SECTION EM

CONTENTS

Supplemental Restraint System (SRS) "AIR BAG" and "SEAT BELT PRE-TENSIONER"

The Supplemental Restraint System "Air Bag" and "Seat Belt Pre-tensioner", used along with a seat belt, help to reduce the risk or severity of injury to the driver and front passenger in a frontal collision. The Supplemental Restraint System consists of air bag modules (located in the center of the steering wheel and on the instrument panel on the passenger side), seat belt pre-tensioners, a diagnosis sensor unit, warning lamp, wiring harness and spiral cable. Information necessary to service the system safely is included in the **RS section** of this Service Manual.

WARNING:

- **To avoid rendering the SRS inoperative, which could increase the risk of personal injury or death in the event of a collision which would result in air bag inflation, all maintenance must be performed by an authorized NISSAN dealer.**
- **Improper maintenance, including incorrect removal and installation of the SRS, can lead to personal injury caused by unintentional activation of the system.**
- **All SRS air bag electrical wiring harnesses and connectors are covered with yellow outer insulation. Do not use electrical test equipment on any circuit related to the SRS.**

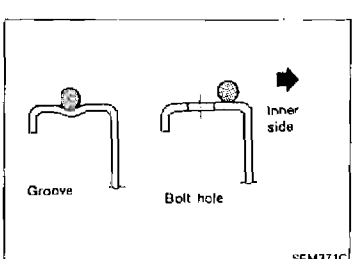
Parts Requiring Angular Tightening

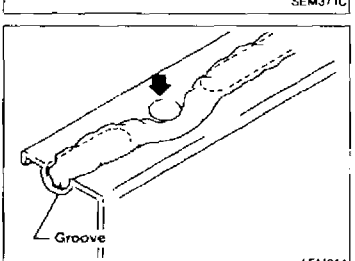
Use an angle wrench for the final tightening of the following engine parts:

- Cylinder head bolts
- Main bearing cap bolts
- Connecting rod bearing cap nuts

Do not use a torque value for final tightening.

The torque values for these parts are for a preliminary step. Ensure thread and seat surfaces are clean and coated with engine oil.





Liquid Gasket Application Procedure

a. **Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also, completely clean any oil from these areas.**

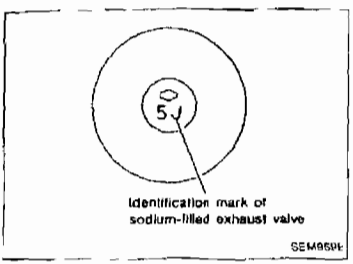
b. **Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Liquid Gasket or equivalent.)**
   - **Be sure liquid gasket is 4.0 to 5.0 mm (0.157 to 0.197 in) wide (for oil pan).**
   - **Be sure liquid gasket is 2.0 to 3.0 mm (0.079 to 0.118 in) wide (in areas except oil pan).**

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 Cautions to Ensure the Safe Disposal of Sodium-filled Exhaust Valves

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



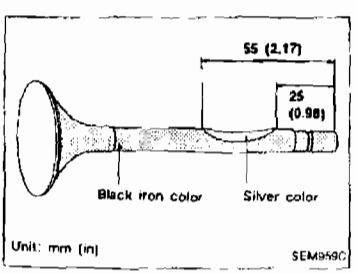
A sodium-filled exhaust valve is identified on the top of its stem as shown in illustration.

DEALER DISPOSAL INSTRUCTIONS

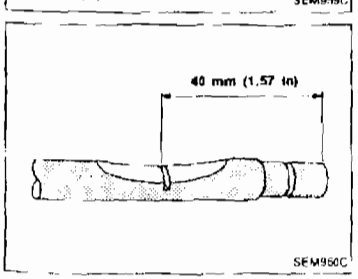
CAUTION:

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

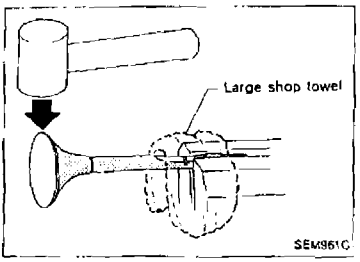
1. Clamp valve stem in a vice.
2. The valve has a specially-hardened surface. To cut through it, first remove a half-round section, approximately 30 mm (1.18 in) long. Use an air-powered grinder until the black iron color is removed and the silver-colored metal appears.



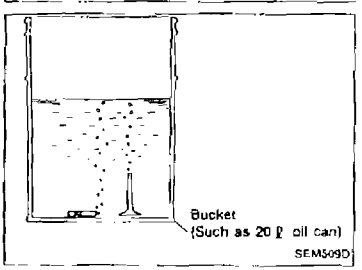
3. Use a hacksaw to cut through approximately half the diameter of the valve stem. Make the serration at a point 40 mm (1.57 in) from the end of the stem.



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



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

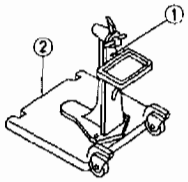
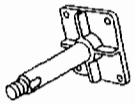
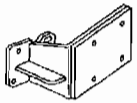
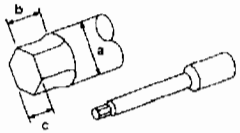
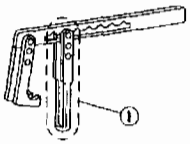
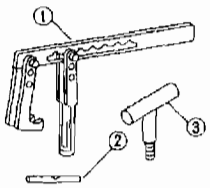


5. Fill a bucket (such as a 20 ℓ oil can) with at least 10 ℓ (2-1/4 Imp gal) of water. Using a pair of large tweezers, carefully place the already-cut (serrated) valves into the water one at a time. Quickly move away at least 2.7 m (9 ft). Place the valves in a standing position as shown in the figure.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

CAUTION:

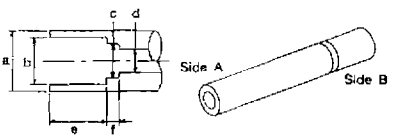
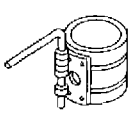
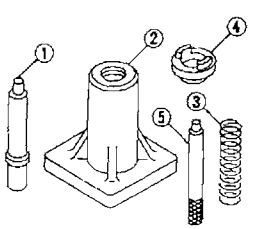
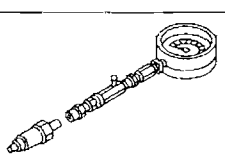
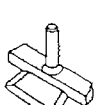
- **Make sure the resultant (high alkalinity) waste water does not contact your skin. If the waste water does contact you, wash the contacted area immediately with large quantities of water.**
- **Check country and local regulations concerning any chemical treatment or waste water discharge permits.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

Special Service Tools

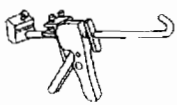
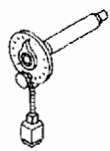
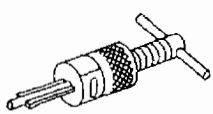
Tool number Tool name	Description	
ST0501S000 Engine stand assembly ① ST05011000 Engine stand ② ST05012000 Base	 NT042	Disassembling and assembling
KV10106500 Engine stand shaft	 NT028	
KV10115300 Engine sub-attachment	 NT008	
ST10120000 Cylinder head bolt wrench	 NT583	Loosening and tightening cylinder head bolt **a: 13 (0.51) dia.** **b: 12 (0.47)** **c: 10 (0.39)** Unit: mm (in)
KV10116200 Valve spring compressor ① KV10115900 Attachment	 NT022	Disassembling valve mechanism
KV101092S0 Valve spring compressor ① KV10109210 Compressor ② KV10109220 Adapter ③ KV10111200 Adapter (Useless)	 NT586	Disassembling valve mechanism

Special Service Tools (Cont'd)

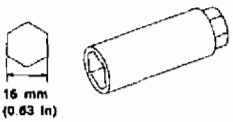
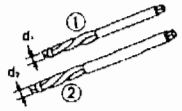
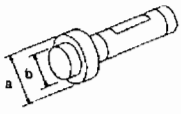
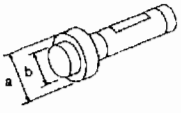
*: Special tool or commercial equivalent

Tool number Tool name	Description
KV10115600 Valve oil seal drift	 NT603 Installing valve oil seal Intake / Exhaust: Side A / Side B Side A: a: 20 (0.79) dia. b: 13 (0.51) dia. c: 10.3 (0.406) dia. d: 8 (0.31) dia. e: 10.7 (0.421) f: 5 (0.20) Side B: a: 20 (0.79) dia. b: 14.2 (0.559) dia. c: 11 (0.43) dia. d: 8 (0.31) dia. e: 10.7 (0.421) dia. f: 5 (0.20) Unit: mm (in)
KV10115700 Dial gauge stand	 NT012 Adjusting shims
EM03470000 Piston ring compressor	 NT044 Installing piston assembly into cylinder bore
KV10107400 Piston pin press stand ① KV10107310 Center shaft ② ST13040020 Stand ③ ST13040030 Spring ④ KV10107320 Cap ⑤ ST13040050 Drift	 NT013 Disassembling and assembling piston pin
ED19600000* Compression gauge set	 NT626
KV10111100 Seal cutter	 NT046 Removing oil pan

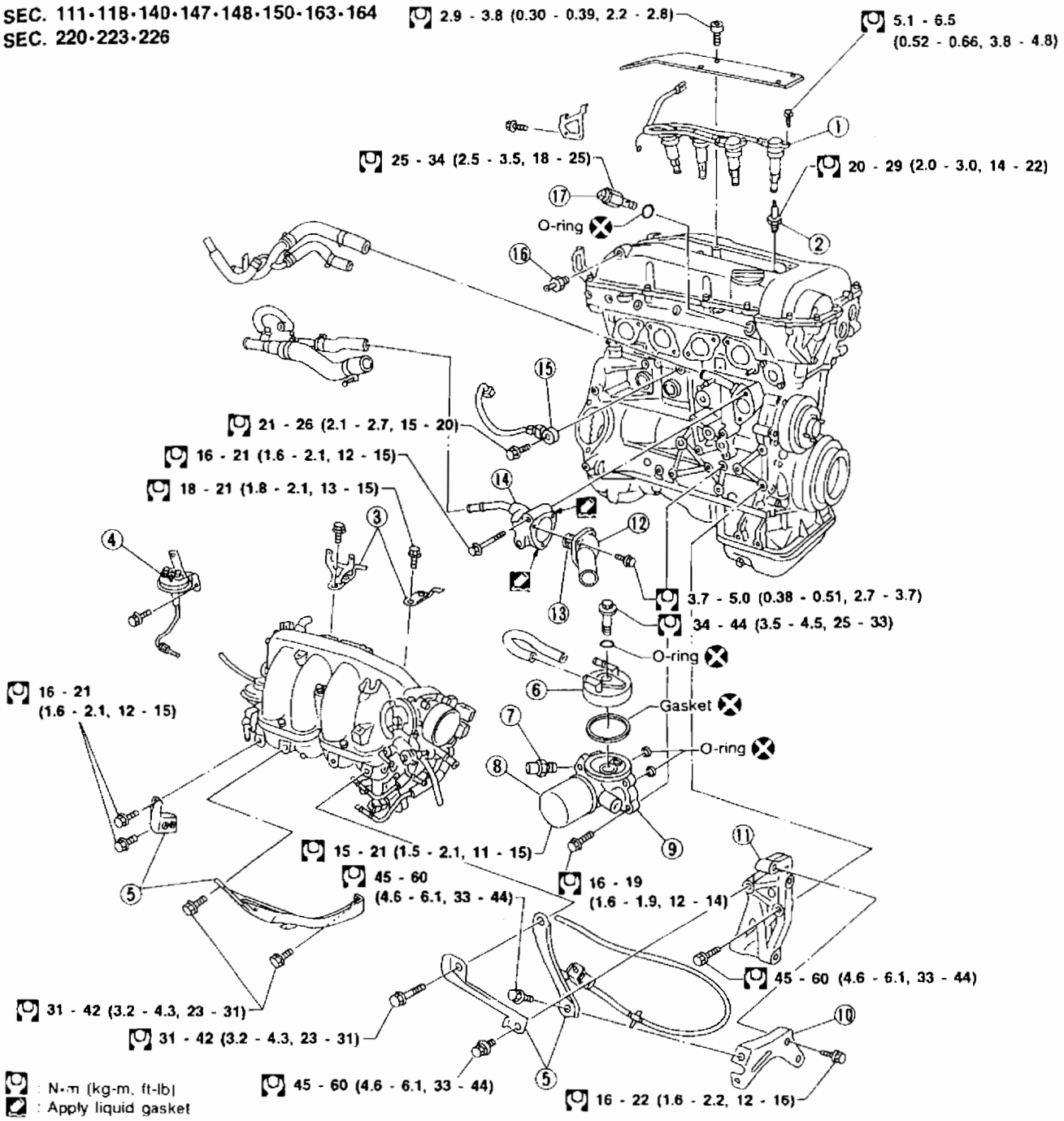
Special Service Tools (Cont'd)

Tool number Tool name	Description	
WS39930000 Tube presser	 NT052	Pressing the tube of liquid gasket
KV10112100 Angle wrench	 NT014	Tightening bolts for bearing cap, cylinder head, etc.
ST16610001 Pilot bushing puller	 NT045	Removing pilot bushing

Commercial Service Tools

Tool name	Description	
Spark plug wrench	 NT047	Removing and installing spark plug
Valve seal cutter set	 NT048	Finishing valve seal dimensions
Piston ring expander	 NT030	Removing and installing piston ring
Valve guide drift	 NT015	Removing and installing valve guide Intake a = 9.5 mm (0.374 in) dia. b = 5.0 mm (0.197 in) dia. Exhaust a = 10.5 mm (0.413 in) dia. b = 6.0 mm (0.236 in) dia.
Valve guide reamer	 NT016	Reaming valve guide ① or hole for oversize valve guide ② Unit: mm (in) d_1: Intake 6.0 (0.236); Exhaust 7.0 (0.276) d_2: Intake 10.175 (0.4006); Exhaust 11.175 (0.4400)
Front oil seal drift	 NT049	Installing front oil seal a = 75 mm (2.95 in) dia. b = 45 mm (1.77 in) dia.
Rear oil seal drift	 NT049	Installing rear oil seal a = 110 mm (4.33 in) dia. b = 80 mm (3.15 in) dia.

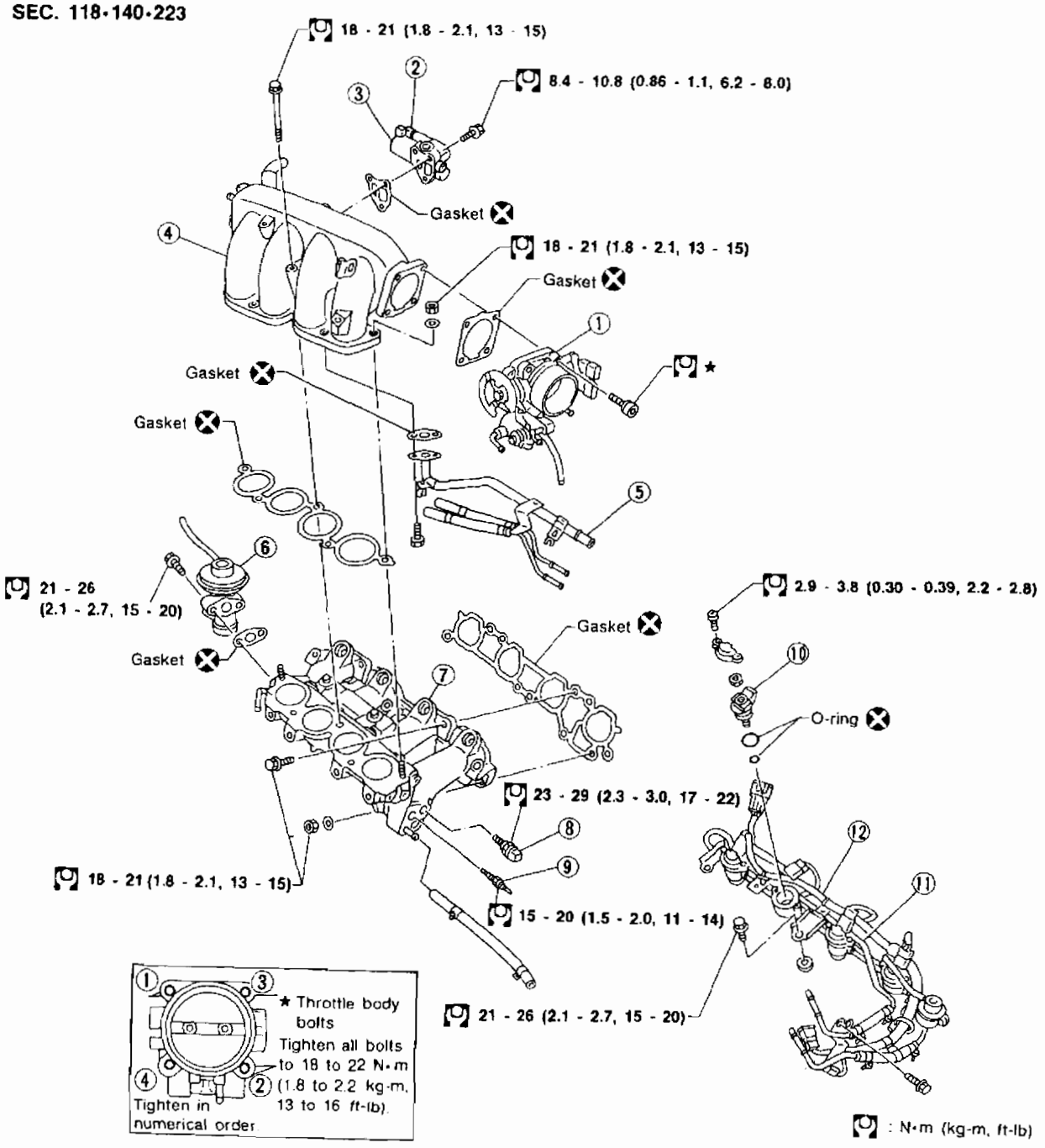
SEC. 111•118•140•147•148•150•163•164
SEC. 220•223•226



SEM970E

① Ignition coil
② Spark plug
③ Intake manifold collector support
④ EGRC-BPT valve
⑤ Intake manifold support
⑥ Oil cooler
⑦ Oil pressure switch
⑧ Oil filter
⑨ Oil filter bracket
⑩ Alternator adjusting bar
⑪ Alternator bracket
⑫ Water outlet
⑬ Thermostat
⑭ Thermostat housing
⑮ Knock sensor
⑯ Blow-by control valve
⑰ VTC solenoid valve

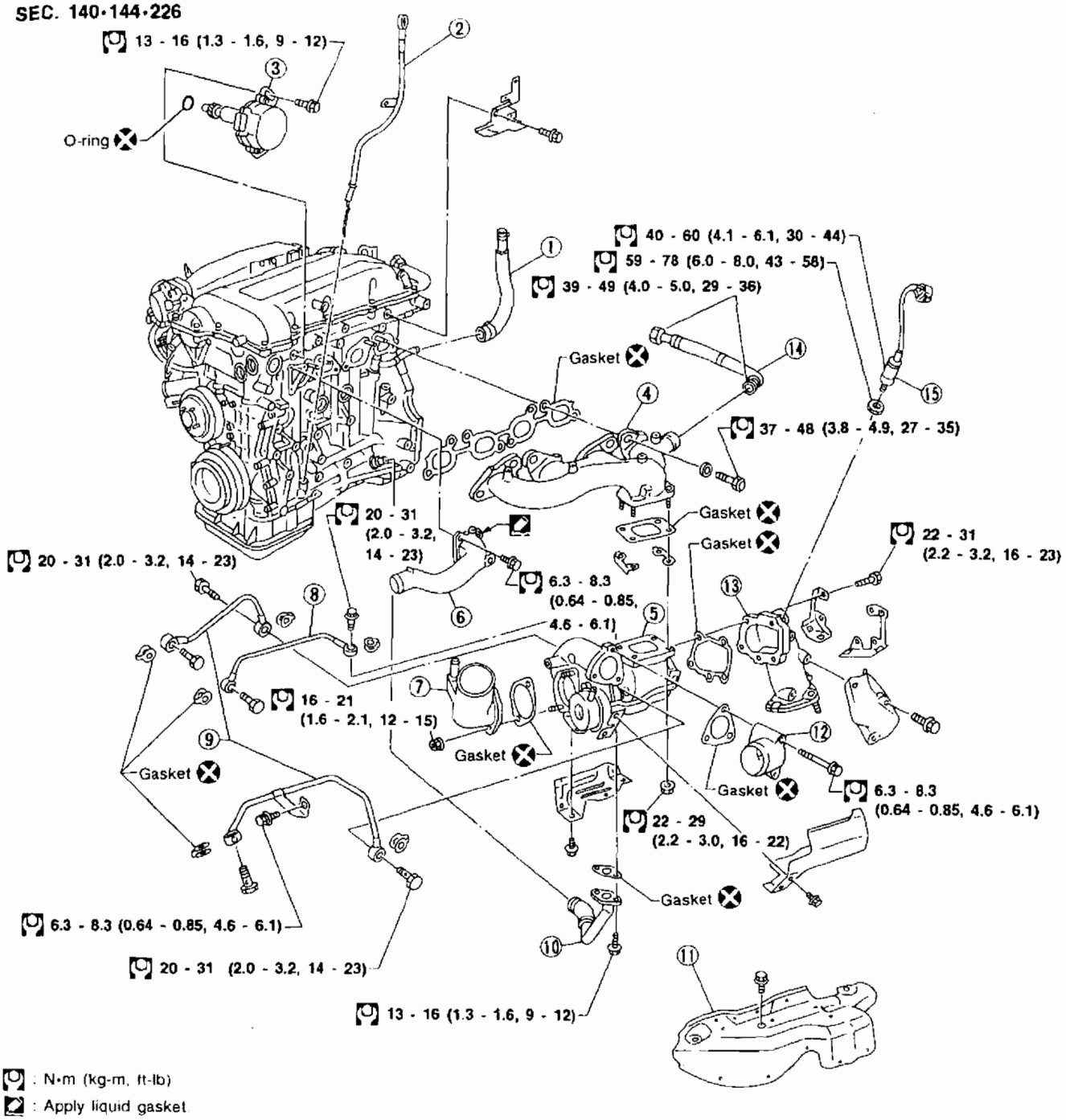
SEC. 118•140•223



SEM971E

① Throttle body
② IACV-FICD valve
③ IACV-AAC valve
④ Intake manifold collector
⑤ Air pipe
⑥ EGR valve
⑦ Intake manifold
⑧ Engine coolant temperature sensor
⑨ Thermal transmitter
⑩ Injector
⑪ Fuel tube assembly
⑫ Injector harness

SEC. 140•144•226



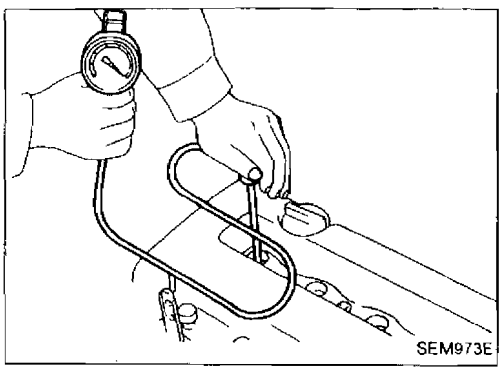
: N•m (kg-m, ft-lb)
: Apply liquid gasket

SEM972E

① Blow-by hose
② Oil level gauge
③ Camshaft position sensor
④ Exhaust manifold
⑤ Turbocharger
⑥ Water outlet
⑦ Air inlet
⑧ Oil tube
⑨ Water tube
⑩ Oil return pipe
⑪ Exhaust manifold cover
⑫ Air outlet
⑬ Exhaust manifold outlet
⑭ EGR pipe
⑮ Heated oxygen sensor

Measurement of Compression Pressure

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


SEM973E

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

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

Compression pressure:

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

Standard	1,079 (10.79, 11.0, 156)
Minimum	883 (8.83, 9.0, 128)
Difference limit between cylinders	98 (0.98, 1.0, 14)

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.

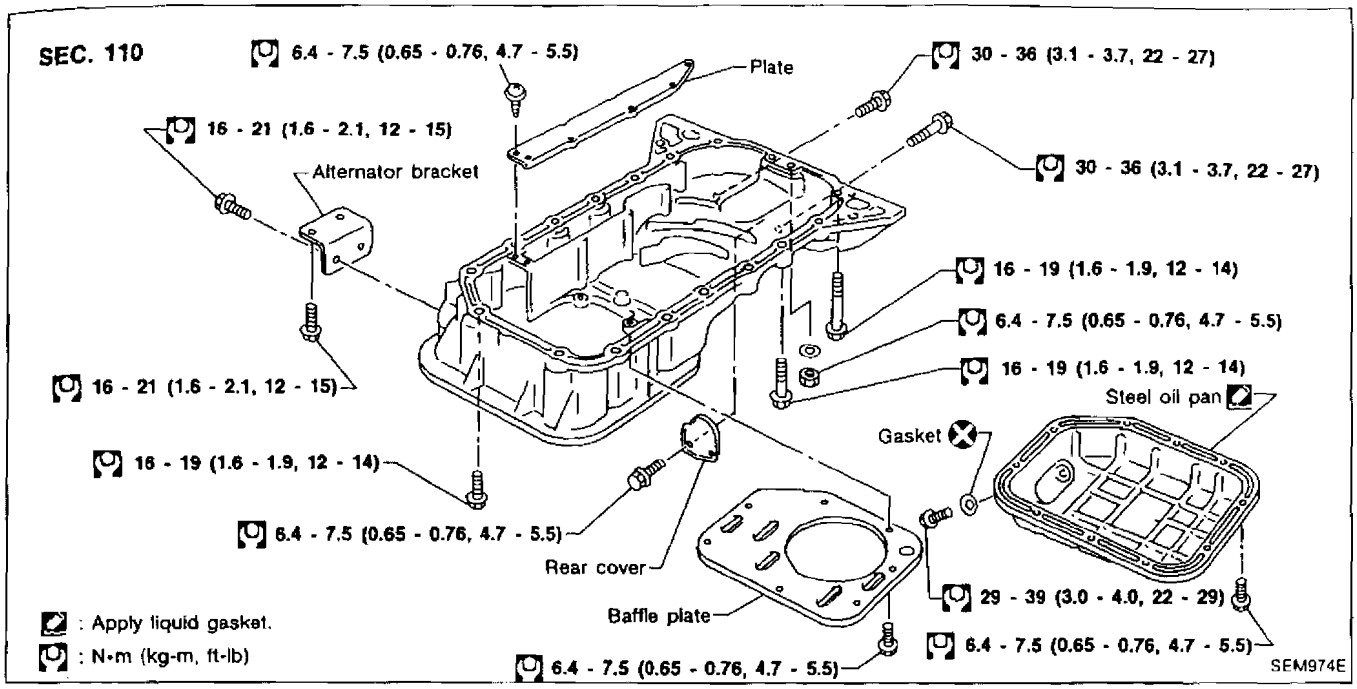
SEM387C

10. If compression in one or more cylinders is low:

a. Pour a small amount of engine oil into cylinders through spark plug holes.
b. Re-test compression.

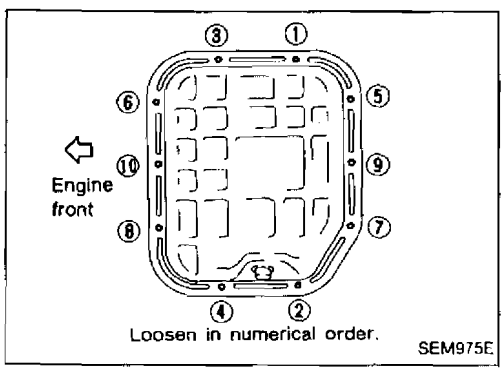
- **If adding oil helps compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston for wear or damage.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. (Refer to SDS.) If valve or valve seat is damaged excessively, replace them.**
- **If compression stays low in two cylinder that are next to each other:**

a. The cylinder head gasket may be leaking, or
b. Both cylinders may have valve component damage. Inspect and repair as necessary.

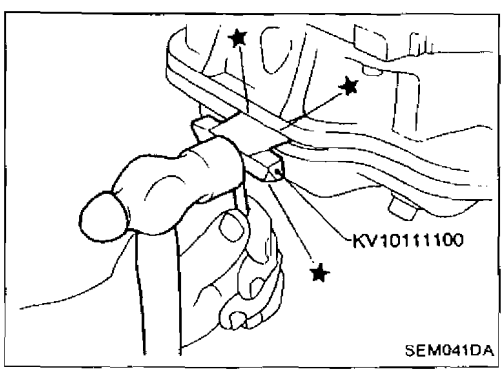


Removal

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



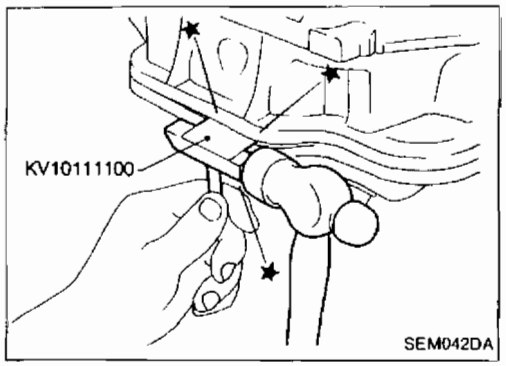
3. Remove steel oil pan bolts.



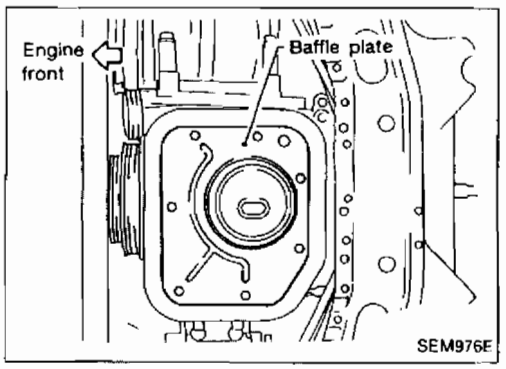
4. Remove steel oil pan.
(1) Insert Tool between aluminum oil pan and steel oil pan.

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

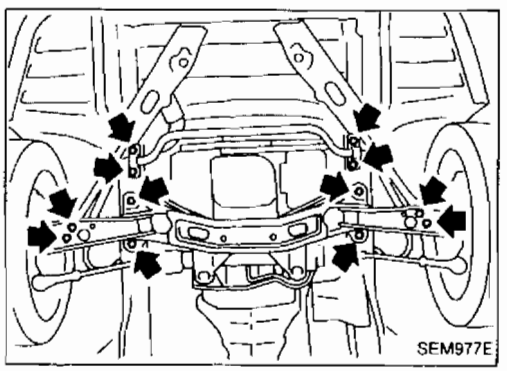
Removal (Cont'd)



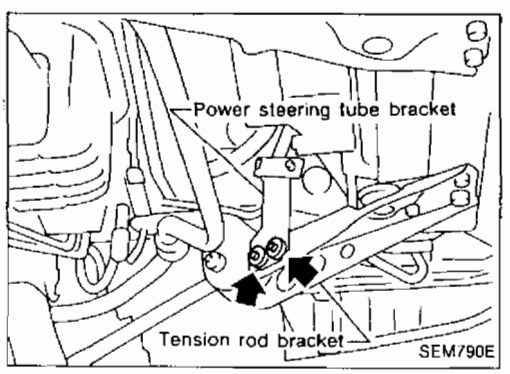
(2) Slide Tool by tapping on the side of the Tool with a hammer.



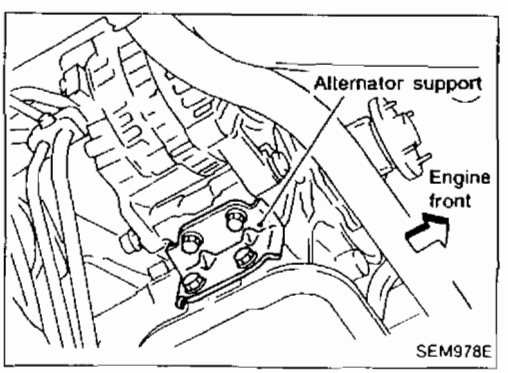
(3) Remove steel oil pan.
(4) Remove baffle plate.



5. Install engine slingers to cylinder head. Refer to "ENGINE REMOVAL" (EM-55).
6. Set a suitable hoist on engine slinger and hold the engine.
7. Remove the following parts.
- Tension rod bolts at transverse links
- Front stabilizer bar securing bolts and nuts from side member.
- Both left and right side engine mounting bolts. Refer to "ENGINE REMOVAL" (EM-55).
8. Disconnect steering shaft lower joint.

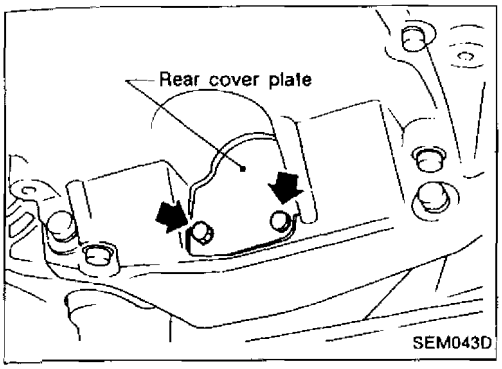


9. Remove power steering tube bracket securing bolts at left tension rod bracket.
10. Remove front suspension member securing bolts while supporting with a jack.
11. Lower front suspension member by around 60 mm (2.36 in).

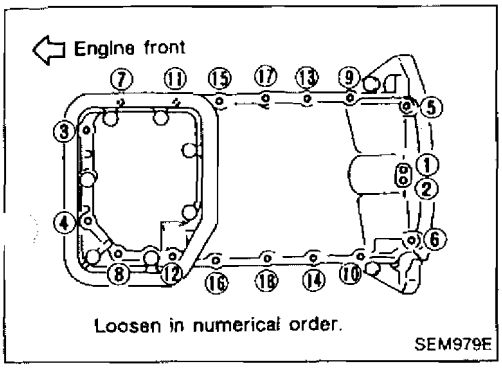


12. Remove alternator support.

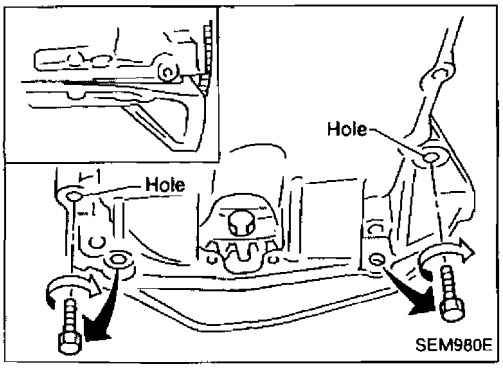
Removal (Cont'd)



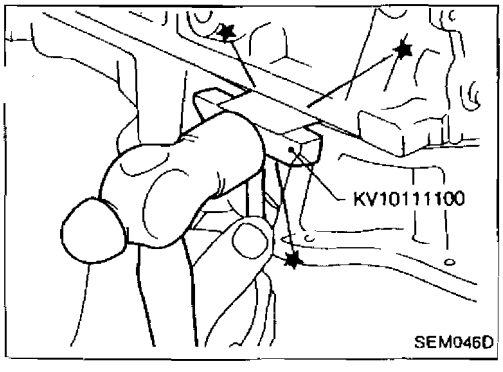
13. Remove rear cover plate.



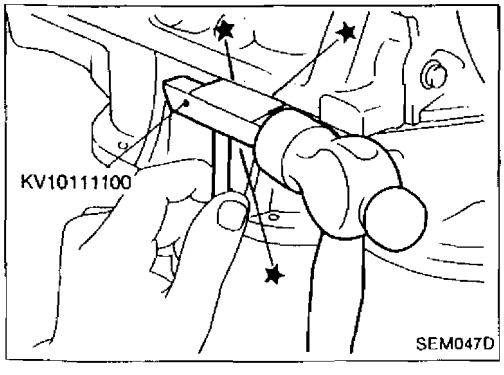
14. Remove aluminum oil pan bolts.



15. Remove four oil pan-to-transmission bolts.
16. Remove two engine-to-transmission bolts and install them into open bolt holes shown. Tighten the two bolts to release aluminum oil pan from cylinder block.

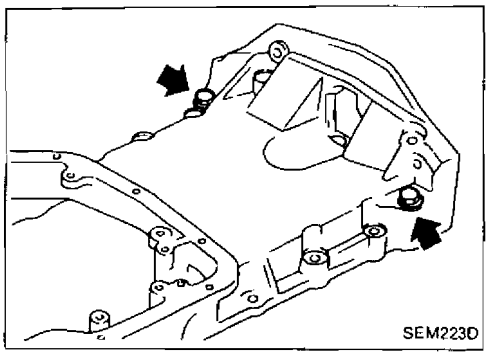


17. Remove aluminum oil pan.
(1) Insert Tool between cylinder block and aluminum oil pan.
- **Be careful not to damage aluminum mating surface.**
- **Do not insert screwdriver, or oil pan flange will be deformed.**



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

Removal (Cont'd)



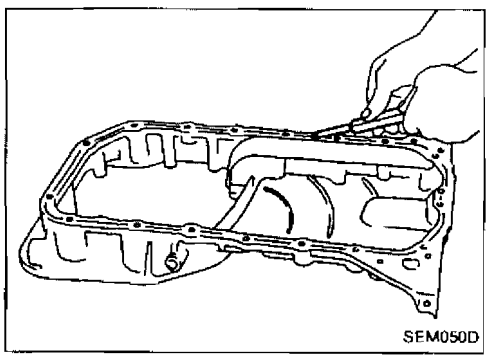
18. Remove the two oil pan-to-transmission bolts previously installed in aluminum oil pan.

Installation

1. Install aluminum oil pan.

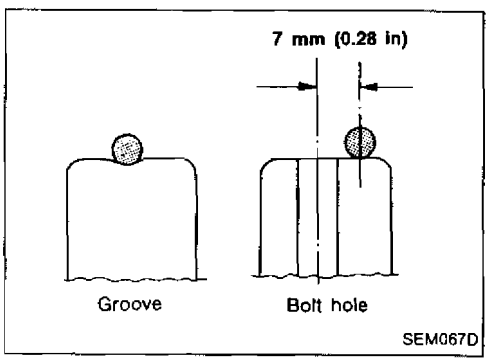
(1) Before installing aluminum oil pan, remove all traces of liquid gasket from mating surfaces using a scraper.

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

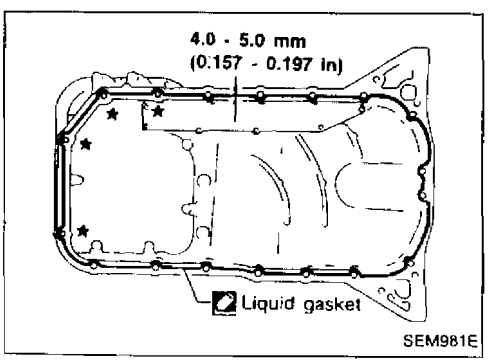


(2) Apply a continuous bead of liquid gasket to mating surface of aluminum oil pan.

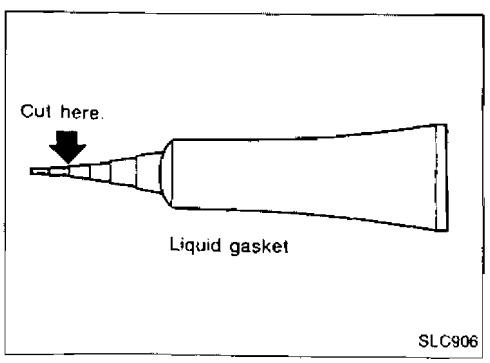
- **Use Genuine Liquid Gasket or equivalent.**



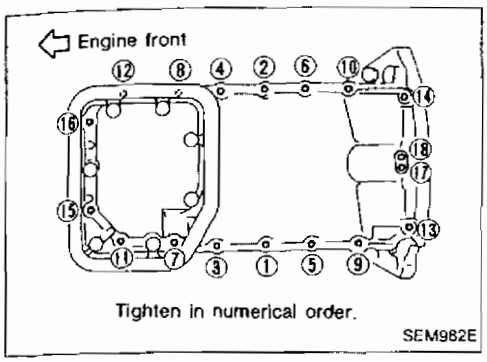
- **For areas marked with "★", apply liquid gasket to the outer side of the bolt hole.**



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

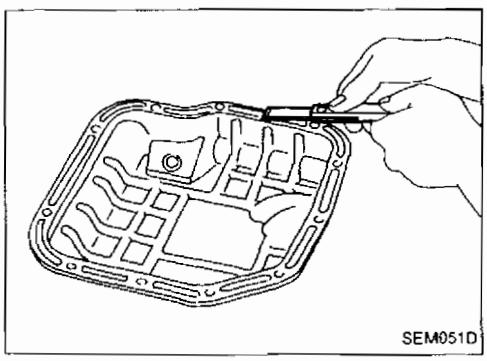


Installation (Cont'd)



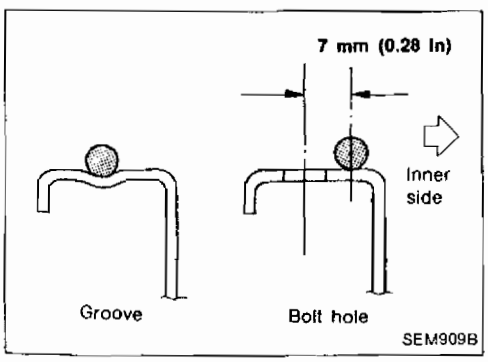
(3) Install aluminum oil pan.
- Tighten bolts in numerical order shown.
  - ① - ⑯ **bolts:**
    [O]: 16 - 19 N·m (1.6 - 1.9 kg-m, 12 - 14 ft-lb)
  - ⑰, ⑱ **bolts:**
    [O]: 6.4 - 7.5 N·m (0.65 - 0.76 kg-m, 4.7 - 5.5 ft-lb)

2. Install the four oil pan-to-transmission bolts.
3. Install rear cover plate.
4. Install alternator support.
5. Tighten front suspension member securing bolts.
6. Install all removed parts after removing steel oil pan.

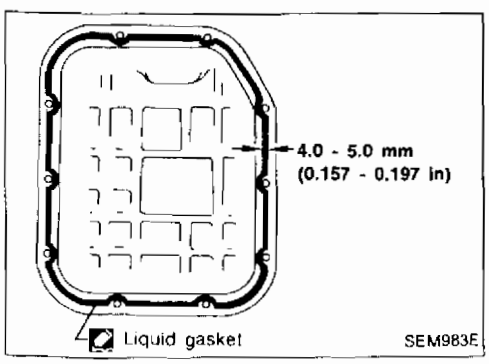


7. Install steel oil pan.

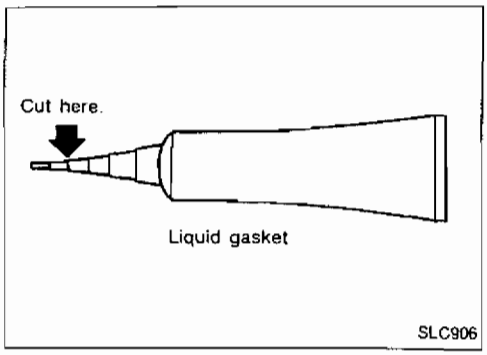
(1) Before installing steel oil pan, remove all traces of liquid gasket from mating surfaces using a scraper.
- Also remove traces of liquid gasket from mating surface of aluminum oil pan.



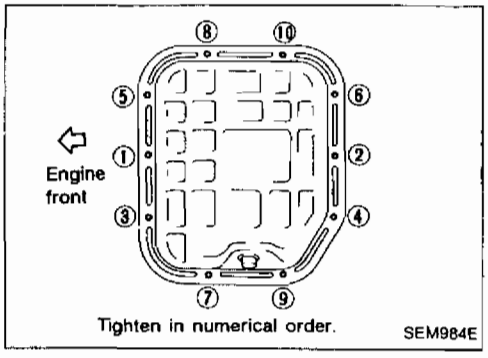
(2) Apply a continuous bead of liquid gasket to mating surface of steel oil pan.
- **Use Genuine Liquid Gasket or equivalent.**



Installation (Cont'd)

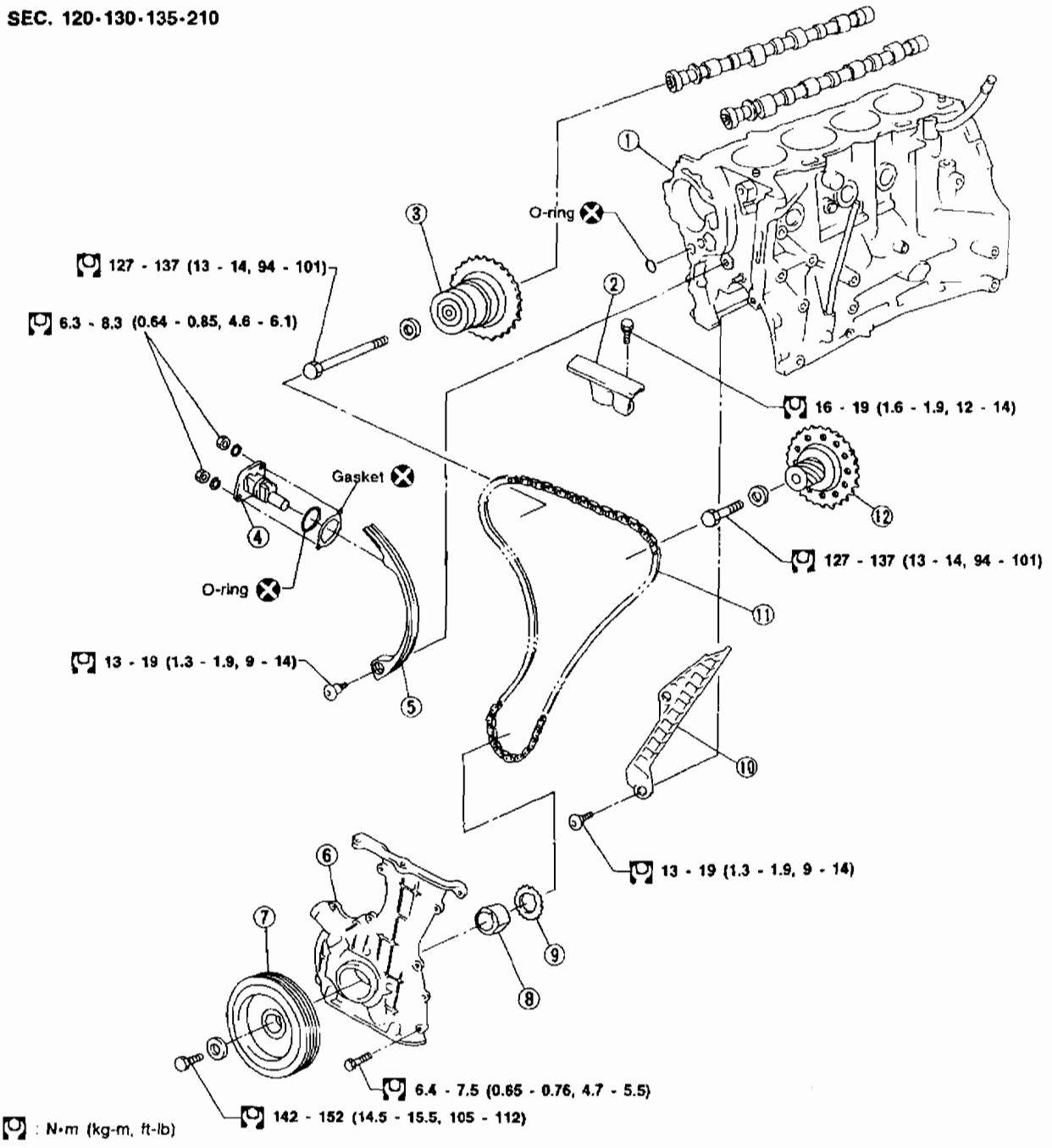


- **Be sure liquid gasket is 4.0 to 5.0 mm (0.157 to 0.197 in) wide.**
- **Attaching should be done within 5 minutes after coating.**



(3) Install steel oil pan.
- Install bolts in numerical order shown.
- Wait at least 30 minutes before refilling engine oil.

SEC. 120•130•135•210



SEM985E

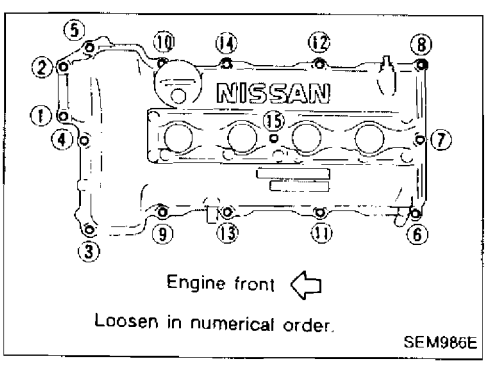
① Cylinder block
② Chain guide
③ RH camshaft sprocket
④ Chain tensioner
⑤ Chain guide
⑥ Front cover
⑦ Crank pulley
⑧ Oil pump spacer
⑨ Crankshaft sprocket
⑩ Chain guide
⑪ Timing chain
⑫ LH camshaft sprocket

CAUTION:

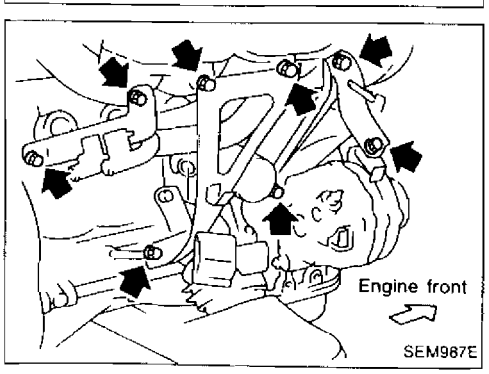
- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing rocker arms, camshafts, chain tensioner, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Apply new engine oil to bolt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

Removal

1. Release fuel pressure.
   Refer to "Releasing Fuel Pressure" in EC section.
2. Remove engine under covers.
3. Drain coolant.
4. Remove radiator.
5. Remove air duct to intake manifold and air recirculation duct.
6. Remove PCV hoses from rocker cover.
7. Remove drive belts and water pump pulley.
8. Remove alternator.
9. Remove power steering oil pump.
10. Remove the following parts from cylinder head and intake manifold: vacuum hoses, fuel hoses, water hoses, wires, harness, connectors and so on.
11. Remove ignition coils and all spark plugs.

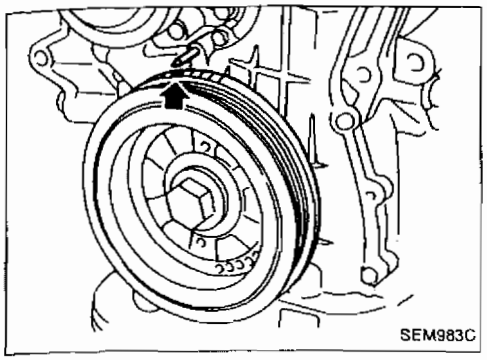


12. Remove rocker cover.

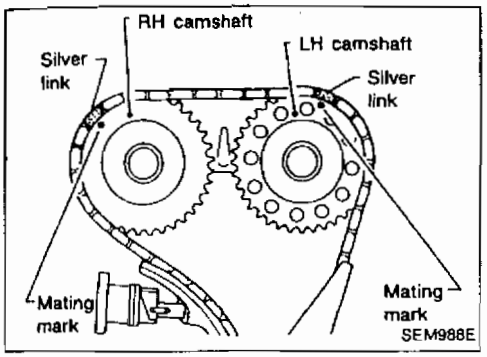


13. Remove intake manifold supports.

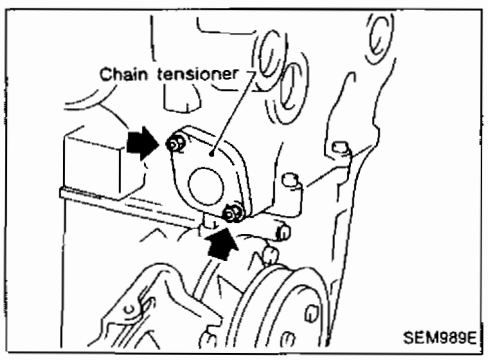
Removal (Cont'd)



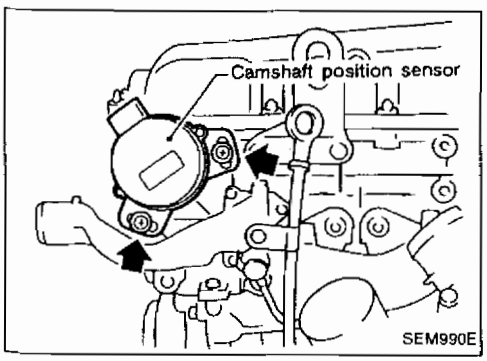
14. Set No. 1 piston at TDC on the compression stroke by rotating crankshaft.



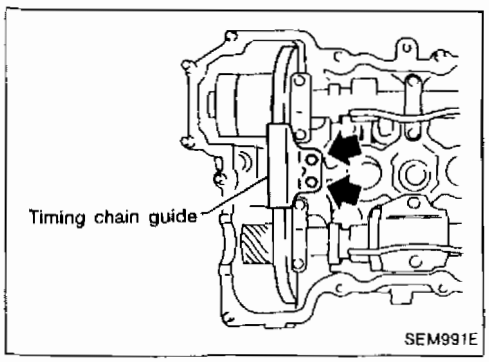
- **Rotate crankshaft until mating mark on camshaft sprocket is set at position indicated in figure at left.**



15. Remove chain tensioner.

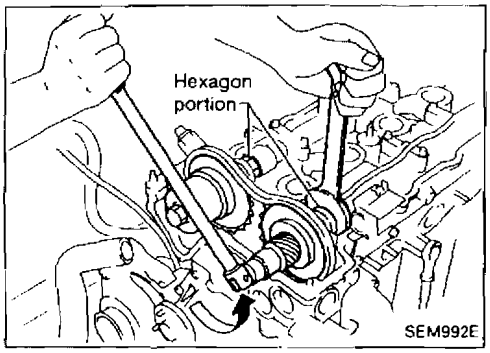


16. Remove camshaft position sensor.

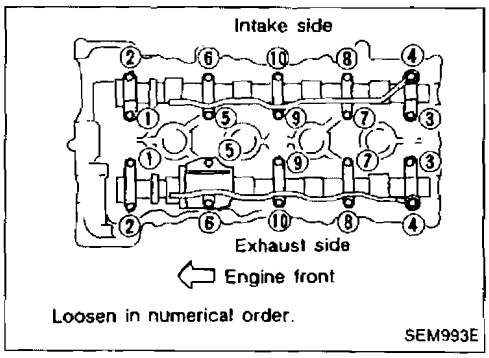


17. Remove timing chain guide.

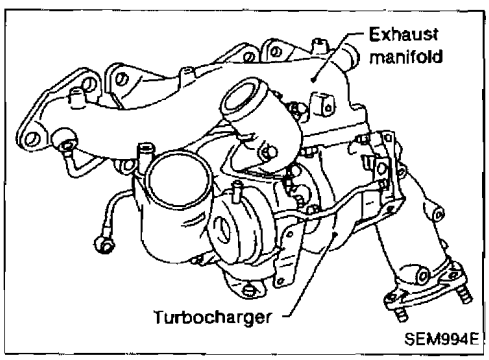
Removal (Cont'd)



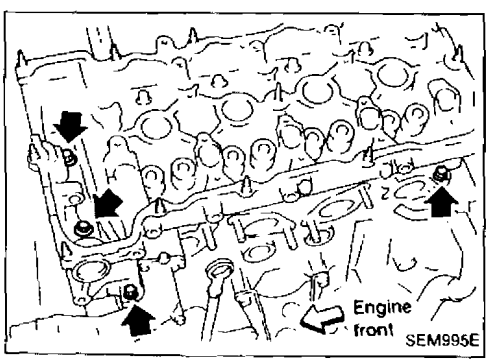
18. Remove camshaft sprockets.



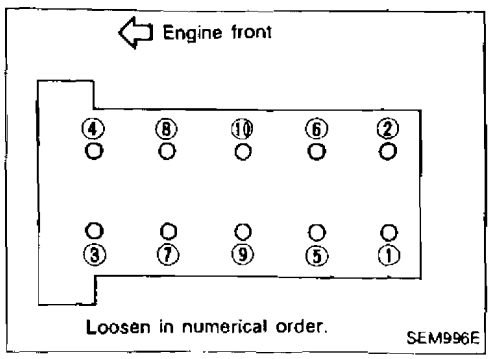
19. Remove camshafts, camshaft brackets, oil tubes and baffle plate.



20. Remove exhaust manifold with turbocharger. Refer to "Removal" in "TURBOCHARGER" (EM-49).



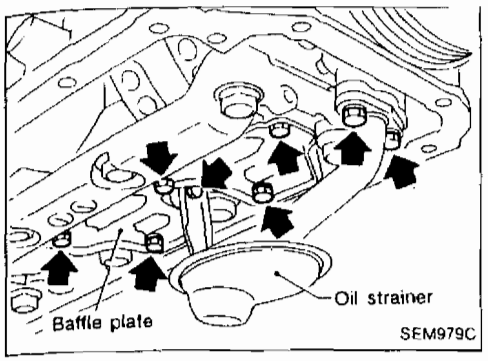
21. Remove cylinder head outside bolts and inside sub bolts.



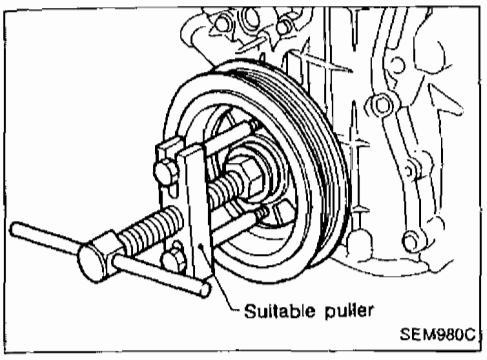
22. Remove cylinder head bolts.
- **A warped or cracked cylinder head may result from removing in incorrect order.**
- **Bolts should be loosened in two or three steps.**

23. Remove cylinder head with intake manifold.

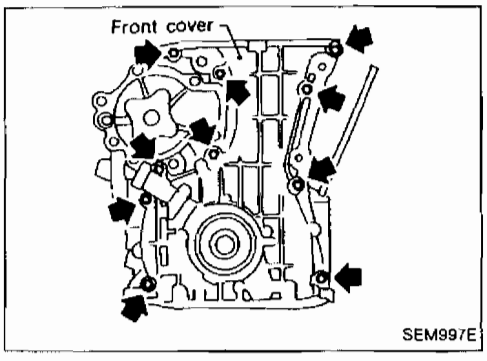
Removal (Cont'd)



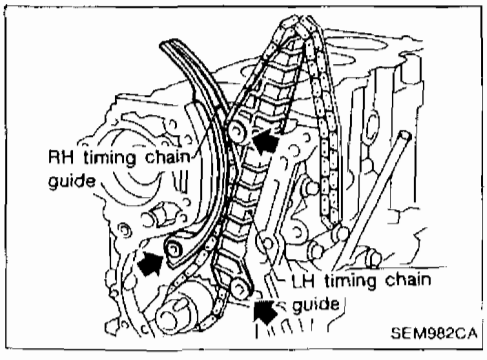
24. Remove oil pans.
    Refer to "Removal" in "OIL PAN" (EM-13).
25. Remove oil strainer and baffle plate.



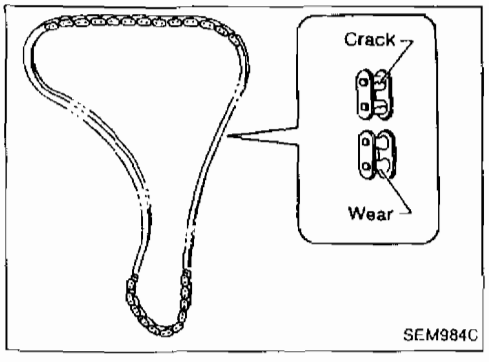
26. Remove crankshaft pulley.



27. Remove front cover.

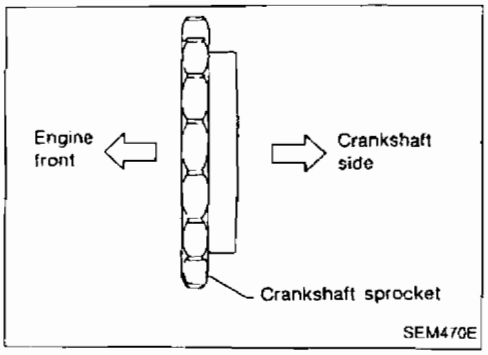


28. Remove timing chain guides and timing chain.



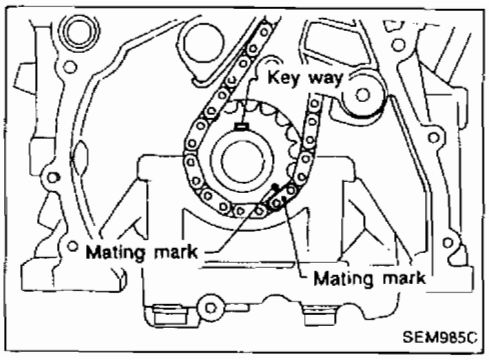
Inspection

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

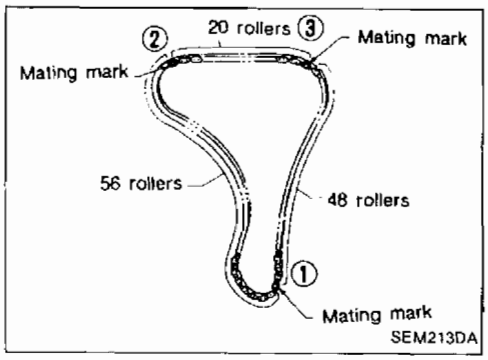


Installation

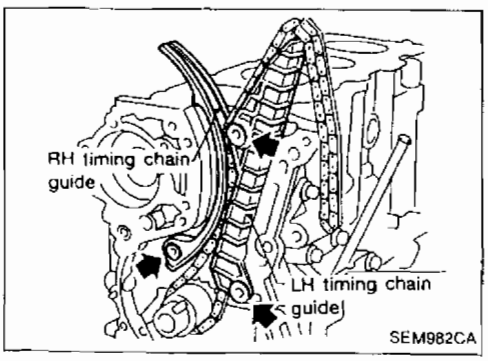
1. Install crankshaft sprocket on crankshaft.



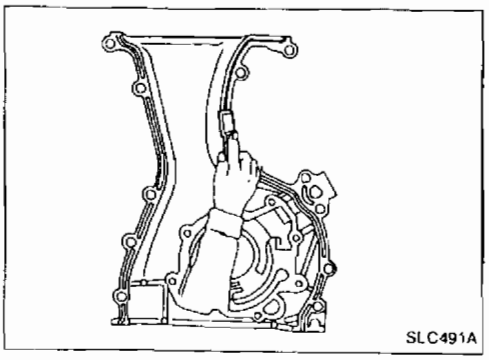
2. Position crankshaft so that No. 1 piston is set at TDC an key way is at 12 o'clock. Fit timing chain on cranksha sprocket, aligning the mating marks.



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

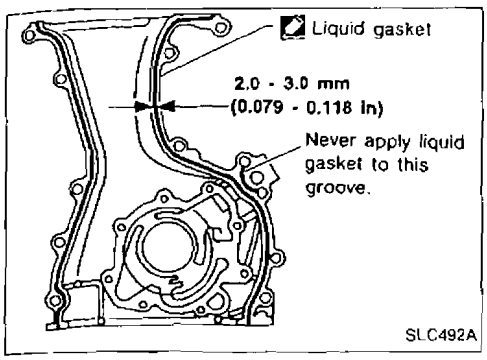


3. Install timing chain and timing chain guides.

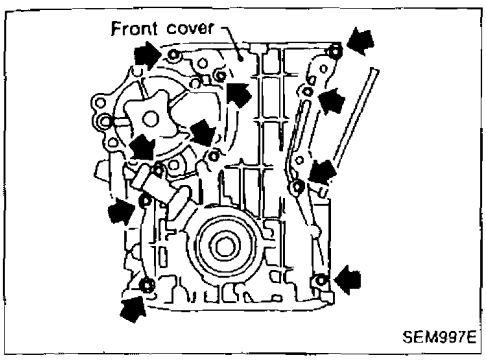


4. Before installing front cover, remove all traces of liquid gasket from mating surface using a scraper.
- Also remove traces of liquid gasket from mating surface of cylinder block.

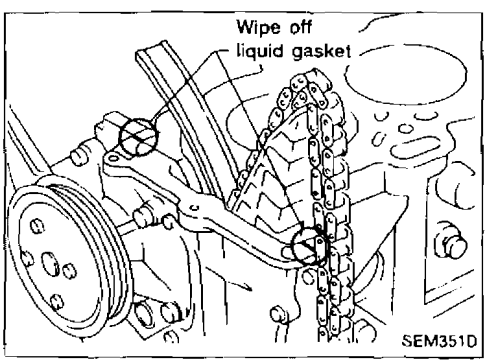
Installation (Cont'd)



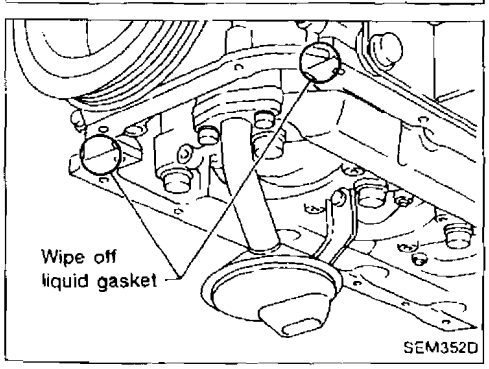
5. Apply a continuous bead of liquid gasket to mating surface of front cover.
- **Use Genuine Liquid Gasket or equivalent.**

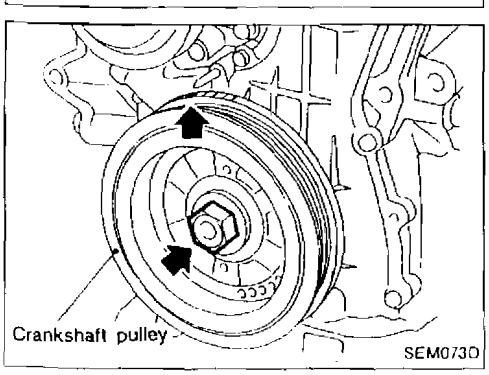


6. Install oil pump drive spacer and front cover.
- **Make sure that O-ring is installed on oil pump outlet passage of cylinder block.**



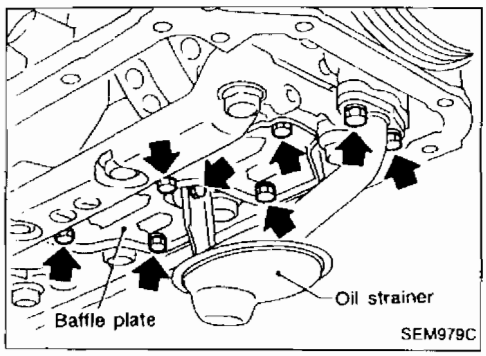
- Wipe off excessive liquid gasket.





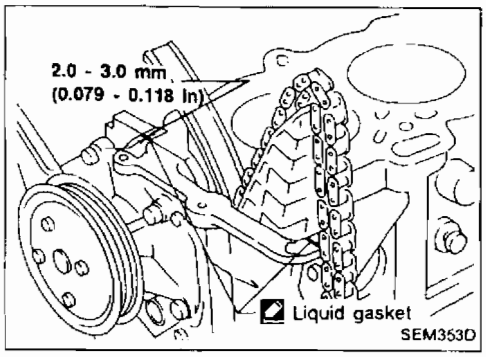
7. Install crankshaft pulley.
8. Set No. 1 piston at TDC on its compression stroke.

Installation (Cont'd)

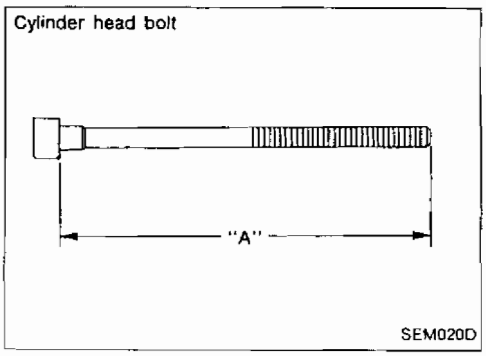


9. Install oil strainer and baffle plate.

10. Install oil pan.
    Refer to "Installation" in "OIL PAN" (EM-13).



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



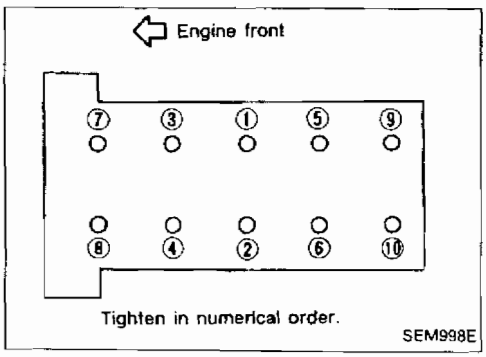
12. Install cylinder head with intake manifold.

CAUTION:

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

Dimension "A":

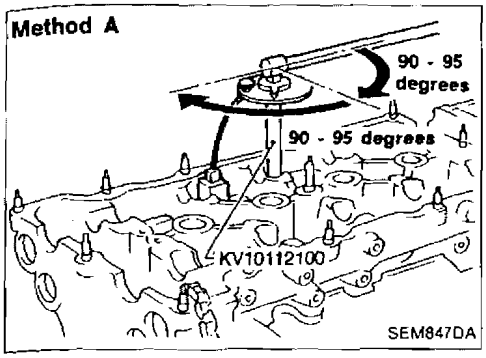
158.2 mm (6.23 in)



- **Cylinder head bolts tightening procedure:**

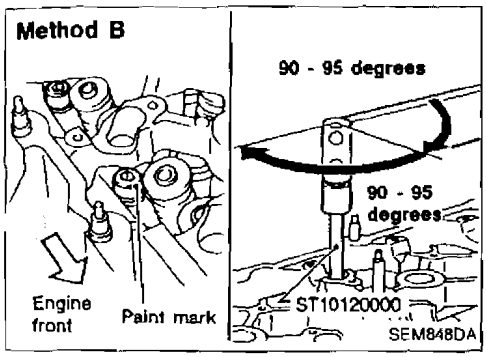
a. **Tighten all bolts to 39 N·m (4.0 kg-m, 29 ft-lb).**
b. **Tighten all bolts to 78 N·m (8.0 kg-m, 58 ft-lb).**
c. **Loosen all bolts completely.**
d. **Tighten all bolts to 34 to 44 N·m (3.5 to 4.5 kg-m, 25 to 33 ft-lb).**

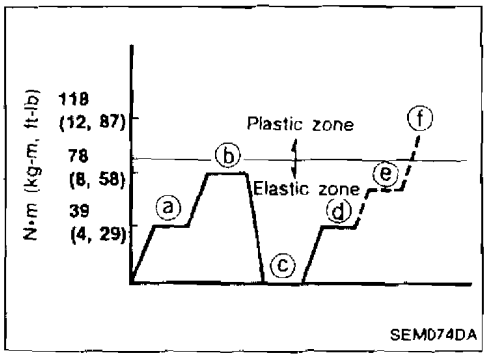
Installation (Cont'd)



e. Method A: Turn all bolts 90 to 95 degrees clockwise with Tool or suitable angle wrench.
   Method B: If an angle wrench is not available, mark all cylinder head bolts on the side facing engine front. Then, turn each cylinder head bolt 90 to 95 degrees clockwise.
f. Turn all bolts 90 to 95 degrees clockwise.
g. Ensure that paint mark on each bolt faces the rear of the engine. (Method B only)

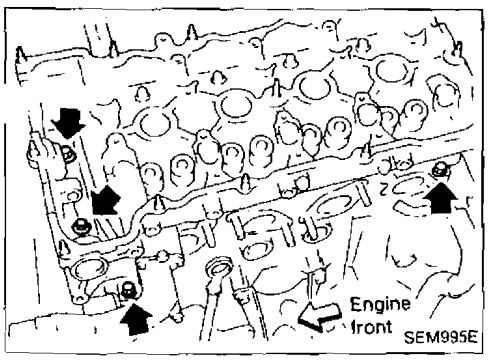
Do not turn any bolt 180 to 190 degrees clockwise all at once.



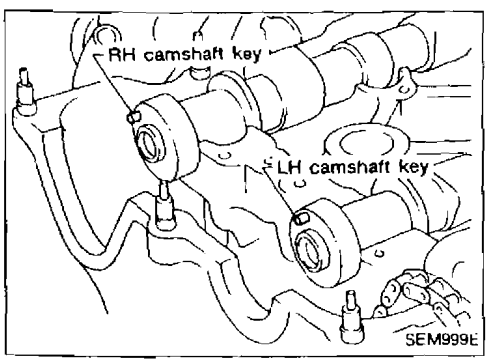


	Tightening torque N·m (kg-m, ft-lb)
ⓐ	39 (4.0, 29)
ⓑ	78 (8.0, 58)
ⓒ	0 (0, 0)
ⓓ	39 ± 5 (4.0 ± 0.5, 28.9 ± 3.6)
ⓔ	90^{+5}_{-0} degrees
ⓕ	90^{+5}_{-0} degrees

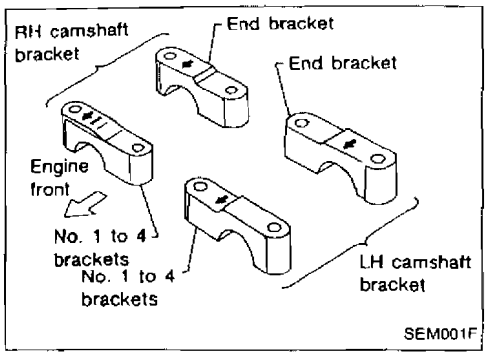
13. Install cylinder head outside bolts and inner sub-bolts.
14. Install exhaust manifold with turbocharger. Refer to "Installation" in "TURBOCHARGER" (EM-53).



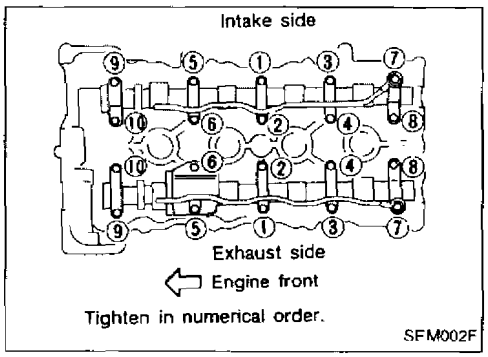
15. Install camshafts, camshaft brackets, oil tubes and baffle plate.
- Position camshaft.
  a. LH camshaft key at about 12 o'clock
  b. RH camshaft key at about 10 o'clock



Installation (Cont'd)



- **Position camshaft bracket.**



- **Camshaft bracket bolts tightening procedure**

  STEP 1:

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

  : 2 N·m (0.2 kg-m, 1.4 ft-lb)

  STEP 2:

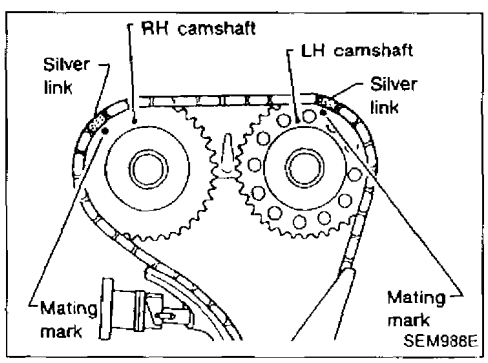
  Tighten bolts in the specified order.

  : 6 N·m (0.6 kg-m, 4.3 ft-lb)

  STEP 3:

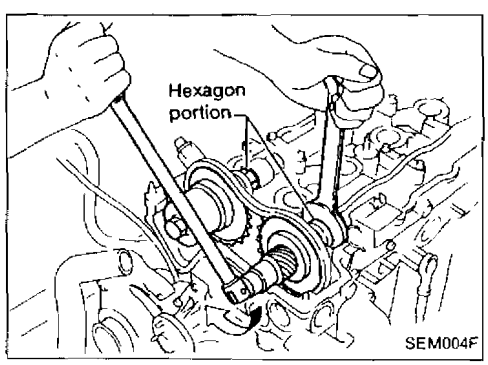
  Tighten bolts in the specified order.

  : 9.0 - 11.8 N·m (0.92 - 1.2 kg-m, 6.7 - 8.7 ft-lb)



16. Install camshaft sprockets.

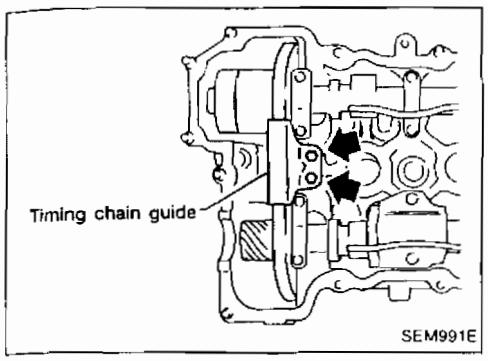
Line up mating marks on timing chain with mating marks on camshaft sprockets.



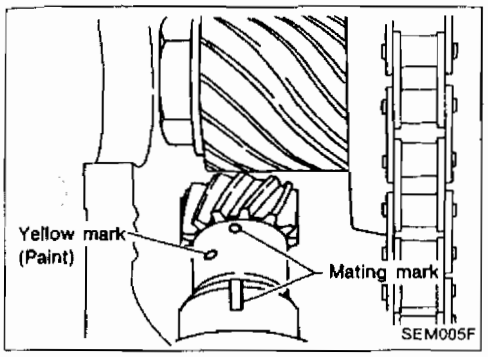
- Lock camshafts as shown in figure and tighten to specified torque.

  : 127 - 137 N·m (13 - 14 kg-m, 94 - 101 ft-lb)

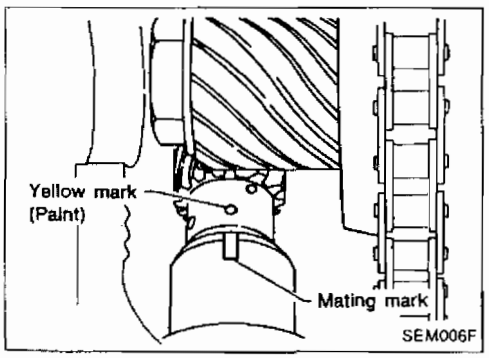
Installation (Cont'd)



17. Install timing chain guide.

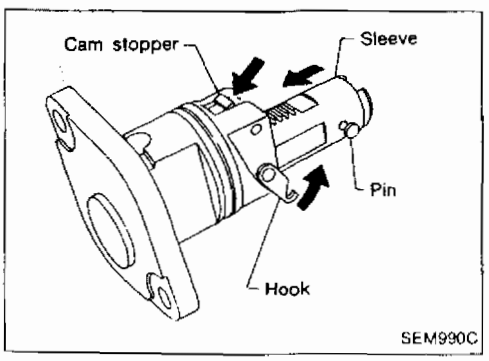


18. Install camshaft position sensor.
a. Make sure that No. 1 piston is at TDC on its compression stroke.
b. Set mating marks on rotor shaft of camshaft position sensor as shown.



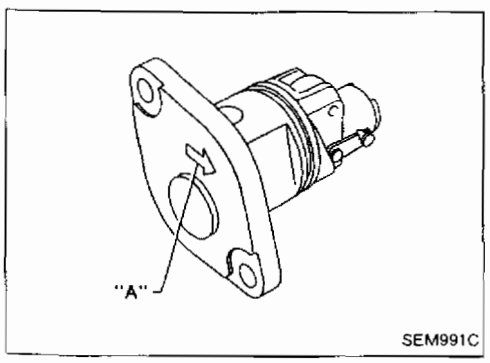
c. Install camshaft position sensor aligning the center of fixing bolt hole.
- **After installing, confirm that mating marks on rotor shaft of camshaft position sensor are as shown.**

d. Tighten fixing bolts.

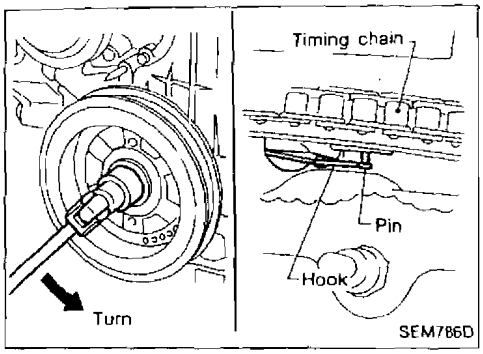


19. Install chain tensioner.

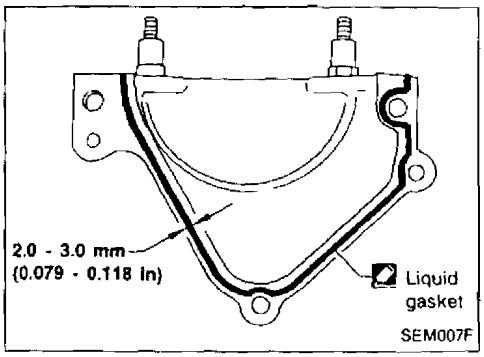
Press cam stopper down and "press-in" sleeve until hook can be engaged on pin. When tensioner is bolted in position the hook will release automatically. Ensure arrow "A" faces the front of the engine.



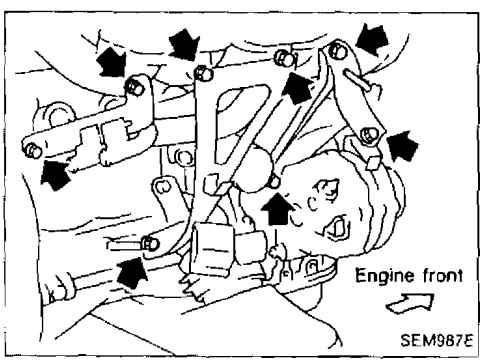
Installation (Cont'd)



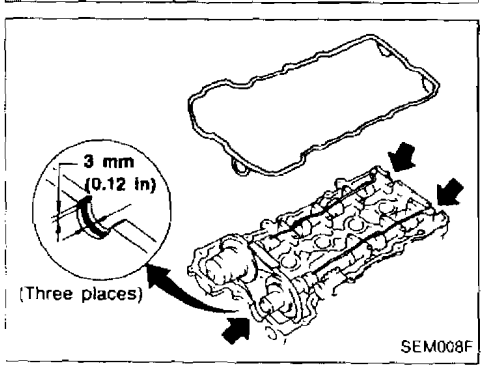
- **If hook does not release automatically, turn crankshaft counterclockwise until it does release.**



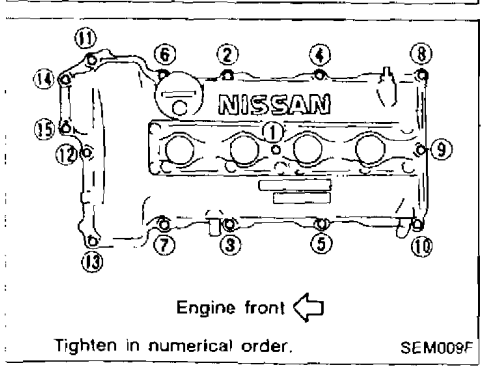
20. Install cylinder head front cover.
- Before installing, remove all traces of liquid gasket from mating surface of cylinder head and the cover using a scraper.
- Apply a continuous bead of liquid gasket to mating surface of cylinder head front cover.
- **Use Genuine Liquid Gasket or equivalent.**



21. Install intake manifold supports.



22. Remove all old liquid gasket from mating surfaces of rocker cover and cylinder head.
23. Apply a continuous bead of liquid gasket to mating surface of rocker cover gasket and cylinder head.
- **Use Genuine Liquid Gasket or equivalent.**



24. Install rocker cover.

Rocker cover tightening procedure:

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

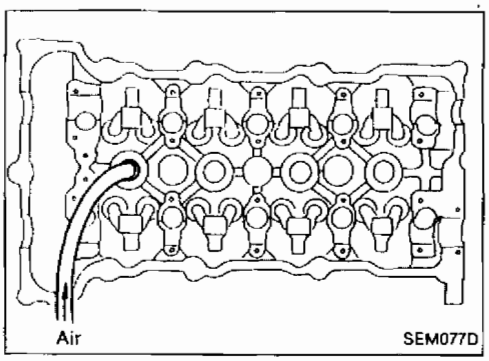
(2) Tighten nuts ① to ⑬ as indicated in figure to 8 to 10 N·m (0.8 to 1.0 kg-m, 5.8 to 7.2 ft-lb).

Installation (Cont'd)

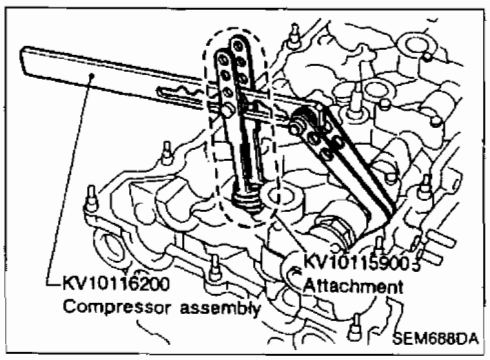
25. Reinstall any parts removed in reverse order of removal.
- When refilling engine coolant, refer to "Engine Maintenance" in MA section.

VALVE OIL SEAL

1. Remove rocker cover.
2. Remove camshafts and sprockets.
   Refer to "Removal" in "TIMING CHAIN" (EM-20).
3. Remove ignition coils on spark plugs.

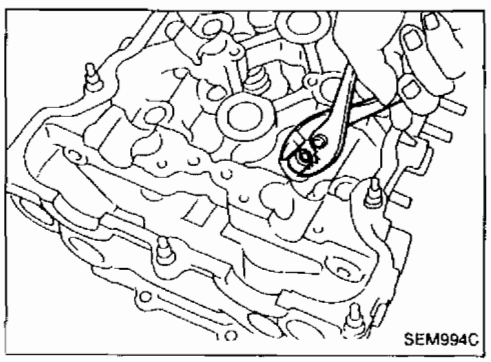


4. Install air hose adapter into spark plug hole and apply air pressure to hold valves in place. Apply a pressure of 490 kPa (4.9 bar, 5 kg/cm^2, 71 psi).
5. Remove rocker arm, rocker arm guide and shim.

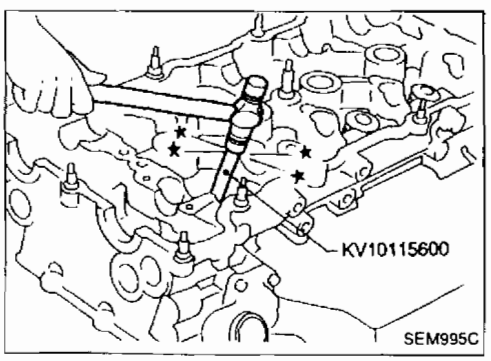


6. Remove valve spring with Tool.

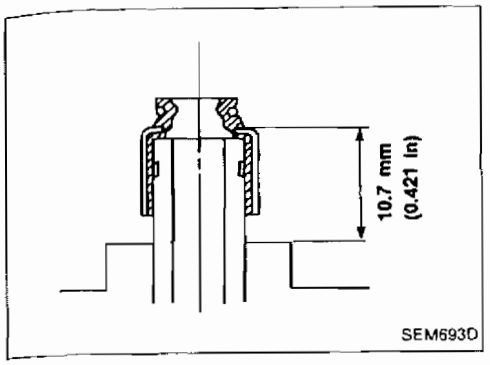
Piston concerned should be set at TDC to prevent valve from falling.



7. Remove valve oil seal.

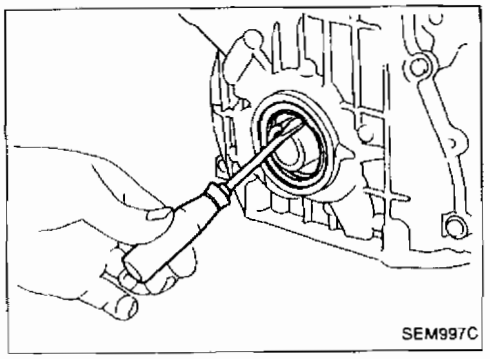


8. Apply engine oil to new valve oil seal and install it with Tool.

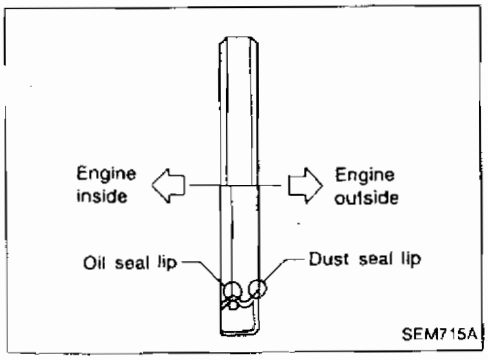


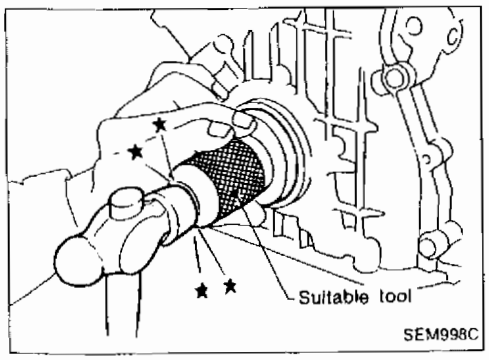
FRONT OIL SEAL

1. Remove the following parts:
- Engine under cover
- Drive belts
- Crankshaft pulley

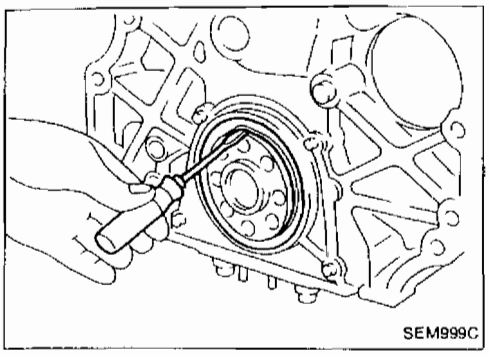


2. Remove front oil seal.
Be careful not to scratch front cover.





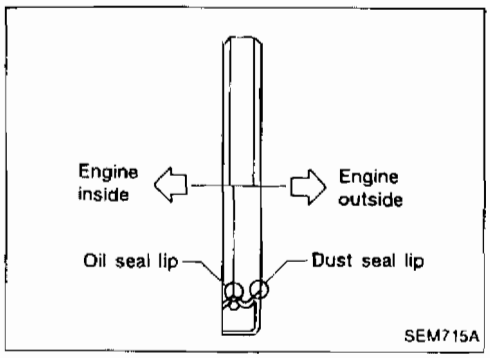
3. Apply engine oil to new oil seal and install it using a suitable tool.


SEM999C

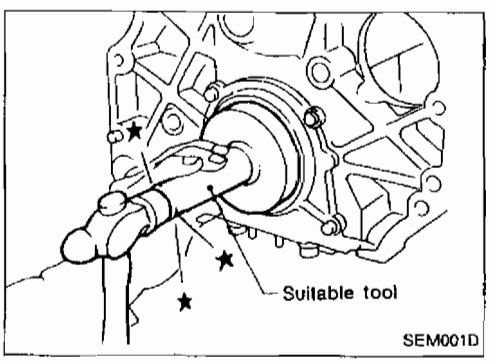
REAR OIL SEAL

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

Be careful not to scratch rear oil seal retainer.



SEM715A

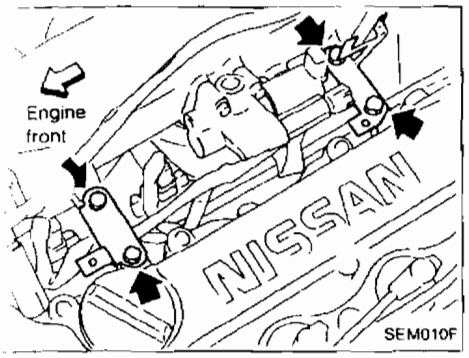


SEM001D

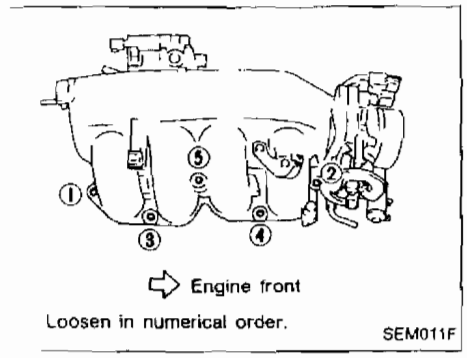
4. Apply engine oil to new oil seal and install it using a suitable tool.

Removal

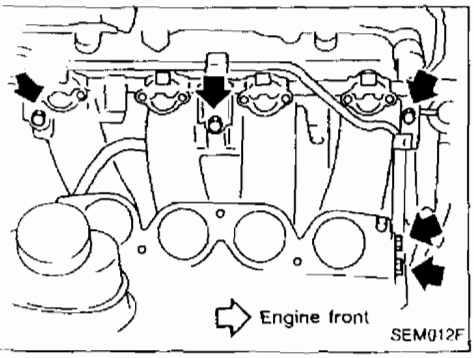
1. Release fuel pressure.
   Refer to "Releasing Fuel Pressure" in EC section.
2. Drain coolant.
3. Remove air duct from intake manifold.
4. Remove PCV hoses from rocker cover.
5. Remove vacuum hoses, fuel hoses, water hoses, wires, harnesses, connectors, etc. from intake manifold.



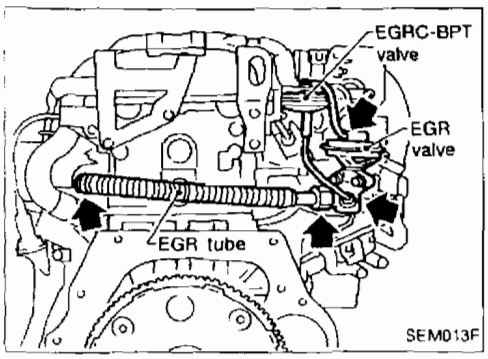
6. Remove intake manifold collector supports.



7. Remove intake manifold collector.

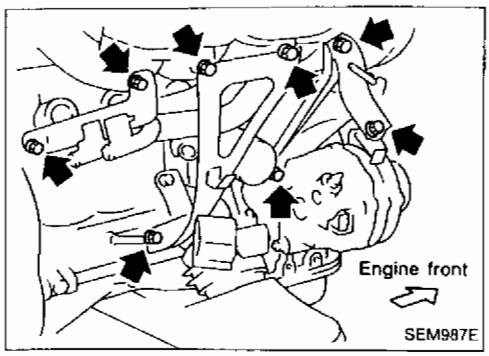


8. Remove harness connectors of engine coolant temperature sensor and thermal transmitter.
9. Remove fuel tube assembly.

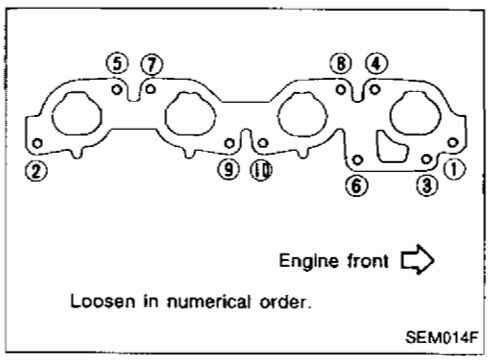


10. Remove EGR tube.
11. Remove hose and tube between EGR valve and EGRC-BPT valve.

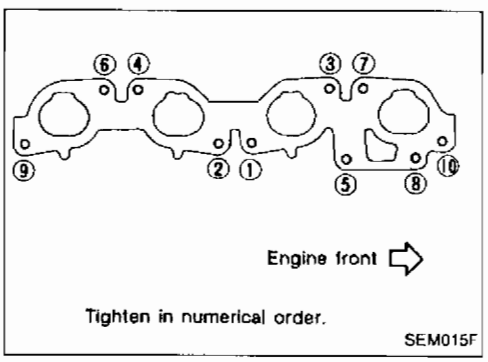
Removal (Cont'd)



12. Remove intake manifold supports.

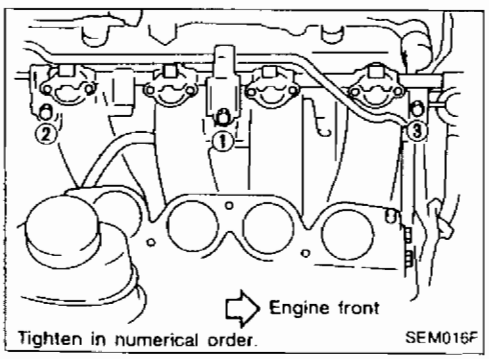


13. Remove intake manifold.

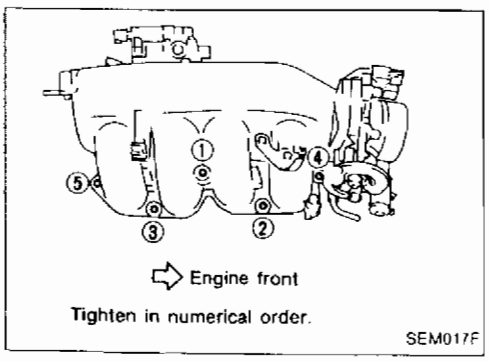


Installation

1. Install intake manifold.
2. Install intake manifold supports.
3. Install EGR tube.
4. Install hose and tube between EGR valve and EGRC-BPT valve.



5. Install fuel tube assembly.
- **Tighten bolts in two steps.**
  1st: 9.3 - 10.8 N·m (0.95 - 1.1 kg-m, 6.9 - 8.0 ft-lb)
  2nd: 21 - 26 N·m (2.1 - 2.7 kg-m, 15 - 20 ft-lb)
6. Connect harness connectors of engine coolant temperature sensor and thermal transmitter.

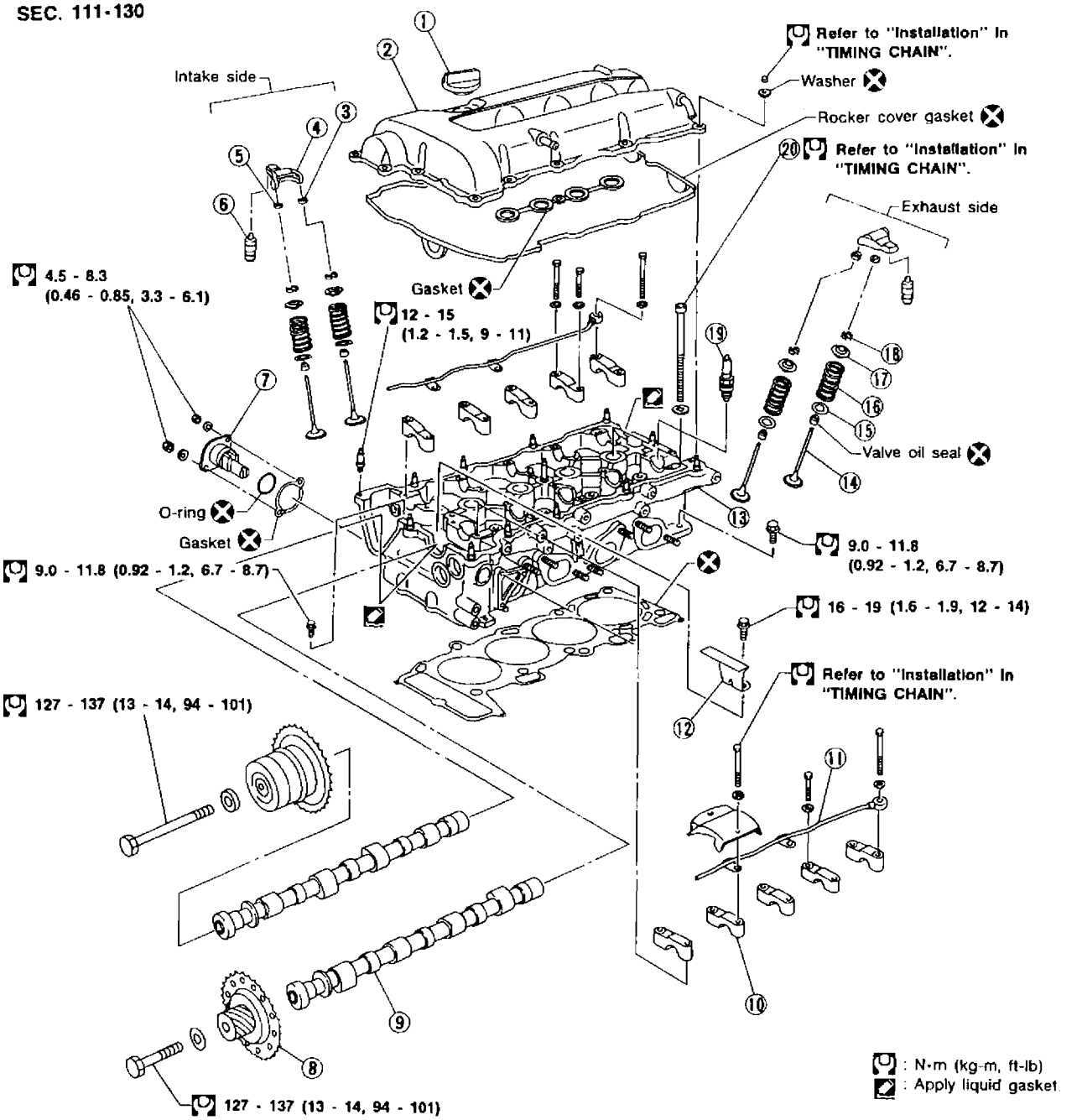


7. Install intake manifold collector.

Installation (Cont'd)

8. Reinstall any parts removed in reverse order of removal.

SEC. 111-130

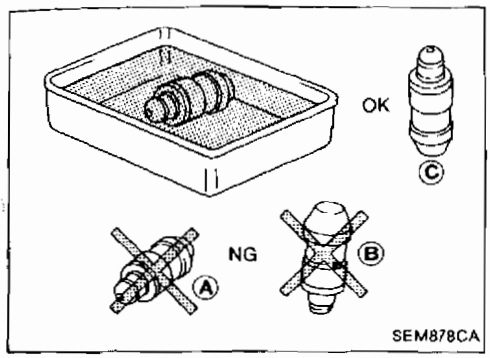


SEM018F

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

CAUTION:

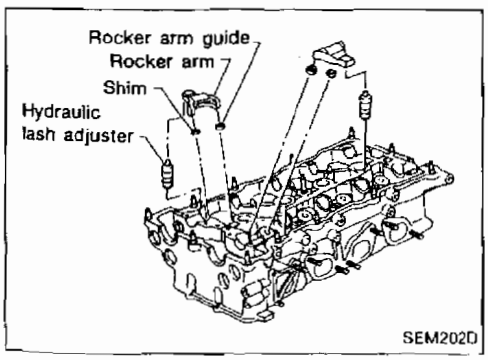
- **When installing rocker arms, camshaft and oil seal, lubricate contacting surfaces with new engine oil.**
- **When tightening cylinder head bolts, camshaft sprocket bolts and camshaft bracket bolts, lubricate thread portions and seat surfaces of bolts with new engine oil.**



- **If a hydraulic lash adjuster is kept on its side, there is a risk of air entering it. When hydraulic lash adjusters are removed, stand them straight up or soak them in new engine oil.**
- **Do not disassemble hydraulic lash adjusters.**
- **Attach tags to lash adjusters so as not to mix them up.**

Removal and Installation

Removal and installation procedures are the same as those for timing chain. Refer to "Removal" and "Installation" in "TIMING CHAIN" (EM-20, EM-24).



Disassembly

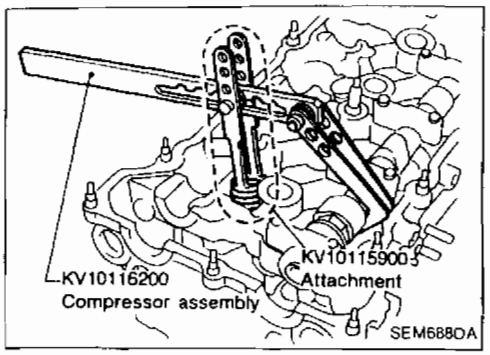
1. Remove rocker arms, shims, rocker arm guides and hydraulic lash adjusters from cylinder head.

CAUTION:

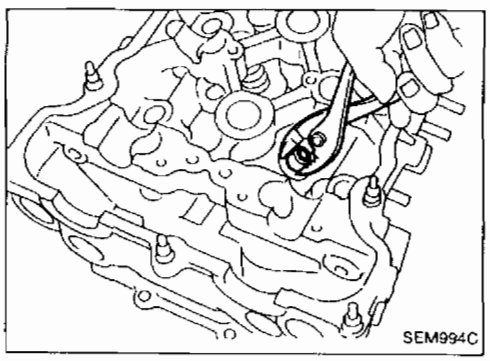
Keep parts in order so that they can be installed in their original positions during assembly. (Install parts in their original positions.)

2. Remove intake manifold. Refer to "Removal" in "INTAKE MANIFOLD" (EM-35).
3. Remove water outlet.

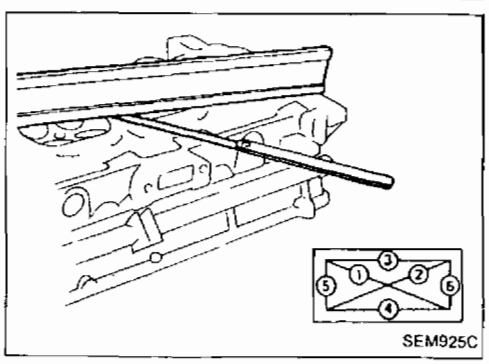
Disassembly (Cont'd)



4. Remove valve components with Tool.



5. Remove valve oil seal with a suitable tool.



Inspection

CYLINDER HEAD DISTORTION

Measure the distorsion in the directions as shown.

Head surface distorsion:

Standard

Less than 0.03 mm (0.0012 in)

Limit

0.1 mm (0.004 in)

If beyond the specified limit, replace or resurface.

Resurfacing limit:

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

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

A + B = 0.2 mm (0.008 in)

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

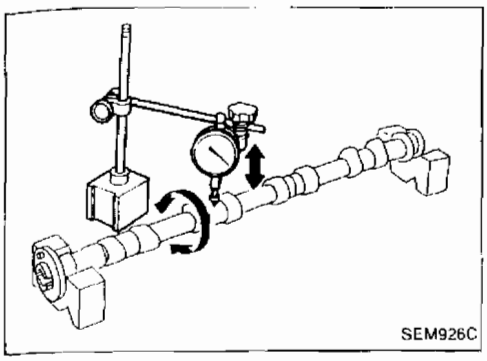
Nominal cylinder head height:

136.9 - 137.1 mm (5.390 - 5.398 in)

CAMSHAFT VISUAL CHECK

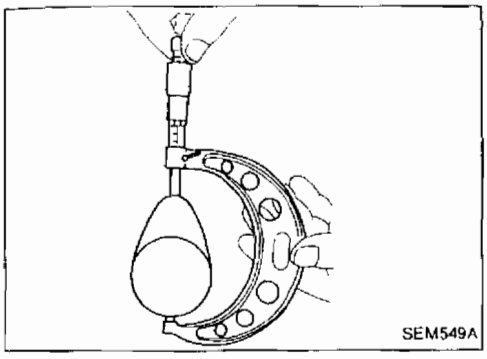
Check camshaft for scratches, seizure and wear.

Inspection (Cont'd)


SEM926C

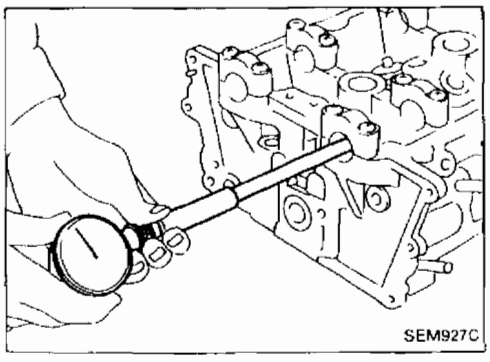
CAMSHAFT RUNOUT

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


SEM549A

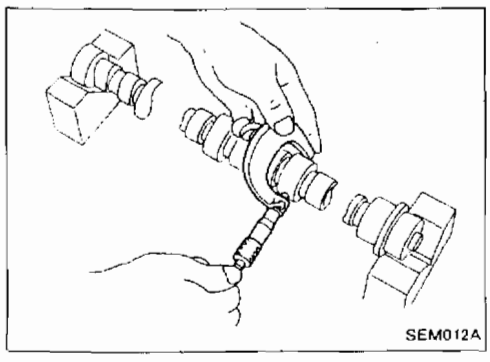
CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height.
   Standard cam height:
   Intake & Exhaust
   37.920 - 38.110 mm (1.4929 - 1.5004 in)
   Cam wear limit:
   Intake & Exhaust
   0.20 mm (0.0079 in)
2. If wear is beyond the limit, replace camshaft.

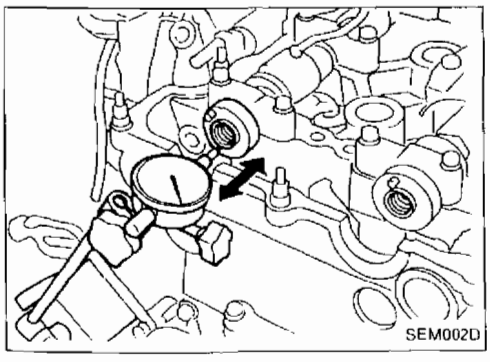

SEM927C

CAMSHAFT JOURNAL CLEARANCE

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


SEM012A

3. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   27.935 - 27.955 mm (1.0998 - 1.1006 in)
4. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance:
   Standard
   0.045 - 0.086 mm (0.0018 - 0.0034 in)
   Limit
   0.15 mm (0.0059 in)

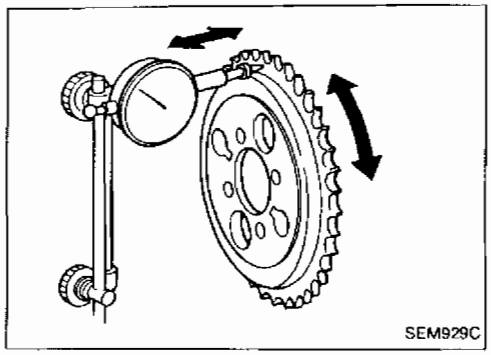

SEM002D

CAMSHAFT END PLAY

1. Install camshaft in cylinder head.
2. Measure camshaft end play.
   Camshaft end play:
   Standard
   0.092 - 0.173 mm (0.0036 - 0.0068 in)
   Limit
   0.20 mm (0.0079 in)

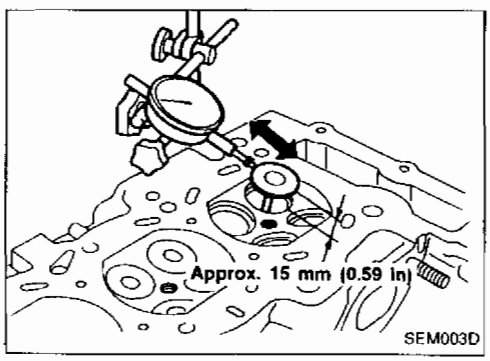
Inspection (Cont'd)

CAMSHAFT SPROCKET RUNOUT

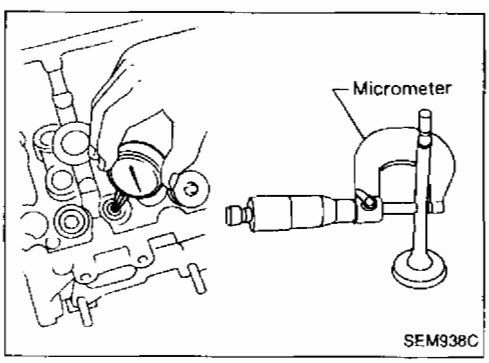


1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.
   Runout (Total indicator reading):
   Limit 0.25 mm (0.0098 in)
3. If it exceeds the limit, replace camshaft sprocket.

VALVE GUIDE CLEARANCE



1. Measure valve deflection in a parallel direction with rocker arm. (Valve and valve guide mostly wear in this direction.)
   Valve deflection limit (Dial gauge reading):
   Intake & Exhaust
   0.2 mm (0.008 in)



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

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

b. Check that clearance is within specification.

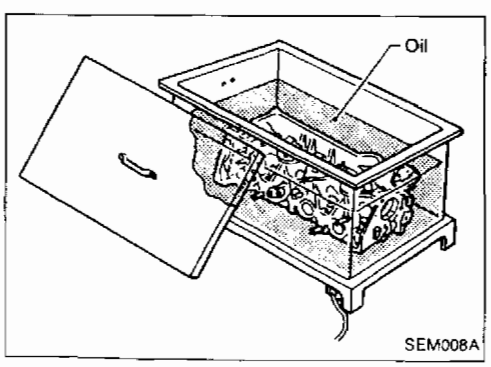
Valve to valve guide clearance:

Unit: mm (in)

	Standard	Limit
Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)

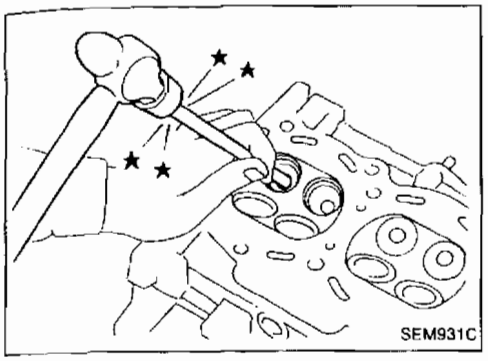
c. If it exceeds the limit, replace valve or valve guide.

VALVE GUIDE REPLACEMENT

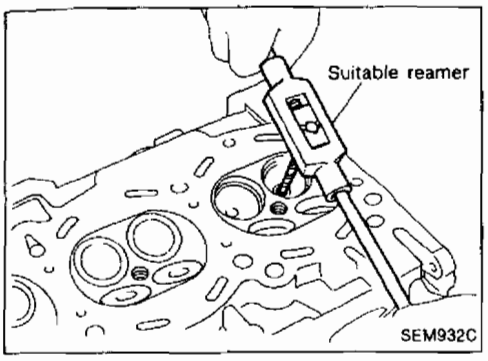


1. To remove valve guide, heat cylinder head to 110 to 130°C (230 to 266°F).

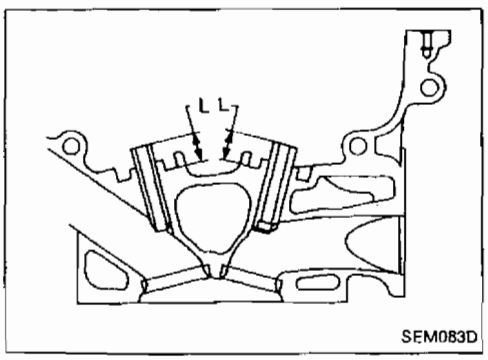
Inspection (Cont'd)



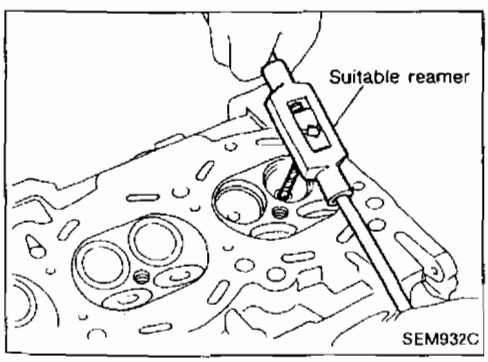
2. Press out valve guide or use a hammer and suitable tool.



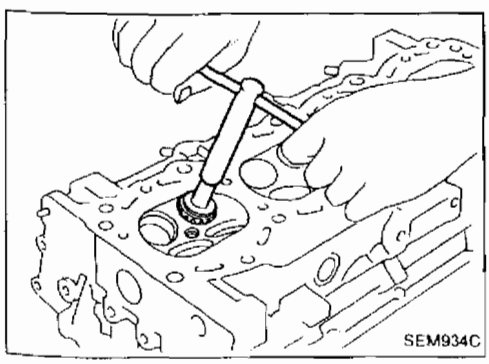
3. Ream cylinder head valve guide hole.
   Valve guide hole diameter (for service parts):
   Intake
   10.175 - 10.196 mm (0.4006 - 0.4014 in)
   Exhaust
   11.175 - 11.196 mm (0.4400 - 0.4408 in)



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



5. Ream valve guide.
   Valve guide inner diameter:
   Intake
   6.000 - 6.018 mm (0.2362 - 0.2369 in)
   Exhaust
   7.000 - 7.018 mm (0.2756 - 0.2763 in)

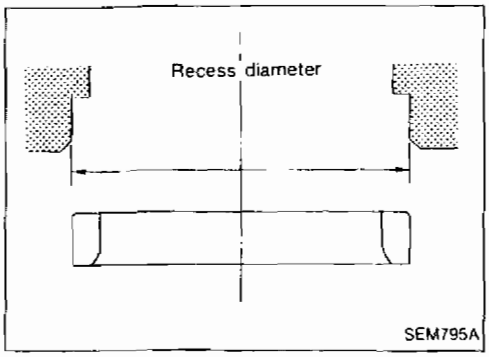


VALVE SEATS

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

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

Inspection (Cont'd)

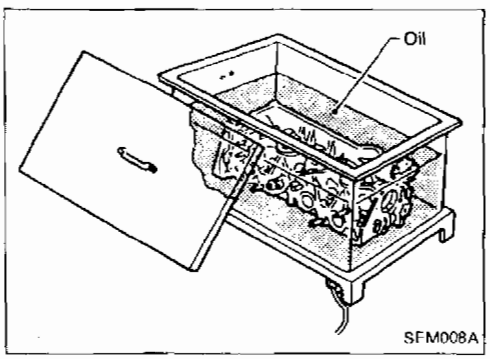


REPLACING VALVE SEAT FOR SERVICE PARTS

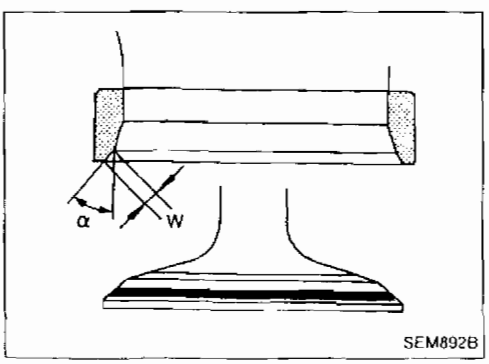
1. Bore out old seat until it collapses. Set machine depth stop so that boring cannot contact bottom face of seat recess in cylinder head.
2. Ream cylinder head recess.

Reaming bore for service valve seat
Oversize [0.5 mm (0.020 in)]:
Intake
35.500 - 35.516 mm (1.3976 - 1.3983 in)
Exhaust
31.500 - 31.516 mm (1.2402 - 1.2408 in)

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

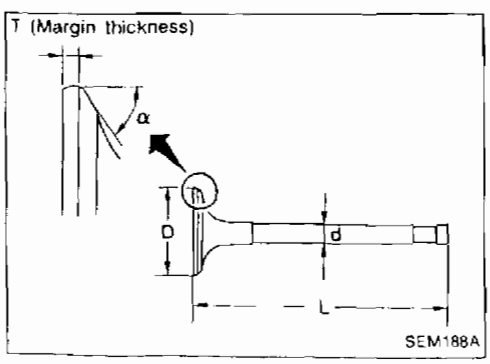


3. Heat cylinder head to 110 to 130°C (230 to 266°F).
4. Press fit valve seat until it seats on the bottom.



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

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



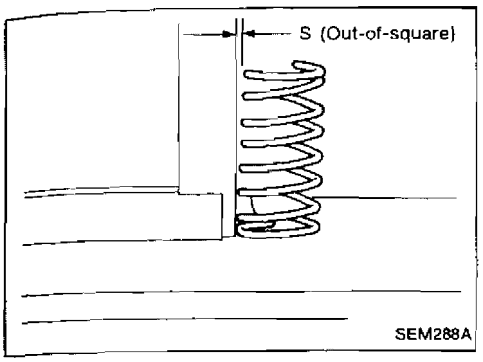
VALVE DIMENSIONS

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

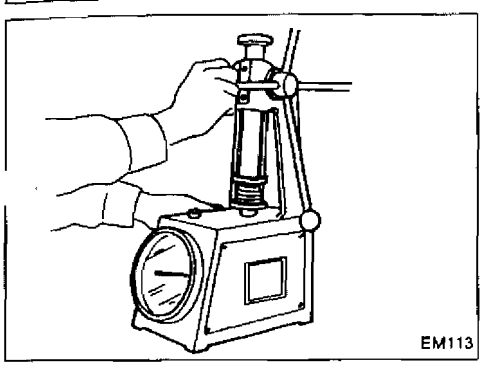
Inspection (Cont'd)



VALVE SPRING

Squareness

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



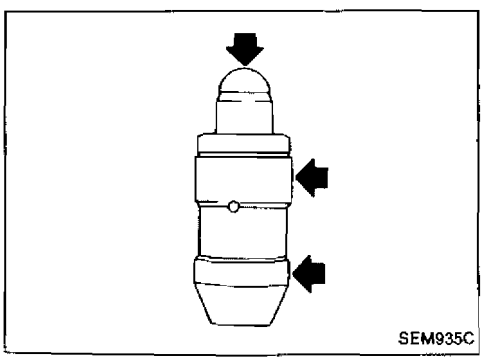
Pressure

Check valve spring pressure.

Standard:
578.02 - 641.57 N
(58.94 - 65.42 kg, 129.96 - 144.25 lb)
at 30.0 mm (1.181 in)

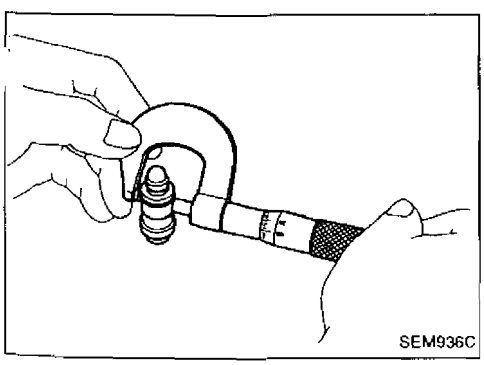
Limit:
More than 549.2 N (56.0 kg, 123.5 lb)
at 30.0 mm (1.181 in)

If it exceeds the limit, replace spring.

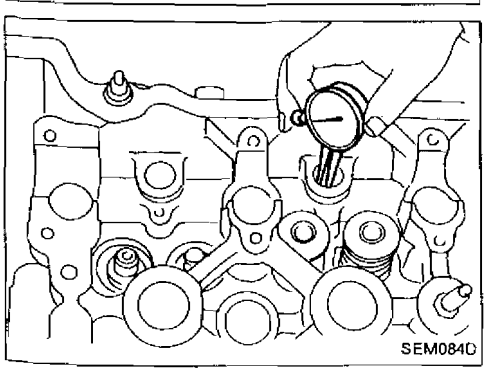


HYDRAULIC LASH ADJUSTER

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)

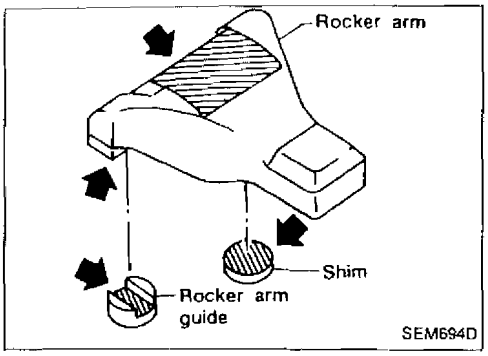


3. Check lash adjuster guide inner diameter.
   Inner diameter:
   17.000 - 17.020 mm (0.6693 - 0.6701 in)
   Standard clearance between lash adjuster and adjuster guide:
   0.007 - 0.040 mm (0.0003 - 0.0016 in)

Inspection (Cont'd)

ROCKER ARM, SHIM AND ROCKER ARM GUIDE

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

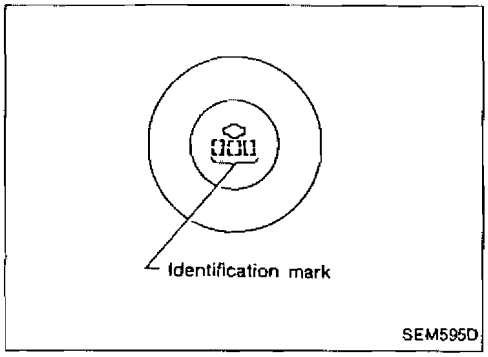


Assembly

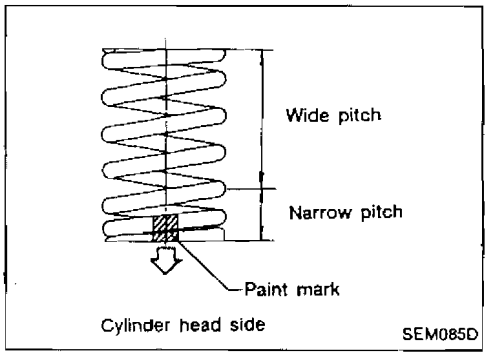
1. Install valve component parts.

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

Valve	Identification mark
Intake valve	53J
Exhaust valve	5J

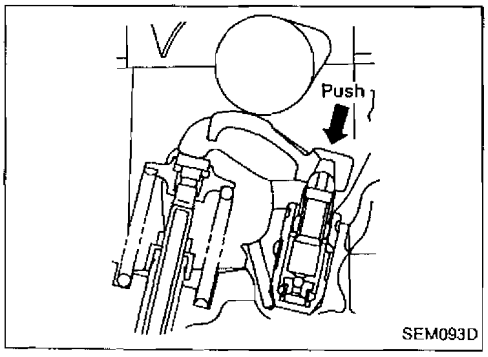


- **Always use new valve oil seal.**
  Refer to OIL SEAL REPLACEMENT.
- **Before installing valve oil seal, install valve spring seat.**
- **Install valve spring (uneven pitch type) with its narrow pitched side toward cylinder head side (paint mark).**
- **After installing valve components, tap valve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



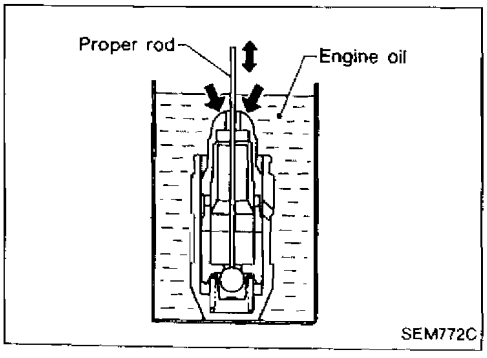
2. Check hydraulic lash adjusters.

a. Push on the rocker arm above the hydraulic lash adjuster. If it moves 1 mm (0.04 in) or more, there is air in the high pressure chamber.
   Noise will be emitted from hydraulic lash adjuster if engine is started without bleeding air.

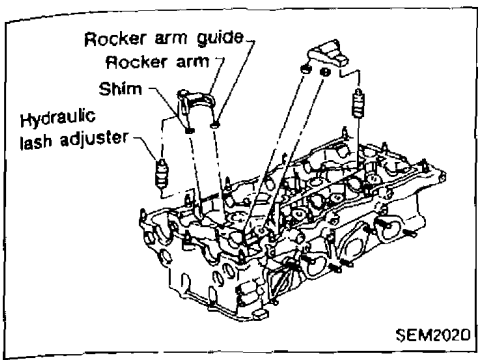


b. Remove hydraulic lash adjuster and dip in a container filled with engine oil. While pushing plunger as shown in figure, lightly push check ball using a thin rod. Air is completely bled when plunger no longer moves.

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

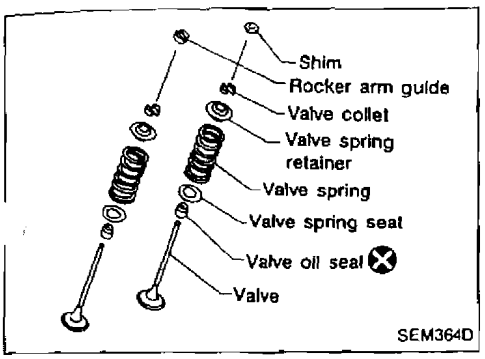


Assembly (Cont'd)



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

CAUTION:
Install all parts in their original positions.

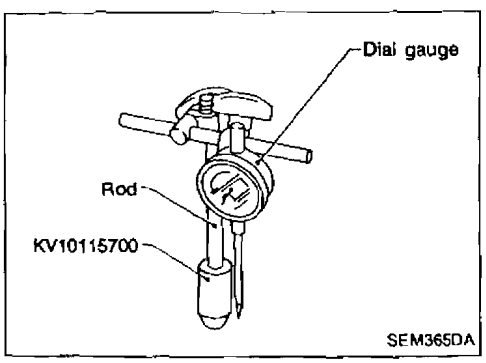


Valve shim clearance adjustment

4. Determine proper shim size when replacing valve, cylinder head, shim, rocker arm guide, or valve seat.

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

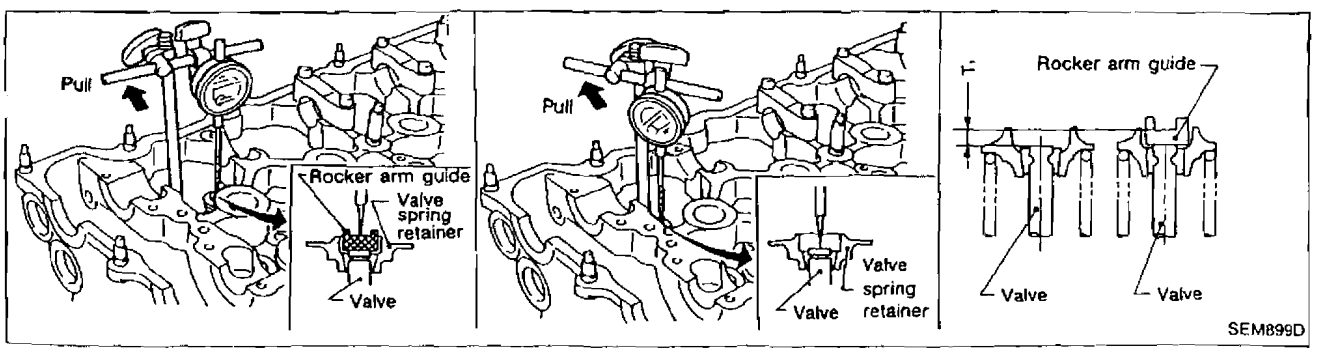
- Always replace rocker arm guide with a new one.



b. Remove hydraulic lash adjuster.

c. Install Tool* into hydraulic lash adjuster fixing hole.

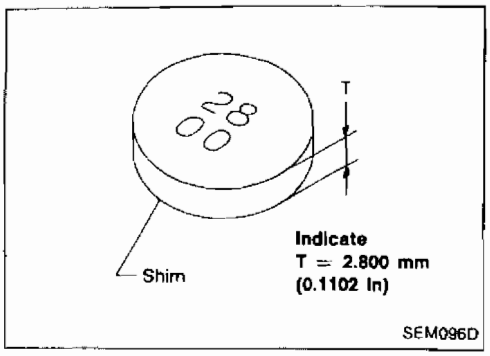
* Tool (KV10115700) is screwed into magnetic stand rod used with dial gauge.



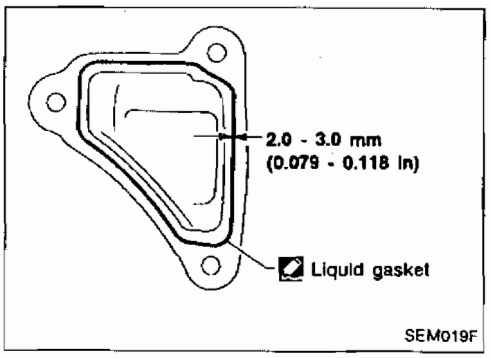
d. Before measuring, make sure the following parts are installed in the cylinder head: valve, valve spring, collet, retainer, and rocker arm guide (except shim). On shim side, measure difference (T_1) between contact surfaces of rocker arm guide and valve stem end.

When measuring, lightly pull dial indicator rod toward you to eliminate play in Tool (KV10115700).

Assembly (Cont'd)



e. Select proper shim.
Shim thickness (T): T_1 ±0.025 mm (0.0010 in)
- Shims are available in thicknesses from 2.800 mm (0.1102 in) to 3.200 mm (0.1260 in) in steps of 0.025 mm (0.0010 in).



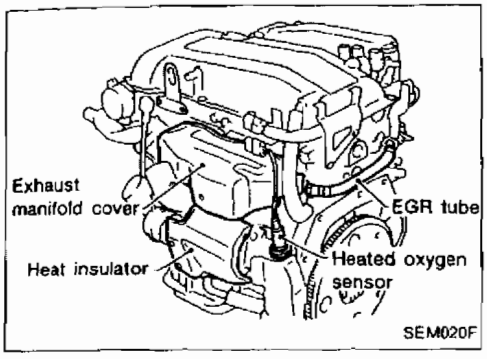
5. Install water outlet.
(1) Before installing water outlet, remove all traces of liquid gasket from mating surface using a scraper.
- Also remove traces of liquid gasket from mating surface of cylinder head.

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

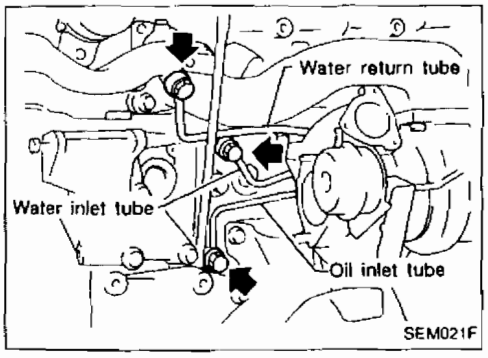
6. Install intake manifold.
Refer to "Installation" in "INTAKE MANIFOLD" (EM-36).

Removal

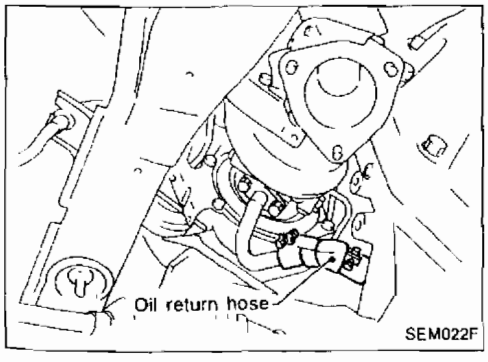
1. Drain coolant from radiator and cylinder block.
2. Remove engine under cover.
3. Remove front exhaust tube.
4. Remove air ducts for turbocharger unit.
5. Remove air cleaner case.
6. Remove wastegate valve control solenoid and its hoses.



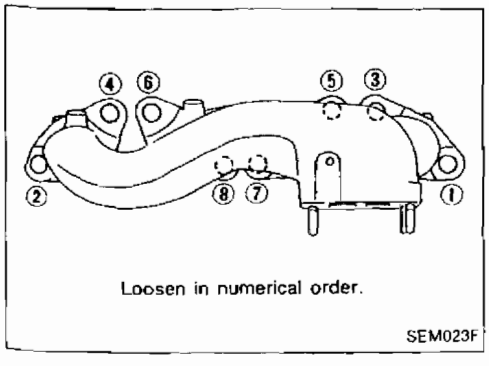
7. Remove exhaust manifold cover.
8. Remove heat insulator.
9. Remove heated oxygen sensor.
10. Remove EGR tube.



11. Remove connector bolts for water inlet and return tubes and oil inlet tube.

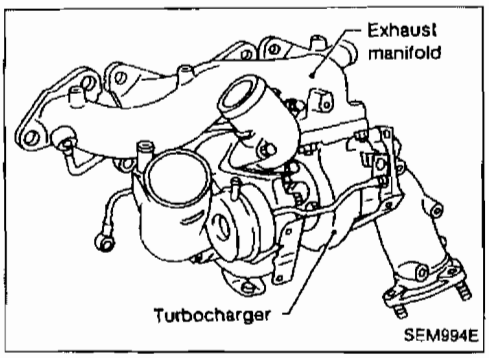


12. Remove oil return hose from cylinder block.



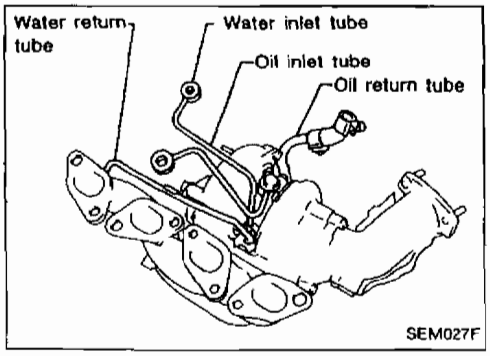
13. Remove exhaust manifold fixing nuts.

Removal (Cont'd)

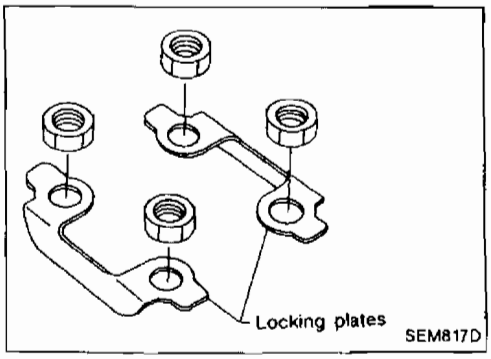


14. Remove steering column shaft lower joint (LHD model only).
15. Remove exhaust manifold with turbocharger unit.

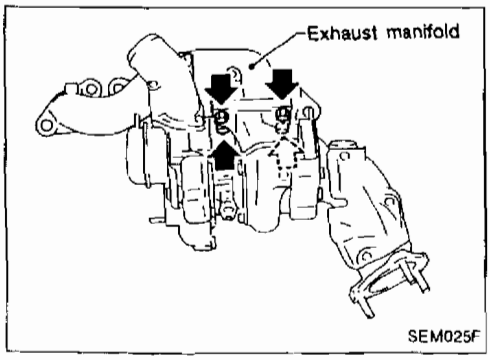
Disassembly



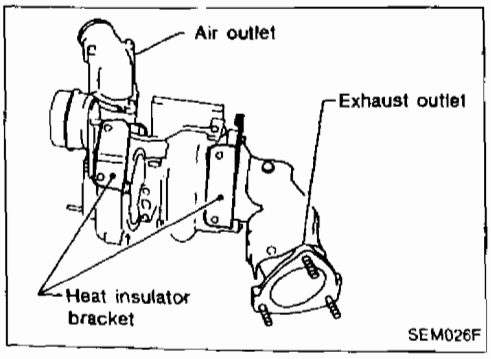
1. Remove oil tubes and water tubes. Before removing tubes, put mating marks on tube connectors and turbocharger.



2. Unbend locking plates for turbocharger unit fastening nuts.



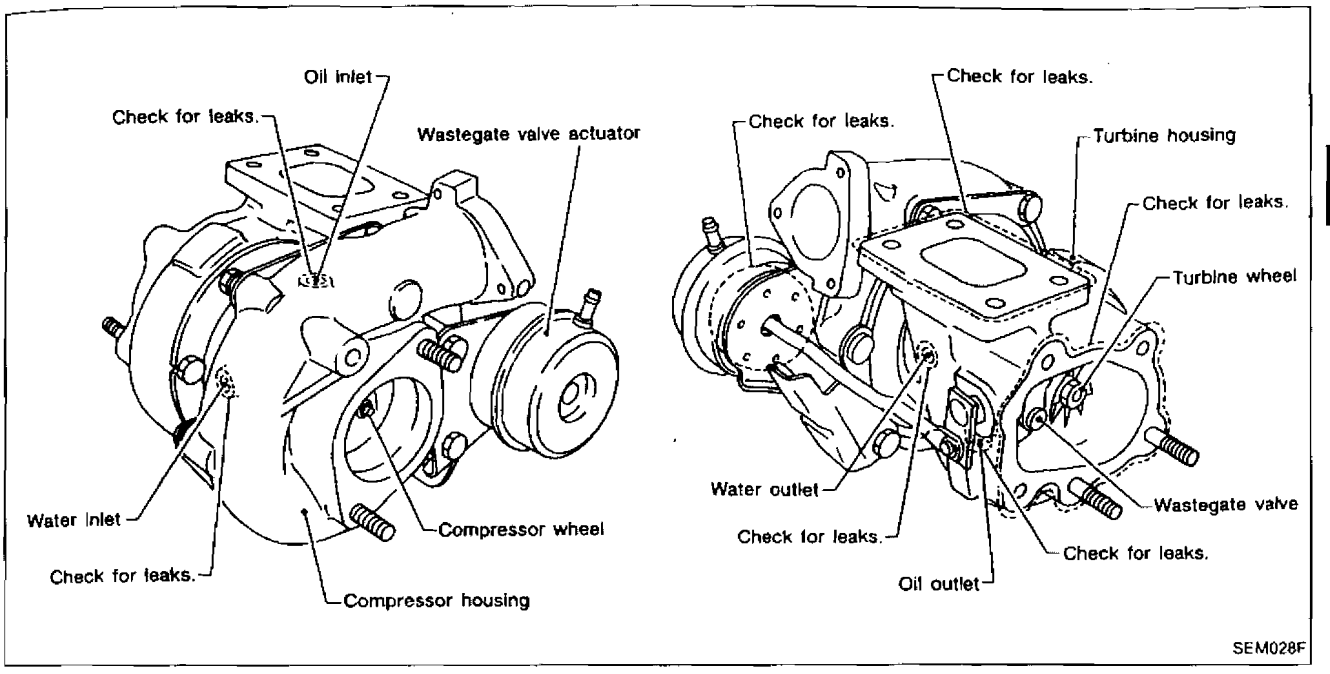
3. Remove exhaust manifold.

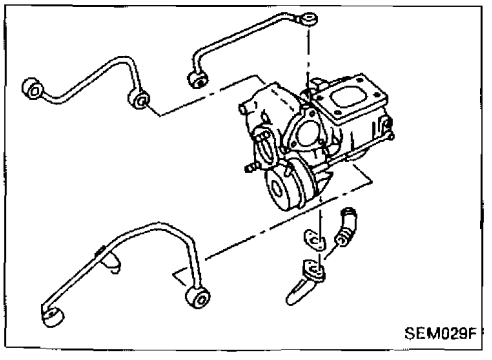


4. Remove exhaust outlet, air outlet and heat insulator brackets.

Inspection

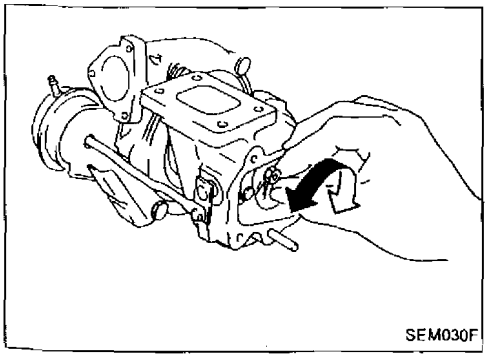
Perform the following checks. If NG, replace turbocharger unit.





OIL AND WATER TUBES

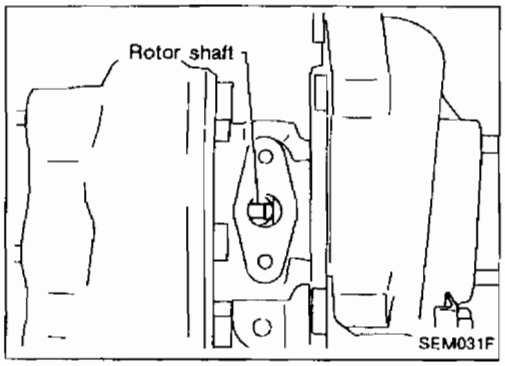
Check tubes for clogging.



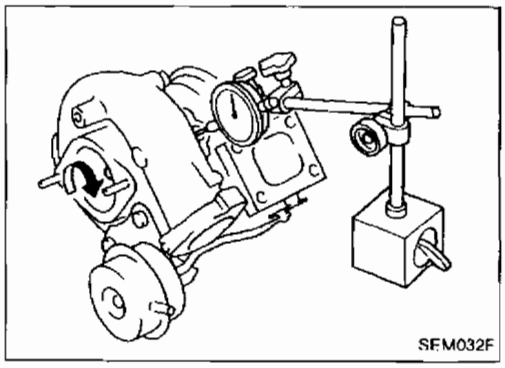
ROTOR SHAFT

1. Check rotor shaft for smooth rotation.

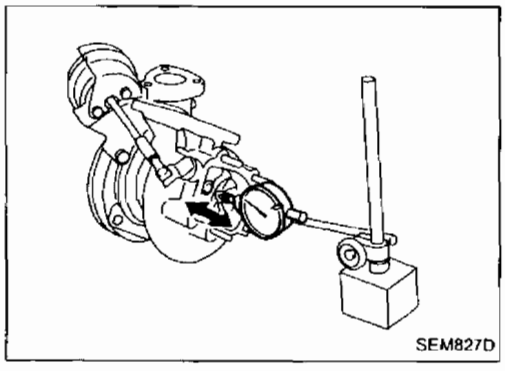
Inspection (Cont'd)



2. Check rotor shaft for carbon deposits.

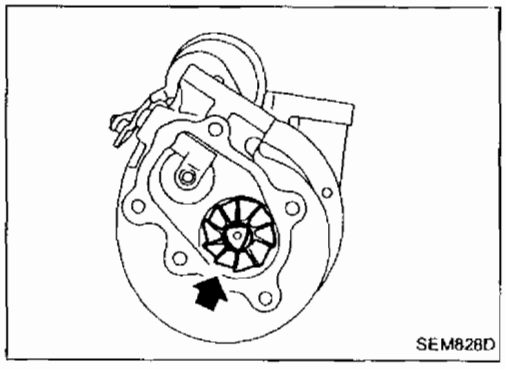


3. Measure rotor shaft runout.
   Runout (Total indicator reading):
   Standard
   0.056 - 0.127 mm (0.0022 - 0.0050 in)



4. Measure rotor shaft end play.
   End play:
   Standard
   0.013 - 0.097 mm (0.0005 - 0.0038 in)

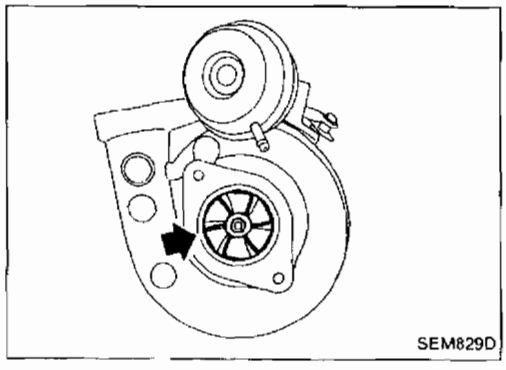
- **Do not allow wheels to turn when axial play is being measured.**



TURBINE WHEEL

Check turbine wheel for the following.

- Oil
- Carbon deposits
- Deformed fins
- Contact with turbine housing



COMPRESSOR WHEEL

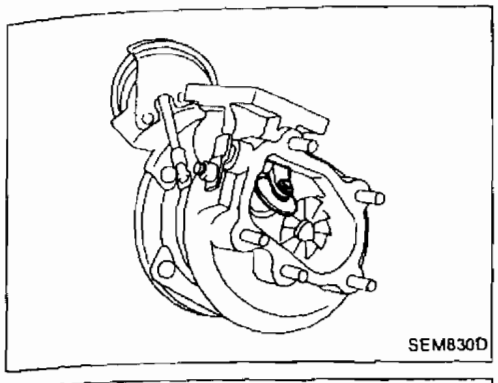
Check compressor wheel for the following.

- Oil
- Deformed fins
- Contact with compressor housing

Inspection (Cont'd)

WASTEGATE VALVE

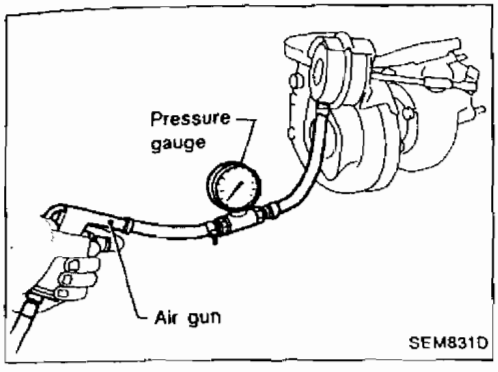
Remove rod pin and check wastegate valve for cracks, deformation and smooth movement. Check valve seat surface for smoothness.


SEM830D

WASTEGATE VALVE ACTUATOR

Apply compressed air to wastegate valve actuator and check it for smooth movement.

- **Do not applying compressed air to the actuator continuously.**
- **The air pressure should be in the range of 38.7 to 44.0 kPa (387 to 440 mbar, 290 to 330 mmHg, 11.42 to 12.99 inHg).**

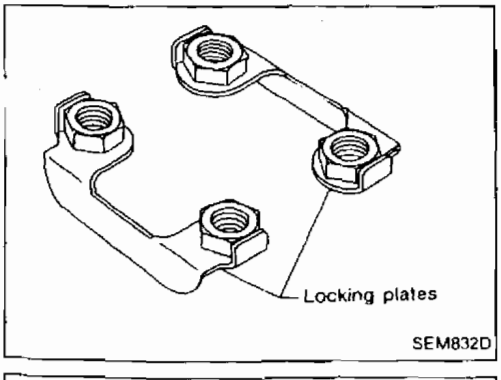


SEM831D

Assembly

Assembly is the reverse order of disassembly.

- Install gasket between exhaust manifold and turbocharger with lappet side facing exhaust manifold.

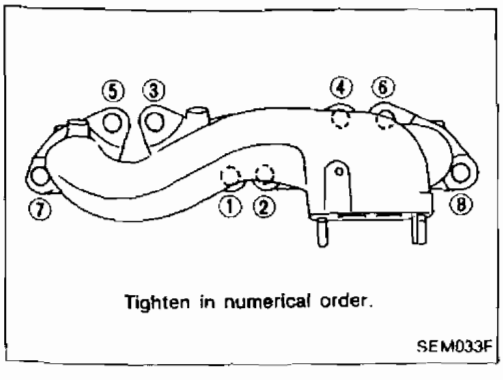


SEM832D

- Bend locking plates along the side of turbocharger fastening nuts.

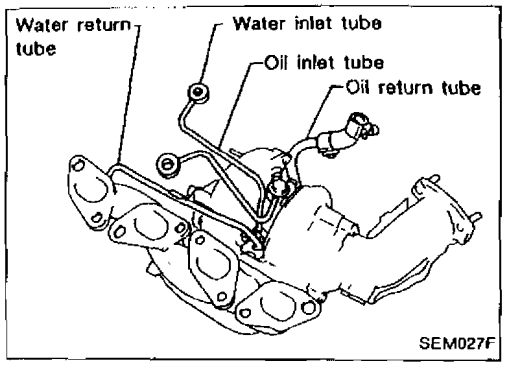
Installation

1. Install exhaust manifold fixing nuts.



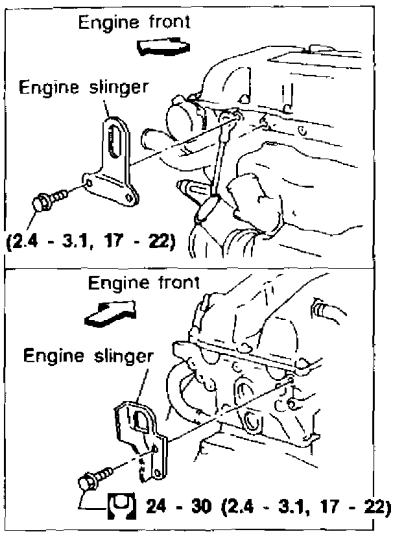
Tighten in numerical order.
SEM033F

Installation (Cont'd)

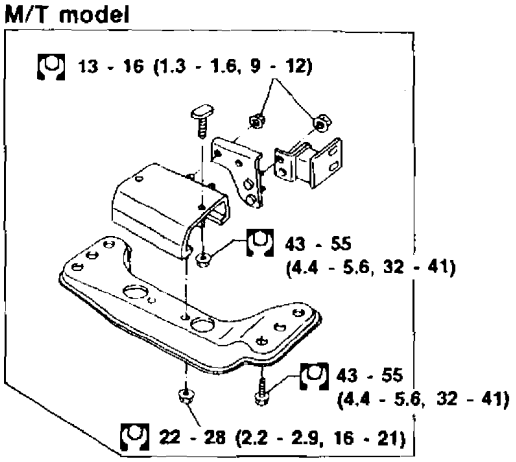


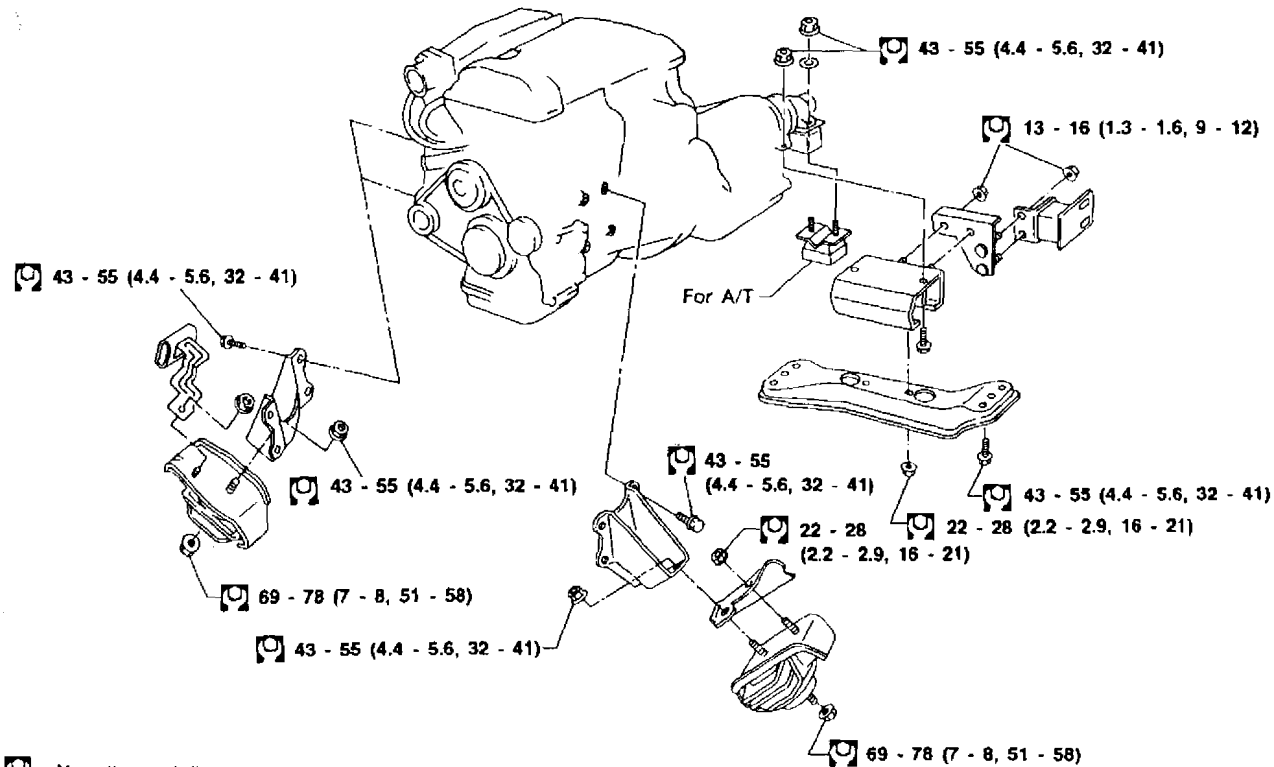
2. Installation is the reverse order of removal.
- Install oil tubes and water tubes in the following order, aligning the mating marks.
  a. Oil feed tube
  b. Water return tube
  c. Water feed tube
  d. Oil return tube

SEC. 112•111



M/T model





: N•m (kg-m, ft-lb)

SEM034F

WARNING:

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

CAUTION:

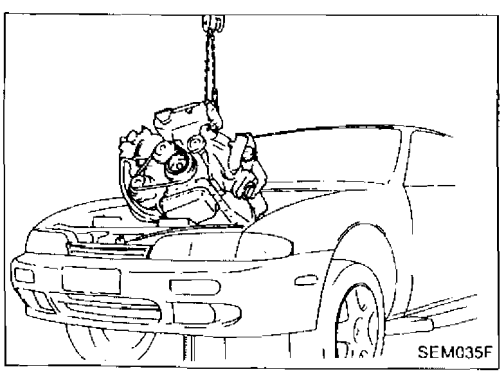
- **When lifting engine, be sure to clear surrounding parts. Take special care for accelerator wire casing, brake lines and brake master cylinder.**
- **In hoisting the engine, always use engine slingers in a safe manner.**

Removal

1. Remove transmission.

Refer to AT or MT section.

2. Remove engine under cover and hood.
3. Drain coolant from both cylinder block drain plug, and radiator drain cock.
4. Drain engine oil from drain plug of oil pan.
5. Remove vacuum hoses, fuel tubes, wires, harness and connectors and so on.
6. Remove front exhaust tubes.
7. Remove radiator and shroud.
8. Remove drive belts.
9. Remove A/C compressor and power steering oil pump from engine.
10. Install engine slingers to cylinder head.
11. Set a suitable hoist on engine slinger.
12. Remove engine mounting bolts from both sides and then slowly raise engine.

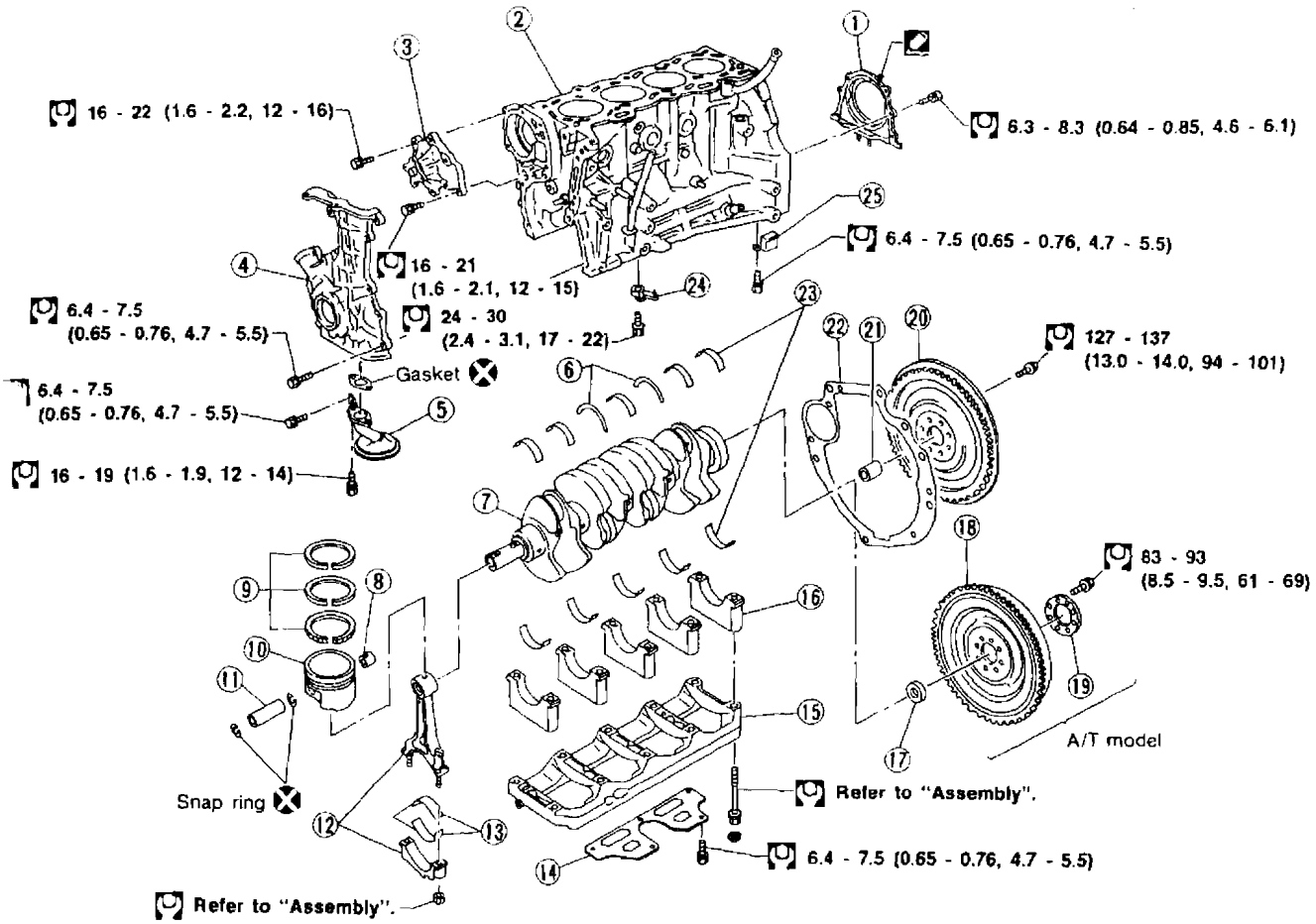


13. Remove engine as shown.

Installation

Installation is in the reverse order of removal.

SEC.110·120



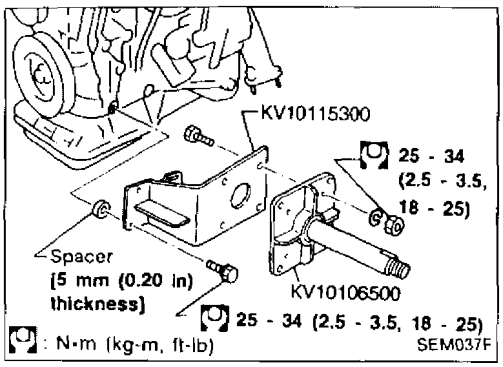
Apply liquid gasket
N·m (kg-m, ft-lb)

SEM036F

① Rear oil seal retainer
② Cylinder block
③ Water pump
④ Front cover with oil pump
⑤ Oil strainer
⑥ Thrust bearing
⑦ Crankshaft
⑧ Connecting rod bushing
⑨ Piston rings
⑩ Piston
⑪ Piston pin
⑫ Connecting rod
⑬ Connecting rod bearing
⑭ Baffle plate
⑮ Main bearing beam
⑯ Main bearing cap
⑰ Pilot converter
⑱ Drive plate
⑲ Reinforcement plate
⑳ Flywheel
㉑ Pilot bushing
㉒ Rear plate
㉓ Main bearing
㉔ Oil jet
㉕ Baffle plate

CAUTION:

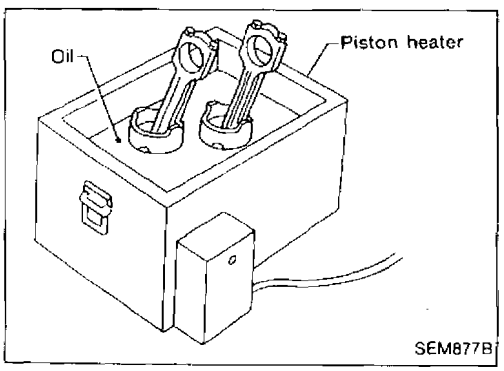
- **When installing bearings, pistons, or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When installing connecting rod nuts, and main bearing cap bolts, apply new engine oil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



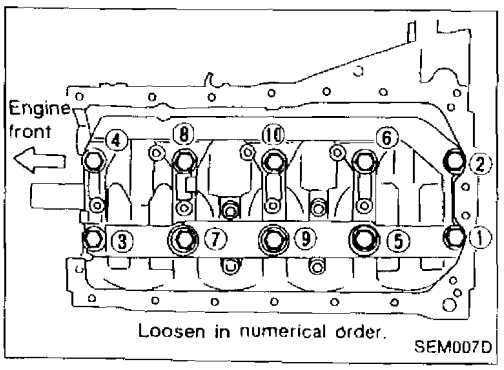
Disassembly

PISTON AND CRANKSHAFT

1. Remove engine.
   Refer to "ENGINE REMOVAL" (EM-55).
2. Remove compressor bracket and engine mounting bracket, then install engine on engine stand (ST0501S000).
3. Remove cylinder head.
   Refer to "Removal" in "TIMING CHAIN" (EM-20).
4. Remove oil pan.
   Refer to "Removal" in "OIL PAN" (EM-13).
5. Remove timing chain.
   Refer to "Removal" in "TIMING CHAIN" (EM-20).

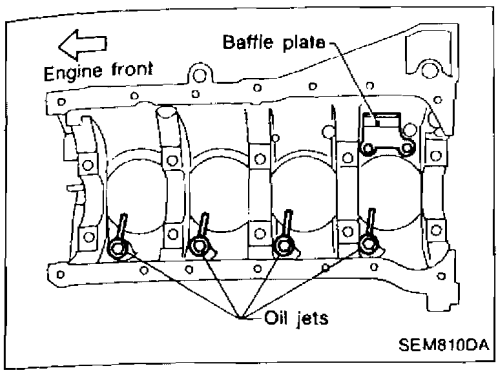


6. Remove pistons with connecting rods.
   - When disassembling piston and connecting rod, remove snap ring first. Then heat piston to 60 to 70°C (140 to 158°F), or use piston pin press stand at room temperature.
7. Remove rear oil seal retainer.



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

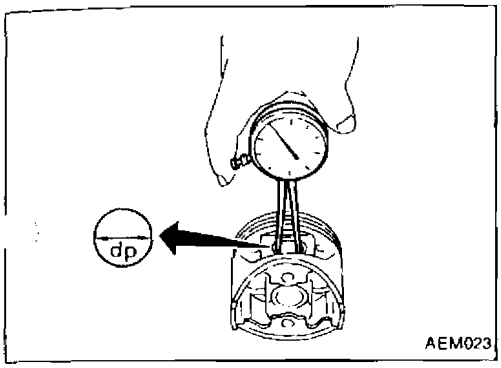
Disassembly (Cont'd)



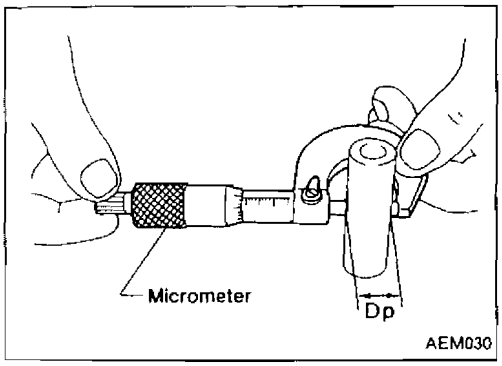
9. Remove baffle plate.
10. Remove oil jets.

Inspection

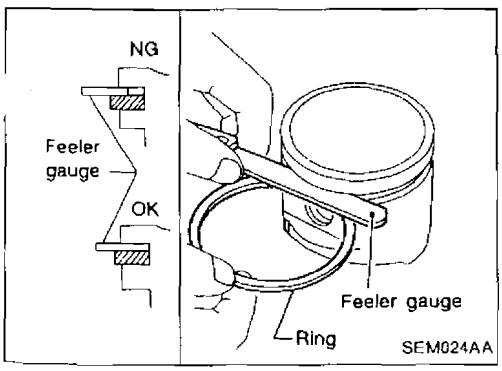
PISTON AND PISTON PIN CLEARANCE



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



2. Measure outer diameter of piston pin "Dp".
   Standard diameter "Dp":
   21.989 - 22.001 mm (0.8657 - 0.8662 in)
3. Calculate piston pin clearance.
   dp – Dp = –0.004 to 0 mm (–0.0002 to 0 in)
   If it exceeds the above value, replace piston assembly with pin.



PISTON RING SIDE CLEARANCE

Side clearance:

Top ring

0.045 - 0.080 mm (0.0018 - 0.0031 in)

2nd ring

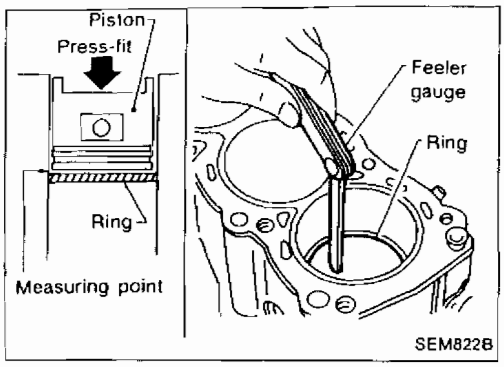
0.030 - 0.065 mm (0.0012 - 0.0026 in)

Max. limit of side clearance:

0.1 mm (0.004 in)

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

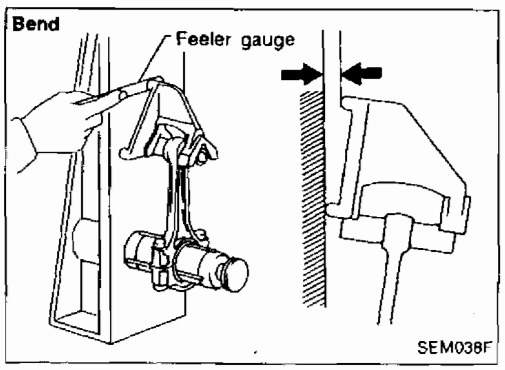
Inspection (Cont'd)

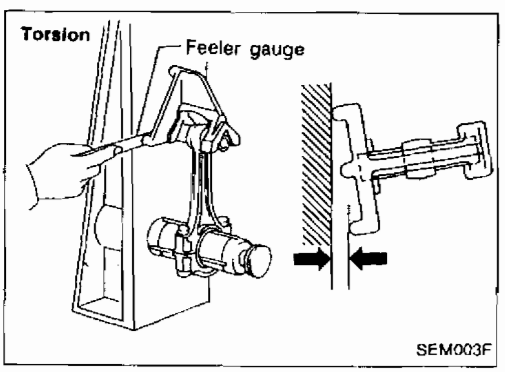


PISTON RING END GAP

Top ring:
Standard
0.20 - 0.30 mm (0.0079 - 0.0118 in)
Limit
0.39 mm (0.0154 in)
2nd ring:
Standard
0.35 - 0.50 mm (0.0138 - 0.0197 in)
Limit
0.59 mm (0.0232 in)
Oil ring:
Standard
0.20 - 0.60 mm (0.0079 - 0.0236 in)
Limit
0.60 mm (0.0272 in)

If out of specification, replace piston ring. If gap exceeds maximum limit with new ring, rebore cylinder and use oversize piston and piston rings.
Refer to SDS (EM-78).



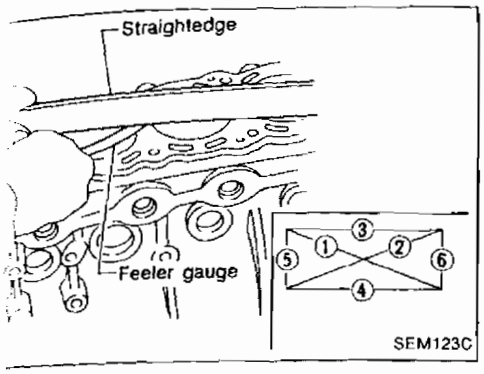


CONNECTING ROD BEND AND TORSION

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)

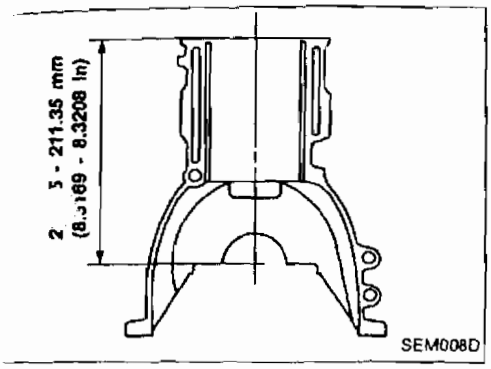


CYLINDER BLOCK DISTORTION AND WEAR

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

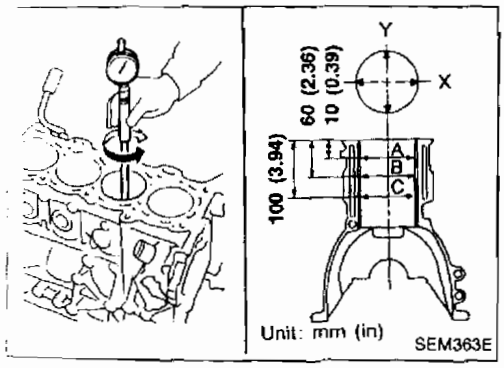
Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".
The maximum limit is as follows:
A + B = 0.2 mm (0.008 in)
Nominal cylinder block height from crankshaft center:
211.25 - 211.35 mm (8.3169 - 8.3208 in)

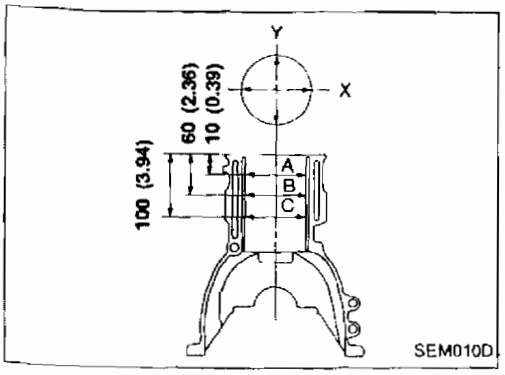
3. If necessary, replace cylinder block.



PISTON-TO-BORE CLEARANCE

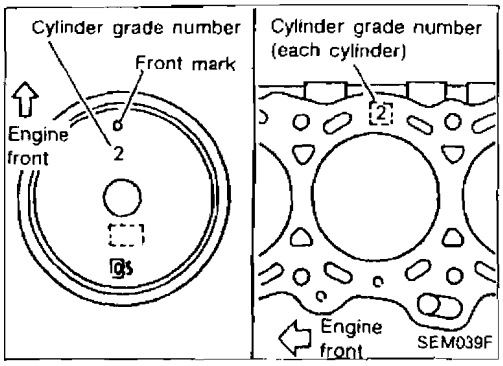
1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.
   Standard inner diameter:
   86.000 - 86.030 mm (3.3858 - 3.3870 in)
   Wear limit:
   0.20 mm (0.0079 in)
   If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.
   Out-of-round (X – Y) standard:
   0.015 mm (0.0006 in)
   Taper (A – B and A – C) standard:
   0.010 mm (0.0004 in)



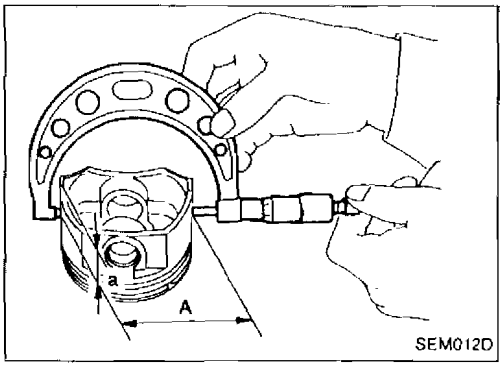


2. Check for scratches and seizure. If seizure is found, hone it.

Inspection (Cont'd)



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



3. Measure piston skirt diameter.
   Piston diameter "A":
   Refer to SDS (EM-78).
   Measuring point "a" (Distance from the bottom):
   10.5 mm (0.413 in)
4. Check that piston-to-bore clearance is within specification.
   Piston-to-bore clearance "B":
   0.010 - 0.030 mm (0.0004 - 0.0012 in)
5. Determine piston oversize according to amount of cylinder wear.

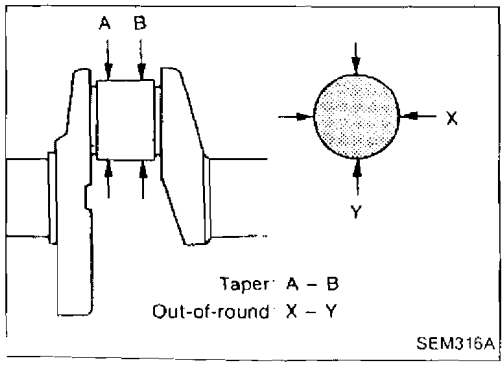
Oversize pistons are available for service. Refer to SDS (EM-78).

6. Cylinder bore size is determined by adding piston-to-bore clearance to piston diameter "A".
   Rebored size calculation:
   D = A + B – C
   where,
   D: Bored diameter
   A: Piston diameter as measured
   B: Piston-to-bore clearance
   C: Honing allowance 0.02 mm (0.0008 in)
7. Install main bearing caps and tighten bolts to the specified torque. This will prevent distortion of cylinder bores.
8. Cut cylinder bores.

- **When any cylinder needs boring, all other cylinders must also be bored.**
- **Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so 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.**



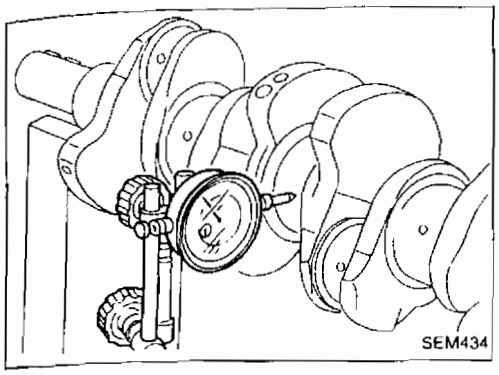
CRANKSHAFT

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

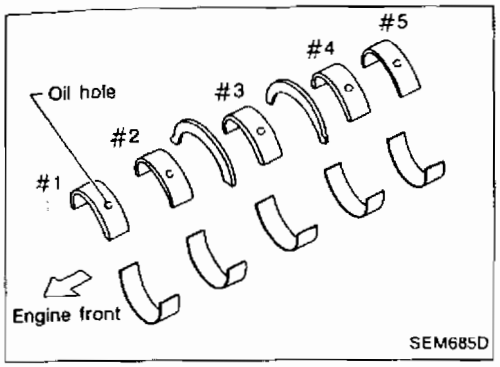
Unit: mm (in)

Out-of-round (X – Y) and Taper (A – B)	Main journal	Less than 0.005 (0.0002)
	Pin journal	Less than 0.0025 (0.0001)

Inspection (Cont'd)



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



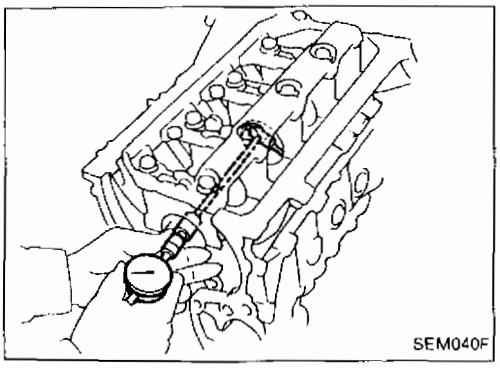
BEARING CLEARANCE

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

Method A (Using bore gauge & micrometer)

Main bearing

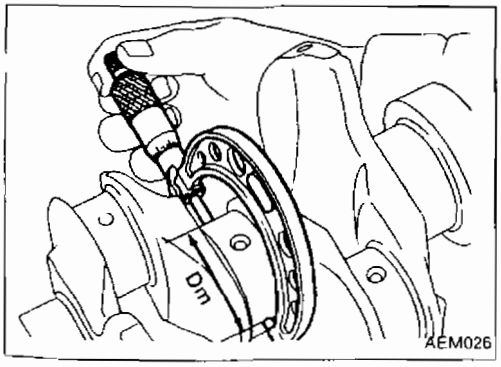
1. Set main bearings in their proper positions on cylinder block and main bearing cap.



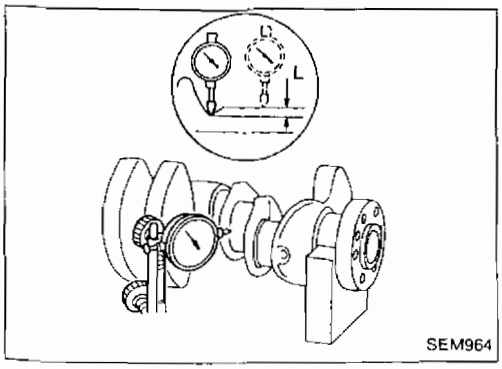
2. Install main bearing cap and main bearing beam to cylinder block.

Tighten all bolts in specified procedure. Refer to "CRANKSHAFT" in "Cylinder Block Assembly" (EM-68).

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

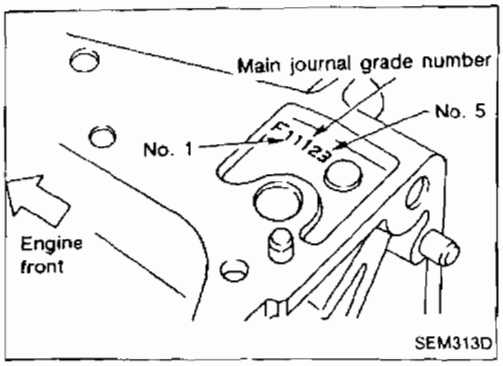


4. Measure outer diameter "Dm" of each crankshaft main journal.
5. Calculate main bearing clearance.
   Main bearing clearance = A – Dm
   Standard: 0.004 - 0.022 mm (0.0002 - 0.0009 in)
   Limit: 0.050 mm (0.0020 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within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



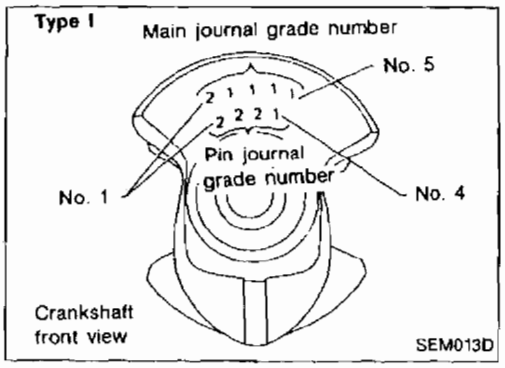
a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.
   "L": 0.1 mm (0.004 in)
b. Refer to SDS for grinding crankshaft and available service parts (EM-80).

Inspection (Cont'd)

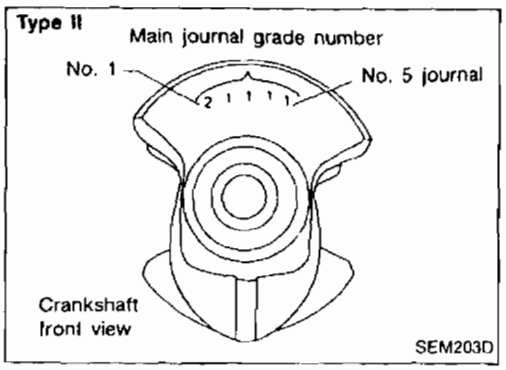


8. If crankshaft is reused, measure main bearing clearances and select thickness of main bearings.
   If crankshaft is replaced, select thickness of main bearings as follows:

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



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



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

How to select main bearings (Identification mark and color)

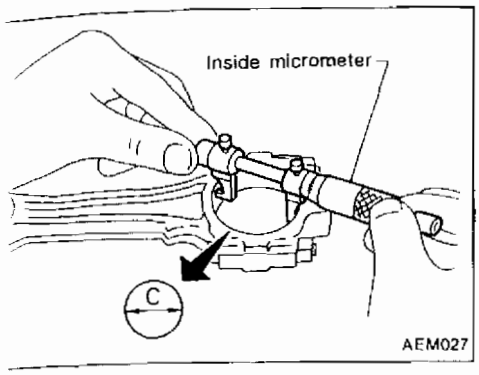
Crankshaft journal grade number	Main journal grade number			
	0	1	2	3
0	0 (A, Black)	1 (B, Brown)	2 (C, Green)	3 (D, Yellow)
1	1 (B, Brown)	2 (C, Green)	3 (D, Yellow)	4 (E, Blue)
2	2 (C, Green)	3 (D, Yellow)	4 (E, Blue)	5 (F, Pink)
3	3 (D, Yellow)	4 (E, Blue)	5 (F, Pink)	6 (G, No color)

For example:

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

Inspection (Cont'd)

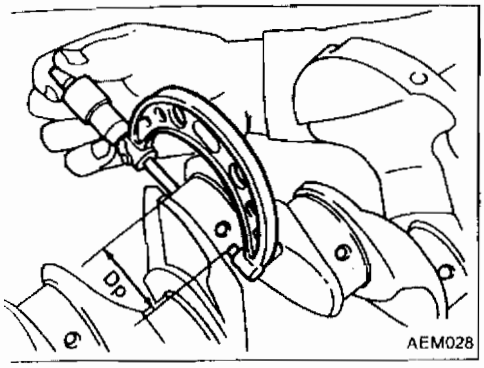
Connecting rod bearing (Big end)



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):

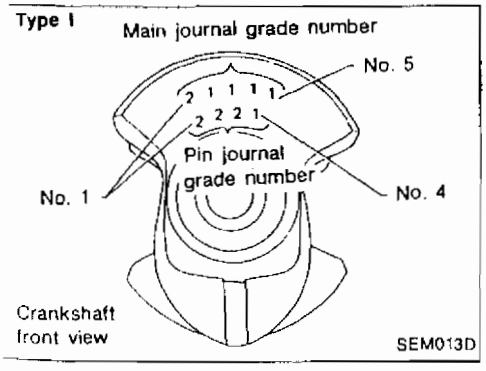
   Standard

   0.020 - 0.045 mm (0.0008 - 0.0018 in)

   Limit

   0.65 mm (0.00256 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-63).

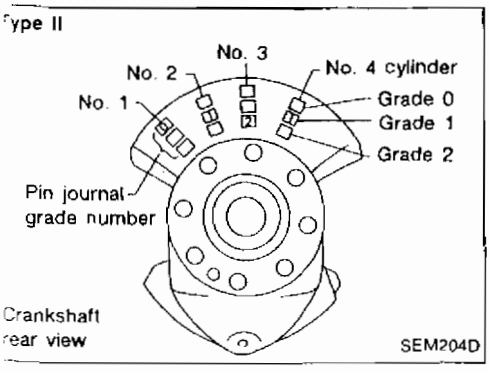


8. If crankshaft is replaced with a new one, select connecting rod bearing according to the following table.

Connecting rod bearing grade number:

These numbers are punched in either Arabic or Roman numerals.

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



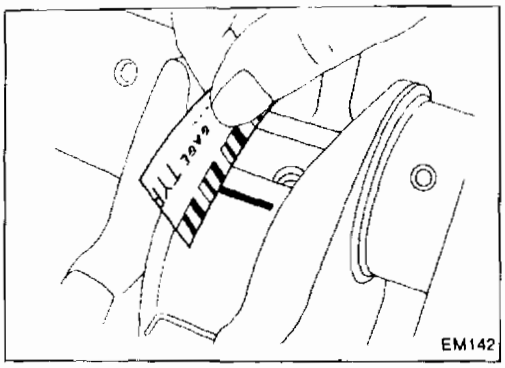
Identification colors of connecting rod bearing:

Grade 0; No color

Grade 1; Black

Grade 2; Brown

Inspection (Cont'd)



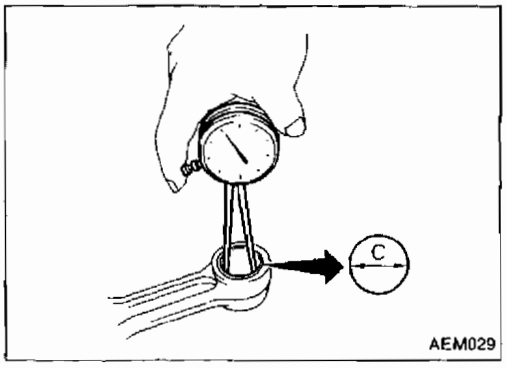
Method B (Using plastigage)

CAUTION:

- **Do not turn crankshaft or connecting rod while plastigage is being inserted.**
- **When bearing clearance exceeds the specified limit, ensure that the proper bearing has been installed. If clearance cannot be adjusted using any standard bearing grade, grind crankshaft journal and use undersized bearing.**

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

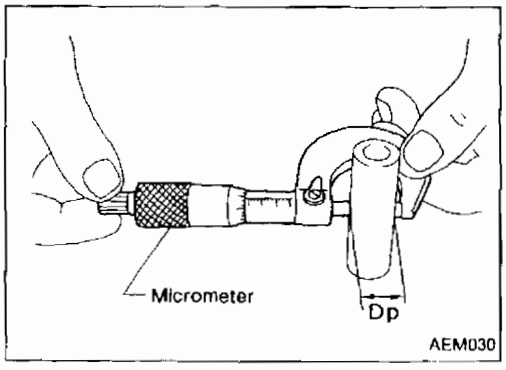
   Standard:

   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)

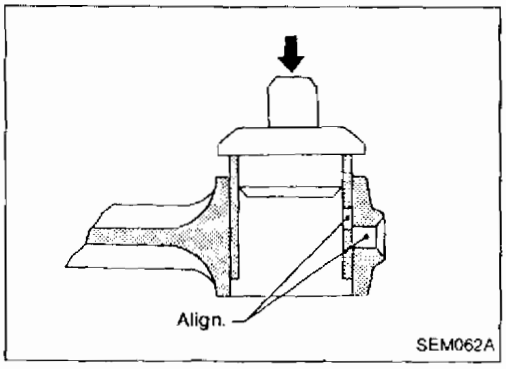
1. Drive in small end bushing until it is flush with end surface of rod.

Be sure to align the oil holes.

2. Ream the bushing so that clearance with piston pin is within specification.

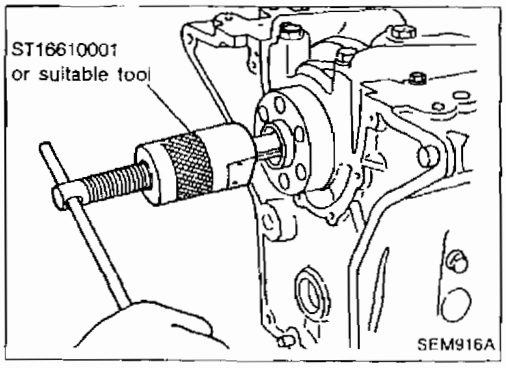
   Clearance between connecting rod bushing and piston pin:

   0.005 - 0.017 mm (0.0002 - 0.0007 in)



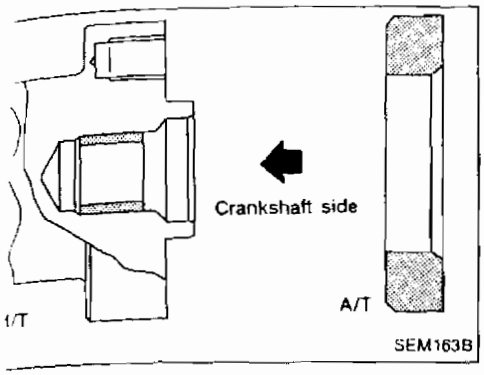
REPLACEMENT OF PILOT BUSHING (M/T) OR PILOT CONVERTER (A/T)

1. Remove pilot bushing or pilot converter using Tool or suitable tool.



Inspection (Cont'd)

2. Install pilot bushing or pilot converter as shown.



FLYWHEEL/DRIVE PLATE RUNOUT

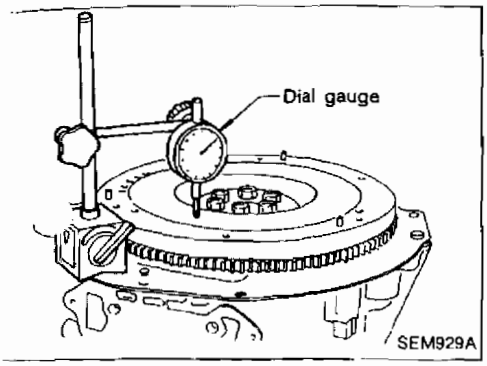
Runout (Total indicator reading):

Flywheel (M/T model)

Less than 0.15 mm (0.0059 in)

Drive plate (A/T model)

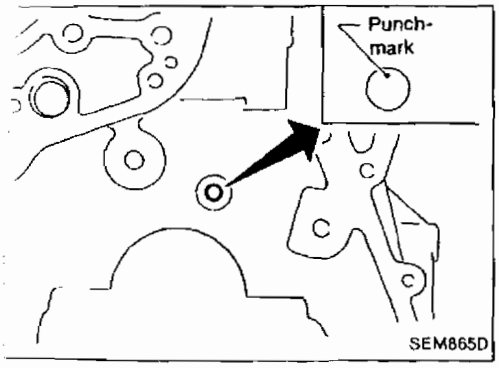
Less than 0.20 mm (0.0079 in)



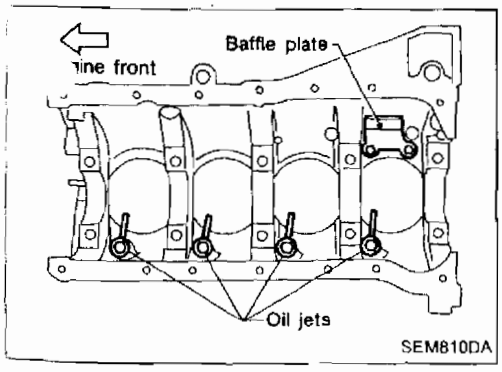
Assembly

1. Install timing chain oil jet.

Drive oil jet into cylinder block with punchmark facing up.

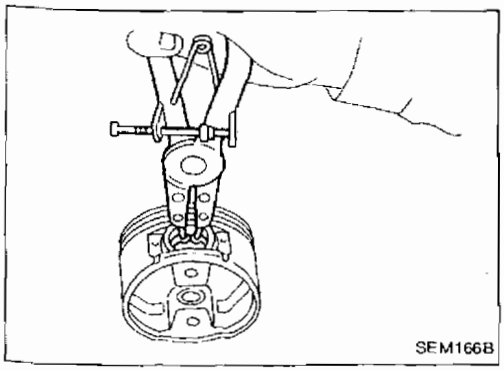


2. Install piston oil jets.
3. Install baffle plate.

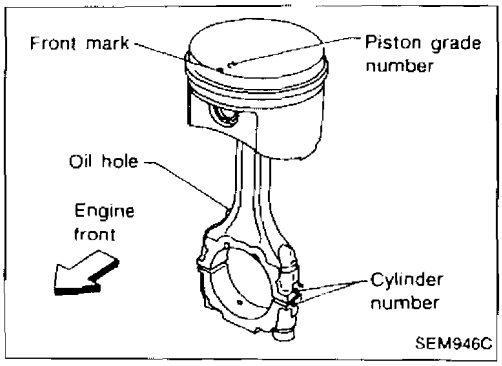


PISTON

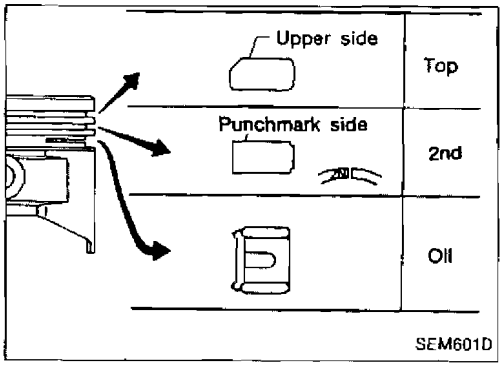
1. Install new snap ring on one side of piston pin hole.



Assembly (Cont'd)

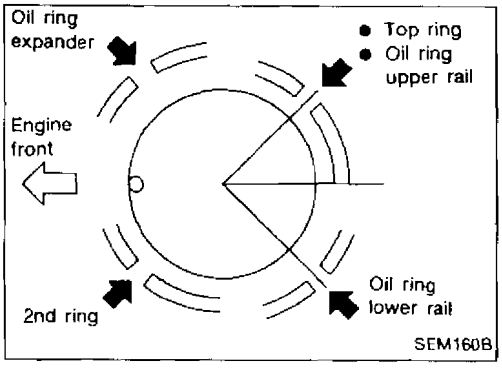


2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.
- **Align the direction of piston and connecting rod.**
- **Numbers stamped on connecting rod and cap correspond to each cylinder.**
- **After assembly, make sure connecting rod swings smoothly.**

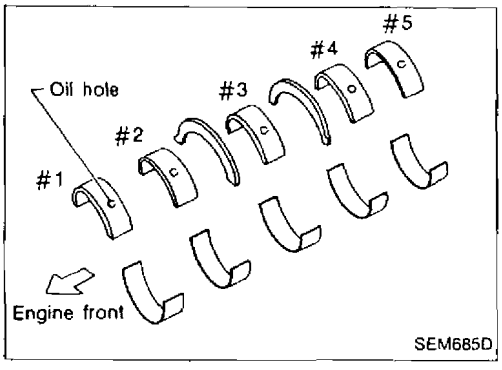


3. Set piston rings as shown.

CAUTION:
- **When piston rings are not replaced, make sure that piston rings are mounted in their original positions.**
- **When replacing piston rings, if there is no punchmark, install with either side up.**



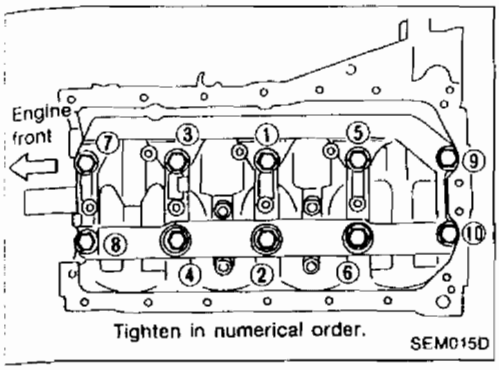
4. Locate the ring gap as shown.



CRANKSHAFT

1. Set main bearings and thrust bearings in their proper positions on cylinder block and main bearing cap.
- **Confirm that correct main bearings are used. Refer to "Inspection" of this section.**
- **Direct the oil grooved side of thrust bearing to crankshaft arm side.**

Assembly (Cont'd)

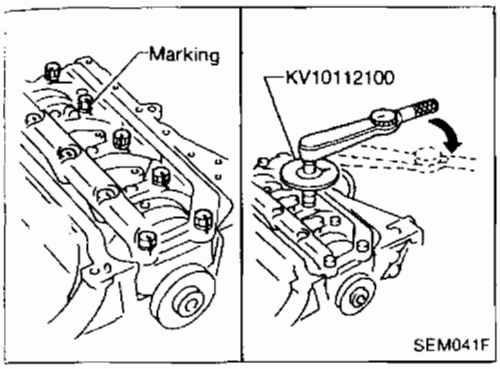


Tighten in numerical order.
SEM015D

2. Install crankshaft, main bearing caps and beam and tighten bolts to the specified torque.
- **Prior to tightening bearing cap bolts, shift crankshaft back and forth to properly seat the bearing cap.**
- **Tightening procedure**

a. **Tighten all bolts to 26 to 32 N·m (2.7 to 3.3 kg-m, 20 to 24 ft-lb).**
b. **Turn all bolts 75 to 80 degrees clockwise with Tool or suitable angle wrench.**
c. **Loosen all bolts completely.**
d. **Tighten all bolts to 32 to 38 N·m (3.3 to 3.9 kg-m, 24 to 28 ft-lb).**
e. **Turn all bolts 45 to 50 degrees clockwise with Tool or suitable angle wrench.**

- **If an angle wrench is not available, mark all bearing cap bolts on the side facing engine rear. Then, turn each bolt specified degrees clockwise. Confirm angle of degrees with a graduator, not by eye-measurement.**
- **After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.**

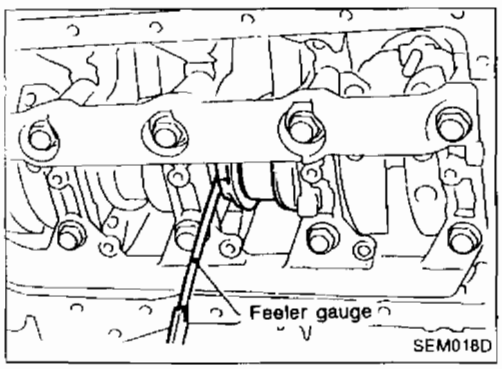


SEM041F

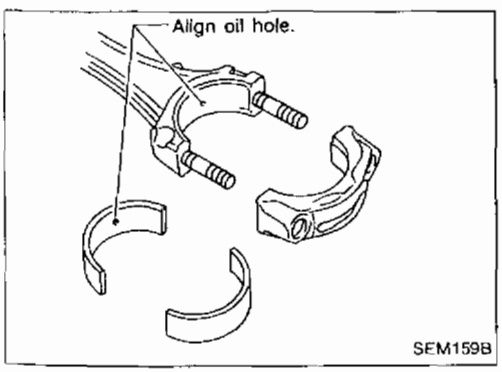
3. Measure crankshaft end play.

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

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

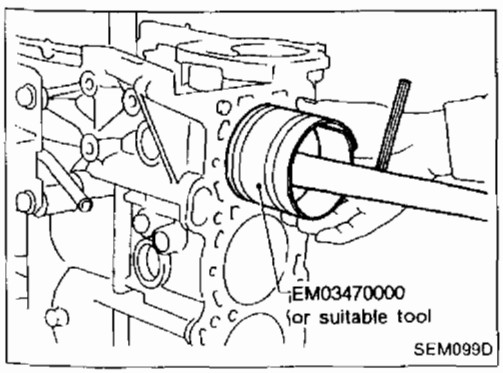


SEM018D



SEM159B

4. Install connecting rod bearings in connecting rods and connecting rod bearing 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.**

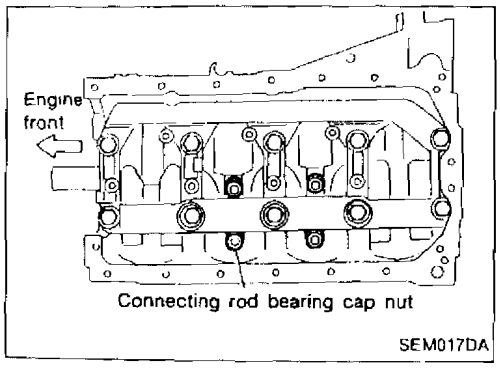


SEM099D

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 engine front.**
- **Be careful not to hit oil jet with connecting rod.**

Assembly (Cont'd)



b. Install connecting rod bearing caps.
Tighten connecting rod bearing cap nuts in the following two steps.

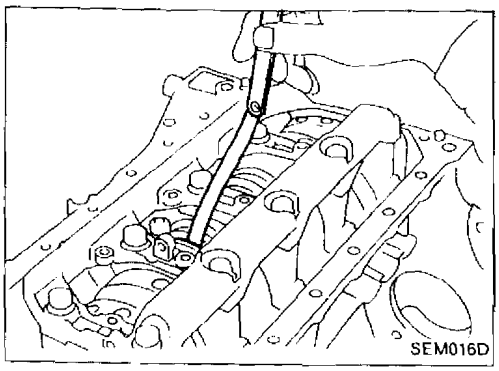
Step 1

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

Step 2

Turn nuts 60 to 65 degrees clockwise with angle wrench. If angle wrench is not available, tighten nuts to 38 to 44 N·m (3.9 to 4.5 kg-m, 28 to 33 ft-lb).

- **After securing connecting rod cap nuts, make sure crankshaft turns smoothly by hand.**



6. Measure connecting rod side clearance.

Connecting rod side clearance:

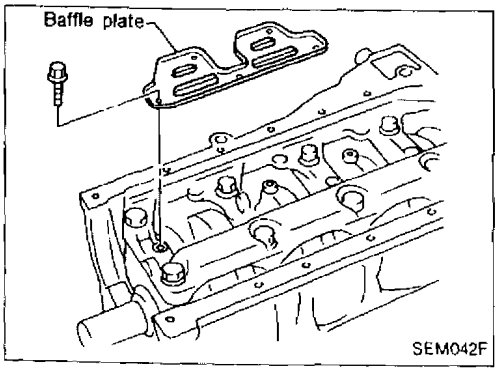
Standard

0.20 - 0.35 mm (0.0079 - 0.0138 in)

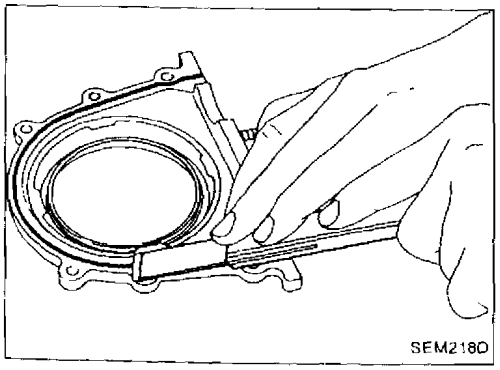
Limit

0.50 mm (0.0197 in)

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



7. Install baffle plate.



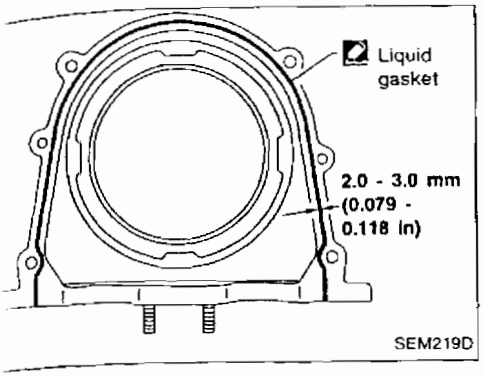
8. Install rear oil seal retainer.

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

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

(2) Install rear oil seal. Refer to "REAR OIL SEAL" in "Oil Seal Replacement" (EM-34).

Assembly (Cont'd)



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

- Use Genuine Liquid Gasket or equivalent.

General Specifications

Cylinder arrangement		In-line 4
Displacement	cm^3 (cu in)	1,998 (121.92)
Bore and stroke	mm (in)	86 x 86 (3.39 x 3.39)
Valve arrangement		DOHC
Firing order		1-3-4-2
Number of piston rings		
Compression		2
Oil		1
Number of main bearings		5
Compression ratio		8.5

COMPRESSION PRESSURE

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

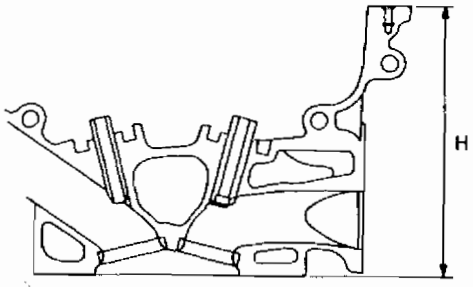
Standard	1,079 (10.79, 11.0, 156)
Minimum	883 (8.83, 9.0, 128)
Differential limit between cylinders	98 (0.98, 1.0, 14)

Inspection and Adjustment

CYLINDER HEAD

Unit: mm (in)

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



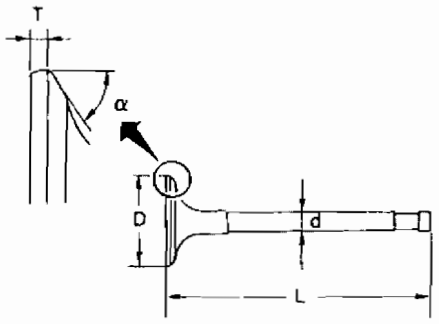
SEM043F

Nominal cylinder head height "H"	136.9 - 137.1 (5.390 - 5.398)
Resurfacing limit	0.2 (0.008)*

*: Sum of resurfacing cylinder head and cylinder block

VALVE

Unit: mm (in)



SEM188-B

Valve head diameter "D"	
Intake	34.0 - 34.2 (1.339 - 1.346)
Exhaust	30.0 - 30.2 (1.181 - 1.189)
Valve length "L"	
Intake	101.19 - 101.61 (3.9839 - 4.0004)
Exhaust	102.11 - 102.53 (4.0201 - 4.0366)
Valve stem diameter "d"	
Intake	5.965 - 5.980 (0.2348 - 0.2354)
Exhaust	6.945 - 6.960 (0.2734 - 0.2740)
Valve seat angle "α"	
Intake	45°15′ - 45°45′
Exhaust	
Valve margin "T"	
Intake	1.1 (0.043)
Exhaust	1.3 (0.051)
Valve margin "T" limit	More than 0.5 (0.020)
Valve stem end surface grinding limit	Less than 0.2 (0.008)

Inspection and Adjustment (Cont'd)

Valve spring

Free height	mm (in)	49.36 (1.9433)
Pressure N (kg, lb) at height mm (in)		
Standard		578.02 - 641.57 (58.94 - 65.42, 129.96 - 144.25) at 30.0 (1.181)
Limit		549.2 (56.0, 123.5) at 30.0 (1.181)
Out-of-square	mm (in)	Less than 2.2 (0.087)

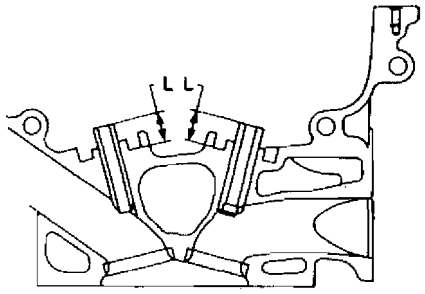
Hydraulic lash adjuster (HLA)

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)



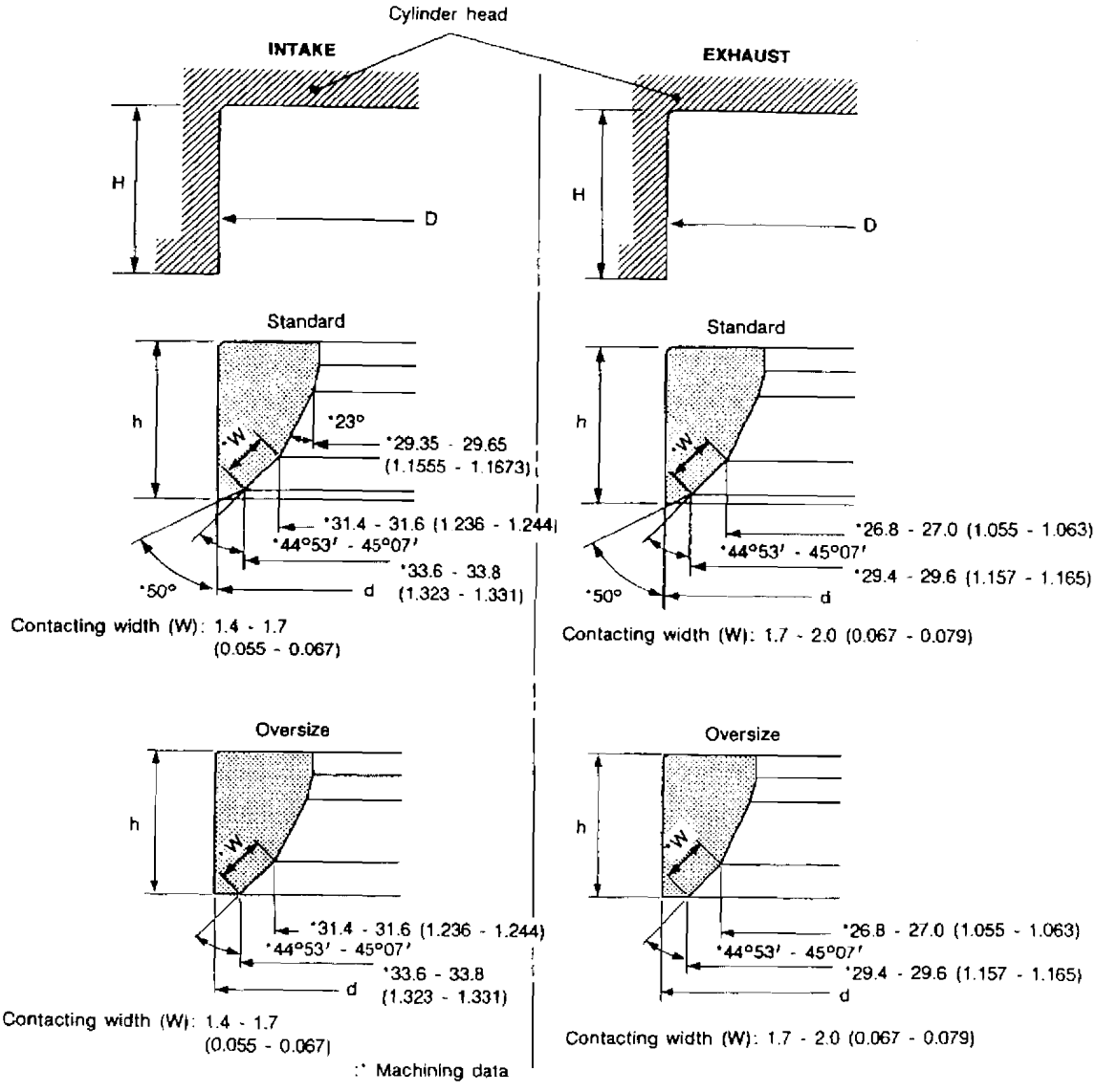
SEM083D

		Standard	Service
Valve guide Outer diameter	Intake	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
	Exhaust	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
Valve guide Inner diameter (Finished size)	Intake	6.000 - 6.018 (0.2362 - 0.2369)	
	Exhaust	7.000 - 7.018 (0.2756 - 0.2763)	
Cylinder head valve guide hole diameter	Intake	9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
	Exhaust	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
		Standard	Limit
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
Valve deflection limit		0.2 (0.008)	
Projection length "L"		14.0 - 14.2 (0.551 - 0.559)	

Inspection and Adjustment (Cont'd)

Valve seat

Unit: mm (in)



SEM651D

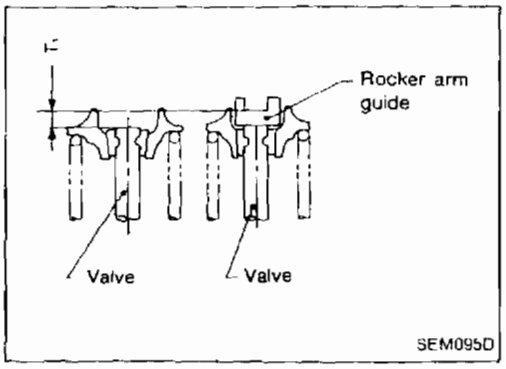
		Standard	Service
Cylinder head seat recess diameter (D)	In.	35.000 - 35.016 (1.3780 - 1.3786)	35.500 - 35.516 (1.3976 - 1.3983)
	Ex.	31.000 - 31.016 (1.2205 - 1.2211)	31.500 - 31.516 (1.2402 - 1.2408)
Valve seat interference fit	In.	0.064 - 0.096 (0.0025 - 0.0038)	
	Ex.	0.064 - 0.096 (0.0025 - 0.0038)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

Inspection and Adjustment (Cont'd)

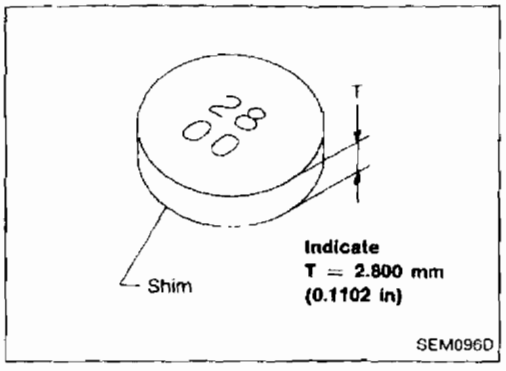
Valve shim clearance adjustment

Unit: mm (in)

Valve shim clearance (Cold)	Less than 0.025 (0.001)
Shim thickness "T"	$T_1 \pm 0.025$ (0.001)



SEM095D



SEM096D

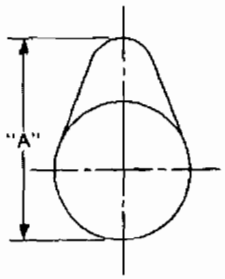
Available shims

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

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	28.000 - 28.021 (1.1024 - 1.1032)	—
Outer diameter of camshaft journal	27.935 - 27.955 (1.0998 - 1.1006)	—
Camshaft runout [TIR*]	Less than 0.02 (0.0008)	0.1 (0.004)
Camshaft sprocket runout [TIR*]	Less than 0.25 (0.0098)	—
Camshaft end play	0.092 - 0.173 (0.0036 - 0.0068)	0.20 (0.0079)

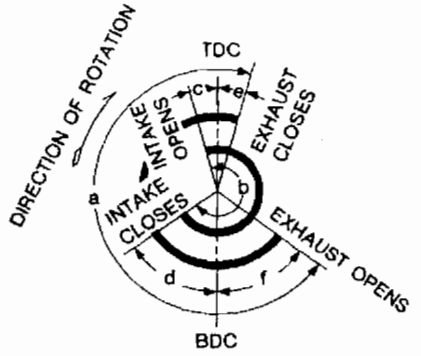


EM671

Cam height "A"	
Intake	37.920 - 38.110 (1.4929 - 1.5004)
Exhaust	37.920 - 38.110 (1.4929 - 1.5004)
Wear limit of cam height	0.2 (0.008)
Valve lift	
Intake	9.2 (0.362)
Exhaust	9.2 (0.362)

*Total indicator reading

Valve timing (VTC solenoid valve OFF)



EM120

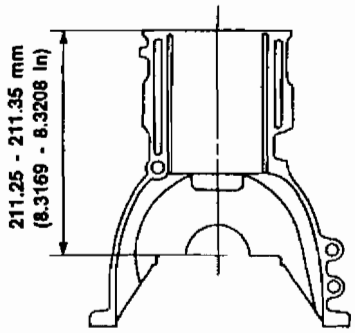
Unit: degree

a	b	c	d	e	f
240°	240°	–6°	66°	7°	53°

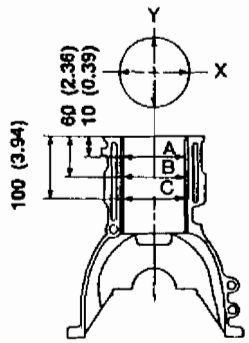
Inspection and Adjustment (Cont'd)

CYLINDER BLOCK

Unit: mm (in)



SEM008D



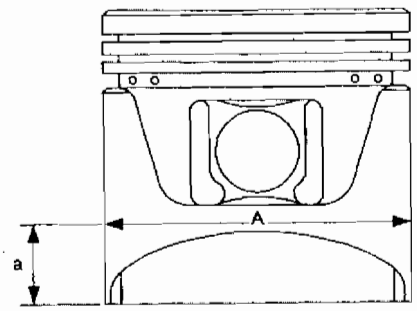
SEM686D

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

PISTON, PISTON RING AND PISTON PIN

Available piston

Unit: mm (in)



SEM750C

Piston skirt diameter "A"	
Standard	
Grade No. 1	85.980 - 85.990 (3.3850 - 3.3854)
Grade No. 2	85.990 - 86.000 (3.3854 - 3.3858)
Grade No. 3	86.000 - 86.010 (3.3858 - 3.3862)
0.20 (0.0079) oversize (Service)	86.180 - 86.210 (3.3929 - 3.3941)
"a" dimension	10.5 (0.413)
Piston clearance to cylinder block	0.010 - 0.030 (0.0004 - 0.0012)
Piston pin hole diameter	21.987 - 21.999 (0.8656 - 0.8661)

Inspection and Adjustment (Cont'd)

Piston ring

Unit: mm (in)

Side clearance	
Top	
Standard	0.045 - 0.080 (0.0018 - 0.0031)
Limit	0.1 (0.004)
2nd	
Standard	0.030 - 0.065 (0.0012 - 0.0026)
Limit	0.1 (0.004)
End gap	
Top	
Standard	0.20 - 0.30 (0.0079 - 0.0118)
Limit	0.39 (0.0154)
2nd	
Standard	0.35 - 0.50 (0.0138 - 0.0197)
Limit	0.59 (0.0232)
Oil	
Standard	0.20 - 0.60 (0.0079 - 0.0236)
Limit	0.69 (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	
Standard	0.005 - 0.017 (0.0002 - 0.0007)
Limit	0.023 (0.0009)

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

CONNECTING ROD

Unit: mm (in)

Center distance	136.30 (5.3661)
Bend [per 100 (3.94)]	
Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	
Limit	0.3 (0.0012)
Connecting rod small end inner diameter	24.980 - 25.000 (0.9835 - 0.9843)
Piston pin bushing inner diameter*	22.000 - 22.012 (0.8661 - 0.8666)
Connecting rod big end inner diameter	51.000 - 51.013 (2.0079 - 2.0084)
Side clearance	
Standard	0.20 - 0.35 (0.0079 - 0.0138)
Limit	0.5 (0.020)

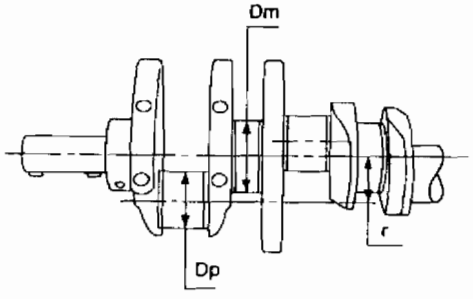
*After installing in connecting rod

Inspection and Adjustment (Cont'd)

CRANKSHAFT

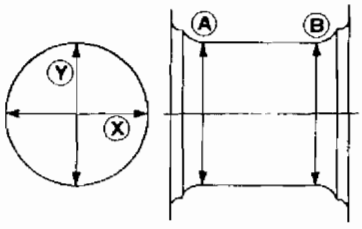
Unit: mm (in)

Main journal dia. "Dm"	
Grade No. 0	54.974 - 54.980 (2.1643 - 2.1646)
Grade No. 1	54.968 - 54.974 (2.1641 - 2.1643)
Grade No. 2	54.962 - 54.968 (2.1639 - 2.1641)
Grade No. 3	54.956 - 54.962 (2.1636 - 2.1639)
Pin journal dia. "Dp"	
Grade No. 0	47.968 - 47.974 (1.8885 - 1.8887)
Grade No. 1	47.962 - 47.968 (1.8883 - 1.8885)
Grade No. 2	47.956 - 47.962 (1.8880 - 1.8883)
Center distance "r"	42.96 - 43.04 (1.6913 - 1.6945)
Out-of-round (X – Y)	
Standard	
Main journal	Less than 0.005 (0.0002)
Pin journal	Less than 0.0025 (0.0001)
Taper (A – B)	
Standard	
Main journal	Less than 0.005 (0.0002)
Pin journal	Less than 0.0025 (0.0001)
Runout [TIR]	
Standard	Less than 0.025 (0.0010)
Limit	Less than 0.05 (0.0020)
Free end play	
Standard	0.10 - 0.26 (0.0039 - 0.0102)
Limit	0.30 (0.0118)



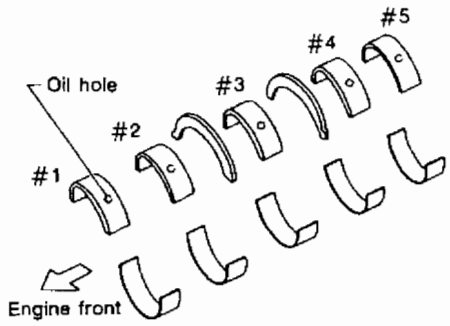
SEM954C

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



EM715

AVAILABLE MAIN BEARING



SEM685D

Main bearing (Standard)

Unit: mm (in)

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

Main bearing (Undersize)

Unit: mm (in)

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

Inspection and Adjustment (Cont'd)

AVAILABLE CONNECTING ROD BEARING

Connecting rod bearing

Standard size

Unit: mm (in)

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

Undersize

Unit: mm (in)

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

Bearing clearance

Unit: mm (in)

Main bearing clearance	
Standard	0.004 - 0.022 (0.0002 - 0.0009)
Limit	0.05 (0.0020)
Connecting rod bearing clearance	
Standard	0.020 - 0.045 (0.0008 - 0.0018)
Limit	0.65 (0.0256)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Camshaft sprocket runout limit [TIR]	0.25 (0.0098)
Flywheel runout limit [TIR]	0.15 (0.0059)