit**

**Less than 0.3 (0.012)**

## Inspection and Replacement (Cont'd)

### REPLACEMENT OF IDLER GEAR BUSHING

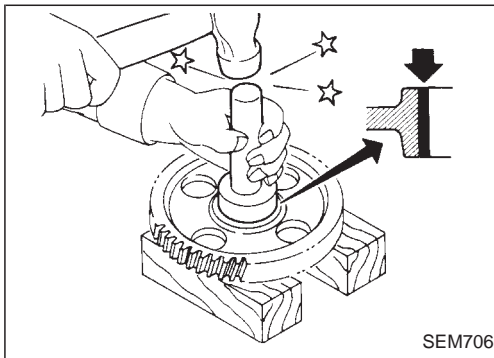
1. Use a suitable tool to replace bushing.
2. Ream idler gear bushing.

**Finished size:**

**42.00 - 42.02 mm (1.6535 - 1.6543 in)**

### Idler gear shaft

Install idler gear shaft so that oil hole of shaft faces upward.



SEM706

## CAMSHAFT AND CAMSHAFT BUSHING

### Camshaft bushing clearance

Measure inside diameter of camshaft bushing and outside diameter of camshaft journal with a suitable gauge.

**Clearance between camshaft and bushing**

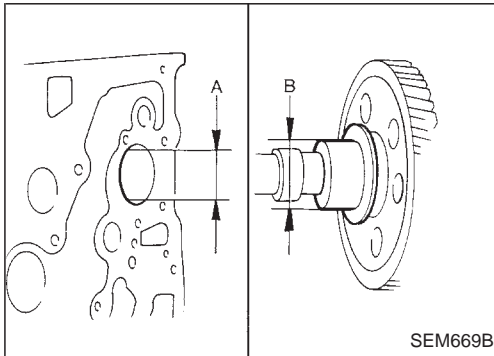
**(A - B): mm (in)**

**Standard**

**0.020 - 0.109 (0.0008 - 0.0043)**

**Limit**

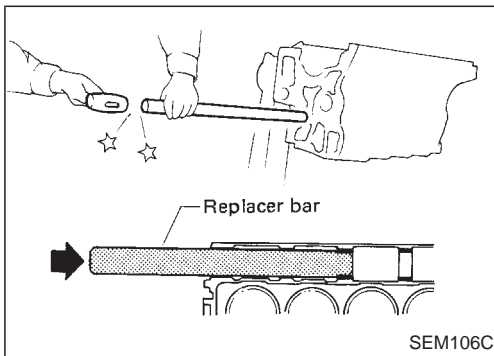
**Less than 0.15 (0.0059)**



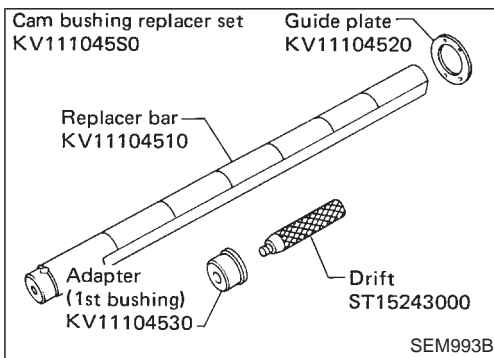
SEM669B

## REPLACING CAMSHAFT BUSHING

1. Using Tool, remove camshaft bushings from the engine. Some bushings must be broken in order to remove.

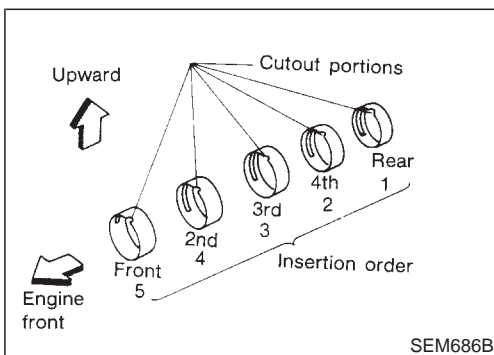


SEM106C



SEM993B

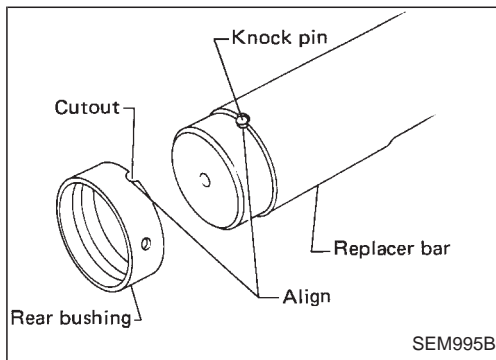
2. Using Tool, install camshaft bushings as follows:



SEM686B

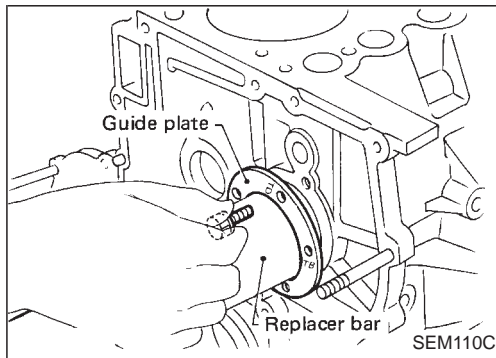
- (1) Install camshaft bushings in the order of "rear", "4th", "3rd", "2nd" and "front". All bushings must be installed from the front.
- (2) Face the cutout upward and toward the front of the engine during installation.

## Inspection and Replacement (Cont'd)



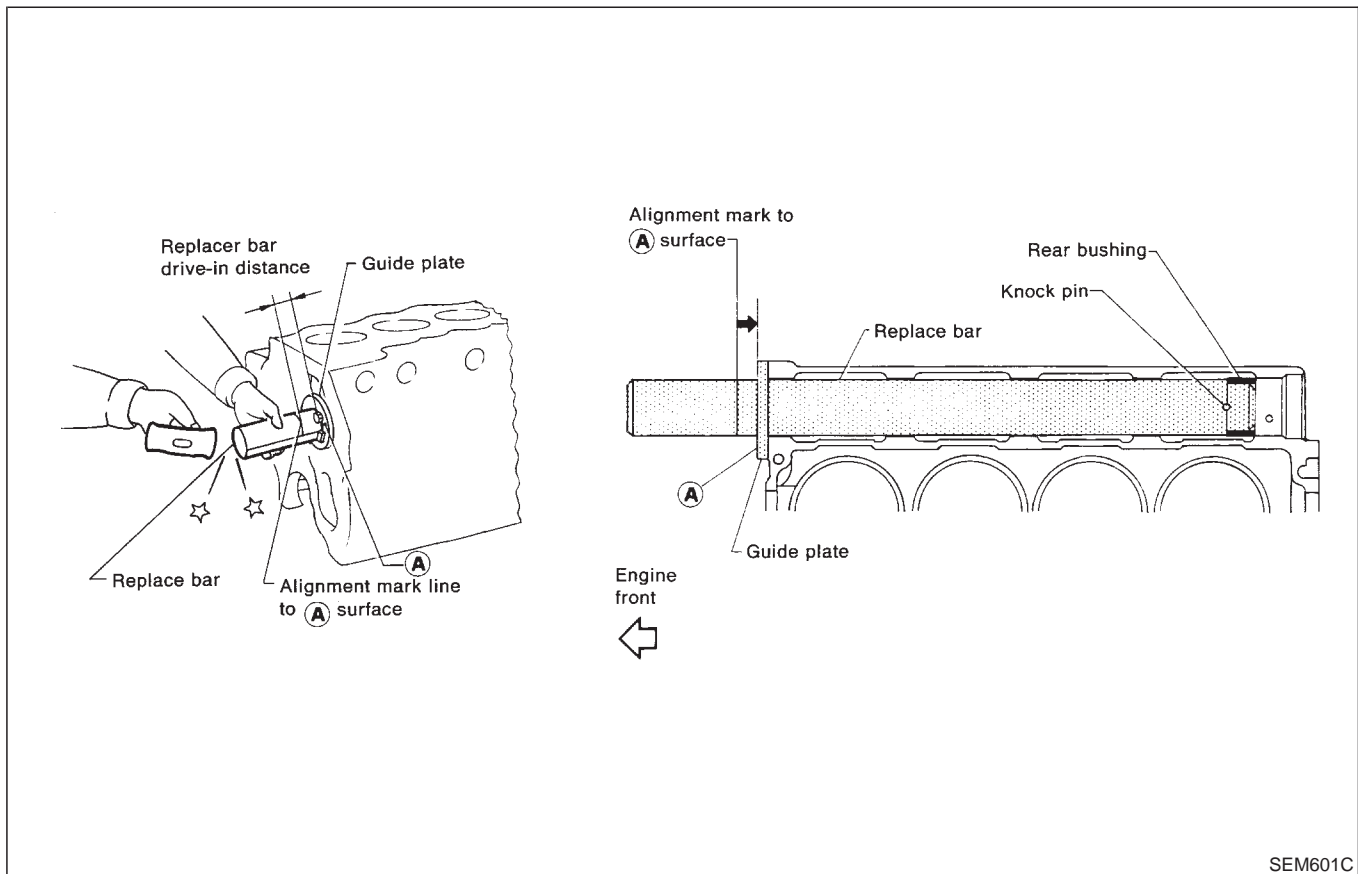
## (3) Rear camshaft bushing

- Align the cutout of rear bushing with knock pin of replacer bar before installation.



- Insert rear bushing with replacer bar into the engine. Install guide plate with bolt holes (on the "TD" mark side) facing upper side of cylinder block. Tighten bolts.

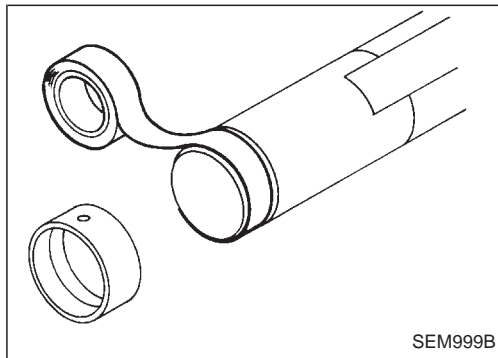
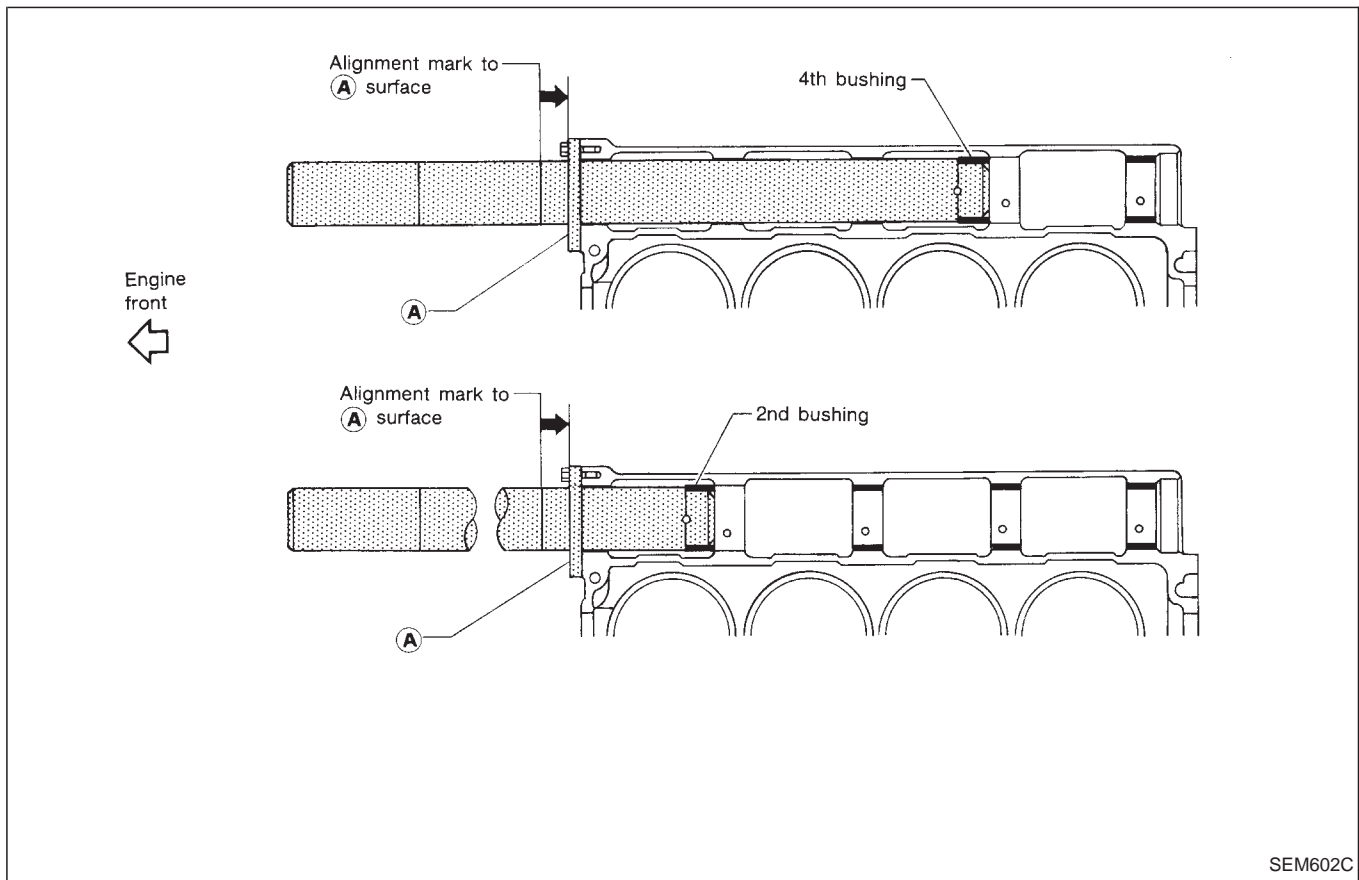
- Drive replacer bar until the alignment mark on replacer bar is aligned with the end of replacer guide. Remove replacer set. After installation, check that oil holes in camshaft bushings are aligned with oil holes in cylinder block.



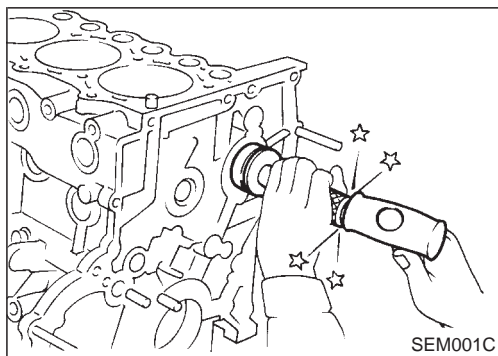
**Inspection and Replacement (Cont'd)**

(4) 4th, 3rd and 2nd camshaft bushings

- Install in the same manner as rear camshaft bushing.



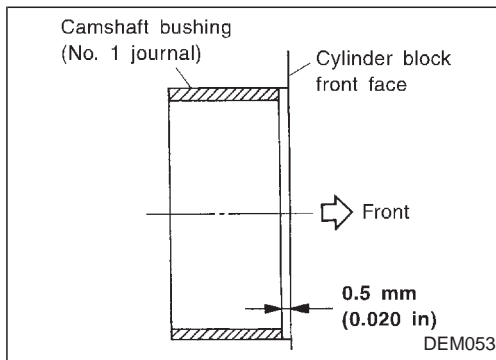
- When setting 4th through 2nd bushings on replacer bar, tape the bar to prevent movement.



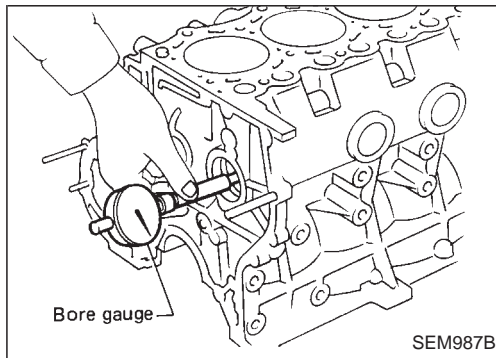
(5) Front camshaft bushing

- Using 1st bushing adapter, position front camshaft bushing so that oil hole in cylinder block is aligned with oil hole in bushing.

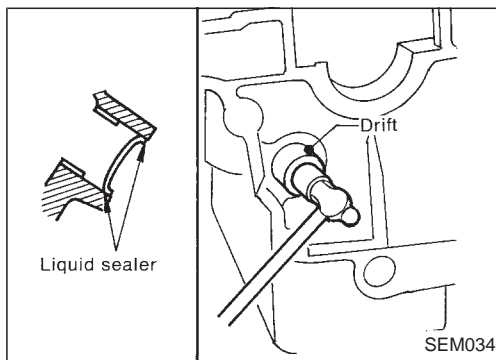
## Inspection and Replacement (Cont'd)



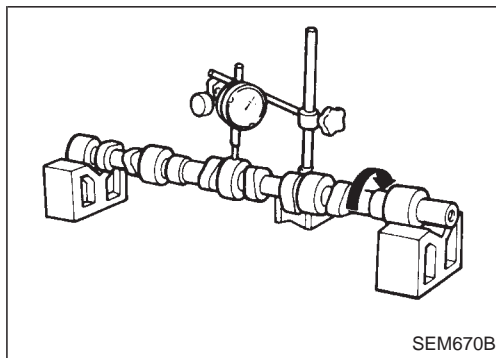
- Press the bushing until its front end is 0.5 mm (0.020 in) from the front surface of the cylinder block.



- Check camshaft bushing clearance.  
**Refer to SDS, EM-199.**



- Install new welch plug into rear camshaft bushing hole with a drift.  
**Apply liquid sealer.**



## CAMSHAFT ALIGNMENT

- Check camshaft journal and cam surface for bend, wear or damage.  
If fault is beyond limit, replace.
- Check camshaft bend at center journal.  
If bend is greater than specified limit, repair or replace camshaft.

**Camshaft bend**  
**(Total indicator reading): mm (in)**  
**Standard**  
 Less than 0.02 (0.0008)  
**Limit**  
 Less than 0.06 (0.0024)

GI

MA

EM

LC

EC

FE

CL

MT

TF

PD

FA

RA

BR

ST

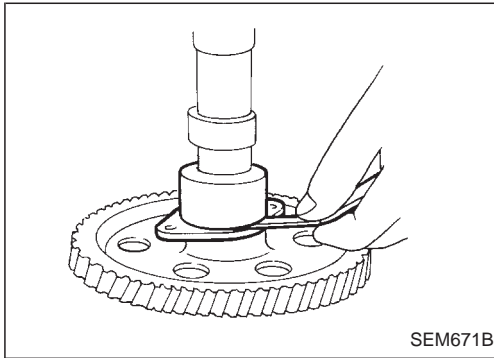
RS

BT

HA

EL

IDX

**Inspection and Replacement (Cont'd)**

3. Measure camshaft end play between locating plate and gear. If beyond the specified limit, replace camshaft locating plate.

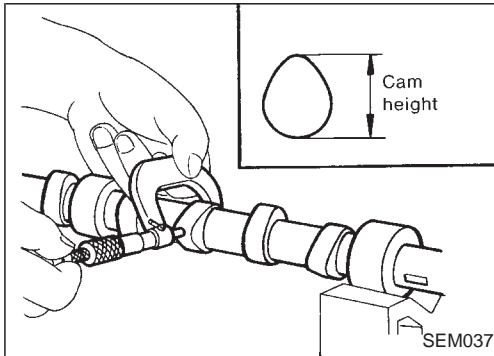
**Camshaft end play: mm (in)**

**Standard**

**0.08 - 0.28 (0.0031 - 0.0110)**

**Limit**

**Less than 0.5 (0.020)**



4. Measure camshaft cam height. If beyond the specified limit, replace camshaft.

**Cam height: mm (in)**

**Standard**

**Intake**

**41.88 - 41.92 (1.6488 - 1.6504)**

**Exhaust**

**41.88 - 41.92 (1.6488 - 1.6504)**

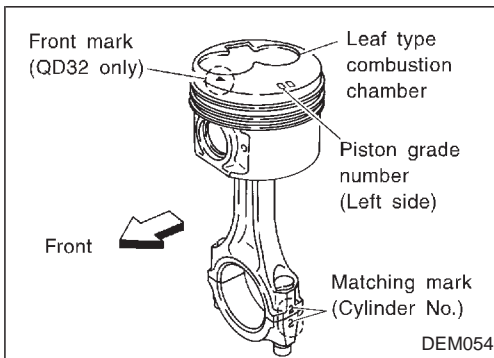
**Limit**

**Intake**

**Less than 41.40 (1.6299)**

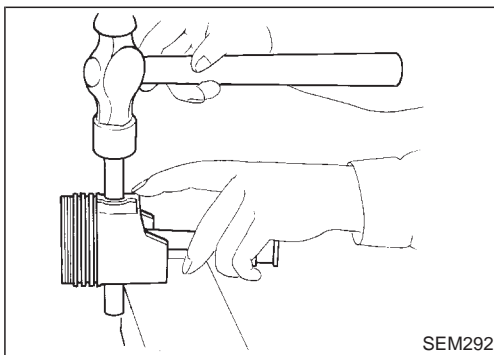
**Exhaust**

**Less than 41.40 (1.6299)**

**Assembly****PISTON**

Assemble pistons, piston pins, snap rings and connecting rods.

- a. **Numbers are stamped on the connecting rod and cap corresponding to each cylinder. Care should be taken to avoid a wrong combination including bearing.**



- b. **When inserting piston pin in connecting rod, heat piston with a heater or hot water [approximately 60 to 70°C (140 to 158°F)] and apply engine oil to pin and small end of connecting rod.**
- c. **After assembling, ascertain that piston swings smoothly.**

## Assembly (Cont'd)

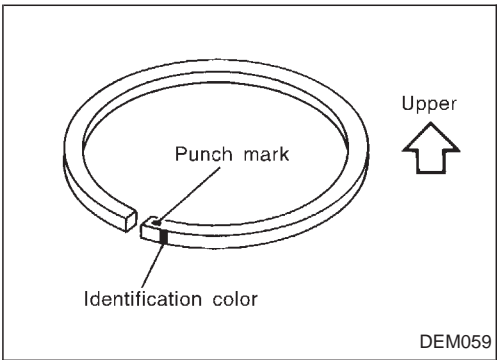
Install piston assembly.

### CAUTION:

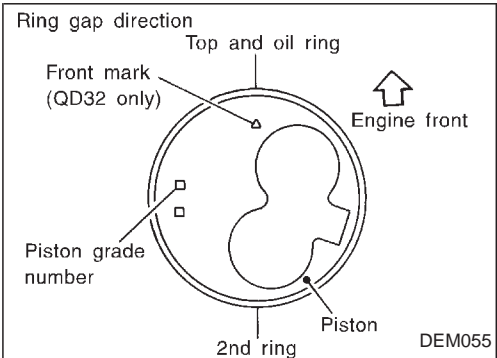
- Stretch the piston rings only enough to fit them in the piston grooves.
- Always install new piston rings with the position marks facing up.

	Identification color
Top ring	Yellow
2nd ring	Red

- Install No. 1 piston ring in such a way that its gap faces the direction of the piston pin; and then install piston rings so that their gap positioned at 180° to one another.



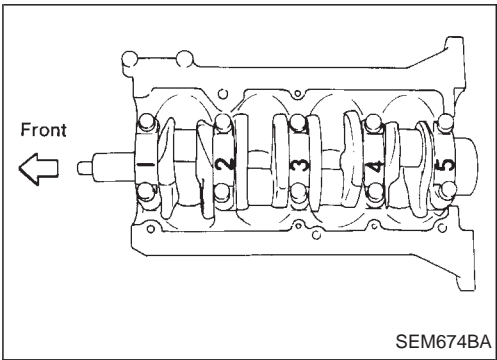
DEM059



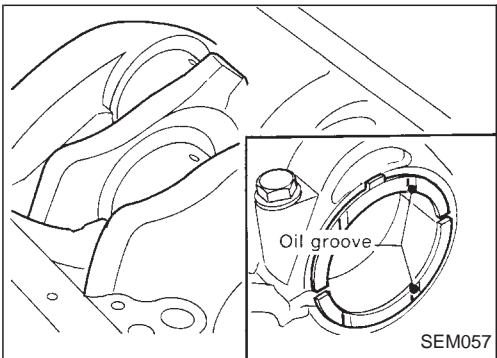
DEM055

## CRANKSHAFT

1. Install crankshaft.
  - (1) Set main bearings in the proper position on cylinder block.
    - a. If either crankshaft, cylinder block or main bearing is reused again, it is necessary to measure main bearing clearance.
    - b. Upper bearings have oil hole and oil groove, however lower bearings do not.



SEM674BA



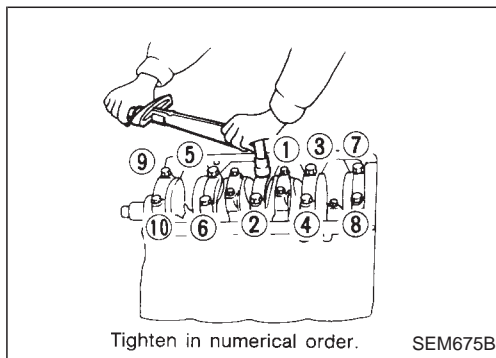
SEM057

- (2) Apply engine oil to crankshaft journal and pin and install crankshaft.
- (3) Install main bearing caps.
  - a. Install main bearing cap with the number facing the front of vehicle.
  - b. Apply engine oil to main bearing cap and cylinder block contact surfaces.
  - c. Install rear oil seal assembly. Apply engine oil to contact surface of rear end oil seal and crankshaft.

- (4) Install crankshaft thrust washer at the 4th journal from front. **Install thrust washer so that oil groove can face crankshaft.**

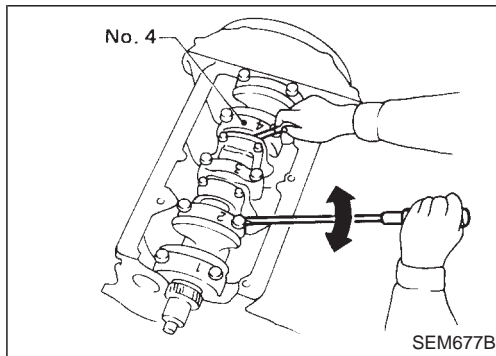


## Assembly (Cont'd)



- (5) Tighten main bearing cap bolts gradually in stages, starting from two to three separate stages, from center bearing and moving outward in sequence.

: 167 - 177 N·m (17.0 - 18.0 kg-m, 123 - 130 ft-lb)



- (6) Measure crankshaft free end play at No. 4 bearing.

**Crankshaft free end play: mm (in)**

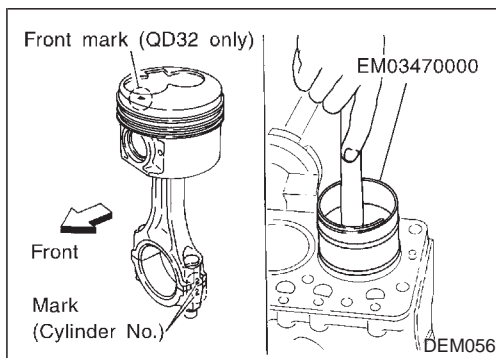
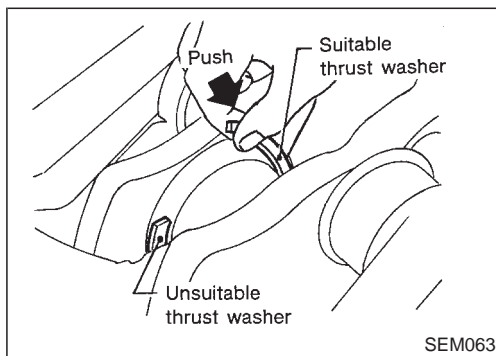
**Standard**

**0.055 - 0.140 (0.0022 - 0.0055)**

**Limit**

**0.40 (0.0157)**

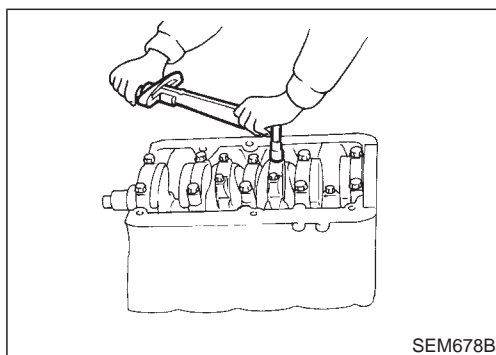
If beyond the limit, replace No. 4 main bearing thrust washer. Refer to SDS, EM-204.



2. Install pistons with connecting rods.

- (1) Install them into corresponding cylinder using Tool.

- Be careful not to scratch cylinder wall with connecting rod.
- Insert the connecting rod. Do not allow the larger end to touch the oil jet.
- Apply engine oil to cylinder wall, piston and bearing.
- The leaf type combustion chamber on piston head must be at right side of engine.



- (2) Install connecting rod bearing caps.

**Assembly (Cont'd)**

3. Measure connecting rod side clearance.

**Connecting rod side clearance: mm (in)**

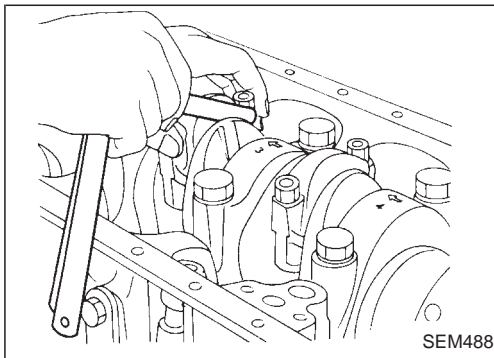
**Standard**

**0.10 - 0.22 (0.0039 - 0.0087)**

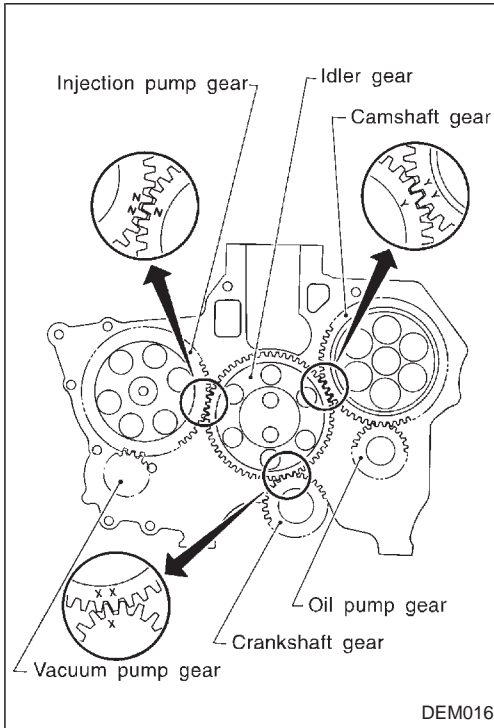
**Limit**

**0.22 (0.0087)**

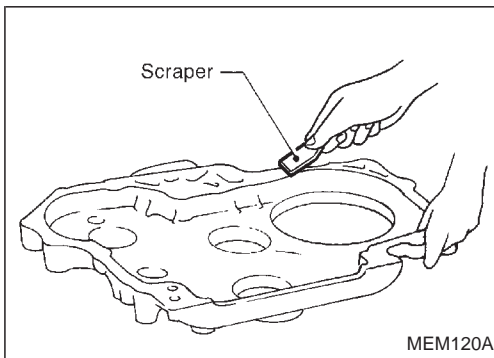
**If beyond the limit, replace connecting rod and/or crankshaft.**

**GEAR TRAIN**

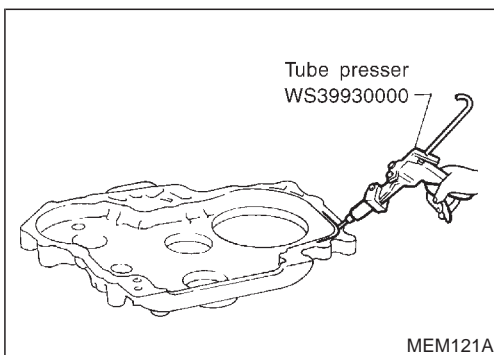
1. Set No. 1 piston at TDC on its compression stroke.
2. Align each gear mark and install gears.

**TIMING GEAR CASE****Installation**

1. Before installing timing gear case, remove all traces of liquid gasket from mating surface using a scraper. Also remove traces of liquid gasket from mating surface of front plate.



2. Apply a continuous bead of liquid gasket to mating surface of timing gear case and dust cover.



GI

MA

EM

LC

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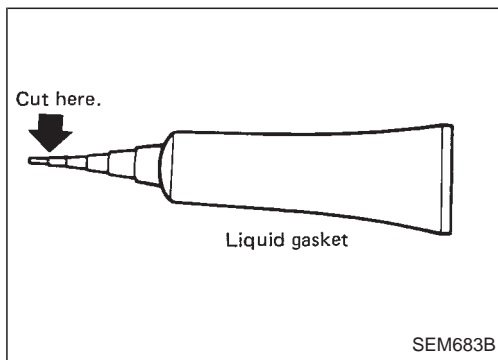
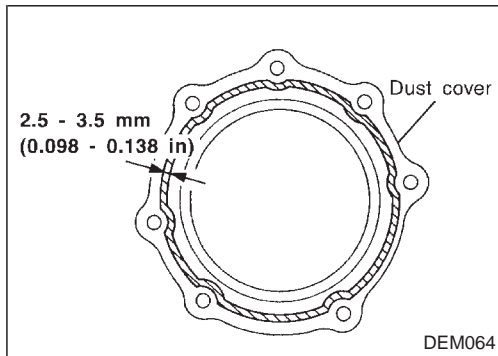
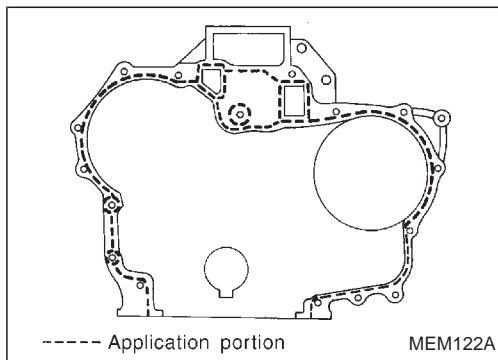
RS

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IDX



- Be sure liquid gasket diameter is 2.5 to 3.5 mm (0.098 to 0.138 in).
- Attach timing gear case to front plate within 10 minutes after coating.
- Wait at least 30 minutes before refilling engine coolant or starting engine.
- Use Genuine Liquid Gasket or equivalent.

## General Specifications

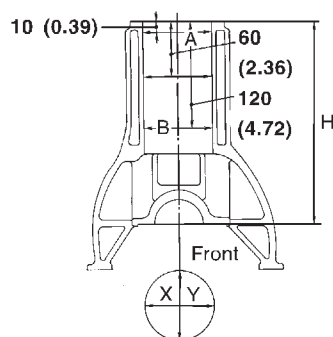
Cylinder arrangement	4, in-line
Displacement	cm <sup>3</sup> (cu in) 2,389 (145.78)
Bore x stroke	mm (in) 89 x 96 (3.50 x 3.78)
Valve arrangement	OHC
Firing order	1-3-4-2
Number of piston rings	
Compression	2
Oil	1
Number of main bearings	5
Compression ratio	8.6

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

Compression pressure	
Standard	1,324 (13.24, 13.5, 192)/300
Minimum	981 (9.8, 10, 142)/300
Differential limit between cylinders	98 (0.98, 1.0, 14)/300

## Inspection and Adjustment

## CYLINDER BLOCK



SEM618F

Unit: mm (in)

			Standard	Limit
Distortion			—	0.1 (0.004)
Cylinder bore	Inner diameter	Grade 1	89.000 - 89.010 (3.5039 - 3.5043)	0.2 (0.008)*
		Grade 2	89.010 - 89.020 (3.5043 - 3.5047)	
		Grade 3	89.020 - 89.030 (3.5047 - 3.5051)	
	Out-of-round (X – Y)		Less than 0.015 (0.0006)	—
	Taper (A – B)		Less than 0.010 (0.0004)	—
Difference in inner diameter between cylinders			Less than 0.05 (0.0020)	0.2 (0.008)
Piston-to-cylinder clearance			0.010 - 0.020 (0.0004 - 0.0008)	—
Cylinder block height (From crankshaft center)			246.95 - 247.05 (9.7224 - 9.7264)	0.2 (0.008)**

\* Wear limit

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

## CYLINDER HEAD

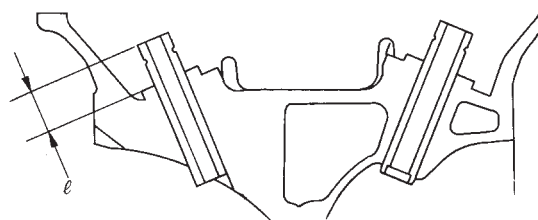
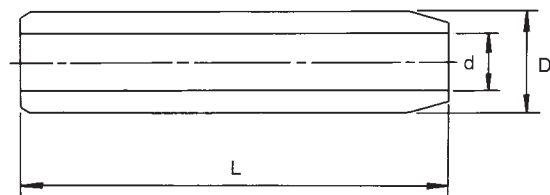
Unit: mm (in)

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

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

## Inspection and Adjustment (Cont'd)

## VALVE GUIDE



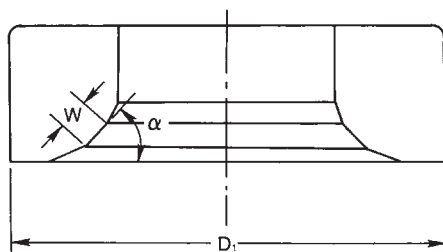
SEM401E

Unit: mm (in)

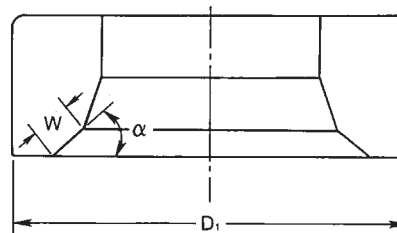
	Standard		Service		Limit
	Intake	Exhaust	Intake	Exhaust	
Length (L)	52.6 (2.071)	56.0 (2.205)	52.6 (2.071)	56.0 (2.205)	—
Outer diameter (D)	11.023 - 11.034 (0.4340 - 0.4344)	12.023 - 12.034 (0.4733 - 0.4738)	11.223 - 11.234 (0.4418 - 0.4423)	12.223 - 12.234 (0.4812 - 0.4817)	—
Inner diameter (d) (Finished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

## VALVE SEAT

Standard



Service



SEM402E

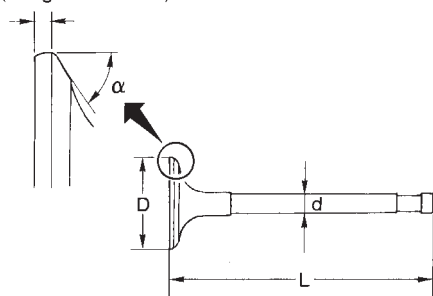
Unit: mm (in)

	Standard		Service	
	Intake	Exhaust	Intake	Exhaust
Cylinder head seat recess diameter	36.000 - 36.016 (1.4173 - 1.4179)	42.000 - 42.016 (1.6535 - 1.6542)	36.500 - 36.516 (1.4370 - 1.4376)	42.500 - 42.516 (1.6732 - 1.6739)
Valve seat outer diameter (D <sub>1</sub> )	36.080 - 36.096 (1.4205 - 1.4211)	42.080 - 42.096 (1.6567 - 1.6573)	36.580 - 36.596 (1.4402 - 1.4408)	42.580 - 42.596 (1.6764 - 1.6770)
Face angle (α)	45°	45°	45°	45°
Contacting width (W)	1.6 - 1.7 (0.063 - 0.067)	1.7 - 2.1 (0.067 - 0.083)	1.6 - 1.7 (0.063 - 0.067)	1.7 - 2.1 (0.067 - 0.083)

## Inspection and Adjustment (Cont'd)

## VALVE

T (Margin thickness)



SEM188A

Unit: mm (in)

		Standard	Limit
Valve head diameter (D)	In.	34.0 - 34.2 (1.339 - 1.346)	—
	Ex.	40.0 - 40.2 (1.575 - 1.583)	—
Valve length (L)	In.	121.05 - 121.65 (4.7657 - 4.7894)	—
	Ex.	122.02 - 122.62 (4.8039 - 4.8283)	—
Valve stem diameter (d)	In.	6.965 - 6.980 (0.2742 - 0.2748)	—
	Ex.	7.948 - 7.960 (0.3129 - 0.3134)	—
Valve face angle ( $\alpha$ )	In.	45°15′ - 45°45′	—
	Ex.	45°15′ - 45°45′	—
Valve head margin (T)	In.	1.15 - 1.45 (0.0453 - 0.0571)	0.5 (0.020)
	Ex.	1.35 - 1.65 (0.0531 - 0.0650)	
Valve clearance		0 (0)	

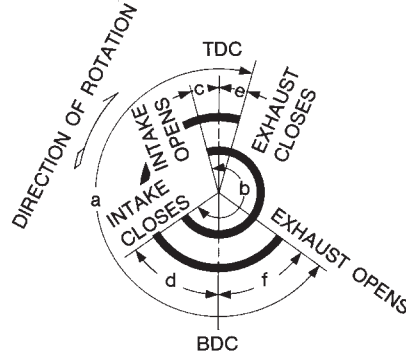
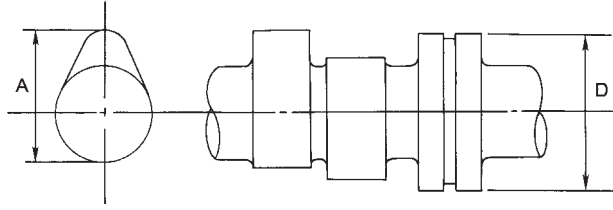
## VALVE SPRING

Unit: mm (in)

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

## Inspection and Adjustment (Cont'd)

## CAMSHAFT AND CAMSHAFT BEARING



SEM568A

EM120

Unit: mm (in)

		Standard	Limit
Cam height (A)		44.43 - 44.58 (1.7492 - 1.7551)	—
Valve lift (h)		9.7 (0.382)	—
Wear limit of cam height		—	0.2 (0.008)
Camshaft journal to bearing clearance		0.045 - 0.090 (0.0018 - 0.0035)	0.12 (0.0047)
Inner diameter of camshaft bearing		33.000 - 33.025 (1.2992 - 1.3002)	—
Outer diameter of camshaft journal (D)		32.935 - 32.955 (1.2967 - 1.2974)	—
Camshaft runout		0 - 0.02 (0 - 0.0008)	—
Camshaft end play		0.07 - 0.15 (0.0028 - 0.0059)	0.2 (0.008)
Valve timing (Degree on crankshaft)	a	232	—
	b	232	—
	c	-5	—
	d	57	—
	e	11	—
	f	41	—

## ROCKER ARM AND ROCKER SHAFT

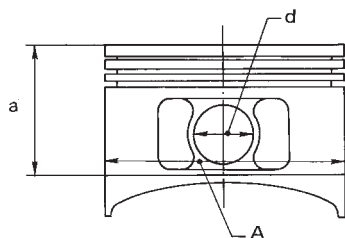
Unit: mm (in)

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

## Inspection and Adjustment (Cont'd)

## PISTON, PISTON RING AND PISTON PIN

## Piston



SEM444C

Unit: mm (in)

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

## Piston pin

Unit: mm (in)

	Standard
Piston pin outer diameter	20.993 - 20.998 (0.8265 - 0.8267)
Pin to piston pin hole clearance	0.008 - 0.012 (0.0003 - 0.0005)
Piston pin to connecting rod clearance	-0.015 to -0.033 (-0.0006 to -0.0013)

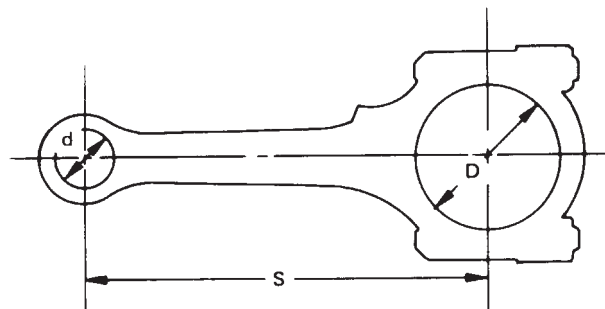
## Piston ring

Unit: mm (in)

		Standard	Limit
Side clearance	Top	0.010 - 0.030 (0.0004 - 0.0012)	0.1 (0.004)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.1 (0.004)
	Oil	0.085 - 0.115 (0.0083 - 0.0045)*	0.1 (0.004)
Ring gap	Top	0.28 - 0.43 (0.0110 - 0.0169)	0.5 (0.020)
	2nd	0.45 - 0.60 (0.0177 - 0.0236)	0.5 (0.020)
	Oil (rail ring)	0.20 - 0.60 (0.0079 - 0.0236)	0.5 (0.020)

\*: Riken-make

## CONNECTING ROD



SEM216E

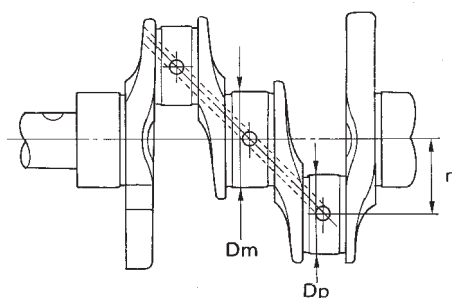
Unit: mm (in)

	Standard	Limit
Center distance (S)	164.95 - 165.05 (6.4941 - 6.4980)	—
Bend [per 100 mm (3.94 in)]	—	0.15 (0.0059)
Torsion [per 100 mm (3.94 in)]	—	0.3 (0.012)
Small end inner diameter (d)	20.965 - 20.978 (0.8254 - 0.8259)	—
Connecting rod big end inner diameter (D)	53.000 - 53.013 (2.0866 - 2.0871)	—
Side clearance	0.2 - 0.4 (0.008 - 0.016)	0.6 (0.024)

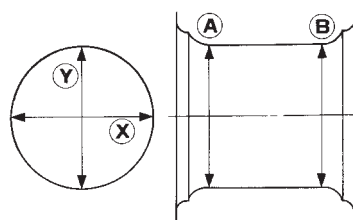


## Inspection and Adjustment (Cont'd)

## CRANKSHAFT



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



SEM394

EM715

Unit: mm (in)

Main journal diameter (Dm)	Grade	No. 0	59.967 - 59.975 (2.3609 - 2.3612)	
		No. 1	59.959 - 59.967 (2.3606 - 2.3609)	
		No. 2	59.951 - 59.959 (2.3603 - 2.3606)	
Pin journal diameter (Dp)	Grade	No. 0	49.968 - 49.974 (1.9672 - 1.9675)	
		No. 1	49.962 - 49.968 (1.9670 - 1.9672)	
		No. 2	49.956 - 49.962 (1.9668 - 1.9670)	
Center distance (r)		47.95 - 48.05 (1.8878 - 1.8917)		
		Standard		Limit
Taper of journal and pin [(A) – (B)]	Journal	—		0.01 (0.0004)
	Pin	—		0.005 (0.0002)
Out-of-round of journal and pin [(X) – (Y)]	Journal	—		0.01 (0.0004)
	Pin	—		0.005 (0.0002)
Runout [TIR]*		—		0.10 (0.0039)
Free end play		0.05 - 0.18 (0.0020 - 0.0071)		0.3 (0.012)
Fillet roll		More than 0.1 (0.004)		

\* Total indicator reading

## BEARING CLEARANCE

Unit: mm (in)

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

## Inspection and Adjustment (Cont'd)

## AVAILABLE MAIN BEARING

## Standard

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

## Undersize (service)

Unit: mm (in)

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

## AVAILABLE CONNECTING ROD BEARING

## Standard

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

## Undersize (service)

Unit: mm (in)

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

## MISCELLANEOUS COMPONENTS

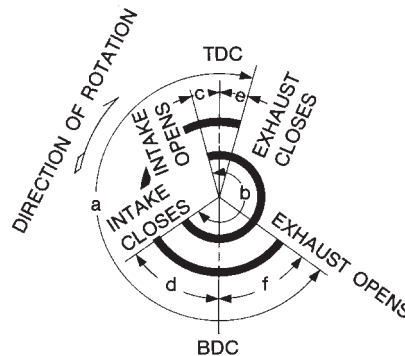
Unit: mm (in)

Camshaft sprocket runout [TIR]*	Less than 0.12 (0.0047)
Flywheel runout [TIR]*	Less than 0.1 (0.004)

\* Total indicator reading

## General Specifications

Engine	NA20S
Cylinder arrangement	4, in-line
Displacement    cm <sup>3</sup> (cu in)	1,998 (121.92)
Bore and stroke    mm (in)	86 x 86 (3.39 x 3.39)
Valve arrangement	OHC
Firing order	1-3-4-2
Number of piston rings	
Compression	2
Oil	1
Number of main bearings	5
Compression ratio	8.7



EM120  
Unit: degree

a	b	c	d	e	f
240	232	2	50	19.5	40.5

## Inspection and Adjustment

## ENGINE COMPRESSION PRESSURE

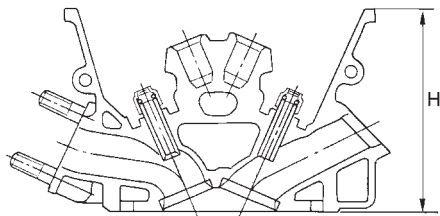
Unit: kPa (bar, kg/cm<sup>2</sup>, psi)/350 rpm

Standard	1,187 (11.87, 12.1, 172)
Minimum	991 (9.91, 10.1, 144)
Difference limit between cylinders	98 (1.0, 1, 14)

## CYLINDER HEAD

Unit: mm (in)

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

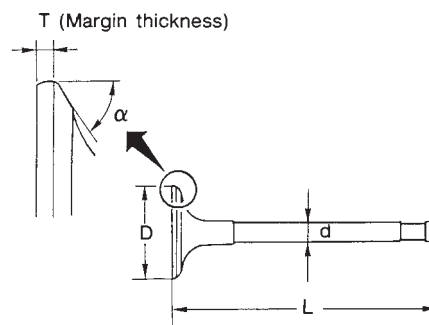


Nominal cylinder head height:  
H = 98.8 - 99.0 (3.890 - 3.898)

SEM956C

## VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	
Intake	38.0 - 38.2 (1.496 - 1.504)
Exhaust	34.0 - 34.2 (1.339 - 1.346)
Valve length "L"	
Intake	121.72 - 122.32 (4.7921 - 4.8157)
Exhaust	123.30 - 123.80 (4.8543 - 4.8740)
Valve stem diameter "d"	
Intake	7.965 - 7.980 (0.3136 - 0.3142)
Exhaust	7.945 - 7.960 (0.3128 - 0.3134)
Valve face angle "α"	
Intake	45°15' - 45°45'
Exhaust	45°15' - 45°45'
Valve margin "T"	
Intake	1.3 (0.051)
Exhaust	1.35 - 1.65 (0.0531 - 0.0650)
Valve margin "T" limit	More than 0.5 (0.020)
Valve stem end surface grinding limit	Less than 0.2 (0.008)

## Inspection and Adjustment (Cont'd)

## Valve clearance

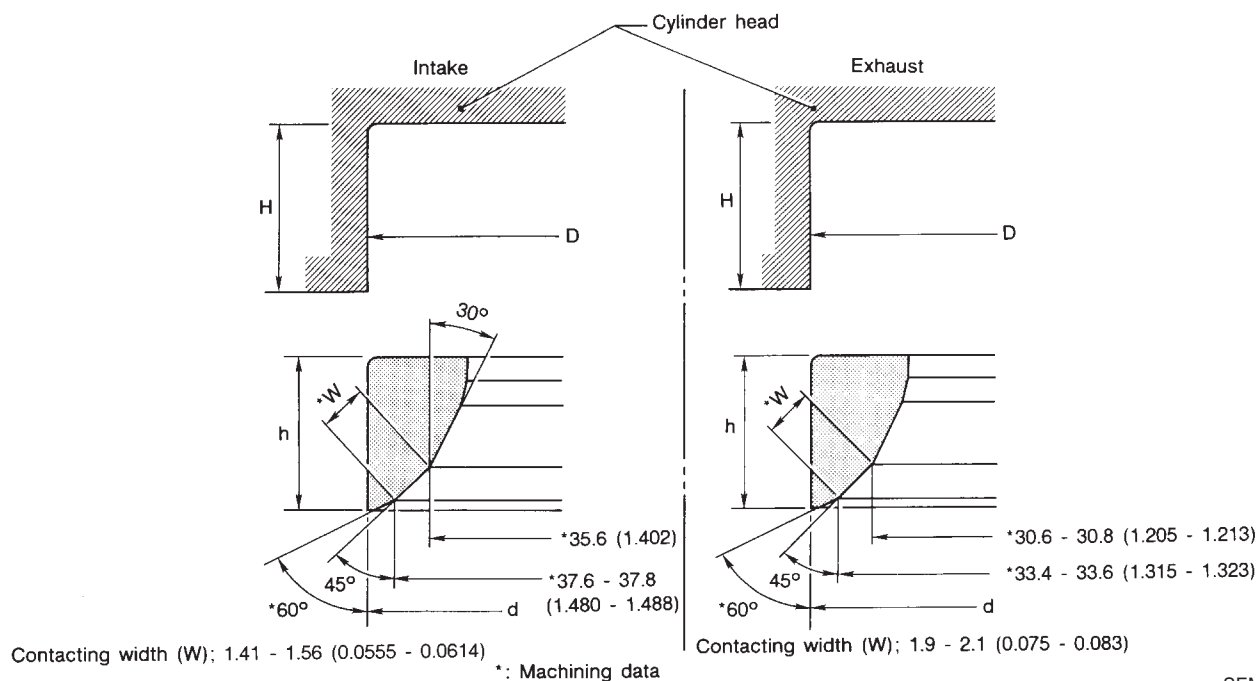
Unit: mm (in)		
	Hot	Cold
Intake	0.3 (0.012)	0.21 (0.008)
Exhaust	0.3 (0.012)	0.23 (0.009)

## Valve spring

Free height	mm (in)	53.8 (2.118)
Pressure	N (kg, lb) at height mm (in)	
Standard	665.0 - 749.0 (67.81 - 76.37, 149.52 - 168.40) at 35 (1.38)	
Limit	631.37 (64.38, 141.96) at 35 (1.38)	
Out-of-square	mm (in)	Less than 2.3 (0.091)

## Valve seat

Unit: mm (in)



SEM509EB

		Standard	Service
Cylinder head seat recess diameter (D)	In.	41.000 - 41.016 (1.6142 - 1.6148)	41.500 - 41.516 (1.6339 - 1.6345)
	Ex.	36.000 - 36.016 (1.4173 - 1.4179)	36.500 - 36.516 (1.4370 - 1.4376)
Valve seat interference fit	In.	0.064 - 0.096 (0.0025 - 0.0038)	
	Ex.	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	In.	41.080 - 41.096 (1.6173 - 1.6179)	41.580 - 41.596 (1.6370 - 1.6376)
	Ex.	36.080 - 36.096 (1.4205 - 1.4211)	36.580 - 36.596 (1.4402 - 1.4408)
Depth (H)	In.	7.7 - 7.8 (0.303 - 0.307)	
	Ex.	7.7 - 7.8 (0.303 - 0.307)	
Height (h)		7.4 - 7.5 (0.291 - 0.295)	

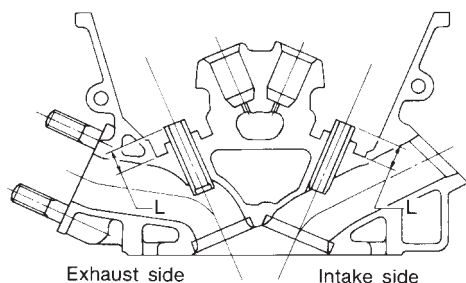
## Inspection and Adjustment (Cont'd)

## CYLINDER BLOCK

## Valve guide

Unit: mm (in)

Unit: mm (in)



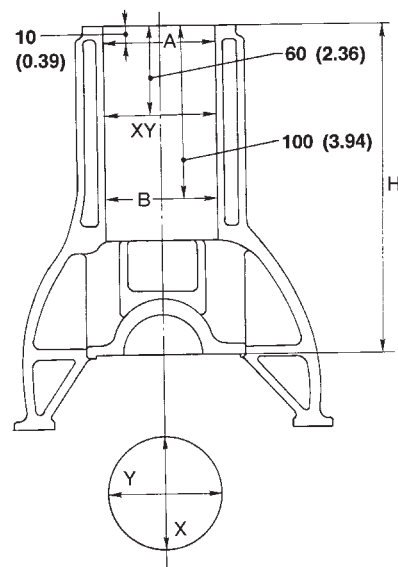
SEM933C

	Standard	Service
Valve guide outer diameter	12.023 - 12.034 (0.4733 - 0.4738)	12.223 - 12.234 (0.4812 - 0.4817)
Valve guide inner diameter (Finish size)	8.000 - 8.018 (0.3150 - 0.3157)	
Cylinder head valve guide hole diameter	11.975 - 11.996 (0.4715 - 0.4723)	12.175 - 12.196 (0.4793 - 0.4802)
Interference fit of valve guide	0.027 - 0.059 (0.0011 - 0.0023)	
	Standard	Limit
Stem to guide clearance		
Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.1 (0.004)
Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
Valve deflection limit (Dial gauge reading)		
Intake	0.12 (0.0047)	
Exhaust	0.12 (0.0047)	
Projection length "L"	17.9 - 18.1 (0.705 - 0.713)	

## Intake manifold

Unit: mm (in)

Distortion	
Limit	0.15 (0.0059)



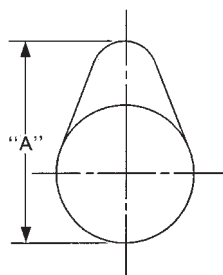
SEM562E

Distortion	
Standard	Less than 0.03 (0.0012)
Limit	0.1 (0.004)
Height "H" (nominal)	227.40 - 227.50 (8.9527 - 8.9567)
Cylinder bore inner diameter	
Standard	Grade No. 1 86.000 - 86.010 (3.3858 - 3.3862)
	Grade No. 2 86.010 - 86.020 (3.3862 - 3.3866)
	Grade No. 3 86.020 - 86.030 (3.3866 - 3.3870)
Wear limit	0.2 (0.008)
Out-of-round (X - Y) standard	Less than 0.015 (0.0006)
Taper (A - B) standard	0.01 (0.0004)
Difference in inner diameter between cylinders	
Limit	Less than 0.03 (0.0012)
Main journal inner diameter	
Grade No. 0	58.645 - 58.654 (2.3089 - 2.3092)
Grade No. 1	58.654 - 58.663 (2.3092 - 2.3096)
Grade No. 2	58.663 - 58.672 (2.3096 - 2.3099)

## Inspection and Adjustment (Cont'd)

## CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)



EM671

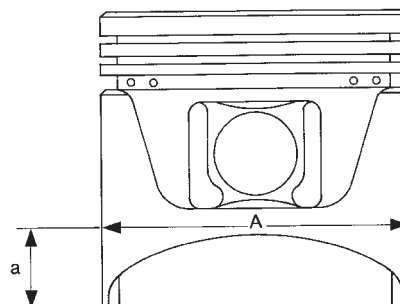
Cam height "A"	
Intake	44.572 - 44.762 (1.7548 - 1.7623)
Exhaust	
Wear limit of cam height	0.25 (0.0098)
Valve lift	
Intake	9.5 (0.374)
Exhaust	9.5 (0.374)
Camshaft journal to bearing clearance	
Standard	0.045 - 0.090 (0.0018 - 0.0035)
Limit	0.12 (0.0047)
Inner diameter of camshaft bearing	33.000 - 33.025 (1.2992 - 1.3002)
Outer diameter of camshaft journal	32.935 - 32.955 (1.2967 - 1.2974)
Camshaft runout (TIR*)	
Limit	0.05 (0.0020)
Camshaft sprocket runout (TIR*)	
Limit	0.25 (0.0098)
Camshaft end play	
Standard	0.070 - 0.148 (0.0028 - 0.0058)
Limit	0.2 (0.008)

\*: Total indicator reading

## PISTON, PISTON RING AND PISTON PIN

## Piston

Unit: mm (in)



SEM750C

Piston skirt diameter "A"	
Standard	
Grade No. 1	85.965 - 85.975 (3.3844 - 3.3848)
Grade No. 2	85.975 - 85.985 (3.3848 - 3.3852)
Grade No. 3	85.985 - 85.995 (3.3852 - 3.3856)
Service (Oversize)	
0.5 (0.020) Oversize	86.465 - 86.495 (3.4041 - 3.4053)
1.0 (0.039) Oversize	86.965 - 86.995 (3.4238 - 3.4250)
"a" dimension	14 (0.55)
Piston clearance to cylinder block	0.025 - 0.045 (0.0010 - 0.0018)
Piston pin hole diameter	21.001 - 21.008 (0.8268 - 0.8271)

## Piston ring

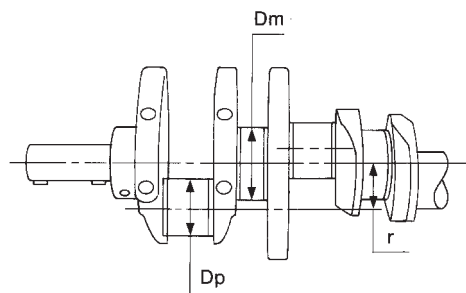
Unit: mm (in)

	Standard	Limit
Side clearance		0.1 (0.004)
Top	0.040 - 0.075 (0.0016 - 0.0030)	
2nd	0.030 - 0.063 (0.0012 - 0.0025)	
End gap		1.0 (0.039)
Top	0.24 - 0.43 (0.0094 - 0.0169)	
2nd	0.42 - 0.66 (0.0165 - 0.0260)	
Oil (rail ring)	0.20 - 0.69 (0.0079 - 0.0272)	

## Inspection and Adjustment (Cont'd)

## Piston pin

Unit: mm (in)	
Piston pin outer diameter	20.993 - 20.998 (0.8265 - 0.8267)
Piston pin to piston clearance	0.008 - 0.012 (0.0003 - 0.0005)
Interference fit of piston pin to connecting rod bushing clearance	
Standard	0.015 - 0.033 (0.0006 - 0.0013)



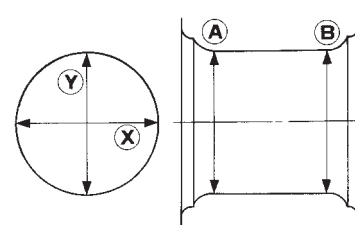
## CONNECTING ROD

Unit: mm (in)	
Center distance	147.95 - 148.05 (5.8248 - 5.8287)
Bend [per 100 (3.94)]	
Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	
Limit	0.3 (0.012)
Piston pin bushing inner diameter*	20.965 - 20.978 (0.8254 - 0.8259)
Connecting rod big end inner diameter	53.000 - 53.013 (2.0866 - 2.0871)
Side clearance	
Standard	0.20 - 0.30 (0.0079 - 0.0118)
Limit	0.3 (0.012)

\*: After installing in connecting rod

SEM954C

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



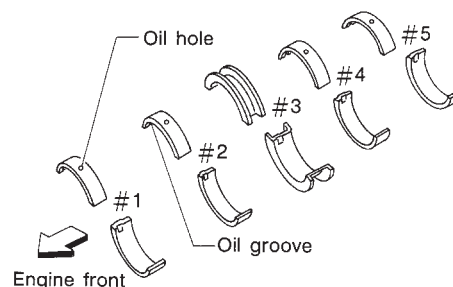
EM715

## CRANKSHAFT

Unit: mm (in)	
Main journal dia. "Dm"	
Standard	54.942 - 54.955 (2.1631 - 2.1636)
Pin journal dia. "Dp"	
Standard	49.961 - 49.974 (1.9670 - 1.9675)
Center distance "r"	43 (1.69)
Out-of-round limit of journal and pin (X - Y)	
Main journal	0.03 (0.0012)
Pin journal	0.03 (0.0012)
Taper limit (A - B)	
Main journal	0.03 (0.0012)
Pin journal	0.03 (0.0012)
Runout (TIR*)	
Standard	Less than 0.025 (0.0010)
Limit	Less than 0.05 (0.0020)
Free end play	
Standard	0.050 - 0.150 (0.0020 - 0.0059)
Limit	0.3 (0.012)

\*: Total indicator reading

## AVAILABLE MAIN BEARINGS

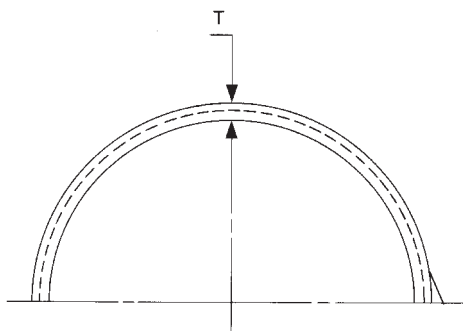


SEM560E

## Inspection and Adjustment (Cont'd)

## Main bearing size

Unit: mm (in)



EM738

	Grade No. on the cylinder block	Bearing top thickness "T"	Crank journal diameter
Standard	0 Green	1.829 - 1.833 (0.0720 - 0.0722)	54.942 - 54.955 (2.1631 - 2.1636)
	1 Yellow	1.833 - 1.837 (0.0722 - 0.0723)	
	2 Blue	1.837 - 1.841 (0.0723 - 0.0725)	
0.25 (0.0098) Undersize		1.954 - 1.958 (0.0769 - 0.0771)	54.691 - 54.722 (2.1532 - 2.1544)
0.50 (0.0197) Undersize		2.079 - 2.083 (0.0819 - 0.0820)	54.441 - 54.472 (2.1433 - 2.1446)
0.75 (0.0295) Undersize		2.204 - 2.208 (0.0868 - 0.0869)	54.191 - 54.222 (2.1335 - 2.1347)
1.00 (0.0394) Undersize		2.329 - 2.333 (0.0917 - 0.0919)	53.941 - 53.972 (2.1237 - 2.1249)

## Connecting rod bearing size

Unit: mm (in)

	Bearing top thickness "T"	Crank pin diameter
STD	1.497 - 1.501 (0.0589 - 0.0591)	49.961 - 49.974 (1.9670 - 1.9675)
0.06 (0.0024) Undersize	1.527 - 1.531 (0.0601 - 0.0603)	49.880 - 49.935 (1.9638 - 1.9659)
0.12 (0.0047) Undersize	1.557 - 1.561 (0.0613 - 0.0615)	49.820 - 49.875 (1.9614 - 1.9636)
0.25 (0.0098) Undersize	1.622 - 1.626 (0.0639 - 0.0640)	49.690 - 49.745 (1.9563 - 1.9585)

## BEARING CLEARANCE

Unit: mm (in)

Main bearing clearance	Standard	0.024 - 0.056 (0.0009 - 0.0022)
	Limit	0.10 (0.0039)
Connecting rod bearing clearance	Standard	0.024 - 0.056 (0.0094 - 0.0022)
	Limit	0.10 (0.0039)

## MISCELLANEOUS COMPONENTS

Unit: mm (in)

Camshaft sprocket runout (TIR*)	Less than 0.25 (0.0098)
Flywheel runout (TIR*)	Less than 0.15 (0.0059)

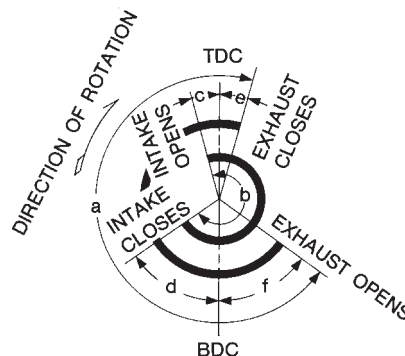
\*: Total indicator reading



## General Specifications

Engine	Z24S
Cylinder arrangement	4, in-line
Displacement	cm <sup>3</sup> (cu in) 2,389 (145.78)
Bore and stroke	mm (in) 89 x 96 (3.50 x 3.78)
Valve arrangement	OHC
Firing order	1-3-4-2
Number of piston rings	
Compression	2
Oil	1
Number of main bearings	5
Compression ratio	8.3

## Valve timing



EM120

Unit: degree

a	b	c	d	e	f
248	240	10	50	12	56

## Inspection and Adjustment

## ENGINE COMPRESSION PRESSURE

Unit: kPa (bar, kg/cm<sup>2</sup>, psi)/350 rpm

Standard	1,196 (11.96, 12.2, 173)
Minimum	902 (9.02, 9.2, 131)
Difference limit between cylinders	98 (0.98, 1.0, 14)

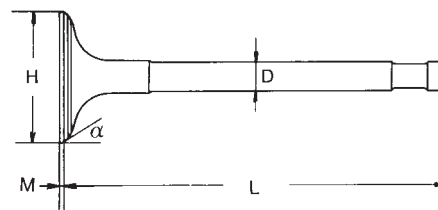
## CYLINDER HEAD

Unit: mm (in)

	Limit
Head distortion	0.1 (0.004)
Head height (Nominal)	98.9±0.1 (3.894±0.004)

## VALVE

Unit: mm (in)



SEM181

		Standard	Limit
Valve head diameter "H"	In.	42.0 - 42.2 (1.654 - 1.661)	—
	Ex.	37.95 - 38.25 (1.4941 - 1.5059)	—
Valve length "L"	In.	122.8 - 123.1 (4.835 - 4.846)	—
	Ex.	123.6 - 123.9 (4.866 - 4.878)	—
Valve stem diameter "D"	In.	7.965 - 7.980 (0.3136 - 0.3142)	—
	Ex.	7.945 - 7.960 (0.3128 - 0.3134)	—
Valve face angle "α"	In.	45°30'	—
	Ex.		
Valve head margin "M"	In.	1.3 (0.051)	0.5 (0.020)
	Ex.	1.5 (0.059)	0.5 (0.020)
Grinding of valve stem end	In.	—	0.2 (0.008)
	Ex.		

## Inspection and Adjustment (Cont'd)

## Valve clearance

Unit: mm (in)

	*Cold	Hot
Intake	0.21 (0.008)	0.30 (0.012)
Exhaust	0.23 (0.009)	0.30 (0.012)

\*: At ambient temperature 20°C (68°F)

Whenever valve clearances are adjusted to cold specifications, check that the clearances satisfy hot specifications and adjust again if necessary.

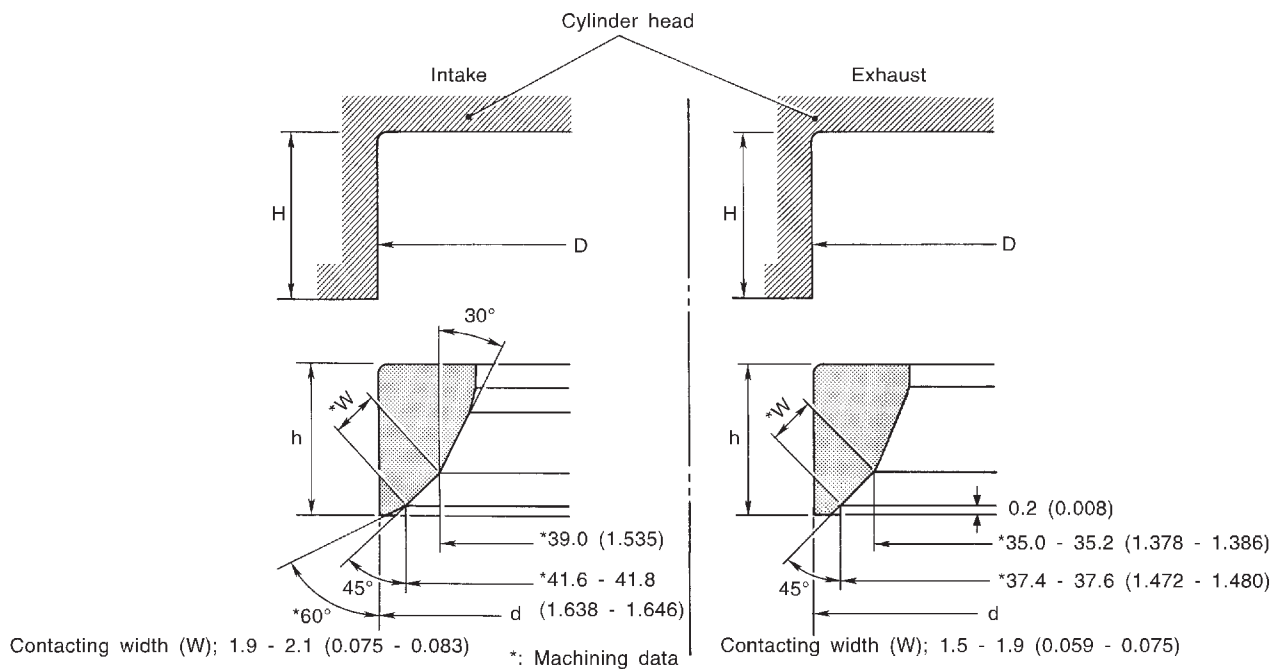
## Valve spring

Unit: mm (in)

			Standard	Limit
Free height	Outer		49.77 (1.9595)	—
	Inner		44.10 (1.7362)	—
Pressure	Outer	N (kg, lb) at height mm (in)	225.6 (23.0, 50.7) at 40.0 (1.575)	189.3 (19.3, 42.6) at 40 (1.58)
	Inner	N (kg, lb) at height mm (in)	107.9 (11.0, 24.3) at 35 (1.38)	87.3 (8.9, 19.6) at 35 (1.38)
Out-of-square	Outer		—	2.2 (0.087)
	Inner		—	1.9 (0.075)

## Valve seat

Unit: mm (in)



SEM620F

		Standard	Service
Cylinder head seat recess diameter (D)	In.	45.000 - 45.016 (1.7717 - 1.7723)	45.500 - 45.516 (1.7913 - 1.7920)
	Ex.	40.000 - 40.016 (1.5748 - 1.5759)	40.500 - 40.516 (1.5945 - 1.5951)
Valve seat interference fit	In.	0.081 - 0.113 (0.0032 - 0.0044)	
	Ex.	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	In.	45.097 - 45.113 (1.7755 - 1.7761)	45.597 - 46.613 (1.7952 - 1.8352)
	Ex.	40.080 - 40.096 (1.5779 - 1.5786)	40.580 - 40.596 (1.5967 - 1.5983)
Depth (H)	In.	7.7 - 7.8 (0.303 - 0.307)	
	Ex.	7.7 - 7.8 (0.303 - 0.307)	
Height (h)	In.	6.7 - 6.8 (0.264 - 0.268)	7.6 - 7.7 (0.299 - 0.303)
	Ex.	7.4 - 7.5 (0.291 - 0.295)	7.4 - 7.5 (0.291 - 0.295)

## Inspection and Adjustment (Cont'd)

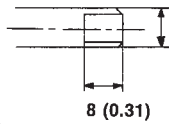
## Valve guide

Unit: mm (in)

## EXHAUST

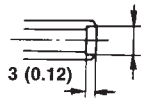
&lt; For leaded fuel only &gt;

8.9 - 9.1 (0.350 - 0.358) dia.

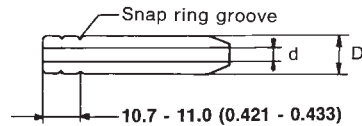


&lt; For unleaded fuel only &gt;

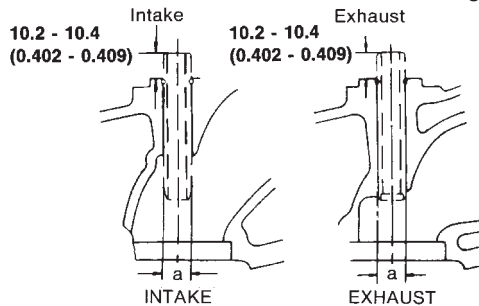
8.3 - 8.5 (0.327 - 0.335) dia.



## INTAKE



SEM484B



EM116

		Standard	Service
Valve guide			
Outer diameter "D"		12.023 - 12.034 (0.4733 - 0.4738)	12.223 - 12.234 (0.4812 - 0.4817)
Inner diameter "d" [Finished size]		8.000 - 8.018 (0.3150 - 0.3157)	
Cylinder head valve guide hole diameter "a"		11.975 - 11.996 (0.4715 - 0.4723)	12.175 - 12.196 (0.4793 - 0.4802)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
		Standard	Limit
Stem to guide clear- ance	In.	0.020 - 0.053 (0.0008 - 0.0021)	0.1 (0.004)
	Ex.	0.040 - 0.073 (0.0016 - 0.0029)	
Stem end deflection		—	0.2 (0.008)

## ROCKER ARM AND ROCKER SHAFT

Unit: mm (in)

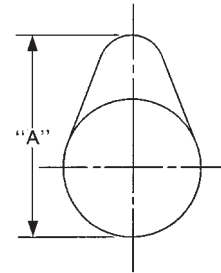
	Standard
Rocker arm to shaft clearance	0.007 - 0.049 (0.0003 - 0.0019)
Rocker shaft diameter	19.979 - 20.000 (0.7866 - 0.7874)
Rocker arm rocker shaft hole diameter	20.007 - 20.028 (0.7877 - 0.7885)

## CAMSHAFT AND CAMSHAFT BEARING

## Camshaft

Unit: mm (in)

	Standard	Limit
Outer diameter of cam- shaft journal	32.920 - 32.940 (1.2961 - 1.2968)	—
Camshaft bend at center journal (Total indicator reading)	—	0.02 (0.0008)
Camshaft end play	—	0.2 (0.008)



EM671

Cam height "A"	INT	38.477 - 38.527 (1.5148 - 1.5168)	0.25 (0.0098)
	EXH	38.481 - 38.531 (1.5150 - 1.5170)	

## Camshaft bearing

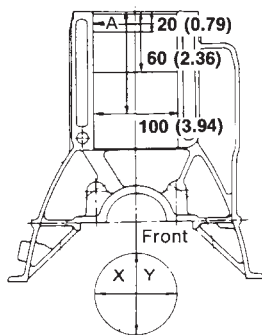
Unit: mm (in)

	Standard	Limit
Inner diameter	33.000 - 33.025 (1.2992 - 1.3002)	—
Camshaft journal to bearing clearance [Oil clearance]	0.060 - 0.105 (0.0024 - 0.0041)	0.12 (0.0047)

## Inspection and Adjustment (Cont'd)

## CYLINDER BLOCK

Unit: mm (in)



EM422-A

			Standard	Limit
Distortion			—	0.1 (0.004)
Cylinder bore	Inner diameter	Grade 1	89.000 - 89.010 (3.5039 - 3.5043)	0.2 (0.008)*
		Grade 2	89.010 - 89.020 (3.5043 - 3.5047)	
		Grade 3	89.020 - 89.030 (3.5047 - 3.5051)	
		Grade 4	89.030 - 89.040 (3.5051 - 3.5055)	
		Grade 5	89.040 - 89.050 (3.5055 - 3.5059)	
	Out-of-round (X - Y)		Less than 0.015 (0.0006)	—
		Taper (A - B)	Less than 0.010 (0.0004)	—
Difference in inner diameter between cylinders			Less than 0.05 (0.0020)	0.2 (0.008)
Piston to cylinder clearance			0.025 - 0.045 (0.0010 - 0.0018)	—
Cylinder block height (From crankshaft center)			247.00±0.05 (9.7244±0.0020)	

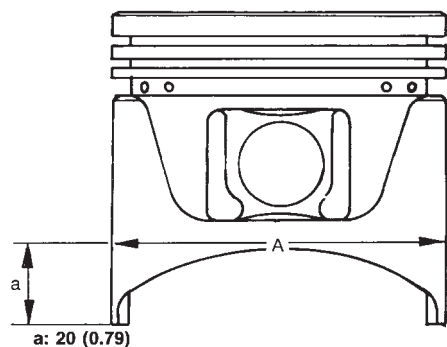
\*: Wear limit

## Inspection and Adjustment (Cont'd)

## PISTON, PISTON RING AND PISTON PIN

## Piston

Unit: mm (in)



SEM178B

## Piston skirt diameter "A"

## Standard

Grade No. 1	88.965 - 88.975 (3.5026 - 3.5029)
Grade No. 2	88.975 - 88.985 (3.5029 - 3.5033)
Grade No. 3	88.985 - 88.995 (3.5033 - 3.5037)
Grade No. 4	88.995 - 89.005 (3.5037 - 3.5041)
Grade No. 5	89.005 - 89.015 (3.5041 - 3.5045)

## Service

0.02 (0.0008) oversize	88.985 - 89.035 (3.5033 - 3.5053)
0.50 (0.0197) oversize	89.465 - 89.515 (3.5222 - 3.5242)
1.00 (0.0394) oversize	89.965 - 90.015 (3.5419 - 3.5439)

## Side clearance of piston ring

Unit: mm (in)

	Standard	Limit
Top ring	0.040 - 0.075 (0.0016 - 0.0030)	0.1 (0.004)
Second ring	0.030 - 0.070 (0.0012 - 0.0028)	
Oil ring	—	—

## Ring gap

Unit: mm (in)

	Standard	Limit
Top ring	0.28 - 0.38 (0.0110 - 0.0150)	1.0 (0.039)
Second ring	0.45 - 0.55 (0.0177 - 0.0217)	
Oil ring	0.20 - 0.60 (0.0079 - 0.0236)	

## Piston pin

Unit: mm (in)

	Standard
Piston pin outside diameter	20.993 - 20.998 (0.8265 - 0.8267)
Piston pin hole diameter	21.001 - 21.008 (0.8268 - 0.8271)
Piston pin to piston clearance	0.003 - 0.015 (0.0001 - 0.0006)
Interference fit of piston pin to connecting rod	0.015 - 0.033 (0.0006 - 0.0013)

## CONNECTING ROD

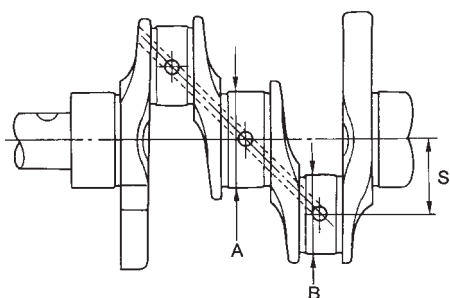
Unit: mm (in)

	Standard	Limit
Connecting rod bend or torsion [per 100 (3.94) length]	0.025 (0.0010)	0.05 (0.0020)
Big end play	0.2 - 0.4 (0.008 - 0.016)	0.6 (0.024)
Center distance	164.97 - 165.03 (6.4949 - 6.4972)	
Piston pin bore diameter	20.965 - 20.978 (0.8254 - 0.8259)	

## Inspection and Adjustment (Cont'd)

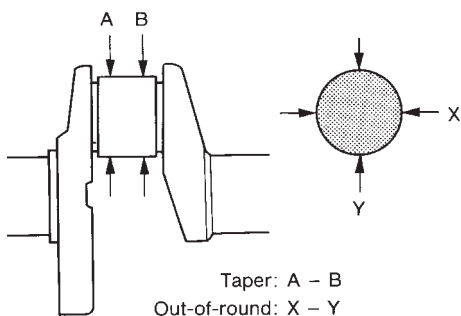
## CRANKSHAFT

Unit: mm (in)



SEM394-A

Journal diameter "A"	59.942 - 59.955 (2.3599 - 2.3604)
Pin diameter "B"	49.961 - 49.974 (1.9670 - 1.9675)
Center distance "S"	47.97 - 48.03 (1.8886 - 1.8909)



Taper: A - B  
Out-of-round: X - Y

SEM316A

	Standard	Limit
Taper of journal and pin "A - B"	Less than 0.005 (0.0002)	0.01 (0.0004)
Out-of-round of journal and pin "X - Y"	Less than 0.005 (0.0002)	0.01 (0.0004)
Crankshaft runout	Less than 0.025 (0.0010)	0.05 (0.0020)
Crankshaft free end play	0.05 - 0.18 (0.0020 - 0.0071)	0.3 (0.012)
Pilot bushing inserting distance	4.0 (0.157)	
Fillet roll	More than 0.1 (0.004)	

## BEARING

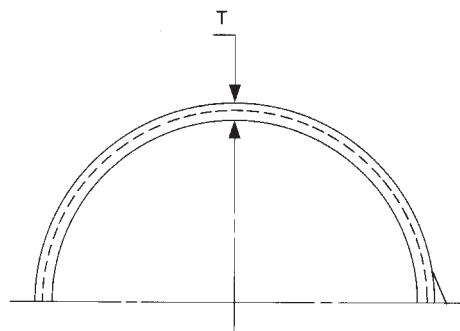
## Bearing clearance

Unit: mm (in)

	Standard	Limit
Main bearing clearance	0.020 - 0.062 (0.0008 - 0.0024)	0.12 (0.0047)
Connecting rod bearing clearance	0.012 - 0.054 (0.0005 - 0.0021)	0.12 (0.0047)

## Main bearing size

Unit: mm (in)



EM738

	Bearing top thickness "T"	Crank journal diameter
Standard	1.827 - 1.835 (0.0719 - 0.0722)	59.942 - 59.955 (2.3599 - 2.3604)
0.25 (0.0098) Undersize	1.947 - 1.960 (0.0767 - 0.0772)	59.692 - 59.705 (2.3501 - 2.3506)

## Connecting rod bearing size

Unit: mm (in)

	Bearing top thickness "T"	Crank pin diameter
STD	1.493 - 1.501 (0.0588 - 0.0591)	49.961 - 49.974 (1.9670 - 1.9675)
0.06 (0.0024) Undersize	1.553 - 1.561 (0.0611 - 0.0615)	49.901 - 49.914 (1.9646 - 1.9651)
0.12 (0.0047) Undersize	1.613 - 1.621 (0.0635 - 0.0638)	49.841 - 49.854 (1.9622 - 1.9628)
0.25 (0.0098) Undersize	1.618 - 1.631 (0.0637 - 0.0642)	49.711 - 49.724 (1.9571 - 1.9576)

## MISCELLANEOUS COMPONENTS

## Camshaft sprocket

Unit: mm (in)

Runout (Total indicator reading)	Limit 0.1 (0.004)
----------------------------------	-------------------

## Flywheel

Unit: mm (in)

Runout (Total indicator reading)	Limit 0.10 (0.0039)
----------------------------------	---------------------

## General Specifications

Engine model		QD32	TD27
Cylinder arrangement		In-line	
Number of cylinders		4	
Valve arrangement		OHV	
Bore x stroke	mm (in)	99.2 x 102.0 (3.906 x 4.016)	96.0 x 92.0 (3.780 x 3.622)
Displacement	cm <sup>3</sup> (cu in)	3,153 (192.40)	2,663 (162.50)
Firing order		1-3-4-2	
Number of piston rings	Compression	2	
	Oil	1	
Number of main bearings		5	

## Inspection and Adjustment

## COMPRESSION PRESSURE

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

Standard	2,942 (29.4, 30, 427)/200
Minimum	2,452 (24.5, 25, 356)/200
Differential limit between cylinders	294 (2.9, 3, 43)/200

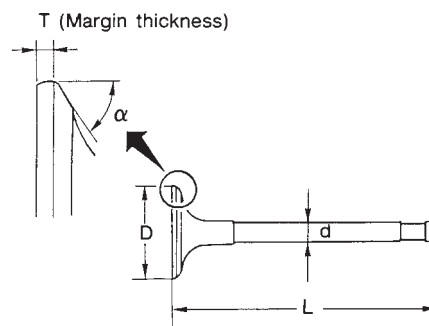
## CYLINDER HEAD

Unit: mm (in)

	Standard	Limit
Head surface distortion	Less than 0.07 (0.0028)	0.2 (0.008)
Nominal cylinder head height	89.9 - 90.1 (3.539 - 3.547)	

## VALVE

Unit: mm (in)



SEM188

Engine	QD32	TD27
Valve head diameter "D"		
Intake	45.4 - 45.6 (1.787 - 1.795)	43.4 - 43.6 (1.709 - 1.717)
Exhaust	38.9 - 39.1 (1.531 - 1.571)	37.9 - 38.1 (1.492 - 1.500)
Valve length "L"		
Intake	117 (4.61)	
Exhaust		
Valve stem diameter "d"		
Intake	7.962 - 7.977 (0.3135 - 0.3141)	
Exhaust	7.945 - 7.960 (0.3128 - 0.3134)	
Valve seat angle "α"		
Intake	45° - 45°30'	
Exhaust		
Valve margin "T" limit	0.5 (0.020)	
Valve stem end surface grinding limit	0.2 (0.008)	
Valve clearance (Hot)		
Intake	0.35 (0.0138)	
Exhaust		

## Inspection and Adjustment (Cont'd)

## Valve guide

Unit: mm (in)

	Standard	Service
Valve guide outside diameter	12.033 - 12.044 (0.4737 - 0.4742)	—
Valve guide inner diameter (Finished size)	8.000 - 8.015 (0.3150 - 0.3156)	
Cylinder head valve guide hole diameter	12.00 - 12.011 (0.4724 - 0.4729)	—
Interference fit of valve guide	0.022 - 0.044 (0.0009 - 0.0017)	
	Standard	Max. tolerance
Stem to guide clearance		
Intake	0.023 - 0.053 (0.0009 - 0.0021)	0.15 (0.0059)
Exhaust	0.04 - 0.07 (0.0016 - 0.0028)	0.20 (0.0079)
Valve deflection limit		
Intake	0.30 (0.0118)	
Exhaust	0.40 (0.0157)	

## Valve spring

Free length	mm (in)	
Painted red		53.4 (2.102)
Pressure height	mm/N (mm/kg, in/lb)	
Painted red		31.8/713.9 - 788.5 (31.8/72.8 - 80.4, 1.252/160.5 - 177.3)
Assembled height	mm/N (mm/kg, in/lb)	
Standard		42.3/314.8 - 361.9 (42.3/32.1 - 36.9, 1.665/70.8 - 81.4)
Limit		42.3/270.7 (42.3/27.6, 1.665/60.9)
Out-of-square	mm (in)	2.3 (0.091)

## VALVE LIFTER AND PUSH ROD

Unit: mm (in)

	Standard	Limit
Valve lifter outer diameter	25.960 - 25.970 (1.0220 - 1.0224)	—
Cylinder block valve lifter hole diameter	26.000 - 26.033 (1.0236 - 1.0249)	—
Valve lifter to lifter hole clear- ance	0.030 - 0.073 (0.0012 - 0.0029)	0.20 (0.0079)
Push rod bend (TIR)*	Less than 0.3 (0.012)	0.5 (0.020)

\*: Total indicator reading

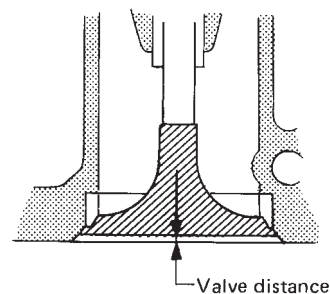
## Rocker shaft and rocker arm

Unit: mm (in)

	Standard	Limit
Rocker shaft		
Outer diameter	19.979 - 20.00 (0.7866 - 0.7874)	—
Rocker shaft bend (TIR)	0 - 0.15 (0 - 0.0059)	Less than 0.30 (0.0118)
Rocker arm		
Inner diameter	20.014 - 20.035 (0.7880 - 0.7888)	—
Clearance between rocker arm and rocker shaft	0.014 - 0.056 (0.0006 - 0.0022)	0.15 (0.0059)

## CYLINDER HEAD TO VALVE DISTANCE

Unit: mm (in)



SEM724C

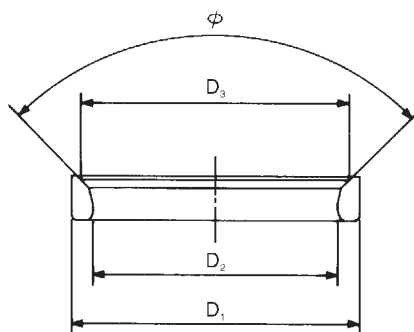
	Standard	Limit
Intake	0.7 - 1.3 (0.028 - 0.051)	1.70 (0.067)
Exhaust	0.7 - 1.3 (0.028 - 0.051)	1.70 (0.067)



## Inspection and Adjustment (Cont'd)

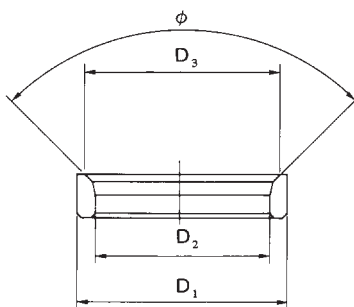
## Valve seat

Unit: mm (in)



SEM258F

	QD32	TD27
Intake		
Outer diameter " $D_1$ "	46.535 - 46.545 (1.8321 - 1.8325)	44.535 - 44.545 (1.7533 - 1.7537)
Inner diameter " $D_2$ "	39.4 - 39.6 (1.551 - 1.559)	37.9 - 38.1 (1.492 - 1.500)
Diameter of seat " $D_3$ "	45.3 - 45.7 (1.783 - 1.799)	42.5 (1.673)
Cylinder head valve seat diameter	46.500 - 46.515 (1.8307 - 1.8313)	44.500 - 44.515 (1.7520 - 1.7526)
Valve seat face angle " $\phi$ "	89° - 90°	89° - 90°



SEM953C

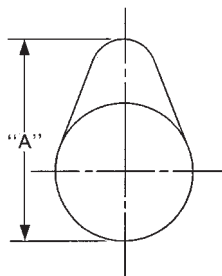
	QD32	TD27
Exhaust		
Outer diameter " $D_1$ "		
Standard	40.535 - 40.545 (1.5959 - 1.5963)	39.535 - 39.545 (1.5565 - 1.5569)
0.2 (0.008) Oversize (Service)	40.735 - 40.745 (1.6037 - 1.6041)	39.735 - 39.745 (1.5644 - 1.5648)
0.4 (0.016) Oversize (Service)	40.935 - 40.945 (1.6116 - 1.6120)	39.935 - 39.945 (1.5722 - 1.5726)
Inner diameter " $D_2$ "	33.65 - 34.35 (1.3248 - 1.3524)	32.4 - 33.1 (1.276 - 1.303)
Diameter of seat " $D_3$ "	37.9 - 38.1 (1.492 - 1.500)	37.0 (1.457)
Cylinder head valve seat diameter		
Standard	40.495 - 40.510 (1.5943 - 1.5949)	39.495 - 39.510 (1.5549 - 1.5555)
0.2 (0.008) Oversize	40.695 - 40.710 (1.6022 - 1.6028)	39.695 - 39.710 (1.5628 - 1.5634)
0.4 (0.016) Oversize	40.895 - 40.910 (1.6100 - 1.6106)	39.895 - 39.910 (1.5707 - 1.5713)
Valve seat face angle " $\phi$ "	89° - 90°	89° - 90°

## Inspection and Adjustment (Cont'd)

## CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

	Standard	Limit
Camshaft journal to bushing clearance [Oil clearance]	0.020 - 0.109 (0.0008 - 0.0043)	0.15 (0.0059)
Camshaft journal diameter		
Front	50.721 - 50.740 (1.9969 - 1.9976)	—
2nd	50.521 - 50.540 (1.9890 - 1.9898)	—
3rd	50.321 - 50.340 (1.9811 - 1.9819)	—
4th	50.121 - 50.140 (1.9733 - 1.9740)	—
Rear	49.921 - 49.940 (1.9654 - 1.9661)	—
Camshaft bend (Total indicator reading)	Less than 0.02 (0.0008)	0.06 (0.0024)
Camshaft end play	0.08 - 0.28 (0.0031 - 0.0110)	0.50 (0.0197)



EM671

	Standard	Limit
Cam height "A"		
Intake & Exhaust	41.88 - 41.92 (1.6488 - 1.6504)	41.40 (1.6299)

GI

MA

EM

LC

EC

FE

CL

MT

TF

PD

FA

RA

BR

ST

RS

BT

HA

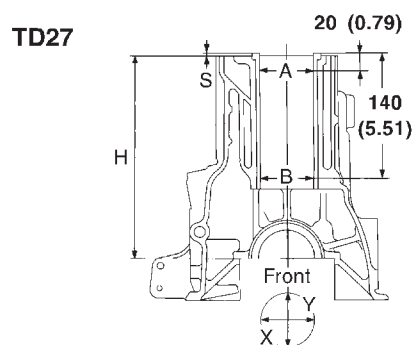
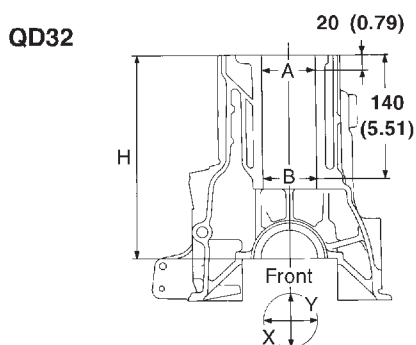
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IDX

## Inspection and Adjustment (Cont'd)

## CYLINDER BLOCK AND CYLINDER LINER

Unit: mm (in)

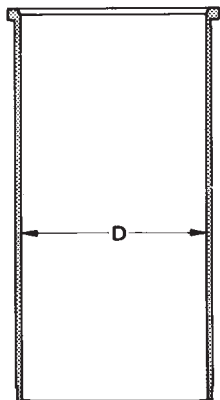


DEM057

	QD32	TD27
Nominal cylinder block height "H" (From crankshaft center)	252.95 - 253.05 (9.9586 - 9.9626)	
Surface flatness (Without cylinder liner)		
Standard	Less than 0.05 (0.0020)	
Limit	0.2 (0.008)	
Cylinder bore (Without cylinder liner)		
Inner diameter		
Standard	99.200 - 99.230 (3.9055 - 3.9067)	99.000 - 99.020 (3.8976 - 3.8984)
Cylinder bore	(Without cylinder liner)	(With cylinder liner for factory)
Inner diameter		
Standard		
Grade No. 1	99.200 - 99.210 (3.9055 - 3.9059)	96.000 - 96.010 (3.7795 - 3.7799)
Grade No. 2	99.210 - 99.220 (3.9059 - 3.9063)	96.010 - 96.020 (3.7799 - 3.7803)
Grade No. 3	99.220 - 99.230 (3.9063 - 3.9067)	96.020 - 96.030 (3.7803 - 3.7807)
Wear limit	0.20 (0.0079)	
Out-of-round (X - Y) standard	Less than 0.020 (0.0008)	
Taper (A - B) standard	Less than 0.020 (0.0008)	
Projection "S"	—	0.02 - 0.09 (0.0008 - 0.0035)
Deviation of each cylinder "S"	—	Less than 0.05 (0.0020)
Interference fit cylinder liner to block	—	-0.01 to 0.03 (-0.0004 to 0.0012)

## Inspection and Adjustment (Cont'd)

Unit: mm (in)



SEM427

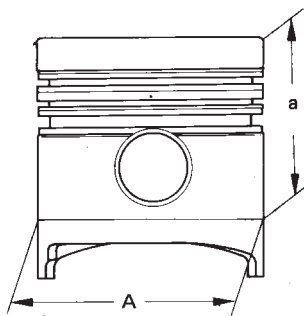
	TD27
Cylinder liner diameter "D" (service)*	96.050 - 96.070 (3.7815 - 3.7823)

\*: Before installing in cylinder block

## PISTON, PISTON RING AND PISTON PIN

## Available piston

Unit: mm (in)



SEM778A

	QD32	TD27
Piston skirt diameter "A"		
Standard		
Grade No. 1	99.140 - 99.150 (3.9031 - 3.9035)	95.940 - 95.950 (3.7772 - 3.7776)
Grade No. 2	99.150 - 99.160 (3.9035 - 3.9039)	95.950 - 95.960 (3.7776 - 3.7779)
Grade No. 3*	99.160 - 99.170 (3.9039 - 3.9043)	95.960 - 95.970 (3.7779 - 3.7783)
"a" dimension	54.8 (2.157)	70 (2.76)
Piston pin hole diameter	32.997 - 33.005 (1.2991 - 1.2994)	29.997 - 30.005 (1.1810 - 1.1813)
Piston to cylinder liner clearance	0.05 - 0.07 (0.0020 - 0.0028)	

\*: Grade No. 3 piston is not provided as a service part.

## Inspection and Adjustment (Cont'd)

## Piston ring

Unit: mm (in)

	Standard	Limit
Side clearance		
Top	0.06 - 0.10 (0.0024 - 0.0039)	0.50 (0.0197)
2nd	0.04 - 0.08 (0.0016 - 0.0031)	0.30 (0.0118)
Oil	0.02 - 0.06 (0.0008 - 0.0024)	0.15 (0.0059)
Ring gap		
Top	0.30 - 0.45 (0.0118 - 0.0177)	1.5 (0.059)
2nd	0.50 - 0.65 (0.0197 - 0.0256)	
Oil (rail ring)	0.30 - 0.50 (0.0118 - 0.0197)	

## CONNECTING ROD

Unit: mm (in)

	QD32	TD27
Center distance	156.975 - 157.025 (6.1801 - 6.1821)	
Bend, torsion [per 100 (3.94)]		
Limit	0.075 (0.0030)	
Piston pin bore dia.	33.025 - 33.038 (1.3002 - 1.3007)	30.025 - 30.038 (1.1821 - 1.1826)
Side clearance		
Standard	0.10 - 0.22 (0.0039 - 0.0087)	
Limit	0.22 (0.0087)	

## Piston pin

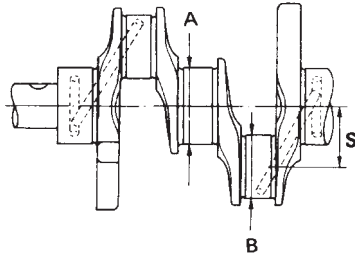
Unit: mm (in)

	QD32	TD27
Piston pin outer diameter	32.993 - 33.000 (1.2989 - 1.2992)	29.993 - 30.000 (1.1808 - 1.1811)
Piston pin to piston clear- ance		
Standard	-0.003 to 0.012 (-0.0001 to 0.0005)	
Limit	0.10 (0.0039)	
Piston pin to connecting rod clearance		
Standard	0.025 - 0.045 (0.0010 - 0.0018)	
Limit	0.15 (0.0059)	

## Inspection and Adjustment (Cont'd)

## CRANKSHAFT

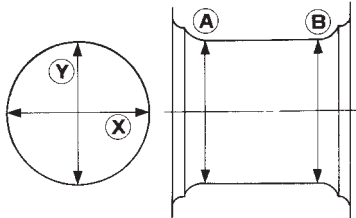
Unit: mm (in)



SEM100A

Journal diameter "A"	70.907 - 70.920 (2.7916 - 2.7921)
Pin diameter "B"	56.913 - 56.926 (2.2407 - 2.2412)
Center distance "S"	
QD32	51.00 (2.0079)
TD27	46.00 (1.8110)

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



EM715

Taper of journal and pin "A - B"	
Standard	0.01 (0.0004)
Limit	0.02 (0.0008)
Out-of-round of journal and pin "X - Y"	
Standard	0.01 (0.0004)
Limit	0.02 (0.0008)
Crankshaft bend	
Standard	0 - 0.03 (0 - 0.0012)
Limit	0.10 (0.0039)
Crankshaft end play	
Standard	0.055 - 0.14 (0.0022 - 0.0055)
Limit	0.40 (0.0157)

## AVAILABLE MAIN BEARING

## Bearing clearance

Unit: mm (in)

Main bearing clearance	
Standard	0.035 - 0.087 (0.0014 - 0.0034)
Limit	0.15 (0.0059)
Connecting rod bearing clearance	
Standard	0.035 - 0.081 (0.0014 - 0.0032)
Limit	0.15 (0.0059)

## Main bearing undersize

Unit: mm (in)

	Crank journal diameter
Standard	70.907 - 70.920 (2.7916 - 2.7921)
Undersize	
0.25 (0.0098)	70.657 - 70.670 (2.7818 - 2.7823)
0.50 (0.0197)	70.407 - 70.420 (2.7719 - 2.7724)
0.75 (0.0295)	70.157 - 70.170 (2.7621 - 2.7626)
1.00 (0.0394)	69.907 - 69.920 (2.7522 - 2.7528)

## AVAILABLE CONNECTING ROD BEARING

## Connecting rod bearing undersize

Unit: mm (in)

	Crank pin journal diameter
Standard	56.913 - 56.926 (2.2407 - 2.2412)
Undersize	
0.25 (0.0098)	56.663 - 56.676 (2.2308 - 2.2313)
0.50 (0.0197)	56.413 - 56.676 (2.2210 - 2.2313)
0.75 (0.0295)	56.163 - 56.176 (2.2111 - 2.2116)
1.00 (0.0394)	55.913 - 55.926 (2.2013 - 2.2018)

## Inspection and Adjustment (Cont'd)

## AVAILABLE THRUST WASHER

## Thrust washer undersize

Unit: mm (in)

	Thrust washer thickness
Standard	
Stamped mark A	2.275 - 2.325 (0.0896 - 0.0915)
B	2.300 - 2.350 (0.0906 - 0.0925)
C	2.325 - 2.375 (0.0915 - 0.0935)
Oversize	
0.20 (0.0079)	2.475 - 2.525 (0.0974 - 0.0994)
0.40 (0.0157)	2.675 - 2.725 (0.1053 - 0.1073)

## MISCELLANEOUS COMPONENTS

Unit: mm (in)

Gear train	
Backlash of each gear	0.07 - 0.11 (0.0028 - 0.0043)
Limit	0.20 (0.0079)
Flywheel	
Runout (Total indicator reading)	Less than 0.15 (0.0059)
Front plate	
Warpage limit	0.2 (0.008)