ENGINE MECHANICAL

SECTION EM

CONTENTS

CONTENTS (Cont'd)

Parts Requiring Angular Tightening

NFEM0001

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

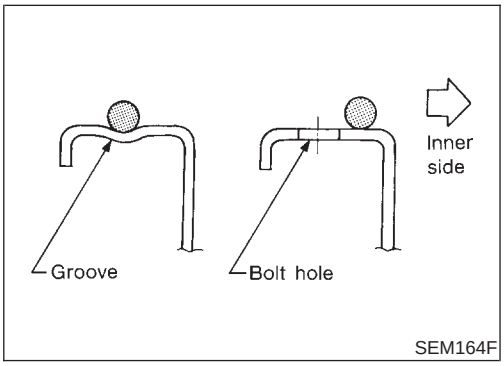
a) Cylinder head bolts
b) Main bearing cap bolts
c) Connecting rod cap nuts
d) Crankshaft pulley bolt

- 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.

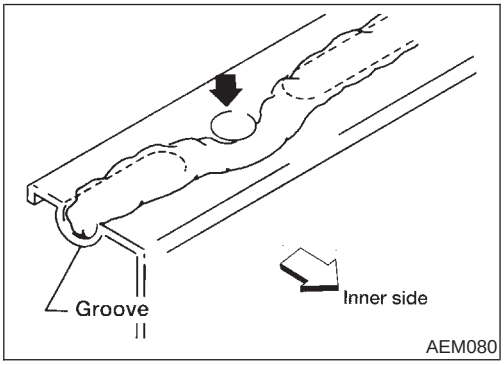
Liquid Gasket Application Procedure

NFEM0002

1. Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also, completely clean any oil from these areas.
2. Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine RTV silicone sealant or equivalent. Refer to GI-52.)
   - Be sure liquid gasket diameter is as specified in this manual.



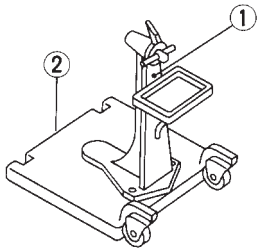
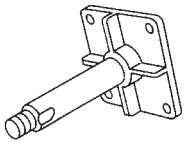
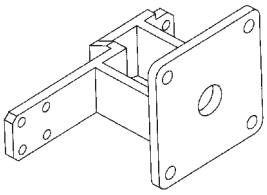
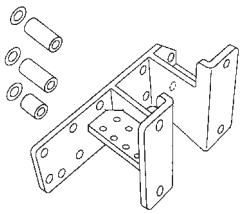
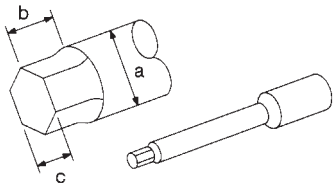
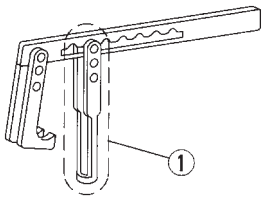
3. Apply liquid gasket around the inner side of bolt holes (unless otherwise specified).
4. Assembly should be done within 5 minutes after coating.
5. Wait at least 30 minutes before refilling engine oil and engine coolant.

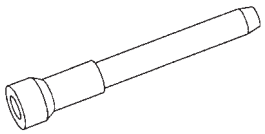
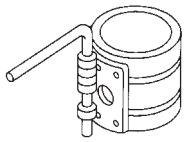
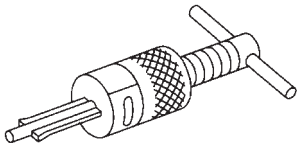
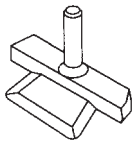
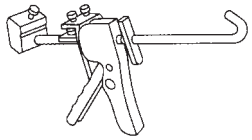
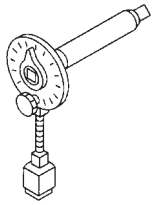


Special Service Tools

NFEM0003

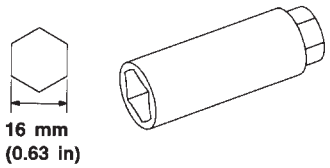
The actual shapes of Kent-Moore tools may differ from those of special service tools illustrated here.

Tool number (Kent-Moore No.) Tool name	Description	
ST0501S000 (—) Engine stand assembly 1 ST05011000 (—) Engine stand 2 ST05012000 (—) Base	 NT042	Disassembling and assembling
KV10106500 (—) Engine stand shaft	 NT028	
KV10117000 (J41262) Engine sub-attachment	 NT373	KV10117000 has been replaced with KV10117001 (KV10117000 is no longer in production, but it is usable).
KV10117001 (—) Engine sub-attachment	 NT372	Installing on the cylinder block
ST10120000 (J24239-01) Cylinder head bolt wrench	 NT583	Loosening and tightening cylinder head bolt **a: 13 (0.51) dia.** **b: 12 (0.47)** **c: 10 (0.39)** Unit: mm (in)
KV10116200 (J26336-A) Valve spring compressor 1 KV10115900 (J26336-20) Attachment	 NT022	Disassembling valve mechanism

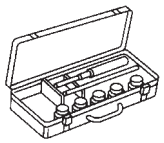
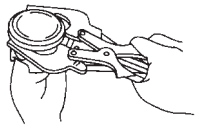
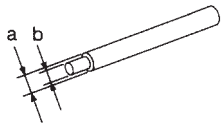
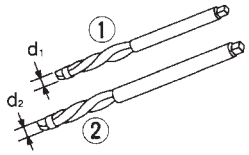
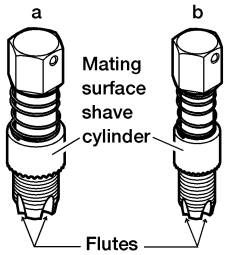
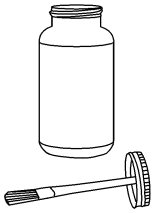
Tool number (Kent-Moore No.) Tool name	Description	
(J39386) Valve oil seal drift	 NT024	Installing valve oil seal
EM03470000 (J8037) Piston ring compressor	 NT044	Installing piston assembly into cylinder bore
ST16610001 (J23907) Pilot bushing puller	 NT045	Removing crankshaft pilot bushing
KV10111100 (J37228) Seal cutter	 NT046	Removing steel oil pan and rear timing chain case
WS39930000 (—) Tube presser	 NT052	Pressing the tube of liquid gasket
KV10112100 (BT8653-A) Angle wrench	 NT014	Tightening bolts for bearing cap, cylinder head, etc.

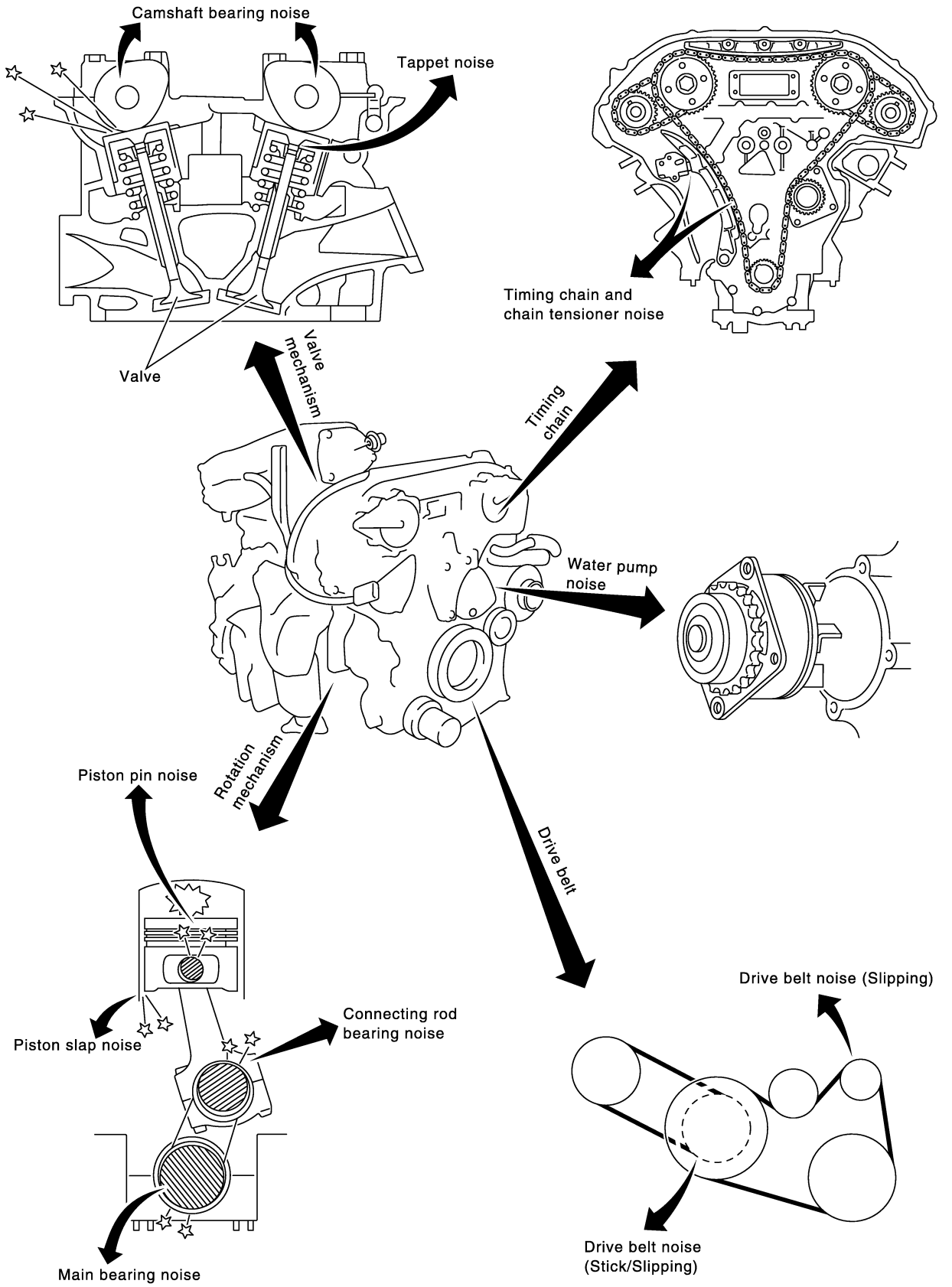
Commercial Service Tools

NFEM0004

Tool number (Kent-Moore No.) Tool name	Description	
Spark plug wrench	 NT047	Removing and installing spark plug

Commercial Service Tools (Cont'd)

Tool number (Kent-Moore No.) Tool name	Description	
Valve seat cutter set	 NT048	Finishing valve seat dimensions
Piston ring expander	 NT030	Removing and installing piston ring
Valve guide drift	 NT015	Removing and installing valve guide **Intake & Exhaust:** **a = 9.5 mm (0.374 in) dia.** **b = 5.5 mm (0.217 in) dia.**
Valve guide reamer	 NT016	Reaming valve guide 1 or hole for oversize valve guide 2 **Intake & Exhaust:** **d_1 = 6.0 mm (0.236 in) dia.** **d_2 = 10.2 mm (0.402 in) dia.**
(J-43897-18) (J-43897-12) Oxygen sensor thread cleaner	 AEM488	Reconditioning the exhaust system threads before installing a new oxygen sensor (Use with anti-seize lubricant shown below.) **a = J-43897-18 (18 mm dia.) for zirconia oxygen sensor** **b = J-43897-12 (12 mm dia.) for titania oxygen sensor**
Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907)	 AEM489	Lubricating oxygen sensor thread cleaning tool when reconditioning exhaust system threads


Camshaft bearing noise
Tappet noise
Valve
Timing chain and chain tensioner noise
Valve mechanism
Timing chain
Water pump noise
Rotation mechanism
Drive belt
Piston pin noise
Piston slap noise
Connecting rod bearing noise
Main bearing noise
Drive belt noise (Slipping)
Drive belt noise (Stick/Slipping)

SEM706G

NVH Troubleshooting — Engine Noise

NFEM0005S01

Use the chart below to help you find the cause of the symptom.

1. Locate the area where noise occurs.
2. Confirm the type of noise.
3. Specify the operating condition of engine.
4. Check specified noise source.

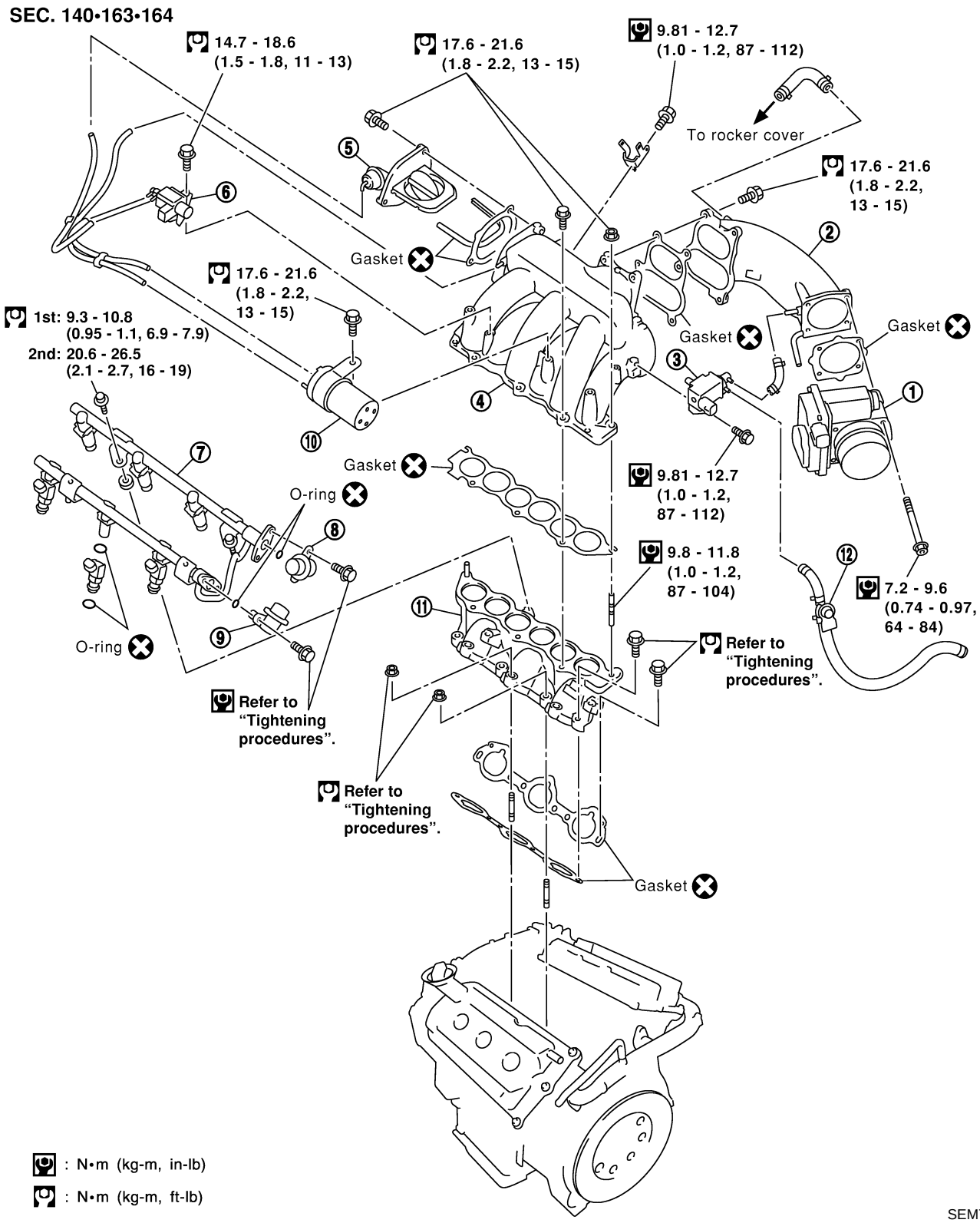
If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-58
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-49, EM-48
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance	EM-68, EM-74
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston-to-bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-70, EM-68, EM-68, EM-69
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing clearance (Small end) Connecting rod bearing clearance (Big end)	EM-74, EM-73
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-71, EM-71
Front of engine Timing chain cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation	EM-32, EM-21
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	MA section (“Checking Drive Belts”, “ENGINE MAINTENANCE”)
	Creaking	A	B	A	B	A	B	Drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	LC section (“Water Pump Inspection”, “ENGINE COOLING SYSTEM”)

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

Removal and Installation

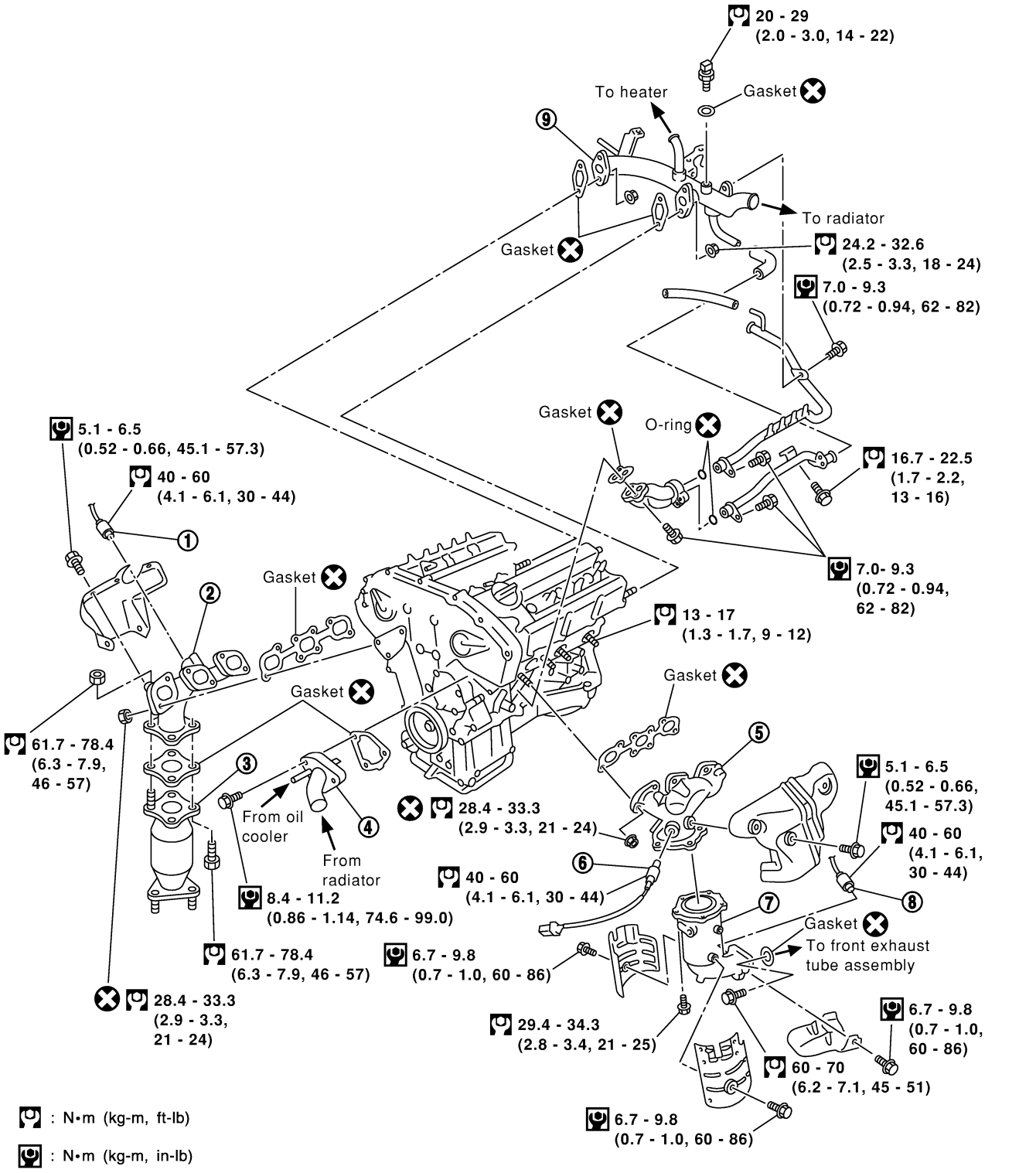
NFEM0006



SEM707GA

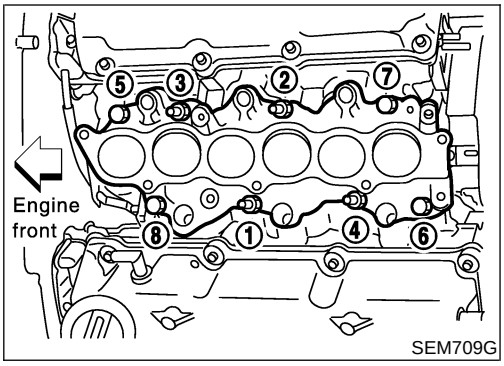
1. Electronic control throttle actuator
2. Intake manifold upper collector
3. EVAP canister purge volume control solenoid valve
4. Intake manifold lower collector
5. Power valve
6. VIAS control solenoid valve
7. Fuel tube
8. Fuel damper
9. Fuel damper
10. Vacuum tank
11. Intake manifold
12. Service port

SEC. 140•208•211



SEM708GA

1. Heated oxygen sensor 1 (front) (bank 1)
2. Exhaust manifold
3. TWC (manifold)
4. Thermostat with water inlet
5. Exhaust manifold
6. Heated oxygen sensor 1 (front) (bank 2)
7. TWC (manifold)
8. Heated oxygen sensor 2 (rear) (bank 2)
9. Water outlet



TIGHTENING PROCEDURES

NFEM0006S01

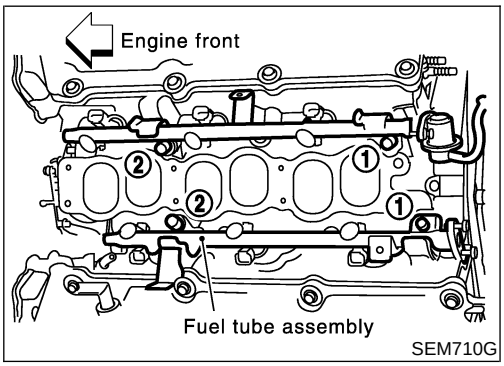
Intake Manifold

NFEM0006S0101

- **Loosen in reverse order and tighten in numerical order shown in the figure.**

1. Tighten all bolts and nuts to 4.9 to 9.8 N·m (0.50 to 0.99 kg-m, 4 to 7 ft-lb).
2. Finally tighten all bolts and nuts to 26.5 to 31.4 N·m (2.7 to 3.2 kg-m, 20 to 23 ft-lb).

- Tighten all bolts and nuts to the final torque, evenly dividing the tightening into at least three steps.

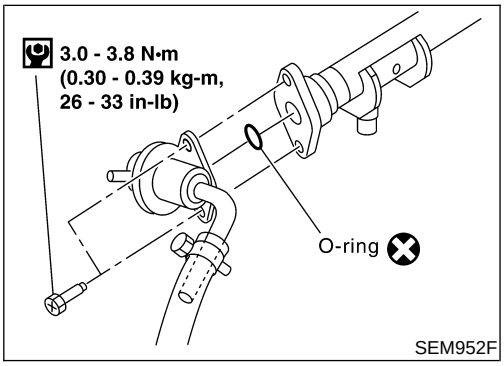


Fuel Tube

NFEM0006S0102

- **Tighten in numerical order shown in the figure.**

1. Tighten all bolts to 9.3 to 10.8 N·m (0.95 to 1.1 kg-m, 6.9 to 7.9 ft-lb).
2. Then tighten all bolts to 20.6 to 26.5 N·m (2.1 to 2.7 kg-m, 16 to 19 ft-lb).

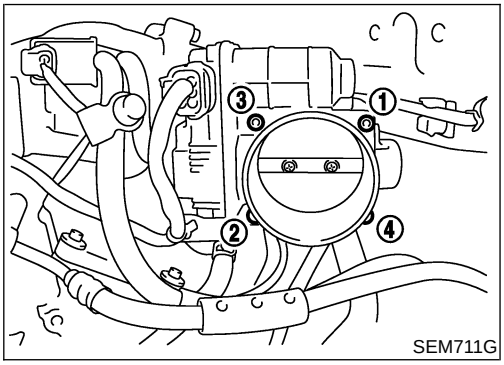


Fuel Damper

NFEM0006S0103

Tighten fuel damper to 2.9 to 3.8 N·m (0.3 to 0.39 kg-m, 26.0 to 33.9 in-lb).

- **Tighten screws evenly several times to have the fuel damper tightened at the specified torque.**
- **Always replace O-ring with new ones.**
- **Lubricate O-ring with new engine oil.**



Electronic Control Throttle Actuator

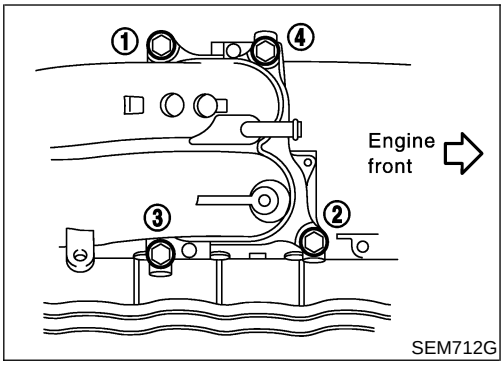
NFEM0006S0105

- **Tighten in numerical order shown in the figure.**

Tighten all bolts to 7.2 to 9.6 N·m (0.74 to 0.97 kg-m, 64 to 84 in-lb).

CAUTION:

- **Perform "Throttle Valve Closed Position Learning" when harness connector of electronic throttle control actuator is disconnected.**
  Refer to "BASIC SERVICE PROCEDURE" in EC section.
- **Perform "Idle Air Volume Learning" when electronic throttle control actuator is replaced.**
  Refer to "BASIC SERVICE PROCEDURE" in EC section.

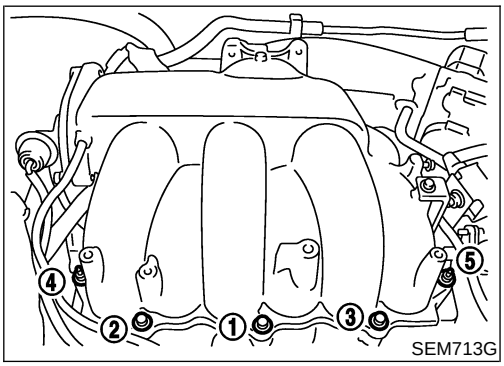


Intake Manifold Upper Collector

NFEM0006S0108

- **Loosen in reverse order and tighten in numerical order shown in the figure.**

Tighten all bolts to 17.6 to 21.6 N·m (1.8 to 2.2 kg-m, 13 to 15 ft-lb).

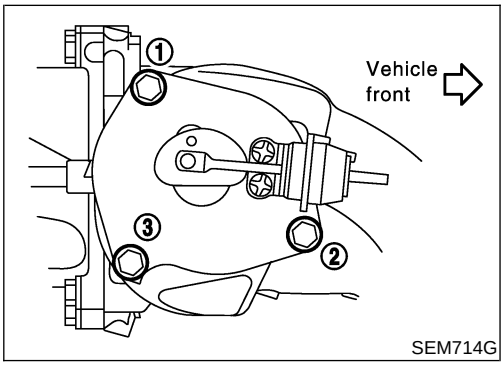


Intake Manifold Lower Collector

NFEM0006S0107

- **Loosen in reverse order and tighten in numerical order shown in the figure.**

Tighten bolts and nuts to 17.6 to 21.6 N·m (1.8 to 2.2 kg-m, 13 to 15 ft-lb).

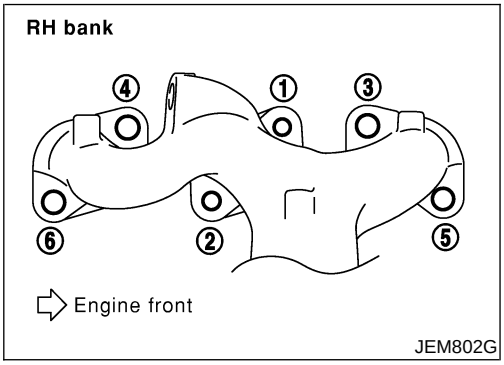


Power Valve

NFEM0006S0109

- **Tighten in numerical order shown in the figure.**

Tighten all bolts to 17.6 to 21.6 N·m (1.8 to 2.2 kg-m, 13 to 15 ft-lb).

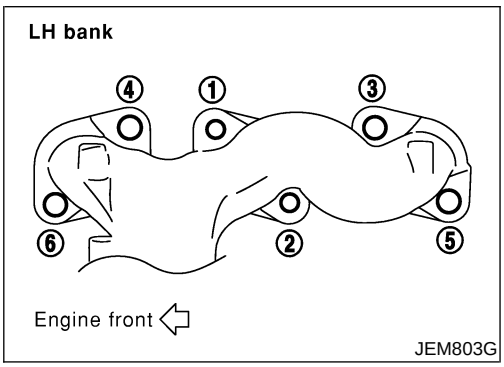


Exhaust Manifold

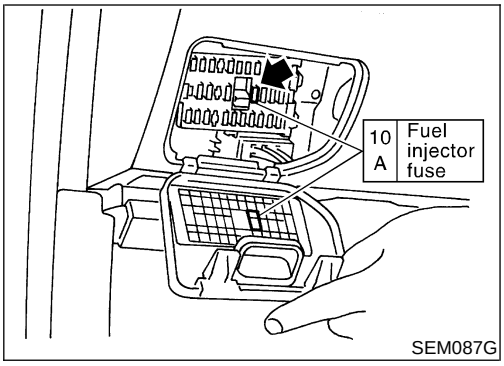
NFEM0006S0110

- **Loosen in reverse order and tighten in numerical order shown in the figure.**

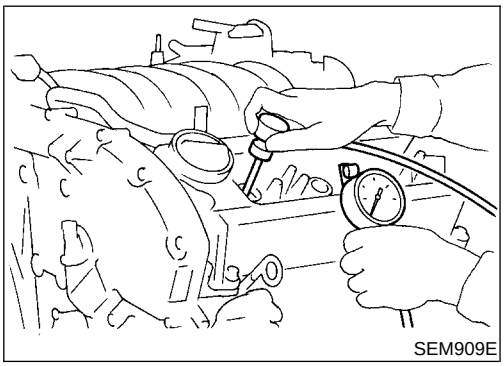
Tighten nuts to 28.4 to 33.3 N·m (2.9 to 3.3 kg-m, 21 to 24 ft-lb).

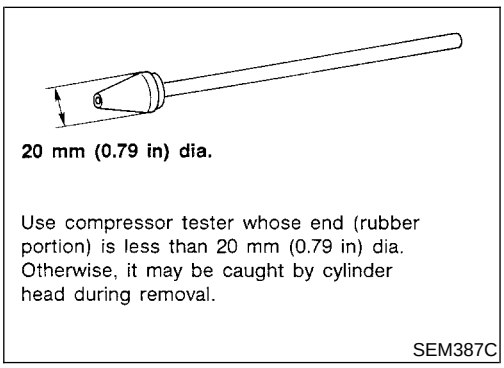


MEASUREMENT OF COMPRESSION PRESSURE



SEM087G


SEM909E



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

SEM387C

1. Warm up engine.
2. Turn ignition switch OFF.
3. Release fuel pressure.
   Refer to EC-56, “Fuel Pressure Release”.
4. Disconnect ignition coil with power transistor harness connectors, then remove ignition coils.
5. Remove all spark plugs.
6. Remove fuse for fuel injector.
7. Attach a compression tester to No. 1 cylinder.
8. Depress accelerator pedal fully to keep throttle valve wide open.
9. Crank engine and record highest gauge indication.
10. Repeat the measurement on each cylinder as shown above.

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

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

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

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

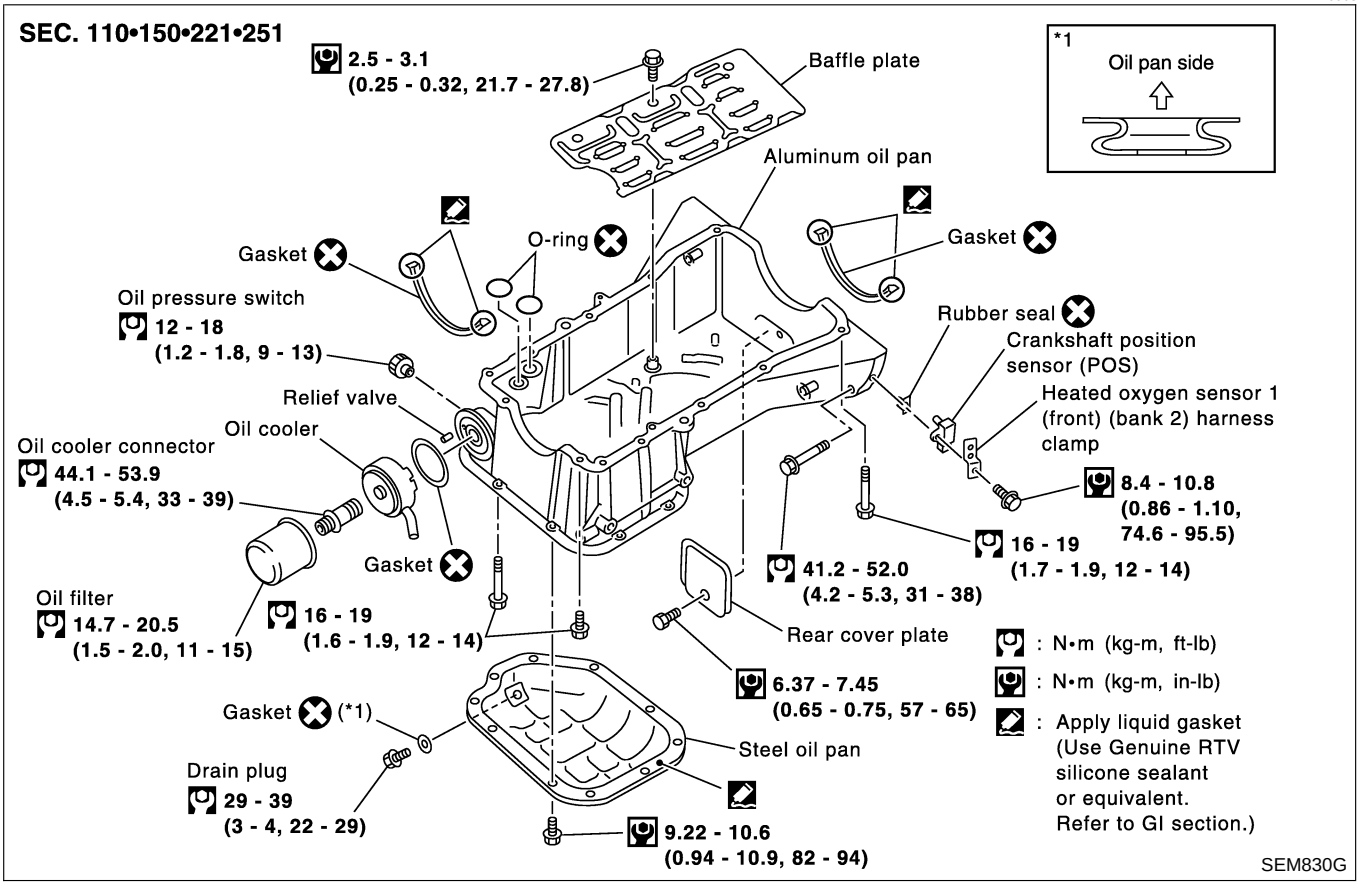
a. Pour a small amount of engine oil into cylinders through spark plug holes.
b. Retest compression.

- **If adding oil helps compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. (Refer to SDS, EM-82 and EM-85.) If valve or valve seat is damaged excessively, replace them.**
- **If compression stays low in two cylinders that are next to each other:**

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

Components

NFEM0008



Removal

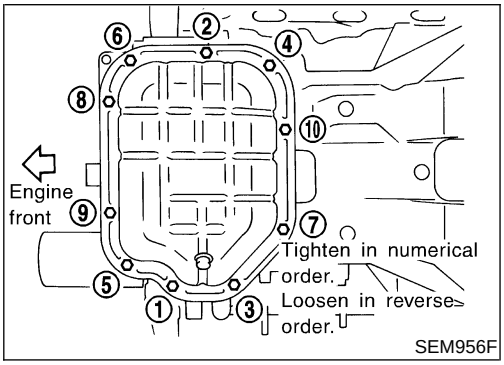
NFEM0009

CAUTION:

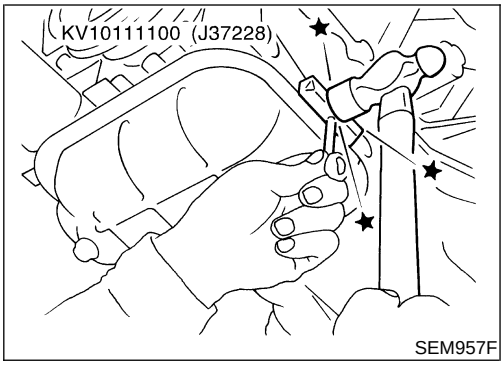
When removing the aluminum oil pan from engine, first remove the crankshaft position sensor (POS) from the assembly.

Be careful not to damage sensor edges and signal plate teeth.

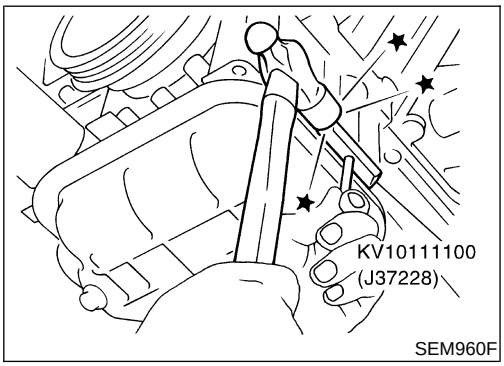
1. Remove engine undercover.
2. Drain engine oil.



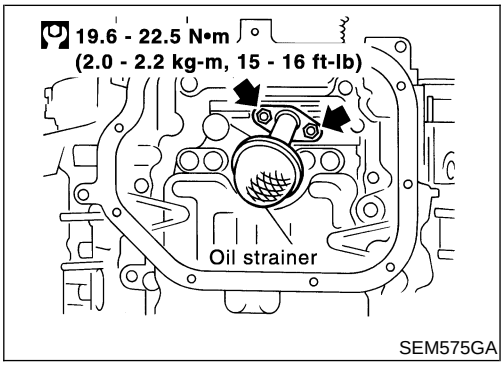
3. Remove steel oil pan bolts.



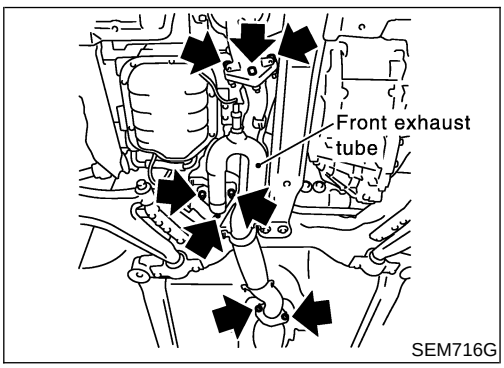
4. Remove steel oil pan.
a. Insert Tool between aluminum oil pan and steel oil pan.
- **Be careful not to damage aluminum mating surface.**
- **Do not insert screwdriver, or oil pan flange will be deformed.**



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

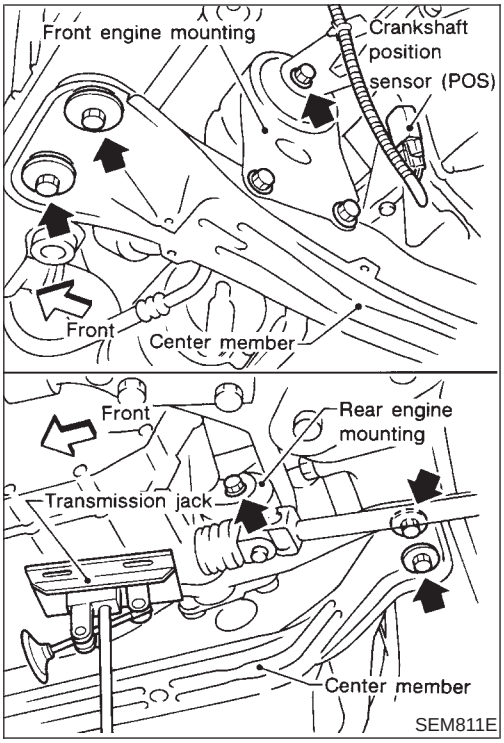


5. Remove oil strainer.



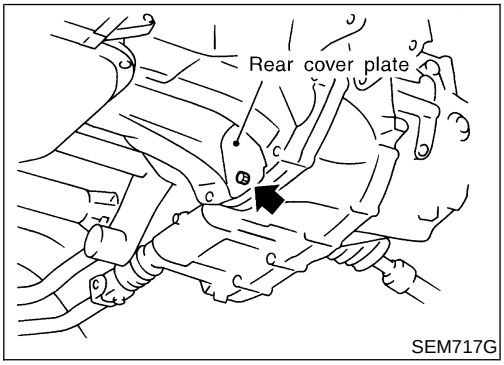
6. Remove front exhaust tube and its support.
Refer to FE-9, "Removal and Installation".

Removal (Cont'd)

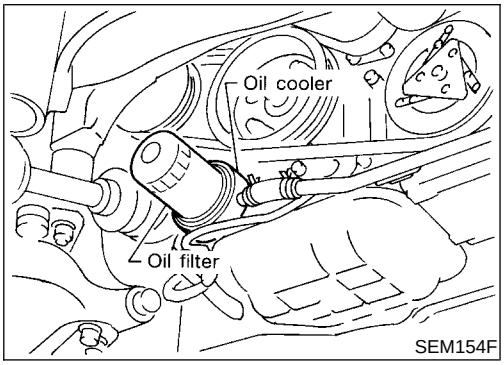


7. Set a suitable transmission jack under transaxle and hoist engine with engine slinger.
8. Remove crankshaft position sensor (POS) from oil pan.
9. Remove front and rear engine mounting nuts and bolts.
10. Remove center member.

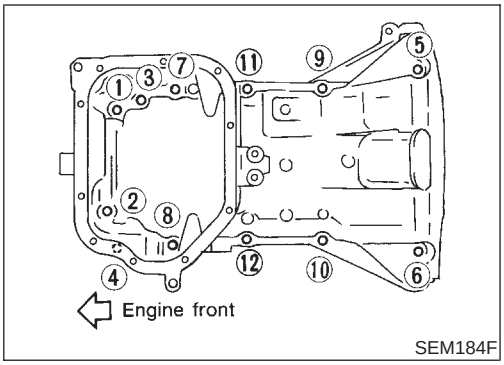
11. Remove drive belts.
12. Remove air conditioner compressor and bracket.
    Refer to HA-143 or HA-230, "REMOVAL AND INSTALLATION".



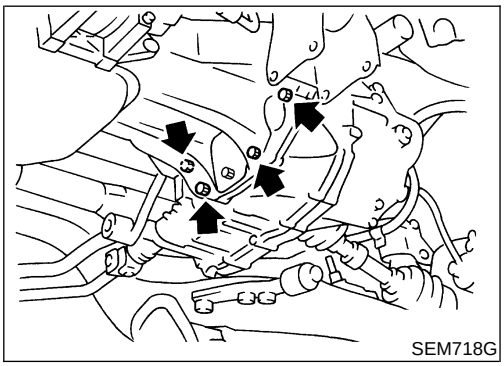
13. Remove rear cover plate.



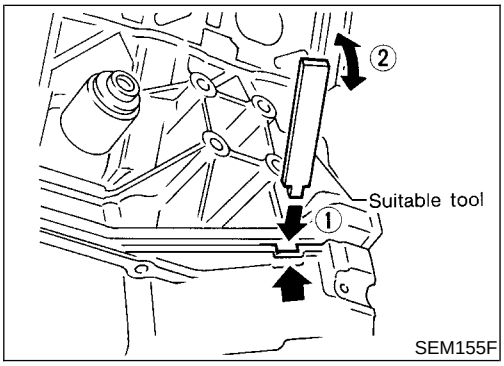
14. Remove oil filter, oil cooler fixing bolt and water hoses, pinching near oil cooler to prevent coolant spill out.



15. Remove aluminum oil pan bolts in numerical order.

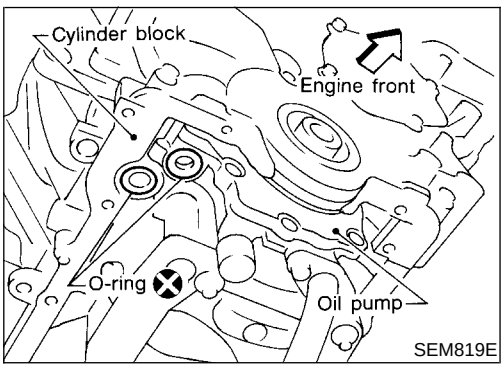


16. Remove four engine-to-transaxle bolts.

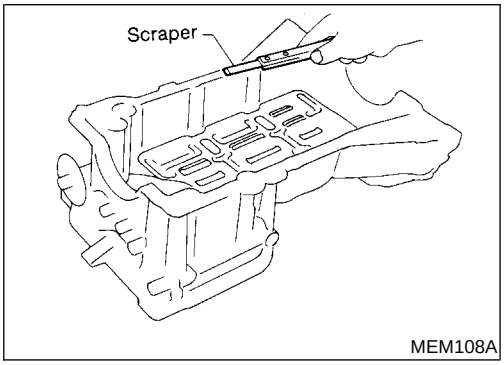


17. Remove aluminum oil pan.
a. Insert an appropriate size tool into the notch of aluminum oil pan as shown in the figure.
- **Be careful not to damage aluminum mating surface.**
- **Do not insert screwdriver, or oil pan flange will be deformed.**

b. Pry off aluminum oil pan by moving the tool up and down.
c. Remove aluminum oil pan.



18. Remove O-rings from cylinder block and oil pump body.

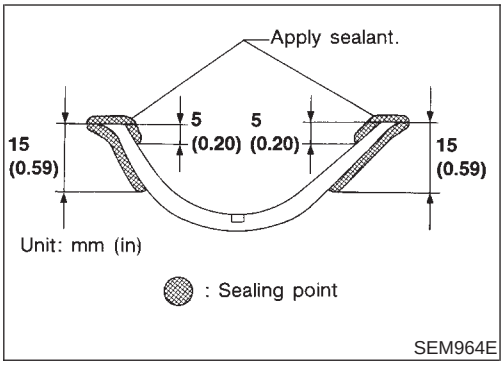


Installation

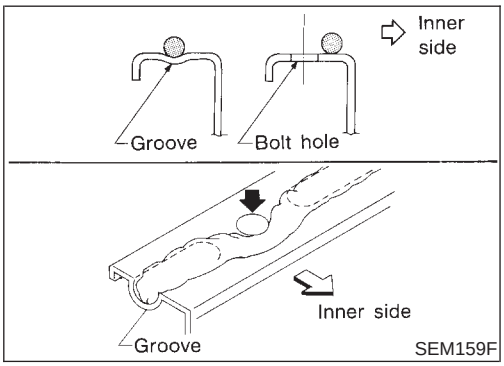
NFEM0010

1. Install aluminum oil pan.
a. Use a scraper to remove old liquid gasket from mating surfaces.
- **Also remove old liquid gasket from mating surface of cylinder block, front cover and steel oil pan.**
- **Remove old liquid gasket from the bolt hole and thread.**

Installation (Cont'd)

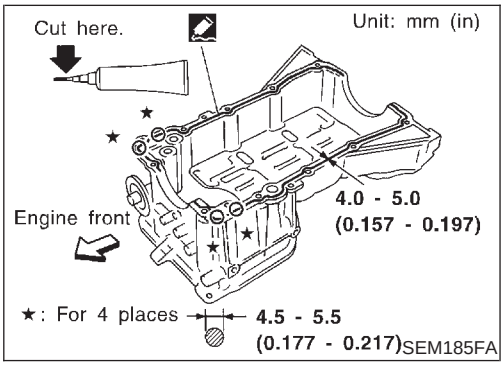


b. Apply sealant to front cover gasket and rear oil seal retainer gasket.



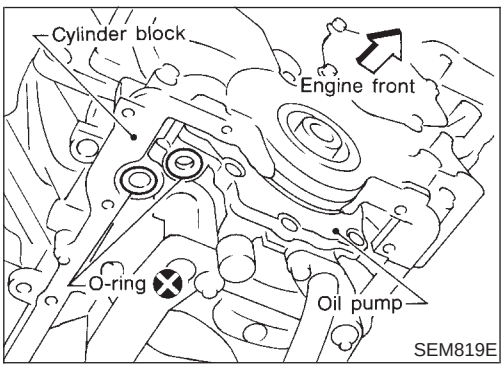
c. Apply a continuous bead of liquid gasket to mating surface of aluminum oil pan.

- **Use Genuine RTV silicone sealant or equivalent. Refer to GI-52.**

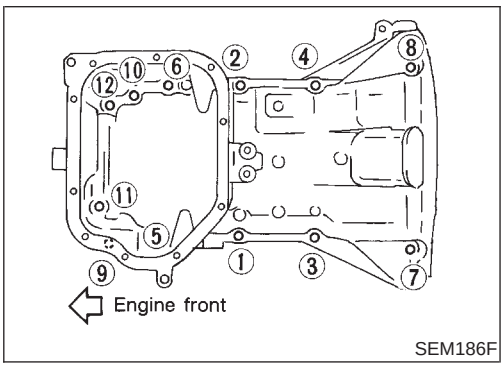


d. Apply liquid gasket to inner sealing surface as shown in figure.

- **Be sure liquid gasket is 4.0 to 5.0 mm (0.157 to 0.197 in) or 4.5 to 5.5 mm (0.177 to 0.217 in) wide as shown in the figure.**
- **Assembly should be done within 5 minutes after coating.**



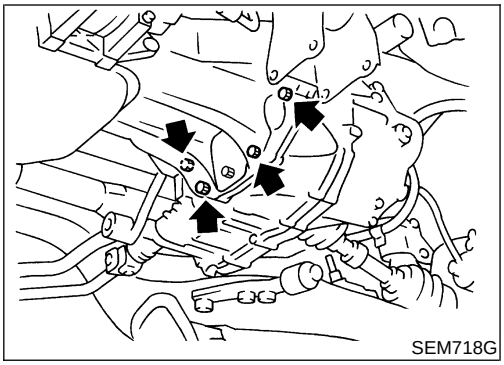
e. Install O-rings, cylinder block and oil pump body.



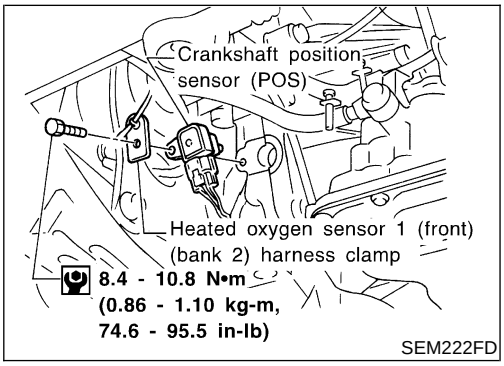
f. Install aluminum oil pan.

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

g. Install oil cooler, oil filter and water hoses.


SEM718G

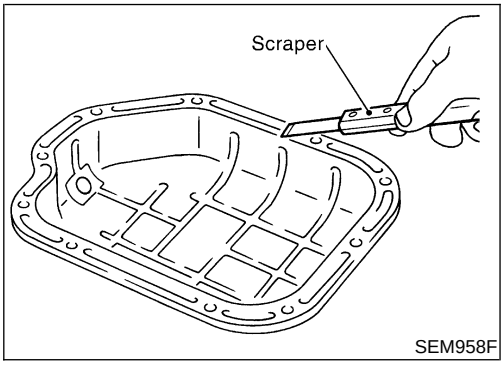
2. Install the four engine-to-transaxle bolts. For tightening torque, refer to AT-281 or MT-14, "Installation".
3. Install rear cover plate.
4. Install air conditioner compressor and bracket.
   Refer to HA-143, "REMOVAL AND INSTALLATION".
5. Install drive belts.
6. Install center member.
7. Install front and rear engine mounting insulator nuts and bolts.



SEM222FD

8. Install crankshaft position sensor (POS) with new rubber seal, and heated oxygen sensor 1 (front) (bank 2) harness clamp.
- **Make sure that crankshaft position sensor (POS) and heated oxygen sensor 1 (front) (bank 2) harness clamp are installed correctly as shown in figure.**

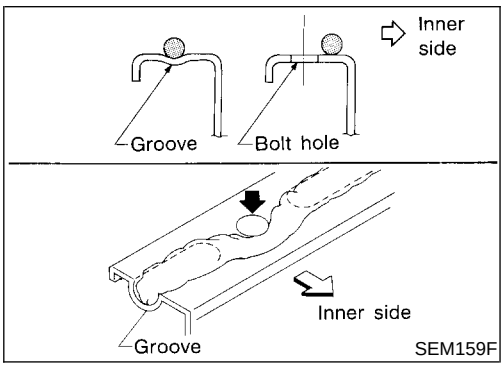
9. Install front exhaust tube and its support.
10. Install oil strainer.



SEM958F

11. Install steel oil pan.

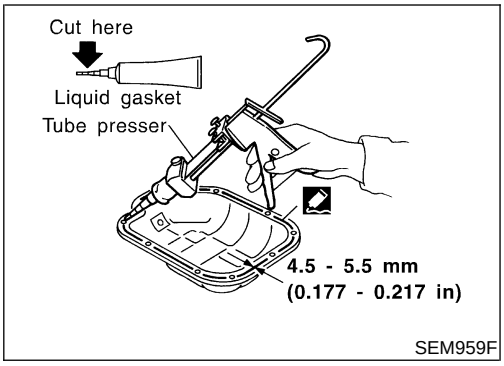
a. Use a scraper to remove old liquid gasket from mating surfaces.
- **Also remove old liquid gasket from mating surface of aluminum oil pan.**



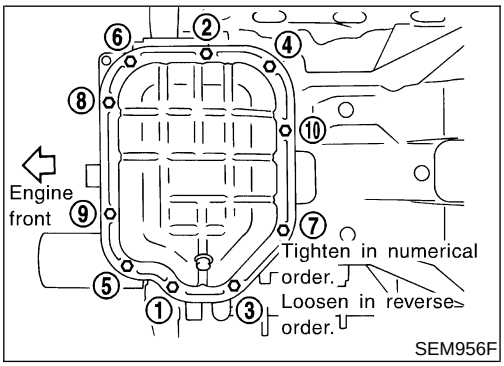
SEM159F

b. Apply a continuous bead of liquid gasket to mating surface of steel oil pan.
- **Use Genuine RTV silicone sealant or equivalent. Refer to GI-52.**

Installation (Cont'd)



- **Be sure liquid gasket is 4.5 to 5.5 mm (0.177 to 0.217 in) wide.**
- **Assembly should be done within 5 minutes after coating.**



c. Install steel oil pan.

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

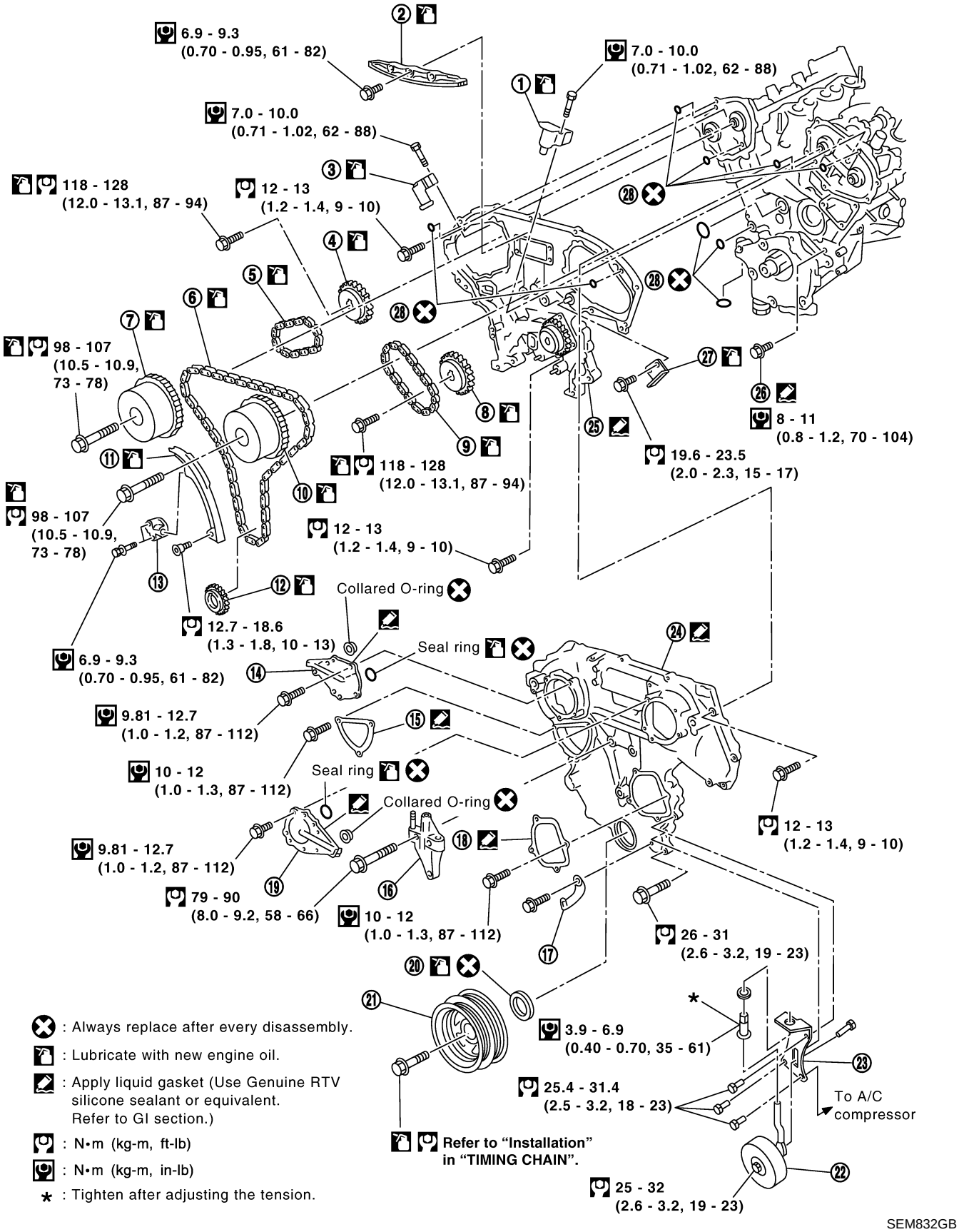
12. Install in the reverse order for steps remain.

- **Check oil and coolant level after refilling engine oil and coolant.**
- **Warm engine up and check for oil and coolant leakage.**

Components

NFEM0011

SEC. 120•130•150•210•275



SEM832GB

Components (Cont'd)

1. Timing chain tensioner
2. Internal chain guide
3. Timing chain tensioner
4. Camshaft sprocket (EXH)
5. Timing chain (Secondary)
6. Timing chain (Primary)
7. Camshaft sprocket (INT)
8. Camshaft sprocket (EXH)
9. Timing chain (Secondary)
10. Camshaft sprocket (INT)
11. Slack guide
12. Crankshaft sprocket
13. Timing chain tensioner
14. Intake valve timing control valve cover
15. Chain tensioner cover
16. Mounting bracket
17. Water hose clamp
18. Water pump cover
19. Intake valve timing control valve cover
20. Front oil seal
21. Crankshaft pulley
22. Idler pulley
23. Idler pulley bracket
24. Front timing chain case
25. Rear timing chain case
26. Water drain plug
27. Tension guide
28. O-ring

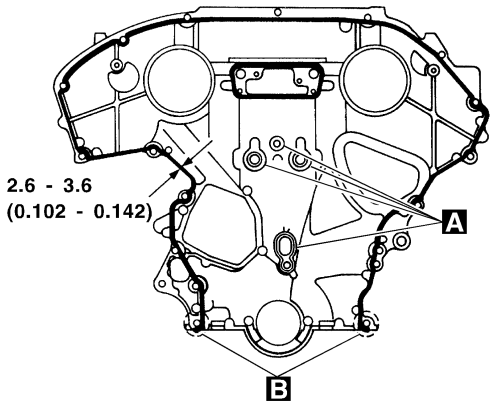
POSITION FOR APPLYING LIQUID GASKET

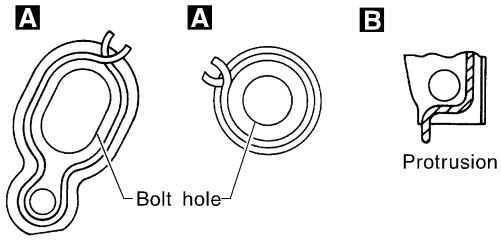
=NFEM0011S01

Refer to "Liquid Gasket Application Procedure" in "PRECAUTIONS", EM-3.

- **Before installation, wipe off the protruding sealant.**

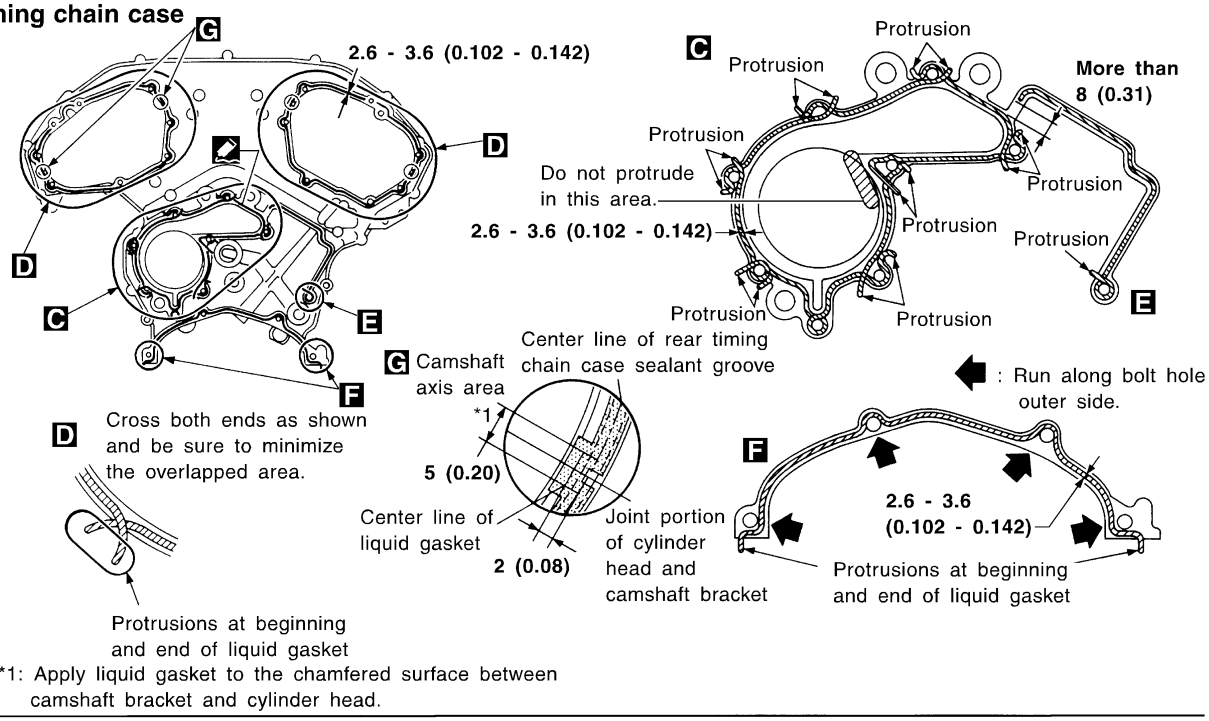
Front timing chain case





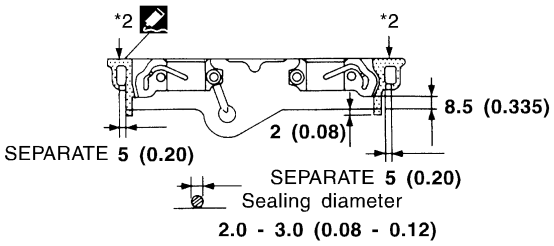
Sealant protrusion away from bolt hole

Rear timing chain case



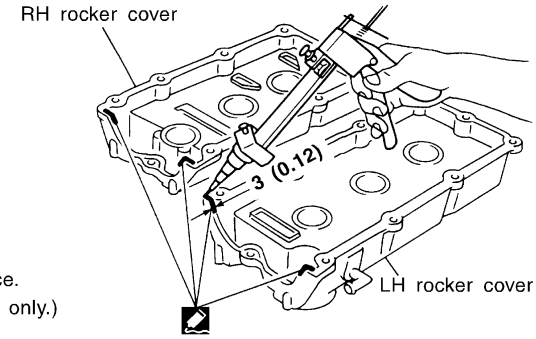
*1: Apply liquid gasket to the chamfered surface between camshaft bracket and cylinder head.

Camshaft bracket



*2: Remove the protruding sealant from front face. (Remove the hardened sealant from surface only.)

Rocker cover



Unit: mm (in)

SEM720GA

CAUTION:

- **After removing timing chain, do not turn crankshaft and**

camshaft separately, or valves will strike piston heads.

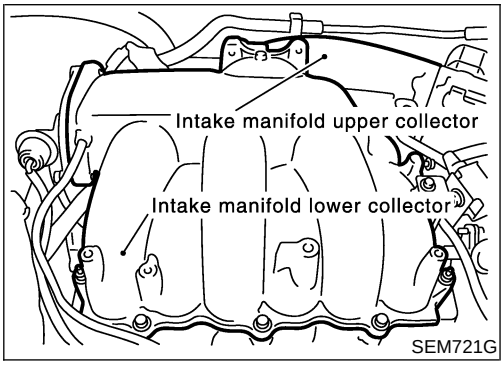
- **When installing camshafts, chain tensioners, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Apply new engine oil to bolt threads and seat surfaces when installing cylinder head, camshaft sprockets, crankshaft pulley and camshaft brackets.**
- **Before disconnecting fuel hose, release fuel pressure. Refer to EC-56, "Fuel Pressure Release".**
- **When removing the oil pans, oil pump assembly and timing chain from engine, first remove the crankshaft position sensor (POS) from the assembly.**
  Be careful not to damage sensor edges.
- **Do not spill engine coolant on drive belts.**

Removal

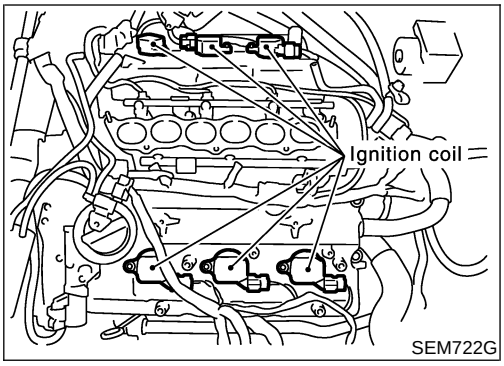
NFEM0012

1. Drain engine oil.
2. Release fuel pressure.
   Refer to EC-56, "Fuel Pressure Release".
3. Drain coolant by removing cylinder block drain plugs. Refer to MA-14, "Changing Engine Coolant".
4. Remove ornament cover.
5. Remove air duct to intake manifold, collector, PCV hose, vacuum hoses, fuel hoses, wires, harness, connectors and so on.
6. Remove the following.

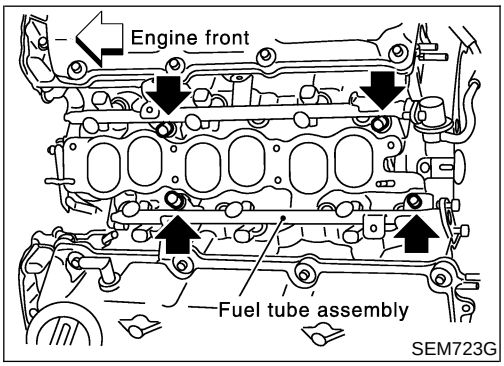
- Water hoses
- EVAP canister purge hose
- PCV hose
- PCV valve
- Water outlet



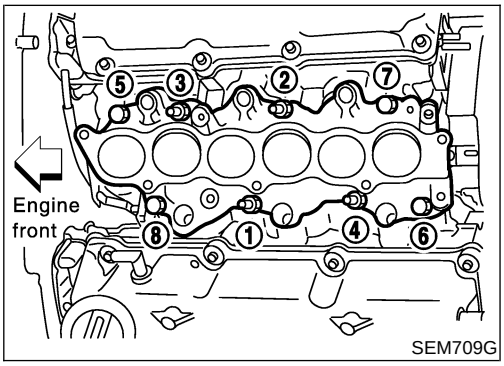
7. Remove intake manifold upper and lower collectors loosening bolts and nuts in reverse order of tightening. Refer to "TIGHTENING PROCEDURES", EM-11.



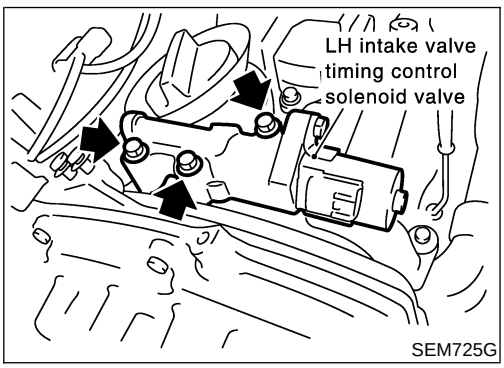
8. Remove RH and LH ignition coils.



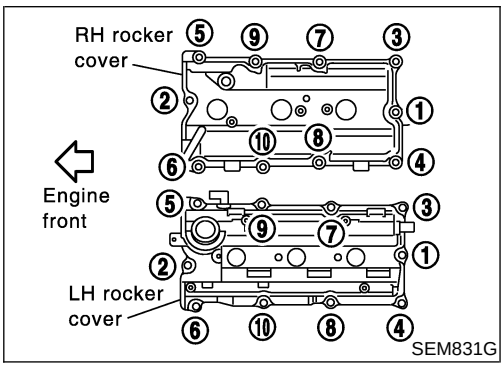
9. Remove fuel tube assembly. Refer to EC-57, "Removal and Installation".



10. Remove intake manifold bolts and nuts in reverse order shown.

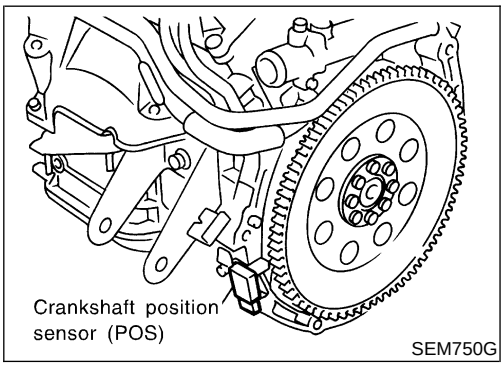


11. Remove RH and LH intake valve timing control solenoid valves.

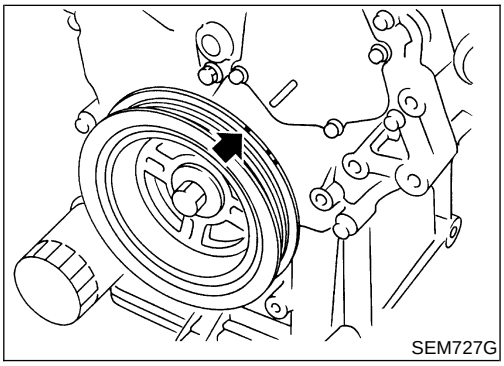


12. Remove RH and LH rocker covers from cylinder head.
- Loosen bolts in numerical order shown in the figure.

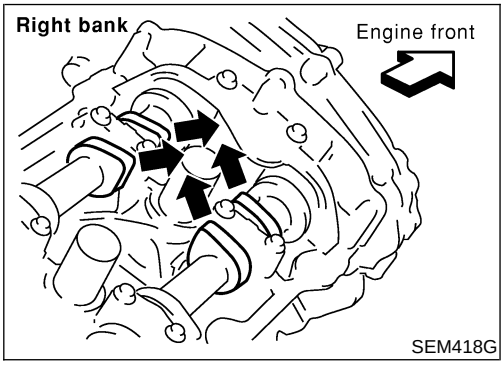
13. Remove engine undercover.
14. Remove front RH wheel and engine side cover.
15. Remove drive belts and idler pulley bracket.
16. Remove power steering oil pump belt and power steering oil pump assembly.
    Refer to ST-24, "Components".



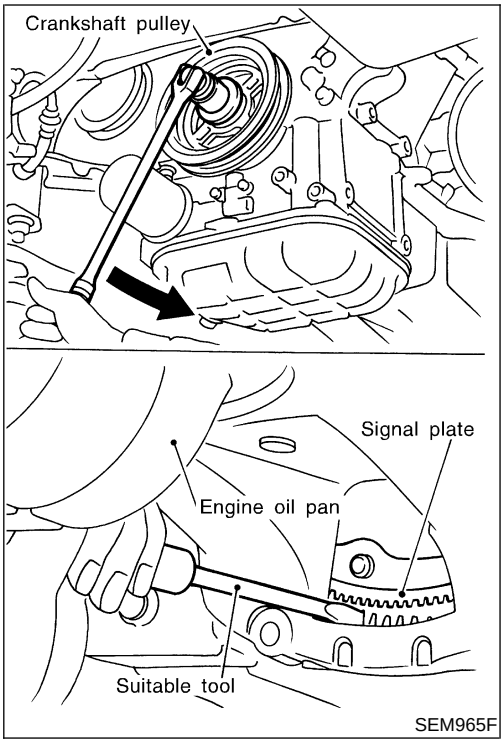
17. Remove crankshaft position sensor (POS).



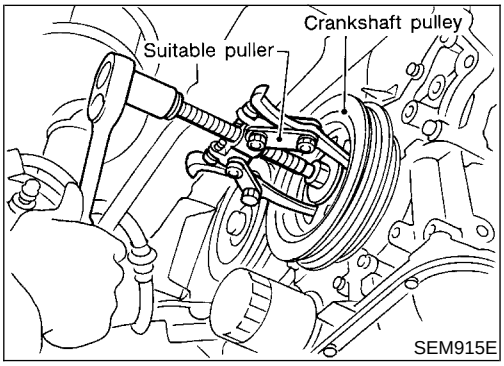
18. Set No. 1 piston at TDC on the compression stroke by rotating crankshaft.



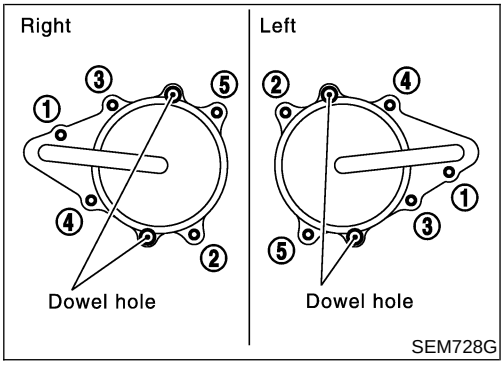
- Check that intake and exhaust cam nose on No. 1 cylinder are installed as shown.
  If not, turn the crankshaft one revolution (360°) and align as above.



19. Loosen crankshaft pulley bolt. (At this time remove oil pan rear cover plate and set a suitable tool to ring gear so that crankshaft cannot rotate.)
- **Be careful not to damage the signal plate teeth.**



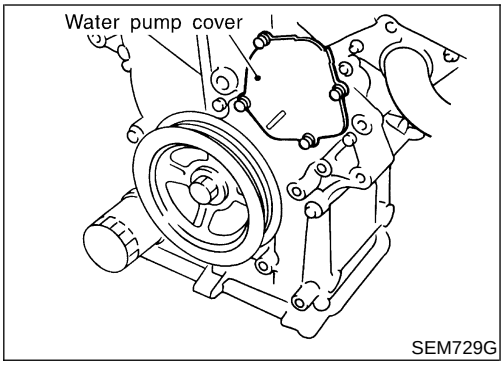
20. Remove crankshaft pulley with a suitable puller.



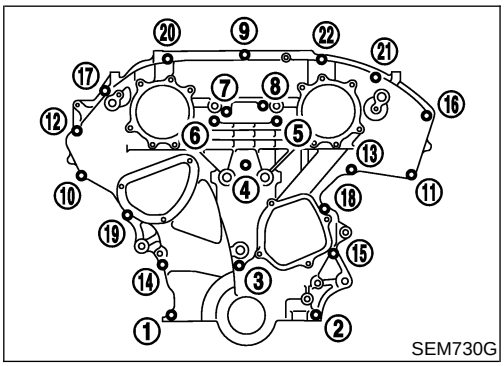
21. Remove intake valve timing control valve covers.
- **Loosen bolts in reverse order shown in the figure.**
- In the cover, the shaft is engaged with the center hole of the intake camshaft sprocket. Remove it straight out until the engagement comes off.

22. Remove air conditioner compressor and bracket. Refer to HA-143 or HA-230, "REMOVAL AND INSTALLATION".
23. Remove front exhaust tube and its support.
24. Hang engine at right and left side engine slingers with a suitable hoist. Refer to EM-62, "Removal and Installation".
25. Remove right side engine mounting, mounting bracket and nuts. Refer to EM-62, "Removal and Installation".
26. Remove center member assembly.
27. Remove upper and lower oil pans. Refer to EM-14, "Removal".

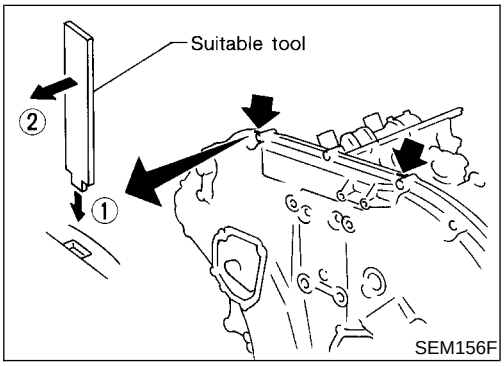
Removal (Cont'd)



28. Remove water pump cover.

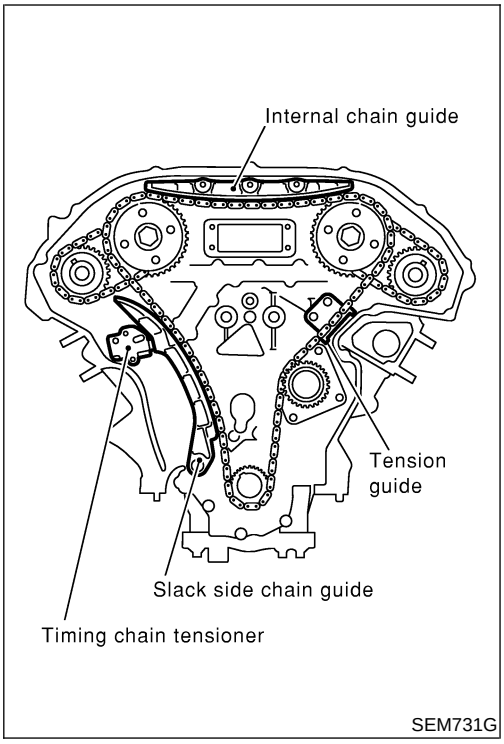


29. Remove front timing chain case bolts.
- **Loosen bolts in reverse order shown in the figure.**

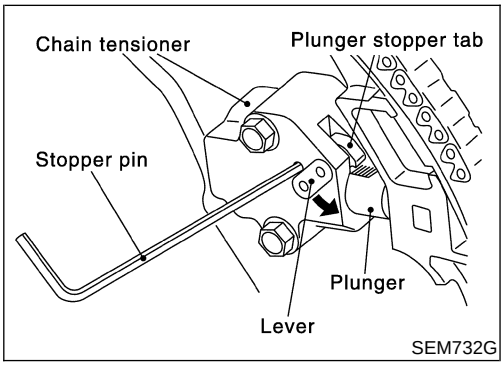


30. Remove front timing chain case.
- **Do not scratch sealing surfaces.**

31. Remove timing chain tensioner cover from front timing chain case.
32. Remove front oil seal from front timing chain case.
Refer to EM-42, "FRONT OIL SEAL".



33. Remove internal chain guide.
34. Remove timing chain tensioner and slack side chain guide.



- Remove chain tensioner as follows.

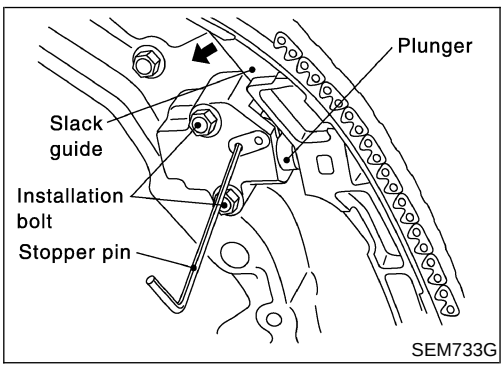
a) Pull lever down, and release plunger stopper tab.

- Plunger stopper tab can be pushed up to release (coaxial structure with lever).

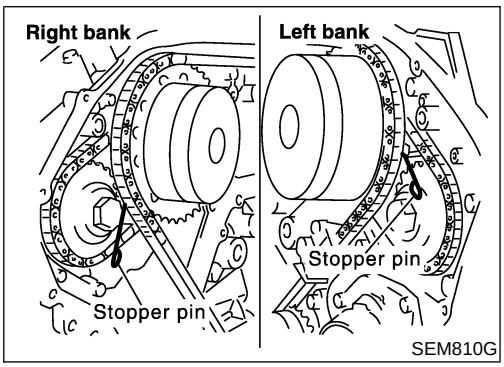
b) Insert stopper pin into tensioner body hole to fix lever, and keep the tab released.

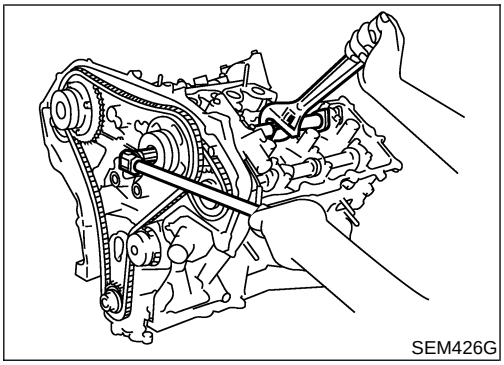
- In figure, Allen wrench [2.5 mm (0.098 in)] is used for stopper pin as an example.

c) Insert plunger into tensioner body by pressing slack guide.
d) Keep slack guide pressed, and fix it by pushing stopper pin through lever hole and body hole.
e) Remove mounting bolts, and remove chain tensioner.

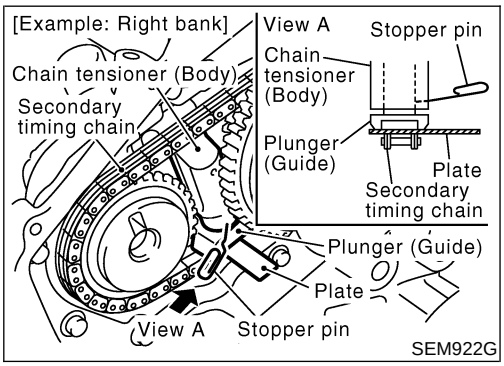


35. Attach a suitable stopper pin to RH and LH camshaft chain tensioners. (For secondary timing chains)




SEM426G

36. Remove intake and exhaust camshaft sprocket bolts.
- **Apply paint to timing chain and camshaft sprockets for alignment during installation.**
- **Secure the hexagonal portion of the camshaft using a spanner to loosen mounting bolts.**



SEM922G

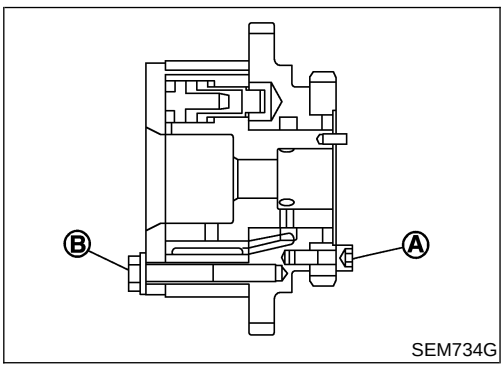
37. Remove primary and secondary timing chains with camshaft sprockets.

a. Rotate camshaft lightly, and slacken timing chain of timing chain tensioner-side.

b. Insert metal or resin plate [0.5 mm (0.020 in)] into guide between timing chain and chain tensioner plunger. Remove cam sprocket and secondary timing chain with timing chain floated from guide groove.

CAUTION:

Chain tensioner plunger may move, while fixed stopper pin and plunger both come off when timing chain is removed. Use caution during removal.

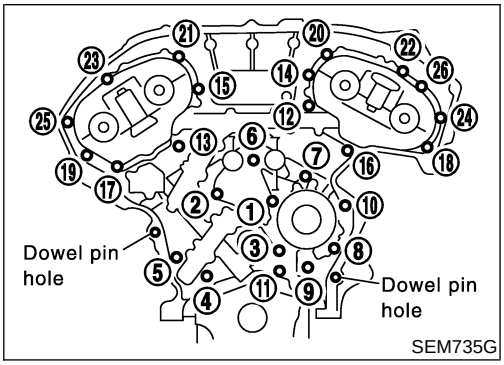


SEM734G

- Intake camshaft sprocket is two-for-one structure of primary and secondary sprockets.
- Handle intake camshaft sprocket, taking care of the following.

CAUTION:

- **Avoid impact.**
- **Do not disassemble (Never loosen bolts A and B).**

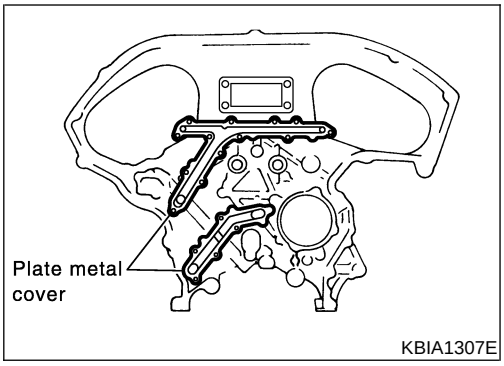


SEM735G

38. Remove chain tension guide and crankshaft sprocket.
39. Remove rear timing chain case as follows.

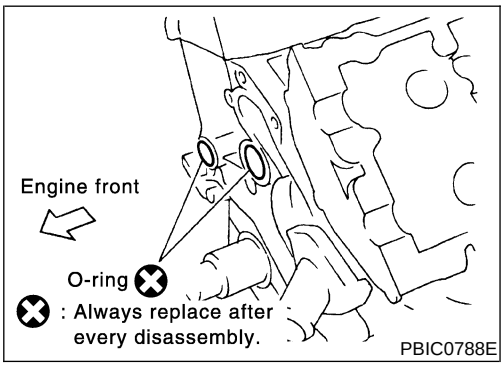
a. Loosen mounting bolts in reverse order shown in figure, and remove them.

b. Disconnect liquid gasket applied portion using seal cutter (special service tool: KV10111100) or an equivalent tool. Then remove rear timing chain case.



CAUTION:

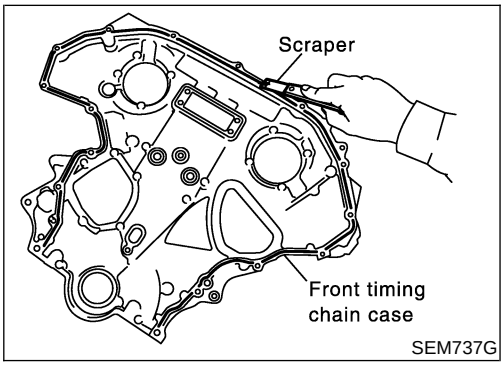
- **Do not remove plate metal cover of oil passage.**
- **After removing chain case, do not apply any load which affects flatness.**



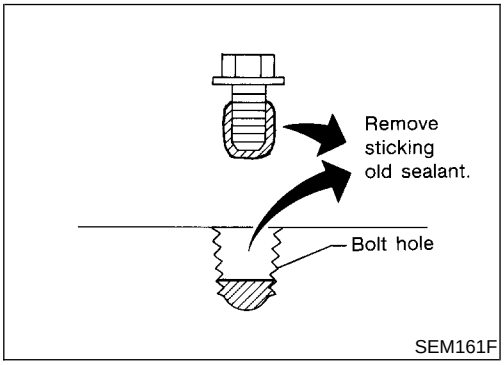
40. Remove O-rings from cylinder block.
41. Remove RH and LH camshaft chain tensioners from cylinder head as follows.

a. Remove No. 1 camshaft brackets.
Refer to EM-45, "Removal".

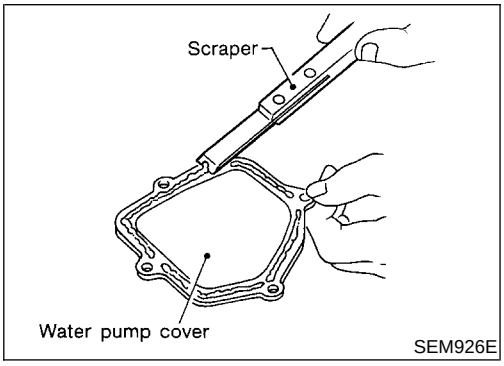
b. Remove chain tensioners with stopper pin attached.



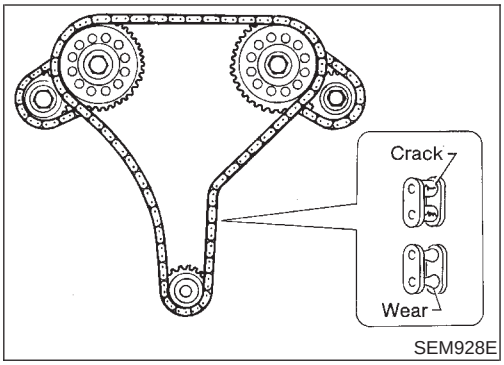
42. Use a scraper to remove all traces of liquid gasket from front timing chain case.



- **Remove old liquid gasket from the bolt hole and thread.**



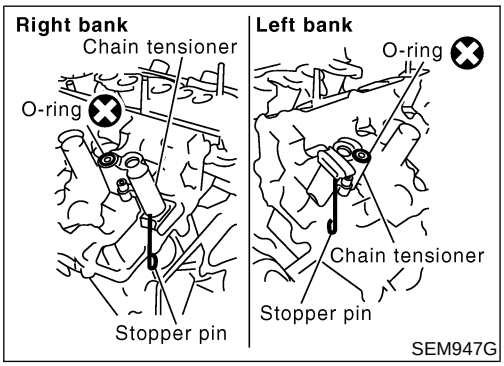
43. Use a scraper to remove all traces of liquid gasket from water pump cover and intake valve timing control solenoid valve covers.



Inspection

NFEM0013

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



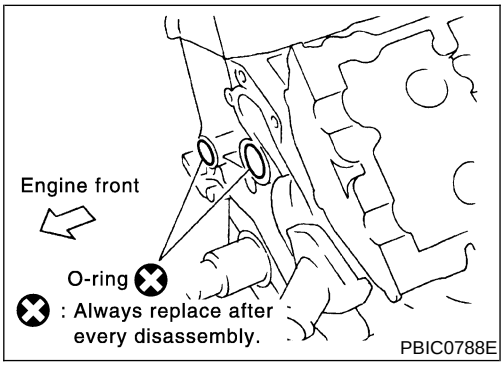
Installation

NFEM0014

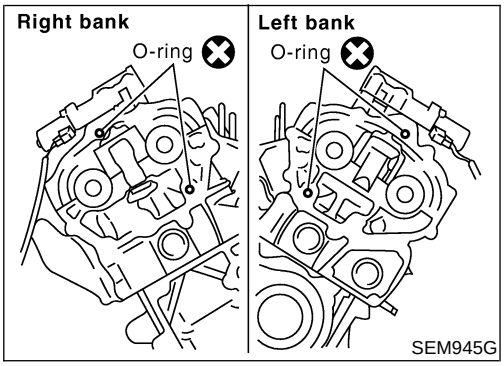
1. Install RH and LH camshaft chain tensioners to cylinder head as follows, if removed.
   Refer to EM-53.

a. Install chain tensioners with stopper pin attached and new O-ring, if removed.

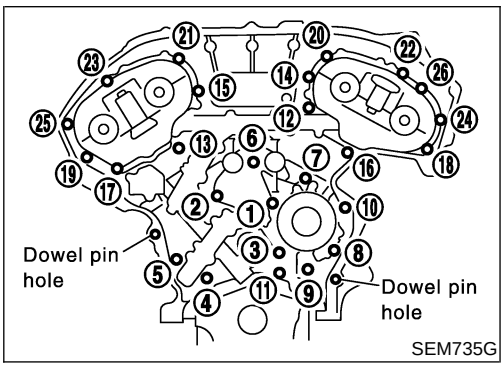
b. Install No. 1 camshaft brackets.



2. Install O-rings onto cylinder block.



3. Install O-rings to cylinder head.
4. Apply liquid gasket to rear timing chain case. Refer to EM-23, “POSITION FOR APPLYING LIQUID GASKET”.



5. Align rear timing chain case and water pump assembly with dowel pins (RH and LH) on cylinder block. Then install it.

- Do not allow O-ring to drop.

a. Tighten mounting bolts in order as shown in the figure.

- Install two types of mounting bolts, referring to the following instructions and figure.

Bolt length:

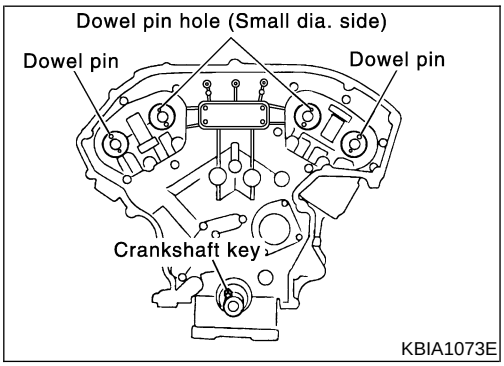
20 mm (0.79 in) (1, 2, 3, 6, 7, 8, 9, and 10 in the figure)

16 mm (0.63 in) (other than the above)

: 12 - 13 N·m (1.2 - 1.4 kg-m, 9 - 10 ft-lb)

b. After all bolts are temporarily tightened, retighten them to specified torque in order shown in the figure.

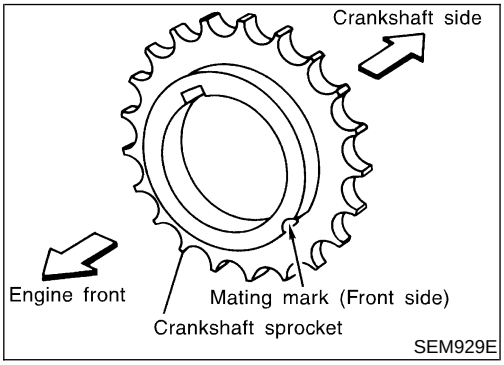
6. Install chain tension guide.



7. Make sure that camshaft and crankshaft are at TDC position of No. 1 cylinder.

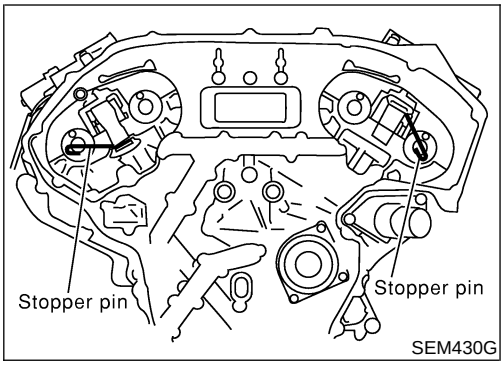
- Make sure that dowel pin hole, dowel pin and crankshaft key are located as shown in the figure.
  Camshaft dowel pin hole (intake-side): At cylinder head upper face side in each bank
  Camshaft dowel pin (exhaust-side): At cylinder head upper face side in each bank
  Crankshaft key: At cylinder head side of RH bank

CAUTION:
Hole on small diameter side must be used for intake dowel pin. Do not misidentify (Ignore big diameter side).



8. Install crankshaft sprocket.

- Install it, with matching mark to timing chain facing front of engine.



9. Install secondary timing chain and camshaft sprocket.

CAUTION:

Matching marks between timing chain and sprockets slip easily. Confirm all matching mark positions repeatedly during the installation process.

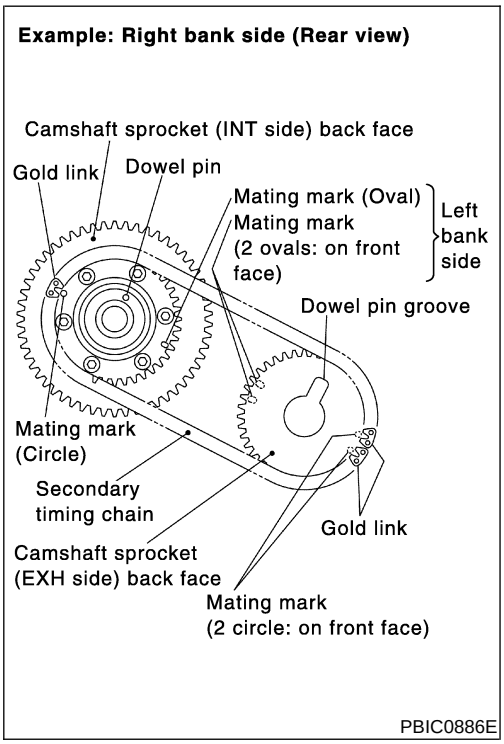
- Push sleeve of secondary chain tensioner, and keep it pressed with stopper pin.

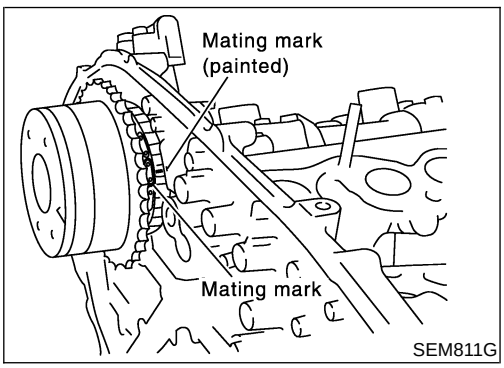
a. Align matching marks on secondary timing chain (gold link) with the ones on intake and exhaust sprockets (stamped). Then install them.

- Matching marks of intake sprocket are on back side of secondary sprocket.
- There are two types of matching marks: round and oval types. They should be used for RH/LH banks respectively.
  RH bank: Use round type.
  LH bank: Use oval type.

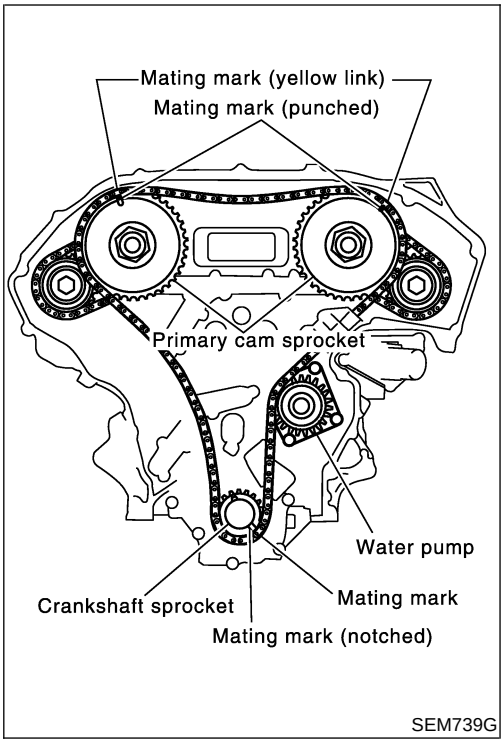
b. Align dowel pin and pin hole on camshaft with groove and dowel pin on sprocket. Then install them.

- On intake side, align pin hole on small diameter side of camshaft front end with dowel pin on back side of camshaft sprocket. Then install them.
- On exhaust side, align dowel pin on camshaft front end with pin groove on camshaft sprocket. Then install them.
- Mounting bolts for camshaft sprockets must be tightened in step 7. Tightening them by hand is enough to prevent dislocation of dowel pins.

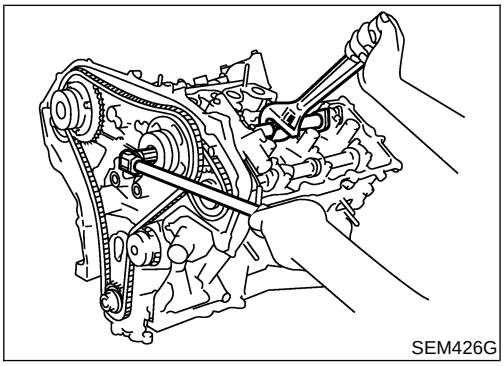




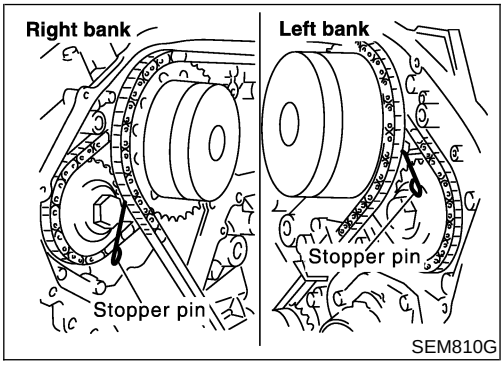
- It may be difficult to visually check the dislocation of mating marks during and after installation. To make the matching easier, make a mating mark on the sprocket teeth in advance using paint.



10. Install secondary timing chain and sprocket to the other bank. Install primary timing chain at the same time.
- Installation of the secondary timing chain follows the procedure described in step 6.
- Install primary timing chain so that mating mark (punched) on camshaft sprocket is aligned with that (yellow link) on the timing chain, and mating mark (notched) on crankshaft sprocket is aligned with that on the timing chain, respectively.
- When it is difficult to align mating marks of the primary timing chain with each sprocket, gradually turn the camshaft hexagonal portion using a spanner so it is aligned with the mating mark.
- During alignment, be careful to prevent dislocation of mating marks on the secondary timing chain.

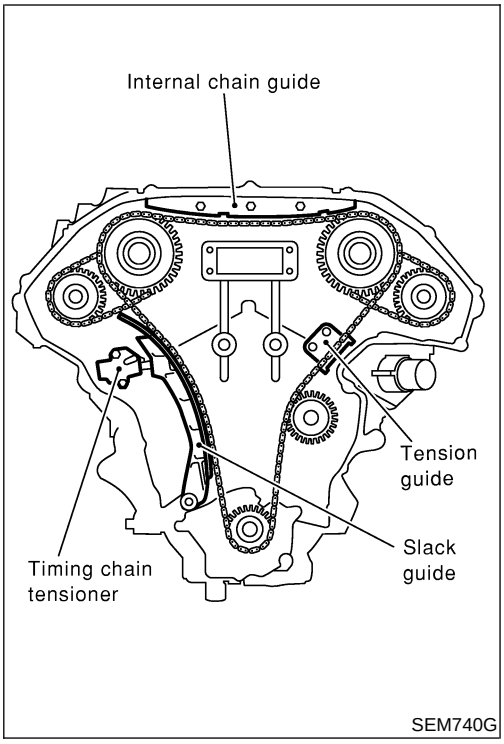


11. After confirming the mating marks are aligned, tighten the camshaft sprocket mounting bolts.
- Secure the camshaft hexagonal portion using a spanner to tighten mounting bolts.

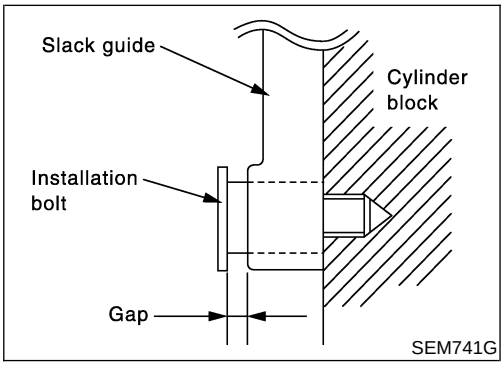


12. Pull out the stopper pin from the secondary timing chain tensioner.

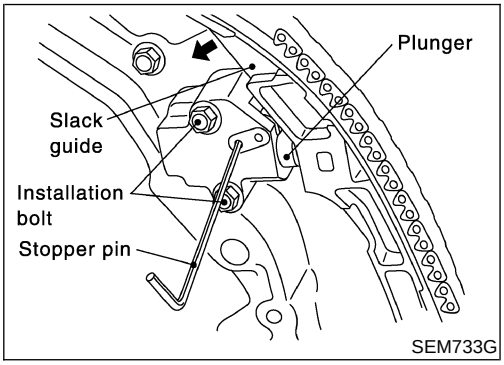
Installation (Cont'd)



13. Install internal chain guide.
14. Install slack guide.

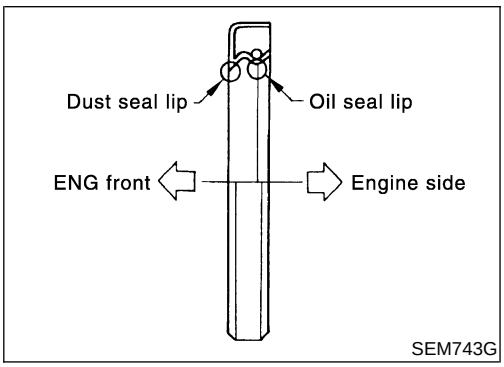


- Take care not to overtighten mounting bolts for slack guide. It is normal for a gap to exist under bolt seats when mounting bolts are tightened to specified torque.

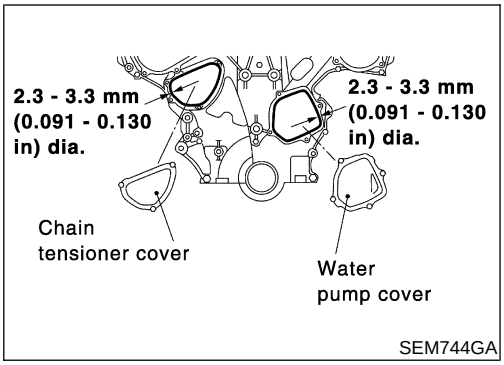


15. Install chain tensioner for slack guide.
- When installing chain tensioner, push in sleeve and keep it pressed with stopper pin.
- Remove dirt and foreign materials completely from back and mounting surfaces of chain tensioner.
- After installing, pull out stopper pin by pressing slack guide.

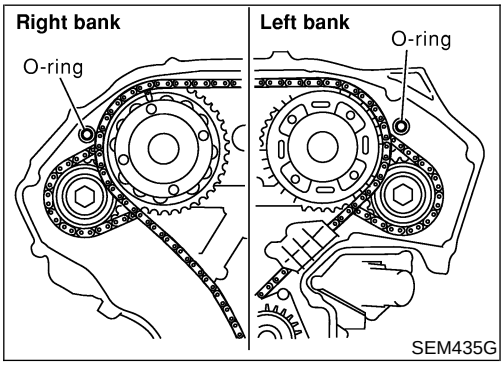
16. Confirm again that matching marks on sprockets and timing chain have not slipped.



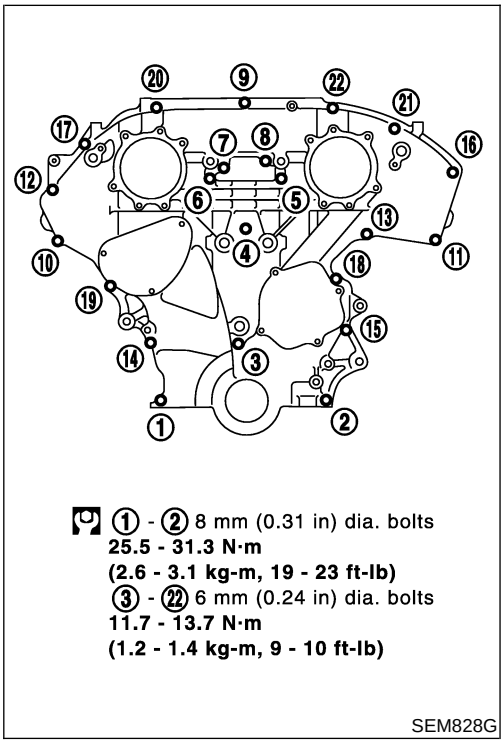
17. Install front oil seal to front timing chain case. Refer to EM-42, "FRONT OIL SEAL".



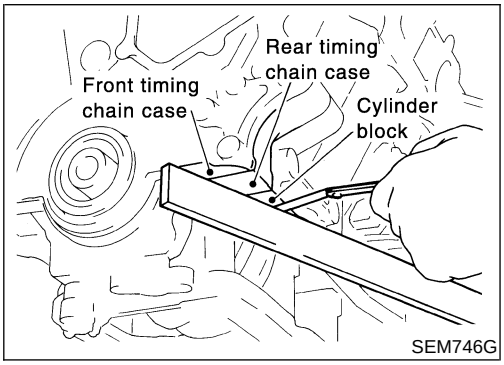
18. Apply liquid gasket to water pump cover and chain tensioner cover.
- **Before installation, wipe off the protruding sealant.**
19. Install water pump cover and chain tensioner cover.



20. Install O-rings on rear timing chain case.
21. Apply liquid gasket to front timing chain case.
- Refer to "POSITION FOR APPLYING LIQUID GASKET", EM-23.
- **Before installation, wipe off the protruding sealant.**



22. Install front timing chain case.
- Align dowel pin on rear timing chain case with hole on front timing chain case.
23. Tighten bolts to the specified torque in order shown in the figure.



24. After installing front timing chain case, check surface height difference between following parts on oil pan mounting surface.

Standard

Front timing chain case to rear timing chain case:
−0.14 to 0.14 mm (−0.0055 to 0.0055 in)

Oil pump to cylinder block:
−0.36 to −0.10 mm (−0.0142 to −0.0039 in)

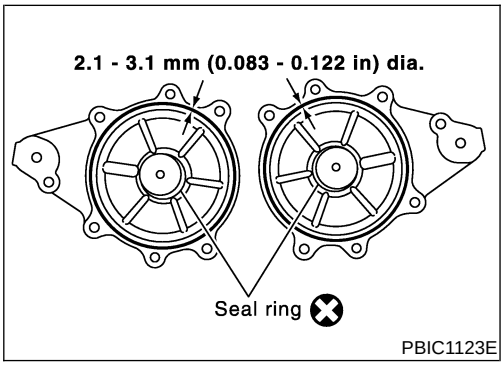
Rear timing chain case to cylinder block:
−0.24 to 0.14 mm (−0.0094 to 0.0055 in)

- If not within standard, repeat above installation procedure.

25. Install intake valve timing control valve cover.

a. Install new seal ring at intake valve timing control valve cover with new engine oil applied on it.

b. Apply liquid gasket to intake valve timing control valve covers. Use genuine RTV silicone sealant or equivalent. Refer to GI-52.



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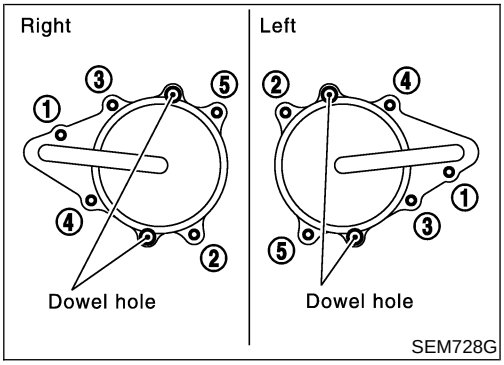
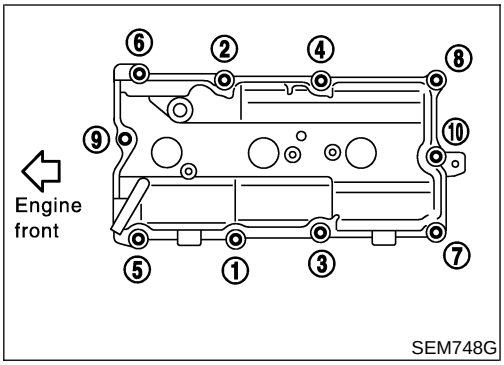
c. Install collared O-ring in front timing chain case oil hole (LH and RH sides).



SEM728G

- Being careful not to move the seal ring from the installation groove, align the dowel pins on the chain case with the holes to install the intake valve timing control valve cover.
- Tighten in numerical order as shown in the figure.

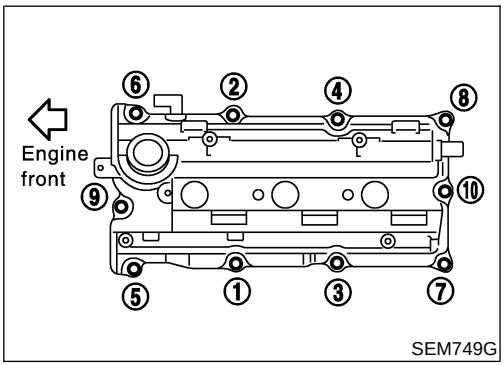


26. Install RH and LH rocker covers.
- **Check spark plug hole oil seal for clacks and damage on sealing portion. Replace rocker cover if necessary.**

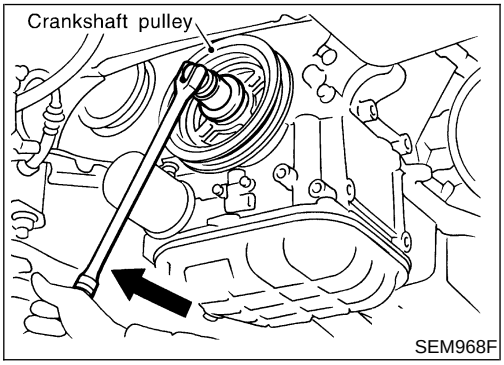
Rocker cover tightening procedure:

- **Tighten in numerical order as shown in the figure.**

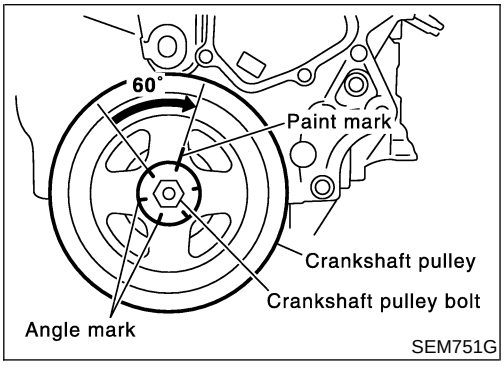
a. Tighten bolts 1 to 10 in that order to 0.96 to 2.96 N·m (0.10 to 0.30 kg-m, 9 to 26 in-lb).
b. Then tighten bolts 1 to 10 as indicated in figure to 7.33 to 9.33 N·m (0.75 to 0.95 kg-m, 65 to 82 in-lb).



27. Install intake manifold. Tighten intake manifold nuts and bolts. **Refer to "TIGHTENING PROCEDURES", EM-11.**
28. Install fuel tube assembly. **Refer to "TIGHTENING PROCEDURES", EM-11.**
29. Install intake manifold collector gasket.
30. Install intake manifold upper and lower collectors. **Refer to "TIGHTENING PROCEDURES", EM-11.**
31. Install RH and LH ignition coils.

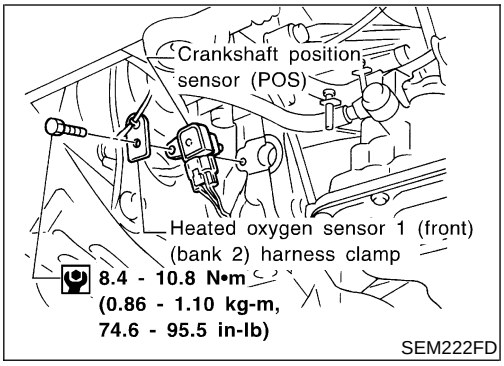


32. Install crankshaft pulley to crankshaft.
a. Tighten to 39 to 49 N·m (4.0 to 5.0 kg-m, 29 to 36 ft-lb).
b. Put a paint mark on the crankshaft pulley.



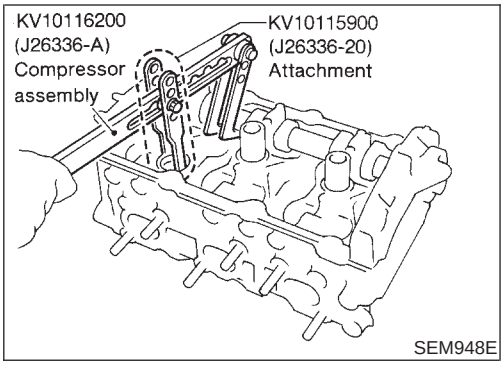
c. Again tighten by turning 60° to 66°, about the angle from one hexagon bolt head corner to another.

Installation (Cont'd)



33. Reinstall removed parts in reverse order of removal.

- **Make sure that crankshaft position sensor (POS) and heated oxygen sensor 1 (front) (bank 2) harness clamp are installed correctly as shown in figure.**
- When installing fuel tube assembly. Refer to EC-57, "Removal and Installation".
- Check oil level after refilling engine oil.
- **After starting engine, keep idling for three minutes. Then rev engine up to 3,000 rpm under no load to purge air from the high-pressure chamber of the chain tensioners. The engine may produce a rattling noise. This indicates that air still remains in the chamber and is not a matter of concern.**



Replacement

NFEM0015

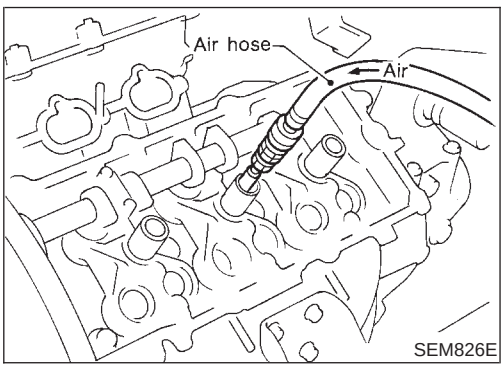
CAUTION:

When removing the oil pans, oil pump assembly and timing chain from engine, first remove the crankshaft position sensor (POS) from the assembly.
Be careful not to damage sensor edges.

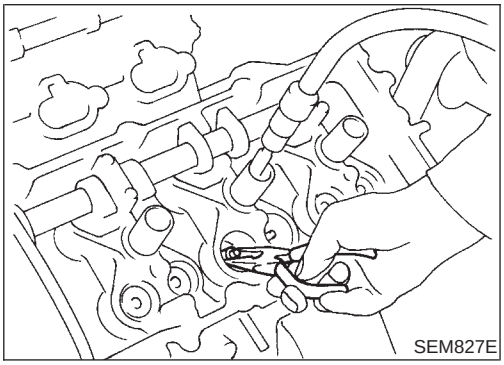
VALVE OIL SEAL

NFEM0015S01

1. Remove ornament cover.
2. Remove intake manifold upper collector and intake manifold lower collector.
3. Remove RH and LH ignition coils.
4. Remove RH and LH rocker covers from cylinder head.
5. Remove crankshaft position sensor (POS).
6. Remove oil pan. Refer to “Removal”, EM-14.
7. Remove timing chain. Refer to “Removal, EM-24.
8. Remove camshaft brackets and camshaft. Refer to “Disassembly”, EM-47.
9. Remove valve lifters.
10. Remove valve spring with Tool.
    Before removing valve spring, fix valve as follows.
    Piston concerned should be set at TDC to prevent valve from falling.

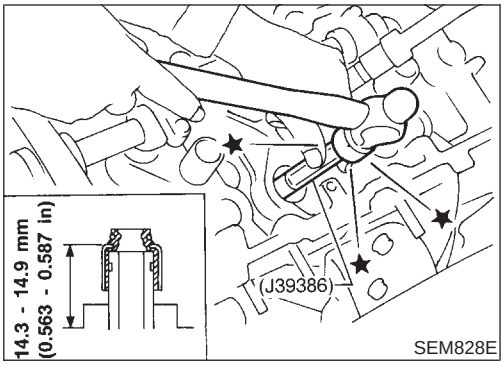


Remove spark plug, then install air hose adapter into spark plug hole and apply air pressure to hold valves in place. Apply a pressure of 490 kPa (5 kg/cm^2, 71 psi).



11. Remove valve oil seal.

Replacement (Cont'd)



12. Apply engine oil to new valve oil seal and install it with Tool.
13. Reinstall any parts removed in reverse order of removal.

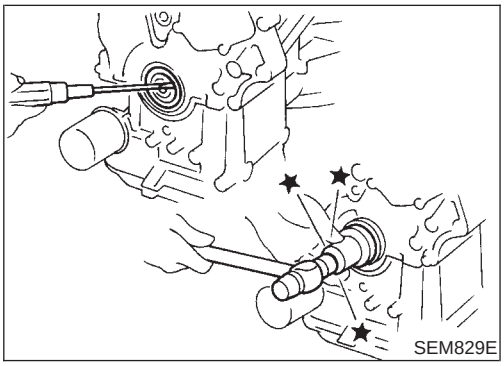
FRONT OIL SEAL

NFEM0015S03

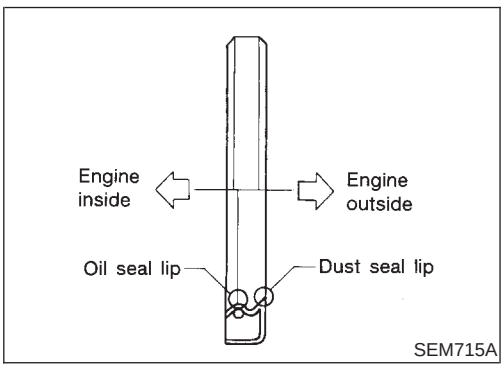
1. Remove the following parts:

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

Be careful not to damage sensor edge.



2. Remove front oil seal using a suitable tool.
Be careful not to scratch front cover.
3. Apply engine oil to new oil seal and install it using a suitable tool.

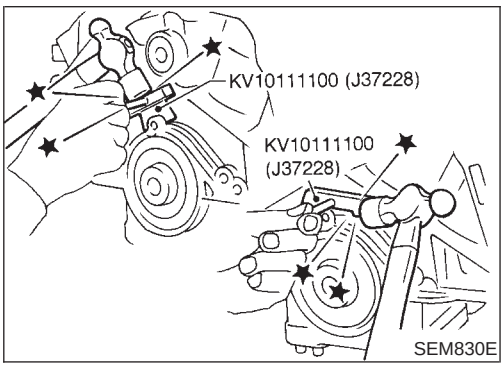


- Install new oil seal in the direction shown in the figure.

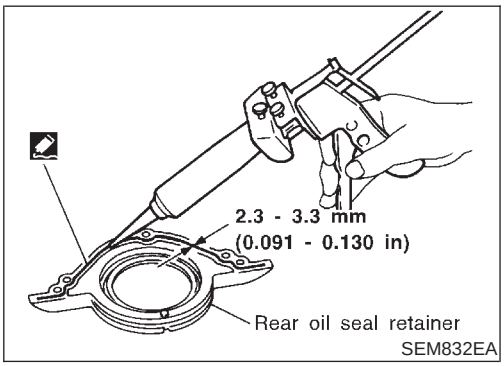
REAR OIL SEAL

NFEM0015S04

1. Remove transaxle. Refer to AT-281 or MT-13.
2. Remove flywheel or drive plate.
3. Remove oil pan. Refer to EM-14.
4. Remove rear oil seal retainer.



5. Remove old liquid gasket on mating surface of cylinder block and oil pan using scraper.
- **Remove old liquid gasket from the bolt hole and thread.**

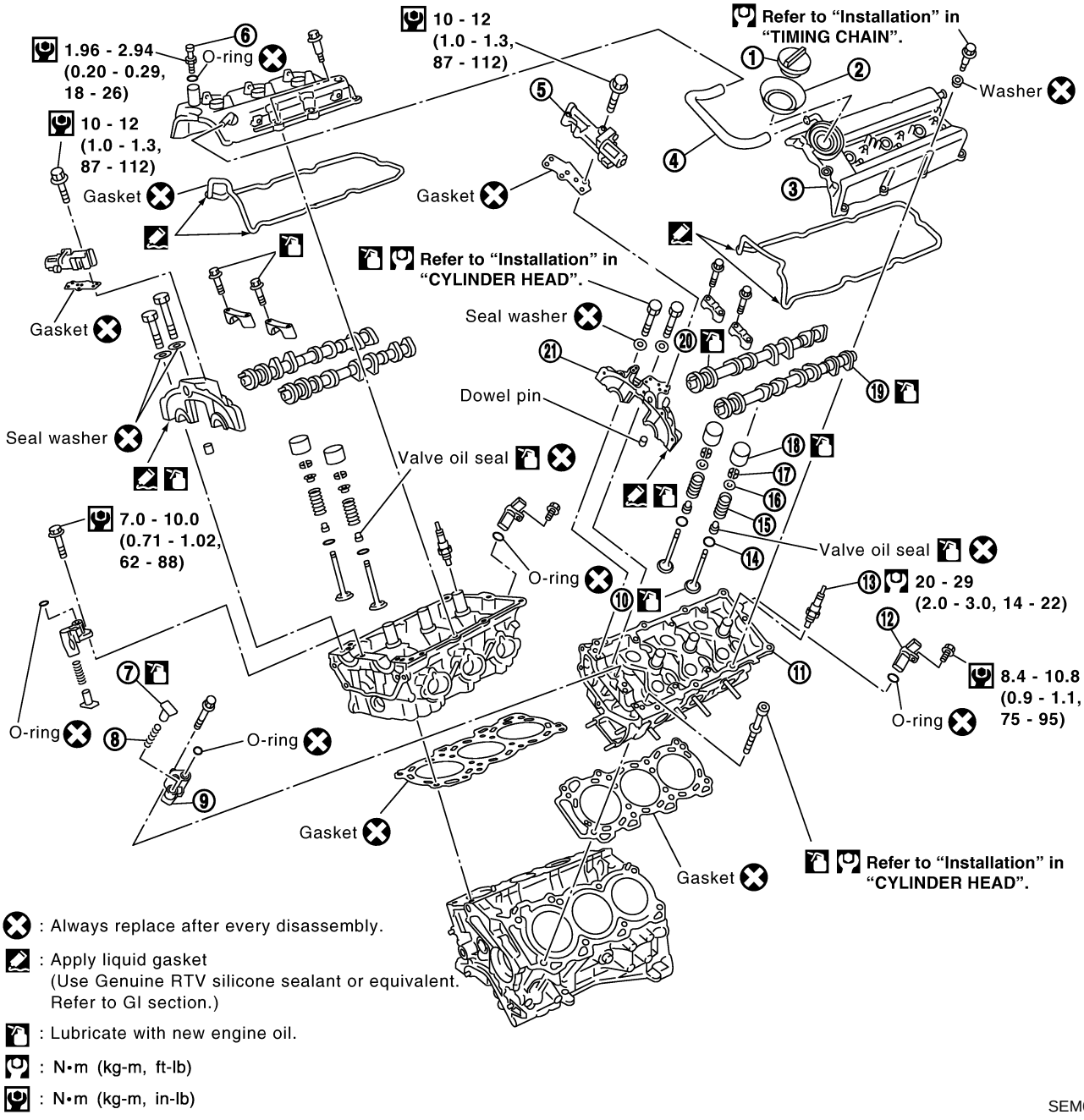


6. Apply liquid gasket to rear oil seal retainer.
- Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-52.
- Assembly should be done within 5 minutes after coating.
- Wait at least 30 minutes before refilling engine oil and engine coolant.

Components

NFEM0043

SEC. 111•118•130•140•220



SEM644GB

1. Oil filler cap
2. Oil catcher
3. Rocker cover
4. PCV hose
5. Intake valve timing control solenoid valve
6. PCV valve
7. Chain tensioner
8. Spring
9. Tensioner sleeve
10. Valve
11. Cylinder head
12. Camshaft position sensor (PHASE)
13. Spark plug
14. Valve spring seat
15. Valve spring
16. Valve spring retainer
17. Valve collet
18. Valve lifter
19. Camshaft (Exhaust)
20. Camshaft (Intake)
21. Camshaft bracket

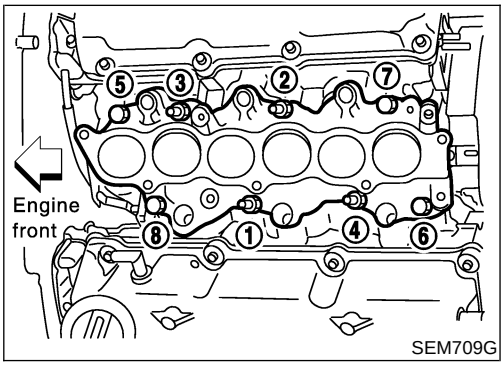
CAUTION:

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

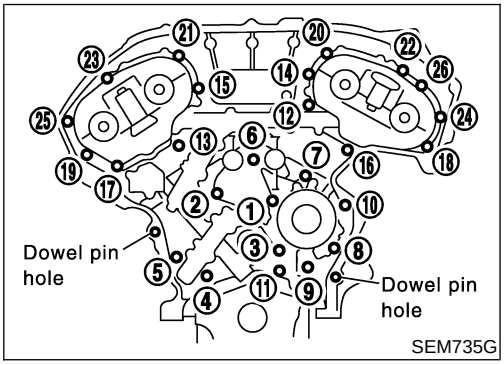
Removal

NFEM0044

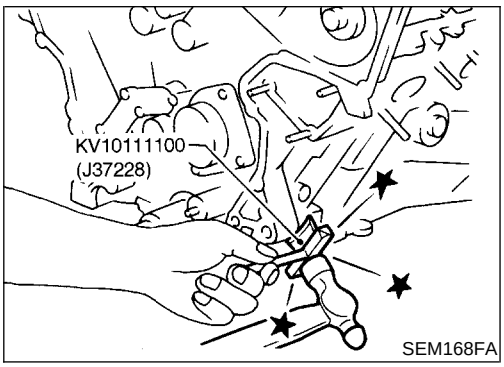
1. Remove engine from vehicle. Refer to EM-62, "Removal and Installation".
2. Remove exhaust manifolds.
3. Place engine on a work stand.
4. Remove aluminum oil pan. Refer to EM-14, "Removal".
5. Remove timing chain. Refer to EM-24, "Removal".



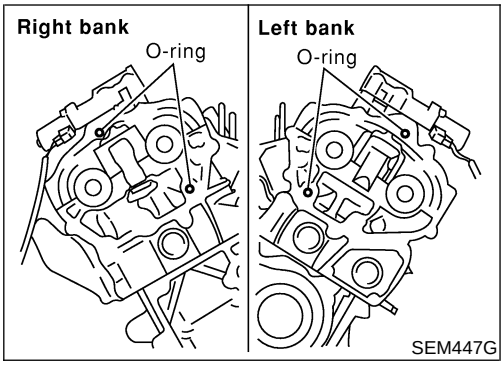
6. Remove intake manifold in reverse order of illustration.
7. Remove water outlet.



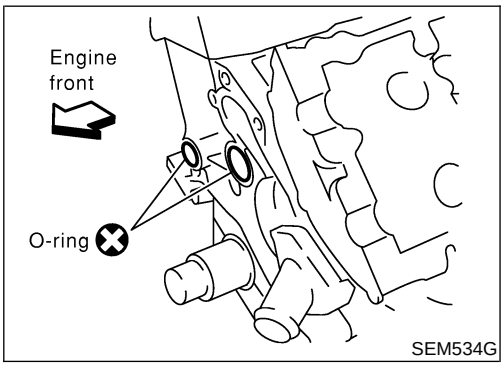
8. Remove rear timing chain case bolts.
- Loosen in reverse order as shown in the figure.



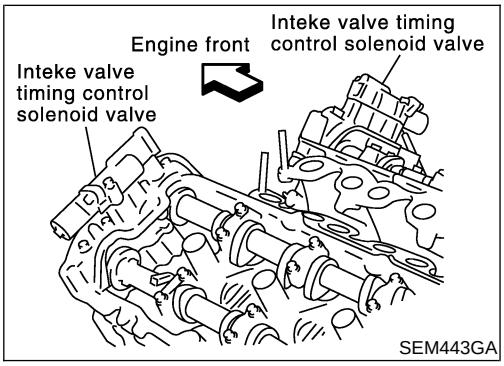
9. Remove rear timing chain case.



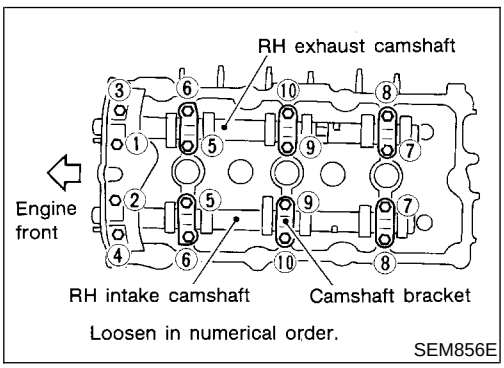
10. Remove O-rings from cylinder head.



11. Remove O-rings from cylinder block.



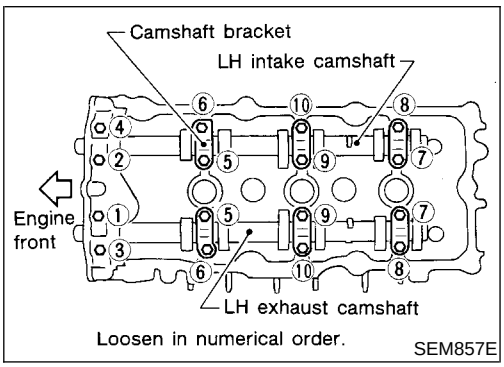
12. Remove intake valve timing control solenoid valves.

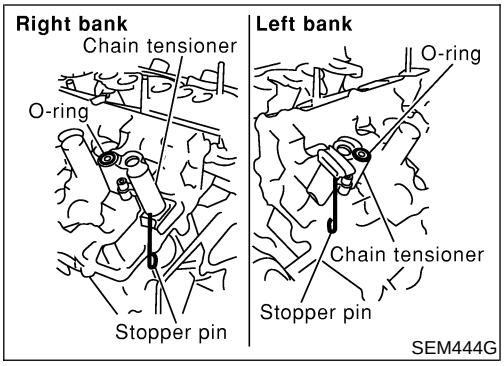


13. Remove intake and exhaust camshafts and camshaft brackets.

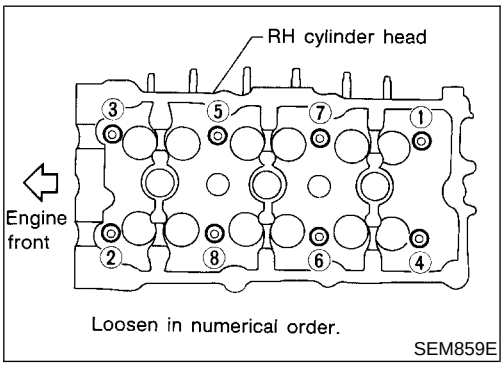
- Equally loosen camshaft bracket bolts in several steps in the numerical order shown in the figure.

  For reinstallation, be sure to put marks on camshaft bracket before removal.

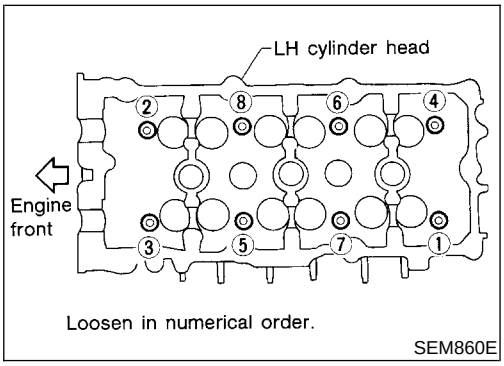


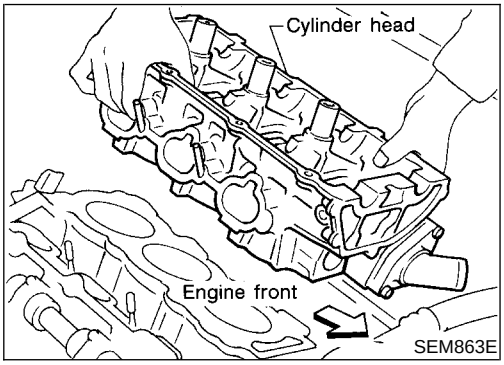


14. Remove RH and LH camshaft chain tensioners from cylinder head.



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



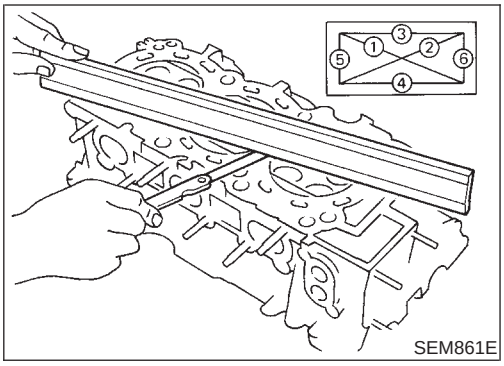


16. Remove cylinder head.

Disassembly

NFEM0045

Remove valve component parts.
Refer to EM-41, "VALVE OIL SEAL".
- Check the clearance before removing the valve guide. Refer to EM-50, "VALVE GUIDE CLEARANCE".



SEM861E

Inspection

NFEM0046

CYLINDER HEAD DISTORTION

NFEM0046S01

Clean surface of cylinder head.

Use a reliable straightedge and feeler gauge to check the flatness of cylinder head surface.

Check along six positions shown in the figure.

Head surface flatness: Limit 0.1 mm (0.004 in)

If beyond the specified limit, resurface or replace it.

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

Resurfacing limit:

Amount of cylinder head resurfacing is "A".

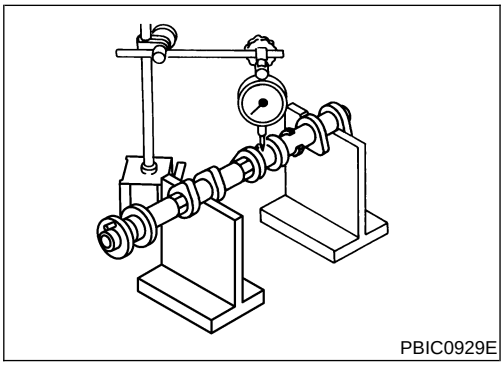
Amount of cylinder block resurfacing is "B".

The maximum limit : A + B = 0.2 mm (0.008 in)

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

Nominal cylinder head height:

126.3 - 126.5 mm (4.972 - 4.980 in)


PBIC0929E

CAMSHAFT VISUAL CHECK

NFEM0046S02

Check camshaft for scratches, seizure and wear.

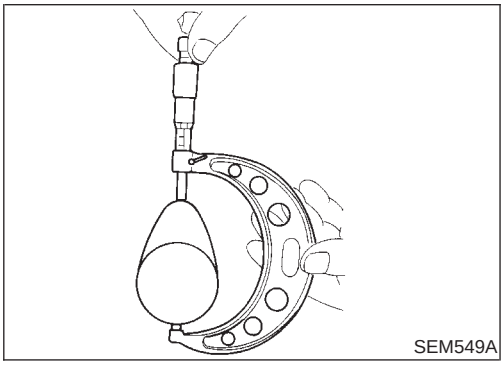
CAMSHAFT RUNOUT

NFEM0046S03

1. Put V block on precise flat bed, and support No. 2 and No. 4 journal of camshaft.
2. Set dial gauge vertically to No. 3 journal.
3. Turn camshaft to one direction with hands, and measure camshaft runout on dial gauge.

   Runout (Total indicator reading):

   Limit 0.05 mm (0.0020 in)
4. If it exceeds the limit, replace camshaft.


SEM549A

CAMSHAFT CAM HEIGHT

NFEM0046S04

1. Measure camshaft cam height.

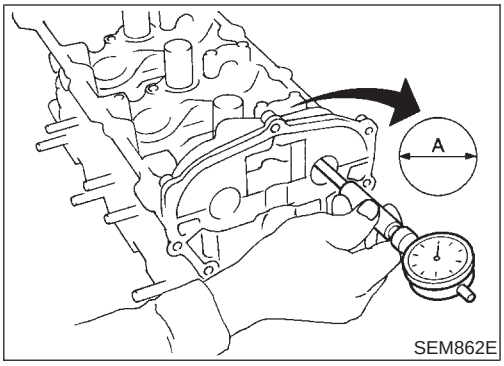
   Standard cam height:

   Intake and exhaust

   44.865 - 45.055 mm (1.7763 - 1.7738 in)

   Cam wear limit:

   0.2 mm (0.008 in)
2. If wear is beyond the limit, replace camshaft.

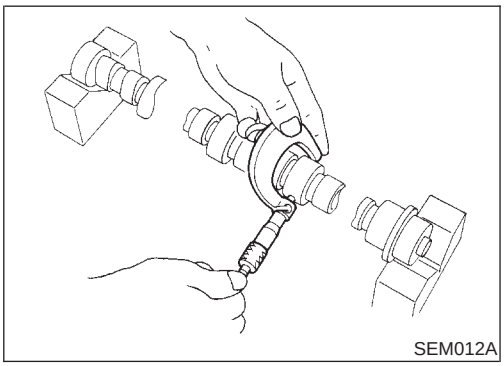


SEM862E

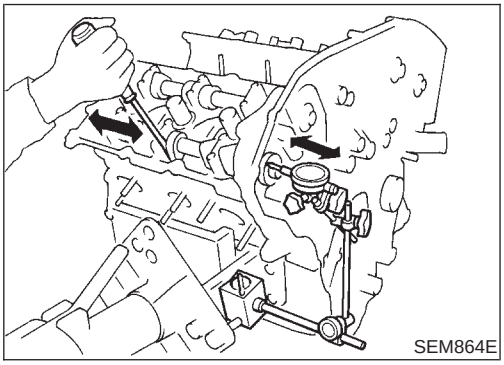
CAMSHAFT JOURNAL CLEARANCE

NFEM0046S05

1. Install camshaft bracket and tighten bolts to the specified torque.
2. Measure inner diameter "A" of camshaft bearing.
   Standard inner diameter:
   No. 1: 26.000 - 26.021 mm (1.0236 - 1.0244 in)
   No. 2, 3, 4: 23.500 - 23.521 mm (0.9252 - 0.9260 in)


SEM012A

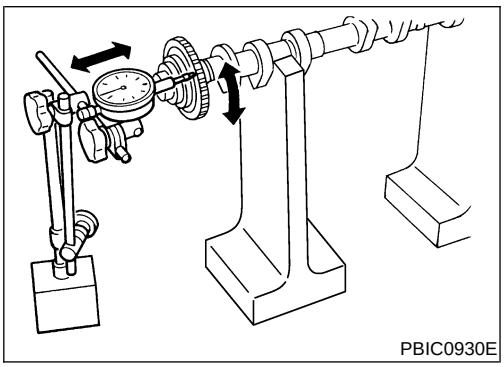
3. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   No. 1: 25.935 - 25.955 mm (1.0211 - 1.0218 in)
   No. 2, 3, 4: 23.445 - 23.465 mm (0.9230 - 0.9238 in)
4. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance:
   Standard
   No. 1: 0.045 - 0.086 mm (0.0018 - 0.0034 in)
   No. 2, 3, 4: 0.035 - 0.076 mm (0.0014 - 0.0030 in)
   Limit
   0.15 mm (0.0059 in)


SEM864E

CAMSHAFT END PLAY

NFEM0046S06

1. Install camshaft in cylinder head.
2. Measure camshaft end play.
   Camshaft end play:
   Standard
   0.115 - 0.188 mm (0.0045 - 0.0074 in)
   Limit
   0.24 mm (0.0094 in)

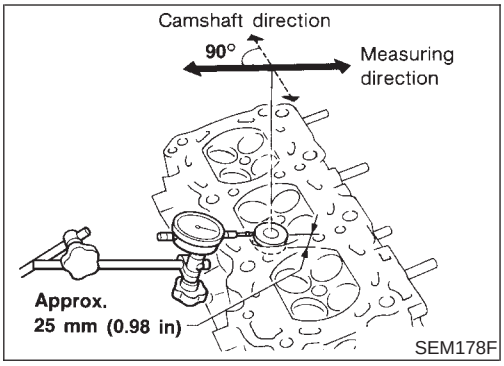

PBIC0930E

CAMSHAFT SPROCKET RUNOUT

NFEM0046S07

1. Put V block on precise flat bed, and support No. 2 and No. 4 journal of camshaft.
2. Install sprocket on camshaft.
3. Measure camshaft sprocket runout.
   Runout (Total indicator reading):
   Less than 0.15 mm (0.0059 in)
4. If it exceeds the limit, replace camshaft sprocket.

Inspection (Cont'd)

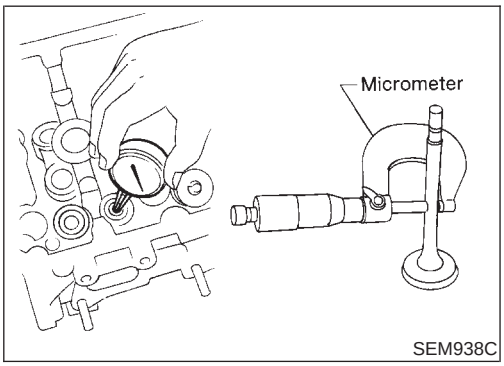


VALVE GUIDE CLEARANCE

NFEM0046S08

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

Valve deflection limit (Dial gauge reading):
Intake 0.24 mm (0.0094 in)
Exhaust 0.28 mm (0.0110 in)



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

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

b. Check that clearance is within specification.

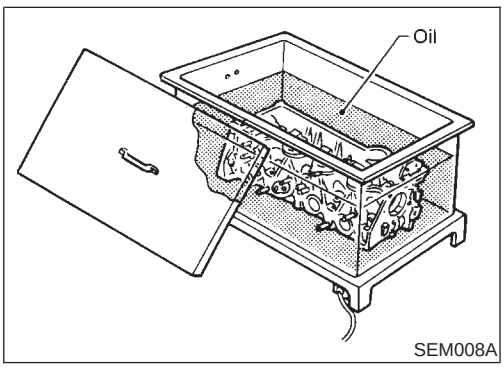
Valve to valve guide clearance limit:
Intake 0.08 mm (0.0031 in)
Exhaust 0.1 mm (0.004 in)

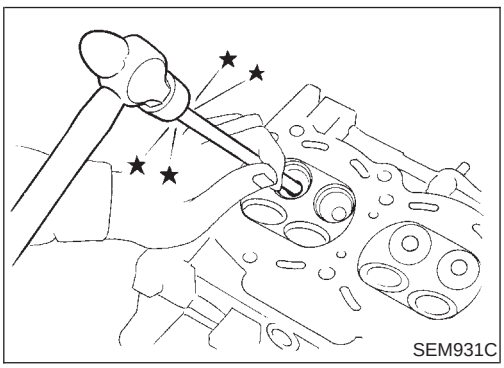
c. If it exceeds the limit, replace valve or valve guide.

VALVE GUIDE REPLACEMENT

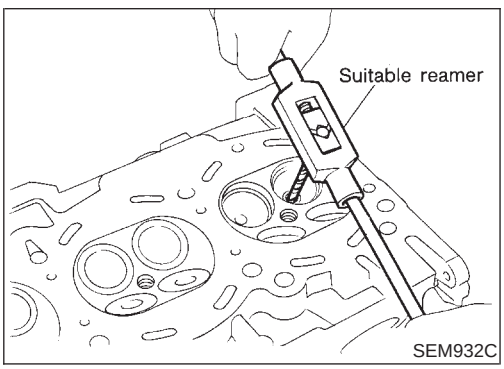
NFEM0046S09

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



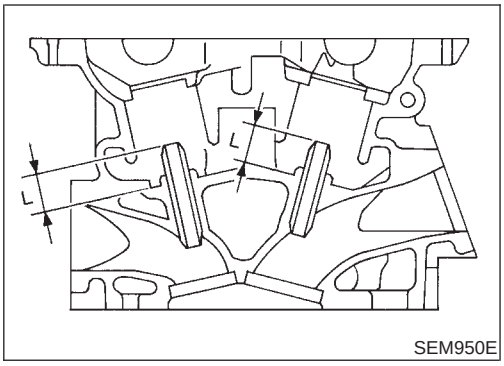


2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.

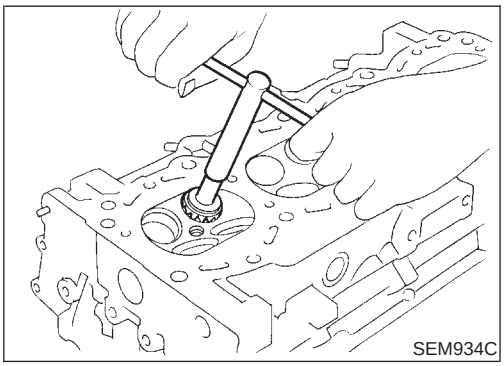


3. Ream cylinder head valve guide hole.

Valve guide hole diameter (for service parts):
10.175 - 10.196 mm (0.4006 - 0.4014 in)


SEM950E

4. Heat cylinder head to 110 to 130°C (230 to 266°F) and press service valve guide onto cylinder head.
   Projection "L":
   12.6 - 12.8 mm (0.496 - 0.504 in)
5. Ream valve guide.
   Finished size:
   6.000 - 6.018 mm (0.2362 - 0.2369 in)

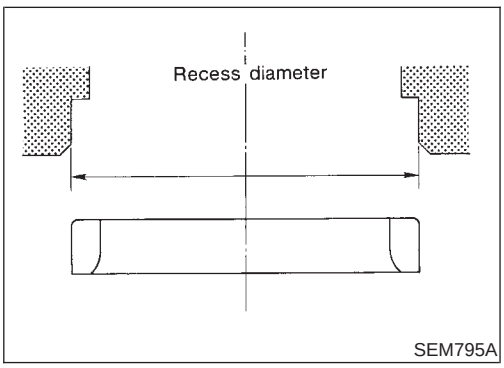

SEM934C

VALVE SEATS

NFEM0046S10

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

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

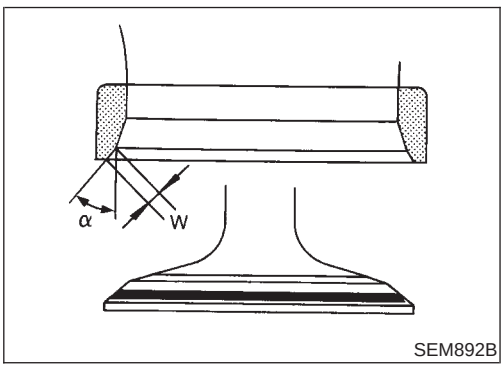


SEM795A

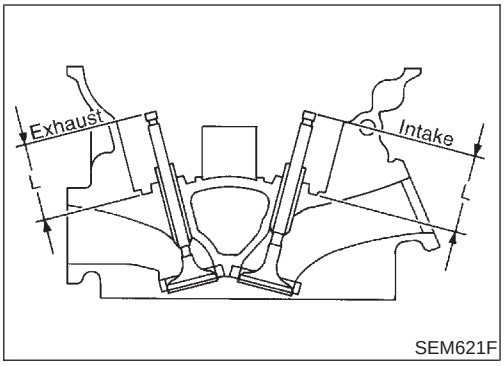
REPLACING VALVE SEAT FOR SERVICE PARTS

NFEM0046S11

1. Bore out old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in cylinder head. Set the machine depth stop to ensure this.
2. Ream cylinder head recess for service valve seat.
   Oversize [0.5 mm (0.020 in)]:
   Intake 38.500 - 38.516 mm (1.5157 - 1.5164 in)
   Exhaust 32.700 - 32.716 mm (1.2874 - 1.2880 in)
   Be sure to ream in circles concentric to the valve guide center.
   This will enable valve seat to fit correctly.
3. Heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.
4. Press fit valve seat until it seats on the bottom.
5. Cut or grind valve seat using suitable tool to the specified dimensions as shown in SDS (EM-85).
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.
   Seat face angle "α": 45°15′ - 45°45′
   Contacting width "W":
   Intake 1.09 - 1.31 mm (0.0429 - 0.0516 in)
   Exhaust 1.29 - 1.51 mm (0.0508 - 0.0594 in)



SEM892B



SEM621F

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

Valve seat resurface limit "L":

Intake 41.07 - 41.67 mm (1.6169 - 1.6405 in)

Exhaust 41.00 - 41.60 mm (1.6142 - 1.6378 in)

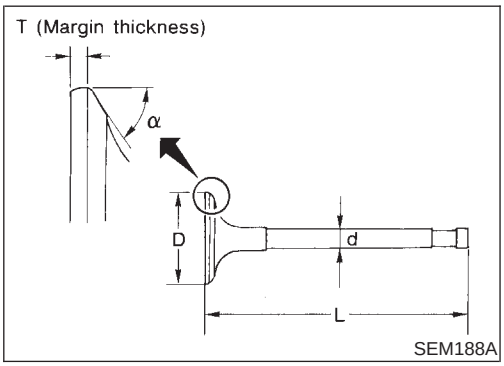
VALVE DIMENSIONS

NFEM0046S12

Check dimensions of each valve. For dimensions, refer to SDS (EM-82).

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.



SEM188A

VALVE SPRING

NFEM0046S13

Squareness

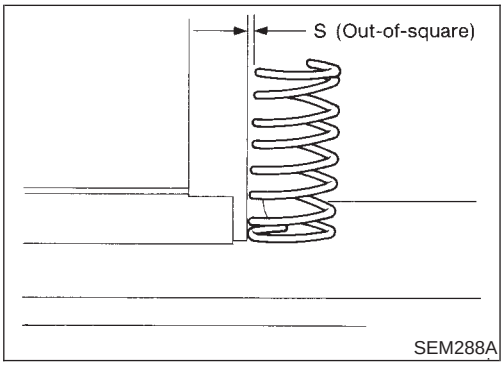
NFEM0046S1301

1. Measure dimension "S".

Out-of-square "S":

Less than 2.0 mm (0.079 in)

2. If it exceeds the limit, replace spring.



SEM288A

Pressure

NFEM0046S1302

Check valve spring pressure at specified spring height.

Pressure:

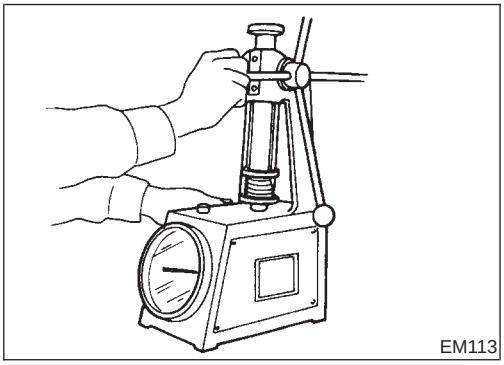
Installation

196 N (20.0 kg, 44.1 lb) at height 37.0 mm (1.457 in)

Valve open

More than 433 N (44.2 kg, 97.3 lb) at height 27.8 mm (1.094 in)

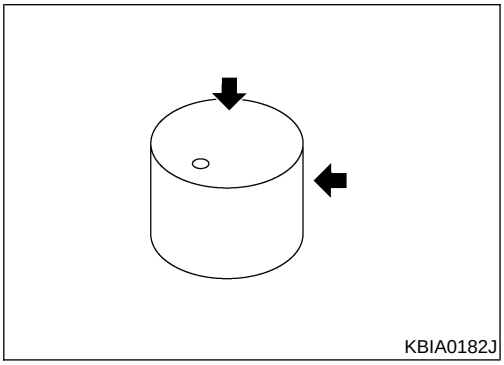
If it exceeds the limit, replace spring.

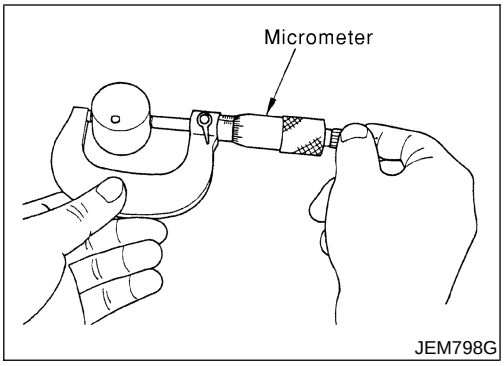

EM113

VALVE LIFTER

NFEM0046S14

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

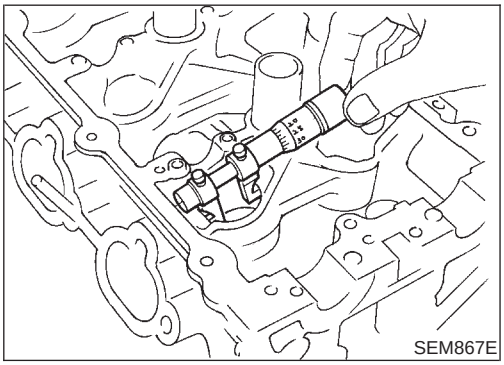

KBIA0182J



2. Check diameter of valve lifter and valve lifter guide bore.

Valve lifter outer diameter:

33.977 - 33.987 mm (1.3377 - 1.3381 in)



Lifter guide bore diameter:

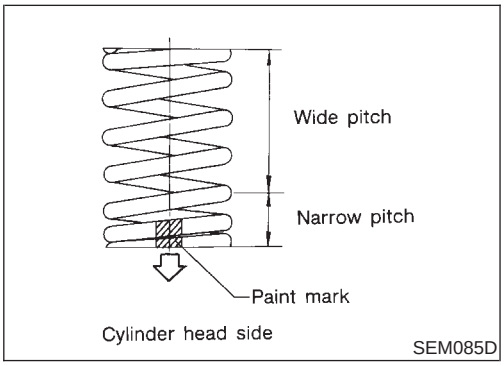
34.000 - 34.016 mm (1.3386 - 1.3392 in)

Assembly

NFEM0047

1. Install valve component parts.

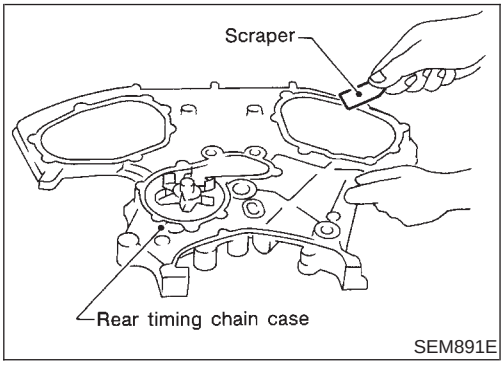
- **Always use new valve oil seal. Refer to "VALVE OIL SEAL", EM-41.**
- **Before installing valve oil seal, install valve spring seat.**
- **Install valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side (paint mark).**
- After installing valve component parts, tap valve stem tip with plastic hammer to assure a proper fit.



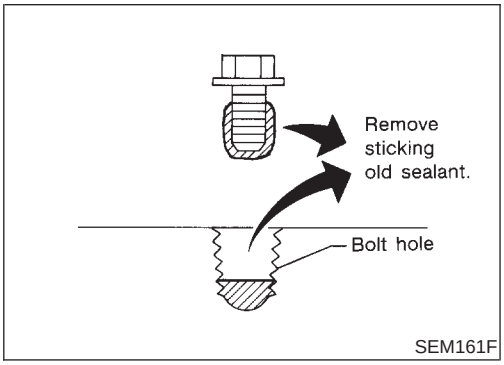
Installation

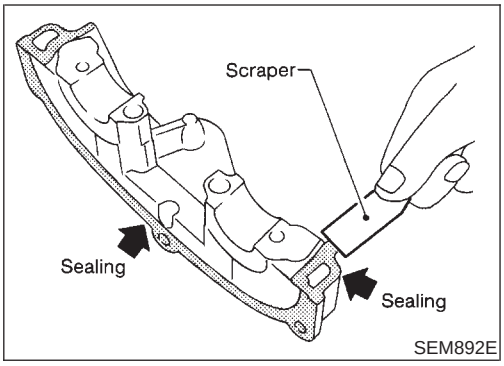
NFEM0048

1. Before installing rear timing chain case, remove old liquid gasket from mating surface using a scraper.
- Also remove old liquid gasket from mating surface of cylinder block.

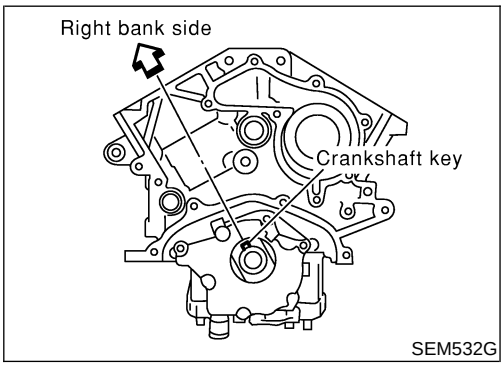


- **Remove old liquid gasket from the bolt hole and thread.**

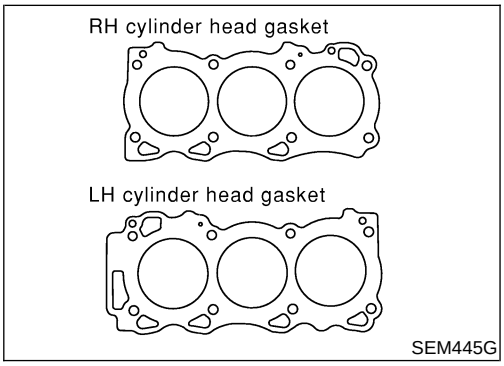




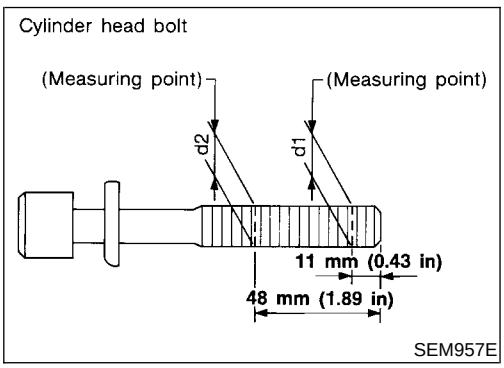
2. Before installing cam bracket, remove old liquid gasket from mating surface using a scraper.



3. Before installing the cylinder head gasket, be sure that No. 1 cylinder is at TDC.
- At this time, the crankshaft key should face toward the right bank.



4. Install cylinder heads with new gaskets.
- **Do not rotate crankshaft and camshaft separately, or valves will strike piston heads.**



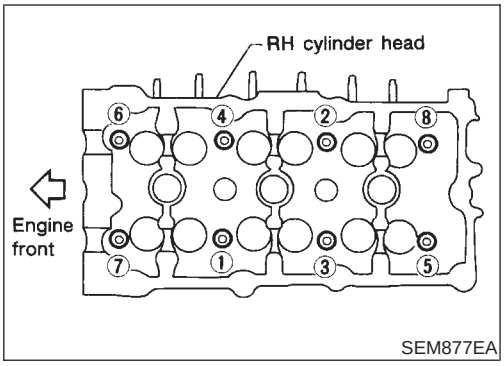
CAUTION:

Cylinder head bolts are tightened by plastic zone tightening method. Whenever the size difference between d1 and d2 exceeds the limit, replace them with new ones.

Limit (d1 - d2):

0.11 mm (0.0043 in)

- **If reduction of outer diameter appears in a position other than d2, use it as d2 point.**
- **Lubricate threads and seat surfaces of the bolts with new engine oil.**

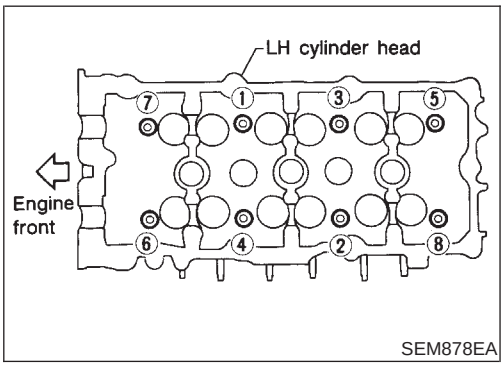


SEM877EA

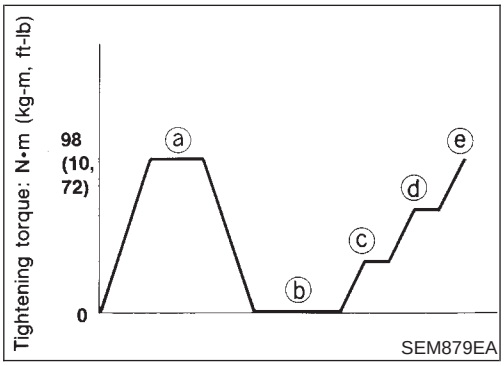
5. Install cylinder head outside bolts.
- **Tightening procedure:**

a. **Tighten all bolts to 98 N·m (10 kg-m, 72 ft-lb).**
b. **Completely loosen all bolts.**
c. **Tighten all bolts to 34.3 to 44.1 N·m (3.5 to 4.4 kg-m, 26 to 32 ft-lb).**
d. **Turn all bolts 90 to 95 degrees clockwise.**
e. **Turn all bolts 90 to 95 degrees clockwise.**

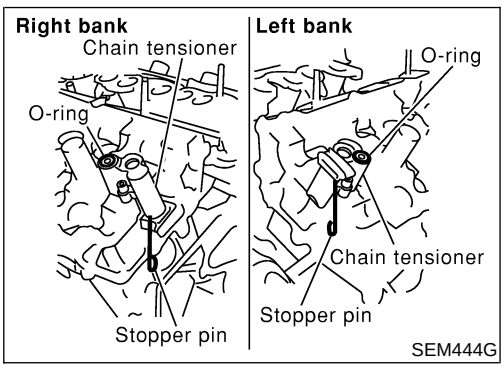
- **Tighten in numerical order shown in the figure.**



SEM878EA

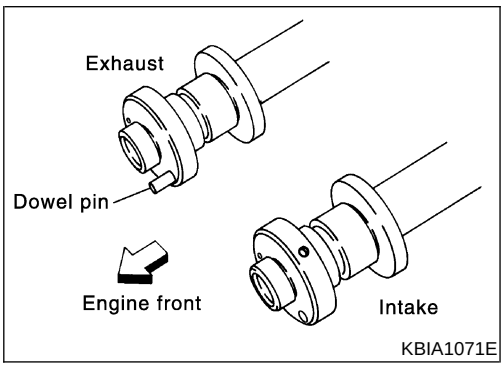


SEM879EA



SEM444G

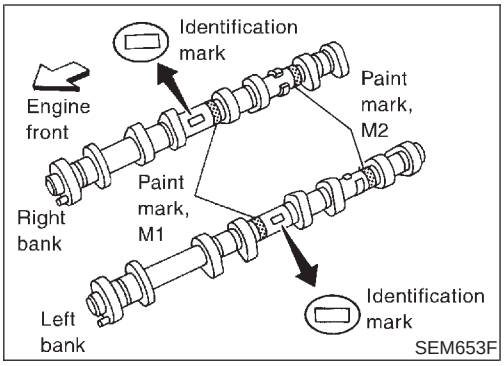
6. Install camshaft chain tensioners on both sides of cylinder head.



KBIA1071E

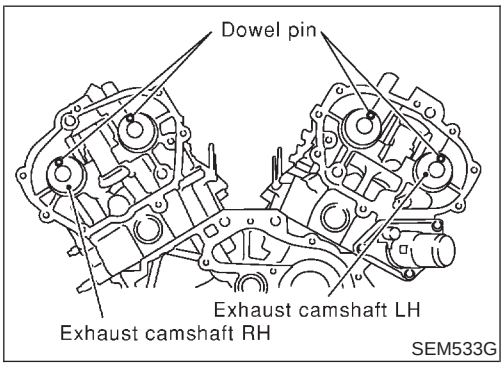
7. Install exhaust and intake camshafts and camshaft brackets.
- **Exhaust camshaft has a dowel pin on camshaft sprocket mounting flange. Install it on the exhaust side.**

Installation (Cont'd)

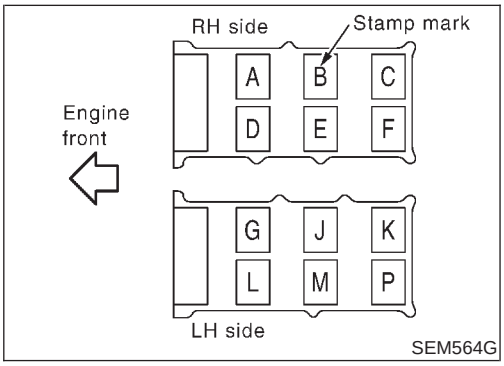


- **Identification marks are present on camshafts.**

Bank	INT/EXH	ID mark	Drill mark	Paint mark	
				M1	M2
RH	INT	RE	Yes	Yes	No
	EXH	RE	No	No	Yes
LH	INT	LH	Yes	Yes	No
	EXH	LH	No	No	Yes



- **Position camshaft**
  RH exhaust camshaft dowel pin at about 10 o'clock
  LH exhaust camshaft dowel pin at about 2 o'clock



8. Before installing camshaft brackets, apply sealant to mating surface of No. 1 camshaft bracket.

- **Refer to "POSITION FOR APPLYING LIQUID GASKET", EM-23.**
- **Use Genuine RTV silicone sealant or equivalent. Refer to GI-52.**
- **Install camshaft brackets in their original positions.**
  Align stamp mark as shown in the figure.
- **If any part of valve assembly or camshaft is replaced, check valve clearance according to reference data.**
  After completing assembly check valve clearance. Refer to "Checking" and "Adjusting", EM-58 and EM-60.

  Reference data valve clearance (Cold):

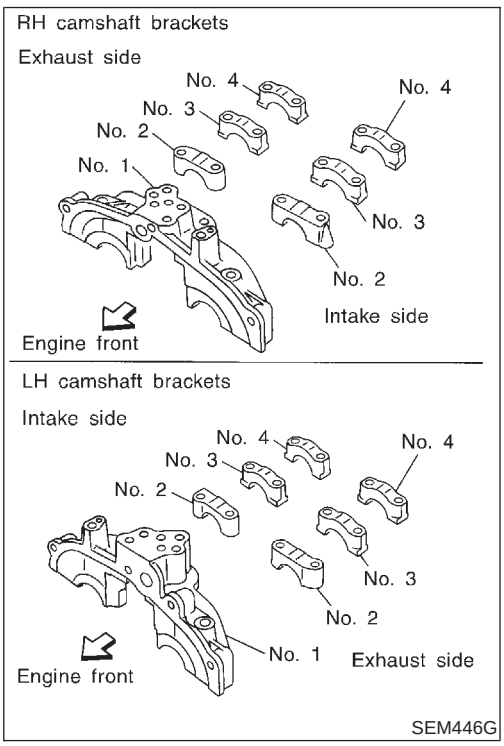
  Intake

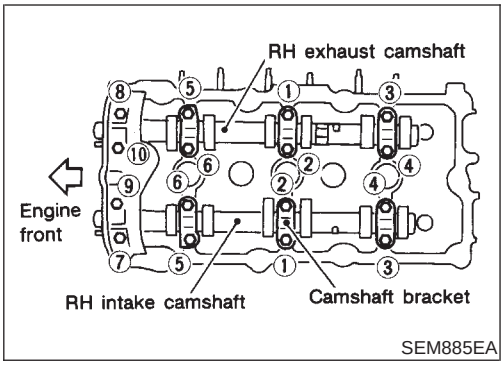
  0.26 - 0.34 mm (0.010 - 0.013 in)

  Exhaust

  0.29 - 0.37 mm (0.011 - 0.015 in)

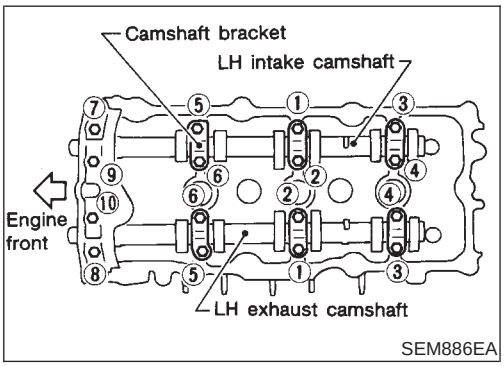
- **Lubricate threads and seat surfaces of camshaft bracket bolts with new engine oil before installing them.**



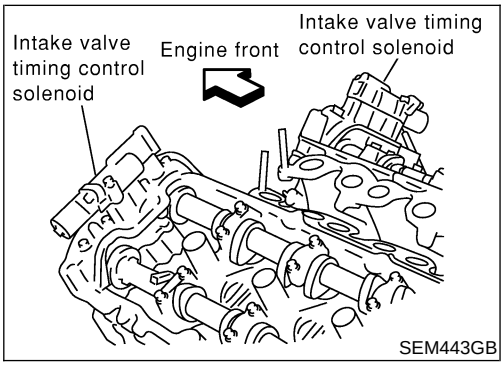


- Tighten the camshaft brackets in the following steps.

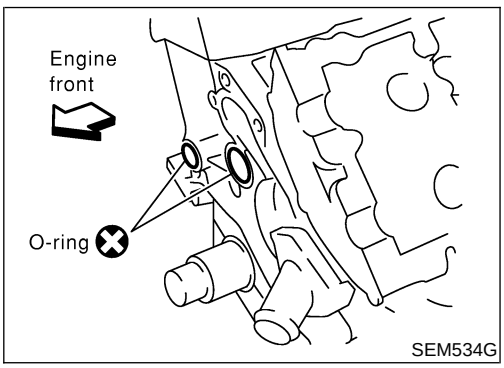
Step	Tightening torque	Tightening order
1	1.96 N·m (0.2 kg-m, 17 in-lb)	Tighten in the order of 7 to 10, then tighten 1 to 6.
2	5.88 N·m (0.6 kg-m, 52 in-lb)	Tighten in the numerical order.
3	9.02 - 11.8 N·m (0.92 - 1.20 kg-m, 79.9 - 104.2 in-lb)	Tighten in the order of 1 to 6.
	8.3 - 10.3 N·m (0.9 - 1.0 kg-m, 74 - 91 in-lb)	Tighten in the order of 7 to 10.



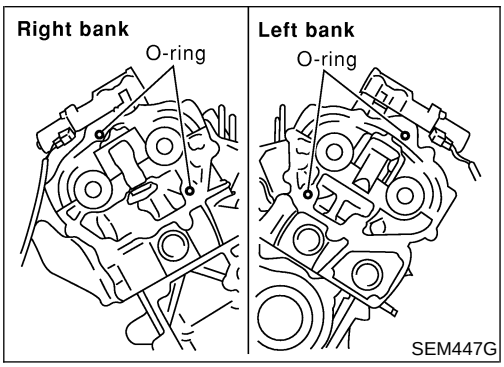
9. Install intake valve timing control solenoid valves.



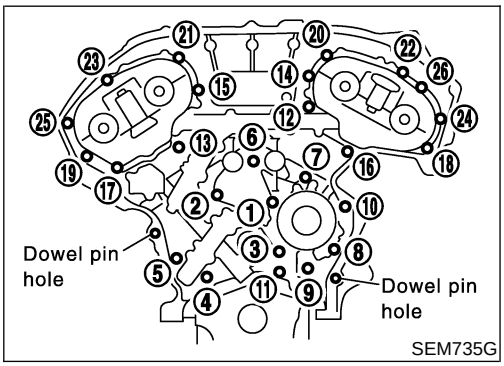
10. Install O-rings to cylinder block.



11. Install O-rings to cylinder head.



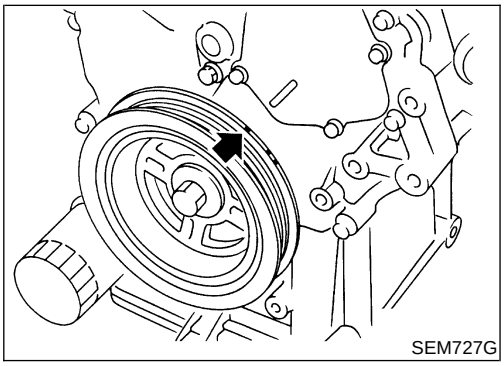
12. Apply sealant to the hatched portion of rear timing chain case. Refer to "POSITION FOR APPLYING LIQUID GASKET", EM-23.
- Apply continuous bead of liquid gasket to mating surface of rear timing chain case.
- **Before installation, wipe off the protruding sealant.**



13. Align rear timing chain case with dowel pins, then install on cylinder head and block.
14. Tighten rear chain case bolts.

a. Tighten bolts in numerical order shown in the figure with smaller torque than specified.
b. Tighten bolts to the specified torque repeating above step a.

15. Reinstall all removed parts in reverse order of removal.



Valve Clearance

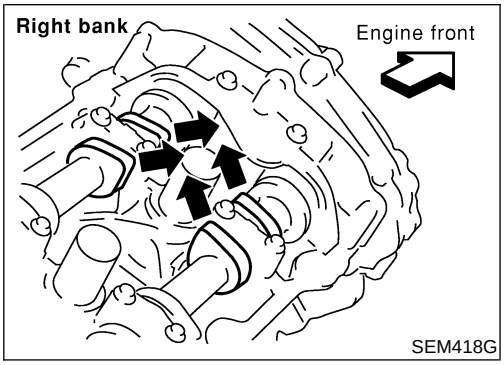
NFEM0049

CHECKING

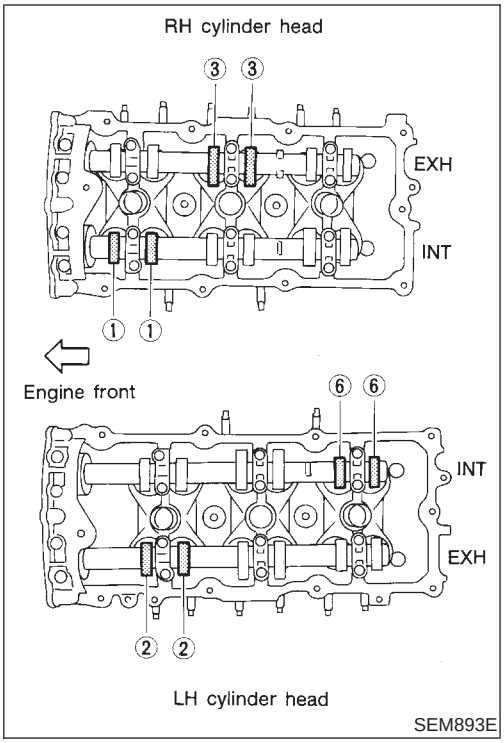
NFEM0049S01

Check valve clearance while engine is cold and not running.

1. Remove ornament cover.
2. Remove air duct with air cleaner case, collectors, hoses, wires, harnesses, connectors and so on.
3. Remove intake manifold collectors.
4. Remove ignition coils and spark plugs.
5. Remove RH and LH rocker covers.
6. Set No. 1 cylinder at TDC on its compression stroke.
- Align pointer with TDC mark on crankshaft pulley.

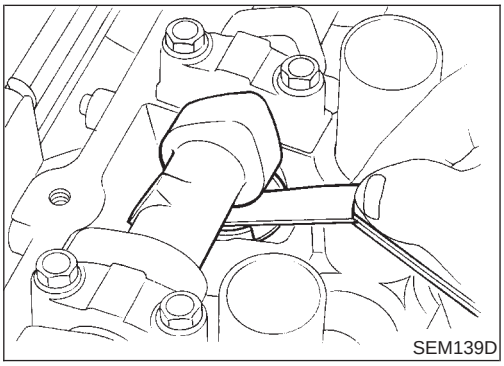


- Check that valve lifters on No. 1 cylinder are loose and valve lifters on No. 4 are tight.
  If not, turn crankshaft one revolution (360°) and align as above.



7. Check only those valves shown in the figure.

Crank position	Valve											
	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6	
	INT	EXH	INT	EXH	INT	EXH	INT	EXH	INT	EXH	INT	EXH
No. 1 TDC	○			○		○					○	



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

Valve clearance for checking (Cold):

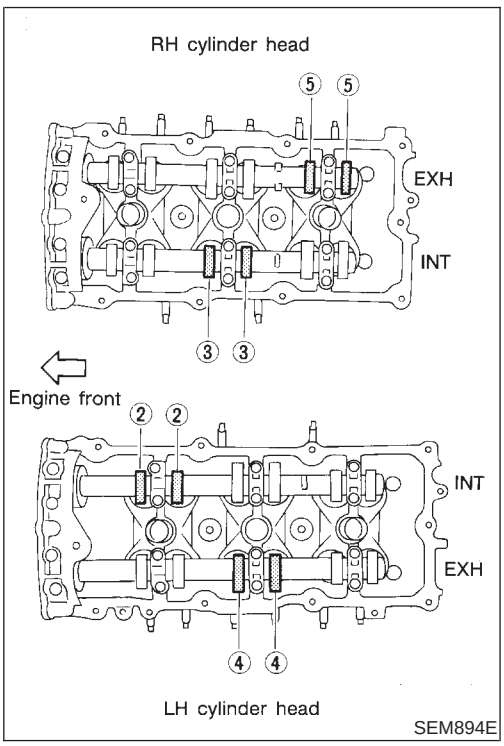
Intake

0.26 - 0.34 mm (0.010 - 0.013 in)

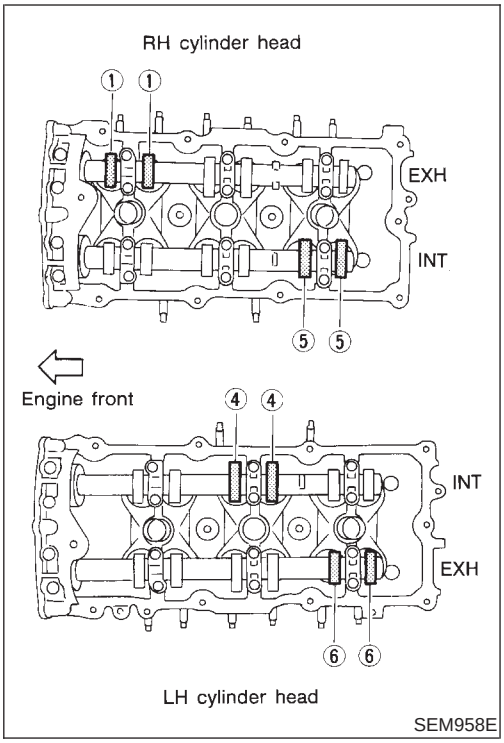
Exhaust

0.29 - 0.37 mm (0.011 - 0.015 in)

8. Turn crankshaft 240° and align as above.
9. Set No. 3 cylinder at TDC on its compression stroke.
10. Check only those valves shown in the figure.



Crank position	Valve											
	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6	
	INT	EXH	INT	EXH	INT	EXH	INT	EXH	INT	EXH	INT	EXH
No. 3 TDC			○		○			○		○		



11. Turn crankshaft 240° and align as above.
12. Set No. 5 cylinder at TDC on its compression stroke.
13. Check only those valves shown in the figure.

Crank position	Valve											
	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6	
	INT	EXH	INT	EXH	INT	EXH	INT	EXH	INT	EXH	INT	EXH
No. 5 TDC		○					○		○			○

14. If all valve clearances are within specification, install the following parts. If they are out of specification, adjust the valve clearances.

- Intake manifold collectors
- RH and LH rocker covers
- All spark plugs
- All ignition coils

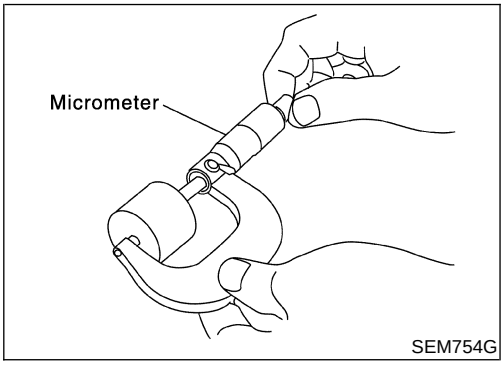
ADJUSTING

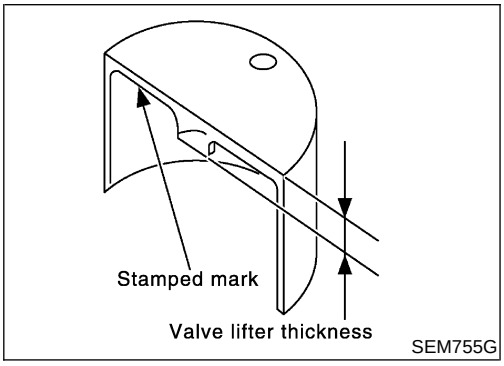
NFEM0049S02

Adjust valve clearance while engine is cold.

Perform adjustment by selecting head thickness of valve lifter (Adjusting shims are not used).

1. Remove camshaft.
2. Remove valve lifter at location where measured value is outside standard.





3. Measure center thickness of removed valve lifter with micrometer.
4. Use equation below to calculate valve lifter thickness for replacement.
   Valve lifter thickness calculation: t = t1 + (C1 − C2)
   t = Thickness of replacement valve lifter
   t1 = Thickness of removed valve lifter
   C1 = Measured valve clearance
   C2 = Standard valve clearance:
   Intake: 0.30 mm (0.012 in)
   Exhaust: 0.33 mm (0.013 in)

- Thickness of new valve lifter can be identified by stamp mark on reverse side (inside cylinder).

Unit: mm (in)

Stamp mark	Thickness of valve lifter
Starting: 788U or 788R	7.88 (0.3102)
Ending: 840U or 840R	8.40 (0.3307)

- Available thickness of valve lifter (Factory setting):
  7.88 - 8.40 mm (0.3102 - 0.3307 in) [in 0.02 mm (0.0008 in) step] in 27 sizes (Intake/Exhaust)

5. Install selected valve lifter.

6. Install camshaft.
7. Rotate crankshaft a few turns by hand.
8. Confirm that valve clearance is within standard.
9. After repair, confirm that valve clearance is within standard with engine warmed-up.

Valve clearance:

Unit: mm (in)

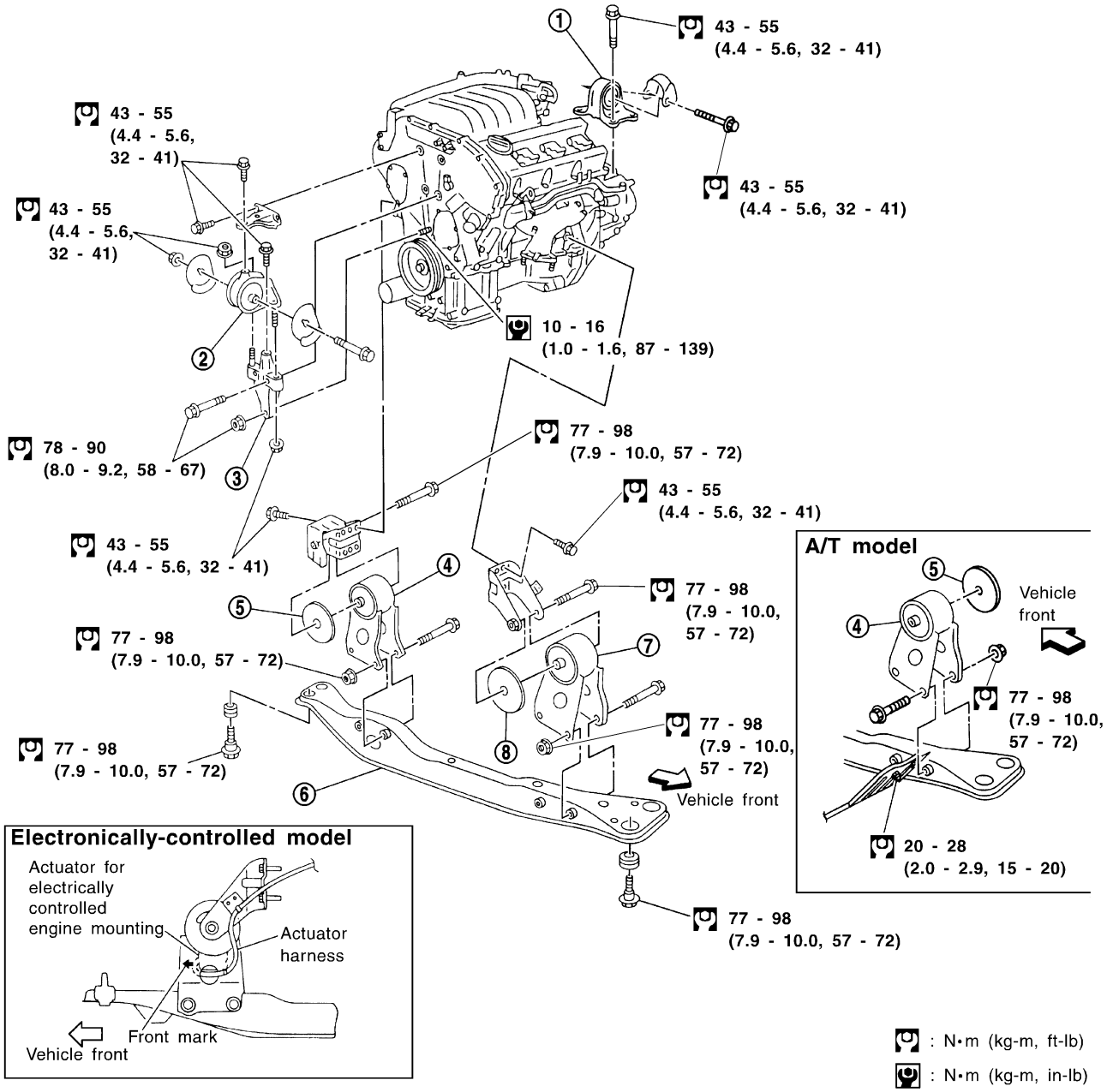
	Cold	Hot* (reference data)
Intake	0.26 - 0.34 (0.010 - 0.013)	0.304 - 0.416 (0.012 - 0.016)
Exhaust	0.29 - 0.37 (0.011 - 0.015)	0.308 - 0.432 (0.012 - 0.017)

*: Approximately 80°C (176°F)

Removal and Installation

NFEM0050

SEC. 112



SEM844G

1. LH engine mounting
2. RH engine mounting
3. Mounting bracket
4. Rear engine mounting (Fluid type)
5. Insulator
6. Center member
7. Front engine mounting (Fluid type)
8. Insulator

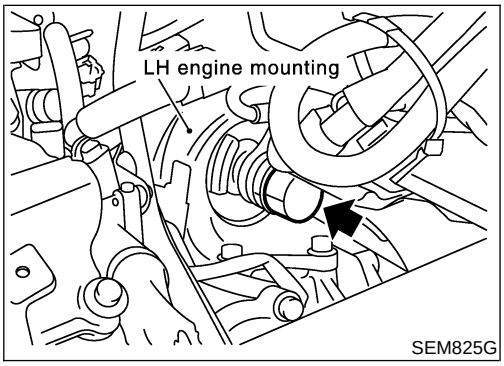
WARNING:

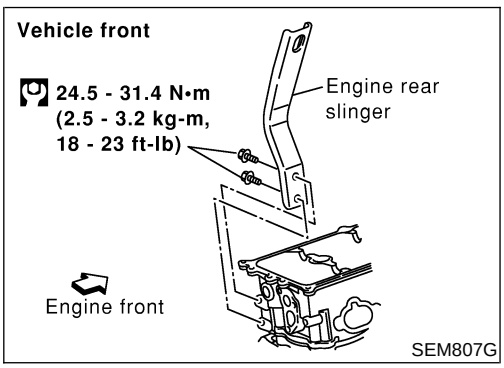
- **Situate vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **Do not remove engine until exhaust system has completely cooled off. Otherwise, you may burn yourself and/or fire may break out in fuel line.**
- **For safety during subsequent steps, the tension of wires should be slackened against the engine.**

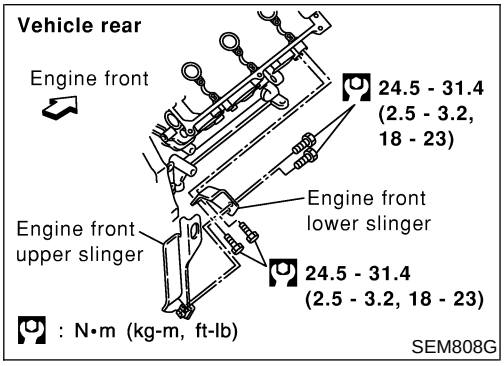
- **Before disconnecting fuel hose, release fuel pressure from fuel line.**
  Refer to EC-56, "Fuel Pressure Release".
- **Before removing front axle from transaxle, place safety stands under designated front supporting points. Refer to GI-48, "Garage Jack and Safety Stand".**
- **Be sure to hoist engine and transaxle in a safe manner.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.**

CAUTION:

- **When lifting engine, be careful not to strike adjacent parts, especially the following: Accelerator wire casing, brake lines, and brake master cylinder.**
- **In hoisting the engine, always use engine slingers in a safe manner.**
- **In removing drive shaft, be careful not to damage grease seal of transaxle.**
- **Before separating engine and transaxle, remove the crankshaft position sensor (POS) from the assembly.**
- **Always pay extra attention not to damage edge of crankshaft position sensor (POS) or ring gear teeth.**



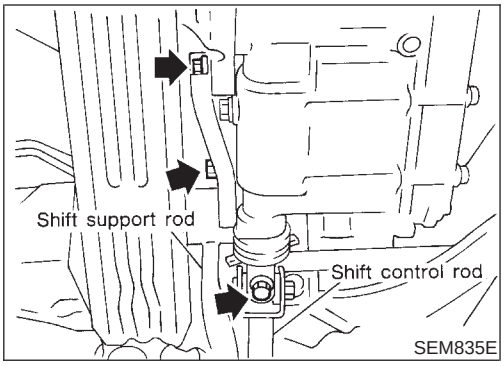




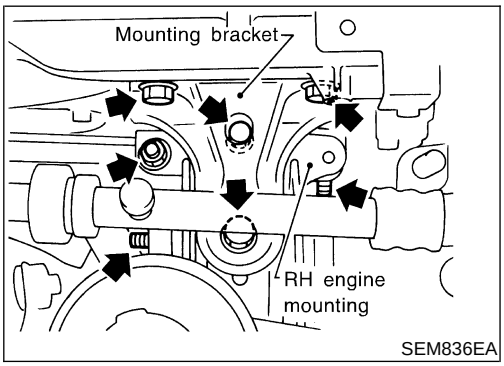
REMOVAL

NFEM0050S01

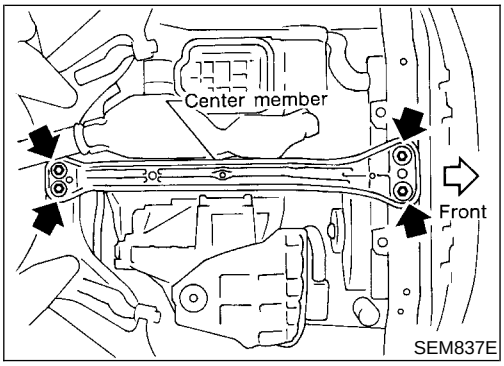
1. Remove engine undercover and hood.
2. Drain coolant from both cylinder block and radiator. Refer to MA-14, "Changing Engine Coolant".
3. Remove vacuum hoses, fuel hoses, wires, harnesses, connectors and so on.
4. Remove front exhaust tubes, ball joints and drive shafts.
5. Remove radiator and fans.
6. Remove drive belts.
7. Remove alternator, compressor and power steering oil pump from engine.
8. Set a suitable transmission jack under transaxle. Hoist engine with engine slinger.
9. Remove LH engine mounting.



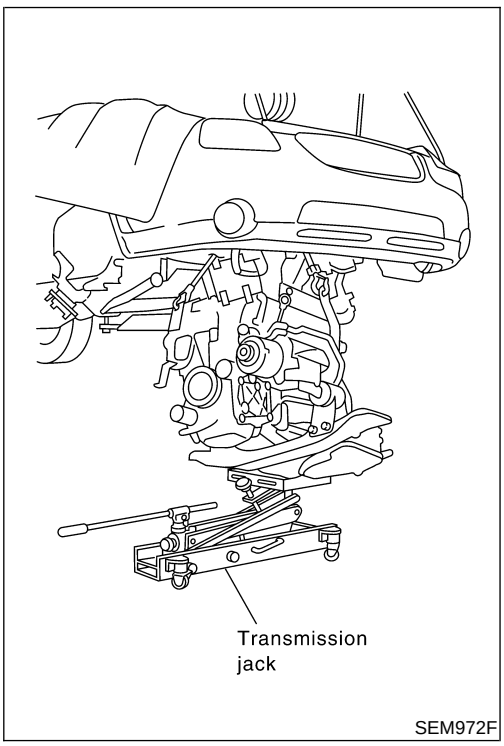
10. Disconnect control rod and support rod from transaxle (M/T model).
11. Disconnect control cable from transaxle (A/T model).



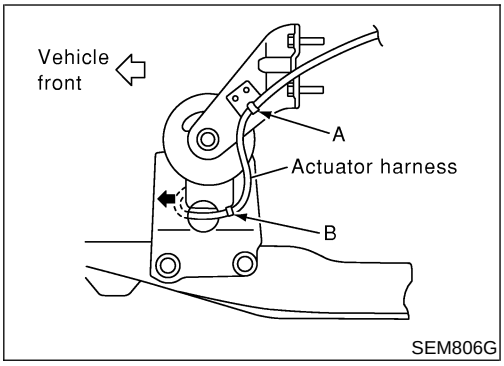
12. Remove RH engine mounting.



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



14. Remove engine with transaxle as shown.



INSTALLATION

NFEM0050S02

Installation is in the reverse order of removal.

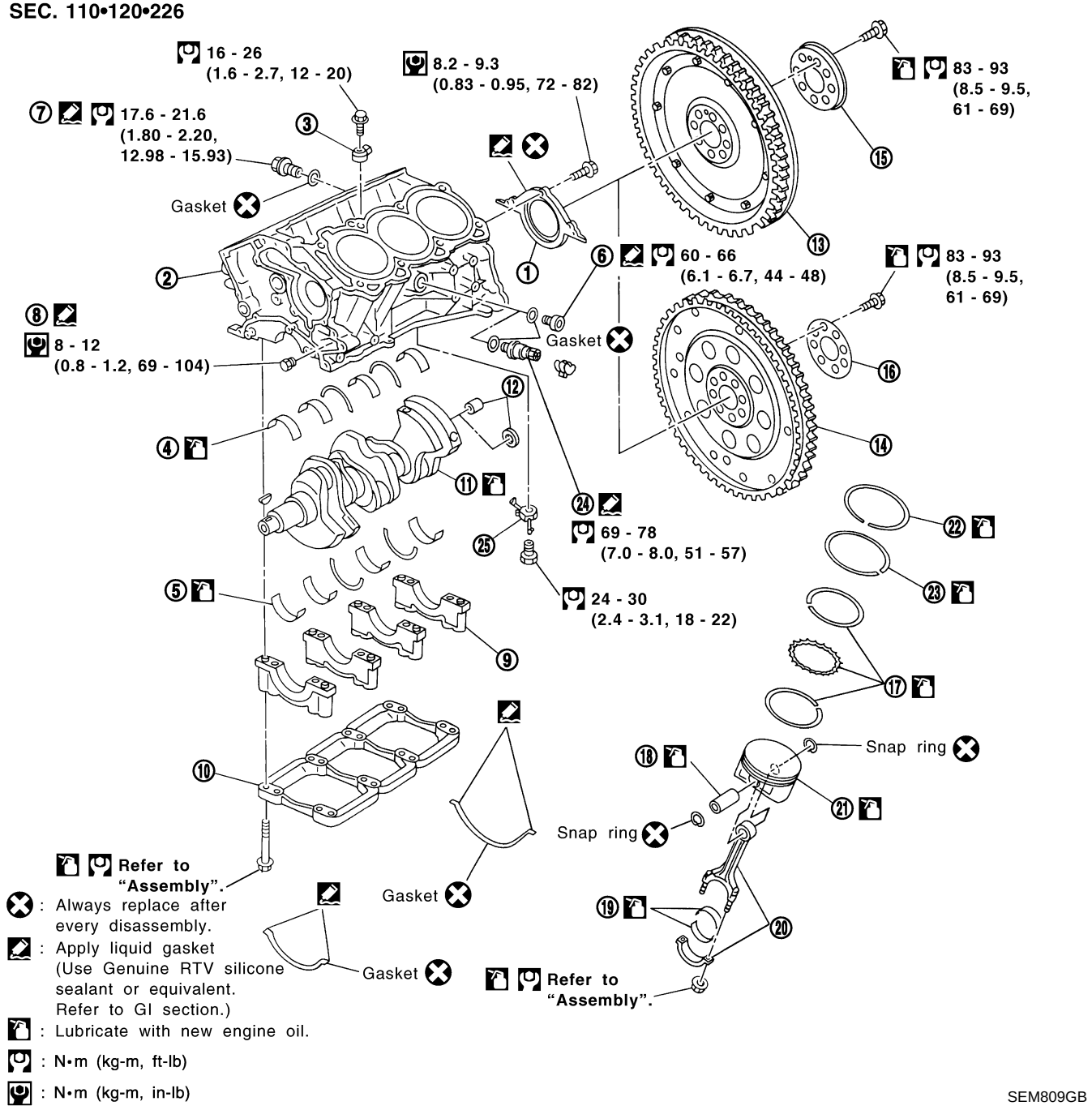
Install the electronically-controlled engine mount harness to match the following values. (Models with electronically-controlled engine mounts)

Length between A and B:
170 mm (6.69 in)

Components

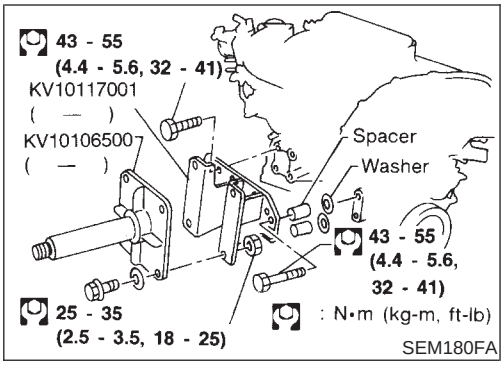
NFEM0051

SEC. 110•120•226



SEM809GB

1. Rear oil seal retainer
2. Cylinder block
3. Knock sensor
4. Upper main bearing
5. Lower main bearing
6. Water drain plug (LH side)
7. Water drain plug (RH side)
8. Water drain plug (Water pump side)
9. Main bearing cap
10. Main bearing beam
11. Crankshaft
12. Pilot bushing or pilot converter
13. Flywheel with signal plate (M/T models)
14. Drive plate with signal plate (A/T model)
15. Flywheel reinforcement
16. Drive plate reinforcement
17. Oil ring
18. Piston pin
19. Connecting rod bearing
20. Connecting rod
21. Piston
22. Top ring
23. 2nd ring
24. Cylinder block heater (For Canada)
25. Oil jet



Removal and Installation

NFEM0052

CAUTION:

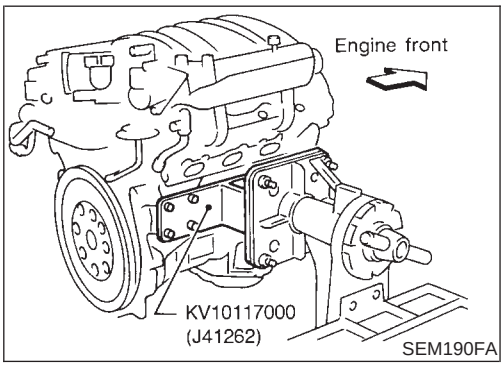
- **When installing bearings, pistons, or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When installing connecting rod nuts, and main bearing cap bolts, apply new engine oil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

Disassembly

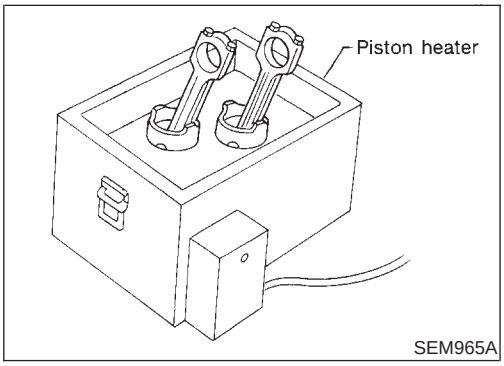
NFEM0053

PISTON, CRANKSHAFT AND OIL JET

NFEM0053S01



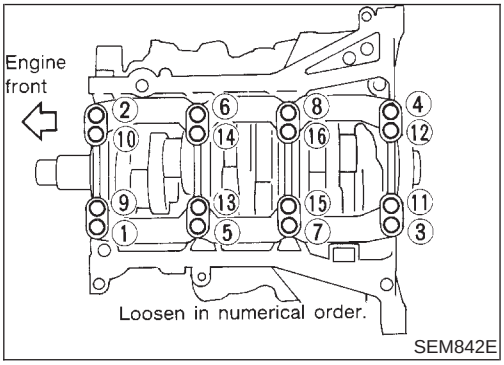
1. Remove engine. Refer to “Removal and Installation”, EM-62.
2. Place engine on a work stand.
3. Drain coolant and oil.
4. Remove oil pan. Refer to “Removal”, EM-14.
5. Remove timing chain. Refer to “Removal”, EM-24.
6. Remove cylinder head. Refer to “Removal”, EM-45.



7. 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).
8. Remove rear oil seal retainer.

CAUTION:

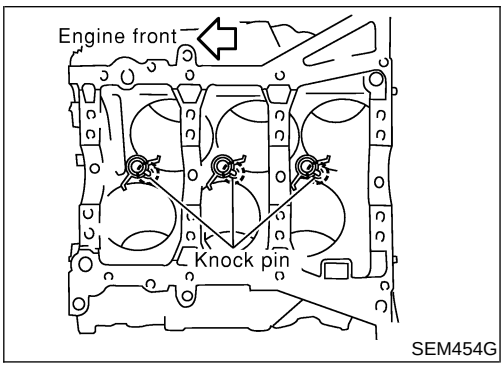
- **When piston rings are not replaced, make sure that piston rings are mounted in their original positions.**
- **When replacing piston rings, if there is no punchmark, install with either side up.**



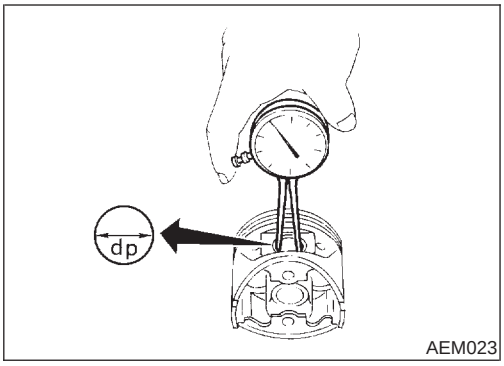
9. Loosen bolts in numerical order as shown and remove main bearing beam, bearing cap and crankshaft.
   - **Before removing bearing beam and bearing cap, measure crankshaft end play. Refer to EM-77.**
   - **Bolts should be loosened in two or three steps.**
10. Remove knock sensor.

CAUTION:

Carefully handle the sensor and avoid impact.



11. Remove oil jets.



Inspection

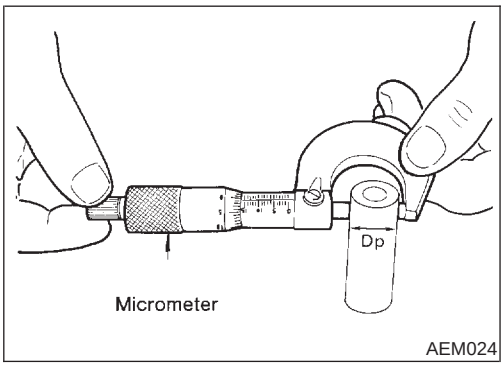
NFEM0054

PISTON AND PISTON PIN CLEARANCE

NFEM0054S01

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

Standard diameter “dp”:
Grade No. 0
21.993 - 21.999 mm (0.8659 - 0.8661 in)
Grade No. 1
21.999 - 22.005 mm (0.8661 - 0.8663 in)



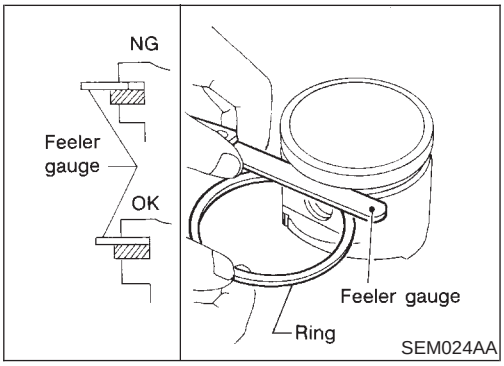
2. Measure outer diameter of piston pin “Dp”.

Standard diameter “Dp”:
Grade No. 0
21.989 - 21.995 mm (0.8657 - 0.8659 in)
Grade No. 1
21.995 - 22.001 mm (0.8659 - 0.8662 in)

3. Calculate interference fit of piston pin to piston.

Dp − dp = 0.002 - 0.006 mm (0.0001 - 0.0002 in)

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

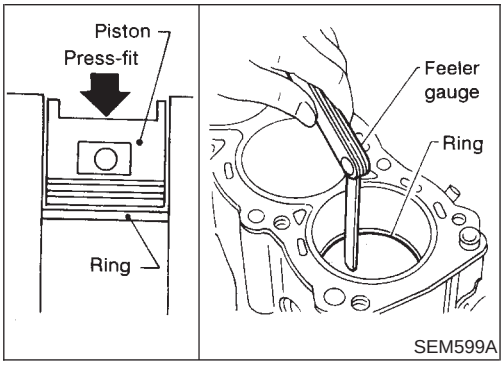


PISTON RING SIDE CLEARANCE

NFEM0054S02

Side clearance:
Top ring
0.045 - 0.080 mm (0.0018 - 0.0031 in)
2nd ring
0.030 - 0.070 mm (0.0012 - 0.0028 in)
Oil ring
0.065 - 0.135 mm (0.0026 - 0.0053 in)
Max. limit of side clearance:
Top ring 0.11 mm (0.0043 in)
2nd ring 0.1 mm (0.004 in)

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



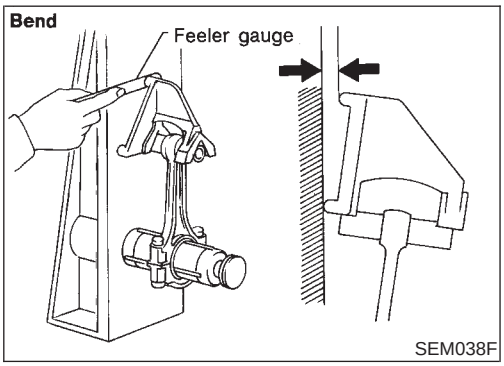
PISTON RING END GAP

NFEM0054S03

End gap:
Top ring 0.23 - 0.33 mm (0.0091 - 0.0130 in)
2nd ring 0.33 - 0.48 mm (0.0130- 0.0189 in)
Oil ring 0.20 - 0.60 mm (0.0079 - 0.0236 in)
Max. limit of ring gap:
Top ring 0.54 mm (0.0213 in)
2nd ring 0.80 mm (0.0315 in)
Oil ring 0.95 mm (0.0374 in)

If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, do the following. Rebore cylinder and use oversized piston and piston rings.
Refer to SDS (EM-88).

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

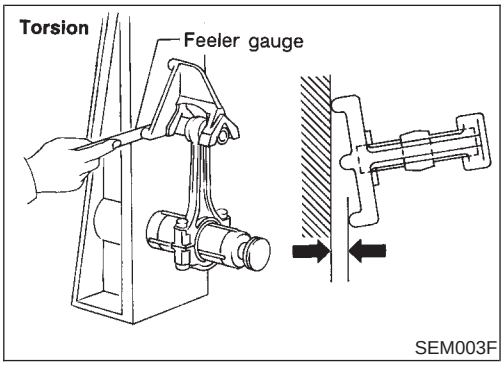


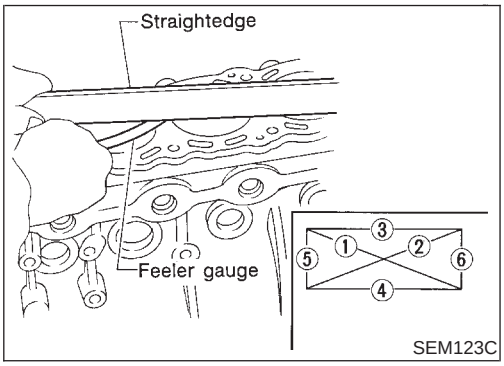
CONNECTING ROD BEND AND TORSION

NFEM0054S04

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

If it exceeds the limit, replace connecting rod assembly.

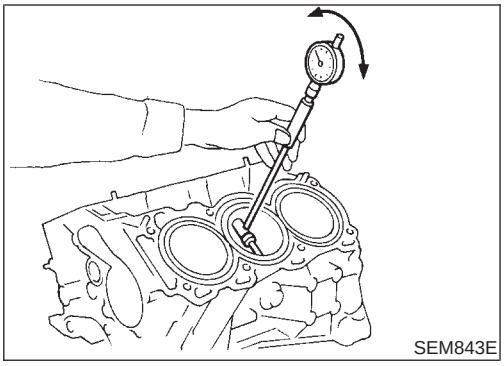




CYLINDER BLOCK DISTORTION AND WEAR

NFEM0054S05

- Clean upper surface of cylinder block.
  Use a reliable straightedge and feeler gauge to check the flatness of cylinder block surface.
  Check along six positions shown in the figure.
  Distortion limit: 0.10 mm (0.0039 in)
- If out of specification, resurface it. The limit for cylinder block resurfacing is determined by cylinder head resurfacing in engine.
  Resurfacing limit:
  Amount of cylinder head resurfacing is "A".
  Amount of cylinder block resurfacing is "B".
  The maximum limit is as follows:
  A + B = 0.2 mm (0.008 in)
  Nominal cylinder block height from crankshaft center:
  214.95 - 215.05 mm (8.4626 - 8.4665 in)
  Refer to SDS (EM-87).
- If necessary, replace cylinder block.


SEM843E

PISTON-TO-BORE CLEARANCE

NFEM0054S06

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

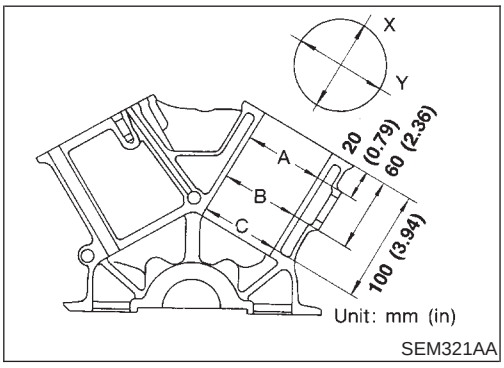
Cylinder bore inner diameter

Grade No.	Standard inner diameter	Wear limit
No. 1	95.500 - 95.510 mm (3.7598 - 3.7602 in)	0.20 mm (0.0079 in)
No. 2	95.510 - 95.520 mm (3.7602 - 3.7606 in)	
No. 3	95.520 - 95.530 mm (3.7606 - 3.7610 in)	

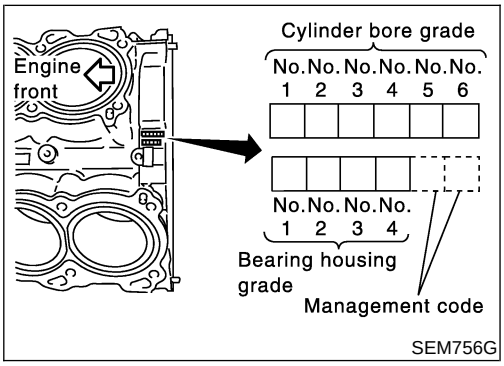
If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.

Out-of-round (X − Y):
Limit 0.015 mm (0.0006 in)
Taper (A − B − C):
Limit 0.015 mm (0.0006 in)

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

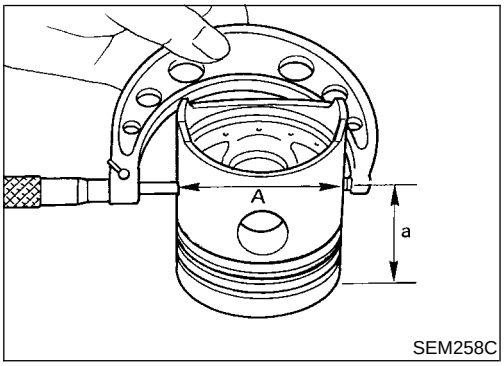


SEM321AA



SEM756G

- **If both cylinder block and piston are replaced with new ones, select piston of the same grade number punched on cylinder block rear position. These numbers are punched in either Arabic or Roman numerals.**



SEM258C

3. Measure piston skirt diameter.
Piston diameter "A": Refer to SDS (EM-88).
Measuring point "a" (Distance from the top):
41.0 mm (1.61 in)
4. Check that piston-to-bore clearance is within specification.
Piston-to-bore clearance "B":
0.010 - 0.030 mm (0.0004 - 0.0012 in)
5. Determine piston oversize according to amount of cylinder wear.
Oversize pistons are available for service.
Refer to SDS (EM-88).

- **If oversize piston is used, use oversize piston ring also.**

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

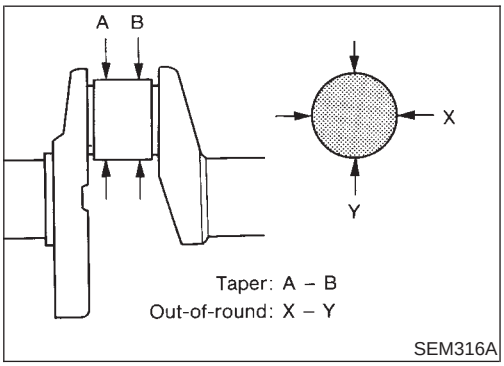
Otherwise, cylinder bores may be distorted in final assembly.

8. Cut cylinder bores.

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

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

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

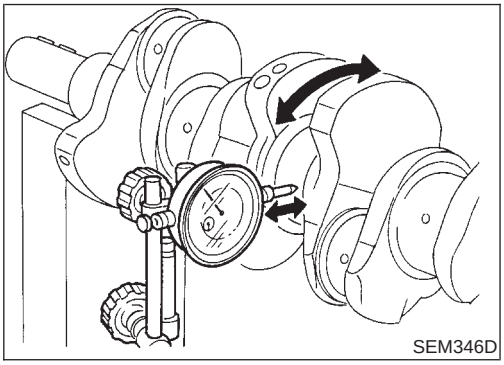


CRANKSHAFT

NFEM0054S07

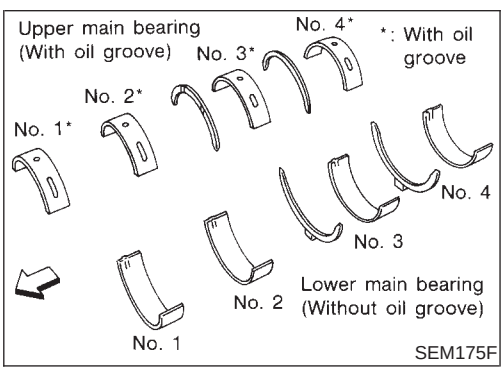
1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.

Out-of-round (X − Y):
Standard
0.002 mm (0.0001 in)
Taper (A − B):
Standard
0.002 mm (0.0001 in)



3. Measure crankshaft runout.

Runout (Total indicator reading):
Limit 0.10 mm (0.0039 in)



BEARING CLEARANCE

NFEM0054S08

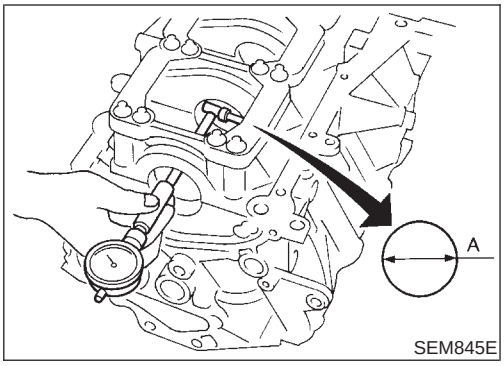
- Use either of the following two methods, however, method "A" gives more reliable results and is preferable.

Method A (Using bore gauge & micrometer)

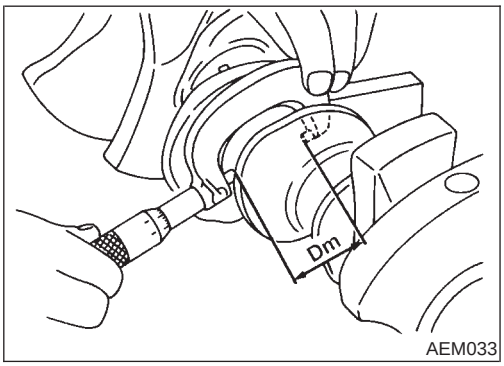
Main bearing

NFEM0054S0801

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

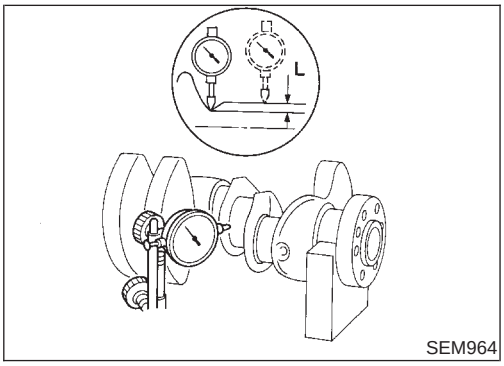


2. Install main bearing cap and bearing beam to cylinder block. **Tighten all bolts in correct order.**
3. Measure inner diameters "A" of each main bearing.

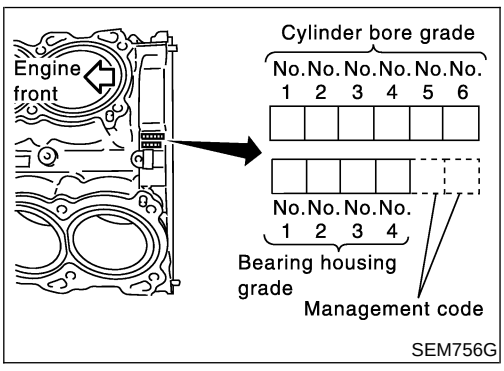


4. Measure outer diameters "Dm" of each crankshaft main journal.
5. Calculate main bearing clearance.
   Main bearing clearance = A − Dm
   Standard: 0.035 - 0.045 mm (0.0014 - 0.0018 in)
   Limit: 0.065 mm (0.0026 in)

- If it exceeds the limit, replace bearing.
- If clearance cannot be adjusted using any standard bearing grade, grind crankshaft journal and use undersized bearing.

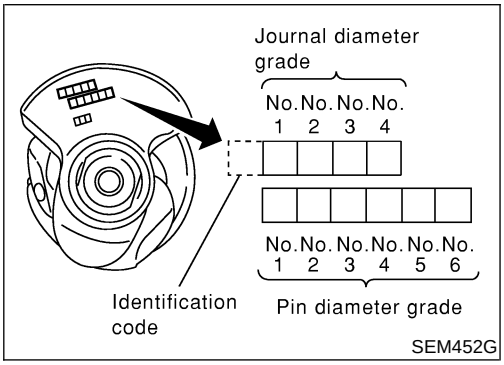


a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.
   "L": 0.1 mm (0.004 in)
b. Refer to SDS for grinding crankshaft and available service parts.



6. If crankshaft or cylinder block is replaced with a new one, select thickness of main bearings as follows:

a. Grade number of each cylinder block main journal is punched on the respective cylinder block. These numbers are punched in either Arabic or Alphabet. Refer to SDS, EM-87.
   If measured diameter is out of grade punched, decide suitable grade using table in SDS.

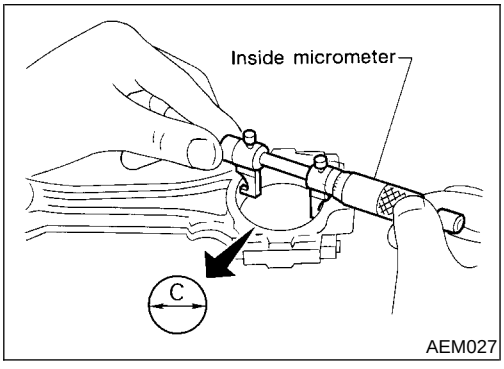


b. Grade number of each crankshaft main journal is punched on the respective crankshaft. These numbers are punched in either Arabic or Alphabet. Refer to SDS, EM-90.
   If measured diameter is out of grade punched, decide suitable grade using table in SDS.
c. Select main bearing with suitable thickness according to the following table.
   Refer to "SDS", EM-91, for available main bearings.

Main bearing selection table

Mark	Axle diameter	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	U	V	W	X	Y	4	7
	Hole diameter	63.993 - 63.994 (2.5194 - 2.5194)	63.994 - 63.995 (2.5194 - 2.5195)	63.995 - 63.996 (2.5195 - 2.5195)	63.996 - 63.997 (2.5195 - 2.5196)	63.997 - 63.998 (2.5196 - 2.5196)	63.998 - 63.999 (2.5196 - 2.5196)	63.999 - 64.000 (2.5196 - 2.5197)	64.000 - 64.001 (2.5197 - 2.5197)	64.001 - 64.002 (2.5197 - 2.5198)	64.002 - 64.003 (2.5198 - 2.5198)	64.003 - 64.004 (2.5198 - 2.5198)	64.004 - 64.005 (2.5198 - 2.5199)	64.005 - 64.006 (2.5199 - 2.5199)	64.006 - 64.007 (2.5199 - 2.5200)	64.007 - 64.008 (2.5200 - 2.5200)	64.008 - 64.009 (2.5200 - 2.5200)	64.009 - 64.010 (2.5200 - 2.5201)	64.010 - 64.011 (2.5201 - 2.5201)	64.011 - 64.012 (2.5201 - 2.5202)	64.012 - 64.013 (2.5202 - 2.5202)	64.013 - 64.014 (2.5202 - 2.5202)	64.014 - 64.015 (2.5202 - 2.5203)	64.015 - 64.016 (2.5203 - 2.5203)	64.016 - 64.017 (2.5203 - 2.5203)
A	59.975 - 59.974 (2.3612 - 2.3612)	0	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34
B	59.974 - 59.973 (2.3612 - 2.3611)	0	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4
C	59.973 - 59.972 (2.3611 - 2.3611)	0	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4
D	59.972 - 59.971 (2.3611 - 2.3611)	01	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4
E	59.971 - 59.970 (2.3611 - 2.3610)	01	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45
F	59.970 - 59.969 (2.3610 - 2.3610)	01	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45
G	59.969 - 59.968 (2.3610 - 2.3609)	1	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45
H	59.968 - 59.967 (2.3609 - 2.3609)	1	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5
J	59.967 - 59.966 (2.3609 - 2.3609)	1	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5
K	59.966 - 59.965 (2.3909 - 2.3608)	12	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5
L	59.965 - 59.964 (2.3608 - 2.3608)	12	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56
M	59.964 - 59.963 (2.3608 - 2.3607)	12	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56
N	59.963 - 59.962 (2.3607 - 2.3607)	2	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56
P	59.962 - 59.961 (2.3607 - 2.3607)	2	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6
R	59.961 - 59.960 (2.3607 - 2.3606)	2	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6
S	59.960 - 59.959 (2.3606 - 2.3606)	23	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6
T	59.959 - 59.958 (2.3606 - 2.3605)	23	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67
U	59.958 - 59.957 (2.3605 - 2.3605)	23	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67
V	59.957 - 59.956 (2.3605 - 2.3605)	3	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67
W	59.956 - 59.955 (2.3605 - 2.3604)	3	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7
X	59.955 - 59.954 (2.3604 - 2.3604)	3	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7
Y	59.954 - 59.953 (2.3604 - 2.3603)	34	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7
4	59.953 - 59.952 (2.3603 - 2.3603)	34	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7	
7	59.952 - 59.951 (2.3603 - 2.3603)	34	4	4	4	45	45	45	5	5	5	56	56	56	6	6	6	67	67	67	7	7	7		

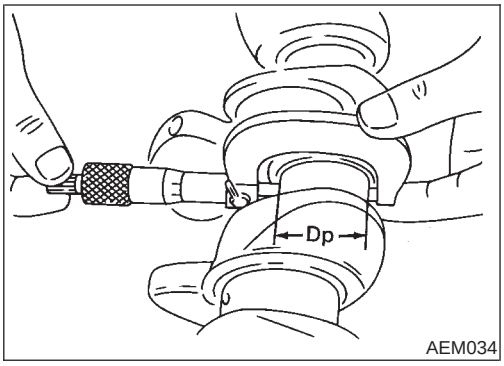
SEM845GA



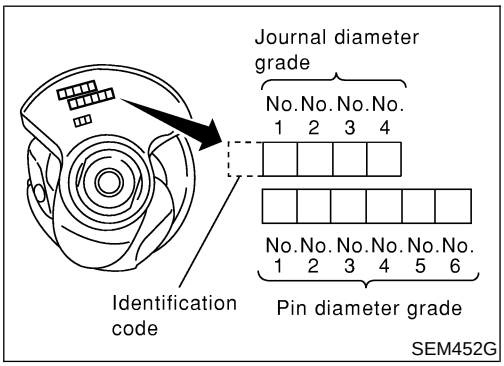
Connecting Rod Bearing (Big end)

NFEM0054S0802

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 connecting rod.

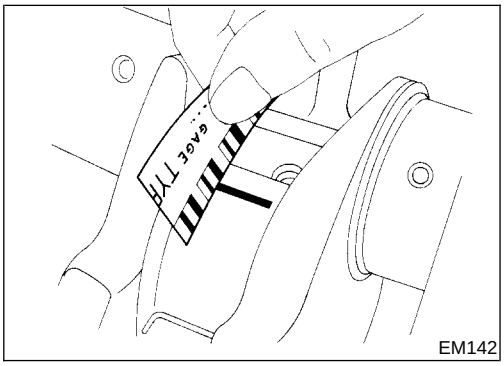


4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.
   Connecting rod bearing clearance = C − Dp
   Standard: 0.034 - 0.059 mm (0.0013 - 0.0023 in)
   Limit: 0.070 mm (0.0028 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to "BEARING CLEARANCE — Main bearing", EM-71.



8. If crankshaft is replaced with a new one, select connecting rod bearing according to the following table.
   Connecting rod bearing grade number (Identification color):
   These numbers are punched in either Arabic or Roman numerals.

Crankshaft pin journal grade number	Connecting rod bearing grade number
0	0 (Black)
1	1 (Brown)
2	2 (Green)



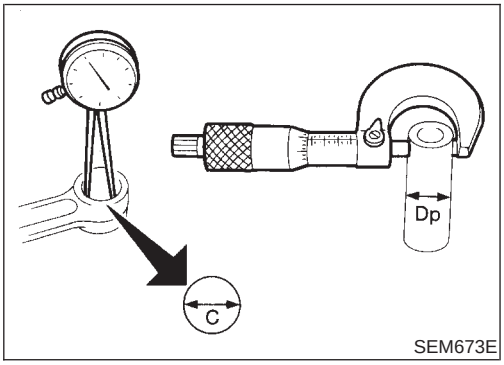
Method B (Using plastigage)

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 incorrect bearing clearance exists, use a thicker or undersized main bearing to ensure specified clearance.**

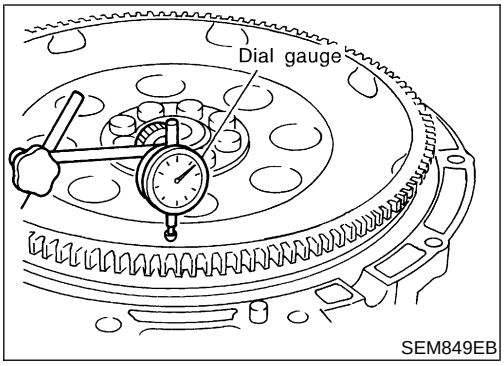
CONNECTING ROD BUSHING CLEARANCE (SMALL END)

NFEM0054S09

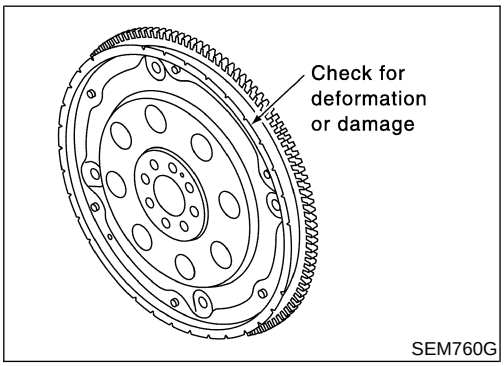


1. Measure inner diameter "C" of bushing.
2. Measure outer diameter "Dp" of piston pin.
3. Calculate connecting rod bushing clearance.
   Connecting rod bushing clearance = C − Dp
   Standard: 0.005 - 0.017 mm (0.0002 - 0.0007 in)
   Limit: 0.030 mm (0.0012 in)

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



SEM849EB



SEM760G

FLYWHEEL/DRIVE PLATE RUNOUT

NFEM0054S10

Runout (Total indicator reading):

Flywheel (M/T model)

Refer to EM-75, "Flywheel Deflection".

Drive plate (A/T model)

Less than 0.15 mm (0.0059 in)

CAUTION:

- **Do not disassemble the flywheel.**
- **Be careful not to damage the signal plate, especially the teeth.**
- **Check the drive plate and signal plate for deformation or cracks.**
- **Never place the flywheel assembly with the signal plate facing down.**
- **Keep any magnetized objects away from the signal plate.**
- **Do not allow any magnetic materials to contact the signal plate teeth.**
- **Do not resurface flywheel. Replace as necessary.**

MOVEMENT AMOUNT OF FLYWHEEL (M/T MODELS)

NFEM0054S12

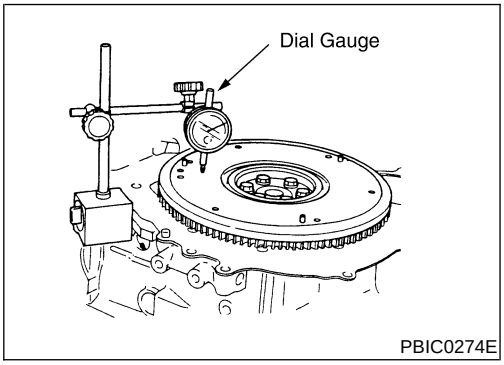
NOTE:

- Inspection for double mass flywheel only.
- Do not disassemble double mass flywheel.

Flywheel Deflection

NFEM0054S1201

- Measure deflection of flywheel contact surface to the clutch with a dial gauge.



PBIC0274E

- Measure deflection at 210 mm (8.27 in) dia.

Standard:

0.45 mm (0.0177 in) or less

Limit:

1.3 mm (0.051 in) or less

- When measured value exceeds the limit, replace it with a new one.

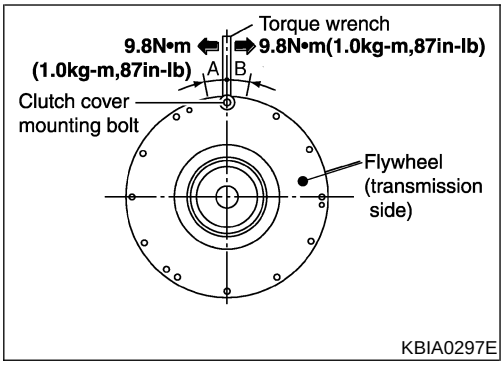
Movement Amount in Radial (rotation) Direction

NFEM0054S1202

- Check the movement amount in the following procedure.

1. Install a bolt to clutch cover mounting hole, and place a torque wrench on the extended line of the flywheel center line.

- Tighten bolt at a force of 9.8 N·m (1 kg-m, 87 in-lb) to keep it from loosening.



KBIA0297E

2. Put a mating mark on circumference of the two flywheel masses without applying any load (Measurement standard points).
3. Apply a force of 9.8 N·m (1 kg-m, 87 in-lb) in each direction, and mark the movement amount on the mass on the transmission side.
4. Measure dimensions of movement amounts A and B on circumference of the flywheel on the transmission side.

Standard: 24 mm (0.94 in) or less

- When measured value is outside the standard, replace flywheel.

Assembly

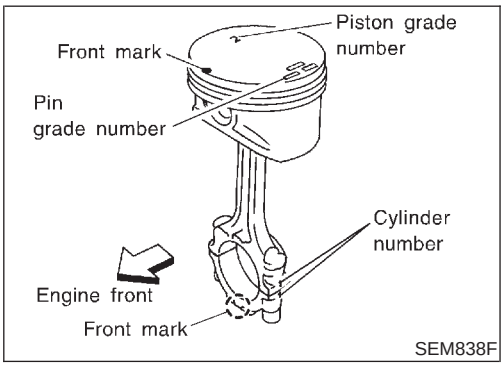
NFEM0055

PISTON

NFEM0055S01

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.**

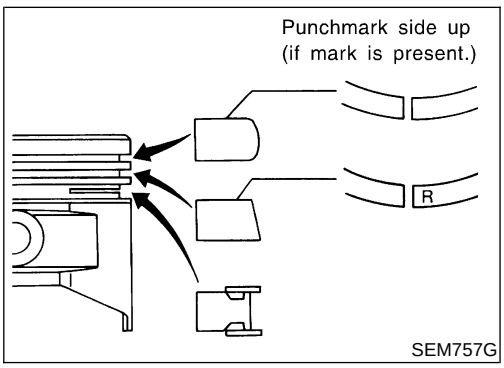


SEM838F

3. Set piston rings as shown.

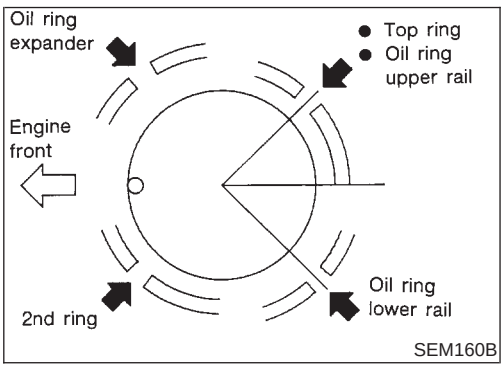
CAUTION:

- **When piston rings are not replaced, make sure that piston rings are mounted in their original positions.**
- **When replacing piston rings, those without punchmarks present can be mounted with either side up.**



SEM757G

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



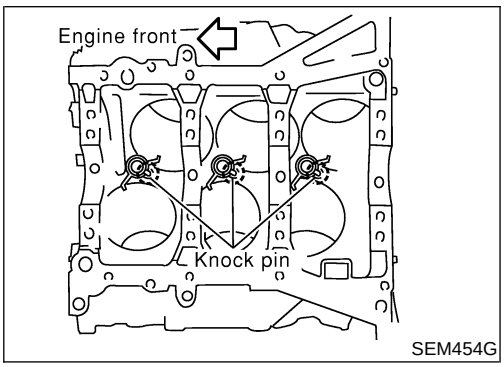
SEM160B

OIL JET

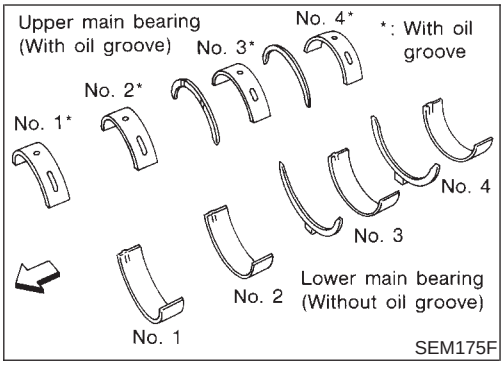
NFEM0055S02

1. Install oil jets.

- Insert oil jet knock pin into the cylinder block knock pin hole, and tighten the mounting bolts.



SEM454G

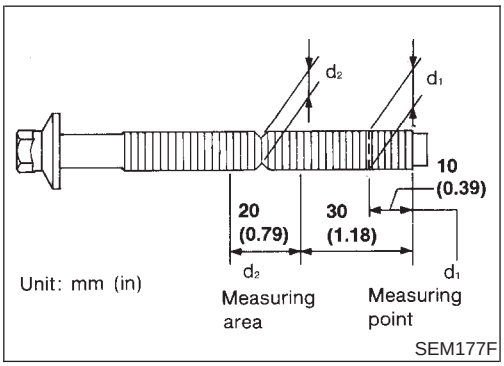


CRANKSHAFT

NFEM0055S03

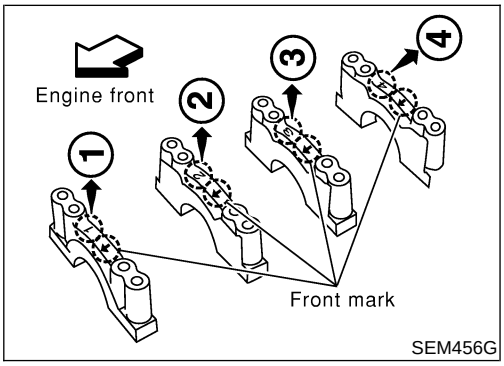
1. Set main bearings in their proper positions on cylinder block and main bearing beam.

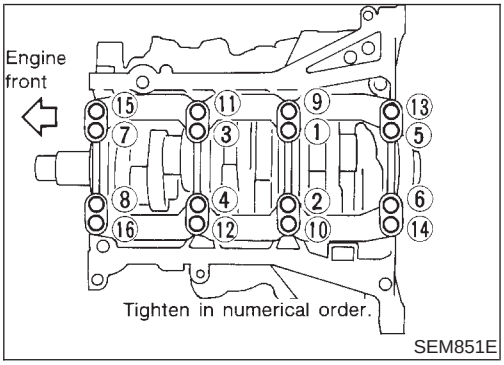
- **Confirm that correct main bearings are used. Refer to "Inspection" of this section.**



2. Instructions for re-use of main bearing cap bolts.

- **A plastic zone tightening method is used for tightening main bearing cap bolts. Measure d1 and d2 as shown in the figure.**
  d2: Select minimum diameter in the measuring area.
  If the difference between d1 and d2 exceeds the limit, replace the bolts with new ones.
  Limit (d1 - d2): 0.11 mm (0.0043 in)





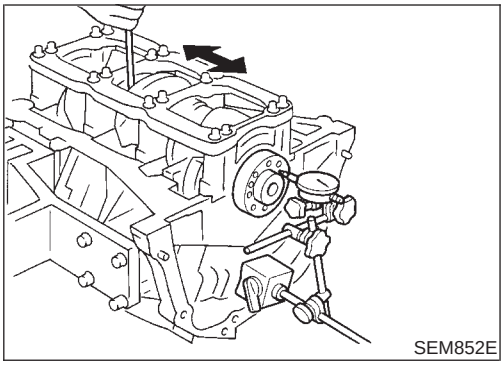
3. After installing crankshaft, main bearing cap, main bearing beam and bearing cap bolts, tighten bearing cap bolts in numerical order as shown.

- **Make sure that the front mark on the main bearing beam faces the front of the engine.**
- **Tightening procedure**

a) **Tighten all bolts to 32 to 38 N·m (3.3 to 3.9 kg-m, 24 to 28 ft-lb).**

b) **Turn all bolts 90 to 95 degrees clockwise with angle wrench.**

- **Prior to tightening bearing cap bolts, place bearing beam in its proper position by shifting crankshaft in the axial direction.**
- **After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.**
- **Lubricate threads and seat surfaces of the bolts with new engine oil.**


SEM852E

4. Measure crankshaft end play.

Crankshaft end play:

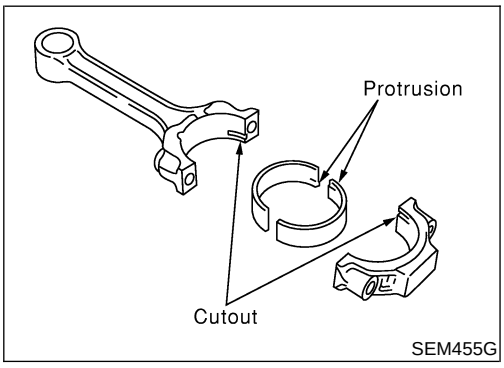
Standard

0.10 - 0.25 mm (0.0039 - 0.0098 in)

Limit

0.30 mm (0.0118 in)

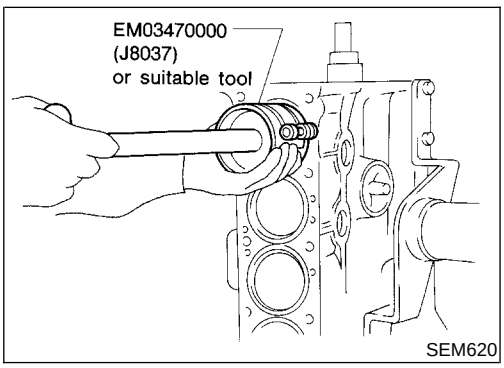
If beyond the limit, replace bearing with a new one.



SEM455G

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

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

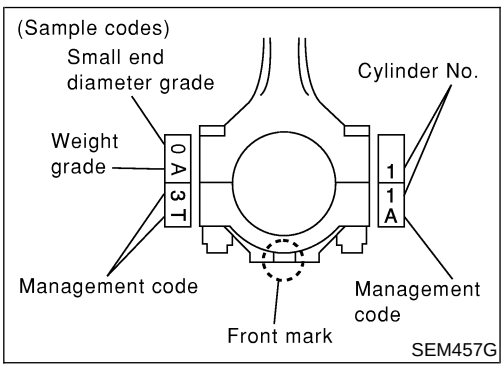


SEM620

6. Install pistons with connecting rods.

a. Install them into corresponding cylinders with Tool.

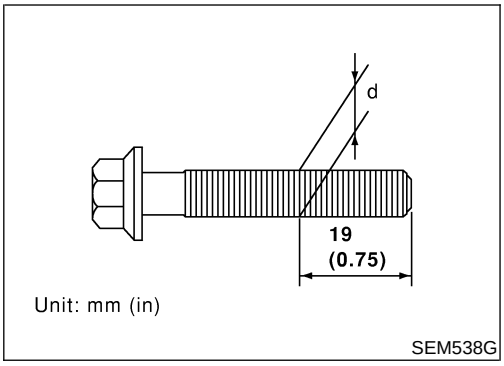
- **Be careful not to scratch cylinder wall with the connecting rod.**
- **Arrange so that front mark on piston head faces toward engine front.**



SEM457G

b. Install connecting rod caps.

- **Lubricate threads and seat surfaces with new engine oil.**
- Install so that the cylinder number stamped on the connecting rod agrees with that stamped on cap side.
- Make sure that front mark on the connecting rod cap faces the front of the engine.



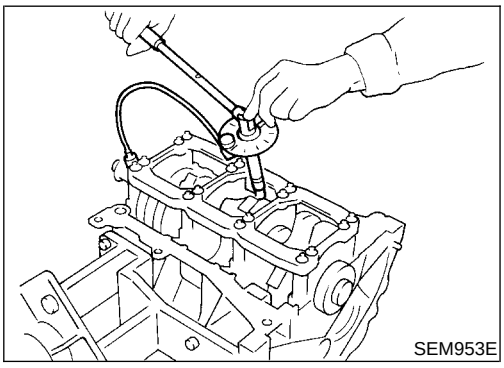
c. Re-use connecting rod cap bolts as follows.

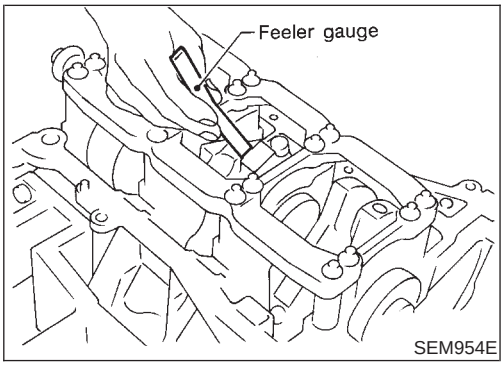
- Make sure that the bolts can be smoothly screwed-in to the end manually.
- If not, measure the outer diameter "d" shown in the figure.

Outer diameter "d" of connecting rod cap bolt:
Standard
7.90 - 8.00 mm (0.3110 - 0.3150 in)
Limit
7.75 mm (0.3051 in)

d. Tighten connecting rod cap bolts to the specified torque.

Connecting rod cap bolt:
(1) Tighten nuts to 19 to 21 N·m (1.9 to 2.1 kg-m, 14 to 15 ft-lb).
(2) Turn nuts 90 to 95 degrees clockwise with angle wrench.



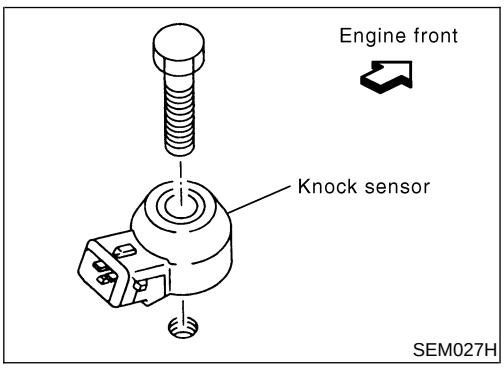


7. Measure connecting rod side clearance.

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.

8. Install rear oil seal retainer.



KNOCK SENSOR

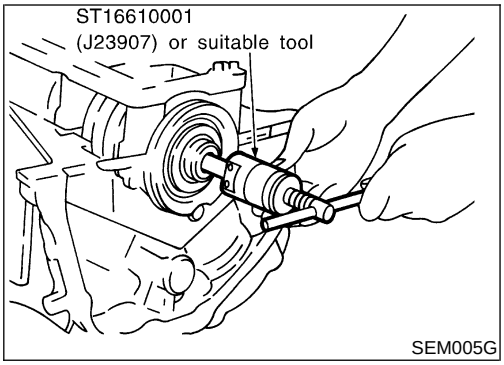
NFEM0055S09

1. Install knock sensor.

- Make sure that there is no foreign material on the cylinder block mating surface and the back surface of the knock sensor.
- Install knock sensor so that connector faces rear of engine.
- Do not tighten the mounting bolts while holding the connector.
- Make sure that the knock sensor does not interfere with other parts.

CAUTION:
If any impact by dropping is applied to the knock sensor, replace it with new one.

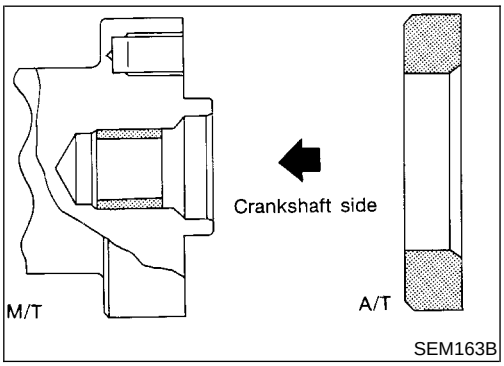
- After installing knock sensor, connect sub-harness, and lay it out to rear of engine.



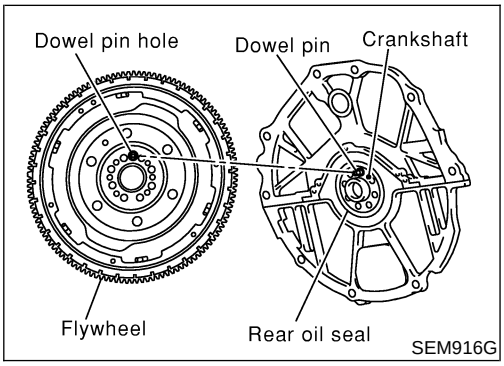
REPLACEMENT OF PILOT BUSHING (M/T) OR PILOT CONVERTER (A/T)

NFEM0055S04

1. Remove pilot converter using tool or suitable tool.



2. Install pilot bushing or pilot converter as shown.

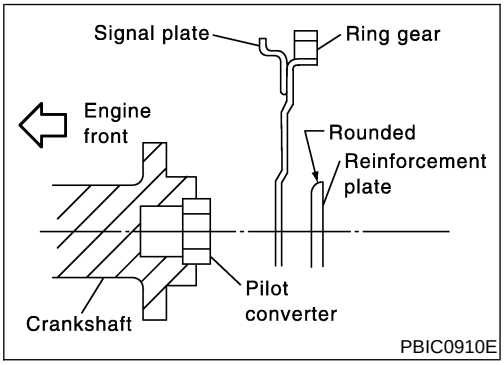


FLYWHEEL

NFEM0055S08

Install flywheel.

- When installing flywheel to crankshaft, be sure to correctly align crankshaft side dowel pin and flywheel side dowel pin hole.



DRIVE PLATE

NFEM0055S07

Install drive plate.

- Install the drive plate and reinforce plate in the direction shown in the figure.
- Align dowel pin of crankshaft rear end with pin holes of each parts.
- Secure the crankshaft using a ring gear stopper.
- Tighten the installation bolts crosswise over several times.

General Specifications

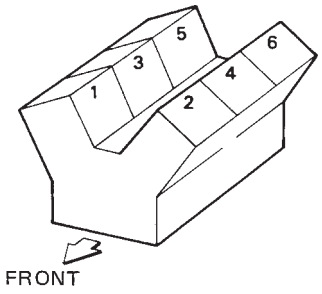
NFEM0056

Cylinder arrangement		V-6
Displacement cm^3 (cu in)		3,498 (213.45)
Bore and stroke mm (in)		95.5 x 81.4 (3.760 x 3.205)
Valve arrangement		DOHC
Firing order		1-2-3-4-5-6
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		4
Compression ratio		10.3

Compression Pressure

NFEM0057

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

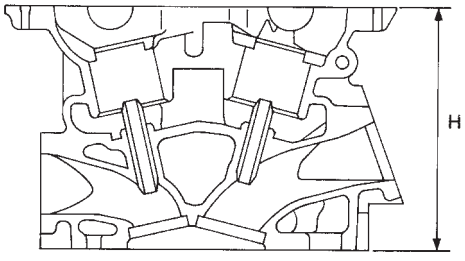
Compression pressure	Standard	1,275 (13.0, 185)
	Minimum	981 (10.0, 142)
	Differential limit between cylinders	98 (1.0, 14)
Cylinder number	 SEM713A	

Cylinder Head

NFEM0058

Unit: mm (in)

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



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

SEM949E

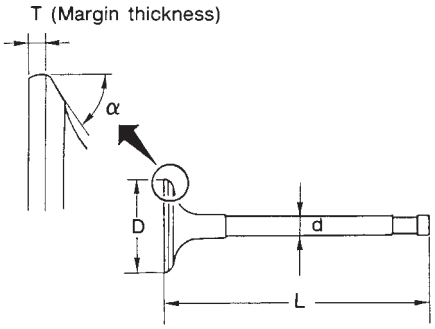
Valve

VALVE

NFEM0059

NFEM0059S01

Unit: mm (in)



SEM188

Valve head diameter “D”	Intake	37.0 - 37.3 (1.4567 - 1.4685)
	Exhaust	31.2 - 31.5 (1.228 - 1.240)
Valve length “L”	Intake	96.12 - 96.62 (3.7842 - 3.8039)
	Exhaust	93.65 - 94.15 (3.6870 - 3.7067)
Valve stem diameter “d”	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.955 - 5.970 (0.2344 - 0.2350)
Valve seat angle “α”	Intake	45°15′ - 45°45′
	Exhaust	
Valve margin “T”	Intake	1.1 (0.043)
	Exhaust	1.3 (0.051)
Valve margin “T” limit		More than 0.5 (0.020)
Valve stem end surface grinding limit		Less than 0.2 (0.008)

VALVE CLEARANCE

NFEM0059S02

Unit: mm (in)

	Cold	Hot* (reference data)
Intake	0.26 - 0.34 (0.010 - 0.013)	0.304 - 0.416 (0.012 - 0.016)
Exhaust	0.29 - 0.37 (0.011 - 0.015)	0.308 - 0.432 (0.012 - 0.017)

*: Approximately 80°C (176°F)

VALVE SPRING

NFEM0059S04

Free height mm (in)		45.62 (1.7961)
Pressure N (kg, lb) at height mm (in)	Installation	196 (20.0, 44.1) at 37.0 (1.457)
	Valve open	433 (44.2, 97.3) at 27.8 (1.094)
Out-of-square mm (in)		Less than 2.0 (0.079)

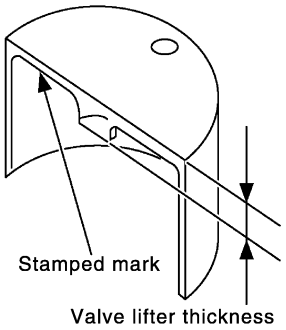
VALVE LIFTER

NFEM0059S05

Unit: mm (in)

Valve lifter outer diameter	33.977 - 33.987 (1.3377 - 1.3381)
Lifter guide inner diameter	34.000 - 34.016 (1.3386 - 1.3392)
Clearance between lifter and lifter guide	0.013 - 0.039 (0.0005 - 0.0015)

Identification mark	Thickness mm (in)
788U or 788R	7.88 (0.3102)
790U or 790R	7.90 (0.3110)
792U or 792R	7.92 (0.3118)
794U or 794R	7.94 (0.3126)
796U or 796R	7.96 (0.3134)
798U or 798R	7.98 (0.3142)
800U or 800R	8.00 (0.3150)
802U or 802R	8.02 (0.3157)
804U or 804R	8.04 (0.3165)
806U or 806R	8.06 (0.3173)
808U or 808R	8.08 (0.3181)
810U or 810R	8.10 (0.3189)
812U or 812R	8.12 (0.3197)
814U or 814R	8.14 (0.3205)
816U or 816R	8.16 (0.3213)
818U or 818R	8.18 (0.3220)
820U or 820R	8.20 (0.3228)
822U or 822R	8.22 (0.3236)
824U or 824R	8.24 (0.3244)
826U or 826R	8.26 (0.3252)
828U or 828R	8.28 (0.3260)
830U or 830R	8.30 (0.3268)
832U or 832R	8.32 (0.3276)
834U or 834R	8.34 (0.3283)
836U or 836R	8.36 (0.3291)
838U or 838R	8.38 (0.3299)
840U or 840R	8.40 (0.3307)

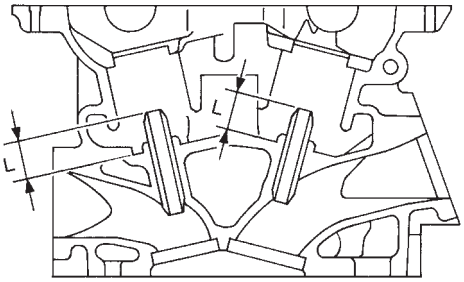


SEM758G

VALVE GUIDE

NFEM0059S06

Unit: mm (in)



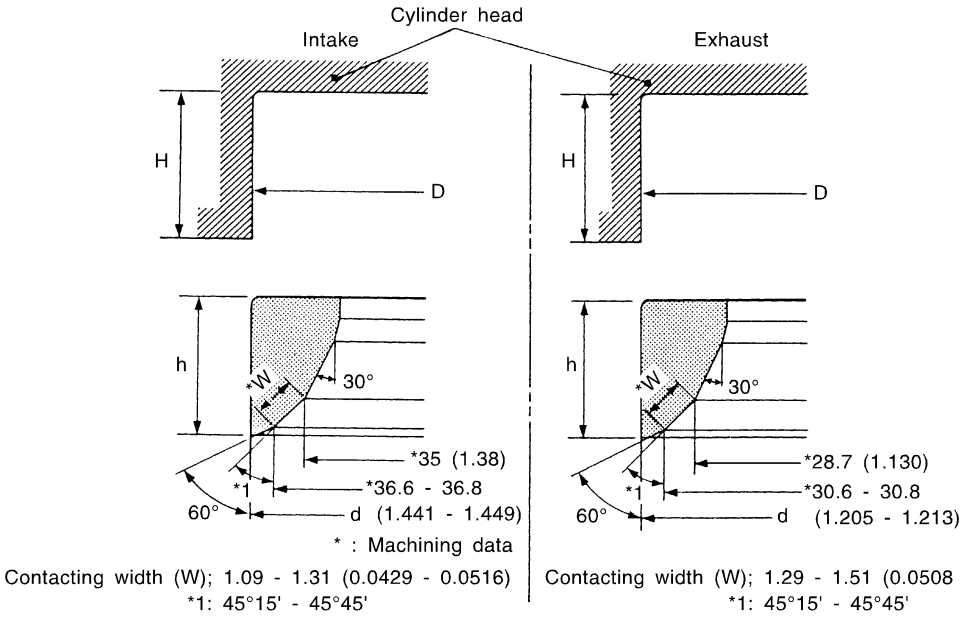
SEM950E

		Standard	Service
Valve guide	Outer diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
Valve guide	Inner diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter		9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
		Standard	Max. tolerance
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
	Exhaust	0.030 - 0.063 (0.0012 - 0.0025)	0.09 (0.0035)
Valve deflection limit	Intake	—	0.24 (0.0094)
	Exhaust	—	0.28 (0.0110)
Projection length "L"		12.6 - 12.8 (0.496 - 0.504)	

Valve Seat

NFEM0060

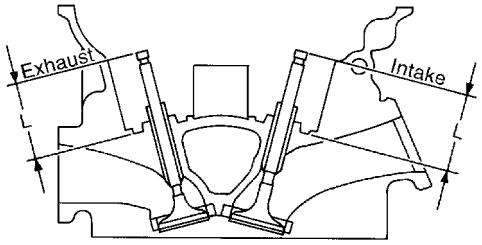
Unit: mm (in)



Contacting width (W); 1.09 - 1.31 (0.0429 - 0.0516)
*1: 45°15' - 45°45'

Contacting width (W); 1.29 - 1.51 (0.0508 - 0.0594)
*1: 45°15' - 45°45'

SEM021EC



SEM621F

		Standard	Service
Cylinder head seat recess diameter (D)	Intake	38.000 - 38.016 (1.4961 - 1.4967)	38.500 - 38.516 (1.5157 - 1.5164)
	Exhaust	32.200 - 32.216 (1.2677 - 1.2683)	32.700 - 32.716 (1.2874 - 1.2880)
Valve seat interference fit	Intake	0.081 - 0.113 (0.0032 - 0.0044)	
	Exhaust	0.064 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (d)	Intake	38.097 - 38.113 (1.4999 - 1.5005)	38.597 - 38.613 (1.5196 - 1.5202)
	Exhaust	32.280 - 32.296 (1.2709 - 1.2715)	32.780 - 32.796 (1.2905 - 1.2912)
Height (h)	Intake	5.9 - 6.0 (0.232 - 0.236)	5.05 - 5.15 (0.1988 - 0.2028)
	Exhaust	5.9 - 6.0 (0.232 - 0.236)	4.95 - 5.05 (0.1949 - 0.1988)
Depth (H)		5.9 - 6.1 (0.232 - 0.240)	
Depth (L)	Intake	41.07 - 41.67 (1.6169 - 1.6405)	
	Exhaust	41.00 - 41.60 (1.6142 - 1.6378)	

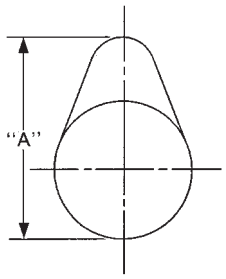
Camshaft and Camshaft Bearing

=NFEM0061

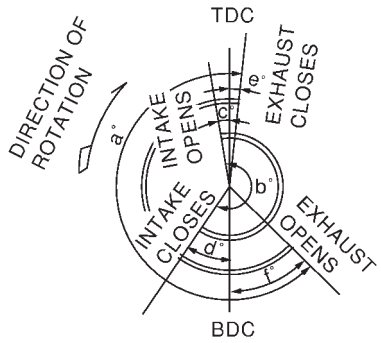
Unit: mm (in)

	Standard	Limit
Camshaft journal to bearing clearance	No. 1 0.045 - 0.086 (0.0018 - 0.0034) No. 2, 3, 4 0.035 - 0.076 (0.0014 - 0.0030)	0.15 (0.0059)
Inner diameter of camshaft bearing	No. 1 26.000 - 26.021 (1.0236 - 1.0244) No. 2, 3, 4 23.500 - 23.521 (0.9252 - 0.9260)	—
Outer diameter of camshaft journal	No. 1 25.935 - 25.955 (1.0211 - 1.0218) No. 2, 3, 4 23.445 - 23.465 (0.9230 - 0.9238)	—
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	0.115 - 0.188 (0.0045 - 0.0074)	0.24 (0.0094)

*: Total indicator reading



EM671

Cam height "A"	Intake and exhaust	44.865 - 45.055 (1.7663 - 1.7738)
Wear limit of cam height		0.2 (0.008)
Valve timing		

PBIC0187E

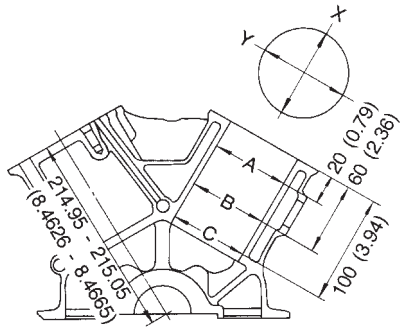
Unit: degree

		a	b	c	d	e	f
Intake valve timing control	OFF	240	238	−6	64	8	52

Cylinder Block

NFEM0062

Unit: mm (in)



SEM022EA

Surface flatness	Standard			Less than 0.03 (0.0012)
	Limit			0.10 (0.0039)
Cylinder bore	Inner diameter	Standard	Grade No. 1	95.500 - 95.510 (3.7598 - 3.7602)
			Grade No. 2	95.510 - 95.520 (3.7602 - 3.7606)
			Grade No. 3	95.520 - 95.530 (3.7606 - 3.7610)
		Wear limit		0.20 (0.0079)
Out-of-round (X − Y)				Less than 0.015 (0.0006)
Taper (A − B − C)				Less than 0.015 (0.0006)
Main journal inner diameter grade (Without bearing)	Grade No. A			63.993 - 63.994 (2.5194 - 2.5194)
	Grade No. B			63.994 - 63.995 (2.5194 - 2.5195)
	Grade No. C			63.995 - 63.996 (2.5195 - 2.5195)
	Grade No. D			63.996 - 63.997 (2.5195 - 2.5196)
	Grade No. E			63.997 - 63.998 (2.5196 - 2.5196)
	Grade No. F			63.998 - 63.999 (2.5196 - 2.5196)
	Grade No. G			63.999 - 64.000 (2.5196 - 2.5197)
	Grade No. H			64.000 - 64.001 (2.5197 - 2.5197)
	Grade No. J			64.001 - 64.002 (2.5197 - 2.5198)
	Grade No. K			64.002 - 64.003 (2.5198 - 2.5198)
	Grade No. L			64.003 - 64.004 (2.5198 - 2.5198)
	Grade No. M			64.004 - 64.005 (2.5198 - 2.5199)
	Grade No. N			64.005 - 64.006 (2.5199 - 2.5199)
	Grade No. P			64.006 - 64.007 (2.5199 - 2.5200)
	Grade No. R			64.007 - 64.008 (2.5200 - 2.5200)
	Grade No. S			64.008 - 64.009 (2.5200 - 2.5200)
	Grade No. T			64.009 - 64.010 (2.5200 - 2.5201)
	Grade No. U			64.010 - 64.011 (2.5201 - 2.5201)
	Grade No. V			64.011 - 64.012 (2.5201 - 2.5202)
	Grade No. W			64.012 - 64.013 (2.5202 - 2.5202)
	Grade No. X			64.013 - 64.014 (2.5202 - 2.5202)
	Grade No. Y			64.014 - 64.015 (2.5202 - 2.5203)
	Grade No. 4			64.015 - 64.016 (2.5203 - 2.5203)
	Grade No. 7			64.016 - 64.017 (2.5203 - 2.5203)
Difference in inner diameter between cylinders	Standard			Less than 0.03 (0.0012)

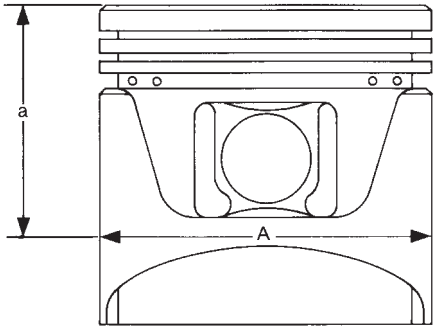
Piston, Piston Ring and Piston Pin

NFEM0063

AVAILABLE PISTON

NFEM0063S01

Unit: mm (in)



SEM882E

Piston skirt diameter “A”	Standard	Grade No. 1	95.480 - 95.490 (3.7590 - 3.7594)
		Grade No. 2	95.490 - 95.500 (3.7594 - 3.7598)
		Grade No. 3	95.500 - 95.510 (3.7598 - 3.7602)
		0.20 (0.0079) oversize (Service)	95.680 - 95.710 (3.7669 - 3.7681)
“a” dimension			41.0 (1.614)
Piston pin hole diameter		Grade No. 0	21.993 - 21.999 (0.8659 - 0.8661)
		Grade No. 1	21.999 - 22.005 (0.8661 - 0.8663)
Piston clearance to cylinder block			0.010 - 0.030 (0.0004 - 0.0012)

PISTON RING

=NFEM0063S02
Unit: mm (in)

		Standard	Limit
Side clearance	Top	0.045 - 0.080 (0.0018 - 0.0031)	0.11 (0.0043)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.1 (0.004)
	Oil ring	0.065 - 0.135 (0.0026 - 0.0053)	—
End gap	Top	0.23 - 0.33 (0.0091 - 0.0130)	0.54 (0.0213)
	2nd	0.33 - 0.48 (0.0130 - 0.0189)	0.80 (0.0315)
	Oil (rail ring)	0.20 - 0.50 (0.0079 - 0.0197)	0.95 (0.0374)

PISTON PIN

NFEM0063S03
Unit: mm (in)

Piston pin outer diameter	Grade No. 0	21.989 - 21.995 (0.8657 - 0.8659)
	Grade No. 1	21.995 - 22.001 (0.8659 - 0.8662)
Interference fit of piston pin to piston		0.002 - 0.006 (0.0001 - 0.0002)
Piston pin to connecting rod bushing clearance	Standard	0.005 - 0.017 (0.0002 - 0.0007)
	Limit	0.030 (0.0012)

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

Connecting Rod

NFEM0064
Unit: mm (in)

Center distance		144.15 - 144.25 (5.6752 - 5.6791)
Bend [per 100 (3.94)]	Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	Limit	0.30 (0.0118)
Connecting rod small end inner diameter		23.980 - 24.000 (0.9441 - 0.9449)
Piston pin bushing inner diameter*	Grade No. 0	22.000 - 22.006 (0.8661 - 0.8664)
	Grade No. 1	22.006 - 22.012 (0.8664 - 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)

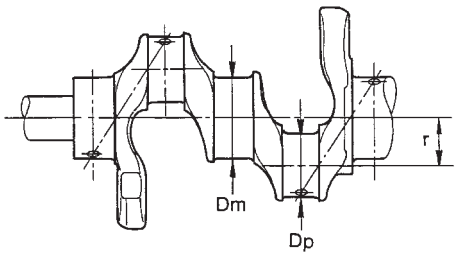
*: After installing in connecting rod

Crankshaft

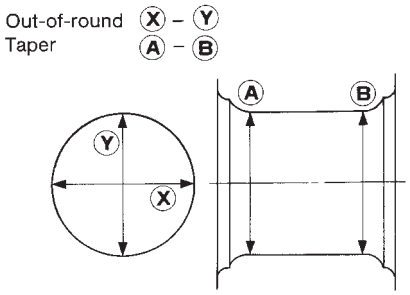
NFEM0065

Unit: mm (in)

Main journal dia. “Dm” grade	Grade No. A	59.975 - 59.974 (2.3612 - 2.3612)
	Grade No. B	59.974 - 59.973 (2.3612 - 2.3611)
	Grade No. C	59.973 - 59.972 (2.3611 - 2.3611)
	Grade No. D	59.972 - 59.971 (2.3611 - 2.3611)
	Grade No. E	59.971 - 59.970 (2.3611 - 2.3610)
	Grade No. F	59.970 - 59.969 (2.3610 - 2.3610)
	Grade No. G	59.969 - 59.968 (2.3610 - 2.3609)
	Grade No. H	59.968 - 59.967 (2.3609 - 2.3609)
	Grade No. J	59.967 - 59.966 (2.3609 - 2.3609)
	Grade No. K	59.966 - 59.965 (2.3609 - 2.3608)
	Grade No. L	59.965 - 59.964 (2.3608 - 2.3608)
	Grade No. M	59.964 - 59.963 (2.3608 - 2.3607)
	Grade No. N	59.963 - 59.962 (2.3607 - 2.3607)
	Grade No. P	59.962 - 59.961 (2.3607 - 2.3607)
	Grade No. R	59.961 - 59.960 (2.3607 - 2.3606)
	Grade No. S	59.960 - 59.959 (2.3606 - 2.3606)
	Grade No. T	59.959 - 59.958 (2.3606 - 2.3605)
	Grade No. U	59.958 - 59.957 (2.3605 - 2.3605)
	Grade No. V	59.957 - 59.956 (2.3605 - 2.3605)
	Grade No. W	59.956 - 59.955 (2.3605 - 2.3604)
	Grade No. X	59.955 - 59.954 (2.3604 - 2.3604)
	Grade No. Y	59.954 - 59.953 (2.3604 - 2.3603)
	Grade No. 4	59.953 - 59.952 (2.3603 - 2.3603)
	Grade No. 7	59.952 - 59.951 (2.3603 - 2.3603)
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 (2.0445 - 2.0457)
Center distance “r”		40.36 - 40.44 (1.5890 - 1.5921)
Out-of-round (X − Y)	Standard	Less than 0.002 (0.0001)
Taper (A − B)	Standard	Less than 0.002 (0.0001)
Runout [TIR*]	Limit	Less than 0.10 (0.0039)
Free end play	Standard	0.10 - 0.25 (0.0039 - 0.0098)
	Limit	0.30 (0.0118)



SEM645

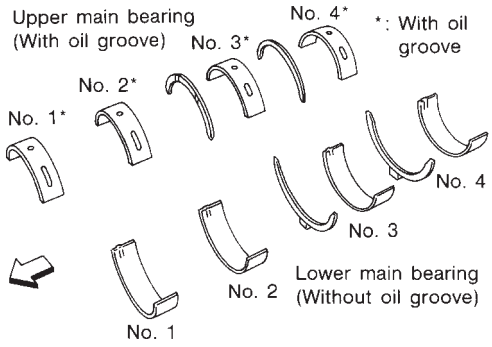


EM715

*: Total indicator reading

Available Main Bearing

NFEM0066



SEM175F

Grade number		Thickness "T" mm (in)	Width "W" mm (in)	Identification color (UPR/LWR)	Remarks
0		2.000 - 2.003 (0.0787 - 0.0789)	19.9 - 20.1 (0.783 - 0.791)	Black	Grade is the same for upper and lower bearings.
1		2.003 - 2.006 (0.0789 - 0.0790)		Brown	
2		2.006 - 2.009 (0.0790 - 0.0791)		Green	
3		2.009 - 2.012 (0.0791 - 0.0792)		Yellow	
4		2.012 - 2.015 (0.0792 - 0.0793)		Blue	
5		2.015 - 2.018 (0.0793 - 0.0794)		Pink	
6		2.018 - 2.021 (0.0794 - 0.0796)		Purple	
7		2.021 - 2.024 (0.0796 - 0.0797)		White	
01	UPP	2.003 - 2.006 (0.0789 - 0.0790)		Brown/Black	Grade is different for upper and lower bearings.
	LWR	2.000 - 2.003 (0.0787 - 0.0789)			
12	UPR	2.006 - 2.009 (0.0790 - 0.0791)		Green/Brown	
	LWR	2.003 - 2.006 (0.0789 - 0.0790)			
23	UPR	2.009 - 2.012 (0.0791 - 0.0792)		Yellow/Green	
	LWR	2.006 - 2.009 (0.0790 - 0.0791)			
34	UPR	2.012 - 2.015 (0.0792 - 0.0793)		Blue/Yellow	
	LWR	2.009 - 2.012 (0.0791 - 0.0792)			
45	UPR	2.015 - 2.018 (0.0793 - 0.0794)		Pink/Blue	
	LWR	2.012 - 2.015 (0.0792 - 0.0793)			
56	UPR	2.018 - 2.021 (0.0794 - 0.0796)		Purple/Pink	
	LWR	2.015 - 2.018 (0.0793 - 0.0794)			
67	UPR	2.021 - 2.024 (0.0796 - 0.0797)		White/Purple	
	LWR	2.018 - 2.021 (0.0794 - 0.0796)			

UNDERSIZE

NFEM0066S01

Unit: mm (in)

	Thickness	Main journal diameter "Dm"
0.25 (0.0098)	2.132 - 2.140 (0.0839 - 0.0843)	Grind so that bearing clearance is the specified value.

Available Connecting Rod Bearing

NFEM0067

CONNECTING ROD BEARING

NFEM0067S01

Grade number	Thickness "T" mm (in)	Identification color (mark)
0	1.500 - 1.503 (0.0591 - 0.0592)	Black
1	1.503 - 1.506 (0.0592 - 0.0593)	Brown
2	1.506 - 1.509 (0.0593 - 0.0594)	Green

UNDERSIZE

NFEM0067S02

Unit: mm (in)

	Thickness	Crank pin journal diameter "Dp"
0.25 (0.0098)	1.626 - 1.634 (0.0640 - 0.0643)	Grind so that bearing clearance is the specified value.

Miscellaneous Components

NFEM0068

Unit: mm (in)

Flywheel deflection [TIR]*	Standard	Less than 0.45 (0.0177)
	Limit	1.3 (0.051)
Drive plate runout [TIR]*		Less than 0.15 (0.0059)
Flywheel movement in radial (rotation) direction		Less than 24 (0.94)

*: Total indicator reading

BEARING CLEARANCE

NFEM0068S01

Unit: mm (in)

Main bearing clearance	Standard	0.035 - 0.045 (0.0014 - 0.0018)
	Limit	0.065 (0.0026)
Connecting rod bearing clearance	Standard	0.034 - 0.059 (0.0013 - 0.0023)
	Limit	0.070 (0.0028)