ENGINE MECHANICAL

SECTION EM

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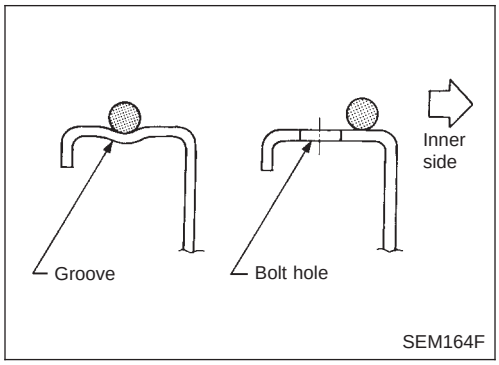
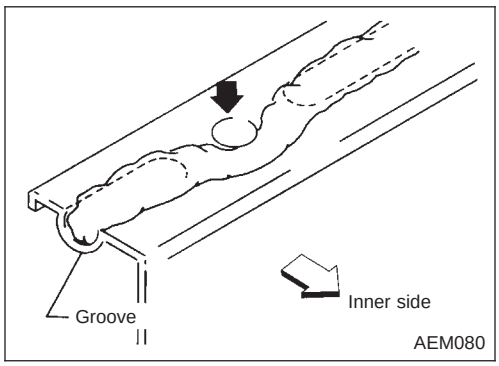
Parts Requiring Angular Tightening

- Some important engine parts are tightened using an angular-tightening method rather than a torque setting method.
- If these parts are tightened using a torque setting method, dispersal of the tightening force (axial bolt force) will be two or three times that of the dispersal produced by using the correct angular-tightening method.
- Although the torque setting values (described in this manual) are equivalent to those used when bolts and nuts are tightened with an angular-tightening method, they should be used for reference only.
- To assure the satisfactory maintenance of the engine, bolts and nuts must be tightened using an angular-tightening method.
- Before tightening the bolts and nuts, ensure that the thread and seating surfaces are clean and then coated with engine oil.
- The bolts and nuts which require the angular-tightening method are as follows:
  (1) Cylinder head bolts ..... SR, CD, QG
  (2) Main bearing cap bolts ..... SR
  (3) Connecting rod cap nuts ..... SR, QG





Liquid Gasket Application Procedure

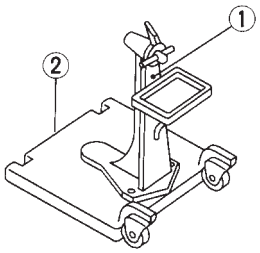
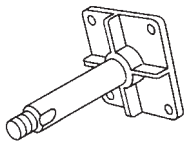
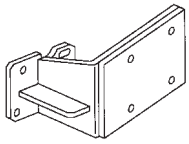
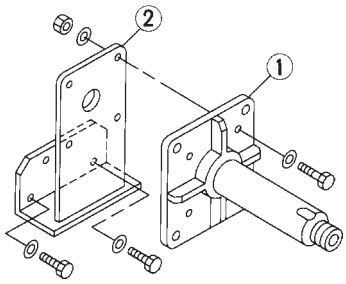
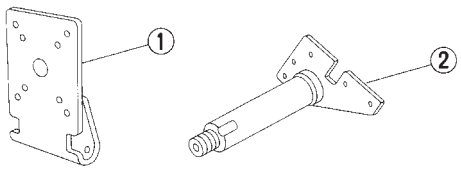
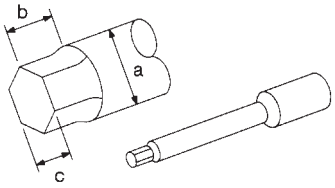
a. Before applying liquid gasket, use a scraper to remove all traces of old liquid gasket from mating surface and groove, and then completely clean any oil stains from these areas.

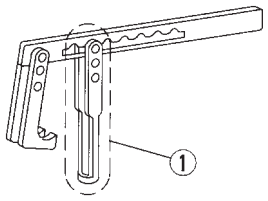
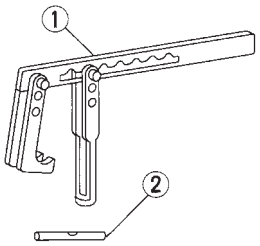
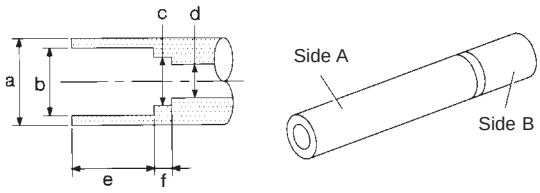
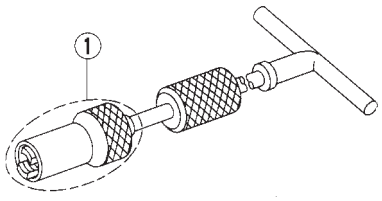
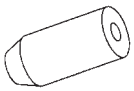
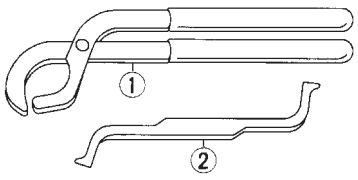
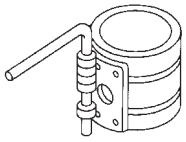
b. Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Liquid Gasket or equivalent.)
- **Be sure liquid gasket is 4.0 to 5.0 mm (0.157 to 0.197 in) wide for SR engine and 3.5 to 4.5 mm (0.138 to 0.177 in) wide for QG and CD engine (for oil pan).**
- **Be sure liquid gasket is 2.0 to 3.0 mm (0.079 to 0.118 in) wide (in areas except oil pan).**

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

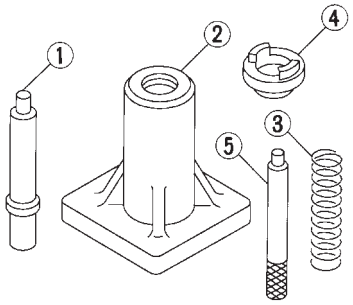
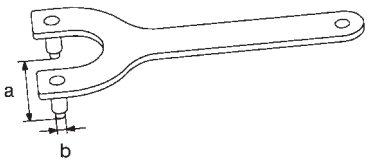
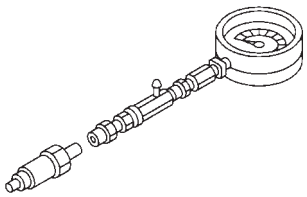
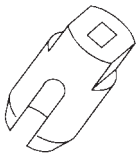
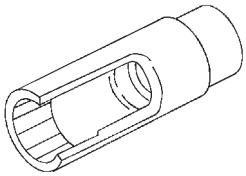
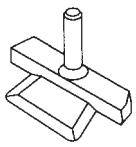
d. Wait at least 30 minutes before refilling with engine oil and engine coolant.

Special Service Tools

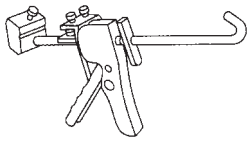
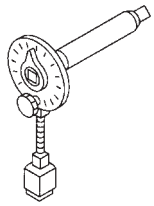
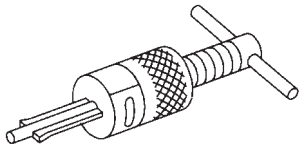
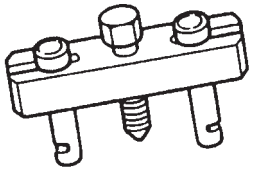
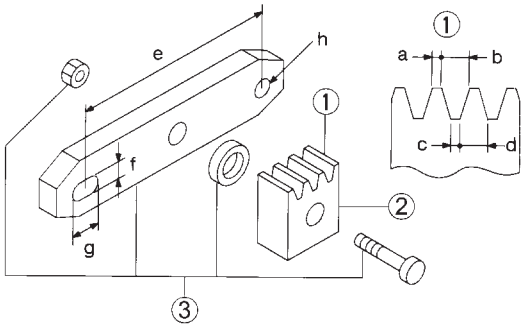
Tool number Tool name	Description		Engine application		
			SR	CD	QG
ST0501S000 Engine stand assembly ① ST05011000 Engine stand ② ST05012000 Base	 NT042	When overhauling engine	X	X	X
KV10106500 Engine stand shaft	 NT028	When overhauling engine	X	—	X
KV10115300 Engine sub-attachment	 NT008	When overhauling engine	X	—	—
Engine attachment assembly ① KV10106500 Engine attachment ② KV10113300 Sub-attachment	 NT029	When overhauling engine	—	—	X
① KV10108101 Engine attachment ② KV10102500 Engine stand shaft	 NT366	When overhauling engine	—	X	—
ST10120000 Cylinder head bolt wrench	 NT583	Loosening and tightening cylinder head bolt **a: 13 (0.51) dia.** **b: 12 (0.47)** **c: 10 (0.39)** Unit: mm (in)	X	—	X

Tool number Tool name	Description		Engine application		
			SR	CD	QG
KV10116200 Valve spring compressor ① KV10115900 Attachment	 NT022	Disassembling and assembling valve mechanism	X	—	X
KV101092S0 Valve spring compressor ① KV10109210 Compressor ② KV10109220 Adapter	 NT021	Disassembling and assembling valve mechanism	—	X	—
KV10115600 Valve oil seal drift	 NT603	Installing valve oil seal **Side A** **Side B** **a: 20 (0.79)** **20 (0.79)** **b: 13 (0.51)** **14.2 (0.559)** **c: 10.3 (0.406)** **11 (0.43)** **d: 8 (0.31)** **8 (0.31)** **e: 10.7 (0.421)** **10.7 (0.421)** **f: 5 (0.20)** **5 (0.20)** Unit: mm (in)	X (Side B)	—	X (Side A)
KV10107902 Valve oil seal puller ① KV10116100 Valve oil seal puller adapter	 NT605	Removing valve oil seal	X	X	X
KV10115700 Dial gauge stand	 NT012	Adjusting shims	—	—	X
KV101151S0 Lifter stopper set ① KV10115110 Camshaft pliers ② KV10115120 Lifter stopper	 NT041	Changing shims	—	X	X
EM03470000 Piston ring compressor	 NT044	Installing piston assembly into cylinder bore	X	X	X

Special Service Tools (Cont'd)

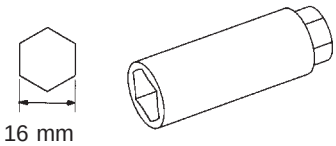
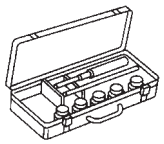
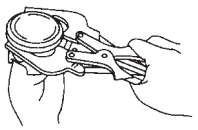
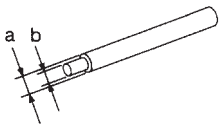
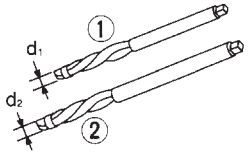
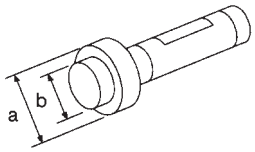
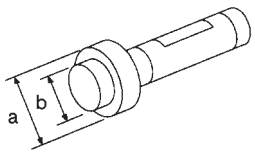
Tool number Tool name	Description		Engine application		
			SR	CD	QG
KV10107400 Piston pin press stand ① KV10107310 Center shaft ② ST13040020 Stand ③ ST13040030 Spring ④ KV10107320 Cap ⑤ ST13040050 Drift	 NT013	Disassembling and assembling piston pin	X	—	X
KV10109300* Pulley holder	 NT628	Removing and installing camshaft sprocket **a: 68 mm (2.68 in)** **b: 8 mm (0.31 in) dia.**	—	X	—
ED19600000* Compression gauge set	 NT626	Measuring compression pressure	—	X	—
KV11100300 Nozzle holder socket No. 2-4 injection nozzle holder socket	 NT563	Loosening and tightening injector nozzle	—	X	—
KV119E0030 No. 1 injection nozzle holder socket	 NT648	Loosening and tightening injector nozzle	—	X	—
KV10111100 Seal cutter	 NT046	Removing oil pan	X	X	X

*: Special tool or commercial equivalent

Tool number Tool name	Description		Engine application		
			SR	CD	QG
WS39930000 Tube presser	 NT052	Pressing the tube of liquid gasket	X	X	X
KV10112100 Angle wrench	 NT014	Tightening bolts for bearing cap, cylinder head, etc.	X	X	X
ST16610001* Pilot bushing puller	 NT045	Removing pilot bushing	X	X	—
KV11102900* Pulley puller	 NT647	Removing injection pump pulley	—	X	—
KV101056S0* Ring gear stopper ① KV10105630 Adapter ② KV10105620 Adapter ③ KV10105610 Plate assembly	 NT617	Preventing crankshaft from rotating **a: 3 (0.12)** **b: 6.4 (0.252)** **c: 2.8 (0.110)** **d: 6.6 (0.260)** **e: 107 (4.21)** **f: 14 (0.55)** **g: 20 (0.79)** **h: 14 (0.55) dia.** Unit: mm (in)	—	X	X

*: Special tool or commercial equivalent

Commercial Service Tools

Tool name	Description		Engine application		
			SR	CD	QG
Spark plug wrench	 NT047	Removing and installing spark plug	X	—	X
Valve seat cutter set	 NT048	Finishing valve seat dimensions	X	X	X
Piston ring expander	 NT030	Removing and installing piston ring	X	X	X
Valve guide drift	 NT015	Removing and installing valve guide **SR Intake & Exhaust** **a = 9.5 mm (0.374 in) dia.** **b = 5.0 mm (0.197 in) dia.** **QG Intake & Exhaust** **a = 9.5 mm (0.374 in) dia.** **b = 5.5 mm (0.217 in) dia.**	X	—	X
Valve guide reamer		Reaming valve guide ① or hole for oversize valve guide ② **SR Intake & Exhaust** **d_1 = 6.0 mm (0.236 in) dia.** **d_2 = 10.175 mm (0.4006 in) dia.** **QG Intake & Exhaust** **d_1 = 5.5 mm (0.217 in) dia.** **d_2 = 9.685 mm (0.3813 in) dia.**	X	—	X
Front oil seal drift	NT016  NT049	Installing front oil seal **a = 75 mm (2.95 in) dia.** **b = 45 mm (1.77 in) dia.**	X	—	X
Rear oil seal drift	 NT049	Installing rear oil seal **a = 110 mm (4.33 in) dia.** **b = 80 mm (3.15 in) dia.**	X	—	X

NVH Troubleshooting — Engine Noise

NCEM0005S01

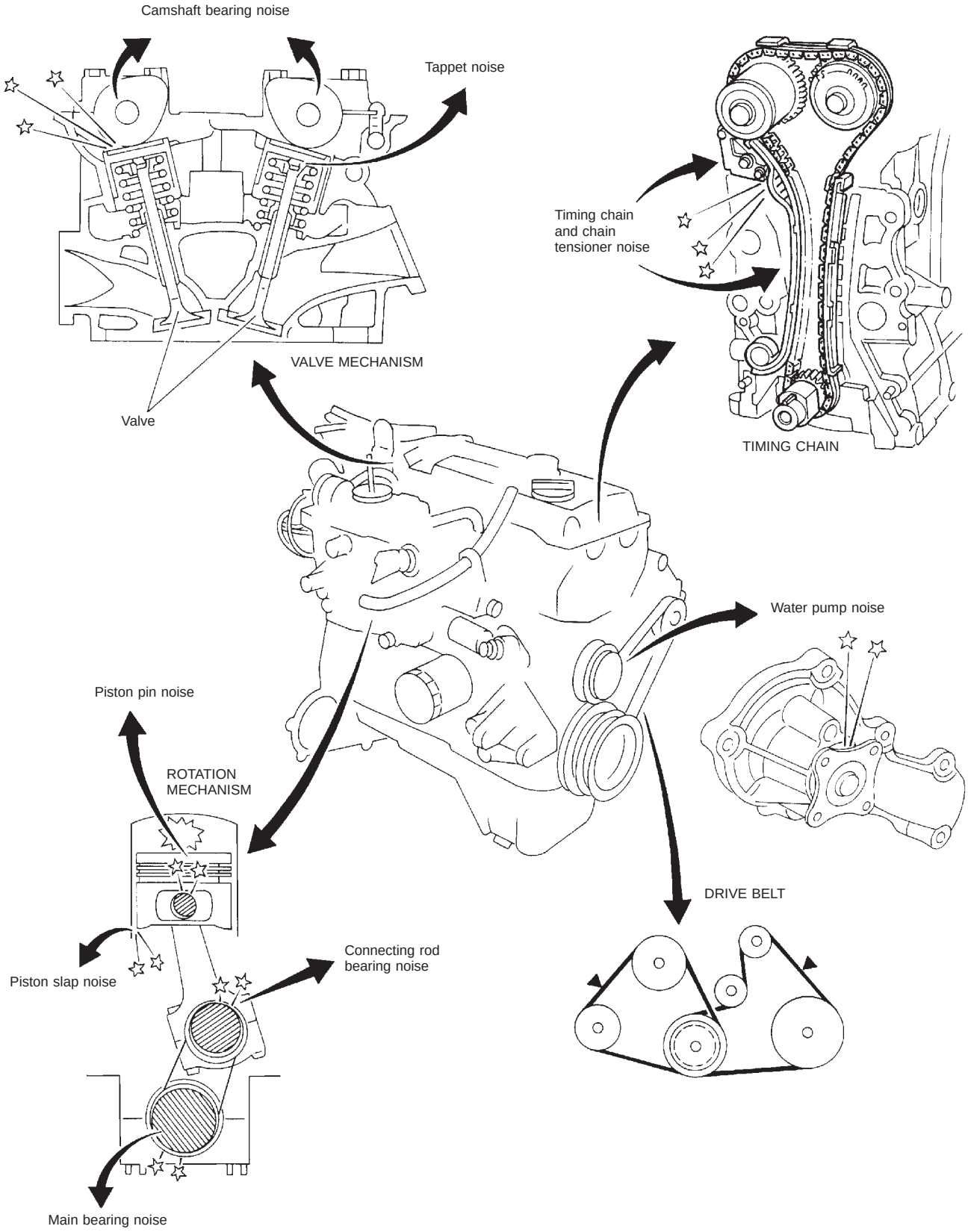
Use the chart below to help you find the cause of the symptom.

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 click	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-40
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-35
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-54, 59
	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-54, 55, 56
	Knock	A	B	C	B	B	B	Connecting rod-bearing noise	Connecting rod bearing clearance (Big end) Connecting rod bushing clearance (Small end)	EM-58, 59
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-57
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-24
Front of Engine	Squeak or fizzing	A	B	—	B	—	C	Other drive belts (sticking or slipping)	Drive belts deflection	MA Section (“Checking Drive Belts”, “Engine Maintenance”)
	Creaking	A	B	A	B	A	B	Other drive belts (slipping)	Idler pulley bearing operation	
	Squall or creak	A	B	—	B	A	B	Water pump noise	Water pump operation	LC Section (“Water Pump Inspection”, “Engine Cooling System”)

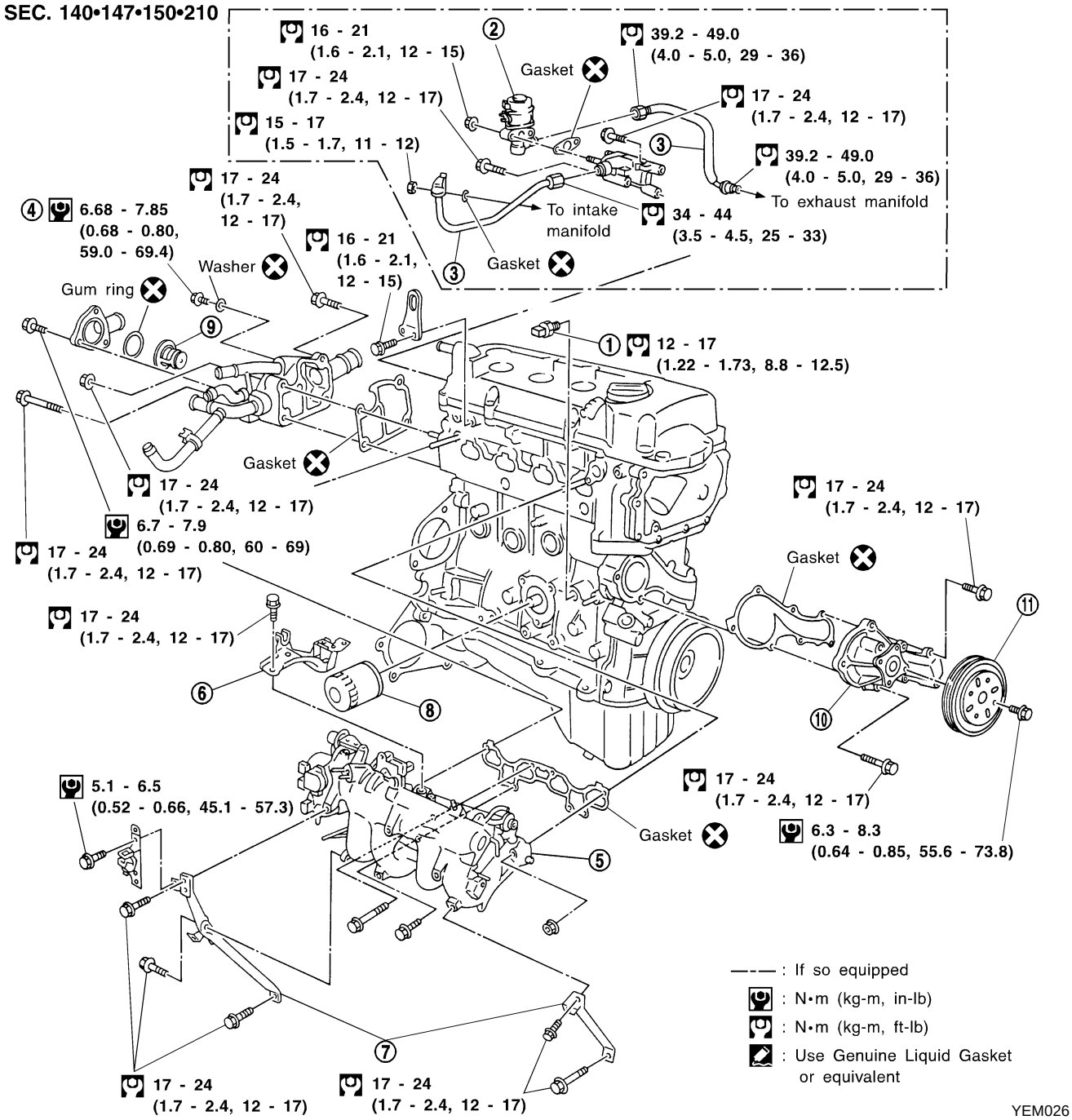
A: Closely related B: Related C: Sometimes related —: Not related


Camshaft bearing noise
Tappet noise
VALVE MECHANISM
Valve
Timing chain
and chain
tensioner noise
TIMING CHAIN
Water pump noise
Piston pin noise
ROTATION
MECHANISM
DRIVE BELT
Piston slap noise
Connecting rod
bearing noise
Main bearing noise
SEM937F

Removal and Installation

NCEM0006

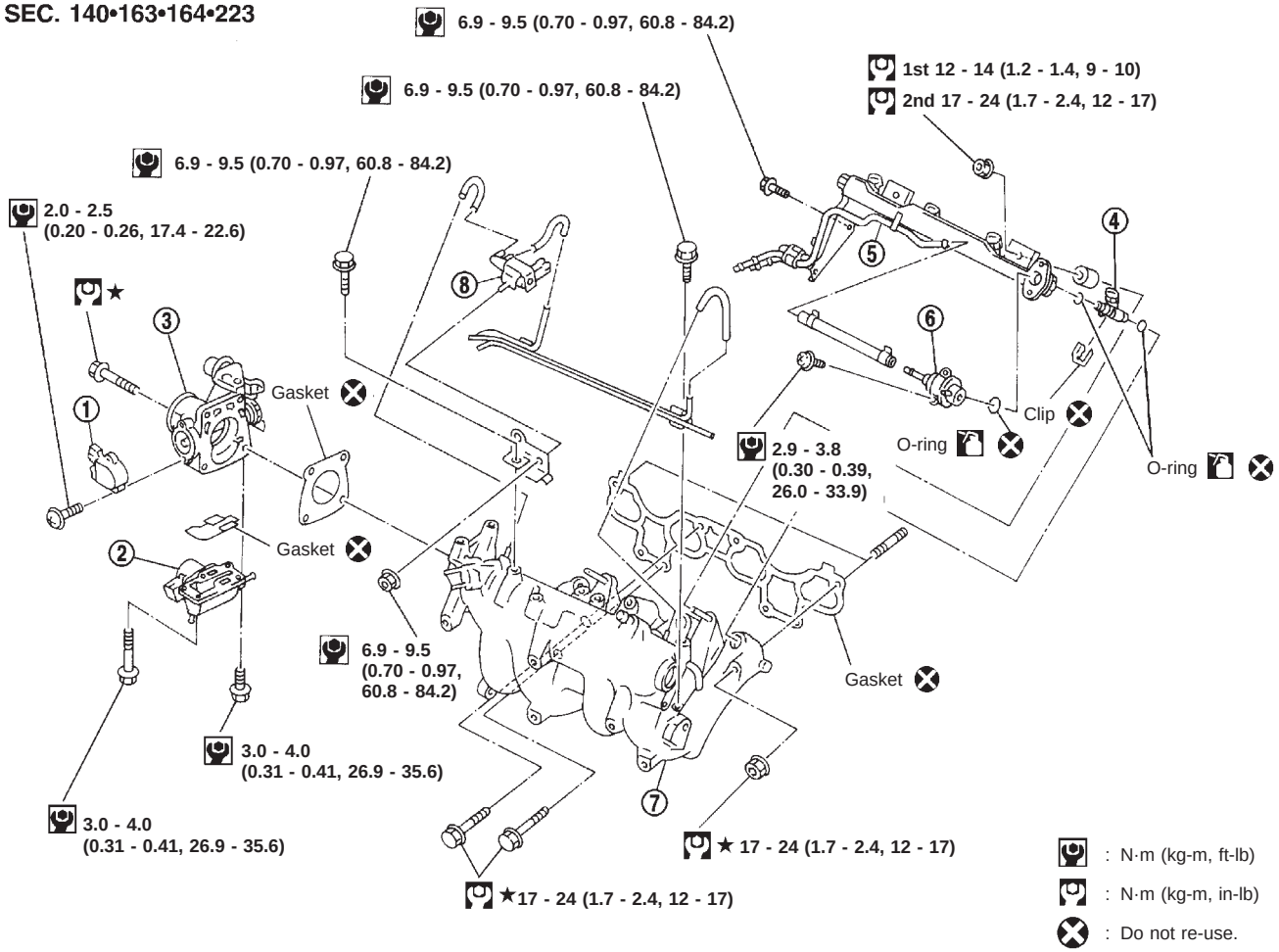
SEC. 140•147•150•210



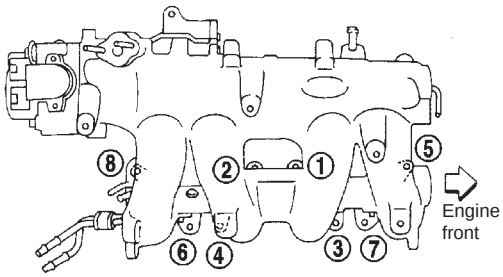
1. Oil pressure switch
2. EGR valve*
3. EGR guide tube*
4. Air relief plug
5. Intake manifold
6. Intake manifold upper support
7. Intake manifold rear supports
8. Oil filter
9. Thermostat
10. Water pump
11. Water pump pulley

*: If so equipped

SEC. 140•163•164•223



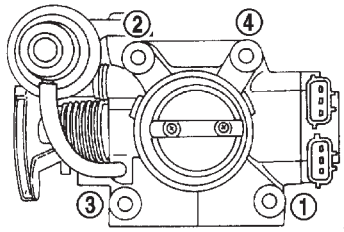
★ **Intake manifold bolts and nuts tightening order**



Tighten in numerical order.

★ **Throttle body bolts tightening procedure**

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

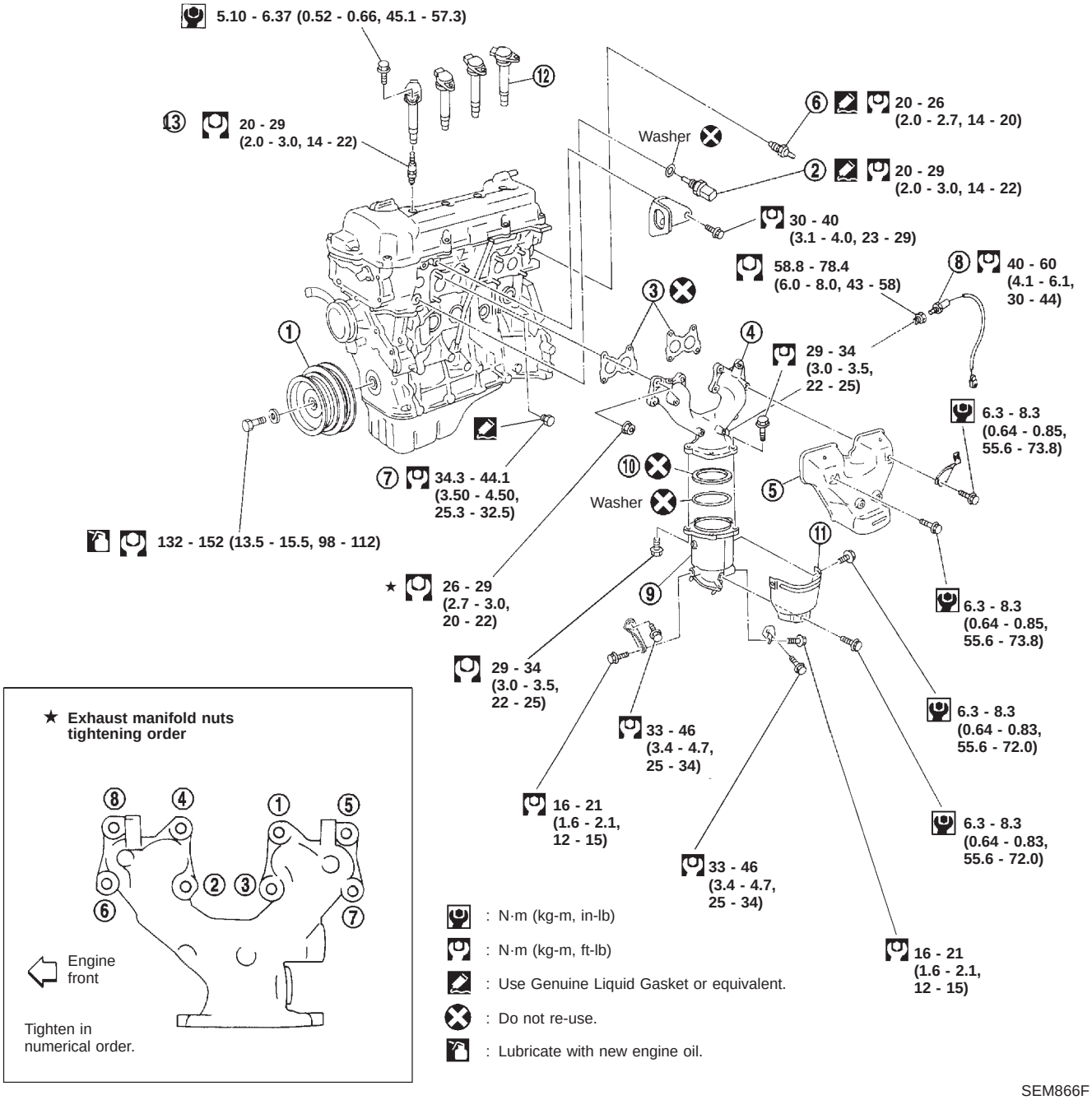


Tighten in numerical order.

SEM865F

1. Throttle position sensor
2. IACV-AAC valve
3. Throttle body
4. Injector
5. Injector tube
6. Pressure regulator
7. Intake manifold
8. Canister purge control valve

SEC. 140•208•210•220•226•253

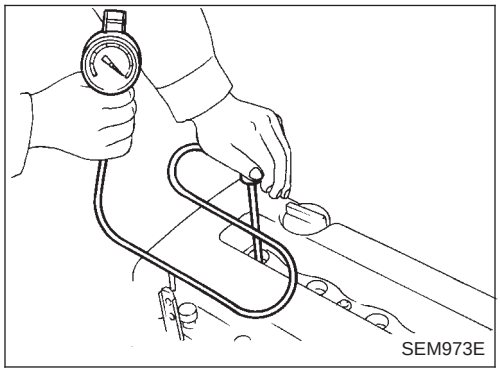


SEM866F

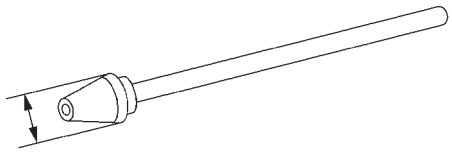
1. Crankshaft pulley
2. Engine coolant temperature
3. Gasket
4. Exhaust manifold
5. Exhaust manifold cover
6. Thermal transmitter
7. Water drain plug
8. Heated oxygen sensor
9. Three way catalyst
10. Converter cap
11. Converter cover
12. Ignition coil
13. Spark plug

1. Warm up engine.
2. Turn ignition switch OFF.
3. Release fuel pressure.
   Refer to “Releasing Fuel Pressure” in EC section.
4. Remove ignition coils.
5. Remove spark plugs.

- Clean area around plug with compressed air before removing the spark plug.



SEM973E



20 mm (0.79 in) dia.

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

AEM308

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

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

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

Standard

1,324 (13.24, 13.5, 192)/350

Minimum

1,128 (11.28, 11.5, 164)/350

Maximum allowable difference between cylinders

98 (0.98, 1.0, 14)/300

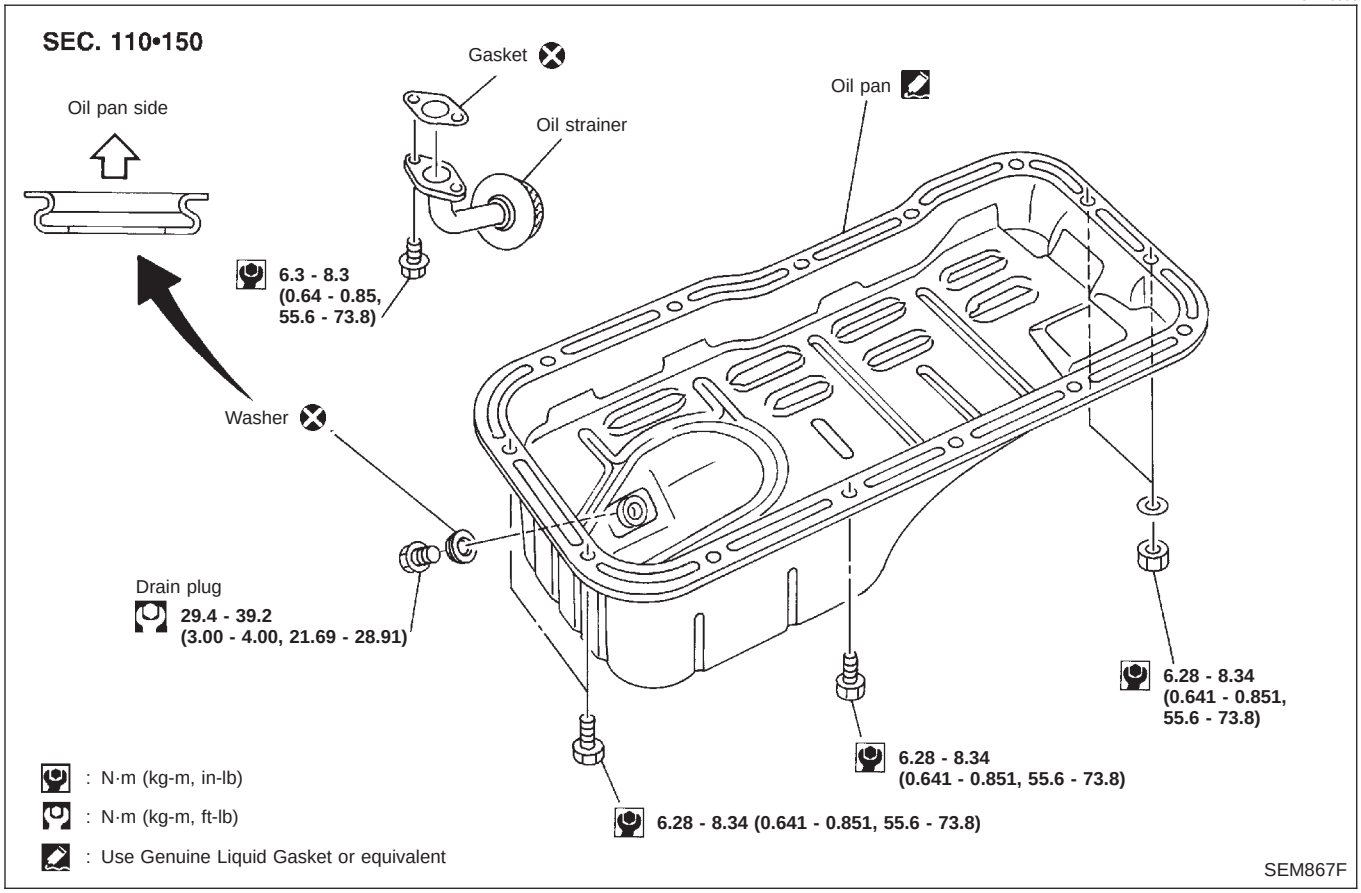
10. If cylinder compression in one or more cylinders is low, pour a small amount of engine oil into the cylinder through the spark plug hole and retest compression.

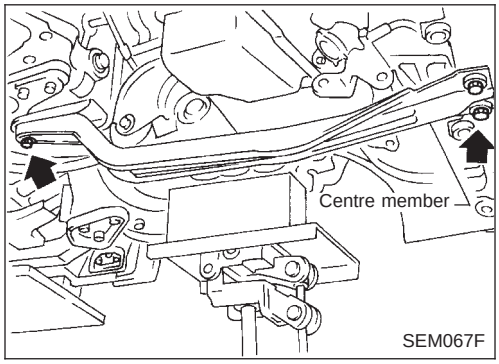
- **If adding oil improves cylinder compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. Refer to SDS, EM-178. If valve or valve seat is damaged excessively, replace them.**
- If compression in any two adjacent cylinders is low and if adding oil does not improve compression, there is leakage past the gasket surface. If so, replace cylinder head gasket.

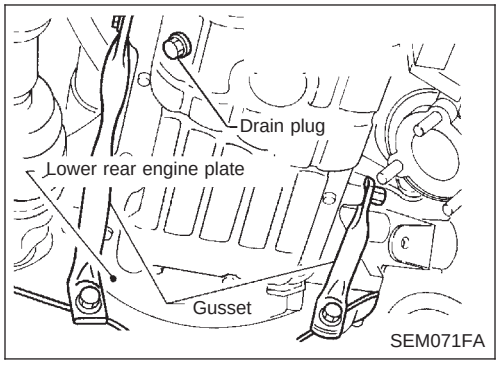
11. Reinstall spark plugs, ignition coils and fuel pump fuse.
12. Perform “Self-diagnosis Procedure” referring to EC section. Erase DTC if any DTC appears.

Components

NCEM0008



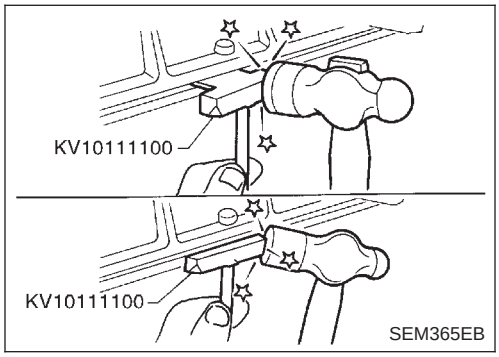




Removal

NCEM0009

1. Remove engine RH side cover and under covers.
2. Drain engine oil.
3. Remove front exhaust tube.
   Refer to FE section (“EXHAUST SYSTEM”).
4. Set a suitable transmission jack under transaxle and lift engine with engine slinger.
5. Remove center member.
6. Remove rear engine gussets.



7. Remove oil pan.

a. Insert Tool between cylinder block and oil pan.

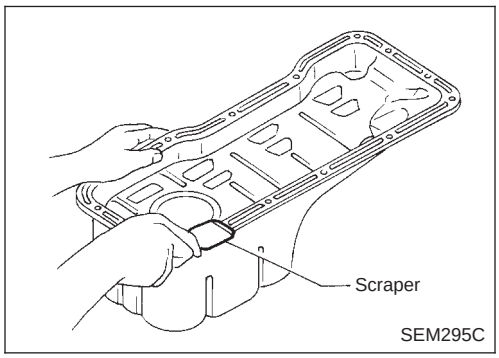
1) **Be careful not to damage aluminum mating face.**

Do not insert screwdriver, or oil pan flange will be damaged.

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

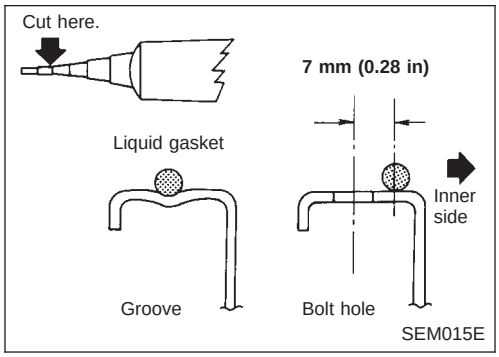
Installation

NCEM0010



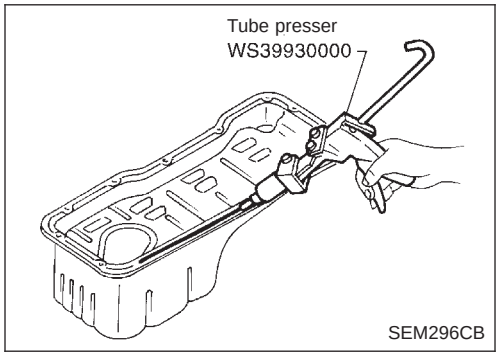
1. Use a scraper to remove old liquid gasket from mating surface of oil pan.

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

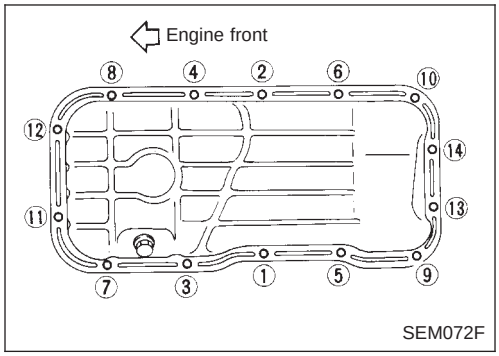


2. Apply a continuous bead of liquid gasket to mating surface of oil pan.

- **Use Genuine Liquid Gasket or equivalent.**
- **Apply to groove on mating surface.**
- **Allow 7 mm (0.28 in) clearance around bolt holes.**



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



3. Install oil pan.

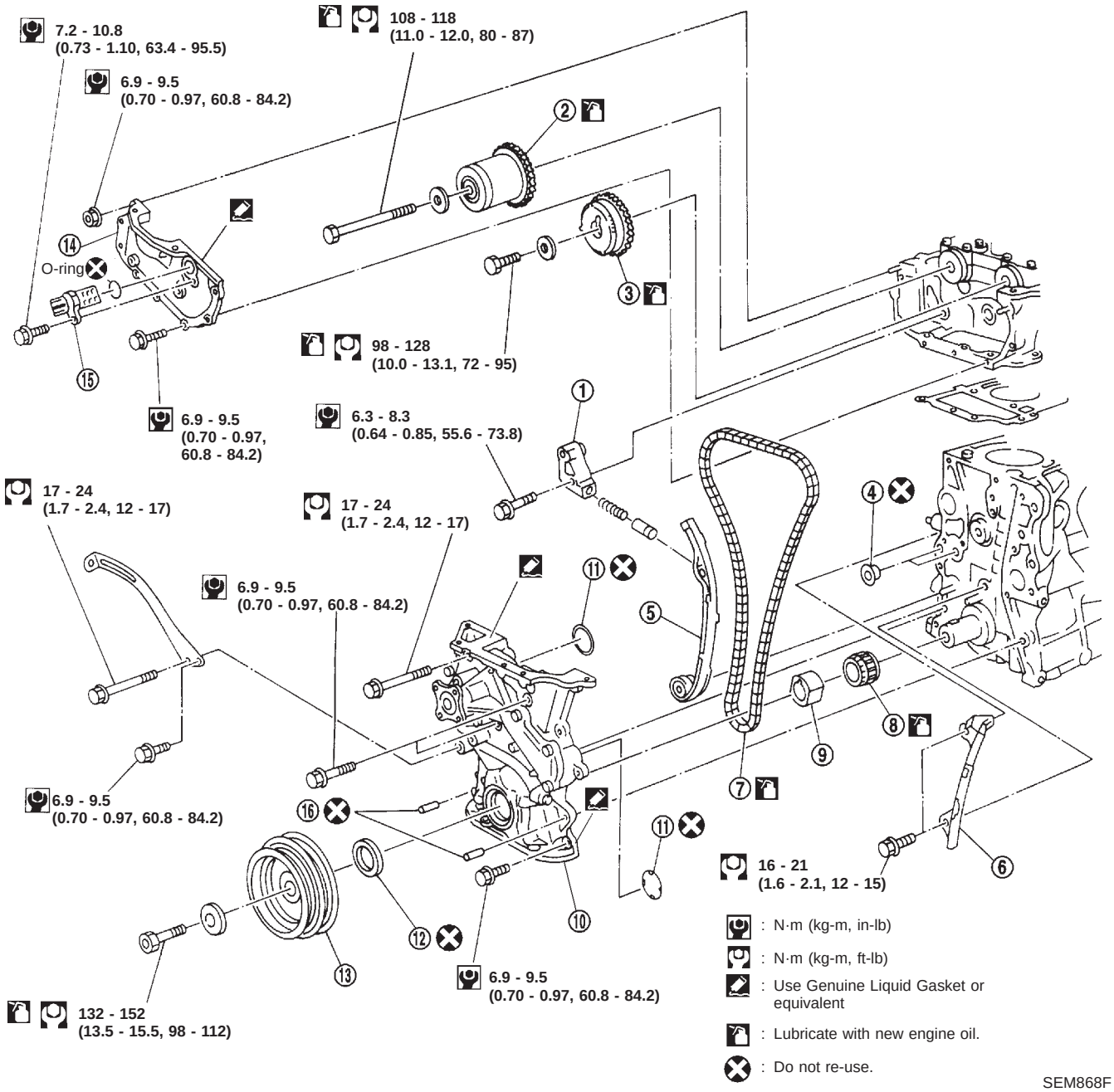
- **Tighten oil pan nuts and bolts in the numerical order.**
- **Wait at least 30 minutes before refilling engine oil.**

4. Install parts in reverse order of removal.

Components

NCEM0011

SEC. 120•130•135

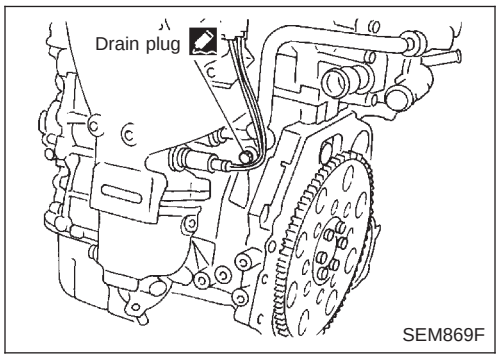


SEM868F

1. Chain tensioner
2. Camshaft sprocket (Intake)
3. Camshaft sprocket (Exhaust)
4. O-ring
5. Slack side timing chain guide
6. Timing chain tension guide
7. Timing chain
8. Crankshaft sprocket
9. Oil pump drive spacer
10. Front cover
11. O-ring
12. Oil seal
13. Crankshaft pulley
14. Cylinder head front cover
15. Camshaft position sensor (PHASE)
16. Cylinder block dowels

CAUTION:

- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing chain tensioner, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Apply new engine oil to bolt threads and seat surfaces when installing camshaft sprocket and crankshaft pulley.**
- **When removing oil pump assembly, remove camshaft position sensor (PHASE), then remove timing chain from engine.**
- **Be careful not to damage sensor edges.**

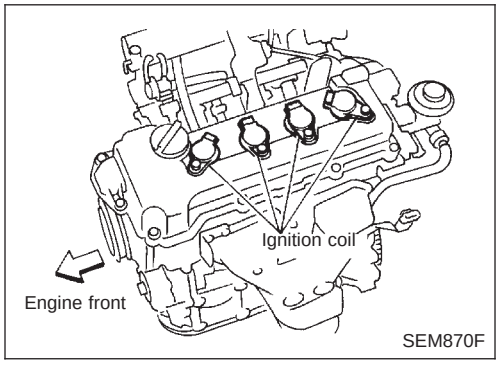


SEM869F

Removal

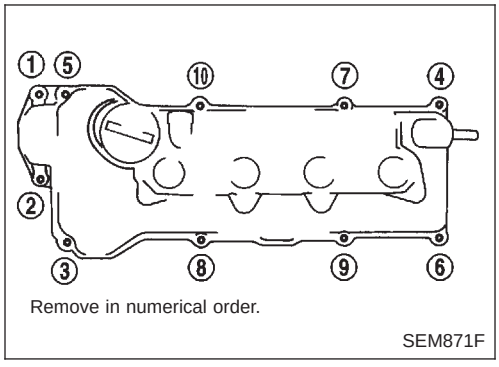
NCEM0012

1. Drain engine coolant from radiator and cylinder block.
   Be careful not to spill coolant on drive belts.
2. Release fuel pressure.
   Refer to EC section ("Fuel Pressure Release", "BASIC SERVICE PROCEDURE").
3. Remove the following belts.
   - Power steering pump drive belt
   - Alternator drive belt
4. Remove power steering pulley and pump with bracket.
5. Remove front right-side wheel.
6. Remove front right-side splash cover.
7. Remove front undercovers.
8. Remove front exhaust tube.



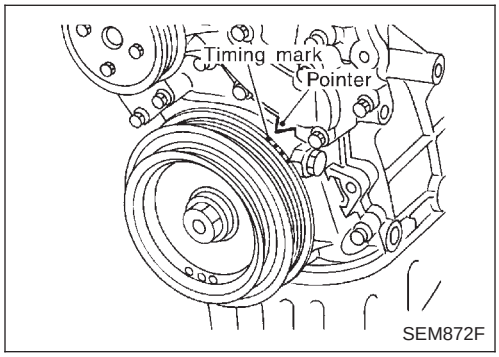
SEM870F

9. Remove vacuum hoses, fuel hoses, and so on.
10. Remove ignition coils.
11. Remove cylinder head front mounting bracket.

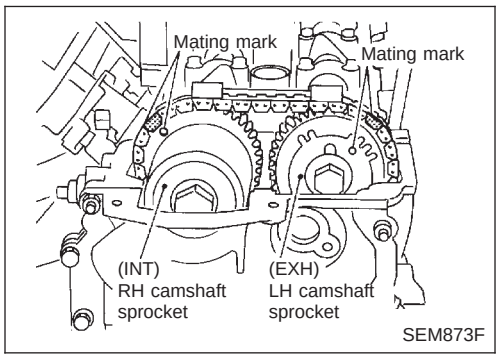


SEM871F

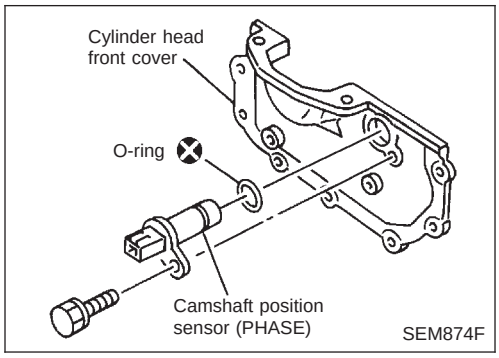
12. Remove rocker cover bolts in numerical order as shown in the figure.
13. Remove spark plugs.



14. Set No. 1 piston at TDC on its compression stroke.

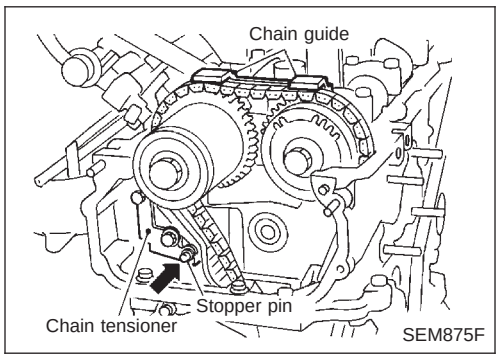


- **Rotate crankshaft until mating mark on camshaft sprocket is set at position indicated in figure at left.**

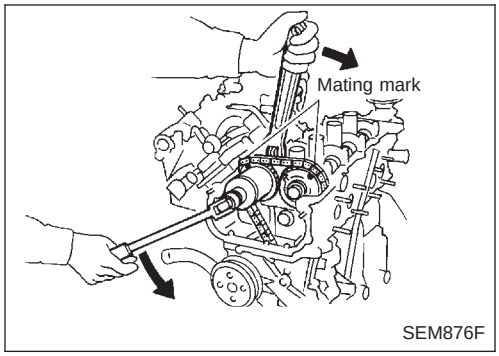


15. Remove camshaft position sensor (PHASE).
- **Do not allow any magnetic materials to contact the camshaft position sensor (PHASE).**
- **Be careful not to damage sensor.**

16. Remove cylinder head front cover.

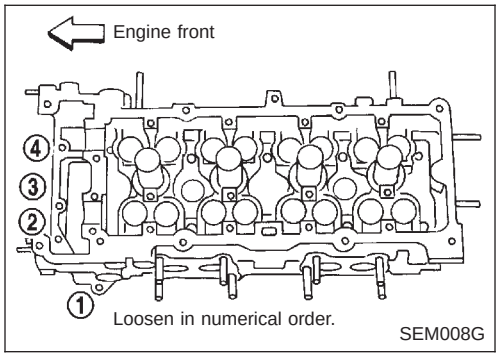


17. Remove timing chain guide from camshaft bracket.
18. Attach a suitable stopper pin to chain tensioner.
19. Remove chain tensioner.

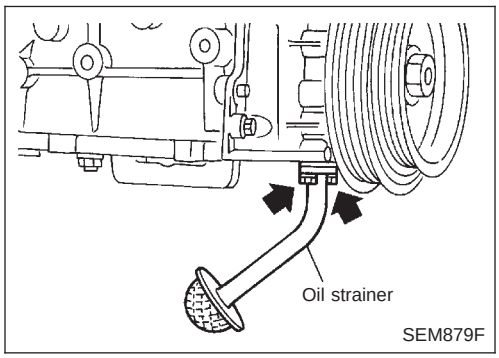


20. Remove camshaft sprocket bolts.
- **Apply paint to timing chain and cam sprockets for alignment during installation.**

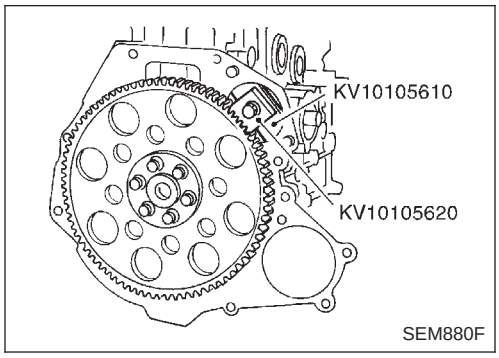
21. Remove camshaft sprockets.



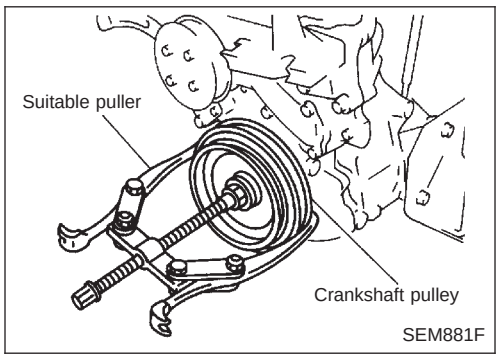
22. Remove cylinder head bolts at engine front side.



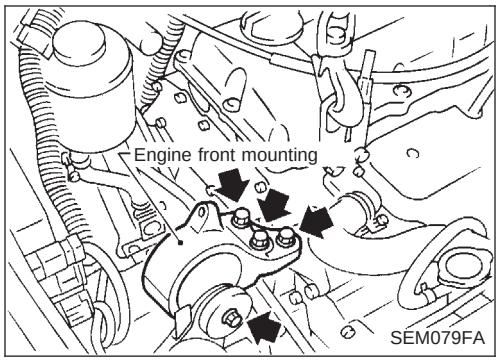
23. Remove center member.
24. Support engine with a suitable hoist or jack.
25. Remove oil pan. Refer to "Removal" in "OIL PAN" (EM-17).
26. Remove oil strainer.



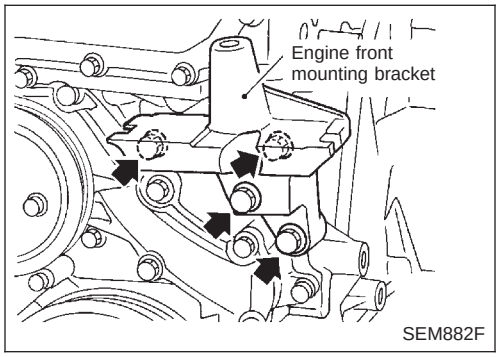
27. Remove starter motor, and set ring gear stopper using mounting bolt holes.



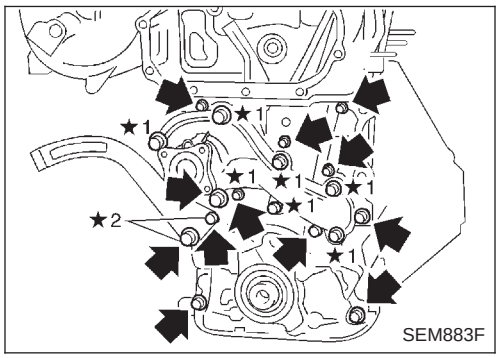
28. Loosen crankshaft pulley bolt.
29. Remove crankshaft pulley with a suitable puller.



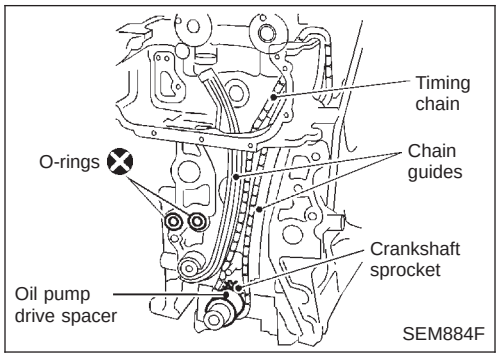
30. Remove engine front mounting.



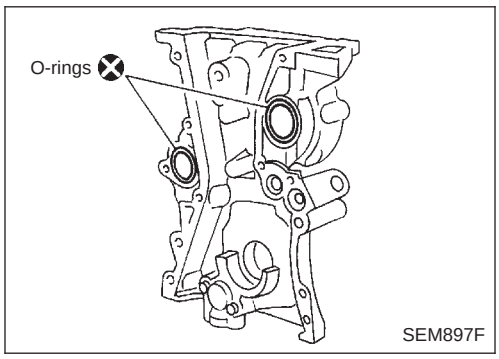
31. Remove engine front mounting bracket.

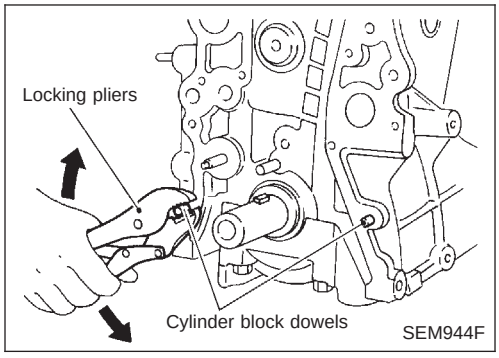


32. Remove water pump pulley and water pump.
33. Remove front cover bolts and front cover as shown.
    ★1: Located on water pump
    ★2: Located on power steering pump adjusting bar
- Inspect for oil leakage at front oil seal. Replace seal if oil leak is present.

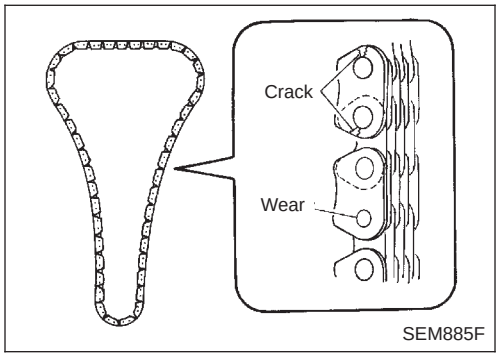


34. Remove timing chain.
35. Remove oil pump drive spacer.
36. Remove chain guides.
37. Remove crankshaft sprocket.
38. Remove O-rings from cylinder block and front cover.





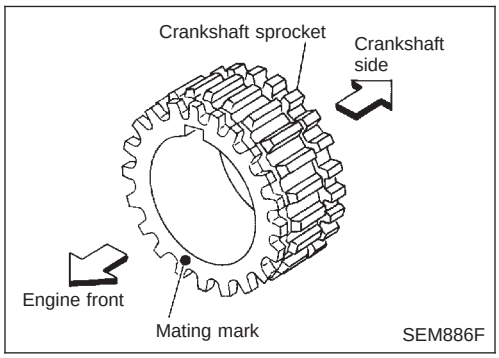
39. Remove cylinder block dowels by using locking pliers for easy-to-install front cover.
- **Do not hit dowels because cylinder block may be cracked.**



Inspection

NCEM0013

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

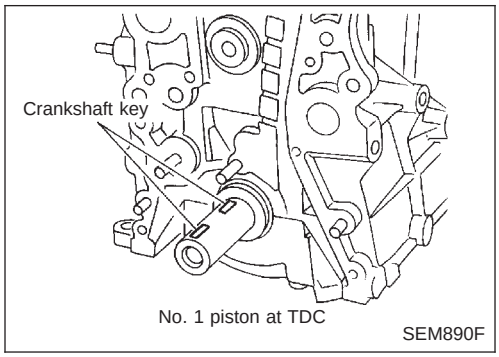


Installation

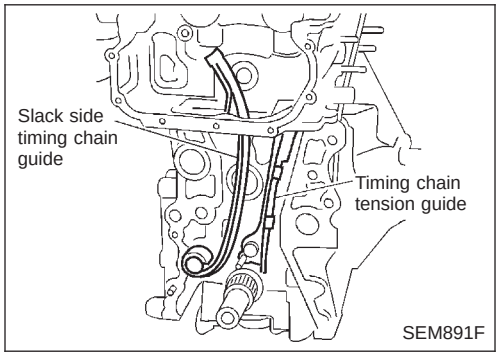
NCEM0014

1. Install crankshaft sprocket on crankshaft.

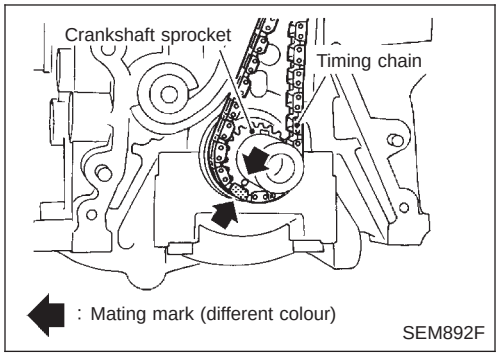
- **Make sure mating marks on crankshaft sprocket face front of engine.**



2. Position crankshaft so that No. 1 piston is at TDC and key way is at 12 o'clock.

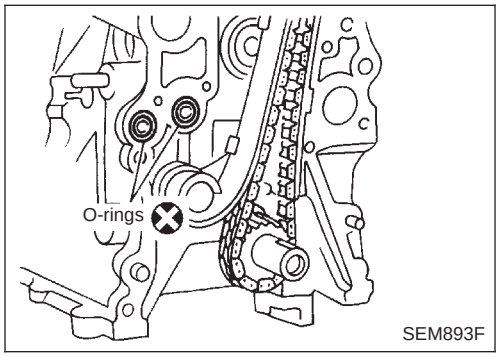


3. Install slack side timing chain guide and timing chain tension guide.

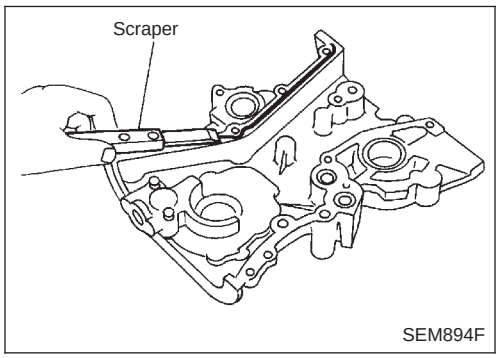


4. Install timing chain on crankshaft sprocket.

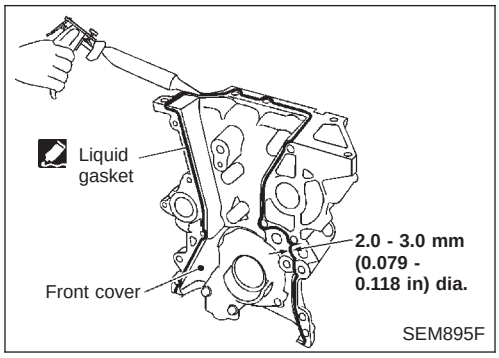
- **Set timing chain by aligning its mating mark with that on the crankshaft sprocket.**
- **Make sure sprocket's mating mark faces engine front.**



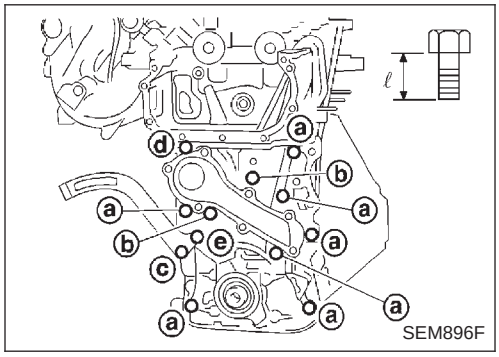
5. Install O-rings to cylinder block.



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



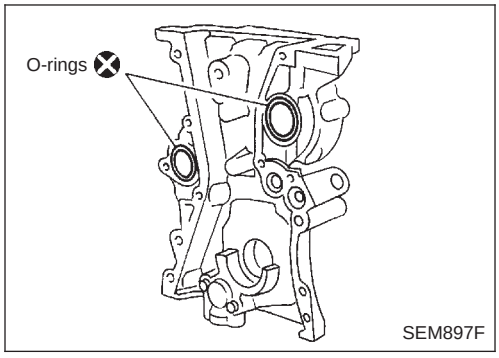
7. Apply a continuous bead of liquid gasket to mating surface of front cover.
- **Check alignment of mating marks on chain and crankshaft sprocket.**
- **Align oil drive spacer with oil pump.**
- **Place timing chain to the side of chain guide. This prevents the chain from making contact with water seal area of front cover.**



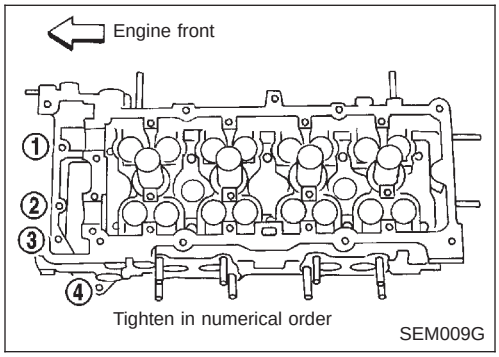
8. Install front cover.

Bolt No.	Tightening torque N·m (kg-m, in-lb)	"ℓ" mm (in)
a.	6.9 - 9.5 (0.70 - 0.97, 61 - 84)	20 (0.79)
b.	6.9 - 9.5 (0.70 - 0.97, 61 - 84)	40 (1.57)
c.	17 - 24 (1.7 - 2.4, 148 - 208*)	70 (2.76)
d.	6.9 - 9.5 (0.70 - 0.97, 61 - 84)	72.8 (2.866)
e.	6.9 - 9.5 (0.70 - 0.97, 61 - 84)	12 (0.47)

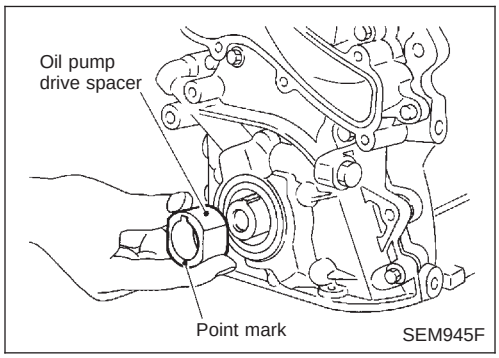
*: 12 - 17 ft-lb



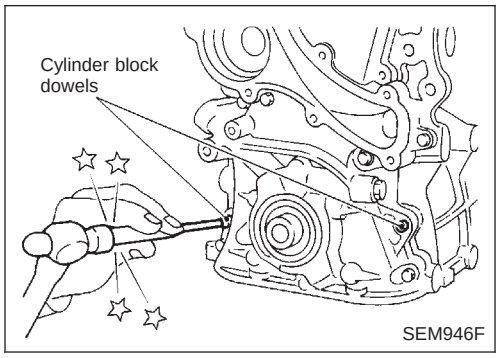
- **Make sure two O-rings are present.**
- **Be careful not to damage oil seal when installing front cover.**



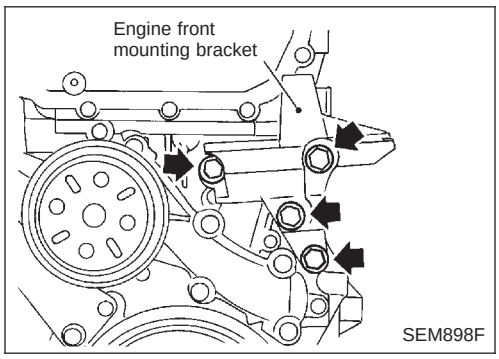
9. Install cylinder head bolts at engine front side.
- **Tightening procedure**
  Tightening bolts (1 - 4) to 6.3 to 8.3 N·m (0.64 to 0.85 kg-m, 55.8 to 73.5 in-lb).



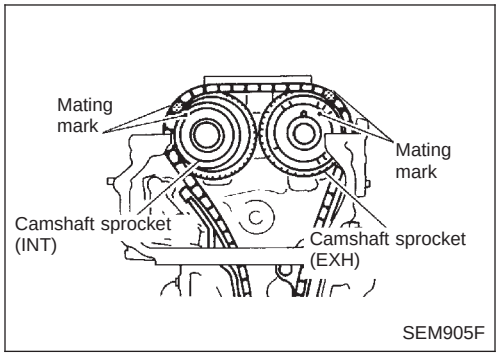
10. Install oil pump drive spacer.



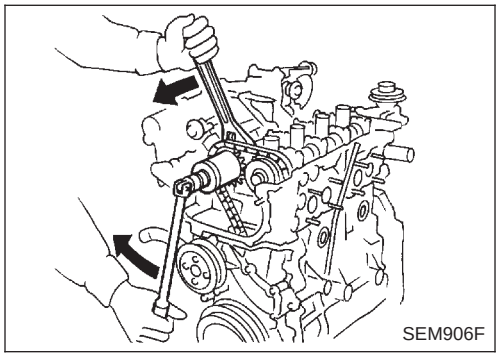
11. Install cylinder block dowels.
- **When installing cylinder block dowels, use new ones.**



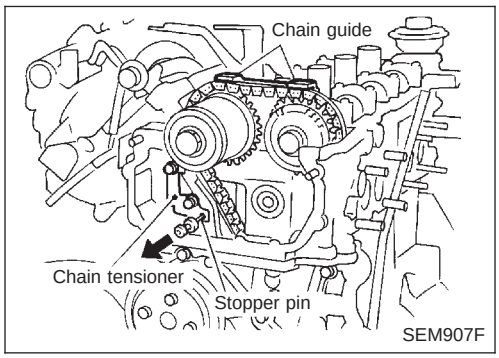
12. Install water pump and water pump pulley.
    Refer to LC section ("Water Pump", "ENGINE COOLING SYSTEM").
13. Install engine front mounting bracket.
14. Install oil strainer.
15. Install oil pan. Refer to "Installation" in "OIL PAN" EM-18.
16. Install crankshaft pulley.
17. Install center member.
18. Remove ring gear stopper.
19. Install starter motor.



20. Install camshaft sprocket.
- **Set timing chain by aligning mating marks with those of camshaft sprockets.**


SEM906F

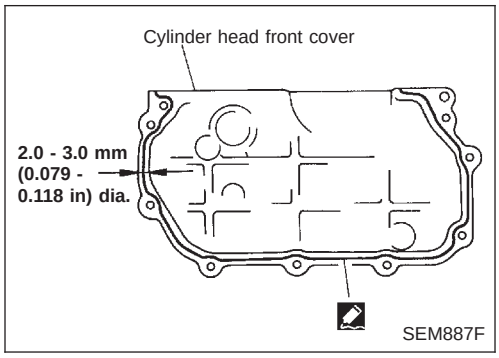
21. Install camshaft sprocket bolts to correct torque.
- **Apply new engine oil to bolt threads and seat surface.**



SEM907F

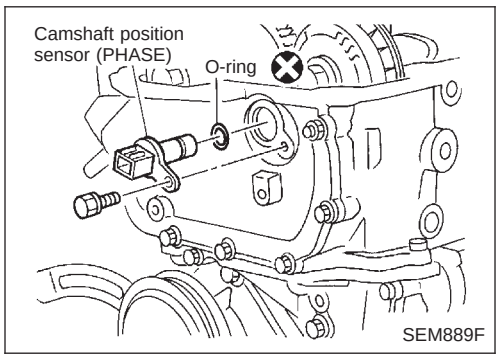
22. Install chain tensioner.
- **Before installing chain tensioner, insert a suitable pin into pin hole of chain tensioner.**
- **After installing chain tensioner, remove the pin.**

23. Install timing chain guide.



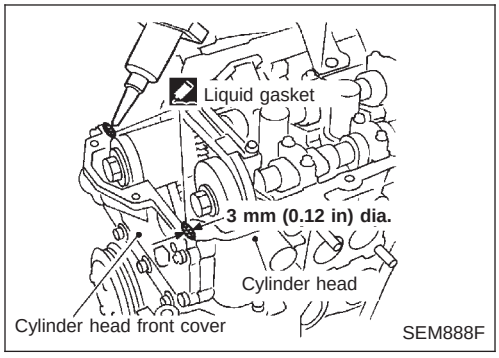
SEM887F

24. Install cylinder head front cover.
- Apply liquid gasket to cylinder head front cover.
- Use Genuine Liquid Gasket or equivalent.



SEM889F

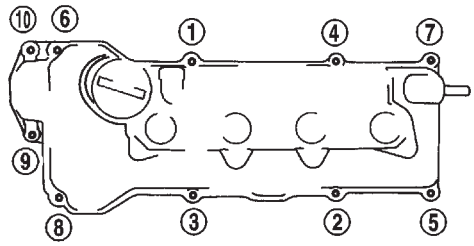
25. Install camshaft position sensor (PHASE).



SEM888F

26. Before installing rocker cover, apply a continuous bead of liquid gasket to mating surface of cylinder head.

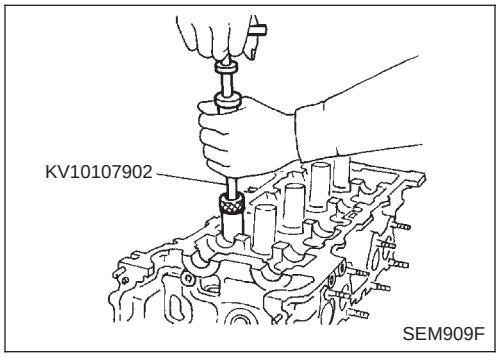
Installation (Cont'd)



Tighten in numerical order

SEM908F

27. Install rocker cover and tighten bolts in numerical order as shown in the figure.
28. Install spark plugs.
29. Install ignition coils.
30. Install engine front mounting.
31. Install front exhaust tube.
32. Install front undercover.
33. Install front right splash cover.
34. Install front right wheel.
35. Install power steering pulley and pump with bracket.
    To check power steering fluid, refer to MA section ("Checking Power Steering Fluid and Lines", "CHASSIS AND BODY MAINTENANCE").
36. Drive belts.
    For adjusting drive belt deflection, refer to MA section ("Checking Drive Belts", "ENGINE MAINTENANCE").
37. Reinstall parts in reverse order of removal.



Replacement

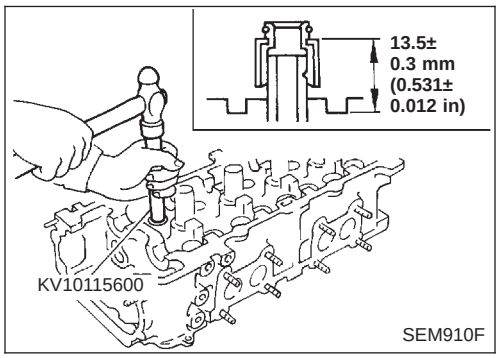
NCEM0015

VALVE OIL SEAL

NCEM0015S01

1. Remove rocker cover.
2. Remove camshaft.
3. Remove valve spring. Refer to EM-34.
4. Remove valve oil seal with Tool.

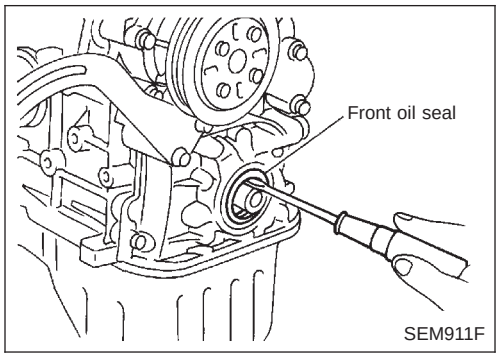
Piston concerned should be set at TDC to prevent valve from falling.



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

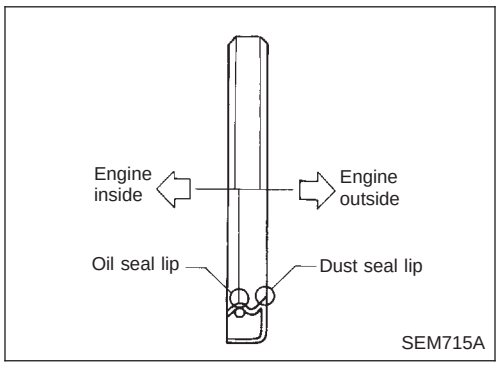
FRONT OIL SEAL

NCEM0015S02

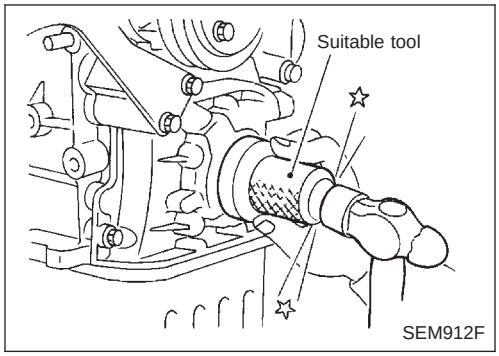


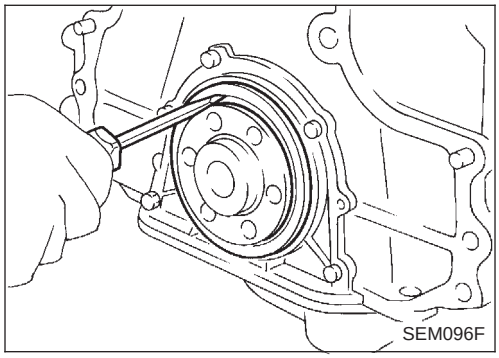
1. Remove the following parts:
- Engine under cover
- RH engine side cover
- Generator and power steering drive belts
- Crankshaft pulley

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



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



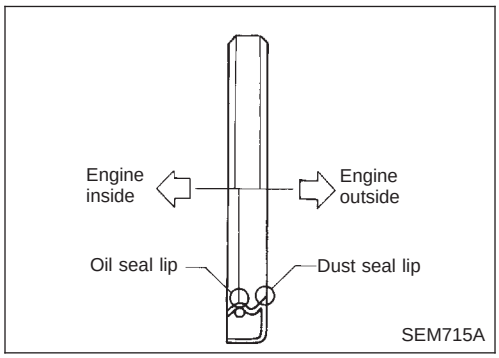


REAR OIL SEAL

NCEM0015S03

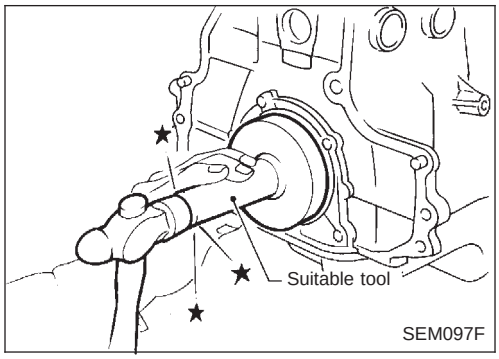
1. Remove flywheel or drive plate.
2. Remove rear oil seal.

- **Be careful not to scratch rear oil seal retainer.**



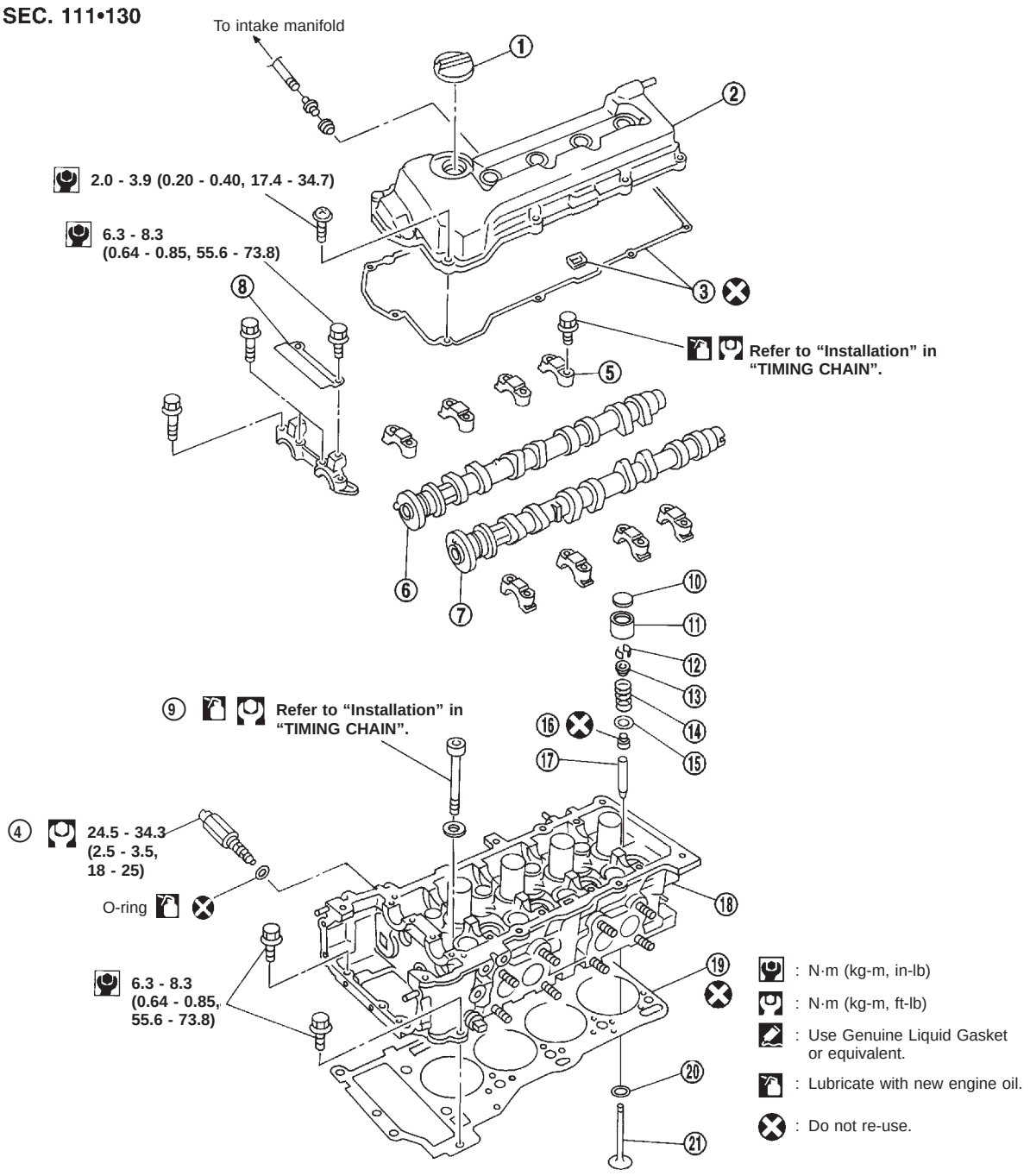
3. Apply new engine oil to new oil seal and install it using a suitable tool.

- Install new oil seal in the direction shown.



Components

NCEM0016

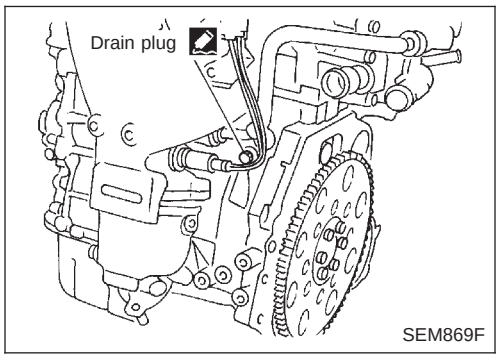


SEM913F

1. Oil filler cap
2. Rocker cover
3. Rocker cover gasket
4. VTC solenoid
5. Camshaft bracket
6. Intake camshaft
7. Exhaust camshaft
8. Timing chain guide
9. Cylinder head bolt
10. Shim
11. Valve lifter
12. Valve cotter
13. Valve spring retainer
14. Valve spring
15. Valve spring seat
16. Valve oil seal
17. Valve guide
18. Cylinder head
19. Cylinder head gasket
20. Valve seat
21. Valve

CAUTION:

- **When installing camshaft and oil seal, lubricate contacting surfaces with new engine oil.**
- **When tightening cylinder head bolts, camshaft sprocket bolts and camshaft bracket bolts, lubricate bolt threads and seat surfaces with new engine oil.**
- **Attach tags to valve lifters so as not to mix them up.**

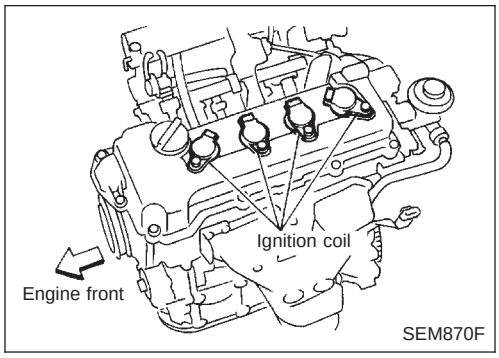


SEM869F

Removal

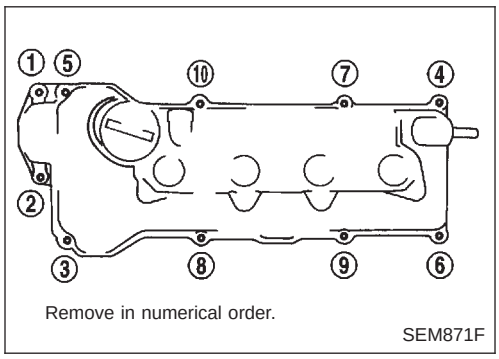
NCEM0017

1. Drain engine coolant from radiator and cylinder block.
   Be careful not to spill coolant on drive belts.
2. Release fuel pressure.
   Refer to EC section ("Fuel Pressure Release", "BASIC SERVICE PROCEDURE").
3. Remove air duct to intake manifold collector.
4. Remove front undercovers.
5. Remove front exhaust tube.



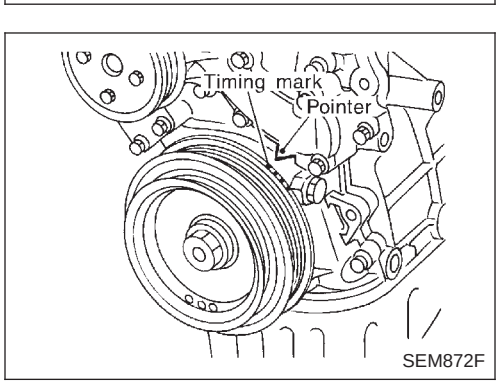
SEM870F

6. Remove vacuum hoses, fuel hoses, water hoses, wires, harness, connectors and so on.
7. Remove ignition coils.



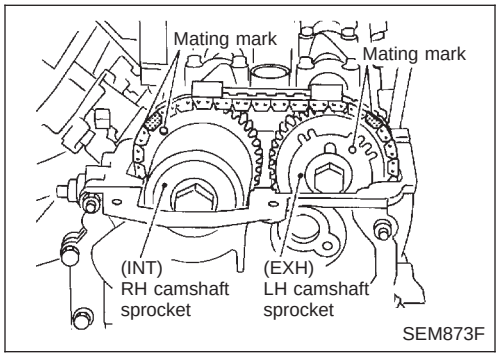
Remove in numerical order.
SEM871F

8. Remove rocker cover bolts in numerical order as shown in the figure.
9. Remove spark plugs.
10. Remove intake manifold rear supports.

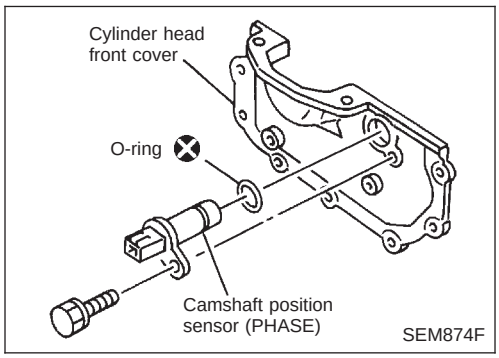


SEM872F

11. Set No. 1 piston at TDC on its compression stroke.

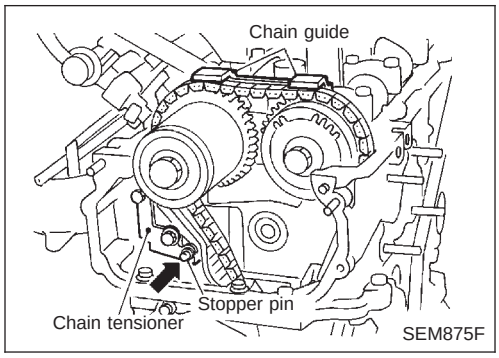


- **Rotate crankshaft until mating mark on camshaft sprocket is set at position indicated in figure at left.**

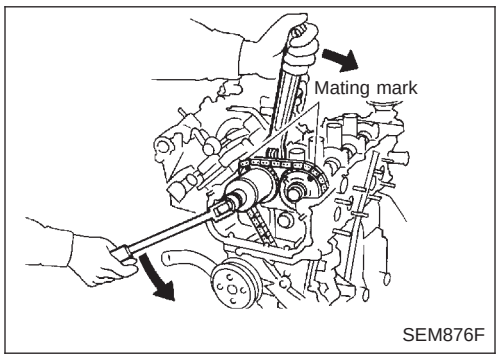


12. Remove camshaft position sensor (PHASE).
- **Do not allow any magnetic materials to contact the camshaft position sensor (PHASE).**
- **Be careful not to damage sensor.**

13. Remove cylinder head front cover.

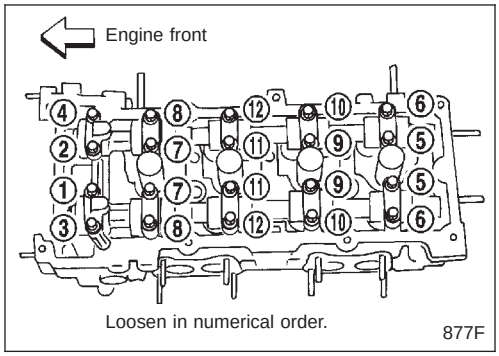


14. Remove timing chain guide from camshaft bracket.
15. Attach a suitable stopper pin to chain tensioner.
16. Remove chain tensioner.

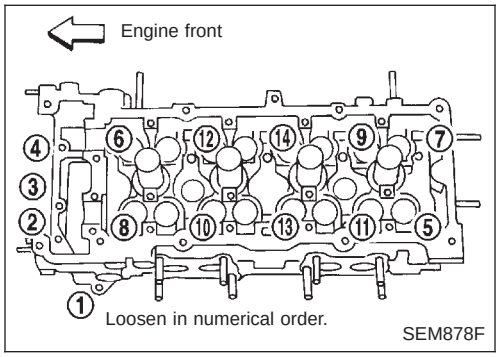


17. Remove camshaft sprocket bolts.
- **Apply paint to timing chain and cam sprockets for alignment during installation.**

18. Remove camshaft sprockets.

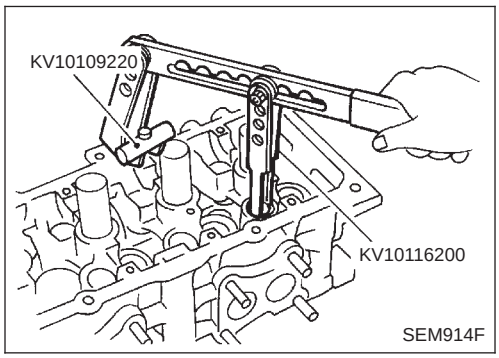


19. Remove camshaft brackets and camshafts.
- **Apply I.D. marks to brackets to ensure correct reassembly.**
- **Bolts should be loosened in two or three steps.**



20. Remove cylinder head bolts.
21. Remove cylinder head with manifolds.

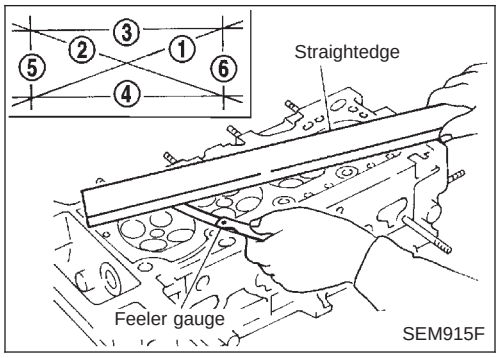
- **Head warpage or cracking could result from removing in incorrect order.**
- **Cylinder head bolts should be loosened in two or three steps.**



Disassembly

NCEM0018

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



Inspection

NCEM0019

CYLINDER HEAD DISTORTION

NCEM0019S01

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

Head surface flatness:

Standard: Less than 0.03 mm (0.0012 in)

Limit: 0.1 mm (0.004 in)

If beyond the specified limit, replace or resurface it.

Resurfacing limit:

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

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

A + B = 0.2 mm (0.008 in)

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

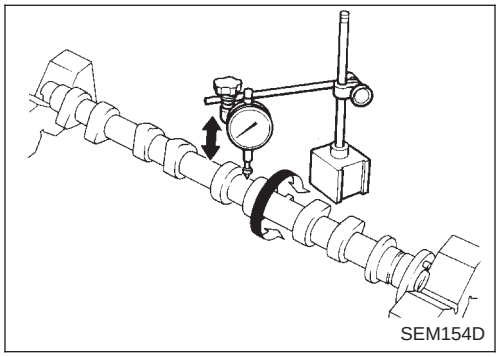
Nominal cylinder head height:

117.8 - 118.0 mm (4.638 - 4.646 in)

CAMSHAFT VISUAL CHECK

NCEM0019S02

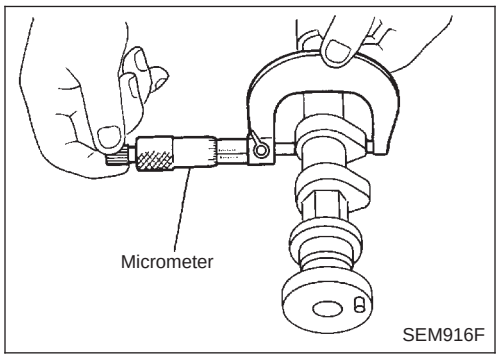
Check camshaft for scratches, seizure and wear.


SEM154D

CAMSHAFT RUNOUT

NCEM0019S03

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

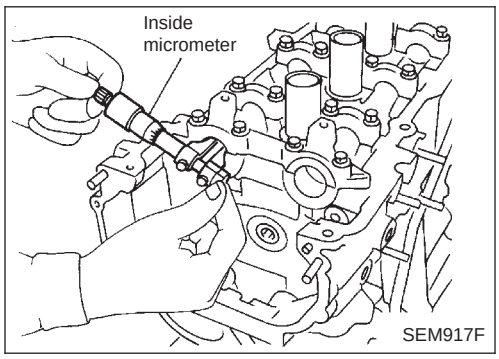


SEM916F

CAMSHAFT CAM HEIGHT

NCEM0019S04

1. Measure camshaft cam height.
   Standard cam height:
   Intake
   QG16DE
   40.220 - 40.410 mm (1.5835 - 1.5909 in)
   QG18DE
   40.610 - 40.800 mm (1.5988 - 1.6063 in)
   Exhaust
   40.056 - 40.245 mm (1.5770 - 1.5844 in)
   Cam wear limit:
   0.20 mm (0.0079 in)
2. If wear is beyond the limit, replace camshaft.

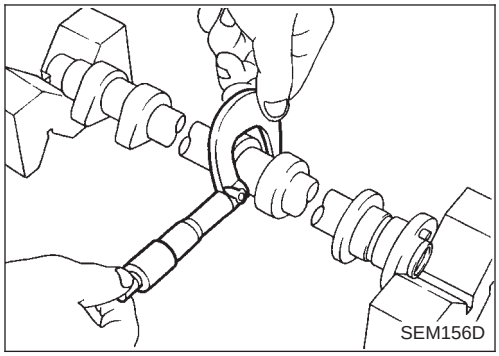


SEM917F

CAMSHAFT JOURNAL CLEARANCE

NCEM0019S05

1. Install camshaft bracket and tighten bolts to the specified torque.
2. Measure inner diameter of camshaft bearing.
   Standard inner diameter:
   No. 1 bearing
   28.000 - 28.021 mm (1.1024 - 1.1032 in)
   No. 2 to No. 5 bearings
   24.000 - 24.021 mm (0.9449 - 0.9457 in)

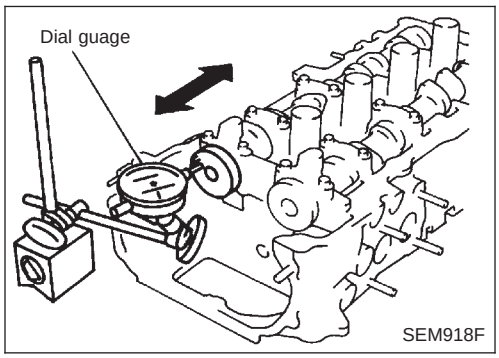

SEM156D

3. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   No. 1 journal
   27.935 - 27.955 mm (1.0998 - 1.1006 in)
   No. 2 to No. 5 journals
   23.935 - 23.955 mm (0.9423 - 0.9431 in)
4. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance:
   Standard

0.045 - 0.086 mm (0.0018 - 0.0034 in)

Limit

0.15 mm (0.0059 in)



CAMSHAFT END PLAY

NCEM0019S06

1. Install camshaft in cylinder head. Refer to EM-24.
2. Measure camshaft end play.

Camshaft end play:

Standard

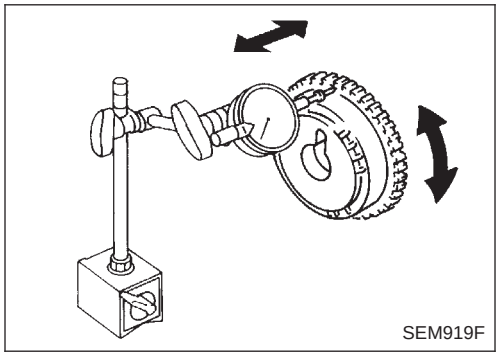
0.115 - 0.188 mm (0.0045 - 0.0074 in)

Limit

0.20 mm (0.0079 in)

3. If limit is exceeded, replace camshaft and remeasure end play.

- **If limit is still exceeded after replacing camshaft, replace cylinder head.**



CAMSHAFT SPROCKET RUNOUT

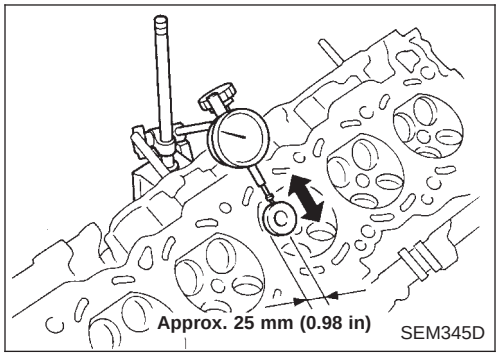
NCEM0019S07

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

Runout (Total indicator reading):

Limit 0.15 mm (0.0059 in)

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



VALVE GUIDE CLEARANCE

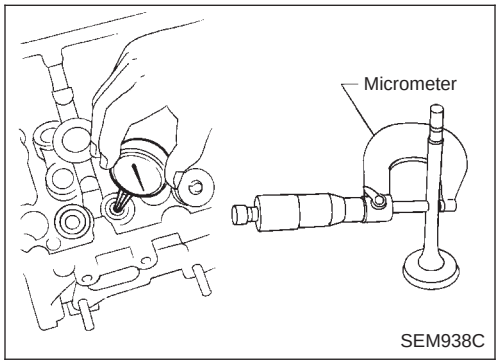
NCEM0019S08

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

Valve deflection limit (Dial gauge reading):

Intake & Exhaust

0.2 mm (0.008 in)



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

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

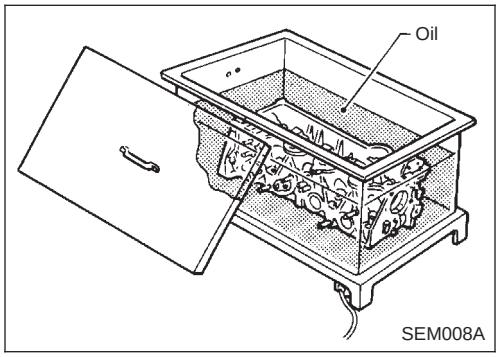
b. Calculate valve to valve guide clearance.
Valve to valve guide clearance = Valve guide inner diameter − Valve stem diameter.

c. Check that clearance is within specification.

Unit: mm (in)

	Standard	Limit
Intake	0.020 - 0.050 (0.0008 - 0.0020)	0.1 (0.004)
Exhaust	0.040 - 0.070 (0.0016 - 0.0028)	0.1 (0.004)

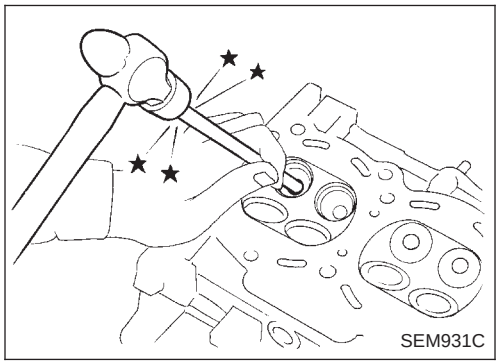
- If it exceeds the limit, replace valve and remeasure clearance.
- **If limit is still exceeded after replacing valve, replace valve guide.**



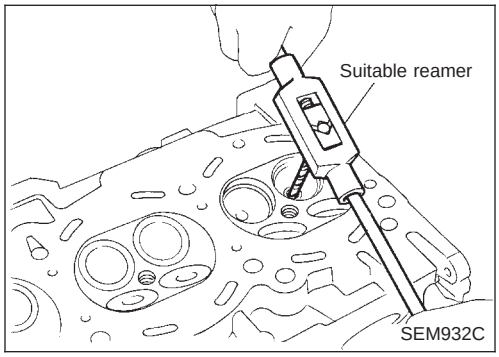
VALVE GUIDE REPLACEMENT

NCEM0019S09

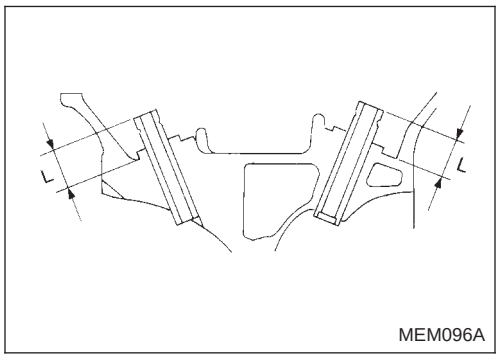
1. To remove valve guide, heat cylinder head to 110 to 130°C (230 to 266°F).



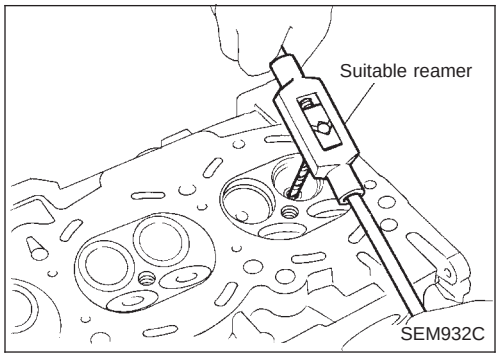
2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.



3. Ream cylinder head valve guide hole.
   Valve guide hole diameter
   (for service parts):
   Intake & Exhaust
   9.685 - 9.696 mm (0.3813 - 0.3817 in)



4. Heat cylinder head to 110 to 130°C (230 to 266°F) and press service valve guide into cylinder head.
   Projection "L":
   11.5 - 11.7 mm (0.453 - 0.461 in)



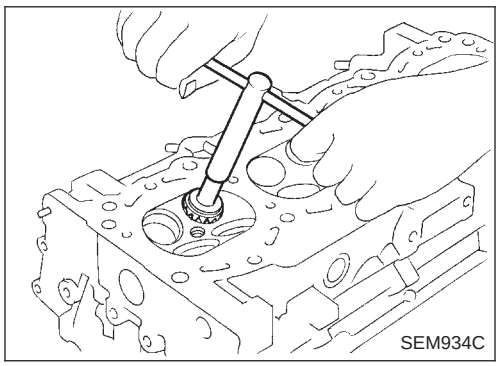
5. Ream valve guide.
   Finished size:
   Intake & Exhaust
   5.500 - 5.515 mm (0.2165 - 0.2171 in)

VALVE SEATS

NCEM0019S10

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

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

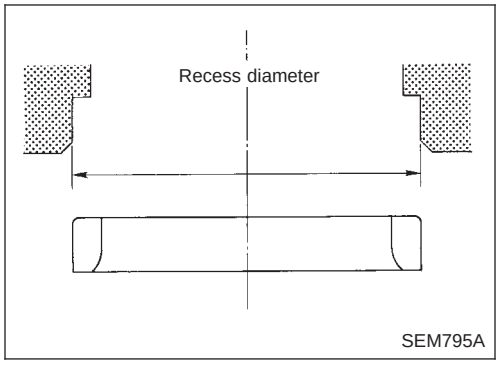


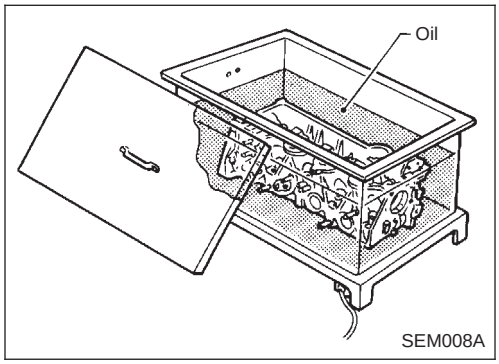
REPLACING VALVE SEAT FOR SERVICE PARTS

NCEM0019S11

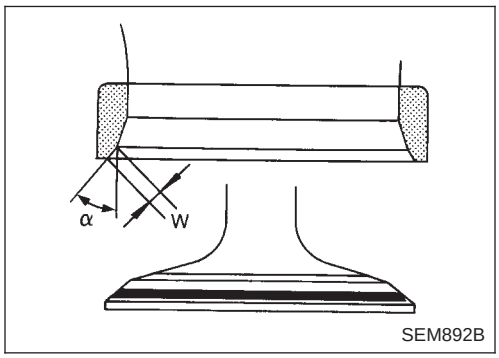
1. Bore out old seat until it collapses. Set machine depth stop so that boring cannot contact the bottom face of seat recess in cylinder head.
2. Ream cylinder head recess.
   Reaming bore for service valve seat
   Oversize [0.5 mm (0.020 in)]:
   Refer to SDS, EM-182.

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



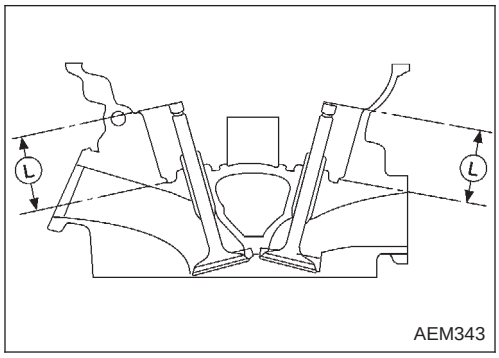


3. Heat cylinder head to 110 to 130°C (230 to 266°F).
4. Press fit valve seat until it seats on the bottom.



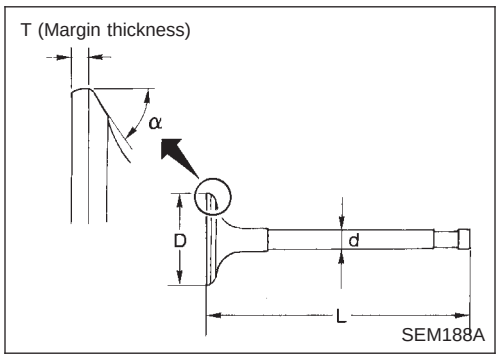
5. Cut or grind valve seat using suitable tool to the specified dimensions as shown in SDS, EM-179.
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

Seat face angle "α":
45°15′ - 45°45′
Contacting width "W":
Intake
1.06 - 1.34 mm (0.0417 - 0.0528 in)
Exhaust
1.20 - 1.68 mm (0.0472 - 0.0661 in)



8. Use a depth gauge to measure the distance "L" 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 correct it. If the distance is longer, replace the valve seat.

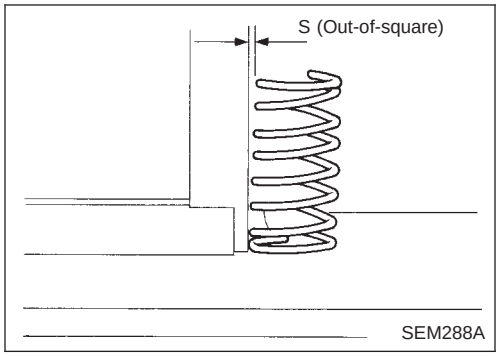
Valve seat resurface limit:
Intake
35.95 - 36.55 mm (1.4154 - 1.4390 in)
Exhaust
35.92 - 36.52 mm (1.4142 - 1.4378 in)



VALVE DIMENSIONS

NCEM0019S12

Check dimensions of each valve. Refer to SDS, EM-182 for dimensions.
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.



VALVE SPRING

NCEM0019S13

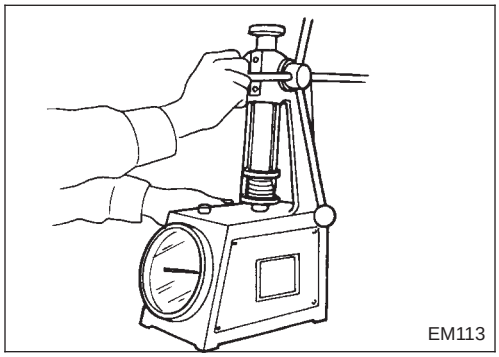
Squareness

NCEM0019S1301

1. Measure dimension "S".

Out-of-square "S":
Less than 1.75 mm (0.0689 in)

2. If it exceeds the limit, replace spring.


EM113

Pressure

NCEM0019S1302

Check valve spring pressure at specified spring height.

Pressure:

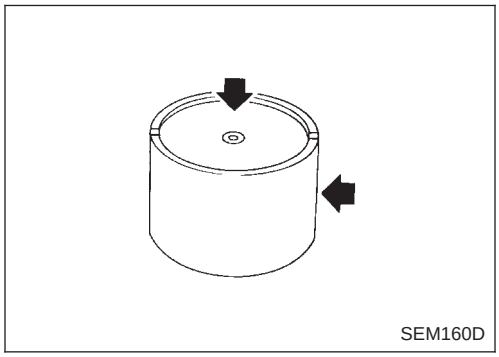
Standard

370.0 N (37.73 kg, 83.19 lb) at 23.64 mm (0.9307 in)

Limit

More than 347.8 N (35.46 kg, 78.19 lb) at 23.64 mm (0.9307 in)

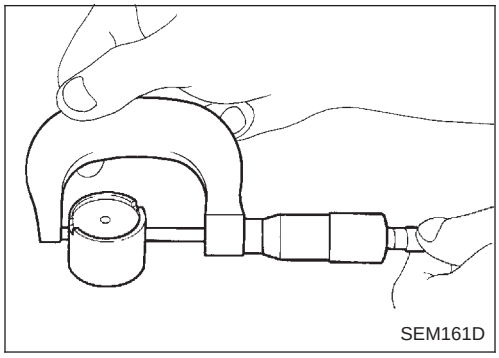
If it exceeds the limit, replace spring.


SEM160D

VALVE LIFTER AND VALVE SHIM

NCEM0019S16

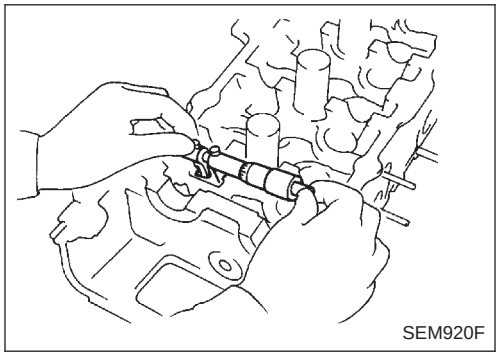
1. Check contact and sliding surfaces for wear or scratches.


SEM161D

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

Valve lifter outside diameter:

29.960 - 29.975 mm (1.1795 - 1.1801 in)


SEM920F

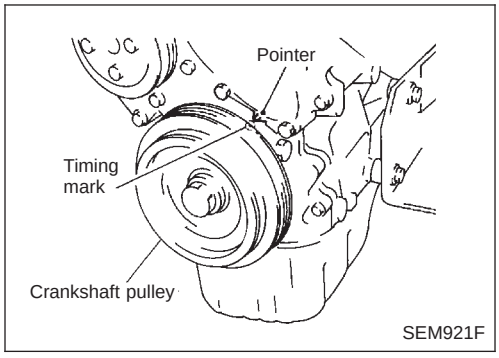
Lifter guide inside diameter:

30.000 - 30.021 mm (1.1811 - 1.1819 in)

Clearance between valve lifter and valve lifter guide:

0.025 - 0.065 mm (0.0010 - 0.0024 in)

If it exceeds the limit, replace valve lifter or cylinder head which exceeds the standard diameter tolerance.



SEM921F

Valve Clearance

NCEM0041

CHECKING

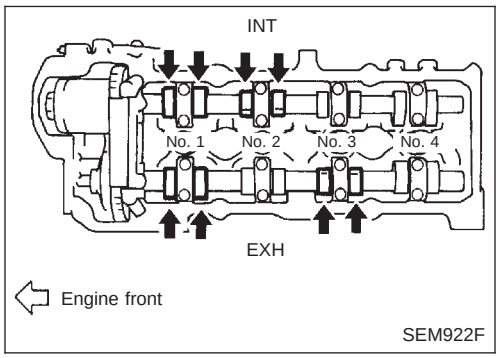
NCEM0041S01

Check valve clearance while engine is warm and not running.

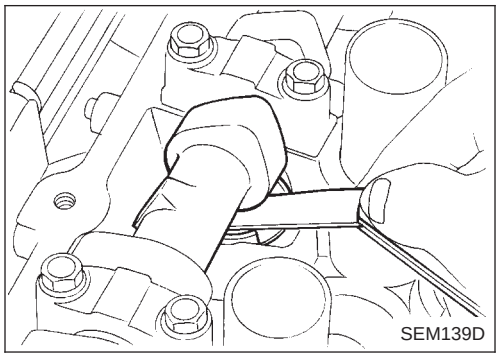
1. Remove rocker cover.
2. Remove all spark plugs.
3. Set No. 1 cylinder at TDC on its compression stroke.

- 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 described above.



4. Check only those valves shown in the figure.



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

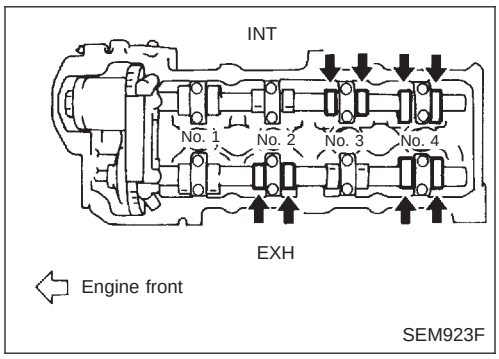
Valve clearance for checking (Hot):

Intake

0.21 - 0.49 mm (0.008 - 0.019 in)

Exhaust

0.30 - 0.58 mm (0.012 - 0.023 in)

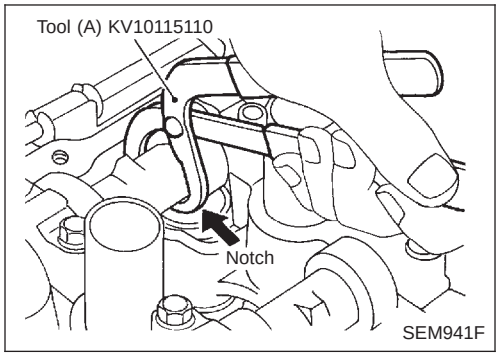


5. Turn crankshaft one revolution (360°) and align mark on crankshaft pulley with pointer.
6. Check only those valves shown in the figure.

- Use the same procedure as mentioned in step 4.

7. If all valve clearances are within specification, install the following parts:

- Rocker cover
- All spark plugs



ADJUSTING

NCEM0041S02

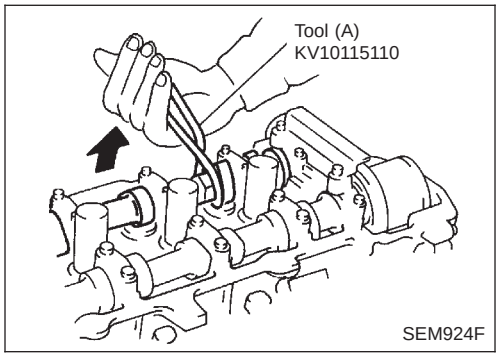
Adjust valve clearance while engine is cold.

1. Turn crankshaft. Position cam lobe upward on camshaft for valve that must be adjusted.
2. Place Tool (A) around camshaft as shown in figure.

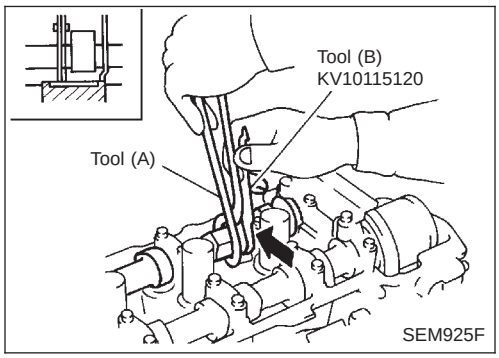
Before placing Tool (A), rotate notch toward center of cylinder head. (See figure.) This will simplify shim removal later.

CAUTION:

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



3. Rotate Tool (A) so that valve lifter is pushed down.

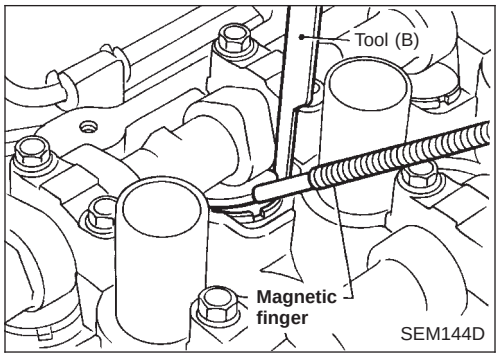


4. Place Tool (B) between camshaft and valve lifter to retain valve lifter.

CAUTION:

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

5. Remove Tool (A).



6. Remove adjusting shim using a small screwdriver and a magnetic finger.
7. Determine replacement adjusting shim size using the following formula.

- Use a micrometer to determine thickness of removed shim.
- Calculate thickness of new adjusting shim so valve clearance comes within specified values.

R = Thickness of removed shim
N = Thickness of new shim
M = Measured valve clearance

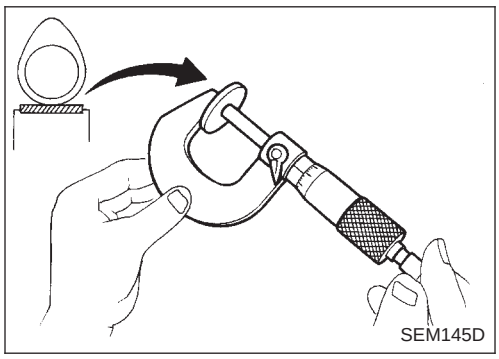
Intake:

N = R + [M − 0.37 mm (0.0146 in)]

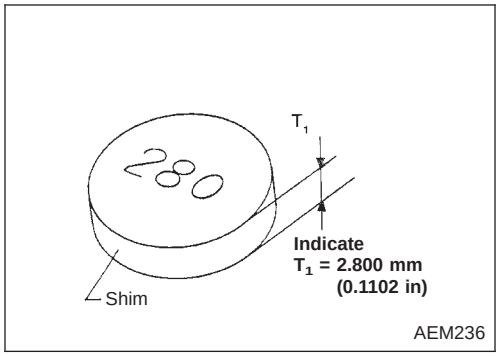
Exhaust:

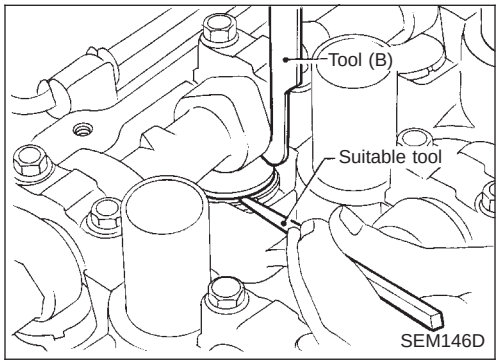
N = R + [M − 0.40 mm (0.0157 in)]

Shims are available in 50 sizes from 2.00 mm (0.0787 in) to 2.98 mm (0.1173 in), in steps of 0.02 mm (0.0008 in).

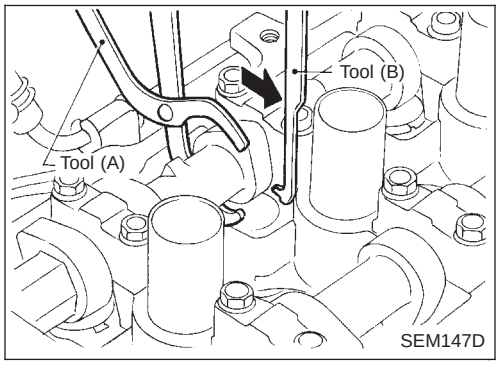


- Select the closest size shim to the calculated thickness. Refer to chart in SDS, EM-180.





8. Install new shim using a suitable tool.
- **Install with the surface on which the thickness is stamped facing down.**



9. Place Tool (A) as explained in steps 2 and 3.
10. Remove Tool (B).
11. Remove Tool (A).
12. Recheck valve clearance.

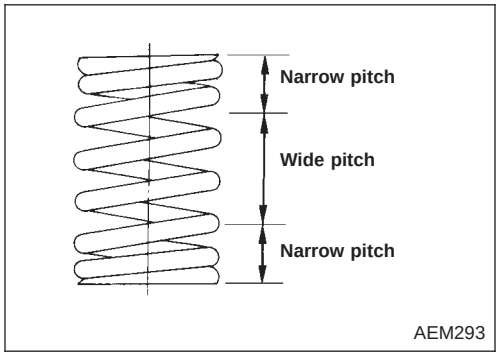
Valve clearance:

Unit: mm (in)

	For adjusting		For checking
	Hot	Cold* (reference data)	Hot
Intake	0.32 - 0.40 (0.013 - 0.016)	0.25 - 0.33 (0.010 - 0.013)	0.21 - 0.49 (0.008 - 0.019)
Exhaust	0.37 - 0.45 (0.015 - 0.018)	0.32 - 0.40 (0.013 - 0.016)	0.30 - 0.58 (0.012 - 0.023)

*: At a temperature of approximately 20°C (68°F)

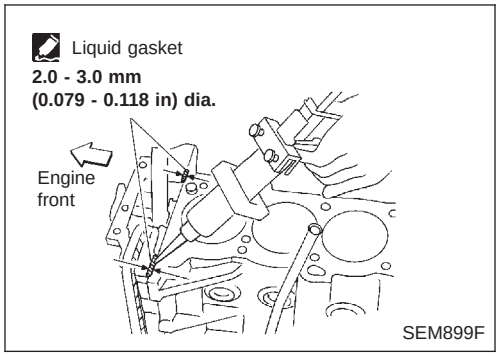
Whenever valve clearances are adjusted to cold specifications, check that the clearances satisfy hot specifications and adjust again if necessary.



Assembly

NCEM0020

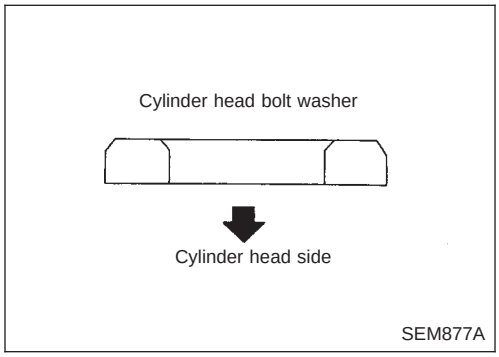
1. Install valve component parts.
- **Always use new valve oil seal. Refer to EM-29.**
- **Before installing valve oil seal, install valve spring seat.**
- **After installing valve components, tap valve stem tip with a plastic hammer to assure a proper fit.**
- **Install valve spring (narrow pitch at both ends of spring) with either end toward cylinder head.**



Installation

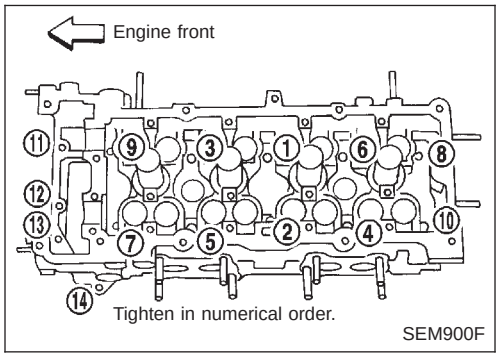
NCEM0021

1. Before installing cylinder head gasket, apply a continuous bead of liquid gasket to mating surface of cylinder block.
2. Install cylinder head gasket.
- **When installing cylinder head with manifolds, use new cylinder head gasket.**

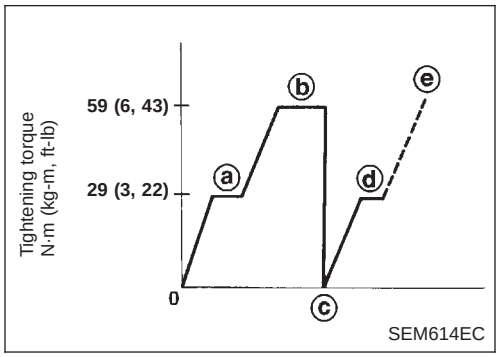


3. Install cylinder head with manifolds.

- **Be sure to install washers between bolts and cylinder head.**
- **Do not rotate crankshaft and camshaft separately, or valves will strike piston heads.**
- **Apply new engine oil to cylinder head bolt threads and seat surfaces.**

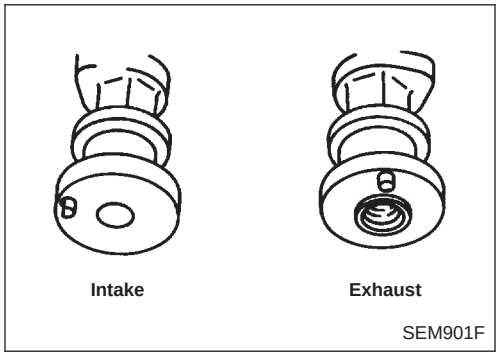


- **Tightening procedure**
  - **ⓐ Tighten bolts to 29 N·m (3 kg-m, 22 ft-lb).**
  - **ⓑ Tighten bolts to 59 N·m (6 kg-m, 43 ft-lb).**
  - **ⓒ Loosen bolts completely.**
  - **ⓓ Tighten bolts to 29 N·m (3 kg-m, 22 ft-lb).**
  - **ⓔ Turn bolts 50 to 55 degrees clockwise or if angle wrench is not available, tighten bolts to 59±4.9 N·m (6±0.5 kg-m, 43±3.6 ft-lb).**
  - **ⓕ Tightening bolts (11 - 14) to 6.3 to 8.3 N·m (0.64 to 0.85 kg-m, 55.8 to 73.5 in-lb).**

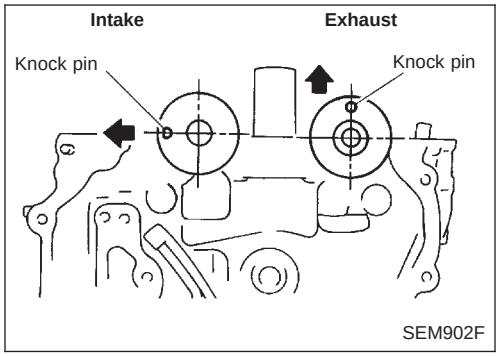


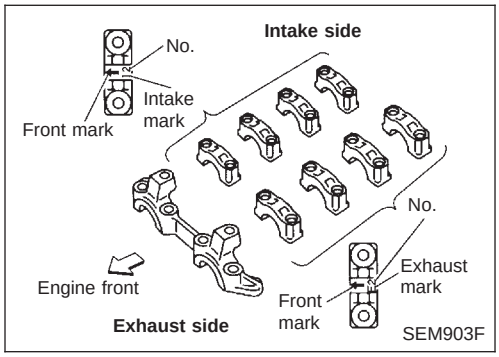
	Tightening torque N·m (kg-m, ft-lb)				
	a	**b**	**c**	**d**	**e, f**
Bolts (**1** - **10**)	29 (3, 22)	59 (6, 43)	0 (0, 0)	29 (3, 22)	50 - 55 degrees or 59±4.9 (6±0.5, 43±3.6 ft-lb)
Bolts (**11** - **14**)	—	—	—	—	6.3 - 8.3 (0.64 - 0.85, 55.8 - 73.5 in-lb)

4. Install camshaft.



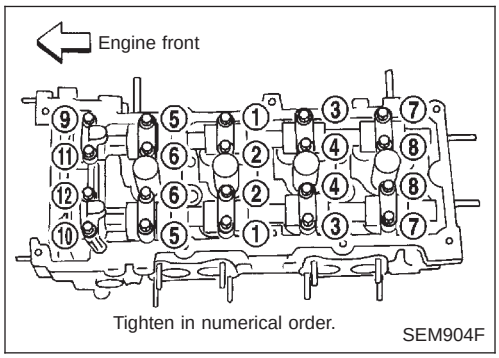
- **Make sure camshafts are aligned as shown in figure.**





5. Install camshaft brackets.

- **Make sure camshaft brackets are aligned as marked during disassembly.**



- **Apply new engine oil to bolt threads and seat surface.**
- **Tighten camshaft bracket bolts in the following steps.**
  a Tighten bolts 9 - 12, then 1 - 8.
  2.0 N·m (0.204 kg-m, 17.7 in-lb)
  b Tighten bolts 1 - 12.
  5.9 N·m (0.60 kg-m, 52.2 in-lb)
  c Tighten bolts 1 - 12.
  9.8 - 11.8 N·m (1.00 - 1.20 kg-m, 86.7 - 104.4 in-lb)
- **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" in "VALVE CLEARANCE" (EM-40).

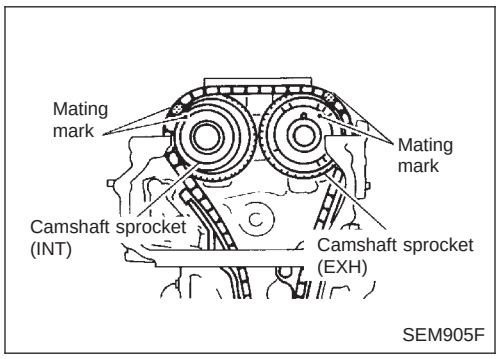
  Reference data valve clearance (Cold):

  Intake

  0.25 - 0.33 mm (0.010 - 0.013 in)

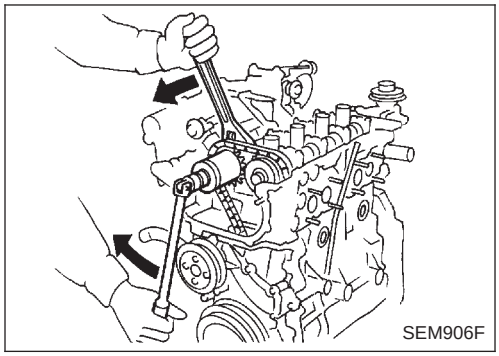
  Exhaust

  0.32 - 0.40 mm (0.013 - 0.016 in)



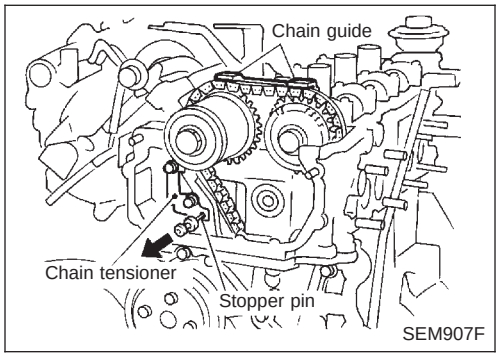
6. Install camshaft sprocket.

- **Set timing chain by aligning mating marks with those of camshaft sprockets.**



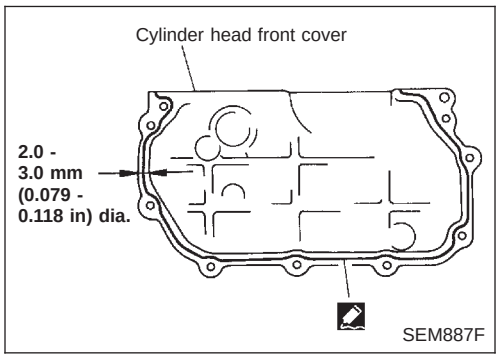
7. Install camshaft sprocket bolts to correct torque.

- **Apply new engine oil to bolt threads and seat surface.**

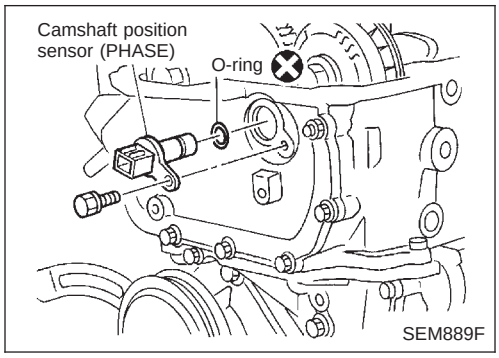


8. Install chain tensioner.
- **Before installing chain tensioner, insert a suitable pin into pin hole of chain tensioner.**
- **After installing chain tensioner, remove the pin.**

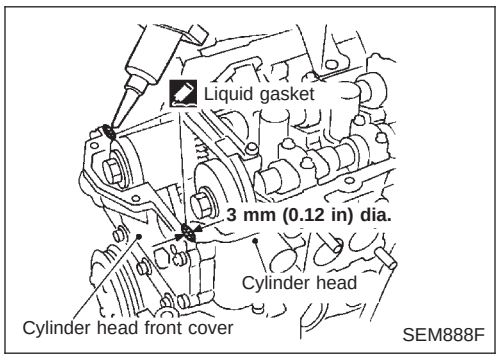
9. Install timing chain guide.



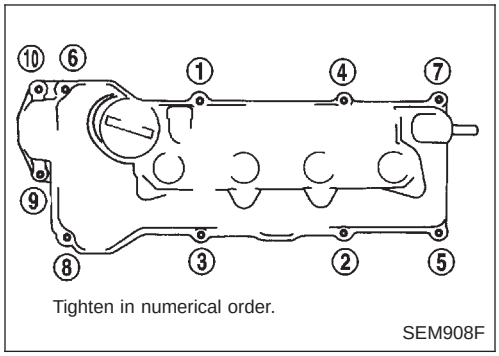
10. Install cylinder head front cover.
- Apply liquid gasket to cylinder head front cover.
- Use Genuine Liquid Gasket or equivalent.



11. Install camshaft position sensor (PHASE).



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



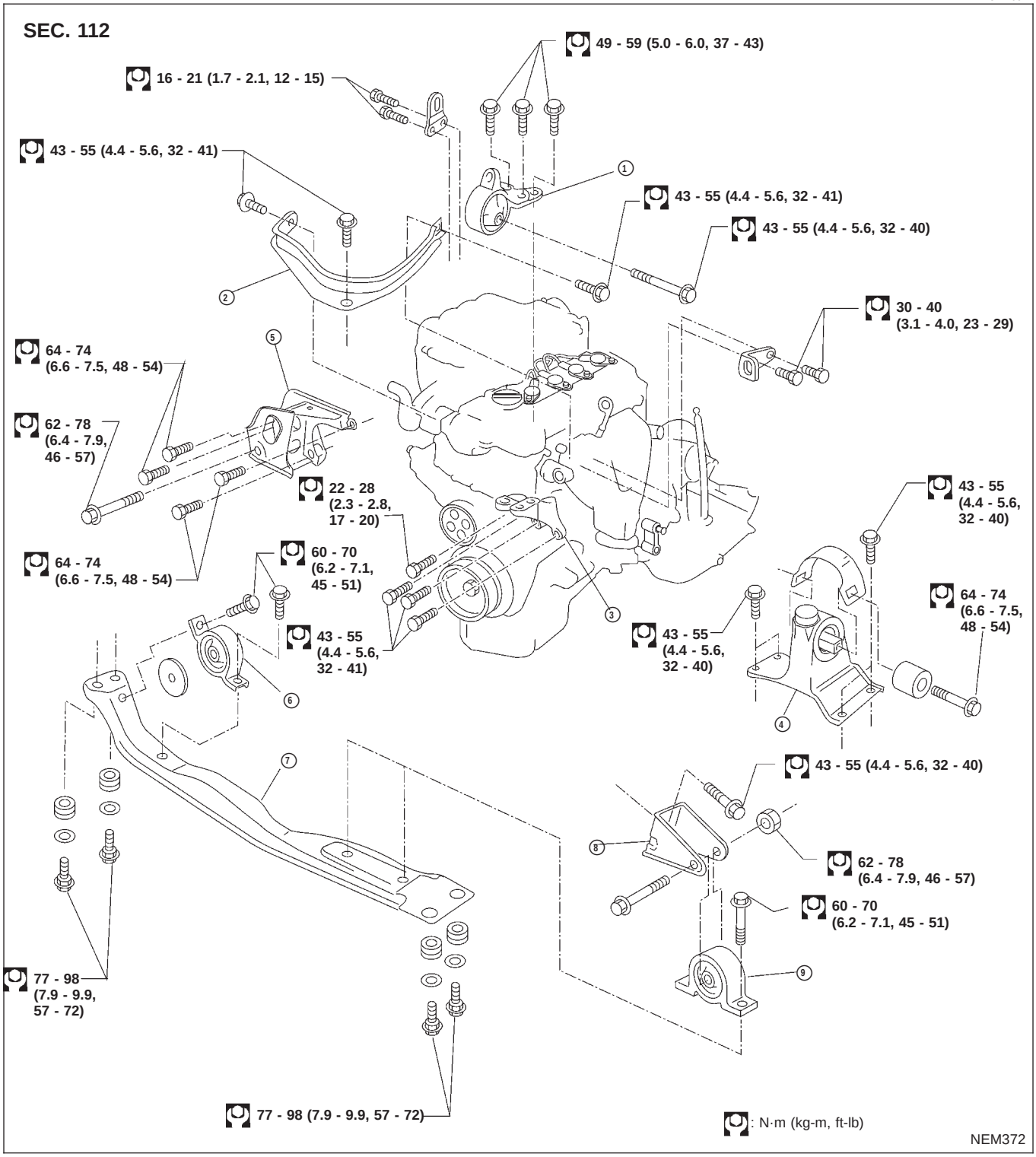
13. Install rocker cover and tighten bolts in numerical order as shown in the figure.
14. Install spark plugs.
15. Install ignition coils.
16. Install intake manifold rear supports.
17. Install front exhaust tube.
18. Install front undercover.
19. Install air duct to intake manifold collector.
20. Install power steering pulley and pump with bracket.
To check power steering fluid, refer to MA section ("Checking

Power Steering Fluid and Lines", "CHASSIS AND BODY MAINTENANCE").

21. Drive belts.
    For adjusting drive belt deflection, refer to MA section ("Checking Drive Belts", "ENGINE MAINTENANCE").
22. Reinstall parts in reverse order of removal.

Removal and Installation

NCEM0022



1. Engine front mounting
2. Cylinder head front mouting bracket
3. Engine front mouting bracket
4. LH engine mounting
5. Engine rear mounting bracket
6. Engine rear mounting
7. Center member
8. Front mounting bracket
9. Front mounting

WARNING:

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

CAUTION:

- **When lifting engine, be sure to clear surrounding parts. Use special care near accelerator wire casing, brake lines and brake master cylinder.**
- **When lifting the engine, always use engine slingers in a safe manner.**
- **When removing drive shaft, be careful not to damage grease seal of transaxle.**
- **Before separating engine and transaxle, remove crankshaft position sensor (POS) from the cylinder block assembly.**
- **Always be extra careful not to damage edge of crankshaft position sensor (POS), or signal plate teeth.**

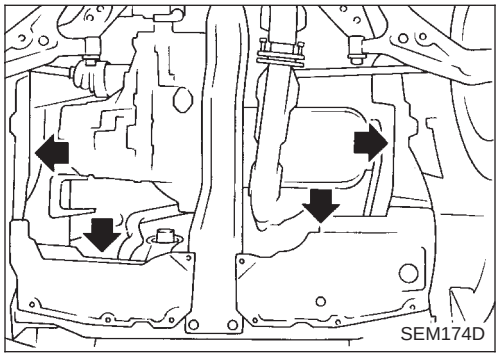
Engine cannot be removed separately from transaxle. Remove engine with transaxle as an assembly.

REMOVAL

NCEM0022S01

1. Drain coolant from radiator and cylinder block. Refer to (LC) section ("Changing Engine Coolant", "ENGINE MAINTENANCE").
2. Drain engine oil.
3. Remove battery.
4. Remove coolant reservoir tank and bracket.
5. Remove drive belts.
6. Remove generator and air conditioner compressor from engine.
7. Remove power steering oil pump from engine and position aside.

Power steering oil pump does not need to be disconnected from power steering tubes.


SEM174D

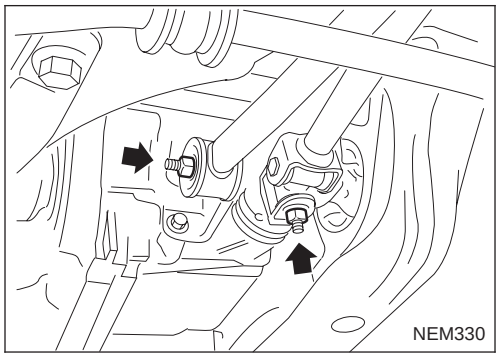
8. Remove the following parts:
- RH and LH front tires
- Undercovers
- Splash covers
- RH and LH brake caliper assemblies

: 54 - 64 N·m (5.5 - 6.5 kg-m, 40 - 47 ft-lb)

Brake hose does not need to be disconnected from brake caliper assembly. Never depress brake pedal.

- RH & LH drive shaft. Refer to FA section ("Drive Shaft", "FRONT AXLE").

When removing drive shaft, be careful not to damage transaxle side grease seal.


NEM330

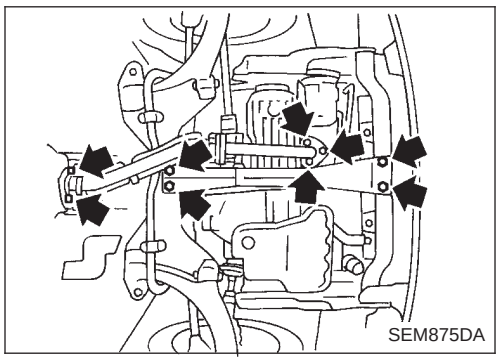
- Disconnect control rod and support rod from transaxle.

Control rod:

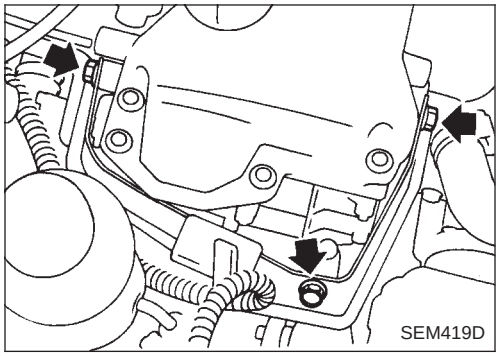
: 14 - 18 N·m (1.4 - 1.8 kg-m, 10 - 13 ft-lb)

Support rod:

: 35 - 47 N·m (3.6 - 4.8 kg-m, 26 - 35 ft-lb)


SEM875DA

- Center member
- Front exhaust tube
- Stabilizer bar
- Cooling fan
- Radiator

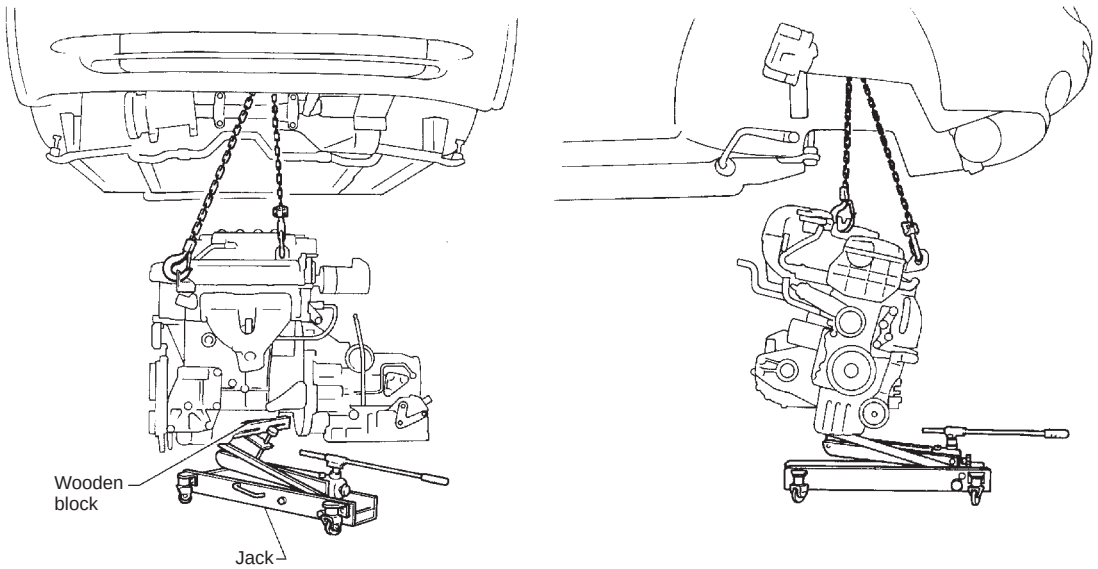

SEM419D

- Cylinder head front mounting bracket
- Remove air duct and disconnect wires, harness, pipes, hoses and so on.

9. Lift up engine slightly and disconnect or remove all engine mountings.

When lifting engine, be sure to clear surrounding parts. Use special care near brake tubes and brake master cylinder.

10. Remove engine with transaxle as shown.



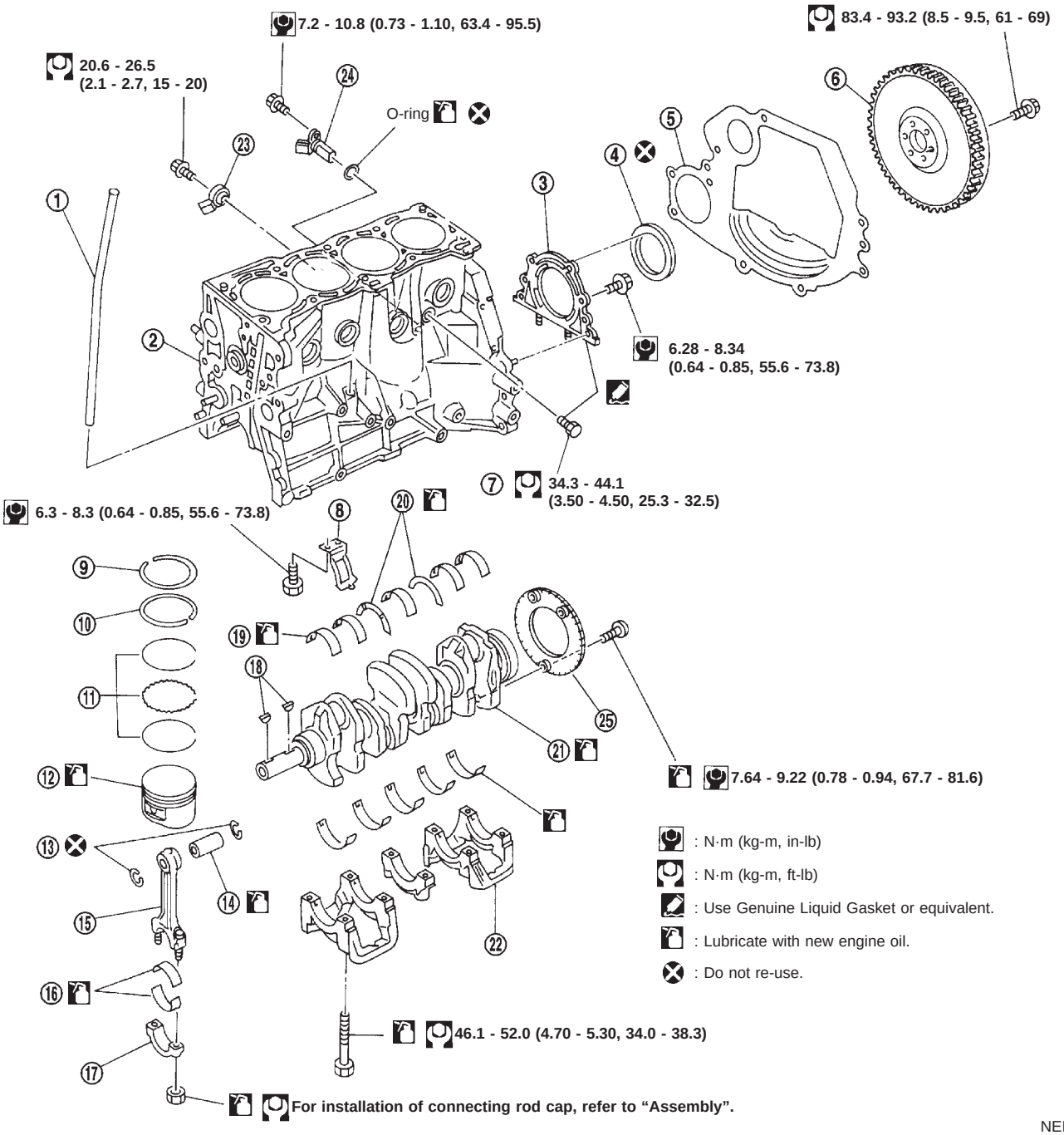
SEM420D

INSTALLATION

NCEM0022S02

- Install in reverse order of removal.

Components



NEM331

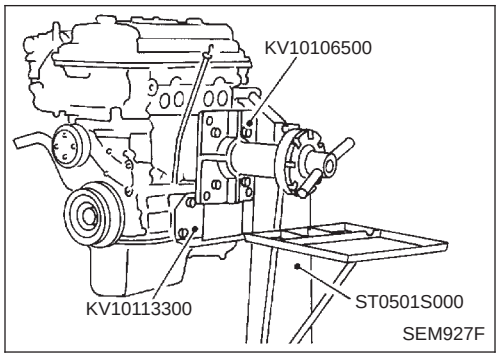
1. Oil level gauge guide
2. Cylinder block
3. Rear oil seal retainer
4. Rear oil seal
5. Rear plate
6. Flywheel
7. Drain plug
8. Buffle plate
9. Top ring
10. 2nd ring
11. Oil ring
12. Piston
13. Snap ring
14. Piston pin
15. Connecting rod
16. Connecting rod bearing
17. Connecting rod cap
18. Key
19. Main bearing
20. Thrust bearing
21. Crankshaft
22. Main bearing cap
23. Knock sensor
24. Crankshaft position sensor (POS)
25. Signal plate

Removal and Installation

NCEM0024

CAUTION:

- **When installing sliding parts such as bearings and pistons, apply engine oil on the sliding surfaces.**
- **Place removed parts, such as bearings and bearing caps, in their proper order and direction.**
- **When installing connecting rod nuts and main bearing cap bolts, apply new engine oil to threads and seating surfaces.**
- **Do not allow any magnetic materials to contact the signal plate teeth of flywheel or drive plate, and rear plate.**
- **Remove the crankshaft position sensor (POS).**
- **Be careful not to damage sensor edges and single plate teeth.**



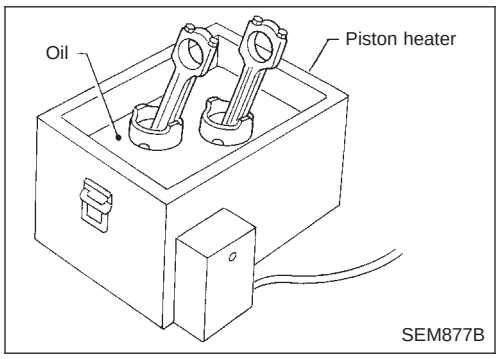
Disassembly

NCEM0025

PISTON AND CRANKSHAFT

NCEM0025S01

1. Place engine on a work stand.
2. Drain coolant and oil.
3. Remove timing chain.
   Refer to EM-20.

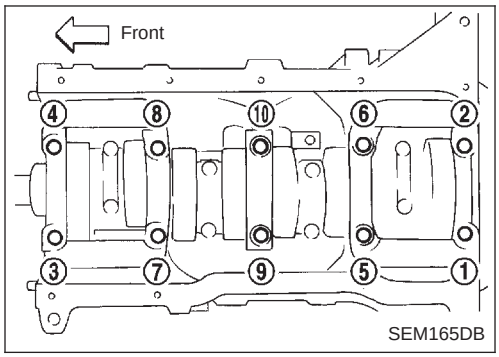


4. Remove pistons with connecting rod.

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

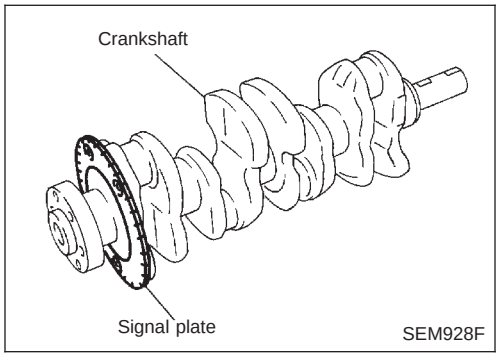
CAUTION:

- **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 punch mark, install with either side up.**



5. Loosen main bearing caps in numerical order as shown in figure.
6. Remove bearing caps, main bearings and crankshaft.

- **Before removing bearing caps, measure crankshaft end play. Refer to EM-61.**
- **Bolts should be loosened in two or three steps.**



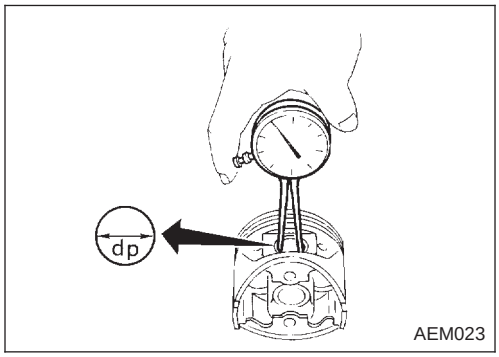
7. Remove signal plate from crankshaft.

Inspection

NCEM0026

PISTON AND PISTON PIN CLEARANCE

NCEM0026S01



1. Measure inner diameter of piston pin hole "dp".

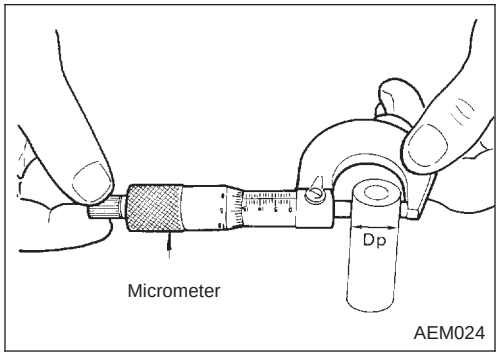
Standard diameter "dp":

QG16DE

18.987 - 18.999 mm (0.7474 - 0.7480 in)

QG18DE

18.993 - 19.005 mm (0.7478 - 0.7482 in)



2. Measure outer diameter of piston pin "Dp".

Standard diameter "Dp":

18.989 - 19.001 mm (0.7476 - 0.7481 in)

3. Calculate piston pin clearance.

QG16DE

Dp - dp: -0.004 - 0 (-0.0002 - 0 in)

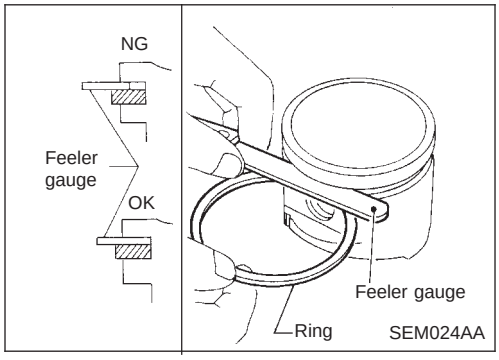
QG18DE

Dp − dp: 0.002 - 0.006 (0.0001 - 0.0002 in)

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

PISTON RING SIDE CLEARANCE

NCEM0026S02



Side clearance:

Refer to SDS, EM-185

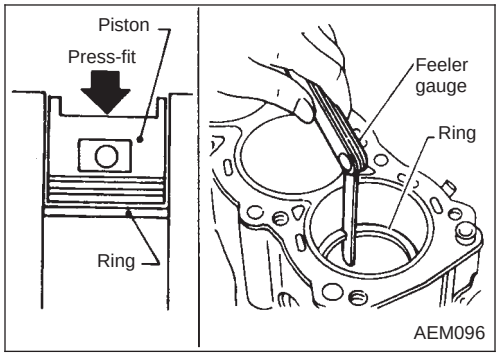
Max. limit of side clearance:

Refer to SDS, EM-185

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

PISTON RING END GAP

NCEM0026S03



End gap:

Refer to SDS, EM-185

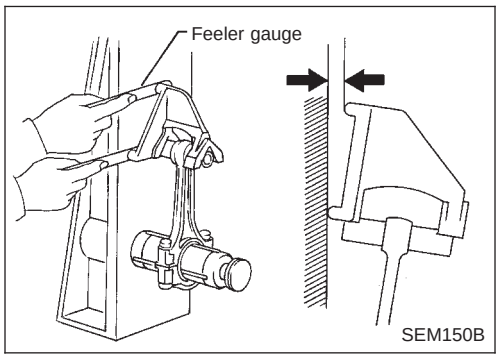
Max. limit of ring gap:

Refer to SDS, EM-185

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

Refer to SDS, EM-185.

- 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.



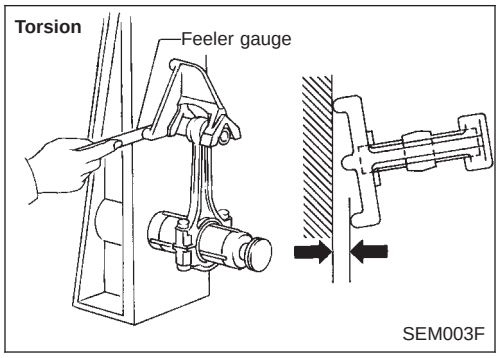
CONNECTING ROD BEND AND TORSION

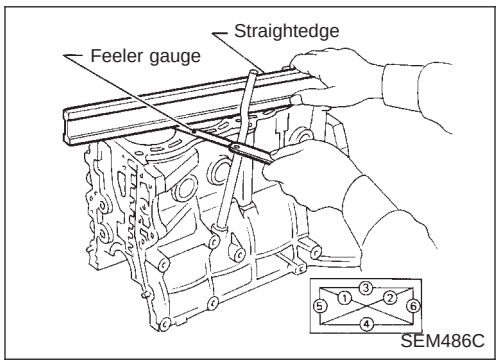
NCEM0026S04

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

Torsion:
Limit 0.3 mm (0.012 in)
per 100 mm (3.94 in) length

If it exceeds the limit, replace connecting rod assembly.





CYLINDER BLOCK DISTORTION AND WEAR

NCEM0026S05

Clean upper surface of cylinder block.

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

Block surface flatness:
Standard Less than 0.03 mm (0.0012 in)
Limit 0.10 mm (0.004 in)

If out of specification, resurface it.

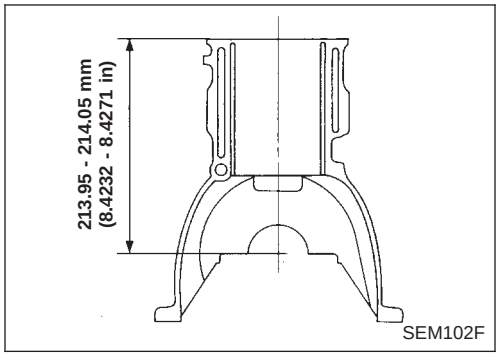
The limit for cylinder block resurfacing is determined by the amount of cylinder head resurfacing.

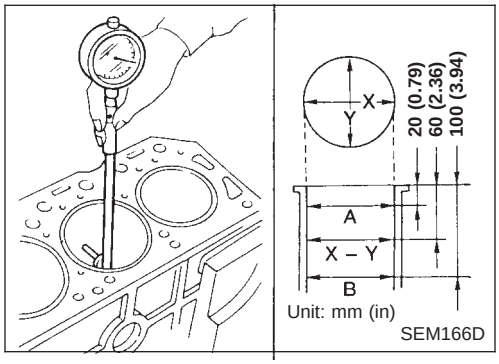
Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".

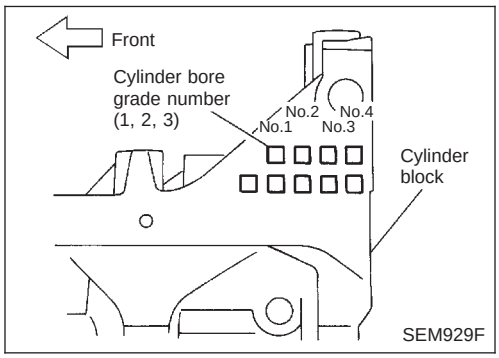
The maximum limit is as follows:
A + B = 0.2 mm (0.008 in)

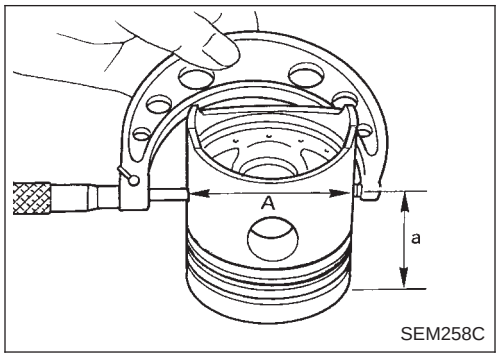
Nominal cylinder block height from crankshaft center:
213.95 - 214.05 mm (8.4232 - 8.4271 in)

If necessary, replace cylinder block.









PISTON-TO-BORE CLEARANCE

NCEM0026S06

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

Standard inner diameter:
Refer to SDS, EM-184
Wear limit:
0.2 mm (0.008 in)
Out-of-round (X − Y) standard:
Less than 0.015 mm (0.0006 in)
Taper (A − B) standard:
Less than 0.01 mm (0.0004 in)

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

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

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

3. Measure piston skirt diameter.

Piston diameter "A":
Refer to SDS, EM-185.
Measuring point "a" (Distance from the top):
Refer to SDS, EM-185

4. Check that piston-to-bore clearance is within specification.

Piston-to-bore clearance = Cylinder bore measurement "B" − Piston diameter "A":
Refer to SDS, EM-185

5. Determine piston oversize according to amount of cylinder wear.

Oversize pistons are available for service. Refer to SDS EM-185.

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

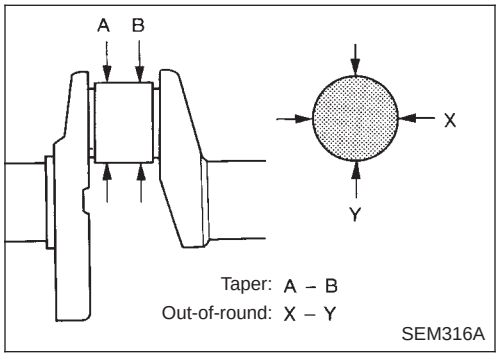
Rebored size calculation:
D = A + B − C
where,
D: Bored diameter
A: Piston diameter as measured
B: Piston-to-bore clearance
C: Honing allowance 0.02 mm (0.0008 in)

7. Install main bearing caps and tighten bolts to the specified torque. This will prevent distortion of cylinder bores.
8. Cut cylinder bores.

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

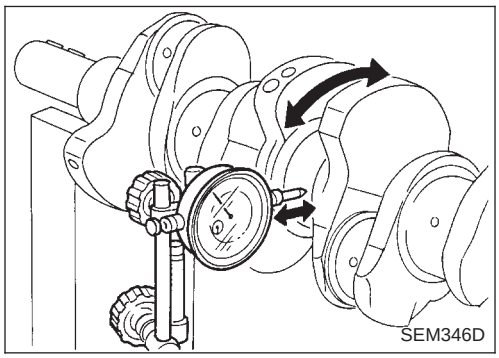


CRANKSHAFT

NCEM0026S07

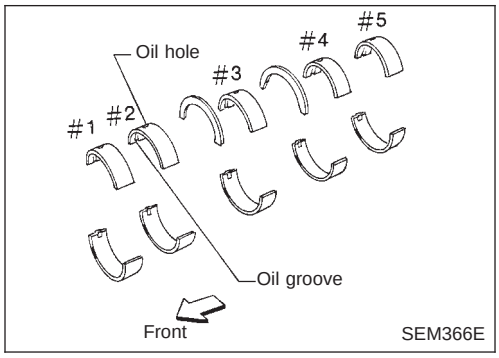
1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.

Out-of-round (X − Y):
Less than 0.003 mm (0.0001 in)
Taper (A − B):
Less than 0.004 mm (0.0002 in)



3. Measure crankshaft runout.

Runout (Total indicator reading):
Less than 0.04 mm (0.0016 in)



BEARING CLEARANCE

NCEM0026S08

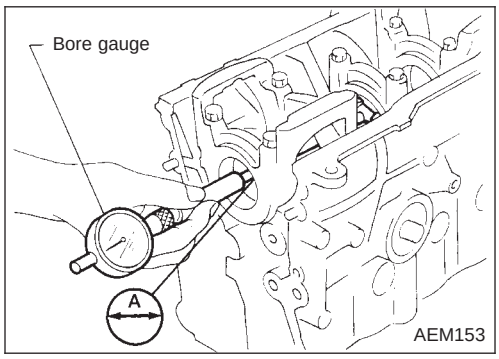
- Use Method A or Method B. Method A is preferred because it is more accurate.

Method A (Using bore gauge and micrometer)

Main bearing

NCEM0026S0801

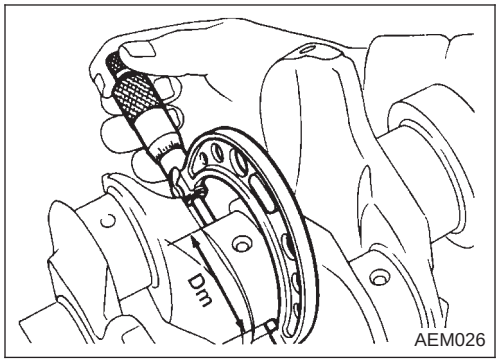
1. Set main bearings in their proper positions on cylinder block and main bearing cap.



2. Install main bearing cap to cylinder block.

Tighten all bolts in correct order in two or three stages. Refer to EM-52.

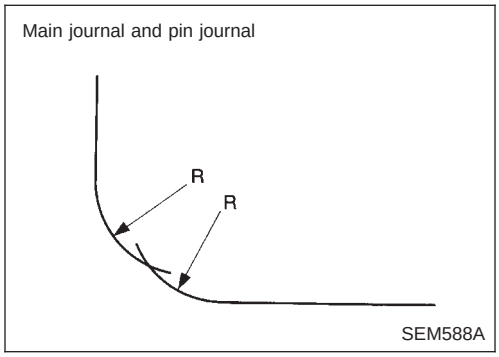
3. Measure inner diameter "A" of each main bearing.



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

Main bearing clearance = A − Dm
Standard: 0.020 - 0.044 mm (0.0008 - 0.0017 in)
Limit: 0.1 mm (0.004 in)

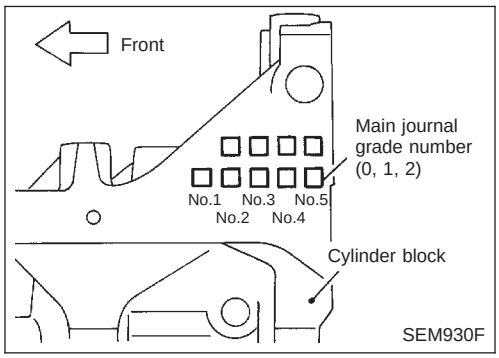
If it exceeds the limit, replace bearing.
If clearance cannot be adjusted within standard of any bearing, grind crankshaft journal and use undersized bearing.



When grinding crank pin and crank journal:

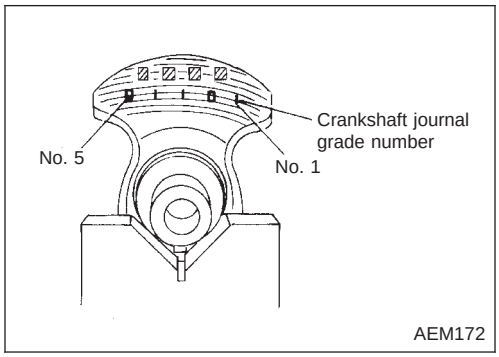
- **Grind until clearance is within specified standard bearing clearance.**
- **Fillets should be finished as shown in the figure. R: 2.3 - 2.5 mm (0.091 - 0.098 in)**

Refer to SDS, EM-187 for standard bearing clearance and available spare parts.



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

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



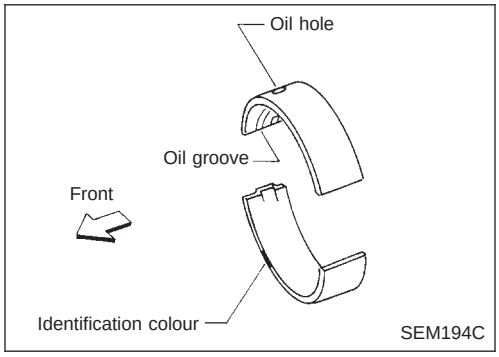
b. Grade number of each crankshaft main journal is punched on the respective crankshaft. These numbers are punched in either Arabic or Roman numerals.

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

Main bearing grade color:

Crankshaft main journal grade number	Cylinder block main journal grade number		
	0	1	2
0	Black	Red	Green
1	Red	Green	Yellow
2	Green	Yellow	Blue

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



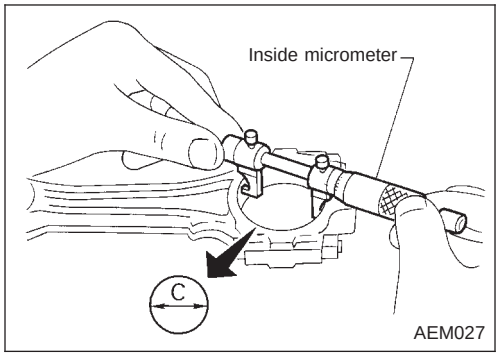
Connecting rod bearing (Big end)

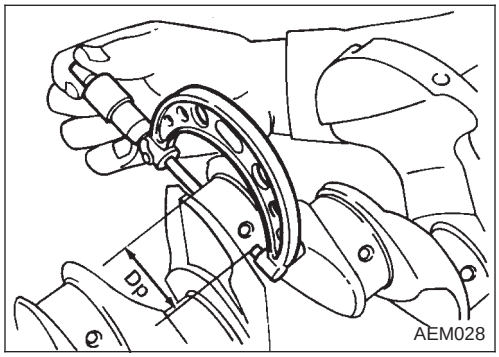
NCEM0026S0802

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

Tighten bolts to the specified torque.

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





AEM028

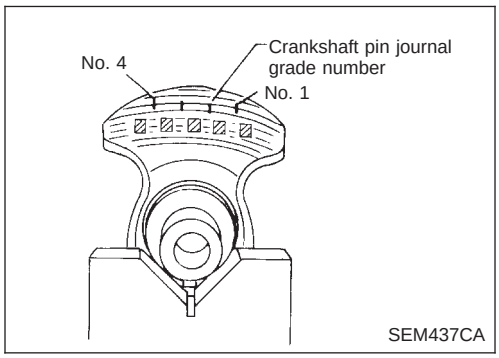
4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.

Connecting rod bearing clearance = C − Dp

Standard: 0.014 - 0.039 mm (0.0006 - 0.0015 in)

Limit: 0.1 mm (0.004 in)

If it exceeds the limit, replace bearing.
If clearance cannot be adjusted using any standard bearing grade, grind crankshaft journal and use undersized bearing. Refer to step 5, EM-57.

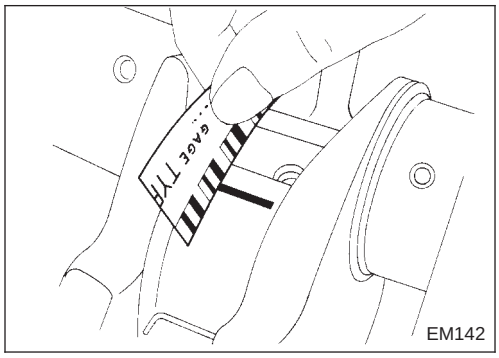


SEM437CA

- If a new bearing, crankshaft or connecting rod is replaced, select connecting rod bearing according to the following table.

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

Crankshaft pin journal grade number	Connecting rod bearing grade color
0	—
1	Brown
2	Green



EM142

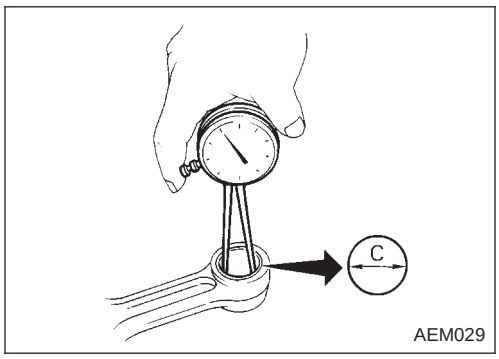
Method B (Using Plastigage)

CAUTION:

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

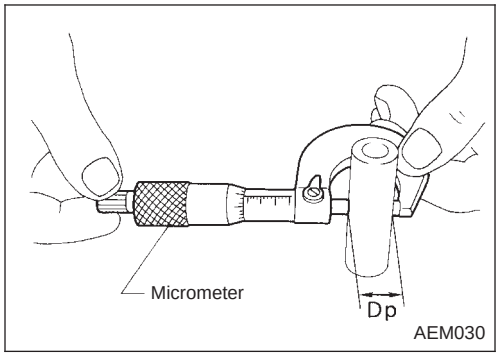
CONNECTING ROD BUSHING CLEARANCE (Small end)

NCEM0026S09



AEM029

1. Measure inner diameter "C" of bushing.



AEM030

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

Connecting rod bushing clearance = C − Dp

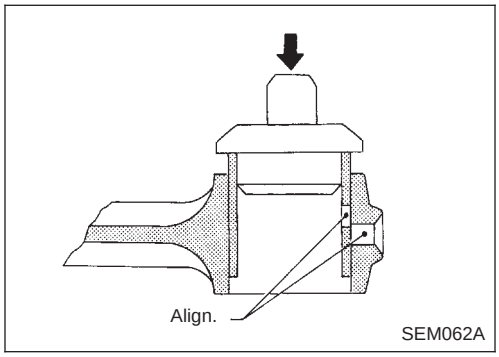
Standard:

0.005 - 0.017 mm (0.0002 - 0.0007 in)

Limit:

0.023 mm (0.0009 in)

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



REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

NCEM0026S10

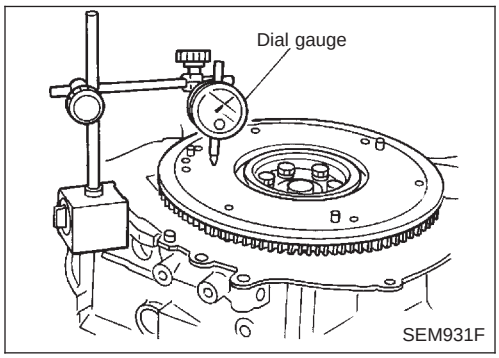
1. Drive in small end bushing until it is flush with end surface of rod.

Be sure to align the oil holes.

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

Clearance between connecting rod bushing and piston pin:

0.005 - 0.017 mm (0.0002 - 0.0007 in)



FLYWHEEL/DRIVE PLATE RUNOUT

NCEM0026S12

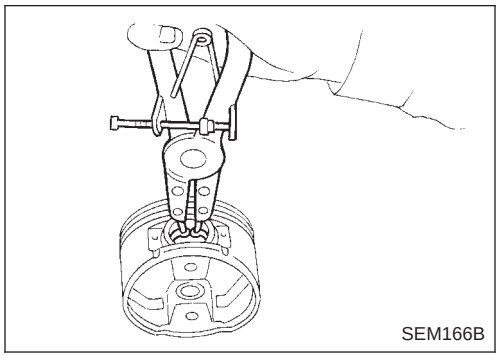
Runout (Total indicator reading):

Flywheel

Less than 0.15 mm (0.0059 in)

CAUTION:

- **Do not allow any magnetic materials to contact the ring gear teeth and rear plate.**
- **Do not resurface flywheel. Replace as necessary.**



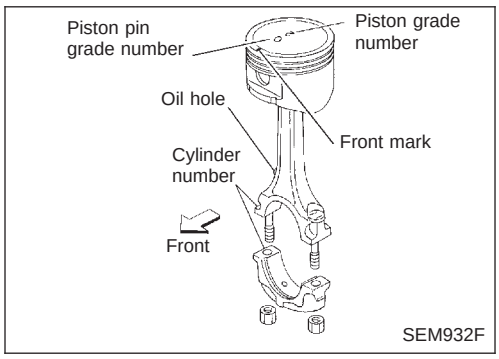
Assembly

NCEM0027

PISTON

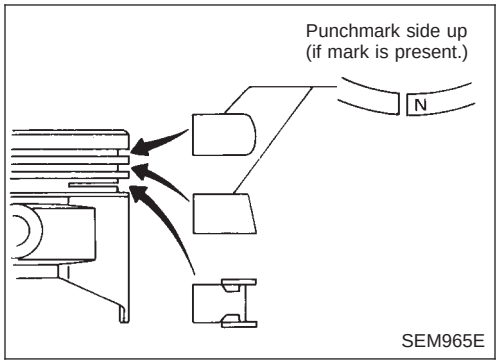
NCEM0027S01

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



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

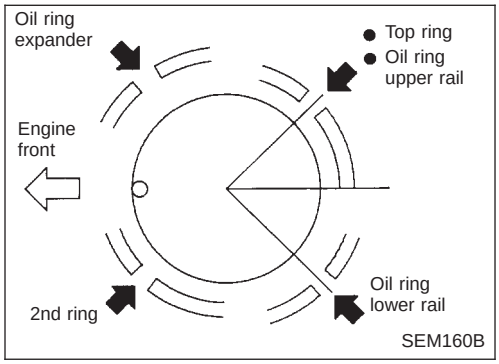
- **Align the direction of piston and connecting rod.**
- **Numbers stamped on connecting rod and cap correspond to each cylinder.**
- **After assembly, make sure connecting rod swings smoothly.**



3. Set piston rings as shown.

CAUTION:

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



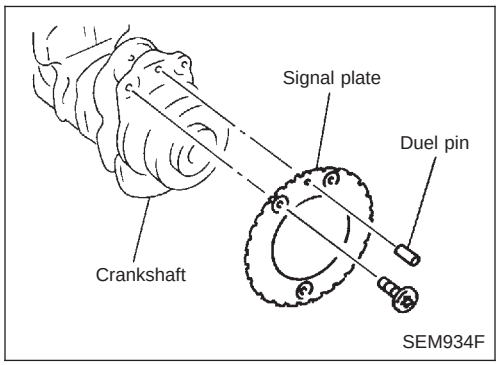
- **Align piston rings so that end gaps are positioned as shown.**

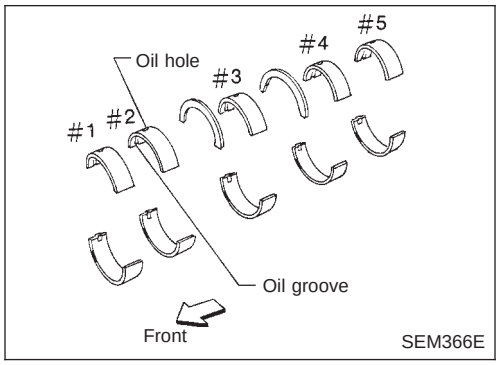
CRANKSHAFT

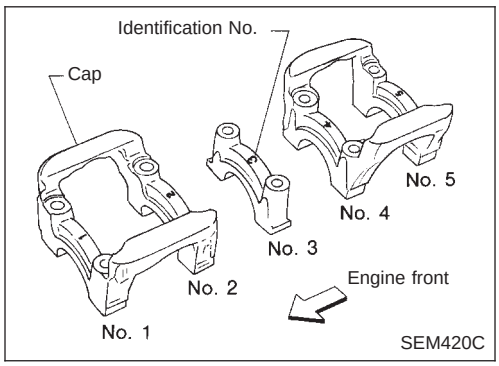
NCEM0027S02

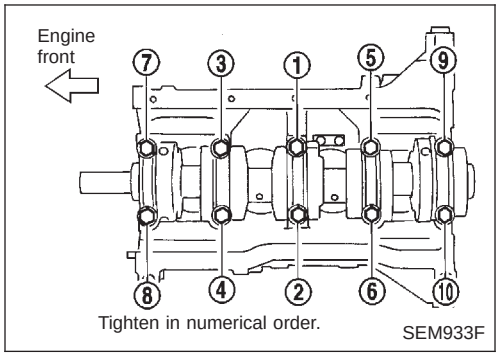
1. Install signal plate to crankshaft.
2. Set main bearings in their proper positions on cylinder block and main bearing cap.

- **Confirm that correct main bearings are selected by using Method A or Method B. Refer to EM-57.**
- **Apply new engine oil to bearing surfaces.**



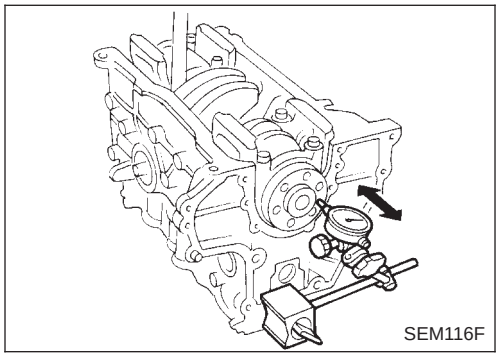






3. Install crankshaft and main bearing caps and tighten bolts to the specified torque.

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


SEM116F

4. Measure crankshaft end play.

Crankshaft end play:

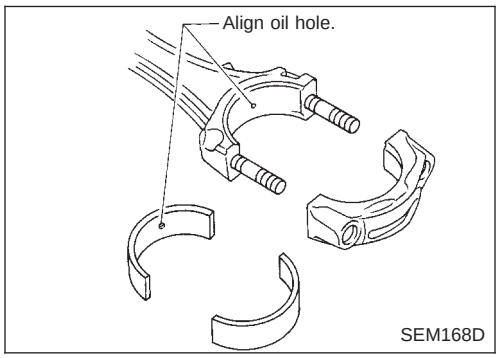
Standard

0.060 - 0.260 mm (0.0024 - 0.0102 in)

Limit

0.3 mm (0.012 in)

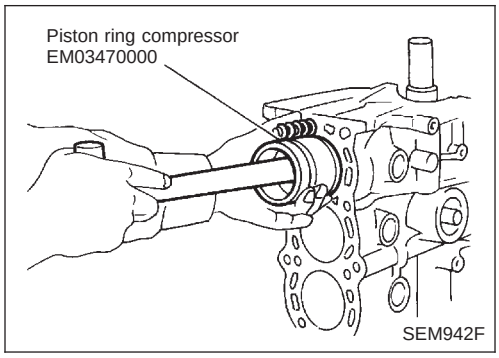
If beyond the limit, replace thrust bearing with new ones.



SEM168D

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

- **Confirm that correct bearings are used. Refer to EM-58.**
- **Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.**
- **Apply new engine oil to bolt threads and bearing surfaces.**

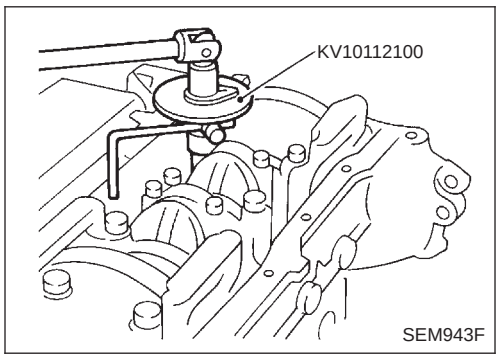


SEM942F

6. Install pistons with connecting rods.

a. Install them into corresponding cylinders with Tool.

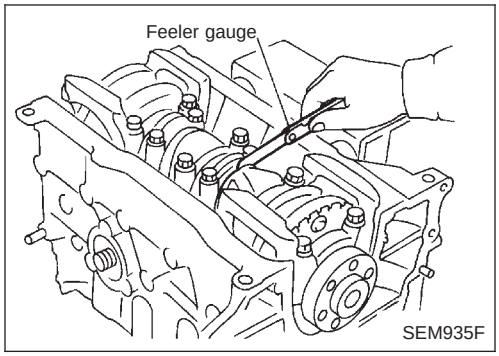
- **Make sure connecting rod does not scratch cylinder wall.**
- **Make sure connecting rod bolts do not scratch crankshaft pin journals.**
- **Arrange so that front mark on piston head faces engine.**
- **Apply new engine oil to piston rings and sliding surface of piston.**



SEM943F

b. Install connecting rod caps.
Apply new engine oil to bolt threads and nut seating surfaces.
Tighten connecting rod cap nuts in the following procedure:

- **Tighten to 13.72 to 15.68 N·m (1.399 to 1.599 kg-m, 10.120 - 11.566 ft-lb).**
- **Turn nuts to 35° to 40° degrees clockwise with an angle wrench. If an angle wrench is not available, tighten nuts to 23 to 28 N·m (2.3 to 2.9 kg-m, 17 to 21 ft-lb).**



SEM935F

7. Measure connecting rod side clearance.

Connecting rod side clearance:

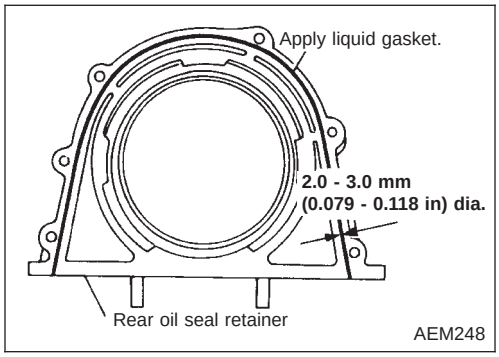
Standard

0.200 - 0.470 mm (0.0079 - 0.0185 in)

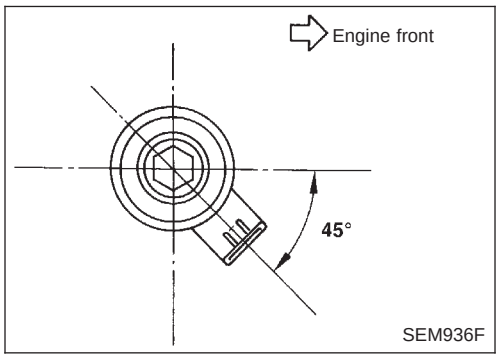
Limit

0.5 mm (0.0205 in)

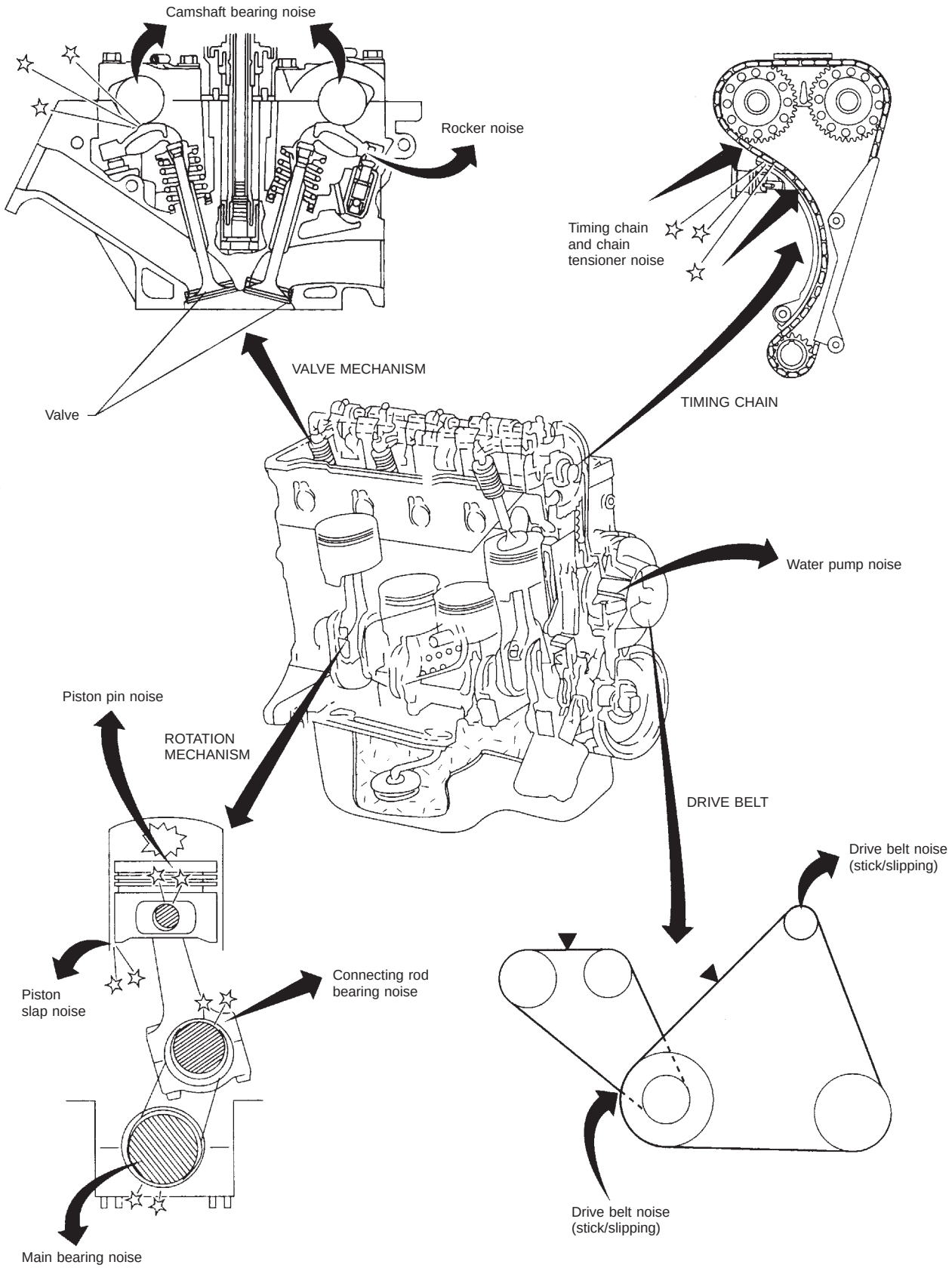
If beyond the limit, replace connecting rod and/or crankshaft.



8. Install rear oil seal retainer.
a. Before installing rear oil seal retainer, remove old liquid gasket from cylinder block and retainer.
b. Apply a continuous bead of liquid gasket to rear oil seal retainer.
- **Use Genuine Liquid Gasket or equivalent.**
- **Apply around inner side of bolt holes.**
9. Install crankshaft positon sensor (POS).



10. Install knock sensor.


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

NEM335

NVH Troubleshooting — Engine Noise

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

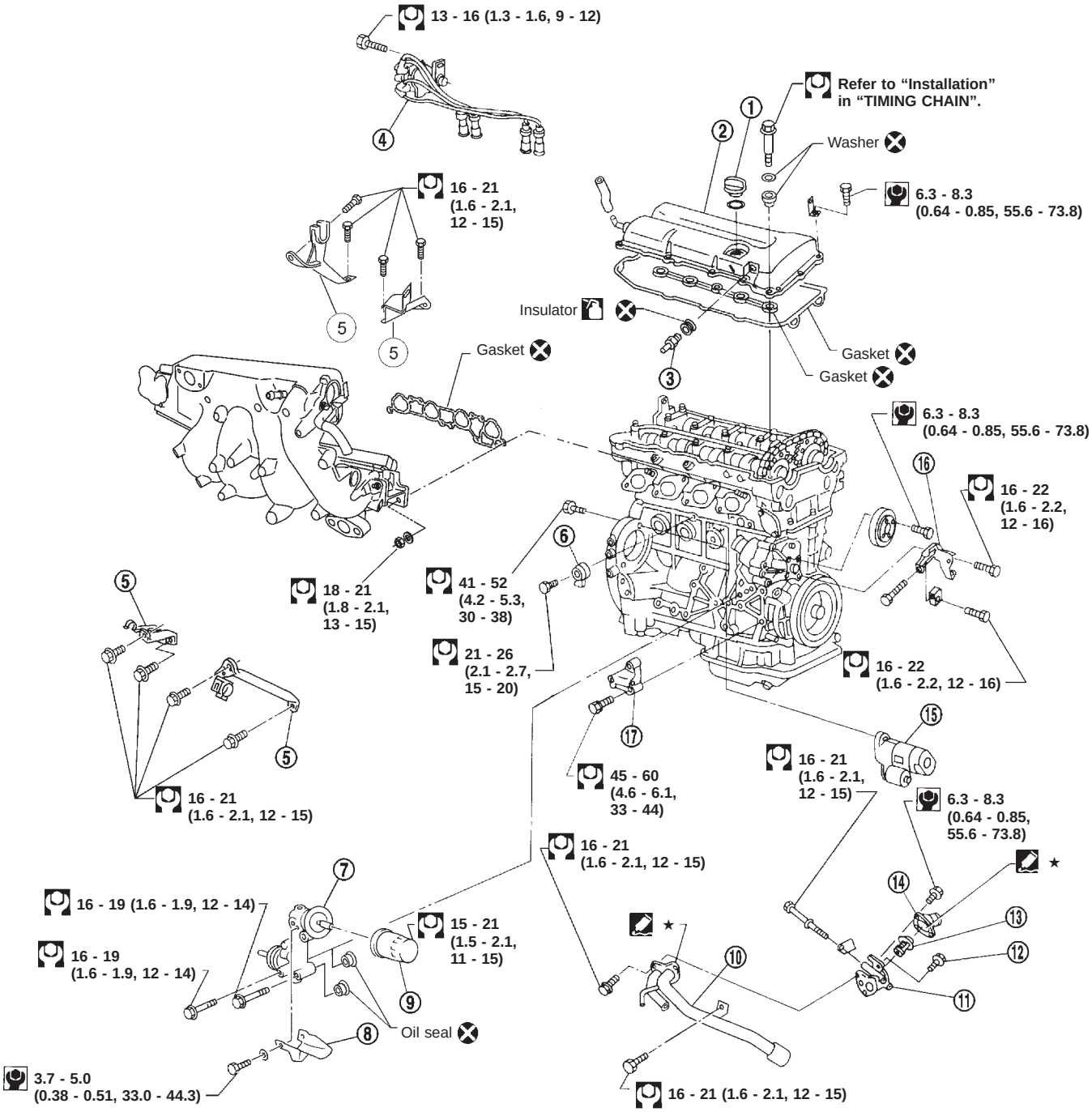
1. Locate the area where noise occurs.
2. Confirm the type of noise.
3. Specify the operating condition of engine.
4. Check specified noise source.

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 start-ing	When idling	When racing	While driving			
Top of Engine rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Rocker noise	Hydraulic lash adjuster	EM-96
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clear-ance Camshaft runout	EM-92
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-110, 116
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston-to-bore clearance Piston ring side clear-ance Piston ring end gap Connecting rod bend and torsion	EM-111, 112
	Knock	A	B	C	B	B	B	Connecting rod-bearing noise	Connecting rod bearing clearance (Big end) Connecting rod bushing clearance (Small end)	EM-115, 116
	Knock	A	B	—	A	B	C	Main bear-ing noise	Main bearing oil clear-ance Crankshaft runout	EM-113, 114
Front of engine Timing chain cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain ten-sioner noise	Timing chain cracks and wear	EM-132
Front of Engine	Squeak or fizzing	A	B	—	B	—	C	Other drive belts (stick-ing or slip-ping)	Drive belt deflection	MA Section (“Checking Drive Belts”, “ENGINE MAINTE-NANCE”)
	Creaking	A	B	A	B	A	B	Other drive belts (slip-ping)	Idler pulley bearing operation	
	Squall or creak	A	B	—	B	A	B	Water pump noise	Water pump operation	LC Section (“Water Pump Inspection”, “ENGINE COOLING SYSTEM”)

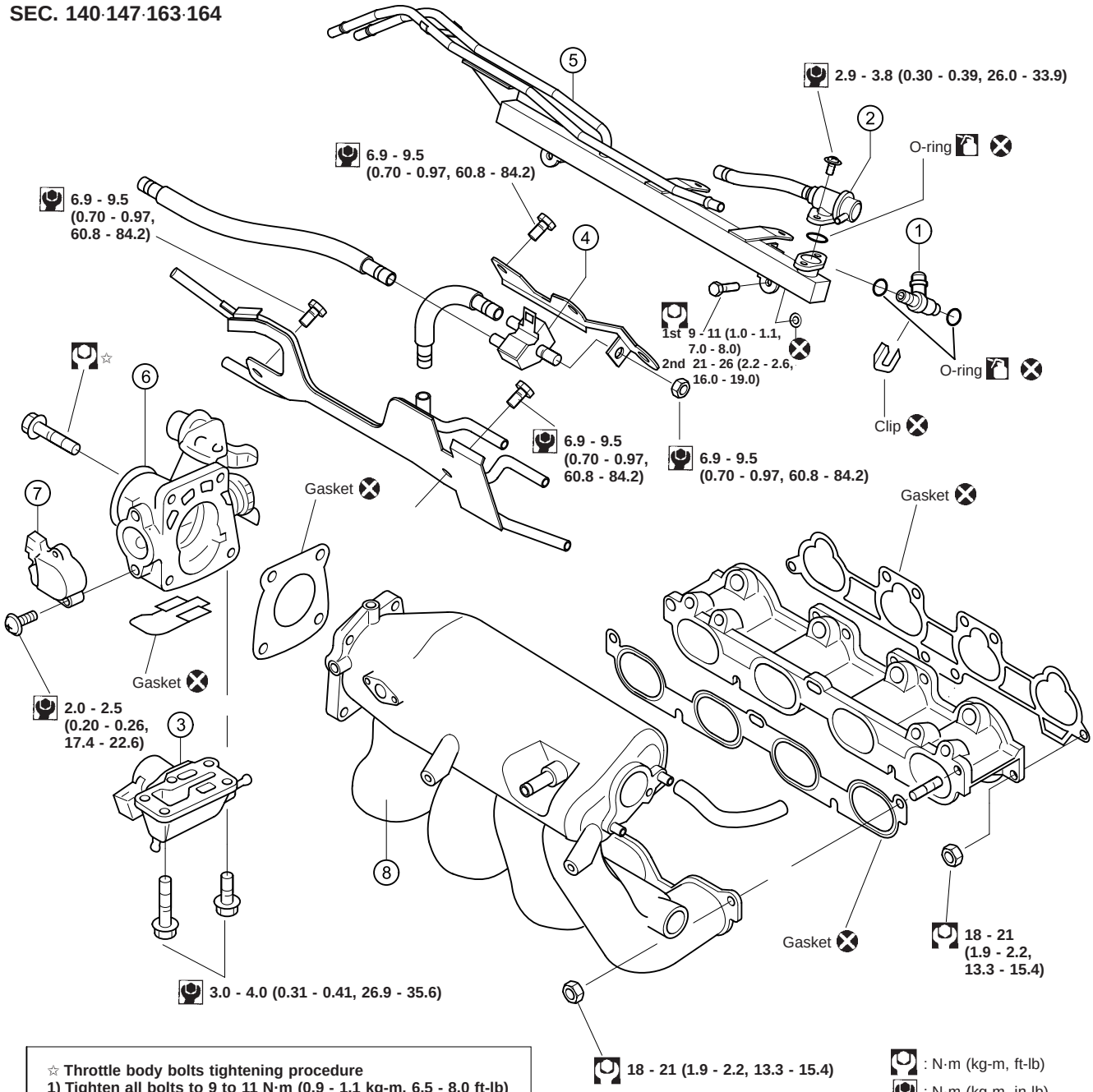
A: Closely related B: Related C: Sometimes related —: Not related

SEC. 130·140·150·210·211·221

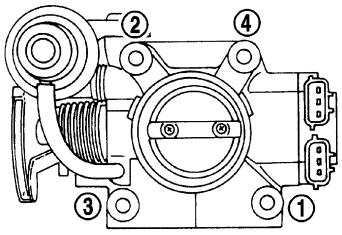


① Oil filler cap
② Rocker cover
③ PCV valve
④ Camshaft position sensor, ignition coil and power transistor built into distributor
⑤ Intake manifold supports
⑥ Knock sensor
⑦ Oil filter bracket
⑧ Oil catcher
⑨ Oil filter
⑩ Water pipe assembly
⑪ Thermostat housing
⑫ Air relief plug
⑬ Thermostat
⑭ Water inlet
⑮ Starter motor
⑯ Power steering oil pump adjusting bar
⑰ Power steering oil pump bracket

SEC. 140·147·163·164



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

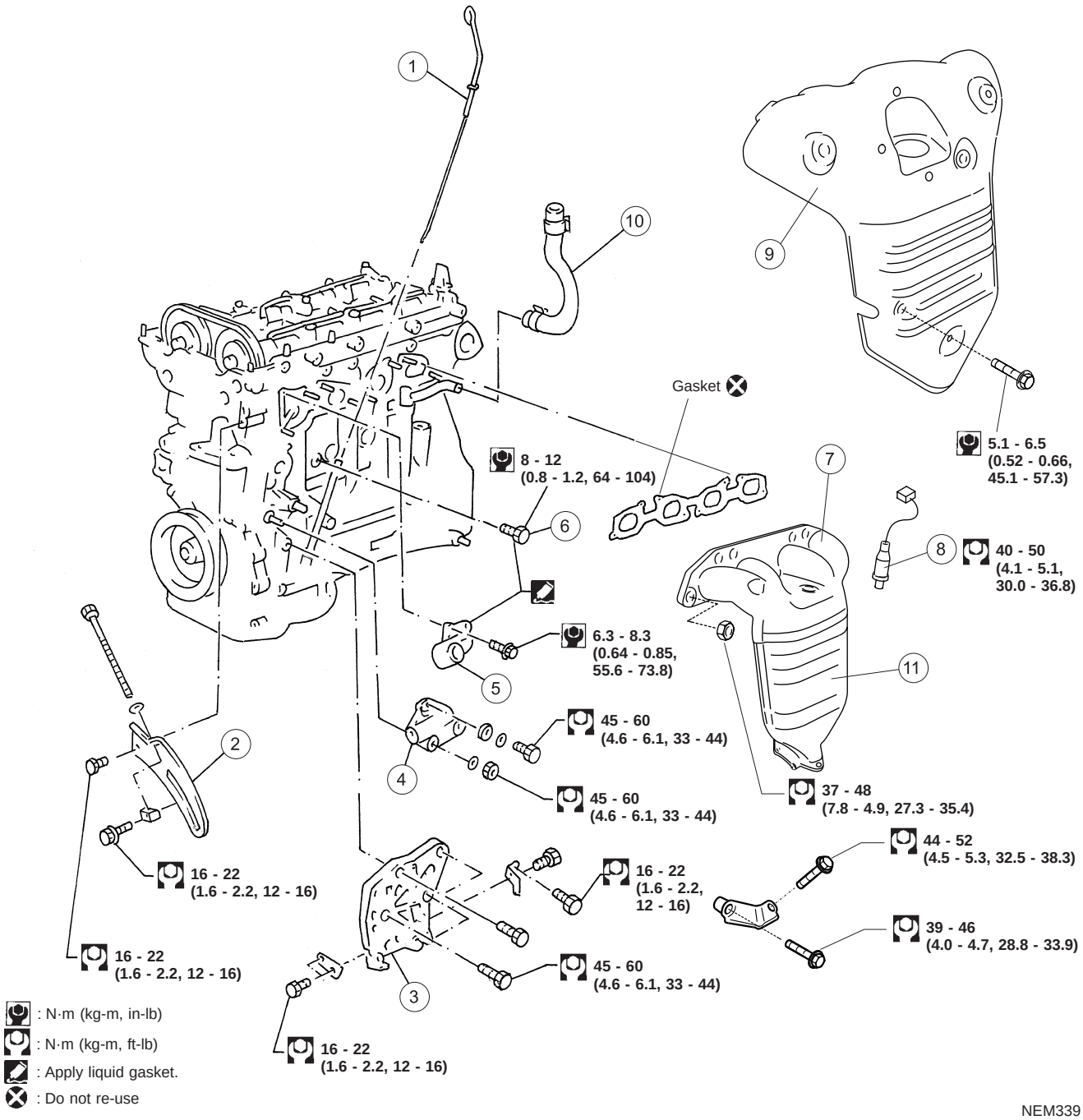


Tighten in numerical order.

NEM337

① Injector
② Pressure regulator
③ IACV-AAC valve
④ Canister purge control valve
⑤ Injector tube
⑥ Throttle body
⑦ Throttle position sensor
⑧ Intake manifold

SEC. 118·140·230·275

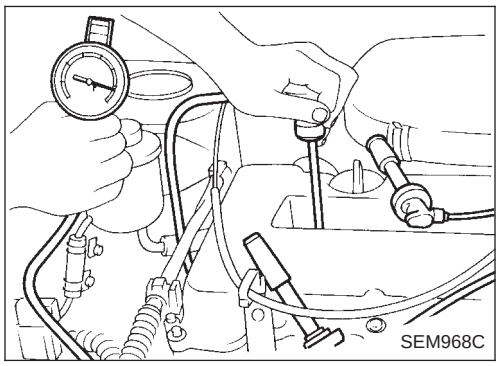


NEM339

① Oil level gauge
② Alternator adjusting bar
③ Compressor bracket
④ Alternator bracket
⑤ Water outlet
⑥ Drain plug
⑦ Exhaust manifold
⑧ Heated oxygen sensor
⑨ Exhaust manifold cover
⑩ Blow-by hose
⑪ Catalytic convertor

Measurement of Compression Pressure

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


SEM968C


20 mm (0.79 in) dia

Compression tester rubber adaptor diameter should be less than 20 mm (0.79 in) to prevent fouling with cylinder head.

NEM118

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

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

Compression pressure:

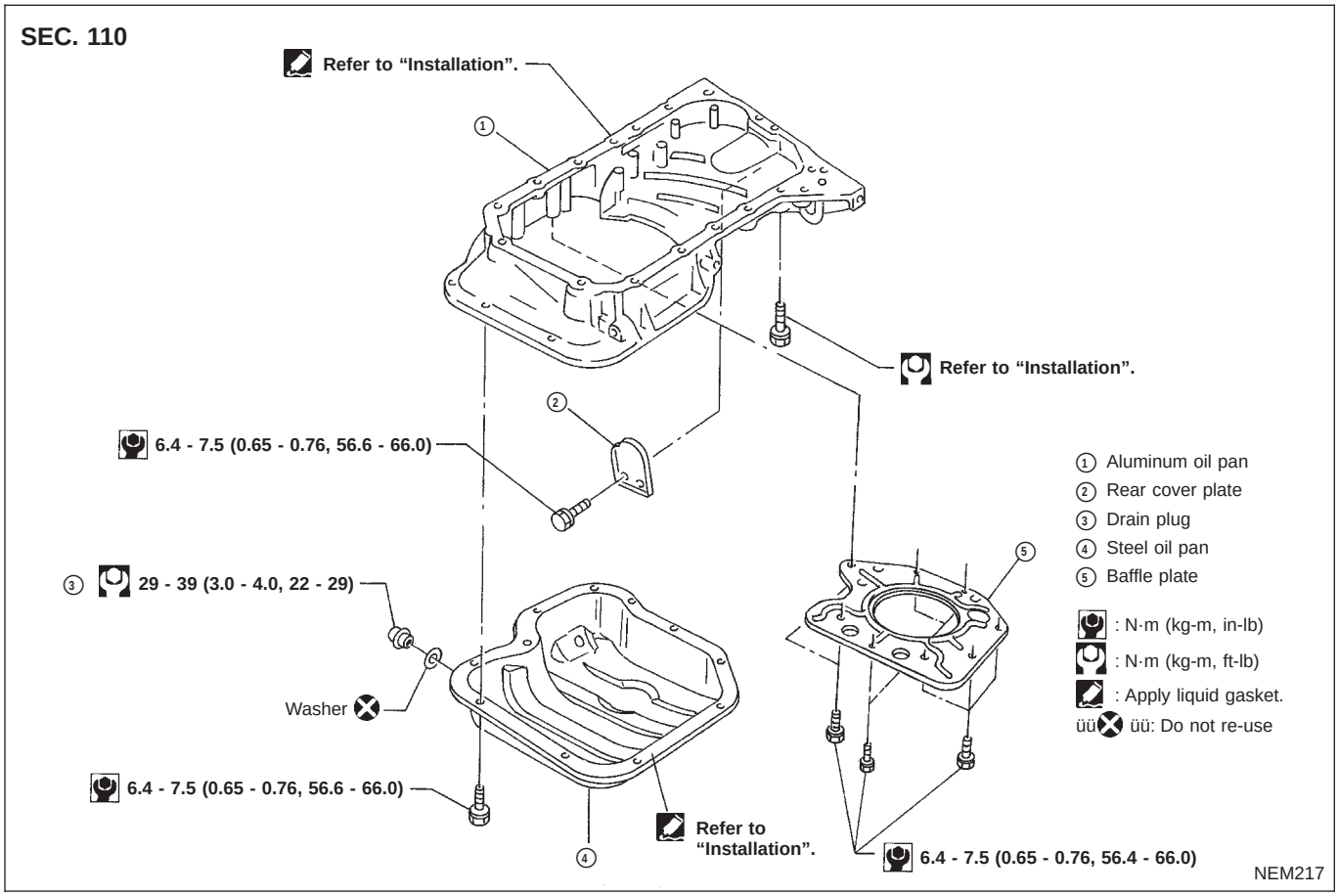
kPa (bar, kg/cm^2, psi)/300 rpm

Standard	1,275 (12.75, 13.0, 185)
Minimum	1,079 (10.79, 11.0, 156)
Difference limit between cylinders	98 (0.98, 1.0, 14)

10. If cylinder 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.

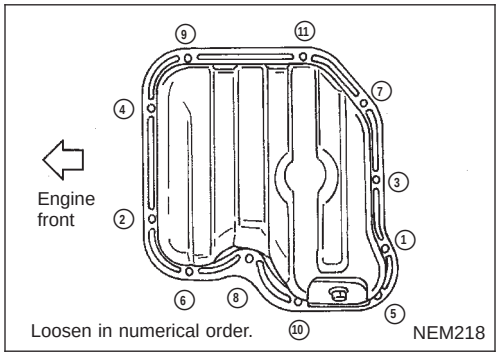
- **If adding oil helps compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston condition.**
- **If pressure stays low, a valve may be sticking or seating badly. Inspect and repair valve and valve seat. (Refer to SDS). If valve or valve seat is damaged excessively,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

SEC. 110

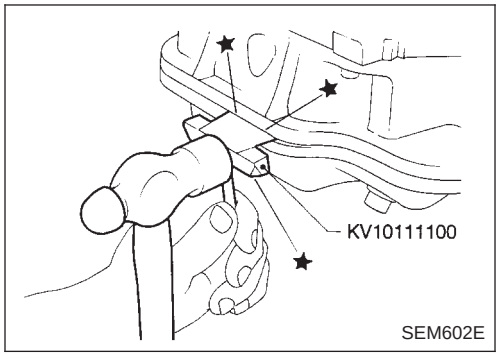


Removal

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



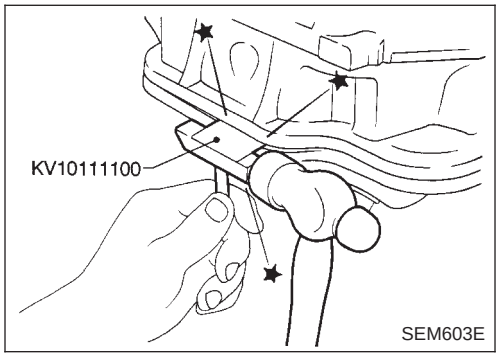
3. Remove steel oil pan bolts.



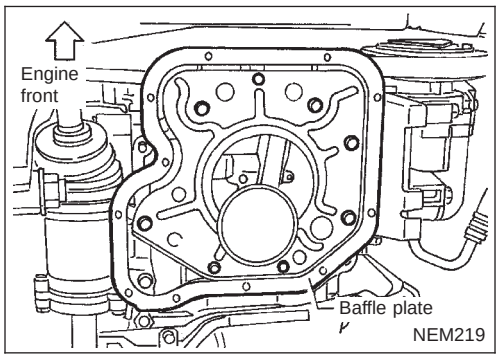
4. Remove steel oil pan.

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

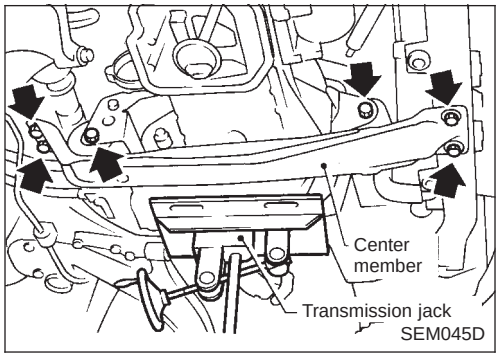
- **Be careful not to damage aluminum mating surface.**
- **Do not insert screwdriver, or oil pan flange will be deformed.**



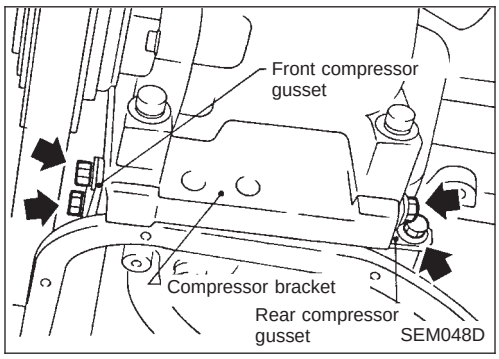
b. Slide Tool by tapping on the side of the Tool with a hammer.
c. Remove steel oil pan.



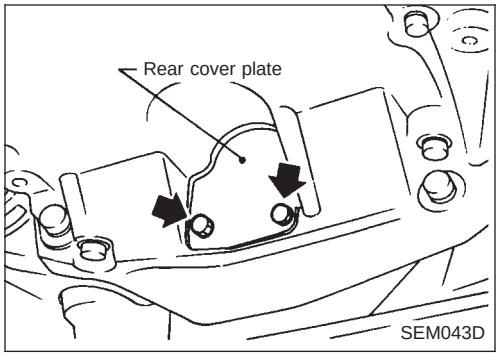
d. Remove baffle plate.



5. Remove front exhaust tube.
6. Set a suitable transmission jack under transaxle and hoist engine with engine slinger.
7. Remove center member.

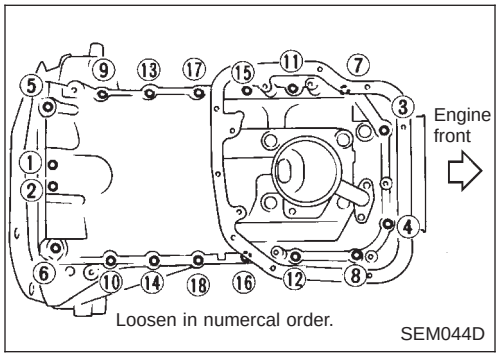


8. Remove compressor gussets.

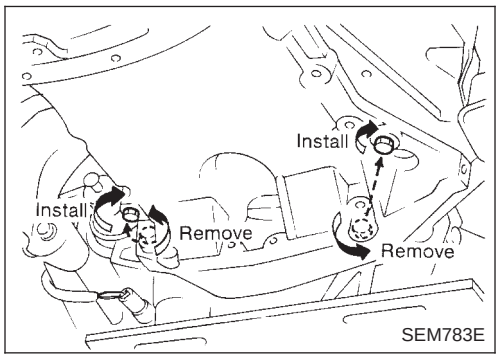


9. Remove rear cover plate.

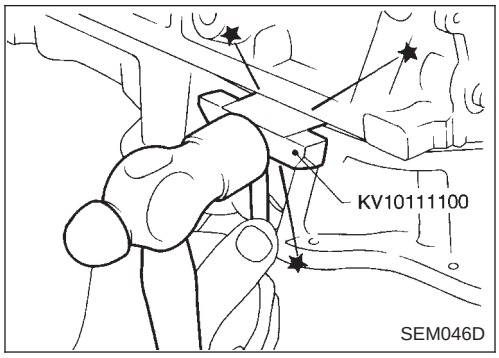
Removal (Cont'd)



10. Remove aluminum oil pan bolts.



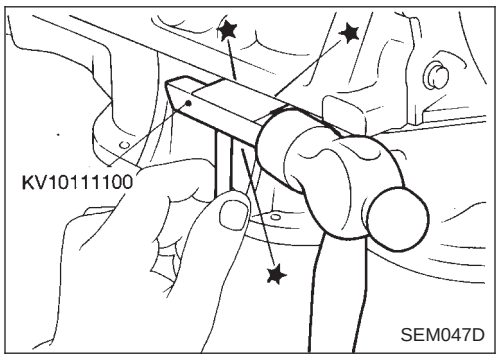
11. Remove the two engine-to-transaxle bolts and install them into open bolt holes shown. Tighten the bolts to release aluminum oil pan from cylinder block.



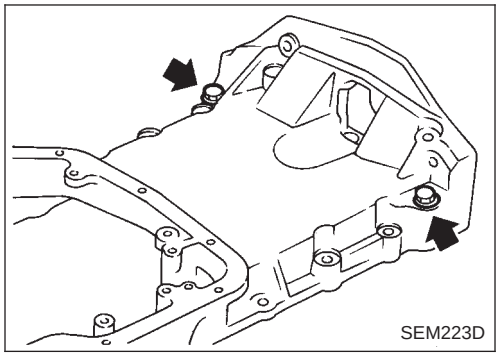
12. Remove aluminum oil pan.

a. Insert Tool between cylinder block and aluminum oil pan.

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

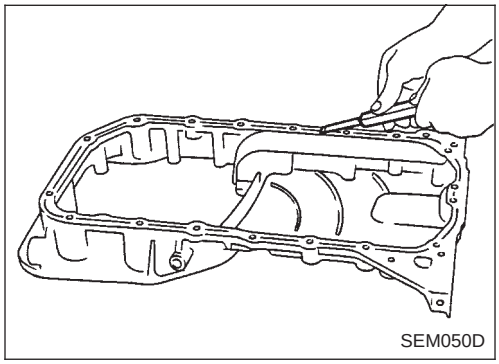


b. Slide Tool by tapping on the side of the Tool with a hammer.



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

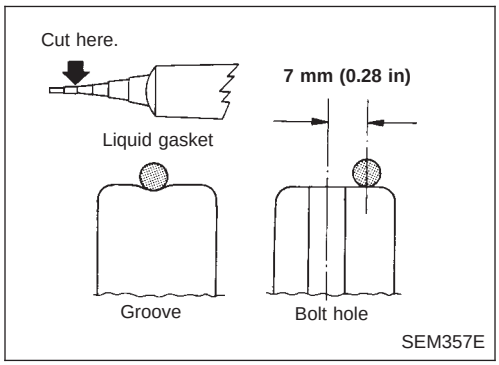
Installation


SEM050D

1. Install aluminum oil pan.

a. Before installation use a scraper to remove all traces of liquid gasket from mating surfaces.

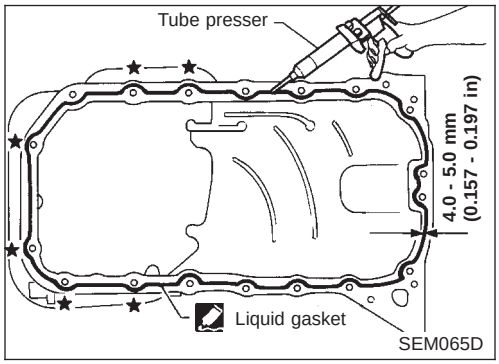
- Also remove traces of liquid gasket from mating surface of cylinder block and front cover.



SEM357E

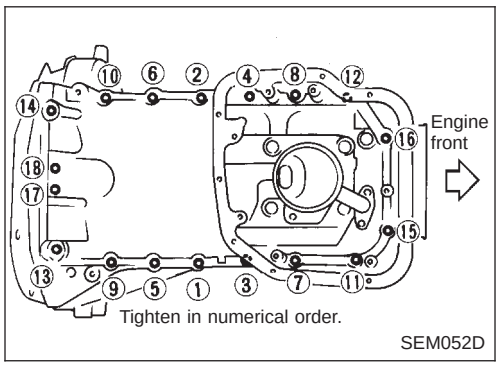
b. Apply a continuous bead of liquid gasket to mating surface of aluminum oil pan.

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



SEM065D

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



SEM052D

c. Install aluminum oil pan.

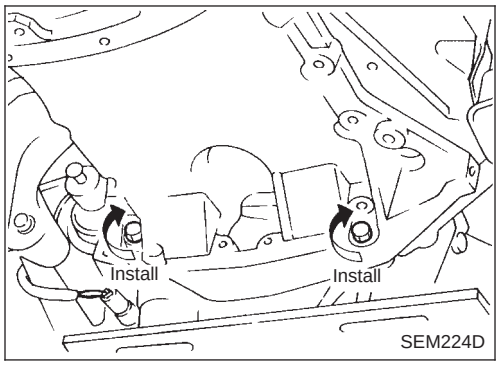
- Install bolts in the reverse order of removal.

① - ⑯ bolts:

: 16 - 19 N·m (1.6 - 1.9 kg-m, 12 - 14 ft-lb)

⑰, ⑱ bolts:

: 8.14 - 9.51 N·m (0.830 - 0.970 kg-m, 72.05 - 84.77 in-lb)



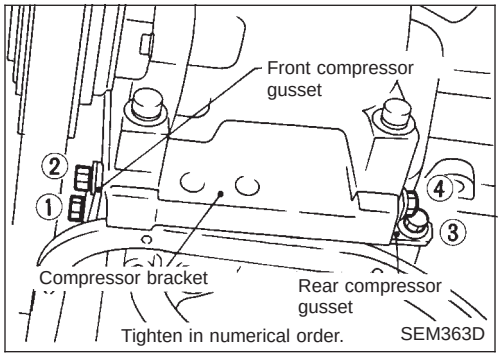
SEM224D

2. Install the two engine to transaxle bolts.

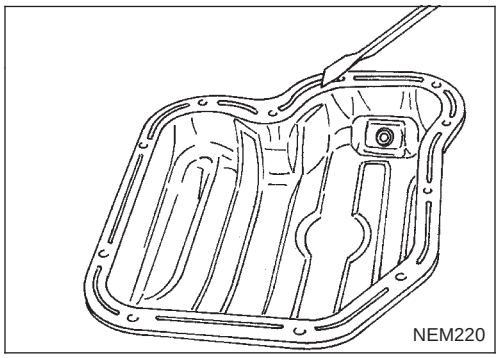
: 30 - 40 N·m (3.1 - 4.1 kg-m, 22 - 30 ft-lb)

3. Install rear cover plate.

Installation (Cont'd)



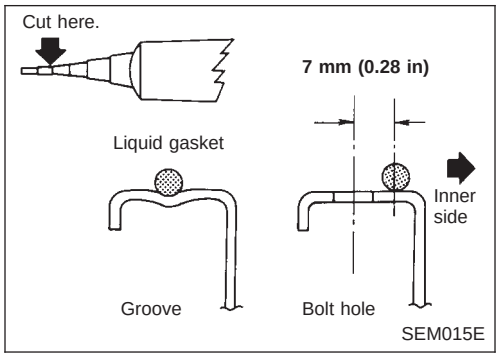
4. Install compressor gussets.
5. Install center member.
6. Install front exhaust tube.
7. Install baffle plate.



8. Install steel oil pan.

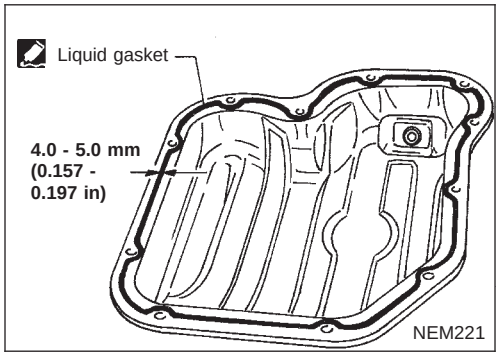
a. Before installation, use a scraper to remove all traces of liquid gasket from mating surfaces.

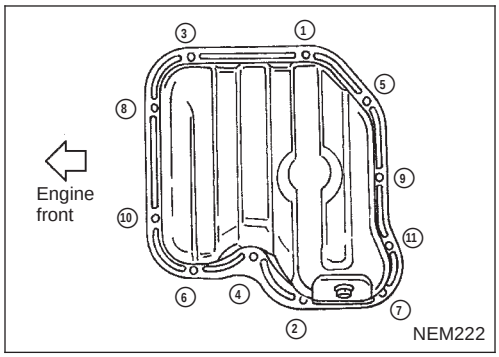
- Also remove traces of liquid gasket from mating surface of aluminum oil pan.



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

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



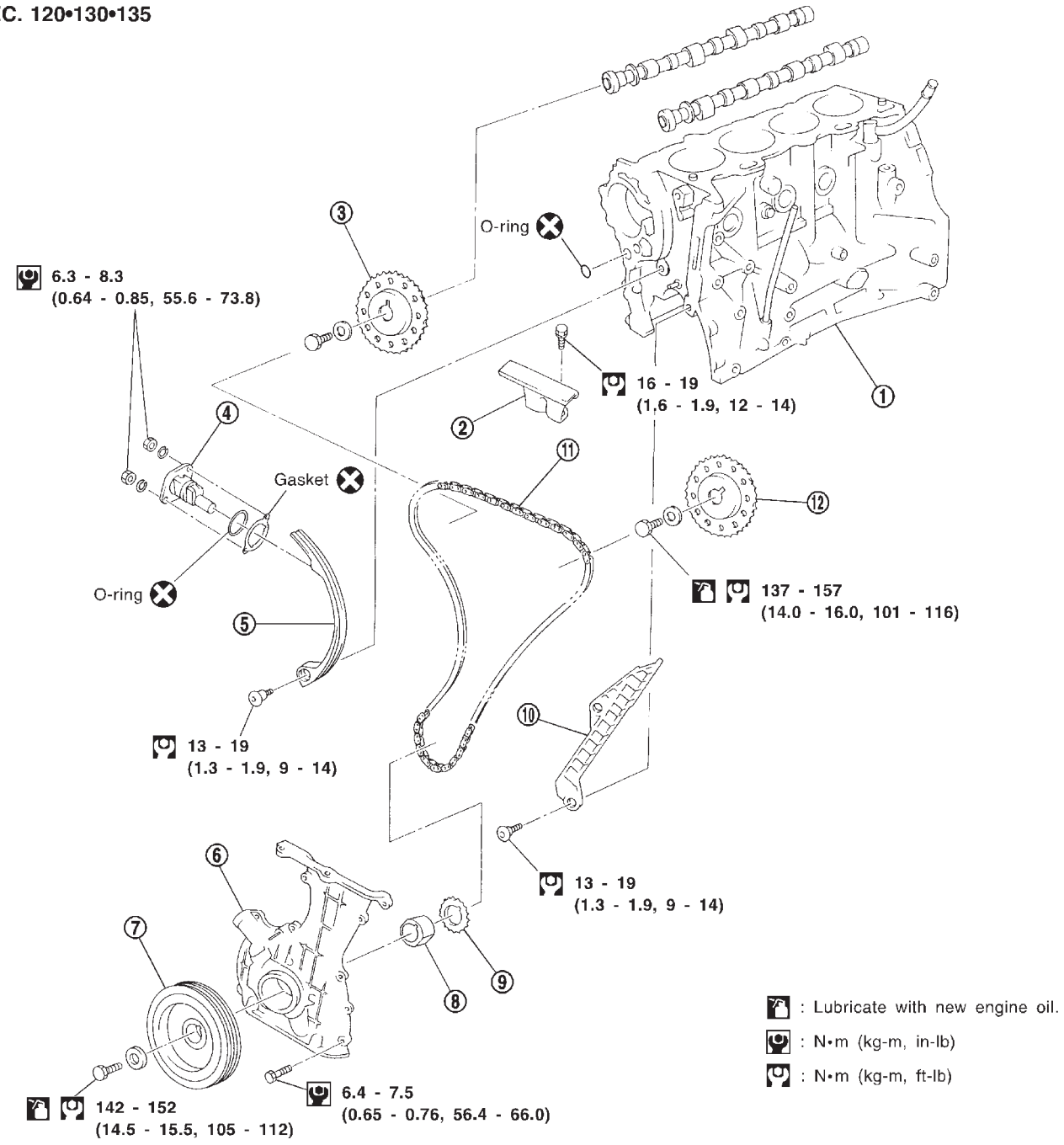


c. Install steel oil pan.

- Tighten bolts in numerical order as shown together with heated oxygen sensor harness bracket.
- Wait at least 30 minutes before refilling engine oil.

Components

SEC. 120•130•135



SEM718EC

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

CAUTION:

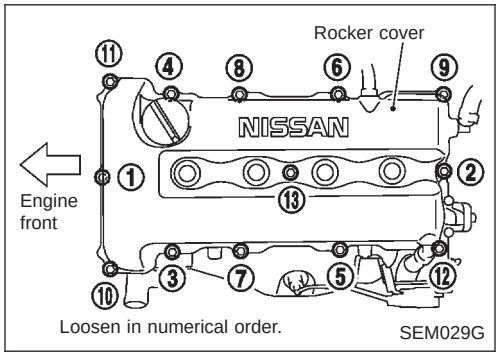
- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When installing chain tensioner, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **Apply new engine oil to bolt threads and seat surfaces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

Removal

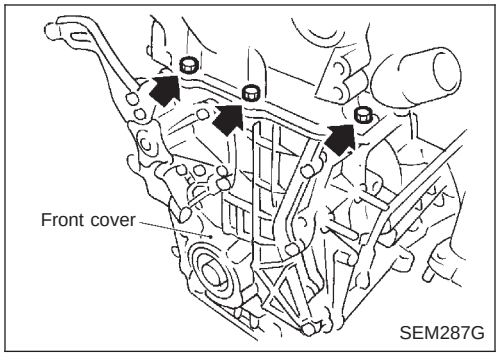
NLEM0126

1. Remove engine under cover.
2. Remove front RH wheel and engine side cover.
3. Drain coolant by removing cylinder block drain plug and lower radiator hose. Refer to MA-29, "Changing Engine Coolant".
4. Remove drive belts and water pump pulley.
5. Disconnect the following parts:

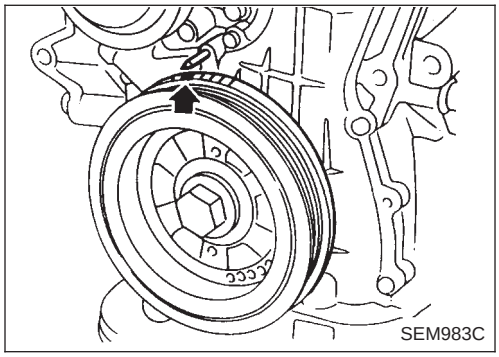
- Vacuum hoses
- Wires
- Harness
- Connectors



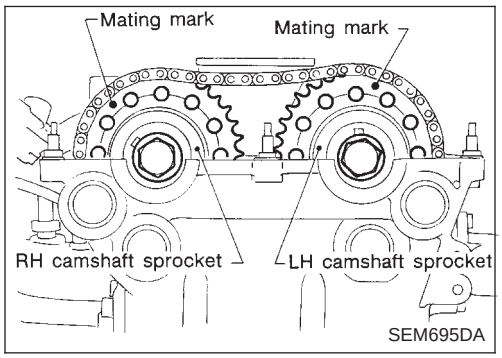
6. Remove rocker cover bolts in numerical order.
7. Remove rocker cover.



8. Remove cylinder head outside bolts.


SEM983C

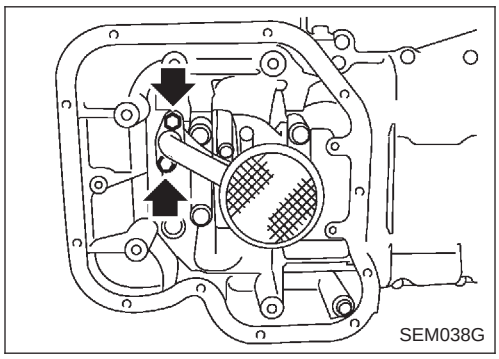
9. Set No. 1 piston at TDC of its compression stroke.



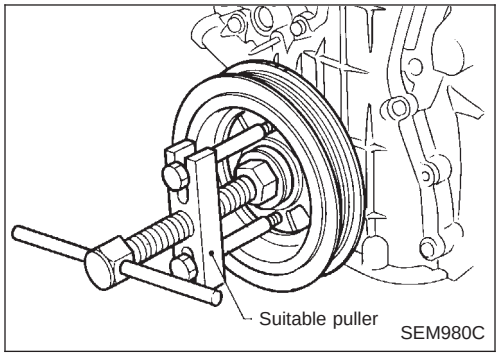
SEM695DA

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

10. Remove oil pans.
    Refer to EM-70, "Oil Pan".


SEM038G

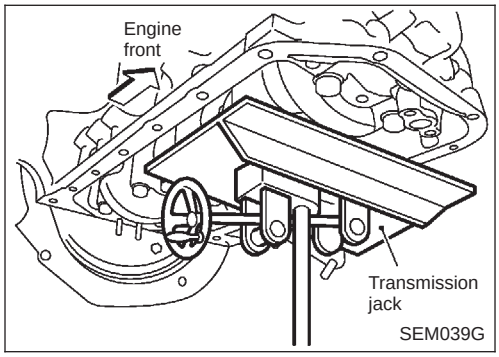
11. Remove oil strainer.
12. Temporarily install center member to support engine.



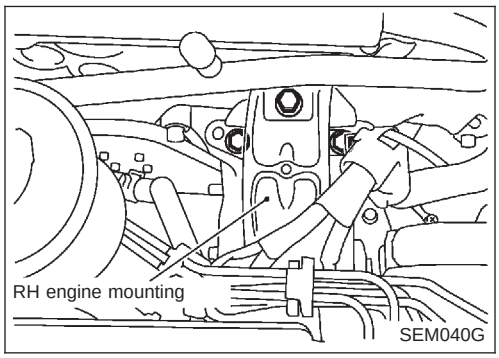
SEM980C

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

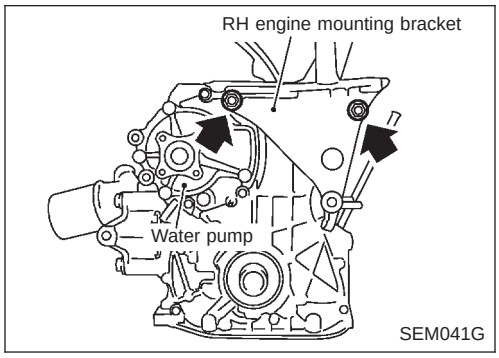
Removal (Cont'd)



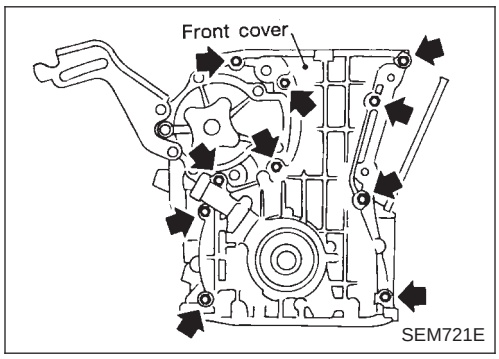
18. Set a suitable transmission jack under main bearing beam.



19. Remove RH engine mounting.



20. Remove RH engine mounting bracket.



21. Remove oil pump drive spacer.

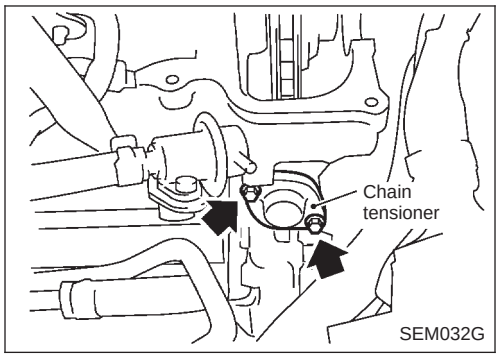
CAUTION:

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

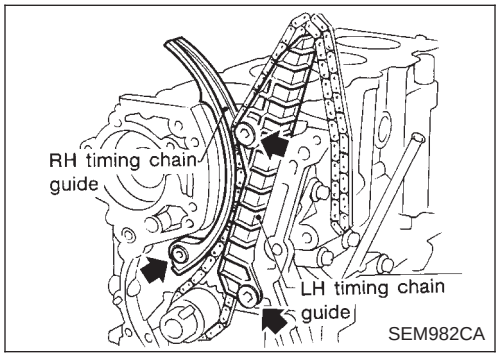
22. Remove front cover.

CAUTION:

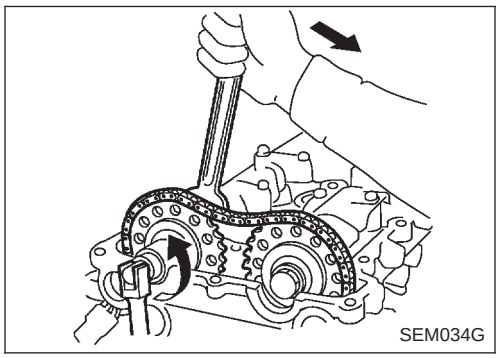
- **Be careful not to tear or damage the cylinder gasket.**
- **Inspect for oil leakage at front oil seal. Replace seal if oil leak is present.**



23. Remove chain tensioner.

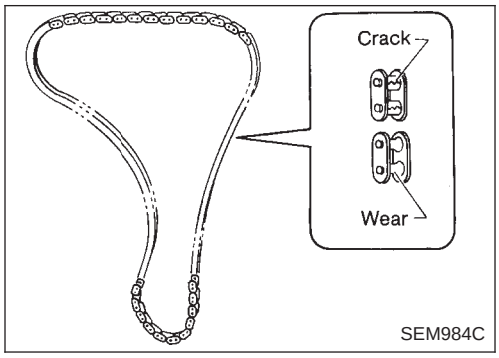


24. Remove timing chain guides.



25. Remove camshaft sprockets.
- **For retiming, apply paint mark to timing chain matched with mating marks of camshaft sprockets.**

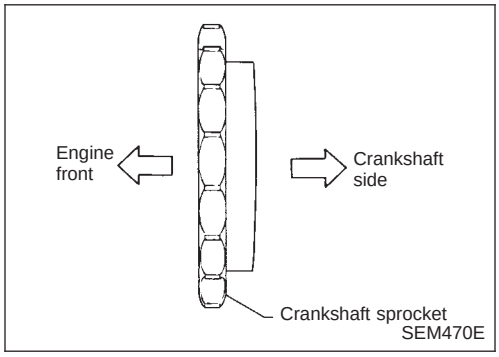
26. Remove timing chain and crankshaft sprocket.



Inspection

NLEM0127

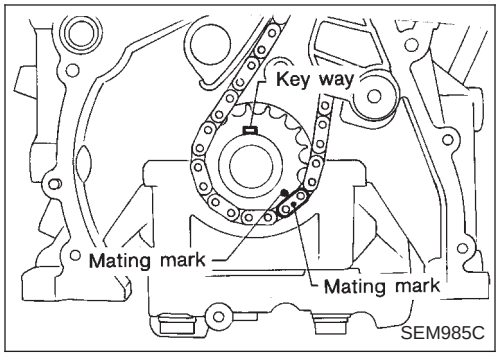
Check for cracks and excessive wear at roller links. Replace chain if necessary.



Installation

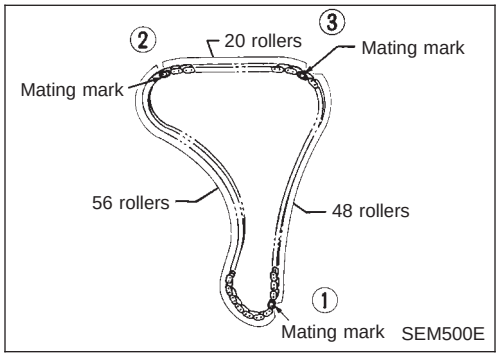
NLEM0128

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

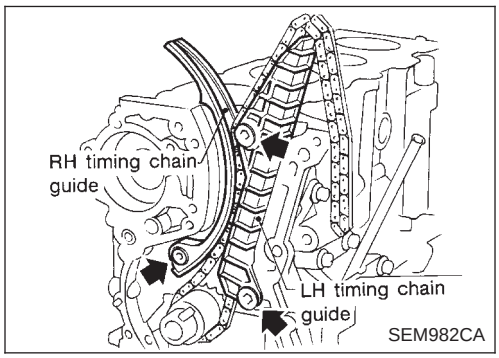


2. Position crankshaft so that No. 1 piston is set at TDC and key way is at 12 oclock. Fit timing chain on crankshaft sprocket, aligning the mating marks.

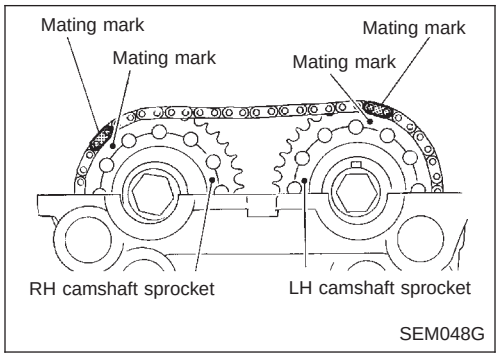
Installation (Cont'd)



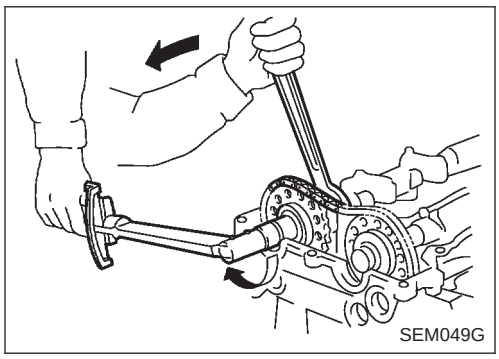
- Mating mark color on timing chain.
  1: Golden
  2, 3: White



3. Install timing chain and timing chain guides.

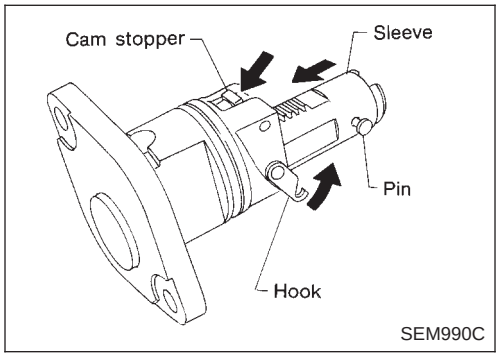


4. Install camshaft sprockets and timing chain on them.
   Line up mating marks on timing chain with mating marks on camshaft sprockets.



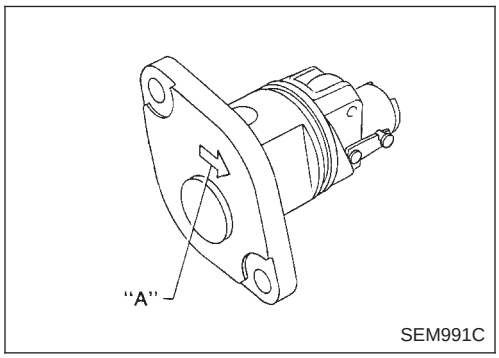
- Lock camshafts as shown in figure and tighten to specified torque.
  : 137 - 157 N·m (14.0 - 16.0 kg-m, 101 - 116 ft-lb)

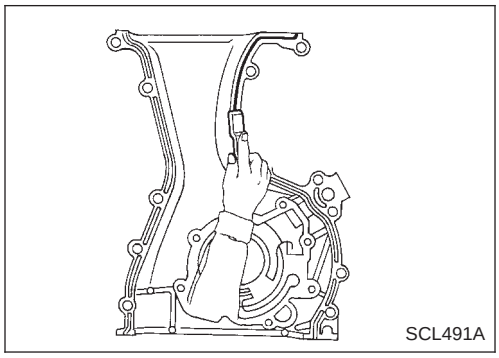
Apply new engine oil to threads and seating surfaces of camshaft sprocket bolts before installing them.



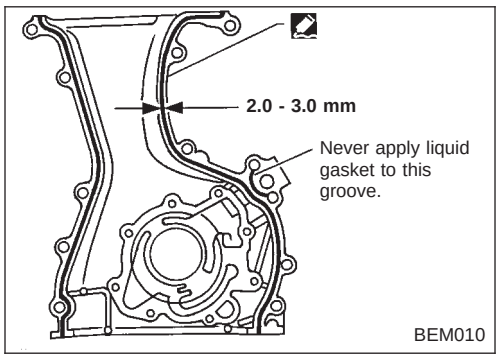
5. Install chain tensioner.

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

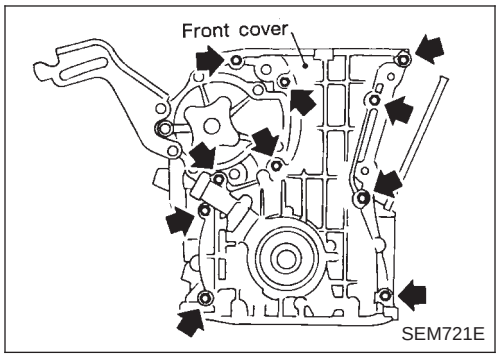




6. Use a scraper to remove old liquid gasket from mating surface of front cover.
- **Also remove old liquid gasket from mating surface of cylinder block.**

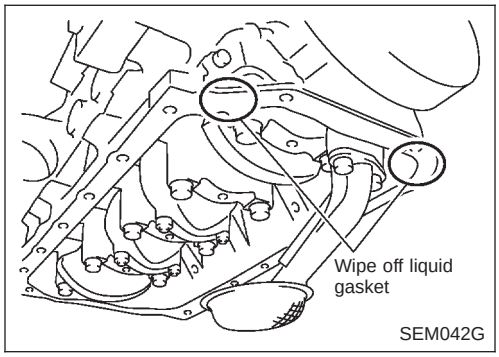


7. Apply a continuous bead of liquid gasket to front cover.
Also apply liquid gasket to matching surface to cylinder head gasket.
- **Use Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent.**
Be sure to install new front oil seal in the right direction. Refer to EM-84, "FRONT OIL SEAL".

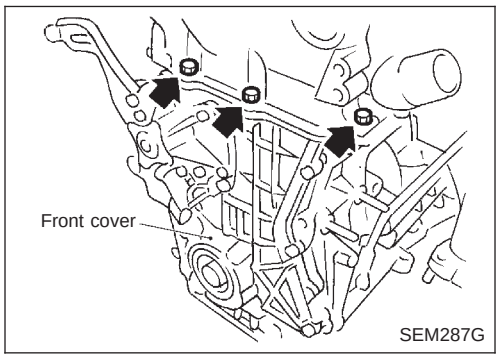


8. Install oil pump drive spacer.
9. Install front cover.

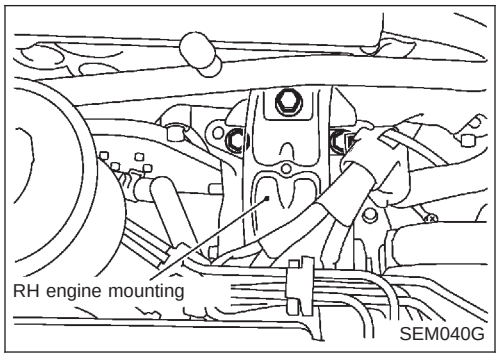
Installation (Cont'd)



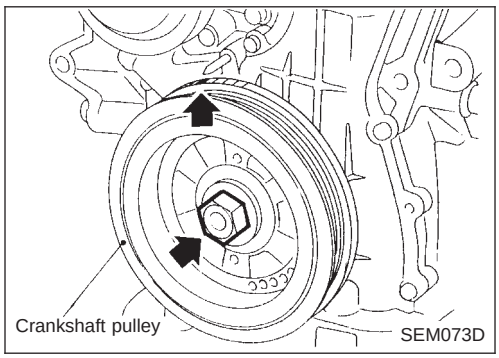
- Wipe off excessive liquid gasket.



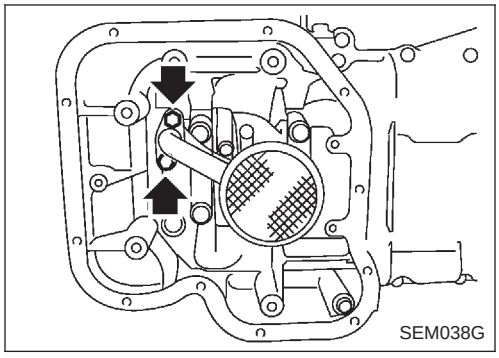
10. Install cylinder head outside bolts.



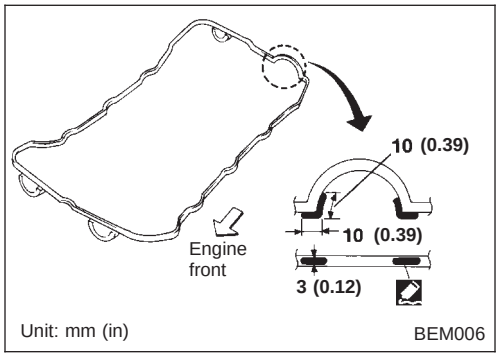
11. Install RH engine mounting and bracket.
12. Install generator bracket and generator.
13. Install A/C compressor bracket and compressor.



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



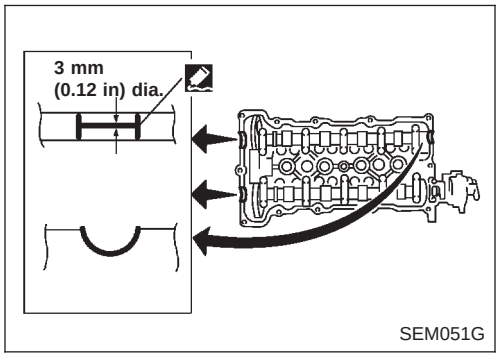
16. Install oil strainer.
17. Install oil pans.
    Refer to EM-70, "Oil Pan".



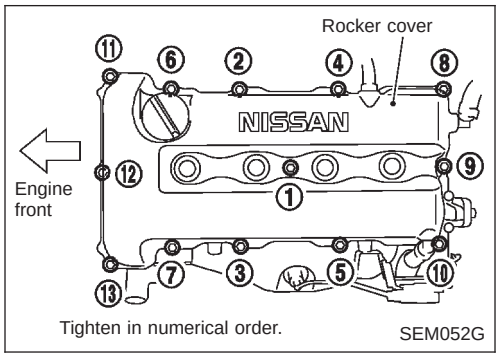
Unit: mm (in)
BEM006

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

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



SEM051G



SEM052G

20. Install rocker cover and oil separator.

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

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

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

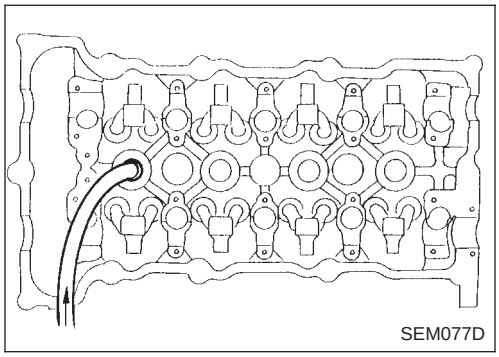
  : 8 - 10 N·m (0.8 - 1.0 kg-m, 69 - 87 in-lb)

21. Install the following parts:

- Spark plugs and leads
- Water pump pulley and drive belts.
  For adjusting drive belt deflection, refer to MA-28, "Checking Drive Belts".
- Refit lower radiator hose and cylinder block drain plug.
- Refill with engine coolant. Refer to MA-29, "Changing Engine Coolant".
- Front RH wheel
- Engine under cover

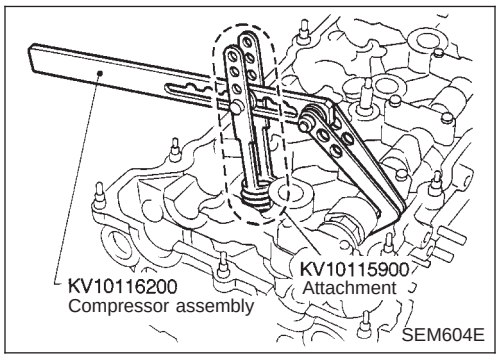
22. Connect the following:

- Vacuum hoses
- Wire harnesses and connectors


SEM077D

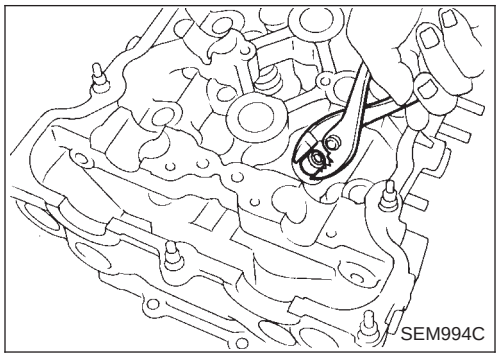
VALVE OIL SEAL

1. Remove accelerator cable.
2. Remove rocker cover and oil separator.
3. Remove camshafts and sprockets.
   Refer to “Removal” in “CYLINDER HEAD” (EM-87).
4. Remove spark plugs.
5. Install air hose adapter into spark plug hole and apply air pressure to hold valves in place. Apply a pressure of 490 kPa (4.9 bar, 5 kg/cm^2, 71 psi).
6. Remove rocker arm, rocker arm guide and shim.

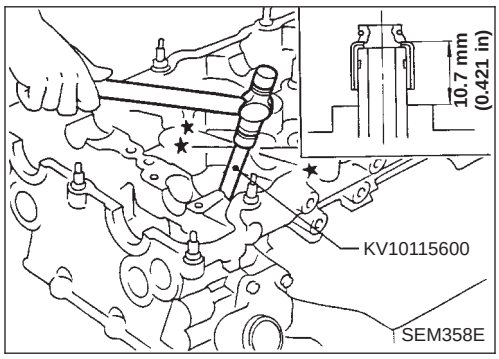


7. Remove valve spring with Tool.

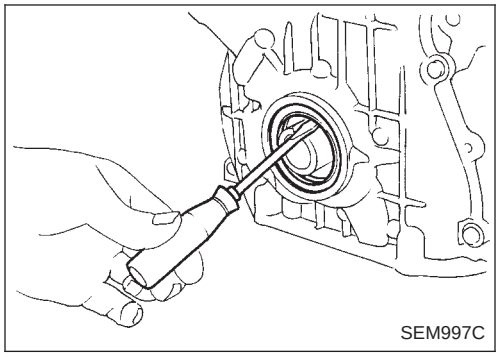
Piston concerned should be set at TDC to prevent valve from falling.


SEM994C

8. Remove valve oil seal.



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


SEM997C

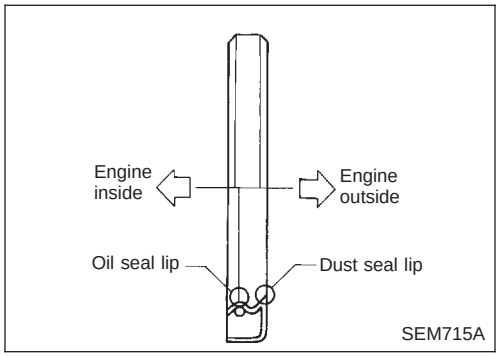
FRONT OIL SEAL

1. Remove the following parts:

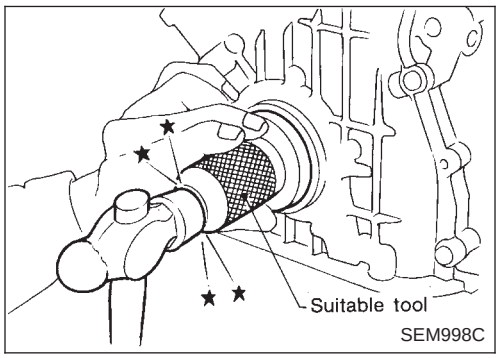
- Engine undercover
- Front RH wheel and engine side cover
- Drive belts
- Crankshaft pulley

2. Remove front oil seal.

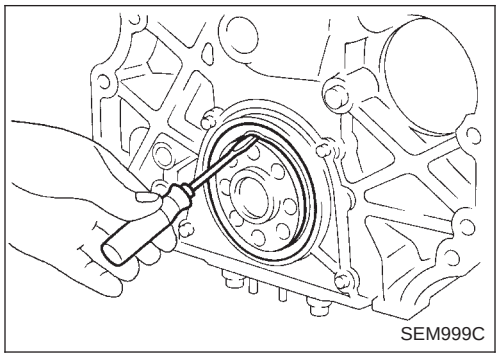
Be careful not to scratch front cover.



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



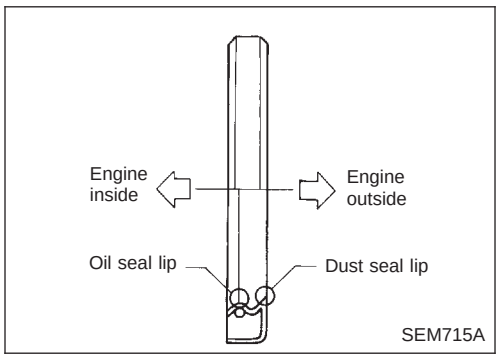
3. Apply engine oil to new oil seal and install it using a suitable tool.



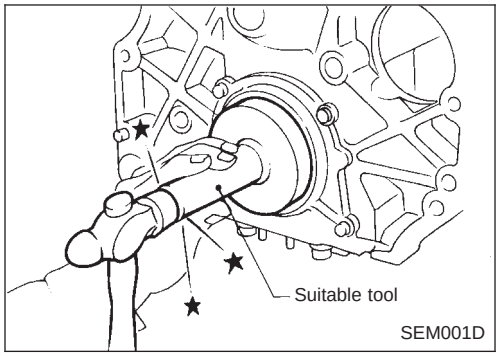
REAR OIL SEAL

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

- **Be careful not to scratch rear oil seal retainer.**



- Install new oil seal in the direction shown.

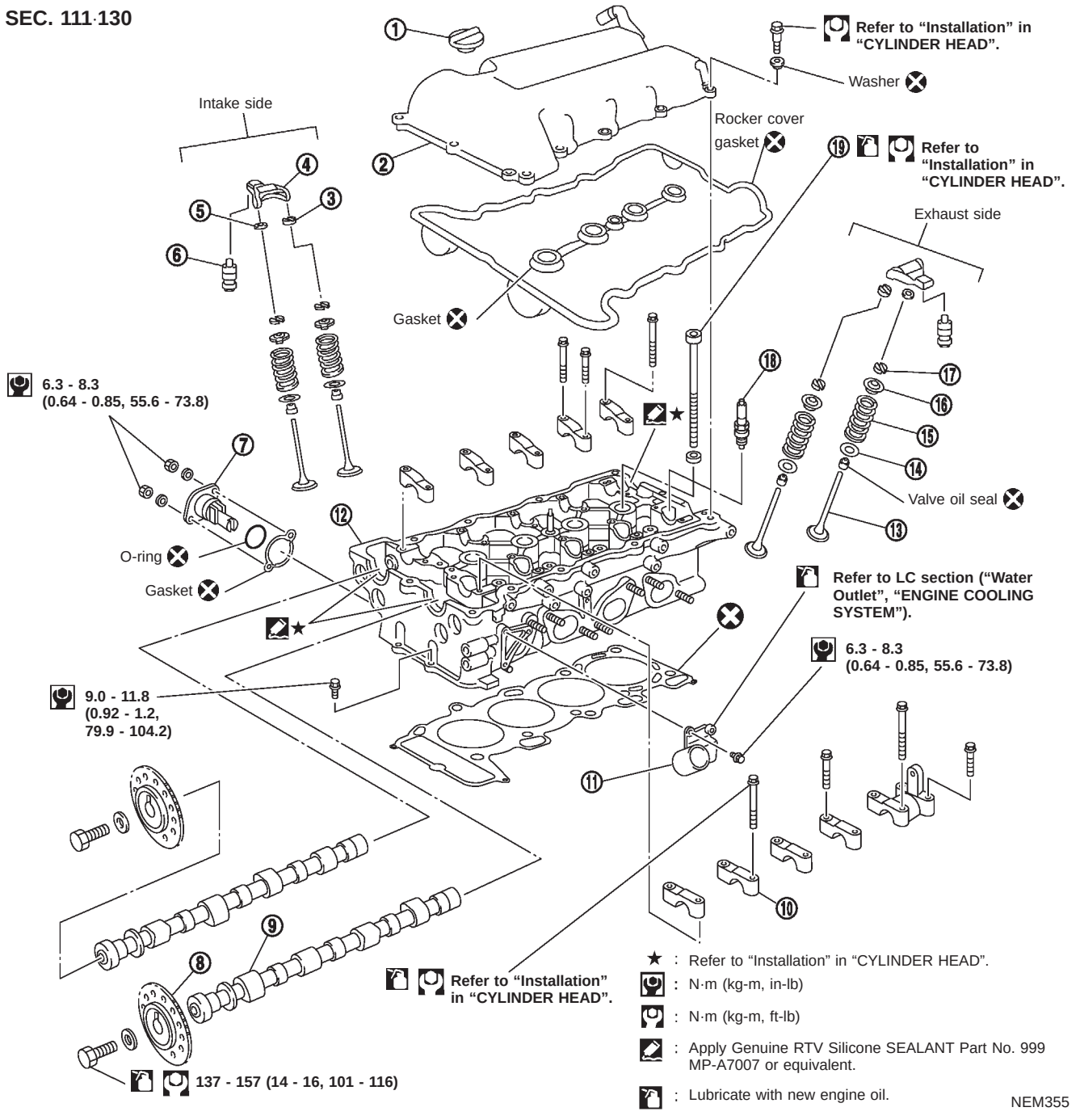


4. Apply engine oil to new oil seal and install it using a suitable tool.

Components

NLEM0130

SEC. 111·130

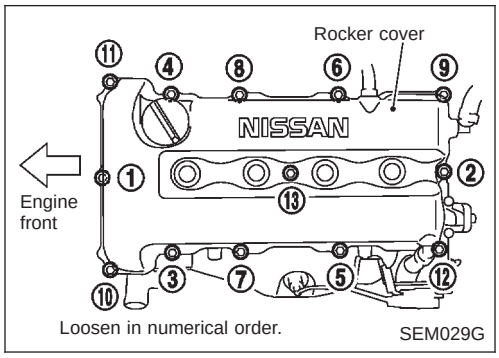


1. Oil filler cap
2. Rocker cover
3. Rocker arm guide
4. Rocker arm
5. Shim
6. Hydraulic lash adjuster
7. Chain tensioner
8. Camshaft sprocket
9. Camshaft
10. Camshaft bracket
11. Water outlet
12. Cylinder head
13. Valve
14. Valve spring seat
15. Valve spring
16. Valve spring retainer
17. Valve collet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

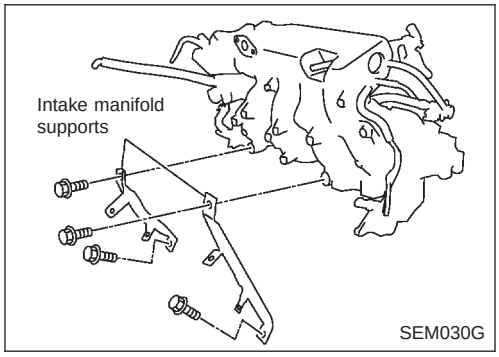
Removal

NLEM0131

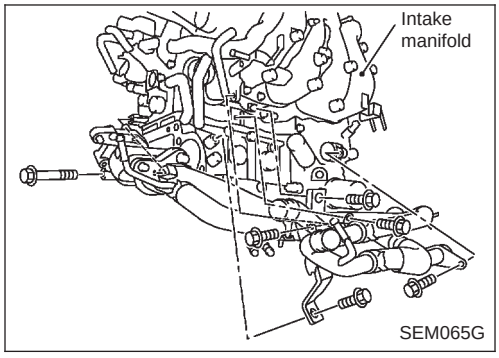
1. Release fuel pressure.
   Refer to EC-SR-31, “Fuel Pressure Release”.
2. Remove engine under covers.
3. Remove front RH wheel and engine side cover.
4. Drain coolant by removing cylinder block drain plug and radiator drain cock. Refer to MA-29, “Changing Engine Coolant”.
5. Remove radiator.
6. Remove air duct to intake manifold.
7. Disconnect the following parts:
- Vacuum hoses
- Fuel hoses
- Wires
- Harness
- Connectors
- Front exhaust tube
8. Remove all spark plugs.



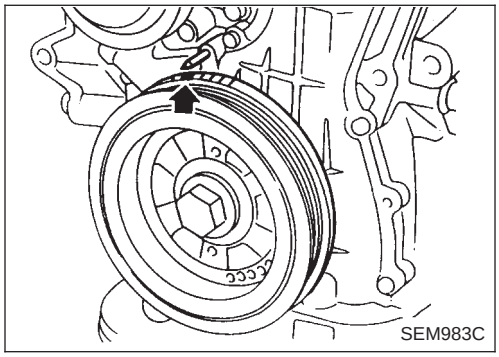
9. Remove rocker cover bolts in numerical order.
10. Remove rocker cover.



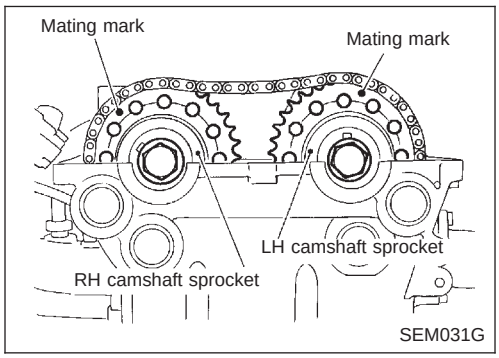
11. Remove intake manifold supports.



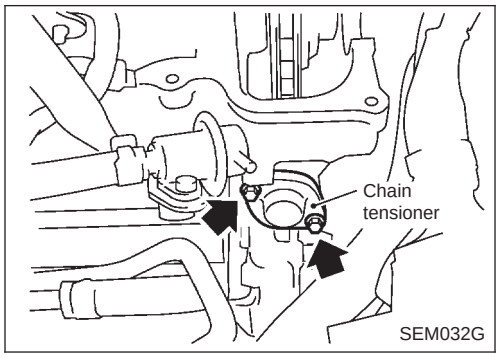
12. Remove water pipe assembly.



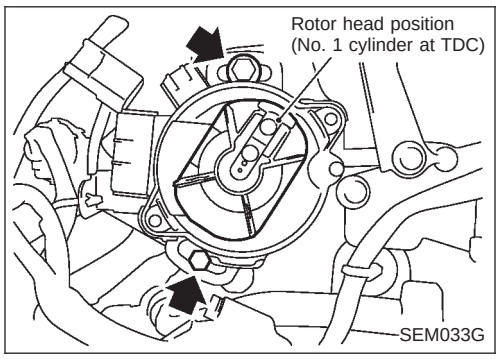
13. Set No. 1 piston at TDC of its compression stroke.



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

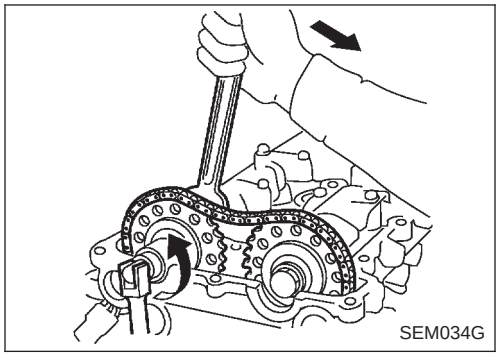


14. Remove chain tensioner.



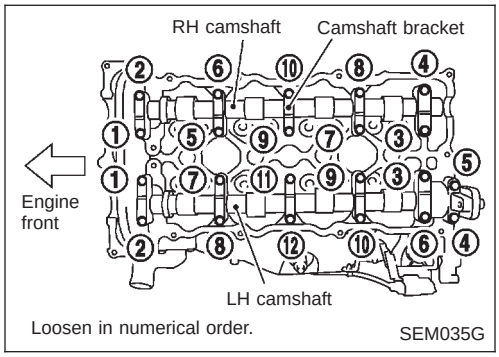
15. Remove distributor.

Do not turn rotor with distributor removed.

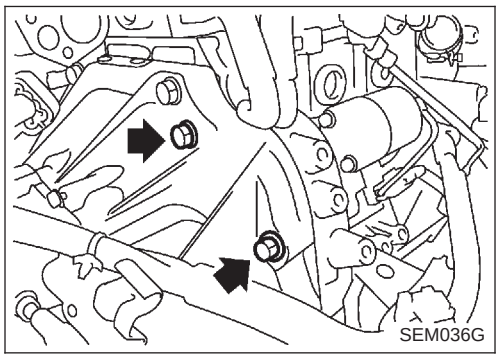


16. Remove camshaft sprockets.

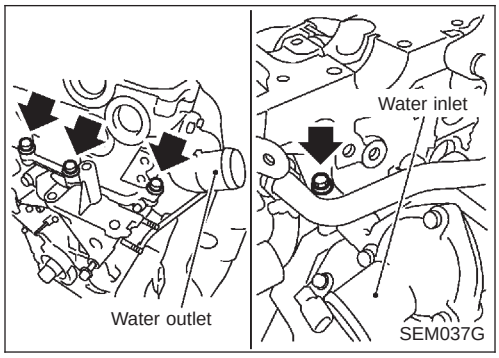
- **For retiming in cylinder head removal, apply paint mark to timing chain matched with mating marks of camshaft sprockets.**



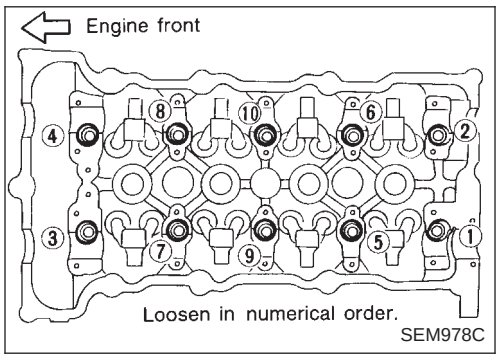
17. Remove camshaft brackets and camshafts.
- **Mark these parts' original positions for reassembly.**



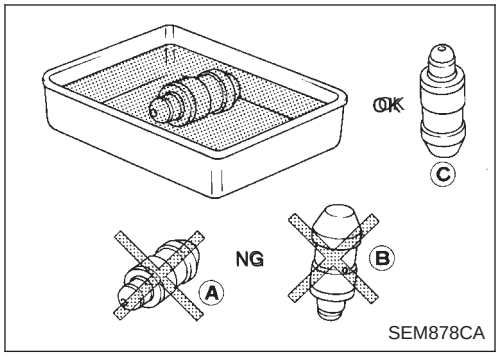
18. Remove starter motor.
19. Remove the following water hoses:
- Water hose for cylinder block.
- Water hoses for heater.



20. Remove cylinder head outside bolts.

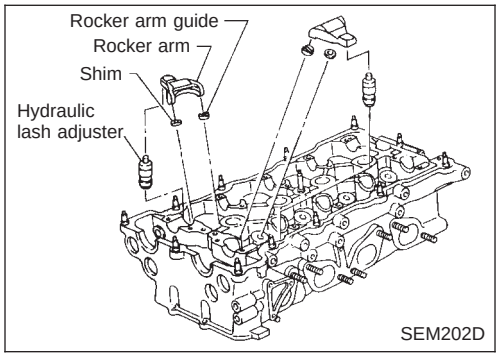


21. Remove cylinder head bolts in numerical order.
- **Removing bolts in incorrect order could result in a warped or cracked cylinder head.**
- **Loosen cylinder head bolts in two or three steps.**
22. Remove cylinder head completely with intake and exhaust manifolds.



Disassembly

CAUTION:
- **When installing camshafts, chain tensioners, oil seals or other sliding parts, lubricate contacting surfaces with new engine oil.**
- **When tightening cylinder head bolts, camshaft sprocket bolts, cramshaft pulley bolt and seat surfaces, lubricate with new engine oil.**
- **If a hydraulic lash adjuster is kept on its side, there is a risk of air entering it. After removal, always set hydraulic**

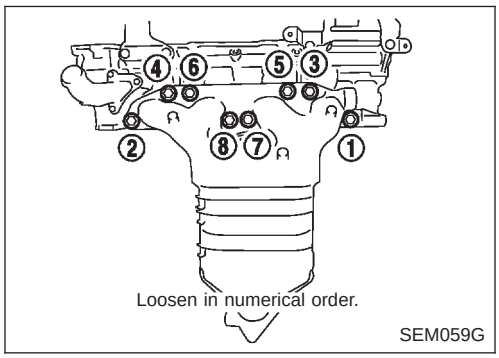


lash adjuster straight up, or keep it soaked in new engine oil.

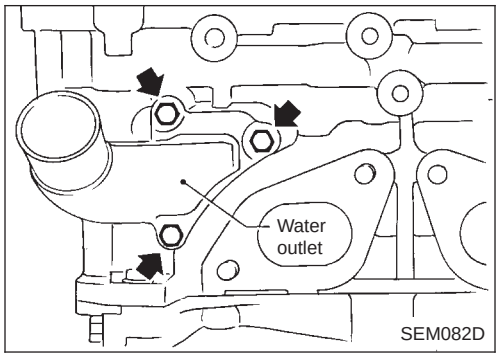
- **Do not disassemble hydraulic lash adjusters.**
- **Attach tags to lash adjusters so as not to mix them up.**

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

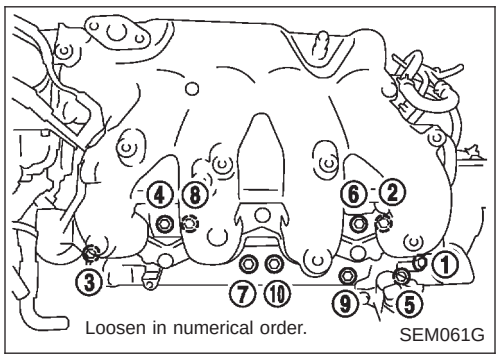
CAUTION:
Keep parts in order so that they can be installed in their original positions during assembly.



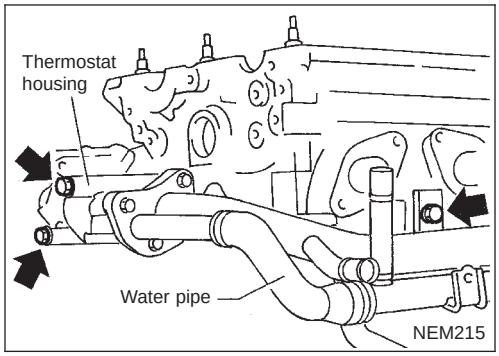
2. Remove exhaust manifold cover.
3. Remove exhaust manifold.



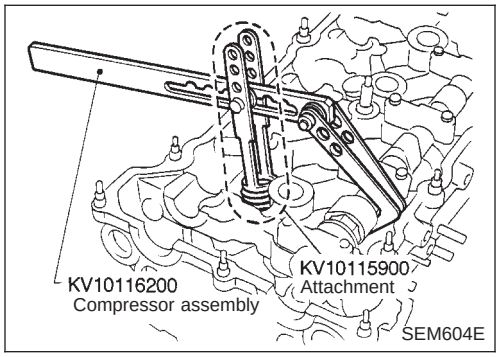
4. Remove water outlet.



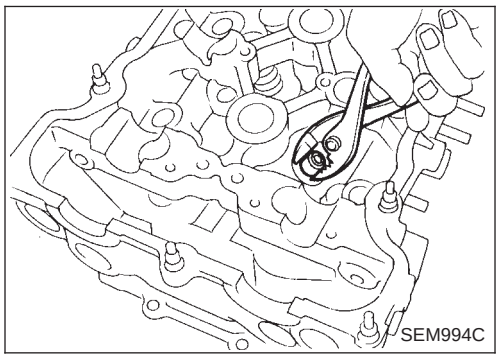
5. Remove intake manifold.



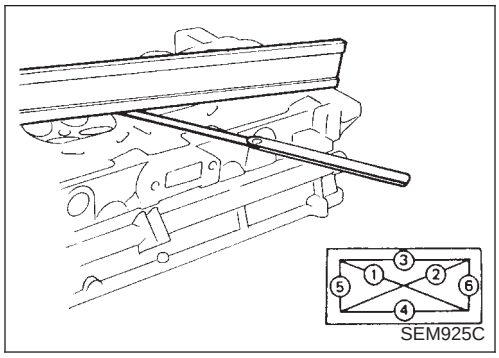
6. Remove thermostat housing with water pipe.



7. Remove valve components with Tool.



8. Remove valve oil seal with a suitable tool.



Inspection

CYLINDER HEAD DISTORTION

Head surface flatness:

Standard

Less than 0.03 mm (0.0012 in)

Limit

0.1 mm (0.004 in)

If beyond the specified limit, replace or resurface.

Resurfacing limit:

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

Amount of cylinder head resurfacing is “A”.

Amount of cylinder block resurfacing is “B”.

The maximum limit is as follows:

A + B = 0.2 mm (0.008 in)

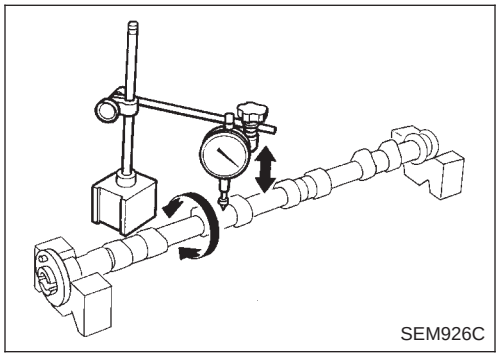
After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.

Nominal cylinder head height:

136.9 - 137.1 mm (5.390 - 5.398 in)

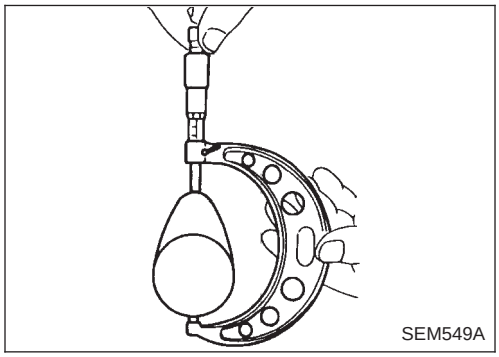
CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.


SEM926C

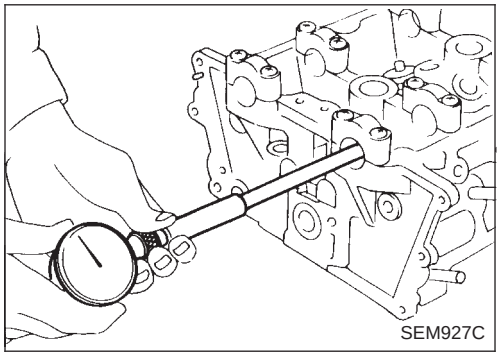
CAMSHAFT RUNOUT

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


SEM549A

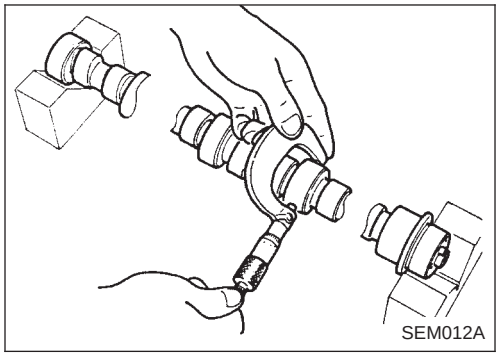
CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height.
   Standard cam height:
   Intake
   37.775 mm (1.4872 in)
   Exhaust
   37.404 mm (1.4726 in)
   Cam wear limit:
   Intake & Exhaust
   0.2 mm (0.008 in)
2. If wear is beyond the limit, replace camshaft.

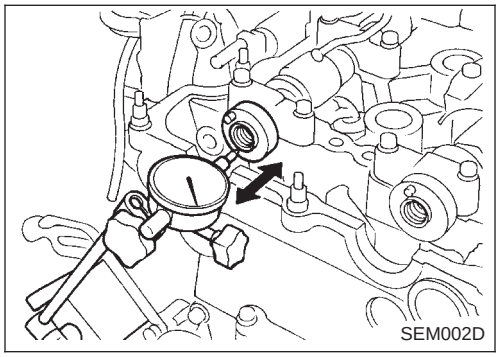

SEM927C

CAMSHAFT JOURNAL CLEARANCE

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


SEM012A

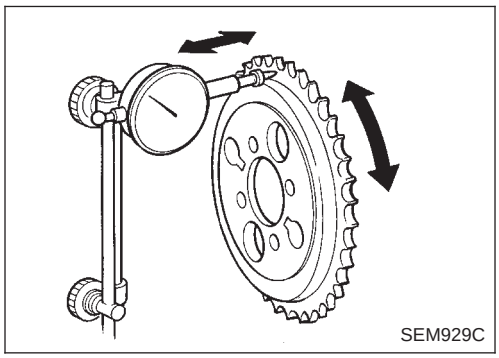
3. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   27.950 - 27.970 mm (1.1004 - 1.1012 in)
4. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance:
   Standard
   0.030 - 0.071 mm (0.0012 - 0.0028 in)
   Limit
   0.15 mm (0.0059 in)


SEM002D

CAMSHAFT END PLAY

1. Install camshaft in cylinder head.
2. Measure camshaft end play.

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

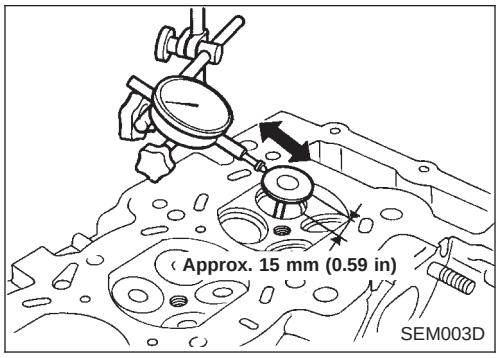

SEM929C

CAMSHAFT SPROCKET RUNOUT

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

Runout (Total indicator reading):
Limit 0.25 mm (0.0098 in)

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

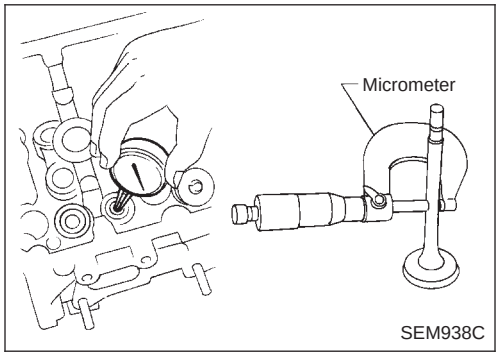


SEM003D

VALVE GUIDE CLEARANCE

1. Measure valve deflection in a parallel direction with rocker arm. (Valve and valve guide mostly wear in this direction.)

Valve deflection limit (Dial gauge reading):
Intake & Exhaust
0.2 mm (0.008 in)



SEM938C

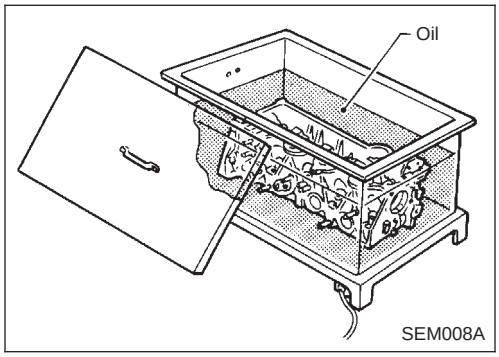
2. If it exceeds the limit, check valve to valve guide clearance.

a. Measure valve stem diameter and valve guide inner diameter.
b. Check that clearance is within specification.

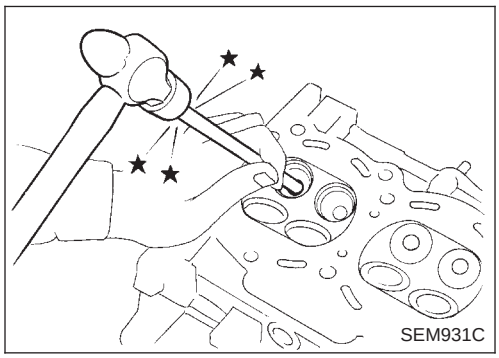
Valve to valve guide clearance:
Standard
Intake 0.020 - 0.053 mm (0.0008 - 0.0021 in)
Exhaust 0.040 - 0.073 mm (0.0016 - 0.0029 in)
Limit
Intake 0.08 mm (0.0031 in)
Exhaust 0.1 mm (0.004 in)

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

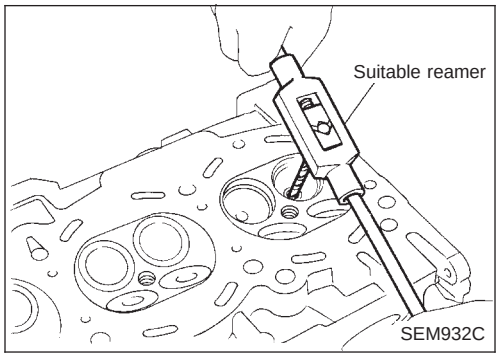
VALVE GUIDE REPLACEMENT



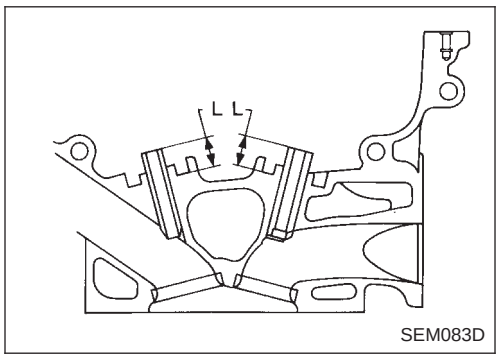
1. To remove valve guide, heat cylinder head to 110 to 130°C (230 to 266°F).



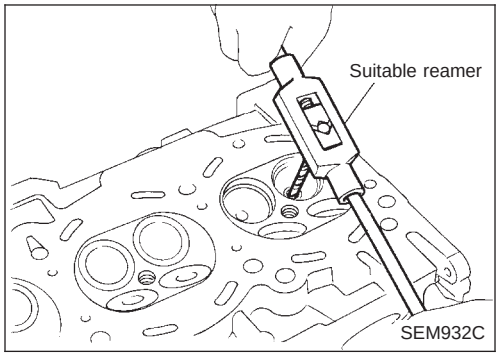
2. Press out valve guide or use a hammer and suitable tool.



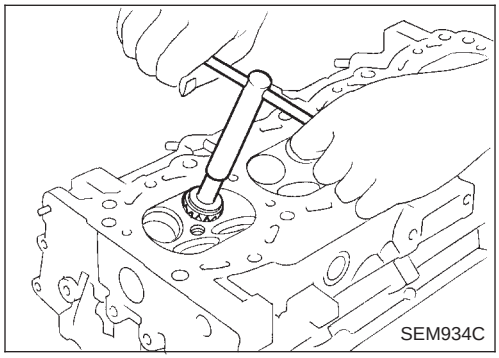
3. Ream cylinder head valve guide hole.
   Valve guide hole diameter (for service parts):
   Intake:
   10.175 - 10.196 mm (0.4006 - 0.4014 in)
   Exhaust:
   10.175 - 10.196 mm (0.4006 - 0.4014 in)



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



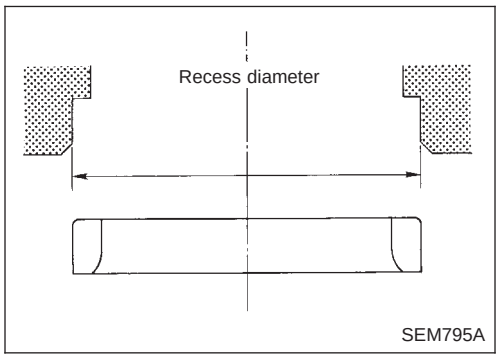
5. Ream valve guide.
   Valve guide inner diameter:
   Intake:
   6.000 - 6.018 mm (0.2362 - 0.2369 in)
   Exhaust:
   6.000 - 6.018 mm (0.2362 - 0.2369 in)


SEM934C

VALVE SEATS

Check valve seats for any evidence of pitting at valve contact surface. Reset 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

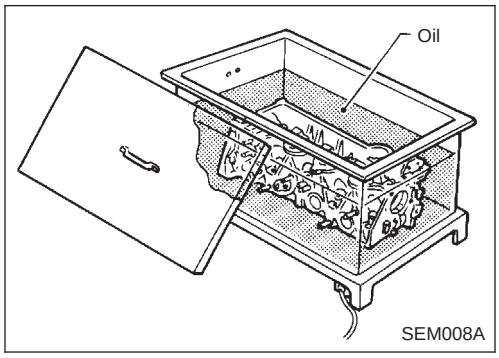
REPLACING VALVE SEAT FOR SERVICE PARTS

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.

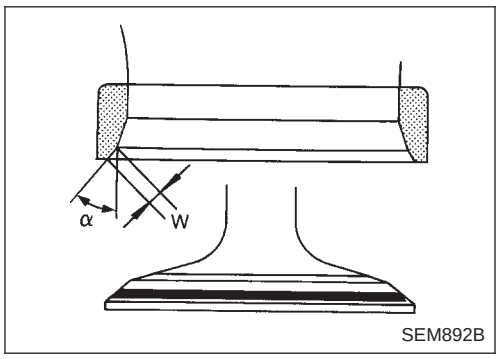
   Reaming bore for service valve seat
   Oversize [0.5 mm (0.020 in)]:
   Intake 35.500 - 35.516 mm (1.3976 - 1.3983 in)
   Exhaust 31.500 - 31.516 mm (1.2402 - 1.2408 in)

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).
4. Press fit valve seat until it seats on the bottom.



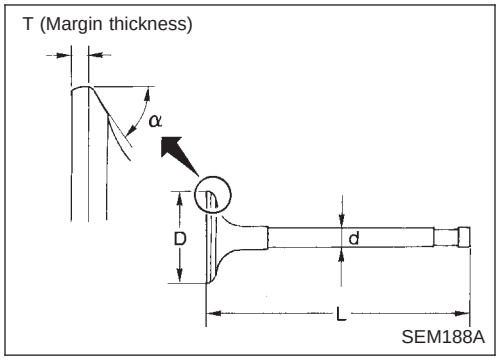
SEM008A



SEM892B

5. Cut or grind valve seat using a suitable tool at the specified dimensions as shown in SDS (EM-190).
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

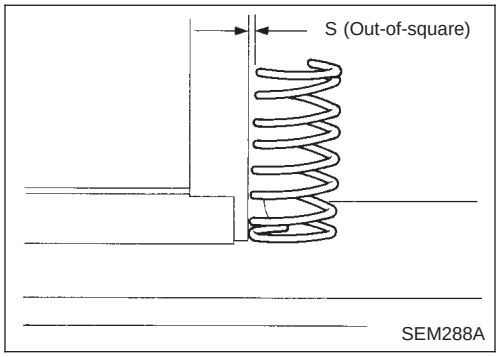
   Seat face angle "α":
   44°53′ - 45°07′
   Contacting width "W":
   Intake
   1.385 - 1.401 mm (0.0545 - 0.0552 in)
   Exhaust
   1.385 - 1.401 mm (0.0545 - 0.0552 in)



SEM188A

VALVE DIMENSIONS

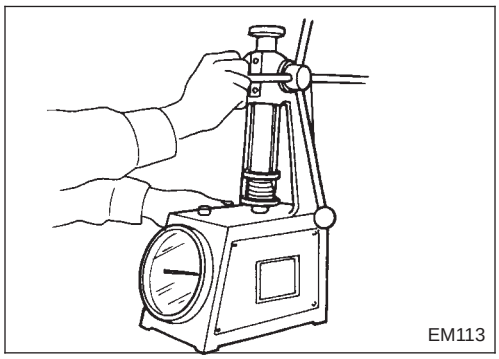
Check dimensions in each valve. For dimensions, refer to SDS (EM-189).
When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace valve.
Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.



VALVE SPRING

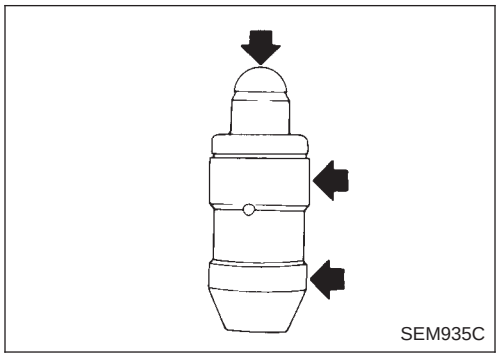
Squareness

1. Measure "S" dimension.
   Out-of-square:
   Less than 2.2 mm (0.087 in)
2. If it exceeds the limit, replace spring.
   Free height
   Check free height: 49.36 mm (1.9433 in)



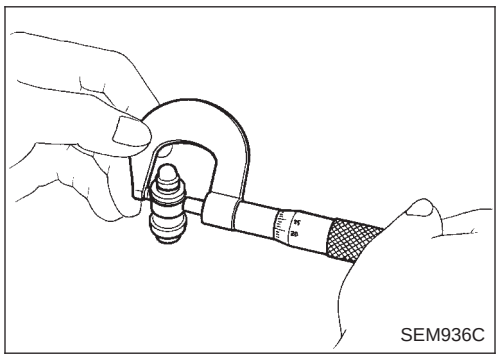
Pressure

Check valve spring pressure.
Pressure: N (kg, lb) at height mm (in)
Standard
519 - 571 (52.9 - 58.2, 116.6 - 128.3) at 27 (1.063)
Limit
Replace if load is less than 501 (51.1 - 112.7) at 27 (1.063)

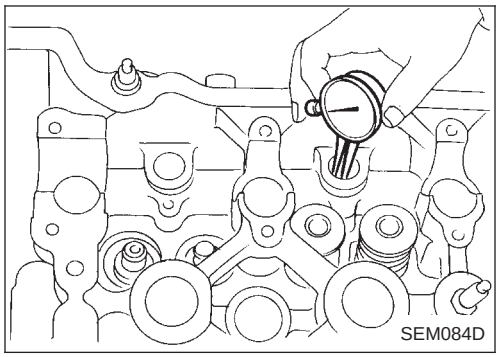


HYDRAULIC LASH ADJUSTER

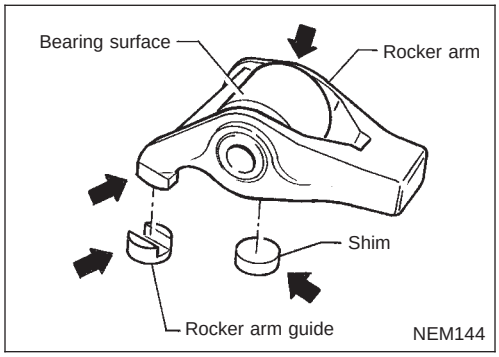
1. Check contact and sliding surfaces for wear or scratches.



2. Check diameter of lash adjuster.
   Outer diameter:
   16.980 - 16.993 mm (0.6685 - 0.6690 in)

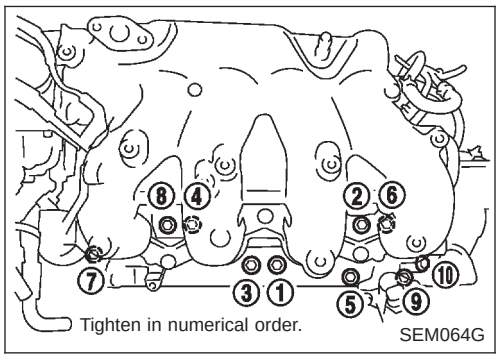


3. Check lash adjuster guide inner diameter.
   Inner diameter:
   17.000 - 17.020 mm (0.6693 - 0.6701 in)
   Standard clearance between lash adjuster and adjuster guide:
   0.007 - 0.040 mm (0.0003 - 0.0016 in)



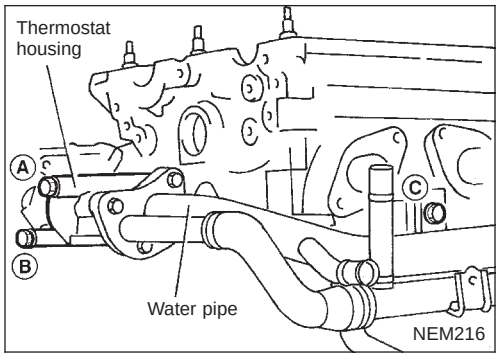
ROCKER ARM, SHIM AND ROCKER ARM GUIDE

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



Assembly

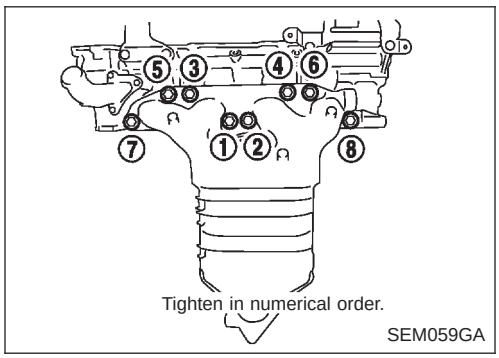
1. Install intake manifold.



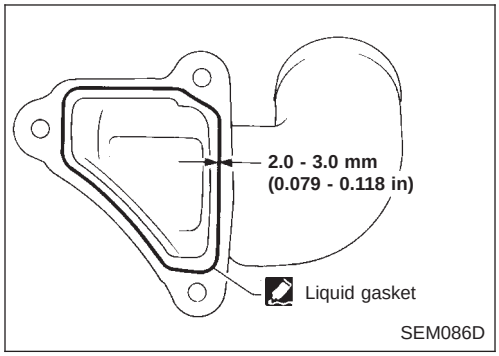
2. Install thermostat housing with water pipe.

- Tightening procedure:

1) Tighten bolt Ⓐ to 2 - 5 N·m (0.2 - 0.5 kg-m, 1.4 - 3.6 ft-lb).
2) Tighten bolt Ⓒ to 16 - 21 N·m (1.6 - 2.1 kg-m, 12 - 15 ft-lb).
3) Tighten bolt Ⓐ to 16 - 21 N·m (1.6 - 2.1 kg-m, 12 - 15 ft-lb).
4) Tighten bolt Ⓑ to 16 - 21 N·m (1.6 - 2.1 kg-m, 12 - 15 ft-lb).



3. Install exhaust manifold.
4. Install exhaust manifold cover.



5. Install water outlet.

a. Before installing water outlet, remove all traces of liquid gasket from mating surface using a scraper.

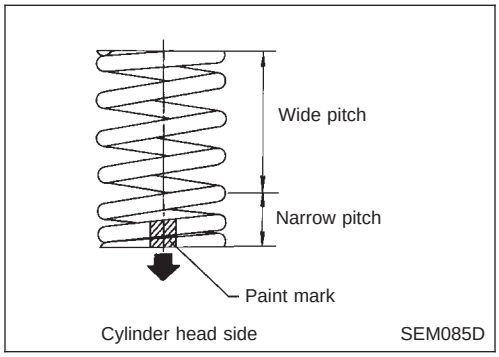
- Also remove traces of liquid gasket from mating surface of cylinder head.

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

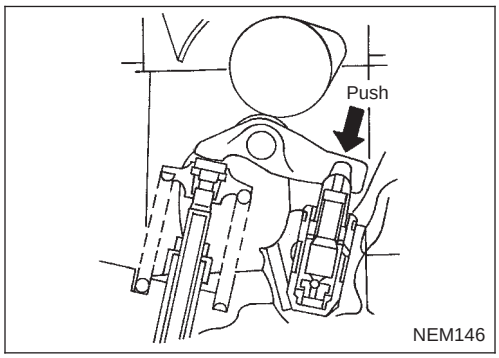
- **Use Genuine Liquid Gasket or equivalent.**

6. Install valve component parts.

- **Install valves with larger diameter head on the intake side.**

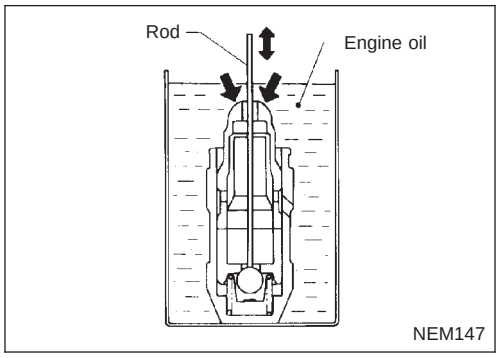


- **Always use new valve oil seal.**
  Refer to OIL SEAL REPLACEMENT.
- **Before installing valve oil seal, install valve spring seat.**
- **Install valve spring (uneven pitch type) with its narrow pitched side toward cylinder head side (paint mark).**
- **After installing valve component parts, tap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



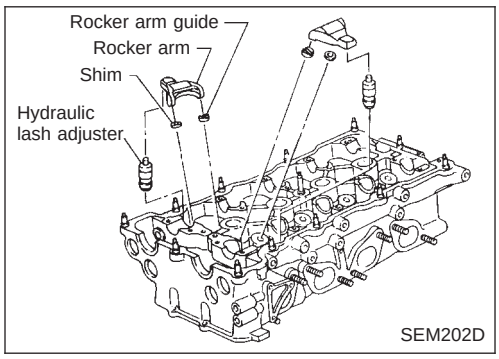
7. Check hydraulic lash adjusters.

a. Push rocker arm at hydraulic lash adjuster location, and see if rocker arm moves. If it moves at least 1 mm (0.04 in), it indicates that there is air in the high pressure chamber.
Noise will be emitted from hydraulic lash adjuster if engine is started without bleeding air.



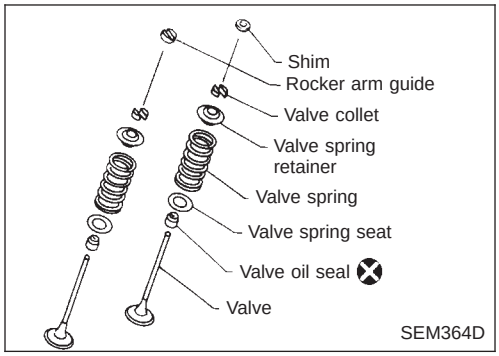
b. Remove hydraulic lash adjuster and dip in a container filled with engine oil. While pushing plunger as shown in figure, lightly push check ball using a thin rod. Air is completely bled when plunger no longer moves.

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



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

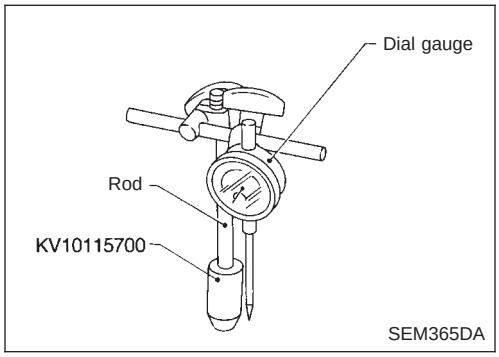
CAUTION:
Install all parts in their original positions.



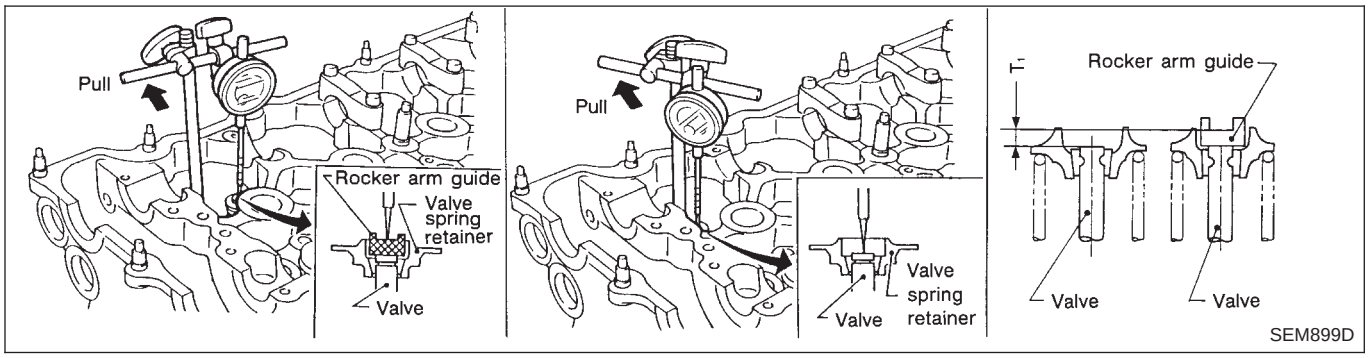
9. Select a suitable shim when replacing any of the following parts with a new one: Cylinder head, shim, rocker arm guide and valve seat. Proceed as follows to select the shim of correct thickness.

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

- Always replace rocker arm guide with a new one.

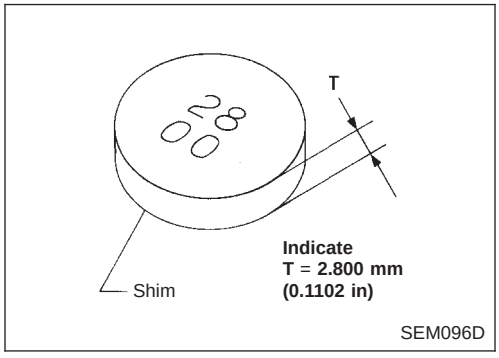


b. Remove hydraulic lash adjuster.
c. Install Tool* into hydraulic lash adjuster fixing hole.
   * Tool (KV10115700) is screwed into magnetic stand rod used with dial gauge.



d. Make sure that the following parts are installed to the cylinder head: Valve, valve spring, collet, retainer and rocker arm guide (except shim). Measure difference (T_1) between sliding surface of rocker arm guide and valve stem end on shim side.

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

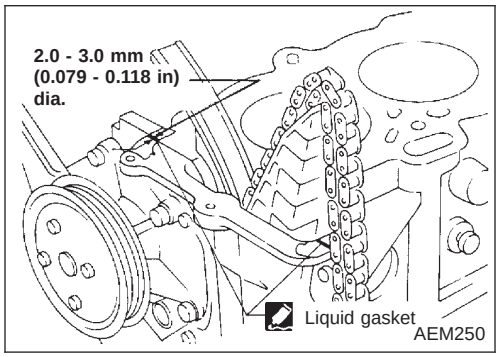


e. Select correct shim.

Shim thickness (T):

T_1 ± 0.025 mm (0.0010 in)

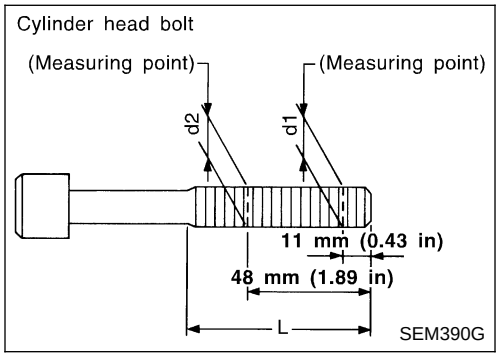
- Shims are available in different thicknesses from 2.800 mm (0.1102 in) to 3.200 mm (0.1260 in) in increments of 0.025 mm (0.0010 in).



Installation

NLEM0136

1. Before installing cylinder head gasket, apply liquid gasket as shown in the illustration.



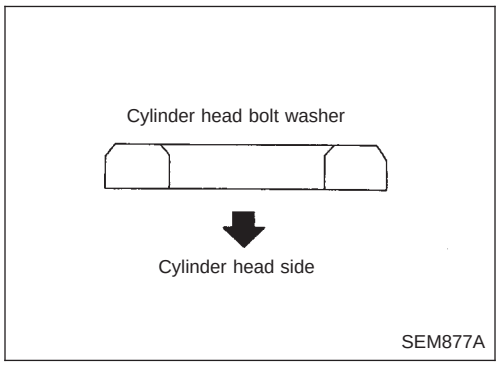
2. Install cylinder head completely with intake and exhaust manifolds.

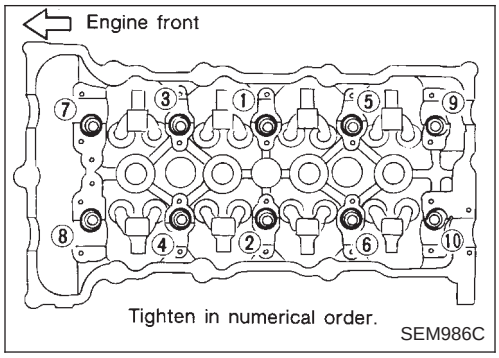
Cylinder head bolts are tightened by plastic zone tightening method. Whenever the size difference between d1 and d2 exceeds the limit, replace them with new ones.

Limit (d1 − d2):
0.15 mm (0.0059 in)

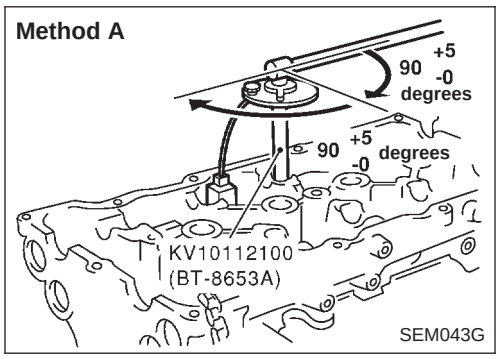
CAUTION:

If reduction of outer diameter appears in a position other than d2, use it as d2 point.



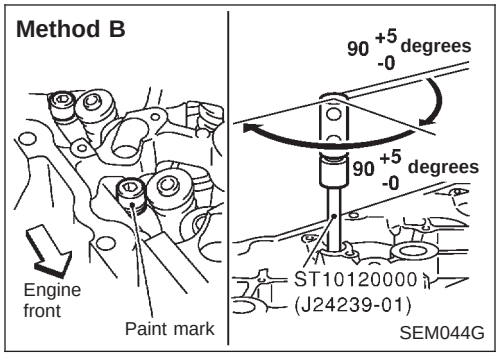


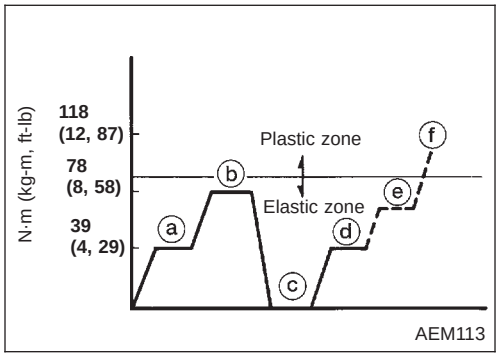
3. Tighten cylinder head bolts using the following procedure.
a. **Tighten all bolts to 39 N·m (4.0 kg-m, 29 ft-lb).**
b. **Tighten all bolts to 78 N·m (8.0 kg-m, 58 ft-lb).**
c. **Loosen all bolts completely.**
d. **Tighten all bolts to 39 N·m (4.0 kg-m, 29 ft-lb).**



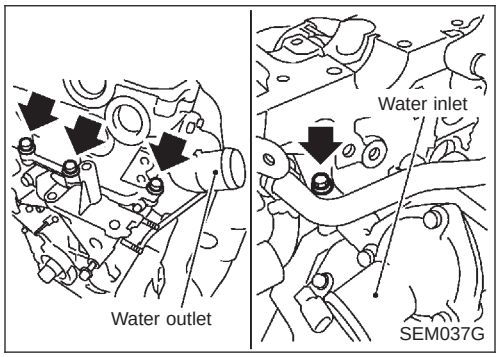
e. **Method A:**
Turn all bolts 90 to 95 degrees clockwise with Tool or suitable angle wrench.
Method B:
If an angle wrench is not available, mark all cylinder head bolts on the side facing engine front. Then, turn each cylinder head bolt 90 to 95 degrees clockwise.
f. **Turn all bolts another 90 to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

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

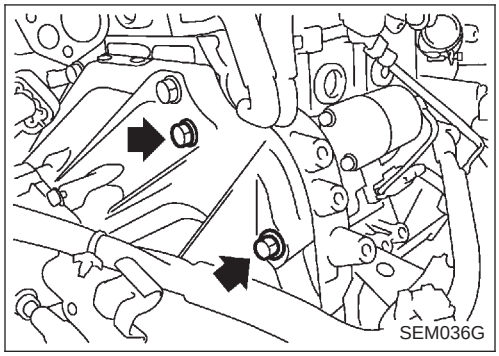




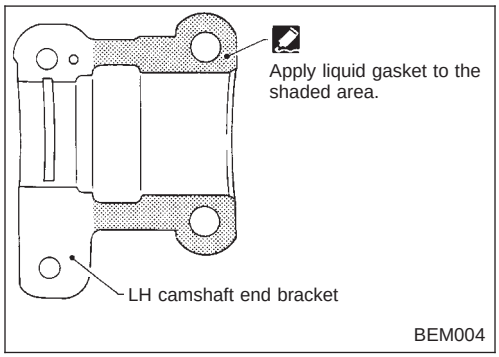
	Tightening torque N·m (kg-m, ft-lb)
a.	39 (4.0, 29)
b.	78 (8.0, 58)
c.	0 (0, 0)
d.	39 (4.0, 29)
e.	90 - 95 degrees (90 degrees preferred)
f.	90 - 95 degrees (90 degrees preferred)



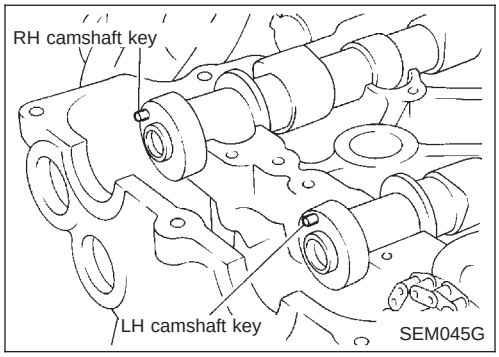
4. Install cylinder head outside bolts.
5. Install the following water hoses:
- Water hose for cylinder block.
- Water hoses for heater.



6. Install starter motor.

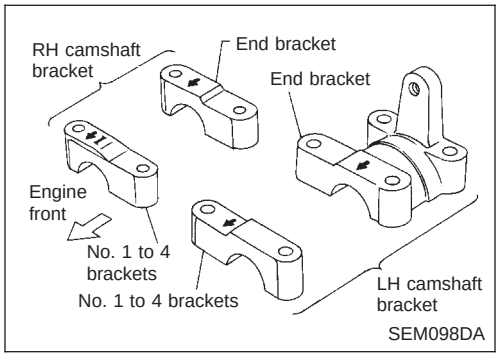


7. Remove old liquid gasket from mating surface of LH camshaft end bracket.
- **Also remove old liquid gasket from mating surface of cylinder head.**
8. Apply liquid gasket to mating surface of LH camshaft end bracket as shown in illustration.
- **Use Genuine RTV silicone sealant part No. 999MP-A7007 or equivalent.**

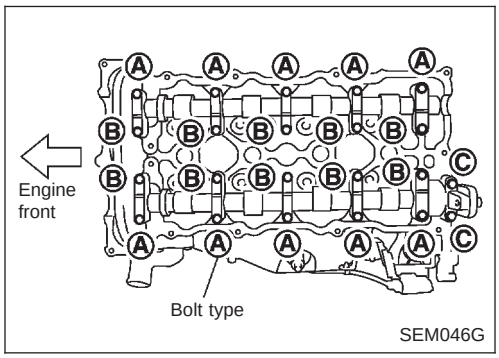


9. Install camshafts, camshaft brackets.
- Position camshaft.
- LH camshaft key at about 12 o'clock.
- RH camshaft key at about 10 o'clock.

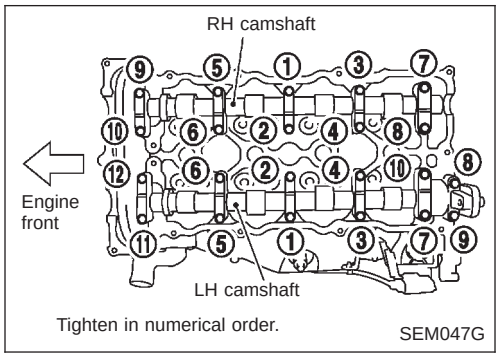
Apply new engine oil to bearing and cam surfaces of camshafts before installing them.



- Position camshaft brackets as shown in the illustration.
  Apply new engine oil to threads and seating surfaces of camshaft bracket bolts before installing them.



- **Arrange bolts (Size and length).**
  A: M6 x 53.8 mm (2.12 in)
  B: M6 x 37 mm (1.46 in)
  C: M8 x 35 mm (1.38 in)



- **Tightening procedure**

  STEP 1:

  RH camshaft

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

  : 2 N·m (0.2 kg-m, 17 in-lb)

  LH camshaft

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

  : 2 N·m (0.2 kg-m, 17 in-lb)

  STEP 2:

  Tighten bolts in numerical order.

  : 6 N·m (0.6 kg-m, 52 in-lb)

  STEP 3:

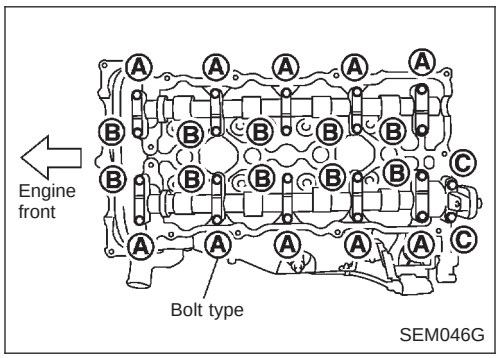
  Tighten bolts in numerical order.

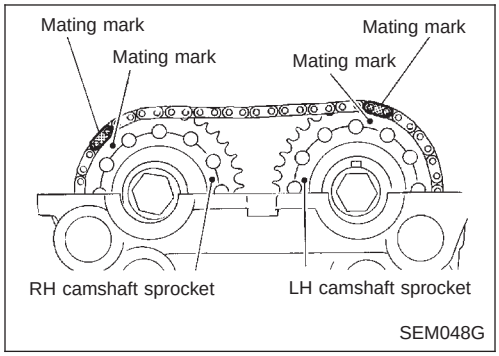
  Bolt type A B

  : 9.8 - 11.8 N·m (1.0 - 1.2 kg-m, 7.2 - 8.7 ft-lb)

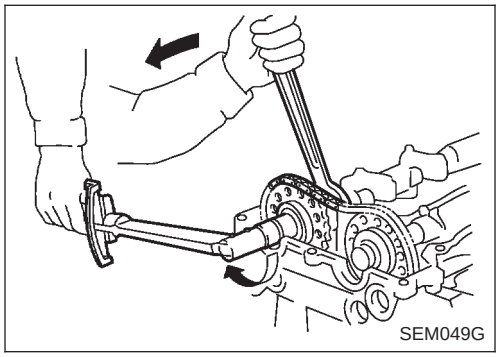
  Bolt type C

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





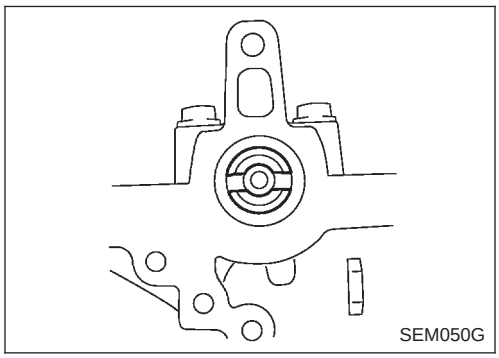
10. Install camshaft sprockets and timing chain on them.
    Line up mating marks on timing chain with mating marks on camshaft sprockets.


SEM049G

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

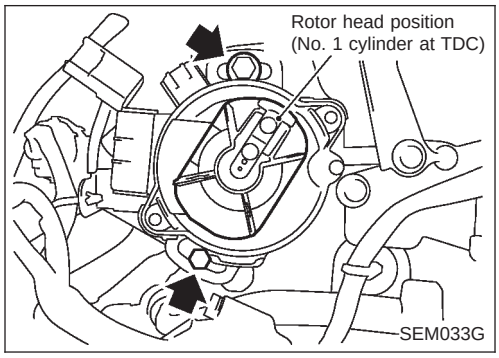
: 137 - 157 N·m (14.0 - 16.0 kg-m, 101 - 116 ft-lb)

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


SEM050G

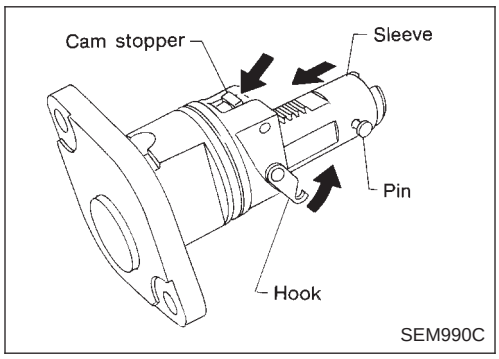
11. Install distributor.

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



SEM033G

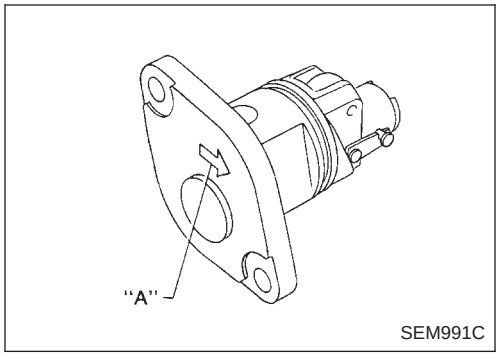
- **Make sure that No. 1 piston is set at TDC and that distributor rotor is set at No. 1 cylinder spark position.**



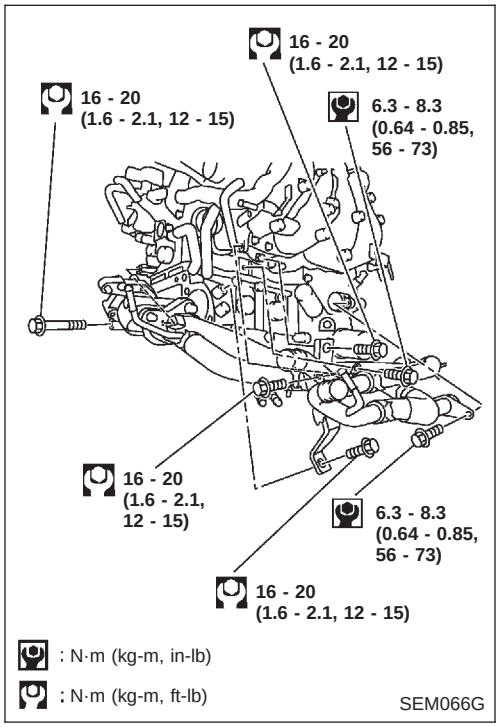
SEM990C

12. Install chain tensioner.

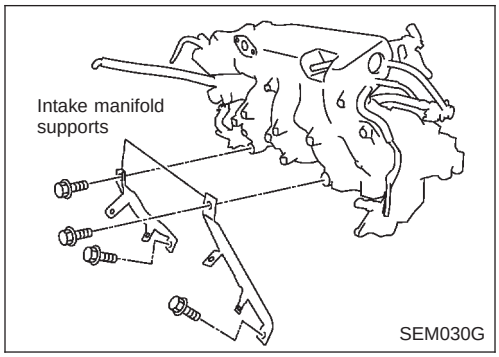
Make sure the camshaft sprockets are tightened completely. Press cam stopper down and "press-in" sleeve until hook can be engaged on pin. When tensioner is bolted in position the hook will release automatically. Make sure arrow "A" points toward engine front.



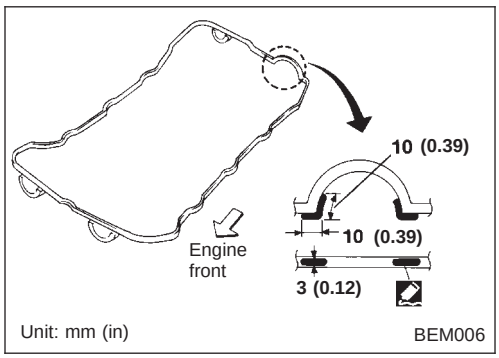
SEM991C



13. Install thermostat housing with water pipe.

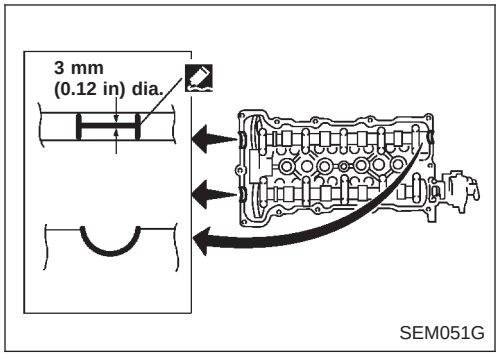


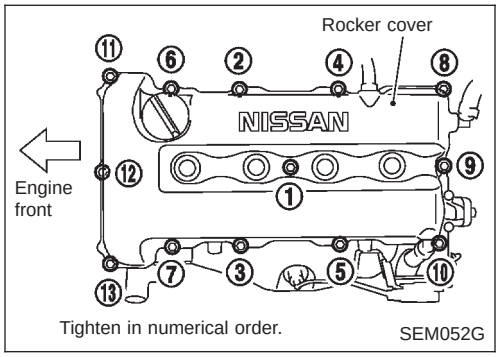
14. Install intake manifold supports.



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

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





17. Install rocker cover and oil separator.
- **Be sure to install washers between bolts and rocker cover.**
- **Tightening procedure**

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

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

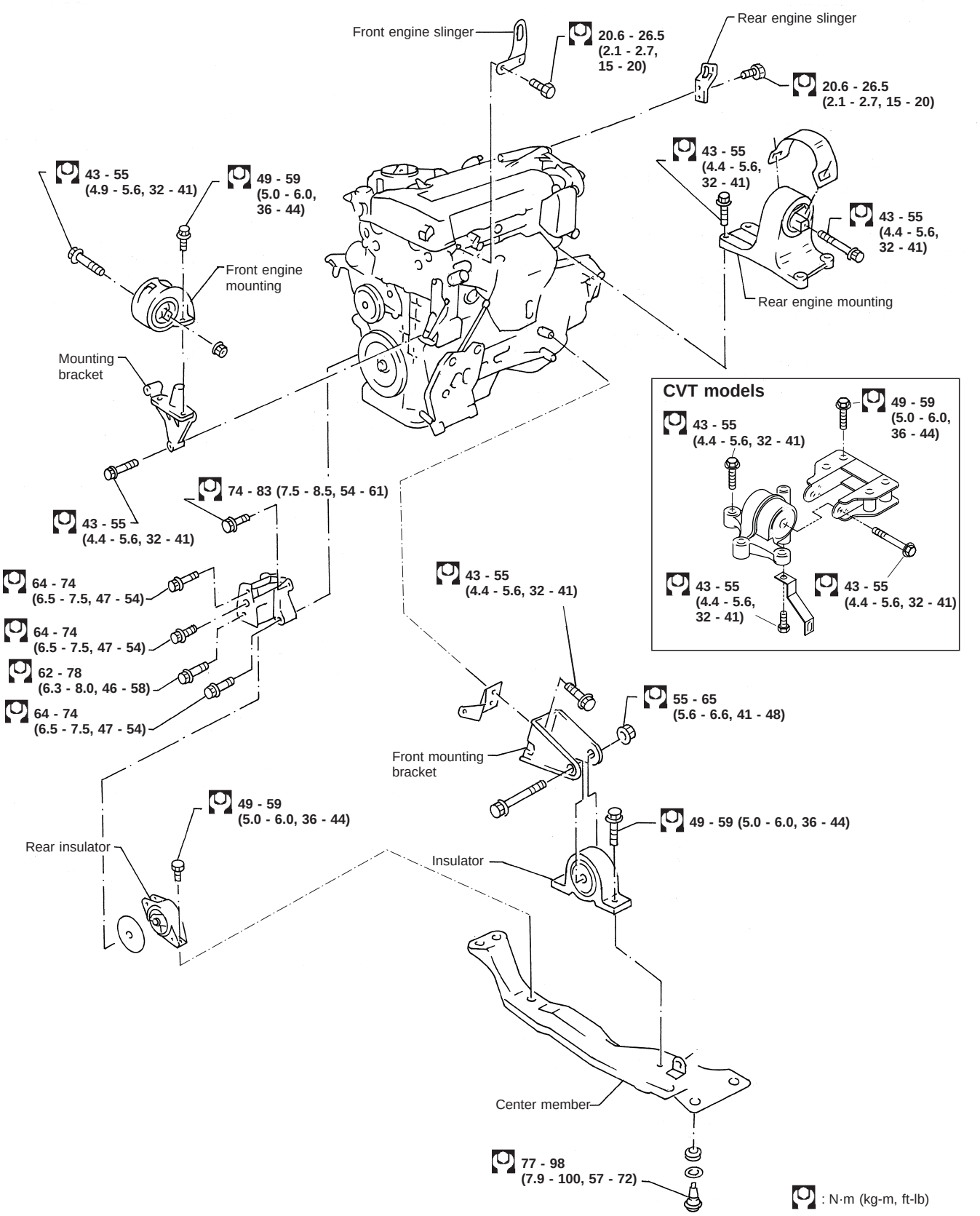
  : 8 - 10 N·m (0.8 - 1.0 kg-m, 69 - 87 in-lb)

18. Install the following parts:
- Spark plugs and leads
- Radiator
  Refit hoses and refill with coolant.
  Refer to MA-29, "Changing Engine Coolant".
- Front RH wheel
- Engine undercovers

19. Connect the following:
- Vacuum hoses
- Fuel hoses
- Wire harnesses and connectors
- Air duct to intake manifold
- Front exhaust tube

Components

SEC. 112



NEM340

WARNING:

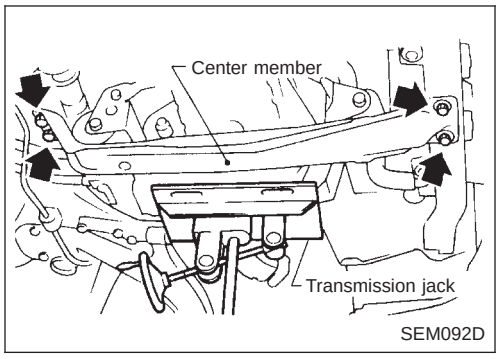
- **Position vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **Do not remove engine until exhaust system has completely cooled;**
  Otherwise, you may burn yourself and/or fire may break out in fuel line.
- **Before disconnecting fuel hose, release fuel pressure from fuel line.**
  Refer to "Releasing Fuel Pressure" in EC section.
- **Be sure to hoist engine and transaxle in a safe manner.**
- **For engines not equipped with engine slingers, attach slingers and bolts described in PARTS CATALOG.**

CAUTION:

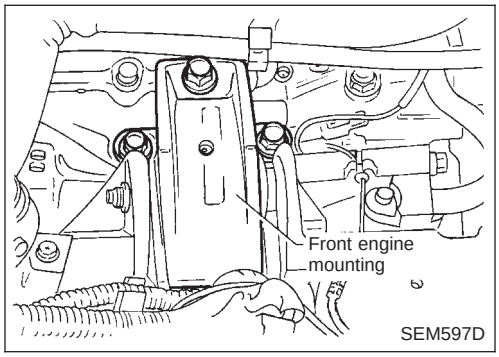
- **When lifting engine, be sure to clear surrounding parts. Use special care for accelerator cable, brake lines and brake master cylinder.**
- **In hoisting the engine, always use engine slingers in a safe manner.**
- **When removing drive shaft, be careful not to damage grease seal of transaxle.**

Removal

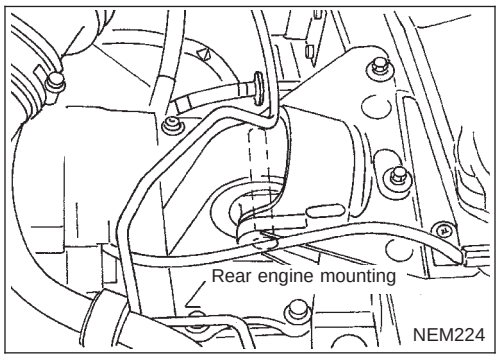
1. Remove engine under cover and hood.
2. Drain coolant from both cylinder block, and radiator.
3. Drain engine oil.
4. Remove vacuum hoses, fuel hoses, wires, harness and connectors.
5. Remove exhaust tubes, ball joints and drive shafts.
6. Remove radiator and fans.
7. Remove drive belts.
8. Remove alternator, compressor and power steering oil pump from engine.
9. Set a suitable transmission jack under transaxle. Hoist engine with engine slinger.

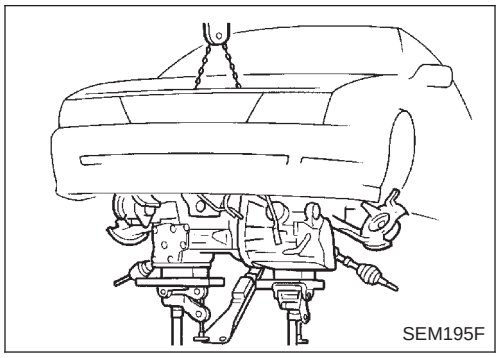


10. Remove center member.



11. Remove engine mounting bolts from both sides and then slowly lower transmission jack.





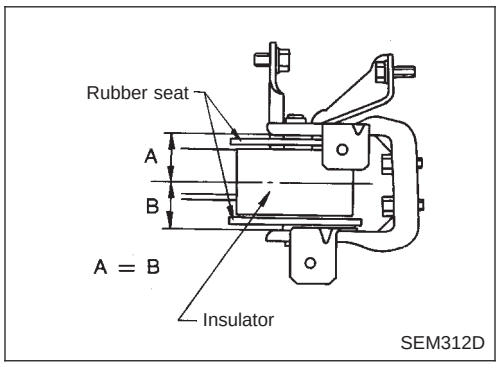
12. Remove engine with transaxle as shown.

Installation

1. Install engine mounting bracket and fixing bolts.

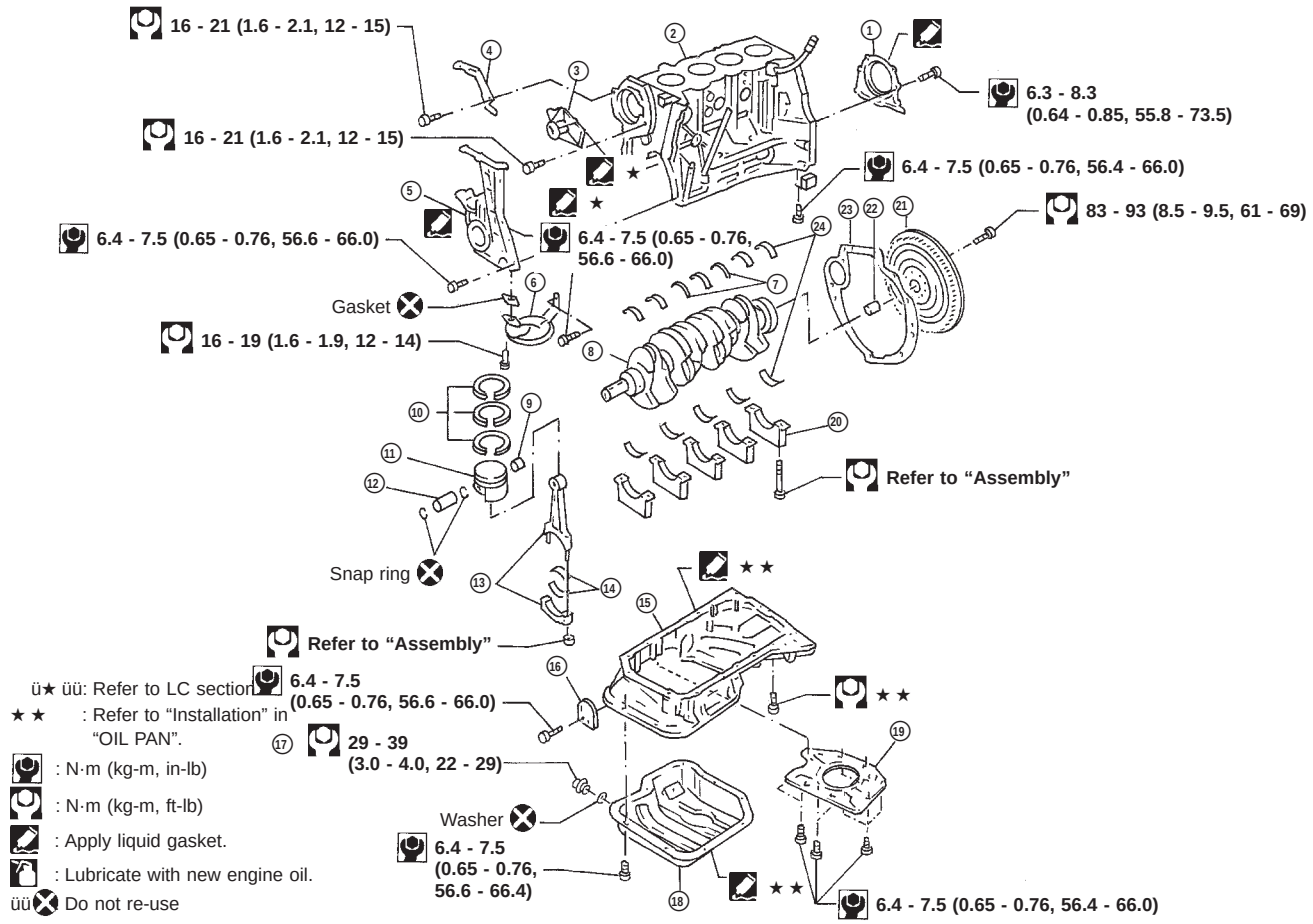
Be sure that insulators are correctly positioned on the brackets.

2. Carefully lower the engine onto engine mounting insulators.



Components

SEC. 110·120·150

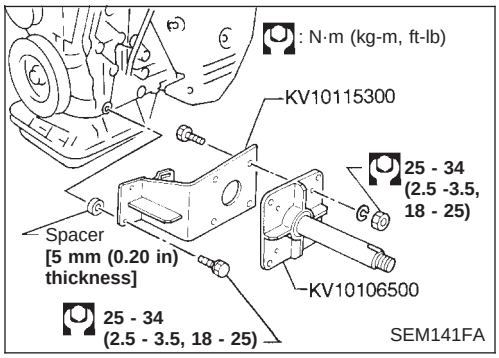


NEM225

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

CAUTION:

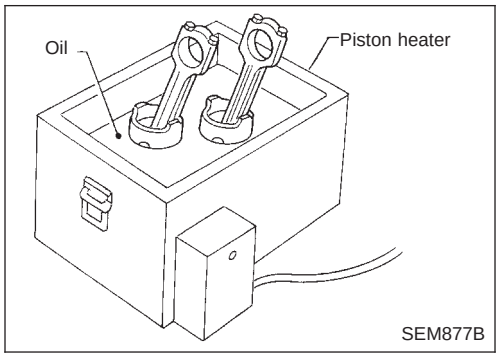
- **When installing sliding parts (bearings, pistons, etc.), apply new engine oil to the sliding surfaces.**
- **Place removed parts such as bearings and bearing caps in their correct order and direction.**
- **When installing connecting rod nuts and main bearing cap bolts, apply new engine oil to threads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



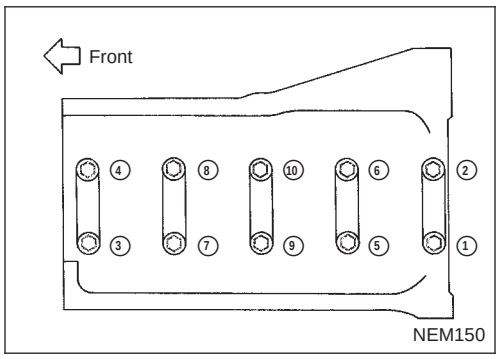
Disassembly

PISTON AND CRANKSHAFT

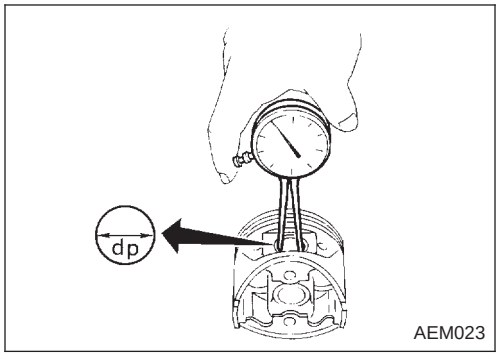
1. Place engine on a work stand.
2. Remove cylinder head.
   Refer to "Removal" in "CYLINDER HEAD" (EM-87).
3. Remove oil pan.
   Refer to "Removal" in "OIL PAN" (EM-70).
4. Remove timing chain.
   Refer to "Removal" in "TIMING CHAIN" (EM-76).



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



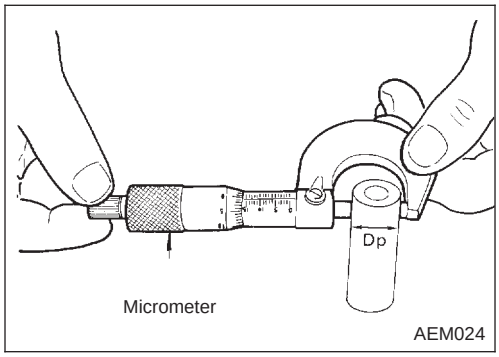
7. Remove bearing caps and crankshaft in numerical order as shown in the figure.
   - **Before removing bearing cap, measure crankshaft end play.**
   - **Bolts should be loosened in two or three steps.**



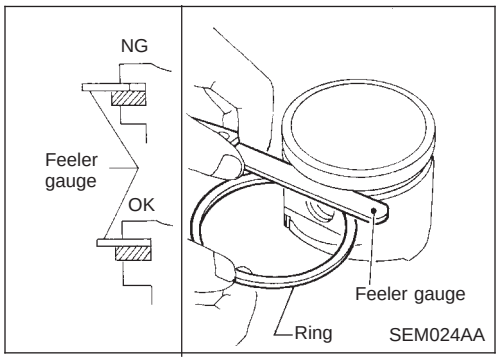
Inspection

PISTON AND PISTON PIN CLEARANCE

1. Measure inner diameter of piston pin hole "dp".
   Standard diameter "dp":
   21.993 - 22.005 mm (0.8659 - 0.8663 in)



2. Measure outer diameter of piston pin "Dp".
   Standard diameter "Dp":
   21.989 - 22.001 mm (0.8657 - 0.8662 in)
3. Calculate piston pin clearance.
   dp − Dp = 0.002 - 0.006 mm (0.0001 - 0.0002 in)
   If it exceeds the above value, replace piston assembly with pin.



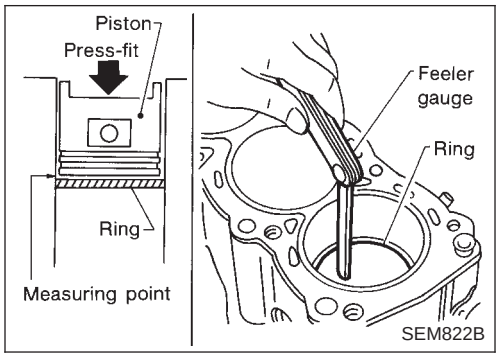
PISTON RING SIDE CLEARANCE

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:
0.2 mm (0.008 in)

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



PISTON RING END GAP

End gap:

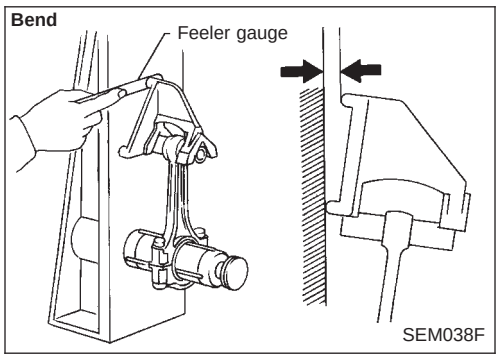
Top ring	**0.20 - 0.30 mm (0.0079 - 0.0118 in)**
2nd ring	**0.35 - 0.50 mm (0.0138 - 0.0197 in)**
Oil ring	**0.20 - 0.60 mm (0.0079 - 0.0236 in)**

Max. limit of ring gap:
1.0 mm (0.039 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 over-sized piston and piston rings.

Refer to SDS (EM-193).

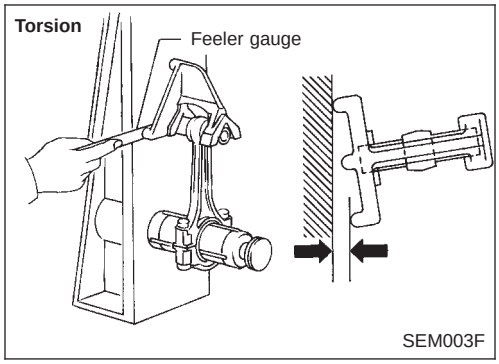
- When replacing the piston, inspect cylinder block surface for scratches or seizure. If scratches or seizure are found, hone or replace the cylinder block.



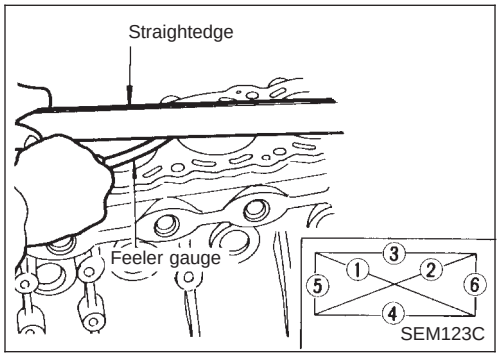
CONNECTING ROD BEND AND TORSION

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

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

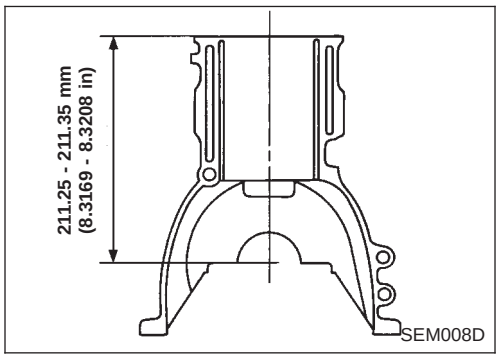


If it exceeds the limit, replace connecting rod assembly.



CYLINDER BLOCK DISTORTION AND WEAR

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

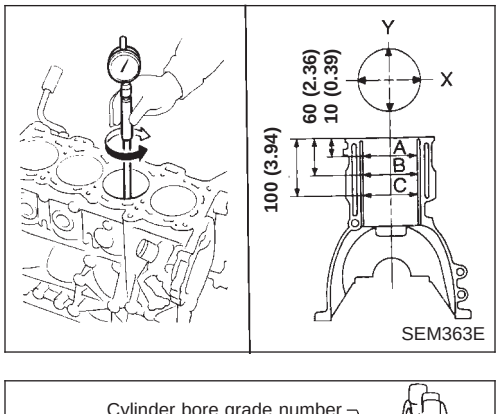


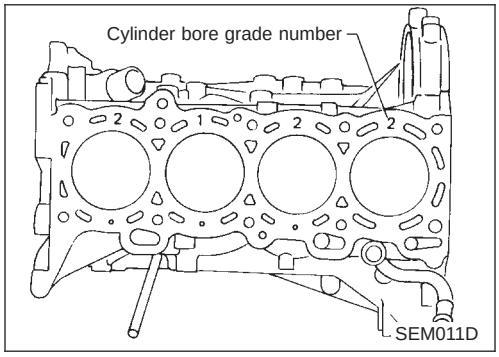
Amount of cylinder head resurfacing is "A".
Amount of cylinder block resurfacing is "B".
The maximum limit is as follows:
A + B = 0.2 mm (0.008 in)
Nominal cylinder block height from crankshaft center:
211.25 - 211.35 mm (8.3169 - 8.3208 in)

3. If necessary, replace cylinder block.

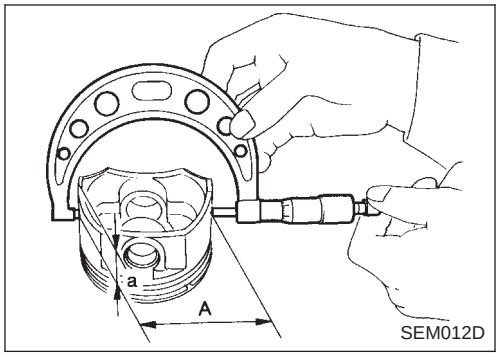
PISTON-TO-BORE CLEARANCE

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





- **When replacing both cylinder block and piston with new ones, select piston making sure of grade numbers. Piston grade number should be the same as the grade number punched on cylinder block upper surface.**



3. Measure piston skirt diameter.
   Piston diameter "A": Refer to SDS (EM-193).
   Measuring point "a" (Distance from the bottom):
   13.1 mm (0.516 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-193).

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.

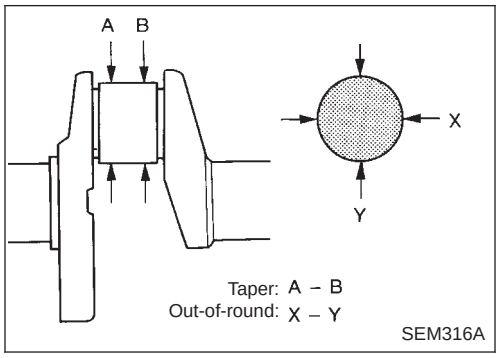
- **Otherwise, cylinder bores may be distorted in final assembly.**

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

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:

Main journal:

Less than 0.005 mm (0.0002 in)

Pin journal:

Less than 0.0025 mm (0.0001 in)

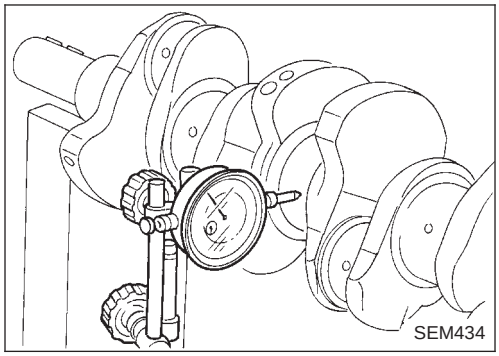
Taper (A − B) standard:

Main journal:

Less than 0.005 mm (0.0002 in)

Pin journal:

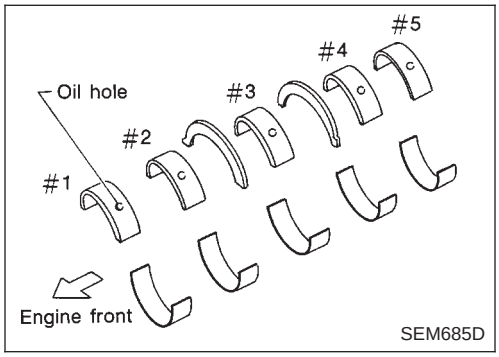
Less than 0.0025 mm (0.0001 in)



3. Measure crankshaft runout.

Runout (Total indicator reading) limit:

Less than 0.05 mm (0.0020 in)



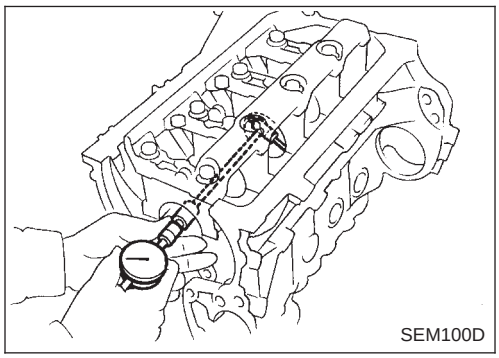
BEARING CLEARANCE

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

Method A (Using bore gauge & micrometer)

Main bearing

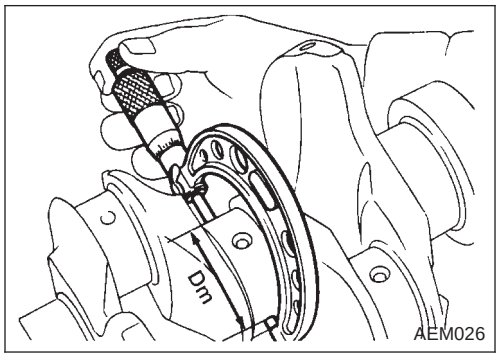
1. Set main bearings in their proper positions on cylinder block and main bearing cap.



2. Install main bearing caps to cylinder block.

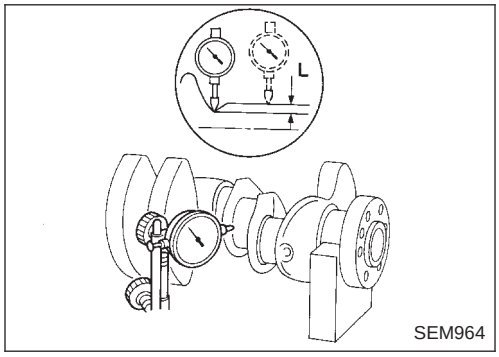
Tighten all bolts in correct order in two or three stages.

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



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

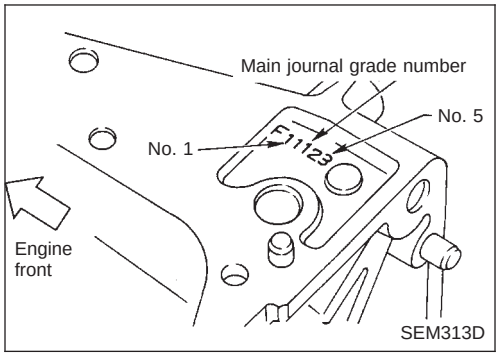
   Standard: 0.004 - 0.022 mm (0.0002 - 0.0009 in)
   Limit: 0.050 mm (0.0020 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.



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

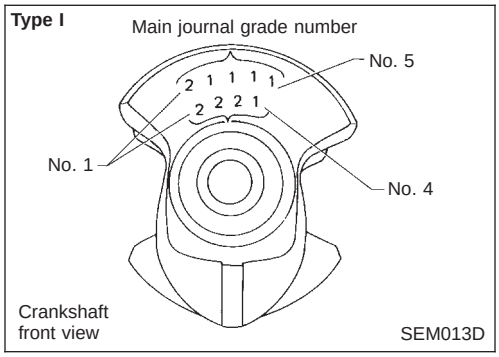
   "L": 0.1 mm (0.004 in)

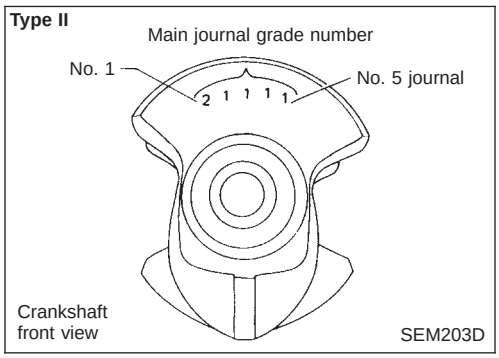
b. Refer to SDS for grinding crankshaft and available service parts.



8. If crankshaft is reused, measure main bearing clearances and select thickness of main bearings.
   If crankshaft 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 Roman numerals.





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

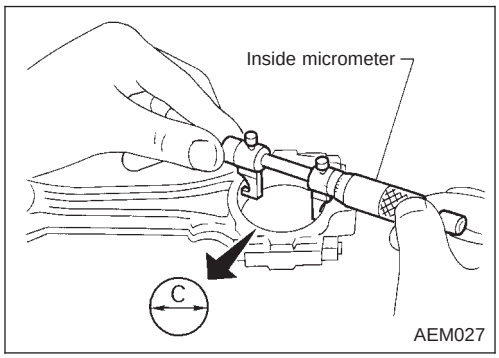
c. Select main bearing with suitable thickness according to the following table.

How to select main bearings (Identification mark and color)

Crankshaft main journal grade number	Cylinder block main journal grade number			
	0	1	2	3
0	0 (A, Black)	1 (B, Red)	2 (C, Green)	3 (D, Yellow)
1	1 (B, Red)	2 (C, Green)	3 (D, Yellow)	4 (E, Blue)
2	2 (C, Green)	3 (D, Yellow)	4 (E, Blue)	5 (F, Pink)
3	3 (D, Yellow)	4 (E, Blue)	5 (F, Pink)	6 (G, White)

For example:

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

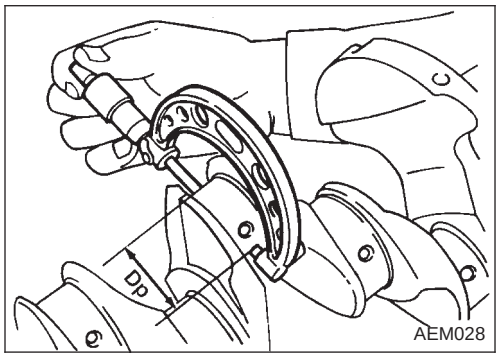


Connecting rod bearing (Big end)

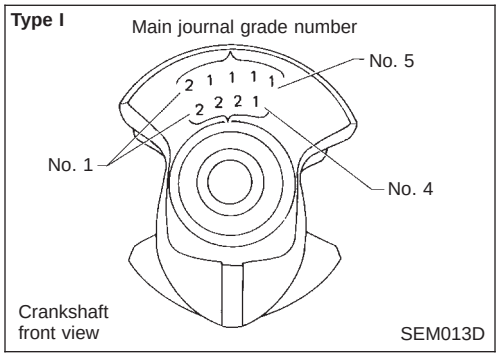
1. Install connecting rod bearing to connecting rod and cap.
2. Install connecting rod cap to connecting rod.

Tighten bolts to the specified torque.

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



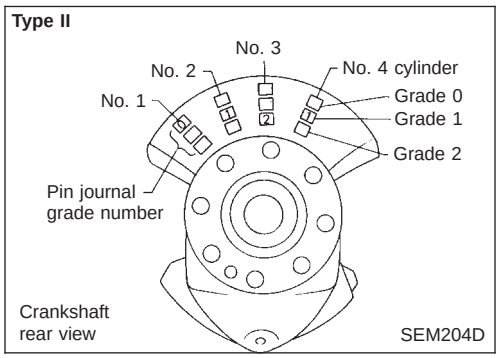
4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.
   Connecting rod bearing clearance = C − Dp
   Standard: 0.020 - 0.045 mm (0.0008 - 0.0018 in)
   Limit: 0.065 mm (0.0026 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to step 7 of "BEARING CLEARANCE − Main bearing" (EM-114).



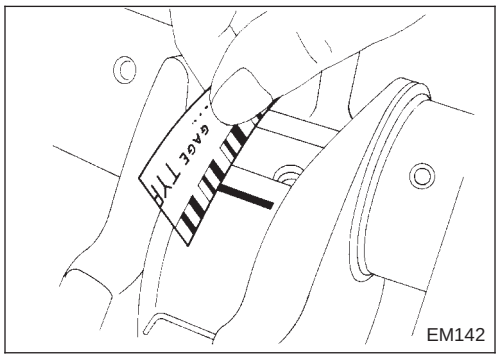
8. If crankshaft is replaced with a new one, select connecting rod bearing according to the following table.

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

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



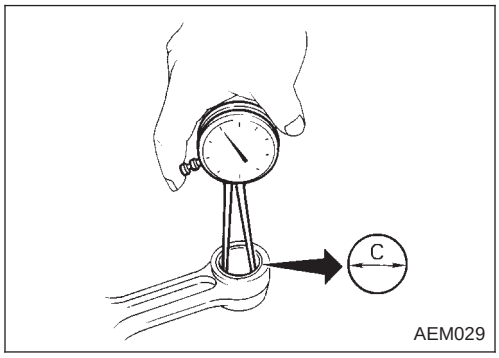
Identification color:
Grade 0; Black or Yellow
Grade 1; Brown or Red
Grade 2; Green or Blue



Method B (Using plastigage)

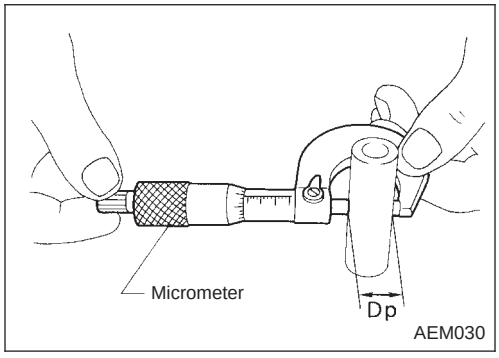
CAUTION:

- **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)

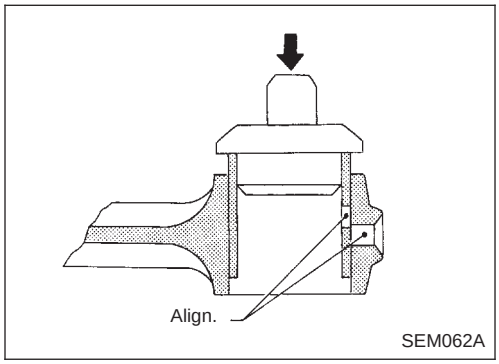
1. Measure inner diameter "C" of bushing.
   Refer to SDS EM-193 - "CONNECTING ROD".



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

Standard:
0.005 - 0.017 mm (0.0002 - 0.0007 in)
Limit:
0.023 mm (0.0009 in)

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



REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

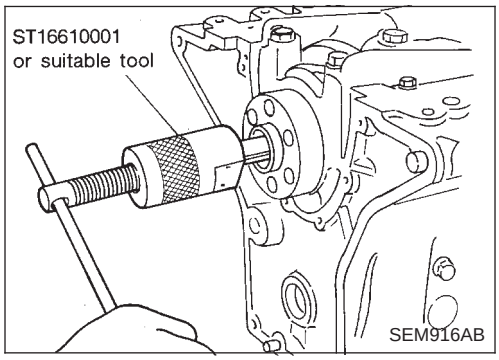
1. Drive in small end bushing until it is flush with end surface of rod.

Be sure to align the oil holes.

2. After driving in small end bushing, ream the bushing. This is to ensure the clearance between connecting rod bushing and piston pin is the specified value.

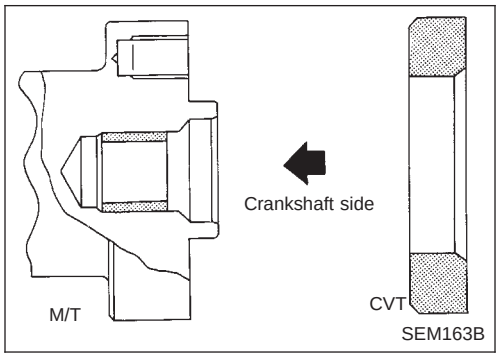
Clearance between connecting rod bushing and piston pin:

0.005 - 0.017 mm (0.0002 - 0.0007 in)

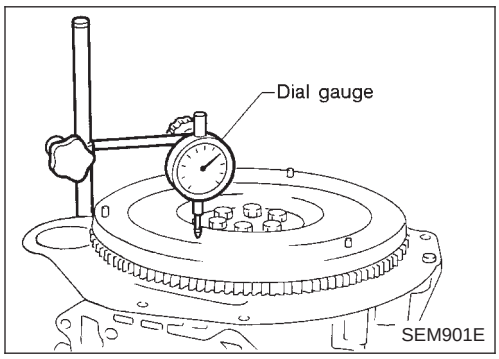


REPLACEMENT OF PILOT BUSHING (M/T) OR PILOT CONVERTER (CVT)

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



2. Install pilot bushing or pilot converter as shown.



FLYWHEEL/DRIVE PLATE RUNOUT

Runout (Total indicator reading):

Flywheel (M/T model)

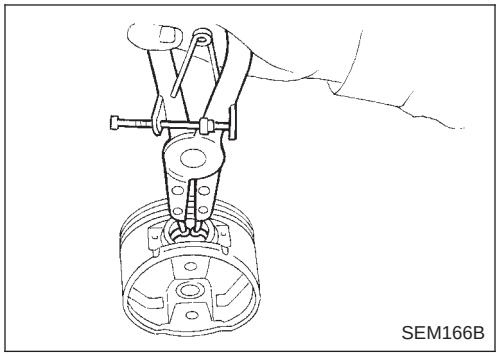
Less than 0.15 mm (0.0059 in)

Drive plate (CVT model)

Less than 0.20 mm (0.0079 in)

CAUTION:

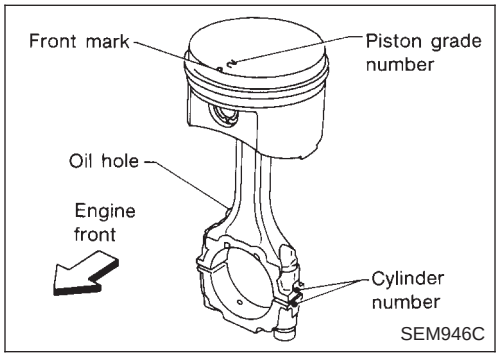
Do not allow any magnetic materials to contact the ring gear teeth.



Assembly

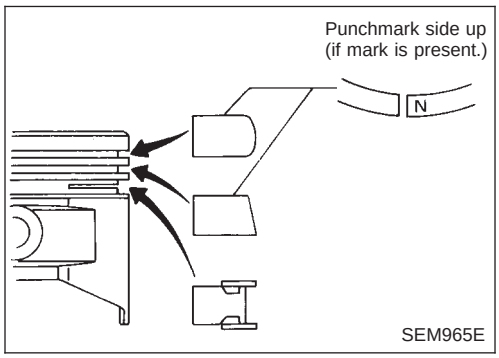
PISTON

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



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

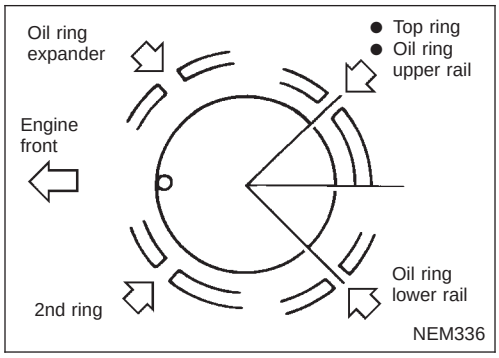
- **Align the direction of piston and connecting rod.**
- **Numbers stamped on connecting rod and cap correspond to each cylinder.**
- **After assembly, make sure connecting rod swings smoothly.**



3. Set piston rings as shown.

CAUTION:

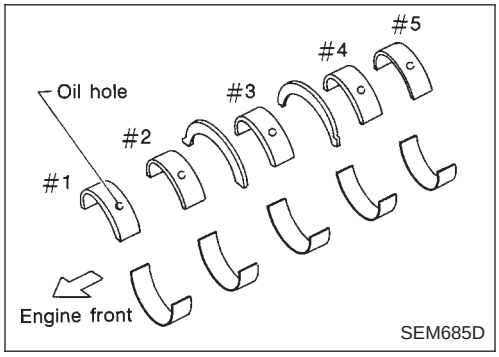
- **When piston rings are not replaced, make sure that piston rings are mounted in their original positions.**
- **When replacing piston rings, those without punchmarks can be mounted with either side up.**

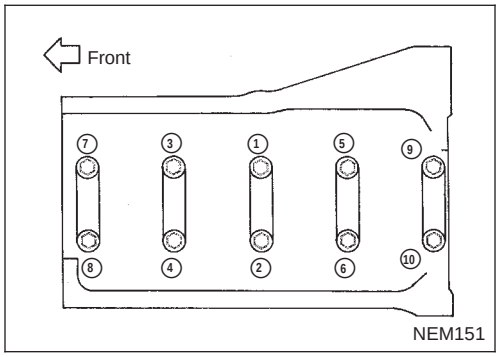


CRANKSHAFT

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

- **Confirm that correct main bearings are used. Refer to "Inspection" of this section.**
- **Apply new engine oil to bearing surfaces.**





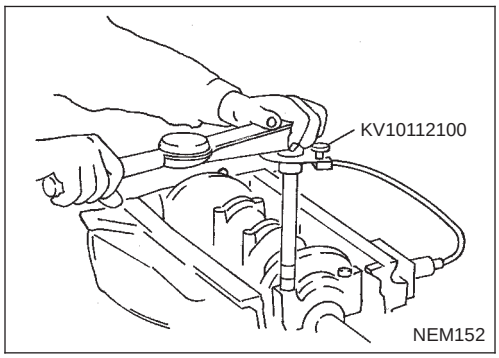
2. Install crankshaft and main bearing caps and tighten bolts to the specified torque and in numerical order as shown in the figure.

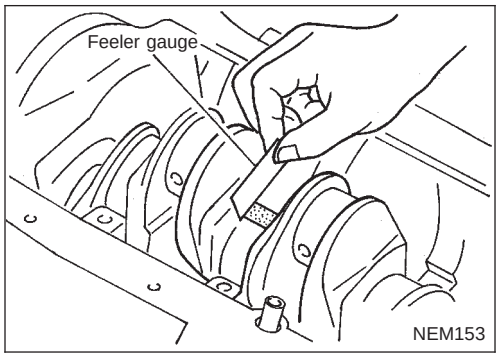
- **Apply new engine oil to thread of bearing cap bolts.**
- **Prior to tightening bearing cap bolts, shift crankshaft back and forth to properly seat the bearing cap.**
- **Tightening procedure**

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 30 to 35 degrees clockwise with Tool or suitable angle wrench.

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

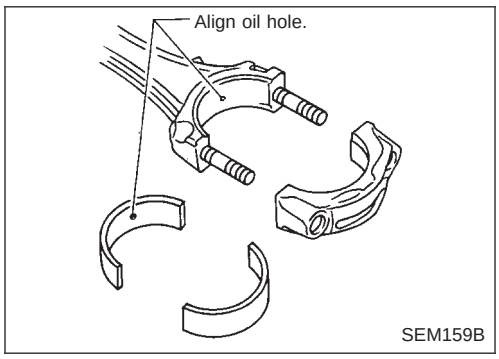




3. Measure crankshaft end play.

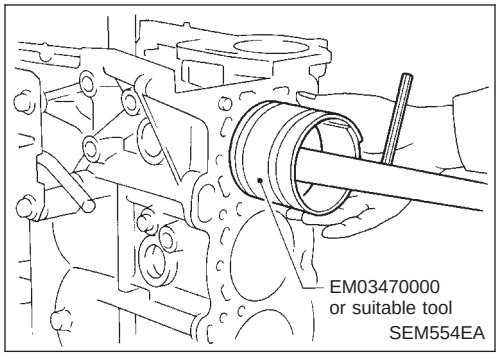
Crankshaft end play:
Standard
0.10 - 0.26 mm (0.0039 - 0.0102 in)
Limit
0.30 mm (0.0118 in)

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



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

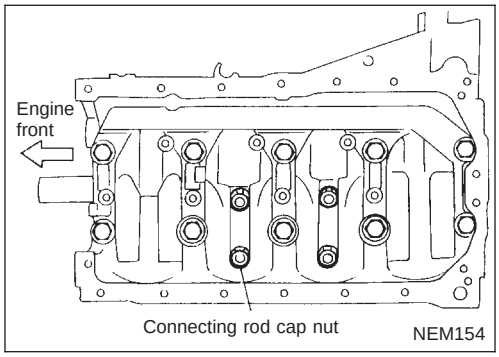
- **Confirm that correct bearings are used. Refer to "Inspection".**
- **Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.**
- **Apply new engine oil to bolt threads and bearing surfaces.**



5. Install pistons with connecting rods.

a. Install them into corresponding cylinders with Tool.

- **Be careful not to scratch cylinder wall by connecting rod.**
- **Arrange so that front mark on piston head faces toward front of engine.**
- **Apply new engine oil to piston rings and sliding surface of piston.**

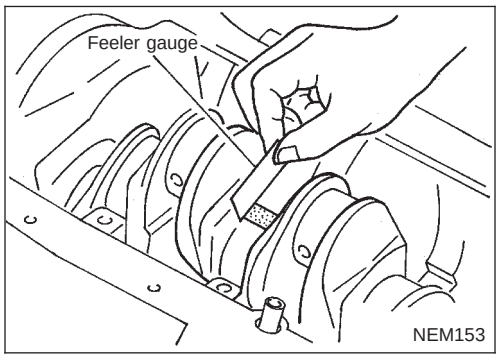


b. Install connecting rod caps.
Tighten connecting rod cap nuts to the specified torque.

Tightening procedure:

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

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



6. Measure connecting rod side clearance.

Connecting rod side clearance:

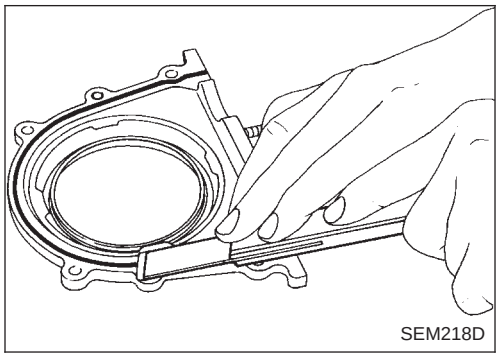
Standard

0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit

0.50 mm (0.0197 in)

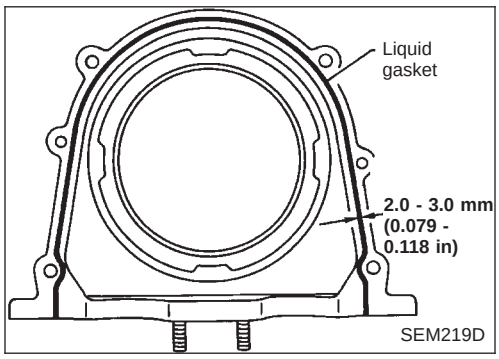
If beyond the limit, replace connecting rod and/or crankshaft.



7. Install rear oil seal retainer.

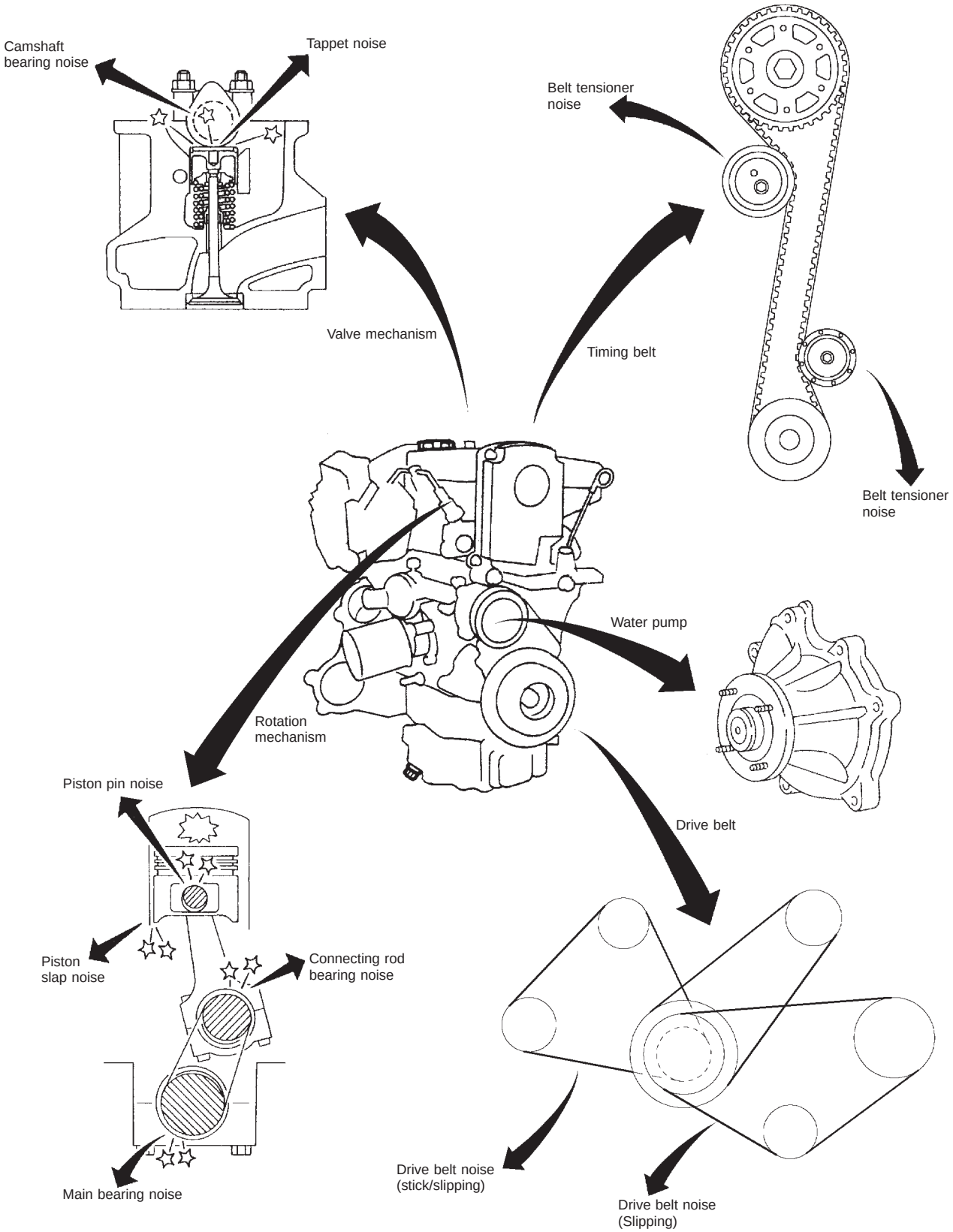
a. Before installing rear oil seal retainer, remove all traces of liquid gasket from mating surface using a scraper.

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



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

- Use Genuine Liquid Gasket or equivalent.


Camshaft bearing noise
Tappet noise
Valve mechanism
Belt tensioner noise
Timing belt
Belt tensioner noise
Water pump
Rotation mechanism
Piston pin noise
Drive belt
Piston slap noise
Connecting rod bearing noise
Main bearing noise
Drive belt noise (stick/slipping)
Drive belt noise (Slipping)

NEM333

NVH Troubleshooting Chart — Engine Noise

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

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.

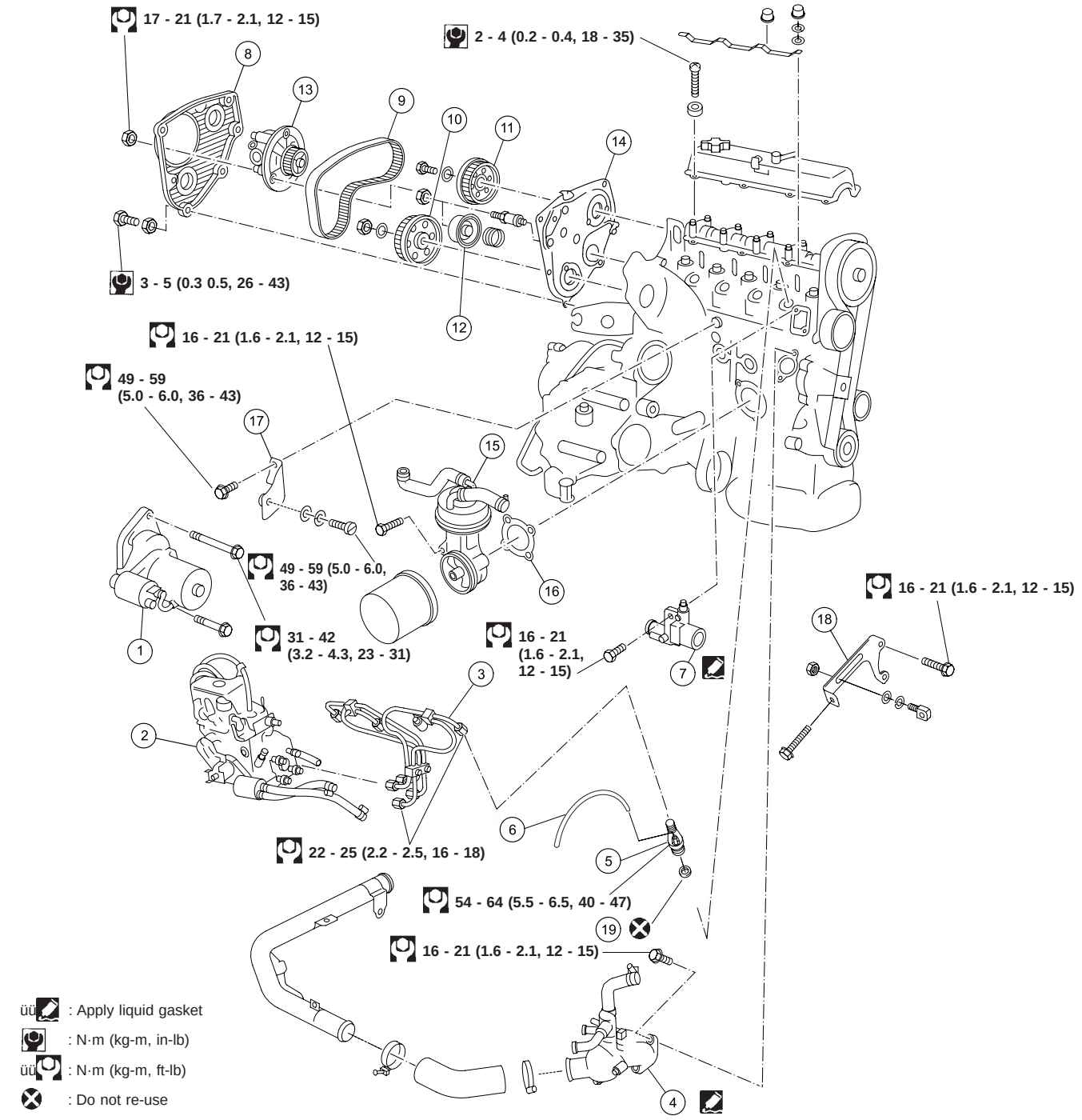
If necessary, repair or replace these parts.

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	—
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-147
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-168, 171
	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-168, 169, 172, 174
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing clearance (Small end) Connecting rod bearing clearance (Big end)	EM-170, 171
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-169, 172
Camshaft and injection pump Timing belt cover	Whine or hissing	C	A	—	A	A	—	Timing belt noise (too tight)	Loose timing belt Belt contacting case	EM-135
	Clatter	A	B	—	C	A	—	Timing belt noise (too loose)		
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Other drive belts (Sticking or slipping)	Drive belts deflection	*1
	Creaking	A	B	A	B	A	B	Other drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	*2

A: Closely related B: Related C: Sometimes related —: Not related
*1: MA section (“Checking Drive Belts”, “ENGINE MAINTENANCE”)
*2: LC section (“Water Pump Inspection”, “ENGINE COOLING SYSTEM”)

Right side

SEC. 130·135·185·186·210·213·233

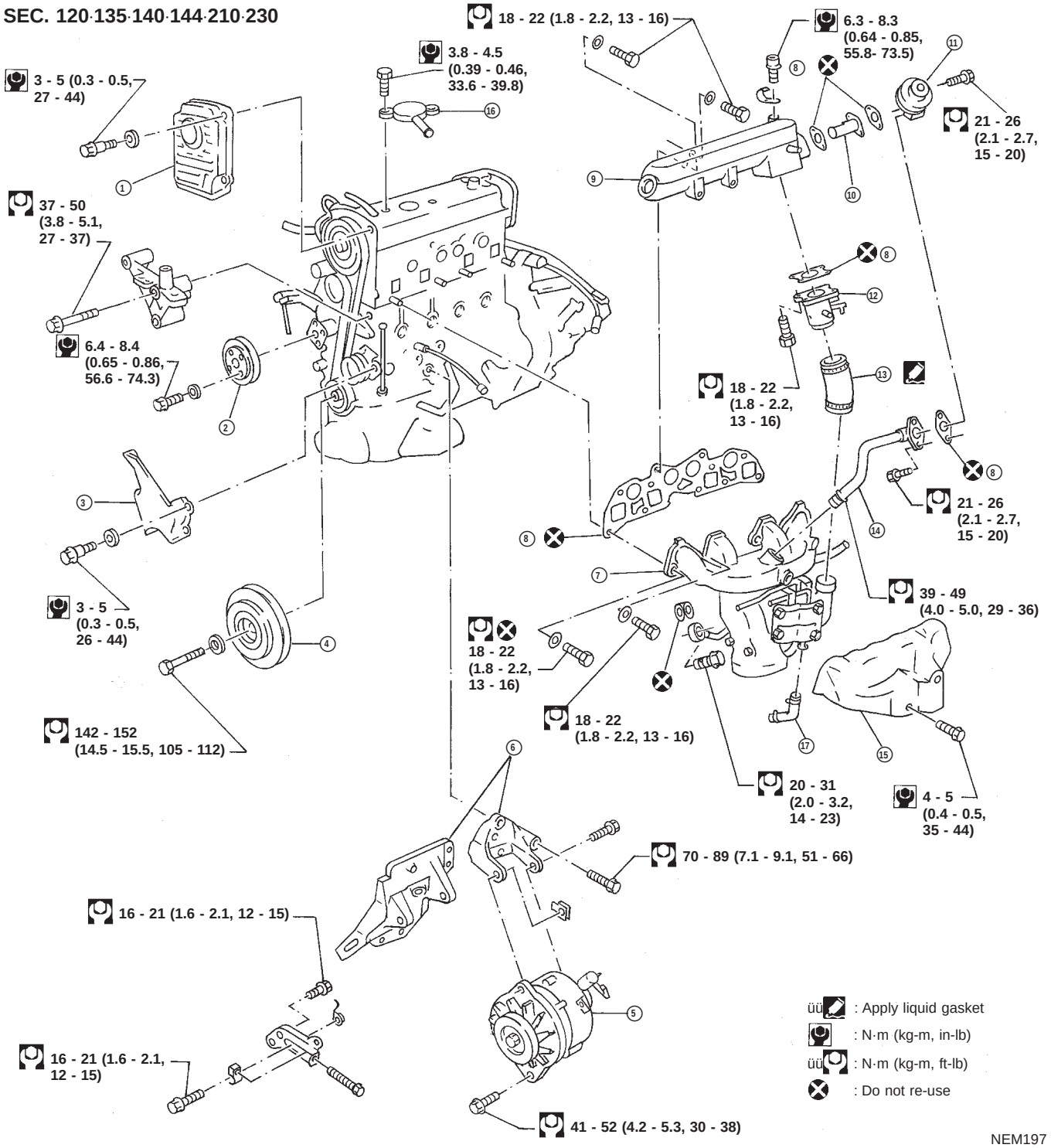


NEM240

① Starter motor
② Injection pump
③ Injection tube
④ Thermostat housing
⑤ Injection nozzle
⑥ Spill hose
⑦ Water outlet
⑧ Belt cover
⑨ Timing belt
⑩ Injection pump sprocket
⑪ Rear camshaft sprocket
⑫ Tensioner
⑬ Vacuum pump
⑭ Rear back cover
⑮ Oil cooler
⑯ Gasket
⑰ Bracket
⑱ Power steering oil pump adjusting bar
⑲ Gasket

Left side

SEC. 120·135·140·144·210·230

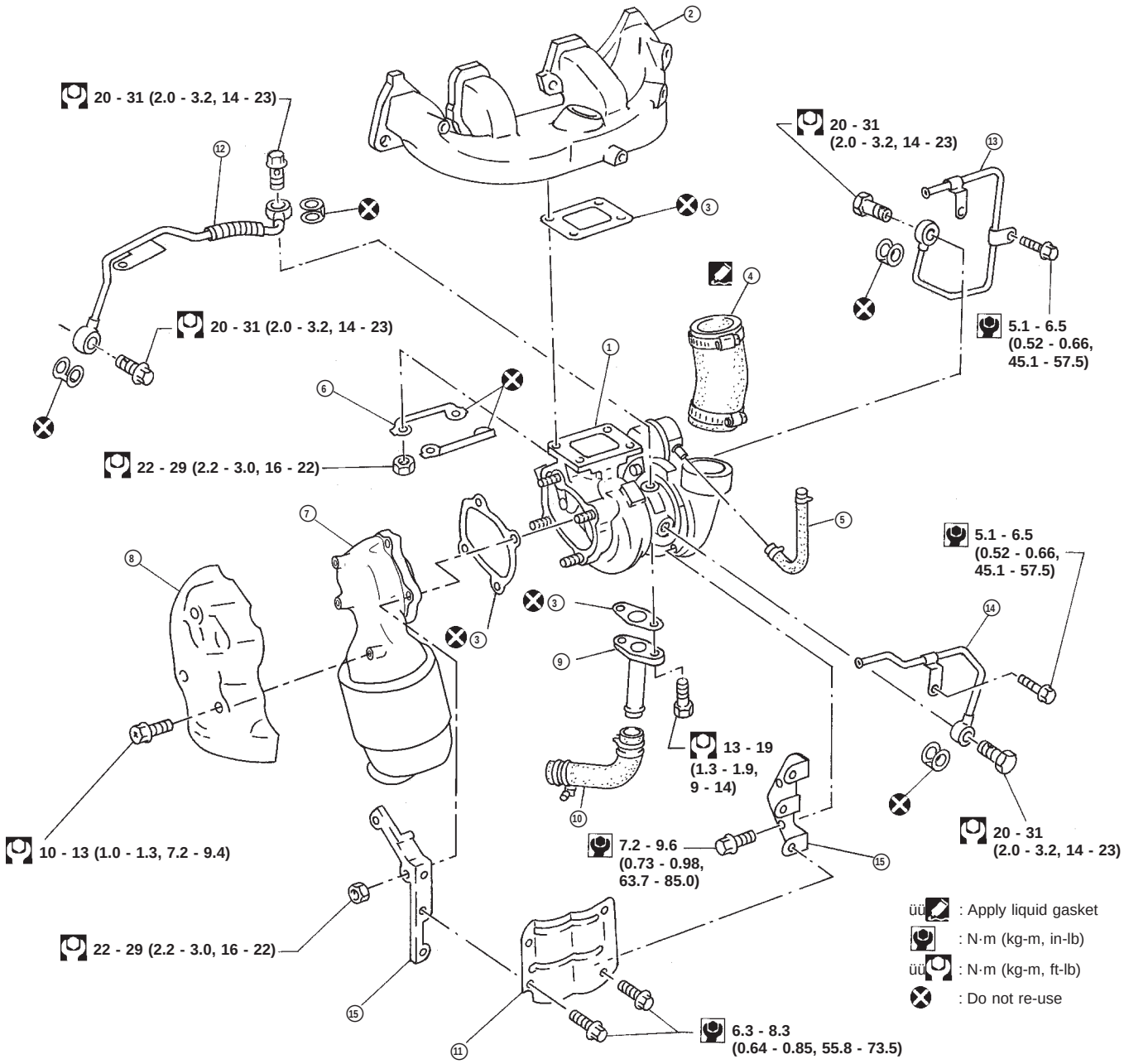


NEM197

① Belt cover upper
② Water pump pulley
③ Belt cover lower
④ Crankshaft pulley
⑤ Alternator
⑥ Alternator bracket
⑦ Exhaust manifold with turbo-charger assembly
⑧ Gasket
⑨ Intake manifold
⑩ EGR passage (To install, face EGR gas discharge port upward)
⑪ EGR valve
⑫ Air inlet
⑬ Air inlet hose
⑭ EGR tube
⑮ Exhaust manifold cover
⑯ Blow-by gas control valve
⑰ Turbocharger oil return hose

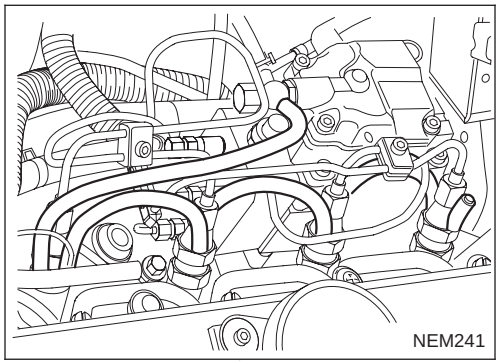
Left side

SEC. 140·144

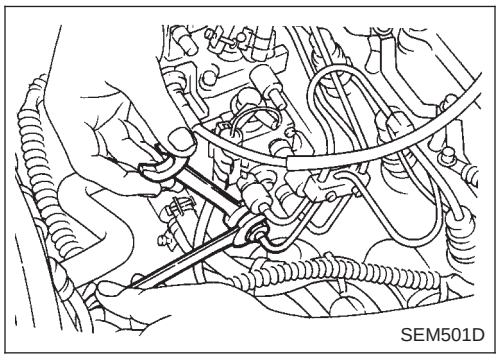


NEM375

① Turbocharger assembly
② Exhaust manifold
③ Gasket
④ Air inlet hose
⑤ Air hose
⑥ Lock plate
⑦ Exhaust outlet
⑧ Exhaust outlet cover
⑨ Turbocharger oil return pipe
⑩ Turbocharger oil return hose
⑪ Insulator
⑫ Turbocharger oil feed tube
⑬ Turbocharger water feed tube
⑭ Turbocharger water return tube
⑮ Bracket

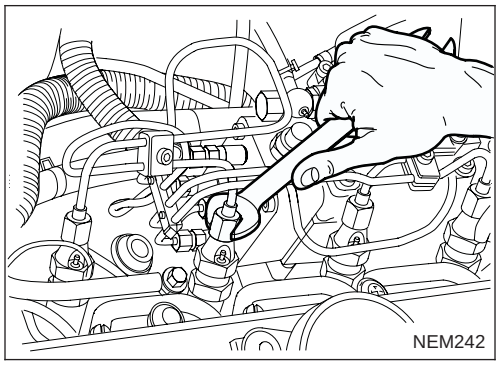

NEM241

1. Warm up engine sufficiently.
2. Remove spill hoses.

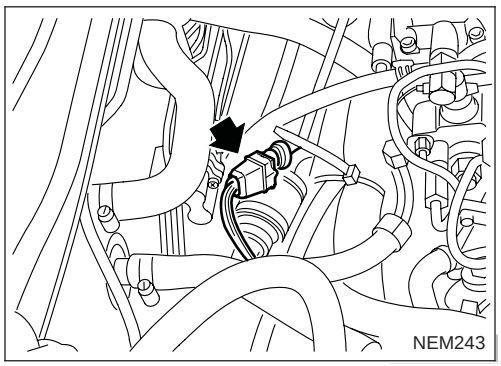

SEM501D

3. Disconnect injection tubes on nozzle side and loosen injection tubes on pump side. Release clamps on injection tubes.

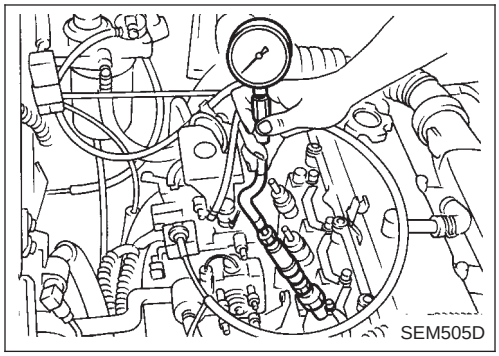
- **Use two wrenches to prevent delivery holder on pump side from loosening.**


NEM242

4. Remove all injection nozzles using S.S.T. KV119E0030.

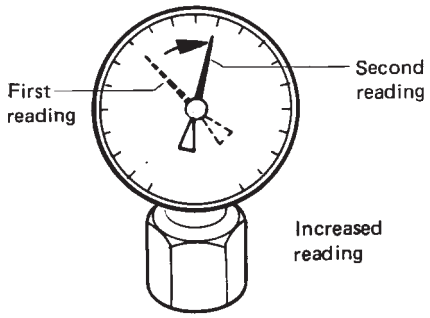
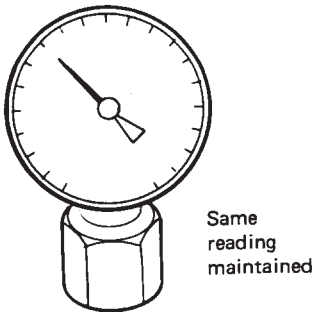

NEM243

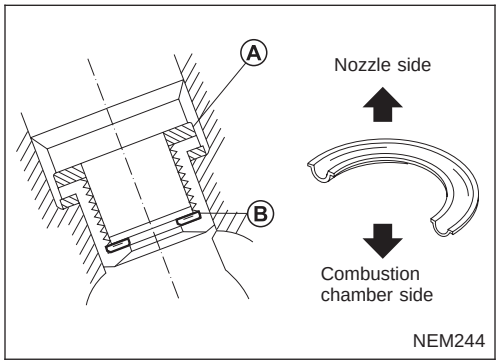
5. Turn ignition switch off and disconnect harness connector (black colored) at injection pump.


SEM505D

6. Fit compression gauge to cylinder head.

7. Crank engine and read compression gauge indication.
   Cranking speed: 200 rpm
   Compression pressure: kPa (bar, kg/cm^2, psi)
   Standard
   3,138 (31.4, 32, 455)
   Limit
   2,452 (24.5, 25, 356)
   Limit of difference between cylinders
   490 (4.9, 5, 71)
8. If the pressure appears low, pour about 3 mℓ (0.11 Imp fl oz) of engine oil through nozzle holes and repeat test.
   For indications of test, refer to the following table.

Gauge indication during tests	Trouble diagnosis
	● Piston rings are worn or damaged.
	● If two adjacent cylinders are low, gasket is damaged. ● Valve is sticking. ● Valve seat or valve contact surface is incorrect.

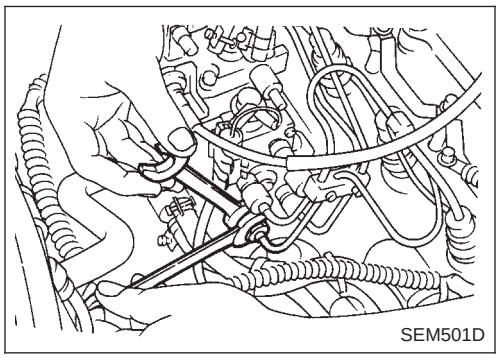


9. Replace nozzle gaskets and re-install injection nozzles.

New nozzle gaskets must be installed in the direction shown.

Nozzle to cylinder head:

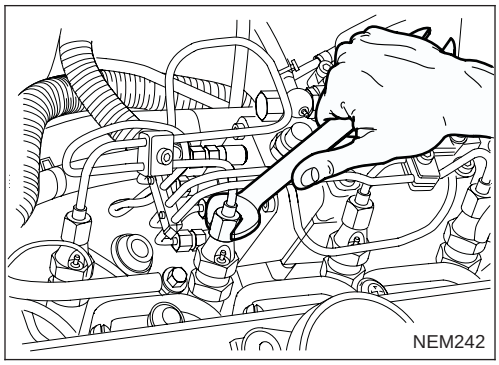
: 54 - 64 N·m (5.5 - 6.5 kg-m, 40 - 47 ft-lb)

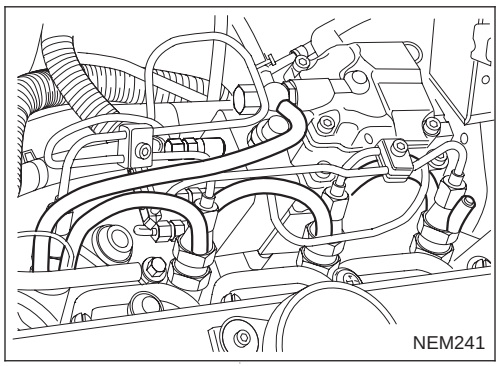


10. Install injection tubes using two wrenches as shown.

Injection tubes:

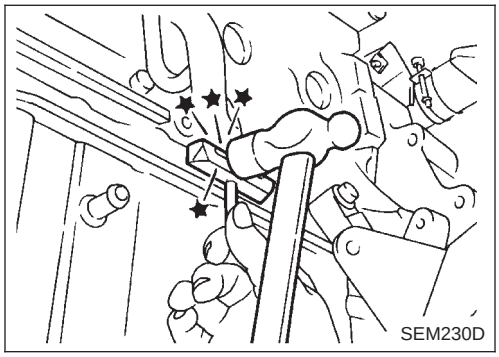
: 22 - 25 N·m (2.2 - 2.5 kg-m, 16 - 18 ft-lb)





11. Install spill hoses.
12. Initialize the ECM.

Refer to EC-section (“HOW TO ERASE DTC”).

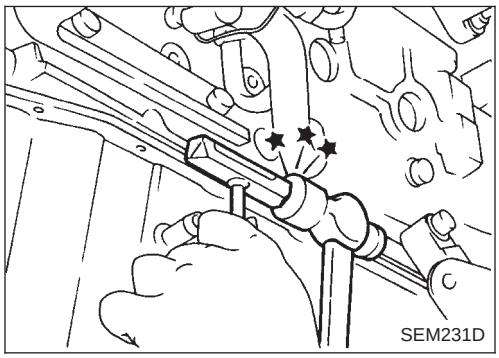

SEM230D

Removal

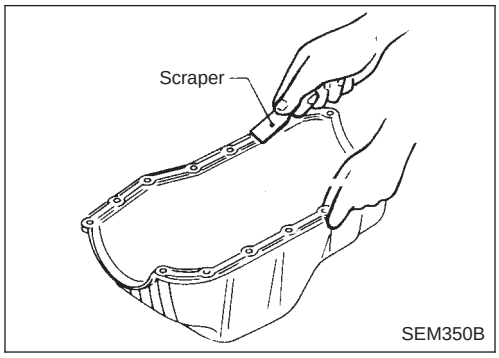
1. Drain oil.
2. Remove oil pan using tool as illustrated.

1) Insert Tool between oil pan and cylinder block.

- **Do not drive seal cutter into oil pump or rear oil seal retainer portion, or aluminum mating surfaces will be damaged.**
- **Do not insert screwdriver, or oil pan flange will be deformed.**


SEM231D

2) Slide Tool by tapping it with a hammer, and remove oil pan.

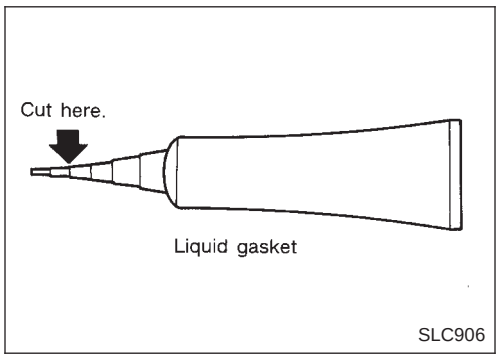


SEM350B

Installation

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

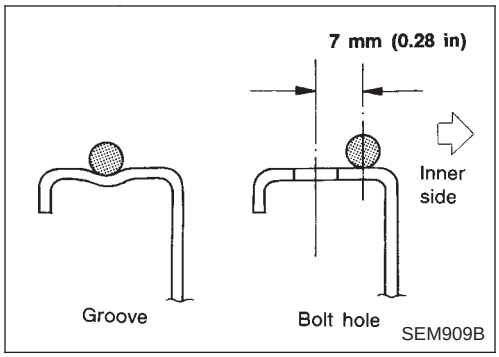
- Also remove traces of liquid gasket from mating surface of cylinder block.



SLC906

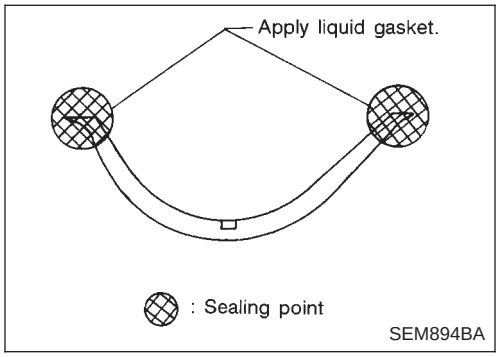
- Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.

Use Genuine Liquid Gasket or equivalent.

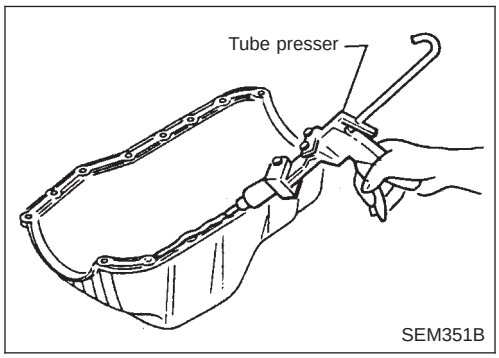


SEM909B

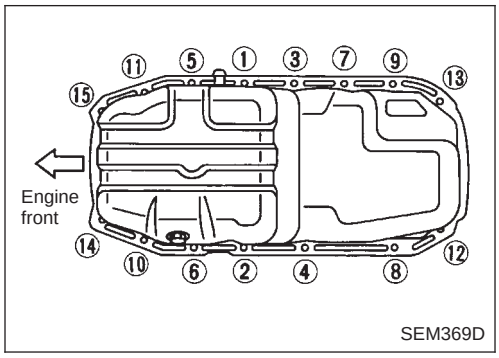
2. Apply liquid gasket to inner sealing surface as shown at left.



3. Apply liquid gasket to oil pan front oil seal and rear oil seal.



4. Apply a continuous bead of liquid gasket to mating surface of oil pan.
- Attaching should be done within 5 minutes after coating.



5. Install oil pan and tighten bolts in the order shown in the figure.

Wait at least 30 minutes before refilling engine oil.

Oil pan bolts:
: 6.3 - 8.3 N·m (0.64 - 0.85 kg-m, 55.8 - 73.5 in-lb)

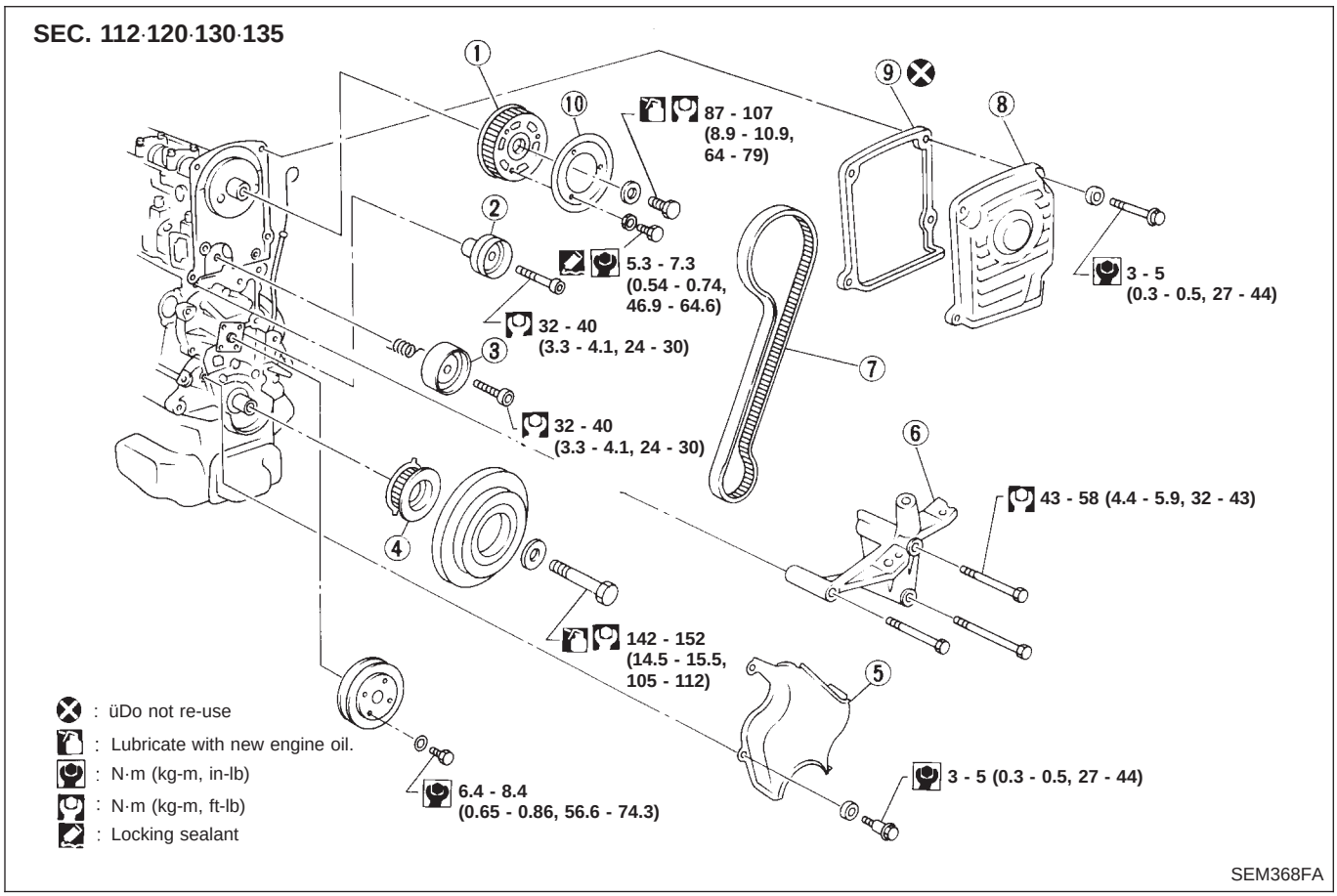
Camshaft Timing Belt

CAUTION:

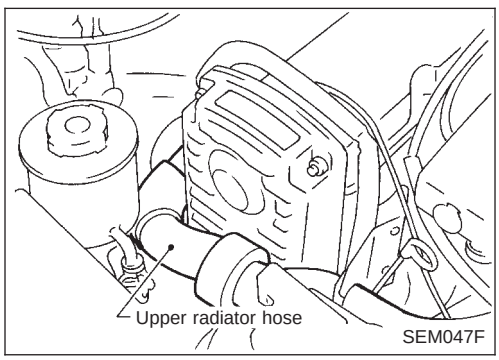
a. Do not bend or twist timing belt.

b. After removing timing belt, do not turn crankshaft and camshaft separately because valves will strike piston heads.

c. Ensure that timing belt, camshaft sprocket, crankshaft sprocket and belt tensioner are clean and free from oil and water.



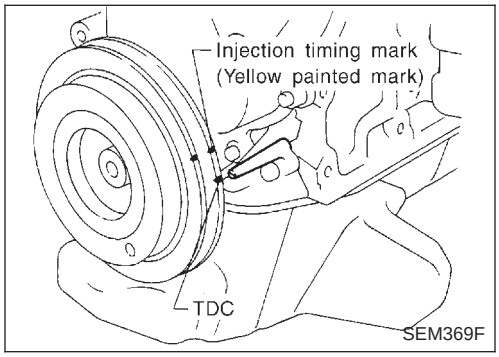
① Front camshaft sprocket
② Idler
③ Belt tensioner
④ Crankshaft sprocket
⑤ Belt cover lower
⑥ Belt cover center (Engine mounting bracket)
⑦ Timing belt
⑧ Belt cover upper
⑨ Gasket
⑩ Front camshaft sprocket plate



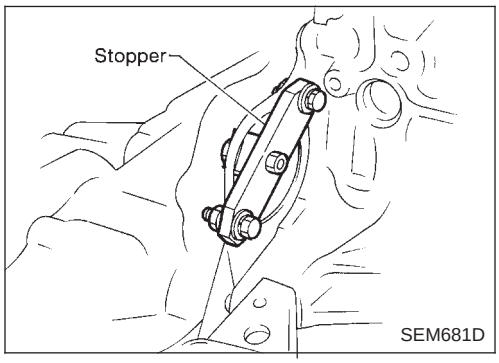
REMOVAL

1. Drain engine coolant from radiator.
2. Remove upper radiator hose and upper belt cover.
3. Remove water pump pulley.

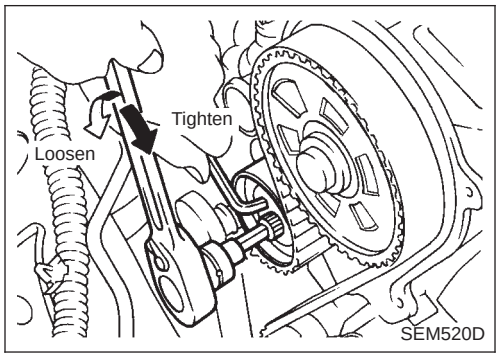
Camshaft Timing Belt (Cont'd)



4. Set No. 1 cylinder at TDC on its compression stroke. (TDC is indicated by crankshaft pulley notch without painted mark.)



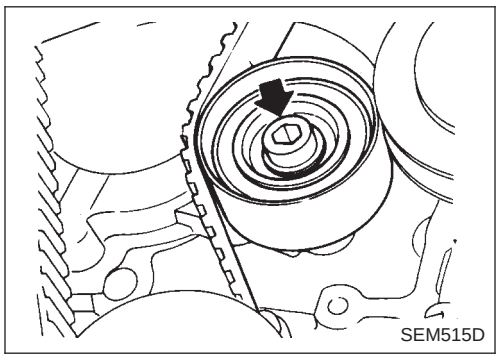
5. Remove starter motor, and install ring gear stopper using mounting bolt holes.
6. Remove crank pulley bolt.
7. Remove crank pulley using puller.
   Be sure to securely attach puller jaws. Attach jaws only to the rear side of pulley.
8. Remove lower belt cover.



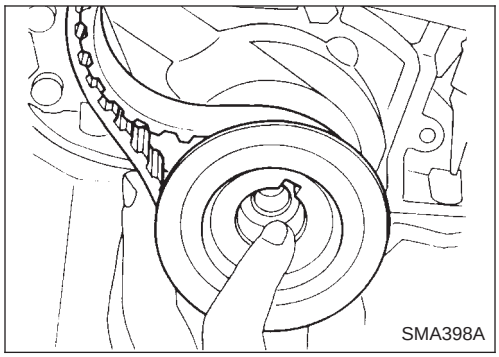
9. Remove timing belt.

(1) Loosen tensioner pulley bolt, turn tensioner pulley counter-clockwise then tighten bolt.

(2) Remove camshaft sprocket plate.



(3) Remove idler pulley.



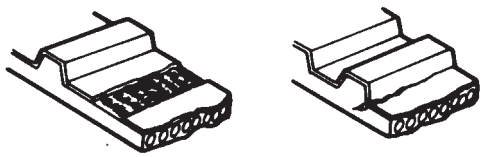
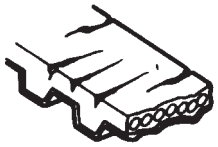
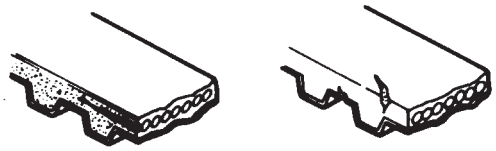
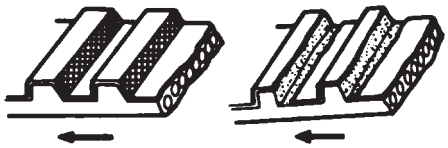
(4) Remove timing belt with crankshaft sprocket.
CAUTION:
Do not allow any magnetic materials to contact crankshaft sprocket.

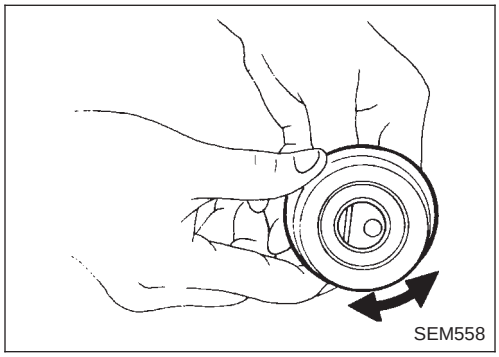
(5) Remove tensioner pulley and return spring.

Inspection

Timing belt

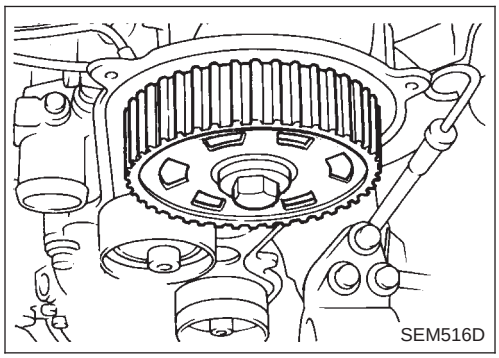
Visually check the condition of timing belt.
Replace if any abnormality is found.

Item to check	Problem	Cause
Tooth is broken/tooth root is cracked.	 SEM394A	• Camshaft jamming • Damaged camshaft/crankshaft oil seal
Back surface is cracked/ worn.	 SEM395A	• Tensioner jamming • Overheated engine • Interference with belt cover
Side surface is worn.	 • Belt corners are worn and round. • Wicks are frayed and coming out. SEM396A	• Improper installation of belt • Malfunctioning crankshaft pulley plate/timing belt plate
Teeth are worn.	 Rotating direction • Canvas on tooth face is worn down. • Canvas on tooth is fluffy, rubber layer is worn down and faded white, or weft is worn down and invisible. SEM397A	• Poor belt cover sealing • Coolant leakage at water pump • Camshaft not functioning properly • Excessive belt tension
Oil, coolant or water is stuck to belt.		• Poor oil sealing of each oil seal • Coolant leakage at water pump • Poor belt cover sealing


SEM558

Belt tensioner, tensioner spring and idler

1. Check belt tensioner and idler for smooth turning.
2. Check condition of tensioner spring.

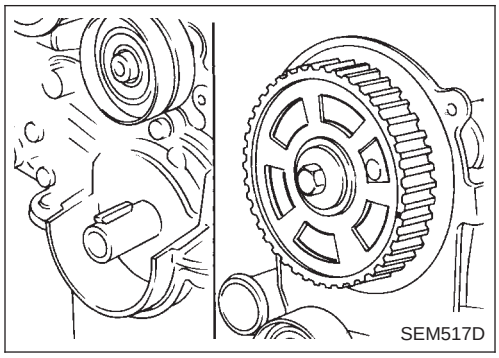

SEM516D

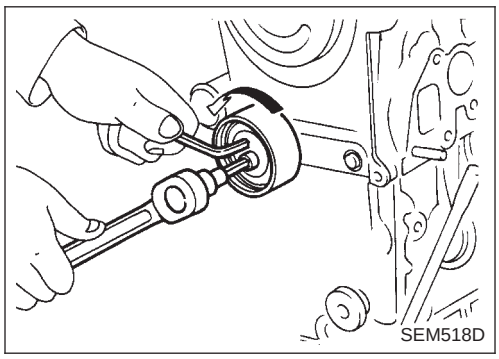
Crankshaft sprocket and front camshaft sprocket

Check teeth for abnormal signs.

Installation

1. Confirm that No. 1 piston is set at TDC on its compression stroke. (TDC is indicated by crankshaft pulley notch without painted mark.)

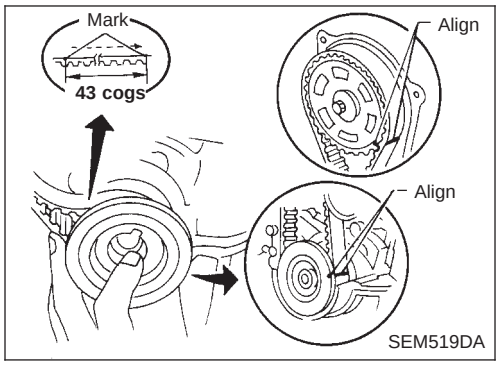

SEM517D


SEM518D

2. Install tensioner and return spring.

Temporarily tighten bolts so that tensioner is set at the fully outside position.

3. Install idler and tighten bolt to the specified torque.



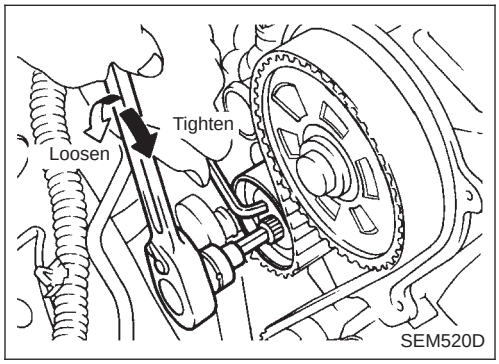
SEM519DA

4. Install timing belt with crankshaft sprocket.

a. Align white lines on timing belt with punchmarks on camshaft sprocket and crankshaft sprocket.

b. Point arrow on timing belt toward belt cover.

5. Install camshaft sprocket plate and secure screws with Loctite.



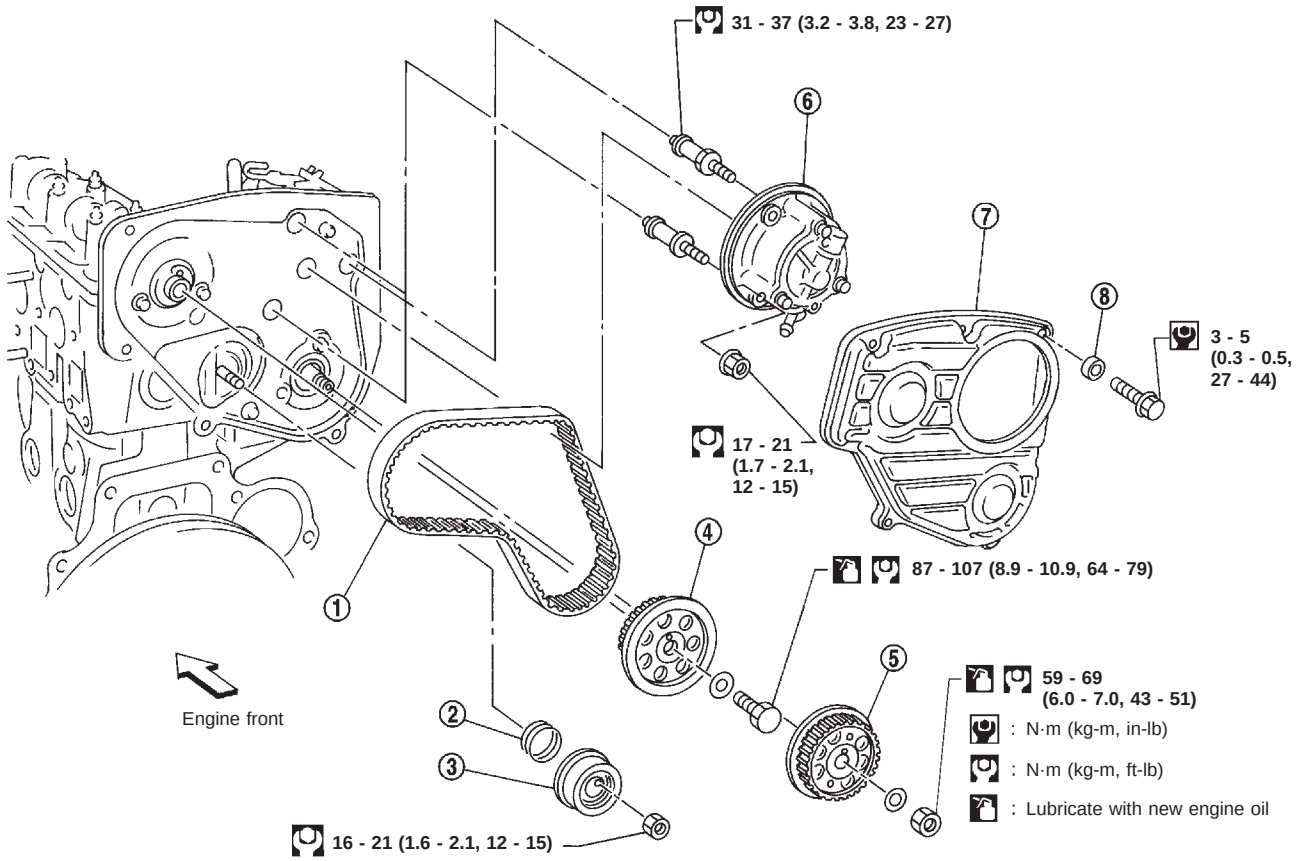
6. Adjust timing belt tension.
1) Loosen tensioner lock bolt to apply tension to timing belt.
2) Rotate crankshaft clockwise two turns to apply the specified tension to timing belt.
3) Tighten tensioner lock bolt while holding tensioner pulley with hexagon wrench.

Belt tension:

147.1 ± 24.5 N (15 ± 2.5 kg, 33.1 ± 5.5 lb)

Injection Pump Timing Belt

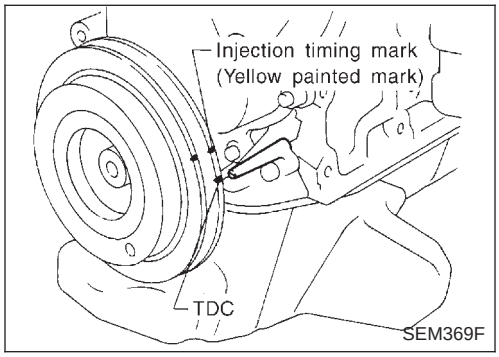
SEC. 130·135



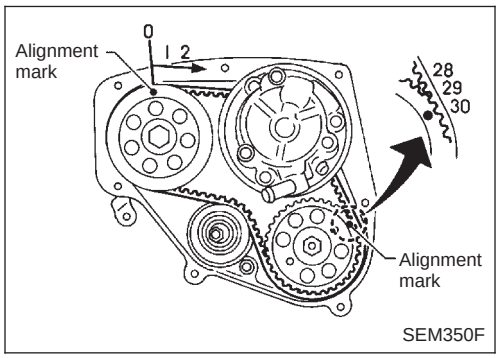
① Timing belt
② Tensioner spring
③ Tensioner
④ Rear camshaft sprocket
⑤ Injection pump sprocket
⑥ Vacuum pump
⑦ Timing belt cover
⑧ Grommet

REMOVAL

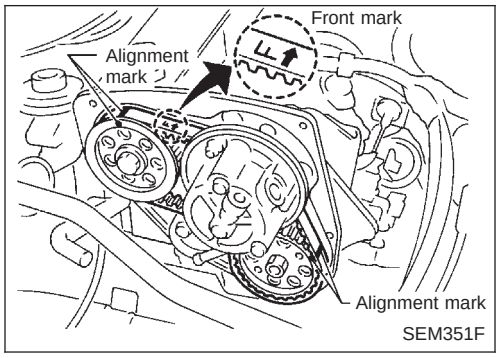
1. Remove battery from engine room.
2. Remove air cleaner case, air duct and resonator.
3. Disconnect all piping connections from vacuum pump.
4. Remove water pipe mounting bolt under injection pump timing belt cover, then remove water pipe.
5. Remove timing belt cover.



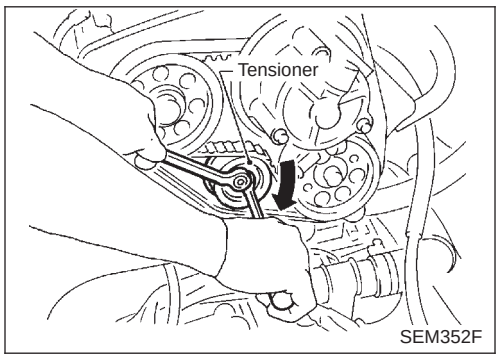
6. Set No. 1 cylinder at TDC on its compression stroke. (TDC is indicated by crankshaft pulley notch without painted mark.)



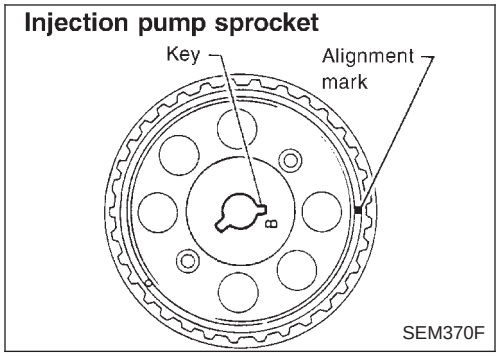
- Make sure that alignment marks of rear camshaft sprocket and injection pump sprocket are positioned as shown.



7. Apply alignment marks on the back of timing belt according to rear camshaft sprocket and injection pump sprocket alignment marks. Also apply a front mark on the back of timing belt.



8. Loosen tensioner mounting nut. Using a screwdriver, turn tensioner in direction of arrow to release belt tension.
9. Remove vacuum pump.
10. Remove timing belt.



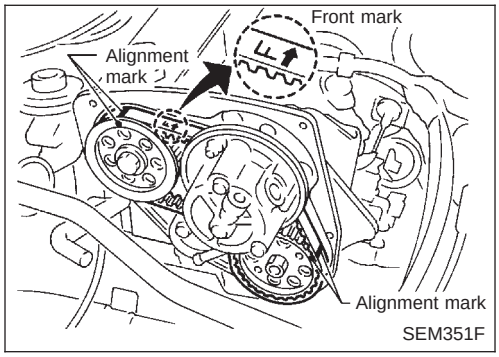
INSTALLATION

1. Confirm that No. 1 piston is set at TDC on its compression stroke. (TDC is indicated by crankshaft pulley notch without painted mark.)

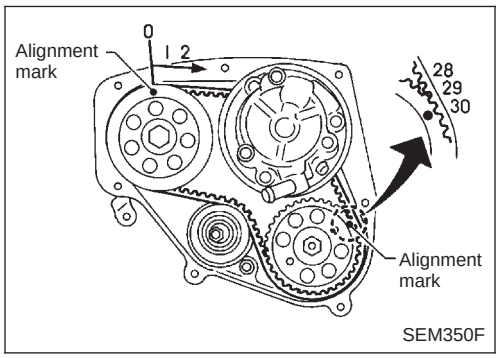
- If injection pump sprocket was removed, confirm that it is reinstalled as illustrated.

Identification of alignment:

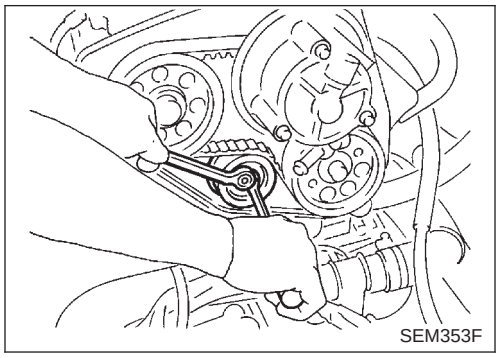
Use mark "Ⓑ"



2. Install timing belt.
1) Set timing belt with the front mark facing front of engine.
2) Install vacuum pump.
3) Position timing belt matching the alignment marks with rear camshaft sprocket and injection pump sprocket alignment marks.



3. Adjust belt tension.
1) Loosen tensioner lock nut to apply tension to timing belt.
- Make sure that all sprocket and timing belt alignment marks are positioned as shown.



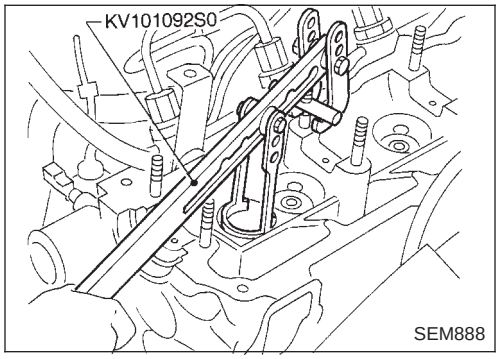
2) Rotate crankshaft clockwise by two revolutions.

Do not turn crankshaft by camshaft sprockets

3) Tighten tensioner lock nut while holding tensioner with a screwdriver.

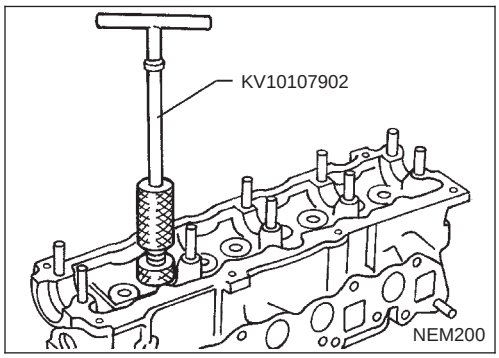
Belt tension:
98±49 N (10±5 kg, 22±11 lb)

4. Install timing belt cover.
5. Install remaining parts in the reverse order of removal.



VALVE OIL SEAL

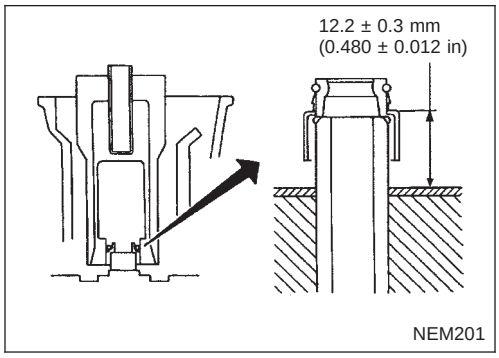
1. Remove both timing belts.
2. Remove camshaft sprockets and back covers.
3. Remove camshaft brackets by loosening bracket nuts from center to outside in two or three stages.
4. Remove camshaft oil seals and camshaft.



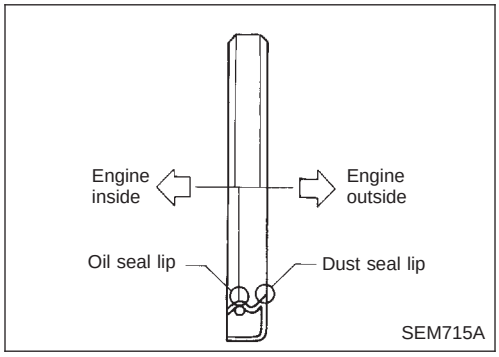
5. Remove valve lifters and mark order No. on each lifter.
6. Replace valve oil seal according to the following procedure.

When replacing valve oil seal, set the corresponding piston at TDC. Failure to do so causes the valve to drop into the cylinder.

1) Set No. 1 cylinder at TDC.
2) Remove valve springs and valve oil seals for No. 1 and No. 4 cylinders. Valve spring seats should not be removed.

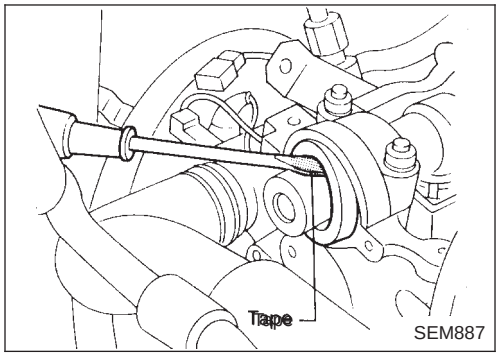


3) Install new valve oil seals for No. 1 and No. 4 cylinders as illustrated. Reinstall valve springs. (Narrow pitch side toward cylinder head)
4) Install valve spring retainers on intake valves and valve rotators on exhaust valves, and remount valve assembly.
5) Set No. 2 cylinder at TDC.
6) Replace valve oil seals for No. 2 and No. 3 cylinders according to steps 2) and 3).
7) Install valve lifters in original positions.



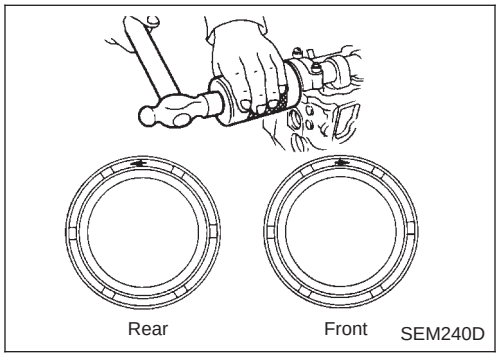
CAMSHAFT AND CRANKSHAFT OIL SEAL INSTALLING DIRECTION AND MANNER

- **When installing camshaft and crankshaft oil seals, be careful to install them correctly, as shown in the figure.**
- **Apply engine oil to oil seal lip, outer face, camshaft and bracket.**
- **Wipe off excess oil after installing oil seal.**



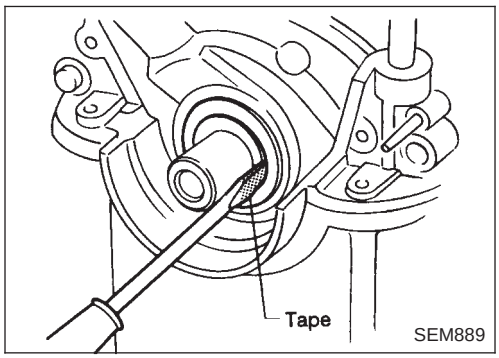
CAMSHAFT OIL SEALS

1. Remove timing belts, sprockets and back covers.
2. Pull out oil seal with a suitable tool.



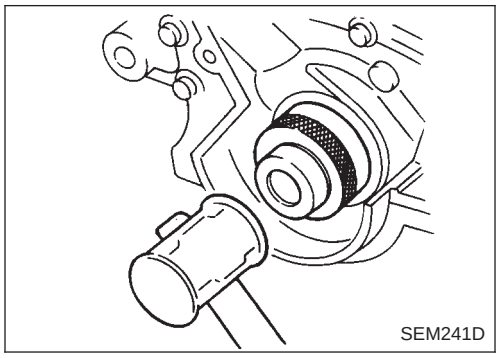
3. Install new oil seals with a suitable tool.

Confirm turning direction of both oil seals and camshaft.

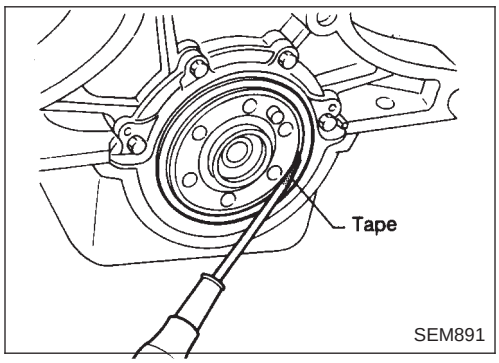


CRANKSHAFT FRONT OIL SEAL

1. Remove valve timing belt and crankshaft sprocket.
2. Remove oil seal with a suitable tool.

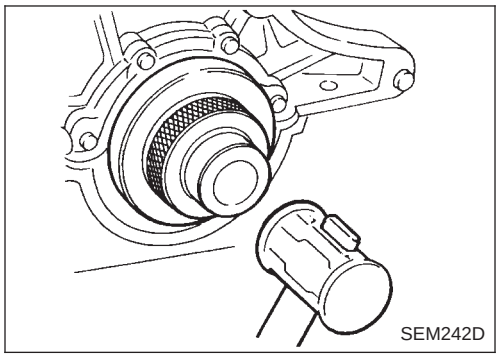


3. Apply engine oil to new oil seal and install oil seal using a suitable tool.



CRANKSHAFT REAR OIL SEAL

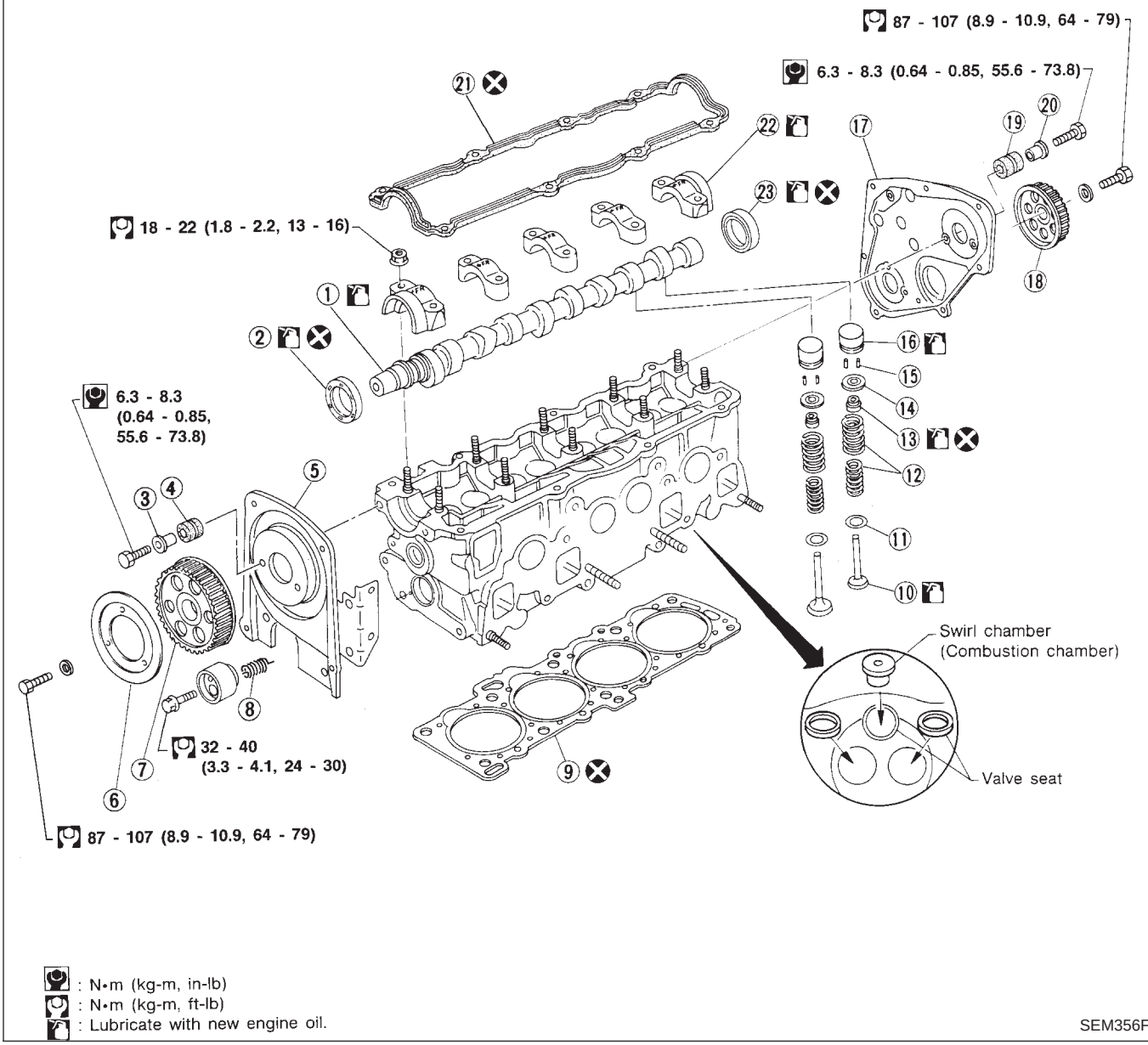
1. Remove transaxle assembly. (Refer to “REMOVAL AND INSTALLATION” in MT section.)
2. Remove flywheel.
3. Remove rear oil seal with a suitable tool.



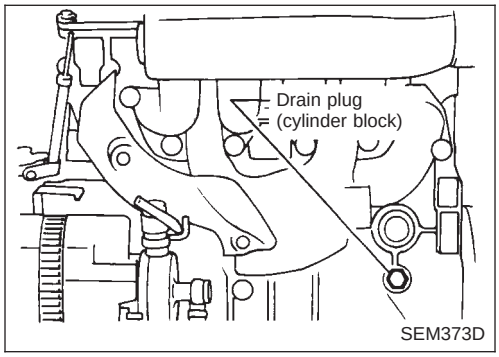
1. Apply engine oil to new oil seal and install oil seal using a suitable tool.

Components

SEC. 111•130•135



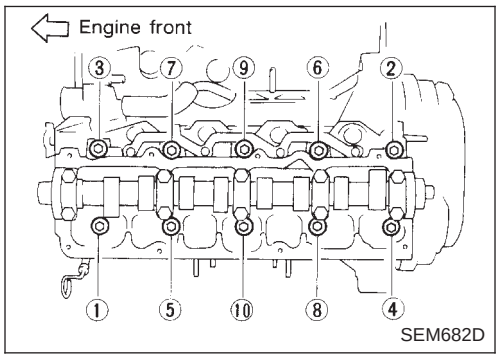
1. Camshaft
2. Front oil seal
3. Collar
4. Grommet
5. Front back cover
6. Front camshaft sprocket plate
7. Front camshaft sprocket
8. Spring
9. Selective cylinder head gasket
10. Valve
11. Spring seat
12. Valve spring
13. Valve oil seal
14. Spring retainer (INT)/Valve rotator (EXH)
15. Valve cotter
16. Valve lifter with shim
17. Rear back cover
18. Rear camshaft sprocket
19. Grommet
20. Collar
21. Rocker cover gasket
22. Cam bracket
23. Rear oil seal



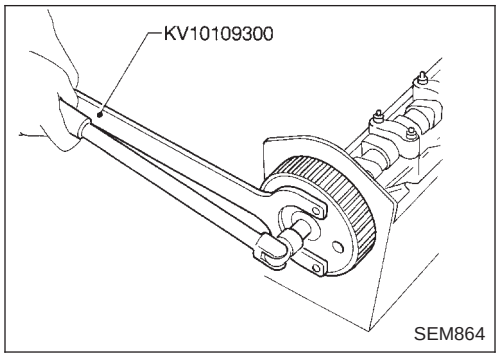
Removal

1. Drain coolant and disconnect front exhaust pipe from manifold.
2. Remove water hoses, air duct and intake manifold.
3. Remove heat shield and exhaust manifold.
4. Remove rocker cover and injection tubes.
5. Remove both timing belts.
   Set No. 1 cylinder at TDC on its compression stroke. Refer to "TIMING BELT" (EM-134).

After timing belts have been removed, do not rotate crankshaft and/or camshaft separately as valves will hit piston heads.



6. Remove cylinder head bolts in numerical order as shown in the figure.



Disassembly

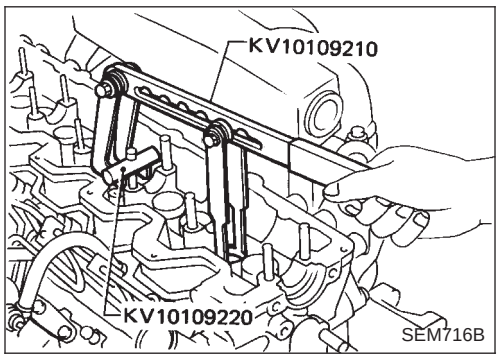
1. Remove front camshaft sprocket plate, front and rear sprockets using special service tool or a suitable tool, and front back cover.
2. Remove camshaft brackets in order from outside to inside.

- Loosen camshaft bracket nuts in two or three stages.

3. Remove camshaft and oil seals.
4. Remove valve lifters.

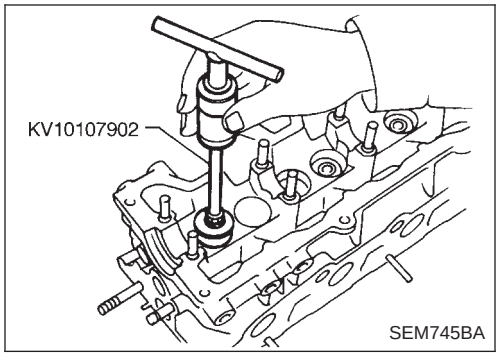
For valve lifter

- Attach tags to valve lifters for identification.

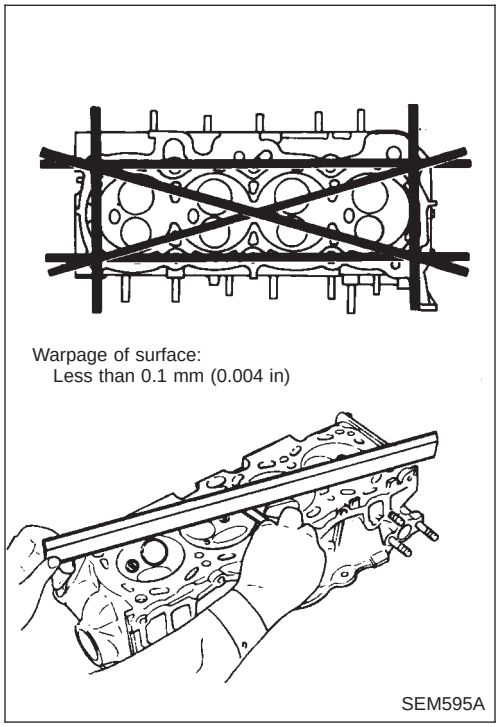


5. Remove valve component parts using special service tool or a suitable tool.

- **Keep each valve and its components together and mark them so they can be reassembled in their original positions.**



6. Remove valve oil seals using special tool.



Inspection

CYLINDER HEAD DISTORTION

1. Visually check for cracks and deformation.
2. Check cylinder head for distortion.

Head surface flatness:

Less than 0.1 mm (0.004 in)

If beyond the specified limit, replace or resurface cylinder head.

Resurfacing limit:

The resurfacing limit of the cylinder head is related to the amount of resurfacing of the cylinder block.

When:

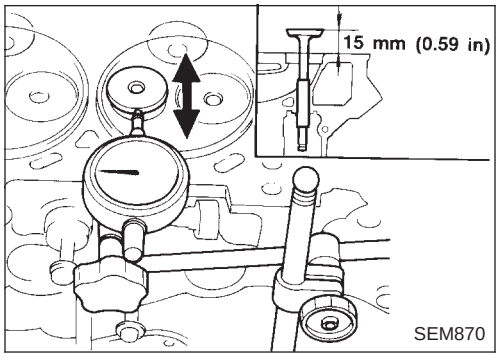
"A" is the amount of resurfacing needed for the cylinder head and "B" is the amount of resurfacing needed for the cylinder block, the maximum limit is determined by

A + B = 0.1 mm (0.004 in)

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

Nominal height of cylinder head:

137.9 - 138.1 mm (5.429 - 5.437 in)

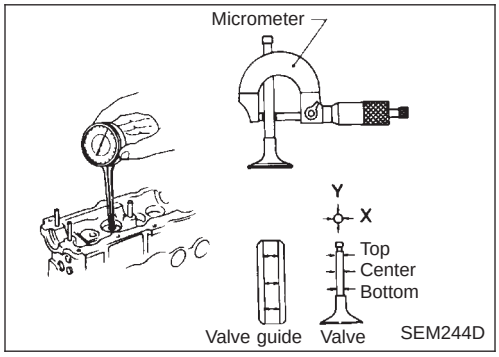


VALVE GUIDE CLEARANCE

1. Measure deflection across the cylinder head as illustrated.

Valve deflection limit (dial gauge reading):

0.1 mm (0.004 in)



2. If exceeding the limit, check valve-to-guide clearance.

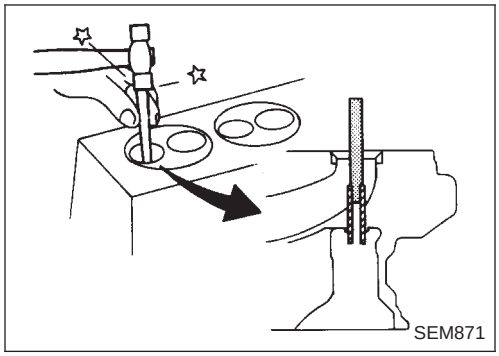
a) Measure valve stem diameter and valve guide inner diameter as illustrated.

b) Check that clearance is within the specification.

Valve stem to valve guide clearance limit:

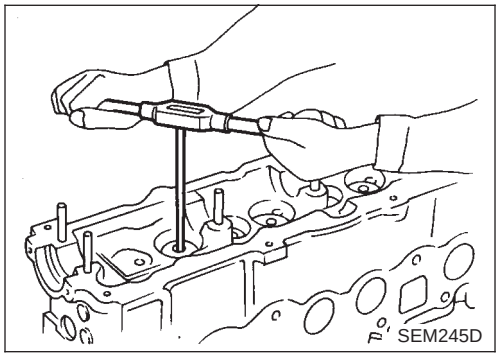
0.1 mm (0.004 in)

c) If exceeding the limit, replace valve or valve guide.

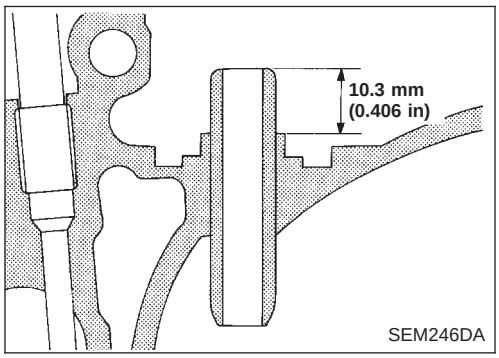


VALVE GUIDE REPLACEMENT

1. Heat cylinder head in oil to 150 to 160°C (302 to 320°F).
2. Drive out valve guide using a press or hammer and a suitable tool.

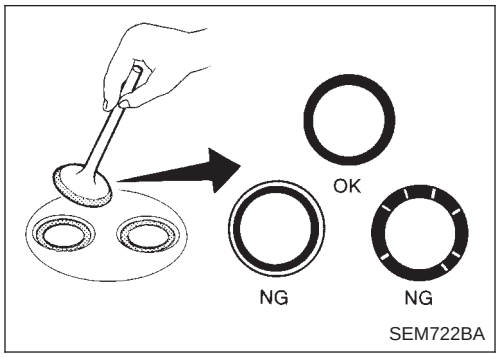

SEM245D

3. Ream cylinder head valve guide bore.
   Reaming bore (service part):
   11.185 - 11.196 mm (0.4404 - 0.4408 in)



SEM246DA

4. Heat cylinder head to 150 to 160°C (302 to 320°F) and press service valve guide onto cylinder head.
5. Ream valve guide.
   Final size:
   7.000 - 7.015 mm (0.2756 - 0.2762 in)



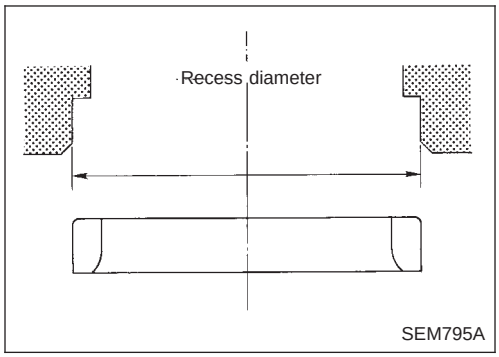
SEM722BA

VALVE SEATS

1. Check valve and valve seat for contact.
   Coat the valve face with prussian red lead. If contact is wrong, correct valve seat. If the valve red lead appears 360° around face, the valve stem and face are concentric. If not, repair or replace valve.

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

When repairing valve seat, check valve and valve guide for wear beforehand. If worn, replace them. Then correct valve seat.



SEM795A

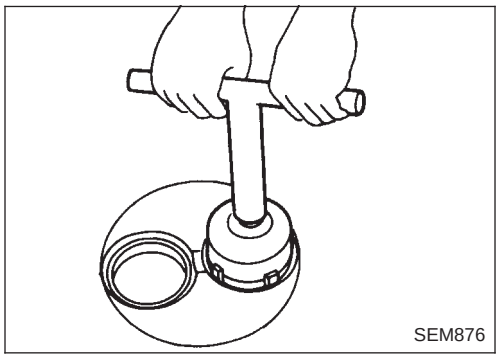
VALVE SEAT REPLACEMENT

1. Bore out old seat until it collapses.
   Set machine depth stop so that boring cannot contact bottom face of seat recess in cylinder head.
2. Ream the cylinder head recess.
   Reaming bore for service valve seat [Oversize 0.5 mm (0.020 in)]:
   Intake 41.432 - 41.454 mm (1.6312 - 1.6320 in)
   Exhaust 35.432 - 35.454 mm (1.3950 - 1.3958 in)

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

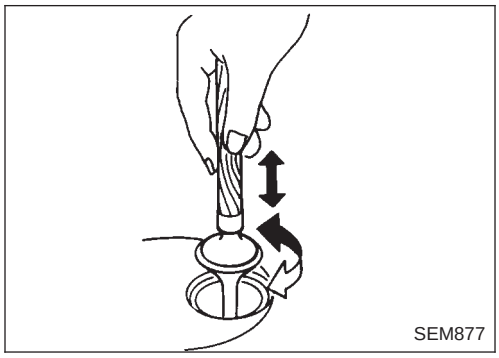
3. Heat cylinder head to a temperature of 150 to 160°C (302 to 320°F) and press fit seat until it seats on the bottom.
4. Install valve seats.

When replacing valve seat, valve should be replaced as well.

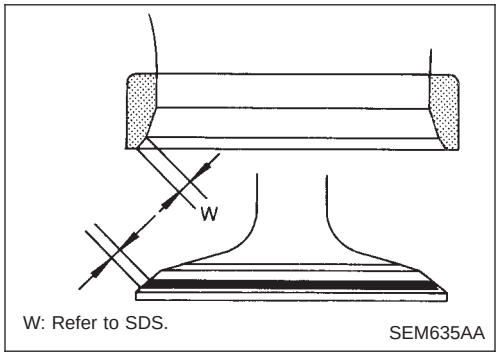

SEM876

5. Cut or grind valve seat using a suitable tool at the specified dimensions as shown in SDS (EM-198).

The cutting should be done with both hands to obtain a uniform and concentric finish.

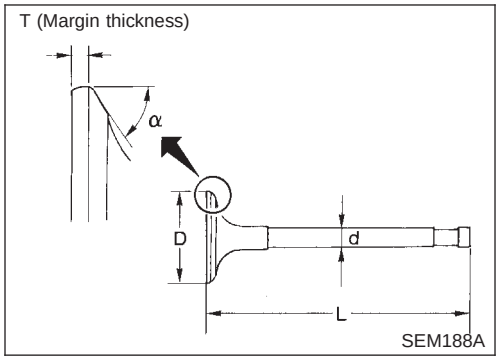

SEM877

6. Apply a small amount of fine grinding compound to the valve's contacting face and put the valve into its guide.
   Lap valve against its seat until proper valve seating is obtained.



W: Refer to SDS.
SEM635AA

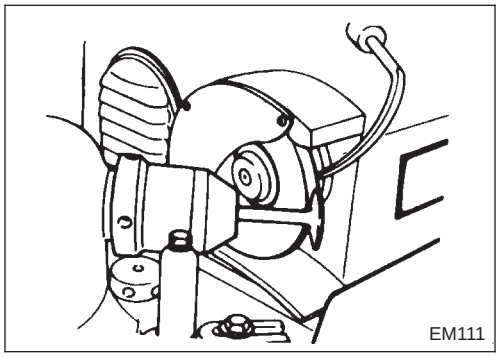
7. Check valve seating condition.



SEM188A

VALVE DIMENSIONS

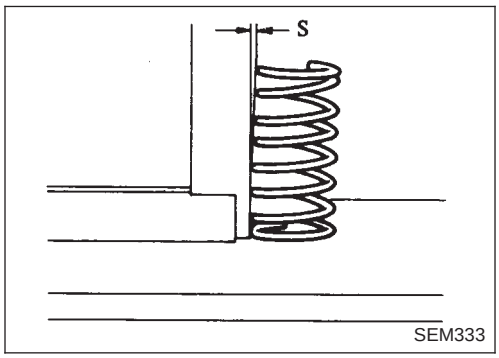
1. Check dimensions of each valve. For dimensions, refer to SDS (EM-197).
2. Correct or replace any valve that is faulty.


EM111

3. Valve face or valve stem end surface should be refaced by using a valve grinder.

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

Grinding allowance for valve stem tip is 0.5 mm (0.020 in) or less.



SEM333

VALVE SPRING SQUARENESS

Check valve spring for squareness using a steel square and flat surface plate.

If spring is out of square "S" more than specified limit, replace with new one.

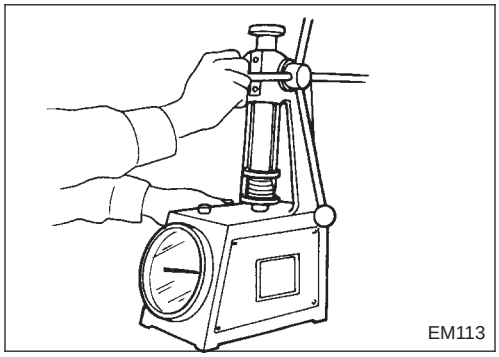
Out-of-square:

Outer

Less than 1.8 mm (0.071 in) — Intake —
Less than 2.2 mm (0.087 in) — Exhaust —

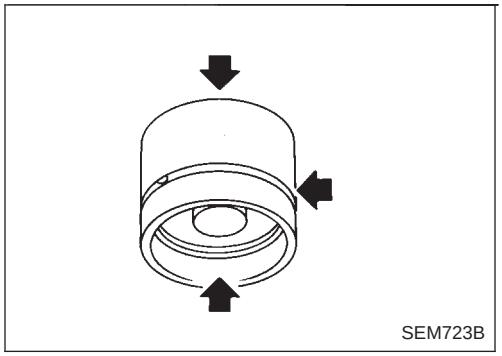
Inner

Less than 1.6 mm (0.063 in) — Intake —
Less than 1.8 mm (0.071 in) — Exhaust —


EM113

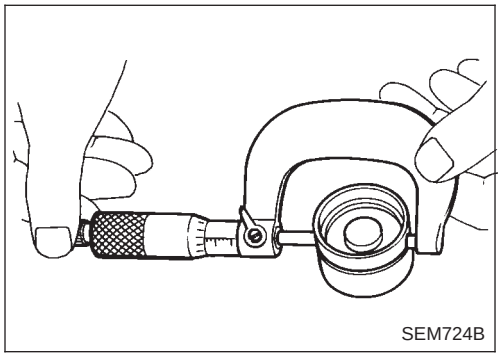
VALVE SPRING PRESSURE LOAD

Measure the free length and the tension of each spring. If the measured value exceeds the specified limit, replace spring. Refer to SDS (EM-197).

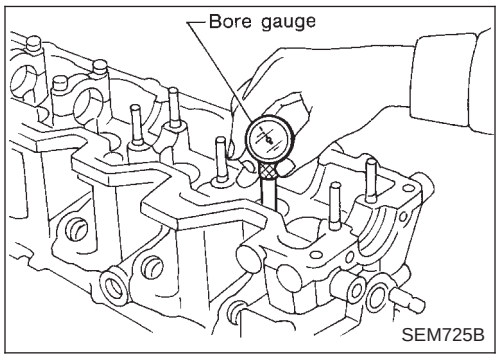

SEM723B

VALVE LIFTER

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

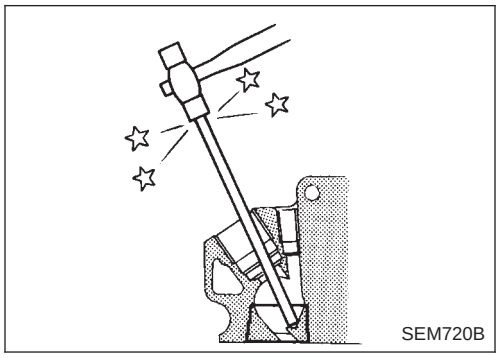

SEM724B

2. Check diameter of valve lifters.
   Outer diameter:
   34.959 - 34.975 mm (1.3763 - 1.3770 in)



SEM725B

3. Check valve lifter guide bore.
   Bore diameter
   34.998 - 35.018 mm (1.3779 - 1.3787 in)
   Standard clearance
   0.023 - 0.059 mm (0.0009 - 0.0023 in)


SEM720B

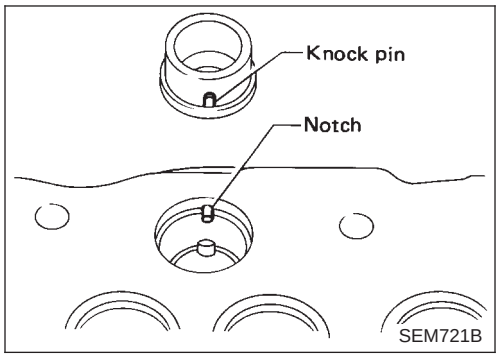
COMBUSTION CHAMBER REPLACEMENT

Usually combustion chambers should not be removed.

However, if they show cracks or extensive damage, they should be replaced.

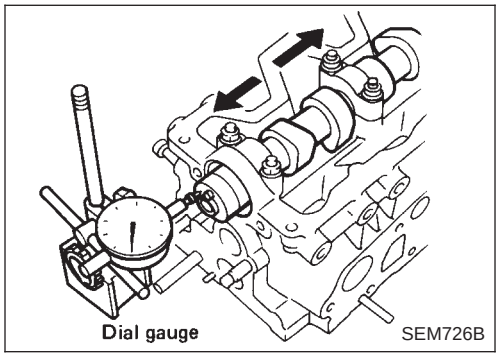
1. Remove glow plug connecting plate, glow plugs and injection nozzle.
2. Heat cylinder head in oil to between 150 and 160°C (302 and 320°F).
3. Remove combustion chamber so that cylinder head will not be damaged.

Be careful not to scratch inside of nozzle hole.



SEM721B

4. Install combustion chamber.
a. Heat cylinder head 150 to 160°C (302 to 320°F) in oil.
b. Align combustion chamber knock pin with cylinder head notch, and install it into cylinder head using a plastic-tip hammer.



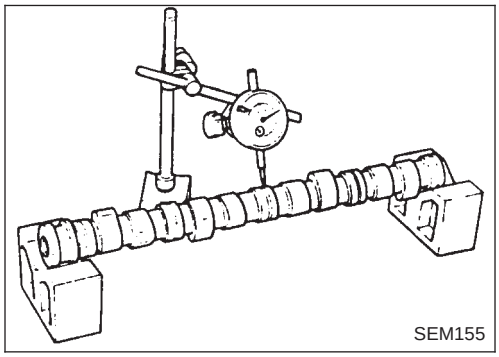
CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.

CAMSHAFT END PLAY

1. Install camshaft in cylinder head.
2. Tighten bracket bolts to the specified torque.
3. Measure camshaft end play.

Camshaft end play: Standard
0.115 - 0.188 mm (0.0045 - 0.0074 in)

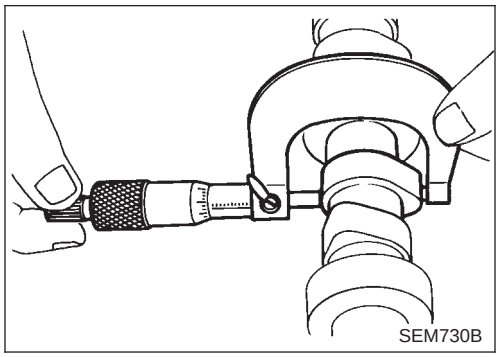


CAMSHAFT RUNOUT

1. Measure camshaft runout at the center journal.

Runout (Total indicator reading):
Limit 0.05 mm (0.0020 in)

2. If it exceeds the limit, replace camshaft.



CAMSHAFT CAM HEIGHT

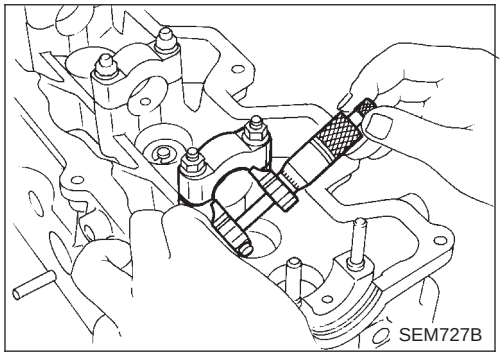
1. Measure camshaft cam height.

Cam height: Standard

Unit: mm (in)

Intake	48.70 - 48.75 (1.9173 - 1.9193)
Exhaust	49.15 - 49.20 (1.9350 - 1.9370)

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



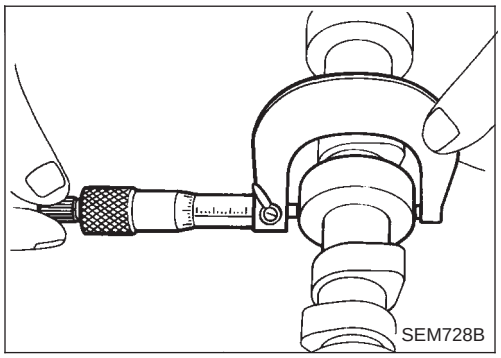
CAMSHAFT JOURNAL CLEARANCE

Using micrometer

1. Measure the inner diameter of camshaft bearings.

Standard inner diameter:
30.000 - 30.021 mm (1.1811 - 1.1819 in)

Tighten bracket bolts to the specified torque.

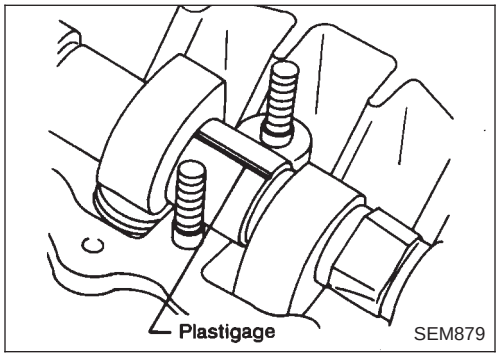


2. Measure the outer diameter of camshaft journals.

Standard outer diameter:
29.935 - 29.955 mm (1.1785 - 1.1793 in)

If clearance exceeds the limit, replace camshaft and/or cylinder head.

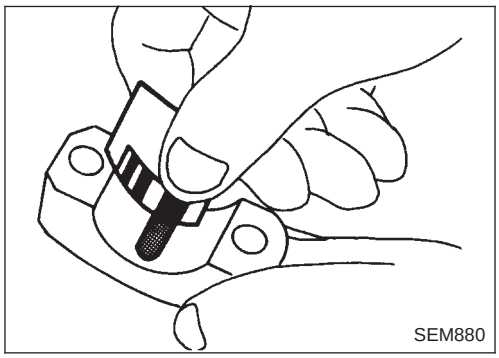
Standard clearance:
0.045 - 0.086 mm (0.0018 - 0.0034 in)
Limit: 0.1 mm (0.004 in)



Using plastigage

1. Wipe off oil from camshaft journal bracket caps and brackets.
2. Install camshaft in journal bracket caps and put plastigage on each camshaft journal.
3. Install cam bracket caps and tighten cam bracket cap nuts in the correct order to the specified torque.

   : 18 - 22 N·m (1.8 - 2.2 kg-m, 13 - 16 ft-lb)



4. Remove cam bracket caps and measure maximum width of plastigage.

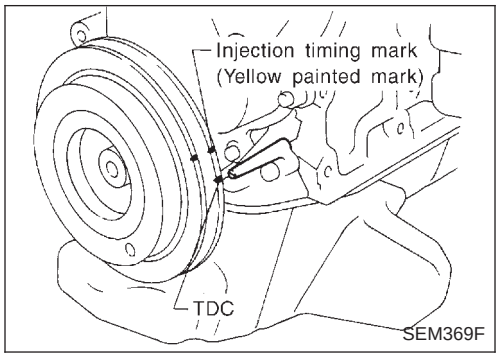
   Camshaft bearing clearance:

   Limit

   0.1 mm (0.004 in)

5. If clearance appears to exceed the limit, replace camshaft or cylinder head.

- Which parts to be replaced should be decided upon after measuring the diameters of the parts concerned.



Valve clearance

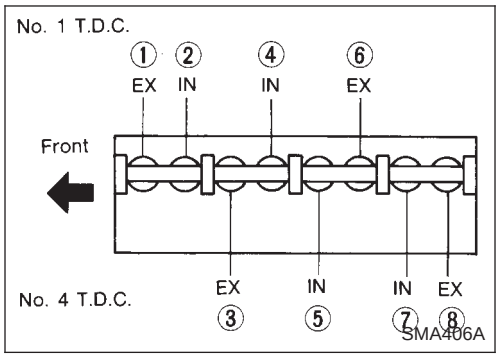
Checking

Check valve clearance while engine is warm and not running.

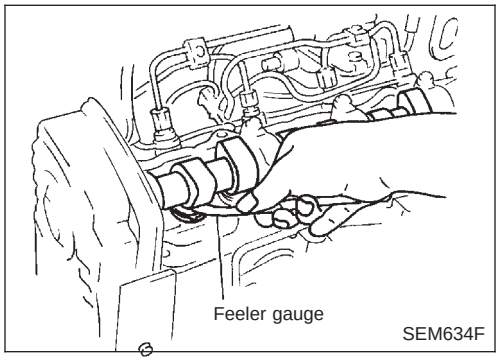
1. Remove rocker cover.
2. Set No. 1 cylinder at TDC on its compression stroke.

- Align pointer with TDC mark on crankshaft pulley.
- Check that valve lifters No. ① and ② are loose and valve lifters No. ⑦ and ⑧ are tight.

  If not, turn crankshaft one revolution (360°) and align as described above.



3. Check valve clearances of valve lifter No. ①, ②, ④ and ⑥.



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

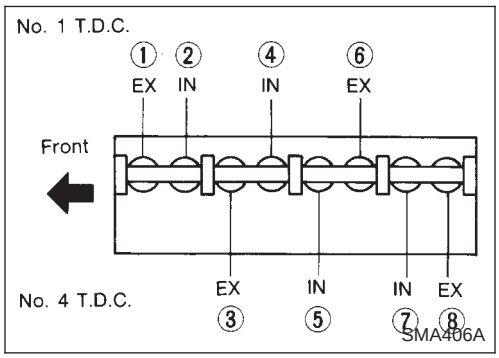
Valve clearance for checking (Hot):

Intake

0.25 - 0.35 mm (0.010 - 0.014 in)

Exhaust

0.39 - 0.49 mm (0.015 - 0.019 in)



3. Turn crankshaft one revolution (360°) until No. 4 cylinder is at TDC on its compression stroke.
4. Check valve clearances of valve lifter No. ③, ⑤, ⑦ and ⑧.

- Use the same procedure as mentioned in step 3.

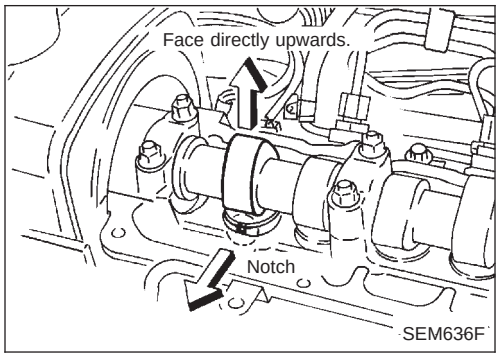
5. If all valve clearances are within specification, install the following parts:

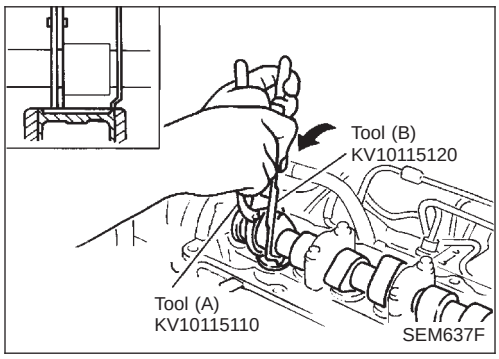
- Rocker cover

Adjusting

Adjust valve clearance while engine is cold.

1. Turn crankshaft. Position cam lobe upward on camshaft for valve that must be adjusted.





2. Place Tool (A) around camshaft as shown in figure.

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

CAUTION:

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

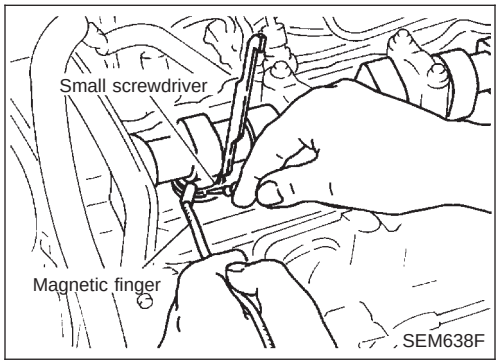
3. Rotate Tool (A) (See figure.) so that valve lifter is pushed down.
4. Place Tool (B) between camshaft and valve lifter to retain valve lifter.

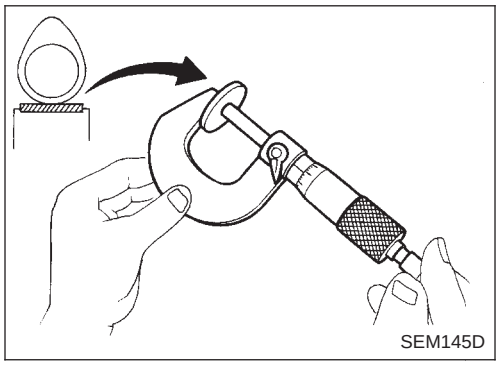
CAUTION:

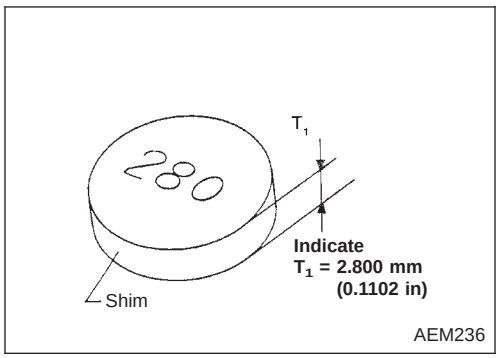
- **Tool (B) must be placed as close to camshaft bracket as possible.**
- **Be careful not to damage cam surface with Tool (B).**

5. Remove Tool (A).

Adjusting (Cont'd)







6. Remove adjusting shim using a small screwdriver and a magnetic finger.
7. Determine replacement adjusting shim size using the following formula.

- Use a micrometer to determine thickness of removed shim.
- Calculate thickness of new adjusting shim so valve clearance comes within specified values.
  R = Thickness of removed shim
  N = Thickness of new shim
  M = Measured valve clearance
  S = Standard valve clearance (neutral value for calculation)

Unit: mm (in)

HOT	Intake	0.30 (0.012)
	Exhaust	0.44 (0.017)
COLD	Intake	0.25 (0.010)
	Exhaust	0.38 (0.015)

Intake:
N = R + [M − S]
Exhaust:
N = R + [M − S]

Shims are available in 15 sizes from 2.20 mm (0.0866 in) to 2.90 mm (0.1142 in), in steps of 0.05 mm (0.0020 in).

- **Select the closest size shim to the calculated thickness. Refer to chart in SDS, EM-198.**

8. Install new shim using a suitable tool.

- **Install with the surface on which the thickness is stamped facing down.**

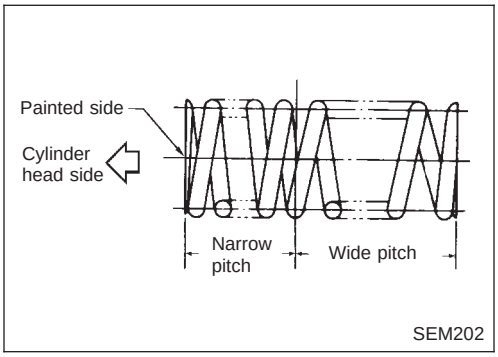
9. Place Tool (A) as explained in steps 2 and 3.
10. Remove Tool (B).
11. Remove Tool (A).
12. Recheck valve clearance.

Valve clearance:

Unit: mm (in)

	For adjusting	
	Hot	Cold* (reference data)
Intake	0.25 - 0.35 (0.010 - 0.014)	0.20 - 0.30 (0.008 - 0.012)
Exhaust	0.39 - 0.49 (0.015 - 0.019)	0.33 - 0.43 (0.013 - 0.017)

*: At a temperature of approximately 20°C (68°F)
Whenever valve clearances are adjusted to cold specifications, check that the clearances satisfy hot specifications and adjust again if necessary.

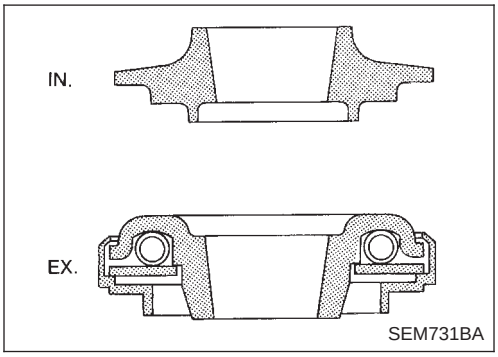


Assembly

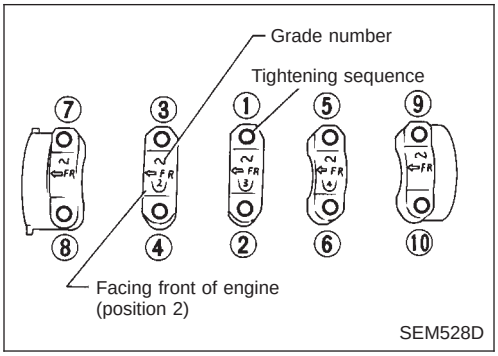
1. Install valve component parts.

Install valve spring with its narrow pitch side toward cylinder head side.

- **Always install new valve oil seals.**
  Refer to oil seal replacement.
- **Before installing oil seal, install valve-spring seat.**
- **When installing valve, apply engine oil on the valve stem and lip of valve oil seal.**
- **Check whether the valve face is free from foreign matter.**



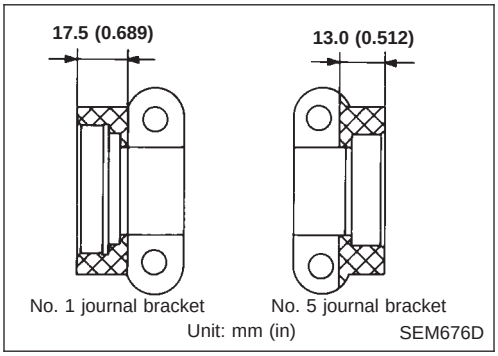
- **Install valve spring retainers on the intake side and valve rotators on the exhaust side.**
- **Valve rotators cannot be disassembled.**
- **Install valve shims**
- **Adjust valve clearance**

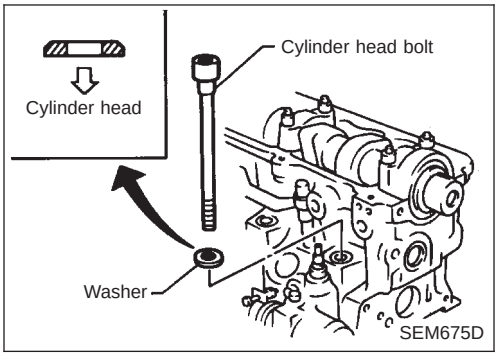


2. Install camshaft and brackets and tighten bracket nuts to the specified torque in two or three stages.

Camshaft-bracket nuts:
: 18 - 22 N·m (1.8 - 2.2 kg-m, 13 - 16 ft-lb)

- **Tighten bracket from center to outside.**
- **Apply sealant to brackets No. 1 and No. 5.**
- **When installing brackets, set camshaft so that the pin of camshaft front head is uppermost.**
- **Install new camshaft oil seals.**
  Refer to oil seal replacement.





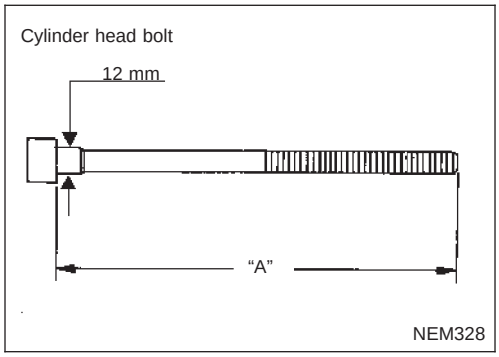
Installation

1. Install cylinder head gasket.

- **When replacing only cylinder head gasket, install same grade gasket as the one formerly used.**
- **When replacing or repairing cylinder block, piston, connecting rod and crankshaft, select gasket referring to "Selecting cylinder head gasket".**
- **Pay attention to the direction of the cylinder head bolt washer as shown in the figure.**

2. Install cylinder head and tighten cylinder head bolts according to the following sequence.

Installation (Cont'd)

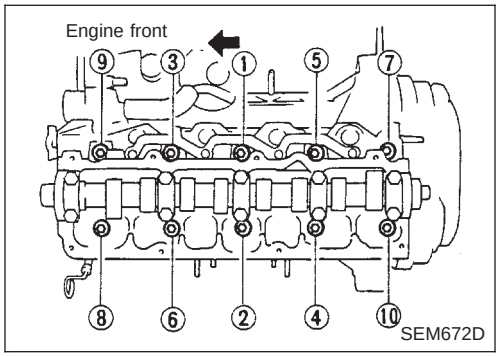


CAUTION:

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

Dimension "A":

118.7 mm (4.6732 in)

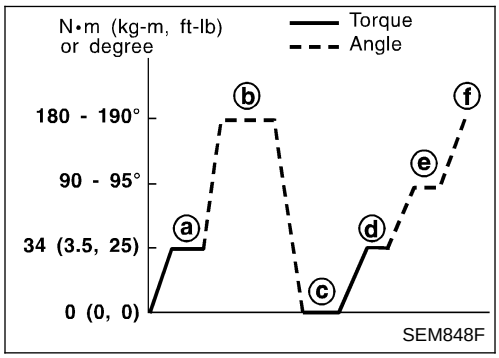


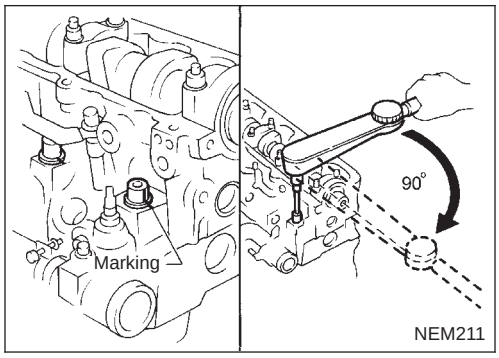
Tightening procedure

- **Apply engine oil to threads and underhead seating face of each bolt.**

Tighten bolts in the numerical order shown in the figure and following the steps below.

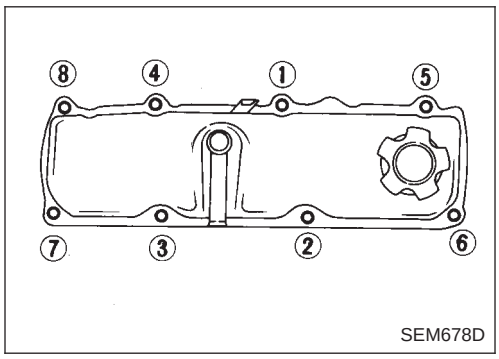
ⓐ 31 - 37 N·m (3.2 - 3.8 kg-m, 23 - 27 ft-lb)
ⓑ Tighten to 180 - 190°
ⓒ Completely loosen the bolts in reverse order
ⓓ 31 - 37 N·m (3.2 - 3.8 kg-m, 23 - 27 ft-lb)
ⓔ Tighten to 90 - 95°
ⓕ Tighten to 90 - 95°

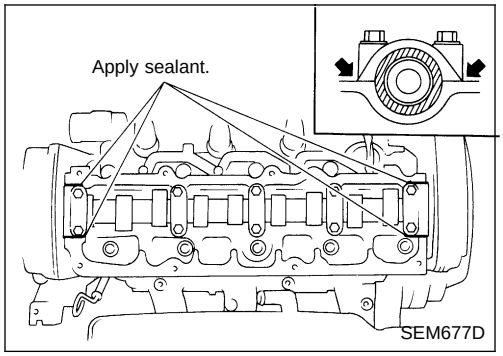




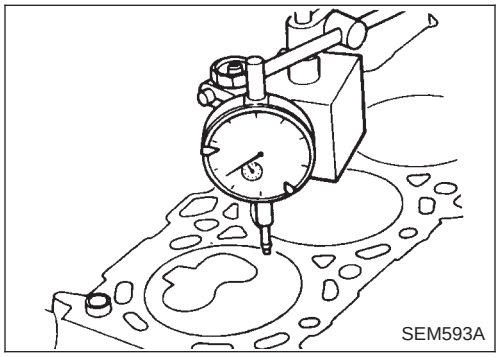
3. Install rocker cover.

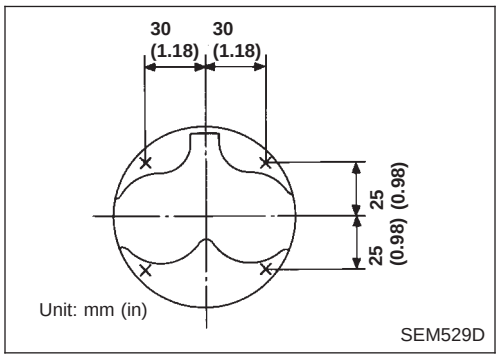
- Install rocker cover in the sequence shown at left.





- Apply sealing compound (THREE-BOND No. 10 or equivalent) to both ends of brackets No. 1 and No. 5.


SEM593A



SEM529D

Selecting cylinder head gasket

When replacing only cylinder head gasket, install the same grade (Number of notches) gasket as the one formerly used.

Step 1
Measure projection of piston to cylinder head surface.

a) Set dial gauge and needle on cylinder block and adjust dial gauge to zero.
b) Set dial gauge needle at measuring point on piston, taking care not to disturb its zero setting.
c) Rotate crankshaft around the top dead center position.
d) Record the maximum value.
e) Reset dial gauge on cylinder block and confirm that zero setting has not been disturbed during measurement.
f) Repeat steps b through d for all measuring points as illustrated and for each cylinder.

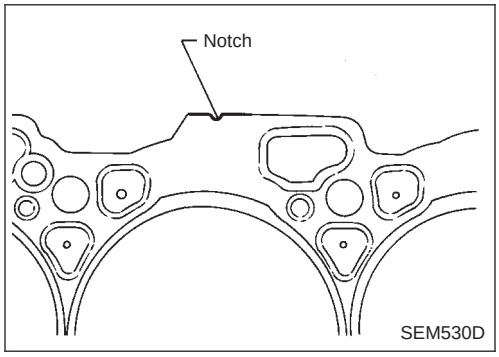
- Be sure that piston whose projection is being measured is at its TDC.

Step 2
Calculate the average value of measurements taken for each piston.

Step 3
Calculate the average value of measurements for all pistons from the values obtained from step 2.

Step 4
Round off the value obtained.

Step 5
Determine required thickness of gasket, referring to chart A.



SEM530D

Relation between piston average projection and cylinder head gasket (Chart A)

Average value of piston projections mm (in)	Gasket thickness mm (in)		Grade (Number of notches)
	New parts	In assembly	
Less than 0.505 (0.0199)	1.30 (0.0512)	$1.15^{\pm 0.05}$ ($0.0453^{\pm 0.0020}$)	1
0.505 - 0.555 (0.0199 - 0.0219)	1.35 (0.0531)	$1.20^{\pm 0.05}$ ($0.0472^{\pm 0.0020}$)	2
Over 0.555 (0.0219)	1.40 (0.0551)	$1.25^{\pm 0.05}$ ($0.0492^{\pm 0.0020}$)	3

Step 6
Check if the average value of each projection obtained from step 2 is larger than the max. value of the standard projection (of selected gasket) incremented by 0.05 mm (0.0020 in).
If so, use gasket that is 1 grade thicker. If not, use gasket as selected in step 4.

Example

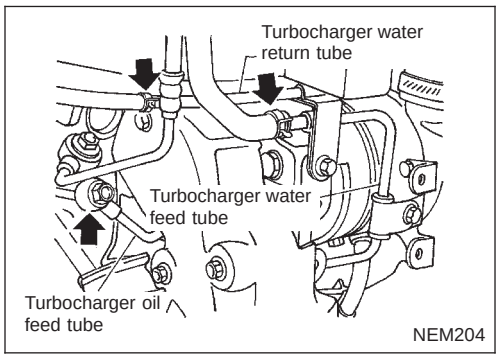
Unit: mm (in)

Step	Cylinder No. / Item	1				2				3				4			
1.	Measured value	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4
		0.53 (0.0209)	0.56 (0.0220)	0.53 (0.0209)	0.56 (0.0220)	0.59 (0.0232)	0.55 (0.0217)	0.59 (0.0232)	0.55 (0.0217)	0.53 (0.0209)	0.58 (0.0228)	0.57 (0.0224)	0.54 (0.0213)	0.58 (0.0228)	0.51 (0.0201)	0.52 (0.0205)	0.57 (0.0224)
2.	Average value of each piston	0.545 (0.0215)				0.570 (0.0224)				0.555 (0.0219)				0.545 (0.0215)			
3.	Average value of all pistons	0.55375 (0.02180)															
4.	Round off value	0.554 (0.0218)*1															
5.	Determined gasket thickness (Temporarily)	1.20 (0.0472) (Grade 2)															
6.	X: Maximum value of standard projection of selected gasket . . . 0.555 (0.0219) (in chart A) + 0.05 (0.0020) = 0.605 (0.0238) Y: Maximum value in step 2 = 0.57 (0.0224) The relationship between X and Y is "X > Y". *2																
7.	Determined gasket thickness (Finally)	1.20 (0.0472) (Grade 2)*2															

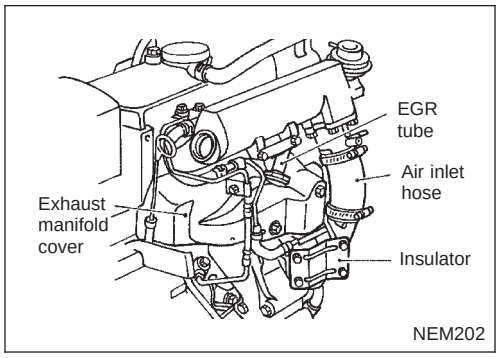
***1: If the average value of projections for all pistons is, for example, 0.553 (7) 5, as shown in the table above, it should be rounded off as follows:**
If the digit in the fourth decimal place (which is enclosed by a circle in this case) is smaller than 5, the average value should be regarded as 0.553 mm (0.0218 in); if it is larger than 5, the average value should be regarded as 0.554 mm (0.0218 in).
***2: If X < Y, then the thicker grade 3 gasket must be used.**

Removal

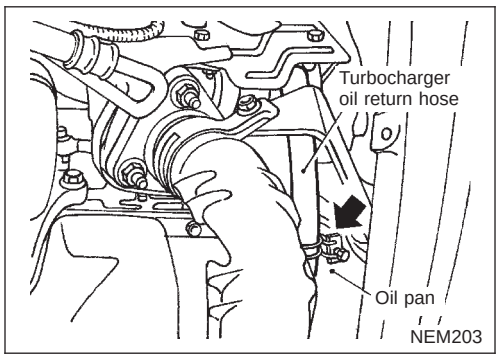
1. Disconnect radiator lower hose and drain coolant.
2. Drain coolant from cylinder block.
3. Remove engine under cover.
4. Remove front exhaust tube.
5. Remove air inlet hose from turbocharger unit.



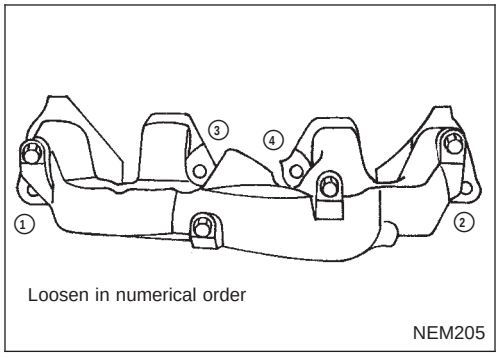
6. Remove connector bolts of turbocharger oil feed tube and hoses for turbocharger water feed and return tubes.



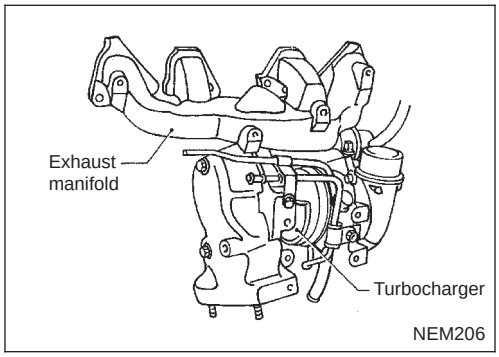
7. Remove EGR tube.
8. Remove exhaust manifold cover.
9. Remove insulator.



10. Remove turbocharger oil return hose from oil pan.

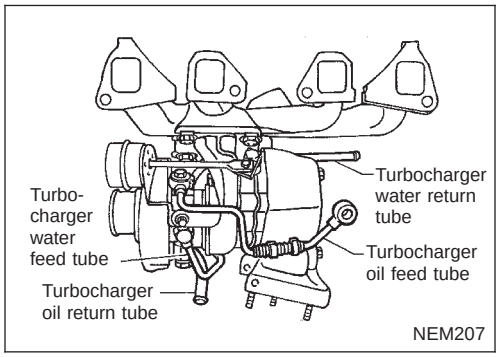


11. Remove exhaust manifold fixing nuts and bolts.

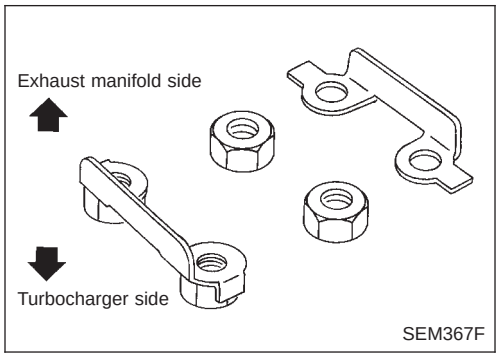


12. Remove exhaust manifold with turbocharger unit.

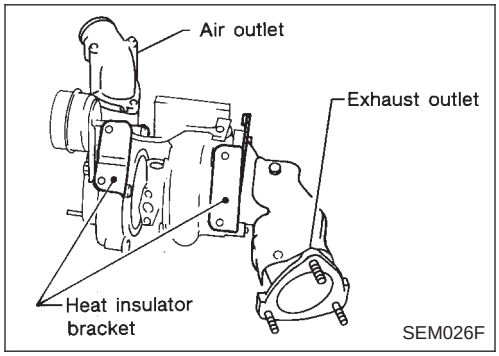
Disassembly



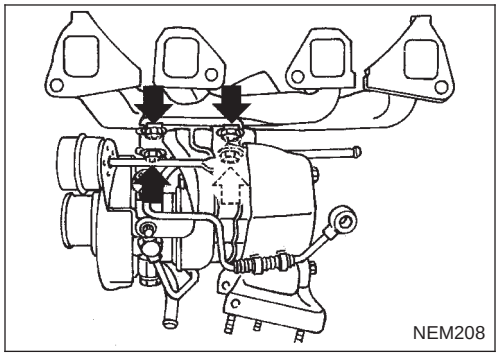
1. Remove oil tubes and water tubes. Before removing tubes, put mating marks on tube connectors and turbocharger.



2. Unbend locking plates for turbocharger unit fastening nuts.



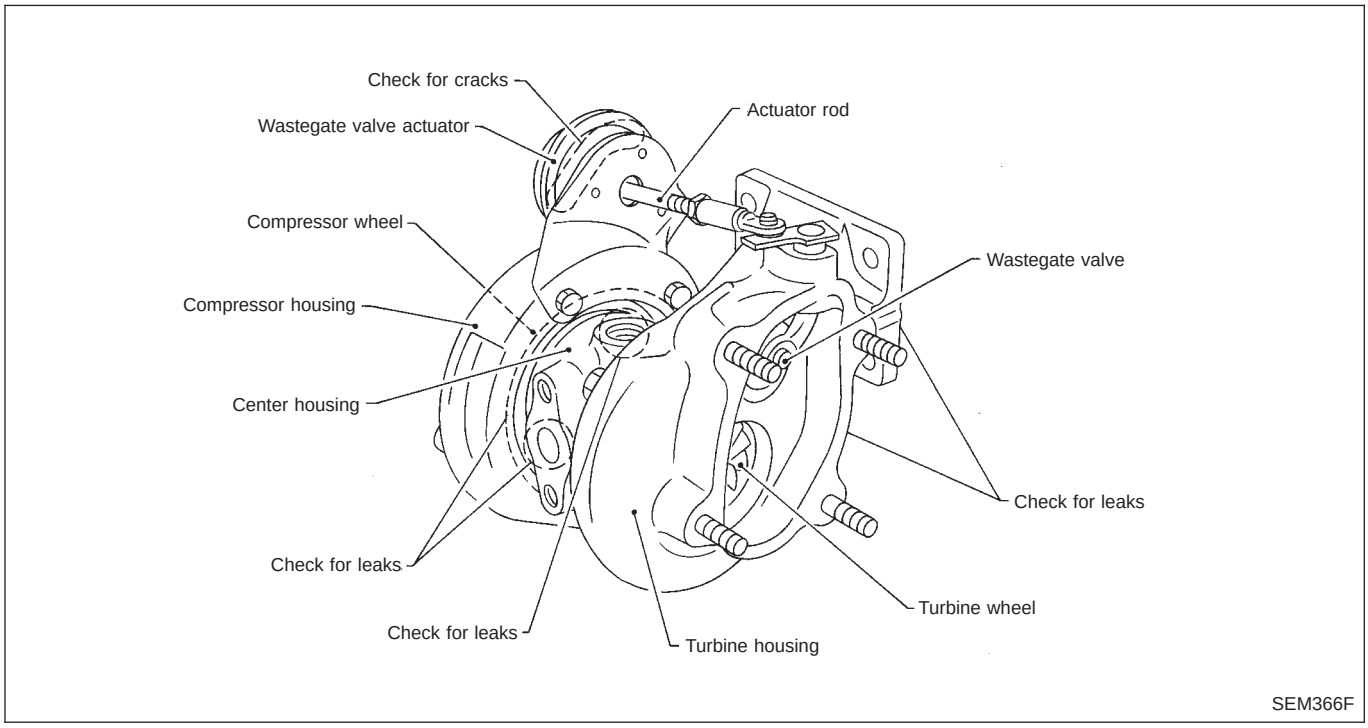
3. Remove exhaust outlet cover, exhaust outlet, and heat insulator brackets.

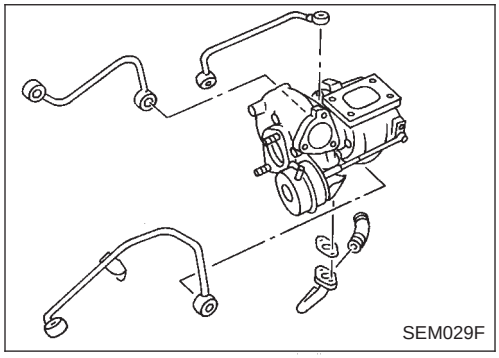


4. Remove exhaust manifold from turbocharger unit.

Inspection

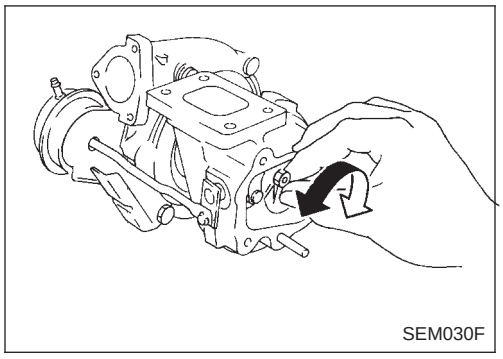
Perform the following checks. If NG, replace turbocharger unit.





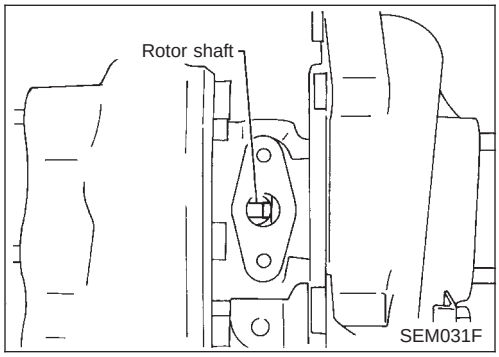
OIL AND WATER TUBES

Check tubes for clogging.

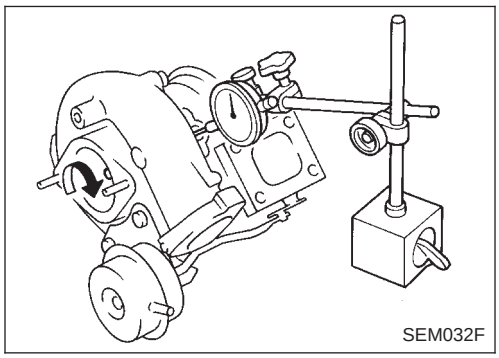


ROTOR SHAFT

1. Check rotor shaft for smooth rotation.



2. Check rotor shaft for carbon deposits.

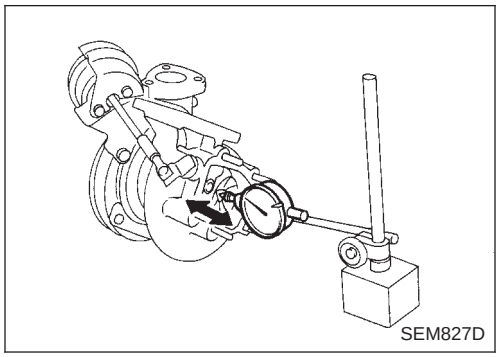


3. Measure rotor shaft runout.

Runout (Total indicator reading):

Standard

0.056 - 0.127 mm (0.0022 - 0.0050 in)



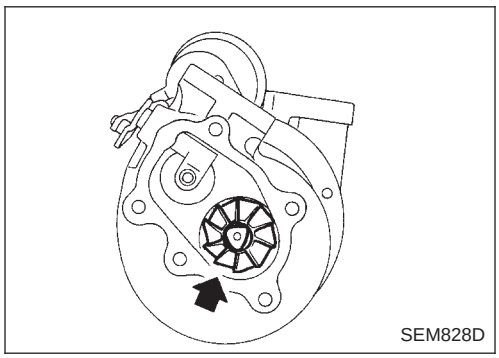
4. Measure rotor shaft end play.

End play:

Standard

0.013 - 0.097 mm (0.0005 - 0.0038 in)

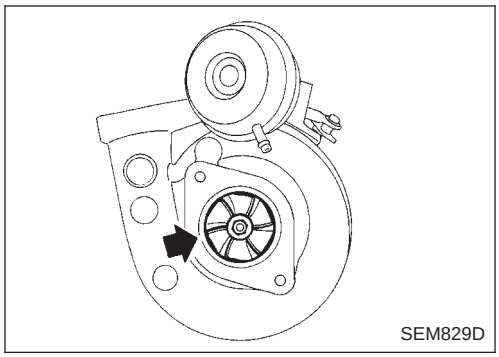
- **Do not allow wheels to turn when axial play is being measured.**



TURBINE WHEEL

Check turbine wheel for the following:

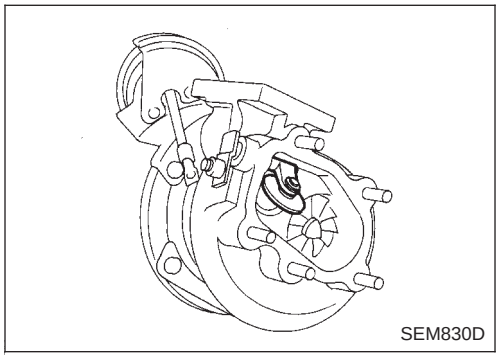
- Oil
- Carbon deposits
- Deformed fins
- Contact with turbine housing



COMPRESSOR WHEEL

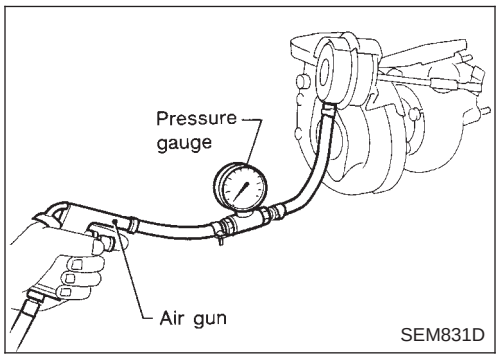
Check compressor wheel for the following:

- Oil
- Deformed fins
- Contact with compressor housing


SEM830D

WASTEGATE VALVE

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



SEM831D

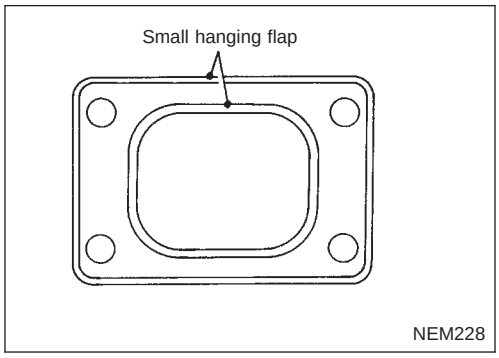
WASTEGATE VALVE ACTUATOR

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

- **Do not apply compressed air to the actuator continuously.**
- **The air pressure should be in the range of 73.3 to 101.3 kPa (733 to 1,013 mbar, 550 to 760 mmHg, 21.65 to 29.92 inHg).**

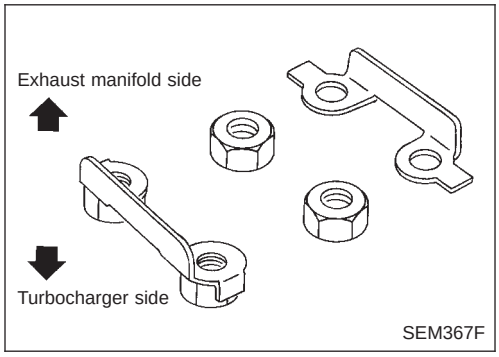
Assembly

Assembly is the reverse order of disassembly.



NEM228

- Install gasket between exhaust manifold and turbocharger with small hanging flap side facing exhaust manifold.

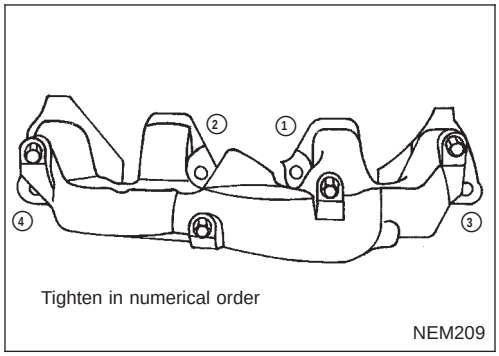


SEM367F

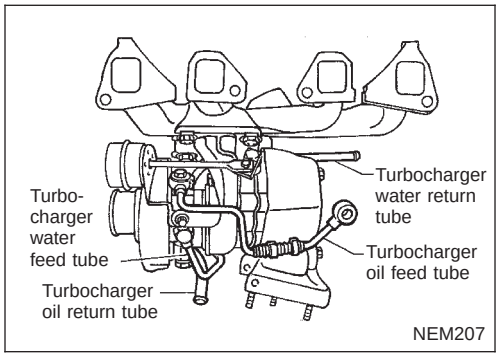
- Bend locking plates along the side of turbocharger fastening nuts.
  Always use new locking plates.

Installation

1. Install exhaust manifold fixing nuts.



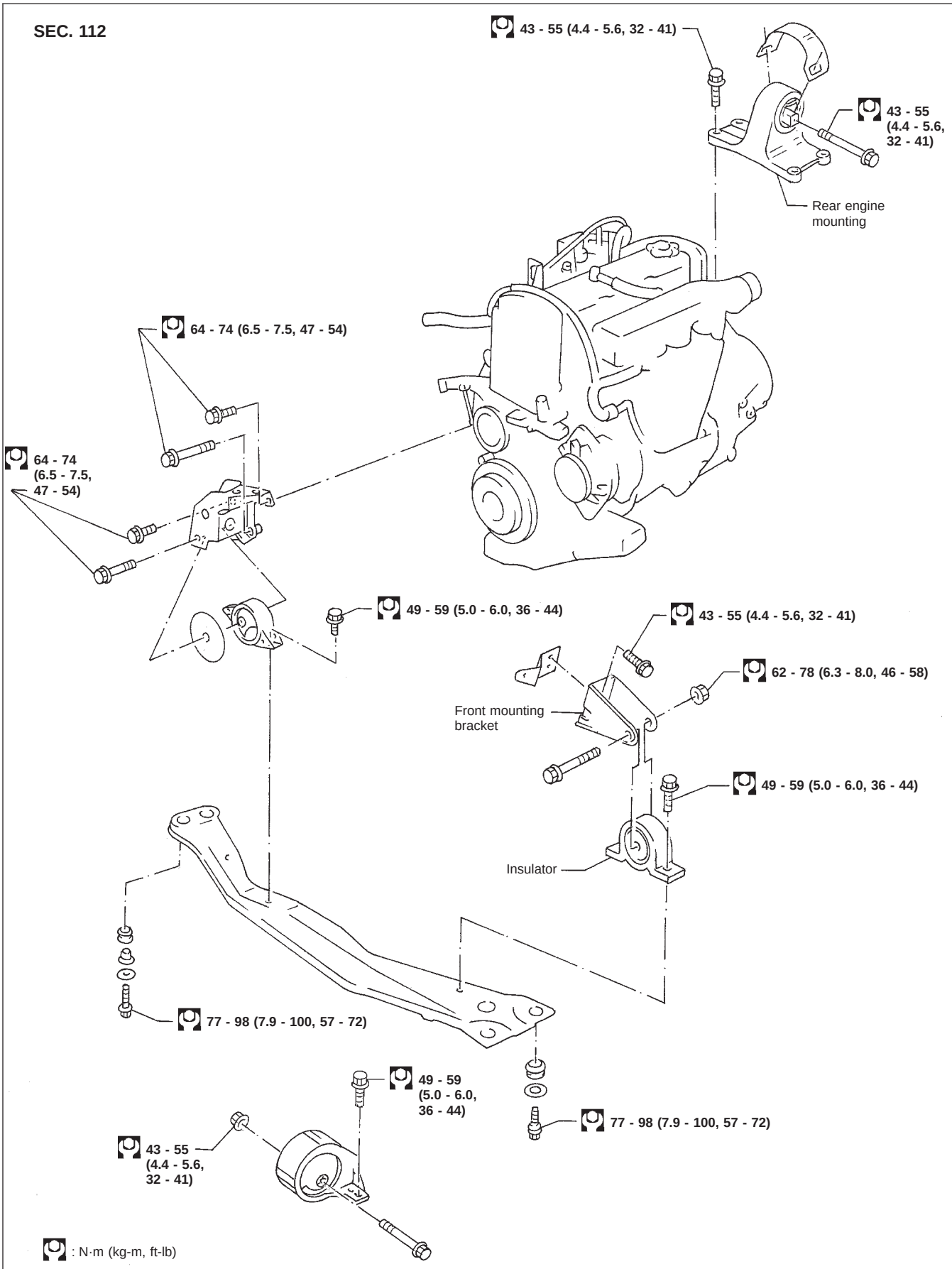
NEM209



2. Installation is the reverse order of removal.

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

SEC. 112



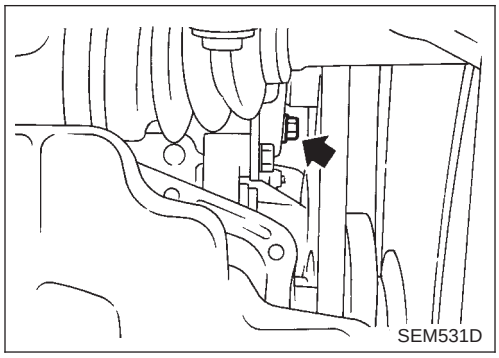
NEM226

WARNING:

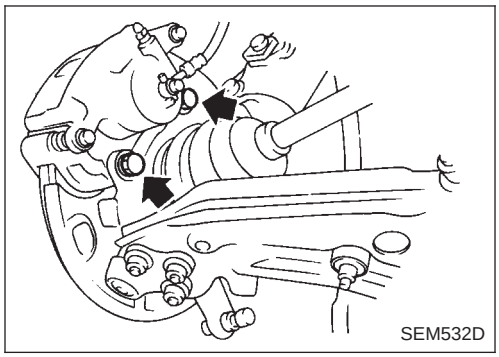
- **Situate vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **Do not remove engine until exhaust system has completely cooled down.**
- **For safety during subsequent steps, the tension of wires should be slackened against the engine.**
- **Before removing front axle from transaxle, place safety stands under designated front supporting points. Refer to GI section for lifting points and towing.**
- **Be sure to hoist engine and transaxle in a safe manner.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG or Eurofast.**

CAUTION:

- **When lifting engine, be careful not to strike adjacent parts, especially accelerator wire casing, brake lines, and brake master cylinder.**
- **Always use engine slingers when hoisting the engine.**
- **When removing drive shaft, be careful not to damage transaxle oil seal.**

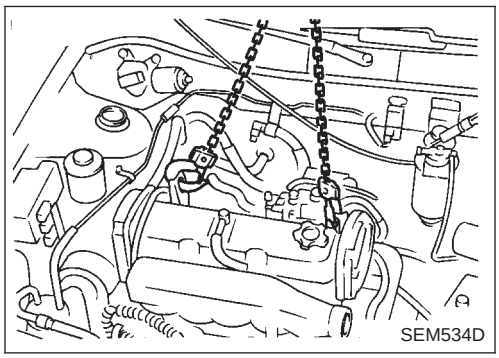

SEM531D

1. Remove engine undercovers and splash covers.
2. Remove front exhaust tube.
3. Disconnect lower water hose from radiator and drain coolant.
4. Drain transaxle oil.
5. Remove power steering mounting bolt. (See left.)
6. Drain coolant from cylinder head.
7. Disconnect water hoses and electrical wiring from radiator and remove radiator.
8. Disconnect fuel tubes and vacuum tubes.
9. Release power steering belt adjusting nut and remove power steering pump from engine.
   Bind pump properly to the vehicle.
10. Remove A/C compressor.
11. Disconnect or remove electrical wiring where necessary.
12. Release clutch lever cable.
13. Release tachometer cable from transaxle housing.
14. Remove front wheels.

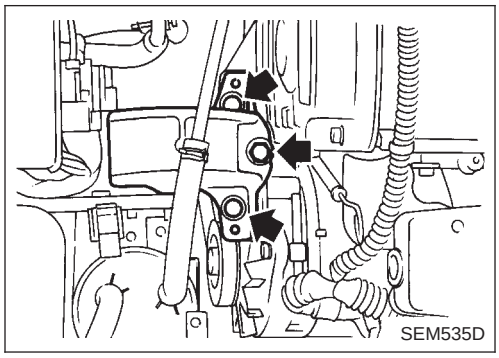

SEM532D

15. Remove brake caliper mounting bolts and bind caliper properly to vehicle LH & RH.

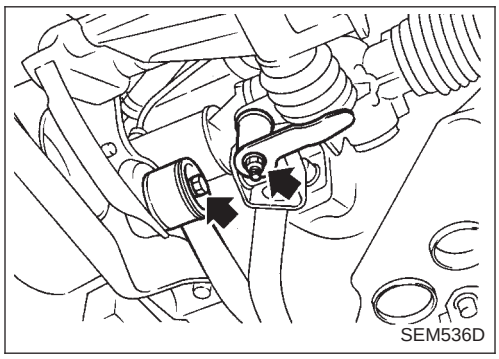
16. Disconnect tie rod ball joints and lower ball joints (LH & RH).
17. Remove stabilizer.
18. Remove drive shafts from transaxle.
    1) RH: Split drive shaft center thrust bearing.
    2) RH & LH: Remove hub mounting bolts and remove drive shaft carefully from transaxle.


SEM534D

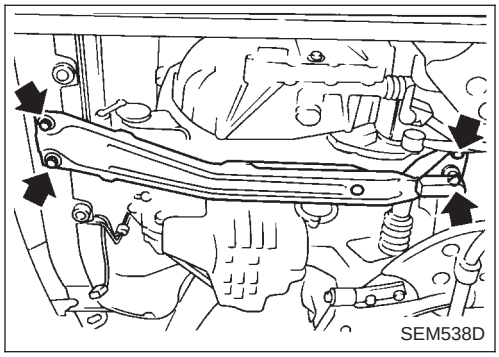
19. Mount suitable slingers to cylinder head. Use a suitable hoist to release the force on the engine mountings.


SEM535D

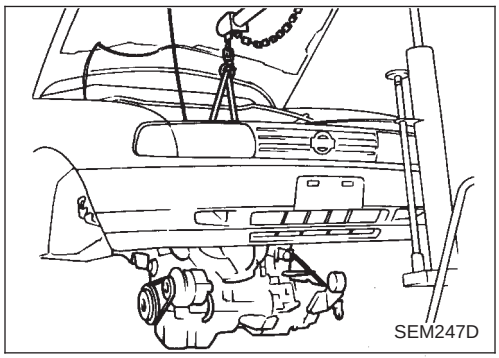
20. Remove upper mounting (Right side).


SEM536D

21. Release transaxle shift linkages.
22. Release left engine mounting.


SEM538D

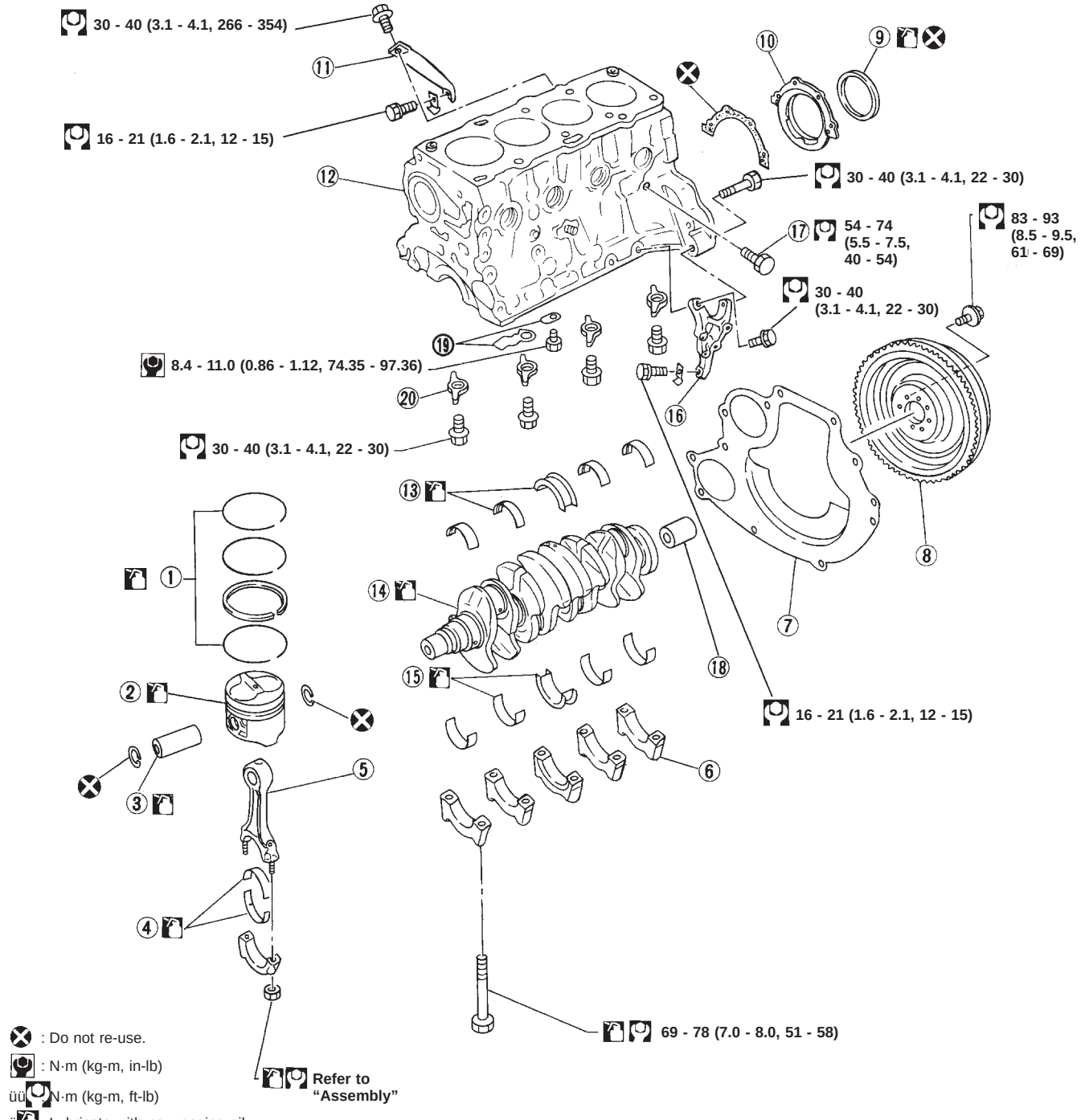
23. Remove center member fixing bolts from chassis.


SEM247D

24. Remove engine with transaxle as shown.

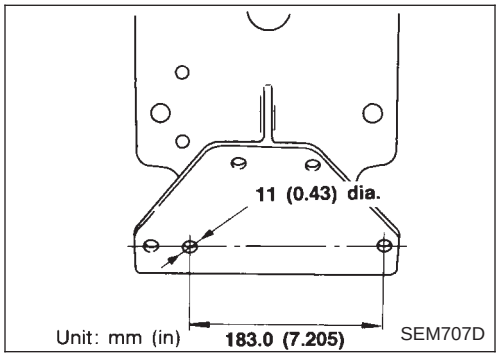
Components

SEC. 110·120



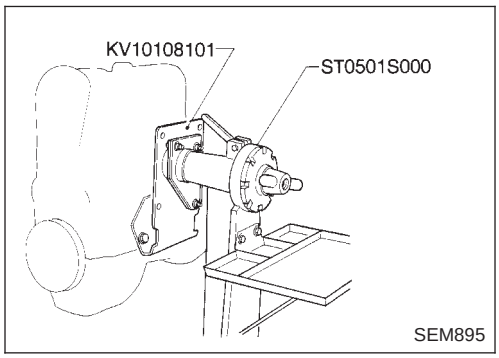
NEM376

① Piston ring
② Piston
③ Piston pin
④ Connecting rod bearing
⑤ Connecting rod
⑥ Main bearing cap
⑦ Rear plate
⑧ Flywheel
⑨ Rear oil seal
⑩ Rear oil seal retainer
⑪ Gusset
⑫ Cylinder block
⑬ Main bearing
⑭ Crankshaft
⑮ Main bearing
⑯ Gusset
⑰ Drain plug
⑱ Pilot bushing
⑲ Plate
⑳ Oil jet



Preparation

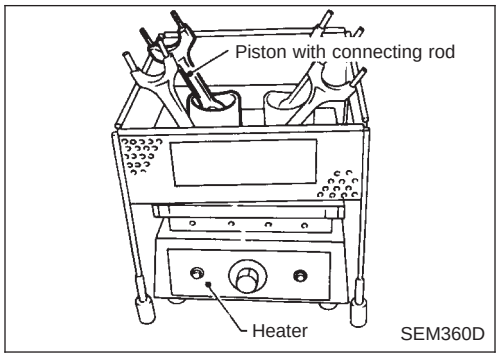
- Drill a hole into the attachment (KV10108101).



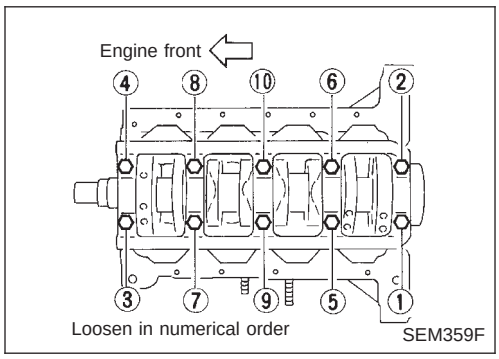
Disassembly

PISTON AND CRANKSHAFT

1. Place engine on a work stand.
2. Drain coolant and oil.
3. Remove timing belt.
4. Remove water pump.
5. Remove oil pan and oil pump.
6. Remove cylinder head.
7. Remove pistons with connecting rods.

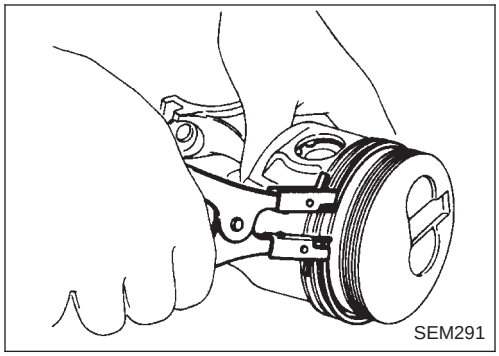


When disassembling piston and connecting rod, heat piston to 60 to 70°C (140 to 158°F) or use piston pin press stand at room temperature.



8. Remove main bearing cap and crankshaft.

Place the bearings and caps in their proper order.
Upper bearings (cylinder block side) have oil groove.



9. Remove piston rings with a tool.

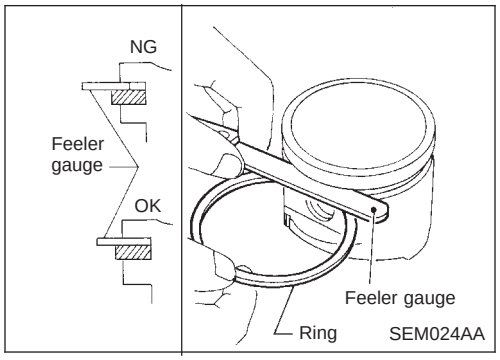
Inspection

PISTON AND PISTON PIN CLEARANCE

1. Measure outer diameter of piston pin and inner diameter of piston pin hole.
2. Calculate piston to piston pin clearance.

Pin diameter:
27.994 - 28.000 mm (1.1021 - 1.1024 in)
Pin hole diameter:
27.991 - 27.999 mm (1.1020 - 1.1023 in)
Clearance:
−0.004 to 0 mm (−0.0002 to 0 in)
(Interference fit)

Service parts are available as a set of piston and piston pin.



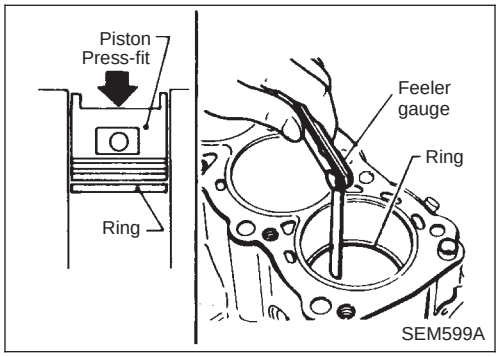
PISTON RING SIDE CLEARANCE

Side clearance:

Unit: mm (in)

	Standard	Limit
Top ring	0.020 - 0.040 (0.0008 - 0.0016)	0.10 (0.0039)
2nd ring	0.050 - 0.085 (0.0020 - 0.0033)	0.10 (0.0039)
Oil ring	0.030 - 0.070 (0.0012 - 0.0028)	0.10 (0.0039)

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



PISTON RING END GAP

End gap:

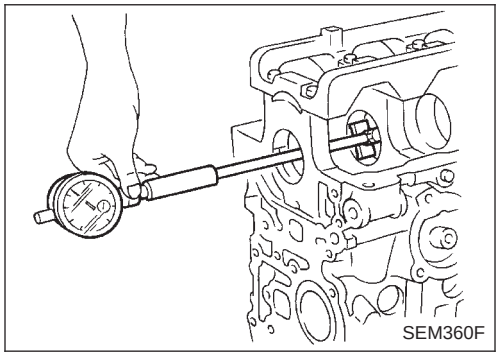
Unit: mm (in)

	Standard	Limit
Top ring	Bore grade 1, 2, 3 0.22 - 0.32 (0.0087 - 0.0126) Bore grade 4, 5 0.12 - 0.22 (0.0047 - 0.0087)	1.0 (0.039)
2nd ring	0.38 - 0.53 (0.0150 - 0.0209)	0.7 (0.028)
Oil ring	0.30 - 0.55 (0.0118 - 0.0217)	0.6 (0.024)

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

Refer to SDS (EM-199).

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



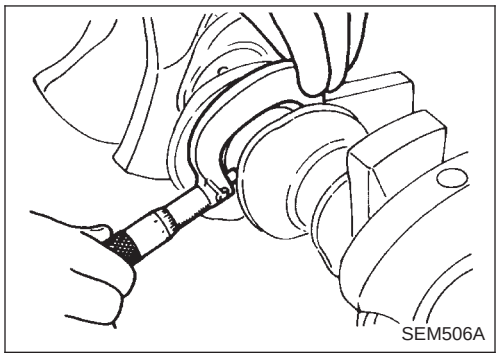
MAIN BEARING CLEARANCE

1. Install main bearings to cylinder block and main bearing cap.
2. Install main bearing cap with bearing to cylinder block.

Tighten all bolts in two or three stages.

: 69 - 78 N·m (7.0 - 8.0 kg-m, 51 - 58 ft-lb)

3. Measure inside diameter "A" of main journal.



4. Measure outside diameter "Dm" of main journal of crankshaft.

   Journal diameter:

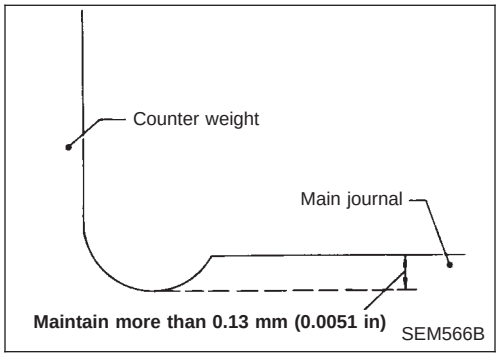
   Refer to SDS (EM-199).

5. Calculate main bearing clearance.
   Main bearing clearance = A − Dm

   Standard:

   0.039 - 0.065 mm (0.0015 - 0.0026 in)

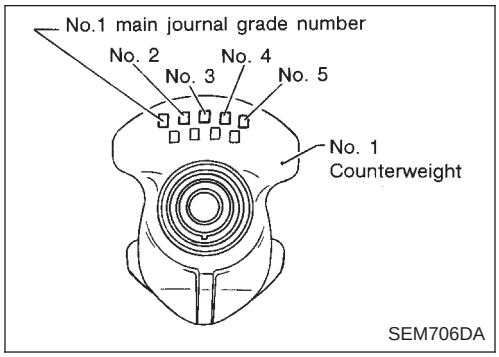
- If it exceeds the limit, replace the bearing.



- If crankshaft main journal is worn or shows any abnormality, regrind crank journal and use undersized bearings to maintain the specified oil clearance.
- **Refer to SDS for regrinding crankshaft journal diameter and available service parts (EM-200).**
- **When regrinding crankshaft journal, do not grind fillet-roll.**

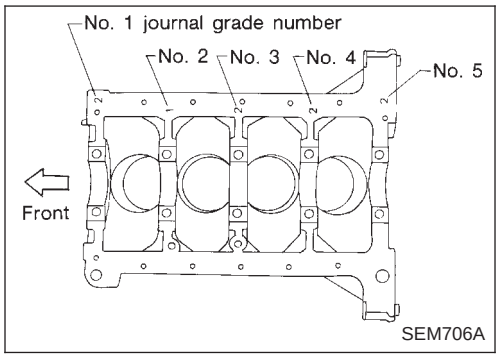
- If either bearing, crankshaft or cylinder block is replaced with a new one, select main bearing according to the following table. These numbers are punched in either Arabic or Roman numerals.

		Main bearing housing grade number		
		0	1	2
		Main bearing grade number		
Crankshaft main journal grade number	0	0	1	2
	1	1	2	3
	2	2	3	4



Identification color:

Grade 0	Yellow
Grade 1	Green
Grade 2	Brown
Grade 3	Black
Grade 4	Blue

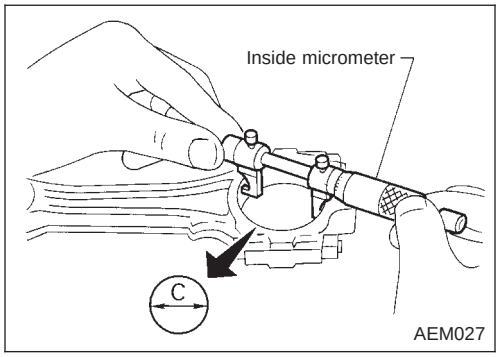


For example:

Main journal grade number: 1
Crankshaft journal grade number: 2
Main bearing grade number = 1 + 2 = 3

Main bearing thickness:

Refer to SDS (EM-200).



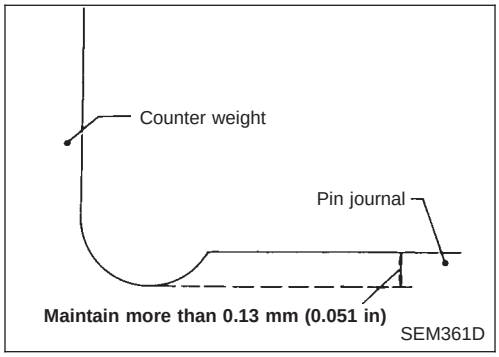
CONNECTING ROD BEARING CLEARANCE (Big end)

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

Apply oil to the threaded portion of bolts and seating surface of nuts.

: 37 - 45 N·m (3.8 - 4.6 kg-m, 27 - 33 ft-lb)

3. Measure inside diameter "C" of bearing.



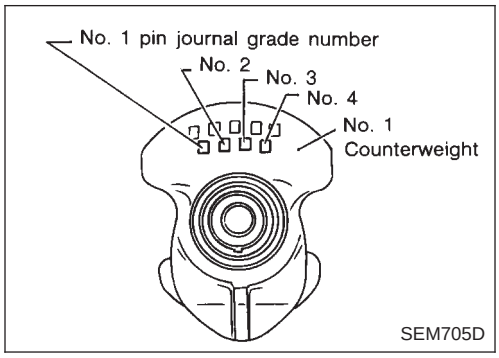
4. Measure outside diameter "Dp" of crankshaft pin journal.
5. Calculate connecting rod bearing clearance.

Connecting rod bearing clearance = C − Dp

Standard:

0.031 - 0.055 mm (0.0012 - 0.0022 in)

- If it exceeds the limit, replace the bearing.
- If crankshaft pin journal is worn or shows any abnormality, regrind crank pin and use undersized bearings to maintain the specified oil clearance.
- **Refer to SDS for regrinding diameter of crankshaft pin and available service parts (EM-200).**
- **When regrinding crankshaft pin, do not grind fillet-roll.**



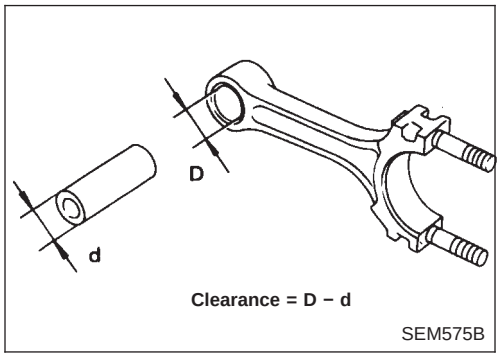
Selective connecting rod bearing

- If either bearings or crankshaft are being replaced with new ones, select connecting rod bearings according to the following table. Grade numbers are punched in either Arabic or Roman numerals.

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

Identification color

Grade 0: Black
Grade 1: Yellow
Grade 2: Blue

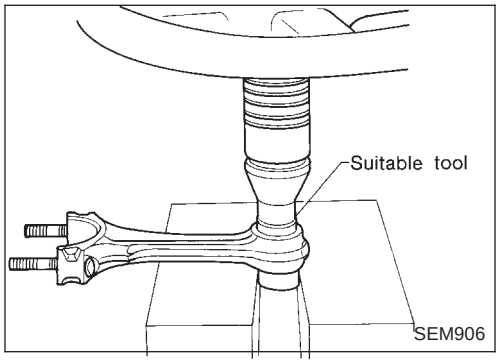


CONNECTING ROD AND PISTON PIN CLEARANCE (Small end)

Clearance (D − d):

0.025 - 0.044 mm (0.0010 - 0.0017 in)

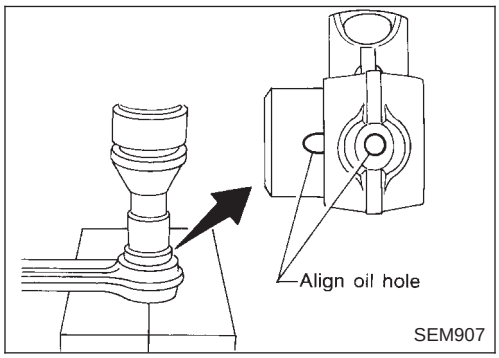
- If clearance exceeds the specifications, replace the bearing.



Bearing replacement

- Remove bearing with a suitable tool.

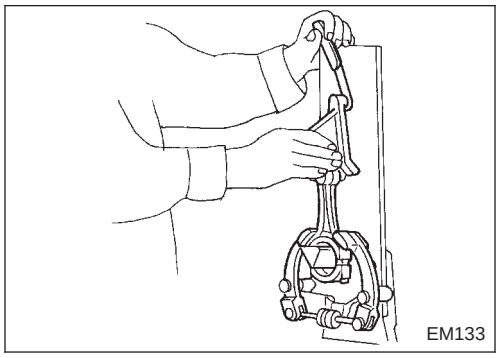
Do not scratch inner surface of connecting rod.



1. Install new bearing with oil holes aligned correctly.
2. Ream bore using a suitable tool.

Ream bore:

28.025 - 28.038 mm (1.1033 - 1.1039 in)

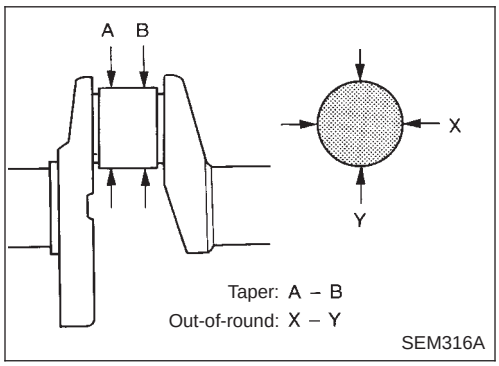


CONNECTING ROD BEND AND TORSION

Bend and torsion [per 100 mm (3.94 in) length]:

Bend Less than 0.025 mm (0.0010 in)

Torsion Less than 0.025 mm (0.0010 in)



CRANKSHAFT

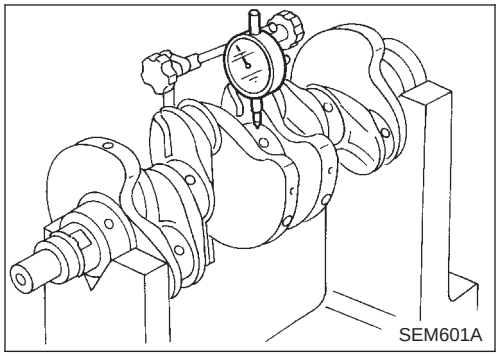
1. Check crankshaft journals and pins for score, bias, wear or cracks. If faults are minor, correct with fine emery paper.
2. Check journals and pins with a micrometer for taper and out-of-round.

Out-of-round (X − Y):

Less than 0.005 mm (0.0002 in)

Taper (A − B):

Less than 0.005 mm (0.0002 in)

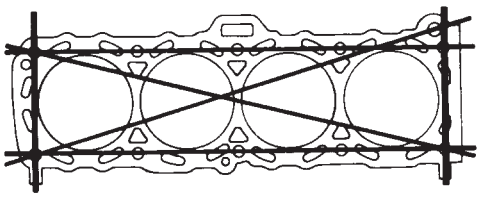


3. Check crankshaft runout.

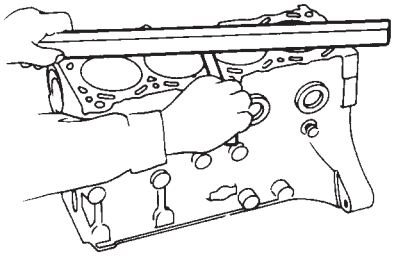
Runout (Total indicator reading):

Less than 0.05 mm (0.0020 in)

Measuring points



Warpage of surface:
Less than 0.1 mm (0.004 in)



SEM655A

CYLINDER BLOCK DISTORTION

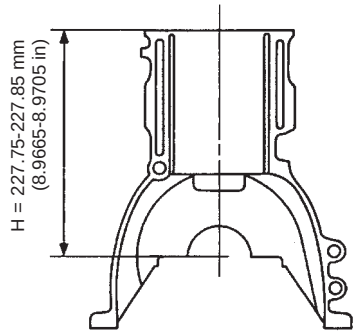
Clean upper face of cylinder block and measure the distortion.

Limit:

0.10 mm (0.0039 in)

If out of specification, resurface it.

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



NEM210

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

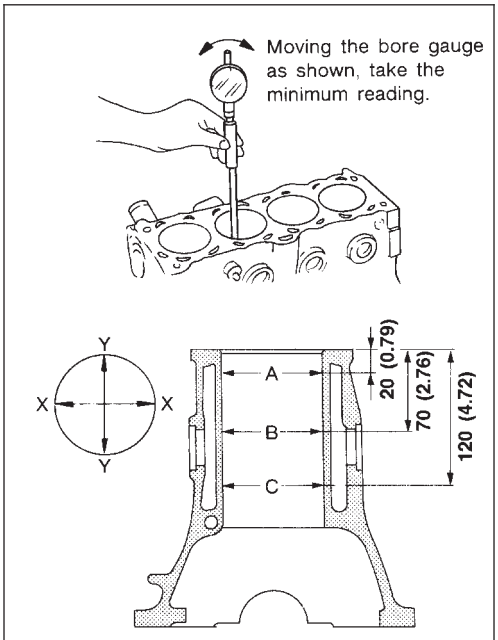
The maximum limit is as follows:

A + B = 0.1 mm (0.004 in)

Nominal cylinder block height from crankshaft center:

227.75 - 227.85 mm (8.9665 - 8.9705 in)

If necessary, replace cylinder block.



Unit: mm (in)

SEM704DA

CYLINDER BORE

1. Check for scratches or seizure. If seizure is found, hone bore.
2. Using a bore gauge, measure cylinder bore for wear, out-of-round or taper.

Standard bore diameter:

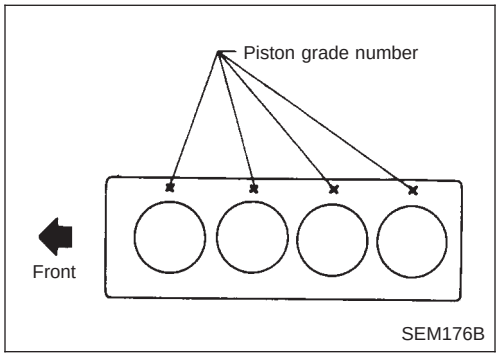
84.500 - 84.550 mm (3.3268 - 3.3287 in)

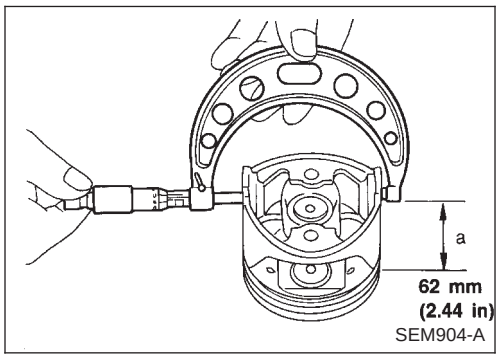
Unit: mm (in)

Bore wear limit	0.2 (0.008)
Out-of-round (X − Y) standard	0.015 (0.0006)
Taper (A − B) standard	0.010 (0.0004)

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

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





Reboring

1. The size to which cylinders must be honed, is determined by adding piston-to-cylinder clearance to the piston skirt diameter "A".

   Dimension "a":

   Approximately 62 mm (2.44 in)

   Rebored size calculation

   D = A + B − C = A + [0.03 to 0.05 mm (0.0012 to 0.0020 in)]

   where,

   D: Honed diameter
   A: Skirt diameter as measured
   B: Piston-to-wall clearance
   C: Machining allowance
   0.02 mm (0.0008 in)

2. Install main bearing caps and tighten bolts to the specified torque. This will prevent distortion of cylinder bores.
3. Cut cylinder bores in the order of 2-4-1-3.

Do not cut too much out of the cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.

4. Hone the cylinders to the required size referring to SDS (EM-199).
5. Measure the finished cylinder bore for out-of-round and taper.

Measurement of a just machined cylinder bore requires utmost care since it is expanded by cutting heat.

PISTON-TO-BORE CLEARANCE

Using micrometer

1. Measure piston and cylinder bore diameter.

   Piston diameter "A":

   Refer to SDS (EM-199).

   Measuring point "a" (Distance from the bottom):

   Approximately 62 mm (2.44 in)

   Bore diameter "D":

   Refer to SDS (EM-199).

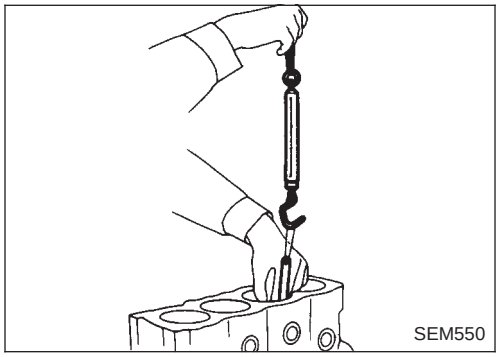
   Measuring point (Distance from the top):

   Approximately 70 mm (2.76 in)

2. Check that piston clearance is within the specification.

   Piston clearance (D − A):

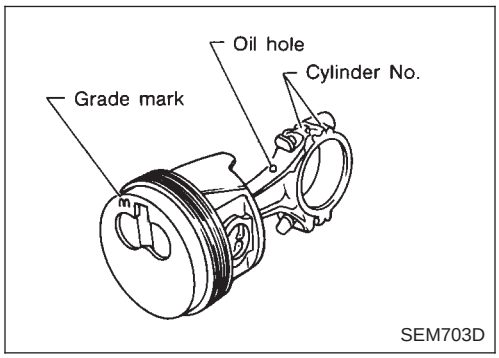
   0.030 - 0.050 mm (0.0012 - 0.0020 in)


SEM550

Using feeler gauge

1. Set piston and feeler gauge with spring scale.
2. Measure extracting force while pulling up scale slowly.

Feeler gauge used:
0.05 - 0.07 mm (0.0020 - 0.0028 in)
Extracting force:
7.8 - 14.7 N (0.8 - 1.5 kg, 1.8 - 3.3 lb)

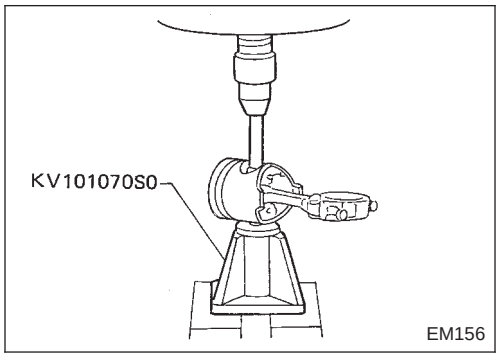


SEM703D

Assembly

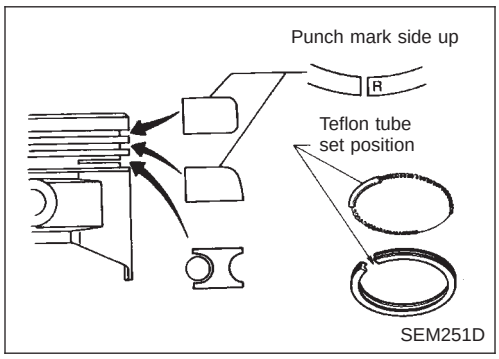
PISTON

- **Numbers stamped on connecting rod and cap correspond to each cylinder. Care should be taken to avoid a wrong combination including bearing and connecting rod direction.**



EM156

- **Install new snap ring on one side of piston pin hole.**
- **When assembling piston and connecting rod with piston pin, heat piston to between 60 and 80°C (140 and 176°F) and install piston pin with a suitable tool.**
- **Install new snap ring.**
- **After assembling, ascertain that piston swings smoothly.**

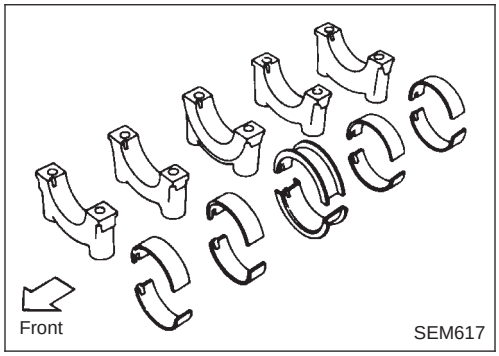


SEM251D

- Install piston rings with a suitable tool.

Selective top ring; When installing new top ring or replacing cylinder block, select top ring to adjust ring gap.

	Cylinder bore grade	
	1, 2, 3	4, 5
Top ring grade No.	No mark	S

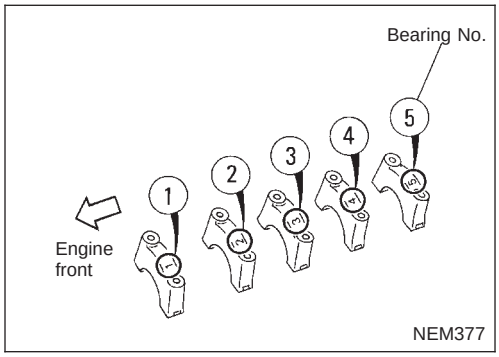


SEM617

CRANKSHAFT

1. Set main bearings in the proper position on cylinder block and main bearing caps.

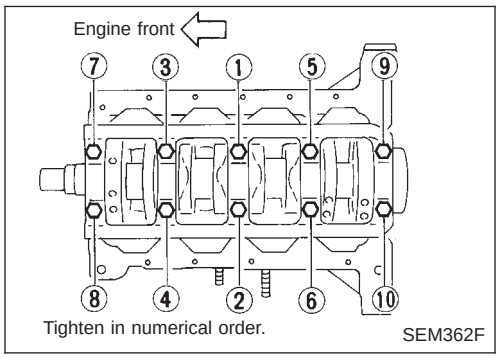
- **If either crankshaft, cylinder block or main bearing is reused again, it is necessary to measure main bearing clearance.**
- **Upper bearings (cylinder block side) have oil groove.**
- **Apply new engine oil to bearing surfaces.**

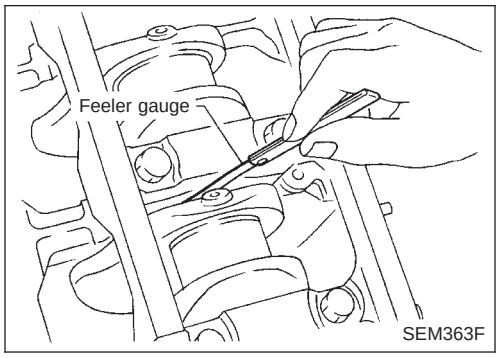


2. Apply engine oil to main bearing surfaces on crankshaft journal side.
3. Install crankshaft and main bearing caps.
4. Tighten main bearing cap bolts.

: 69 - 78 N·m (7.0 - 8.0 kg-m, 51 - 58 ft-lb)

- **Arrange the parts so that the indicated numbers on bearing caps are in a row from the front of engine.**
- **Tighten bearing cap bolts gradually in two or three stages and outwardly from center bearing in sequence.**
- **After securing bearing cap bolts, ascertain that crankshaft turns smoothly.**
- **Apply new engine oil to threads of bearing cap bolts.**





5. Measure crankshaft free end play at center bearing.

Crankshaft free end play:
Standard
0.05 - 0.18 mm (0.0020 - 0.0071 in)
Limit
0.30 mm (0.0118 in)

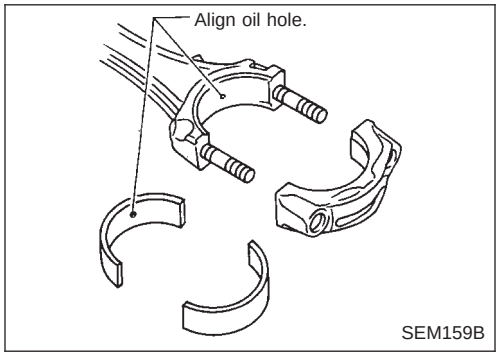
PISTON WITH CONNECTING ROD

1. Install connecting rod bearings in the connecting rods and connecting rod caps.

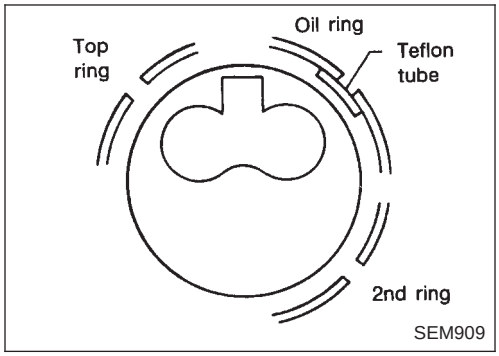
- Confirm that correct size of bearings is used.

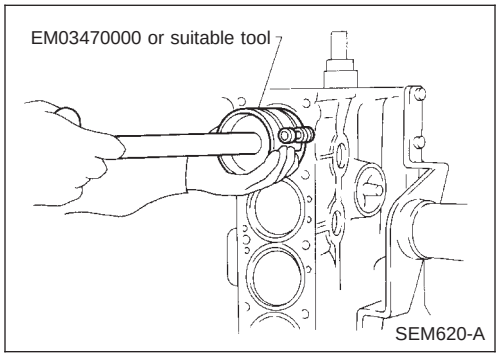
Refer to "Inspection" (EM-170).

- Install the bearings so that the oil hole in the connecting rod aligns with the oil hole of the bearing.
- **Apply engine oil to connecting rod bearing surfaces on the crankshaft journal side.**

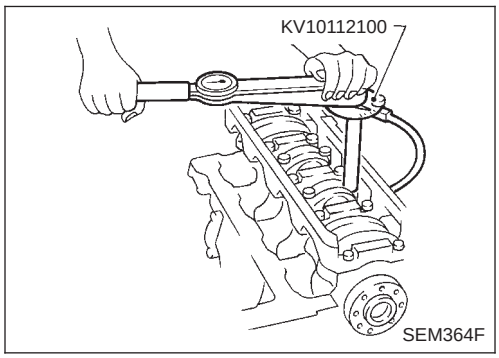


- Set piston rings as shown.





2. Install pistons with connecting rods.
- Install them into corresponding cylinder using Tool.
- **Be careful not to scratch cylinder wall with connecting rod.**
- **Apply engine oil to cylinder wall, piston and bearing.**
- **Arrange so that the front mark on piston head faces to the front of engine.**



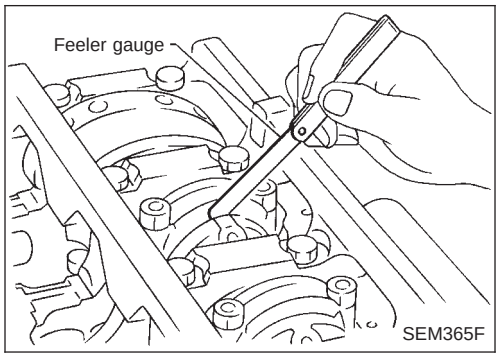
3. Install connecting rod bearing caps.
- **Apply engine oil to the thread of connecting rod bearing nut.**

(1) Tighten connecting rod bearing nut to 15±1 N·m (1.5±0.1 kg-m, 10.8±0.7 ft-lb).

(2) Then tighten an additional $60^{+5^\circ}_{-0^\circ}$ turns with an angular tightening wrench.

: 15±1 N·m (1.5±0.1 kg-m, 11±0.7 ft-lb) plus $60^{+5^\circ}_{-0^\circ}$ or

: 37 - 45 N·m (3.8 - 4.6 kg-m, 27 - 33 ft-lb)

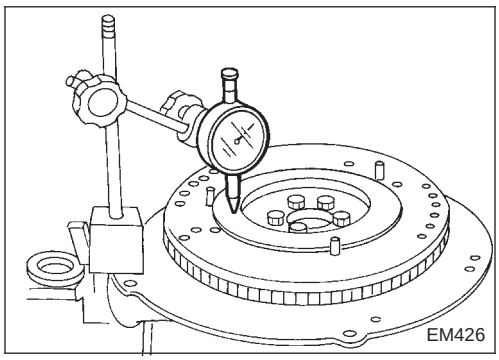


4. Measure connecting rod side clearance.

Connecting rod side clearance (Big end play):

Limit

0.3 mm (0.012 in)



FLYWHEEL RUNOUT

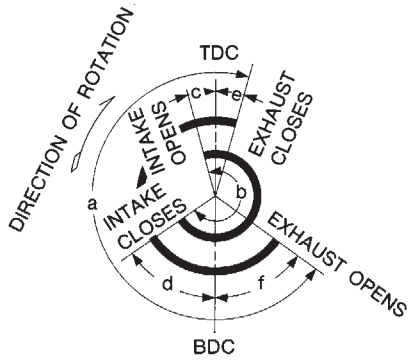
Runout (Total indicator reading):

Less than 0.15 mm (0.0059 in)

General Specifications

NCEM0028

Engine		QG16DE	QG18DE
Classification		Gasoline	
Cylinder arrangement		4, in-line	
Displacement cm^3 (cu in)		1,596 (97.39)	1,769 (107.94)
Bore × stroke mm (in)		76.0 × 88.0 (2.992 × 3.465)	80.0 × 88.0 (3.150 × 3.465)
Valve arrangement		DOHC	
Firing order		1-3-4-2	
Number of piston rings	Compression	2	
	Oil	1	
Number of main bearings		5	
Compression ratio		9.5	



EM120

		a	b	c	d	e	f
Valve timing	QG16DE	222°	228°	-4° (16°)	52° (32°)	−2°	44°
	QG18DE	222°	236°	0° (20°)	56° (36°)	−2°	44°

( ): Valve timing control ON

Compression Pressure

NJEM0029

Unit: kPa (bar, kg/cm^2, psi)/350 rpm

Standard	1,324 (13.24, 13.5, 192)
Minimum	1,128 (11.28, 11.5, 164)
Difference limit between cylinders	98 (0.98, 1.0, 14)

Cylinder Head

NCEM0030

Unit: mm (in)

	Standard	Limit
Head surface flatness	Less than 0.03 (0.0012)	0.1 (0.004)
Height	117.8 - 118.0 (4.638 - 4.646)	—

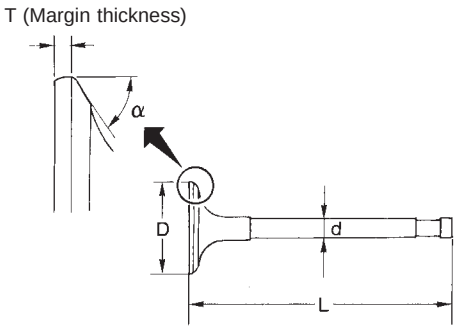
Valve

NCEM0031

VALVE

NCEM0031S01

Unit: mm (in)



SEM188A

Valve head diameter “D”	Intake	29.9 - 30.2 (1.177 - 1.189)
	Exhaust	24.9 - 25.2 (0.980 - 0.992)
Valve length “L”	Intake	92.00 - 92.50 (3.6220 - 3.6417)
	Exhaust	92.37 - 92.87 (3.6366 - 3.6563)
Valve stem diameter “d”	Intake	5.465 - 5.480 (0.2152 - 0.2157)
	Exhaust	5.445 - 5.460 (0.2144 - 0.2150)
Valve face angle “α”		45°15′ - 45°45′
Valve margin “T” limit		More than 0.5 (0.020)
Valve stem end surface grinding limit		0.2 (0.008)

VALVE SPRING

NCEM0031S02

Free height mm (in)		40.0 (1.575)
Pressure N (kg, lb) at height mm (in)	Standard	370.0 (37.73, 83.19) at 23.64 (0.9307)
	Limit	347.8 (35.46, 78.19) at 23.64 (0.9307)
Out-of-square mm (in)		Less than 1.75 (0.0689)

VALVE LIFTER

NCEM0031S10

Unit: mm (in)

Valve lifter outside diameter	29.960 - 29.975 (1.1795 - 1.1801)
Lifter guide inside diameter	30.000 - 30.021 (1.1811 - 1.1819)
Clearance between valve lifter and valve lifter guide	0.025 - 0.061 (0.0010 - 0.0024)

VALVE CLEARANCE

NCEM0031S11

Unit: mm (in)

	For adjusting		For checking
	Hot	Cold* (reference data)	Hot
Intake	0.32 - 0.40 (0.013 - 0.016)	0.25 - 0.33 (0.010 - 0.013)	0.21 - 0.49 (0.008 - 0.019)
Exhaust	0.37 - 0.45 (0.015 - 0.018)	0.32 - 0.40 (0.013 - 0.016)	0.30 - 0.58 (0.012 - 0.023)

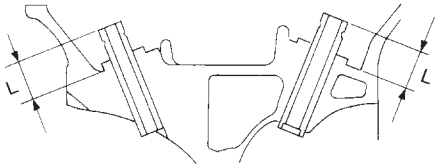
*: At a temperature of approximately 20°C (68°F)

Whenever valve clearances are adjusted to cold specifications, check that the clearances satisfy hot specifications and adjust again if necessary.

VALVE GUIDE

NCEM0031S04

Unit: mm (in)



MEM096A

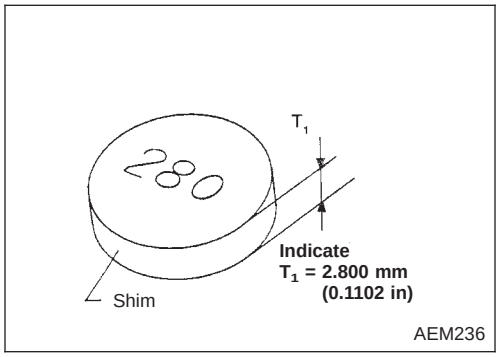
		Intake		Exhaust	
		Standard	Service	Standard	Service
Valve guide	Outer diameter	9.523 - 9.534 (0.3749 - 0.3754)	9.723 - 9.734 (0.3828 - 0.3832)	9.523 - 9.534 (0.3749 - 0.3754)	9.723 - 9.734 (0.3828 - 0.3832)
	Inner diameter [Finished size]	5.500 - 5.515 (0.2165 - 0.2171)		5.500 - 5.515 (0.2165 - 0.2171)	
Cylinder head valve guide hole diameter		9.475 - 9.496 (0.3730 - 0.3739)	9.685 - 9.696 (0.3813 - 0.3817)	9.475 - 9.496 (0.3730 - 0.3739)	9.685 - 9.696 (0.3813 - 0.3817)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	0.027 - 0.049 (0.0011 - 0.0019)	0.027 - 0.059 (0.0011 - 0.0023)	0.027 - 0.049 (0.0011 - 0.0019)
Stem to guide clearance		0.020 - 0.050 (0.0008 - 0.0020)		0.040 - 0.070 (0.0016 - 0.0028)	
Valve deflection limit (Dial gauge reading)		0.2 (0.008)			
Projection length "L"		11.5 - 11.7 (0.453 - 0.461)			

AVAILABLE SHIMS

NCEM0031S07

Thickness mm (in)	Identification mark
2.00 (0.0787)	2.00
2.02 (0.0795)	2.02
2.04 (0.0803)	2.04
2.06 (0.0811)	2.06
2.08 (0.0819)	2.08
2.10 (0.0827)	2.10
2.12 (0.0835)	2.12
2.14 (0.0843)	2.14
2.16 (0.0850)	2.16
2.18 (0.0858)	2.18
2.20 (0.0866)	2.20
2.22 (0.0874)	2.22
2.24 (0.0882)	2.24
2.26 (0.0890)	2.26
2.28 (0.0898)	2.28
2.30 (0.0906)	2.30
2.32 (0.0913)	2.32

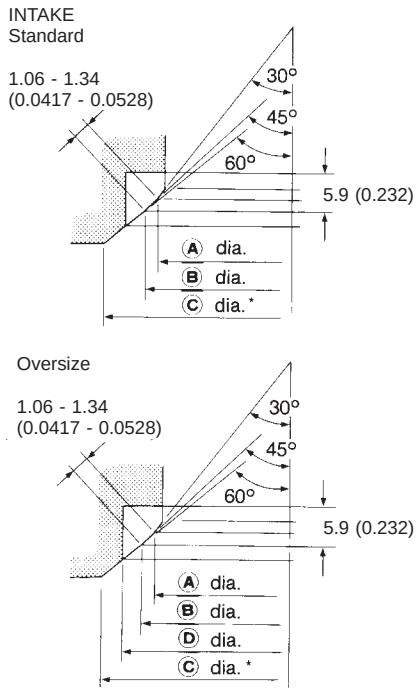
Thickness mm (in)	Identification mark
2.34 (0.0921)	2.34
2.36 (0.0929)	2.36
2.38 (0.0937)	2.38
2.40 (0.0945)	2.40
2.42 (0.0953)	2.42
2.44 (0.0961)	2.44
2.46 (0.0969)	2.46
2.48 (0.0976)	2.48
2.50 (0.0984)	2.50
2.52 (0.0992)	2.52
2.54 (0.1000)	2.54
2.56 (0.1008)	2.56
2.58 (0.1016)	2.58
2.60 (0.1024)	2.60
2.62 (0.1031)	2.62
2.64 (0.1039)	2.64
2.66 (0.1047)	2.66
2.68 (0.1055)	2.68
2.70 (0.1063)	2.70
2.72 (0.1071)	2.72
2.74 (0.1079)	2.74
2.76 (0.1087)	2.76
2.78 (0.1094)	2.78
2.80 (0.1102)	2.80
2.82 (0.1110)	2.82
2.84 (0.1118)	2.84
2.86 (0.1126)	2.86
2.88 (0.1134)	2.88
2.90 (0.1142)	2.90
2.92 (0.1150)	2.92
2.94 (0.1157)	2.94
2.96 (0.1165)	2.96
2.98 (0.1173)	2.98

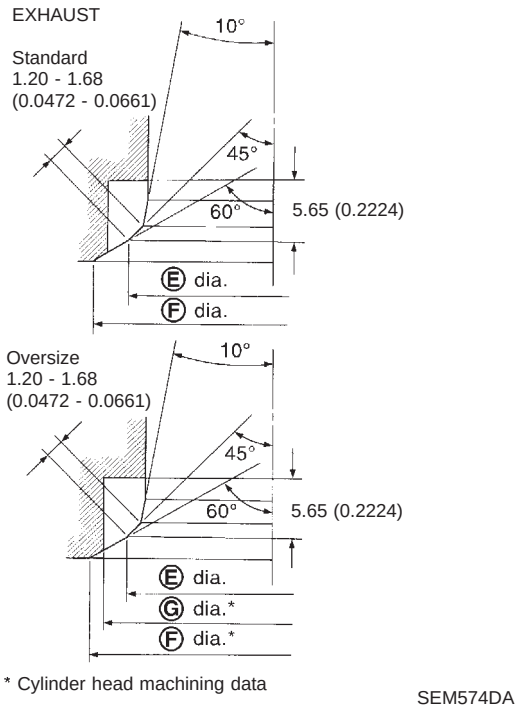


VALVE SEAT

NCEM0031S05

Unit: mm (in)



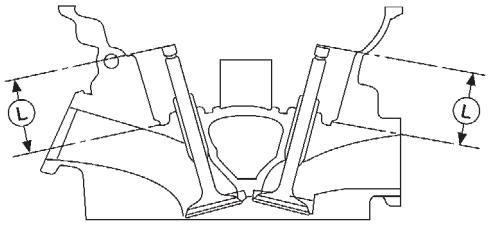


Dia.	QG	Dia.	QG
A	27.8 - 28.0 (1.094 - 1.102) dia.	E	24.5 - 24.7 (0.965 - 0.972)
B	29.5 - 29.7 (1.161 - 1.169) dia.	F	26.2 - 26.4 (1.031 - 1.039)
C	31.9 - 32.1 (1.256 - 1.264)	G	26.500 - 26.516 (1.0433 - 1.0439)
D	31.500 - 31.516 (1.2402 - 1.2408)		

VALVE SEAT RESURFACE LIMIT

NCEM0031S08

Unit: mm (in)



AEM343

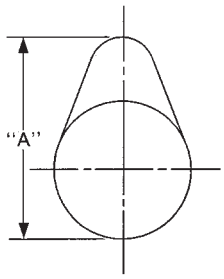
Depth (L)	Intake	35.95 - 36.55 (1.4154 - 1.4390)
	Exhaust	35.92 - 36.52 (1.4142 - 1.4378)

Camshaft and Camshaft Bearing

NCEM0032

Unit: mm (in)

Engine model		QG16DE	QG18DE
Cam height "A"	Intake	40.220 - 40.410 (1.5835 - 1.5909)	40.610 - 40.800 (1.5988 - 1.6063)
	Exhaust	40.056 - 40.245 (1.5770 - 1.5844)	
Cam wear limit		0.20 (0.0079)	



EM671

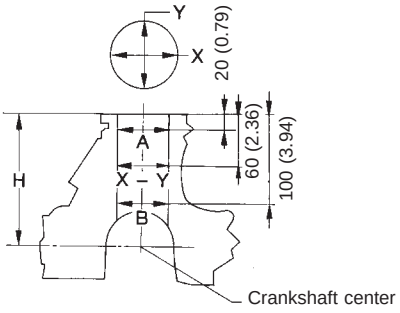
		Standard	Limit
Camshaft journal to bearing clearance		0.045 - 0.086 (0.0018 - 0.0034)	0.15 (0.0059)
Inner diameter of camshaft bearing	No. 1	28.000 - 28.021 (1.1024 - 1.1032)	—
	No. 2 to No. 5	24.000 - 24.021 (0.9449 - 0.9457)	
Outer diameter of camshaft journal	No. 1	27.935 - 27.955 (1.0998 - 1.1006)	—
	No. 2 to No. 5	23.935 - 23.955 (0.9423 - 0.9431)	
Camshaft runout [TIR*]		Less than 0.02 (0.0008)	0.1 (0.004)
Camshaft end play		0.115 - 0.188 (0.0045 - 0.0074)	0.20 (0.0079)

*Total indicator reading

Cylinder Block

NCEM0033

Unit: mm (in)



SEM171D

			QG16DE	QG18DE	Limit
			Standard		
Surface flatness			Less than 0.03 (0.0012)		0.1 (0.004)
Height “H” (nominal)			213.95 - 214.05 (8.4232 - 8.4271)		—
Cylinder bore inner diameter	Standard	Grade No. 1	76.000 - 76.0610 (2.9921 - 2.9925)	80.000 - 80.010 (3.1496 - 3.1500)	0.2 (0.008)
		Grade No. 2	76.010 - 76.020 (2.7957 - 2.7961)	80.010 - 80.020 (3.1500 - 3.1504)	
		Grade No. 3	76.020 - 76.030 (2.7961 - 2.9933)	80.020 - 80.030 (3.1504 - 3.1508)	
Out-of-round (X − Y)			Less than 0.015 (0.0006)		—
Taper (A − B)			Less than 0.01 (0.0004)		—
Difference in inner diameter between cylinders			0.05 (0.0020)		0.2 (0.008)

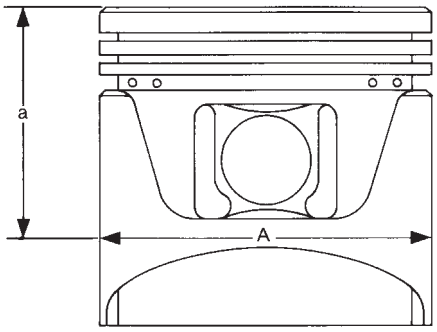
Piston, Piston Ring and Piston Pin

NCEM0034

PISTON

NCEM0034S01

Unit: mm (in)



SEM882E

			QG16DE	QG18DE
Piston skirt diameter “A”	Standard	Grade No. 1	75.975 - 75.985 (2.9911 - 2.9915)	79.965 - 79.975 (3.1482 - 3.1486)
		Grade No. 2	75.985 - 75.995 (2.9915 - 2.9919)	79.975 - 79.985 (3.1486 - 3.1490)
		Grade No. 3	75.995 - 76.005 (2.9919 - 2.9923)	79.985 - 79.995 (3.1490 - 3.1494)
0.5 (0.002) oversize (service)			76.475 - 76.505 (3.0108 - 3.0120)	80.215 - 80.245 (3.1581 - 3.1592)
1.0 (0.039) oversize (service)			76.975 - 77.005 (3.0305 - 3.0317)	80.465 - 80.495 (3.1679 - 3.1691)
“a” dimension			44.5 (1.7520)	42.3 (1.665)
Piston pin hole inner diameter			18.987 - 18.999 (0.7475 - 0.7080)	18.993 - 19.005 (0.7478 - 0.7482)
Piston to bore clearance			0.015 - 0.035 (0.0006 - 0.0014)	0.025 - 0.045 (0.0010 - 0.0018)

PISTON RING

NCEM0034S02

Unit: mm (in)

		QG16DE	QG18DE	Limit
		Standard		
Side clearance	Top	0.045 - 0.080 (0.0018 - 0.0031)	0.040 - 0.080 (0.0016 - 0.0031)	0.110 (0.0043)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)		0.100 (0.0039)
	Oil	0.065 - 0.135 (0.0026 - 0.0053)	0.045 - 0.155 (0.0018 - 0.0061)	—
End gap	Top	0.20 - 0.30 (0.0079 - 0.0118)		0.53 (0.0209)
	2nd	0.50 - 0.65 (0.0197 - 0.0256)	0.32 - 0.47 (0.0126 - 0.0185)	0.98 (0.0386)
	Oil	0.20 - 0.60 (0.0079 - 0.0236)		0.95 (0.0374)

PISTON PIN

NCEM0034S03

Unit: mm (in)

		QG16DE	QG18DE
Piston pin outer diameter		18.989 - 19.001 (0.7476 - 0.7481)	
Piston pin to piston clearance		−0.004 to 0 (−0.0002 to 0)	0.002 - 0.006 (0.0001 - 0.0002)
Piston pin to connecting rod bushing clearance	Standard	0.005 - 0.017 (0.0002 - 0.0007)	
	Limit	0.023 (0.0009)	

Connecting Rod

NCEM0035

Unit: mm (in)

Center distance		140.45 - 140.55 (5.5295 - 5.5335)
Bend limit [per 100 (3.94)]		0.15 (0.0059)
Torsion limit [per 100 (3.94)]		0.3 (0.012)
Connecting rod bushing inner diameter* (small end)		19.000 - 19.012 (0.7480 - 0.7485)
Connecting rod big end inner diameter		43.000 - 43.013 (1.6929 - 1.6934)
Side clearance	Standard	0.200 - 0.470 (0.0079 - 0.0185)
	Limit	0.5 (0.020)

*After installing in connecting rod

Crankshaft

NCEM0036

Unit: mm (in)

Main journal dia. “Dm”	Grade No. 0	49.956 - 49.964 (1.9668 - 1.9671)
	Grade No. 1	49.948 - 49.956 (1.9665 - 1.9668)
	Grade No. 2	49.940 - 49.948 (1.9661 - 1.9665)
Pin journal dia. “Dp”	Grade No. 0	39.968 - 39.974 (1.5735 - 1.5738)
	Grade No. 1	39.962 - 39.968 (1.5733 - 1.5735)
	Grade No. 2	39.956 - 39.962 (1.5731 - 1.5733)
Center distance “r”		43.95 - 44.05 (1.7303 - 1.7342)
Out-of-round (X − Y)	Standard	Less than 0.003 (0.0001)
	Limit	Less than 0.005 (0.0002)
Taper (A − B)	Standard	Less than 0.004 (0.0002)
	Limit	Less than 0.005 (0.0002)
Runout [TIR*]	Standard	Less than 0.04 (0.0016)
	Limit	Less than 0.05 (0.0020)
Free end play	Standard	0.060 - 0.260 (0.0024 - 0.0102)
	Limit	0.3 (0.012)

*: Total indicator reading

Main Bearing

NCEM0037

STANDARD

NCEM0037S01

Grade No.	Thickness “T” mm (in)	Identification color
0	1.826 - 1.830 (0.0719 - 0.0720)	Black
1	1.830 - 1.834 (0.0720 - 0.0722)	Red
2	1.834 - 1.838 (0.0722 - 0.0724)	Green
3	1.838 - 1.842 (0.0724 - 0.0725)	Yellow
4	1.842 - 1.846 (0.0725 - 0.0727)	Blue

UNDERSIZE

NCEM0037S02

Unit: mm (in)

	Thickness “T”
0.25 (0.0098)	1.960 - 1.964 (0.0772 - 0.0773)
0.50 (0.0197)	2.085 - 2.089 (0.0821 - 0.0822)

Connecting Rod Bearing

NCEM0038

STANDARD SIZE

NCEM0038S01

Unit: mm (in)

Grade No.	Thickness	Identification color or number
0	1.503 - 1.506 (0.0592 - 0.0593)	—
1	1.506 - 1.509 (0.0593 - 0.0594)	Brown
2	1.509 - 1.512 (0.0594 - 0.0595)	Green

UNDERSIZE

NCEM0038S02

Unit: mm (in)

Grade No.	Thickness	Identification color or number
0.08 (0.0031)	1.542 - 1.546 (0.0607 - 0.0609)	—
0.12 (0.0047)	1.562 - 1.566 (0.0615 - 0.0617)	—
0.25 (0.0098)	1.627 - 1.631 (0.0641 - 0.0642)	—

Bearing Clearance

NCEM0039

Unit: mm (in)

Main bearing clearance	Standard	0.020 - 0.044 (0.0008 - 0.0017)
	Limit	0.1 (0.004)
Connecting rod bearing clearance	Standard	0.014 - 0.039 (0.0006 - 0.0015)
	Limit	0.1 (0.004)

Miscellaneous Components

NCEM0040

Unit: mm (in)

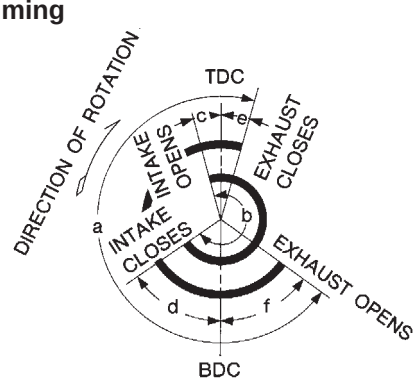
Flywheel runout [TIR*]	Less than 0.15 (0.0059)
Camshaft sprocket runout [TIR*]	Less than 0.15 (0.0059)

*: Total indicator reading

General Specifications

Cylinder arrangement		In-line 4
Displacement	cm^3 (cu in)	1,998 (121.92)
Bore and stroke	mm (in)	86 x 86 (3.39 x 3.39)
Valve arrangement		DOHC
Firing order		1-3-4-2
Number of piston rings		
Compression		2
Oil		1
Number of main bearings		5
Compression ratio		10.0

Valve timing



EM120

Unit: degree

	a	b	c	d	e	f
SR20DE	232°	240°	6°	54°	3°	49°

Inspection and Adjustment

COMPRESSION PRESSURE

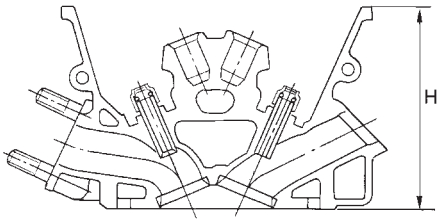
Unit: kPa (bar, kg/cm^2, psi)/300 rpm

Standard	1,275 (12.75, 13.0, 185)
Minimum	1,079 (10.79, 11.0, 156)
Differential limit between cylinders	98 (0.98, 1.0, 14)

CYLINDER HEAD

Unit: mm (in)

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

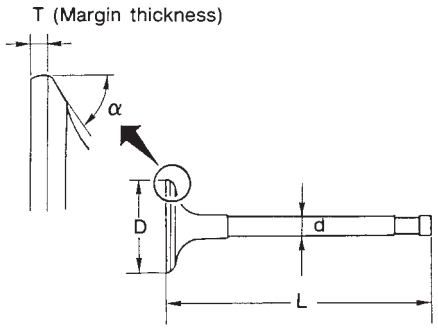


Nominal cylinder head height:
H = 136.9 - 137.1 mm (5.390 - 5.398 in)

SEM956C

VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	
Intake	34.0 - 34.2 (1.339 - 1.346)
Exhaust	30.0 - 30.2 (1.181 - 1.189)
Valve length "L"	
Intake	98.17 - 98.63 (3.8650 - 3.8831)
Exhaust	99.09 - 99.55 (3.9012 - 3.9193)
Valve stem diameter "d"	
Intake	5.965 - 5.980 (0.2348 - 0.2354)
Exhaust	5.945 - 5.960 (0.2341 - 0.2346)
Valve seat angle "α"	
Intake	45°15′ - 45°45′
Exhaust	
Valve margin "T"	
Intake	1.3 (0.051)
Exhaust	1.6 (0.063)
Valve margin "T" limit	More than 0.5 (0.020)
Valve stem end surface grinding limit	Less than 0.2 (0.008)
Valve clearance	
Intake	0 (0)
Exhaust	0 (0)

Valve spring

Free height	mm (in)	49.36 (1.9433)
Pressure N (kg, lb) at height mm (in)		
Standard		569.00 - 641.57 (58.02 - 65.42, 127.93 - 144.25) at 30.0 (1.181)
Limit		549.2 (56.0, 123.5) at 30.0 (1.181)
Out-of-square	mm (in)	Less than 2.2 (0.087)

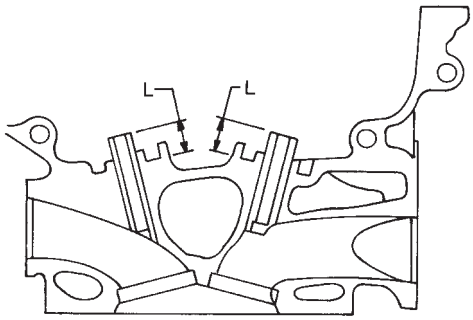
Hydraulic lash adjuster (HLA)

Unit: mm (in)

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

Valve guide

Unit: mm (in)

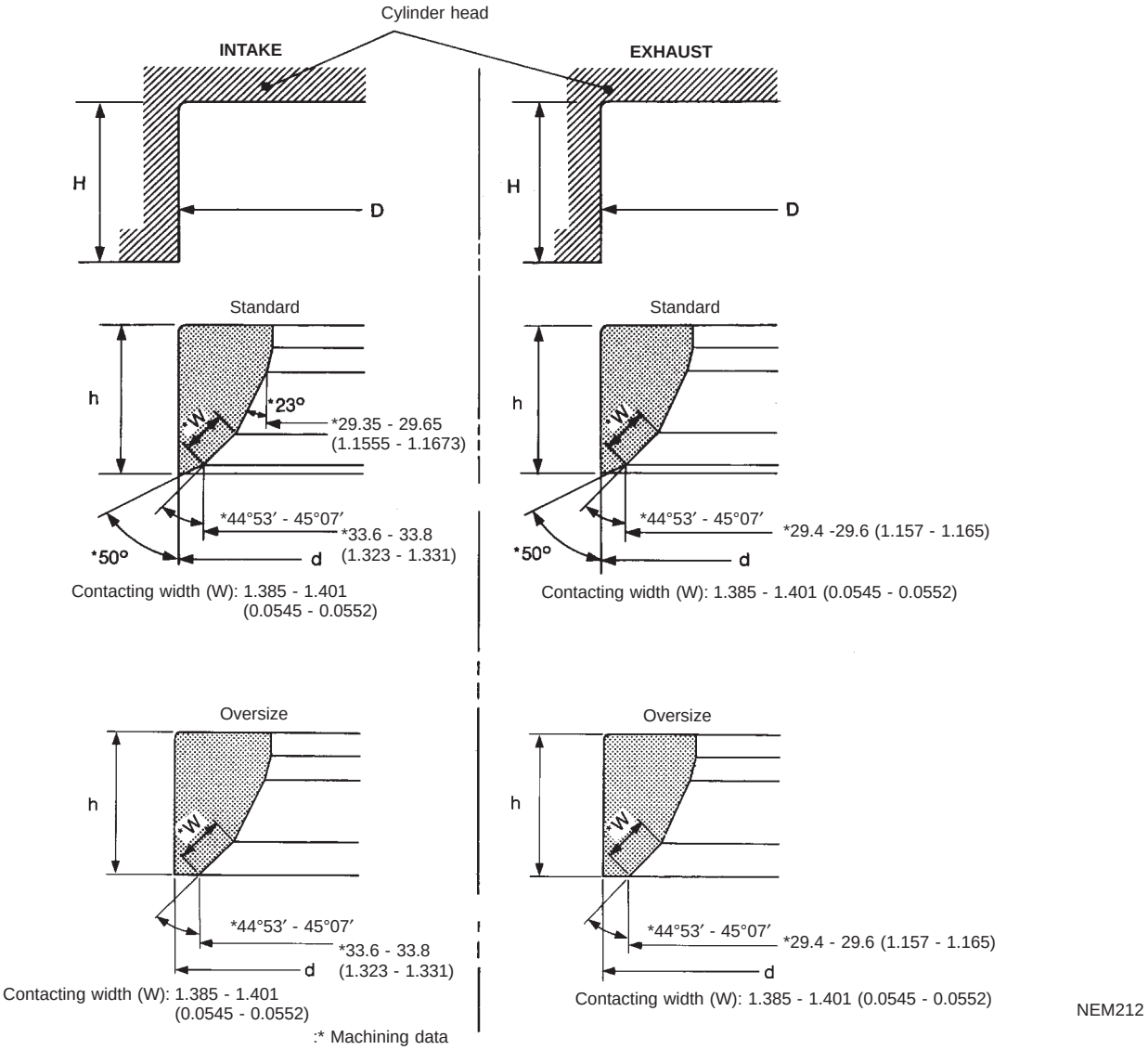


NEM032

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

Valve seat
SR20DE engine

Unit: mm (in)

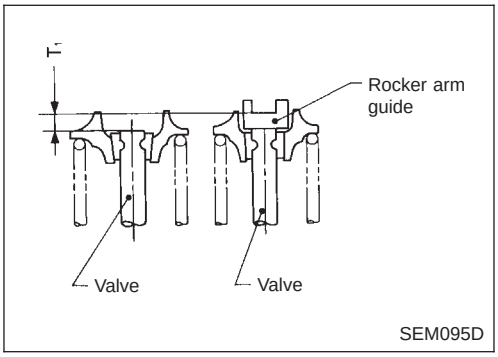


		Standard	Service
Cylinder head seat recess diameter (D)	In.	35.000 - 35.016 (1.3780 - 1.3786)	35.500 - 35.516 (1.3976 - 1.3983)
	Ex.	31.000 - 31.016 (1.2205 - 1.2211)	31.500 - 31.516 (1.2402 - 1.2408)
Valve seat interference fit	In.	0.064 - 0.096 (0.0025 - 0.0038)	
	Ex.	0.064 - 0.096 (0.0025 - 0.0038)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

Valve clearance adjustment

Unit: mm (in)

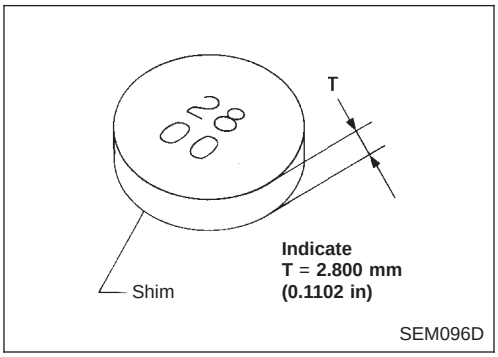
Valve clearance	
Intake	0 (0)
Exhaust	0 (0)
Valve clearance "T"	T_1±0.025 (0.001)



SEM095D

Available shim

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

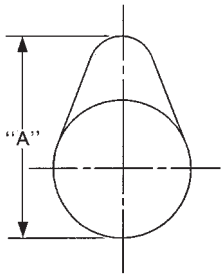


SEM096D

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

	Standard	Limit
Camshaft journal to bearing clearance	0.030 - 0.071 (0.0012 - 0.0028)	0.15 (0.0059)
Inner diameter of camshaft bearing	28.000 - 28.021 (1.1024 - 1.1032)	—
Outer diameter of camshaft journal	27.950 - 27.970 (1.1004 - 1.1012)	—
Camshaft runout [TIR*]	Less than 0.02 (0.0008)	0.1 (0.004)
Camshaft sprocket runout [TIR*]	Less than 0.25 (0.0098)	—
Camshaft end play	0.055 - 0.139 (0.0022 - 0.0055)	0.20 (0.0079)



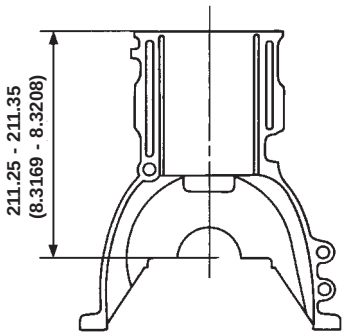
EM671

	SR20DE
Cam height "A"	
Intake	37.775 (1.4872)
Exhaust	37.404 (1.4726)
Cam wear limit	0.2 (0.008)

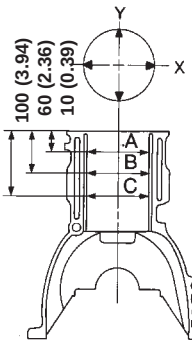
*Total indicator reading

CYLINDER BLOCK

Unit: mm (in)



SEM008D



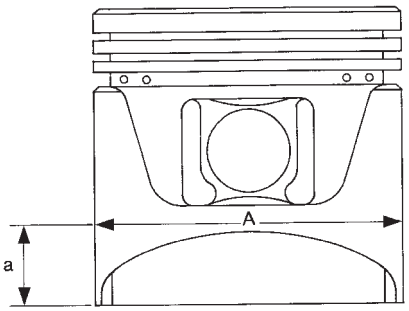
SEM010D

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

PISTON, PISTON RING AND PISTON PIN

Available piston

Unit: mm (in)



SEM750C

Piston skirt diameter "A"	
Standard	
Grade No. 1	85.980 - 85.990 (3.3850 - 3.3854)
Grade No. 2	85.990 - 86.000 (3.3854 - 3.3858)
Grade No. 3	86.000 - 86.010 (3.3858 - 3.3862)
0.20 (0.0079) oversize (Service)	86.180 - 86.210 (3.3929 - 3.3941)
"a" dimension	13.1 (0.5157)
Piston clearance to cylinder block	0.010 - 0.030 (0.0004 - 0.0012)
Piston pin hole diameter	21.993 - 22.005 (0.8659 - 0.8663)

Piston ring

Unit: mm (in)

Side clearance	
Top	
Standard	0.045 - 0.080 (0.0018 - 0.0031)
Limit	0.2 (0.008)
2nd	
Standard	0.030 - 0.070 (0.0012 - 0.0028)
Limit	0.2 (0.008)
Oil ring	0.065 - 0.135 (0.0026 - 0.0053)
Ring gap	
Top	
Standard	0.20 - 0.30 (0.0079 - 0.0118)
Limit	1.0 (0.039)
2nd	
Standard	0.35 - 0.50 (0.0138 - 0.0197)
Limit	1.0 (0.039)
Oil	
Standard	0.20 - 0.60 (0.0079 - 0.0236)
Limit	1.0 (0.039)

Piston pin

Unit: mm (in)

Piston pin outer diameter	21.989 - 22.001 (0.8657 - 0.8662)
Interference fit of piston pin to piston	0.002 - 0.006 (0.0001 - 0.0002)
Piston pin to connecting rod bushing clearance	
Standard	0.005 - 0.017 (0.0002 - 0.0007)
Limit	0.023 (0.0009)

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

CONNECTING ROD

Unit: mm (in)

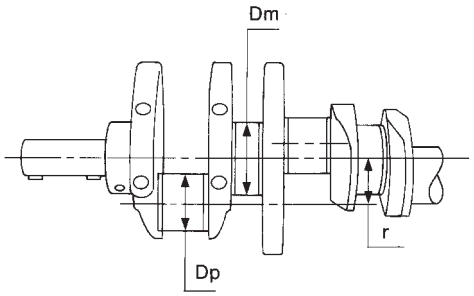
Center distance	136.30 (5.3661)
Bend, torsion [per 100 (3.94)]	
Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	
Limit	0.3 (0.0012)
Connecting rod small end inner diameter	24.980 - 25.000 (0.9835 - 0.9843)
Piston pin bushing inner diameter*	22.000 - 22.012 (0.8661 - 0.8666)
Connecting rod big end inner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

* After installing in connecting rod

CRANKSHAFT

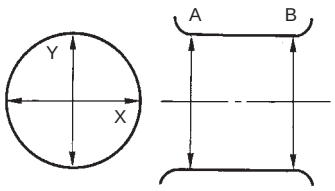
Unit: mm (in)

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



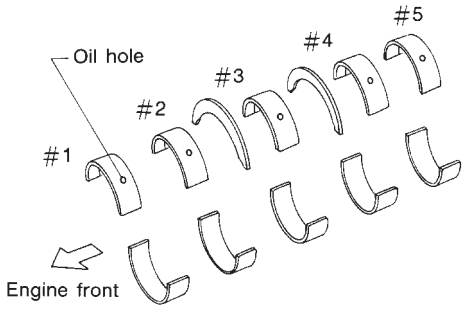
SEM954C

Out-of-round X - Y
Taper A - B



EM715

AVAILABLE MAIN BEARING



SEM021D

Main bearing (Standard)

Unit: mm (in)

Grade number	Thickness "T"	Width "W"	Identification color (mark)
0	1.977 - 1.980 (0.0778 - 0.0780)	18.9 - 19.1 (0.744 - 0.752)	Black (A)
1	1.980 - 1.983 (0.0780 - 0.0781)		Red (B)
2	1.983 - 1.986 (0.0781 - 0.0782)		Green (C)
3	1.986 - 1.989 (0.0782 - 0.0783)		Yellow (D)
4	1.989 - 1.992 (0.0783 - 0.0784)		Blue (E)
5	1.992 - 1.995 (0.0784 - 0.0785)		Pink (F)
6	1.995 - 1.998 (0.0785 - 0.0787)		White (G)

Main bearing (Undersize)

Unit: mm (in)

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

AVAILABLE CONNECTING ROD BEARING

Connecting rod bearing

Standard size

Unit: mm (in)

Grade number	Thickness "T"	Width "W"	Identification color (mark)
0	1.500 - 1.503 (0.0591 - 0.0592)	16.9 - 17.1 (0.665 - 0.673)	Black or Yellow
1	1.503 - 1.506 (0.0592 - 0.0593)		Brown or Red
2	1.506 - 1.509 (0.0593 - 0.0594)		Green or Blue

Undersize

Unit: mm (in)

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

Bearing clearance

Unit: mm (in)

Main bearing clearance	
Standard	0.004 - 0.022 (0.0002 - 0.0009)
Limit	0.05 (0.0020)
Connecting rod bearing clearance	
Standard	0.020 - 0.045 (0.0008 - 0.0018)
Limit	0.065 (0.00256)

MISCELLANEOUS COMPONENTS

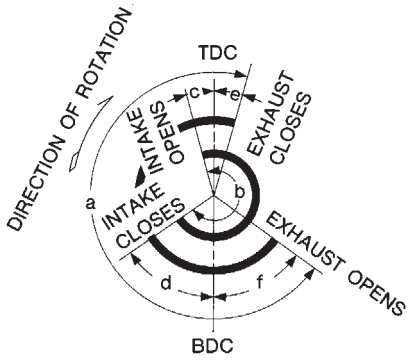
Unit: mm (in)

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

General Specifications

Cylinder arrangement		In-line 4
Displacement	cm^3 (cu in)	1,974 (120.45)
Bore and stroke	mm (in)	84.5 × 88.0 (3.329 × 3.465)
Valve arrangement		OHC
Firing order		1-3-4-2
Number of piston rings		
Compression		2
Oil		1
Number of main bearing		5
Compression ratio		22.2

Valve timing



EM120

Unit: degree

a	b	c	d	e	f
248°	232°	14°	38°	12°	56°

Inspection and Adjustment

COMPRESSION PRESSURE

Unit: kPa (bar, kg/cm^2, psi) at 200 rpm

Standard	3,138 (31.4, 32, 455)
Limit	2,452 (24.5, 25, 356)
Difference limit between cylinders	490 (4.9, 5, 71)

CYLINDER HEAD

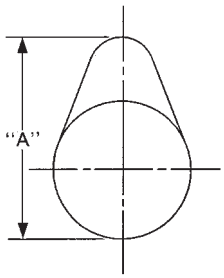
Unit: mm (in)

Head surface flatness	
Standard	Less than 0.03 (0.0012)
Limit	0.1 (0.004)
Nominal cylinder head height	137.9 - 138.1 (5.429 - 5.437)

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

	Standard	Max. tolerance
Camshaft journal clearance	0.045 - 0.086 (0.0018 - 0.0034)	0.1 (0.004)
Inner diameter of camshaft bearing	30.000 - 30.021 (1.1811 - 1.1819)	—
Outer diameter of camshaft journal	29.935 - 29.955 (1.1785 - 1.1793)	—
Camshaft runout	Less than 0.02 (0.0008)	0.05 (0.0020)
Camshaft end play	0.115 - 0.188 (0.0045 - 0.0074)	—

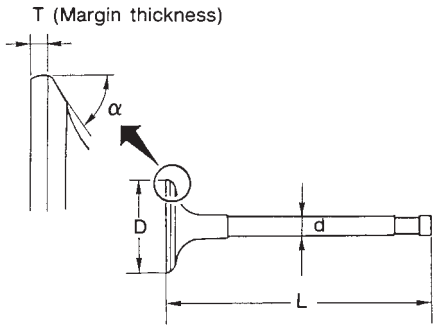


EM671

Cam height "A"	
Intake	48.70 - 48.75 (1.9173 - 1.9193)
Exhaust	49.15 - 49.20 (1.9350 - 1.9370)

VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	
Intake	39.0 - 39.3 (1.535 - 1.547)
Exhaust	32.0 - 32.3 (1.260 - 1.272)
Valve length "L"	
Intake	99.53 - 99.97 (3.9185 - 3.9358)
Exhaust	99.38 - 99.82 (3.9126 - 3.9299)
Valve stem diameter "d"	
Intake	6.965 - 6.980 (0.2742 - 0.2748)
Exhaust	6.945 - 6.960 (0.2734 - 0.2740)
Valve seat angle "α"	45°30′
Valve margin "T" limit	0.5 (0.020)
Valve stem end surface grinding limit	0.5 (0.020)

Valve spring

		Inner	Outer
Free height	mm (in)		
	Intake	36.57 (1.4398)	42.25 (1.6634)
	Exhaust	41.27 (1.6248)	49.35 (1.9429)
Pressure			
N (kg, lb) at height	mm (in)		
Standard	Intake	233.21 (23.78, 52.43) at 22.2 (0.874)	437.69 (44.63, 98.41) at 25.7 (1.012)
	Exhaust	233.4 (23.8, 52.5) at 22.2 (0.874)	437.4 (44.6, 98.3) at 25.7 (1.012)
Limit	Intake	208.01 (21.21, 46.77) at 22.2 (0.874)	392.28 (40.00, 88.20) at 25.7 (1.012)
	Exhaust	208.69 (21.28, 46.92) at 22.2 (0.874)	390.42 (39.81, 87.78) at 25.7 (1.012)
Out-of-square	mm (in)		
	Intake	Less than 1.6 (0.063)	Less than 1.8 (0.071)
	Exhaust	Less than 1.8 (0.071)	Less than 2.2 (0.087)

Valve guide

Unit: mm (in)

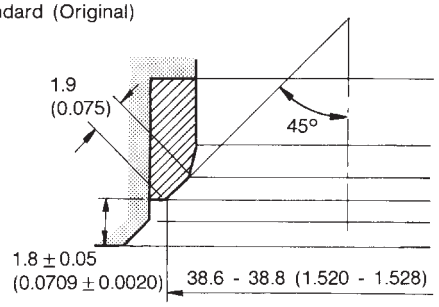
	Standard	Service
Valve guide		
Outer diameter	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
Valve guide		
Inner diameter (Finished size)	7.000 - 7.015 (0.2756 - 0.2762)	
Cylinder head valve guide hole diameter	10.985 - 10.996 (0.4325 - 0.4329)	11.185 - 11.196 (0.4404 - 0.4408)
Interference fit of valve guide	0.027 - 0.049 (0.0011 - 0.0019)	
	Standard	Max. tolerance
Stem to guide clearance		
Intake	0.020 - 0.050 (0.0008 - 0.0020)	0.10 (0.0039)
Exhaust	0.040 - 0.070 (0.0016 - 0.0028)	0.10 (0.0039)
Valve deflection limit		0.1 (0.004)

Valve seat resurfacing

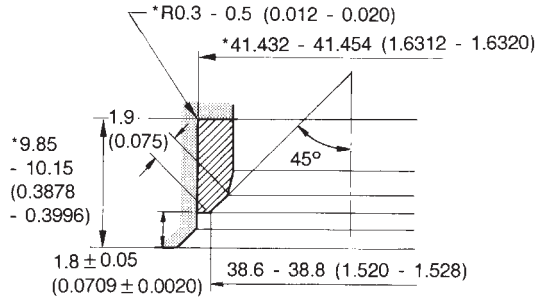
Unit: mm (in)

Intake

Standard (Original)



0.5 (0.020) Oversize

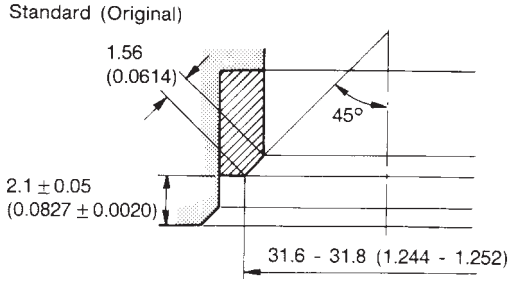


*: Cylinder head machining data

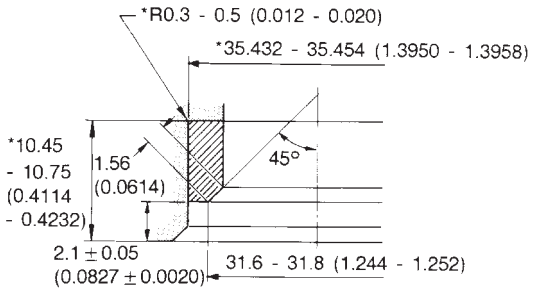
SEM917-B

Exhaust

Standard (Original)



0.5 (0.020) Oversize



*: Cylinder head machining data

SEM113FA

VALVE LIFTER

Unit: mm (in)

Valve lifter outer diameter	
Standard	34.959 - 34.975 (1.3763 - 1.3770)
Cylinder head valve lifter hole diameter	34.998 - 35.018 (1.3779 - 1.3787)
Clearance	
Standard	0.023 - 0.059 (0.0009 - 0.0023)
Limit	0.1 (0.004)

AVAILABLE SHIMS

Thickness mm (in)	Identification mark
2.20 (0.0866)	220
2.25 (0.0886)	225
2.30 (0.0906)	230
2.35 (0.0925)	235
2.40 (0.0945)	240
2.45 (0.0965)	245
2.50 (0.0984)	250
2.55 (0.1004)	255
2.60 (0.1024)	260
2.65 (0.1043)	265
2.70 (0.1063)	270
2.75 (0.1083)	275
2.80 (0.1102)	280
2.85 (0.1122)	285
2.90 (0.1142)	290

VALVE CLEARANCE

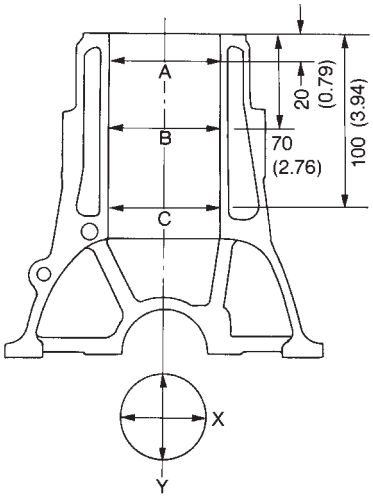
Unit: mm (in)

	For adjusting	
	Hot	Cold* (reference data)
Intake	0.25 - 0.35 (0.010 - 0.014)	0.20 - 0.30 (0.008 - 0.012)
Exhaust	0.39 - 0.49 (0.015 - 0.019)	0.33 - 0.43 (0.013 - 0.017)

*: At a temperature of approximately 20°C (68°F)

CYLINDER BLOCK

Unit: mm (in)



SEM902-A

		Standard	Limit
Surface flatness		Less than 0.03 (0.0012)	0.10 (0.0039)
Cylinder bore	Inner diameter	Grade No. 1 84.500 - 84.510 (3.3268 - 3.3272) Grade No. 2 84.510 - 84.520 (3.3272 - 3.3276) Grade No. 3 84.520 - 84.530 (3.3276 - 3.3279) Grade No. 4 84.530 - 84.540 (3.3279 - 3.3283) Grade No. 5 84.540 - 84.550 (3.3283 - 3.3287)	0.2 (0.008)
	Out-of-round (X − Y)	Less than 0.015 (0.0006)	0.04 (0.0016)
	Taper (A − B)	Less than 0.010 (0.0004)	0.04 (0.0016)
Piston to cylinder clearance		0.030 - 0.050 (0.0012 - 0.0020)	—
Main journal inner diameter		Grade No. 0 56.654 - 56.663 (2.2305 - 2.2308) Grade No. 1 56.663 - 56.672 (2.2308 - 2.2312) Grade No. 2 56.672 - 56.680 (2.2312 - 2.2315)	—

PISTON, PISTON RING AND PISTON PIN

Piston

Unit: mm (in)

Piston skirt diameter	Standard	Grade No. 1	84.460 - 84.470 (3.3252 - 3.3256)
		Grade No. 2	84.470 - 84.480 (3.3256 - 3.3260)
		Grade No. 3	84.480 - 84.490 (3.3260 - 3.3264)
		Grade No. 4	84.490 - 84.500 (3.3264 - 3.3268)
		Grade No. 5	84.500 - 84.510 (3.3268 - 3.3272)
	Oversize	0.25 (0.0098)	84.710 - 84.760 (3.3350 - 3.3370)
		0.5 (0.020)	84.960 - 85.010 (3.3449 - 3.3468)
Measure position (From Top)			62 (2.44)
Piston pin hole diameter			27.991 - 27.999 (1.1020 - 1.1023)

Piston ring

Unit: mm (in)

Side clearance			
	Top		
		Standard	0.020 - 0.040 (0.0008 - 0.0016)
		Limit	0.10 (0.0039)
	2nd		
		Standard	0.050 - 0.085 (0.0020 - 0.0033)
		Limit	0.10 (0.0039)
	Oil		
		Standard	0.030 - 0.070 (0.0012 - 0.0028)
End gap			
	Top		
		Standard	
		Bore grade 1, 2, 3	0.22 - 0.32 (0.0087 - 0.0126)
		Bore grade 4, 5	0.12 - 0.22 (0.0047 - 0.0087)
		Limit	1.0 (0.039)
	2nd		
		Standard	0.38 - 0.53 (0.0150 - 0.0209)
		Limit	0.7 (0.028)
	Oil		
		Standard	0.30 - 0.55 (0.0118 - 0.0217)
		Limit	0.6 (0.024)

Piston pin

Unit: mm (in)

Piston pin outer diameter	27.994 - 28.000 (1.1021 - 1.1024)
Interference fit of piston pin to piston	−0.004 to 0 (−0.0002 to 0)
Piston pin to connecting rod clearance	0.025 - 0.044 (0.0010 - 0.0017)

CONNECTING ROD

Unit: mm (in)

Bend [per 100 mm (3.94 in)]	
Standard	Less than 0.025 (0.0010)
Torsion	
Standard	Less than 0.025 (0.0010)
Piston pin bore dia.	28.025 - 28.038 (1.1033 - 1.1039)
Big end play	
Limit	0.3 (0.012)

CRANKSHAFT

Unit: mm (in)

Main journal dia.	Grade No. 0 52.967 - 52.975 (2.0853 - 2.0856) Grade No. 1 52.959 - 52.967 (2.0850 - 2.0853) Grade No. 2 52.951 - 52.959 (2.0847 - 2.0850)
Pin journal dia.	Grade No. 0 49.968 - 49.974 (1.9672 - 1.9675) Grade No. 1 49.961 - 49.968 (1.9670 - 1.9672) Grade No. 2 49.954 - 49.961 (1.9667 - 1.9670)
Out-of-round (X − Y) and taper (A − B)	
Standard	Less than 0.005 (0.0002)
Runout	
Standard	Less than 0.05 (0.0020)
Free end play	
Standard	0.05 - 0.18 (0.0020 - 0.0071)
Limit	0.3 (0.012)

AVAILABLE MAIN BEARINGS

No. 1, No. 2, No. 4 and No. 5 main bearings

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color
0	1.816 - 1.820 (0.0715 - 0.0717)	20.0 (0.787) 17.8 (0.701)*	Yellow
1	1.820 - 1.824 (0.0717 - 0.0718)		Green
2	1.824 - 1.828 (0.0718 - 0.0720)		Brown
3	1.828 - 1.832 (0.0720 - 0.0721)		Black
4	1.832 - 1.836 (0.0721 - 0.0723)		Blue

*: Contacting width

No. 3 main bearings

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color
0	1.816 - 1.820 (0.0715 - 0.0717)	27.95 (1.1004) 21.35 (0.8405)*	Yellow
1	1.820 - 1.824 (0.0717 - 0.0718)		Green
2	1.824 - 1.828 (0.0718 - 0.0720)		Brown
3	1.828 - 1.832 (0.0720 - 0.0721)		Black
4	1.832 - 1.836 (0.0721 - 0.0723)		Blue

*: Contacting width

Main bearing undersize

Unit: mm (in)

	Crank journal diameter
STD	52.951 - 52.975 (2.0847 - 2.0856)
0.25 (0.0098) undersize	52.701 - 52.725 (2.0748 - 2.0758)

Connecting rod bearing undersize

Unit: mm (in)

			Crank pin diameter
STD	Grade 0	Black	49.968 - 49.974 (1.9672 - 1.9675)
	Grade 1	Yellow	49.961 - 49.968 (1.9670 - 1.9672)
	Grade 2	Blue	49.954 - 49.961 (1.9667 - 1.9670)
0.08 (0.0031) undersize			49.874 - 49.894* (1.9635 - 1.9643)
0.12 (0.0047) undersize			49.834 - 49.854* (1.9620 - 1.9628)
0.25 (0.0098) undersize			49.704 - 49.724* (1.9568 - 1.9576)

*: Reference value

Bearing clearance

Unit: mm (in)

Main bearing clearance	
Standard	0.039 - 0.065 (0.0015 - 0.0026)
Connecting rod bearing clearance	
Standard	0.031 - 0.055 (0.0012 - 0.0022)

TURBOCHARGER

Unit: mm (in)

Rotor shaft	
Runout [TIR*]	0.056 - 0.127 (0.0022 - 0.0050)
End play	0.013 - 0.097 (0.0005 - 0.0038)

*: Total indicator reading

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Flywheel	
Runout [TIR*]	Less than 0.15 (0.0059)

*: Total indicator reading

NOTE