SECTION EM

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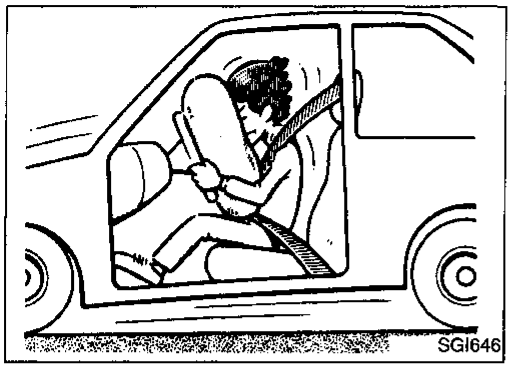
CONTENTS (Cont'd.)


SGI646

Precautions for Supplemental Restraint System "AIR BAG"

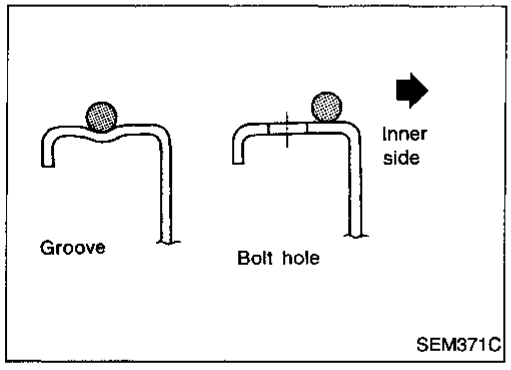
The Supplemental Restraint System "Air Bag", used along with a seat belt, helps to reduce the risk or severity of injury to the driver and front passenger in a frontal collision. The Supplemental Restraint System consists of air bag modules (located in the center of the steering wheel and on the instrument panel on the passenger side), a diagnosis sensor unit, warning lamp, wiring harness and spiral cable. Information necessary to service the system safely is included in **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 electrical wiring harnesses and connectors are covered with yellow outer insulation. Do not use electrical test equipment on any circuit related to the SRS "Air Bag".**

Parts Requiring Angular Tightening

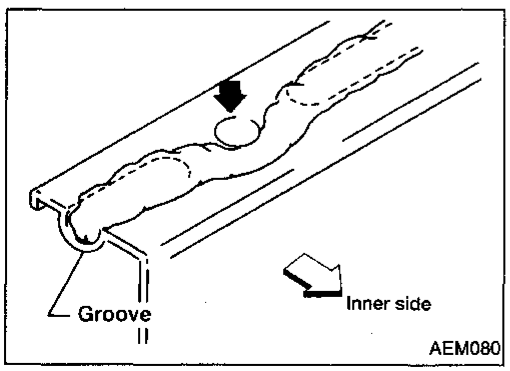
- Use an angle wrench for the final tightening of the following engine parts:
  (1) Cylinder head bolts
  (2) Main bearing cap bolts
  (3) Connecting rod cap nuts
- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread and seat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



SEM371C

Liquid Gasket Application Procedure

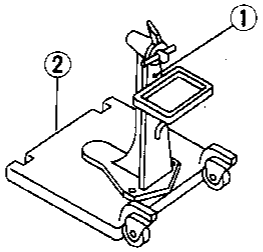
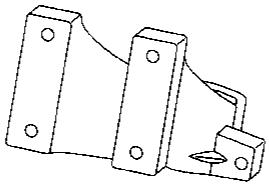
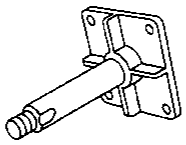
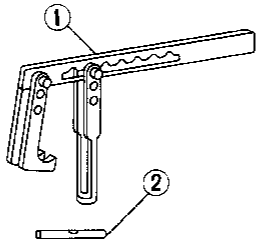
a. **Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also, completely clean any oil from these areas.**
b. **Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Liquid Gasket or equivalent.)**
   - **For oil pan, be sure liquid gasket diameter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



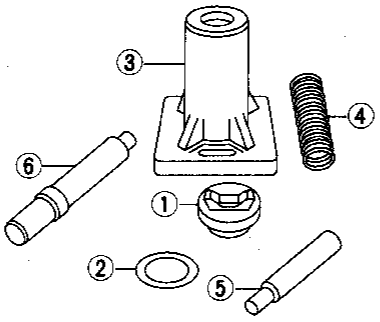
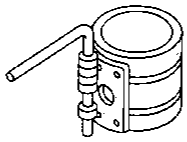
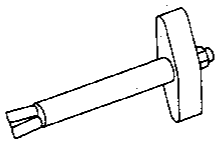
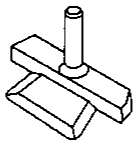
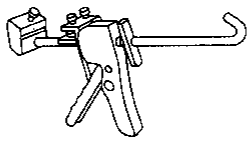
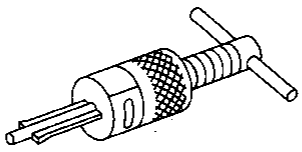
AEM080

c. **Apply liquid gasket around the inner side of bolt holes (unless otherwise specified).**
d. **Assembly should be done within 5 minutes after coating.**
e. **Wait at least 30 minutes before refilling engine oil and engine coolant.**

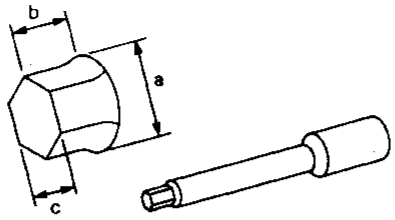
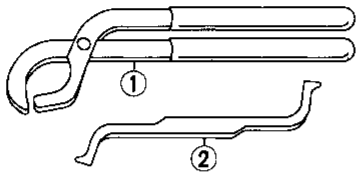
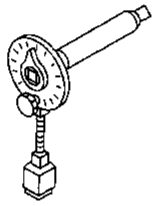
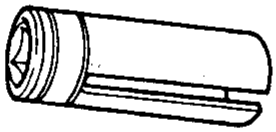
Special Service Tools

Tool number (Kent-Moore No.) Tool name	Description	
ST0501S000 (—) Engine stand assembly ① ST05011000 (—) Engine stand ② ST05012000 (—) Base		Disassembling and assembling
KV10114300 (—) Engine sub-attachment		
KV101065001 (—) Engine stand shaft		
KV101092S0 (—) Valve spring compressor ① KV10109210 (—) Compressor ② KV10109220 (—) Adapter		Disassembling and assembling valve components
KV10116300 (J-38955) Valve oil seal drift		Installing valve oil seal

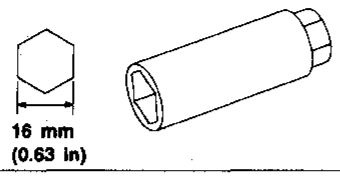
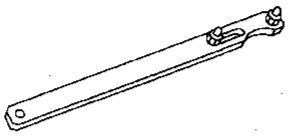
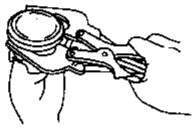
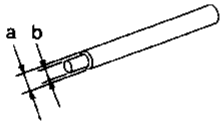
Special Service Tools (Cont'd)

Tool number (Kent-Moore No.) Tool name	Description	
KV10110300 (—) Piston pin press stand assembly ① KV10110310 (—) Cap ② KV10110330 (—) Spacer ③ ST13030020 (—) Press stand ④ ST13030030 (—) Spring ⑤ KV10110340 (—) Drift ⑥ KV10110320 (—) Center shaft		Disassembling and assembling piston with connecting rod
EM03470000 (J8037) Piston ring compressor		Installing piston assembly into cylinder bore
(J36467) Valve oil seal remover		Displacement valve oil seal
KV10111100 (J37228) Seal cutter		Removing oil pan
WS39930000 (—) Tube presser		Pressing the tube of liquid gasket
ST16610001 (J23907) Pilot bushing puller		Removing crankshaft pilot bushing

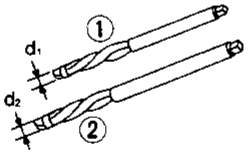
Special Service Tools (Cont'd)

Tool number (Kent-Moore No.) Tool name	Description	
ST10120000 (J-24239-01) Cylinder head bolt wrench		Loosening and tightening cylinder head bolt **a: 13 (0.51) dia.** **b. 12 (0.47)** **c: 10 (0.39)** Unit: mm (in)
KV10115150 (J-38972) Lifter stopper set ① KV10115110 (J-38972-01) Camshaft pliers ② KV10115120 (J-38972-02) Lifter stopper		Changing shims
KV10112100 Angle wrench		Tightening bolts for bearing cap, cylinder head, etc.
(J36471) Front oxygen sensor wrench		Loosening or tightening front oxygen sensor

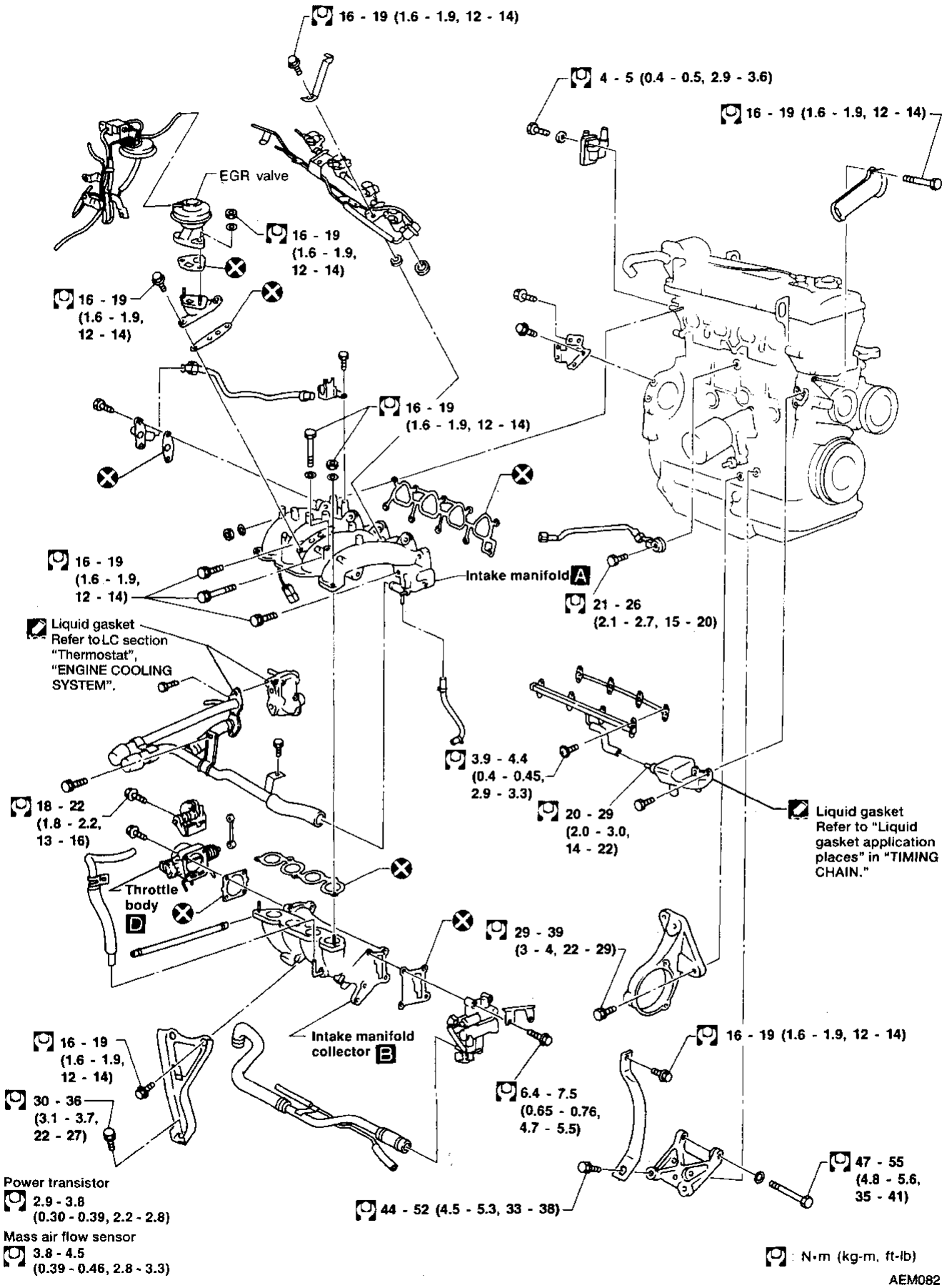
Commercial Service Tools

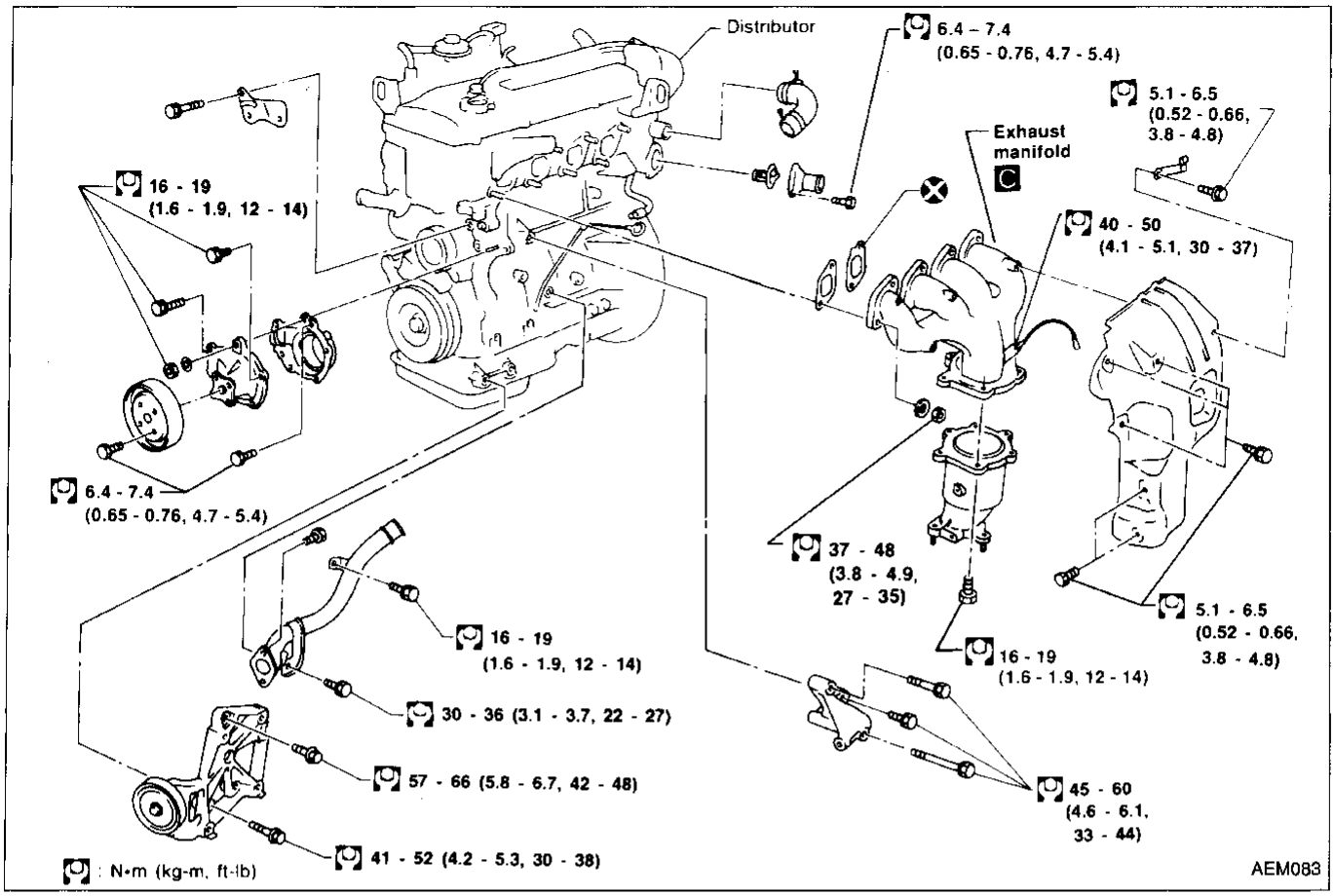
Tool name	Description
Spark plug wrench	 Removing and installing spark plug
Pulley holder	 Holding camshaft pulley while tightening or loosening camshaft bolt
Valve seat cutter set	 Finishing valve seat dimensions
Piston ring expander	 Removing and installing piston ring
Valve guide drift	 Removing and installing valve guide **Diameter:** mm (in)

	Intake & Exhaust
a	10.5 (0.413)
b	6.6 (0.260)

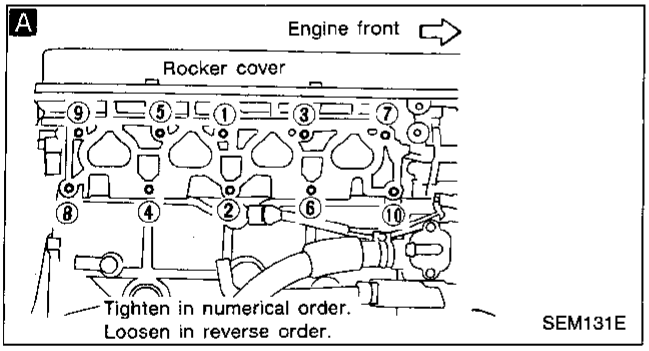
Valve guide reamer	 Reaming valve guide (①) or hole for oversize valve guide (②) **Diameter:** mm (in)

	Intake & Exhaust
d_1	7 (0.28)
d_2	11.175 (0.4400)

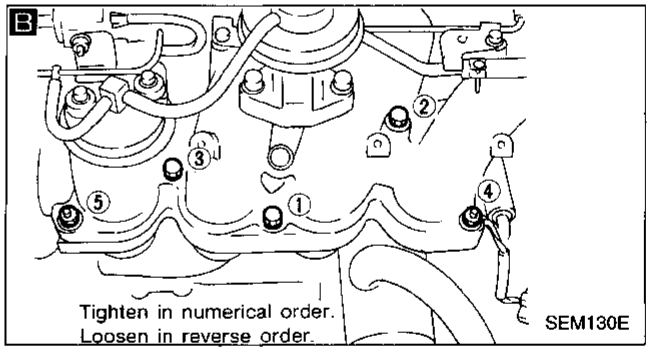

16 - 19 (1.6 - 1.9, 12 - 14)
4 - 5 (0.4 - 0.5, 2.9 - 3.6)
16 - 19 (1.6 - 1.9, 12 - 14)
EGR valve
16 - 19 (1.6 - 1.9, 12 - 14)
16 - 19 (1.6 - 1.9, 12 - 14)
16 - 19 (1.6 - 1.9, 12 - 14)
16 - 19 (1.6 - 1.9, 12 - 14)
Intake manifold A
21 - 26 (2.1 - 2.7, 15 - 20)
Liquid gasket
Refer to LC section "Thermostat", "ENGINE COOLING SYSTEM".
3.9 - 4.4 (0.4 - 0.45, 2.9 - 3.3)
18 - 22 (1.8 - 2.2, 13 - 16)
20 - 29 (2.0 - 3.0, 14 - 22)
Liquid gasket
Refer to "Liquid gasket application places" in "TIMING CHAIN."
Throttle body D
29 - 39 (3 - 4, 22 - 29)
Intake manifold collector B
16 - 19 (1.6 - 1.9, 12 - 14)
16 - 19 (1.6 - 1.9, 12 - 14)
30 - 36 (3.1 - 3.7, 22 - 27)
6.4 - 7.5 (0.65 - 0.76, 4.7 - 5.5)
47 - 55 (4.8 - 5.6, 35 - 41)
Power transistor
2.9 - 3.8 (0.30 - 0.39, 2.2 - 2.8)
Mass air flow sensor
3.8 - 4.5 (0.39 - 0.46, 2.8 - 3.3)
44 - 52 (4.5 - 5.3, 33 - 38)
N·m (kg-m, ft-lb)
AEM082



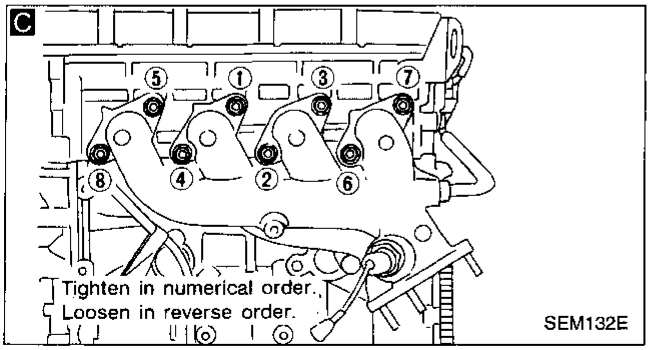
Intake manifold tightening procedure



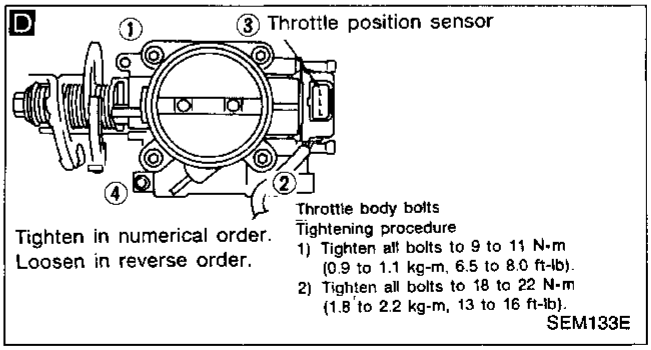
Intake manifold collector tightening procedure

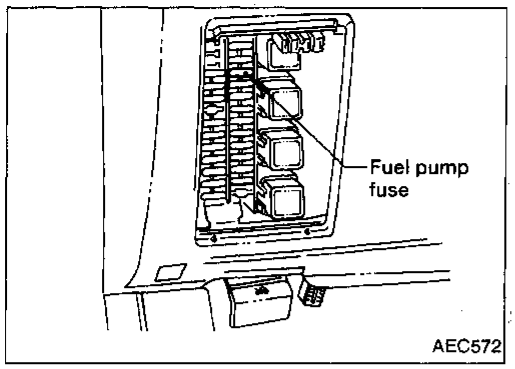


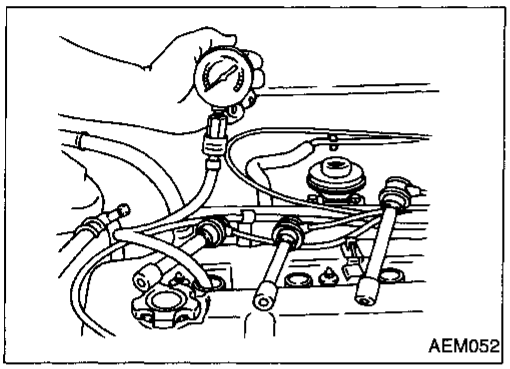
Exhaust manifold tightening procedure



Throttle body tightening procedure







Measurement of Compression Pressure

1. Warm up engine.
2. Turn ignition switch off.
3. Release fuel pressure.
   Refer to EC section ("Fuel Pressure Release", "BASIC SERVICE PROCEDURE").
4. Remove all spark plugs.
5. Disconnect distributor center cable.
6. Attach a compression tester to No. 1 cylinder.
7. Depress accelerator pedal fully to keep throttle valve wide open.
8. Crank engine and record highest gauge indication.
9. Repeat the measurement on each cylinder as shown above.

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

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

Standard

1,226 (12.5, 178)/300

Minimum

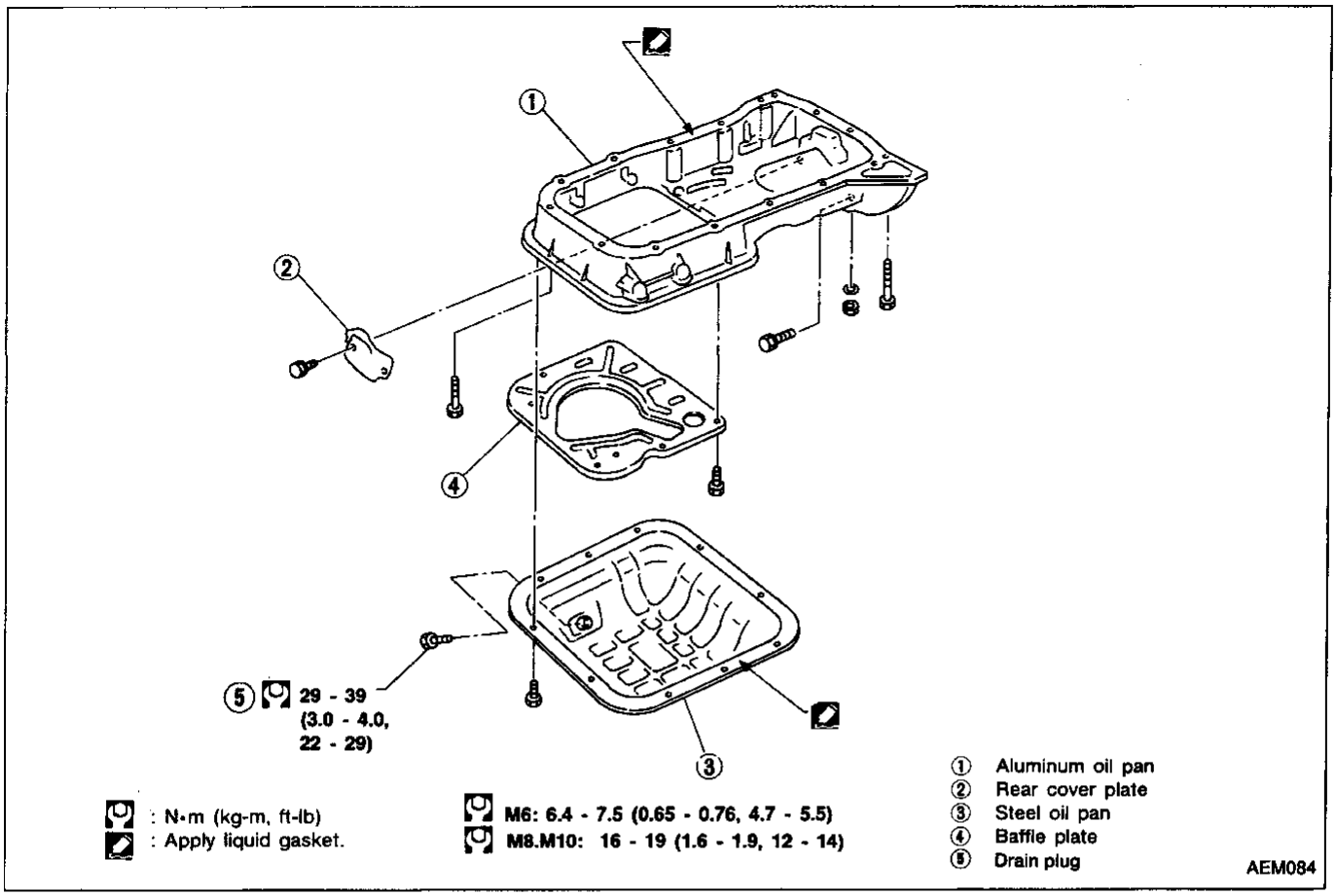
1,030 (10.5, 149)/300

Difference limit between cylinders

98 (1.0, 14)/300

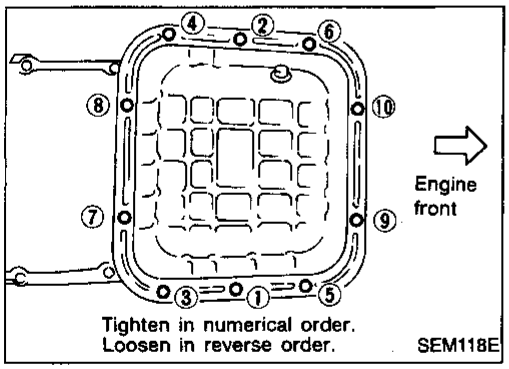
10. If compression in one or more cylinders is low:
    a. Pour a small amount of engine oil into cylinders through spark plug holes.
    b. Retest compression.

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

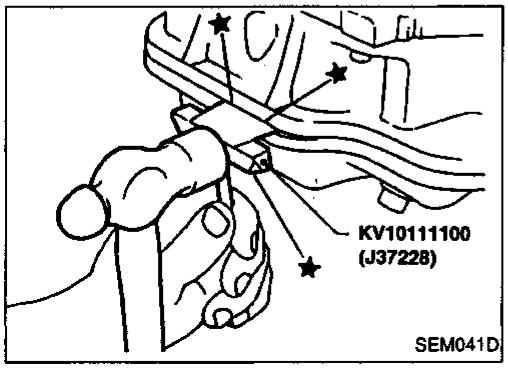


Removal

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



3. Remove steel oil pan bolts.

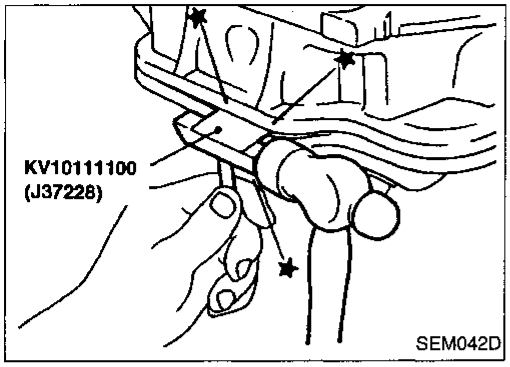


4. Remove steel oil pan.

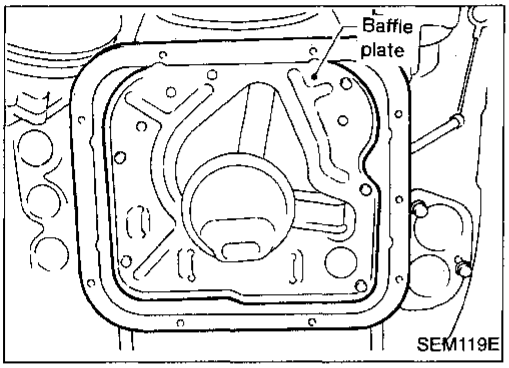
a. Insert Tool between aluminum oil pan and steel oil pan.

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

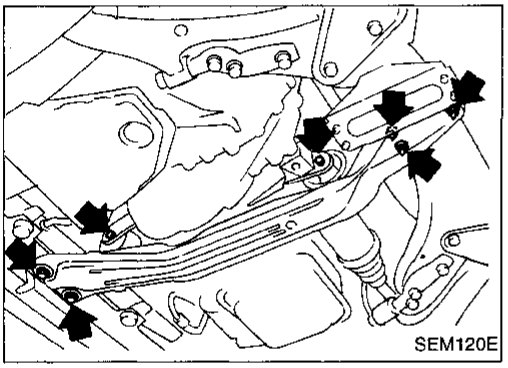
Removal (Cont'd)



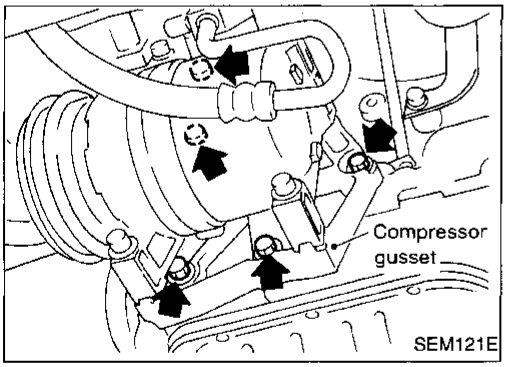
b. Slide Tool by tapping on the side of the Tool with a hammer.
c. Remove steel oil pan.



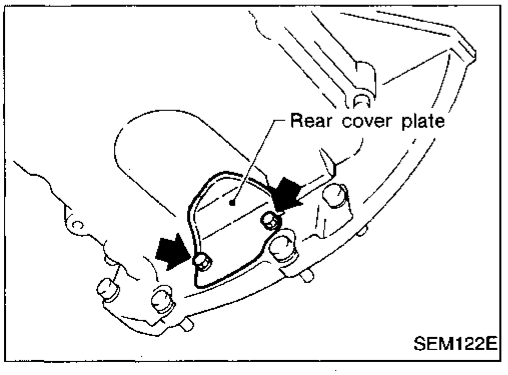
5. Remove baffle plate.
6. Remove oil strainer.



7. Remove front tube.
8. Set a suitable transmission jack under transaxle and hoist engine with engine slinger.
9. Remove center member.

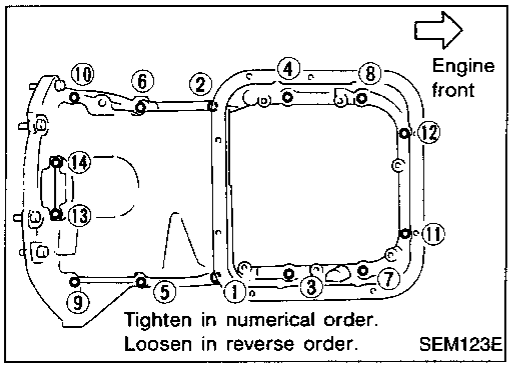


10. Remove compressor gussets.

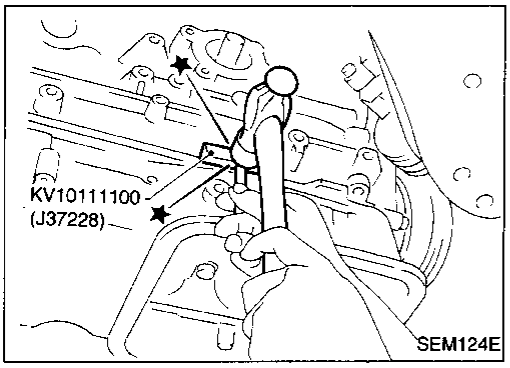


11. Remove rear cover plate.

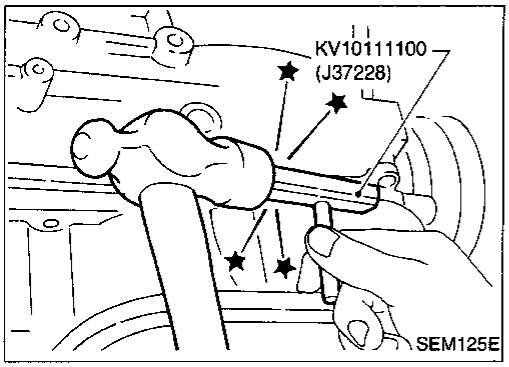
Removal (Cont'd)



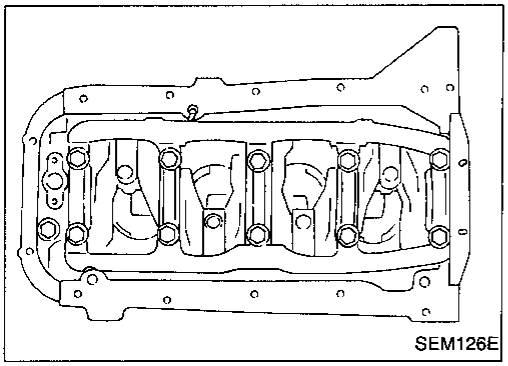
12. Remove aluminum oil pan nuts and bolts.
- Remove in reverse order shown.



13. Remove aluminum oil pan.
a. 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 damaged.**

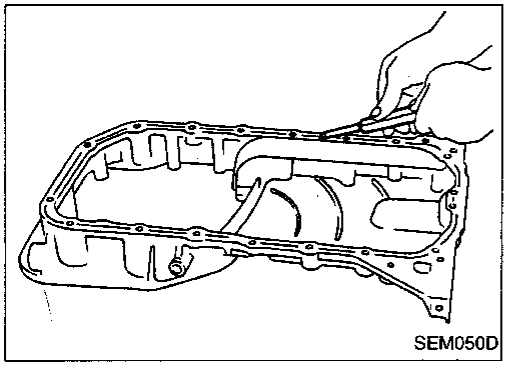


b. Slide Tool by tapping on the side of the Tool with a hammer.



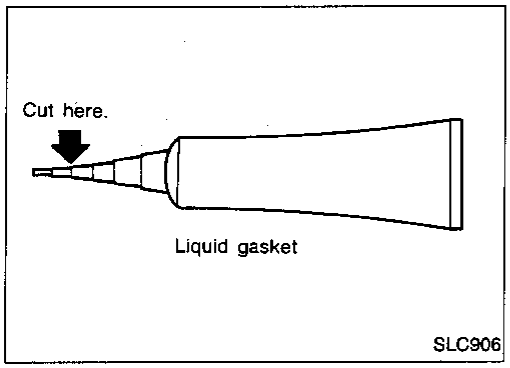
c. Remove aluminum oil pan.

Installation



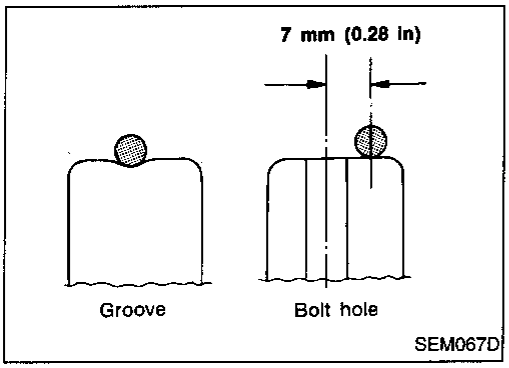
1. Install aluminum oil pan.
a. Use a scraper to remove all traces of liquid gasket from mating surfaces.
- Also remove traces of liquid gasket from mating surfaces of cylinder block, front cover and steel oil pan.

Installation (Cont'd)

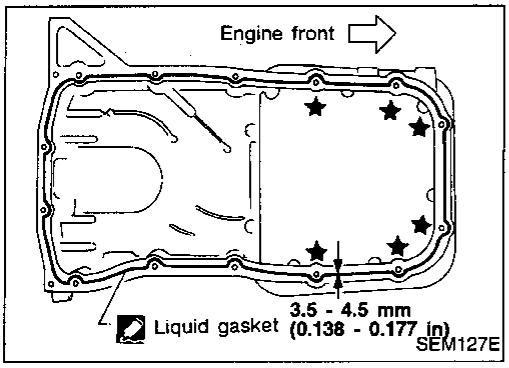


b. Apply a continuous bead of liquid gasket to mating surface of aluminum oil pan.

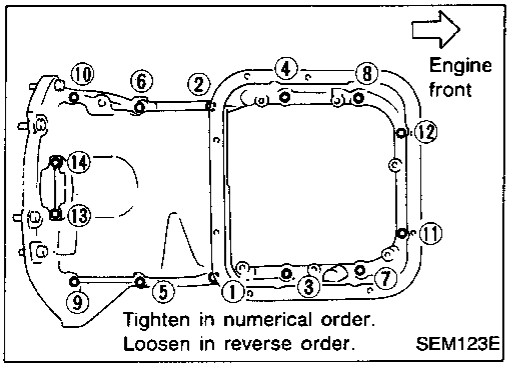
- **Use Genuine Liquid Gasket or equivalent.**



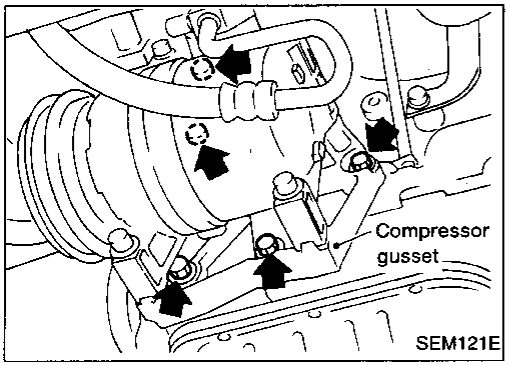
- **Apply to groove on mating surface.**
- **Allow 7 mm (0.28 in) clearance around bolt holes.**



- **For areas marked with "★", apply liquid gasket around the outer side of the bolt hole.**
- **Be sure liquid gasket diameter is 3.5 to 4.5 mm (0.138 to 0.177 in).**
- **Attaching should be done within 5 minutes after coating.**

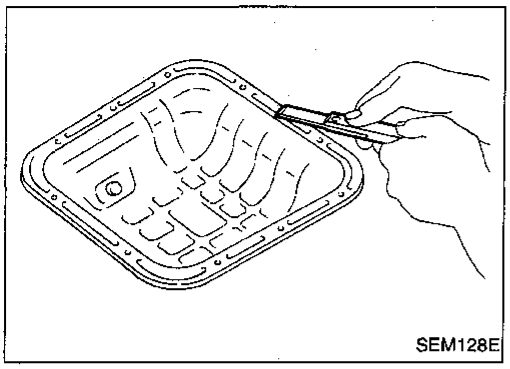


c. Install aluminum oil pan.
- Tighten nuts and bolts in numerical order.



2. Install compressor gussets.
3. Install center member.
4. Install front tube.
   Install oil strainer baffle plate.

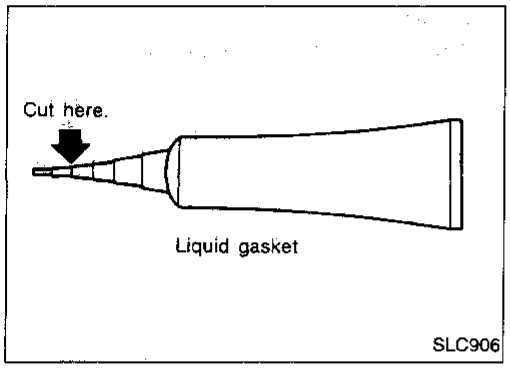
Installation (Cont'd)


SEM128E

5. Install steel oil pan.

a. Use a scraper to remove all traces of liquid gasket from mating surfaces.

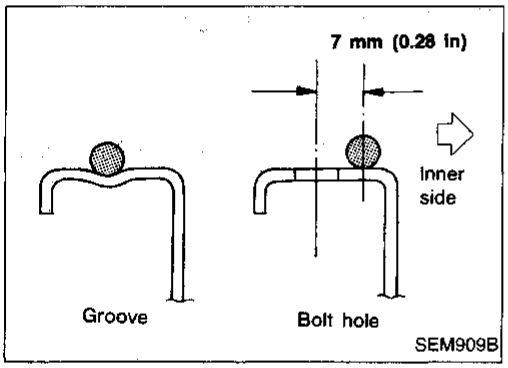
- Also remove traces of liquid gasket from mating surface of aluminum oil pan.



SLC906

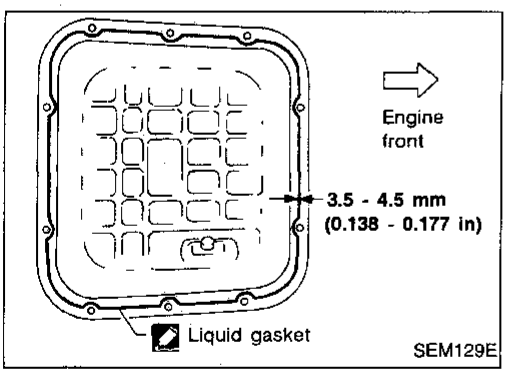
b. Apply a continuous bead of liquid gasket to mating surface of steel oil pan.

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



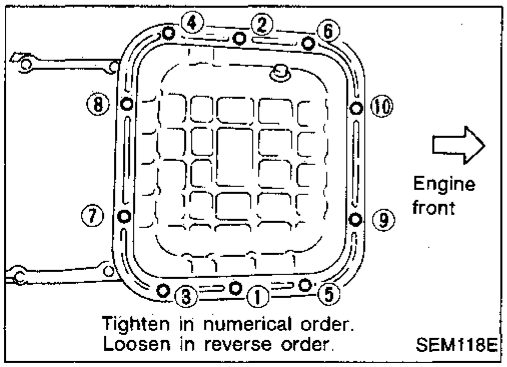
SEM909B

- **Apply to groove on mating surface.**
- **Allow 7 mm (0.28 in) clearance around bolt holes.**



SEM129E

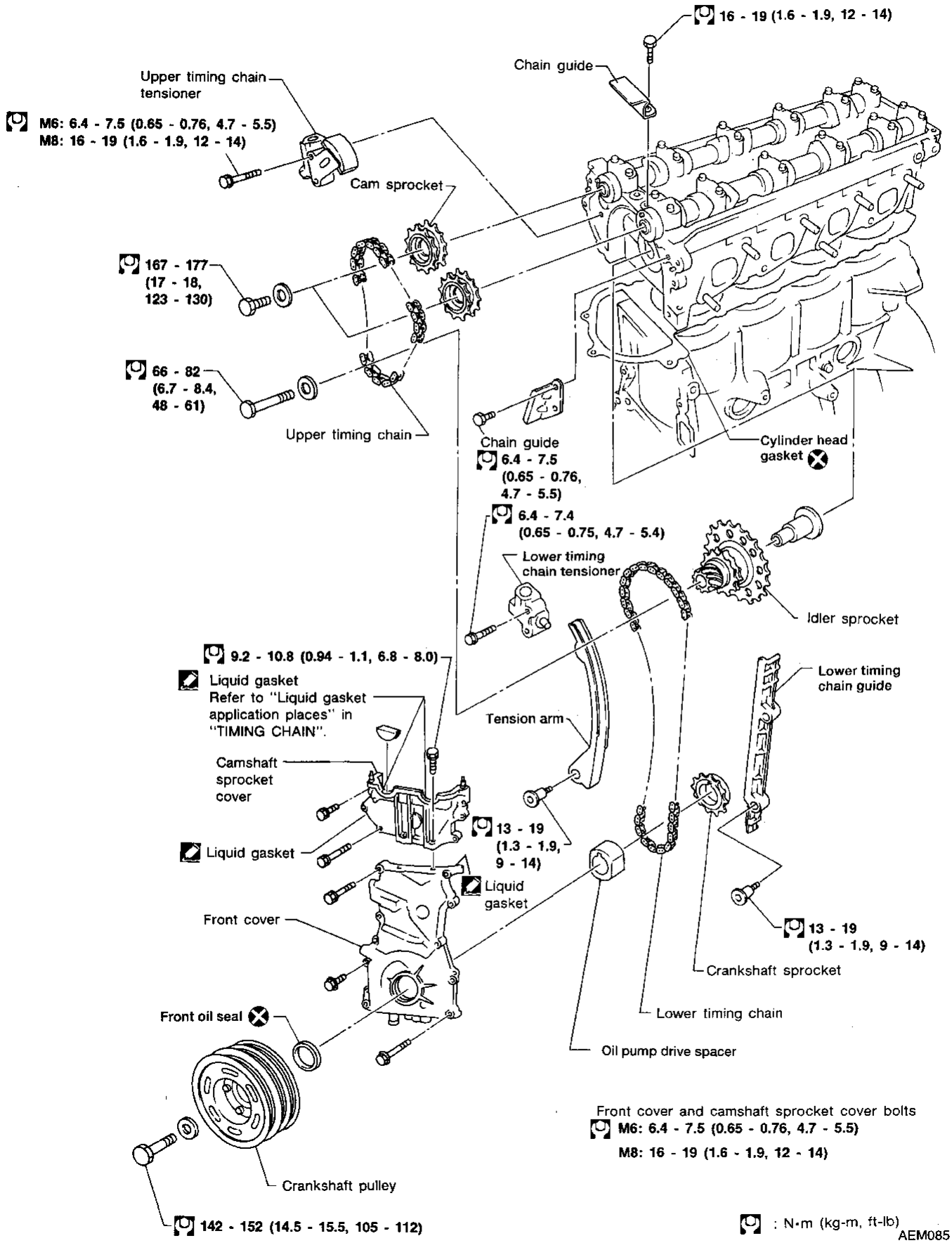
- **Be sure liquid gasket diameter is 3.5 to 4.5 mm (0.138 to 0.177 in).**
- **Attaching should be done within 5 minutes after coating.**



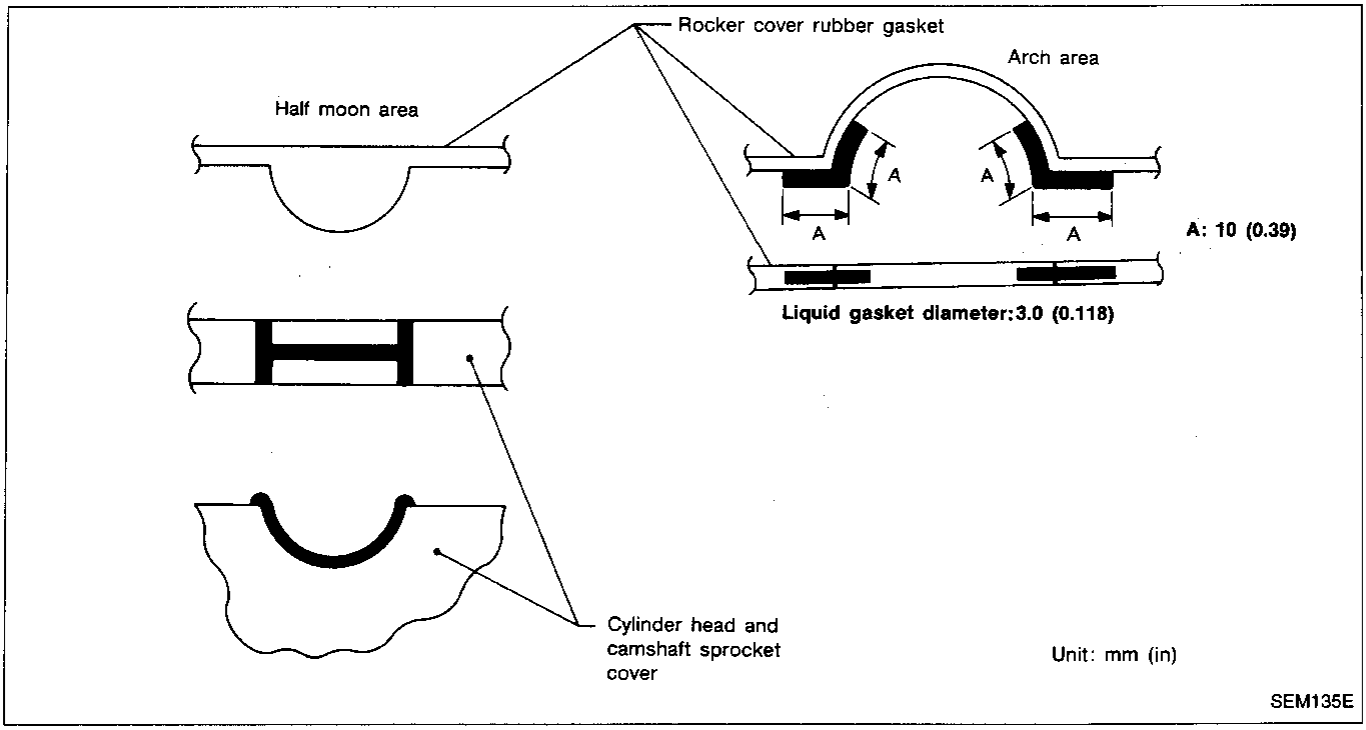
SEM118E

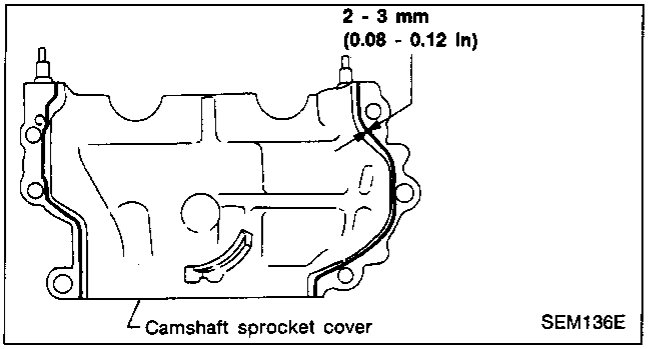
c. Install steel oil pan.

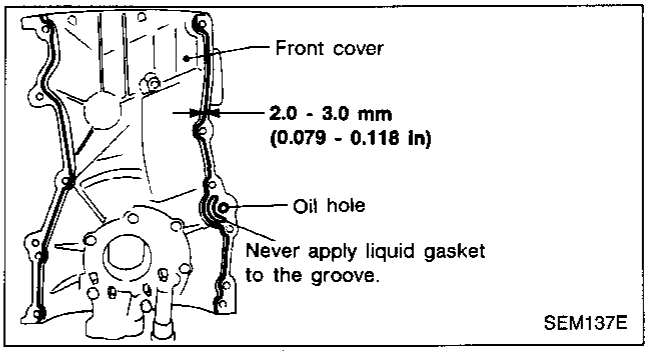
- Tighten bolts in numerical order shown.
- Wait at least 30 minutes before refilling engine oil.

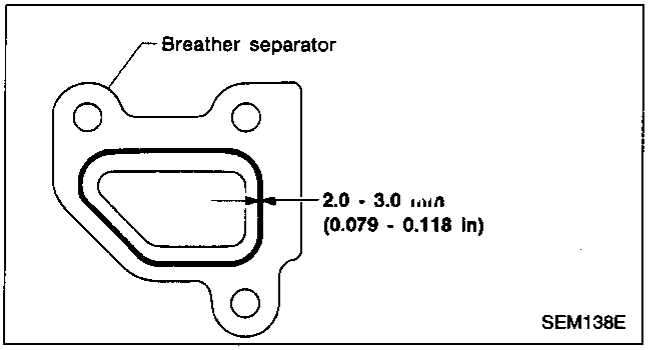

16 - 19 (1.6 - 1.9, 12 - 14)
Chain guide
Upper timing chain tensioner
M6: 6.4 - 7.5 (0.65 - 0.76, 4.7 - 5.5)
M8: 16 - 19 (1.6 - 1.9, 12 - 14)
Cam sprocket
167 - 177 (17 - 18, 123 - 130)
66 - 82 (6.7 - 8.4, 48 - 61)
Upper timing chain
Chain guide
6.4 - 7.5 (0.65 - 0.76, 4.7 - 5.5)
Cylinder head gasket
6.4 - 7.4 (0.65 - 0.75, 4.7 - 5.4)
Lower timing chain tensioner
Idler sprocket
9.2 - 10.8 (0.94 - 1.1, 6.8 - 8.0)
Liquid gasket
Refer to "Liquid gasket application places" in "TIMING CHAIN".
Tension arm
Lower timing chain guide
Camshaft sprocket cover
13 - 19 (1.3 - 1.9, 9 - 14)
Liquid gasket
Liquid gasket
Front cover
13 - 19 (1.3 - 1.9, 9 - 14)
Crankshaft sprocket
Front oil seal
Lower timing chain
Oil pump drive spacer
Front cover and camshaft sprocket cover bolts
M6: 6.4 - 7.5 (0.65 - 0.76, 4.7 - 5.5)
M8: 16 - 19 (1.6 - 1.9, 12 - 14)
Crankshaft pulley
142 - 152 (14.5 - 15.5, 105 - 112)
: N·m (kg-m, ft-lb)
AEM085

Liquid gasket application places



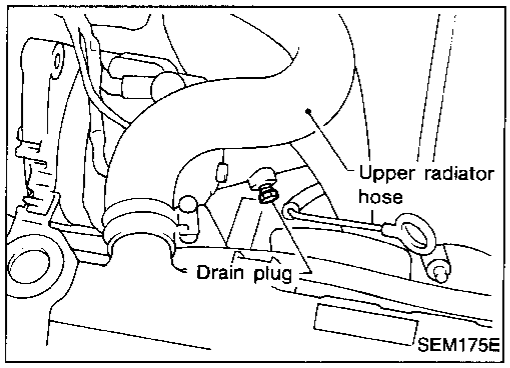






CAUTION:

- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing camshafts, chain tensioners, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Apply new engine oil to bolt threads and seat surfaces when installing cylinder head, camshaft sprockets, crankshaft pulley, and camshaft brackets.**
- **Before disconnecting fuel hose, release fuel pressure. Refer to EC section ("Fuel Pressure Release", "BASIC SERVICE PROCEDURE").**

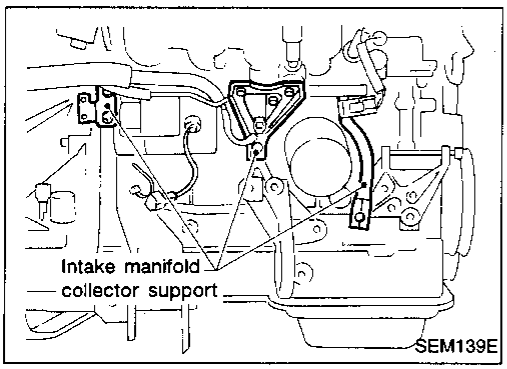


Removal

UPPER TIMING CHAIN

1. Drain coolant from drain plug on water pipe and radiator drain cock. Refer to MA section ("Changing Engine Coolant", "ENGINE MAINTENANCE").
2. Remove vacuum hoses, fuel hoses, wires, harness and connectors and so on.
3. Remove the following parts:

- Generator and bracket
- Air duct
- Upper radiator hose
- Cooling fan assembly
- Front exhaust tube

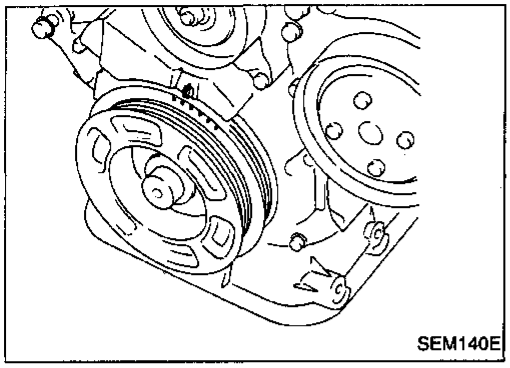


4. Remove the following:

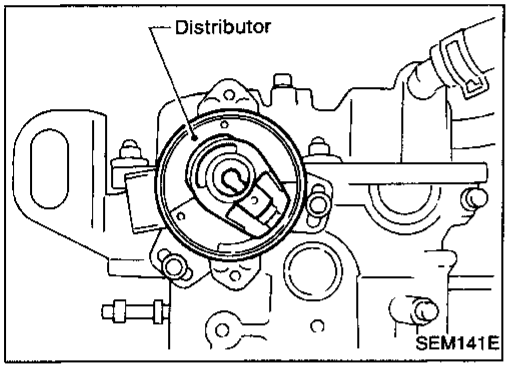
- Intake manifold collector supports
- Intake manifold
- Exhaust manifold with warm-up three way catalyst

Refer to EM-7.

Removal (Cont'd)

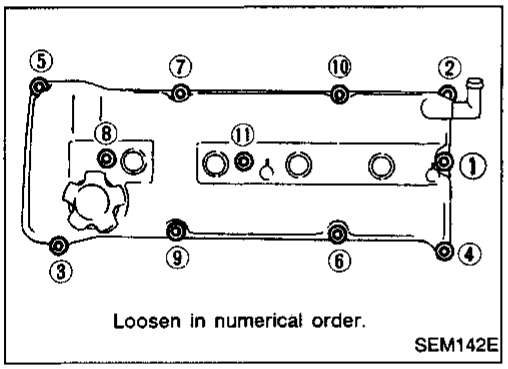

SEM140E

5. Set No. 1 piston at TDC on its compression stroke.
6. Remove distributor.
7. Set a suitable transmission jack under aluminum oil pan and remove front engine mounting.



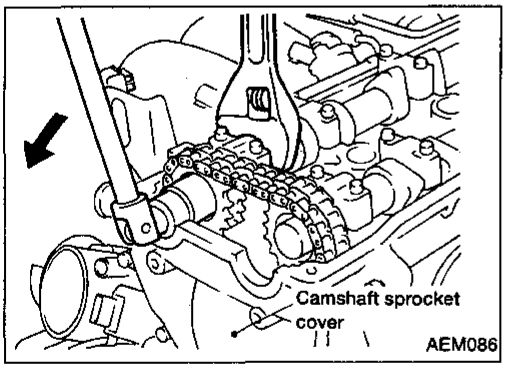
SEM141E

8. Remove rocker cover.



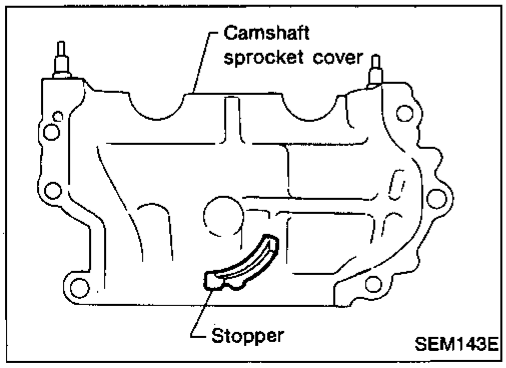
Loosen in numerical order.
SEM142E

9. Remove cam sprocket.



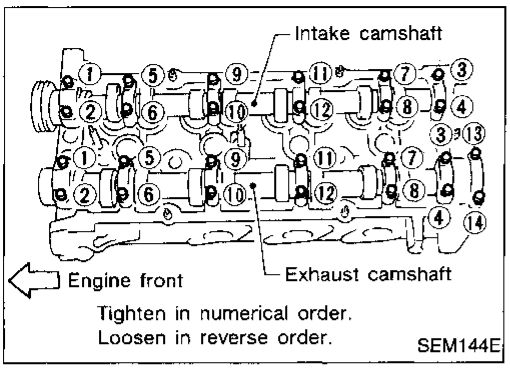
AEM086

- The stoppers on camshaft sprocket cover prevent upper timing chain from disengaging idler sprocket.

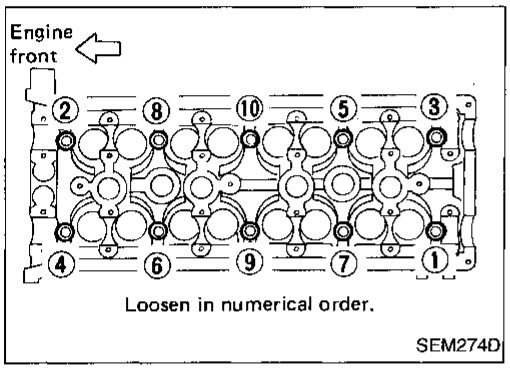


SEM143E

Removal (Cont'd)

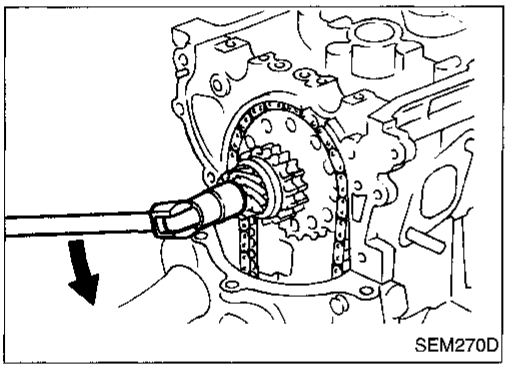


10. Remove camshaft brackets and camshafts.
- These parts must be reassembled in their original positions.

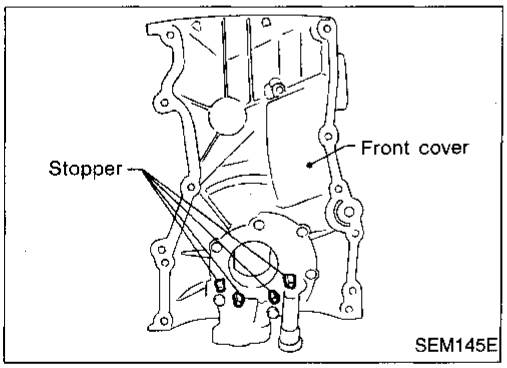


11. Loosen cylinder head bolts.
- Removing in incorrect order could result in a warped or cracked cylinder head.
- Loosen cylinder head bolts in two or three steps.

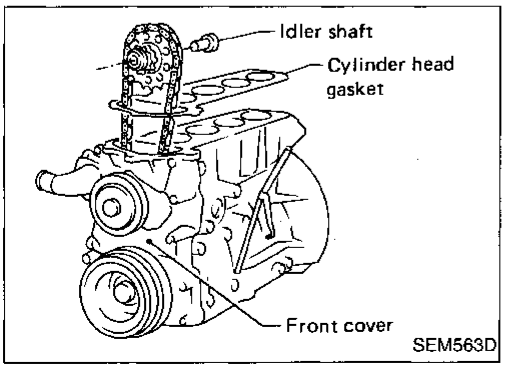
12. Remove camshaft sprocket cover.
13. Remove upper chain tensioner and upper chain guides.
14. Remove upper timing chain.



15. Remove idler sprocket bolt.



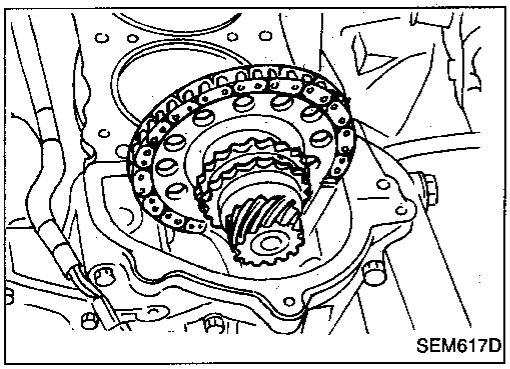
- The stoppers on front cover prevent lower timing chain from disengaging crankshaft sprocket.



16. Remove cylinder head and cylinder head gasket.

Removal (Cont'd)

LOWER TIMING CHAIN

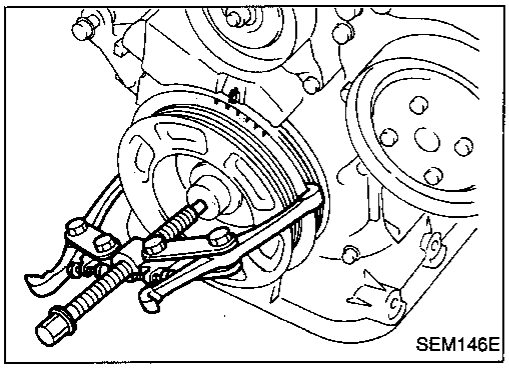

SEM617D

1. Remove upper timing chain.

Refer to EM-17.

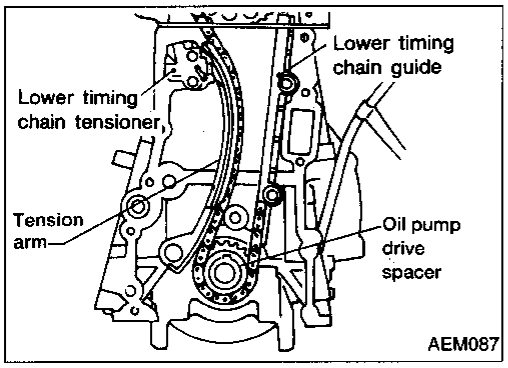
2. Remove oil pan.

Refer to EM-10.


SEM146E

3. Remove crankshaft pulley.
4. Remove front cover.

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



AEM087

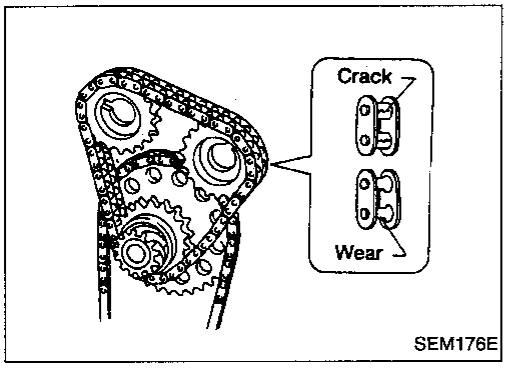
5. Remove the following parts:

- Oil pump drive spacer
- Lower timing chain tensioner
- Tension arm
- Lower timing chain guide

6. Remove lower timing chain and idler sprocket.

Inspection

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



SEM176E

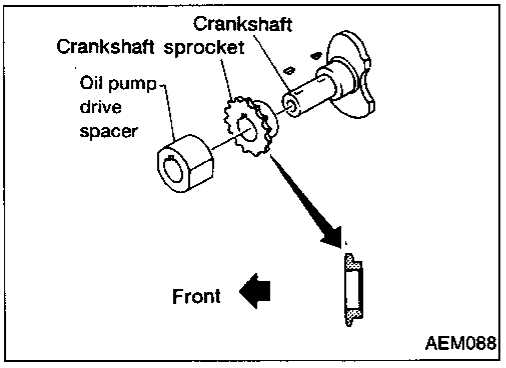
Installation

LOWER TIMING CHAIN

1. Install crankshaft sprocket and oil pump drive spacer.

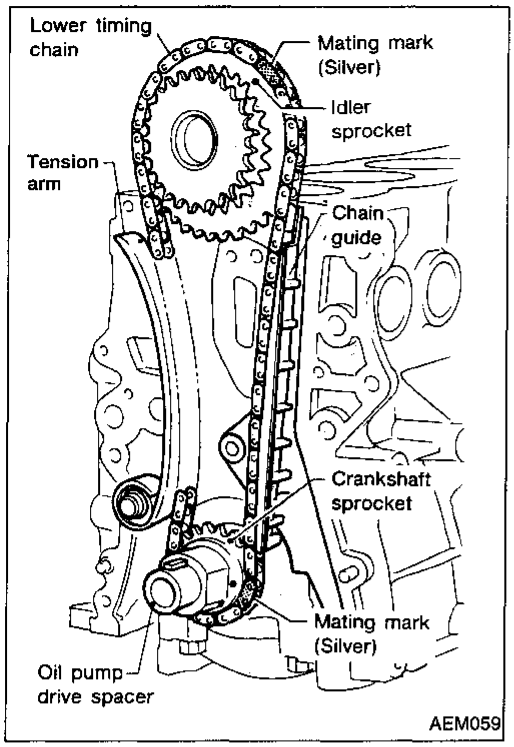
- **Make sure that mating marks on crankshaft sprocket face front of engine.**

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

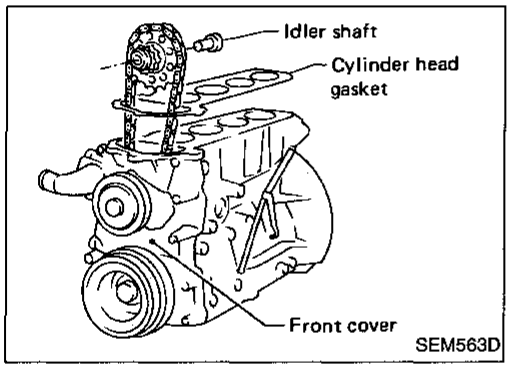


AEM088

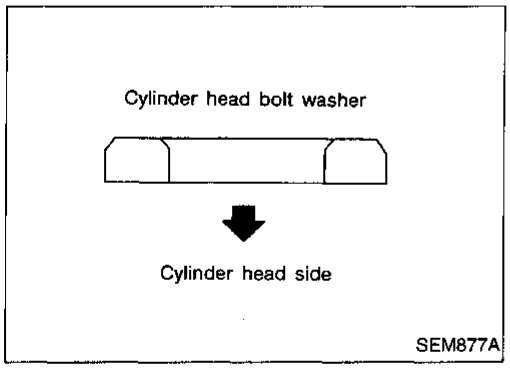
Installation (Cont'd)



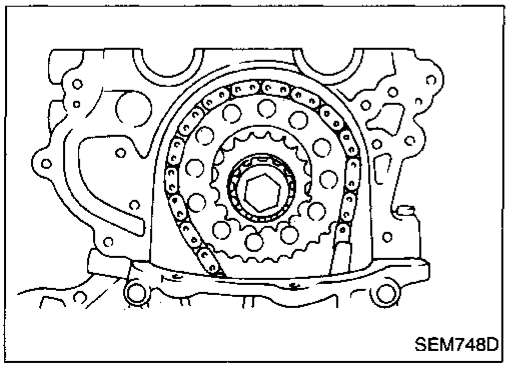
3. Install idler sprocket and lower timing chain.
- **Fit lower timing chain on the sprockets, aligning mating marks.**
4. Install tension arm and chain guide.
5. Install lower timing chain tensioner.



6. Install front cover.
- **Apply a continuous bead of liquid gasket to front cover. Refer to EM-16.**
- **Be sure to install new front oil seal in the right direction. Refer to EM-24.**
7. Install the following parts:
- Crankshaft pulley
- Oil strainer
- Oil pan
- New cylinder head gasket



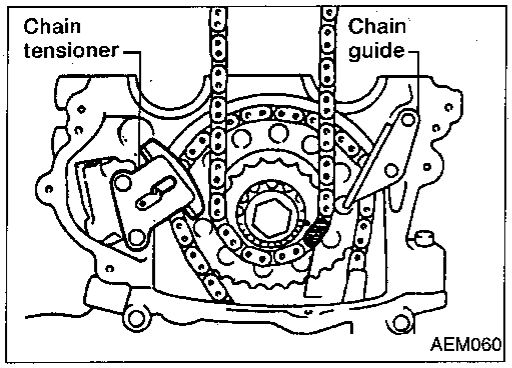
8. When installing front cover, install cylinder head and cylinder head bolts.
- **Apply new engine oil to bolt threads and seat surfaces.**
- **Be sure to install washers between bolts and cylinder head.**
9. Slightly tighten the cylinder head bolts.
- **Slightly tighten cylinder head bolts. This is necessary to avoid damaging cylinder head gasket.**



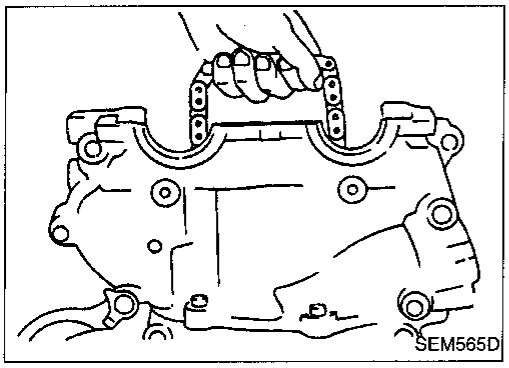
UPPER TIMING CHAIN

1. Install lower timing chain. **Refer to EM-20.**

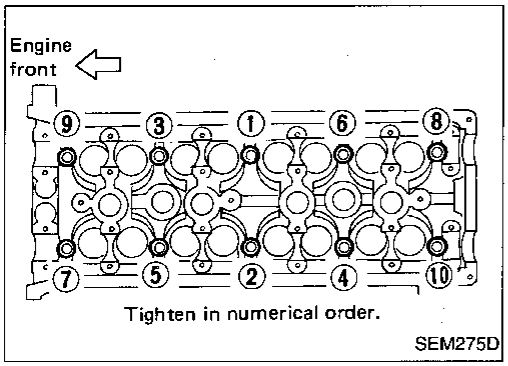
Installation (Cont'd)



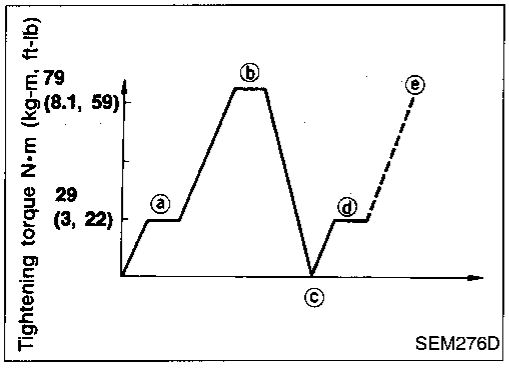
2. Install upper timing chain, chain tensioner and chain guide.
- **Set upper timing chain on the idler sprocket, aligning mating marks.**

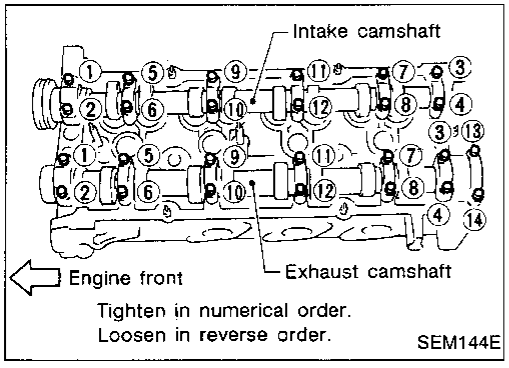


3. Install cam sprocket cover.
- **Apply a continuous bead of liquid gasket to camshaft sprocket cover. Refer to EM-16.**
- **Be careful not to damage cylinder head gasket.**
- **Be careful upper timing chain does not slip or jump off idler sprocket.**



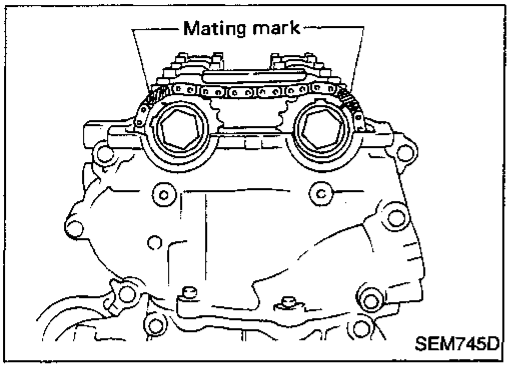
4. Tighten cylinder head bolts using the following procedure:
a. **Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).**
b. **Tighten all bolts to 79 N·m (8.1 kg-m, 59 ft-lb).**
c. **Loosen all bolts completely**
d. **Tighten all bolts to 25 to 34 N·m (2.5 to 3.5 kg-m, 18 to 25 ft-lb).**
e. **Turn all bolts 86 to 91 degrees clockwise. If an angle wrench is not available, mark all cylinder head bolts on the side facing engine front. Then, turn each cylinder head bolt 86 to 91 degrees clockwise.**



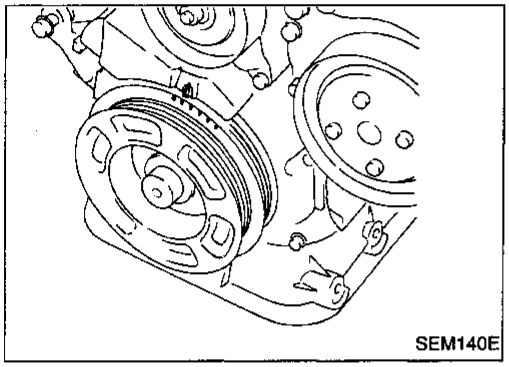


5. Install camshafts and camshaft brackets using the following procedure:
a. **Set camshafts and camshaft brackets.**
b. **Tighten all bolts to 2 N·m (0.2 kg-m, 1.4 ft-lb).**
c. **Tighten all bolts to 9.0 to 11.8 N·m (0.92 to 1.2 kg-m, 6.7 to 8.7 ft-lb).**

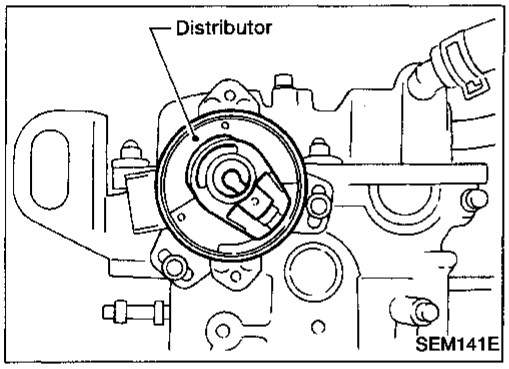
Installation (Cont'd)

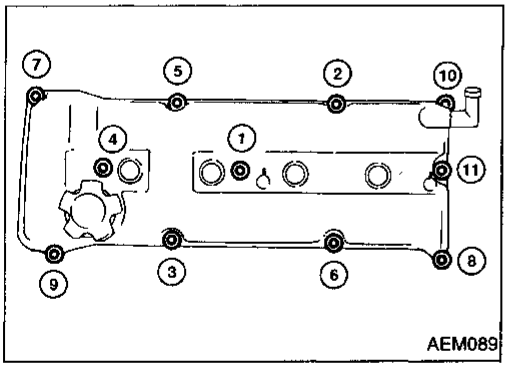


6. Install camshaft sprockets.
7. Install chain guide between both camshaft sprockets.



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





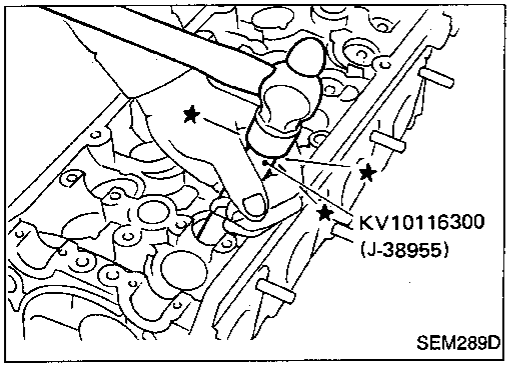
9. Install rocker cover gasket.
- Apply liquid gasket to rocker cover rubber gasket, cylinder head and camshaft sprocket cover. Refer to EM-16.

10. Install rocker cover using the following procedure:

a. **Tighten nuts ①-⑤-⑥-④ in that order to 4 N·m (0.4 kg-m, 2.9 ft-lb).**

b. **Tighten nuts ① to ⑪ in numerical order to 8 to 11 N·m (0.8 to 1.1 kg-m, 5.8 to 8.0 ft-lb).**

11. Install all spark plugs with high-tension cords.
12. Install vacuum hoses, fuel tubes, wires, harness and connectors and so on.

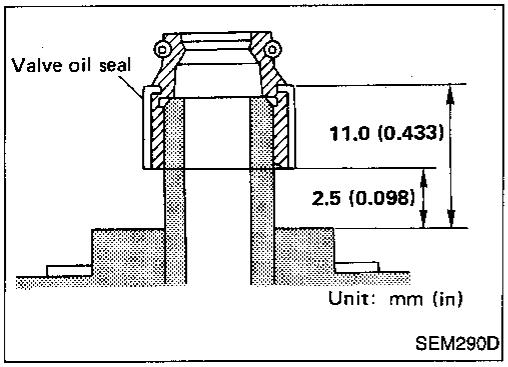


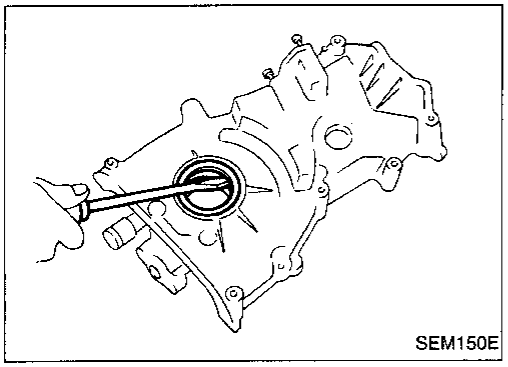
Valve Oil Seal

1. Remove rocker cover.
2. Remove camshaft. Refer to EM-17.
3. Remove valve spring and valve oil seal with Tool or a suitable tool.

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

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

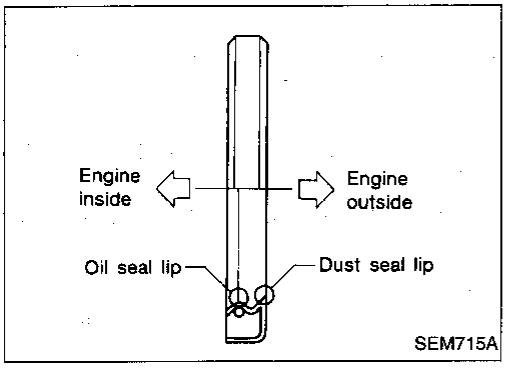




Front Oil Seal

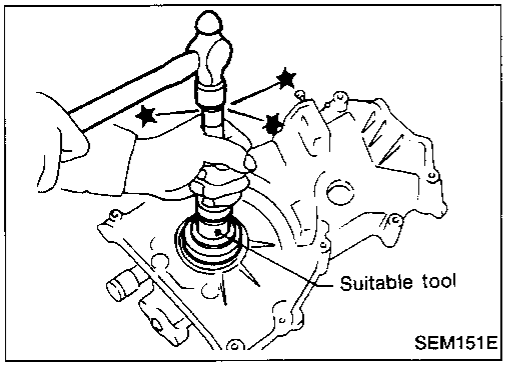
1. Remove radiator shroud and crankshaft pulley.
2. Remove front oil seal.

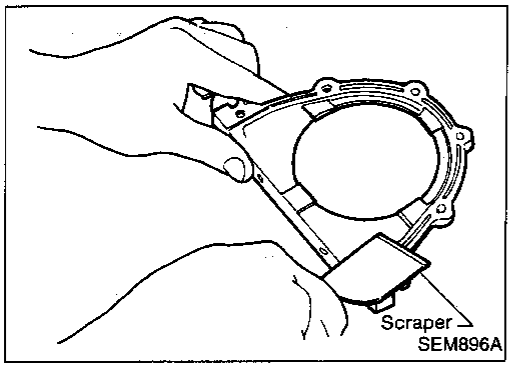
- **Be careful not to scratch front cover.**



3. Install new oil seal in the direction shown.

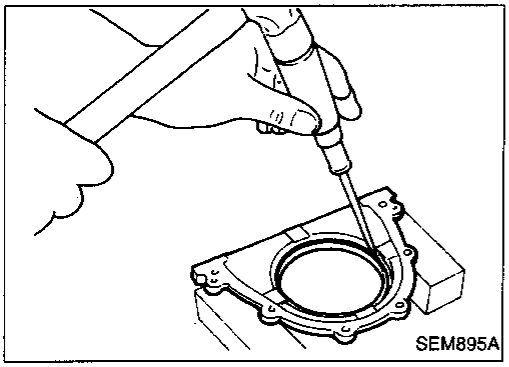
- Apply engine oil to new oil seal and install it using a suitable tool.



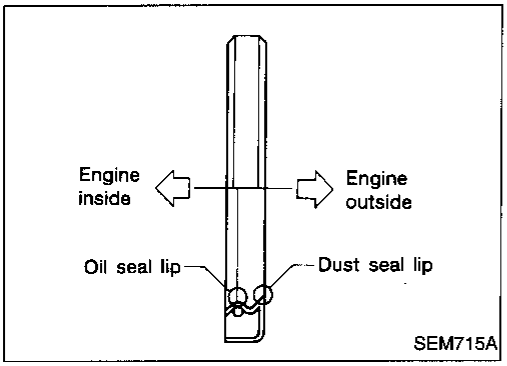


Rear Oil Seal

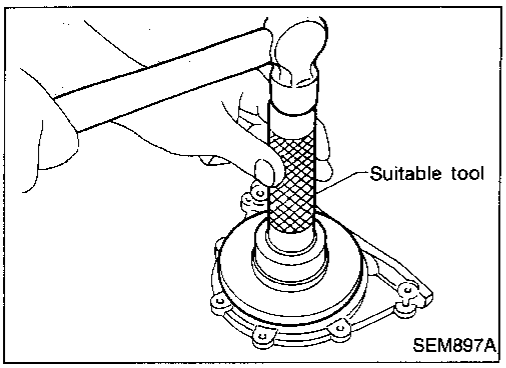
1. Remove drive plate or flywheel.
2. Remove rear oil seal retainer.
3. Remove traces of liquid gasket using scraper.

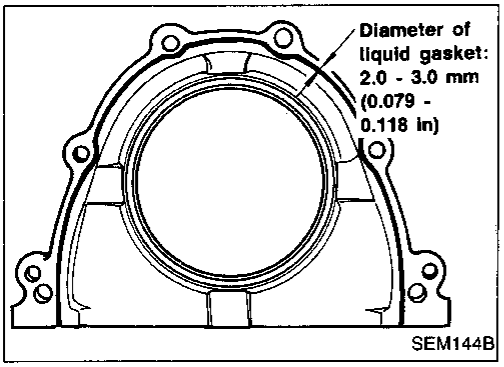


4. Remove rear oil seal from rear oil seal retainer.

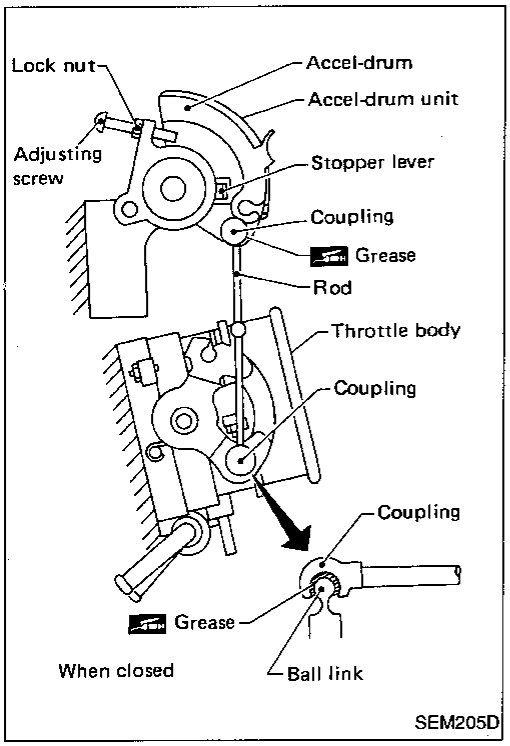


5. Install new oil seal in the direction shown.
- Apply engine oil to new oil seal and install it using a suitable tool.





6. Apply a continuous bead of liquid gasket to rear oil seal retainer.
- Apply around inner side of bolt holes.



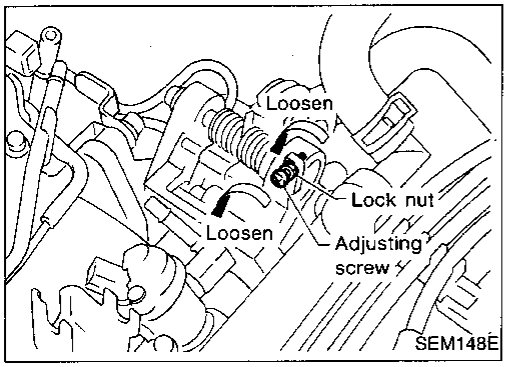
Adjust accel-drum unit after any of the following parts are installed:

- **Accel-drum unit**
- **Throttle body**
- **Rod (Always replace with a new one after removal.)**

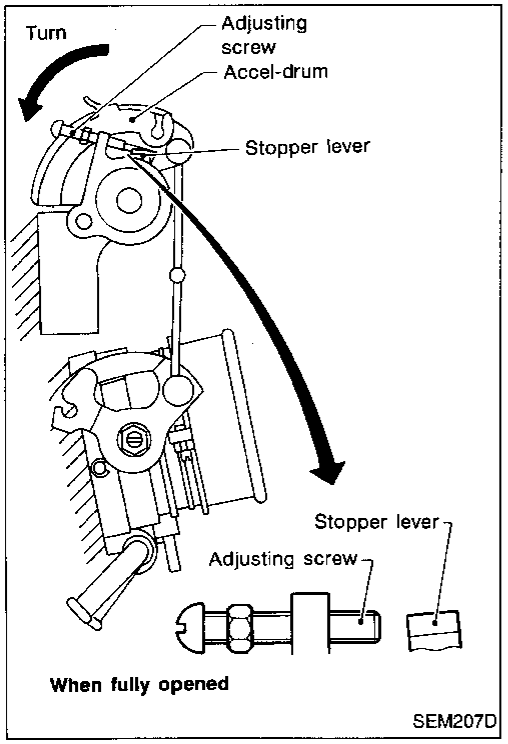
1. Install accel-drum unit and throttle body.
2. Apply grease all over the inside of the rod couplings.

Use genuine Nissan grease or equivalent.

3. Attach each coupling to ball links on throttle body and accel-drum unit.

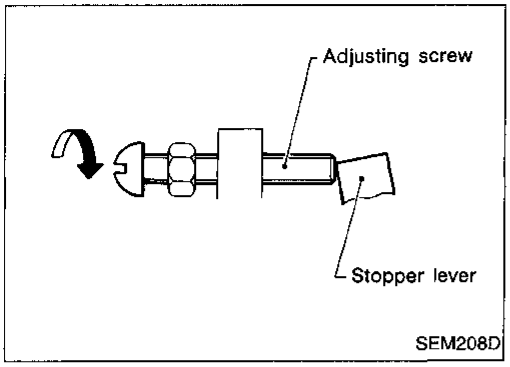


4. Loosen lock nut.
5. Loosen adjusting screw.

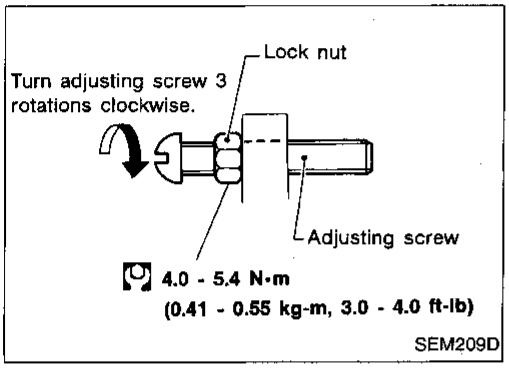


6. Manually turn accel-drum until throttle valve is fully open.

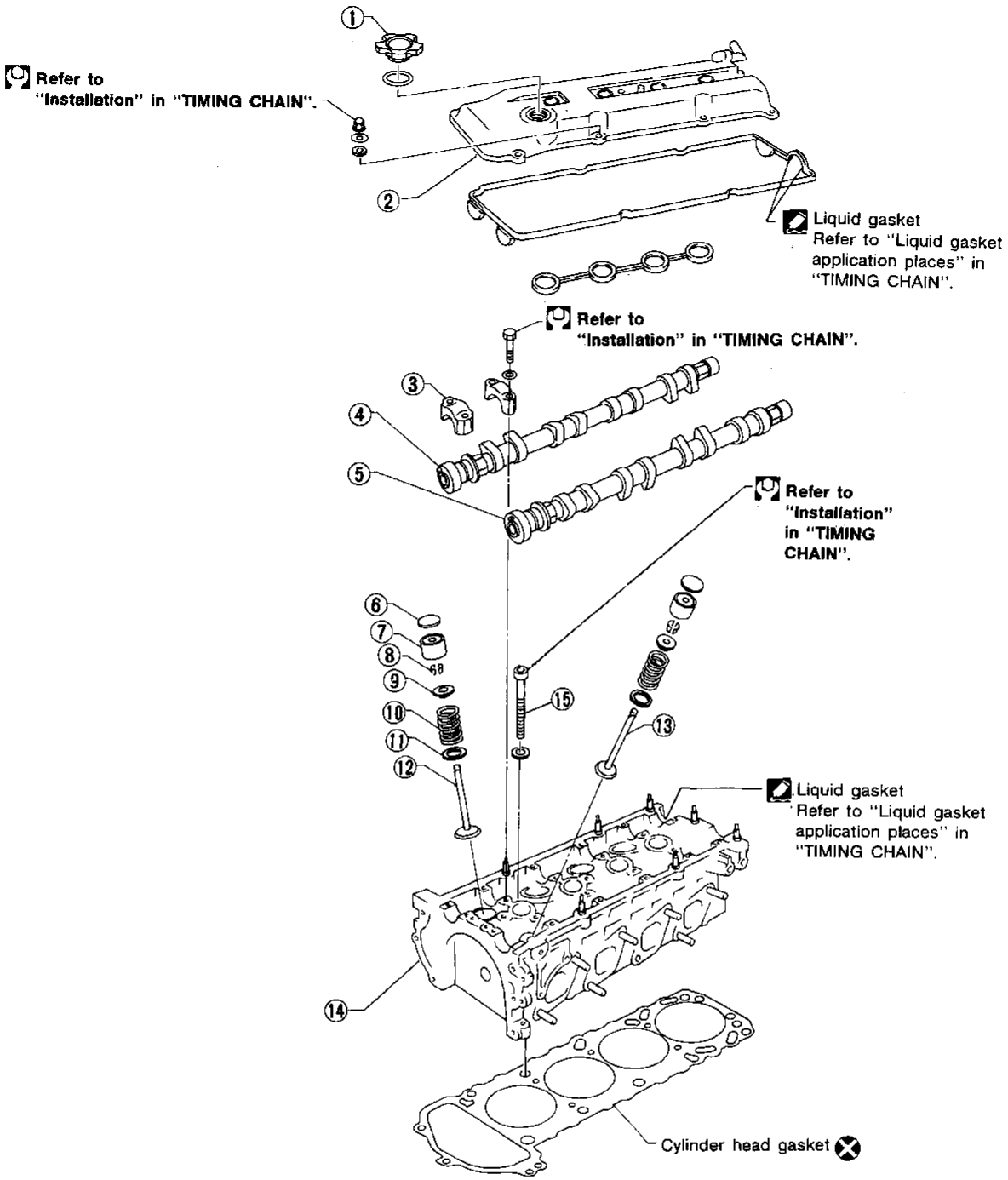
- Check that stopper lever is not touching adjusting screw. If it is, loosen adjusting screw to maintain clearance between the two.



7. Turn adjusting screw until it touches stopper lever.
8. Release accel-drum.



9. Turn adjusting screw 3 rotations clockwise.
10. Tighten lock nut to specification.



SEM149E

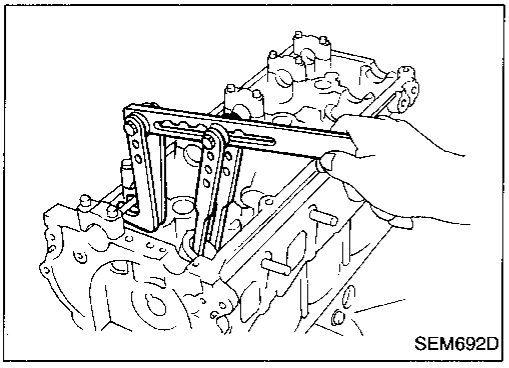
① Oil filler cap
② Rocker cover
③ Camshaft bracket
④ Intake camshaft
⑤ Exhaust camshaft
⑥ Shim
⑦ Valve lifter
⑧ Valve cotter
⑨ Spring retainer
⑩ Valve spring
⑪ Spring seat
⑫ Intake valve
⑬ Exhaust valve
⑭ Cylinder head
⑮ Cylinder head bolt

CAUTION:

- **When installing camshafts, chain tensioners, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Apply new engine oil to threads and seat surfaces when installing cylinder head, camshaft sprocket, crankshaft pulley, and camshaft bracket.**
- **Attach tags to valve lifters so as not to mix them up.**

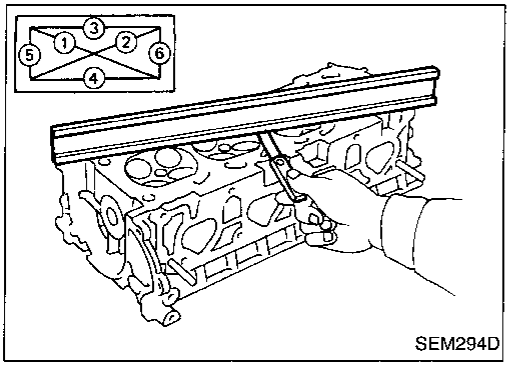
Removal and Installation

- Removal and installation procedures are the same as those for timing chain. Refer to EM-17.


SEM692D

Disassembly

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



SEM294D

Inspection

CYLINDER HEAD DISTORTION

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

Head surface flatness:
Standard: Less than 0.03 mm (0.0012 in)
Limit: 0.1 mm (0.004 in)

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

Resurfacing limit:
The limit for cylinder head resurfacing is determined by the cylinder block resurfacing.
Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".
The maximum limit is as follows:
A + B = 0.2 mm (0.008 in)

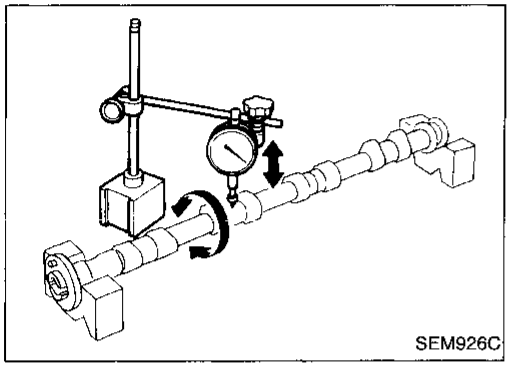
After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.

Nominal cylinder head height:
126.3 - 126.5 mm (4.972 - 4.980 in)

Inspection (Cont'd)

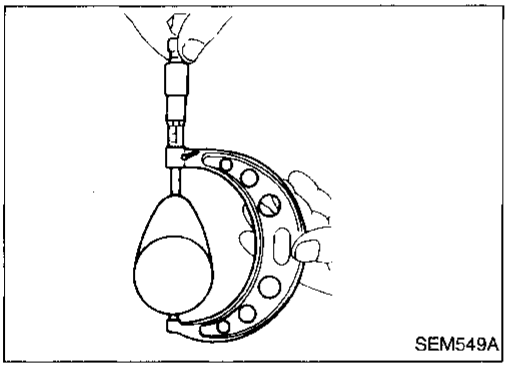
CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.


SEM926C

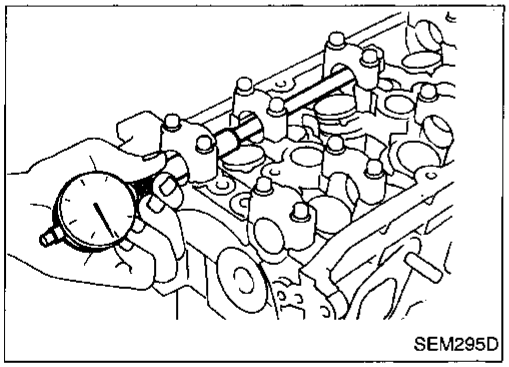
CAMSHAFT RUNOUT

1. Measure camshaft runout at the center journal.
   Runout (Total indicator reading):
   Standard
   Less than 0.02 mm (0.0008 in)
   Limit
   0.04 mm (0.0016 in)
2. If it exceeds the limit, replace camshaft.


SEM549A

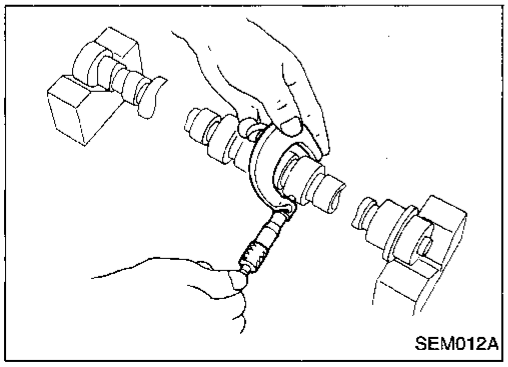
CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height.
   Standard cam height:
   Intake
   42.415 - 42.605 mm (1.6699 - 1.6774 in)
   Exhaust
   42.415 - 43.005 mm (1.6699 - 1.6931 in)
   Cam wear limit:
   Intake & Exhaust
   0.2 mm (0.008 in)
2. If wear is beyond the limit, replace camshaft.


SEM295D

CAMSHAFT JOURNAL CLEARANCE

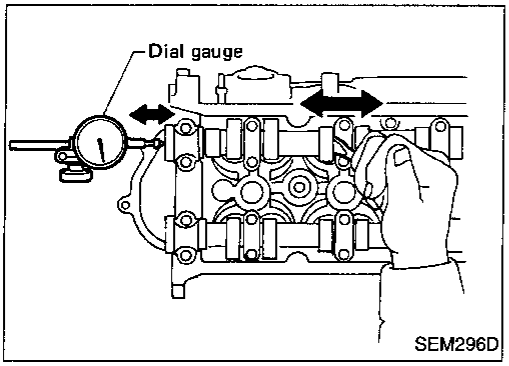
1. Install camshaft bracket and tighten bolts to the specified torque. Refer to EM-22.
2. Measure inner diameter of camshaft bearing.
   Standard inner diameter:
   #1 journal
   28.000 - 28.025 mm (1.1024 - 1.1033 in)
   #2 to #5 journals
   24.000 - 24.025 mm (0.9449 - 0.9459 in)


SEM012A

3. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   #1 journal
   27.935 - 27.955 mm (1.0998 - 1.1006 in)
   #2 to #5 journals
   23.935 - 23.955 mm (0.9423 - 0.9431 in)
4. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance:
   Standard 0.045 - 0.090 mm (0.0018 - 0.0035 in)
   Limit 0.12 mm (0.0047 in)

Inspection (Cont'd)

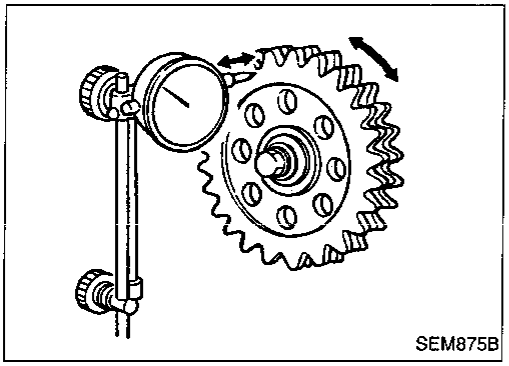
CAMSHAFT END PLAY



1. Install camshaft in cylinder head. Refer to EM-22.
2. Measure camshaft end play.

Camshaft end play:
Standard
0.070 - 0.15 mm (0.0028 - 0.0059 in)
Limit
0.20 mm (0.0079 in)

CAMSHAFT SPROCKET RUNOUT

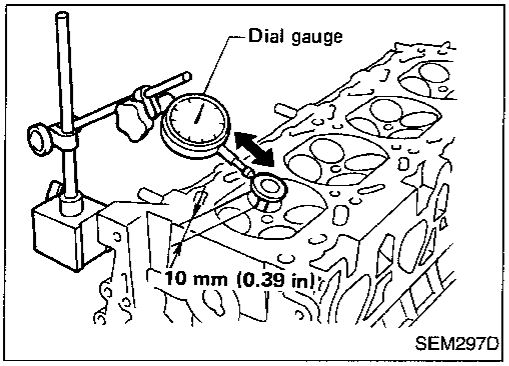


1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.

Runout (Total indicator reading):
Limit 0.12 mm (0.0047 in)

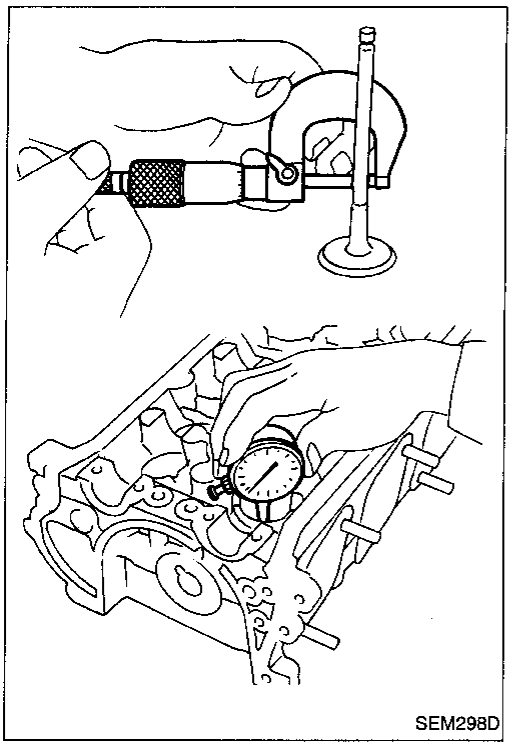
3. If it exceeds the limit, replace camshaft sprocket.

VALVE GUIDE CLEARANCE



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

Valve intake and exhaust deflection limit (Dial gauge reading):
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:

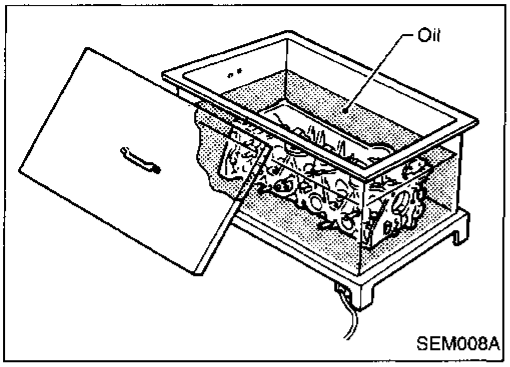
Unit: mm (in)

	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)

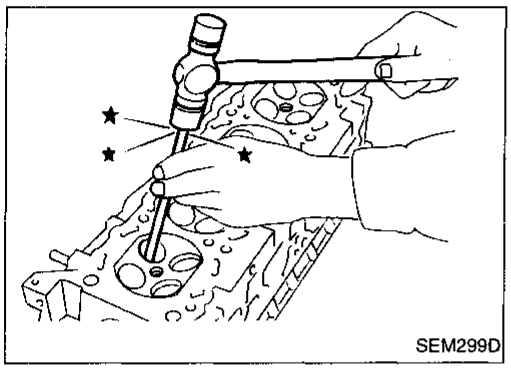
c. If it exceeds the limit, replace valve or valve guide.

Inspection (Cont'd)

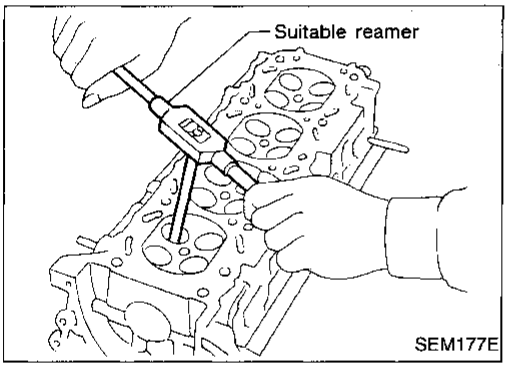
VALVE GUIDE REPLACEMENT



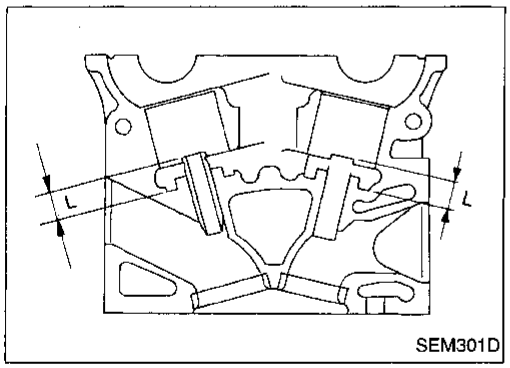
1. To remove valve guide, heat cylinder head to 120 to 140°C (248 to 284°F).



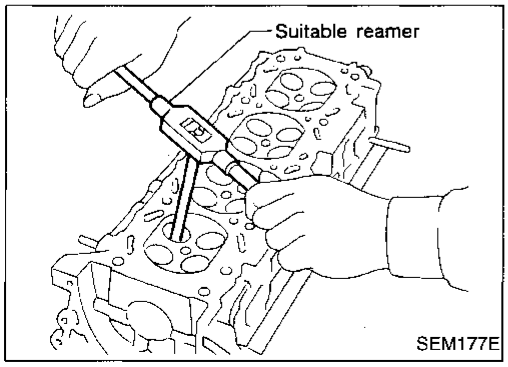
2. Drive out valve guide with a press [less than 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.



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

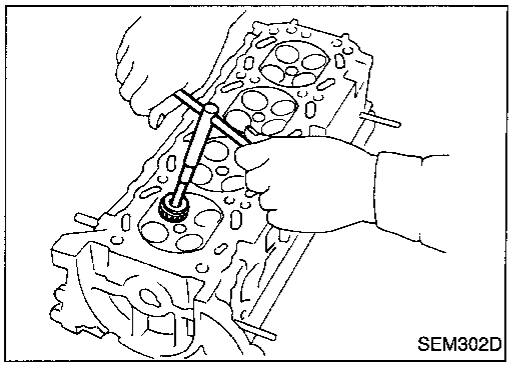


4. Heat cylinder head to 120 to 140°C (230 to 266°F) and press service valve guide onto cylinder head.
   Projection "L":
   13.3 - 13.9 mm (0.524 - 0.547 in)



5. Ream valve guide.
   Finished size:
   Intake & Exhaust
   7.000 - 7.018 mm (0.2756 - 0.2763 in)

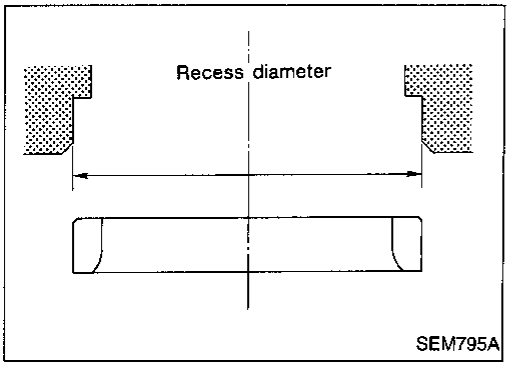
Inspection (Cont'd)


SEM302D

VALVE SEATS

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

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

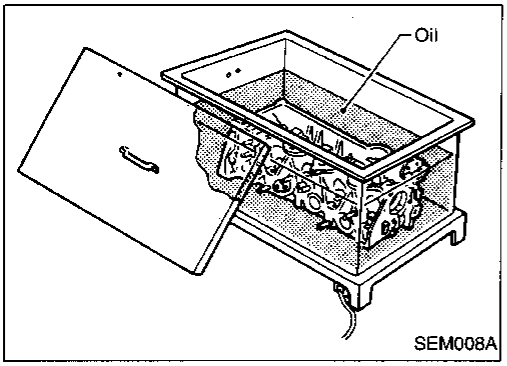


SEM795A

REPLACING VALVE SEAT FOR SERVICE PARTS

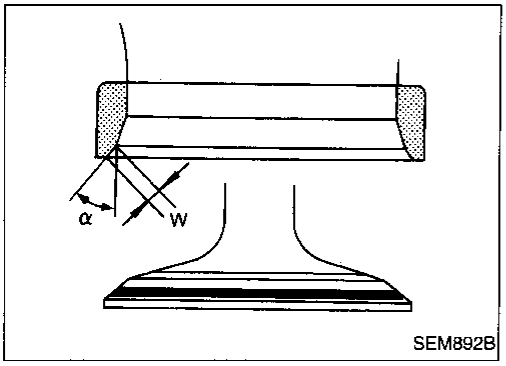
1. Bore out old seat until it collapses. Set machine depth stop so that boring cannot contact bottom face of seat recess in cylinder head.
2. Ream cylinder head recess.
   Reaming bore for service valve seat
   Oversize [0.5 mm (0.020 in)]:
   Intake 38.000 - 38.016 mm (1.4961 - 1.4967 in)
   Exhaust 32.700 - 32.716 mm (1.2874 - 1.2880 in)

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



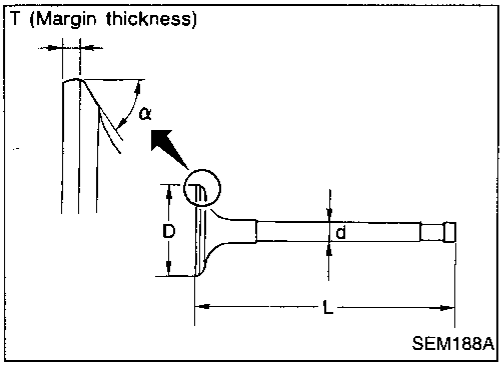
SEM008A

3. Heat cylinder head to 120 to 140°C (248 to 284°F).
4. Press fit valve seat until it seats on the bottom.



SEM892B

5. Cut or grind valve seat using suitable tool to 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′
   Contacting width "W":
   Intake
   1.48 - 1.63 mm (0.0583 - 0.0642 in)
   Exhaust
   1.8 - 2.0 mm (0.071 - 0.079 in)



SEM188A

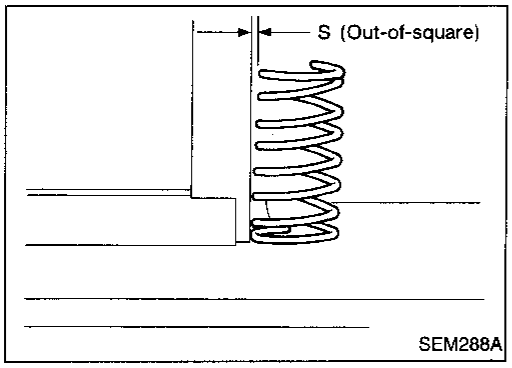
VALVE DIMENSIONS

Check dimensions of each valve. For dimensions, refer to SDS, (EM-52).

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.

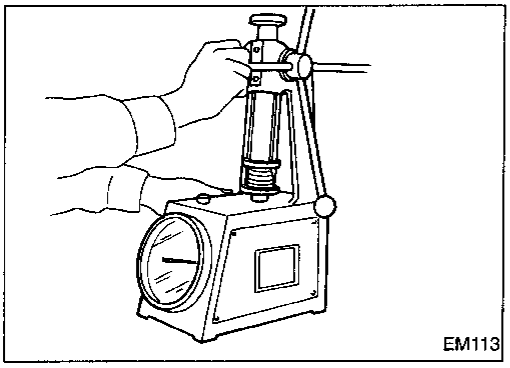
Inspection (Cont'd)



VALVE SPRING

Squareness

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

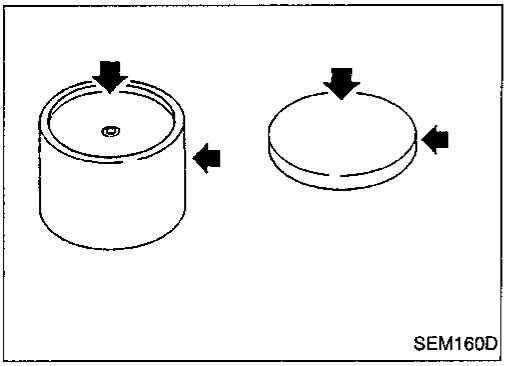


Pressure

Check valve spring pressure at specified spring height.

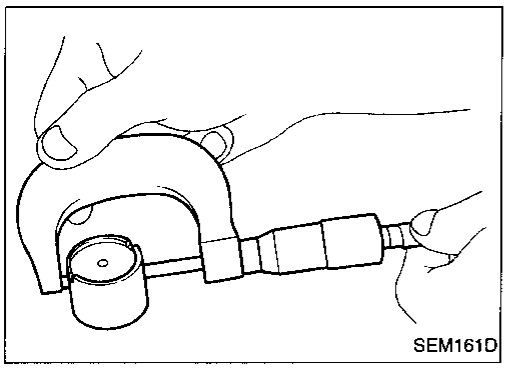
Pressure:
Standard
471.7 N (48.1 kg, 106.1 lb) at 26.06 mm (1.0260 in)
Limit
More than 421.31 N (42.96 kg, 94.73 lb) at 26.06 mm (1.0260 in)

If it exceeds the limit, replace spring.

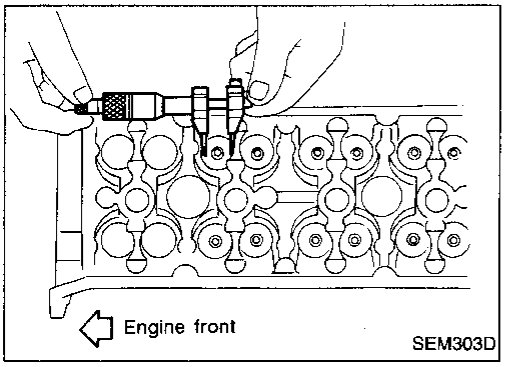


VALVE LIFTER AND VALVE SHIM

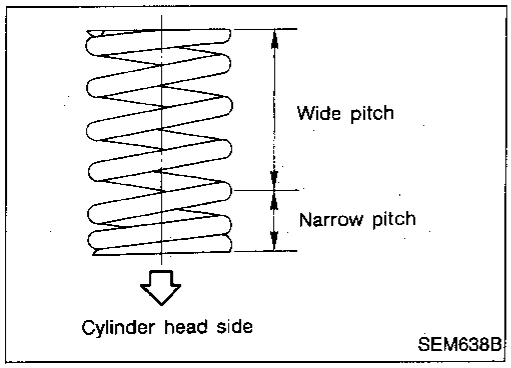
1. Visually check contact and sliding surfaces for wear or scratches.



2. Check diameter of valve lifter and valve lifter guide bore.
   Valve lifter diameter:
   33.960 - 33.975 mm (1.3370 - 1.3376 in)



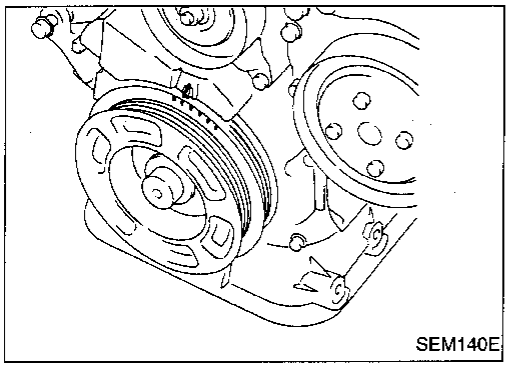
Lifter guide bore diameter:
34.000 - 34.021 mm (1.3386 - 1.3394 in)
Valve lifter to valve lifter guide clearance:
0.025 - 0.061 mm (0.0010 - 0.0024 in)



Assembly

1. Install valve component parts.

- **Always use new valve oil seal. Refer to EM-24.**
- **Before installing valve oil seal, install valve spring seat.**
- **Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.**
- **After installing valve components, tap valve stem tip with plastic hammer to assure a proper fit.**

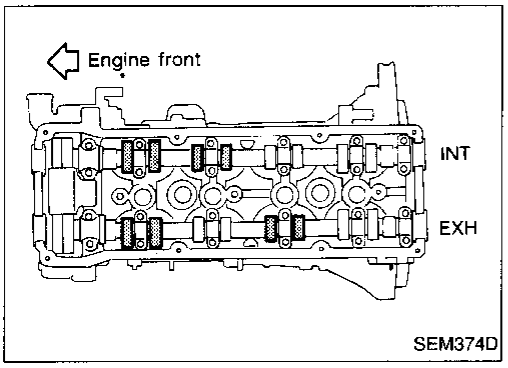


Valve Clearance

CHECKING

Check valve clearance while engine is warm but not running.

1. Remove rocker cover and all spark plugs.
2. Set No. 1 cylinder at TDC on its compression stroke.
- Align pointer with TDC mark on crankshaft pulley.
- Check that valve lifters on No. 1 cylinder are loose and valve lifters on No. 4 are tight.
  If not, turn crankshaft one revolution (360°) and align as above.
3. Check only those valves shown in the figure.



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

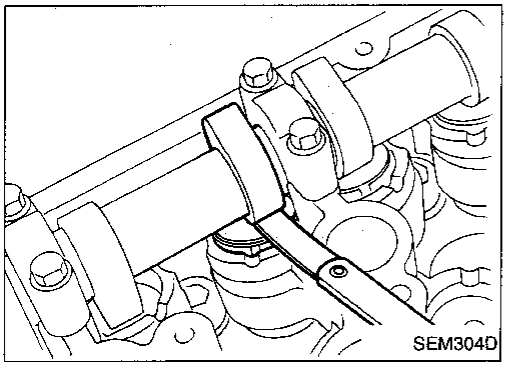
Valve clearance (Hot):

Intake

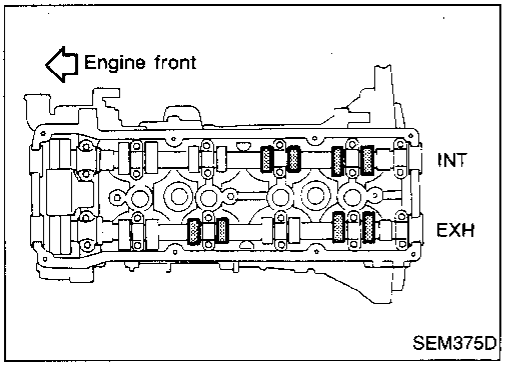
0.31 - 0.39 mm (0.012 - 0.015 in)

Exhaust

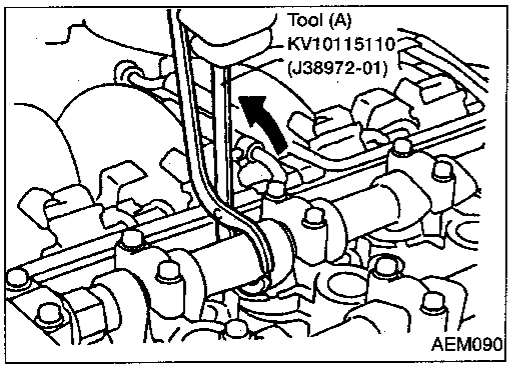
0.33 - 0.41 mm (0.013 - 0.016 in)



4. Turn crankshaft one revolution (360°) and align mark on crankshaft pulley with pointer.
5. Check those valves shown in the figure.
- Use the same procedure as mentioned in step 4.
6. If all valve clearances are within specification, install the following parts:
- Rocker cover
- All spark plugs



Valve Clearance (Cont'd)



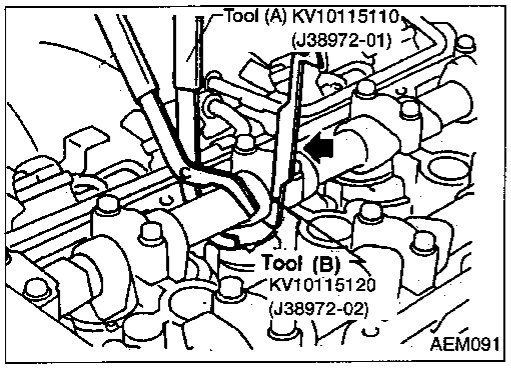
ADJUSTING

Adjust valve clearance while engine is cold.

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

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

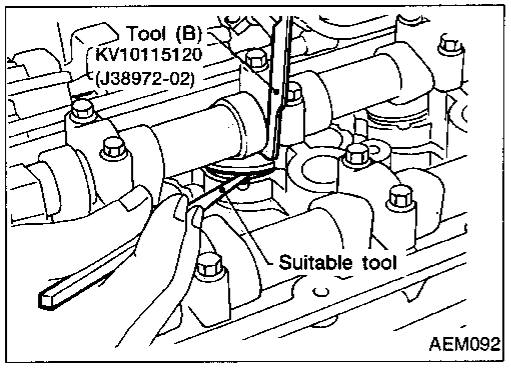
CAUTION:
Be careful not to damage cam surface with Tool (A).



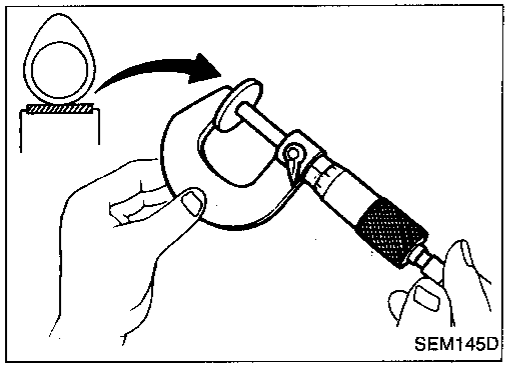
4. Place Tool (B) between camshaft and valve lifter to retain valve lifter.

CAUTION:
- **Tool (B) must be placed as close to camshaft bracket as possible.**
- **Be careful not to damage cam surface with Tool (B).**

5. Remove Tool (A).



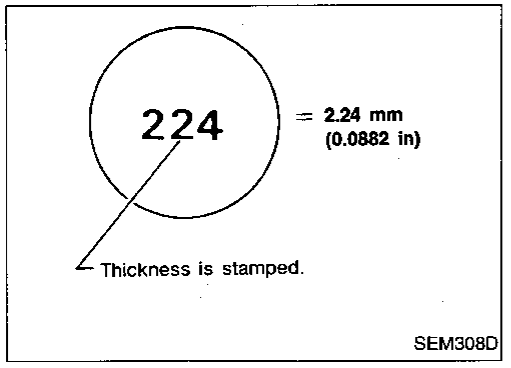
6. Remove adjusting shim using a small screwdriver and a magnetic finger.



7. Determine replacement adjusting shim size as follows:

a. Using a micrometer determine thickness of removed shim.

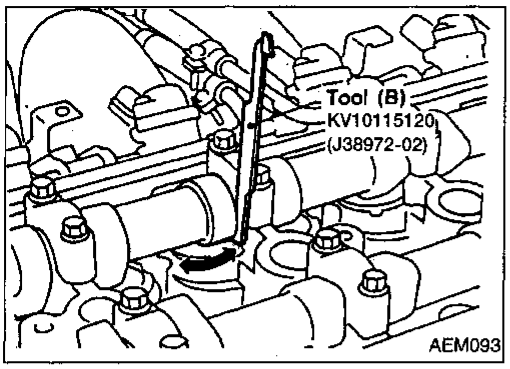
b. Calculate thickness of new adjusting shim so valve clearance comes within specified values.
   R = Thickness of removed shim
   N = Thickness of new shim
   M = Measured valve clearance
   Intake: N = R + [M – 0.35 mm (0.0138 in)]
   Exhaust: N = R + [M – 0.37 mm (0.0146 in)]



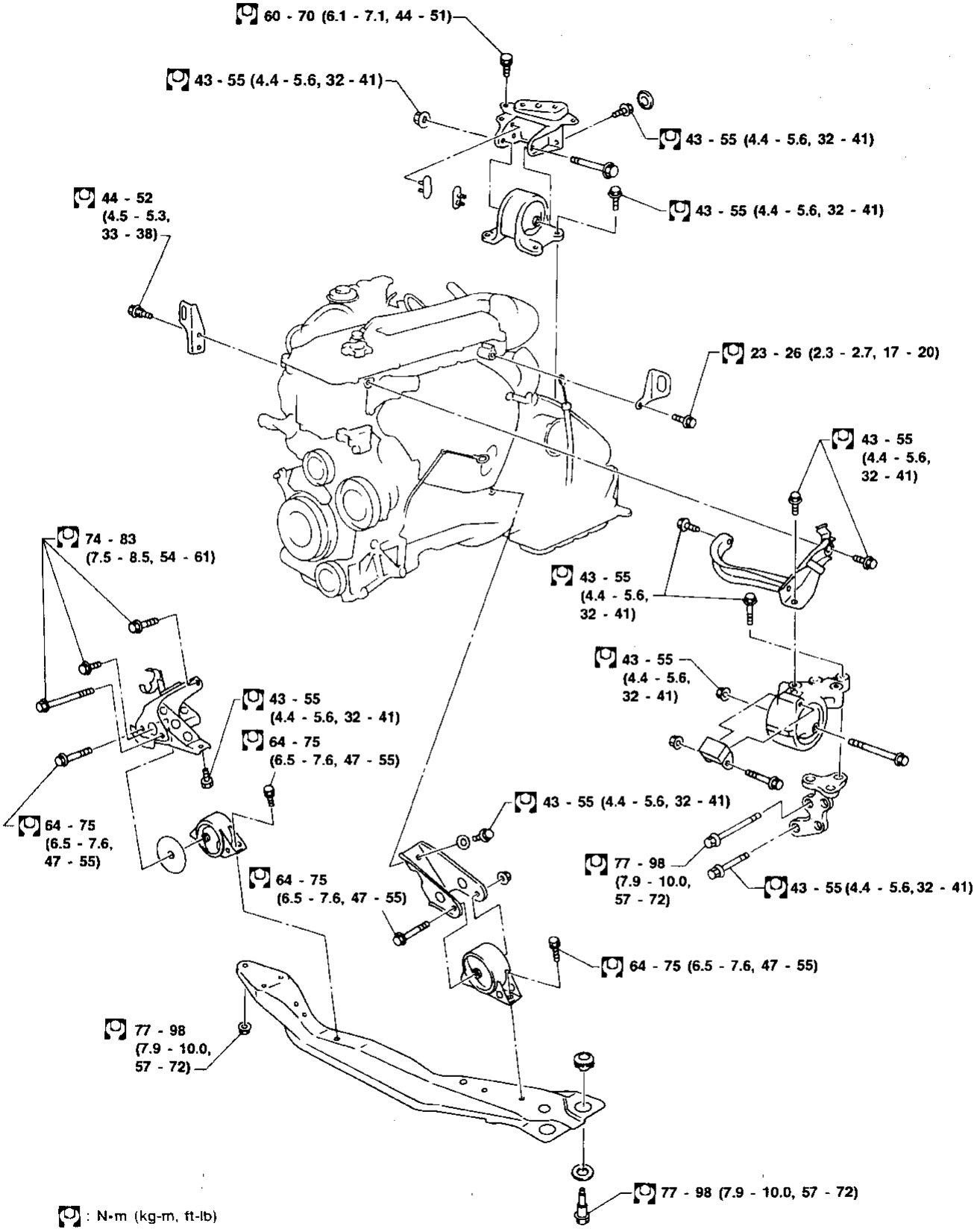
Shims are available in thicknesses from 1.96 mm (0.0772 in) to 2.68 mm (0.1055 in), in steps of 0.02 mm (0.0008 in).

c. Select new shim with thickness as close as possible to calculated value.
   Refer to EM-54.

Valve Clearance (Cont'd)



8. Install new shim using a suitable tool.
- **Install with the surface on which the thickness is stamped facing down.**
9. Place Tool (A) as mentioned in steps 2 and 3.
10. Remove Tool (B).
11. Remove Tool (A).
12. Recheck valve clearance.
    Refer to EM-35.


60 - 70 (6.1 - 7.1, 44 - 51)
43 - 55 (4.4 - 5.6, 32 - 41)
43 - 55 (4.4 - 5.6, 32 - 41)
43 - 55 (4.4 - 5.6, 32 - 41)
44 - 52 (4.5 - 5.3, 33 - 38)
23 - 26 (2.3 - 2.7, 17 - 20)
43 - 55 (4.4 - 5.6, 32 - 41)
74 - 83 (7.5 - 8.5, 54 - 61)
43 - 55 (4.4 - 5.6, 32 - 41)
43 - 55 (4.4 - 5.6, 32 - 41)
43 - 55 (4.4 - 5.6, 32 - 41)
64 - 75 (6.5 - 7.6, 47 - 55)
64 - 75 (6.5 - 7.6, 47 - 55)
43 - 55 (4.4 - 5.6, 32 - 41)
77 - 98 (7.9 - 10.0, 57 - 72)
43 - 55 (4.4 - 5.6, 32 - 41)
64 - 75 (6.5 - 7.6, 47 - 55)
64 - 75 (6.5 - 7.6, 47 - 55)
77 - 98 (7.9 - 10.0, 57 - 72)
77 - 98 (7.9 - 10.0, 57 - 72)
: N·m (kg-m, ft-lb)

AEM055

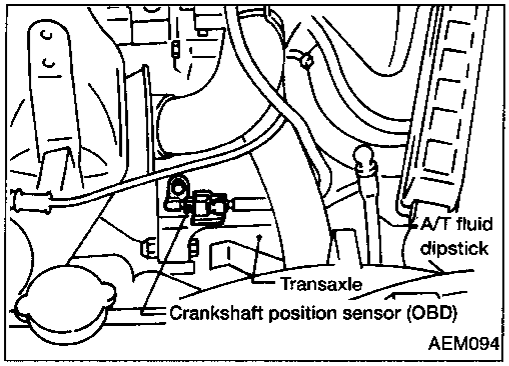
Valve Clearance

WARNING:

- **Position vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **Do not remove engine until exhaust system has completely cooled off.**
  Otherwise, you may burn yourself and/or fire may break out in fuel line.
- **Before disconnecting fuel hose, release fuel pressure. Refer to EC section ("Fuel Pressure Release", "BASIC SERVICE PROCEDURE").**
- **Before removing front axle from transaxle, place safety stands under designated front supporting points. Refer to GI section for lifting points and towing.**
- **Be sure to hoist engine and transaxle in a safe manner.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.**

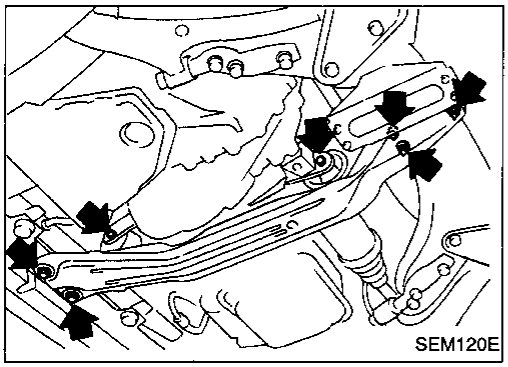
CAUTION:

- **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.**
- **In removing drive shaft, be careful not to damage grease seal of transaxle.**
- **Before separating engine and transaxle, remove crankshaft position sensor (OBD) from the assembly.**
- **Always take extra care not to damage edge of crankshaft position sensor (OBD), or ring gear teeth.**



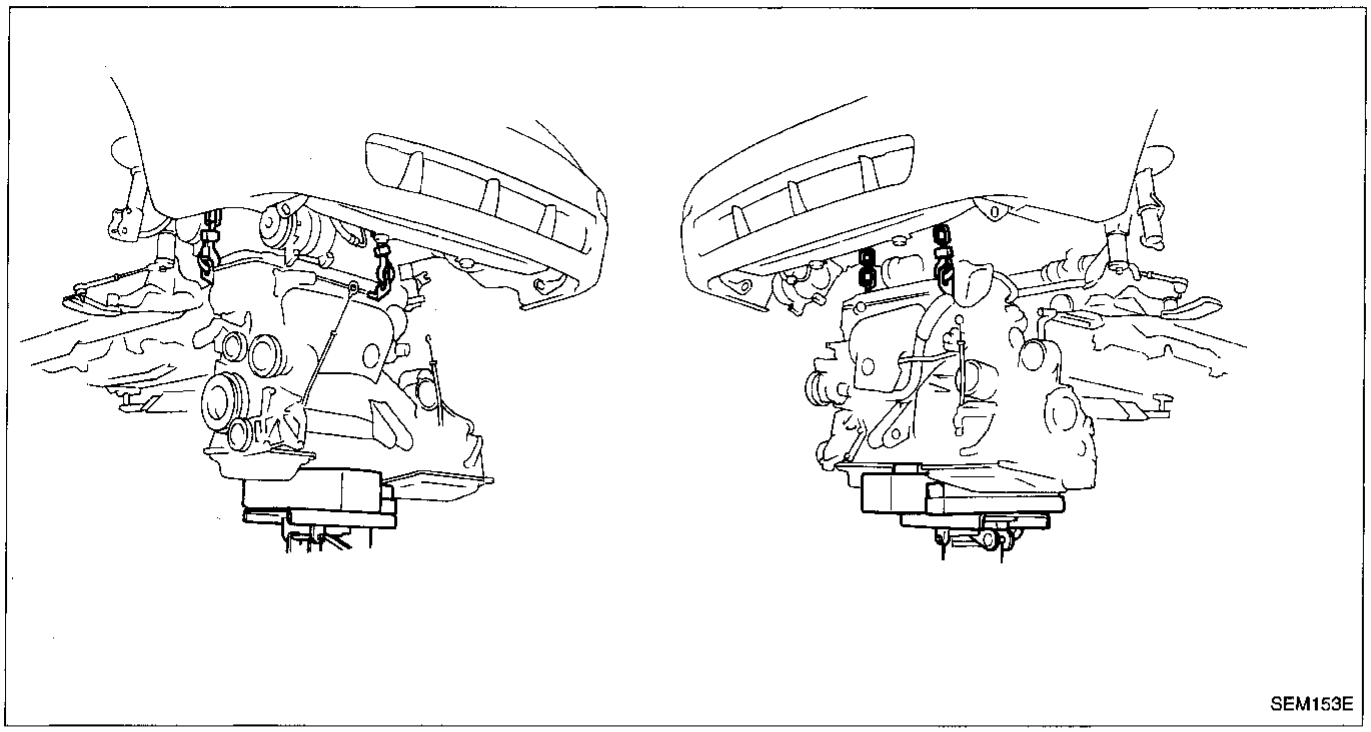
Removal

1. Remove engine under cover and hood.
2. Drain coolant from drain plug on water pipe, and radiator.
3. Remove vacuum hoses, fuel hoses, wires, harnesses and connectors and so on.
4. Remove front exhaust tube and drive shafts.
5. Remove drive belts.
6. Remove generator, compressor and power steering oil pump from engine.
7. Set a suitable transmission jack under transaxle. Hoist engine with engine slinger.
8. Remove RH and LH engine mountings and center member.
9. Remove front and rear engine mountings.



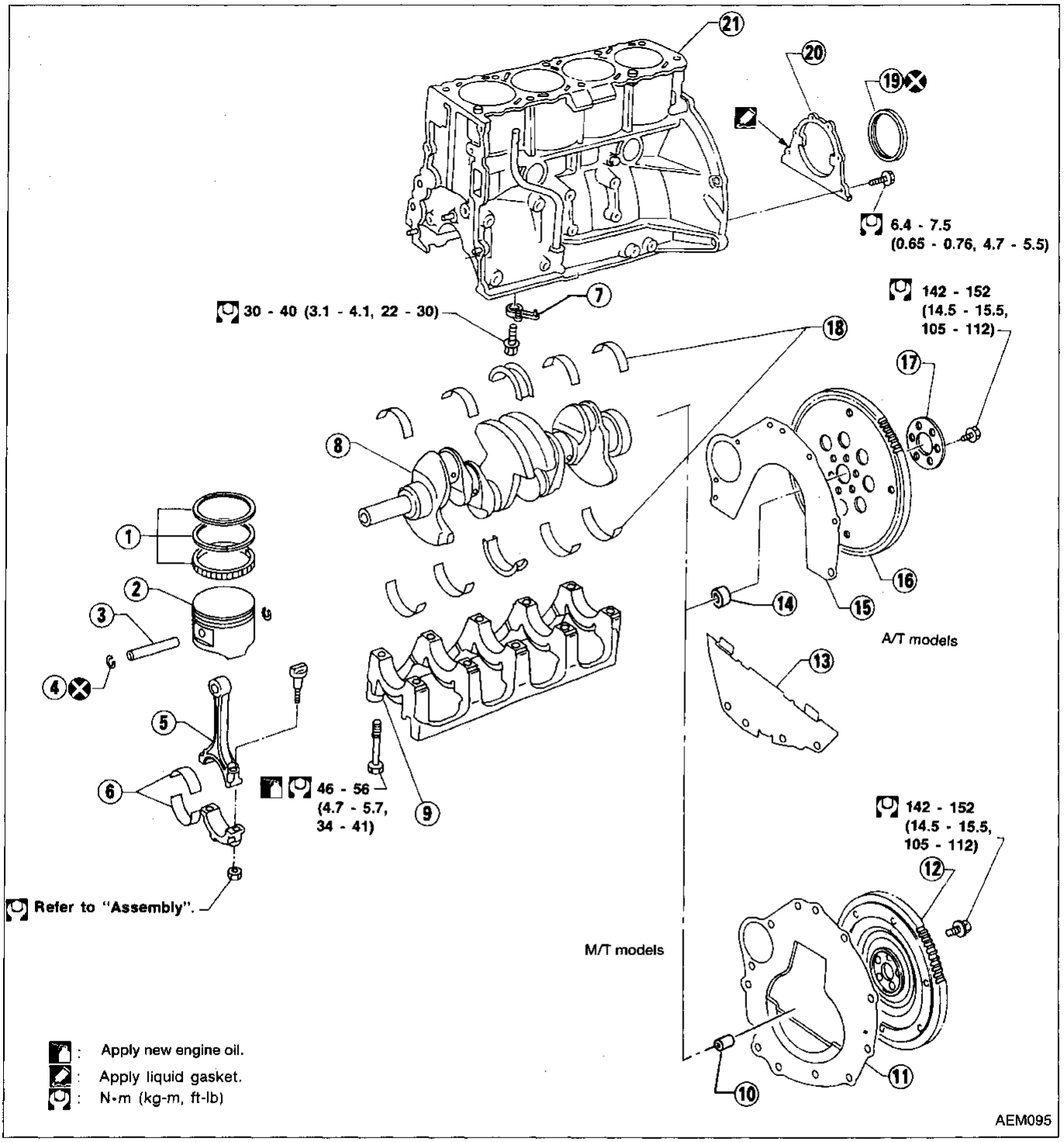
Removal (Cont'd)

10. Remove engine with transaxle as shown.



Installation

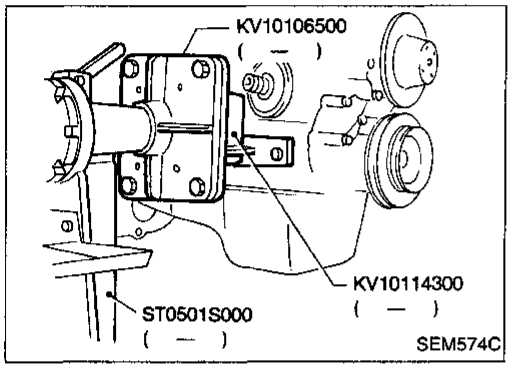
Installation is in the reverse order of removal.



① Piston rings
② Piston
③ Piston pin
④ Snap ring
⑤ Connecting rod
⑥ Connecting rod bearing
⑦ Oil jet
⑧ Crankshaft
⑨ Main bearing cap
⑩ Pilot bushing (M/T)
⑪ Rear plate (M/T)
⑫ Flywheel (M/T)
⑬ Dust cover (A/T)
⑭ Pilot converter (A/T)
⑮ Rear plate (A/T)
⑯ Drive plate (A/T)
⑰ Drive plate reinforcement
⑱ Main bearing
⑲ Rear oil seal
⑳ Rear oil seal retainer
㉑ Cylinder block

CAUTION:

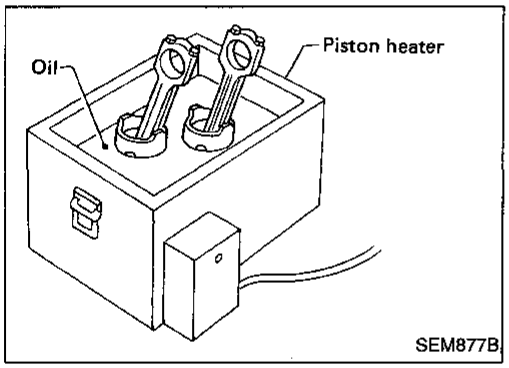
- **When installing bearings, pistons, or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When installing connecting rod nuts, and main bearing cap bolts, apply new engine oil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



Disassembly

PISTON AND CRANKSHAFT

1. Place engine on a work stand.
2. Remove timing chains.
   Refer to EM-17.

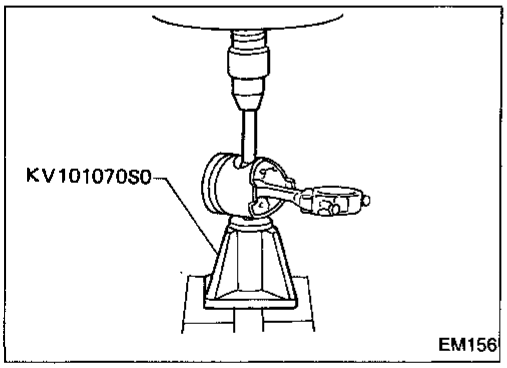


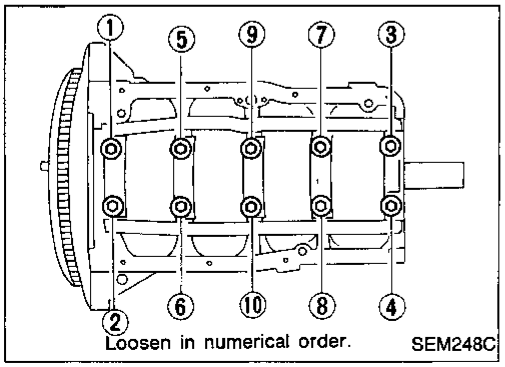
3. Remove pistons with connecting rods.

- To disassemble piston and connecting rod, first remove snap rings. Heat piston to 60 to 70°C (140 to 158°F) then use piston pin press to remove pin.

CAUTION:

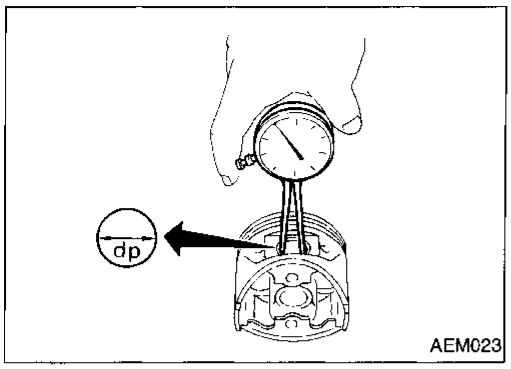
- **When piston rings are not replaced, make sure that piston rings are mounted in their original positions.**
- **When replacing piston rings, if there is no punchmark, install with either side up.**

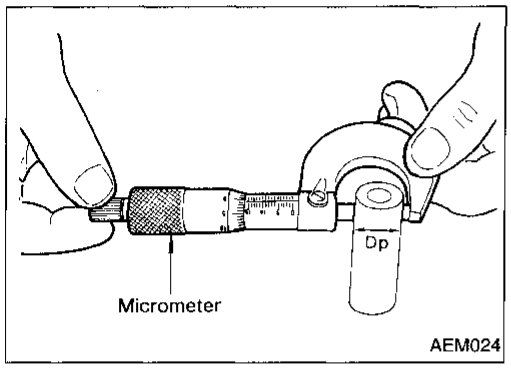


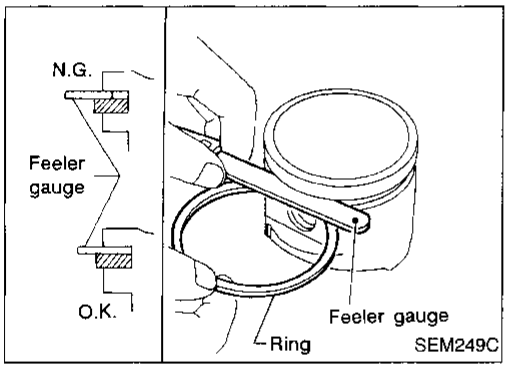


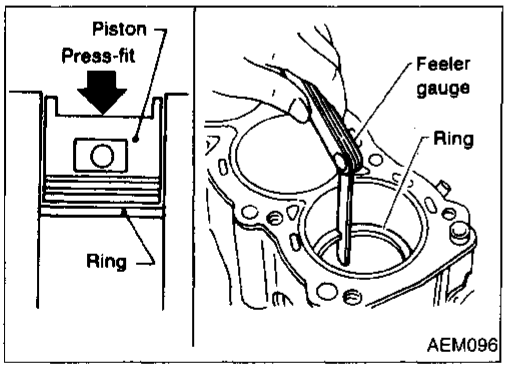
4. Remove main bearing cap and crankshaft.

- **Before removing main bearing cap, measure crankshaft end play. Refer to EM-50.**
- **Bolts should be loosened in two or three steps.**









Inspection

PISTON AND PISTON PIN CLEARANCE

1. Measure inner diameter of piston pin hole "dp".
   Standard diameter "dp":
   20.987 - 20.999 mm (0.8263 - 0.8267 in)
2. Measure outer diameter of piston pin "Dp".
   Standard diameter "Dp":
   20.989 - 21.001 mm (0.8263 - 0.8268 in)
3. Calculate interference fit of piston pin to piston.
   Dp – dp: 0 - 0.004 mm (0 - 0.0002 in)
   If it exceeds the above value, replace piston assembly with pin.

PISTON RING SIDE CLEARANCE

Side clearance:
Top ring
0.040 - 0.080 mm (0.0016 - 0.0031 in)
2nd ring
0.030 - 0.070 mm (0.0012 - 0.0028 in)
Max. limit of side clearance:
0.1 mm (0.004 in)

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

PISTON RING END GAP

End gap:
Top ring
0.28 - 0.52 mm (0.0110 - 0.0205 in)
2nd ring
0.45 - 0.69 mm (0.0177 - 0.0272 in)
Oil ring
0.20 - 0.69 mm (0.0079 - 0.0272 in)
Max. limit of ring gap:
1.0 mm (0.039 in)

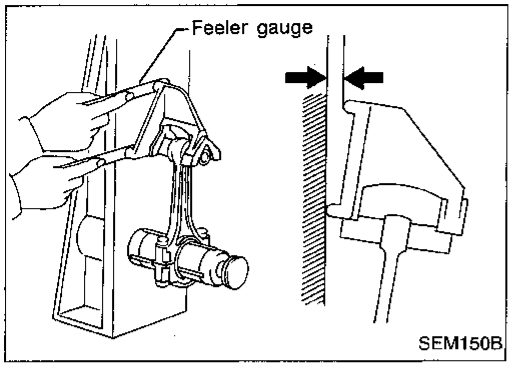
If out of specification, replace piston ring. If gap exceeds maximum limit with new ring, rebore cylinder and use oversized piston and piston rings.

Refer to EM-58.

When replacing the piston, check the cylinder block surface for scratches or seizure.

If scratches or seizure is found, hone or replace the cylinder block.

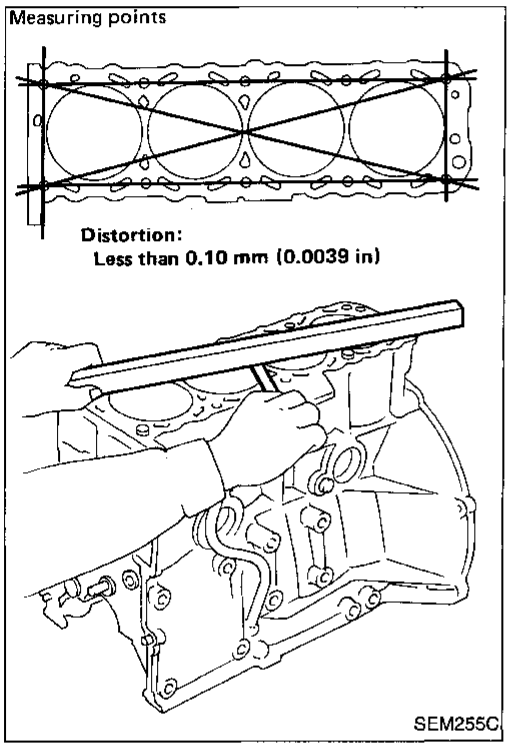
Inspection (Cont'd)



CONNECTING ROD BEND AND TORSION

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

If it exceeds the limit, replace connecting rod assembly.



CYLINDER BLOCK DISTORTION

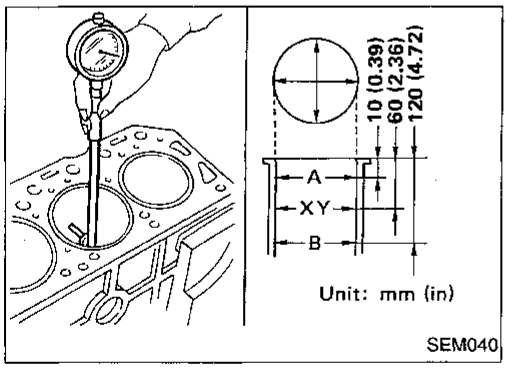
Clean upper surface of cylinder block.
Use a reliable straightedge and feeler gauge to check the flatness of cylinder block surface.
Check along six positions shown in figure.

Block surface flatness:
Standard: Less than 0.03 mm (0.0012 in)
Limit: 0.1 mm (0.004 in)

If out of specification, resurface it.

Resurfacing limit:
The limit for cylinder block resurfacing is determined by the cylinder head resurfacing.
Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".
The maximum limit is as follows:
A + B = 0.2 mm (0.008 in)
Nominal cylinder block height from crankshaft center:
246.95 - 247.05 mm (9.7224 - 9.7264 in)

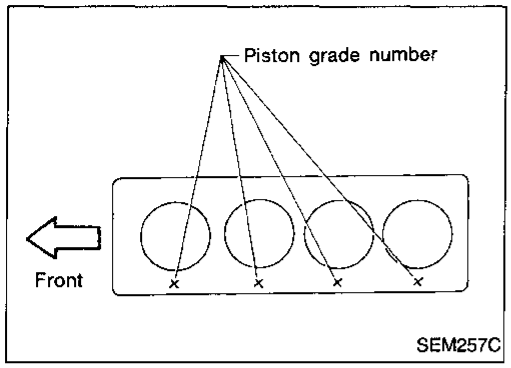
If necessary, replace cylinder block.



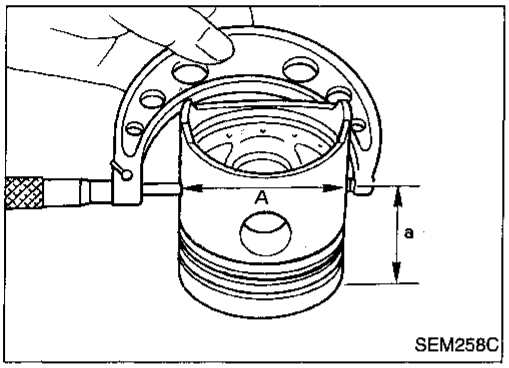
PISTON-TO-BORE CLEARANCE

1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.
   Standard inner diameter:
   89.000 - 89.030 mm (3.5039 - 3.5051 in)
   Wear limit:
   0.2 mm (0.008 in)
   Out-of-round (X – Y):
   Less than 0.015 mm (0.0006 in)
   Taper (A – B):
   Less than 0.01 mm (0.0004 in)
   If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.
2. Check for scratches and seizure. If seizure is found, hone it.

Inspection (Cont'd)



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



3. Measure piston skirt diameter.
   Piston diameter "A":
   Refer to EM-58.
   Measuring point "a" (Distance from the top):
   52 mm (2.05 in)
4. Check that piston-to-bore clearance is within specification.
   Piston-to-bore clearance "B":
   0.020 - 0.040 mm (0.0008 - 0.0016 in)
5. Determine piston oversize according to amount of cylinder wear.

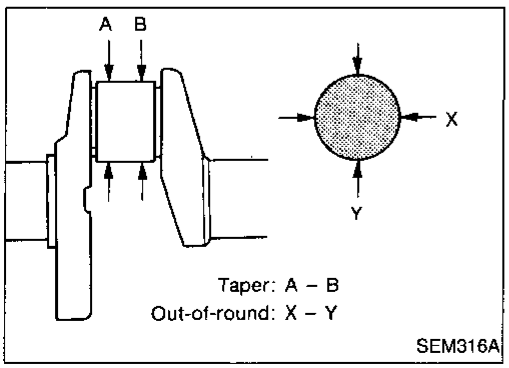
Oversize pistons are available for service. Refer to EM-58.

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

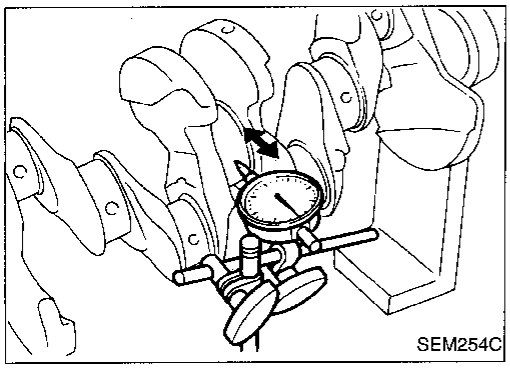
- **Measurement should be done after cylinder bore cools down.**



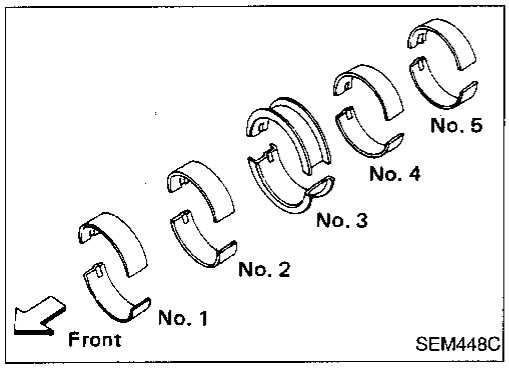
CRANKSHAFT

- Check crankshaft main and pin journals for score, wear or cracks.
- With a micrometer, measure journals for taper and out-of-round.
  Out-of-round (X – Y):
  Less than 0.005 mm (0.0002 in)
  Taper (A – B):
  Less than 0.002 mm (0.0001 in)

Inspection (Cont'd)



- Measure crankshaft runout.
  Runout (Total indicator reading):
  Less than 0.04 mm (0.0016 in)



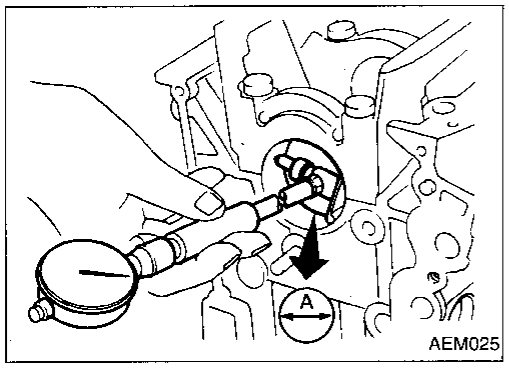
BEARING CLEARANCE

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

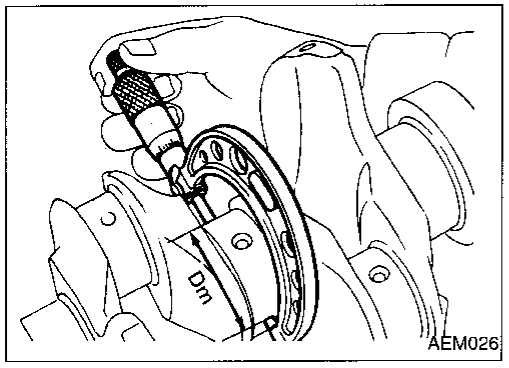
Method A (Using bore gauge & micrometer)

Main bearing

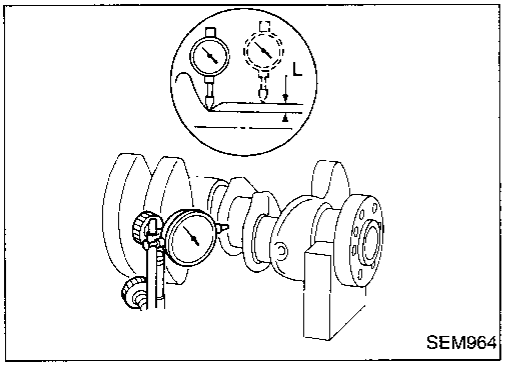
1. Set main bearings in their proper positions on cylinder block and main bearing cap.



2. Install main bearing cap to cylinder block.
   Tighten all bolts in correct order in two or three stages. Refer to EM-50.
3. Measure inner diameter "A" of each main bearing.

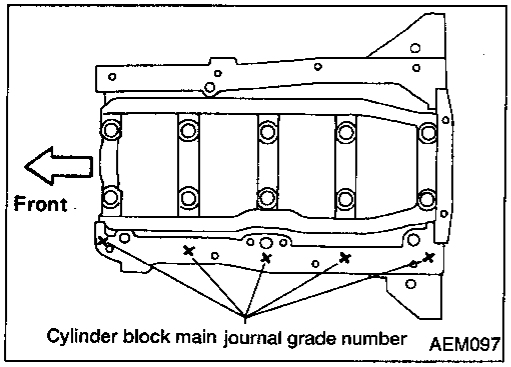


4. Measure outer diameter "Dm" of each crankshaft main journal.
5. Calculate main bearing clearance.
   Main bearing clearance = A – Dm
   Standard:
   0.020 - 0.047 mm (0.0008 - 0.0019 in)
   Limit: 0.1 mm (0.004 in)
   If it exceeds the limit, replace bearing.
   If clearance cannot be adjusted using any standard bearing grade, grind crankshaft main journal and use undersized bearing.



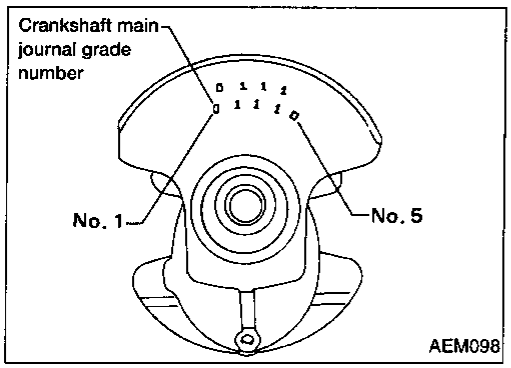
When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.
"L": 0.1 mm (0.004 in)
Refer to EM-59 for grinding crankshaft and available service parts.

Inspection (Cont'd)



- If crankshaft is replaced, select thickness of main bearings as follows:

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



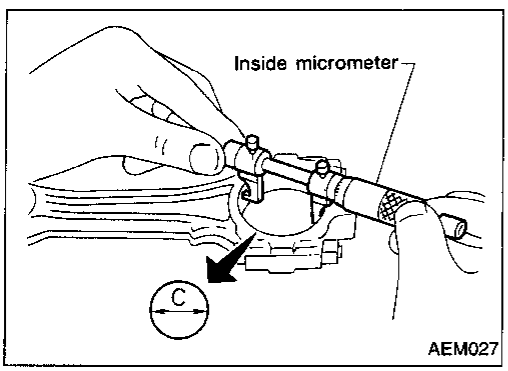
b. Grade number of each crankshaft main journal is punched on crankshaft. These numbers are punched in either Arabic or Roman numerals.

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

Main bearing grade number:

Crankshaft main journal grade number	Cylinder block main journal grade number		
	0	1	2
0	0	1	2
1	1	2	3
2	2	3	4

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



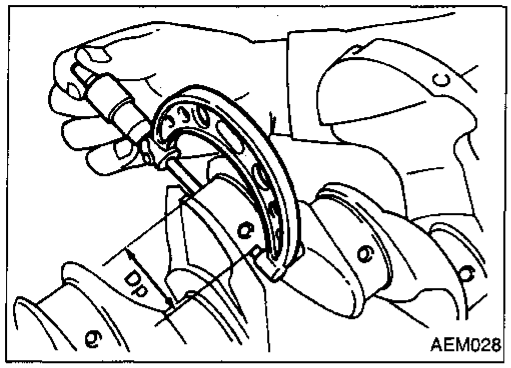
Connecting rod bearing (Big end)

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

Tighten bolts to the specified torque.

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

Inspection (Cont'd)



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

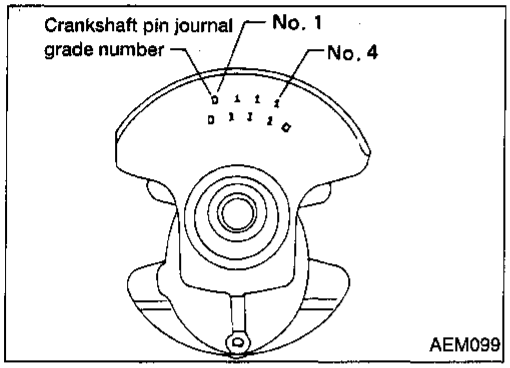
Connecting rod bearing clearance = C – Dp

Standard: 0.010 - 0.035 mm (0.0004 - 0.0014 in)

Limit: 0.09 mm (0.0035 in)

If it exceeds the limit, replace bearing.

If clearance cannot be adjusted using any standard bearing grade, grind crankshaft pin journal and use undersized bearing. Refer to step 5 on EM-46 for fillet roll remarks and EM-59 for grinding crankshaft and available service parts.

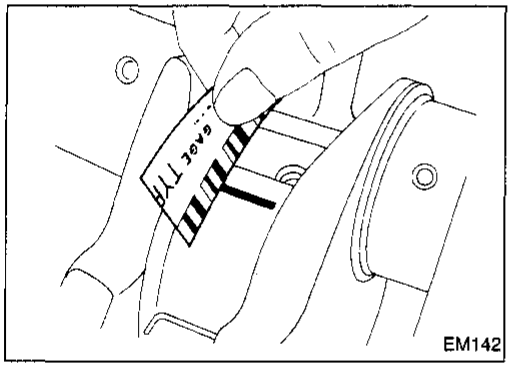


- If crankshaft is replaced with a new one, select connecting rod bearings according to the following table.

Connecting rod bearing grade number:

These numbers are punched in either Arabic or Roman numerals.

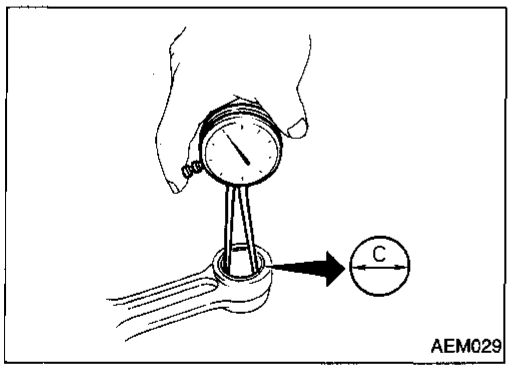
Crankshaft pin journal grade number	Connecting rod bearing grade number
0	0
1	1
2	2



Method B (Using plastigage)

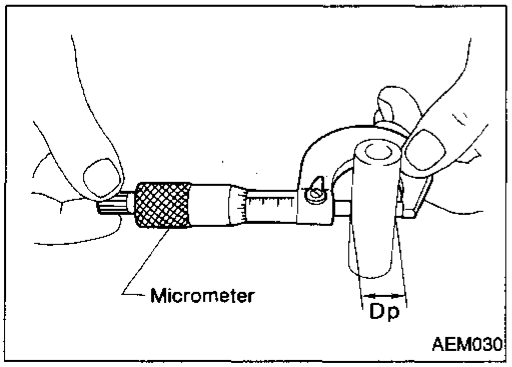
CAUTION:

- **Do not turn crankshaft or connecting rod while plastigage is being inserted.**
- **If incorrect bearing clearance exists, use a thicker or undersized main bearing to ensure specified clearance.**



CONNECTING ROD BUSHING CLEARANCE (Small end)

1. Measure inner diameter "C" of bushing.



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

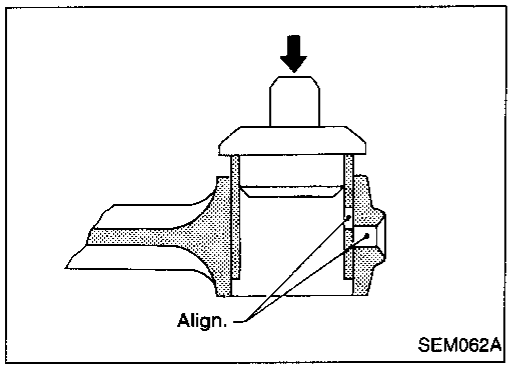
C – Dp =

0.005 - 0.017 mm (0.0002 - 0.0007 in) (Standard)

0.023 mm (0.0009 in) (Limit)

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

Inspection (Cont'd)



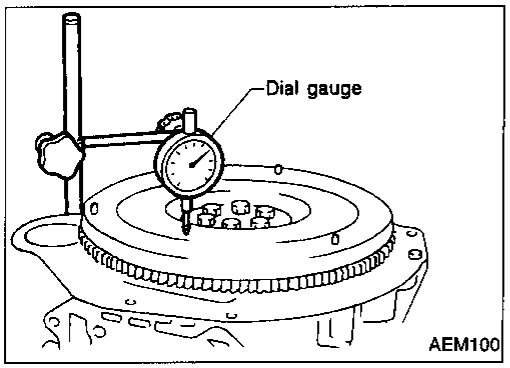
REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

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

Be sure to align the oil holes.

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

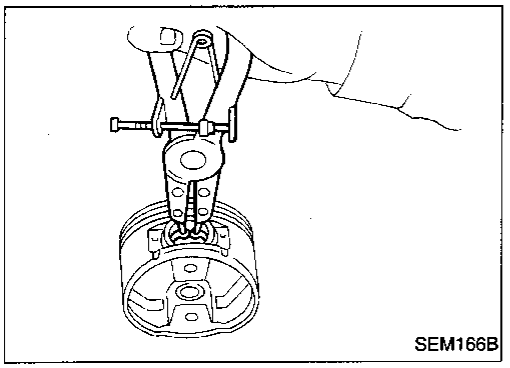
Clearance between small end bushing and piston pin:
0.005 - 0.017 mm (0.0002 - 0.0007 in)



FLYWHEEL/DRIVE PLATE RUNOUT

Runout (Total indicator reading):
Flywheel (M/T model)
Less than 0.15 mm (0.0059 in)
Drive plate (A/T model)
Less than 0.15 mm (0.0059 in)

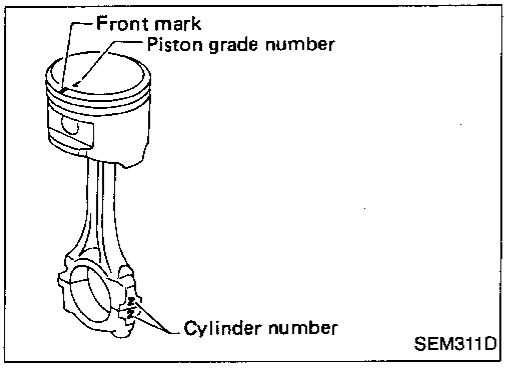
CAUTION:
Do not allow any magnetic materials to contact the ring gear teeth.



Assembly

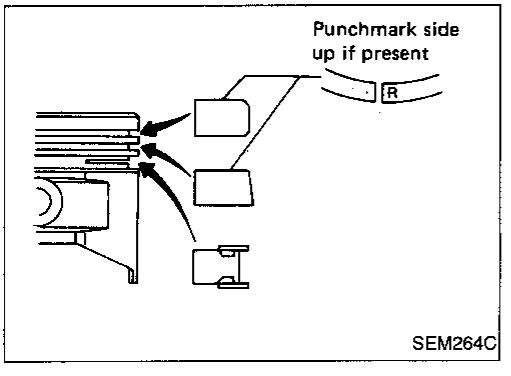
PISTON

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



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

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

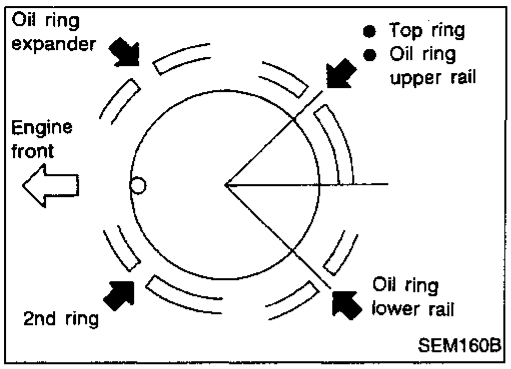


3. Set piston rings as shown.

CAUTION:

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

Assembly (Cont'd)

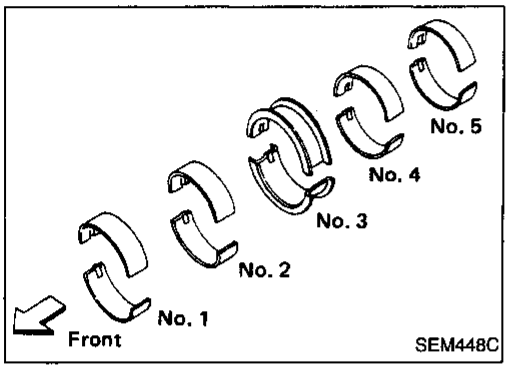


- Align piston rings so that end gaps are positioned as shown.

CRANKSHAFT

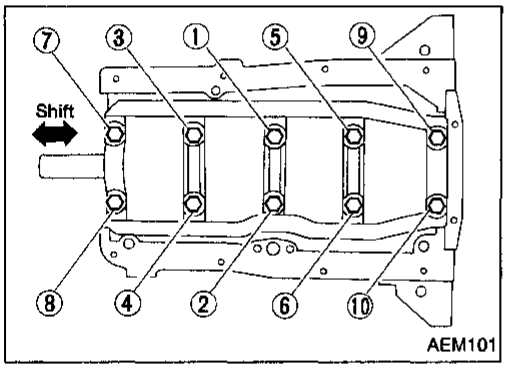
1. Set main bearings in their proper positions on cylinder block and main bearing cap.

- **Confirm that correct main bearings are used. Refer to EM-45.**



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

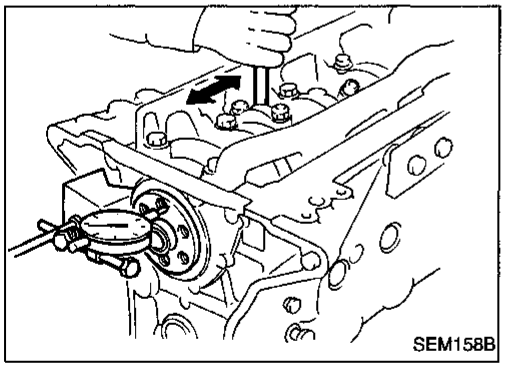
- **Apply new engine oil to bolt threads and seat surfaces.**
- **Prior to tightening bearing cap bolts, shift crankshaft back and forth to properly seat the bearing cap.**
- **Tighten bearing cap bolts gradually in two or three stages. Start with center bearing and move outward sequentially.**
- **After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.**

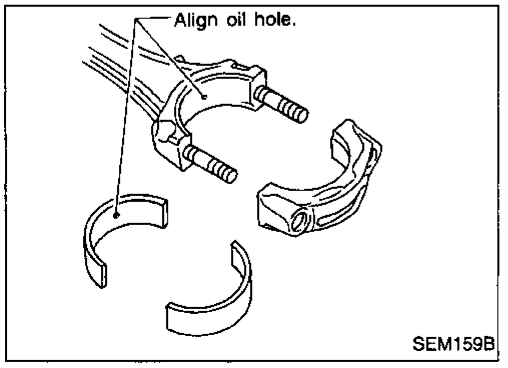


3. Measure crankshaft end play.

Crankshaft end play:
Standard
0.05 - 0.18 mm (0.0020 - 0.0071 in)
Limit
0.3 mm (0.012 in)

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

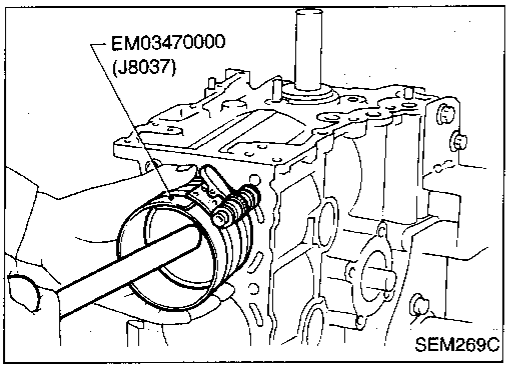




4. Install connecting rod bearings in connecting rods and connecting rod caps.

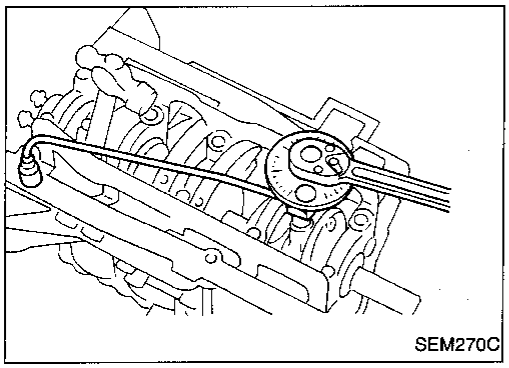
- **Confirm that correct bearings are used. Refer to EM-47.**
- **Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.**

Assembly (Cont'd)



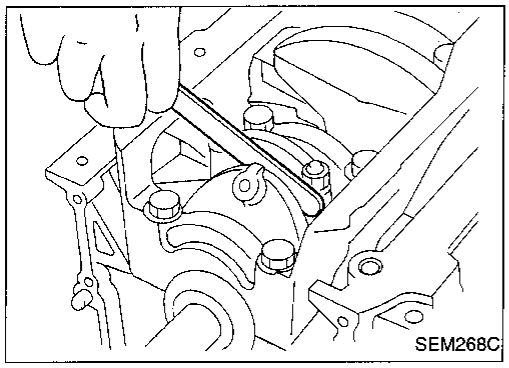
5. Install pistons with connecting rods.
a. Install them into corresponding cylinders with Tool.

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



b. Install connecting rod bearing caps.
Tighten connecting rod bearing cap nuts in the following procedure:

(1) Tighten to 14 to 16 N·m (1.4 to 1.6 kg-m, 10 to 12 ft-lb).
(2) Turn all nuts 60 to 65 degrees clockwise. If an angle wrench is not available, mark all connecting rod bearing cap nuts on the side facing engine front. Then, turn each nut 60 to 65 degrees clockwise.

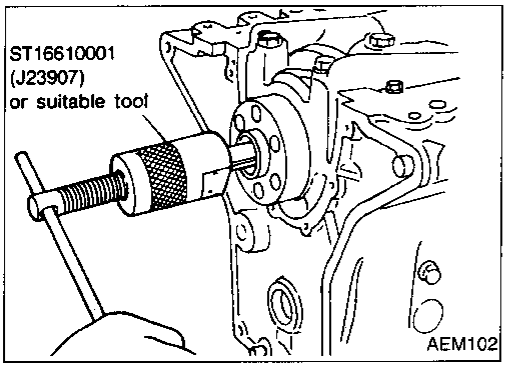


6. Measure connecting rod side clearance.

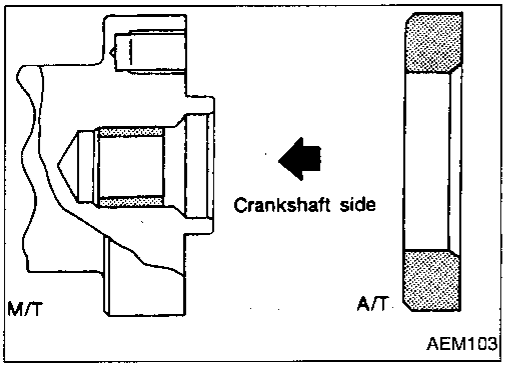
Connecting rod side clearance:
Standard
0.2 - 0.4 mm (0.008 - 0.016 in)
Limit
0.6 mm (0.024 in)

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

REPLACING PILOT BUSHING



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



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

General Specifications

Cylinder arrangement		In-line 4
Displacement	cm^3 (cu in)	2,389 (145.78)
Bore and stroke	mm (in)	89 x 96 (3.50 x 3.78)
Valve arrangement		D.O.H.C.
Firing order		1-3-4-2
Number of piston rings		
Compression		2
Oil		1
Number of main bearings		5
Compression ratio		9.2

COMPRESSION PRESSURE

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

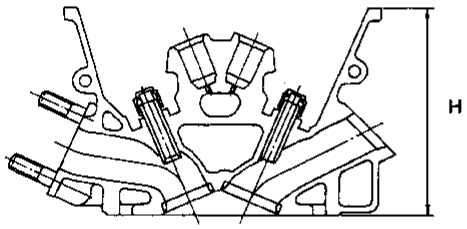
Compression pressure	
Standard	1,226 (12.5, 178)
Minimum	1,030 (10.5, 149)
Differential limit between cylinders	98 (1.0, 14)

Inspection and Adjustment

CYLINDER HEAD

Unit: mm (in)

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

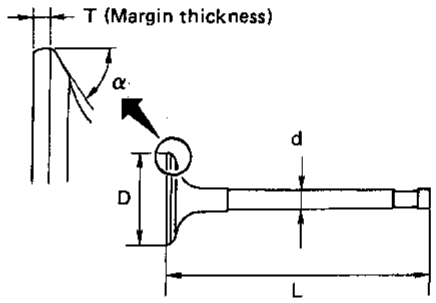


Nominal cylinder head height:
H = 126.3 - 126.5 (4.972 - 4.980)
Limit:
0.2 (0.008)* SEM956C

* Total amount of cylinder head resurfacing plus cylinder block resurfacing

VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	
Intake	36.5 - 36.7 (1.437 - 1.445)
Exhaust	31.2 - 31.4 (1.228 - 1.236)
Valve length "L"	
Intake	101.02 - 101.62 (3.9772 - 4.0008)
Exhaust	98.52 - 99.72 (3.8787 - 3.9260)
Valve stem diameter "d"	
Intake	6.965 - 6.980 (0.2742 - 0.2748)
Exhaust	6.945 - 6.960 (0.2734 - 0.2740)
Valve seat angle "α"	
Intake	45°15' - 45°45'
Exhaust	
Valve margin "T"	
Intake	0.95 - 1.25 (0.0374 - 0.0492)
Exhaust	1.15 - 1.45 (0.0453 - 0.0571)
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)	45.79 (1.8028)
Pressure N (kg, lb) at height mm (in)		
Standard		471.7 (48.1, 106.1) at 26.06 (1.0260)
Limit		421.31 (42.96, 94.73) at 26.06 (1.0260)
Out-of-square	mm (in)	Less than 2.0 (0.079)

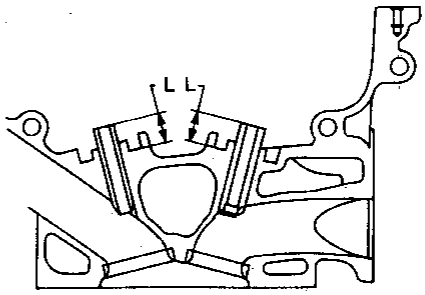
VALVE LIFTER

Unit: mm (in)

Valve lifter outer diameter	33.960 - 33.975 (1.3370 - 1.3376)
Lifter guide inner diameter	34.000 - 34.021 (1.3386 - 1.3394)
Clearance between lifter and filter guide	0.025 - 0.061 (0.0010 - 0.0024)

VALVE GUIDE

Unit: mm (in)



SEM301D

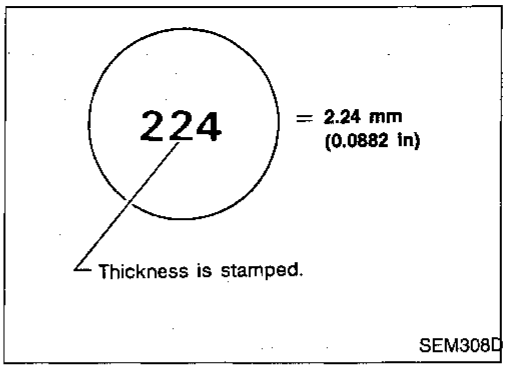
		Standard	Service
Valve guide Outer diameter	Intake & Exhaust	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
Valve guide Inner diameter (Finished size)	Intake	7.000 - 7.018 (0.2756 - 0.2763)	
	Exhaust	7.000 - 7.018 (0.2756 - 0.2763)	
Cylinder head valve guide hole diameter	Intake & 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"		13.3 - 13.9 (0.524 - 0.547)	

Inspection and Adjustment (Cont'd)

VALVE CLEARANCE ADJUSTMENT

Unit: mm (in)

Valve clearance	
Intake	0.31 - 0.39 (0.012 - 0.015)
Exhaust	0.33 - 0.41 (0.013 - 0.016)



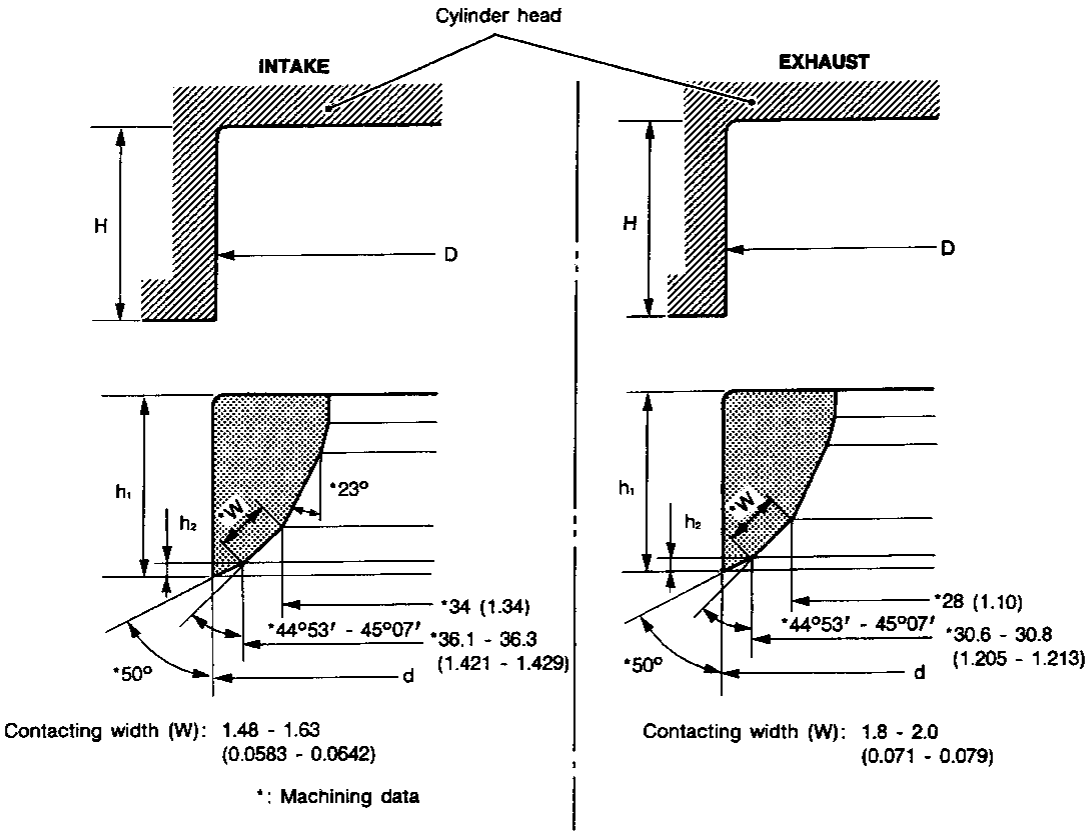
Available shims

Thickness mm (in)	Identification mark
1.96 (0.0772)	196
1.98 (0.0780)	198
2.00 (0.0787)	200
2.02 (0.0795)	202
2.04 (0.0803)	204
2.06 (0.0811)	206
2.08 (0.0819)	208
2.10 (0.0827)	210
2.12 (0.0835)	212
2.14 (0.0843)	214
2.16 (0.0850)	216
2.18 (0.0858)	218
2.20 (0.0866)	220
2.22 (0.0874)	222
2.24 (0.0882)	224
2.26 (0.0890)	226
2.28 (0.0898)	228
2.30 (0.0906)	230
2.32 (0.0913)	232
2.34 (0.0921)	234
2.36 (0.0929)	236
2.38 (0.0937)	238
2.40 (0.0945)	240
2.42 (0.0953)	242
2.44 (0.0961)	244
2.46 (0.0969)	246
2.48 (0.0976)	248
2.50 (0.0984)	250
2.52 (0.0992)	252
2.54 (0.1000)	254
2.56 (0.1008)	256
2.58 (0.1016)	258
2.60 (0.1024)	260
2.62 (0.1031)	262
2.64 (0.1039)	264
2.66 (0.1047)	266
2.68 (0.1055)	268

Inspection and Adjustment (Cont'd)

VALVE SEAT

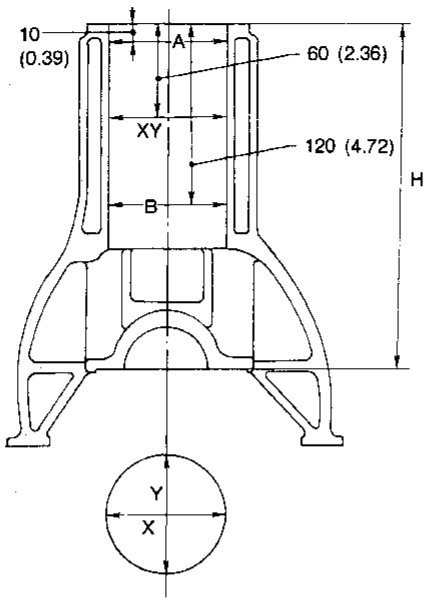
Unit: mm (in)



		Standard	Service
Cylinder head seat recess diameter (D)	In.	37.500 - 37.516 (1.4764 - 1.4770)	38.000 - 38.016 (1.4961 - 1.4967)
	Ex.	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)
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.	37.580 - 37.596 (1.4795 - 1.4802)	38.080 - 38.096 (1.4992 - 1.4998)
	Ex.	32.280 - 32.296 (1.2709 - 1.2715)	32.780 - 32.796 (1.2905 - 1.2912)
Depth (H)	In.	6.19 - 6.21 (0.2437 - 0.2445)	
	Ex.	6.1 - 6.3 (0.240 - 0.248)	
Height (h_1)		5.9 - 6.0 (0.232 - 0.236)	
Height (h_2)	In.	0.44 - 0.64 (0.0173 - 0.0252)	
	Ex.	0.53 - 0.73 (0.0209 - 0.0287)	

Inspection and Adjustment (Cont'd)

CYLINDER BLOCK



SEM447C

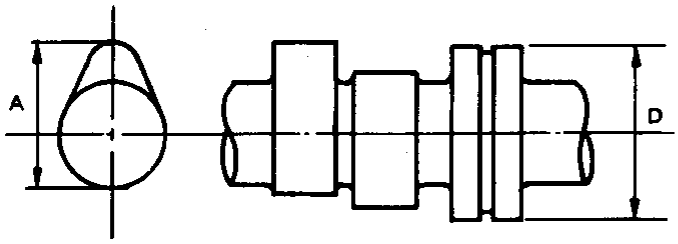
Unit: mm (in)

			Standard	Limit
Distortion			Less than 0.03 (0.0012)	0.1 (0.004)
Cylinder bore	Inner diameter	Grade 1	89.000 - 89.010 (3.5039 - 3.5043)	0.2 (0.008)
		Grade 2	89.010 - 89.020 (3.5043 - 3.5047)	
		Grade 3	89.020 - 89.030 (3.5047 - 3.5051)	
	Out-of-round (X – Y)		Less than 0.015 (0.0006)	—
	Taper (A – B)		Less than 0.010 (0.0004)	—
Difference in inner diameter between cylinders			Less than 0.03 (0.0012)	0.2 (0.008)
Nominal cylinder block height : H (From crankshaft center)			246.95 - 247.05 (9.7224 - 9.7264)	0.2 (0.008)*

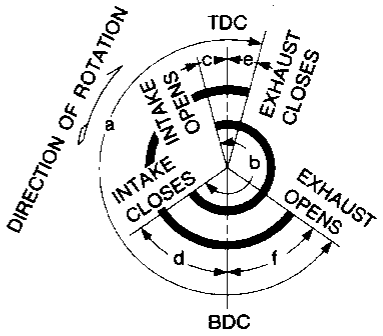
* Total amount of cylinder head resurfacing plus cylinder block resurfacing

Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BEARING



SEM568A



EM120

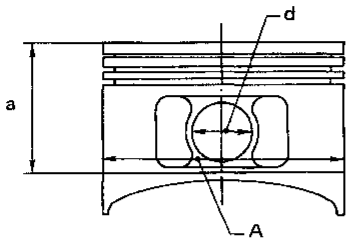
Unit: mm (in)

		Standard	Limit
Cam height (A)	Intake	42.415 - 42.605 (1.6699 - 1.6774)	—
	Exhaust	42.415 - 43.005 (1.6699 - 1.6931)	—
Wear limit of cam height		—	0.2 (0.008)
Camshaft journal to bearing clearance		0.045 - 0.090 (0.0018 - 0.0035)	0.12 (0.0047)
Inner diameter of camshaft bearing	#1 journal	28.000 - 28.025 (1.1024 - 1.1033)	—
	#2 to #5 journal	24.000 - 24.025 (0.9449 - 0.9459)	
Outer diameter of camshaft journal (D)	#1 journal	27.935 - 27.955 (1.0998 - 1.1006)	—
	#1 to #5 journal	23.935 - 23.955 (0.9423 - 0.9431)	
Camshaft runout*		Less than 0.02 (0.0008)	0.04 (0.0016)
Camshaft end play		0.07 - 0.15 (0.0028 - 0.0059)	0.20 (0.0079)
Valve timing (Degree on crankshaft)	a	248	—
	b	240	—
	c	−1	—
	d	61	—
	e	8	—
	f	60	—

* Total indicator reading

PISTON, PISTON RING AND PISTON PIN

Piston



SEM444C

Unit: mm (in)

Piston skirt diameter (A)	Standard	Grade No. 1	88.970 - 88.980 (3.5027 - 3.5031)
		Grade No. 2	88.980 - 88.990 (3.5031 - 3.5035)
		Grade No. 3	88.990 - 89.000 (3.5035 - 3.5039)
	Service (Oversize)	0.5 (0.020)	89.470 - 89.500 (3.5224 - 3.5236)
		1.0 (0.039)	89.970 - 90.000 (3.5421 - 3.5433)
Dimension (a)		Approximately 52 (2.05)	
Piston pin hole diameter (d)		20.987 - 20.999 (0.8263 - 0.8267)	
Piston-to-cylinder bore clearance		0.020 - 0.040 (0.0008 - 0.0016)	

Piston pin

Unit: mm (in)

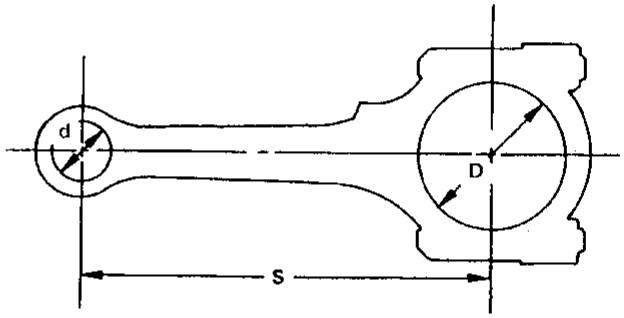
	Standard	Limit
Piston pin outer diameter	20.989 - 21.001 (0.8263 - 0.8268)	—
Interference fit of piston pin to piston pin hole	0 - 0.004 (0 - 0.0002)	—
Piston pin to connecting rod bearing clearance	0.005 - 0.017 (0.0002 - 0.0007)	0.023 (0.0009)

Piston ring

Unit: mm (in)

		Standard	Limit
Side clearance	Top	0.040 - 0.080 (0.0016 - 0.0031)	0.1 (0.004)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.1 (0.004)
Ring gap	Top	0.28 - 0.52 (0.0110 - 0.0205)	1.0 (0.039)
	2nd	0.45 - 0.69 (0.0177 - 0.0272)	1.0 (0.039)
	Oil (rail ring)	0.20 - 0.69 (0.0079 - 0.0272)	1.0 (0.039)

CONNECTING ROD



SEM180E

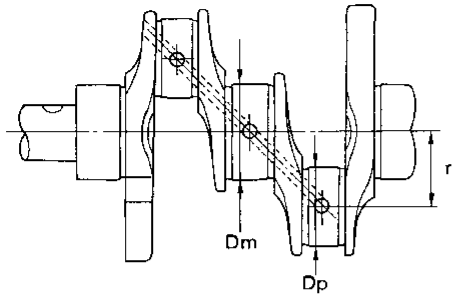
Unit: mm (in)

	Standard	Limit
Center distance (S)	164.95 - 165.05 (6.4941 - 6.4980)	—
Bend [per 100 mm (3.94 in)]	—	0.15 (0.0059)
Torsion [per 100 mm (3.94 in)]	—	0.30 (0.0118)
Piston pin bushing inner diameter (d)*	21.000 - 21.012 (0.8268 - 0.8272)	—
Connecting rod big end inner diameter (D)*	53.000 - 53.013 (2.0866 - 2.0871)	—
Side clearance	0.2 - 0.4 (0.008 - 0.016)	0.6 (0.024)

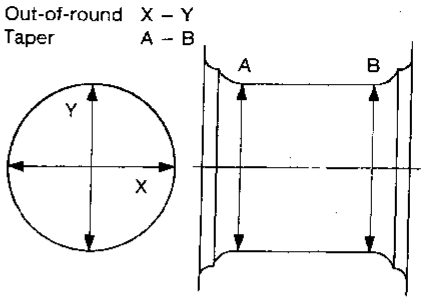
* Without bearing

Inspection and Adjustment (Cont'd)

CRANKSHAFT



SEM394



EM715

Unit: mm (in)

Main journal diameter (Dm)	Grade	No. 0	59.967 - 59.975 (2.3609 - 2.3612)
		No. 1	59.959 - 59.967 (2.3606 - 2.3609)
		No. 2	59.951 - 59.959 (2.3603 - 2.3606)
Pin journal diameter (Dp)	Grade	No. 0	49.968 - 49.974 (1.9672 - 1.9675)
		No. 1	49.962 - 49.968 (1.9670 - 1.9672)
		No. 2	49.956 - 49.962 (1.9668 - 1.9670)
Center distance (r)			47.97 - 48.05 (1.8886 - 1.8917)

	Standard	Limit
Taper of journal and pin [Ⓐ – Ⓑ]	Less than 0.002 (0.0001)	—
Out-of-round of journal and pin [Ⓧ – Ⓨ]	Less than 0.005 (0.0002)	—
Runout [T.I.R.]*	Less than 0.04 (0.0016)	—
Free end play	0.05 - 0.18 (0.0020 - 0.0071)	0.3 (0.012)
Fillet roil	More than 0.1 (0.004)	

* Total indicator reading

Inspection and Adjustment (Cont'd)

BEARING CLEARANCE

Unit: mm (in)

	Standard	Limit
Main bearing clearance	0.020 - 0.047 (0.0008 - 0.0019)	0.1 (0.004)
Connecting rod bearing clearance	0.010 - 0.035 (0.0004 - 0.0014)	0.09 (0.0035)

AVAILABLE MAIN BEARING

Standard

Grade number	Thickness mm (in)	Identification color
0	1.821 - 1.825 (0.0717 - 0.0719)	Black
1	1.825 - 1.829 (0.0719 - 0.0720)	Brown
2	1.829 - 1.833 (0.0720 - 0.0722)	Green
3	1.833 - 1.837 (0.0722 - 0.0723)	Yellow
4	1.837 - 1.841 (0.0723 - 0.0725)	Blue

Undersize (service)

Unit: mm (in)

	Thickness	Main journal diameter "Dm"
0.25 (0.0098)	1.952 - 1.960 (0.0769 - 0.0772)	Grind so that bearing clearance is the specified value.

AVAILABLE CONNECTING ROD BEARING

Standard

Grade number	Thickness mm (in)	Identification color
0	1.505 - 1.508 (0.0593 - 0.0594)	—
1	1.508 - 1.511 (0.0594 - 0.0595)	Brown
2	1.511 - 1.514 (0.0595 - 0.0596)	Green

Undersize (service)

Unit: mm (in)

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

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Camshaft sprocket runout	[T.I.R.]*	Less than 0.12 (0.0047)
Flywheel runout	[T.I.R.]*	Less than 0.15 (0.0059)
Drive plate runout	[T.I.R.]*	Less than 0.15 (0.0059)

* Total indicator reading