ENGINE MECHANICAL

SECTION EM

CONTENTS

CONTENTS (Cont'd)

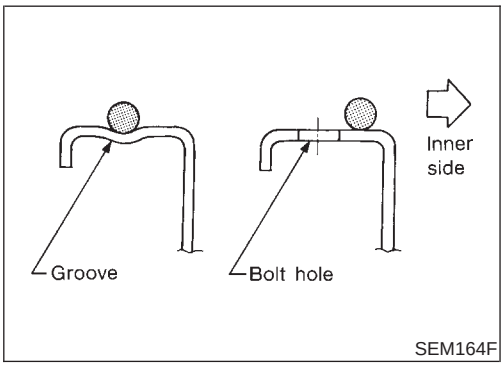
Parts Requiring Angular Tightening

NCEM0001

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

a) Cylinder head bolts
b) Main bearing cap bolts
c) 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.

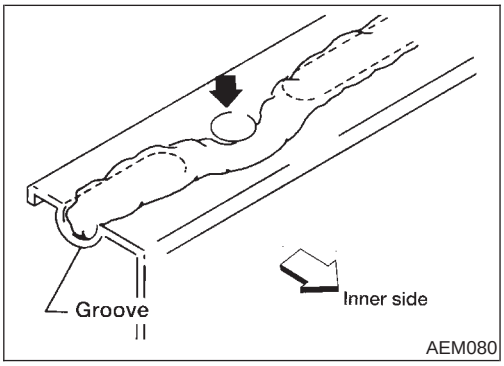


SEM164F

Liquid Gasket Application Procedure

NCEM0002

1. **Use a scraper to remove old liquid gasket from mating surfaces and grooves. Also, completely clean any oil from these areas.**
2. **Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent.)**
   - **For oil pan, be sure liquid gasket diameter is 4.0 to 5.0 mm (0.157 to 0.197 in).**
   - **For areas except oil pan, be sure liquid gasket diameter is 2.0 to 3.0 mm (0.079 to 0.118 in).**
3. **Apply liquid gasket around the inner side of bolt holes (unless otherwise specified).**
4. **Assembly should be done within 5 minutes after coating.**
5. **Wait at least 30 minutes before refilling engine oil and engine coolant.**

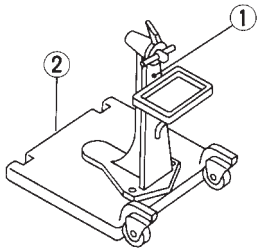
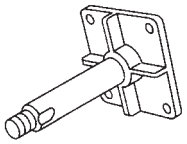
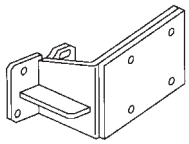
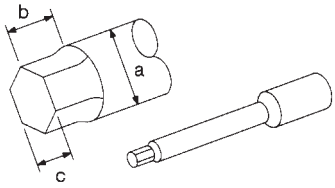
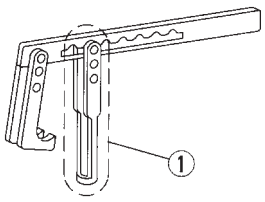
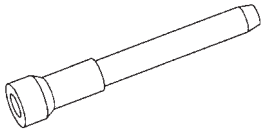
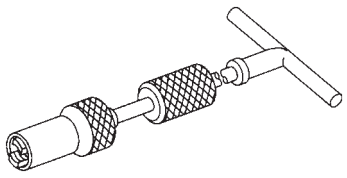


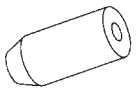
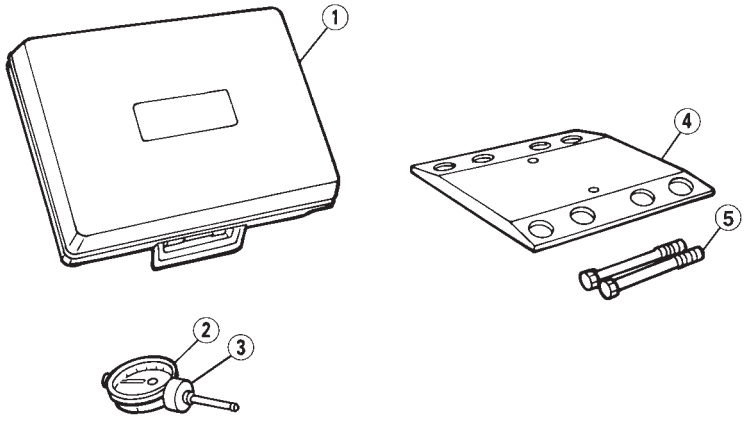
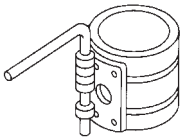
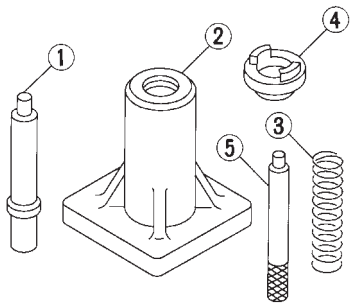
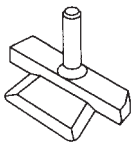
AEM080

Special Service Tools

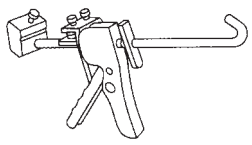
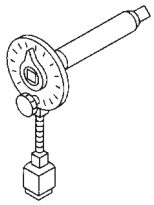
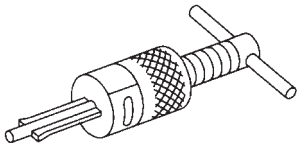
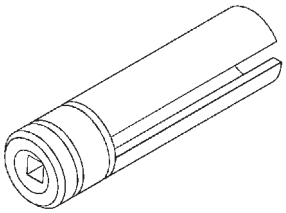
NCEM0003

The actual shapes of Kent-Moore tools may differ from those of special service tools illustrated here.

Tool number (Kent-Moore No.) Tool name	Description	
ST0501S000 (—) Engine stand assembly 1 ST05011000 (—) Engine stand 2 ST05012000 (—) Base	 NT042	Disassembling and assembling
KV10106500 (—) Engine stand shaft	 NT028	
KV10115300 (—) Engine sub-attachment	 NT008	
ST10120000 (J24239-01) Cylinder head bolt wrench	 NT583	Loosening and tightening cylinder head bolt **a: 13 (0.51) dia.** **b: 12 (0.47)** **c: 10 (0.39)** Unit: mm (in)
KV10116200 (J26336-B) Valve spring compressor 1 KV10115900 (J26336-20) Attachment	 NT022	Disassembling valve mechanism
KV10115600 (J38958) Valve oil seal drift	 NT024	Installing valve oil seal
KV10107902 (J38959) Valve oil seal puller	 NT011	Displacement valve lip seal

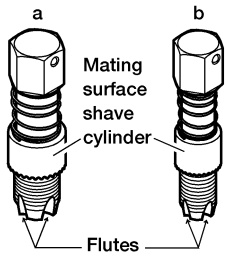
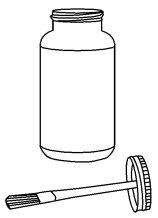
Tool number (Kent-Moore No.) Tool name	Description
KV10115700 (J38957) Dial gauge stand	 NT012 Adjusting shims
(J38957-N) Valve shim gauge plate kit 1 — (J35772) Plastic case 2 — (J38957-8) Dial indicator 3 — (J38957-2) Collar 4 — (J38957-1) Plate 5 — (—) Hex bolts	 AEM274 Measuring valve shims
EM03470000 (J8037) Piston ring compressor	 NT044 Installing piston assembly into cylinder bore
KV10107400 (J26365-12, J26365) Piston pin press stand 1 KV10107310 (—) Center shaft 2 ST13040020 (—) Stand 3 ST13040030 (—) Spring 4 KV10107320 (—) Cap 5 ST13040050 (—) Drift	 NT013 Disassembling and assembling piston pin
KV10111100 (J37228) Seal cutter	 NT046 Removing oil pan

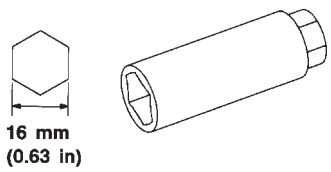
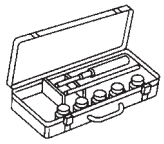
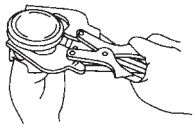
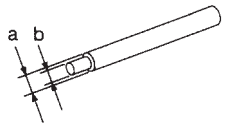
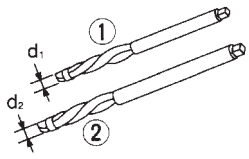
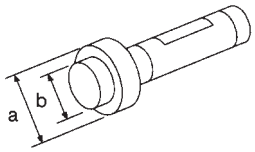
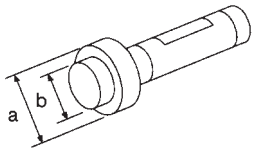
Special Service Tools (Cont'd)

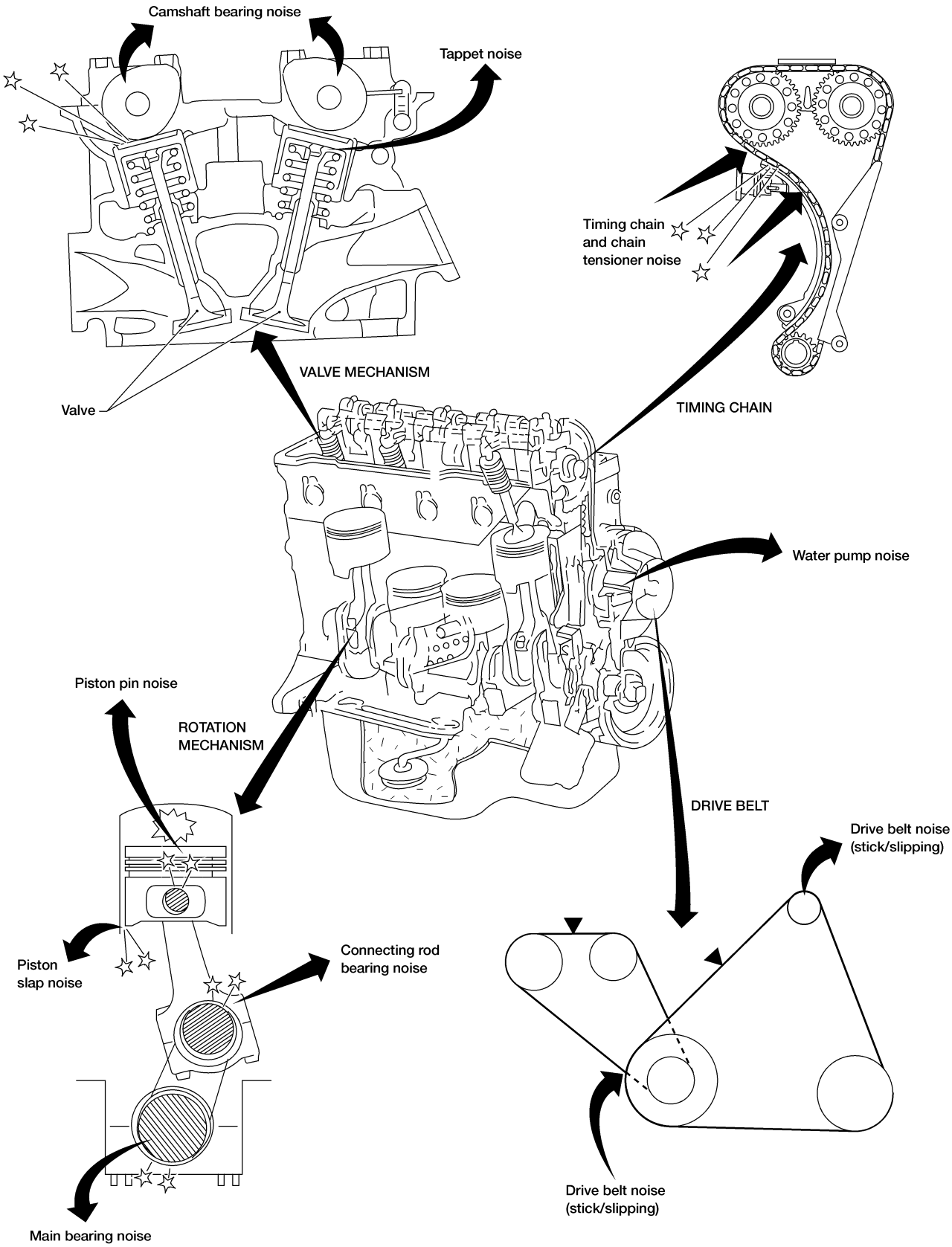
Tool number (Kent-Moore No.) Tool name	Description	
WS39930000 (—) Tube presser	 NT052	Pressing the tube of liquid gasket
KV10112100 (BT-8653-A) Angle wrench	 NT014	Tightening bolts for bearing cap, cylinder head, etc.
ST16610001 (J23907) Pilot bushing puller	 NT045	Removing pilot bushing
(J36471-A) Front (heated) oxygen sensor wrench	 NT379	Loosening or tightening front (heated) oxygen sensor

Commercial Service Tools

NCEM0004

Tool number (Kent-Moore No.) Tool name	Description	
(J-43897–18) (J-43897–12) Oxygen sensor thread cleaner	 AEM488	Reconditioning the exhaust system threads before installing a new oxygen sensor (Use with anti-seize lubricant shown below.) **a: J-43897-18 [18 mm (0.71 in) dia.] for zirconia oxygen sensor** **b: J-43897-12 [12 mm (0.47 in) dia.] for titania oxygen sensor**
Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907)	 AEM489	Lubricating oxygen sensor thread cleaning tool when reconditioning exhaust system threads

Tool number (Kent-Moore No.) Tool name	Description	
Spark plug wrench	 NT047	Removing and installing spark plug
Valve seat cutter set	 NT048	Finishing valve seat dimensions
Piston ring expander	 NT030	Removing and installing piston ring
Valve guide drift	 NT015	Removing and installing valve guide **Intake & Exhaust:** **a: 9.5 mm (0.374 in) dia.** **b: 5.0 mm (0.197 in) dia.**
Valve guide reamer	 NT016	Reaming valve guide 1 or hole for oversize valve guide 2 **Intake & Exhaust:** **d_1: 6.0 mm (0.236 in) dia.** **d_2: 10.175 mm (0.4006 in) dia.**
Front oil seal drift	 NT049	Installing front oil seal **a: 75 mm (2.95 in) dia.** **b: 45 mm (1.77 in) dia.**
Rear oil seal drift	 NT049	Installing rear oil seal **a: 110 mm (4.33 in) dia.** **b: 80 mm (3.15 in) dia.**


Camshaft bearing noise
Tappet noise
Timing chain and chain tensioner noise
VALVE MECHANISM
Valve
TIMING CHAIN
Water pump noise
Piston pin noise
ROTATION MECHANISM
DRIVE BELT
Drive belt noise (stick/slipping)
Piston slap noise
Connecting rod bearing noise
Drive belt noise (stick/slipping)
Main bearing noise

AEM400

Use the table below to help you find the cause of the symptom.
1. Locate the area where noise occurs.
2. Confirm the type of noise.
3. Specify the operating condition of the engine.
4. Check the specified noise source.

If necessary, repair or replace these parts.

NVH Troubleshooting — Engine Noise

NCEM0005S01

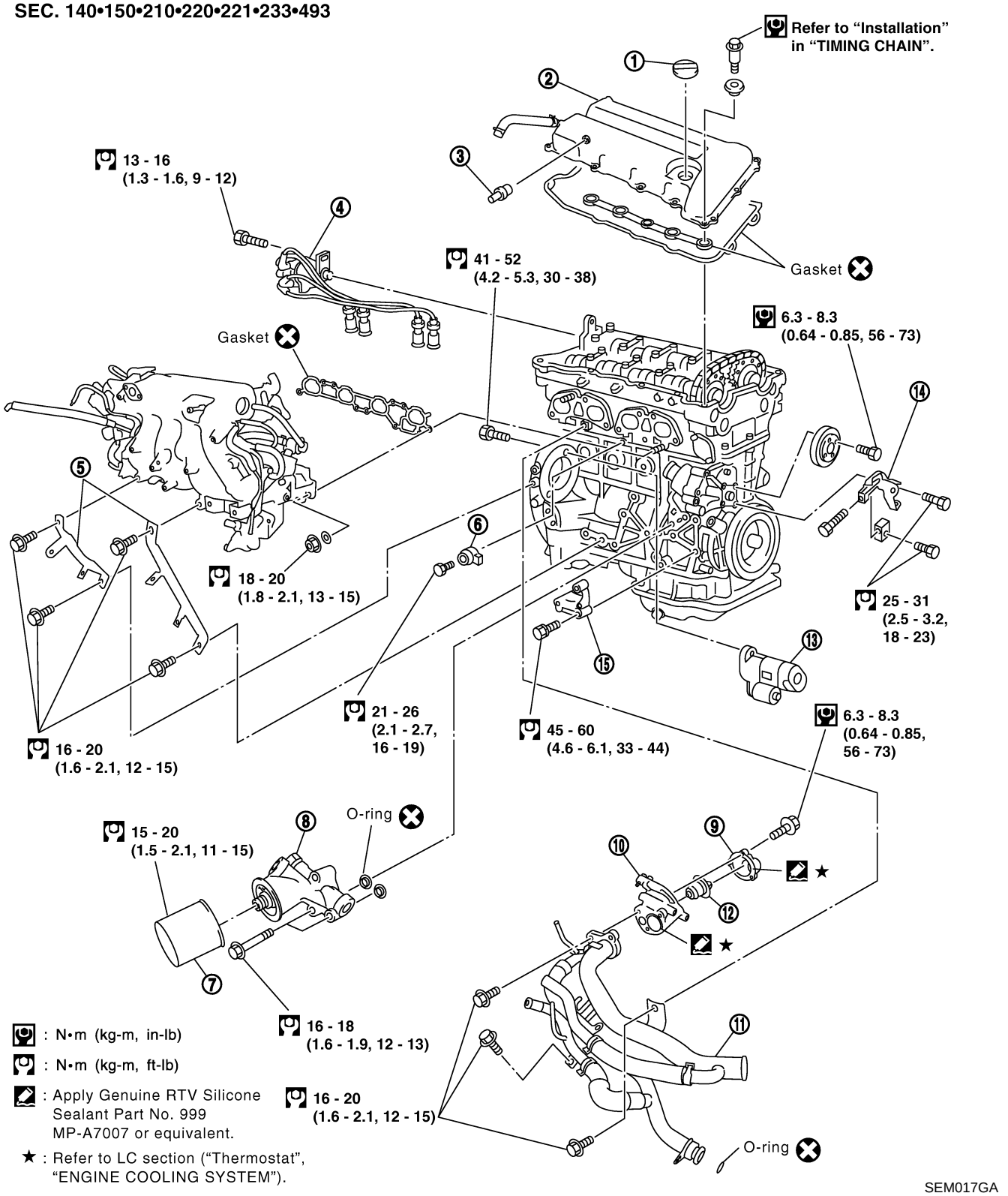
Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Hydraulic lash adjuster	EM-41
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-36, 37
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance	EM-59, 66
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston-to-bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-62, 60
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing clearance (Small end) Connecting rod bearing clearance (Big end)	EM-65, 66
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-63, 63
Front of engine Timing chain cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear	EM-23
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Other drive belts (Sticking or slipping)	Drive belt deflection	MA-13, “Checking Drive Belts”
	Creaking	A	B	A	B	A	B	Other drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	LC-11, “Water Pump Inspection”

A: Closely related B: Related C: Sometimes related —: Not related

Removal and Installation

NCEM0006

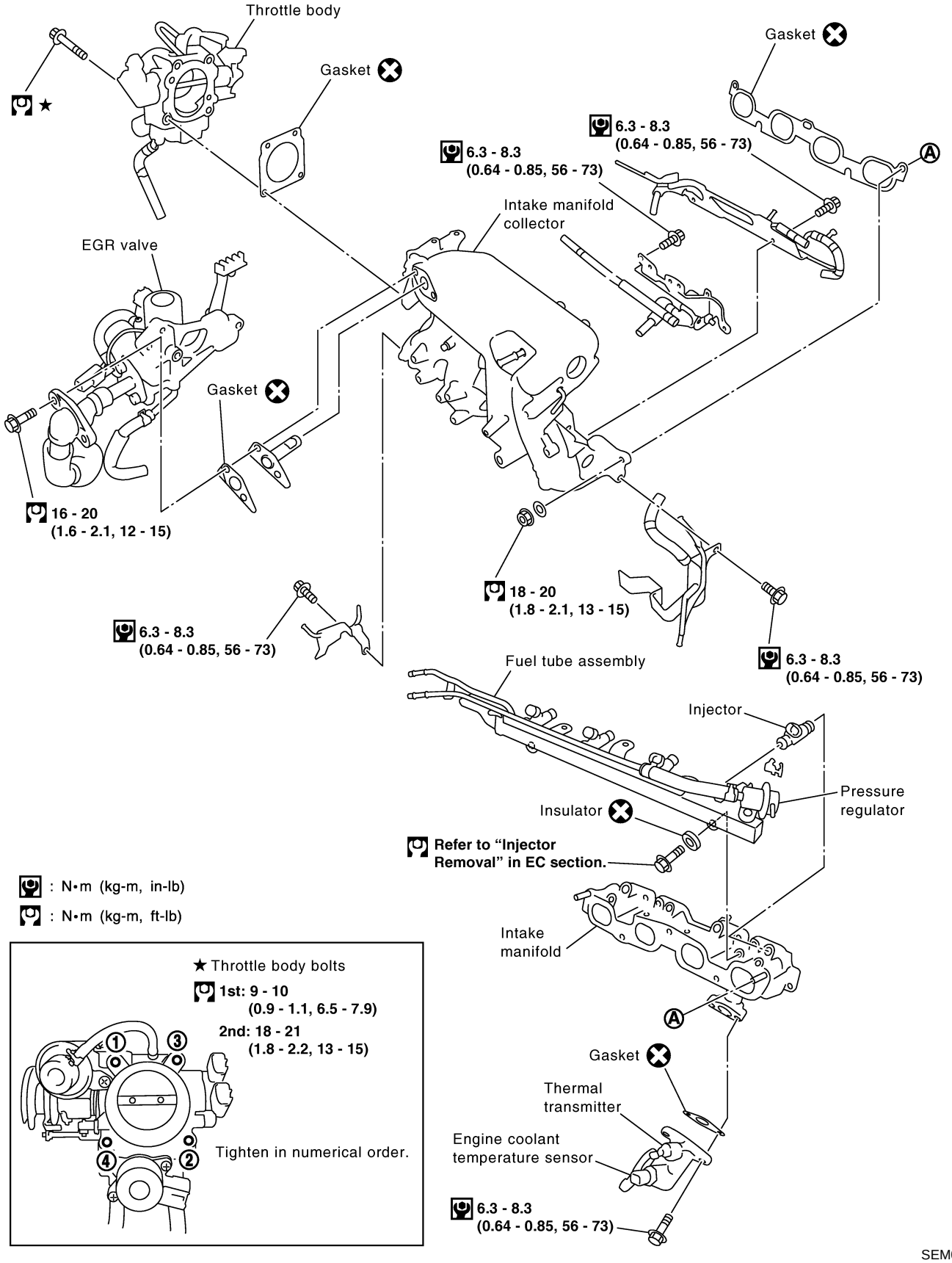
SEC. 140•150•210•220•221•233•493



SEM017GA

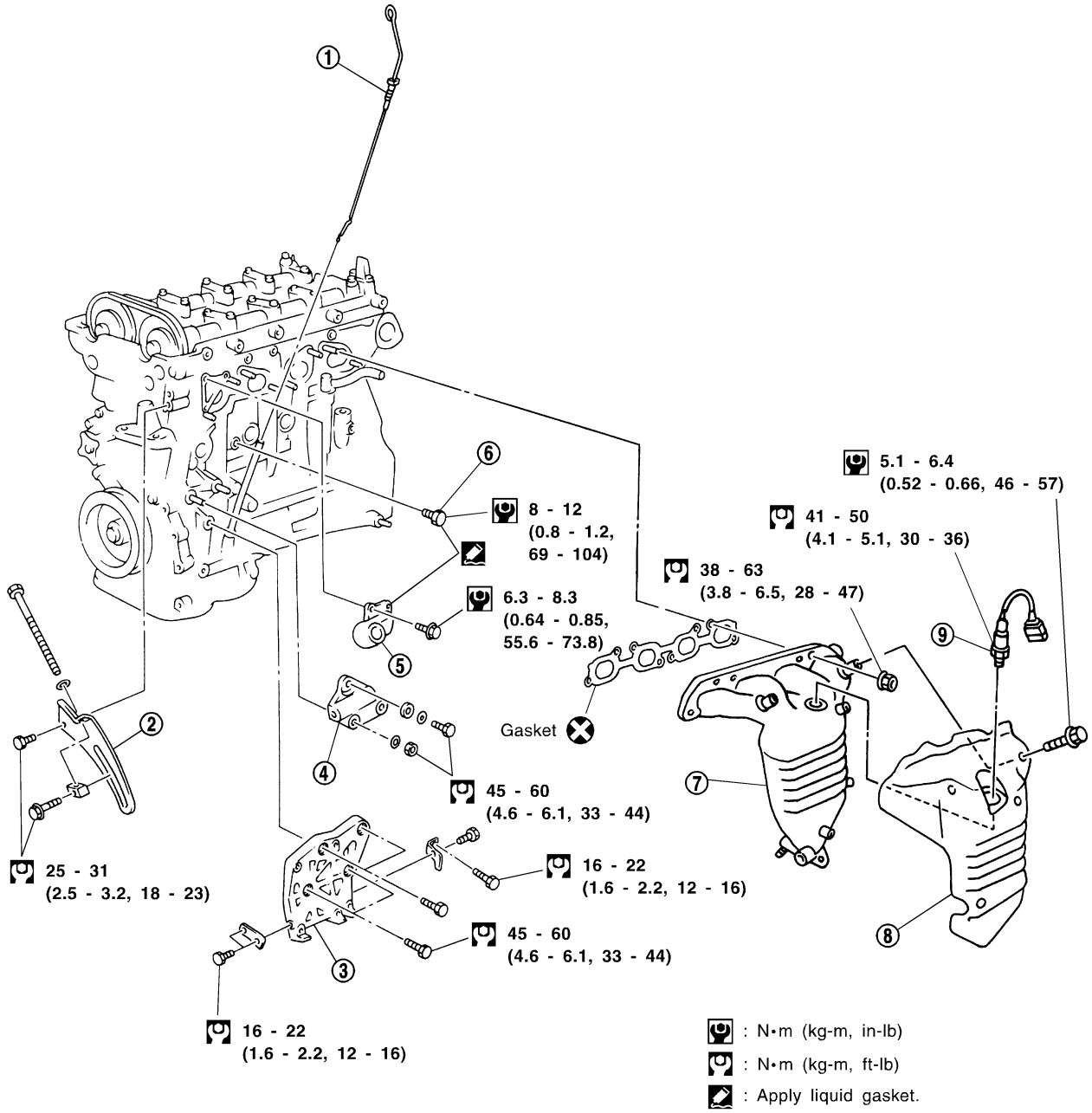
1. Oil filler cap
2. Rocker cover
3. PCV valve
4. Distributor
5. Intake manifold supports
6. Knock sensor
7. Oil filter
8. Oil filter bracket
9. Water inlet
10. Thermostat housing
11. Water pipe assembly
12. Thermostat
13. Starter motor
14. Power steering oil pump adjusting bar
15. Power steering oil pump bracket

SEC. 140•146•147•148•163•164•210•226



SEM018G

SEC. 140•230•275

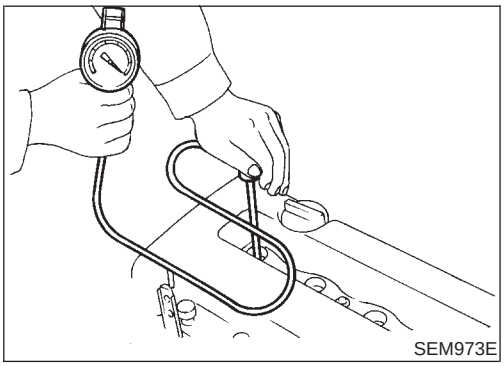


SEM019GA

1. Oil level gauge
2. Generator adjusting bar
3. A/C compressor bracket
4. Generator bracket
5. Water outlet
6. Cylinder block drain plug
7. Exhaust manifold (With three way catalyst)
8. Exhaust manifold cover
9. Heated oxygen sensor

MEASUREMENT OF COMPRESSION PRESSURE

1. Warm up engine.
2. Turn ignition switch OFF.
3. Release fuel pressure.
   Refer to EC-50, “Fuel Pressure Release”.
4. Remove all spark plugs.
5. Disconnect distributor coil connector.


SEM973E

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

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

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

Standard

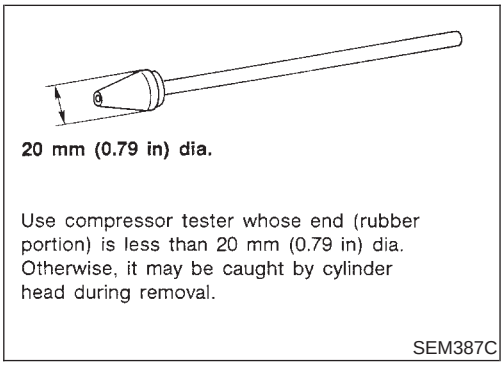
1,275 (13.0, 185)/300

Minimum

1,079 (11.0, 156)/300

Difference limit between cylinders

98 (1.0, 14)/300



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

SEM387C

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

a. Pour a small amount of engine oil into cylinders through spark plug holes.

b. Retest compression.

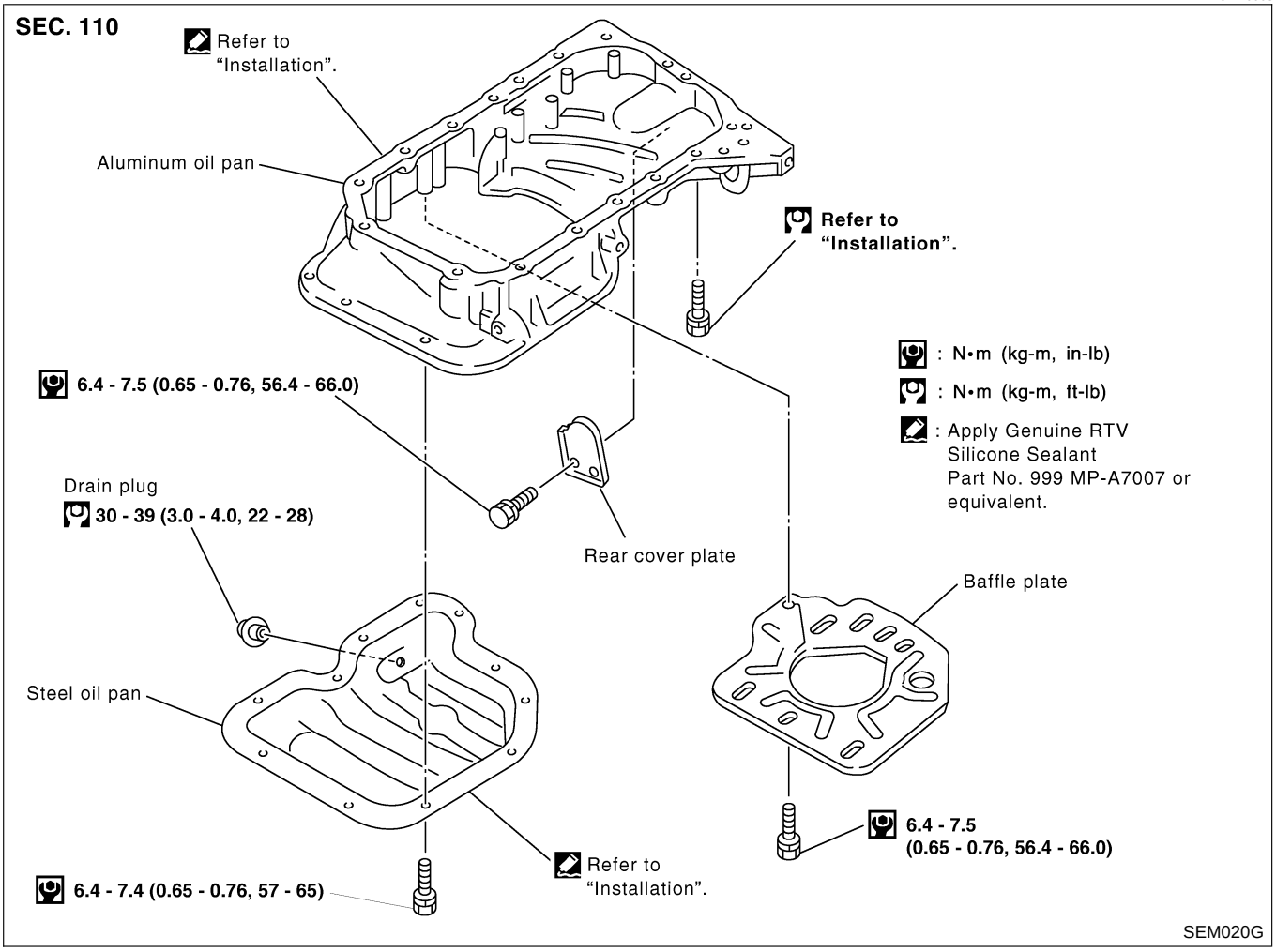
- **If adding oil helps compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. Refer to SDS, EM-75. If valve or valve seat is damaged excessively, 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.**

Components

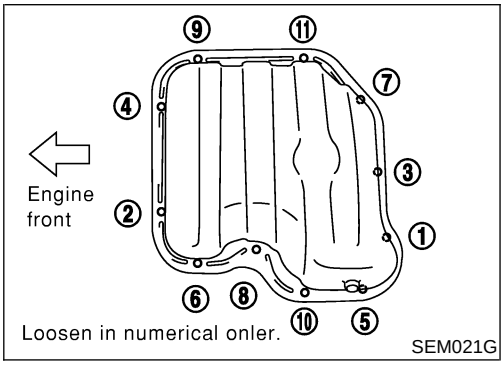
NCEM0008



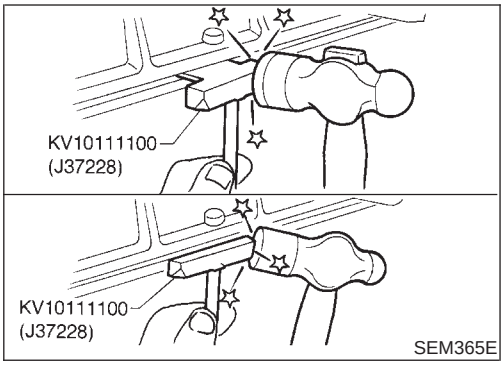
Removal

NCEM0009

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

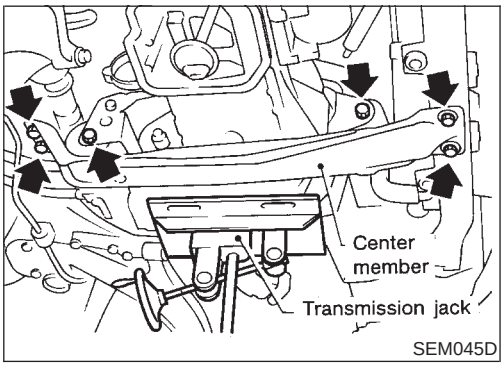


3. Remove steel oil pan bolts in numerical order.

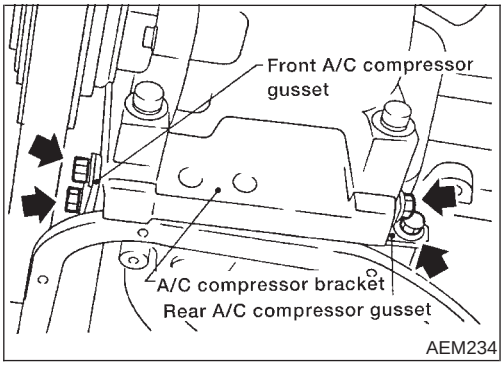


4. Remove steel oil pan.
a. Insert Tool between aluminum oil pan and steel oil pan.
- **Be careful not to damage aluminum mating surface.**
- **Do not insert screwdriver, or oil pan flange will be damaged.**

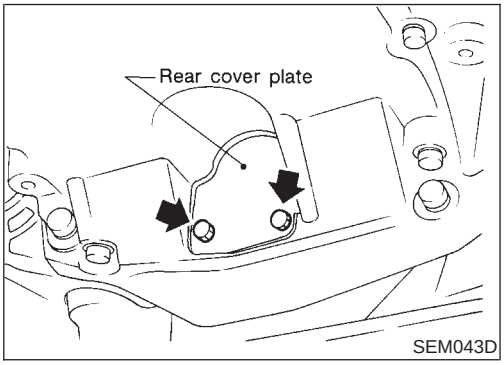
b. Slide Tool by tapping on the side of the Tool with a hammer.
c. Remove steel oil pan.



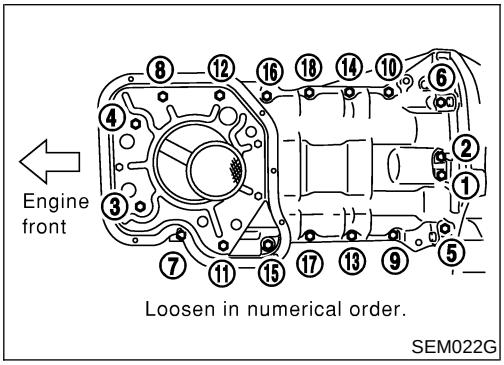
5. Remove front exhaust tube. Refer to FE-8, "EXHAUST SYSTEM".
6. Set a suitable transmission jack under transaxle and lift engine with engine slinger.
7. Remove center member.
8. Remove A/T control cable. (A/T only)



9. Remove A/C compressor gussets.

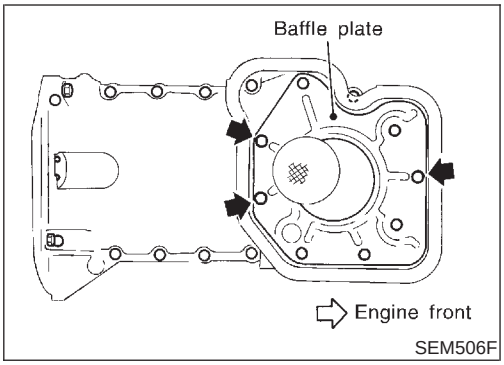


10. Remove rear cover plate.

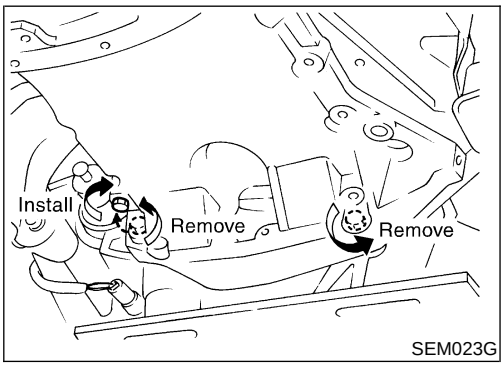


11. Remove aluminum oil pan bolts in numerical order.

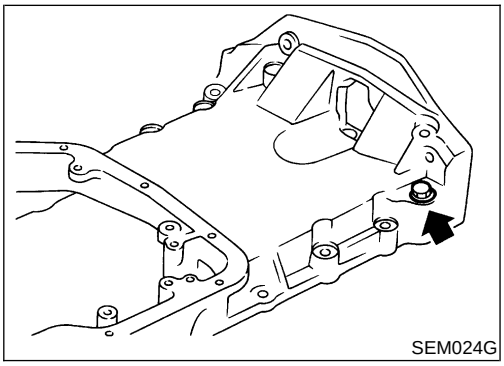
Removal (Cont'd)



12. Remove baffle plate.



13. Remove two engine-to-transaxle bolts and install one of them into open bolt hole as shown. Tighten installed bolt to separate aluminum oil pan from cylinder block.
14. Remove aluminum oil pan.



15. Remove the engine-to-transaxle bolts previously installed in aluminum oil pan.

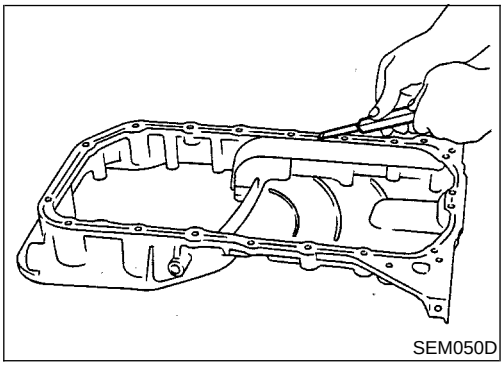
Installation

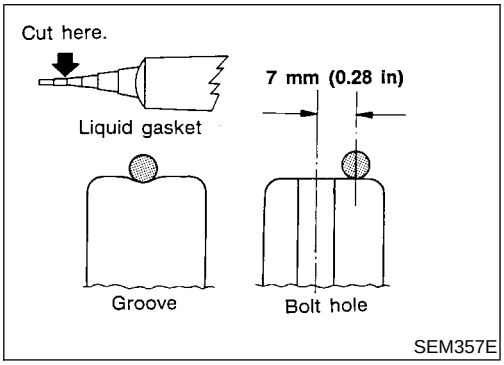
NCEM0010

1. Install aluminum oil pan.

a. Use a scraper to remove old liquid gasket from mating surfaces.

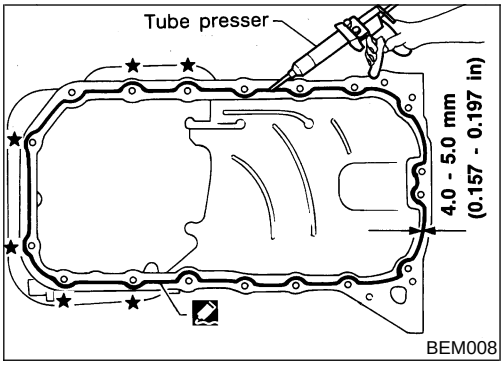
- **Also remove old liquid gasket from mating surfaces of cylinder block and front cover.**





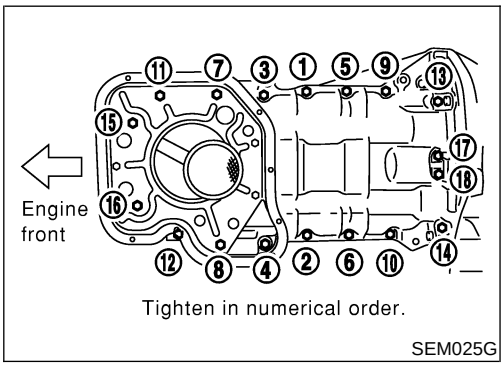
b. Apply a continuous bead of liquid gasket to mating surface of aluminum oil pan.

- **Use Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent.**
- **Apply to groove on mating surface.**
- **Allow 7 mm (0.28 in) clearance around bolt holes.**



BEM008

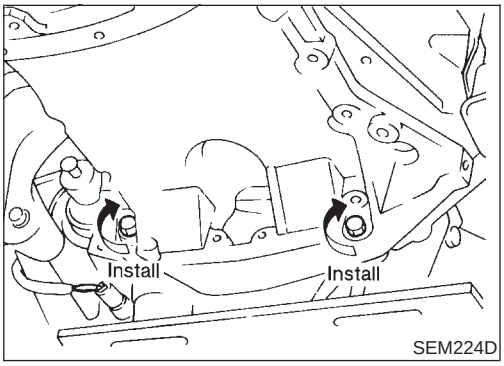
- **For areas marked with "★", apply liquid gasket around the outer side of the bolt hole as shown.**
- **Be sure liquid gasket diameter is 4.0 to 5.0 mm (0.157 to 0.197 in).**
- **Attaching should be done within 5 minutes after coating.**



SEM025G

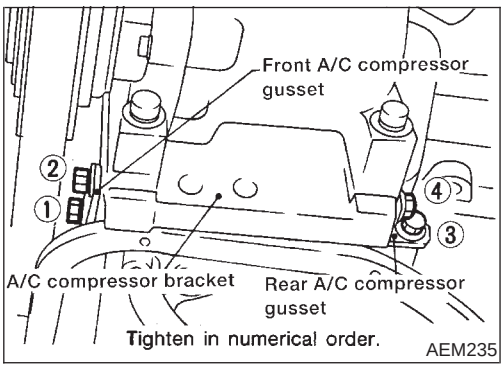
c. Tighten nuts and bolts in numerical order.

Bolts 1 - 16:
: 16 - 19 N·m (1.6 - 1.9 kg-m, 12 - 14 ft-lb)
Bolts 17, 18:
: 6.4 - 7.5 N·m (0.65 - 0.76 kg-m, 56.4 - 66.0 in-lb)



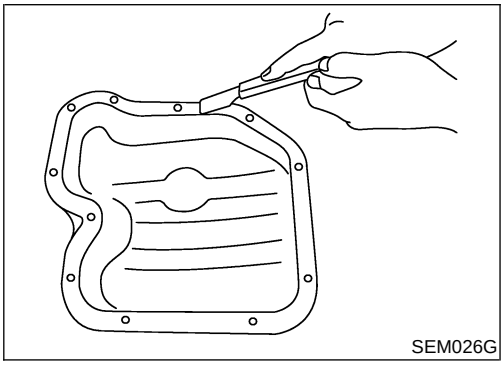
SEM224D

2. Install the two engine-to-transaxle bolts.
   For tightening torque, refer to MT-12 or AT-283, "REMOVAL AND INSTALLATION".
3. Install rear cover plate.



AEM235

4. Install A/C compressor gussets.
5. Install A/T control cable. (A/T only)
6. Install center member.
7. Install front exhaust tube.
8. Install baffle plate.

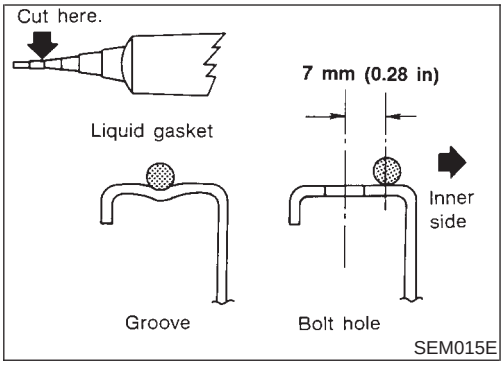

SEM026G

9. Install steel oil pan.

a. Use a scraper to remove old liquid gasket from mating surface of steel oil pan.

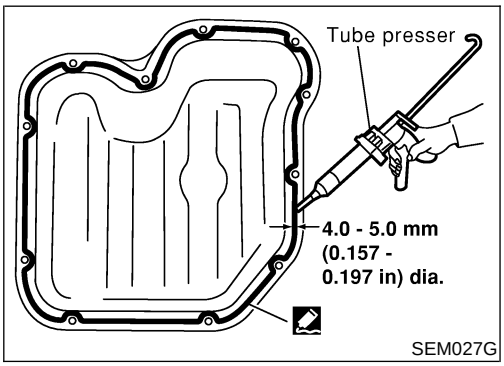
- **Also remove old liquid gasket from mating surface of aluminum oil pan.**

Installation (Cont'd)

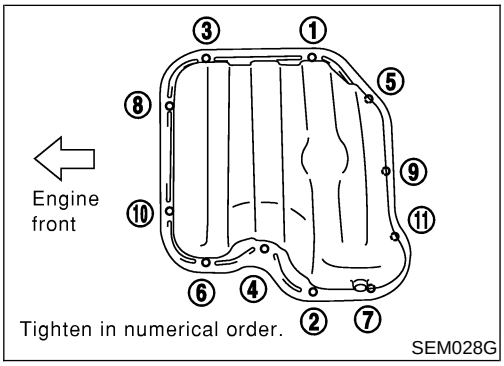


b. Apply a continuous bead of liquid gasket to mating surface of steel oil pan.

- **Use Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent.**
- **Apply to groove on mating surface.**
- **Allow 7 mm (0.28 in) clearance around bolt hole.**



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



c. Tighten bolts in numerical order as shown.

- **Wait at least 30 minutes before refilling engine oil.**

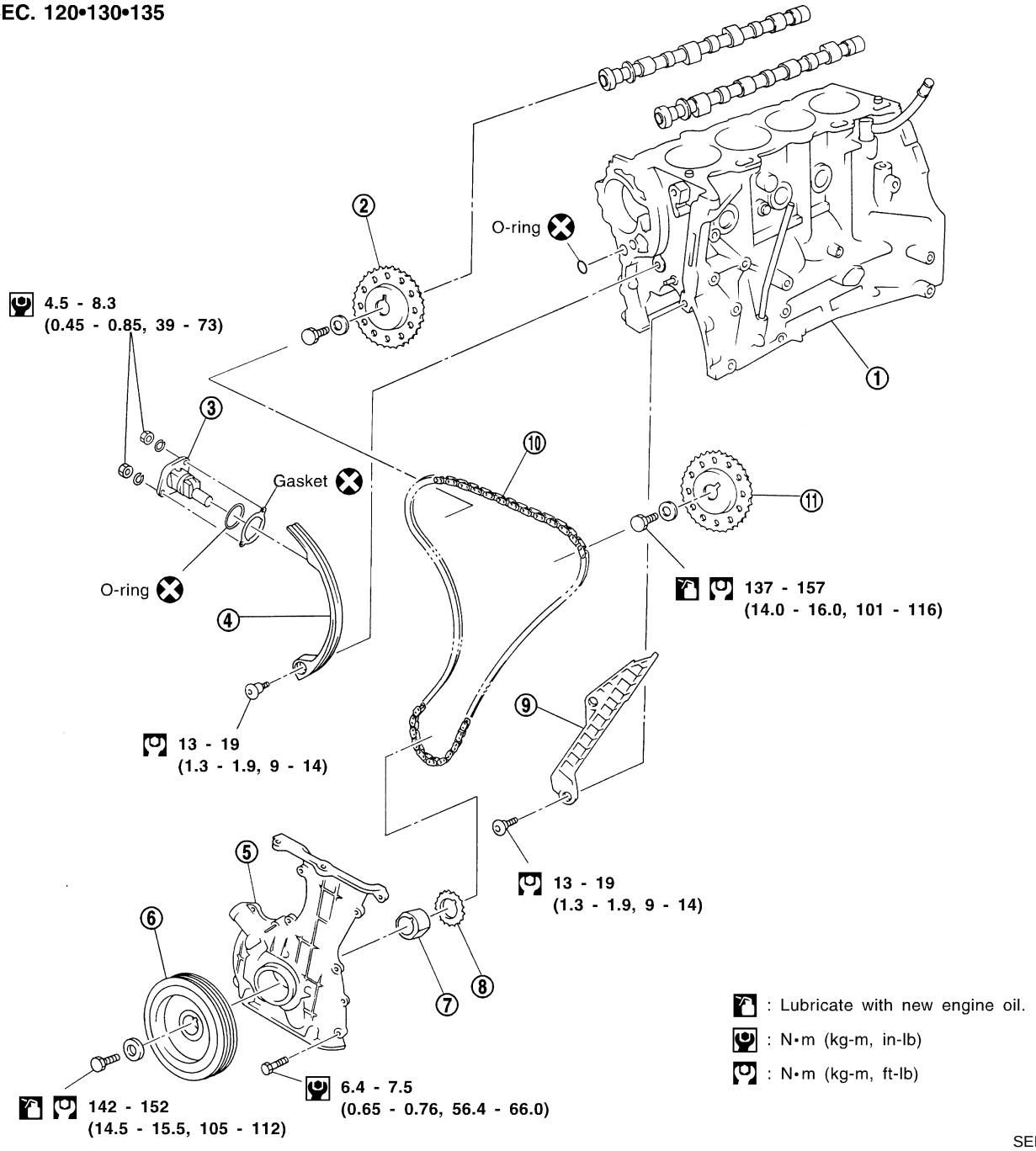
Components

NCEM0011

CAUTION:

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

SEC. 120•130•135



SEM081GA

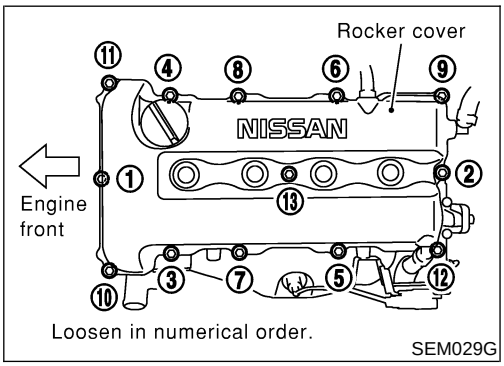
1. Cylinder block
2. RH camshaft sprocket
3. Chain tensioner
4. Chain guide
5. Front cover
6. Crankshaft pulley
7. Oil pump drive spacer
8. Crankshaft sprocket
9. Chain guide
10. Timing chain
11. LH camshaft sprocket

Removal

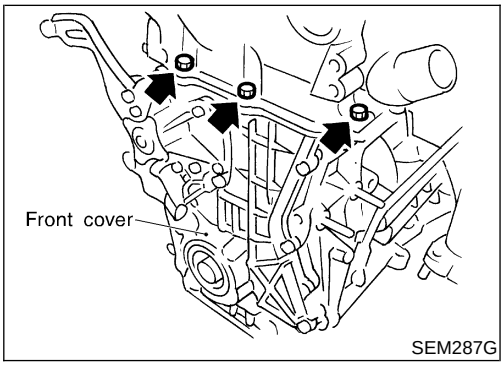
NCEM0012

1. Remove engine under cover.
2. Remove front RH wheel and engine side cover.
3. Remove drive belts and water pump pulley.
4. Disconnect the following parts:

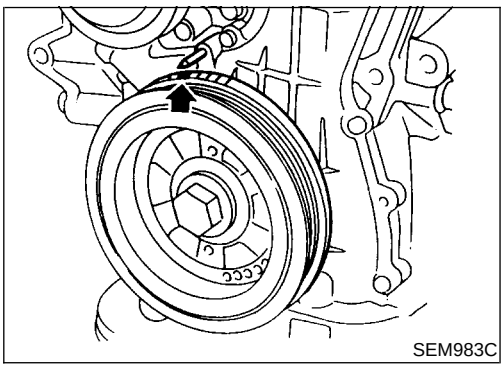
- Vacuum hoses
- Wires
- Harness
- Connectors



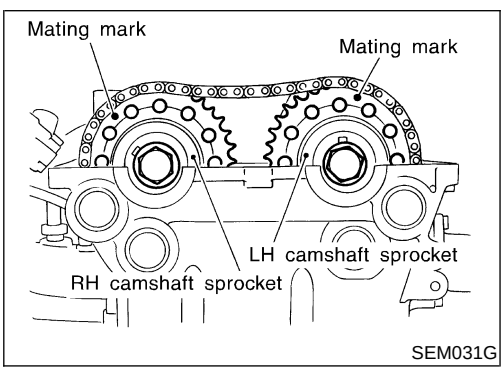
5. Remove rocker cover bolts in numerical order.
6. Remove rocker cover.



7. Remove cylinder head outside bolts.

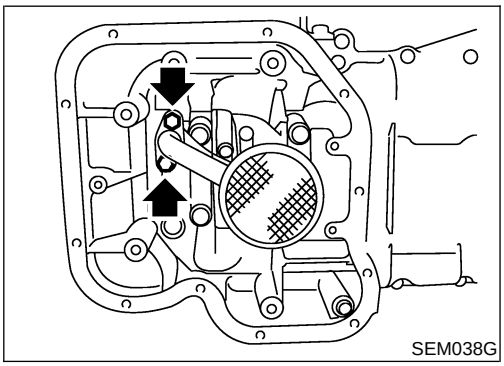


8. Set No. 1 piston at TDC of its compression stroke.

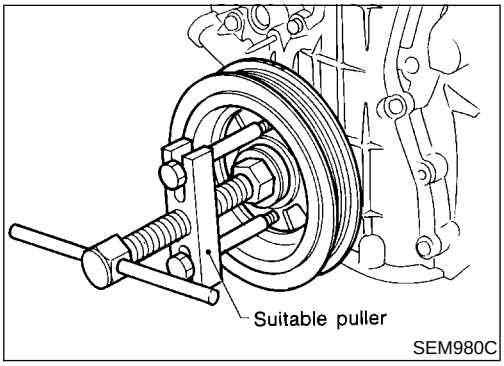


- **Rotate crankshaft until mating mark on camshaft sprocket is set at position indicated in figure.**

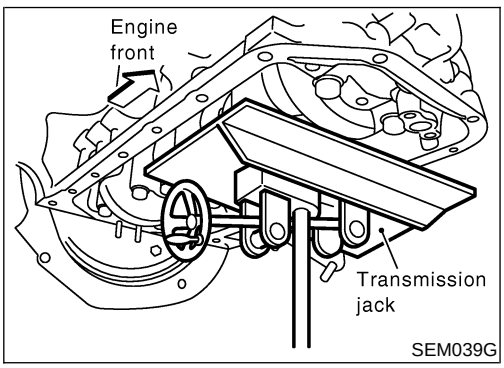
9. Remove oil pans.
   Refer to EM-14.



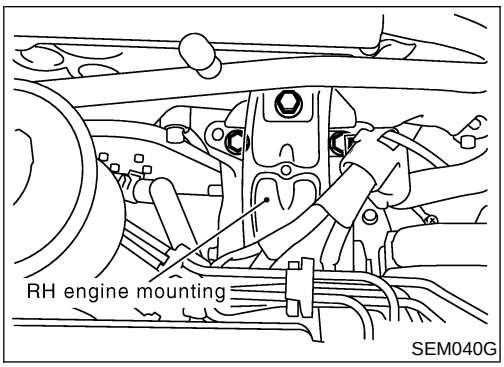
10. Remove oil strainer.
11. Temporarily install center member to support engine.



12. Remove crankshaft pulley.
13. Remove generator.
14. Remove A/C compressor and position it to the side.
15. Remove A/C bracket.
16. Remove generator bracket.

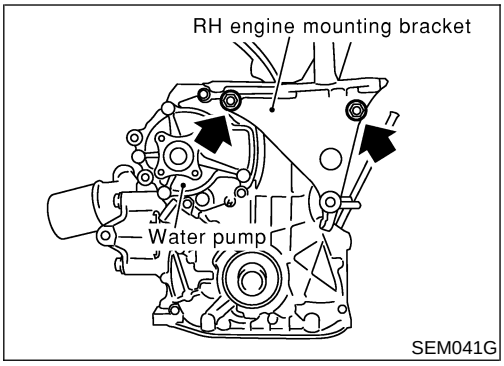


17. Set a suitable transmission jack under main bearing beam.

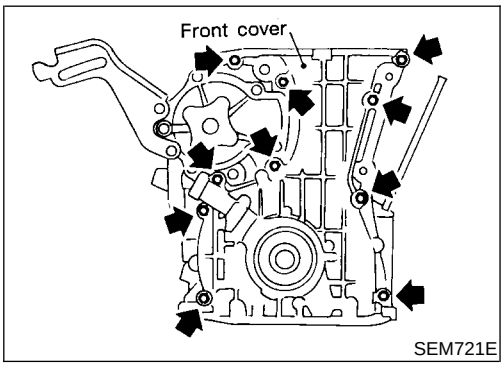


18. Remove RH engine mounting.

Removal (Cont'd)



19. Remove RH engine mounting bracket.



20. Remove oil pump drive spacer.

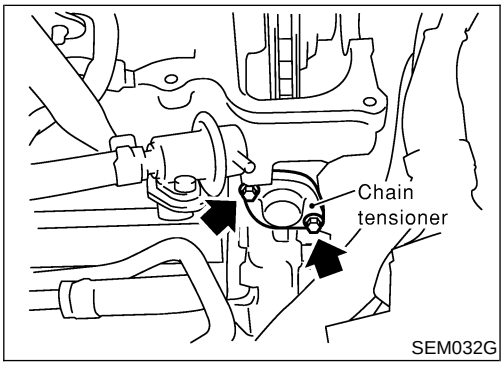
CAUTION:

Be careful not to damage oil pump drive spacer and front oil seal.

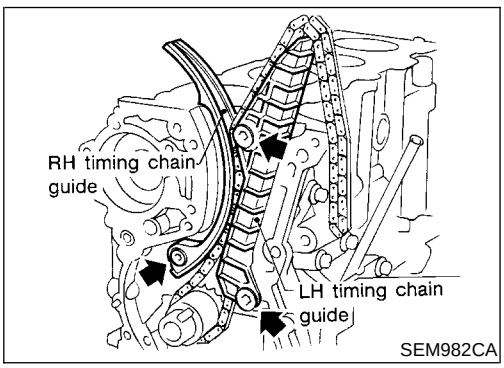
21. Remove front cover.

CAUTION:

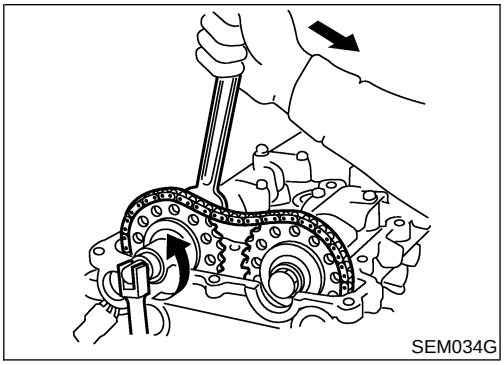
- **Be careful not to rear or damage the cylinder gasket.**
- **Inspect for oil leakage at front oil seal. Replace seal if oil leak is present.**



22. Remove chain tensioner.



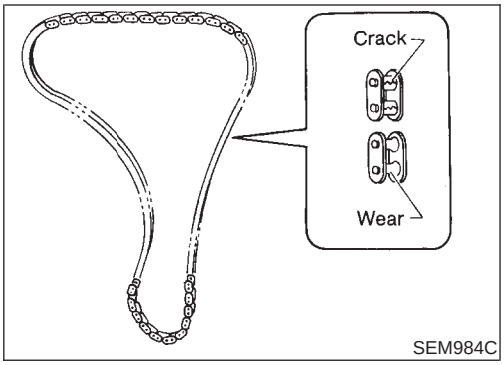
23. Remove timing chain guides.



24. Remove camshaft sprockets.

- **For retiming in cylinder head removal, apply paint mark to timing chain matched with mating marks of camshaft sprockets.**

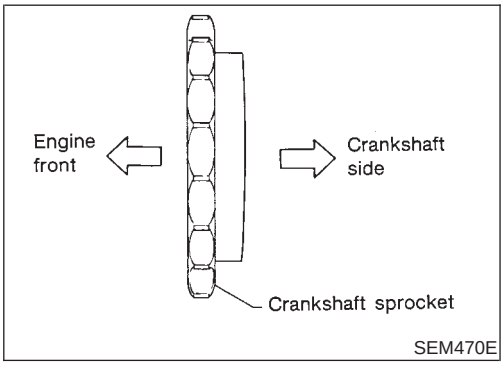
25. Remove timing chain and crankshaft sprocket.



Inspection

NCEM0013

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

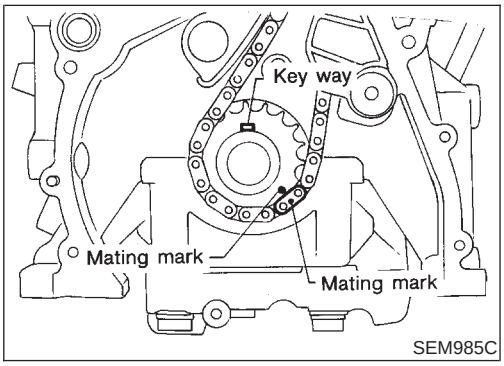


Installation

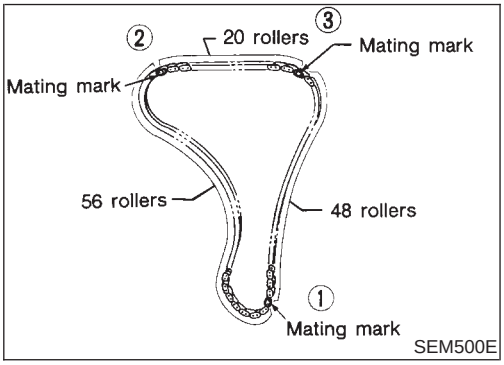
NCEM0014

1. Install crankshaft sprocket on crankshaft.

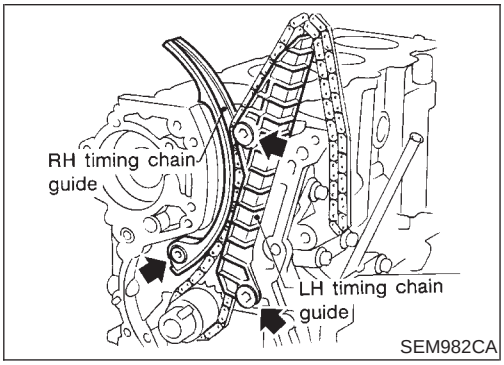
- **Make sure that mating marks on crankshaft sprocket face front of engine.**



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

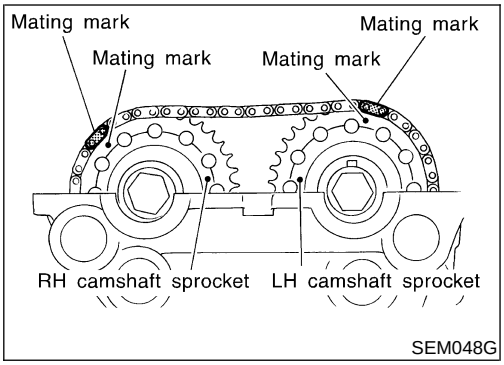


- Mating mark color on timing chain.
  - **1: Yellow**
  - **2, 3: Blue**



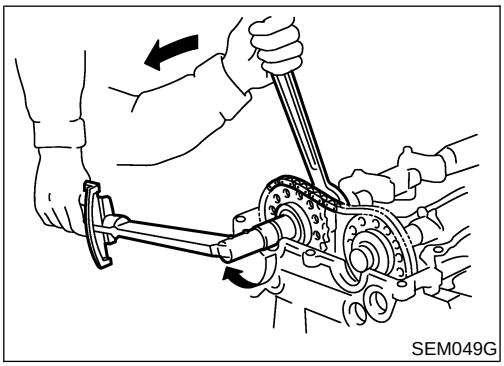
3. Install timing chain and timing chain guides.

Installation (Cont'd)



SEM048G

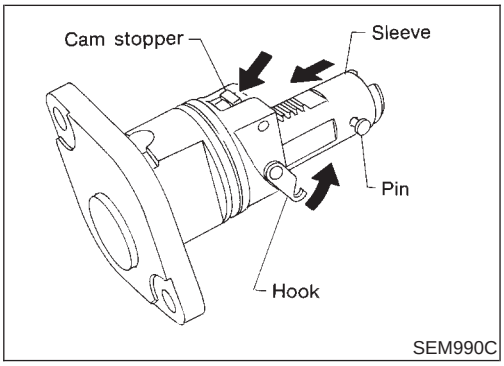
4. Install camshaft sprockets and timing chain on them.
Line up mating marks on timing chain with mating marks on camshaft sprockets.


SEM049G

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

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

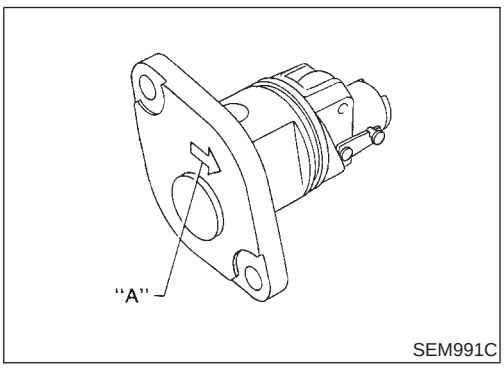
Apply new engine oil to threads and seating surfaces of camshaft sprocket bolts before installing them.



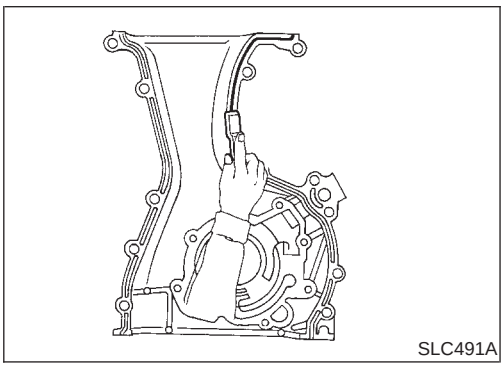
SEM990C

5. Install chain tensioner.

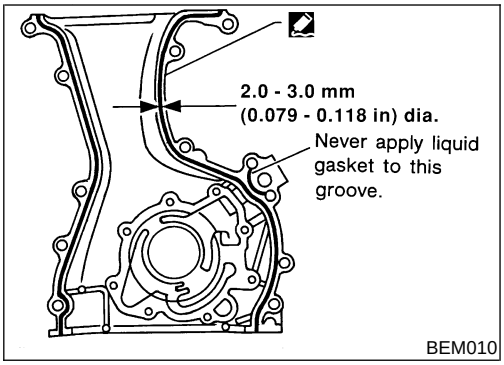
Make sure the camshaft sprockets are tightened completely. Press cam stopper down and "press-in" sleeve until hook can be engaged on pin. When tensioner is bolted in position the hook will release automatically. Make sure arrow "A" points toward engine front.



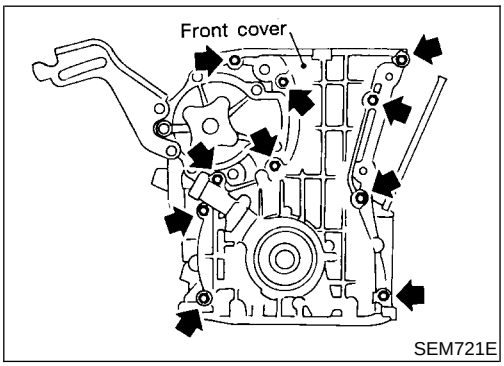
SEM991C


SLC491A

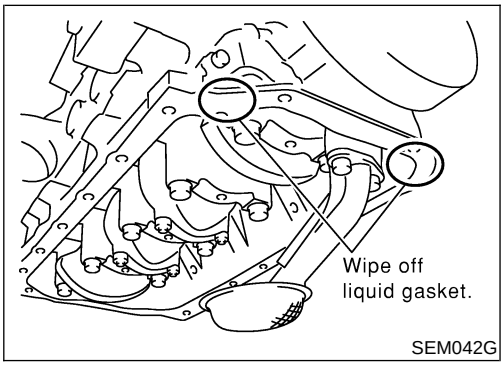
6. Use a scraper to remove old liquid gasket from mating surface of front cover.
- **Also remove old liquid gasket from mating surface of cylinder block.**



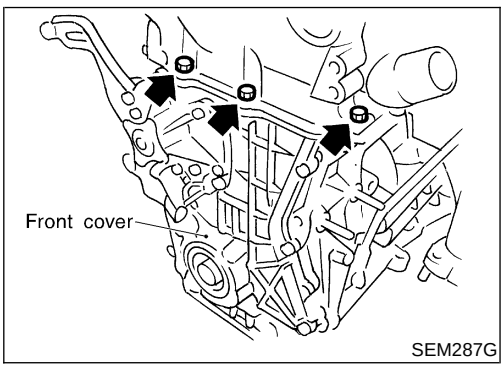
7. Apply a continuous bead of liquid gasket to front cover.
   Also apply liquid gasket to matching surface to cylinder head gasket.
   - **Use Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent.**
     Be sure to install new front oil seal in the right direction. Refer to "OIL SEAL", EM-28.



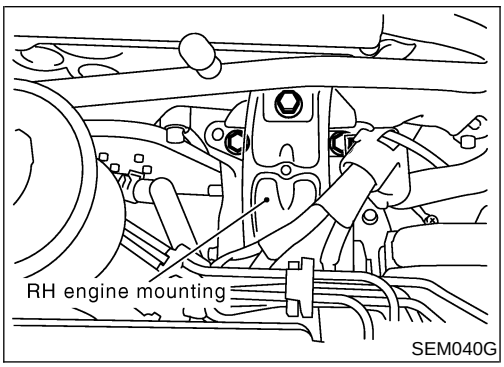
8. Install oil pump drive spacer.
9. Install front cover.



- Wipe off excessive liquid gasket.

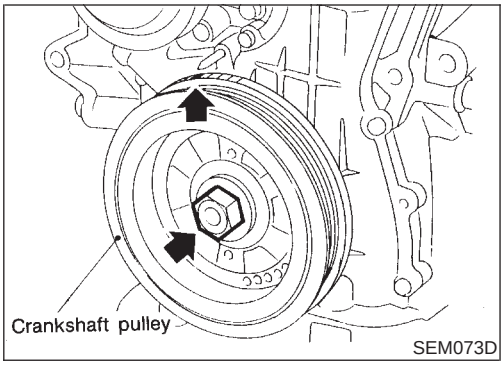


10. Install cylinder head outside bolts.

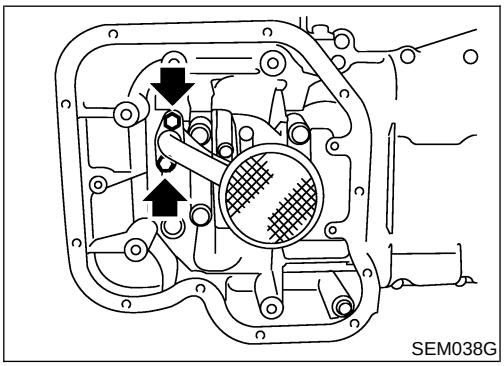


11. Install RH engine mounting and bracket.
12. Install generator bracket and generator.
13. Install A/C compressor bracket and compressor.

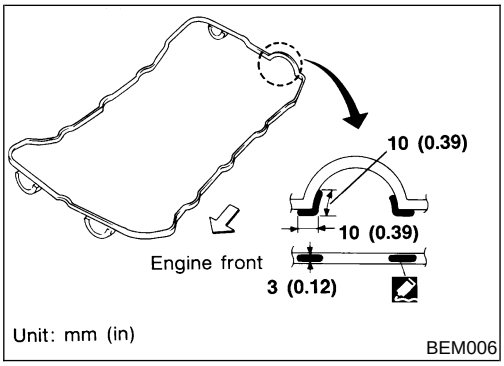
Installation (Cont'd)



14. Install crankshaft pulley.
15. Set No. 1 piston at TDC of its compression stroke.

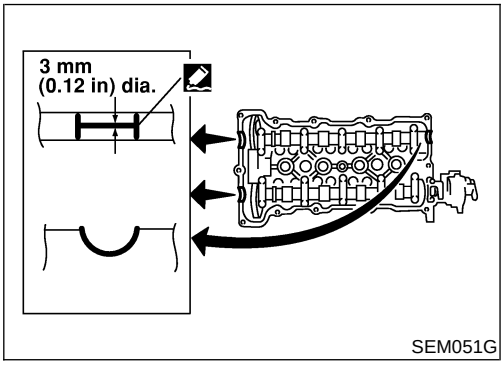


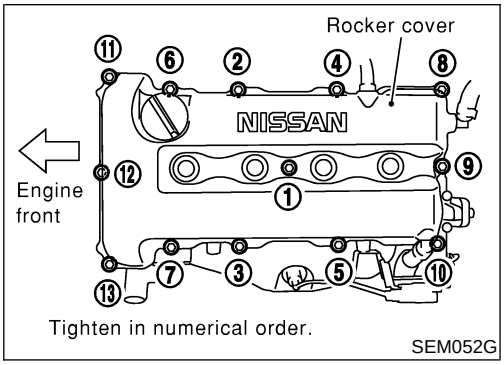
16. Install oil strainer.
17. Install oil pans.
    Refer to EM-16.



18. Remove old liquid gasket from mating surfaces of rocker cover and cylinder head.
19. Apply a continuous bead of liquid gasket to rocker cover gasket and cylinder head as shown in the illustrations.

- **Use Genuine RTV silicone sealant Part No. 999MP-A7007 or equivalent.**





20. Install rocker cover and oil separator.

- **Be sure to install washers between bolts and rocker cover.**
- **Tightening procedure**

  STEP 1: Tighten bolts 1 - 10 - 11 - 13 - 8 in that order.

  STEP 2: Tighten bolts 1 - 13 in that order.

  : 8 - 10 N·m (0.8 - 1.0 kg-m, 69 - 87 in-lb)

21. Install the following parts:

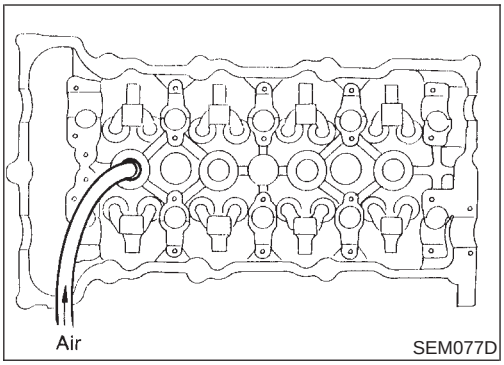
- Spark plugs and leads
- Water pump pulley and drive belts.

For adjusting drive belt deflection, refer to MA-13, "Checking Drive Belts".

- Front RH wheel
- Engine under cover

22. Connect the following:

- Vacuum hoses
- Wire harnesses and connectors



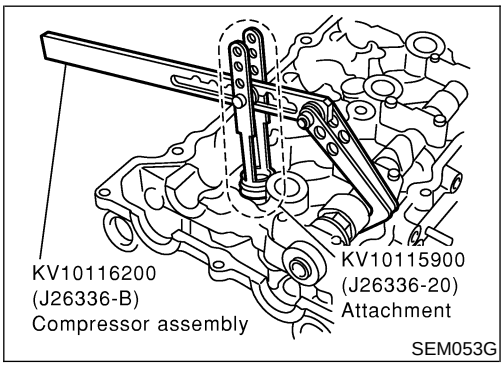
Replacement

NCEM0015

VALVE OIL SEAL

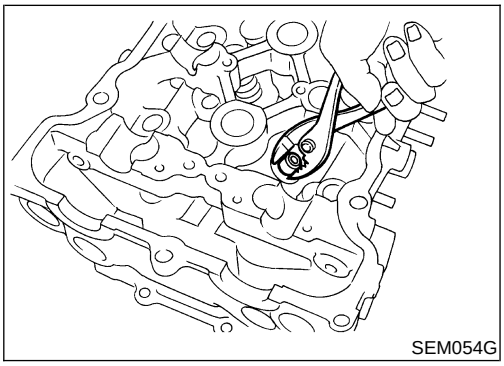
NCEM0015S01

1. Remove accelerator wire.
2. Remove rocker cover.
3. Remove camshafts and sprockets. Refer to EM-20.
4. Remove spark plugs.
5. Install air hose adapter into spark plug hole and apply air pressure to hold valves in place. Apply a pressure of 490 kPa (5 kg/cm^2, 71 psi).
6. Remove rocker arm, rocker arm guide and shim.

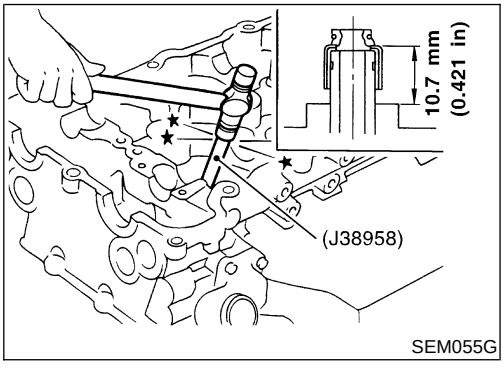


7. Remove valve spring with Tool. Temporarily install camshaft as shown.

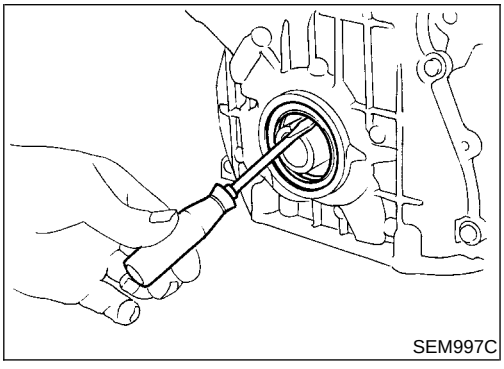
Piston concerned should be set at TDC to prevent valve from falling.



8. Remove valve oil seal with a suitable tool.



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



FRONT OIL SEAL

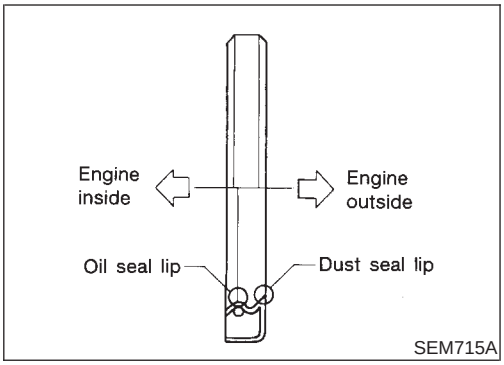
NCEM0015S02

1. Remove the following parts:

- Engine under cover
- Front RH wheel and engine side cover
- Drive belts
- Crankshaft pulley

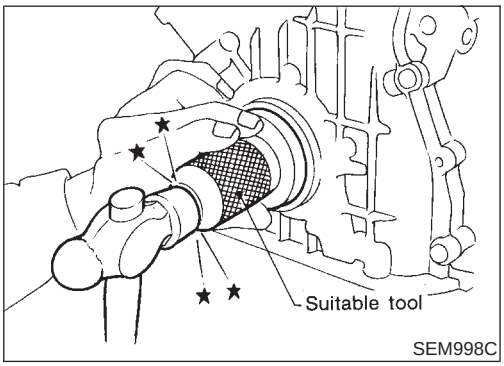
2. Remove front oil seal.

Be careful not to scratch front cover.



SEM715A

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

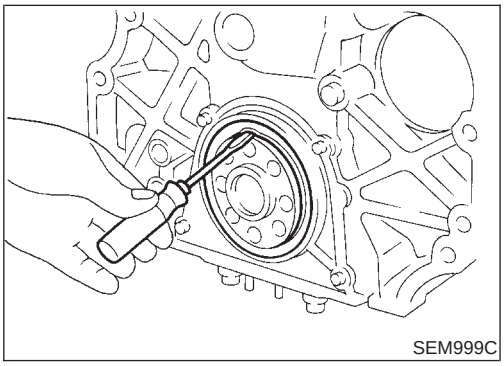


SEM998C

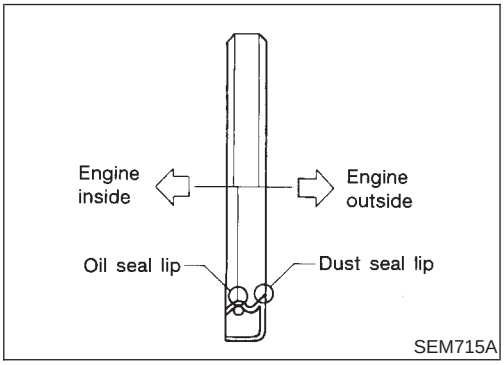
REAR OIL SEAL

NCEM0015S03

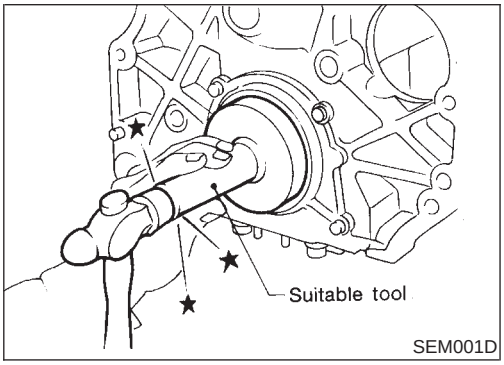
1. Remove transaxle. (Refer to MT or AT section.)
2. Remove flywheel or drive plate.
3. Remove rear oil seal.
- **Be careful not to scratch rear oil seal retainer.**


SEM999C

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



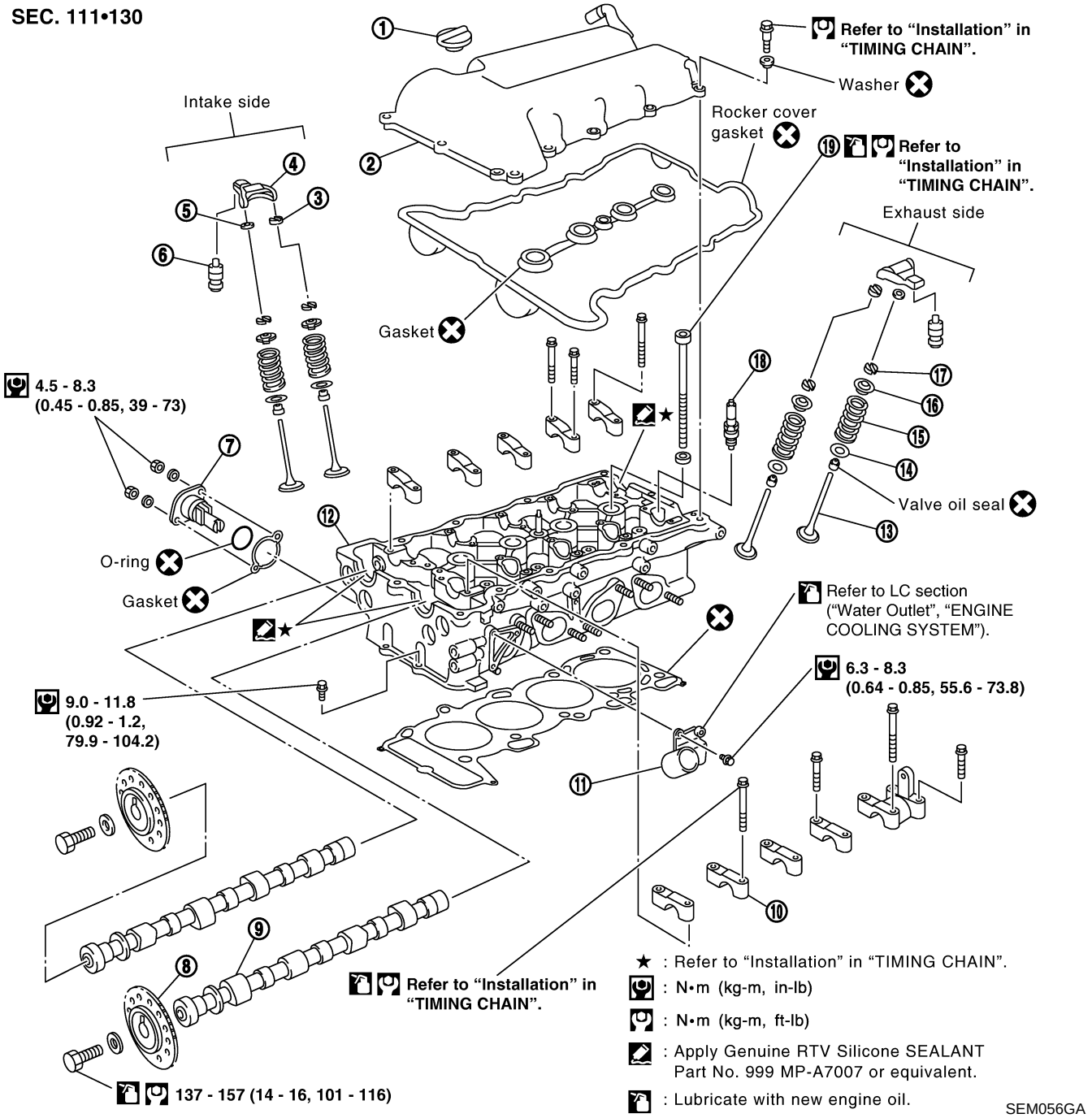
SEM715A



SEM001D

Components

NCEM0016

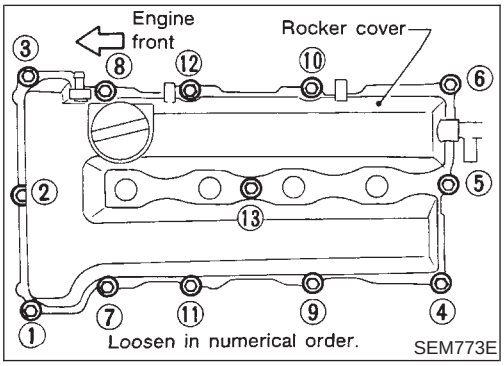


1. Oil filler cap
2. Rocker cover
3. Rocker arm guide
4. Rocker arm
5. Shim
6. Hydraulic lash adjuster
7. Chain tensioner
8. Camshaft sprocket
9. Camshaft
10. Camshaft bracket
11. Water outlet
12. Cylinder head
13. Valve
14. Valve spring seat
15. Valve spring
16. Valve spring retainer
17. Valve collet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

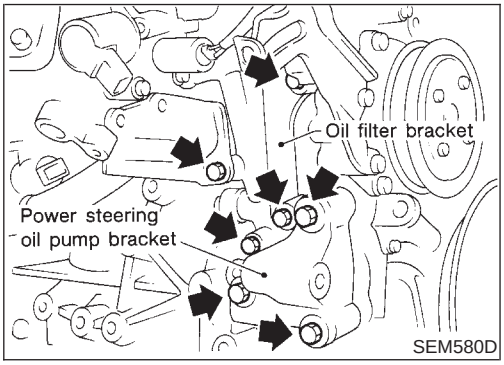
Removal

NCEM0017

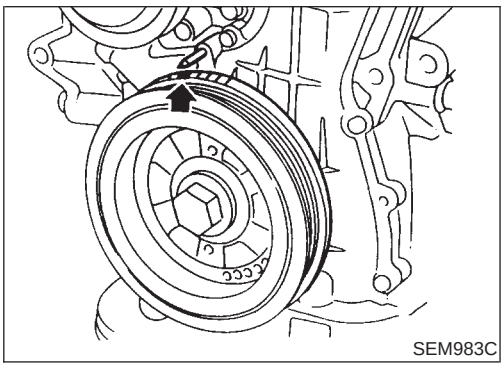
1. Release fuel pressure.
   Refer to “Releasing Fuel Pressure” in EC-50.
2. Remove engine under covers.
3. Remove front RH wheel and engine side cover.
4. Drain coolant by removing cylinder block drain plug and lower radiator hose.
5. Remove radiator.
6. Remove air duct to intake manifold.
7. Remove drive belts and water pump pulley.
8. Remove alternator and power steering oil pump.
9. Remove vacuum hoses, fuel hoses, wires, and harness connectors.
10. Remove all spark plugs.



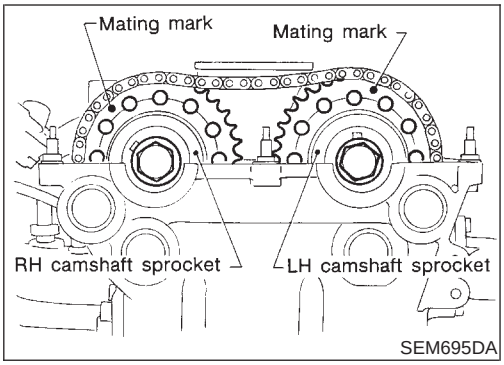
11. Remove rocker cover, loosen bolts in numerical order.
12. Remove front exhaust tube. Refer to FE-8 (“Exhaust System”).
13. Remove the lower intake manifold supports.



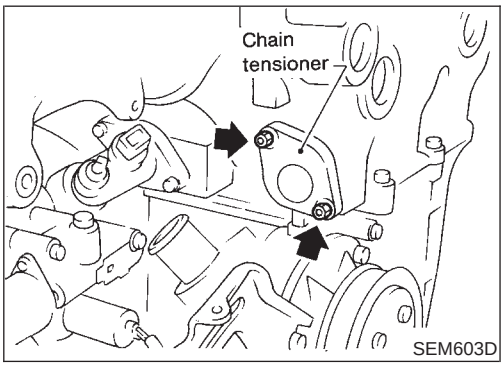
14. Remove oil filter bracket and power steering oil pump bracket.



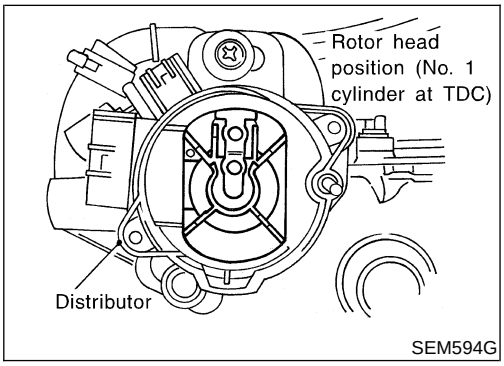
15. Set No. 1 piston at TDC on the compression stroke by rotating crankshaft.



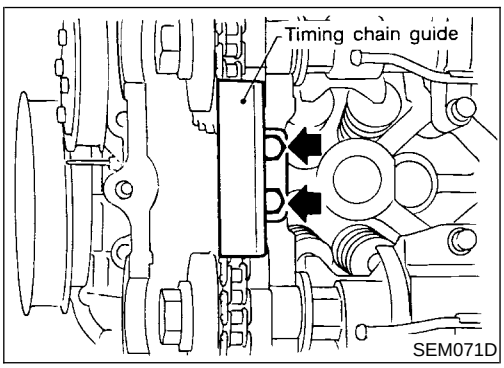
- **Rotate crankshaft until mating mark on camshaft sprocket is set at position indicated in figure at left.**
- **Apply paint to timing chain and camshaft sprockets for alignment during installation.**



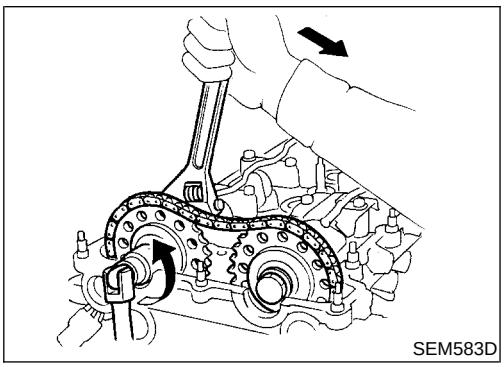
16. Remove chain tensioner.



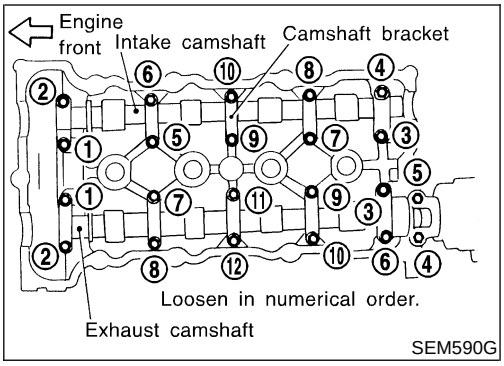
17. Remove distributor.
    Do not turn rotor with distributor removed.



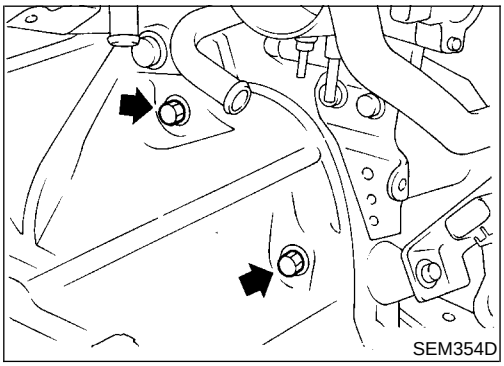
18. Remove timing chain guide.



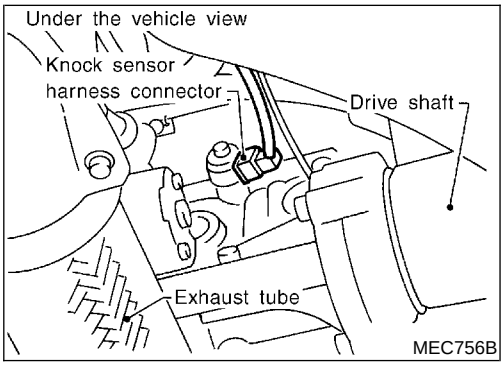
19. Remove camshaft sprockets.



20. Remove camshafts and camshaft brackets.

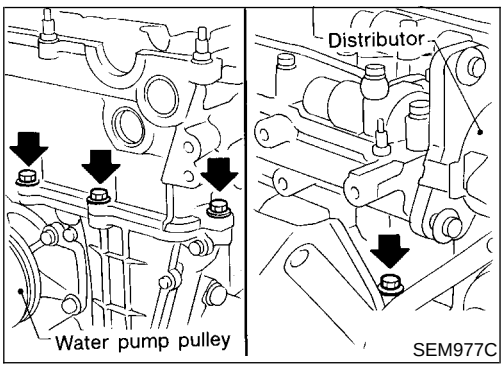


21. Remove starter motor.

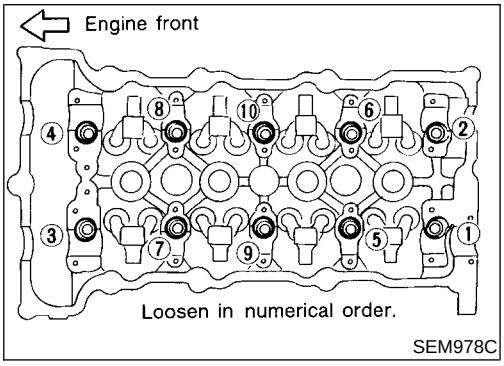


22. Remove the following water hoses:
- Water hose to water pump.
- Water hoses for heater.

23. Remove knock sensor harness connector.



24. Remove cylinder head outside bolts.



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

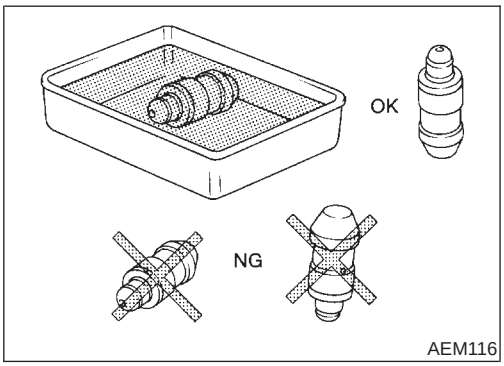
26. Remove cylinder head completely with intake and exhaust manifolds.

Disassembly

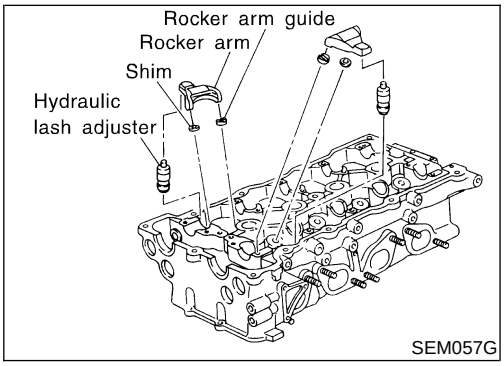
NCEM0018

CAUTION:

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



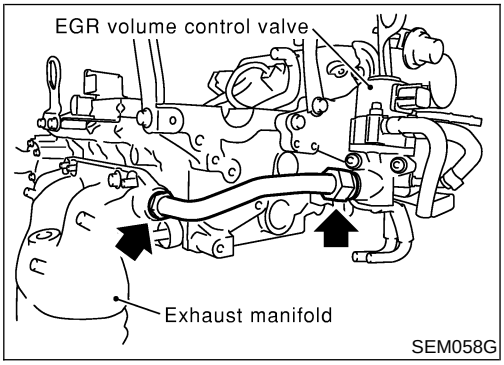
- **If a hydraulic lash adjuster is kept on its side, there is a risk of air entering it. When hydraulic lash adjusters are removed, stand them straight up or soak them in new engine oil.**
- **Do not disassemble hydraulic lash adjusters.**
- **Attach tags to lash adjusters so as not to mix them up.**



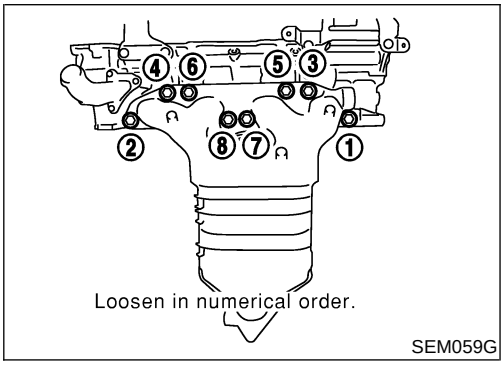
1. Remove rocker arms, shims, rocker arm guides and hydraulic lash adjusters from cylinder head.

CAUTION:

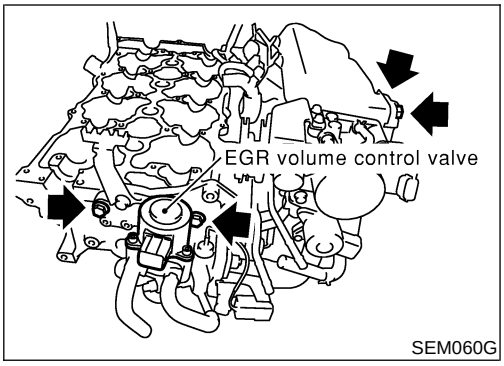
Keep parts in order so they can be installed in their original positions during assembly.



2. Remove exhaust manifold cover.
3. Remove EGR tube.

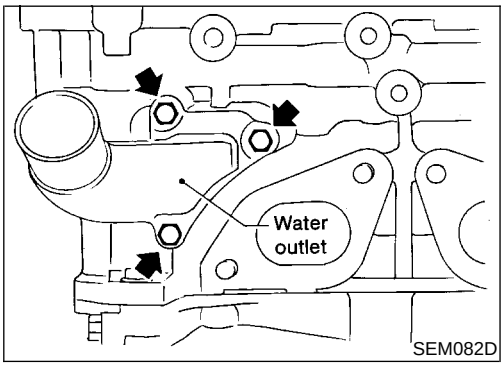


4. Remove exhaust manifold as shown.



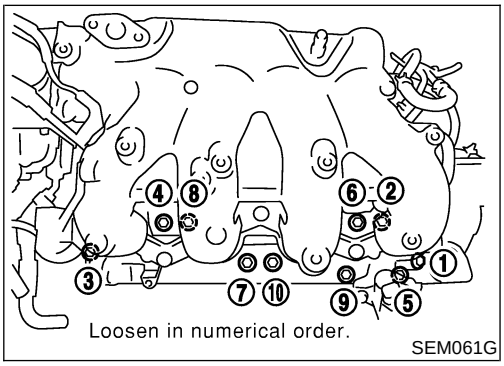
SEM060G

5. Remove EGR volume control valve assembly.



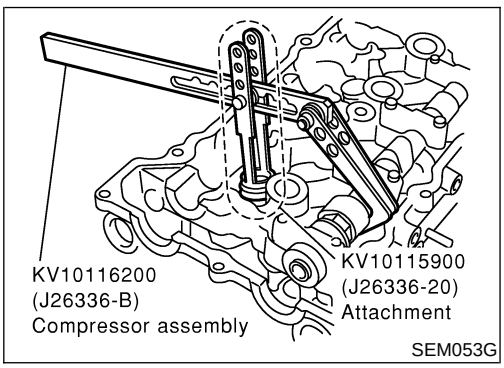
SEM082D

6. Remove water outlet.



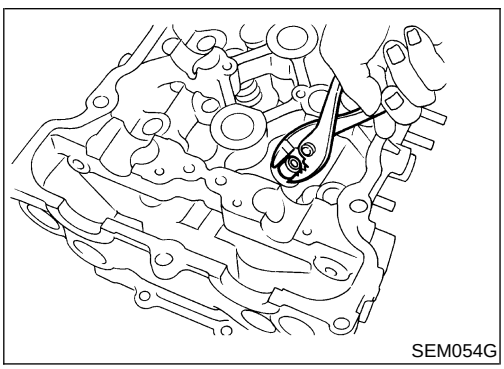
SEM061G

7. Remove intake manifold with intake manifold collector as shown.

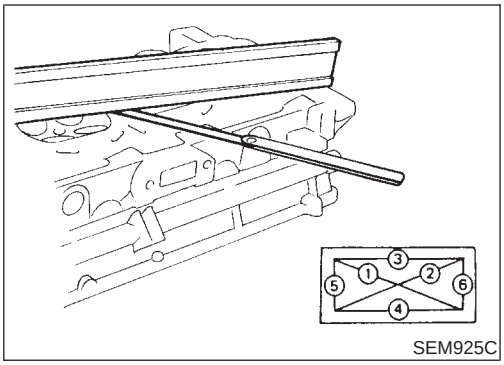


SEM053G

8. Remove valve components with Tool. Install camshaft temporarily.


SEM054G

9. Remove valve oil seal with a suitable tool.



SEM925C

Inspection

NCEM0019

CYLINDER HEAD DISTORTION

NCEM0019S01

- Clean mating surface of cylinder head.
- Use a reliable straightedge and feeler gauge to check the flatness of cylinder head mating 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 or resurface it.

Resurfacing limit:

The limit for cylinder head resurfacing is determined by the amount of cylinder block resurfacing.

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

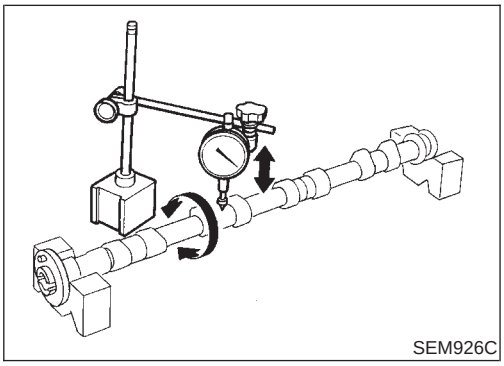
The maximum limit is as follows:

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:

136.9 - 137.1 mm (5.390 - 5.398 in)


SEM926C

CAMSHAFT VISUAL CHECK

NCEM0019S02

Check camshaft for scratches, seizure and wear.

CAMSHAFT RUNOUT

NCEM0019S03

1. Measure camshaft runout at the center journal.

Runout (Total indicator reading):

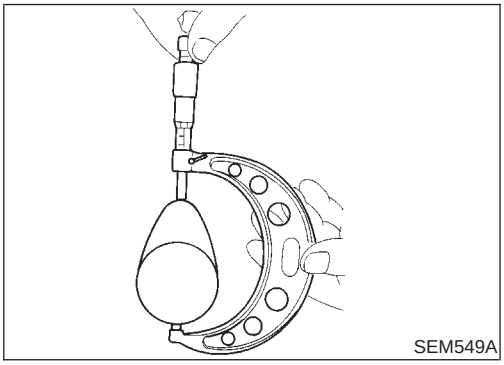
Standard

Less than 0.02 mm (0.0008 in)

Limit

0.1 mm (0.004 in)

2. If it exceeds the limit, replace camshaft.


SEM549A

CAMSHAFT CAM HEIGHT

NCEM0019S04

1. Measure camshaft cam height.

Standard cam height:

Intake

37.550 - 37.740 mm (1.4783 - 1.4858 in)

Exhaust

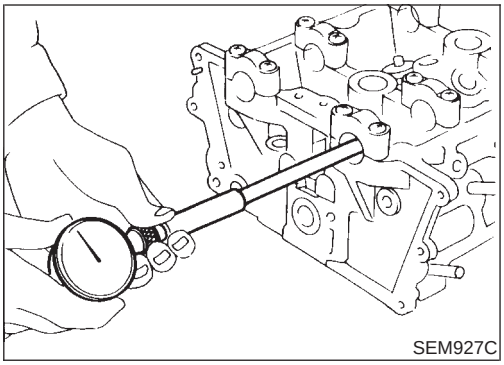
37.920 - 38.110 mm (1.4929 - 1.5004 in)

Cam height wear limit:

Intake & Exhaust

0.2 mm (0.008 in)

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

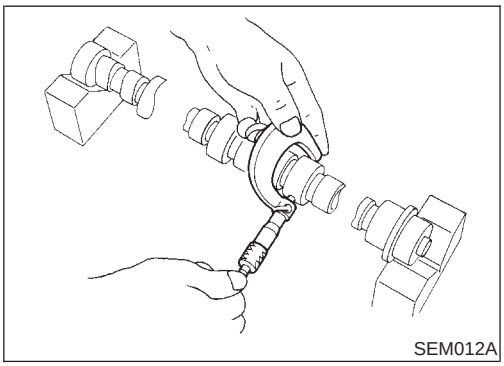

SEM927C

CAMSHAFT JOURNAL CLEARANCE

NCEM0019S05

1. Install camshaft bracket and tighten bolts. Refer to EM-23.
2. Measure inner diameter of camshaft bearing.

Standard inner diameter:
28.000 - 28.021 mm (1.1024 - 1.1032 in)


SEM012A

3. Measure outer diameter of camshaft journal.

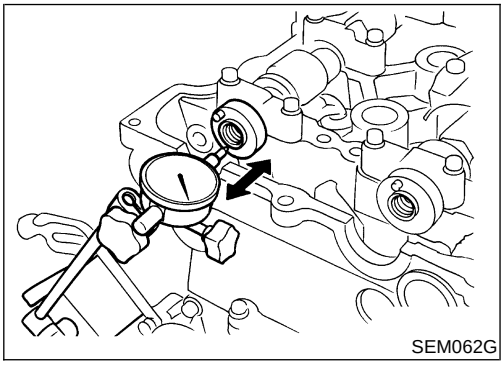
Standard outer diameter:
27.935 - 27.955 mm (1.0998 - 1.1006 in)

4. Calculate camshaft journal clearance.

Camshaft journal clearance = standard inner diameter − standard outer diameter:
Standard
0.030 - 0.071 mm (0.0012 - 0.0028 in)
Limit
0.15 mm (0.0059 in)

5. If clearance exceeds the limit, replace camshaft and remeasure camshaft journal clearance.

- If clearance still exceeds the limit after replacing camshaft, replace cylinder head.


SEM062G

CAMSHAFT END PLAY

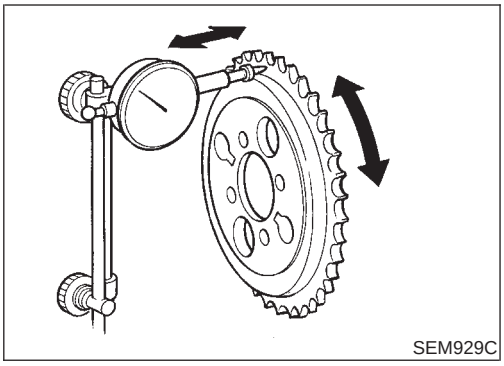
NCEM0019S06

1. Install camshaft in cylinder head. Refer to EM-23.
2. Measure camshaft end play.

Camshaft end play:
Standard
0.055 - 0.139 mm (0.0022 - 0.0055 in)
Limit
0.20 mm (0.0079 in)

3. If end play exceeds the limit, replace camshaft and remeasure camshaft end play.

- If end play still exceeds the limit after replacing camshaft, replace cylinder head.


SEM929C

CAMSHAFT SPROCKET RUNOUT

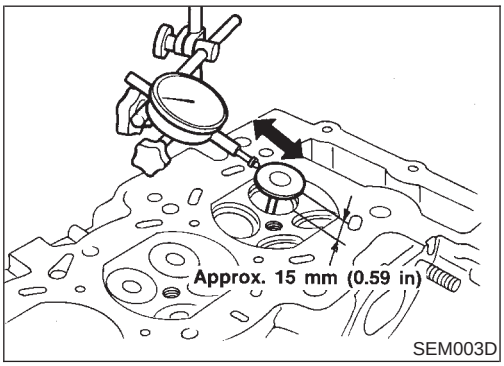
NCEM0019S07

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

Runout (Total indicator reading):

Limit 0.25 mm (0.0098 in)

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



SEM003D

VALVE GUIDE CLEARANCE

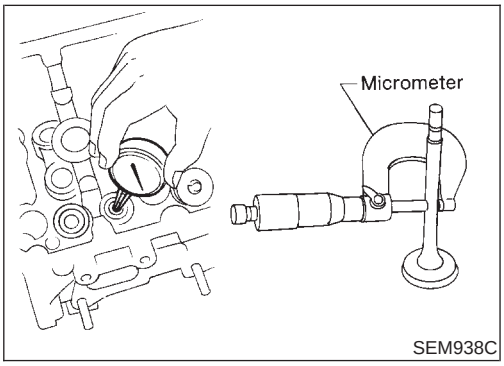
NCEM0019S08

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

Valve deflection limit (Dial gauge reading):

Intake & Exhaust

0.2 mm (0.008 in)



SEM938C

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

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

b. Calculate valve to valve guide clearance.

Valve to valve guide clearance = valve guide inner diameter − valve stem diameter:

Standard

Intake 0.020 - 0.053 mm (0.0008 - 0.0021 in)

Exhaust 0.040 - 0.073 mm (0.0016 - 0.0029 in)

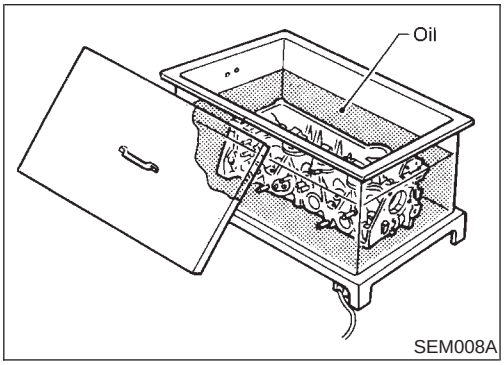
Limit

Intake 0.08 mm (0.0031 in)

Exhaust 0.1 mm (0.004 in)

c. If it exceeds the limit, replace valve and remeasure clearance.

- If clearance still exceeds the limit after replacing valve, replace valve guide.

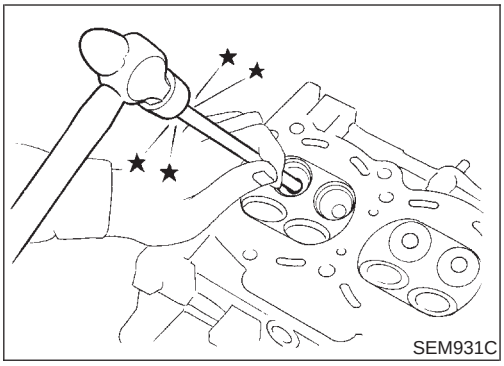


SEM008A

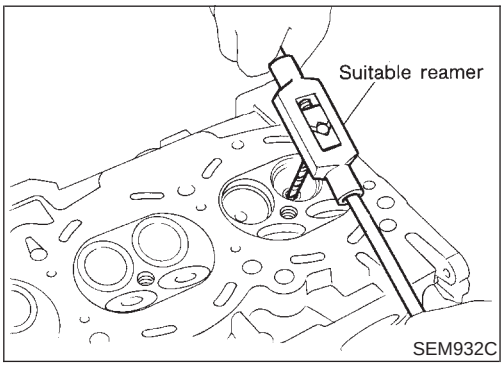
VALVE GUIDE REPLACEMENT

NCEM0019S09

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

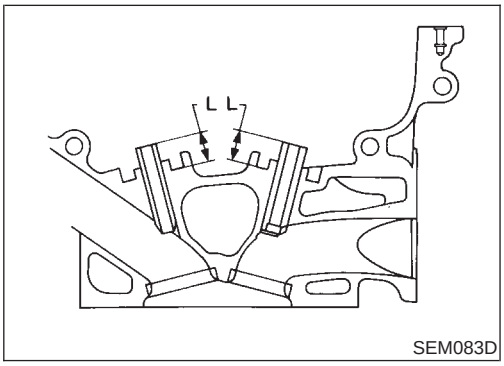

SEM931C

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



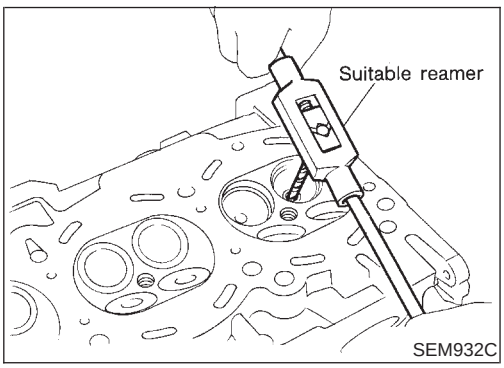
SEM932C

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



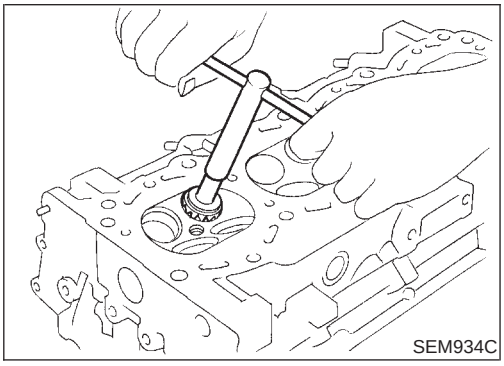
SEM083D

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



SEM932C

5. Ream valve guide.
   Finished size:
   Intake & Exhaust
   6.000 - 6.018 mm (0.2362 - 0.2369 in)

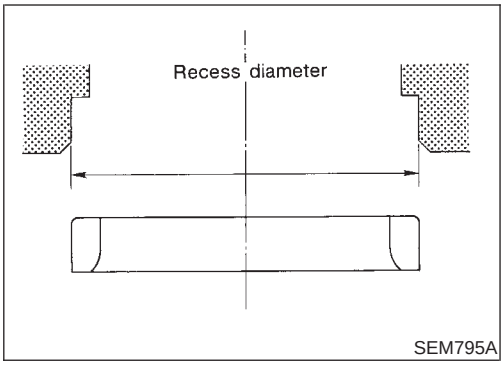

SEM934C

VALVE SEATS

NCEM0019S10

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 are worn, replace them. Then correct valve seat.**
- **Use both hands to cut uniformly.**



REPLACING VALVE SEAT FOR SERVICE PARTS

NCEM0019S11

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

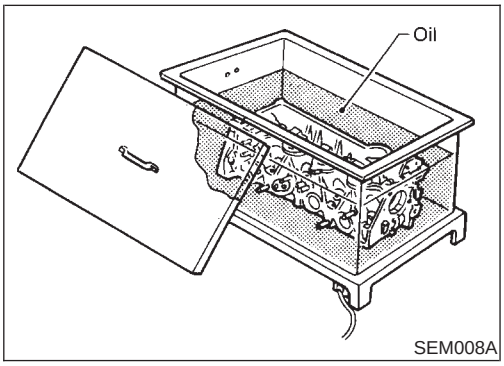
Reaming bore for service valve seat

Oversize [0.5 mm (0.020 in)]:

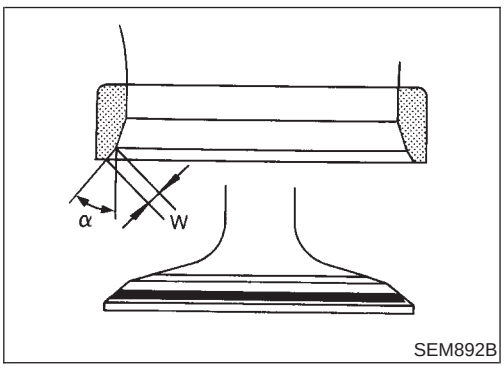
Intake 35.500 - 35.516 mm (1.3976 - 1.3983 in)

Exhaust 31.500 - 31.516 mm (1.2402 - 1.2408 in)

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



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



5. Cut or grind valve seat to the specified dimensions using a suitable tool. Refer to SDS, EM-75.
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

Seat face angle "α":

44°53′ - 45°07′

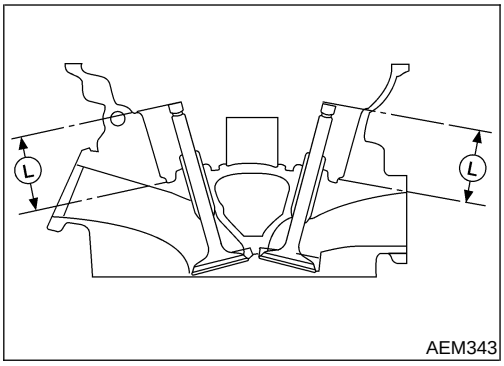
Contacting width "W":

Intake

1.05 - 1.35 mm (0.0413 - 0.0531 in)

Exhaust

1.25 - 1.55 mm (0.0492 - 0.0610 in)

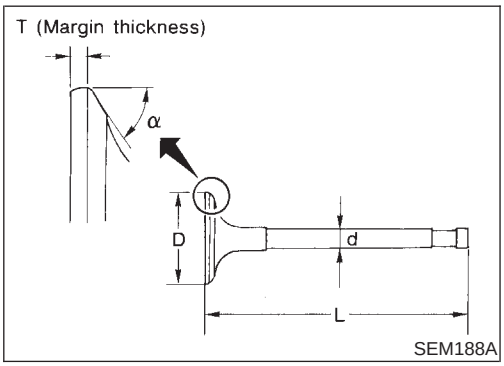


AEM343

Use a depth gauge to measure the distance between the mounting surface of the cylinder head spring seat and the valve stem end.
If the distance is shorter than the specified valve, repeat step 5 above to adjust it.
If it is longer, replace the valve seat with a new one.

Valve seat resurface limit:

42.74 - 43.26 mm (1.6827 - 1.7031 in)

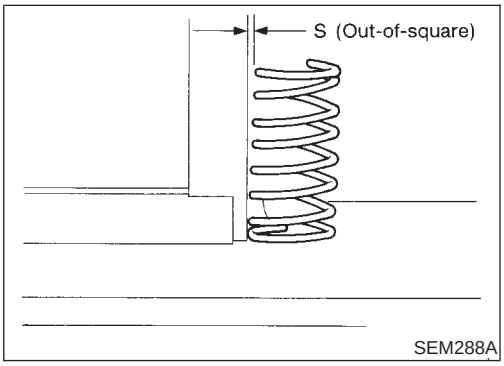


SEM188A

VALVE DIMENSIONS

NCEM0019S12

Check dimensions of each valve. Refer to SDS, EM-72.
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.



SEM288A

VALVE SPRING

NCEM0019S13

Squareness

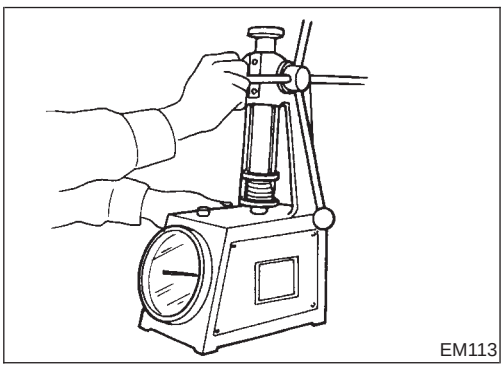
NCEM0019S1301

1. Measure dimension "S".

Out-of-square "S":

Less than 2.1 mm (0.083 in)

2. If it exceeds the limit, replace spring.


EM113

Pressure

NCEM0019S1302

Check valve spring pressure at specified spring height.

Pressure:

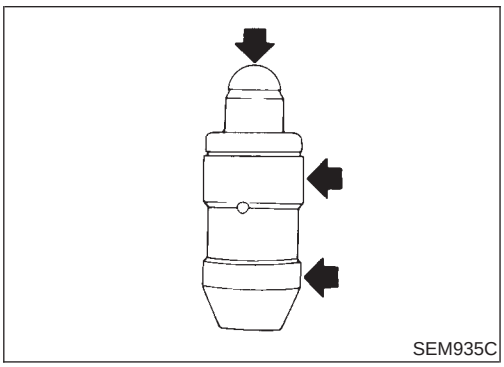
Standard

519 - 571 N (52.9 - 58.2 kg, 116.7 - 128.4 lb) at 27.0 mm (1.063 in)

Limit

More than 491.8 N (50.16 kg, 110.56 lb) at 27.0 mm (1.063 in)

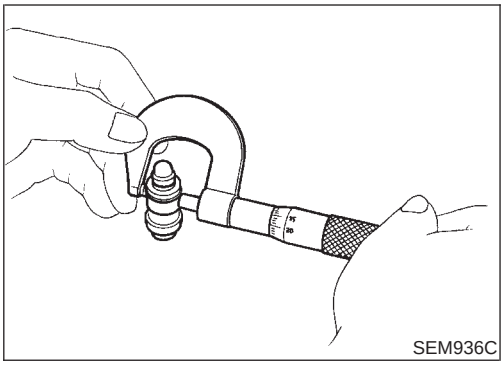
If it exceeds the limit, replace spring.


SEM935C

HYDRAULIC LASH ADJUSTER

NCEM0019S14

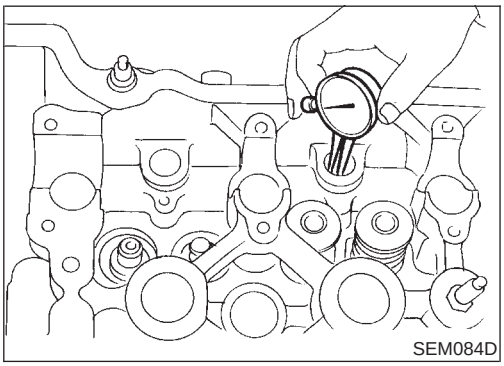
1. Check contact and sliding surfaces for wear or score.


SEM936C

2. Check diameter of lash adjuster.

Outer diameter:

16.980 - 16.993 mm (0.6685 - 0.6690 in)


SEM084D

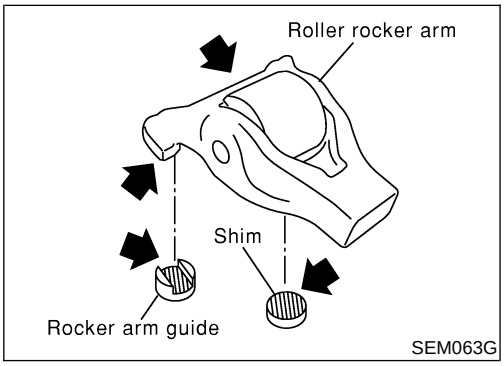
3. Check lash adjuster guide hole diameter.

Inner diameter:

17.000 - 17.020 mm (0.6693 - 0.6701 in)

Standard clearance between lash adjuster and adjuster guide hole:

0.007 - 0.040 mm (0.0003 - 0.0016 in)



SEM063G

ROCKER ARM, SHIM AND ROCKER ARM GUIDE

NCEM0019S15

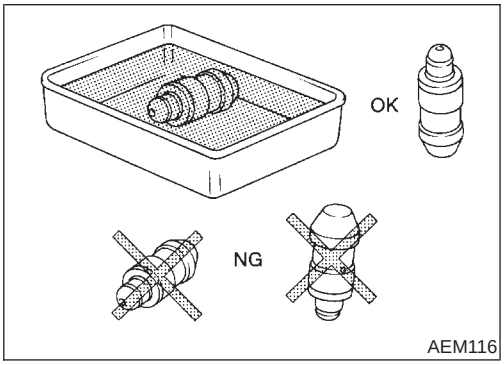
Check contact and sliding surfaces of rocker arms, shims and rocker arm guides for wear or score.

Assembly

NCEM0020

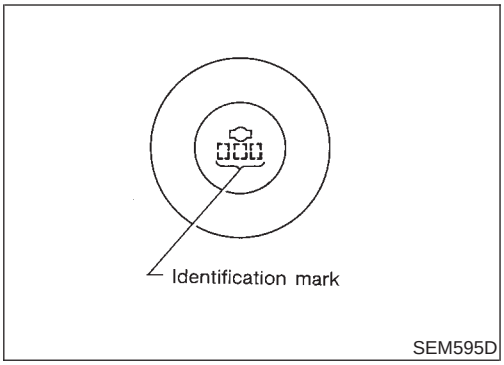
CAUTION:

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



AEM116

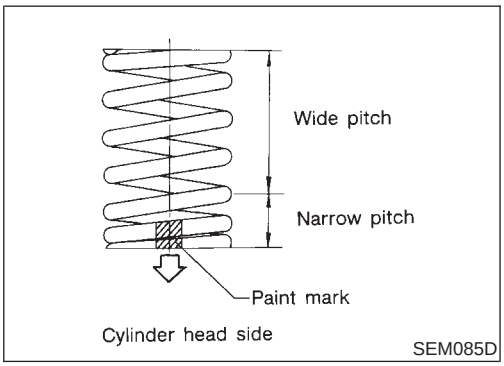
- **If a hydraulic lash adjuster is kept on its side, there is a risk of air entering it. When hydraulic lash adjusters are removed, stand them straight up or soak them in new engine oil.**
- **Do not disassemble hydraulic lash adjusters.**
- **Attach tags to lash adjusters so as not to mix them up.**



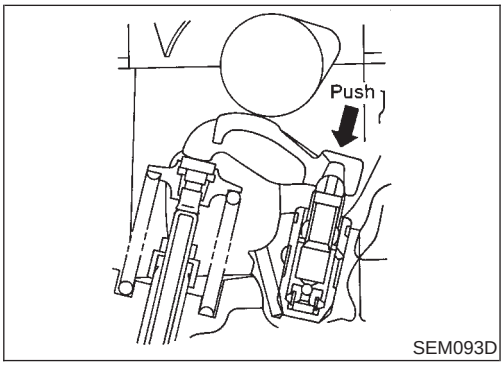
1. Install valve component parts.

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

	Identification mark
Intake valve	2J3
Exhaust valve	J21

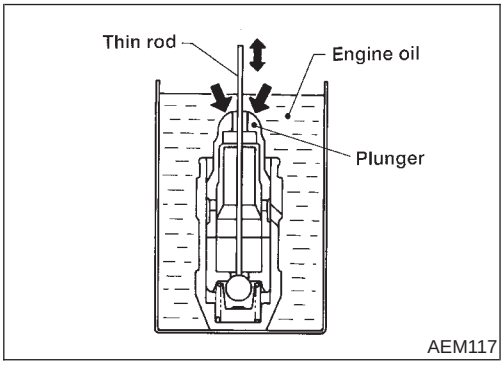


- **Always use new valve oil seal.**
  Refer to EM-28.
- **Before installing valve oil seal, install valve spring seat.**
- **Install valve spring (uneven pitch type) with its narrow pitched side (paint mark) toward cylinder head side.**
- **After installing valve components, use plastic hammer to lightly tap valve stem tip to assure a proper fit.**



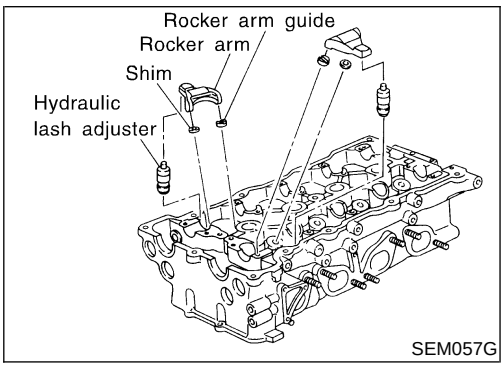
2. Check hydraulic lash adjusters.

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

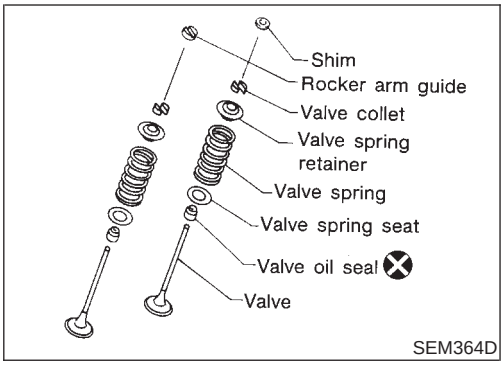


b. Remove hydraulic lash adjuster and dip in a container filled with new engine oil. While pushing plunger as shown in figure, lightly push check ball using a thin rod. Air is completely bled when plunger no longer moves.

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



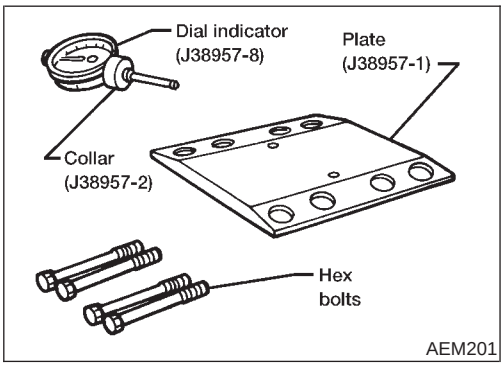
3. Remove camshafts, rocker arms and shims. For future reference, identify each shim with the cylinder it was removed from. Since the shims are reusable, it may not be necessary to replace all of the existing shims.



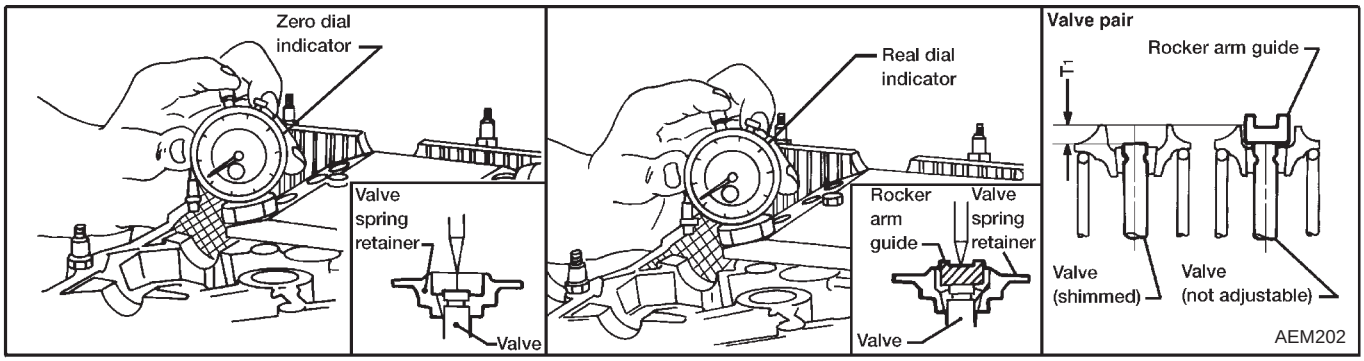
4. Before attempting any measurement, make sure the valve, valve spring, collet, retainer and rocker arm guide are properly installed in the head.

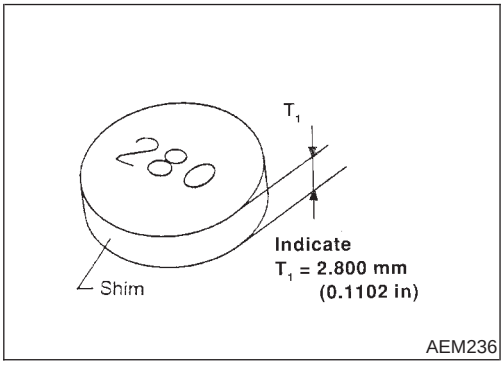
- **Always replace rocker arm guide with a new one.**

CAUTION:
Install parts in their original positions.



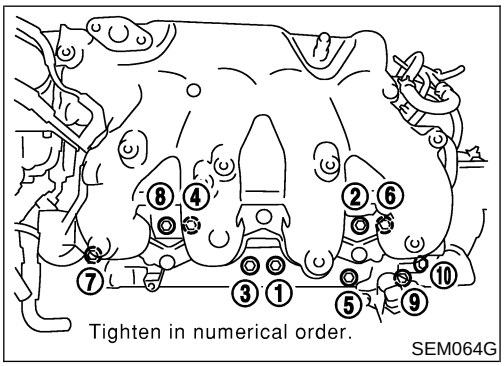
5. Install the J38957-1 gauge plate into the tapped holes at the cam journals and secure it to the head using two of the hex bolts supplied with the kit. (The two remaining bolts are spares.)



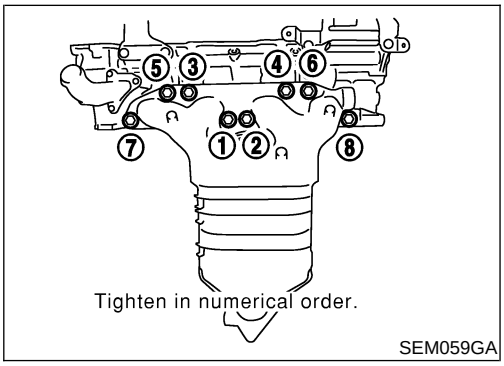


6. Place the J38957-2 collar on the J38957-8 dial indicator. Make sure the dished side of the collar is facing "up" (toward the dial indicator). Secure the collar to the dial indicator by tightening the set screw in the collar.
7. Place the indicator and collar over #1 cylinder intake valve shim side. Slide the tip of the dial indicator through the access hole and place it on the end of the valve stem. While resting the dial indicator collar on the gauge plate, "zero" the dial indicator.
8. Move the dial indicator and collar to the adjacent hole in the gauge plate and place the tip of the indicator in the center of the rocker arm guide. Write down the dial indicator reading. This measured distance between the valve stem end and the contact surface of the rocker arm guide is the "T_1" dimension.
9. Match the measured "T_1" dimension (in inches) to the available shim chart (in millimeters). Refer to SDS, EM-74. (The "T_1" dimension is equivalent to the thickness and size designation of the valve shim.) Select the closest size shim to the measured "T_1" dimension. For example, if the measured "T_1" dimension is 0.1152 in, use a 2.925 mm (0.1152 in) shim. Shims are available in 17 different thicknesses ranging from 2.800 mm (0.1102 in) to 3.200 mm (0.1260 in) and increase in increments of 0.025 mm (0.0010 in).

10. Repeat this procedure on the remaining cylinders.



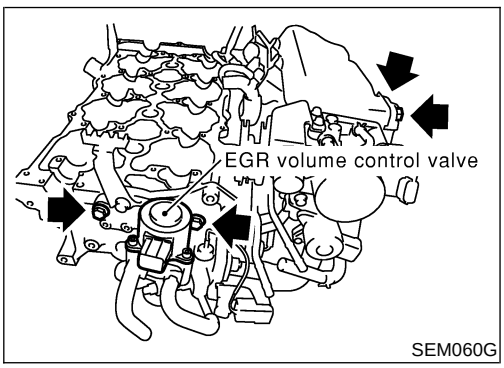
11. Install intake manifold with intake manifold collector as shown.



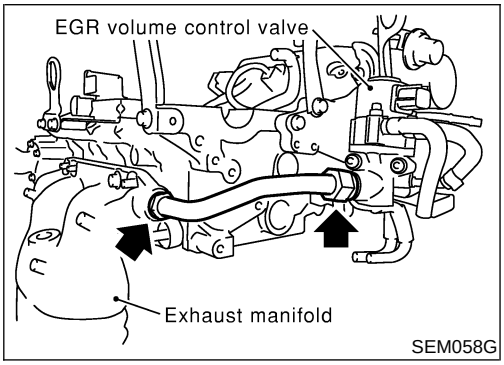
12. Install exhaust manifold.
- Tighten exhaust manifold bolts in numerical order.

Exhaust manifold:

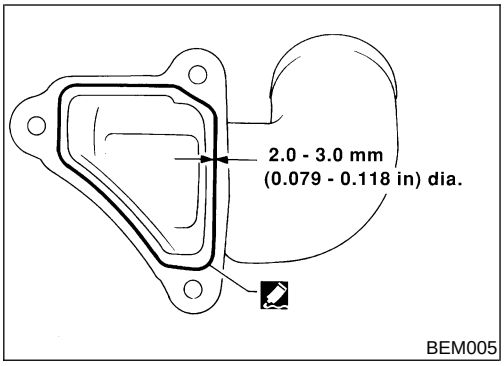
: 37.8 - 48.1 N·m (3.8 - 4.9 kg-m, 28 - 35 ft-lb)



13. Install EGR volume control valve assembly.



14. Install EGR tube.
15. Install exhaust manifold cover.



16. Install water outlet.

a. Remove old liquid gasket from mating surface of water outlet.

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

b. Apply a continuous bead of liquid gasket to mating surface of water outlet.

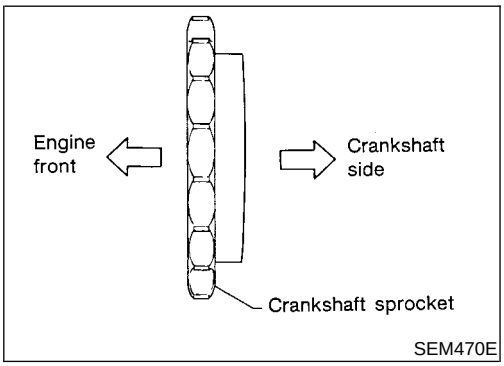
- **Use Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent.**

Installation

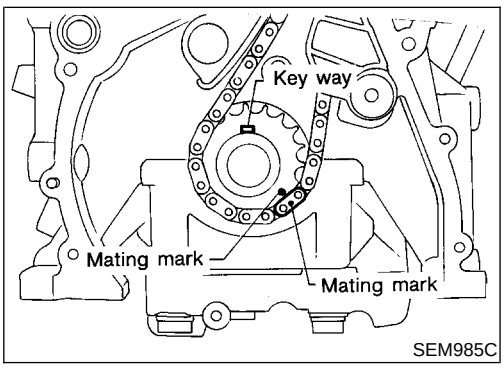
NCEM0041

1. Install crankshaft sprocket on crankshaft.

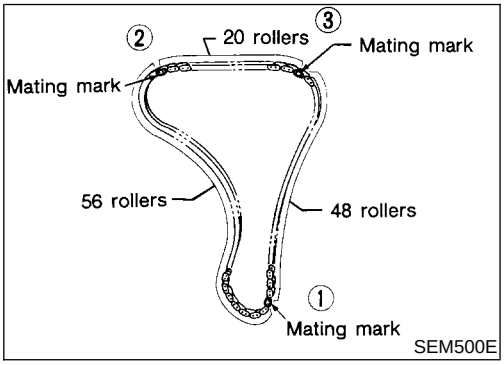
- **Make sure that mating marks on crankshaft sprocket face front of engine.**



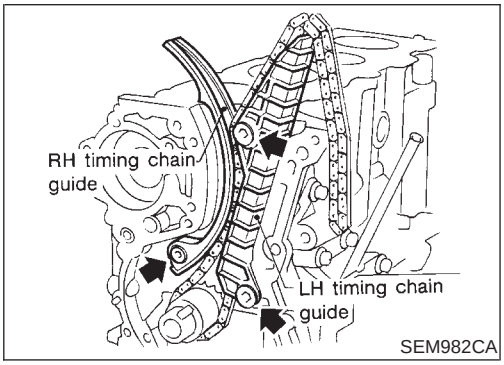
2. Position crankshaft so that No. 1 piston is set at TDC and key way is at 12 o'clock. Fit timing chain on crankshaft sprocket, aligning the mating marks.

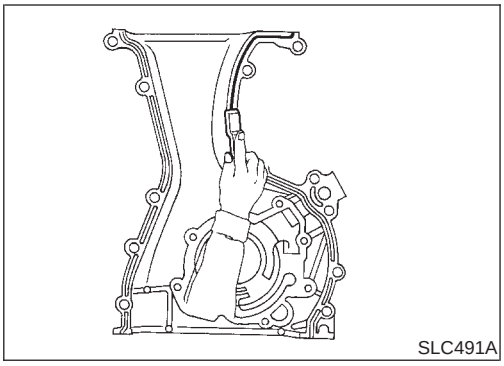


- Mating mark color on timing chain.
  - **1: Copper**
  - **2, 3: Silver**

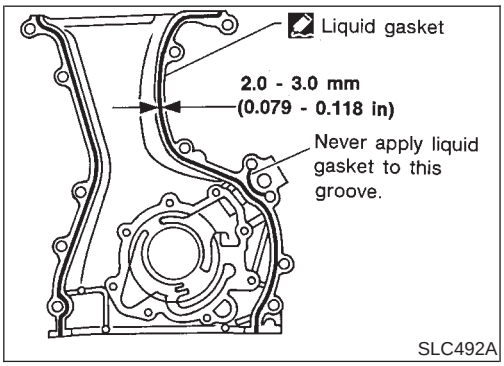


3. Install timing chain and timing chain guides.



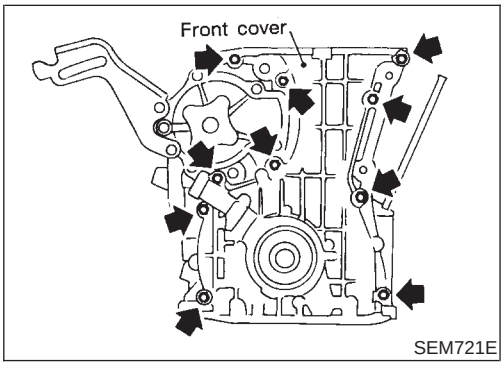

SLC491A

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



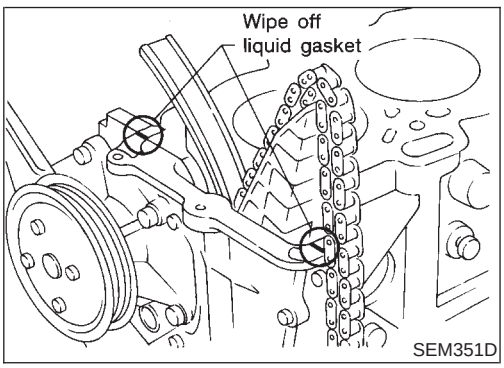
SLC492A

5. Apply a continuous bead of liquid gasket to mating surface of front cover.
- **Use Genuine Liquid Gasket or equivalent.**
- **Be sure to install new front oil seal in the right direction. Refer to EM-28.**



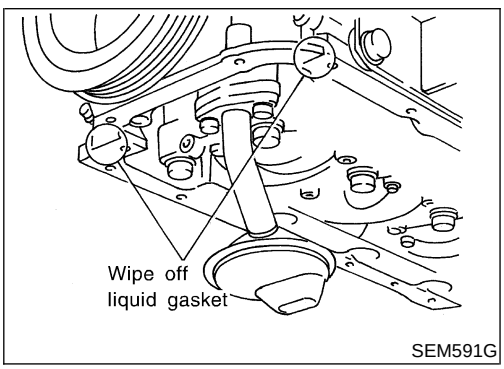
SEM721E

6. Install oil pump drive spacer and front cover.



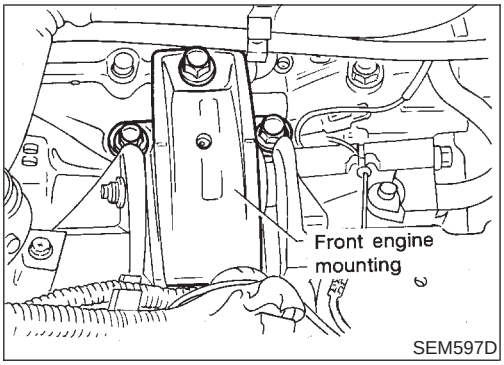
SEM351D

- Wipe off excessive liquid gasket.

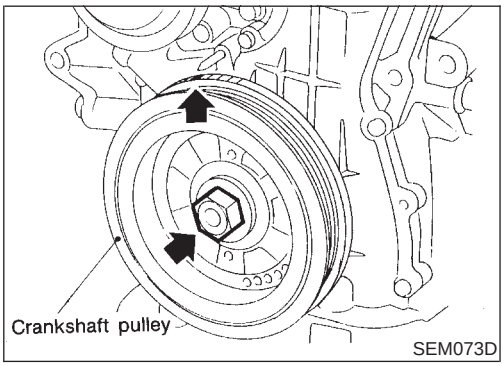


SEM591G

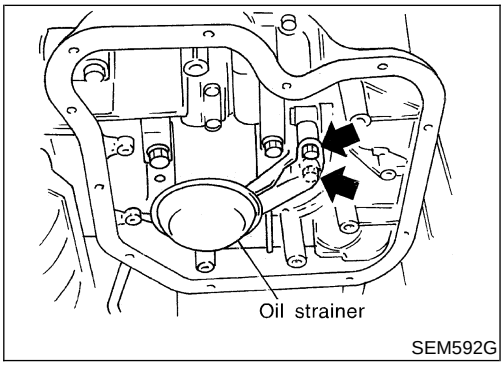
Installation (Cont'd)



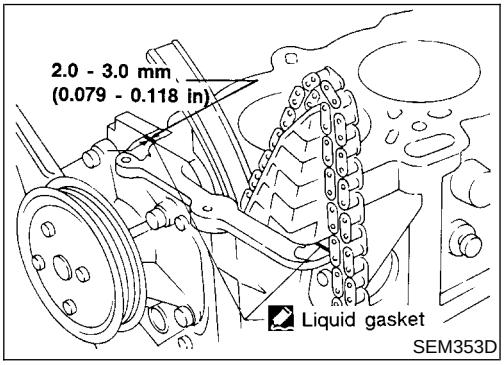
7. Install front engine mounting.



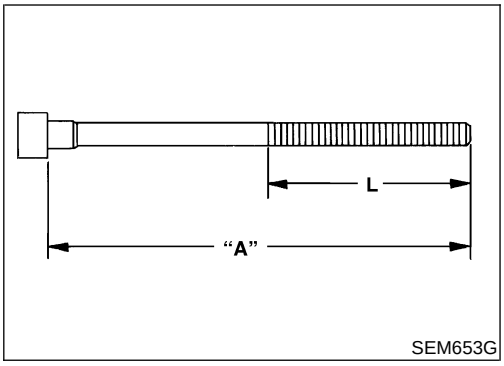
8. Install crankshaft pulley.
9. Set No. 1 piston at TDC on its compression stroke.



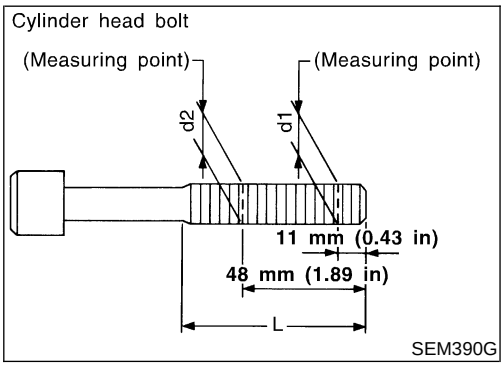
10. Install oil strainer.
11. Install oil pan.
    Refer to "Installation" in "OIL PAN" (EM-16).



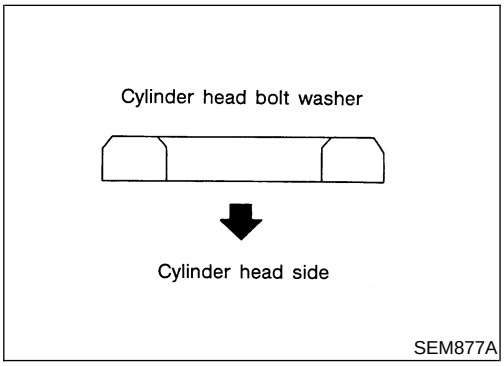
12. Before installing cylinder head gasket, apply a continuous bead of liquid gasket to mating surface of cylinder block.



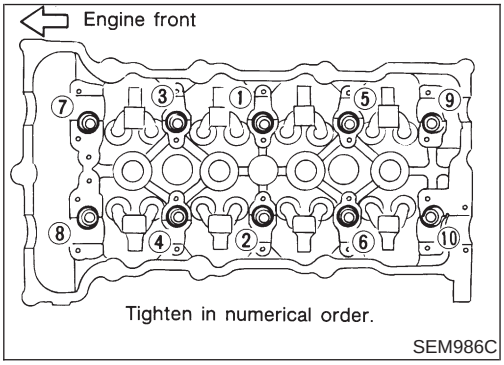
SEM653G



SEM390G



SEM877A



SEM986C

13. Install cylinder head completely with intake and exhaust manifolds.

- **Apply engine oil to threads and seating surfaces of cylinder head bolts before installing them.**
- **Be sure to install washers between bolts and cylinder head.**

CAUTION:
Old specificaiton (Production before August 2000):
The cylinder head bolts can be reused providing dimension "A" is not exceeded.

Dimension "A":
158.2 mm (6.228 in)

- **Bolt identification, old specification:**
  L: 75 mm (2.95 in)

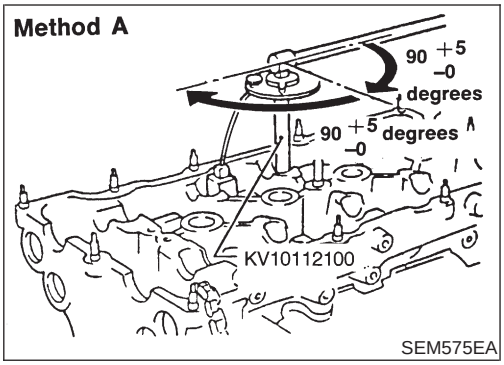
CAUTION:
New specification (production from September, 2000):
Cylinder head bolts are tightened by plastic zone tightening method. Whenever the size difference between d1 and d2 exceeds the limit, replace them with new ones.

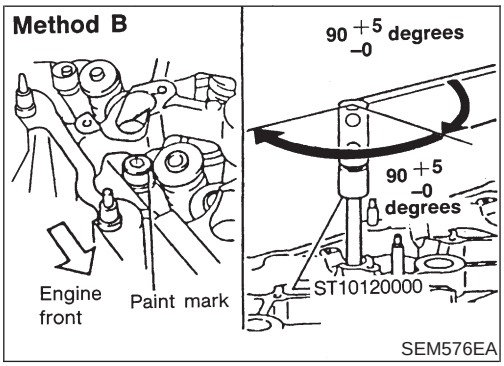
Limit (d1 − d2):
0.15 mm (0.0059 in)

- **If reduction of outer diameter appears in a position other than d2, use it as d2 point.**
- **Bolt identification, new specification:**
  L: 55 mm (2.17 in)

- **Tightening procedure:**

a) **Tighten all bolts to 39.2 N·m (4.0 kg-m, 29 ft-lb).**
b) **Tighten all bolts to 78.5 N·m (8.0 kg-m, 58 ft-lb).**
c) **Loosen all bolts completely.**
d) **Tighten all bolts to 39.2 N·m (4.0 kg-m, 29 ft-lb).**



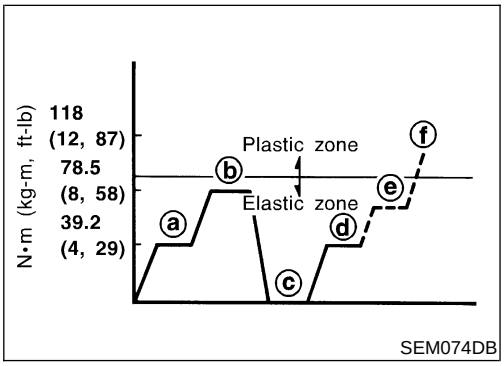


e) **Method A:**
Turn all bolts 90 to 95 degrees clockwise with Tool or suitable angle wrench.
Method B:
If angle wrench is not available, do the following. Mark the side of all bolts with paint marks facing the front of the engine. Then turn them 90 to 95 degrees clockwise.

f) **Turn all bolts 90 to 95 degrees clockwise.**

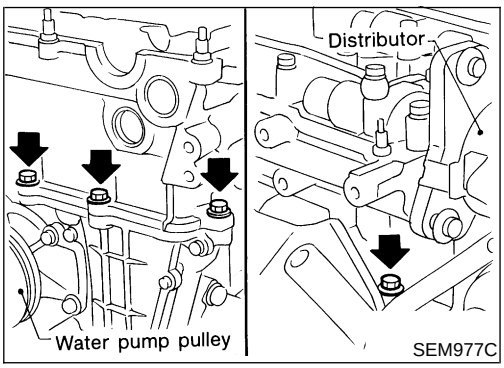
g) **Ensure that paint mark on each bolt faces the rear of the engine. (Method B only)**

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

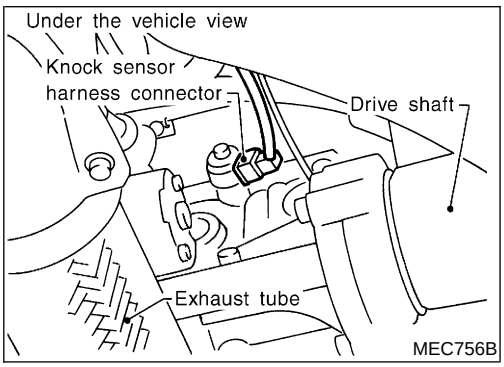


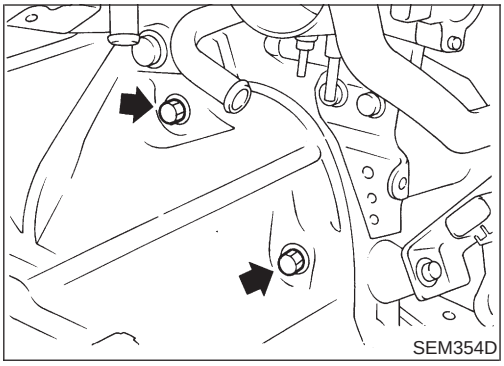
	Tightening torque N·m (kg-m, ft-lb)
a	39.2 (4.0, 29)
b	78.5 (8.0, 58)
c	0 (0, 0)
d	39.2 (4.0, 27)
e	90 - 95 degrees (90 degree preferred)
f	90 - 95 degrees (90 degree preferred)

14. Install cylinder head outside bolts.
15. Install the following water hoses.
- Water hose for cylinder block.
- Water hoses for heater.

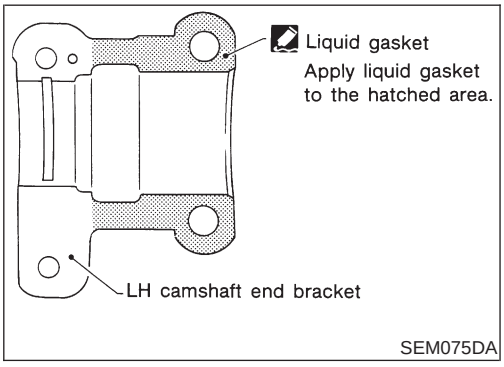


16. Install knock sensor harness connector.




SEM354D

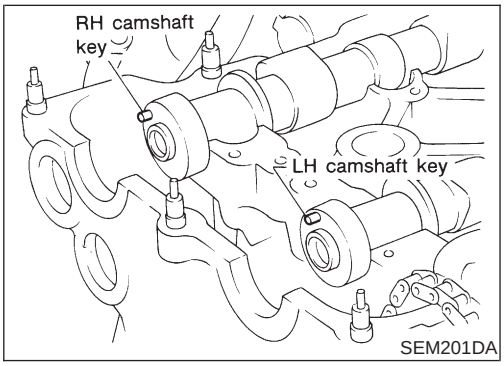
17. Install starter motor.



SEM075DA

18. Remove all traces of liquid gasket from mating surface of LH camshaft end bracket.
- Also remove traces of liquid gasket from mating surface of cylinder head.

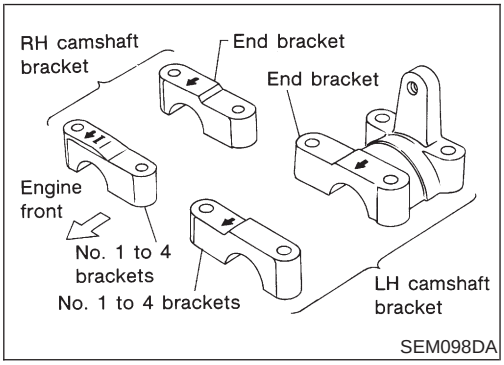
19. Apply liquid gasket to mating surface of LH camshaft end bracket as shown in illustration.
- Use Genuine Liquid Gasket or equivalent.



SEM201DA

20. Install camshafts and camshaft brackets.
- Position camshaft.
- Exhaust camshaft key at about 12 o'clock
- Intake camshaft key at about 10 o'clock

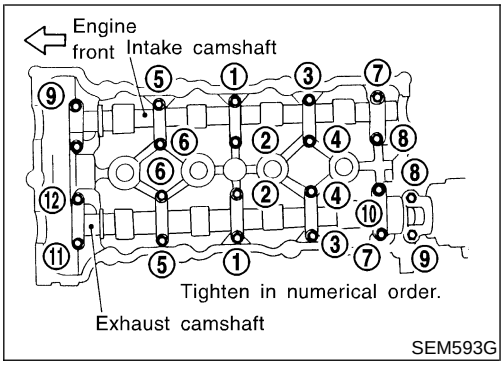
Apply engine oil to bearings and cam surfaces of camshafts before installing them.

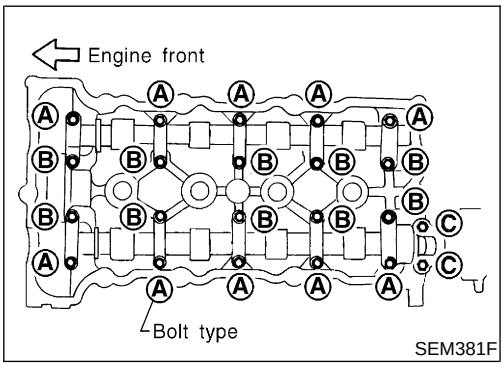


SEM098DA

- Position camshaft brackets as shown in illustration.

Apply engine oil to threads and seating surfaces of camshaft bracket bolts before installing them.





- **Tightening procedure**

  STEP 1:

  Intake camshaft

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

  : 2 N·m (0.2 kg-m, 1.4 ft-lb)

  Exhaust camshaft

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

  : 2 N·m (0.2 kg-m, 1.4 ft-lb)

  STEP 2:

  Tighten bolts in the specified order.

  : 6 N·m (0.6 kg-m, 4.3 ft-lb)

  STEP 3:

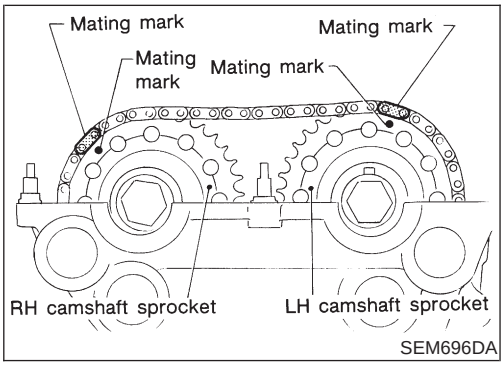
  Tighten bolts in the specified order.

  Bolt type A B

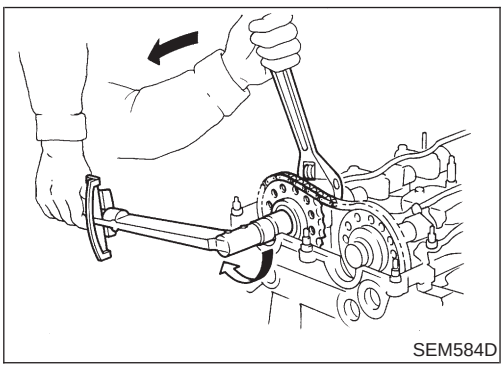
  : 10 - 12 N·m (1.0 - 1.2 kg-m, 7.2 - 8.7 ft-lb)

  Bolt type C

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



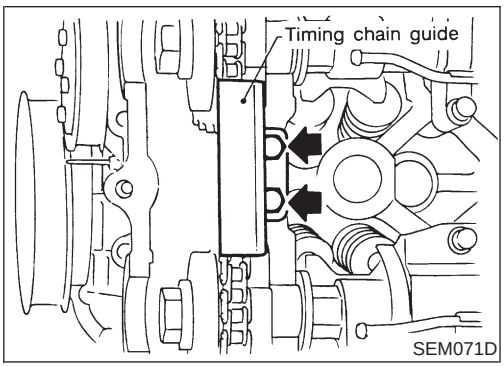
21. Install camshaft sprockets.
    Line up mating marks on timing chain with mating marks on camshaft sprockets.



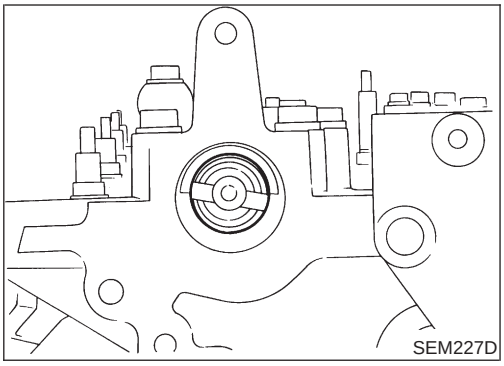
- Lock camshafts as shown in figure and tighten to specified torque.

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

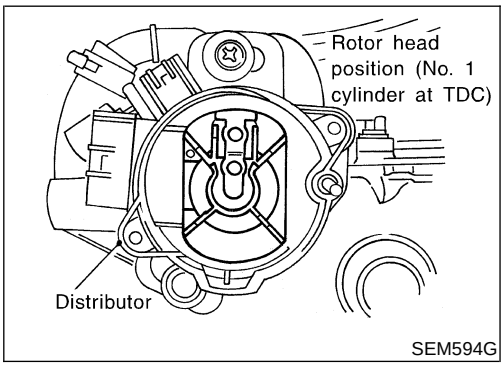
  Apply engine oil to threads and seating surfaces of camshaft sprocket bolts before installing them.



22. Install timing chain guide.

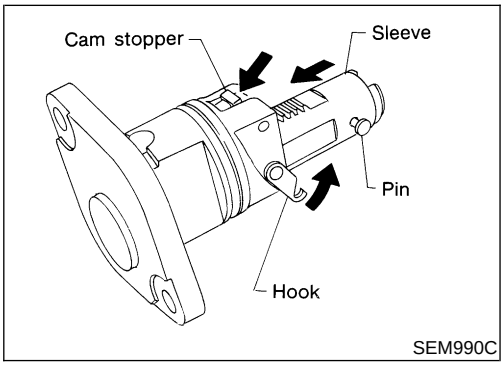

SEM227D

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



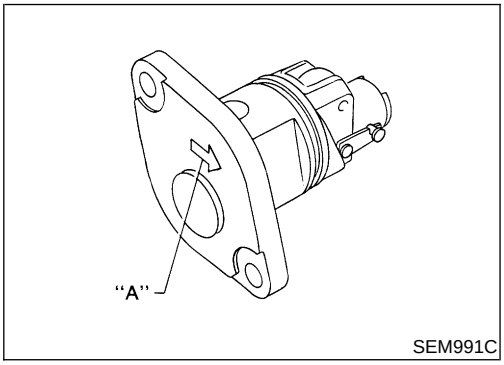
SEM594G

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



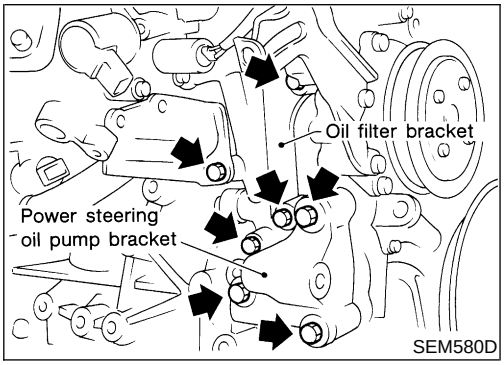
SEM990C

24. Install chain tensioner.
- **Make sure the camshaft sprockets are tightened completely.**
  Press cam stopper down and "press-in" sleeve until hook can be engaged on pin. When tensioner is bolted in position the hook will release automatically.



SEM991C

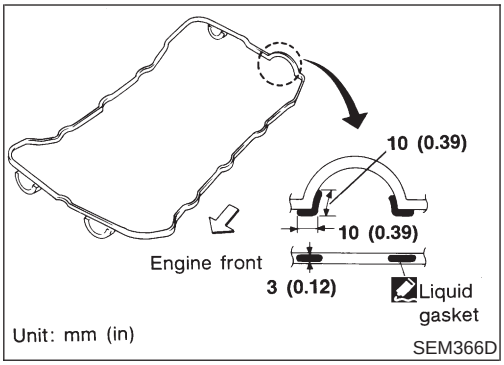
- **Make sure arrow "A" points toward engine front.**



SEM580D

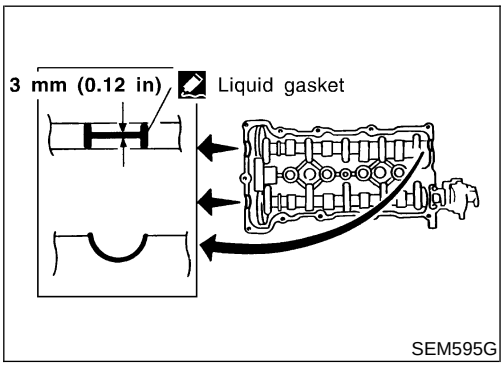
25. Install oil filter bracket (SR20DE engine only) and power steering oil pump bracket.
26. Install intake manifold supports.

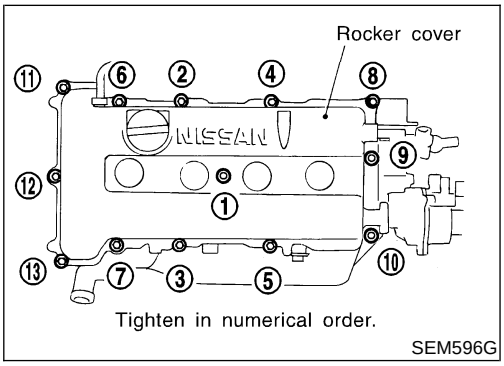
Installation (Cont'd)



27. Remove all old liquid gasket from mating surfaces of rocker cover and cylinder head.
28. Apply a continuous bead of liquid gasket to mating surfaces of rocker cover gasket and cylinder head.

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



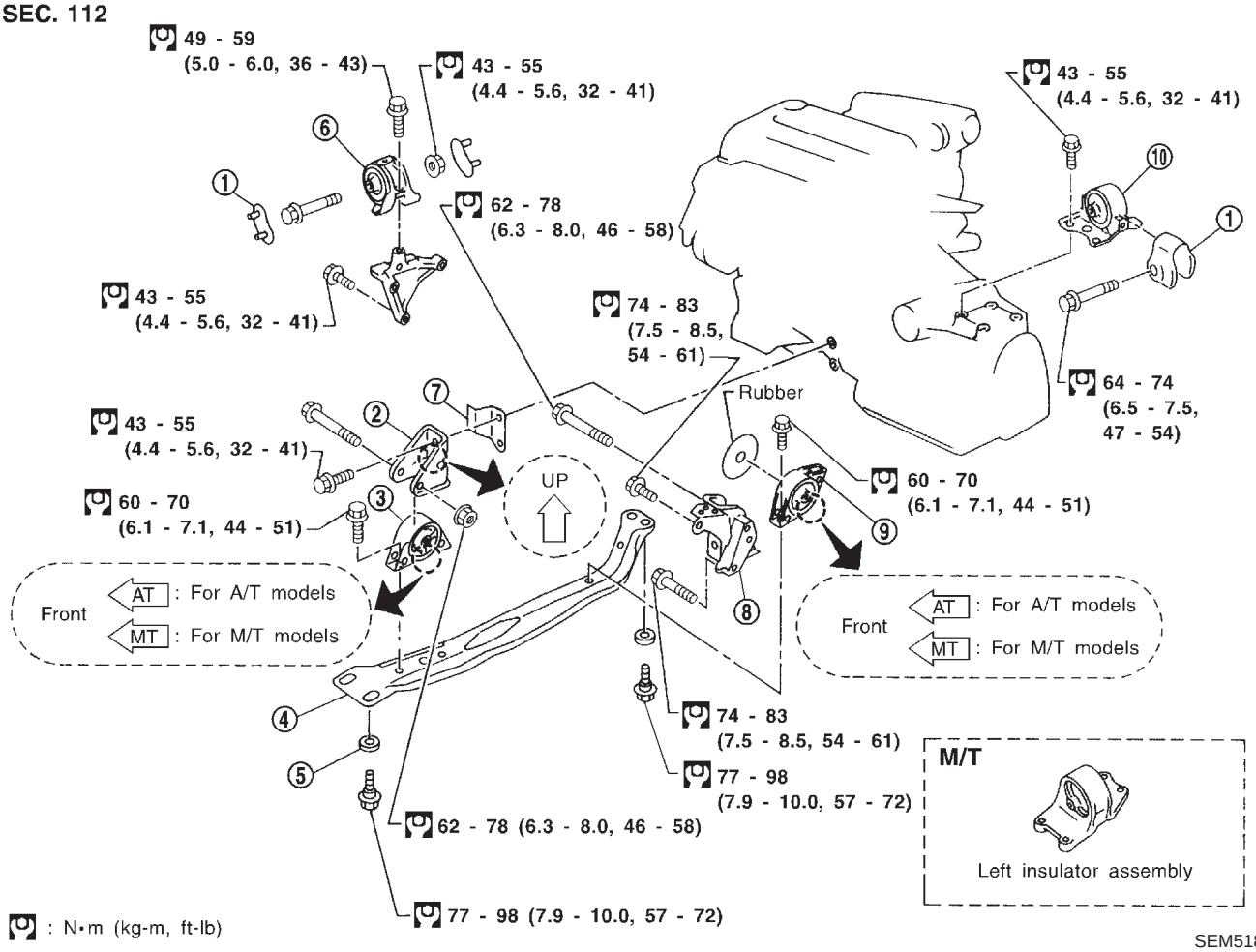


29. Install rocker cover.
1) **Tighten bolts 1 - 10 - 11 - 13 - 8 in that order to 8 to 10 N·m (0.8 to 1.0 kg-m, 69 to 89 in-lb).**
2) **Tighten bolts 1 through 13 in numerical order to 8 to 10 N·m (0.8 to 1.0 kg-m, 70 to 89 in-lb).**
30. Refit spark plugs and leads.
31. Install vacuum hoses, fuel hoses, wires, harness, connectors and so on.
32. Install power steering oil pump and alternator.
33. Install water pump pulley and drive belts.
34. Install intake manifold collector and brackets.
35. Refit air duct to intake manifold.
36. Install radiator.
37. Refit hoses and refill with coolant. (Refer to MA-15.)
38. Install engine side cover and front RH wheel.
39. Install engine under covers.

Removal and Installation

NCEM0022

SEC. 112



SEM518F

1. Stopper
2. Bracket
3. Front insulator assembly
4. Center member
5. Pad
6. Right insulator assembly
7. Exhaust bracket
8. Bracket
9. Rear insulator assembly
10. Left insulator assembly (A/T)

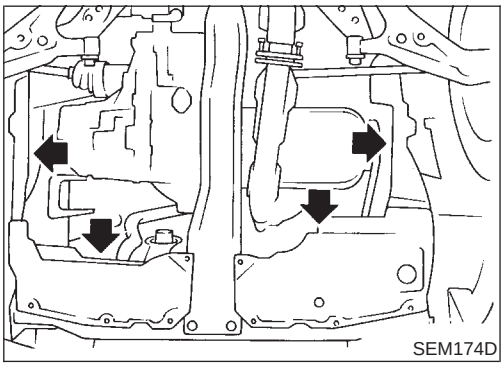
WARNING:

- **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 pressure. Refer to EC-50, “Fuel Pressure Release”.**
- **Before removing front axle from transaxle, place safety stands under designated front supporting points. Refer to GI-47, “Garage Jack and Safety Stand”.**
- **Be sure to lift 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. Use special care near accelerator wire casing, brake lines and brake master cylinder.**

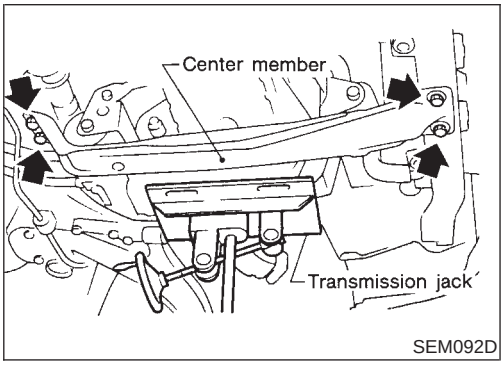
- **In lifting the engine, always use engine slingers in a safe manner.**
- **In removing drive shaft, be careful not to damage grease seal of transaxle.**
- **Before separating engine and transaxle, remove the crankshaft position sensor (OBD) from the assembly.**
- **Always be extra careful not to damage edge of crankshaft position sensor (OBD) or ring gear teeth.**


SEM174D

REMOVAL

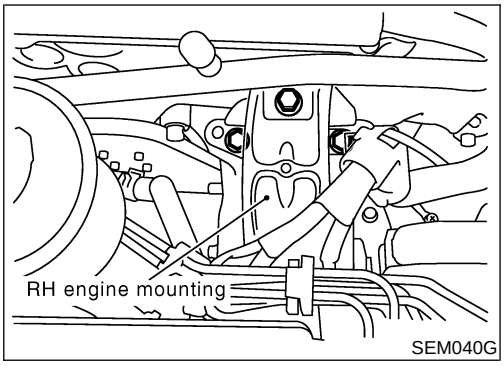
NCEM0022S01

1. Remove engine under covers and engine side cover.
2. Drain coolant from both cylinder block and radiator. Refer to MA-14, "Changing Engine Coolant".
3. Drain engine oil.
4. Remove air cleaner assembly and duct.
5. Remove the battery and battery tray.
6. Disconnect the following:
- Vacuum hoses
- Heater hoses
- A/T cooler hoses
- Power steering hoses
- Fuel lines
- Wires
- Harnesses and connectors
- Throttle cable
- ASCD cable
- A/T control cable
7. Remove the cooling fans, radiator and recovery tank.
8. Remove front LH and RH wheels and drive shafts. Refer to AX-10, "Drive Shaft".
9. Remove front exhaust pipe.
10. Remove starter and intake manifold support.
11. Remove the drive belts.
12. Remove power steering oil pump and A/C compressor.
13. Set a suitable transmission jack under transaxle. Lift engine with engine slinger.

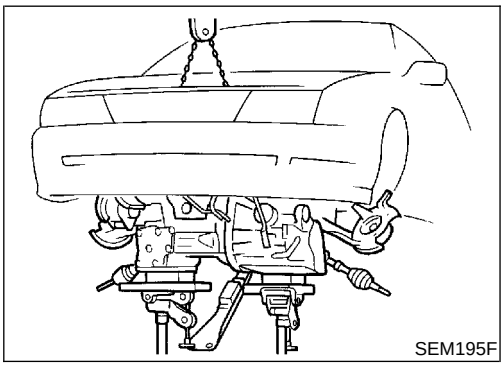


SEM092D

14. Remove center member.
15. Remove generator and adjusting bracket.



16. Remove engine mounting bolts from both sides, then slowly lower transmission jack.



17. Remove engine with transaxle as shown.

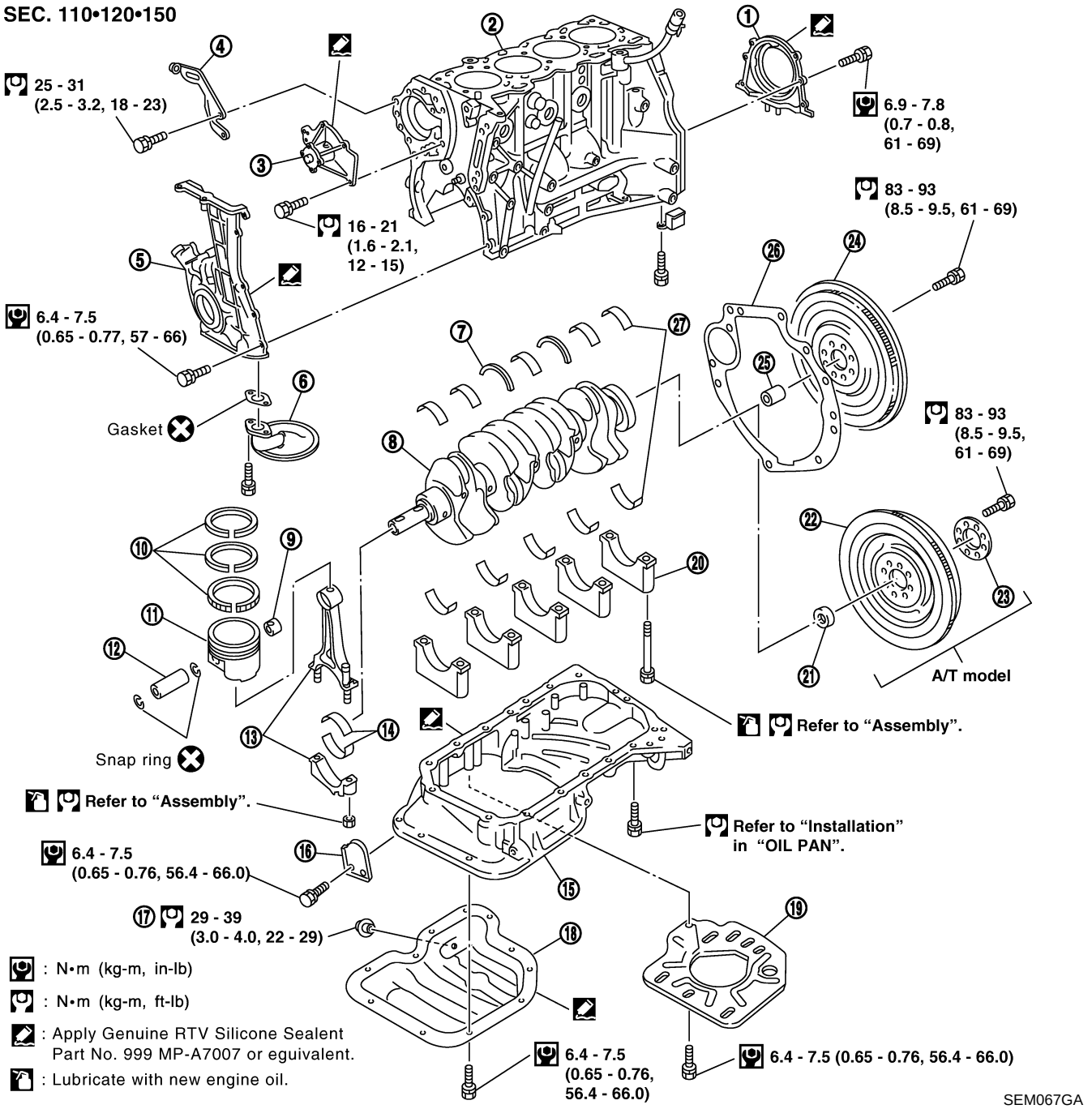
INSTALLATION

NCEM0022S02

1. Install in the reverse order of removal.

Components

NCEM0023



SEM067GA

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

Removal and Installation

NCEM0024

CAUTION:

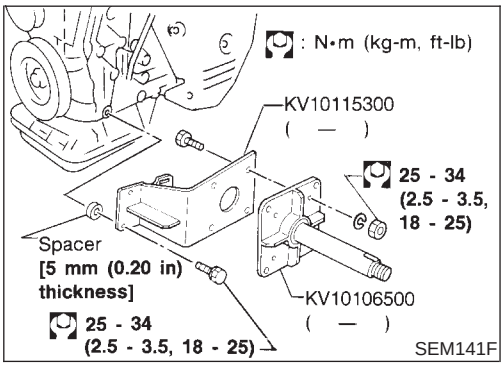
- **When installing sliding parts (bearings, pistons, etc.), lubricate contacting surfaces with new engine oil.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When installing connecting rod nuts and main bearing cap bolts, apply new engine oil to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

Disassembly

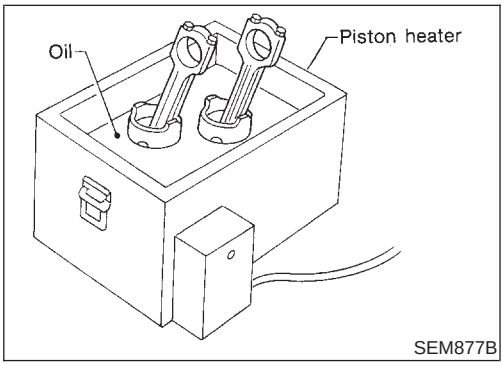
NCEM0025

PISTON AND CRANKSHAFT

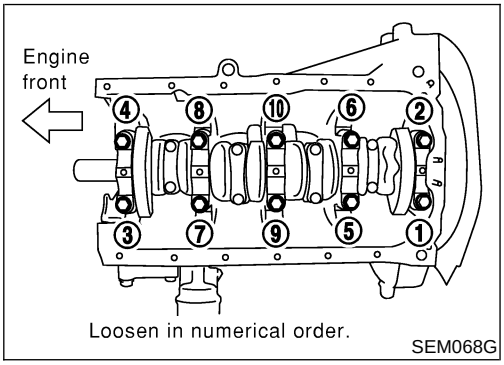
NCEM0025S01



1. Place engine on engine stand (ST0501S000).
2. Remove cylinder head and timing chain.
   Refer to EM-20.
3. Remove oil pan.
   Refer to EM-14.



4. 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.
   - **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.**
5. Remove rear oil seal retainer.



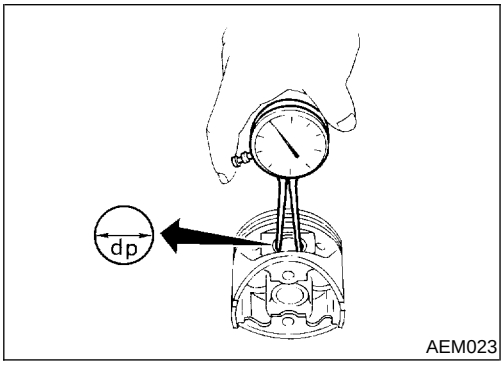
6. Remove main bearing cap and crankshaft as shown.
   - **Bolts should be loosened in two or three steps.**

Inspection

NCEM0026

PISTON AND PISTON PIN CLEARANCE

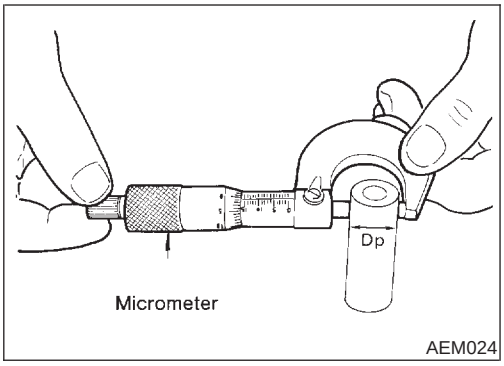
NCEM0026S01



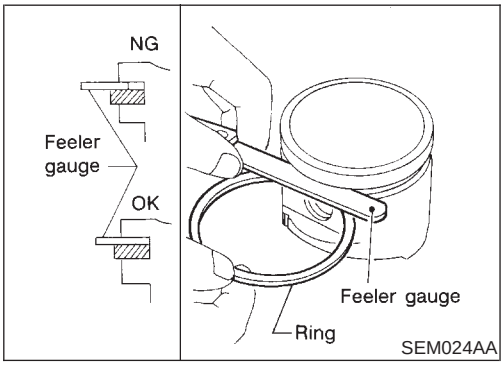
1. Measure inner diameter of piston pin hole “dp”.

   Standard diameter “dp”:

   21.993 - 22.005 mm (0.8659 - 0.8663 in)



2. Measure outer diameter of piston pin "Dp".
   Standard diameter "Dp":
   21.989 - 22.001 mm (0.8657 - 0.8622 in)
3. Calculate interference fit of piston pin to piston.
   Dp − dp: 0.005 - 0.017 mm (0.0002 - 0.0007 in)
   If it exceeds the above value, replace piston assembly with pin.

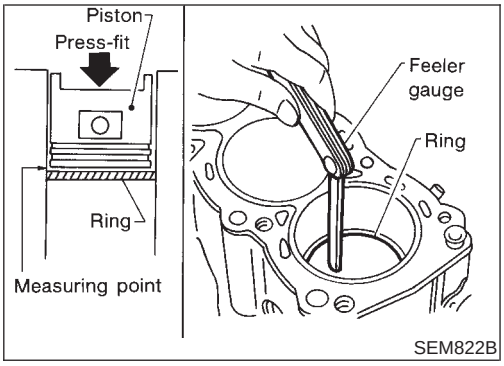


PISTON RING SIDE CLEARANCE

NCEM0026S02

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:
Top and 2nd ring
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

NCEM0026S03

End gap:

Top ring 0.20 - 0.39 mm (0.0079 - 0.0154 in)

2nd ring 0.35 - 0.59 mm (0.0138 - 0.0232 in)

Oil ring 0.20 - 0.69 mm (0.0079 - 0.0272 in)

Max. limit of ring gap:

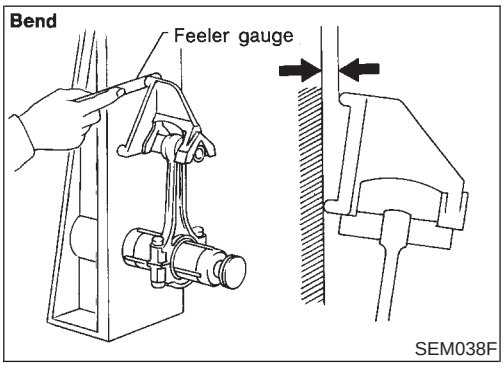
Top ring 0.53 mm (0.0209 in)

2nd ring 0.7 mm (0.028 in)

Oil ring 0.95 mm (0.374 in)

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

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



CONNECTING ROD BEND AND TORSION

NCEM0026S04

Bend:

Limit 0.15 mm (0.0059 in)

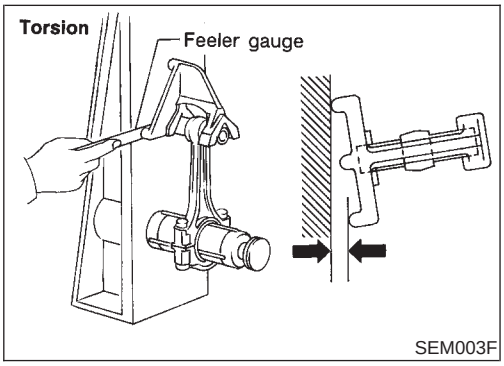
per 100 mm (3.94 in) length

Torsion:

Limit 0.30 mm (0.0118 in)

per 100 mm (3.94 in) length

If it exceeds the limit, replace connecting rod assembly.

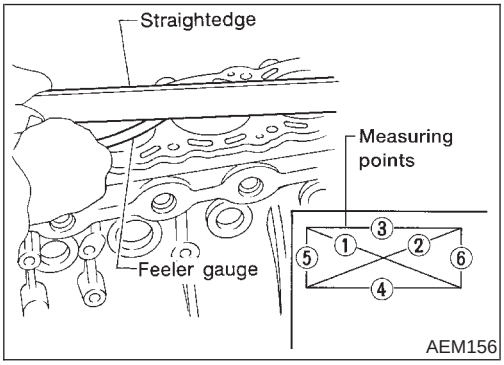


CYLINDER BLOCK DISTORTION AND WEAR

NCEM0026S05

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 0.10 mm (0.0039 in)

If out of specification, resurface it.

The limit for cylinder block resurfacing is determined by the amount of cylinder head resurfacing.

Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".

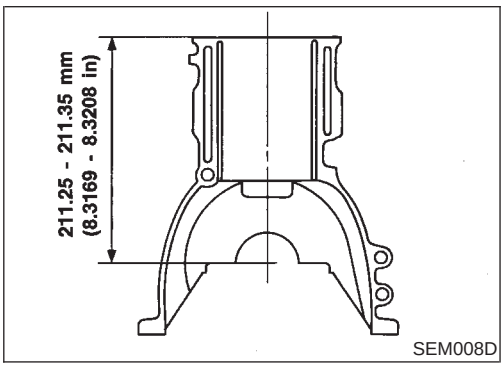
The maximum limit is as follows:

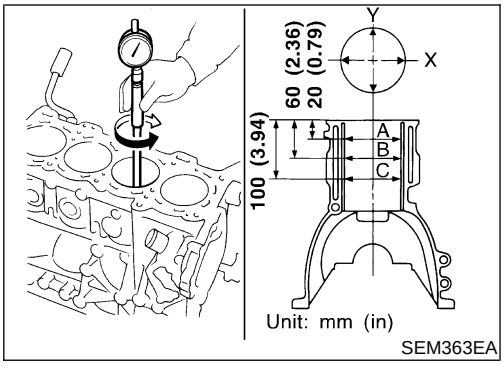
A + B = 0.2 mm (0.008 in)

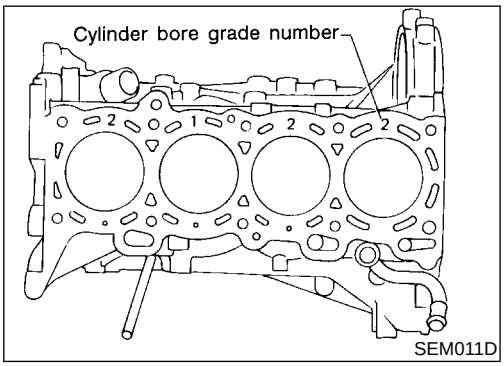
Nominal cylinder block height from crankshaft center:

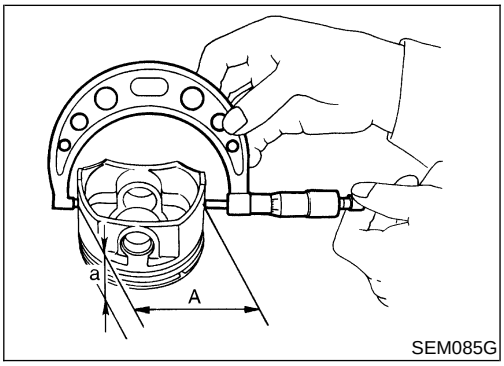
211.25 - 211.35 mm (8.3169 - 8.3208 in)

If necessary, replace cylinder block.









PISTON-TO-BORE CLEARANCE

NCEM0026S06

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

   Standard inner diameter:
   86.000 - 86.030 mm (3.3858 - 3.3870 in)
   Wear limit:
   0.20 mm (0.0079 in)
   Out-of-round (X − Y) standard:
   0.015 mm (0.0006 in)
   Taper (A − B and A − C) standard:
   0.010 mm (0.0004 in)

   If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.
2. Check for score and seizure. If seizure is found, hone it.

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

3. Measure piston skirt diameter.

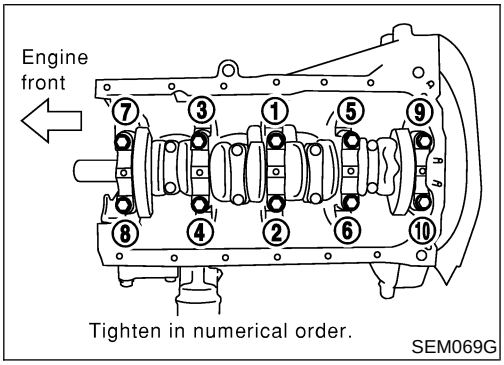
   Piston diameter "A": Refer to SDS, EM-78.
   Measuring point "a" (Distance from the top):
   45.0 mm (1.772 in)
4. Check that piston-to-bore clearance is within specification.

   Piston-to-bore clearance = bore measurement "C" − Piston diameter "A":
   0.010 - 0.030 mm (0.0004 - 0.0012 in)
5. Determine piston oversize according to amount of cylinder wear.

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

6. Cylinder bore size is determined by adding piston-to-bore clearance to piston diameter "A".

   Rebored size calculation:
   D = A + B − C
   where,
   D: Bored diameter
   A: Piston diameter as measured
   B: Piston-to-bore clearance
   C: Honing allowance 0.02 mm (0.0008 in)

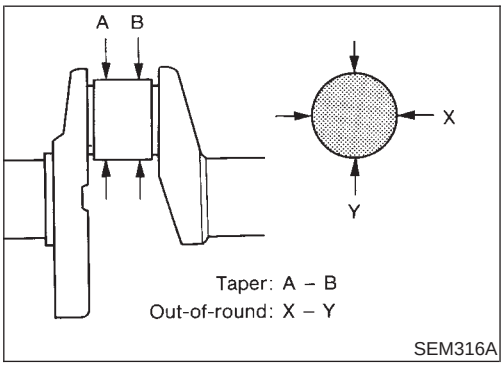


7. Install main bearing caps and tighten to the specified torque. This will prevent distortion of cylinder bores, otherwise cylinder bores may be distorted in final assembly.
8. Cut cylinder bores.

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



SEM316A

CRANKSHAFT

NCEM0026S07

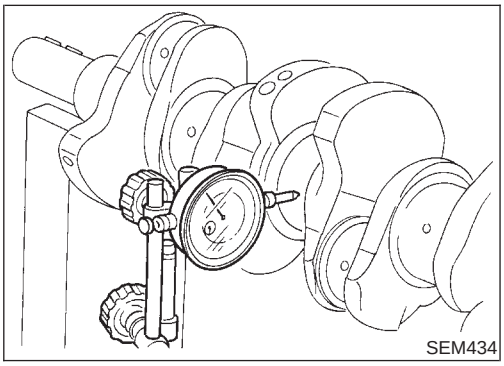
1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.

Out-of-round (X − Y):

Taper (A − B):

Main journal: Less than 0.005 mm (0.0002 in)

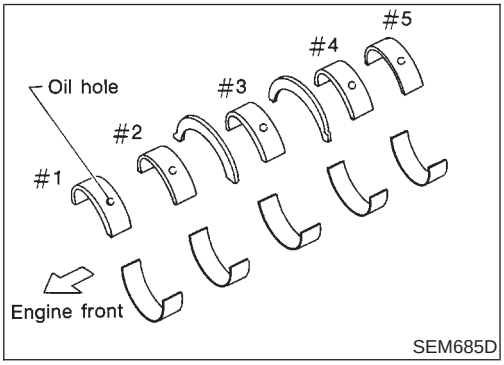
Pin journal: Less than 0.003 mm (0.0001 in)


SEM434

3. Measure crankshaft runout.

Runout (Total indicator reading):

Less than 0.05 mm (0.0020 in)



SEM685D

BEARING CLEARANCE

NCEM0026S08

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

Method A (Using bore gauge and micrometer)

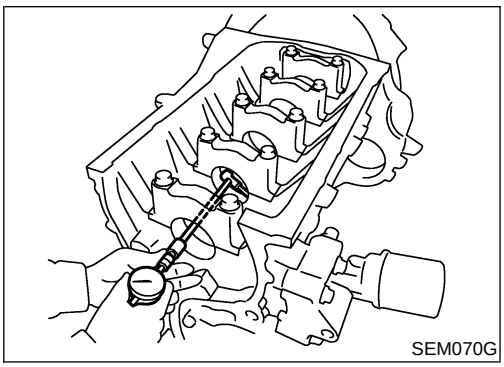
Main bearing

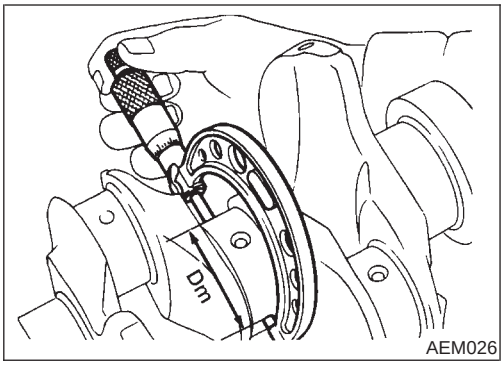
NCEM0026S0801

1. Set main bearings in their proper positions on cylinder block and main bearing cap.
2. Install main bearing cap and main bearing beam to cylinder block.

Tighten all bolts in correct order in two or three stages. Refer to EM-68.

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


SEM070G



AEM026

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

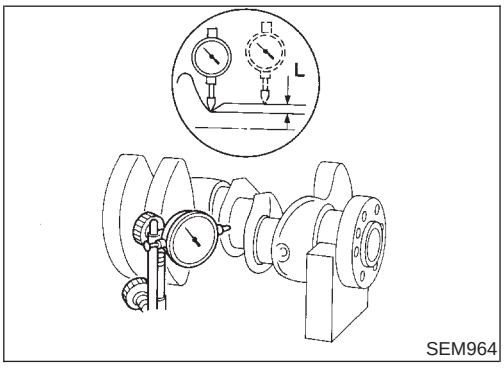
Main bearing clearance = A − Dm

Standard: 0.004 - 0.022 mm (0.0002 - 0.0009 in)

Limit: 0.050 mm (0.0020 in)

If it exceeds the limit, replace bearing.

- If clearance cannot be adjusted within the standard of any bearing, grind crankshaft main journal and use undersized bearing.

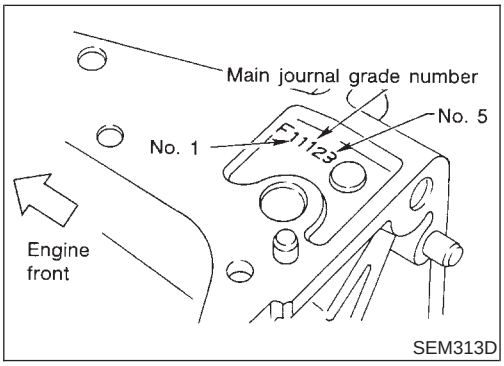


SEM964

- **When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.**

"L": 0.05 mm (0.0020 in)

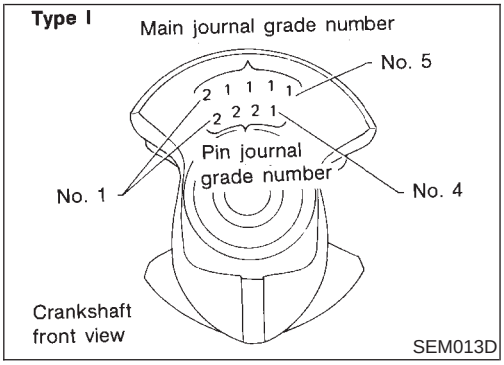
- **Refer to SDS, EM-80 for grinding crankshaft and available service parts.**



SEM313D

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

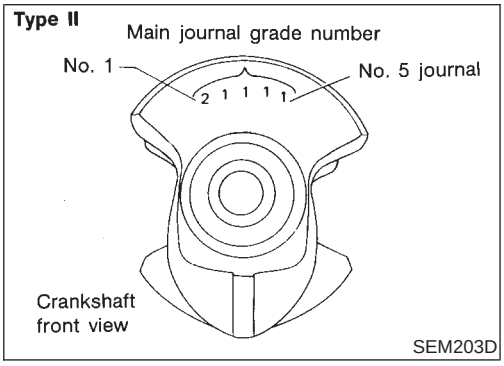
a. Grade number of each cylinder block main journal is punched on the respective cylinder block. These numbers are punched in either Arabic or Roman numerals.



SEM013D

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

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



SEM203D

How to Select Main Bearings (Identification mark and color)

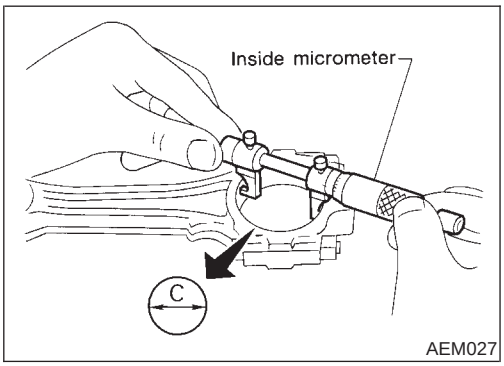
NCEM0026S0803

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

For example:

Cylinder block main journal grade number: 1

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



AEM027

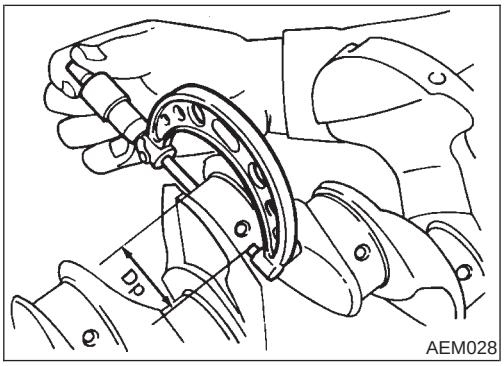
Connecting Rod Bearing (Big end)

NCEM0026S0802

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

Tighten bolts to the specified torque. Refer to EM-68.

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



AEM028

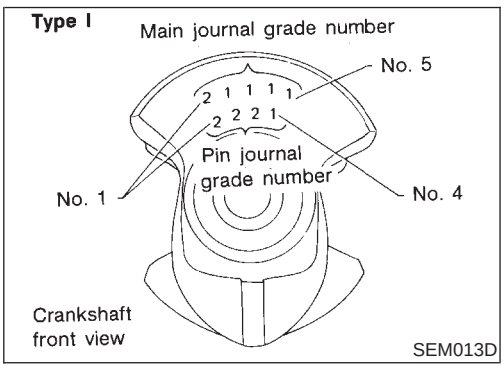
4. Measure outer diameter "Dp" of corresponding crankshaft pin journal.
5. Calculate connecting rod bearing clearance.

Connecting rod bearing clearance = C − Dp
Standard: 0.020 - 0.045 mm (0.0008 - 0.0018 in)
Limit: 0.065 mm (0.0026 in)

If it exceeds the limit, replace bearing.

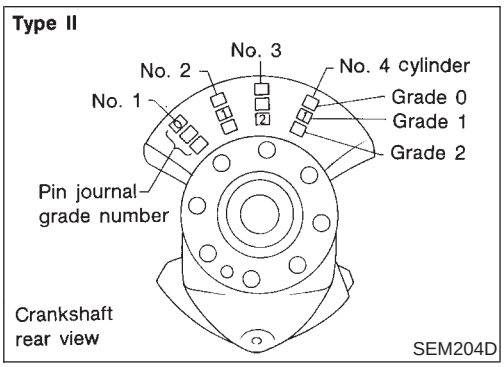
- If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to EM-63 for fillet roll remarks, grinding crankshaft and available service parts.
- If crankshaft is replaced with a new one, select connecting rod bearing according to the following table.

Connecting rod bearing grade number:
These numbers are punched in either Arabic or Roman numerals.



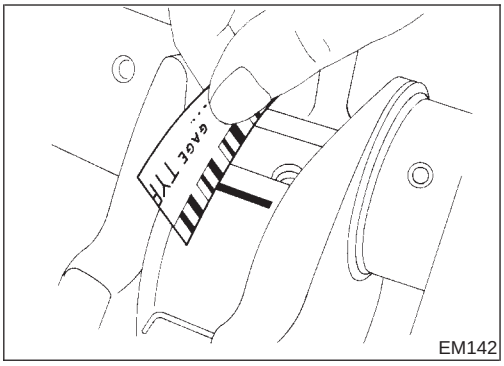
SEM013D

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



SEM204D

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



EM142

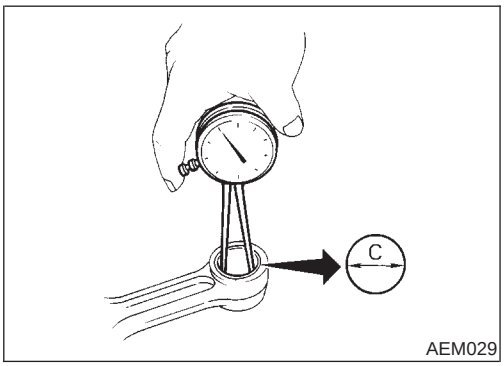
Method B (Using Plastigage)

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.**

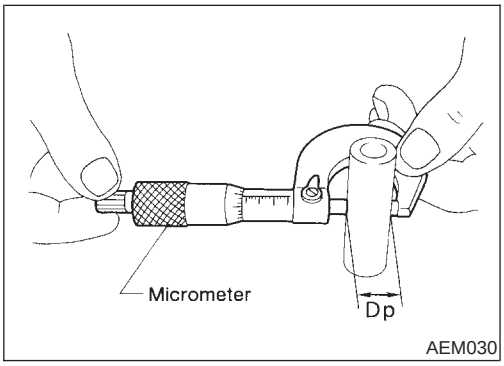
CONNECTING ROD BUSHING CLEARANCE (SMALL END)

NCEM0026S09



AEM029

1. Measure inner diameter "C" of bushing.



AEM030

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

Connecting rod bushing clearance = C − Dp

Standard:

0.005 - 0.017 mm (0.0002 - 0.0007 in)

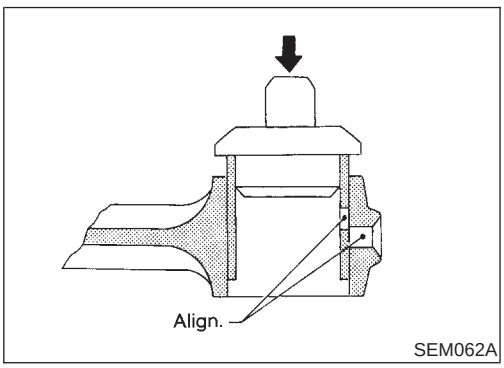
Limit:

0.023 mm (0.0009 in)

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

REPLACEMENT OF CONNECTING ROD BUSHING (SMALL END)

NCEM0026S10



SEM062A

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

Be sure to align the oil holes.

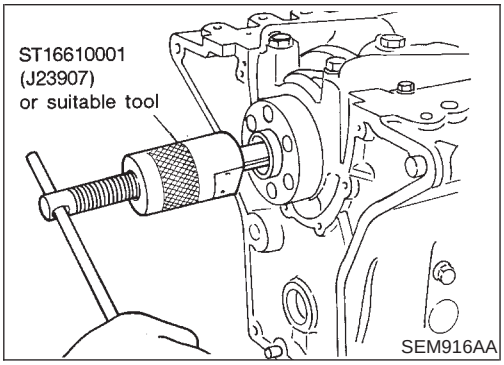
2. Ream the bushing so that clearance with piston pin is within specification.

Clearance between connecting rod bushing and piston pin:

0.005 - 0.017 mm (0.0002 - 0.0007 in)

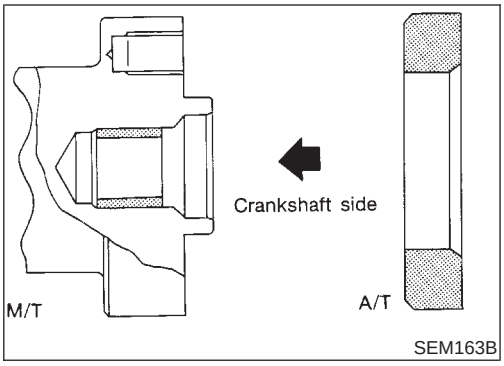
REPLACEMENT OF PILOT BUSHING (M/T) OR PILOT CONVERTER (A/T)

NCEM0026S11



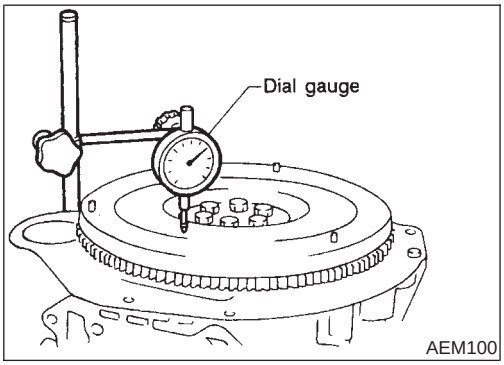
SEM916AA

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



SEM163B

2. Install pilot bushing or pilot converter as shown.



AEM100

FLYWHEEL/DRIVE PLATE RUNOUT

NCEM0026S12

Runout (Total indicator reading):

Flywheel (M/T model)

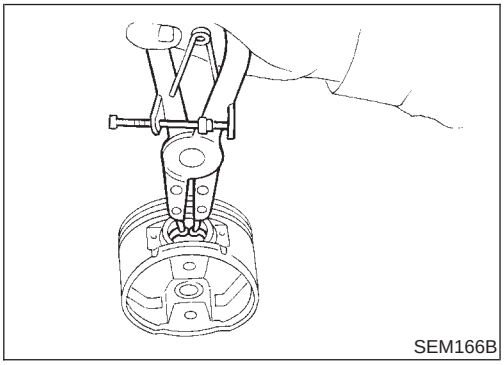
Less than 0.15 mm (0.0059 in)

Drive plate (A/T model)

Less than 0.20 mm (0.0079 in)

CAUTION:

- **Be careful not to damage the ring gear teeth.**
- **Check the drive plate for deformation or cracks.**
- **Do not allow any magnetic materials to contact the ring gear teeth.**
- **Do not resurface flywheel. Replace as necessary.**


SEM166B

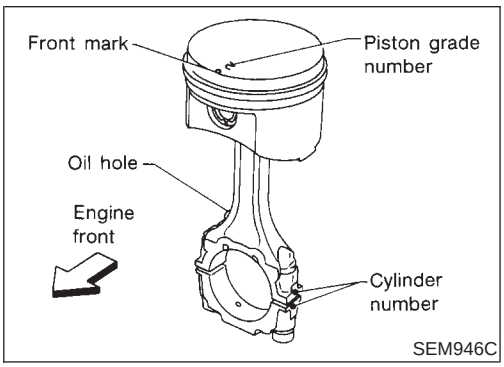
Assembly

NCEM0027

PISTON

NCEM0027S01

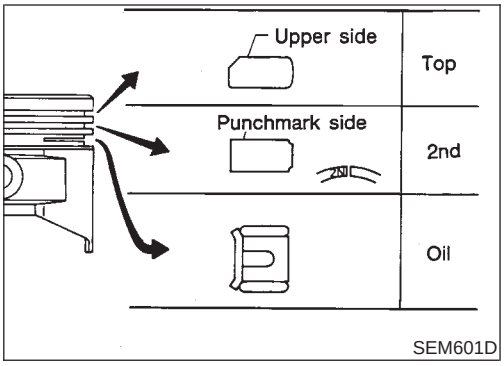
1. Install new snap ring on one side of piston pin hole.



SEM946C

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

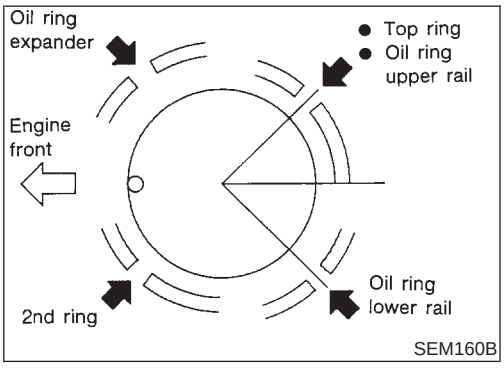
- **Align the direction of piston and connecting rod.**
- **Numbers stamped on connecting rod and cap correspond to each cylinder.**
- **After assembly, make sure connecting rod swings smoothly.**



3. Set piston rings as shown.

CAUTION:

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



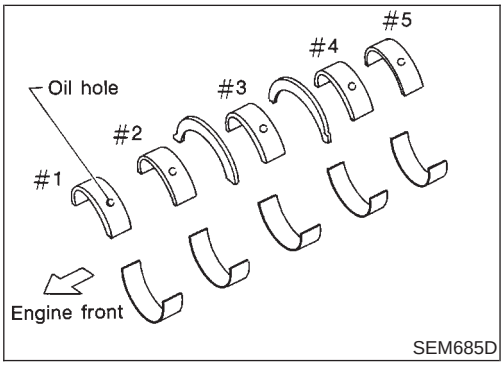
- **Align piston rings so that end gaps are positioned as shown.**

CRANKSHAFT

NCEM0027S02

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

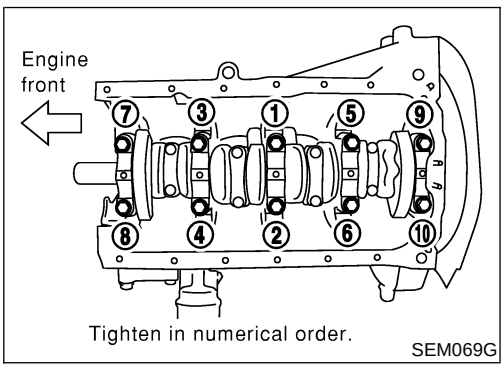
- **Confirm that correct main bearings are selected by using Method A or Method B. Refer to EM-63.**
- **Apply new engine oil to bearing surfaces.**

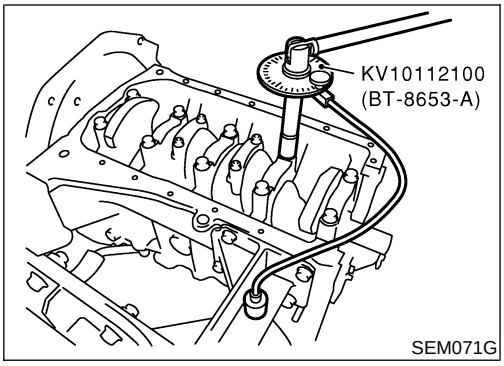


2. Install crankshaft and main bearing caps, then tighten bolts to the specified torque.

- **Prior to tightening bearing cap bolts, shift crankshaft back and forth to properly seat the bearing cap.**
- **Apply new engine oil to threads and seating surfaces of bearing cap bolts before installing them.**
- **Tightening procedure:**

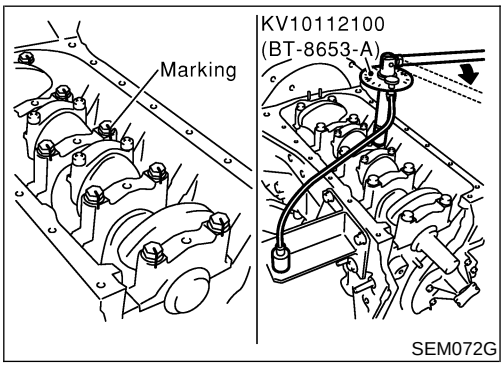
a. **Tighten all bolts to 7 to 12 N·m (0.7 to 1.3 kg-m, 61 to 112 ft-lb).**





b. **Turn all bolts 70 to 80 degrees clockwise with Tool or suitable angle wrench.**
c. **Loosen all bolts completely.**
d. **Tighten all bolts to 33 to 38 N·m (3.3 to 3.9 kg-m, 24 to 28 ft-lb).**
e. **Turn all bolts 30 to 35 degrees clockwise with Tool or suitable angle wrench.**

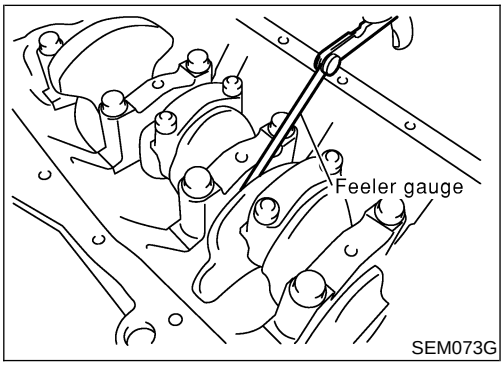
- **If an angle wrench is not available, mark all bearing cap bolts on the side facing engine rear. Then, turn each bolt specified degrees clockwise. Confirm angle of degrees with a graduator, not by eye measurement.**
- **After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.**

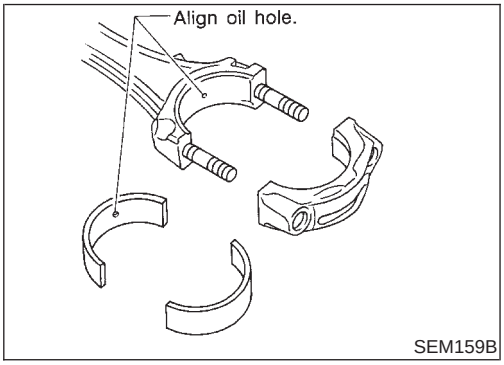


3. Measure crankshaft end play.

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

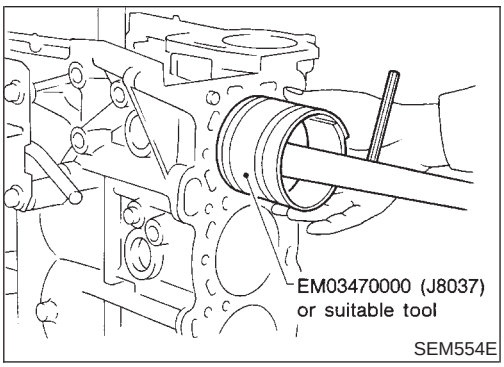
If beyond the limit, replace thrust bearing with new one.





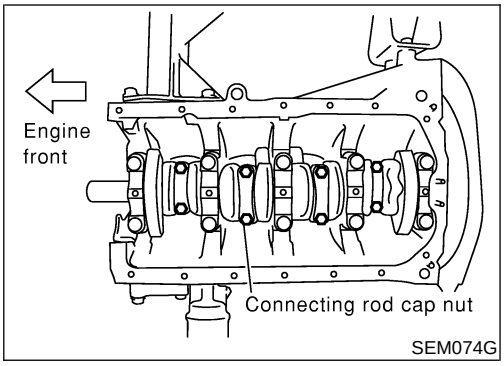
4. Install connecting rod bearings in connecting rods and connecting rod caps.

- **Confirm that correct bearings are used. Refer to EM-64.**
- **Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.**
- **Apply new engine oil to bolt threads and bearing surfaces.**



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

- **Make sure connecting rod does not scratch cylinder wall.**
- **Make sure connecting rod bolts do scratch crankshaft pin journals.**
- **Arrange so that front mark on piston head faces engine front.**
- **Apply new engine oil to piston rings and sliding surface of piston.**



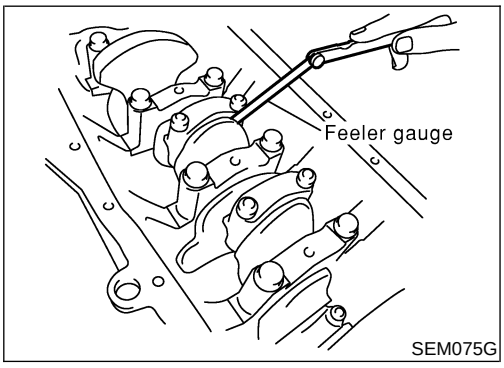
b. Install connecting rod caps.

- **Apply new engine oil to threads and seat surfaces.**

Tighten connecting rod cap nuts using the following procedure:

a) **Tighten nuts to 13.7 to 15.7 N·m (1.4 to 1.6 kg-m, 10 to 12 ft-lb).**

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



6. Measure connecting rod side clearance.

Connecting rod side clearance:

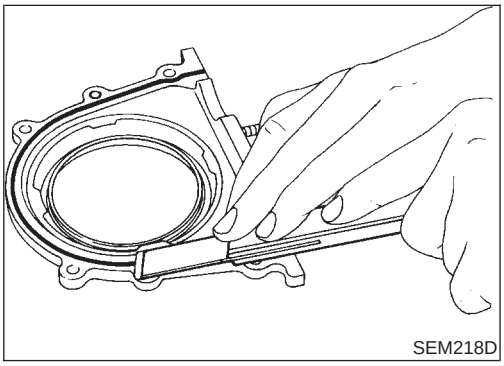
Standard

0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit

0.40 mm (0.0157 in)

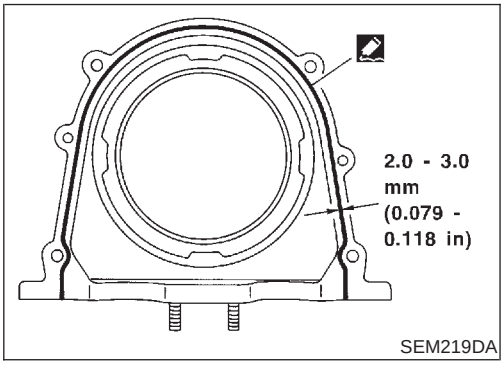
If beyond the limit, replace connecting rod and/or crankshaft.



7. Install rear oil seal retainer.

a. Before installing rear oil seal retainer, remove old liquid gasket from mating surface.

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



b. Apply a continuous bead of liquid gasket to mating surface of rear oil seal retainer.

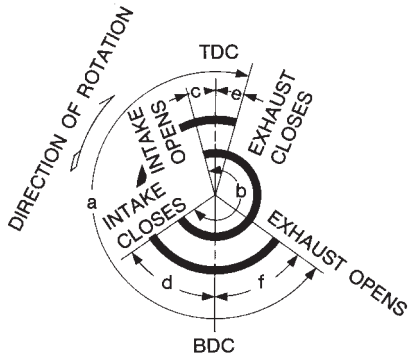
- **Use Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent.**
- **Apply around inner side of bolt holes.**

General Specifications

NCEM0028

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

Valve timing
Unit: degree



EM120

a	b	c	d	e	f
240°	232°	5°	47°	3°	57°

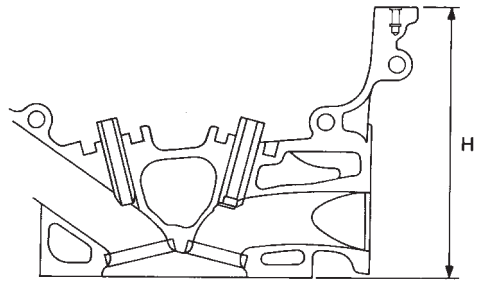
Compression Pressure

NCEM0029
Unit: kPa (kg/cm^2, psi)/300 rpm

Compression pressure	Standard	1,275 (13, 185)
	Minimum	1,079 (11, 156)
	Differential limit between cylinders	98 (1.0, 14)

Cylinder Head

NCEM0030
Unit: mm (in)



SEM043F

	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.1 (0.004)
Nominal cylinder head height “H”	136.9 - 137.1 (5.390 - 5.398)	
Resurfacing limit	0.2 (0.008)*	

*Total amount of cylinder head resurfacing plus cylinder block resurfacing

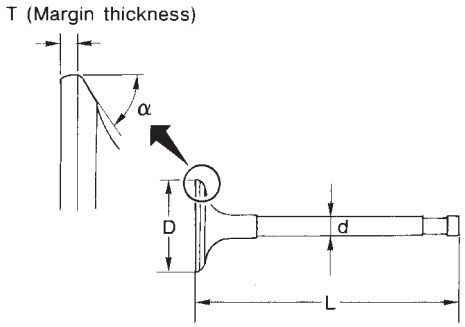
Valve

VALVE

NCEM0031

NCEM0031S01

Unit: mm (in)



SEM188A

Valve head diameter “D”	Intake	34.0 - 34.3 (1.339 - 1.350)
	Exhaust	30.0 - 30.3 (1.181 - 1.193)
Valve length “L”	Intake	97.04 - 97.16 (3.8205 - 3.8252)
	Exhaust	97.66 - 97.78 (3.8449 - 3.8496)
Valve stem diameter “d”	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.945 - 5.960 (0.2341 - 0.2346)
Valve seat angle “α”	Intake	45°15′ - 45°45′
	Exhaust	
Valve margin “T”	Intake	1.1 (0.043)
	Exhaust	1.3 (0.051)
Valve margin “T” limit		More than 0.5 (0.020)
Valve stem end surface grinding limit		Less than 0.2 (0.008)

VALVE SPRING

NCEM0031S02

Free height mm (in)		47.53 (1.8713)
Pressure N (kg, lb) at height mm (in)	Standard	519 - 571 (53.0 - 58.2, 117 - 128) at 27.0 (1.063)
	Limit	491.8 (50.16, 110.6) at 27.0 (1.063)
Out-of-square mm (in)		Less than 2.1 (0.083)

HYDRAULIC LASH ADJUSTER (HLA)

NCEM0031S03

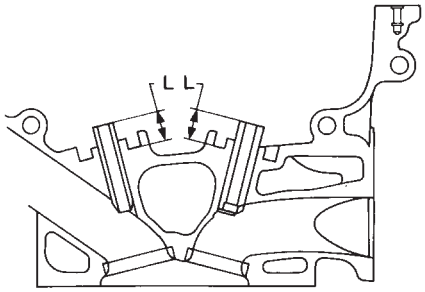
Unit: mm (in)

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

VALVE GUIDE

NCEM0031S04

Unit: mm (in)



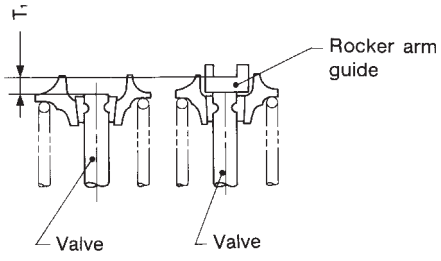
SEM083D

		Standard	Service
Valve guide Outer diameter	Intake	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
	Exhaust	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
Valve guide Inner diameter (Finished size)	Intake	6.000 - 6.018 (0.2362 - 0.2369)	
	Exhaust	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter	Intake	9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
	Exhaust	9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
		Standard	Limit
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
Valve deflection limit		0.2 (0.008)	
Projection length "L"		14.0 - 14.2 (0.551 - 0.559)	

VALVE SHIM CLEARANCE ADJUSTMENT

NCEM0031S06

Unit: mm (in)

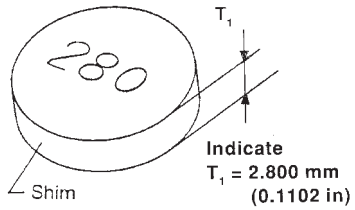


SEM095D

Valve shim clearance (cold) Intake & Exhaust	Less than 0.025 (0.001)
Shim thickness "T_1"	$T_1 \pm 0.025$ (0.001)

AVAILABLE SHIM

NCEM0031S07



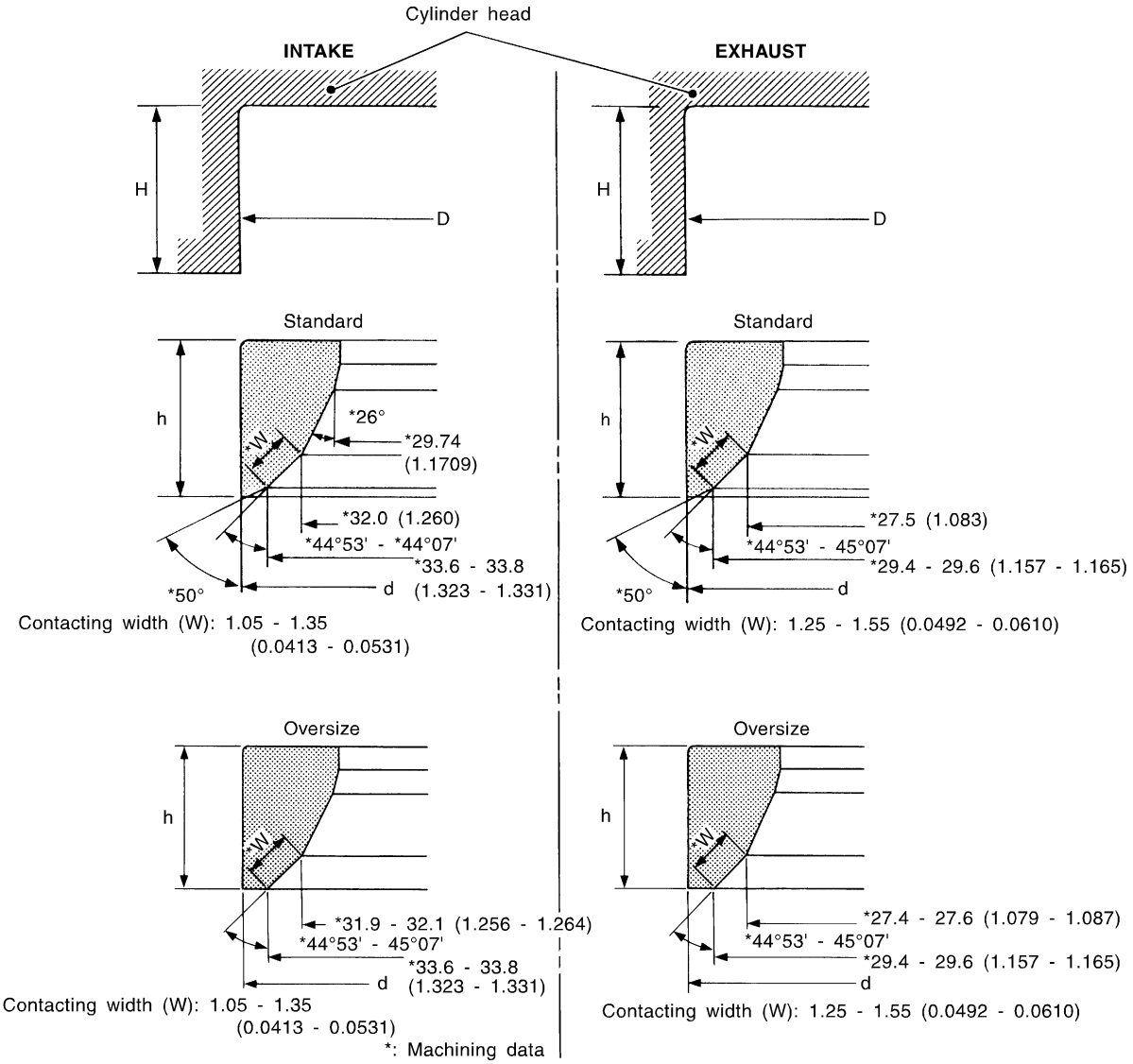
AEM236

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

VALVE SEAT

NCEM0031S05

Unit: mm (in)



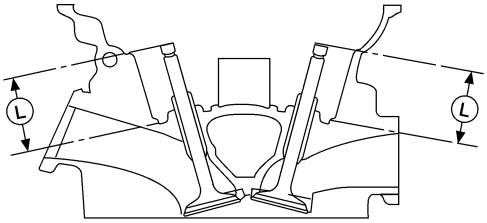
SEM651DE

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

VALVE SEAT RESURFACE LIMIT

NCEM0031S08

Unit: mm (in)



AEM343

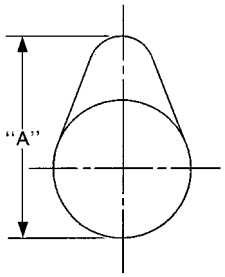
Depth (L)	42.74 - 43.26 (1.6827 - 1.7031)

Camshaft and Camshaft Bearing

NCEM0032

Unit: mm (in)

	Standard	Limit
Camshaft journal to bearing clearance	0.030 - 0.071 (0.0012 - 0.0028)	0.15 (0.0059)
Inner diameter of camshaft bearing	28.000 - 28.021 (1.1024 - 1.1032)	—
Outer diameter of camshaft journal	27.935 - 27.955 (1.0998 - 1.1006)	—
Camshaft runout [TIR*]	Less than 0.02 (0.0008)	0.1 (0.004)
Camshaft sprocket runout [TIR*]	Less than 0.25 (0.0098)	—
Camshaft end play	0.055 - 0.139 (0.0022 - 0.0055)	0.20 (0.0079)



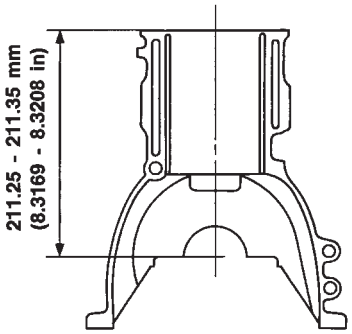
EM671

Cam height "A"	Intake	37.550 - 37.740 (1.4783 - 1.4858)
	Exhaust	37.920 - 38.110 (1.4929 - 1.5004)
Wear limit of cam height		0.2 (0.008)
Valve lift	Intake	9.4 (0.370)
	Exhaust	8.8 (0.346)

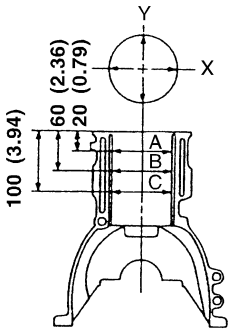
*Total indicator reading

Cylinder Block

NCEM0033
Unit: mm (in)



SEM008D



SEM686DB

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

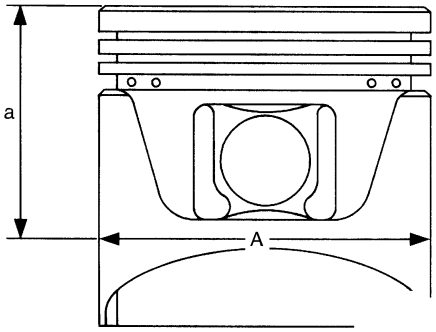
Piston, Piston Ring and Piston pin

NCEM0034

PISTON

NCEM0034S01

Unit: mm (in)



SEM086G

Piston skirt diameter “A” Standard	Grade No. 1	85.980 - 85.990 (3.3850 - 3.3854)
	Grade No. 2	85.990 - 86.000 (3.3854 - 3.3858)
	Grade No. 3	86.000 - 86.010 (3.3858 - 3.3862)
	0.20 (0.0079) oversize (Service)	86.180 - 86.210 (3.3929 - 3.3941)
“a” dimension		45.0 (1.772)
Piston clearance to cylinder block		0.010 - 0.030 (0.0004 - 0.0012)
Piston pin hole diameter		21.993 - 22.005 (0.8659 - 0.8663)

PISTON RING

NCEM0034S02

Unit: mm (in)

Side clearance	Top	Standard	0.04 - 0.08 (0.0016 - 0.0031)
		Limit	0.1 (0.004)
	2nd	Standard	0.03 - 0.07 (0.0012 - 0.0028)
		Limit	0.1 (0.004)
	Oil	Standard	0.065 - 0.135 (0.0026 - 0.0053)
		Limit	—
Ring end gap	Top	Standard	0.20 - 0.39 (0.0079 - 0.0154)
		Limit	0.53 (0.0209)
	2nd	Standard	0.35 - 0.59 (0.0138 - 0.0232)
		Limit	0.7 (0.028)
	Oil	Standard	0.20 - 0.69 (0.0079 - 0.0272)
		Limit	0.95 (0.0374)

PISTON PIN

NCEM0034S03

Unit: mm (in)

Piston pin outer diameter		21.989 - 22.001 (0.8657 - 0.8622)
Interference fit of piston pin to piston		0.002 - 0.006 (0.0001 - 0.0002)
Piston pin to connecting rod bushing clearance	Standard	0.005 - 0.017 (0.0002 - 0.0007)
	Limit	0.023 (0.0009)

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

Connecting Rod

NCEM0035

Unit: mm (in)

Center distance		136.25 - 136.35 (5.3642 - 5.3681)
Bend [per 100 (3.94)]	Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	Limit	0.30 (0.0118)
Connecting rod small end inner diameter		24.980 - 25.000 (0.9835 - 0.9843)
Piston pin bushing inner diameter*		22.000 - 22.012 (0.8661 - 0.8666)
Connecting rod big end inner diameter		51.000 - 51.013 (2.0079 - 2.0084)
Side clearance	Standard	0.20 - 0.35 (0.0079 - 0.0138)
	Limit	0.5 (0.020)

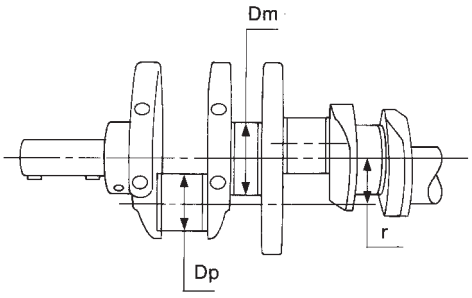
*After installing in connecting rod

Crankshaft

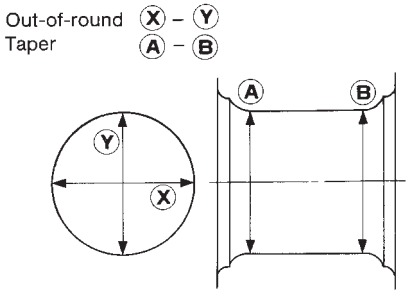
NCEM0036

Unit: mm (in)

Main journal dia. “Dm”	Grade No. 0	54.974 - 54.980 (2.1643 - 2.1646)
	Grade No. 1	54.968 - 54.974 (2.1641 - 2.1643)
	Grade No. 2	54.962 - 54.968 (2.1639 - 2.1641)
	Grade No. 3	54.956 - 54.962 (2.1636 - 2.1639)
Pin journal dia. “Dp”	Grade No. 0	47.968 - 47.974 (1.8885 - 1.8887)
	Grade No. 1	47.962 - 47.968 (1.8883 - 1.8885)
	Grade No. 2	47.956 - 47.962 (1.8880 - 1.8883)
Center distance “r”		42.96 - 43.04 (1.6913 - 1.6945)
Out-of-round (X − Y) Standard	Main journal	Less than 0.005 (0.0002)
	Pin journal	Less than 0.003 (0.0001)
Taper (A − B) Standard	Main journal	Less than 0.005 (0.0002)
	Pin journal	Less than 0.0025 (0.0001)
Runout [TIR]	Standard	Less than 0.025 (0.0010)
	Limit	Less than 0.05 (0.0020)
Free end play	Standard	0.10 - 0.26 (0.0039 - 0.0102)
	Limit	0.30 (0.0118)



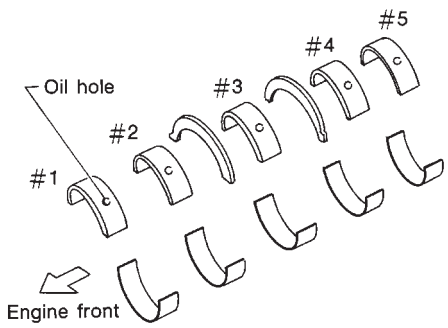
SEM954C



EM715

Main Bearing

NCEM0037



SEM685D

STANDARD

NCEM0037S01
Unit: mm (in)

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

UNDERSIZE

NCEM0037S02
Unit: mm (in)

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

Connecting Rod Bearing

NCEM0038

STANDARD SIZE

NCEM0038S01
Unit: mm (in)

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

UNDERSIZE

NCEM0038S02
Unit: mm (in)

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

Bearing Clearance

NCEM0039

Unit: mm (in)

Main bearing clearance	Standard	0.004 - 0.022 (0.0002 - 0.0009)
	Limit	0.05 (0.0020)
Connecting rod bearing clearance	Standard	0.020 - 0.045 (0.0008 - 0.0018)
	Limit	0.065 (0.0026)

Miscellaneous Components

NCEM0040

Unit: mm (in)

Camshaft sprocket runout limit [TIR]	0.25 (0.0098)
Flywheel runout limit [TIR]	0.15 (0.0059)
Drive plate runout limit [TIR]	0.2 (0.008)