SECTION EM

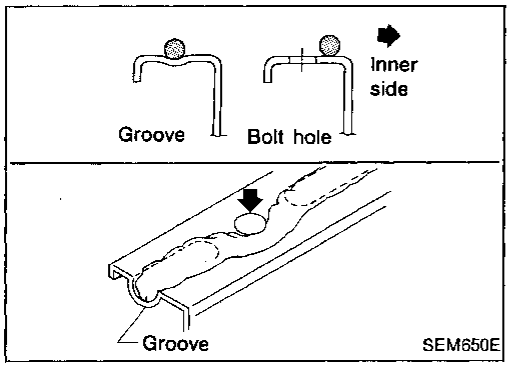
CONTENTS

Parts Requiring Angular Tightening

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

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



Liquid Gasket Application Procedure

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

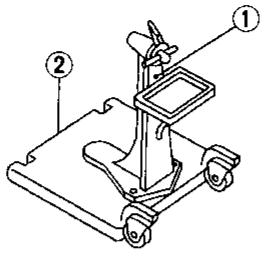
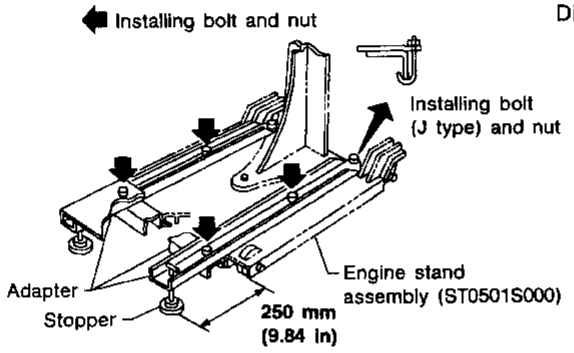
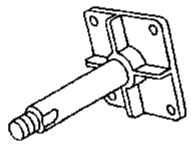
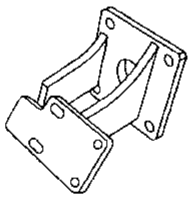
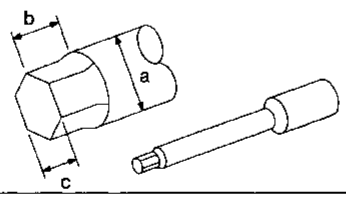
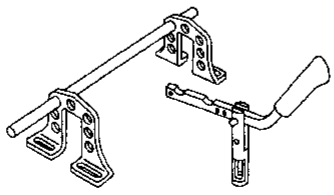
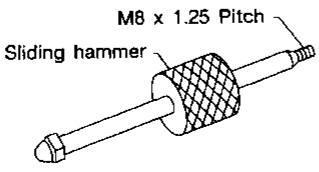
b. Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Liquid Gasket or equivalent.)

- **Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide (for oil pan).**
- **Be sure liquid gasket is 2.0 to 3.0 mm (0.079 to 0.118 in) wide (in areas except oil pan).**

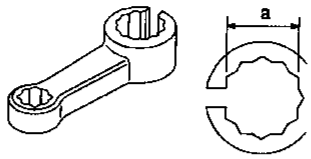
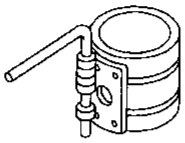
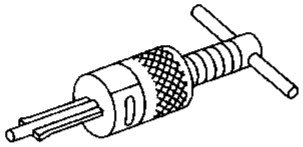
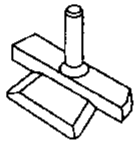
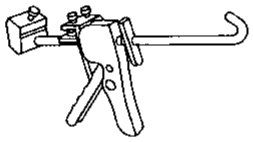
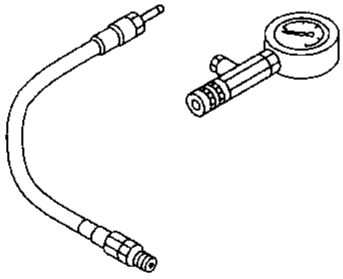
c. Apply liquid gasket to inner surface around bolt holes. (Assembly should be done within 5 minutes after coating.)

d. Wait at least 30 minutes before refilling engine oil and engine coolant.

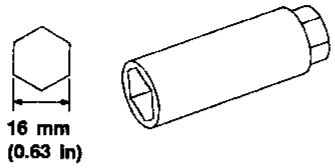
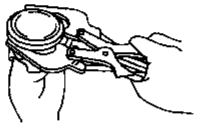
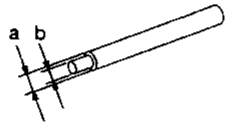
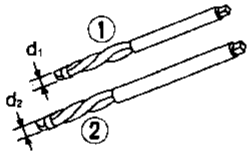
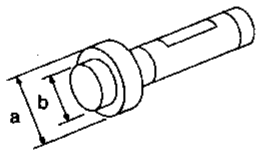
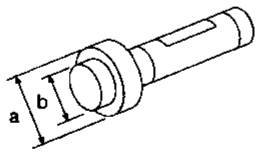
Special Service Tools

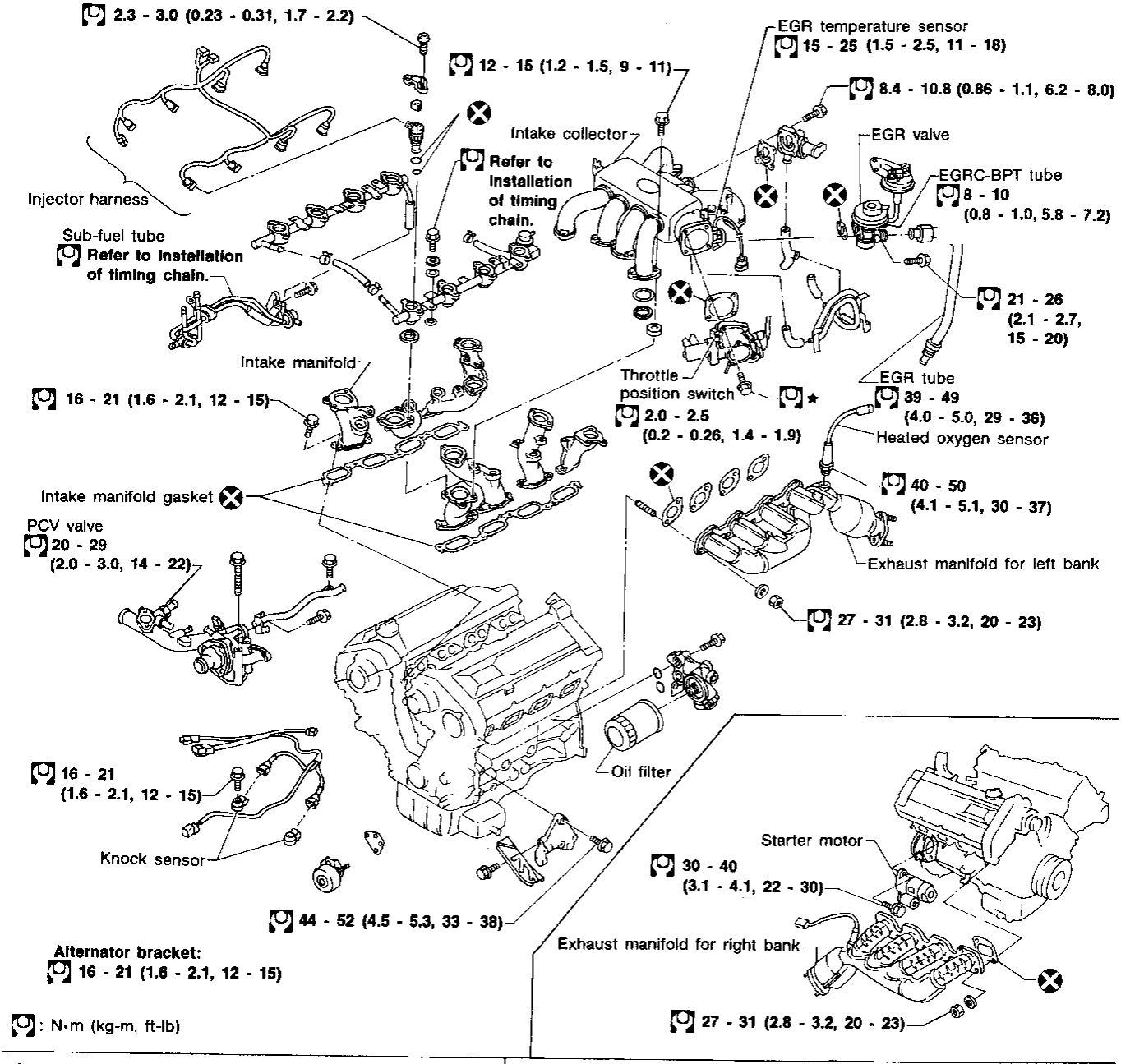
Tool number (Kent-Moore No.) Tool name	Description
ST0501S000 (—) Engine stand assembly ① ST05011000 (—) Engine stand ② ST05012000 (—) Base	Disassembling and assembling  NT042
KV10114900 (—) Engine stand support arm	Disassembling and assembling  NT043
KV10106500 (—) Engine stand shaft	When overhauling engine  NT028
KV10114601 (—) Engine sub-attachment	 NT240
ST10120000 (J24239-01) Cylinder head bolt wrench	Loosening and tightening cylinder head bolt **a: 13 mm (0.51 in) dia.** **b: 12 mm (0.47 in)** **c: 10 mm (0.39 in)**  NT583
(J39773) Valve spring compressor	Disassembling and assembling valve components  NT103
KV10114700 (—) Main bearing cap remover	Removing main bearing cap  NT633

Special Service Tools (Cont'd)

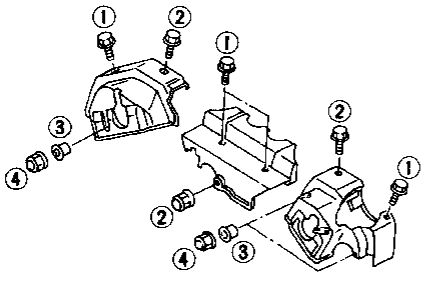
Tool number (Kent-Moore No.) Tool name	Description	
KV10114400 (J-38365) Heated oxygen sensor wrench	 NT636	Loosening or tightening heated oxygen sensor **a: 22 mm (0.87 in)**
EM03470000 (J8037) Piston ring compressor	 NT044	Installing piston assembly into cylinder bore
ST16610001 (J23907) Pilot bushing puller	 NT045	Removing crankshaft pilot bushing
KV10111100 (J37228) Seal cutter	 NT046	Removing oil pan
WS39930000 (—) Tube presser	 NT052	Pressing the tube of liquid gasket
EG15060000 (—) Compression gauge and adapter	 NT238	

Commercial Service Tools

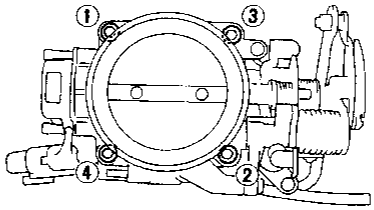
Tool name	Description	
Spark plug wrench	 NT047	Removing and installing spark plug
Valve seat cutter set	 NT048	Finishing valve seat dimensions
Piston ring expander	 NT030	Removing and installing piston ring
Valve guide drift	 NT015	Removing and installing valve guide **Intake:** **a = 11.5 mm (0.453 in) dia.** **b = 6.5 mm (0.256 in) dia.** **Exhaust:** **a = 12.5 mm (0.492 in) dia.** **b = 7.5 mm (0.295 in) dia.**
Valve guide reamer	 NT016	Reaming valve guide ① or hole for oversize valve guide ② **Intake:** **d_1 = 7.000 mm (0.2756 in) dia.** **Exhaust:** **d_1 = 8.000 mm (0.3150 in) dia.** **Intake:** **d_2 = 11.175 mm (0.4400 in) dia.** **Exhaust:** **d_2 = 12.175 mm (0.4793 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.**



Front ornament cover



Tighten in numerical order.
6.3 - 8.3 (0.64 - 0.85, 4.6 - 6.1)



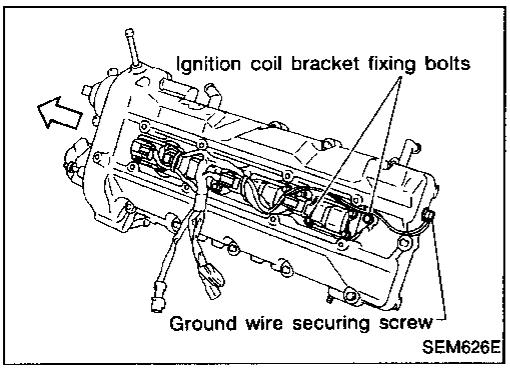
Tighten in numerical order.

★ Throttle body bolts

Tightening procedure

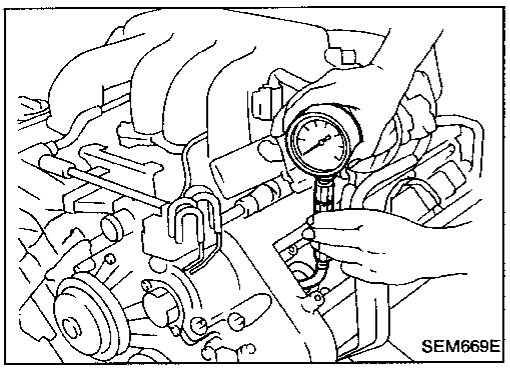
1) Tighten all bolts to 9 to 11 N·m (0.9 to 1.1 kg-m, 6.5 to 8.0 ft-lb).
2) Tighten all bolts to 18 to 22 N·m (1.8 to 2.2 kg-m, 13 to 16 ft-lb).

MEM091A



Measurement of Compression Pressure

1. Warm up engine.
2. Turn ignition switch off.
3. Release fuel pressure.
   Refer to "Releasing Fuel Pressure" in EF & EC section.
4. Remove air duct (only left bank).
5. Disconnect power transistor connectors.
6. Remove harness connector bracket (only left bank).
7. Remove ornamental rocker covers.
8. Disconnect harness connector between ignition coil and power transistor.
9. Remove ignition coil bracket fixing bolts and ground wire securing screw, and pull out this bracket with ignition coils.
10. Remove all spark plugs.



11. Attach a compression tester to No. 1 cylinder.
12. Depress gas pedal fully to keep throttle valve wide open.
13. Crank engine and record highest gauge indication.
14. Repeat the measurement on each cylinder.

- **Use a fully-charged battery to get specified engine speed.**

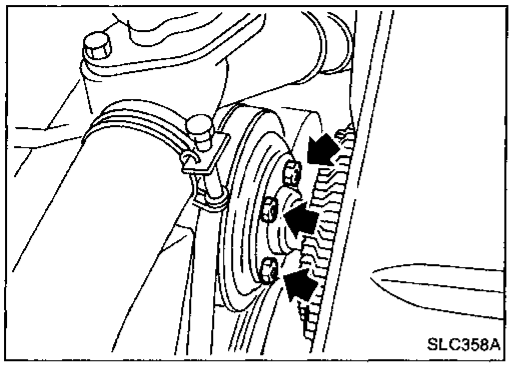
Compression pressure: kPa (kg/cm^2, psi)/rpm

Standard
1,275 (13.0, 185)/300
Minimum
981 (10.0, 142)/300
Difference limit between cylinders
98 (1.0, 14)/300

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

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

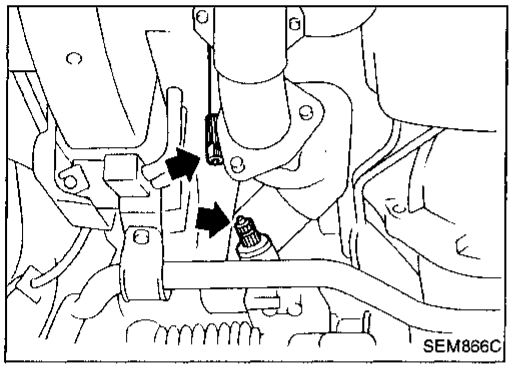
- **If adding oil improves cylinder compression, piston rings may be worn or damaged. Replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect valve and valve seat. Refer to SDS (EM-45).**
- **Compression stays low in two cylinders that are next to each other:**
  The cylinder head gasket may be leaking, or
  Both cylinders may have valve component damage.
  Inspect and repair as necessary.



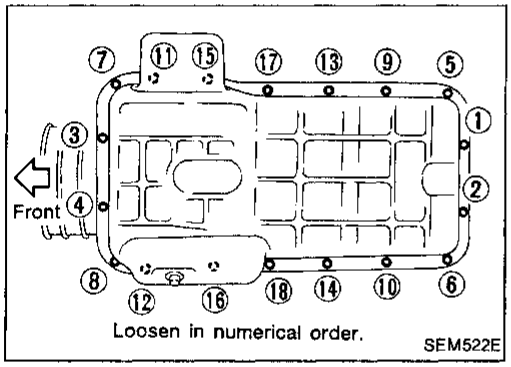
Removal

1. Remove engine under cover.
2. Drain engine oil.
3. Remove fan coupling with fan.
4. Remove the following parts.

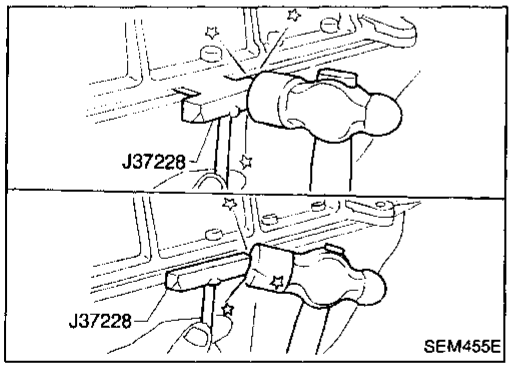
- All drive belts
- Alternator
- A/C compressor
- Engine gusset



5. Remove steering lower joint.
6. Set a suitable transmission jack under the transmission. Hoist engine with engine slinger.
7. Remove suspension member assembly.



8. Remove oil pan.

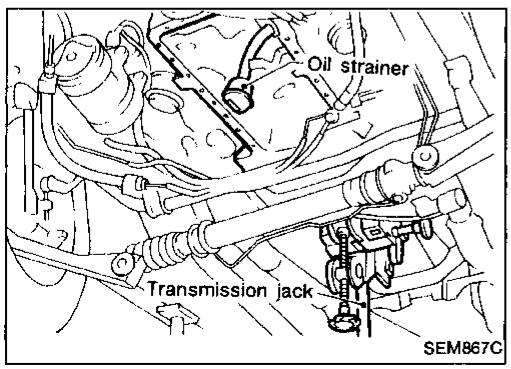


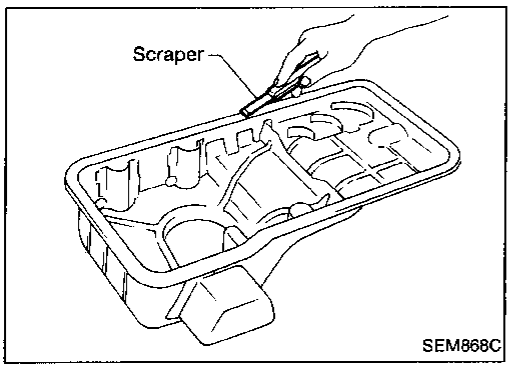
9. Remove oil pan.

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

- **Do not drive seal cutter into oil pump or rear oil seal retainer portion. Doing so will damage the aluminum mating face.**
- **Do not insert screwdriver, or oil pan flange will be deformed.**

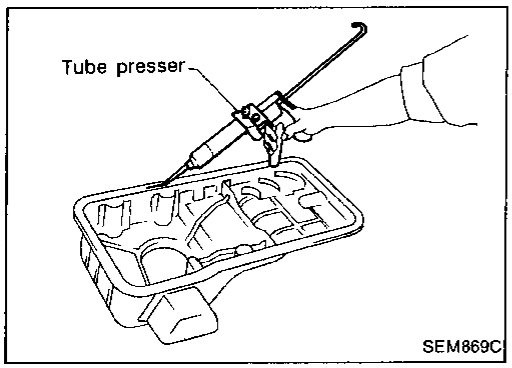
(2) Slide Tool by tapping its side with a hammer, and remove oil pan.



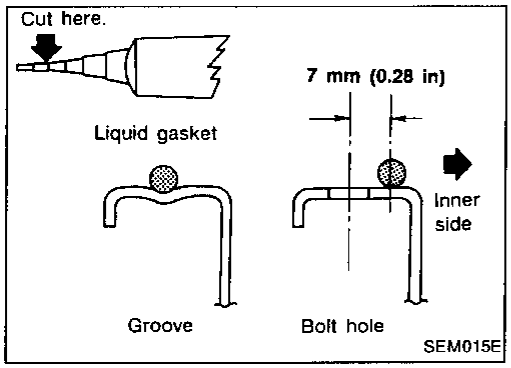


Installation

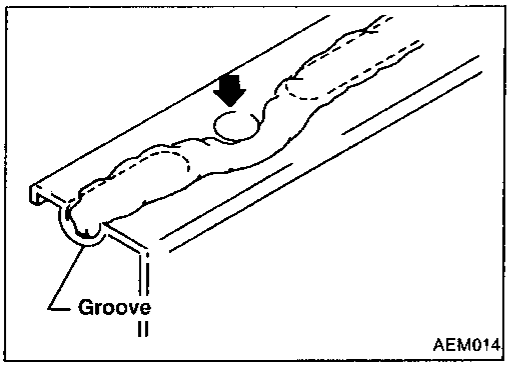
1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
- Also remove traces of liquid gasket from mating surface of cylinder block.

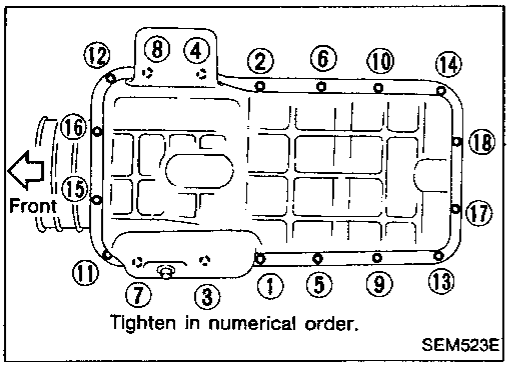


2. Apply a continuous bead of liquid gasket to mating surface of oil pan.
- **Use Genuine Liquid Gasket or equivalent.**

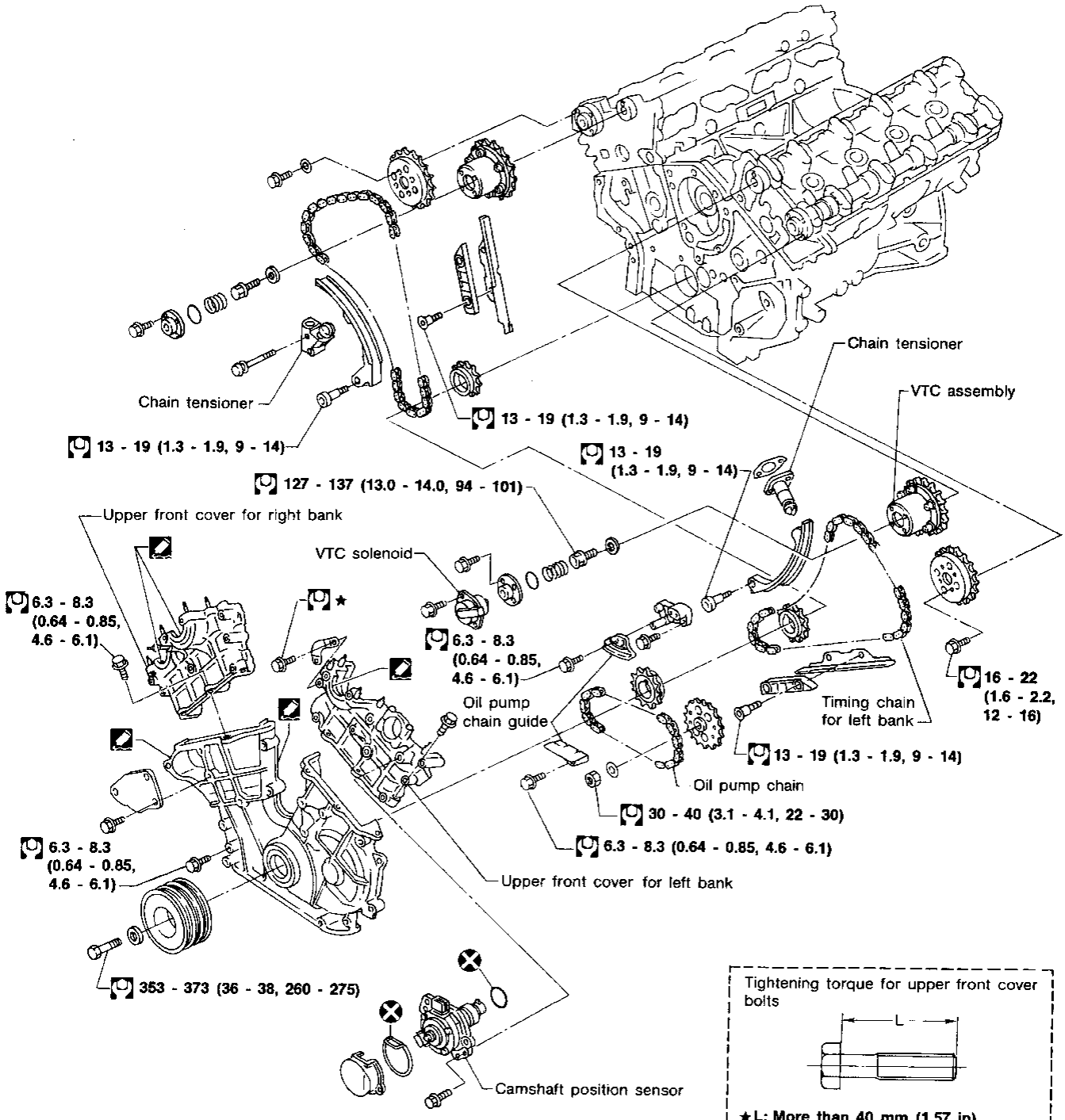


- Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.
3. Apply liquid gasket to inner sealing surface as shown in figure.
- Attaching should be done within 5 minutes after coating.

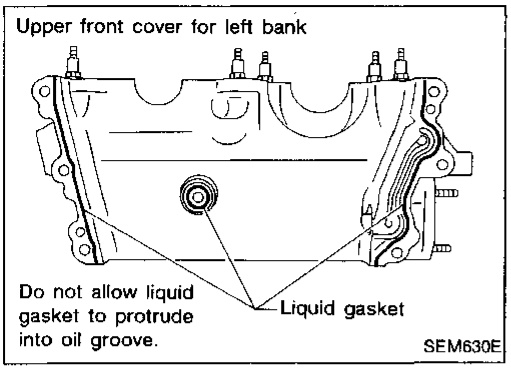


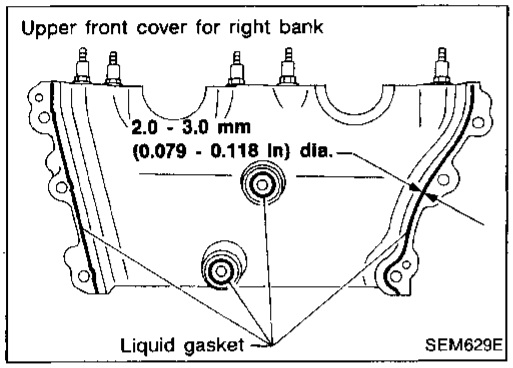


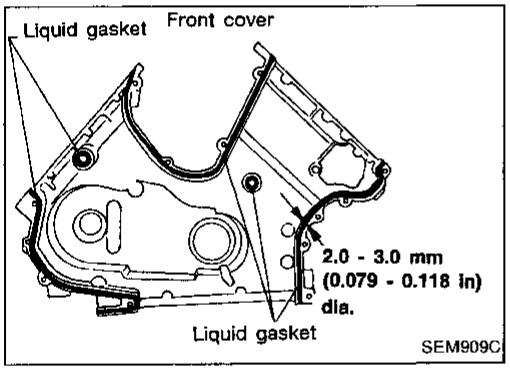
4. Install oil pan.
- Install bolts/nuts in the reverse order of removal.
- Wait at least 30 minutes before refilling engine oil.

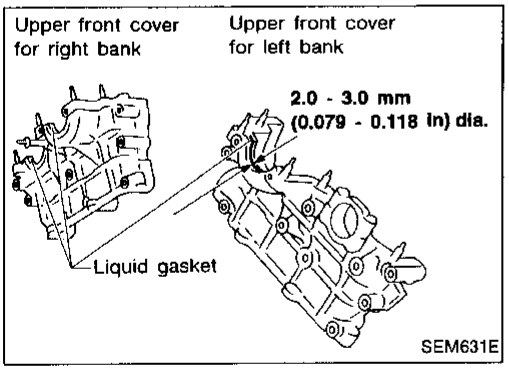

Chain tensioner
13 - 19 (1.3 - 1.9, 9 - 14)
13 - 19 (1.3 - 1.9, 9 - 14)
Chain tensioner
VTC assembly
13 - 19 (1.3 - 1.9, 9 - 14)
127 - 137 (13.0 - 14.0, 94 - 101)
Upper front cover for right bank
VTC solenoid
6.3 - 8.3 (0.64 - 0.85, 4.6 - 6.1)
★
6.3 - 8.3 (0.64 - 0.85, 4.6 - 6.1)
Oil pump chain guide
16 - 22 (1.6 - 2.2, 12 - 16)
Timing chain for left bank
13 - 19 (1.3 - 1.9, 9 - 14)
Oil pump chain
30 - 40 (3.1 - 4.1, 22 - 30)
6.3 - 8.3 (0.64 - 0.85, 4.6 - 6.1)
6.3 - 8.3 (0.64 - 0.85, 4.6 - 6.1)
Upper front cover for left bank
353 - 373 (36 - 38, 260 - 275)
Camshaft position sensor
: N•m (kg-m, ft-lb)
: Liquid gasket
Tightening torque for upper front cover bolts
L
★L: More than 40 mm (1.57 in)
6.3 - 8.3 (0.64 - 0.85, 4.6 - 6.1)
Less than 40 mm (1.57 in)
9.0 - 11.8 (0.92 - 1.2, 6.7 - 8.7)

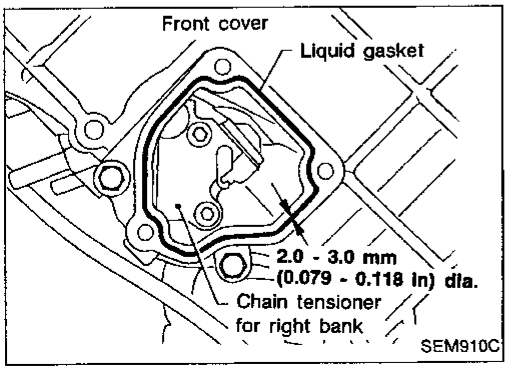
SEM628E









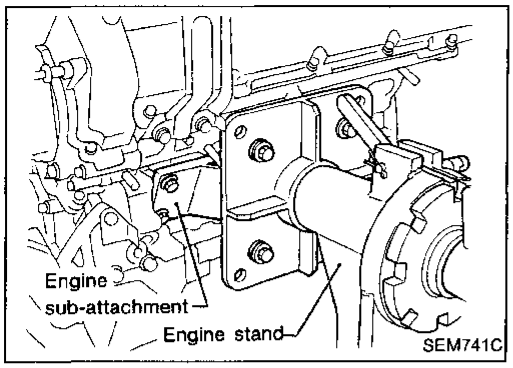


POSITION FOR APPLYING LIQUID GASKET

Refer to "Installation" in "OIL PAN" for installing oil pan (EM-9).

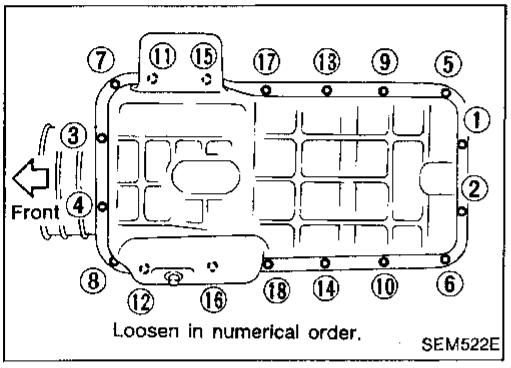
CAUTION:

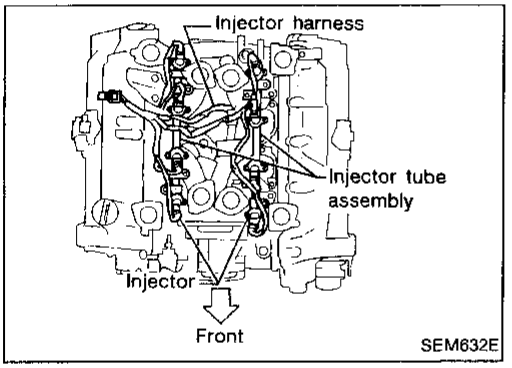
- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**



Removal

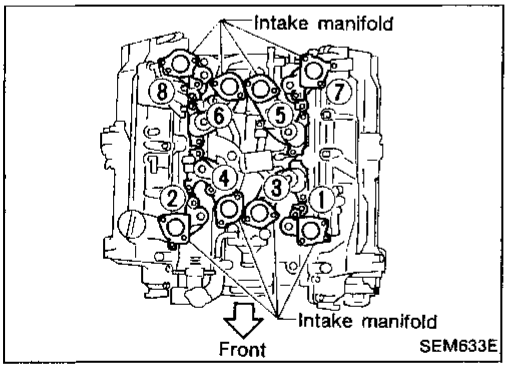
1. Remove engine with transmission. Refer to "ENGINE REMOVAL" (EM-31).
2. Remove the following parts
- Suspension member
- Engine mounts
- A/C compressor bracket
- Exhaust manifold
- Cooling fan with coupling
- Engine gusset
- Transmission
3. Place engine on a work stand.
4. Remove oil pan.
5. Remove intake collector.



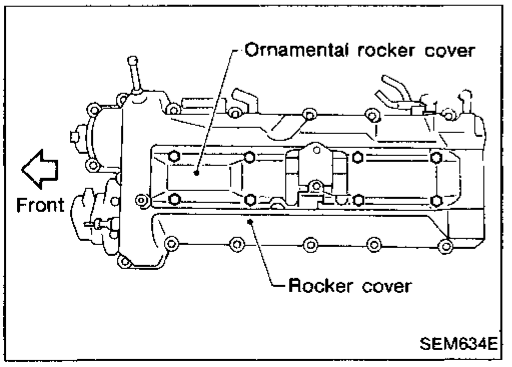


6. Disconnect injector harness connector and remove injector tube assembly with injector.

Be careful not to let rubber washer fall into intake manifold.

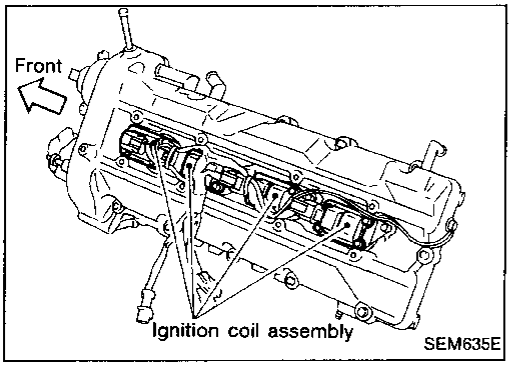


7. Remove intake manifold.

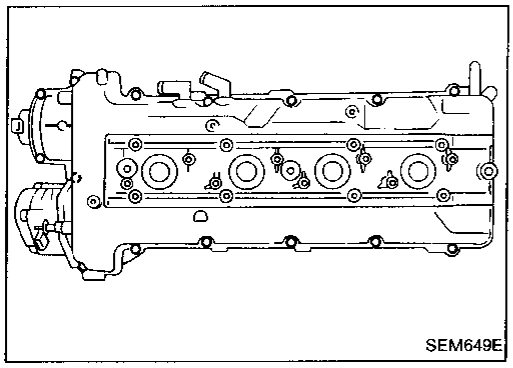


8. Remove ornamental rocker cover.

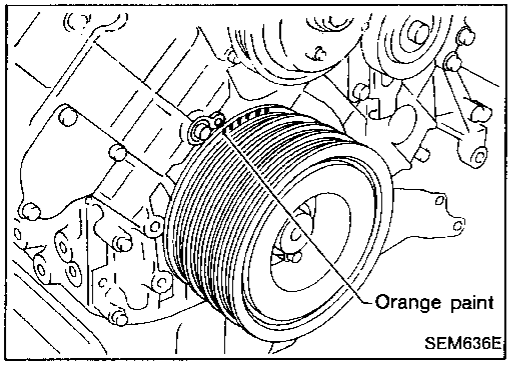
Removal (Cont'd)



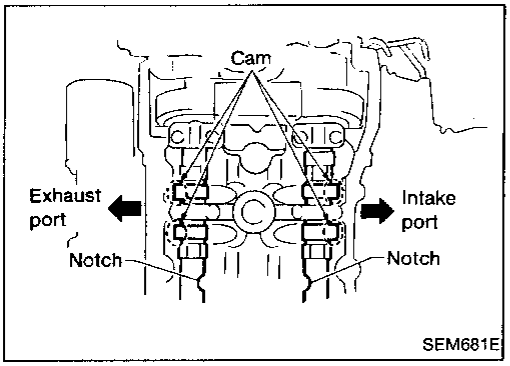
9. Remove all ignition coils and spark plugs.



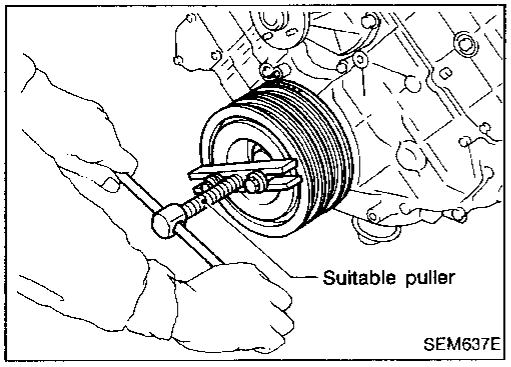
10. Remove rocker covers.



11. Set No. 1 piston at TDC on its compression stroke.
    Align the timing mark (orange paint) on crank pulley with timing indicator on front cover.

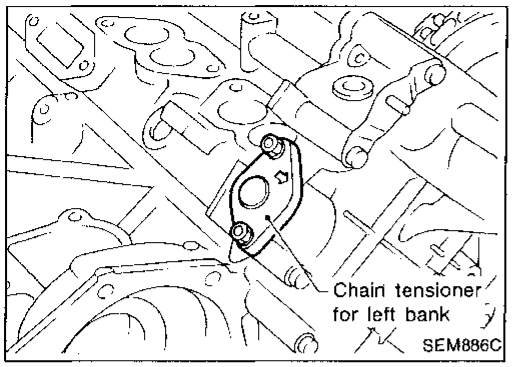


Make sure the intake camshaft lobe for the No. 1 cylinder faces the intake port and the exhaust lobe faces the exhaust port.
Reference:
It is possible to confirm camshaft positions by checking notch positions on the camshaft when No. 1 piston is at TDC of the compression stroke. This is the position where cylinder head bolts can be removed.

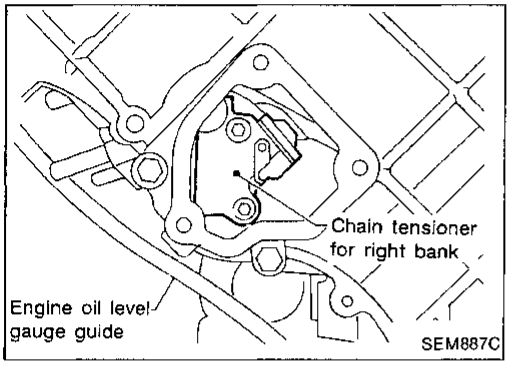


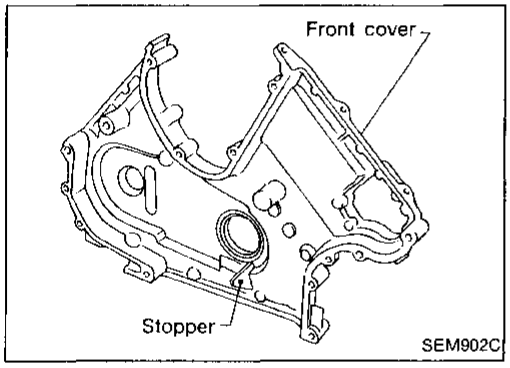
12. Remove crankshaft pulley.
13. Remove camshaft position sensor and VTC solenoid.

Removal (Cont'd)



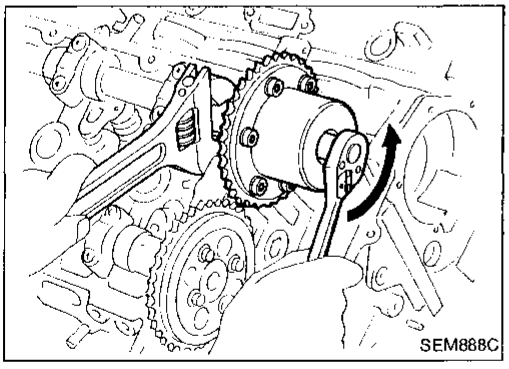
14. Remove chain tensioners.
15. Remove upper front covers.



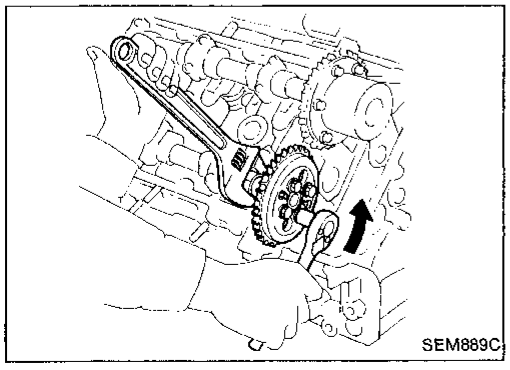


16. Remove front cover.
- Timing chain will not be disengaged or dislocated from crankshaft sprocket unless front cover is removed. For this reason, stopper need not be used.

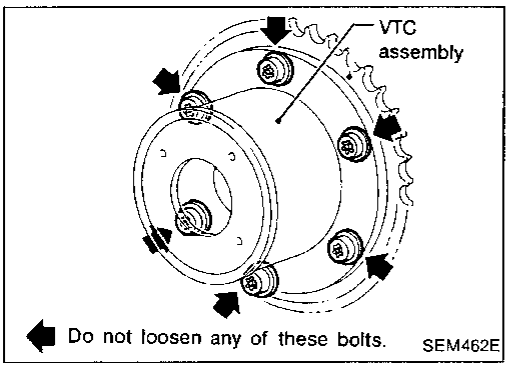
Cast portion of front cover is located on lower side of the crankshaft sprocket. Therefore, the timing chain is not disengaged from the sprocket.



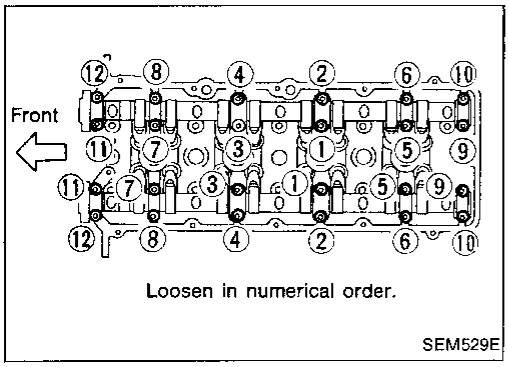
17. Remove VTC assembly and camshaft sprocket.
18. Remove oil pump chain and timing chains.



Removal (Cont'd)

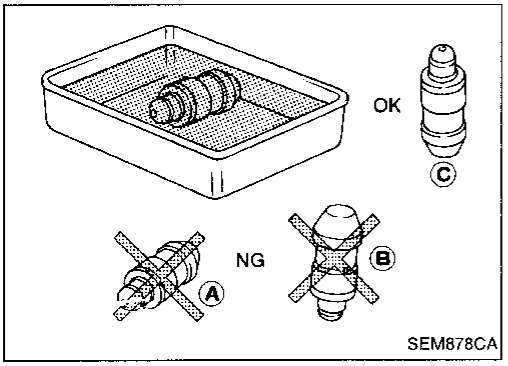


CAUTION:
Valve timing control (VTC) assembly
Do not attempt to disassemble VTC assembly since it is difficult to reassemble accurately in the field. If they should be disassembled, VTC assembly must be replaced with a new one.

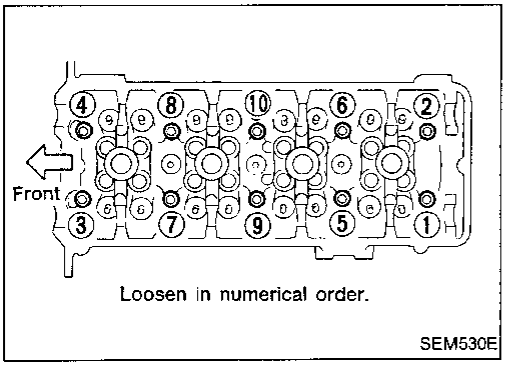


19. Remove camshaft bracket and camshaft.
- These parts should be reassembled in their original positions.

20. Remove rocker arm and hydraulic lash adjusters.
- Tie up each hydraulic lash adjuster with a string. This will allow each to be reassembled to its original position.

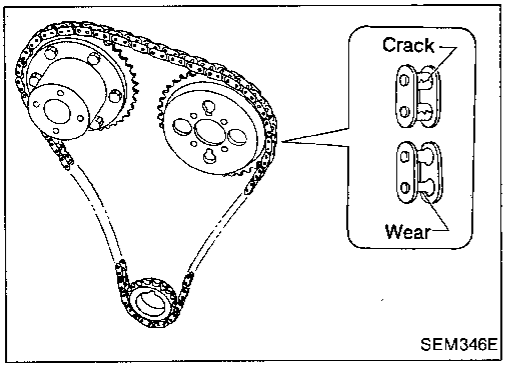


- **If hydraulic lash adjuster is kept on its side, there is a risk of air entering it. When hydraulic lash adjusters are removed, stand them straight up or soak them in new engine oil.**
- **Do not disassemble hydraulic lash adjuster.**
- **Attach tags to valve lifters so as not to mix them up.**

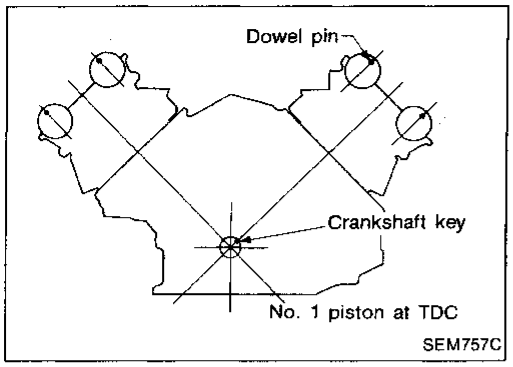


21. Remove cylinder head assembly and cylinder head gasket.
- Head warpage or cracking could result from removing in incorrect order.
- Cylinder head bolts should be loosened in two or three steps.

Inspection

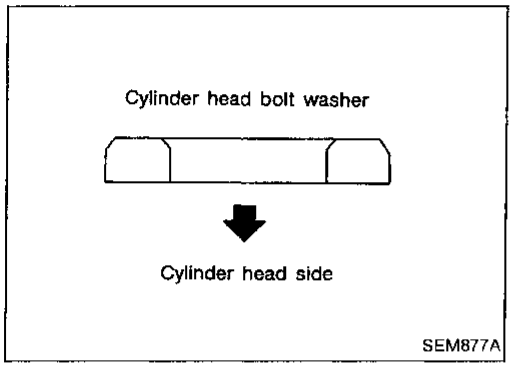


Check for cracks and excessive wear at roller links. Replace if necessary.

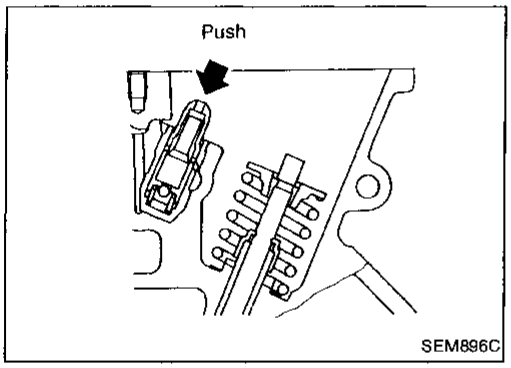


Installation

1. Position crankshaft so that No. 1 piston is set at TDC on compression stroke.
2. Turn crankshaft until No. 1 piston is set at approximately 45° before TDC on compression stroke. (At this point, No. 3 piston will be at the same height as No. 1 piston to prevent interference of valves and pistons.)

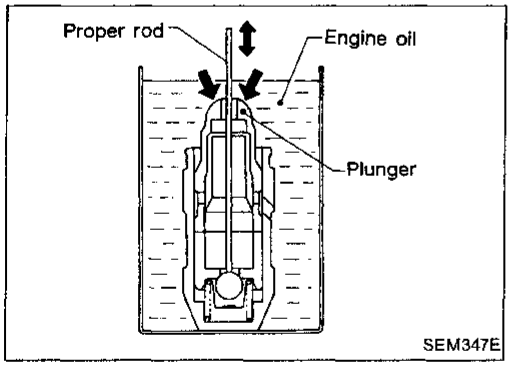


3. Install cylinder heads with new gaskets. Temporarily tighten cylinder head bolts for right and left bank cylinder heads when installing front cover.
- Temporarily tighten cylinder head bolts. This is necessary to avoid damaging cylinder head gaskets.
- Be sure to install washers between bolts and cylinder head.
- Do not rotate crankshaft and camshaft separately, or valves will hit piston heads.



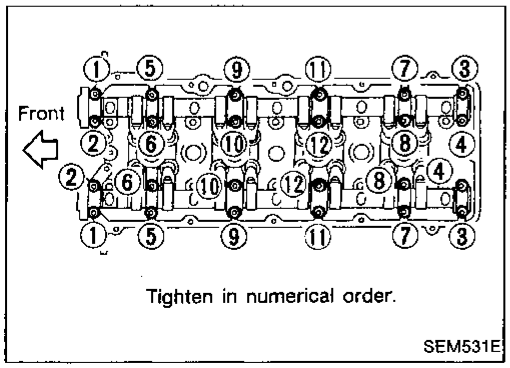
4. Install hydraulic lash adjusters and check them.

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



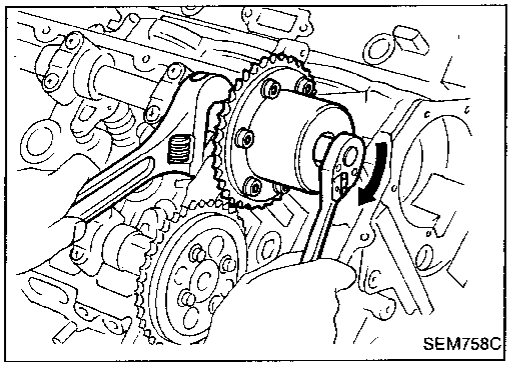
2) Remove hydraulic lash adjuster and dip in a container filled with engine oil. While pushing plunger as shown in figure, lightly push check ball using proper rod. Air is completely bled when plunger no longer moves.

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

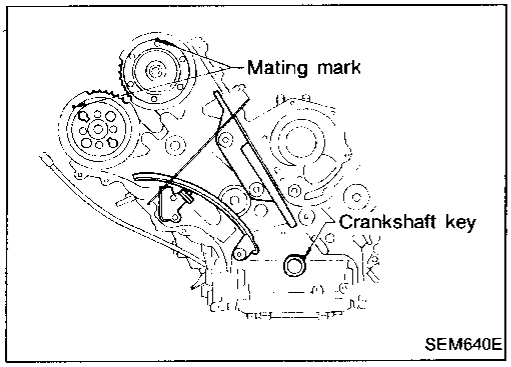


5. Install rocker arm, camshaft and camshaft bracket for right bank.

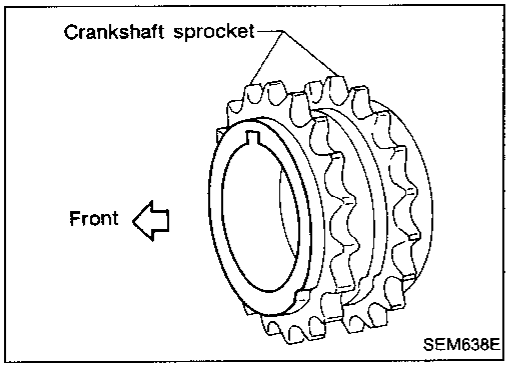
Installation (Cont'd)



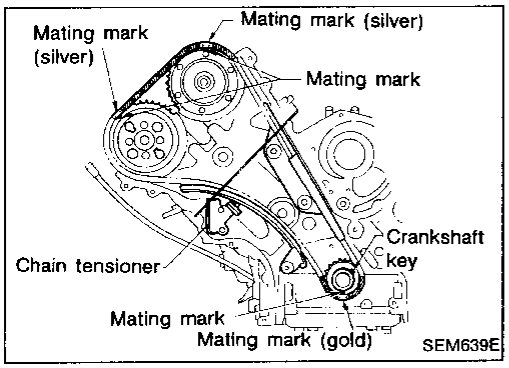
6. Install VTC assembly and exhaust cam sprocket on right bank.



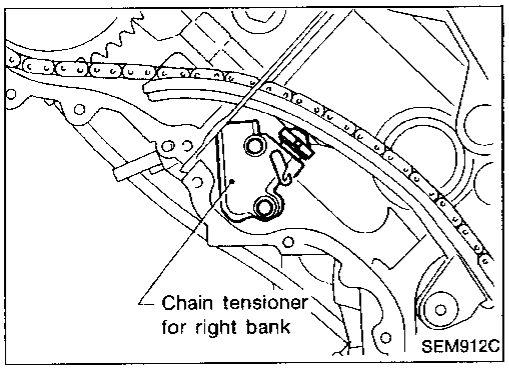
7. Ensure that camshafts are still correctly positioned. Then turn crankshaft clockwise to set No. 1 piston at TDC on compression stroke.



8. Install two sprockets on crankshaft.

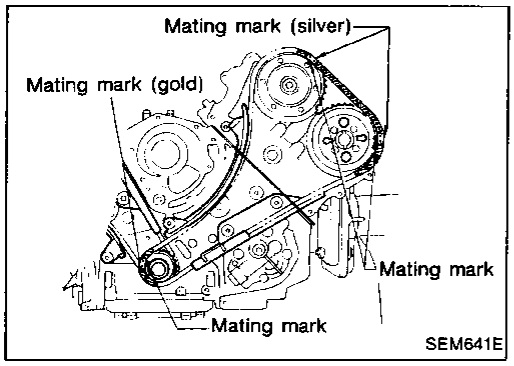


9. Align mating marks on crankshaft sprocket and camshaft sprockets (on both intake and exhaust sides) with those on chain. Then install chain on right bank.
- Be careful not to damage cylinder head gasket when installing chain.

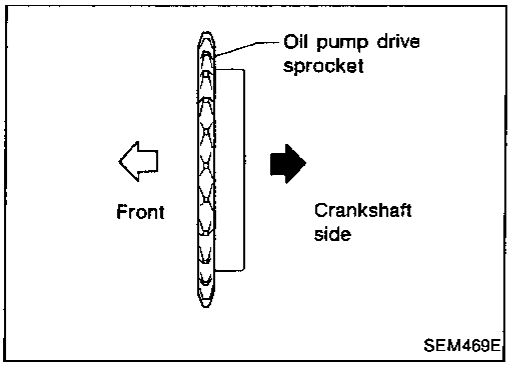


10. Install chain tensioner on right bank.

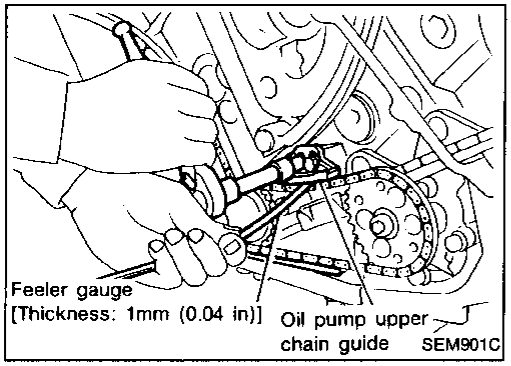
Installation (Cont'd)



11. Turn crankshaft approximately 120° clockwise from the point where No. 1 piston is at TDC on compression stroke. (At this point, valves in left bank still remain unlifted.)
12. Correctly position camshafts for left cylinder head.
13. Install VTC assembly and exhaust cam sprocket on left bank.
14. Align mating marks on crankshaft sprocket and camshaft sprockets (on both intake and exhaust sides) with those on chain. Then install chain on left bank.

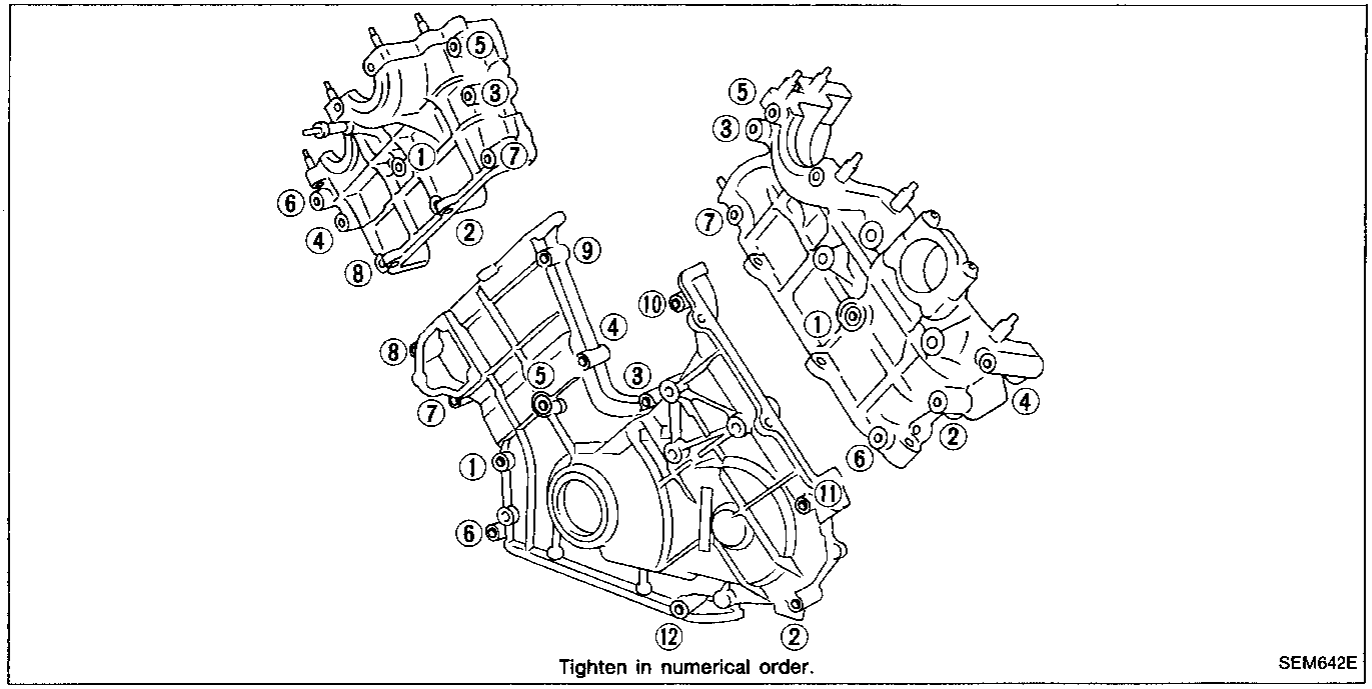


15. Install oil pump chain and sprockets.

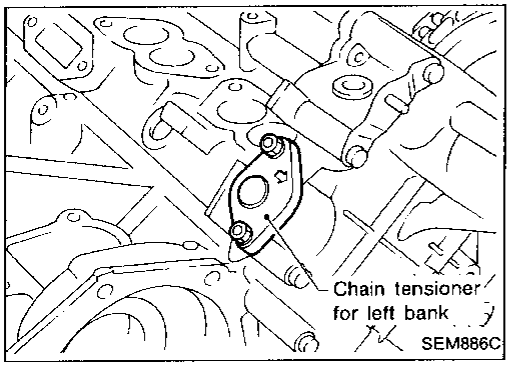


16. Install oil pump chain guides.
- Place a 1 mm (0.04 in) feeler gauge between the upper chain guide and chain before assembling chain guides. Force applied to chain is equivalent to upper chain guide weight.

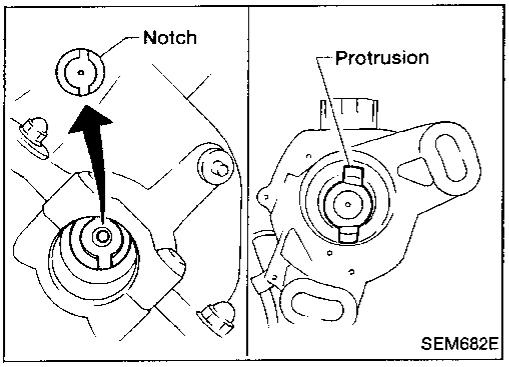
17. Install front covers.
- Be careful not to damage cylinder head gasket when installing front cover.



Installation (Cont'd)



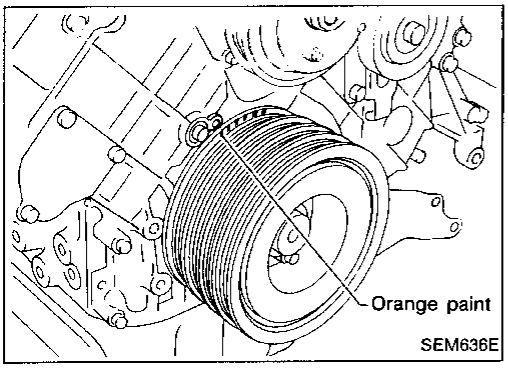
18. Install chain tensioner for left bank.



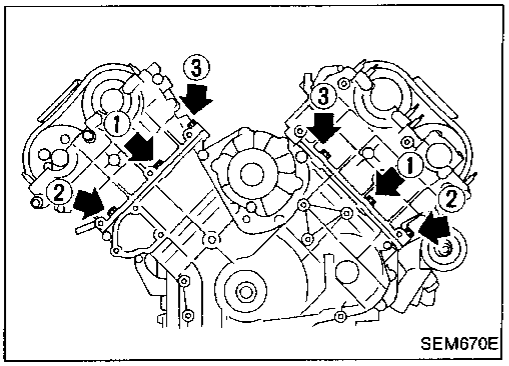
19. Install the following parts.
- Camshaft position sensor
- VTC solenoid

Note:
Notch on exhaust camshaft on left bank is off-centered so that camshaft position sensor can be installed properly.

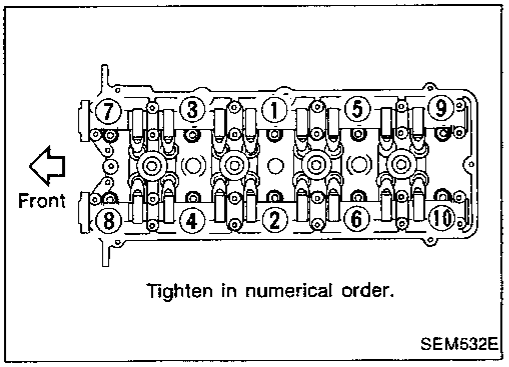
20. Install crank pulley.



21. Set No. 1 piston at TDC on its compression stroke.
Align the timing mark (orange paint) on crank pulley with timing indicator on front cover.



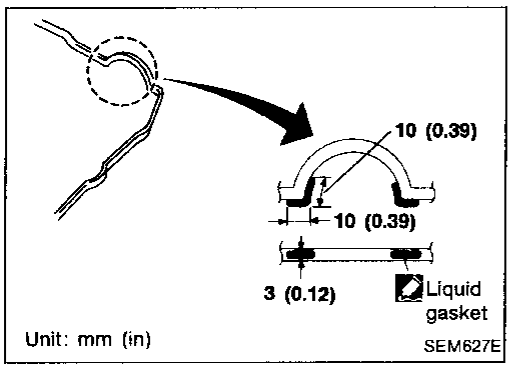
22. Tighten front cover bolts.



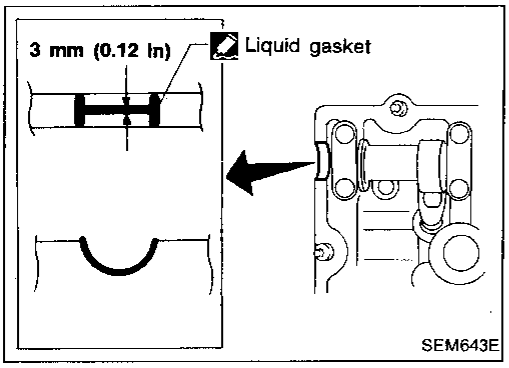
23. Tighten cylinder head bolts.
- **Tightening procedure**

ⓐ Tighten bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
ⓑ Tighten bolts to 93 N·m (9.5 kg-m, 69 ft-lb).
ⓒ Loosen bolts completely.
ⓓ Tighten bolts to 25 to 34 N·m (2.5 to 3.5 kg-m, 18 to 25 ft-lb).
ⓔ Turn bolts 90 to 95 degrees clockwise or if angle wrench is not available, tighten bolts to 93 to 98 N·m (9.5 to 10.0 kg-m, 69 to 72 ft-lb).

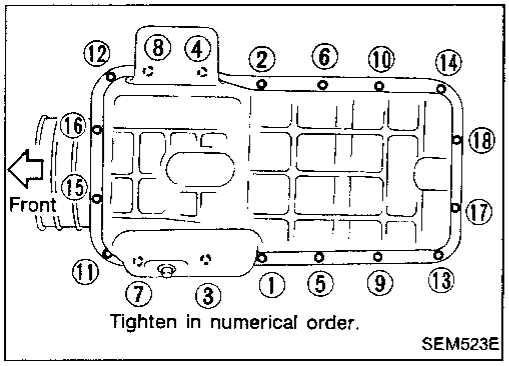
Installation (Cont'd)



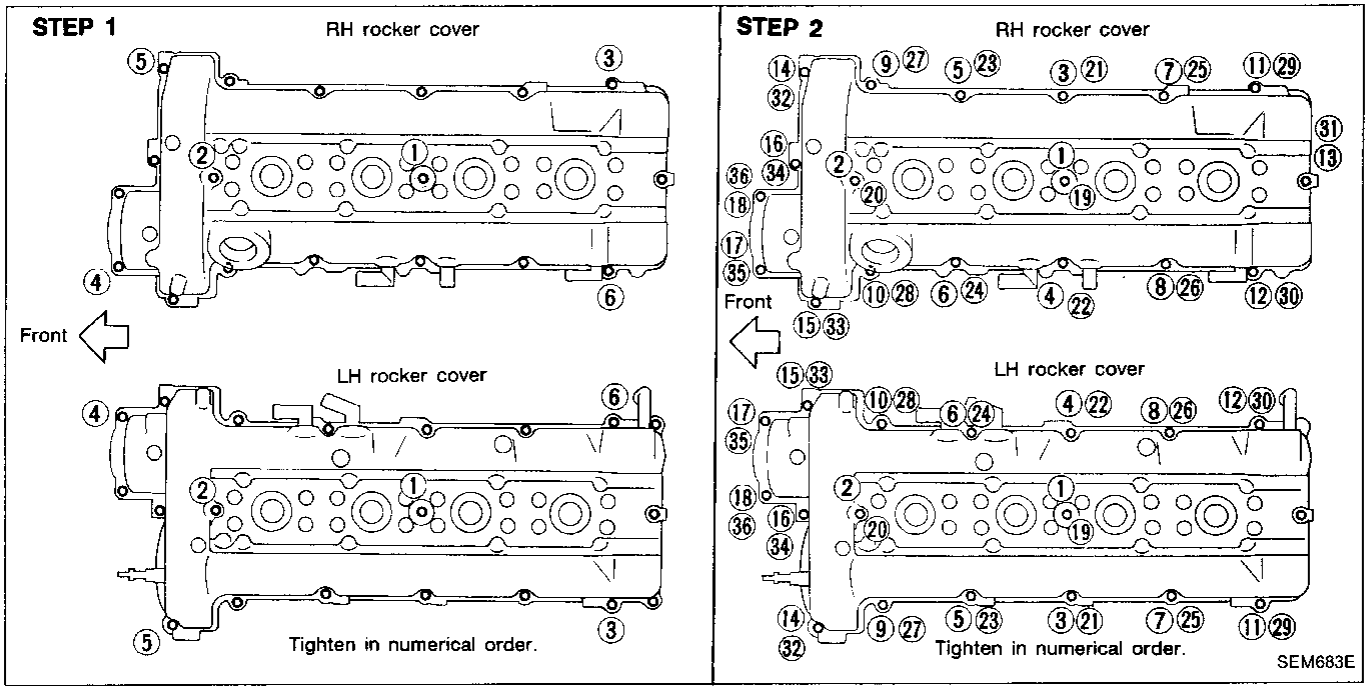
24. Remove all old liquid gasket from mating surfaces of rocker cover and cylinder head.
25. Apply a continuous bead of liquid gasket to mating surface of rocker cover gasket and cylinder head.
- **Use Genuine Liquid Gasket or equivalent.**



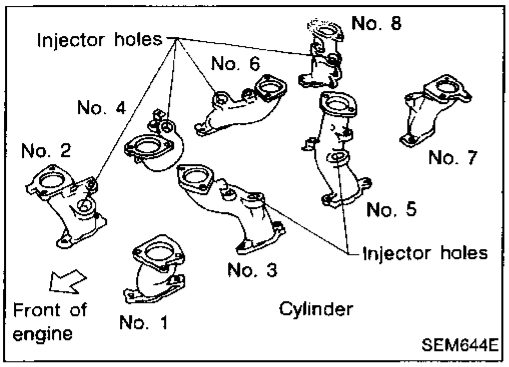
26. Install rocker cover.



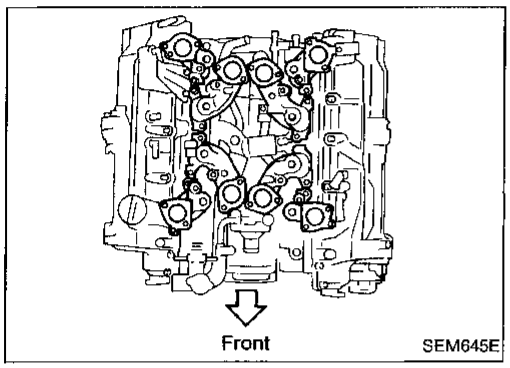
27. Install oil pan. (Refer to "Installation" in "OIL PAN", EM-9.)
28. Tighten rocker cover nuts.
- Tightening procedure
  STEP1
  Tighten nuts to 4 N·m (0.4 kg-m, 2.9 ft-lb).
  STEP2
  Tighten nuts to 10 - 12 N·m (1.0 - 1.2 kg-m, 7 - 9 ft-lb).



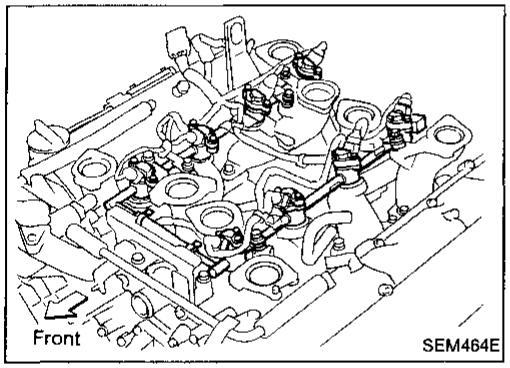
Installation (Cont'd)



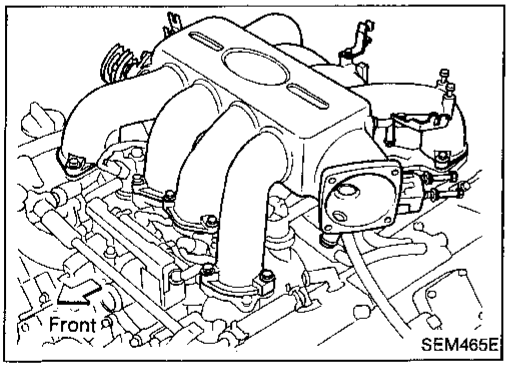
29. Install intake manifolds, fuel tube assemblies (including fuel injectors) and intake collector.
- Follow procedures 1) - 9) in order to make installation of the fuel tube assemblies and collectors less difficult. These procedures are necessary for proper alignment of intake manifolds, fuel tube and intake collector.



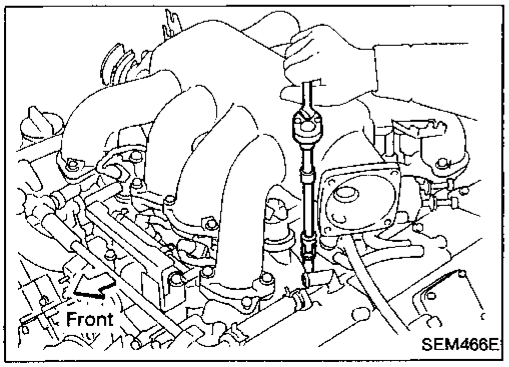
1) Install the eight intake manifolds in their proper positions on cylinder head, and lightly tighten mounting bolts.



2) Connect injector tube assemblies (including fuel injectors) to intake manifolds, and lightly tighten mounting bolts.
- **Be careful not to let rubber washer fall into intake manifold.**

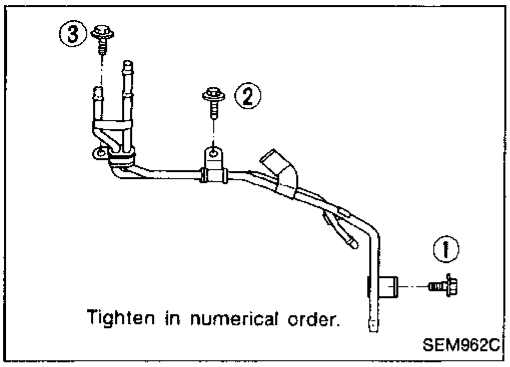


3) Install intake collector and lightly tighten mounting bolts.



4) Tighten intake manifolds mounting bolts at cylinder head.
5) Remove intake collectors.
6) Tighten intake manifolds to the specified torque.

Installation (Cont'd)

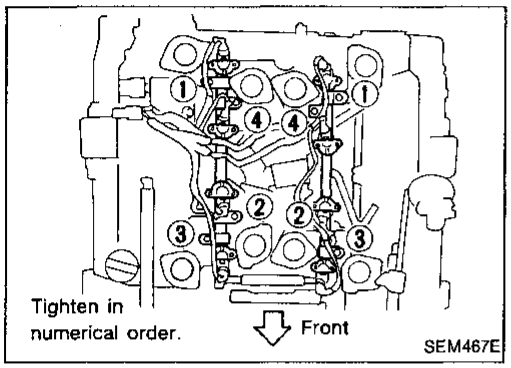


7) Tighten sub-fuel tubes in numerical order.

- **Tightening procedure**

(1) Tighten all bolts to 4.2 to 5.9 N·m (0.43 to 0.60 kg-m, 3.1 to 4.3 ft-lb).

(2) Tighten all bolts to 8.4 to 10.8 N·m (0.86 to 1.1 kg-m, 6.2 to 8.0 ft-lb).

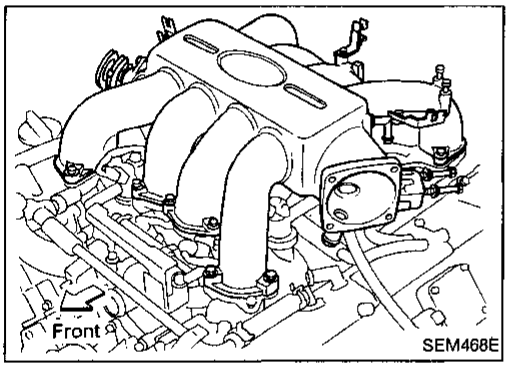


8) Tighten injector tube assemblies in numerical order.

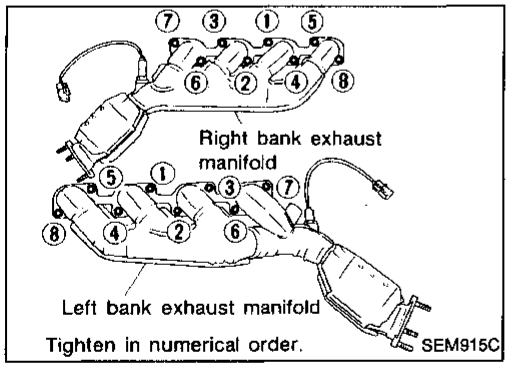
- **Tightening procedure**

(1) Tighten all bolts to 9.3 to 10.8 N·m (0.95 to 1.1 kg-m, 6.9 to 8.0 ft-lb).

(2) Tighten all bolts to 21 to 26 N·m (2.1 to 2.7 kg-m, 15 to 20 ft-lb).



9) Install intake collectors and tighten to the specified torque.

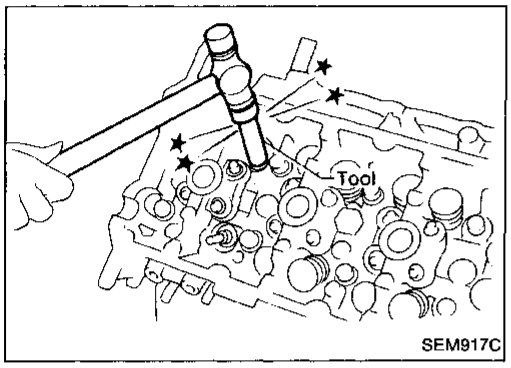


30. Install exhaust manifolds.

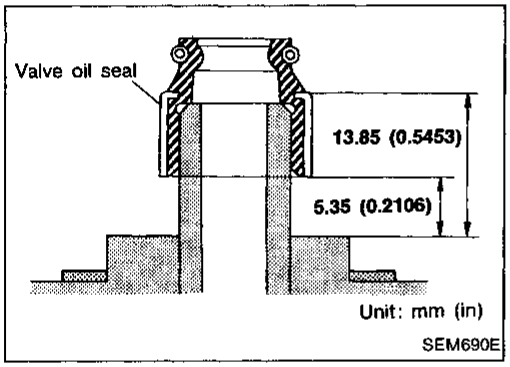
VALVE OIL SEAL

1. Remove engine with transmission from vehicle.
2. Remove rocker cover.
3. Remove camshaft.
4. Remove rocker arm.
5. Remove valve spring and valve oil seal with suitable tool.

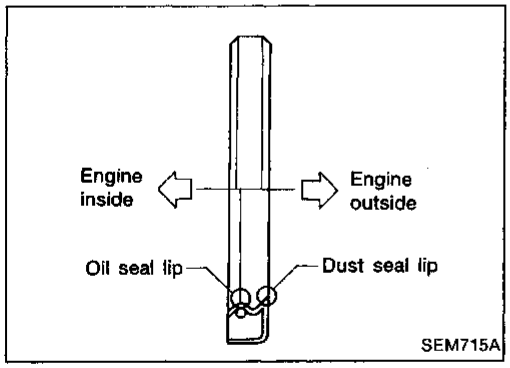
Piston concerned should be set at TDC to prevent valves from falling.



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



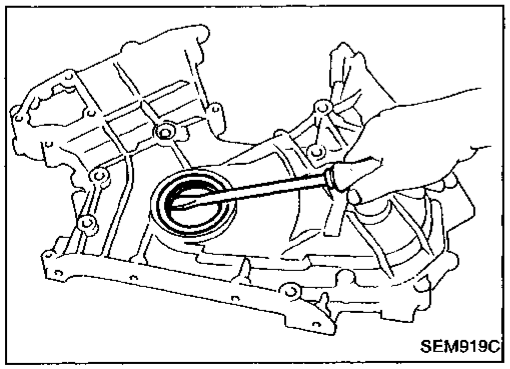
OIL SEAL INSTALLING DIRECTION

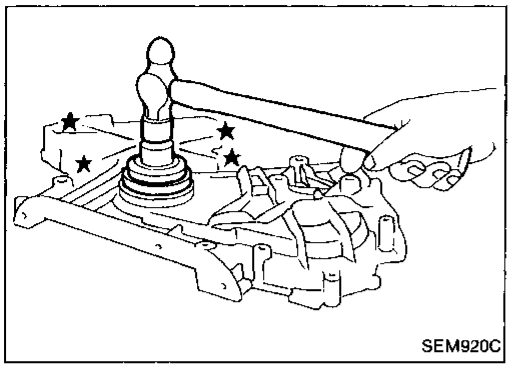


FRONT OIL SEAL

1. Remove the following parts.
- Engine under cover
- Cooling fan
- Engine gusset
- Lower rear plate (Removal of crankshaft pulley bolt requires removal of this part.)
- Crankshaft pulley

2. Remove front oil seal.

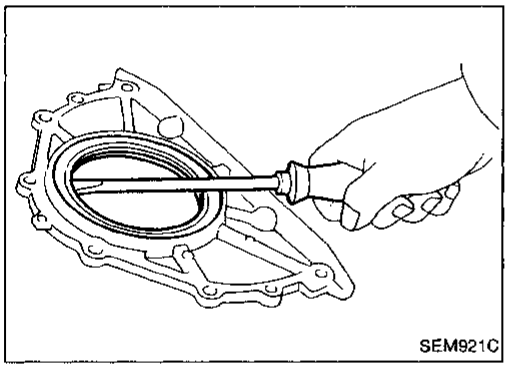



SEM920C

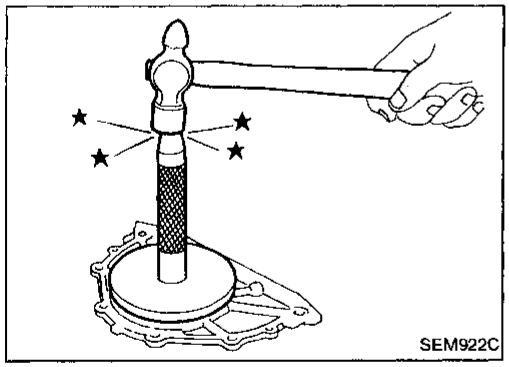
3. Apply engine oil to new oil seal and install it using suitable tool.

REAR OIL SEAL

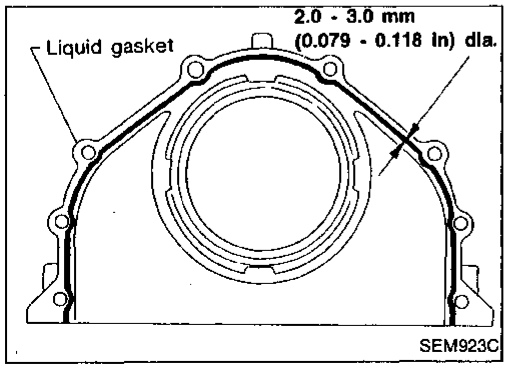
1. Remove drive plate.
2. Remove rear oil seal retainer.
3. Remove traces of liquid gasket using scraper.


SEM921C

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

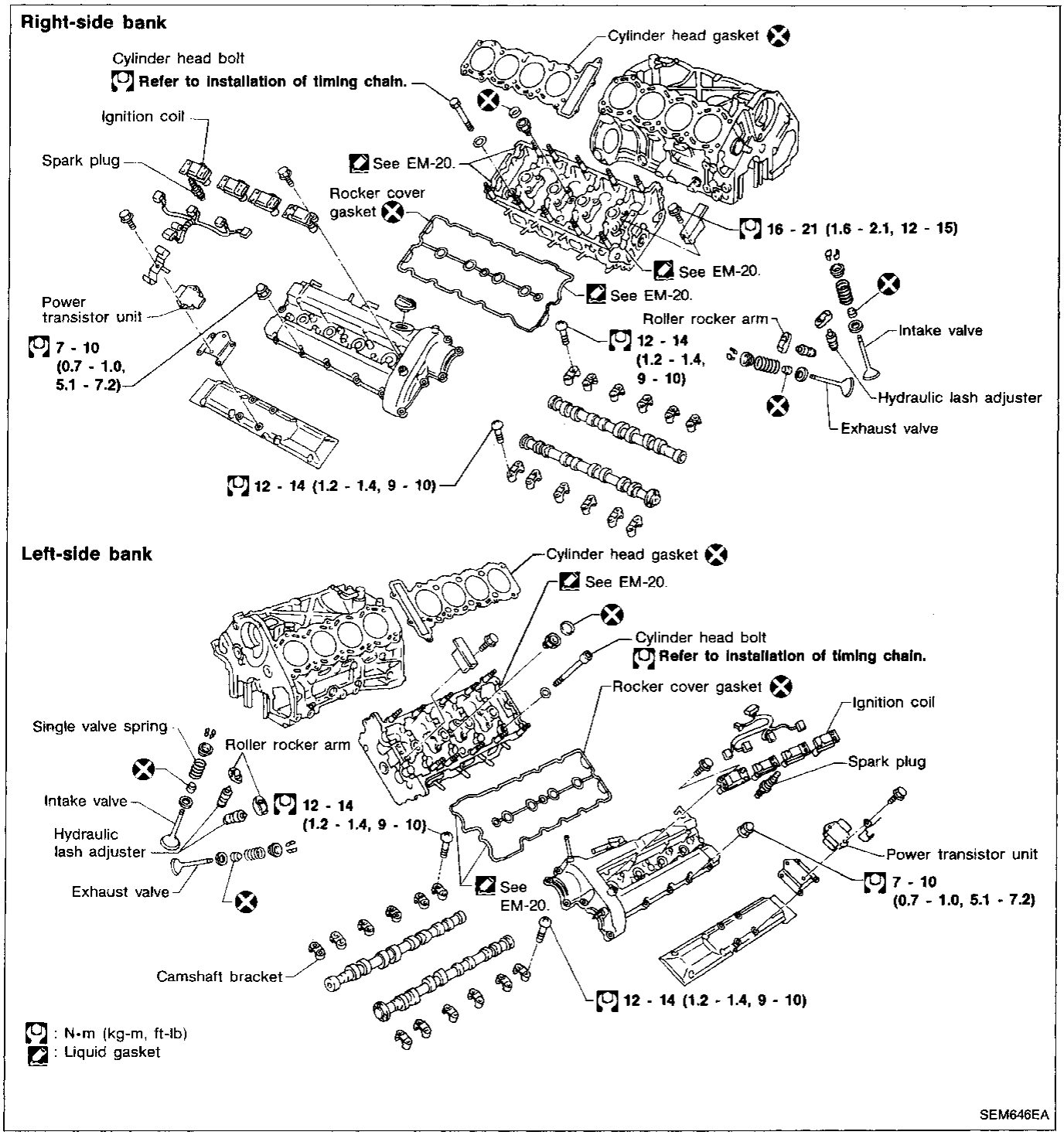

SEM922C

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



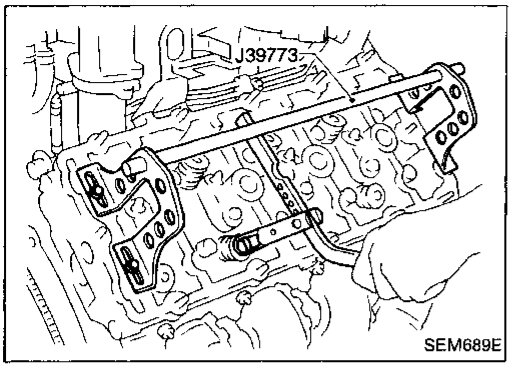
SEM923C

6. Apply a continuous bead of liquid gasket to rear oil seal retainer.



CAUTION:

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

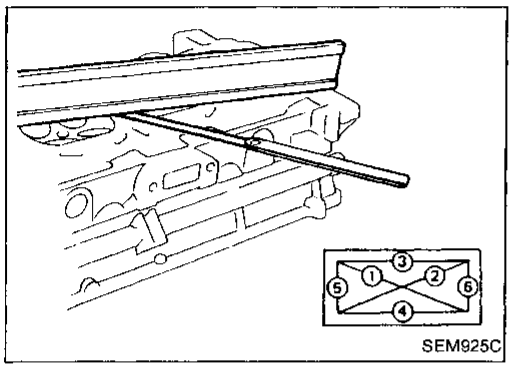


Removal

- This removal is the same procedure as those for timing chain. Refer to "Removal" in "TIMING CHAIN" (EM-15).

Disassembly

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



Inspection

CYLINDER HEAD DISTORTION

Head surface flatness:

Standard

Less than 0.03 mm (0.0012 in)

Limit

0.1 mm (0.004 in)

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

Resurfacing limit:

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

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

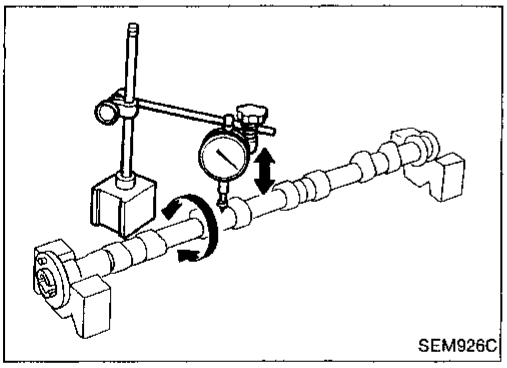
The maximum limit is as follows:

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:

130.7 - 130.9 mm (5.146 - 5.154 in)



CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.

CAMSHAFT RUNOUT

1. Measure camshaft runout at the center journal.

Runout (Total indicator reading):

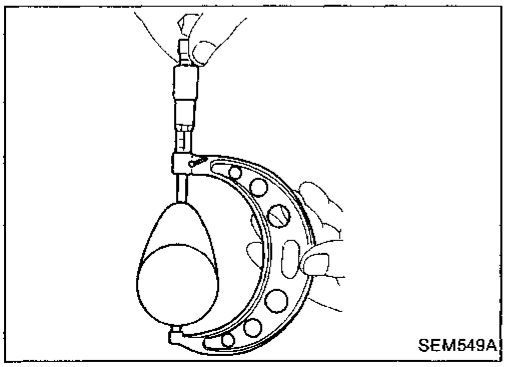
Standard

Less than 0.02 mm (0.0008 in)

Limit

0.05 mm (0.0020 in)

2. If it exceeds the limit, replace camshaft.



CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height.

Standard cam height:

Intake

37.919 - 38.109 mm (1.4929 - 1.5004 in)

Exhaust

35.279 - 35.469 mm (1.3889 - 1.3964 in)

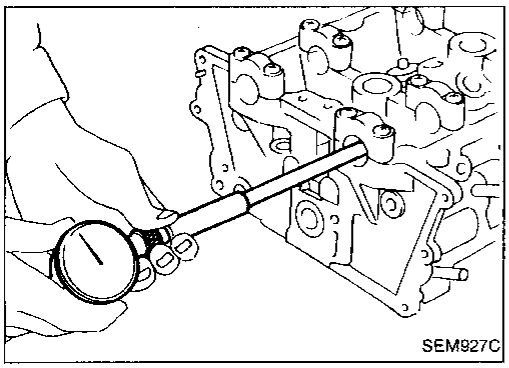
Cam wear limit:

Intake & Exhaust

0.05 mm (0.0020 in)

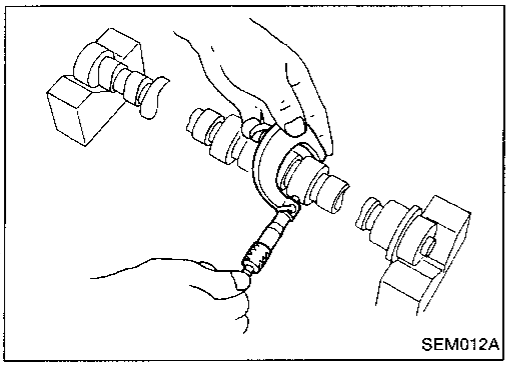
2. If wear is beyond the limit, replace camshaft.

Inspection (Cont'd)

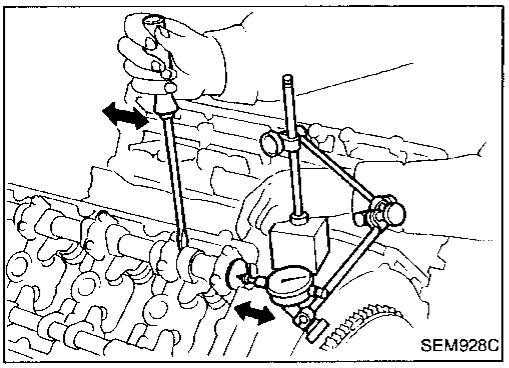

SEM927C

CAMSHAFT JOURNAL CLEARANCE

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

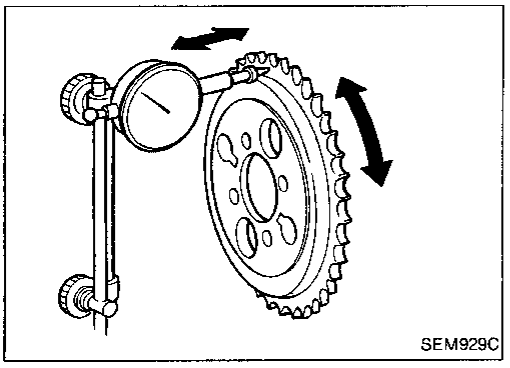

SEM012A

3. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   25.935 - 25.955 mm (1.0211 - 1.0218 in)
4. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance:
   Standard
   0.045 - 0.086 mm (0.0018 - 0.0034 in)
   Limit
   0.15 mm (0.0059 in)


SEM928C

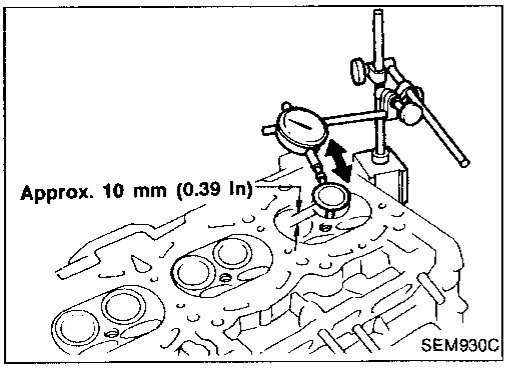
CAMSHAFT END PLAY

1. Install camshaft and thermostat housing in cylinder head.
2. Measure camshaft end play.
   Camshaft end play:
   Standard
   0.070 - 0.148 mm (0.0028 - 0.0058 in)
   Limit
   0.20 mm (0.0079 in)


SEM929C

CAMSHAFT SPROCKET RUNOUT

1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.
   Runout (Total indicator reading):
   Limit 0.15 mm (0.0059 in)
3. If it exceeds the limit, replace camshaft sprocket.

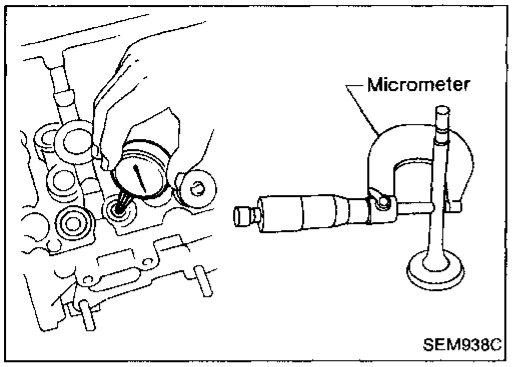


SEM930C

VALVE GUIDE CLEARANCE

1. Measure valve deflection in a parallel direction with rocker arm. (Valve and valve guide mostly wear in this direction.)
   Valve deflection limit (Dial gauge reading):
   Intake & Exhaust
   0.15 mm (0.0059 in)

Inspection (Cont'd)



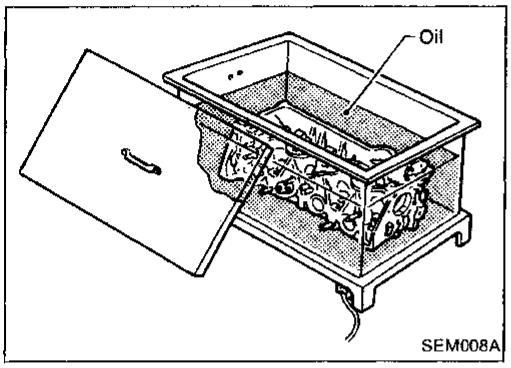
2. If it exceeds the limit, check valve to valve guide clearance.
a. Measure valve stem diameter and valve guide inner diameter.
b. Check that clearance is within specification.

Valve to valve guide clearance:

Unit: mm (in)

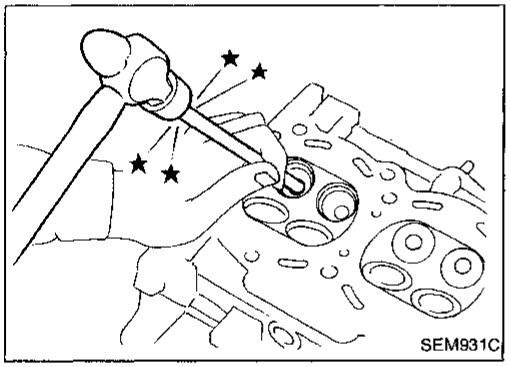
	Standard	Limit
Intake	0.029 - 0.052 (0.0011 - 0.0020)	0.080 (0.0031)
Exhaust	0.035 - 0.051 (0.0014 - 0.0020)	0.080 (0.0031)

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

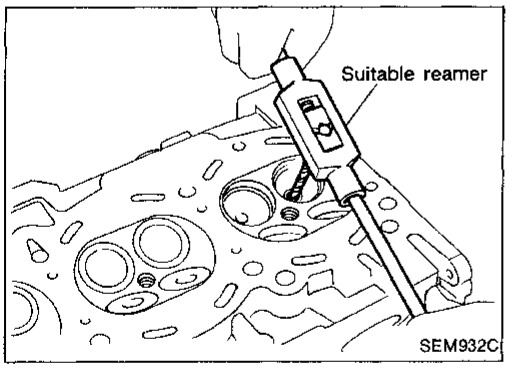


VALVE GUIDE REPLACEMENT

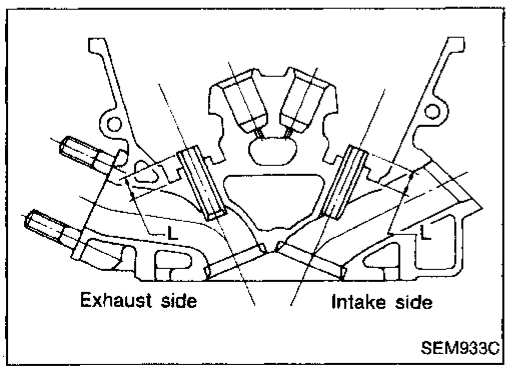
1. To remove valve guide, heat cylinder head to 110 to 130°C (230 to 266°F).



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

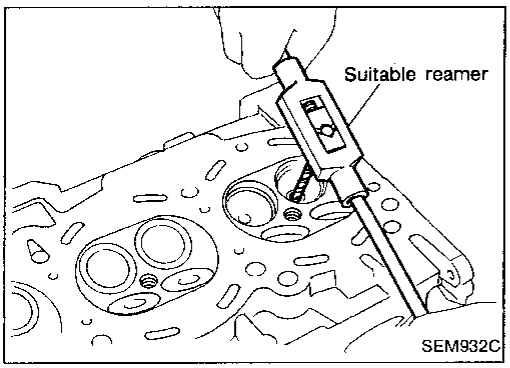


3. Ream cylinder head valve guide hole.
Valve guide hole diameter (for service parts):
Intake
11.175 - 11.196 mm (0.4400 - 0.4408 in)
Exhaust
12.175 - 12.196 mm (0.4793 - 0.4802 in)

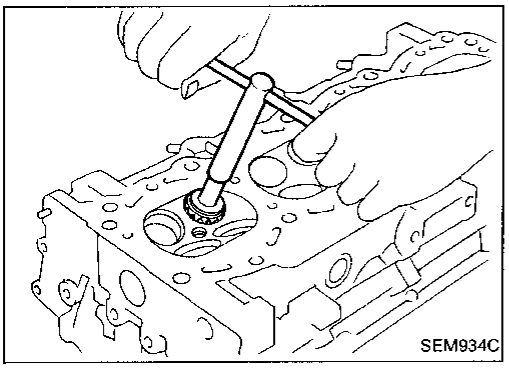


4. Heat cylinder head to 110 to 130°C (230 to 266°F) and press service valve guide onto cylinder head.
Projection "L":
17.15 - 17.35 mm (0.6725 - 0.6831 in)

Inspection (Cont'd)



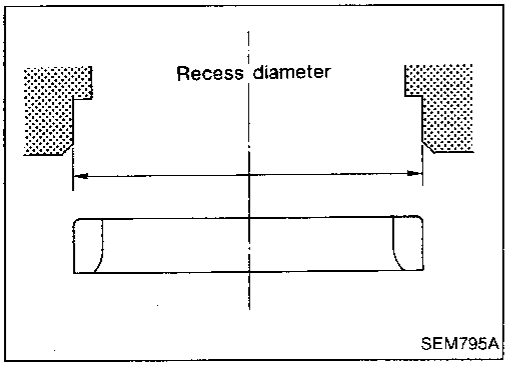
5. Ream valve guide.
   Finished size:
   Intake
   7.000 - 7.018 mm (0.2756 - 0.2763 In)
   Exhaust
   8.000 - 8.011 mm (0.3150 - 0.3154 in)



VALVE SEATS

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

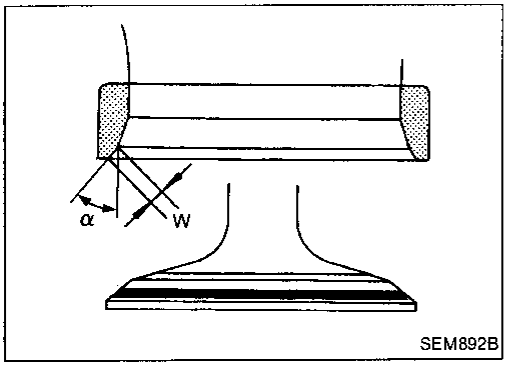
- **Before repairing valve seats, check valve and valve guide for wear. If they have worn, replace them. Then correct valve seat.**
- **Cut with both hands to uniform the cutting surface.**



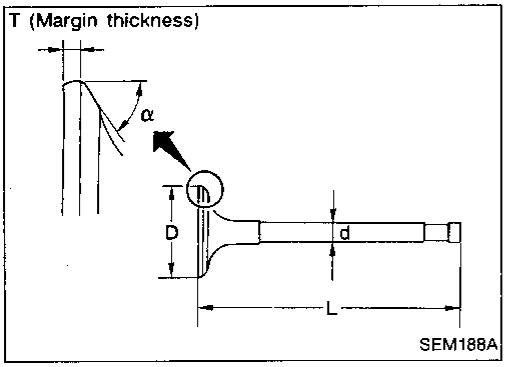
REPLACING VALVE SEAT FOR SERVICE PARTS

1. Bore out old seat until it collapses. Set machine depth stop so that boring cannot contact bottom face of seat recess in cylinder head.
2. Ream cylinder head recess.
   Reaming bore for service valve seat
   Oversize [0.5 mm (0.020 in)]:
   Intake 39.500 - 39.516 mm (1.5551 - 1.5557 in)
   Exhaust 34.500 - 34.516 mm (1.3583 - 1.3589 in)

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



3. Heat cylinder head to 110 to 130°C (230 to 266°F).
4. Press fit valve seat until it seats on the bottom.
5. Cut or grind valve seat using suitable tool at the specified dimensions as shown in SDS (EM-45).
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.
   Seat face angle "α": 44°53′ - 45°07′ deg.
   Contacting width "W":
   Intake 1.13 - 1.27 mm (0.0445 - 0.0500 in)
   Exhaust 1.45 - 1.48 mm (0.0571 - 0.0583 in)



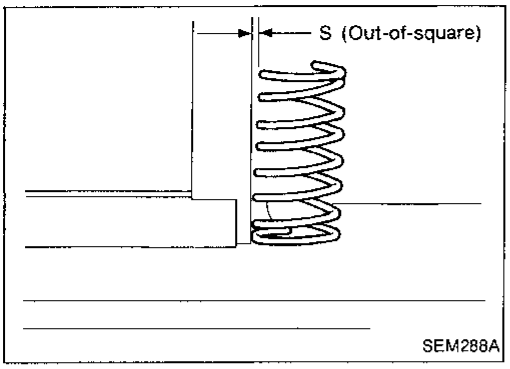
VALVE DIMENSIONS

Check dimensions in each valve. For dimensions, refer to SDS (EM-44).

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

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

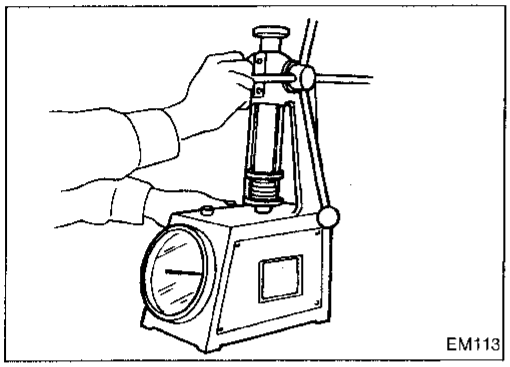
Inspection (Cont'd)



VALVE SPRING

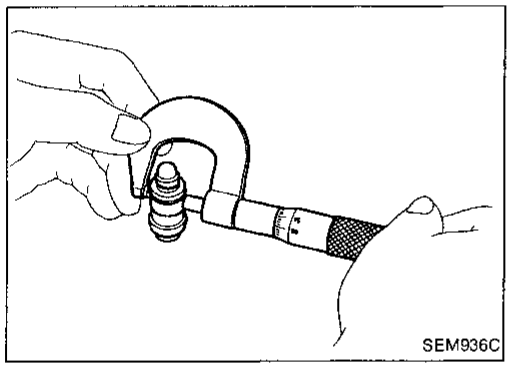
Squareness

1. Measure "S" dimension.
   Out-of-square:
   Less than 2.06 mm (0.0811 in)
2. If it exceeds the limit, replace spring.



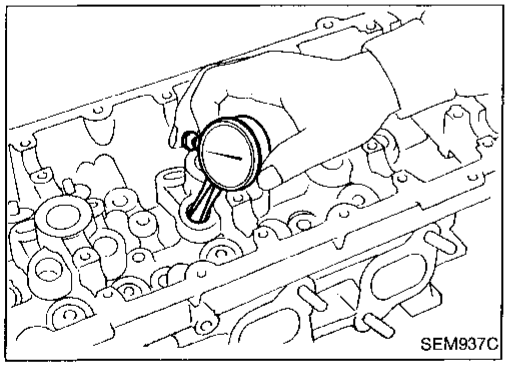
Pressure

Check valve spring pressure.
Pressure: N (kg, lb) at height mm (in)
Standard
535.5 (54.6, 120.4) at 26.8 (1.055)
Limit
More than 477.6 (48.7, 107.4) at 26.8 (1.055)
If it exceeds the limit, replace spring.

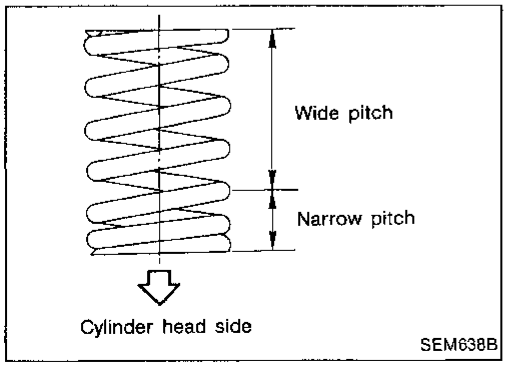


HYDRAULIC LASH ADJUSTER

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



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



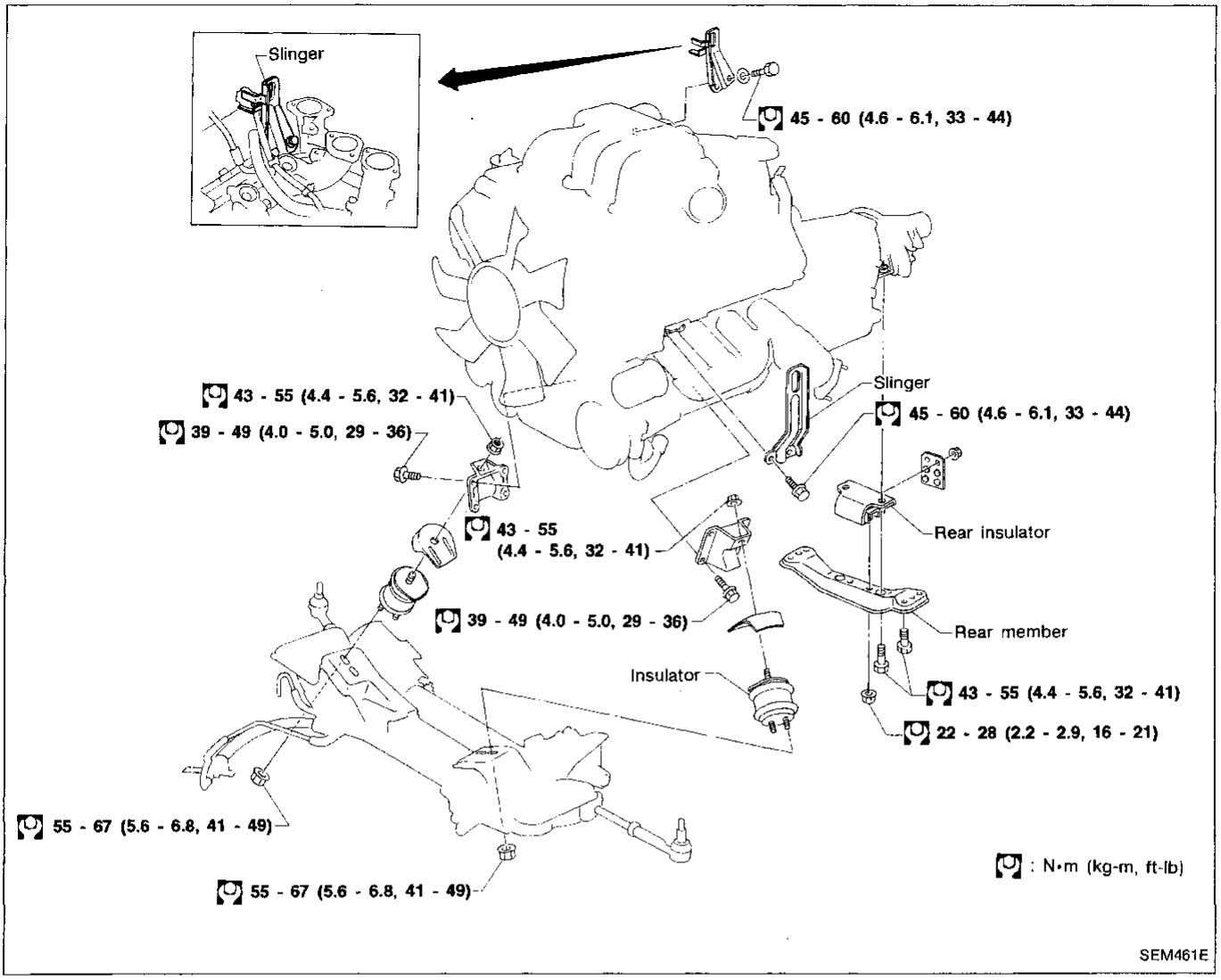
Assembly

1. Install valve component parts.

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

Installation

- This installation is the same procedure as those for timing chain. Refer to "Installation" in "TIMING CHAIN" (EM-16).

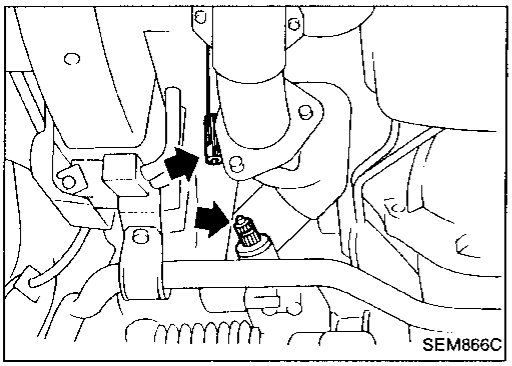


WARNING:

a. Locate vehicle on a flat and solid surface and place chocks at front and back of rear wheels.
b. 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.
c. Be sure to hoist engine and transmission in a safe manner.
   For safety during subsequent steps, the tension of wires should be slackened against the engine.
d. Before disconnecting fuel hose, release fuel pressure. Refer to "Releasing Fuel Pressure" in EF & EC section.
e. For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.

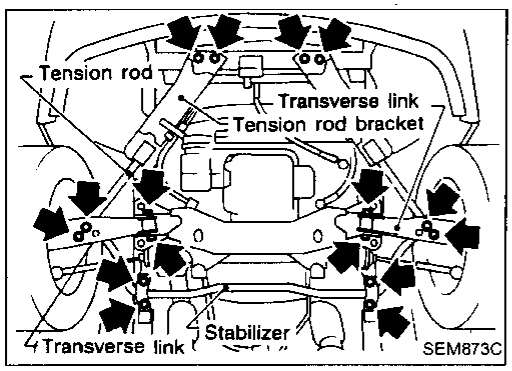
CAUTION:

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

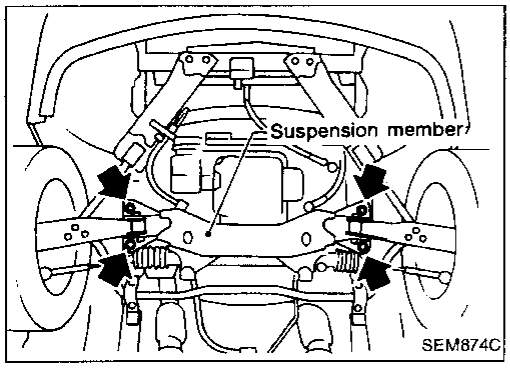

SEM866C

Removal

1. Remove engine under cover and hood.
2. Drain coolant from both cylinder block drain plugs and radiator drain cock.
3. Drain engine oil from drain plug of oil pan.
4. Remove vacuum hoses, fuel tubes, wires, harness and connectors and so on.
5. Remove exhaust tubes and propeller shaft.
6. Remove radiator and shroud.
7. Remove drive belts.
8. Remove alternator, A/C compressor and power steering tube from engine.
9. Remove steering lower joint.
10. Remove stabilizer, transverse link and tension rod with bracket.
11. Set a suitable transmission jack under transmission. Hoist engine with engine slinger.

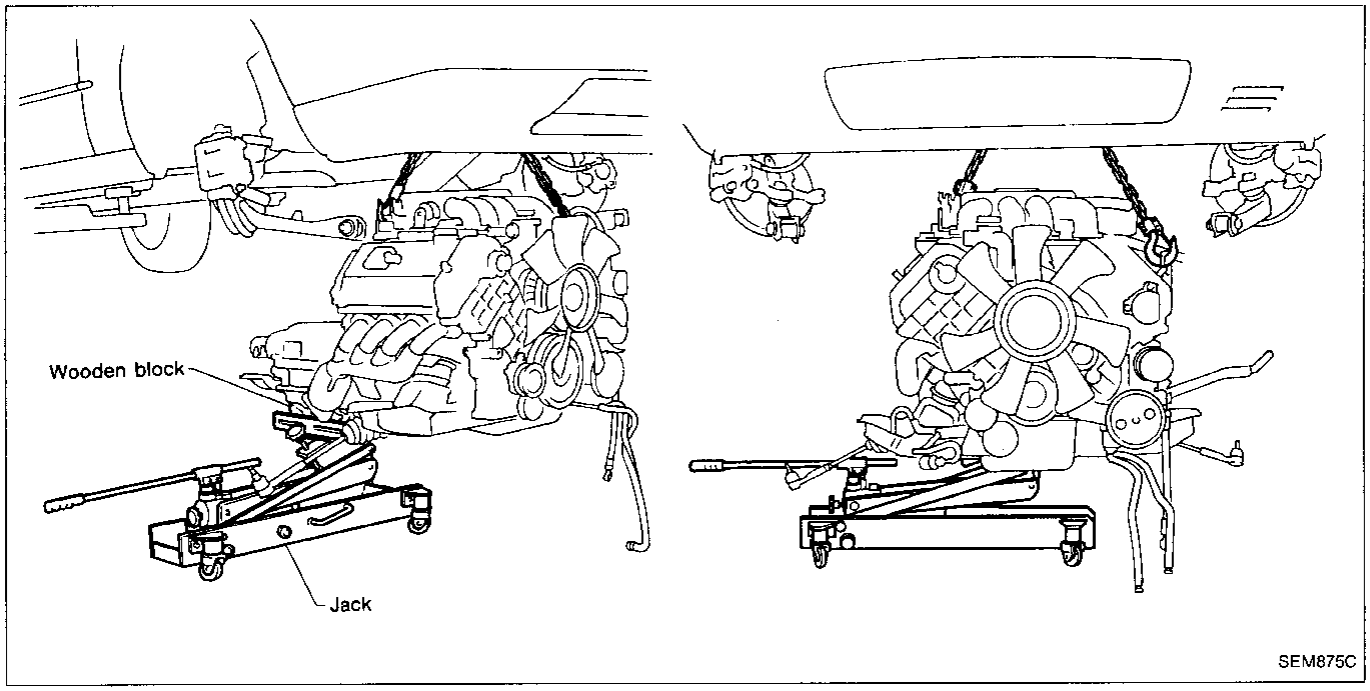


SEM873C

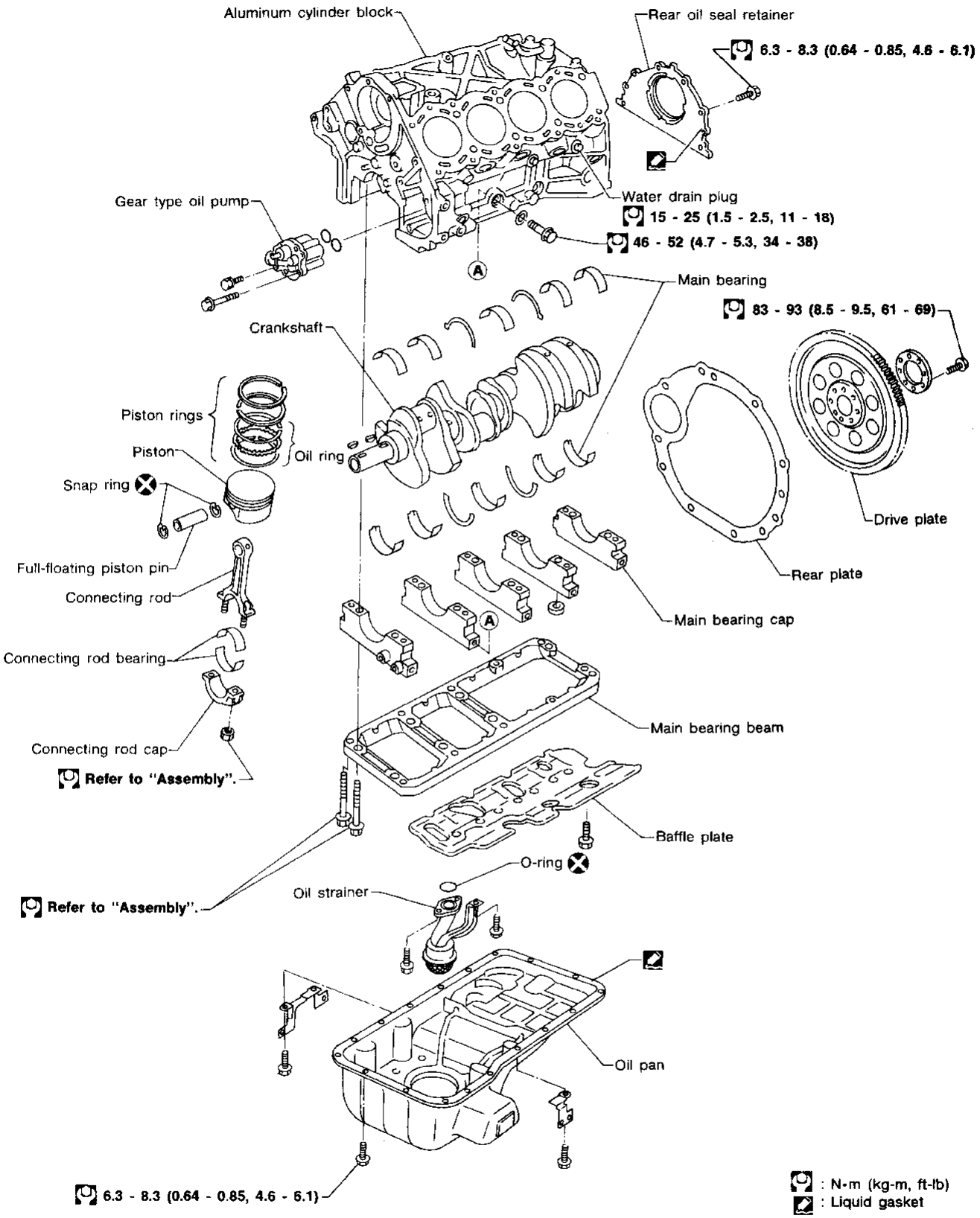


SEM874C

12. Remove suspension member fixing bolts.
13. Remove engine mounting bolts from both sides and then slowly lower transmission jack.
14. Remove engine with transmission as shown in following figure.



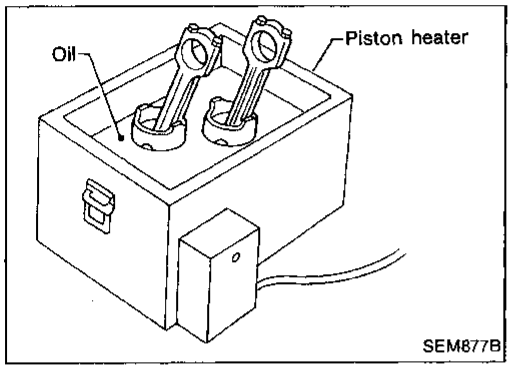
SEM875C


Aluminum cylinder block
Rear oil seal retainer
6.3 - 8.3 (0.64 - 0.85, 4.6 - 6.1)
Gear type oil pump
Water drain plug
15 - 25 (1.5 - 2.5, 11 - 18)
46 - 52 (4.7 - 5.3, 34 - 38)
A
Main bearing
83 - 93 (8.5 - 9.5, 61 - 69)
Crankshaft
Piston rings
Piston
Oil ring
Snap ring
Drive plate
Rear plate
Full-floating piston pin
Connecting rod
Main bearing cap
Connecting rod bearing
Main bearing beam
Connecting rod cap
Refer to "Assembly".
Baffle plate
O-ring
Refer to "Assembly".
Oil strainer
Oil pan
6.3 - 8.3 (0.64 - 0.85, 4.6 - 6.1)
: N·m (kg-m, ft-lb)
: Liquid gasket

SEM967E

CAUTION:

- **When installing sliding parts (bearings and pistons, etc.), apply new engine oil on the sliding surfaces.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When installing connecting rod nuts, and main bearing cap bolts, apply new engine oil to threads and seating surfaces.**

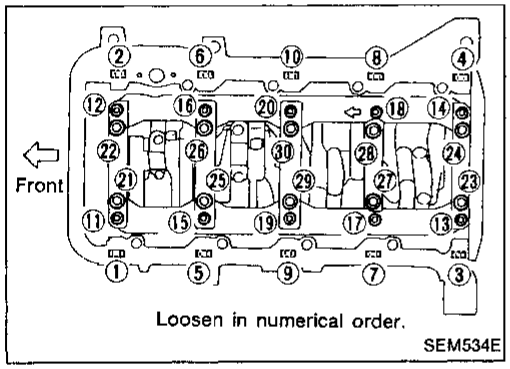


Disassembly

PISTON AND CRANKSHAFT

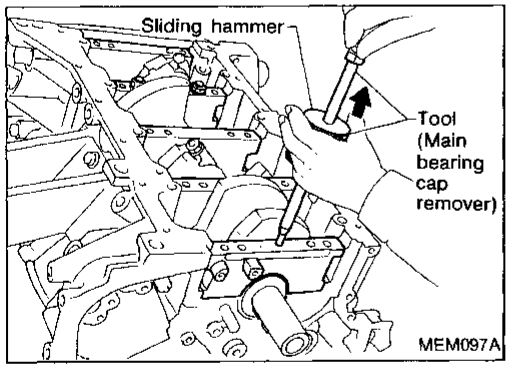
1. Remove timing chain.
   Refer to "Removal" in "TIMING CHAIN".
2. Remove baffle plate.
3. Remove pistons with connecting rods.

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



4. Remove bearing beam, bearing cap and crankshaft.

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

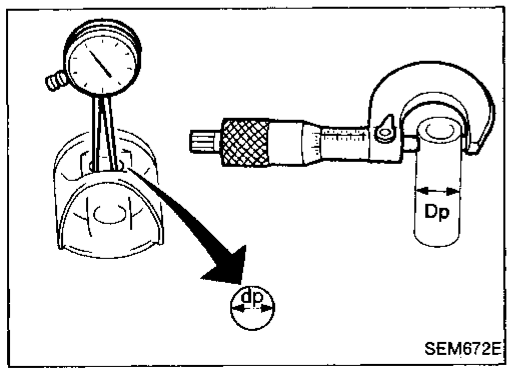


Inspection

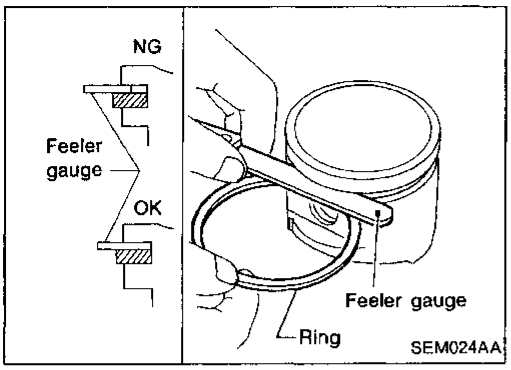
PISTON AND PISTON PIN CLEARANCE

1. Measure inner diameter of piston pin hole "dp".
   Standard diameter "dp":
   21.987 - 21.999 mm (0.8656 - 0.8661 in)
2. Measure outer diameter of piston pin "Dp".
   Standard diameter "Dp":
   21.989 - 22.001 mm (0.8657 - 0.8662 in)
3. Calculate piston pin clearance.
   dp – Dp = –0.004 to 0 mm (–0.0002 to 0 in)

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



Inspection (Cont'd)



PISTON RING SIDE CLEARANCE

Side clearance:

Top ring

0.040 - 0.080 mm (0.0016 - 0.0031 in)

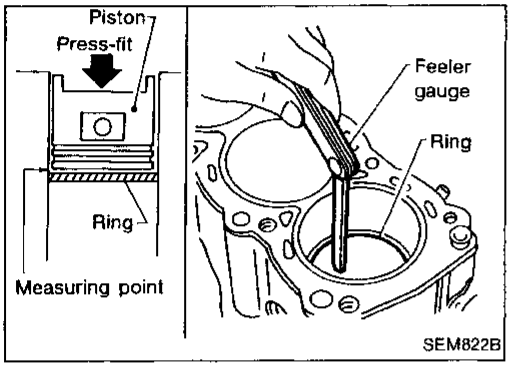
2nd ring

0.030 - 0.070 mm (0.0012 - 0.0028 in)

Max. limit of side clearance:

0.1 mm (0.004 in)

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



PISTON RING END GAP

End gap:

Top ring 0.27 - 0.46 mm (0.0106 - 0.0181 in)

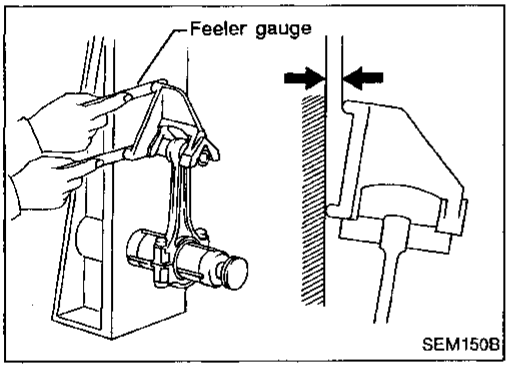
2nd ring 0.39 - 0.63 mm (0.0154 - 0.0248 in)

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

Max. limit of ring gap: 1.0 mm (0.039 in)

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

Refer to SDS (EM-47).

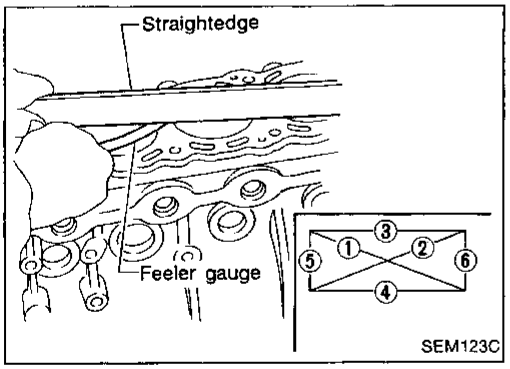


CONNECTING ROD BEND AND TORSION

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

Torsion: Limit 0.30 mm (0.012 in)
per 100 mm (3.94 in) length

If it exceeds the limit, replace connecting rod assembly.



CYLINDER BLOCK DISTORTION AND WEAR

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

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

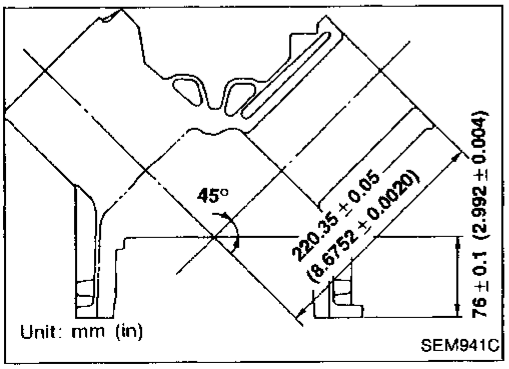
The maximum limit is as follows:

A + B = 0.2 mm (0.008 in)

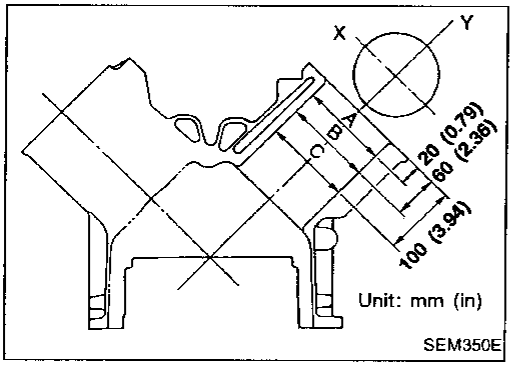
Nominal cylinder block height from crankshaft center:

220.3 - 220.4 mm (8.673 - 8.677 in)

3. If necessary, replace cylinder block.



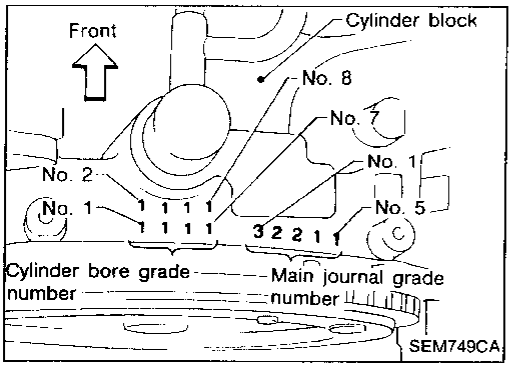
Inspection (Cont'd)

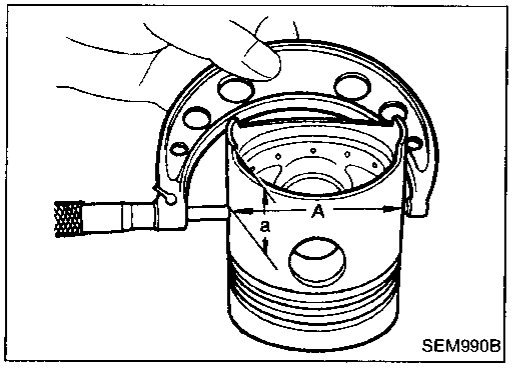


PISTON-TO-BORE CLEARANCE AND BORING

1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.
   Standard inner diameter:
   93.000 - 93.030 mm (3.6614 - 3.6626 in)
   Wear limit: 0.20 mm (0.0079 in)
   Out-of-round (X – Y) limit: 0.015 mm (0.0006 in)
   Taper (A – B – C) limit: 0.010 mm (0.0004 in)
   If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.
2. Check for scratches and seizure. If necessary, hone it.

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





3. Measure piston skirt diameter.
   Piston diameter "A":
   Refer to SDS.
   Measuring point "a" (Distance from the bottom):
   11.5 mm (0.453 in)
4. Check that piston-to-bore clearance is within specification.
   Piston-to-bore clearance:
   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-47).

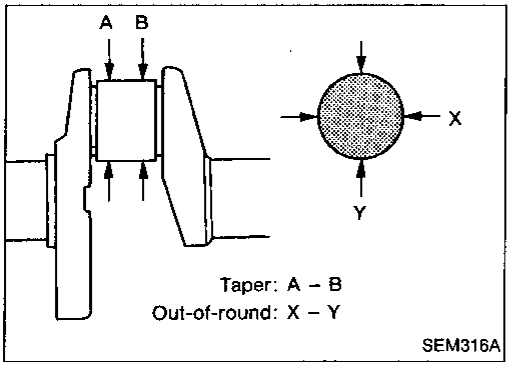
6. Cylinder bore size is determined by adding piston-to-bore clearance to piston diameter "A".
   Rebored size calculation: D = A + B – C
   where, D: Bored diameter
   A: Piston diameter as measured
   B: Piston-to-bore clearance
   C: Honing allowance 0.02 mm (0.0008 in)
7. Install main bearing caps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

- **When any cylinder needs boring, all other cylinders must also be bored.**
- **Do not cut cylinder bore too deeply at a time. Bore only about 0.05 mm (0.0020 in) in diameter at a time.**

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

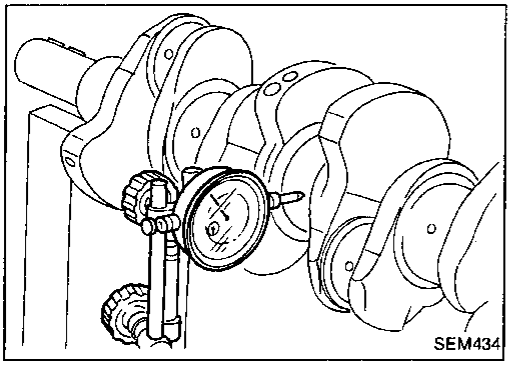
- **Measurement should be done after cylinder bore cools down.**

Inspection (Cont'd)

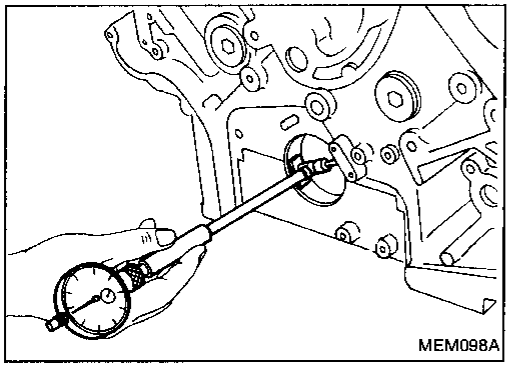


CRANKSHAFT

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



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



BEARING CLEARANCE

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

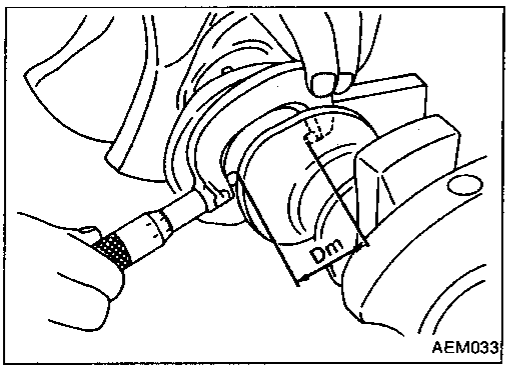
Method A (Using bore gauge & micrometer)

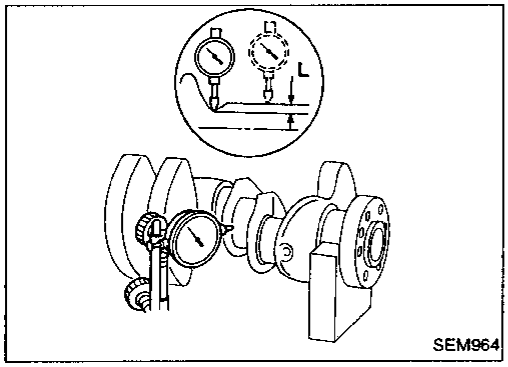
Main bearing

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

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

3. Measure inner diameter "A" of each main bearing.
4. Measure outer diameter "Dm" of each crankshaft main journal.
5. Calculate main bearing clearance.
   Main bearing clearance = A – Dm
   Standard: 0.012 - 0.030 mm (0.0005 - 0.0012 in)
   Limit: 0.050 mm (0.0020 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard, grind crankshaft journal and use undersized bearing.

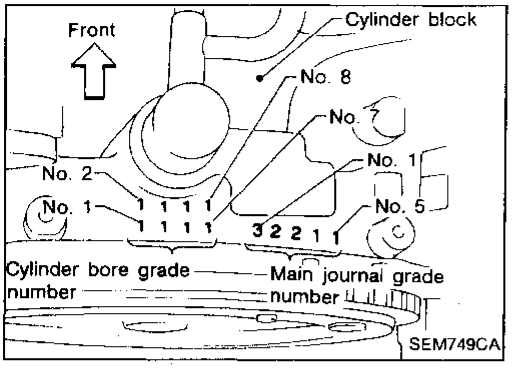




CAUTION:

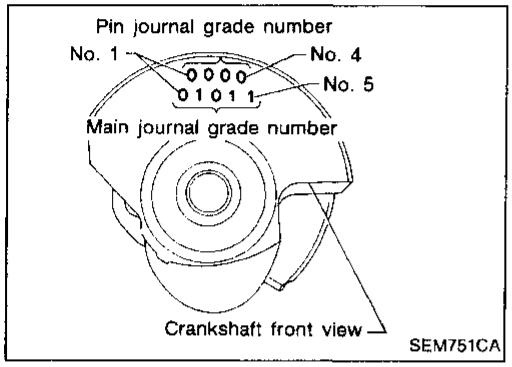
- **When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.**
  "L": 0.1 mm (0.004 in)
- **Refer to SDS for available service parts when grinding it.**

Inspection (Cont'd)



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

a. The grade number of each cylinder block main journal is punched in either Arabic or Roman numerals.



b. The grade number of each crankshaft main journal is punched in either Arabic or Roman numerals.

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

How to select main bearings

Main Bearing		Cylinder block journal grade number			
		0	1 (I)	2 (II)	3 (III)
Crankshaft journal grade number	0	0	1	2	3
	1 (I)	1	2	3	4
	2 (II)	2	3	4	5
	3 (III)	3	4	5	6

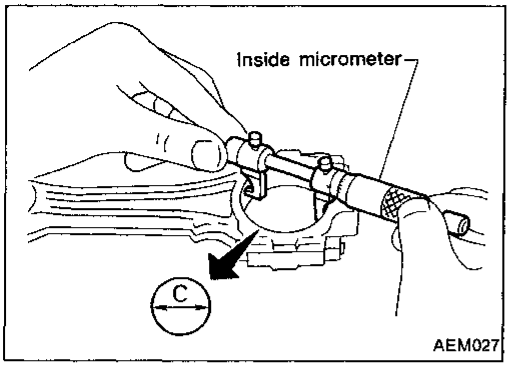
Identification mark and color

0	1	2	3	4	5	6
A, Black	B, Brown	C, Green	D, Yellow	E, Blue	F, Pink	G, No color

For example:

Cylinder block journal grade number: 1
Crankshaft journal grade number: 2
Main bearing grade number = 1 + 2
= 3
= D, Yellow

Inspection (Cont'd)

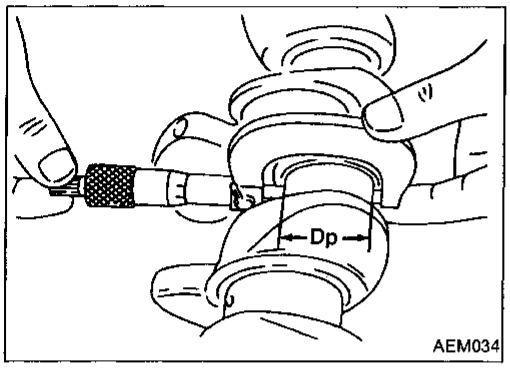


Connecting rod bearing (Big end)

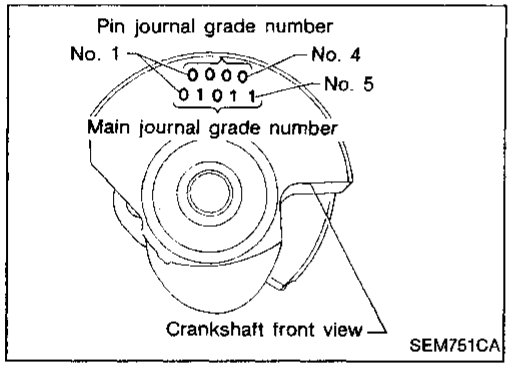
1. Install connecting rod bearing to connecting rod and cap.
2. Install connecting rod cap to connecting rod.

Tighten bolts to the specified torque.

3. Measure inner diameter "C" of each bearing.
4. Measure outer diameter "Dp" of each crankshaft pin journal.



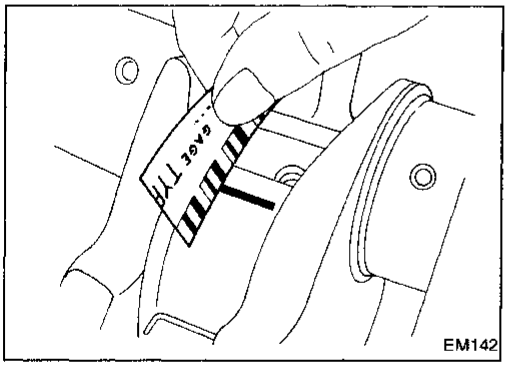
5. Calculate connecting rod bearing clearance.
   Connecting rod bearing clearance = C – Dp
   Standard: 0.020 - 0.045 mm (0.0008 - 0.0018 in)
   Limit: 0.065 mm (0.0026 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.
   Refer to step 7 of "BEARING CLEARANCE — Main bearing" (EM-37).



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

Connecting rod bearing grade number:

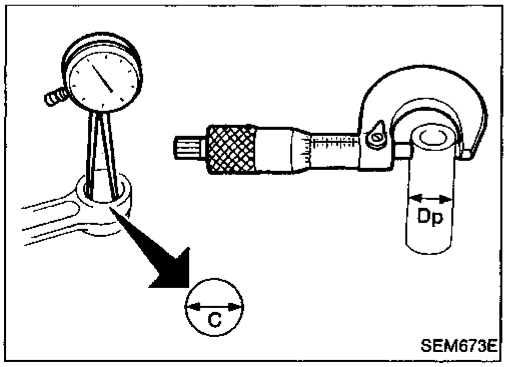
Crank pin grade number	Connecting rod bearing grade number	Identification color
0	0	No color
1 (I)	1 (I)	Brown
2 (II)	2 (II)	Green



Method B (Using plastigage)

CAUTION:

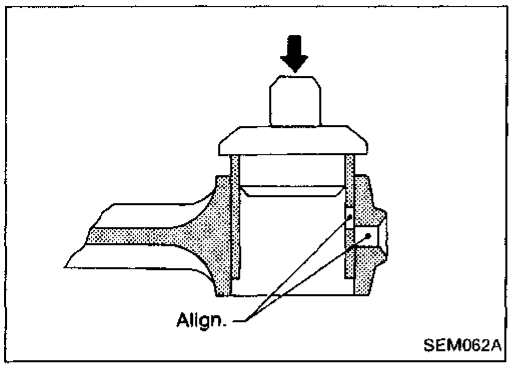
- **Do not turn crankshaft or connecting rod while plastigage is being inserted.**
- **When bearing clearance exceeds the specified limit, ensure that the proper bearing has been installed. If clearance cannot be adjusted using any standard bearing grade, grind crankshaft journal and use undersized bearing.**



CONNECTING ROD BUSHING CLEARANCE (Small end)

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

Inspection (Cont'd)



REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

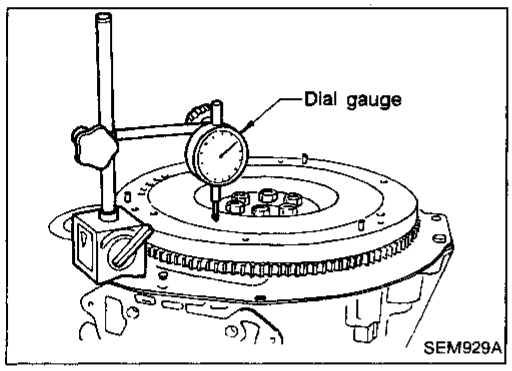
1. Drive in small end bushing until it is flush with end surface of rod.

Be sure to align oil holes.

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

Clearance:

0.005 - 0.017 mm (0.0002 - 0.0007 in)



DRIVE PLATE RUNOUT

Drive plate runout (Total indicator reading):

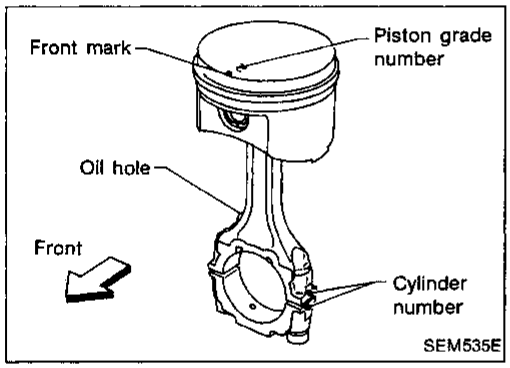
Less than 0.20 mm (0.0079 in)

Assembly

PISTON

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

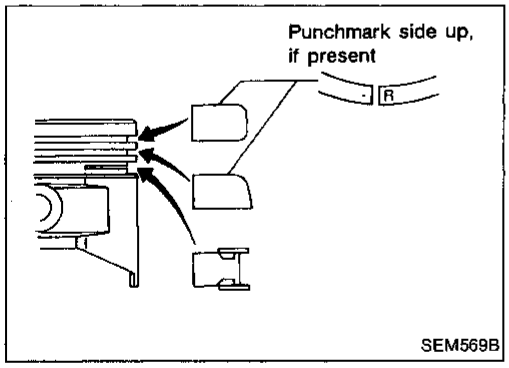
- **Align the direction of piston and connecting rod.**
- **Numbers stamped on connecting rod and cap correspond to each cylinder.**
- **After assembly, make sure connecting rod swings smoothly.**

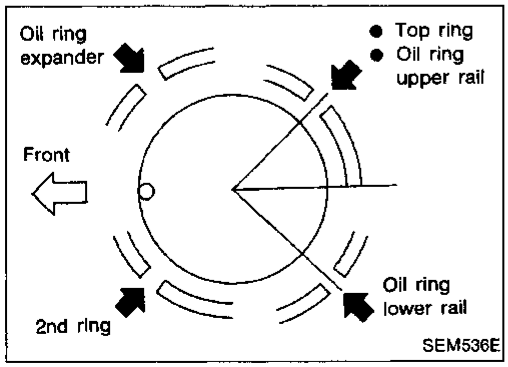


3. Set piston rings as shown.

CAUTION:

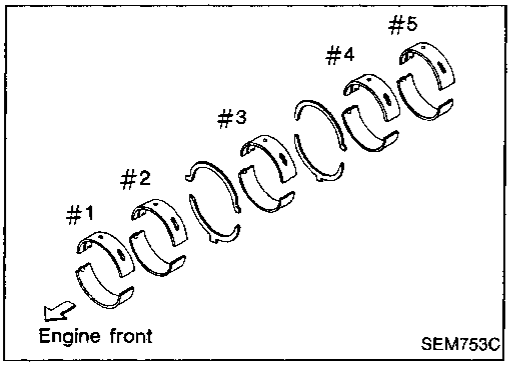
- **When piston rings are not replaced, make sure that piston rings are mounted in their original positions.**
- **When replacing piston rings, if there is no punchmark, install with either side up.**





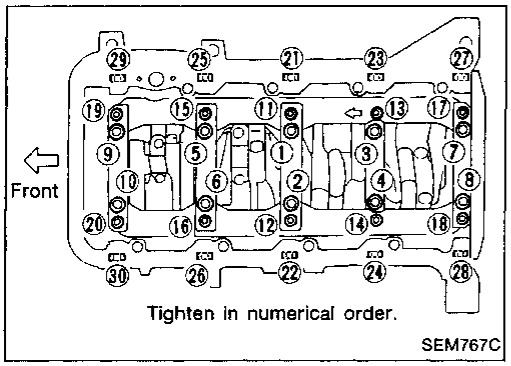
Assembly (Cont'd)

CRANKSHAFT



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

- **Confirm that correct main bearings are used. Refer to "Inspection" of this section (EM-38).**



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

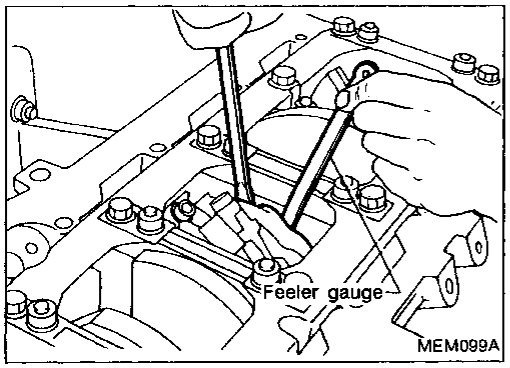
- **Prior to tightening bearing cap bolts, shift crankshaft back and forth to properly seat the bearing cap.**
- **Tightening procedure**

1) Tighten bolts (① - ⑳) to ⓐ.
2) Turn bolts (① - ⑳) ⓑ degrees clockwise.
3) Tighten all bolts (㉑ - ㉚) to ⓒ.

Unit: N·m (kg-m, ft-lb)

	Bolts (① ② ⑤ - ⑩)	Bolts (③ ④)	Bolts (⑪ - ⑳)	Bolts (㉑ - ㉚)
ⓐ	39 ± 3 (4.0 ± 0.3, 29 ± 2.2)	39 ± 3 (4.0 ± 0.3, 29 ± 2.2)	29 ± 3 (3.0 ± 0.3, 22 ± 2.2)	—
ⓑ	60^{+5}_{-0} degrees	40^{+5}_{-0} degrees	35^{+5}_{-0} degrees	—
ⓒ	—	—	—	49 ± 3 (5.0 ± 0.3, 36.2 ± 2.2)

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

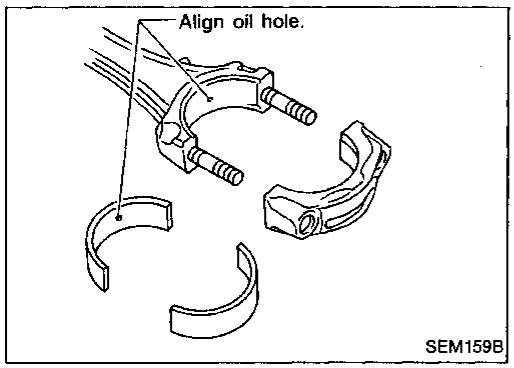


3. Measure crankshaft end play.

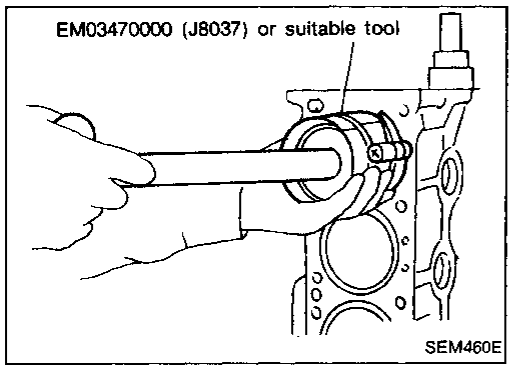
Crankshaft end play:
Standard
0.10 - 0.26 mm (0.0039 - 0.0102 in)
Limit
0.30 mm (0.0118 in)

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

Assembly (Cont'd)

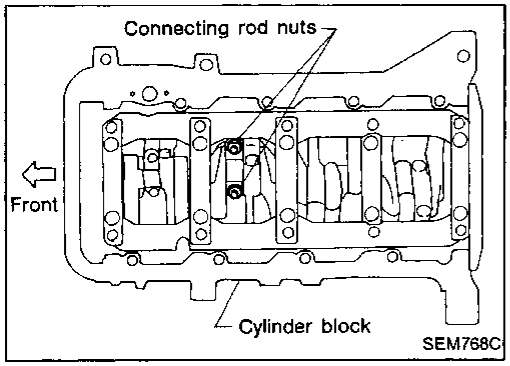


4. Install connecting rod bearings in connecting rods and connecting rod caps.
- **Confirm that correct bearings are used. Refer to "Inspection".**
- **Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.**



5. Install pistons with connecting rods.

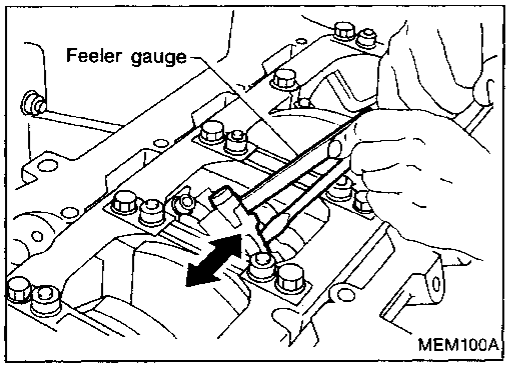
a. Install them into corresponding cylinders with Tool.
- **Be careful not to scratch cylinder wall by connecting rod.**
- **Arrange so that front mark on piston head faces toward front of engine.**



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

Tightening procedure:

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



6. Measure connecting rod side clearance.

Connecting rod side clearance:

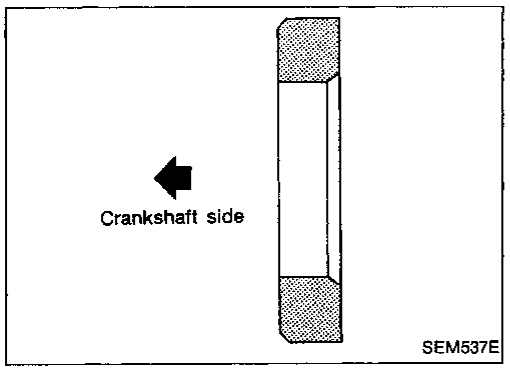
Standard

0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit

0.40 mm (0.0157 in)

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



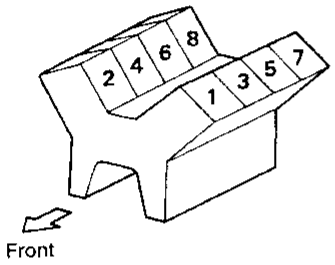
REPLACING PILOT CONVERTER

1. Remove pilot converter.
2. Install pilot converter.

General Specifications

Cylinder arrangement		V-8
Displacement	cm^3 (cu in)	4,494 (274.22)
Bore and stroke	mm (in)	93 x 82.7 (3.66 x 3.256)
Valve arrangement		DOHC
Firing order		1-8-7-3-6-5-4-2
Number of piston rings		
Compression		2
Oil		1
Number of main bearings		5
Compression ratio		10.2

Cylinder number



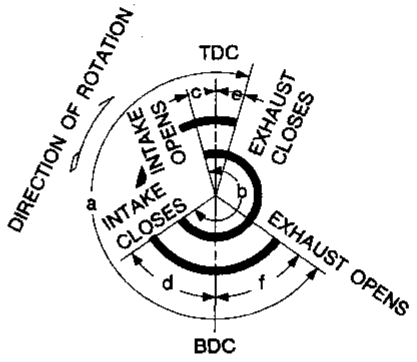
SEM957C

COMPRESSION PRESSURE

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

Compression pressure	
Standard	1,275 (13.0, 185)
Minimum	981 (10.0, 142)
Differential limit between cylinders	98 (1.0, 14)

Valve timing



EM120

Unit: degree

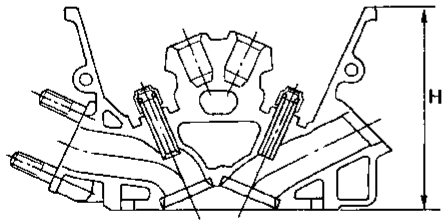
a	b	c	d	e	f
248	248	0	68	8	60

Inspection and Adjustment

CYLINDER HEAD

Unit: mm (in)

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



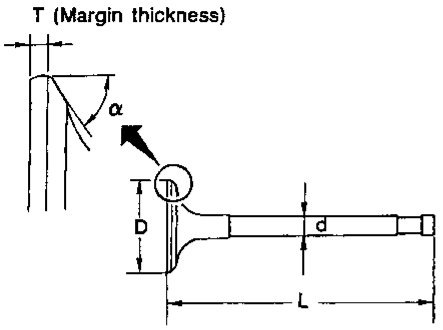
Nominal cylinder head height:
H = 130.7 - 130.9 mm (5.146 - 5.154 in)

SEM956C

Inspection and Adjustment (Cont'd)

VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	
Intake	38.0 - 38.3 (1.496 - 1.508)
Exhaust	33.0 - 33.2 (1.299 - 1.307)
Valve length "L"	
Intake	101.70 - 102.30 (4.0039 - 4.0276)
Exhaust	102.12 - 102.72 (4.0205 - 4.0441)
Valve stem diameter "d"	
Intake	6.966 - 6.971 (0.2743 - 0.2744)
Exhaust	7.960 - 7.965 (0.3134 - 0.3136)
Valve seat angle "α"	
Intake	45°15' - 45°45'
Exhaust	
Valve margin "T"	
Intake	1.15 - 1.45 (0.0453 - 0.0571)
Exhaust	1.45 - 1.75 (0.0571 - 0.0689)
Valve margin "T" limit	More than 0.5 (0.020)
Valve stem end surface grinding limit	Less than 0.2 (0.008)
Valve clearance	
Intake	0 (0)
Exhaust	0 (0)

Valve spring

Free height	mm (in)	47.31 (1.8626)
Pressure N (kg, lb) at height mm (in)		
Standard		535.5 (54.6, 120.4) at 26.8 (1.055)
Limit		477.6 (48.7, 107.4) at 26.8 (1.055)
Out-of-square	mm (in)	Less than 2.06 (0.0811)

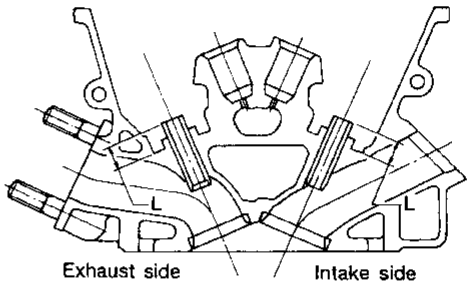
Hydraulic lash adjuster (HLA)

Unit: mm (in)

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

Valve guide

Unit: mm (in)



SEM933C

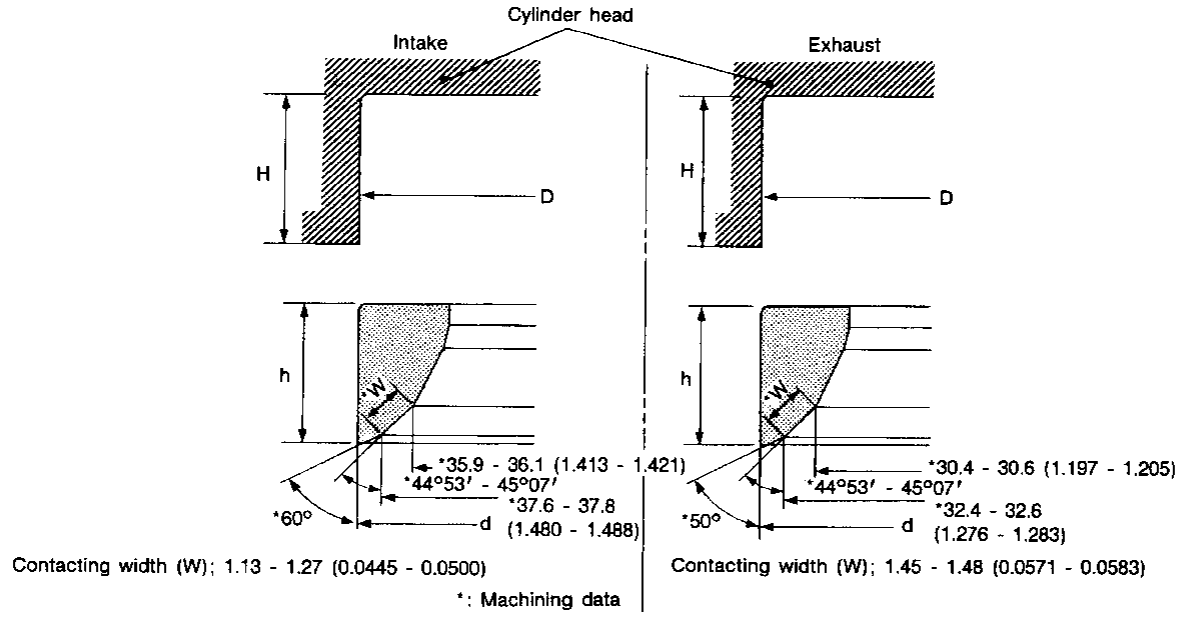
		Standard	Service
Valve guide Outer diameter	Intake	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
	Exhaust	12.023 - 12.034 (0.4733 - 0.4738)	12.223 - 12.234 (0.4812 - 0.4817)
Valve guide Inner diameter (Finished size)	Intake	7.000 - 7.018 (0.2756 - 0.2763)	
	Exhaust	8.000 - 8.011 (0.3150 - 0.3154)	
Cylinder head valve guide hole diameter	Intake	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
	Exhaust	11.975 - 11.996 (0.4715 - 0.4723)	12.175 - 12.196 (0.4793 - 0.4802)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	

		Standard	Limit
Stem to guide clearance	Intake	0.029 - 0.052 (0.0011 - 0.0020)	0.080 (0.0031)
	Exhaust	0.035 - 0.051 (0.0014 - 0.0020)	0.080 (0.0031)
Valve deflection limit		—	0.15 (0.0059)
Projection length "L"		17.15 - 17.35 (0.6752 - 0.6831)	

Inspection and Adjustment (Cont'd)

VALVE SEAT

Unit: mm (in)



SEM687E

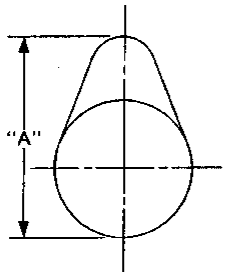
		Standard	Service
Cylinder head seat recess diameter (D)	In.	39.000 - 39.016 (1.5354 - 1.5361)	39.500 - 39.516 (1.5551 - 1.5557)
	Ex.	34.000 - 34.016 (1.3386 - 1.3392)	34.500 - 34.516 (1.3583 - 1.3589)
Valve seat interference fit	In.	0.081 - 0.113 (0.0032 - 0.0044)	
	Ex.	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	In.	39.097 - 39.113 (1.5392 - 1.5399)	39.597 - 39.613 (1.5589 - 1.5596)
	Ex.	34.080 - 34.096 (1.3417 - 1.3424)	34.580 - 34.596 (1.3614 - 1.3620)
Depth (H)	In.	6.32 - 6.52 (0.2488 - 0.2567)	
	Ex.	6.15 - 6.35 (0.2421 - 0.2500)	
Height (h)		6.2 - 6.3 (0.244 - 0.248)	

Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

	Standard	Limit
Camshaft journal to bearing clearance	0.045 - 0.086 (0.0018 - 0.0034)	0.15 (0.0059)
Inner diameter of camshaft bearing	26.000 - 26.021 (1.0236 - 1.0244)	—
Outer diameter of camshaft journal	25.935 - 25.955 (1.0211 - 1.0218)	—
Camshaft runout [TIR*]	Less than 0.02 (0.0008)	0.05 (0.0020)
Camshaft sprocket runout [TIR*]	Less than 0.15 (0.0059)	—
Camshaft end play	0.070 - 0.148 (0.0028 - 0.0058)	0.20 (0.0079)



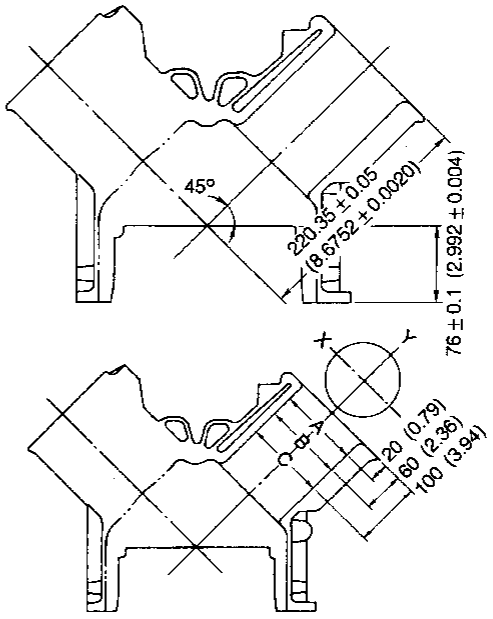
EM671

Cam height "A"	
Intake	37.919 - 38.109 (1.4929 - 1.5004)
Exhaust	35.279 - 35.469 (1.3889 - 1.3964)
Wear limit of cam height	0.05 (0.0020)

*Total indicator reading

CYLINDER BLOCK

Unit: mm (in)



SEM955C

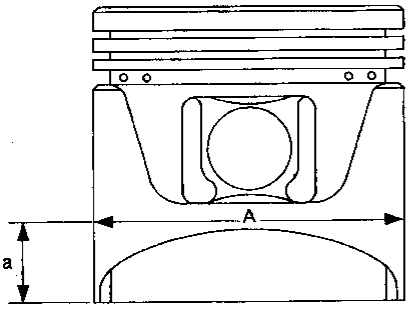
Surface flatness	
Standard	Less than 0.03 (0.0012)
Limit	0.10 (0.0039)
Cylinder bore	
Inner diameter	
Standard	
Grade No. 1	93.000 - 93.010 (3.6614 - 3.6618)
Grade No. 2	93.010 - 93.020 (3.6618 - 3.6622)
Grade No. 3	93.020 - 93.030 (3.6622 - 3.6626)
Wear limit	0.20 (0.0079)
Out-of-round (X – Y)	Less than 0.015 (0.0006)
Taper (A – B – C)	Less than 0.010 (0.0004)
Difference in inner diameter between cylinders	
Limit	Less than 0.03 (0.0012)
Main journal inner diameter	
Grade No. 0	68.944 - 68.950 (2.7143 - 2.7146)
Grade No. 1	68.950 - 68.956 (2.7146 - 2.7148)
Grade No. 2	68.956 - 68.962 (2.7148 - 2.7150)
Grade No. 3	68.962 - 68.968 (2.7150 - 2.7153)

Inspection and Adjustment (Cont'd)

PISTON, PISTON RING AND PISTON PIN

Available piston

Unit: mm (in)



SEM750C

Piston skirt diameter "A"	
Standard	
Grade No. 1	92.980 - 92.990 (3.6606 - 3.6610)
Grade No. 2	92.990 - 93.000 (3.6610 - 3.6614)
Grade No. 3	93.000 - 93.010 (3.6614 - 3.6618)
0.20 (0.0079) oversize (Service)	93.180 - 93.210 (3.6685 - 3.6697)
"a" dimension	11.5 (0.453)
Piston clearance to cylinder block	0.010 - 0.030 (0.0004 - 0.0012)
Piston pin hole diameter	21.987 - 21.999 (0.8656 - 0.8661)

Piston ring

Unit: mm (in)

	Standard	Limit
Side clearance		
Top	0.040 - 0.080 (0.0016 - 0.0031)	0.1 (0.004)
2nd	0.030 - 0.070 (0.0012 - 0.0028)	
End gap		
Top	0.27 - 0.46 (0.0106 - 0.0181)	1.0 (0.039)
2nd	0.39 - 0.63 (0.0154 - 0.0248)	
Oil (rail ring)	0.20 - 0.69 (0.0079 - 0.0272)	

Piston pin

Unit: mm (in)

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

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

CONNECTING ROD

Unit: mm (in)

Center distance	146.95 - 147.05 (5.7854 - 5.7894)
Bend, torsion [per 100 (3.94)]	
Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	
Limit	0.3 (0.0012)
Connecting rod small end inner diameter	24.980 - 25.000 (0.9835 - 0.9843)
Piston pin bushing inner diameter*	22.000 - 22.012 (0.8661 - 0.8666)
Connecting rod big end inner diameter	55.000 - 55.013 (2.1654 - 2.1659)
Side clearance	
Standard	0.20 - 0.35 (0.0079 - 0.0138)
Limit	0.40 (0.0157)

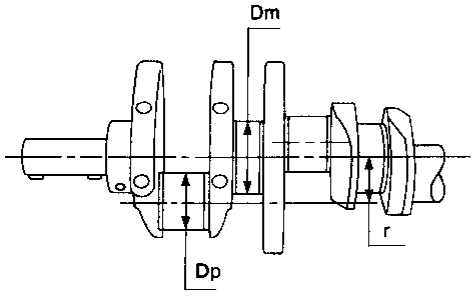
*After installing in connecting rod

Inspection and Adjustment (Cont'd)

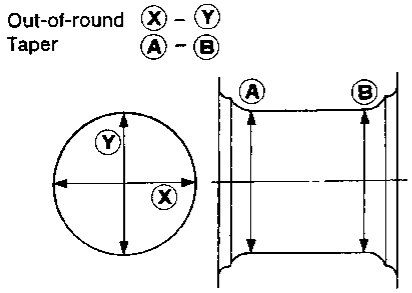
CRANKSHAFT

Unit: mm (in)

Main journal dia. "Dm"	
Grade No. 0	63.958 - 63.964 (2.5180 - 2.5183)
Grade No. 1	63.952 - 63.958 (2.5178 - 2.5180)
Grade No. 2	63.946 - 63.952 (2.5176 - 2.5178)
Grade No. 3	63.940 - 63.946 (2.5173 - 2.5176)
Pin journal dia. "Dp"	
Grade No. 0	51.968 - 51.974 (2.0460 - 2.0462)
Grade No. 1	51.962 - 51.968 (2.0457 - 2.0460)
Grade No. 2	51.956 - 51.962 (2.0455 - 2.0457)
Center distance "r"	41.31 - 41.39 (1.6264 - 1.6295)
Out-of-round (X – Y)	
Standard	Less than 0.005 (0.0002)
Taper (A – B)	
Standard	Less than 0.005 (0.0002)
Runout [TIR]	
Standard	Less than 0.025 (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)

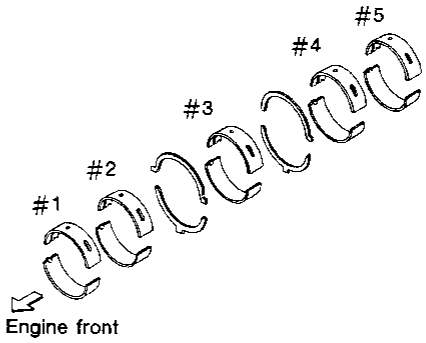


SEM954C



EM715

AVAILABLE MAIN BEARING



SEM753C

No. 1 and 5 main bearing

Standard size

Unit: mm (in)

Grade number	Thickness "T"	Width "W"	Identification color (mark)
0	2.481 - 2.484 (0.0977 - 0.0978)	20.0 (0.787)	Black (A)
1	2.484 - 2.487 (0.0978 - 0.0979)		Brown (B)
2	2.487 - 2.490 (0.0979 - 0.0980)		Green (C)
3	2.490 - 2.493 (0.0980 - 0.0981)		Yellow (D)
4	2.493 - 2.496 (0.0981 - 0.0983)		Blue (E)
5	2.496 - 2.499 (0.0983 - 0.0984)		Pink (F)
6	2.499 - 2.502 (0.0984 - 0.0985)		No color (G)

Inspection and Adjustment (Cont'd)

No. 2 and 4 main bearing

Standard size

Unit: mm (in)

Grade number	Thickness "T"	Width "W"	Identification color (mark)
0	2.481 - 2.484 (0.0977 - 0.0978)	22.3 (0.878)	Black (A)
1	2.484 - 2.487 (0.0978 - 0.0979)		Brown (B)
2	2.487 - 2.490 (0.0979 - 0.0980)		Green (C)
3	2.490 - 2.493 (0.0980 - 0.0981)		Yellow (D)
4	2.493 - 2.496 (0.0981 - 0.0983)		Blue (E)
5	2.496 - 2.499 (0.0983 - 0.0984)		Pink (F)
6	2.499 - 2.502 (0.0984 - 0.0985)		No color (G)

No. 3 main bearing

Standard size

Unit: mm (in)

Grade number	Thickness "T"	Width "W"	Identification color (mark)
0	2.481 - 2.484 (0.0977 - 0.0978)	21.3 (0.839)	Black (A)
1	2.484 - 2.487 (0.0978 - 0.0979)		Brown (B)
2	2.487 - 2.490 (0.0979 - 0.0980)		Green (C)
3	2.490 - 2.493 (0.0980 - 0.0981)		Yellow (D)
4	2.493 - 2.496 (0.0981 - 0.0983)		Blue (E)
5	2.496 - 2.499 (0.0983 - 0.0984)		Pink (F)
6	2.499 - 2.502 (0.0984 - 0.0985)		No color (G)

Undersize

Unit: mm (in)

	Thickness	Main journal diameter "Dm"
0.25 (0.0098)	2.613 - 2.621 (0.1029 - 0.1032)	Grind so that bearing clearance is the specified value.

AVAILABLE CONNECTING ROD BEARING

Connecting rod bearing

Standard size

Unit: mm (in)

Grade number	Thickness "T"	Identification color (mark)
0	1.500 - 1.503 (0.0591 - 0.0592)	No color (A)
1	1.503 - 1.506 (0.0592 - 0.0593)	Brown (B)
2	1.506 - 1.509 (0.0593 - 0.0594)	Green (C)

Undersize

Unit: mm (in)

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

Bearing clearance

Unit: mm (in)

Main bearing clearance	
Standard	0.012 - 0.030 (0.0005 - 0.0012)
Limit	0.050 (0.0020)
Connecting rod bearing clearance	
Standard	0.020 - 0.045 (0.0008 - 0.0018)
Limit	0.065 (0.0026)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Drive plate	
Runout [TIR]*	Less than 0.20 (0.0079)

*Total indicator reading