ENGINE MECHANICAL

SECTION EM

CONTENTS

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.
- The bolts and nuts which require the angular-tightening method are as follows:

(1) Cylinder head bolts
(2) Connecting rod cap nuts

Supplemental Restraint System "AIR BAG"

The Supplemental Restraint System "Air Bag" helps to reduce the risk or severity of injury to the driver in a frontal collision. The Supplemental Restraint System consists of an air bag (located in the center of the steering wheel), sensors, a diagnosis unit, warning lamp, wiring harness and spiral cable. Information necessary to service the system safely is included in the **BF section** of this Service Manual.

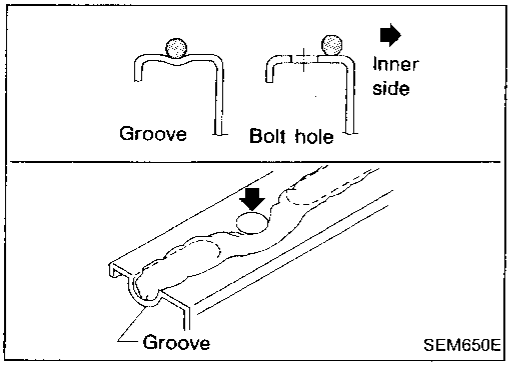
WARNING:

a. To avoid rendering the SRS inoperative, which could lead to personal injury or death in the event of a severe frontal collision, all maintenance must be performed by an authorized NISSAN dealer.
b. Improper maintenance, including incorrect removal and installation of the SRS, can lead to personal injury caused by unintentional activation of the system.
c. All SRS electrical wiring harnesses and connectors are covered with yellow outer insulation. Do not use electrical test equipment on any circuit related to the SRS "Air Bag".

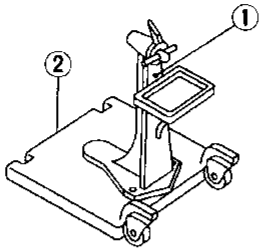
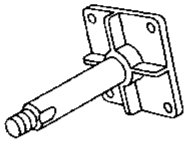
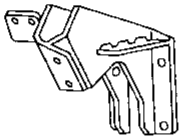
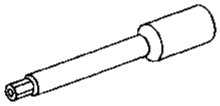
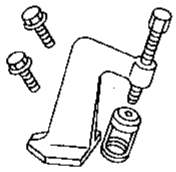
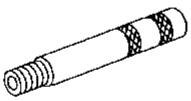
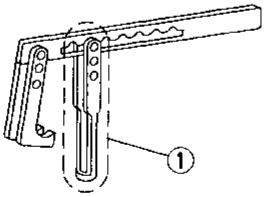
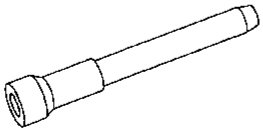
Liquid Gasket Application Procedure

a. Before applying liquid gasket, use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves, 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 3.5 to 4.5 mm (0.138 to 0.177 in) wide (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).**

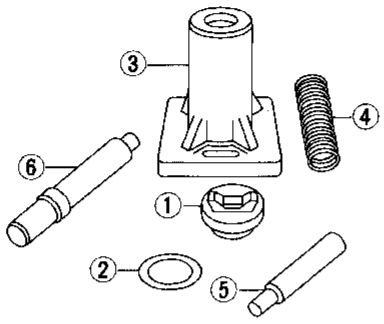
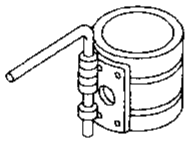
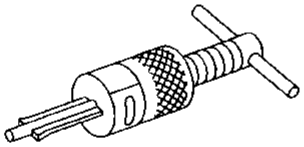
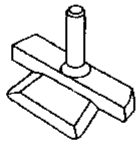
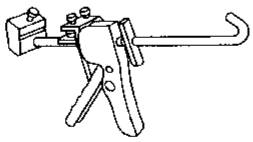
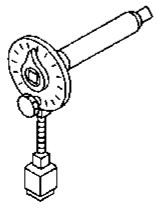
c. Apply liquid gasket to inner surface around hole perimeter area.
(Assembly should be done within 5 minutes after coating.)
d. Wait at least 30 minutes before refilling engine oil and engine coolant.



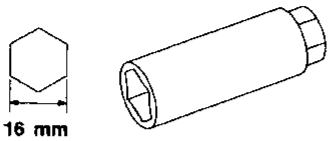
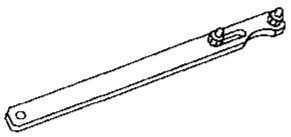
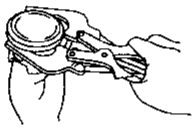
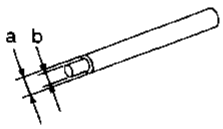
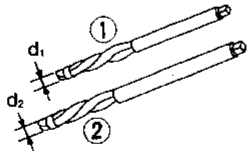
Special Service Tools

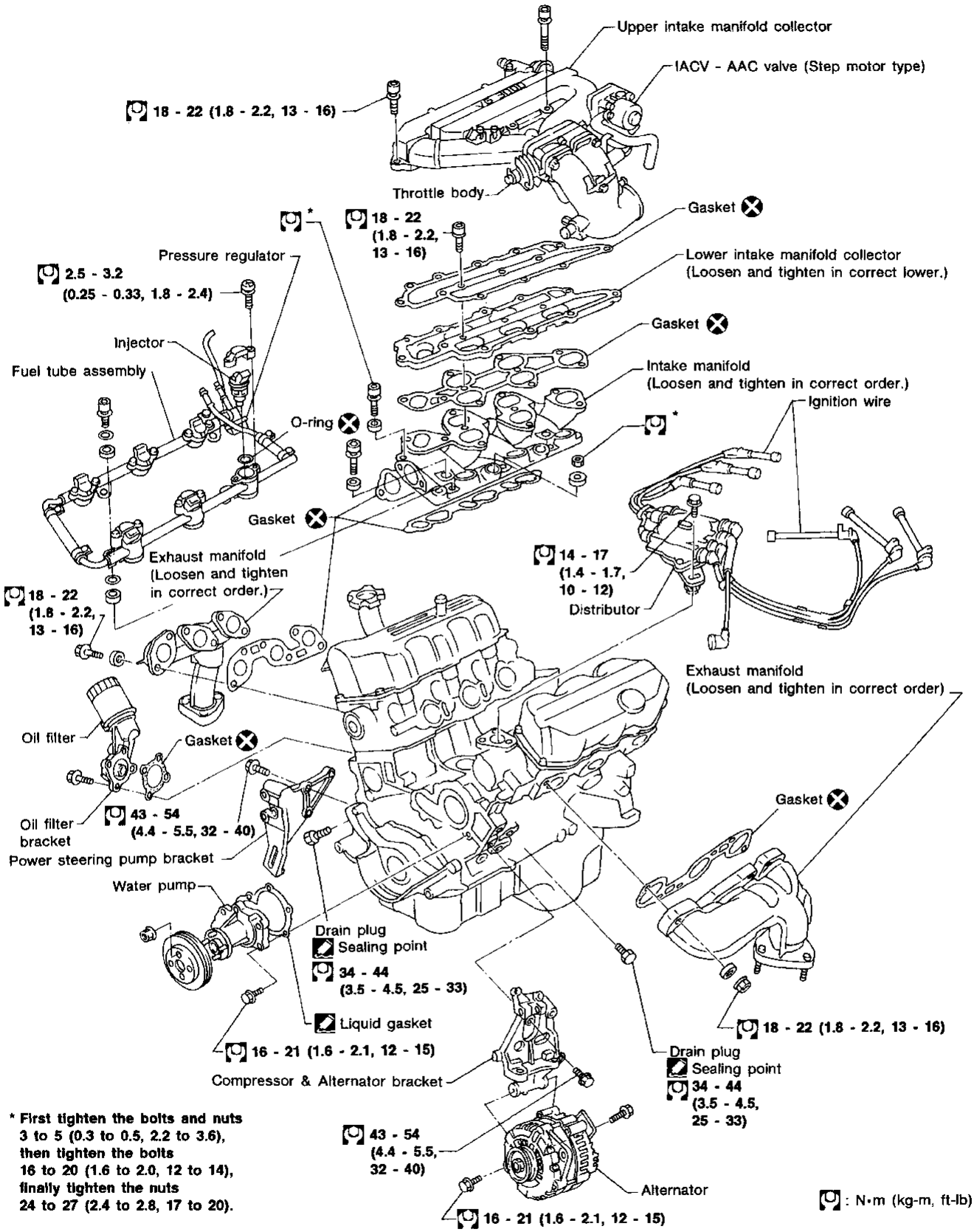
Tool number (Kent-Moore No.) Tool name	Description		Engine application VG	Engine application VE
ST0501S000 (—) Engine stand assembly ① ST05011000 (—) Engine stand ② ST05012000 (—) Base	 NT042	Disassembling and assembling	X	X
KV10106500 (—) Engine stand shaft	 NT028		X	X
KV10110001 (—) Engine sub-attachment	 NT032		X	X
ST10120000 (J24239-01) Cylinder head bolt wrench	 NT019	Loosening and tightening cylinder head bolt	X	X
KV10110600 (J33986) Valve spring compressor	 NT033	Disassembling and assembling valve components	X	—
KV10107501 (—) Valve oil seal drift	 NT025	Installing valve oil seal	X	—
KV10116200 (J26336-A) Valve spring compressor ① KV10115900 (J26336-20) Attachment	 NT022	Disassembling valve mechanism	—	X
(J39386) Valve oil seal drift	 NT024	Installing valve oil seal	—	X

Special Service Tools (Cont'd)

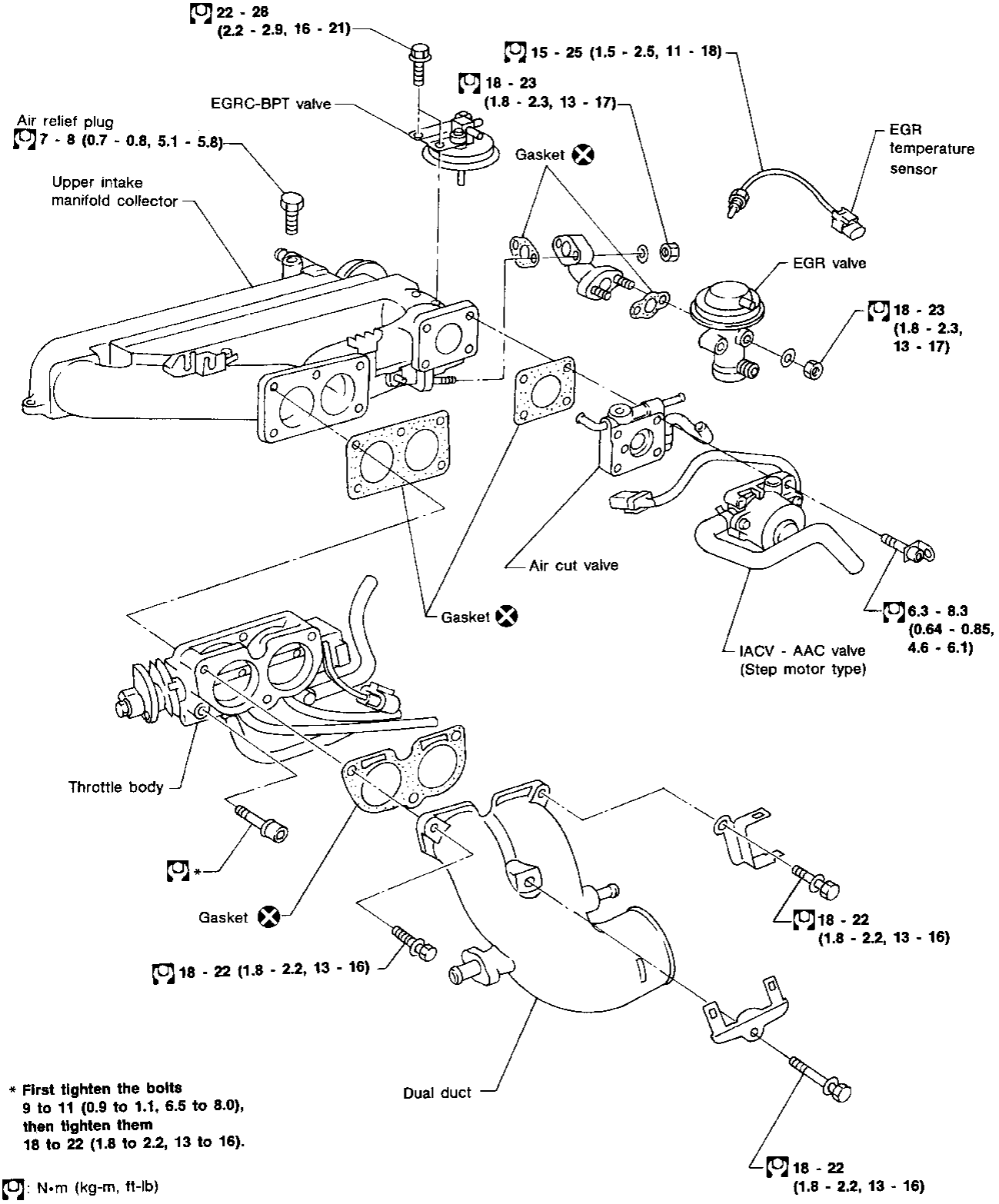
Tool number (Kent-Moore No.) Tool name	Description		Engine application	
			VG	VE
KV10110300 (—) Piston pin press stand assembly ① KV10110310 (—) Cap ② KV10110330 (—) Spacer ③ ST13030020 (—) Press stand ④ ST13030030 (—) Spring ⑤ KV10110340 (—) Drift ⑥ KV10110320 (—) Center shaft	 NT036	Disassembling and assembling piston with connecting rod	X	X
EM03470000 (J8037) Piston ring compressor	 NT044	Installing piston assembly into cylinder bore	X	X
ST16610001 (J23907) Pilot bushing puller	 NT045	Removing crankshaft pilot bushing	X	X
KV10111100 (J37228) Seal cutter	 NT046	Removing oil pan	X	X
WS39930000 (—) Tube presser	 NT052	Pressing the tube of liquid gasket	X	X
KV10112100 (BT8653-A) Angle wrench	 NT014	Tightening bolts for bearing cap, cylinder head, etc.	X	X

Commercial Service Tools

Tool name	Description		Engine application	
			VG	VE
Spark plug wrench	 16 mm (0.63 in) NT047	Removing and installing spark plug	X	X
Pulley holder	 NT035	Holding camshaft pulley while tightening or loosening camshaft bolt	X	—
Valve seat cutter set	 NT048	Finishing valve seat dimensions	X	X
Piston ring expander	 NT030	Removing and installing piston ring	X	X
Valve guide drift	 NT015	Removing and installing valve guide **VG Intake & Exhaust:** **a = 10.5 mm (0.413 in) dia.** **b = 6.6 mm (0.260 in) dia.** **VE Intake & Exhaust:** **a = 9.5 mm (0.374 in) dia.** **b = 5.5 mm (0.217 in) dia.**	X	X
Valve guide reamer	 NT016	Reaming valve guide ① or hole for oversize valve guide ② **VG Intake:** **d_1 = 7.0 mm (0.276 in) dia.** **d_2 = 11.2 mm (0.441 in) dia.** **Exhaust:** **d_1 = 8.0 mm (0.315 in) dia.** **d_2 = 12.2 mm (0.480 in) dia.** **VE Intake & Exhaust:** **d_1 = 6.0 mm (0.236 in) dia.** **d_2 = 10.2 mm (0.402 in) dia.**	X	X


Upper intake manifold collector
IACV - AAC valve (Step motor type)
18 - 22 (1.8 - 2.2, 13 - 16)
Throttle body
Gasket
18 - 22 (1.8 - 2.2, 13 - 16)
Pressure regulator
2.5 - 3.2 (0.25 - 0.33, 1.8 - 2.4)
Lower intake manifold collector (Loosen and tighten in correct lower.)
Gasket
Injector
Fuel tube assembly
Intake manifold (Loosen and tighten in correct order.)
Ignition wire
O-ring
Gasket
Exhaust manifold (Loosen and tighten in correct order.)
14 - 17 (1.4 - 1.7, 10 - 12)
Distributor
18 - 22 (1.8 - 2.2, 13 - 16)
Exhaust manifold (Loosen and tighten in correct order)
Oil filter
Gasket
Gasket
Oil filter bracket
43 - 54 (4.4 - 5.5, 32 - 40)
Power steering pump bracket
Water pump
Drain plug
Sealing point
34 - 44 (3.5 - 4.5, 25 - 33)
Liquid gasket
16 - 21 (1.6 - 2.1, 12 - 15)
18 - 22 (1.8 - 2.2, 13 - 16)
Drain plug
Sealing point
34 - 44 (3.5 - 4.5, 25 - 33)
Compressor & Alternator bracket
43 - 54 (4.4 - 5.5, 32 - 40)
Alternator
16 - 21 (1.6 - 2.1, 12 - 15)
* First tighten the bolts and nuts 3 to 5 (0.3 to 0.5, 2.2 to 3.6), then tighten the bolts 16 to 20 (1.6 to 2.0, 12 to 14), finally tighten the nuts 24 to 27 (2.4 to 2.8, 17 to 20).
: N•m (kg-m, ft-lb)

SEM450E



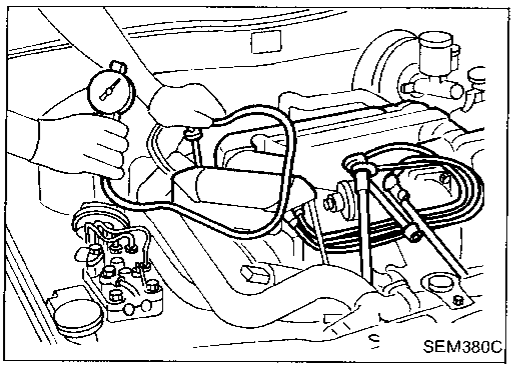
* First tighten the bolts 9 to 11 (0.9 to 1.1, 6.5 to 8.0), then tighten them 18 to 22 (1.8 to 2.2, 13 to 16).

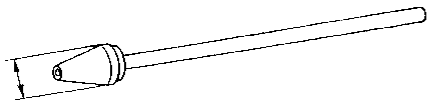
: N·m (kg-m, ft-lb)

SEM703E

Measurement of Compression Pressure

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


SEM380C



20 mm (0.79 in) dia.

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

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.

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

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

Standard

1,196 (12.2, 173)

Minimum

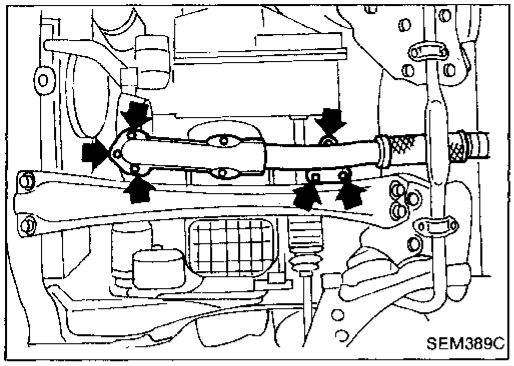
883 (9.0, 128)

Difference limit between cylinders

98 (1.0, 14)

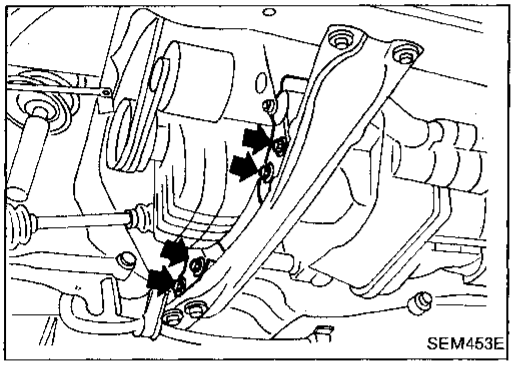
10. If cylinder compression in one or more cylinders is low, pour a small amount of engine oil into cylinders through spark plug holes and retest compression.

- **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 SDS) 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.**

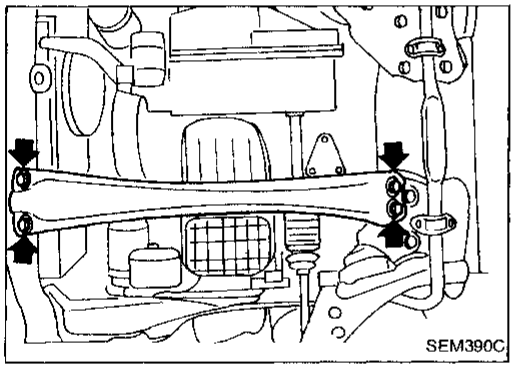


Removal

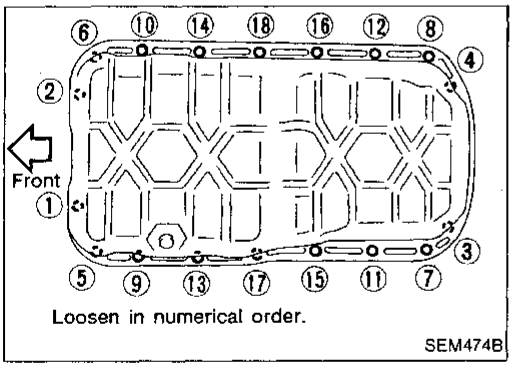
1. Drain engine oil.
2. Remove engine lower covers.
3. Remove exhaust tube fixing nuts.



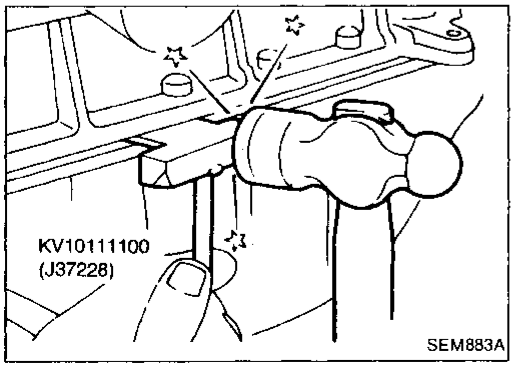
4. Support engine at right side engine slinger with a suitable hoist.
5. Remove engine mounting insulator bolts and nuts.



6. Remove center member assembly.



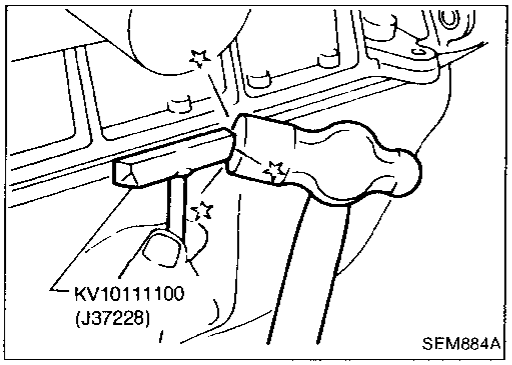
7. Remove oil pan bolts.



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

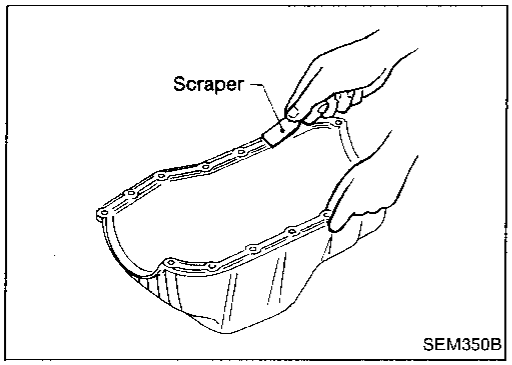
- **Do not drive seal cutter into oil pump or rear oil seal retainer portion, or aluminum mating surfaces will be damaged.**
- **Do not insert screwdriver, or oil pan flange will be deformed.**

Removal (Cont'd)

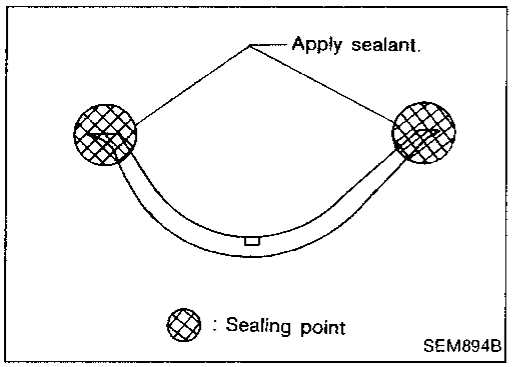


(2) Slide Tool by tapping its side with a hammer, and remove oil pan.

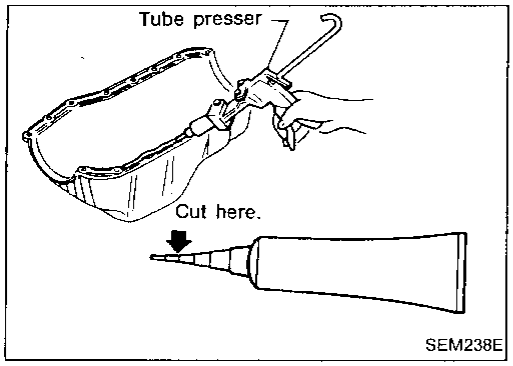
Installation



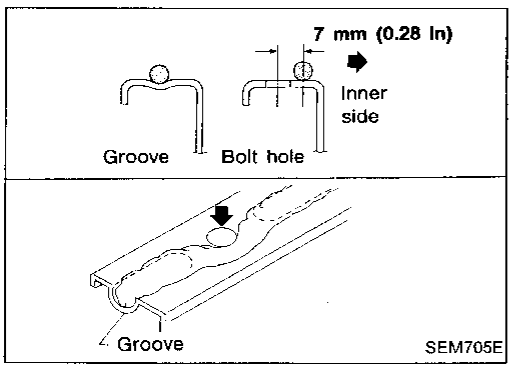
1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
- Also remove traces of liquid gasket from cylinder block mating surface.



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



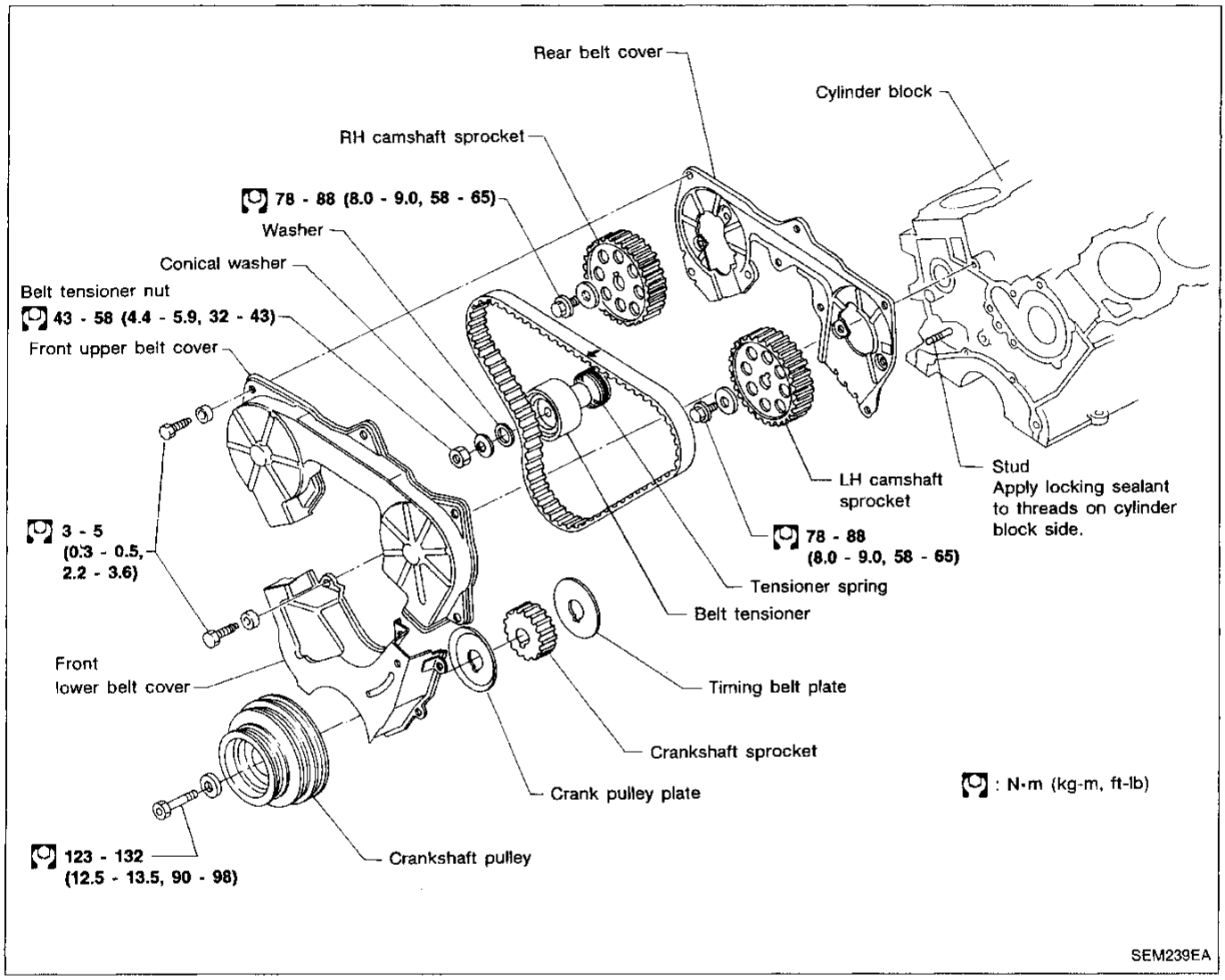
3. Apply a continuous bead of liquid gasket to oil pan mating surface.
- **Use Genuine Liquid Gasket or equivalent.**
- Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.



4. Apply liquid gasket to inner sealing surface as shown in figure.
- Attaching should be done within 5 minutes after coating.
5. Install oil pan.
- **Install bolts/nuts in their reverse order of removal.**
- **Wait at least 30 minutes before refilling engine oil.**

CAUTION:

a. **Do not bend or twist timing belt.**
b. **After removing timing belt, do not turn crankshaft and camshaft separately because valves will strike piston heads.**
c. **Make sure that timing belt, camshaft sprocket, crankshaft sprocket and belt tensioner are clean and free from oil and water.**
d. **Installation should be carried out when engine is cold.**

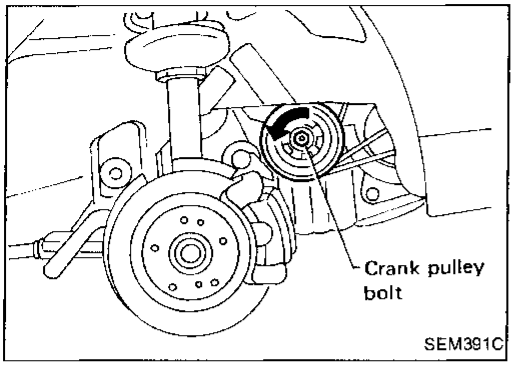


Removal

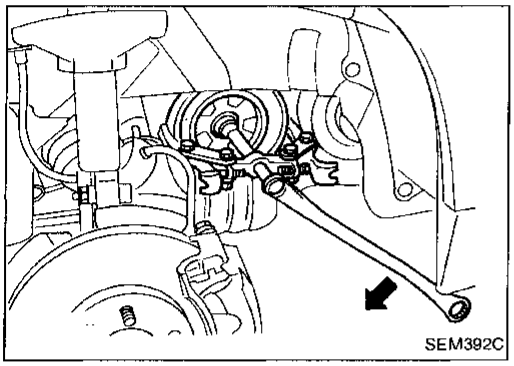
1. Jack up the vehicle front and support with safety stand.
2. Remove engine under covers and drain engine coolant from radiator.
3. Remove front RH wheel and engine side cover.
4. Remove the following belts.

- Alternator drive belt
- Power steering drive belt
- Compressor drive belt

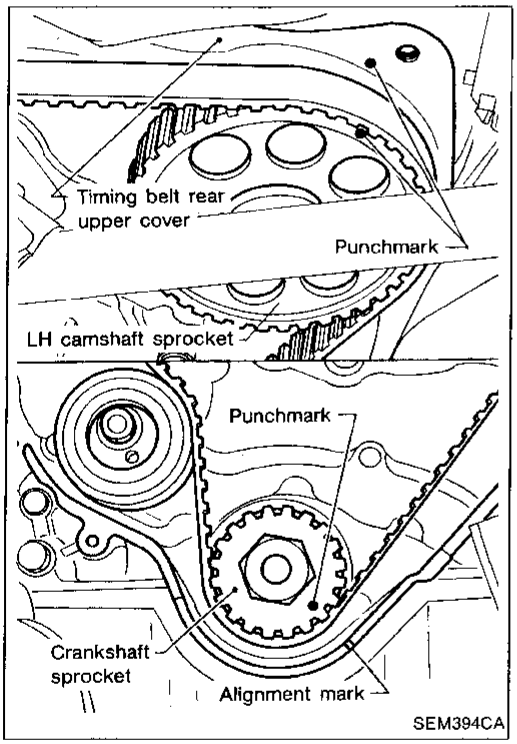
Removal (Cont'd)



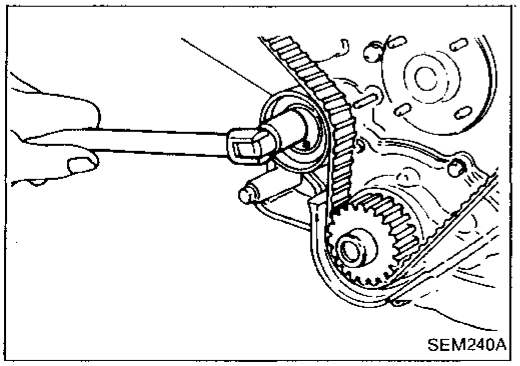
5. Loosen crankshaft pulley bolt.



6. Remove crank pulley with a suitable puller.
7. Remove radiator upper hose and water inlet hose.
8. Remove compressor drive belt idler bracket.
9. Remove water pump pulley.
10. Remove front upper and lower belt covers.



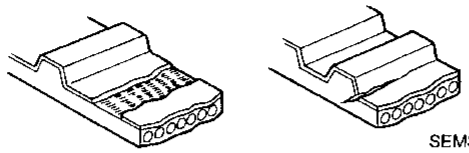
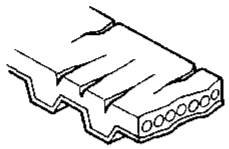
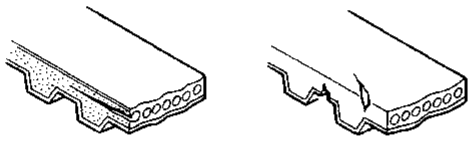
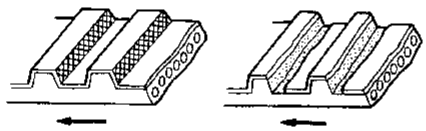
11. Set No. 1 piston at TDC on its compression stroke by rotating crankshaft.
- **Align punchmark on LH camshaft sprocket with punchmark on timing belt upper rear cover.**
- **Align punchmark on crankshaft sprocket with notch on oil pump housing.**
- **Temporarily install crank pulley bolt on crankshaft so that crankshaft can be rotated.**

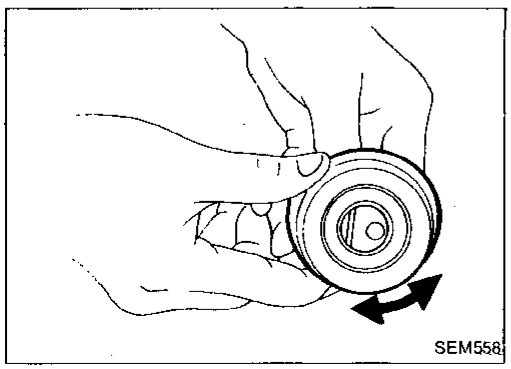


12. Loosen timing belt tensioner nut, turn tensioner, then remove timing belt.

Inspection

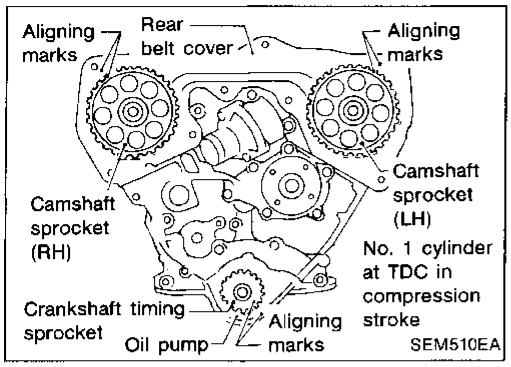
Visually check the condition of timing belt.
Replace if any abnormality is found.

Item to check	Problem	Cause
Tooth is broken/tooth root is cracked.	 SEM394A	• Camshaft jamming • Distributor 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


SEM558

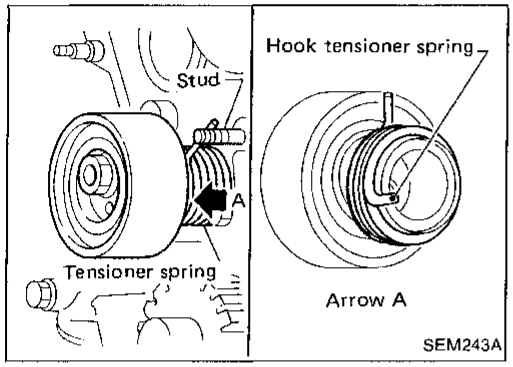
BELT TENSIONER AND TENSIONER SPRING

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



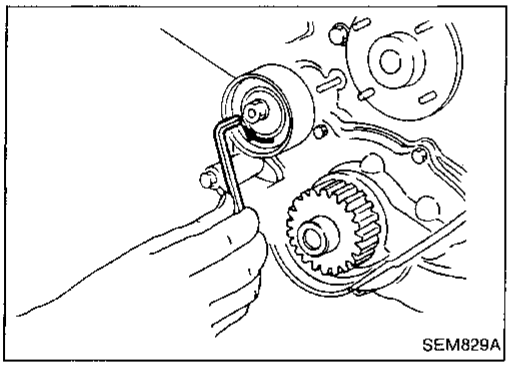
Installation

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

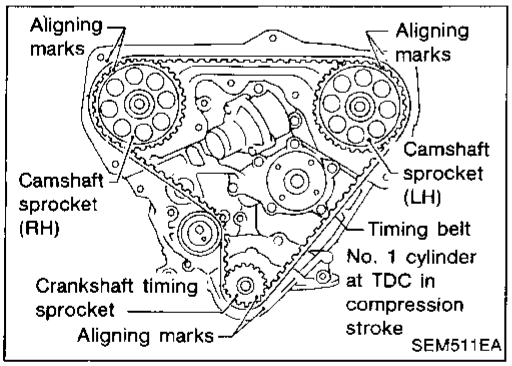


2. Install tensioner and tensioner spring.

Whenever the stud is replaced apply locking sealant to the threads on cylinder block side before installation.



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



4. Set timing belt.

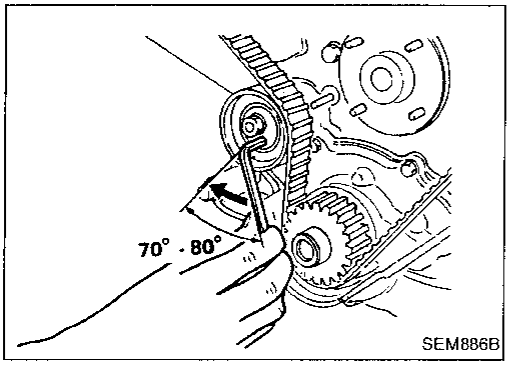
(1) Align white lines on timing belt with punchmarks on camshaft sprockets and crankshaft sprocket.

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

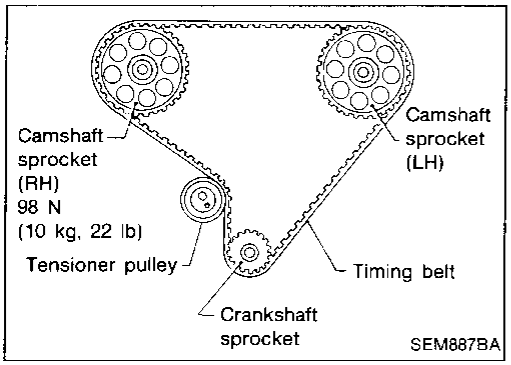
Number of teeth (reference):

Number of timing belt teeth		133
Number of teeth between timing marks	Between LH and RH camshaft sprockets	40
	Between LH camshaft sprocket and crankshaft timing sprocket	43

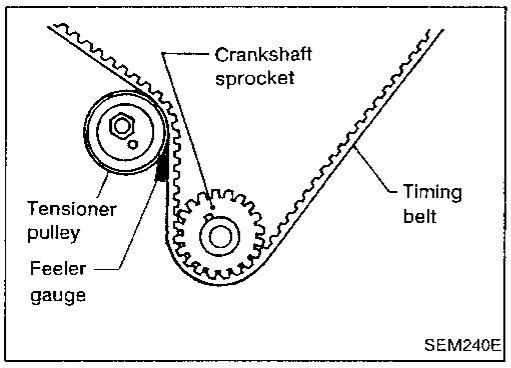
Installation (Cont'd)



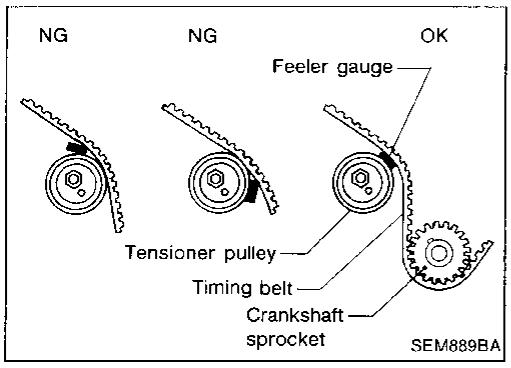
5. Loosen tensioner lock nut, keeping tensioner steady with hexagon wrench.
6. Turn tensioner 70 to 80 degrees clockwise with hexagon wrench, and temporarily tighten lock nut.
7. Turn crankshaft clockwise at least 2 times, then slowly set No. 1 piston at TDC on its compression stroke.



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



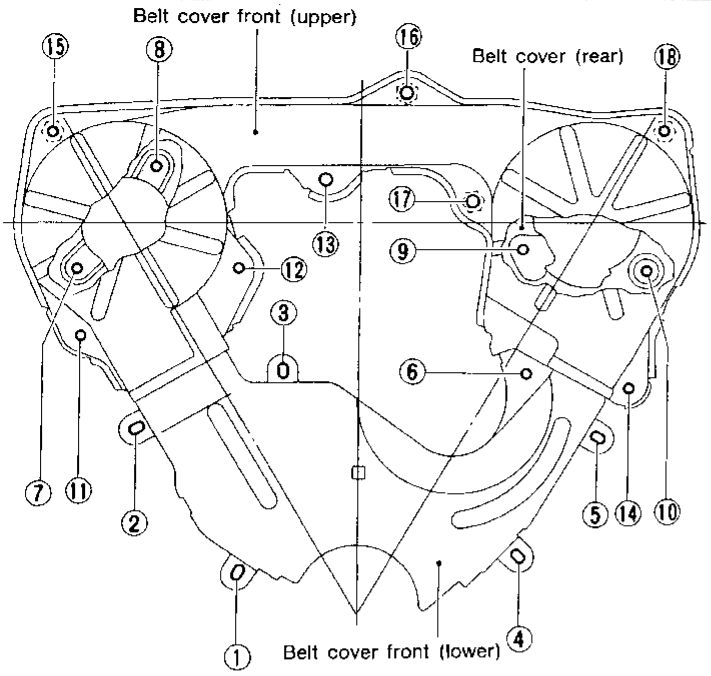
10. Set feeler gauge as shown in figure which is 0.35 mm (0.0138 in) thick and 12.7 mm (0.500 in) wide.



11. Turn crankshaft clockwise, and set feeler gauge as shown in figure.
- Timing belt will move about 2.5 teeth.

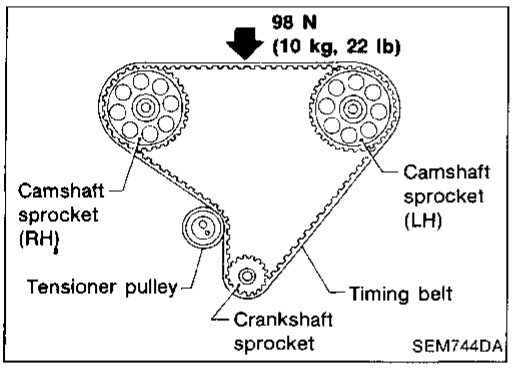
12. Tighten tensioner lock nut, keeping tensioner steady with hexagon wrench.
13. Turn crankshaft clockwise or counterclockwise, and remove feeler gauge.
14. Turn crankshaft clockwise at least 2 times, then slowly set No. 1 piston at TDC on its compression stroke.
15. Install lower and upper belt covers.

Installation (Cont'd)



Tightened parts	Section	Parts tightened with bolts
Bolt A (6 pcs.) Rubber washer Belt cover front (lower)	①, ②, ③ ④, ⑤, ⑭	②, ③: Cylinder block ⑤, ⑭: Compressor bracket ①, ④: Oil pump
Bolt B (1 pc.) Rubber washer Belt cover front (lower) Water pump mounting bolts	⑥	Water pump mounting bolt
Bolt C (4 pcs.) Belt cover (rear)	⑦, ⑧, ⑨ ⑩	Cylinder head
Bolt A (7 pcs.) Rubber washer Belt cover front (upper) Belt cover (rear) Welded nut (4 pcs.)	⑮, ⑯, ⑰ ⑱, ⑪, ⑫ ⑬	⑮, ⑯, ⑰, ⑱: Welded nuts ⑪, ⑫: Cylinder head ⑬: Water outlet

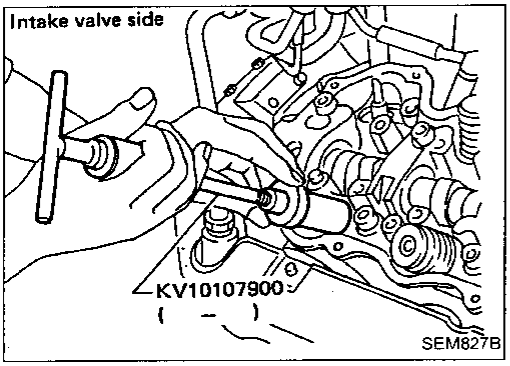
SEM475E

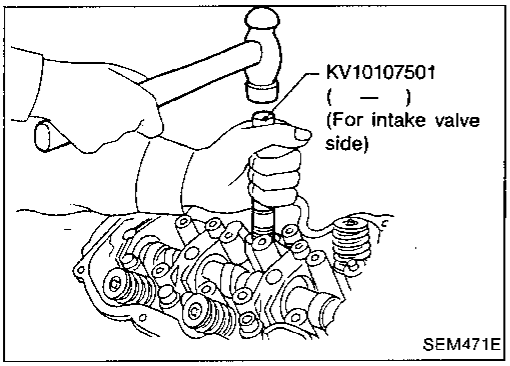


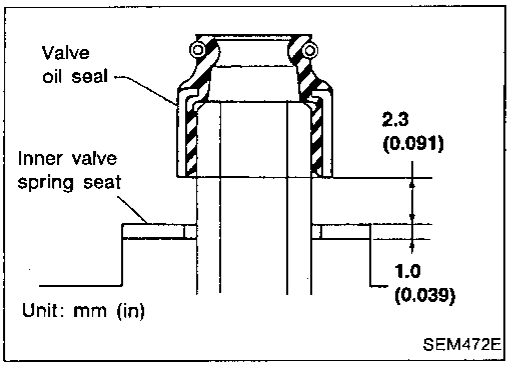
BELT TENSION CHECK

1. Set No. 1 piston at TDC on its compression stroke.
2. Measure deflection of timing belt midway between camshaft pulleys while pushing on belt with 98 N (10 kg, 22 lb) force.

Belt deflection (Reference value):
13 - 15 mm (0.51 - 0.59 in)/98 N (10 kg, 22 lb)







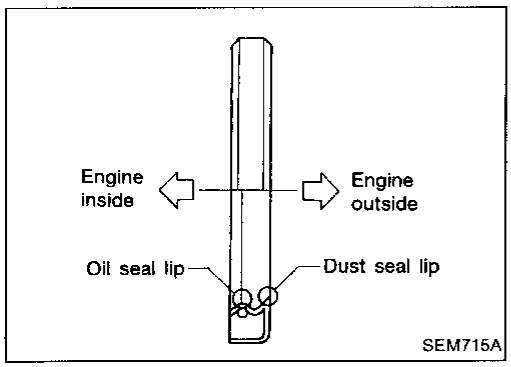
VALVE OIL SEAL

1. Remove rocker cover.
2. Remove rocker shaft assembly and valve lifters with valve lifter guide.
3. Remove valve springs and valve oil seal.

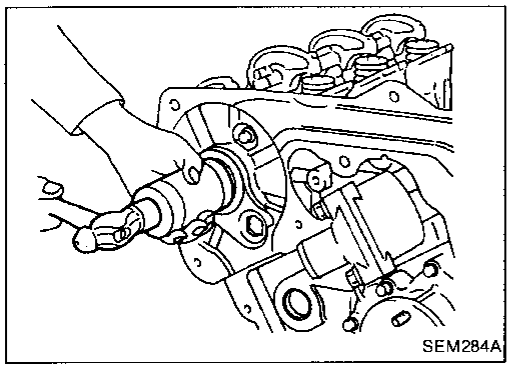
- Piston concerned should be set at TDC to prevent valve from falling.
- When removing intake side valve oil seal, use Tool or suitable tool.
- When removing exhaust side valve oil seal, pull it out with suitable tool.

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

- Before installing valve oil seal, install inner valve spring seat.
- When installing intake side valve oil seal, use Tool.
- When installing exhaust side valve oil seal, set it by hand.



OIL SEAL INSTALLING DIRECTION

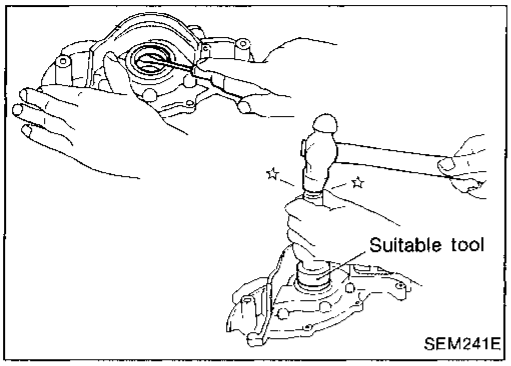


CAMSHAFT OIL SEAL

1. Remove timing belt.
2. Remove camshaft sprocket.
3. Remove camshaft.
4. Remove camshaft oil seal.

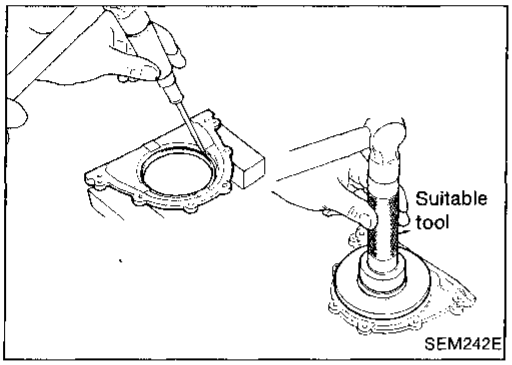
Be careful not to scratch camshaft.

5. Apply engine oil to new camshaft oil seal.



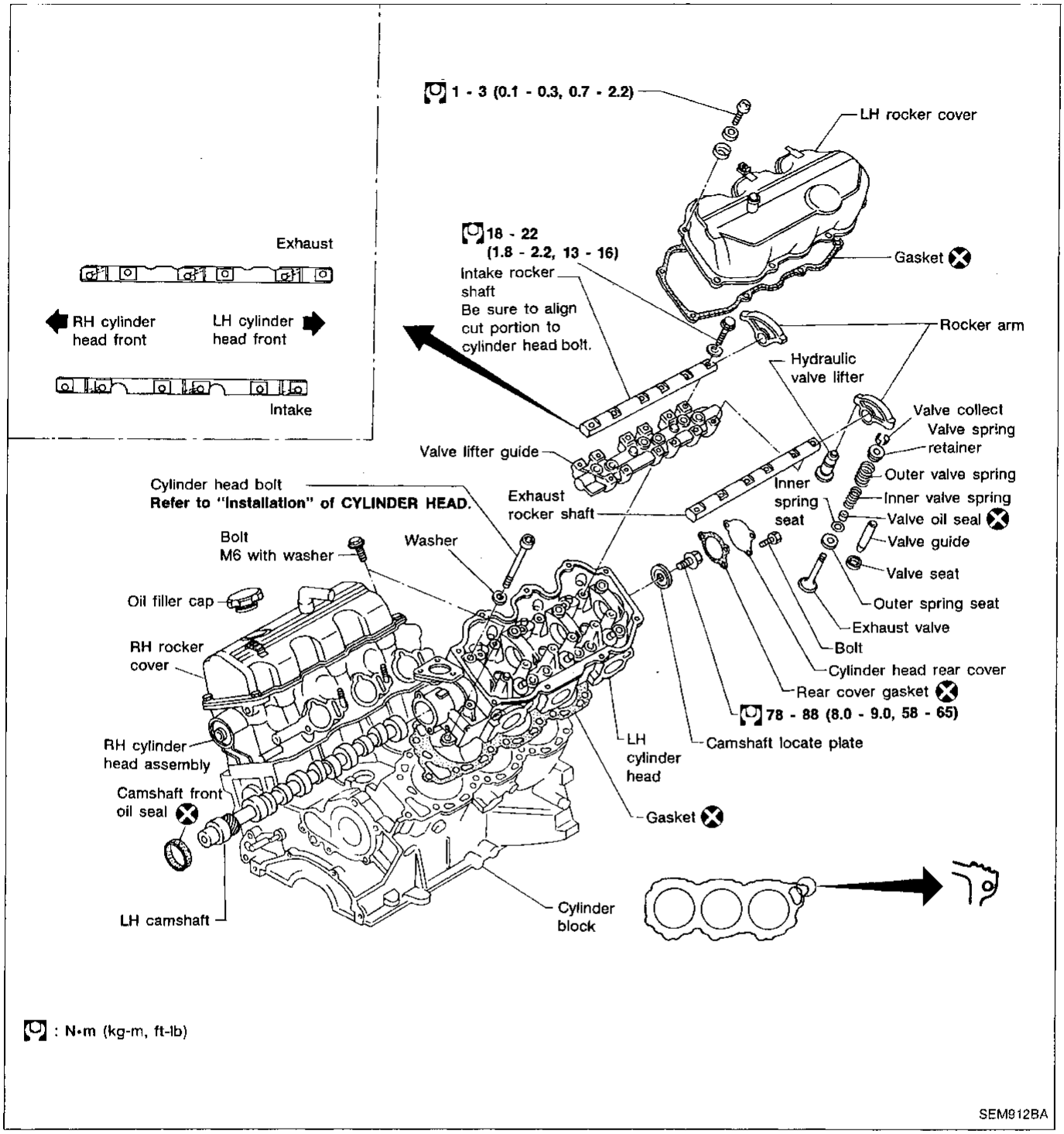
FRONT OIL SEAL

1. Remove timing belt and crankshaft sprocket.
2. Remove oil pump assembly.
3. Remove front oil seal from oil pump body.
4. Apply engine oil to new oil seal and install it using suitable tool.



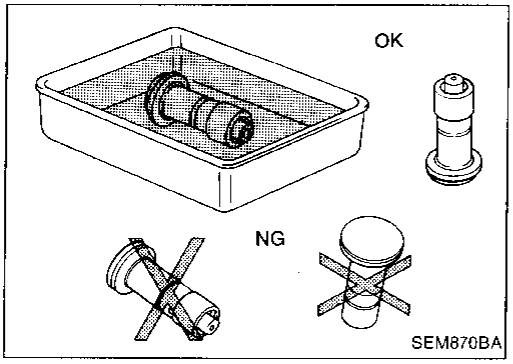
REAR OIL SEAL

1. Remove flywheel or drive plate.
2. Remove rear oil seal retainer.
3. Remove rear oil seal from retainer.
4. Apply engine oil to new oil seal and install it using suitable tool.
5. Install rear oil seal retainer with a new gasket to cylinder block.

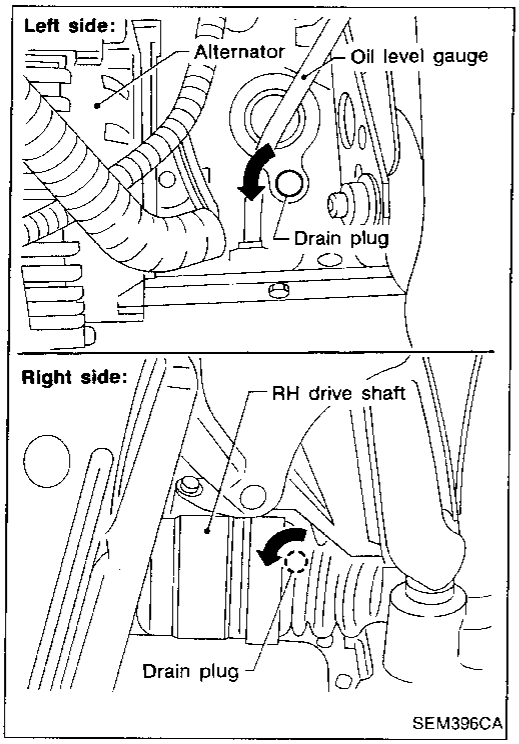


CAUTION:

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



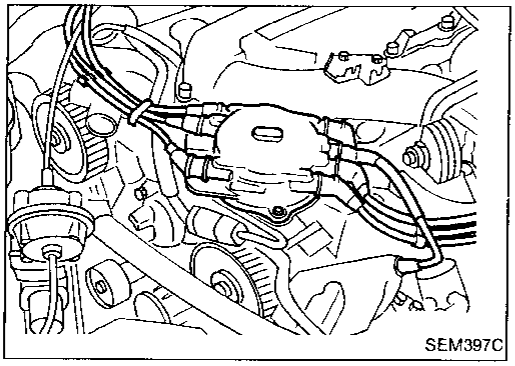
- **If hydraulic valve lifter is kept on its side, there is a risk of air entering it. After removal, always set hydraulic valve lifter straight up, or when laying it on its side, have it soak in new engine oil.**
- **Do not disassemble hydraulic valve lifter.**
- **Attach tags to valve lifters so as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



Removal

1. Release fuel pressure.
   Refer to "Releasing Fuel Pressure" in EF & EC section.
2. Remove timing belt.
   Refer to "TIMING BELT — Removal" (EM-11).
3. Drain coolant by removing drain plugs from both sides of cylinder block.

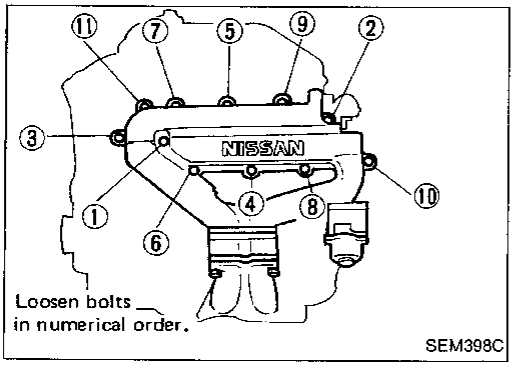
Right side of drain plug is located behind RH drive shaft.



4. Remove distributor and ignition wires.

After pulling out distributor from cylinder head, do not rotate distributor rotor.

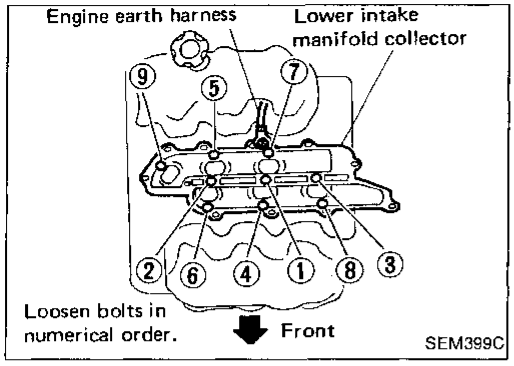
5. Separate ASCD and accelerator control wire from intake manifold collector.



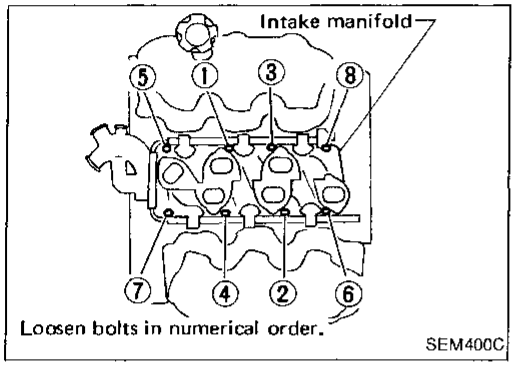
6. Remove upper intake manifold collector from engine. The following parts should be disconnected to remove upper intake manifold collector.

a. Harness connectors for: IACV-AAC valve, Throttle position sensor, Closed throttle position switch
b. Water hose for air cut valve
c. PCV hoses
d. Vacuum hoses from: Vacuum gallery, Swirl control valve, Master brake cylinder, EGR valve
e. EGR flare tube

Removal (Cont'd)



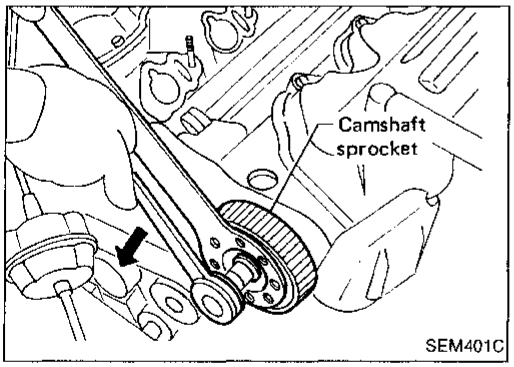
7. Remove lower intake manifold collector from engine.
- Remove engine earth harness.



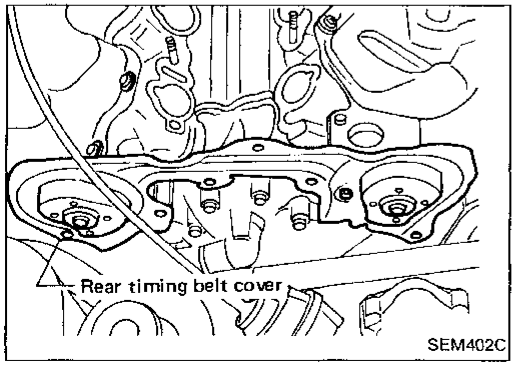
8. Remove intake manifold from engine.
The following parts should be disconnected to remove intake manifold.
a. Harness connectors for
- All injectors
- Engine coolant temperature switch
- Engine coolant temperature sensor
- Power valve control solenoid valve
- EGRC-solenoid valve
- EGR temperature sensor

b. Vacuum gallery
c. Vacuum hoses for
- Pressure regulator valve
- All vacuum hoses connected with vacuum gallery

d. Heater hose (Engine rear side)
e. Fuel feed and return hose
f. Injector fuel tube assembly

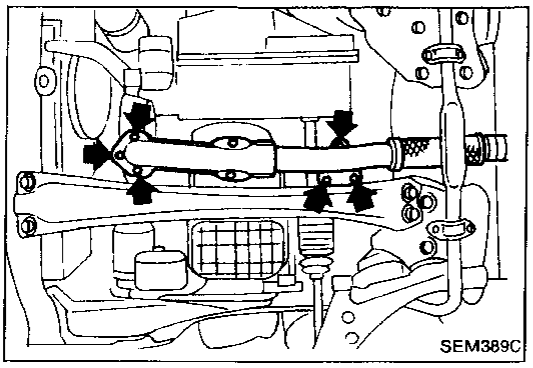


9. Remove both camshaft sprockets.

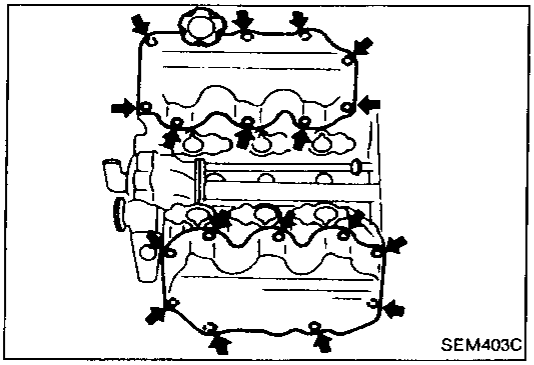


10. Remove rear timing belt cover.

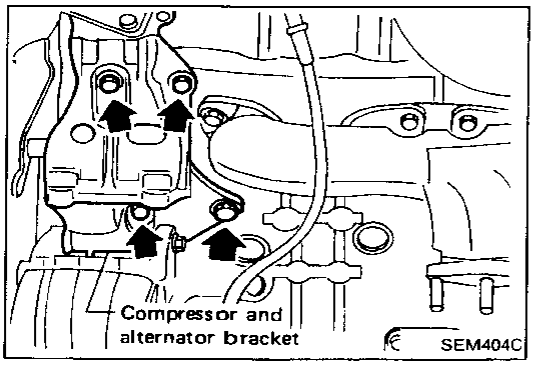
Removal (Cont'd)



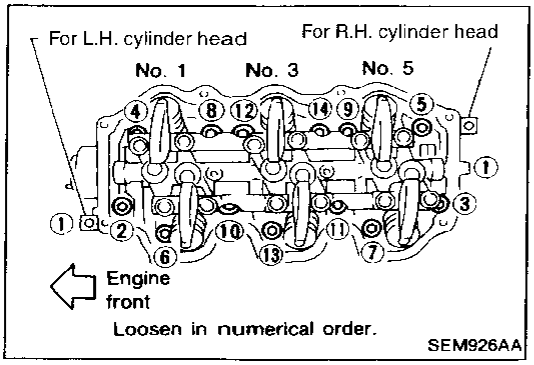
11. Remove front exhaust tube from exhaust manifold.



12. Remove both rocker covers.

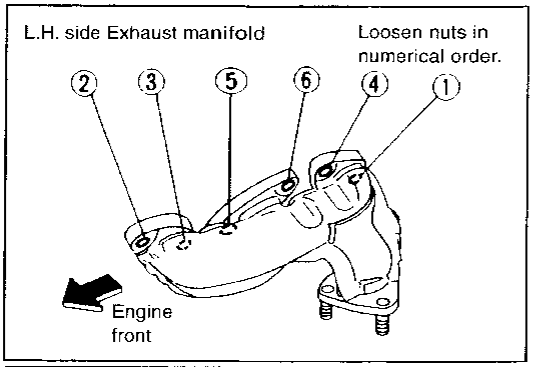


13. Remove compressor from its bracket.
14. Remove alternator from its bracket.
15. Remove compressor and alternator bracket.



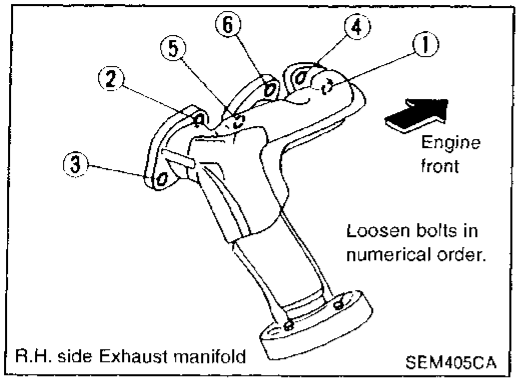
16. Remove cylinder head with exhaust manifold bolt.
- **A warped or cracked cylinder head could result from removing in incorrect order.**
- **Cylinder head bolts should be loosened in two or three steps.**

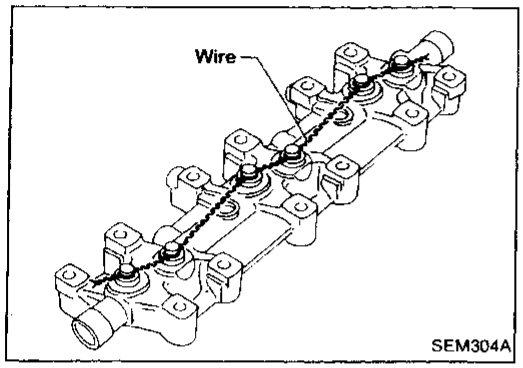
Disassembly



1. Remove exhaust manifolds from cylinder head.

Disassembly (Cont'd)





2. Remove rocker shafts with rocker arms.

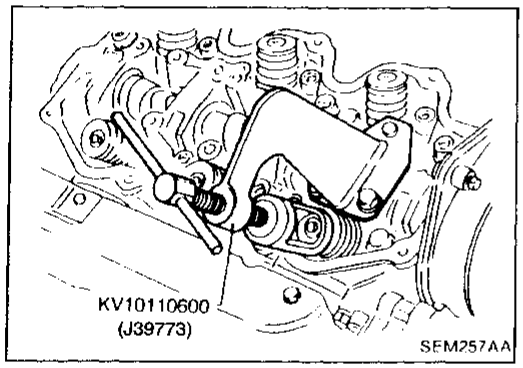
Bolts should be loosened in two or three steps.

3. Remove hydraulic valve lifters and lifter guide.

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

4. Remove oil seal and camshaft.

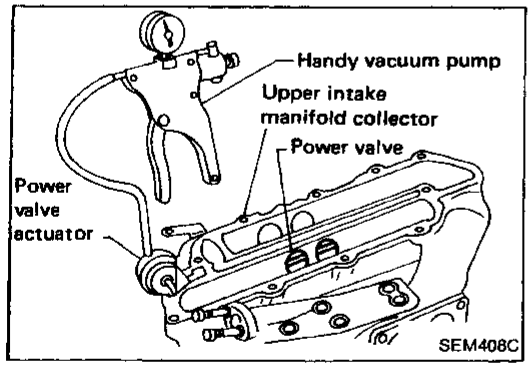
- **Before removing camshaft, measure camshaft end play.**



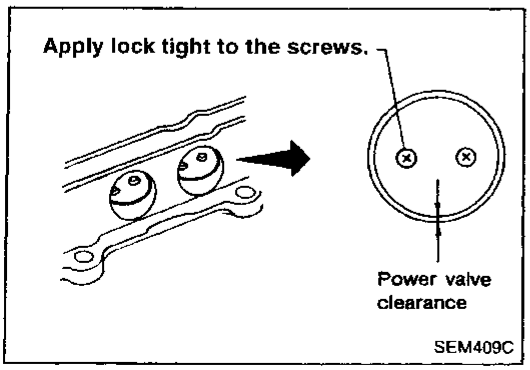
5. Remove valve components with Tool.
6. Remove valve oil seals with Tool or suitable tool.

Inspection

POWER VALVE ACTUATOR



1. Disconnect power valve actuator vacuum hose.
2. Connect handy vacuum pump with power valve actuator.
3. Apply vacuum. Make sure that power valve begins to open between –13.3 and –26.7 kPa (–100 and –200 mmHg, –3.94 and –7.87 inHg) vacuum and there is no vacuum leak in the actuator.
4. If there is vacuum leakage, replace upper intake manifold collector assembly with a new one.

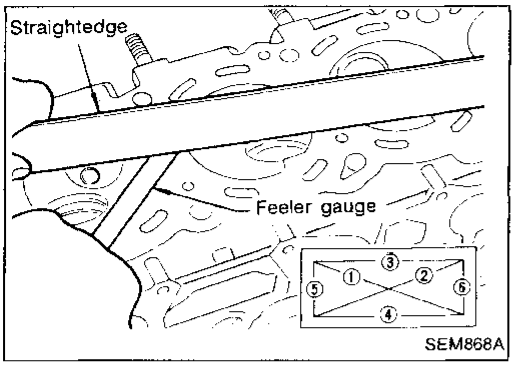


5. When installing power valve, fully lift power valve actuator. Position power valve properly while placing feeler gauges on left, right, upper and lower sides of power valve. Apply lock tight to screw threads before tightening screws.

Power valve clearance:

$0.30^{+0.06}_{-0.02}$ mm ($0.0118^{+0.0024}_{-0.0008}$ in)

Inspection (Cont'd)



CYLINDER HEAD DISTORTION

Head surface flatness:

Less than 0.1 mm (0.004 in)

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

Resurfacing limit:

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

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

A + B = 0.2 mm (0.008 in)

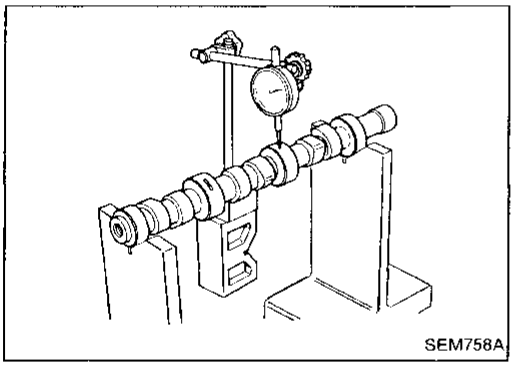
After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.

Nominal cylinder head height:

106.8 - 107.2 mm (4.205 - 4.220 in)

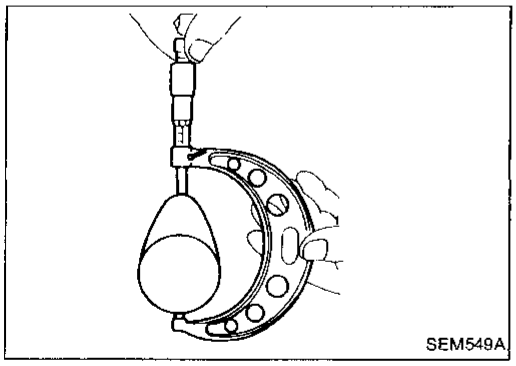
CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.



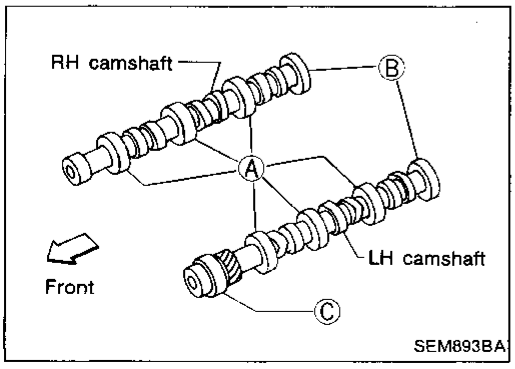
CAMSHAFT RUNOUT

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



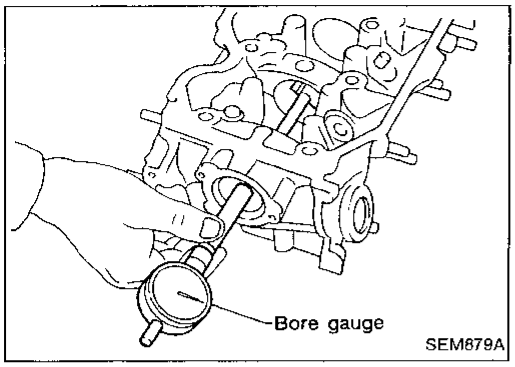
CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height.
   Standard cam height:
   39.537 - 39.727 mm (1.5566 - 1.5641 in)
   Cam wear limit:
   0.15 mm (0.0059 in)
2. If wear is beyond the limit, replace camshaft.

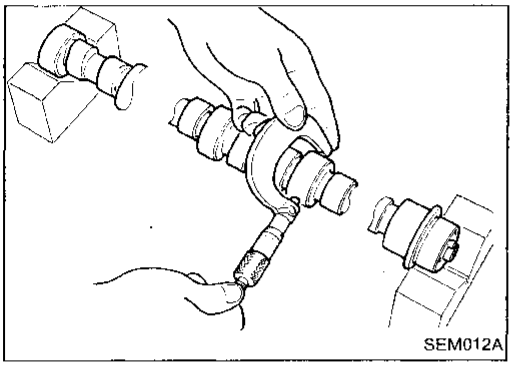


CAMSHAFT JOURNAL CLEARANCE

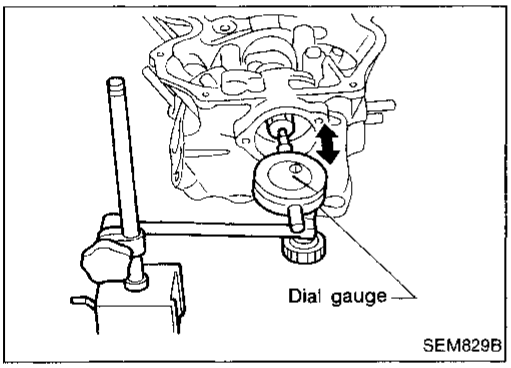
Inspection (Cont'd)



1. Measure inner diameter of camshaft bearing.
   Standard inner diameter:
   A 47.000 - 47.025 mm (1.8504 - 1.8514 in)
   B 42.500 - 42.525 mm (1.6732 - 1.6742 in)
   C 48.000 - 48.025 mm (1.8898 - 1.8907 in)

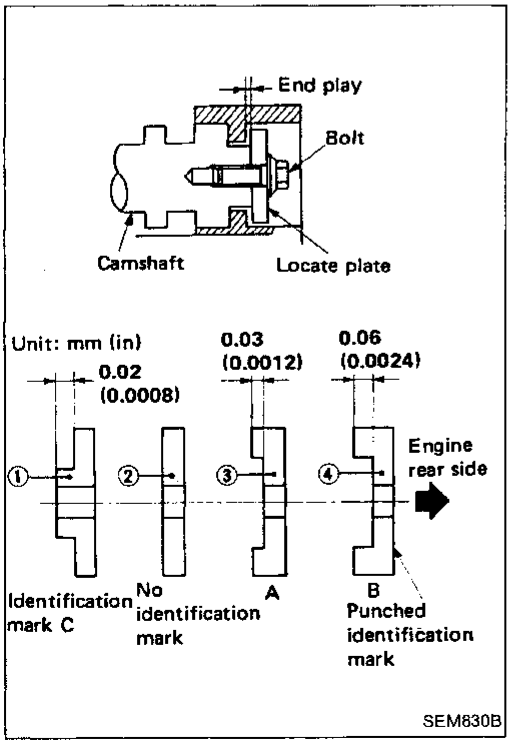


2. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   A 46.920 - 46.940 mm (1.8472 - 1.8480 in)
   B 42.420 - 42.440 mm (1.6701 - 1.6709 in)
   C 47.920 - 47.940 mm (1.8866 - 1.8874 in)
3. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance limit:
   0.15 mm (0.0059 in)



CAMSHAFT END PLAY

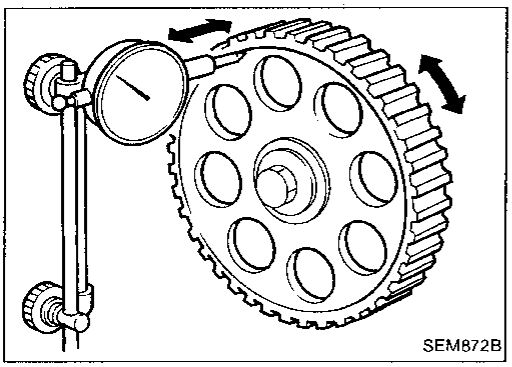
1. Install camshaft and locate plate in cylinder head.
2. Measure camshaft end play.
   Camshaft end play:
   Standard 0.03 - 0.06 mm (0.0012 - 0.0024 in)



3. If it is out of the specified range, select thickness of camshaft locate plate to obtain standard specified end play.
   Example:
   When camshaft end play is 0.08 mm (0.0031 in) with camshaft locate plate ②, replace camshaft locate plate ② with camshaft locate plate ③ to set the end play at 0.05 mm (0.0020 in).

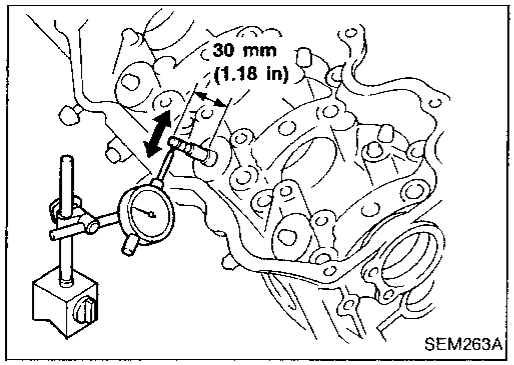
Inspection (Cont'd)

CAMSHAFT SPROCKET RUNOUT

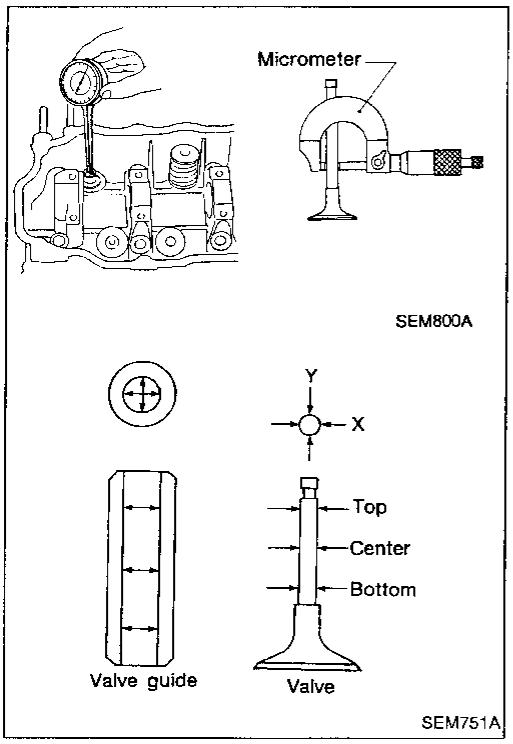


1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.
   Runout (Total indicator reading):
   Limit 0.1 mm (0.004 in)
3. If it exceeds the limit, replace camshaft sprocket.

VALVE GUIDE CLEARANCE



1. Measure valve deflection in a right-angled direction with camshaft. (Valve and valve guide mostly wear in this direction.)
   Valve deflection limit (Dial gauge reading):
   0.20 mm (0.0079 in)



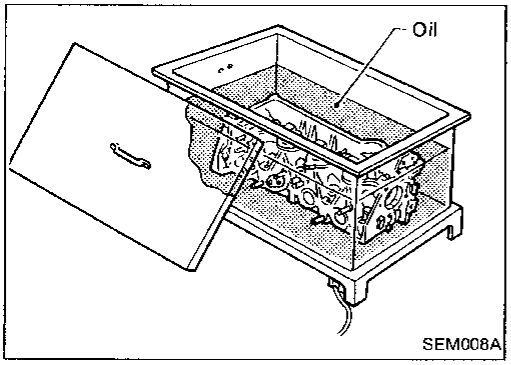
2. If it exceeds the limit, check valve to valve guide clearance.

a. Measure valve stem diameter and valve guide inner diameter.

b. Check that clearance is within specification.
   Valve to valve guide clearance:
   Intake
   0.020 - 0.053 mm (0.0008 - 0.0021 in)
   Exhaust
   0.040 - 0.073 mm (0.0016 - 0.0029 in)
   Limit
   0.10 mm (0.0039 in)

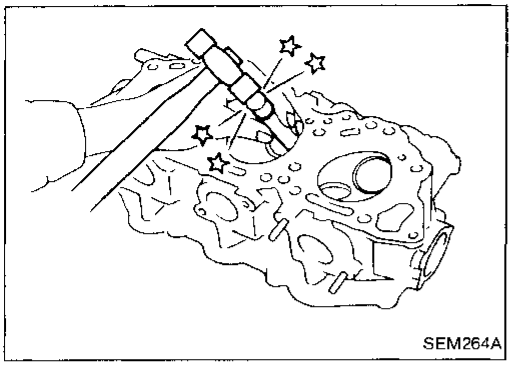
c. If it exceeds the limit, replace valve or valve guide.

VALVE GUIDE REPLACEMENT

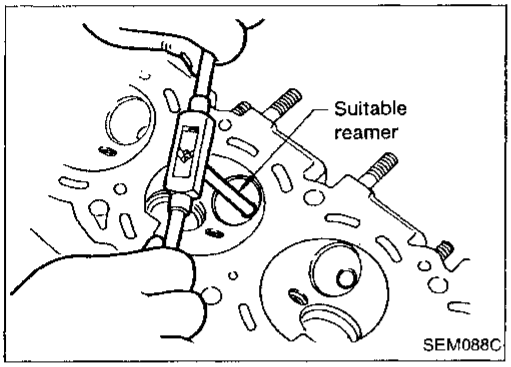


1. To remove valve guide, heat cylinder head to 150 to 160°C (302 to 320°F) by soaking in heated oil.

Inspection (Cont'd)

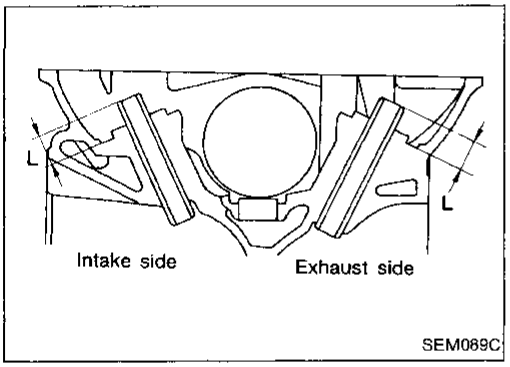

SEM264A

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.



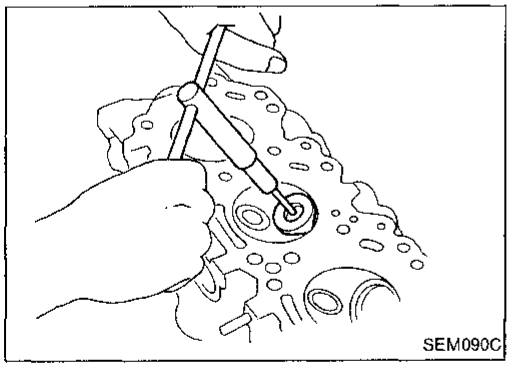
SEM088C

3. Ream cylinder head valve guide hole.
   Valve guide hole diameter (for service parts):
   Intake
   11.175 - 11.196 mm (0.4400 - 0.4408 in)
   Exhaust
   12.175 - 12.196 mm (0.4793 - 0.4802 in)



SEM089C

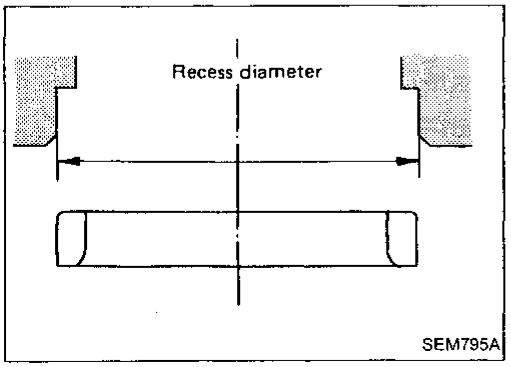
4. Heat cylinder head to 150 to 160°C (302 to 320°F) and press service valve guide onto cylinder head.
   Projection "L":
   13.2 - 13.4 mm (0.520 - 0.528 in)
5. Ream valve guide.
   Finished size:
   Intake
   7.000 - 7.018 mm (0.2756 - 0.2763 in)
   Exhaust
   8.000 - 8.018 mm (0.3150 - 0.3157 in)


SEM090C

VALVE SEATS

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

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



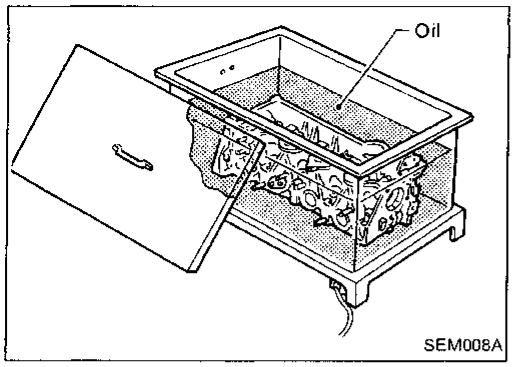
SEM795A

REPLACING VALVE SEAT FOR SERVICE PARTS

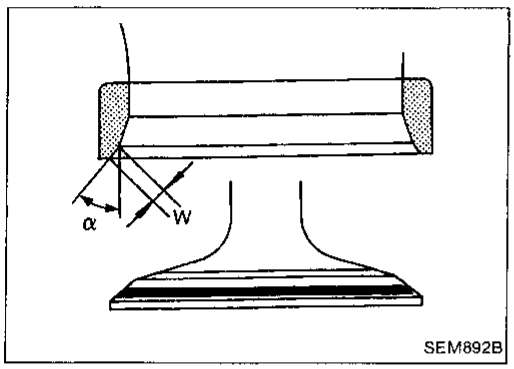
1. Bore out old seat until it collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the seat recess in cylinder head.
2. Ream cylinder head recess.
   Reaming bore for service valve seat
   Oversize [0.5 mm (0.020 in)]:
   Intake 44.500 - 44.516 mm (1.7520 - 1.7526 in)
   Exhaust 37.500 - 37.516 mm (1.4764 - 1.4770 in)

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

Inspection (Cont'd)

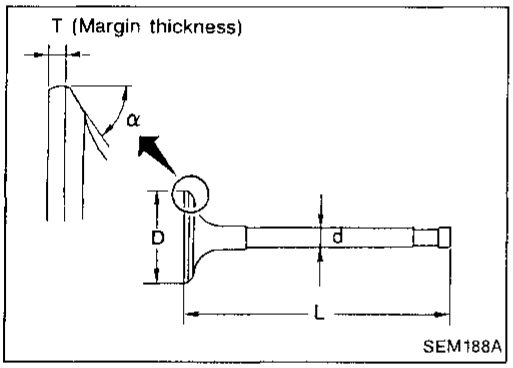


3. Heat cylinder head to 150 to 160°C (302 to 320°F) by soaking in heated oil.
4. Press fit valve seat until it seats on the bottom.



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

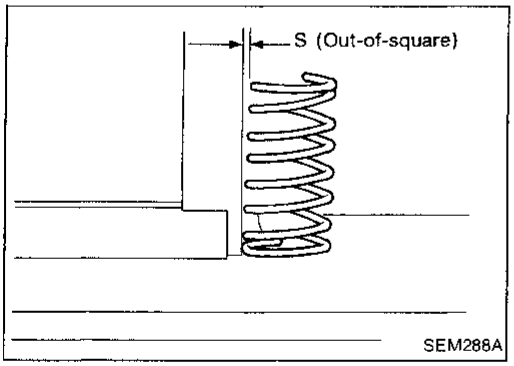
		Intake	Exhaust
Seat face angle "α"	degree	45	45
Contacting width "W"	mm (in)	1.75 (0.0689)	1.7 (0.067)



VALVE DIMENSIONS

Check dimensions in each valve. For dimensions, refer to SDS. When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace valve.

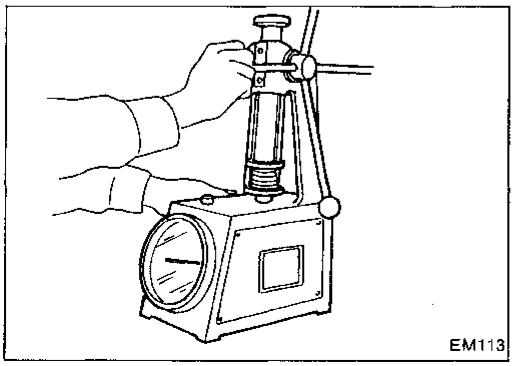
Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.



VALVE SPRING

Squareness

1. Measure "S" dimension.
   Out-of-square:
   Outer
   Less than 2.2 mm (0.087 in)
   Inner
   Less than 1.9 mm (0.075 in)
2. If it exceeds the limit, replace spring.



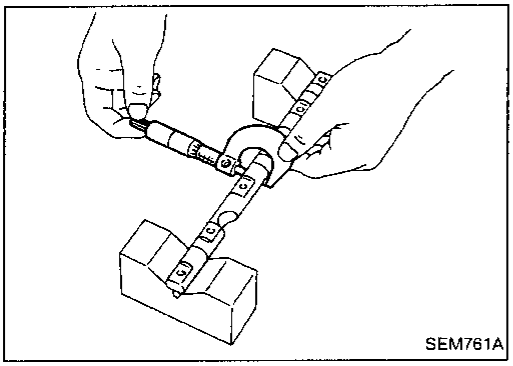
Pressure

Check valve spring pressure.

Pressure: N (kg, lb) at height mm (in)
Standard
Outer 523.7 (53.4, 117.7) at 30.0 (1.181)
Inner 255.0 (26.0, 57.3) at 25.0 (0.984)
Limit
Outer More than 462.9 (47.2, 104.1) at 30.0 (1.181)
Inner More than 225.6 (23.0, 50.7) at 25.0 (0.984)

If it exceeds the limit, replace spring.

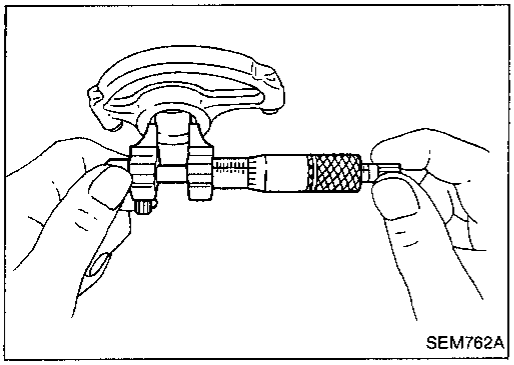
Inspection (Cont'd)


SEM761A

ROCKER SHAFT AND ROCKER ARM

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

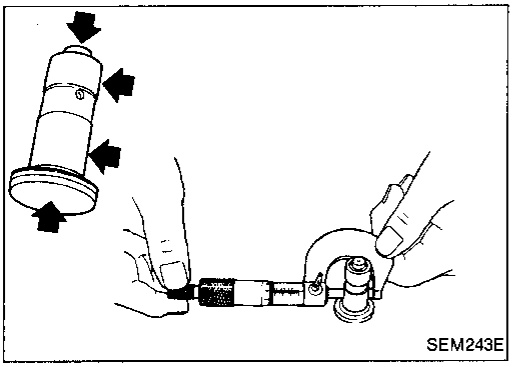
Diameter:
17.988 - 18.000 mm (0.7082 - 0.7087 in)


SEM762A

3. Check inner diameter of rocker arm.

Diameter:
18.007 - 18.028 mm (0.7089 - 0.7098 in)
Rocker arm to shaft clearance:
0.007 - 0.049 mm (0.0003 - 0.0019 in)

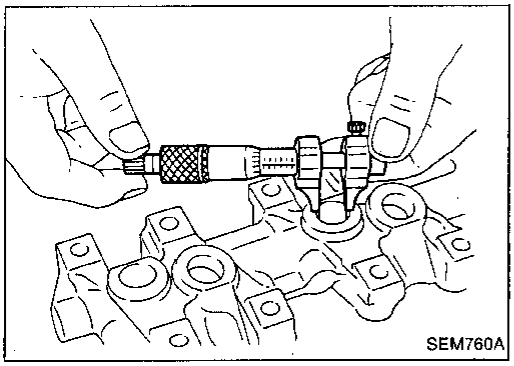
- **Keep rocker arm/hydraulic valve lifter standing to prevent air from entering hydraulic valve lifter when checking.**


SEM243E

HYDRAULIC VALVE LIFTER

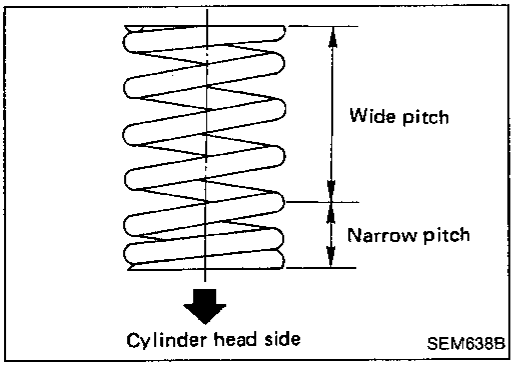
1. Check contact and sliding surfaces for wear or scratches.
2. Check diameter of valve lifter.

Outer diameter:
15.947 - 15.957 mm (0.6278 - 0.6282 in)


SEM760A

3. Check valve lifter guide inner diameter.

Inner diameter:
16.000 - 16.013 mm (0.6299 - 0.6304 in)
Standard clearance between valve lifter and lifter guide:
0.043 - 0.066 mm (0.0017 - 0.0026 in)



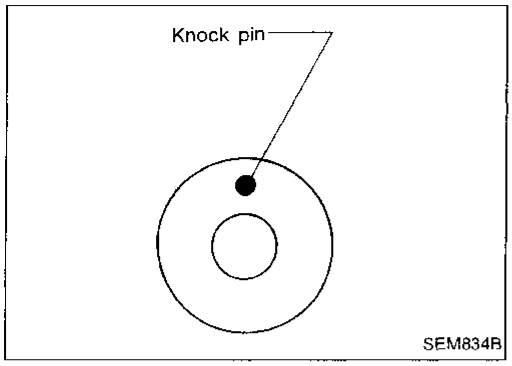
SEM638B

Assembly

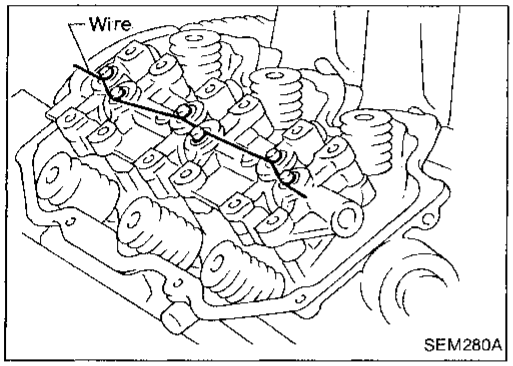
1. Install valve component parts.

- **Always use new valve oil seal. Refer to OIL SEAL REPLACEMENT (EM-17).**
- **Before installing valve oil seal, install inner valve spring seat.**
- **Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.**
- **After installing valve component parts, use plastic hammer to lightly tap valve stem tip to assure a proper fit.**

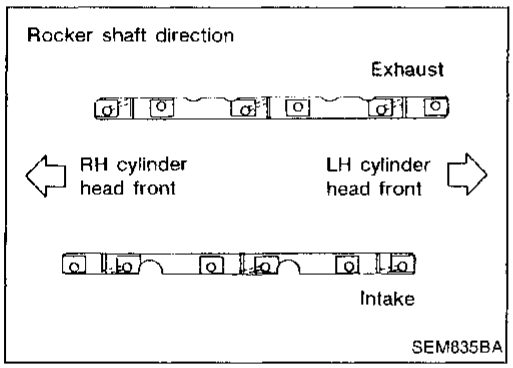
Assembly (Cont'd)



2. Install camshafts, locator plates and cylinder head rear covers.
- **Set knock pin of camshaft at the top.**



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

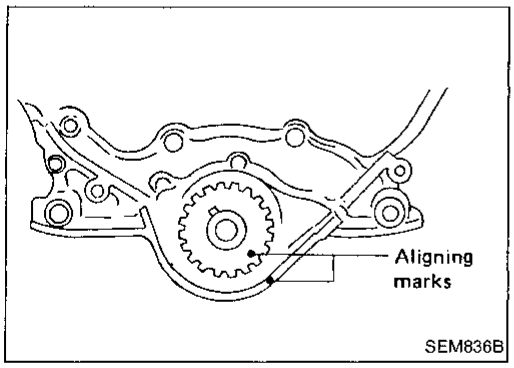


4. Install rocker shafts with rocker arms.
- **Tighten bolts gradually in two or three stages.**
- **Before tightening, be sure to set camshaft the lobe at the position where lobe is not lifted.**

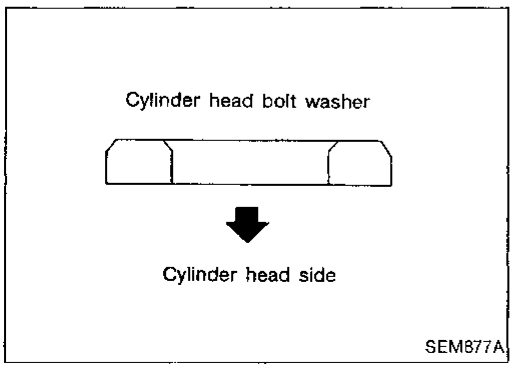
a. Set No. 1 piston at TDC on its compression stroke and tighten rocker shaft bolts for No. 2, 4 and 6 cylinders.
b. Set No. 4 piston at TDC on its compression stroke and tighten rocker shaft bolts for No. 1, 3 and 5 cylinders.

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

Installation

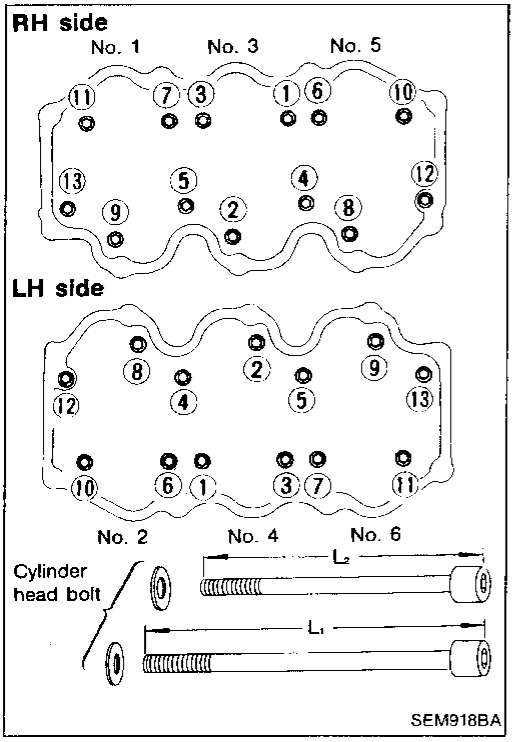


1. Set No. 1 piston at TDC on its compression stroke as follows:
a. Align crankshaft sprocket alignment mark with mark on oil pump body.
b. Confirm that knock pin on camshaft is set at the top.
2. Install drain plugs, one on each side of cylinder block.
- Apply sealant to drain plug threads.



3. Install cylinder head with new gasket.
- **Be sure to install washers between bolts and cylinder head.**
- **Do not rotate crankshaft and camshaft separately, or valves will hit piston heads.**

Installation (Cont'd)

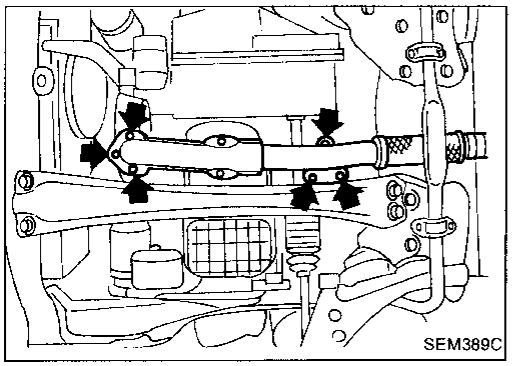


4. Tighten cylinder head bolts in numerical order using ST10120000 (J24239-01).

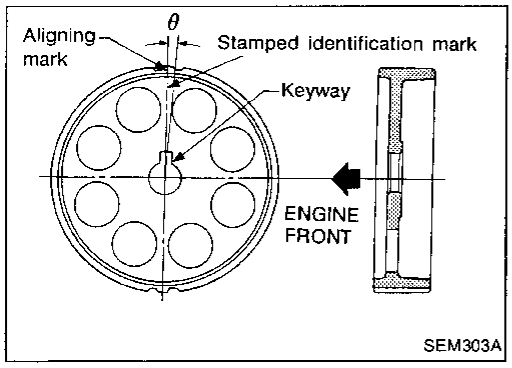
- **Tightening procedure:**

(1) Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
(2) Tighten all bolts to 59 N·m (6.0 kg-m, 43 ft-lb).
(3) Loosen all bolts completely.
(4) Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
(5) Turn all bolts 60 to 65 degrees clockwise.
If an angle wrench is not available, tighten all bolts to 54 to 64 N·m (5.5 to 6.5 kg-m, 40 to 47 ft-lb).

- **Bolts for ④, ⑤, ⑫ and ⑬ are longer than the others.**
  L_1: 127 mm (5.00 in) for ④, ⑤, ⑫ and ⑬
  L_2: 106 mm (4.17 in) for others



5. Install exhaust front tube to exhaust manifold.



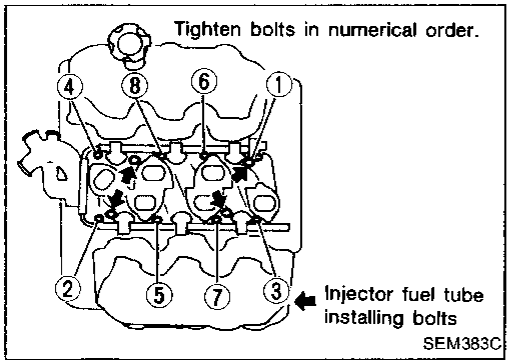
6. Install rear belt cover and camshaft sprocket.

- **RH camshaft sprocket and LH camshaft sprocket are different parts. Be sure to install them in the correct location.**

	Identification mark	θ
RH camshaft sprocket	R3	0°53′
LH camshaft sprocket	L3	−3°27′

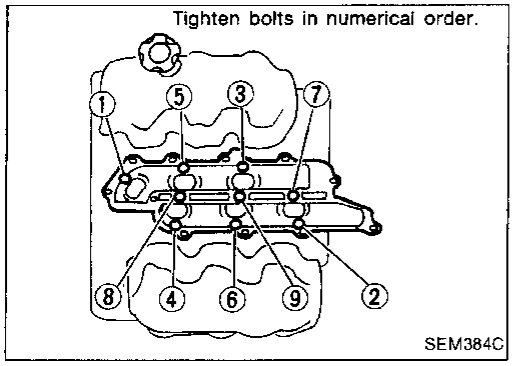
7. Install timing belt and adjust belt tension.

Refer to "TIMING BELT — Installation" (EM-14).

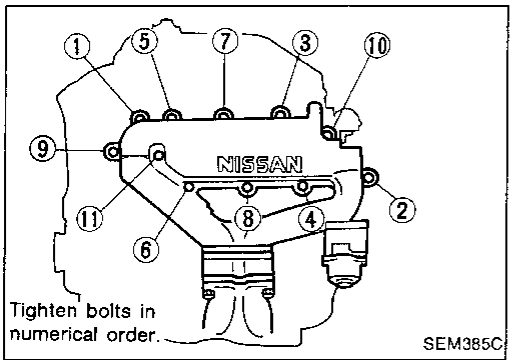


8. Install intake manifold.
- Install injector fuel tube assembly.
  Install all parts which were removed in step 8 under "CYLINDER HEAD — Removal". (See page EM-21.)

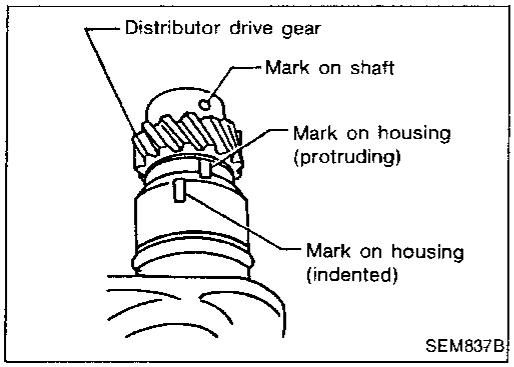
Installation (Cont'd)



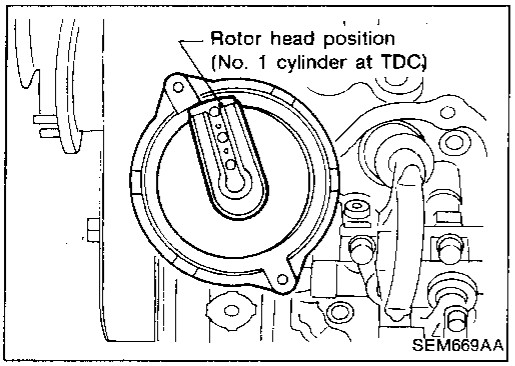
9. Install lower intake manifold collector.



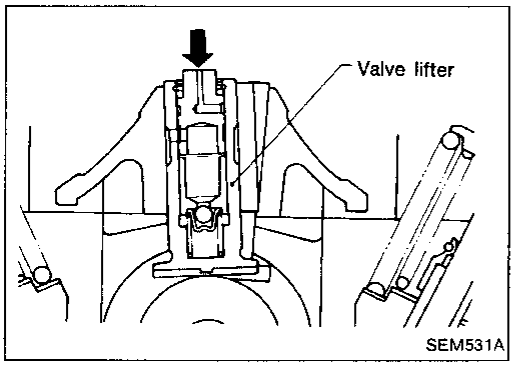
10. Install upper intake manifold collector.
Install all parts which were removed in step 6 under "CYLINDER HEAD — Removal". (See page EM-20.)



11. Install distributor.
(1) Align mark on shaft with protruding mark on housing.

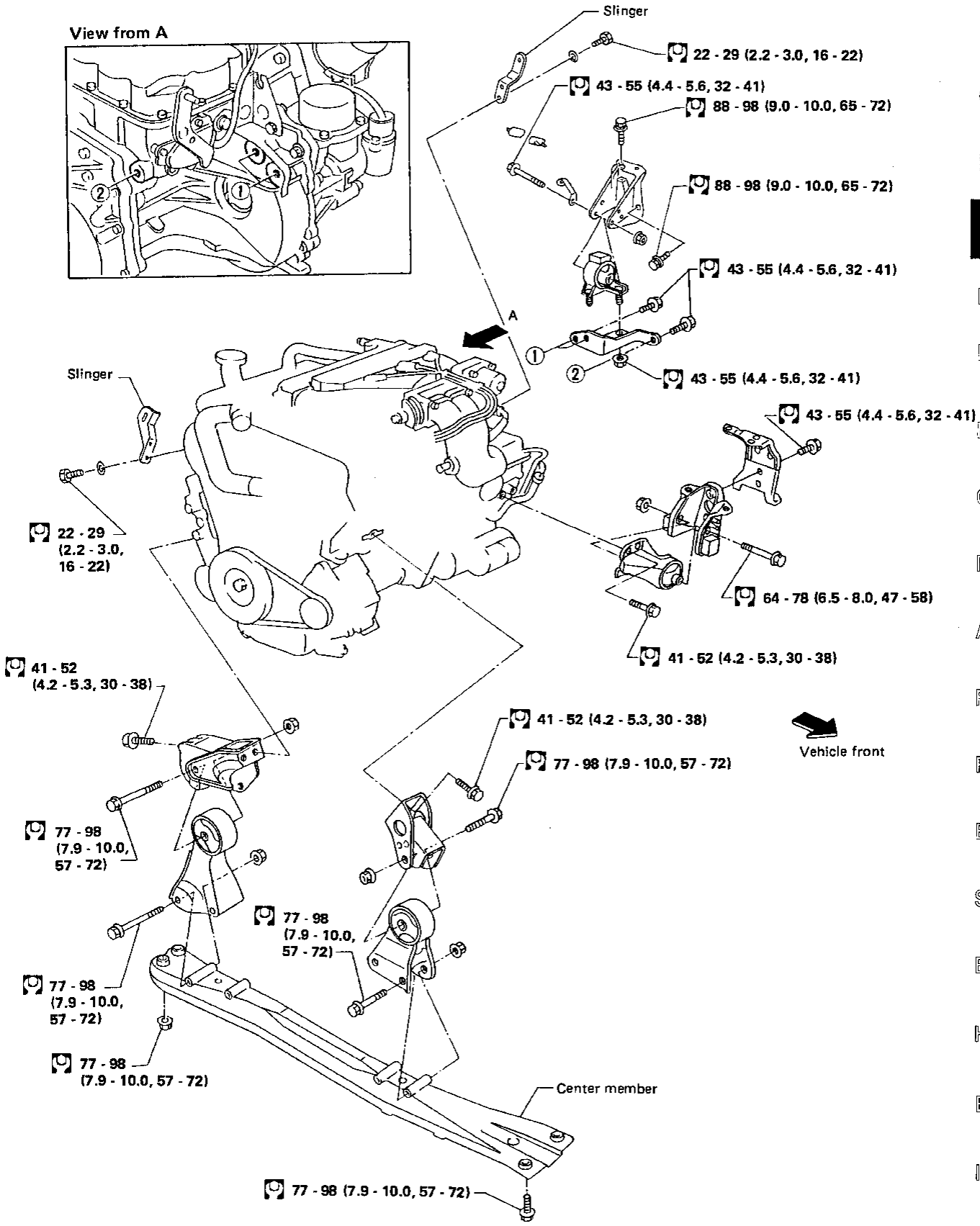


(2) After installing, confirm that distributor rotor head is set as shown in figure.
12. Install both rocker covers.
13. Install ASCD and accelerator control wire.



14. Check hydraulic valve lifter.
a. Push plunger forcefully with your finger.
- **Be sure to check it with rocker arm in its free position (not on the lobe).**

b. If valve lifter moves more than 1 mm (0.04 in), air may be inside.
c. Bleed air off by running engine at 1,000 rpm under no load for about 10 minutes.
d. If hydraulic valve lifters are still noisy, replace them and bleed air off again in the same manner as in step 14 (C).



: N·m (kg-m, ft-lb)

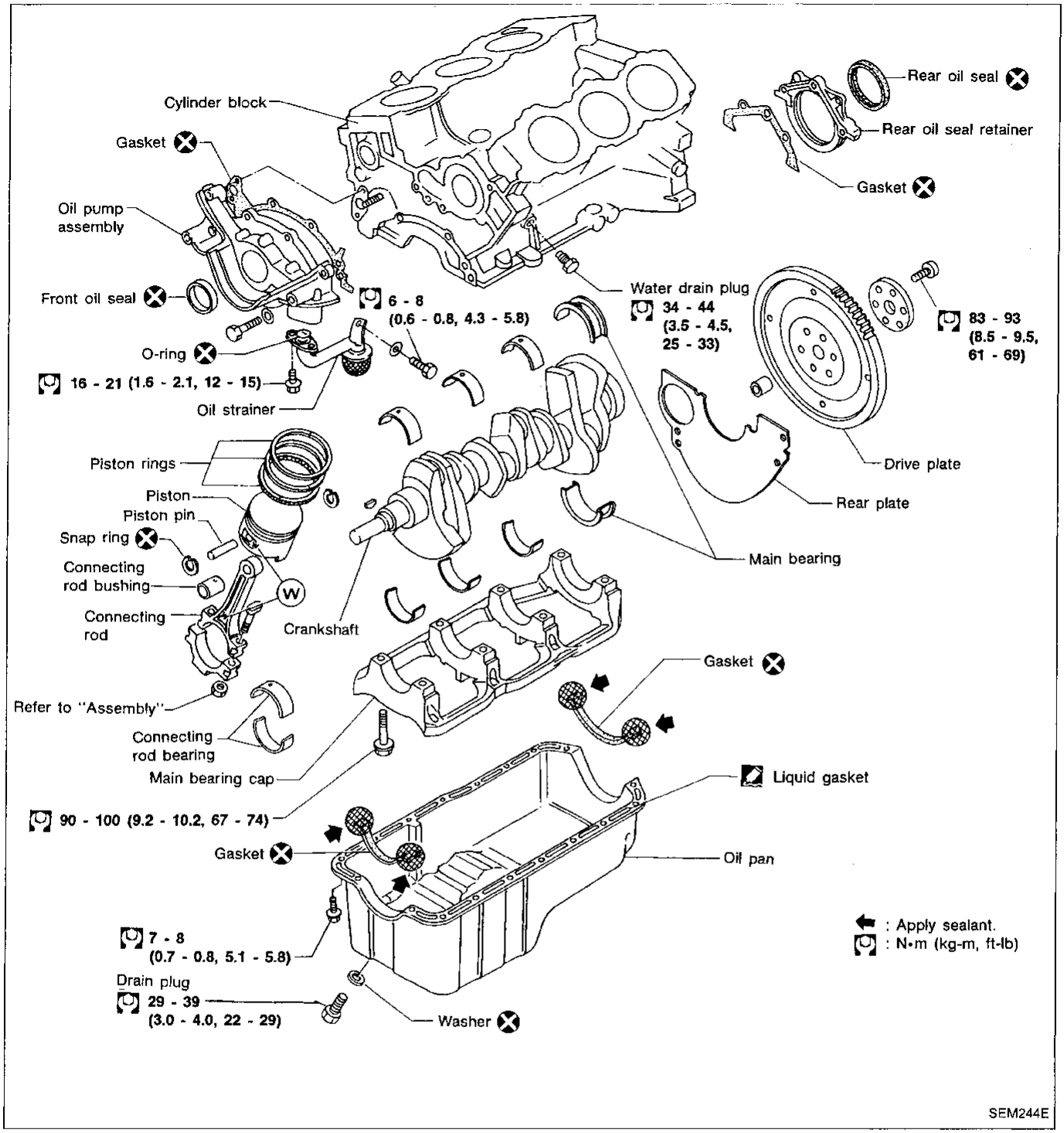
SEM901D

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 EF & EC section.
f. Before removing front axle from transaxle, place safety stands under designated front supporting points. Refer to GI section for lifting points and towing.
g. Be sure to hoist engine and transaxle in a safe manner.
h. For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.

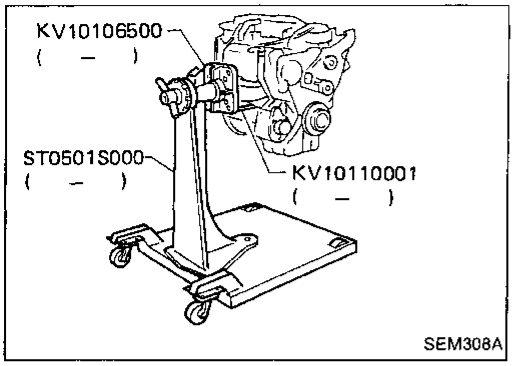
CAUTION:

- 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.
- In removing drive shaft, be careful not to damage grease seal of transaxle.



CAUTION:

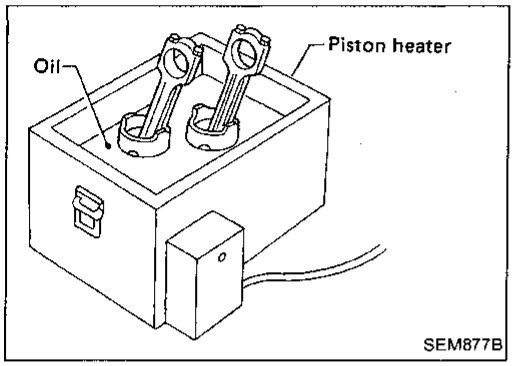
- **When installing sliding parts such as bearings and pistons, be sure to apply engine oil on the sliding surfaces.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When tightening connecting rod bolts and main bearing cap bolts, apply engine oil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



Disassembly

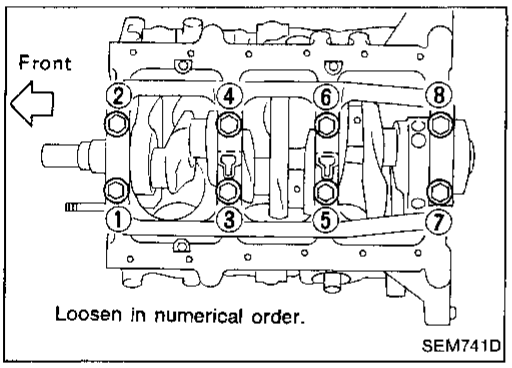
PISTON AND CRANKSHAFT

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



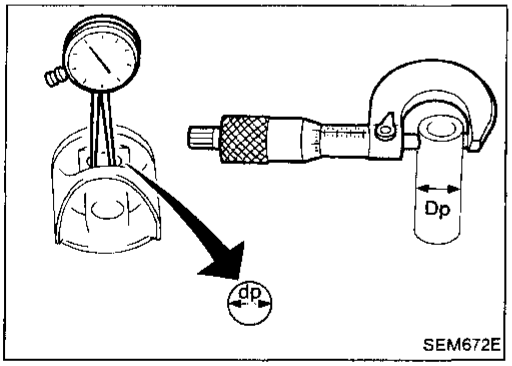
7. Remove pistons.

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



8. Remove bearing cap and crankshaft.

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



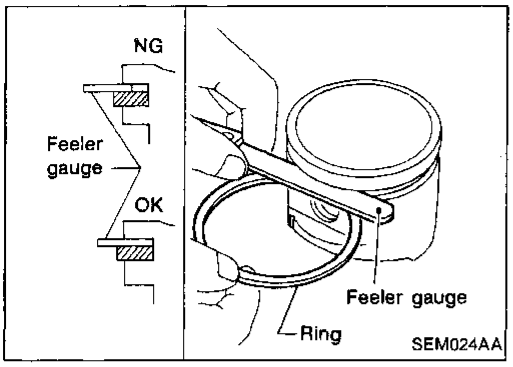
Inspection

PISTON AND PISTON PIN CLEARANCE

1. Measure inner diameter of piston pin hole "dp".
   Standard diameter "dp":
   20.969 - 20.981 mm (0.8255 - 0.8260 in)
2. Measure outer diameter of piston pin "Dp".
   Standard diameter "Dp":
   20.971 - 20.983 mm (0.8256 - 0.8261 in)
3. Calculate piston pin clearance.
   dp – Dp = 0 to –0.004 mm (0 to –0.0002 in)

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

Inspection (Cont'd)

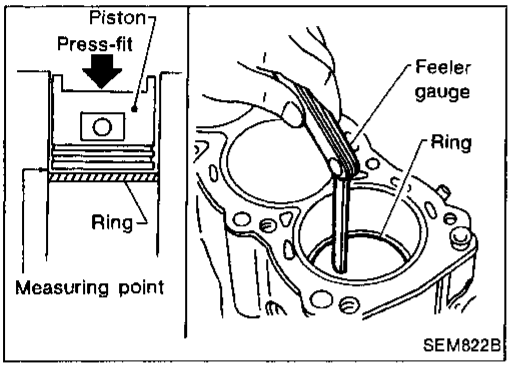


PISTON RING SIDE CLEARANCE

Side clearance:

Top ring 0.040 - 0.073 mm (0.0016 - 0.0029 in)
2nd ring 0.030 - 0.063 mm (0.0012 - 0.0025 in)
Max. limit of side clearance: 0.1 mm (0.004 in)

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



PISTON RING END GAP

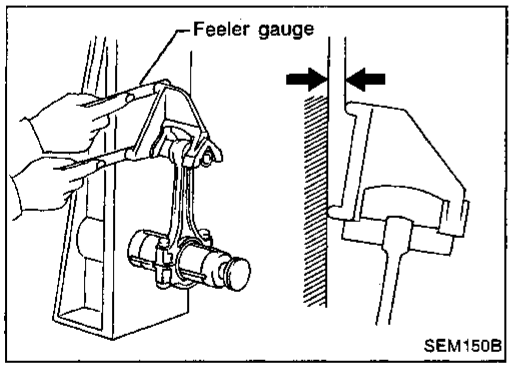
End gap:

Top ring 0.21 - 0.44 mm (0.0083 - 0.0173 in)
2nd ring 0.18 - 0.44 mm (0.0071 - 0.0173 in)
Oil ring 0.20 - 0.76 mm (0.0079 - 0.0299 in)
Max. limit of ring gap: 1.0 mm (0.039 in)

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

Refer to SDS.

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



CONNECTING ROD BEND AND TORSION

Bend:

Limit 0.1 mm (0.004 in)
per 100 mm (3.94 in) length

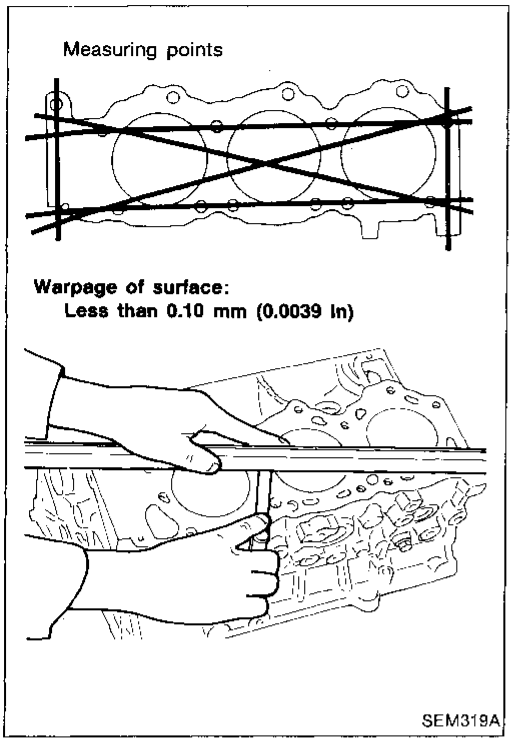
Torsion:

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

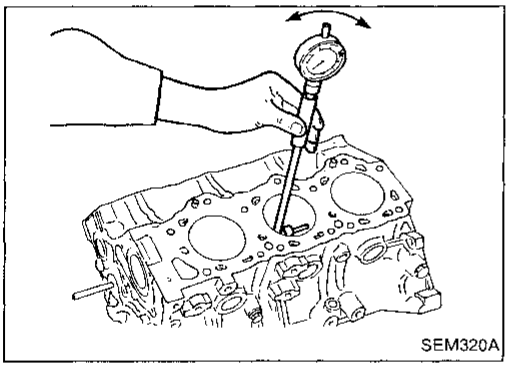


1. Clean upper face of cylinder block and measure the distortion.
   Limit:
   0.10 mm (0.0039 in)
2. If out of specification, resurface it.
   The resurfacing limit is determined by cylinder head resurfacing in engine.

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:
227.60 - 227.70 mm (8.9606 - 8.9645 in)

3. If necessary, replace cylinder block.

PISTON-TO-BORE CLEARANCE

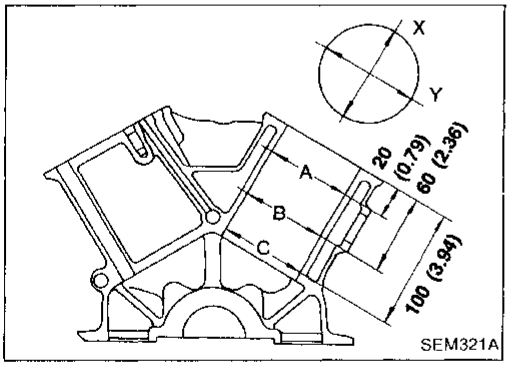


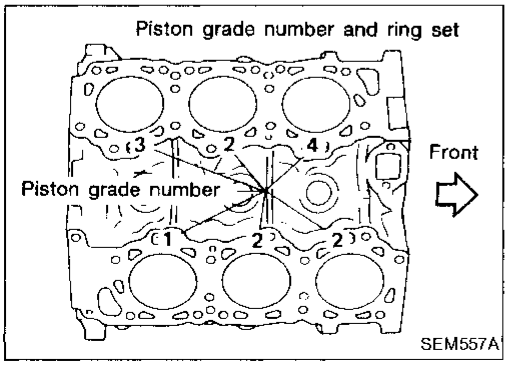
1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.
   Standard inner diameter:
   87.000 - 87.030 mm (3.4252 - 3.4264 in)
   Wear limit:
   0.20 mm (0.0079 in)

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

Out-of-round (X – Y) standard:
0.015 mm (0.0006 in)
Taper (A – B) standard:
0.015 mm (0.0006 in)

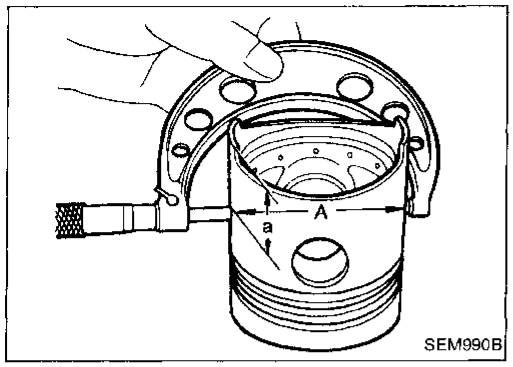
2. Check for scratches and seizure. If seizure is found, hone it.





- **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 SDS.
   Measuring point "a" (Distance from the bottom):
   18 mm (0.71 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.

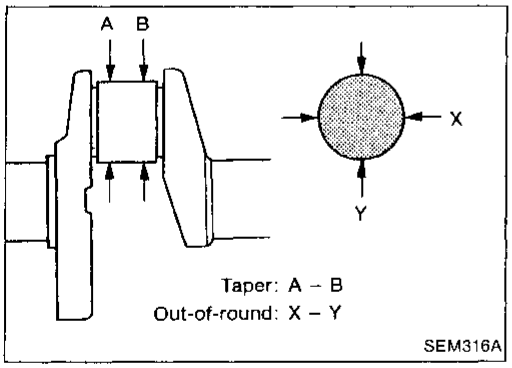
Oversize pistons are available for service. Refer to SDS (EM-94).

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.**

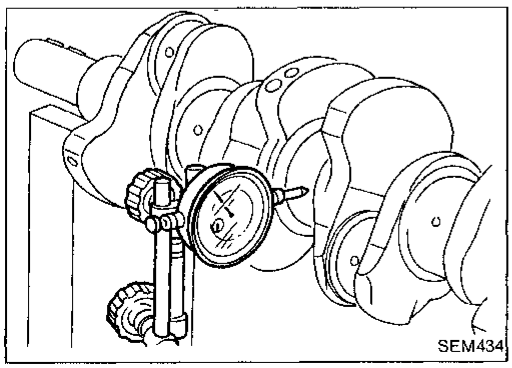
9. Hone cylinders to obtain specified piston-to-bore clearance.
10. Measure finished cylinder bore for out-of-round and taper.

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



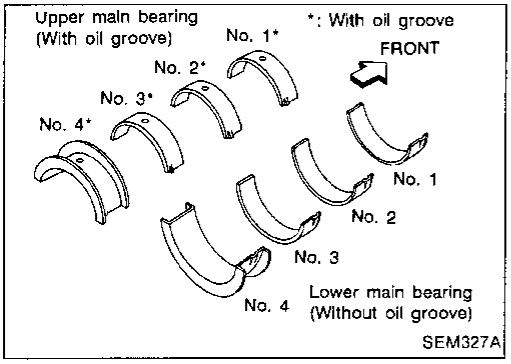
CRANKSHAFT

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 0.10 mm (0.0039 in)

Inspection (Cont'd)



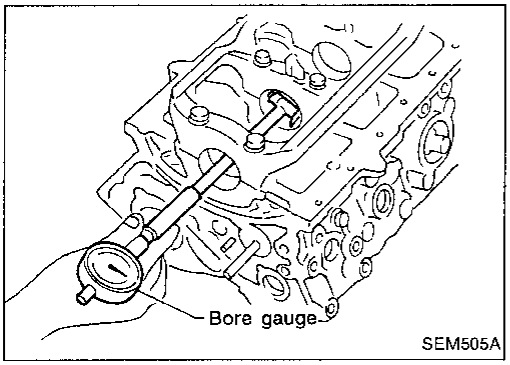
BEARING CLEARANCE

- 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

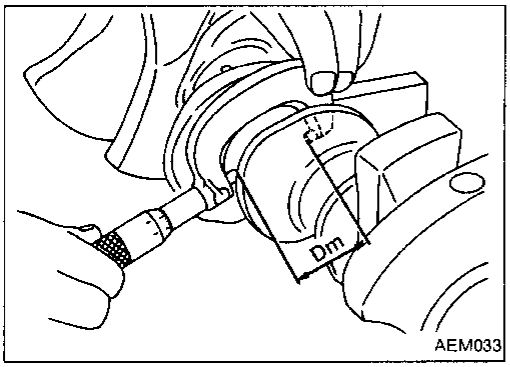
1. Set main bearings in their proper positions on cylinder block and main bearing cap.



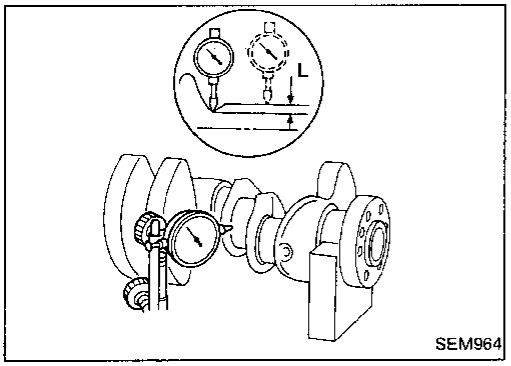
2. Install main bearing cap to cylinder block.

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

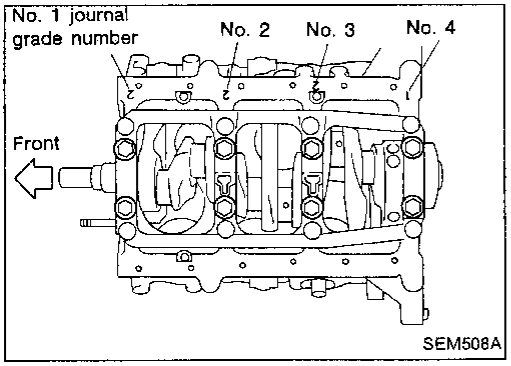
3. Measure inner diameter "A" of each main bearing.



4. Measure outer diameter "Dm" of each crankshaft main journal.
5. Calculate main bearing clearance.
   Main bearing clearance (A – Dm):
   Standard 0.028 - 0.055 mm (0.0011 - 0.0022 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.

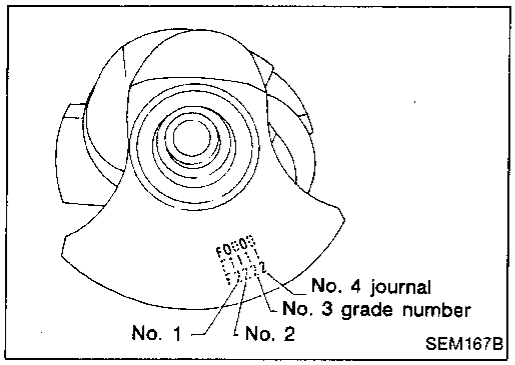


a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.
   "L": 0.1 mm (0.004 in)
b. Refer to SDS for grinding crankshaft and available service parts.



8. If crankshaft is reused, measure main bearing 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.

Inspection (Cont'd)



b. Grade number of each crankshaft main journal is punched on the respective crankshaft.
c. Select main bearing with suitable thickness according to the following calculation or table.
   Example of calculation:
   Main journal grade number: 1
   Crankshaft journal grade number: 2
   Main bearing grade number = 1 + 2 = 3 (Yellow)

Main bearing grade number (Identification color):

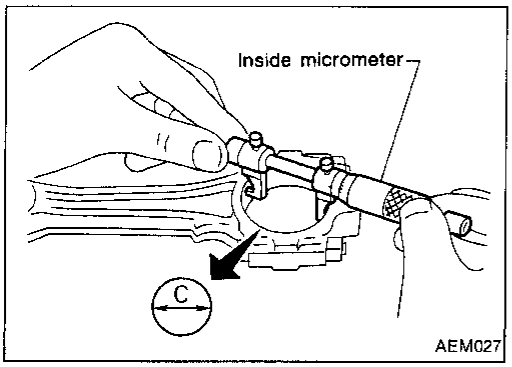
		Main journal grade number		
		"0"	"1"	"2"
Crankshaft journal grade number	"0"	0 (Black)	1 (Brown)	2 (Green)
	"1"	1 (Brown)	2 (Green)	3 (Yellow)
	"2"	2 (Green)	3 (Yellow)	4 (Blue)

Connecting rod bearing (Big end)

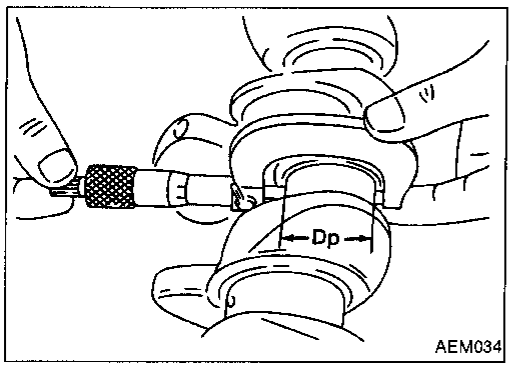
1. Install connecting rod bearing to connecting rod and cap.
2. Install connecting rod cap to connecting rod.

Tighten bolts to the specified torque.

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



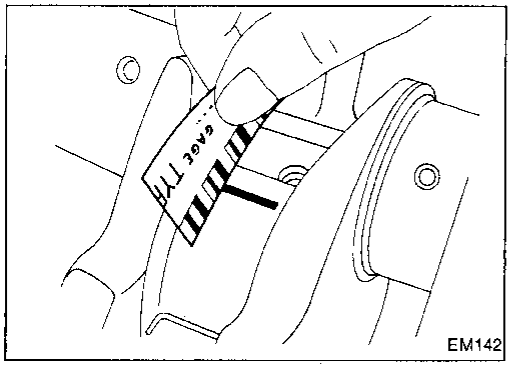
4. Measure outer diameter "Dp" of each crankshaft pin.
5. Calculate connecting rod bearing clearance.
   Connecting rod bearing clearance (C – Dp):
   Standard 0.014 - 0.054 mm (0.0006 - 0.0021 in)
   Limit 0.090 mm (0.0035 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.
   Refer to step 7 of "BEARING CLEARANCE — Main bearing". (See page EM-40.)



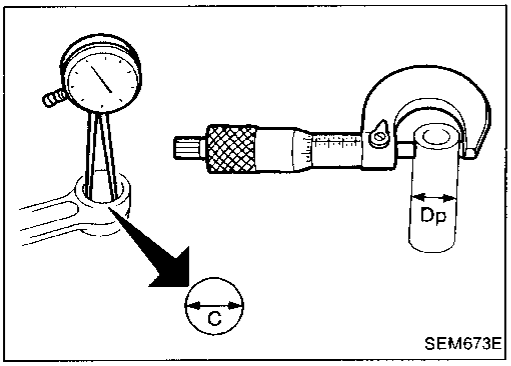
Method B (Using plastigage)

CAUTION:

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



Inspection (Cont'd)

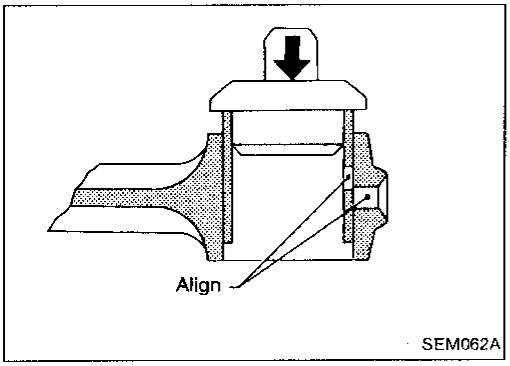


CONNECTING ROD BUSHING CLEARANCE (Small end)

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

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.



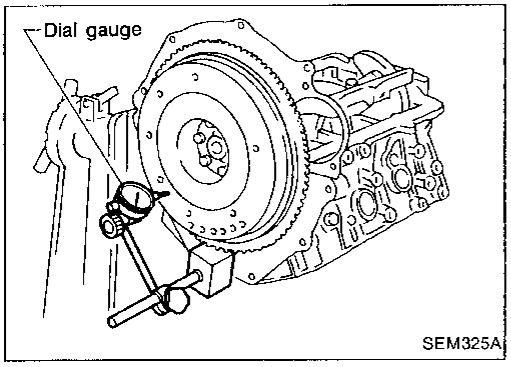
REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

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

Be sure to align the oil holes.

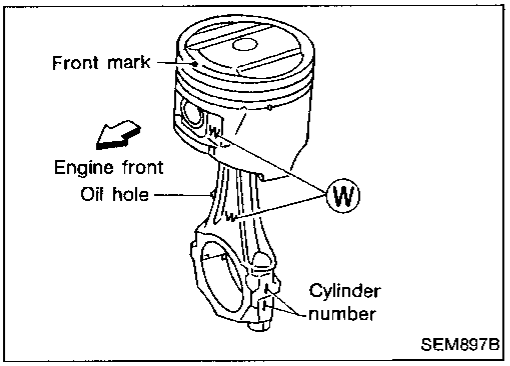
2. After driving in small end bushing, ream the bushing so that clearance between connecting rod bushing and piston pin is the specified value.

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



DRIVE PLATE RUNOUT

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

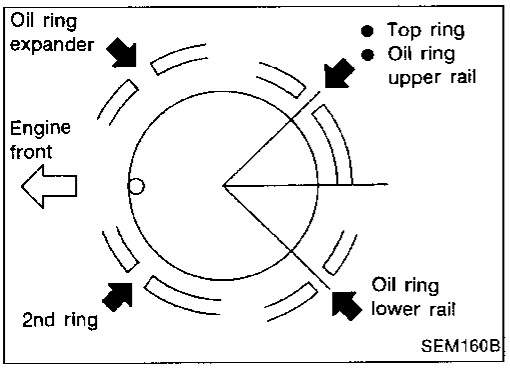


Assembly

PISTON

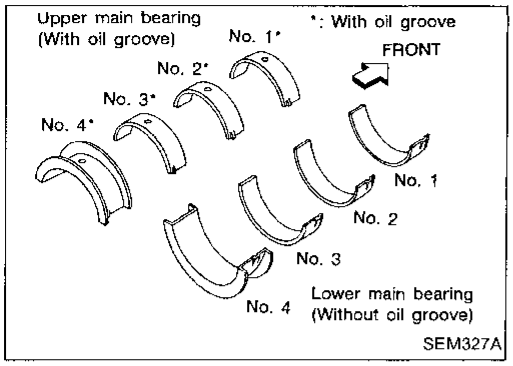
1. Install new snap ring on one side of piston pin hole.
2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.

- **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.**



3. Set piston rings as shown.

Assembly (Cont'd)

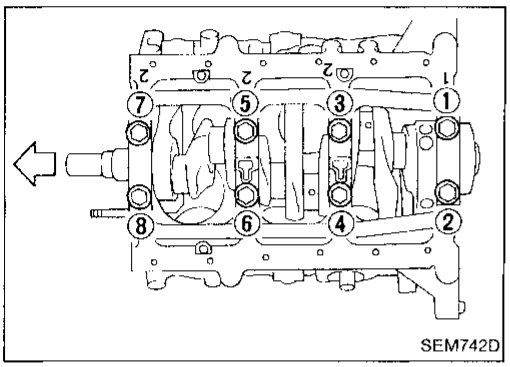


CRANKSHAFT

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

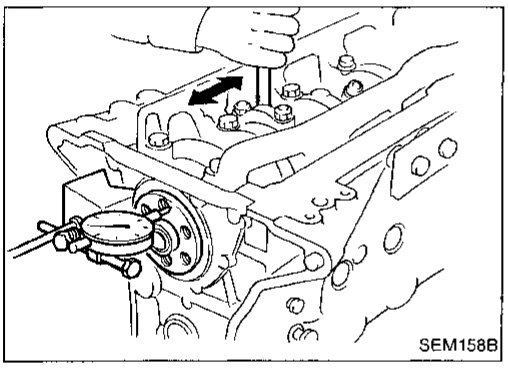
- **Confirm that correct main bearings are used.**

Refer to "Inspection".



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

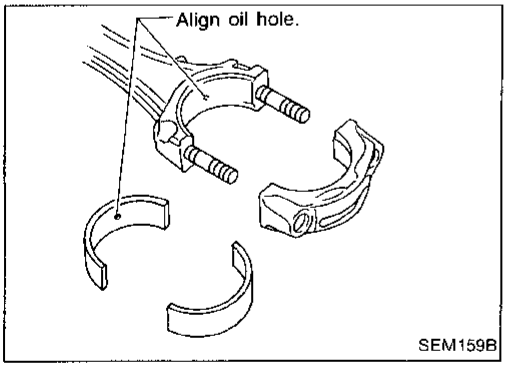
- **Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting crankshaft in the axial direction.**
- **Tighten bearing cap bolts gradually in two or three stages. Start with center bearing and move outward sequentially.**
- **After securing bearing cap bolts, make sure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



3. Measure crankshaft end play.

Crankshaft end play:
Standard
0.050 - 0.170 mm (0.0020 - 0.0067 in)
Limit
0.30 mm (0.0118 in)

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

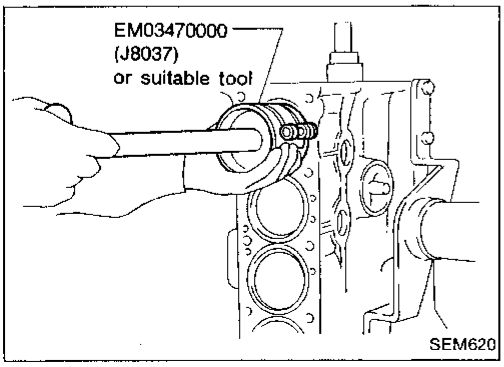


4. Install connecting rod bearings in connecting rods and connecting rod caps.

- **Confirm that correct bearings are used.**

Refer to "Inspection".

- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.

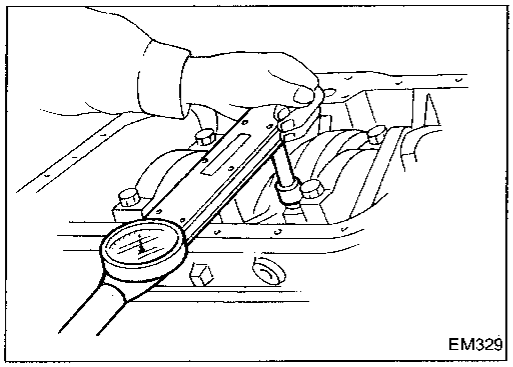


5. Install pistons with connecting rods.

a. Install them into corresponding cylinders with Tool.

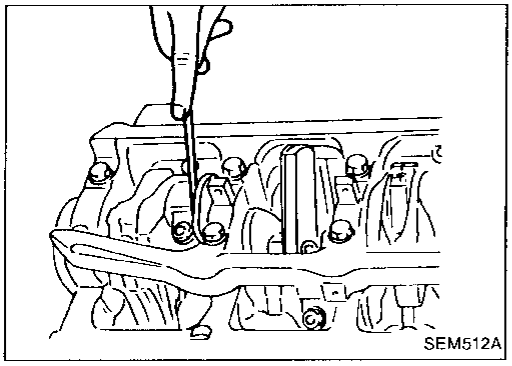
- **Be careful not to scratch cylinder wall by connecting rod.**
- **Arrange so that front mark on piston head faces toward front of engine.**

Assembly (Cont'd)


EM329

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

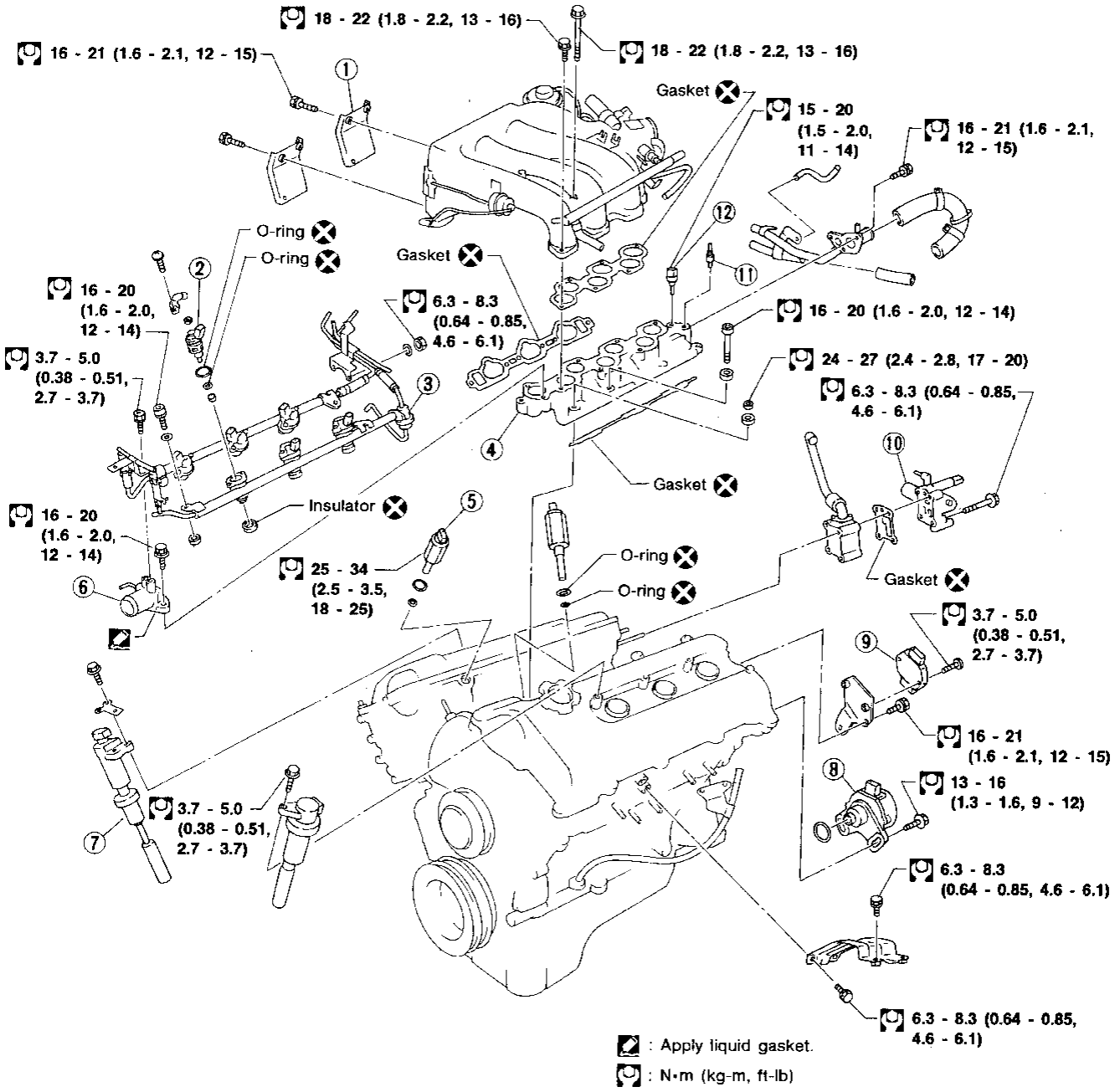
: Connecting rod bearing nut
(1) Tighten to 14 to 16 N·m (1.4 to 1.6 kg-m, 10 to 12 ft-lb).
(2) Turn nuts 60 to 65 degrees clockwise.
If an angle wrench is not available, tighten nuts to 38 to 44 N·m (3.9 to 4.5 kg-m, 28 to 33 ft-lb).


SEM512A

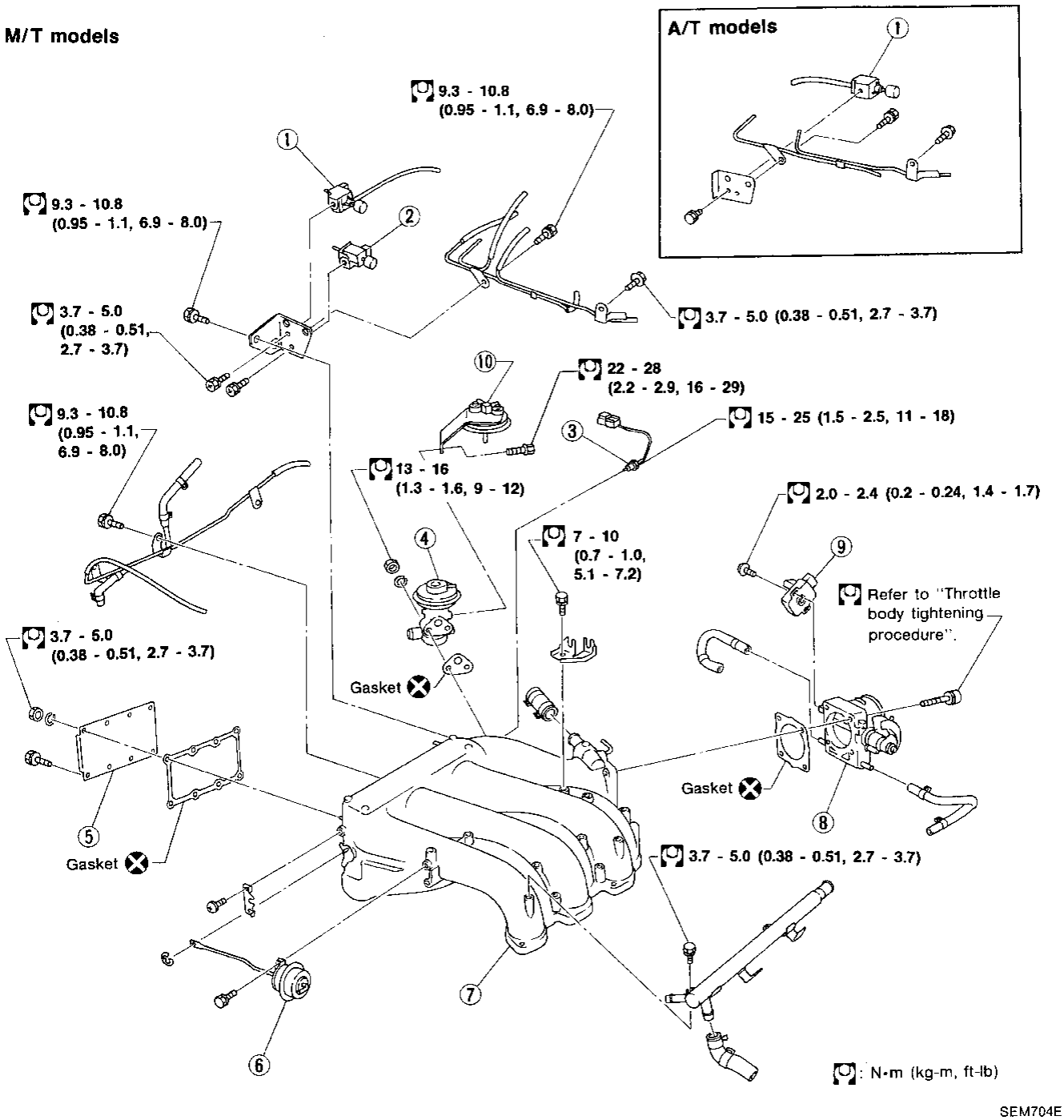
6. Measure connecting rod side clearance.

Connecting rod side clearance:
Standard
0.20 - 0.35 mm (0.0079 - 0.0138 in)
Limit
0.40 mm (0.0157 in)

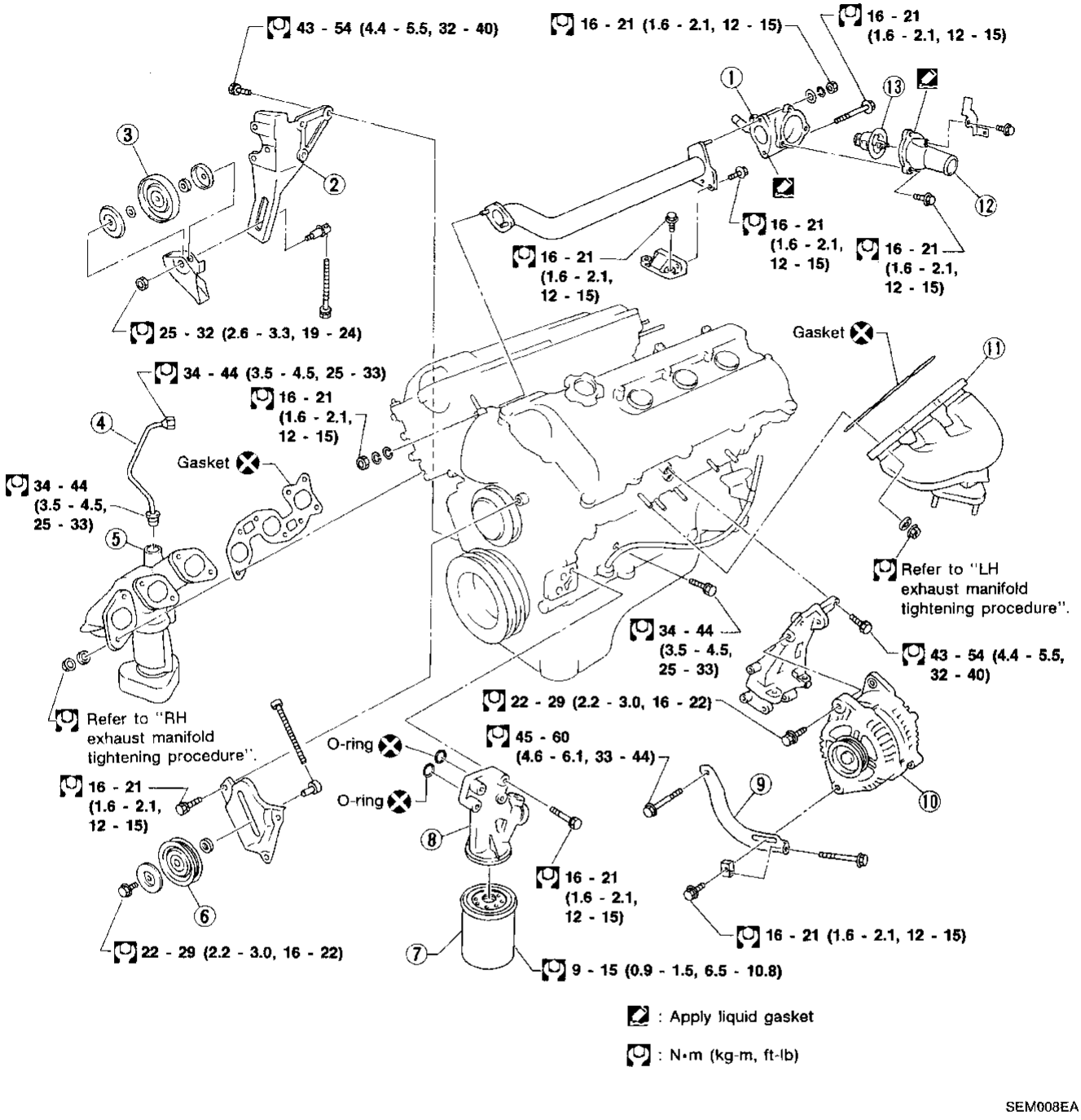
If beyond the limit, replace connecting rod and/or crankshaft.



① Intake manifold collector support
② Injector
③ Pressure regulator
④ Intake manifold
⑤ VTC solenoid valve
⑥ Water outlet
⑦ Ignition coil
⑧ Camshaft position sensor
⑨ Power transistor unit
⑩ IAA unit
⑪ Thermal transmitter
⑫ Engine coolant temperature sensor



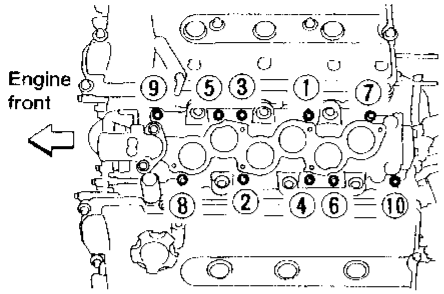
① EGRC-solenoid valve
② Power valve control solenoid valve (M/T only)
③ EGR temperature sensor
④ EGR valve
⑤ Intake manifold collector cover (M/T only)
⑥ Power valve actuator (M/T only)
⑦ Intake manifold collector
⑧ Throttle body
⑨ Throttle position sensor
⑩ EGRC-BPT valve



SEM008EA

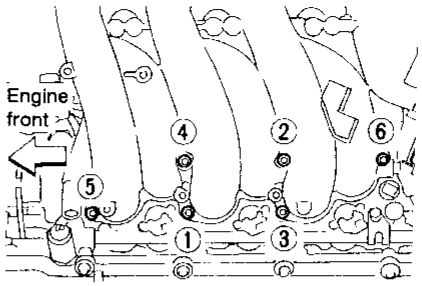
① Thermostat housing
② Power steering oil pump bracket
③ Idler pulley
④ EGR tube
⑤ RH exhaust manifold
⑥ Idler pulley
⑦ Oil filter
⑧ Oil filter bracket
⑨ Alternator adjusting bar
⑩ Alternator
⑪ LH exhaust manifold
⑫ Water inlet
⑬ Thermostat

Intake manifold tightening procedure



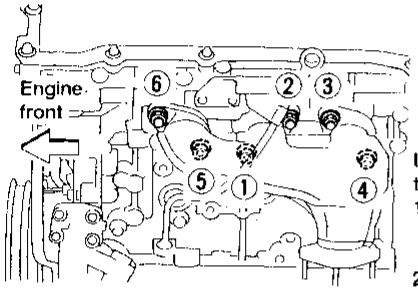
Tighten in numerical order.

Intake manifold collector tightening procedure



Tighten in numerical order.

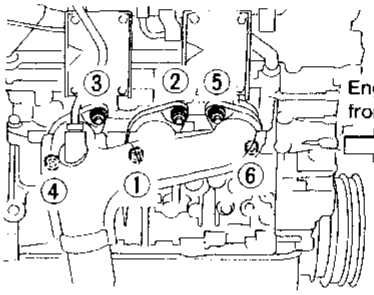
LH exhaust manifold tightening procedure



Tighten in numerical order.

LH exhaust manifold tightening procedure
1) Tighten all bolts to 18 to 22 N•m (1.8 to 2.2 kg-m, 13 to 16 ft-lb).
2) Tighten all bolts to 24 to 27 N•m (2.4 to 2.8 kg-m, 17 to 20 ft-lb).

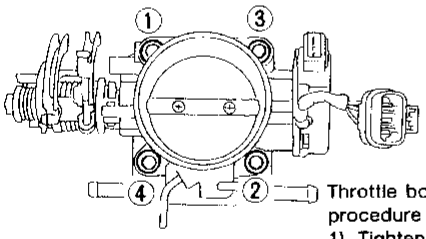
RH exhaust manifold tightening procedure



Tighten in numerical order.

RH exhaust manifold tightening procedure
1) Tighten all bolts to 18 to 22 N•m (1.8 to 2.2 kg-m, 13 to 16 ft-lb).
2) Tighten all bolts to 24 to 27 N•m (2.4 to 2.8 kg-m, 17 to 20 ft-lb).

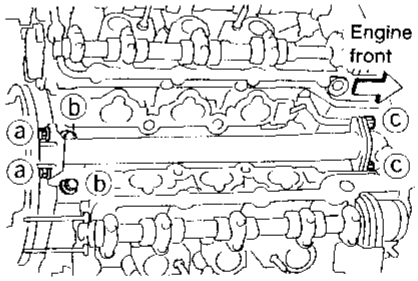
Throttle body tightening procedure



Tighten in numerical order.

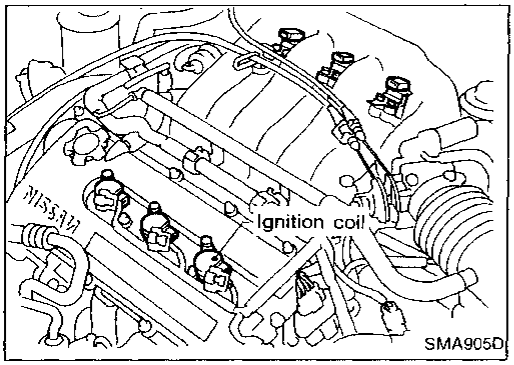
Throttle body bolts tightening procedure
1) Tighten all bolts to 9 to 11 N•m (0.9 to 1.1 kg-m, 6.5 to 8.0 ft-lb).
2) Tighten all bolts to 18 to 22 N•m (1.8 - 2.2 kg-m, 13 to 16 ft-lb).

Water pipe tightening procedure



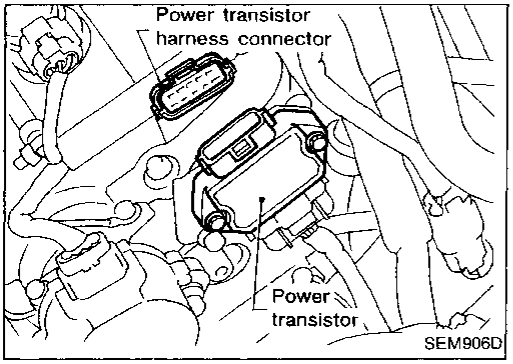
Water pipe bolts tightening procedure
1) Tighten ⓐ and ⓑ bolts to finger tight
2) Tighten ⓒ bolts to 16 to 21 N•m (1.6 to 2.1 kg-m, 12 to 15 ft-lb).
3) Tighten ⓐ bolts to 3 to 9 N•m (0.3 to 0.9 kg-m, 2.2 to 6.5 ft-lb).
4) Tighten ⓑ bolts to 16 to 21 N•m (1.6 to 2.1 kg-m, 12 to 15 ft-lb).
5) Tighten ⓐ bolts to 16 to 21 N•m (1.6 to 2.1 kg-m, 12 to 15 ft-lb).

SEM477EA

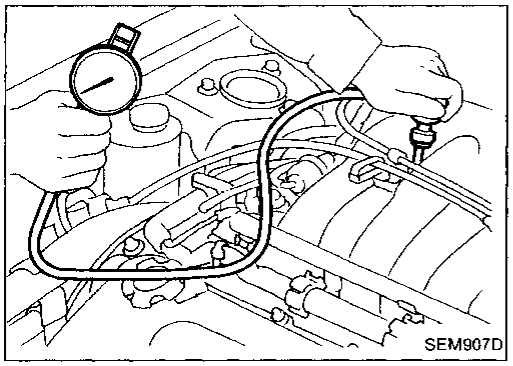


Measurement of Compression Pressure

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



5. Disconnect power transistor harness connector.

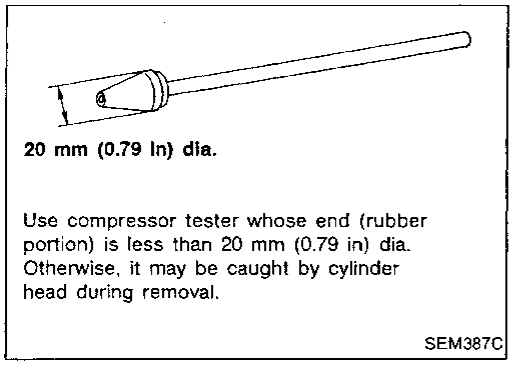


6. Attach a compression tester to No. 1 cylinder.
7. Depress accelerator pedal fully to keep throttle valve wide open.
8. Crank engine and record highest gauge indication.
9. Repeat the measurement on each cylinder as shown above.

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

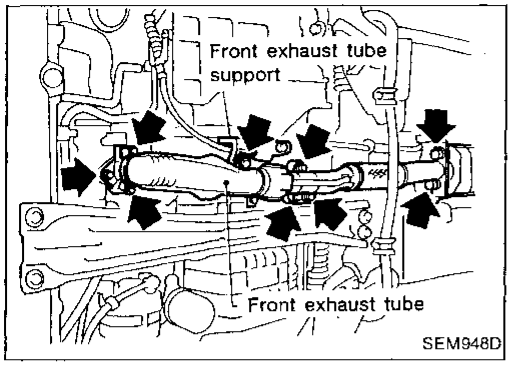
Compression pressure: kPa (kg/cm^2, psi)/rpm

Standard	**1,265 (12.9, 183)/300**
Minimum	**981 (10.0, 142)/300**
Difference limit between cylinders:	**98 (1.0, 14)/300**



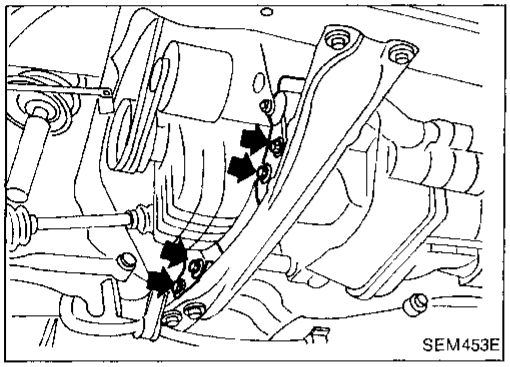
10. If cylinder compression in one or more cylinders is low, pour a small amount of engine oil into cylinders through spark plug holes and retest compression.

- **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 SDS.) 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.**

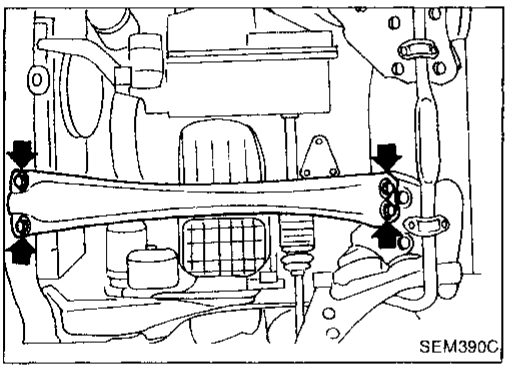


Removal

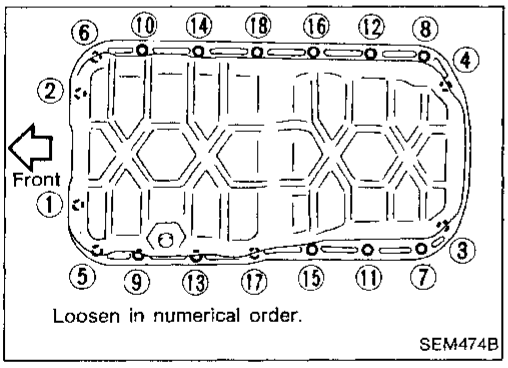
1. Drain engine oil.
2. Remove engine lower covers.
3. Remove front exhaust tube and its support.



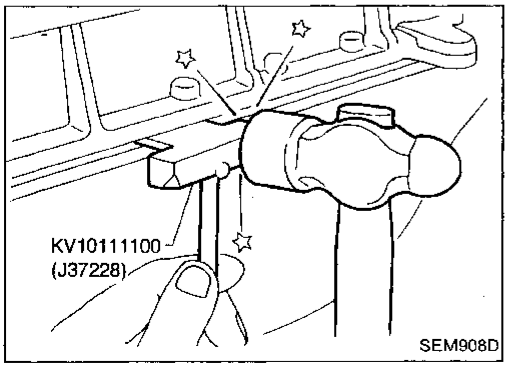
4. Support engine at right side engine slinger with a suitable hoist.
5. Remove engine mounting insulator bolts and nuts.



6. Remove center member assembly.



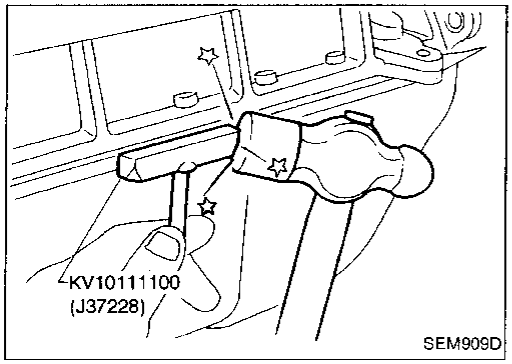
7. Remove oil pan bolts.



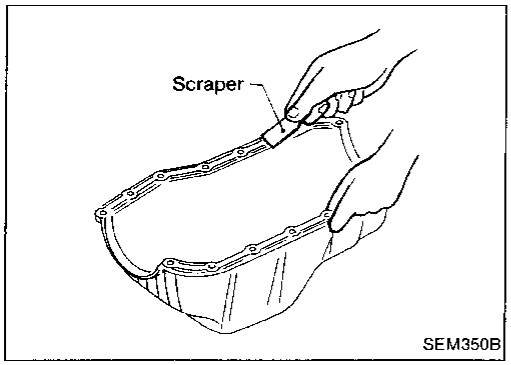
8. Remove oil pan.
(1) Insert Tool between cylinder block and oil pan.

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

Removal (Cont'd)

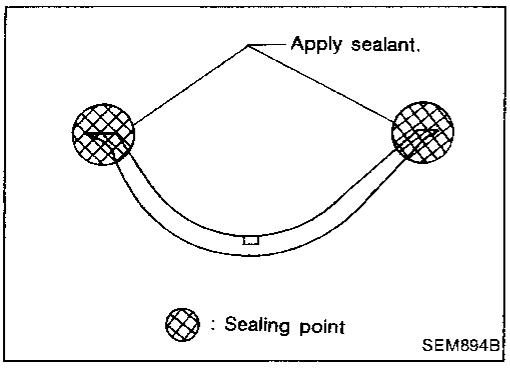


(2) Slide Tool by tapping its side with a hammer, and remove oil pan.

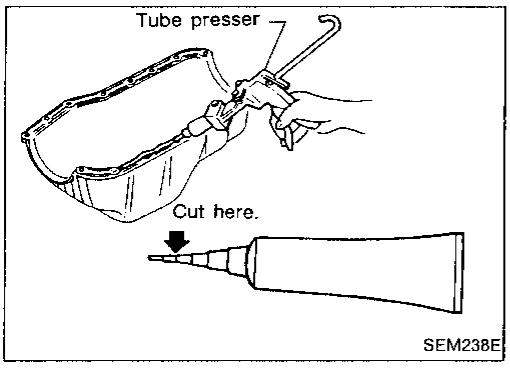


Installation

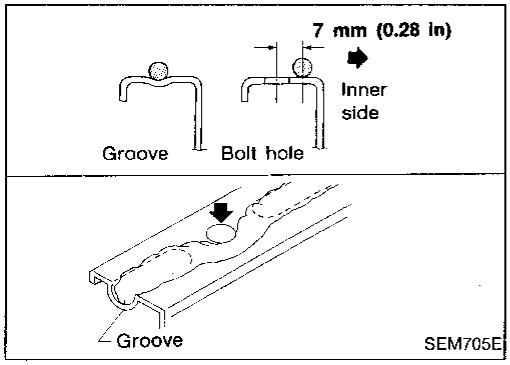
1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
- Also remove traces of liquid gasket from mating surface of cylinder block and front cover.



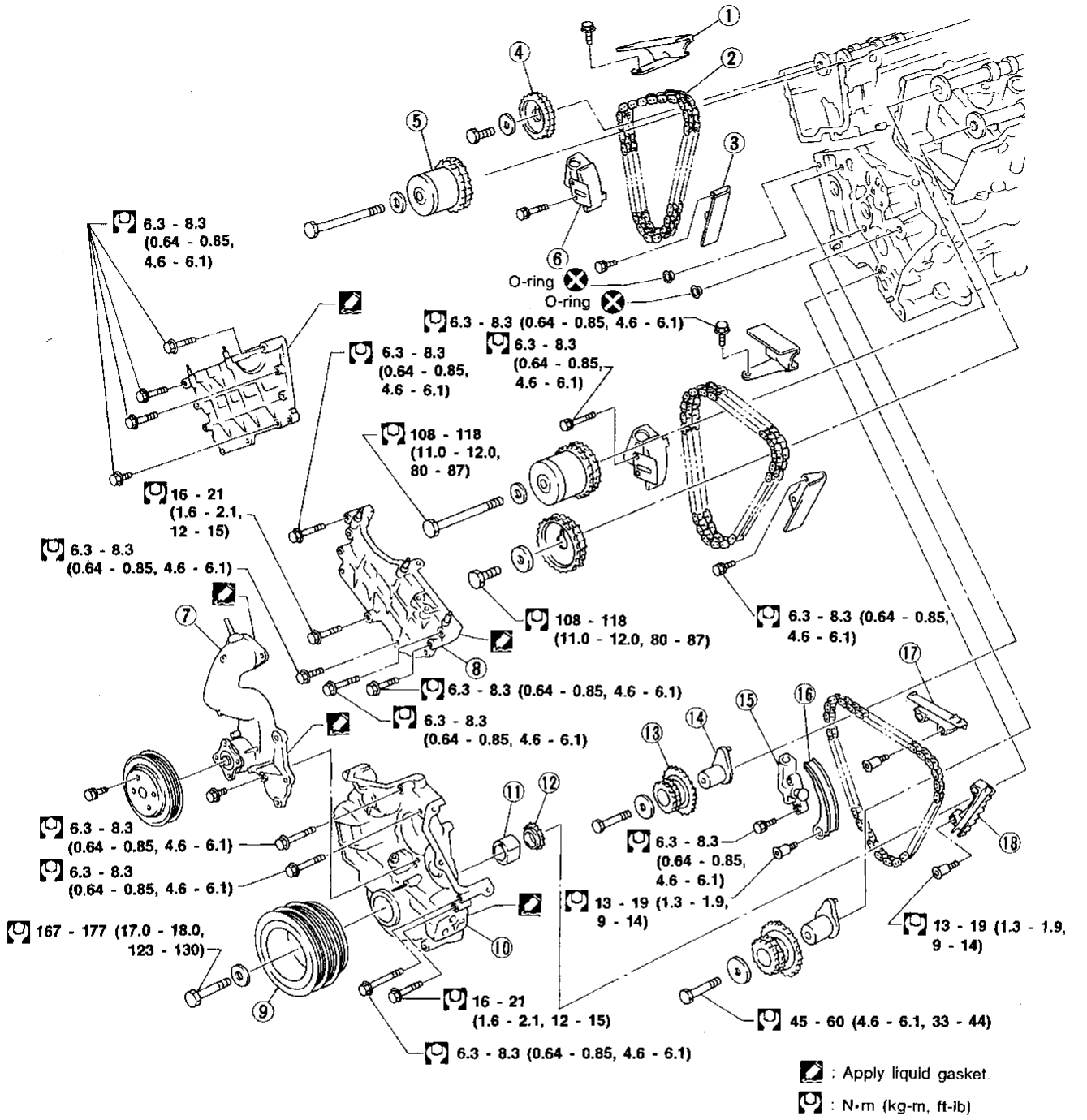
2. Apply sealant to front cover gasket and rear oil seal retainer gasket.



3. Apply a continuous bead of liquid gasket to mating surface of oil pan.
- **Use Genuine Liquid Gasket or equivalent.**
- **Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.**



4. Apply liquid gasket to inner sealing surface as shown in figure.
- **Attaching should be done within 5 minutes after coating.**
5. Install oil pan.
- **Install bolts/nuts in their reverse order of removal.**
- **Wait at least 30 minutes before refilling engine oil.**

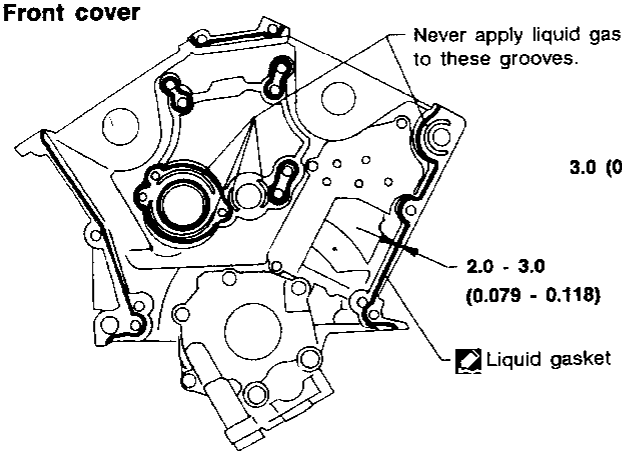


① Chain guide
② Upper timing chain
③ Chain guide (Tension side)
④ Camshaft sprocket
⑤ VTC assembly
⑥ Chain tensioner
⑦ Water pump
⑧ Upper front cover
⑨ Crank pulley
⑩ Front cover
⑪ Oil pump spacer
⑫ Crankshaft sprocket
⑬ Idler sprocket
⑭ Idler shaft
⑮ Chain tensioner
⑯ Chain guide (Slack side)
⑰ Chain guide
⑱ Chain guide (Tension side)

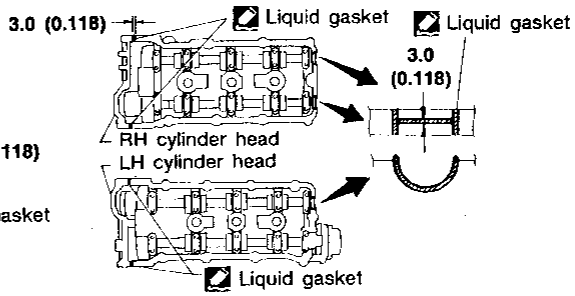
POSITION FOR APPLYING LIQUID GASKET

Refer to "Installation" in "OIL PAN" for installing oil pan.

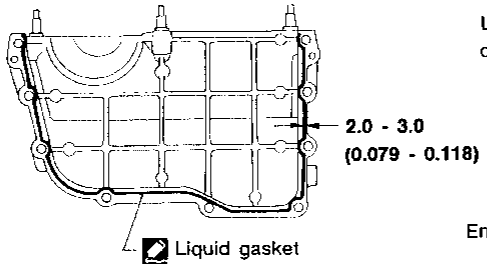
Front cover



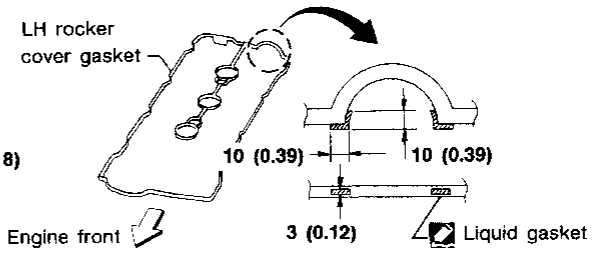
Cylinder head



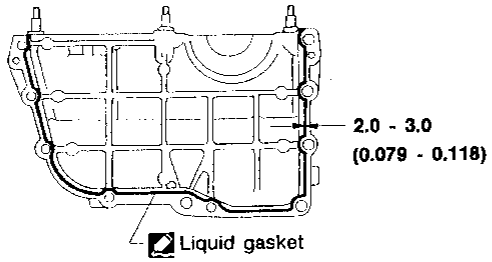
RH upper front cover



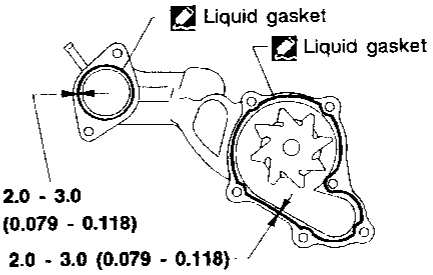
LH rocker cover gasket



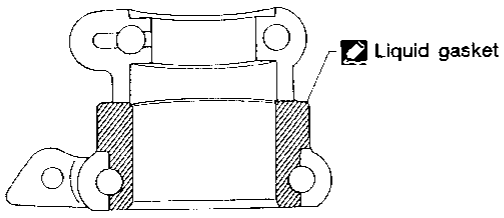
LH upper front cover



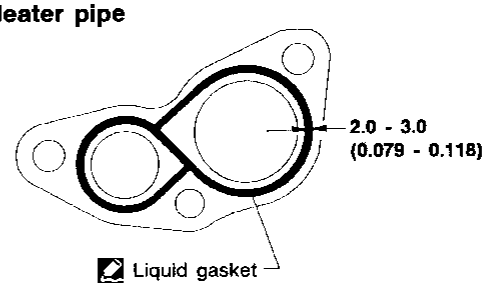
Water pump



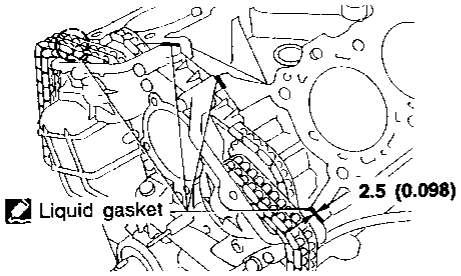
LH exhaust camshaft end bracket



Heater pipe



Cylinder block



Unit: mm (in)

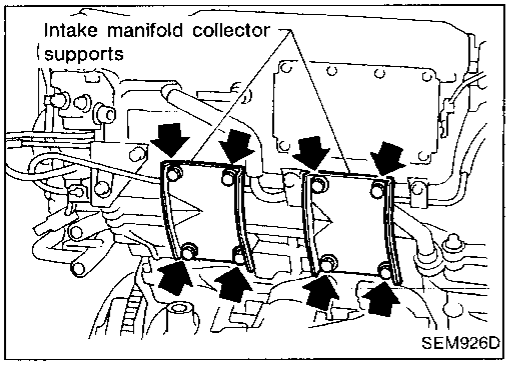
SEM917DA

CAUTION:

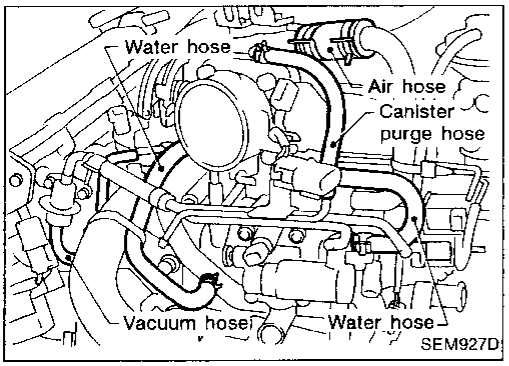
- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing sliding parts such as rocker arms, camshafts, chain tensioner and oil seal, be sure to apply new engine oil on their sliding surfaces.**
- **When tightening cylinder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

Removal

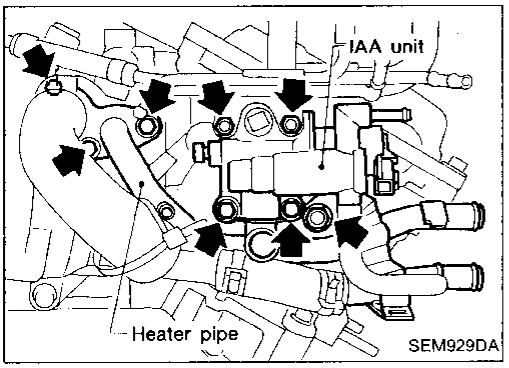
1. Release fuel pressure.
   Refer to "Releasing Fuel Pressure" in EF & EC section.
2. Remove engine under covers.
3. Remove front RH wheel and engine side cover.
4. Drain coolant by removing cylinder block drain plugs and radiator drain cock.
5. Remove radiator.
6. Remove air duct to intake manifold, blow-by pipe, vacuum hoses, fuel hoses, wires, harness, connectors and so on.
7. Remove EGR tube.
8. Remove RH ignition coils.



9. Remove intake manifold collector supports.

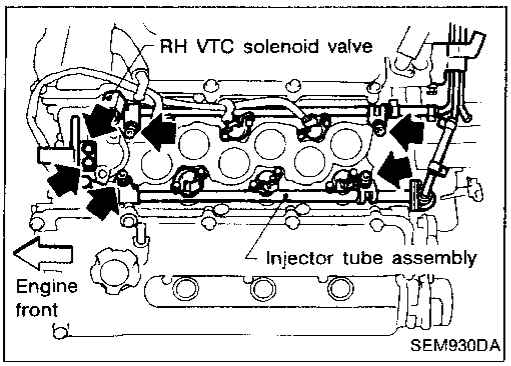


10. Remove the following hoses:
    - Vacuum hose for pressure regulator
    - Water hoses for throttle body
    - Air hose for IACV-AAC valve
    - Canister purge hose
    - Blow-by hose
11. Remove intake manifold collector in reverse order of installation. Refer to "Intake manifold collector tightening procedure" in "OUTER COMPONENT PARTS" (EM-45).
12. Remove LH ignition coils.
13. Remove all spark plugs.

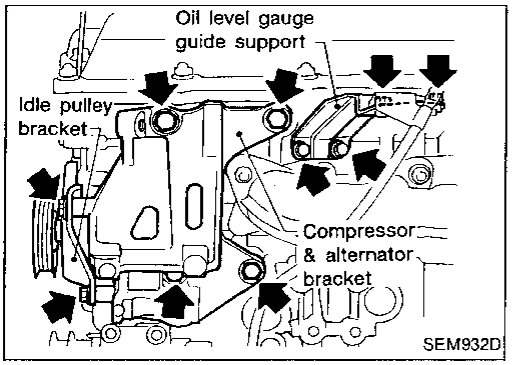


14. Remove IAA unit and heater pipe.

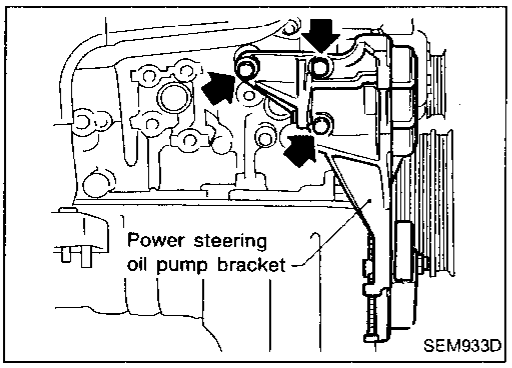
Removal (Cont'd)



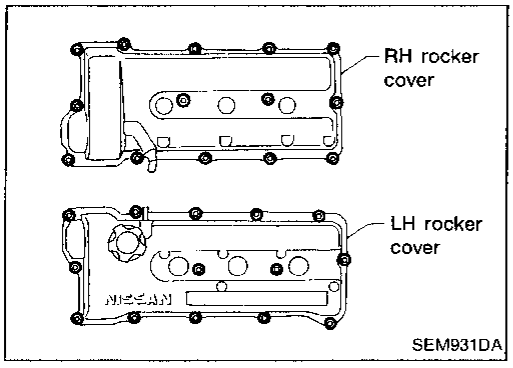
15. Remove injector tube assembly.
16. Remove RH VTC solenoid valve.
17. Remove intake manifold in reverse order of installation. Refer to "Intake manifold tightening procedure" in "OUTER COMPONENT PARTS" (EM-45).
18. Remove drive belts.



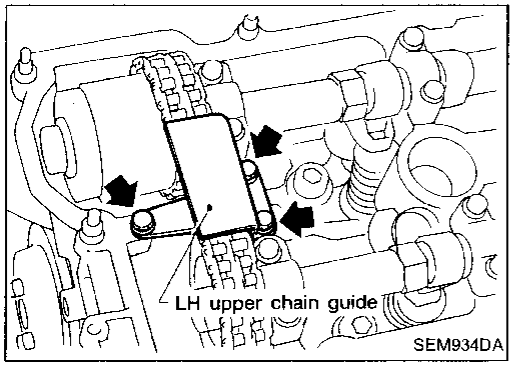
19. Remove compressor and alternator.
20. Remove compressor & alternator bracket.
21. Remove idler pulley bracket.
22. Remove oil level gauge guide support.
23. Remove LH exhaust manifold in reverse order of installation. Refer to "LH exhaust manifold tightening procedure" in "OUTER COMPONENT PARTS" (EM-45).



24. Remove power steering oil pump and its bracket.
25. Remove RH exhaust manifold in reverse order of installation. Refer to "RH exhaust manifold tightening procedure" in "OUTER COMPONENT PARTS" (EM-45).

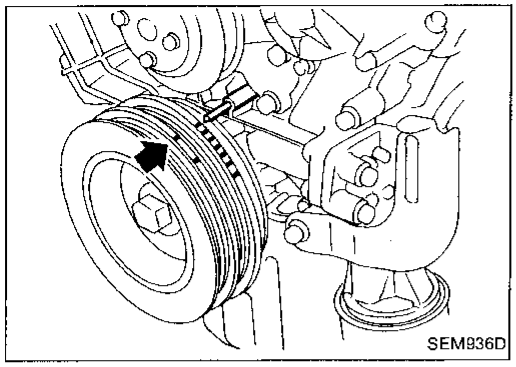


26. Remove RH and LH rocker covers.

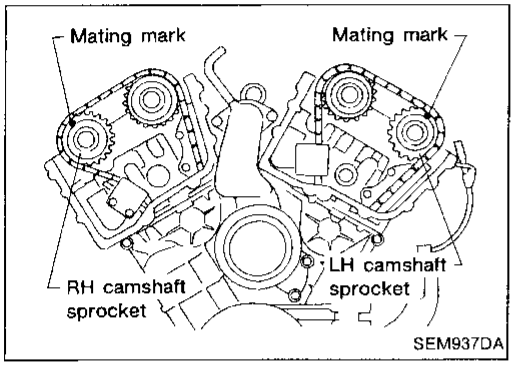


27. Remove RH and LH upper chain guides.
28. Remove RH and LH upper front covers.

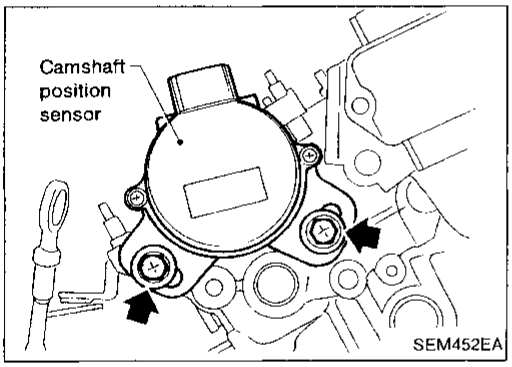
Removal (Cont'd)



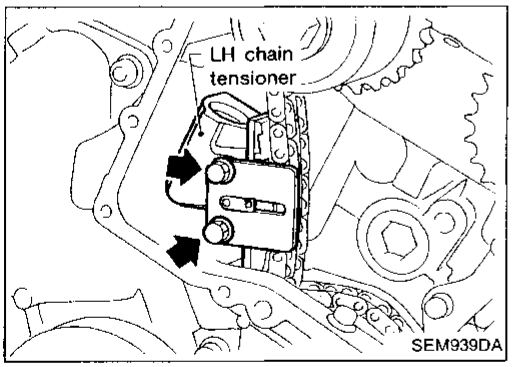
29. Set No. 1 piston at TDC on the compression stroke by rotating crankshaft.



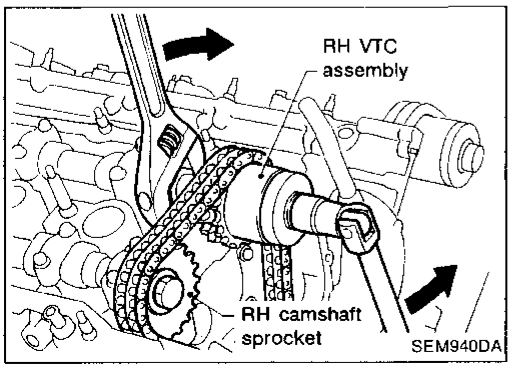
- **Rotate crankshaft until mating marks on camshaft sprockets are set at position indicated in figure at left.**



30. Remove camshaft position sensor.

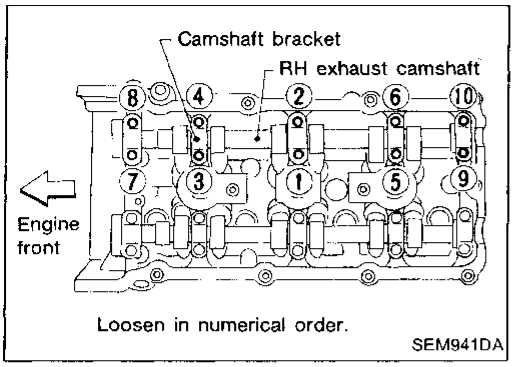


31. Remove RH and LH chain tensioners.

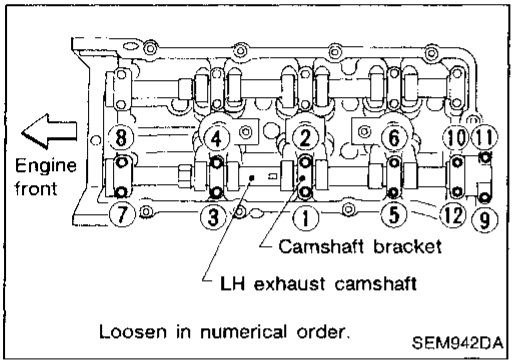


32. Remove camshaft sprockets and VTC assemblies.

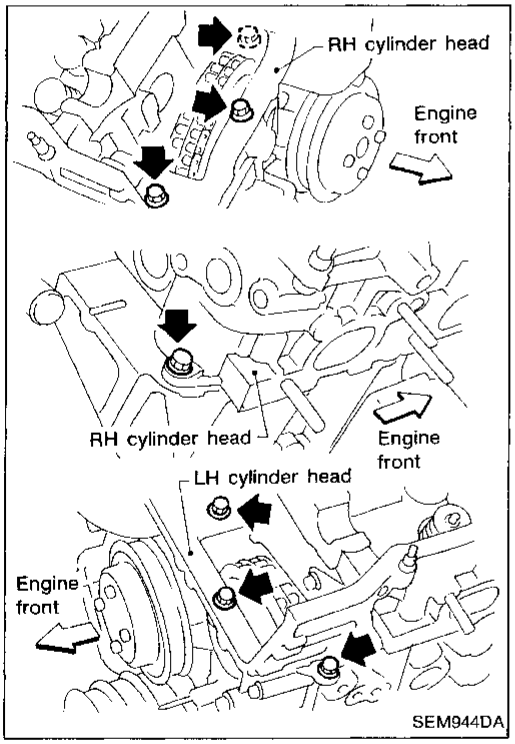
Removal (Cont'd)



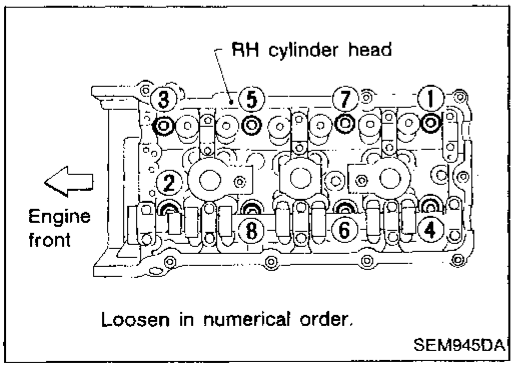
33. Remove RH exhaust camshaft, camshaft brackets and rocker arms.



34. Remove LH exhaust camshaft, camshaft brackets and rocker arms.



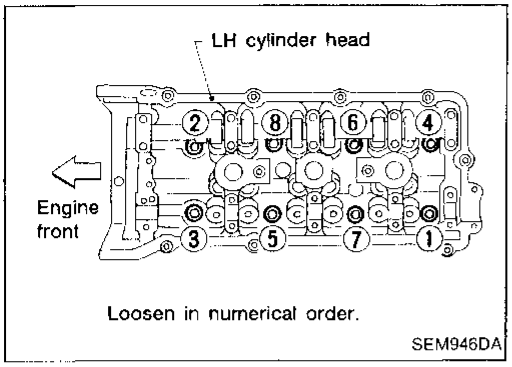
35. Remove cylinder head outside bolts.

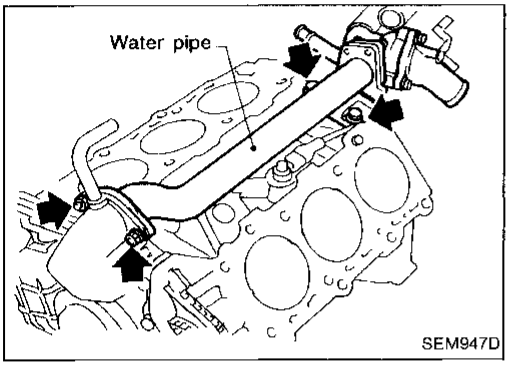


36. Remove cylinder heads.

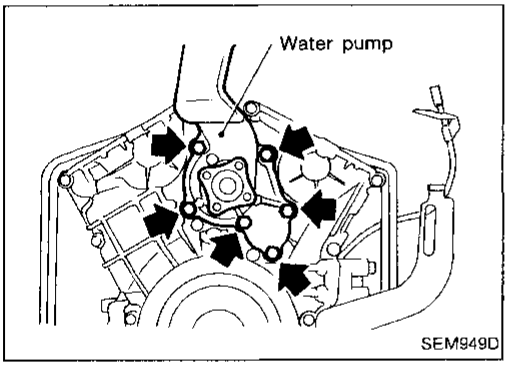
- **Cylinder head bolts should be loosened in two or three steps.**
- **A warped or cracked cylinder head could result from removing in incorrect order.**

Removal (Cont'd)

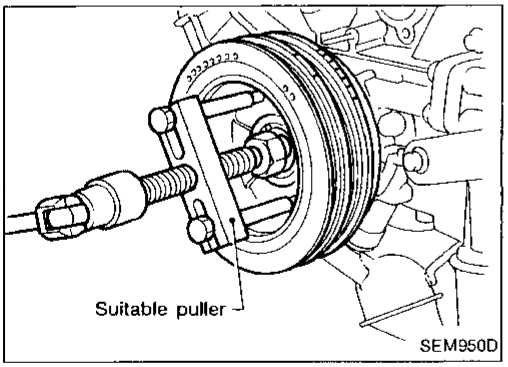




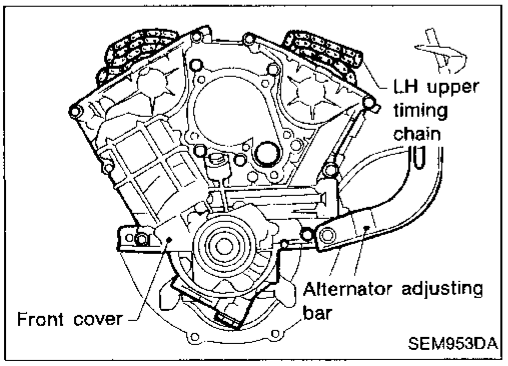
37. Remove water pipe.



38. Remove water pump pulley and water pump.
39. Remove oil pan. Refer to "Removal" in "OIL PAN" (EM-50).

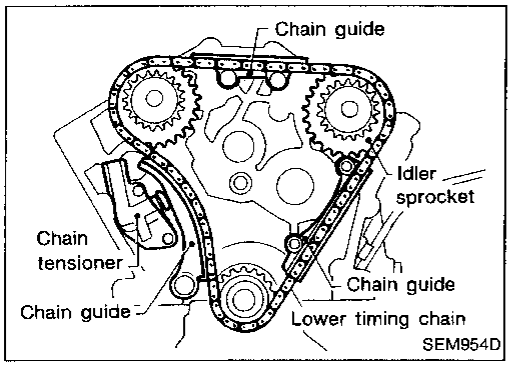


40. Remove crankshaft pulley.
41. Remove oil strainer.
42. Remove oil filter bracket.

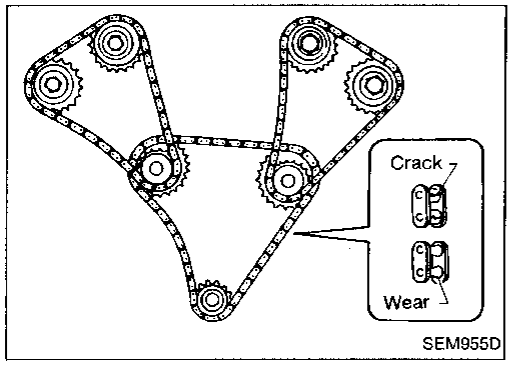


43. Remove front cover, alternator adjusting bar and upper timing chains.

Removal (Cont'd)

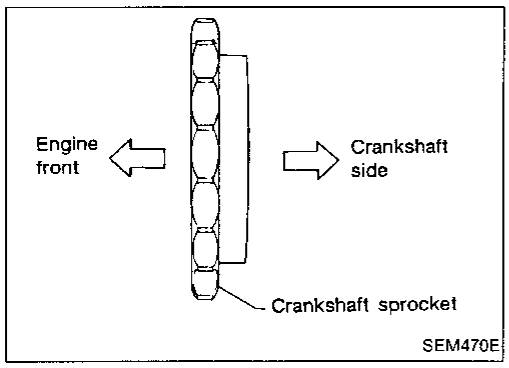


44. Remove chain tensioner.
45. Remove chain guides.
46. Remove idler sprockets and lower timing chain.



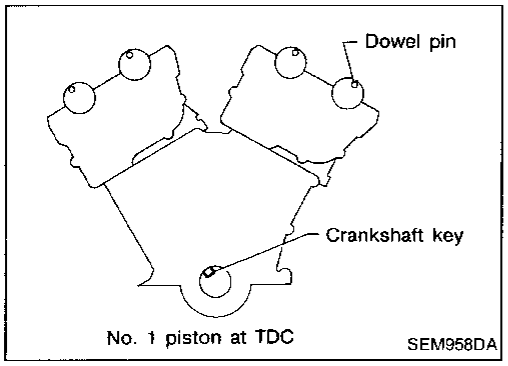
Inspection

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

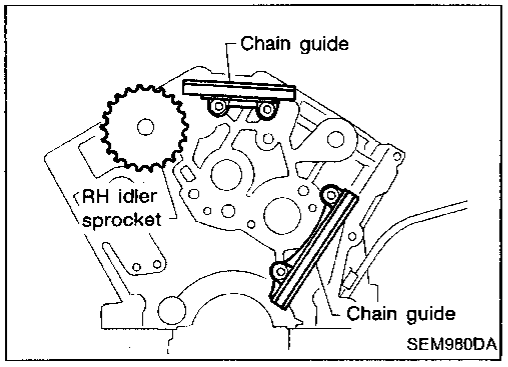


Installation

1. Install crankshaft sprocket on crankshaft.

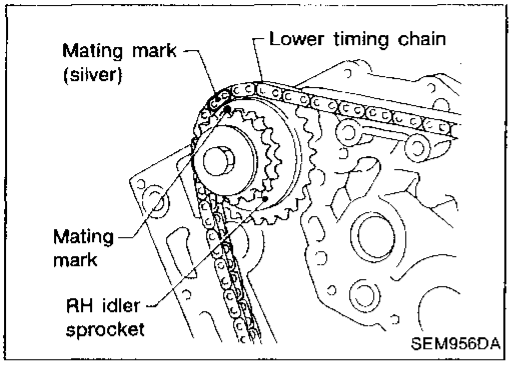


2. Position crankshaft so that No. 1 piston is set at TDC on compression stroke.

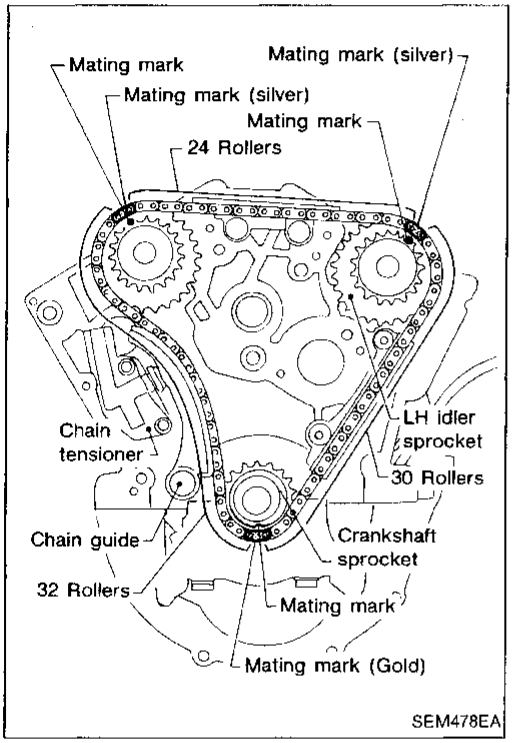


3. Install RH idler sprocket and chain guides.

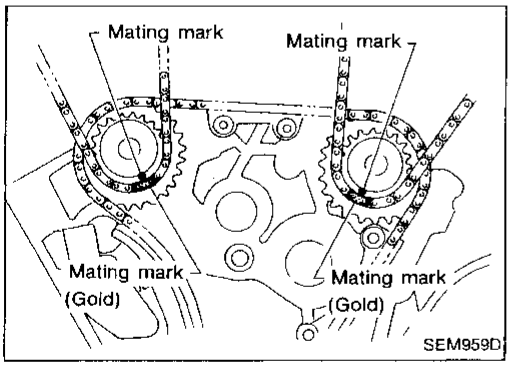
Installation (Cont'd)



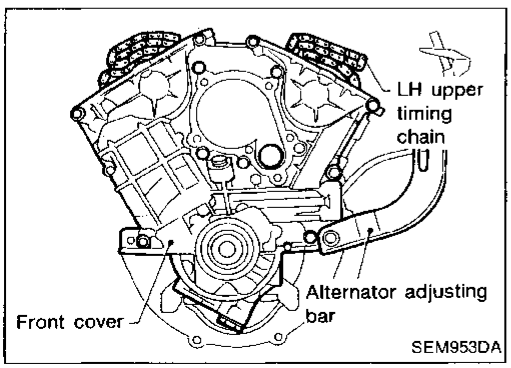
4. Position lower timing chain on RH idler sprocket by aligning the mating mark on the RH idler sprocket with the silver mating mark on the lower timing chain.



5. Install LH idler sprocket with lower timing chain.
- **Line up mating marks on lower timing chain with mating marks on LH idler sprocket and crankshaft sprocket.**
6. Install chain guide and chain tensioner.

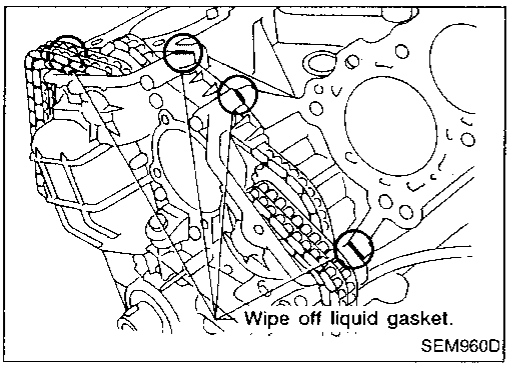


7. Position upper timing chains on idler sprockets by aligning the mating marks on the idler sprockets with the gold mating marks on the upper timing chains.

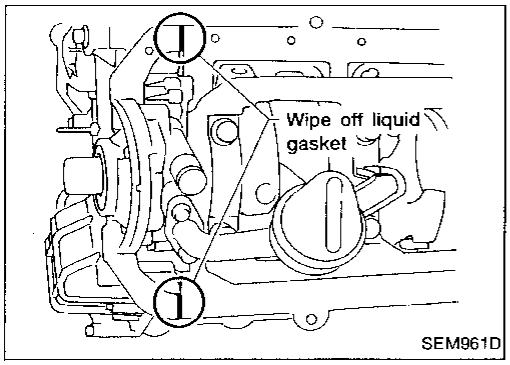


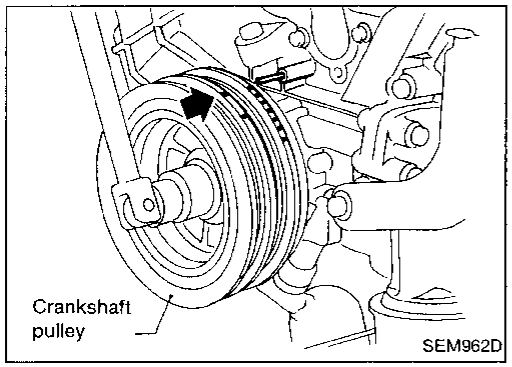
8. Install oil pump drive spacer, front cover and alternator adjusting bar.
- Before installing front cover, remove all traces of liquid gasket from mating surface and grooves using a scraper and then completely clean any oil stains.
- Also remove traces of liquid gasket from mating surface of cylinder block.
- Apply a continuous bead of liquid gasket to mating surface of front cover. Refer to "POSITION FOR APPLYING LIQUID GASKET" (EM-53).
- Use Genuine Liquid Gasket or equivalent.

Installation (Cont'd)



- Wipe off excessive liquid gasket.

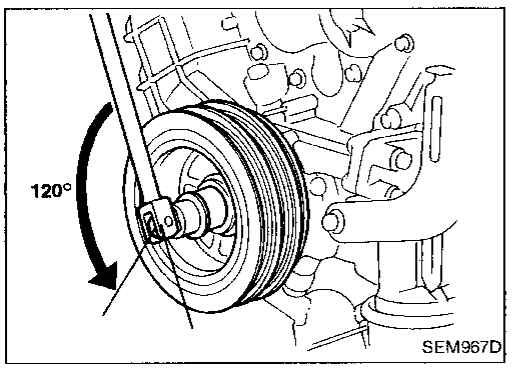




9. Install oil filter bracket.
10. Install oil strainer.
11. Install crankshaft pulley.
12. Set No. 1 piston at TDC on its compression stroke.
13. Install oil pan.
    Refer to "Installation" in "OIL PAN".
14. Install water pump.

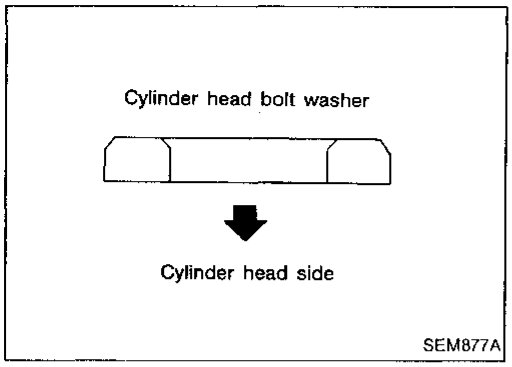
- **Before installing water pump, remove all traces of liquid gasket from mating surface and groove using a scraper.**
- **Also remove traces of liquid gasket from mating surface of front cover and water pipe.**
- **Apply a continuous bead of liquid gasket to mating surface of water pump. Refer to "POSITION FOR APPLYING LIQUID GASKET" (EM-53).**
- **Use Genuine Liquid Gasket or equivalent.**

15. Install water pump pulley.
16. Install water pipe.
    Refer to "Water pipe tightening procedure" in "OUTER COMPONENT PARTS".



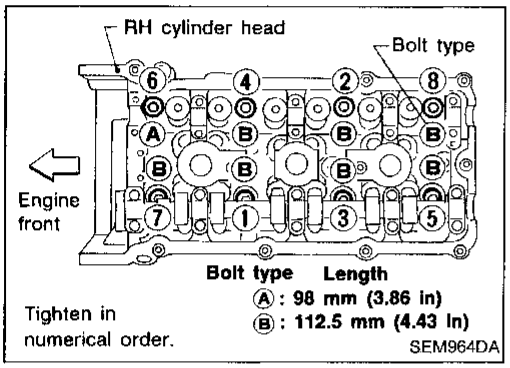
17. Turn crankshaft until No. 1 piston is set at approximately 120° before TDC on compression stroke to prevent interference of valves and pistons.

Installation (Cont'd)



18. Install cylinder heads with new gaskets.

- **Before installing cylinder head gaskets, apply a continuous bead of liquid gasket to mating surface of cylinder block. Refer to "POSITION FOR APPLYING LIQUID GASKET" (EM-53).**
- **Be sure to install washers between bolts and cylinder head.**
- **Do not rotate crankshaft and camshaft separately, or valves will strike piston heads.**

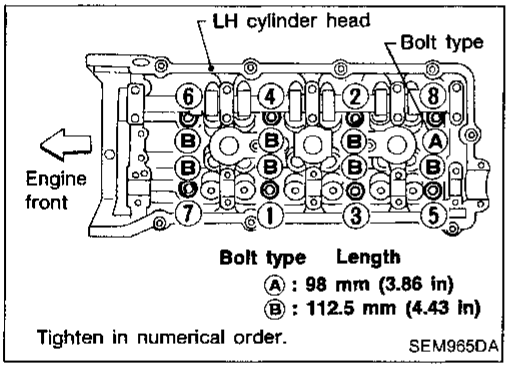


- **Tightening procedure:**

ⓐ **Tighten all bolts to 39 N·m (4.0 kg-m, 29 ft-lb).**

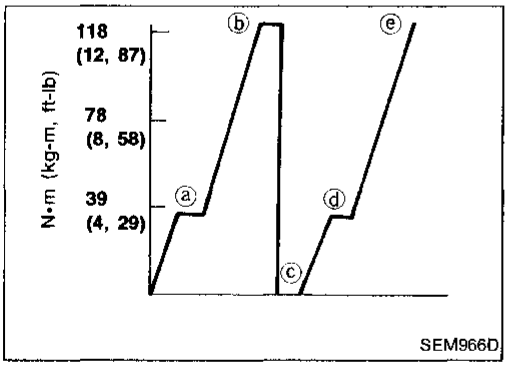
ⓑ **Bolts of Ⓐ type: Turn Ⓐ bolts 65 to 70 degrees clockwise with Tool or suitable angle wrench.**
Bolts of Ⓑ type: Turn Ⓑ bolts 70 to 75 degrees clockwise with Tool or suitable angle wrench.
If angle wrench is not available, tighten all bolts to 123 N·m (12.5 kg-m, 90 ft-lb)

ⓒ **Loosen all bolts completely.**



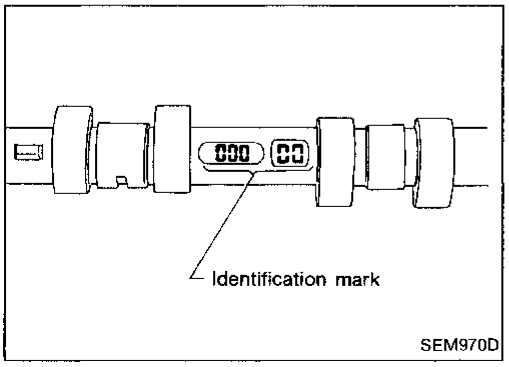
ⓓ **Tighten all bolts to 34 to 44 N·m (3.5 to 4.5 kg-m, 25 to 33 ft-lb).**

ⓔ **Bolts of Ⓐ type: Turn Ⓐ bolts 65 to 70 degrees clockwise with Tool or suitable angle wrench.**
Bolts of Ⓑ type: Turn Ⓑ bolts 70 to 75 degrees clockwise with Tool or suitable angle wrench.
If angle wrench is not available, tighten all bolts to 118 to 127 N·m (12.0 to 13.0 kg-m, 87 to 94 ft-lb).



	Tightening torque N·m (kg-m, ft-lb)
ⓐ	39 (4.0, 29)
ⓑ	Bolts of Ⓐ type: 65 to 70 degrees or 123 (12.5, 90) Bolts of Ⓑ type: 70 to 75 degrees or 123 (12.5, 90)
ⓒ	0 (0, 0)
ⓓ	39 ± 5 (4.0 ± 0.5, 28.9 ± 3.6)
ⓔ	Bolts of Ⓐ type: 65 to 70 degrees or 123 ± 5 (12.5 ± 0.5, 90.4 ± 3.6) Bolts of Ⓑ type: 70 to 75 degrees or 123 ± 5 (12.5 ± 0.5, 90.4 ± 3.6)

19. Install cylinder head outside bolts.

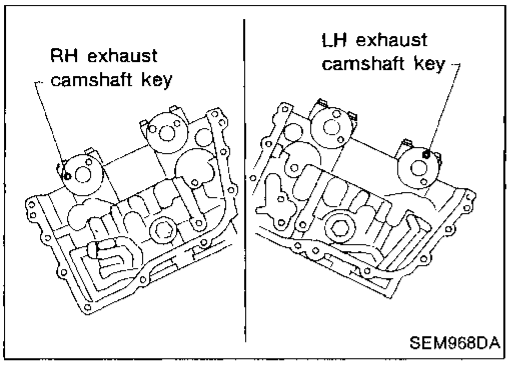


20. Install exhaust camshafts, camshaft brackets and rocker arms.

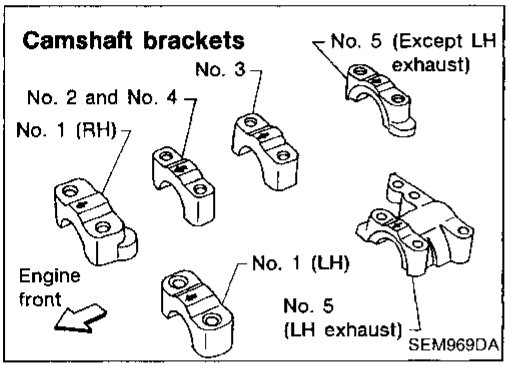
- **Install exhaust camshafts, noting their identification marks as indicated in the table below.**

	Identification mark
RH exhaust camshaft	96E RE
LH exhaust camshaft	96E LE

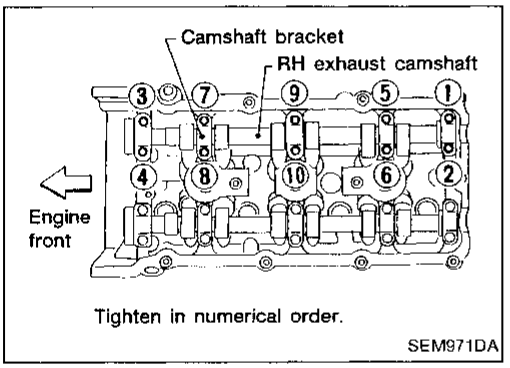
Installation (Cont'd)

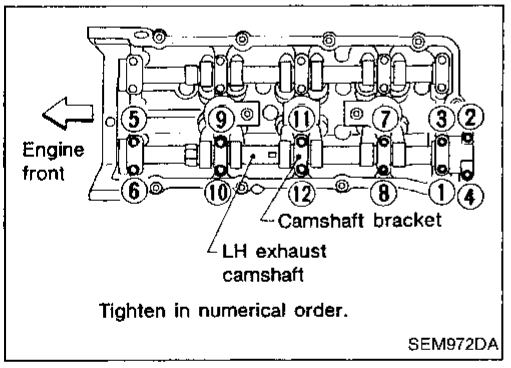


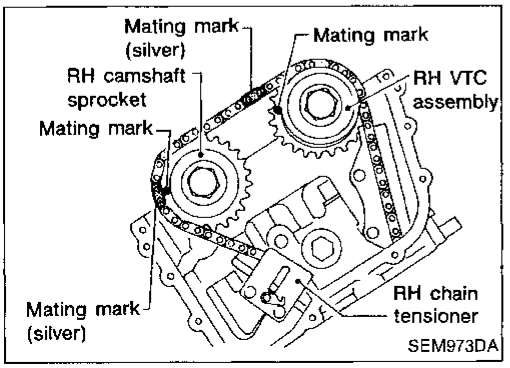
- **Position camshaft**
  RH exhaust camshaft key at about 10 o'clock
  LH exhaust camshaft key at about 12 o'clock



- **Install camshaft brackets in their original positions.**
- **Before installing LH exhaust camshaft end bracket, remove all traces of liquid gasket from mating surface, and then completely clean any oil stains.**
- **Also remove traces of liquid gasket from mating surface of cylinder head.**
- **Apply a continuous bead of liquid gasket to mating surface of LH exhaust camshaft end bracket.**
  Refer to "POSITION FOR APPLYING LIQUID GASKET"(EM-53).
- **Use Genuine Liquid Gasket or equivalent.**





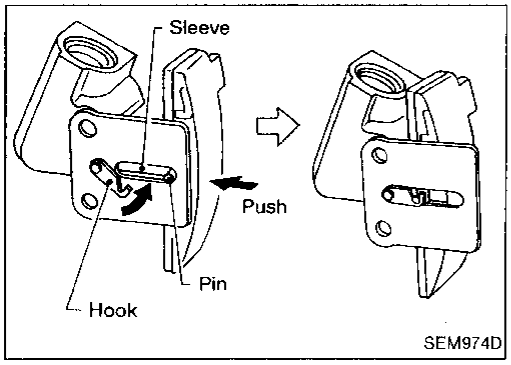


21 Install RH VTC assembly.
22. Install RH camshaft sprocket.

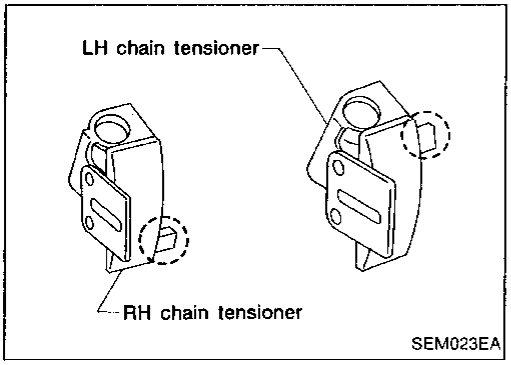
Line up mating marks on RH upper timing chain with mating marks on RH VTC assembly and RH camshaft sprocket.

23. Install RH chain tensioner.

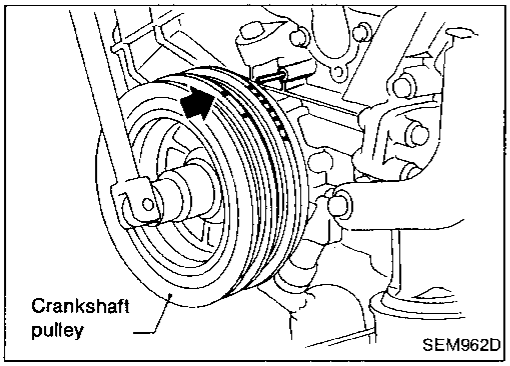
Installation (Cont'd)



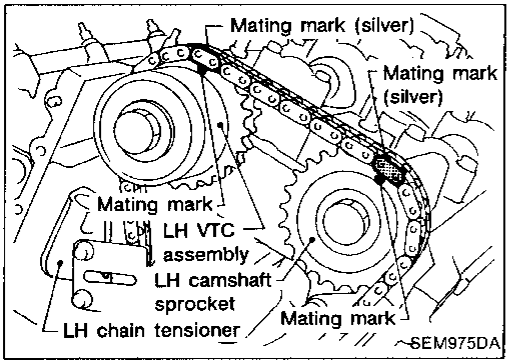
Before installing chain tensioner, press-in sleeve until hook can be engaged on pin.
Make sure that hook used to retain chain tensioner is released.



There are two types of chain tensioner.
Be careful not to install LH chain tensioner onto RH cylinder head.



24. Turn crankshaft clockwise to set No. 1 piston at TDC compression stroke.

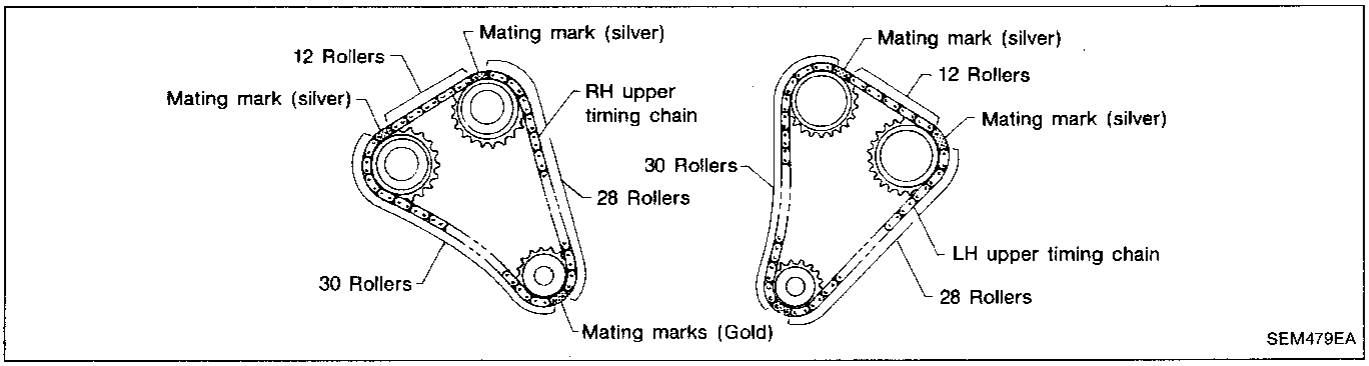


25. Install LH VTC assembly
26. Install LH camshaft sprocket.

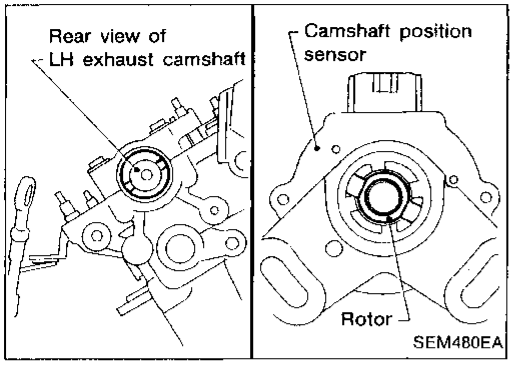
Line up mating marks on LH upper timing chain with mating marks on LH VTC assembly and LH camshaft sprocket.

27. Install LH chain tensioner

- **Make sure that upper timing chains are in the correct position.**

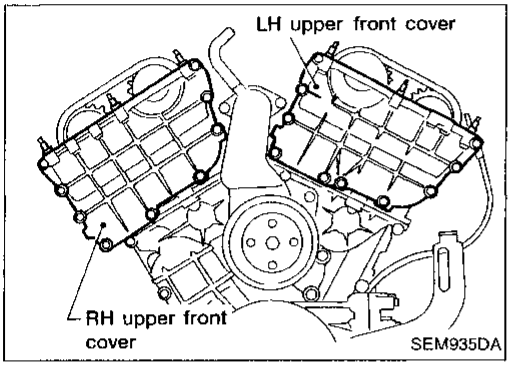


Installation (Cont'd)



28. Install camshaft position sensor.

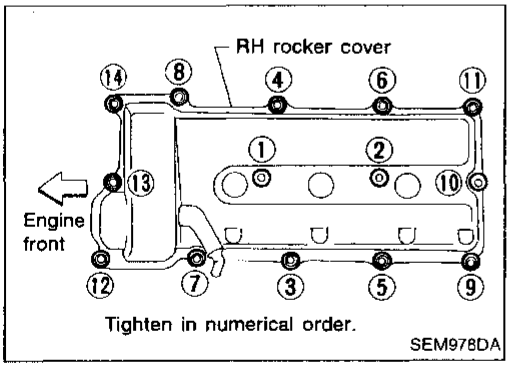
Make sure that position of camshaft and rotor position of camshaft position sensor are as shown in figure.



29. Install RH and LH upper front covers.

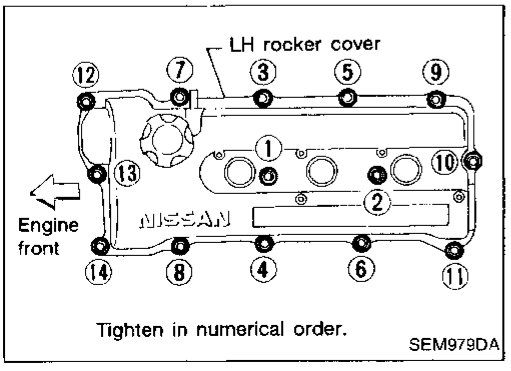
- **Before installing RH and LH upper front covers, remove all traces of liquid gasket from mating surface and groove using a scraper, and completely clean any oil stains.**
- **Also remove traces of liquid gasket from mating surface of cylinder head.**
- **Apply a continuous bead of liquid gasket to mating surface of RH and LH upper front covers.**
  Refer to "POSITION FOR APPLYING LIQUID GASKET" (EM-53).
- **Use Genuine Liquid Gasket or equivalent.**

30. Install RH and LH upper chain guides.



31. Install RH and LH rocker covers.

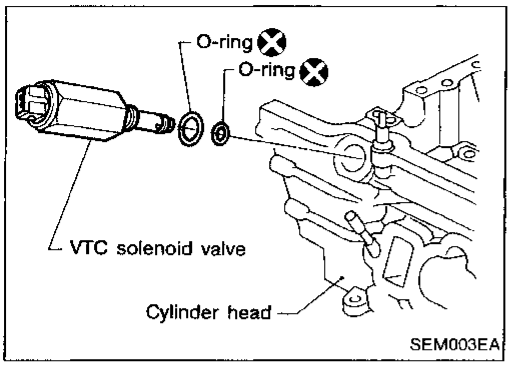
- **Before installing rocker covers, remove all traces of liquid gasket from mating surface of rocker cover to cylinder head, and then completely clean any oil stains.**
- **Apply a continuous bead of liquid gasket to mating surface of rocker cover gaskets and cylinder heads.**
  Refer to "POSITION FOR APPLYING LIQUID GASKET" (EM-53).
- **Use Genuine Liquid Gasket or equivalent.**



Rocker cover tightening procedure:

(1) Tighten nuts ①-②-⑫-⑪-⑨-⑭ in that order to 4 N·m (0.4 kg-m, 2.9 ft-lb).
(2) Tighten nuts ① to ⑭ as indicated in figure to 8 to 10 N·m (0.8 to 1.0 kg-m, 5.8 to 7.2 ft-lb).

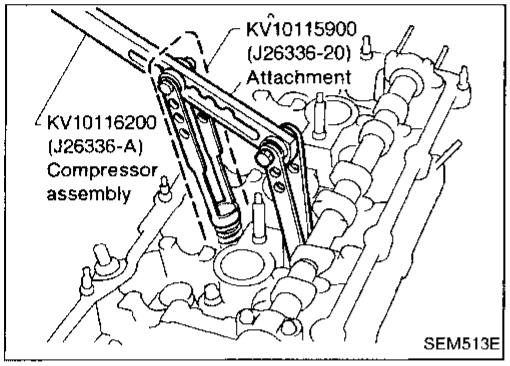
Installation (Cont'd)



32. Reinstall any parts removed in reverse order of removal
- When installing exhaust manifolds, intake manifold and intake manifold collector, refer to "Their tightening procedure" in "OUTER COMPONENT PARTS" (EM-45).
- When installing injector tube assembly, refer to "Injector Removal and Installation" in EF & EC section.
- When installing VTC solenoid valve, always use new O-rings, and apply engine oil to new O-rings.

VALVE OIL SEAL

1. Remove intake manifold collector. (RH cylinder head only)
2. Remove rocker cover.
3. Remove camshaft sprocket and VTC assembly.
4. Remove camshafts, camshaft brackets and rocker arms. Refer to "Removal" in "TIMING CHAIN".

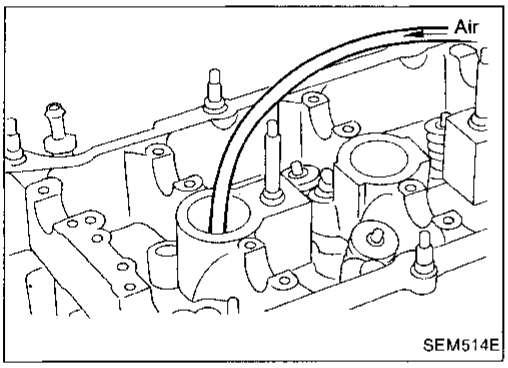


5. Remove valve spring with Tool.

Before removing valve spring, fix valve as follows.

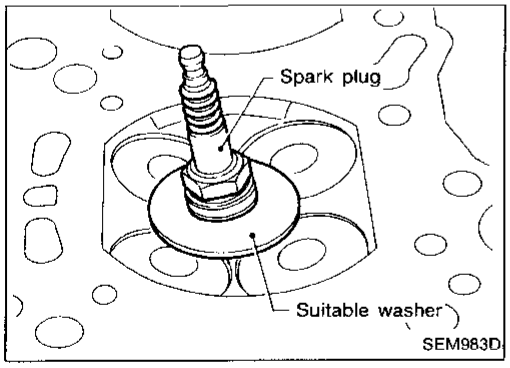
Method A:

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



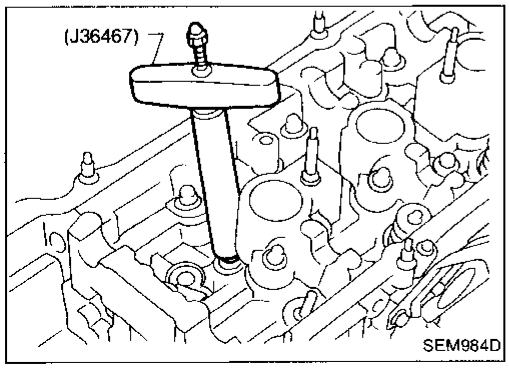
Method B:

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

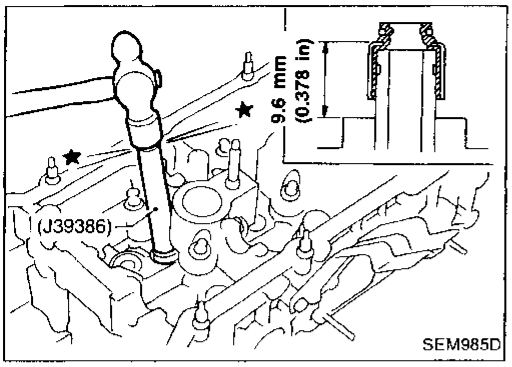


Method C:

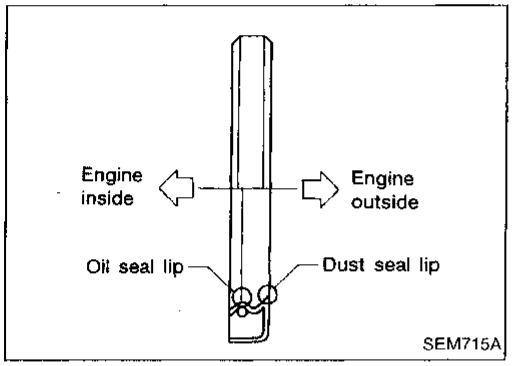
Install spark plug with suitable washer into spark plug hole from combustion chamber side.



6. Remove valve oil seal with Tool.



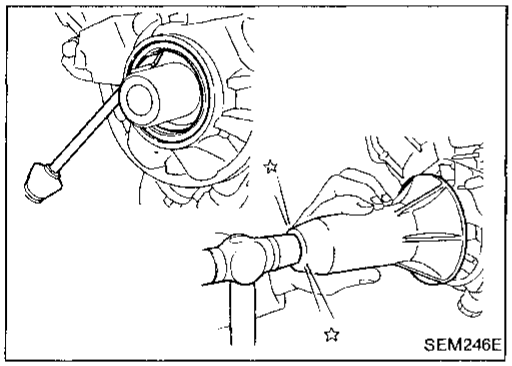
7. Apply engine oil to new valve oil seal and install it with Tool.



OIL SEAL INSTALLATION DIRECTION

FRONT OIL SEAL

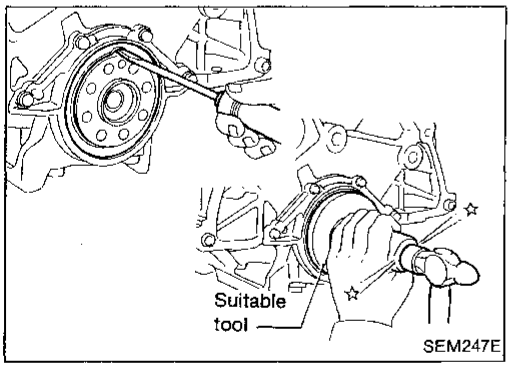
1. Remove the following parts:
- Engine under cover
- Front RH wheel and engine side cover
- Drive belts
- Crankshaft pulley



2. Remove front oil seal using a suitable tool.

Be careful not to scratch front cover.

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

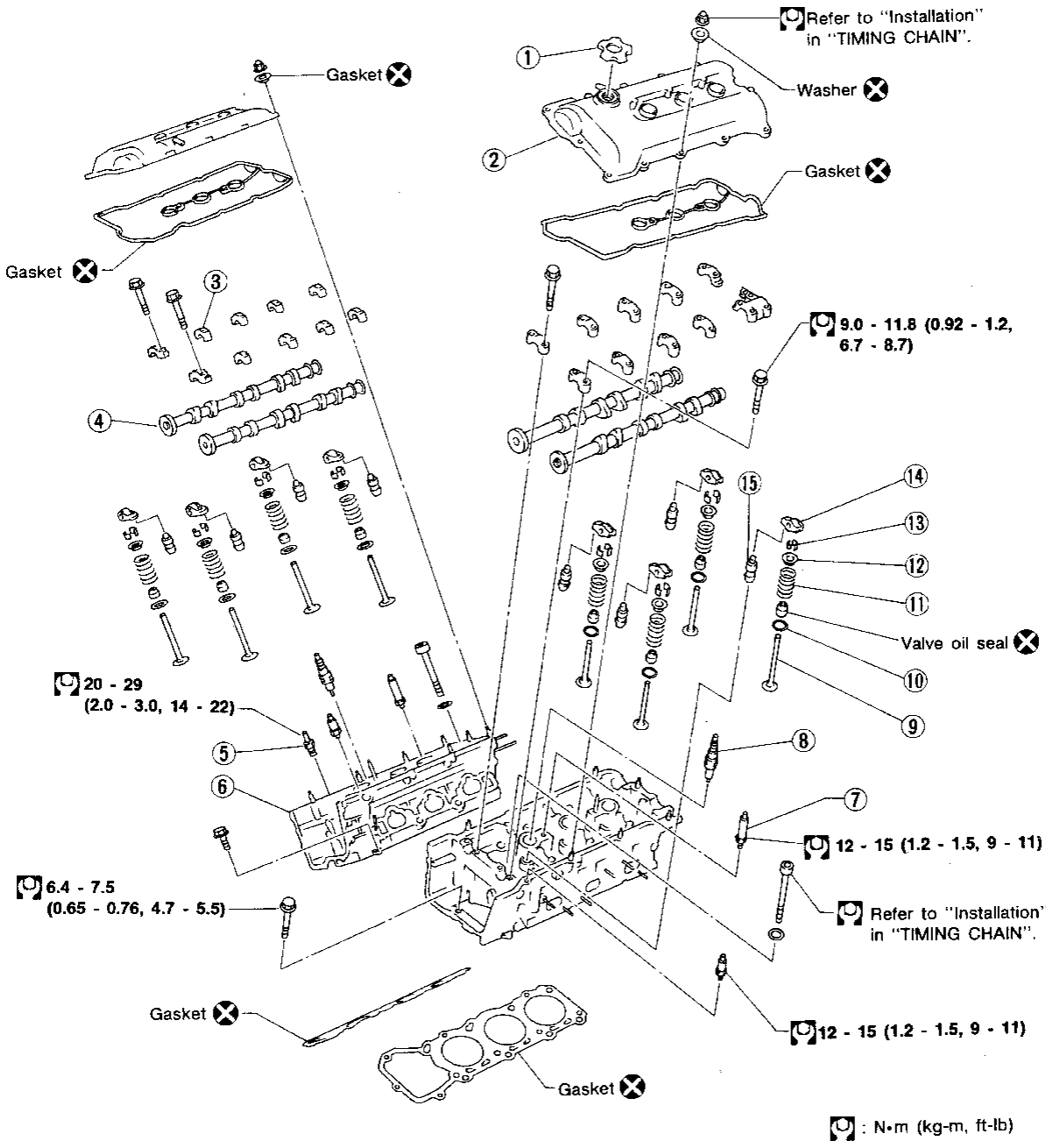


REAR OIL SEAL

1. Remove transaxle. (Refer to MT or AT section.)
2. Remove flywheel or drive plate.
3. Remove rear oil seal using a suitable tool.

Be careful not to scratch rear oil seal retainer.

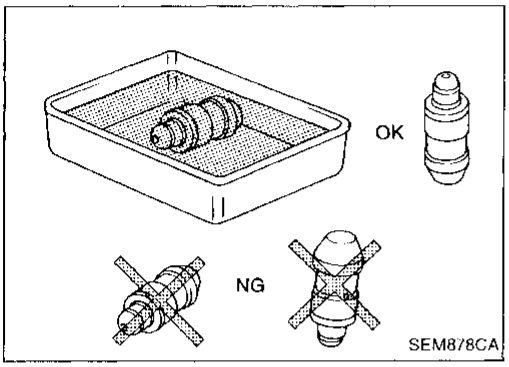
4. Apply engine oil to new oil seal and install it using a suitable tool.



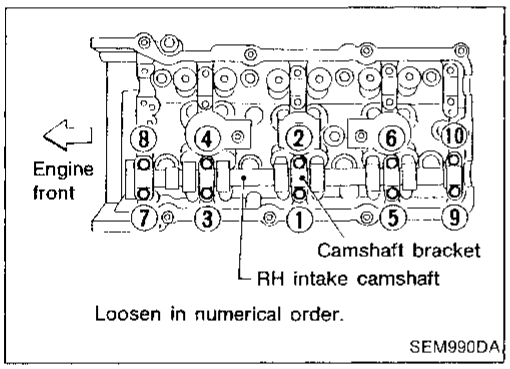
① Oil filler cap
② Rocker cover
③ Camshaft bracket
④ Camshaft
⑤ PCV valve
⑥ Cylinder head
⑦ Stud bolt
⑧ Spark plug
⑨ Valve
⑩ Valve spring seat
⑪ Valve spring
⑫ Valve spring retainer
⑬ Valve collet
⑭ Rocker arm
⑮ Hydraulic lash adjuster

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, intake 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.**

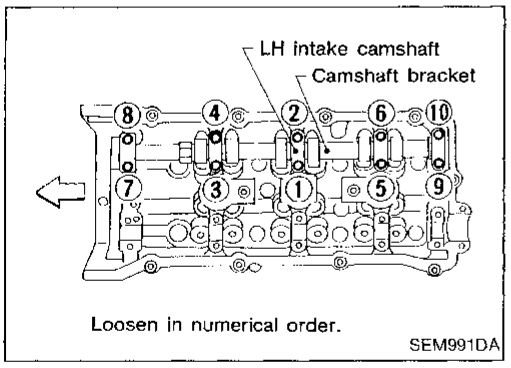


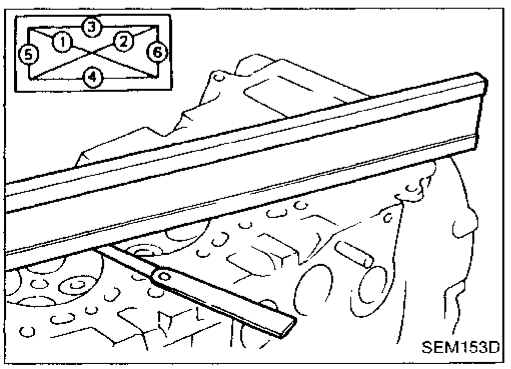
Removal

This removal is the same procedure as that for timing chain. Refer to "Removal" in "TIMING CHAIN" (EM-54).

Disassembly

1. Remove intake camshafts, camshaft brackets, rocker arms and hydraulic lash adjusters.
2. Remove valve component parts.
   Refer to "VALVE OIL SEAL" in "OIL SEAL REPLACEMENT" (EM-67).





Inspection

CYLINDER HEAD DISTORTION

Head surface flatness: Limit 0.1 mm (0.004 in)

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

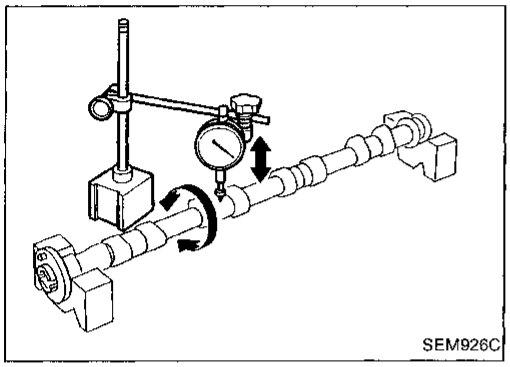
The resurfacing limit of cylinder head is determined by the cylinder block resurfacing in an engine.

Inspection (Cont'd)

Resurfacing limit:
Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".
The maximum limit : 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:
138.72 - 138.92 mm (5.4614 - 5.4693 in)

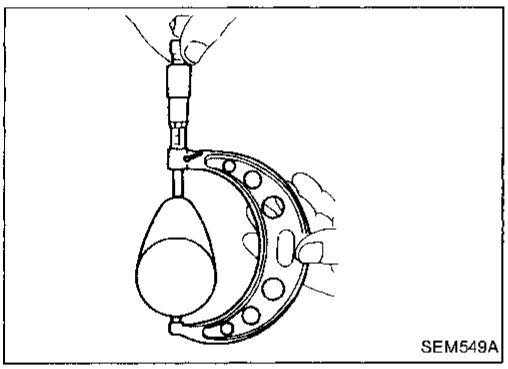

SEM926C

CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.

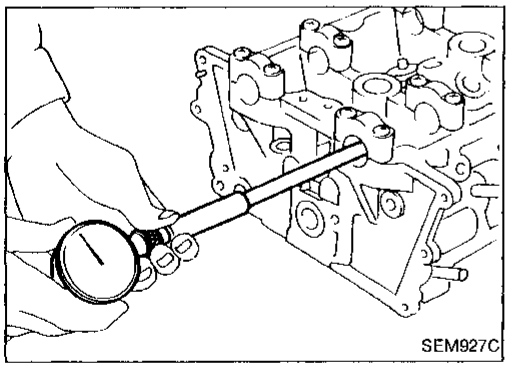
CAMSHAFT RUNOUT

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


SEM549A

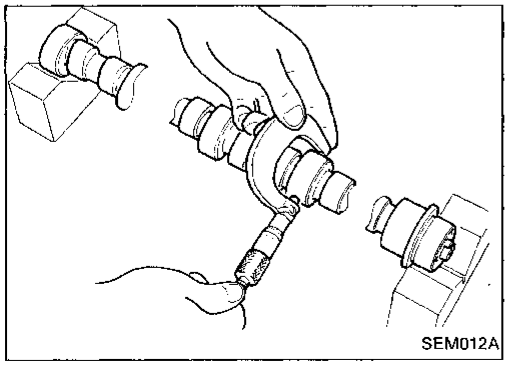
CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height.
   Standard cam height:
   37.678 - 37.868 mm (1.4834 - 1.4909 in)
   Cam wear limit:
   0.05 mm (0.0020 in)
2. If wear is beyond the limit, replace camshaft.


SEM927C

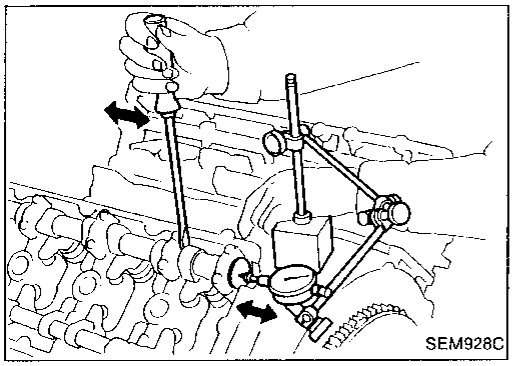
CAMSHAFT JOURNAL CLEARANCE

1. Install camshaft bracket and tighten bolts to the specified torque.
2. Measure inner diameter of camshaft bearing.
   Standard inner diameter:
   26.000 - 26.021 mm (1.0236 - 1.0244 in)


SEM012A

3. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   25.935 - 25.955 mm (1.0211 - 1.0218 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)

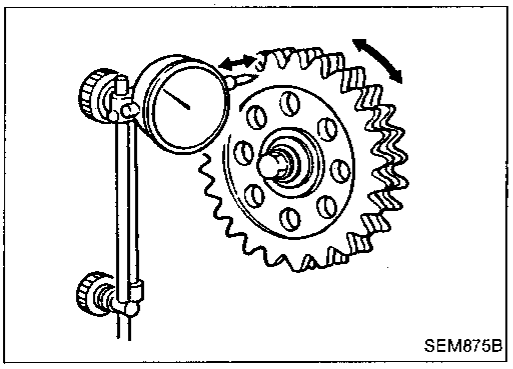
Inspection (Cont'd)



CAMSHAFT END PLAY

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

Camshaft end play:
Standard
0.070 - 0.148 mm (0.0028 - 0.0058 in)
Limit
0.20 mm (0.0079 in)

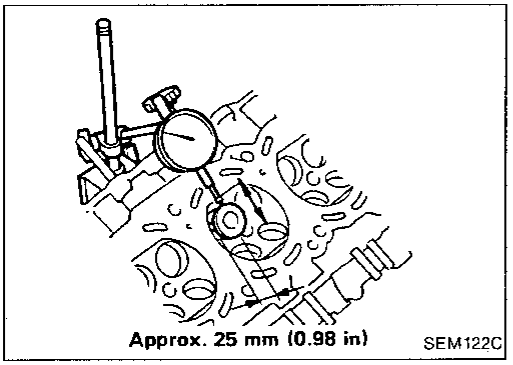


CAMSHAFT SPROCKET RUNOUT

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

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

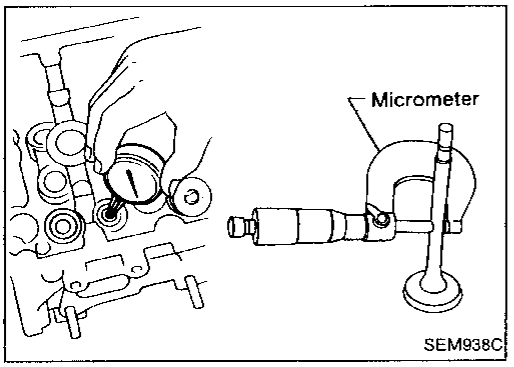
3. If it exceeds the limit, replace camshaft sprocket.



VALVE GUIDE CLEARANCE

1. Measure valve deflection at right-angles direction to camshaft. (Valve and valve guide mostly wear in this direction.)

Valve deflection limit (Dial gauge reading):
0.20 mm (0.0079 in)

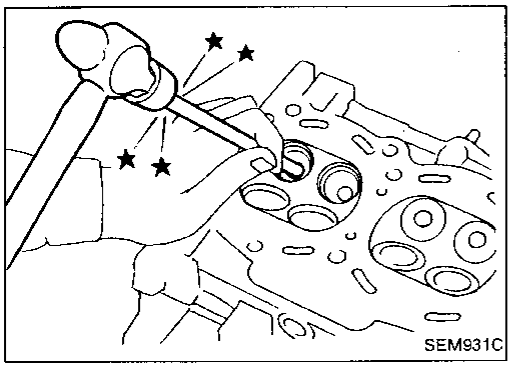


2. If it exceeds the limit, check valve to valve guide clearance.

a. Measure valve stem diameter and valve guide inner diameter.
b. Check that clearance is within specification.

Valve to valve guide clearance limit:
Intake 0.08 mm (0.0031 in)
Exhaust 0.1 mm (0.004 in)

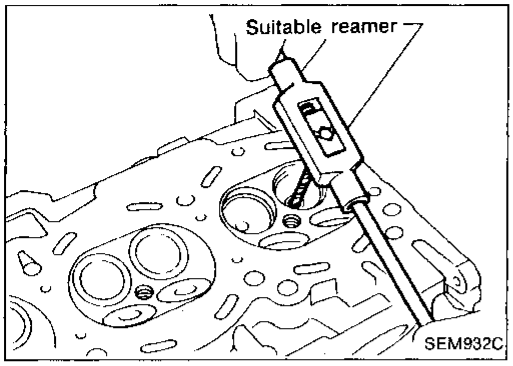
c. If it exceeds the limit, replace valve or valve guide.



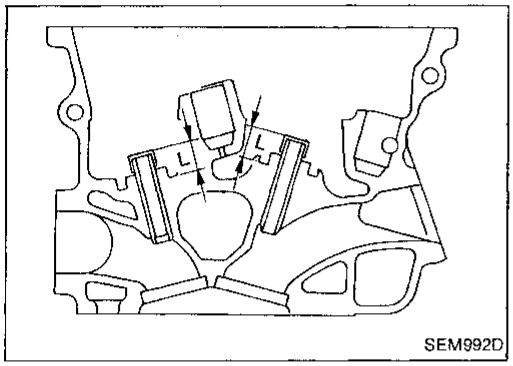
VALVE GUIDE REPLACEMENT

1. To remove valve guide, heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.
2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.

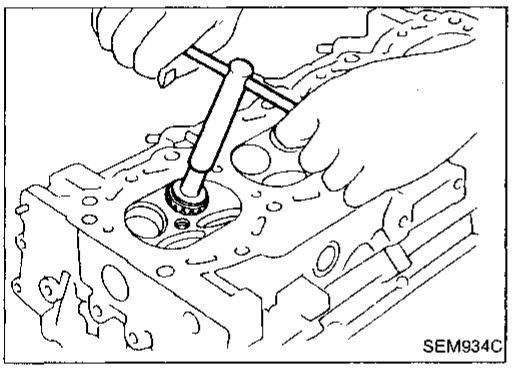
Inspection (Cont'd)



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



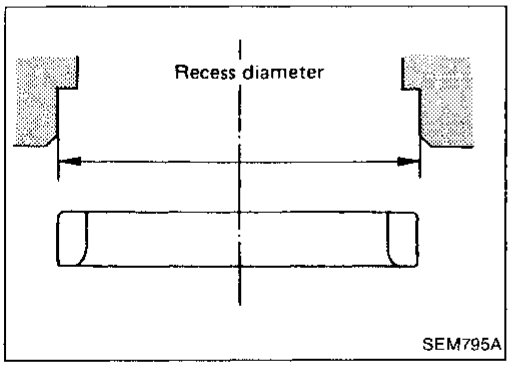
4. Heat cylinder head to 110 to 130°C (230 to 266°F) and press service valve guide onto cylinder head.
   Projection "L":
   13.6 - 13.8 mm (0.535 - 0.543 in)
5. Ream valve guide.
   Finished size:
   6.000 - 6.018 mm (0.2362 - 0.2369 in)



VALVE SEATS

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

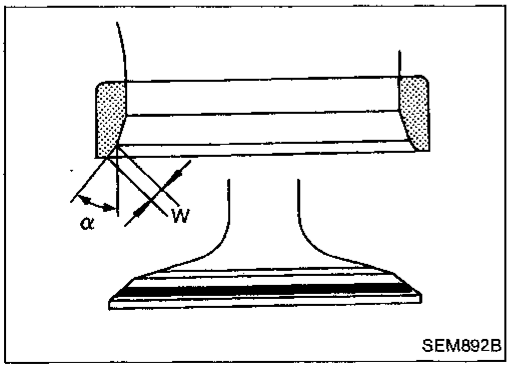
- **Before repairing valve seats, check valve and valve guide for wear. If they have worn, replace them. Then correct valve seat.**
- **Cut with both hands to uniform the cutting surface.**



REPLACING VALVE SEAT FOR SERVICE PARTS

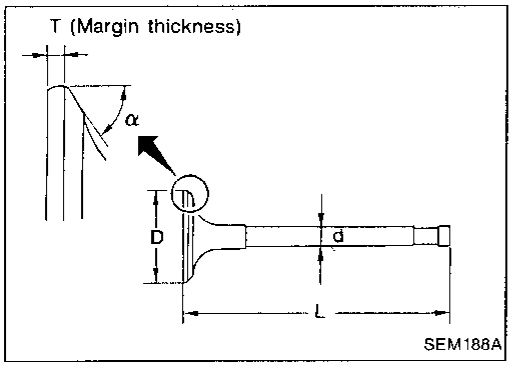
1. Bore out old seat until it collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the seat recess in cylinder head.
2. Ream cylinder head recess for service valve seat.
   Oversize [0.5 mm (0.020 in)]:
   Intake 36.500 - 36.516 mm (1.4370 - 1.4376 in)
   Exhaust 32.000 - 32.016 mm (1.2598 - 1.2605 in)

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



3. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.
4. Press fit valve seat until it seats on the bottom.
5. Cut or grind valve seat using suitable tool at the specified dimensions as shown in SDS (EM-99).
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: 1.06 - 1.34 mm (0.0417 - 0.0528 in)
   Exhaust: 1.27 - 1.55 mm (0.0500 - 0.610 in)

Inspection (Cont'd)

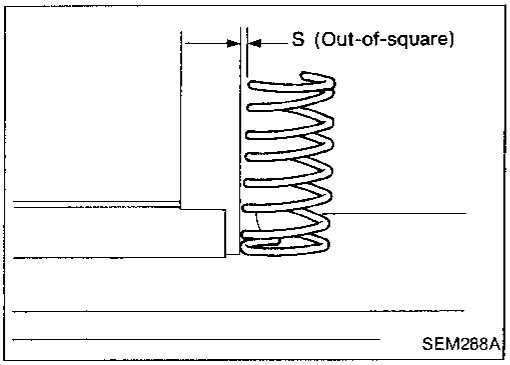


VALVE DIMENSIONS

Check dimensions in each valve. For dimensions, refer to SDS (EM-97).

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

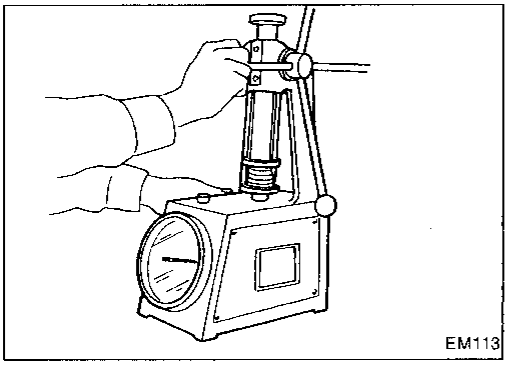
Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.



VALVE SPRING

Squareness

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

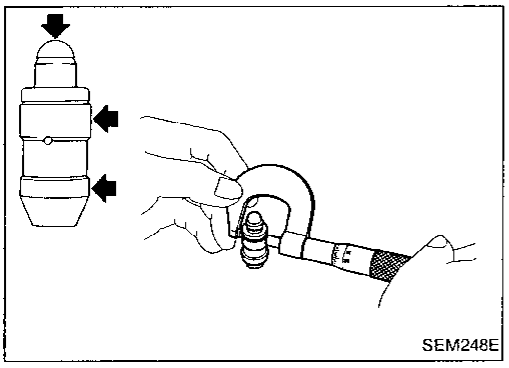


Pressure

Check valve spring pressure.

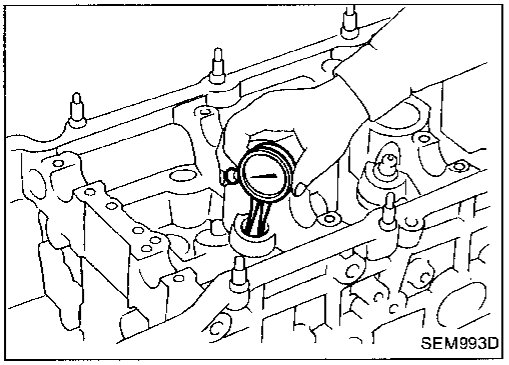
Pressure: N (kg, lb) at height mm (in)
Standard
535.5 (54.6, 120.4) at 26.9 (1.059)
Limit
More than 477.6 (48.7, 107.4) at 26.9 (1.059)

If it exceeds the limit, replace spring.

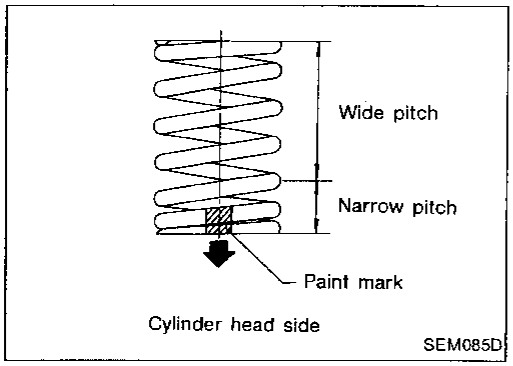


HYDRAULIC LASH ADJUSTER

1. Check contact and sliding surfaces for wear or scratches.
2. Check diameter of lash adjuster.
   Outer diameter:
   16.980 - 16.993 mm (0.6685 - 0.6690 in)



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)



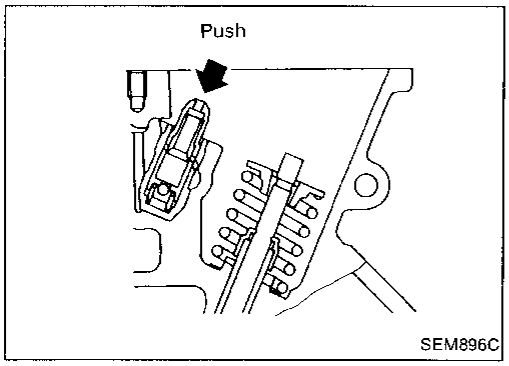
Assembly

1. Install valve component parts.

- **Always use new valve oil seal. Refer to OIL SEAL REPLACEMENT (EM-67).**
- **Before installing valve oil seal, install valve spring seat.**
- **Install valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side (paint mark).**

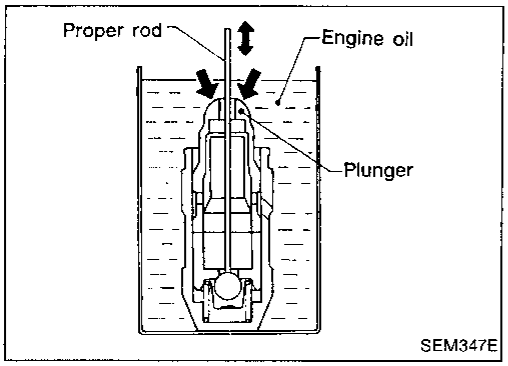
	Intake valve spring	Exhaust valve spring
Paint mark	Green	White

- After installing valve component parts, use plastic hammer to lightly tap valve stem tip to assure a proper fit.



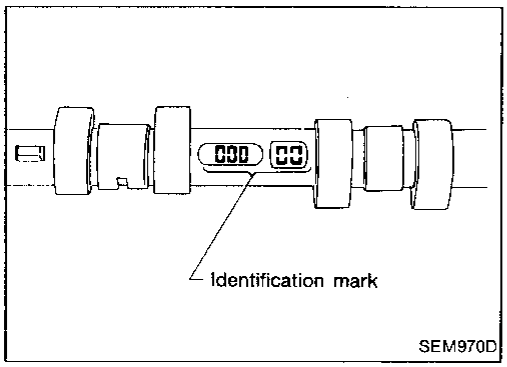
2. Install hydraulic lash adjusters and check them.

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 the 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.

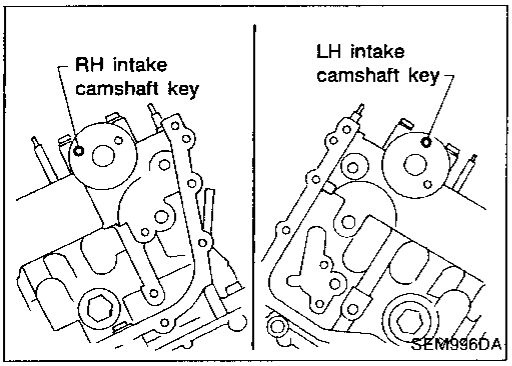


3. Install intake camshafts, camshaft brackets and rocker arms.

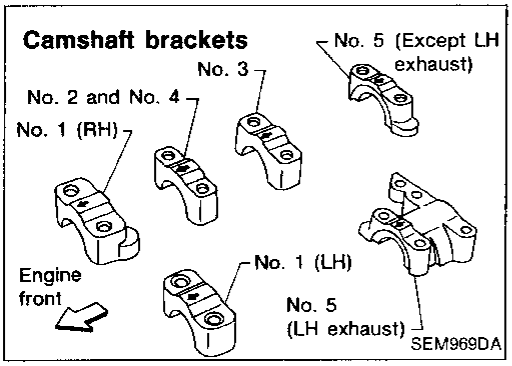
- **Install intake camshafts, noting their identification marks as indicated in the table below.**

	Identification mark
RH intake camshaft	96E RI
LH intake camshaft	96E LI

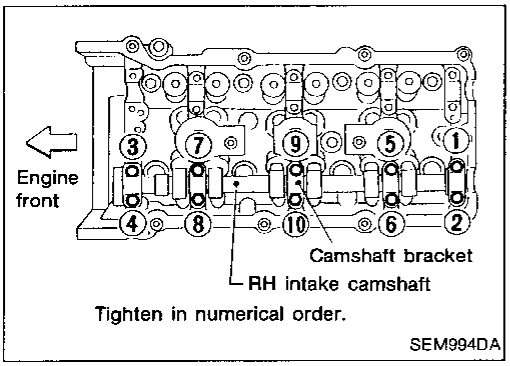
Assembly (Cont'd)

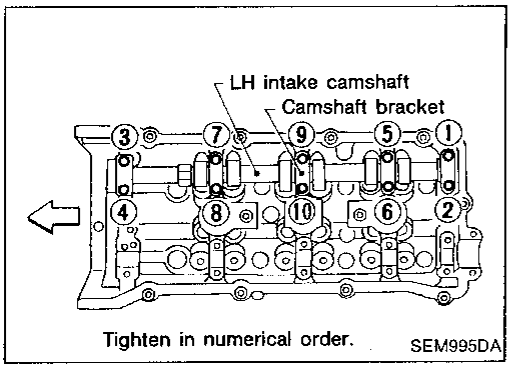


- **Position camshaft**
  RH intake camshaft key at about 10 o'clock.
  LH intake camshaft key at about 12 o'clock.



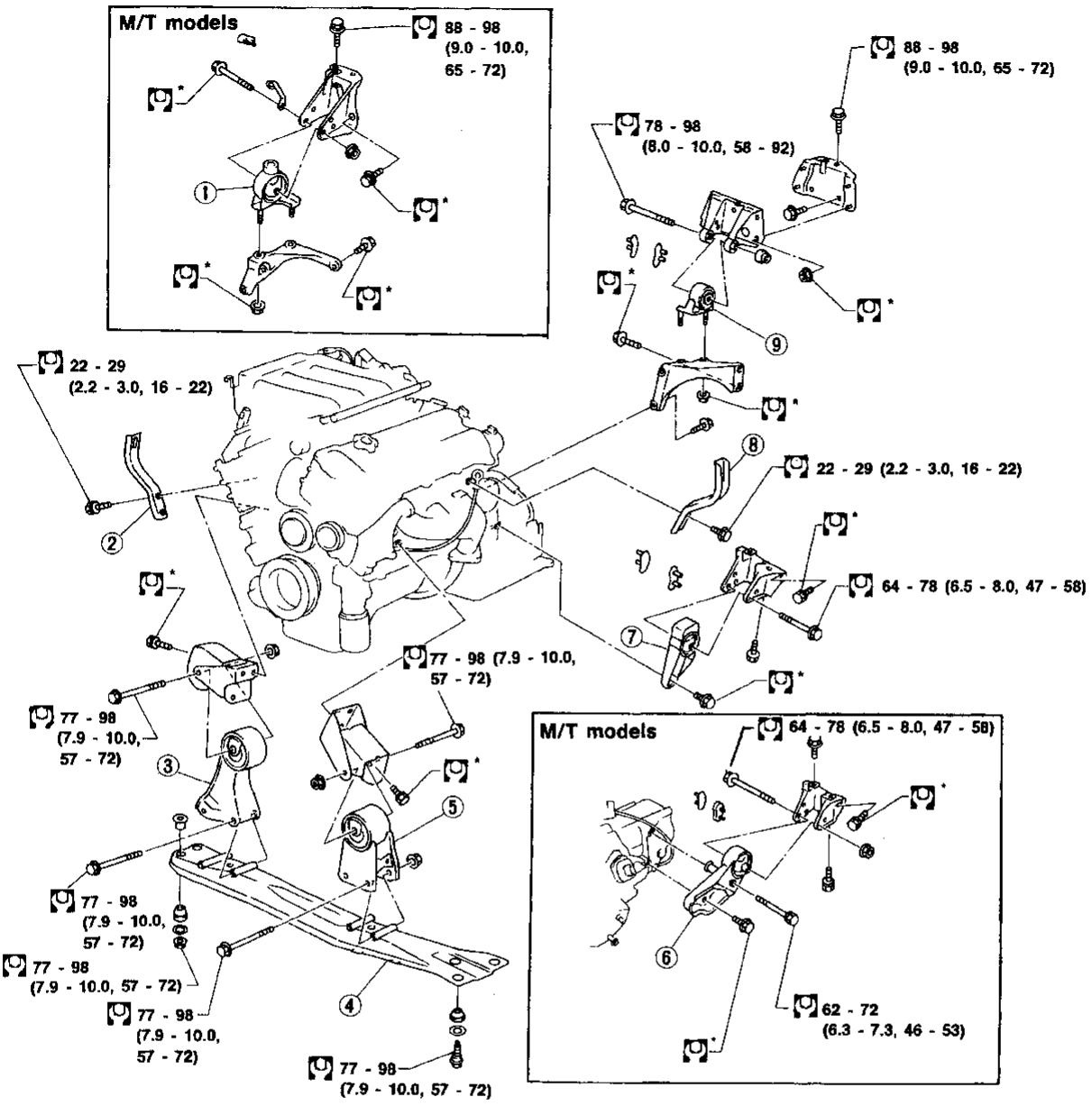
- **Install camshaft brackets in their original positions.**





Installation

- This installation is the same procedure as that for timing chain. Refer to "Installation" in "TIMING CHAIN" (EM-59).



SEM011E

① RH rear engine mounting (M/T models)
② Front engine slinger
③ RH front engine mounting
④ Center member
⑤ LH front engine mounting
⑥ LH rear engine mounting (M/T models)
⑦ LH rear engine mounting (A/T models)
⑧ Rear engine slinger
⑨ RH rear engine slinger (A/T models)

WARNING:

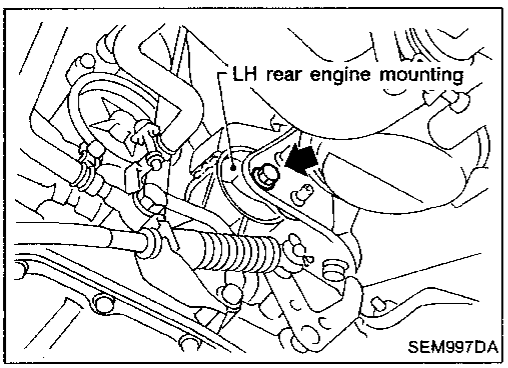
a. Position vehicle on a flat and solid surface.
b. Place chocks at front and back of rear wheels.
c. Do not remove engine until exhaust system has completely cooled off.
Otherwise, you may burn yourself and/or fire may break out in fuel line.
d. For safety during subsequent steps, the tension of wires should be slackened against the engine.
e. Before disconnecting fuel hose, release fuel pressure from fuel line. (Except carburetor model)
Refer to "Release Fuel Pressure" in EF & EC section.
f. Before removing front axle from transaxle, place safety stands under designated front supporting points. Refer to GI section for lifting points and towing.
g. Be sure to hoist engine and transaxle in a safe manner.
h. 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.**
- **In removing drive shaft, be careful not to damage grease seal of transaxle.**

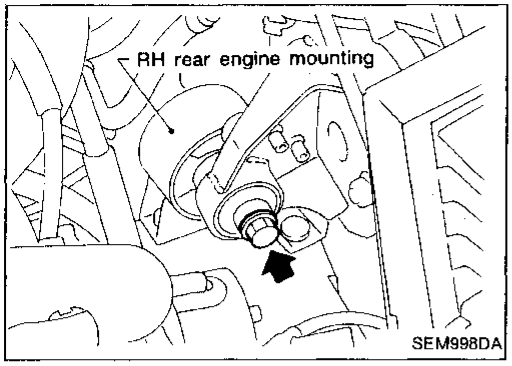
Removal

1. Remove engine under cover and hood.
2. Drain coolant from both cylinder block, and radiator.
3. Remove vacuum hoses, fuel hoses, wires, harnesses and connectors and so on.
4. Remove exhaust tubes, ball joints and drive shafts.
5. Remove radiator and fans.
6. Remove drive belts.
7. Remove alternator, compressor and power steering oil pump from engine.

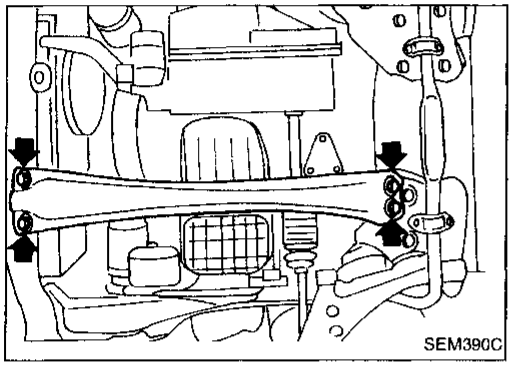


8. Set a suitable transmission jack under transaxle. Hoist engine with engine slinger.
9. Remove LH rear engine mounting.

Removal (Cont'd)

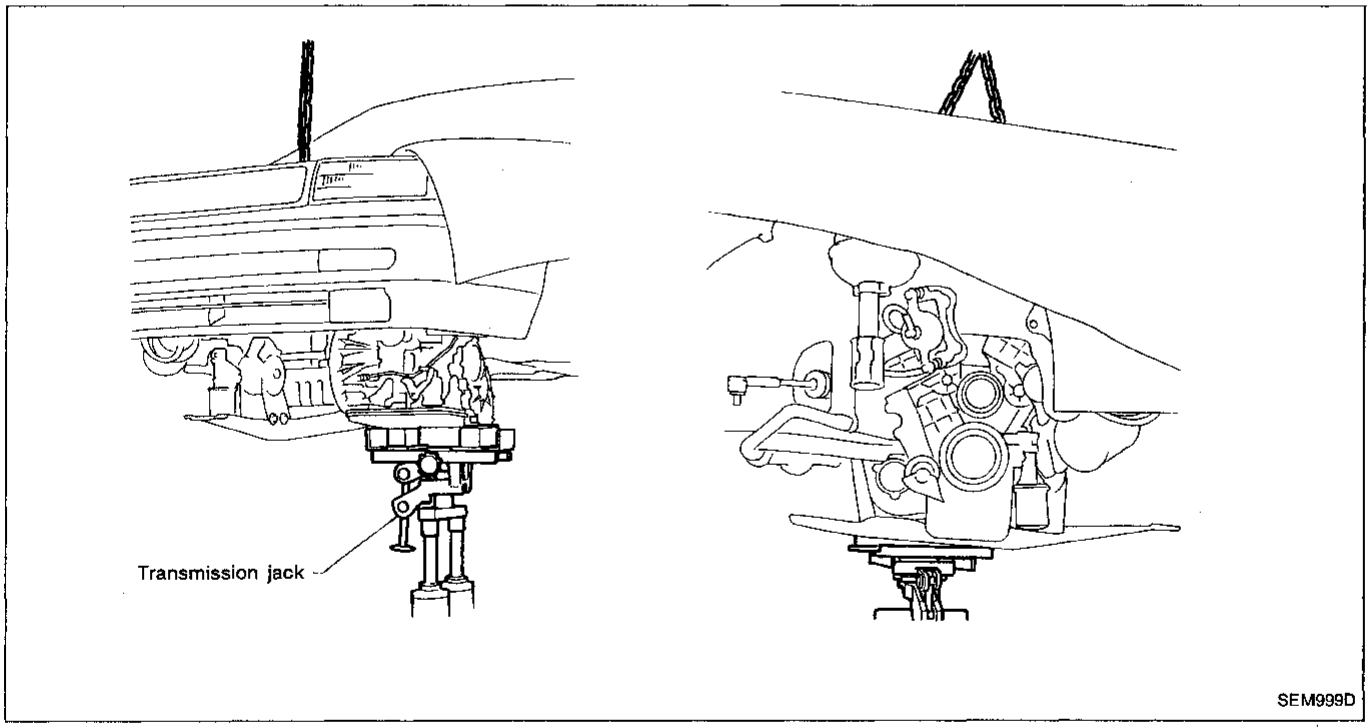


10. Remove RH rear engine mounting.



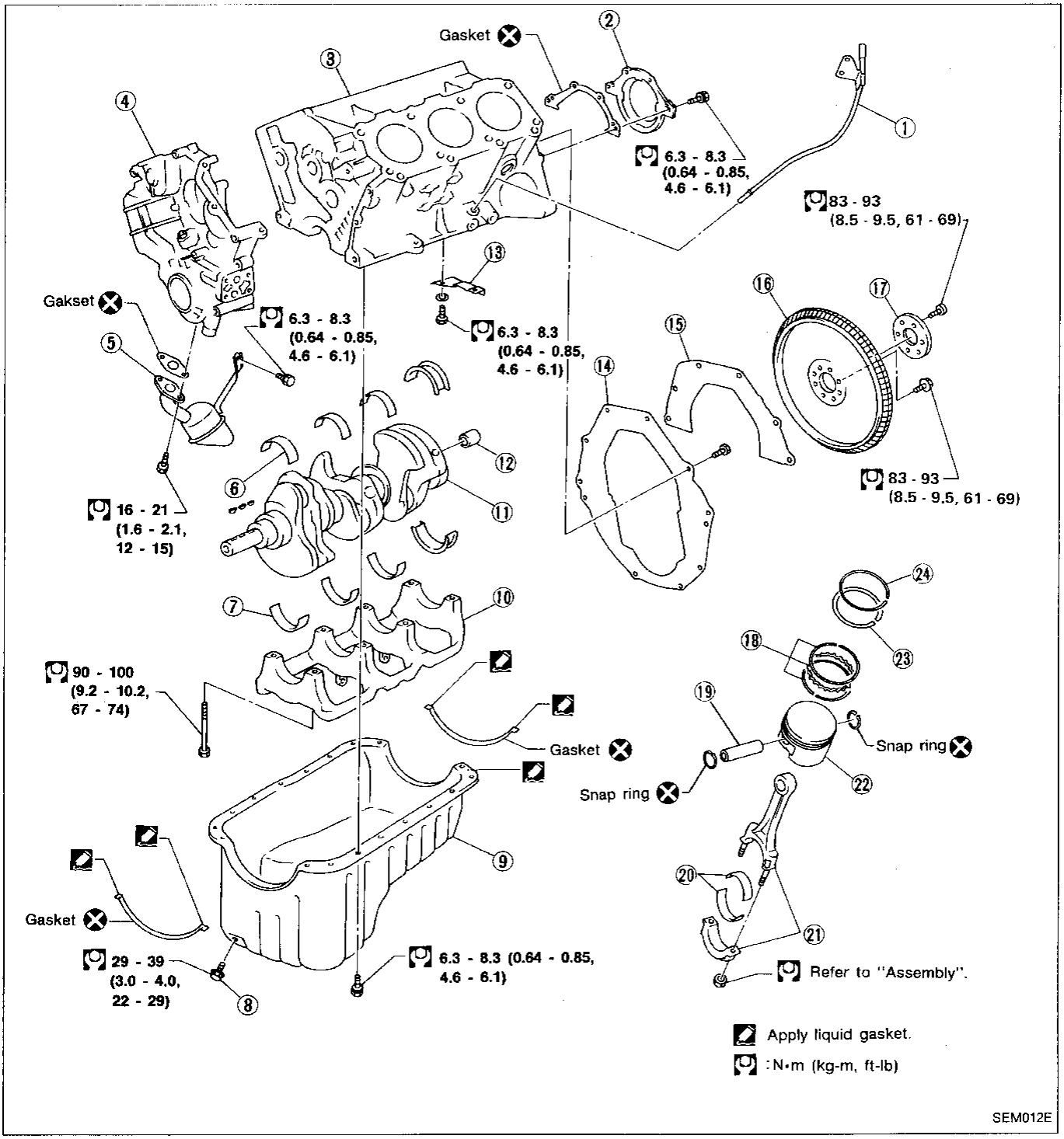
11. Remove center member and then slowly lower transmission jack.

12. Remove engine with transaxle as shown.



Installation

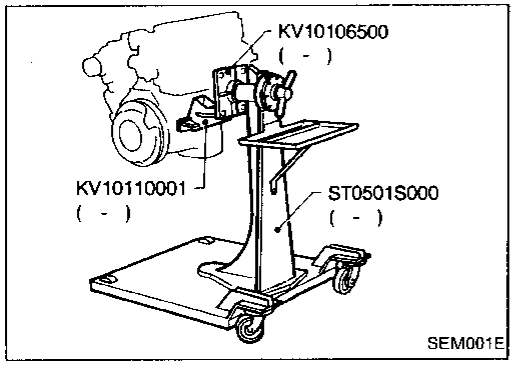
1. Installation is in the reverse order of removal.



① Oil level gauge guide
② Rear oil seal retainer
③ Cylinder block
④ Front cover
⑤ Oil strainer
⑥ Upper main bearing
⑦ Lower main bearing
⑧ Drain plug
⑨ Oil pan
⑩ Main bearing beam
⑪ Crankshaft
⑫ Pilot bushing or pilot converter
⑬ Oil separator
⑭ Rear plate (M/T models)
⑮ Rear plate (A/T models)
⑯ Flywheel or driver plate
⑰ Drive plate reinforcement
⑱ Oil ring
⑲ Piston pin
⑳ Connecting rod bearing
㉑ Connecting rod
㉒ Piston
㉓ 2nd ring
㉔ Top ring

CAUTION:

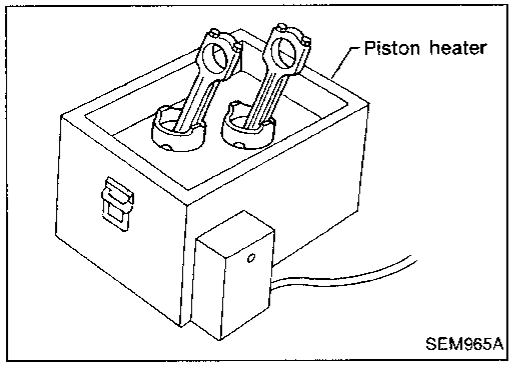
- **When installing sliding parts such as bearings and pistons, be sure to apply engine oil on the sliding surfaces.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When tightening connecting rod bolts and main bearing cap bolts, apply engine oil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



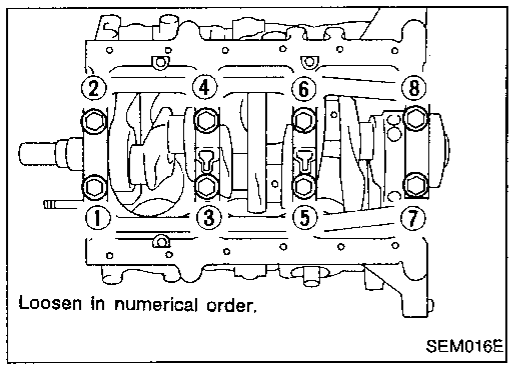
Disassembly

PISTON AND CRANKSHAFT

1. Remove engine. Refer to "ENGINE REMOVAL".
2. Place engine on a work stand.
3. Drain coolant and oil.
4. Remove cylinder head. Refer to "Removal" in "TIMING CHAIN".
5. Remove oil pan. Refer to "Removal" in "OIL PAN".
6. Remove timing chain. Refer to "Removal" in "TIMING CHAIN" (EM-54).



7. 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.
8. Remove rear oil seal retainer.

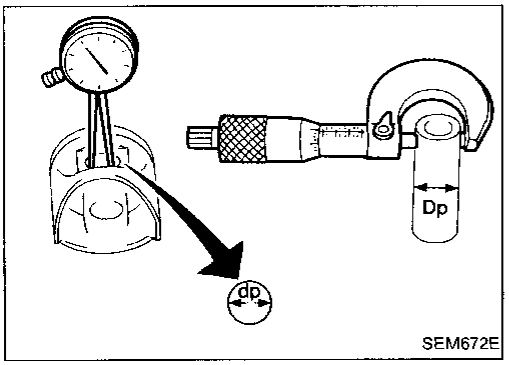


9. Remove main bearing beam and crankshaft.
   - **Before removing main bearing beam, measure crankshaft end play.**
   - **Bolts should be loosened in two or three steps.**

Inspection

PISTON AND PISTON PIN CLEARANCE

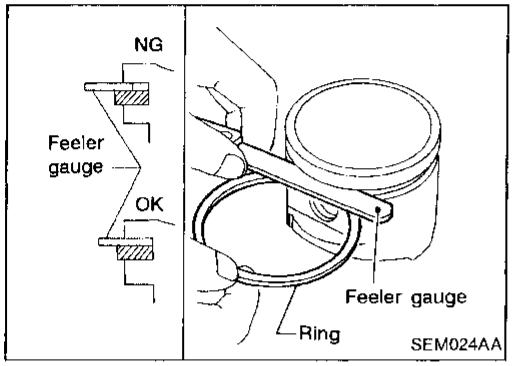
1. Measure inner diameter of piston pin hole "dp".
   Standard diameter "dp":
   21.987 - 21.999 mm (0.8656 - 0.8661 in)



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)

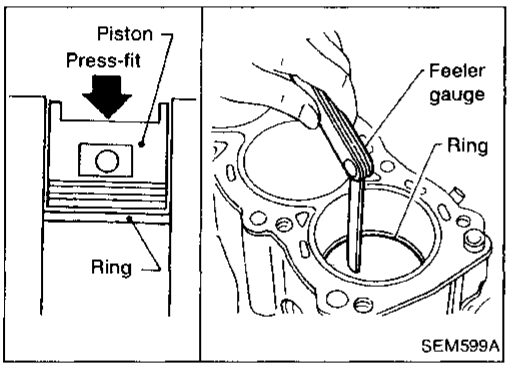
If it exceeds the above value, replace piston assembly with pin.



PISTON RING SIDE CLEARANCE

Side clearance:
Top ring
0.040 - 0.080 mm (0.0016 - 0.0031 in)
2nd ring
0.030 - 0.063 mm (0.0012 - 0.0025 in)
Max. limit of side clearance:
0.1 mm (0.004 in)

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



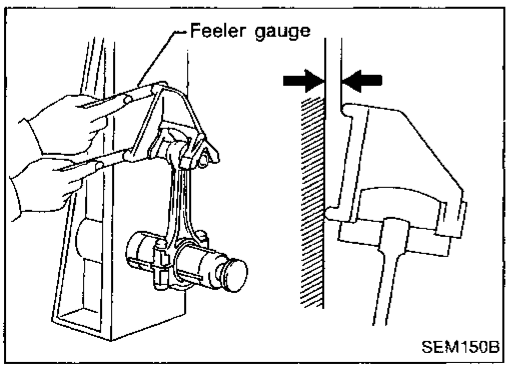
PISTON RING END GAP

End gap:
Top ring 0.21 - 0.40 mm (0.0083 - 0.0157 in)
2nd ring 0.50 - 0.69 mm (0.0197 - 0.0272 in)
Oil ring 0.20 - 0.69 mm (0.0079 - 0.0272 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 SDS (EM-101).

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

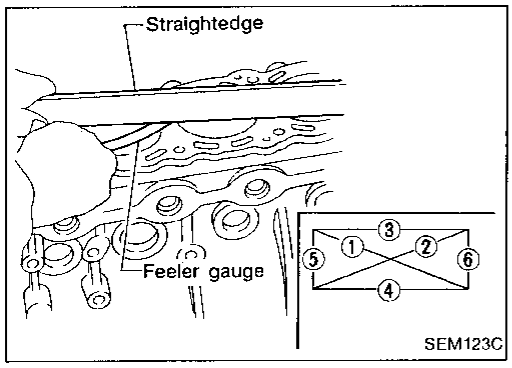


CONNECTING ROD BEND AND TORSION

Bend:
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)



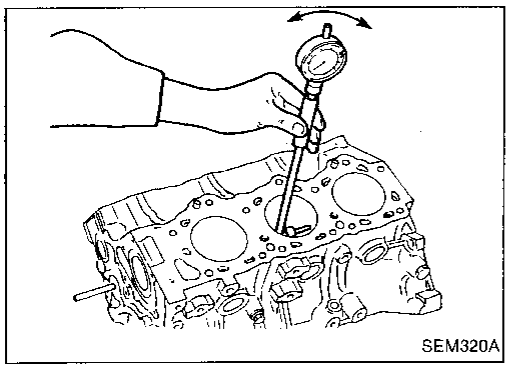
CYLINDER BLOCK DISTORTION AND WEAR

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

Resurfacing limit:

Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".
The maximum limit is as follows:
A + B = 0.2 mm (0.008 in)
Nominal cylinder block height from crankshaft center:
227.60 - 227.70 mm (8.9606 - 8.9645 in)

3. If necessary, replace cylinder block.



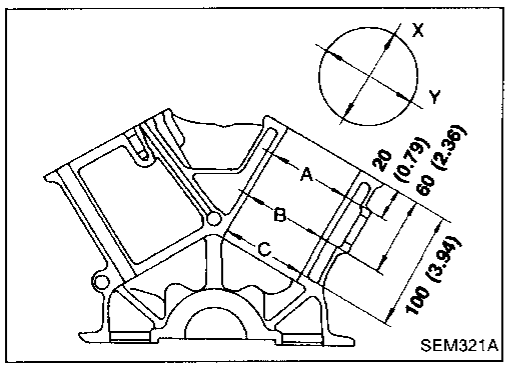
PISTON-TO-BORE CLEARANCE

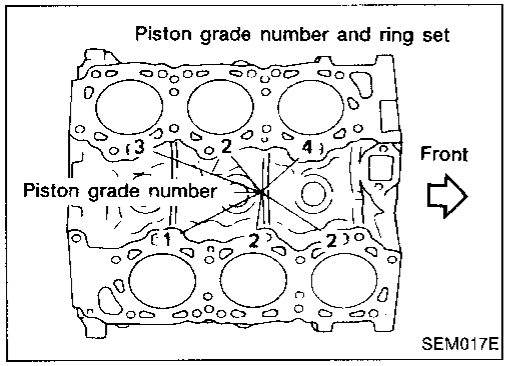
1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.
   Standard inner diameter:
   87.000 - 87.030 mm (3.4252 - 3.4264 in)
   Wear limit:
   0.20 mm (0.0079 in)

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

Out-of-round (X – Y) standard:
0.015 mm (0.0006 in)
Taper (A – B) standard:
0.010 mm (0.004 in)

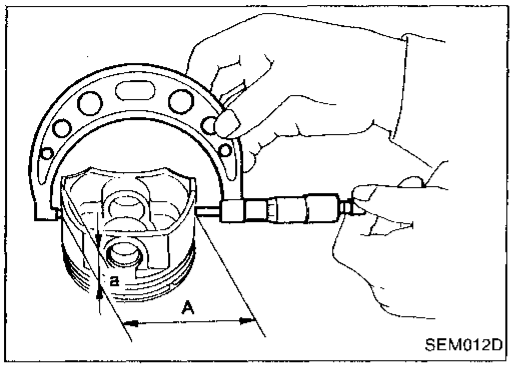
2. Check for scratches and seizure. If seizure is found, hone it.





- **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 SDS (EM-101).
   Measuring point "a" (Distance from the bottom):
   16.5 mm (0.650 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.

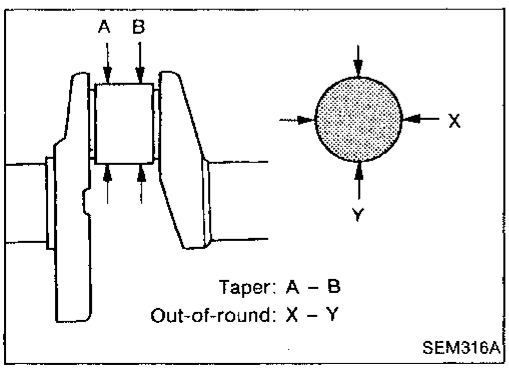
Oversize pistons are available for service. Refer to SDS (EM-101).

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.**

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

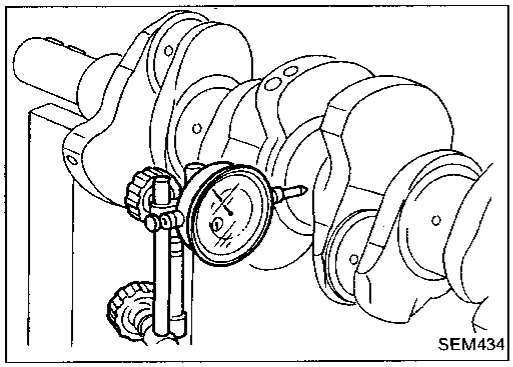
- **Measurement should be done after cylinder bore cools down.**



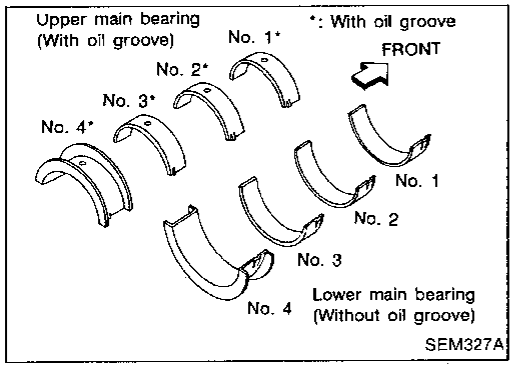
CRANKSHAFT

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)

Inspection (Cont'd)


SEM434

3. Measure crankshaft runout.
   Runout (Total indicator reading):
   Less than 0.10 mm (0.0039 in)



SEM327A

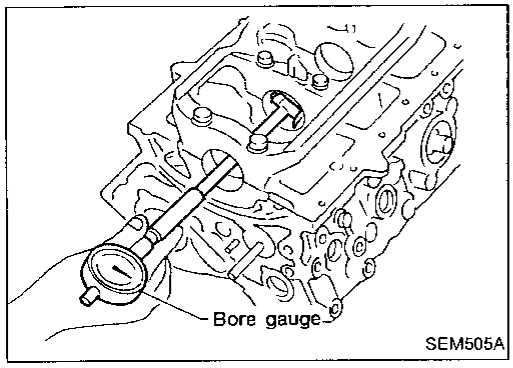
BEARING CLEARANCE

- 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.

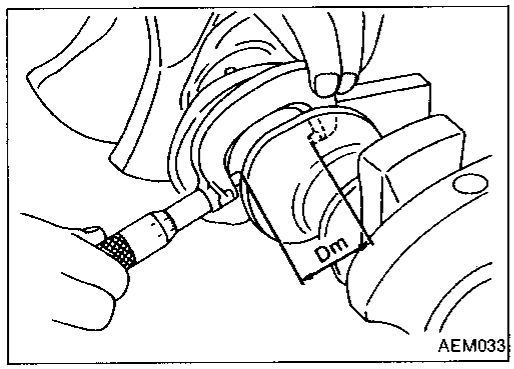


SEM505A

2. Install main bearing cap to cylinder block.

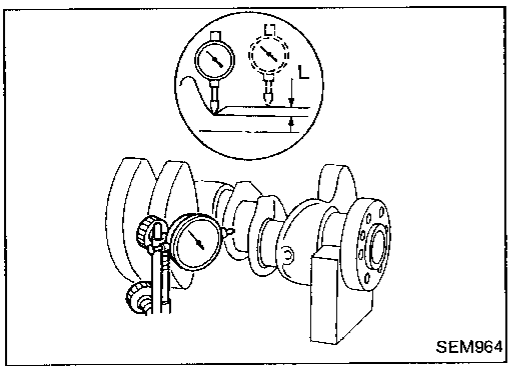
Tighten all bolts in correct order in two or three stages.

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



AEM033

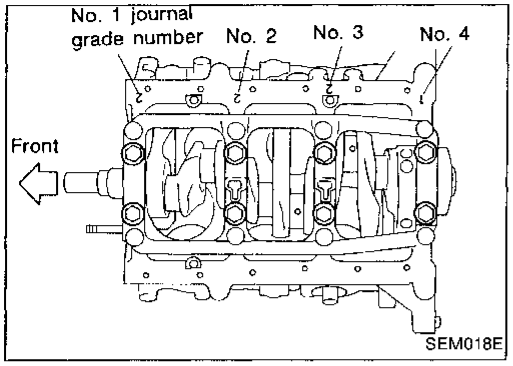
4. Measure outer diameters "Dm" of each crankshaft main journal.
5. Calculate main bearing clearance.
   Main bearing clearance = A – Dm
   Standard: 0.028 - 0.055 mm (0.0011 - 0.0022 in)
   Limit: 0.090 mm (0.0035 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.



SEM964

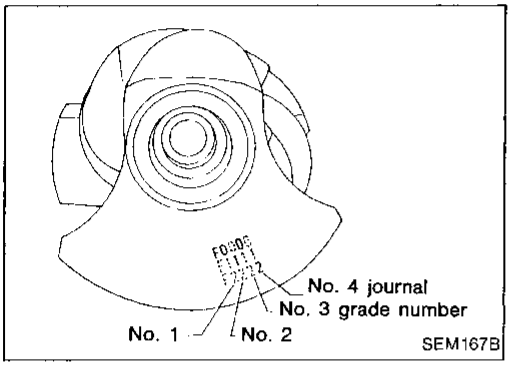
a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.
   "L": 0.1 mm (0.004 in)
b. Refer to SDS for grinding crankshaft and available service parts.

Inspection (Cont'd)



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.

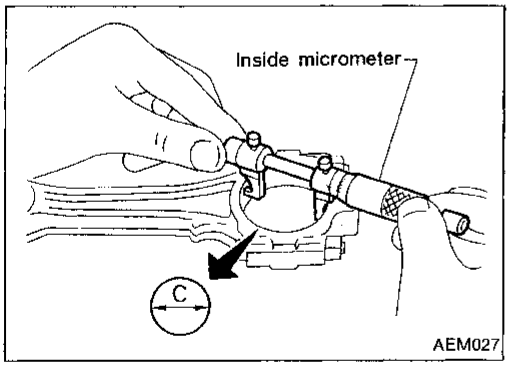


b. Grade number of each crankshaft main journal is punched on the respective crankshaft. These numbers are punched in either Arabic or Roman numerals.

c. Select main bearing with suitable thickness according to the following calculation or table.
   Example of calculation:
   Main journal grade number: 1
   Crankshaft journal grade number: 2
   Main bearing grade number = 1 + 2 = 3 (Yellow)

Main bearing grade number (Identification color):

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

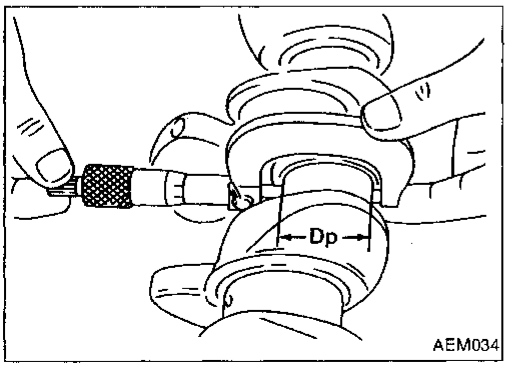


Connecting rod bearing (Big end)

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

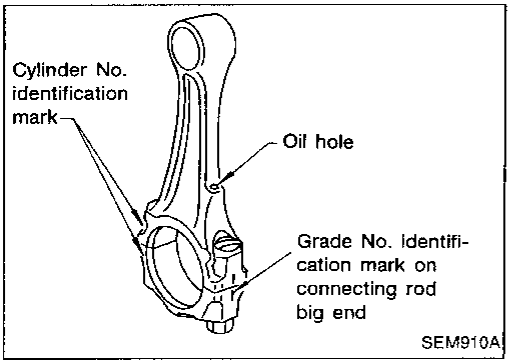
Tighten bolts to the specified torque.

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



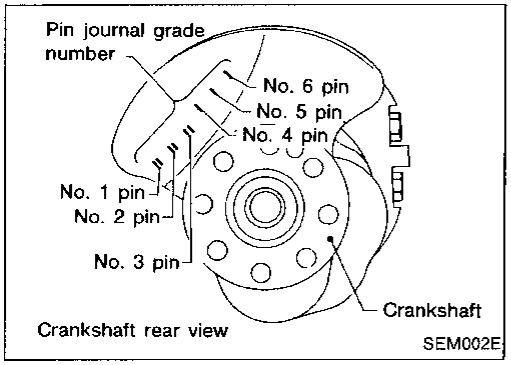
4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.
   Connecting rod bearing clearance = C – Dp
   Standard: 0.028 - 0.048 mm (0.0011 - 0.0019 in)
   Limit: 0.090 mm (0.0035 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to step 7 of "BEARING CLEARANCE — Main bearing" (EM-85).

Inspection (Cont'd)



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.



b. Grade number of each crankshaft pin journal is punched on the No. 5 counter weight of crankshaft. These numbers are punched in either Arabic or Roman numerals.

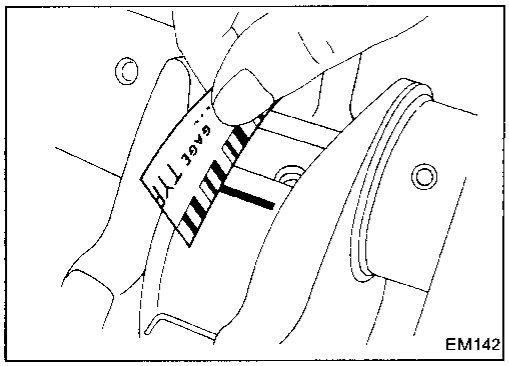
c. Select connecting rod bearing with suitable thickness according to the following calculation and table.

Example of calculation:

Connecting rod big end grade number: 1
Crankshaft pin grade number: 2
Connecting rod bearing grade number
= 1 + 2
= 3 (Yellow)

Connecting rod bearing grade number (Identification color):

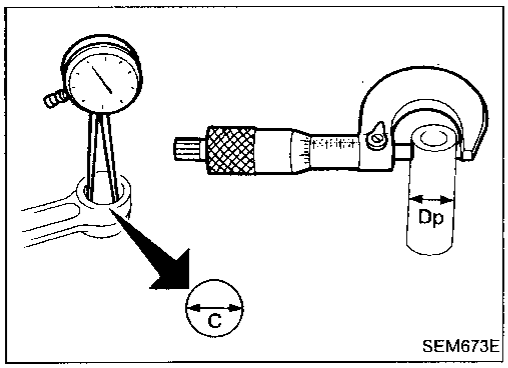
		Connecting rod end grade number	
		"0"	"1(I)"
Crankshaft pin grade number	"0"	0 (No color)	1 (Brown)
	"1 (I)"	1 (Brown)	2 (Green)
	"2 (II)"	2 (Green)	3 (Yellow)



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)

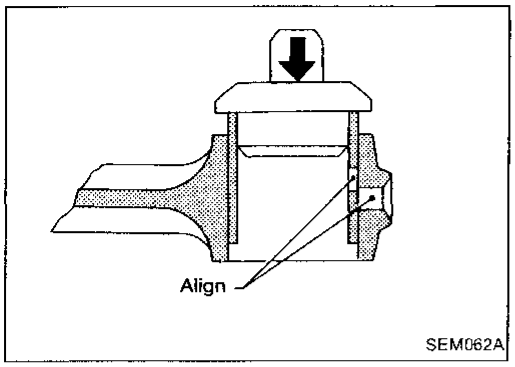
1. Measure inner diameter "C" of bushing.
2. Measure outer diameter "Dp" of piston pin.
3. Calculate connecting rod bushing clearance.

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 set with pin.

Inspection (Cont'd)



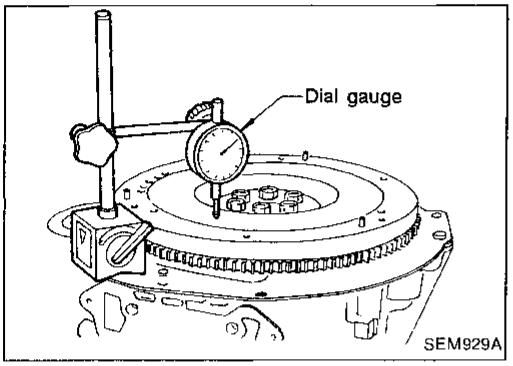
REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

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 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)



FLYWHEEL/DRIVE PLATE RUNOUT

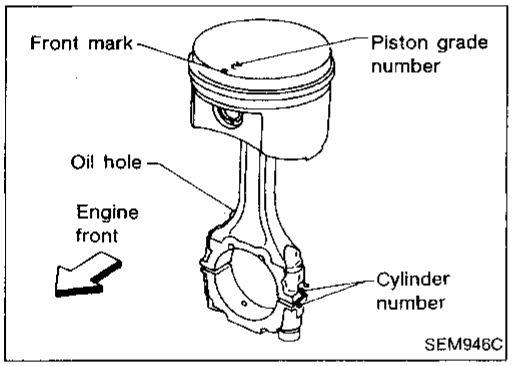
Runout (Total indicator reading):

Flywheel (M/T model)

Less than 0.15 mm (0.0059 in)

Drive plate (A/T model)

Less than 0.15 mm (0.0059 in)



Assembly

PISTON

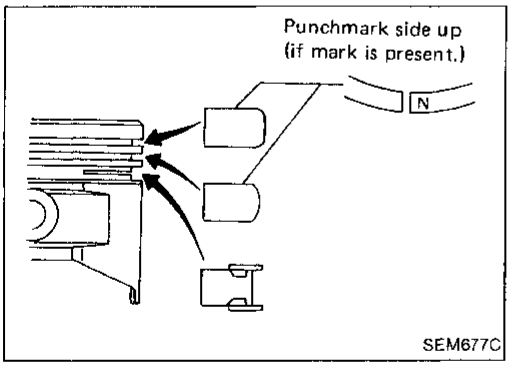
1. Install new snap ring on one side of piston pin hole.
2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.

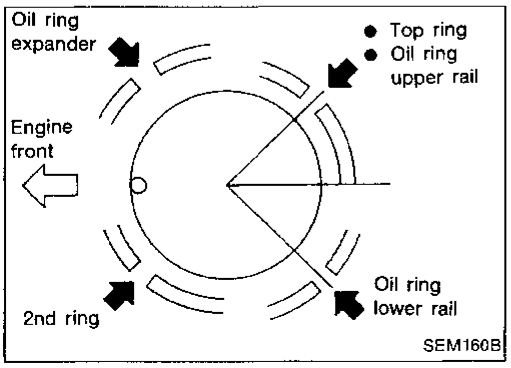
- **Align the direction of piston and connecting rod.**
- **Numbers stamped on connecting rod and cap correspond to each cylinder.**
- **After assembly, make sure connecting rod swings smoothly.**

3. Set piston rings as shown.

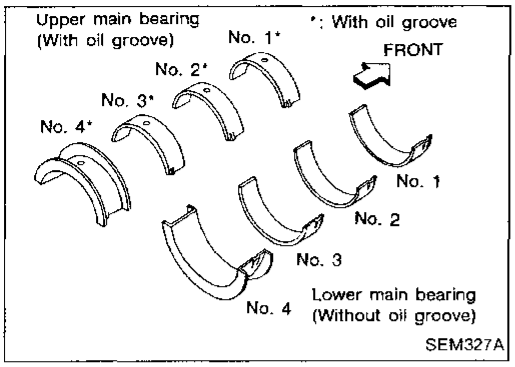
CAUTION:

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





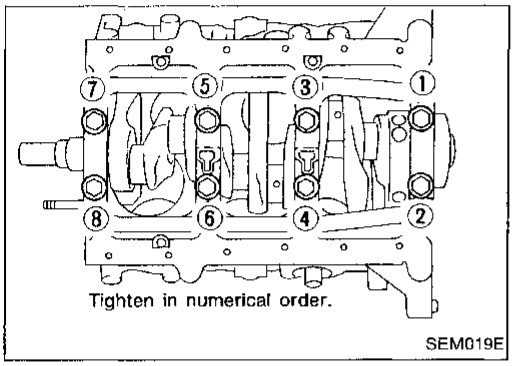
Assembly (Cont'd)



CRANKSHAFT

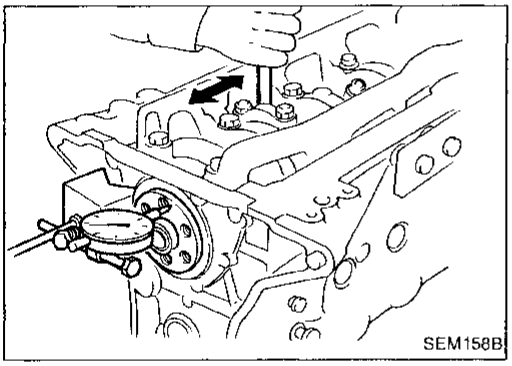
1. Set main bearings in their proper positions on cylinder block and main bearing beam.

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



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

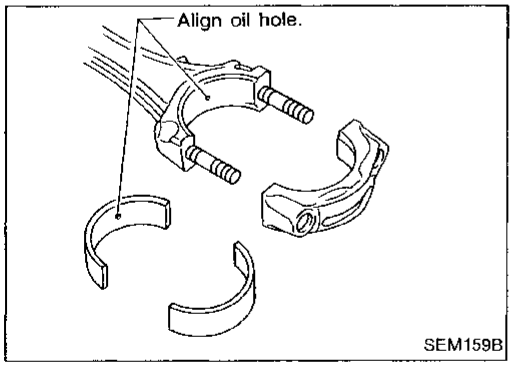
- **Prior to tightening bearing beam bolts, place bearing beam in its proper position by shifting crankshaft in the axial direction.**
- **Tighten bearing beam bolts gradually in two or three stages. Start with center bearing and move outward sequentially.**
- **After securing bearing beam bolts, make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



3. Measure crankshaft end play.

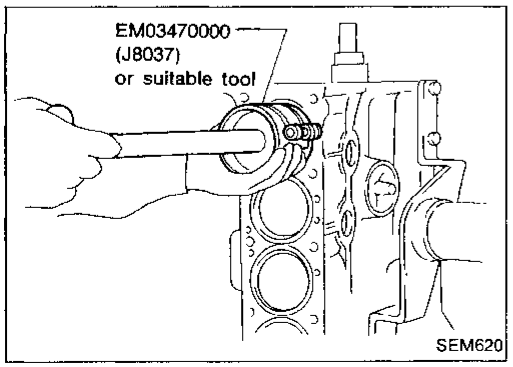
Crankshaft end play:
Standard
0.05 - 0.17 mm (0.0020 - 0.0067 in)
Limit
0.30 mm (0.0118 in)

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



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

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

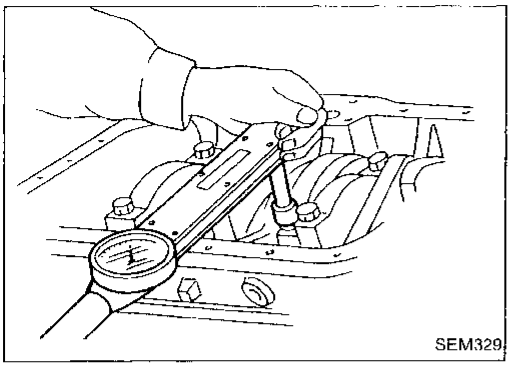


5. Install pistons with connecting rods.

a. Install them into corresponding cylinders with Tool.

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

Assembly (Cont'd)

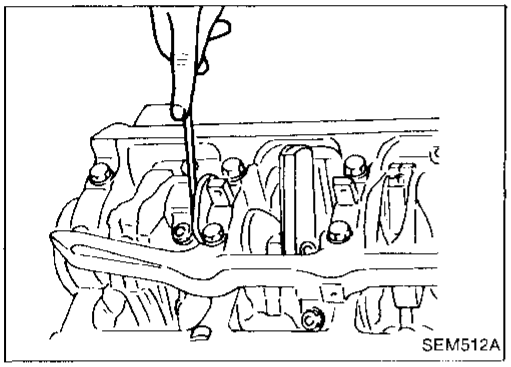

SEM329

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

Connecting rod bearing nut:

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

(2) Turn nuts 60 to 65 degrees clockwise.
If an angle wrench is not available, tighten nuts to 59 to 65 N·m (6.0 to 6.6 kg-m, 43 to 48 ft-lb).


SEM512A

6. Measure connecting rod side clearance.

Connecting rod side clearance:

Standard
0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit
0.40 mm (0.0157 in)

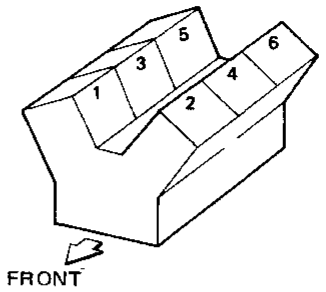
If beyond the limit, replace connecting rod and/or crankshaft.

7. Install rear oil seal retainer.

General Specifications

Cylinder arrangement		V-6
Displacement	cm^3 (cu in)	2,960 (180.62)
Bore and stroke	mm (in)	87 x 83 (3.43 x 3.27)
Valve arrangement		OHC
Firing order		1-2-3-4-5-6
Number of piston rings		
Compression		2
Oil		1
Number of main bearings		4
Compression ratio		9.0

Cylinder number



SEM713A

COMPRESSION PRESSURE

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

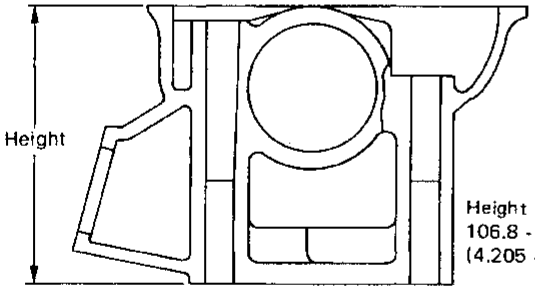
Compression pressure	
Standard	1,196 (12.2, 173)
Minimum	883 (9.0, 128)
Differential limit between cylinders	98 (1.0, 14)

Inspection and Adjustment

CYLINDER HEAD

Unit: mm (in)

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



SEM082B

Rocker shaft and rocker arm

Unit: mm (in)

Rocker shaft	
Outer diameter	17.988 - 18.000 (0.7082 - 0.7087)
Rocker arm	
Inner diameter	18.007 - 18.028 (0.7089 - 0.7098)
Clearance between rocker arm and rocker shaft	0.007 - 0.049 (0.0003 - 0.0019)

Valve spring

Free height	mm (in)	Outer	51.2 (2.016)
		Inner	44.1 (1.736)
Pressure N (kg, lb) at height mm (in)		Outer	523.7 (53.4, 117.7) at 30.0 (1.181)
		Inner	255.0 (26.0, 57.3) at 25.0 (0.984)
Out-of-square	mm (in)	Outer	2.2 (0.087)
		Inner	1.9 (0.075)

Hydraulic valve lifter

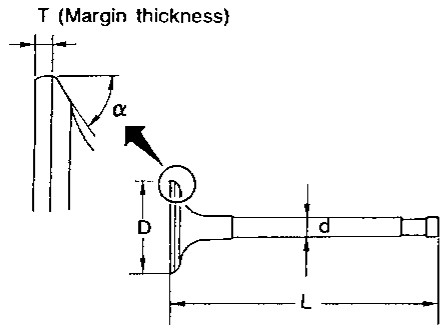
Unit: mm (in)

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

Inspection and Adjustment (Cont'd)

VALVE

Unit: mm (in)



SEM188

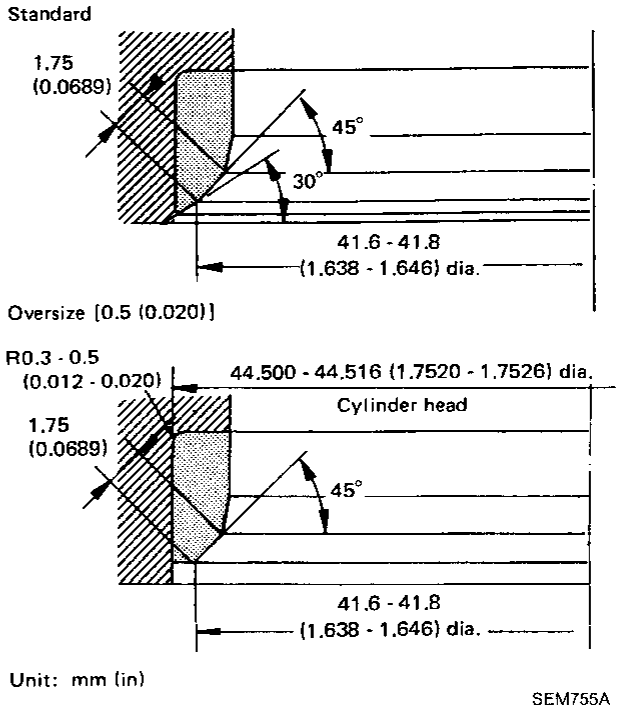
Valve head diameter "D"	
Intake	42.0 - 42.2 (1.654 - 1.661)
Exhaust	35.0 - 35.2 (1.378 - 1.386)
Valve length "L"	
Intake	125.3 - 125.9 (4.933 - 4.957)
Exhaust	124.2 - 124.8 (4.890 - 4.913)
Valve stem diameter "d"	
Intake	6.965 - 6.980 (0.2742 - 0.2748)
Exhaust	7.965 - 7.970 (0.3136 - 0.3138)
Valve seat angle "α"	
Intake	45°15' - 45°45'
Exhaust	
Valve margin "T"	
Intake	1.15 - 1.45 (0.0453 - 0.0571)
Exhaust	1.35 - 1.65 (0.0531 - 0.0650)
Valve margin "T" limit	More than 0.5 (0.020)
Valve stem end surface grinding limit	Less than 0.2 (0.008)
Valve clearance	
Intake	0 (0)
Exhaust	0 (0)

Valve guide

Unit: mm (in)

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

Intake valve seat

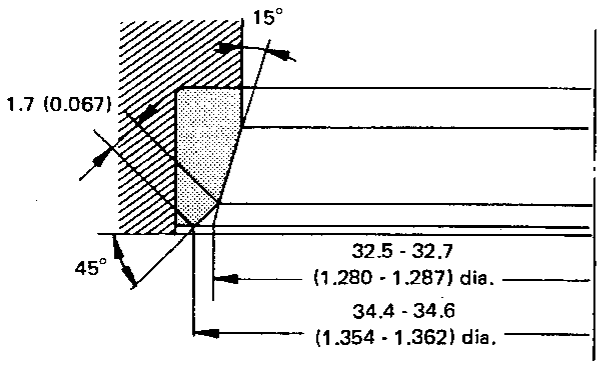


SEM755A

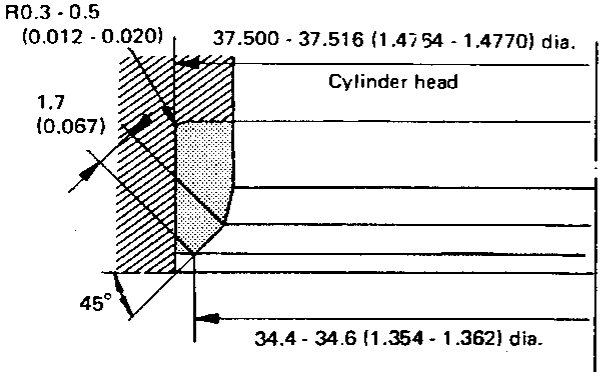
Inspection and Adjustment (Cont'd)

Exhaust valve seat

Standard



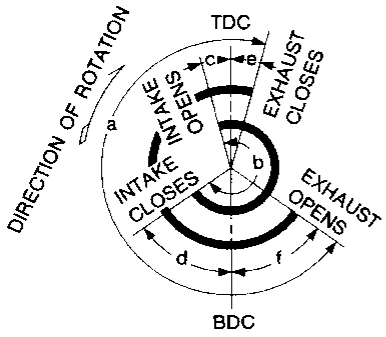
Oversize [0.5 (0.020)]



Unit: mm (in)

SEM756A

Valve timing



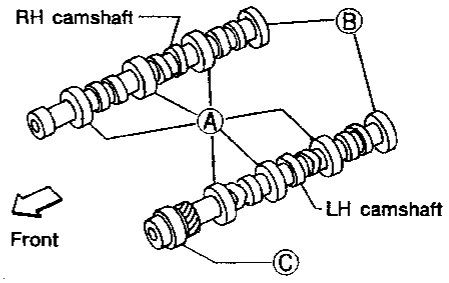
EM120

Unit: degree

a	b	c	d	e	f
248	248	10	58	10	58

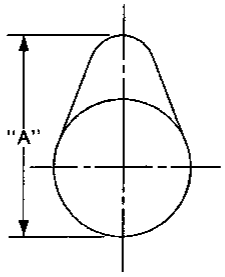
CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)



SEM893BA

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



EM671

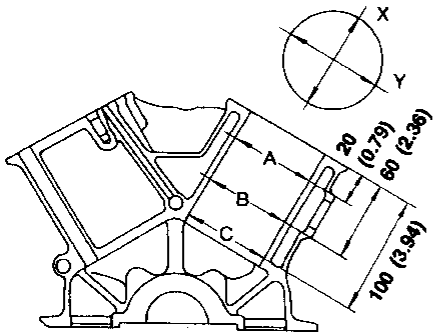
Cam height "A"		
	Intake	39.537 - 39.727 (1.5566 - 1.5641)
	Exhaust	
Wear limit of cam height		0.15 (0.0059)

*Total indicator reading

Inspection and Adjustment (Cont'd)

CYLINDER BLOCK

Unit: mm (in)



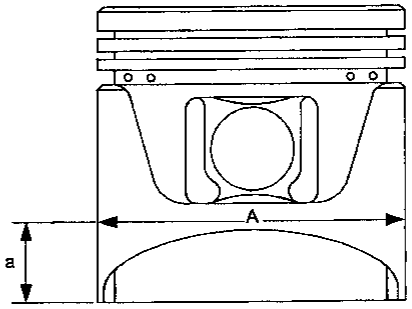
SEM321A

Surface flatness	
Standard	Less than 0.03 (0.0012)
Limit	0.10 (0.0039)
Cylinder bore	
Inner diameter	
Standard	
Grade No. 1	87.000 - 87.010 (3.4252 - 3.4256)
Grade No. 2	87.010 - 87.020 (3.4256 - 3.4260)
Grade No. 3	87.020 - 87.030 (3.4260 - 3.4264)
Wear limit	0.20 (0.0079)
Out-of-round (X - Y)	Less than 0.015 (0.0006)
Taper (A - B - C)	Less than 0.015 (0.0006)
Main journal inner diameter	
Grade No. 0	66.645 - 66.654 (2.6238 - 2.6242)
Grade No. 1	66.654 - 66.663 (2.6242 - 2.6245)
Grade No. 2	66.663 - 66.672 (2.6245 - 2.6249)
Difference in inner diameter between cylinders	
Standard	Less than 0.05 (0.0020)

PISTON, PISTON RING AND PISTON PIN

Available piston

Unit: mm (in)



SEM750C

Piston skirt diameter "A"	
Standard	
Grade No. 1	86.965 - 86.975 (3.4238 - 3.4242)
Grade No. 2	86.975 - 86.985 (3.4242 - 3.4246)
Grade No. 3	86.985 - 86.995 (3.4246 - 3.4250)
0.25 (0.0098) oversize (Service)	87.215 - 87.265 (3.4337 - 3.4356)
0.50 (0.0197) oversize (Service)	87.465 - 87.515 (3.4435 - 3.4455)
"a" dimension	18 (0.71)
Piston pin hole diameter	20.969 - 20.981 (0.8255 - 0.8260)
Piston clearance to cylinder block	0.015 - 0.035 (0.0006 - 0.0014)

Piston ring

Unit: mm (in)

	Standard	Limit
Side clearance		
Top	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
2nd	0.030 - 0.063 (0.0012 - 0.0025)	
Oil	0.015 - 0.19 (0.0006 - 0.0075)	—
Ring gap		
Top	0.21 - 0.44 (0.0083 - 0.0173)	1.0 (0.039)
2nd	0.18 - 0.44 (0.0071 - 0.0173)	
Oil (rail ring)	0.20 - 0.76 (0.0079 - 0.0299)	

Inspection and Adjustment (Cont'd)

Piston pin

Unit: mm (in)

Piston pin outer diameter	20.971 - 20.983 (0.8256 - 0.8261)
Interference fit of piston pin to piston	0 - 0.004 (0 - 0.0002)
Piston pin to connecting rod bushing clearance	0.005 - 0.017 (0.0002 - 0.0007)

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

CONNECTING ROD

Unit: mm (in)

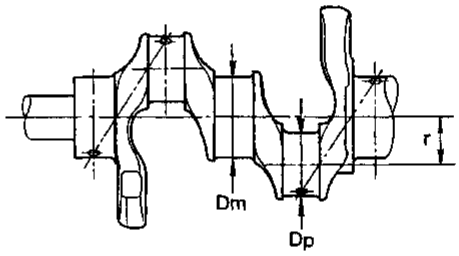
Center distance	154.1 - 154.2 (6.067 - 6.071)
Bend, torsion [per 100 (3.94)]	
Limit	0.10 (0.0039)
Piston pin bushing inner diameter*	20.982 - 20.994 (0.8261 - 0.8265)
Connecting rod big end inner diameter	53.000 - 53.013 (2.0866 - 2.0871)
Side clearance	
Standard	0.20 - 0.35 (0.0079 - 0.0138)
Limit	0.40 (0.0157)

*After installing in connecting rod

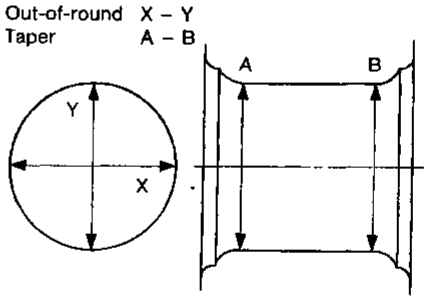
CRANKSHAFT

Unit: mm (in)

Main journal dia. "Dm"	
Grade No. 0	62.967 - 62.975 (2.4790 - 2.4793)
Grade No. 1	62.959 - 62.967 (2.4787 - 2.4790)
Grade No. 2	62.951 - 62.959 (2.4784 - 2.4787)
Pin journal dia. "Dp"	49.955 - 49.974 (1.9667 - 1.9675)
Center distance "r"	41.5 (1.634)
Out-of-round (X - Y)	
Standard	Less than 0.005 (0.0002)
Taper (A - B)	
Standard	Less than 0.005 (0.0002)
Runout [TIR]	
Standard	Less than 0.10 (0.0039)
Free end play	
Standard	0.050 - 0.170 (0.0020 - 0.0067)
Limit	0.30 (0.0118)



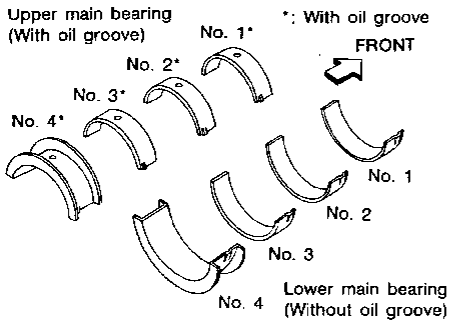
SEM645



EM715

Inspection and Adjustment (Cont'd)

AVAILABLE MAIN BEARING



SEM327A

No. 1 main bearing

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)		Black
1	1.821 - 1.825 (0.0717 - 0.0719)		Brown
2	1.825 - 1.829 (0.0719 - 0.0720)	22.4 - 22.6 (0.882 - 0.890)	Green
3	1.829 - 1.833 (0.0720 - 0.0722)		Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)		Blue

No. 2 and 3 main bearing

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)		Black
1	1.821 - 1.825 (0.0717 - 0.0719)		Brown
2	1.825 - 1.829 (0.0719 - 0.0720)	18.9 - 19.1 (0.744 - 0.752)	Green
3	1.829 - 1.833 (0.0720 - 0.0722)		Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)		Blue

No. 4 main bearing

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

Main bearing 0.25 mm (0.0098 in) undersize

Unit: mm (in)

Thickness "T"	1.943 - 1.956 (0.0765 - 0.0770)

AVAILABLE CONNECTING ROD BEARING

Connecting rod bearing undersize

Unit: mm (in)

	Crank pin journal diameter "Dp"
Standard	49.955 - 49.974 (1.9667 - 1.9675)
Undersize	
0.08 (0.0031)	49.875 - 49.894 (1.9636 - 1.9643)
0.12 (0.0047)	49.835 - 49.854 (1.9620 - 1.9628)
0.25 (0.0098)	49.705 - 49.724 (1.9569 - 1.9576)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Flywheel	
Runout [TIR]	Less than 0.15 (0.0059)

Bearing clearance

Unit: mm (in)

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

General Specifications

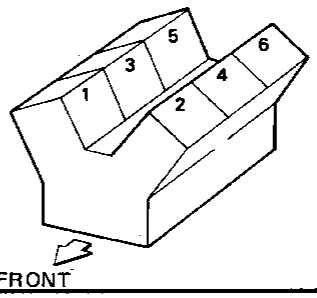
Cylinder arrangement		V-6
Displacement	cm^3 (cu in)	2,960 (180.62)
Bore and stroke	mm (in)	87 x 83 (3.43 x 3.27)
Valve arrangement		DOHC
Firing order		1-2-3-4-5-6
Number of piston rings		
Compression		2
Oil		1
Number of main bearings		4
Compression ratio		10.0

COMPRESSION PRESSURE

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

Compression pressure	
Standard	1,265 (12.9, 183)
Minimum	981 (10.0, 142)
Differential limit between cylinders	98 (1.0, 14)

Cylinder number



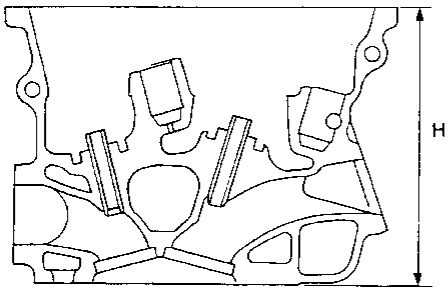
SEM713A

Inspection and Adjustment

CYLINDER HEAD

Unit: mm (in)

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

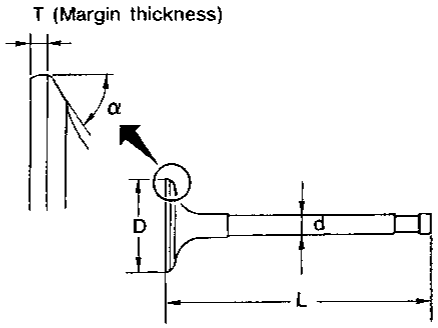


Nominal cylinder head height:
H = 138.72 - 138.92 mm (5.4614 - 5.4693 in)

SEM020E

VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	
Intake	35.0 - 35.2 (1.378 - 1.386)
Exhaust	30.5 - 30.7 (1.201 - 1.209)
Valve length "L"	
Intake	110.25 - 110.75 (4.3405 - 4.3602)
Exhaust	102.45 - 102.95 (4.0335 - 4.0531)
Valve stem diameter "d"	
Intake	5.975 - 5.980 (0.2352 - 0.2354)
Exhaust	5.955 - 5.960 (0.2344 - 0.2346)
Valve seat angle "α"	
Intake	45°15' - 45°45'
Exhaust	
Valve margin "T"	
Intake	1.15 - 1.45 (0.0453 - 0.0571)
Exhaust	1.45 - 1.75 (0.0571 - 0.0689)
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)	45.13 (1.7768)
Pressure N (kg, lb) at height mm (in)		
Standard		535.5 (54.6, 120.4) at 26.9 (1.059)
Limit		477.6 (48.7, 107.4) at 26.9 (1.059)
Out-of-square	mm (in)	Less than 2.0 (0.079)

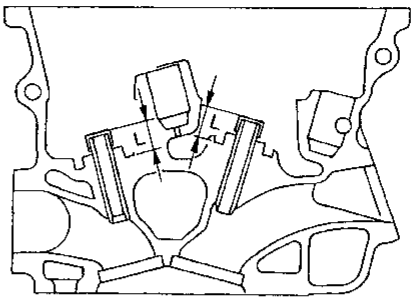
Hydraulic lash adjuster (HLA)

Unit: mm (in)

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

Valve guide

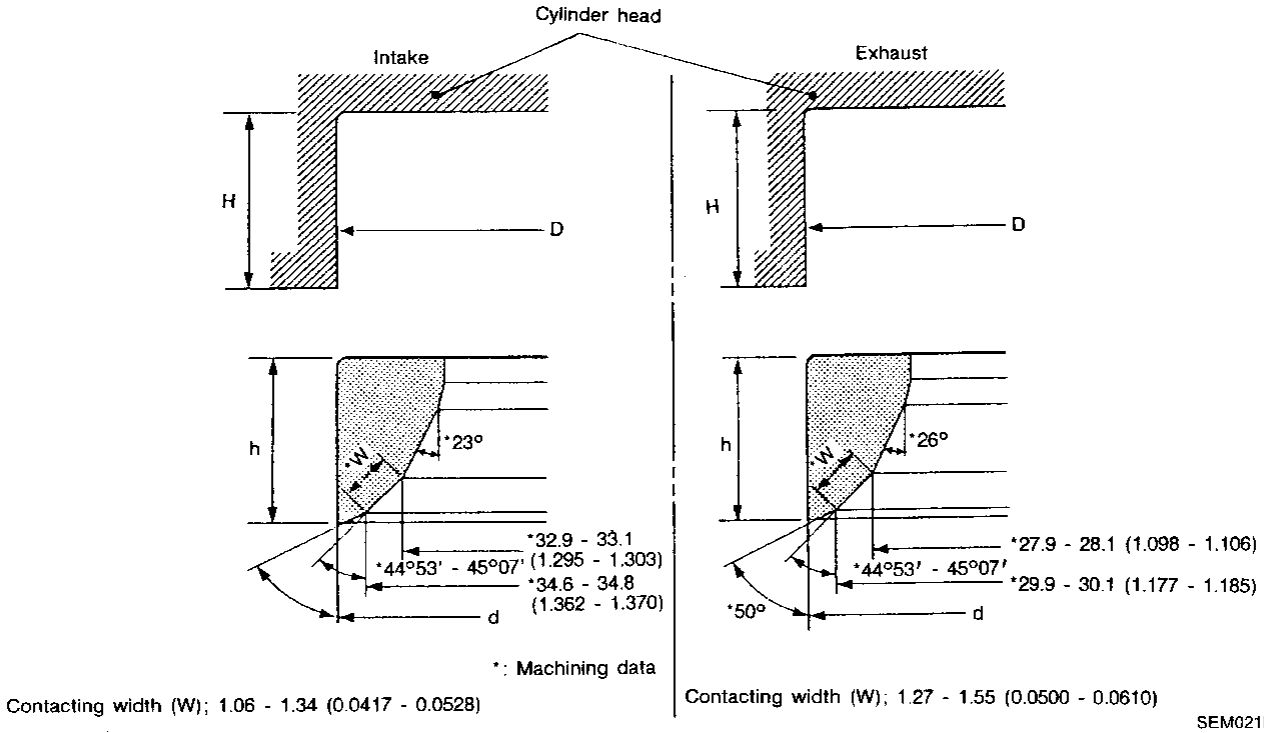
Unit: mm (in)



SEM992D

		Standard	Service
Valve guide Outer diameter		10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
Valve guide Inner diameter (Finished size)		6.00 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter		9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
		Standard	Max. tolerance
Stem to guide clearance	Intake	0.020 - 0.043 (0.008 - 0.0017)	0.08 (0.0031)
	Exhaust	0.040 - 0.063 (0.0016 - 0.0025)	0.1 (0.004)
Valve deflection limit		—	0.20 (0.0079)
Projection length "L"		13.6 - 13.8 (0.535 - 0.543)	

VALVE SEAT



Unit: mm (in)

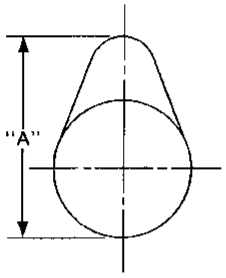
		Standard	Service
Cylinder head seat recess diameter (D)	In.	36.000 - 36.016 (1.4173 - 1.4179)	36.500 - 36.516 (1.4370 - 1.4376)
	Ex.	31.500 - 31.516 (1.2402 - 1.2408)	32.000 - 32.016 (1.2598 - 1.2605)
Valve seat interference fit	In.	0.081 - 0.113 (0.0032 - 0.0044)	
	Ex.	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	In.	36.097 - 36.113 (1.4211 - 1.4218)	36.597 - 36.613 (1.4408 - 1.4415)
	Ex.	31.580 - 31.596 (1.2433 - 1.2439)	32.080 - 32.096 (1.2630 - 1.2636)
Height (h)	In.	5.9 - 6.0 (0.232 - 0.236)	
	Ex.	5.9 - 6.0 (0.232 - 0.236)	
Depth (H)		5.9 - 6.1 (0.232 - 0.240)	

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)	0.15 (0.0059)
Inner diameter of camshaft bearing	26.000 - 26.021 (1.0236 - 1.0244)	—
Outer diameter of camshaft journal	25.935 - 25.955 (1.0211 - 1.0218)	—
Camshaft runout [TIR*]	Less than 0.02 (0.0008)	0.05 (0.0020)
Camshaft sprocket runout [TIR*]	Less than 0.15 (0.0059)	—
Camshaft end play	0.070- 0.148 (0.0028 - 0.0058)	0.20 (0.0079)

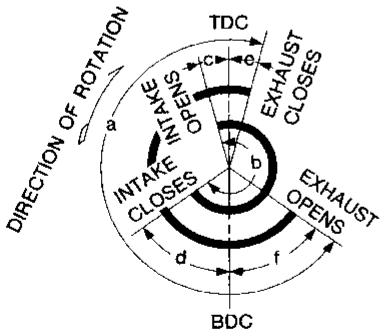


EM671

Cam height "A"	
Intake	37.678 - 37.868 (1.4834 - 1.4909)
Exhaust	37.678 - 37.868 (1.4834 - 1.4909)
Wear limit of cam height	0.05 (0.0020)

*Total indicator reading

Valve timing

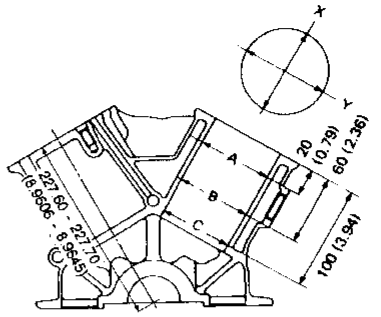


EM120
Unit: degree

a	b	c	d	e	f
248	248	–1	69	9	59

CYLINDER BLOCK

Unit: mm (in)



SEM022E

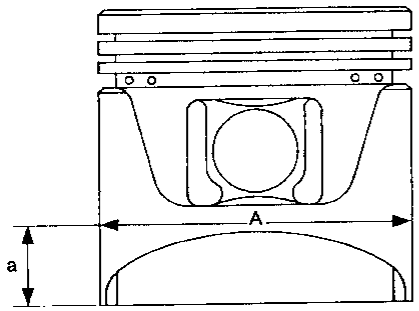
Surface flatness	
Standard	Less than 0.03 (0.0012)
Limit	0.10 (0.0039)
Cylinder bore	
Inner diameter	
Standard	
Grade No. 1	87.000 - 87.010 (3.4252 - 3.4256)
Grade No. 2	87.010 - 87.020 (3.4256 - 3.4260)
Grade No. 3	87.020 - 87.030 (3.4260 - 3.4264)
Wear limit	0.20 (0.0079)
Out-of-round (X – Y)	Less than 0.015 (0.0006)
Taper (A – B – C)	Less than 0.010 (0.0004)
Main journal inner diameter	
Grade No. 0	66.645 - 66.654 (2.6238 - 2.6242)
Grade No. 1	66.654 - 66.663 (2.6242 - 2.6245)
Grade No. 2	66.663 - 66.672 (2.6245 - 2.6249)
Difference in inner diameter between cylinders	
Standard	Less than 0.05 (0.0020)

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	86.975 - 86.985 (3.4242 - 3.4246)
Grade No. 2	86.985 - 86.995 (3.4246 - 3.4250)
Grade No. 3	86.995 - 87.005 (3.4250 - 3.4254)
0.25 (0.0098) oversize (Service)	87.225 - 87.275 (3.4340 - 3.4360)
0.50 (0.0197) oversize (Service)	87.475 - 87.525 (3.4439 - 3.4459)
"a" dimension	16.5 (0.650)
Piston pin hole diameter	21.987 - 21.999 (0.8656 - 0.8661)
Piston clearance to cylinder block	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)	0.1 (0.004)
2nd	0.030 - 0.063 (0.0012 - 0.0025)	
End gap		
Top	0.21 - 0.40 (0.0083 - 0.0157)	1.0 (0.039)
2nd	0.50 - 0.69 (0.0197 - 0.0272)	
Oil (rail ring)	0.20 - 0.69 (0.0079 - 0.0272)	

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	0.005 - 0.017 (0.0002 - 0.0007)

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

CONNECTING ROD

Unit: mm (in)

Center distance	154.1 - 1.54.2 (6.067 - 6.071)
Bend, [per 100 (3.94)]	
Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	
Limit	0.30 (0.0118)
Connecting rod small end inner diameter	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	53.000 - 53.013 (2.0866 - 2.0871)
Side clearance	
Standard	0.20 - 0.35 (0.0079 - 0.0138)
Limit	0.40 (0.0157)

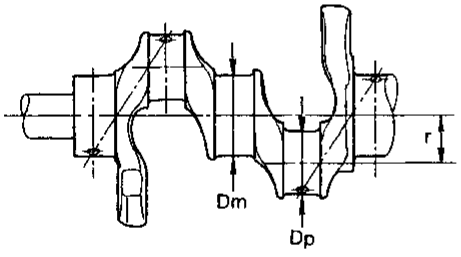
*After installing in connecting rod

Inspection and Adjustment (Cont'd)

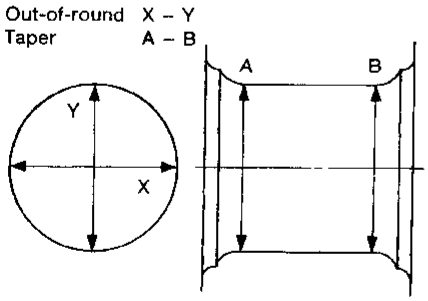
CRANKSHAFT

Unit: mm (in)

Main journal dia. "Dm"	
Grade No. 0	62.967 - 62.975 (2.4790 - 2.4793)
Grade No. 1	62.959 - 62.967 (2.4787 - 2.4790)
Grade No. 2	62.951 - 62.959 (2.4784 - 2.4787)
Pin journal dia. "Dp"	
Grade No. 0	49.968 - 49.974 (1.9672 - 1.9675)
Grade No. 1	49.962 - 49.968 (1.9670 - 1.9672)
Grade No. 2	49.955 - 49.962 (1.9667 - 1.9670)
Center distance "r"	41.47 - 41.53 (1.6327 - 1.6350)
Out-of-round (X – Y)	
Standard	Less than 0.005 (0.0002)
Limit	0.02 (0.0008)
Taper (A – B)	
Standard	Less than 0.005 (0.0002)
Limit	0.02 (0.0008)
Runout [TIR]	
Standard	Less than 0.10 (0.0039)
Free end play	
Standard	0.05 - 0.17 (0.0020 - 0.0067)
Limit	0.30 (0.0118)

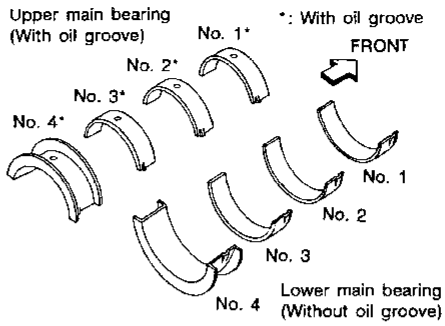


SEM645



EM715

AVAILABLE MAIN BEARING



SEM327A

No. 1 main bearing

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)	22.4 - 22.6 (0.882 - 0.890)	Black
1	1.821 - 1.825 (0.0717 - 0.0719)		Brown
2	1.825 - 1.829 (0.0719 - 0.0720)		Green
3	1.829 - 1.833 (0.0720 - 0.0722)		Yellow (D)
4	1.833 - 1.837 (0.0722 - 0.0723)		Blue

No. 2 and 3 main bearing

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)	18.9 - 19.1 (0.744 - 0.752)	Black
1	1.821 - 1.825 (0.0717 - 0.0719)		Brown
2	1.825 - 1.829 (0.0719 - 0.0720)		Green
3	1.829 - 1.833 (0.0720 - 0.0722)		Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)		Blue

No. 4 main bearing

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

Undersize

Unit: mm (in)

	Thickness	Main journal diameter "Dm"
0.25 (0.0098)	1.948 - 1.956 (0.0767 - 0.0770)	Grind so that bearing clearance is the specified value.

AVAILABLE CONNECTING ROD BEARING

Connecting rod bearing

Grade number	Thickness "T" mm (in)	Identification color (mark)
0	1.496 - 1.499 (0.0589 - 0.0590)	No color
1	1.499 - 1.502 (0.0590 - 0.0591)	Brown
2	1.502 - 1.505 (0.0591 - 0.0593)	Green
3	1.505 - 1.508 (0.0593 - 0.0594)	Yellow

Undersize

Unit: mm (in)

	Thickness	Crank pin journal diameter "Dp"
0.08 (0.0031)	1.540 - 1.548 (0.0606 - 0.0609)	Grind so that bearing clearance is the specified value.
0.12 (0.0047)	1.560 - 1.568 (0.0614 - 0.0617)	
0.25 (0.0098)	1.625 - 1.633 (0.0640 - 0.0643)	

MISCELLANEOUS COMPONENTS

Unit: mm (in)

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

*Total indicator reading

Bearing clearance

Unit: mm (in)

Main bearing clearance	
Standard	0.028 - 0.055 (0.0011 - 0.0022)
Limit	0.090 (0.0035)
Connecting rod bearing clearance	
Standard	0.028 - 0.048 (0.0011 - 0.0019)
Limit	0.090 (0.0035)