

ENGINE MECHANICAL

SECTION **EM**

EM

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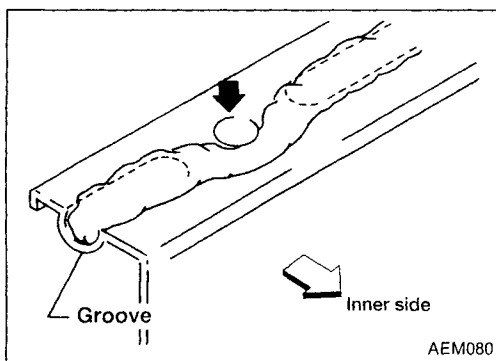
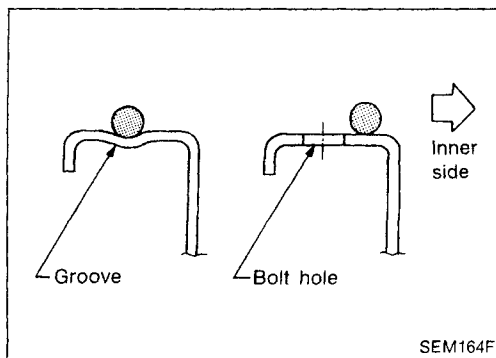
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PRECAUTIONS

Parts Requiring Angular Tightening

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

EM

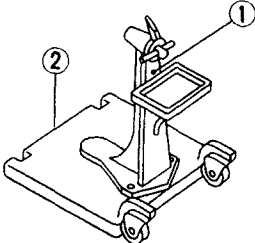
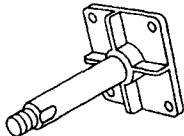
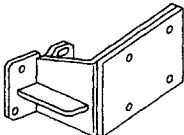
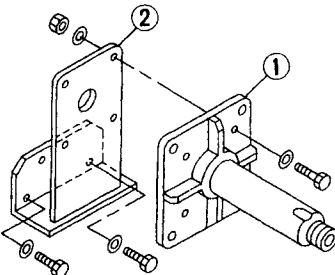
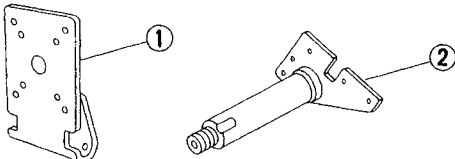
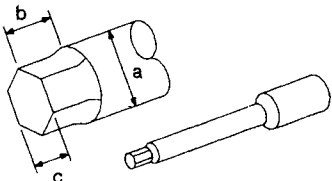


Liquid Gasket Application Procedure

- Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also, completely clean any oil from these areas.
- Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Liquid Gasket or equivalent.)
 - For oil pan, be sure liquid gasket diameter is 4.0 to 5.0 mm (0.157 to 0.197 in) for SR engine. Be sure liquid gasket diameter is 3.5 to 4.5 mm (0.138 to 0.177 in) for GA and CD engine.
 - For areas except oil pan, be sure liquid gasket diameter is 2.0 to 3.0 mm (0.079 to 0.118 in).
- Apply liquid gasket to inner surface around hole perimeter area.
- Assembly should be done within 5 minutes after coating.
- Wait at least 30 minutes before refilling engine oil and engine coolant.

PREPARATION

Special Service Tools

Tool number Tool name	Description	Engine application			
		GA	SR	CD	
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	—
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 KV10106500 Engine stand shaft or 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	—

PREPARATION

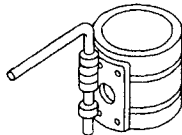
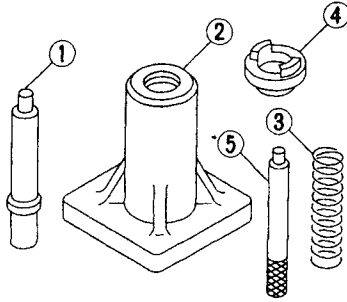
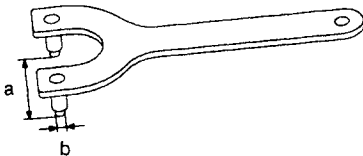
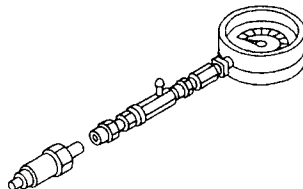
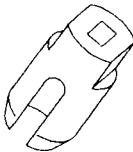
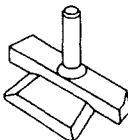
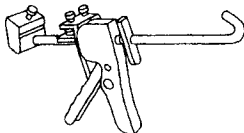
Special Service Tools (Cont'd)

Tool number Tool name	Description	Engine application																	
		GA	SR	CD															
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 <table><tr><td>Side A</td><td>Side B</td></tr><tr><td>a: 20 (0.79)</td><td>20 (0.79)</td></tr><tr><td>b: 13 (0.51)</td><td>14.2 (0.559)</td></tr><tr><td>c: 10.3 (0.406)</td><td>11 (0.43)</td></tr><tr><td>d: 8 (0.31)</td><td>8 (0.31)</td></tr><tr><td>e: 10.7 (0.421)</td><td>10.7 (0.421)</td></tr><tr><td>f: 5 (0.20)</td><td>5 (0.20)</td></tr></table> Unit: mm (in)	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)	X (Side A)	X (Side A)	—
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)																		
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	—	—														

EM

PREPARATION

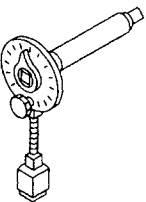
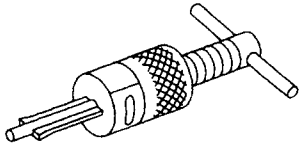
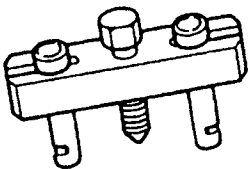
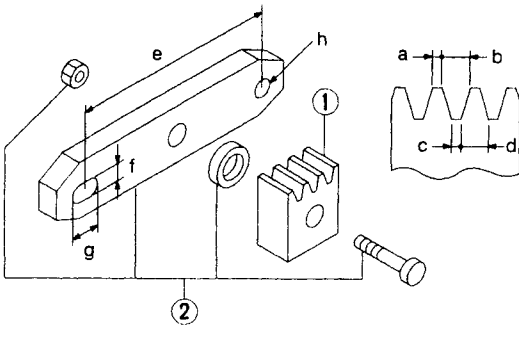
Special Service Tools (Cont'd)

Tool number Tool name	Description	Engine application			
		GA	SR	CD	
EM03470000 Piston ring compressor	 NT044	Installing piston assembly into cylinder bore	X	X	X
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	 NT563	Loosening and tightening injector nozzle	—	—	X
KV10111100 Seal cutter	 NT046	Removing oil pan	X	X	X
WS39930000 Tube presser	 NT052	Pressing the tube of liquid gasket	X	X	X

*: Special tool or commercial equivalent

PREPARATION

Special Service Tools (Cont'd)

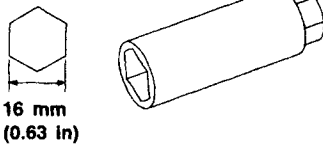
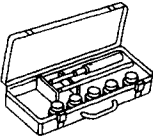
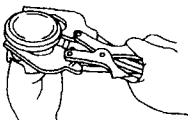
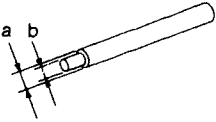
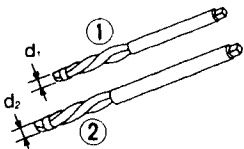
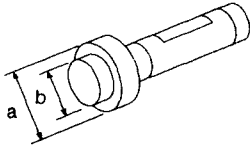
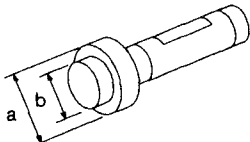
Tool number Tool name	Description		Engine application		
			GA	SR	CD
KV10112100 Angle wrench	 NT014	Tightening bolts for bearing cap, cylinder head, etc.	X	X	X
ST16610001* Pilot bushing puller	 NT045	Removing pilot bushing	—	X	X
KV11102900* Pulley puller	 NT647	Removing injection pump pulley	—	—	X
KV101056S0* Ring gear stopper ① KV10105630 Adapter ② 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

*: Special tool or commercial equivalent

EM

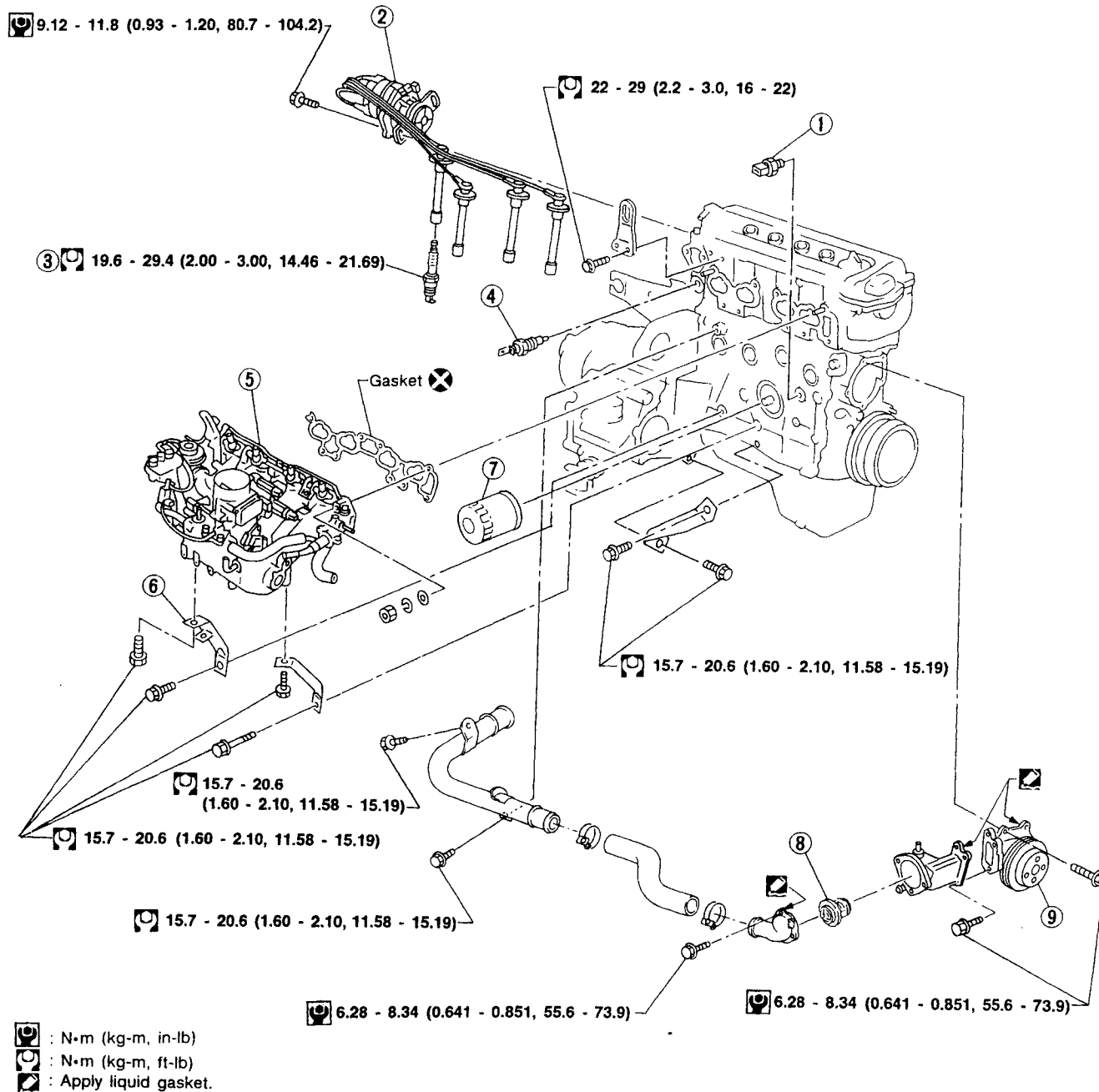
PREPARATION

Commercial Service Tools

Tool name	Description	Engine application		
		GA	SR	CD
Spark plug wrench	 NT047	X	X	—
Valve seat cutter set	 NT048	X	X	X
Piston ring expander	 NT030	X	X	X
Valve guide drift	 NT015	X	X	—
Valve guide reamer	 NT016	X	X	—
Front oil seal drift	 NT049	X	X	—
Rear oil seal drift	 NT049	X	X	—

GA16DE WITHOUT VTC, 14DE AND 15DE

SEC. 140•150•210•211•220•221•253

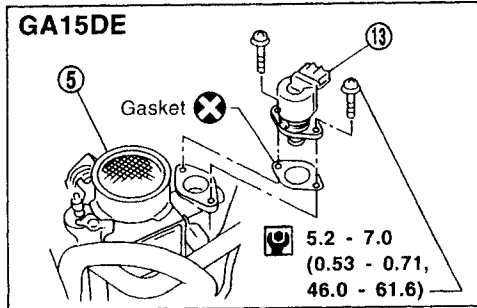


SEM060FA

- | | | |
|-----------------------|----------------------------|--------------|
| ① Oil pressure switch | ④ Thermal transmitter | ⑦ Oil filter |
| ② Distributor | ⑤ Intake manifold | ⑧ Thermostat |
| ③ Spark plug | ⑥ Intake manifold supports | ⑨ Water pump |

GA16DE WITHOUT VTC, 14DE AND 15DE

SEC. 140•147•163•164

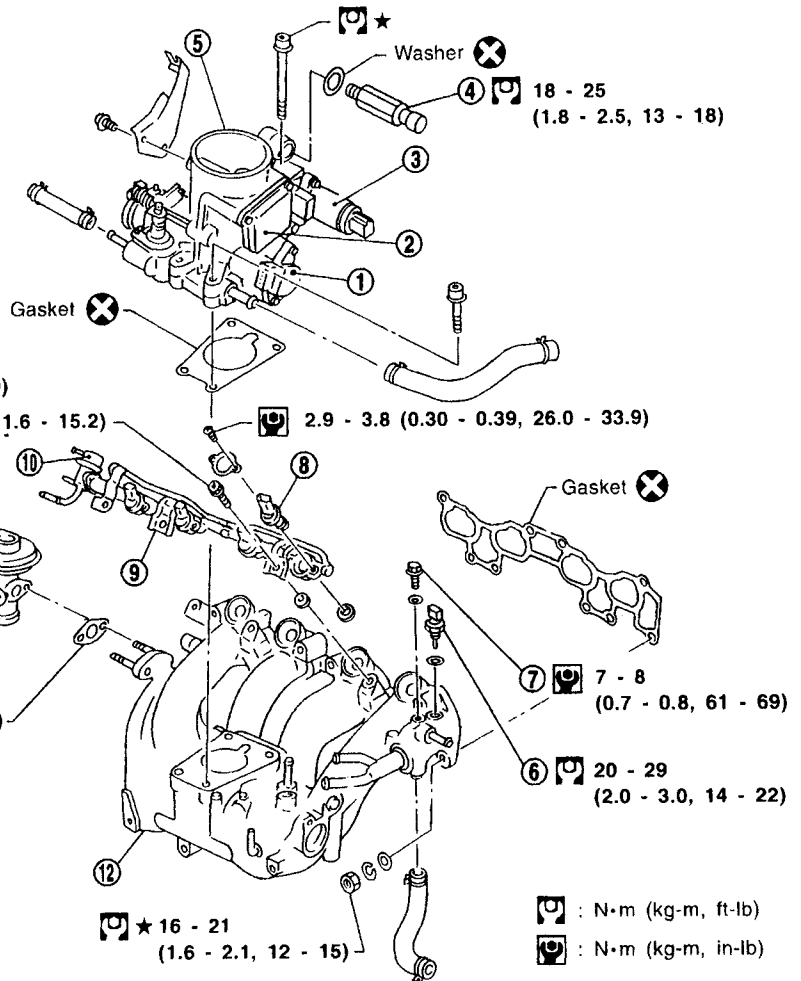


1st. 8 - 11 (0.8 - 1.1, 5.8 - 8.0)

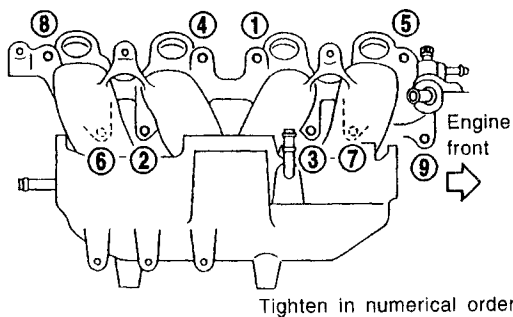
2nd. 15.7 - 20.6 (1.60 - 2.10, 11.6 - 15.2)

16 - 21 (1.6 - 2.1, 12 - 15)

8 - 10 (0.8 - 1.0, 69 - 87)



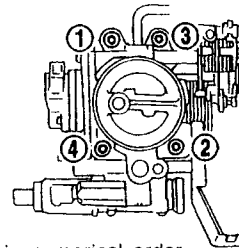
★ Intake manifold bolts and nuts tightening order



★ 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)

Engine front

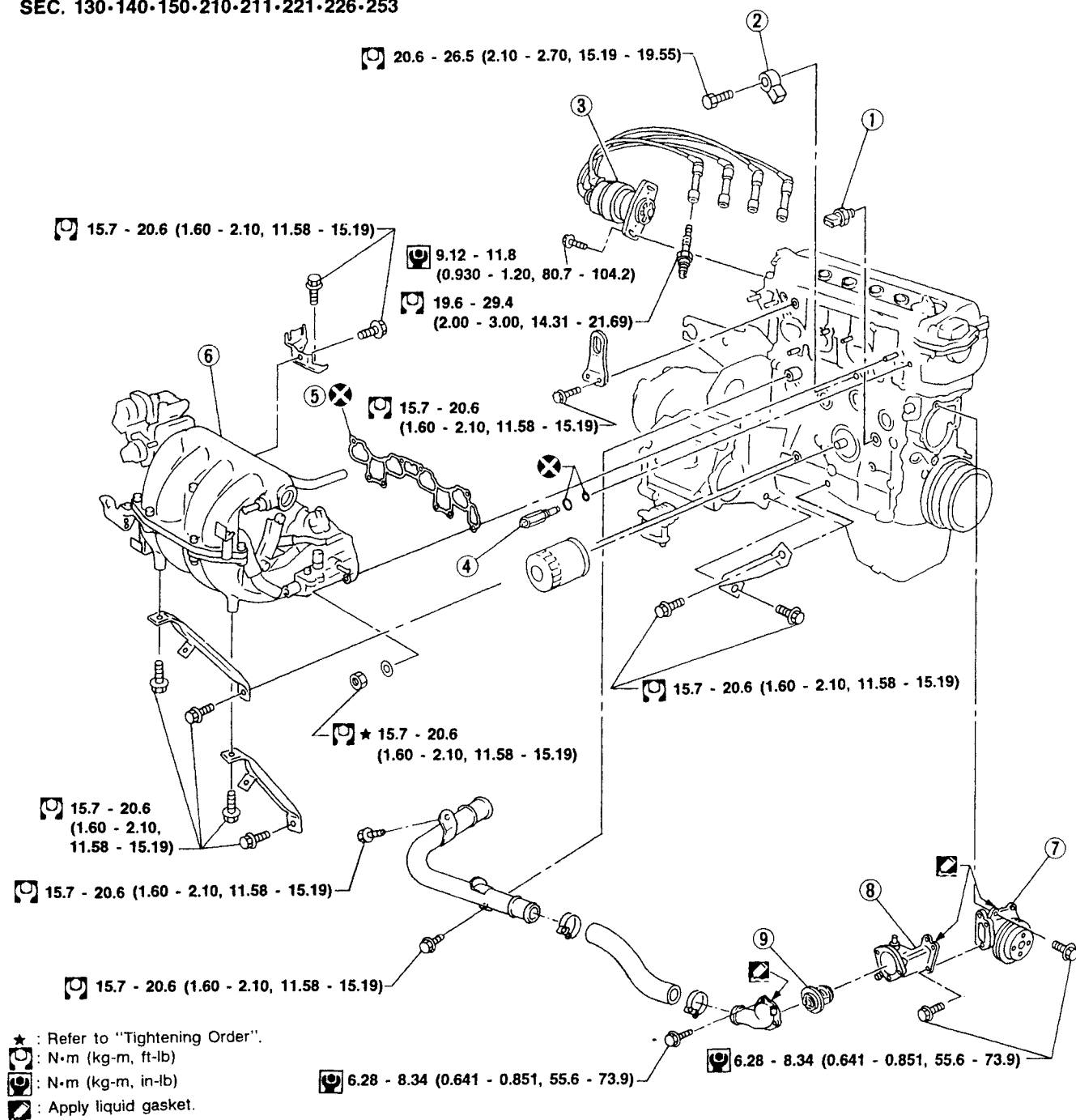


SEM220F

- | | | |
|----------------------------|-------------------------------------|--|
| ① Throttle position sensor | ⑥ Engine coolant temperature sensor | ⑩ Pressure regulator |
| ② Mass air flow sensor | ⑦ Air relief plug | ⑪ EGR valve (GA15DE M/T model only) |
| ③ IACV-AAC valve | ⑧ Injector | ⑫ Intake manifold |
| ④ IACV-FICD solenoid valve | ⑨ Injector tube | ⑬ IACV-AAC valve (GA15DE engine models only) |
| ⑤ Throttle body | | |

GA16DE WITH VTC

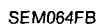
SEC. 130•140•150•210•211•221•226•253



SEM223F

- | | | |
|-----------------------|----------------------------|----------------------|
| ① Oil pressure switch | ④ VTC solenoid valve | ⑦ Water pump |
| ② Knock sensor | ⑤ Intake manifold gasket | ⑧ Thermostat housing |
| ③ Distributor | ⑥ Intake manifold assembly | ⑨ Thermostat |

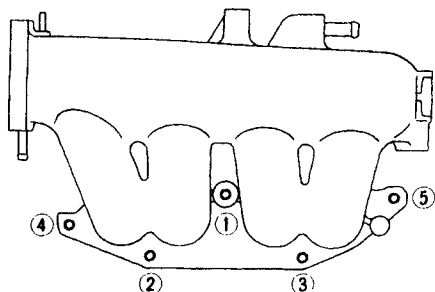
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- EM-12**

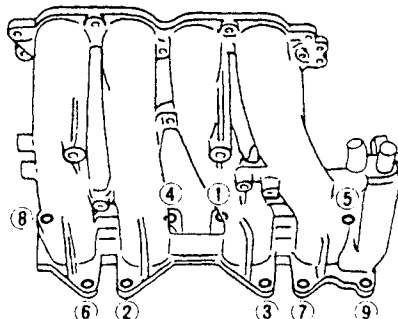
Tightening order

*Intake manifold collector bolts tightening order



Tighten in numerical order.

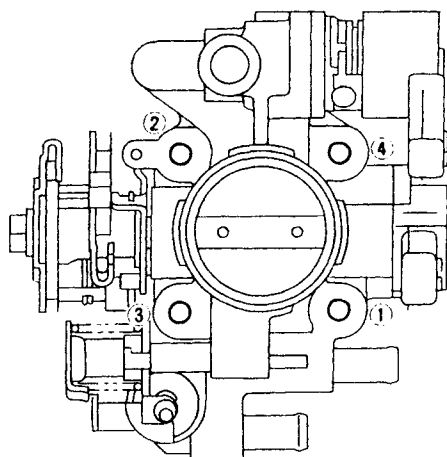
*Intake manifold bolts and nuts tightening order



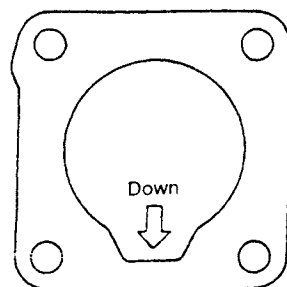
Tighten in numerical order.

*Throttle body bolts tightening procedure

- 1) Tighten all bolts to 8.8 to 10.8 N·m (0.90 to 1.10 kg-m, 6.5 to 8.0 ft-lb)
 - 2) Tighten all bolts to 17.7 to 21.6 N·m (1.81 to 2.20 kg-m, 13.06 to 15.93 ft-lb)
- Make sure the direction of the gasket is as shown in figure.

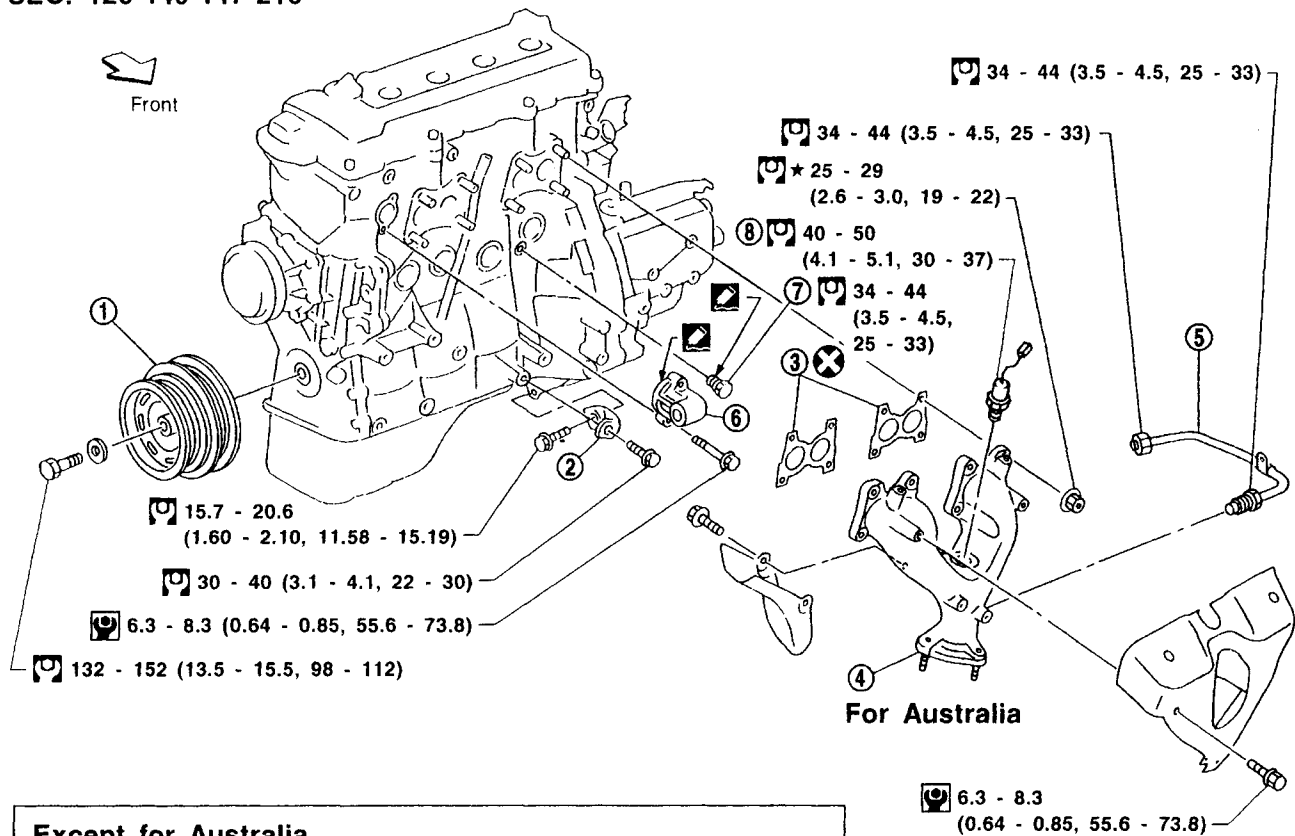


Tighten in numerical order.

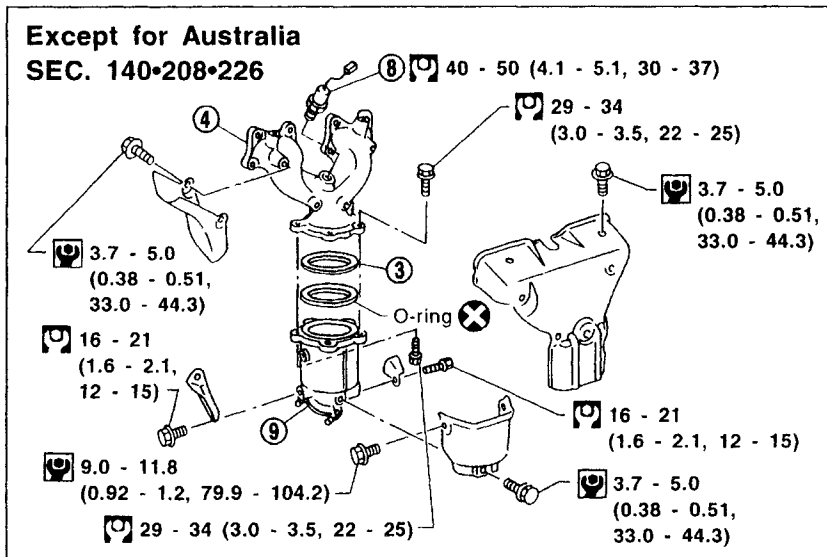


Gasket

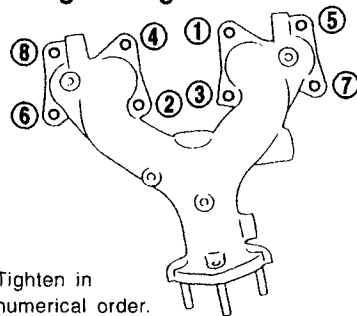
SEC. 120•140•147•210



Except for Australia SEC. 140•208•226



★ Exhaust manifold nuts tightening order



☐ : N·m (kg-m, ft-lb)

☐ : N·m (kg-m, in-lb)

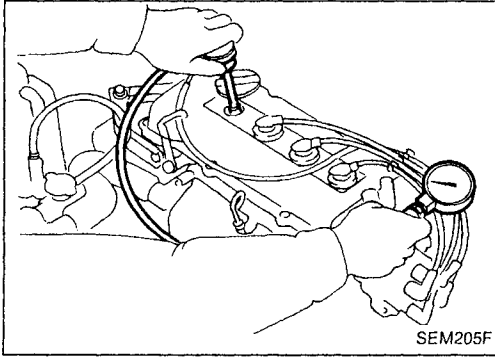
☐ : Apply liquid gasket.

SEM242F

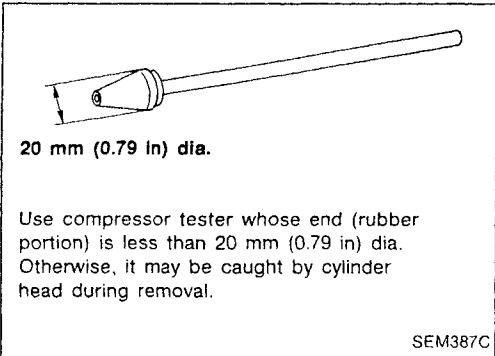
- ① Crankshaft pulley
- ② Gusset
- ③ Gasket
- ④ Exhaust manifold
- ⑤ EGR tube

- ⑥ Water outlet
- ⑦ Water drain plug
- ⑧ ● Heated oxygen sensor
(Australia A/T models and
Europe models)

- Oxygen sensor
(Except Australia A/T models
and Europe models)
- ⑨ Three-way catalyst



SEM205F



SEM387C

Measurement of Compression Pressure

1. Warm up engine.
2. Turn ignition switch off.
3. Cut fuel line.
Release fuel pressure.
Refer to "Releasing Fuel Pressure" in EC section.
4. Remove all spark plugs.
5. Disconnect distributor center cable.
6. Attach a compression tester to No. 1 cylinder.
7. Depress accelerator pedal fully to keep throttle valve wide open.
8. Crank engine and record highest gauge indication.
9. Repeat the measurement on each cylinder as shown above.
- **Always use a fully-charged battery to obtain specified engine revolution.**

Compression pressure:

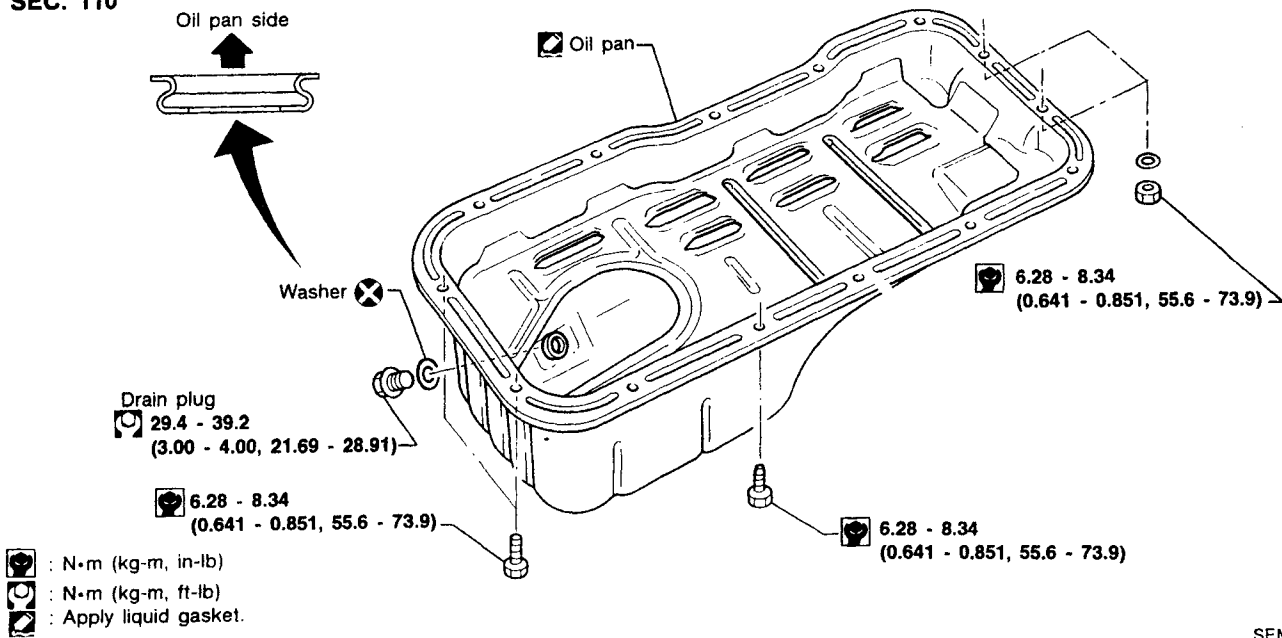
Unit: kPa (bar, kg/cm², psi)/rpm

Compression ratio Refer to SDS (EM-155).	Standard	Minimum	Difference limit between cylinders
9.5	1,324 (13.24, 13.5, 192)/350	1,128 (11.28, 11.5, 164)/350	98 (0.98, 1.0, 14)/350
9.8	1,353 (13.53, 13.8, 196)/350	1,157 (11.57, 11.8, 168)/350	
9.9	1,373 (13.7, 14, 199)/350	1,177 (11.8, 12, 171)/350	

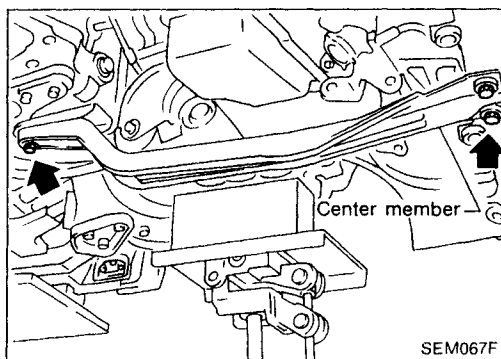
10. If compression in one or more cylinders is low:
 - a. Pour a small amount of engine oil into cylinders through spark plug holes.
 - b. Re-test compression.
- **If adding oil helps compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. Refer to SDS (EM-156, 159). If valve or valve seat is damaged excessively, replace them.**
- **If compression stays low in two cylinder that are next to each other:
The cylinder head gasket may be leaking, or both cylinders may have valve component damage. Inspect and repair as necessary.**

EM

SEC. 110

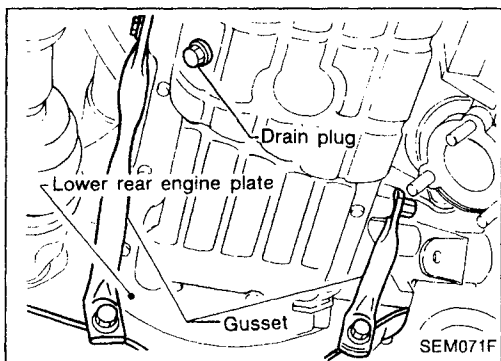


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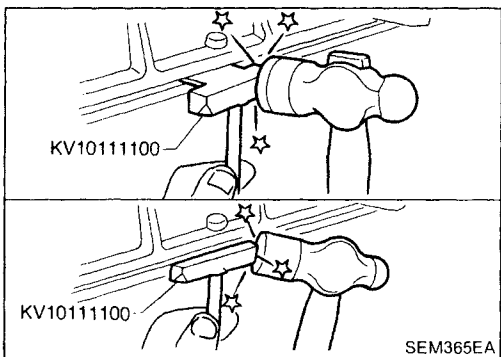


Removal

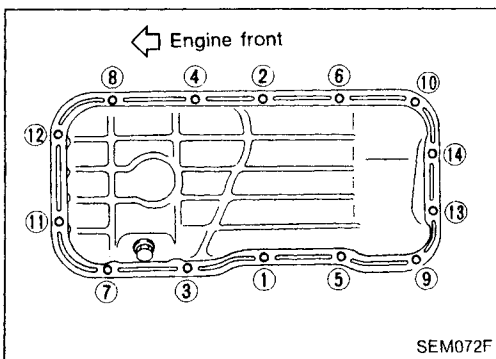
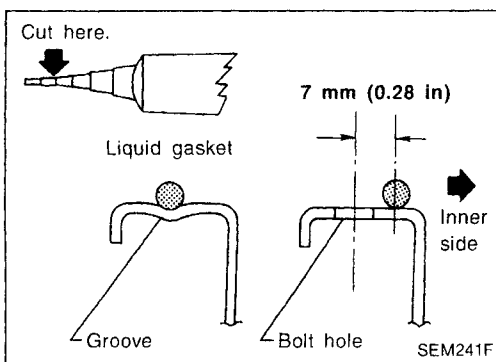
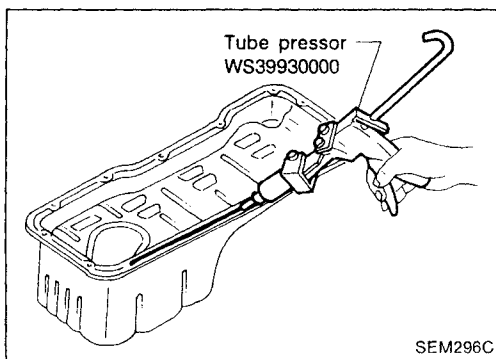
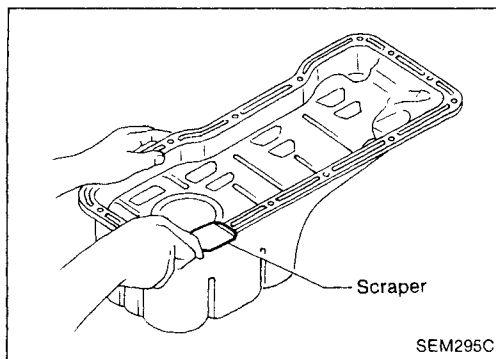
1. Remove undercovers.
2. Drain engine oil.
3. Remove front exhaust tube. Refer to "Exhaust system" in FE section.
4. Remove center member.



5. Remove engine front and rear gussets.
6. Remove engine lower rear plate (A/T models).



7. Remove oil pan.
 - (1) Insert Tool between cylinder block and oil pan.
 - Be careful not to damage aluminum mating face.
 - Do not insert screwdriver, or oil pan flange will be deformed.
 - (2) Slide Tool by tapping its side with a hammer, and remove oil pan.



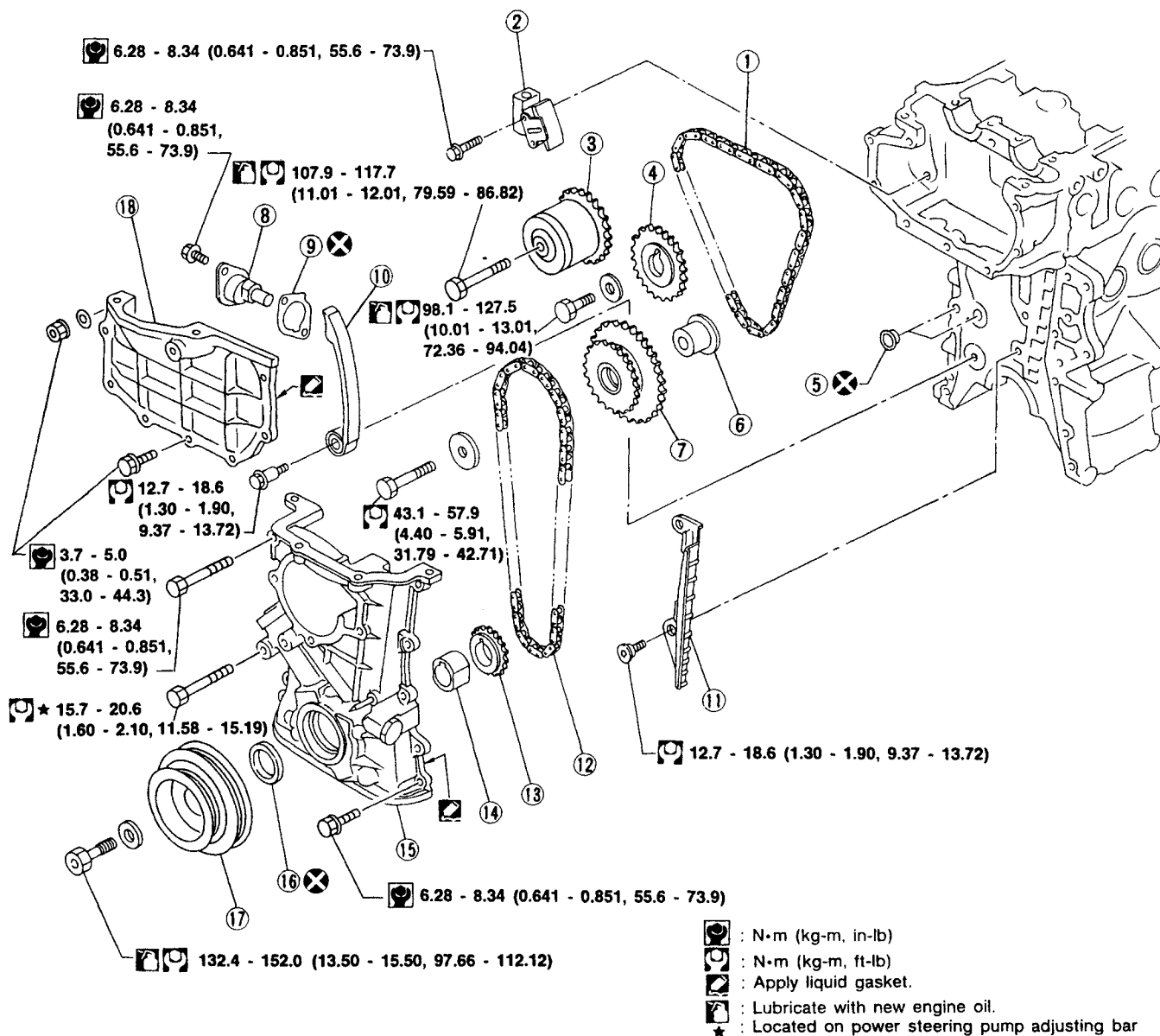
Installation

1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
 - Also remove traces of liquid gasket from mating surface of cylinder block.
2. Apply a continuous bead of liquid gasket to mating surface of oil pan.
 - **Use Genuine Liquid Gasket or equivalent.**
- Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.
- Apply liquid gasket to inner sealing surface as shown in figure.
- Attaching should be done within 5 minutes after coating.
3. Install oil pan.
 - Tighten oil pan bolts in the numerical order.
 - Wait at least 30 minutes before refilling engine oil.
4. Install other removed parts in the reverse order of removal.

EM

WITH VTC

SEC. 111-120-130-135

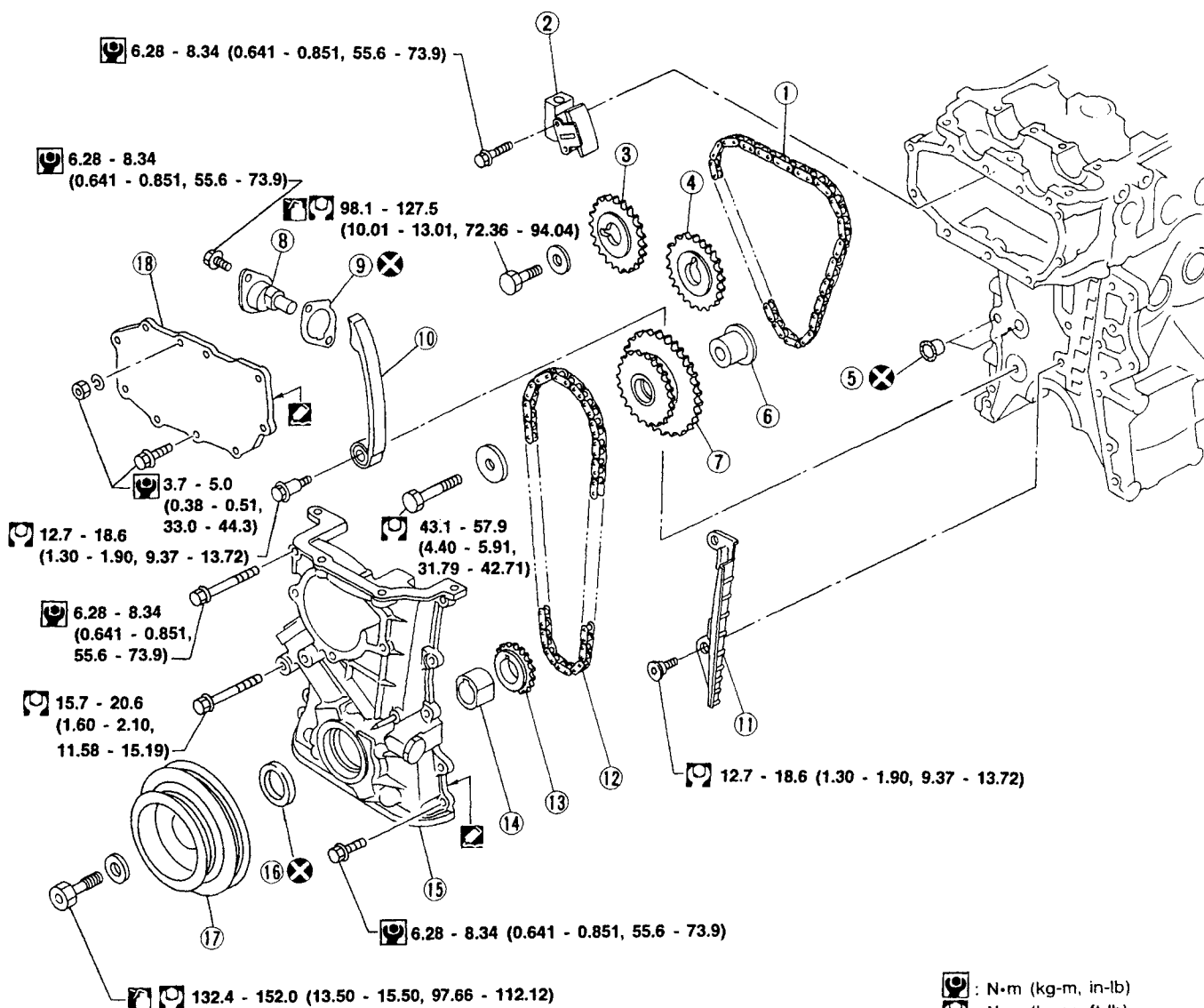


SEM069FB

- | | | |
|----------------------------------|---------------------------------|-----------------------------|
| ① Upper timing chain | ⑦ Idler sprocket | ⑬ Crankshaft sprocket |
| ② Upper timing chain tensioner | ⑧ Lower timing chain tensioner | ⑭ Oil pump drive spacer |
| ③ VTC camshaft sprocket (Intake) | ⑨ Gasket | ⑮ Front cover |
| ④ Camshaft sprocket (Exhaust) | ⑩ Slack side timing chain guide | ⑯ Oil seal |
| ⑤ O-ring | ⑪ Timing chain tension guide | ⑰ Crankshaft pulley |
| ⑥ Idler shaft | ⑫ Lower timing chain | ⑱ Cylinder head front cover |

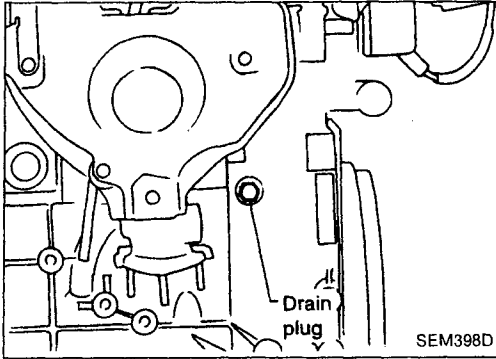
WITHOUT VTC

SEC. 111•120•130•135



SEM068FA

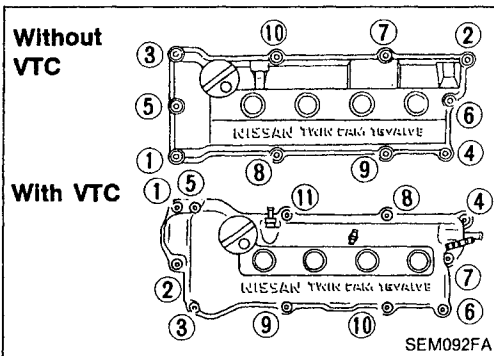
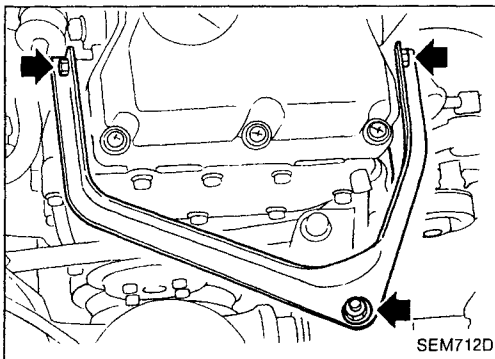
- | | | |
|-------------------------------|---------------------------------|-----------------------------|
| ① Upper timing chain | ⑦ Idler sprocket | ⑬ Crankshaft sprocket |
| ② Upper chain tensioner | ⑧ Lower chain tensioner | ⑭ Oil pump drive spacer |
| ③ Camshaft sprocket (Intake) | ⑨ Gasket | ⑮ Front cover |
| ④ Camshaft sprocket (Exhaust) | ⑩ Slack side timing chain guide | ⑯ Oil seal |
| ⑤ O-ring | ⑪ Timing chain guide | ⑰ Crankshaft pulley |
| ⑥ Idler shaft | ⑫ Lower timing chain | ⑱ Cylinder head front cover |

**CAUTION:**

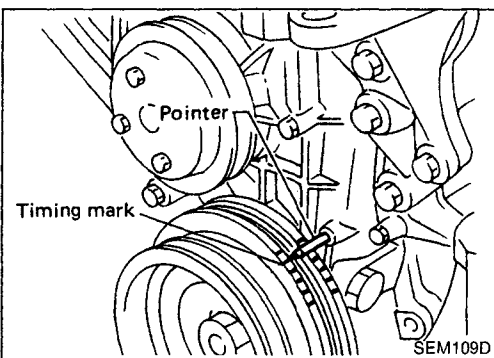
- After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.
- When installing camshafts, chain tensioner, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.
- Apply new engine oil to bolt threads and seat surfaces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

Removal

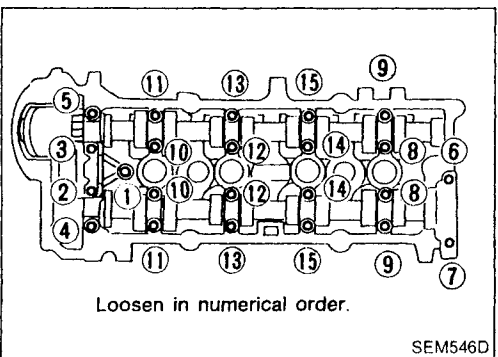
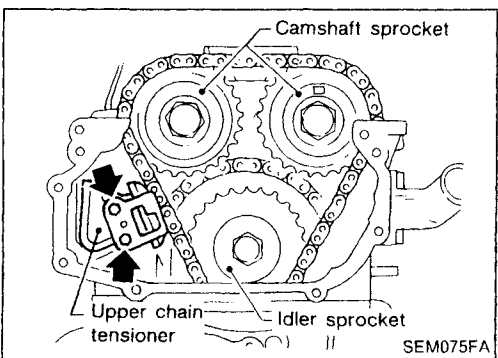
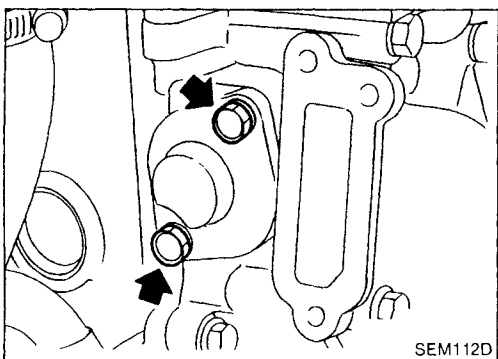
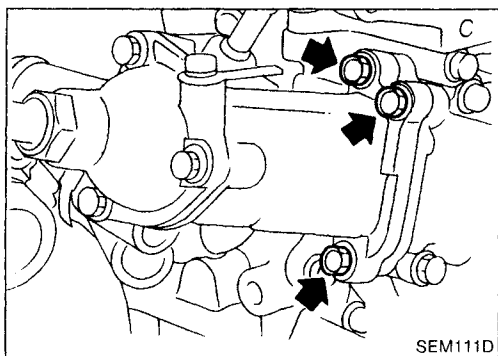
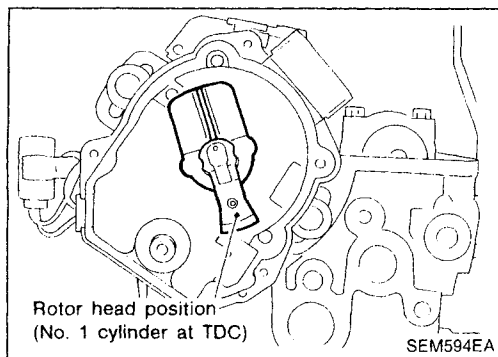
1. Drain engine coolant from radiator and cylinder block. Be careful not to spill coolant on drive belts.
2. Release fuel pressure. Refer to "Releasing Fuel Pressure" in EC section.
3. Remove the following belts.
 - Power steering pump drive belt
 - Alternator drive belt
4. Remove power steering pulley and pump with bracket.
5. Remove air duct to intake manifold collector.
6. Remove front right-side wheel.
7. Remove front right-side splash cover.
8. Remove front undercovers.
9. Remove front exhaust tube.
10. Remove cylinder head front mounting bracket.



11. Remove rocker cover.
12. Remove distributor cap.
13. Remove all spark plugs.
14. Remove intake manifold support.



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



Removal (Cont'd)

- Make sure No. 1 cylinder is at TDC by looking at distributor rotor position.
16. Remove distributor.
 17. Remove cylinder head front cover.
 18. Remove water pump pulley.

19. Remove thermostat housing.

20. Remove lower chain tensioner.

21. Remove upper chain tensioner.
22. Loosen idler sprocket bolt.
23. Remove camshaft sprocket bolts.
24. Remove camshaft sprockets.
25. Remove camshaft brackets and camshafts.
- **These parts should be reassembled in their original positions.**
- **Bolts should be loosened in two or three steps.**
26. Remove idler sprocket bolt.

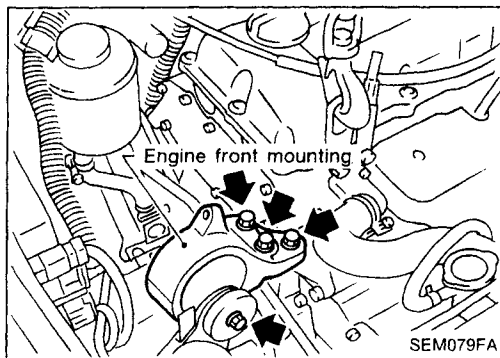
27. Remove cylinder head with manifolds.
- **Head warpage or cracking could result from removing in incorrect order.**
- **Cylinder head bolts should be loosened in two or three steps.**
28. Remove idler sprocket shaft from rear side.
29. Remove upper timing chain.
30. Remove center member.
31. Remove oil pan. Refer to "Removal" in "OIL PAN" (EM-16).
32. Remove oil strainer.
33. Remove crankshaft pulley.
34. Support engine with a suitable hoist or jack.

TIMING CHAIN

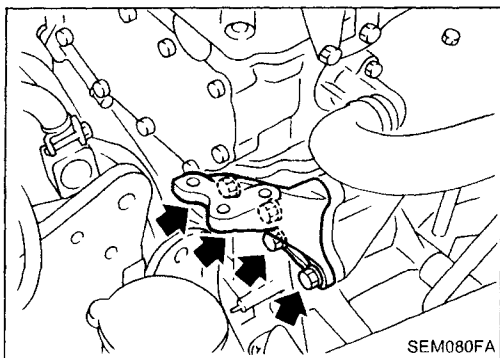
GA

Removal (Cont'd)

35. Remove engine front mounting.



36. Remove engine front mounting bracket.

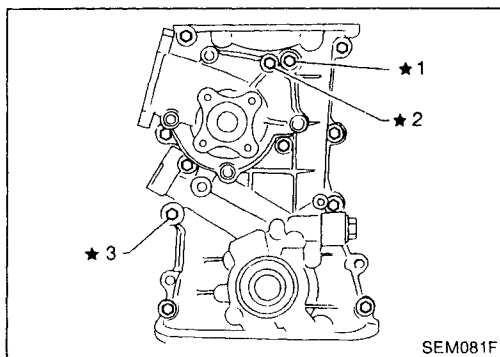


37. Remove front cover bolts and front cover as shown.

★1: Located on engine front mounting bracket

★2: Located on water pump

★3: Located on power steering pump adjusting bar



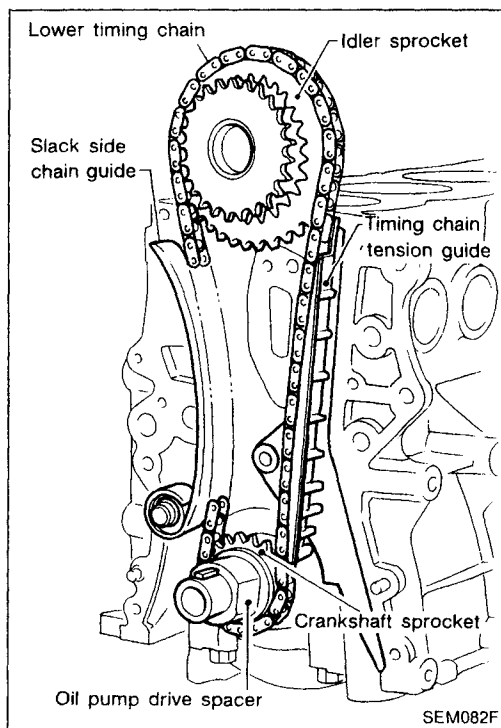
38. Remove idler sprocket.

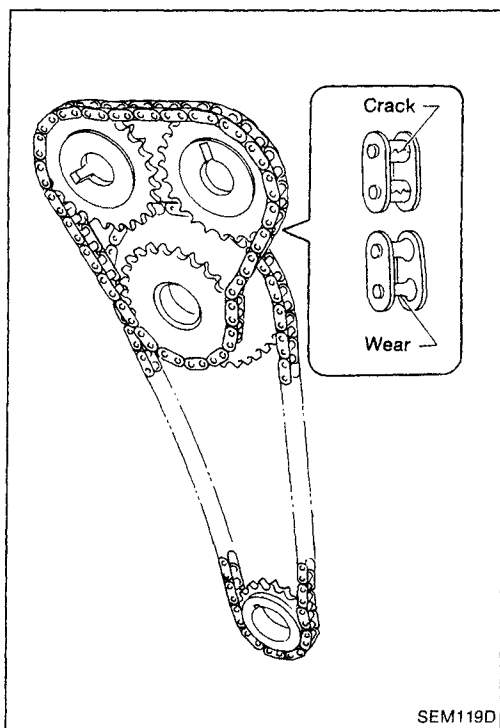
39. Remove lower timing chain.

40. Remove oil pump drive spacer.

41. Remove chain guides.

42. Remove crankshaft sprocket.

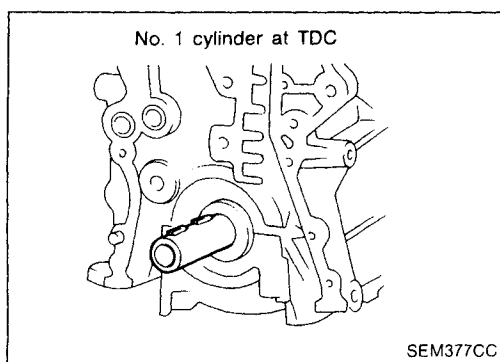




Inspection

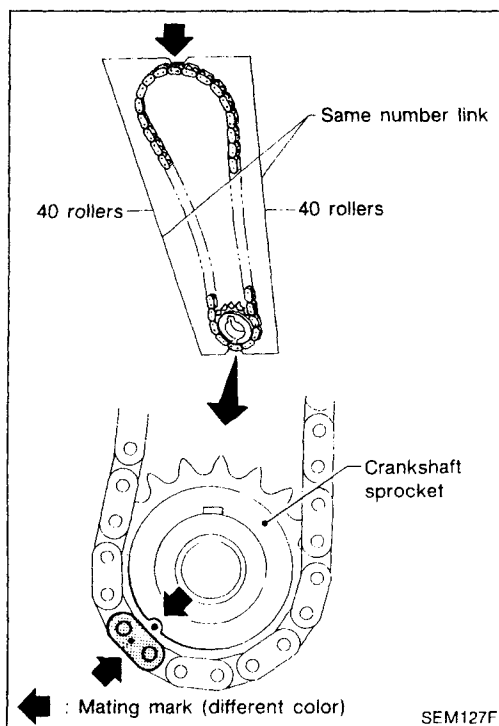
Check for cracks and excessive wear at roller links. Replace if necessary.

EM



Installation

1. Position crankshaft so that No. 1 piston is at TDC and key way is at 12 o'clock.
 - a. Install crankshaft sprocket.
 - **Make sure mating marks on crankshaft sprocket face front of engine.**
 - b. Install oil pump drive spacer.

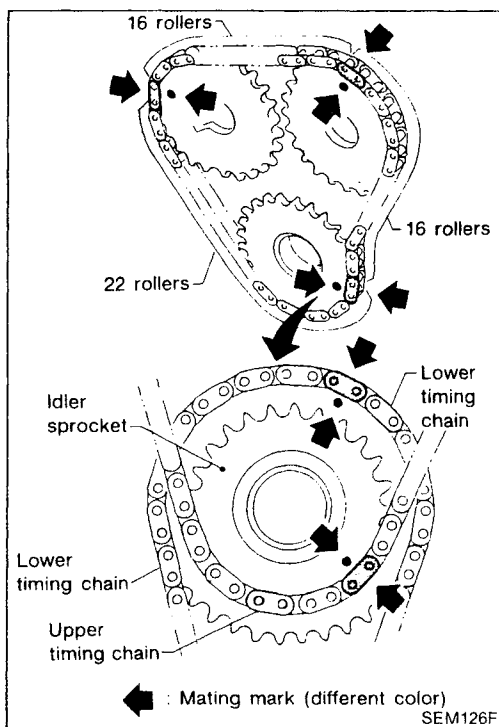
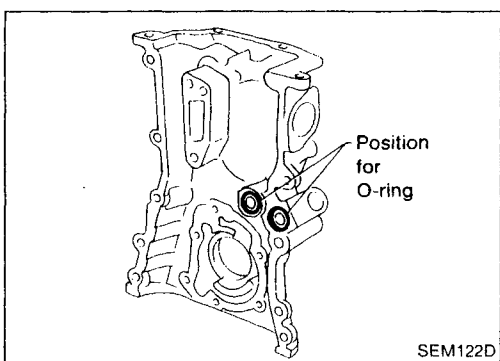
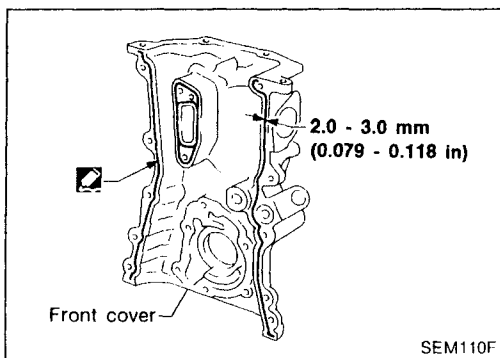
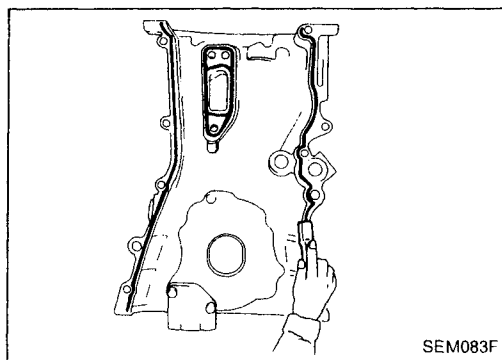


2. Install chain guide.
3. Install crankshaft sprocket and lower timing chain.
 - **Set timing chain by aligning its mating mark with the one on crankshaft sprocket.**
 - **Make sure sprocket's mating mark faces engine front.**
 - **The number of links between alignment marks are the same for the left and right sides. Either side can be used during alignment with the sprocket.**

TIMING CHAIN

GA

Installation (Cont'd)



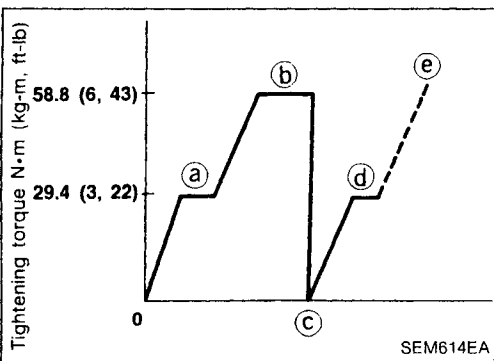
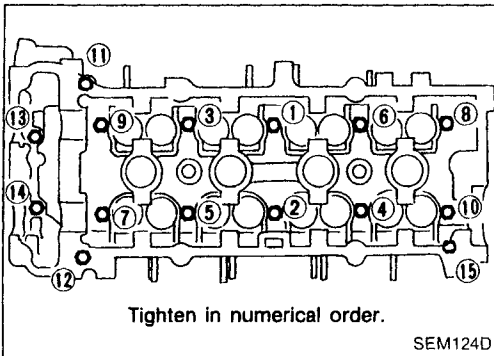
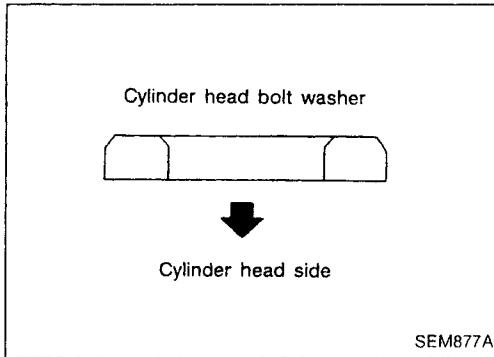
4. Before installing front cover, remove all traces of liquid gasket from mating surface using a scraper.
- Also remove traces of liquid gasket from mating surface of cylinder block.

5. Apply liquid gasket to front cover.
6. Install 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.
- Make sure two O-rings are present.
- Be careful not to damage oil seal when installing front cover.

7. Install engine front mounting bracket and mounting.
8. Install oil strainer.
9. Install oil pan. Refer to "Installation" in "OIL PAN" (EM-16).
10. Install crankshaft pulley.
11. Install center member.

12. Set idler sprocket by aligning the mating mark on the larger sprocket with mating mark on the lower timing chain.
13. Install upper timing chain and set it by aligning mating marks on the smaller sprocket with mating mark on upper timing chain.
- Make sure sprocket's mating mark faces engine front.
14. Install idler sprocket shaft from the rear side.

Installation (Cont'd)



15. Install cylinder head with new gasket.

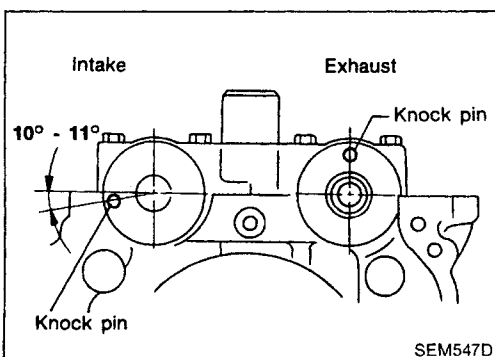
- Be sure to install washers between bolts and cylinder head.
- Do not rotate crankshaft and camshaft separately, or valves will strike piston heads.
- Apply new engine oil to cylinder head bolt threads and seat surfaces.

● Tightening procedure

- a Tighten bolts to 29.4 N·m (3 kg-m, 22 ft-lb).
- b Tighten bolts to 58.8 N·m (6 kg-m, 43 ft-lb).
- c Loosen bolts completely.
- d Tighten bolts to 29.4 N·m (3 kg-m, 22 ft-lb).
- e Turn bolts 50 to 55 degrees clockwise or if angle wrench is not available, tighten bolts to 58.8 ± 4.9 N·m (6 ± 0.5 kg-m, 43.4 ± 3.6 ft-lb).
- f Tighten bolts (11 - 15) to 6.3 to 8.3 N·m (0.64 to 0.85 kg-m, 55.6 to 73.8 in-lb).

	Tightening torque N·m (kg-m, ft-lb)				
	a	b	c	d	e, f
Bolts (1 - 10)	29.4 (3, 22)	58.8 (6, 43)	0 (0, 0)	29.4 (3, 22)	50 - 55 degrees or 58.8 ± 4.9 (6 ± 0.5 , 43.4 ± 3.6 ft-lb)
Bolts (11 - 15)	—	—	—	—	6.3 - 8.3 (0.64 - 0.85, 55.6 - 73.8 in-lb)

16. Install idler sprocket bolt.

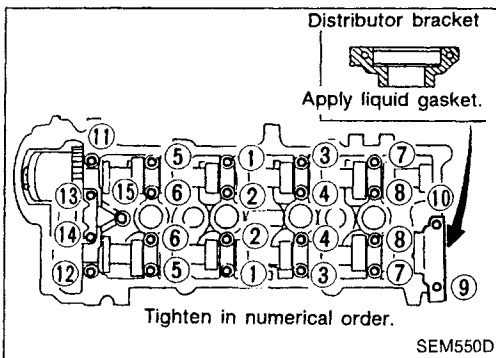
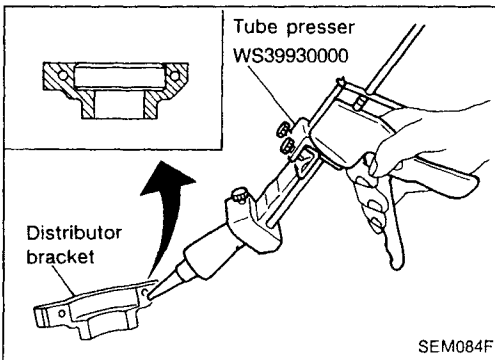
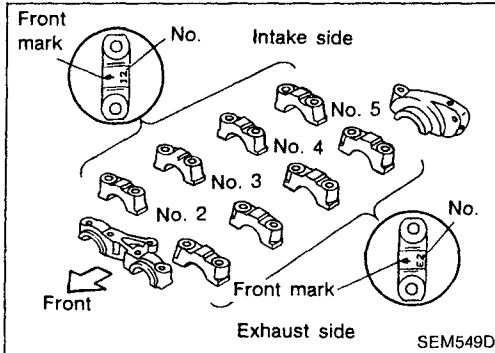
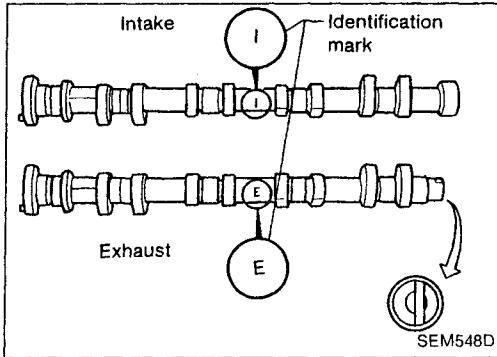


17. Install camshaft.

- Make sure camshafts are aligned as shown in figure.

Installation (Cont'd)

- Identification marks are present on camshafts.



18. Install camshaft brackets and distributor bracket.

- Make sure camshaft brackets are aligned as shown in figure.

- Apply liquid gasket to distributor bracket as shown in the figure.

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

- Tighten camshaft bracket bolts in the following steps.

(Bolt 15 is applied only for GA16DE)

- Tighten bolts 11 - 15, then 1 - 10.

Ⓐ: 2.0 N·m (0.204 kg-m, 17.7 in-lb)

- Tighten bolts 1 - 15.

Ⓑ: 5.9 N·m (0.60 kg-m, 52.1 in-lb)

- Tighten bolts 1 - 14.

Ⓒ: 9.8 - 11.8 N·m (1.00 - 1.20 kg-m, 86.8 - 104.2 in-lb)

Tighten bolt 15.

Ⓓ: 6.3 - 8.3 N·m (0.64 - 0.85 kg-m, 55.6 - 73.8 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-41).

Reference data valve clearance (Cold):

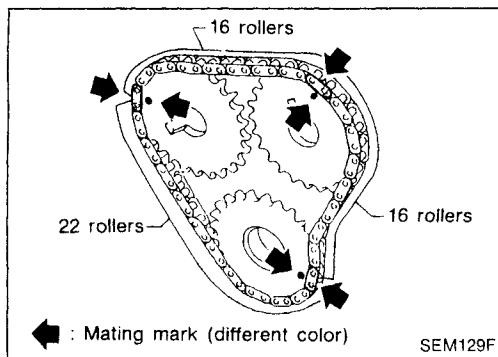
Intake

0.25 - 0.33 mm (0.010 - 0.013 in)

Exhaust

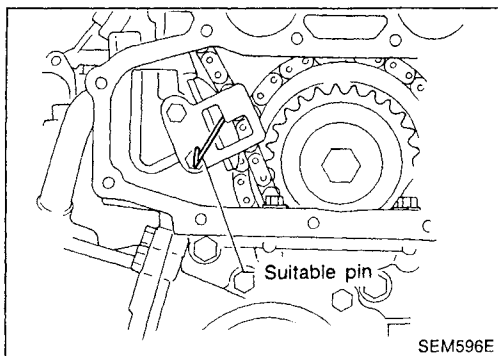
0.32 - 0.40 mm (0.013 - 0.016 in)

Installation (Cont'd)



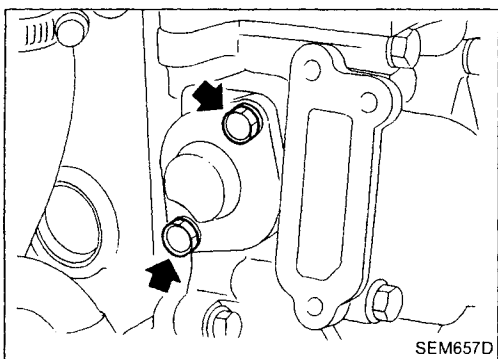
19. Assemble camshaft sprocket with chain.

- Set timing chain by aligning mating marks with those of camshaft sprockets.
 - Make sure sprocket's mating marks face engine front.
20. Install camshaft sprocket bolts.
- Apply new engine oil to bolt threads and seat surface.



21. Install upper chain tensioner.

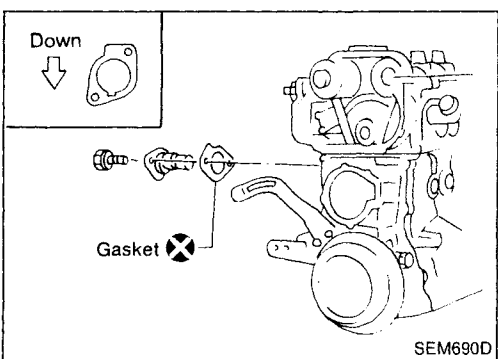
- Before installing chain tensioner, insert a suitable pin into pin hole of chain tensioner.
- After installing chain tensioner, remove the pin.



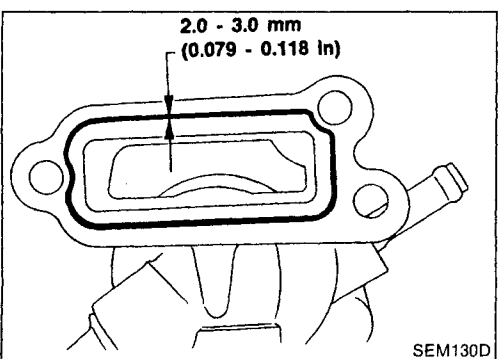
22. Install lower chain tensioner.

CAUTION:

- Check no problems occur when engine is rotated.
- Make sure that No. 1 piston is set at TDC on its compression stroke.



- Make sure of the direction of the gasket before installing lower chain tensioner.



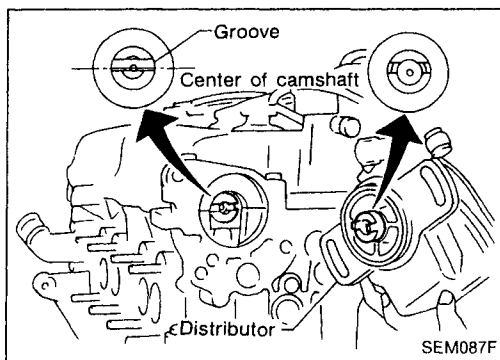
23. Apply liquid gasket to thermostat housing.

- Use Genuine Liquid Gasket or equivalent.

24. Install thermostat housing.

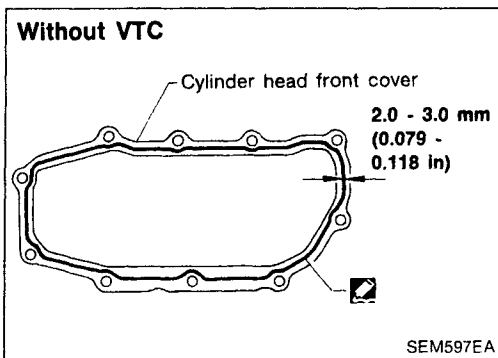
25. Install water pump pulley.

Installation (Cont'd)



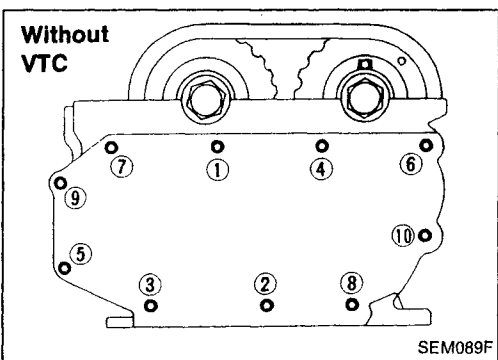
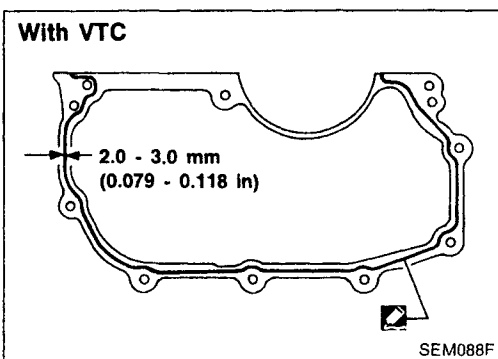
26. Install distributor.

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

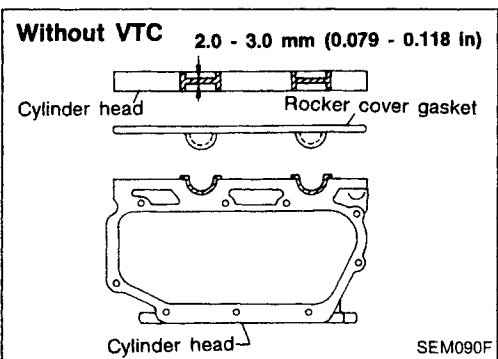


27. Install cylinder head front cover.

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



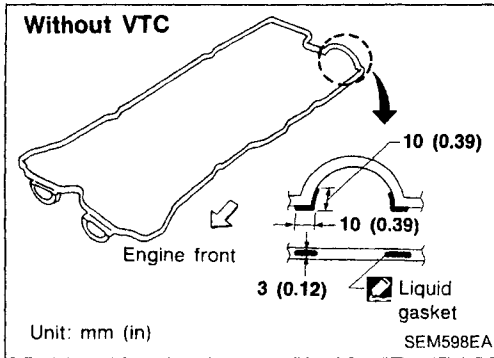
- Tighten bolts and nuts in numerical order as shown in the figure.



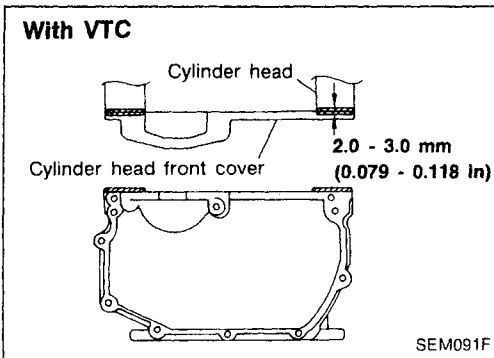
Without VTC

28. Apply liquid gasket to cylinder head.

Installation (Cont'd)

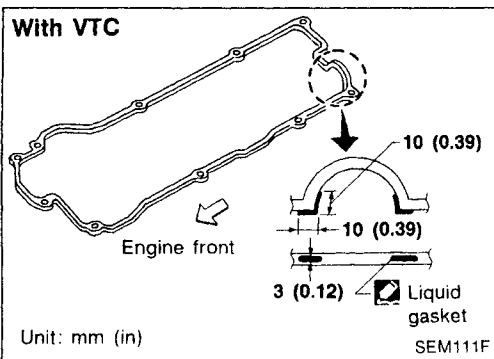


29. Apply liquid gasket to rocker cover gasket.

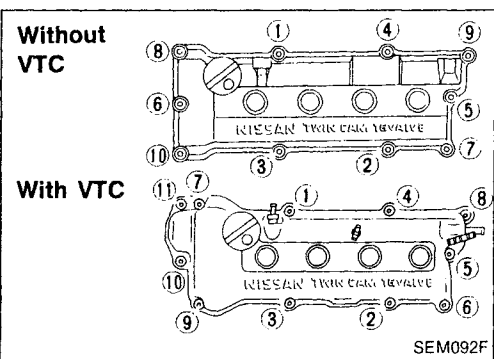


With VTC

28. Apply liquid gasket to mating surfaces of the cylinder head and cylinder head front covers shown in the figure.



29. Apply liquid gasket to rocker cover gasket.



30. Install rocker cover and tighten in numerical order as shown in the figure.

31. Install all spark plugs and leads.

32. Install engine front mounting bracket and mounting.

33. Install front exhaust tube.

34. Install front undercover.

35. Install front right splash cover.

36. Install front right wheel.

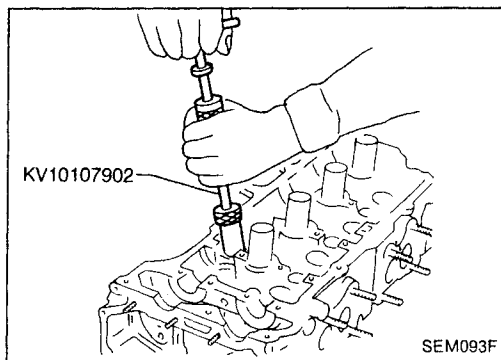
37. Install air cleaner.

38. 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").

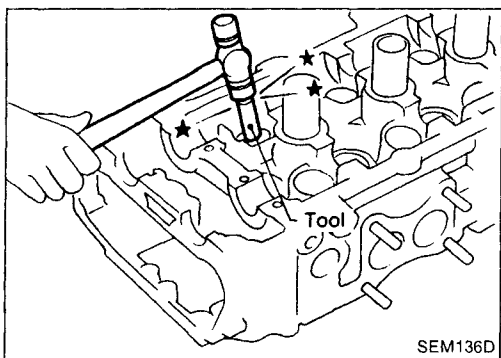
39. Drive belts.

For adjusting drive belt deflection, refer to MA section ("Checking Drive Belts", "ENGINE MAINTENANCE").

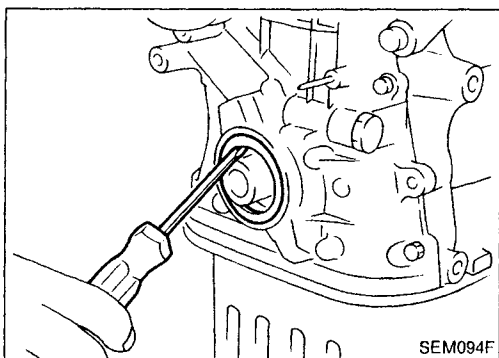
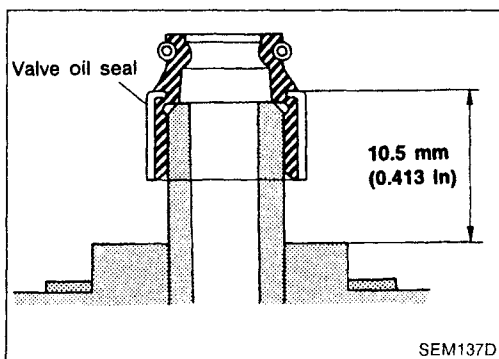


VALVE OIL SEAL

1. Remove rocker cover.
 2. Remove camshaft.
 3. Remove valve spring. Refer to "CYLINDER HEAD".
 4. Remove valve oil seal with a suitable tool.
- Piston concerned should be set at TDC to prevent valve from falling.**



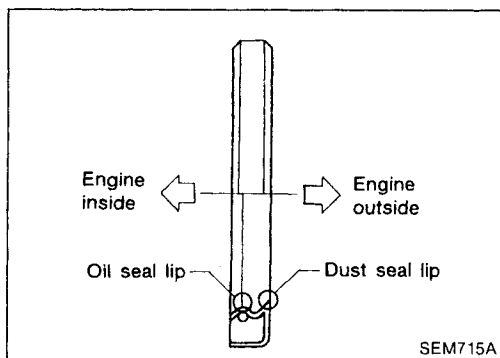
5. Apply engine oil to new valve oil seal and install it with Tool.

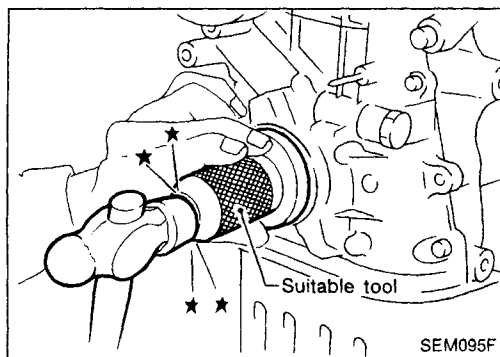


FRONT OIL SEAL

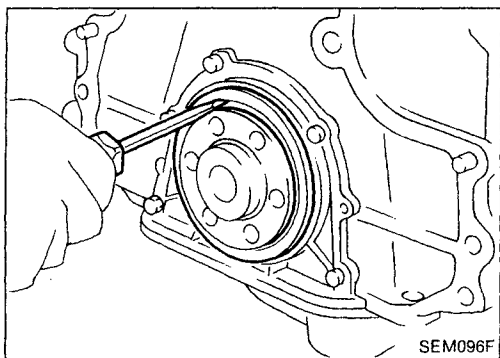
1. Remove the following parts:
 - Engine undercover
 - Right-side splash cover
 - Alternator and power steering drive belts
 - Crankshaft pulley
 2. Remove front oil seal from front cover.
- Be careful not to damage oil seal portion.**

- Install new oil seal in the direction shown.





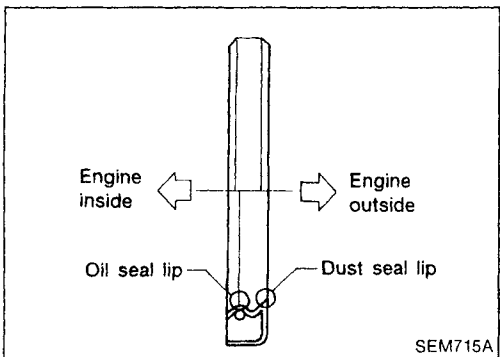
3. Apply engine oil to new oil seal and install it using a suitable tool.



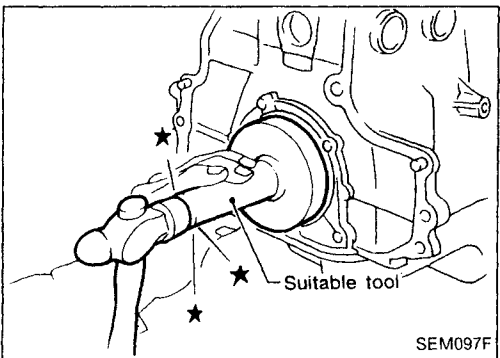
REAR OIL SEAL

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

Be careful not to scratch rear oil seal retainer.



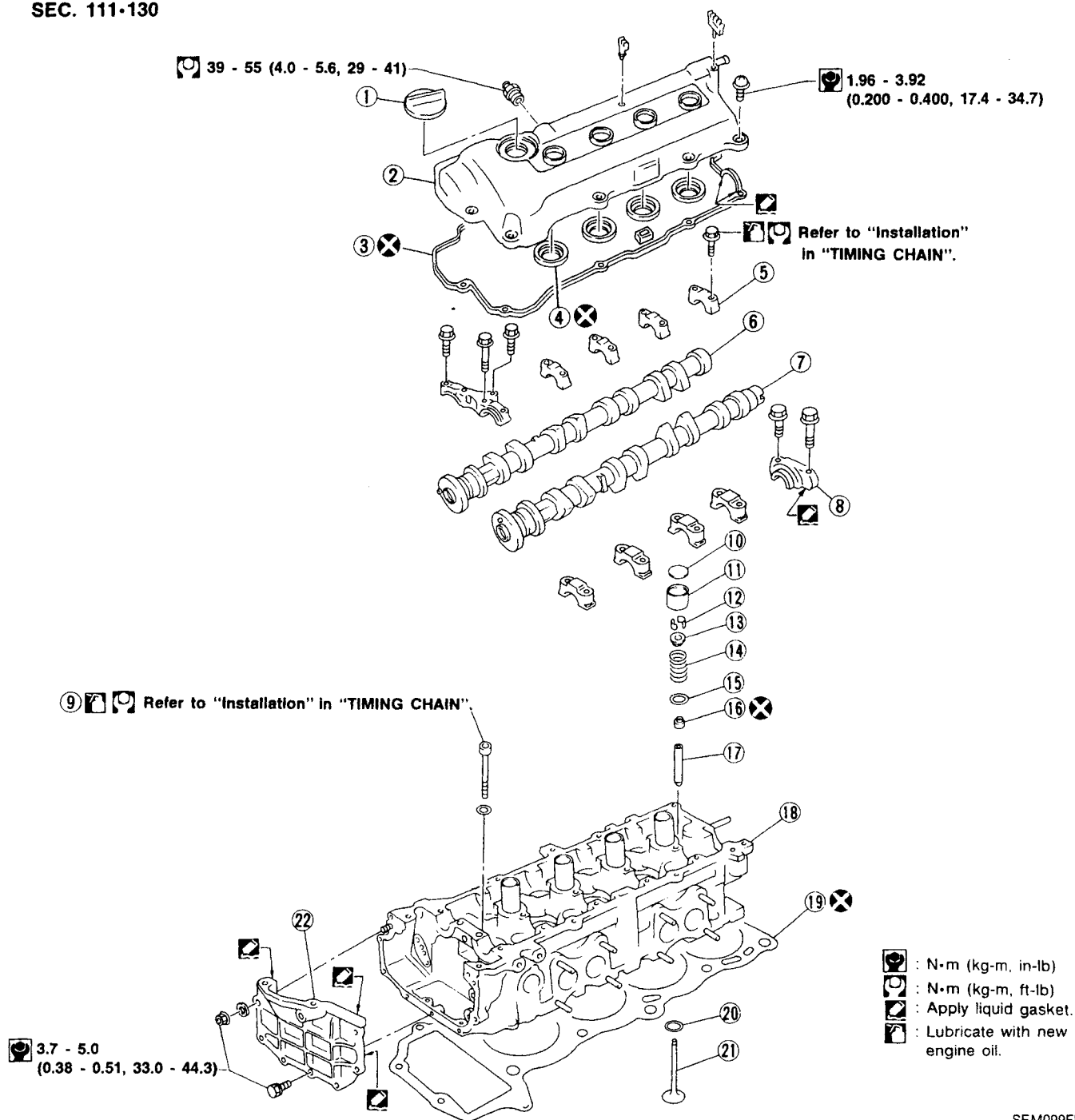
- Install new oil seal in the direction shown.



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

WITH VTC

SEC. 111-130



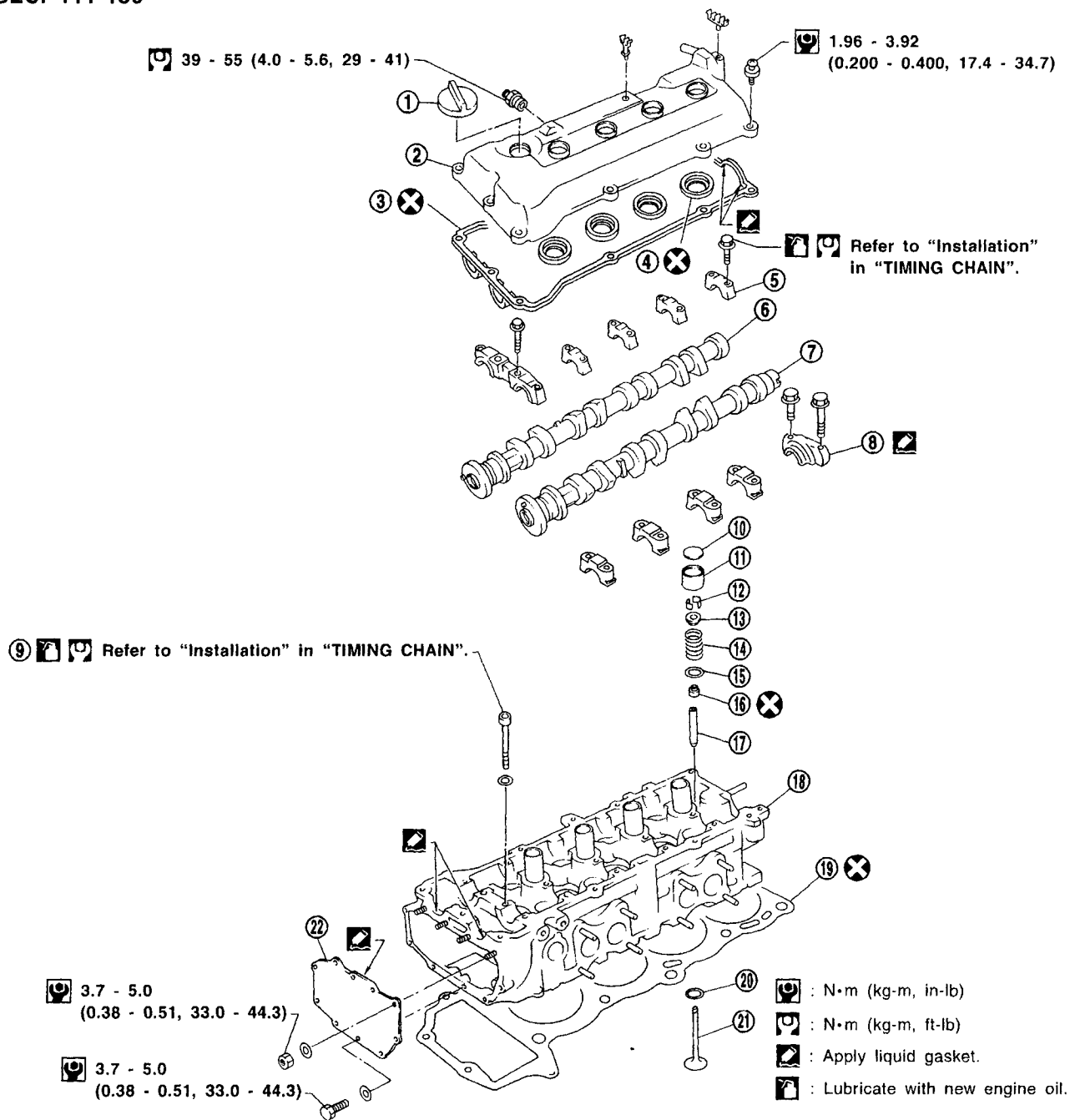
SEM099FB

- | | | |
|-----------------------|-------------------------|-----------------------------|
| ① Oil filler cap | ⑨ Cylinder head bolt | ⑯ Valve oil seal |
| ② Rocker cover | ⑩ Shim | ⑰ Valve guide |
| ③ Rocker cover gasket | ⑪ Valve lifter | ⑱ Cylinder head |
| ④ Oil seal | ⑫ Valve cotter | ⑲ Cylinder head gasket |
| ⑤ Camshaft bracket | ⑬ Valve spring retainer | ⑳ Valve seat |
| ⑥ Intake camshaft | ⑭ Valve spring | ㉑ Valve |
| ⑦ Exhaust camshaft | ⑮ Valve spring seat | ㉒ Cylinder head front cover |
| ⑧ Distributor bracket | | |

WITHOUT VTC

SEC. 111•130

EM



SEM244F

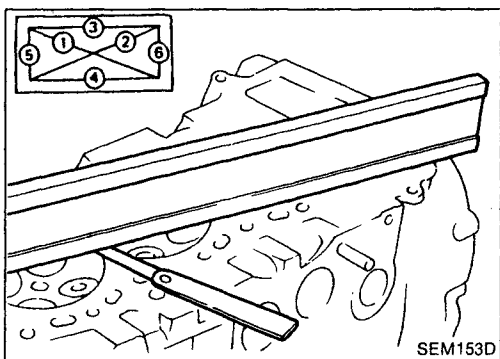
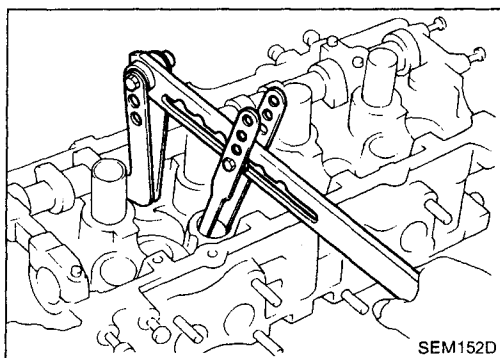
- | | | |
|-----------------------|-------------------------|-----------------------------|
| ① Oil filler cap | ⑨ Cylinder head bolt | ⑯ Valve oil seal |
| ② Rocker cover | ⑩ Shim | ⑰ Valve guide |
| ③ Rocker cover gasket | ⑪ Valve lifter | ⑱ Cylinder head |
| ④ Oil seal | ⑫ Valve cotter | ⑲ Cylinder head gasket |
| ⑤ Camshaft bracket | ⑬ Valve spring retainer | ⑳ Valve seat |
| ⑥ Intake camshaft | ⑭ Valve spring | ㉑ Valve |
| ⑦ Exhaust camshaft | ⑮ Valve spring seat | ㉒ Cylinder head front cover |
| ⑧ Distributor bracket | | |

CAUTION:

- When installing camshaft, oil seals or other sliding parts, lubricate contacting surfaces with new engine oil.
- When tightening cylinder head bolts, camshaft sprocket bolts and camshaft bracket bolts, lubricate thread portions and seat surfaces of bolts with new engine oil.
- Attach tags to valve lifters so as not to mix them up.

Removal

- This removal is the same procedure as those for timing chain. Refer to "Removal" in "TIMING CHAIN" (EM-20).

**Disassembly**

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

Inspection**CYLINDER HEAD DISTORTION**

Clean surface of cylinder head.

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

Check along six positions shown in figure.

Head surface flatness:**Standard:**

Less than 0.03 mm (0.0012 in)

Limit:

0.1 mm (0.004 in)

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

Resurfacing limit:

The resurfacing 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:

$$A + B = 0.2 \text{ mm (0.008 in)}$$

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

Nominal cylinder head height:

117.8 - 118.0 mm (4.638 - 4.646 in)

CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.

Inspection (Cont'd)**CAMSHAFT RUNOUT**

1. Measure camshaft runout at the center journal.

Runout (Total indicator reading):

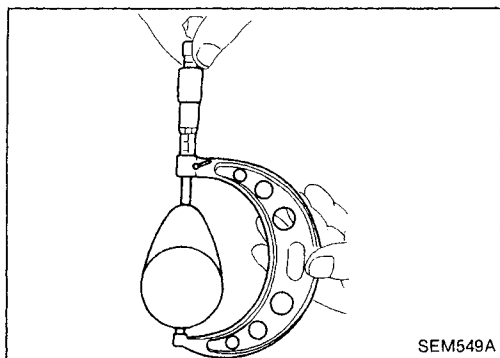
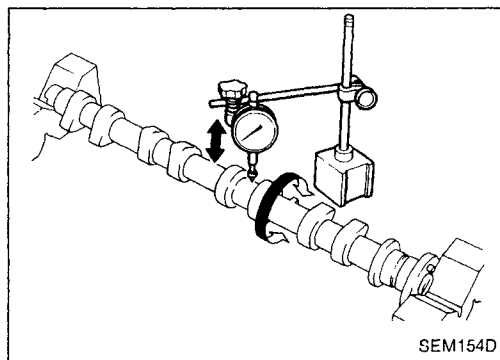
Standard:

Less than 0.02 mm (0.0008 in)

Limit:

0.1 mm (0.004 in)

2. If it exceeds the limit, replace camshaft.

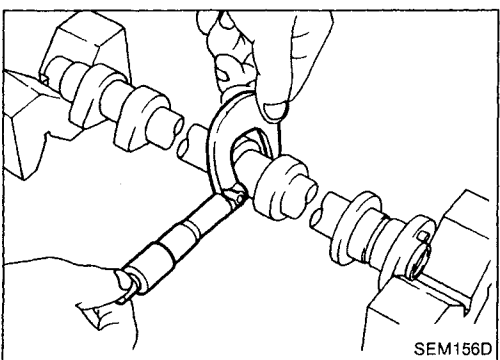
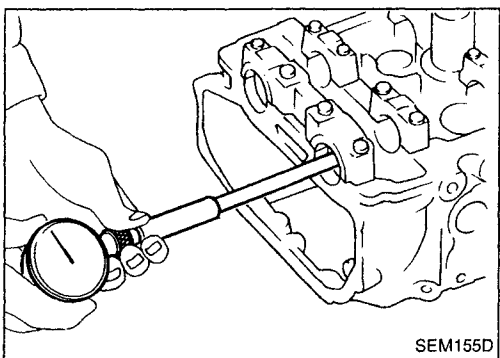
**CAMSHAFT CAM HEIGHT**

1. Measure camshaft cam height.

Unit: mm (in)

Engine model		GA14DE	GA15DE	GA16DE without VTC	GA16DE with VTC for Aus- tralia	GA16DE with VTC except for Australia
Standard cam height	Intake	39.380 - 39.570	39.880 - 40.070 (1.5701 - 1.5776)	39.380 - 39.570 (1.5504 - 1.5579)	40.610 - 40.800 (1.5988 - 1.6063)	
	Exhaust	(1.5504 - 1.5579)	40.056 - 40.246 (1.5770 - 1.5845)	39.880 - 40.070 (1.5701 - 1.5776)	39.910 - 40.010 (1.5713 - 1.5752)	40.056 - 40.246 (1.5770 - 1.5845)
Cam wear limit		0.20 (0.0079)				

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

**CAMSHAFT JOURNAL CLEARANCE**

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)

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)

CYLINDER HEAD

Inspection (Cont'd)

CAMSHAFT END PLAY

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

Camshaft end play:

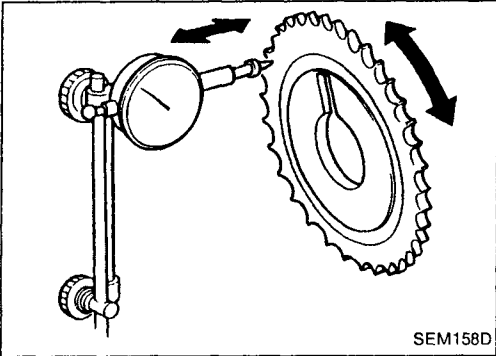
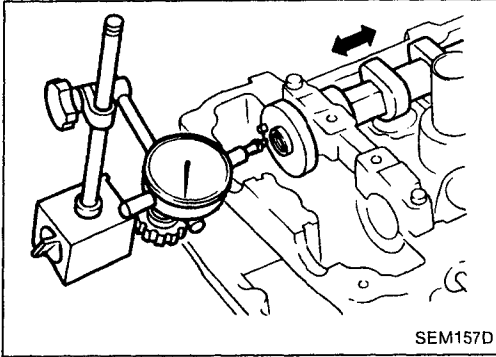
Standard

For Europe 0.070 - 0.143 mm (0.0028 - 0.0056 in)

Except for Europe 0.115 - 0.188 mm (0.0045 - 0.0074 in)

Limit

0.20 mm (0.0079 in)



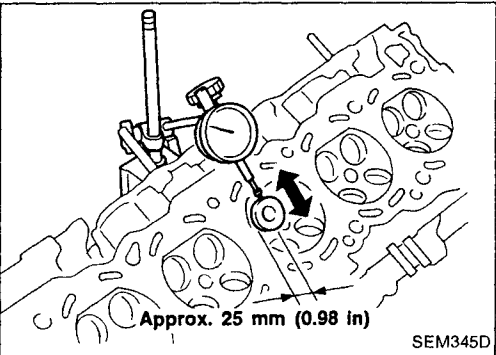
CAMSHAFT SPROCKET RUNOUT

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

Runout (Total indicator reading):

Limit 0.1 mm (0.004 in)

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



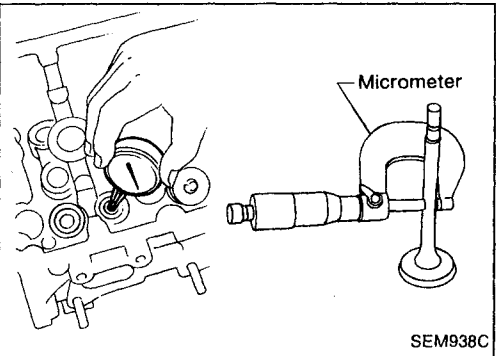
VALVE GUIDE CLEARANCE

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)



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

Valve to valve guide clearance:

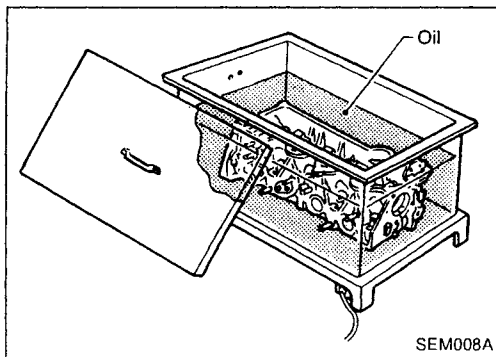
Unit: mm (in)

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

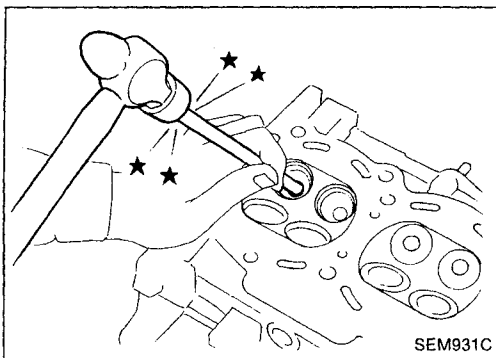
- c. If it exceeds the limit, replace valve or valve guide.

Inspection (Cont'd)

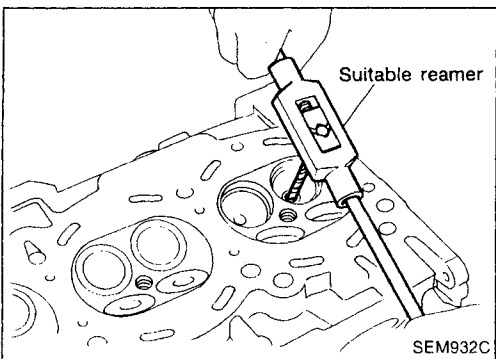
VALVE GUIDE REPLACEMENT



1. To remove valve guide, heat cylinder head to 110 to 120°C (230 to 248°F).



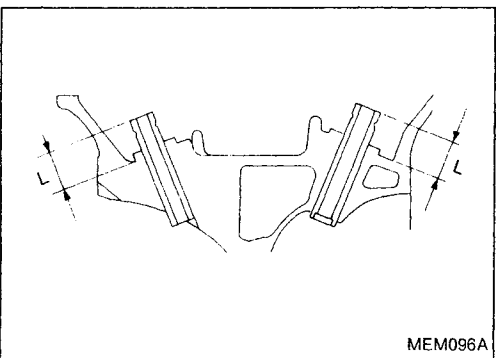
2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.



3. Ream cylinder head valve guide hole.

Valve guide hole diameter**(for service parts):****Intake & Exhaust**

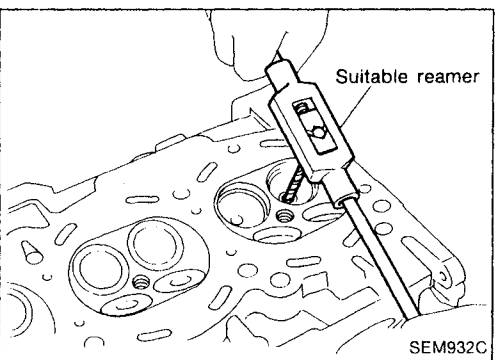
9.685 - 9.696 mm (0.3813 - 0.3817 in)



4. Heat cylinder head to 110 to 120°C (230 to 248°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)

CYLINDER HEAD

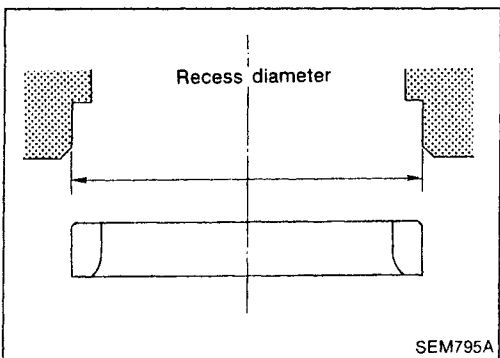
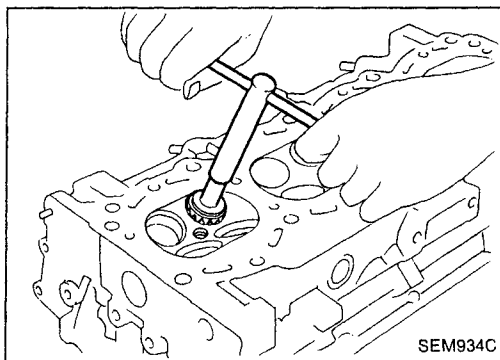
GA

Inspection (Cont'd)

VALVE SEATS

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

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



REPLACING VALVE SEAT FOR SERVICE PARTS

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

Reaming bore for service valve seat

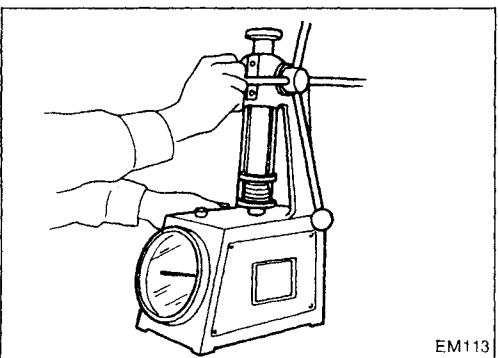
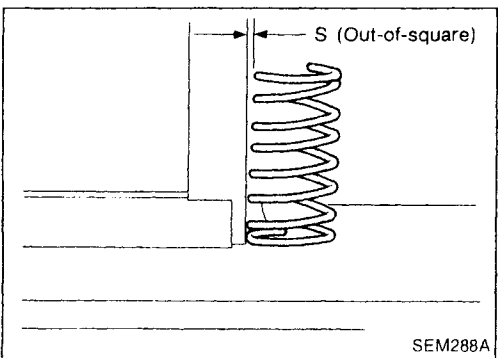
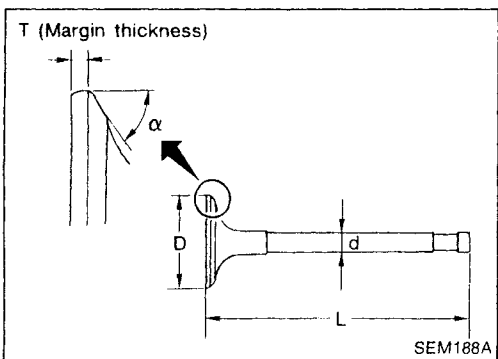
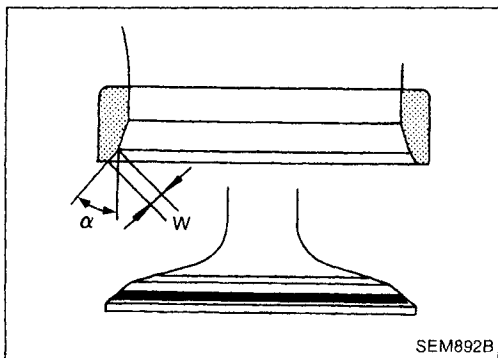
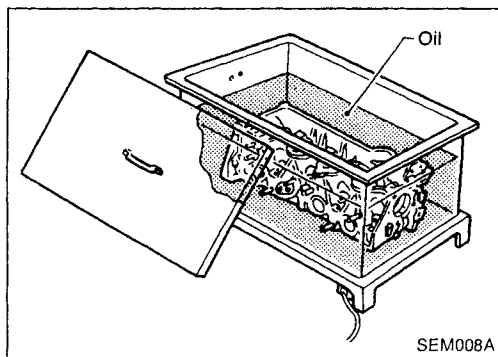
Oversize [0.5 mm (0.020 in)]:

Unit: mm (in)

Engine model	GA16DE without VTC, 14DE and 15DE	GA16DE with VTC
Intake	30.500 - 30.516 (1.2008 - 1.2014) 31.500 - 31.516 (1.2402 - 1.2408)*	31.500 - 31.516 (1.2402 - 1.2408)
Exhaust	25.500 - 25.516 (1.0039 - 1.0046)	26.500 - 26.516 (1.0433 - 1.0439)

*: GA16DE without VTC

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

Inspection (Cont'd)

3. Heat cylinder head to 110 to 120°C (230 to 248°F).
4. Press fit valve seat until it seats on the bottom.

5. Cut or grind valve seat using suitable tool at the specified dimensions as shown in SDS (EM-159).
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

Seat face angle "α":

45°15' - 45°45' deg.

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)

VALVE DIMENSIONS

Check dimensions in each valve. For dimensions, refer to SDS (EM-156).

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 1.80 mm (0.0709 in)

2. If it exceeds the limit, replace spring.

Pressure

Check valve spring pressure.

Pressure: N (kg, lb) at height mm (in)

Standard

344.42 (35.12, 77.44) at 25.26 (0.9945)

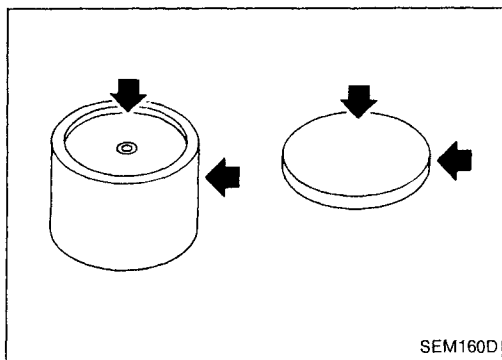
Limit

More than 323.73 (33.01, 72.79) at 25.26 (0.9945)

If it exceeds the limit, replace spring.

Inspection (Cont'd)**VALVE LIFTER AND VALVE SHIM**

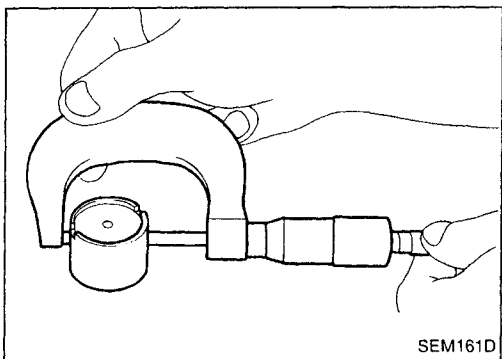
1. Check contact and sliding surfaces for wear or scratches.



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

Valve lifter diameter:

29.960 - 29.975 mm (1.1795 - 1.1801 in)



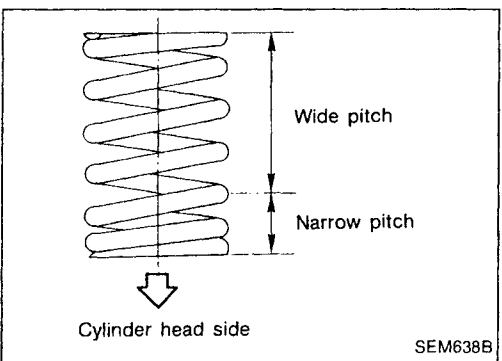
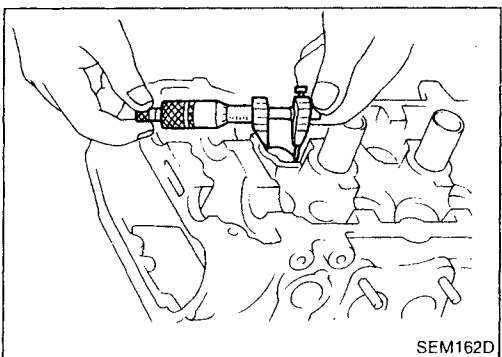
Lifter guide bore diameter:

30.000 - 30.021 mm (1.1811 - 1.1819 in)

Clearance between valve lifter and valve lifter guide

0.025 - 0.061 mm (0.0010 - 0.0024 in)

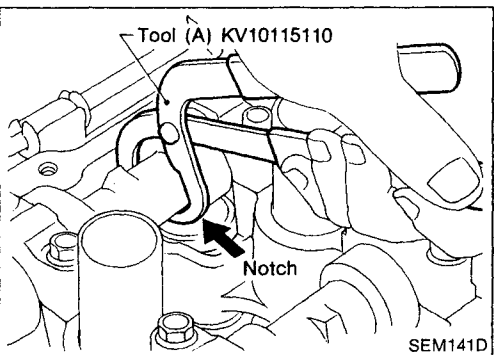
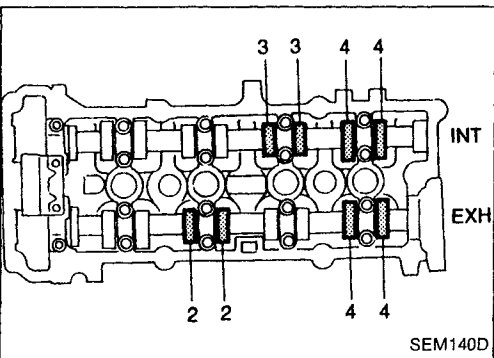
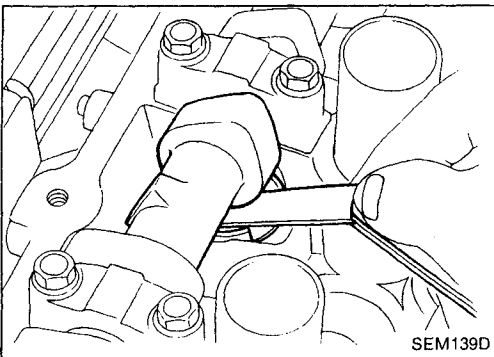
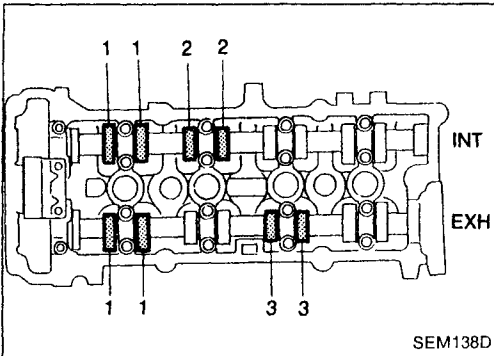
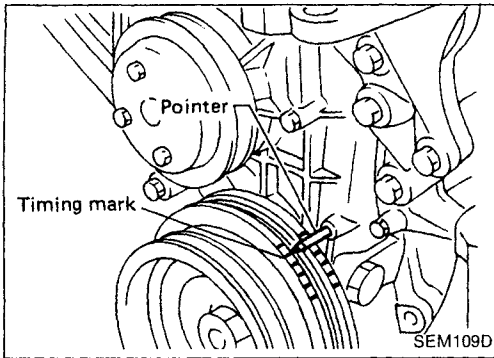
If it exceeds the limit, replace valve lifter or cylinder head which exceeds the standard diameter tolerance.

**Assembly**

1. Install valve component parts.
 - **Always use new valve oil seal. Refer to OIL SEAL REPLACEMENT (EM-30).**
 - **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 uneven pitch type spring with its narrow pitch end toward cylinder head. (Identification color side down, if present.)**

Installation

- This installation is the same procedure as those for timing chain. Refer to "Installation" in "TIMING CHAIN" (EM-23).



Checking

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 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 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

Adjust valve clearance while engine is cold.

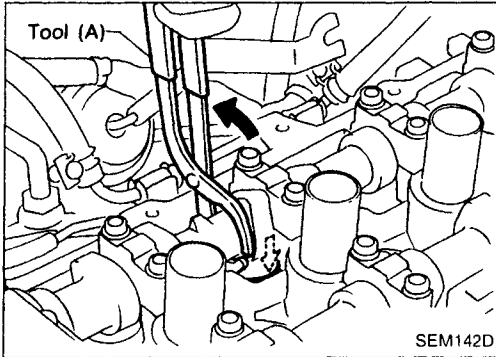
1. Turn crankshaft, to position cam lobe on camshaft of valve that must be adjusted upward.
2. Place Tool (A) around camshaft as shown in figure.

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

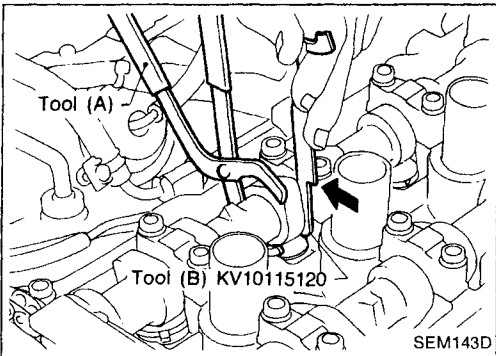
CAUTION:

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

Adjusting (Cont'd)



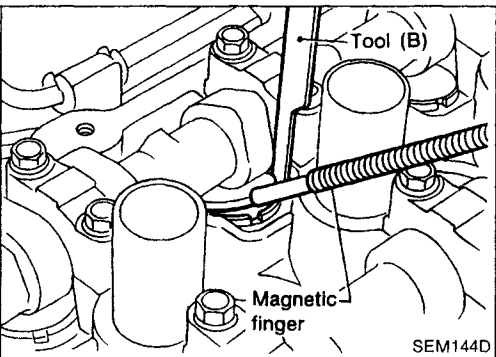
3. Rotate Tool (A) (See figure.) so that valve lifter is pushed down.



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).



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

- Using a micrometer 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:

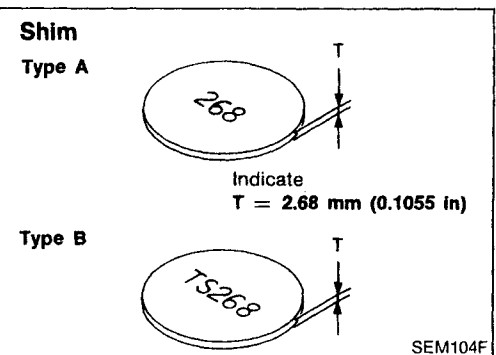
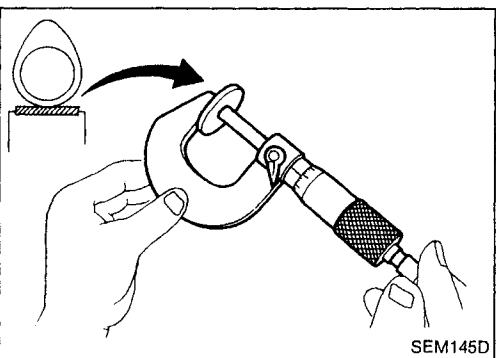
$$N = R + [M - 0.37 \text{ mm (0.0146 in)}]$$

Exhaust:

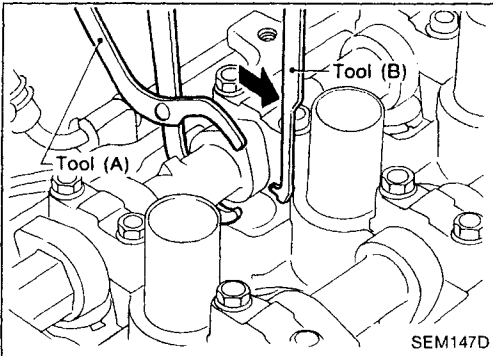
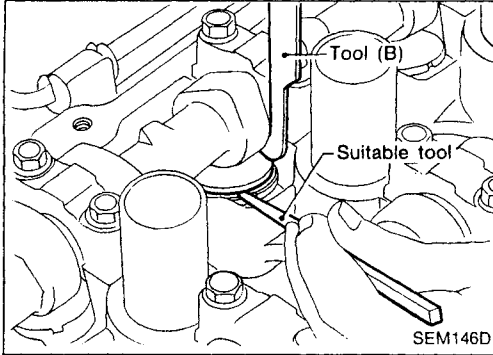
$$N = R + [M - 0.40 \text{ mm (0.0157 in)}]$$

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 new shim with thickness as close as possible to calculated value.



Adjusting (Cont'd)



8. Install new shim using a suitable tool.

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

9. Place Tool (A) as mentioned in steps 2 and 3.

10. Remove Tool (B).

11. Remove Tool (A).

12. Recheck valve clearance.

Valve clearance:

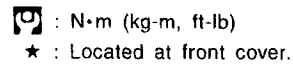
Unit: mm (in)

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

22 - 29 (2.2 - 3.0, 16 - 22) 44 - 54 (4.5 - 5.5, 33 - 40)



① Engine front mounting	⑤ Transaxle mounting	⑨ Center member
② Cylinder head front mounting bracket	⑥ Transaxle mounting bracket	⑩ Buffer rod bracket
③ Engine front mounting bracket	⑦ Engine rear mounting	⑪ Buffer rod
④ Engine rear mounting bracket	⑧ Dynamic damper (A/T models)	

WARNING:

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

CAUTION:

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

Engine cannot be removed separately from transaxle. Remove engine with transaxle.

Removal

1. Drain water.
2. Remove hood.
3. Remove battery.
4. Remove reservoir tank and bracket.
5. Remove drive belts.
6. Remove alternator, compressor and power steering oil pump from engine.

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

7. Remove the following parts:

- Right and left front tires
- Under covers
- Splash covers
- Brake caliper assembly

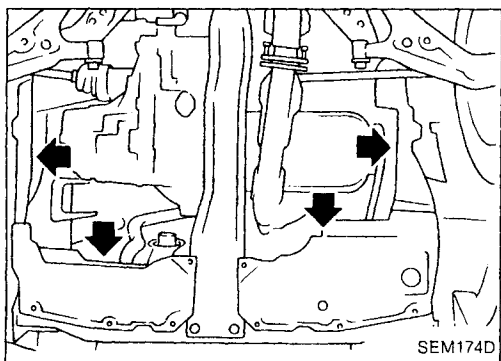
: 72 - 97 N·m (7.3 - 9.9 kg-m, 53 - 72 ft-lb)

Brake hose does not need to be disconnected from brake caliper assembly.

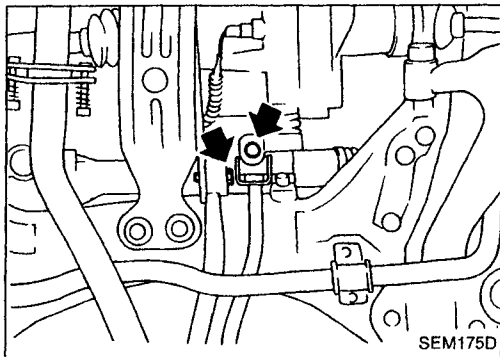
Never depress brake pedal.

- Disconnect tie-rod ball joint (RH & LH).
: 29 - 39 N·m (3.0 - 4.0 kg-m, 22 - 29 ft-lb)
- RH & LH drive shaft

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



Removal (Cont'd)



- Disconnect control rod and support rod from transaxle. (M/T models)

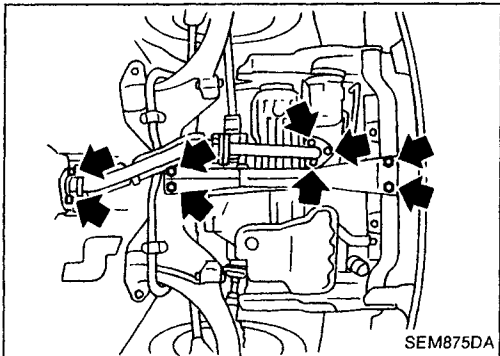
Control rod:

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

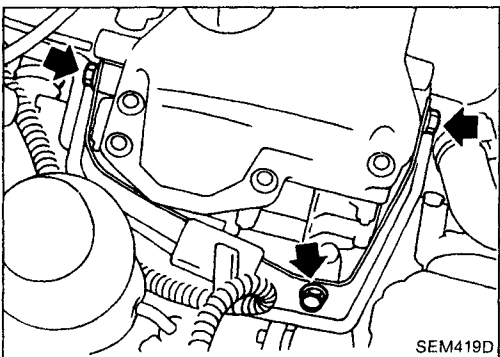
Support rod:

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

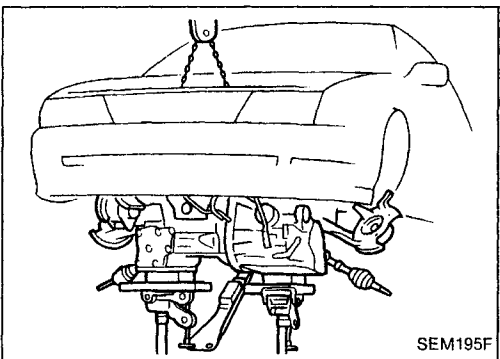
- Disconnect control cable from transaxle. (A/T models)



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



- Cylinder head front mounting bracket



- Remove air duct and disconnect wires, harness, pipes, hoses and so on.

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

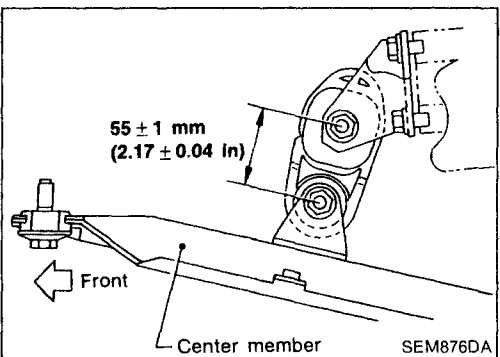
When lifting engine, be careful not to hit it against adjacent parts, especially against brake tubes and brake master cylinder.

9. Remove engine with transaxle as shown.

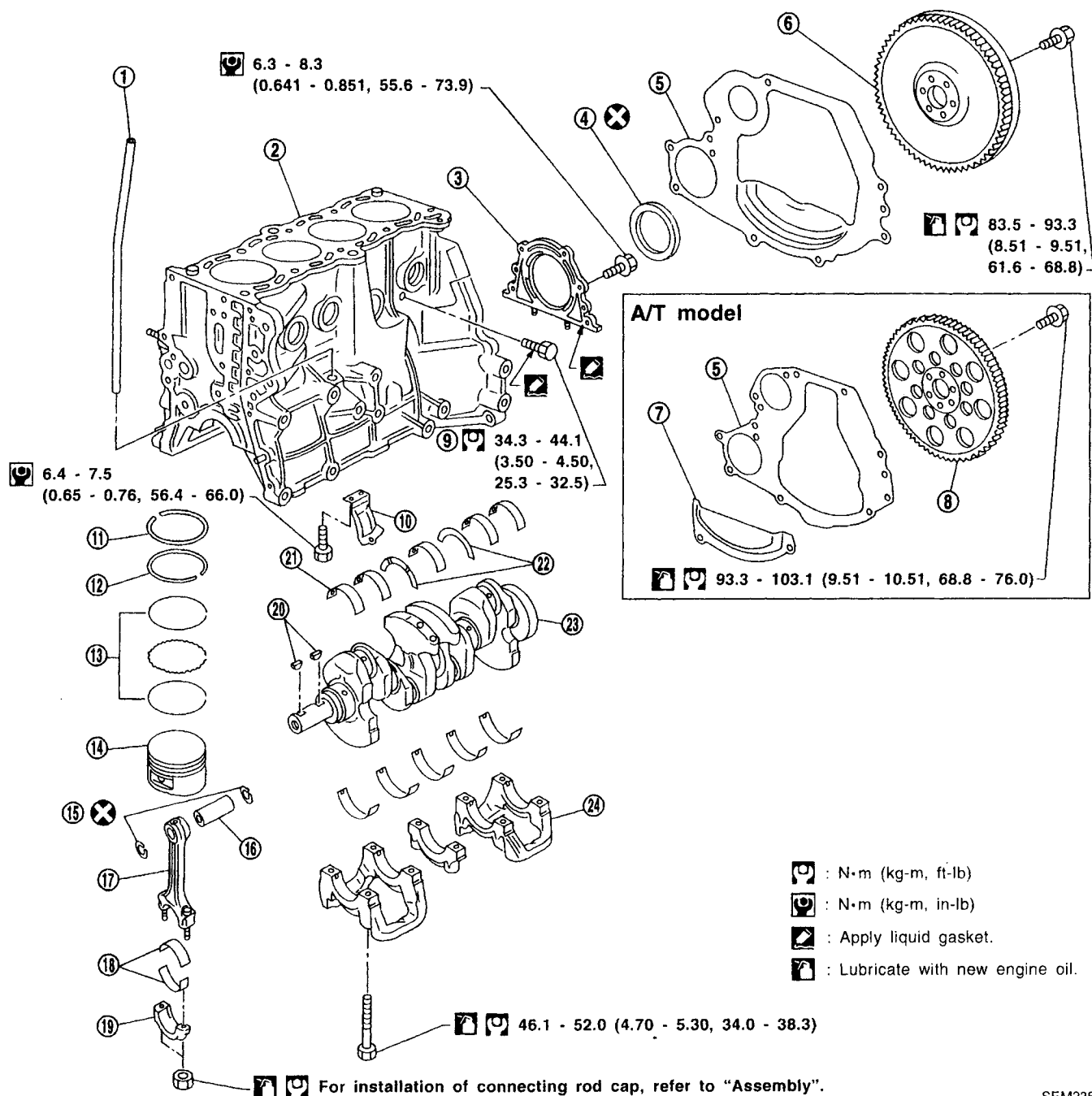
Installation

When installing the engine, adjust the height of buffer rod as shown. (For M/T)

- Installation is the reverse order of removal.



SEC. 110-120



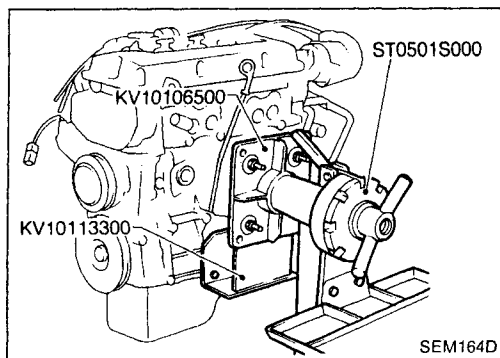
- | | | |
|--------------------------|----------------------------------|--------------------------|
| ① Oil level gauge guide | ⑨ Drain plug | ⑰ Connecting rod |
| ② Cylinder block | ⑩ Buffer plate | ⑱ Connecting rod bearing |
| ③ Rear oil seal retainer | ⑪ Top ring | ⑲ Connecting rod cap |
| ④ Rear oil seal | ⑫ 2nd ring (Only Europe models*) | ⑳ Key |
| ⑤ Rear plate | ⑬ Oil ring | ㉑ Main bearing |
| ⑥ Flywheel | ⑭ Piston | ㉒ Thrust bearing |
| ⑦ Rear lower plate | ⑮ Snap ring | ㉓ Crankshaft |
| ⑧ Drive plate | ⑯ Piston pin | ㉔ Main bearing cap |

*: Applies to GA16DE without VTC, 14DE.

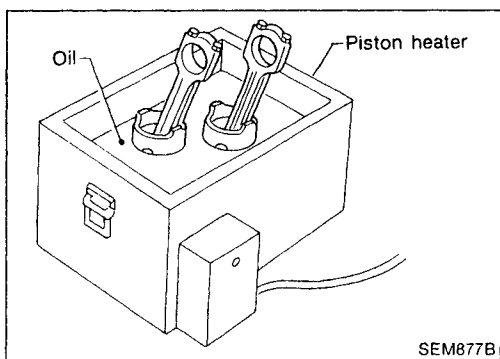
SEM238F

CAUTION:

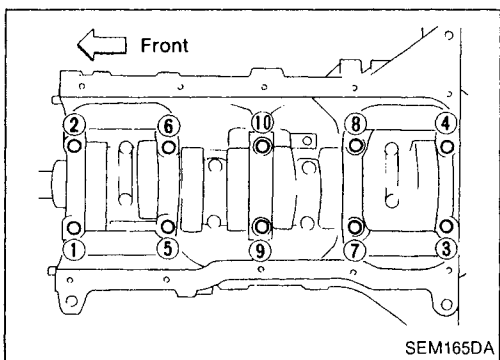
- When installing sliding parts (bearings, pistons, etc.), lubricate contacting surfaces with new engine oil.
- Place removed parts such as bearings and bearing caps in their proper order and direction.
- When installing connecting rod nuts, and main bearing cap bolts, apply new engine oil to threads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

**Disassembly****PISTON AND CRANKSHAFT**

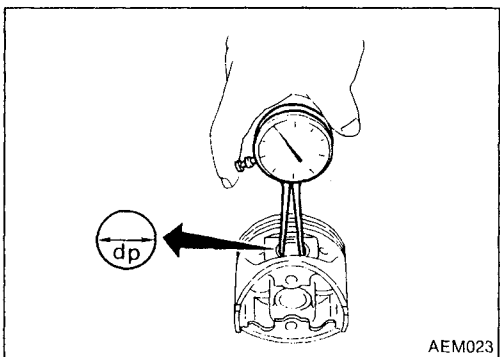
1. Place engine on a work stand.
2. Drain coolant and oil.
3. Remove timing chain.
Refer to "Removal" in "TIMING CHAIN" (EM-20).



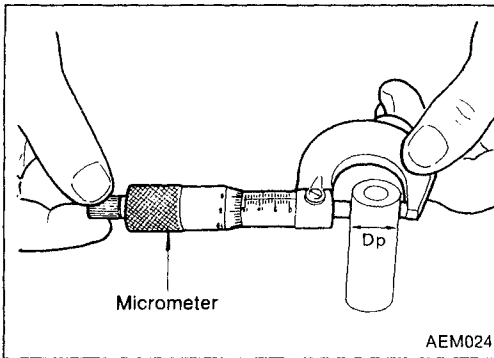
4. Remove pistons with connecting rods.
 - When disassembling piston and connecting rod, remove snap ring first, then heat piston to 60 to 70°C (140 to 158°F) or use piston pin press stand at room temperature.



5. Loosen main bearing cap in numerical order as shown in the figure.
6. Remove bearing caps, main bearings and crankshaft.
 - **Before removing bearing caps, 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":
 18.987 - 18.999 mm (0.7475 - 0.7480 in)

Inspection (Cont'd)

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.

$dp - Dp = -0.004$ to 0 mm (-0.0002 to 0 in)

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

EM

PISTON RING SIDE CLEARANCE

Side clearance:

Top ring

0.040 - 0.080 mm (0.0016 - 0.0031 in)

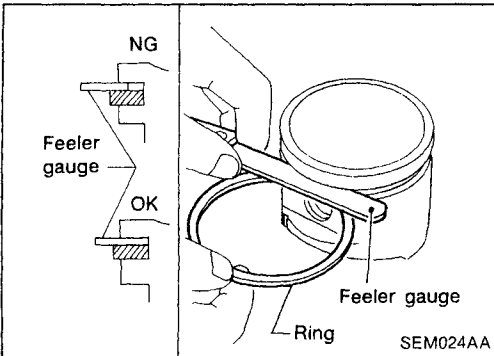
2nd ring (Only Europe models)

0.030 - 0.070 mm (0.0012 - 0.0028 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 - 0.35 mm (0.0079 - 0.0138 in)

2nd ring (Only Europe models)

0.37 - 0.52 mm (0.0146 - 0.0205 in)

Oil ring

0.20 - 0.60 mm (0.0079 - 0.0236 in)

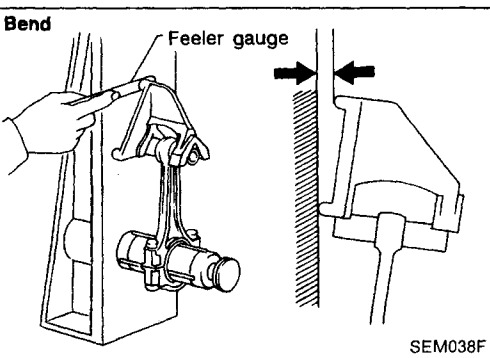
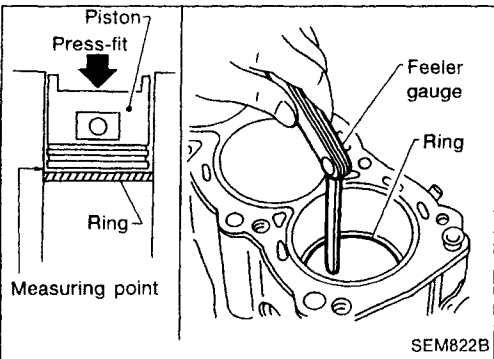
Max. limit of ring gap:

1.0 mm (0.039 in)

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

Refer to SDS (EM-161).

- 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**

Bend:

Limit 0.15 mm (0.0059 in)

per 100 mm (3.94 in) length

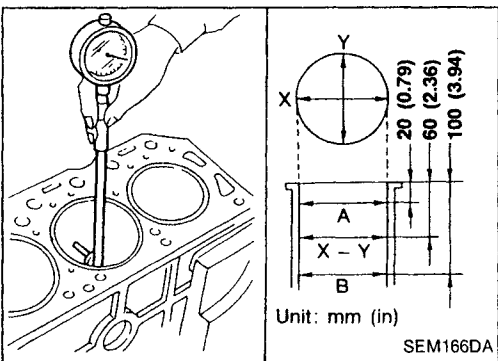
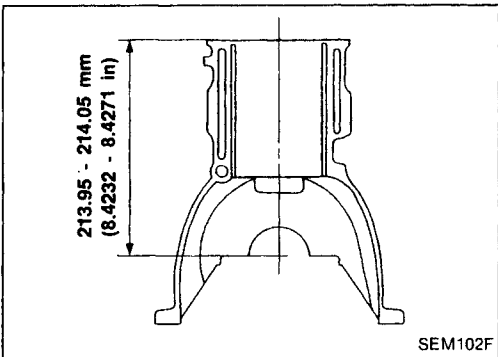
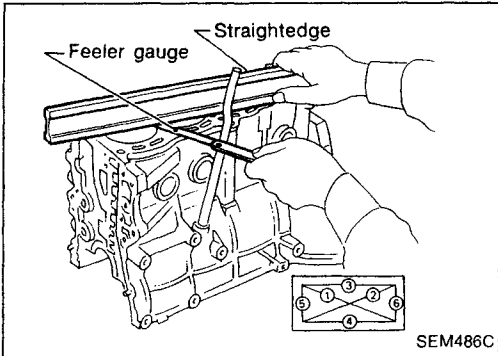
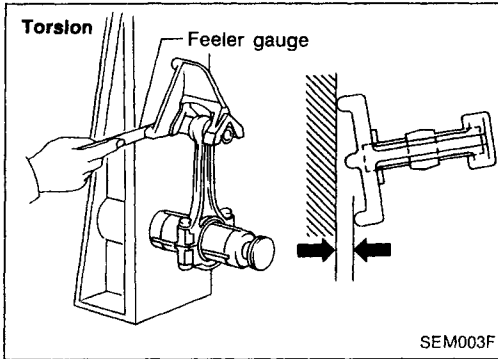
Torsion:

Limit 0.3 mm (0.012 in)

per 100 mm (3.94 in) length

If it exceeds the limit, replace connecting rod assembly.

Inspection (Cont'd)



CYLINDER BLOCK DISTORTION AND WEAR

1. Clean upper face of cylinder block and measure the distortion.

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:

213.95 - 214.05 mm (8.4232 - 8.4271 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:

GA16DE 76.000 - 76.030 mm (2.9921 - 2.9933 in)

GA14, 15DE 73.600 - 73.630 mm (2.8976 - 2.8988 in)

Wear limit:

0.2 mm (0.008 in)

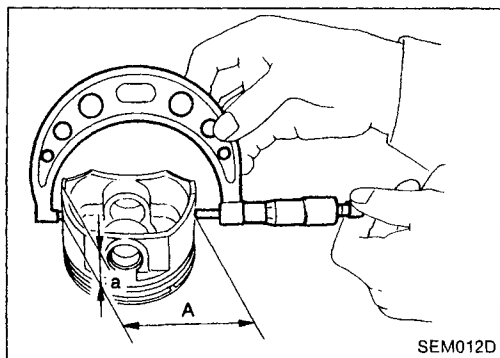
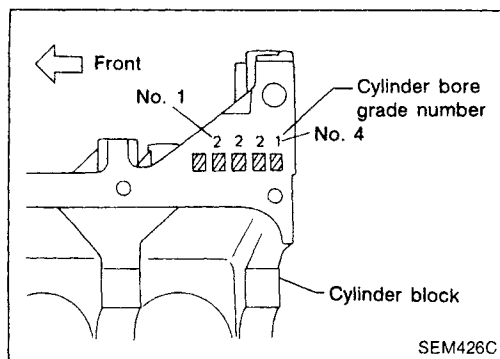
If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.

Out-of-round (X - Y) standard:

0.015 mm (0.0006 in)

Taper (A - B) standard:

0.01 mm (0.0004 in)

**Inspection (Cont'd)**

2. Check for scratches 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-161).

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

Refer to SDS (EM-161).

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

Piston-to-bore clearance "B":

0.015 - 0.035 mm (0.0006 - 0.0014 in)

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

Oversize pistons are available for service. Refer to SDS (EM-161).

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 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.

CYLINDER BLOCK

Inspection (Cont'd)

CRANKSHAFT

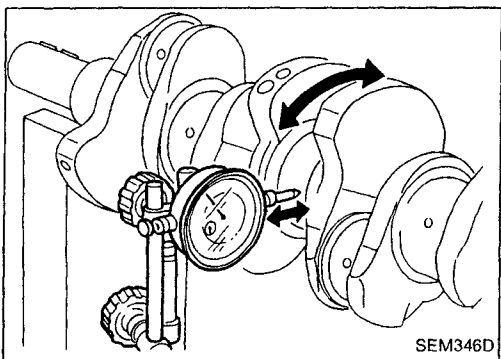
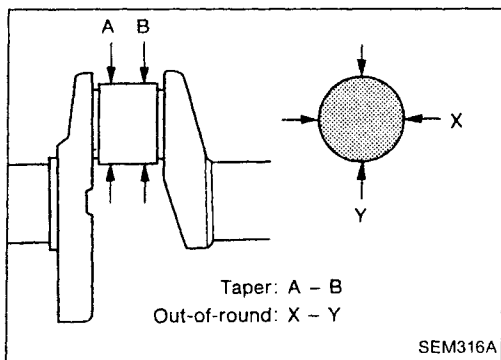
1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.

Out-of-round ($X - Y$):

Less than 0.005 mm (0.0002 in)

Taper ($A - B$):

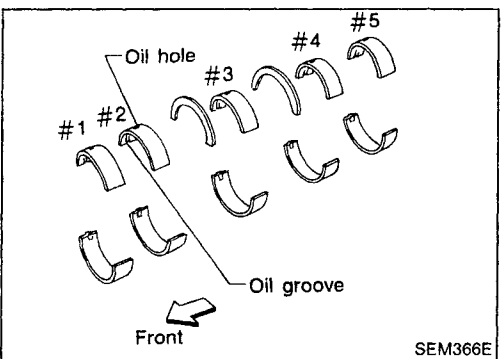
Less than 0.002 mm (0.0001 in)



3. Measure crankshaft runout.

Runout (Total indicator reading):

Less than 0.05 mm (0.0020 in)



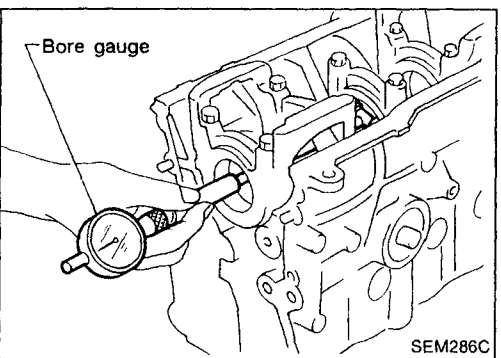
BEARING CLEARANCE

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

Method A (Using bore gauge & micrometer)

Main bearing

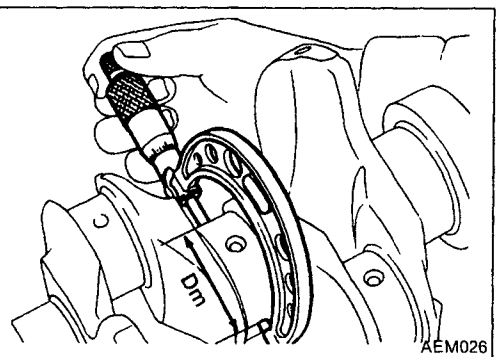
1. Set main bearings in their proper positions on cylinder block and main bearing cap.



2. Install main bearing cap to cylinder block.

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

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



4. Measure outer diameter "Dm" of each main journal in crankshaft.

5. Calculate main bearing clearance.

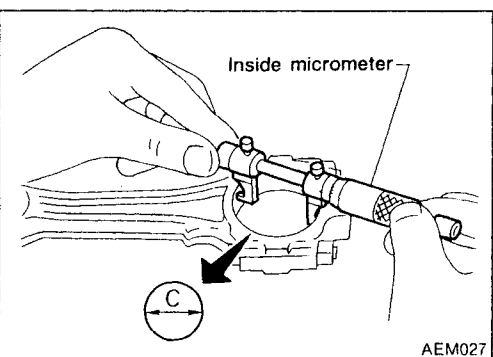
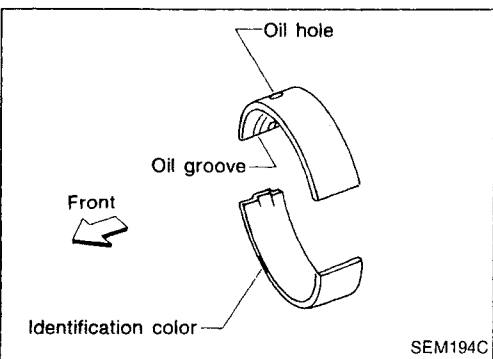
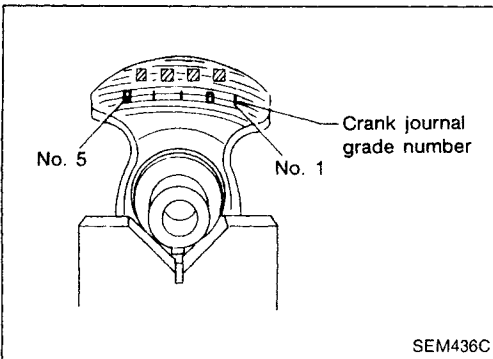
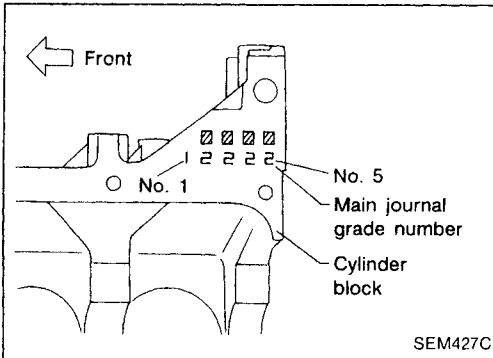
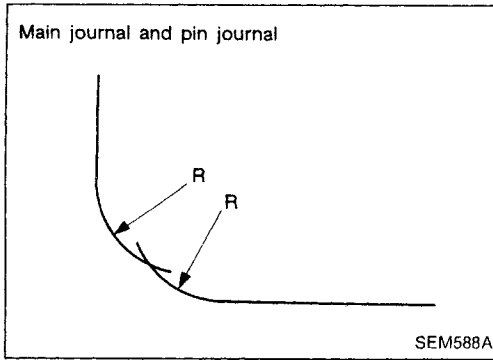
Main bearing clearance = $A - Dm$

Standard:

0.018 - 0.042 mm (0.0007 - 0.0017 in)

Limit: 0.1 mm (0.004 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.



Inspection (Cont'd)

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)

8. If crankshaft, cylinder block or main bearing is reused again, measure main bearing clearance. If the above parts are all replaced, select thickness of main bearings as follows:

- 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.

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

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

Main bearing grade color:

Main journal grade number	0	1	2
Crankshaft journal grade number			
0	Black	Brown	Green
1	Brown	Green	Yellow
2	Green	Yellow	Blue

For example:

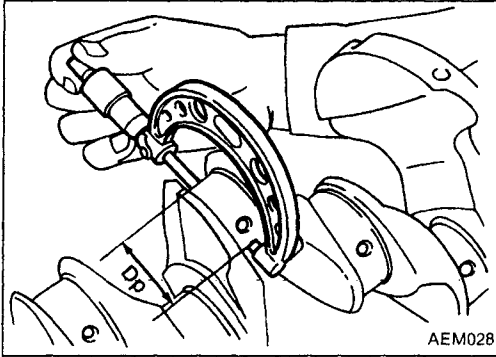
Main journal grade number: 1

Crankshaft journal grade number: 2

Main bearing grade number = 1 + 2 = Yellow

Connecting rod bearing (Big end)

- Install connecting rod bearing to connecting rod and cap.
- Install connecting rod cap to connecting rod.
- Tighten bolts to the specified torque.
- Measure inner diameter "C" of each bearing.

**Inspection (Cont'd)**

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

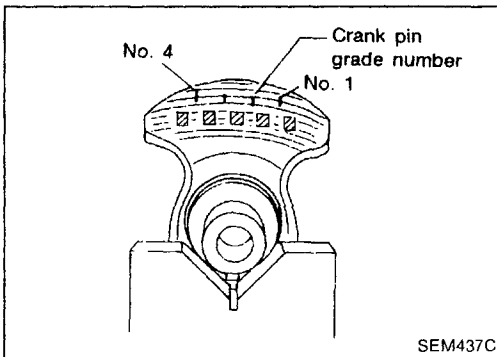
$$\text{Connecting rod bearing clearance} = C - Dp$$

Standard:

0.014 - 0.039 mm (0.0006 - 0.0015 in)

Limit: 0.1 mm (0.004 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-52).



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

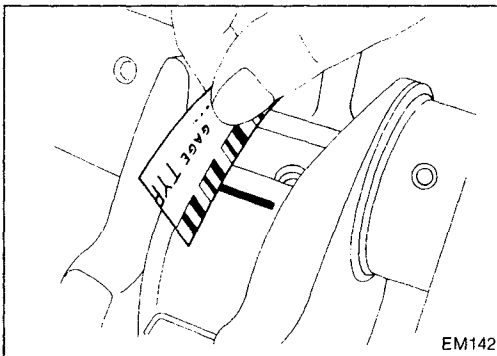
Connecting rod bearing grade number:

Grade numbers are punched in either Arabic or Roman numerals.

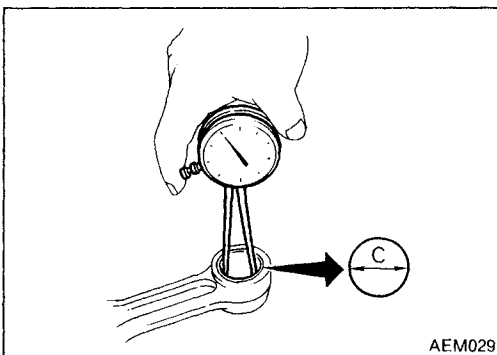
Crank pin grade color	Connecting rod bearing grade color
0	—
1	Brown
2	Green

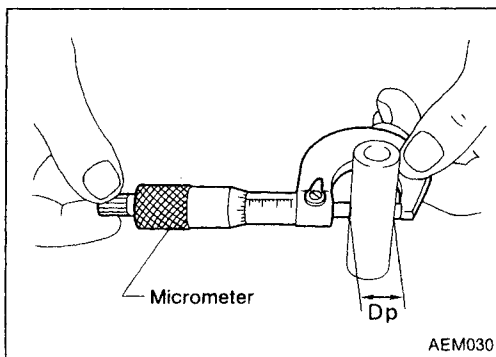
Method B (Using plastigage)**CAUTION:**

- Do not turn crankshaft or connecting rod while plastigage is being inserted.
- When bearing clearance exceeds the specified limit, ensure that the proper bearing has been installed. Then if excessive bearing clearance exists, use a thicker main bearing or undersized bearing so that the specified bearing clearance is obtained.

**CONNECTING ROD BUSHING CLEARANCE (Small end)**

1. Measure inner diameter "C" of bushing.



**Inspection (Cont'd)**

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

$$\text{Connecting rod bushing clearance} = C - Dp$$

Standard:

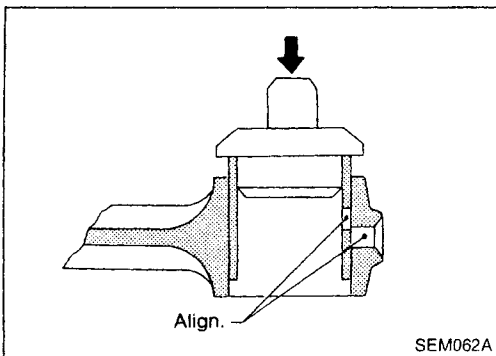
0.005 - 0.017 mm (0.0002 - 0.0007 in)

Limit:

0.023 mm (0.0009 in)

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

EM

**REPLACEMENT OF CONNECTING ROD BUSHING (Small end)**

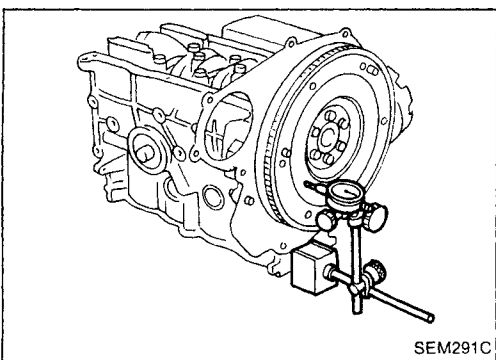
1. Drive in small end bushing until it is flush with end surface of rod.

Be sure to align the oil holes.

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

Clearance between connecting rod bushing and piston pin:

0.005 - 0.017 mm (0.0002 - 0.0007 in)

**FLYWHEEL RUNOUT**

Runout (Total indicator reading):

Flywheel (M/T model)

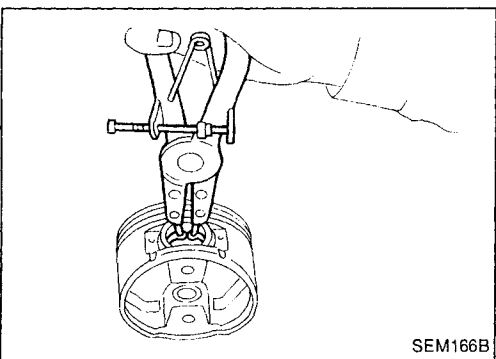
Less than 0.15 mm (0.0059 in)

Drive plate (A/T model)*

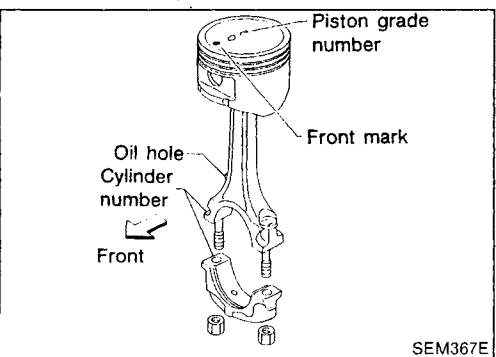
Less than 0.2 mm (0.008 in)

*: Measuring points

Approximately 115 mm (4.53 in) from crankshaft center

**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.**

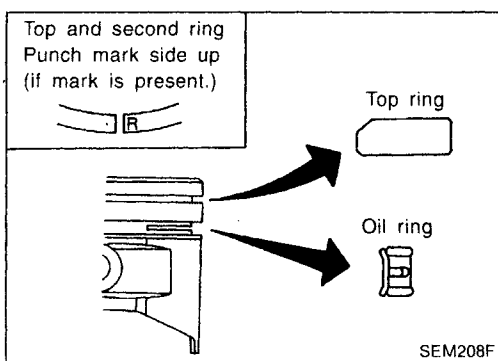
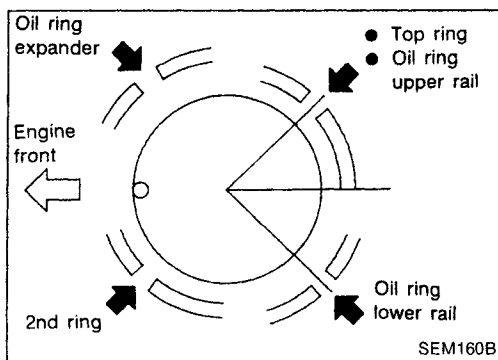
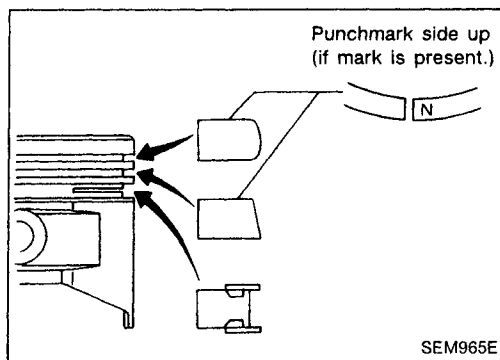
Assembly (Cont'd)

3. Set piston rings as shown.

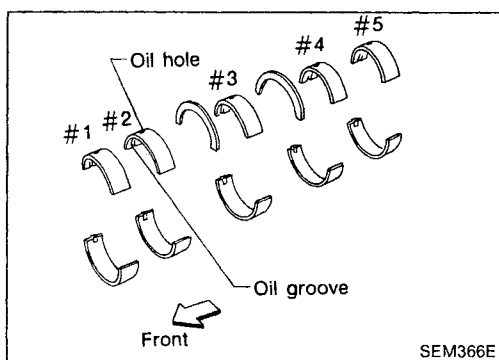
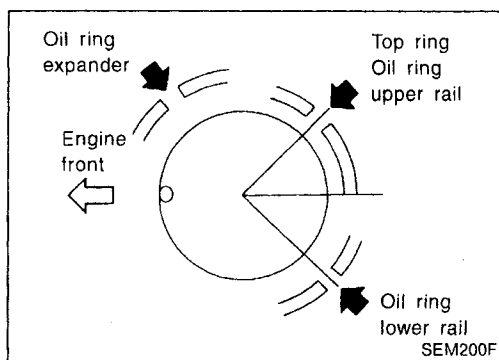
CAUTION:

- When piston rings are not replaced, make sure that piston rings are mounted in their original position.
- When piston rings are being replaced and no punch mark is present, piston rings can be mounted with either side up.

For Europe and Israel models



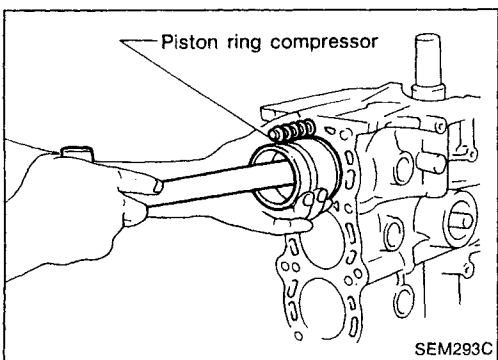
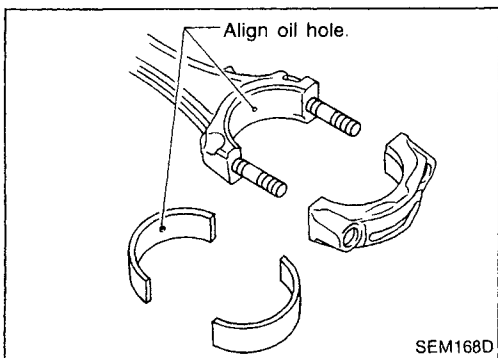
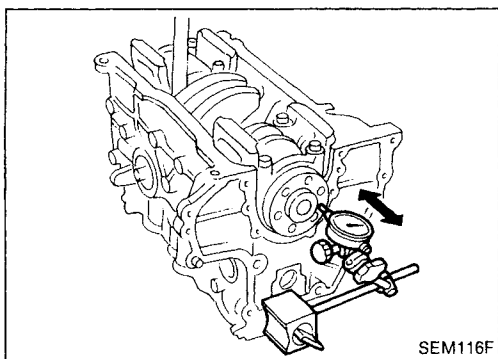
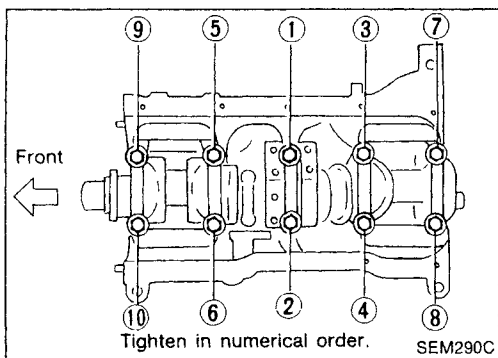
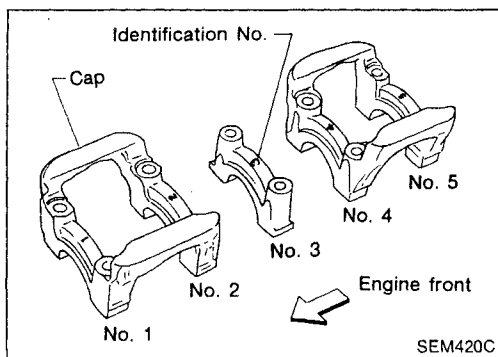
Except for Europe and Israel models

**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" (EM-52).
- Apply engine oil to bearing surfaces.

Assembly (Cont'd)



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

- Apply new engine oil to bolt threads and seat surface.
- Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting crankshaft in the axial direction.
- Tighten bearing cap bolts gradually in two or three stages. Start with center bearing and move outward sequentially.
- After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.

3. Measure crankshaft end play.

Crankshaft end play:**Standard:**

0.060 - 0.180 mm (0.0024 - 0.0071 in)

Limit:

0.3 mm (0.012 in)

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

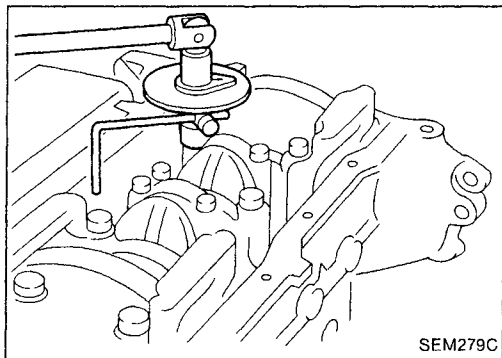
4. Install connecting rod bearings in connecting rods and connecting rod caps.

- Confirm that correct bearings are used. Refer to "Inspection" (EM-52).
- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.
- Apply 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 engine oil to piston rings and sliding surface of piston.

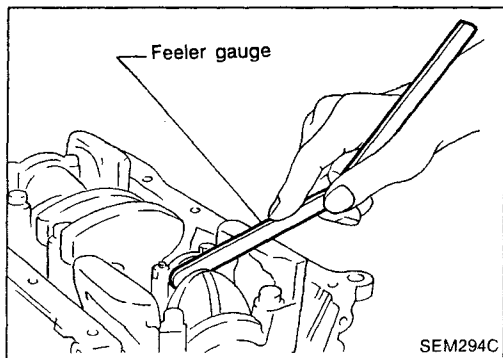
Assembly (Cont'd)

- b. Install connecting rod caps.

Tighten connecting rod cap nuts to the specified torque.

□: Connecting rod cap nuts

- (1) Tighten to 13.72 to 15.68 N·m (1.399 to 1.599 kg-m, 10.120 to 11.566 ft-lb).
- (2) 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).



6. Measure connecting rod side clearance.

Connecting rod side clearance:

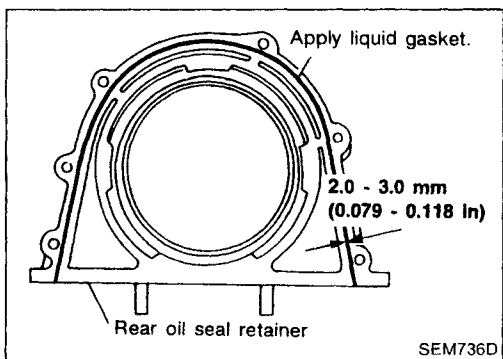
Standard:

0.200 - 0.470 mm (0.0079 - 0.0185 in)

Limit:

0.52 mm (0.0205 in)

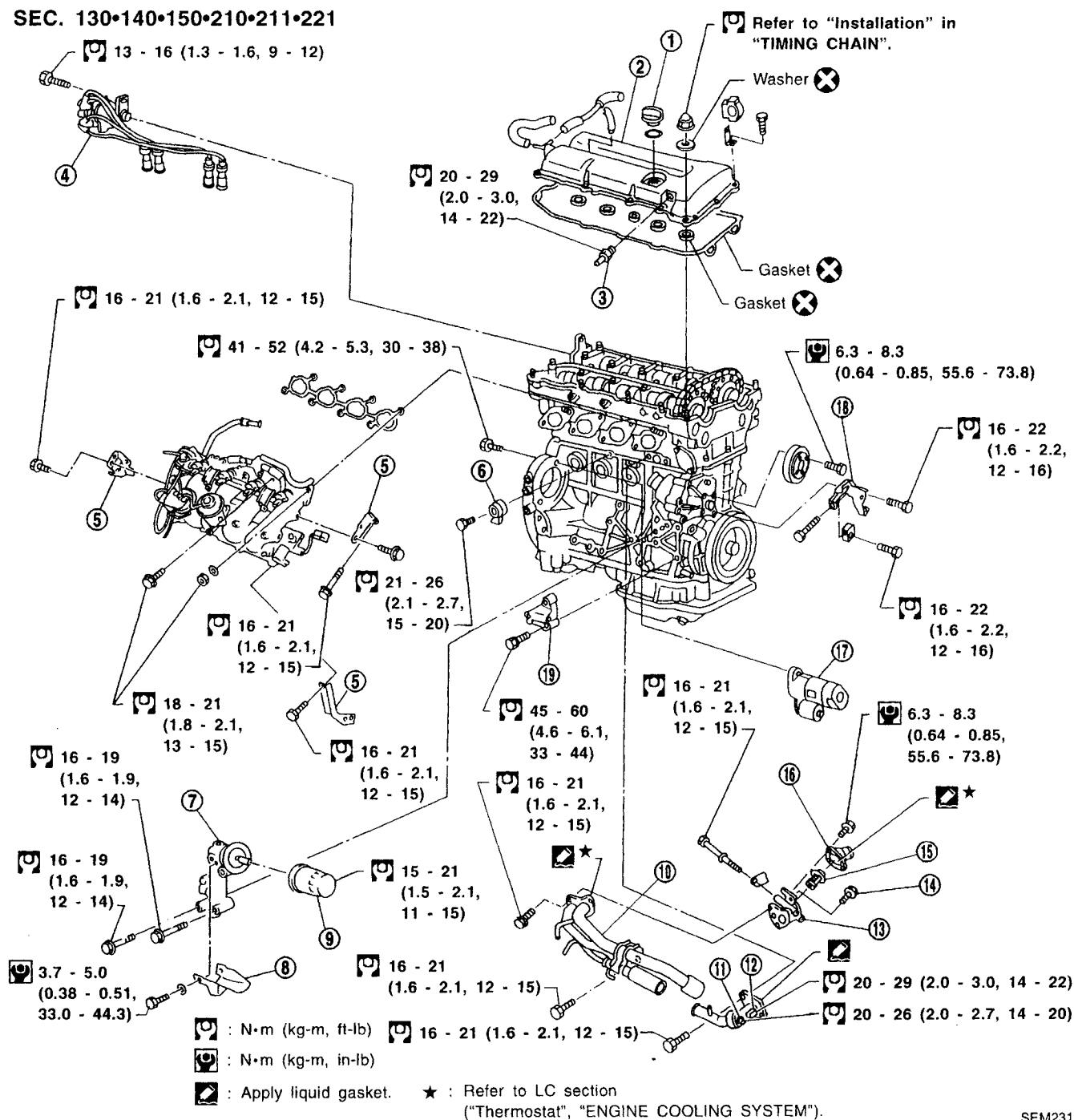
If beyond the limit, replace connecting rod and/or crankshaft.



7. Install rear oil seal retainer.

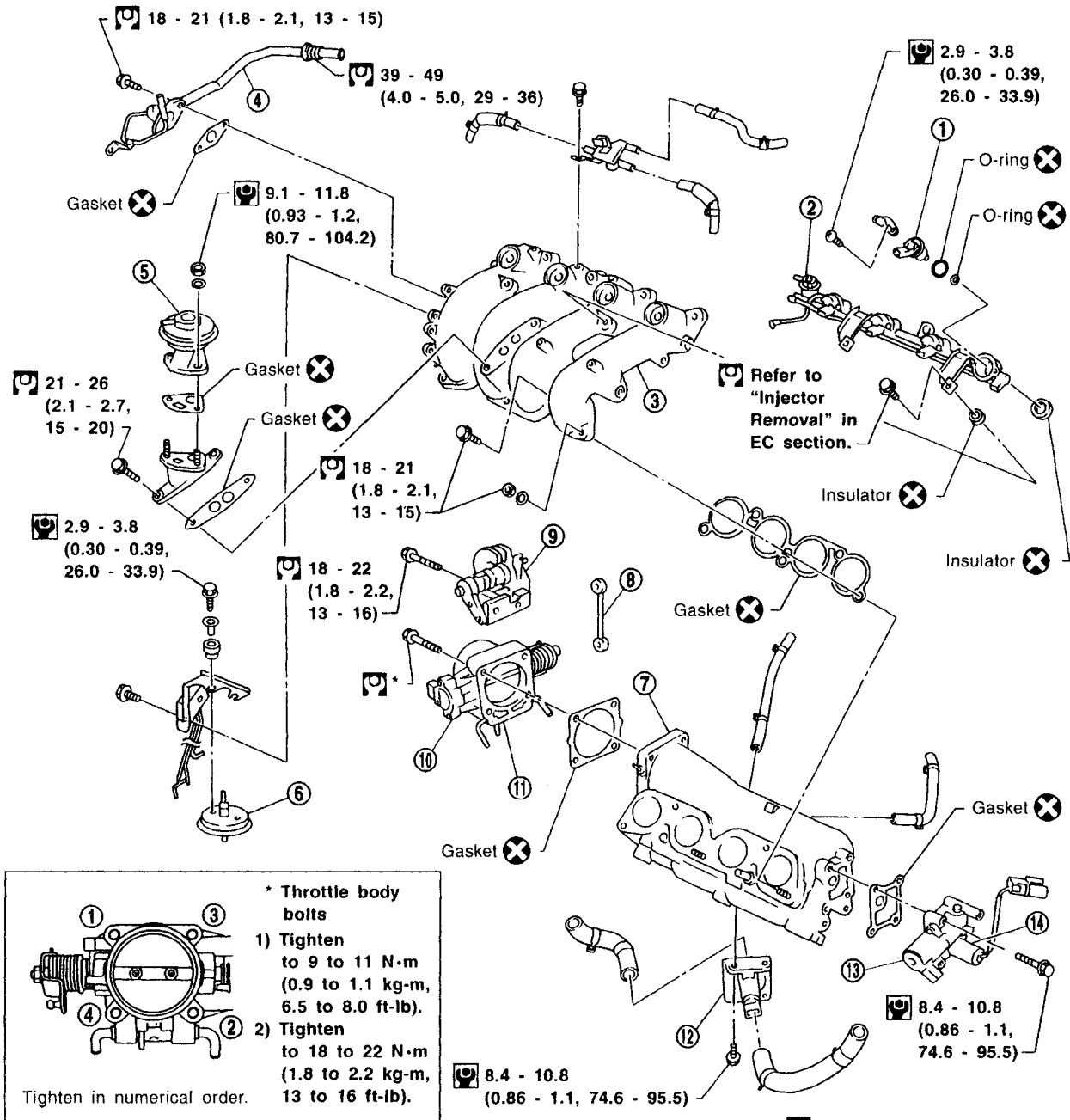
- a. Before installing rear oil seal retainer, remove all traces of liquid gasket from cylinder block and retainer with a scraper.
 - b. Apply a continuous bead of liquid gasket to rear oil seal retainer.
- Apply around inner side of bolt holes.

SEC. 130•140•150•210•211•221



- | | | |
|---|-------------------------------------|---|
| ① Oil filler cap | ⑧ Oil catcher | ⑮ Thermostat |
| ② Rocker cover | ⑨ Oil filter | ⑯ Water inlet |
| ③ PCV valve | ⑩ Water pipe assembly | ⑰ Starter motor |
| ④ Camshaft position sensor, ignition coil and power transistor built into distributor | ⑪ Thermal transmitter | ⑱ Power steering oil pump adjusting bar |
| ⑤ Intake manifold supports | ⑫ Engine coolant temperature sensor | ⑲ Power steering oil pump bracket |
| ⑥ Knock sensor | ⑬ Thermostat housing | |
| ⑦ Oil filter bracket | ⑭ Air relief plug | |

SEC. 140•147•163•164



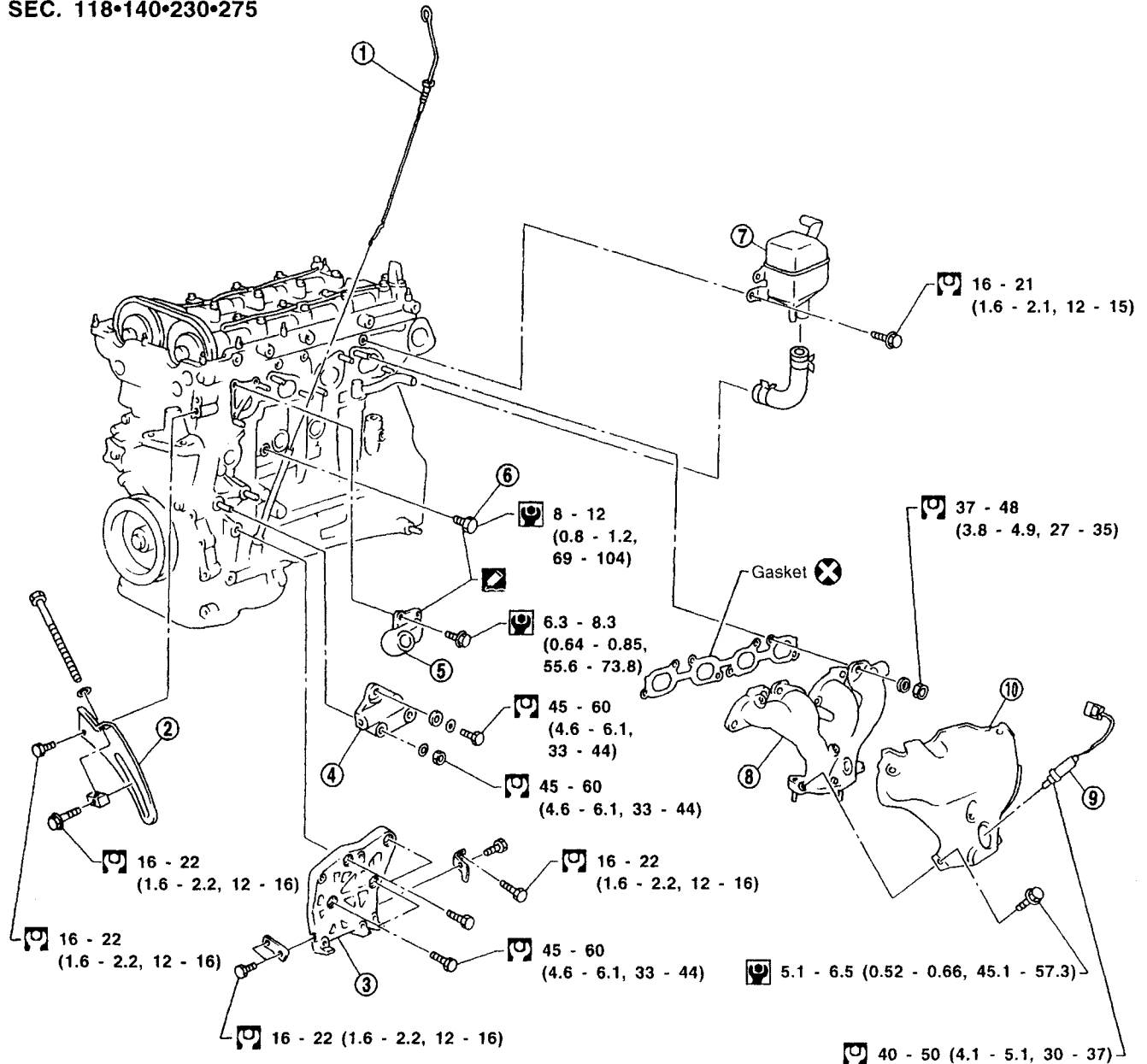
⌚ : N·m (kg-m, ft-lb)

⌚ : N·m (kg-m, in-lb)

SEM232F

- | | | |
|----------------------|-----------------------------|----------------------------|
| ① Injector | ⑥ EGRC-BPT valve | ⑪ Throttle body |
| ② Pressure regulator | ⑦ Intake manifold collector | ⑫ IACV-air regulator |
| ③ Intake manifold | ⑧ Rod | ⑬ IACV-AAC valve |
| ④ EGR tube | ⑨ Accel-drum unit | ⑭ IACV-FICD solenoid valve |
| ⑤ EGR valve | ⑩ Throttle position sensor | |

SEC. 118•140•230•275



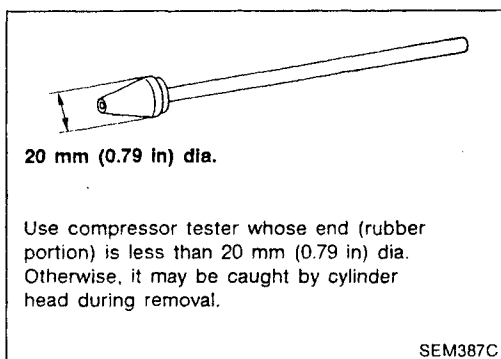
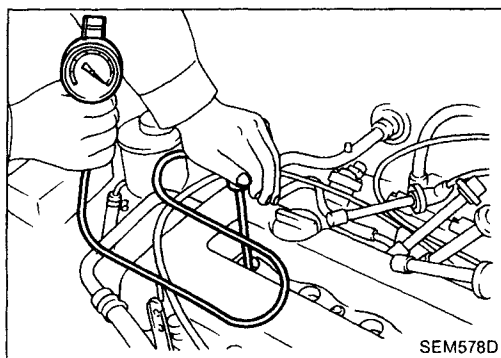
- : N•m (kg-m, in-lb)
- : N•m (kg-m, ft-lb)
- : Apply liquid gasket.

SEM233F

- | | | |
|----------------------------|---------------------------------------|--------------------------|
| ① Oil level gauge | ⑤ Water outlet | ⑧ Exhaust manifold |
| ② Alternator adjusting bar | ⑥ Drain plug | ⑨ Heated oxygen sensor |
| ③ Compressor bracket | ⑦ Crankcase ventilation oil separator | ⑩ Exhaust manifold cover |
| ④ Alternator bracket | | |

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 coil connector.



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/cm², psi)/300 rpm

Standard

1,226 (12.26, 12.5, 178)

Minimum

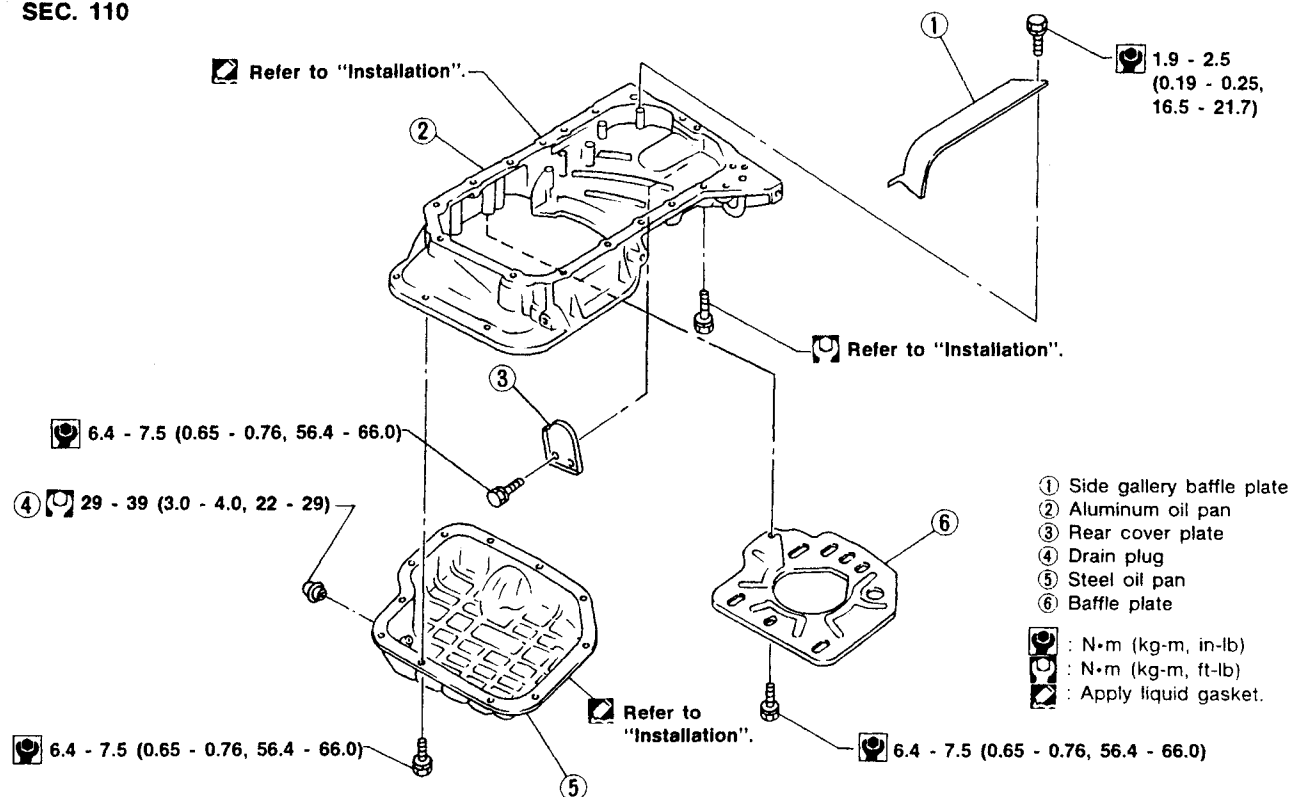
1,030 (10.30, 10.5, 149)

Difference limit between cylinders

98 (0.98, 1.0, 14)

10. If compression in one or more cylinders is low:
 - a. Pour a small amount of engine oil into cylinders through spark plug holes.
 - b. Retest compression.
- **If adding oil helps compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. Refer to SDS. If valve or valve seat is damaged excessively, replace them.**
- **There is leakage past the gasket surface if the following is observed. Compression in two adjacent cylinders is low and adding oil does not improve compression. If so, replace cylinder head gasket.**

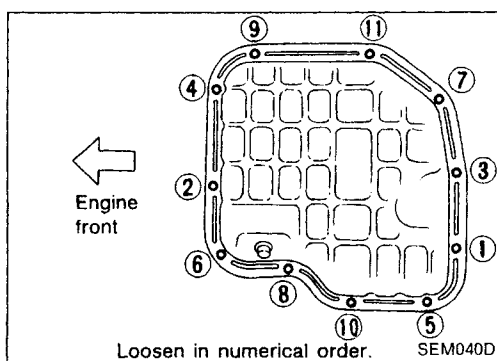
SEC. 110



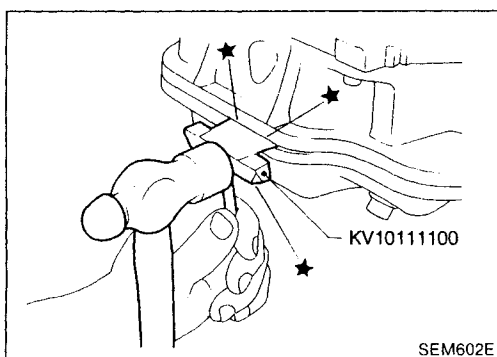
SEM142FA

Removal

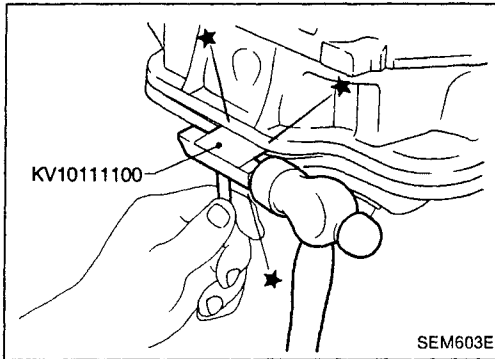
1. Remove engine under cover.
2. Drain engine oil.



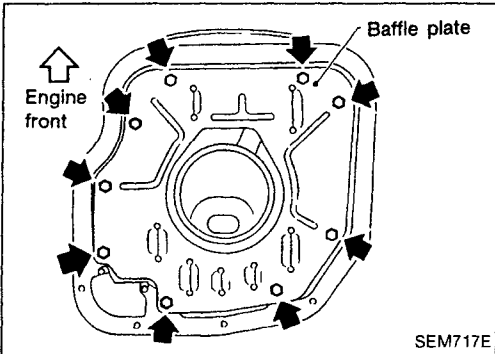
3. Remove steel oil pan bolts.



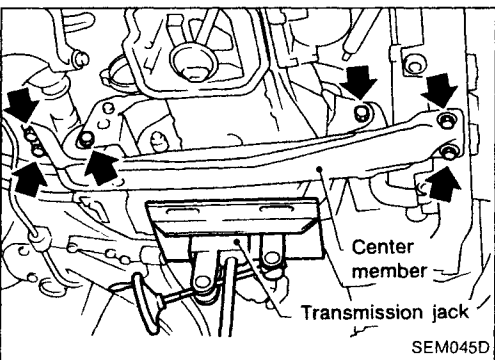
4. Remove steel oil pan.
 - a. Insert Tool between aluminum oil pan and steel oil pan.
 - Be careful not to damage aluminum mating surface.
 - Do not insert screwdriver, or oil pan flange will be deformed.

Removal (Cont'd)

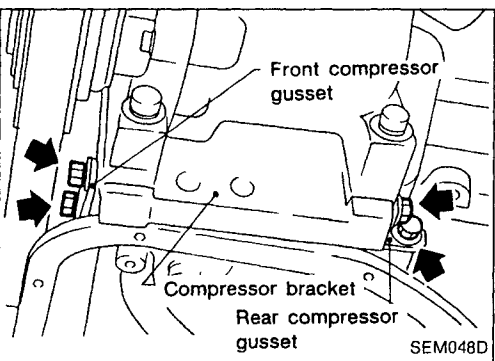
- b. Slide Tool by tapping on the side of the Tool with a hammer.
- c. Remove steel oil pan.



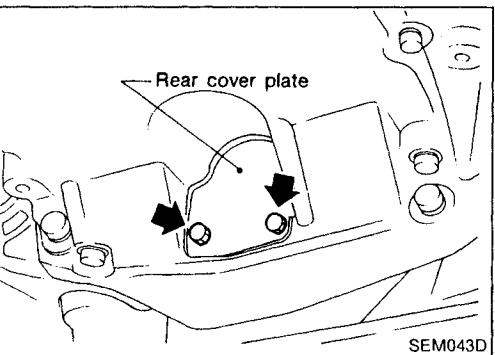
- d. Remove baffle plate.



5. Remove front tube.
6. Set a suitable transmission jack under transaxle and hoist engine with engine slinger.
7. Remove center member.
8. Remove A/T shift control cable. (A/T only)



9. Remove compressor gussets.



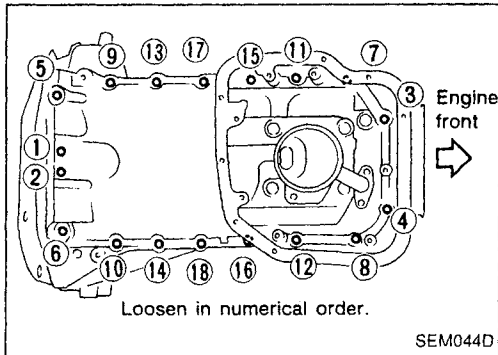
10. Remove rear cover plate.

OIL PAN

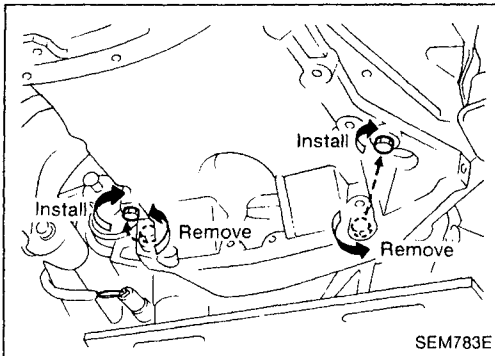
SR

Removal (Cont'd)

11. Remove aluminum oil pan bolts.

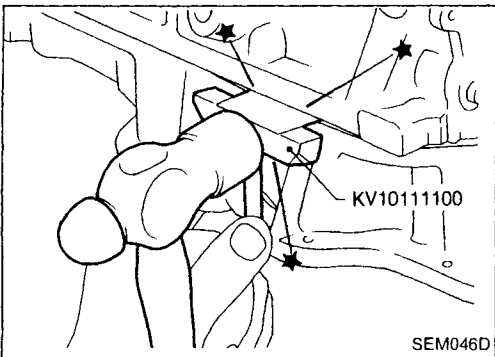


12. Remove the two engine-to-transaxle bolts and install them into open bolt holes shown. Tighten the bolts to release aluminum oil pan from cylinder block.

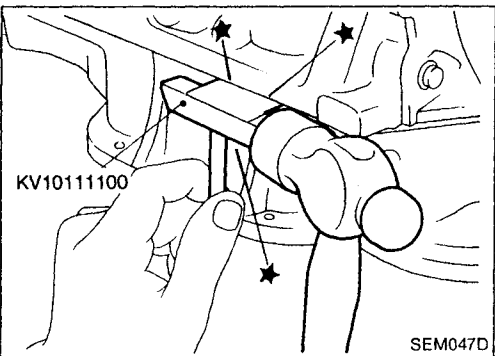


13. Remove aluminum oil pan.

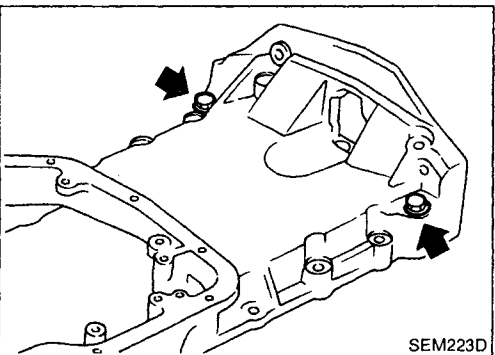
- a. Insert Tool between cylinder block and aluminum oil pan.
 - **Be careful not to damage aluminum mating surface.**
 - **Do not insert screwdriver, or oil pan flange will be damaged.**



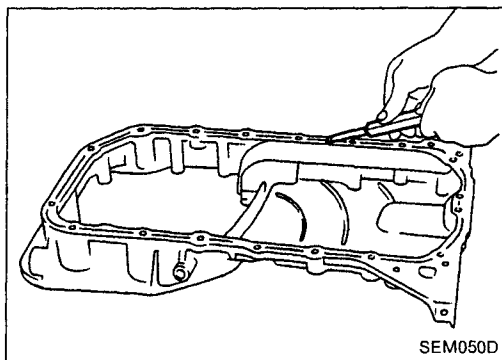
- b. Slide Tool by tapping on the side of the Tool with a hammer.



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

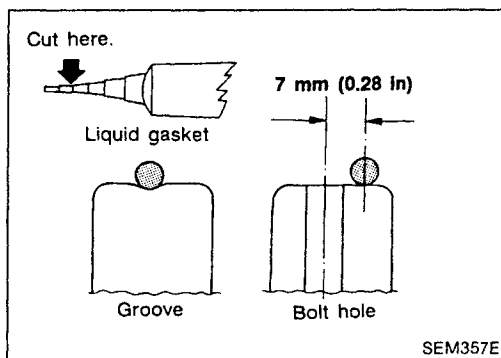


EM

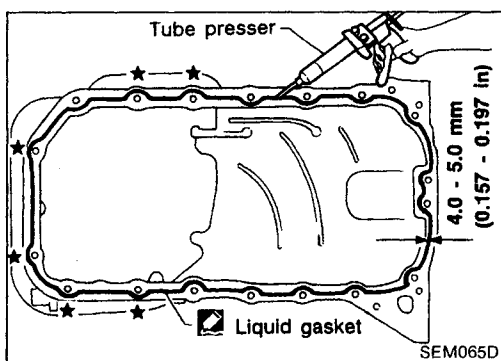


Installation

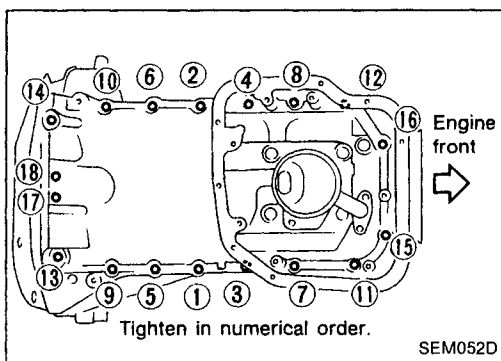
1. Install aluminum oil pan.
 - a. Use a scraper to remove all traces of liquid gasket from mating surfaces.
 - Also remove traces of liquid gasket from mating surface of cylinder block and front cover.



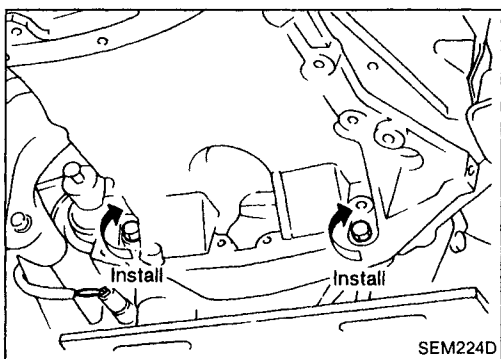
- b. Apply a continuous bead of liquid gasket to mating surface of aluminum oil pan.
 - **Use Genuine Liquid Gasket or equivalent.**
 - **Be sure liquid gasket diameter is 4.0 to 5.0 mm (0.157 to 0.197 in).**
 - **Attaching should be done within 5 minutes after coating.**



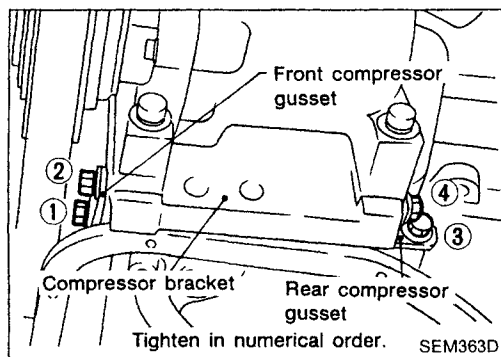
- For areas marked with "★", apply liquid gasket to the outer side of the bolt hole.



- 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:
 - ⌚: 6.4 - 7.5 N·m (0.65 - 0.76 kg-m, 56.4 - 66.0 in-lb)

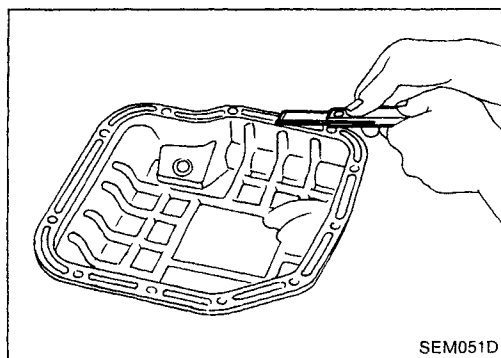


2. Install the two engine to transaxle bolts. For tightening torque, refer to MT or AT section ("REMOVAL AND INSTALLATION").
3. Install rear cover plate.

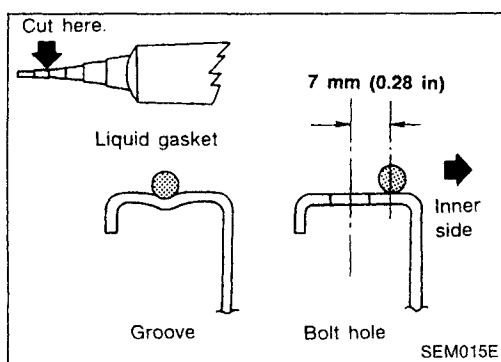


Installation (Cont'd)

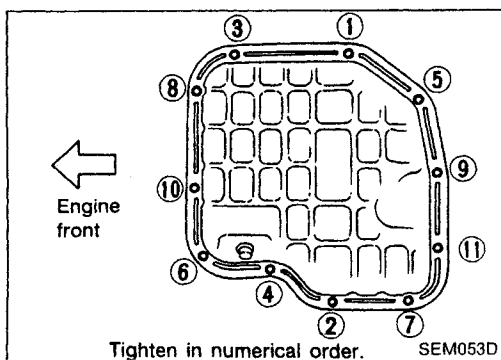
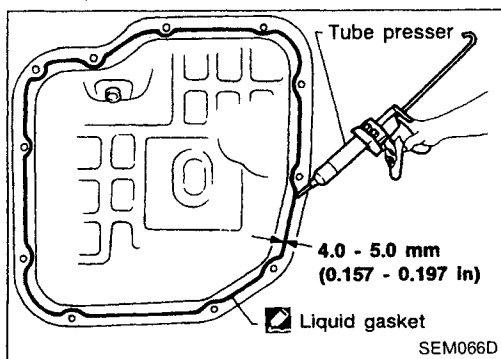
4. Install compressor gussets.
5. Install A/T shift control cable. (A/T only)
6. Install center member.
7. Install front tube.
8. Install baffle plate.



9. Install steel oil pan.
 - a. Use a scraper to remove all traces of liquid gasket from mating surfaces.
 - Also remove traces of liquid gasket from mating surface of aluminum oil pan.



- 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.

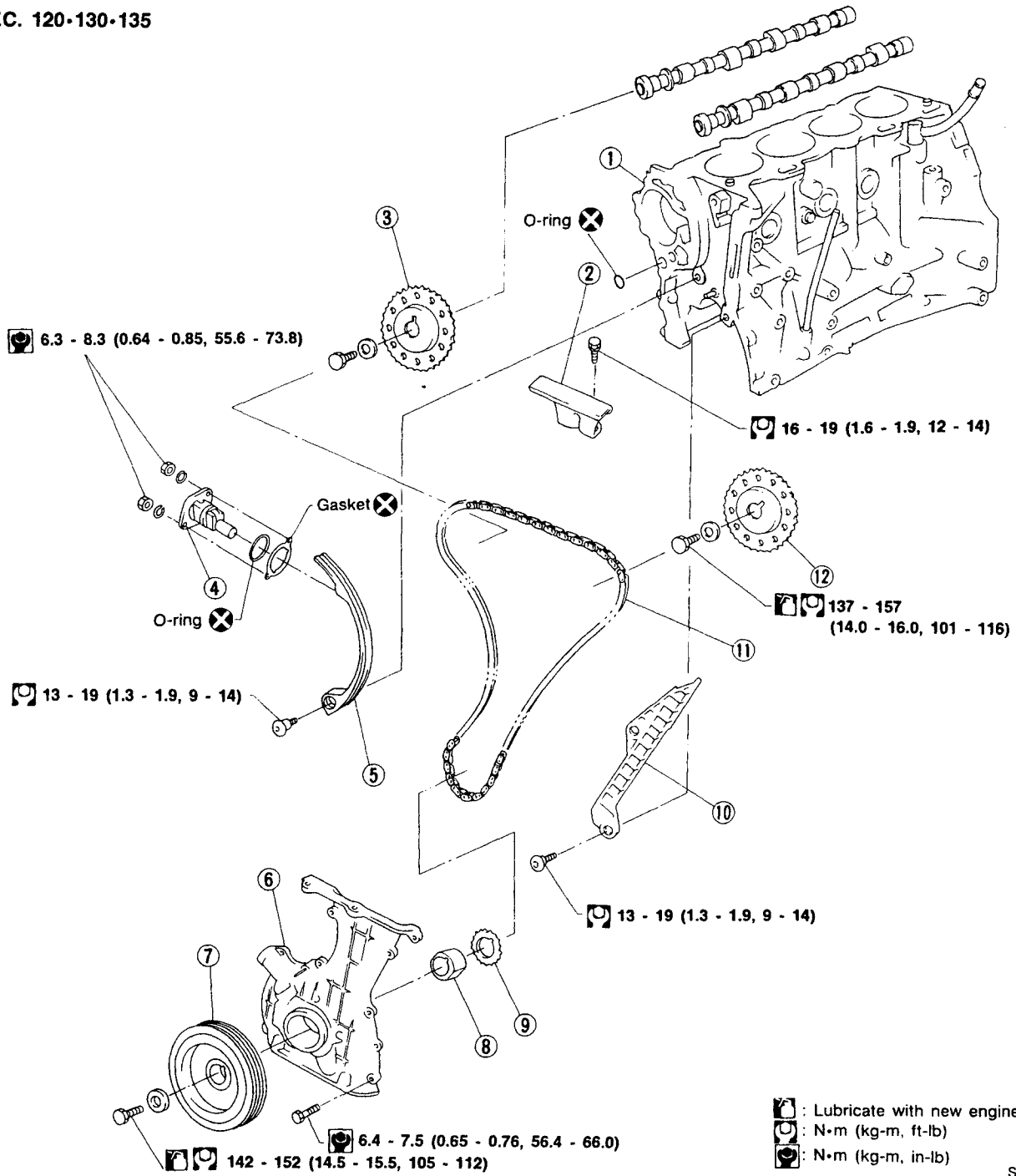


- c. Install steel oil pan.
 - Install bolts in the reverse order of removal together with heated oxygen sensor harness bracket.
 - Wait at least 30 minutes before refilling engine oil.

TIMING CHAIN

SR

SEC. 120-130-135



SEM718EC

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

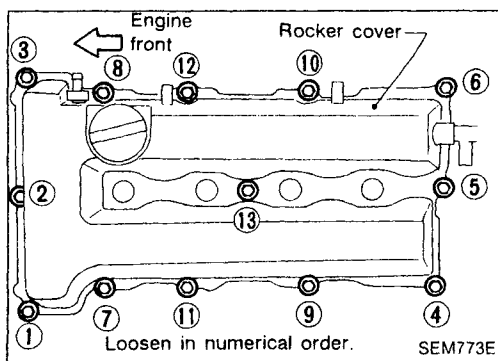
CAUTION:

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

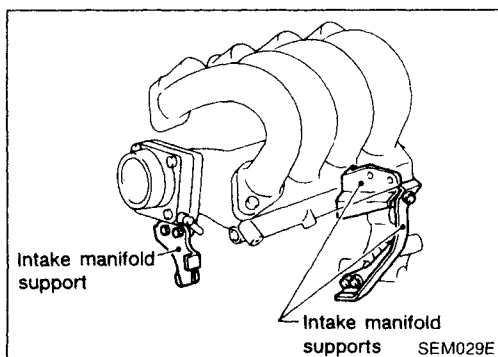
EM

Removal

1. Release fuel pressure.
Refer to "Releasing Fuel Pressure" in EC section.
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.
5. Remove radiator.
6. Remove air duct to intake manifold.
7. Remove drive belts and water pump pulley.
8. Remove alternator and power steering oil pump.
9. Remove vacuum hoses, fuel hoses, wires, harness, connectors and so on.
10. Remove all spark plugs.



11. Remove rocker cover and oil separator.

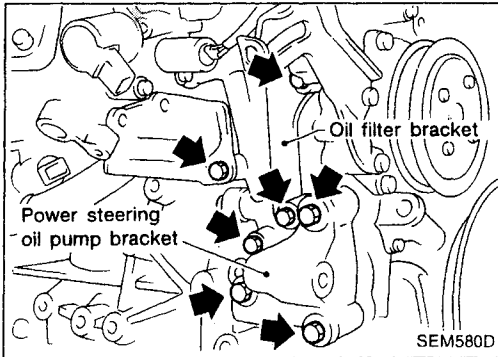


12. Remove intake manifold supports.

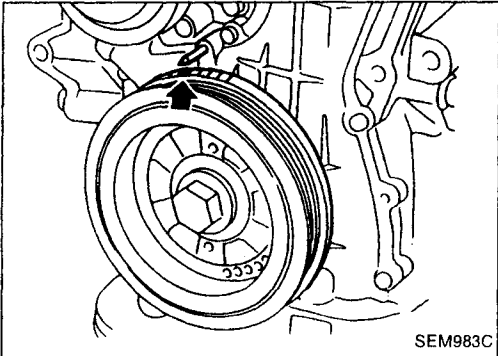
TIMING CHAIN

SR

Removal (Cont'd)

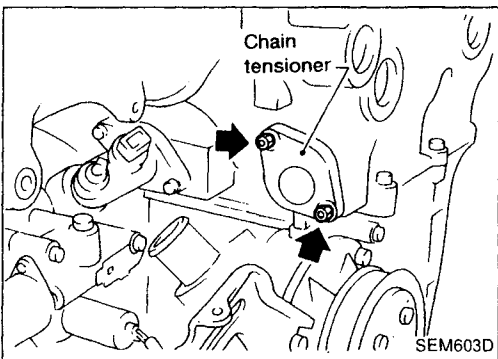
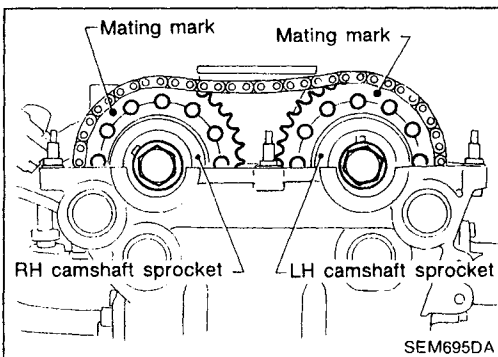


13. Remove oil filter bracket and power steering oil pump bracket.

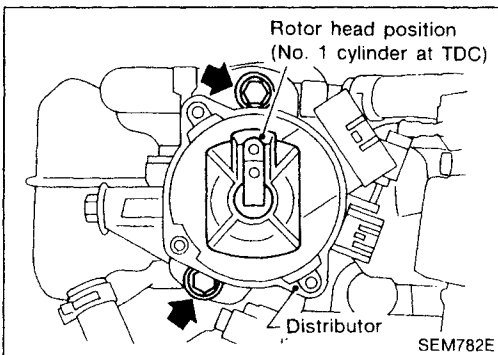


14. Set No. 1 piston at TDC on the compression stroke by rotating crankshaft.

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



15. Remove chain tensioner.



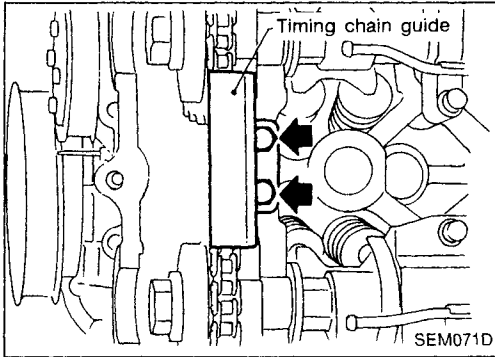
16. Remove distributor.
Do not turn rotor with distributor removed.

TIMING CHAIN

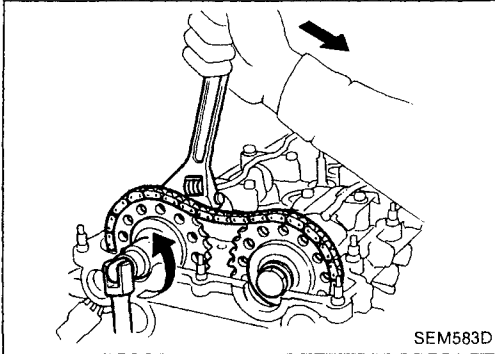
SR

Removal (Cont'd)

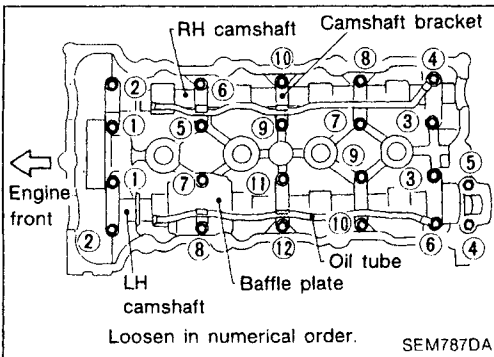
17. Remove timing chain guide.



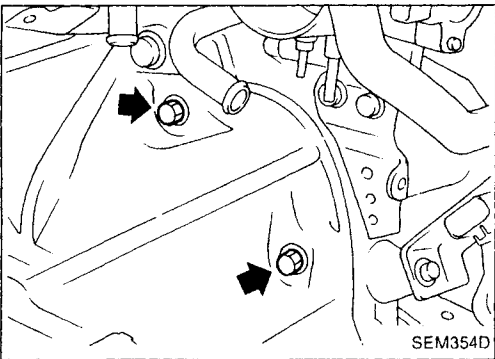
18. Remove camshaft sprockets.



19. Remove camshafts, camshaft brackets, oil tubes and baffle plate.



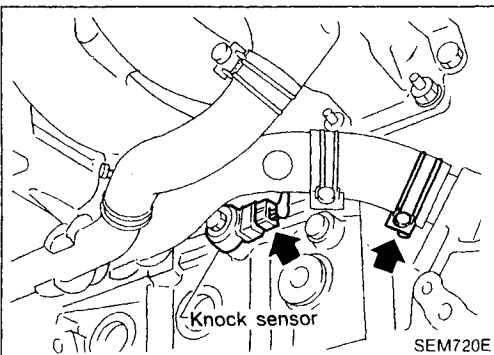
20. Remove starter motor.



21. Remove the following water hoses.

- Water hose for cylinder block.
- Water hoses from heater.

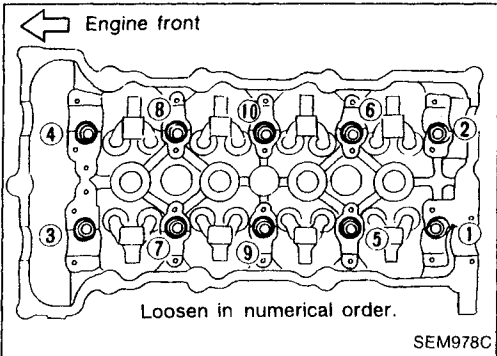
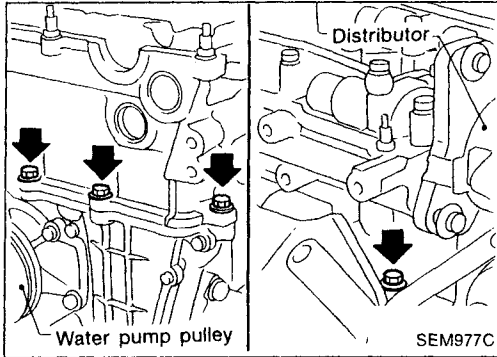
22. Remove knock sensor harness connector.



EM

Removal (Cont'd)

23. Remove cylinder head outside bolts.



24. Remove cylinder head bolts.

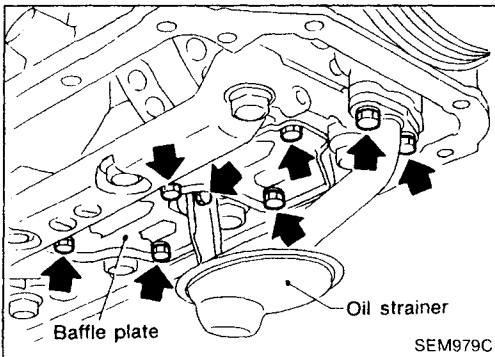
● **Bolts should be loosened in two or three steps.**

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

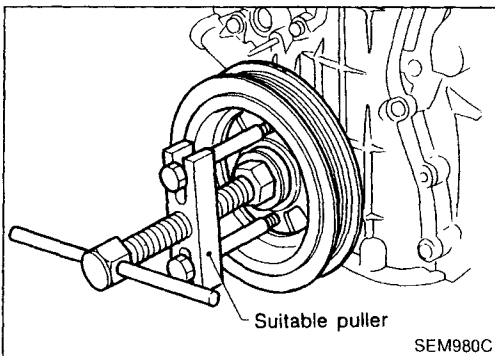
26. Remove oil pans.

Refer to "Removal" in "OIL PAN" (EM-63).

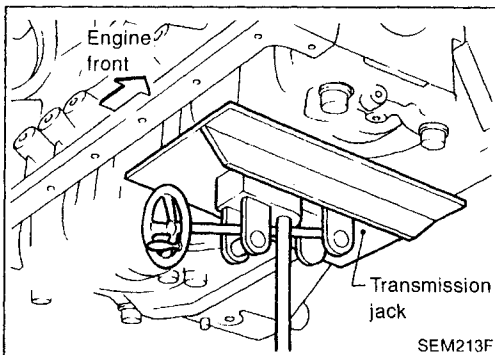
27. Remove oil strainer.



28. Remove crankshaft pulley.

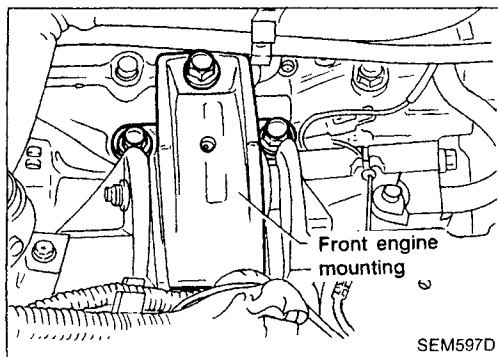


29. Set a suitable transmission jack under main bearing.



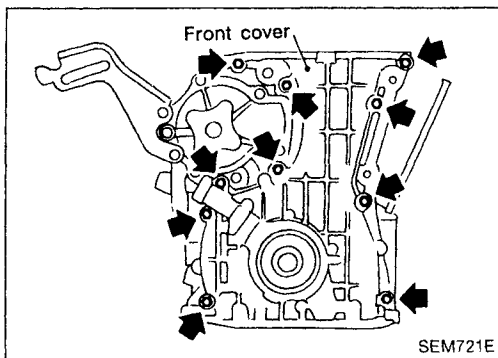
Removal (Cont'd)

30. Remove front engine mounting.

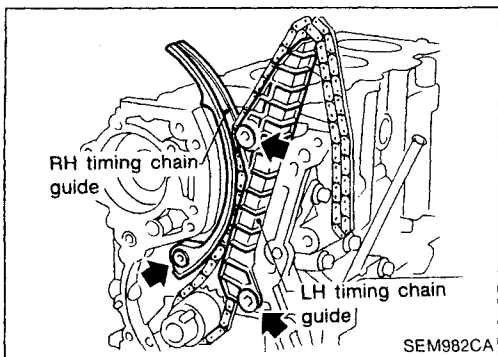


31. Remove front cover and oil pump drive spacer.

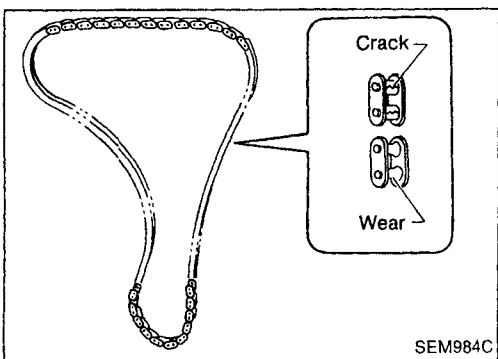
- Inspect for oil leakage at front oil seal. Replace seal if oil leak is present.



32. Remove timing chain guides and timing chain.

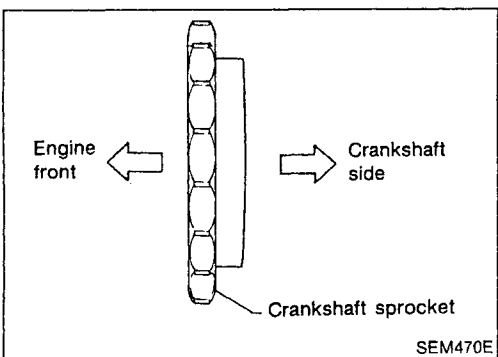
**Inspection**

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

**Installation**

1. Install crankshaft sprocket on crankshaft.

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

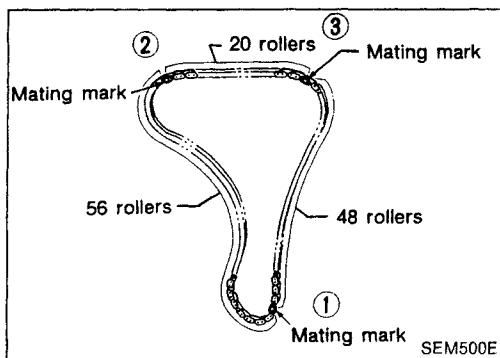
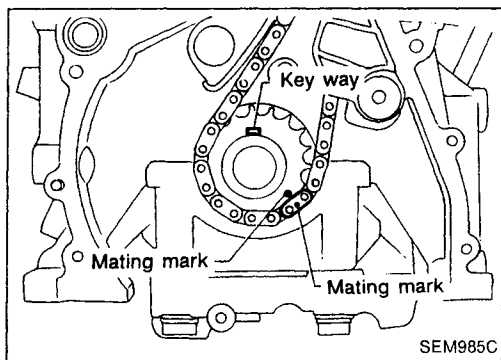


TIMING CHAIN

SR

Installation (Cont'd)

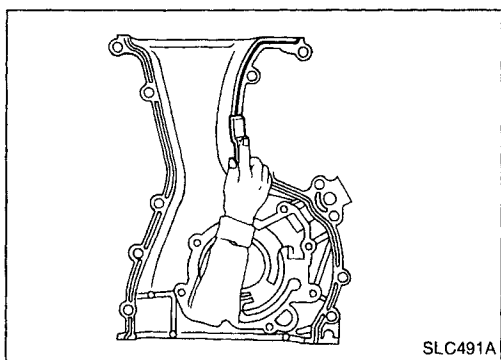
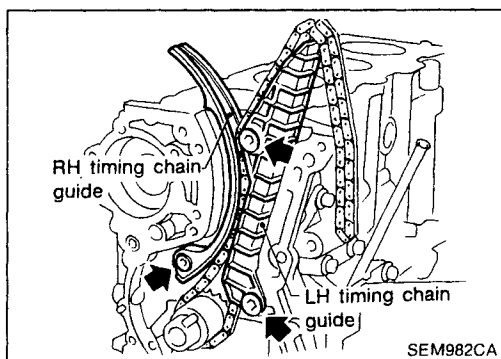
- Position crankshaft so that No. 1 piston is set at TDC and key way is at 12 o'clock. Fit timing chain on crankshaft sprocket, aligning the mating marks.



- Mating mark color on timing chain.

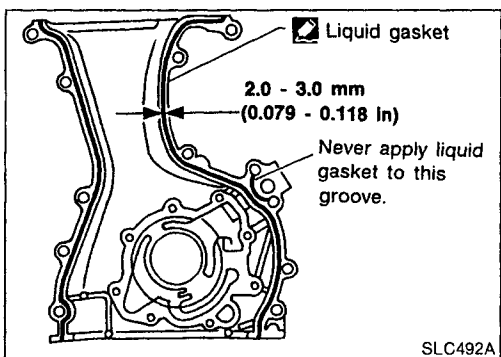
① : Gold
②, ③ : Silver

- Install timing chain and timing chain guides.



- 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.

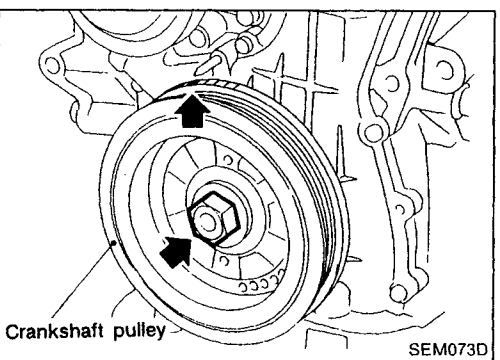
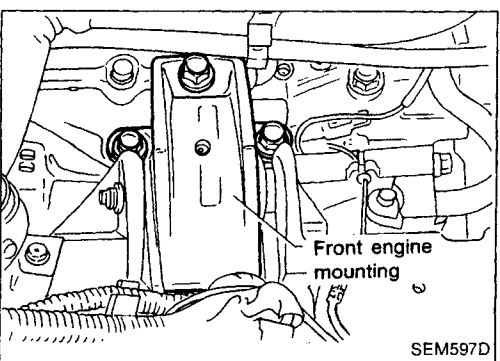
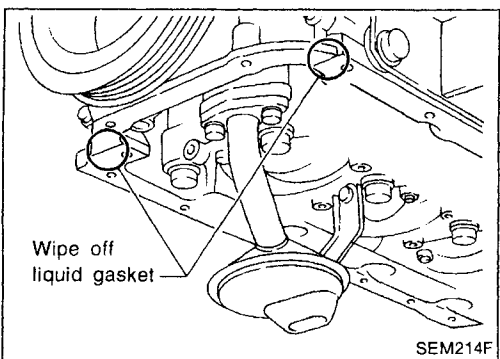
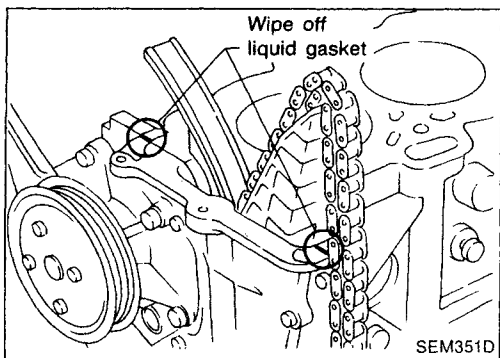
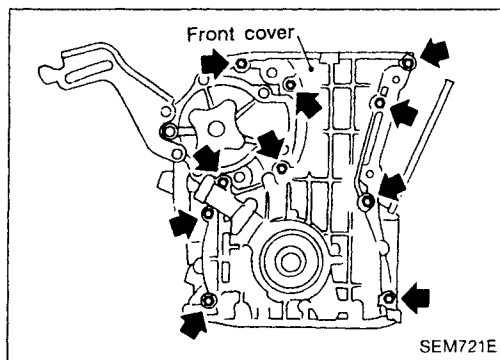


- Apply a continuous bead of liquid gasket to mating surface of front cover.

- Use Genuine Liquid Gasket or equivalent.
- Be sure to install new front oil seal in the right direction. Refer to EM-82.

Installation (Cont'd)

6. Install oil pump drive spacer and front cover.



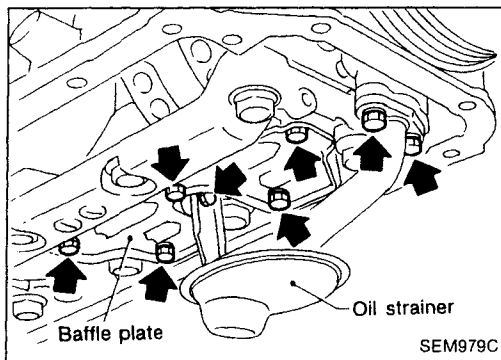
- Wipe off excessive liquid gasket.

7. Install front engine mounting.

8. Install crankshaft pulley.

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

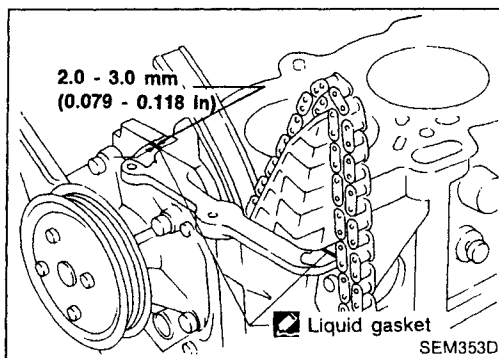
Installation (Cont'd)



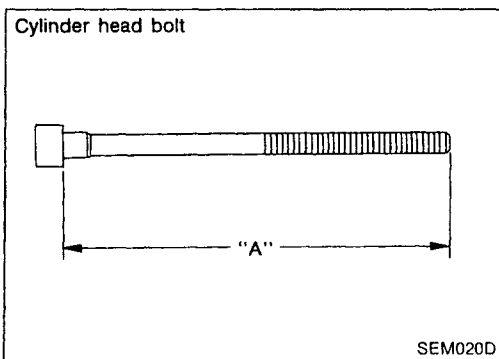
10. Install oil strainer.

11. Install oil pan.

Refer to "Installation" in "OIL PAN" (EM-66).



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



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

- Apply engine oil to threads and seating surfaces of cylinder head bolts before installing them.

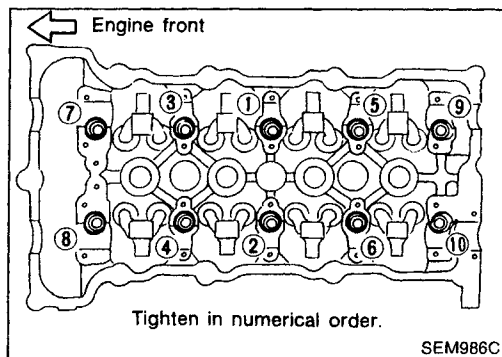
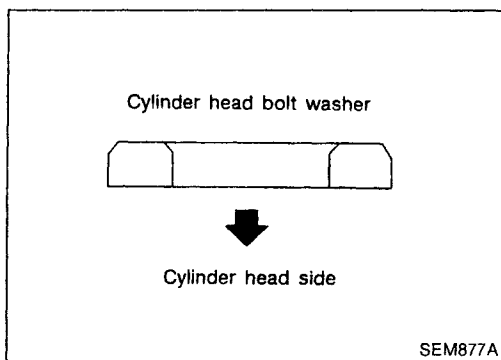
- Be sure to install washers between bolts and cylinder head.

CAUTION:

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

Dimension "A":

158.2 mm (6.228 in)

● **Tightening procedure:**

a Tighten all bolts to 39 N·m (4.0 kg-m, 29 ft-lb).

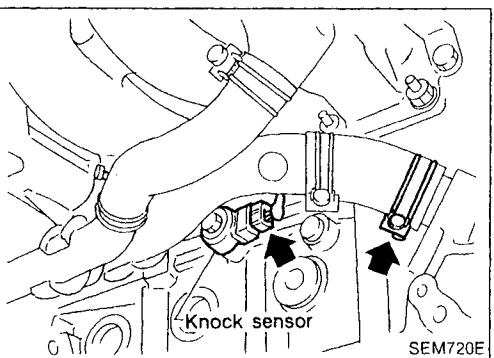
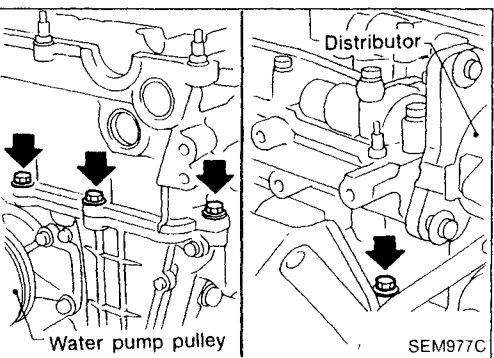
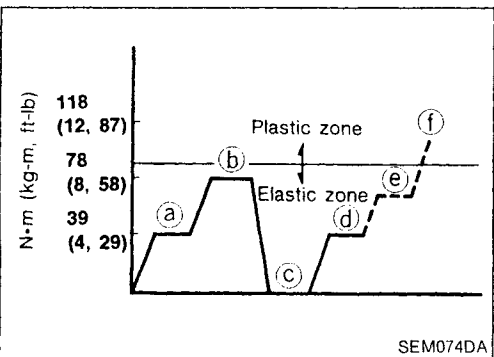
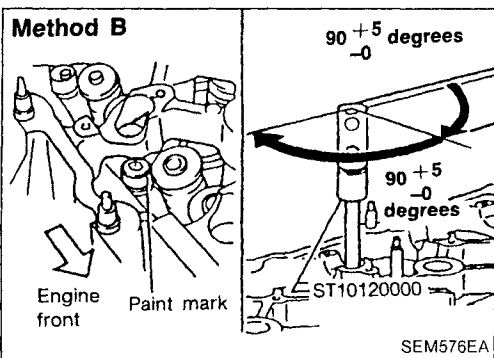
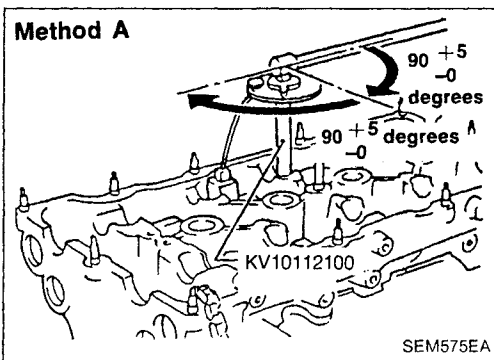
b Tighten all bolts to 78 N·m (8.0 kg-m, 58 ft-lb).

c Loosen all bolts completely.

d Tighten all bolts to 34 to 44 N·m (3.5 to 4.5 kg-m, 25 to 33 ft-lb).

TIMING CHAIN

SR



Installation (Cont'd)

- ⑤ Method A: Turn all bolts 90 to 95 degrees clockwise with Tool or suitable angle wrench.

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

- ⑥ Turn all bolts 90 to 95 degrees clockwise.
⑦ 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)
⑧	39 (4.0, 29)
⑨	78 (8.0, 58)
⑩	0 (0, 0)
⑪	34 - 44 (3.5 - 4.5, 25 - 33)
⑫	90 - 95 degrees (90 degree preferred)
⑬	90 - 95 degrees (90 degree preferred)

14. Install cylinder head outside bolts.

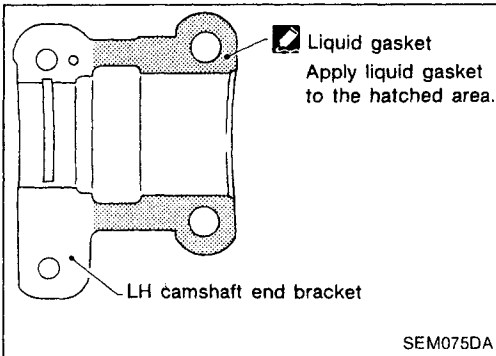
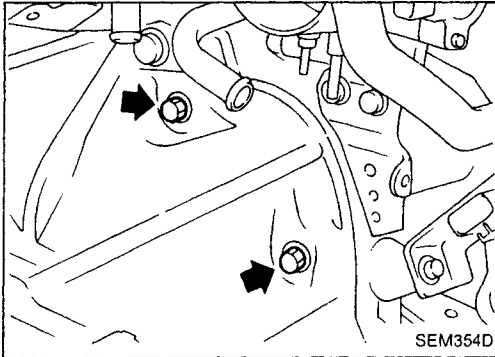
15. Install the following water hoses.

- Water hose for cylinder block.
- Water hoses for heater.

16. Install knock sensor harness connector.

Installation (Cont'd)

17. Install starter motor.

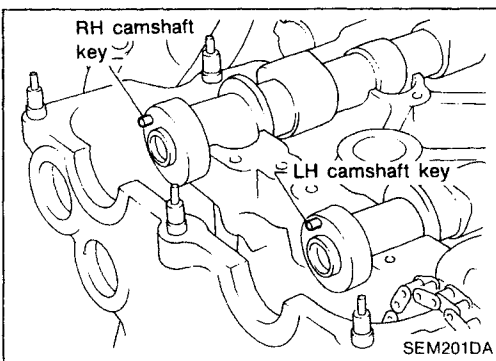


18. Remove all traces of liquid gasket from mating surface of LH camshaft end bracket.

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

19. Apply liquid gasket to mating surface of LH camshaft end bracket as shown in illustration.

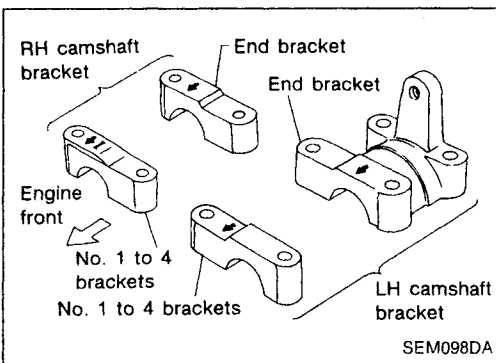
- Use Genuine Liquid Gasket or equivalent.



20. Install camshafts, camshaft brackets, oil tubes and baffle plate.

- Position camshaft.
- LH camshaft key at about 12 o'clock
- RH camshaft key at about 10 o'clock

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



- Position camshaft brackets as shown in illustration.

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

Installation (Cont'd)

● Tightening procedure

STEP 1:

RH camshaft

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

⌚: 2 N·m (0.2 kg-m, 1.4 ft-lb)

LH camshaft

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

⌚: 2 N·m (0.2 kg-m, 1.4 ft-lb)

STEP 2:

Tighten bolts in the specified order.

⌚: 6 N·m (0.6 kg-m, 4.3 ft-lb)

STEP 3:

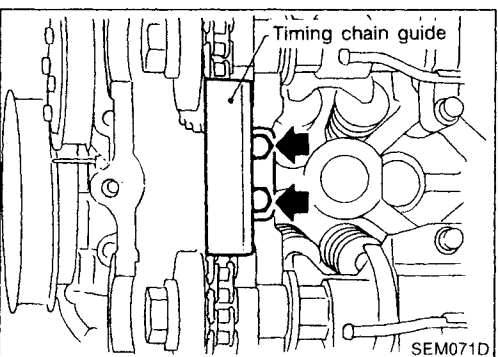
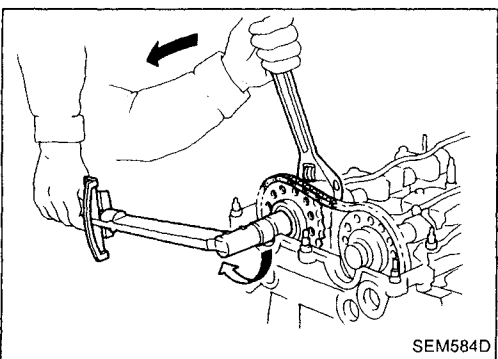
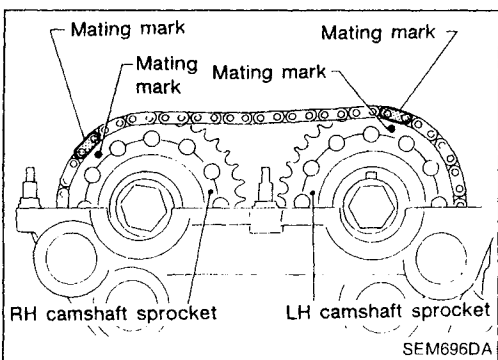
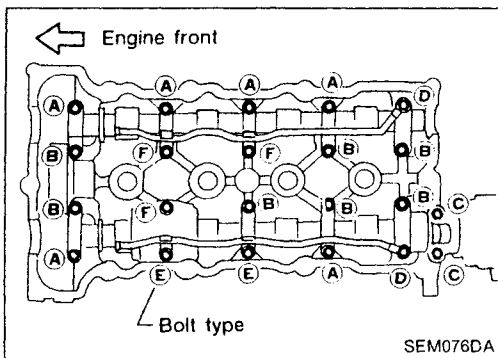
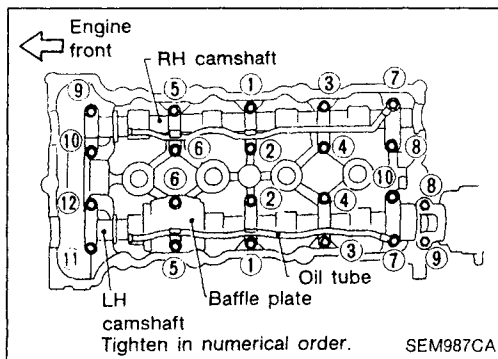
Tighten bolts in the specified order.

Bolt type ① ② ③ ④ ⑤ ⑥

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

Bolt type ⑦

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



21. Install camshaft sprockets.

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

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

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

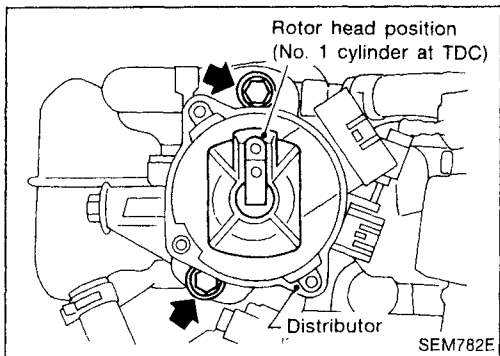
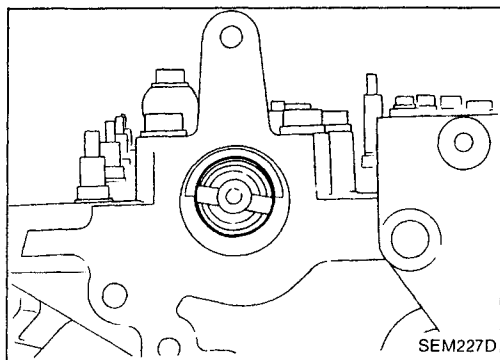
Apply engine oil to threads and seating surfaces of camshaft sprocket bolts before installing them.

22. Install timing chain guide.

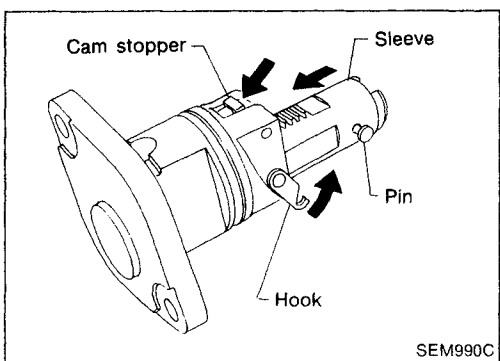
Installation (Cont'd)

23. Install distributor.

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

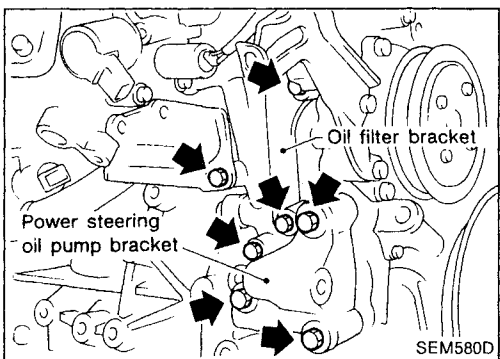
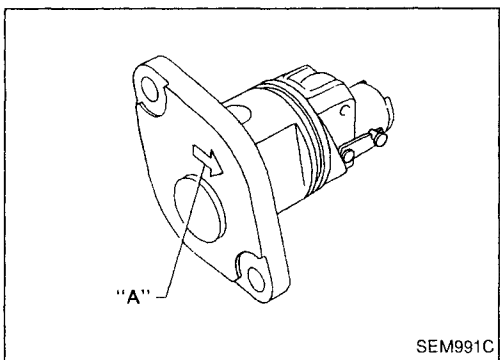


- Make sure that No. 1 piston is set at TDC and that distributor is set at No. 1 cylinder spark position.



24. Install chain tensioner.

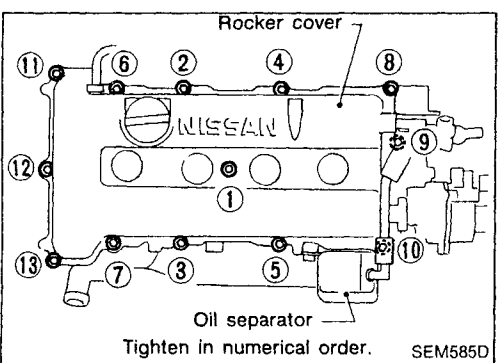
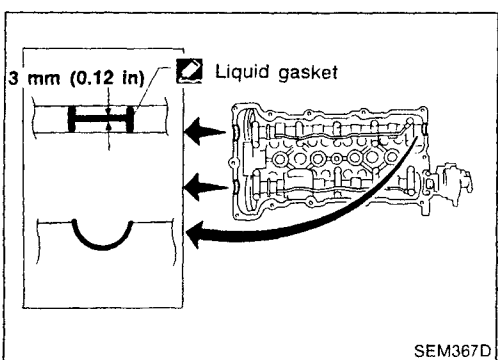
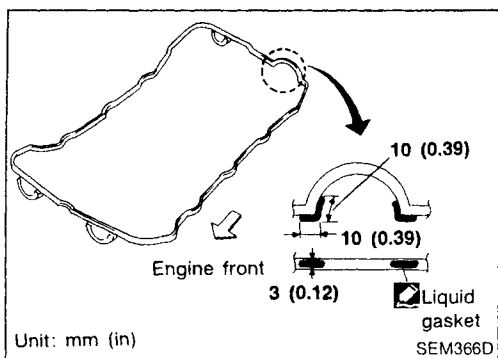
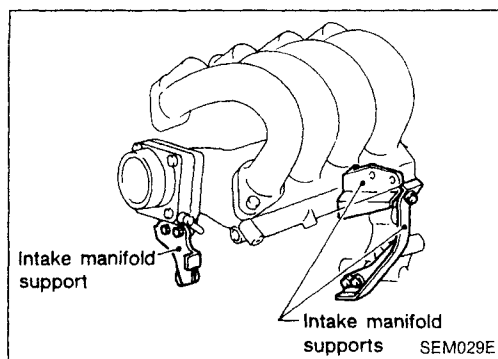
Make sure the camshaft sprockets are tightened completely. Press cam stopper down and "press-in" sleeve until hook can be engaged on pin. When tensioner is bolted in position the hook will release automatically. Make sure arrow "A" points toward engine front.



25. Install oil filter bracket and power steering oil pump bracket.

Installation (Cont'd)

26. Install intake manifold supports.



27. Remove all old liquid gasket from mating surfaces of rocker cover gasket and cylinder head.

28. Apply a continuous bead of liquid gasket to mating surfaces of rocker cover gasket and cylinder head.

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

29. Install rocker cover and oil separator.

(1) Tighten nuts ① - ⑩ - ⑪ - ⑬ - ⑧ in that order to 4 N·m (0.4 kg-m, 35 in-lb).

(2) Tighten nuts ① through ⑬ in numerical order to 8 to 10 N·m (0.8 to 1.0 kg-m, 69 to 87 in-lb).

30. Refit spark plugs and leads.

31. Install vacuum hoses, fuel hoses, wires, harness, connectors and so on.

32. Install power steering oil pump and alternator.

33. Install water pump pulley and drive belts.

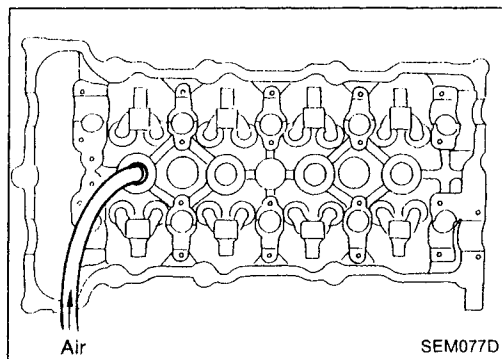
34. Refit air duct to intake manifold.

35. Install radiator.

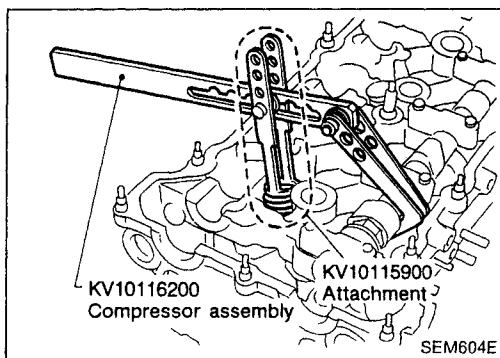
36. Refit hoses and refill with coolant. (Refer to MA section.)

37. Install engine side cover and front RH wheel.

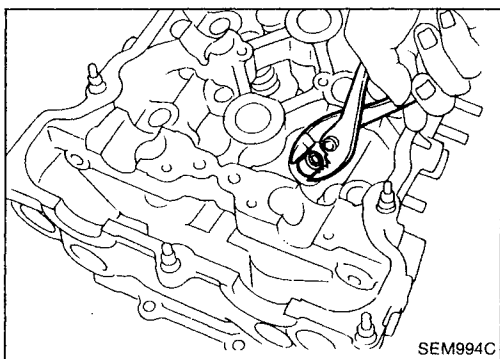
38. Install engine under covers.

**VALVE OIL SEAL**

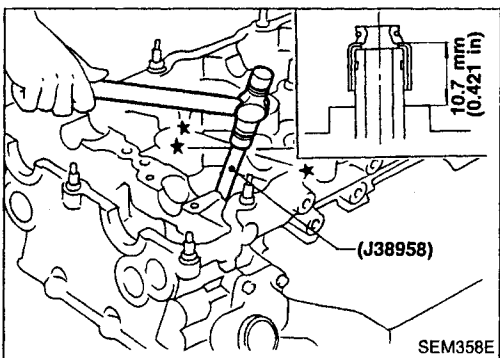
1. Remove accelerator cable.
2. Remove rocker cover and oil separator.
3. Remove camshafts and sprockets.
Refer to "Removal" in "TIMING CHAIN" (EM-69).
4. Remove spark plugs.
5. Install air hose adapter into spark plug hole and apply air pressure to hold valves in place. Apply a pressure of 490 kPa (4.9 bar, 5 kg/cm², 71 psi).
6. Remove rocker arm, rocker arm guide and shim.



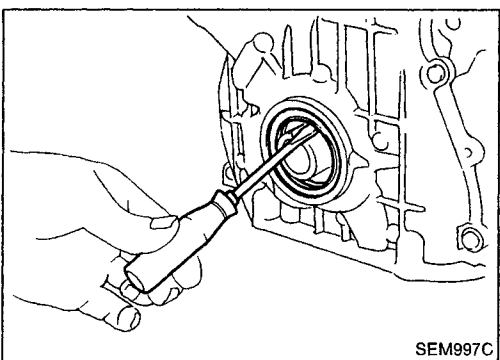
7. Remove valve spring with Tool.
Piston concerned should be set at TDC to prevent valve from falling.



8. Remove valve oil seal.

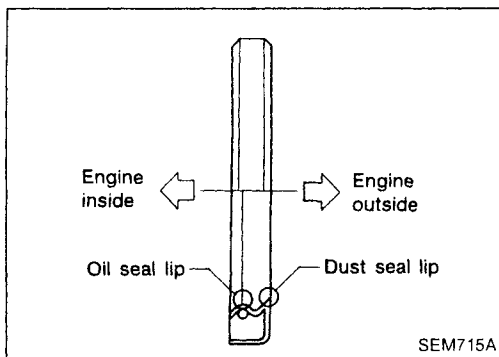


9. Apply engine oil to new valve oil seal and install it with Tool.

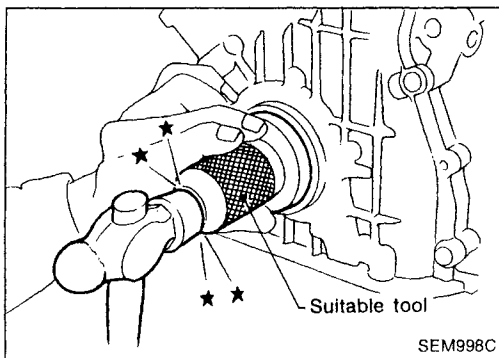
**FRONT OIL SEAL**

1. Remove the following parts:
 - Engine under cover
 - Front RH wheel and engine side cover
 - Drive belts
 - Crankshaft pulley
2. Remove front oil seal.

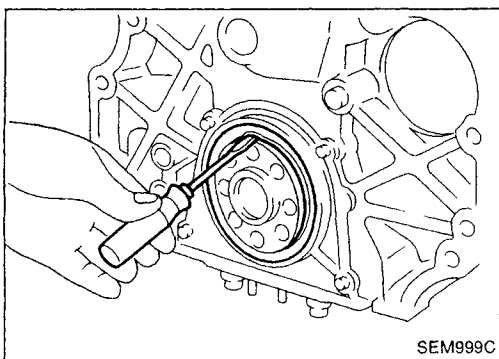
Be careful not to scratch front cover.



- Install new oil seal in the direction shown.



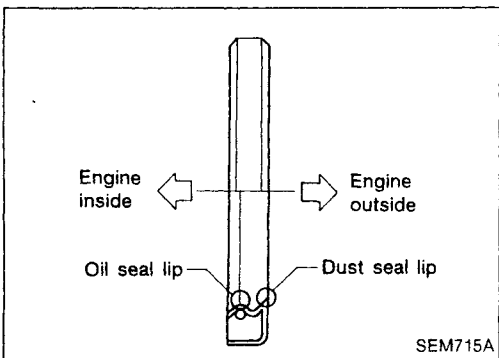
3. Apply engine oil to new oil seal and install it using a suitable tool.



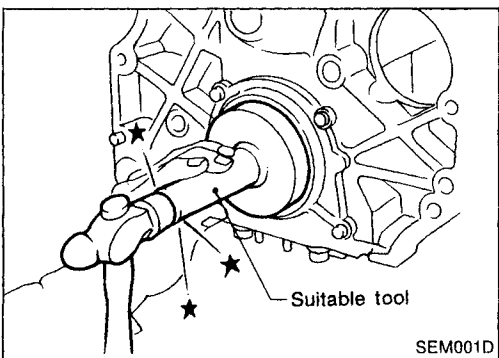
REAR OIL SEAL

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

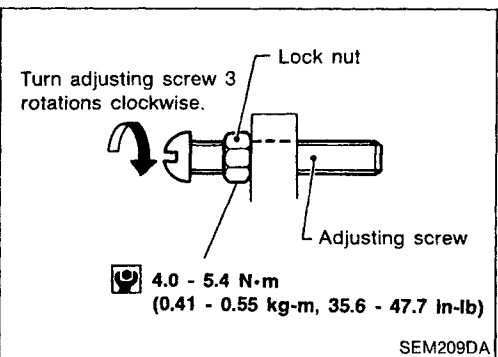
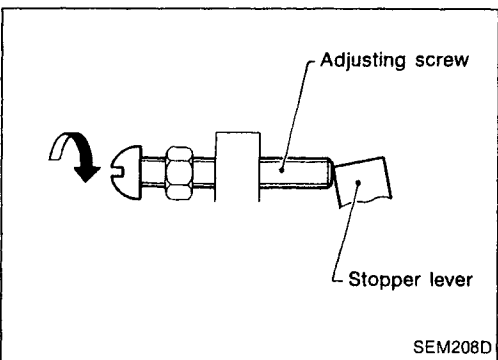
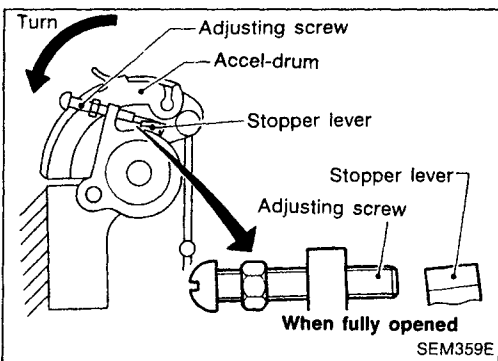
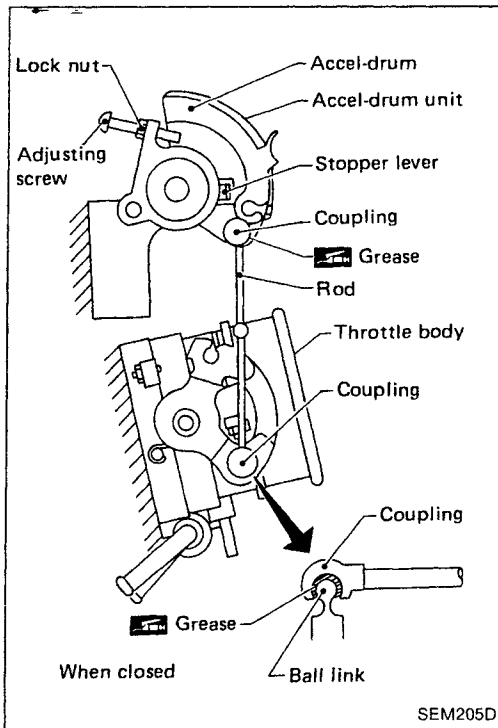
Be careful not to scratch rear oil seal retainer.



- Install new oil seal in the direction shown.



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



Adjust accel-drum unit whenever any of the following parts (new or old) are installed:

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

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

Use genuine Nissan grease or equivalent.

3. Insert each one coupling to ball links of throttle chamber and accel-drum unit.
4. Loosen lock nut.
5. Loosen adjusting screw enough.

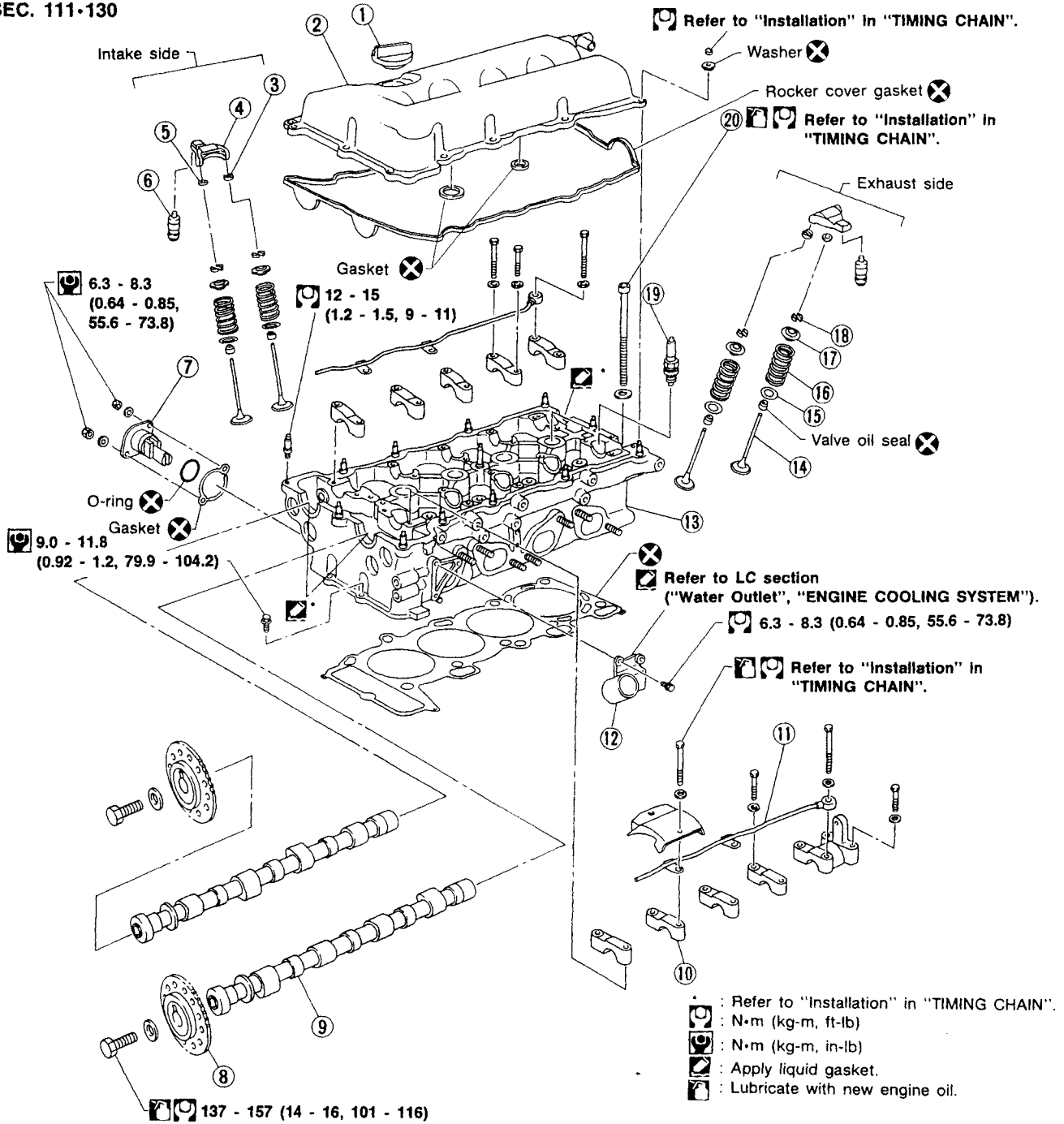
6. Manually turn accel-drum until throttle valve is fully open.
- Check that stopper lever is not touching adjusting screw. If it is, loosen adjusting screw to maintain clearance between the two.

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

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

SEC. 111-130

EM



- ① Oil filler cap
- ② Rocker cover
- ③ Rocker arm guide
- ④ Rocker arm
- ⑤ Shim
- ⑥ Hydraulic lash adjuster
- ⑦ Chain tensioner

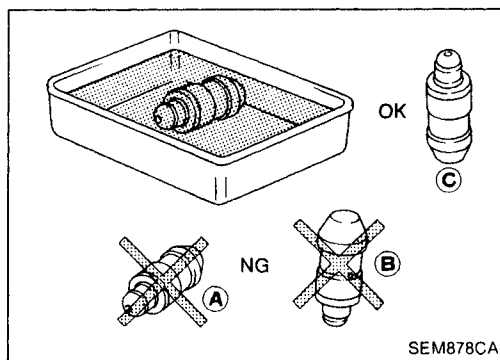
- ⑧ Camshaft sprocket
- ⑨ Camshaft
- ⑩ Camshaft bracket
- ⑪ Oil tube
- ⑫ Water outlet
- ⑬ Cylinder head
- ⑭ Valve

- ⑮ Valve spring seat
- ⑯ Valve spring
- ⑰ Valve spring retainer
- ⑱ Valve collet
- ⑲ Spark plug
- ⑳ Cylinder head bolt

SEM722ED

CAUTION:

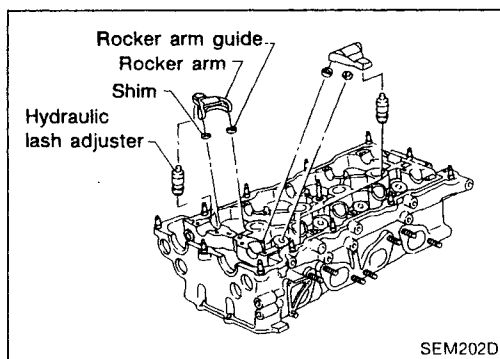
- Apply new engine oil to the sliding surfaces when installing sliding parts. Sliding parts include rocker arms, camshafts, oil seal, etc.
- Apply new engine oil to bolt thread and seat surfaces when tightening the following: Cylinder head bolts, camshaft sprocket bolts and camshaft bracket bolts.



- 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.

Removal

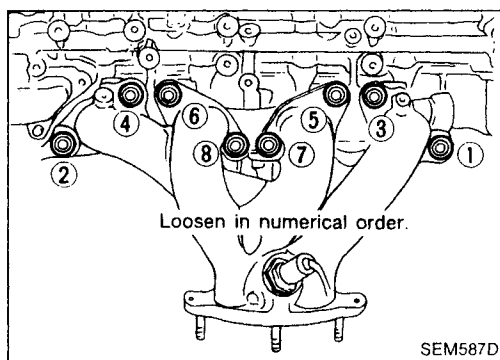
- This removal procedure is the same as for timing chain. Refer to EM-69.

**Disassembly**

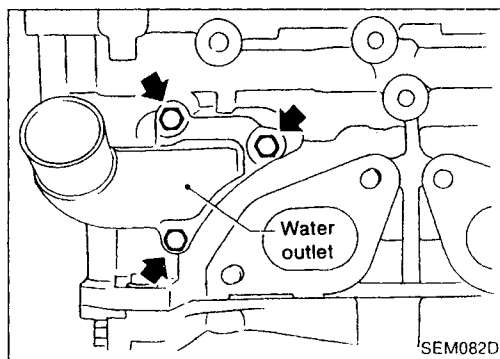
1. Remove rocker arms, shims, rocker arm guides and hydraulic lash adjusters from cylinder head.

CAUTION:

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



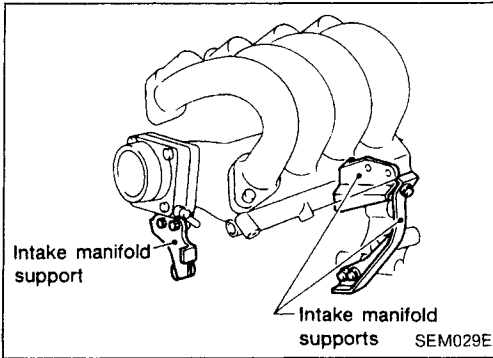
2. Remove crankcase ventilation oil separator.
3. Remove exhaust manifold cover.
4. Remove exhaust manifold.



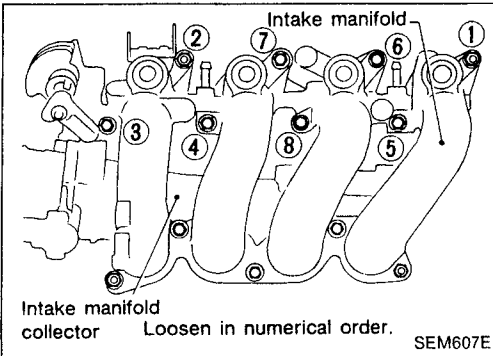
5. Remove water outlet.

Disassembly (Cont'd)

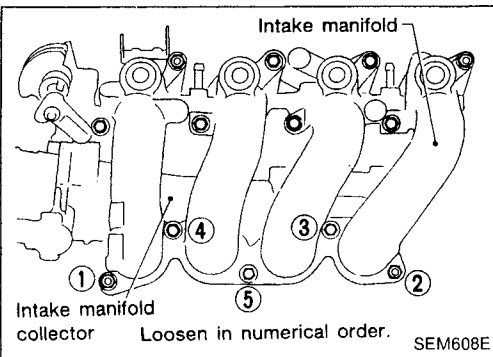
6. Remove intake manifold supports.



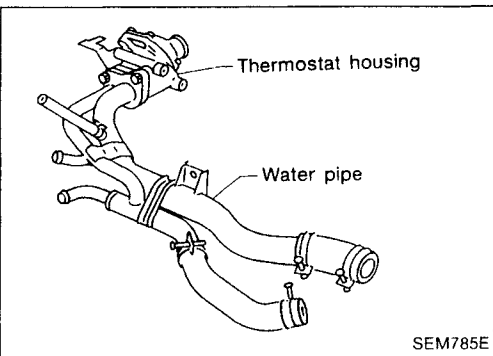
7. Remove fuel tube assembly.
Refer to "Injector Removal and Installation" in EC section.
8. Remove intake manifold.



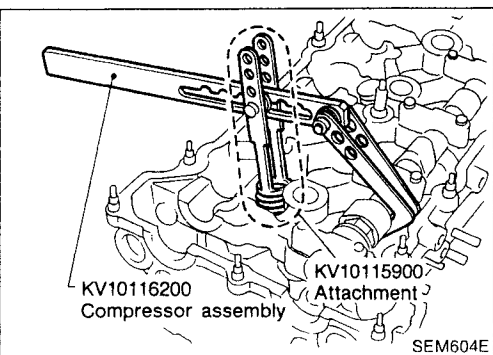
9. Remove intake manifold collector from intake manifold.



10. Remove thermostat housing with water pipe.

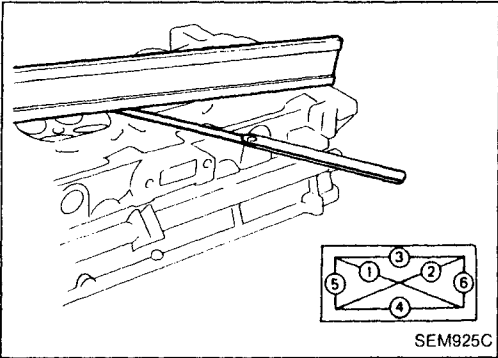
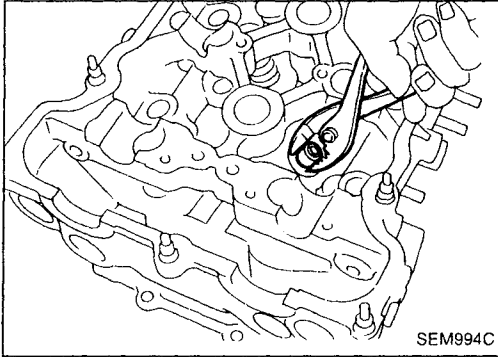


11. Remove valve components with Tool.



Disassembly (Cont'd)

12. 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 resurfacing 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:

$A + B = 0.2 \text{ mm (0.008 in)}$

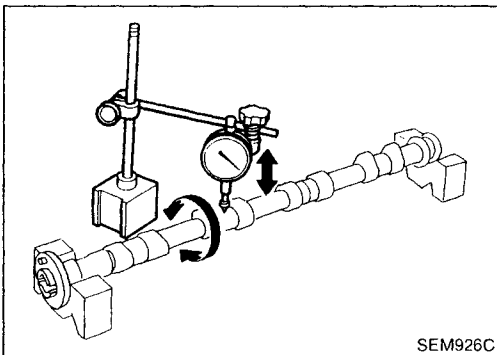
After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.

Nominal cylinder head height:

136.9 - 137.1 mm (5.390 - 5.398 in)

CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.

**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.

Inspection (Cont'd)**CAMSHAFT CAM HEIGHT**

1. Measure camshaft cam height.

Standard cam height:

Intake

38.408 - 38.598 mm (1.5121 - 1.5196 in)

Exhaust

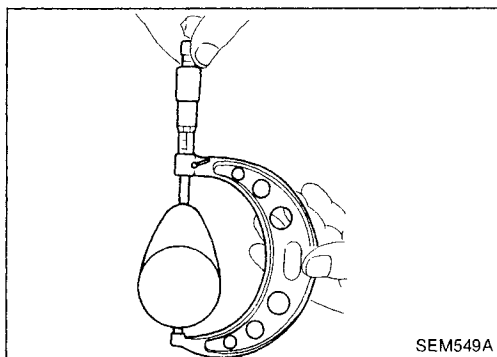
37.920 - 38.110 mm (1.4929 - 1.5004 in)

Cam wear limit:

Intake & Exhaust

0.2 mm (0.008 in)

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

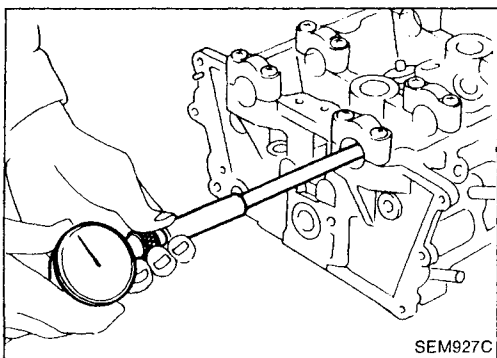
**CAMSHAFT JOURNAL CLEARANCE**

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)



3. Measure outer diameter of camshaft journal.

Standard outer diameter:

27.935 - 27.955 mm (1.0998 - 1.1006 in)

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

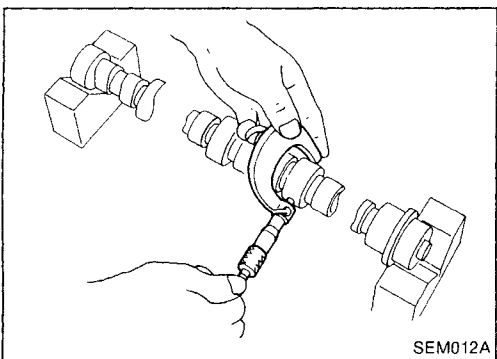
Camshaft journal clearance:

Standard

0.045 - 0.086 mm (0.0018 - 0.0034 in)

Limit

0.15 mm (0.0059 in)

**CAMSHAFT END PLAY**

1. Install camshaft in cylinder head.

2. Measure camshaft end play.

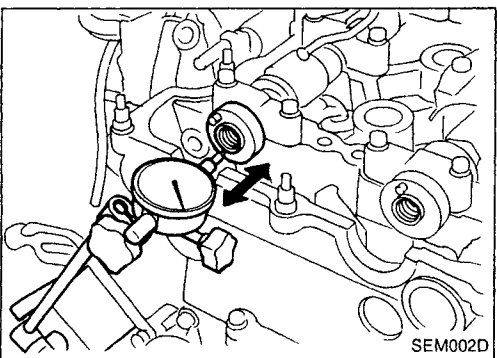
Camshaft end play:

Standard

0.055 - 0.139 mm (0.0022 - 0.0055 in)

Limit

0.20 mm (0.0079 in)

**CAMSHAFT SPROCKET RUNOUT**

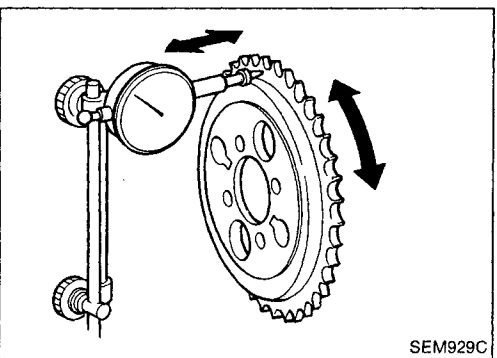
1. Install sprocket on camshaft.

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.



CYLINDER HEAD

Inspection (Cont'd)

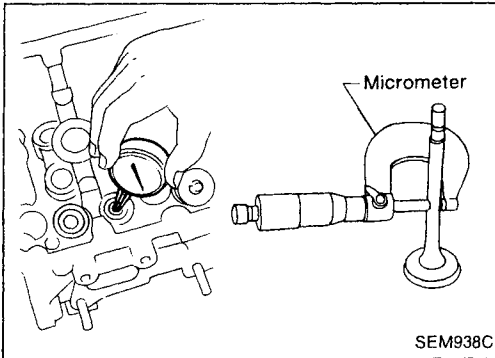
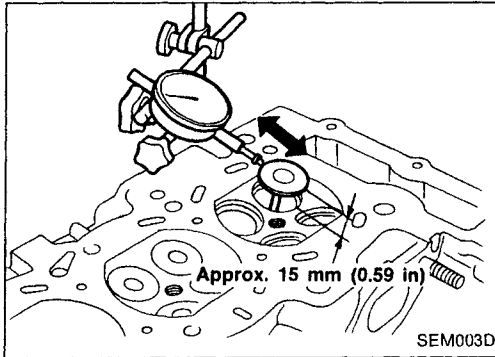
VALVE GUIDE CLEARANCE

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)



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)

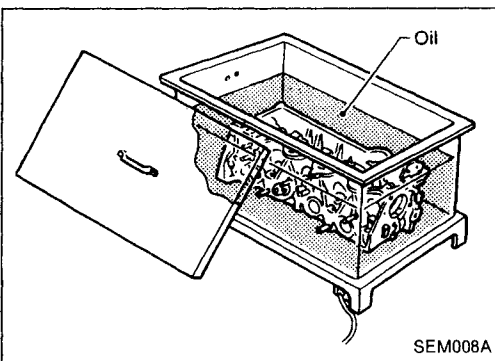
Exhaust 0.040 - 0.073 mm (0.0016 - 0.0029 in)

Limit

Intake 0.08 mm (0.0031 in)

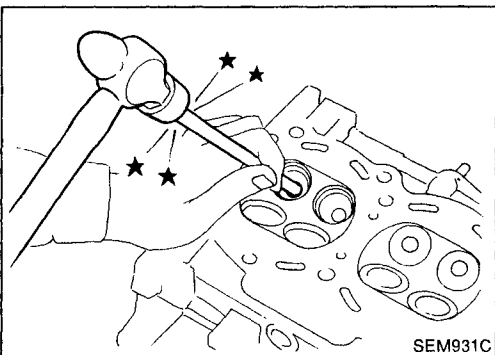
Exhaust 0.1 mm (0.004 in)

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

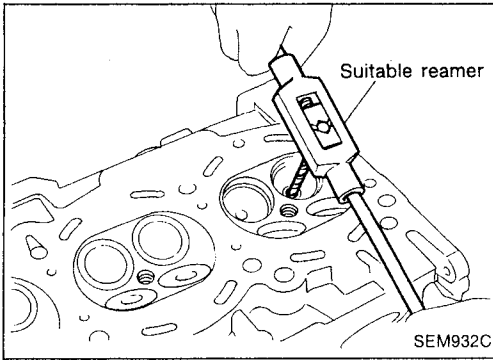


VALVE GUIDE REPLACEMENT

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.

Inspection (Cont'd)

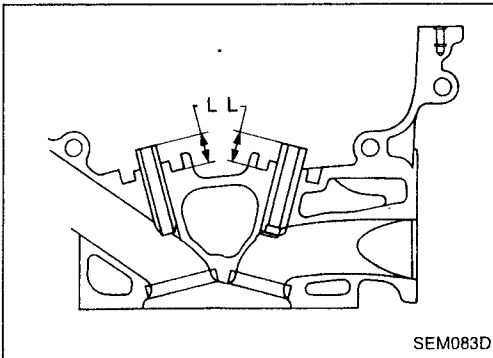
3. Ream cylinder head valve guide hole.

Valve guide hole diameter

(for service parts):

Intake & Exhaust

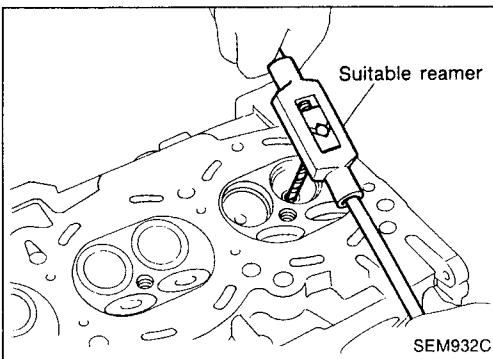
10.175 - 10.196 mm (0.4006 - 0.4014 in)



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)

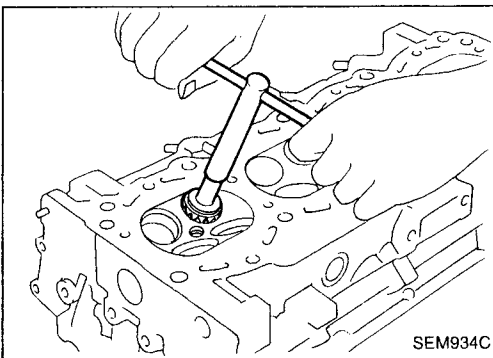


5. Ream valve guide.

Valve guide inner diameter:

Intake & Exhaust

6.000 - 6.018 mm (0.2362 - 0.2369 in)

**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.**
- **Cut with both hands to uniform the cutting surface.**

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.

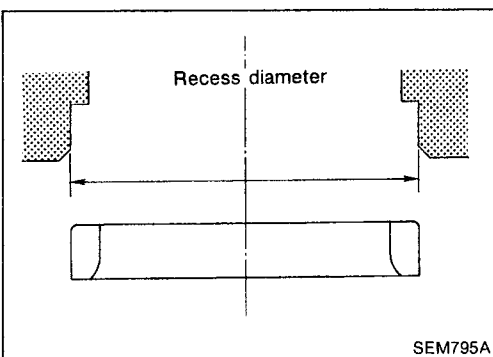
Reaming bore for service valve seat

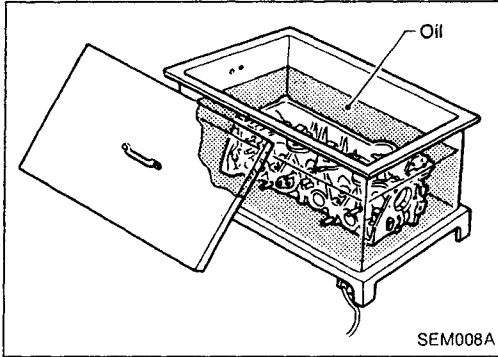
Oversize [0.5 mm (0.020 in)]:

Intake 35.500 - 35.516 mm (1.3976 - 1.3983 in)

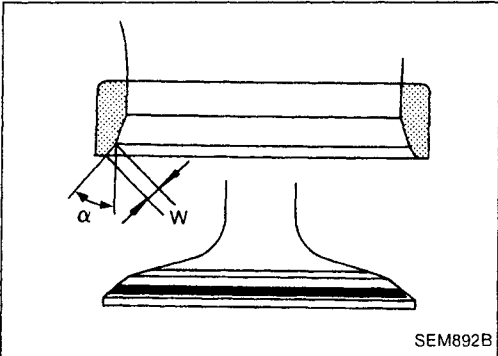
Exhaust 31.500 - 31.516 mm (1.2402 - 1.2408 in)

Be sure to ream in circles concentric to the valve guide center. This will enable valve seat to fit correctly.



Inspection (Cont'd)

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 a suitable tool at the specified dimensions as shown in SDS (EM-165).
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

Seat face angle "α":

44°53' - 45°07'

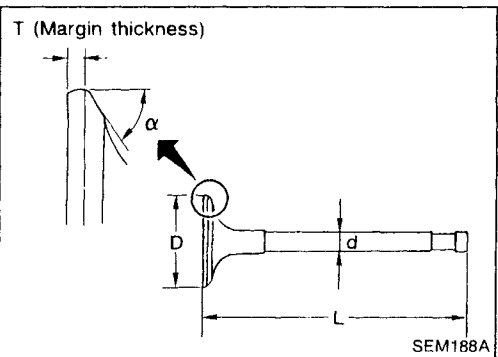
Contacting width "W":

Intake

1.05 - 1.35 mm (0.0413 - 0.0531 in)

Exhaust

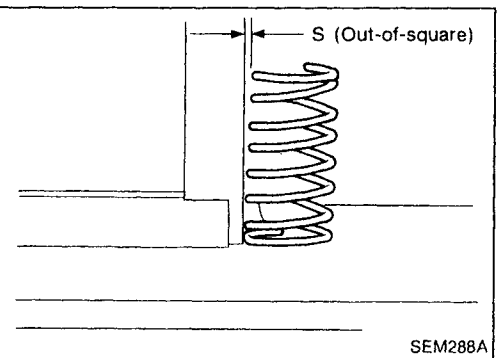
1.25 - 1.55 mm (0.0492 - 0.0610 in)

**VALVE DIMENSIONS**

Check dimensions in each valve. For dimensions, refer to SDS (EM-164).

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.

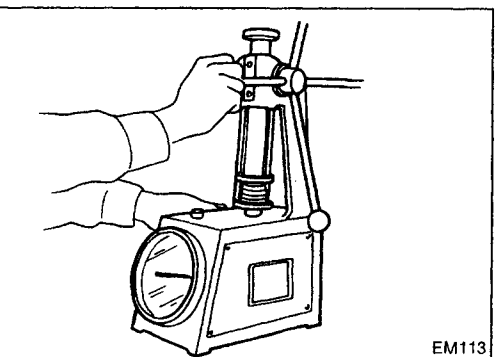
**VALVE SPRING****Squareness**

1. Measure "S" dimension.

Out-of-square:

Less than 2.2 mm (0.087 in)

2. If it exceeds the limit, replace spring.

**Pressure**

Check valve spring pressure.

Pressure: N (kg, lb) at height mm (in)

Standard

578.02 - 641.57 (58.94 - 65.42,

129.96 - 144.25) at 30.0 (1.181)

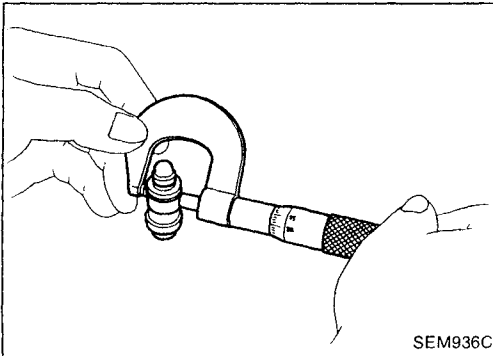
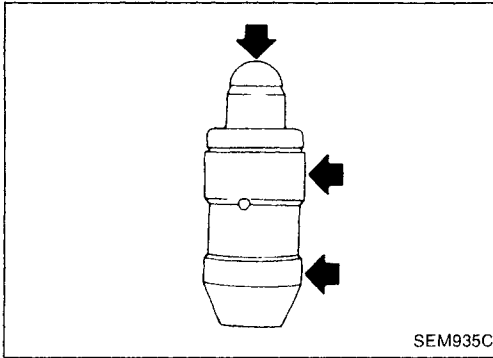
Limit

More than 549.2 (56.0, 123.5) at 30.0 (1.181)

If it exceeds the limit, replace spring.

Inspection (Cont'd)**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)

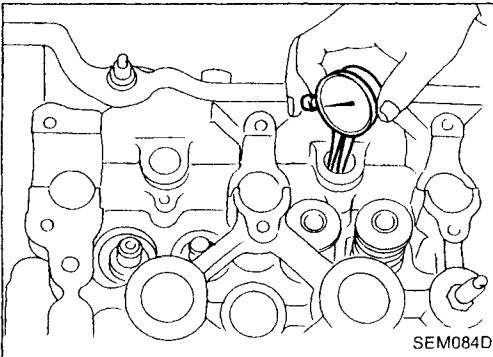
3. Check lash adjuster guide inner diameter.

Inner diameter:

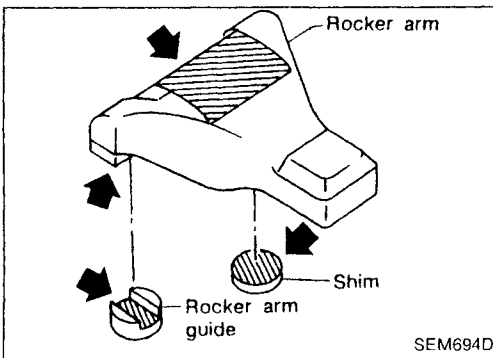
17.000 - 17.020 mm (0.6693 - 0.6701 in)

Standard clearance between lash adjuster and adjuster guide:

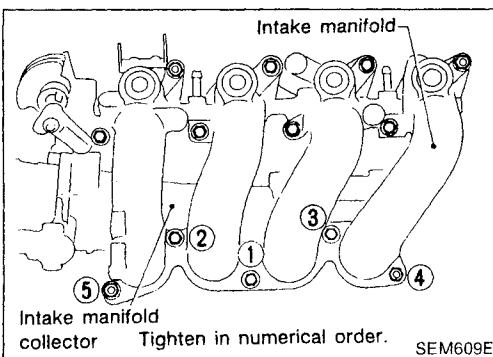
0.007 - 0.040 mm (0.0003 - 0.0016 in)

**ROCKER ARM, SHIM AND ROCKER ARM GUIDE**

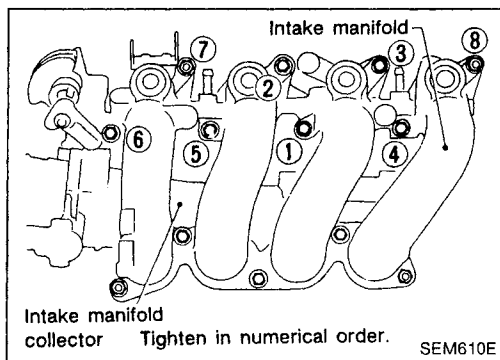
Check contact and sliding surfaces of rocker arms, shims and rocker arm guides for wear or scratches.

**Assembly**

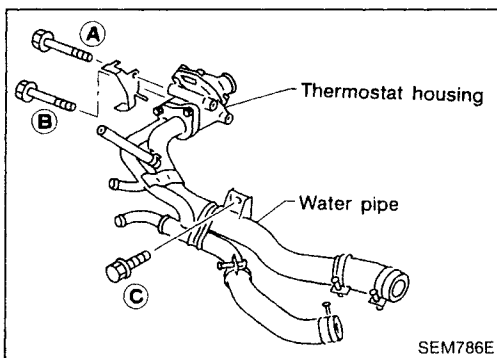
1. Install intake manifold collector to intake manifold.



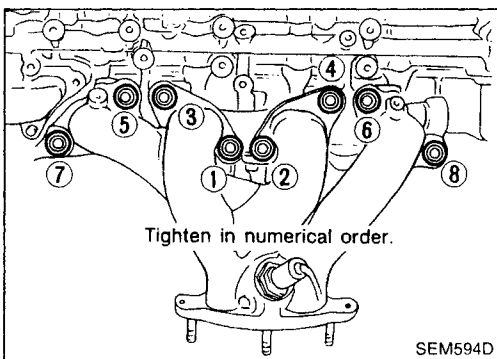
Assembly (Cont'd)



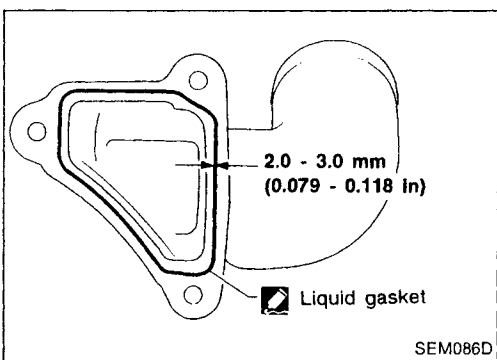
2. Install intake manifold.
 3. Install fuel tube assembly.
- Refer to "Injector Removal and Installation" in EC section.



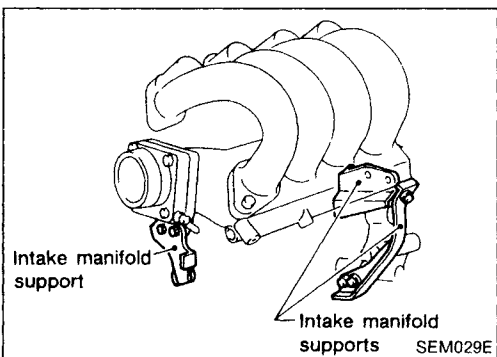
4. Install thermostat housing with water pipe.
- Tightening procedure:
 - 1) Tighten bolt **A** to 2 - 5 N·m (0.2 - 0.5 kg-m, 1.4 - 3.6 ft-lb).
 - 2) Tighten bolt **C** to 16 - 21 N·m (1.6 - 2.1 kg-m, 12 - 15 ft-lb).
 - 3) Tighten bolt **A** to 16 - 21 N·m (1.6 - 2.1 kg-m, 12 - 15 ft-lb).
 - 4) Tighten bolt **B** to 16 - 21 N·m (1.6 - 2.1 kg-m, 12 - 15 ft-lb).



5. Install exhaust manifold.
6. Install exhaust manifold cover.



7. 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.**

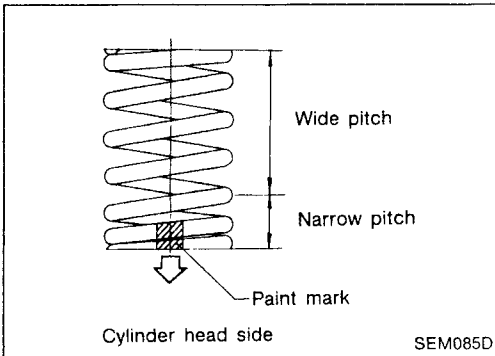


8. Install intake manifold supports.
9. Install crankcase ventilation oil separator.

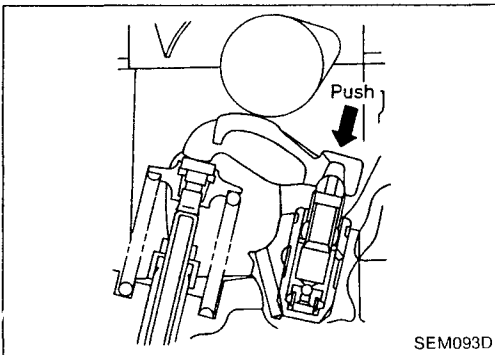
Assembly (Cont'd)

10. Install valve component parts.

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

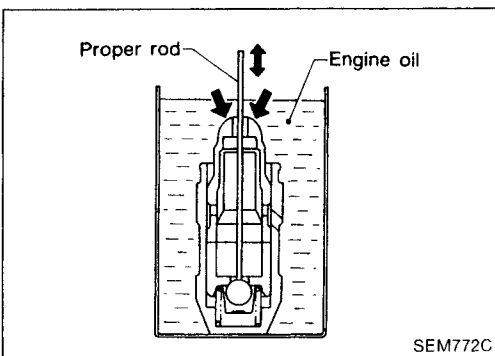


- Always use new valve oil seal. Refer to OIL SEAL REPLACEMENT.
- Before installing valve oil seal, install valve spring seat.
- Install valve spring (uneven pitch type) with its narrow pitched side toward cylinder head side (paint mark).
- After installing valve component parts, tap valve stem tip with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



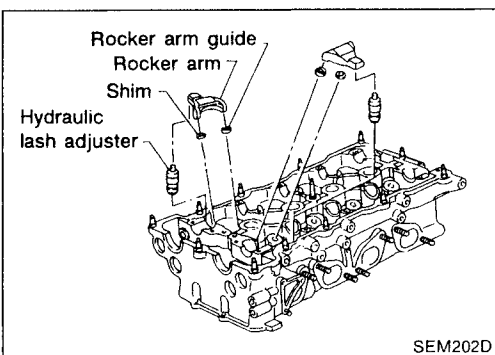
11. Check hydraulic lash adjusters.

- 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.



- 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.



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

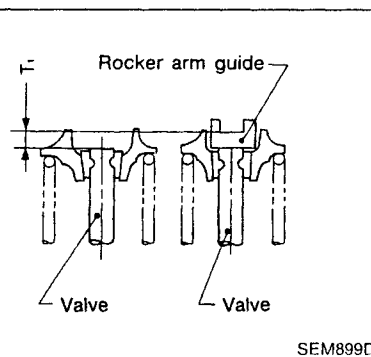
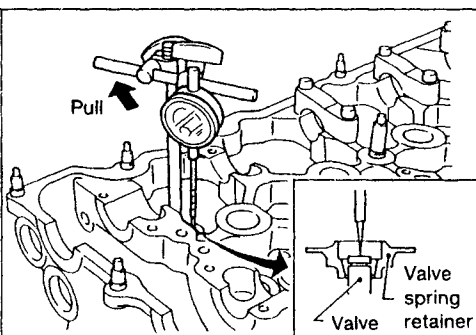
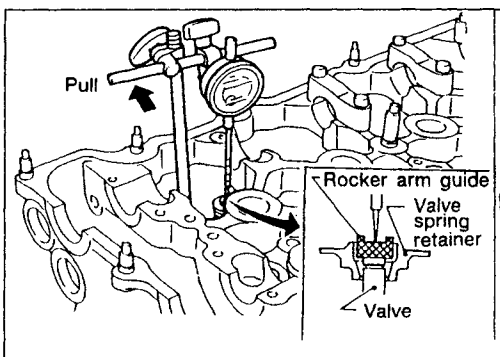
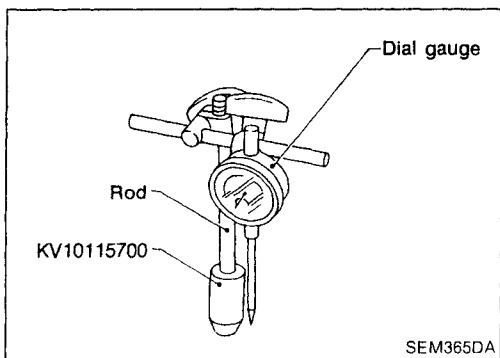
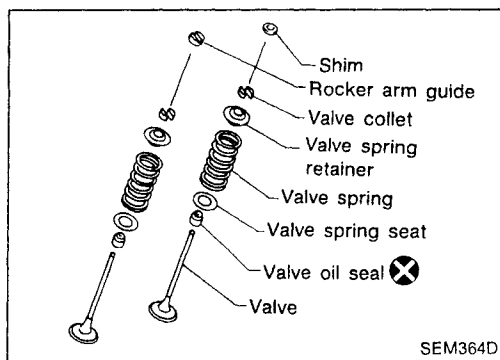
CAUTION:

Install all parts in their original positions.

CYLINDER HEAD

SR

Assembly (Cont'd)



13. 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.

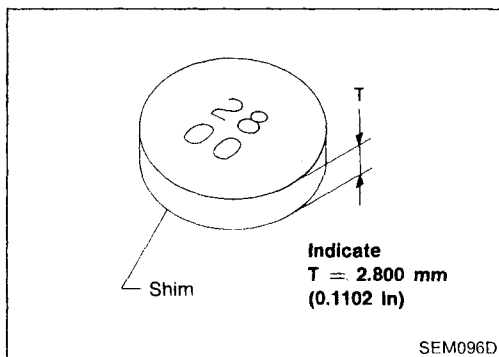
b. Remove hydraulic lash adjuster.

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 proper shim.

Shim thickness (T):

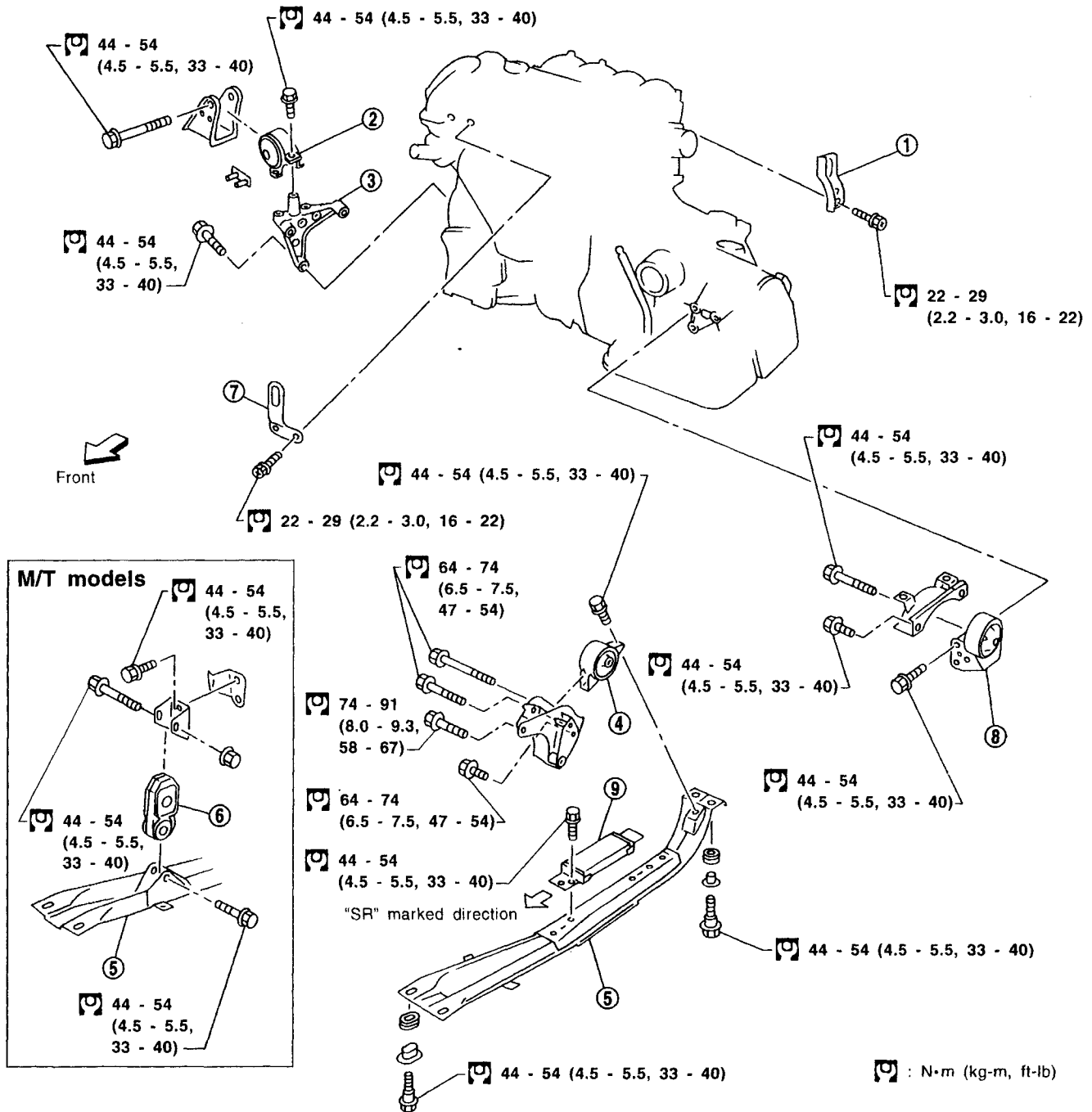
$T_1 \pm 0.025 \text{ mm (0.0010 in)}$

• 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

- This installation is the same procedure as those for timing chain. Refer to "Installation" in "TIMING CHAIN" (EM-73).

SEC. 112



SEM234F

- | | | |
|-------------------------|------------------|------------------------|
| ① Rear engine slinger | ④ Rear insulator | ⑦ Front engine slinger |
| ② Front engine mounting | ⑤ Center member | ⑧ Rear engine mounting |
| ③ Mounting bracket | ⑥ Buffer | ⑨ Dynamic damper |

WARNING:

- Situate vehicle on a flat and solid surface.
- Place chocks at front and back of rear wheels.
- Do not remove engine until exhaust system has completely cooled off.

Otherwise, you may burn yourself and/or fire may break out in fuel line.

- For safety during subsequent steps, the tension of wires should be slackened against the engine.
- Before disconnecting fuel hose, release fuel pressure from fuel line.

Refer to "Releasing Fuel Pressure" in EC section.

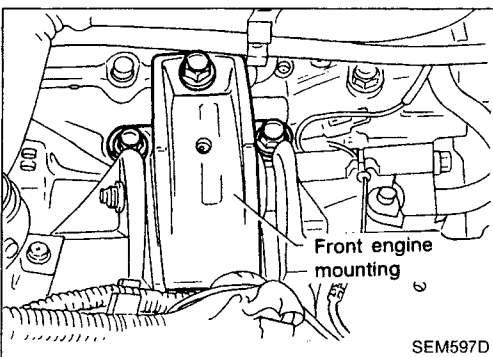
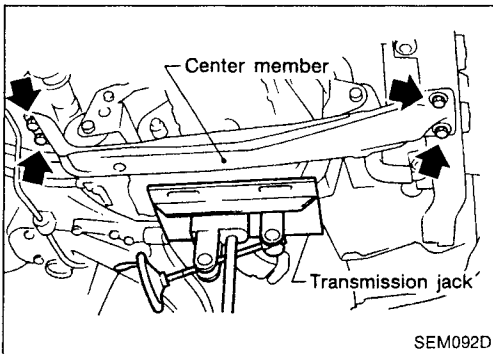
- Be sure to hoist engine and transaxle in a safe manner.
- For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.

CAUTION:

- When lifting engine, be careful not to strike adjacent parts, especially the following: Accelerator wire casing, brake lines, and brake master cylinder.
- In hoisting the engine, always use engine slingers in a safe manner.

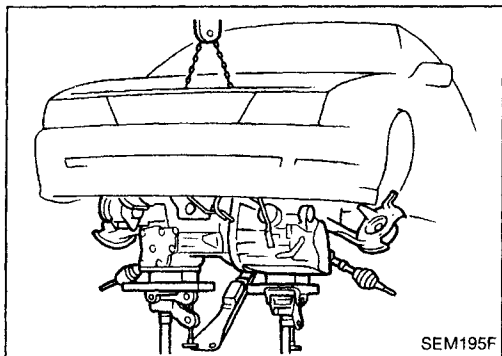
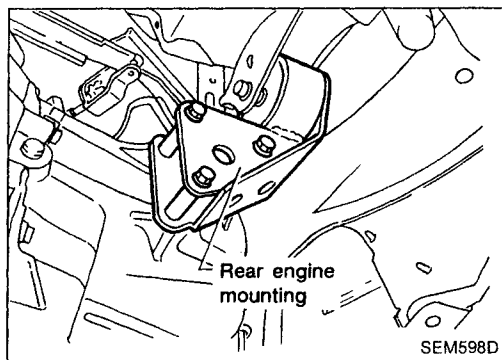
Removal

1. Remove engine under cover and hood.
2. Drain coolant from both cylinder block, and radiator.
3. Drain engine oil from drain plug of oil pan.
4. Remove vacuum hoses, fuel hoses, wires, harness and connectors and so on.
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.

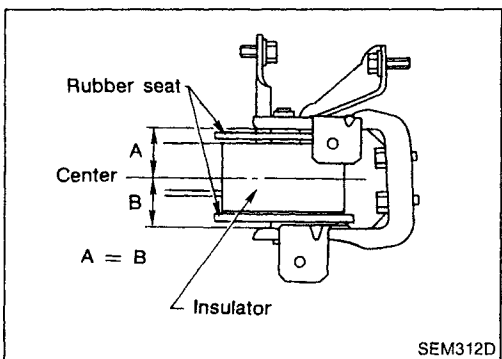


11. Remove engine mounting bolts from both sides and then slowly lower transmission jack.

Removal (Cont'd)

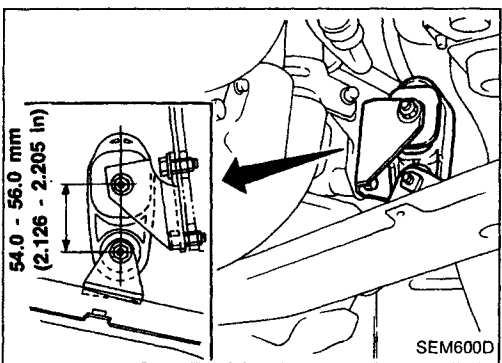


12. Remove engine with transaxle as shown.



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.

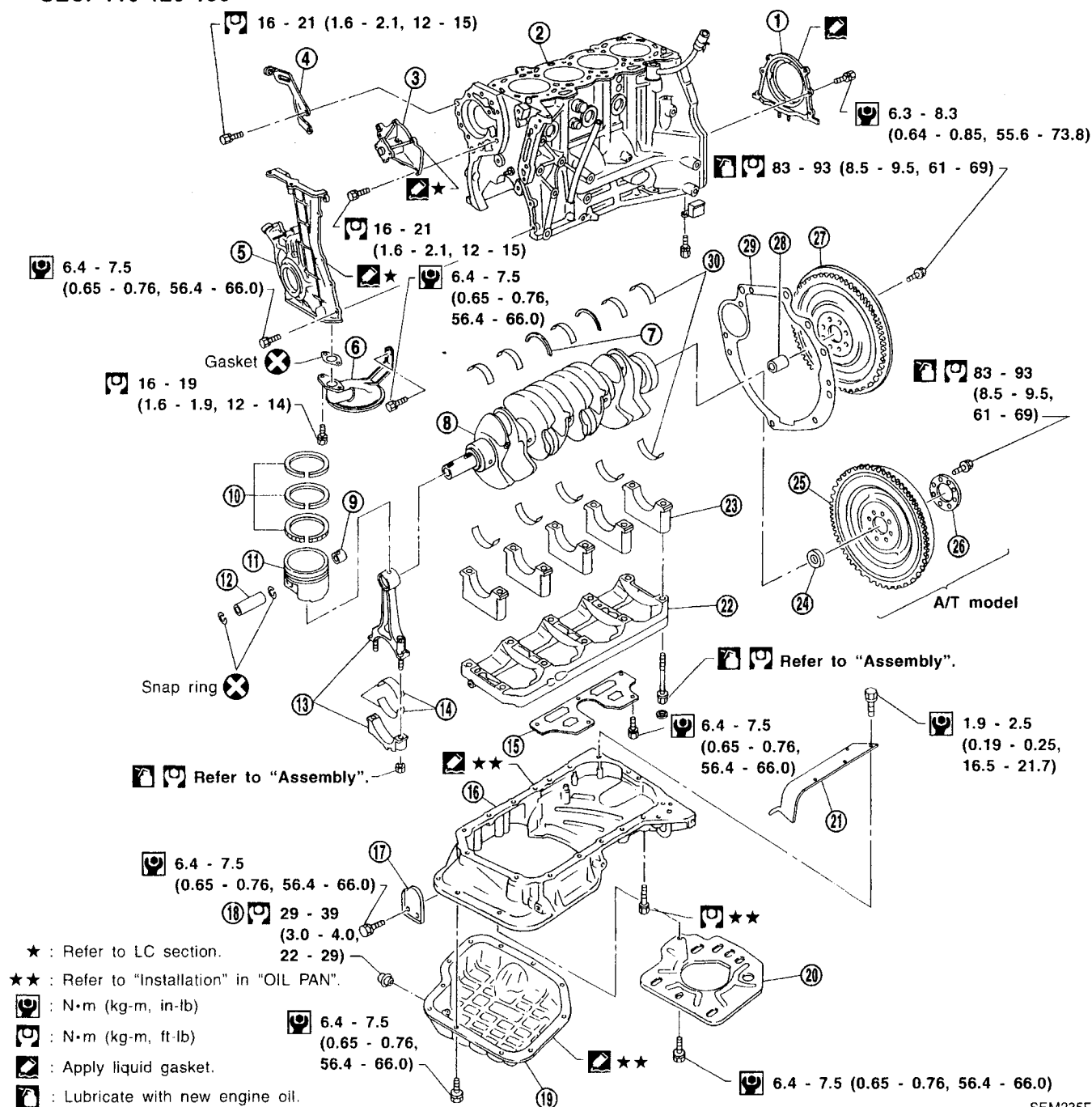


When installing the engine, adjust the height of the engine mounting as shown. (For M/T)

3. Installation is in the reverse order of removal.

SEC. 110•120•150

EM

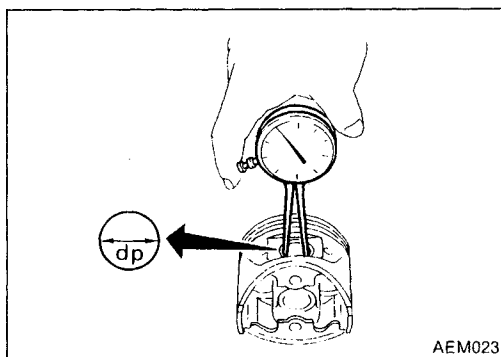
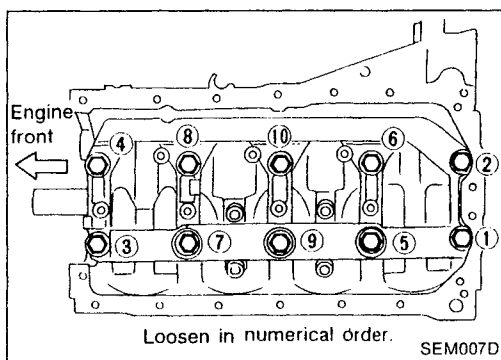
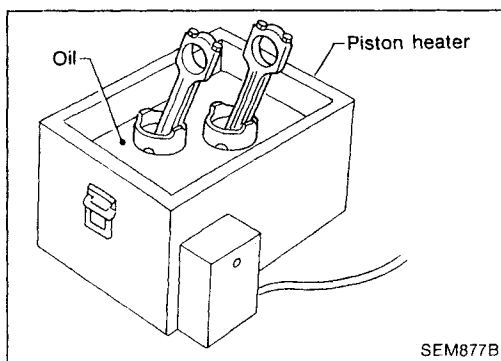
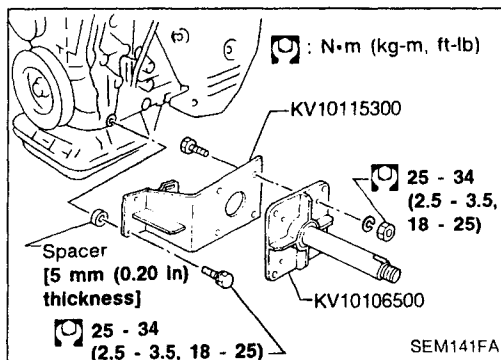


SEM235F

- | | | |
|---|--------------------------|-----------------------------|
| ① Rear oil seal retainer | ⑪ Piston | ⑳ Side gallery baffle plate |
| ② Cylinder block | ⑫ Piston pin | ㉑ Main bearing beam |
| ③ Water pump | ⑬ Connecting rod | ㉒ Main bearing cap |
| ④ Power steering oil pump adjusting bar | ⑭ Connecting rod bearing | ㉓ Pilot converter |
| ⑤ Front cover with oil pump | ⑮ Baffle plate | ㉔ Drive plate |
| ⑥ Oil strainer | ⑯ Aluminum oil pan | ㉕ Reinforcement plate |
| ⑦ Thrust bearing | ⑰ Rear cover plate | ㉖ Flywheel |
| ⑧ Crankshaft | ⑱ Drain plug | ㉗ Pilot bushing |
| ⑨ Connecting rod bushing | ㉙ Steel oil pan | ㉘ Rear plate |
| ⑩ Piston rings | ㉚ Baffle plate | ㉛ 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 proper order and direction.
- Apply new engine oil to bolt thread and seat surfaces when tightening the following: Connecting rod bolts and main bearing cap bolts.
- Do not allow any magnetic materials to contact the ring gear teeth of flywheel/drive plate.

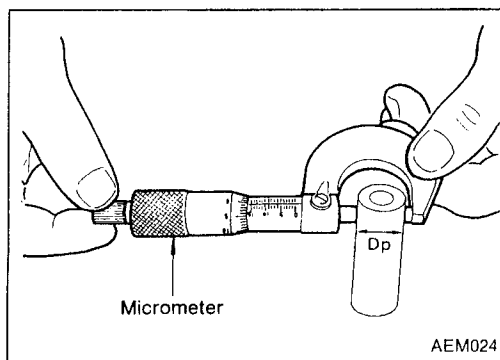
**Disassembly****PISTON AND CRANKSHAFT**

1. Place engine on a work stand.
2. Remove cylinder head.
Refer to "Removal" in "TIMING CHAIN" (EM-69).
3. Remove oil pan.
Refer to "Removal" in "OIL PAN" (EM-63).
4. Remove timing chain.
Refer to "Removal" in "TIMING CHAIN" (EM-69).
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 beam, bearing cap and crankshaft.
 - **Before removing bearing cap, measure crankshaft end play.**
 - **Bolts should be loosened in two or three steps.**

Inspection**PISTON AND PISTON PIN CLEARANCE**

1. Measure inner diameter of piston pin hole "dp".
Standard diameter "dp":
21.987 - 21.999 mm (0.8656 - 0.8661 in)

Inspection (Cont'd)



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

Standard diameter "Dp":

21.989 - 22.001 mm (0.8657 - 0.8662 in)

3. Calculate piston pin clearance.

$dp - Dp = -0.004$ to 0 mm (-0.0002 to 0 in)

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

EM

PISTON RING SIDE CLEARANCE

Side clearance:

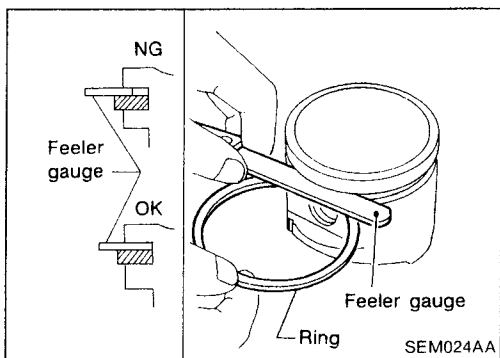
Top ring 0.045 - 0.080 mm (0.0018 - 0.0031 in)

2nd ring 0.030 - 0.065 (0.0012 - 0.0026 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)

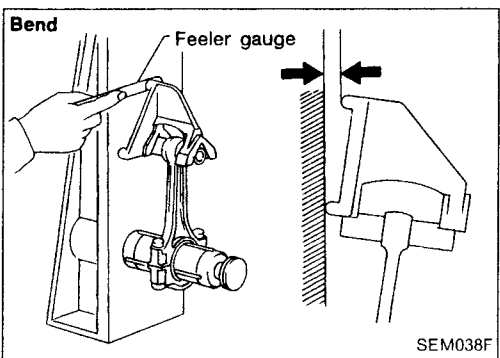
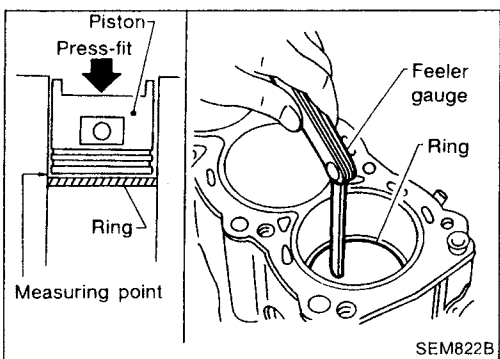
Max. limit of ring gap:

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-168).

- 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)

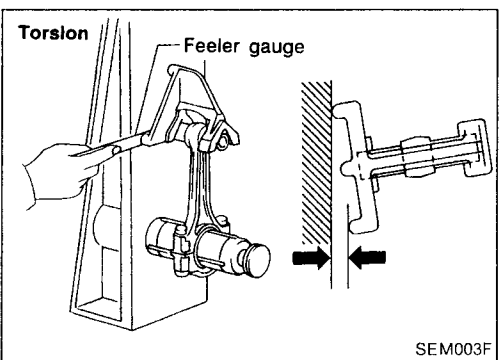
per 100 mm (3.94 in) length

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

Inspection (Cont'd)

CYLINDER BLOCK DISTORTION AND WEAR

1. Clean upper face of cylinder block and measure the distortion.

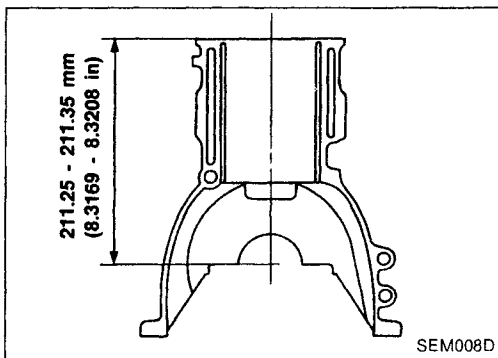
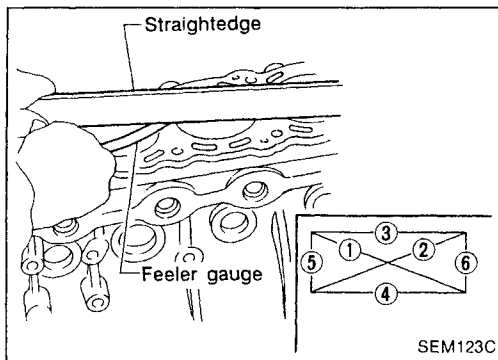
Standard:

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".

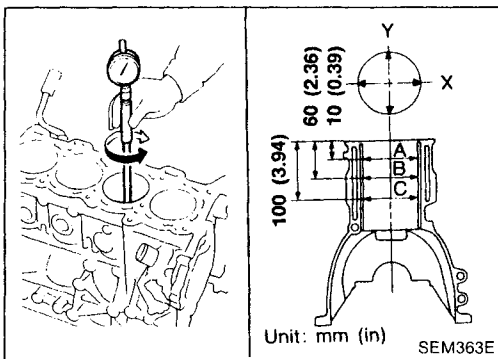
The maximum limit is as follows:

$A + B = 0.2 \text{ mm (0.008 in)}$

**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:

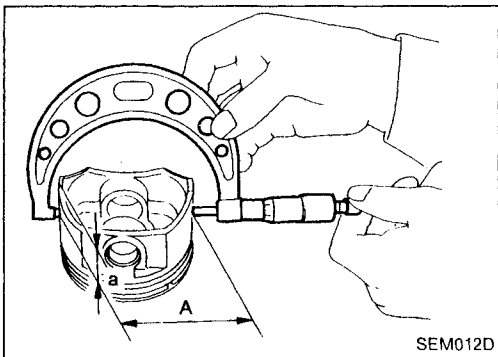
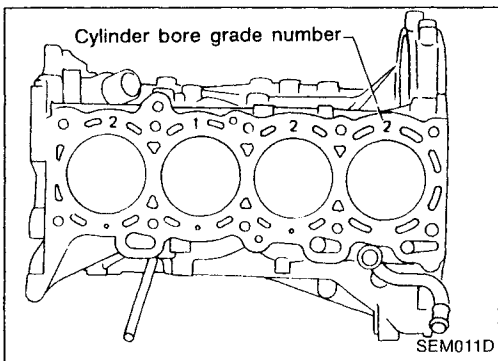
Less than 0.015 mm (0.0006 in)

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-168).

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

14.0 mm (0.551 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-168).

Inspection (Cont'd)

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

Rebored size calculation:

$$D = A + B - C$$

where,

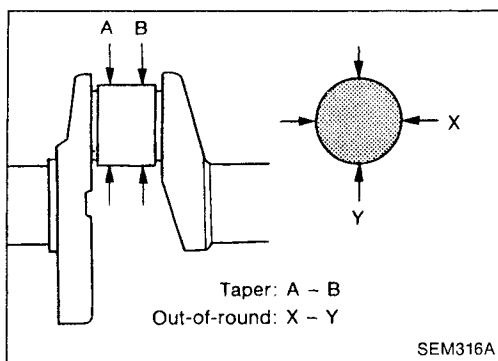
D: Bored diameter

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 0.005 mm (0.0001 in)

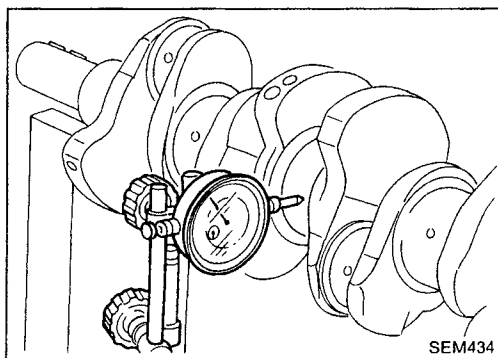
Taper (A - B) standard:

Main journal:

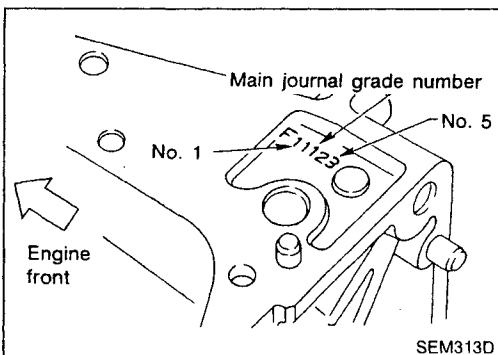
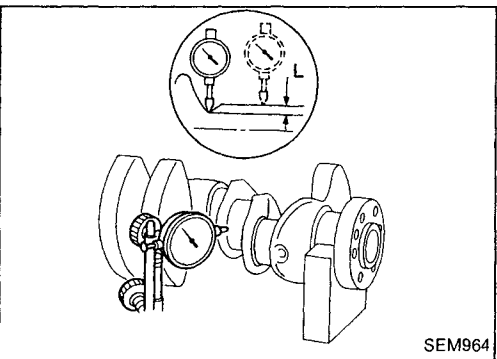
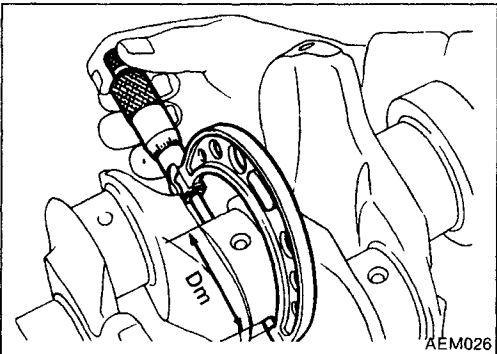
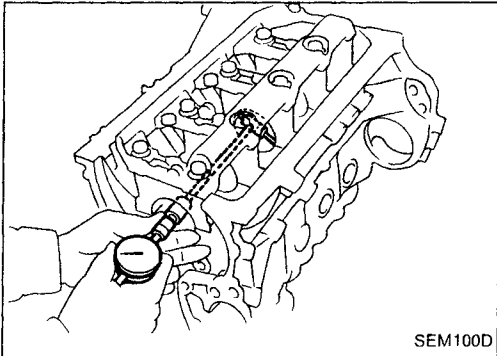
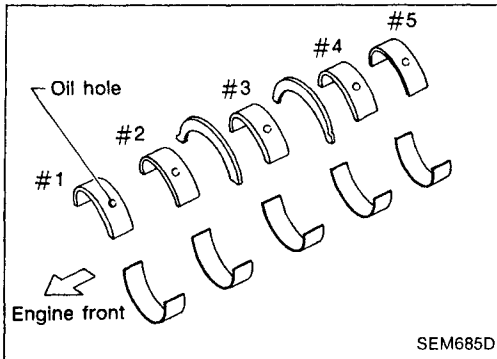
Less than 0.005 mm (0.0002 in)

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)**

**Inspection (Cont'd)****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 cap and main bearing beam 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.

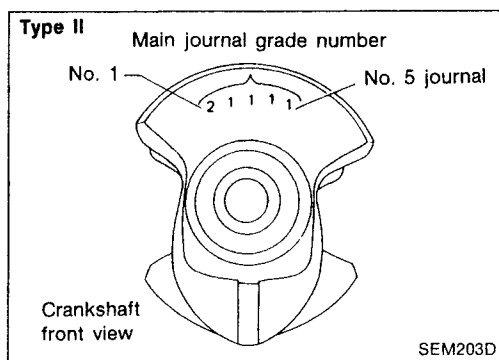
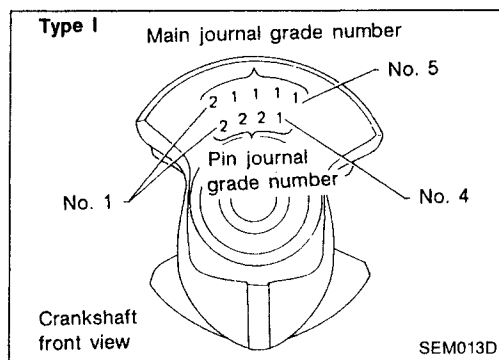
"L": 0.1 mm (0.004 in)

- 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.



Inspection (Cont'd)

- Grade number of each crankshaft main journal is punched on the respective crankshaft. These numbers are punched in either Arabic or Roman numerals.
- Select main bearing with suitable thickness according to the following table.

How to select main bearings (Identification mark and color)

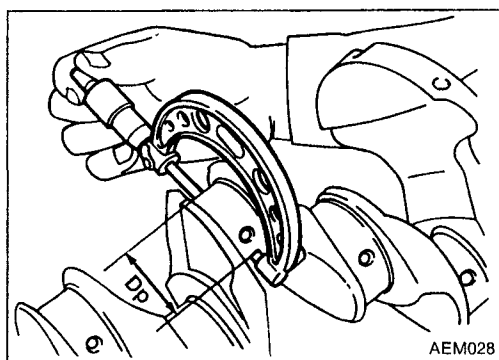
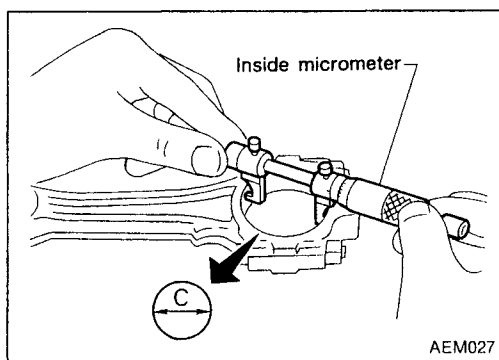
Crankshaft main journal grade number	Cylinder block main journal grade number			
	0	1	2	3
0	0 (A, Black)	1 (B, Brown)	2 (C, Green)	3 (D, Yellow)
1	1 (B, Brown)	2 (C, Green)	3 (D, Yellow)	4 (E, Blue)
2	2 (C, Green)	3 (D, Yellow)	4 (E, Blue)	5 (F, Pink)
3	3 (D, Yellow)	4 (E, Blue)	5 (F, Pink)	6 (G, No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

For example:

Main journal grade number: 1

Crankshaft journal grade number: 2

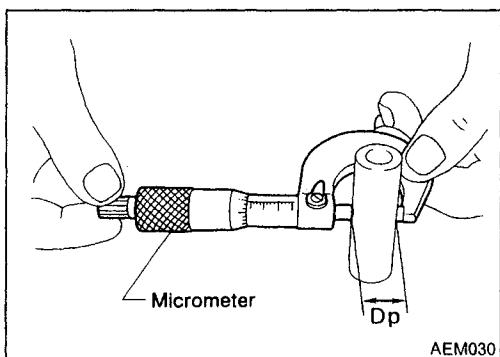
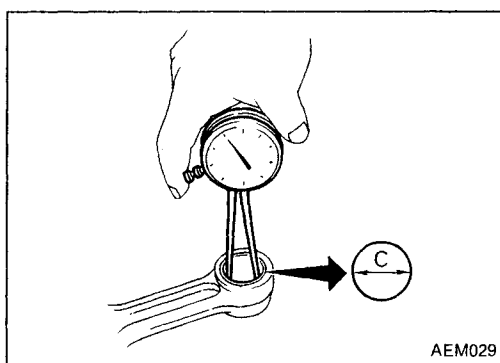
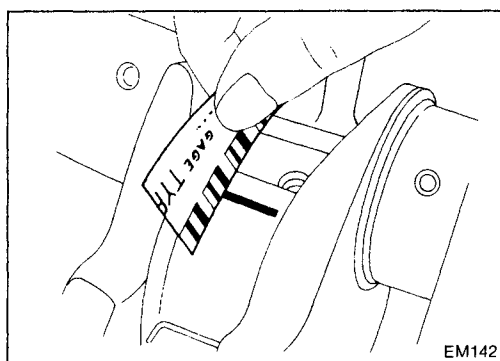
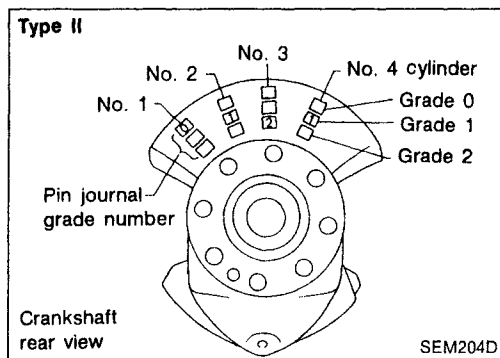
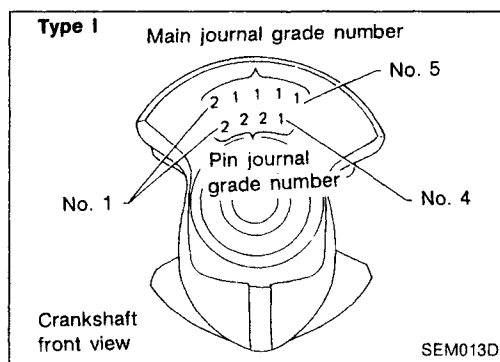
Main bearing grade number = 1 + 2
= 3 (D, Yellow)



Connecting rod bearing (Big end)

- Install connecting rod bearing to connecting rod and cap.
- Install connecting rod cap to connecting rod.
- Tighten bolts to the specified torque.**
- Measure inner diameter "C" of each bearing.

- Measure outer diameter "Dp" of each crankshaft pin journal.
- Calculate connecting rod bearing clearance.
Connecting rod bearing clearance = C - Dp
Standard: 0.020 - 0.045 mm (0.0008 - 0.0018 in)
Limit: 0.065 mm (0.0026 in)
- If it exceeds the limit, replace bearing.
- If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to step 7 of "BEARING CLEARANCE — Main bearing" (EM-106).



Inspection (Cont'd)

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; No color

Grade 1; Black

Grade 2; Brown

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.

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.

CYLINDER BLOCK

Inspection (Cont'd)

REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

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

Be sure to align the oil holes.

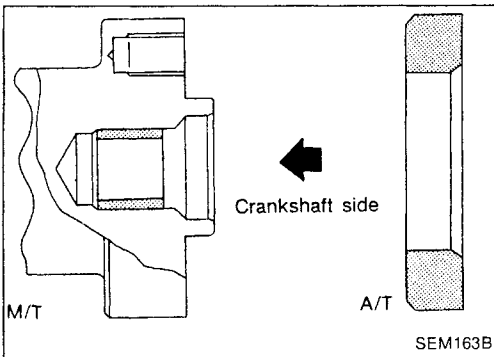
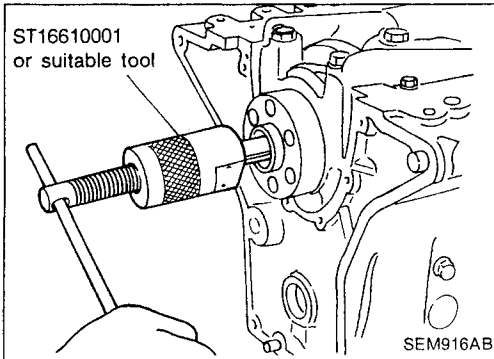
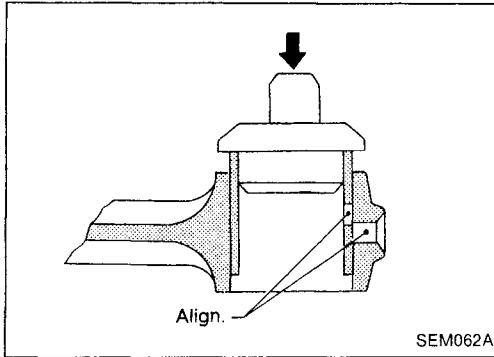
2. After driving in small end bushing, ream the bushing. This is to ensure the clearance between connecting rod bushing and piston pin is the specified value.

Clearance between connecting rod bushing and piston pin:

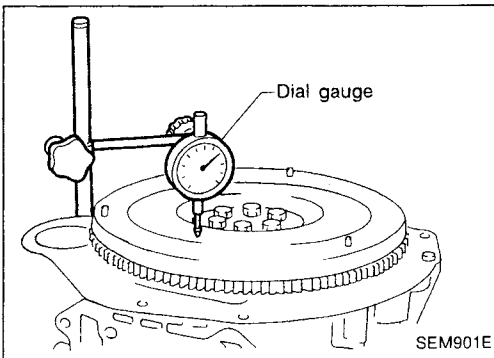
0.005 - 0.017 mm (0.0002 - 0.0007 in)

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

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 (A/T model)

Less than 0.20 mm (0.0079 in)

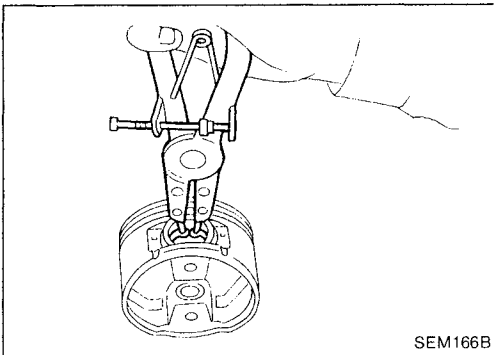
CAUTION:

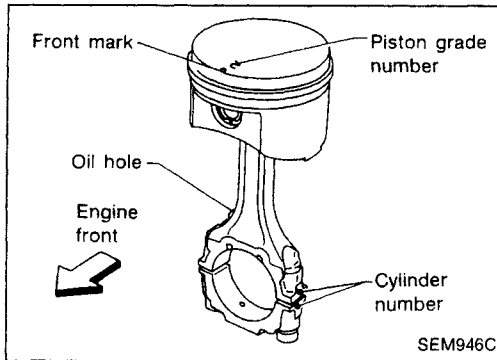
Do not allow any magnetic materials to contact the ring gear teeth.

Assembly

PISTON

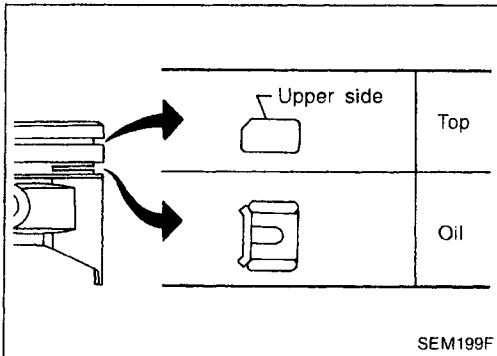
1. Install new snap ring on one side of piston pin hole.



Assembly (Cont'd)

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

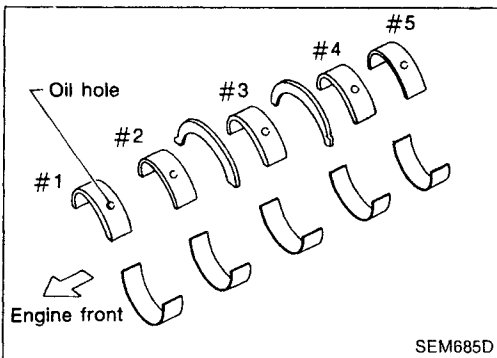
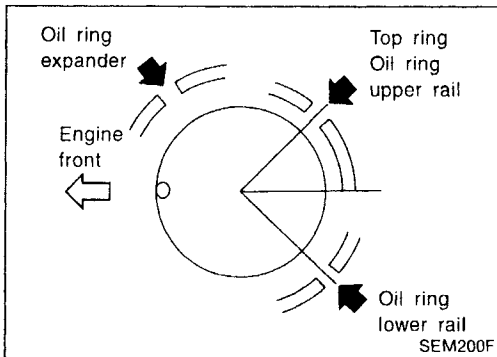
- **Align the direction of piston and connecting rod.**
- **Numbers stamped on connecting rod and cap correspond to each cylinder.**
- **After assembly, make sure connecting rod swings smoothly.**



3. Set piston rings as shown.

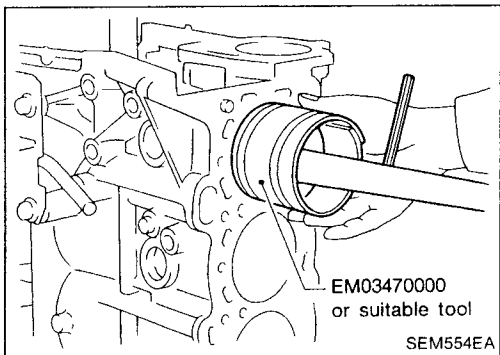
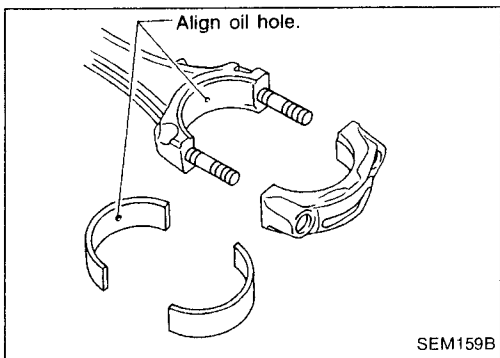
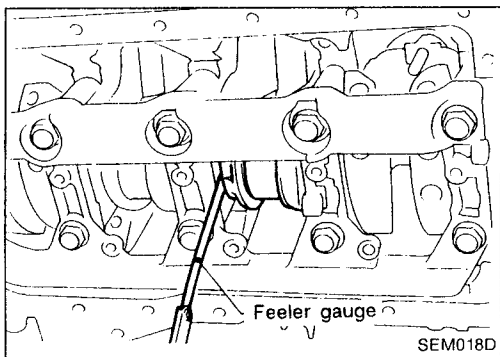
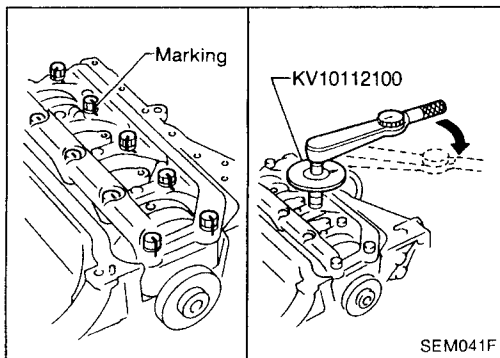
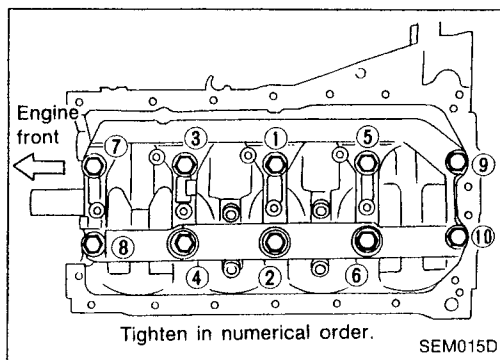
CAUTION:

- **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.**



Assembly (Cont'd)

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

- 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 26 to 32 N·m (2.7 to 3.3 kg-m, 20 to 24 in-lb).
 - b. Turn all bolts 75 to 80 degrees clockwise with Tool or suitable angle wrench.
 - c. Loosen all bolts completely.
 - d. Tighten all bolts to 32 to 38 N·m (3.3 to 3.9 kg-m, 24 to 28 ft-lb).
 - e. Turn all bolts 45 to 50 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.

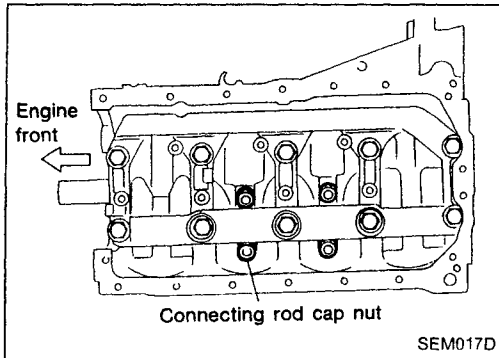
4. Install connecting rod bearings in connecting rods and connecting rod caps.

- 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.

EM

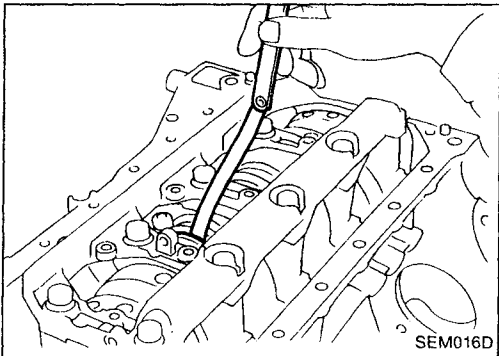
Assembly (Cont'd)

- 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.

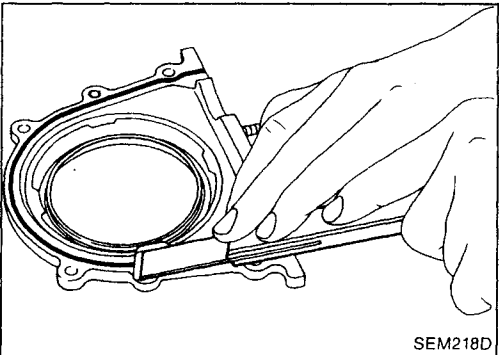
Connecting rod side clearance:**Standard**

0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit

0.50 mm (0.0197 in)

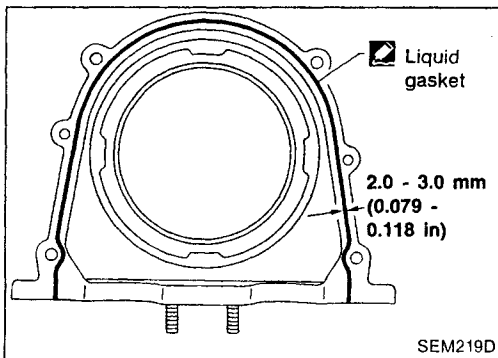
If beyond the limit, replace connecting rod and/or crankshaft.



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.

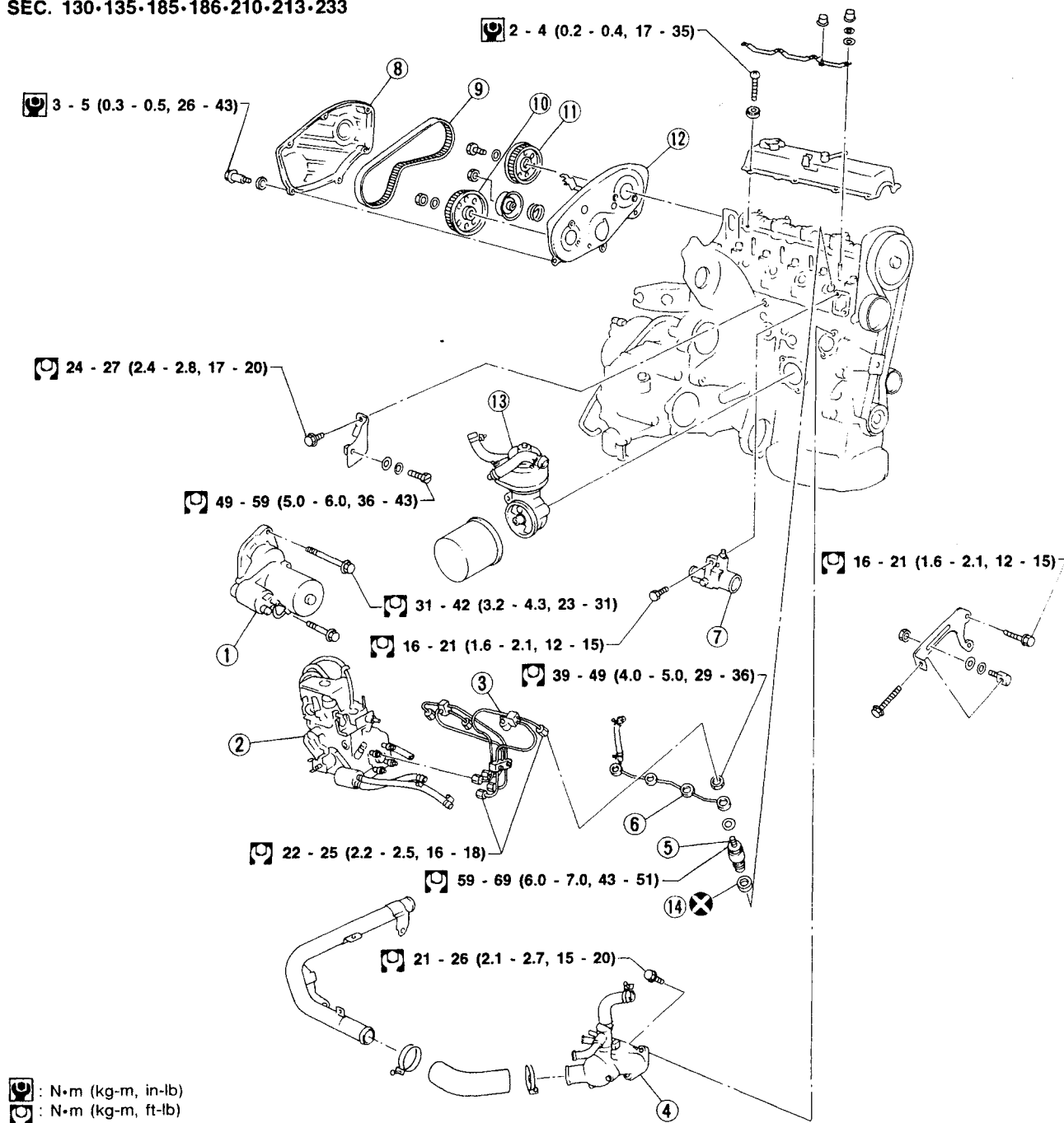


- b. Apply a continuous bead of liquid gasket to mating surface of rear oil seal retainer.

- Use Genuine Liquid Gasket or equivalent.

Right side

SEC. 130•135•185•186•210•213•233



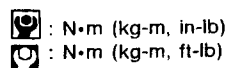
SEM044FA

- ① Starter motor
- ② Injection pump
- ③ Injection tube
- ④ Thermostat housing

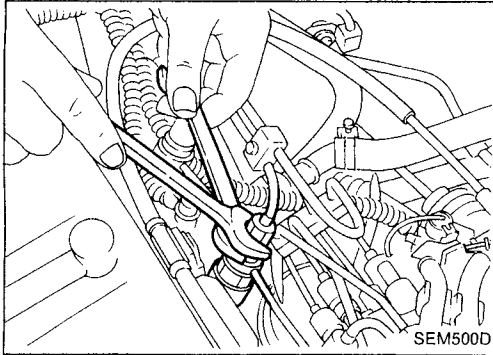
- ⑤ Injection nozzle
- ⑥ Spill tube
- ⑦ Water outlet
- ⑧ Belt cover

- ⑨ Timing belt
- ⑩ Injection pump sprocket
- ⑪ Rear camshaft sprocket
- ⑫ Rear back cover
- ⑬ Oil cooler
- ⑭ Gasket

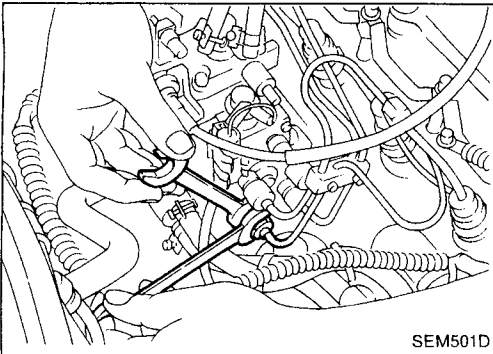
SEC. 120-135-140-210-230



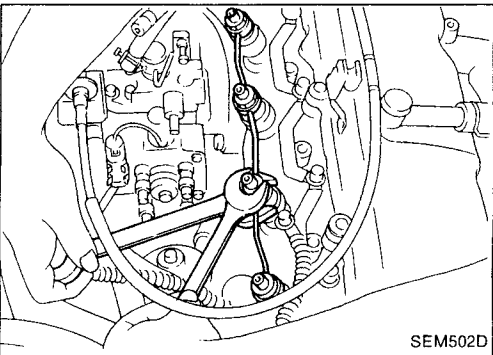
- SEM045FA



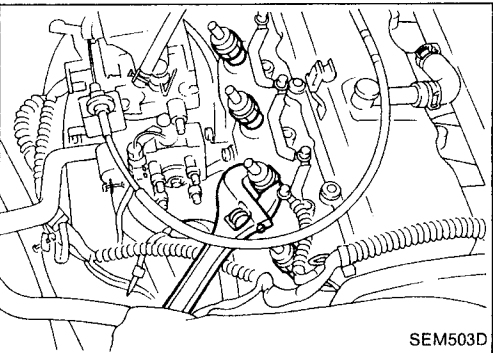
1. Warm up engine sufficiently.
2. Disconnect injection tubes on nozzle side and loosen injection tubes on pump side. Release clamps on injection tubes.
 - **Use two wrenches to prevent delivery holder on pump side from loosening.**



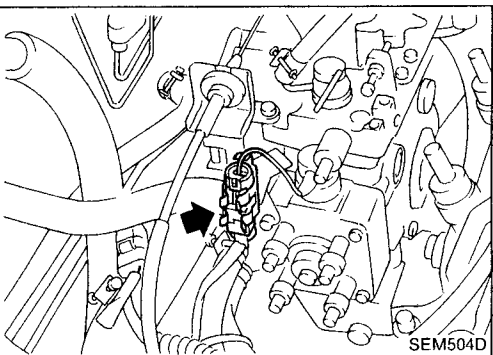
3. Remove spill-tube assembly.
 - **To prevent spill tube from breaking, remove it by gripping nozzle holder.**

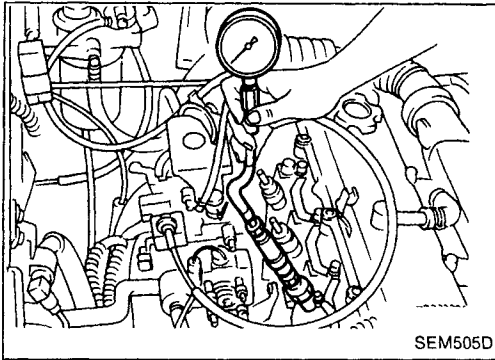


4. Remove all injection nozzles using a suitable tool.



5. Disconnect fuel-cut solenoid valve connector.





6. Fit compression gauge to cylinder head.

7. Crank engine and read compression gauge indication.

Cranking speed: 200 rpm

Compression pressure: kPa (bar, kg/cm², psi)

Standard

3,138 (31.4, 32, 455)

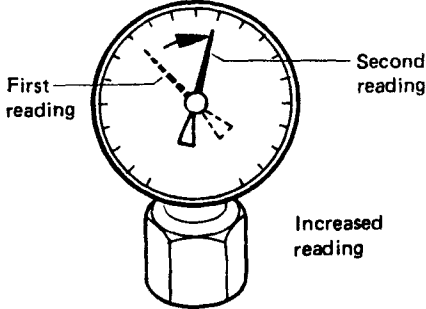
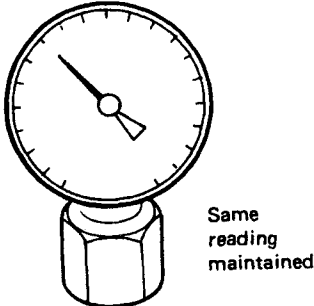
Limit

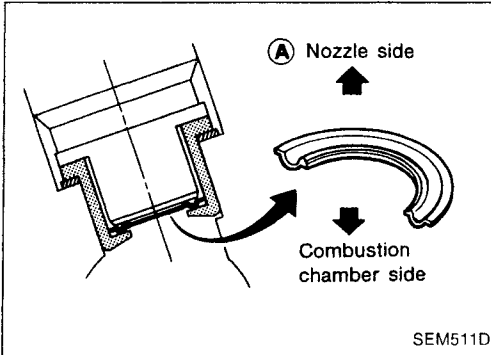
2,452 (24.5, 25, 356)

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.

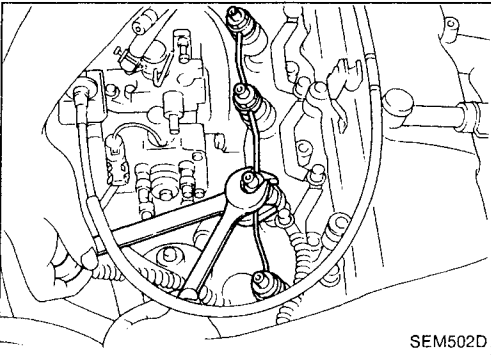
Gauge indication during tests	Trouble diagnosis
	● Piston rings are worn or damaged.
	● If two adjacent cylinders are low, gasket is damaged. ● Valve is sticking. ● Valve seat or valve contact surface is incorrect.



9. Replace nozzle gaskets and re-install injection nozzles.
New nozzle gaskets must be installed in the direction shown.

Nozzle to cylinder head:

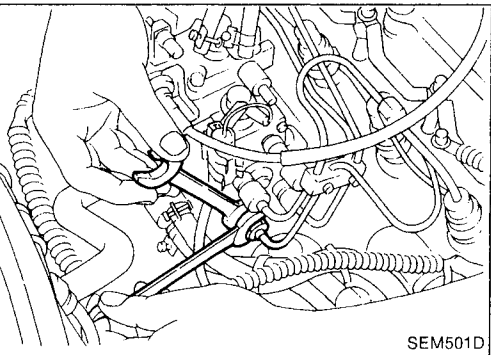
: 59 - 69 N·m (6 - 7 kg-m, 43 - 51 ft-lb)



10. Install spill tube by holding nozzle holder.

Spill tube nut:

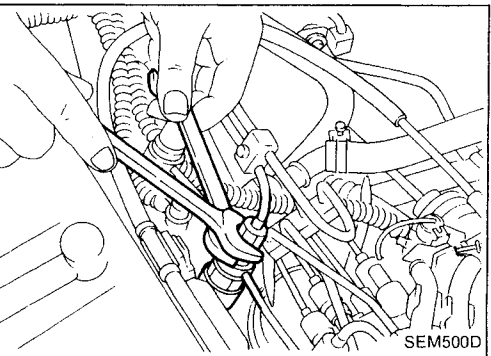
: 39 - 49 N·m (4 - 5 kg-m, 29 - 36 ft-lb)

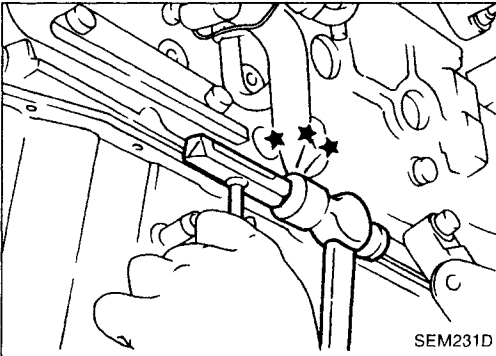
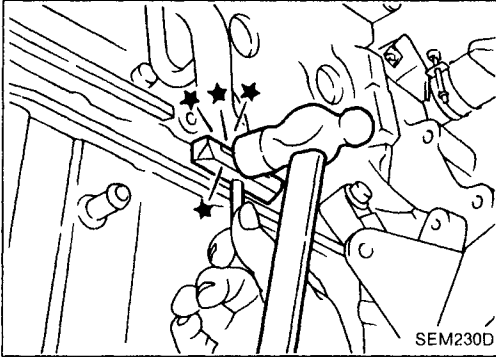


11. Install injection tubes using two wrenches as shown.

Injection tubes:

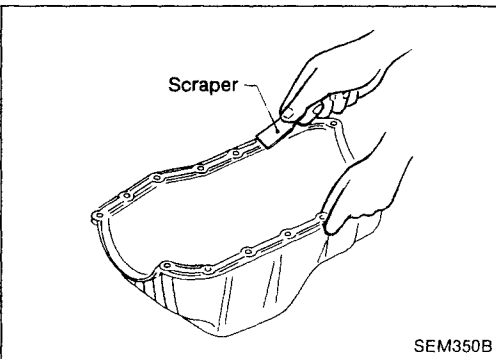
: 22 - 25 N·m (2.2 - 2.5 kg-m, 16 - 18 ft-lb)





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

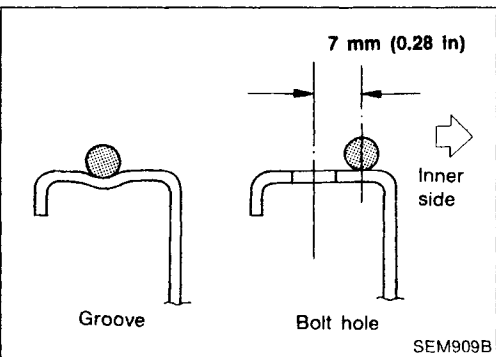
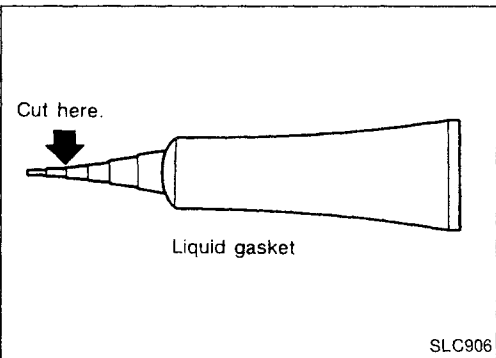


Installation

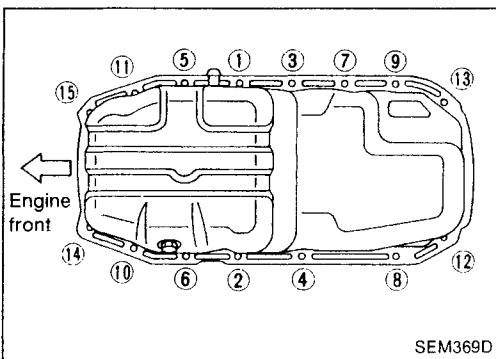
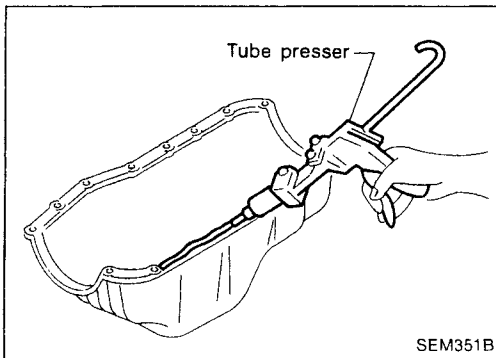
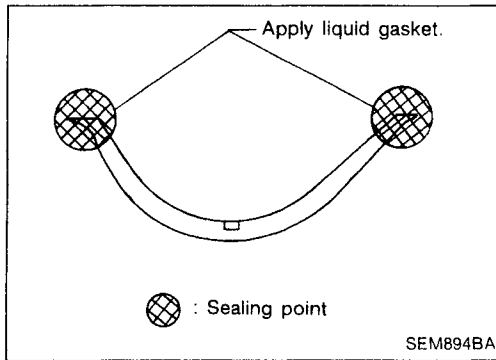
1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
 - Also remove traces of liquid gasket from mating surface of cylinder block.

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

Use Genuine Liquid Gasket or equivalent.



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

Installation (Cont'd)

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:

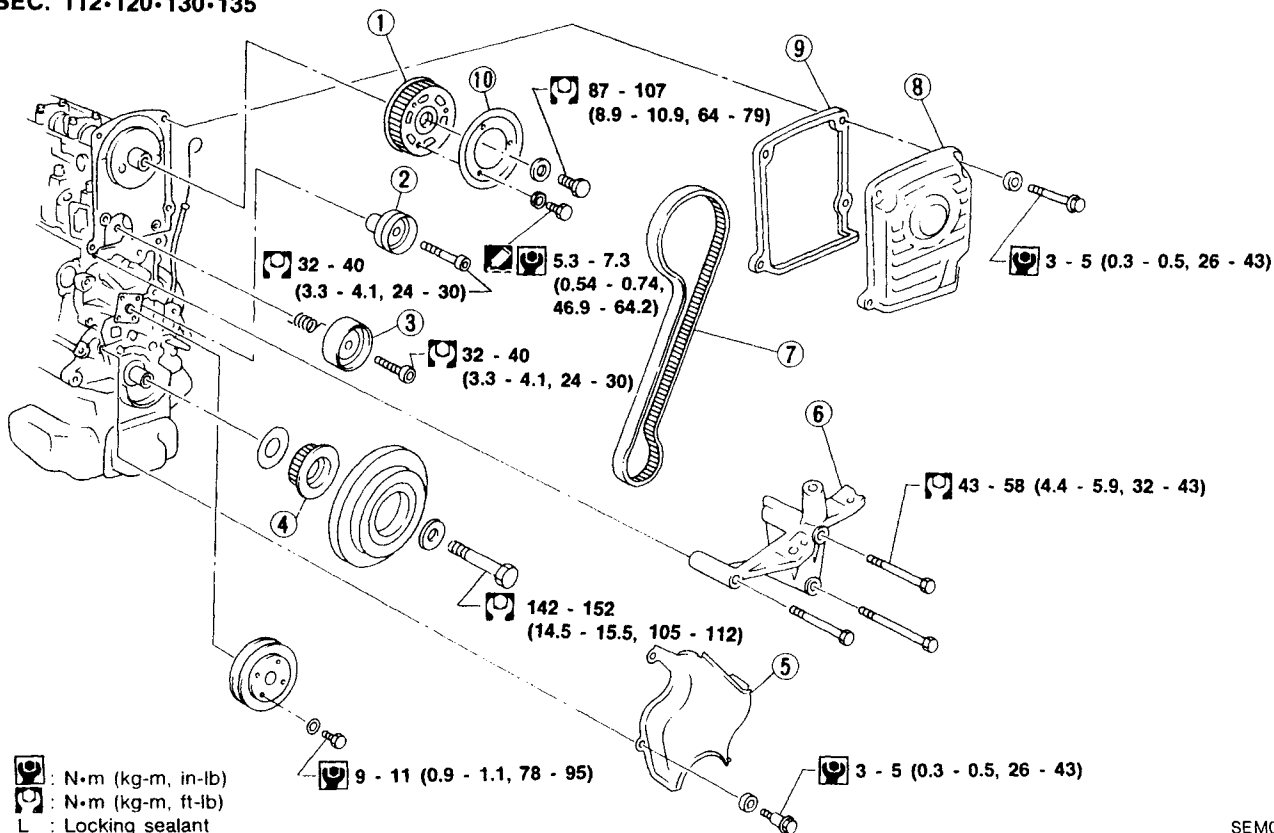
⊗ : 7 - 8 N·m (0.7 - 0.8 kg-m, 61 - 69 in-lb)

Camshaft Timing Belt

CAUTION:

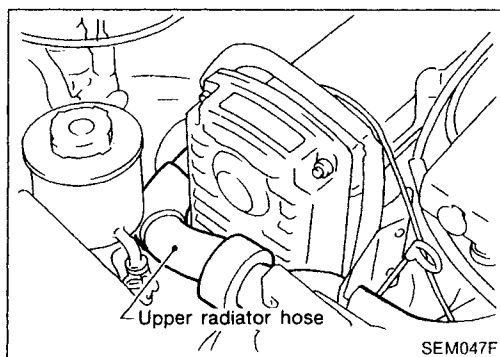
- Do not bend or twist timing belt.
- After removing timing belt, do not turn crankshaft and camshaft separately because valves will strike piston heads.
- Ensure that timing belt, camshaft sprocket, crankshaft sprocket and belt tensioner are clean and free from oil and water.

SEC. 112-120-130-135



SEM046FA

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

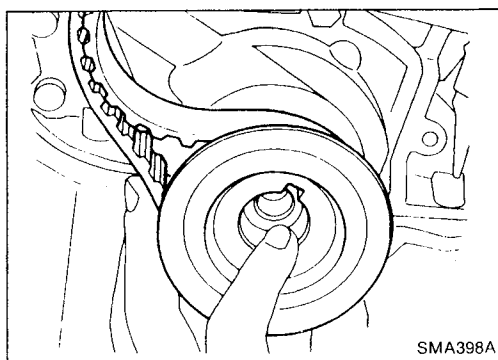
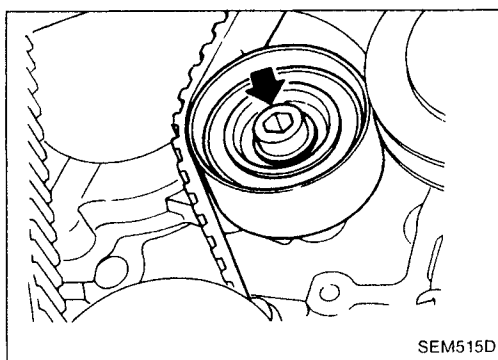
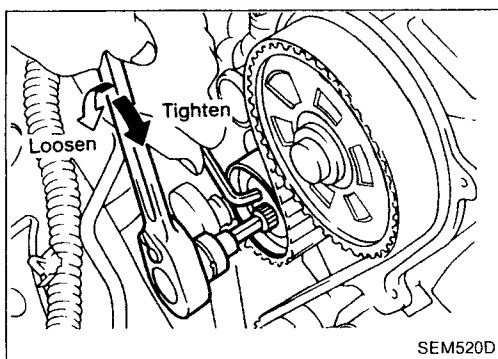
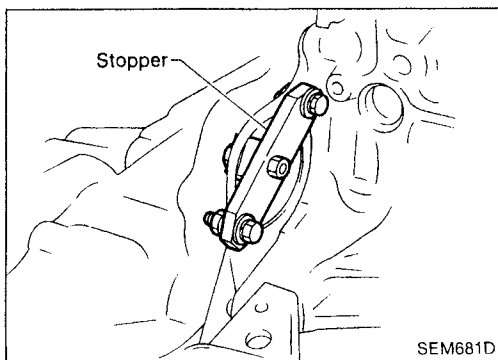
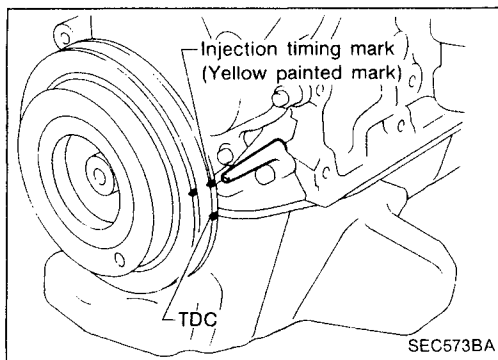


SEM047F

REMOVAL

- Drain engine coolant from radiator.
- Remove upper radiator hose and upper belt cover.
- 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.

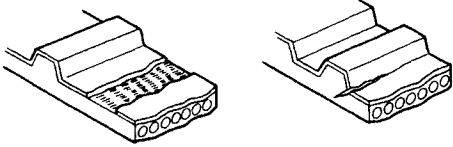
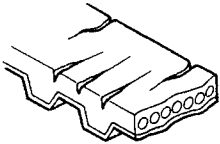
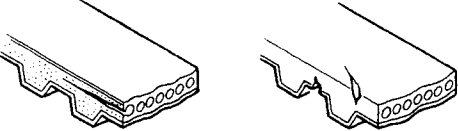
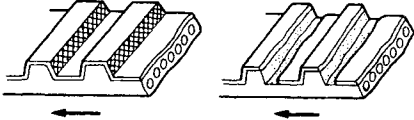
- (4) Remove timing belt with crankshaft sprocket.
- (5) Remove tensioner pulley and return spring.

Camshaft Timing Belt (Cont'd)

INSPECTION

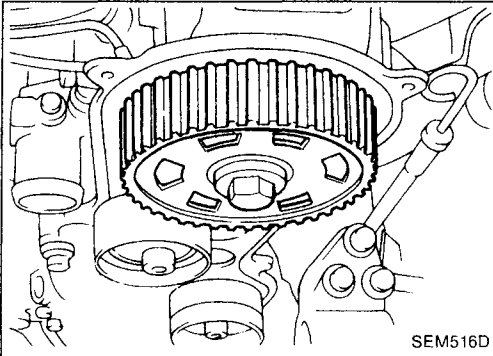
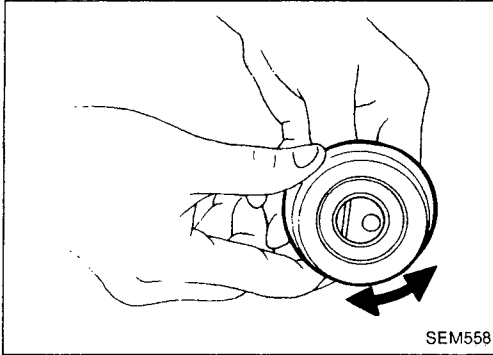
Timing belt

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

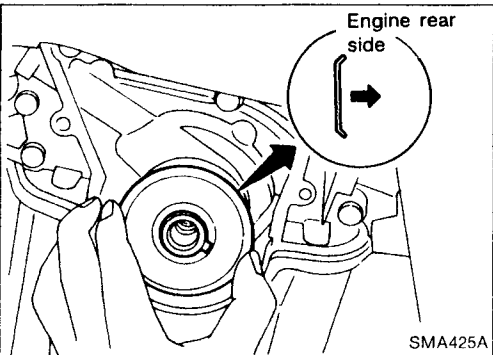
Item to check	Problem	Cause
Tooth is broken/tooth root is cracked.	 SEM394A	● Camshaft jamming ● Distributor jamming ● Damaged camshaft/crankshaft oil seal
Back surface is cracked/worn.	 SEM395A	● Tensioner jamming ● Overheated engine ● Interference with belt cover
Side surface is worn.	 ● Belt corners 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 web is worn down and invisible. SEM397A	● Poor belt cover sealing ● Coolant leakage at water pump ● Camshaft not functioning properly ● Distributor 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

Camshaft Timing Belt (Cont'd)**Belt tensioner, tensioner spring and idler**

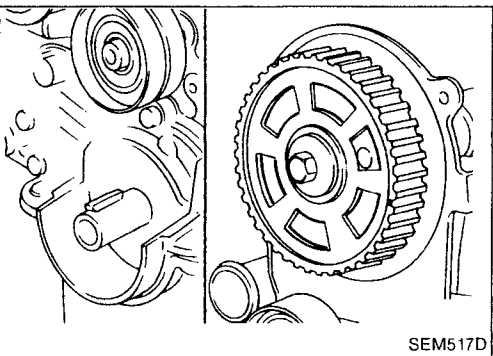
1. Check belt tensioner and idler for smooth turning.
2. Check condition of tensioner spring.

**Crankshaft sprocket and front camshaft sprocket**

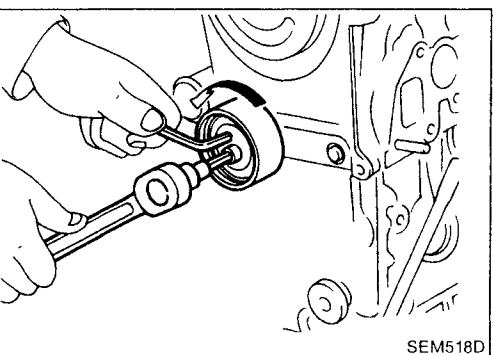
Check teeth for abnormal signs.

**INSTALLATION**

1. Install crankshaft sprocket plate in correct direction.

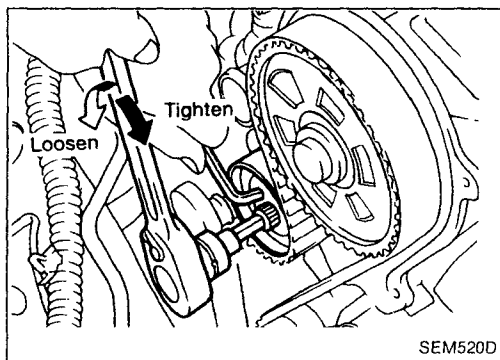
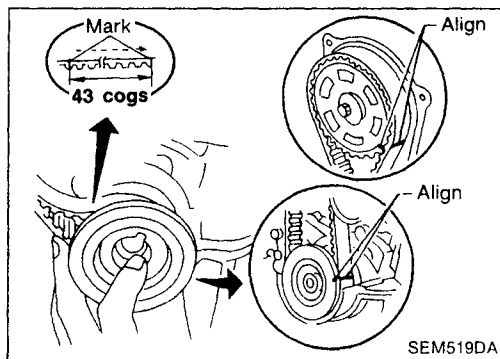


2. Confirm that No. 1 piston is set at TDC on its compression stroke. (TDC is indicated by crankshaft pulley notch without painted mark.)



3. Install tensioner and return spring.
Temporarily tighten bolts so that tensioner is set at the fully outside position.
4. Install idler and tighten bolt to the specified torque.

Camshaft Timing Belt (Cont'd)



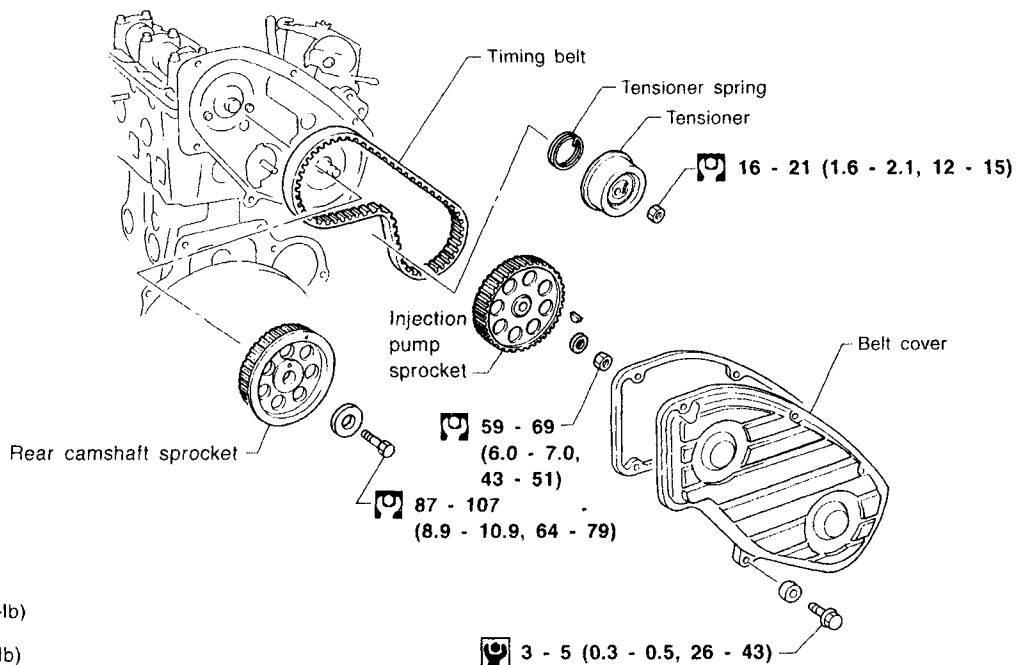
5. Install timing belt with crankshaft sprocket.
 - a. **Align white lines on timing belt with punchmarks on camshaft sprocket and crankshaft sprocket.**
 - b. **Point arrow on timing belt toward belt cover.**
6. Install camshaft sprocket plate and secure screws with lock-tite.
7. Adjust timing belt 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

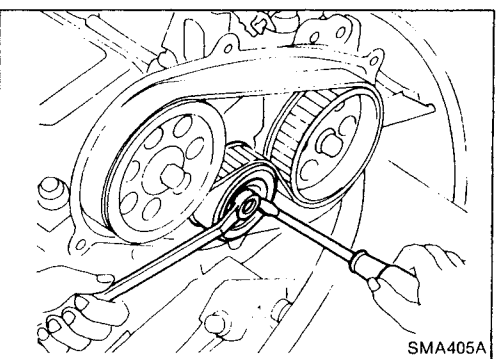
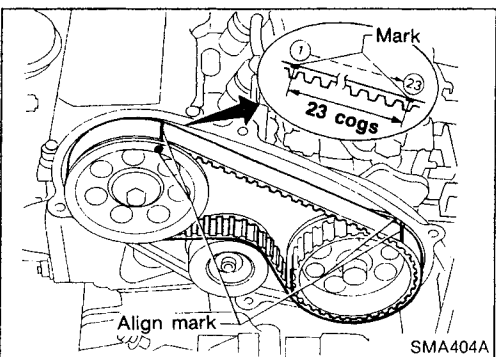
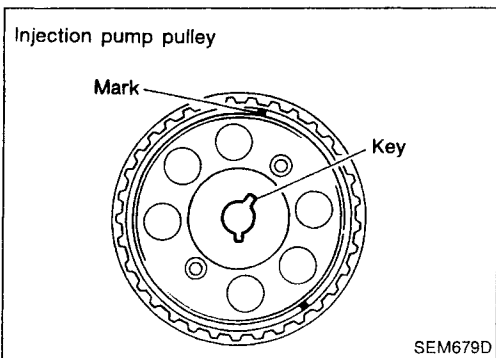
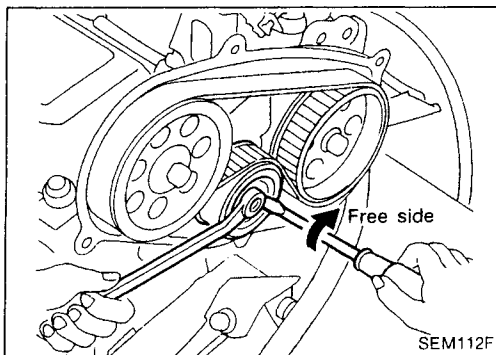
SEC. 130•135



SEM225F

REMOVAL

1. Set No. 1 cylinder at TDC on its compression stroke. (TDC is indicated by crankshaft pulley notch without painted mark.)
2. Remove air duct with resonator and timing belt cover.



Injection Pump Timing Belt (Cont'd)

3. Remove timing belt.
 - 1) Loosen tensioner lock nut and turn tensioner clockwise to free belt from tension. Then temporarily tighten tensioner nut.
 - 2) 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 pulley was removed, confirm that it is re-installed as illustrated.

Identification of alignment:

Use mark "A"

2. Set timing belt.
 - a. **Align white lines on timing belt with punchmarks on camshaft sprocket and injection pump sprocket.**
 - b. **Point arrow on timing belt toward belt cover.**

3. Adjust belt tension.
 - 1) Loosen tensioner lock nut to apply tension to timing belt.
 - 2) Rotate crankshaft clockwise two turns.
 - 3) Tighten tensioner lock nut while holding tensioner with a screwdriver.

Belt tension:

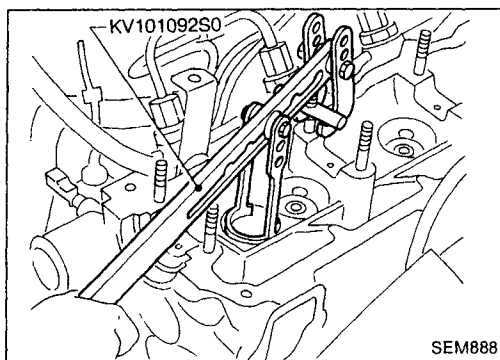
147 ± 49 N (15 ± 5 kg, 33 ± 11 lb)

INSPECTION

Refer to INSPECTION in "Camshaft Timing Belt" (EM-122).

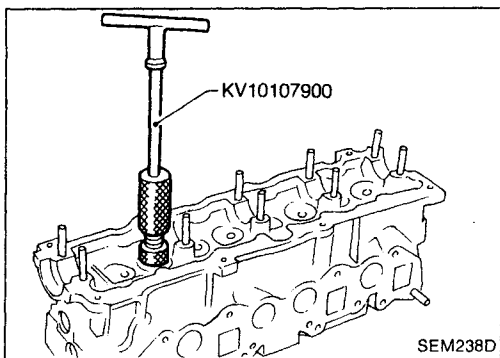
INJECTION TIMING ADJUSTMENT

Refer to EC section.



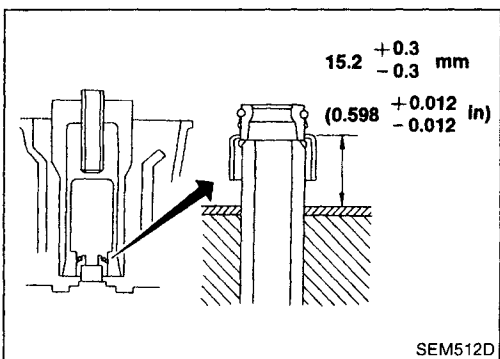
VALVE OIL SEAL

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.

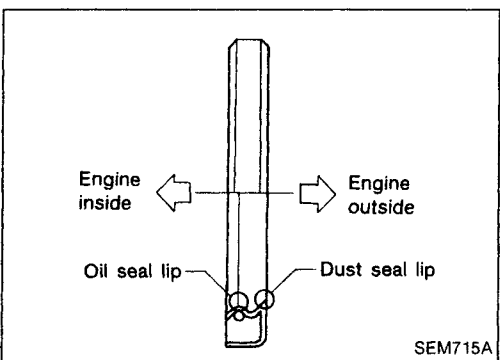


5. Remove valve lifters and mark order No. on each lifter.
6. Replace valve oil seal according to the following procedure.
When replacing valve oil seal, set the corresponding piston at TDC. Failure to do so causes the valve to drop into the cylinder.

- 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.

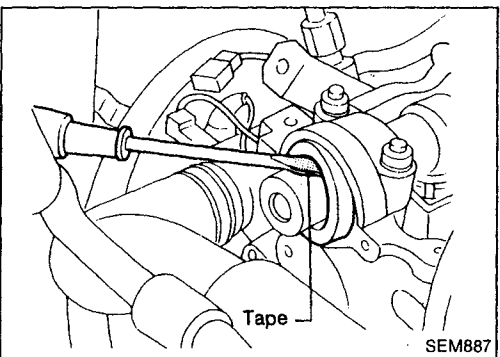


- 3) Install new valve oil seals for No. 1 and No. 4 cylinders as illustrated. Reinstall valve springs. (narrow pitch side toward cylinder head)
- 4) Install valve spring retainers on intake valves and valve rotators on exhaust valves, and remount valve assembly.
- 5) Set No. 2 cylinder at TDC.
- 6)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



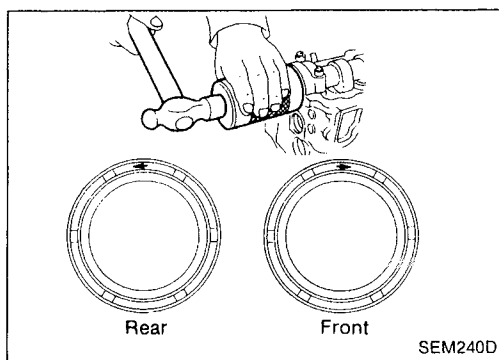
CAMSHAFT AND CRANKSHAFT OIL SEAL INSTALLING DIRECTION AND MANNER

- 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.

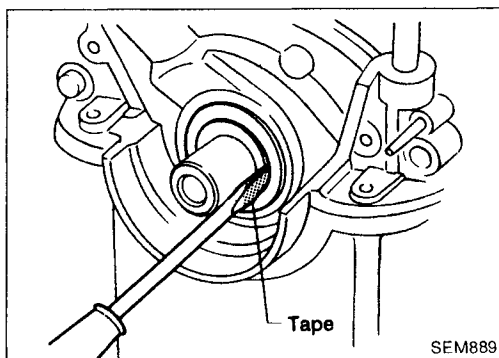


3. Install new oil seals with a suitable tool.
Confirm turning direction of both oil seals and camshaft.

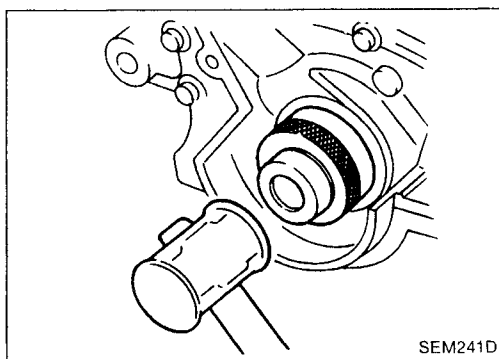
EM

CRANKSHAFT FRONT OIL SEAL

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

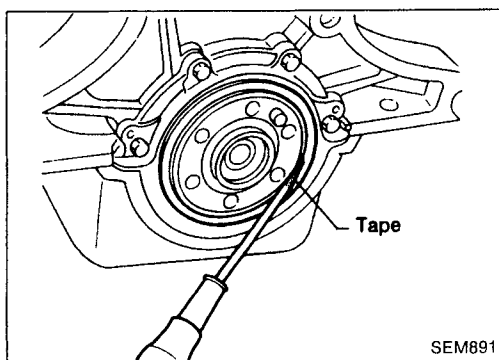


3. Apply engine oil to new oil seal and install oil seal using a suitable tool.

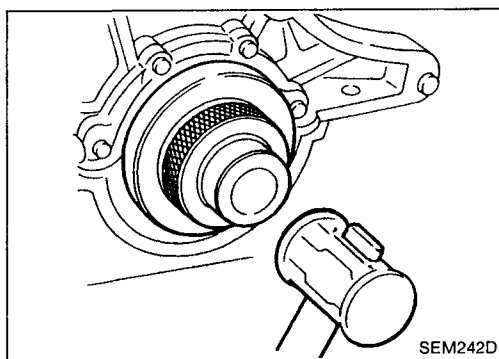


CRANKSHAFT REAR OIL SEAL

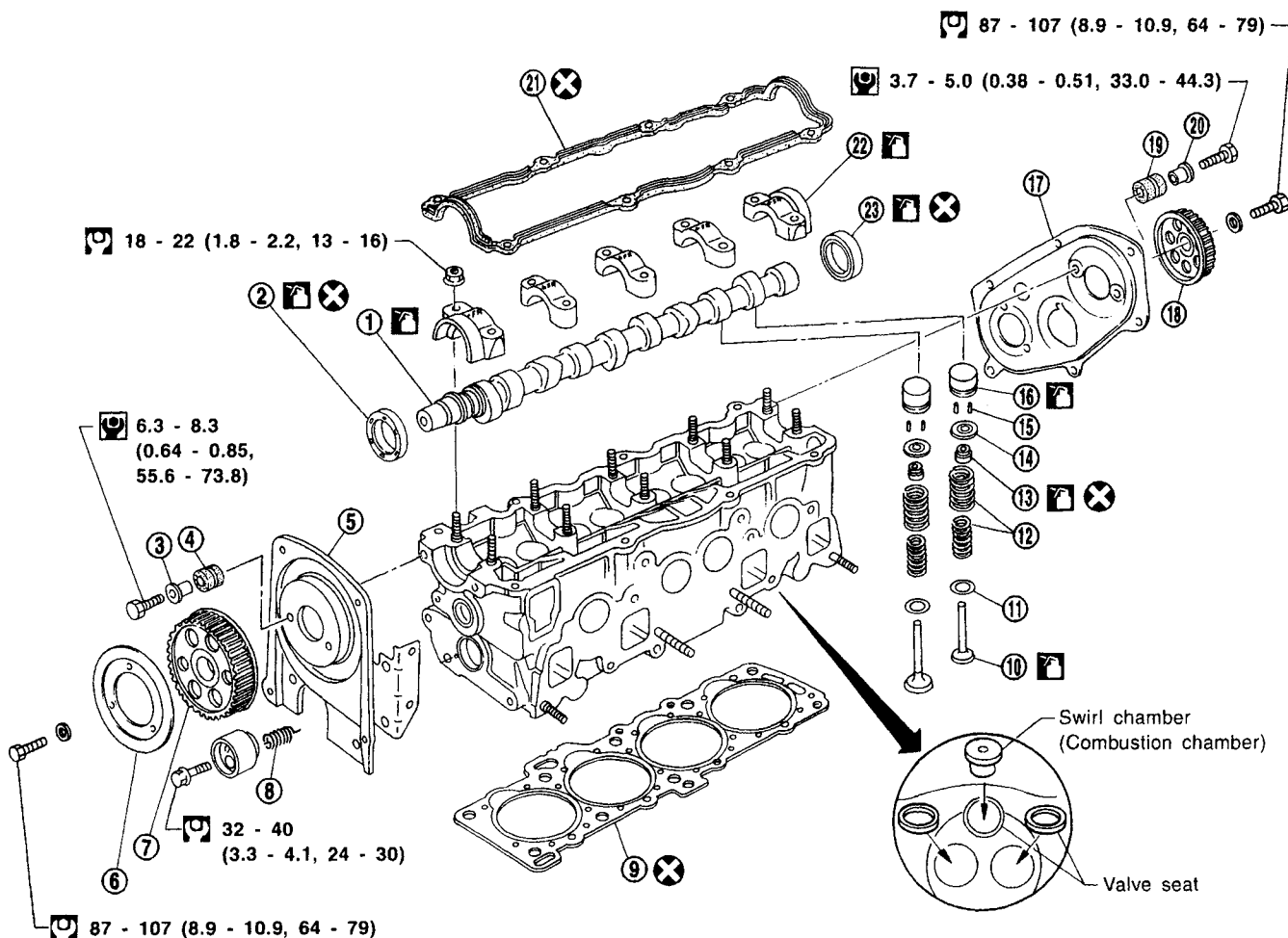
1. Remove transaxle assembly. (Refer to "REMOVAL AND INSTALLATION" in MT section.)
2. Remove flywheel.
3. Remove rear oil seal with a suitable tool.



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



SEC. 111•130•135



: N·m (kg-m, in-lb)

: N·m (kg-m, ft-lb)

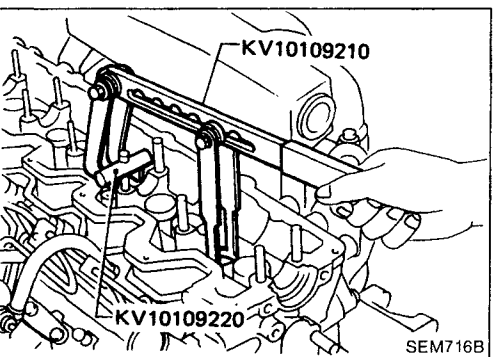
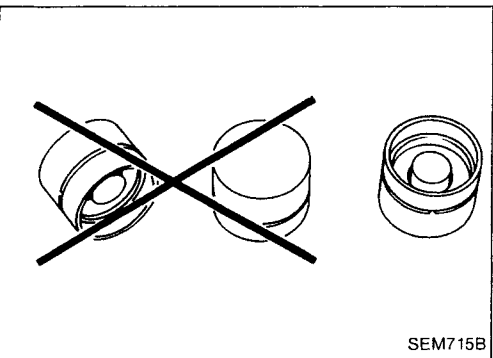
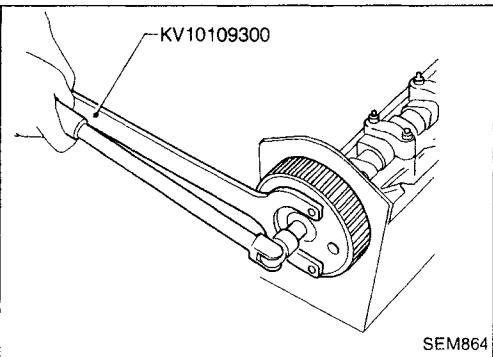
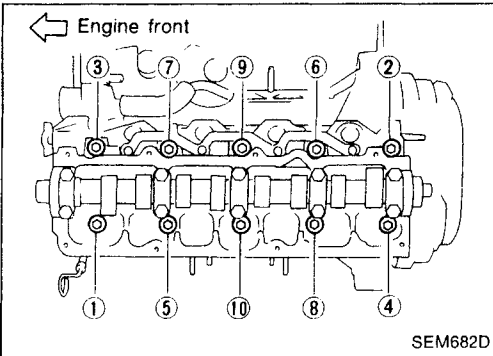
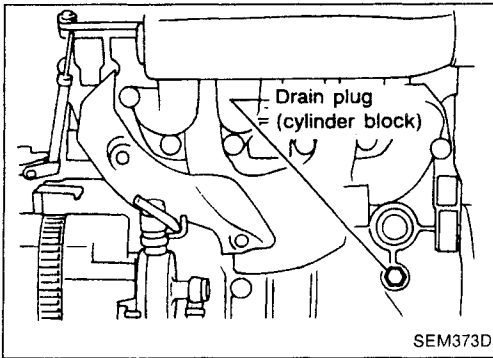
: Lubricate with new engine oil.

SEM226F

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

For hydraulic valve lifter

- Before starting engine, make sure that valve does not hit piston when rotating crankshaft by hand.
- When bleeding air out from hydraulic valve lifter, run engine at more than 2,400 rpm for 20 minutes or more.



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-120).

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

6. Remove cylinder head 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 hydraulic valve lifter

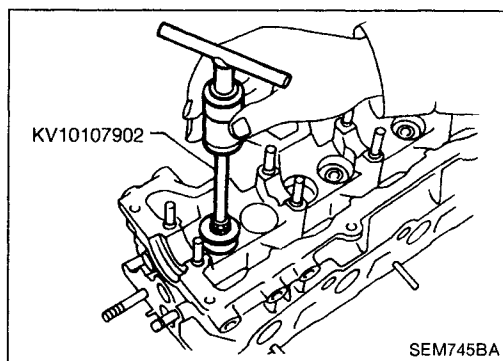
- Do not set hydraulic valve lifters as illustrated as air will enter valve lifter causing malfunction.
- Do not disassemble hydraulic valve lifters.
- Attach tags to valve lifters to prevent mixing them up.
- Valve lifters must be put in engine oil after removal.

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.

Disassembly (Cont'd)

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:

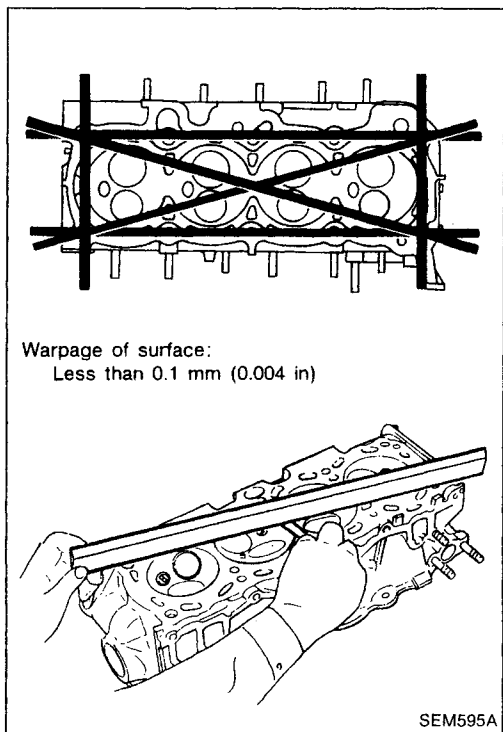
"A" is the amount of resurfacing needed for the cylinder head and "B" is the amount of resurfacing needed for the cylinder block, the maximum limit is determined by

$$A + B = 0.1 \text{ mm (0.004 in)}$$

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:

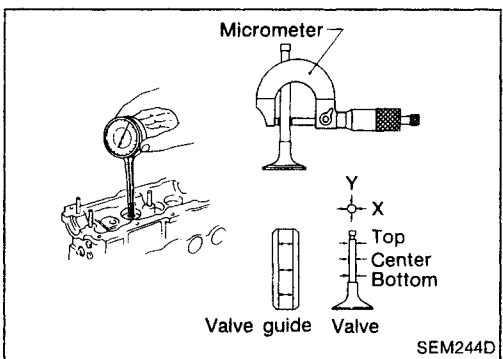
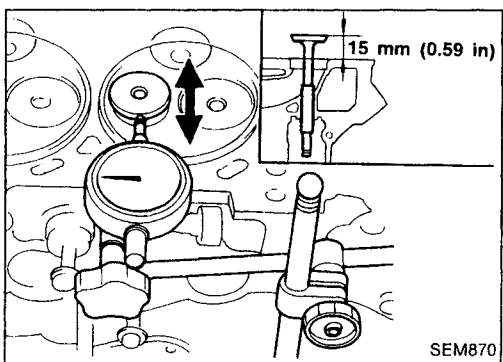
137.9 - 138.1 mm (5.429 - 5.437 in)

**VALVE GUIDE CLEARANCE**

1. Measure deflection across the cylinder head as illustrated.

Valve deflection limit (dial gauge reading):

0.1 mm (0.004 in)



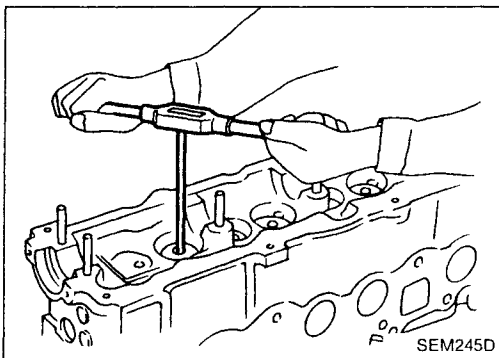
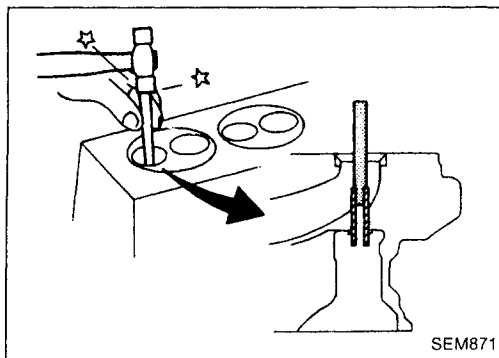
2. If exceeding the limit, check valve-to-guide clearance.
 - a) Measure valve stem diameter and valve guide inner diameter as illustrated.
 - b) Check that clearance is within the specification.

Valve stem to valve guide clearance limit:
0.1 mm (0.004 in)
 - c) If exceeding the limit, replace valve or valve guide.

Inspection (Cont'd)

VALVE GUIDE REPLACEMENT

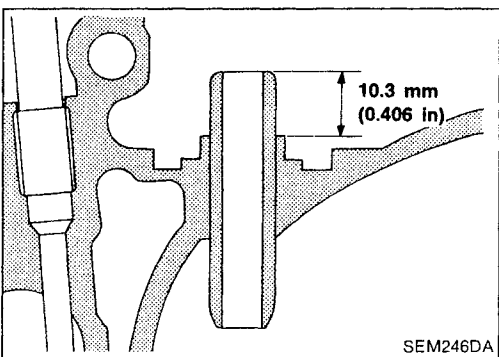
1. Heat cylinder head in oil to 150 to 160°C (302 to 320°F).
2. Drive out valve guide using a press or hammer and a suitable tool.



3. Ream cylinder head valve guide bore.

Reaming bore (service part):

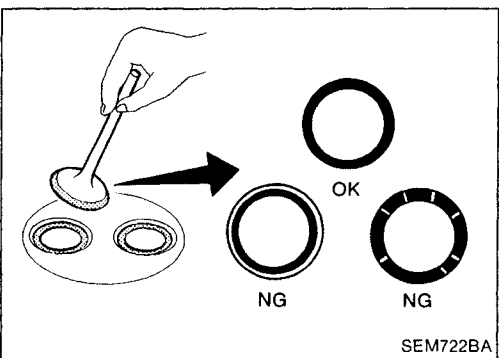
11.185 - 11.196 mm (0.4404 - 0.4408 in)



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)



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.

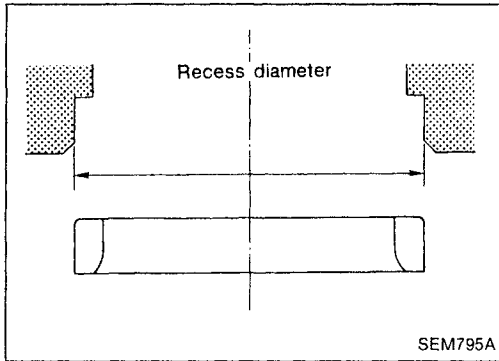
Inspection (Cont'd)

VALVE SEAT REPLACEMENT

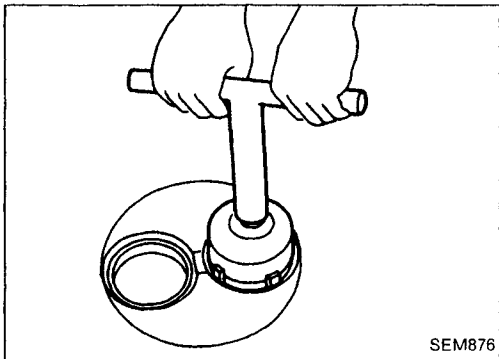
1. Bore out old seat until it collapses.
Set machine depth stop so that boring cannot contact bottom face of seat recess in cylinder head.
2. Ream the cylinder head recess.

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.**

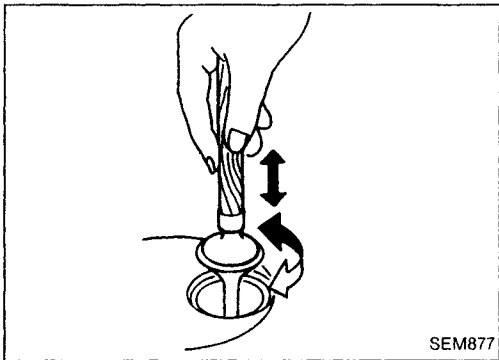
3. Heat cylinder head to a temperature of 150 to 160°C (302 to 320°F) and press fit seat until it seats on the bottom.
4. Install valve seats.

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

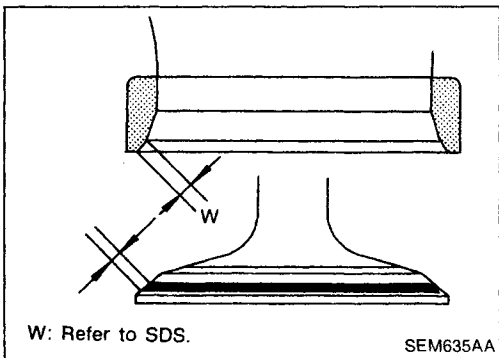
SEM795A



SEM876



SEM877



W: Refer to SDS.

SEM635AA

5. Cut or grind valve seat using a suitable tool at the specified dimensions as shown in SDS (EM-172).

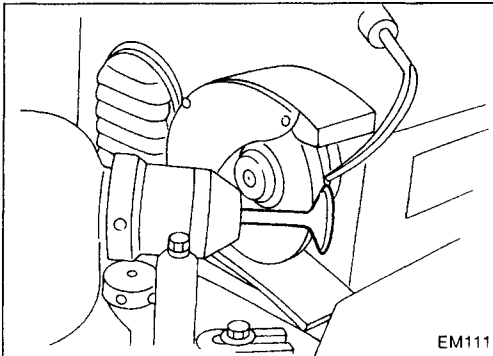
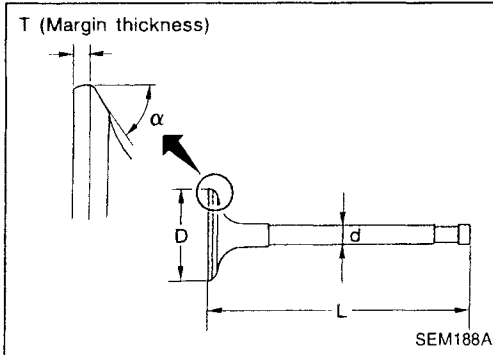
The cutting should be done with both hands to obtain a uniform and concentric finish.

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.

7. Check valve seating condition.

Inspection (Cont'd)**VALVE DIMENSIONS**

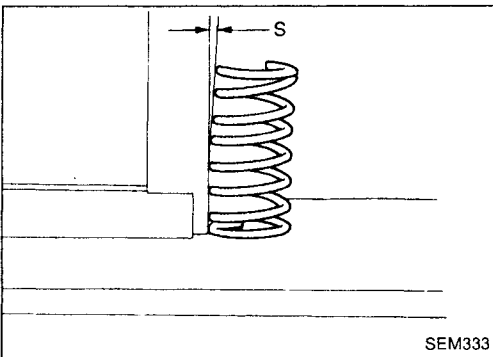
1. Check dimensions of each valve. For dimensions, refer to SDS (EM-171).
2. Correct or replace any valve that is faulty.



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.

**VALVE SPRING SQUARENESS**

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

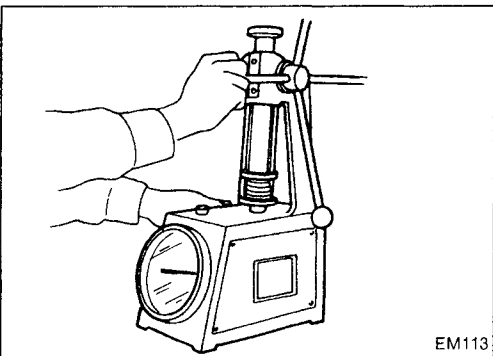
If spring is out of square "S" more than specified limit, replace with new one.

Out-of-square:**Outer**

Less than 2.1 mm (0.083 in)

Inner

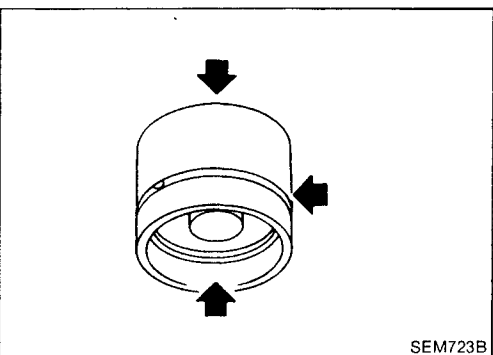
Less than 1.9 mm (0.075 in)

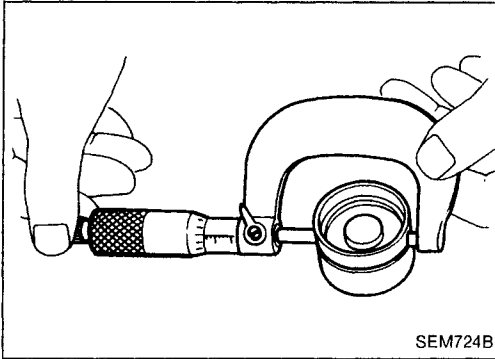
**VALVE SPRING PRESSURE LOAD**

Measure the free length and the tension of each spring. If the measured value exceeds the specified limit, replace spring. Refer to SDS (EM-172).

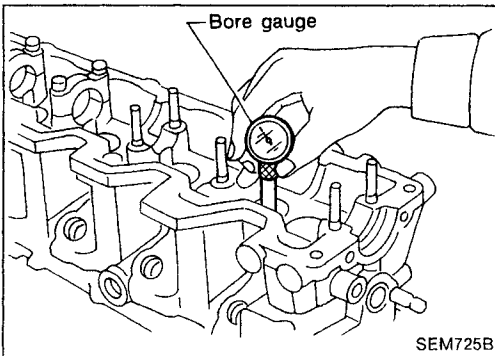
HYDRAULIC VALVE LIFTER

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

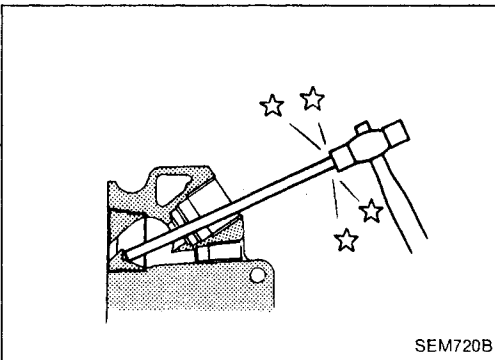


Inspection (Cont'd)

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



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)

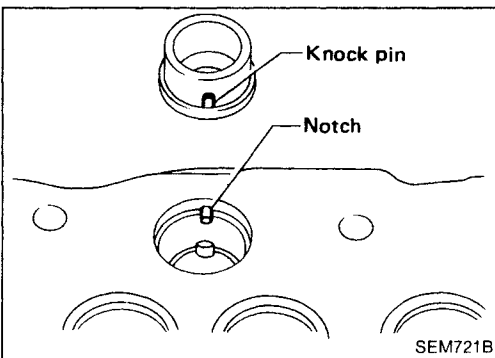
**COMBUSTION CHAMBER REPLACEMENT**

Usually combustion chambers should not be removed.

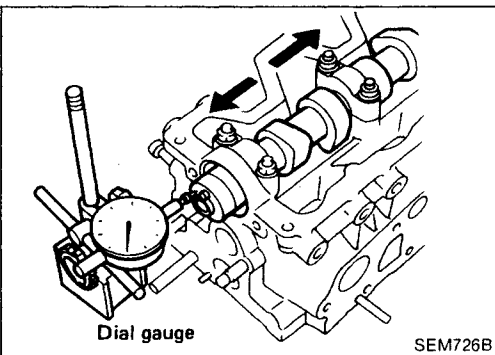
However, if they show cracks or extensive damage, they should be replaced.

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.



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

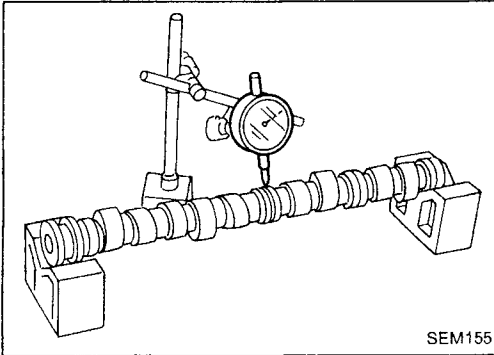
1. Install camshaft in cylinder head.
2. Tighten bracket bolts to the specified torque.
3. Measure camshaft end play.

Camshaft end play: Standard

0.115 - 0.188 mm (0.0045 - 0.0074 in)

Inspection (Cont'd)**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**

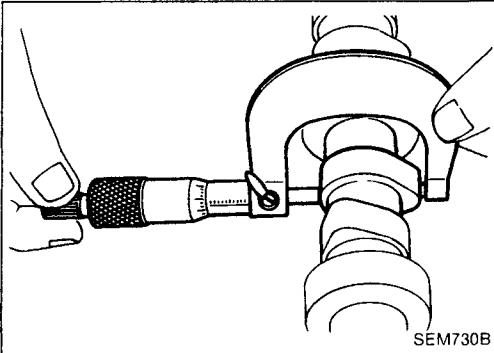
1. Measure camshaft cam height.

Cam height: Standard

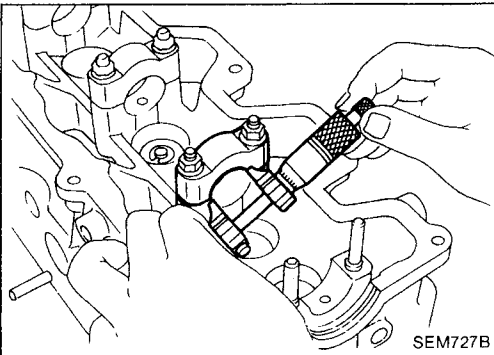
Unit: mm (in)

Intake	49.20 - 49.25 (1.9370 - 1.9390)
Exhaust	49.15 - 49.20 (1.9350 - 1.9370)

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

**CAMSHAFT JOURNAL CLEARANCE****Using micrometer**

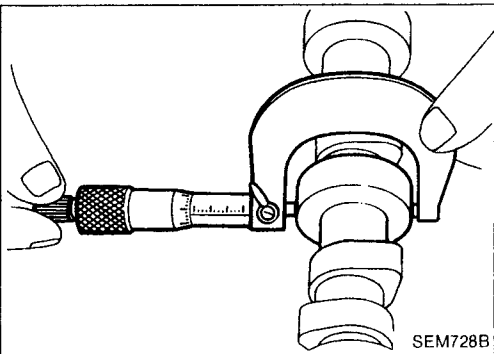
1. Measure the inner diameter of camshaft bearings.

Standard inner diameter:**30.000 - 30.021 mm (1.1811 - 1.1819 in)****Tighten bracket bolts to the specified torque.**

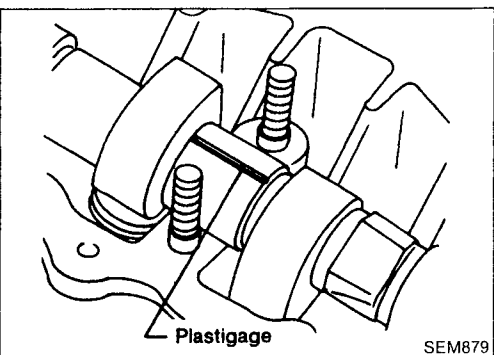
2. Measure the outer diameter of camshaft journals.

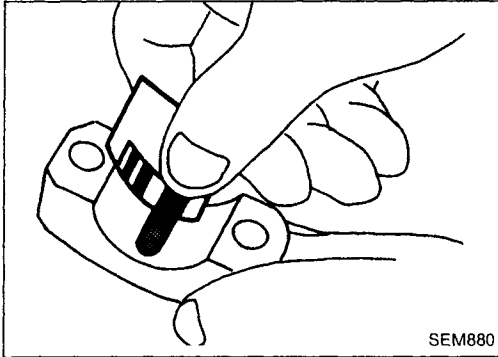
Standard outer diameter:**29.935 - 29.955 mm (1.1785 - 1.1793 in)**

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)



Inspection (Cont'd)

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

Camshaft bearing clearance:

Limit

0.1 mm (0.004 in)

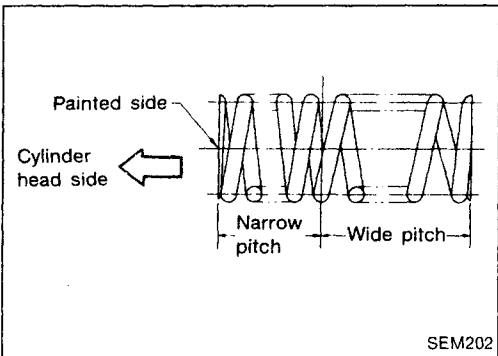
- If clearance appears to exceed the limit, replace camshaft or cylinder head.
- Which parts to be replaced should be decided upon after measuring the diameters of the parts concerned.

Assembly

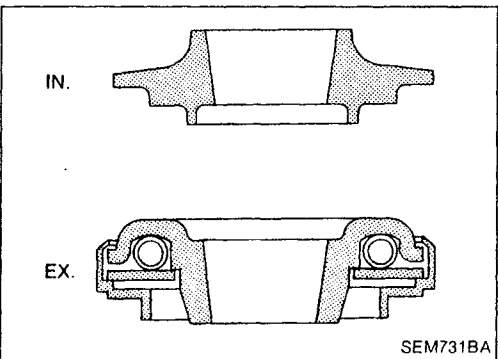
- Install valve component parts.

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.

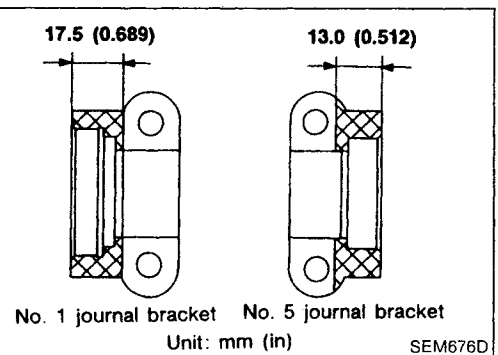
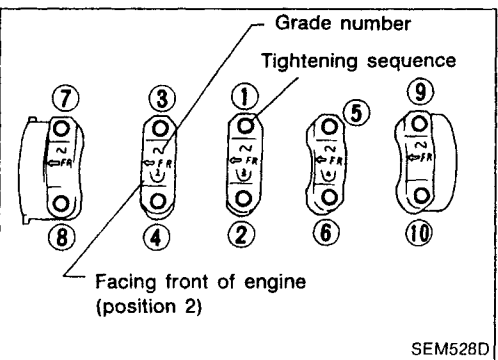


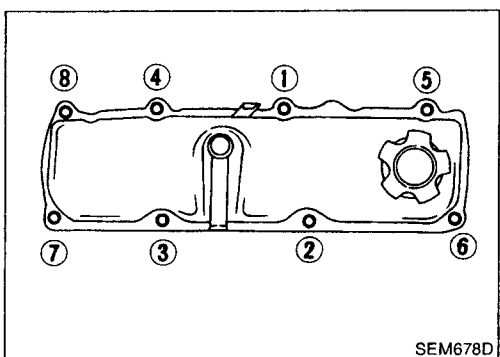
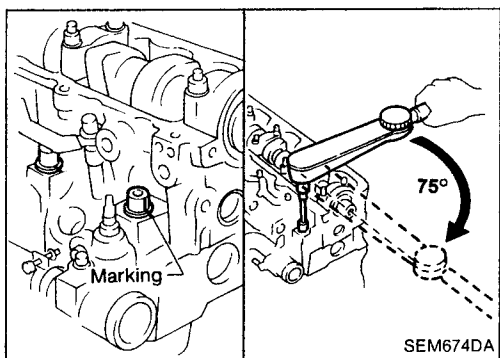
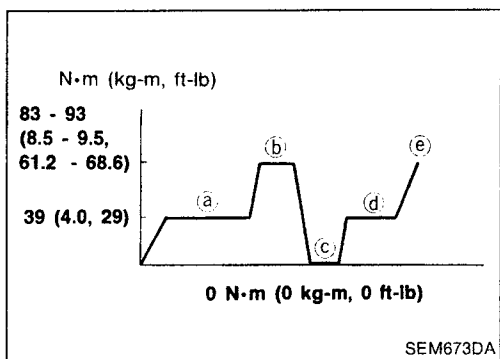
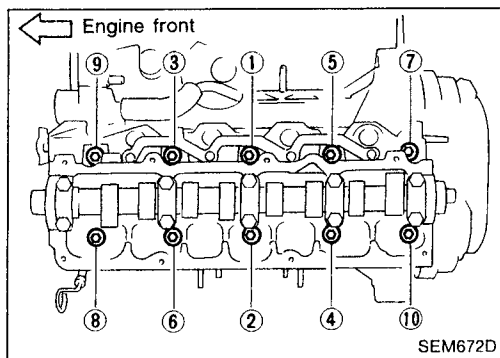
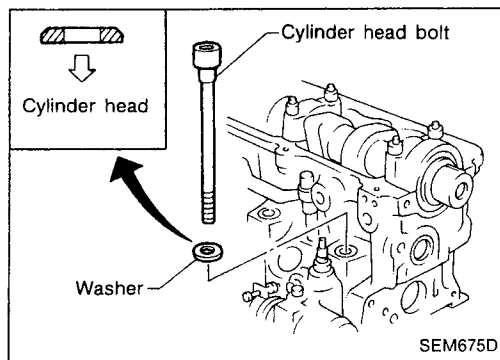
- Install camshaft and brackets and tighten bracket nuts to the specified torque in two or three stages.

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

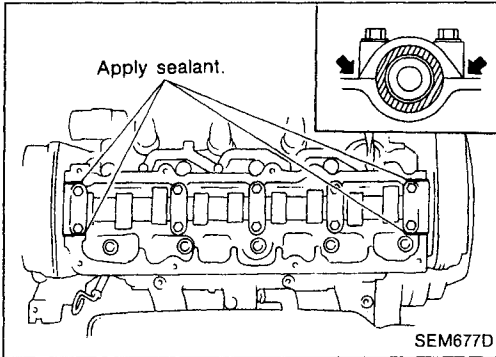
1. Install cylinder head gasket.
 - When replacing only cylinder head gasket, install same grade gasket as the one formerly used.
 - When replacing or repairing cylinder block, piston, connecting rod and crankshaft, select gasket referring to "Selecting cylinder head gasket".
 - Pay attention to the 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.

Tightening procedure

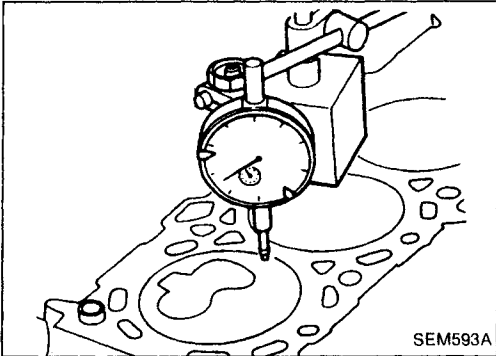
- Apply engine oil to threads and underhead seating face of each bolt.
1. Tighten bolts in numerical order shown in the figure following steps below.
 - (a) 39 N·m (4.0 kg-m, 29 ft-lb)
 - (b) 83 - 93 N·m (8.5 - 9.5 kg-m, 61.2 - 68.6 ft-lb)
 - (c) Return to 0 N·m (0 kg-m, 0 ft-lb)
 - (d) 39 N·m (4.0 kg-m, 29 ft-lb)
 - (e) Tighten to 75 - 80°

If it is difficult to check tightening angle of bolt, tighten to 83 to 93 N·m (8.5 to 9.5 kg-m, 61 to 69 ft-lb).

2. Install rocker cover.
 - Install rocker cover in the sequence shown at left.

Installation (Cont'd)

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

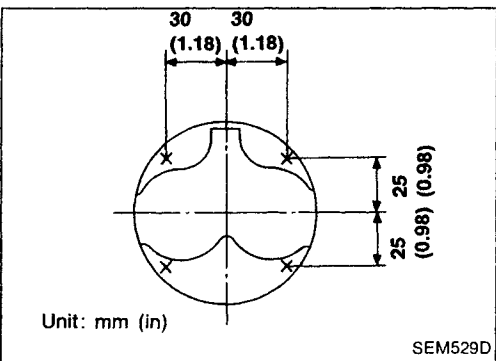
**Selecting cylinder head gasket**

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.

- Set dial gauge and needle on cylinder block and adjust dial gauge to zero.
- Set dial gauge needle at measuring point on piston, taking care not to disturb its zero setting.
- Rotate crankshaft around the top dead center position.



- Read and write down the maximum value.
 - Reset dial gauge on cylinder block and confirm that zero setting has not been disturbed during measurement.
 - 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

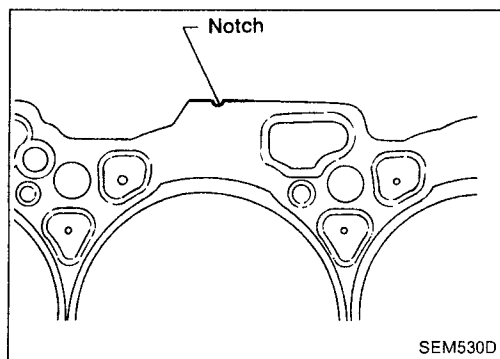
Determine required thickness of gasket, referring to chart A.

CYLINDER HEAD

CD

Installation (Cont'd)

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)	1.25 (0.0492)	1.1 ^{+0.03} _{-0.03} (0.0433 ^{+0.0012} _{-0.0012})	0
	1.30 (0.0512)	1.15 ^{+0.05} _{-0.05} (0.0453 ^{+0.0020} _{-0.0020})	1
0.505 - 0.555 (0.0199 - 0.0219)	1.35 (0.0931)	1.20 ^{+0.05} _{-0.05} (0.0472 ^{+0.0020} _{-0.0020})	2
Over 0.555 (0.0219)	1.40 (0.0551)	1.25 ^{+0.05} _{-0.05} (0.0492 ^{+0.0020} _{-0.0020})	3

EM

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 so, use gasket as selected in step 4.

Example

Unit: mm (in)

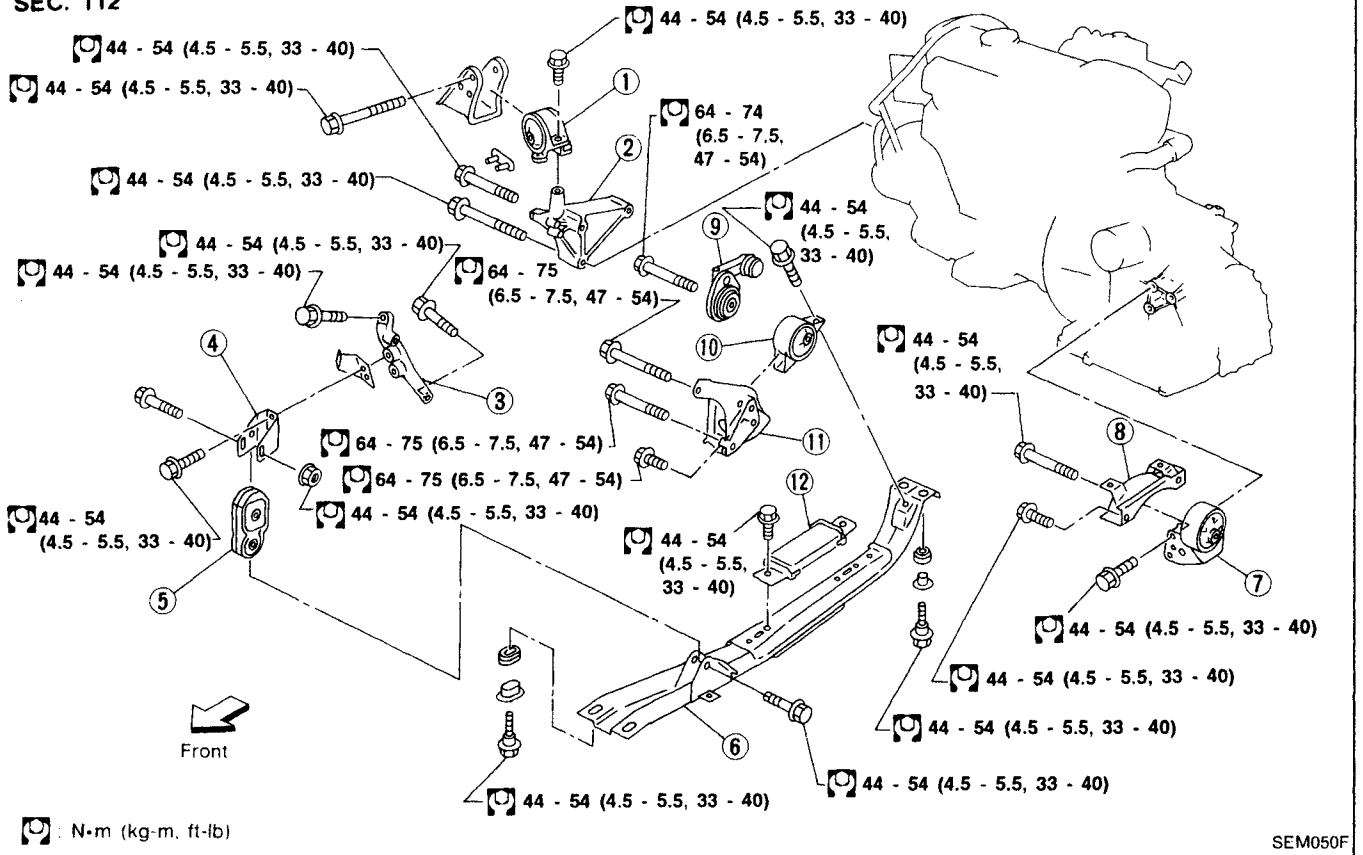
Step	Cylinder No. Item	1				2				3				4			
1.	Measured value	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4	M1	M2	M3	M4
		0.53	0.56	0.53	0.56	0.59	0.55	0.59	0.55	0.53	0.58	0.57	0.54	0.58	0.51	0.52	0.57
		(0.0209)	(0.0220)	(0.0209)	(0.0220)	(0.0232)	(0.0217)	(0.0232)	(0.0217)	(0.0209)	(0.0228)	(0.0224)	(0.0213)	(0.0228)	(0.0201)	(0.0205)	(0.0224)
2.	Average value of each piston	0.545 (0.0215)				0.57 (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 thick- ness (Tempo- rarily)	1.20 (0.0472) (Grade B)															
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 thick- ness (Finally)	1.20 (0.0472) (Grade B)*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 forth 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 C gasket must be used.

SEC. 112



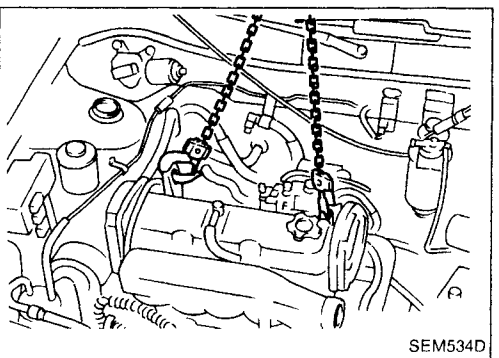
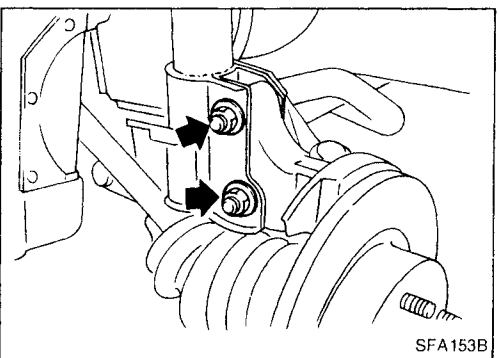
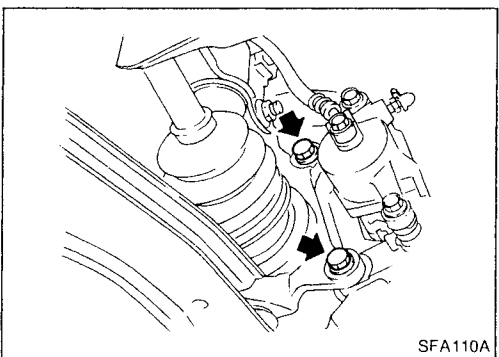
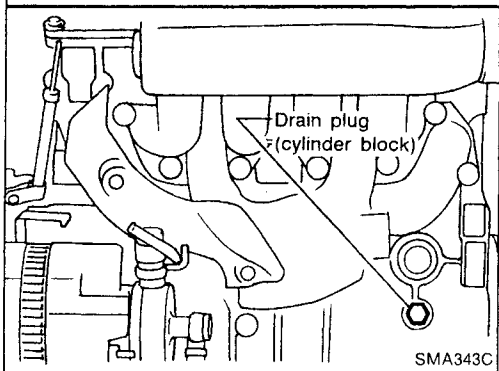
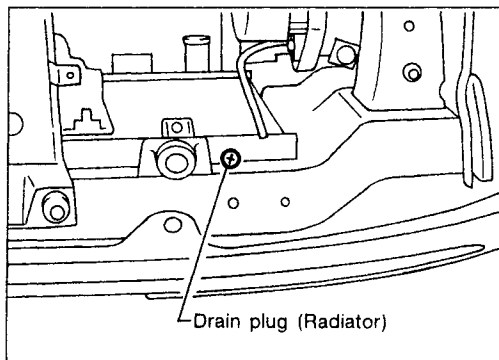
- | | | |
|---------------------------|------------------------------|--------------------------------|
| ① Engine front mounting | ⑤ Buffer rod | ⑨ Roll damper |
| ② Engine mounting bracket | ⑥ Center member | ⑩ Engine rear mounting |
| ③ Gusset | ⑦ Transaxle mounting | ⑪ Engine rear mounting bracket |
| ④ Buffer rod bracket | ⑧ Transaxle mounting bracket | ⑫ Dynamic damper |

WARNING:

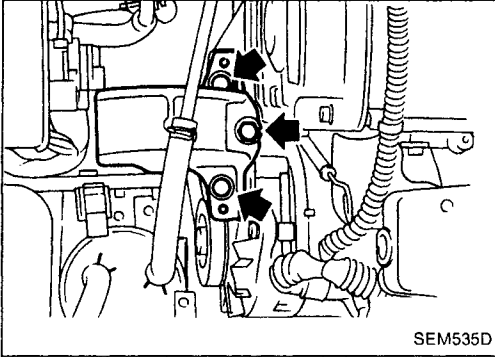
- Situate vehicle on a flat and solid surface.
- Place chocks at front and back of rear wheels.
- Do not remove engine until exhaust system has completely cooled off. Otherwise, you may burn yourself and/or fire may break out in the fuel line.
- For safety during subsequent steps, the tension of wires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

CAUTION:

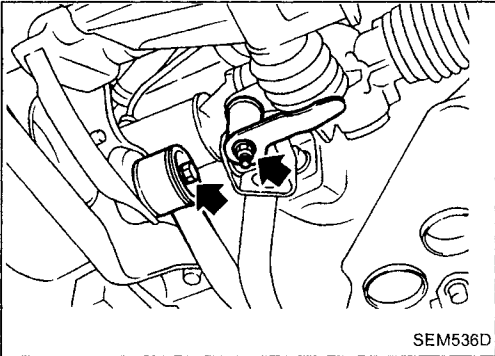
- When lifting engine, be sure to clear surrounding parts. Take special care for accelerator wire casing, brake lines and brake master cylinder.
- In hoisting the engine, always use engine slingers in a safe manner.
- In removing drive shaft, be careful not to damage transaxle oil seal.



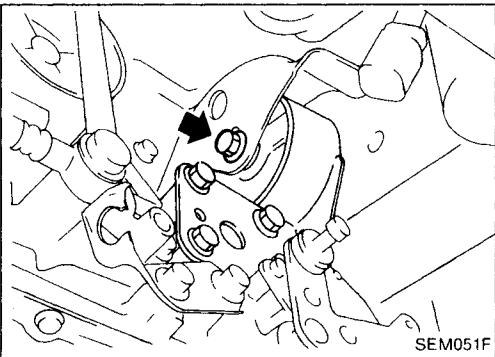
1. Remove engine undercovers and splash covers.
2. Remove front exhaust tube.
3. Drain coolant and disconnect lower water hose from radiator.
4. Drain transaxle oil.
5. Disconnect electrical wiring from cooling fan.
6. Remove power steering mounting bolt.
7. Drain coolant from cylinder block.
8. Disconnect water hoses and remove radiator.
9. Disconnect fuel tubes and vacuum tubes.
10. Release power steering belt adjusting nut and remove power steering pump from engine.
Bind pump properly to the vehicle.
11. Disconnect or remove electrical wiring where necessary.
12. Release clutch lever cable and accelerator cable.
13. Remove speedometer pinion connector from transaxle.
14. Remove front wheels.
15. Remove brake caliper mounting bolts and bind caliper properly to vehicle (coil spring) LH & RH.
16. Remove lower ball joint nuts and release the upper hub mounting bolts.
17. Release steering arm ball joint using a suitable tool. 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.
18. Mount suitable slingers to cylinder head. Fit hoist with studge and hoist engine to release force on engine mountings.



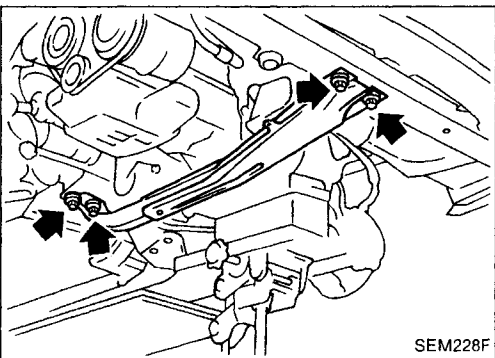
19. Remove engine mounting bracket.



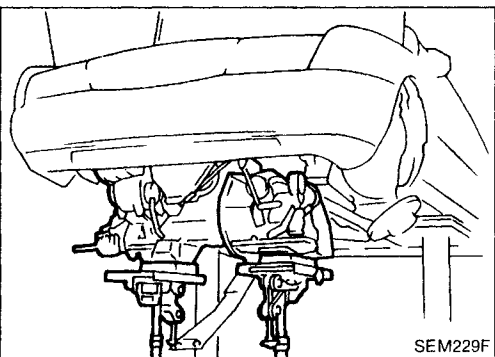
20. Release transaxle shift linkages.



21. Release transaxle mounting.

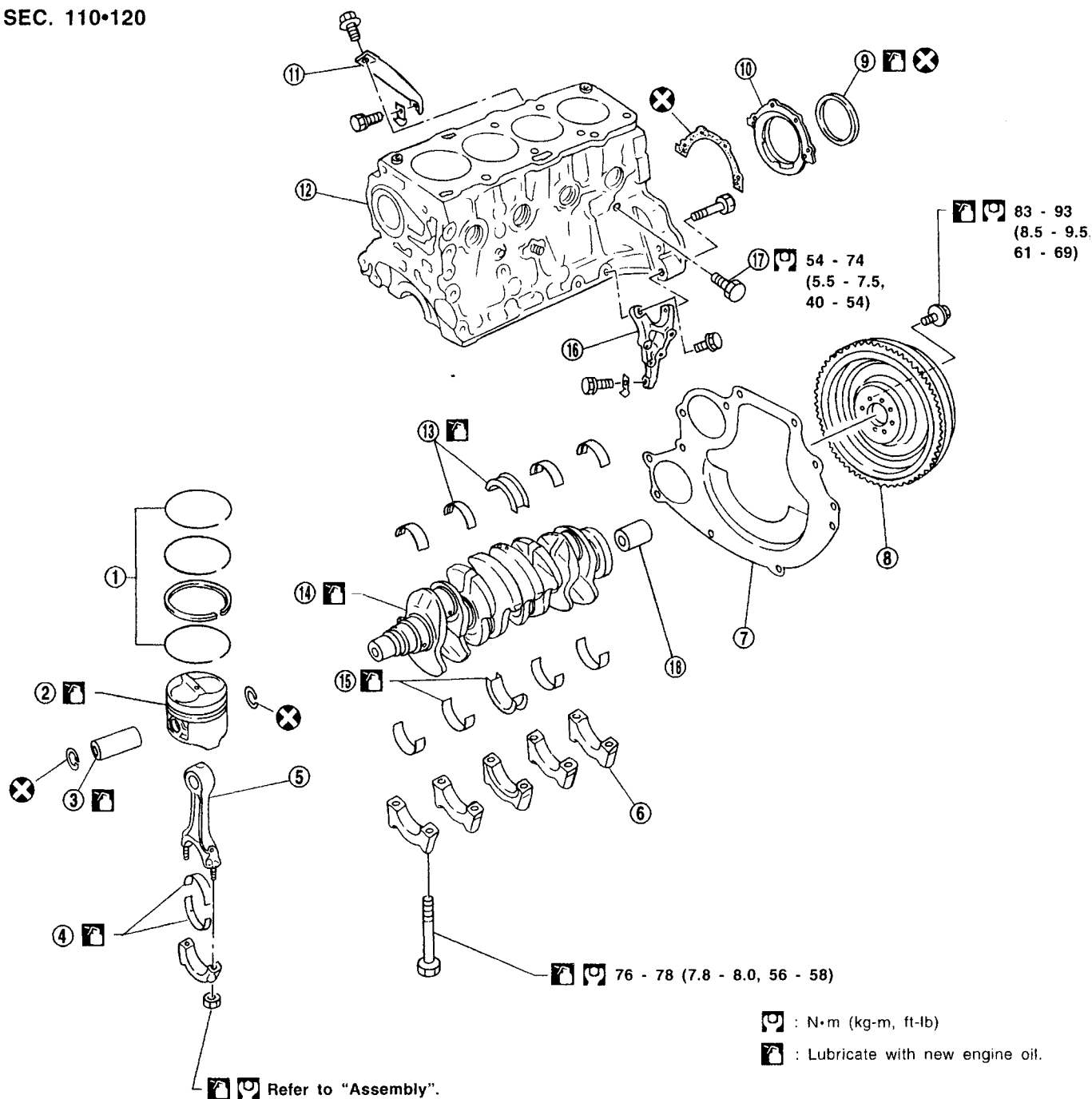


22. Remove center member from chassis.



23. Remove engine with transaxle as shown.

SEC. 110•120



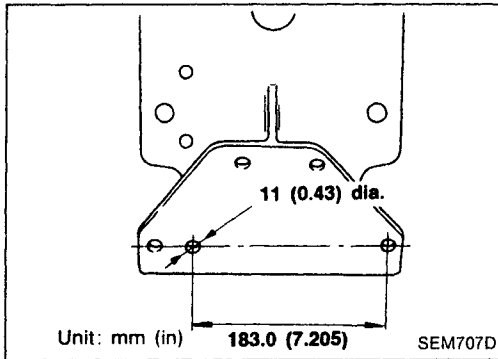
EM

- 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

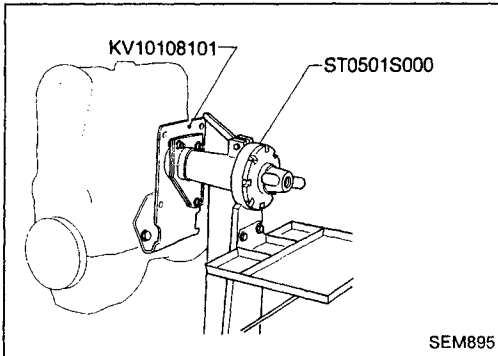
- ⑬ Main bearing
- ⑭ Crankshaft
- ⑮ Main bearing
- ⑯ Gusset
- ⑰ Drain plug
- ⑱ Pilot bushing

SEM227F



Preparation

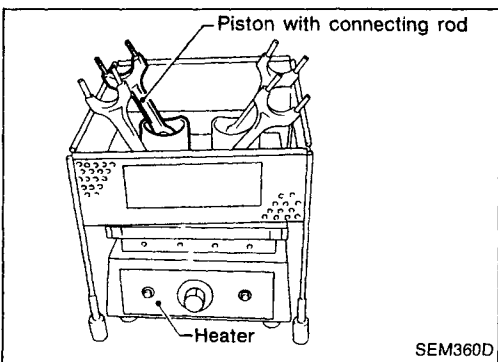
- Drill a hole into the attachment (KV10108101).



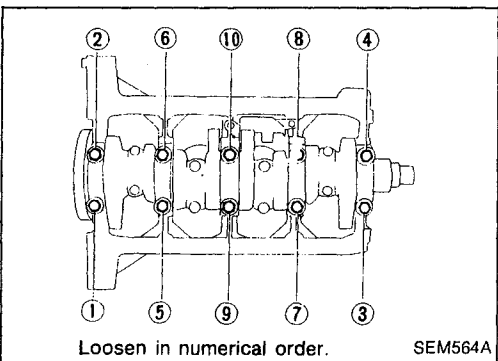
Disassembly

PISTON AND CRANKSHAFT

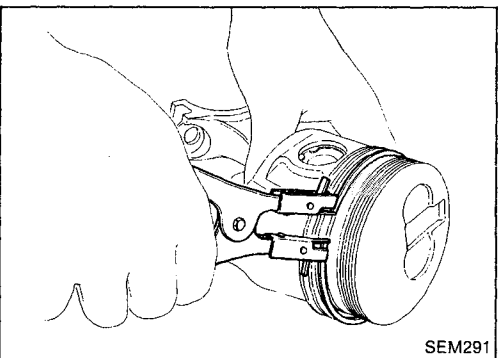
1. Place engine on a work stand.
2. Drain coolant and oil.
3. Remove timing belt.
4. Remove water pump.
5. Remove oil pan and oil pump.
6. Remove cylinder head.
7. Remove pistons with connecting rods.



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 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:

24.994 - 25.000 mm (0.9840 - 0.9843 in)

Pin hole diameter:

24.991 - 24.999 mm (0.9839 - 0.9842 in)

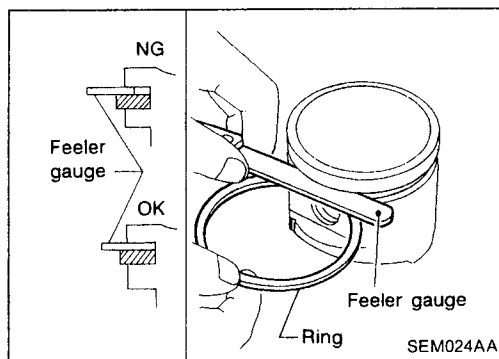
Clearance:

-0.004 to 0 mm (-0.0002 to 0 in)

(Interference fit)

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

EM

**PISTON RING SIDE CLEARANCE****Side clearance:**

Unit: mm (in)

	Standard	Limit
Top ring	0.060 - 0.095 (0.0024 - 0.0037)	0.10 (0.0039)
2nd ring	0.040 - 0.075 (0.0016 - 0.0030)	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.

Inspection (Cont'd)

PISTON RING END GAP

End gap:

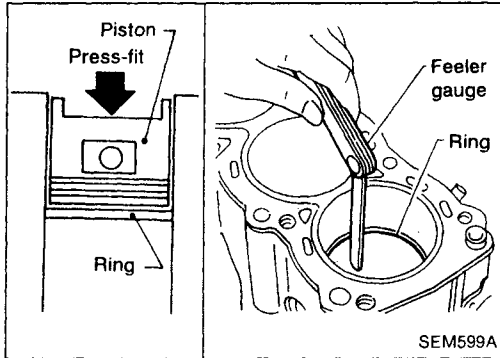
Unit: mm (in)

	Standard	Limit
Top ring	Bore grade 1, 2, 3	1.0 (0.039)
	0.20 - 0.30 (0.0079 - 0.0118)	
	Bore grade 4, 5	
	0.12 - 0.22 (0.0047 - 0.0087)	
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 over-size piston and piston rings.

Refer to SDS (EM-174).

- 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

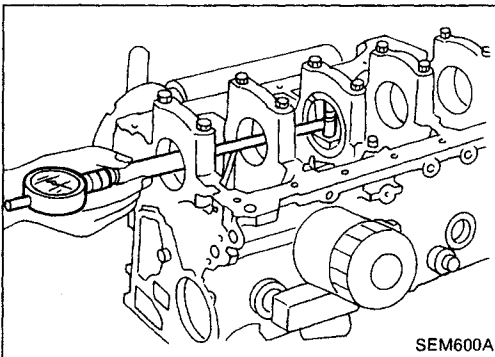
1. Install main bearings to cylinder block and main bearing cap.

2. Install main bearing cap with bearing to cylinder block.

Tighten all bolts in two or three stages.

: 44 - 54 N·m (4.5 - 5.5 kg-m, 33 - 40 ft-lb)

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



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

Journal diameter:

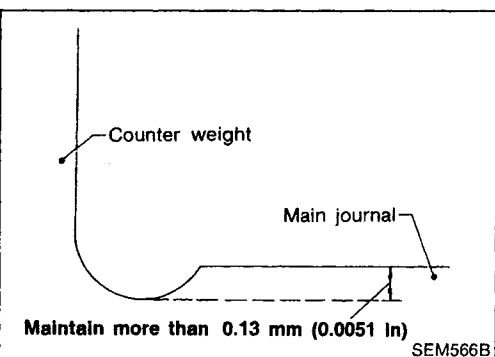
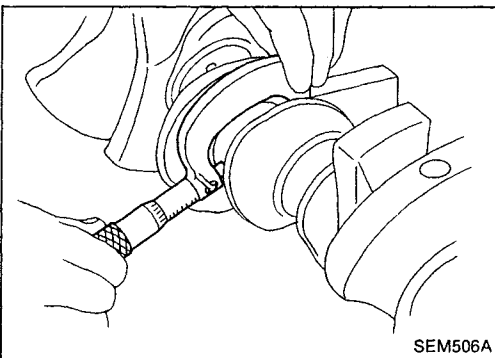
Refer to SDS (EM-174).

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.



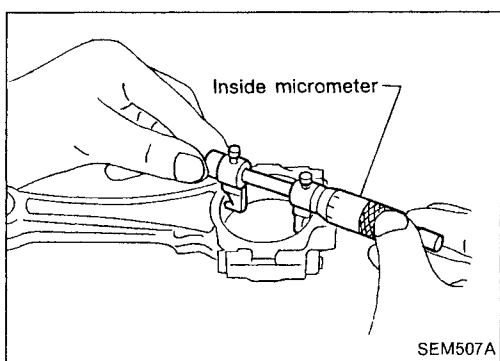
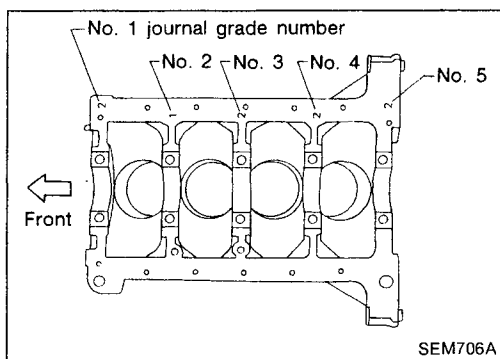
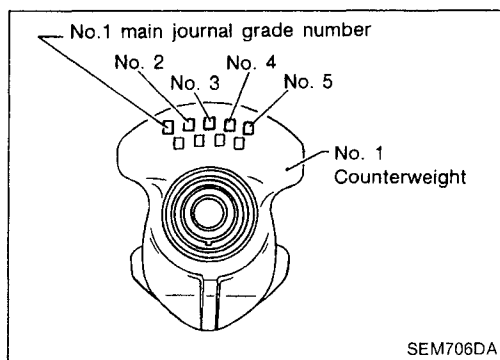
- If crankshaft main journal is worn or shows any abnormality, regrind crank journal and use undersized bearings to maintain the specified oil clearance.
- **Refer to SDS for regrinding crankshaft journal diameter and available service parts (EM-174).**
- **When regrinding crankshaft journal, do not grind fillet-roll.**

Inspection (Cont'd)

- 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

EM



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

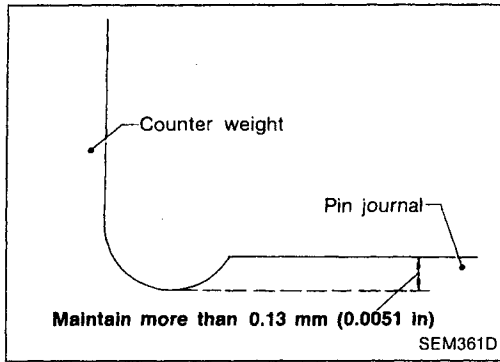
Main bearing thickness:**Refer to SDS (EM-175).**

CONNECTING ROD BEARING CLEARANCE (Big end)

- Install connecting rod bearing to connecting rod and cap.
 - Install connecting rod cap with bearing to connecting rod.
- Apply oil to the thread portion of bolts and seating surface of nuts.**

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

- Measure inside diameter "C" of bearing.

**Inspection (Cont'd)**

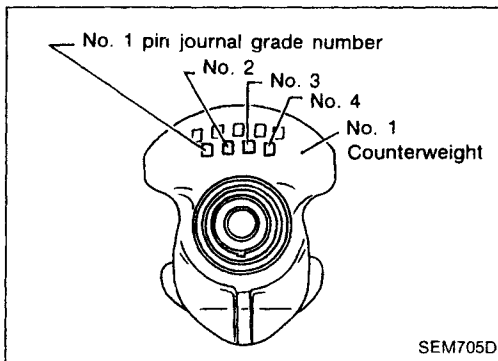
4. Measure outside diameter "Dp" of crankshaft pin journal.
5. Calculate connecting rod bearing clearance.

$$\text{Connecting rod bearing clearance} = C - D_p$$

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-174).**
- **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.

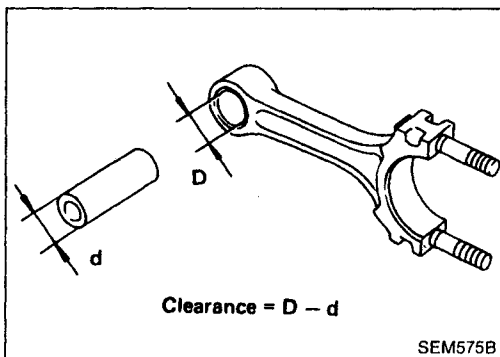
	Crankshaft pin journal grade number		
	0	1	2
Connecting rod bearing grade number	0	1	2

Identification color

Grade 0: Black

Grade 1: Yellow

Grade 2: Blue

**CONNECTING ROD AND PISTON PIN CLEARANCE (Small end)**

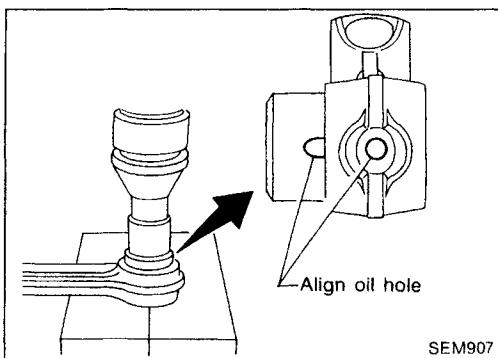
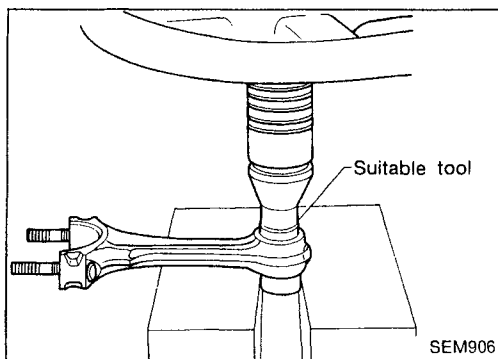
Clearance (D - d):

0.025 - 0.044 mm (0.0010 - 0.0017 in)

- If clearance exceeds the specifications, replace the bearing.

Inspection (Cont'd)**Bearing replacement**

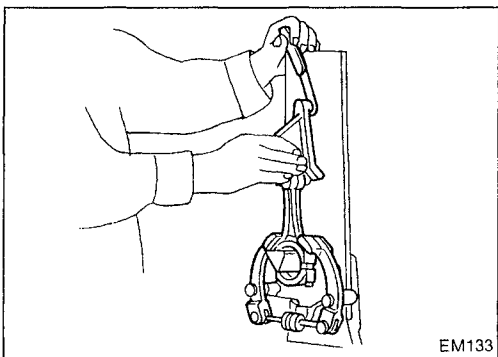
1. Remove bearing with a suitable tool.
Do not scratch inner surface of connecting rod.



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

Ream bore:

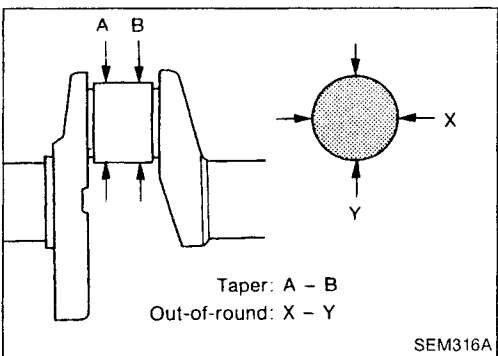
25.025 - 25.038 mm (0.9852 - 0.9857 in)

**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**

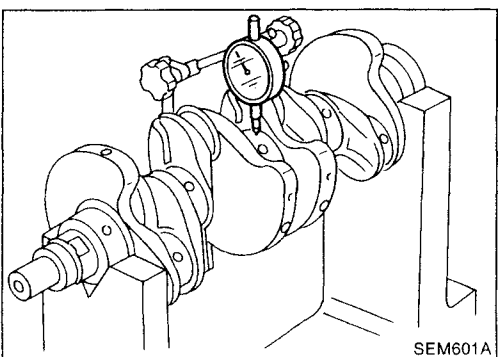
1. Check crankshaft journals and pins for score, bias, wear or cracks. If faults are minor, correct with fine crocus cloth.
2. Check journals and pins with a micrometer for taper and out-of-round.

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)

Inspection (Cont'd)**CYLINDER BLOCK DISTORTION**

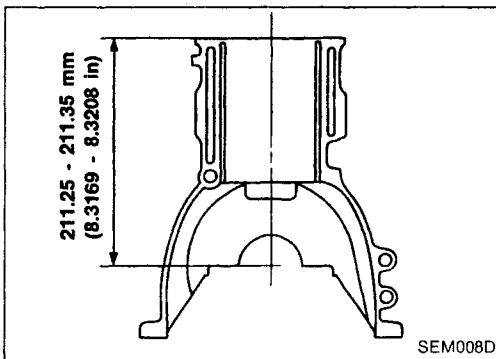
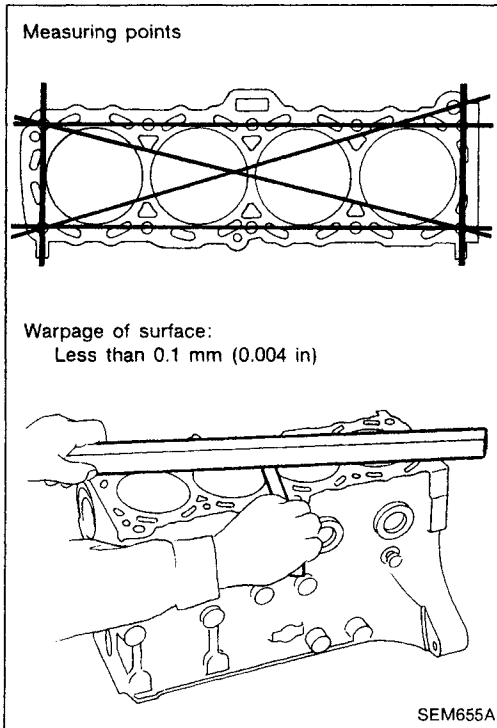
Clean upper face of cylinder block and measure the distortion.

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.



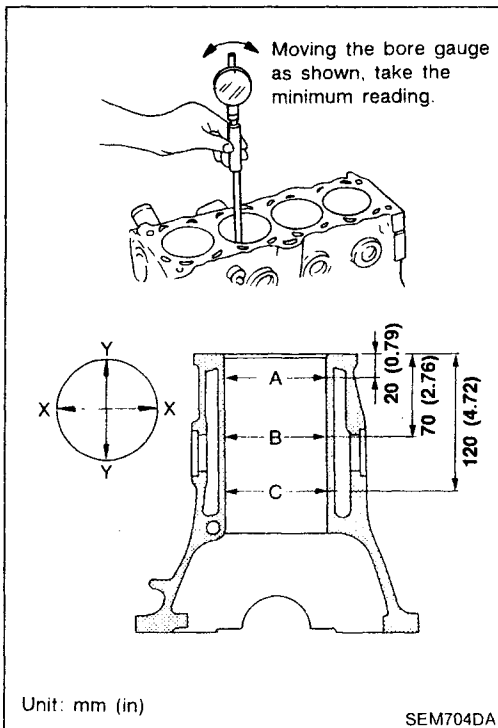
Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

$$A + B = 0.1 \text{ mm (0.004 in)}$$

If necessary, replace cylinder block.

**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)

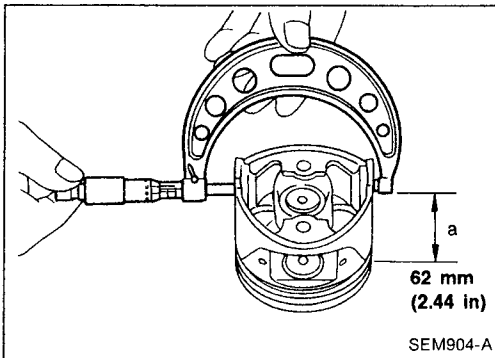
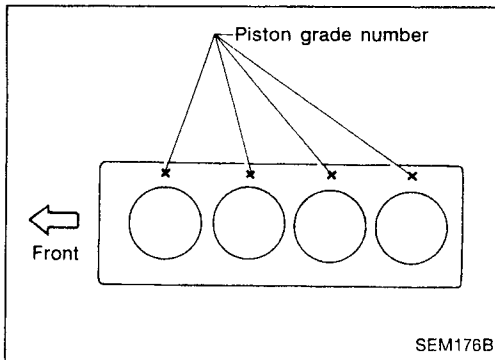
Unit: mm (in)

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.

Inspection (Cont'd)



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

$$D = A + B - C = A + [0.03 \text{ to } 0.05 \text{ mm} (0.0012 \text{ to } 0.0020 \text{ in})]$$

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-173).
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-174).

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

Approximately 62 mm (2.44 in)

Bore diameter "D":

Refer to SDS (EM-173).

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):

0.025 - 0.045 mm (0.0010 - 0.0018 in)

Inspection (Cont'd)

Using feeler gauge

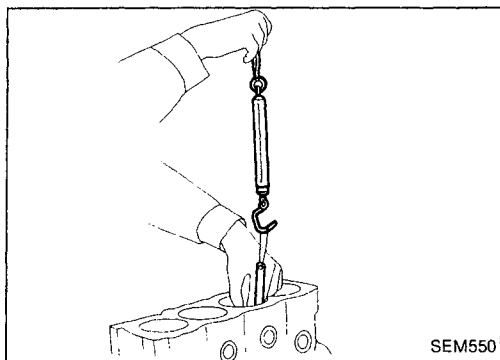
1. Set piston and feeler gauge with spring scale.
2. Measure extracting force while pulling up scale slowly.

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)

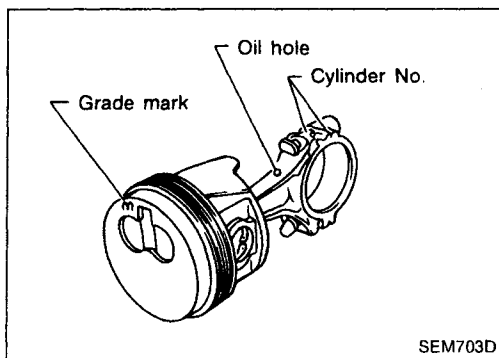


SEM550

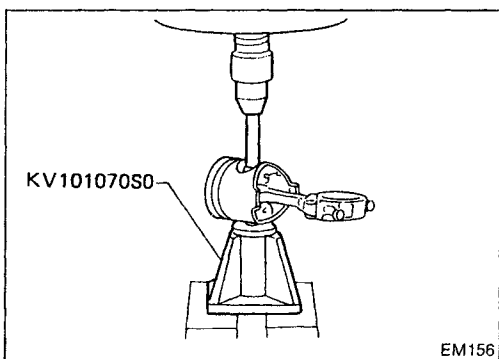
Assembly

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.

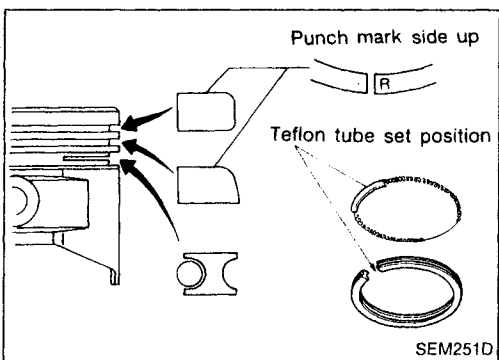


SEM703D



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.



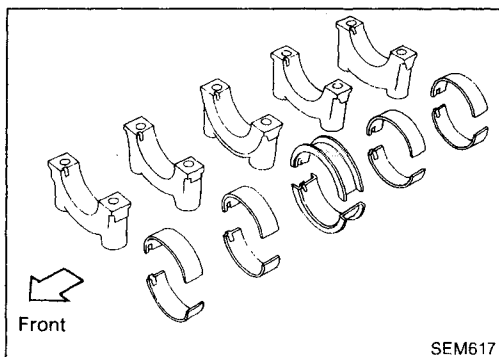
SEM251D

- 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.**

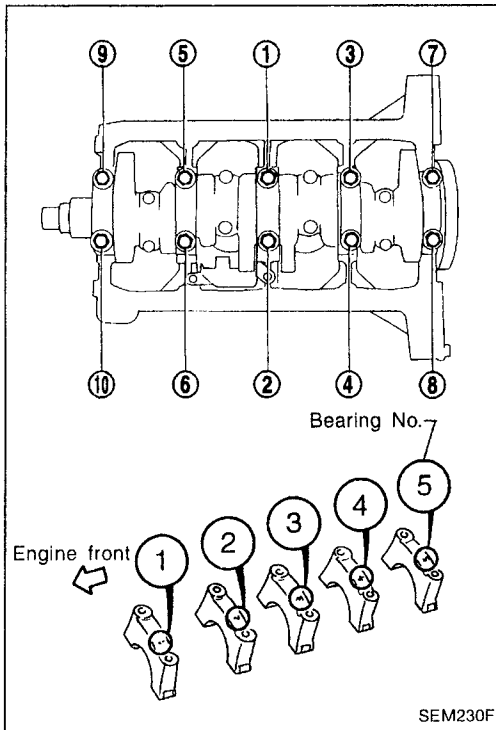
	Cylinder bore grade	
	1, 2, 3	4, 5
Top ring grade No.	No mark	S

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.



SEM617

**Assembly (Cont'd)**

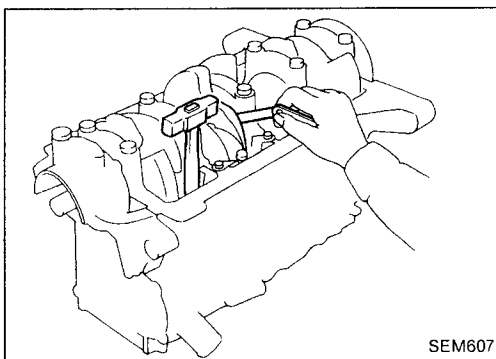
2. Apply engine oil to main bearing surfaces on crankshaft journal side.
3. Install crankshaft and main bearing caps.

Main bearing cap bolt:

: 44 - 54 N·m (4.5 - 5.5 kg-m, 33 - 40 ft-lb)

4. Tighten main bearing cap bolts.
 - 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.

EM



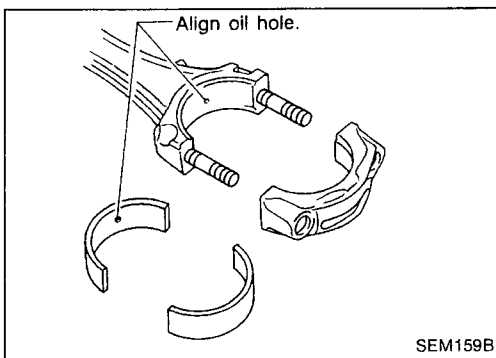
5. Measure crankshaft free end play at center bearing.

Crankshaft free end play:**Standard**

0.05 - 0.18 mm (0.0020 - 0.0071 in)

Limit

0.30 mm (0.0118 in)

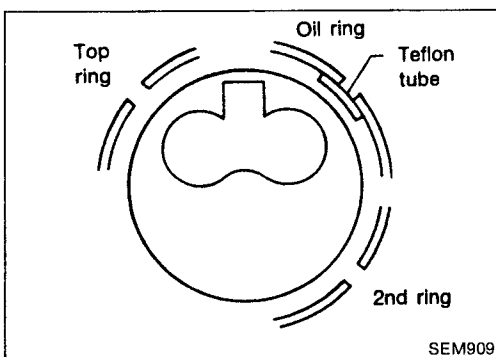
**PISTON WITH CONNECTING ROD**

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

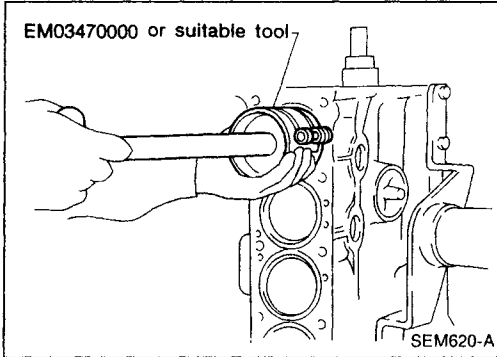
- Confirm that correct size of bearings is used.

Refer to "Inspection" (EM-147).

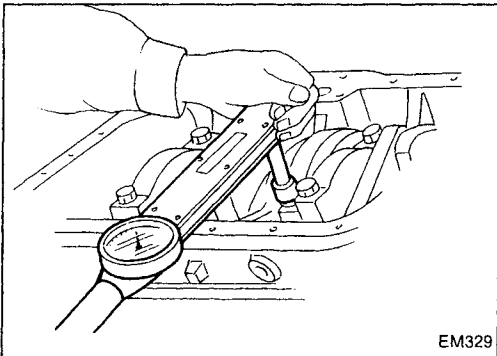
- Install the bearings so that the oil hole in the connecting rod aligns with the oil hole of the bearing.
- Apply engine oil to connecting rod bearing surfaces on the crankshaft journal side.



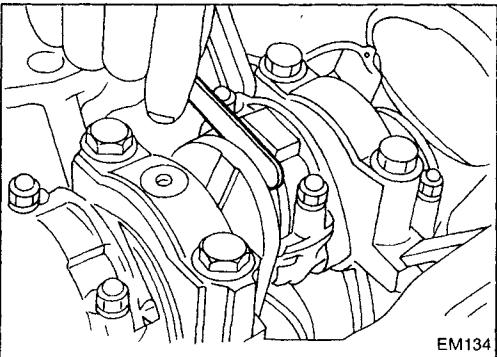
- Set piston rings as shown.

Assembly (Cont'd)

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}_{-0} turns with an angular tightening wrench.
 - ⌚: 15 ± 1 N·m (1.5 ± 0.1 kg-m, 10.8 ± 0.7 ft-lb) plus 60^{+5}_{-0} or
 - ⌚: 37 - 45 N·m (3.8 - 4.6 kg-m, 27 - 33 ft-lb)

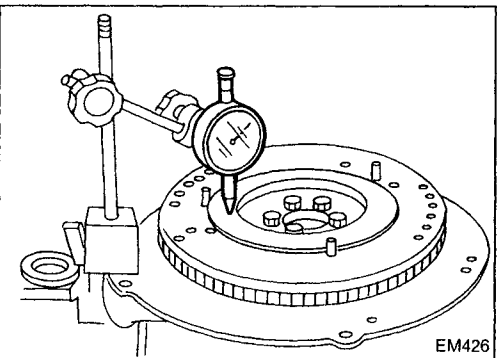


4. Measure connecting rod side clearance.

Connecting rod side clearance (Big end play):

Limit

0.3 mm (0.012 in)

**FLYWHEEL RUNOUT**

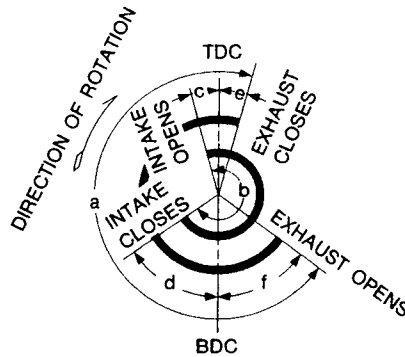
Runout (Total indicator reading):
Less than 0.15 mm (0.0059 in)

General Specifications

GENERAL SPECIFICATIONS

Engine	GA14DE	GA15DE	GA16DE
Classification	Gasoline		
Cylinder arrangement	4, in-line		
Displacement cm ³ (cu in)	1,392 (84.94)	1,498 (91.41)	1,597 (97.45)
Bore x stroke mm (in)	73.6 x 81.8 (2.898 x 3.220)	73.6 x 88.0 (2.898 x 3.465)	76.0 x 88.0 (2.992 x 3.465)
Valve arrangement	DOHC		
Firing order	1-3-4-2		
Number of piston rings			
Compression	1*2, 2		
Oil	1		
Number of main bearings	5		
Compression ratio	9.5	9.9	9.8*1, 9.9*2

Valve timing


 EM120
 Unit: degree

	a	b	c	d	e	f
GA14DE	214°	214°	0°	34°	-4°	38°
GA15DE	222°	222°	0°	42°	-4°	46°
GA16DE without VTC	222°	214°	0°	34°	0°	42°
GA16DE with VTC for Australia	222°	236°	-12°	68°	0°	42°
GA16DE with VTC except for Australia	222°	248°	2°	66°	-4°	46°

*1: For Europe and Israel

*2: Except for Europe and Israel

Inspection and Adjustment

ENGINE COMPRESSION PRESSURE

Unit: kPa (bar, kg/cm², psi)/rpm

Compression ratio Refer to SDS (EM-155).	Standard	Minimum	Difference limit between cylinders
9.5	1,324 (13.24, 13.5, 192)/350	1,128 (11.28, 11.5, 164)/350	98 (0.98, 1.0, 14)/350
9.8	1,353 (13.53, 13.8, 196)/350	1,157 (11.57, 11.8, 168)/350	
9.9	1,373 (13.7, 14, 199)/350	1,177 (11.8, 12, 171)/350	

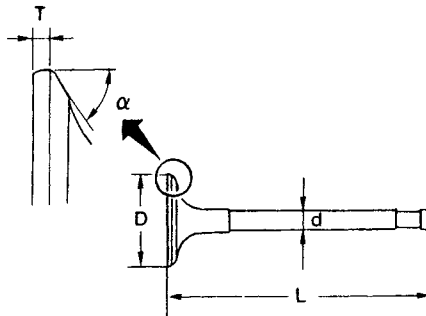
CYLINDER HEAD

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

Unit: mm (in)



SEM188-b

		GA14DE and GA15DE	GA16DE
Valve head diameter "D"	Intake	28.9 - 29.2 (1.138 - 1.150)	29.9 - 30.2 (1.177 - 1.189)
	Exhaust	23.9 - 24.2 (0.941 - 0.953)	23.9 - 24.2 (0.941 - 0.949): without VTC 24.9 - 25.2 (0.980 - 0.992): with VTC
Valve length "L"	Intake	92.00 - 92.5 (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		0.9 - 1.1 (0.035 - 0.043)	
Valve stem end surface grinding limit		Less than 0.2 (0.008)	

Valve clearance

Unit: mm (in)

	For adjusting		For checking
	Hot	Cold*	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)

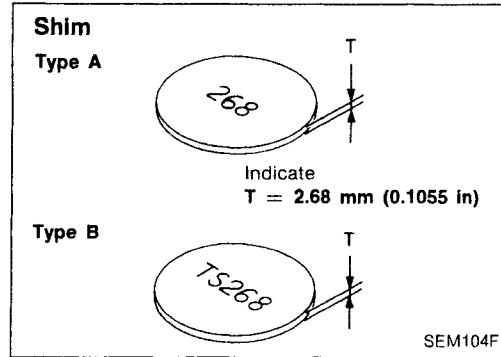
*: At a temperature of approximately 20°C (68°F)

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

Inspection and Adjustment (Cont'd)

Available shims

Thickness	mm (in)	Identification mark
2.00	(0.0787)	200
2.02	(0.0795)	202
2.04	(0.0803)	204
2.06	(0.0811)	206
2.08	(0.0819)	208
2.10	(0.0827)	210
2.12	(0.0835)	212
2.14	(0.0843)	214
2.16	(0.0850)	216
2.18	(0.0858)	218
2.20	(0.0866)	220
2.22	(0.0874)	222
2.24	(0.0882)	224
2.26	(0.0890)	226
2.28	(0.0898)	228
2.30	(0.0906)	230
2.32	(0.0913)	232
2.34	(0.0921)	234
2.36	(0.0929)	236
2.38	(0.0937)	238
2.40	(0.0945)	240
2.42	(0.0953)	242
2.44	(0.0961)	244
2.46	(0.0969)	246
2.48	(0.0976)	248
2.50	(0.0984)	250
2.52	(0.0992)	252
2.54	(0.1000)	254
2.56	(0.1008)	256
2.58	(0.1016)	258
2.60	(0.1024)	260
2.62	(0.1031)	262
2.64	(0.1039)	264
2.66	(0.1047)	266
2.68	(0.1055)	268
2.70	(0.1063)	270
2.72	(0.1071)	272
2.74	(0.1079)	274
2.76	(0.1087)	276
2.78	(0.1094)	278
2.80	(0.1102)	280
2.82	(0.1110)	282
2.84	(0.1118)	284
2.86	(0.1126)	286
2.88	(0.1134)	288
2.90	(0.1142)	290
2.92	(0.1150)	292
2.94	(0.1157)	294
2.96	(0.1165)	296
2.98	(0.1173)	298



EM

SERVICE DATA AND SPECIFICATIONS (SDS)

GA

Inspection and Adjustment (Cont'd)

Valve guide

Unit: mm (in)

	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)
Valve guide				
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)		0.2 (0.008)	
Projection length	11.5 - 11.7 (0.453 - 0.461)			

Valve spring

Free height	mm (in)	41.19 (1.6217)
Pressure N (kg, lb) at height mm (in)	Standard	344.42 (35.12, 77.44) at 25.26 (0.9945)
	Limit	323.73 (33.01, 72.79) at 25.26 (0.9945)
Out-of-square	mm (in)	Less than 1.80 (0.0709)

Valve lifter

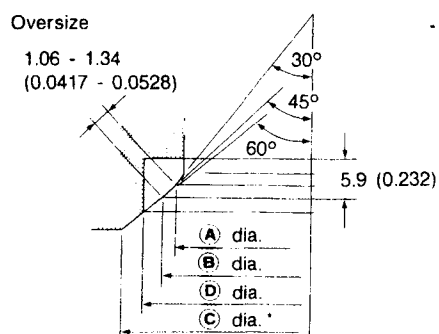
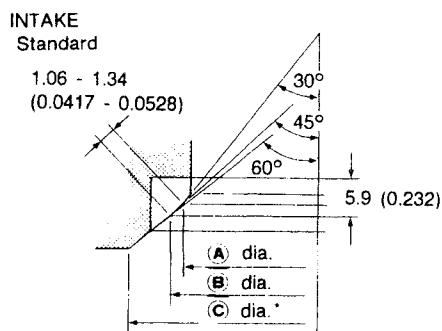
Unit: mm (in)

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 lifter and lifter guide	0.025 - 0.061 (0.0010 - 0.0024)

Inspection and Adjustment (Cont'd)

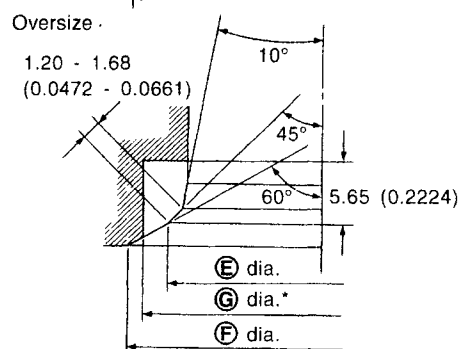
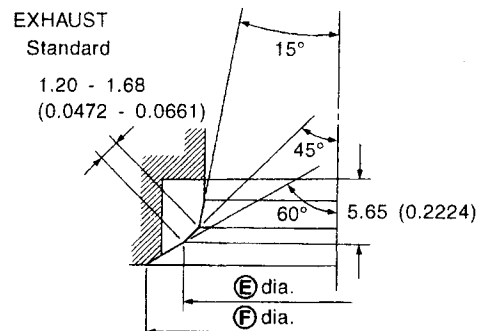
Valve seat

Unit: mm (in)



*Cylinder head machining data

SEM573DA



*Cylinder head machining data

SEM239F

Dia.	GA16DE without VTC	GA14DE and 15DE	GA16DE with VTC
(A)	27.8 - 28.0 (1.094 - 1.102)	26.4 - 26.6 (1.039 - 1.047)	27.8 - 28.0 (1.094 - 1.102)
(B)	29.5 - 29.7 (1.161 - 1.169)	28.5 - 28.7 (1.122 - 1.130)	29.5 - 29.7 (1.161 - 1.169)
(C)	31.9 - 32.1 (1.256 - 1.264)	30.2 - 30.4 (1.189 - 1.197)	31.9 - 32.1 (1.256 - 1.264)
(D)	31.500 - 31.516 (1.2402 - 1.2408)	30.500 - 30.516 (1.2008 - 1.2014)	31.500 - 31.516 (1.2402 - 1.2408)
(E)	23.5 - 23.7 (0.925 - 0.933)	23.5 - 23.7 (0.925 - 0.933)	24.5 - 24.7 (0.965 - 0.972)
(F)	25.200 - 25.4 (0.9921 - 1.0000)	25.200 - 25.4 (0.9921 - 1.0000)	26.2 - 26.4 (1.031 - 1.039)
(G)	25.500 - 25.516 (1.0039 - 1.0046)	25.500 - 25.516 (1.0039 - 1.0046)	26.500 - 26.516 (1.0433 - 1.0439)

Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BEARING

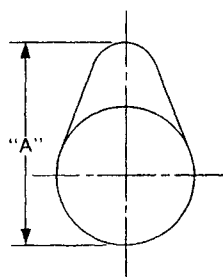
CYLINDER BLOCK

Unit: mm (in)

Camshaft

Unit: mm (in)

Engine model	GA14DE	GA15DE	GA16DE without VTC	GA16DE with VTC except for Europe	GA16DE with VTC for Australia
Cam height "A"	Intake 39.380 - 39.570 (1.5504 - 1.5579)	39.880 - 40.070 (1.5701 - 1.5776)	39.380 - 39.570 (1.5504 - 1.5579)	40.610 - 40.800 (1.5988 - 1.6063)	40.610 - 40.800 (1.5988 - 1.6063)
Exhaust		40.056 - 40.246 (1.5770 - 1.5845)	39.880 - 40.070 (1.5701 - 1.5776)	40.056 - 40.246 (1.5770 - 1.5845)	39.91 - 40.100 (1.5713 - 1.5787)
Cam wear limit	0.20 (0.0079)				



EM671

Camshaft bearing

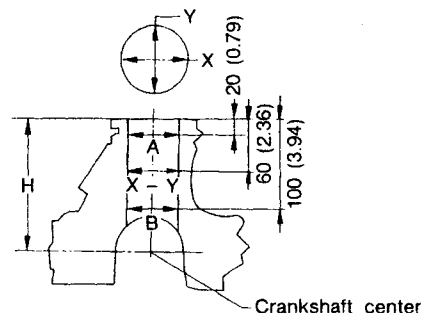
Unit: mm (in)

		Standard	Limit
Camshaft journal to bearing clearance		0.045 - 0.086 (0.0018 - 0.0034)	0.15 (0.0059)
Inner diameter of camshaft bearing	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*1]		Less than 0.02 (0.0008)	0.1 (0.004)
Camshaft end play		0.070 - 0.143 (0.0028 - 0.0056)*2 0.115 - 0.188 (0.0045 - 0.0074)*3	0.20 (0.0079)

*1: Total indicator reading

*2: GA16DE without VTC and 14DE

*3: GA16DE with VTC and GA15DE



SEM171D

	GA14DE GA15DE	GA16DE	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)		—
Standard			
Inner diameter			
Grade No. 1	73.600 - 73.610 (2.8976 - 2.8980)	76.000 - 76.010 (2.9921 - 2.9925)	0.2 (0.008)
Grade No. 2	73.610 - 73.620 (2.8980 - 2.8984)	76.010 - 76.020 (2.9925 - 2.9929)	
Grade No. 3	73.620 - 73.630 (2.8984 - 2.8988)	76.020 - 76.030 (2.9929 - 2.9933)	
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)

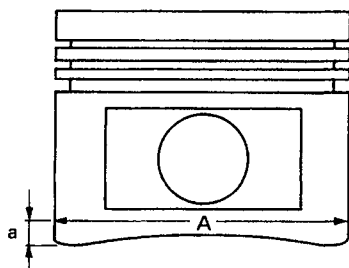
Inspection and Adjustment (Cont'd)

PISTON, PISTON RING AND PISTON PIN

Piston ring

Piston

Unit: mm (in)



SEM658D

	GA14DE	GA15DE	GA16DE without VTC	GA16DE with VTC
Piston skirt diameter "A"				
Standard				
Grade No. 1	73.575 - 73.585 (2.8966 - 2.8970)		75.975 - 75.985 (2.9911 - 2.9915)	
Grade No. 2	73.585 - 73.595 (2.8970 - 2.8974)		75.985 - 75.995 (2.9915 - 2.9919)	
Grade No. 3	73.595 - 73.605 (2.8974 - 2.8978)		75.995 - 76.005 (2.9919 - 2.9923)	
0.5 (0.020) oversize (service)	74.075 - 74.105 (2.9163 - 2.9175)		76.475 - 76.505 (3.0108 - 3.0120)	
1.0 (0.039) oversize (service)	74.575 - 74.605 (2.9360 - 2.9372)		76.975 - 77.005 (3.0305 - 3.0317)	
"a" dimension	7.5 (0.295)	7.9 (0.311)	9.5 (0.374)	9.9 (0.390)
Piston pin hole inner diameter	18.987 - 18.999 (0.7475 - 0.7480)			
Piston pin outer diameter	18.989 - 19.001 (0.7476 - 0.7481)			
Piston to bore clearance	0.015 - 0.035 (0.0006 - 0.0014)			

Unit: mm (in)

		Standard	Limit
Side clearance	Top	0.040 - 0.080 (0.0016 - 0.0031)	0.2 (0.008)
	2nd*	0.030 - 0.070 (0.0012 - 0.0028)	
End gap	Top	0.20 - 0.35 (0.0079 - 0.0138)	1.0 (0.039)
	2nd*	0.37 - 0.52 (0.0146 - 0.0205)	
	Oil	0.20 - 0.60 (0.0079 - 0.0236)	

*: Applies to GA16DE without VTC, and 14DE.

Piston pin

Unit: mm (in)

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)
Piston pin to connecting rod, bushing clearance	0.005 - 0.017 (0.0002 - 0.0007)

CONNECTING ROD

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	0.52 (0.0205)

*: After installing in connecting rod

SERVICE DATA AND SPECIFICATIONS (SDS)

GA

Inspection and Adjustment (Cont'd)

CRANKSHAFT

Unit: mm (in)

	GA14DE	GA15DE GA16DE
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"	40.85 - 40.95 (1.6083 - 1.6122)	43.95 - 44.05 (1.7303 - 1.7342)
Out-of-round (X - Y)		
Standard	Less than 0.005 (0.0002)	
Taper (A - B)		
Standard	Less than 0.002 (0.0001)	
Runout [TIR*]		
Standard	Less than 0.05 (0.0020)	
Free end play		
Standard	0.060 - 0.180 (0.0024 - 0.0071)	
Limit	0.3 (0.012)	

*: Total indicator reading

MAIN BEARING

Standard

Grade No.	Thickness "T" mm (in)	Identification color
0	1.827 - 1.831 (0.0719 - 0.0721)	Black
1	1.831 - 1.835 (0.0721 - 0.0722)	Brown
2	1.835 - 1.839 (0.0722 - 0.0724)	Green
3	1.839 - 1.843 (0.0724 - 0.0726)	Yellow
4	1.843 - 1.847 (0.0726 - 0.0727)	Blue

Undersize

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)

AVAILABLE CONNECTING ROD BEARING

Connecting rod bearing

Unit: mm (in)

	Grade No.	Thickness	Identification color or number
Standard	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	0.08 (0.0031)	1.542 - 1.546 (0.0607 - 0.0609)	8
	0.12 (0.0047)	1.562 - 1.566 (0.0615 - 0.0617)	12
	0.25 (0.0098)	1.627 - 1.631 (0.0641 - 0.0642)	25

Bearing clearance

Unit: mm (in)

Main bearing clearance	
Standard	0.018 - 0.042 (0.0007 - 0.0017)
Limit	0.1 (0.004)
Connecting rod bearing clearance	
Standard	0.014 - 0.039 (0.0006 - 0.0015)
Limit All	0.1 (0.004)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

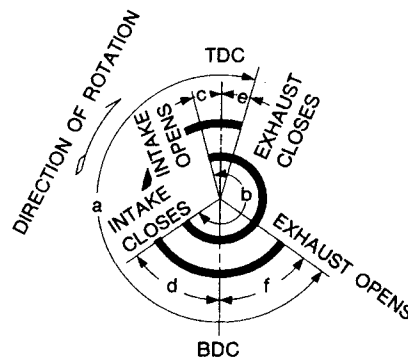
Camshaft sprocket runout limit [TIR*]	0.17 (0.0067)
Flywheel runout [TIR*]	Less than 0.15 (0.0059)
Drive plate runout [TIR*]	Less than 0.2 (0.008)

*: 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	9.5

Valve timing

EM120
Unit: degree

a	b	c	d	e	f
240°	248°	13°	55°	3°	57°

Inspection and Adjustment

COMPRESSION PRESSURE

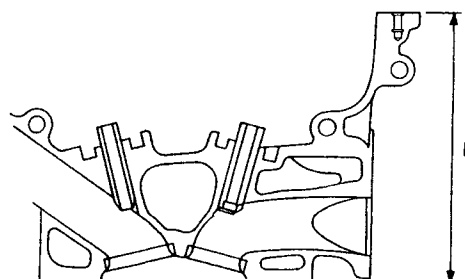
Unit: kPa (kg/cm², psi)/300 rpm

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

CYLINDER HEAD

Unit: mm (in)

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



SEM043F

Nominal cylinder head height "H"	136.9 - 137.1 (5.390 - 5.398)
Resurfacing limit	0.2 (0.008)*

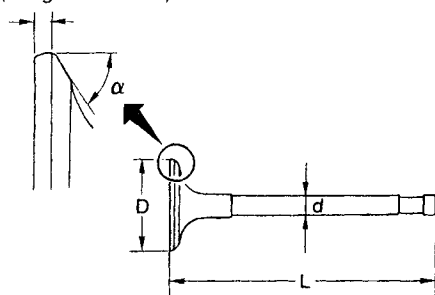
*Total amount of cylinder head resurfacing plus cylinder block resurfacing

Inspection and Adjustment (Cont'd)

VALVE

Unit: mm (in)

T (Margin thickness)



SEM188A

Valve head diameter "D"

Intake	34.0 - 34.3 (1.339 - 1.350)
Exhaust	30.0 - 30.2 (1.181 - 1.189)

Valve length "L"

Intake	101.19 - 101.61 (3.9839 - 4.0004)
Exhaust	102.11 - 102.53 (4.0201 - 4.0366)

Valve stem diameter "d"

Intake	5.965 - 5.980 (0.2348 - 0.2354)
Exhaust	5.945 - 5.960 (0.2341 - 0.2346)

Valve seat angle "α"

Intake	45°15' - 45°45'
Exhaust	

Valve margin "T"

Intake	1.1 (0.043)
Exhaust	1.3 (0.051)

Valve margin "T" limit

More than 0.5 (0.020)

Valve stem end surface grinding limit

Less than 0.2 (0.008)

Valve spring

Free height	mm (in)	49.36 (1.9433)
Pressure	N (kg, lb) at height mm (in)	
Standard		578.02 - 641.57 (58.94 - 65.42, 129.96 - 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)

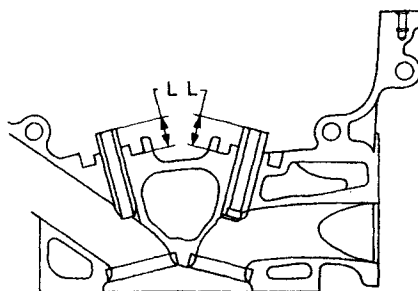
Hydraulic lash adjuster (HLA)

Unit: mm (in)

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

Valve guide

Unit: mm (in)



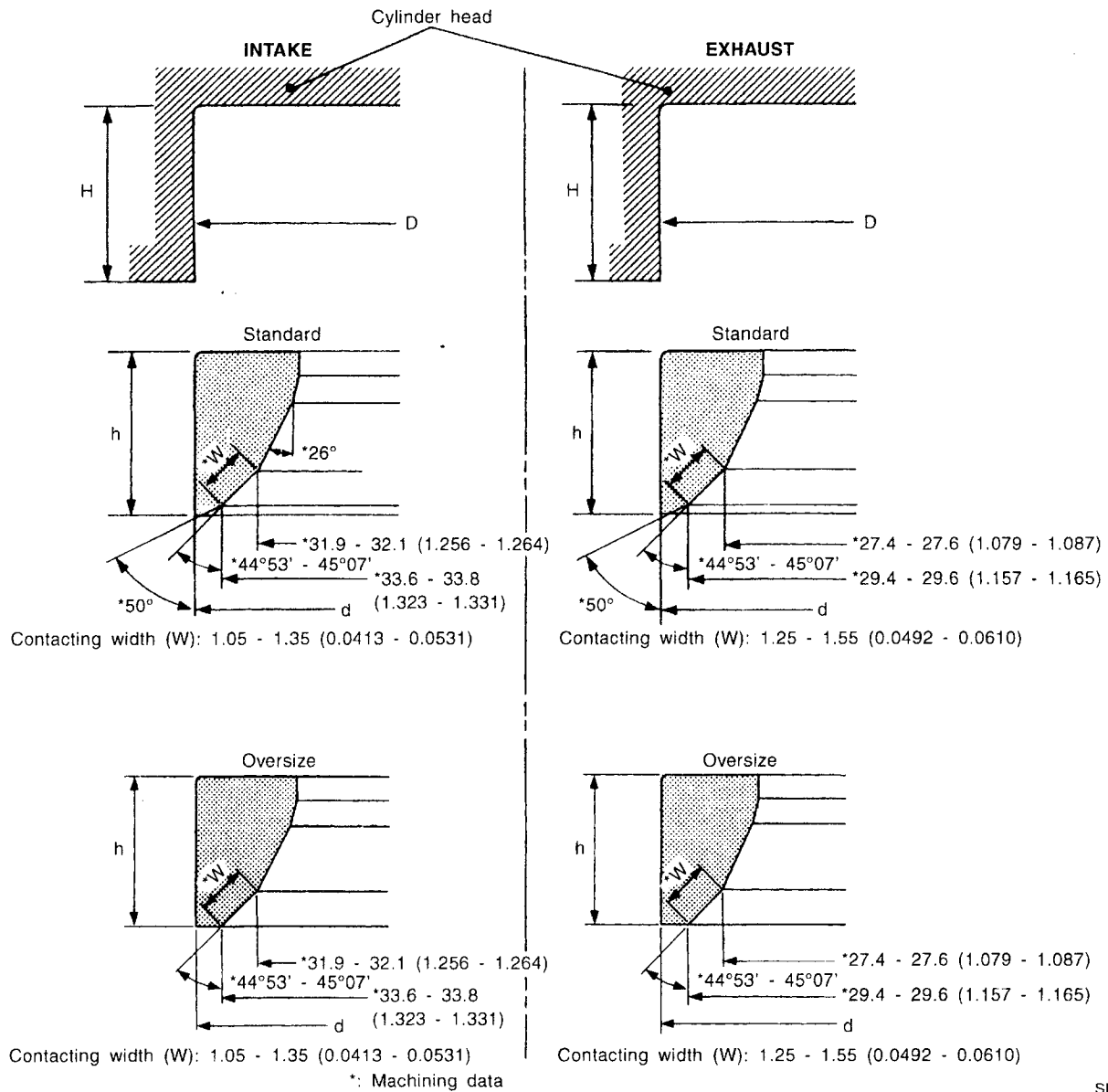
SEM083D

		Standard	Service
Valve guide	Outer diameter	Intake	10.023 - 10.034 (0.3946 - 0.3950)
		Exhaust	10.023 - 10.034 (0.3946 - 0.3950)
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)	

Inspection and Adjustment (Cont'd)

Valve seat

Unit: mm (in)



SEM243F

		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)	In.	6.2 - 6.3 (0.244 - 0.248)	5.4 - 5.5 (0.213 - 0.217)
	Ex.	6.2 - 6.3 (0.244 - 0.248)	5.32 - 5.42 (0.2094 - 0.2134)

Inspection and Adjustment (Cont'd)

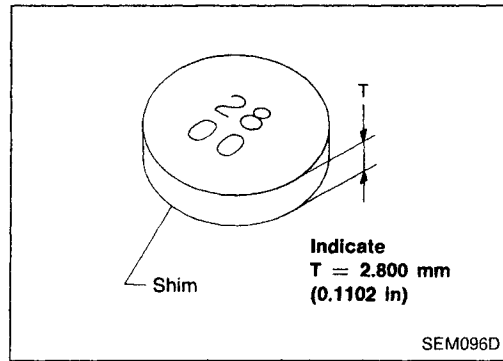
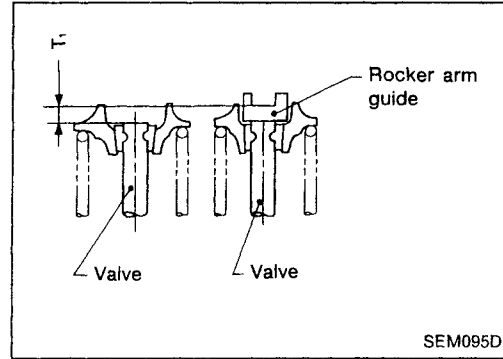
Valve shim clearance adjustment

Unit: mm (in)

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

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



SERVICE DATA AND SPECIFICATIONS (SDS)

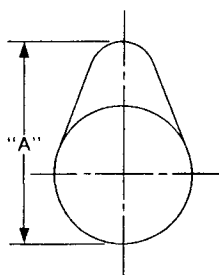
SR

Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

	Standard	Limit
Camshaft journal to bearing clearance	0.045 - 0.086 (0.0018 - 0.0034)	0.15 (0.0059)
Inner diameter of camshaft bearing	28.000 - 28.021 (1.1024 - 1.1032)	—
Outer diameter of camshaft journal	27.935 - 27.955 (1.0998 - 1.1006)	—
Camshaft runout [TIR*]	Less than 0.02 (0.0008)	0.1 (0.004)
Camshaft sprocket runout [TIR*]	Less than 0.25 (0.0098)	—
Camshaft end play	0.055 - 0.139 (0.0022 - 0.0055)	0.20 (0.0079)



EM671

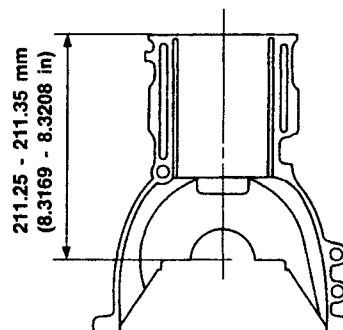
Cam height "A"

Intake	38.408 - 38.598 (1.5121 - 1.5196)
Exhaust	37.920 - 38.110 (1.4929 - 1.5004)
Wear limit of cam height	0.2 (0.008)
Valve lift	
Intake	10.0 (0.394)
Exhaust	9.2 (0.362)

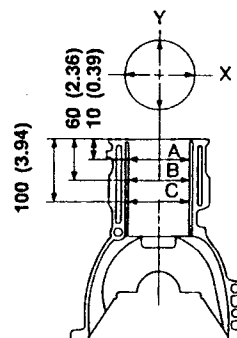
*Total indicator reading

CYLINDER BLOCK

Unit: mm (in)



SEM964E



SEM686D

Surface flatness

Standard	Less than 0.03 (0.0012)
Limit	0.1 (0.004)

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)
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Out-of-round (X - Y)

Standard	Less than 0.015 (0.0006)
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Taper (A - B and A - C)

Standard	Less than 0.010 (0.0004)
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Difference in inner diameter between cylinders

Limit	Less than 0.05 (0.0020)
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Main journal inner diameter

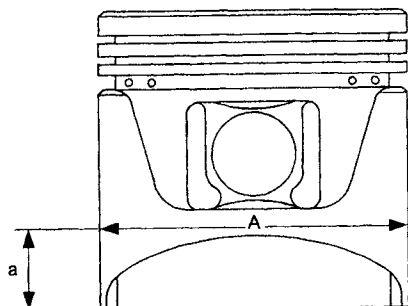
Grade No. 0	58.944 - 58.950 (2.3206 - 2.3209)
Grade No. 1	58.950 - 58.956 (2.3209 - 2.3211)
Grade No. 2	58.956 - 58.962 (2.3211 - 2.3213)
Grade No. 3	58.962 - 58.968 (2.3213 - 2.3216)

Inspection and Adjustment (Cont'd)

PISTON, PISTON RING AND PISTON PIN

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) over-size (Service)	86.180 - 86.210 (3.3929 - 3.3941)

"a" dimension	14.0 (0.551)
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Piston clearance to cylinder block	0.010 - 0.030 (0.0004 - 0.0012)
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Piston pin hole diameter	21.987 - 21.999 (0.8656 - 0.8661)
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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 - 0.065 (0.0012 - 0.0026)
Limit	0.2 (0.008)
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 - 0.004 (0 - 0.0002)
Piston pin to connecting rod bushing clearance	
Standard	0.005 - 0.017 (0.0002 - 0.0007)
Limit	0.023 (0.0009)

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

Inspection and Adjustment (Cont'd)

CONNECTING ROD

Unit: mm (in)

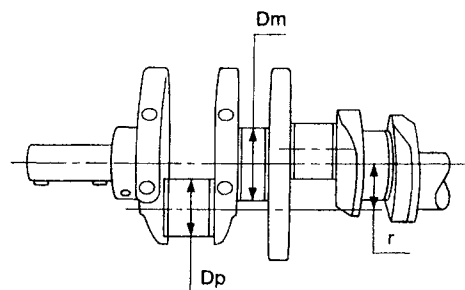
Center distance	136.30 (5.3661)
Bend [per 100 (3.94)]	
Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	
Limit	0.3 (0.012)
Connecting rod small end inner diameter	24.980 - 25.000 (0.9835 - 0.9843)
Piston pin bushing inner diameter*	22.000 - 22.012 (0.8661 - 0.8666)
Connecting rod big end inner diameter	51.000 - 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

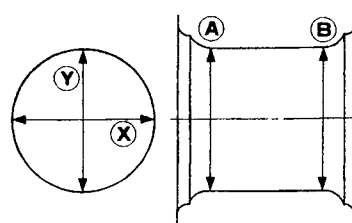
CRANKSHAFT

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	Main journal	Less than 0.005 (0.0002)
	Pin journal	Less than 0.0025 (0.0001)
Taper (A - B)		
Standard	Main journal	Less than 0.005 (0.0002)
	Pin journal	Less than 0.0025 (0.0001)
Runout [TIR]		
Standard	Less than 0.025 (0.0010)	
Limit	Less than 0.05 (0.0020)	
Free end play		
Standard	0.10 - 0.26 (0.0039 - 0.0102)	
Limit	0.30 (0.0118)	



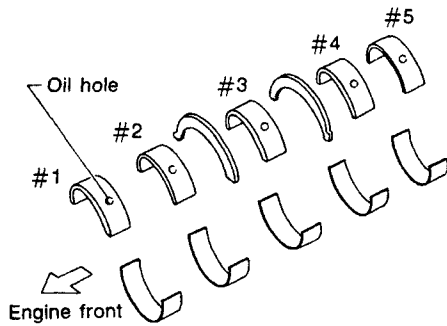
Out-of-round (X - Y)
Taper (A - B)



SEM954C

Inspection and Adjustment (Cont'd)

MAIN BEARING



SEM685D

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)		Brown (B)
2	1.983 - 1.986 (0.0781 - 0.0782)		Green (C)
3	1.986 - 1.989 (0.0782 - 0.0783)		Yellow (D)
4	1.989 - 1.992 (0.0783 - 0.0784)		Blue (E)
5	1.992 - 1.995 (0.0784 - 0.0785)		Pink (F)
6	1.995 - 1.998 (0.0785 - 0.0787)		No color (G)

Undersize

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

CONNECTING ROD BEARING

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)	No color (A)
1	1.503 - 1.506 (0.0592 - 0.0593)		Black (B)
2	1.506 - 1.509 (0.0593 - 0.0594)		Brown (C)

Undersize

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 (0.065 - 0.00256)	

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)

Inspection and Adjustment

COMPRESSION PRESSURE

Unit: kPa (bar, kg/cm², 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

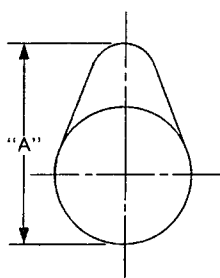
Unit: mm (in)

Head surface flatness	
Standard	Less than 0.05 (0.0020)
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)	—

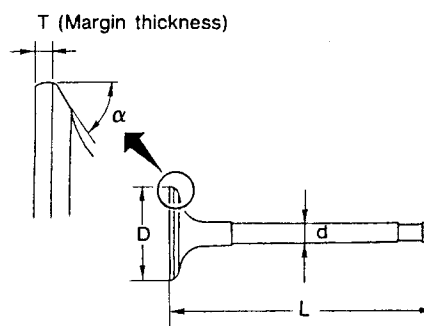


EM671

Cam height "A"	
Intake	49.20 - 49.25 (1.9370 - 1.9390)
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 - 32.2 (1.260 - 1.268)

Valve length "L"

Intake	100.53 - 100.97 (3.9579 - 3.9752)
Exhaust	100.38 - 100.82 (3.9520 - 3.9693)

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)

Inspection and Adjustment (Cont'd)

Valve spring

Free height	mm (in)
Outer	43.2 (1.701)
Inner	38.2 (1.504)
Standard	
Assembled height	mm/N (mm/kg, in/lb)
Outer	36.1/164.8 (36.1/16.8, 1.421/37.0)
Inner	32.6/78.5 (32.6/8.0, 1.283/17.6)
Out-of-square "S"	mm (in)
Outer	2.1 (0.083)
Inner	1.9 (0.075)

Valve guide

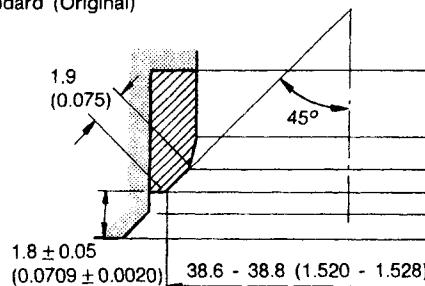
	Unit: mm (in)	
	Standard	Service
Valve guide		
Outer diameter	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
Valve guide		
Inner diameter (Finished size)	7.000 - 7.015 (0.2756 - 0.2762)	
Cylinder head valve guide hole diameter	10.985 - 10.996 (0.4325 - 0.4329)	11.185 - 11.196 (0.4404 - 0.4408)
Interference fit of valve guide	0.027 - 0.049 (0.0011 - 0.0019)	
	Standard	Max. tolerance
Stem to guide clear- ance		
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

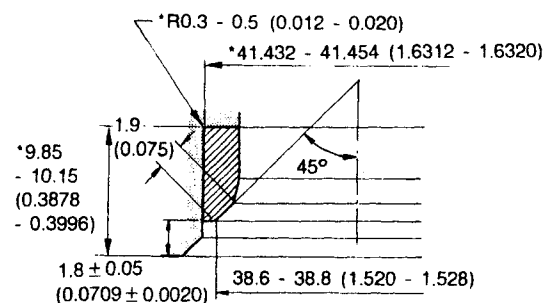
Unit: mm (in)

Intake

Standard (Original)



0.5 (0.020) Oversize

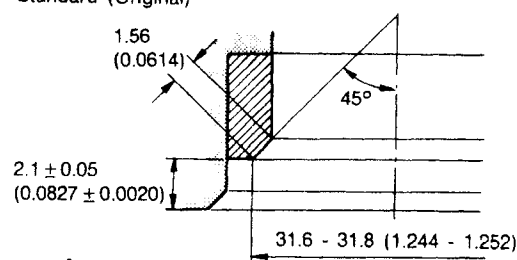


*: Cylinder head machining data

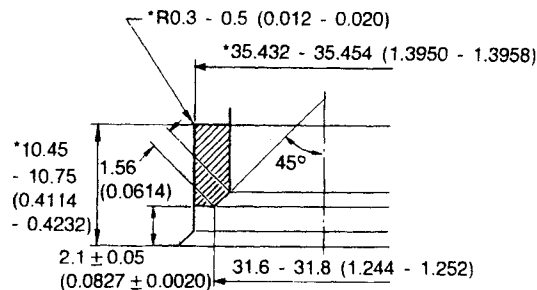
SEM917-B

Exhaust

Standard (Original)



0.5 (0.020) Oversize



*: Cylinder head machining data

SEM113FA

Inspection and Adjustment (Cont'd)

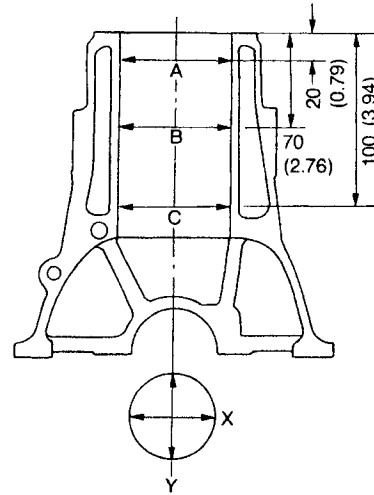
VALVE LIFTER

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)

CYLINDER BLOCK

Unit: mm (in)



SEM902-A

		Standard	Limit
Surface flatness		Less than 0.05 (0.0020)	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	0.025 - 0.045 (0.0010 - 0.0018)	—
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)	—

Inspection and Adjustment (Cont'd)

PISTON, PISTON RING AND PISTON PIN

Piston

Unit: mm (in)			
Piston skirt diameter	Standard	Grade No. 1	84.465 - 84.475 (3.3254 - 3.3258)
		Grade No. 2	84.475 - 84.485 (3.3258 - 3.3262)
		Grade No. 3	84.485 - 84.495 (3.3262 - 3.3266)
		Grade No. 4	84.495 - 84.505 (3.3266 - 3.3270)
		Grade No. 5	84.505 - 84.515 (3.3270 - 3.3274)
	Oversize	0.25 (0.0098)	84.715 - 84.765 (3.3352 - 3.3372)
		0.5 (0.020)	84.965 - 85.015 (3.3451 - 3.3470)
	Measure position (From Top)		
	62 (2.44)		
	Piston pin hole diameter		
	24.991 - 24.999 (0.9839 - 0.9842)		

Piston ring

Unit: mm (in)			
Side clearance			
Top			
Standard		0.060 - 0.095 (0.0024 - 0.0037)	
Limit		0.10 (0.0039)	
2nd			
Standard		0.040 - 0.075 (0.0016 - 0.0030)	
Limit		0.10 (0.0039)	
Oil			
Standard		0.030 - 0.070 (0.0012 - 0.0028)	
End gap			
Top			
Standard			
Bore grade 1, 2, 3		0.20 - 0.30 (0.0079 - 0.0118)	
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	24.994 - 25.000 (0.9840 - 0.9843)
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.	25.025 - 25.038 (0.9852 - 0.9857)
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)

Inspection and Adjustment (Cont'd)

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)		Yellow
1	1.820 - 1.824 (0.0717 - 0.0718)		Green
2	1.824 - 1.828 (0.0718 - 0.0720)	20.0 (0.787) 17.8 (0.701)*	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)		Yellow
1	1.820 - 1.824 (0.0717 - 0.0718)		Green
2	1.824 - 1.828 (0.0718 - 0.0720)	27.95 (1.1004) 20.8 (0.819)*	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)	

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)	

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

MISCELLANEOUS COMPONENTS

		Unit: mm (in)
Flywheel		
Runout [TIR*]	Less than 0.15 (0.0059)	

*: Total indicator reading