

# ENGINE MECHANICAL

## SECTION EM

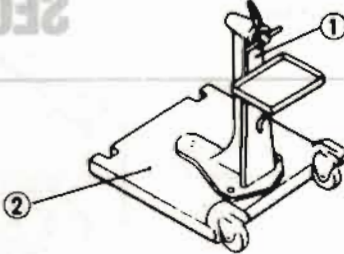
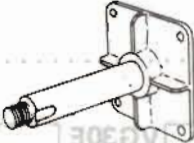

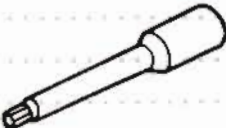


EM

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# PREPARATION





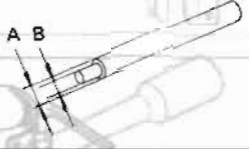
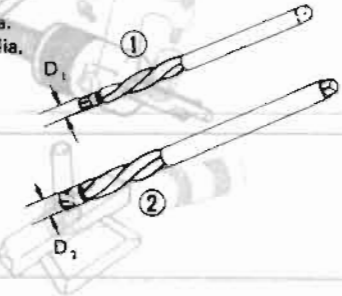
## SPECIAL SERVICE TOOLS

Tool number (Kent-Moore No.) Tool name	Description
ST0501S000 ( - ) Engine stand assembly ① ST05011000 ( - ) Engine stand ② ST05012000 ( - ) Base	Disassembling and assembling 
KV10106500 ( - ) Engine stand shaft	
KV10110001 ( - ) Engine sub- attachment	
ST10120000 (J24239-01) Cylinder head bolt wrench	Loosening and tightening cylinder head bolt 
KV10110600 (J33986) Valve spring compressor	Disassembling and assembling valve components 
KV10107501 ( - ) Valve oil seal drift	Installing valve oil seal 

Tool number (Kent-Moore No.) Tool name	Description	Description	Tool name
KV10110300 ( - ) Piston pin press stand assembly	Disassembling and assembling piston with connecting rod		
① KV10110310 ( - ) Cap			
② KV10110330 ( - ) Spacer			
③ ST13030020 ( - ) Press stand			
④ ST13030030 ( - ) Spring			
⑤ KV10110340 ( - ) Drift			
⑥ KV10110320 ( - ) Center shaft			
EM03470000 (J8037) Piston ring compressor	Installing piston assembly into cylinder bore		
ST16610001 (J23907) Pilot bushing puller	Removing crankshaft pilot bushing		
KV10111100 ( - ) Seal cutter	Removing oil pan		
WS39930000 ( - ) Tube presser	Pressing the tube of liquid gasket		



# PREPARATION

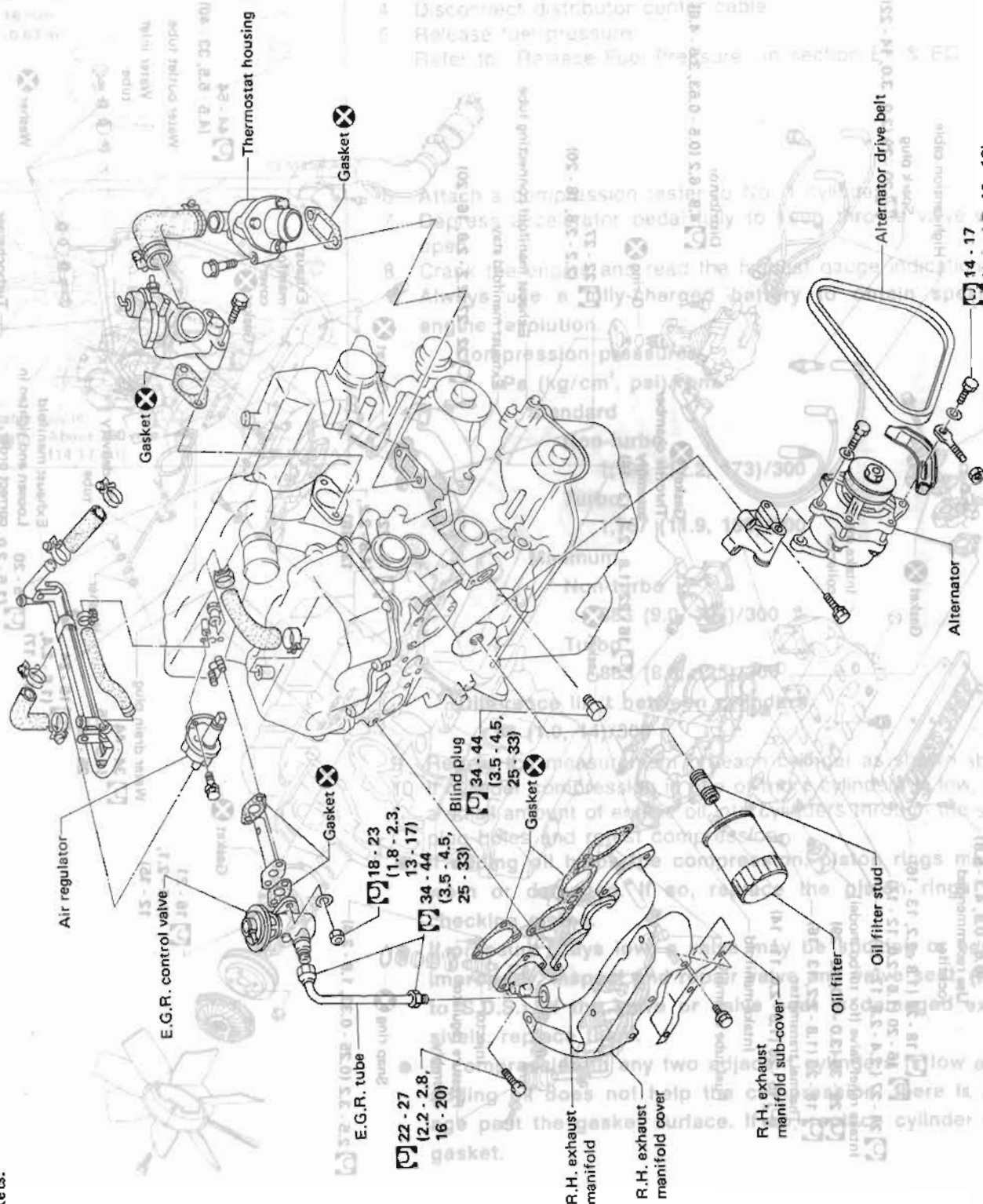
Tool name	Description	
Spark plug wrench		Removing and installing spark plug
Pulley holder		Holding camshaft pulley while tightening or loosening camshaft bolt
Valve seat cutter set		Finishing valve seat dimensions
Piston ring expander		Removing and installing piston ring
Valve guide drift	<p>Intake &amp; Exhaust:  A = 10.5 mm (0.413 in) dia.  B = 6.6 mm (0.260 in) dia.</p> 	Removing and installing valve guide
Valve guide reamer	<p>Intake:  D<sub>1</sub> = 7.0 mm (0.276 in) dia.  D<sub>2</sub> = 11.2 mm (0.441 in) dia.  Exhaust:  D<sub>1</sub> = 8.0 mm (0.315 in) dia.  D<sub>2</sub> = 12.2 mm (0.480 in) dia.</p> 	Reaming valve guide (①) or hole for oversize valve guide (②)

Use new gaskets.

## Measurement of Compression Pressure

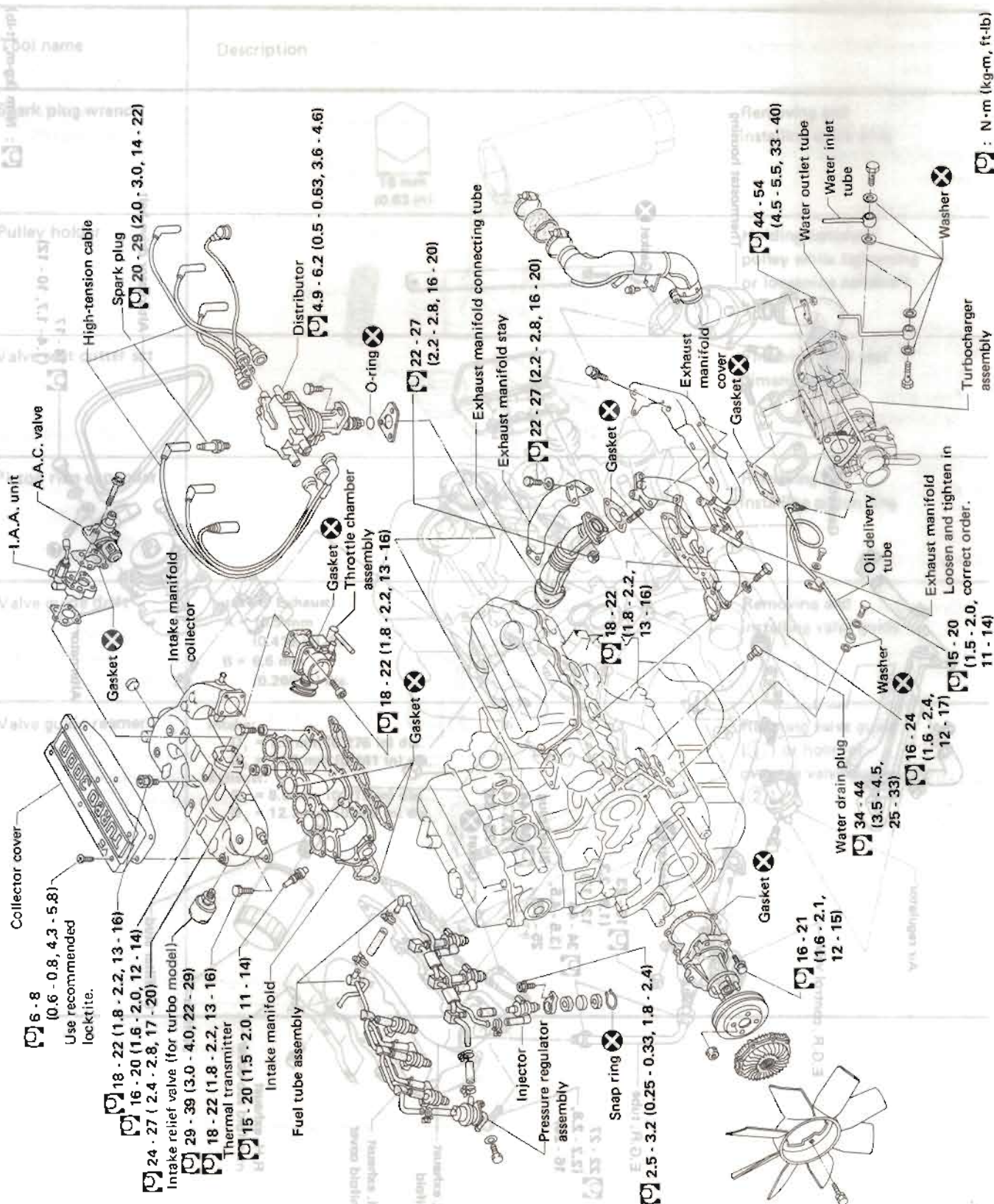
- 1 Warm up engine
- 2 Turn ignition switch off
- 3 Removal all spark plugs
- 4 Disconnect distributor center cable
- 5 Release fuel pressure
- 6 Refer to Release Fuel Pressure in section 5-14 & 5-15

Ⓜ : N·m (kg·m, ft·lb)

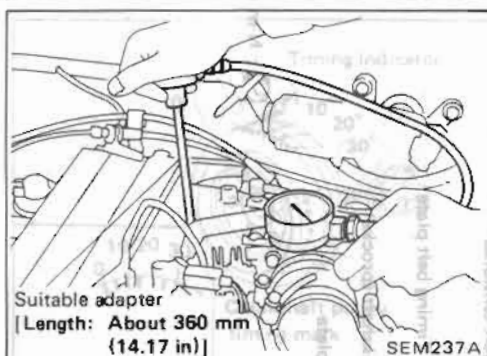
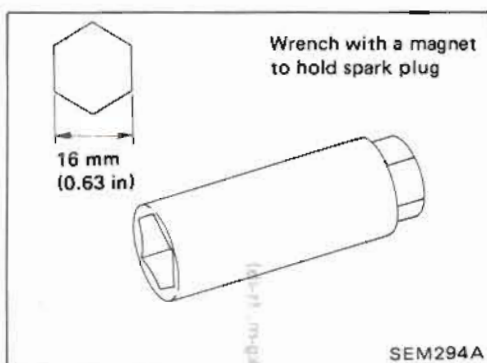




# ENGINE COMPONENTS — Outer Parts



⌘ : N·m (kg-m, ft-lb)



## Measurement of Compression Pressure

1. Warm up engine.
  2. Turn ignition switch off.
  3. Removal all spark plugs.
  4. Disconnect distributor center cable.
  5. Release fuel pressure.  
Refer to "Release Fuel Pressure" in section EF & EC.
  6. Attach a compression tester to No. 1 cylinder.
  7. Depress accelerator pedal fully to keep throttle valve wide open.
  8. Crank the engine and read the highest gauge indication.
- Always use a fully-charged battery to obtain specified engine revolution.

Compression pressure:

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

Standard

Non-turbo

1,196 (12.2, 173)/300

Turbo

1,167 (11.9, 169)/300

Minimum

Non-turbo

883 (9.0, 128)/300

Turbo

863 (8.8, 125)/300

Difference limit between cylinders:

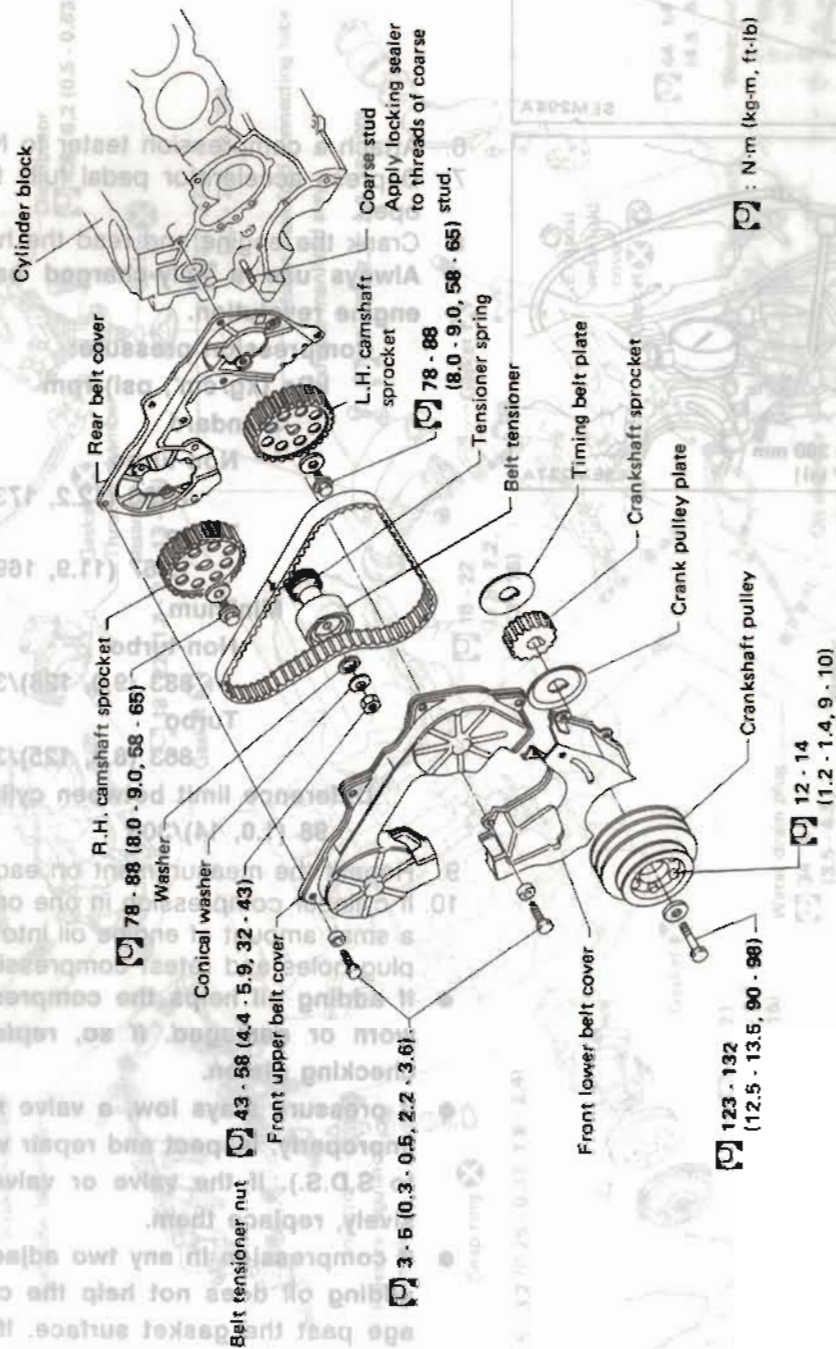
98 (1.0, 14)/300

9. Repeat the measurement on each cylinder as shown above.
  10. If cylinder compression in one or more cylinders is low, pour a small amount of engine oil into cylinders through the spark plug holes and retest compression.
- If adding oil helps the compression, piston rings may be worn or damaged. If so, replace the 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 S.D.S.). If the valve or valve seat is damaged excessively, replace them.
  - If compression in any two adjacent cylinders is low and if adding oil does not help the compression, there is leakage past the gasket surface. If so, replace cylinder head gasket.



# CAUTION:

- a. Do not bend or twist timing belt.
- b. After removing timing belt, do not turn crankshaft and camshaft separately because valves will strike piston heads.
- c. Make sure that timing belt, camshaft sprocket, crankshaft sprocket and belt tensioner are clean and free from oil and water.

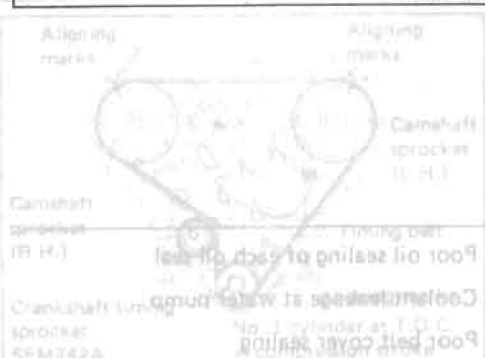
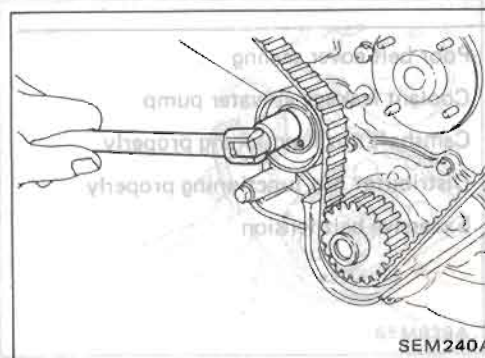
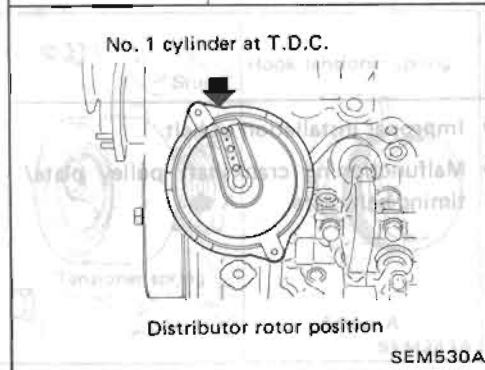
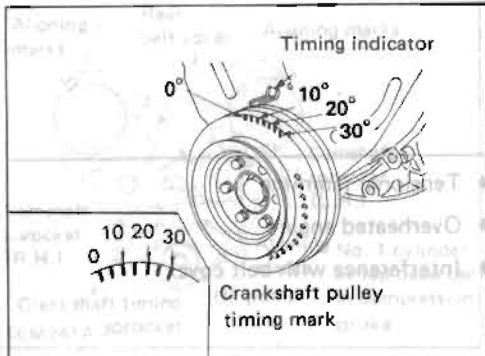




# TIMING BELT

## Removal

1. Remove engine under cover.
2. Drain engine coolant from radiator.  
**Be careful not to spill coolant on drive belts.**
3. Remove radiator shroud and fan.
4. Remove the following belts.
  - Power steering drive belt
  - Compressor drive belt
  - Alternator drive belt
5. Remove suction pipe bracket of coolant and lower hose from suction pipe.
6. Remove all spark plugs.
7. Set No. 1 cylinder at T.D.C. on its compression stroke.
8. Remove idler bracket of the compressor drive belt and crankshaft pulley.
9. Remove front upper and lower belt covers.



10. Loosen timing belt tensioner nut, turn tensioner, and then remove timing belt.




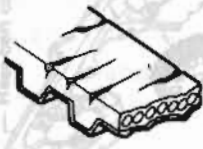
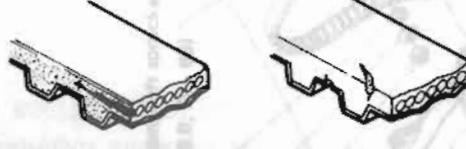
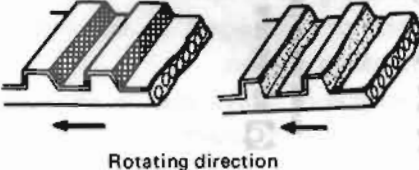
1. Set timing belt
  - (1) Align white lines on timing belt with punchmarks on camshaft sprocket
  - (2) Split lower timing belt cover

Number of timing belt teeth	Between L.H. and R.H. camshaft sprockets	Oil-cooled or water is stuck to belt
Number of teeth between timing marks	Between L.H. camshaft sprocket and crankshaft timing sprocket	43

# TIMING BELT

## Inspection

Visually check the condition of the timing belt.  
Replace if any abnormality is found.

Item to check	Problem	Cause
Tooth is broken/ tooth root is cracked.	 <p>SEM394A</p>	<ul style="list-style-type: none"> <li>Camshaft jamming</li> <li>Distributor jamming</li> <li>Damaged camshaft/crankshaft oil seal</li> </ul>
Back surface is cracked/worn.	 <p>SEM395A</p>	<ul style="list-style-type: none"> <li>Tensioner jamming</li> <li>Overheated engine</li> <li>Interference with belt cover</li> </ul>
Side surface is worn.	 <p>SEM396A</p> <ul style="list-style-type: none"> <li>Belt corners are worn and round.</li> <li>Wicks are frayed and coming out.</li> </ul>	<ul style="list-style-type: none"> <li>Improper installation of belt</li> <li>Malfunctioning crankshaft pulley plate/ timing belt plate</li> </ul>
Teeth are worn.	 <p>SEM397A</p> <ul style="list-style-type: none"> <li>Canvas on tooth face is worn down.</li> <li>Canvas on tooth is fluffy, rubber layer is worn down and faded white, or weft is worn down and invisible.</li> </ul>	<ul style="list-style-type: none"> <li>Poor belt cover sealing</li> <li>Coolant leakage at water pump</li> <li>Camshaft not functioning properly</li> <li>Distributor not functioning properly</li> <li>Excessive belt tension</li> </ul>
Oil/Coolant or water is stuck to belt.		<ul style="list-style-type: none"> <li>Poor oil sealing of each oil seal</li> <li>Coolant leakage at water pump</li> <li>Poor belt cover sealing</li> </ul>

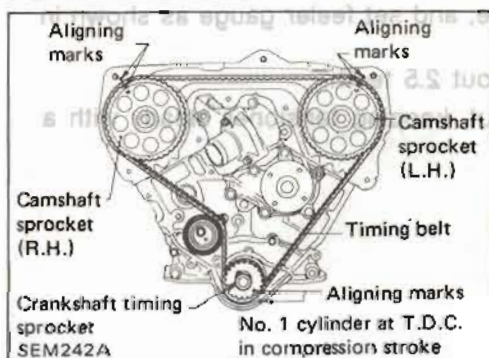
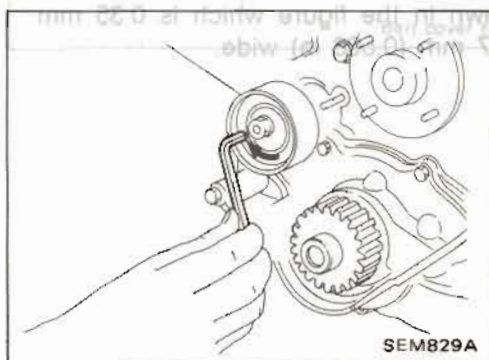
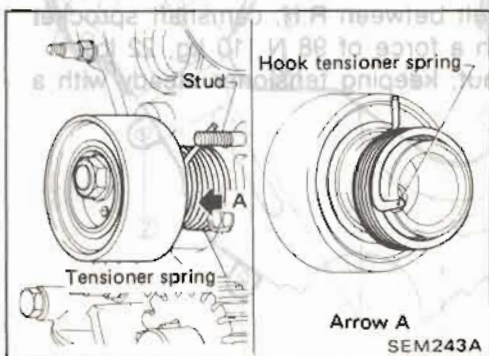
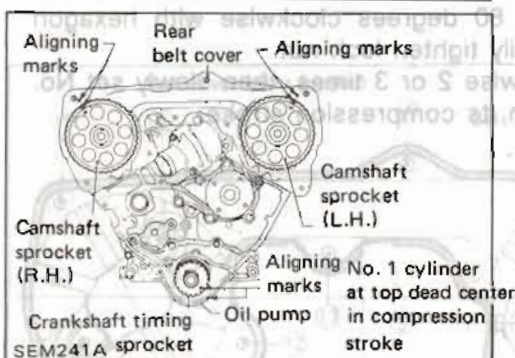
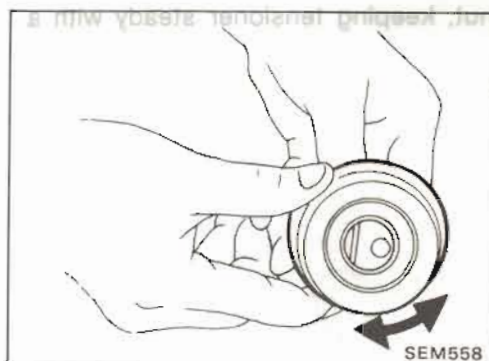


## TIMING BELT

### Inspection (Cont'd)

#### BELT TENSIONER AND TENSIONER SPRING

1. Check belt tensioner for smooth turning.
2. Check condition of tensioner spring.



### Installation

1. Confirm that No. 1 cylinder is set at T.D.C. on its compression stroke.

2. Install tensioner and tensioner spring.

If stud is once removed, apply locking sealant to threads of stud before installing.

3. Turn tensioner fully clockwise with hexagon wrench, and temporarily tighten lock nut.

4. Set timing belt.

(1) Align white lines on timing belt with punchmarks on camshaft sprockets and crankshaft sprocket.

(2) Point arrow on timing belt toward front belt cover.

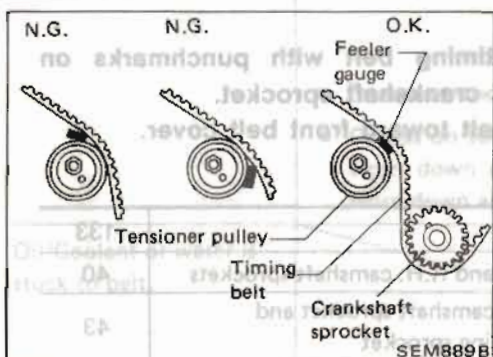
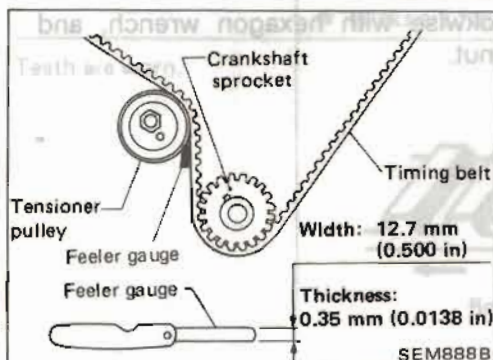
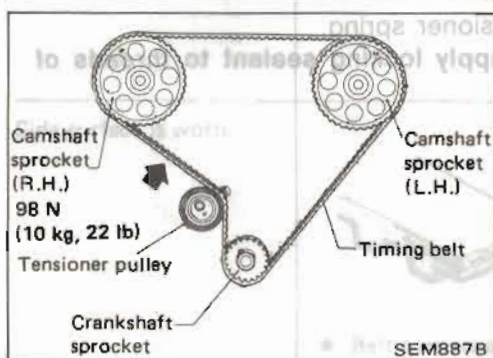
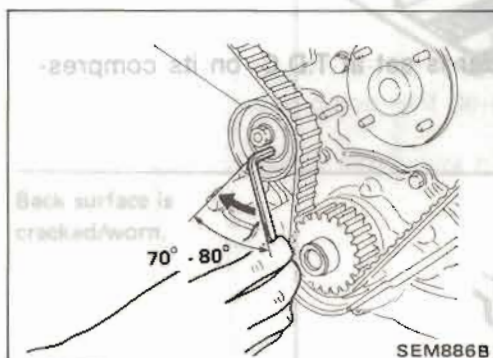
Number of teeth (reference):

Number of timing belt teeth		133
Number of teeth between timing marks	Between L.H. and R.H. camshaft sprockets	40
	Between L.H. camshaft sprocket and crankshaft timing sprocket	43

## TIMING BELT

### Installation (Cont'd)

5. Loosen tensioner lock nut, keeping tensioner steady with a hexagon wrench.



6. Turn tensioner 70 to 80 degrees clockwise with hexagon wrench, and temporarily tighten lock nut.
7. Turn crankshaft clockwise 2 or 3 times, then slowly set No. 1 cylinder at T.D.C. on its compression stroke.

8. Push middle of timing belt between R.H. camshaft sprocket and tensioner pulley with a force of 98 N (10 kg, 22 lb).
9. Loosen tensioner lock nut, keeping tensioner steady with a hexagon wrench.

10. Set feeler gauge as shown in the figure which is 0.35 mm (0.0138 in) thick and 12.7 mm (0.500 in) wide.

11. Turn crankshaft clockwise, and set feeler gauge as shown in the figure.
  - Timing belt will move about 2.5 teeth.
12. Tighten tensioner lock nut, keeping tensioner steady with a hexagon wrench.

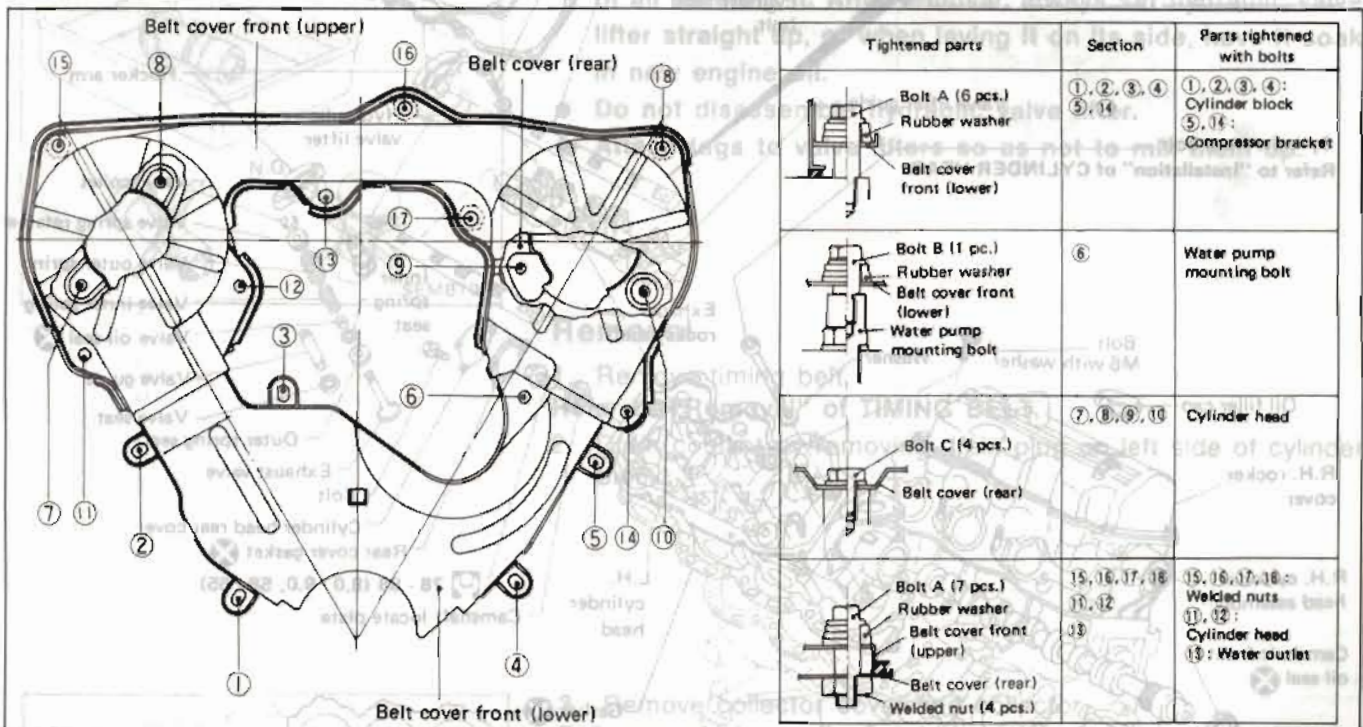


## TIMING BELT

### Installation (Cont'd)

13. Turn crankshaft clockwise or counterclockwise, and remove feeler gauge.
14. Turn crankshaft clockwise 2 or 3 times, then slowly set No. 1 cylinder at T.D.C. on its compression stroke.

15. Install lower and upper belt covers.



SEM248A

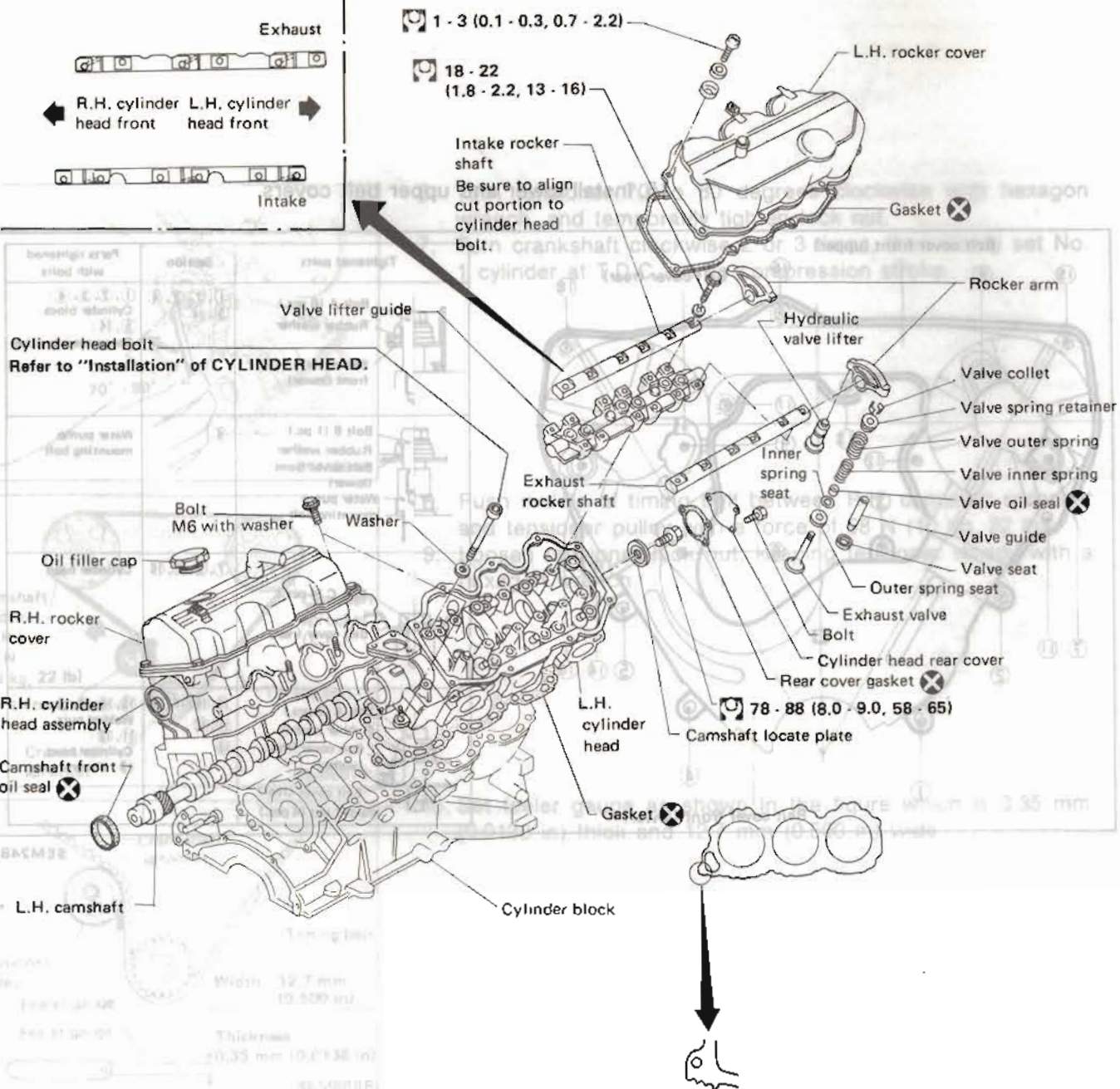
1. Remove intake manifold with fuel tube assembly.
2. Loosen intake manifold bolts in numerical order.



# CYLINDER HEAD

(Installation)

1. Turn crankshaft clockwise or counterclockwise, and remove  
14. Turn crankshaft clockwise 2 or 3 times, then slowly set No.  
1 cylinder at T.D.C. on the compression stroke.



N : N·m (kg·m, ft·lb)

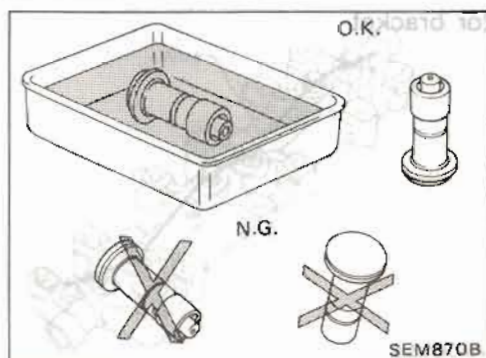


## CYLINDER HEAD

### Removal (Cont'd)

#### 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 the thread portions and seat surfaces of bolts.



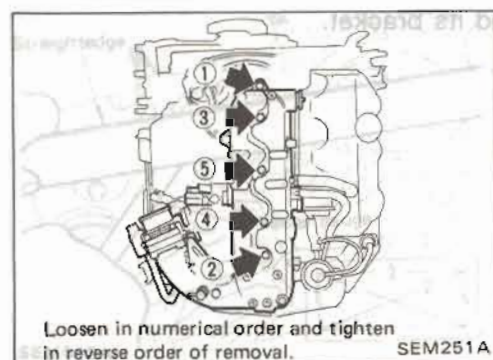
- If a hydraulic valve lifter is kept on its side, there is a risk of air entering it. After removal, always set hydraulic valve lifter straight up, or when laying it on its side, have it soak in new engine oil.
- Do not disassemble hydraulic valve lifter.
- Attach tags to valve lifters so as not to mix them up.

### Removal

1. Remove timing belt.

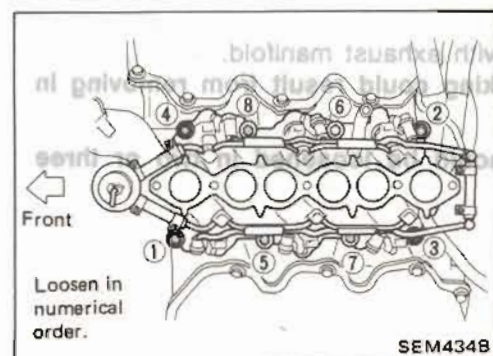
Refer to "Removal" of TIMING BELT.

2. Drain coolant by removing drain plug on left side of cylinder block.



3. Remove collector cover and collector.

Before removing collector, be sure to drain coolant removing drain plug in cylinder block.



4. Remove intake manifold with fuel tube assembly.

- Loosen intake manifold bolts in numerical order.

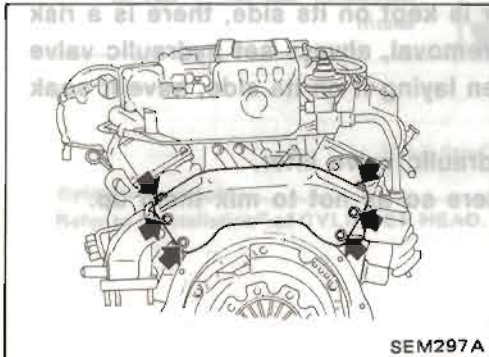
## CYLINDER HEAD

### Removal (Cont'd)

5. Remove power steering pump bracket.

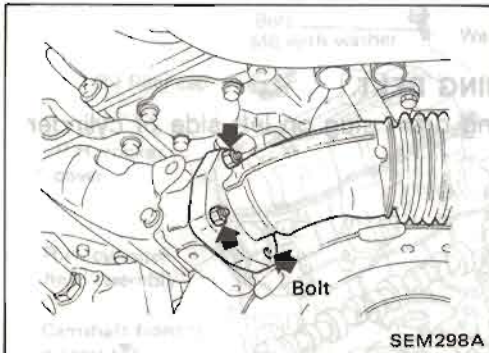
● When installing sliding parts such as rocker arms, camshaft and oil seal, be sure to apply new engine oil on their sliding surfaces.

● When tightening cylinder head bolts and rocker shaft bolts, apply new engine oil to the thread portions and seat surfaces of bolts.



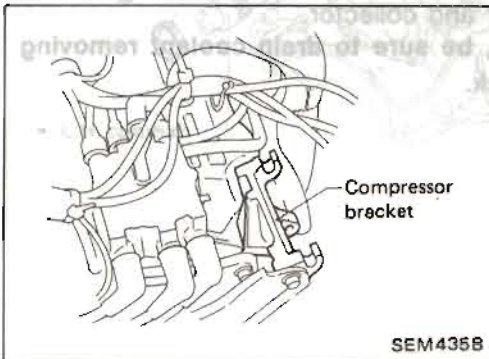
SEM297A

6. Remove exhaust collector bracket.



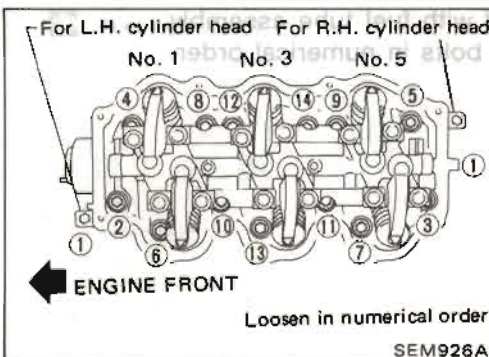
SEM298A

7. Disconnect exhaust manifold balance tube.
8. Disconnect exhaust tube from exhaust manifold.
9. Remove camshaft sprockets and rear timing belt cover.



SEM435B

10. Remove compressor and its bracket.

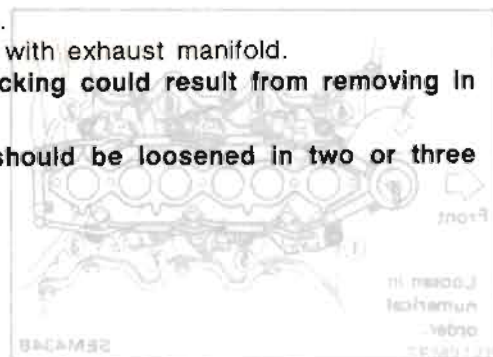


SEM926A

11. Remove rocker covers.

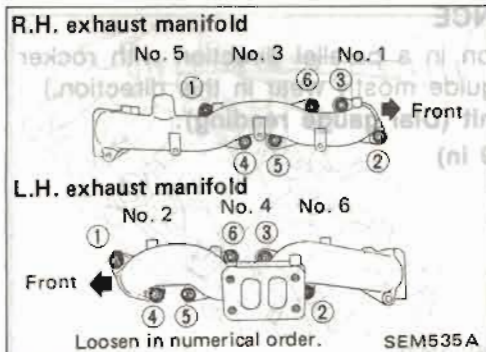
12. Remove cylinder head with exhaust manifold.

- Head warpage or cracking could result from removing in incorrect order.
- Cylinder head bolts should be loosened in two or three steps.



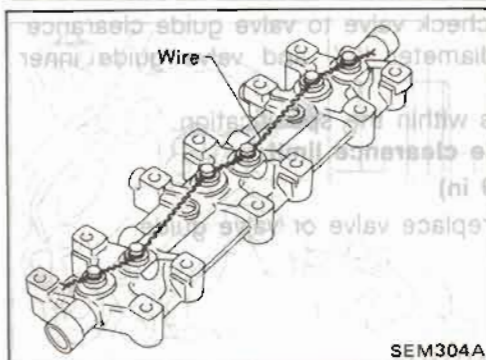


# CYLINDER HEAD



## Disassembly

1. Remove exhaust manifolds from cylinder head.

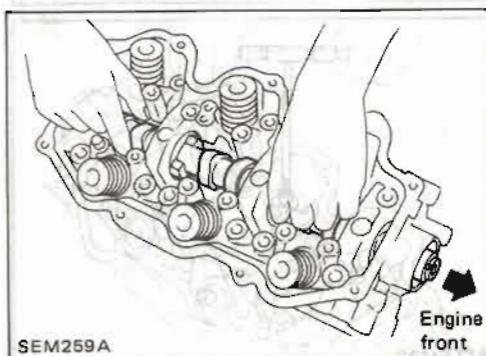


2. Remove rocker shafts with rocker arms.

**Bolts should be loosened in two or three steps.**

3. Remove hydraulic valve lifters and lifter guide.

● **Hold hydraulic valve lifters with wire so that they will not drop from lifter guide.**

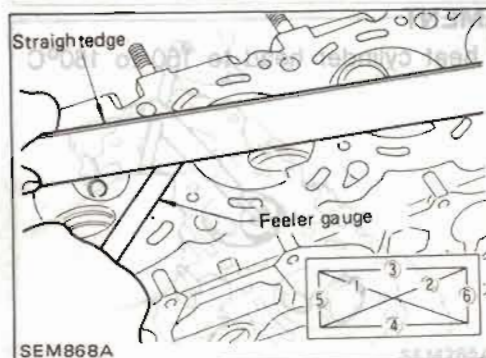


4. Remove oil seal and camshaft.

5. Remove valve components with Tool.

Tool: KV10110600 (J33986)

6. Remove valve oil seals.



## Inspection

### CYLINDER HEAD DISTORTION

**Head surface flatness:**

- **Before** 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 the cylinder head, check that camshaft rotates freely by hand. If resistance is felt, the cylinder head must be replaced.

**Nominal cylinder head height:**

$$106.8 - 107.2 \text{ mm (4.205 - 4.220 in)}$$

Intake:

$$44.500 - 44.516 \text{ mm (1.7520 - 1.7526 in)}$$

Exhaust:

$$37.500 - 37.516 \text{ mm (1.4764 - 1.4770 in)}$$

## CYLINDER HEAD

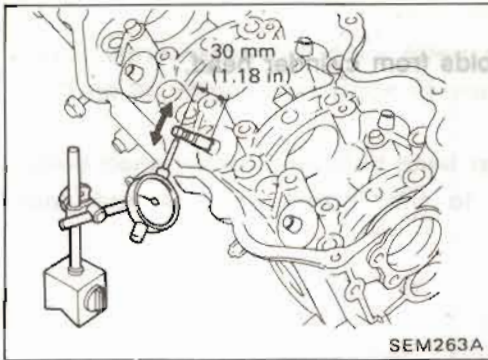
### Inspection (Cont'd)

#### VALVE GUIDE CLEARANCE

1. Measure valve deflection in a parallel direction with rocker arm. (Valve and valve guide mostly wear in this direction.)

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

**0.20 mm (0.0079 in)**



2. If it exceeds the limit, check valve to valve guide clearance.

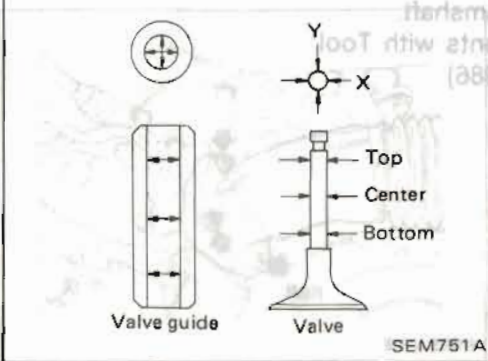
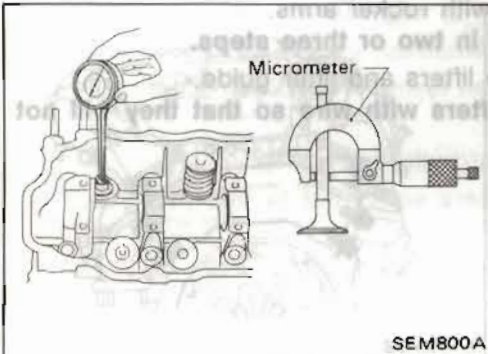
(1) Measure valve stem diameter "d" and valve guide inner diameter.

(2) Check that clearance is within the specification.

**Valve to valve guide clearance limit:**

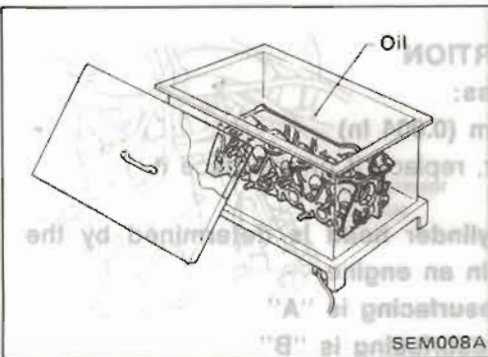
**0.10 mm (0.0039 in)**

(3) If it exceeds the limit, replace valve or valve guide.

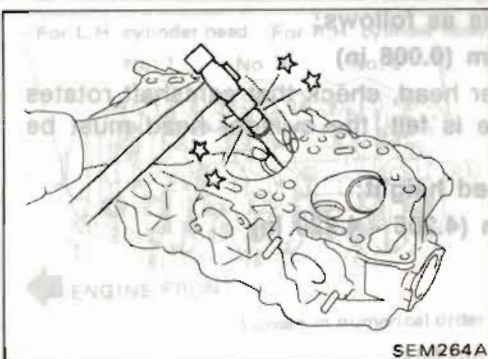


#### VALVE GUIDE REPLACEMENT

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



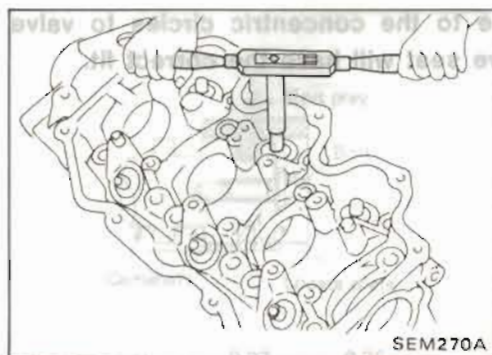
2. Drive out valve guide with a press [under a 20 kN (2 t, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.





## CYLINDER HEAD

### (b) Inspection (Cont'd)



3. Ream cylinder head valve guide hole.

**Valve guide hole diameter**

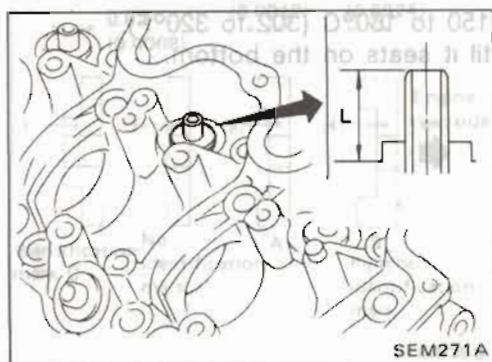
(for service parts):

Intake:

11.175 - 11.196 mm (0.4400 - 0.4408 in)

Exhaust:

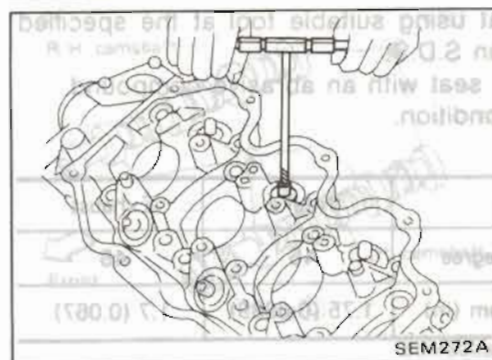
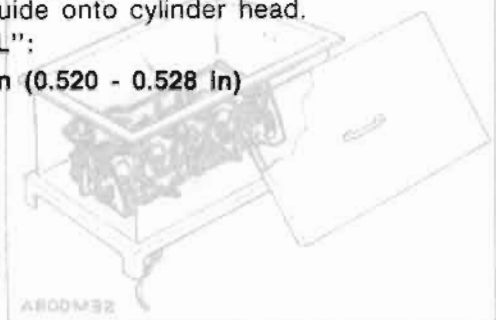
12.175 - 12.196 mm (0.4793 - 0.4802 in)



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

**Tapping length "L":**

13.2 - 13.4 mm (0.520 - 0.528 in)



5. Ream valve guide.

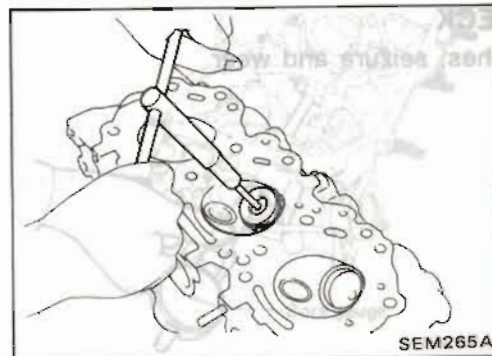
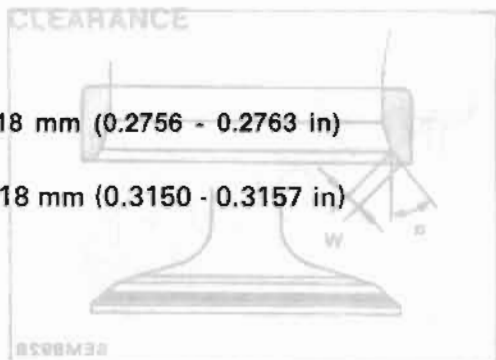
**Finished size:**

Intake:

7.000 - 7.018 mm (0.2756 - 0.2763 in)

Exhaust:

8.000 - 8.018 mm (0.3150 - 0.3157 in)



### VALVE SEATS

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

- Before repairing valve seats, check valve and valve guide for wear. If they have worn, replace them. Then correct valve seat.
- Cut with both hands to uniform the cutting surface.

### 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**

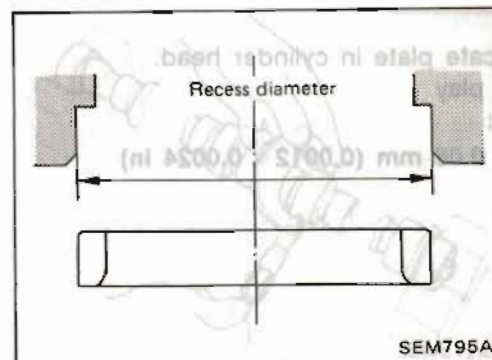
[Oversize 0.5 mm (0.020 in)]:

Intake:

44.500 - 44.516 mm (1.7520 - 1.7526 in)

Exhaust:

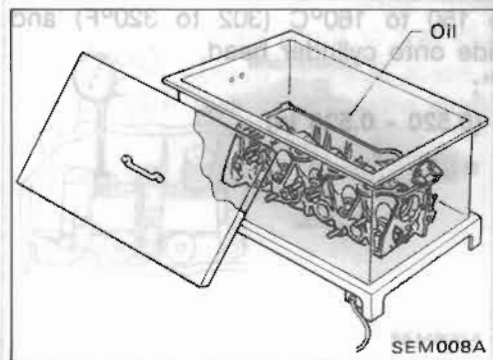
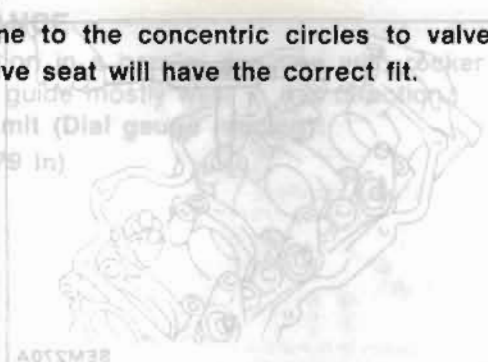
37.500 - 37.516 mm (1.4764 - 1.4770 in)



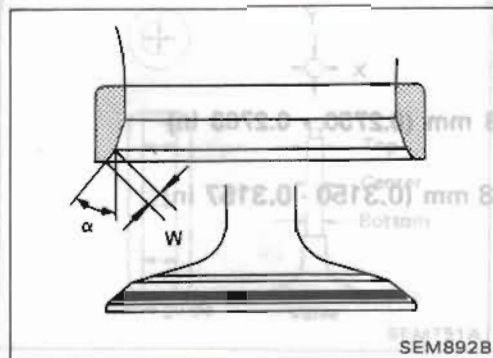
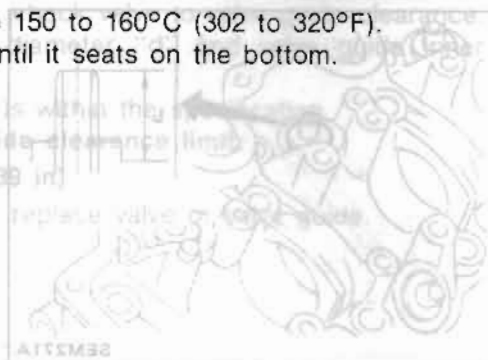
## CYLINDER HEAD

### (b) Inspection (Cont'd)

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



3. Heat cylinder head to 150 to 160°C (302 to 320°F).
4. Press fit valve seat until it seats on the bottom.



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

		Intake	Exhaust
Seat face angle "α"	degree	45	45
Contacting width "W"	mm (in)	1.75 (0.0689)	1.7 (0.067)

### CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.

Before repairing valve seats, check valve and valve guide for wear. If they have worn, replace them. Then correct valve seat.

Cut with both hands to uniform the cutting surface.

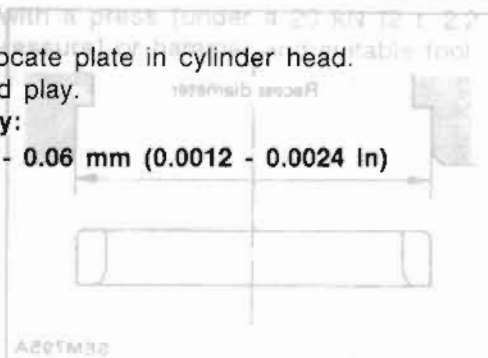
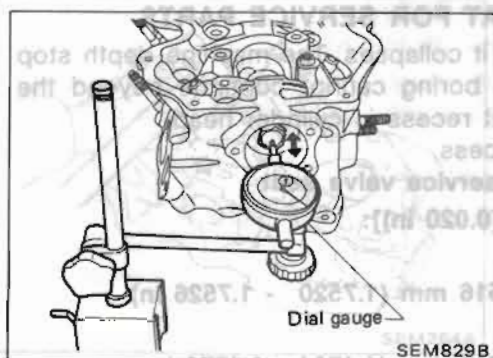


### CAMSHAFT END PLAY

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

Camshaft end play:

Standard 0.03 - 0.06 mm (0.0012 - 0.0024 in)





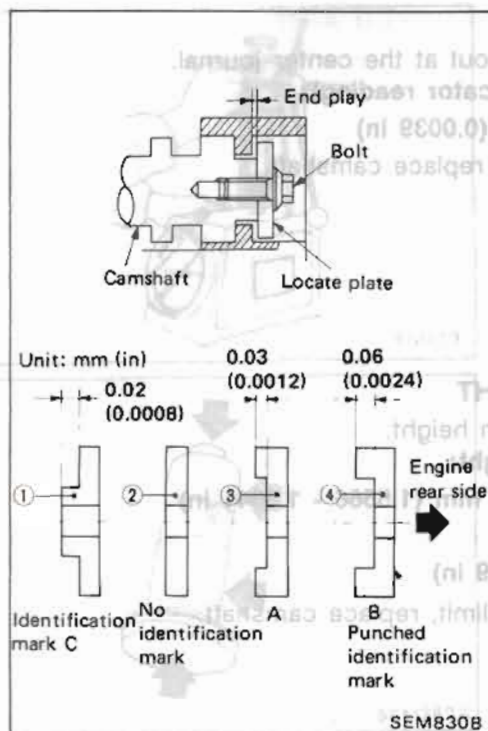
## CYLINDER HEAD

### Inspection (Cont'd)

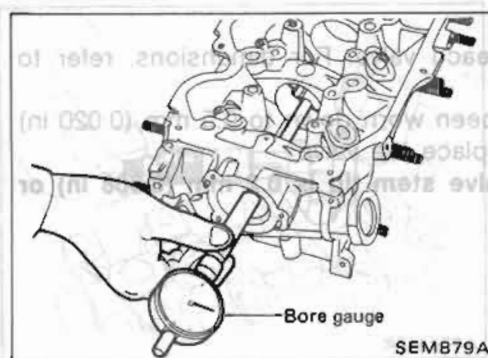
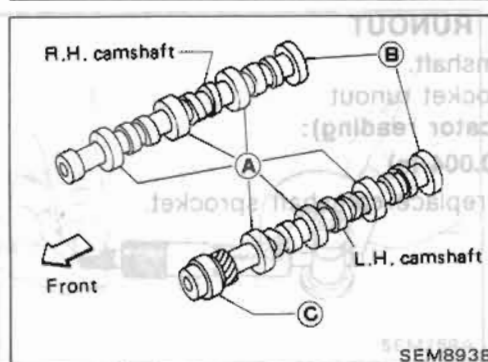
3. If it is out of the specified range, select thickness of camshaft locate plate to obtain the standard specified end play.

Example:

When camshaft end play is 0.08 mm (0.0031 in) with shim ②, replace shim ② with shim ③ to set the end play at 0.05 mm (0.0020 in).



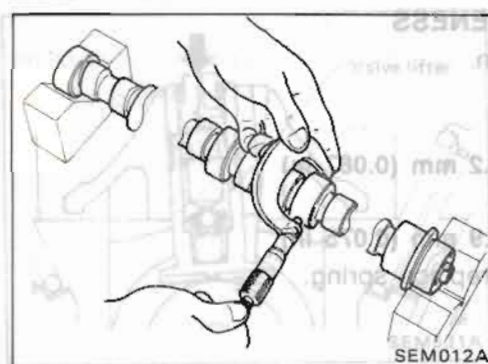
### CAMSHAFT JOURNAL CLEARANCE



1. Measure the inner diameter of camshaft bearing.

Standard inner diameter:

- ① 47.000 - 47.025 mm (1.8504 - 1.8514 in)
- ② 42.500 - 42.525 mm (1.6732 - 1.6742 in)
- ③ 48.000 - 48.025 mm (1.8898 - 1.8907 in)



2. Measure the outer diameter of camshaft journal.

Standard outer diameter:

- ① 46.920 - 46.940 mm (1.8472 - 1.8480 in)
- ② 42.420 - 42.440 mm (1.6701 - 1.6709 in)
- ③ 47.920 - 47.940 mm (1.8866 - 1.8874 in)

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

Camshaft journal clearance limit:

0.15 mm (0.0059 in)

## CYLINDER HEAD

### Inspection (Cont'd)

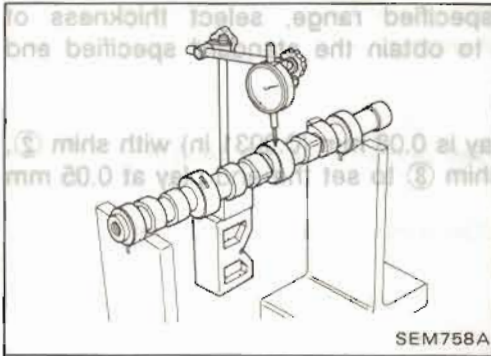
#### CAMSHAFT RUNOUT

1. Measure camshaft runout at the center journal.

**Runout (Total indicator reading):**

**Limit 0.10 mm (0.0039 in)**

2. If it exceeds the limit, replace camshaft.



#### CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height.

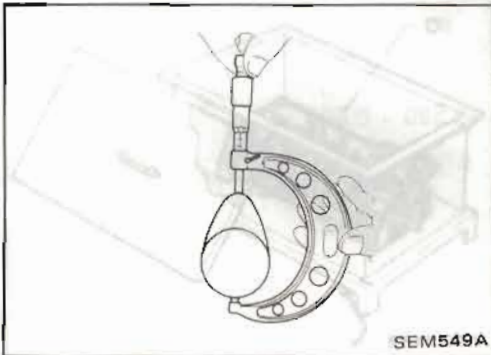
**Standard cam height:**

**39.537 - 39.727 mm (1.5566 - 1.5641 in)**

**Cam wear limit:**

**0.15 mm (0.0059 in)**

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



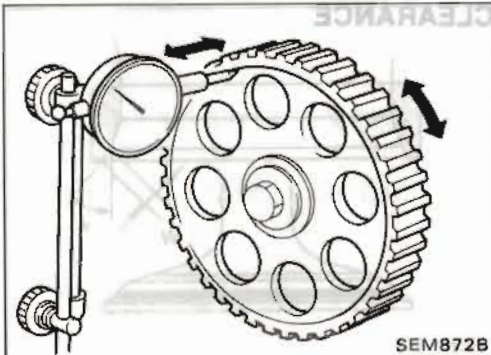
#### CAMSHAFT SPROCKET RUNOUT

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

**Runout (Total indicator reading):**

**Limit 0.1 mm (0.004 in)**

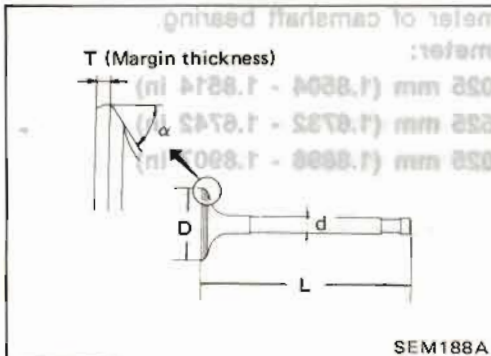
3. If it exceeds the limit, replace camshaft sprocket.



#### VALVE DIMENSIONS

1. Check dimensions in each valve. For dimensions, refer to S.D.S.
2. 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

1. Measure "S" dimension.

**Out-of-square:**

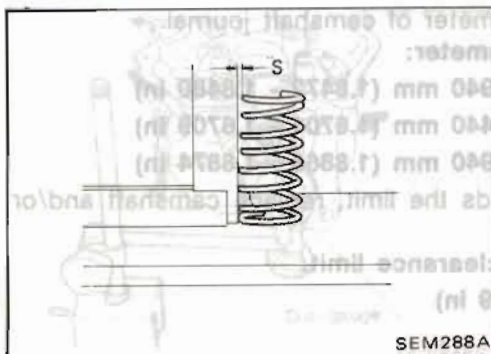
**Outer**

**Less than 2.2 mm (0.087 in)**

**Inner**

**Less than 1.9 mm (0.075 in)**

2. If it exceeds the limit, replace spring.





## CYLINDER HEAD

### (b) Inspection (Cont'd)

#### VALVE SPRING PRESSURE HEIGHT

Check valve spring pressure height.

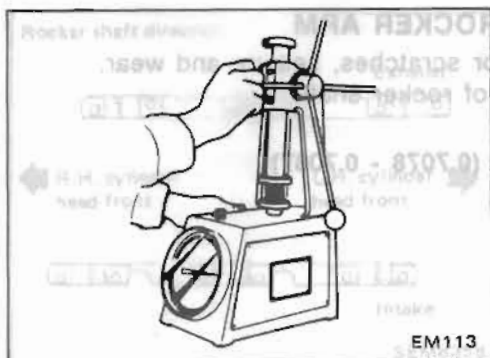
Pressure height: mm/N (mm/kg, in/lb)

Outer

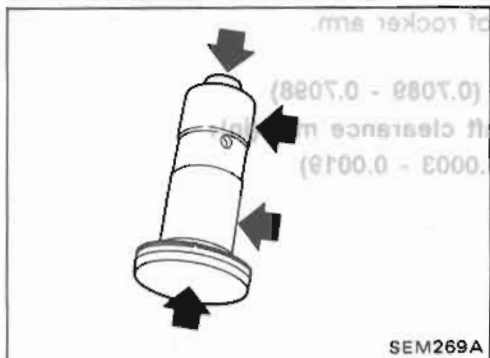
40.0/250.1 (40.0/25.5, 1.575/56.2)

Inner

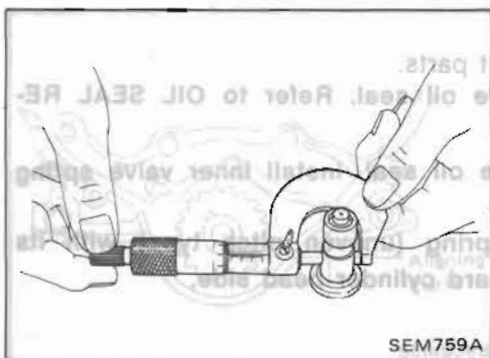
25.0/255.0 (25.0/26.0, 0.984/57.3)



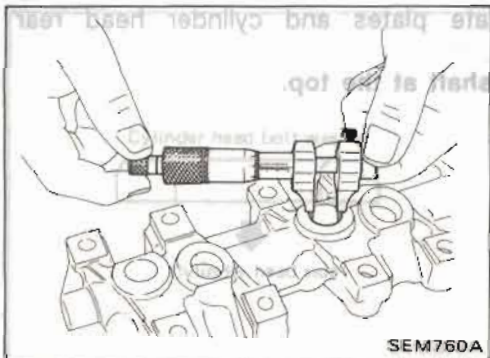
EM113



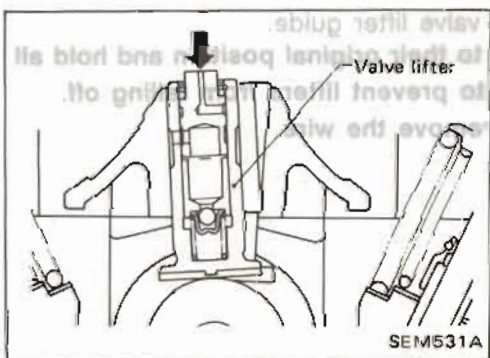
SEM269A



SEM759A



SEM760A



SEM531A

#### HYDRAULIC VALVE LIFTER

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

2. Check diameter of a valve lifter.

Outer diameter:

15.947 - 15.957 mm (0.6278 - 0.6282 in)

3. Check valve lifter guide inner diameter.

Inner diameter:

16.000 - 16.013 mm (0.6299 - 0.6304 in)

Standard clearance between valve lifter and lifter guide:

0.043 - 0.066 mm (0.0017 - 0.0026 in)

4. Check hydraulic valve lifter.

(1) Push plunger forcefully with your finger.

● Be sure to check it with rocker arm in its free position (not on the lobe).

(2) If valve lifter moves more than 1 mm (0.04 in), air may be inside of it.

(3) Bleed air off by running engine at 1,000 rpm under no load for about 10 minutes.

(4) If hydraulic valve lifters are still noisy, replace them and bleed air off again in the same manner as in step (3).

## CYLINDER HEAD

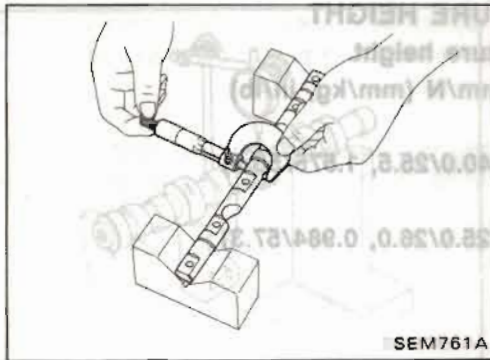
### (b) Inspection (Cont'd)

#### ROCKER SHAFT AND ROCKER ARM

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

Diameter mm (in):

17.979 - 18.000 (0.7078 - 0.7087)



SEM761A

3. Check inner diameter of rocker arm.

Diameter mm (in):

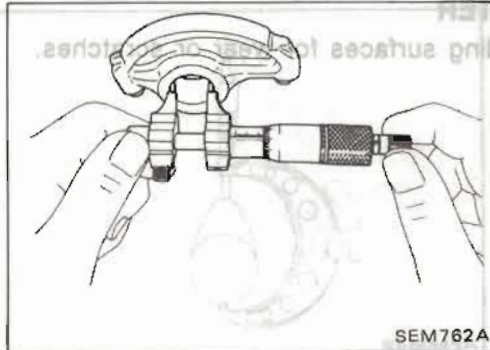
18.007 - 18.028 (0.7089 - 0.7098)

Rocker arm to shaft clearance mm (in):

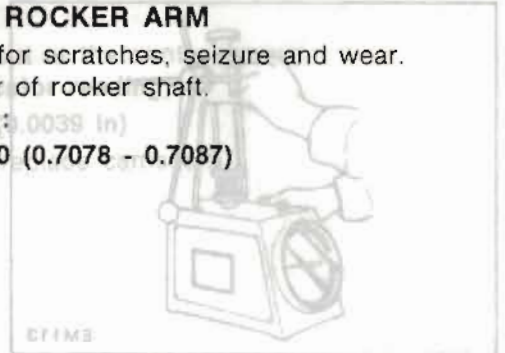
0.007 - 0.049 (0.0003 - 0.0019)

0.15 mm (0.0059 in)

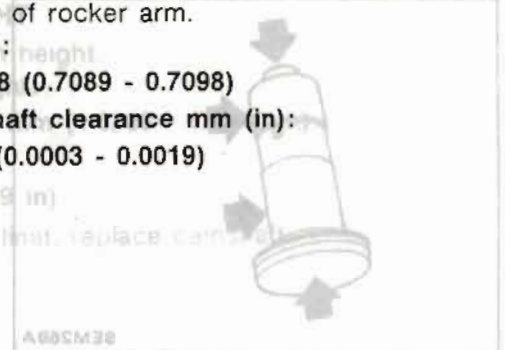
2. If wear is beyond the limit, replace camshaft.



SEM762A



SEM763A

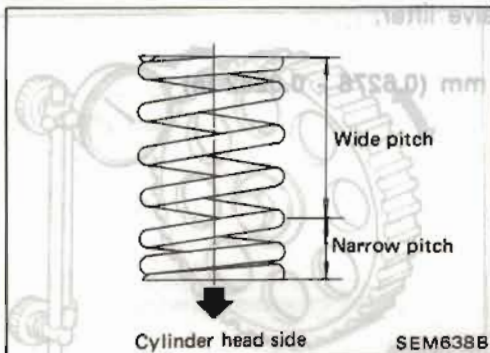


SEM764A

### Assembly

1. Install valve component parts.

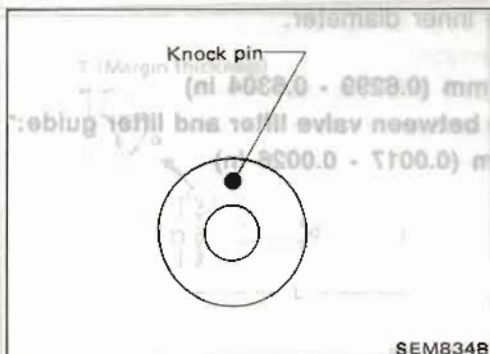
- Always use new valve oil seal. Refer to OIL SEAL REPLACEMENT.
- Before installing valve oil seal, install inner valve spring seat.
- Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.



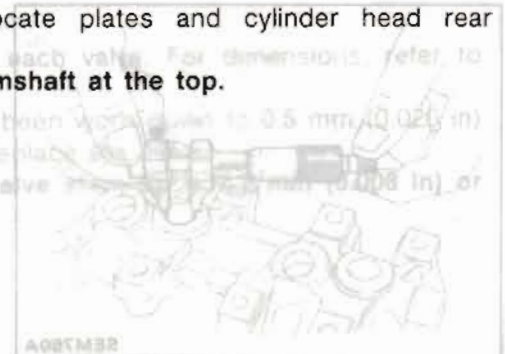
SEM638B

2. Install camshafts, locate plates and cylinder head rear covers.

- Set knock pin of camshaft at the top.



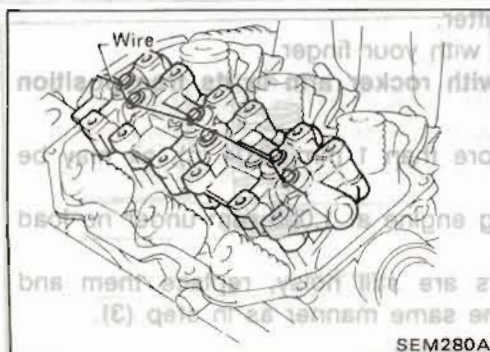
SEM834B



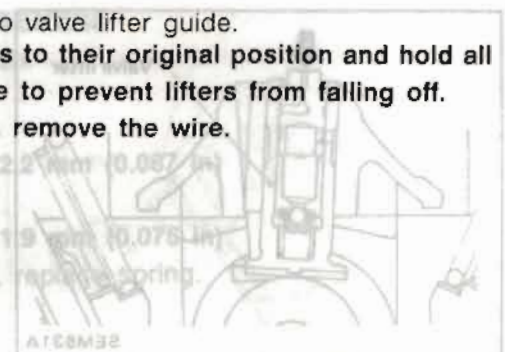
SEM780A

3. Install valve lifters into valve lifter guide.

- Assemble valve lifters to their original position and hold all valve lifters with wire to prevent lifters from falling off.
- After installing them, remove the wire.



SEM280A

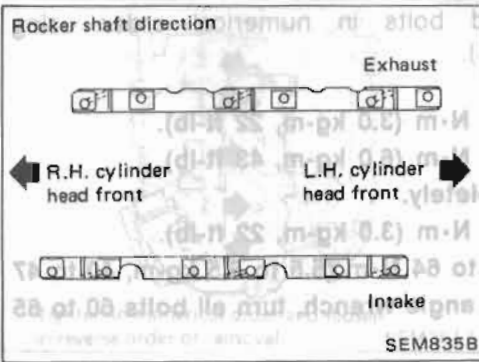


SEM781A



## CYLINDER HEAD

### (b) Assembly (Cont'd)



4. Install rocker shafts with rocker arms.

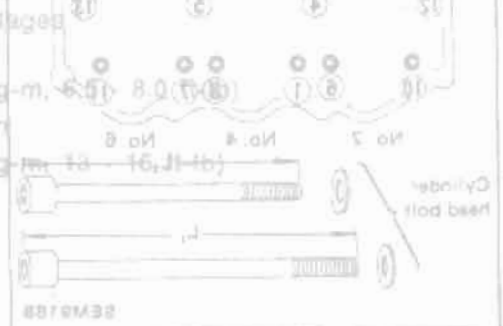
● Tighten bolts gradually in two or three stages.

● Before tightening, be sure to set camshaft lobe at the position where lobe is not lifted.

(1) Set No. 1 piston at T.D.C. on its compression stroke and tighten rocker shaft bolts for No. 2, No. 4 and No. 6 cylinders.

(2) Set No. 4 piston at T.D.C. on its compression stroke and tighten rocker shaft bolts for No. 1, No. 3 and No. 5 cylinders.

5. Install exhaust manifold to cylinder head in reverse order of removal.

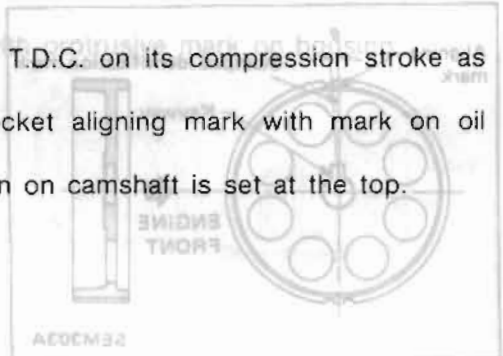
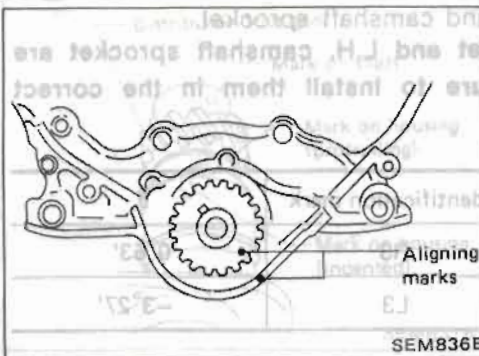


### Installation

1. Set No. 1 cylinder at T.D.C. on its compression stroke as follows:

(1) Align crankshaft sprocket aligning mark with mark on oil pump body.

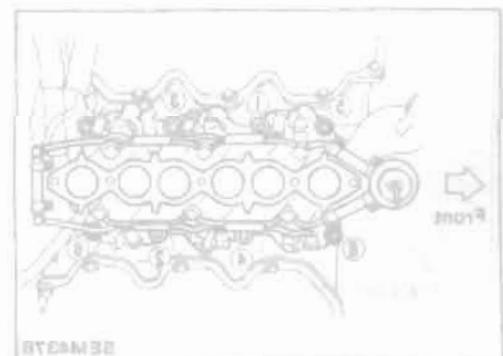
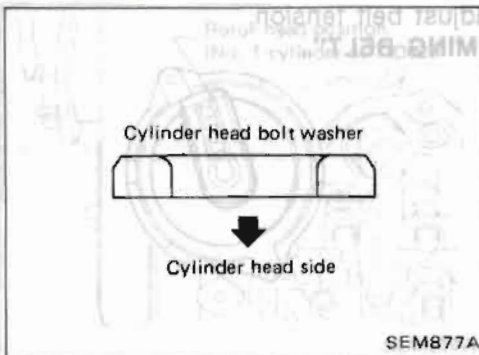
(2) Confirm that knock pin on camshaft is set at the top.



2. Install cylinder head with new gasket.

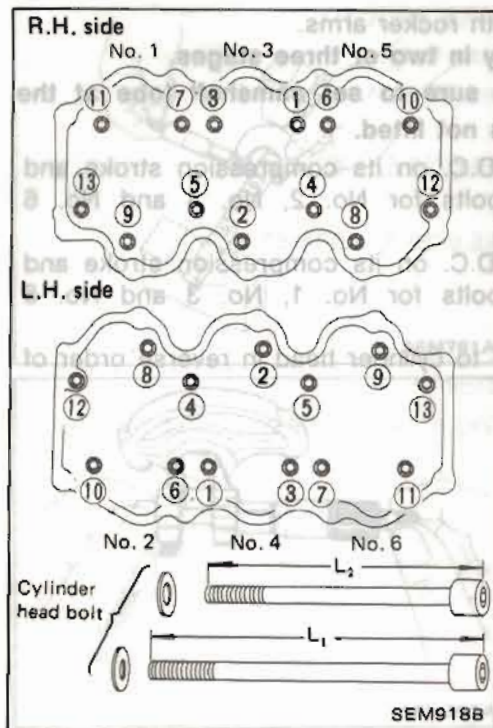
● Be sure to install washers between bolts and cylinder head.

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



## CYLINDER HEAD

### Installation (Cont'd)



3. Tighten cylinder head bolts in numerical order using ST10120000 (J24239-01).

#### ● Tightening procedure.

- (1) Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
- (2) Tighten all bolts to 59 N·m (6.0 kg-m, 43 ft-lb).
- (3) Loosen all bolts completely.
- (4) Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
- (5) Tighten all bolts to 54 to 64 N·m (5.5 to 6.5 kg-m, 40 to 47 ft-lb) or if you have an angle wrench, turn all bolts 60 to 65 degrees clockwise.

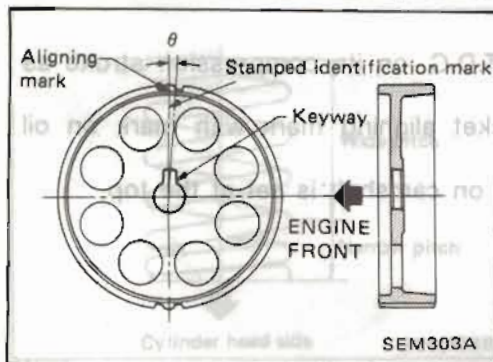
#### ● Bolts for ④, ⑤, ⑫ and ⑬ are longer than the others.

L<sub>1</sub>: 127 mm (5.00 in) for ④, ⑤, ⑫ and ⑬

L<sub>2</sub>: 106 mm (4.17 in) for others

Rocker arm to shaft clearance mm (in):

0.007 - 0.049 (0.0003 - 0.0019)



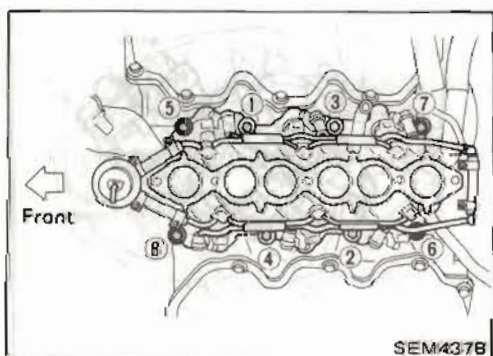
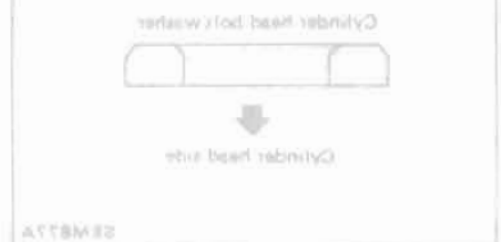
4. Install rear belt cover and camshaft sprocket.

#### ● R.H. camshaft sprocket and L.H. camshaft sprocket are different parts. Be sure to install them in the correct positions.

	Identification mark	$\theta$
R.H. camshaft sprocket	R3	0°53'
L.H. camshaft sprocket	L3	-3°27'

5. Install timing belt and adjust belt tension.

Refer to Installation in "TIMING BELT".



6. Install intake manifold, valve lift guide

#### ● Tighten manifold bolts and nuts in two or three stages in reverse order of removal.

#### ● After installing them, remove the wire

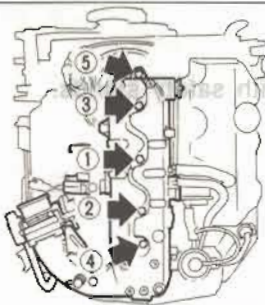


## CYLINDER HEAD

### Installation (Cont'd)

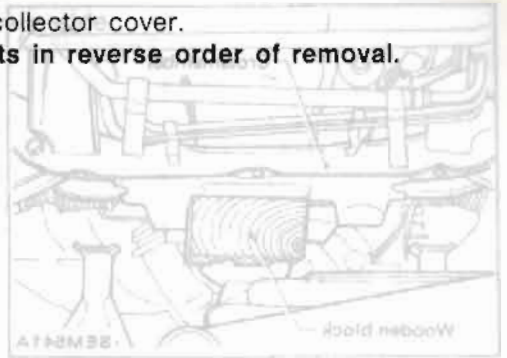
7. Install collector and collector cover.

- Tighten manifold bolts in reverse order of removal.



Tighten in numerical order and loosen in reverse order of removal.

SEM251A



8. Install throttle chamber.

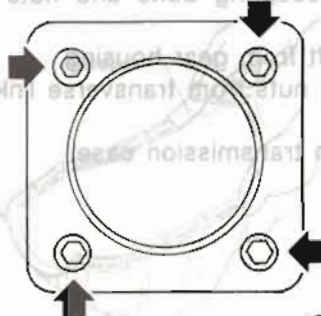
- Tighten bolts in two stages.

(1) 9 - 11 N·m

(0.9 - 1.1 kg-m, 6.5 - 8.0 ft-lb)

(2) 18 - 22 N·m

(1.8 - 2.2 kg-m, 13 - 16 ft-lb)



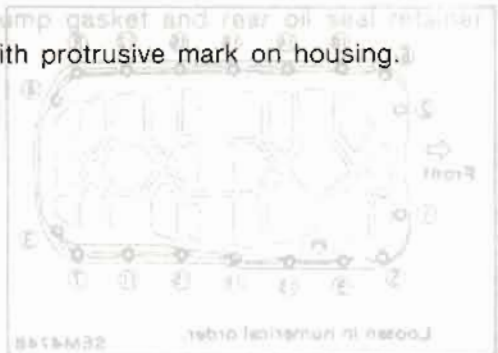
SEM479B

9. Install distributor.

- (1) Align mark on shaft with protrusive mark on housing.

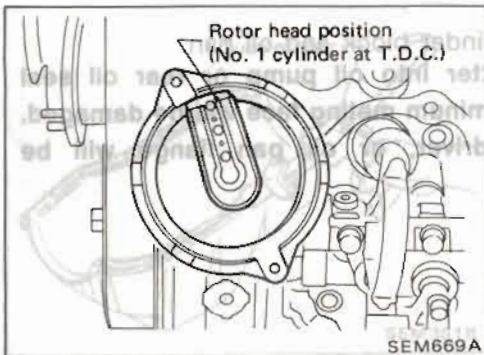


SEM837B

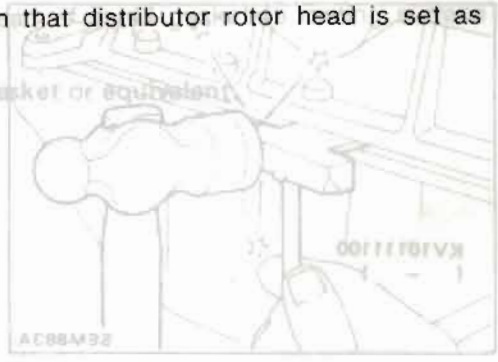


- (2) After installing, confirm that distributor rotor head is set as shown in the figure.

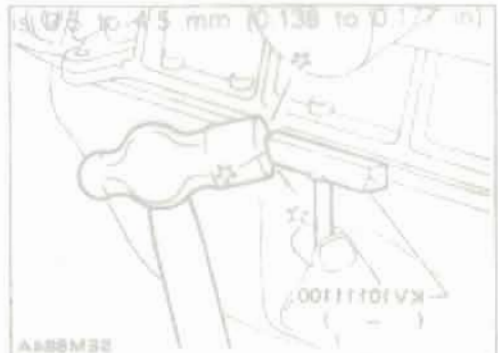
Rotor head position  
(No. 1 cylinder at T.D.C.)

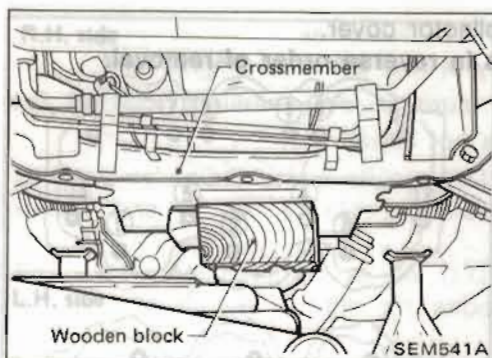


SEM669A



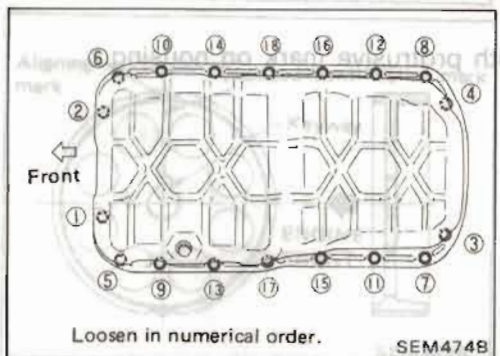
Cut here





## Removal

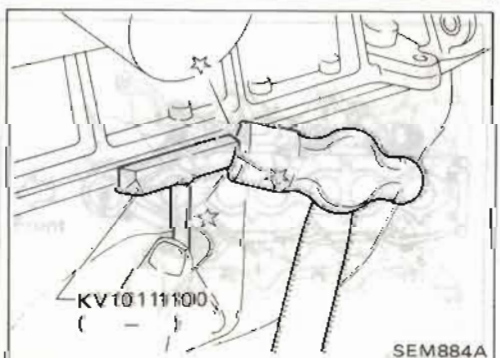
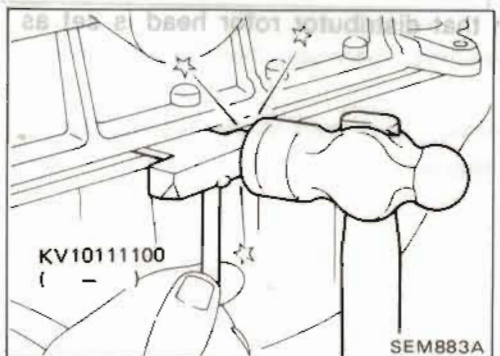
1. Drain engine oil.
2. Raise vehicle and support it with safety stands.
3. Remove front stabilizer bar securing bolts and nuts from suspension crossmember.
4. Remove steering column shaft from gear housing.
5. Remove tension rod securing nuts from transverse link.
6. Lift engine.
7. Remove rear plate cover from transmission case.



8. Remove oil pan bolts.
9. Remove suspension crossmember securing bolts.
10. Remove strut mounting insulator securing nuts.
11. Remove screws securing refrigerant lines and power steering tubes to suspension crossmember.
12. Lower suspension crossmember.

## 13. Remove oil pan.

- (1) Insert Tool between cylinder block and oil pan.
  - Do not drive seal cutter into oil pump or rear oil seal retainer portion, or aluminum mating face will be damaged.
  - Do not insert screwdriver, or oil pan flange will be deformed.

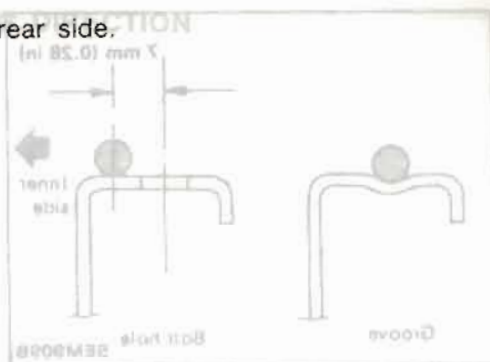


- (2) Slide Tool by tapping its side with a hammer, and remove oil pan.
  - Tighten manifold bolts and nuts in two or three stages in reverse order of removal.



## (b) Removal (Cont'd)

14. Pull out oil pan from rear side.

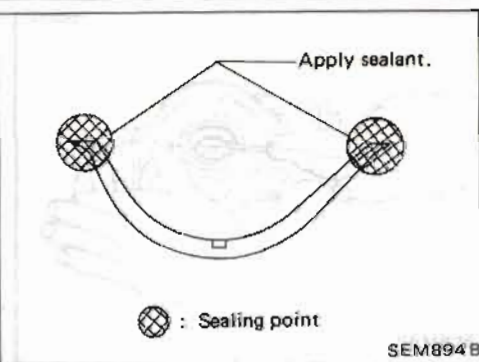
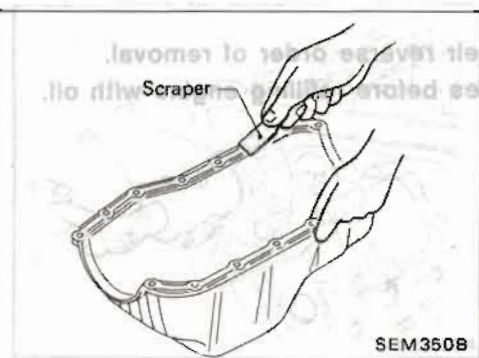


## Installation

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

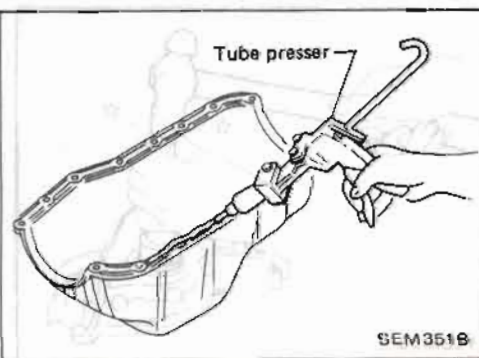
• Also remove traces of liquid gasket from mating surface of cylinder block.

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



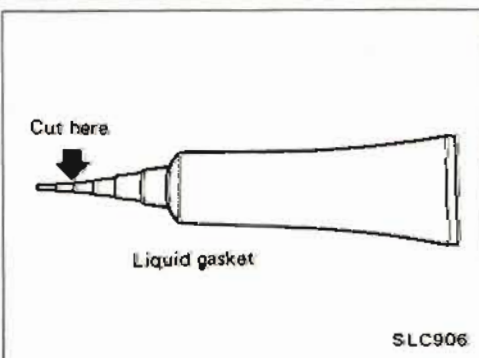
2. Apply sealant to oil pump gasket and rear oil seal retainer gasket.

1. Remove timing belt and crankshaft sprocket.  
2. Remove oil pump assembly.  
3. Remove front oil seal from oil pump body.



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

• Use Genuine Liquid Gasket or equivalent.

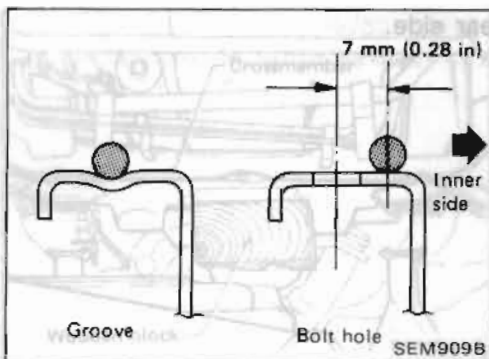


• Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.

1. Remove flywheel/drive plate.  
2. Remove rear oil seal retainer.  
3. Remove rear oil seal from retainer.

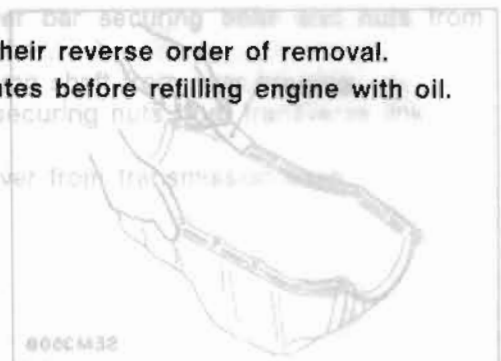
## OIL PAN

### Installation (Cont'd)

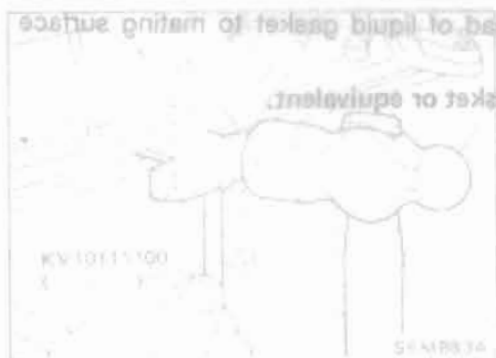


4. Apply liquid gasket to inner sealing surface instead of surface where there is no groove at bolt hole.
  - Attaching should be done within 5 minutes after coating.

5. Install oil pan.
  - Install bolts/nuts in their reverse order of removal.
  - Wait at least 30 minutes before refilling engine with oil.



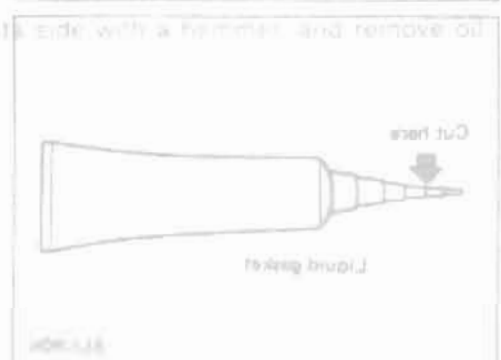
9. Remove oil pump gasket.
10. Remove strut mounting insulator securing nuts.
11. Remove screws securing refrigerant lines and power steering tubes to suspension cross member.
12. Lower suspension cross member.



3. Apply a compound bead of liquid gasket to mating surface of oil pan.
  - Use Genuine Liquid Gasket or equivalent.
  - Do not use seal cutter to cut oil pump or rear oil seal retainer portion, or aluminum mating face will be damaged.
  - Do not insert screwdriver. Oil pan flange will be deformed.

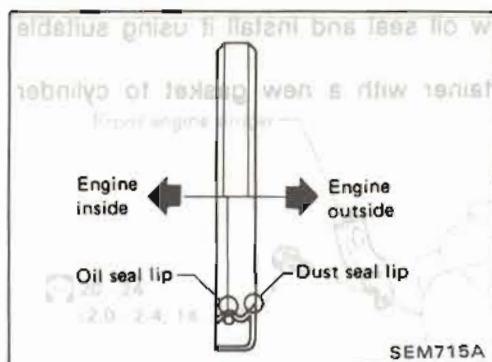


3. Apply a compound bead of liquid gasket to mating surface of oil pan.
  - Use Genuine Liquid Gasket or equivalent.
  - Do not use seal cutter to cut oil pump or rear oil seal retainer portion, or aluminum mating face will be damaged.
  - Do not insert screwdriver. Oil pan flange will be deformed.



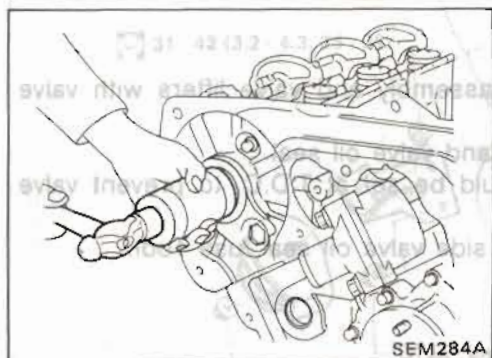


## OIL SEAL INSTALLING DIRECTION



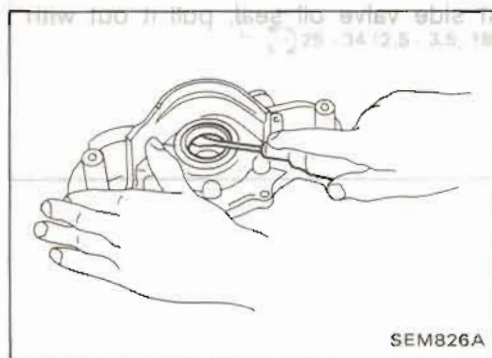
## CAMSHAFT OIL SEAL

1. Remove timing belt.
  2. Remove camshaft sprocket.
  3. Remove camshaft oil seal.
- Be careful not to scratch camshaft.**
4. Apply engine oil to camshaft oil seal and install it using suitable tool.

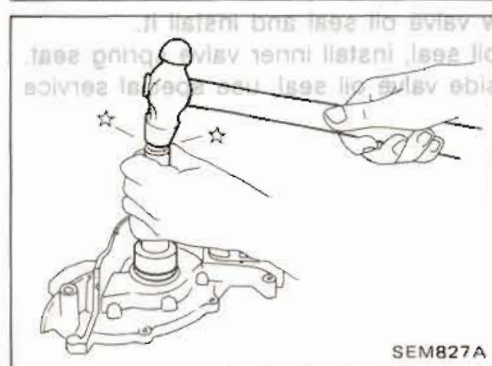


## FRONT OIL SEAL

1. Remove timing belt and crankshaft sprocket.
2. Remove oil pump assembly.
3. Remove front oil seal from oil pump body.

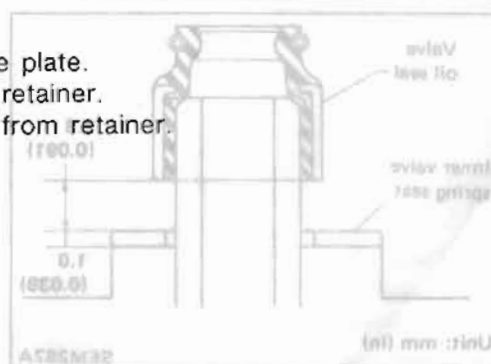
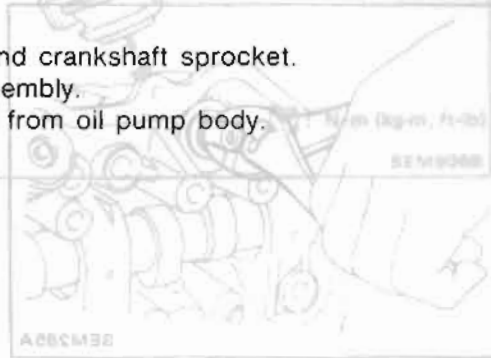
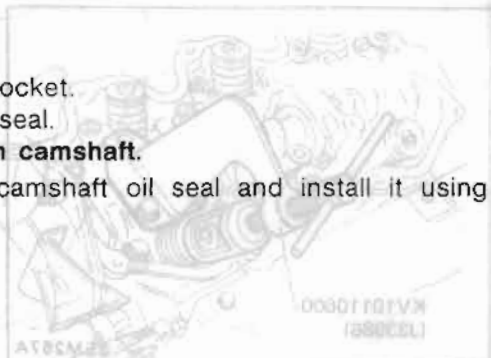
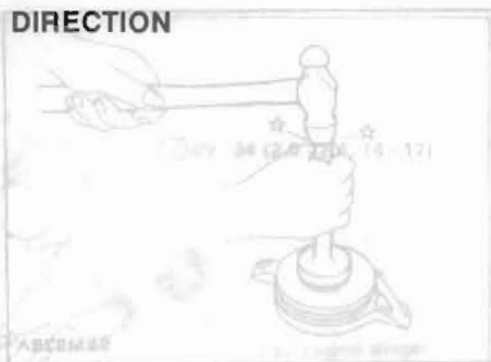


4. Apply engine oil to new oil seal and install it using suitable tool.



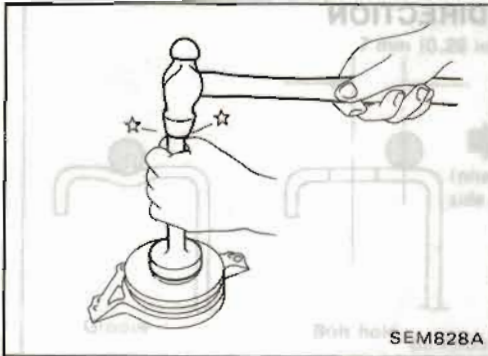
## REAR OIL SEAL

1. Remove flywheel/drive plate.
2. Remove rear oil seal retainer.
3. Remove rear oil seal from retainer.

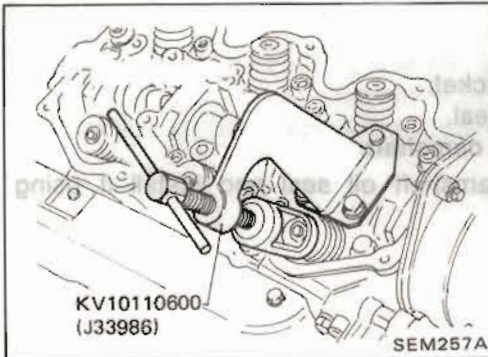


# OIL SEAL REPLACEMENT

## Installation (Cont'd)

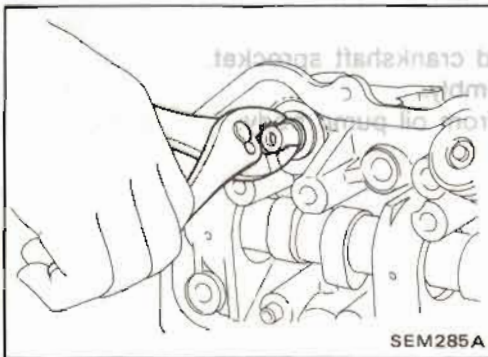
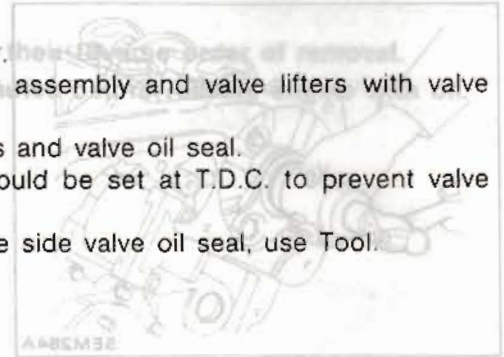


4. Apply engine oil to new oil seal and install it using suitable tool, face where there is no gasket.
5. Install rear oil seal retainer with a new gasket to cylinder block.

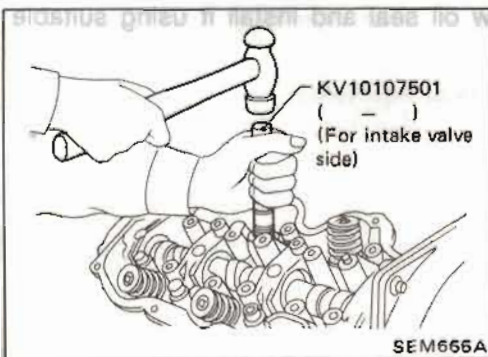
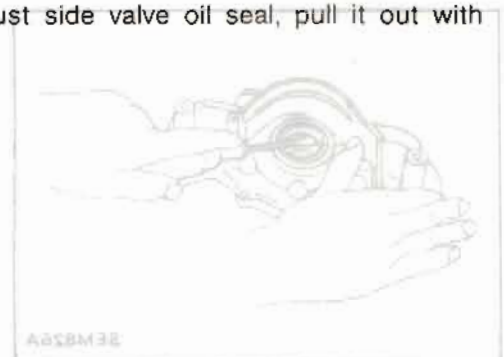


## VALVE OIL SEAL

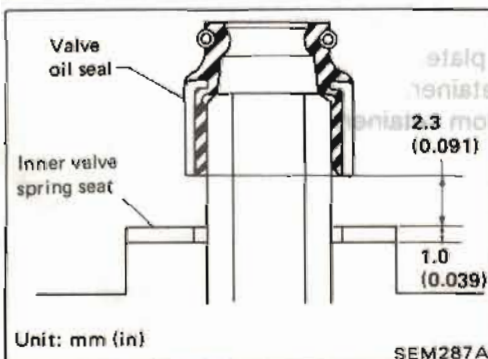
1. Remove rocker cover.
2. Remove rocker shaft assembly and valve lifters with valve lifter guide.
3. Remove valve springs and valve oil seal.
  - Piston concerned should be set at T.D.C. to prevent valve from falling off.
  - When removing intake side valve oil seal, use Tool.



- When removing exhaust side valve oil seal, pull it out with pliers.

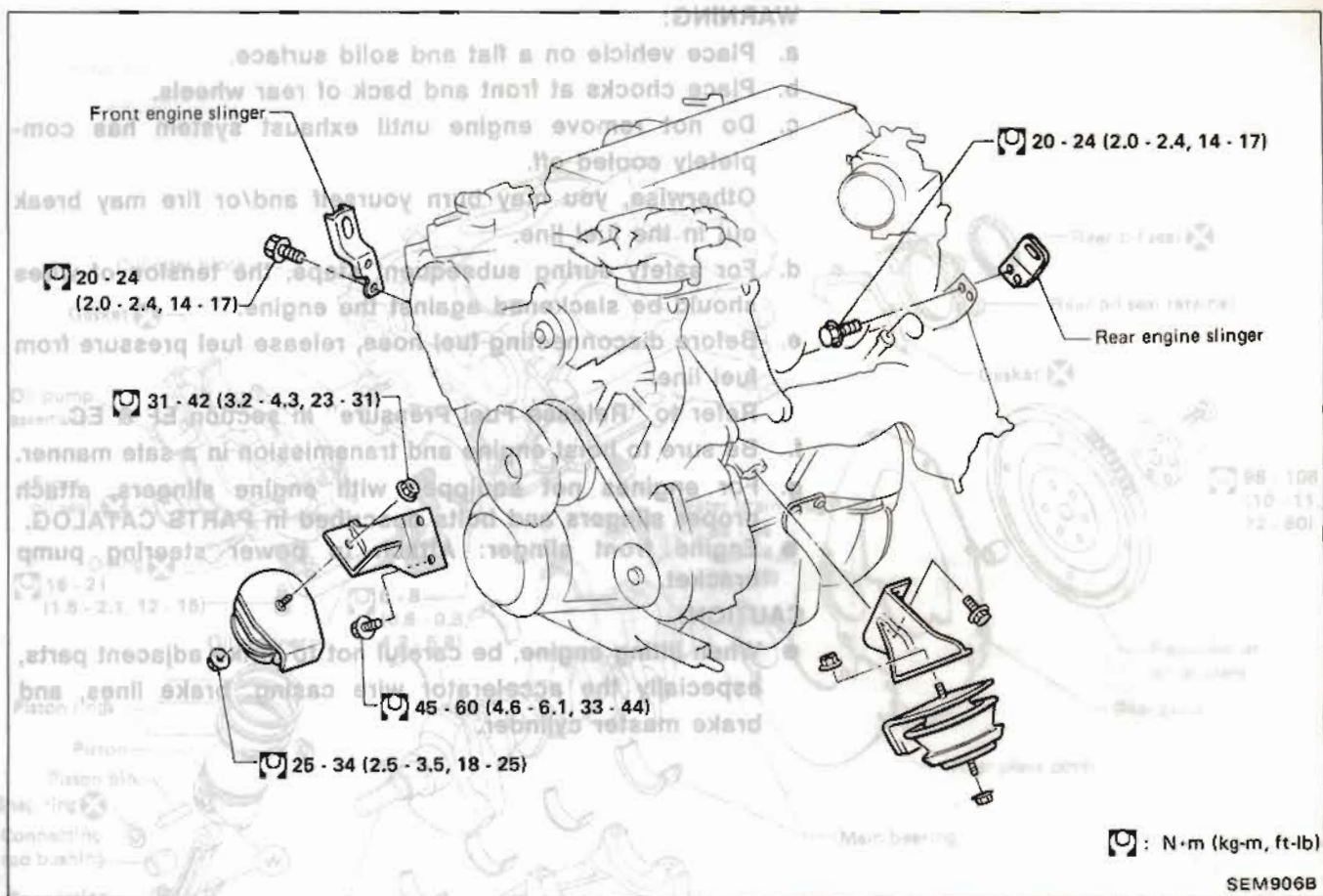


4. Apply engine oil to new valve oil seal and install it.
  - Before installing valve oil seal, install inner valve spring seat.
  - When installing intake side valve oil seal, use special service tool.



- When installing exhaust side valve oil seal, set it by hand.





Refer to  
"A" and  
"B" in  
ENGINE OVERHAUL

Remove R.H. exhaust manifold and exhaust connecting tube.  
then separate engine and transmission.



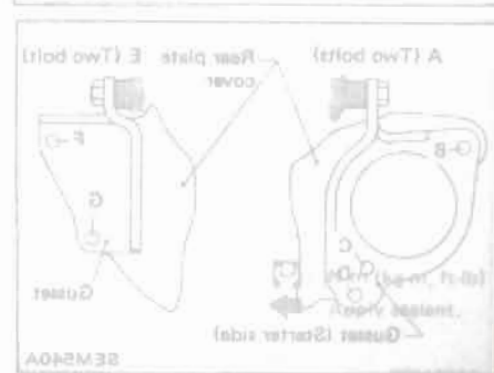
When installing engine gaskets, tighten bolts in 6 stages as shown below

Tightening order

1st	2nd	3rd	4th	5th	6th
A*1	D*2	A*2	F*2 and G*2	E*2	A*2 and E*2

\*1 : Tighten temporarily  
\*2 : Tighten completely

Ⓐ : 29 - 39 N·m (3.0 - 4.0 kg-m, 22 - 29 ft-lb)



## ENGINE REMOVAL

**WARNING:**

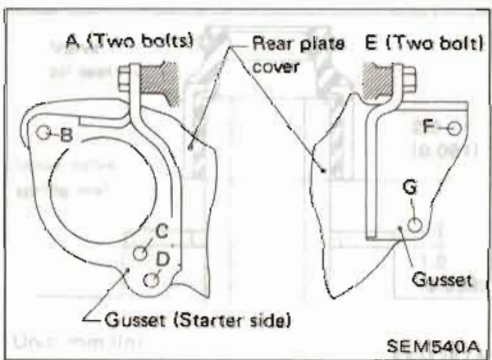
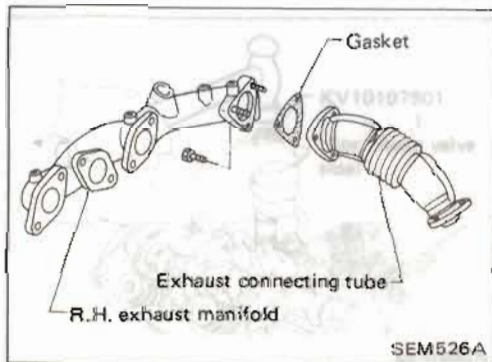
- Place vehicle on a flat and solid surface.
- Place chocks at front and back of rear wheels.
- Do not remove engine until exhaust system has completely cooled off.  
Otherwise, you may burn yourself and/or fire may break out in the fuel line.
- For safety during subsequent steps, the tension of wires should be slackened against the engine.
- Before disconnecting fuel hose, release fuel pressure from fuel line.

Refer to "Release Fuel Pressure" in section EF & EC.

- f. Be sure to hoist engine and transmission in a safe manner.
- g. For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.
- Engine front slinger: Attach to power steering pump bracket.

**CAUTION:**

- When lifting engine, be careful not to strike adjacent parts, especially the accelerator wire casing, brake lines, and brake master cylinder.



- Remove R.H. exhaust manifold and exhaust connecting tube, then separate engine and transmission.

- When installing engine gussets, tighten bolts in 6 stages as shown below.

### Tightening order

1st	2nd	3rd	4th	5th	6th
A*1	D*2	A*2	F*2 and G*2	E*2	A*2 and E*2

\* 1: Tighten temporarily.

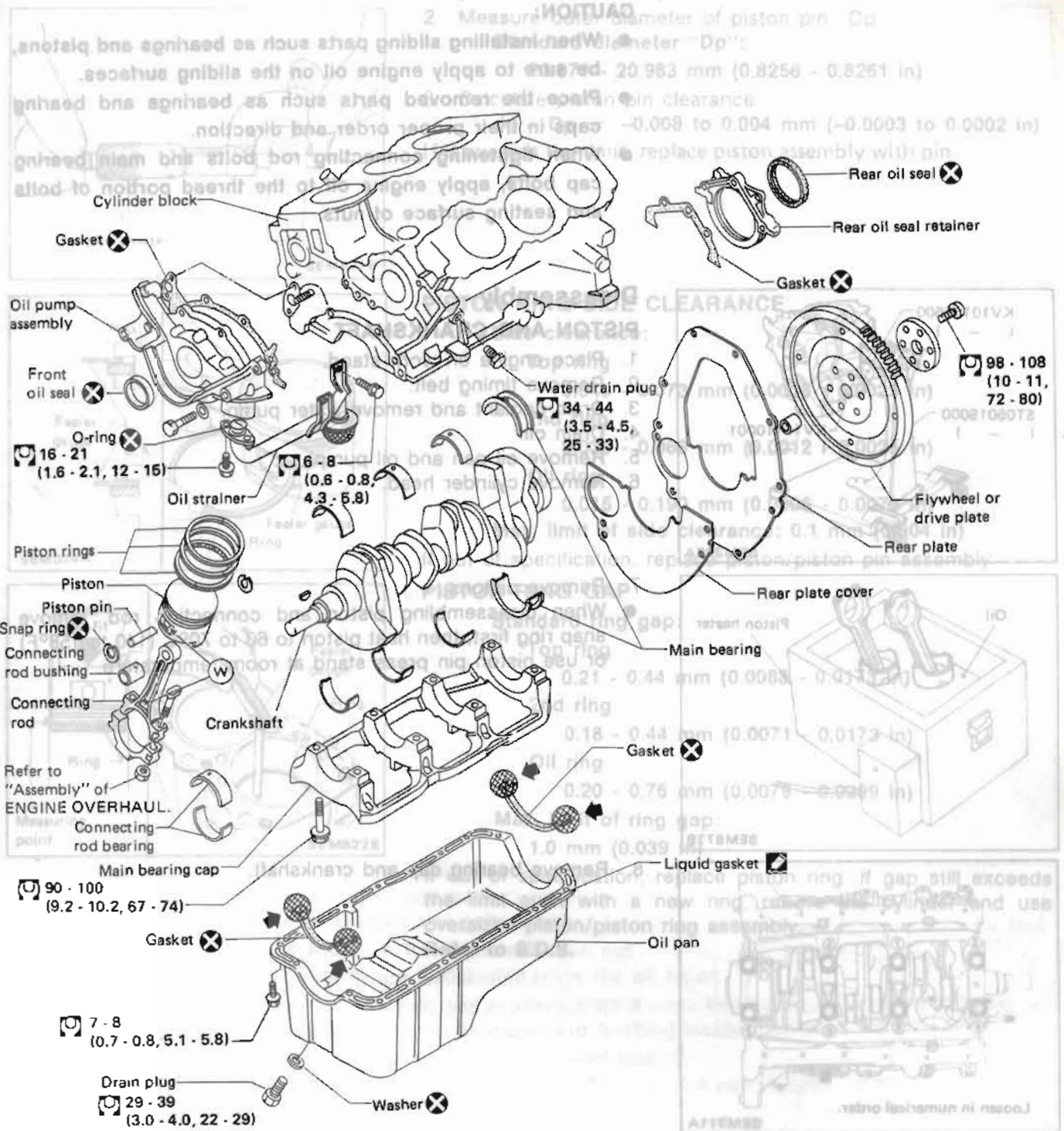
\*2: Tighten completely.

**Ⓐ: 29 - 39 N·m (3.0 - 4.0 kg-m, 22 - 29 ft-lb)**



# ENGINE OVERHAUL

## Inspection (Cont'd)



## ENGINE OVERHAUL

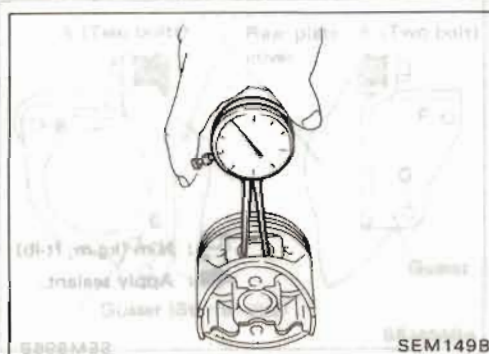
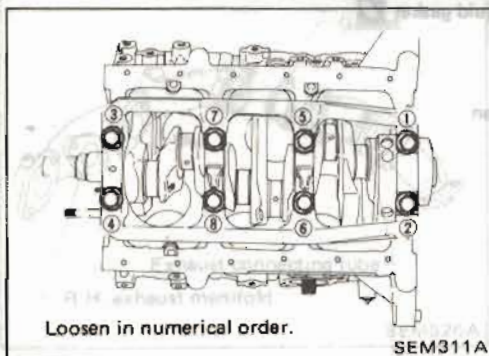
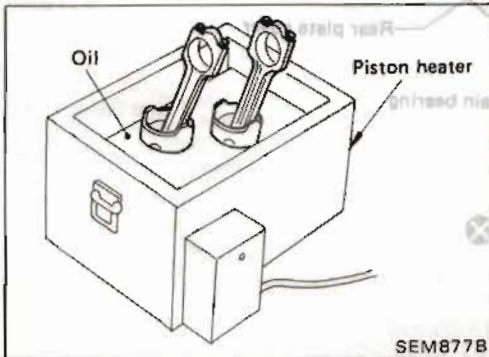
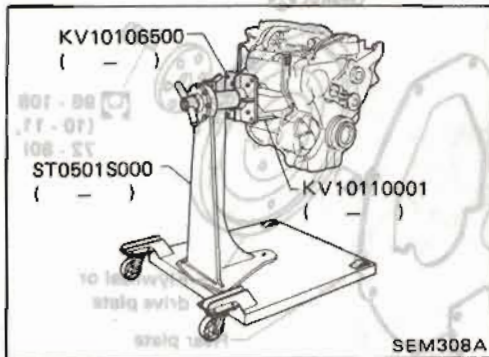
### CAUTION:

- When installing sliding parts such as bearings and pistons, be sure to apply engine oil on the sliding surfaces.
- Place the removed parts such as bearings and bearing caps in their proper order and direction.
- When tightening connecting rod bolts and main bearing cap bolts, apply engine oil to the thread portion of bolts and seating surface of nuts.

### Disassembly

#### PISTON AND CRANKSHAFT

1. Place engine on work stand.
2. Remove timing belt.
3. Drain coolant and remove water pump.
4. Drain oil.
5. Remove oil pan and oil pump.
6. Remove cylinder head.
7. Remove pistons.
  - When disassembling piston and connecting rod, remove snap ring first, then heat piston to 60 to 70°C (140 to 158°F) or use piston pin press stand at room temperature.
8. Remove bearing cap and crankshaft.



### Inspection

#### PISTON AND PISTON PIN CLEARANCE

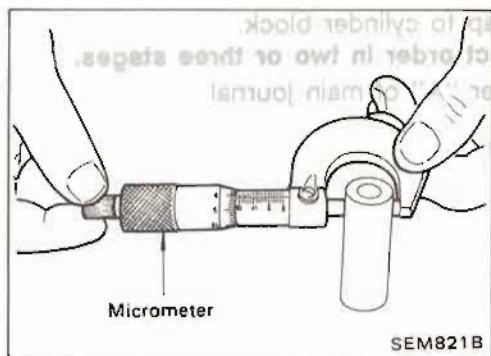
1. Measure inner diameter of piston pin hole "dp".
 

**Standard diameter "dp":**  
20.969 - 20.981 mm (0.8255 - 0.8260 in)



## ENGINE OVERHAUL

### Inspection (Cont'd)



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

**Standard diameter "Dp":**

20.971 - 20.983 mm (0.8256 - 0.8261 in)

3. Calculate piston pin clearance.

$dp - Dp = -0.008 \text{ to } 0.004 \text{ mm } (-0.0003 \text{ to } 0.0002 \text{ in})$

If it exceeds the limit, replace piston assembly with pin.

**Standard**

0.014 - 0.054 mm (0.0005 - 0.0021 in)

**Limit**

0.090 mm (0.0035 in)

### PISTON RING SIDE CLEARANCE

**Side clearance:**

**Top ring**

0.040 - 0.073 mm (0.0016 - 0.0029 in)

**2nd ring**

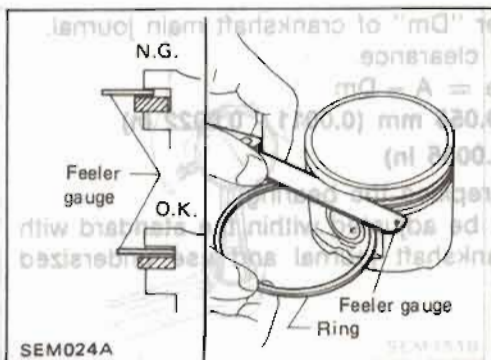
0.030 - 0.063 mm (0.0012 - 0.0025 in)

**Oil ring**

0.015 - 0.190 mm (0.0006 - 0.0075 in)

**Max. limit of side clearance: 0.1 mm (0.004 in)**

If out of specification, replace piston/piston pin assembly.



### PISTON RING GAP

**Standard ring gap:**

**Top ring**

0.21 - 0.44 mm (0.0083 - 0.0173 in)

**2nd ring**

0.18 - 0.44 mm (0.0071 - 0.0173 in)

**Oil ring**

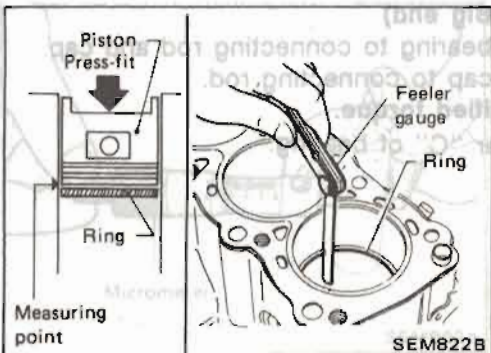
0.20 - 0.76 mm (0.0079 - 0.0299 in)

**Max. limit of ring gap:**

1.0 mm (0.039 in)

If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, rebore the cylinder and use oversized piston/piston ring assembly.

**Refer to S.D.S.**

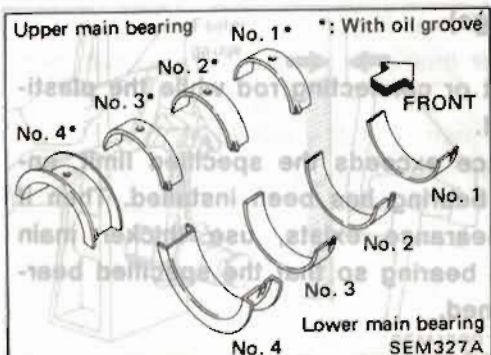


### BEARING CLEARANCE

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

**Main bearing**

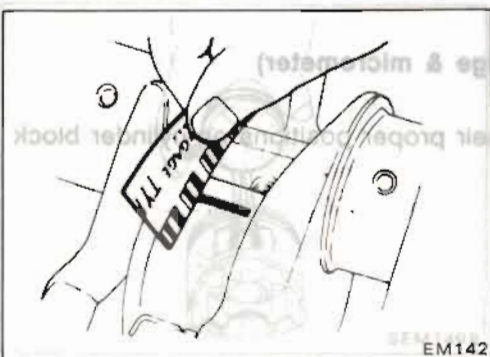
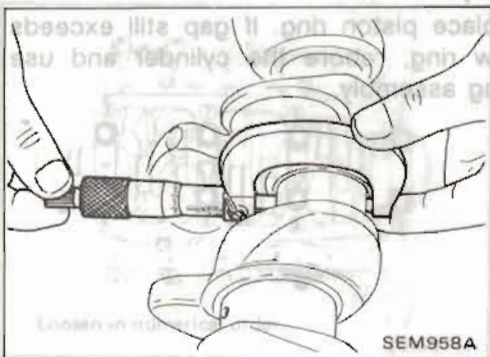
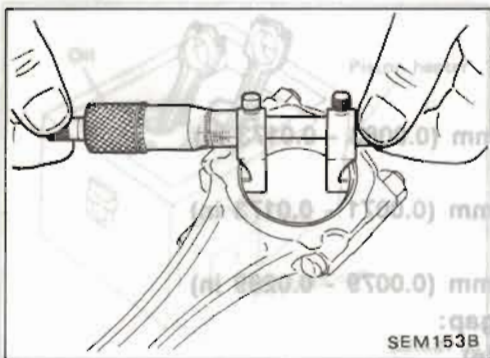
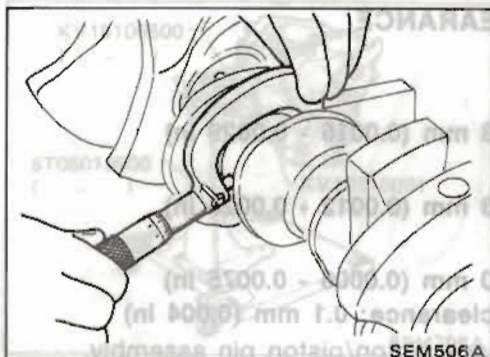
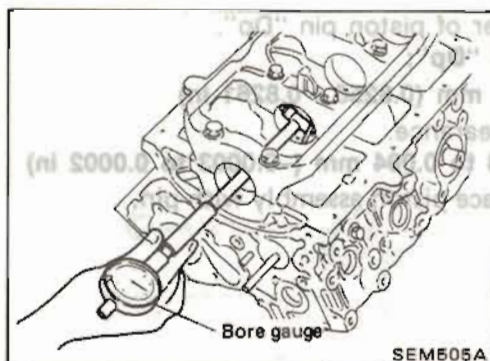
1. Set main bearings in their proper positions on cylinder block and main bearing cap.





## ENGINE OVERHAUL

### (b) 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 main journal.

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

5. Calculate main bearing clearance.

Main bearing clearance = A - Dm

**Standard: 0.028 - 0.055 mm (0.0011 - 0.0022 in)**

**Limit: 0.090 mm (0.0035 in)**

6. If it exceeds the limit, replace the bearing.

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

#### 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 bearing.

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

5. Calculate connecting rod bearing clearance.

Connecting rod bearing clearance = C - Dp

**Standard: 0.014 - 0.054 mm (0.0006 - 0.0021 in)**

**Limit: 0.090 mm (0.0035 in)**

6. If it exceeds the limit, replace the bearing.

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

Refer to step 7 of "MAIN BEARING CLEARANCE".

#### 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.



## ENGINE OVERHAUL

### (b) Inspection (Cont'd)

Main bearing clearance:

Standard

0.028 - 0.055 mm (0.0011 - 0.0022 in)

Limit

0.090 mm (0.0035 in)

Connecting rod bearing clearance:

Standard

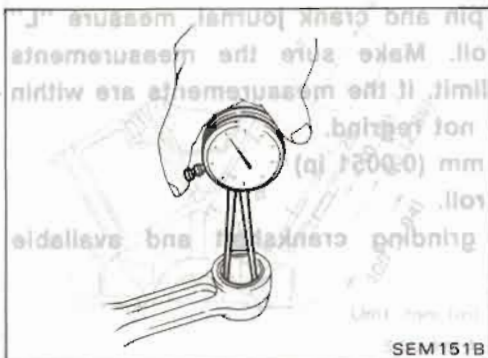
0.014 - 0.054 mm (0.0006 - 0.0021 in)

Limit

0.090 mm (0.0035 in)

### CONNECTING ROD BUSHING CLEARANCE (Small end)

1. Measure inner diameter "C" of bushing.

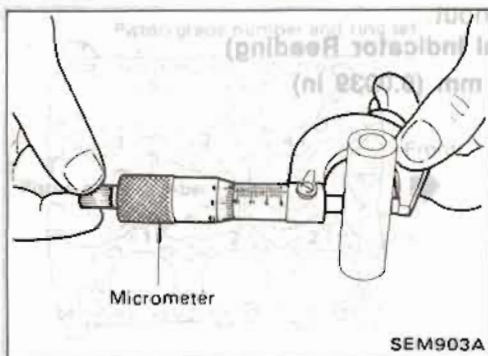


2. Measure outer diameter "Dp" of piston pin.

3. Calculate connecting rod bushing clearance.

$$C - Dp = 0.005 - 0.017 \text{ mm (0.0002 - 0.0007 in)}$$

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



### 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.

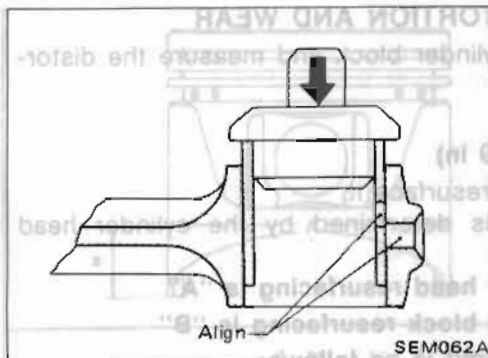
Be sure to align the oil holes.

2. After driving in the small end bushing, ream the bushing.

Small end bushing inside diameter:

Finished size:

20.982 - 20.994 mm (0.8261 - 0.8265 in)



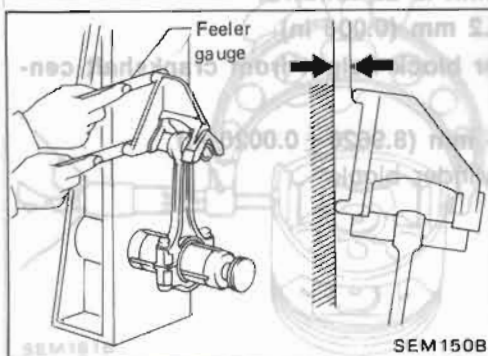
### CONNECTING ROD BEND AND TORSION

Bend and torsion:

Limit 0.1 mm (0.004 in)

per 100 mm (3.94 in) length

If it exceeds the limit, replace connecting rod assembly.



## ENGINE OVERHAUL

### (b) Inspection (Cont'd)

#### CRANKSHAFT

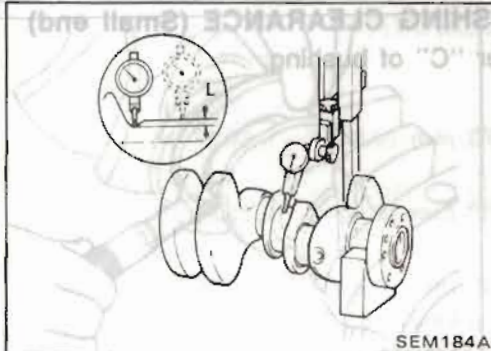
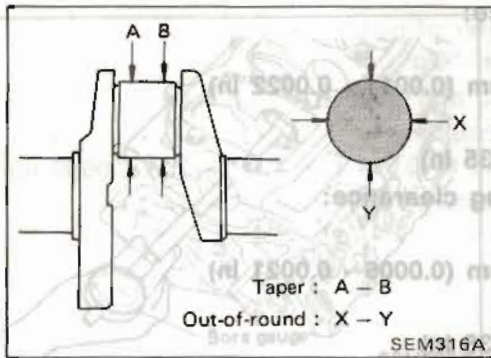
1. Check crankshaft journals for score, bias, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.

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

**Less than 0.005 mm (0.0002 in)**

**Taper (A-B):**

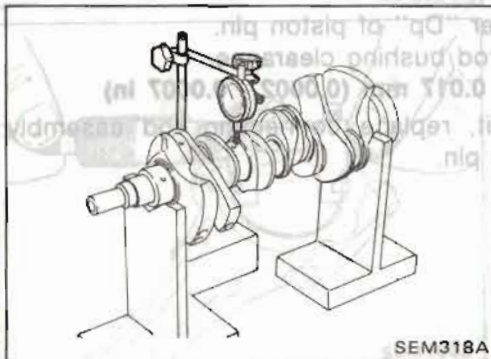
**Less than 0.005 mm (0.0002 in)**



- a. When grinding 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 0.13 mm (0.0051 in)**

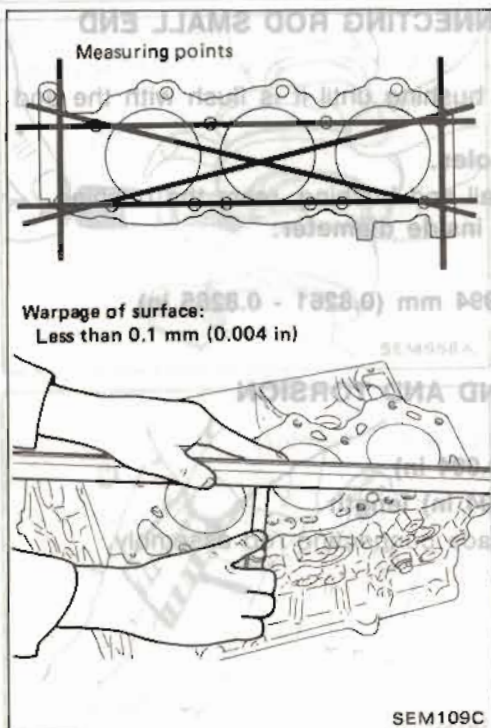
- b. Do not grind off fillet roll.
- c. Refer to S.D.S. for grinding crankshaft and available service parts.



3. Measure crankshaft runout.

**Runout T.I.R. (Total Indicator Reading)**

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



#### CYLINDER BLOCK DISTORTION AND WEAR

1. Clean upper face of cylinder block and measure the distortion.

**Limit:**

**0.10 mm (0.0039 in)**

2. If out of specification, resurface it.

The resurfacing limit is determined by the cylinder head resurfacing in 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)**

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

**227.65 ± 0.05 mm (8.9626 ± 0.0020 in)**

3. If necessary, replace cylinder block.



## (b) Inspection (Cont'd)

### PISTON-TO-BORE CLEARANCE

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

**Standard inner diameter:**

87.00 - 87.05 mm (3.4252 - 3.4272 in)

Refer to S.D.S.

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

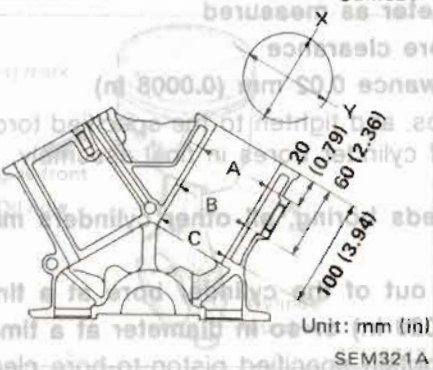
Limit 0.015 mm (0.0006 in)

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

Limit 0.015 mm (0.0006 in)

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

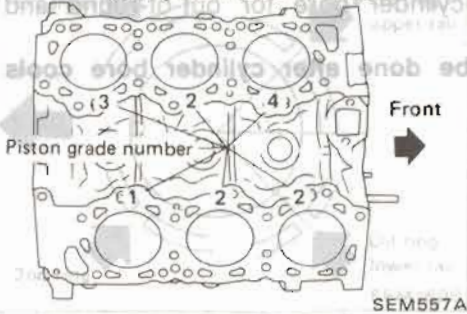
- Check for scratches or seizure. If seizure is found, hone it.



Unit: mm (in)

SEM321A

Piston grade number and ring set



SEM557A

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

- Measure piston skirt diameter.

**Piston diameter "A":**

Refer to S.D.S.

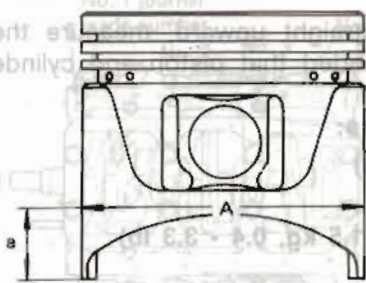
**Measuring point "a" (Distance from the bottom):**

20 mm (0.79 in)

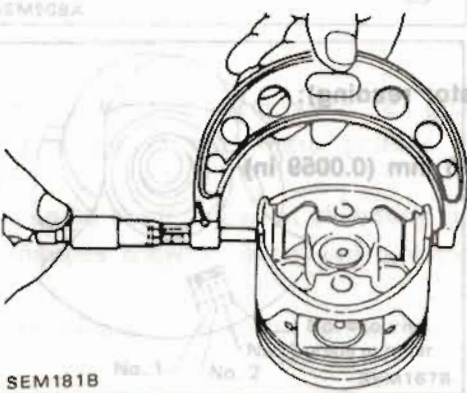
- Check that piston-to-bore clearance is within the specification.

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

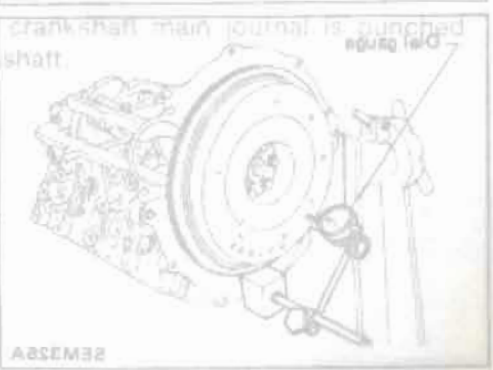
0.025 - 0.045 mm (0.0010 - 0.0018 in)



SEM325A



SEM181B



SEM325A

## ENGINE OVERHAUL

### (b) Inspection (Cont'd)

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

Oversize pistons are available for service. Refer to S.D.S. 6. Cylinder size is determined by adding piston-to-bore clearance to piston diameter "A".

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: Piston diameter as measured

B: Piston-to-bore clearance

C: Honing allowance 0.02 mm (0.0008 in)

7. Install main bearing caps, and tighten to the specified torque to prevent distortion of cylinder bores in final assembly.

8. Cut cylinder bores.

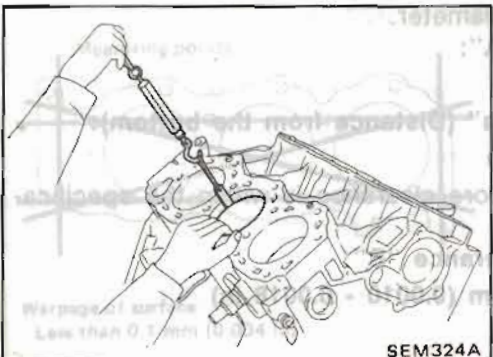
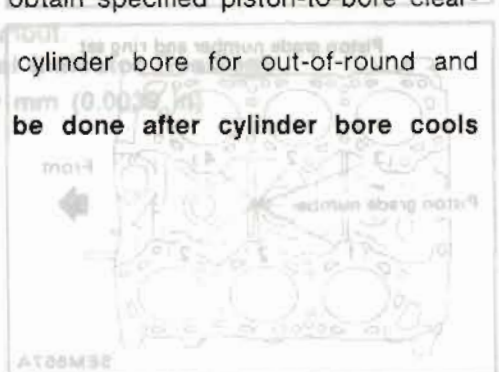
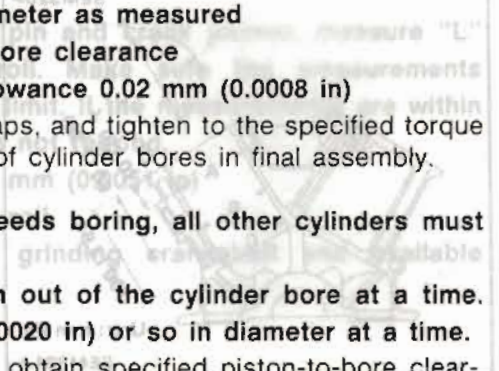
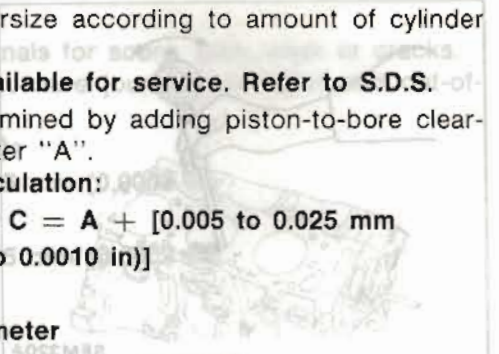
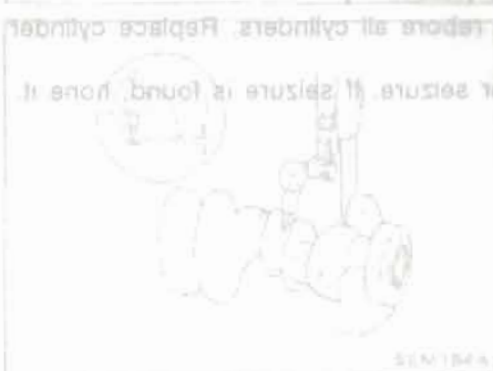
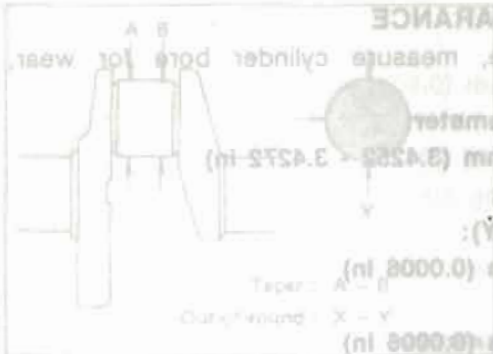
● When any cylinder needs boring, all other cylinders must also be bored.

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

9.hone the cylinders to obtain specified piston-to-bore clearance.

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

● Measurement should be done after cylinder bore cools down.



#### Using feeler gauge

When pulling feeler gauge straight upward, measure the extracting force. It is recommended that piston and cylinder be heated to 20°C (68°F).

Feeler gauge thickness:

0.04 mm (0.0016 in)

Extracting force:

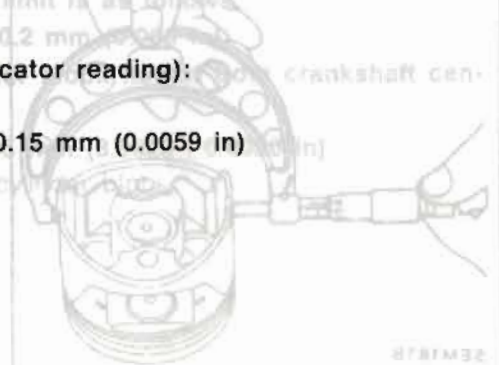
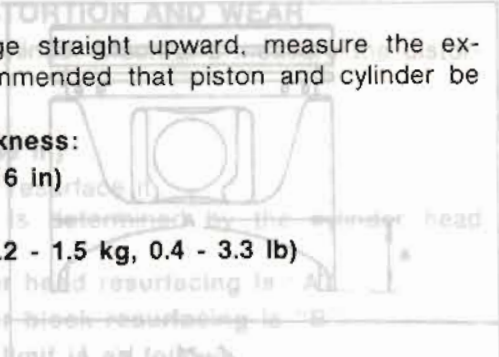
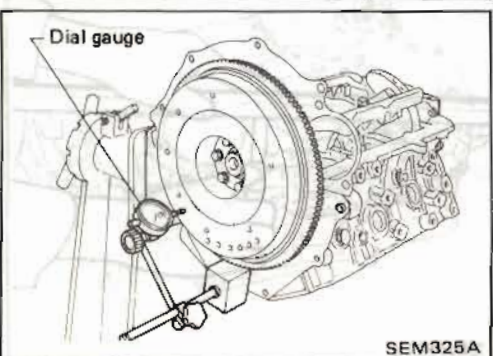
2.0 - 14.7 N (0.2 - 1.5 kg, 0.4 - 3.3 lb)

#### FLYWHEEL RUNOUT

Runout (Total indicator reading):

Flywheel

Less than 0.15 mm (0.0059 in)





## Assembly

### PISTON

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

Limit 0.30 mm (0.0118 in)

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

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

3. Set piston rings as shown.

- Be careful not to scratch cylinder wall by connecting rod.
- Arrange so that front mark on piston head faces toward front of engine.

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

- a. Grade number of each cylinder block main journal is punched on the respective cylinder block.

(2) Tighten to 38 to 44 N·m (3.9 to 4.5 kg-m, 28 to 32 ft-lb) or if you have an angle wrench, tighten bolts 90 to 95 degrees clockwise.

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

0.20 to 0.35 mm (0.0079 to 0.0138 in)  
0.10 to 0.15 mm (0.0039 to 0.0059 in)

After securing bearing cap bolts, replace connecting rod and/or crankshaft.

## Assembly (Cont'd)

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

Main bearing grade number:

Crankshaft journal grade number	Main journal grade number		
	0	1	2
0	0	1	2
1	1	2	3
2	2	3	4

For example:

Main journal grade number: 1

Crankshaft journal grade number: 2

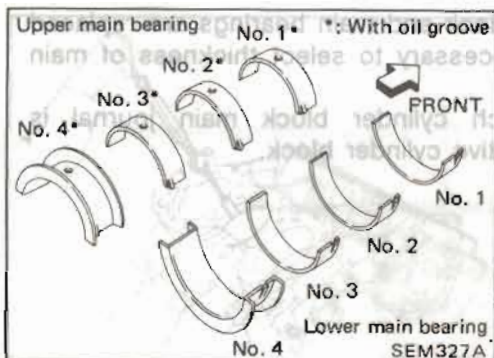
Main bearing grade number = 1 + 2  
= 3

- Do not cut too much out of the cylinder bore at a time. Cut only 0.05 mm (0.0020 in) oversize diameter at a time.

8. Hone the cylinders to obtain specified piston-to-bore clearance.

5. If crankshaft, cylinder block or main bearing is reused again, measure main bearing clearance.

- Measurement should be done with cylinder bore gauge.

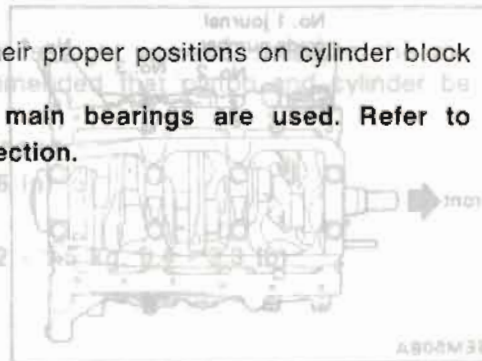


## CRANKSHAFT

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

- Confirm that correct main bearings are used. Refer to "Inspection" of this section.

0.04 mm (0.0016 in)   
 Extracting force:   
 2.0 - 14.7 N (0.2 - 3.3 lbf)



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

- 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 the center bearing and move outward sequentially.

- After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.



# (Assembly (Cont'd)

3. Measure crankshaft end play.

**Crankshaft end play:**

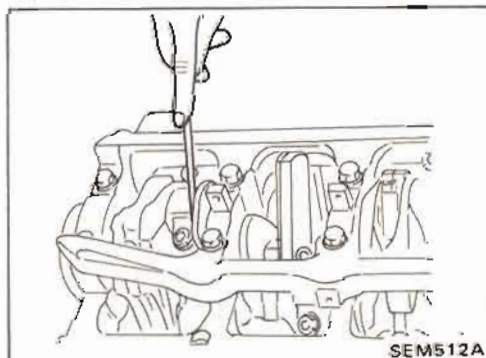
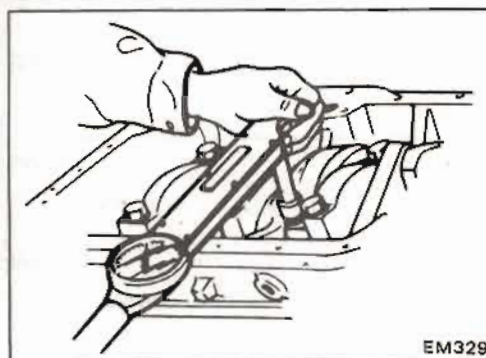
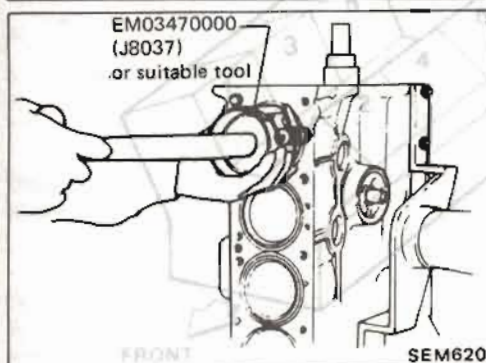
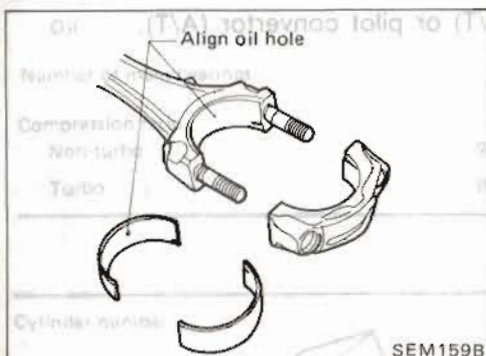
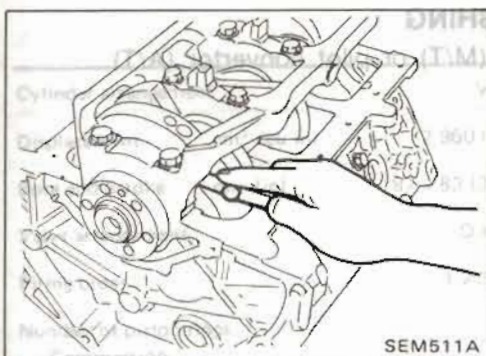
**Standard**

0.05 - 0.17 mm (0.0020 - 0.0067 in)

**Limit**

0.30 mm (0.0118 in)

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



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

- Confirm that correct bearings are used. Refer to "Inspection" of ENGINE OVERHAUL.
- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.

5. Install pistons with connecting rods.

(1) Install them into corresponding cylinders with Tool.

- Be careful not to scratch cylinder wall by connecting rod.
- Arrange so that front mark on piston head faces toward front of engine.

(2) Install connecting rod bearing caps.

- Tighten connecting rod bearing cap nuts to the specified torque.

(1) Tighten to 14 to 16 N·m

(1.4 to 1.6 kg-m, 10 to 12 ft-lb).

(2) Tighten to 38 to 44 N·m

(3.9 to 4.5 kg-m, 28 to 33 ft-lb) or If you have an angle wrench, tighten bolts 60 to 65 degrees clockwise.

6. Measure connecting rod side clearance.

**Connecting rod side clearance:**

**Standard**

0.20 - 0.35 mm (0.0079 - 0.0138 in)

**Limit**

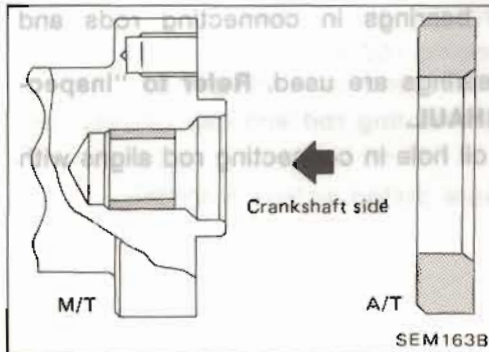
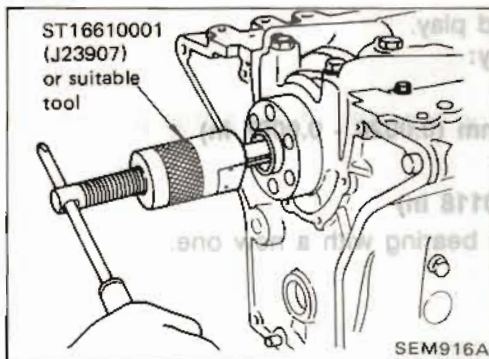
0.40 mm (0.0157 in)

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

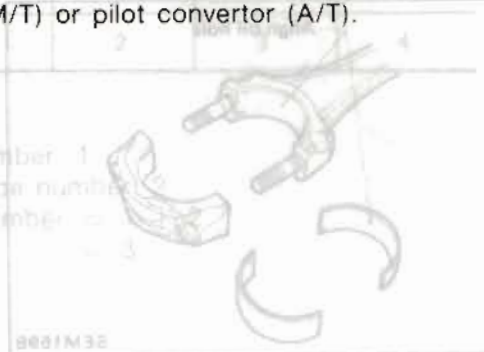
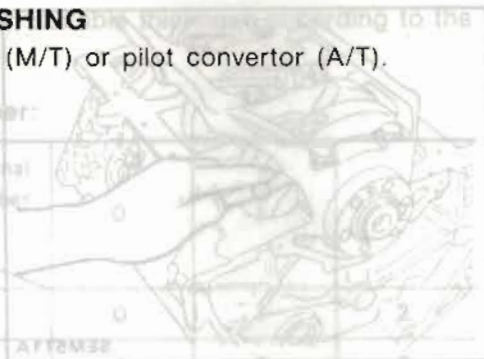
## Assembly (Cont'd)

### REPLACING PILOT BUSHING

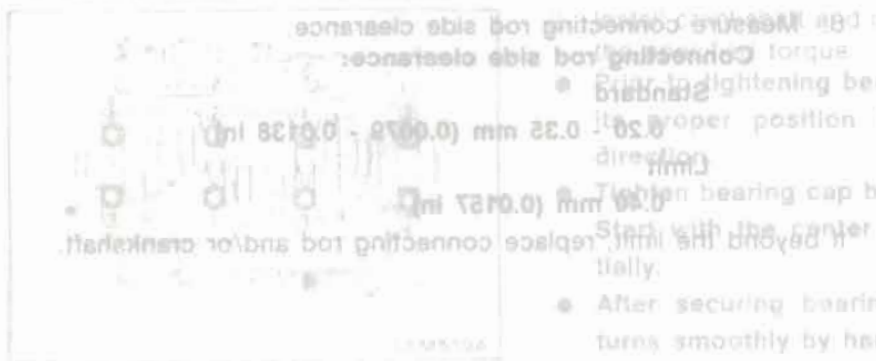
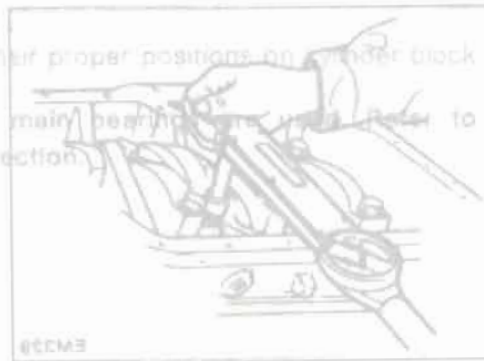
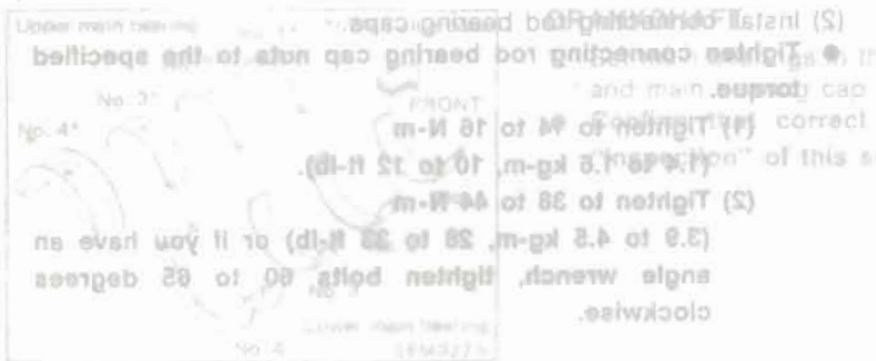
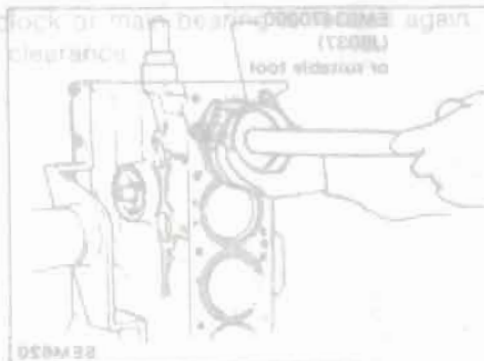
1. Remove pilot bushing (M/T) or pilot convertor (A/T).



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



- Arrange so that front mark on piston head faces toward front of engine.
- Be careful not to scratch cylinder wall by connecting rod.
- Install piston into corresponding cylinders with Tool.
- Lock piston with connecting rods.





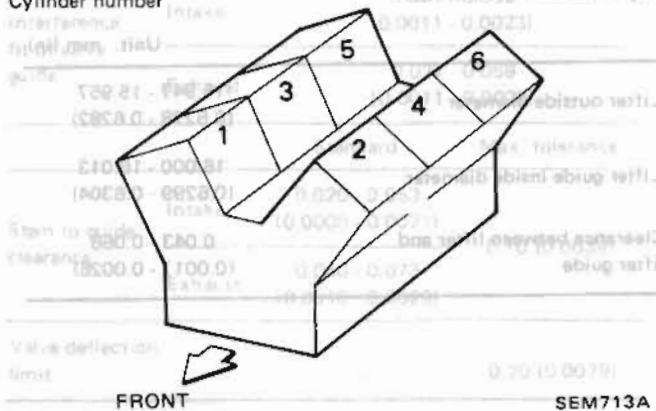
# SERVICE DATA AND SPECIFICATIONS (S.D.S.)

## General Specifications

### Valve guide

Cylinder arrangement	V-6
Displacement	cm <sup>3</sup> (cu in) 2,960 (180.62)
Bore and Stroke	mm (in) 87 x 83 (3.43 x 3.27)
Valve arrangement	O.H.C.
Firing order	1-2-3-4-5-6
Number of piston rings	2
Oil	1
Number of main bearings	4
Compression ratio	9.0
Non-turbo	8.3
Turbo	

### Cylinder number



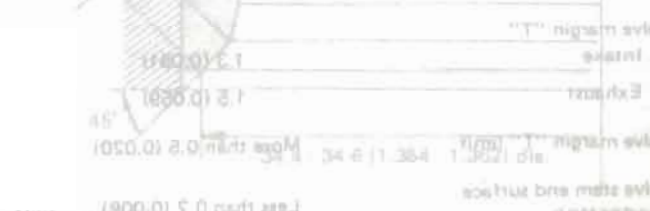
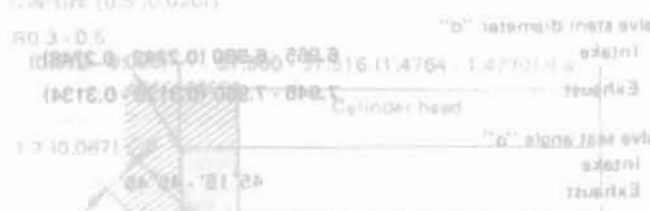
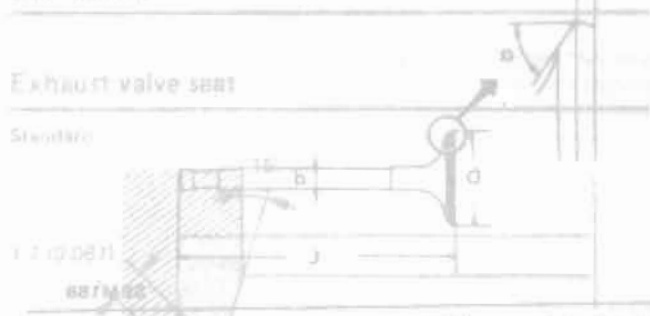
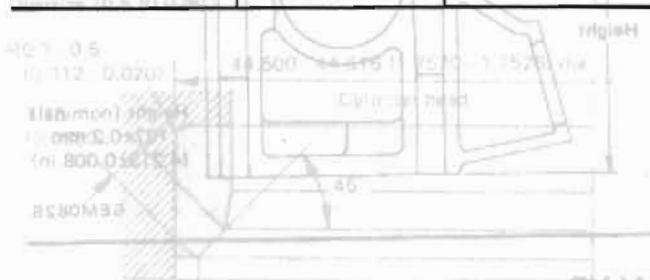
### Rocker shaft and rocker arm

Rocker shaft	Outer diameter	mm (in)
Rocker arm	Inner diameter	mm (in)
Clearance between rocker arm and rocker shaft		mm (in)

### COMPRESSION PRESSURE

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

	Non-turbo	Turbo
Compression pressure		
Standard	1,196 (12.2, 173)/300	1,167 (11.9, 169)/300
Minimum	883 (9.0, 128)/300	863 (8.8, 125)/300
Differential limit between cylinders	98 (1.0, 14)/300	98 (1.0, 14)/300



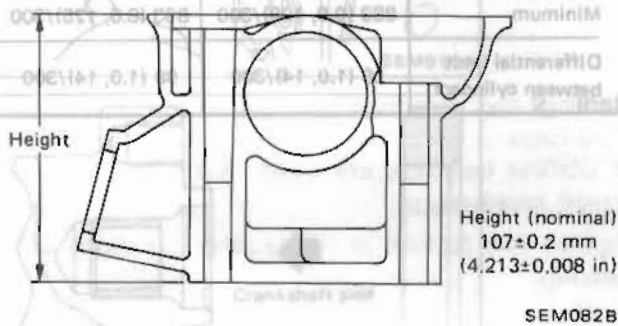
# SERVICE DATA AND SPECIFICATIONS (S.D.S.)

(Cont'd) Assembly

## Inspection and Adjustment

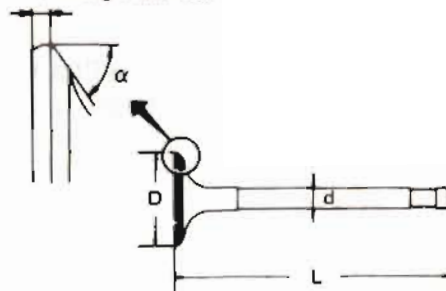
### CYLINDER HEAD

	Unit: mm (in)	
	Standard	Limit
Head surface distortion	Less than 0.05 (0.0020)	0.1 (0.004)



### VALVE

T (Margin thickness)



Valve head diameter "D"	
Intake	42.0 - 42.2 (1.654 - 1.661)
Exhaust	35.0 - 35.2 (1.378 - 1.386)
Valve length "L"	
Intake	125.3 - 125.9 (4.933 - 4.957)
Exhaust	124.2 - 124.8 (4.890 - 4.913)
Valve stem diameter "d"	
Intake	6.965 - 6.980 (0.2742 - 0.2748)
Exhaust	7.945 - 7.960 (0.3128 - 0.3134)
Valve seat angle "α"	
Intake	45° 15' - 45° 45'
Exhaust	
Valve margin "T"	
Intake	1.3 (0.051)
Exhaust	1.5 (0.059)
Valve margin "T" limit	More than 0.5 (0.020)
Valve stem end surface grinding limit	Less than 0.2 (0.008)
Valve clearance	
Intake	0 (0)
Exhaust	0 (0)

### Valve spring

Free height	Outer	51.2 (2.016)
	Inner	44.1 (1.736)
Pressure height	Outer	30.0/523.7 (30.0/53.4, 1.181/117.7)
	Inner	25.0/255.0 (25.0/26.0, 0.984/57.3)
Assembled height	Outer	40.0/250.1 (40.0/25.5, 1.575/56.2)
	Inner	35.0/107.9 (35.0/11.0, 1.378/24.3)
Out of square	Outer	2.2 (0.087)
	Inner	1.9 (0.075)

### Hydraulic valve lifter

Unit: mm (in)	
Lifter outside diameter	15.947 - 15.957 (0.6278 - 0.6282)
Lifter guide inside diameter	16.000 - 16.013 (0.6299 - 0.6304)
Clearance between lifter and lifter guide	0.043 - 0.066 (0.0017 - 0.0026)



# SERVICE DATA AND SPECIFICATIONS (S.D.S.)

## Inspection and Adjustment (Cont'd)

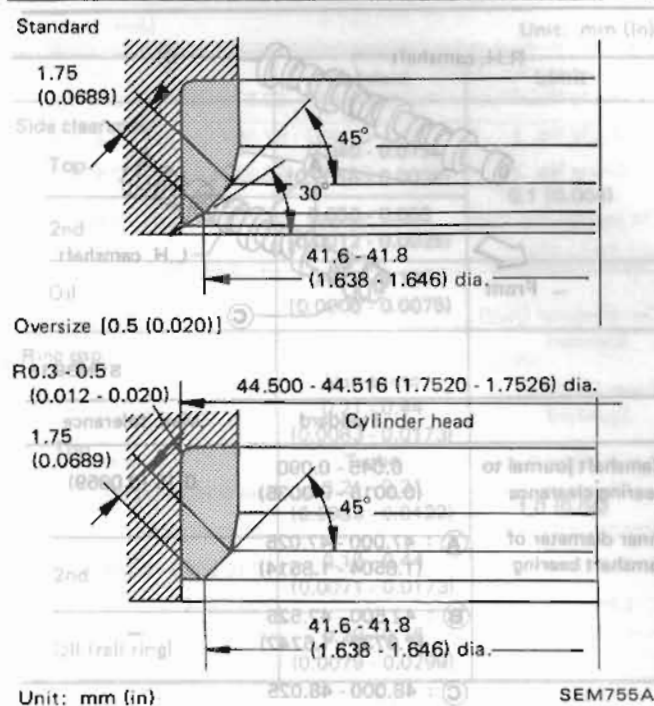
### Valve guide

Available piston		Unit: mm (in)	
		Standard	Service
Valve guide	Intake	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
	Exhaust	12.023 - 12.034 (0.4733 - 0.4738)	12.223 - 12.234 (0.4812 - 0.4817)
Valve guide			
Inner diameter	Intake	7.000 - 7.018 (0.2756 - 0.2763)	
	Exhaust	8.000 - 8.018 (0.3150 - 0.3157)	
Cylinder head valve guide hole diameter	Intake	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
	Exhaust	11.975 - 11.996 (0.4715 - 0.4723)	12.175 - 12.196 (0.4793 - 0.4802)
Interference fit of valve guide	Intake	0.027 - 0.059 (0.0011 - 0.0023)	
	Exhaust	0.027 - 0.059 (0.0011 - 0.0023)	
		Standard	Max. tolerance
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.10 (0.0039)
Valve deflection limit		—	0.20 (0.0079)

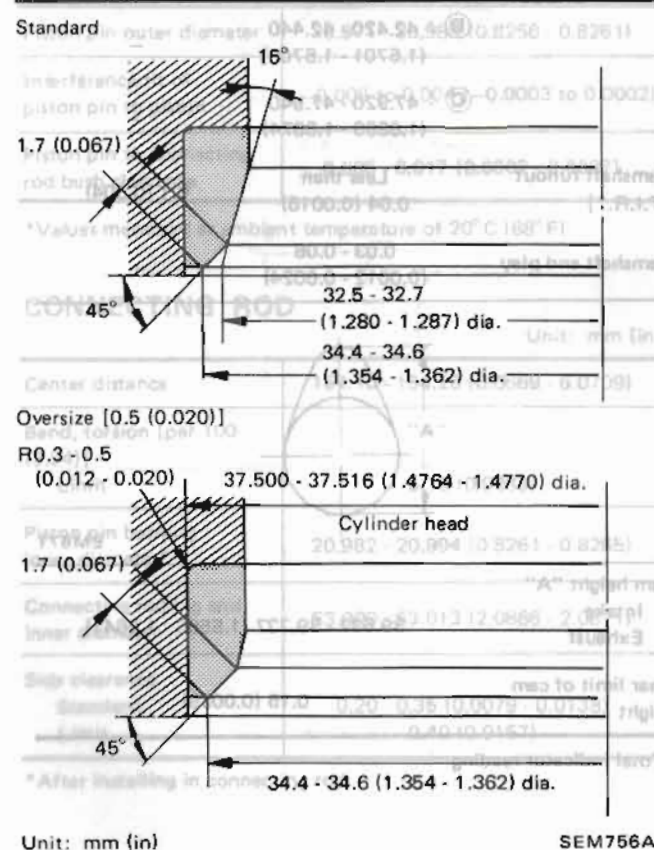
### Rocker shaft and rocker arm

		Unit: mm (in)
Rocker shaft	Outer diameter	17.979 - 18.000 (0.7078 - 0.7087)
	Inner diameter	18.007 - 18.028 (0.7089 - 0.7098)
Clearance between rocker arm and rocker shaft		0.007 - 0.049 (0.0003 - 0.0019)

### Intake valve seat



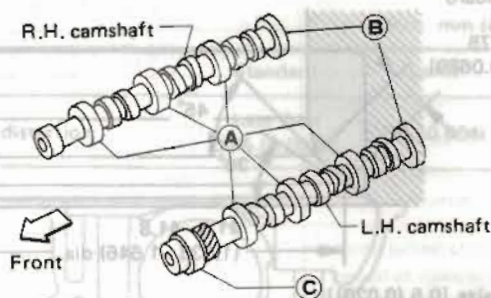
### Exhaust valve seat



## Inspection and Adjustment (Cont'd)

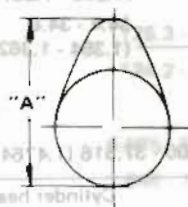
### CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)



SEM893B

	Standard	Max. tolerance
Camshaft journal to bearing clearance	0.045 - 0.090 (0.0018 - 0.0035)	0.15 (0.0059)
Inner diameter of camshaft bearing	(A) : 47.000 - 47.025 (1.8504 - 1.8514)	
	(B) : 42.500 - 42.525 (1.6732 - 1.6742)	
	(C) : 48.000 - 48.025 (1.8898 - 1.8907)	
Outer diameter of camshaft journal	(A) : 46.920 - 46.940 (1.8472 - 1.8480)	
	(B) : 42.420 - 42.440 (1.6701 - 1.6709)	
	(C) : 47.920 - 47.940 (1.8866 - 1.8874)	
Camshaft runout [T.I.R.*]	Less than 0.04 (0.0016)	0.1 (0.004)
Camshaft end play	0.03 - 0.06 (0.0012 - 0.0024)	

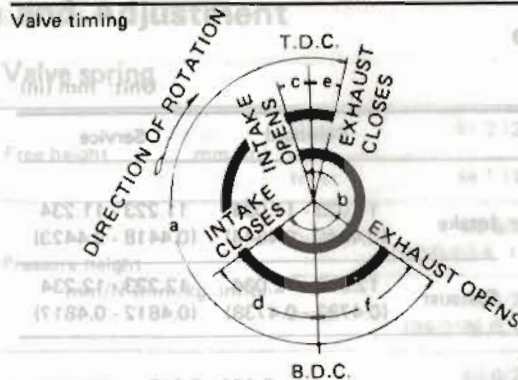


EM671

Cam height "A"	
Intake	39.537 - 39.727 (1.5566 - 1.5641)
Exhaust	
Wear limit of cam height	0.15 (0.0059)

\*Total indicator reading

Valve timing

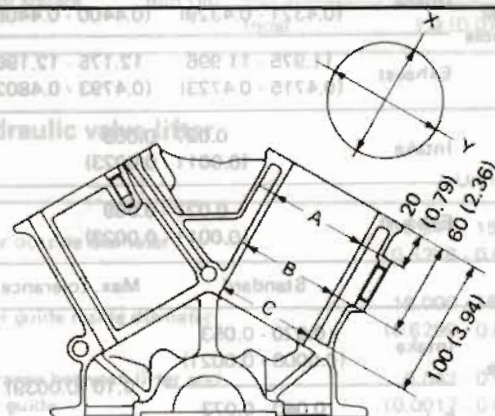


Unit: degree

a	b	c	d	e	f
248°	248°	10°	58°	10°	58°

### CYLINDER BLOCK

Unit: mm (in)



SEM321A

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

Cylinder bore	
Inner diameter	
Standard	
Grade No. 1	87.000 - 87.010 (3.4252 - 3.4256)
Grade No. 2	87.010 - 87.020 (3.4256 - 3.4260)
Grade No. 3	87.020 - 87.030 (3.4260 - 3.4264)
Grade No. 4	87.030 - 87.040 (3.4264 - 3.4268)
Grade No. 5	87.040 - 87.050 (3.4268 - 3.4272)

Wear limit 0.20 (0.0079)

Out-of-round (X-Y)	Less than 0.015 (0.0006)
--------------------	--------------------------

Taper (A-B-C)	Less than 0.015 (0.0006)
---------------	--------------------------

Main journal inner diameter	
Grade No. 0	66.645 - 66.654 (2.6238 - 2.6242)
Grade No. 1	66.654 - 66.663 (2.6242 - 2.6245)
Grade No. 2	66.663 - 66.672 (2.6245 - 2.6249)

Difference in inner diameter between cylinders	
Standard	Less than 0.05 (0.0020)
Wear limit	0.20 (0.0079)

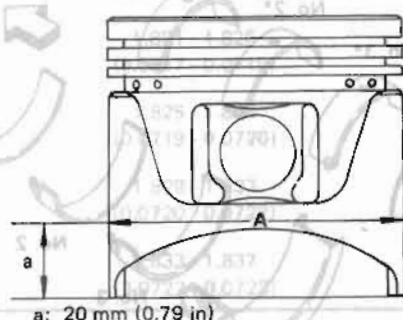


**Inspection and Adjustment (Cont'd)**

**PISTON, PISTON RING AND PISTON PIN**

**Available piston**

Unit: mm (in)



SEM891B

Standard	
Grade No. 1	86.965 - 86.975 (3.4238 - 3.4242)
Grade No. 2	86.975 - 86.985 (3.4242 - 3.4246)
Piston skirt diameter	Grade No. 3 86.985 - 86.995 (3.4246 - 3.4250)
	Grade No. 4 86.995 - 87.005 (3.4250 - 3.4254)
	Grade No. 5 87.005 - 87.015 (3.4254 - 3.4258)
"A" 0.25 (0.0098) oversize (Service)	87.215 - 87.265 (3.4337 - 3.4356)
0.50 (0.0197) oversize (Service)	87.465 - 87.515 (3.4435 - 3.4455)
"a" dimension	20 (0.79)
Piston pin hole diameter	20.969 - 20.981 (0.8255 - 0.8260)
Piston clearance to cylinder block	0.025 - 0.045 (0.0010 - 0.0018)

**Piston ring**

Unit: mm (in)

	Standard	Limit
Side clearance		
Top	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
2nd	0.030 - 0.063 (0.0012 - 0.0025)	
Oil	0.015 - 0.190 (0.0006 - 0.0075)	—
Ring gap		
Top	Non-turbo 0.21 - 0.44 (0.0083 - 0.0173)	1.0 (0.04)
	Turbo 0.21 - 0.31 (0.0083 - 0.0122)	
2nd	0.18 - 0.44 (0.0071 - 0.0173)	
Oil (rail ring)	0.20 - 0.76 (0.0079 - 0.0299)	

**Piston pin**

Unit: mm (in)

Piston pin outer diameter	20.971 - 20.983 (0.8256 - 0.8261)
Interference fit of piston pin to piston	-0.008 to 0.004 (-0.0003 to 0.0002)
Piston pin to connecting rod bush clearance	0.005 - 0.017 (0.0002 - 0.0007)

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

**CONNECTING ROD**

Unit: mm (in)

Center distance	154.10 - 154.20 (6.0669 - 6.0709)
Bend, torsion (per 100 (3.94))	
Limit	0.10 (0.0039)
Piston pin bushing inner diameter*	20.982 - 20.994 (0.8261 - 0.8265)
Connecting rod big end inner diameter	53.000 - 53.013 (2.0866 - 2.0871)
Side clearance	
Standard	0.20 - 0.35 (0.0079 - 0.0138)
Limit	0.40 (0.0157)

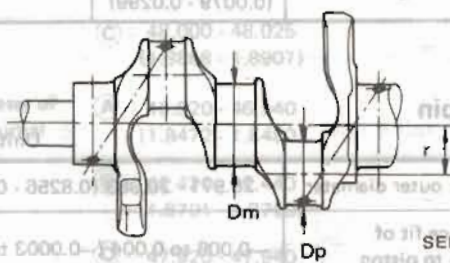
\*After installing in connecting rod

# SERVICE DATA AND SPECIFICATIONS (S.D.S.)

## Inspection and Adjustment (Cont'd)

### CRANKSHAFT

Unit: mm (in)	
Main journal dia. "Dm"	
Grade No. 0	62.967 - 62.975 (2.4790 - 2.4793)
Grade No. 1	62.959 - 62.967 (2.4787 - 2.4790)
Grade No. 2	62.951 - 62.959 (2.4784 - 2.4787)
Pin journal dia. "Dp"	49.955 - 49.974 (1.9667 - 1.9675)
Center distance "r"	41.5 (1.634)
Out-of-round (X-Y)	
Standard	Less than 0.005 (0.0002)
Taper (A-B)	
Standard	Less than 0.005 (0.0002)
Runout (T.I.R.)	
Standard	Less than 0.10 (0.0039)
Free end play	
Standard	0.05 - 0.17 (0.0020 - 0.0067)
Limit	0.30 (0.0118)



Out-of-round

X-Y

Taper

A-B



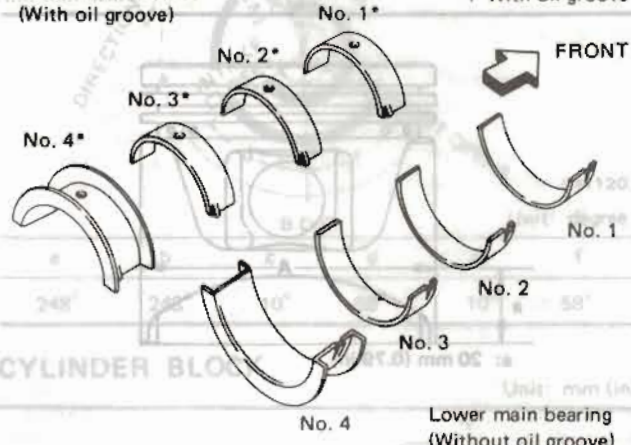
SEM645

EM715

### AVAILABLE MAIN BEARING

Upper main bearing  
(With oil groove)

\*: With oil groove



SEM327A

#### No. 1 main bearing

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)		Black
1	1.821 - 1.825 (0.0717 - 0.0719)		Brown
2	1.825 - 1.829 (0.0719 - 0.0720)	22.5 (0.886)	Green
3	1.829 - 1.833 (0.0720 - 0.0722)		Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)		Blue

#### No. 2 and 3 main bearing

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)		Black
1	1.821 - 1.825 (0.0717 - 0.0719)		Brown
2	1.825 - 1.829 (0.0719 - 0.0720)	19.0 (0.748)	Green
3	1.829 - 1.833 (0.0720 - 0.0722)		Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)		Blue



# A AND SPECIFICATIONS (S.D.S.)

## Inspection and Adjustment (Cont'd)

### No. 4 main bearing

Grade number	Thickness "T" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)	Black
1	1.821 - 1.825 (0.0717 - 0.0719)	Brown
2	1.825 - 1.829 (0.0719 - 0.0720)	Green
3	1.829 - 1.833 (0.0720 - 0.0722)	Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)	Blue

### Main bearing 0.25 mm (0.0098 in) undersize

Thickness "T"	Unit: mm (in)
1.948 - 1.956 (0.0767 - 0.0770)	

## AVAILABLE CONNECTING ROD BEARING

### Connecting rod bearing undersize

	Unit: mm (in)
Crank pin journal diameter "Dp"	
Standard	49.955 - 49.974 (1.9667 - 1.9675)
Undersize	
0.08 (0.0031)	49.881 - 49.894 (1.9638 - 1.9643)
0.12 (0.0047)	49.841 - 49.854 (1.9622 - 1.9628)
0.25 (0.0098)	49.711 - 49.724 (1.9571 - 1.9576)

## MISCELLANEOUS COMPONENTS

Unit: mm (in)	
Flywheel	
Runout [T.I.R.]	Less than 0.15 (0.0059)

### Bearing clearance

Unit: mm (in)	
Main bearing clearance	
Standard	0.028 - 0.055 (0.0011 - 0.0022)
Limit	0.090 (0.0035)
Connecting rod bearing clearance	
Standard	0.014 - 0.054 (0.0006 - 0.0021)
Limit	0.090 (0.0035)

# SERVICE DATA AND SPECIFICATIONS (S.D.S.)

## Tightening Torque

### ENGINE OUTER PARTS

Main journal dia. "Dm"	N-m	kg-m	ft-lb
Collector cover	6 - 8	0.6 - 0.8	4.3 - 5.8
Collector	18 - 22	1.8 - 2.2	13 - 16
Throttle chamber	Refer to "Installation" of CYLINDER HEAD.		
Intake relief valve	29 - 39	3.0 - 4.0	22 - 29
Intake manifold bolt	Refer to "Installation" of CYLINDER HEAD.		
Intake manifold nut			
Injector holder	2.5 - 3.2	0.25 - 0.33	1.8 - 2.4
Cylinder head temperature sensor	12 - 16	1.2 - 1.6	9 - 12
Thermal transmitter	15 - 20	1.5 - 2.0	11 - 14
Exhaust manifold	18 - 22	1.8 - 2.2	13 - 16
Exhaust outlet	25 - 29	2.5 - 3.0	18 - 22
E.G.R. control valve	18 - 23	1.8 - 2.3	13 - 17
E.G.R. tube	34 - 44	3.5 - 4.5	25 - 33
Exhaust connecting tube	22 - 27	2.2 - 2.8	16 - 20
Exhaust gas sensor			
Non-turbo	40 - 50	4.1 - 5.1	30 - 37
Turbo	18 - 24	1.8 - 2.4	13 - 17
Crankshaft pulley	123 - 132	12.5 - 13.5	90 - 98
Water inlet	16 - 21	1.6 - 2.1	12 - 15
Detonation sensor	25 - 34	2.5 - 3.5	18 - 25
P.C.V. valve	29 - 39	3.0 - 4.0	22 - 29
Distributor bolt	4.9 - 6.2	0.50 - 0.63	3.6 - 4.6
Alternator adjusting bar bolt	14 - 17	1.4 - 1.7	10 - 12
Air regulator	4.9 - 6.2	0.50 - 0.63	3.6 - 4.6
Starter motor	30 - 36	3.1 - 3.7	22 - 27

### ENGINE PARTS

	N-m	kg-m	ft-lb
Upper main bearing			
Rocker cover	1 - 3	0.1 - 0.3	0.7 - 2.2
Tensioner nut	43 - 58	4.4 - 5.9	32 - 43
Belt cover	3 - 5	0.3 - 0.5	2.2 - 3.6
Rocker shaft	18 - 22	1.8 - 2.2	13 - 16
Camshaft pulley	78 - 88	8.0 - 9.0	58 - 65
Cylinder head	Refer to "Installation" of CYLINDER HEAD.		
Camshaft locate plate	78 - 88	8.0 - 9.0	58 - 65
Water pump	16 - 21	1.6 - 2.1	12 - 15
Drain plug (Oil pan)	29 - 39	3.0 - 4.0	22 - 29
Oil pan	7 - 8	0.7 - 0.8	5.1 - 5.8
Oil pump regulator valve	39 - 49	4.0 - 5.0	29 - 36
Oil pump securing bolts	6 - 7	0.6 - 0.7	4.3 - 5.1
	12 - 16	1.2 - 1.6	9 - 12
Oil strainer	16 - 21	1.6 - 2.1	12 - 15
Oil strainer bracket	6 - 8	0.6 - 0.8	4.3 - 5.8
Flywheel	98 - 108	10 - 11	72 - 80
Rear oil seal retainer	6 - 7	0.6 - 0.7	4.3 - 5.1
Connecting rod	Refer to "Installation" of ENGINE OVERHAUL.		
Main bearing cap	90 - 100	9.2 - 10.2	67 - 74
Water drain plug	34 - 44	3.5 - 4.5	25 - 33
Spark plug	20 - 29	2.0 - 3.0	14 - 22

### No. 2 and 3 main bearing

Grade number	Thickness T (mm/in.)	Height H (mm/in.)	Identification color
1	1.50 - 1.52	1.50 - 1.52	Blue
2	1.52 - 1.54	1.52 - 1.54	Green
3	1.54 - 1.56	1.54 - 1.56	Yellow
4	1.56 - 1.58	1.56 - 1.58	Red
5	1.58 - 1.60	1.58 - 1.60	White
6	1.60 - 1.62	1.60 - 1.62	Black
7	1.62 - 1.64	1.62 - 1.64	Grey
8	1.64 - 1.66	1.64 - 1.66	Brown
9	1.66 - 1.68	1.66 - 1.68	Pink
10	1.68 - 1.70	1.68 - 1.70	Orange