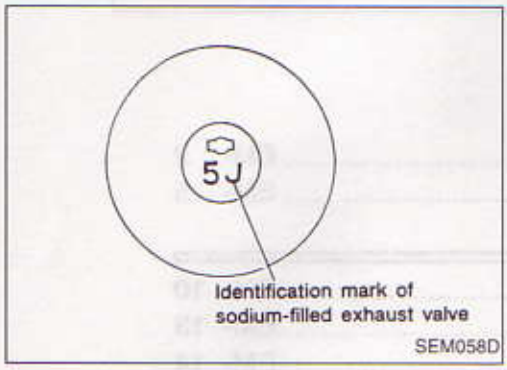
ENGINE MECHANICAL

SECTION EM

CONTENTS

Special Cautions to Ensure the Safe Disposal of Sodium-filled Exhaust Valves (SR20DE Engines)

The handling and disposal of sodium-filled exhaust valves requires special care and consideration. Under conditions such as breakage with subsequent exposure to water, the sodium metal which lines the inner portion of the exhaust valve will react violently, forming sodium hydroxide and releasing hydrogen gas which may result in an explosion or fire.



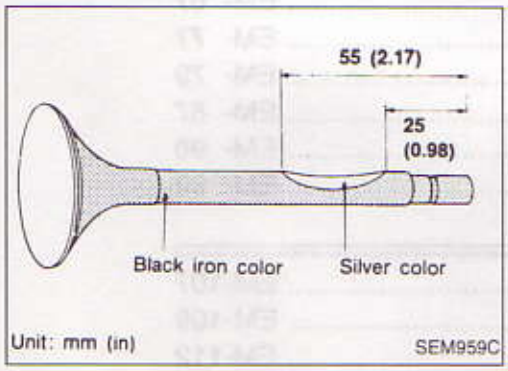
A sodium-filled exhaust valve is identified on the top of its stem as shown in illustration.

DEALER DISPOSAL INSTRUCTIONS

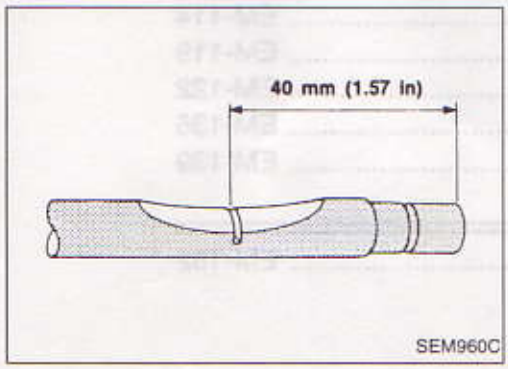
CAUTION:

- **Use approved shatter-resistant eye protection when performing this procedure.**
- **Perform this and all subsequent disposal work procedures in an open room, away from flammable liquids. Keep a fire extinguisher, rated at least 10 ABC, in close proximity to the work area.**
- **Be sure to wear rubber gloves when performing the following operations.**

1. Clamp valve stem in a vice.

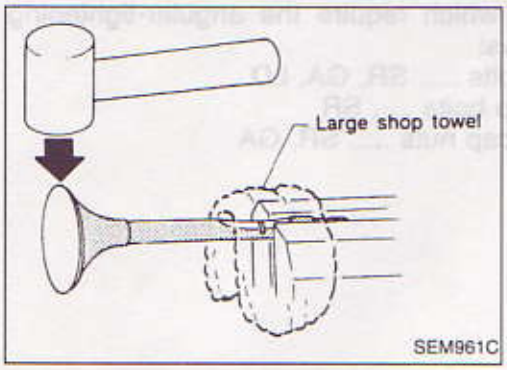


2. The valve has a specially-hardened surface. To cut through it, first remove a half-round section, approximately 30 mm (1.18 in) long. Use an air-powered grinder until the black iron color is removed and the silver-colored metal appears.

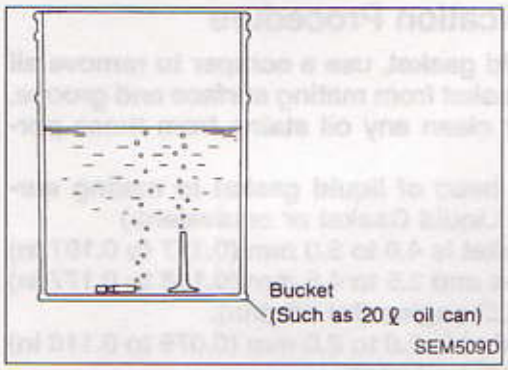


3. Use a hacksaw to cut through approximately half the diameter of the valve stem. Make the serration at a point 40 mm (1.57 in) from the end of the stem.

Special Cautions to Ensure the Safe Disposal of Sodium-filled Exhaust Valves (SR20DE Engines) (Cont'd)



4. Cover the serrated end of the valve with a large shop towel. Strike the valve face end with a hammer, separating it into two pieces.



5. Fill a bucket (such as a 20 ℓ oil can) with at least 10 ℓ (2-1/4 Imp gal) of water. Carefully place the already-cut (serrated) valves into the water one-at-a-time using a set of large tweezers and quickly move away at least 2.7 m (9 ft). The valves should be placed in a standing position as shown in the illustration to allow complete reaction of the sodium with the water. The major portion of the resultant chemical reaction lasts 1 to 2 minutes. After the bubbling action has subsided, additional valves can be placed into the bucket allowing each subsequent chemical reaction to subside. However, no more than 8 valves should be placed in the same 10 ℓ (2-1/4 Imp gal) amount of water. The complete chemical reaction may take as long as 4 to 5 hours. Remove the valves using a set of large tweezers after the chemical reaction has stopped. Afterwards, the valves can be mixed with ordinary scrap metal.

CAUTION:

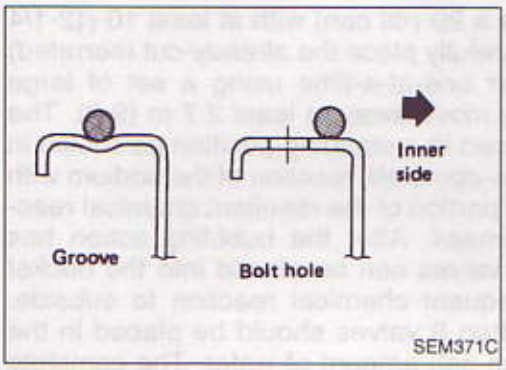
- **Make sure the resultant (high alkalinity) waste water does not contact your skin. If the waste water does contact you, wash the contacted area immediately with large quantities of water.**
- **Dealers should check their respective country and local regulations concerning any chemical treatment or waste water discharge permits which may be required to dispose of the resultant (high alkalinity) waste water.**

Parts Requiring Angular Tightening

- Some important engine parts are tightened using an angular-tightening method rather than a torque setting method.
- If these parts are tightened using a torque setting method, dispersal of the tightening force (axial bolt force) will be two or three times that of the dispersal produced by using the correct angular-tightening method.
- Although the torque setting values (described in this manual) are equivalent to those used when bolts and nuts are tightened with an angular-tightening method, they should be used for reference only.
- To assure the satisfactory maintenance of the engine, bolts and nuts must be tightened using an angular-tightening method.
- Before tightening the bolts and nuts, ensure that the thread and seating surfaces are clean and then coated with engine oil.

Parts Requiring Angular Tightening (Cont'd)

- The bolts and nuts which require the angular-tightening method are as follows:
  (1) Cylinder head bolts ..... SR, GA, LD
  (2) Main bearing cap bolts ..... SR
  (3) Connecting rod cap nuts ..... SR, GA

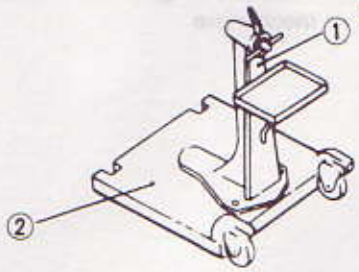
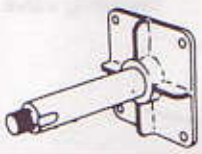
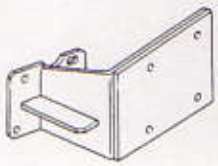
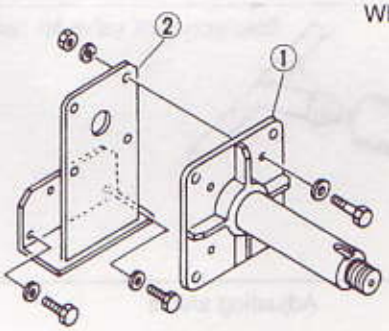
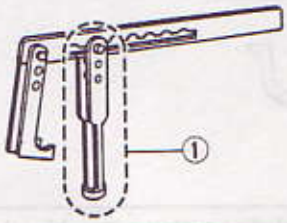


Liquid Gasket Application Procedure

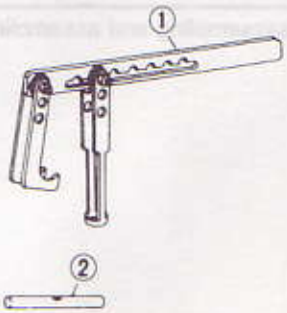
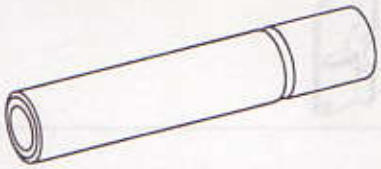
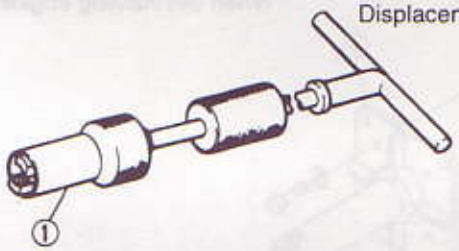
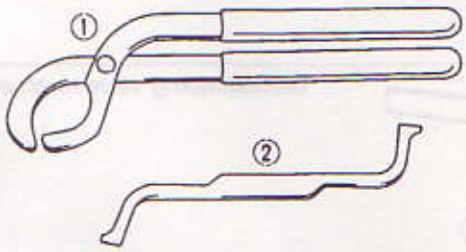
a. **Before applying liquid gasket, use a scraper to remove all traces of old liquid gasket from mating surface and groove, and then completely clean any oil stains from these portions.**
b. **Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Liquid Gasket or equivalent.)**
   - **Be sure liquid gasket is 4.0 to 5.0 mm (0.157 to 0.197 in) wide for SR engine and 3.5 to 4.5 mm (0.138 to 0.177 in) wide for GA and LD engine (for oil pan).**
   - **Be sure liquid gasket is 2.0 to 3.0 mm (0.079 to 0.118 in) wide (in areas except oil pan).**
c. **Apply liquid gasket to inner surface around hole perimeter area.**
   (Assembly should be done within 5 minutes after coating.)
d. **Wait at least 30 minutes before refilling engine oil and engine coolant.**

SPECIAL SERVICE TOOLS

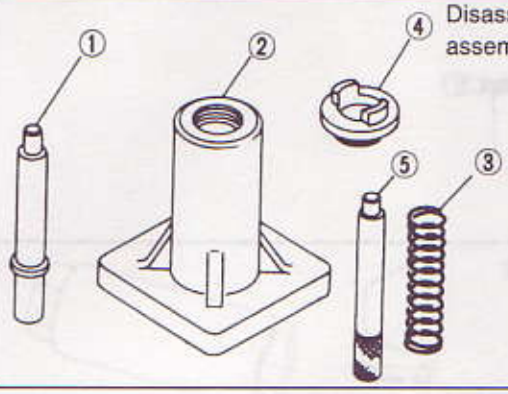
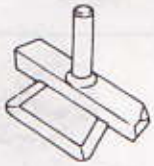
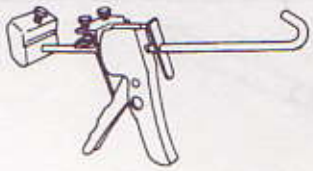
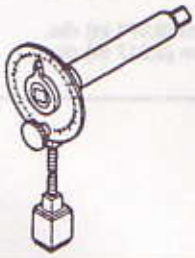
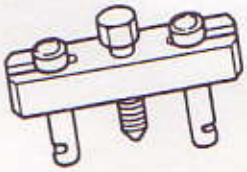
*: Special tool or commercial equivalent

Tool number Tool name	Description	Engine application		
		SR	GA	LD
ST0501S000 Engine stand assembly ① ST05011000 Engine stand ② ST05012000 Base	 Disassembling and assembling	X	X	X
KV10106500 Engine stand shaft		X	—	—
KV10115300 Engine sub-attachment		X	—	—
Engine attachment assembly ① KV10106500 Engine attachment ② KV10113300 Sub-attachment	 When overhauling engine	—	X	—
ST10120000 Cylinder head bolt wrench	 Loosening and tightening cylinder head bolt	X	X	—
KV10116200 Valve spring compressor ① KV10115900 Attachment	 Disassembling valve mechanism	X	X	—

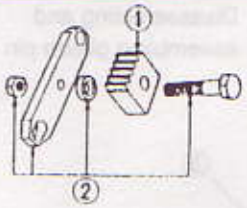
*: Special tool or commercial equivalent

Tool number Tool name	Description	Engine application		
		SR	GA	LD
KV101092S0 Valve spring compressor ① KV10109210 Compressor ② KV10109220 Adapter	 Disassembling valve mechanism	X	—	—
KV10115600 Valve oil seal drift	 Installing valve oil seal Intake: Side A (SR), Side A (GA) Exhaust: Side B (SR), Side A (GA)	X	X	—
KV10107902 Valve oil seal puller ① KV10116100 Holder (Holder design differs between KV10107900 and KV10107902.)	 Displacement valve lip seal	X	X	—
KV10115700 Dial gauge stand	 Adjusting shims	X	—	—
KV101151S0 Lifter stopper set ① KV10115110 Camshaft pliers ② KV10115120 Lifter stopper	 Changing shims	—	X	—
EM03470000 Piston ring compressor	 Installing piston assembly into cylinder bore	X	X	X

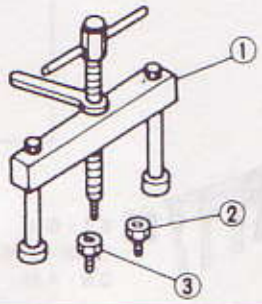
*: Special tool or commercial equivalent

Tool number Tool name	Description	Engine application		
		SR	GA	LD
KV10107400 Piston pin press stand ① KV10107310 Center shaft ② ST13040020 Stand ③ ST13040030 Spring ④ KV10107320 Cap ⑤ ST13040050 Drift	 Disassembling and assembling piston pin	X	X	—
KV11100300* Nozzle holder socket		—	—	X
KV10111100 Seal cutter	 Removing oil pan	X	X	X
WS39930000 Tube presser	 Pressing the tube of liquid gasket	X	X	X
KV10112100 Angle wrench	 Tightening bolts for bearing cap, cylinder head, etc.	X	X	X
KV11102900* Pulley puller		—	—	X

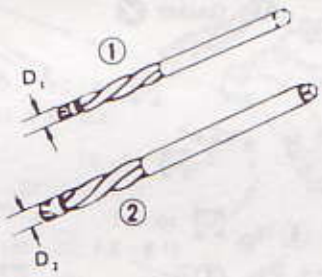
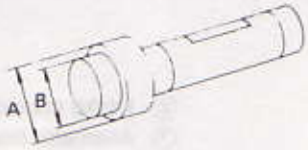
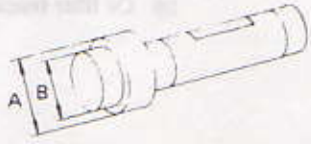
*: Special tool or commercial equivalent

Tool number Tool name	Description	Engine application		
		SR	GA	LD
KV101056S0 Ring gear stopper ① KV10105630 Adapter ② KV10105610 Plate assembly		—	—	X
Spark plug wrench	Removing and installing spark plug 	X	X	—
Valve seat cutter set	Finishing valve seat dimensions 	X	X	X
Piston ring expander	Removing and installing piston ring 	X	X	X
Valve guide drift	Removing and installing valve guide  SR Intake & Exhaust A = 9.5 mm (0.374 in) dia. B = 5.0 mm (0.197 in) dia. GA Intake & Exhaust A = 9.5 mm (0.374 in) dia. B = 5.5 mm (0.217 in) dia.	X	X	—

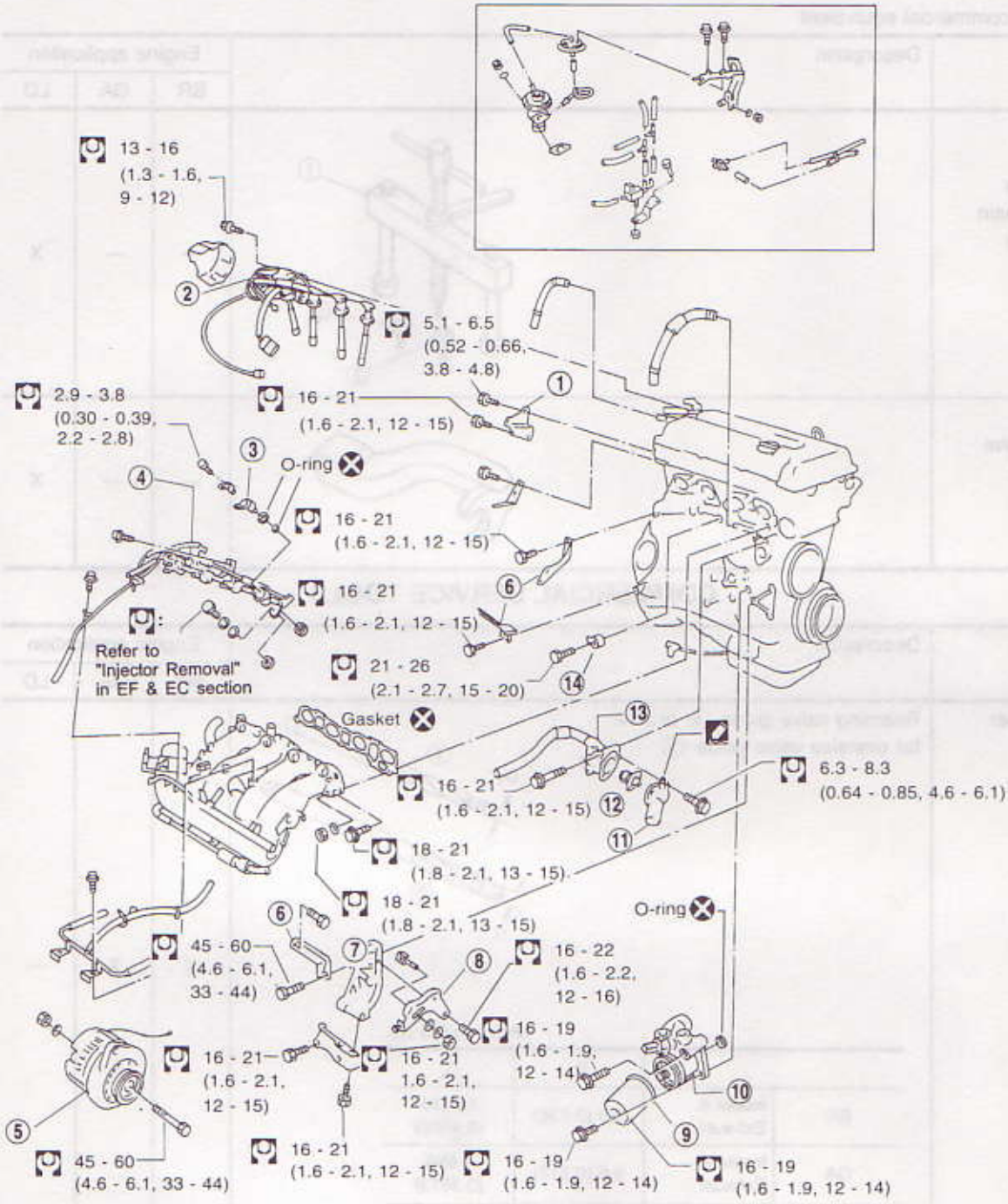
*: Special tool or commercial equivalent

Tool number Tool name	Description	Engine application		
		SR	GA	LD
KV101041S0 Crankshaft main bearing cap puller ① Crankshaft main bearing puller ② Adapter ③ Adapter		—	—	X
ST10640001 Pivot adjuster (valve clearance)		—	—	X

COMMERCIAL SERVICE TOOLS

Tool number Tool name	Description	Engine application		
		SR	GA	LD
Valve guide reamer	Reaming valve guide ① or hole for oversize valve guide ②  Unit: mm (in) dia.	X	X	—
Front oil seal drift	Installing front oil seal  **A = 75 mm (2.95 in) dia.** **B = 45 mm (1.77 in) dia.**	X	X	—
Rear oil seal drift	Installing rear oil seal  **A = 110 mm (4.33 in) dia.** **B = 80 mm (3.15 in) dia.**	X	X	—

		D_1	D_2
SR	Intake & Exhaust	6.0 (0.236)	10.175 (0.4006)
GA	Intake & Exhaust	5.5 (0.217)	9.685 (0.3813)

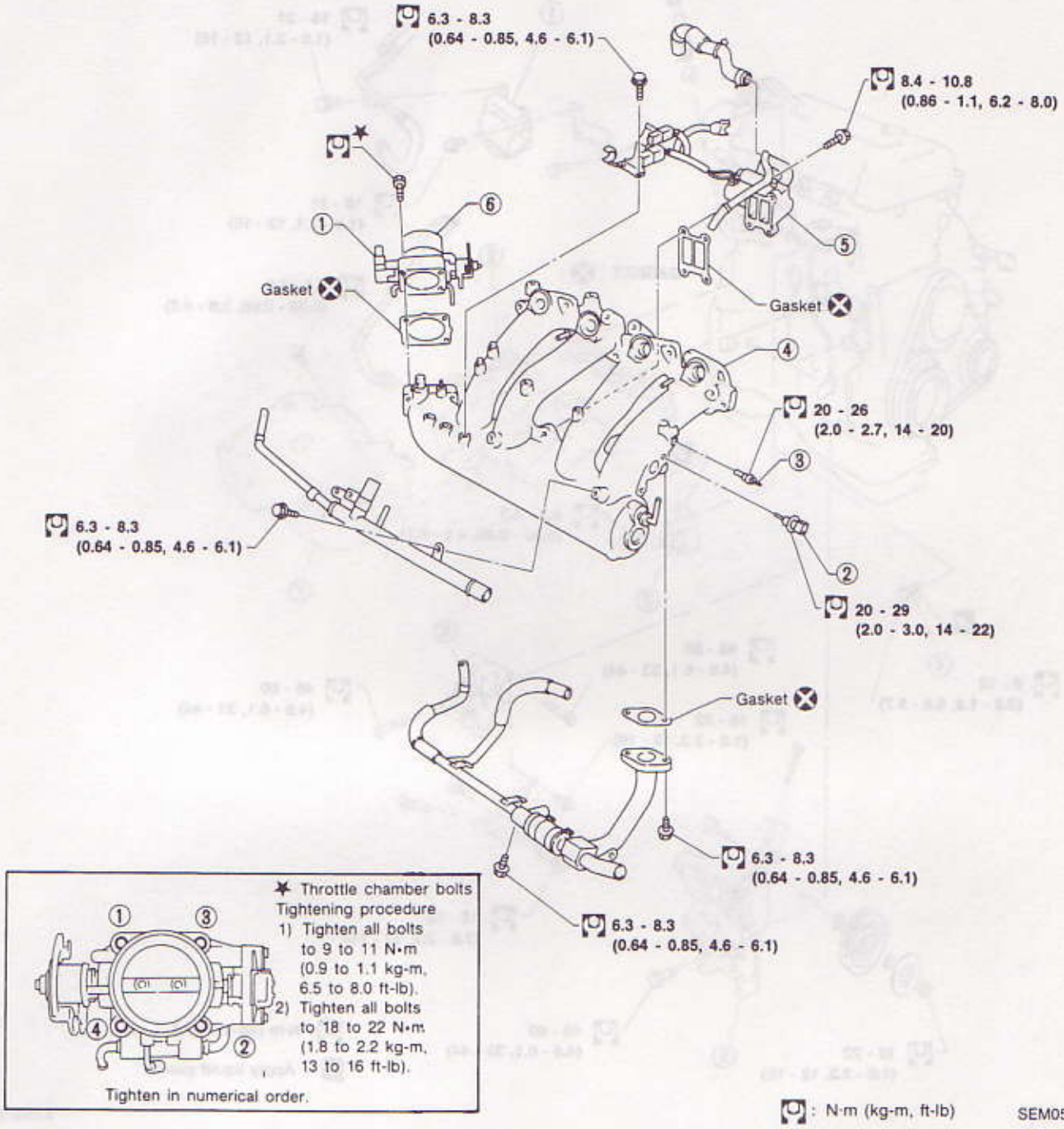


EEM018

: N·m (kg-m, ft-lb)

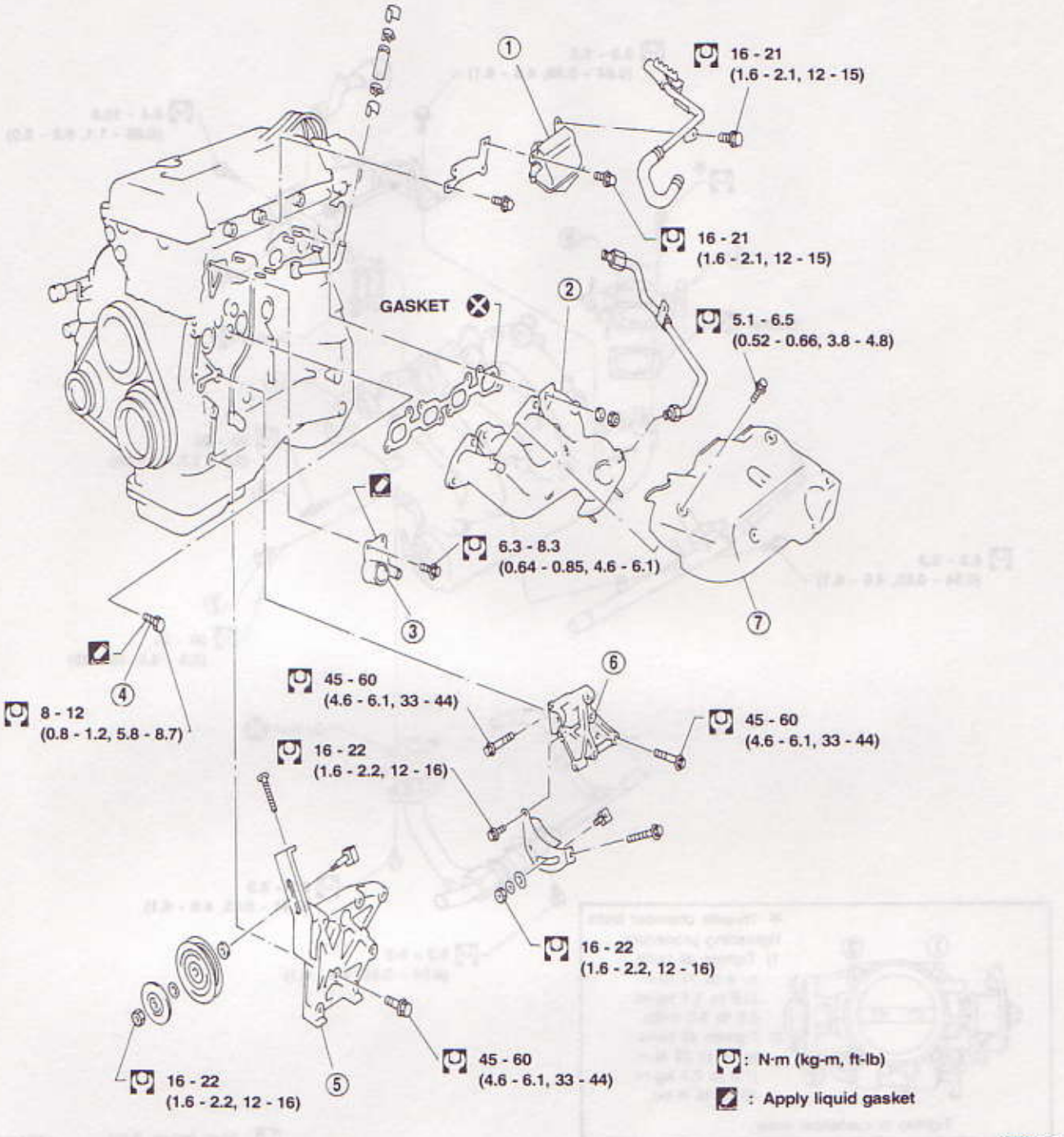
: Apply liquid gasket

① Air duct bracket
② Crank angle sensor built into distributor
③ Injector
④ Pressure regulator
⑤ Alternator
⑥ Intake manifold supports
⑦ Alternator bracket
⑧ Alternator adjusting bar
⑨ Oil filter
⑩ Oil filter bracket
⑪ Water inlet
⑫ Thermostat
⑬ Thermostat housing
⑭ Detonation sensor



① Throttle sensor
② Engine temperature sensor
③ Thermal transmitter
④ Intake manifold
⑤ I.A.A. unit
⑥ Throttle chamber

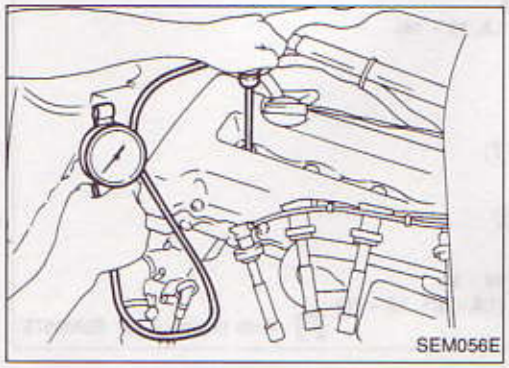
OUTER COMPONENT PARTS



① Oil separator
② Exhaust manifold
③ Water outlet
④ Cylinder block drain plug
⑤ Compressor bracket
⑥ Power steering oil pump bracket
⑦ Exhaust manifold cover

Measurement of Compression Pressure

1. Warm up engine.
2. Turn ignition switch off.
3. Release fuel pressure.
   Refer to "Releasing Fuel Pressure" in section EF & EC.
4. Remove all spark plugs.
5. Disconnect distributor center cable.


SEM056E

6. Attach a compression tester to No. 1 cylinder.
7. Depress accelerator pedal fully to keep throttle valve wide open.
8. Crank engine and record highest gauge indication.
9. Repeat the measurement on each cylinder as shown above.

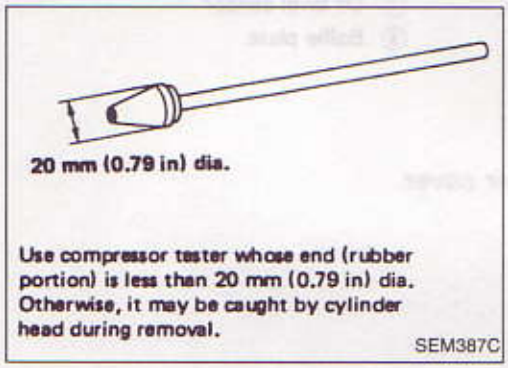
- **Always use a fully-charged battery to obtain specified engine revolution.**

Compression pressure: kPa (bar, kg/cm^2, psi)/300 rpm

Standard
1,226 (12.26, 12.5, 178)

Minimum
1,079 (10.79, 11.0, 156)

Difference limit between cylinders
98 (0.98, 1.0, 14)

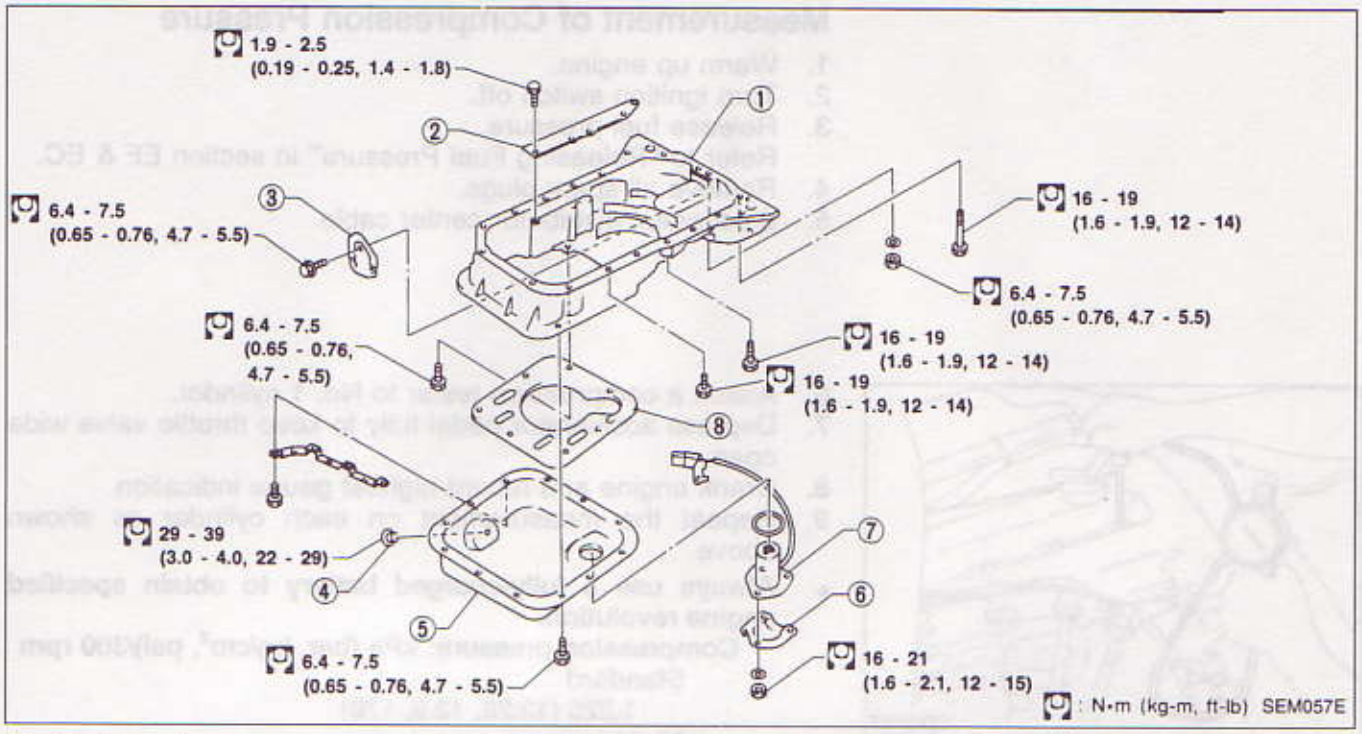


Use compressor tester whose end (rubber portion) is less than 20 mm (0.79 in) dia. Otherwise, it may be caught by cylinder head during removal.

SEM387C

10. If cylinder compression in one or more cylinders is low, pour a small amount of engine oil into cylinders through spark plug holes and retest compression.

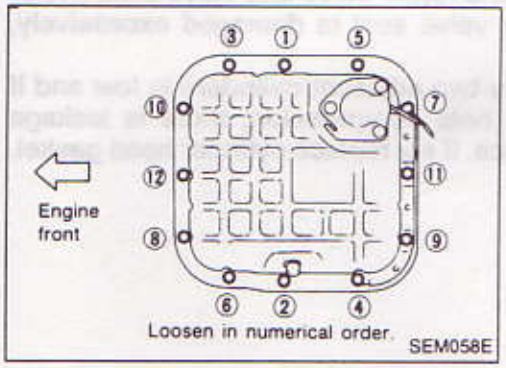
- **If adding oil helps compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. (Refer to S.D.S.) If valve or valve seat is damaged excessively, replace them.**
- **If compression in any two adjacent cylinders is low and if adding oil does not help compression, there is leakage past the gasket surface. If so, replace cylinder head gasket.**



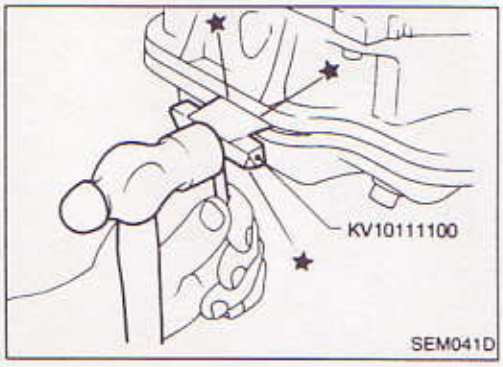
① Aluminum oil pan
② Side gallery baffle plate
③ Rear cover plate
④ Drain plug
⑤ Steel oil pan
⑥ Oil level sensor cover
⑦ Oil level sensor
⑧ Baffle plate

Removal

1. Remove engine under cover.
2. Drain engine oil.



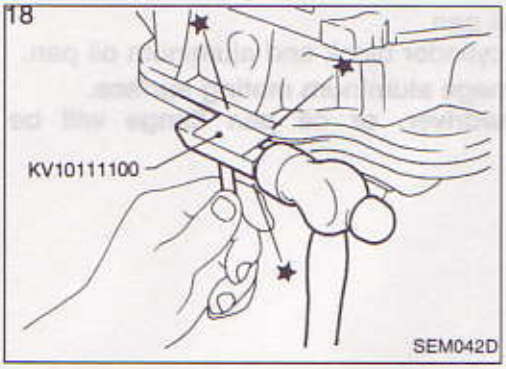
3. Remove steel oil pan bolts.



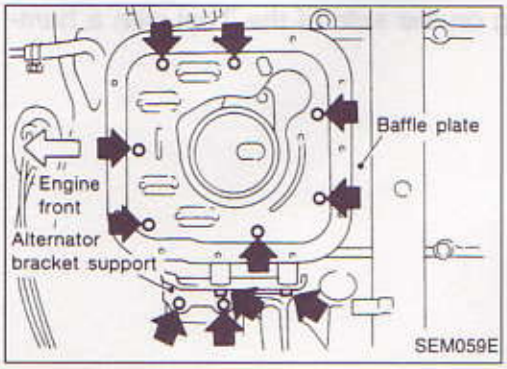
4. Remove steel oil pan.
(1) Insert Tool between aluminum oil pan and steel oil pan.

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

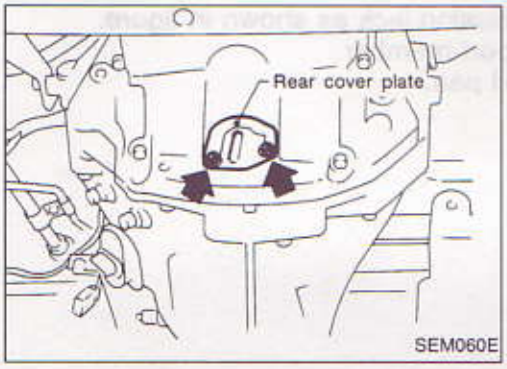
Removal (Cont'd)



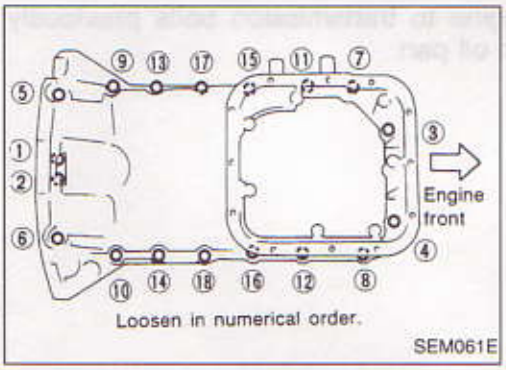
(2) Slide Tool by tapping on the side of the Tool with a hammer.
(3) Remove steel oil pan.



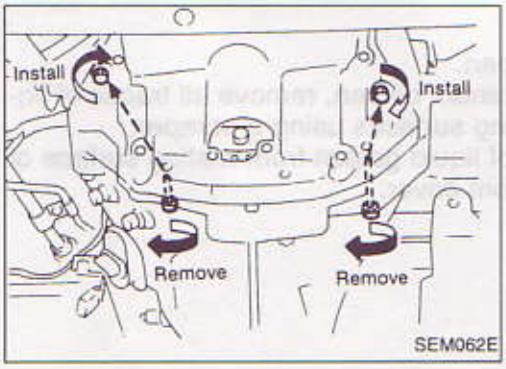
5. Remove baffle plate.
6. Remove alternator bracket support.



7. Remove rear cover plate.

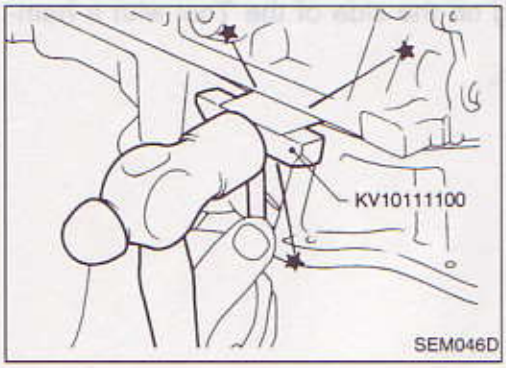


8. Remove aluminum oil pan bolts/nuts.

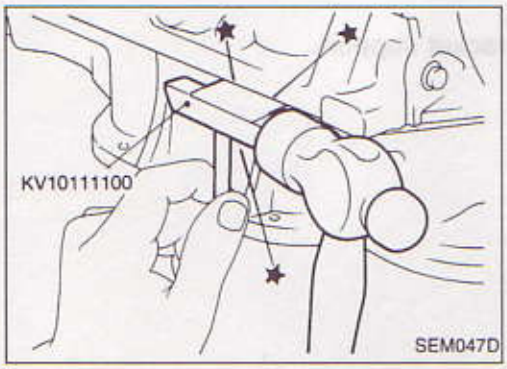


9. Remove the two engine to transaxle bolts and refit them into vacant holes as indicated. Tighten bolts to release aluminum oil pan from cylinder block.

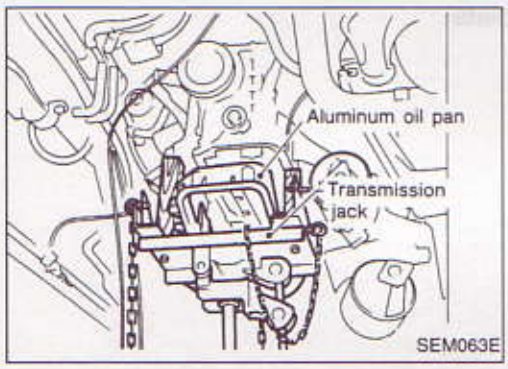
Removal (Cont'd)



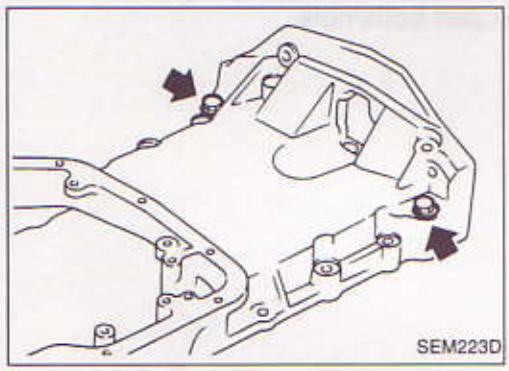
10. Remove aluminum oil pan.
(1) Insert Tool between cylinder block and aluminum oil pan.
- **Be careful not to damage aluminum mating surface.**
- **Do not insert screwdriver, or oil pan flange will be deformed.**



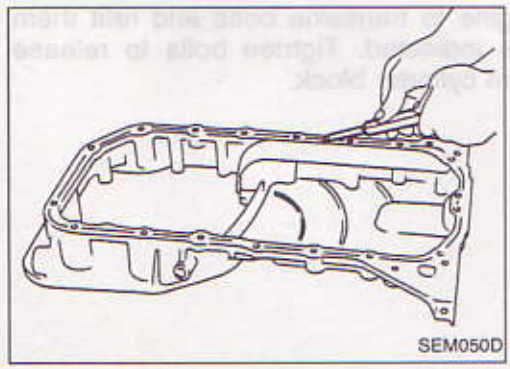
(2) Slide Tool by tapping on the side of the Tool with a hammer.



(3) Set a suitable transmission jack as shown in figure.
(4) Remove engine support member.
(5) Remove aluminum oil pan.



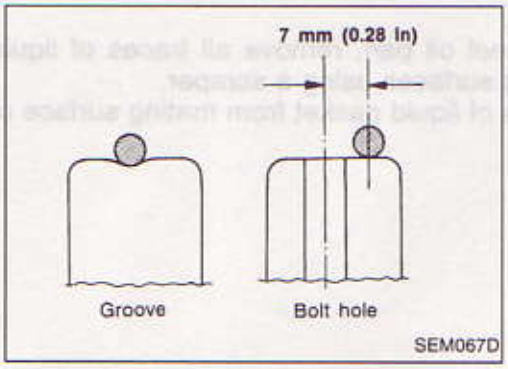
11. Remove the two engine to transmission bolts previously installed in aluminum oil pan.



Installation

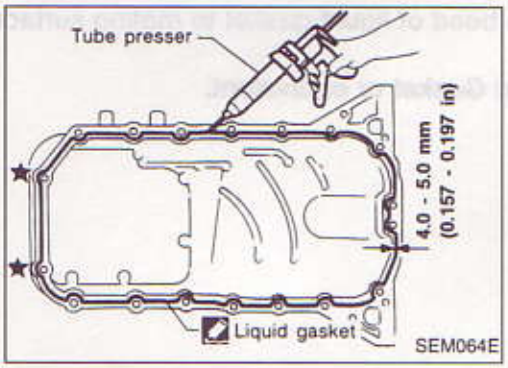
1. Install aluminum oil pan.
(1) Before installing aluminum oil pan, remove all traces of liquid gasket from mating surfaces using a scraper.
- Also remove traces of liquid gasket from mating surface of cylinder block and front cover.

Installation (Cont'd)

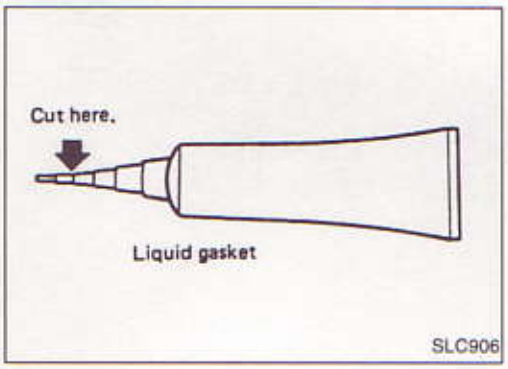


(2) Apply a continuous bead of liquid gasket to mating surface of aluminum oil pan.

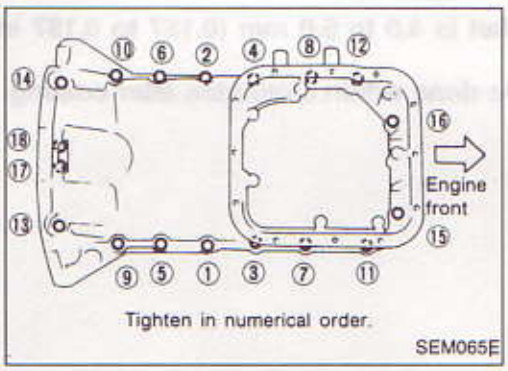
- **Use Genuine Liquid Gasket or equivalent.**



- **For areas marked with "★", apply liquid gasket to the outer side of the bolt hole.**

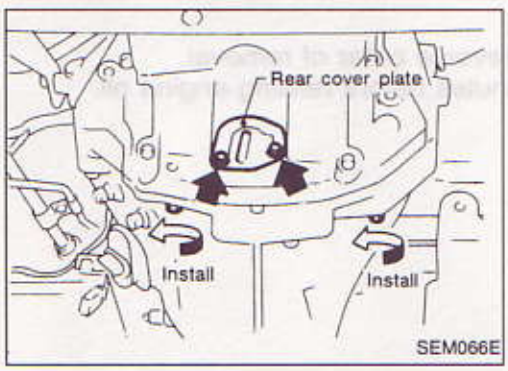


- **Be sure liquid gasket is 4.0 to 5.0 mm (0.157 to 0.197 in) wide.**
- **Attaching should be done within 5 minutes after coating.**



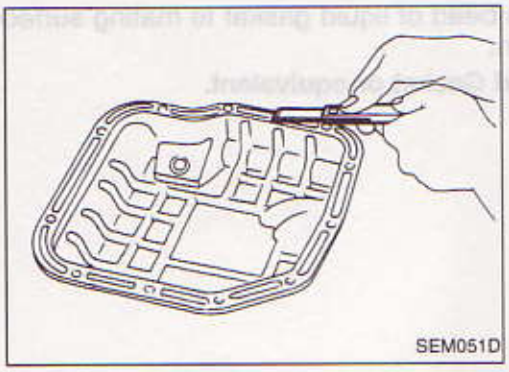
(3) Install aluminum oil pan.
- Install bolts/nuts in the reverse order of removal.

2. Install engine support member.

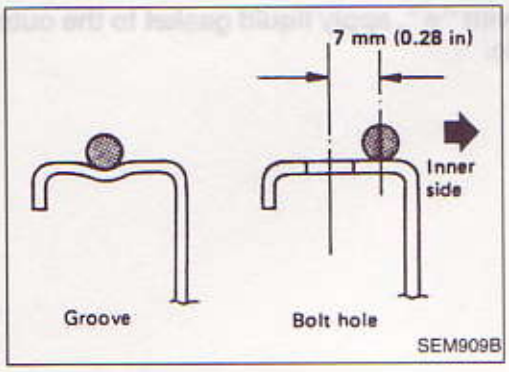


3. Install the two engine to transmission bolts.
4. Install rear cover plate.
5. Install alternator bracket support.
6. Install baffle plate.

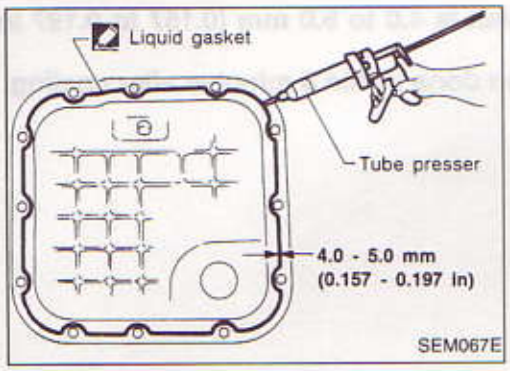
Installation (Cont'd)



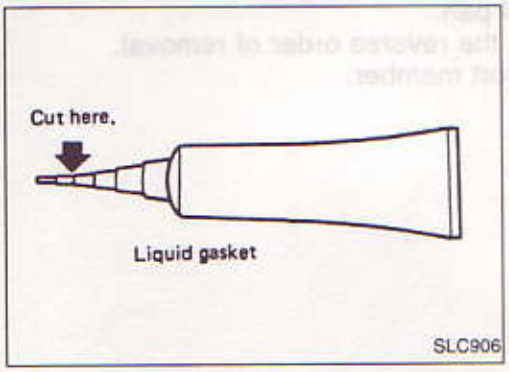
7. Install steel oil pan.
(1) Before installing steel oil pan, remove all traces of liquid gasket from mating surfaces using a scraper.
- Also remove traces of liquid gasket from mating surface of aluminum oil pan.



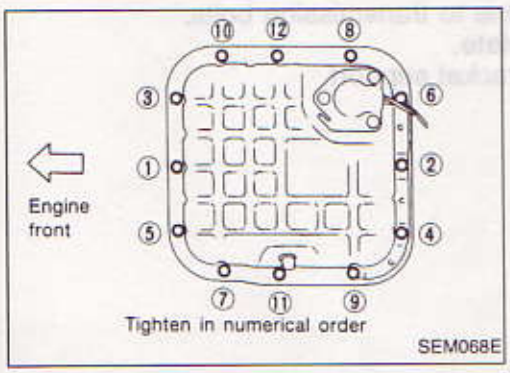
(2) Apply a continuous bead of liquid gasket to mating surface of steel oil pan.
- **Use Genuine Liquid Gasket or equivalent.**

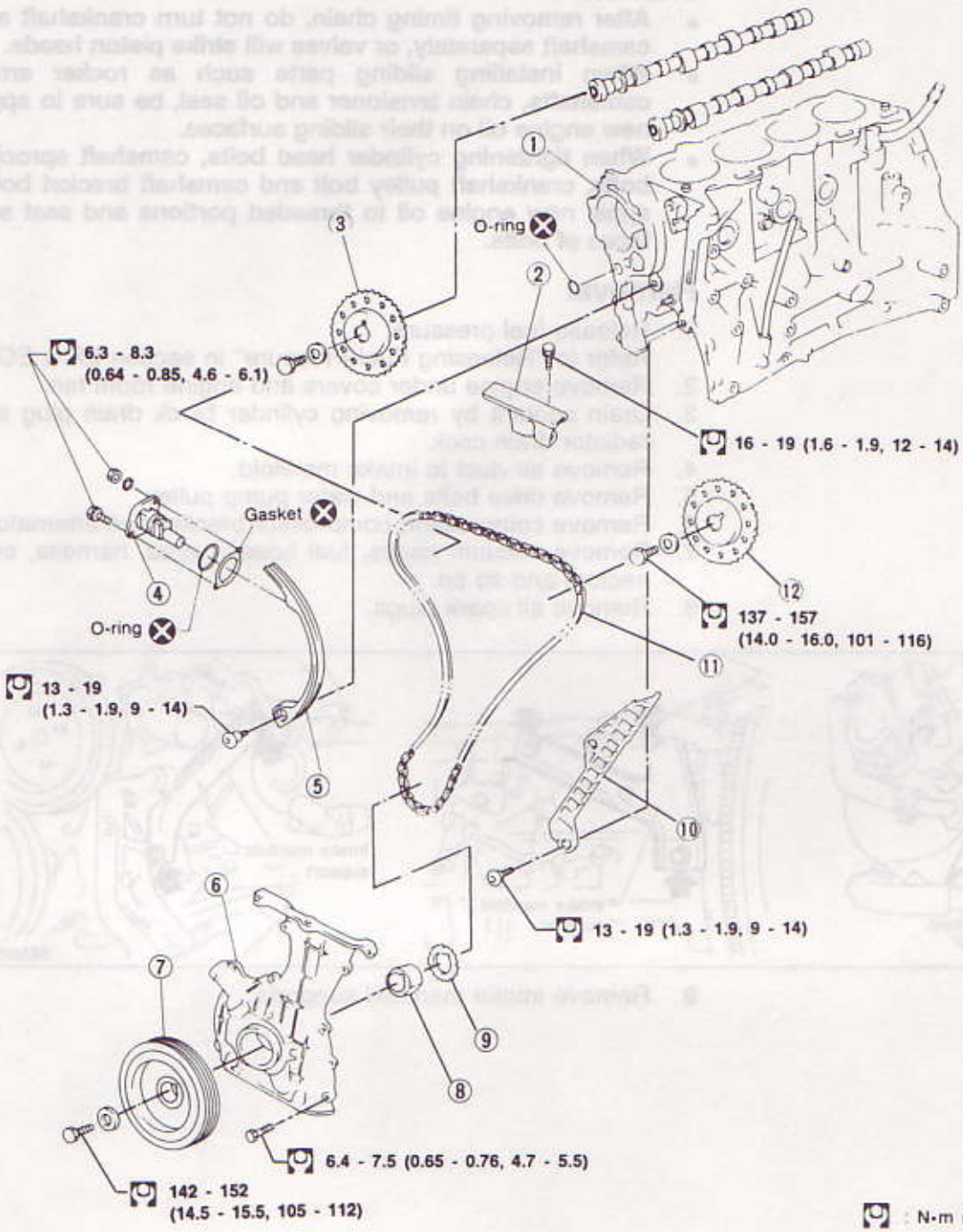


- **Be sure liquid gasket is 4.0 to 5.0 mm (0.157 to 0.197 in) wide.**
- **Attaching should be done within 5 minutes after coating.**



(3) Install steel oil pan.
- Install bolts in the reverse order of removal.
- Wait at least 30 minutes before refilling engine oil.





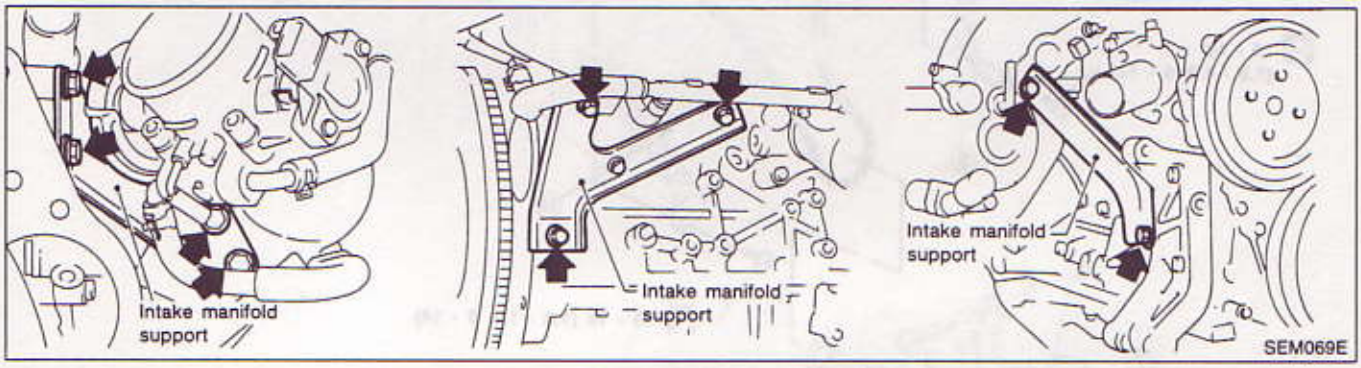
① Cylinder block
② Chain guide
③ R.H. camshaft sprocket
④ Chain tensioner
⑤ Chain guide
⑥ Front cover
⑦ Crank pulley
⑧ Oil pump spacer
⑨ Crankshaft sprocket
⑩ Chain guide
⑪ Timing chain
⑫ L.H. camshaft sprocket

CAUTION:

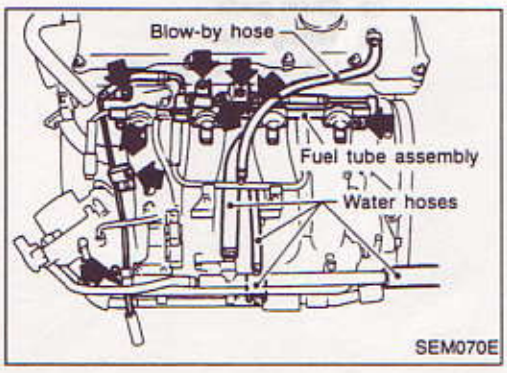
- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing sliding parts such as rocker arms, camshafts, chain tensioner and oil seal, be sure to apply new engine oil on their sliding surfaces.**
- **When tightening cylinder head bolts, camshaft sprocket bolts, crankshaft pulley bolt and camshaft bracket bolts, apply new engine oil to threaded portions and seat surfaces of bolts.**

Removal

1. Release fuel pressure.
   Refer to "Releasing Fuel Pressure" in section EF & EC.
2. Remove engine under covers and engine room fan.
3. Drain coolant by removing cylinder block drain plug and radiator drain cock.
4. Remove air duct to intake manifold.
5. Remove drive belts and water pump pulley.
6. Remove compressor, compressor bracket and alternator.
7. Remove vacuum hoses, fuel hoses, wires, harness, connectors and so on.
8. Remove all spark plugs.

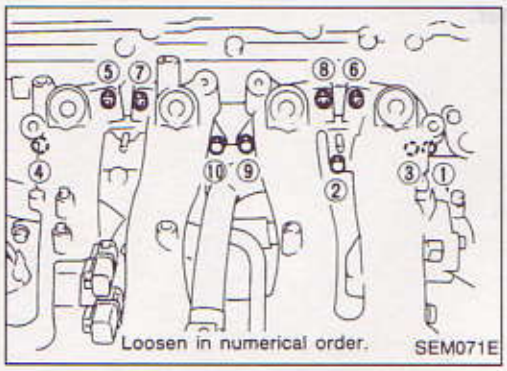


9. Remove intake manifold supports.

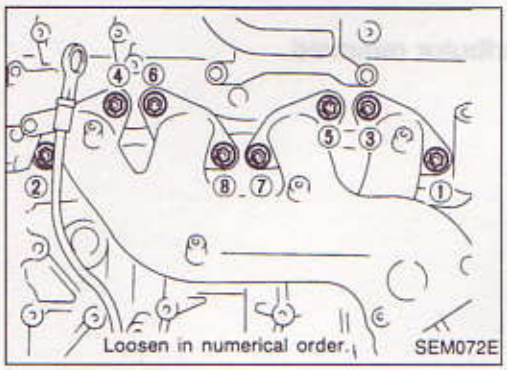


10. Remove blow-by hose.
11. Remove fuel tube assembly.
12. Remove water hoses from intake manifold.

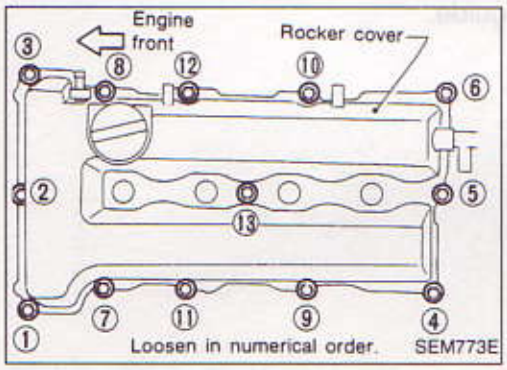
Removal (Cont'd)



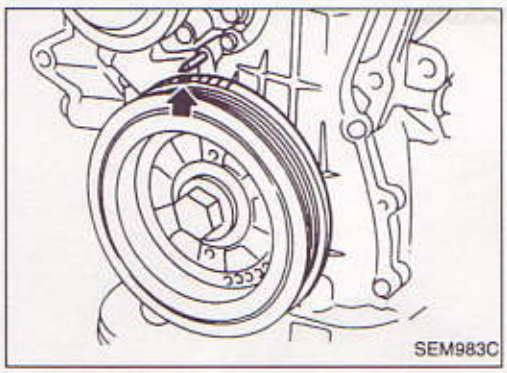
13. Remove intake manifold.



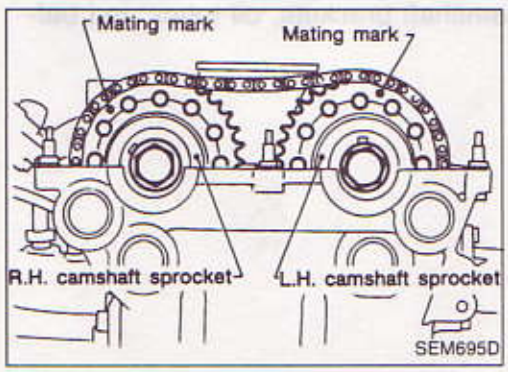
14. Remove oil separator.
15. Remove exhaust manifold cover and exhaust manifold.



16. Remove rocker cover.

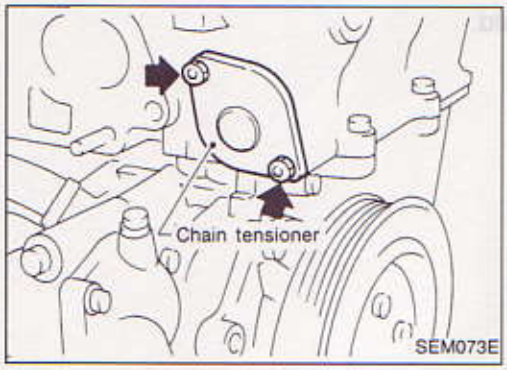


17. Set No. 1 piston at T.D.C. on the compression stroke by rotating crankshaft.

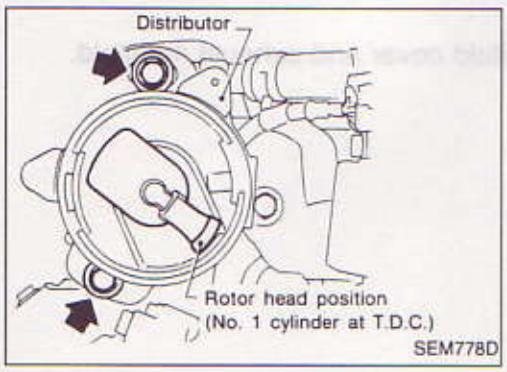


- **Rotate crankshaft until mating mark on camshaft sprocket is set at position indicated in figure at left.**

Removal (Cont'd)

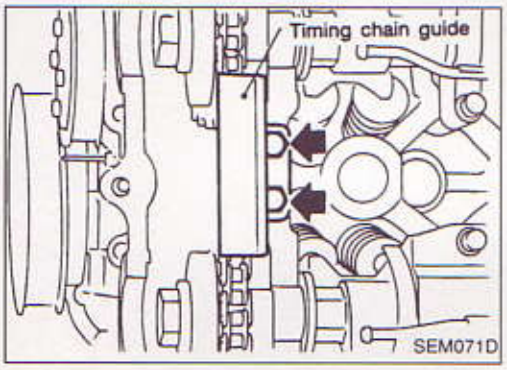


18. Remove chain tensioner.

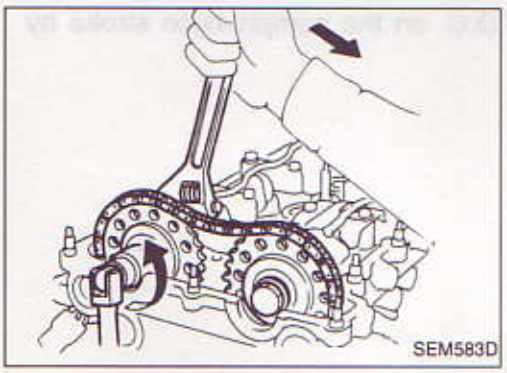


19. Remove distributor.

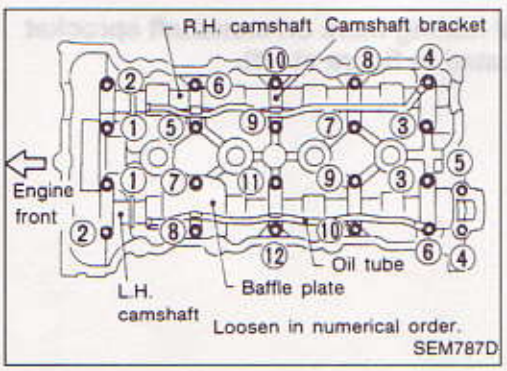
Do not turn rotor with distributor removed.



20. Remove timing chain guide.

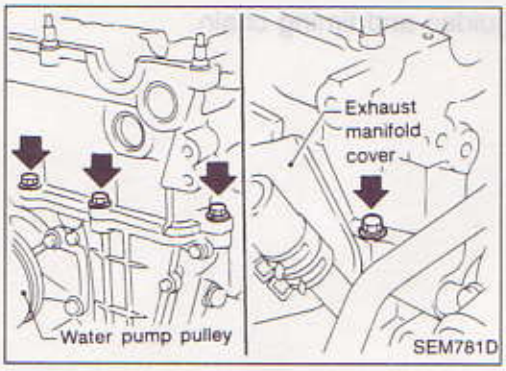


21. Remove camshaft sprockets.

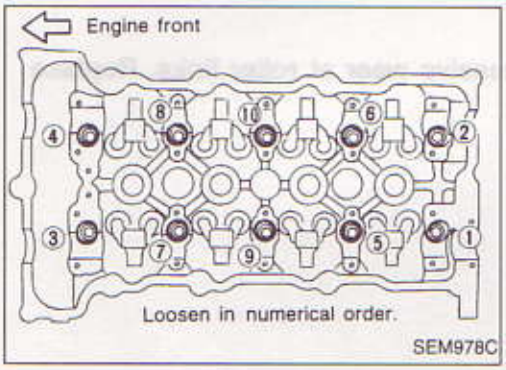


22. Remove camshafts, camshaft brackets, oil tubes and baffle plate.

Removal (Cont'd)

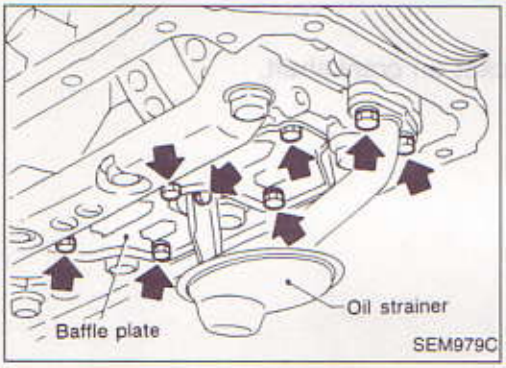


23. Remove cylinder head outside bolts.

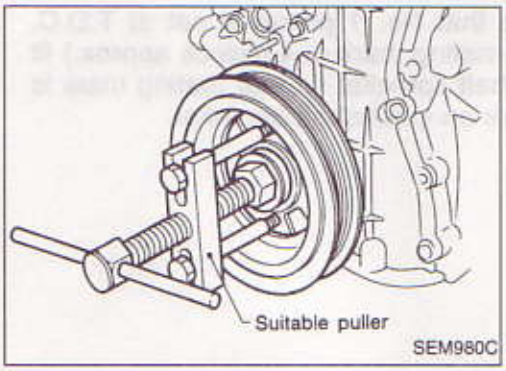


24. Remove cylinder head bolts.
- **Bolts should be loosened in two or three steps.**

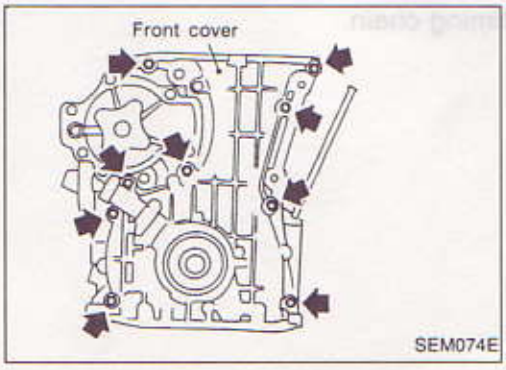
25. Remove cylinder head.
26. Remove oil pans.
Refer to "Removal" in "OIL PAN".



27. Remove oil strainer and baffle plate.



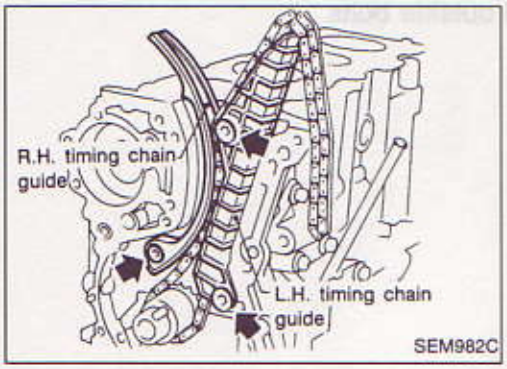
28. Remove crankshaft pulley.



29. Remove front cover.

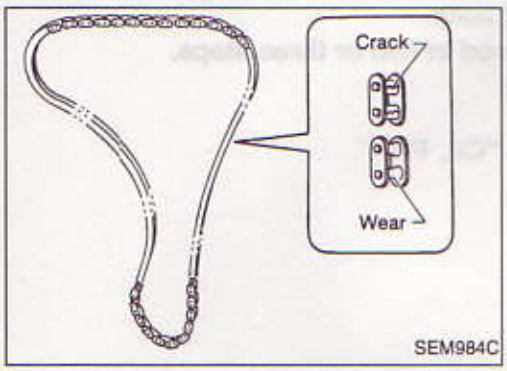
Removal (Cont'd)

30. Remove timing chain guides and timing chain.



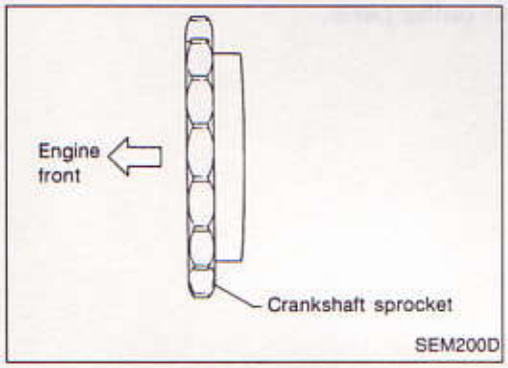
Inspection

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

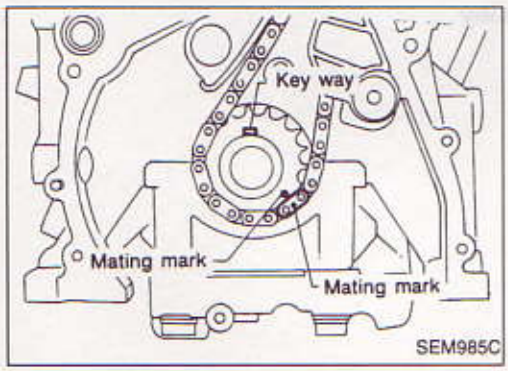


Installation

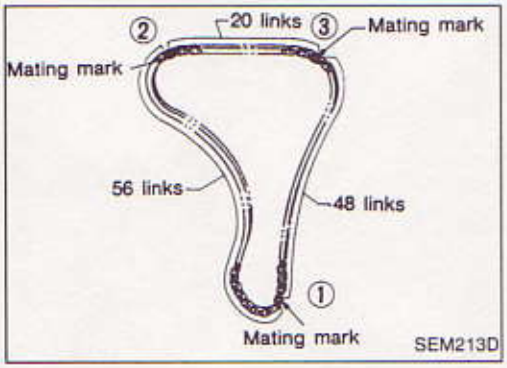
1. Install crankshaft sprocket on crankshaft.



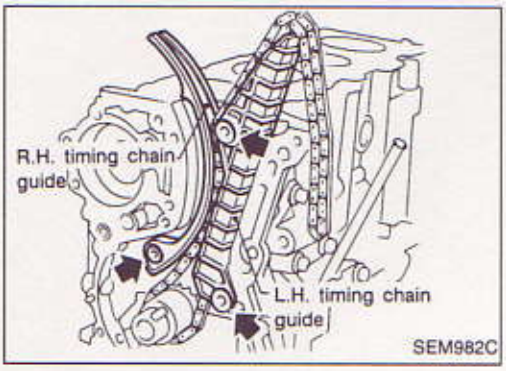
2. Position crankshaft so that No. 1 piston is set at T.D.C. (Keyway at 12 o'clock-mating mark at 4 o'clock approx.) fit timing chain to crankshaft sprocket so that mating mark is in line with mating mark on crankshaft sprocket.



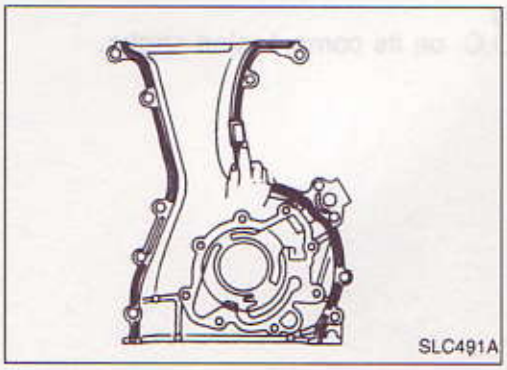
- Mating mark color on timing chain.
  - ① : **Gold**
  - ②, ③ : **Silver**



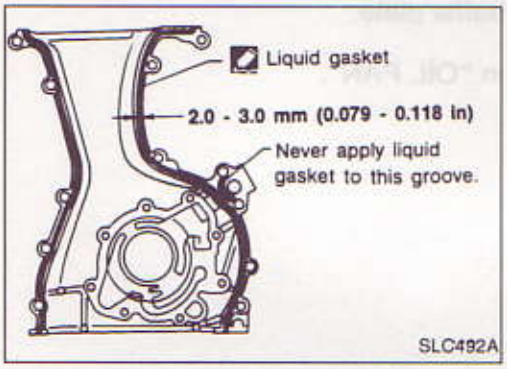
Installation (Cont'd)



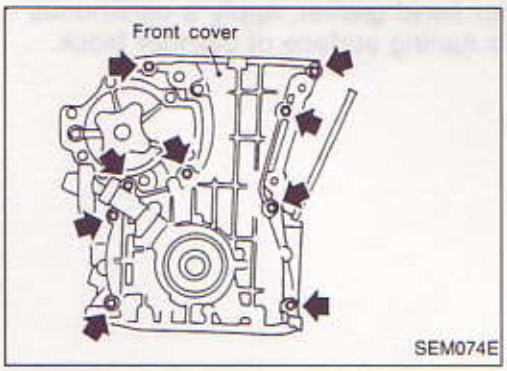
3. Install timing chain and timing chain guides.



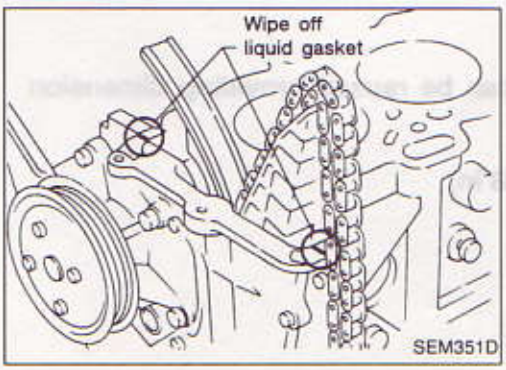
4. Before installing front cover, remove all traces of liquid gasket from mating surface using a scraper.
   - Also remove traces of liquid gasket from mating surface of cylinder block.



5. Apply a continuous bead of liquid gasket to mating surface of front cover.
   - Use Genuine Liquid Gasket or equivalent.

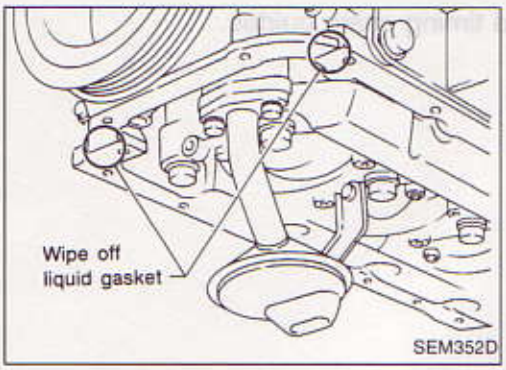


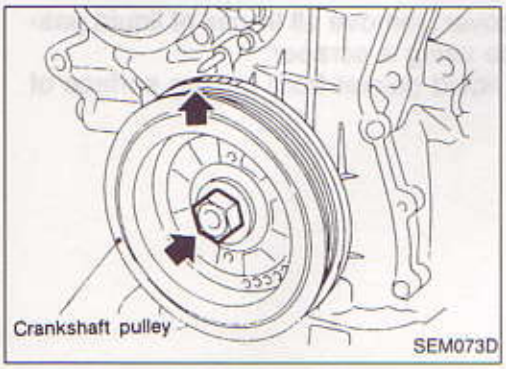
6. Install oil pump drive spacer and front cover.



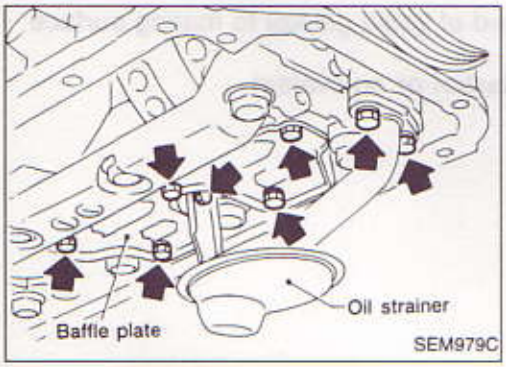
- Wipe off excessive liquid gasket.

Installation (Cont'd)

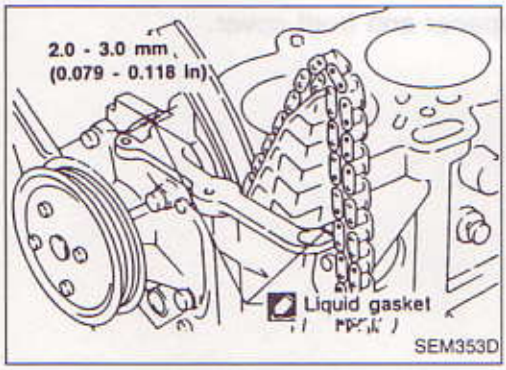




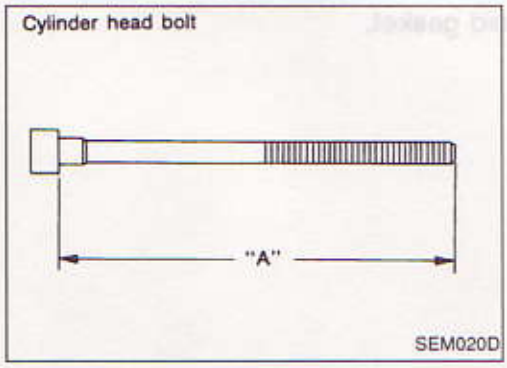
7. Install crankshaft pulley.
8. Set No. 1 piston at T.D.C. on its compression stroke.



9. Install oil strainer and baffle plate.
10. Install oil pan.
    Refer to "Installation" in "OIL PAN".



11. Before installing cylinder head gasket, apply a continuous bead of liquid gasket to mating surface of cylinder block.



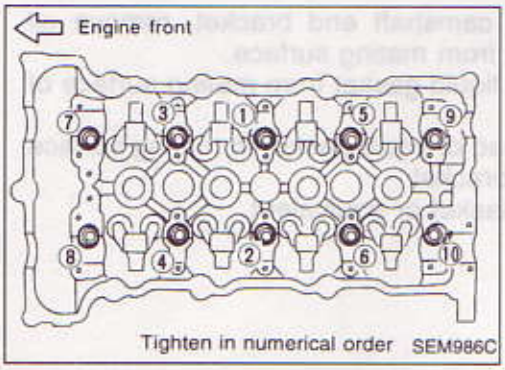
12. Install cylinder head.

CAUTION:

The cylinder head bolts can be reused providing dimension "A" is not exceeded.

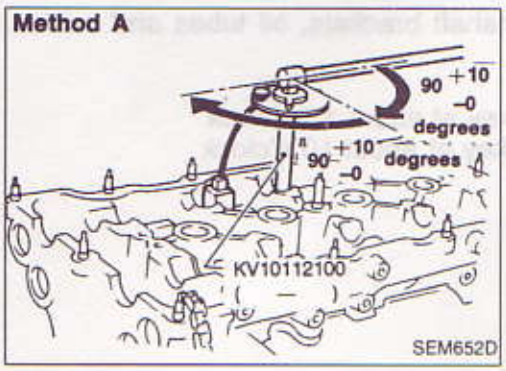
Dimension "A":
158.2 mm (6.228 in)

Installation (Cont'd)



- **Tightening procedure:**

ⓐ **Tighten all bolts to 39 N·m (4.0 kg-m, 29 ft-lb).**
ⓑ **Tighten all bolts to 78 N·m (8.0 kg-m, 58 ft-lb).**
ⓒ **Loosen all bolts completely.**
ⓓ **Tighten all bolts to 34 to 44 N·m (3.5 to 4.5 kg-m, 25 to 33 ft-lb).**

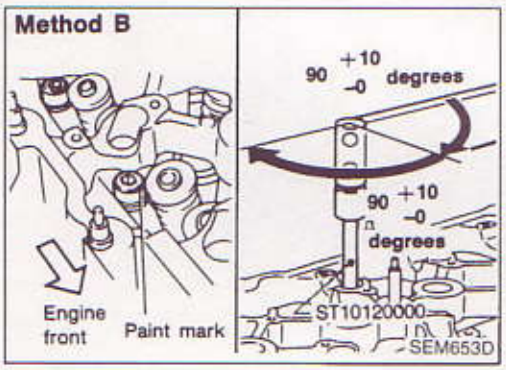


ⓔ **Method A:** Turn all bolts 90 to 100 degrees clockwise with Tool or suitable angle wrench.

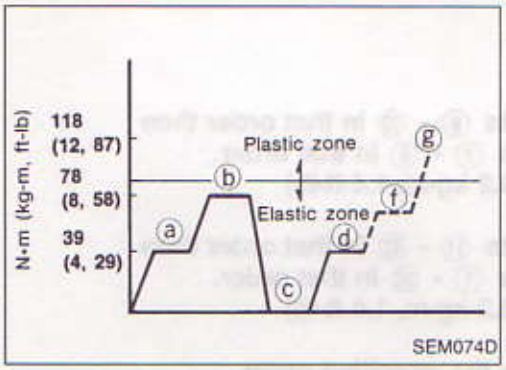
Method B: If angle wrench is not available, mark the side of each cylinder head bolt with a paint mark facing the front of the engine, then turn all bolts 90 to 100 degrees clockwise.

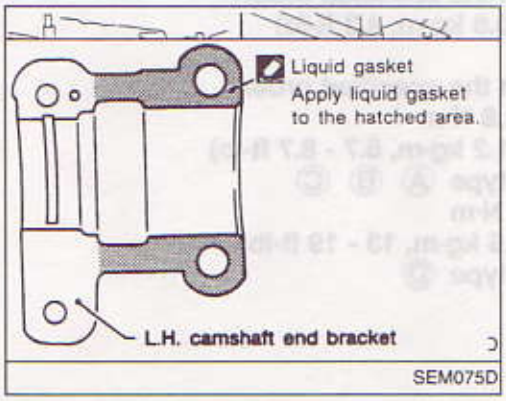
ⓕ **Turn all bolts 90 to 100 degrees clockwise.**
ⓖ **Ensure that paint mark on each bolt faces the rear of the engine. (Method B only)**

Do not turn any bolt 180 to 200 degrees clockwise all at once.



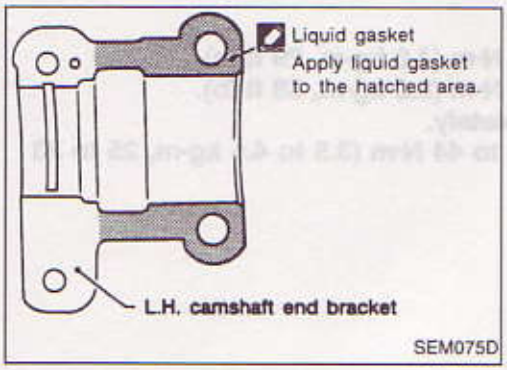
	Tightening torque N·m (kg-m, ft-lb)
ⓐ	39 (4.0, 29)
ⓑ	78 (8.0, 58)
ⓒ	0 (0, 0)
ⓓ	39 ± 5 (4.0 ± 0.5, 28.9 ± 3.6)
ⓔ	90 $^{+10}_{-0}$ degrees
ⓕ	90 $^{+10}_{-0}$ degrees





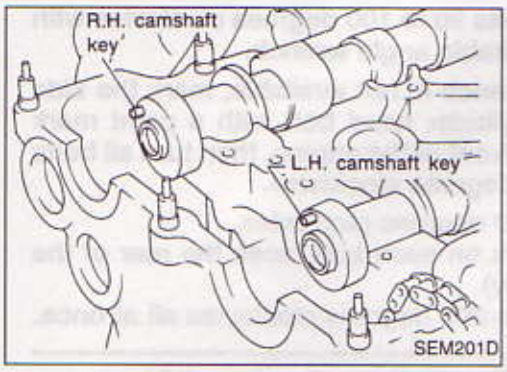
13. Install cylinder head outside bolts.

Installation (Cont'd)

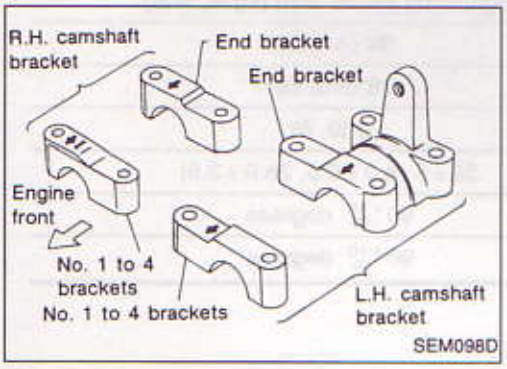


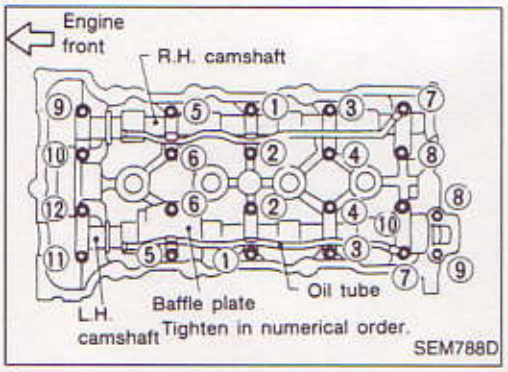
14. Before installing L.H. camshaft end bracket, remove all traces of liquid gasket from mating surface.
- Also remove traces of liquid gasket from mating surface of cylinder head.

15. Apply a continuous bead of liquid gasket to mating surface of L.H. camshaft end bracket.
- Use Genuine Liquid Gasket or equivalent.



16. Install camshafts, camshaft brackets, oil tubes and baffle plate.
- Position camshaft.
  - L.H. camshaft key at about 12 o'clock
  - R.H. camshaft key at about 10 o'clock





- **Tightening procedure**

STEP 1:

R.H. camshaft

Tighten bolts ⑨ - ⑩ in that order then tighten bolts ① - ⑧ in that order.

: 2 N·m (0.2 kg-m, 1.4 ft-lb)

L.H. camshaft

Tighten bolts ⑪ - ⑫ in that order then tighten bolts ① - ⑩ in that order.

: 2 N·m (0.2 kg-m, 1.4 ft-lb)

STEP 2:

Tighten bolts in the specified order.

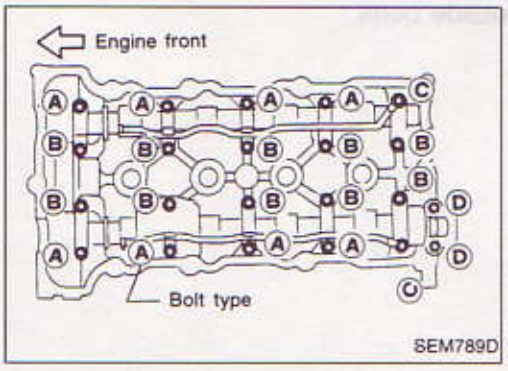
: 6 N·m (0.6 kg-m, 4.3 ft-lb)

STEP 3:

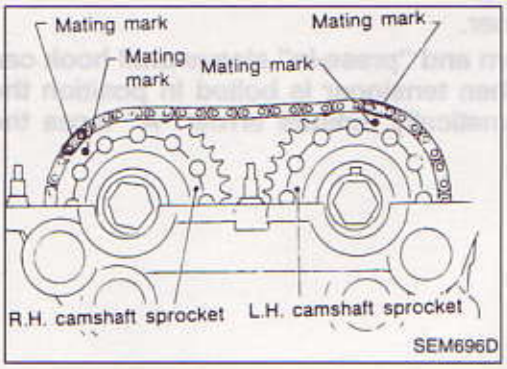
Tighten bolts in the specified order.

: 9.0 - 11.8 N·m (0.92 - 1.2 kg-m, 6.7 - 8.7 ft-lb) ... Bolt type Ⓐ Ⓑ Ⓒ

: 18 - 25 N·m (1.8 - 2.6 kg-m, 13 - 19 ft-lb) ... Bolt type Ⓓ

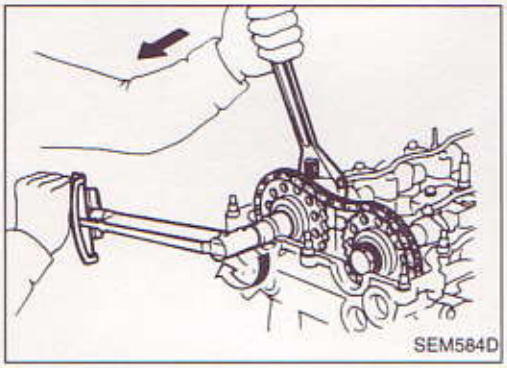


Installation (Cont'd)



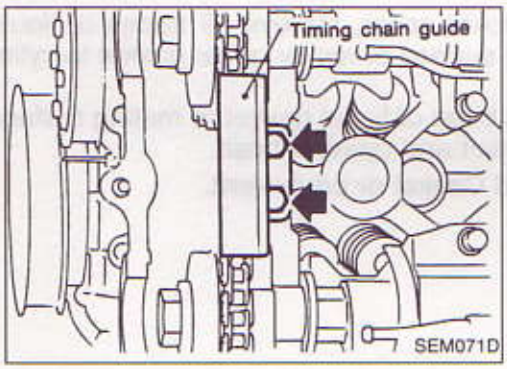
17. Install camshaft sprockets.

Line up mating marks on timing chain with mating marks on camshaft sprockets.

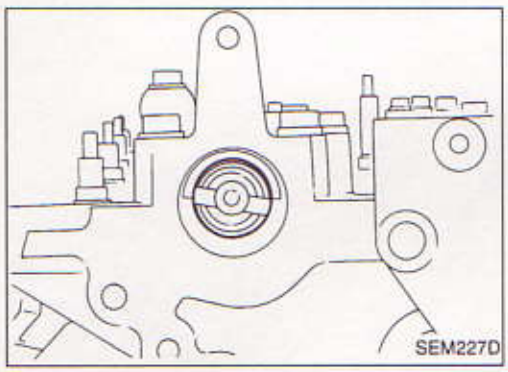


- Lock camshafts as shown in figure and tighten to specified torque.

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

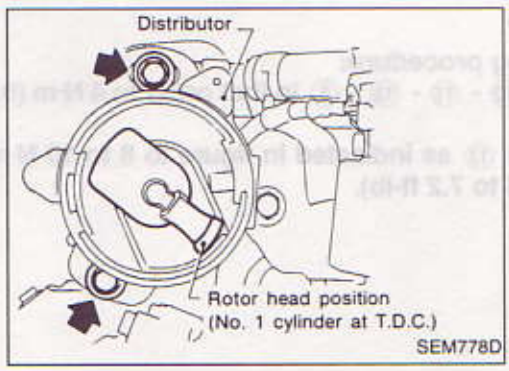


18. Install timing chain guide.



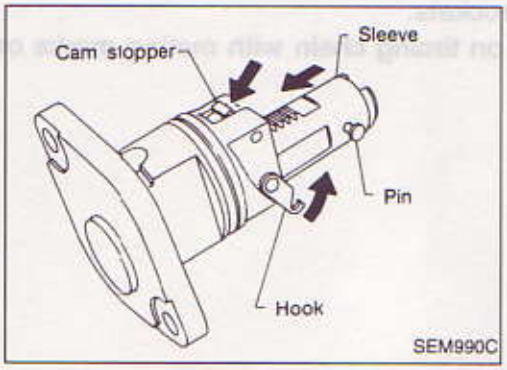
19. Install distributor.

- **Make sure that position of camshaft is as shown in figure.**



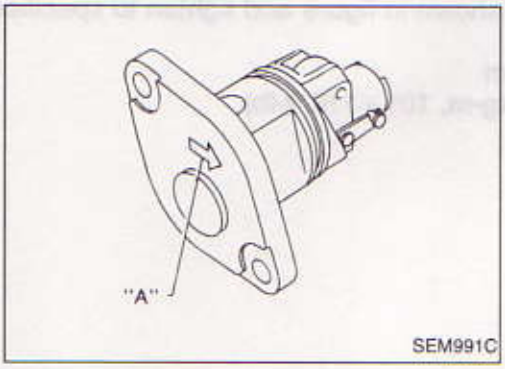
- **After installing, confirm that distributor rotor head is set as shown in figure.**

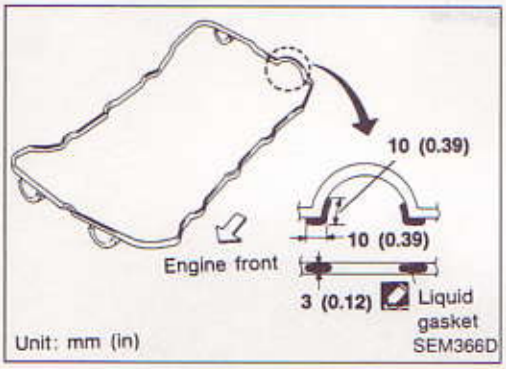
Installation (Cont'd)



20. Install chain tensioner.

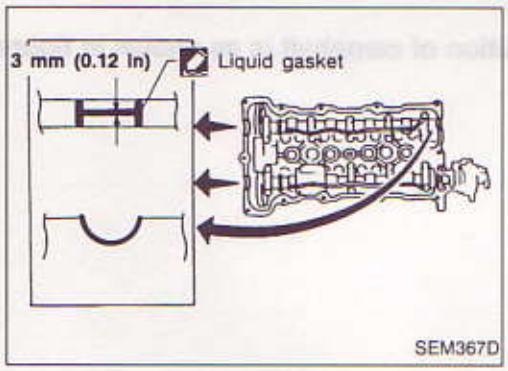
Press cam stopper down and "press-in" sleeve until hook can be engaged on pin. When tensioner is bolted in position the hook will release automatically. Ensure arrow "A" faces the front of the engine.

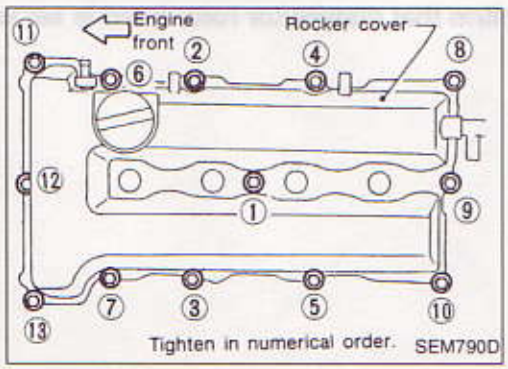




21. Before installing rocker cover, remove all traces of liquid gasket from mating surface of rocker cover gasket to cylinder head.
22. Apply a continuous bead of liquid gasket to mating surface of rocker cover gasket and cylinder head.

- **Use Genuine Liquid Gasket or equivalent.**





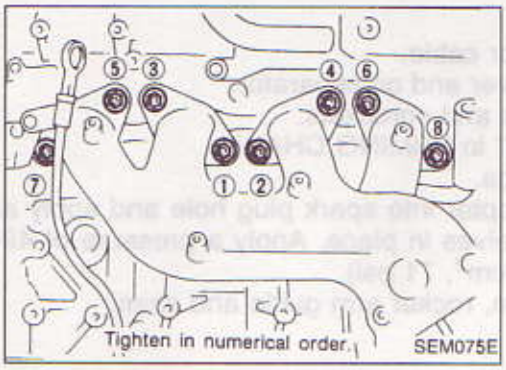
23. Install rocker cover.

Rocker cover tightening procedure:

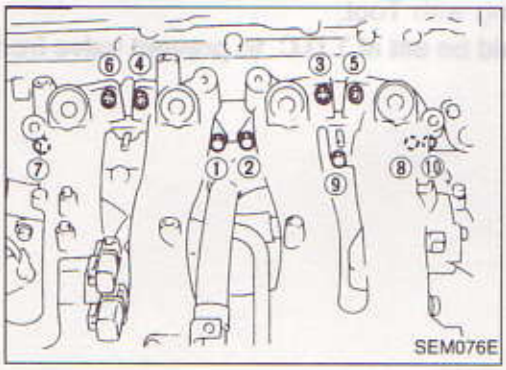
(1) Tighten nuts ① - ⑩ - ⑪ - ⑬ - ⑧ in that order to 4 N·m (0.4 kg-m, 2.9 ft-lb).

(2) Tighten nuts ① to ⑬ as indicated in figure to 8 to 10 N·m (0.8 to 1.0 kg-m, 5.8 to 7.2 ft-lb).

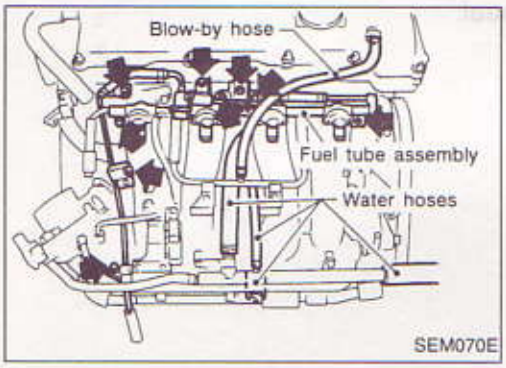
Installation (Cont'd)



24. Install exhaust manifold and exhaust manifold cover.
25. Install oil separator.

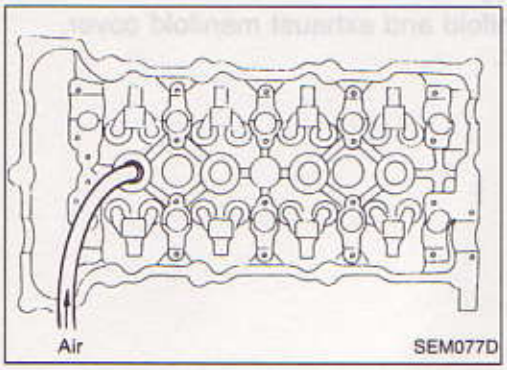


26. Install intake manifold.



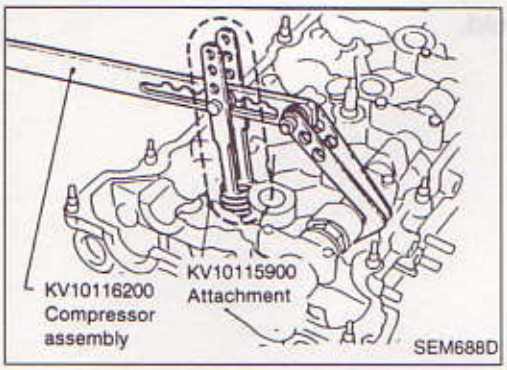
27. Install water hoses.
28. Install fuel tube assembly.
29. Install blow-by hose.

30. Refit spark plugs and leads.
31. Install vacuum hoses, fuel hoses, wires, harness, connectors and so on.
32. Install alternator, compressor and compressor bracket.
33. Install water pump pulley and drive belts.
34. Refit air duct to intake manifold.
35. Install engine room fan.
36. Install radiator and refill with coolant. Refer to MA section.
37. Install engine under covers.



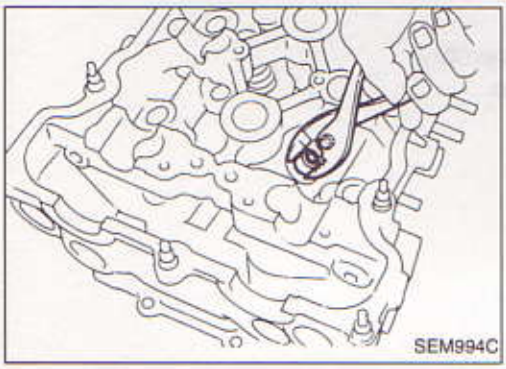
VALVE OIL SEAL

1. Remove accelerator cable.
2. Remove rocker cover and oil separator.
3. Remove camshafts and sprockets.
   Refer to "Removal" in "TIMING CHAIN".
4. Remove spark plugs.
5. Install air hose adapter into spark plug hole and apply air pressure to hold valves in place. Apply a pressure of 490 kPa (4.9 bar, 5 kg/cm^2, 71 psi).
6. Remove rocker arm, rocker arm guide and shim.

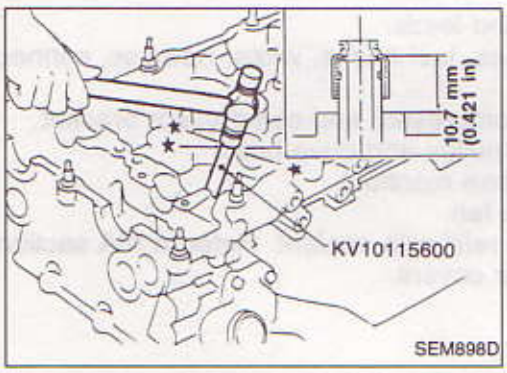


7. Remove valve spring with Tool.

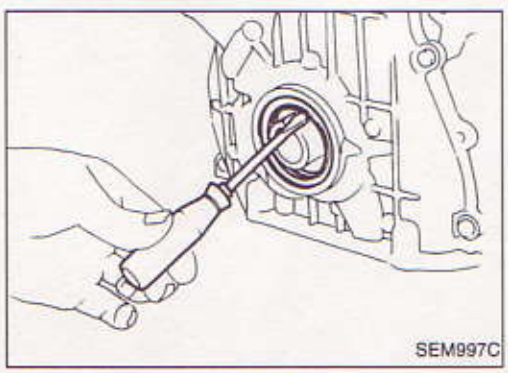
Piston concerned should be set at T.D.C. to prevent valve from falling.



8. Remove valve oil seal.



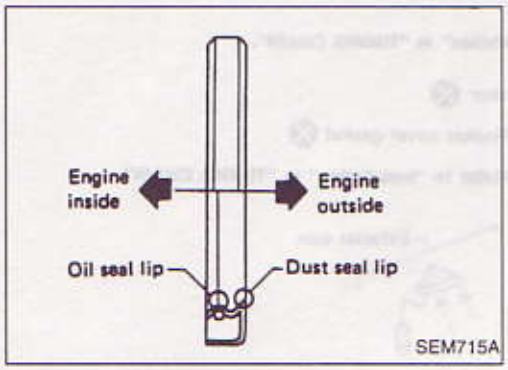
9. Apply engine oil to new valve oil seal and install it with Tool.

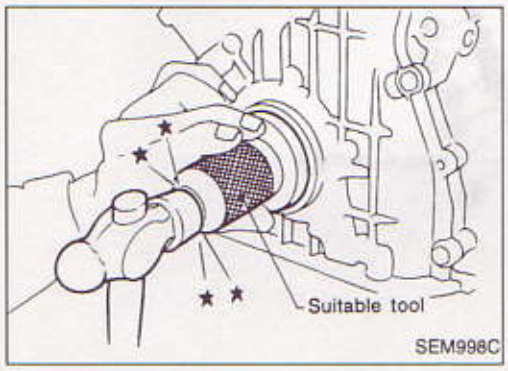


FRONT OIL SEAL

1. Remove the following parts:
   - Engine under cover
   - Front R.H. wheel and engine side cover
   - Drive belts
   - Crankshaft pulley
2. Remove front oil seal.

Be careful not to scratch front cover.



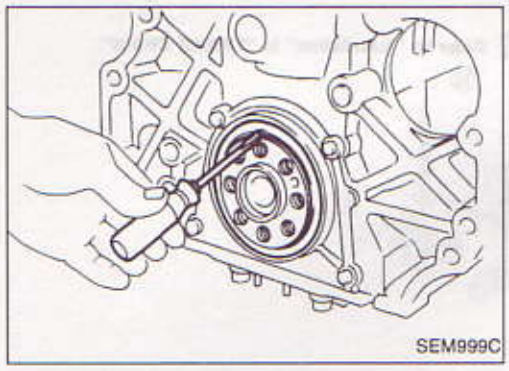


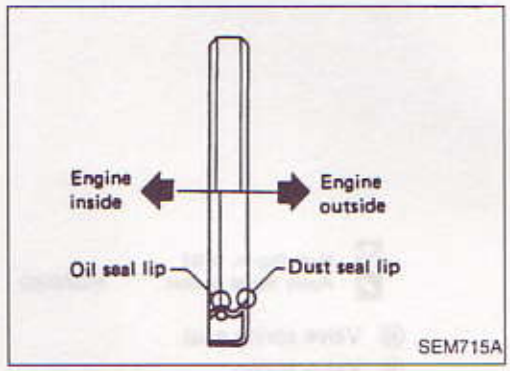
3. Apply engine oil to new oil seal and install it using a suitable tool.

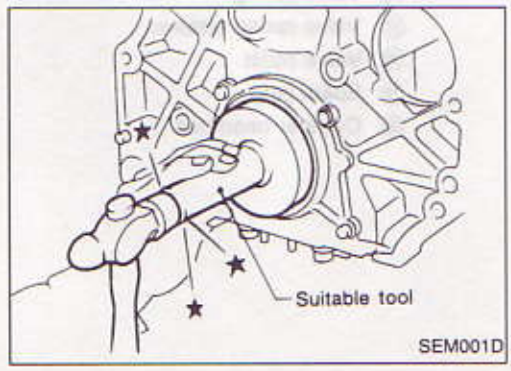
REAR OIL SEAL

1. Remove transmission. (Refer to MT section.)
2. Remove flywheel or drive plate.
3. Remove rear oil seal.

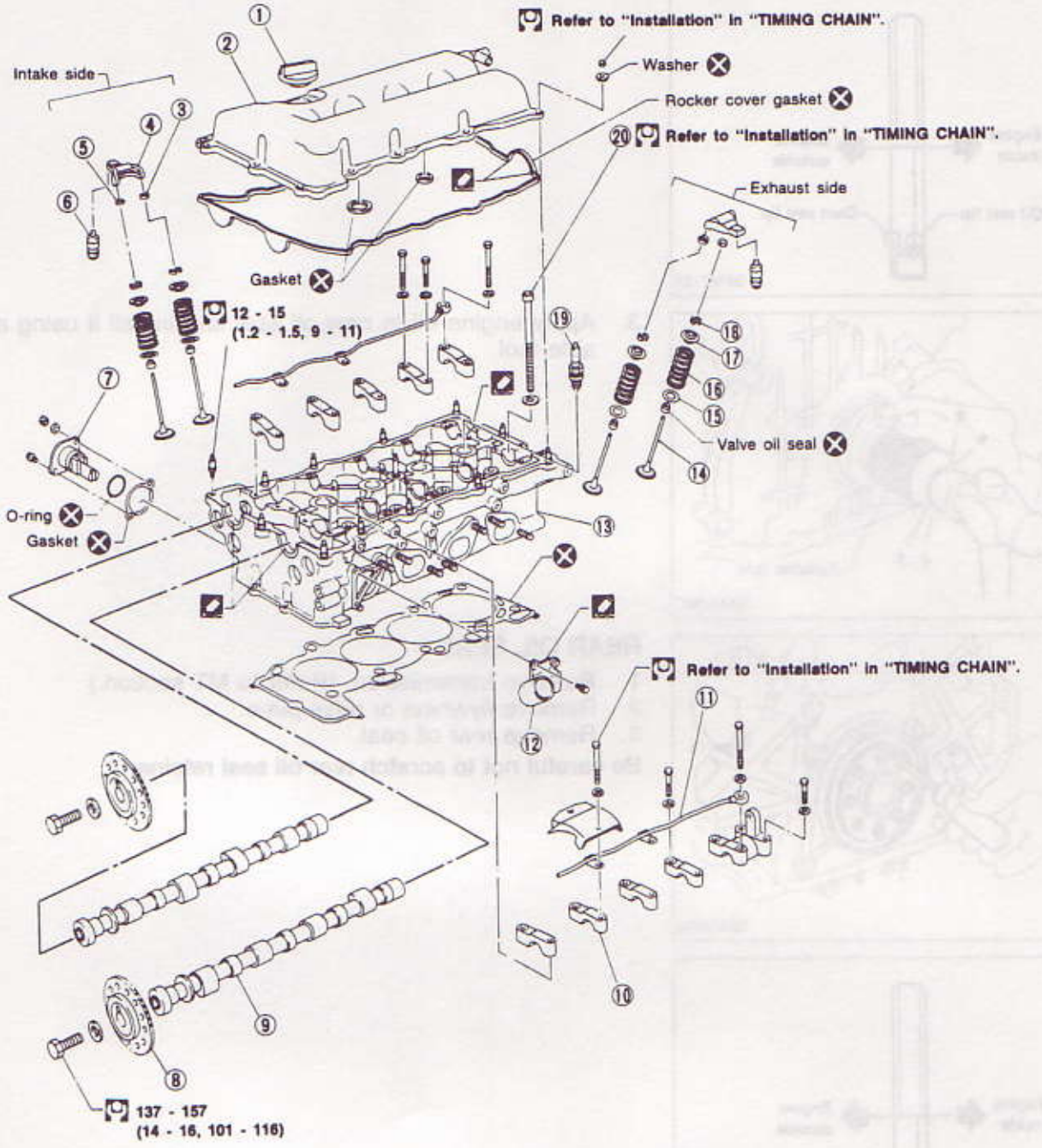
Be careful not to scratch rear oil seal retainer.







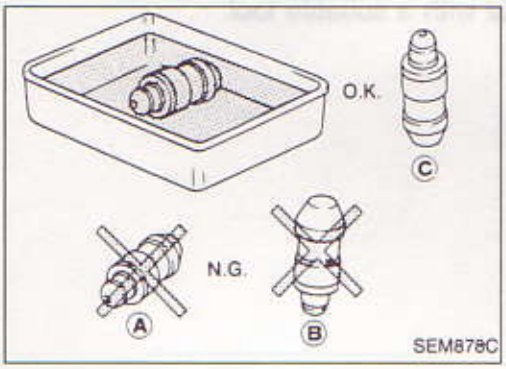
4. Apply engine oil to new oil seal and install it using a suitable tool.



① Oil filler cap
② Rocker cover
③ Rocker arm guide
④ Rocker arm
⑤ Shim
⑥ Hydraulic lash adjuster
⑦ Chain tensioner
⑧ Camshaft sprocket
⑨ Camshaft
⑩ Camshaft bracket
⑪ Oil tube
⑫ Water outlet
⑬ Cylinder head
⑭ Valve
⑮ Valve spring seat
⑯ Valve spring
⑰ Valve spring retainer
⑱ Valve collet
⑲ Spark plug
⑳ Cylinder head bolt

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, camshaft sprocket bolts and camshaft bracket bolts, apply new engine oil to thread portions and seat surfaces of bolts.**

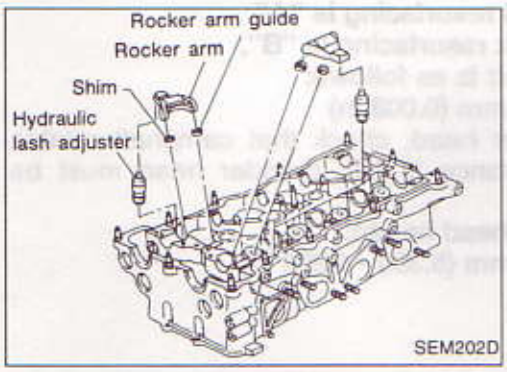


- **If a hydraulic lash adjuster is kept on its side, there is a risk of air entering it. After removal, always set hydraulic lash adjuster straight up, or when laying it on its side, have it soak in new engine oil.**
- **Do not disassemble hydraulic lash adjusters.**
- **Attach tags to lash adjusters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

Removal

- This removal is the same procedure as those for timing chain. Refer o "Removal" in "TIMING CHAIN".

The removal of cylinder head and timing chain has already been explained in chapter "Removal" in "TIMING CHAIN". Refer to this chapter for removal.

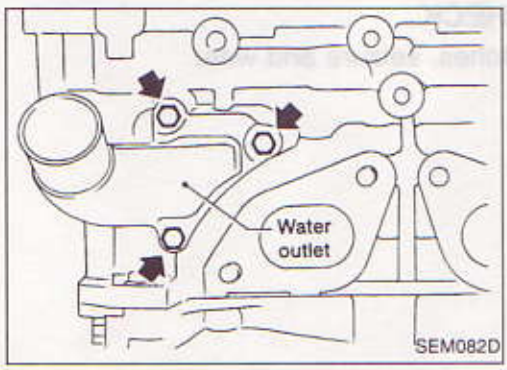


Disassembly

1. Remove rocker arms, shims, rocker arm guides and hydraulic lash adjusters from cylinder head.

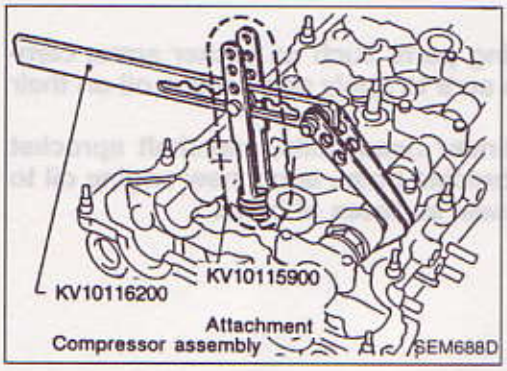
CAUTION:

Keep parts in order so that they can be installed in their original positions during assembly. (Install parts in their original positions.)



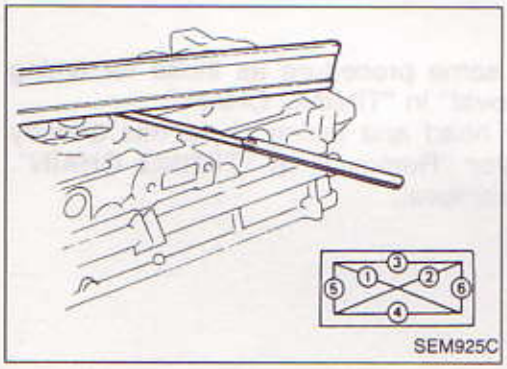
2. Remove water outlet.

Disassembly (Cont'd)



3. Remove valve components with Tool.

4. Remove valve oil seal with a suitable tool.



Inspection

CYLINDER HEAD DISTORTION

Head surface flatness:

Standard

Less than 0.03 mm (0.0012 in)

Limit

0.1 mm (0.004 in)

If beyond the specified limit, replace or resurface.

Resurfacing limit:

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

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

A + B = 0.2 mm (0.008 in)

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

Nominal cylinder head height:

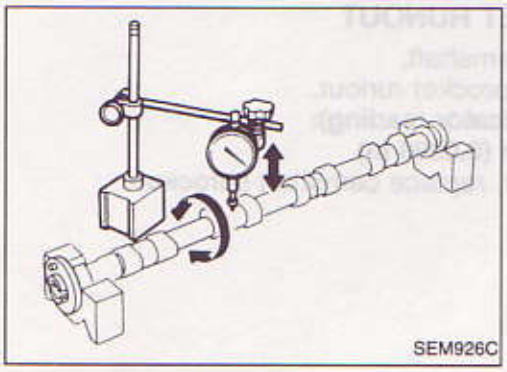
136.9 - 137.1 mm (5.390 - 5.398 in)

CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.

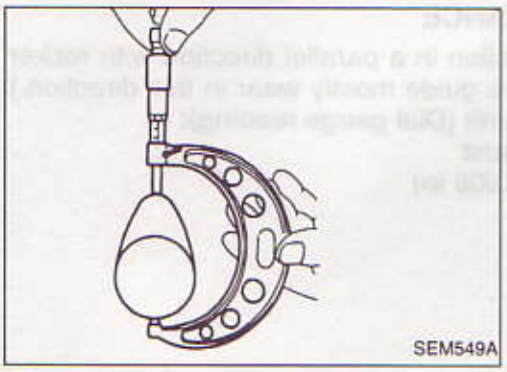
Inspection (Cont'd)

CAMSHAFT RUNOUT


SEM926C

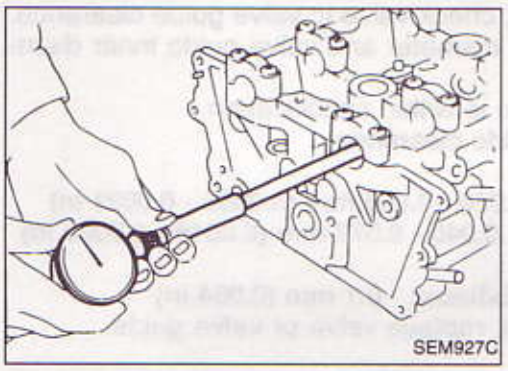
1. Measure camshaft runout at the center journal.
   Runout (Total indicator reading):
   Standard
   Less than 0.02 mm (0.0008 in)
   Limit
   0.1 mm (0.004 in)
2. If it exceeds the limit, replace camshaft.

CAMSHAFT CAM HEIGHT

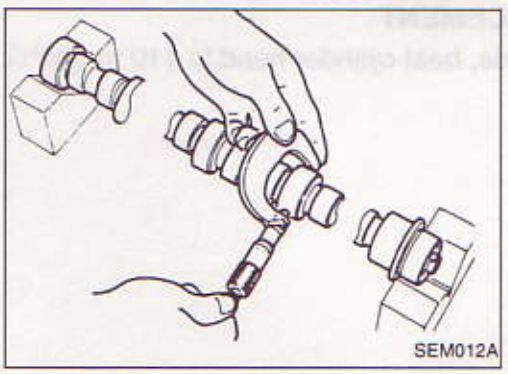

SEM549A

1. Measure camshaft cam height.
   Standard cam height:
   Intake
   37.550 - 37.740 mm (1.4783 - 1.4858 in)
   Exhaust
   37.920 - 38.110 mm (1.4929 - 1.5004 in)
   Cam wear limit:
   Intake & Exhaust
   0.2 mm (0.008 in)
2. If wear is beyond the limit, replace camshaft.

CAMSHAFT JOURNAL CLEARANCE

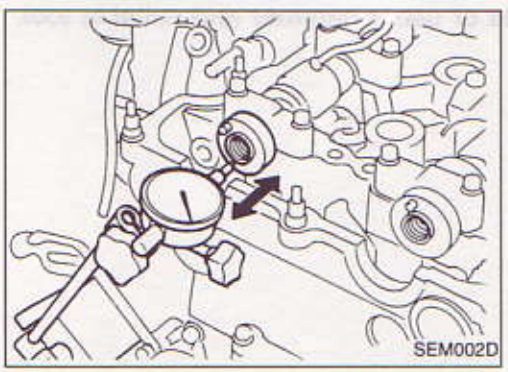

SEM927C

1. Install camshaft bracket and tighten bolts to the specified torque.
2. Measure inner diameter of camshaft bearing.
   Standard inner diameter:
   28.000 - 28.021 mm (1.1024 - 1.1032 in)


SEM012A

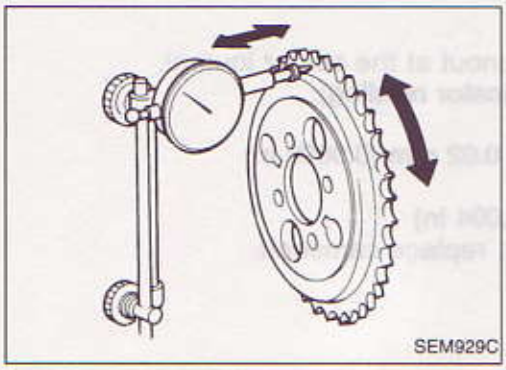
3. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   27.935 - 27.955 mm (1.0998 - 1.1006 in)
4. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance:
   Standard
   0.045 - 0.086 mm (0.0018 - 0.0034 in)
   Limit
   0.12 mm (0.0047 in)

CAMSHAFT END PLAY


SEM002D

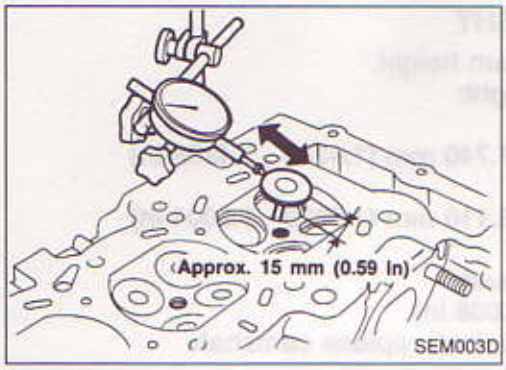
1. Install camshaft in cylinder head.
2. Measure camshaft end play.
   Camshaft end play:
   Standard
   0.055 - 0.139 mm (0.0022 - 0.0055 in)
   Limit
   0.20 mm (0.0079 in)

Inspection (Cont'd)


SEM929C

CAMSHAFT SPROCKET RUNOUT

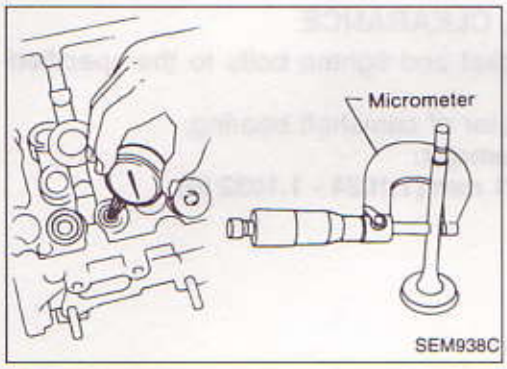
1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.
   Runout (Total indicator reading):
   Limit 0.25 mm (0.0098 in)
3. If it exceeds the limit, replace camshaft sprocket.



SEM003D

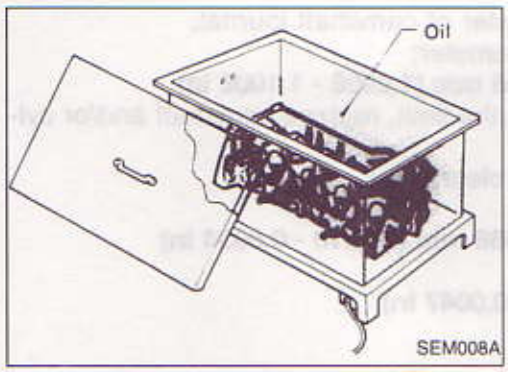
VALVE GUIDE CLEARANCE

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):
   Intake & Exhaust
   0.2 mm (0.008 in)



SEM938C

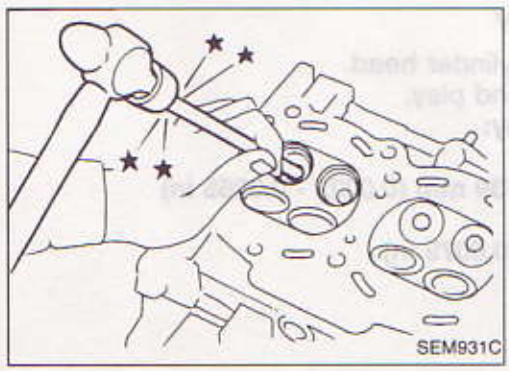
2. If it exceeds the limit, check valve to valve guide clearance.
   a. Measure valve stem diameter and valve guide inner diameter.
   b. Check that clearance is within specification.
      Valve to valve guide clearance:
      Standard
      Intake 0.020 - 0.053 mm (0.0008 - 0.0021 in)
      Exhaust 0.040 - 0.073 mm (0.0016 - 0.0029 in)
      Limit
      Intake & Exhaust 0.1 mm (0.004 in)
   c. If it exceeds the limit, replace valve or valve guide.



SEM008A

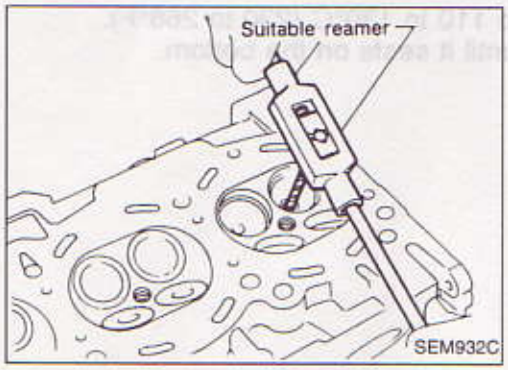
VALVE GUIDE REPLACEMENT

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

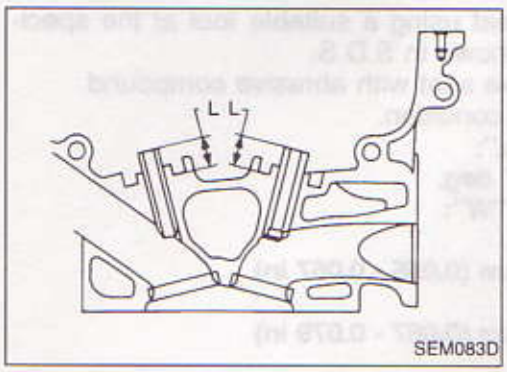

SEM931C

2. Press out valve guide or use a hammer and suitable tool.

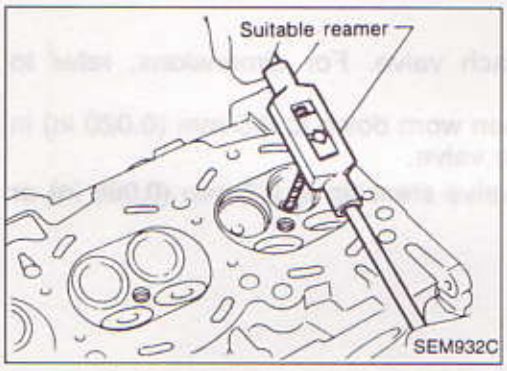
Inspection (Cont'd)



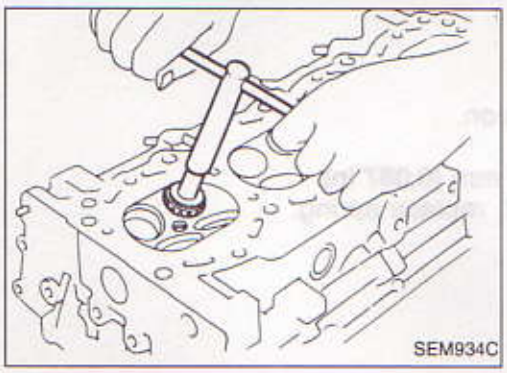
3. Ream cylinder head valve guide hole.
   Valve guide hole diameter
   (for service parts):
   Intake & Exhaust
   10.175 - 10.196 mm (0.4006 - 0.4014 in)



4. Heat cylinder head to 110 to 130°C (230 to 266°F) and press service valve guide onto cylinder head.
   Projection "L":
   14.0 - 14.2 mm (0.551 - 0.559 in)



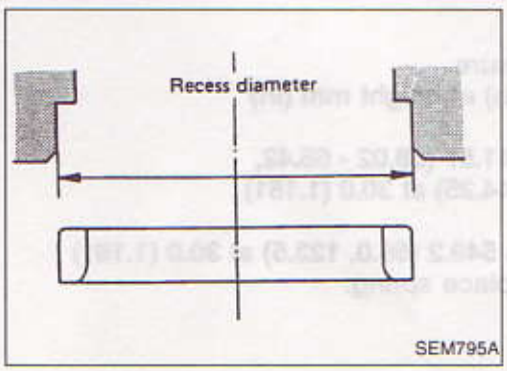
5. Ream valve guide.
   Valve guide inner diameter:
   Intake & Exhaust
   6.000 - 6.018 mm (0.2362 - 0.2369 in)



VALVE SEATS

Check valve seats for any evidence of pitting at valve contact surface, and reset 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.**

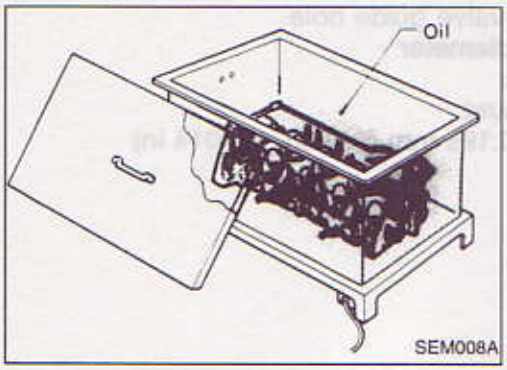


REPLACING VALVE SEAT FOR SERVICE PARTS

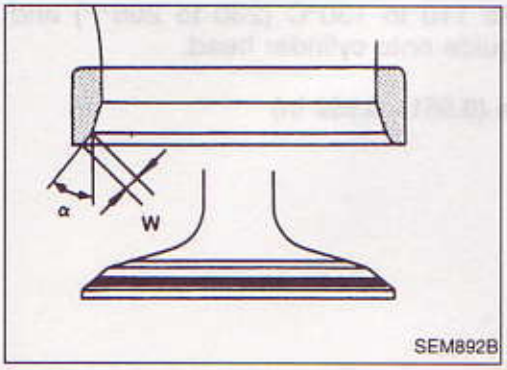
1. Bore out old seat until it collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the eat recess in cylinder head.
2. Ream cylinder head recess.
   Reaming bore for service valve seat
   Oversize [0.5 mm (0.020 in)]:
   Intake 35.500 - 35.516 mm (1.3976 - 1.3983 in)
   Exhaust 31.500 - 31.516 mm (1.2402 - 1.2408 in)

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

Inspection (Cont'd)

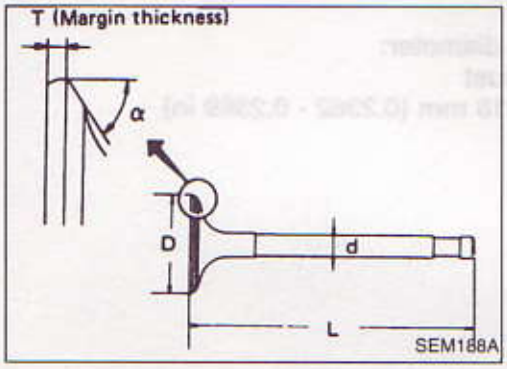


3. Heat cylinder head to 110 to 130°C (230 to 266°F).
4. Press fit valve seat until it seats on the bottom.



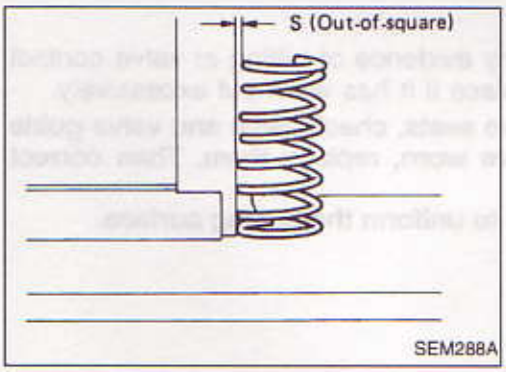
5. Cut or grind valve seat using a suitable tool at the specified dimensions as shown in S.D.S.
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

Seat face angle "α":
44°53' - 45°07' deg.
Contacting width "W":
Intake
1.4 - 1.7 mm (0.055 - 0.067 in)
Exhaust
1.7 - 2.0 mm (0.067 - 0.079 in)



VALVE DIMENSIONS

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



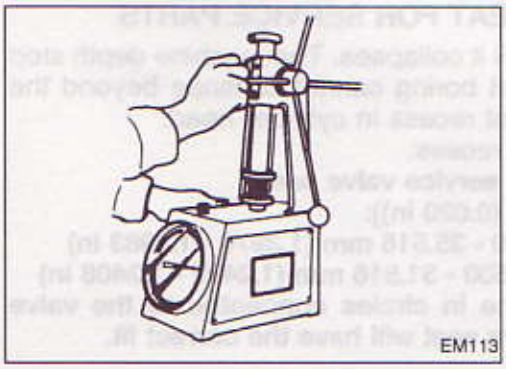
VALVE SPRING

Squareness

1. Measure "S" dimension.

Out-of-square:
Less than 2.2 mm (0.087 in)

2. If it exceeds the limit, replace spring.



Pressure

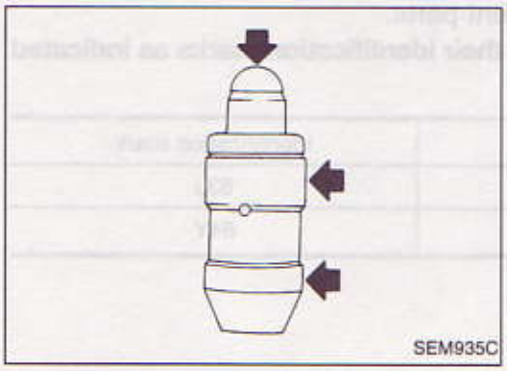
Check valve spring pressure.

Pressure: N (kg, lb) at height mm (in)
Standard
569.00 - 641.57 (58.02 - 65.42, 127.93 - 144.25) at 30.0 (1.181)
Limit
More than 549.2 (56.0, 123.5) at 30.0 (1.181)

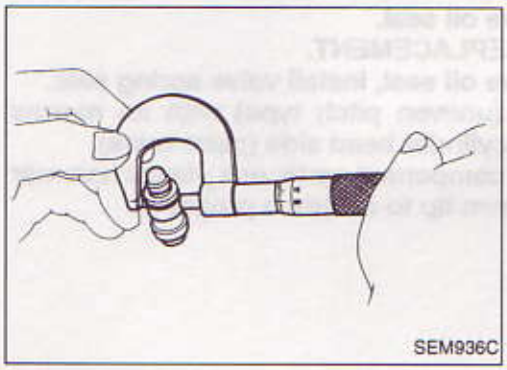
If it exceeds the limit, replace spring.

Inspection (Cont'd)

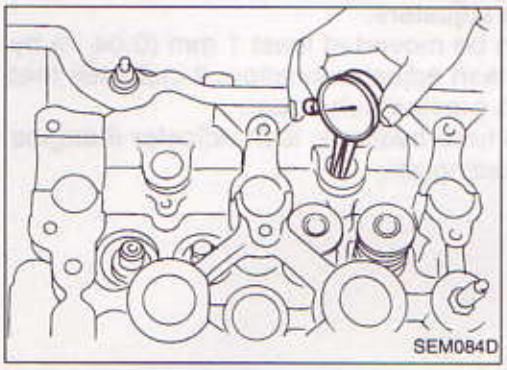
HYDRAULIC LASH ADJUSTER


SEM935C

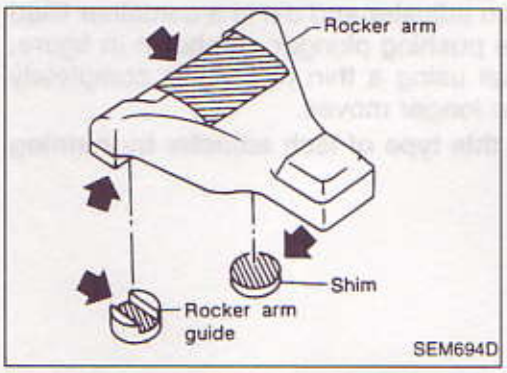
1. Check contact and sliding surfaces for wear or scratches.


SEM936C

2. Check diameter of lash adjuster.
   Outer diameter:
   16.980 - 16.993 mm (0.6685 - 0.6690 in)


SEM084D

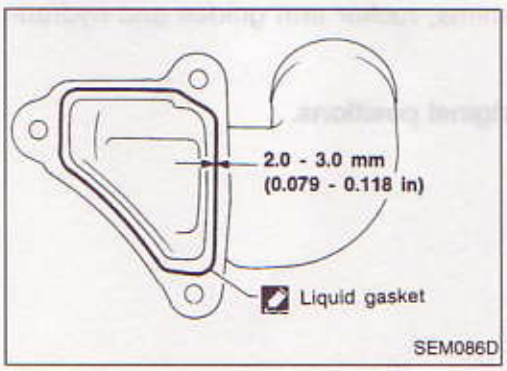
3. Check lash adjuster guide inner diameter.
   Inner diameter:
   17.000 - 17.020 mm (0.6693 - 0.6701 in)
   Standard clearance between lash adjuster and adjuster guide:
   0.007 - 0.040 mm (0.0003 - 0.0016 in)



SEM694D

ROCKER ARM, SHIM AND ROCKER ARM GUIDE

Check contact and sliding surfaces of rocker arms, shims and rocker arm guides for wear or scratches.



SEM086D

Assembly

1. Install water outlet.

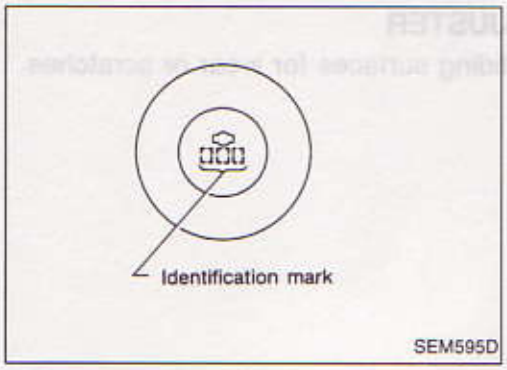
(1) Before installing water outlet, remove all traces of liquid gasket rom mating surface using a scraper.

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

(2) Apply a continuous bead of liquid gasket to mating surface of water outlet.

- **Use Genuine Liquid Gasket or equivalent.**

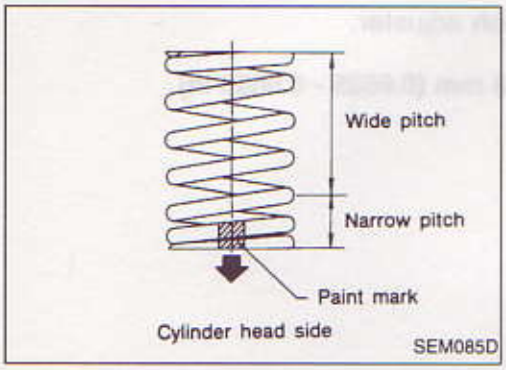
Assembly (Cont'd)



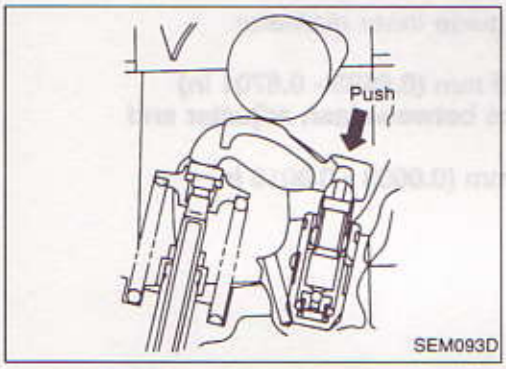
2. Install valve component parts.

- **Install valves, noting their identification marks as indicated in the table below.**

	Identification mark
Intake valve	53J
Exhaust valve	64Y

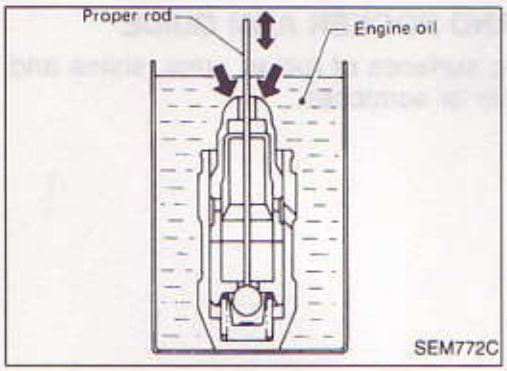


- **Always use new valve oil seal.**
  Refer to OIL SEAL REPLACEMENT.
- **Before installing valve oil seal, install valve spring seat.**
- **Install valve spring (uneven pitch type) with its narrow pitched side toward cylinder head side (paint mark).**
- **After installing valve component parts, use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



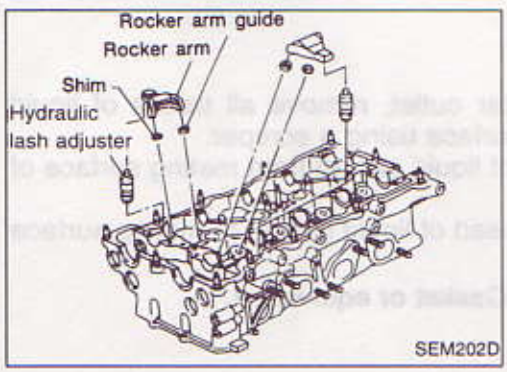
3. Check hydraulic lash adjusters.

(1) When rocker arm can be moved at least 1 mm (0.04 in) by pushing at hydraulic lash adjuster location, it indicates that there is air in he high pressure chamber.
Noise will be emitted from hydraulic lash adjuster if engine is started without bleeding air.



(2) Remove hydraulic lash adjuster and dip in a container filled with engine oil. While pushing plunger as shown in figure, lightly push check ball using a thin rod. Air is completely bled when plunger no longer moves.

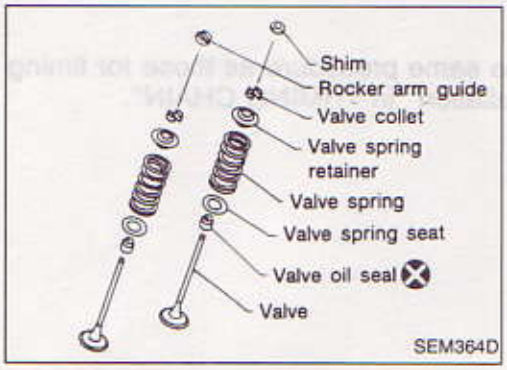
Air cannot be bled from this type of lash adjuster by running the engine.



4. Install rocker arms, shims, rocker arm guides and hydraulic lash adjusters.

CAUTION:
Install all parts in their original positions.

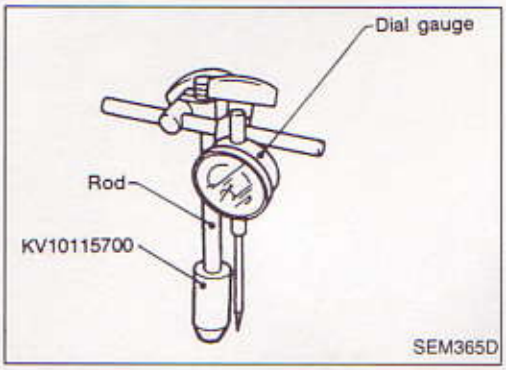
Assembly (Cont'd)



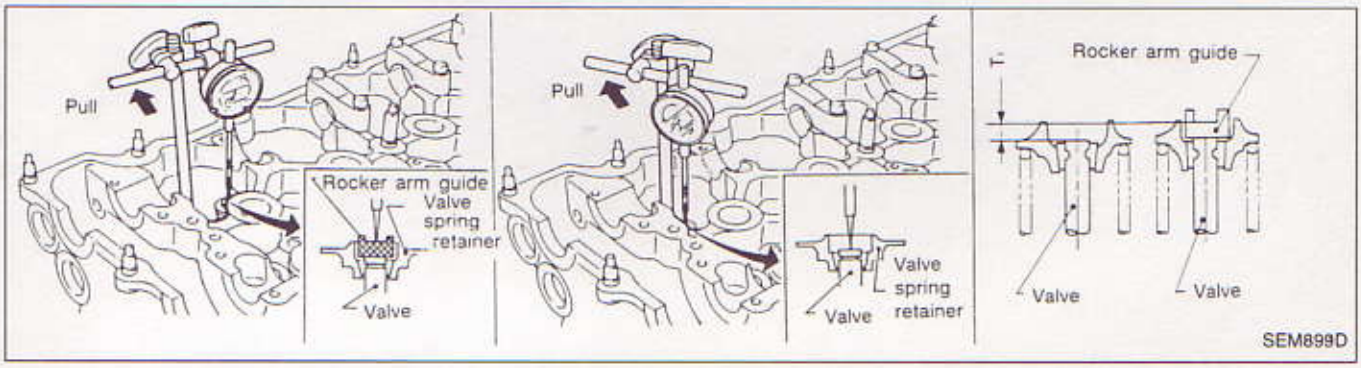
5. Select a suitable shim when replacing valve, cylinder head, shim, rocker arm guide and/or valve seat with new one(s), as follows:

1) Install valve component parts to cylinder head (Except shim).

- Always replace rocker arm guide with a new one.

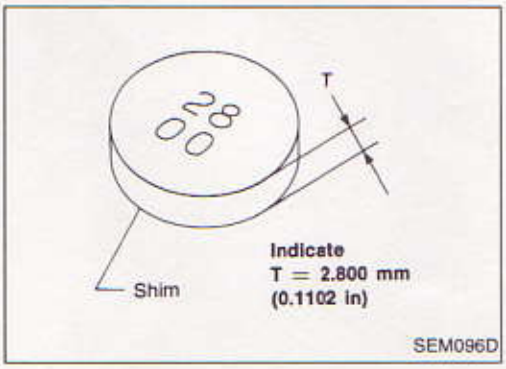


2) Remove hydraulic lash adjuster.
3) Install Tool* into hydraulic lash adjuster fixing hole.
   * Tool [KV10115700 (J38957)] is screwed into magnetic stand rod used with dial gauge.



4) Measure difference in level (T_1) between sliding surface of rocker arm guide against rocker arm and valve stem end on shim side with valve, valve spring, collet, retainer and rocker arm guide installed to the head (Except shim),

When measuring, lightly pull dial indicator rod towards you to eliminate play in Tool [KV10115700].

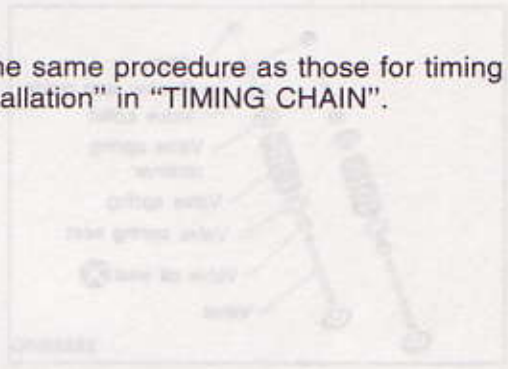


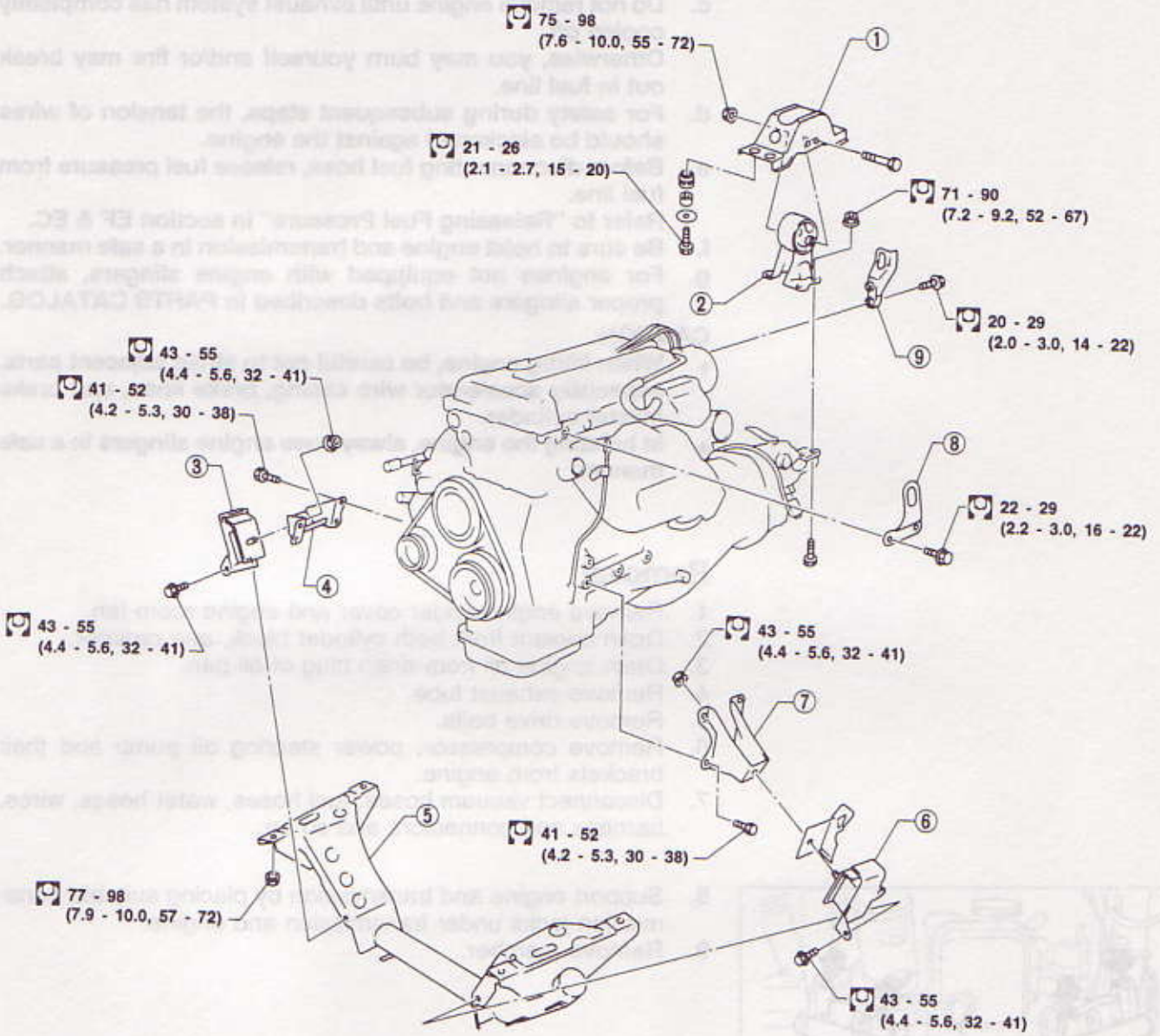
5) Select a shim having a thickness (T) that makes -0.025 mm (-0.0010 in) $\leqq [(T) - (T_1)] \leqq 0.025$ mm (0.0010 in).

- Shims are available in 17 different thicknesses ranging from 2.800 mm (0.1102 in) to 3.200 mm (0.1260 in) in increments of 0.025 mm (0.0010 in).

Installation

- This installation is the same procedure as those for timing chain. Refer to "Installation" in "TIMING CHAIN".





: N•m (kg-m, ft-lb)

SEM077E

① Mounting bracket
② Rear engine mounting
③ Insulator
④ Bracket
⑤ Member
⑥ Insulator
⑦ Bracket
⑧ Front engine slinger
⑨ Rear engine slinger

WARNING:

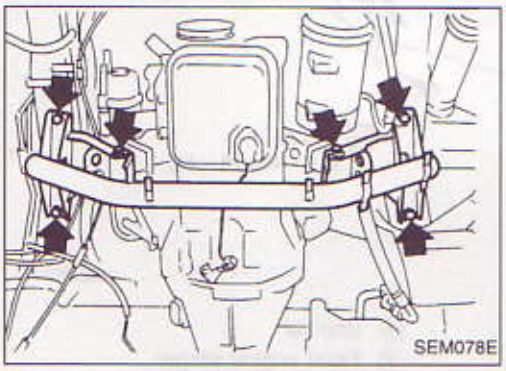
a. Situate vehicle on a flat and solid surface.
b. Place chocks at front and back of rear wheels.
c. Do not remove engine until exhaust system has completely cooled off.
Otherwise, you may burn yourself and/or fire may break out in fuel line.
d. For safety during subsequent steps, the tension of wires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

CAUTION:

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

Removal

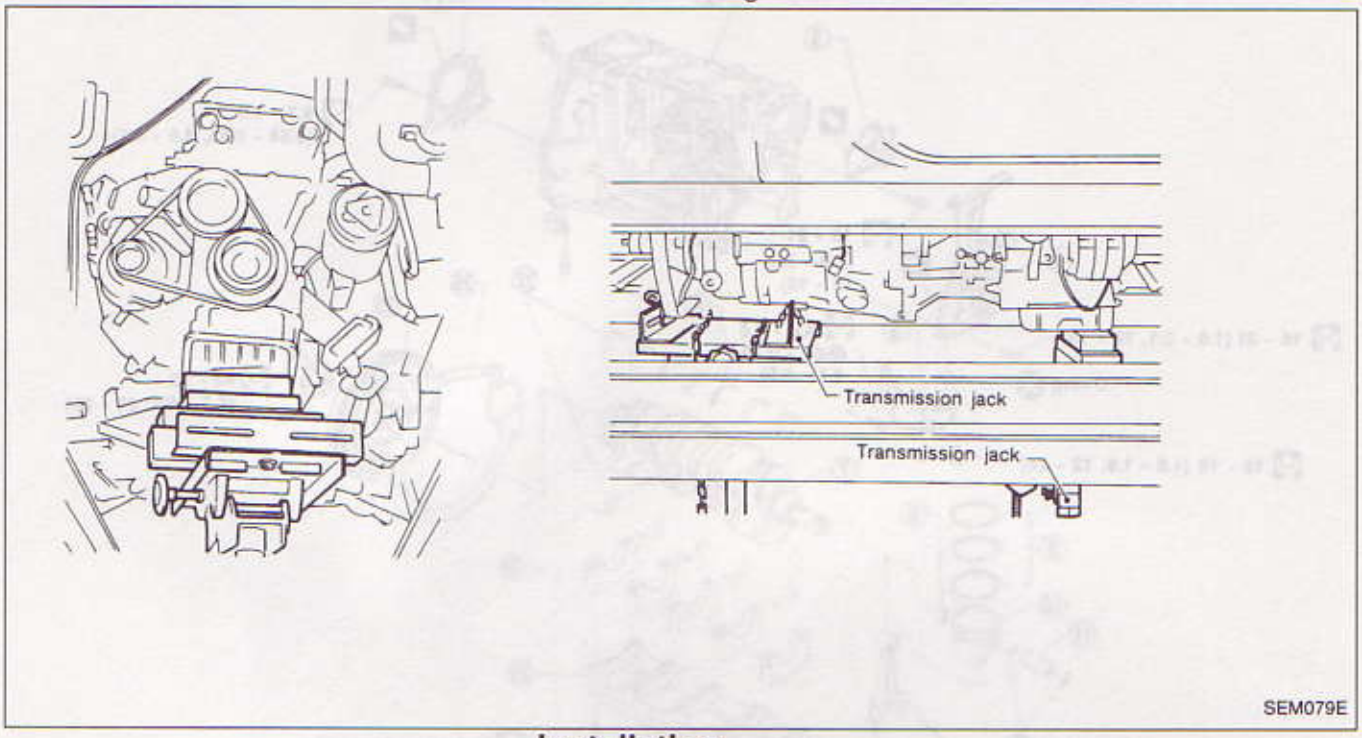
1. Remove engine under cover and engine room fan.
2. Drain coolant from both cylinder block, and radiator.
3. Drain engine oil from drain plug of oil pan.
4. Remove exhaust tube.
5. Remove drive belts.
6. Remove compressor, power steering oil pump and their brackets from engine.
7. Disconnect vacuum hoses, fuel hoses, water hoses, wires, harness and connectors and so on.



8. Support engine and transmission by placing suitable transmission jacks under transmission and engine.
9. Remove member.

Removal (Cont'd)

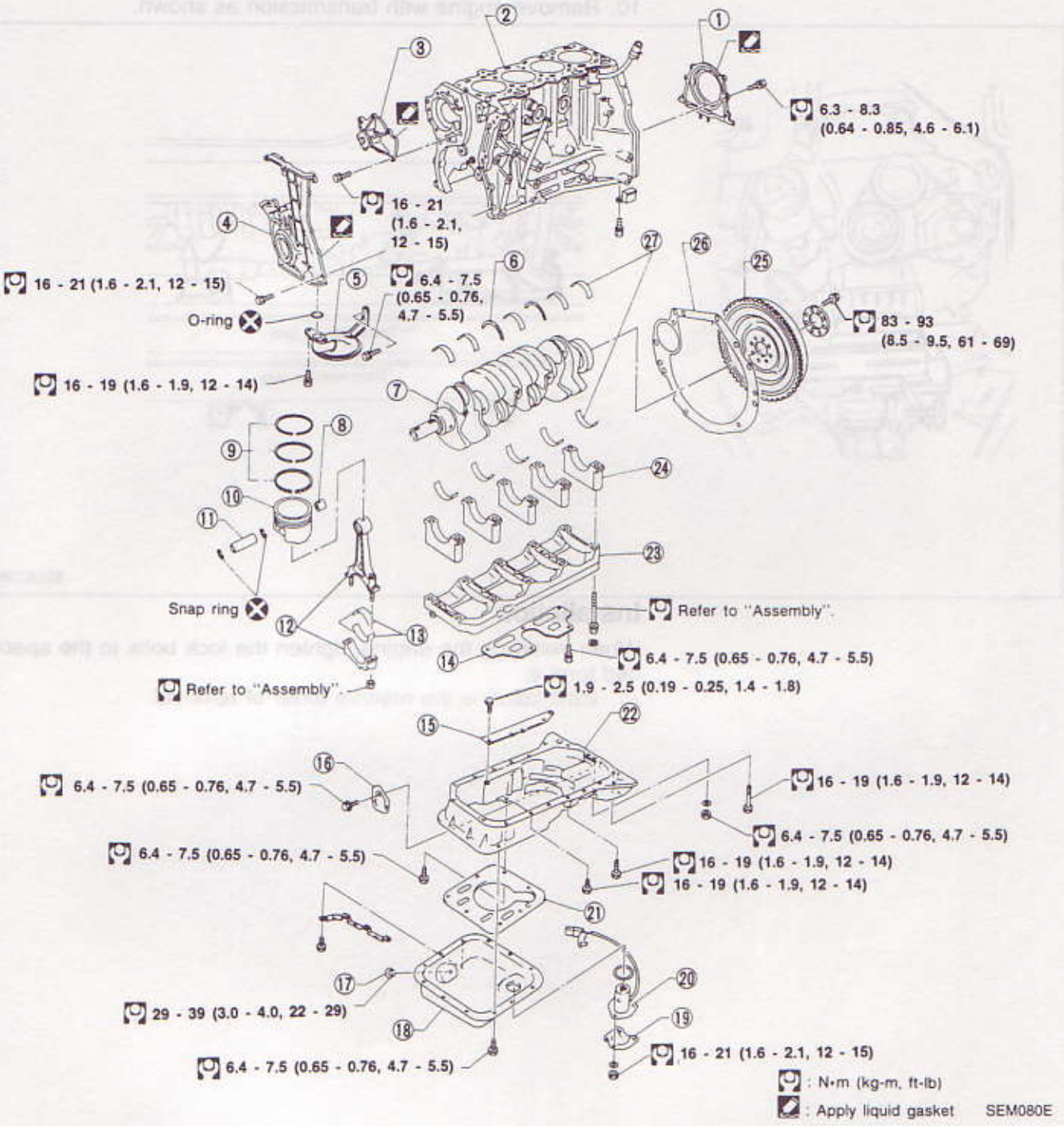
10. Remove engine with transmission as shown.



Installation

When installing the engine, tighten the lock bolts to the specified torque.

- Installation is the reserve order of removal.



① Rear oil seal retainer
② Cylinder block
③ Water pump
④ Front cover with oil pump
⑤ Oil strainer
⑥ Thrust bearing
⑦ Crankshaft
⑧ Connecting rod bushing
⑨ Piston rings
⑩ Piston
⑪ Piston pin
⑫ Connecting rod
⑬ Connecting rod bearing
⑭ Baffle plate
⑮ Side gallery baffle plate
⑯ Rear cover plate
⑰ Drain plug
⑱ Steel oil pan
⑲ Oil level sensor cover
⑳ Oil level sensor
㉑ Baffle plate
㉒ Aluminum oil pan
㉓ Main bearing beam
㉔ Main bearing cap
㉕ Flywheel or drive plate
㉖ Rear plate
㉗ Main bearing

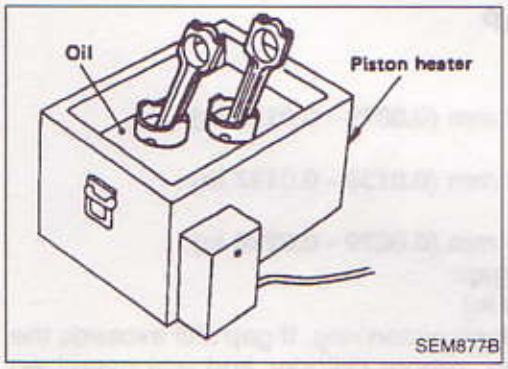
CAUTION:

- **When installing sliding parts such as bearings and pistons, be sure to apply new engine oil on the sliding surfaces.**
- **Place 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 thread portion of bolts and seating surface of us.**

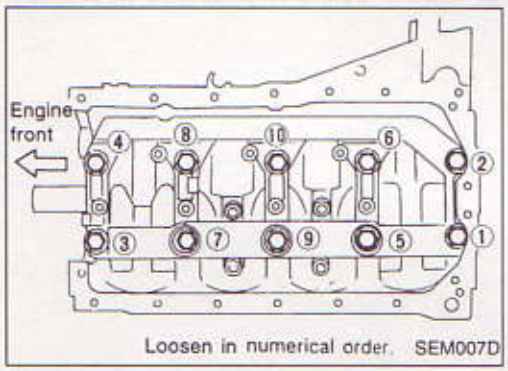
Disassembly

PISTON AND CRANKSHAFT

1. Remove engine.
   Refer to "ENGINE REMOVAL".
2. Remove cylinder head.
   Refer to "Removal" in "TIMING CHAIN".
3. Remove oil pan.
   Refer to "Removal" in "OIL PAN".
4. Remove timing chain.
   Refer to "Removal" in "TIMING CHAIN".



5. Remove pistons with connecting rod.
   - 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.
6. Remove rear oil seal retainer.

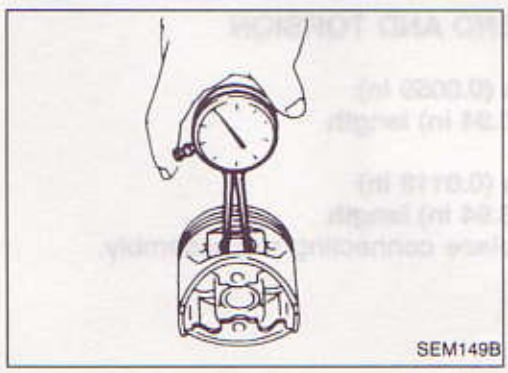


7. Remove bearing beam, bearing cap and crankshaft.
   - **Before removing bearing cap, measure crankshaft end play.**
   - **Bolts should be loosened in two or three steps.**

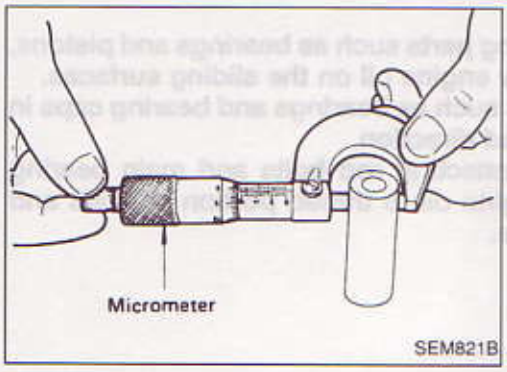
Inspection

PISTON AND PISTON PIN CLEARANCE

1. Measure inner diameter of piston pin hole "dp".
   Standard diameter "dp":
   21.987 - 21.999 mm (0.8656 - 0.8661 in)

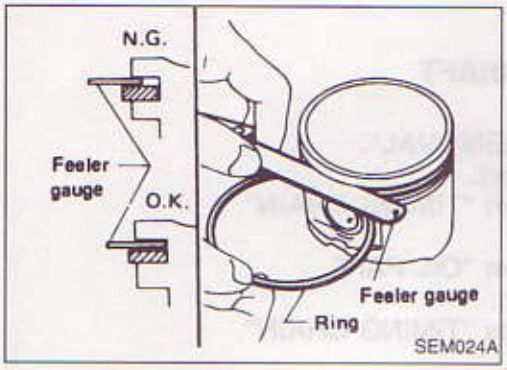


Inspection (Cont'd)



2. Measure outer diameter of piston pin "Dp".
   Standard diameter "Dp":
   21.989 - 22.001 mm (0.8657 - 0.8662 in)
3. Calculate piston pin clearance.
   dp − Dp = −0.004 to 0 mm (−0.0002 to 0 in)

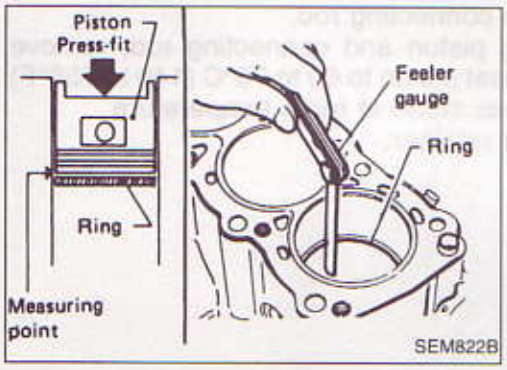
If it exceeds the above value, replace piston assembly with pin.



PISTON RING SIDE CLEARANCE

Side clearance:
Top ring
0.045 - 0.080 mm (0.0018 - 0.0031 in)
2nd ring
0.030 - 0.065 mm (0.0012 - 0.0026 in)
Max. limit of side clearance:
0.2 mm (0.008 in)

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

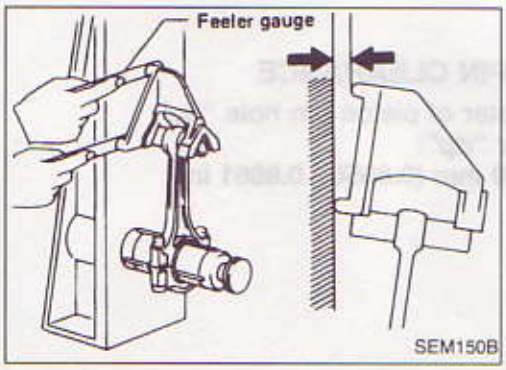


PISTON RING END GAP

End gap:
Top ring
0.20 - 0.30 mm (0.0079 - 0.0118 in)
2nd ring
0.35 - 0.50 mm (0.0138 - 0.0197 in)
Oil ring
0.20 - 0.60 mm (0.0079 - 0.0236 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 cylinder and use oversized piston and piston rings.

Refer to S.D.S.



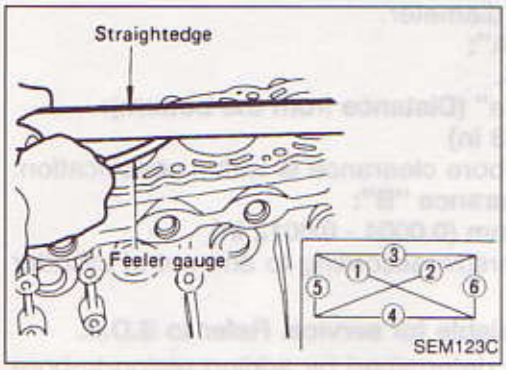
CONNECTING ROD BEND AND TORSION

Bend:
Limit 0.15 mm (0.0059 in)
per 100 mm (3.94 in) length
Torsion:
Limit 0.30 mm (0.0118 in)
per 100 mm (3.94 in) length

If it exceeds the limit, replace connecting rod assembly.

Inspection (Cont'd)

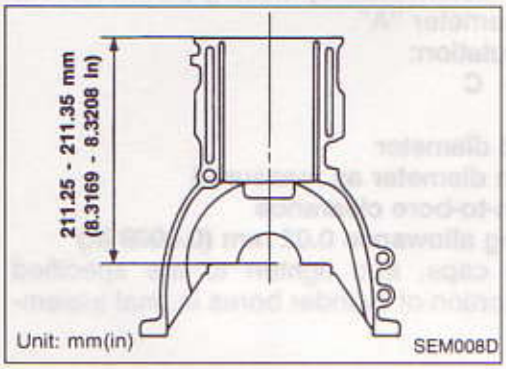
CYLINDER BLOCK DISTORTION AND WEAR



1. Clean upper face of cylinder block and measure the distortion.
   Standard:
   Less than 0.03 mm (0.0012 in)
   Limit:
   0.10 mm (0.0039 in)
2. If out of specification, resurface it.
   The resurfacing limit is determined by cylinder head resurfacing in engine.

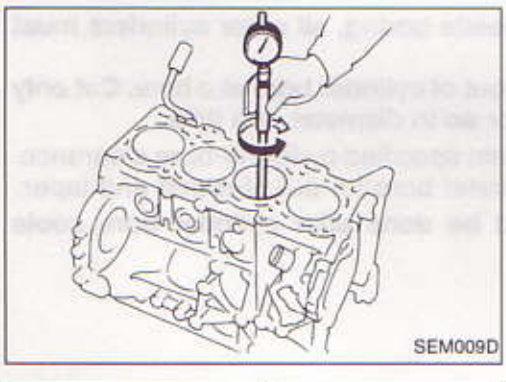
Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".
The maximum limit is as follows:
A + B = 0.2 mm (0.008 in)
Nominal cylinder block height from crankshaft center:
211.25 - 211.35 mm (8.3169 - 8.3208 in)

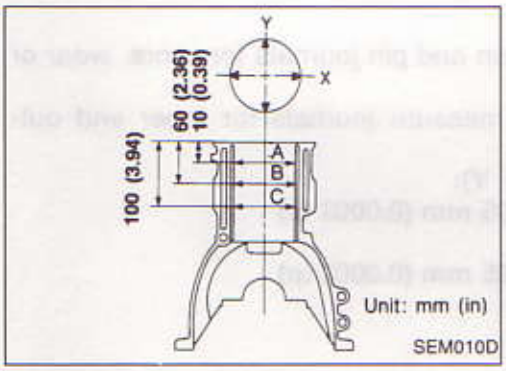
3. If necessary, replace cylinder block.

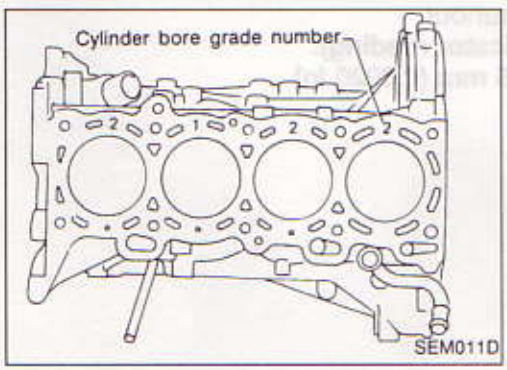


PISTON-TO-BORE CLEARANCE

1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.
   Standard inner diameter:
   86.000 - 86.030 mm (3.3858 - 3.3870 in)
   Wear limit:
   0.20 mm (0.0079 in)
   Out-of-round limit:
   0.015 mm (0.0006 in)
   Taper limit:
   0.010 mm (0.0004 in)
   If it exceeds the limit, rebore all cylinders. Replace cylinder lock if necessary.
2. Check for scratches and seizure. If seizure is found, hone it.

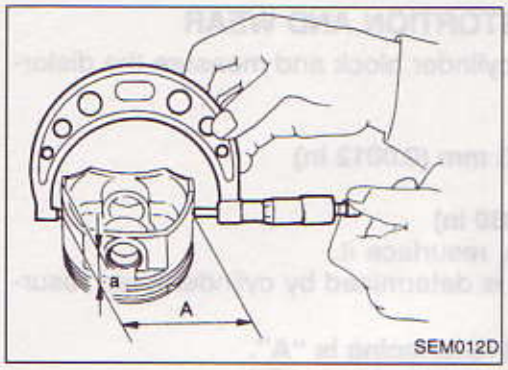






- **If both cylinder block and piston are replaced with new ones, select piston of the same grade number punched on cylinder block upper surface.**

Inspection (Cont'd)



3. Measure piston skirt diameter.
   Piston diameter "A":
   Refer to S.D.S.
   Measuring point "a" (Distance from the bottom):
   11.0 mm (0.433 in)
4. Check that piston-to-bore clearance is within specification.
   Piston-to-bore clearance "B":
   0.010 - 0.030 mm (0.0004 - 0.0012 in)
5. Determine piston oversize according to amount of cylinder wear.

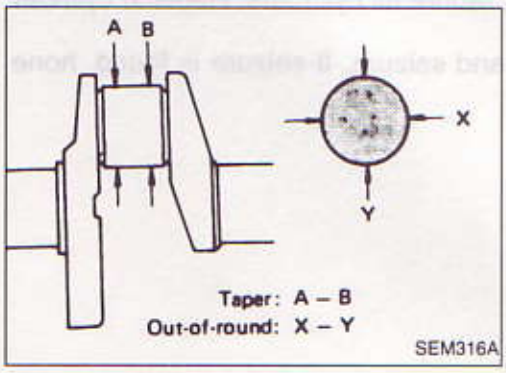
Oversize pistons are available for service. Refer to S.D.S.

6. Cylinder bore size is determined by adding piston-to-bore clearance o piston diameter "A".
   Rebored size calculation:
   D = A + B − C
   where,
   D: Bored diameter
   A: Piston diameter as measured
   B: Piston-to-bore clearance
   C: Honing allowance 0.02 mm (0.0008 in)
7. Install main bearing caps, and tighten to the specified torque 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 cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.**

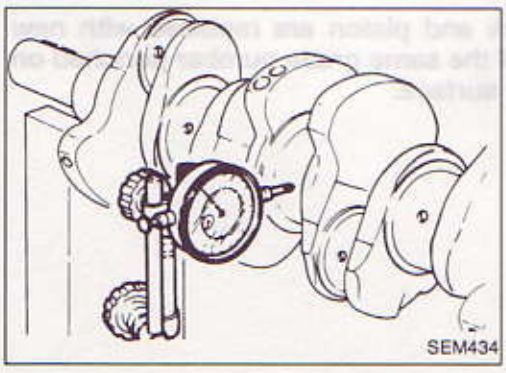
9. Hone cylinders to obtain specified piston-to-bore clearance.
10. Measure finished cylinder bore for out-of-round and taper.

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



CRANKSHAFT

1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.
   Out-of-round (X − Y):
   Less than 0.005 mm (0.0002 in)
   Taper (A − B):
   Less than 0.005 mm (0.0002 in)



3. Measure crankshaft runout.
   Runout (Total indicator reading):
   Less than 0.05 mm (0.0020 in)

Inspection (Cont'd)

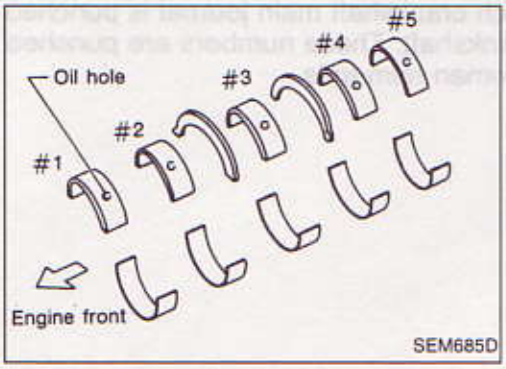
BEARING CLEARANCE

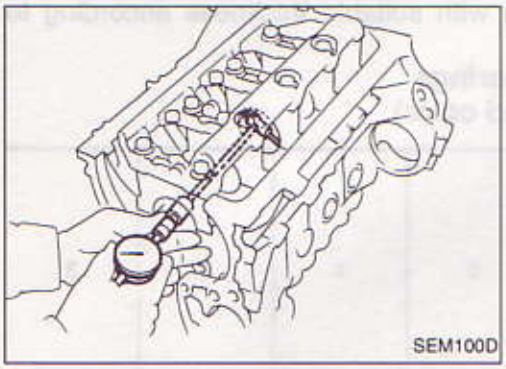
- Either of the following two methods may be used, however, method "A" gives more reliable results and is preferable.

Method A (Using bore gauge & micrometer)

Main bearing

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

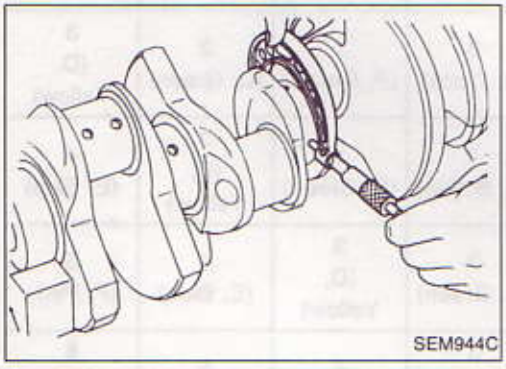




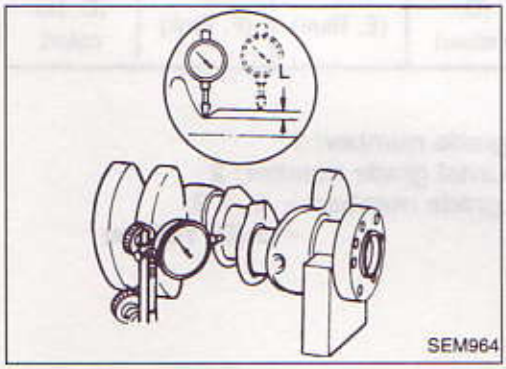
2. Install main bearing cap and main bearing beam to cylinder block.

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

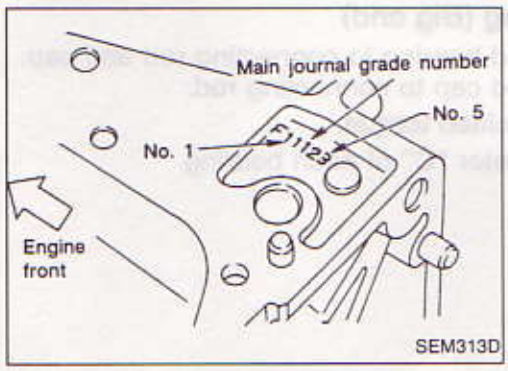
3. Measure inner diameter "A" of each main bearing.



4. Measure outer diameter "Dm" of each crankshaft main journal.
5. Calculate main bearing clearance.
   Main bearing clearance = A − Dm
   Standard: 0.004 - 0.022 mm (0.0002 - 0.0009 in)
   Limit: 0.050 mm (0.0020 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.



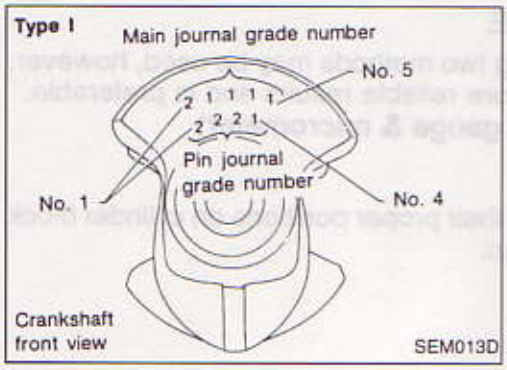
a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.
   "L": 0.1 mm (0.004 in)
b. Refer to S.D.S. for grinding crankshaft and available service parts.



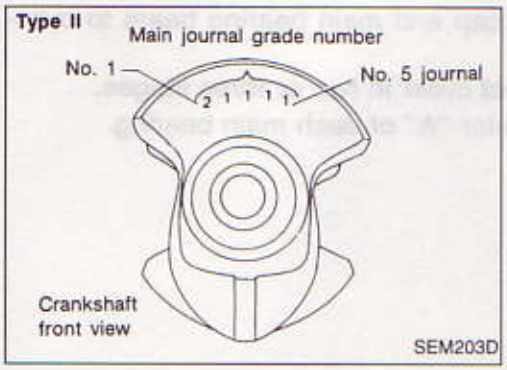
8. If crankshaft is reused, measure main bearing clearances and select thickness of main bearings.
   If crankshaft is replaced with a new one, it is necessary to select thickness of main bearings as follows:

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

Inspection (Cont'd)



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

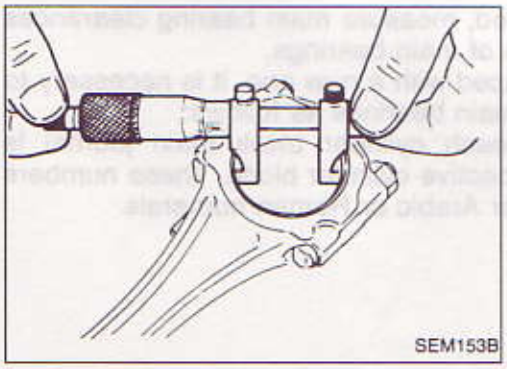


c. Select main bearing with suitable thickness according to the following table.

How to select main bearings (Identification mark and color)

Crankshaft journal grade number \ Main journal grade number	0	1	2	3
0	0 (A, Black)	1 (B, Brown)	2 (C, Green)	3 (D, Yellow)
1	1 (B, Brown)	2 (C, Green)	3 (D, Yellow)	4 (E, Blue)
2	2 (C, Green)	3 (D, Yellow)	4 (E, Blue)	5 (F, Pink)
3	3 (D, Yellow)	4 (E, Blue)	5 (F, Pink)	6 (G, No color)

For example:
Main journal grade number: 1
Crankshaft journal grade number: 2
Main bearing grade number = 1 + 2
= 3 (D, Yellow)



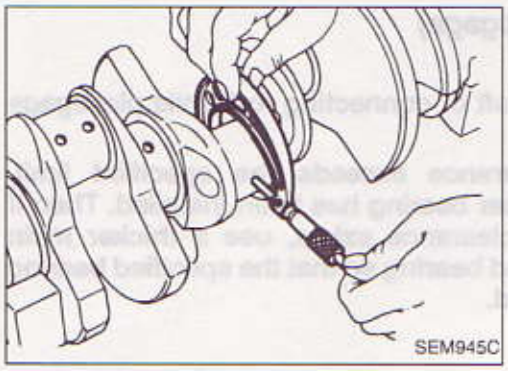
Connecting rod bearing (Big end)

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

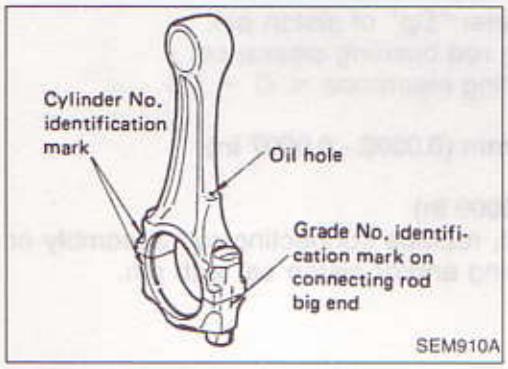
Tighten bolts to the specified torque.

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

Inspection (Cont'd)

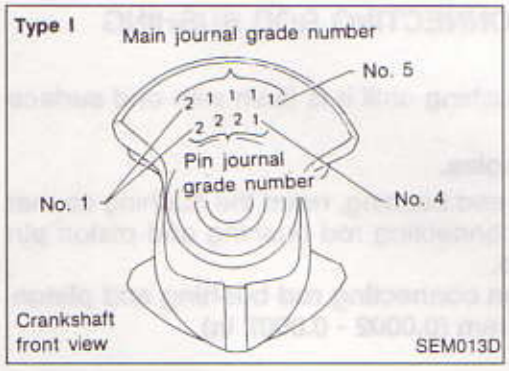

SEM945C

4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.
   Connecting rod bearing clearance = C − Dp
   Standard:
   0.020 - 0.045 mm (0.0008 - 0.0018 in)
   Limit:
   0.090 mm (0.0035 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.
   Refer to step 7 of "BEARING CLEARANCE — Main bearing".



SEM910A

8. If crankshaft is replaced with a new one, select connecting rod bearing according to the following table.
   a. Grade number of each connecting rod big end is punched on the respective connecting rod. These numbers are punched in either Arabic or Roman numerals.

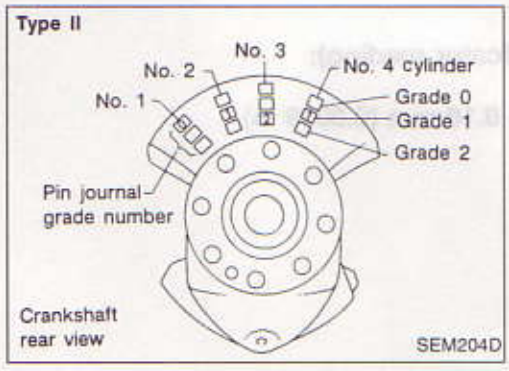


SEM013D

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

Connecting rod bearing grade number:

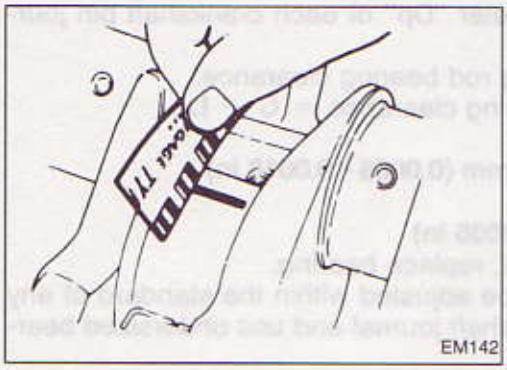
Crank pin grade number	Connecting rod bearing grade number
0	0
1	1
2	2



SEM204D

Identification color:
Grade 0; No color
Grade 1; Black
Grade 2; Brown

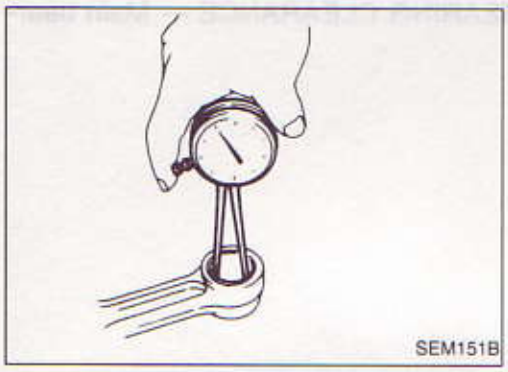
Inspection (Cont'd)


EM142

Method B (Using plastigage)

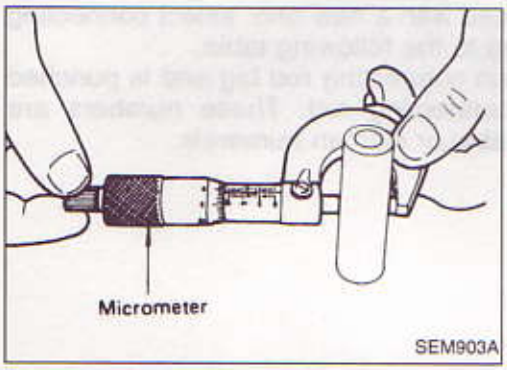
CAUTION:

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


SEM151B

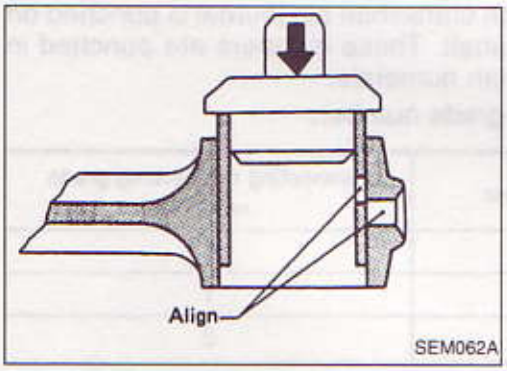
CONNECTING ROD BUSHING CLEARANCE (Small end)

1. Measure inner diameter "C" of bushing.



SEM903A

2. Measure outer diameter "Dp" of piston pin.
3. Calculate connecting rod bushing clearance.
   Connecting rod bushing clearance = C − Dp
   Standard:
   0.005 - 0.017 mm (0.0002 - 0.0007 in)
   Limit:
   0.023 mm (0.0009 in)
   If it exceeds the limit, replace connecting rod assembly or connecting rod bushing and/or piston set with pin.



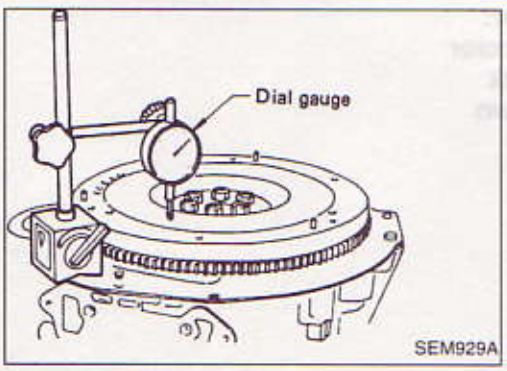
SEM062A

REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

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

Be sure to align the oil holes.

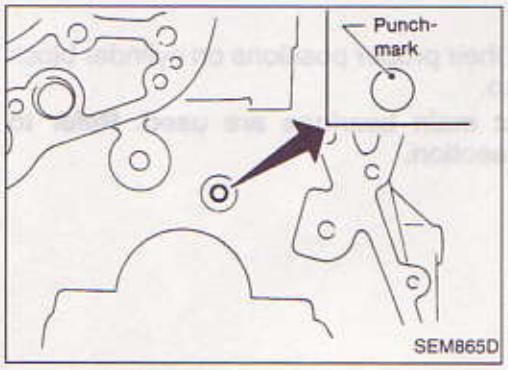
2. After driving in small end bushing, ream the bushing so that clearance between connecting rod bushing and piston pin is the specified value.
   Clearance between connecting rod bushing and piston pin: 0.005 - 0.017 mm (0.0002 - 0.0007 in)



SEM929A

FLYWHEEL

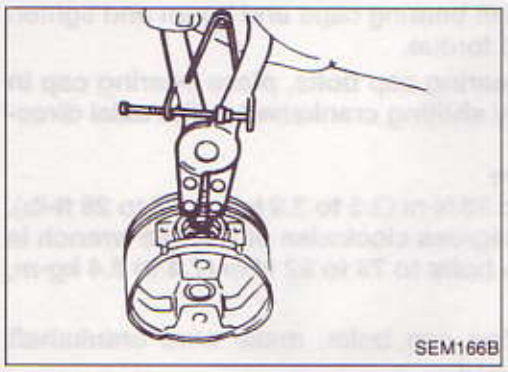
Runout (Total indicator reading):
Flywheel
Less than 0.10 mm (0.0039 in)



Assembly

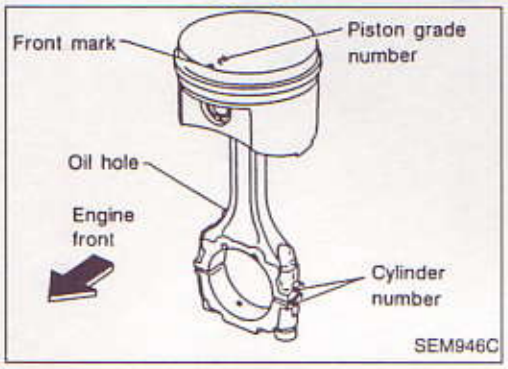
Install timing chain oil jet.

Drive oil jet into cylinder block with punchmark facing up.



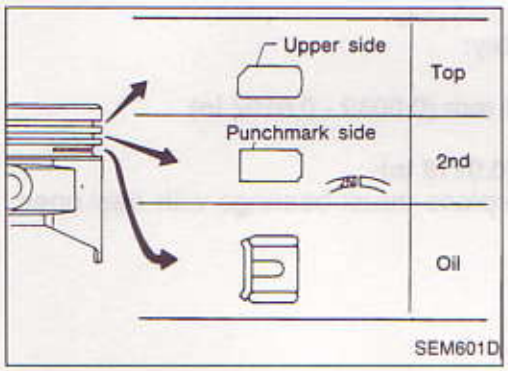
PISTON

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



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

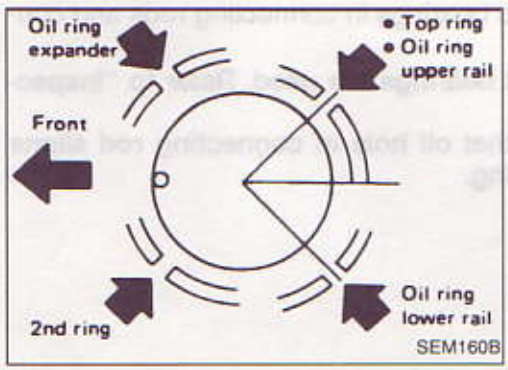
- **Align the direction of piston and connecting rod.**
- **Numbers stamped on connecting rod and cap correspond to each cylinder.**
- **After assembly, make sure connecting rod swings smoothly.**



3. Set piston rings as shown.

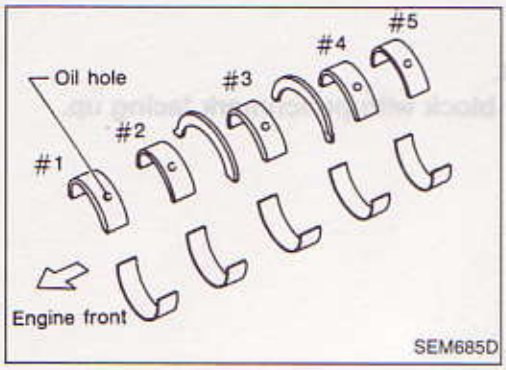
CAUTION:

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



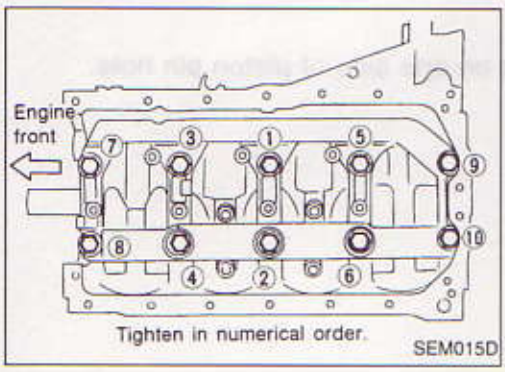
Assembly (Cont'd)

CRANKSHAFT



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

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

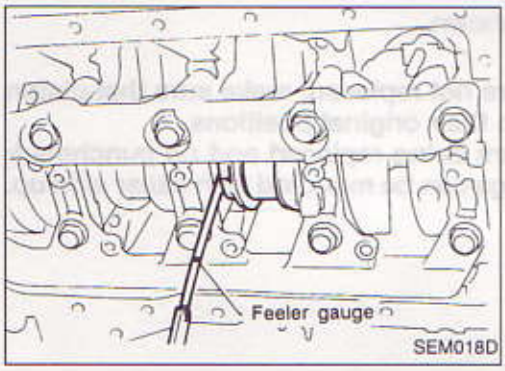


2. Install crankshaft, main bearing caps and beam and tighten bolts to the specified torque.

- **Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting crankshaft in the axial direction.**
- **Tightening procedure**

1) **Tighten bolts to 32 to 38 N·m (3.3 to 3.9 kg-m, 24 to 28 ft-lb).**
2) **Turn bolts 45 to 50 degrees clockwise or if angle wrench is not available, tighten bolts to 73 to 82 N·m (7.4 to 8.4 kg-m, 54 to 61 ft-lb).**

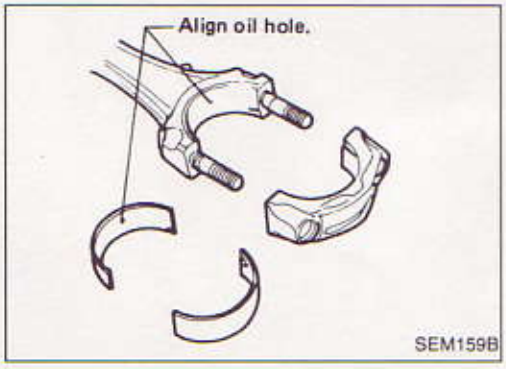
- **After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.**



3. Measure crankshaft end play.

Crankshaft end play:
Standard
0.10 - 0.26 mm (0.0039 - 0.0102 in)
Limit
0.30 mm (0.0118 in)

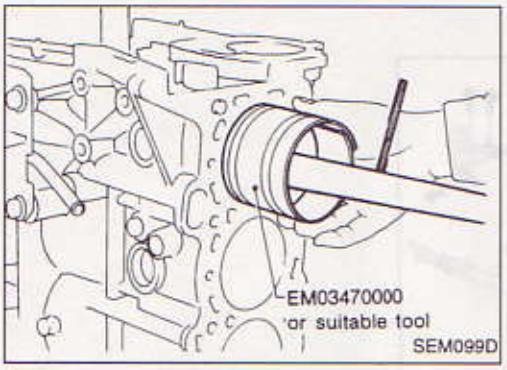
If beyond the limit, replace thrust bearings with new ones.



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

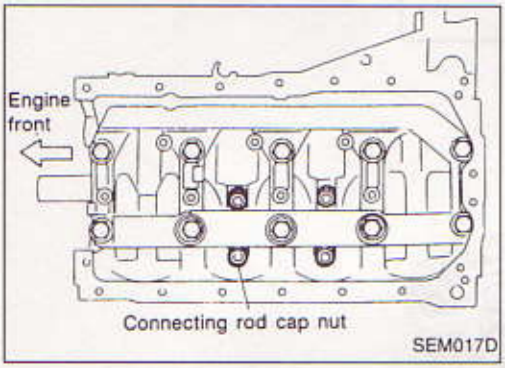
- **Confirm that correct bearings are used. Refer to "Inspection".**
- **Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.**

Assembly (Cont'd)



5. Install pistons with connecting rods.
a. Install them into corresponding cylinders with Tool.

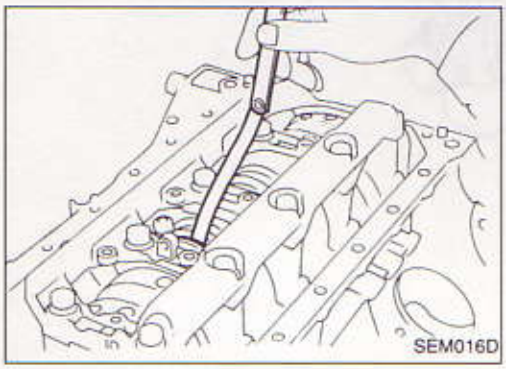
- **Be careful not to scratch cylinder wall by connecting rod.**
- **Arrange so that front mark on piston head faces toward front of engine.**



b. Install connecting rod caps.
Tighten connecting rod cap nuts to the specified torque.

Tightening procedure:

1) **Tighten nuts to 14 to 16 N·m (1.4 to 1.6 kg-m, 10 to 12 ft-lb).**
2) **Turn nuts 60 to 65 degrees clockwise or if angle wrench is not available, tighten nuts to 38 to 44 N·m (3.9 to 4.5 kg-m, 28 to 33 ft-lb).**



6. Measure connecting rod side clearance.

Connecting rod side clearance:

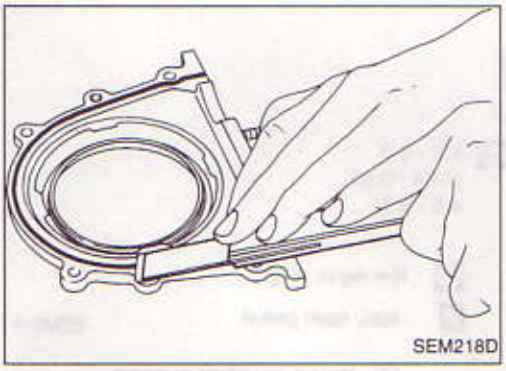
Standard

0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit

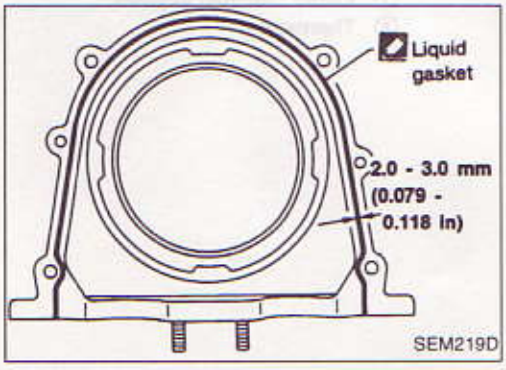
0.50 mm (0.0197 in)

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



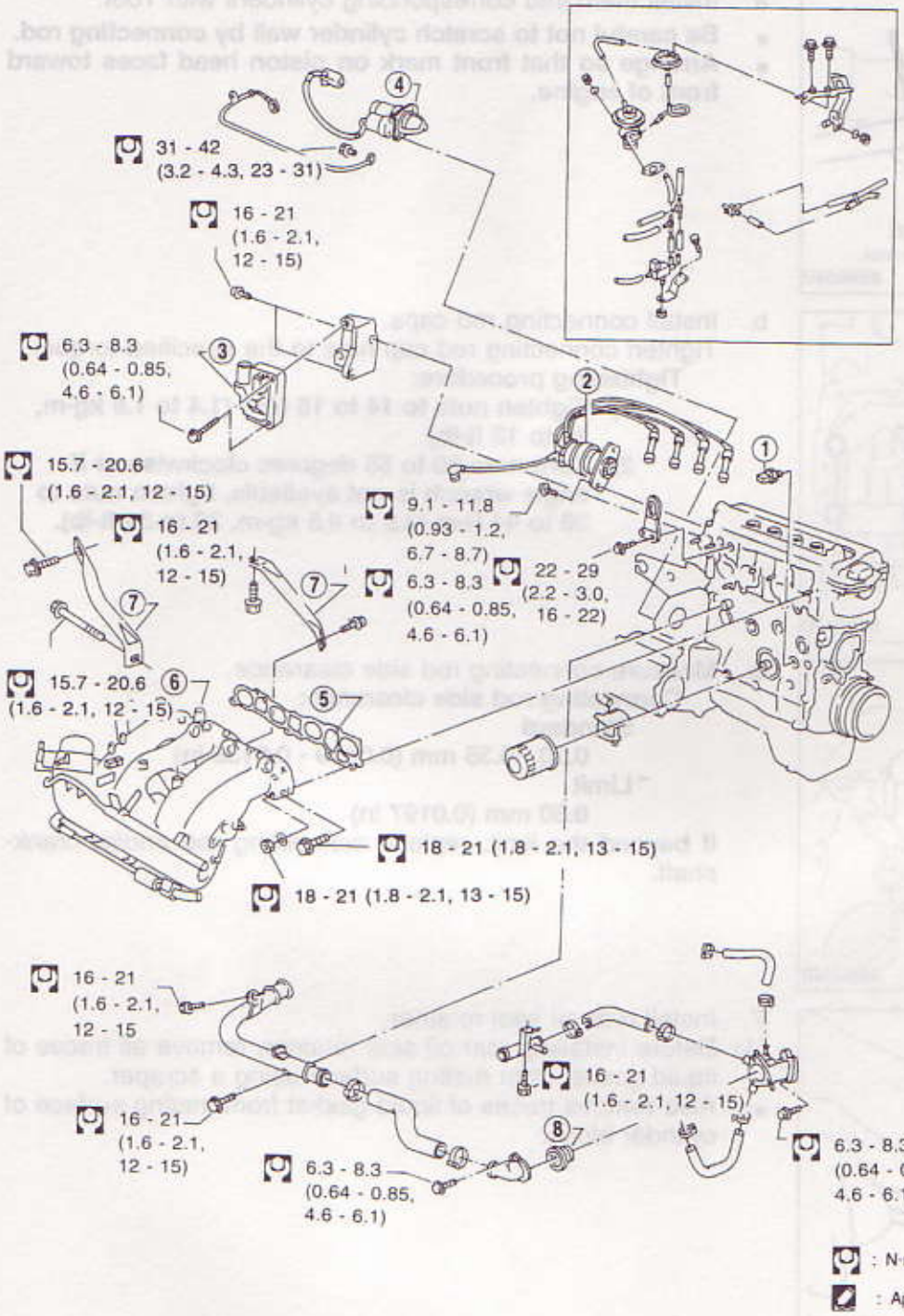
7. Install rear oil seal retainer.
(1) Before installing rear oil seal retainer, remove all traces of liquid gasket from mating surface using a scraper.

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

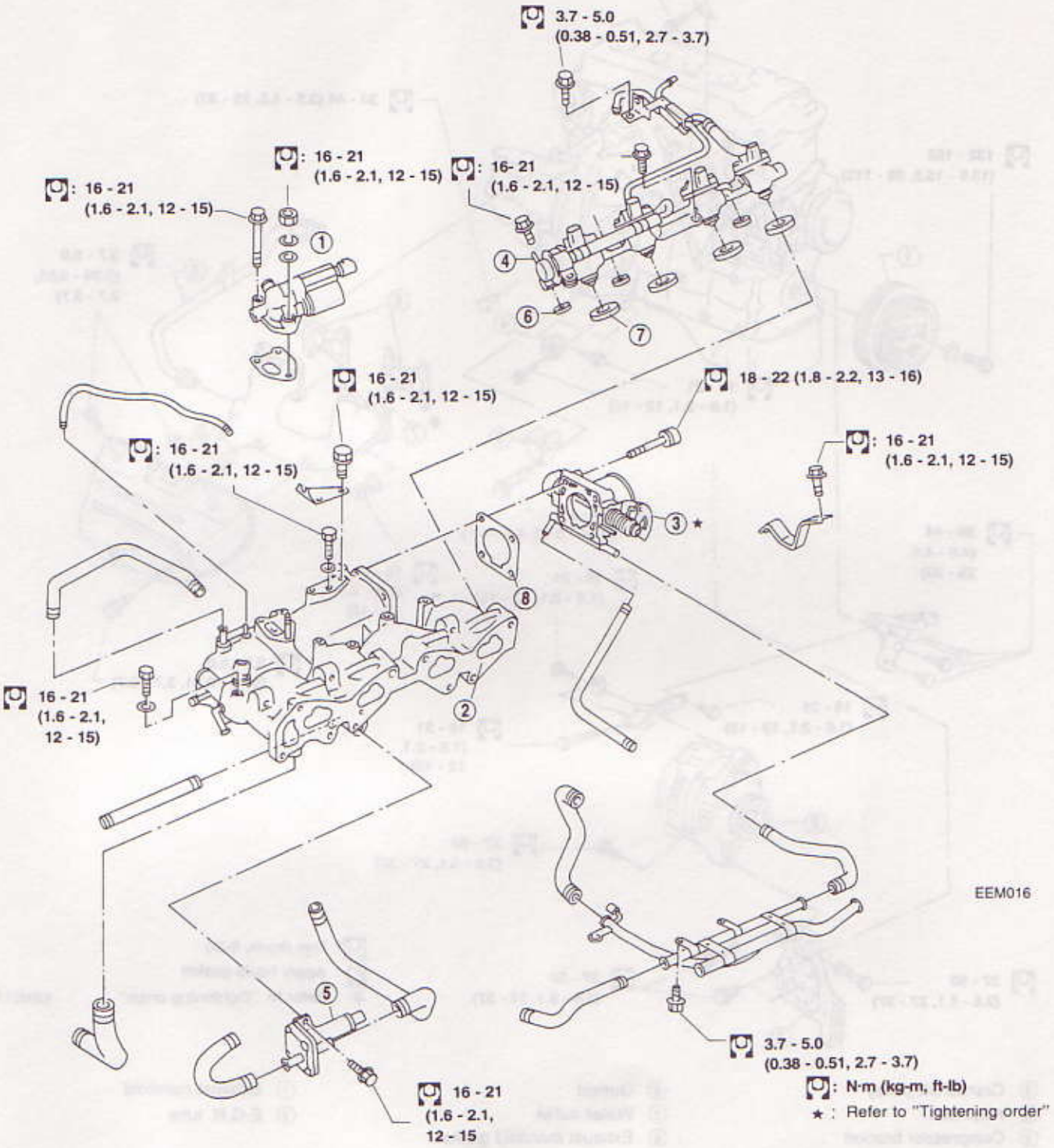


(2) Apply a continuous bead of liquid gasket to mating surface of rear oil seal retainer.

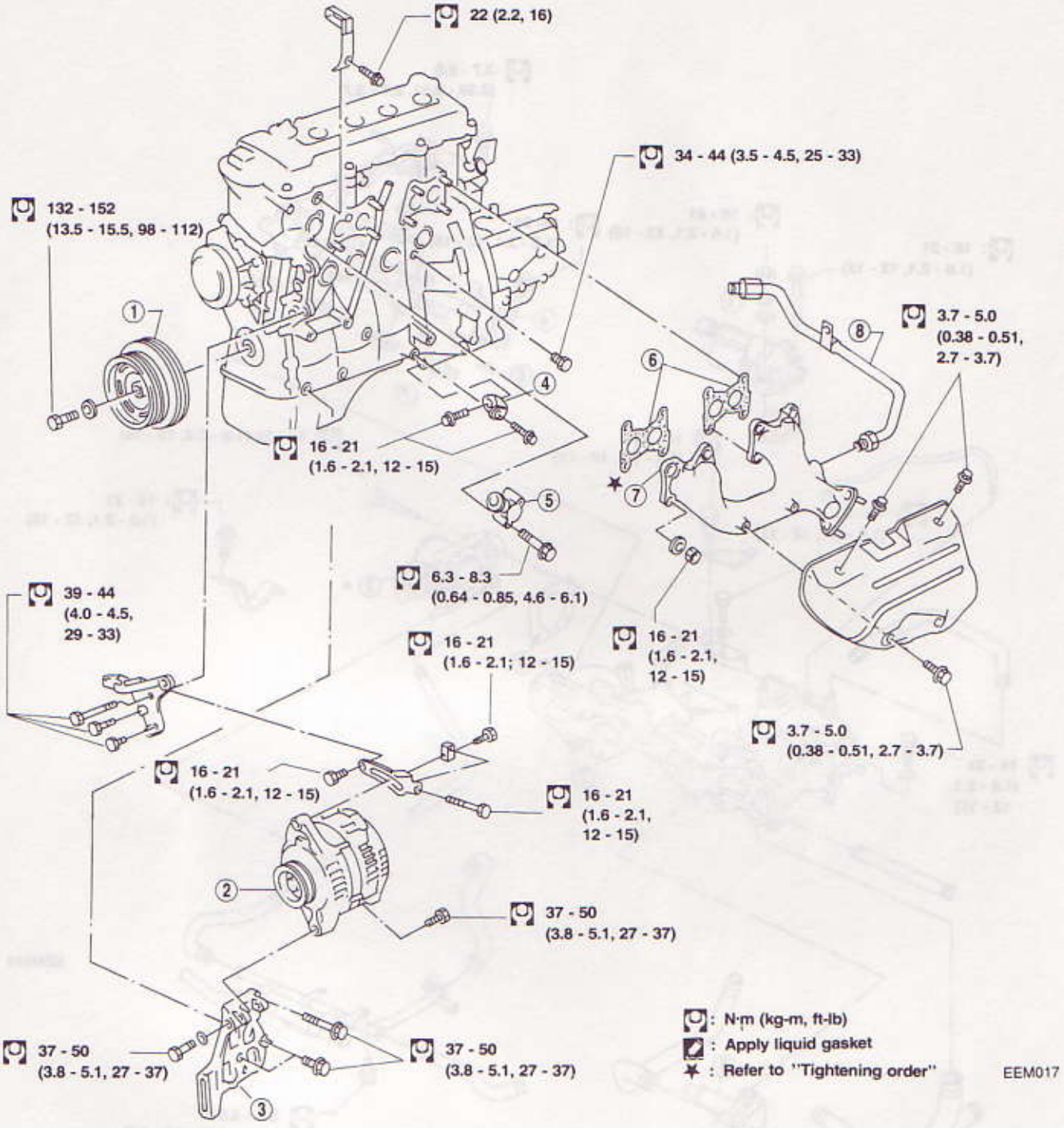
- Use Genuine Liquid Gasket or equivalent.



① Oil pressure switch
② Crank angle snecor built into distributor
③ Ignition coil
④ Starter motor
⑤ Intake manifold gasket
⑥ Intake manifold assembly
⑦ Intake manifold support
⑧ Thermostat

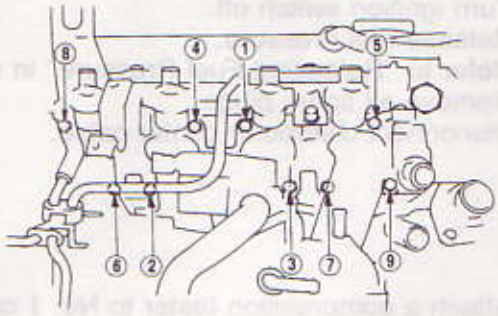


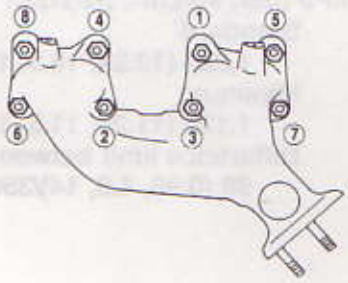
① Idle air adjusting unit
② Intake manifold
③ Throttle chamber
④ Fuel gallery assembly
⑤ Air regulator
⑥ Insulator
⑦ Insulator
⑧ Throttle chamber gasket

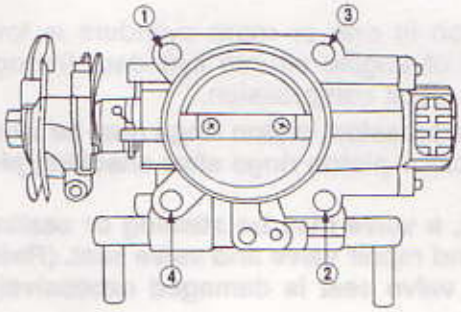


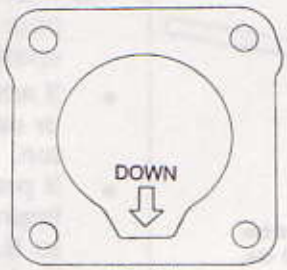
① Crankshaft pulley
② Alternator
③ Compressor bracket
④ Gusset
⑤ Water outlet
⑥ Exhaust manifold gasket
⑦ Exhaust manifold
⑧ E.G.R. tube

Tightening Order







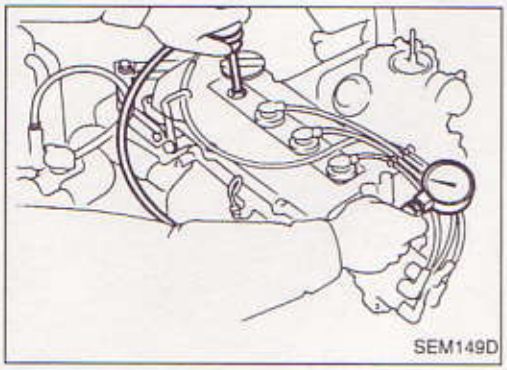


Gasket

EEM036

Measurement of Compression Pressure

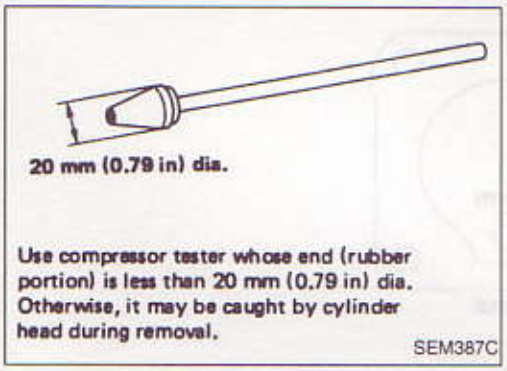
1. Warm up engine.
2. Turn ignition switch off.
3. Release fuel pressure.
   Refer to "Releasing Fuel Pressure" in section EF & EC.
4. Remove all spark plugs.
5. Disconnect distributor center cable.


SEM149D

6. Attach a compression tester to No. 1 cylinder.
7. Depress accelerator pedal fully to keep throttle valve wide open.
8. Crank engine and record highest gauge indication.
9. Repeat the measurement on each cylinder as shown above.

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

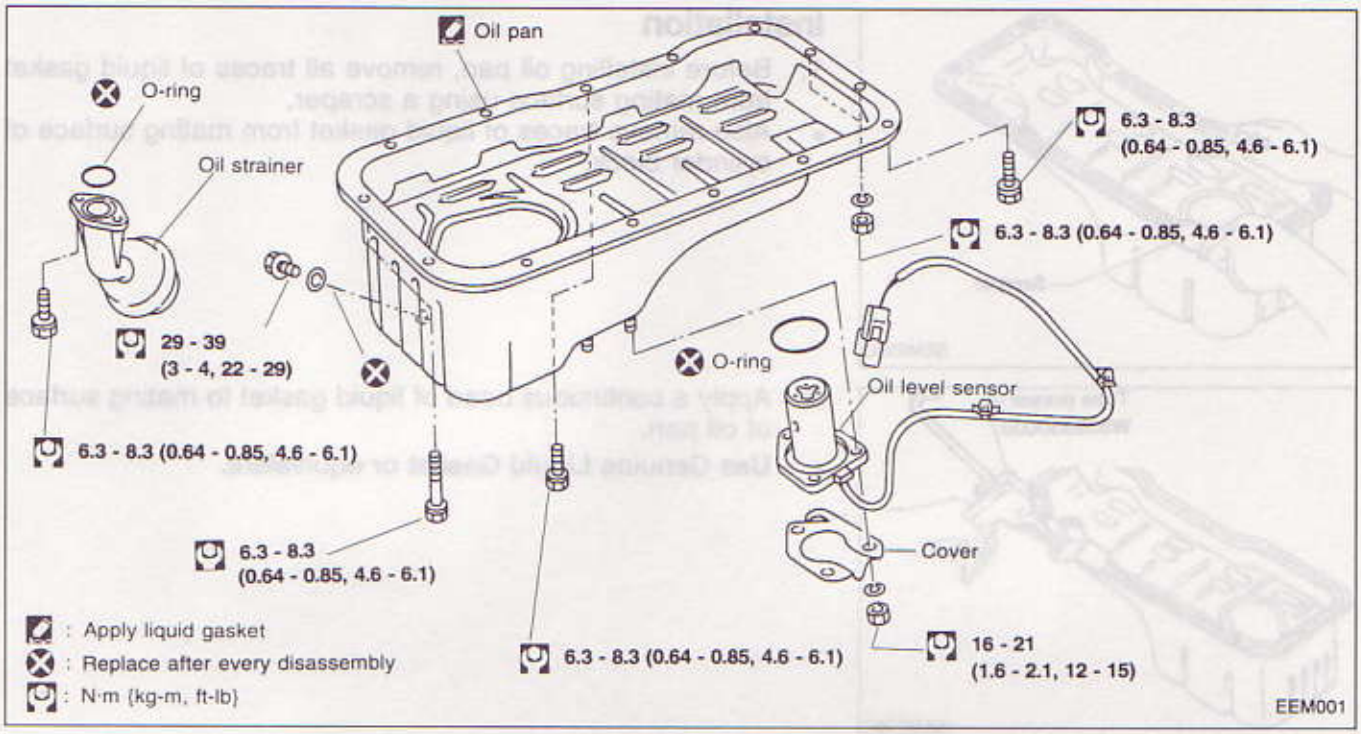
Compression pressure:
kPa (bar, kg/cm^2, psi)/rpm
Standard
1,324 (13.24, 13.5, 192)/350
Minimum
1,128 (11.28, 11.5, 164)/350
Difference limit between cylinders
98 (0.98, 1.0, 14)/350

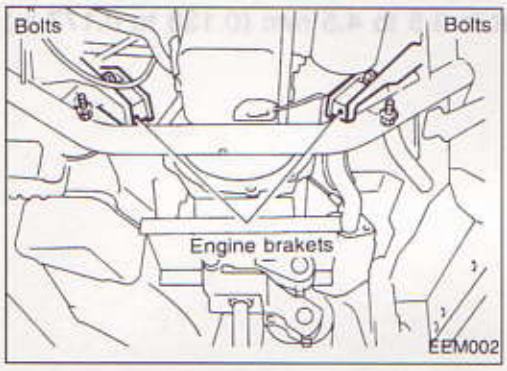


Use compressor tester whose end (rubber portion) is less than 20 mm (0.79 in) dia. Otherwise, it may be caught by cylinder head during removal.
SEM387C

10. If cylinder compression in one or more cylinders is low, pour a small amount of engine oil into cylinders through spark plug holes and retest compression.

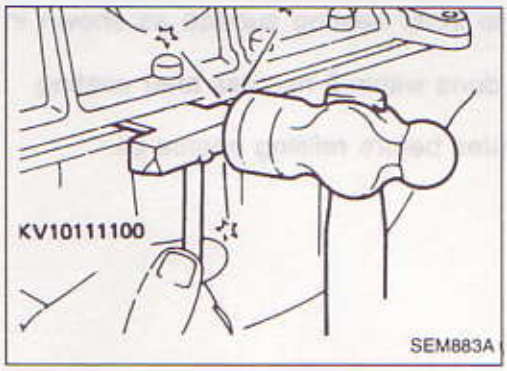
- **If adding oil helps compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. (Refer to S.D.S.) If valve or valve seat is damaged excessively, replace them.**
- **If compression in any two adjacent cylinders is low and if adding oil does not help compression, there is leakage past the gasket surface. If so, replace cylinder head gasket.**





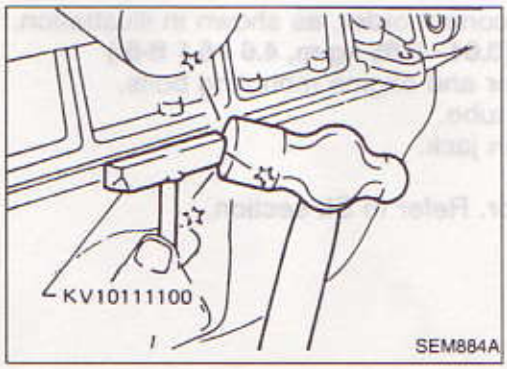
Removal

1. Remove engine under cover.
2. Drain engine oil.
3. Remove front exhauxt tube.
4 Suport engine by placing a transmission jack under transaxle.
5. Remove center member and engine mounting bolts.

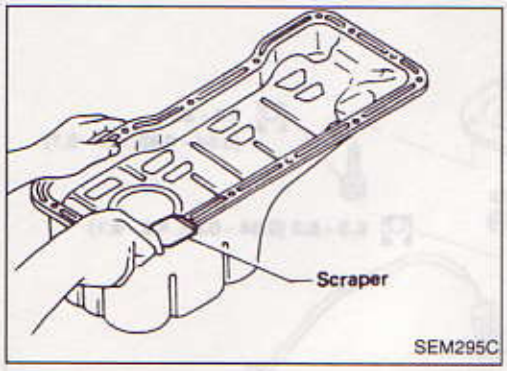


6. Remove oil pan.
(1) Insert Tool between cylinder block and oil pan.

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

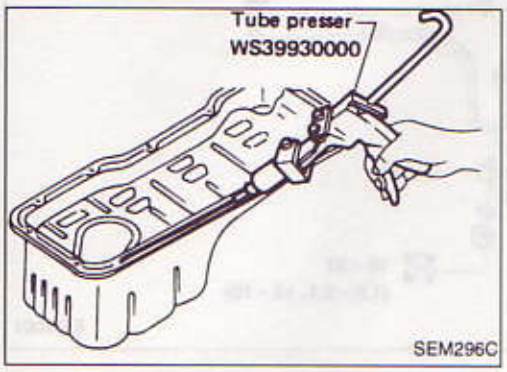


(2) Slide Tool by tapping its side with a hammer, and remove oil pan.

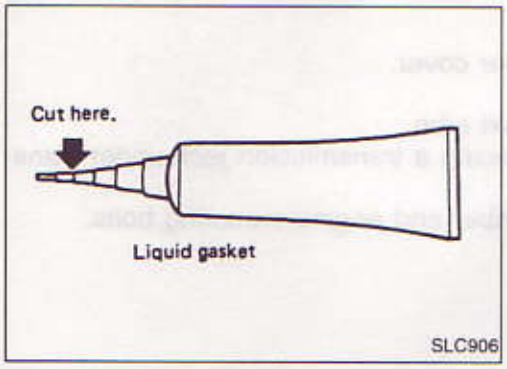


Installation

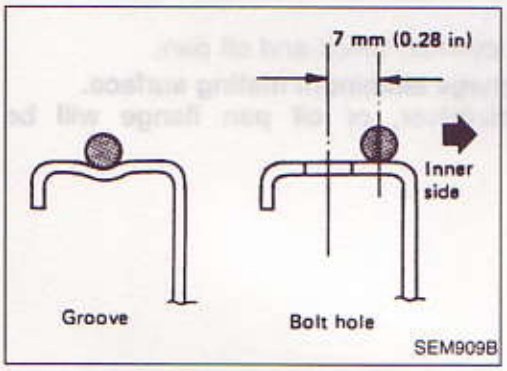
1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
   - Also remove traces of liquid gasket from mating surface of cylinder block.



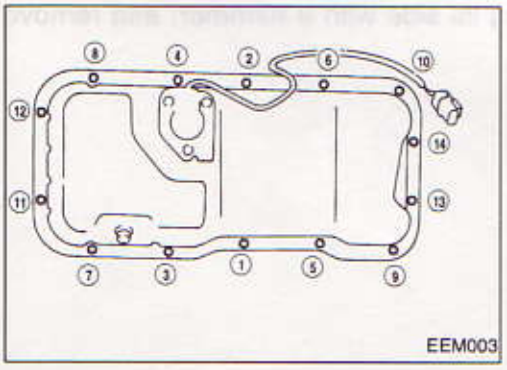
2. Apply a continuous bead of liquid gasket to mating surface of oil pan.
   - **Use Genuine Liquid Gasket or equivalent.**



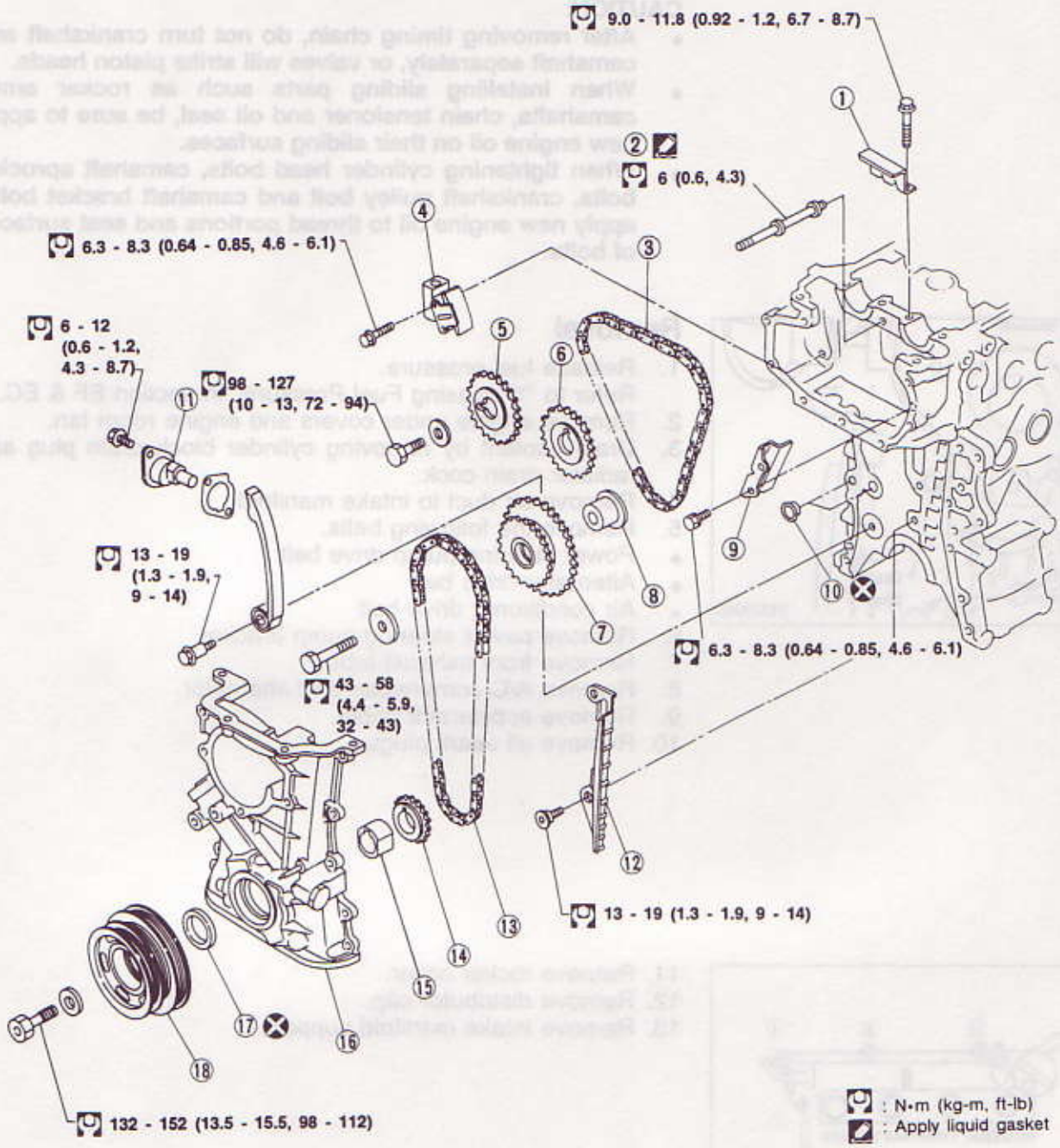
- Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.



3. Apply liquid gasket to inner sealing surface as shown in figure.
   - Attaching should be done within 5 minutes after coating.
4. Install oil pan.
   - Wait at least 30 minutes before refilling engine oil.



- Tighten bolts in the correct order, as shown in illustration.
  6.3 - 8.3 N·m (0.64 - 0.85 kg-m, 4.6 - 6.1 ft-lb)
5. Install center member and engine mounting bolts.
6. Install front exhaust tube.
7. Remove transmission jack.
8. Install under covers.
9. Install oil level sensor. Refer to EL section.

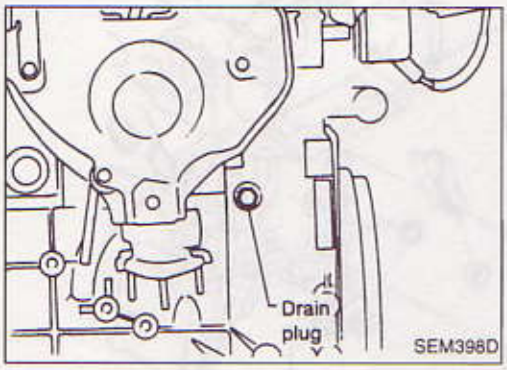


SEM397D

① Chain guide
② Cylinder head front cover gusset
③ Upper timing chain
④ Chain tensioner
⑤ Camshaft sprocket (Intake)
⑥ Camshaft sprocket (Exhaust)
⑦ Idler sprocket
⑧ Idler shaft
⑨ Chain guide
⑩ O-ring
⑪ Chain tensioner
⑫ Chain guide
⑬ Lower timing chain
⑭ Crankshaft sprocket
⑮ Oil pump drive spacer
⑯ Front cover
⑰ Oil seal
⑱ Crankshaft pulley

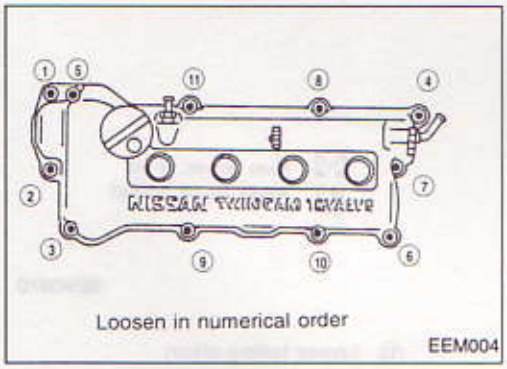
CAUTION:

- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing sliding parts such as rocker arms, camshafts, chain tensioner and oil seal, be sure to apply new engine oil on their sliding surfaces.**
- **When tightening cylinder head bolts, camshaft sprocket bolts, crankshaft pulley bolt and camshaft bracket bolts, apply new engine oil to thread portions and seat surfaces of bolts.**

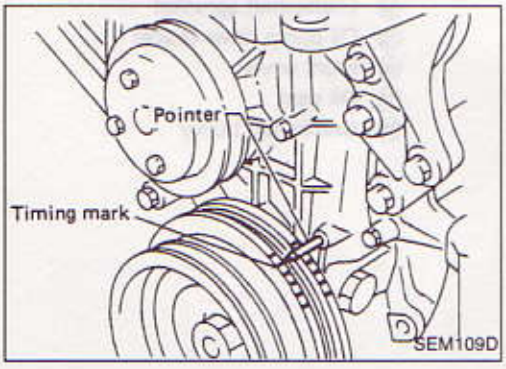


Removal

1. Release fuel pressure.
   Refer to "Releasing Fuel Pressure" in section EF & EC.
2. Remove engine under covers and engine room fan.
3. Drain coolant by removing cylinder block drain plug and radiator drain cock.
4. Remove air duct to intake manifold.
5. Remove the following belts.
   - Power steering pump drive belt
   - Alternator drive belt
   - Air conditioner drive belt
6. Remove power steering pump bracket.
7. Remove front exhaust tube.
8. Remove A/C compressor and alternator.
9. Remove accelerator cable.
10. Remove all spark plugs

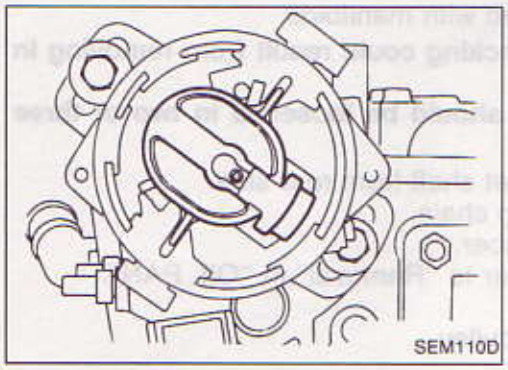


11. Remove rocker cover.
12. Remove distributor cap.
13. Remove intake manifold support.



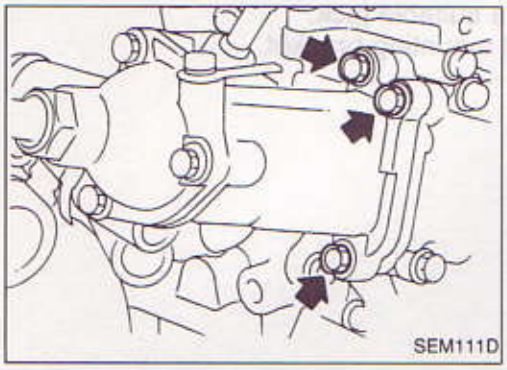
14. Set No. 1 piston at T.D.C. on its compression stroke.

Removal (Cont'd)

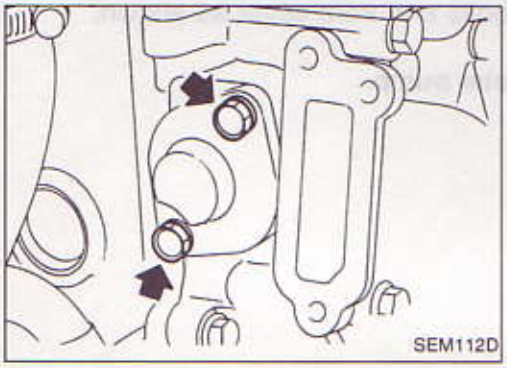


- Make sure No. 1 cylinder is at T.D.C. by looking at distributor rotor position.

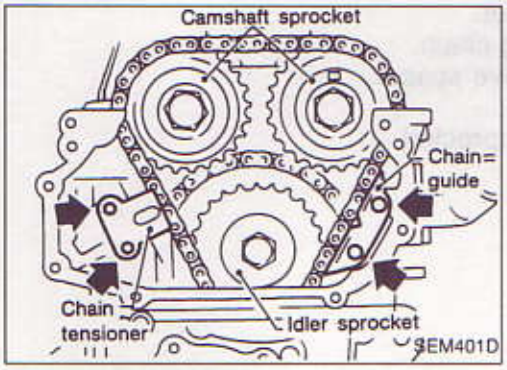
15. Remove distributor.
16. Remove cam sprocket cover and gusset.
17. Remove water pump pulley.



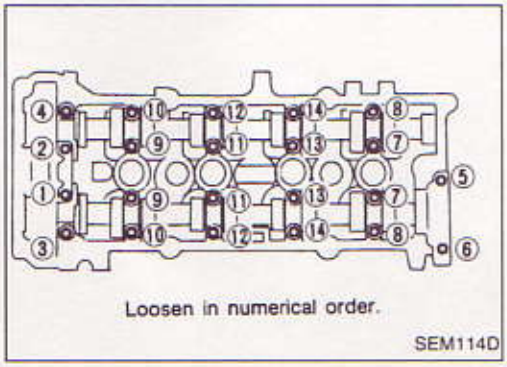
18. Remove thermostat housing.



19. Remove chain tensioner.



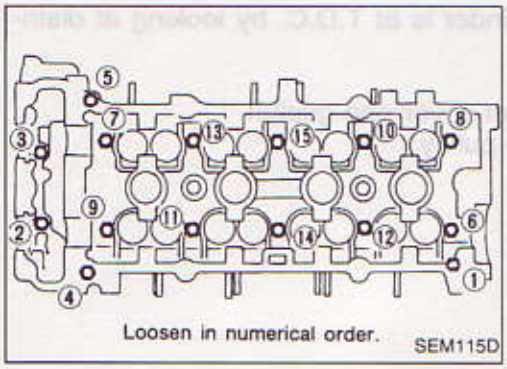
20. Remove chain tensioner and chain guide.
21. Loosen idler sprocket bolt.
22. Remove camshaft sprocket bolts.
23. Remove camshaft sprockets.



24. Remove camshaft brackets and camshafts.
- **These parts should be reassembled in their original positions.**
- **Bolts should be loosened in two or three steps.**

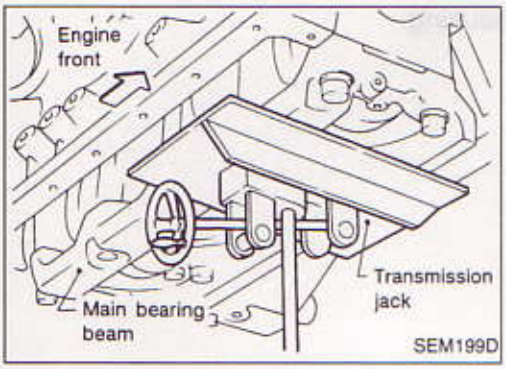
25. Remove idler sprocket bolt.

Removal (Cont'd)

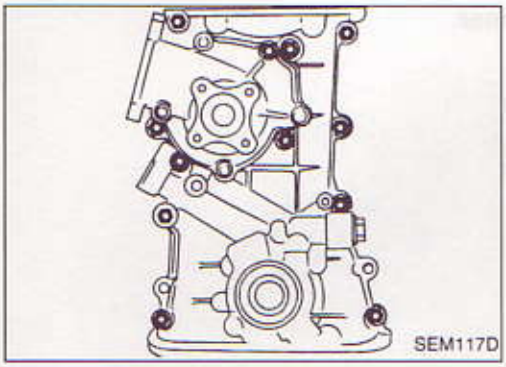


26. Remove cylinder head with manifolds.
- **Head warpage or cracking could result from removing in incorrect order.**
- **Cylinder head bolts should be loosened in two or three steps.**

27. Remove idler sprocket shaft from rear side.
28. Remove upper timing chain.
29. Remove center member.
30. Remove oil pan. Refer to "Removal" in "OIL PAN".
31. Remove oil strainer.
32. Remove crankshaft pulley.

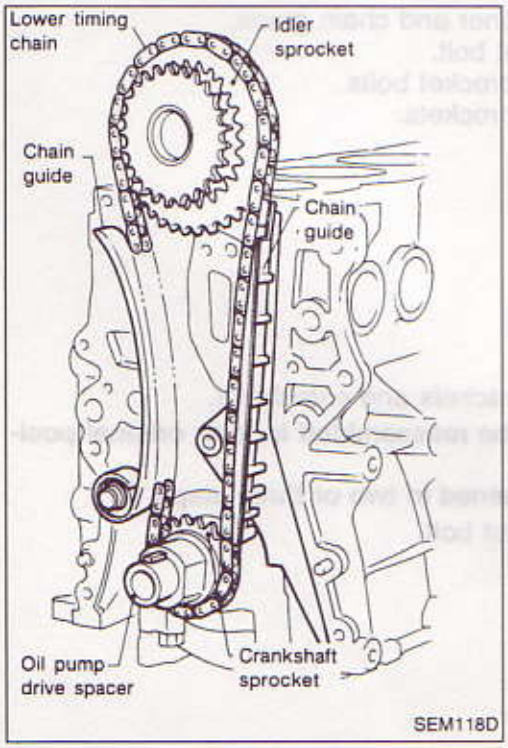


33. Support engine with a suitable jack.
34. Remove engine front mounting bracket.

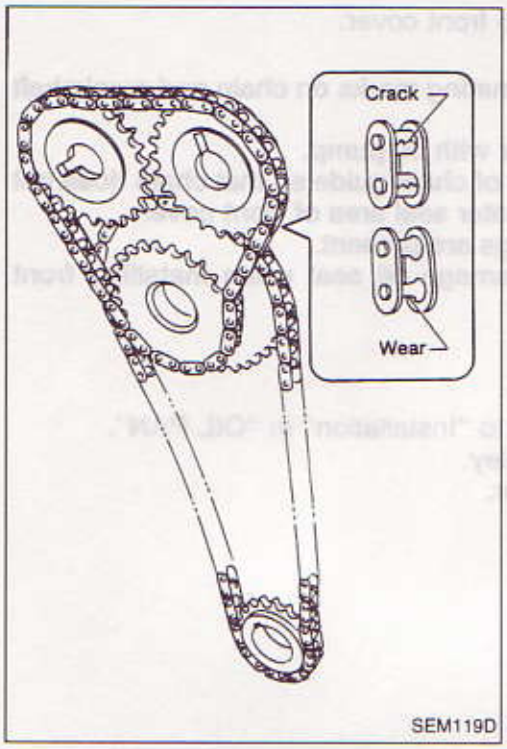


35. Remove front cover bolts and front cover as shown.

CAUTION:
One bolt is located on water pump.

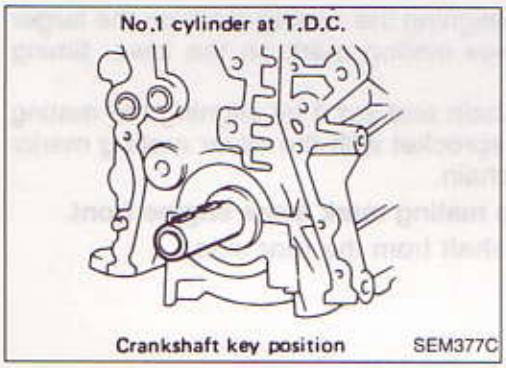


36. Remove idler sprocket.
37. Remove lower timing chain.
38. Remove oil pump drive spacer.
39. Remove chain guide.
40. Remove crankshaft sprocket.



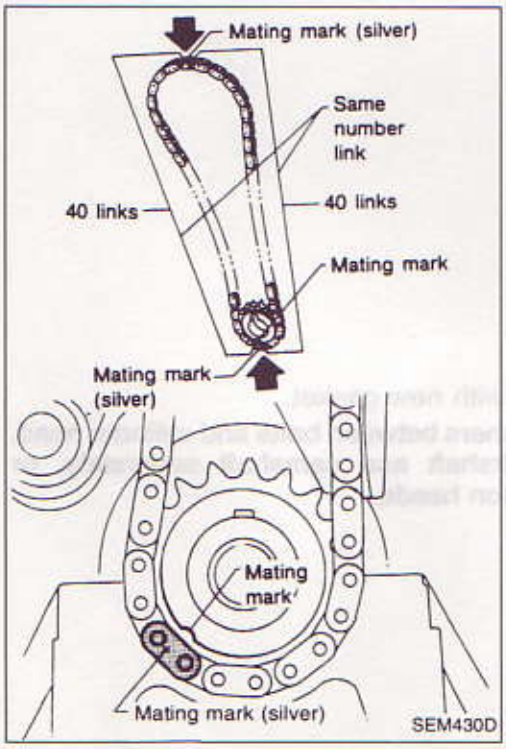
Inspection

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



Installation

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



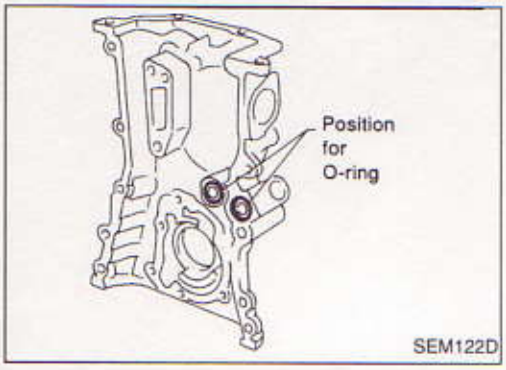
2. Install chain guide.
3. Install crankshaft sprocket and lower timing chain.

- **Set timing chain by aligning its mating mark with the one on crankshaft sprocket.**
- **Make sure sprocket's mating mark faces engine front.**
- **The number of links between the alignment marks (gold) are the same for the left and right sides, so either side can be used during alignment with the sprocket.**

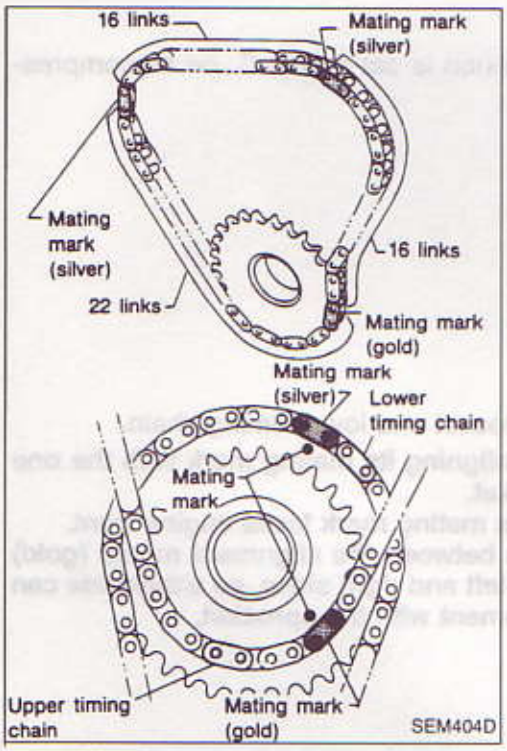
Installation (Cont'd)

4. Apply liquid gasket to front cover.
5. Install front cover.

- **Check alignment of mating marks on chain and crankshaft sprocket.**
- **Align oil drive spacer with oil pump.**
- **Put chain to the side of chain guide so that chain does not make contact with water seal area of front cover.**
- **Make sure two O-rings are present.**
- **Be careful not to damage oil seal when installing front cover.**



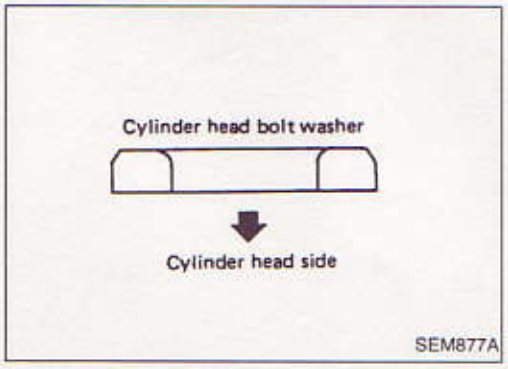
6. Install oil strainer.
7. Install oil pan. Refer to "Installation" in "OIL PAN".
8. Install crankshaft pulley.
9. Install center member.



10. Set idler sprocket by aligning the mating mark on the larger sprocket with the silver mating mark on the lower timing chain.
11. Install upper timing chain and set it by aligning the mating mark on the smaller sprocket with the silver mating marks on the upper timing chain.

- **Make sure sprocket's mating mark faces engine front.**

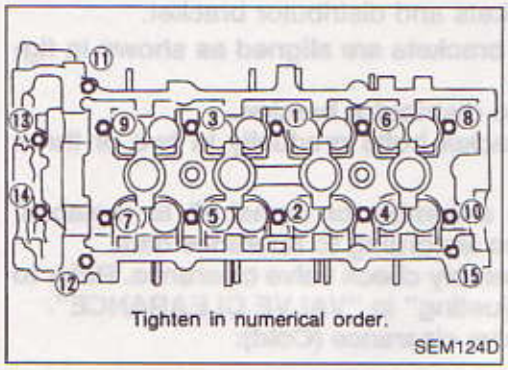
12. Install idler sprocket shaft from the rear side.

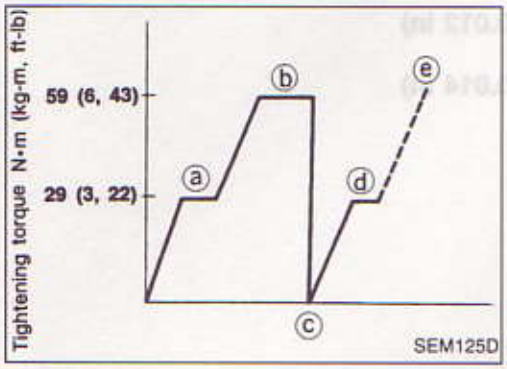


13. Install cylinder head with new gasket.

- **Be sure to install washers between bolts and cylinder head.**
- **Do not rotate crankshaft and camshaft separately, or valves will strike piston heads.**

Installation (Cont'd)



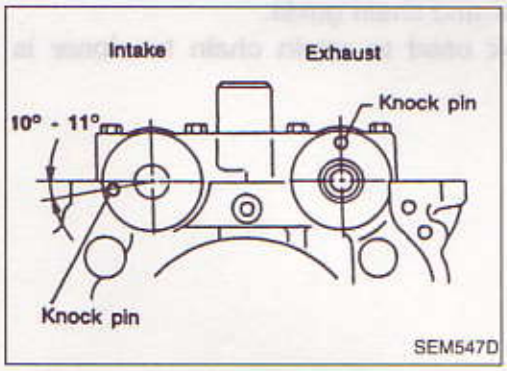


- **Tightening procedure**

ⓐ Tighten bolts to 29 N·m (3 kg-m, 22 ft-lb).
ⓑ Tighten bolts to 59 N·m (6 kg-m, 43 ft-lb).
ⓒ Loosen bolts completely.
ⓓ Tighten bolts to 29 N·m (3 kg-m, 22 ft-lb).
ⓔ Turn bolts 50 to 55 degrees clockwise or if angle wrench is not available, tighten bolts to 59±5 N·m (6±0.5 kg-m, 43.4±3.6 ft-lb).
ⓕ Tighten bolts (⑪ - ⑮) to 6.3 to 8.3 N·m (0.64 to 0.85 kg-m, 4.6 to 6.1 ft-lb).

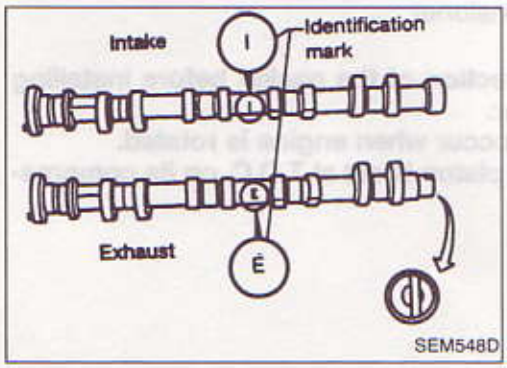
	Tightening torque N·m (kg-m, ft-lb)				
	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ, ⓕ
Bolts (① - ⑩)	29 (3, 22)	59 (6, 43)	0 (0, 0)	29 (3, 22)	50 - 55 degrees or 59±5 (6±0.5, 43.4±3.6)
Bolts (⑪ - ⑮)	—	—	—	—	6.3 - 8.3 (0.64 - 0.85, 4.6 - 6.1)

14. Install idler sprocket bolt.



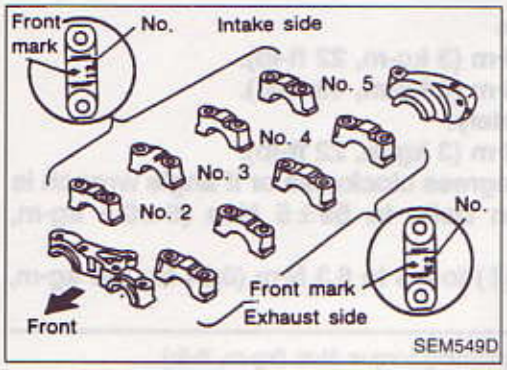
15. Install camshaft.

- **Make sure camshafts are aligned as shown in figure.**

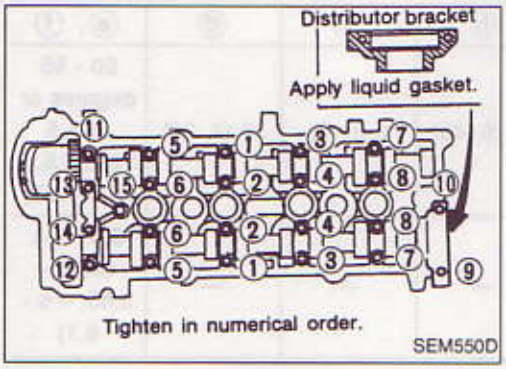


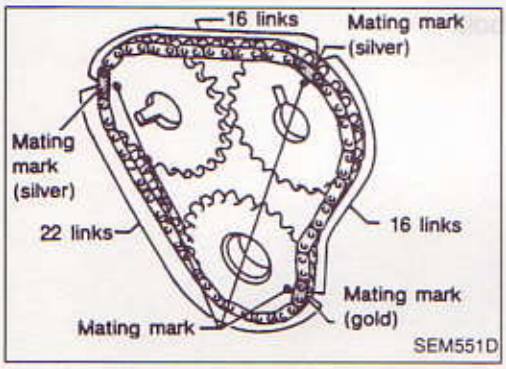
- **Identification marks are present on camshafts.**

Installation (Cont'd)



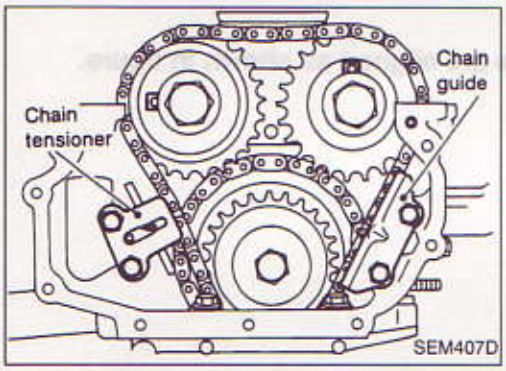
16. Install camshaft brackets and distributor bracket.
- **Make sure camshaft brackets are aligned as shown in figure.**
- **Apply liquid gasket to distributor bracket.**
- **Tighten camshaft bracket bolts gradually in two or three stages.**
- **If any part of valve assembly or camshaft is replaced, check valve clearance according to reference data.**
  After completing assembly check valve clearance. Refer to "Checking" and "Adjusting" in "VALVE CLEARANCE".
  Reference data valve clearance (Cold):
  Intake
  0.30 mm (0.012 in)
  Exhaust
  0.35 mm (0.014 in)



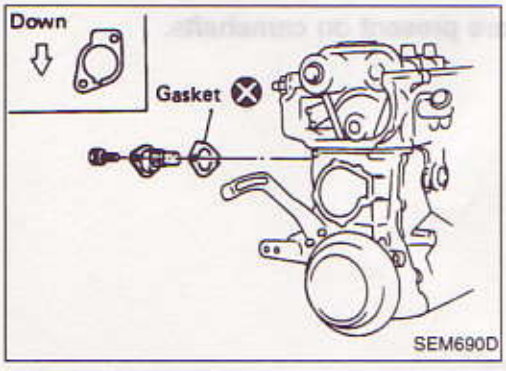


17. Assemble camshaft sprocket with chain.
- **Set timing chain by aligning mating marks with those of camshaft sprockets.**
- **Make sure sprocket's mating marks face engine front.**

18. Install camshaft sprocket bolts.
- **Make sure camshafts are aligned as shown in figure.**



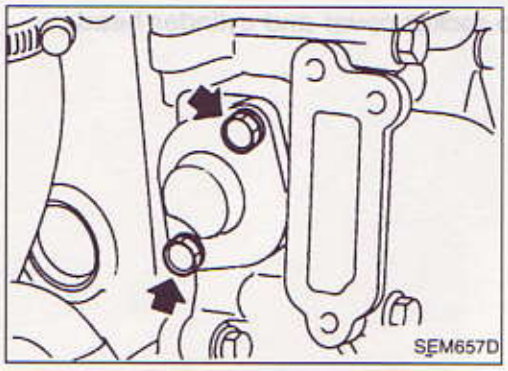
19. Install chain tensioner and chain guide.
- **Make sure that hook used to retain chain tensioner is released.**

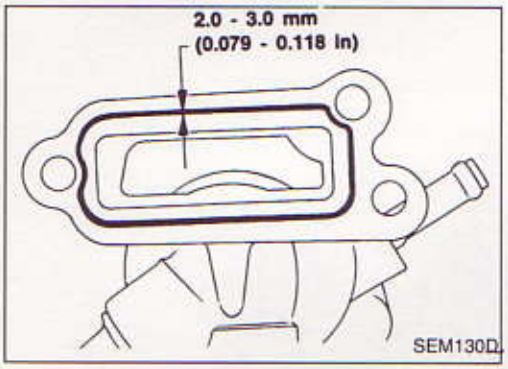


20. Install lower chain tensioner.

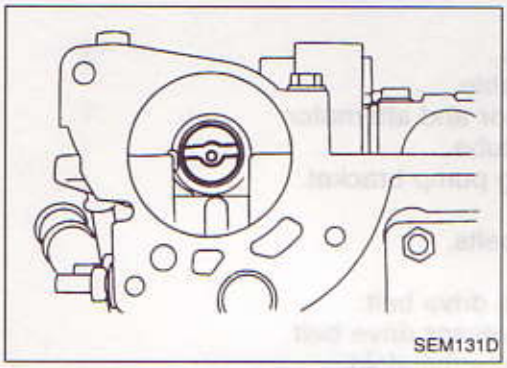
CAUTION:
- **Make sure of the direction of the gasket before installing lower chain tensioner.**
- **Check no problems occur when engine is rotated.**
- **Make sure that No. 1 piston is set at T.D.C. on its compression stroke.**

Installation (Cont'd)

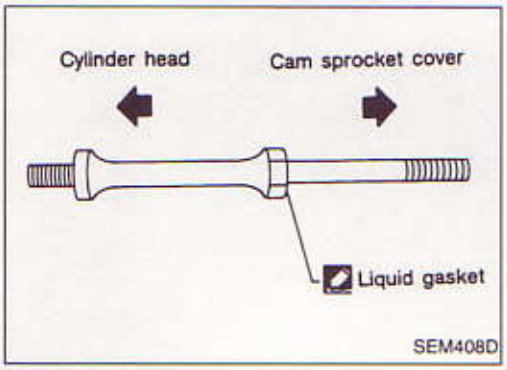




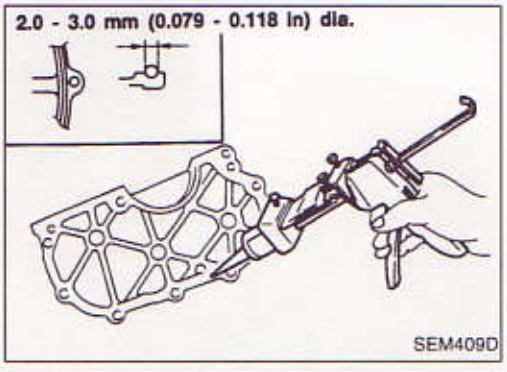
21. Apply liquid gasket to thermostat housing.
22. Install thermostat housing.
23. Install water pump pulley.



24. Install distributor.
- **Make sure that position of camshaft is as shown in figure.**

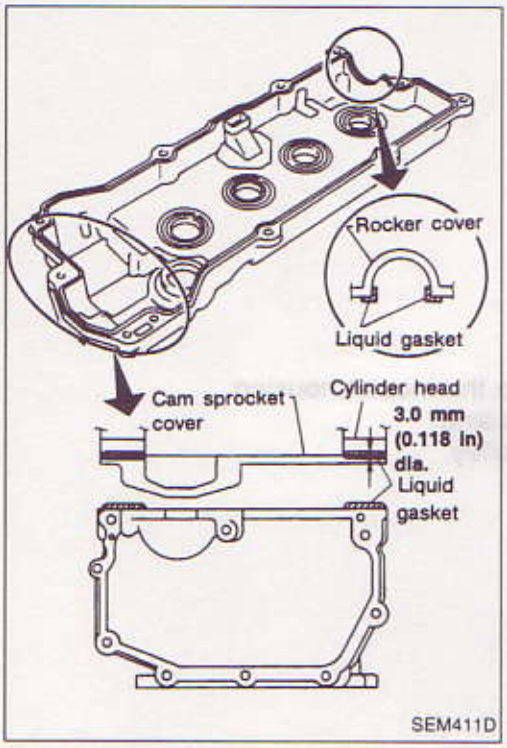


25. Install cam sprocket cover gusset and cam sprocket cover.
- Apply liquid gasket to cam sprocket cover gusset.

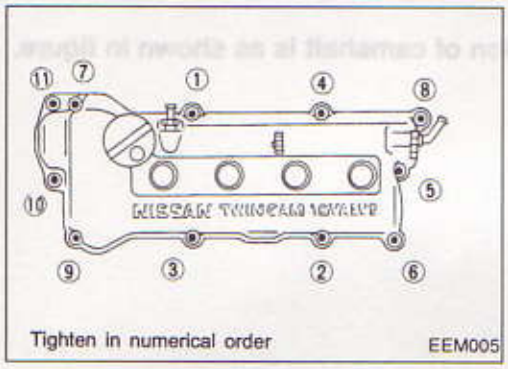


- Apply liquid gasket to cam sprocket cover.

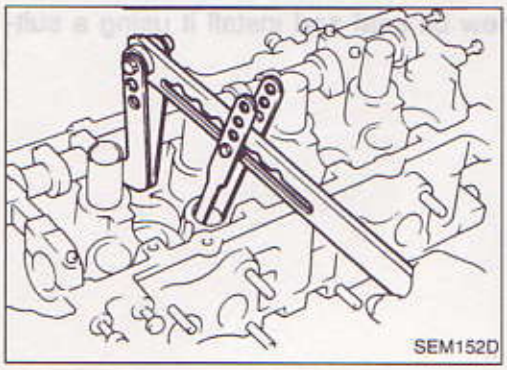
Installation (Cont'd)



26. Apply liquid gasket to rocker cover and cylinder head.



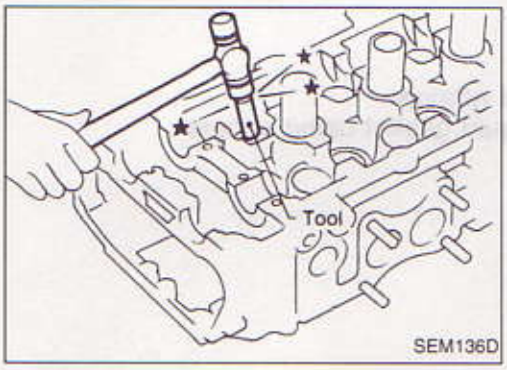
27. Install rocker cover.
28. Install all spark plugs.
29. Install accellerator cable.
30. Install A/C compressor and alternator.
31. Install front exhaust tube.
32. Install power steering pump bracket.
33. Install air cleaner.
34. Install the following belts.
    - Alternator drive belt
    - Power steering pump drive belt
    - Air conditioner compressor drive belt
35. Install air duct to intake manifold.
36. Fill cooling system.
37. Install under covers.


SEM152D

VALVE OIL SEAL

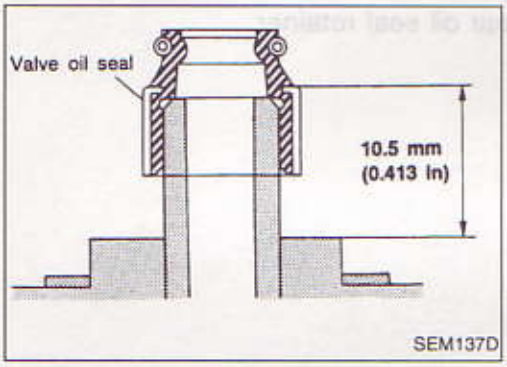
1. Remove rocker cover.
2. Remove camshaft.
3. Remove valve spring and valve oil seal with Tool or a suitable tool.

Piston concerned should be set at T.D.C. to prevent valve from falling.



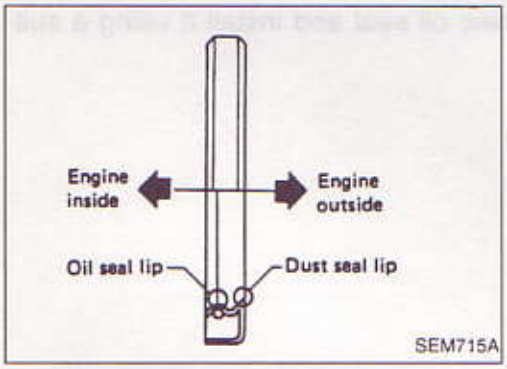
SEM136D

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



SEM137D

OIL SEAL INSTALLING DIRECTION

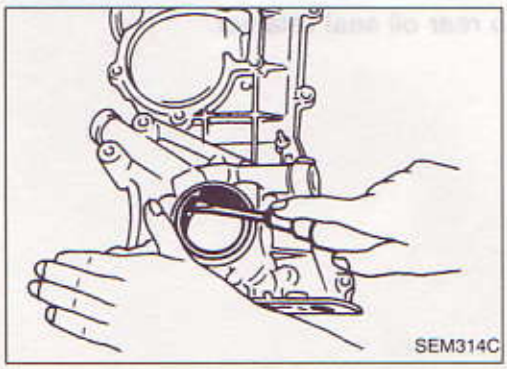


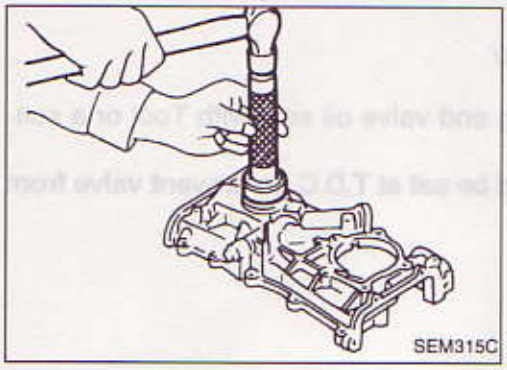
SEM715A

FRONT OIL SEAL

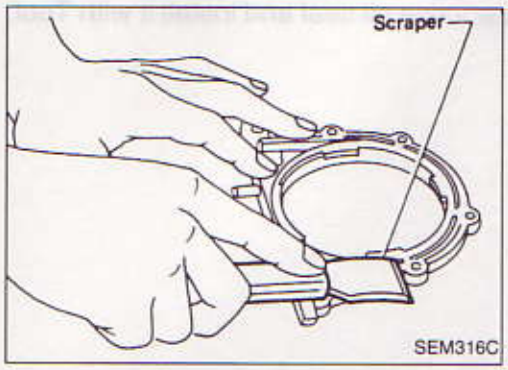
1. Remove front cover. Refer to "Removal" in "TIMING CHAIN".
2. Remove front oil seal from front cover.

Be careful not to damage oil seal retainer.


SEM314C

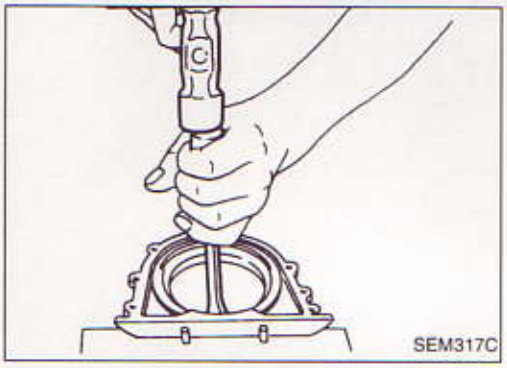


3. Apply engine oil to new oil seal and install it using a suitable tool.

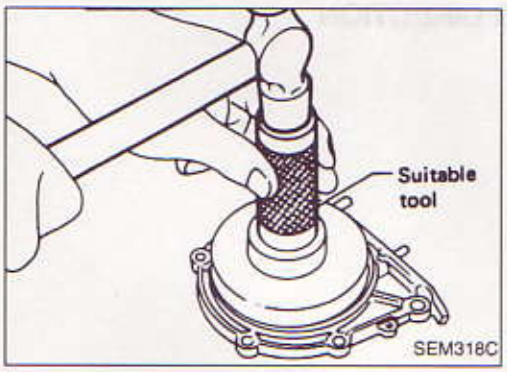


REAR OIL SEAL

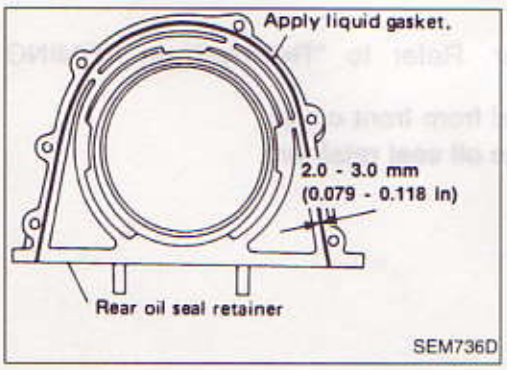
1. Remove flywheel.
2. Remove rear oil seal retainer.
3. Remove traces of liquid gasket using scraper.



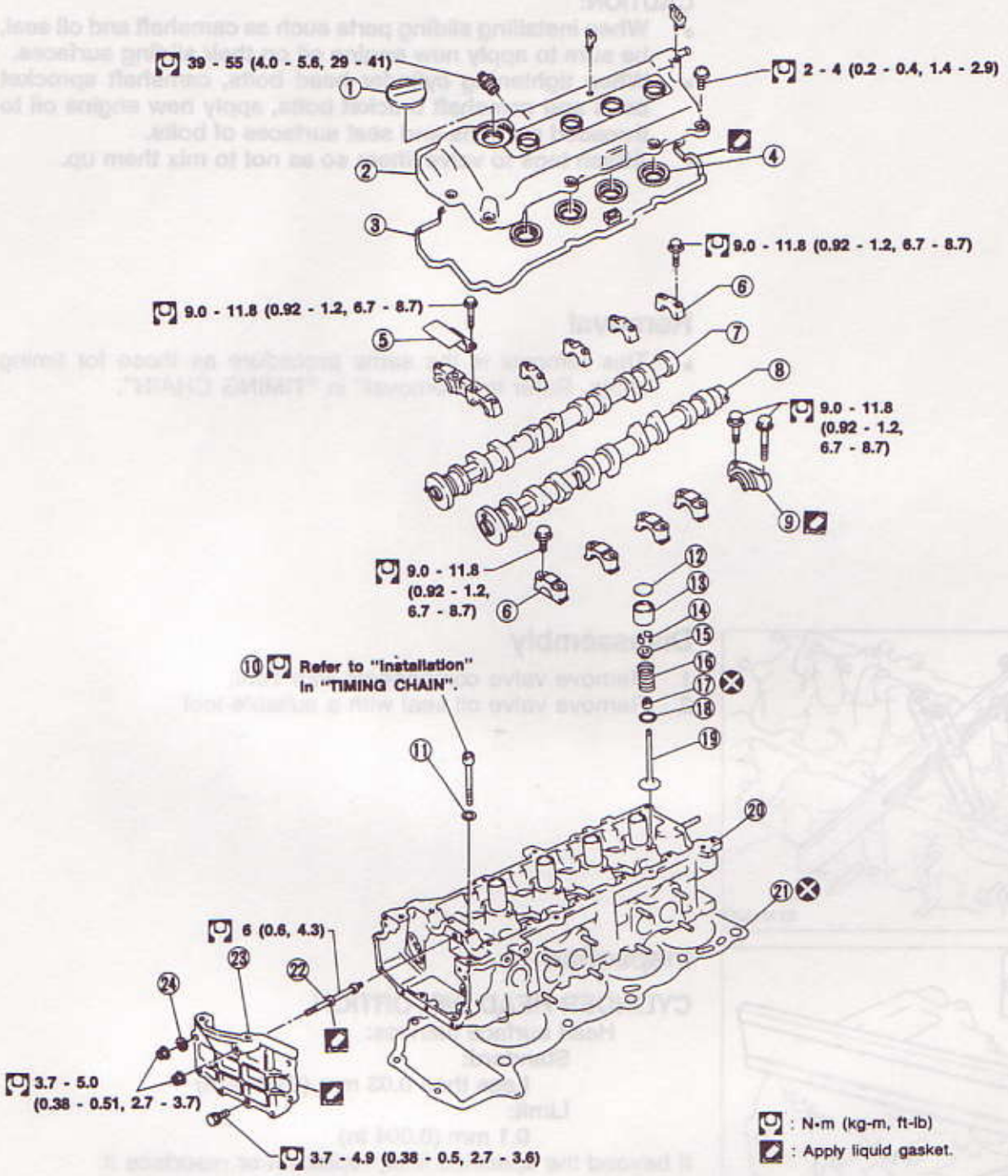
4. Remove seal from rear oil seal retainer.



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



6. Apply liquid gasket to rear oil seal retainer.



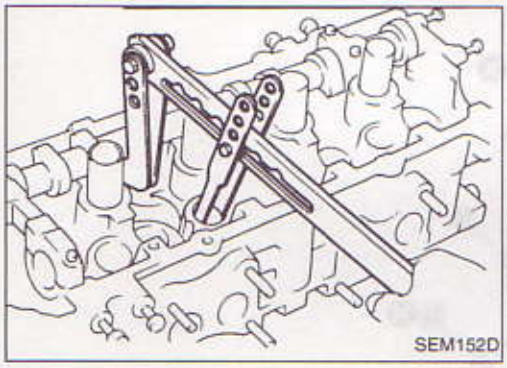
① Oil filler cap
② Rocker cover
③ Rocker cover gasket
④ Oil seal
⑤ Chain guide
⑥ Camshaft bracket
⑦ Intake camshaft
⑧ Exhaust camshaft
⑨ Distributor bracket
⑩ Cylinder head bolt
⑪ Washer
⑫ Shim
⑬ Valve lifter
⑭ Valve cotter
⑮ Valve spring retainer
⑯ Valve spring
⑰ Valve oil seal
⑱ Spring seat
⑲ Valve
⑳ Cylinder head
㉑ Cylinder head gasket
㉒ Cam sprocket cover gusset
㉓ Cam sprocket cover
㉔ Washer

CAUTION:

- **When installing sliding parts such as camshaft and oil seal, be sure to apply new engine oil on their sliding surfaces.**
- **When tightening cylinder head bolts, camshaft sprocket bolts and camshaft bracket bolts, apply new engine oil to threaded portions and seat surfaces of bolts.**
- **Attach tags to valve lifters so as not to mix them up.**

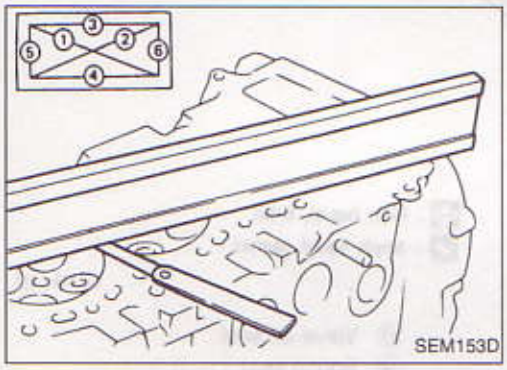
Removal

- This removal is the same procedure as those for timing chain. Refer to "Removal" in "TIMING CHAIN".


SEM152D

Disassembly

1. Remove valve components with Tool.
2. Remove valve oil seal with a suitable tool.



SEM153D

Inspection

CYLINDER HEAD DISTORTION

Head surface flatness:

Standard:

Less than 0.03 mm (0.0012 in)

Limit:

0.1 mm (0.004 in)

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

Resurfacing limit:

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

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

A + B = 0.2 mm (0.008 in)

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

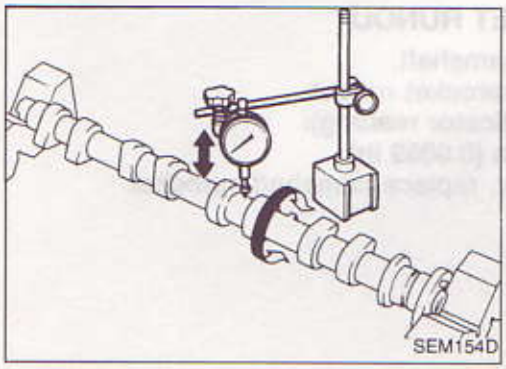
Nominal cylinder head height:

117.8 - 118.0 mm (4.638 - 4.646 in)

Inspection (Cont'd)

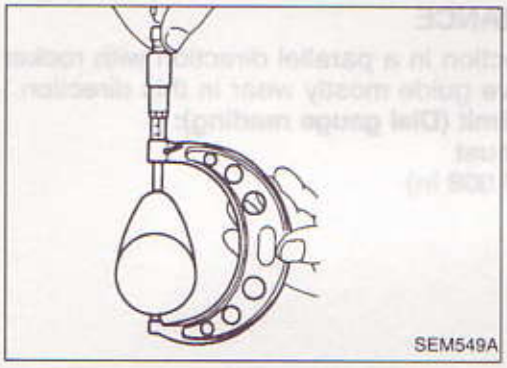
CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.



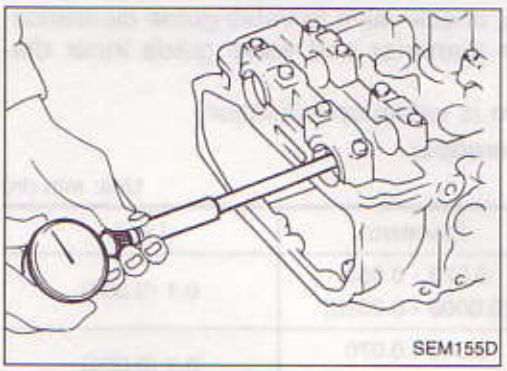
CAMSHAFT RUNOUT

1. Measure camshaft runout at the center journal.
   Runout (Total indicator reading):
   Standard:
   Less than 0.02 mm (0.0008 in)
   Limit:
   0.1 mm (0.004 in)
2. If it exceeds the limit, replace camshaft.



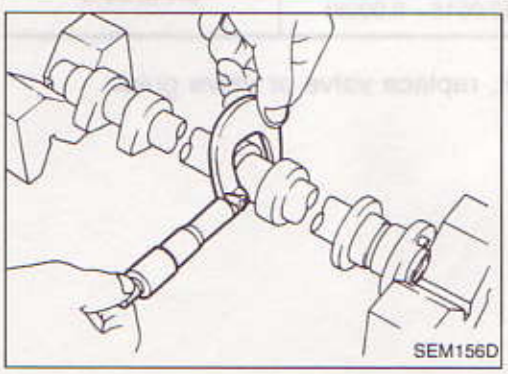
CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height:
   Standard cam height:
   Intake
   40.600 - 40.790 mm (1.5984 - 1.6059 in)
   Exhaust
   39.880 - 40.070 mm (1.5701 - 1.5776 in)
   Cam wear limit:
   Intake and exhaust
   0.20 mm (0.008 in).
2. If wear is beyond the limit, replace camshaft.



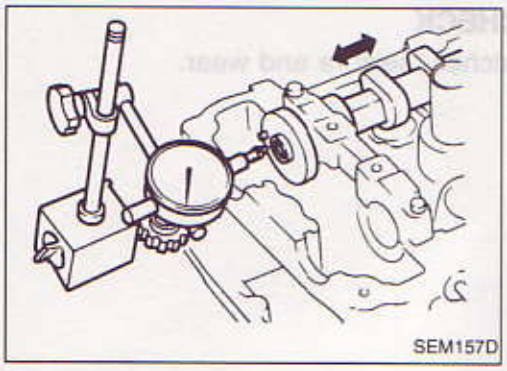
CAMSHAFT JOURNAL CLEARANCE

1. Install camshaft bracket and tighten bolts to the specified torque.
2. Measure inner diameter of camshaft bearing.
   Standard inner diameter:
   No. 1 bearing
   28.000 - 28.021 mm (1.1024 - 1.1032 in)
   No. 2 to No. 5 bearings
   24.000 - 24.021 mm (0.9449 - 0.9457 in)
3. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   No. 1 journal
   27.935 - 27.955 mm (1.0998 - 1.1006 in)
   No. 2 to No. 5 journals
   23.935 - 23.955 mm (0.9423 - 0.9431 in)
4. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance:
   Standard
   0.045 - 0.086 mm (0.0018 - 0.0034 in)
   Limit
   0.15 mm (0.0059 in)



Inspection (Cont'd)

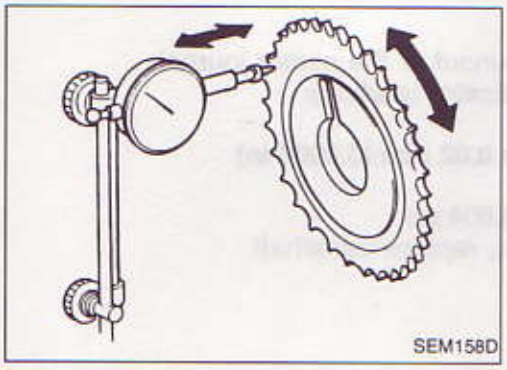
CAMSHAFT END PLAY


SEM157D

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

Camshaft end play:
Standard
0.070 - 0.143 mm (0.0028 - 0.0056 in)
Limit
0.20 mm (0.0079 in)

CAMSHAFT SPROCKET RUNOUT

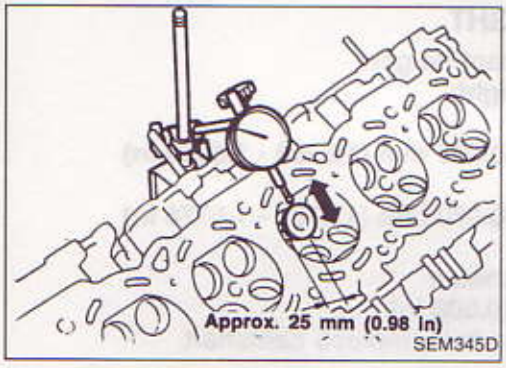

SEM158D

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

Runout (Total indicator reading):
Limit 0.15 mm (0.0059 in)

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

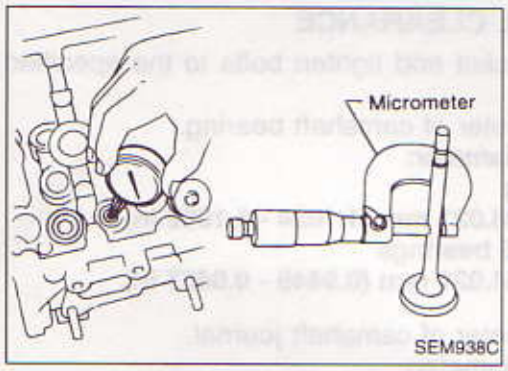
VALVE GUIDE CLEARANCE



SEM345D

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):
Intake & Exhaust
0.2 mm (0.008 in)



SEM938C

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

Valve to valve guide clearance:

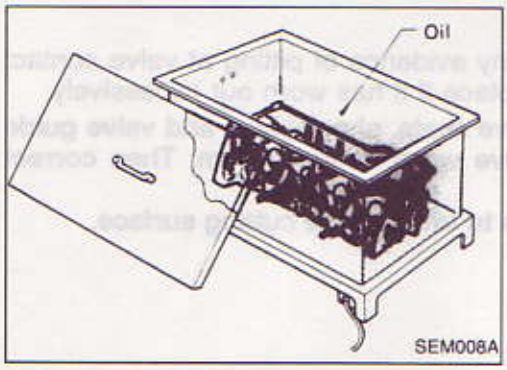
Unit: mm (in)

	Standard	Limit
Intake	0.020 - 0.050 (0.0008 - 0.0020)	0.1 (0.004)
Exhaust	0.040 - 0.070 (0.0016 - 0.0028)	0.1 (0.004)

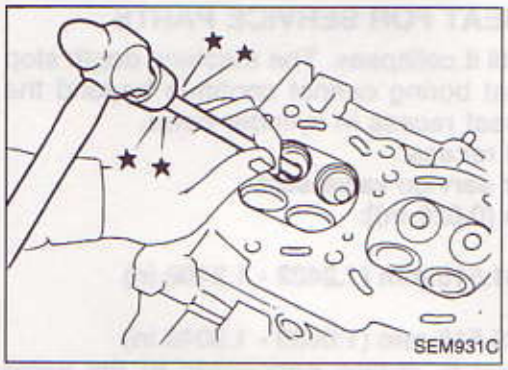
c. If it exceeds the limit, replace valve or valve guide.

Inspection (Cont'd)

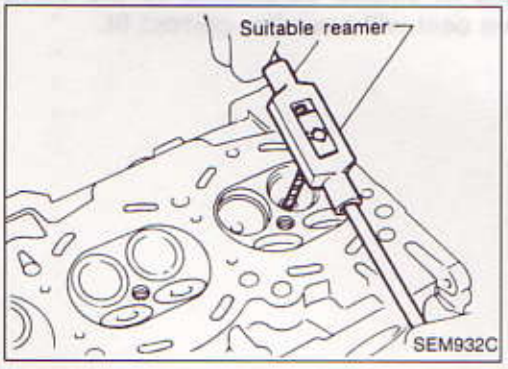
VALVE GUIDE REPLACEMENT



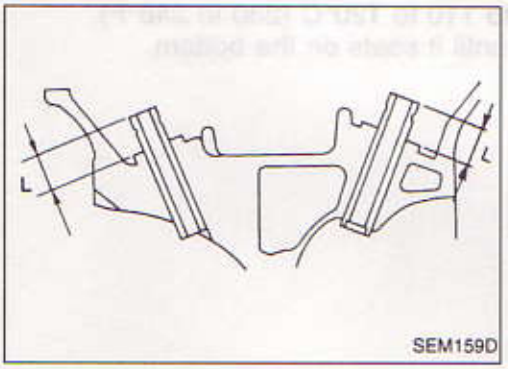
1. To remove valve guide, heat cylinder head to 110 to 120°C (230 to 248°F).



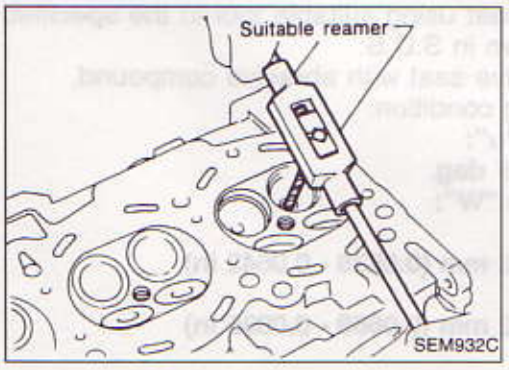
2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.



3. Ream cylinder head valve guide hole.
   Valve guide hole diameter
   (for service parts):
   Intake & Exhaust
   9.685 - 9.696 mm (0.3813 - 0.3817 in)

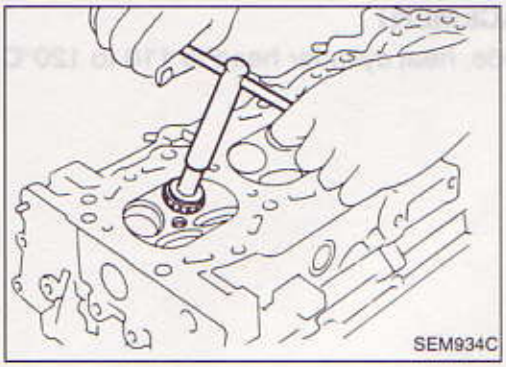


4. Heat cylinder head to 110 to 120°C (230 to 248°F) and press service valve guide into cylinder head.
   Projection "L":
   11.5 - 11.7 mm (0.453 - 0.461 in)



5. Ream valve guide.
   Finished size:
   Intake & Exhaust
   5.500 - 5.515 mm (0.2165 - 0.2171 in)

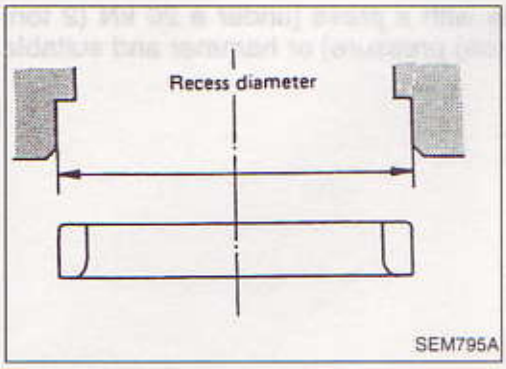
Inspection (Cont'd)


SEM934C

VALVE SEATS

Check valve seats for any evidence of pitting at valve contact surface, and reset 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.**

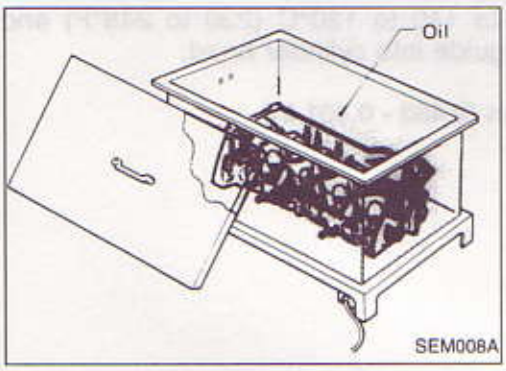


SEM795A

REPLACING VALVE SEAT FOR SERVICE PARTS

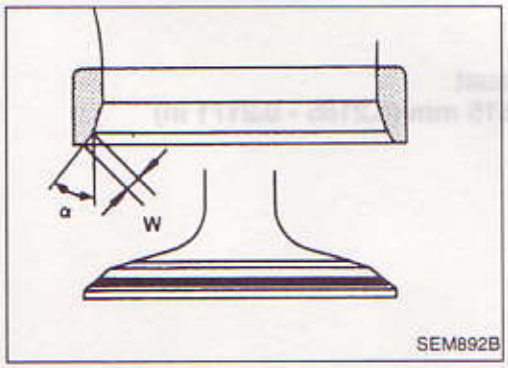
1. Bore out old seat until it collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the seat recess in cylinder head.
2. Ream cylinder head recess.
   Reaming bore for service valve seat
   Oversize [0.5 mm (0.020 in)]:
   Intake
   31.500 - 31.516 mm (1.2402 - 1.2408 in)
   Exhaust
   25.500 - 25.516 mm (1.0039 - 1.0046 in)

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



SEM008A

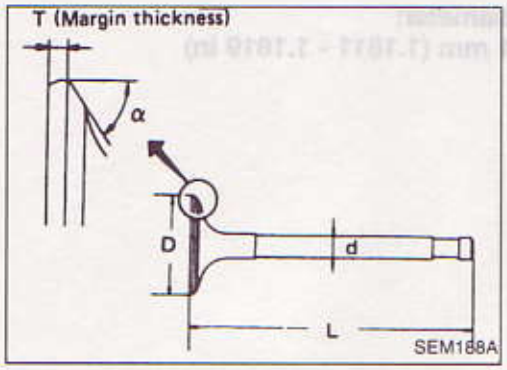
3. Heat cylinder head to 110 to 120°C (230 to 248°F).
4. Press fit valve seat until it seats on the bottom.



SEM892B

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 abrasive compound.
7. Check valve seating condition.
   Seat face angle "α":
   45°15′ - 45°45′ deg.
   Contacting width "W":
   Intake
   1.34 - 1.63 mm (0.0528 - 0.0642 in)
   Exhaust
   1.70 - 2.12 mm (0.0669 - 0.0835 in)

Inspection (Cont'd)

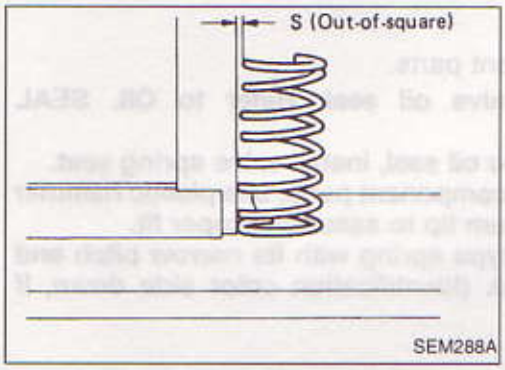


VALVE DIMENSIONS

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

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

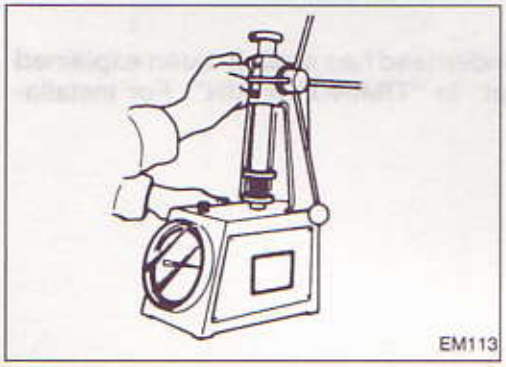
Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.



VALVE SPRING

Squareness

1. Measure "S" dimension.
   Out-of-square:
   Less than 1.80 mm (0.0709 in)
2. If it exceeds the limit, replace spring.

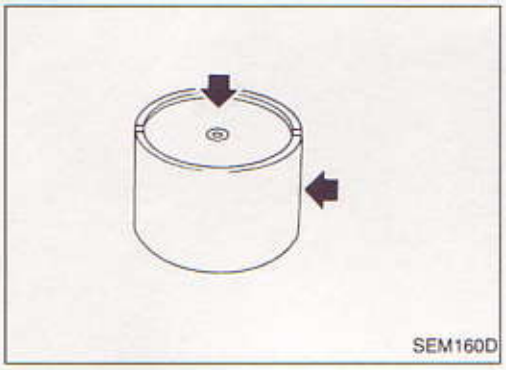


Pressure

Check valve spring pressure.

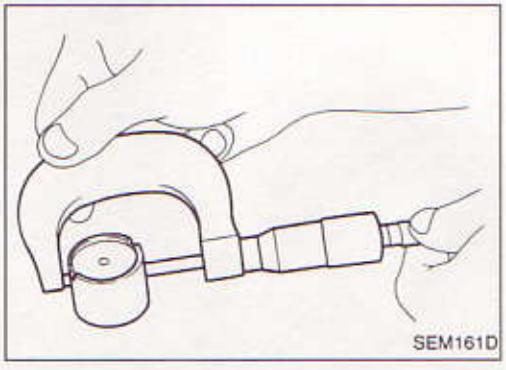
Pressure: N (kg, lb) at height mm (in)
Standard
344.42 (35.12, 77.44) at 25.26 (0.9945)
Limit
More than 323.73 (33.01, 72.79) at 25.26 (0.9945)

If it exceeds the limit, replace spring.



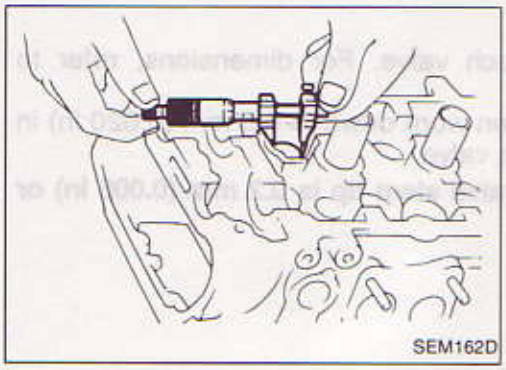
VALVE LIFTER

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

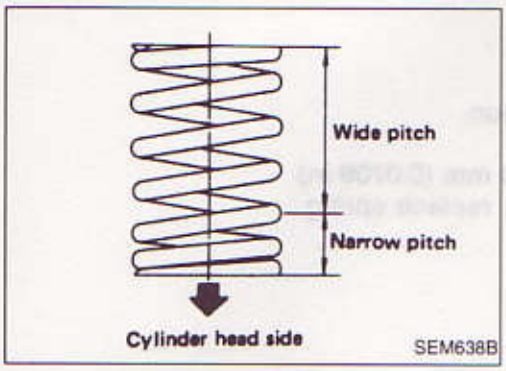


2. Check diameter of valve lifter and valve lifter guide bore.
   Valve lifter diameter:
   29.960 - 29.975 mm (1.1795 - 1.1801 in)

Inspection (Cont'd)


SEM162D

Lifter guide bore diameter:
30.000 - 30.021 mm (1.1811 - 1.1819 in)



SEM638B

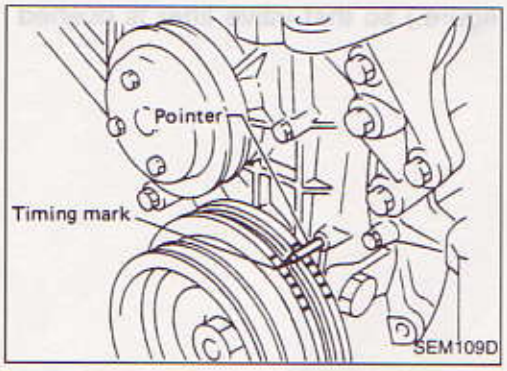
Assembly

1. Install valve component parts.

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

Installation

- The installation of cylinderhead has already been explained in chapter "Installation" in "TIMING CHAIN". For installation see this chapter.



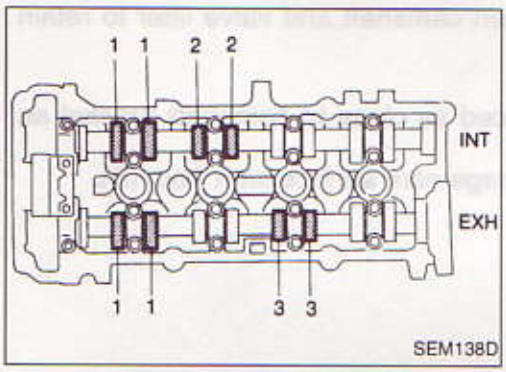
Checking

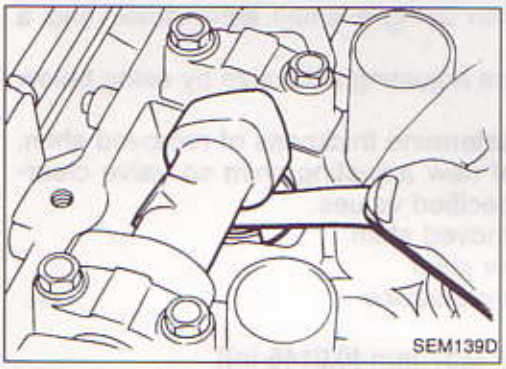
Check valve clearance while engine is warm and not running.

1. Remove rocker cover.
2. Remove all spark plugs.
3. Set No. 1 cylinder at T.D.C. on its compression stroke.
- Align pointer with T.D.C. mark on crankshaft pulley.
- Check that valve lifters on No. 1 cylinder are loose and valve lifters on No. 4 are tight.

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

4. Check only those valves shown in the figure.





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

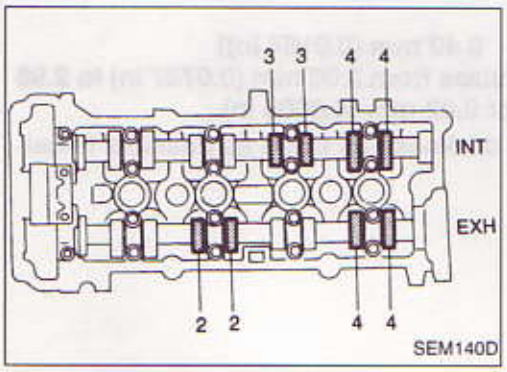
Valve clearance for checking (Hot):

Intake

0.21 - 0.49 mm (0.008 - 0.019 in)

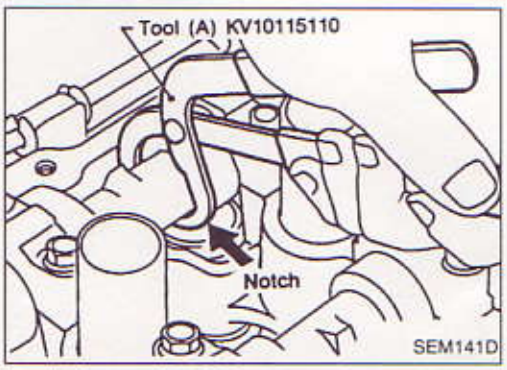
Exhaust

0.30 - 0.58 mm (0.012 - 0.023 in)



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

7. If all valve clearances are within specification, install the following parts.
- Rocker cover
- All spark plugs



Adjusting

Adjust valve clearance while engine is cold.

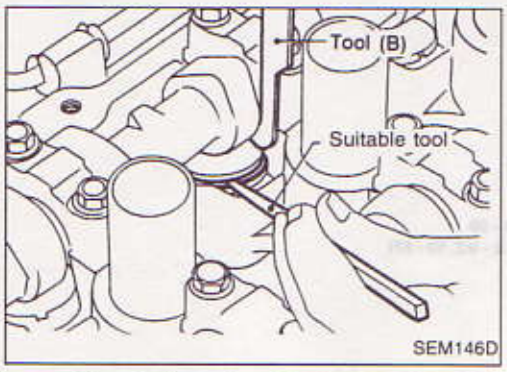
1. Turn crankshaft, to position cam lobe on camshaft of valve that must be adjusted upward.
2. Place Tool (A) around camshaft as shown in figure.

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

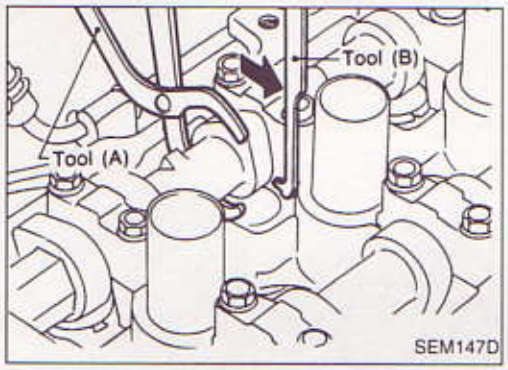
CAUTION:

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

Adjusting (Cont'd)



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



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

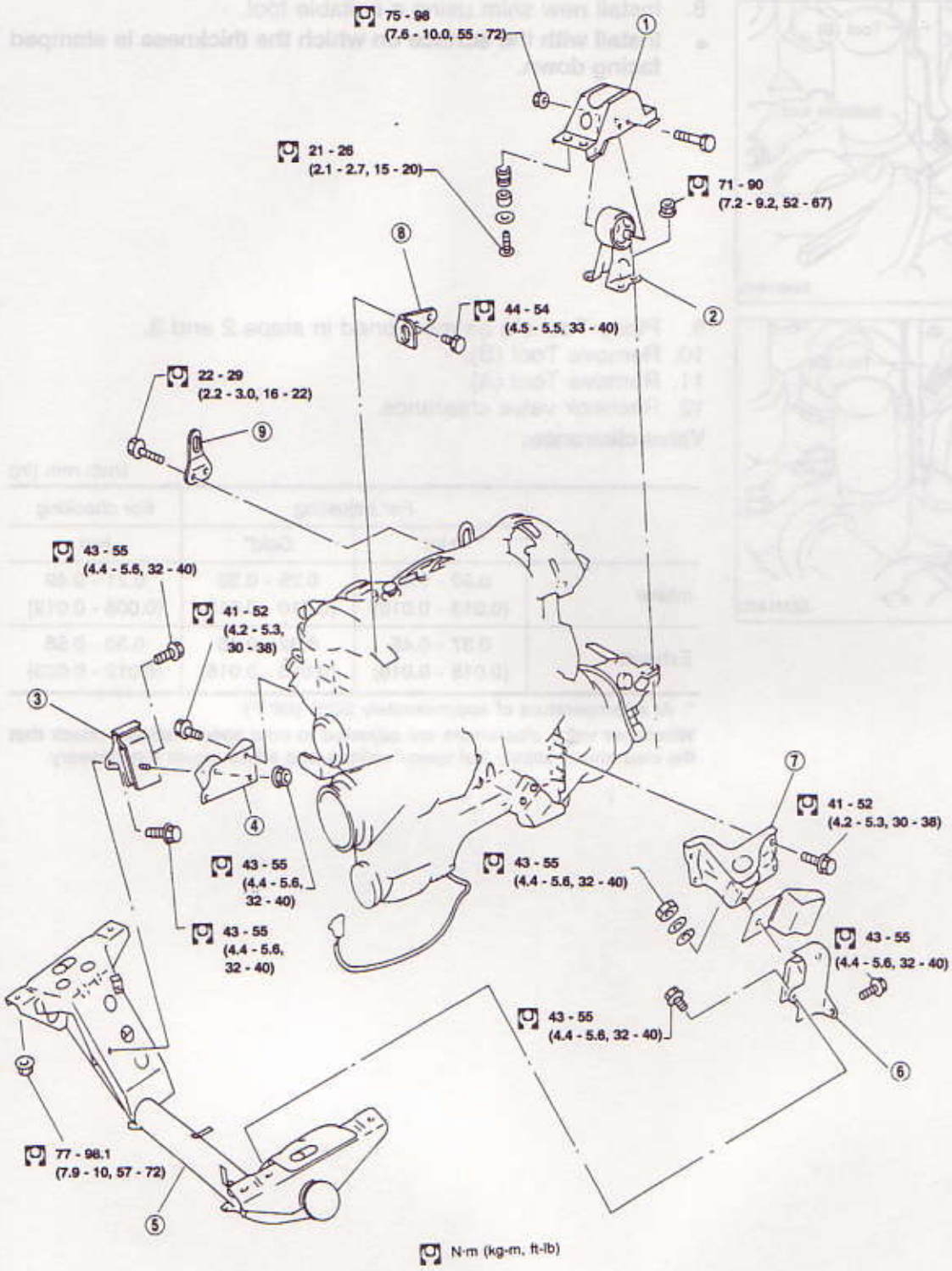
Valve clearance:

Unit: mm (in)

	For adjusting		For checking
	Hot	Cold*	Hot
Intake	0.32 - 0.40 (0.013 - 0.016)	0.25 - 0.33 (0.010 - 0.013)	0.21 - 0.49 (0.008 - 0.019)
Exhaust	0.37 - 0.45 (0.015 - 0.018)	0.32 - 0.40 (0.013 - 0.016)	0.30 - 0.58 (0.012 - 0.023)

*: At a temperature of approximately 20°C (68°F)

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



EEM006

① Mounting bracket
② Rear engine mounting
③ Insulator
④ Bracket
⑤ Member
⑥ Insulator
⑦ Bracket
⑧ Front engine slinger
⑨ Rear engine slinger

WARNING:

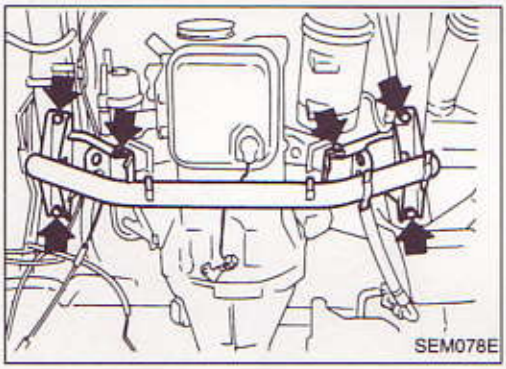
a. Situate vehicle on a flat and solid surface.
b. Place chocks at front and back of rear wheels.
c. Do not remove engine until exhaust system has completely cooled off.
Otherwise, you may burn yourself and/or fire may break out in fuel line.
d. For safety during subsequent steps, the tension of wires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

CAUTION:

- **When lowering engine, be careful not to strike adjacent parts, especially accelerator wire casing and brake lines**
- **In hoisting the engine, always use engine slingers in a safe manner.**

Removal

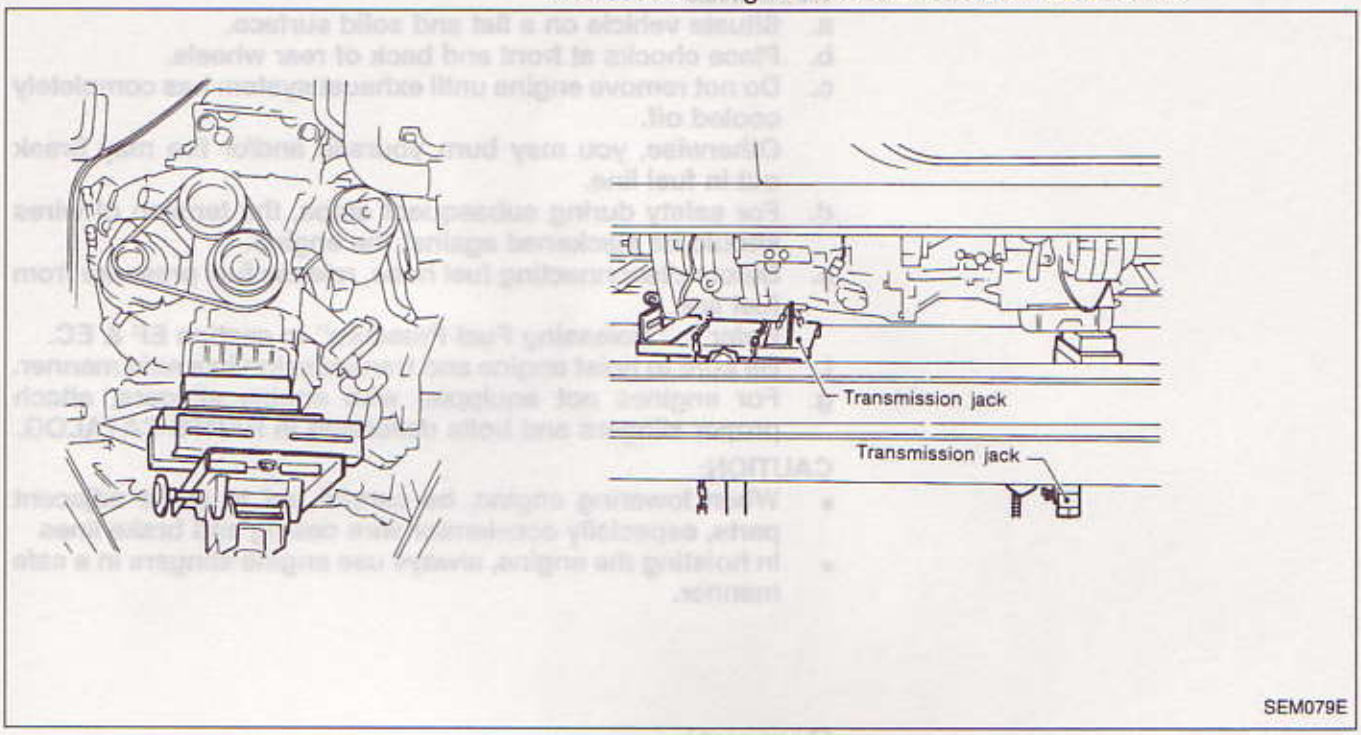
1. Remove engine under cover and engine room fan.
2. Drain coolant from both cylinder block, and radiator.
3. Drain engine oil from drain plug of oil pan.
4. Remove exhaust tube.
5. Remove drive belts.
6. Remove compressor, power steering oil pump and their brackets from engine.
7. Disconnect vacuum hoses, fuel hoses, water hoses, wires, harness and connectors and so on.


SEM078E

8. Support engine/transmission assembly by placing suitable transmission jacks under transmission and engine.
9. Remove center member.

Removal (Cont'd)

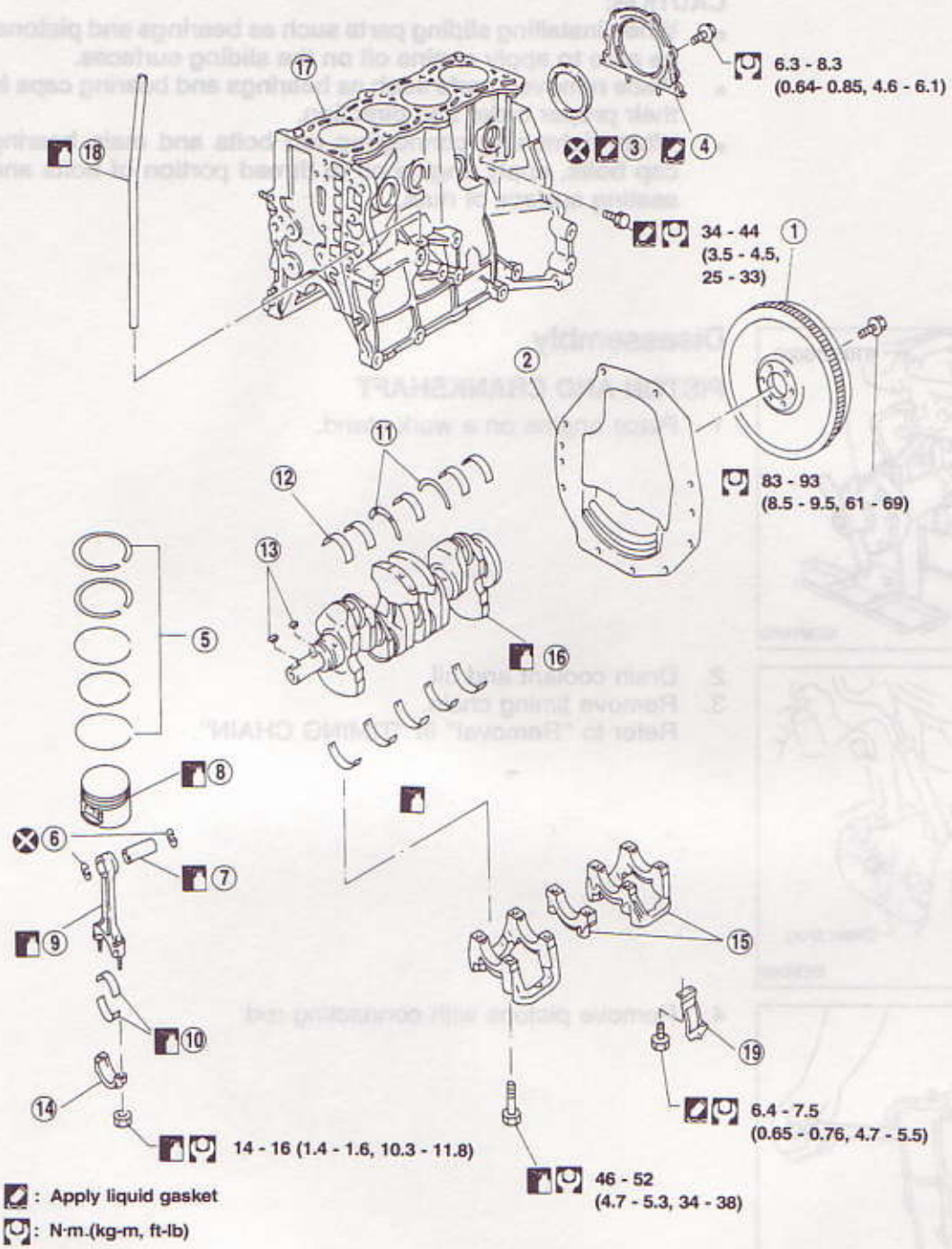
10. Remove engine with transmission as shown.



Installation

When installing the engine, tighten the lock bolts to the specified torque.

- Installation is the reverse order of removal.

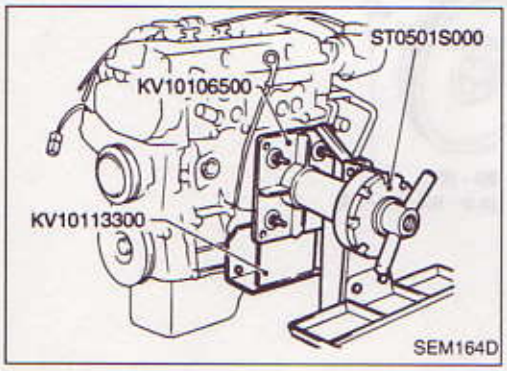


EEM007

① Flywheel
② Rear plate
③ Rear oil seal
④ Rear oil seal retainer
⑤ Piston ring
⑥ Snap ring
⑦ Piston pin
⑧ Piston
⑨ Connecting rod
⑩ Connecting rod bearing
⑪ Thrust bearing
⑫ Main bearing
⑬ Key
⑭ Connecting rod cap
⑮ Bearing beam cap
⑯ Crankshaft
⑰ Cylinder block
⑱ Oil level guide tube
⑲ Deflector

CAUTION:

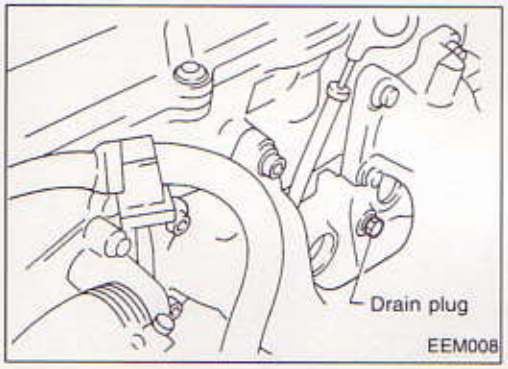
- **When installing sliding parts such as bearings and pistons, be sure to apply engine oil on the sliding surfaces.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When tightening connecting rod bolts and main bearing cap bolts, apply engine oil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



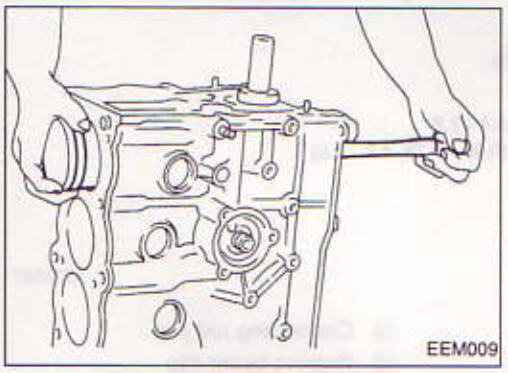
Disassembly

PISTON AND CRANKSHAFT

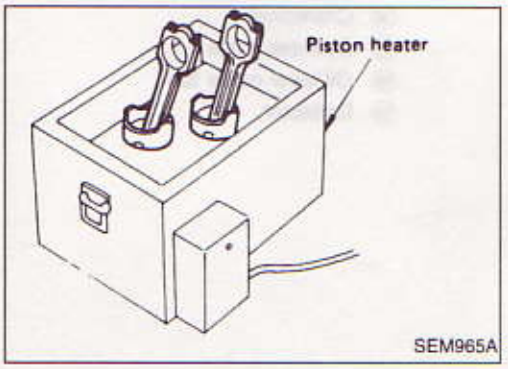
1. Place engine on a work stand.



2. Drain coolant and oil.
3. Remove timing chain.
   Refer to "Removal" in "TIMING CHAIN".

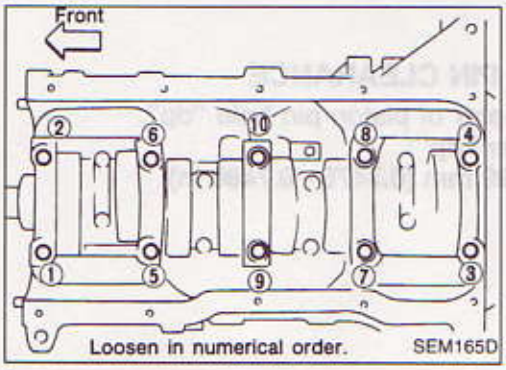


4. Remove pistons with connecting rod.



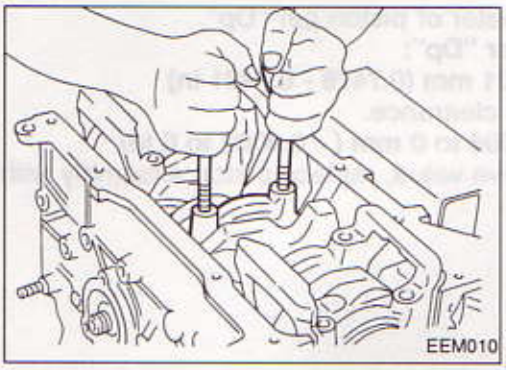
- When disassembling piston and connecting rod, remove snap ring first, then heat piston to 60 to 70°C (140 to 158°F) or use piston pin press stand at room temperature.

Disassembly (Cont'd)

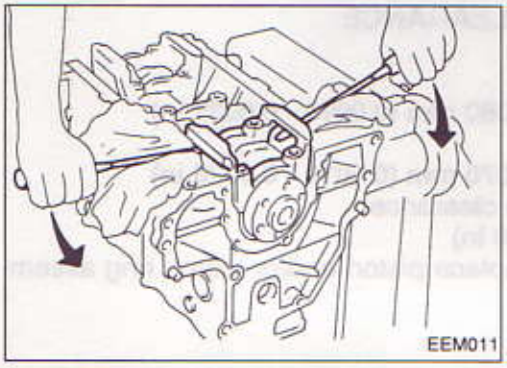


5. Remove bearing caps and crankshaft.

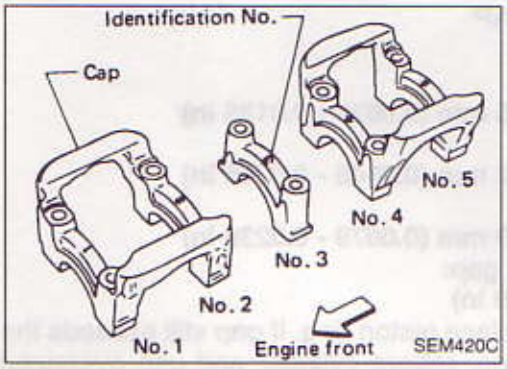
- **Before removing bearing caps, measure crankshaft end play.**
- **Bolts should be loosened in two or three steps.**



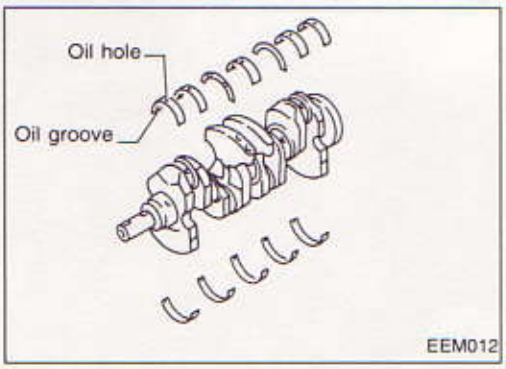
- Remove central bearing cap.



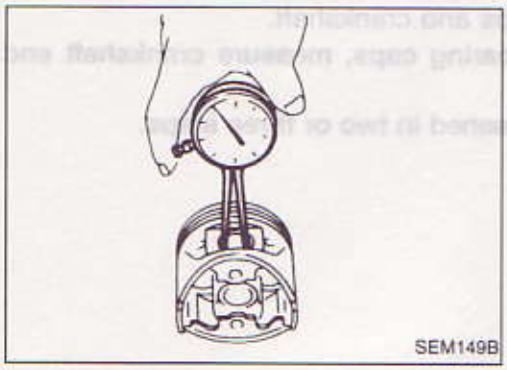
- Remove the remaining bearing beam caps.



- Place bearings and caps in their proper order.



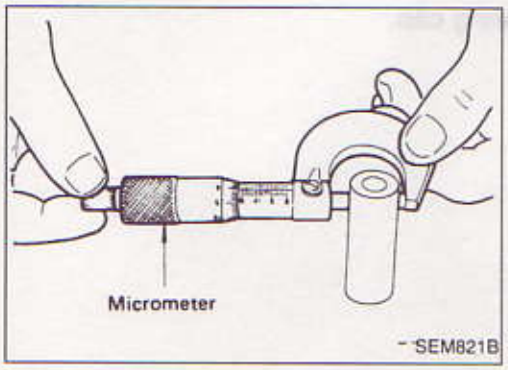
- Remove bearing and crankshaft.


SEM149B

Inspection

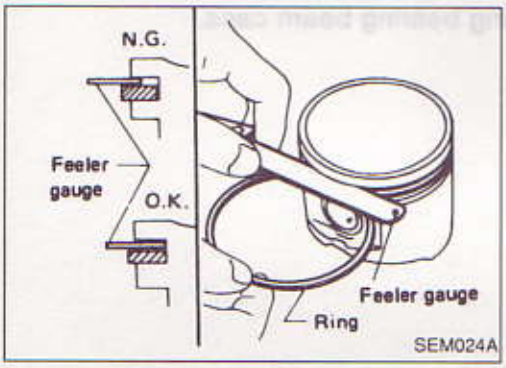
PISTON AND PISTON PIN CLEARANCE

1. Measure inner diameter of piston pin hole "dp".
   Standard diameter "dp":
   18.987 - 18.999 mm (0.7475 - 0.7480 in)



SEM821B

2. Measure outer diameter of piston pin "Dp".
   Standard diameter "Dp":
   18.989 - 19.001 mm (0.7476 - 0.7481 in)
3. Calculate piston pin clearance.
   dp − Dp = −0.004 to 0 mm (−0.0002 to 0 in)
   If it exceeds the above value, replace piston assembly with pin.

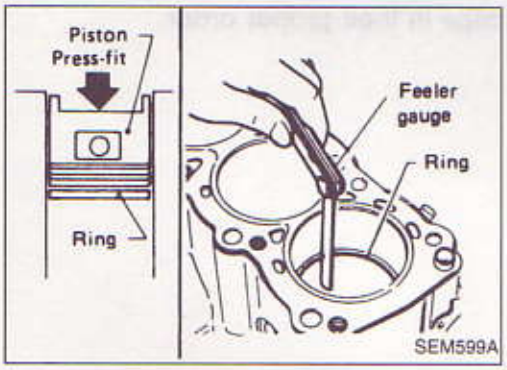


SEM024A

PISTON RING SIDE CLEARANCE

Side clearance:
Top ring
0.040 - 0.080 mm (0.0016 - 0.0031 in)
2nd ring
0.030 - 0.070 mm (0.0012 - 0.0028 in)
Max. limit of side clearance:
0.2 mm (0.008 in)

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



SEM599A

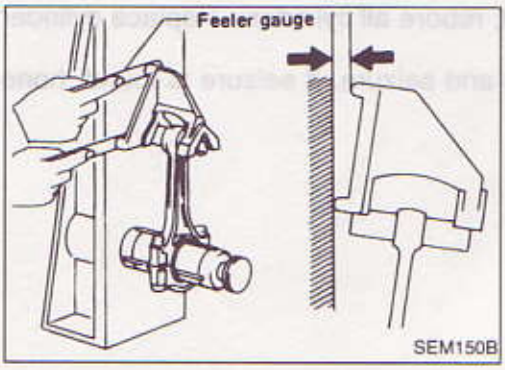
PISTON RING END GAP

End gap:
Top ring
0.20 - 0.35 mm (0.0079 - 0.0138 in)
2nd ring
0.37 - 0.52 mm (0.0146 - 0.0205 in)
Oil ring
0.20 - 0.60 mm (0.0079 - 0.0236 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 cylinder and use oversized piston and piston rings.

Refer to S.D.S.

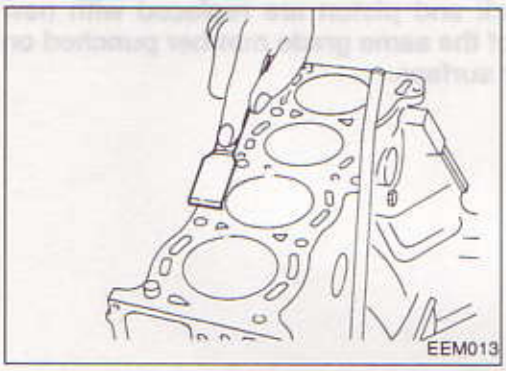
Inspection (Cont'd)



CONNECTING ROD BEND AND TORSION

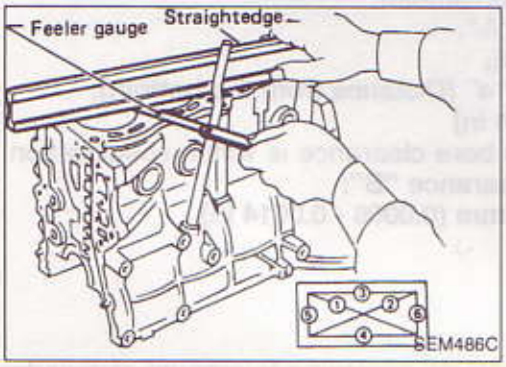
Bend limit:
0.15 mm (0.0059 in)
per 100 mm (3.94 in) length
Torsion limit:
0.3 mm (0.012 in)
per 100 mm (3.94 in) length

If it exceeds the limit, replace connecting rod assembly.



CYLINDER BLOCK DISTORTION AND WEAR

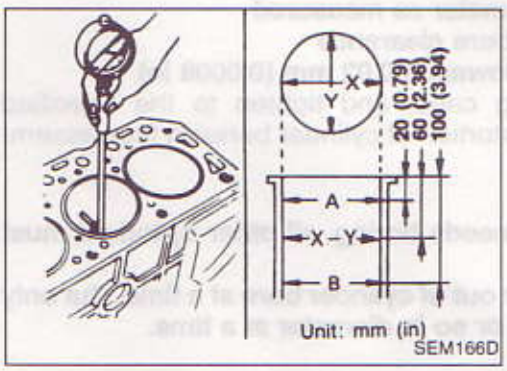
1. Clean upper face of cylinder block.



2. Measure the distortion.
   Limit:
   0.10 mm (0.0039 in)
3. If out of specification, resurface it.
   The resurfacing limit is determined by 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:
213.95 - 214.05 mm (8.4232 - 8.4271 in)

4. If necessary, replace cylinder block.



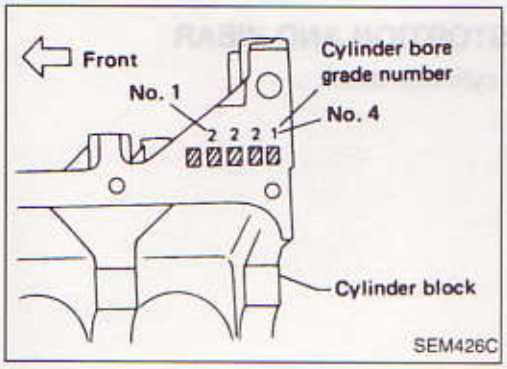
PISTON-TO-BORE CLEARANCE

1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.
   Standard inner diameter:
   76.000 - 76.030 mm (2.9921 - 2.9933 in).
   Wear limit:
   0.2 mm (0.008 in)
   Out-of-round (X − Y) limit:
   0.015 mm (0.0006 in)
   Taper (A − B) limit:
   0.01 mm (0.0004 in)

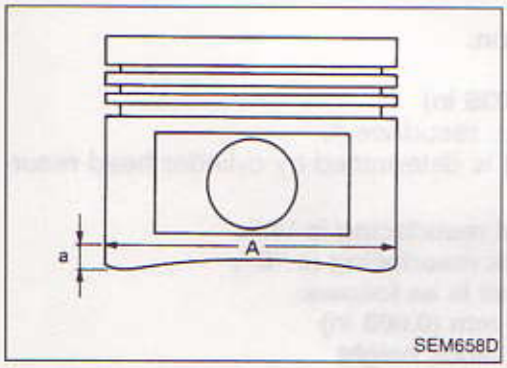
Inspection (Cont'd)

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

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



- **If both cylinder block and piston are replaced with new ones, select piston of the same grade number punched on cylinder block lower surface.**



3. Measure piston skirt diameter.
   Piston diameter "A":
   Refer to S.D.S.
   Measuring point "a" (Distance from the bottom):
   9.5 mm (0.374 in)
4. Check that piston-to-bore clearance is within specification.
   Piston-to-bore clearance "B":
   0.015 - 0.035 mm (0.0006 - 0.0014 in)
5. Determine piston oversize according to amount of cylinder wear.

Oversize pistons are available for service. Refer to S.D.S.

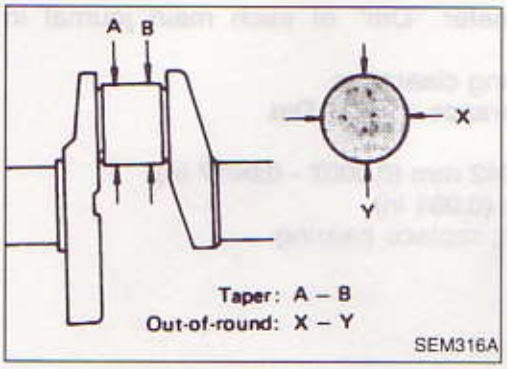
6. Cylinder bore size is determined by adding piston-to-bore clearance to piston diameter "A".
   Rebored size calculation:
   D = A + B − C
   where,
   D: Bored diameter
   A: Piston diameter as measured
   B: Piston-to-bore clearance
   C: Honing allowance 0.02 mm (0.0008 in)
7. Install main bearing caps, and tighten to the specified torque 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 cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.**

Inspection (Cont'd)

9. Hone cylinders to obtain specified piston-to-bore clearance.
10. Measure finished cylinder bore for out-of-round and taper.

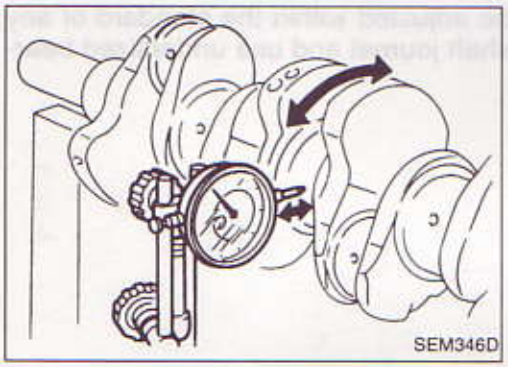
- **Measurement should be done after cylinder bore cools down.**



CRANKSHAFT

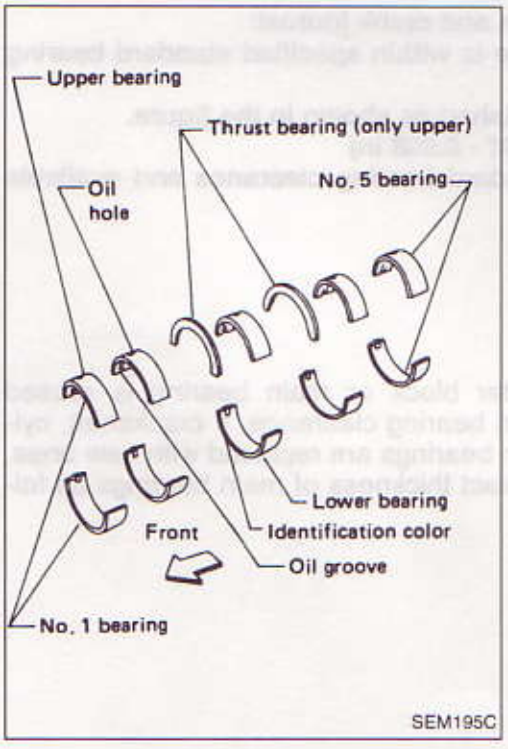
1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.

Out-of-round (X – Y):
Less than 0.005 mm (0.0002 in)
Taper (A – B):
Less than 0.002 mm (0.0001 in)



3. Measure crankshaft runout.

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



BEARING CLEARANCE

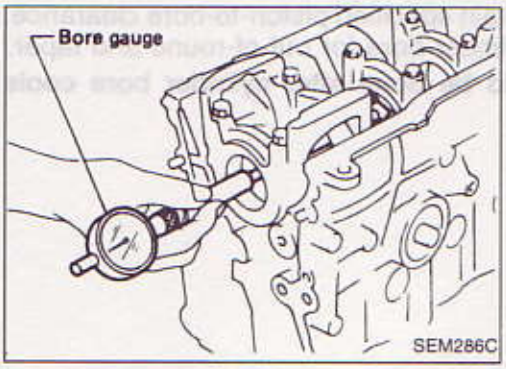
- Either of the following two methods may be used, however, method "A" gives more reliable results and is preferable.

Method A (Using bore gauge & micrometer)

Main bearing

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

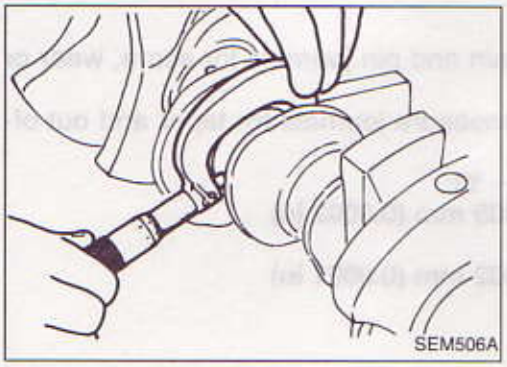
Inspection (Cont'd)



2. Install main bearing cap to cylinder block.

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

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



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

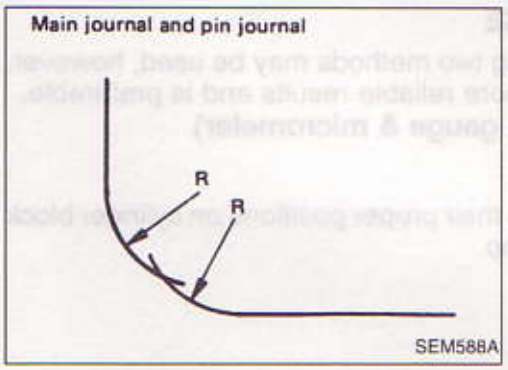
Main bearing clearance = A − Dm

Standard:

0.018 - 0.042 mm (0.0007 - 0.0017 in)

Limit: 0.1 mm (0.004 in)

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



When grinding crank pin and crank journal:

a. Grind until clearance is within specified standard bearing clearance.

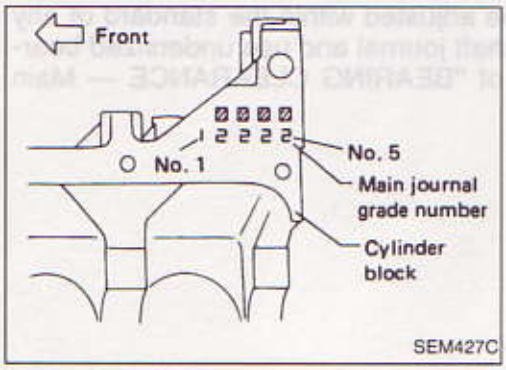
b. Fillets should be finished as shown in the figure.

R: 2.3 - 2.5 mm (0.091 - 0.098 in)

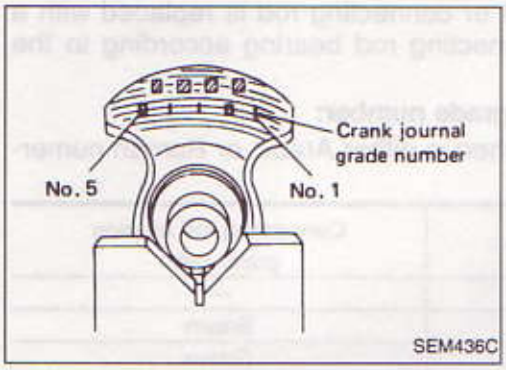
Refer to S.D.S. for standard bearing clearance and available spare parts.

8. If crankshaft, cylinder block or main bearing is reused again, measure main bearing clearance. If crankshaft, cylinder block and main bearings are replaced with new ones, it is necessary to select thickness of main bearings as follows:

Inspection (Cont'd)



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

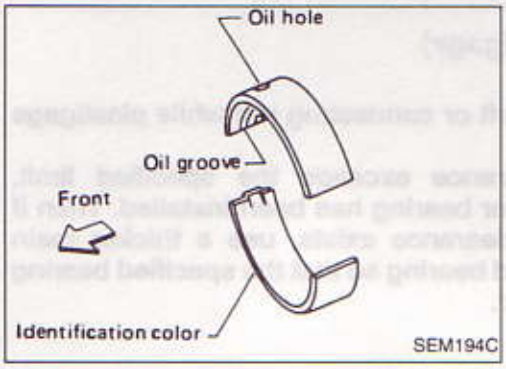


b. Grade number of each crankshaft main journal is punched on the respective crankshaft. These numbers are punched in either Arabic or Roman numerals.

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

Main bearing grade color:

Crankshaft journal grade number \ Main journal grade number	0	1	2
0	Black	Brown	Green
1	Brown	Green	Yellow
2	Green	Yellow	Blue



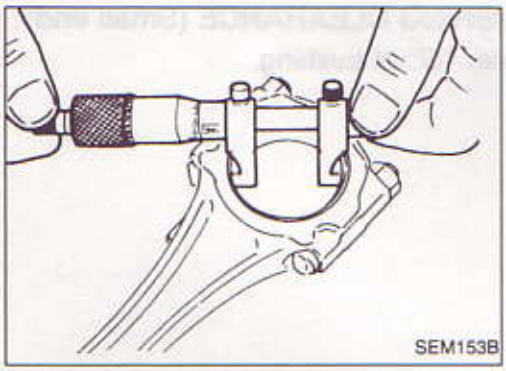
For example:
Main journal grade number: 1
Crankshaft journal grade number: 2
Main bearing grade number = 1 + 2 = Yellow

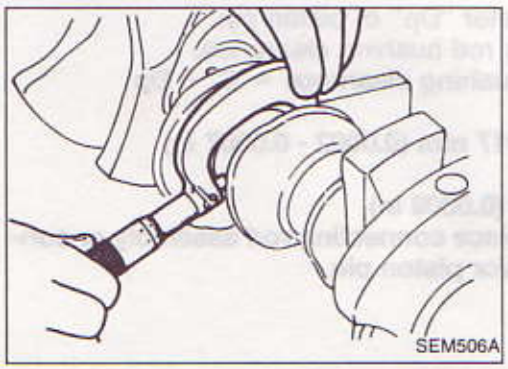
Connecting rod bearing (Big end)

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

Tighten bolts to the specified torque.

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

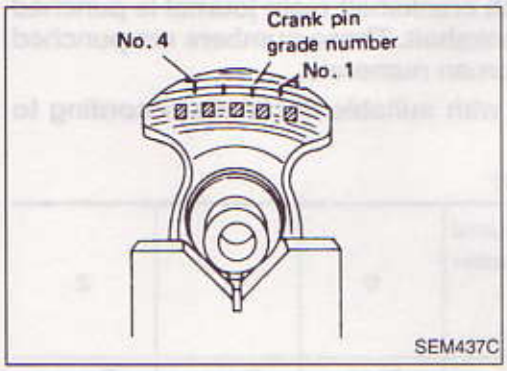




4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.
   Connecting rod bearing clearance = C − Dp
   Standard:
   0.010 - 0.035 mm (0.0004 - 0.0014 in)
   Limit: 0.1 mm (0.004 in)
6. If it exceeds the limit, replace bearing.

Inspection (Cont'd)

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

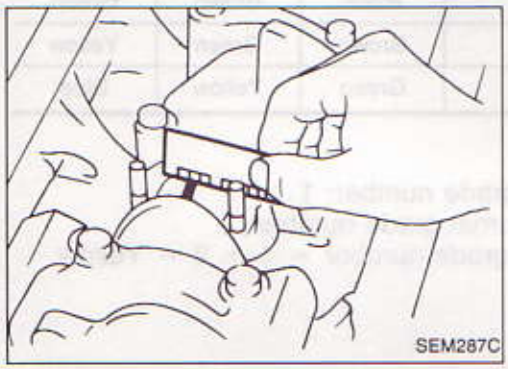


8. If bearing, crankshaft or connecting rod is replaced with a new one, select connecting rod bearing according to the following table.

Connecting rod bearing grade number:

Grade numbers are punched in either Arabic or Roman numerals.

Crank pin grade color	Connecting rod bearing grade color
0	—
1	Brown
2	Green



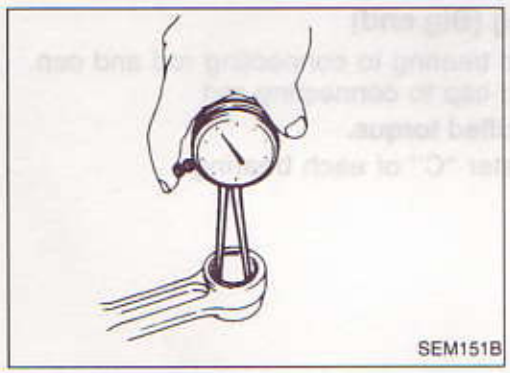
Method B (Using plastigage)

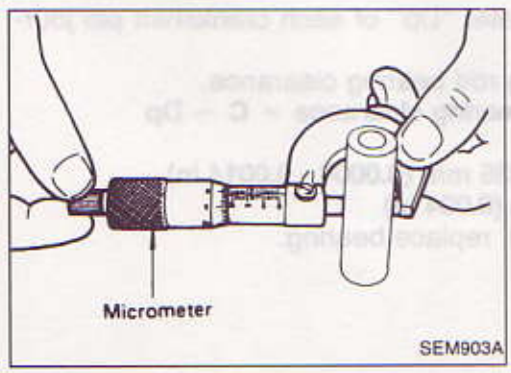
CAUTION:

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

CONNECTING ROD BUSHING CLEARANCE (Small end)

1. Measure inner diameter "C" of bushing.





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

Connecting rod bushing clearance = C − Dp

Standard:

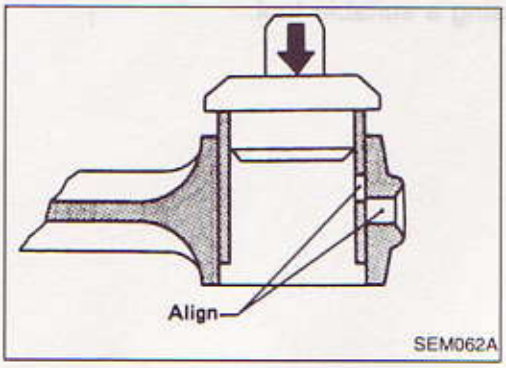
0.005 - 0.017 mm (0.0002 - 0.0007 in)

Limit:

0.023 mm (0.0009 in)

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

Inspection (Cont'd)



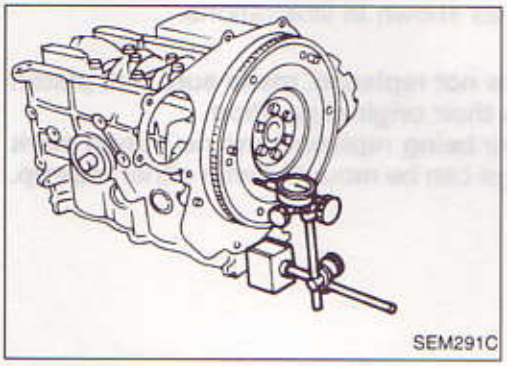
REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

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

Be sure to align the oil holes.

2. After driving in small end bushing, ream the bushing so that clearance between connecting rod busing and piston pin achieves specified value.

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



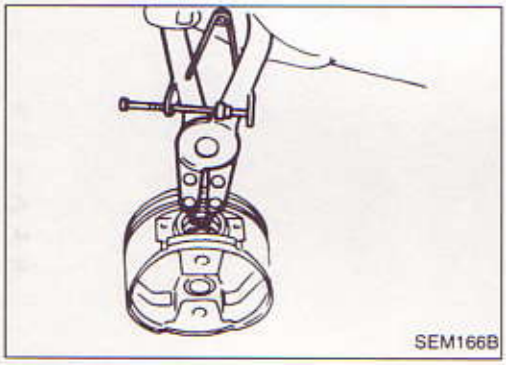
FLYWHEEL RUNOUT

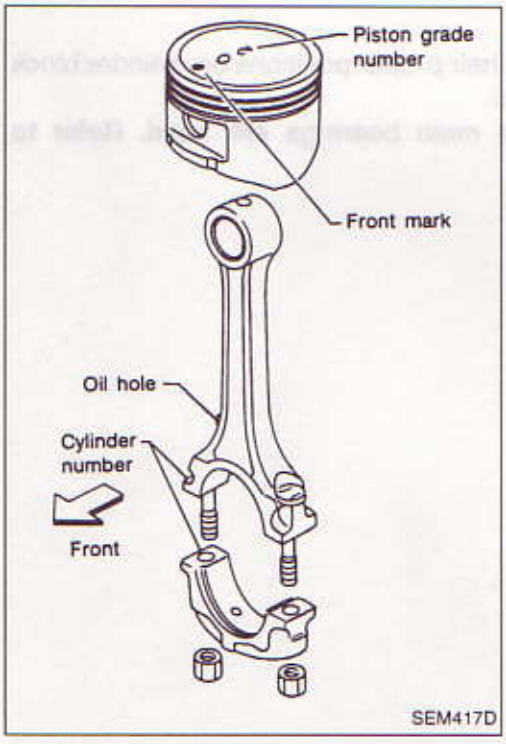
Runout (Total indicator reading):
Flywheel
Less than 0.15 mm (0.0059 in)

Assembly

PISTON

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



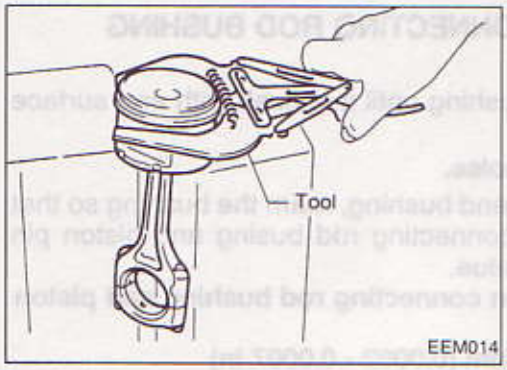


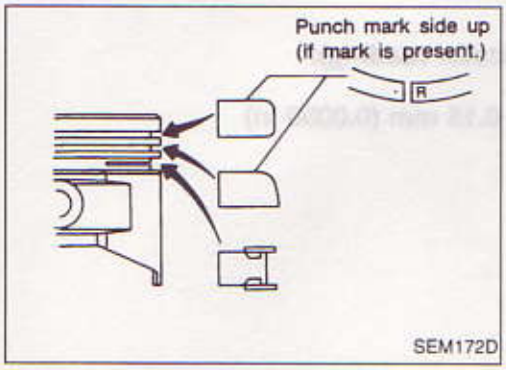
2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.

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

Assembly (Cont'd)

3. Install piston rings, using a suitable tool.

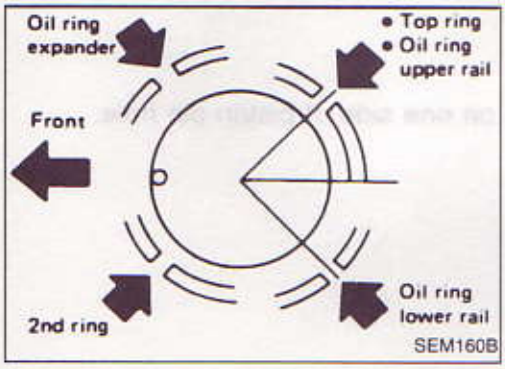




4. Position piston rings as shown in illustrations.

CAUTION:

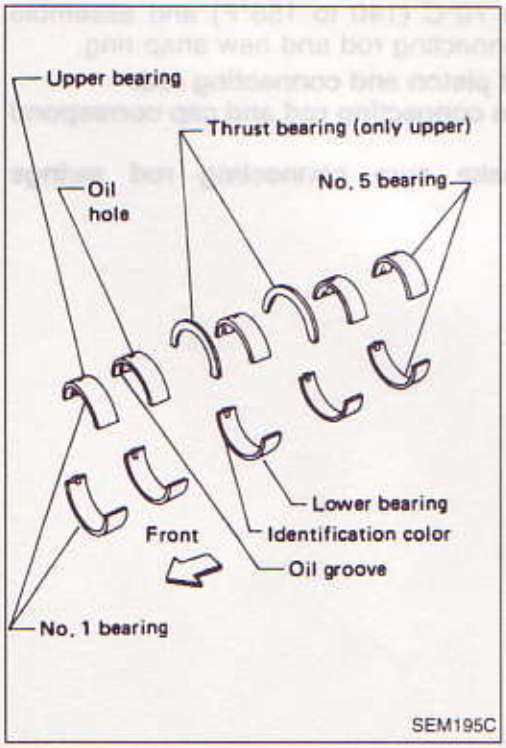
- **When piston rings are not replaced, make sure that piston rings are mounted in their original position.**
- **When piston rings are being replaced and no punch mark is present, piston rings can be mounted with either side up.**



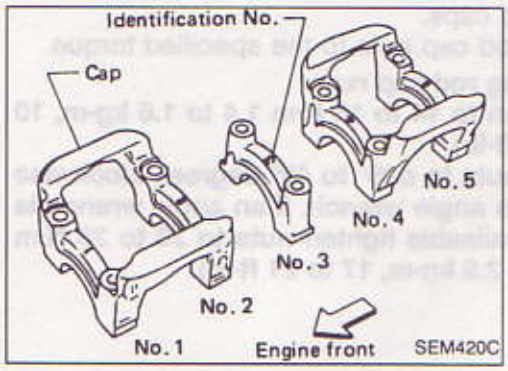
CRANKSHAFT

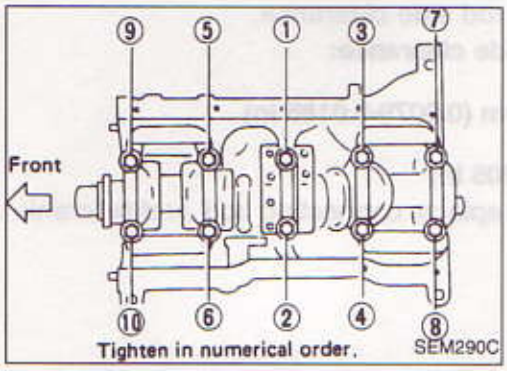
1. Set main bearings in their proper positions on cylinder block and main bearing cap.

- **Confirm that correct main bearings are used. Refer to "Inspection".**



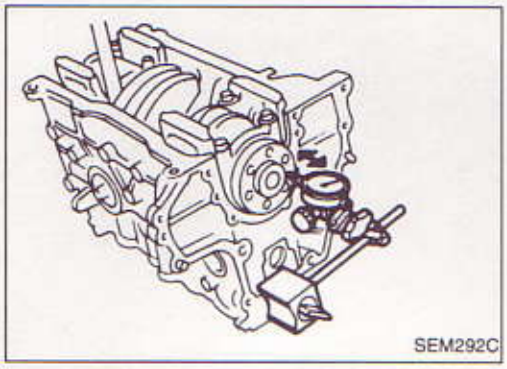
Assembly (Cont'd)





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

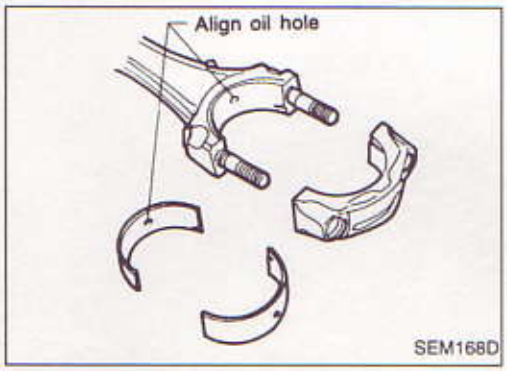
- **Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting crankshaft in the axial direction.**
- **Tighten bearing cap bolts gradually in two or three stages. Start with center bearing and move outward sequentially.**
- **After securing bearing cap bolts, make sure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



3. Measure crankshaft end play.

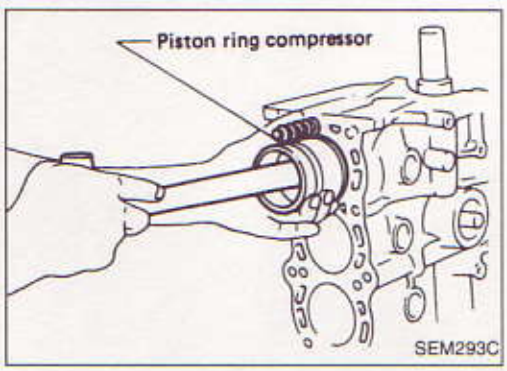
Crankshaft end play:
Standard
0.060 - 0.180 mm (0.0024 - 0.0071 in)
Limit
0.3 mm (0.012 in)

If beyond the limit, replace thrust bearing with anew one.



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

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

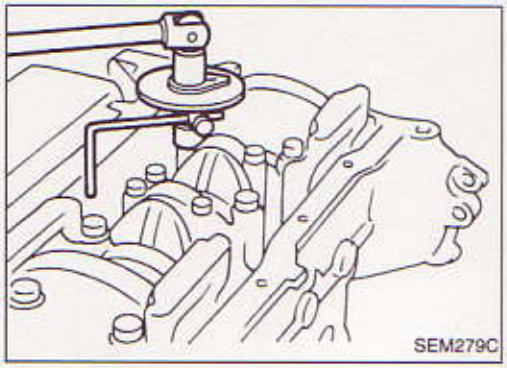


5. Install pistons with connecting rods.

a. 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.**

Assembly (Cont'd)

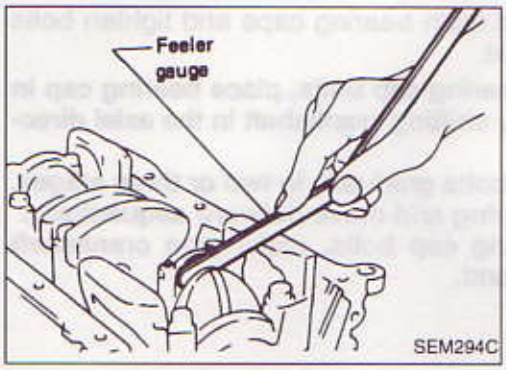


Install connecting rod caps.
Tighten connecting rod cap nuts to the specified torque

: Connecting rod cap nuts

(1) Tighten to 14 to 16 N·m 1.4 to 1.6 kg-m, 10 to 12 ft-lb).

(2) Turn nuts to o35° to 40° degrees clockwise with an angle wrench. If an angle wrench is not availaable tighten nuts to 23 to 28 N·m (2.3 to 2.9 kg-m, 17 to 21 ft-lb).



6. Measure connecting rod side clearance.

Connecting rod side clearance:

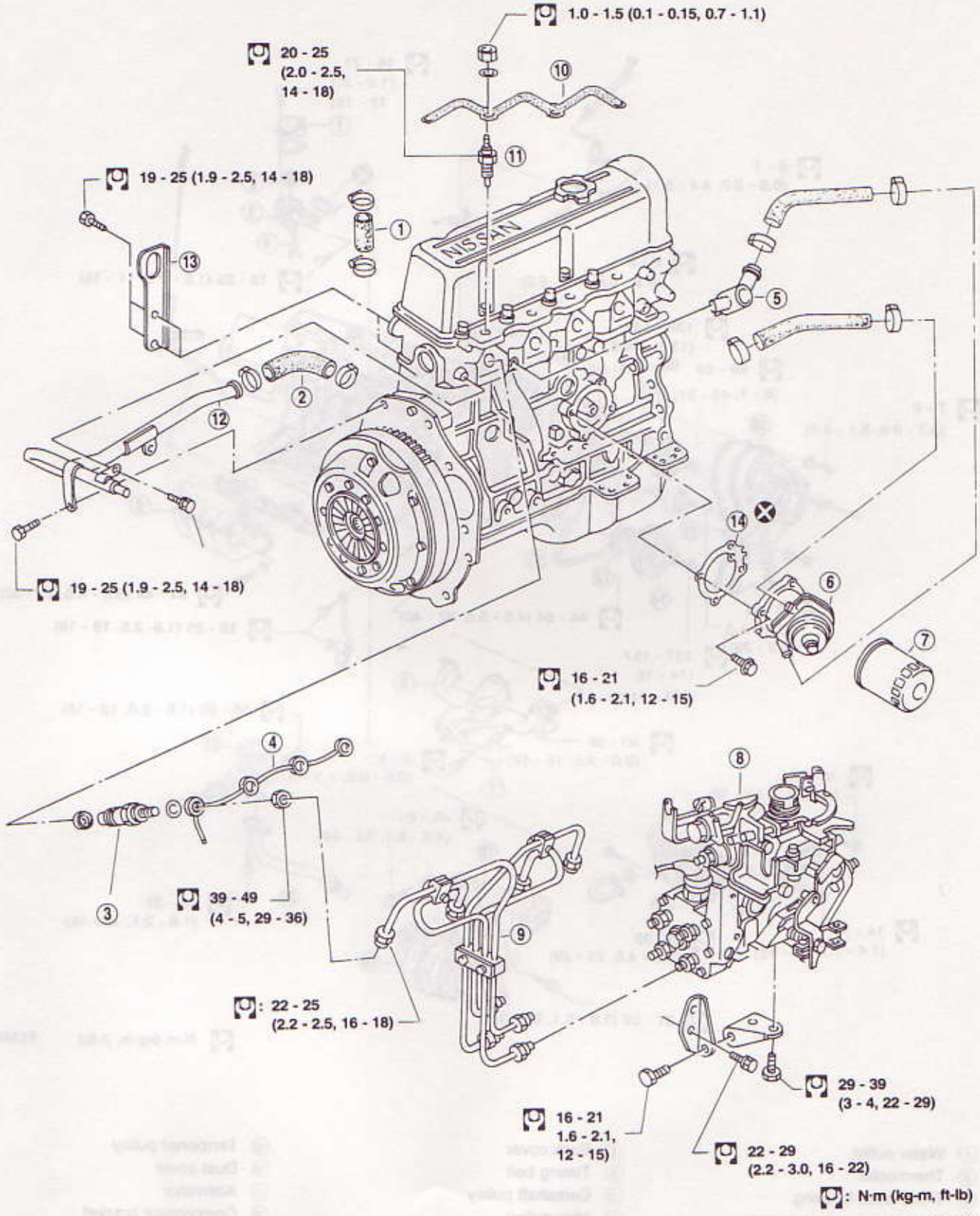
Standard:

0.200-0.470 mm (0.0079-0.0185 in)

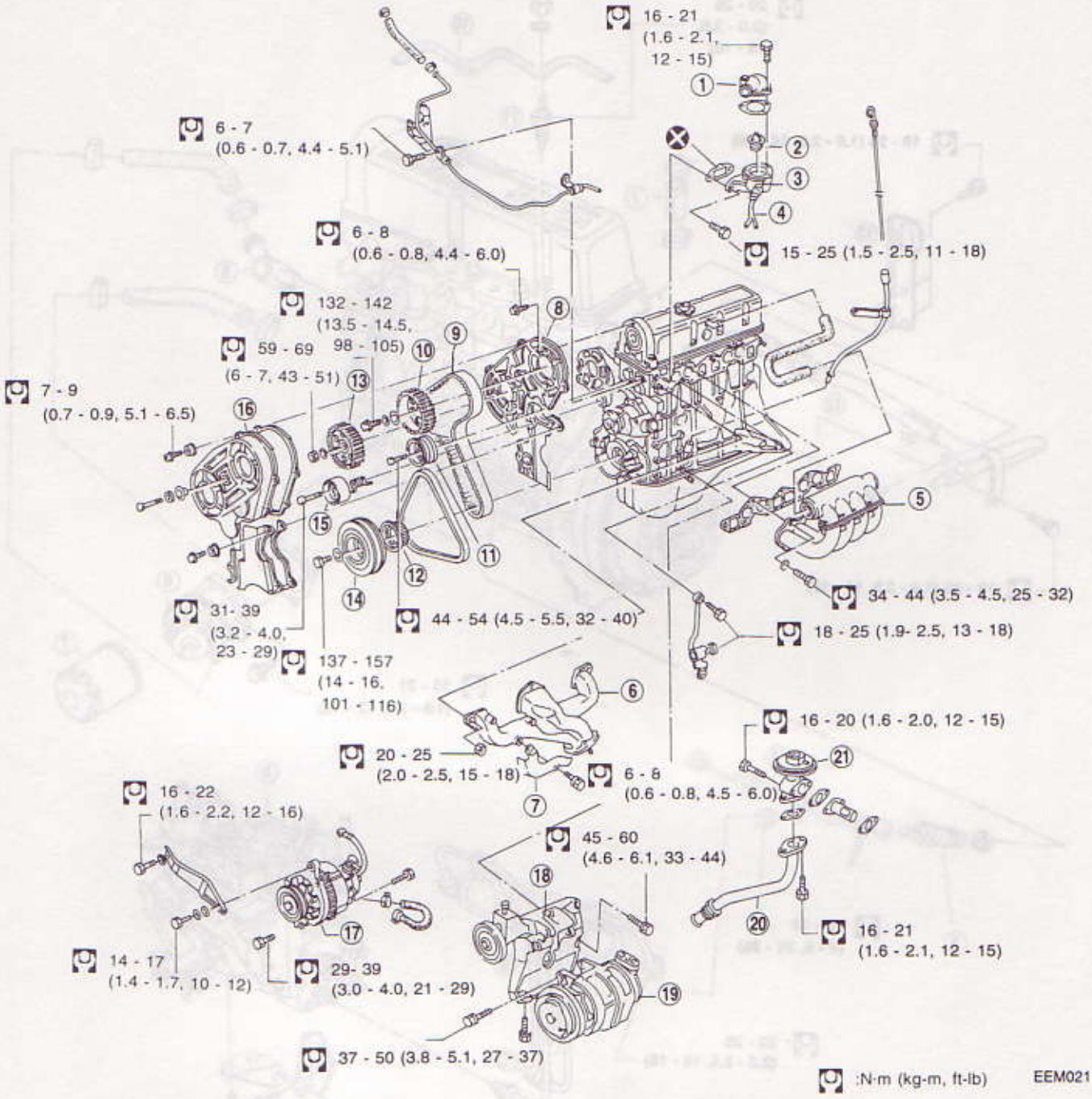
Limit

0.52 mm (0.0205 in)

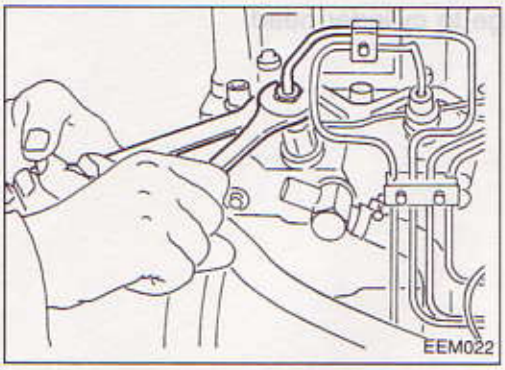
If beyond the limit, replace connecting rod and/or crankshaft



① Water pipe
② To water pump
③ Injection nozzle
④ Spill tube
⑤ Oil cooler
⑥ Oil cooler
⑦ Oil filter
⑧ Injection pump
⑨ Injection tube
⑩ Glow plug connecting plate
⑪ Glow plug
⑫ Metallic pipe
⑬ Engine slinger
⑭ Oil coller gasket

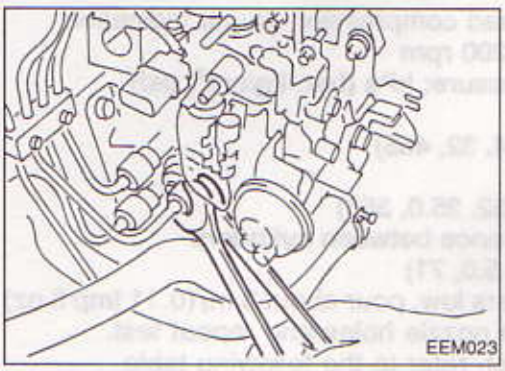


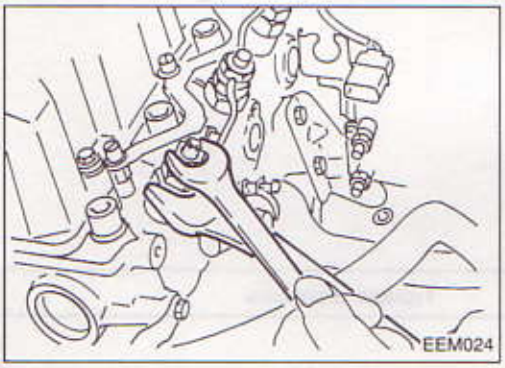
① Water outlet
② Thermostat
③ Thermostat housing
④ Water temperature sensor
⑤ Intake manifold
⑥ Exhaust manifold
⑦ Exhaust manifold cover
⑧ Back cover
⑨ Timing belt
⑩ Camshaft pulley
⑪ Idler pulley
⑫ Cranktiming pulley
⑬ Injection pump pulley
⑭ Crank damper pulley
⑮ Tensioner pulley
⑯ Dust cover
⑰ Alternator
⑱ Compressor bracket
⑲ Compressor
⑳ E.G.R. tube
㉑ E.G.R. valve



1. Warm up engine sufficiently.
2. Disconnect injection tubes on nozzle side and loosen injection tubes on pump side. Release clamps on injection tubes.

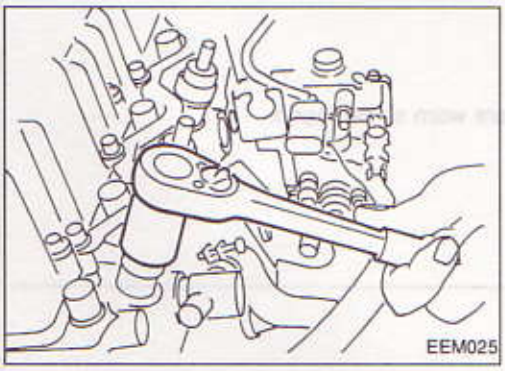
- **Use two wrenches to prevent delivery holder on pump side from loosening.**



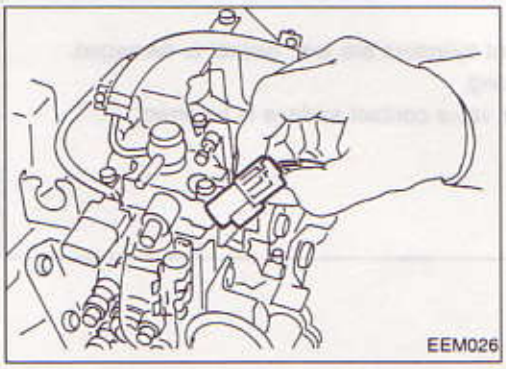


3. Remove spill-tube assembly.

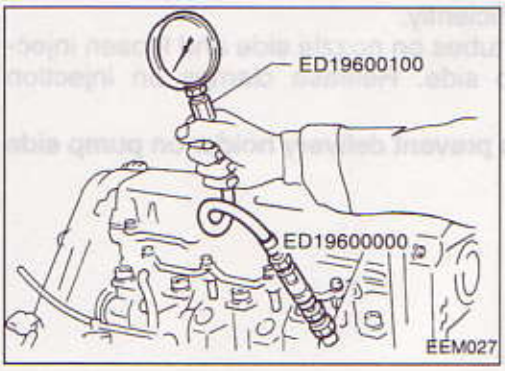
- **To prevent spill tube from breaking, remove it by gripping nozzle holder.**



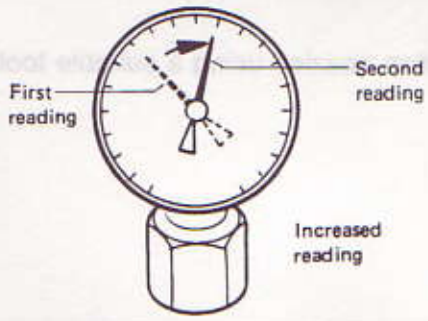
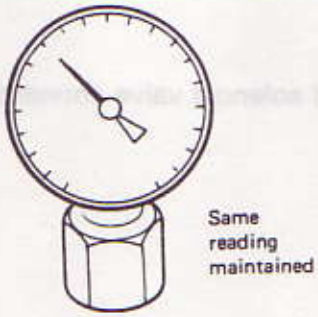
4. Remove all injection nozzles using a suitable tool.

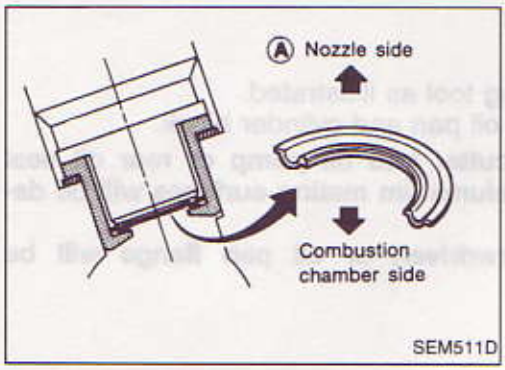


5. Disconnect fuel-cut solenoid valve connector.

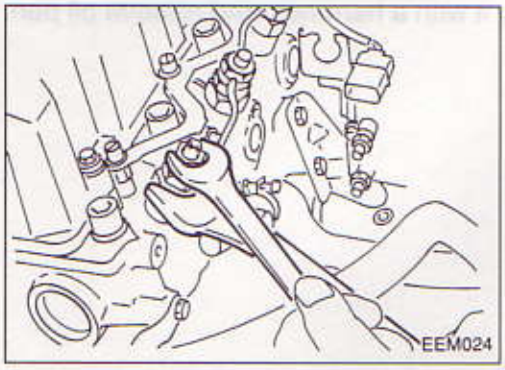


6. Fit compression gauge to cylinder head.
7. Crank engine and read compression gauge indication.
   Cranking speed: 200 rpm
   Compression pressure: kPa (bar, kg/cm^2, psi)
   Standard
   3,138 (31.4, 32, 455)
   Limit
   2,452 (24.52, 25.0, 356)
   Limit of difference between cylinders
   490 (4.90, 5.0, 71)
8. If the pressure appears low, pour about 3 mℓ (0.11 Imp fl oz) of engine oil through nozzle holes and repeat test.
   For indications of test, refer to the following table.

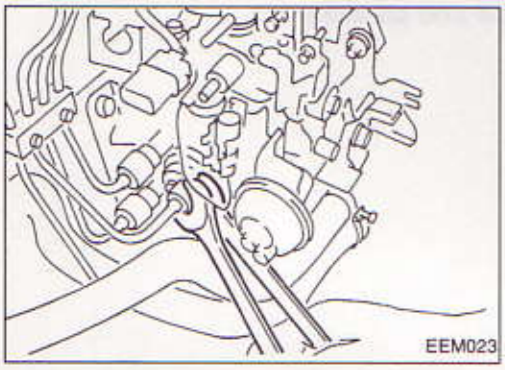
Gauge indication during tests	Trouble diagnosis
	• Piston rings are worn or damaged.
	• If two adjacent cylinders are low, gasket is damaged. • Valve is sticking. • Valve seat or valve contact surface is incorrect.



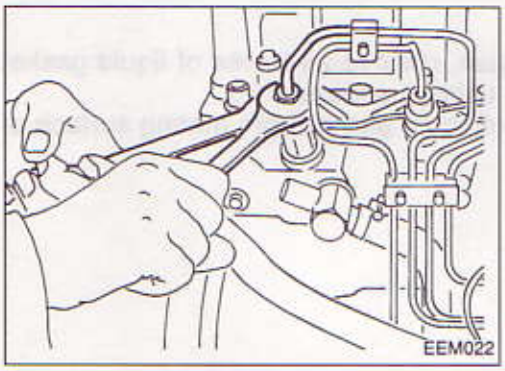
9. Replace nozzle gaskets and re-install injection nozzles.
New nozzle gaskets must be installed in the direction shown.
Nozzle to cylinder head:
: 59 - 69 N·m
(6 - 7 kg-m, 43 - 51 ft-lb)

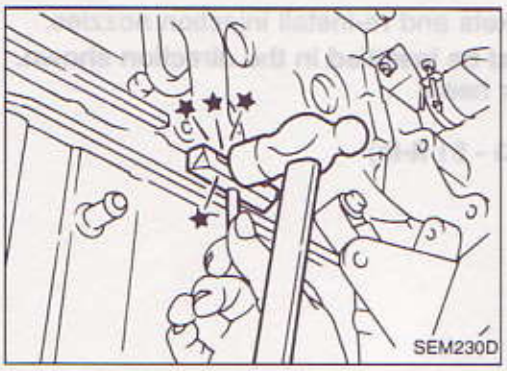


10. Install spill tube by holding nozzle holder.
Spill tube nut:
: 39 - 49 N·m
(4 - 5 kg-m, 29 - 36 ft-lb)



11. Install injection tubes using two wrenches as shown.
Injection tubes:
: 22 - 25 N·m
(2.2 - 2.5 kg-m, 16 - 18 ft-lb)





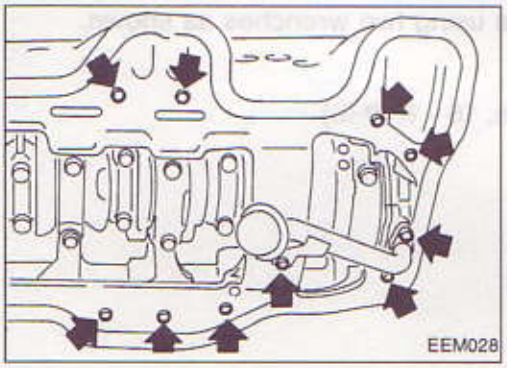
Removal

1. Drain oil.
2. Remove oil pan using tool as illustrated.

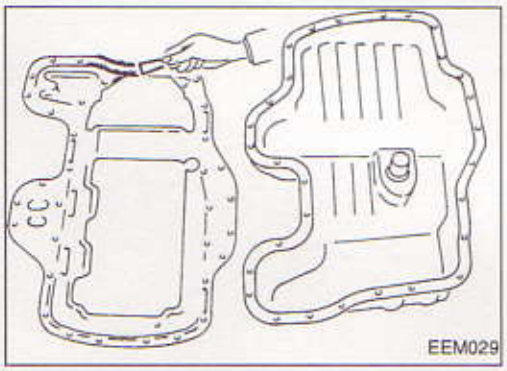
1) Insert Tool between oil pan and cylinder block.

- **Do not drive seal cutter into oil pump or rear oil seal retainer portion, or aluminum mating surfaces will be damaged.**
- **Do not insert screwdriver, or oil pan flange will be deformed.**

2) Slide Tool by tapping it with a hammer, and remove oil pan.



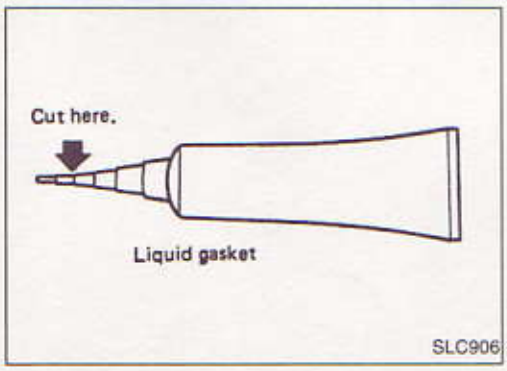
3. Remove adaptor plate and oil strainer.



Installation

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

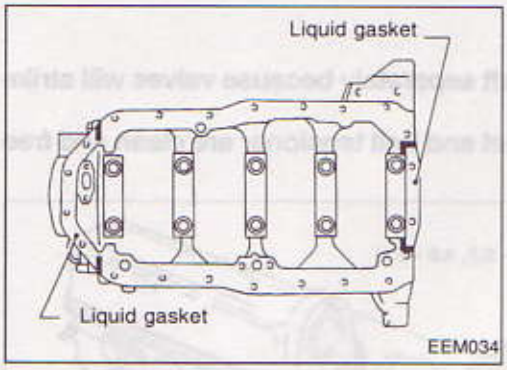
- Also remove traces of liquid gasket from mating surface of cylinder block.



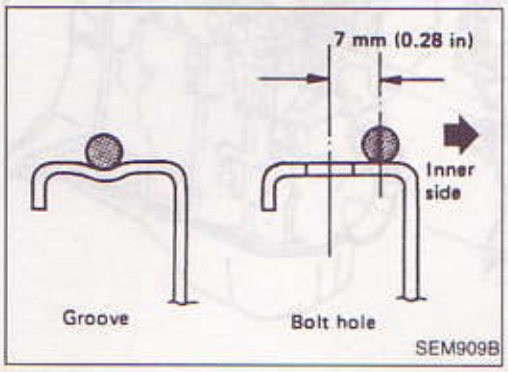
- Be sure liquid gasket is 4.0 to 4.5 mm (0.157 to 0.177 in) wide.

Use Genuine Liquid Gasket or equivalent.

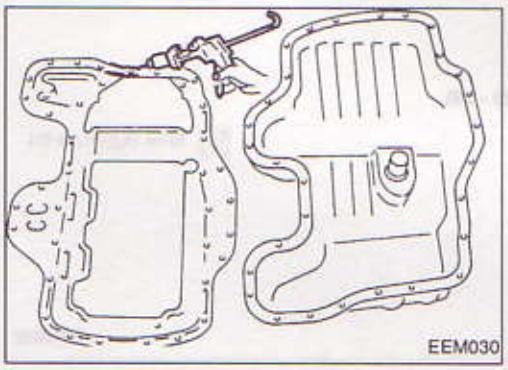
Installation (Cont'd)



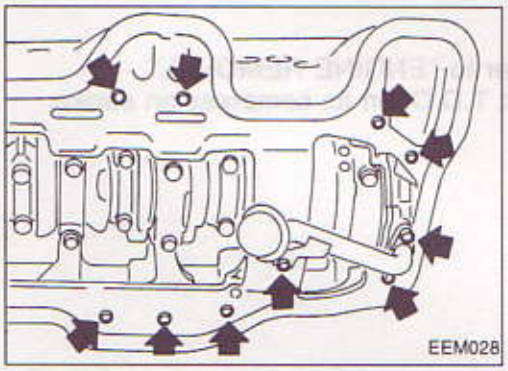
2. Apply liquid gasket to oil pan front oil seal and rear oil seal, at the locations as shown in the illustration.



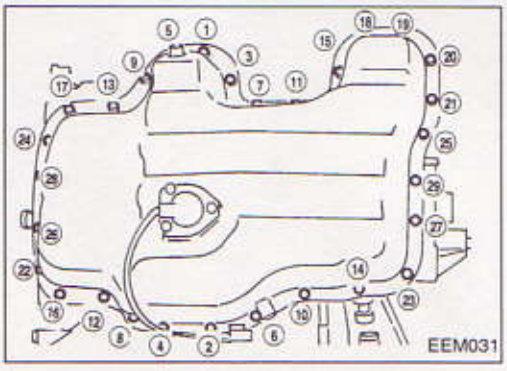
3. Apply liquid gasket to inner sealing surface as shown at left.



4. Apply a continuous bead of liquid gasket to mating surface of oil pan.
- Attaching should be done within 5 minutes after coating.



5. Install adaptor plate and oil strainer.
   Adaptor plate bolts:
   : 7 - 9 N·m (0.7 - 0.9 kg-m, 5.1 - 6.5 ft-lb)
   Oil strainer bolts:
   : 16 - 20 N·m (1.6 - 2.0 kg-m, 12 - 15 ft-lb)



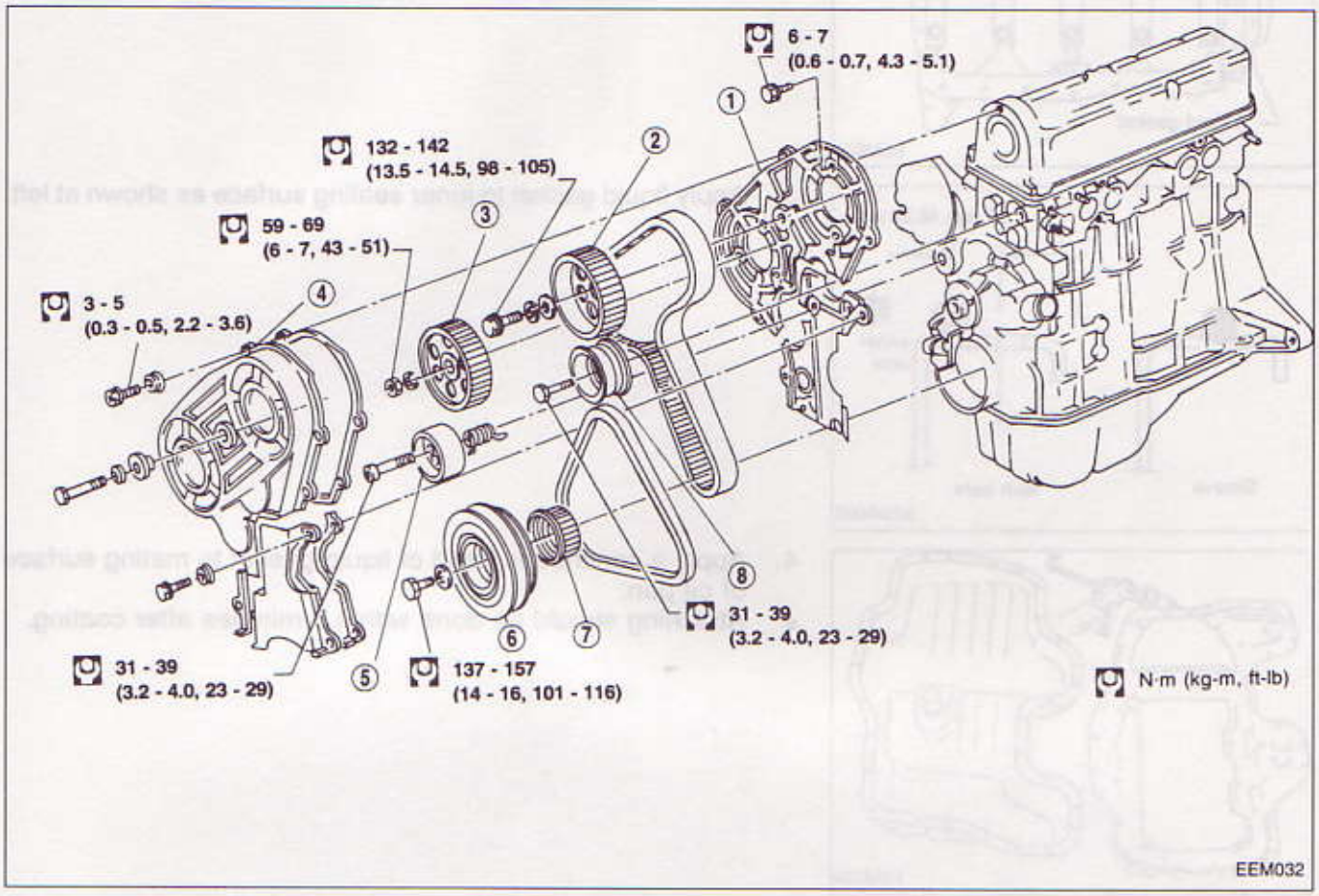
6. Install oil pan and tighten bolts in the order shown in the figure.

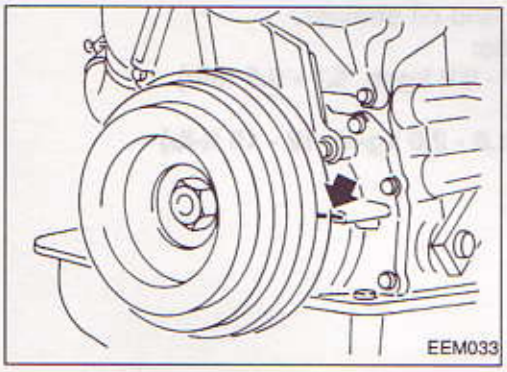
Wait at least 30 minutes before refilling engine oil.

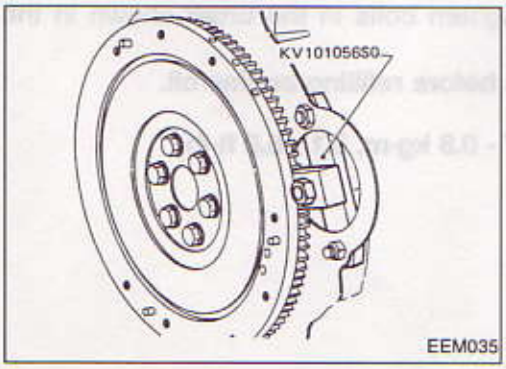
Oil pan bolts:
: 7 - 8 N·m (0.7 - 0.8 kg-m, 5.1 - 5.8 ft-lb)

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. **Ensure that timing belt, camshaft sprocket, crankshaft sprocket and belt tensioner are clean and free from oil and coolant.**



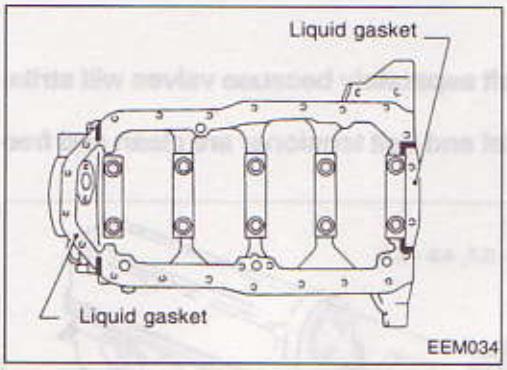




Removal

1 Remove engine; refer to "ENGINE REMOVAL".
2 Set No. 1 cylinder at T.D.C. on its compression stroke.

Installation (Cont'd)



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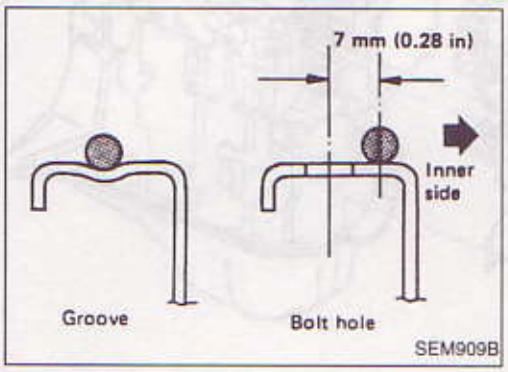
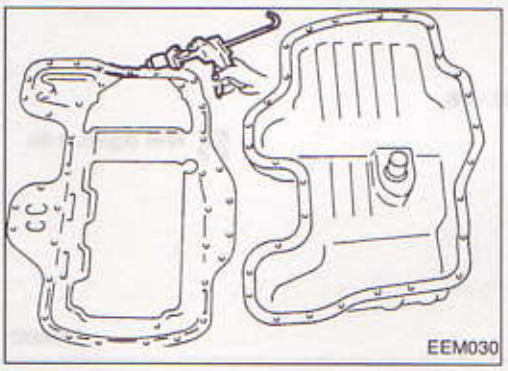
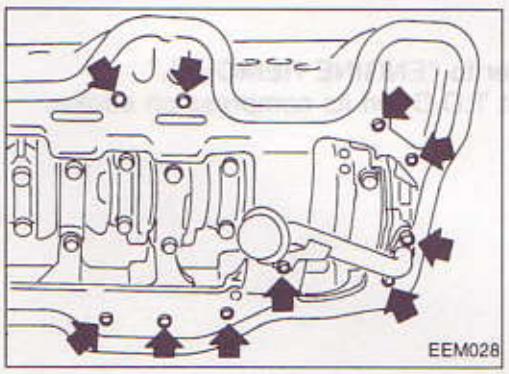


3. Apply liquid gasket to inner sealing surface as shown at left.



4. Apply a continuous bead of liquid gasket to mating surface of oil pan.
- Attaching should be done within 5 minutes after coating.



5. Install adaptor plate and oil strainer.
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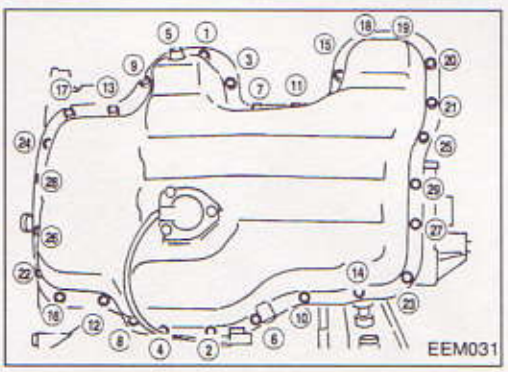


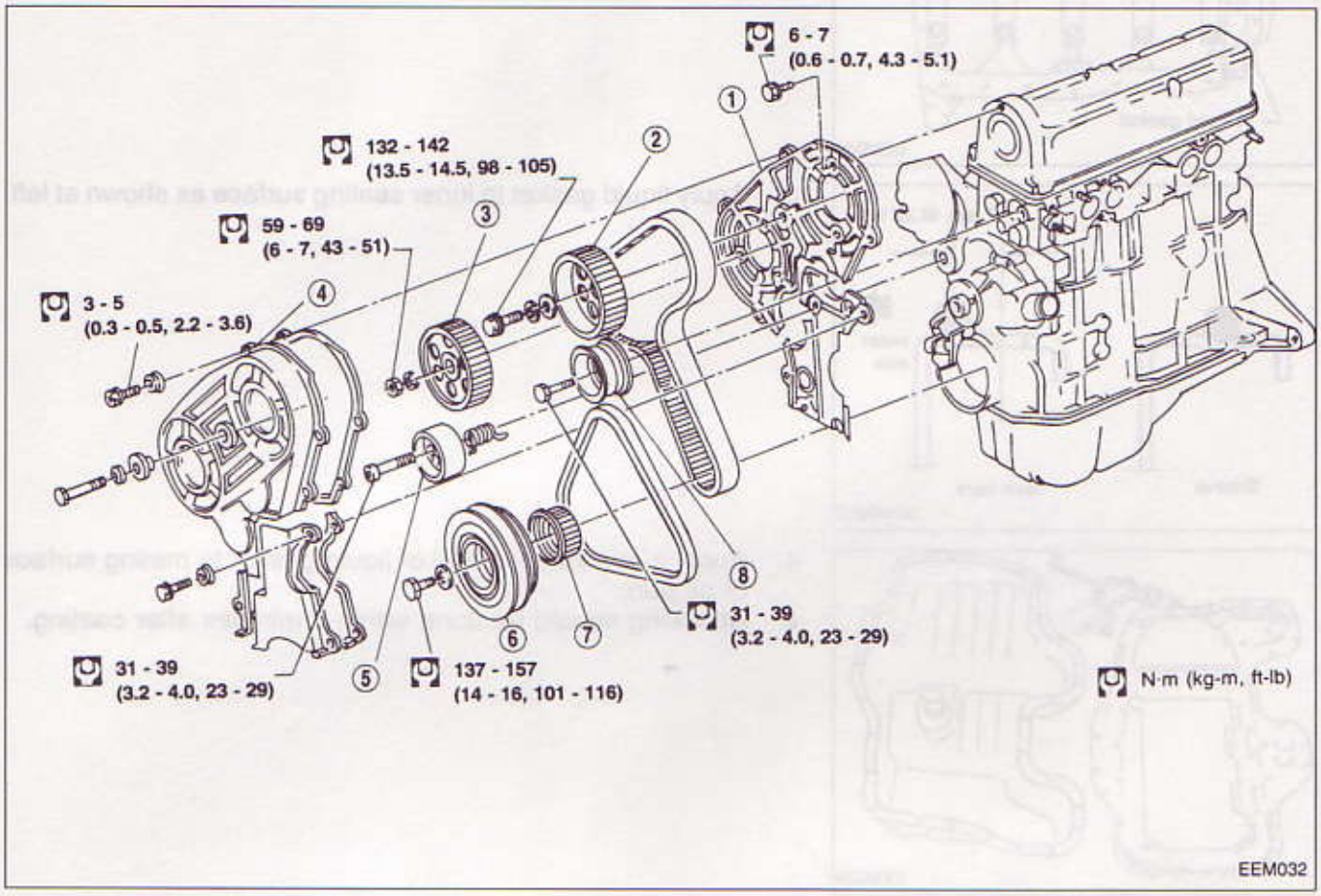
6. Install oil pan and tighten bolts in the order shown in the figure.

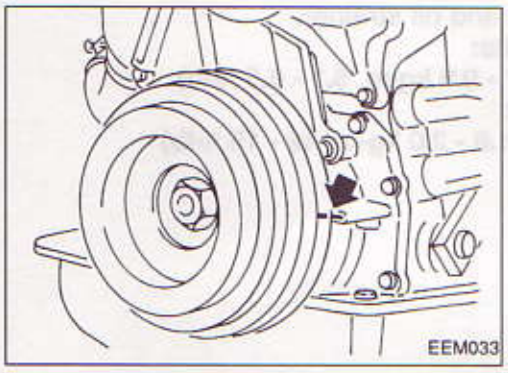
Wait at least 30 minutes before refilling engine oil.

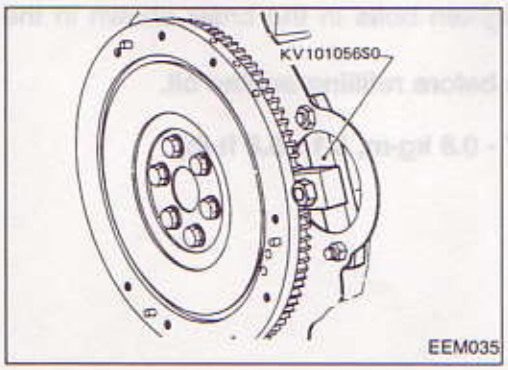
Oil pan bolts:
: 7 - 8 N·m (0.7 - 0.8 kg-m, 5.1 - 5.8 ft-lb)

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. **Ensure that timing belt, camshaft sprocket, crankshaft sprocket and belt tensioner are clean and free from oil and coolant.**



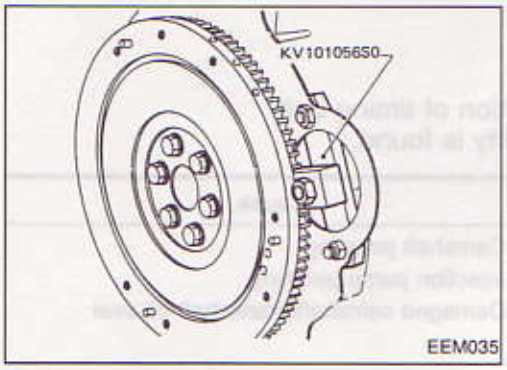




Removal

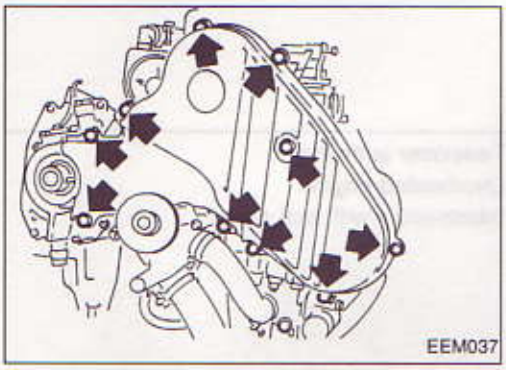
1 Remove engine; refer to "ENGINE REMOVAL".
2 Set No. 1 cylinder at T.D.C. on its compression stroke.

REMOVAL (Cont'd)

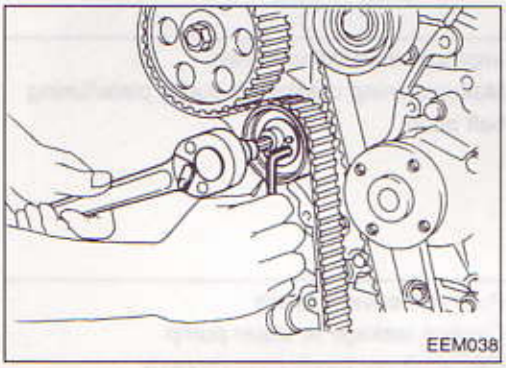


- Remove starter motor, and install ring gear stopper using mounting bolt holes.
- Remove crank pulley bolt.
- Remove crank pulley using puller.

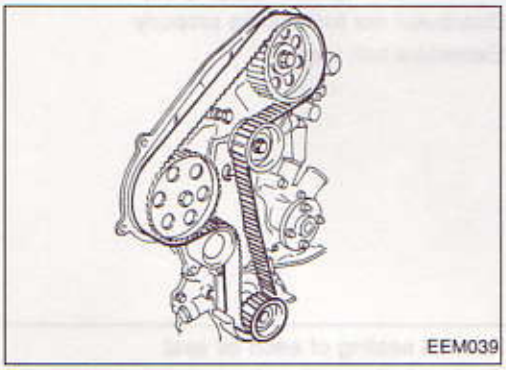
Be sure to securely attach puller jaws. Attach jaws only to the rear side of pulley.



- Remove belt covers.



2. Remove timing belt.
(1) Loosen tensioner pulley bolt, turn tensioner pulley counter-clockwise and re-tighten bolt.

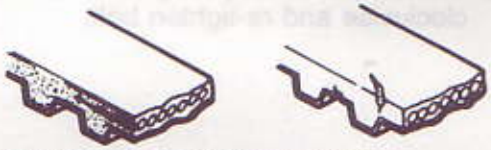


(2) Remove timing belt with crankshaft sprocket.

Inspection

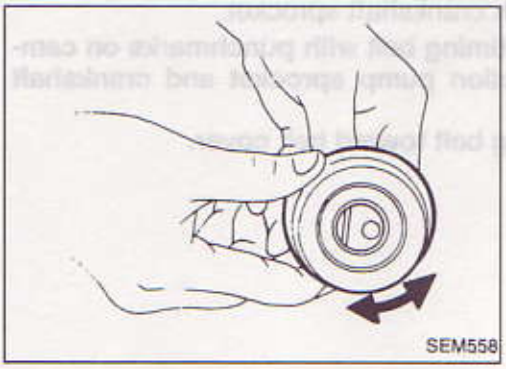
TIMING BELT

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

Item to check	Problem	Cause
Tooth is broken/tooth root is cracked.	 SEM394A	• Camshaft jamming • Injection pump jamming • Damaged camshaft/crankshaft oil seal
Back surface is cracked/worn.	 SEM395A	• Tensioner jamming • Overheated engine • Interference with belt cover
Side surface is worn.	 • Belt corners are worn and round. • Wicks are frayed and coming out. SEM396A	• Improper installation of belt • Malfunctioning crankshaft pulley plate/timing belt plate
Teeth are worn.	 Rotating direction • Canvas on tooth face is worn down. • Canvas on tooth is fluffy, rubber layer is worn down and faded white, or weft is worn down and invisible. SEM397A	• Poor belt cover sealing • Coolant leakage at water pump • Camshaft not functioning properly • Distributor not functioning properly • Excessive belt tension
Oil, coolant or water is stuck to belt.		• Poor oil sealing of each oil seal • Coolant leakage at water pump • Poor belt cover sealing

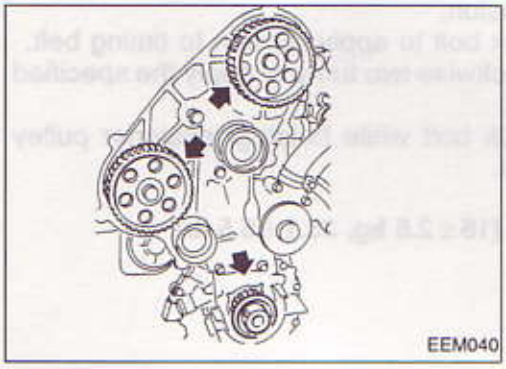
Inspection (Cont'd)

Belt tensioner, tensioner spring and idler


SEM558

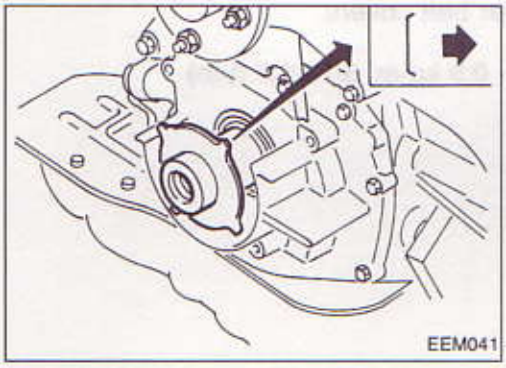
1. Check belt tensioner and idler for smooth turning.
2. Check condition of tensioner spring.

Crankshaft sprocket and front camshaft sprocket

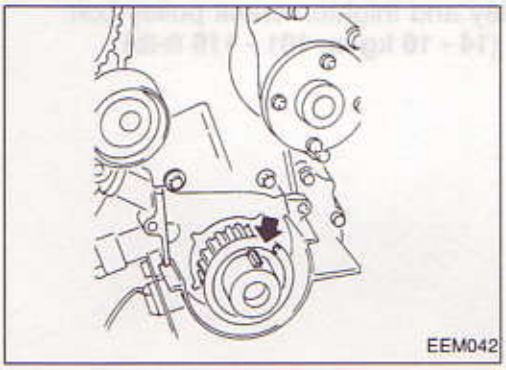

EEM040

Check teeth for abnormal signs.

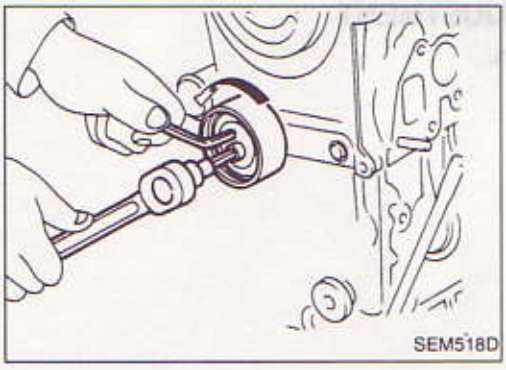
Installation


EEM041

1. Install crankshaft sprocket plate in correct direction.


EEM042

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


SEM518D

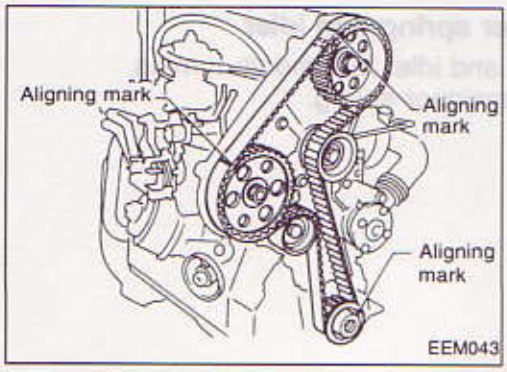
3. Install tensioner and return spring.

Temporarily tighten bolts so that tensioner is set at the fully outside position.

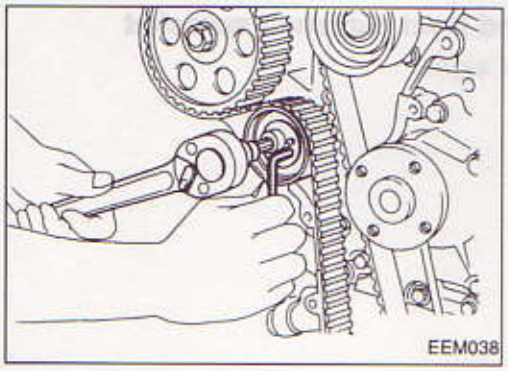
4. Install idler and tighten bolt to the specified torque.

: 44 - 54 N·m (4.5 - 5.5 kg-m, 33 - 39 ft-lb)

Installation (Cont'd)

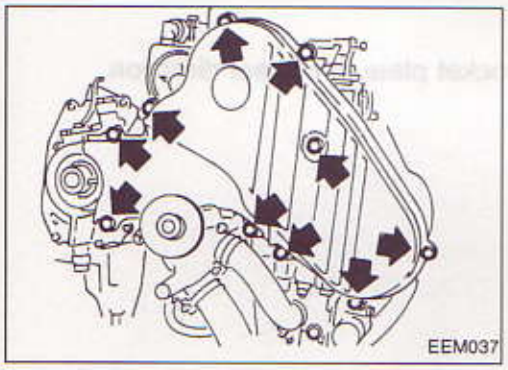


5. Install timing belt with crankshaft sprocket.
   a. **Align white lines on timing belt with punchmarks on camshaft sprocket, injection pump sprocket and crankshaft sprocket.**
   b. **Point arrow on timing belt toward belt cover.**



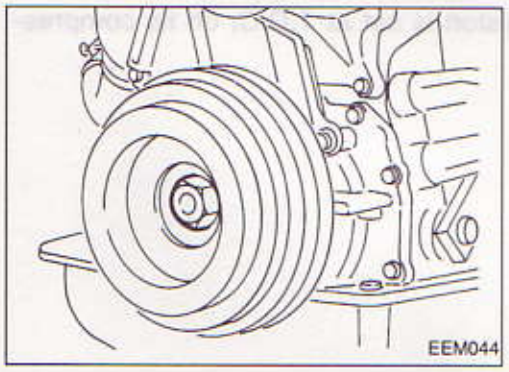
6. Adjust timing belt tension.
   1) Loosen tensioner lock bolt to apply tension to timing belt.
   2) Rotate crankshaft clockwise two turns to apply the specified tension to timing belt.
   3) Tighten tensioner lock bolt while holding tensioner pulley with hexagon wrench.

   Belt tension:
   147.1 ± 24.5 N (15 ± 2.5 kg, 33.1 ± 5.5 lb)



7. Install lower and upper belt covers.

   Belt cover bolts:
   : 7 - 9 N·m (0.7 - 0.9 kg-m, 5.1 - 6.5 ft-lb)

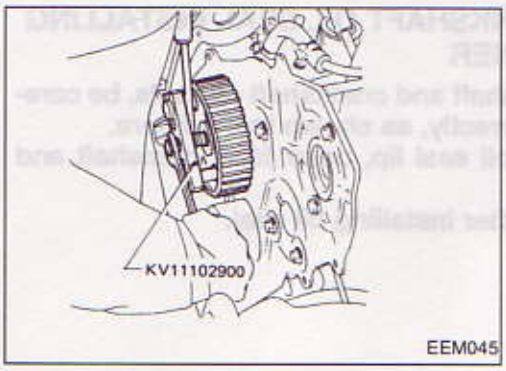


8. Install crankshaft pulley and thighten crank pulley bolt.

   : 137 - 157 N·m (14 - 16 kg-m, 101 - 116 ft-lb)

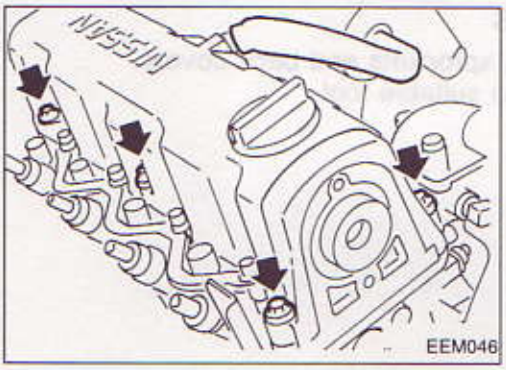
INJECTION TIMING ADJUSTMENT

Refer to EF & EC section.

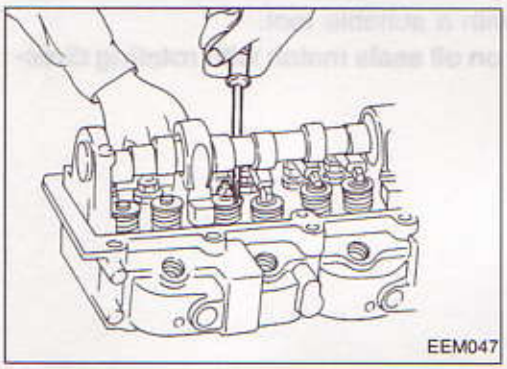


VALVE OIL SEAL

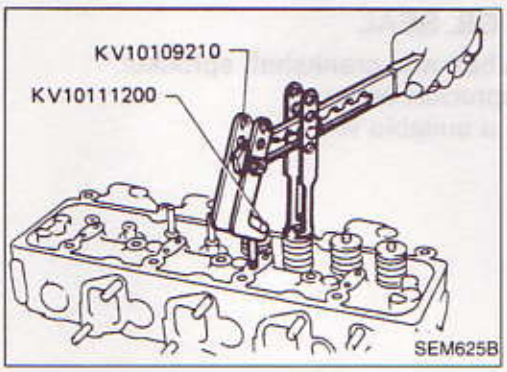
1. Remove timing belt, refer to "Removal" in "TIMING BELT".
2. Remove camshaft sprockets, injection pump, tensioner pulley and idler pulley.
   If it is hard to remove pulleys, use a puller.



3. Remove rocker cover and ventilation hose.



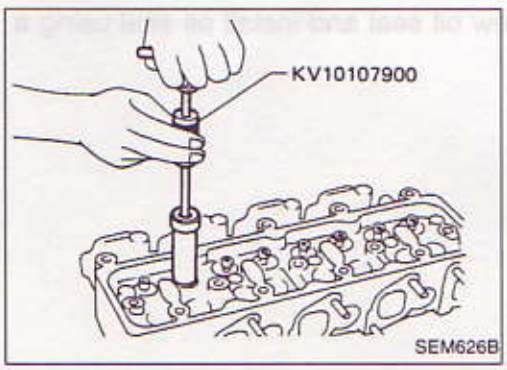
4. Remove valve rocker spring.
5. Remove valve rocker arm and valve rocker arm guide.
6. Remove camshaft brackets and camshaft.



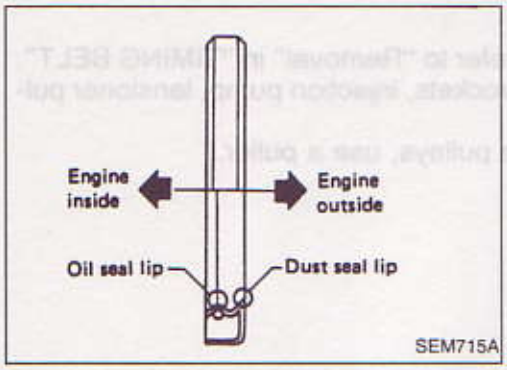
7. Replace valve oil seal according to the following procedure.

When replacing valve oil seal, set the corresponding piston at T.D.C. Failure to do so causes the valve to drop into the cylinder.

1) Set No. 1 cylinder at T.D.C.
2) Remove valve springs and valve oil seals for No. 1 and No. 4 cylinders.

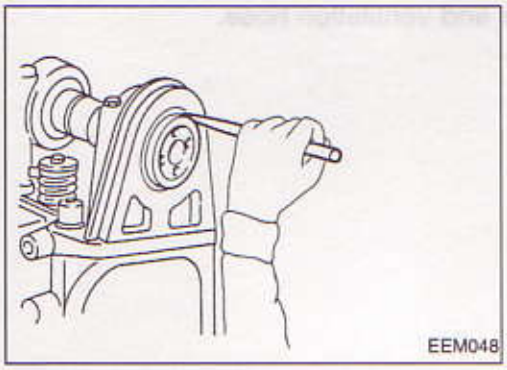


3) Install new valve oil seals for No. 1 and No. 4 cylinders as illustrated. Reinstall valve springs. (narrow pitch side towards cylinder head)
4) Set No. 2 cylinder at T.D.C.
5) Replace valve oil seals for No. 2 and No. 3 cylinders according to steps 2) and 3).



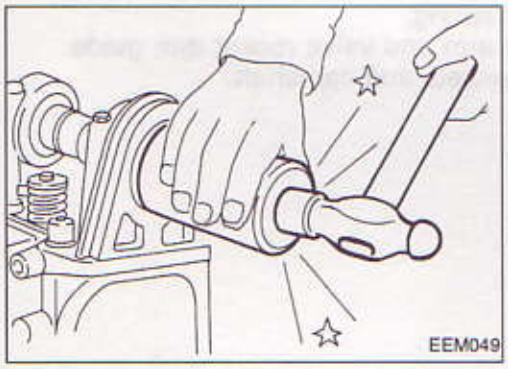
CAMSHAFT AND CRANKSHAFT OIL SEAL INSTALLING DIRECTION AND MANNER

- **When installing camshaft and crankshaft oil seals, be careful to install them correctly, as shown in the figure.**
- **Apply engine oil to oil seal lip, outer face, camshaft and bracket.**
- **Wipe off excess oil after installing oil seal.**



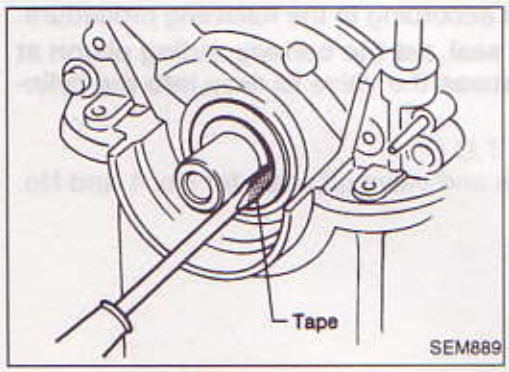
CAMSHAFT OIL SEALS

1. Remove timing belts, sprockets and back covers.
2. Pull out oil seal with a suitable tool.



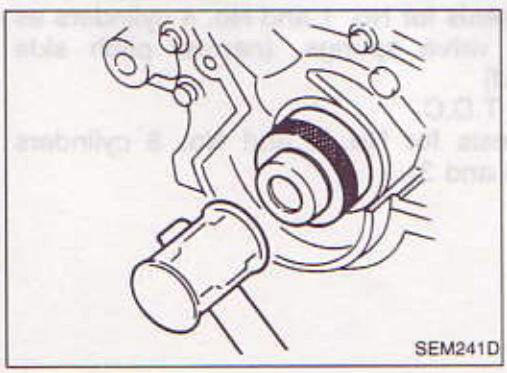
3. Install new oil seals with a suitable tool.

Confirm that arrowmarks on oil seals match with rotating direction of camshaft.

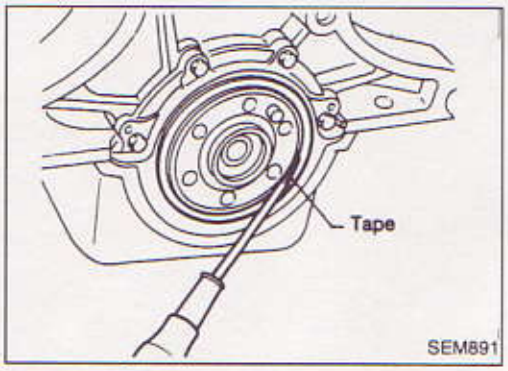


CRANKSHAFT FRONT OIL SEAL

1. Remove valve timing belt and crankshaft sprocket.
2. Remove crankshaft sprocket cover.
3. Remove oil seal with a suitable tool.

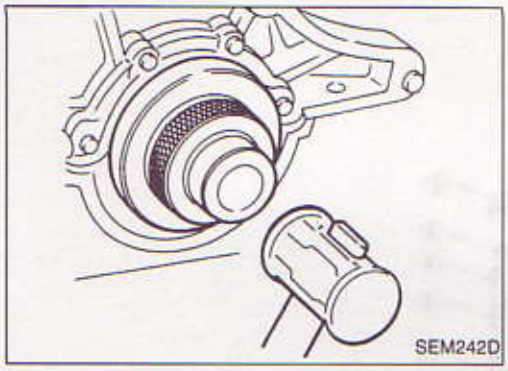


4. Apply engine oil to new oil seal and install oil seal using a suitable tool.

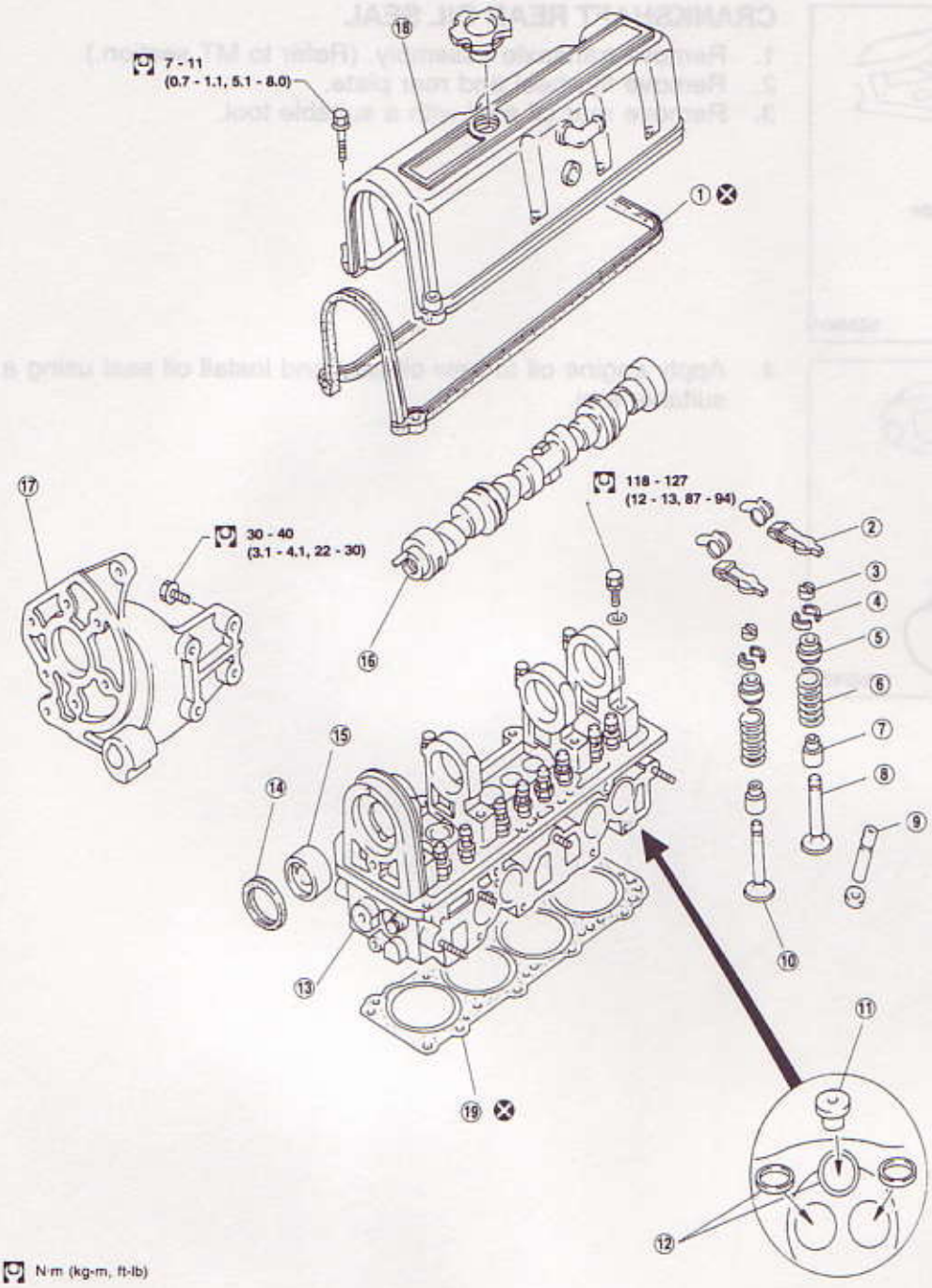


CRANKSHAFT REAR OIL SEAL

1. Remove transaxle assembly. (Refer to MT section.)
2. Remove flywheel and rear plate.
3. Remove rear oil seal with a suitable tool.



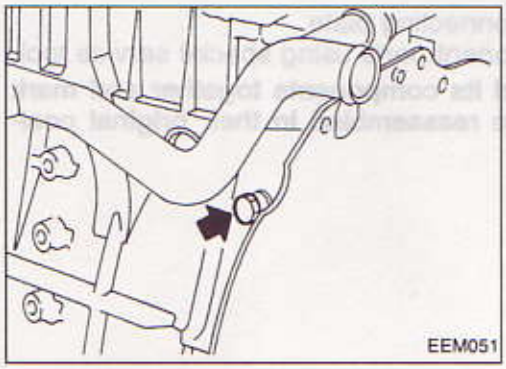
4. Apply engine oil to new oil seal and install oil seal using a suitable tool.



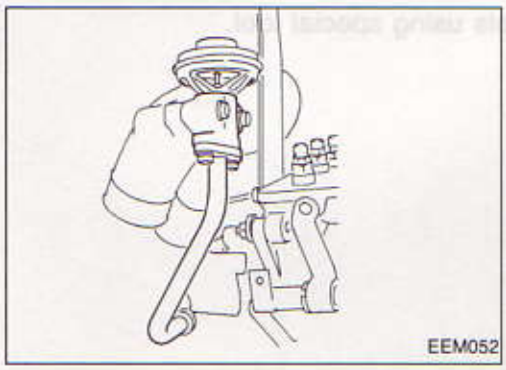
N·m (kg-m, ft-lb)

EEM050

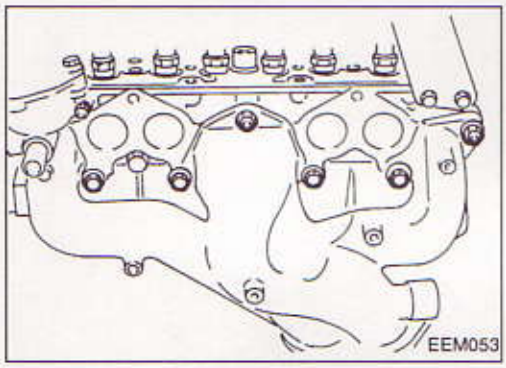
① Rocker cover gasket
② Valve rocker arm
③ Valve rotate
④ Valve cotter
⑤ Spring retainer
⑥ Valve spring
⑦ Valve lip seal
⑧ Intake valve
⑨ Valve guide
⑩ Exhaust valve
⑪ Combustion chamber
⑫ Valve seat
⑬ Cylinder head
⑭ Oil seal
⑮ Spacer
⑯ Camshaft
⑰ Injection pump bracket
⑱ Rocker cover
⑲ Cylinder head gasket



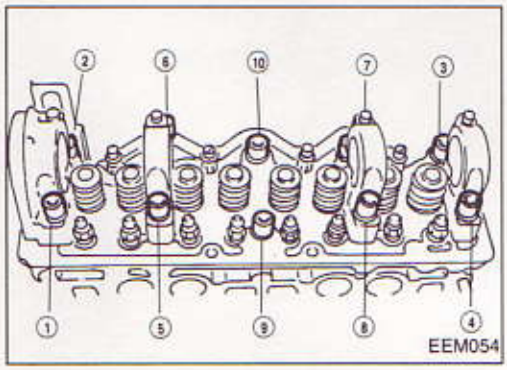
1. Drain coolant and disconnect front exhaust pipe from manifold.
2. Remove water hoses, air duct and rocker cover.
3. Remove timing belt, refer to "Removal" in "TIMING BELT".
4. Remove camshaft sprockets and camshaft, refer to "VALVE OIL SEAL" in "OIL SEAL REPLACEMENT".



5. Remove E.G.R. valve and -tube.
6. Remove heat shield from exhaust manifold.
7. Remove intake manifold.

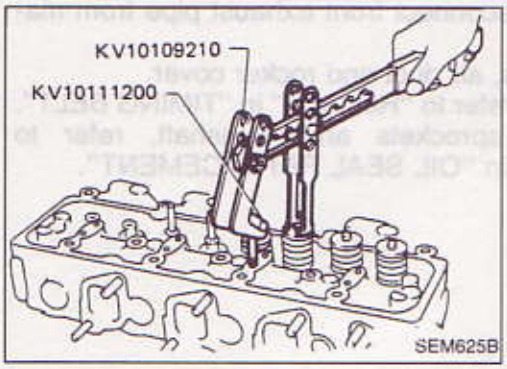


8. Remove exhaust manifold and thermostat assembly.
9. Disconnect injection tubes, refer to "COMPRESSION PRESSURE".



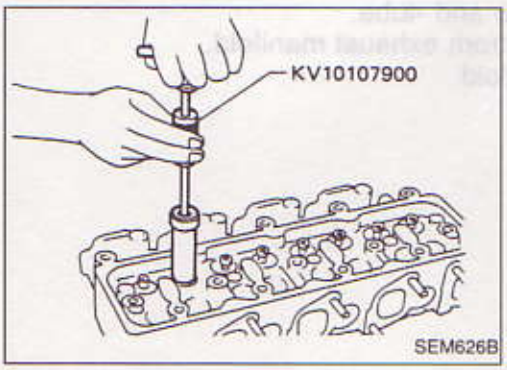
10. Remove cylinder head.
    Loosen in numerical order.

The bolts should be loosened in two or three steps.

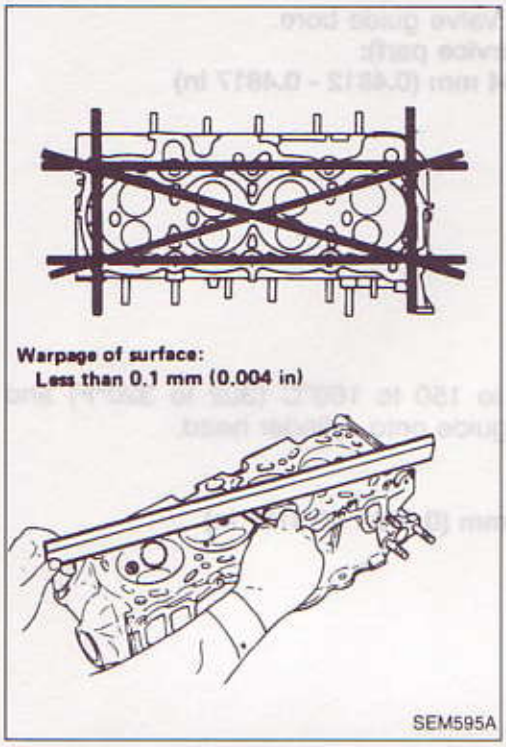


1. Remove glow plug connecting plate.
2. Remove valve component parts using special service tool.

- **Keep each valve and its components together and mark them so they can be reassembled in their original positions.**



3. Remove valve oil seals using special tool.



CYLINDER HEAD DISTORTION

1. Visually check for cracks and deformation.
2. Check cylinder head for distortion.

Head surface flatness:

Less than 0.1 mm (0.004 in)

If beyond the specified limit, replace or resurface cylinder head.

Resurfacing limit:

The resurfacing limit of the cylinder head is related to the amount of resurfacing of the cylinder block.

When:

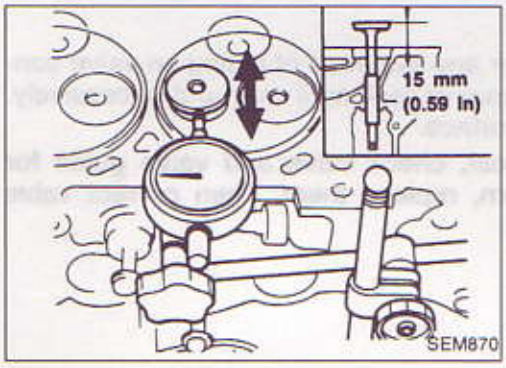
"A" is the amount of resurfacing needed for the cylinder head and "B" is the amount of resurfacing needed for the cylinder block, the maximum limit is determined by

A + B = 0.1 mm (0.004 in)

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

Nominal height of cylinder head:

89.4 - 89.6 mm (3.520 - 3.528 in)

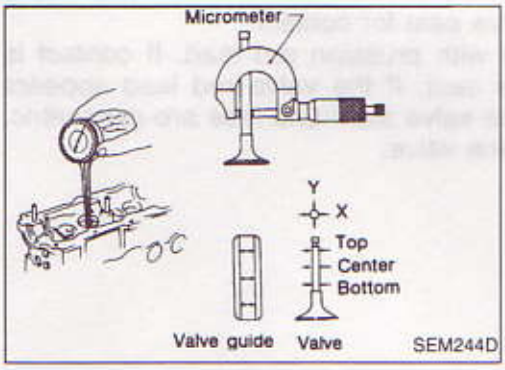


VALVE GUIDE CLEARANCE

1. Measure deflection across the cylinder head as illustrated.

Valve deflection limit (dial gauge reading):

0.1 mm (0.004 in)



2. If exceeding the limit, check valve-to-guide clearance.

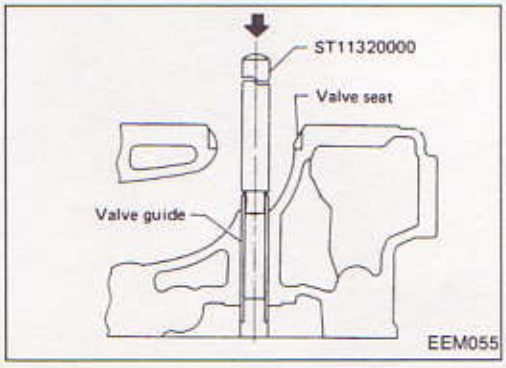
a) Measure valve stem diameter and valve guide inner diameter as illustrated.

b) Check that clearance is within the specification.

Valve stem to valve guide clearance limit:

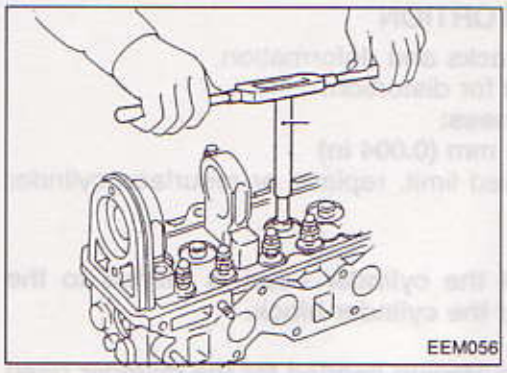
0.1 mm (0.004 in)

c) If exceeding the limit, replace valve or valve guide.

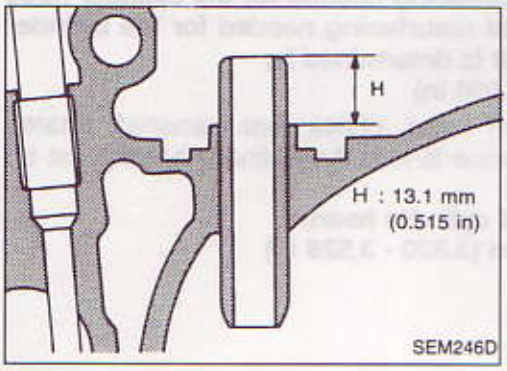


VALVE GUIDE REPLACEMENT

1. Heat cylinder head in oil to 150 to 160°C (300 to 320°F).
2. Drive out valve guide using a press or hammer and a suitable tool.


EEM056

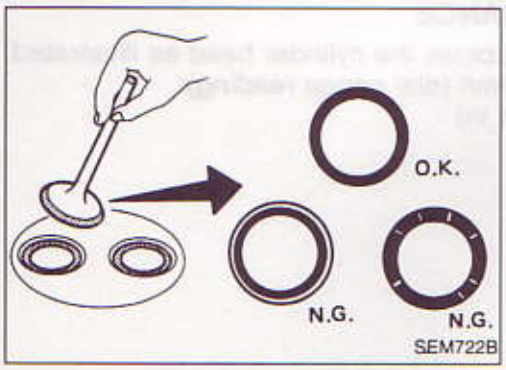
3. Ream cylinder head valve guide bore.
   Reaming bore (service part):
   12.223 - 12.234 mm (0.4812 - 0.4817 in)



SEM246D

4. Heat cylinder head to 150 to 160°C (302 to 320°F) and press service valve guide onto cylinder head.
5. Ream valve guide.
   Final size:
   8.000 - 8.018 mm (0.3150 - 0.3157 in)

VALVE SEATS

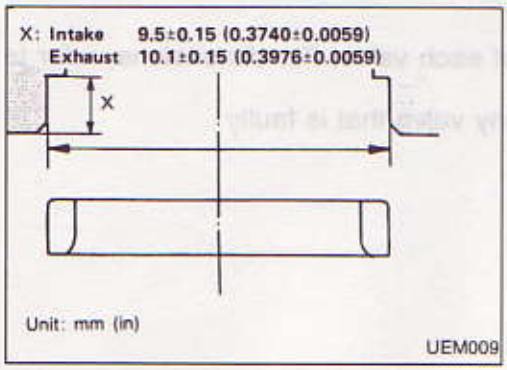


SEM722B

1. Check valve seats for any evidence of pitting on valve contact surface, and reseat or replace if worn out excessively. Correct valve seat surface.

When repairing valve seat, check valve and valve guide for wear beforehand. If worn, replace them. Then correct valve seat.

2. Check valve and valve seat for contact.
   Coat the valve face with prussian red lead. If contact is wrong, correct valve seat. If the valve red lead appears 360° around face, the valve stem and face are concentric. If not, repair or replace valve.



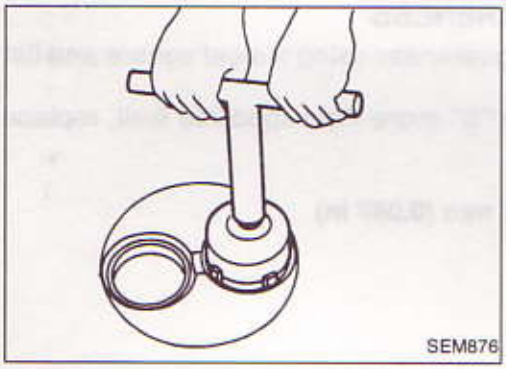
VALVE SEAT REPLACEMENT

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 the cylinder head recess.
   Reaming bore for service valve seat
   Intake 38.6 - 38.8 mm (1.520 - 1.528 in)
   Exhaust 31.6 - 31.8 mm (1.244 - 1.252 in)

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

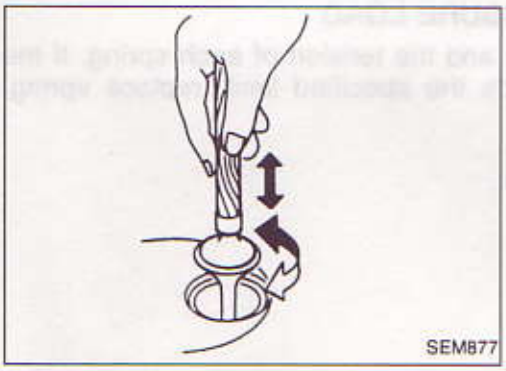
3. Heat cylinder head to a temperature of 150 to 160°C (302 to 320°F) and press fit seat until it seats on the bottom.
4. Install valve seats.

When replacing valve seat, valve should be replaced as well.

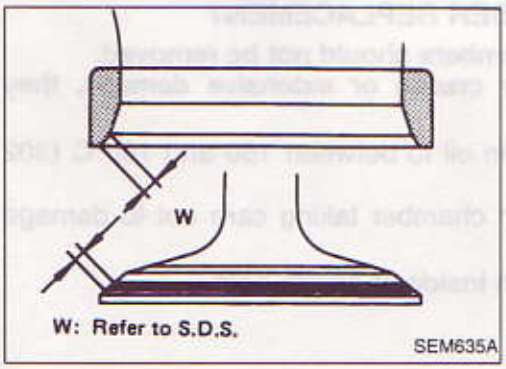


5. Cut or grind valve seat using a suitable tool at the specified dimensions as shown in S.D.S.

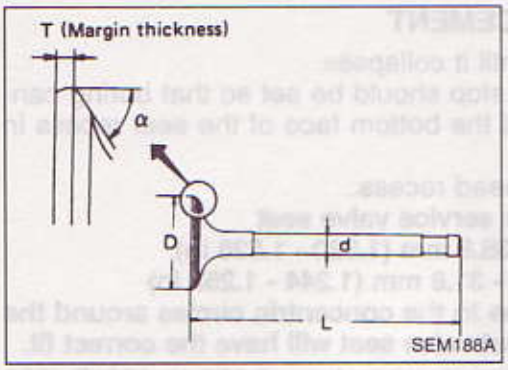
The cutting should be done with both hands to obtain a uniform and concentric finish.



6. Apply a small amount of fine grinding compound to the valve's contacting face and put the valve into its guide.
   Lap valve against its seat until proper valve seating is obtained.
   Clean valve and valve seat.

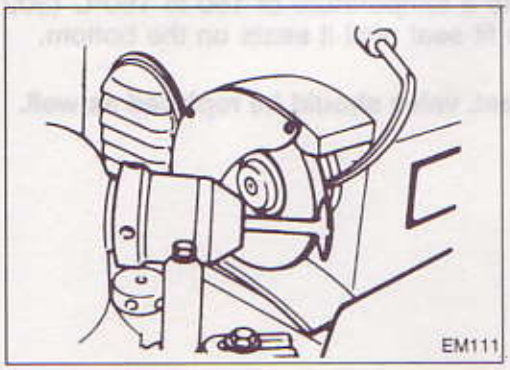


7. Check valve seating condition.
   Valve seat contact "W":
   Intake
   1.91 mm (0.0752 in)
   Exhaust
   1.63 mm (0.0642 in)



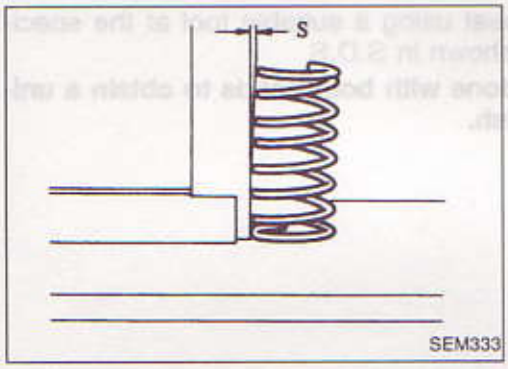
VALVE DIMENSIONS

1. Check dimensions of each valve. For dimensions, refer to S.D.S.
2. Correct or replace any valve that is faulty.



3. Valve face or valve stem end surface should be refaced by using a valve grinder.

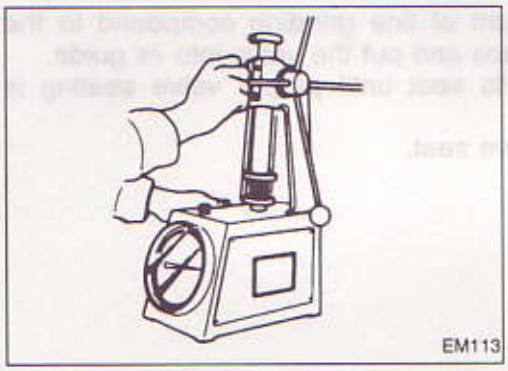
When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace the valve.
Grinding allowance for valve stem tip is 0.5 mm (0.020 in) or less.



VALVE SPRING SQUARENESS

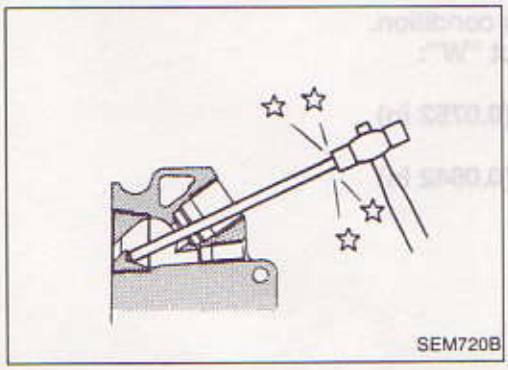
Check valve spring for squareness using a steel square and flat surface plate.
If spring is out of square "S" more than specified limit, replace with new one.

Out-of-square:
Less than 2.2 mm (0.087 in)



VALVE SPRING PRESSURE LOAD

Measure the free length and the tension of each spring. If the measured value exceeds the specified limit, replace spring. Refer to S.D.S.

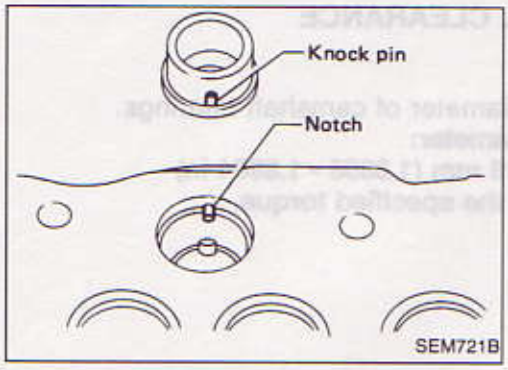


COMBUSTION CHAMBER REPLACEMENT

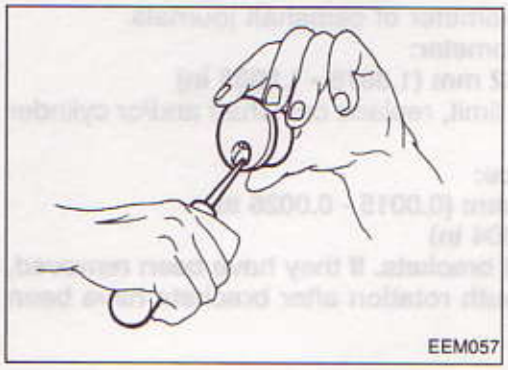
Usually combustion chambers should not be removed. However, if they show cracks or extensive damage, they should be replaced.

1. Heat cylinder head in oil to between 150 and 160°C (302 and 320°F).
2. Remove combustion chamber taking care not to damage cylinder head.

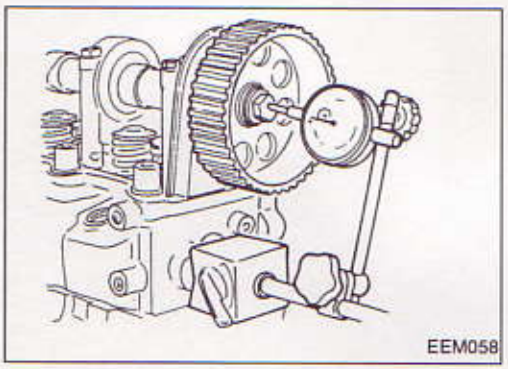
Be careful not to scratch inside of nozzle hole.



3. Install combustion chamber.
a. Heat cylinder head to 150 to 160°C (302 to 320°F) in oil.
b. Align combustion chamber knock pin with cylinder head notch, and install it into cylinder head using a plastic-tip hammer.



- Before installing combustion chamber, clean auxiliar chanal, as shown at left.



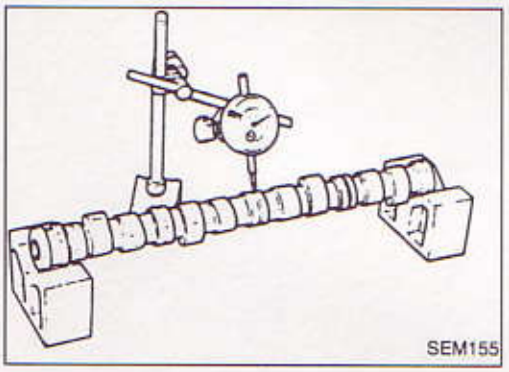
CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.

CAMSHAFT END PLAY

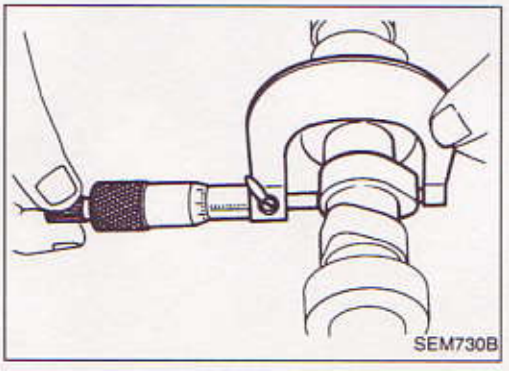
1. Install camshaft in cylinder head.
2. Tighten bracket bolts to the specified torque.
3. Measure camshaft end play.

Camshaft end play:
Standard
0.08 - 0.38 mm (0.0031 - 0.0150 in)



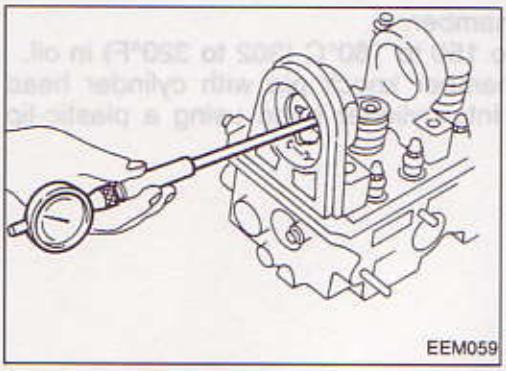
CAMSHAFT RUNOUT

1. Measure camshaft runout at the center journal.
Runout (Total indicator reading):
Limit 0.05 mm (0.0020 in)
2. If it exceeds the limit, replace camshaft.



CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height.
Standard cam height:
Intake
39.95 - 40.00 mm (1.5728 - 1.5748 in)
Exhaust
40.30 - 40.35 (1.5866 - 1.5886 in)
Wear limit of cam height:
0.15 mm (0.0059 in)
2. If wear is beyond the limit, replace camshaft.


EEM059

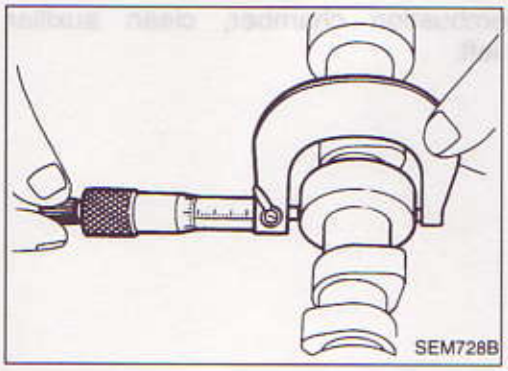
CAMSHAFT JOURNAL CLEARANCE

Using micrometer

1. Measure the inner diameter of camshaft bearings.

Standard inner diameter:
48.000 - 48.016 mm (1.8898 - 1.8904 in)

Tighten bracket bolts to the specified torque.


SEM728B

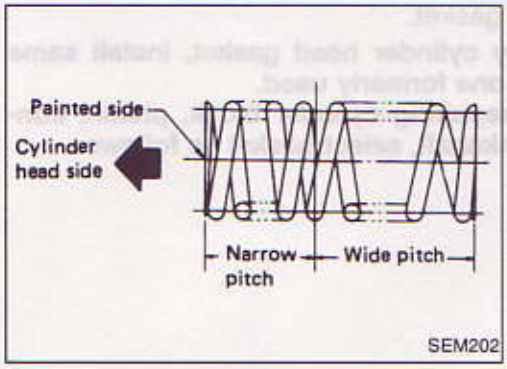
2. Measure the outer diameter of camshaft journals.

Standard outer diameter:
47.949 - 47.962 mm (1.8878 - 1.8883 in)

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

Standard clearance:
0.038 - 0.067 mm (0.0015 - 0.0026 in)
Limit: 0.1 mm (0.004 in)

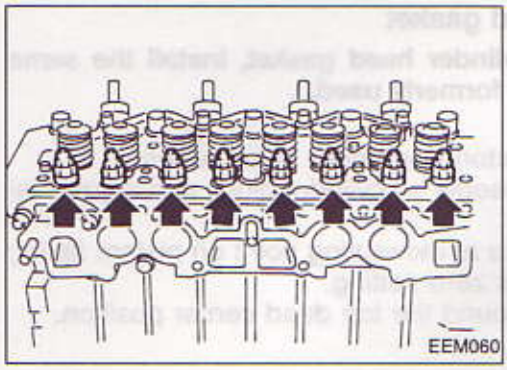
Do not remove camshaft brackets. If they have been removed, check camshaft for smouth rotation after brackets have been reinstalled.



1. Install valve component parts.

Install valve spring with its narrow pitch side toward cylinder head side.

- **Always install new valve oil seals.**
  Rewfer to oil seal replacement.
- **Before installing oil seal, install valve-spring seat.**
- **When installing valve, apply engine oil on the valve stem and lip of valve oil seal.**
- **Check whether the valve face is free from foreign matter.**

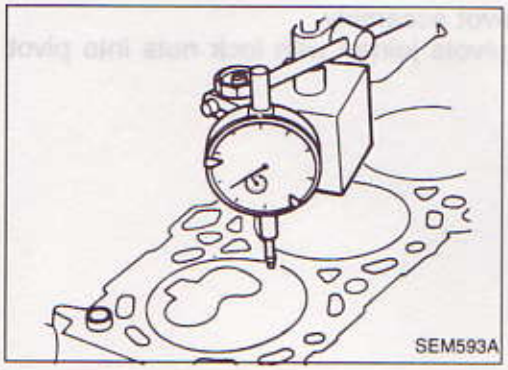


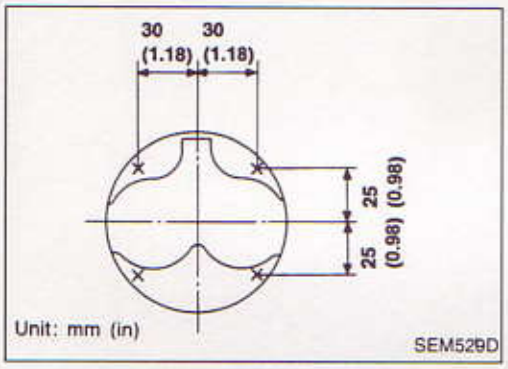
2. Install valve rocker pivot assembly.
   Screw valve rocker pivots joined with lock nuts into pivot bushing.

1. Install cylinder head gasket.

a. When replacing only cylinder head gasket, install same grade gasket as the one formerly used.

b. When replacing or repairing cylinder block, piston, connecting rod and crankshaft, select gasket as follows:


SEM593A



SEM529D

Selecting cylinder head gasket

When only replacing cylinder head gasket, install the same grade gasket as the one formerly used.

Step 1

Measure projection of piston to cylinder head surface.

a) Set dial gauge and needle on cylinder block and adjust dial gauge to zero.
b) Set dial gauge needle at measuring point on piston, taking care not to disturb its zero setting.
c) Rotate crankshaft around the top dead center position.
d) Read and write down the maximum value.
e) Reset dial gauge on cylinder block and confirm that zero setting has not been disturbed during measurement.
f) Repeat steps b through e for all measuring points as illustrated and for each cylinder.

- Be sure to measure the projection at 4 points for each cylinder as shown.

Step 2

Calculate the average value of measurements taken for each piston.

Step 3

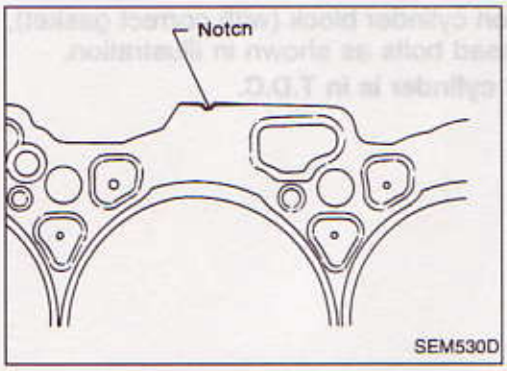
Calculate the average value of measurements for all pistons from the values obtained from step 2.

Step 4

Round of the value obtained.

Step 5

Determine required thickness of gasket, referring to chart A.



Relation between piston average projection and cylinder head gasket (Chart A)

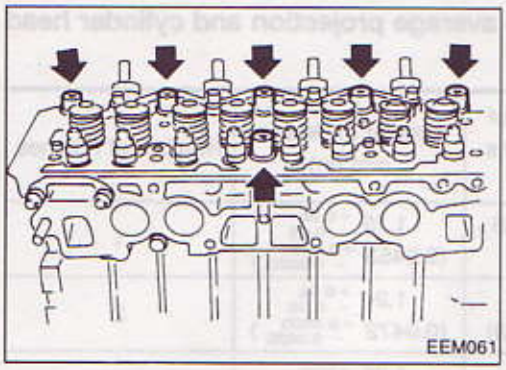
Grade	Average value of piston projections mm (in)	Gasket thickness mm (in)	Number of notches
A	Less than 0.505 (0.0199)	$1.15^{+0.05}_{-0.05}$ ($0.0453^{+0.0020}_{-0.0020}$)	1
B	0.505 - 0.555 (0.0199 - 0.0219)	$1.20^{+0.05}_{-0.05}$ ($0.0472^{+0.0020}_{-0.0020}$)	2
C	Over 0.555 (0.0219)	$1.25^{+0.05}_{-0.05}$ ($0.0492^{+0.0020}_{-0.0020}$)	3

Step 6
Check if the average value of each projection obtained from step 2 is larger than the max. value of the standard projection (of selected gasket) incremented by 0.05 mm (0.0020 in).
If so, use gasket that is 1 grade thicker. If not so, use gasket as selected in step 4.

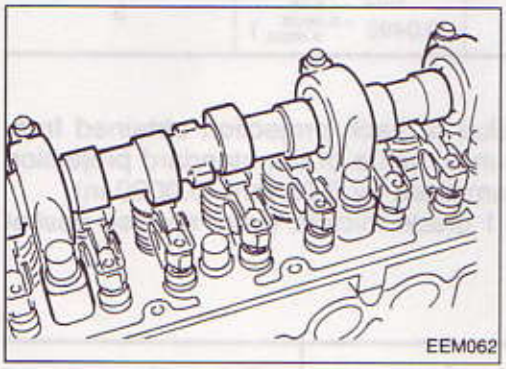
Example

Step	Cylinder No. / Item	1				2				3				4			
1.	Measured value	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4
		0.53	0.56	0.53	0.56	0.59	0.55	0.59	0.55	0.53	0.58	0.57	0.54	0.58	0.51	0.52	0.57
2.	Average value of each piston	0.545				0.57				0.555				0.545			
3.	Average value of all pistons	0.55375															
4.	Round off value	0.554*1															
5.	Determined gasket thickness (Temporarily)	1.20 (Grade B)															
6.	X: Maximum value of standard projection of selected gasket ... 0.555 (in chart A) + 0.05 = 0.605 Y: Maximum value in step 2 = 0.57 The relationship between X and Y is "X > Y".*2																
7.	Selected gasket thickness (Finally)	1.20 (Grade B)*2															

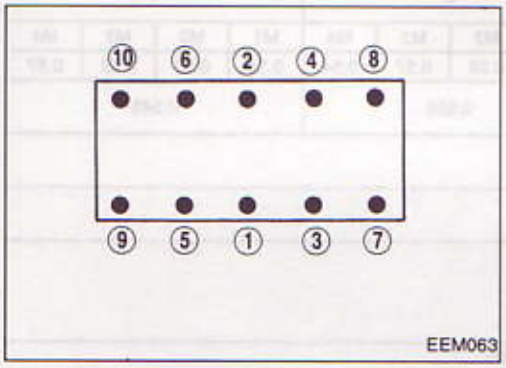
***1: If the average value of projections for all pistons is, for example, 0.553 (7) 5, as shown in the table above, it should be rounded off as follows:**
If the digit in the forth decimal place (which is enclosed by a circle in this case) is smaller than 5, the average value should be regarded as 0.553 mm; if it is larger than 5, the average value should be regarded as 0.554 mm.
***2: If X < Y, then the thicker grade C gasket must be used.**


EEM061

2. Place cylinder head on cylinder block (with correct gasket), and install cylinder head bolts as shown in illustration.
- **Make sure that no. 1 cylinder is in T.D.C.**

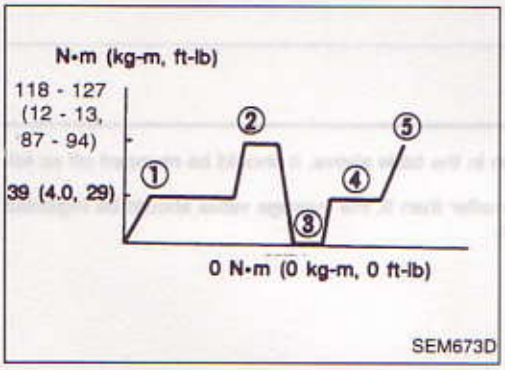

EEM062

3. Install camshaft and camshaft brackets into cylinder head.
- **Be carefull not to damage the inner surfaces of camshaft bearings.**
- **Make sure that no. 1 cam of camshaft is at T.D.C. on its compression stroke.**



EEM063

4. Tighten cylinder head bolts according to the sequence as shown at left.

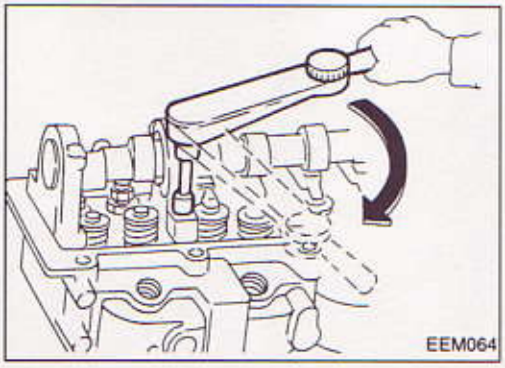


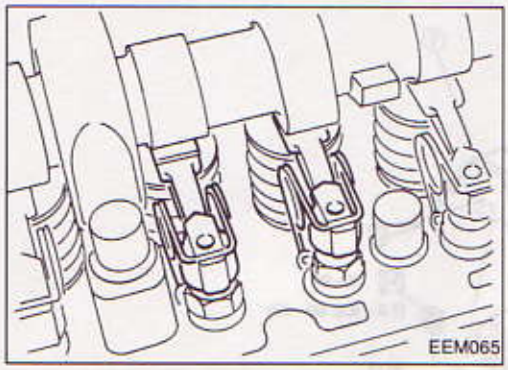
SEM673D

Tightening procedure

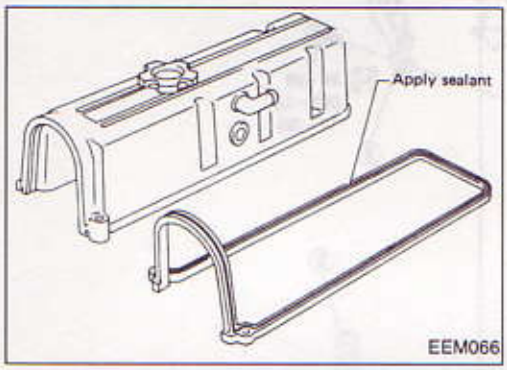
1. Apply engine oil to threads and underhead seating face of each bolt.
2. Tighten bolt progressively in the following steps.
   ① 39 N·m (4.0 kg-m, 29 ft-lb)
   ② 118 - 127 N·m (12 - 13 kg-m, 87 - 94 ft-lb)
   ③ Return to 0 N·m (0 kg-m, 0 ft-lb)
   ④ 39 N·m (4.0 kg-m, 29 ft-lb)
   ⑤ Tighten to 100 $^{+5^\circ}_{-0^\circ}$

   If it is difficult to check tightening angle of bolt, tighten to 118 to 127 N·m (12 to 13 kg-m, 87 to 94 ft-lb).


EEM064

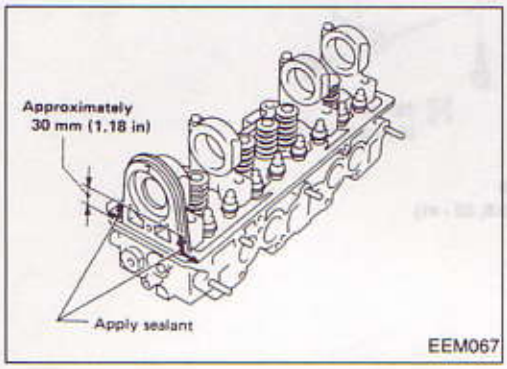

EEM065

3. Install valve rocker arm and valve rocker spring.



EEM066

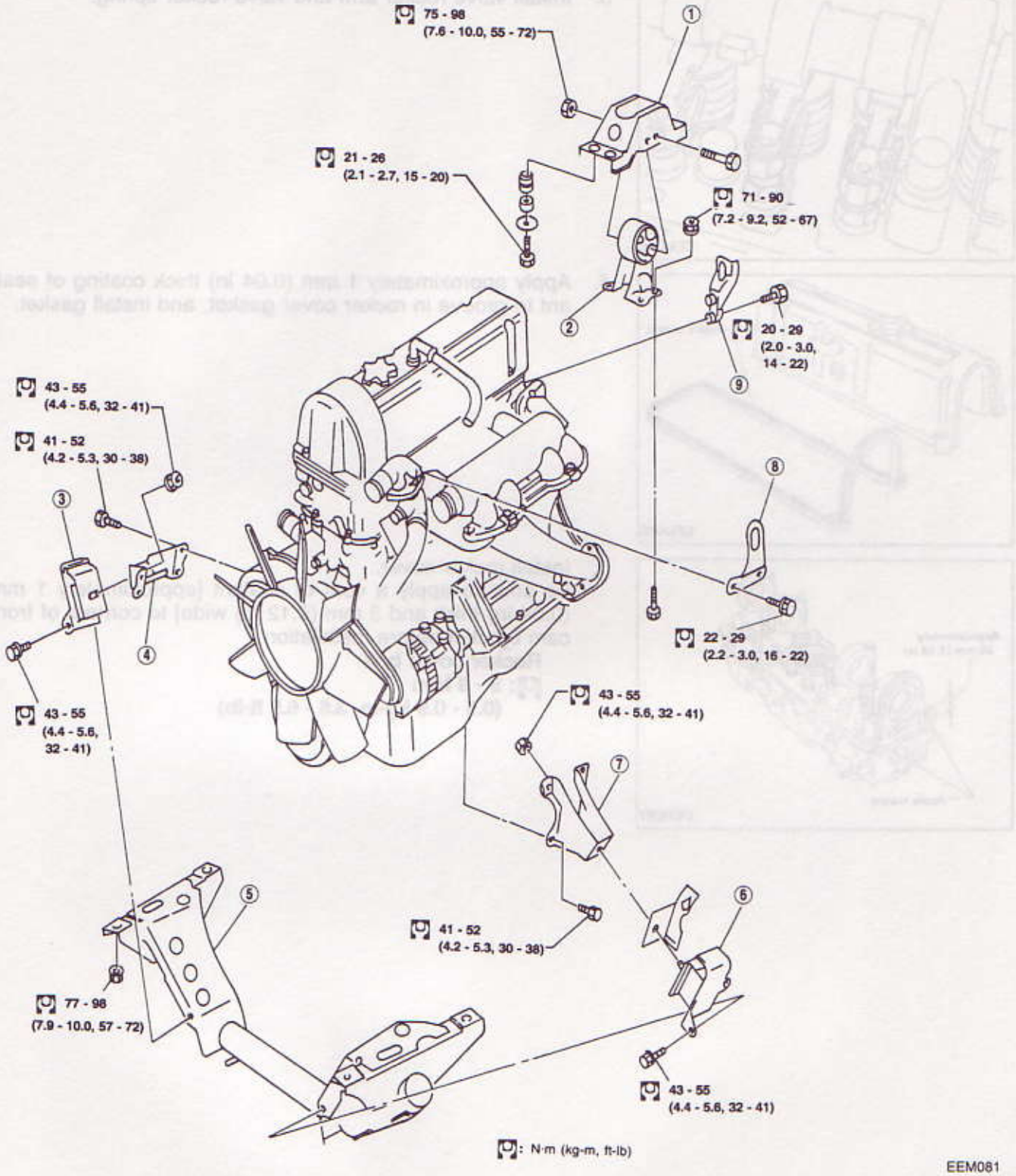
4. Apply approximately 1 mm (0.04 in) thick coating of sealant to groove in rocker cover gasket, and install gasket.



EEM067

5. Install rocker cover.
Be sure to apply a coat of sealant [approximately 1 mm (0.04 in) thick and 3 mm (0.12 in) wide] to corners of front cam bracket before installation.

Rocker cover bolt
: 5 - 9 N·m
(0.5 - 0.9 kg-m, 3.6 - 6.5 ft-lb)



EEM081

① Mounting bracket
② Rear engine mounting
③ Insulator
④ Bracket
⑤ Member
⑥ Insulator
⑦ Bracket
⑧ Front engine slinger
⑨ Rear engine slinger

WARNING:

a. **Situate vehicle on a flat and solid surface.**
b. **Place chocks at front and back of rear wheels**
c. **Do not remove engine until exhaust system has completely cooled off.**
   Otherwise, you may burn yourself.
d. **For safety during subsequent steps, make sure transmission jack is set securely.**
e. **Before disconnecting fuel hose, place a tray to catch overflow of fuel or use shop towels.**
f. **Be sure to hoist engine and transmission in a safe manner.**

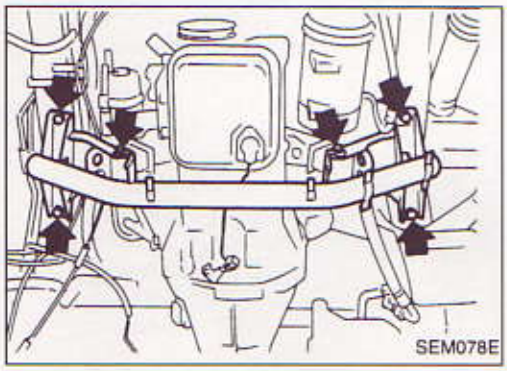
CAUTION:

- **When lowering engine, be careful not to strike adjacent parts, especially accelerator wire casing and idling control electrical wires and brake lines.**
- **Always use engine supports in a safe manner.**
- **When removing drive shafts, be careful not to damage oil seals of transmission.**

Engine cannot be removed seperately from transmission. Remove engine with transmission.

Removal

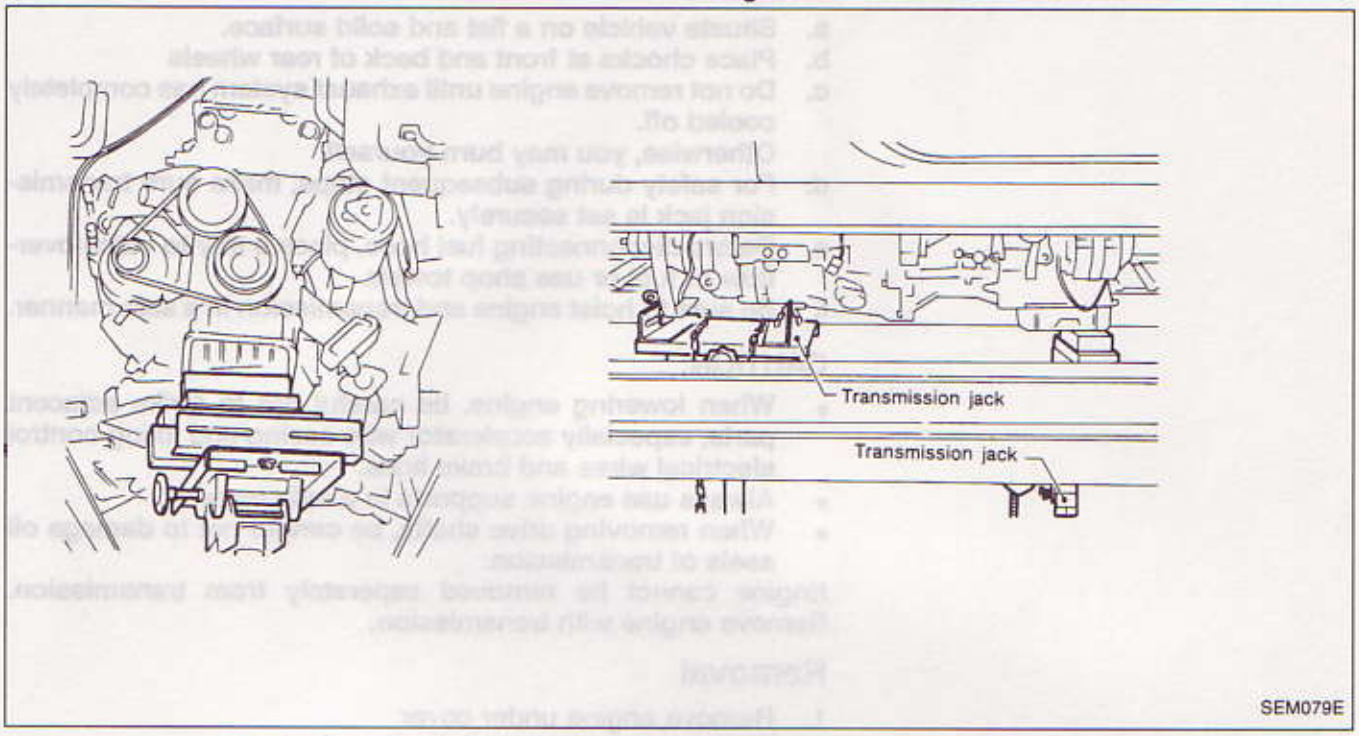
1. Remove engine under cover
2. Drain engine oil from drain plug of oil pan.
3 Remove exhaust tube.
4. Remove drive belts.
5. Drain coolant from both cylinder block, and radiator.
   Remove alternator, compressor, power steering oil pump.
7. Disconnect vacuum hoses, fuel hoses, water hoses, electrical connections, accelerator and idling control wires.



8. Support engine/transmission assembly by placing suitable transmission jacks under transmission and engine.
9. Remove center member and mounting brackets from engine.

Removal (Cont'd)

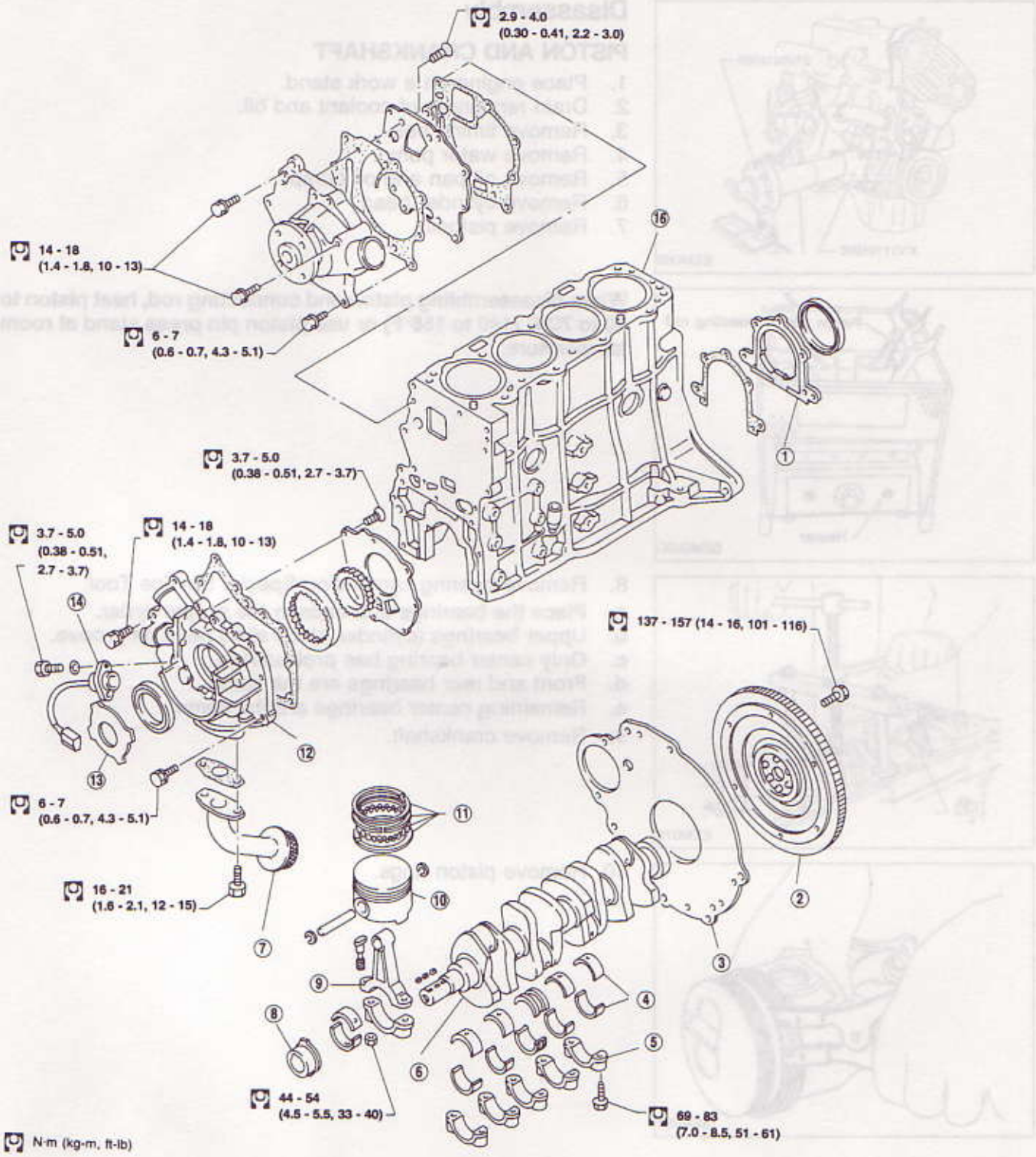
10. Remove engine with transmission as shown.



Installation

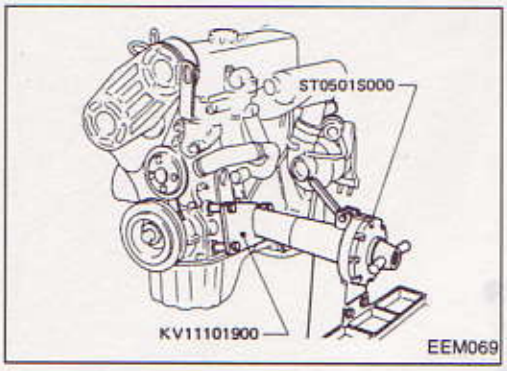
When installing the engine, tighten the lock bolts to the specified torque.

- Installation is the reverse order of removal.



EEM068

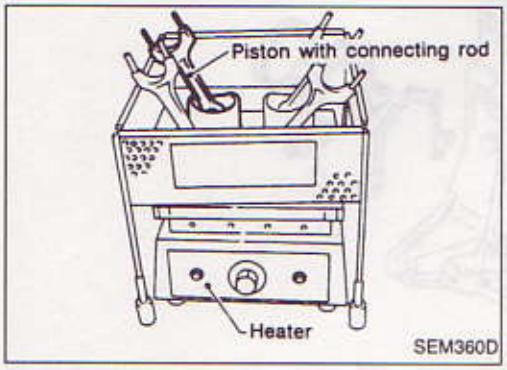
① Oil seal retainer
② Flywheel
③ Rear plate
④ Main bearing
⑤ Cap
⑥ Crankshaft
⑦ Oil strainer
⑧ Oil pump drive spacer
⑨ Connecting rod
⑩ Piston
⑪ Piston ring
⑫ Oil pump
⑬ Timing plate
⑭ Rotation sensor
⑮ Water pump
⑯ Cylinder block



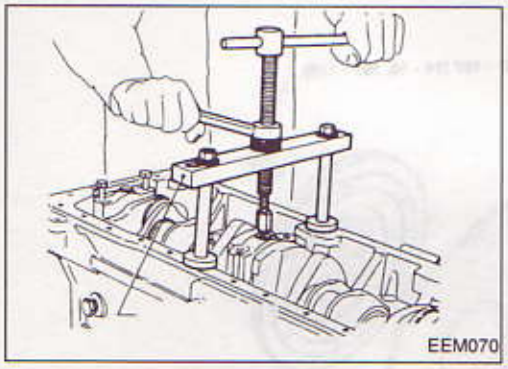
Disassembly

PISTON AND CRANKSHAFT

1. Place engine on a work stand.
2. Drain remainder of coolant and oil.
3. Remove timing belt.
4. Remove water pump.
5. Remove oil pan and oil pump.
6. Remove cylinder head.
7. Remove pistons.



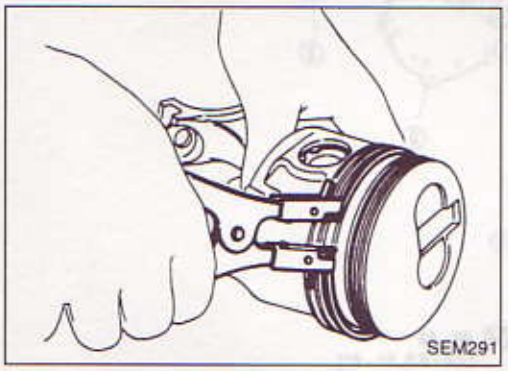
When disassembling piston and connecting rod, heat piston to 60 to 70°C (140 to 158°F) or use piston pin press stand at room temperature.



8. Remove bearing caps using Special Service Tool.

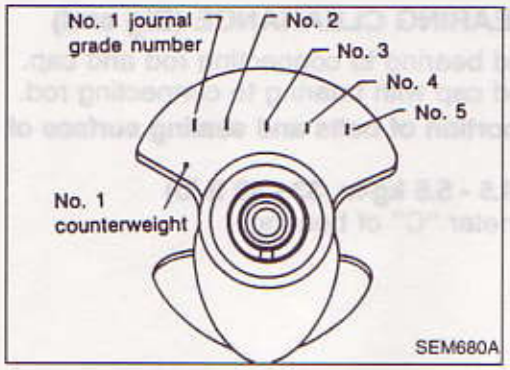
a. Place the bearings and caps in the proper order.
b. Upper bearings (cylinder block side) have oil groove.
c. Only center bearing has protrudings.
d. Front and rear bearings are the same.
e. Remaining center bearings are the same.

9. Remove crankshaft.



10. Remove piston rings.

Inspection (Cont'd)



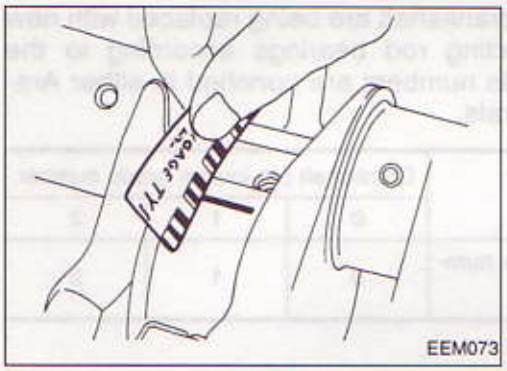
- If either bearing, crankshaft or cylinder block is replaced with a new one, select main bearing according to the following table. These numbers are punched in either Arabic or Roman numerals.

		Main bearing housing grade number		
		0	1	2
		Main bearing grade number		
Crankshaft main journal grade number	0	0	1	2
	1	1	2	3

Identification color:
Grade 0: Black
Grade 1: Brown
Grade 2: Green
Grade 3: Yellow

For example:
Main journal grade number: 1
Crankshaft journal grade number: 2
Main bearing grade number = 1 + 2 = 3

Main bearing thickness:
Refer to S.D.S.



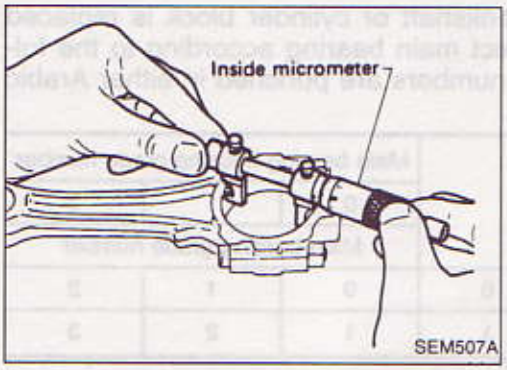
Using plastigage

1. Wipe off oil from crankshaft main journal and main bearing inner surface.
2. Install crankshaft and put plastigage on each crankshaft main journal.
3. Install crankshaft main bearing caps with main bearings and tighten nuts to the specified torque:
   : 69 - 83 N·m (7.0 - 8.5 kg-m, 51 - 61 ft-lb)
4. Remove main bearing caps and measure maximum width of plastigage.

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

Inspection (Cont'd)

CONNECTING ROD BEARING CLEARANCE (Big end)

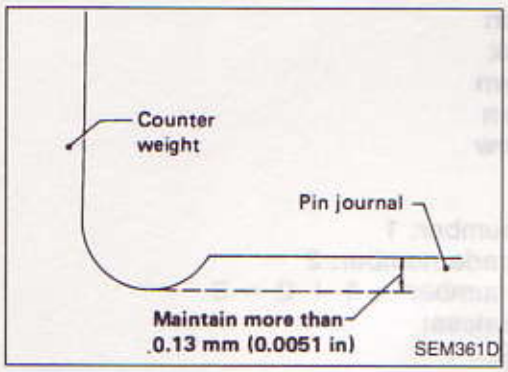


1. Install connecting rod bearing to connecting rod and cap.
2. Install connecting rod cap with bearing to connecting rod.

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

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

3. Measure inside diameter "C" of bearing.



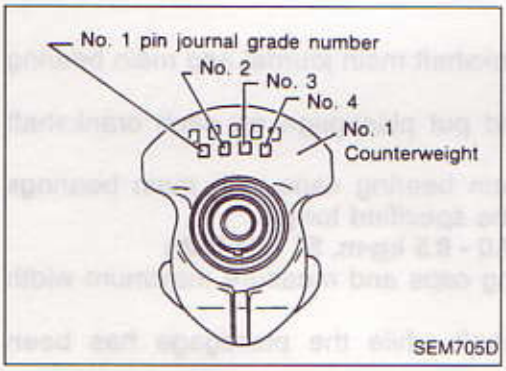
4. Measure outside diameter "Dp" of crankshaft pin journal.
5. Calculate connecting rod bearing clearance.

Connecting rod bearing clearance = C − Dp

Standard:

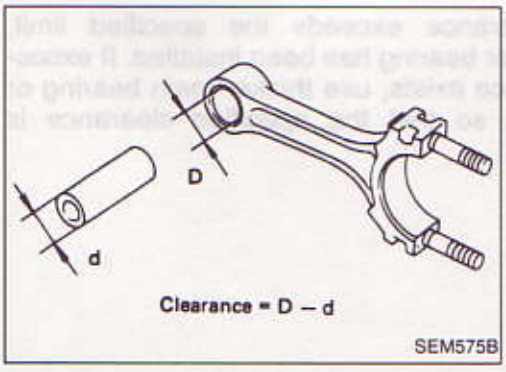
0.024 - 0.066 mm (0.0009 - 0.0026 in)

- If it exceeds the limit, replace the bearing.
- If crankshaft pin journal is worn or shows any abnormality, regrind crank pin and use undersized bearings to maintain the specified oil clearance.
- **Refer to S.D.S. for regrinding diameter of crankshaft pin and available service parts.**
- **When regrinding crankshaft pin, do not grind fillet-roll.**



- If either bearings or crankshaft are being replaced with new ones, select connecting rod bearings according to the following table. Grade numbers are punched in either Arabic or Roman numerals.

	Crankshaft pin journal grade number		
	0	1	2
Connecting rod baring grade number	0	1	2



CONNECTING ROD AND PISTON PIN CLEARANCE (Small end)

Clearance (D − d):

0.025 - 0.044 mm (0.0010 - 0.0017 in)

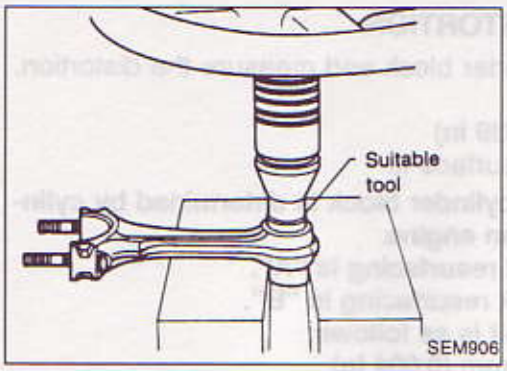
- If clearance exceeds the specifications, replace the bearing.

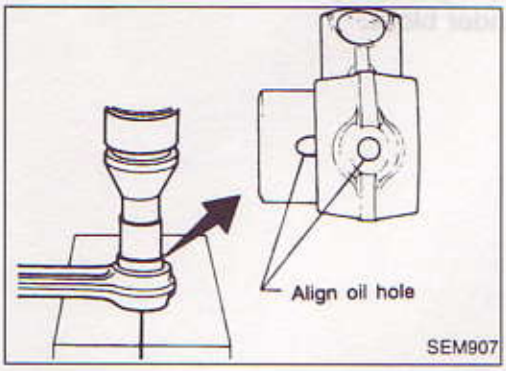
Inspection (Cont'd)

Bearing replacement

1. Remove bearing with a suitable tool.

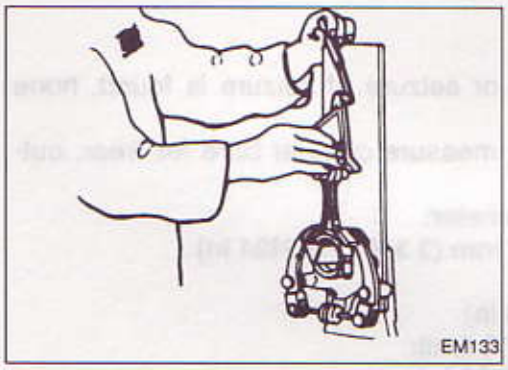
Do not scratch inner surface of connecting rod.





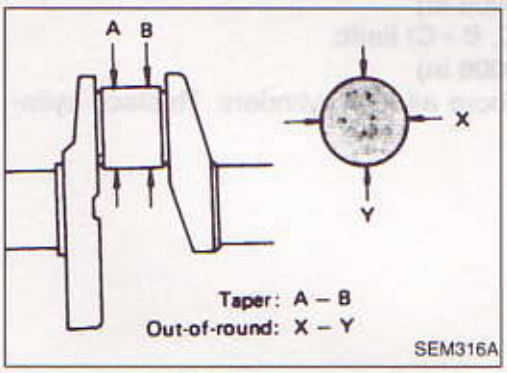
2. Install new bearing with oil holes aligned correctly.
3. Ream bore using a suitable tool.

Ream bore:
25.025 - 25.038 mm (0.9852 - 0.9857 in)



CONNECTING ROD BEND AND TORSION

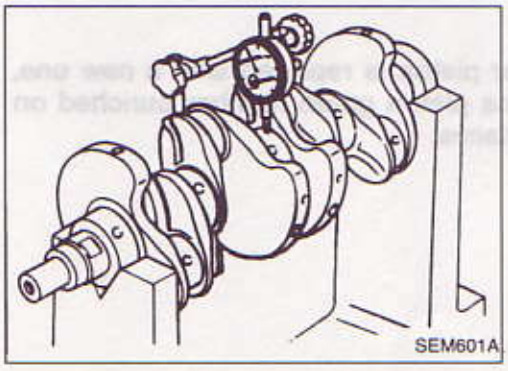
Bend and torsion [per 100 mm (3.94 in) length]:
Bend
Less than 0.05 mm (0.0020 in)
Torsion
Less than 0.05 mm (0.0020 in)



CRANKSHAFT

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

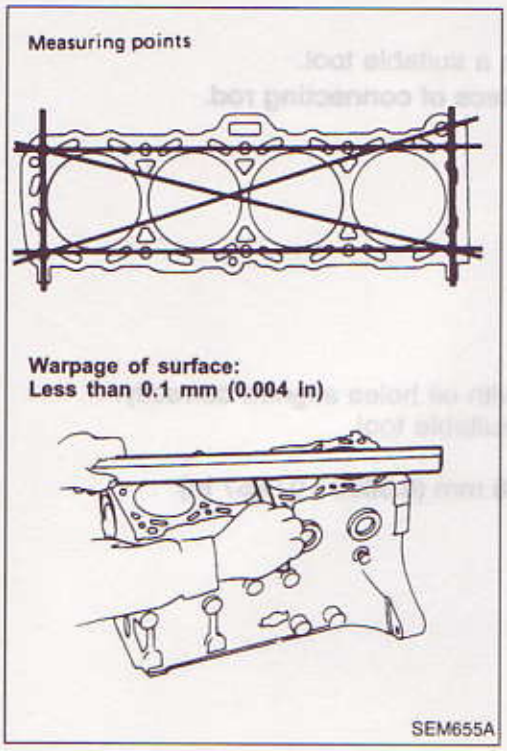
Out-of-round (X – Y):
Less than 0.03 mm (0.0012 in)
Taper (A – B):
Less than 0.03 mm (0.0012 in)



3. Check crankshaft runout.

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

Inspection (Cont'd)



CYLINDER BLOCK DISTORTION

Clean upper face of cylinder block and measure the distortion.

Limit:

0.10 mm (0.0039 in)

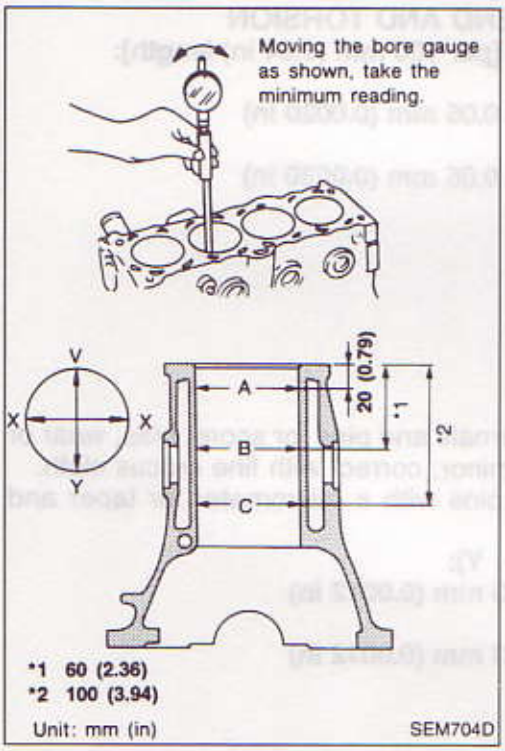
If out of specification, resurface it.

The resurfacing limit of cylinder block is determined by cylinder head resurfacing in an engine.
Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

A + B = 0.1 mm (0.004 in)

If necessary, replace cylinder block.

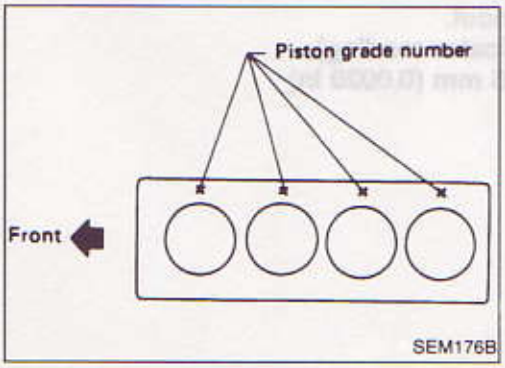


CYLINDER BORE

1. Check for scratches or seizure. If seizure is found, hone bore.
2. Using a bore gauge, measure cylinder bore for wear, out-of-round or taper.

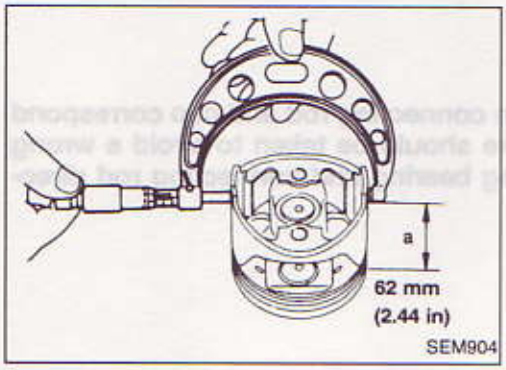
Standard bore diameter:
85.00 - 85.050 mm (3.3465 - 3.3484 in)
Bore wear limit
0.2 mm (0.008 in)
Out-of-round (X - Y) limit:
0.020 mm (0.0008 in)
Taper (A - B, A - C, B - C) limit:
0.020 mm (0.0008 in)

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



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

Inspection (Cont'd)



Reboring

1. The size to which cylinders must be honed, is determined by adding piston-to-cylinder clearance to the piston skirt diameter "A".
   Dimension "a":
   Approximately 60 mm (2.44 in)
   Rebored size calculation
   D = A + B − C = A + [0.03 to 0.05 mm (0.0012 to 0.0020 in)]
   where,
   D : Honed diameter
   A : Skirt diameter as measured
   B : Piston-to-wall clearance
   C : Machining allowance
   0.02 mm (0.0008 in)
2. Install main bearing caps in place, and tighten to the specified torque to prevent distortion of the cylinder bores in final assembly.
3. Cut cylinder bores in the order of 1-3-4-2.

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.

4. Hone the cylinders to the required size referring to S.D.S.
- Use clean sharp stones of proper grade.
- Cross-hatch pattern should be approximately 45°.

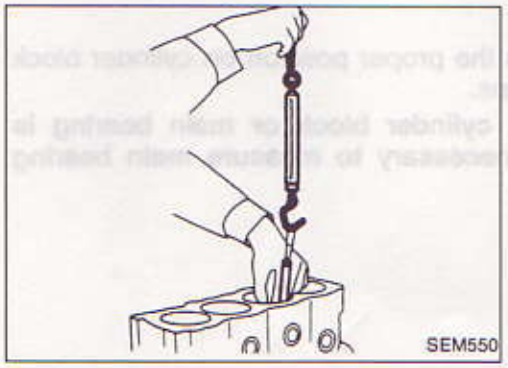
5. Measure the finished cylinder bore for out-of-round and taper.

Measurement of a just machined cylinder bore requires utmost care since it is expanded by cutting heat.

PISTON TO CYLINDER WALL CLEARANCE

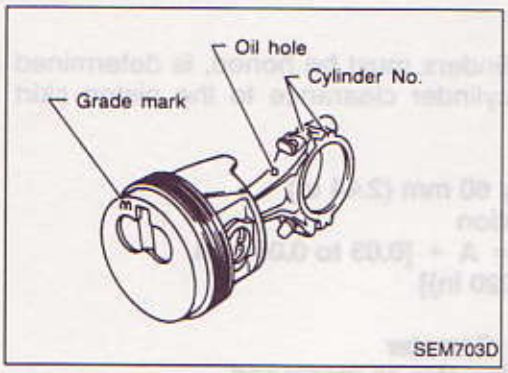
Using micrometer

1. Measure piston and cylinder bore diameter.
   Piston diameter "A":
   Refer to S.D.S.
   Measuring point "a" (Distance from the bottom):
   Approximately 62 mm (2.44 in)
   Bore diameter "D":
   Refer to S.D.S.
   Measuring point (Distance from the top):
   Approximately 60 mm (2.36 in)
2. Check that piston clearance is within the specification.
   Piston clearance (D − A):
   0.050 - 0.070 mm (0.0020 - 0.0028 in)



Using feeler gauge

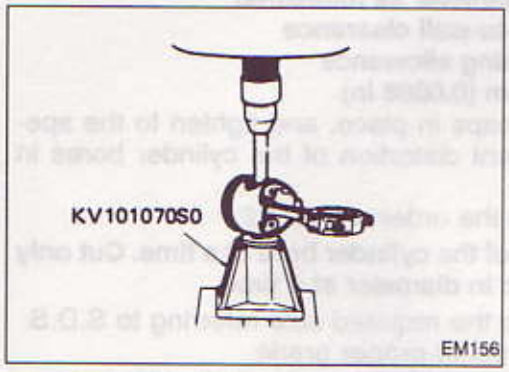
1. Set piston and feeler gauge with spring scale.
2. Measure extracting force while pulling up scale slowly.
   Feeler gauge used:
   0.06 mm (0.0024 in)
   Extracting force:
   5.9 - 11.8 N (0.6 - 1.2 kg, 1.3 - 2.6 lb)



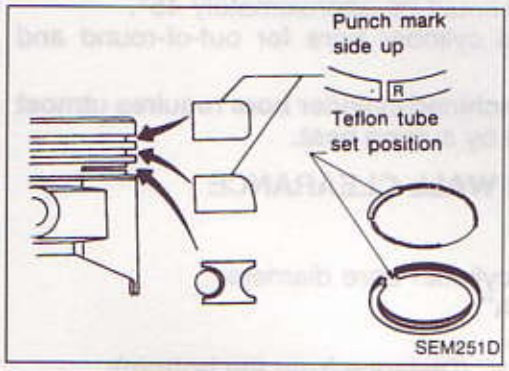
Assembly

PISTON

- **Numbers stamped on connecting rod and cap correspond to each cylinder. Care should be taken to avoid a wrong combination including bearing and connecting rod direction.**



- **Install new snap ring on one side of piston pin hole.**
- **When assembling piston and connecting rod with piston pin, heat piston to between 60 and 80°C (140 and 176°F) and install piston pin with a suitable tool.**
- **Install new snap ring.**
- **After assembling, ascertain that piston swings smoothly.**

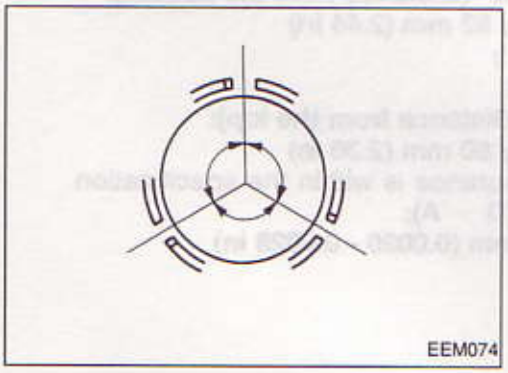


- Install piston rings with a suitable tool.

a) When installing pistong rings, make sure that stamped mark "TOP" is facing top of position.

b) When installing new top ring or replacing cylinder block, select top ring to adjust gap.

	Cylinder bore grade	
	1, 2	3, 4, 5
Top ring grade No.	No mark	S



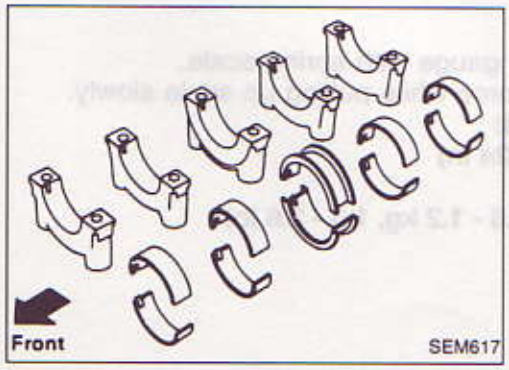
c) Align teflon tube with gap of oil ring.

d) Align gaps of piston rings with intervals of 120°, as shown in illustration.

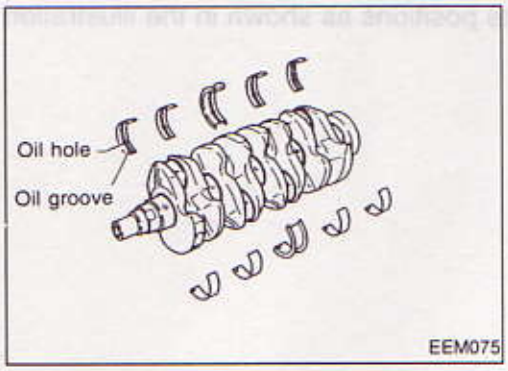
CRANKSHAFT

1. Set main bearings in the proper position on cylinder block and main bearing caps.

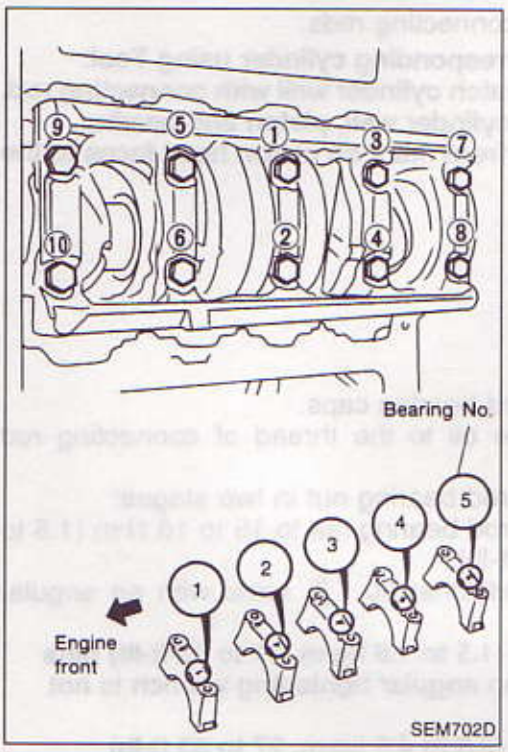
- **If either crankshaft, cylinder block or main bearing is reused again, it is necessary to measure main bearing clearance.**



Assembly (Cont'd)



- **Upper bearings (cylinder block side) have oil groove.**
- **Only center bearing has protrudings.**
- **Front and rear bearings are equal.**
- **Remain two center bearings are the same.**

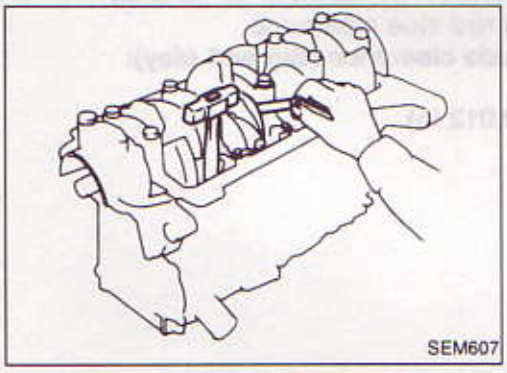


2. Apply engine oil to main bearing surfaces on both sides of cylinder block and cap.
3. Install crankshaft and main bearing caps.

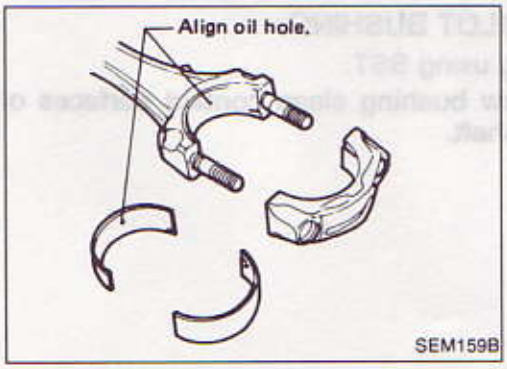
- **Arrange bearing caps so that the indicated numbers are in order from the front of the engine.**

4. Tighten main bearing cap bolts.
   : 69 - 83 N·m (7.0 - 8.5 kg-m, 51 - 61 ft-lb)

- **Tighten bearing cap bolts gradually in two or three stages and outwardly from center bearing in sequence.**
- **After securing bearing cap bolts, ascertain that crankshaft turns smoothly.**



5. Measure crankshaft free end play at center bearing.
   Crankshaft free end play:
   Standard
   0.05 - 0.18 mm (0.0020 - 0.0071 in)
   Limit
   0.30 mm (0.0118 in)



PISTON WITH CONNECTING ROD

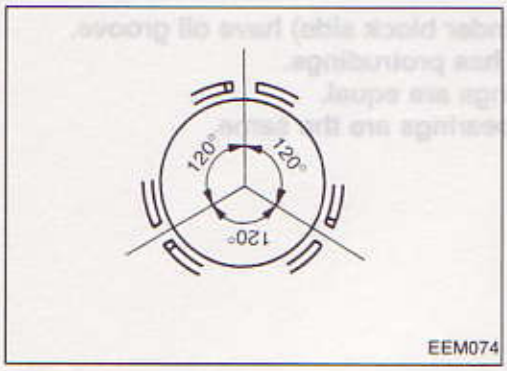
1. Install connecting rod bearings in the connecting rods and connecting rod caps.

- Confirm that correct size of bearings is used.

Refer to "Inspection".

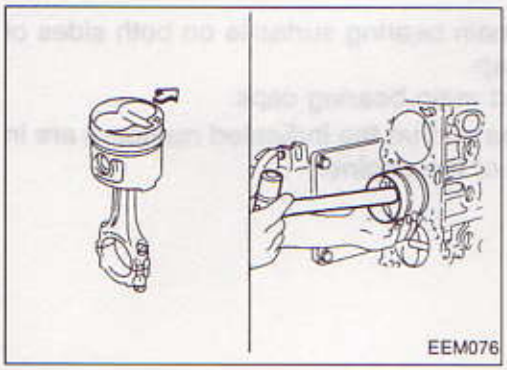
- Install the bearings so that the oil hole in the connecting rod aligns with the oil hole of the bearing.
- Lubricate connecting rod bearings and crankshaft journals with engine oil.

Assembly (Cont'd)

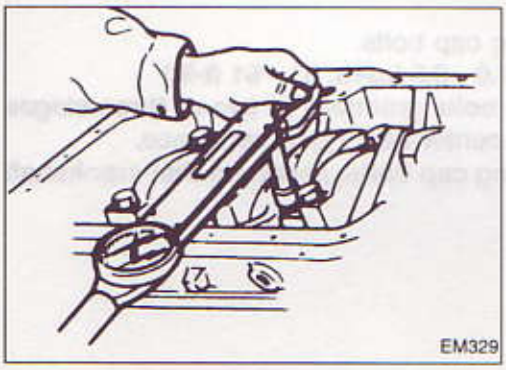


EEM074

- Set piston rings in the positions as shown in the illustration at left.


EEM076

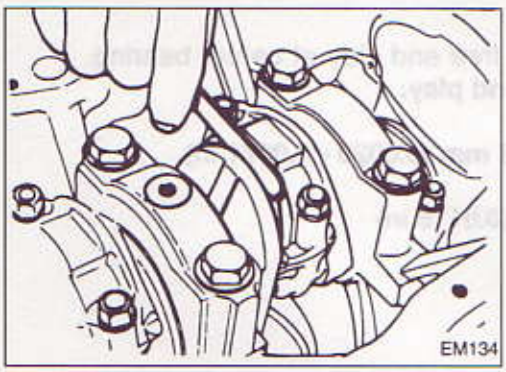
2. Install pistons with connecting rods.
- **Install them into corresponding cylinder using Tool.**
- **Be careful not to scratch cylinder wall with connecting rod.**
- **Apply engine oil to cylinder wall, piston and bearing.**
- **Arrange so that the front mark on piston head faces to the front of engine.**


EM329

3. Install connecting rod bearing caps.
- Apply a little engine oil to the thread of connecting rod bearing nut.
- Tighten connecting rod bearing nut in two stages:

(1) Tighten connecting rod bearing nut to 15 to 16 N·m (1.5 to 1.6 kg-m, 11 to 12 ft-lb).
(2) Then tighten an additional 60 $^{+5^\circ}_{0^\circ}$ turns with an angular tightening wrench.

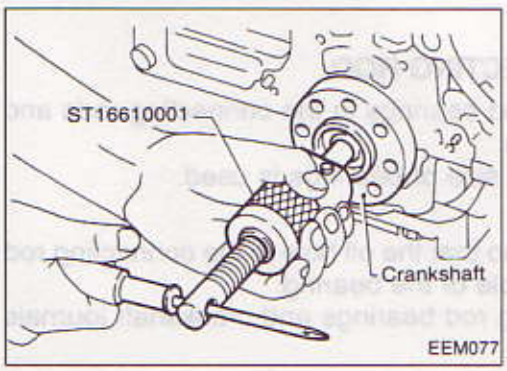
: 15 to 16 N·m (1.5 to 1.6 kg-m, 11 to 12 ft-lb) plus 60 $^{+5^\circ}_{0^\circ}$ or, if an angular tightening wrench is not available,
37 to 45 N·m (3.8 to 4.6 kg-m, 27 to 33 ft-lb)


EM134

4. Measure connecting rod side clearance.

Connecting rod side clearance (Big end play):
Limit
0.3 mm (0.012 in)

REPLACEMENT OF PILOT BUSHING

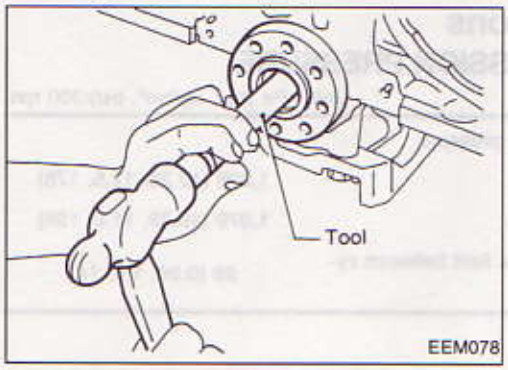


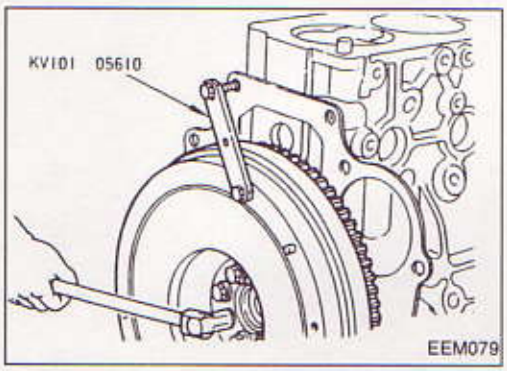
EEM077

1. Extract pilot bushing using SST.
- **Before installing new bushing clean contact surfaces of bushing and crankshaft.**

Assembly (Cont'd)

2. Drive in pilot bushing by using appropriate tool.

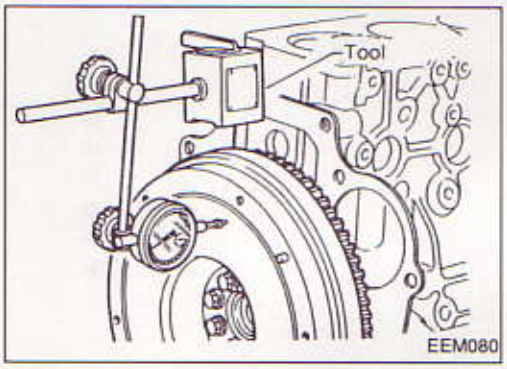




FLYWHEEL

Installation

1. Install flywheel and tighten flywheel bolts to the specified torque:
   : 137 - 157 N·m (14 - 16 kg-m, 101 - 116 ft-lb)



Flywheel runout

Runout (Total indicator reading):
Less than 0.15 mm (0.0059 in)

General Specifications

Cylinder arrangement		In-line 4
Displacement	cm^3 (cu in)	1,998 (121.92)
Bore and stroke	mm (in)	86 x 86 (3.39 x 3.39)
Valve arrangement		D.O.H.C.
Firing order		1-3-4-2
Number of piston rings		
Compression		2
Oil		1
Number of main bearings		5
Compression ratio		9.5 ± 0.2

COMPRESSION PRESSURE

Unit: kPa (bar, kg/cm^2, psi)/300 rpm

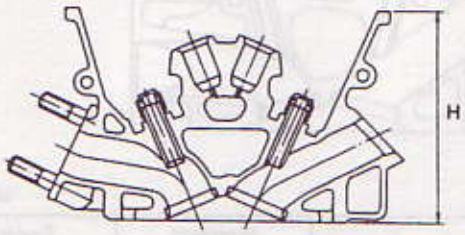
Compression pressure	
Standard	1,226 (12.26, 12.5, 178)
Minimum	1,079 (10.79, 11.0, 156)
Difference limit between cylinders	98 (0.98, 1.0, 14)

Inspection and Adjustment

CYLINDER HEAD

Unit: mm (in)

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

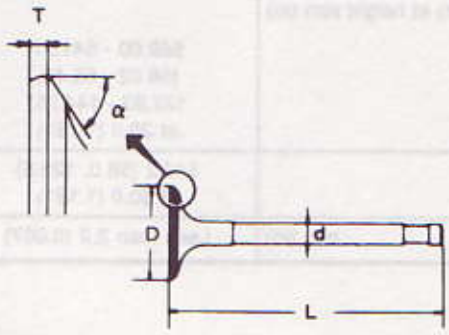


Nominal cylinder head height:
H = 136.9 - 137.1 (5.390 - 5.398)

SEM956C

VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	
Intake	34.0 - 34.2 (1.339 - 1.346)
Exhaust	30.0 - 30.2 (1.181 - 1.189)
Valve length "L"	
Intake	101.19 - 101.61 (3.9839 - 4.0004)
Exhaust	102.11 - 102.53 (4.0201 - 4.0366)
Valve stem diameter "d"	
Intake	5.965 - 5.980 (0.2348 - 0.2354)
Exhaust	5.945 - 5.960 (0.2341 - 0.2346)
Valve seat angle "α"	
Intake	45°15' - 45°45'
Exhaust	
Valve margin "T"	
Intake	1.1 (0.043)
Exhaust	1.3 (0.051)
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)

Inspection and Adjustment (Cont'd)

Valve spring

Free height	mm (in)	49.36 (1.9433)
Pressure N (kg, lb) at height mm (in)		
Standard		569.00 - 641.57 (58.02 - 65.42, 127.93 - 144.25) at 30.0 (1.181)
Limit		549.2 (56.0, 123.5) at 30.0 (1.181)
Out-of-square	mm (in)	Less than 2.2 (0.087)

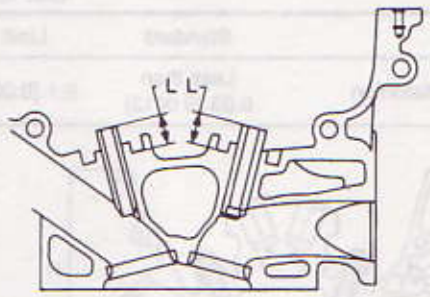
Hydraulic lash adjuster (H.L.A.)

Unit: mm (in)

H.L.A. outer diameter	16.980 - 16.993 (0.6685 - 0.6690)
H.L.A. guide inner diameter	17.000 - 17.020 (0.6693 - 0.6701)
Clearance between H.L.A. and H.L.A. guide	0.007 - 0.040 (0.0003 - 0.0016)

Valve guide

Unit: mm (in)



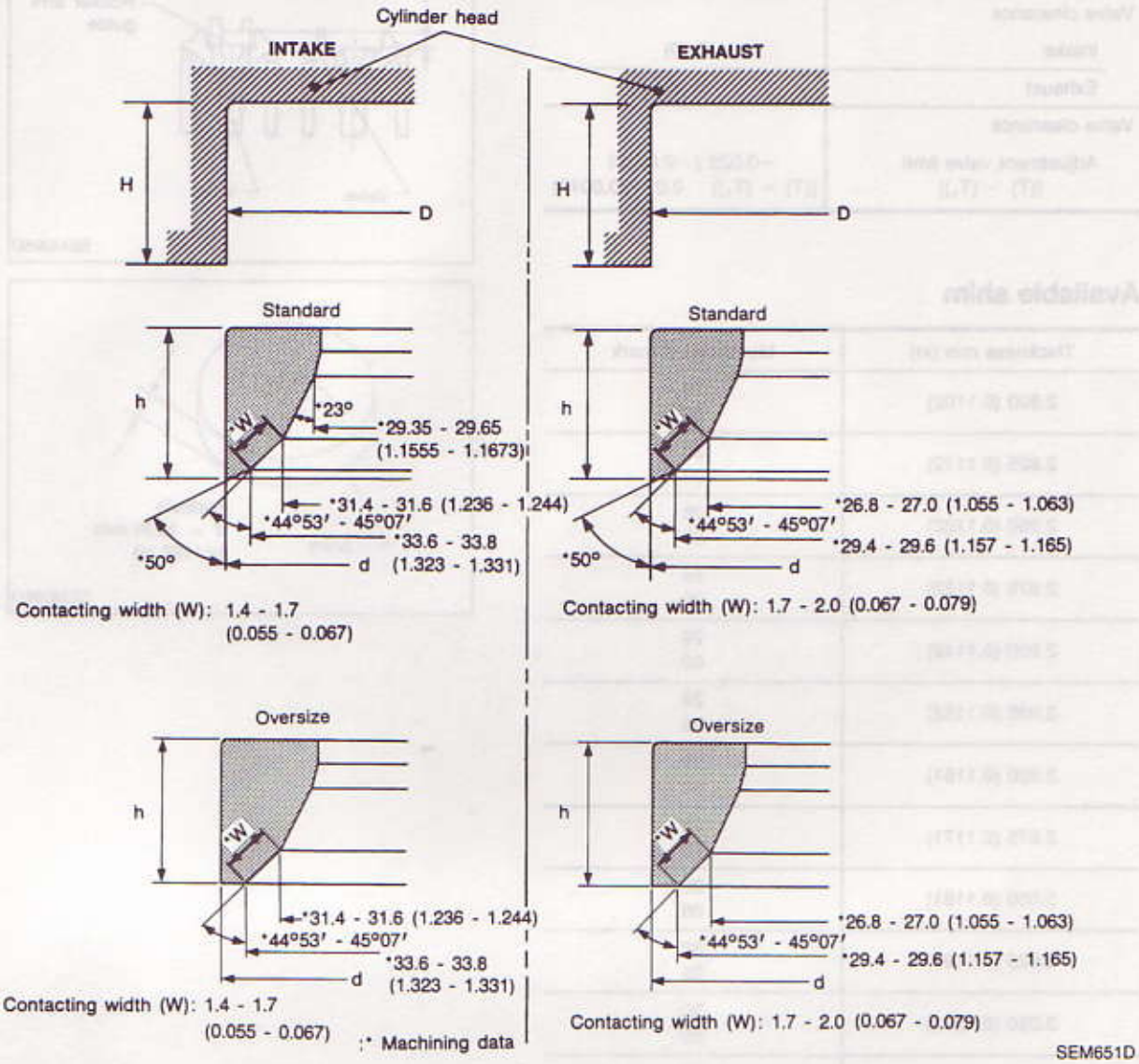
SEM083D

		Standard	Service
Valve guide Outer diameter	Intake	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
	Exhaust	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
Valve guide Inner diameter (Finished size)	Intake	6.000 - 6.018 (0.2362 - 0.2369)	
	Exhaust	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter	Intake	9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
	Exhaust	9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
		Standard	Limit
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.1 (0.004)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
Valve deflection limit		0.2 (0.008)	
Projection length "L"		14.0 - 14.2 (0.551 - 0.559)	

Inspection and Adjustment (Cont'd)

Valve seat

Unit: mm (in)



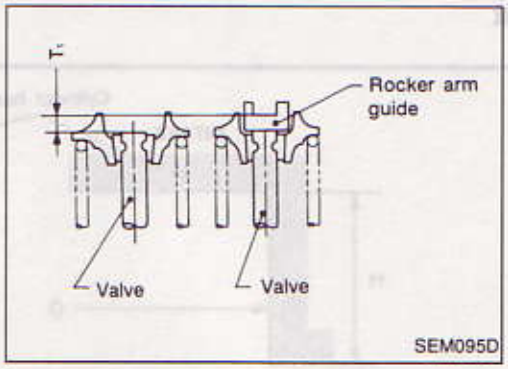
		Standard	Service
Cylinder head seat recess diameter (D)	In.	35.000 - 35.016 (1.3780 - 1.3786)	35.500 - 35.516 (1.3976 - 1.3983)
	Ex.	31.000 - 31.016 (1.2205 - 1.2211)	31.500 - 31.516 (1.2402 - 1.2408)
Valve seat interference fit	In.	0.064 - 0.096 (0.0025 - 0.0038)	
	Ex.	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	In.	35.080 - 35.096 (1.3811 - 1.3817)	35.580 - 35.596 (1.4008 - 1.4014)
	Ex.	31.080 - 31.096 (1.2236 - 1.2242)	31.580 - 31.596 (1.2433 - 1.2439)
Depth (H)	In.	6.25 (0.2461)	
	Ex.	6.25 (0.2461)	
Height (h)		6.2 - 6.3 (0.244 - 0.248)	5.4 - 5.5 (0.213 - 0.217)

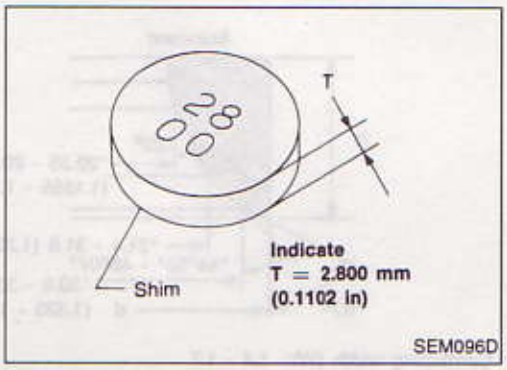
Inspection and Adjustment (Cont'd)

Valve clearance adjustment

Unit: mm (in)

Valve clearance	
Intake	0 (0)
Exhaust	0 (0)
Valve clearance	
Adjustment valve limit [(T) − (T_1)]	−0.025 (−0.0010) [(T) − (T_1)] 0.025 (0.0010)





Available shim

Thickness mm (in)	Identification mark
2.800 (0.1102)	28 00
2.825 (0.1112)	28 25
2.850 (0.1122)	28 50
2.875 (0.1132)	28 75
2.900 (0.1142)	29 00
2.925 (0.1152)	29 25
2.950 (0.1161)	29 50
2.975 (0.1171)	29 75
3.000 (0.1181)	30 00
3.025 (0.1191)	30 25
3.050 (0.1201)	30 50
3.075 (0.1211)	30 75
3.100 (0.1220)	31 00
3.125 (0.1230)	31 25
3.150 (0.1240)	31 50
3.175 (0.1250)	31 75
3.200 (0.1260)	32 00

Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

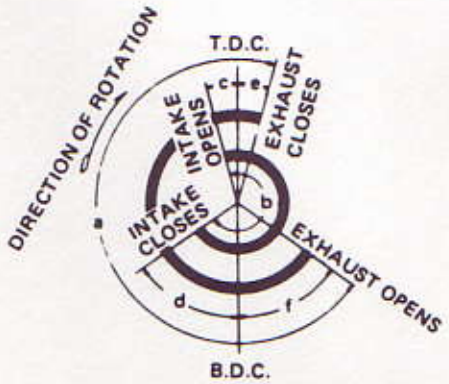
	Standard	Limit
Camshaft journal to bearing clearance	0.045 - 0.086 (0.0018 - 0.0034)	0.12 (0.0047)
Inner diameter of camshaft bearing	28.000 - 28.021 (1.1024 - 1.1032)	—
Outer diameter of camshaft journal	27.935 - 27.955 (1.0998 - 1.1006)	—
Camshaft runout [T.I.R.*]	Less than 0.02 (0.0008)	0.1 (0.004)
Camshaft sprocket runout [T.I.R.*]	Less than 0.25 (0.0098)	—
Camshaft end play	0.055 - 0.139 (0.0022 - 0.0055)	0.20 (0.0079)

EM671

Cam height "A"	
Intake	37.550 - 37.740 (1.4783 - 1.4858)
Exhaust	37.920 - 38.110 (1.4929 - 1.5004)
Wear limit of cam height	0.2 (0.008)
Valve lift	
Intake	8.6 (0.339)
Exhaust	9.2 (0.362)

*Total indicator reading

Valve timing



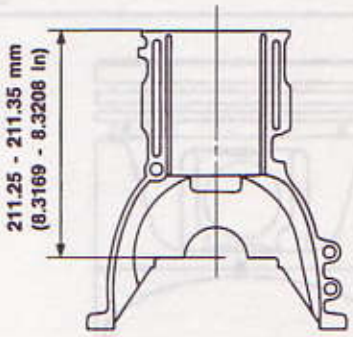
EM120

Unit: degree

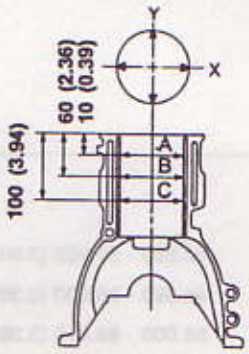
a	b	c	d	e	f
240°	232°	9°	43°	1°	59°

CYLINDER BLOCK

Unit: mm (in)



SEM008D



SEM686D

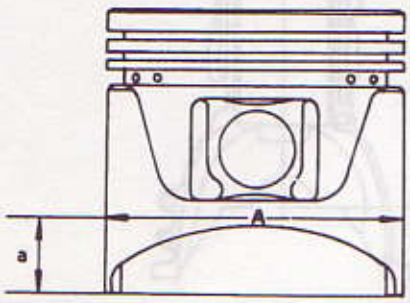
Surface flatness	
Standard	Less than 0.03 (0.0012)
Limit	0.10 (0.0039)
Cylinder bore	
Inner diameter	
Standard	
Grade No. 1	86.000 - 86.010 (3.3858 - 3.3862)
Grade No. 2	86.010 - 86.020 (3.3862 - 3.3866)
Grade No. 3	86.020 - 86.030 (3.3866 - 3.3870)
Wear limit	0.20 (0.0079)
Out-of-round (X − Y)	Less than 0.015 (0.0006)
Taper (A − B − C)	Less than 0.010 (0.0004)
Difference in inner diameter between cylinders	
Limit	Less than 0.05 (0.0020)
Main journal inner diameter	
Grade No. 0	58.944 - 58.950 (2.3206 - 2.3209)
Grade No. 1	58.950 - 58.956 (2.3209 - 2.3211)
Grade No. 2	58.956 - 58.962 (2.3211 - 2.3213)
Grade No. 3	58.962 - 58.968 (2.3213 - 2.3216)

Inspection and Adjustment (Cont'd)

PISTON, PISTON RING AND PISTON PIN

Available piston

Unit: mm (in)



SEM750C

Piston skirt diameter "A"	
Standard	
Grade No. 1	85.980 - 85.990 (3.3850 - 3.3854)
Grade No. 2	85.990 - 86.000 (3.3854 - 3.3858)
Grade No. 3	86.000 - 86.010 (3.3858 - 3.3862)
0.20 (0.0079) oversize (Service)	86.180 - 86.210 (3.3929 - 3.3941)
"a" dimension	11.0 (0.433)
Piston clearance to cylinder block	0.010 - 0.030 (0.0004 - 0.0012)
Piston pin hole diameter	21.987 - 21.999 (0.8656 - 0.8661)

Piston ring

Unit: mm (in)

Side clearance	
Top	
Standard	0.045 - 0.080 (0.0018 - 0.0031)
Limit	0.2 (0.008)
2nd	
Standard	0.030 - 0.065 (0.0012 - 0.0026)
Limit	0.2 (0.008)
Ring gap	
Top	
Standard	0.20 - 0.30 (0.0079 - 0.0118)
Limit	1.0 (0.039)
2nd	
Standard	0.35 - 0.50 (0.0138 - 0.0197)
Limit	1.0 (0.039)
Oil	
Standard	0.20 - 0.60 (0.0079 - 0.0236)
Limit	1.0 (0.039)

Piston pin

Unit: mm (in)

Piston pin outer diameter	21.989 - 22.001 (0.8657 - 0.8662)
Interference fit of piston pin to piston	0 - 0.004 (0 - 0.0002)
Piston pin to connecting rod bushing clearance	
Standard	0.005 - 0.017 (0.0002 - 0.0007)
Limit	0.023 (0.0009)

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

Inspection and Adjustment (Cont'd)

CONNECTING ROD

Unit: mm (in)

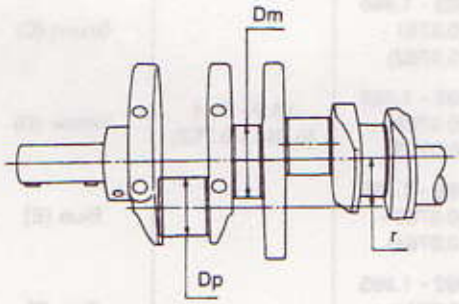
Center distance	136.30 (5.3661)
Bend, torsion [per 100 (3.94)]	
Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	
Limit	0.3 (0.012)
Connecting rod small end inner diameter	24.980 - 25.000 (0.9835 - 0.9843)
Piston pin bushing inner diameter*	22.000 - 22.012 (0.8661 - 0.8666)
Connecting rod big end inner diameter	51.000 - 51.013 (2.0079 - 2.0084)
Side clearance	
Standard	0.20 - 0.35 (0.0079 - 0.0138)
Limit	0.5 (0.020)

*After installing in connecting rod

CRANKSHAFT

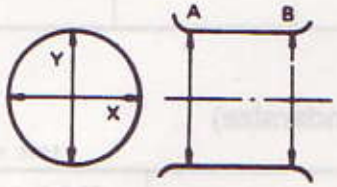
Unit: mm (in)

Main journal dia. "Dm"	
Grade No. 0	54.974 - 54.980 (2.1643 - 2.1646)
Grade No. 1	54.968 - 54.974 (2.1641 - 2.1643)
Grade No. 2	54.962 - 54.968 (2.1639 - 2.1641)
Grade No. 3	54.956 - 54.962 (2.1636 - 2.1639)
Pin journal dia. "Dp"	
Grade No. 0	47.968 - 47.974 (1.8885 - 1.8887)
Grade No. 1	47.962 - 47.968 (1.8883 - 1.8885)
Grade No. 2	47.956 - 47.962 (1.8880 - 1.8883)
Center distance "r"	47.2 (1.858)
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 0.025 (0.0010)
Limit	Less than 0.05 (0.0020)
Free end play	
Standard	0.10 - 0.26 (0.0039 - 0.0102)
Limit	0.30 (0.0118)



SEM954C

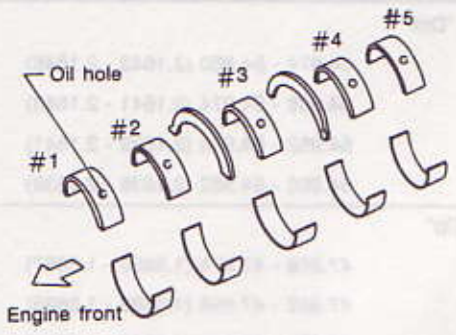
Out-of-round X – Y
Taper A – B



EM715

Inspection and Adjustment (Cont'd)

AVAILABLE MAIN BEARING



SEM685D

Main bearing (Standard)

Unit: mm (in)

Grade number	Thickness "T"	Width "W"	Identification color (mark)
0	1.977 - 1.980 (0.0778 - 0.0780)	18.9 - 19.1 (0.744 - 0.752)	Black (A)
1	1.980 - 1.983 (0.0780 - 0.0781)		Brown (B)
2	1.983 - 1.986 (0.0781 - 0.0782)		Green (C)
3	1.986 - 1.989 (0.0782 - 0.0783)		Yellow (D)
4	1.989 - 1.992 (0.0783 - 0.0784)		Blue (E)
5	1.992 - 1.995 (0.0784 - 0.0785)		Pink (F)
6	1.995 - 1.998 (0.0785 - 0.0787)		No color (G)

Main bearing (Undersize)

Unit: mm (in)

Undersize	Thickness "T"	Main journal diameter "Dm"
0.25 (0.0098)	2.109 - 2.117 (0.0830 - 0.0833)	Grind so that bearing clearance is the specified value.

AVAILABLE CONNECTING ROD BEARING

Connecting rod bearing

Standard size

Unit: mm (in)

Grade number	Thickness "T"	Width "W"	Identification color (mark)
0	1.500 - 1.503 (0.0591 - 0.0592)	16.9 - 17.1 (0.665 - 0.673)	No color (A)
1	1.503 - 1.506 (0.0592 - 0.0593)		Black (B)
2	1.506 - 1.509 (0.0593 - 0.0594)		Brown (C)

Undersize

Unit: mm (in)

Undersize	Thickness "T"	Crank pin journal diameter "Dp"
0.08 (0.0031)	1.541 - 1.549 (0.0607 - 0.0610)	Grind so that bearing clearance is the specified value.
0.12 (0.0047)	1.561 - 1.569 (0.0615 - 0.0618)	
0.25 (0.0098)	1.626 - 1.634 (0.0640 - 0.0643)	

Bearing clearance

Unit: mm (in)

Main bearing clearance	
Standard	0.004 - 0.022 (0.0002 - 0.0009)
Limit	0.05 (0.0020)
Connecting rod bearing clearance	
Standard	0.020 - 0.045 (0.0008 - 0.0018)
Limit	0.09 (0.0035)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

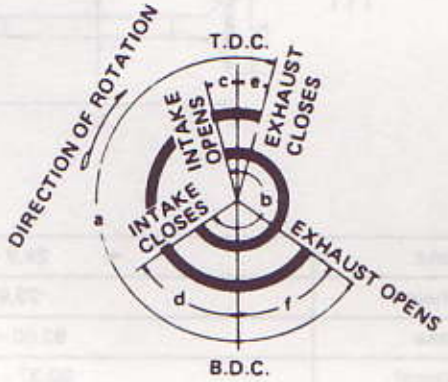
Camshaft sprocket runout limit [T.I.R.]	0.25 (0.0098)
Flywheel runout limit [T.I.R.]	0.1 (0.004)
Drive plate runout limit [T.I.R.]	0.2 (0.008)

General Specifications

GENERAL SPECIFICATIONS

Engine		GA16DE
Classification		Gasoline
Cylinder arrangement		4, in-line
Displacement	cm^3 (cu in)	1,597 (97.45)
Bore × stroke	mm (in)	76.0 × 88.0 (2.992 × 3.465)
Valve arrangement		D.O.H.C.
Firing order		1-3-4-2
Number of piston rings		
Compression		2
Oil		1
Number of main bearings		5
Compression ratio		9.8 ± 0.2

Valve timing



EM120

Unit: degree

a	b	c	d	e	f
222°	236°	−2°	58°	0°	42°

Inspection and Adjustment

ENGINE COMPRESSION PRESSURE

Unit: kPa (bar, kg/cm², psi)/350 rpm

Standard	1,324 (13.24, 13.5, 192)
Minimum	1,128 (11.28, 11.5, 164)
Difference limit between cylinders	98 (0.98, 1.0, 14)

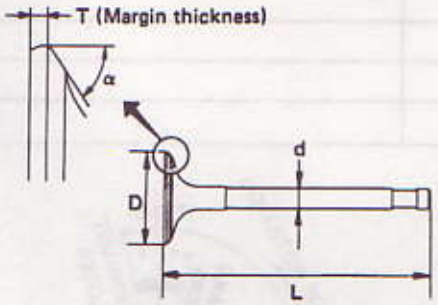
CYLINDER HEAD

Unit: mm (in)

	Standard	Limit
Head surface flatness	Less than 0.03 (0.0012)	0.1 (0.004)
Height	117.8 - 118.0 (4.638 - 4.646)	—

VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	Intake	29.9 - 30.1 (1.177 - 1.185)
	Exhaust	23.9 - 24 (0.941 - 0.945)
Valve length "L"	Intake	92.00 - 92.5 (3.6220 - 3.6417)
	Exhaust	92.37 - 92.87 (3.6366 - 3.6563)
Valve stem diameter "d"	Intake	5.465 - 5.480 (0.2152 - 0.2157)
	Exhaust	5.445 - 5.460 (0.2144 - 0.2150)
Valve face angle "α"		45°15' - 45°45'
Valve margin "T" limit		0.9 - 1.1 (0.035 - 0.043)
Valve stem end surface grinding limit		Less than 0.2 (0.008)

Valve clearance

Unit: mm (in)

	For adjusting		For checking
	Hot	Cold*	Hot
Intake	0.32 - 0.40 (0.013 - 0.016)	0.25 - 0.33 (0.010 - 0.013)	0.21 - 0.49 (0.008 - 0.019)
Exhaust	0.37 - 0.45 (0.015 - 0.018)	0.32 - 0.40 (0.013 - 0.016)	0.30 - 0.58 (0.012 - 0.023)

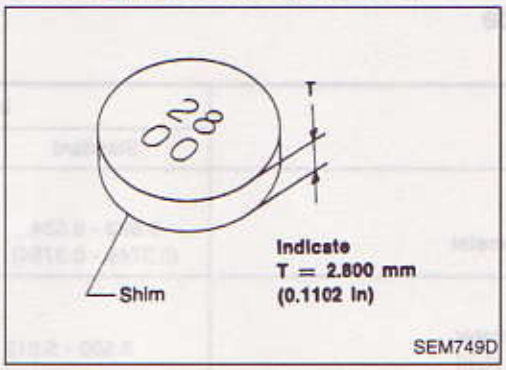
*: At a temperature of approximately 20°C (68°F)

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

Inspection and Adjustment (Cont'd)

Available shims

Thickness mm (in)	Identification mark
2.00 (0.0787)	200
2.02 (0.0795)	202
2.04 (0.0803)	204
2.06 (0.0811)	206
2.08 (0.0819)	208
2.10 (0.0827)	210
2.12 (0.0835)	212
2.14 (0.0843)	214
2.16 (0.0850)	216
2.18 (0.0858)	218
2.20 (0.0866)	220
2.22 (0.0874)	222
2.24 (0.0882)	224
2.26 (0.0890)	226
2.28 (0.0898)	228
2.30 (0.0906)	230
2.32 (0.0913)	2.32
2.34 (0.0921)	234
2.36 (0.0929)	236
2.38 (0.0937)	238
2.40 (0.0945)	240
2.42 (0.0953)	242
2.44 (0.0961)	244
2.46 (0.0969)	246
2.48 (0.0976)	248
2.50 (0.0984)	250
2.52 (0.0992)	252
2.54 (0.1000)	254
2.56 (0.1008)	256
2.58 (0.1016)	258
2.60 (0.1024)	260
2.62 (0.1031)	262
2.64 (0.1039)	264
2.66 (0.1047)	266
2.68 (0.1055)	268
2.70 (0.1063)	270
2.72 (0.1071)	272
2.74 (0.1079)	274
2.76 (0.1087)	276
2.78 (0.1094)	278
2.80 (0.1102)	280
2.82 (0.1110)	282
2.84 (0.1118)	284
2.86 (0.1126)	286
2.88 (0.1134)	288
2.90 (0.1142)	290
2.92 (0.1150)	292
2.94 (0.1157)	294
2.96 (0.1165)	296
2.98 (0.1173)	298



Inspection and Adjustment (Cont'd)

Valve guide

Unit: mm (in)

	Intake		Exhaust	
	Standard	Service	Standard	Service
Valve guide Outer diameter	9.523 - 9.534 (0.3749 - 0.3754)	9.723 - 9.734 (0.3828 - 0.3832)	9.523 - 9.534 (0.3749 - 0.3754)	9.723 - 9.734 (0.3828 - 0.3832)
Valve guide Inner diameter [Finished size]	5.500 - 5.515 (0.2165 - 0.2171)		5.500 - 5.515 (0.2165 - 0.2171)	
Cylinder head valve guide hole diameter	9.475 - 9.496 (0.3730 - 0.3739)	9.685 - 9.696 (0.3813 - 0.3817)	9.475 - 9.496 (0.3730 - 0.3739)	9.685 - 9.696 (0.3813 - 0.3817)
Interference fit of valve guide	0.027 - 0.059 (0.0011 - 0.0023)	0.027 - 0.049 (0.0011 - 0.0019)	0.027 - 0.059 (0.0011 - 0.0023)	0.027 - 0.049 (0.0011 - 0.0019)
Stem to guide clearance	0.020 - 0.050 (0.0008 - 0.0020)		0.040 - 0.070 (0.0016 - 0.0028)	
Valve deflection limit (Dial gauge reading)	0.2 (0.008)		0.2 (0.008)	

Valve spring

Free height	mm (in)	41.19 (1.6217)
Pressure N (kg, lb) at height mm (in)	Standard	344.42 (35.12, 77.44) at 25.26 (0.9945)
	Limit	323.73 (33.01, 72.79) at 25.26 (0.9945)
Out-of-square	mm (in)	Less than 1.80 (0.0709)

Valve lifter

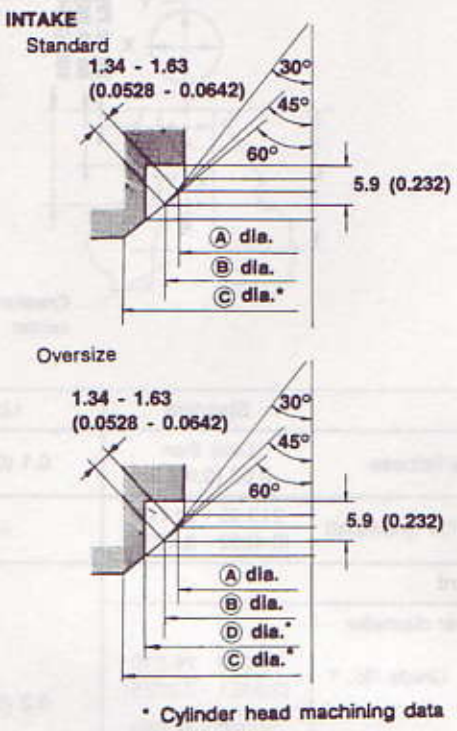
Unit: mm (in)

Valve lifter outside diameter	29.960 - 29.975 (1.1795 - 1.1801)
Lifter guide inside diameter	30.000 - 30.021 (1.1811 - 1.1819)
Clearance between lifter and lifter guide	0.025 - 0.061 (0.0010 - 0.0024)

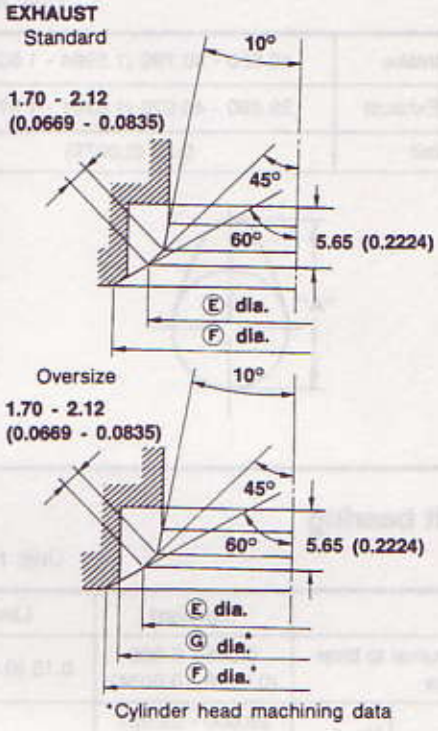
Inspection and Adjustment (Cont'd)

Valve seat

Unit: mm (in)



SEM573D



SEM574D

Dia.	Ⓐ	27.4 - 27.6 (1.079 - 1.087)
	Ⓑ	29.5 - 29.7 (1.161 - 1.169)
	Ⓒ	31.9 - 32.1 (1.256 - 1.264)
	Ⓓ	31.500 - 31.516 (1.2402 - 1.2408)
	Ⓔ	23.5 - 23.7 (0.925 - 0.933)
	Ⓕ	25.2 - 25.4 (0.992 - 1.000)
	Ⓖ	25.500 - 25.516 (1.0039 - 1.0046)

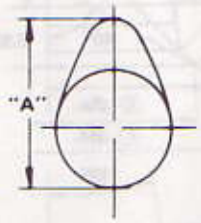
Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BEARING

Camshaft

Unit: mm (in)

Cam height "A"	Intake	40.600 - 40.790 (1.5984 - 1.6059)
	Exhaust	39.880 - 40.070 (1.5701 - 1.5776)
Cam wear limit		0.20 (0.0079)



EM671

Camshaft bearing

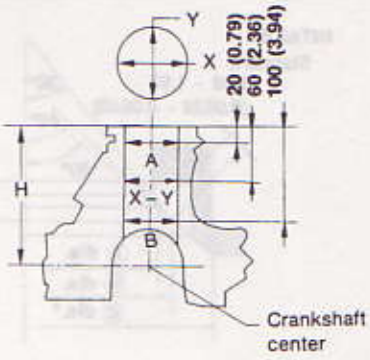
Unit: mm (in)

		Standard	Limit
Camshaft journal to bearing clearance		0.045 - 0.086 (0.0018 - 0.0034)	0.15 (0.0059)
Inner diameter of camshaft bearing	No. 1	28.000 - 28.021 (1.1024 - 1.1032)	—
	No. 2 to No. 5	24.000 - 24.021 (0.9449 - 0.9457)	
Outer diameter of camshaft journal	No. 1	27.935 - 27.955 (1.0998 - 1.1006)	—
	No. 2 to No. 5	23.935 - 23.955 (0.9423 - 0.9431)	
Camshaft runout [T.I.R.*]		Less than 0.02 (0.0008)	0.1 (0.004)
Camshaft end play		0.070 - 0.143 (0.0028 - 0.0056)	0.20 (0.0079)

*: Total indicator reading

CYLINDER BLOCK

Unit: mm (in)



SEM171D

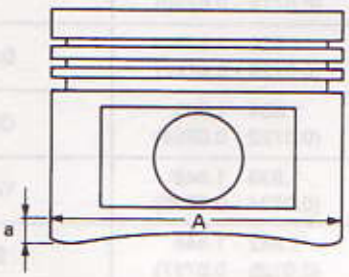
		Standard	Limit
Surface flatness		Less than 0.03 (0.0012)	0.1 (0.004)
Height "H" (nominal)		213.95 - 214.05 (8.4232 - 8.4271)	—
Standard			0.2 (0.008)
Inner diameter			
	Grade No. 1	76.000 - 76.010 (2.9921 - 2.9925)	
	Grade No. 2	76.010 - 76.020 (2.9925 - 2.9929)	
	Grade No. 3	76.020 - 76.030 (2.9929 - 2.9933)	
Out-of-round (X–Y)		Less than 0.015 (0.0006)	—
Taper (A–B)		Less than 0.010 (0.0004)	—
Difference in inner diameter between cylinders		0.05 (0.0020)	0.2 (0.008)

Inspection and Adjustment (Cont'd)

PISTON, PISTON RING AND PISTON PIN

Piston

Unit: mm (in)



SEM658D

Piston skirt diameter "A" Standard	
Grade No. 1	75.975 - 75.985 (2.9911 - 2.9915)
Grade No. 2	75.985 - 75.995 (2.9915 - 2.9919)
Grade No. 3	75.995 - 76.005 (2.9919 - 2.9923)
0.5 (0.020) oversize (service)	76.475 - 76.505 (3.0108 - 3.0120)
1.0 (0.039) oversize (service)	76.975 - 77.005 (3.0305 - 3.0317)
"a" dimension	9.5 (0.374)
Piston pin hole inner diameter	18.987 - 18.999 (0.7475 - 0.7480)
Piston pin outer diameter	18.989 - 19.001 (0.7476 - 0.7481)
Piston to bore clearance	0.015 - 0.035 (0.0006 - 0.0014)

Piston ring

Unit: mm (in)

		Standard	Limit
Side clearance	Top	0.040 - 0.080 (0.0016 - 0.0031)	0.2 (0.008)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	
End gap	Top	0.20 - 0.35 (0.0079 - 0.0138)	1.0 (0.039)
	2nd	0.37 - 0.52 (0.0146 - 0.0205)	
	Oil	0.20 - 0.60 (0.0079 - 0.0236)	

Piston pin

Unit: mm (in)

Piston pin outer diameter	18.989 - 19.001 (0.7476 - 0.7481)
Piston pin to piston clearance	−0.004 to 0 (−0.0002 to 0)
Piston pin to connecting rod, bushing clearance	0.005 - 0.017 (0.0002 - 0.0007)

CONNECTING ROD

Unit: mm (in)

Center distance	140.45 - 140.55 (5.5295 - 5.5335)
Bend limit [per 100 (3.94)]	0.15 (0.0059)
Torsion limit [per 100 (3.94)]	0.3 (0.012)
Connecting rod bushing inner diameter* (small end)	19.000 - 19.012 (0.7480 - 0.7485)
Connecting rod big end inner diameter	43.000 - 43.013 (1.6929 - 1.6934)
Side clearance	
Standard	0.20 - 0.47 (0.0079 - 0.0185)
Limit	0.52 (0.0205)

*: After installing in connecting rod

Inspection and Adjustment (Cont'd)

CRANKSHAFT

Unit: mm (in)

Main journal dia. "Dm"	
Grade No. 0	49.956 - 49.964 (1.9668 - 1.9671)
Grade No. 1	49.948 - 49.956 (1.9665 - 1.9668)
Grade No. 2	49.940 - 49.948 (1.9661 - 1.9665)
Pin journal dia. "Dp"	
Grade No. 0	39.968 - 39.974 (1.5735 - 1.5738)
Grade No. 1	39.962 - 39.968 (1.5733 - 1.5735)
Grade No. 2	39.956 - 39.962 (1.5731 - 1.5733)
Center distance "r"	43.95 - 44.05 (1.7303 - 1.7342)
Out-of-round (X — Y)	
Standard	Less than 0.005 (0.0002)
Taper (A — B)	
Standard	Less than 0.002 (0.0001)
Runout [T.I.R.*]	
Standard	Less than 0.05 (0.0020)
Free end play	
Standard	0.060 - 0.180 (0.0024 - 0.0071)
Limit	0.3 (0.012)

*: Total indicator reading

MAIN BEARING

AVAILABLE CONNECTING ROD BEARING

Connecting rod bearing

Unit: mm (in)

	Grade No.	Thickness	Identification color or number
Standard	0	1.505 - 1.508 (0.0593 - 0.0594)	—
	1	1.508 - 1.511 (0.0594 - 0.0595)	Brown
	2	1.511 - 1.514 (0.0595 - 0.0596)	Green
Undersize	0.08 (0.0031)	1.542 - 1.546 (0.0607 - 0.0609)	8
	0.12 (0.0047)	1.562 - 1.566 (0.0615 - 0.0617)	12
	0.25 (0.0098)	1.627 - 1.631 (0.0641 - 0.0642)	25

Bearing clearance

Unit: mm (in)

Main bearing clearance	
Standard	0.018 - 0.042 (0.0007 - 0.0017)
Limit	0.1 (0.004)
Connecting rod bearing clearance	
Standard	0.010 - 0.035 (0.0004 - 0.0014)
Limit All	0.1 (0.004)

Standard

Grade No.	Thickness "T" mm (in)	Identification color
0	1.826 - 1.830 (0.0719 - 0.0720)	Black
1	1.830 - 1.834 (0.0720 - 0.0722)	Brown
2	1.834 - 1.838 (0.0722 - 0.0724)	Green
3	1.838 - 1.842 (0.0724 - 0.0725)	Yellow
4	1.842 - 1.846 (0.0725 - 0.0727)	Blue

Undersize

Unit: mm (in)

	Thickness "T"
0.25 (0.0098)	1.957 - 1.965 (0.0770 - 0.0774)
0.50 (0.0197)	2.082 - 2.090 (0.0820 - 0.0823)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Flywheel Runout [T.I.R.*]	Less than 0.15 (0.0059)

*: Total indicator reading

Inspection and Adjustment

COMPRESSION PRESSURE

Unit: kPa (bar, kg/cm², psi) at 200 rpm

Standard	3,138 (31.4, 32, 455)
Limit	2,452 (24.5, 25, 356)
Difference limit between cylinders	490 (4.9, 5, 71)

CYLINDER HEAD

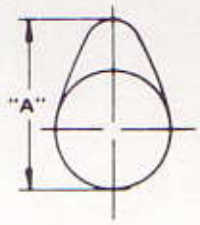
Unit: mm (in)

Head surface flatness	
Standard	Less than 0.05 (0.0020)
Limit	0.1 (0.004
Nominal cylinder head height	89.4 - 89.6 (3.520 - 3.528)

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

	Standard	Max. tolerance
Camshaft journal clearance	0.038 - 0.067 (0.0015 - 0.0026)	0.1 (0.004)
Inner diameter of camshaft bearing	48.000 - 48.016 (1.8898 - 1.8904)	—
Outer diameter of camshaft journal	47.949 - 47.962 (1.8878 - 1.8883)	—
Camshaft runout	Less than 0.02 (0.0008)	0.05 (0.0020)
Camshaft end play	0.08 - 0.38 (0.0031 - (0.0150)	

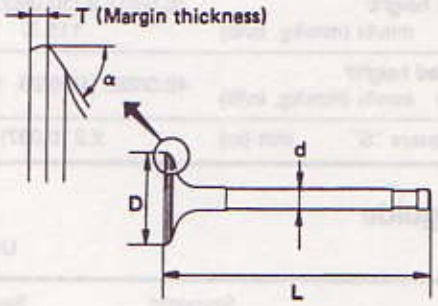


EM671

Cam height "A"	
Intake	39.95 - 40.00 (1.5728 - 1.5748)
Exhaust	40.30 - 40.35 (1.5866 - 1.5886)

VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	
Intake	39.20 - 39.24 (1.543 - 1.545)
Exhaust	32.0 - 32.2 (1.260 - 1.268)
Valve lenght "L"	
Intake	116.59 - 116.62 (4.5901 - 4.5913)
Exhaust	116.1 - 116.4 (4.5709 - 4.5827)
Valve stem diameter "d"	
Intake	7.956 - 7.980 (0.3132 - 0.3142)
Exhaust	7.945 - 7.960 (0.3128 - 0.3134)
Valve seat angle "α"	45°30' ± 15'
Valve margin "T" limit	0.5 (0.020)
Valve stem end surface grinding limit	0.5 (0.020)

Valve clearance

Unit: mm (in)

	Hot	Cold
Intake	0.25 (0.010)	0.18 (0.007)
Exhaust	0.30 (0.012)	0.25 (0.010)

Inspection and Adjustment (Cont'd)

Valve spring

Free height	mm (in)	49.77 (1.9594)
		Standard
Pressure height/ mm/N (mm/kg, in/lb)		30.0/512.9 (30.0/52.3, 1.181/ 115.3)
Assembled height/ Pressure mm/N (mm/kg, in/lb)		40.0/226 (40.0/23, 1.575/51)
Out-of-square "S"	mm (in)	2.2 (0.087)

Valve guide

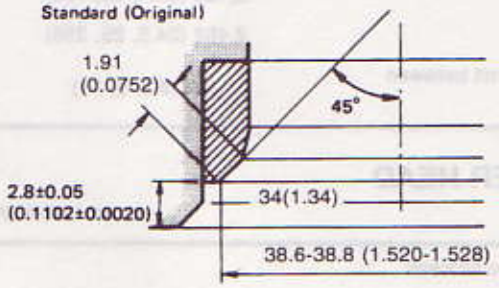
Unit: mm (in)

	Standard	Service
Valve guide		
Outer diameter	12.023 - 12.034 (0.4733 - 0.4738)	12.223 - 12.234 (0.4812 - 0.4817)
Valve guide		
Inner diameter (Finished size)	8.000 - 8.018 (0.3150 - 0.3157)	
Cylinder head valve guide hole diameter	11.985 - 11.996 (0.4718 - 0.4723)	12.185 - 12.196 (0.4797 - 0.4802
Interference fit of valve guide	0.027 - 0.049 (0.0011 - 0.0019)	
	Standard	Max. tolerance
Stem to guide clearance		
Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.10 (0.0039)
Exhaust	0.040 - 0.0073 (0.0016 - 0.029)	0.10 (0.0039)
Valve deflection limit		0.1 (0.004)

Valve seat resurfacing

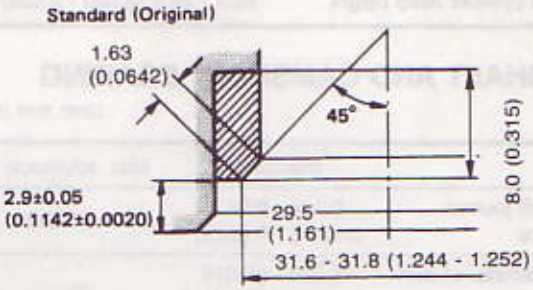
Unit: mm (in)

Intake



SEM917

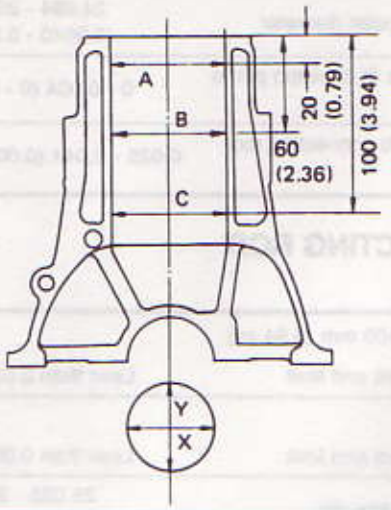
Exhaust



SEM918

CYLINDER BLOCK

Unit: mm (in)



SEM902

		Standard	Limit
Surface flatness		Less than 0.05 (0.0020)	0.10 (0.0039)
Cylinder bore	Inner diameter	Grade No. 1 85.000 - 85.010 (3.3465 - 3.3468) Grade No. 2 85.010 - 85.020 (3.3468 - 3.3472) Grade No. 3 85.020 - 85.030 (3.3472 - 3.3476) Grade No. 4 85.030 - 85.040 (3.3476 - 3.3480) Grade No. 5 85.040 - 85.050 (3.3480 - 3.3484)	—
	Out-of-round (X–Y)	Less than 0.020 (0.0008)	0.020 (0.0008)
	Taper (A–B, A–C, B–C)	Less than 0.020 (0.0008)	0.020 (0.0008)
Piston to cylinder clearance		0.050 - 0.070 (0.0020 - 0.0028)	—
Feeler gauge extracting force [with gauge thickness 0.06 mm (0.0024 in)] N (kg, lb)		5.9 - 11.8 (0.6 - 1.2, 1.3 - 2.6 lb)	—
Main journal inner diameter		Grade No. 0 63.645 - 63.654 (2.5057 - 2.5061) Grade No. 1 63.654 - 63.663 (2.5061 - 2.5064) Grade No. 2 63.663 - 63.672 (2.5064 - 2.5068)	—

Inspection and Adjustment (Cont'd)

PISTON, PISTON RING AND PISTON PIN

Piston

Unit: mm (in)

Piston skirt diameter	Standard	Grade No. 1	84.94 - 84.95 (3.3441 - 3.3445)
		Grade No. 2	84.95 - 84.96 (3.3445 - 3.3449)
		Grade No. 3	84.96 - 84.97 (3.3449 - 3.3453)
		Grade No. 4	84.97 - 84.98 (3.3453 - 3.3457)
		Grade No. 5	84.98 - 84.99 (3.3457 - 3.3461)
	Oversize	Standard	84.96 - 85.01 (3.3449 - 3.3468)
		0.5 (0.020	85.44 85.49 (3.3638 - 3.3657)
		1.0 (0.039)	85.94 - 85.99 (3.3835 - 3.3854)
Measure position (From Top)			62 (2.44)
Piston pin hole diameter			24.991 - 24.999 (0.9839 - 0.9842)

Piston ring

Unit: mm (in)

Side clearance		
Top		
Standard		0.060 - 0.100 (0.0024 - 0.0039)
Limit		0.20 (0.0079)
2nd		
Standard		0.040 - 0.080 (0.0016 - 0.0031)
Limit		0.15 (0.0059)
Oil		
Standard		0.030 - 0.070 (0.0012 - 0.0028)
Limit		0.10 (0.0039)
Ring gap		
Top		
Standard	(Without "S")	0.20 - 0.29 (0.0079 - 0.0114)
	(With "S")	0.14 - 0.22 (0.0055 - 0.0087)
Limit		0.6 (0.024)
2nd		
Standard		0.20 - 0.35 (0.0079 - 0.0138)
Limit		0.8 (0.031)
Oil		
Standard		0.30 - 0.45 (0.0118 - 0.0177)
Limit		1.0 (0.039)

Piston pin

Unit: mm (in)

Piston pin outer diameter	24.994 - 25.000 (0.9840 - 0.9843)
Interference fit of piston pin to piston	0 - 0.004 (0 - 0.0002)
Piston pin to connecting rod clearance	0.025 - 0.044 (0.0010 - 0.0017)

CONNECTING ROD

Unit: mm (in)

Bend [per 100 mm (3.94 in)]	
Standard and limit	Less than 0.05 (0.0020)
Torsion	
Standard and limit	Less than 0.05 (0.0020)
Piston pin bore dia.	25.025 - 25.038 (0.9852 - 0.9857)
Big end play	
Limit	0.6 (0.024)

CRANKSHAFT

Unit: mm (in)

Main journal dia.	Grade No. 0 59.949 - 59.956 (2.3602 - 2.3605 Grade No. 1 59.942 - 59.949 (2.3599 - 2.3602)
Pin journal dia.	49.961 - 49.974 (1.9670 - 1.9675)
Out-of-round (X–Y) and taper (A–B)	
Standard	Less than 0.01 (0.0004)
Limit	0.03 (0.0012)
Runout	
Standard	Less than 0.05 (0.0020)
Limit	0.10 (0.0039)
Free end play	
Standard	0.05 - 0.18 (0.0020 - 0.0071)
Limit	0.3 (0.012)

Inspection and Adjustment (Cont'd)

AVAILABLE MAIN BEARINGS

No. 1 and No. 5 main bearing (with oil groove)

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	*Part number	Identification color
0	1.822 - 1.826 (0.0717 - 0.0719)	22 ± 0.1 (0.866 ± 0.004)	12215-G5500	Black
1	1.826 - 1.830 (0.0719 - 0.0720)		12215-G5501	Brown
2	1.830 - 1.834 (0.0720 - 0.0722)		12215-G5502	Green
3	1.834 - 1.838 (0.0722 - 0.0724)		12215-G5503	Yellow

No. 1 and No. 5 main bearing (without oil groove)

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	*Part number	Identification color
0	1.822 - 1.826 (0.0717 - 0.0719)	22 ± 0.1 (0.866 ± 0.004)	12239-G5500	Black
1	1.826 - 1.830 (0.0719 - 0.0720)		12239-G5501	Brown
2	1.830 - 1.834 (0.0720 - 0.0722)		12239-G5502	Green
3	1.834 - 1.838 (0.0722 - 0.0724)		12239-G5503	Yellow

No. 2 and No. 4 main bearing (with oil groove)

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	*Part number	Identification color
0	1.822 - 1.826 (0.0717 - 0.0719)	22 ± 0.1 (0.866 ± 0.004)	12231-G5500	Black
1	1.826 - 1.830 (0.0719 - 0.0720)		12231-G5501	Brown
2	1.830 - 1.834 (0.0720 - 0.0722)		12231-G5502	Green
3	1.834 - 1.838 (0.0722 - 0.0724)		12231-G5503	Yellow

No. 2 and No. 4 main bearing (without oil groove)

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	*Part number	Identification color
0	1.822 - 1.826 (0.0717 - 0.0719)	22 ± 0.1 (0.866 ± 0.004)	12239-G5500	Black
1	1.826 - 1.830 (0.0719 - 0.0720)		12239-G5501	Brown
2	1.830 - 1.834 (0.0720 - 0.0722)		12239-G5502	Green
3	1.834 - 1.838 (0.0722 - 0.0724)		12239-G5503	Yellow

No. 3 main bearing (with oil groove)

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	*Part number	Identification color
0	1.822 - 1.826 (0.0717 - 0.0719)	31.870 - 31.950 (1.2547 - 1.2579)	12247-G5500	Black
1	1.826 - 1.830 (0.0719 - 0.0720)		12247-G5501	Brown
2	1.830 - 1.834 (0.0720 - 0.0722)		12247-G5502	Green
3	1.834 - 1.838 (0.0722 - 0.0724)		12247-G5503	Yellow

No. 3 main bearing (without oil groove)

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	*Part number	Identification color
0	1.822 - 1.826 (0.0717 - 0.0719)	31.870 - 31.950 (1.2547 - 1.2579)	12255-G5500	Black
1	1.826 - 1.830 (0.0719 - 0.0720)		12255-G5501	Brown
2	1.830 - 1.834 (0.0720 - 0.0722)		12255-G5502	Green
3	1.834 - 1.838 (0.0722 - 0.0724)		12255-G5503	Yellow

Inspection and Adjustment (Cont'd)

Main bearing undersize

Unit: mm (in)

	MAIN JOURNAL DIAMETER "Dm"
Standard	59.942 - 59.956 (2.3599 - 2.3605)
Undersize	
0.25 (0.0098)	59.692 - 59.706 (2.3501 - 2.3506)

Available connecting rod bearing connecting rod bearing undersize

Unit: mm (in)

	CRANK PIN DIAMETER "Dp"
Standard	49.961 - 49.974 (1.9670 - 1.9675)
Undersize	
0.06 (0.0024)	49.901 - 49.914 (1.9646 - 1.9651)
0.12 (0.0047)	49.841 - 49.854 (1.9622 - 1.9628)
0.25 (0.0098)	49.711 - 49.724 (1.9571 - 1.9576)

BEARING CLEARANCE

Unit: mm (in)

Main bearing clearance	
Standard	0.036 - 0.063 (0.0014 - 0.0025)
Limit	0.12 (0.0047)
Connecting rod bearing clearance	
Standard	0.024 - 0.066 (0.0009 - 0.0026)
Limit	0.12 (0.0047)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Flywheel Runout (T.I.R.)	Less than 0.15 (0.0059)

Tightening Torque

ENGINE OUTER PARTS

Unit	N·m	kg-m	ft-lb
Alternator bracket	29 - 39	3.0 - 4.0	22 - 29
Alternator to adjusting bar bolt	16 - 21	1.6 - 2.1	12 - 15
Alternator to bracket	44 - 59	4.5 - 6.0	33 - 43
Crank pulley bolt	137 - 157	14.0 - 16.0	101 - 116
Dust cover bolt	3 - 5	0.3 - 0.5	2.2 - 3.6
Back cover bolt	7 - 9	0.7 - 0.9	5.1 - 6.5
Engine mounting bracket	29 - 39	3.0 - 4.0	22 - 29
Glow plug	20 - 25	2.0 - 2.5	14 - 18
Glow plug connecting plate	1.0 - 1.5	0.1 - 0.15	0.7 - 1.1
Injection pump bracket	30 - 40	3.1 - 4.1	22 - 30
Injection pump drive gear nut	59 - 69	6.0 - 7.0	43 - 51
Injection pump nut	16 - 21	1.6 - 2.1	12 - 15
Injection tube flare nut	22 - 25	2.2 - 2.5	16 - 18
Manifold Bolt and Nut			
Upper bolt (M10)	34 - 44	3.5 - 4.5	25 - 33
Lower nut & bolt (M8)	20 - 25	2.0 - 2.5	14 - 18
Injection nozzle	59 - 69	6.0 - 7.0	43 - 51
Oil cooler bracket bolt	14 - 21	1.4 - 2.1	10 - 15
Oil feed pipe bolt	19 - 25	1.9 - 2.5	14 - 18
Oil pump bolt			
M6	6 - 8	0.6 - 0.8	4.3 - 5.8
M8	16 - 21	1.6 - 2.1	12 - 15
Pwer steering pump bracket bolt	34 - 39	3.5 - 4.0	25 - 29
Spill tube nut	39 - 49	4.0 - 5.0	29 - 36
Tension pulley	32 - 40	3.3 - 4.1	24 - 30
Camshaft pulley bolt	132 - 142	13.5 - 14.5	98 - 105
Idler pulley bolt	44 - 54	4.5 - 5.5	33 - 40
Thermostat housing	15 - 20	1.5 - 2.0	11 - 14
Vacuum pump pipe bolt	20 - 25	2.0 - 2.5	14 - 18
Water outlet bolt	20 - 25	2.0 - 2.5	14 - 18
Water pump bolt			
M6	6 - 8	0.6 - 0.8	4.3 - 5.8
M8	16 - 21	1.6 - 2.1	12 - 15

ENGINE BODY PARTS

Unit	N·m	kg-m	ft-lb
Connecting rod big end nut	44 - 54	4.5 - 5.5	33 - 40
Cylinder head bolt	118 - 127	12 - 13	87 - 94
Flywheel bolt	137 - 157	14 - 16	101 - 116
Main bearing cap bolt	69 - 83	7.0 - 8.5	51 - 61
Oil pan bolt	7 - 8	0.7 - 0.9	5.1 - 6.5
Plate fixer bolt	7 - 8	0.7 - 0.9	5.1 - 6.5
Oil pan drain plug	29 - 39	3.0 - 4.0	22 - 29
Oil strainer bolt	16 - 20	1.6 - 2.0	12 - 14
Pivot lock nut	49 - 59	5.0 - 6.0	36 - 43
Rocker cover bolt	5 - 9	0.5 - 0.9	3.6 - 6.5