

SECTION EM

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PRECAUTIONS

Parts Requiring Angular Tightening

Parts Requiring Angular Tightening

NAEM0001

- Use an angle wrench for the final tightening of the following engine parts:
 - a) Cylinder head bolts
 - b) Main bearing cap bolts
 - c) Connecting rod cap bolts
 - d) Crankshaft pulley bolt (No angle wrench is required as bolt flange is provided with notches for angle tightening)
- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread and seat surfaces are clean and coated with engine oil.

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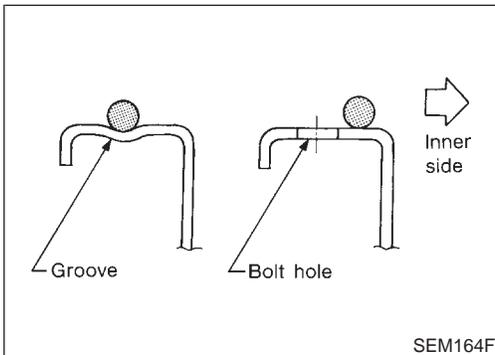
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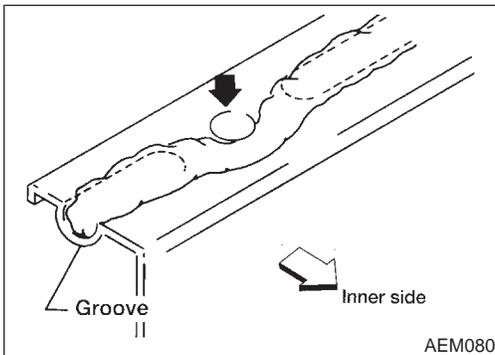
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AEM080

Liquid Gasket Application Procedure

NAEM0002

1. Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also, completely clean any oil from these areas.
2. Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine RTV silicone sealant or equivalent. Refer to GI-53.)
 - Be sure liquid gasket diameter is as specified.
3. Apply liquid gasket around the inner side of bolt holes (unless otherwise specified).
4. Assembly should be done within 5 minutes after coating.
5. Wait at least 30 minutes before refilling engine oil and engine coolant.

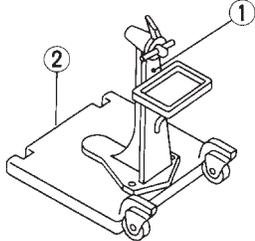
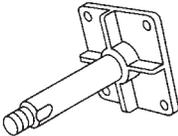
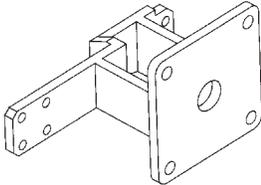
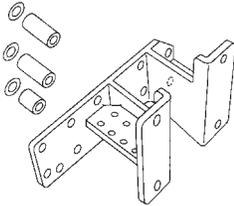
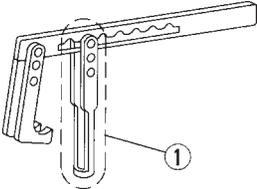
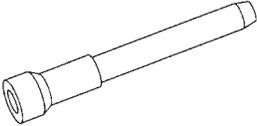
PREPARATION

Special Service Tools

Special Service Tools

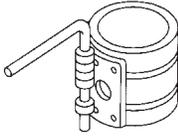
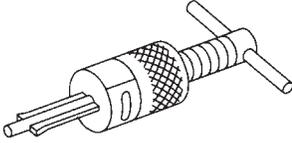
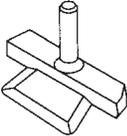
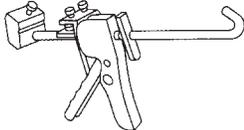
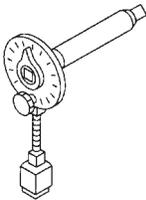
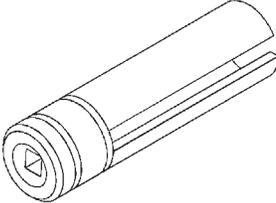
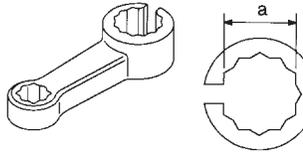
NAEM0003

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

Tool number (Kent-Moore No.) Tool name	Description	
ST0501S000 (—) Engine stand assembly 1 ST05011000 (—) Engine stand 2 ST05012000 (—) Base	 <p>NT042</p>	Disassembling and assembling engine
KV10106500 (—) Engine stand shaft	 <p>NT028</p>	
KV10117000 (J41262) Engine sub-attachment	 <p>NT373</p>	KV10117000 has been replaced with KV10117001 (KV10117000 is no longer in production, but it is usable).
KV10117001 (—) Engine sub-attachment	 <p>NT372</p>	Installing on the cylinder block
KV10116200 (J26336-A) Valve spring compressor 1 KV10115900 (J26336-20) Attachment	 <p>NT022</p>	Disassembling valve mechanism
— (J39386) Valve oil seal drift	 <p>NT024</p>	Installing valve oil seal

PREPARATION

Special Service Tools (Cont'd)

Tool number (Kent-Moore No.) Tool name	Description	
EM03470000 (J8037) Piston ring compressor	 <p>NT044</p>	Installing piston assembly into cylinder bore
ST16610001 (J23907) Pilot bushing puller	 <p>NT045</p>	Removing crankshaft pilot bushing (M/T models) or pilot converter (A/T models)
KV10111100 (J37228) Seal cutter	 <p>NT046</p>	Removing steel oil pan, aluminum oil pan and rear timing chain case, etc.
WS39930000 (—) Tube presser	 <p>NT052</p>	Pressing the tube of liquid gasket
KV10112100 (BT8653-A) Angle wrench	 <p>NT014</p>	Tightening bolts for bearing cap, cylinder head, etc.
KV10117100 (J3647-A) Heated oxygen sensor wrench	 <p>NT379</p>	Loosening or tightening heated oxygen sensor For 22 mm (0.87 in) hexagon nut
KV10114400 (J38365) Heated oxygen sensor wrench	 <p>NT636</p>	Loosening or tightening heated oxygen sensor a: 22 mm (0.87 in)

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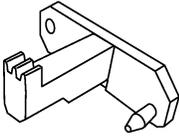
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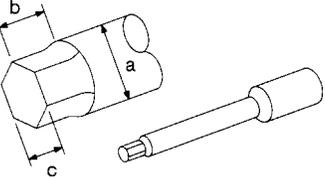
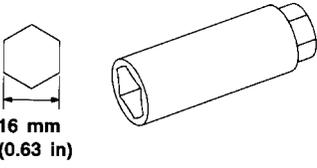
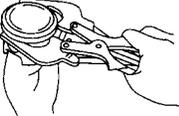
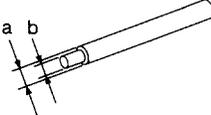
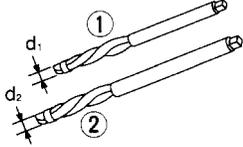
PREPARATION

Special Service Tools (Cont'd)

Tool number (Kent-Moore No.) Tool name	Description
KV10117700 (J44716) Ring gear stopper	 <p>Removing and installing crankshaft pulley</p> <p>NT822</p>

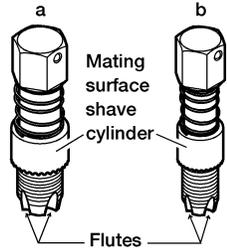
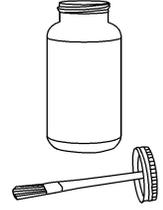
Commercial Service Tools

NAEM0004

(Kent-Moore No.) Tool name	Description
(J24239-01) Cylinder head bolt wrench	 <p>Loosening and tightening cylinder head bolt, and used with angle wrench [SST: KV10112100 (BT8653-A)] a: 13 (0.51) dia. b: 12 (0.47) c: 10 (0.39) Unit: mm (in)</p> <p>NT583</p>
Spark plug wrench	 <p>Removing and installing spark plug</p> <p>16 mm (0.63 in)</p> <p>NT047</p>
Valve seat cutter set	 <p>Finishing valve seat dimensions</p> <p>NT048</p>
Piston ring expander	 <p>Removing and installing piston ring</p> <p>NT030</p>
Valve guide drift	 <p>Removing and installing valve guide Intake & Exhaust: a = 9.5 mm (0.374 in) dia. b = 5.5 mm (0.217 in) dia.</p> <p>NT015</p>
Valve guide reamer	 <p>Reaming valve guide with (1) or hole for oversize valve guide with (2) Intake & Exhaust: d₁ = 6.0 mm (0.236 in) dia. d₂ = 10.2 mm (0.402 in) dia.</p> <p>NT016</p>

PREPARATION

Commercial Service Tools (Cont'd)

(Kent-Moore No.) Tool name	Description
(J-43897-18) (J-43897-12) Oxygen sensor thread cleaner	<div style="display: flex; align-items: center;">  <div style="margin-left: 20px;"> <p>Reconditioning the exhaust system threads before installing a new heated oxygen sensor (Use with anti-seize lubricant shown below.)</p> <p>a = J-43897-18 (18 mm dia.) for zirconia heated oxygen sensor</p> <p>b = J-43897-12 (12 mm dia.) for titania heated oxygen sensor</p> </div> </div> <p style="text-align: left; margin-top: 10px;">AEM488</p>
Anti-seize lubricant (Permatex 133AR or equivalent meeting MIL specification MIL-A-907)	<div style="text-align: center;">  </div> <p style="text-align: left; margin-top: 10px;">AEM489</p>

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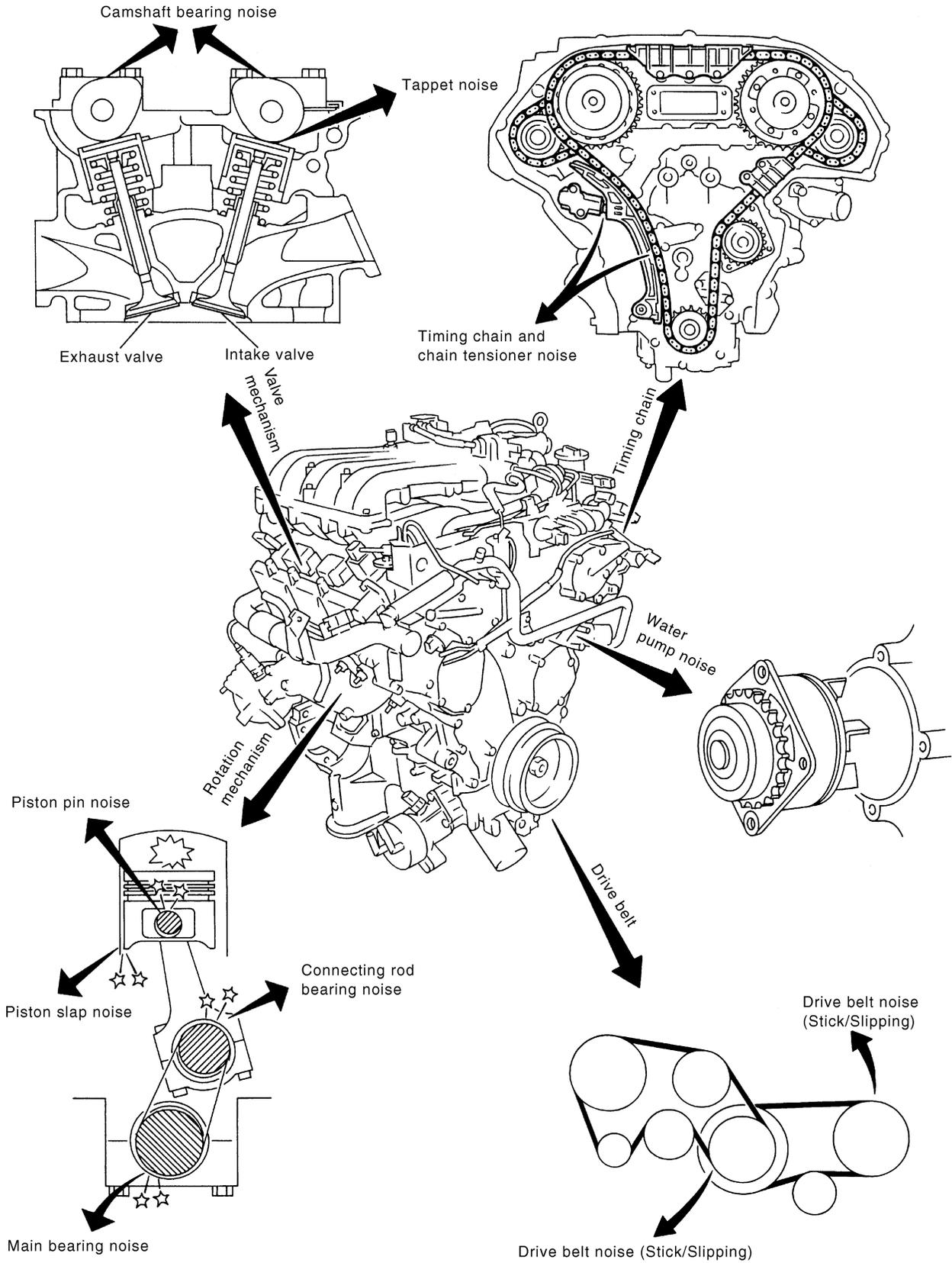
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NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING



NOISE, VIBRATION AND HARSHNESS (NVH) TROUBLESHOOTING

NVH Troubleshooting — Engine Noise

NVH Troubleshooting — Engine Noise

NAEM0005S01

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

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

If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Valve clearance	EM-60
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-48, 49
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance	EM-69, 75
	Slap or rap	A	—	—	B	B	A	Piston slap noise	Piston-to-bore clearance Piston ring side clearance Piston ring end gap Connecting rod bend and torsion	EM-69, 69, 70, 71
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing clearance (Small end) Connecting rod bearing clearance (Big end)	EM-75, 74
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-72, 72
Front of engine Timing chain cover	Tapping or ticking	A	A	—	B	B	B	Timing chain and chain tensioner noise	Timing chain cracks and wear Timing chain tensioner operation	EM-34, 24
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Drive belts (Sticking or slipping)	Drive belts deflection	MA section ("Checking Drive Belts", "ENGINE MAINTENANCE")
	Creaking	A	B	A	B	A	B	Drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	LC section ("Water Pump Inspection", "ENGINE COOLING SYSTEM")

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

OUTER COMPONENT PARTS

Removal and Installation

Removal and Installation

NAEM0006

SEC. 111•140•148•163•164•220•223

Refer to
"TIGHTENING PROCEDURES".

8.5 - 10.7
(0.86 - 1.1, 75 - 95)

9.0 - 13.0
(0.91 - 1.33, 79 - 115)

4.6 - 5.8
(0.47 - 0.59, 41 - 51)

8.4 - 10.8
(0.86 - 1.1, 75 - 95)

Refer to
"TIGHTENING PROCEDURES".

Refer to
"TIGHTENING PROCEDURES".

Refer to
"TIGHTENING PROCEDURES".

Refer to
"TIGHTENING PROCEDURES".

9.0 - 13.0
(0.91 - 1.33, 79 - 115)

17.6 - 21.6
(1.8 - 2.2,
13 - 15)

8.4 - 10.8
(0.86 - 1.1, 75 - 95)

Refer to
"TIGHTENING PROCEDURES".

Refer to
"TIGHTENING PROCEDURES".

9.8 - 11.8
(1.0 - 1.2, 87 - 104)

8.5 - 10.8
(0.87 - 1.1, 76 - 95)

⊗ : Always replace after every disassembly.

🔧 : Lubricate with new engine oil.

🔩 : N•m (kg-m, in-lb)

🔩 : N•m (kg-m, ft-lb)

SEM924G

1. Intake manifold collector support
2. Lower intake manifold collector
3. Fuel damper and fuel feed hose assembly
4. Fuel injector
5. Fuel tube assembly

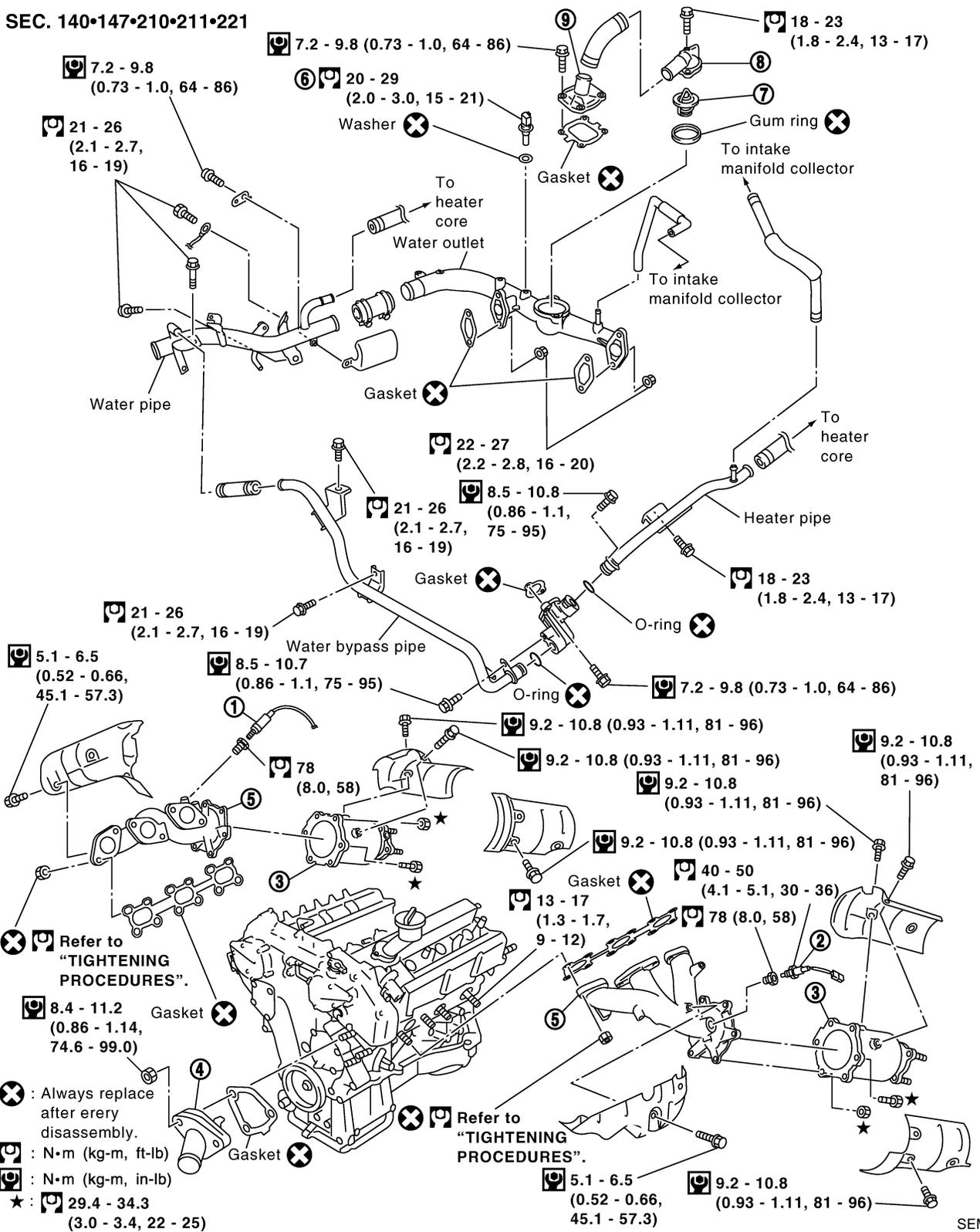
6. Fuel pressure regulator
7. Ignition coil with power transistor
8. Upper intake manifold collector
9. Intake manifold
10. Electric throttle control actuator

11. EVAP canister purge volume control solenoid valve
12. Swirl control valve actuator
13. Power valve actuator (A/T)
14. Oil level gauge

OUTER COMPONENT PARTS

Removal and Installation (Cont'd)

SEC. 140•147•210•211•221



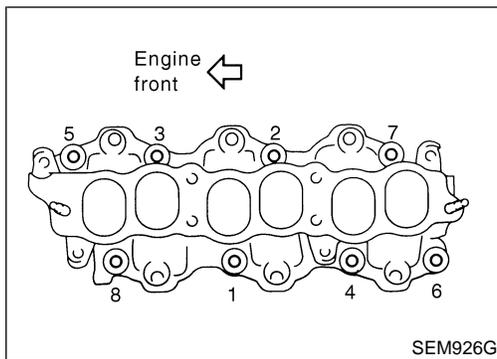
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|------------------------------------|--------------------------------------|--------------------------------|
| 1. Heated oxygen sensor 1 (bank 1) | 5. Exhaust manifold | 8. Water outlet housing |
| 2. Heated oxygen sensor 1 (bank 2) | 6. Engine coolant temperature sensor | 9. Cylinder block water outlet |
| 3. TWC (manifold) | 7. Water control valve | |
| 4. Thermostat with water inlet | | |

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OUTER COMPONENT PARTS

Removal and Installation (Cont'd)



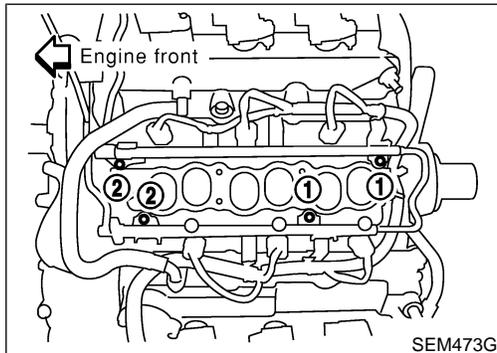
TIGHTENING PROCEDURES

Intake Manifold

NAEM0006S01

NAEM0006S0101

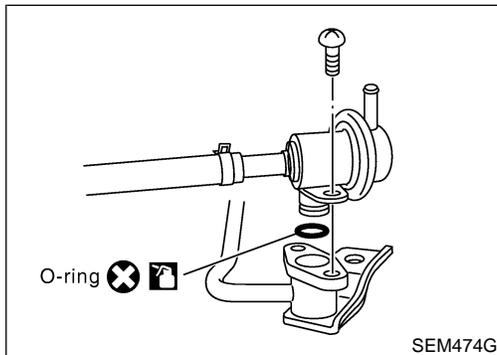
- Loosen in reverse order and tighten in numerical order shown in the figure.
1. Tighten all bolts and nuts to 4.9 to 9.8 N·m (0.5 to 1.0 kg·m, 44 to 86 in·lb).
 2. Finally tighten all bolts and nuts to 26.5 to 31.4 N·m (2.7 to 3.2 kg·m, 20 to 23 ft·lb).
- Tighten all bolts and nuts to the final torque, evenly dividing the tightening into at least three steps.



Fuel Tube

NAEM0006S0102

- Loosen in reverse order shown in the figure.
 - Tighten in numerical order shown in the figure.
1. Tighten all bolts to 9.3 to 10.8 N·m (0.95 to 1.1 kg·m, 83 to 95 in·lb).
 2. Then tighten all bolts to 20.6 to 26.5 N·m (2.1 to 2.7 kg·m, 16 to 19 ft·lb).

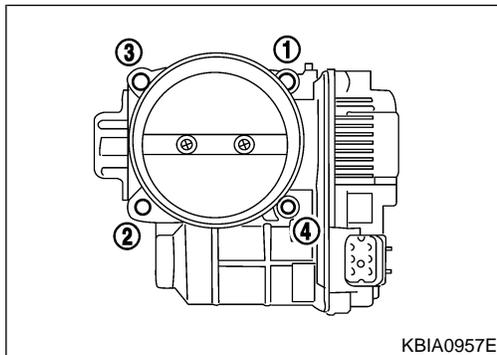


Fuel Pressure Regulator

NAEM0006S0103

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

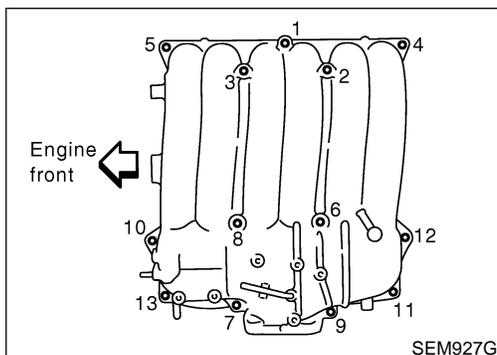
- Tighten screws evenly several times to have the fuel pressure regulator tightened at the specified torque.
- Always replace O-ring with new ones.
- Lubricate O-ring with new engine oil.



Electric Throttle Control Actuator

NAEM0006S0105

- Loosen in reverse order shown in the figure.
- Tighten all bolts to 7.2 to 9.7 (0.74 to 0.98 kg·m, 64 to 85 in·lb) in numerical order shown in the figure.
- Perform the "Throttle Valve Closed Position Learning" when harness connector of electric throttle control actuator is disconnected. Refer to EC-73, "Throttle Valve Closed Position Learning".
- Perform the "Idle Air Volume Learning" and "Throttle Valve Closed Position Learning" when electric throttle control actuator is replaced. Refer to EC-73, "Idle Air Volume Learning".



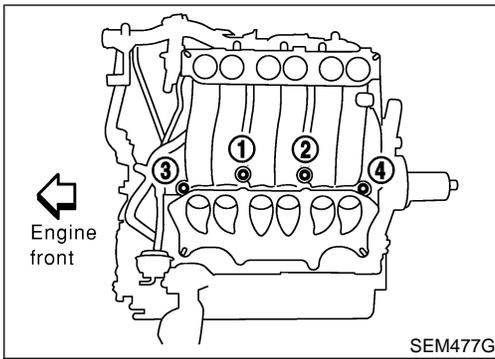
Upper Intake Manifold Collector

NAEM0006S0107

Loosen bolts and nuts in reverse order and tighten to 17.6 to 21.6 N·m (1.8 to 2.2 kg·m, 13 to 15 ft·lb) in numerical order shown in the figure.

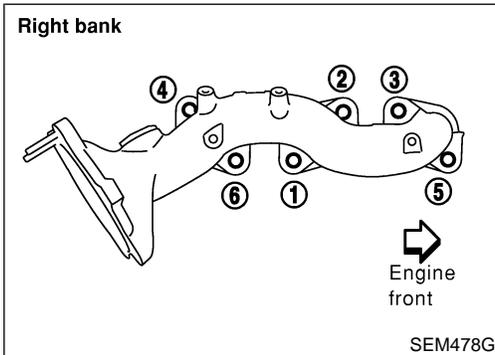
OUTER COMPONENT PARTS

Removal and Installation (Cont'd)



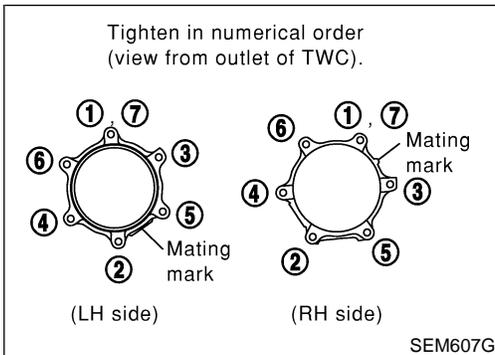
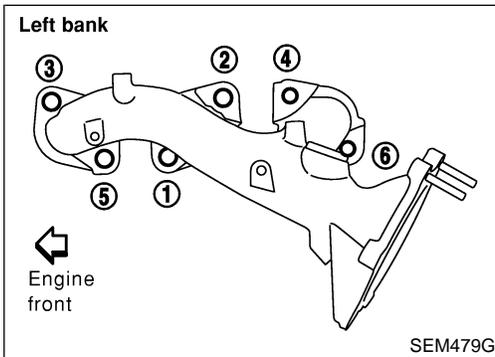
Lower Intake Manifold Collector

Tighten bolts and nuts to 17.6 to 21.6 N-m (1.8 to 2.2 kg-m, 13 to 15 ft-lb) in numerical order shown in the figure. NAEM0006S0108



Exhaust Manifold

Tighten nuts to 28.5 to 32.4 N-m (2.9 to 3.3 kg-m, 21 to 23 ft-lb) in numerical order shown in the figure. NAEM0006S0109



TWC (Manifold)

- Align the mating mark as shown for locating exhaust flange. NAEM0006S0110

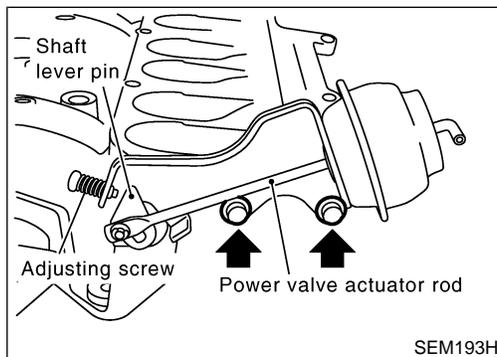
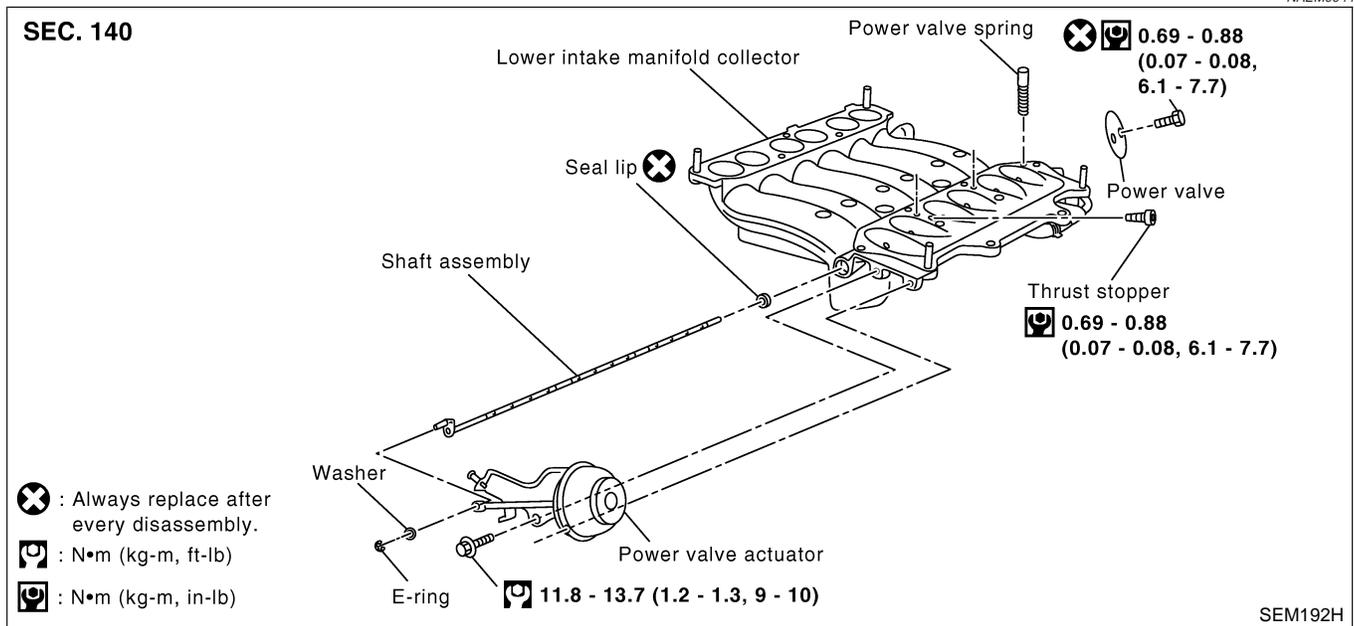
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OUTER COMPONENT PARTS

Disassembly and Assembly of Power Valve (A/T)

Disassembly and Assembly of Power Valve (A/T)

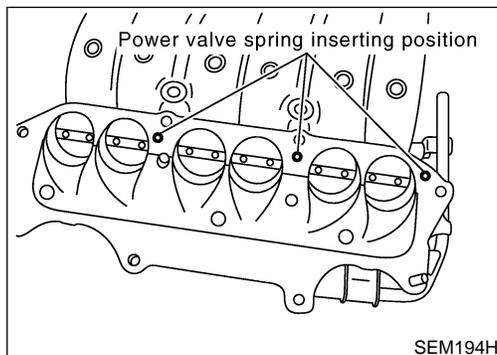
NAEM0044



DISASSEMBLY

NAEM0044S01

1. Loosen adjusting screw until it separates from shaft lever pin.
2. Remove power valve actuator rod from shaft lever pin.
3. Remove power valve actuator from lower intake manifold collector.
4. Remove thrust stopper.
5. Remove power valve.



6. Slowly pull out shaft assembly from lower intake manifold collector while rotating counterclockwise.

CAUTION:
Hold power valve spring by hand so as not to lose it because it pops out when pulling out shaft assembly.

7. Remove seal lip from lower intake manifold collector.

OUTER COMPONENT PARTS

Disassembly and Assembly of Power Valve (A/T) (Cont'd)

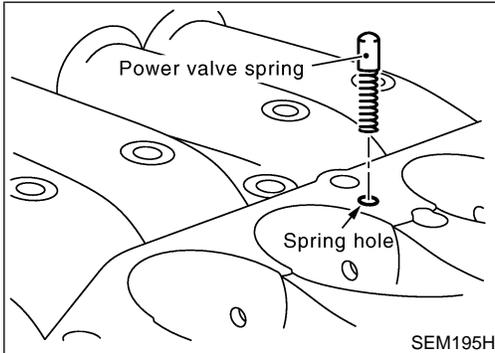
ASSEMBLY

NAEM0044S02

1. Press in seal lip.

CAUTION:

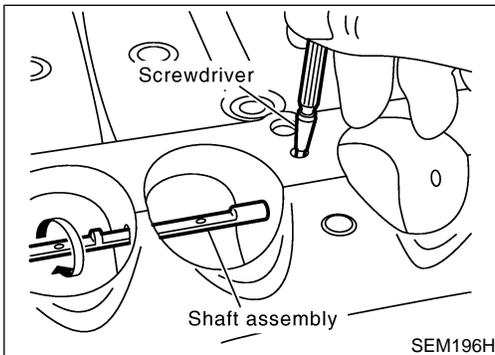
- Be careful not to damage lip when installing.
- Do not reuse seal lip.



2. Insert power valve spring into lower intake manifold collector.

CAUTION:

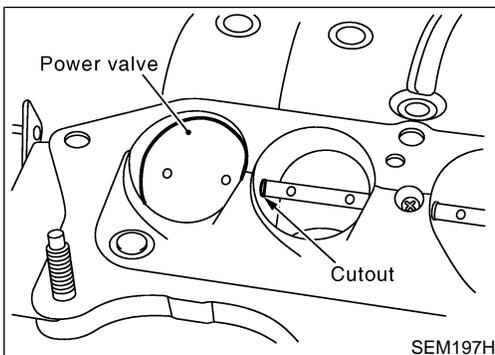
Insert power valve spring facing spring down into lower intake manifold collector.



3. Insert shaft assembly into lower intake manifold collector while rotating clockwise.

CAUTION:

- Be careful not to damage seal lip.
- Insert shaft assembly while holding power valve spring using a small screwdriver.



4. Install power valve.

CAUTION:

- Install power valve with cutout of shaft assembly moving toward left side of port. Push it toward shaft assembly so that there is no clearance with port.

Power valve mounting screw:

 : 0.69 - 0.88 N·m (0.07 - 0.08 kg·m, 6.1 - 7.7 in·lb)

- Do not reuse mounting screw.
- Operate power valve by hand after installation, and then make sure that it operates smoothly.

5. Install thrust stopper.

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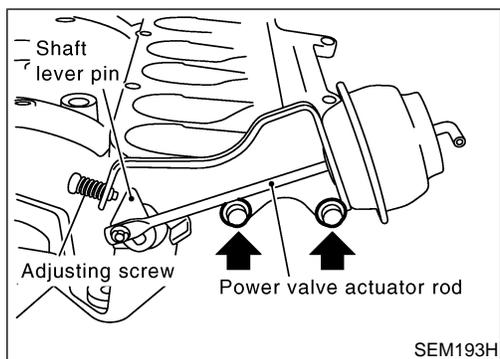
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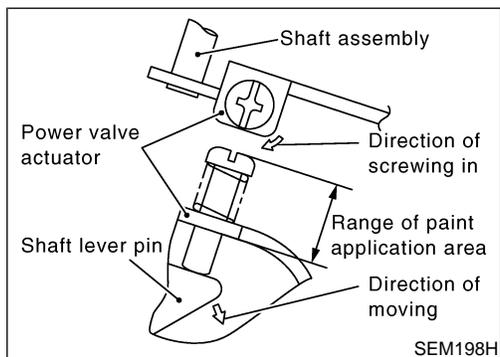
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OUTER COMPONENT PARTS

Disassembly and Assembly of Power Valve (A/T) (Cont'd)



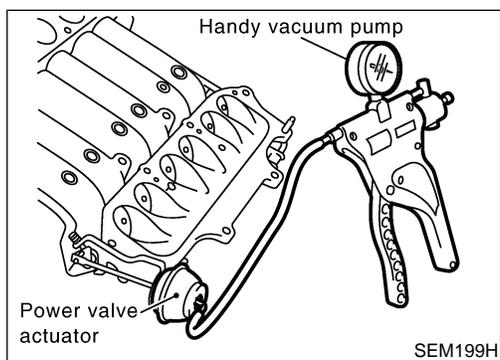
6. Install power valve actuator.
7. Install power valve actuator rod to shaft lever pin.
8. Screw in adjusting screw until its tip contacts with shaft lever pin.



9. Screw in one more turn after contacting the tip of adjusting screw with shaft lever pin.

NOTE:

The paint is applied on adjusting screw thread. Refer to the range of paint application area shown in the figure when installing.



INSPECTION AFTER ASSEMBLY

NAEM0044S03

Power Valve Actuator

NAEM0044S0301

Connect a handy vacuum pump. Make sure that power valve moves smoothly when applying the following vacuum pressure.

Unit: kPa (mmHg, inHg)

	Standard (approximate)
Power valve starts opening	-17.3 (-130, -5.12)
Power valve fully opens	-30.7 (-230, -9.06)
Power valve fully closes	-6.7 (-50, -1.97)

MEASUREMENT OF COMPRESSION PRESSURE

1. Warm up engine.
2. Turn ignition switch OFF.
3. Release fuel pressure.
Refer to EC-56, "Fuel Pressure Release".

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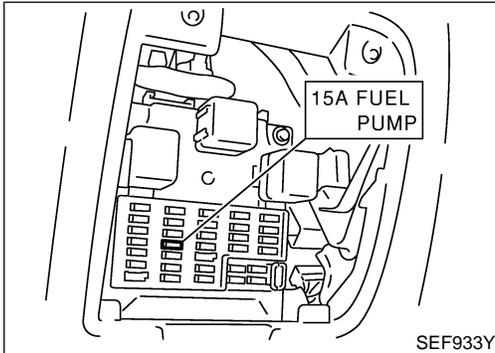
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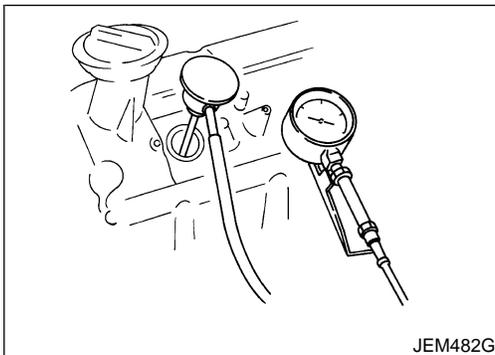
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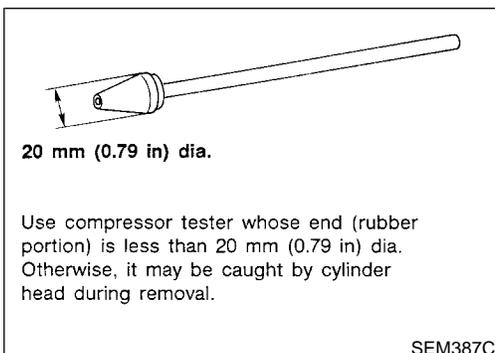
4. Disconnect fuel pump fuse to avoid injection during measurement.
5. Remove engine cover.
6. Remove air duct with air cleaner case.
7. Remove harness connectors and harness brackets around ignition coils.
8. Remove Electric throttle control actuator. Refer to EM-12, "Electric Throttle Control Actuator".
9. Disconnect ignition coil with power transistor harness connectors, then remove ignition coils.
10. Remove all spark plugs.
 - Clean area around plug with compressed air before removing the spark plug.
11. Connect engine tachometer (not required in use of CONSULT-II).



12. Attach a compression tester to No. 1 cylinder.
13. Crank engine and record highest gauge indication.
14. Repeat the measurement on each cylinder as shown above.
 - **Always use a fully-charged battery to obtain specified engine speed.**

Unit: kPa (kg/cm², psi)/rpm

Standard	Minimum	Difference limit between cylinders
1,270 (13.0, 184)/300	980 (10.0, 142)/300	100 (1.0, 15)/300



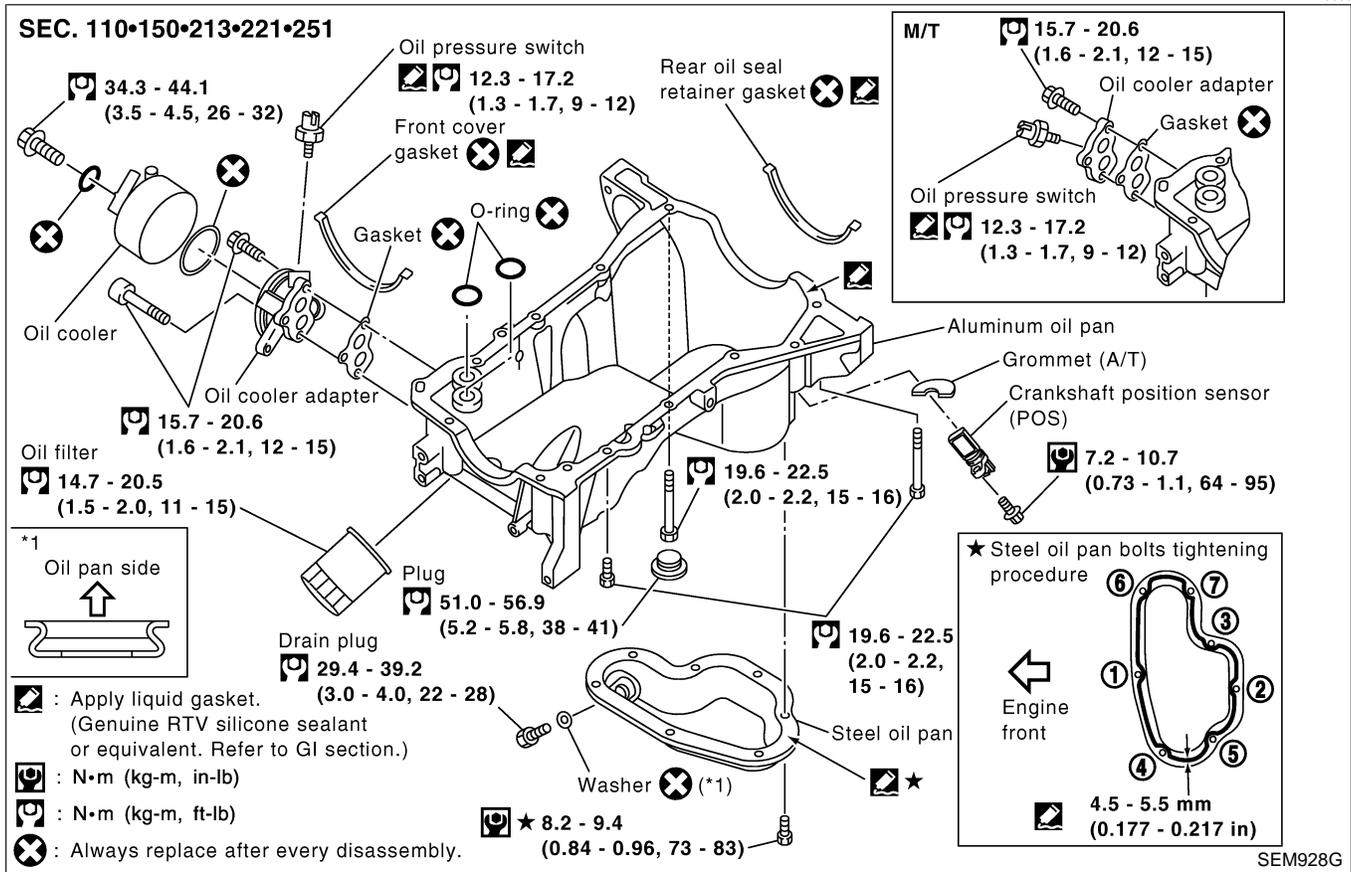
15. If compression in one or more cylinders is low:
 - a. Pour a small amount of engine oil into cylinders through spark plug holes.
 - b. Retest compression.
 - **If adding oil helps compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
 - **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. (Refer to SDS, EM-83 and EM-85.) If valve or valve seat is damaged excessively, replace them.**

MEASUREMENT OF COMPRESSION PRESSURE

- **If compression stays low in two cylinders that are next to each other:**
 - a) The cylinder head gasket may be leaking, or
 - b) Both cylinders may have valve component damage. Inspect and repair as necessary.
- 16. Install removed parts in reverse order of removal.
- 17. Perform “Self-diagnosis Procedure” referring to EC-91, “How to Erase DTC” if any DTC appears.

Components

NAEM0008



Removal

NAEM0009

WARNING:

- Place vehicle on a flat and solid surface.
- You should not remove oil pan until exhaust system and cooling system have completely cooled off. Otherwise, you may burn yourself and/or fire may break out in the fuel line.
- When removing front engine mounting nuts, lift up slightly engine for safety work.

CAUTION:

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

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

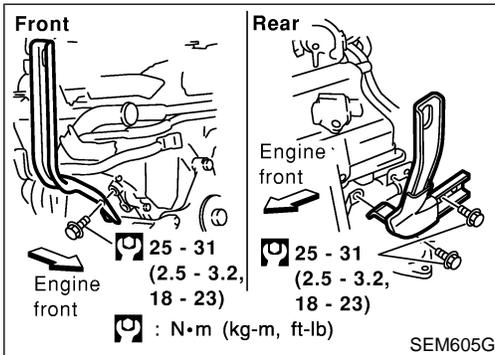
1. Remove front RH and LH wheels.
2. Remove battery.
3. Remove oil level gauge.
4. Remove engine undercover.
5. Remove suspension member stay.
6. Drain engine coolant from radiator drain plug.
7. Disconnect A/T oil cooler hoses. (A/T)
8. Drain engine oil.

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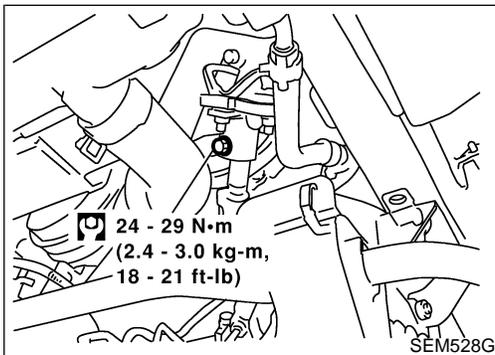
OIL PAN

Removal (Cont'd)

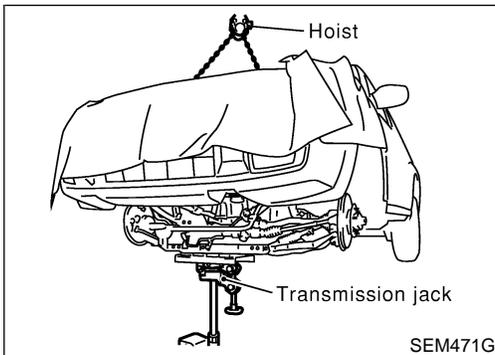
9. Remove the crankshaft position sensor (POS).
10. Remove drive belts and idler pulley with bracket.
11. Remove power steering oil pump, then put it aside holding with a suitable wire.
12. Remove alternator.



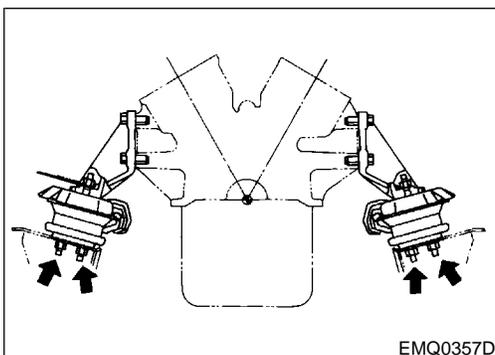
13. Install engine slingers.
14. Remove front propeller shaft. (4WD)
Refer to PD-8, "Removal and Installation".
15. Remove exhaust front tube heat insulators, then remove rear heated oxygen sensors with Tool.
16. Remove exhaust front tube from both sides.
Refer to FE-9, "Removal and Installation".
17. Remove front final drive. (4WD)
Refer to PD-19, "Removal and Installation".
18. Remove starter motor.
19. Disconnect oil pressure switch harness connector.
20. Loosen and disconnect the bolts fixing the steering column assembly lower joint and the power steering gear.



21. Set a suitable transmission jack under the front suspension member and hoist engine with engine slingers.

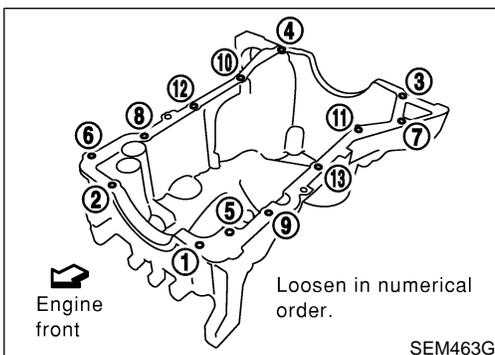
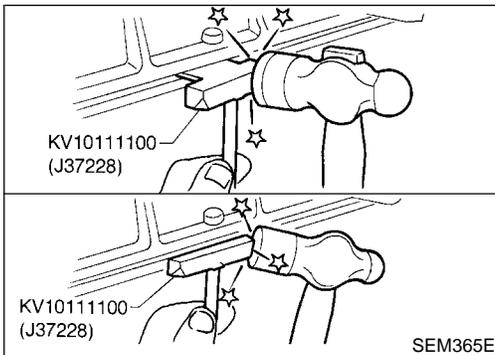
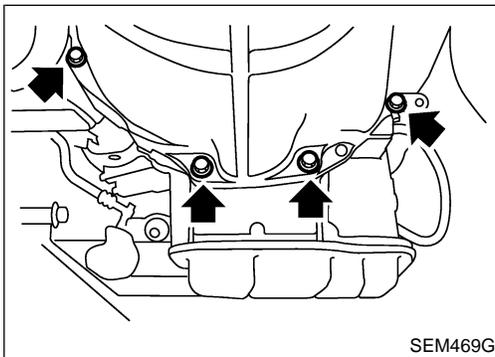
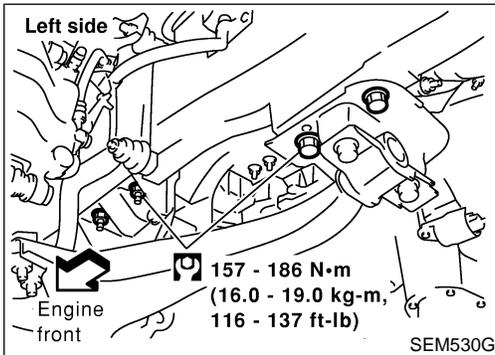
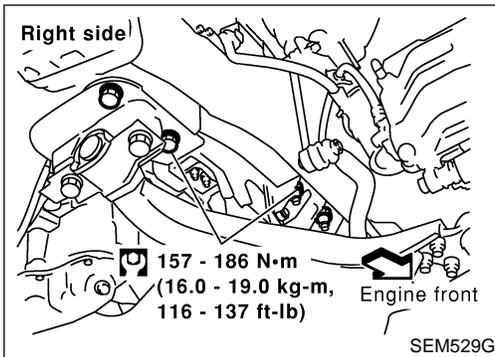


22. Remove front engine mounting nuts from both sides.



OIL PAN

Removal (Cont'd)



23. Remove front suspension member bolts and nuts.
24. Lower the transmission jack carefully to secure clearance between the oil pan and suspension member.
25. Remove A/T oil cooler tube. (A/T)
26. Remove water hose and tube. (A/T)

27. Remove the four engine-to-transmission bolts.
28. Loosen steel oil pan bolts in reverse order of tightening. Refer to "Components", EM-19.

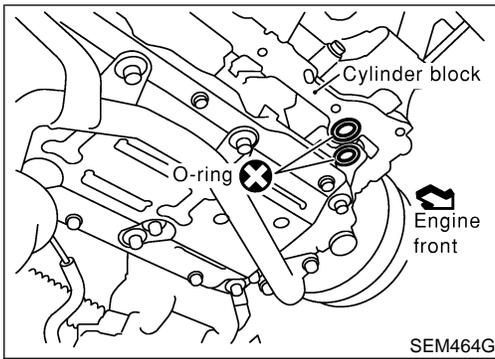
29. Remove steel oil pan.
 - a. Insert seal cutter (special service tool) between aluminum oil pan and steel oil pan.
 - **Be careful not to damage aluminum mating surface.**
 - **Do not insert screwdriver, or oil pan flange will be deformed.**
 - b. Slide seal cutter by tapping on the side of the tool with a hammer.

30. Remove plug from rear right of aluminum oil pan.
 - Plug position is under No. 4 bolt in the figure.
31. Remove aluminum oil pan bolts in numerical order.
32. Remove aluminum oil pan.
 - a. Insert seal cutter between aluminum oil pan and cylinder block.
 - **Be careful not to damage aluminum mating surface.**
 - **Do not insert screwdriver, or oil pan flange will be deformed.**
 - b. Slide seal cutter by tapping its side with a hammer.

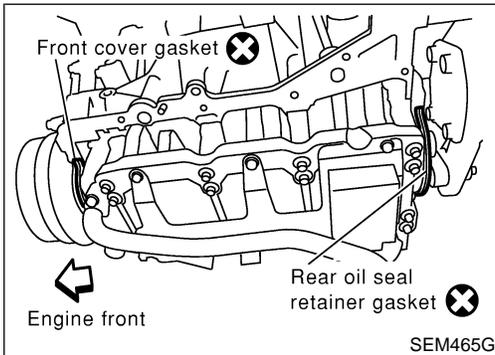
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OIL PAN

Removal (Cont'd)

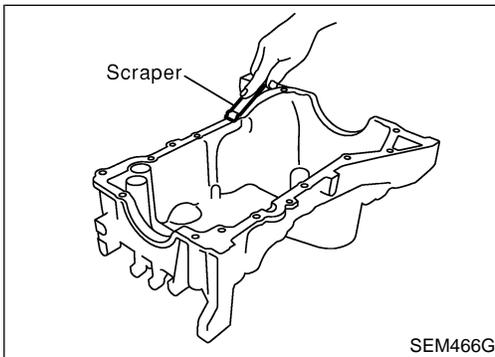


33. Remove O-rings from cylinder block and oil pump body.



34. Remove front cover gasket and rear oil seal retainer gasket.

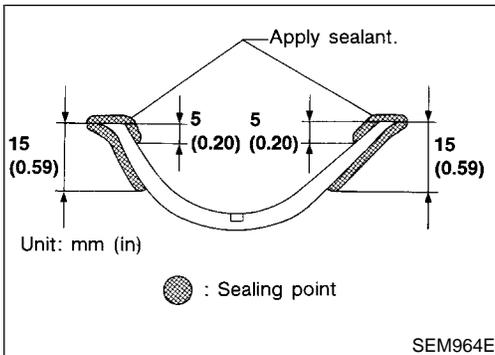
35. Clean oil strainer if any object attached.



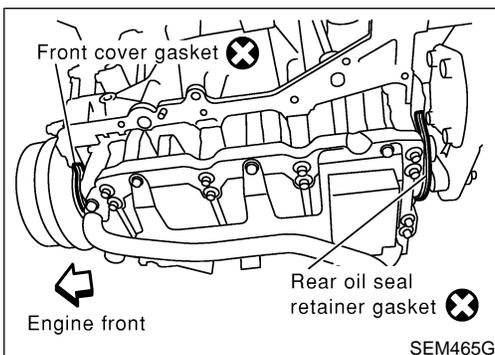
Installation

NAEM0010

1. Before installing oil pan, remove old liquid gasket from mating surface using a scraper.
 - Also remove old liquid gasket from mating surface of cylinder block.
 - Remove old liquid gasket from the bolt hole and thread.



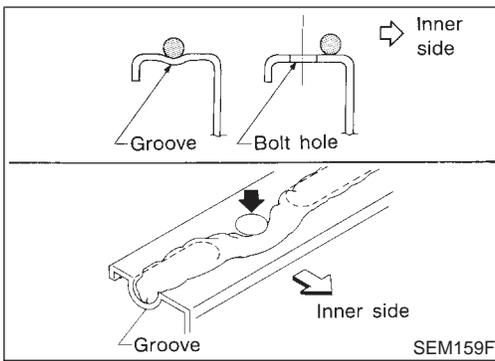
2. Apply sealant to front cover gasket and rear oil seal retainer gasket.



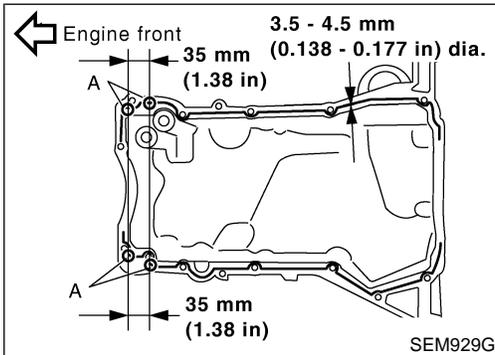
3. Install front cover gasket and rear oil seal retainer gasket.

OIL PAN

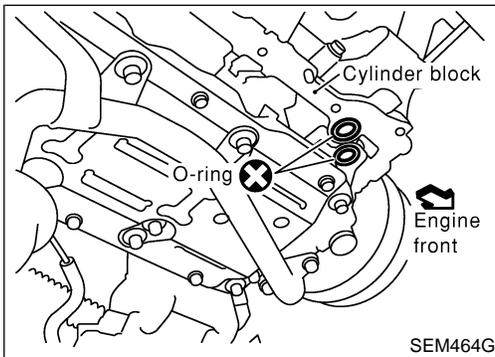
Installation (Cont'd)



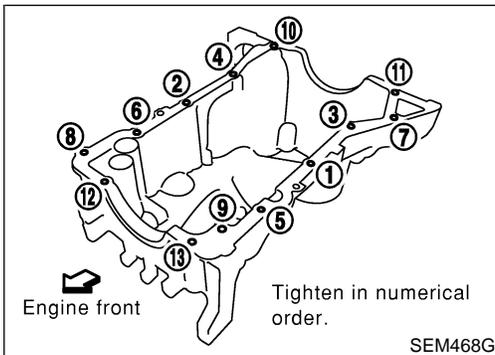
4. Apply a continuous bead of liquid gasket to mating surface of aluminum oil pan.
 - Use Genuine RTV silicone sealant or equivalent. Refer to GI-53.



5. Apply liquid gasket to inner sealing surface as shown in figure.
 - Be sure to apply it inside to all bolt holes.
 - Be sure to apply it to part A at [4.5 to 5.5 mm (0.177 to 0.217 in)].
 - Attaching should be done within 5 minutes after coating.



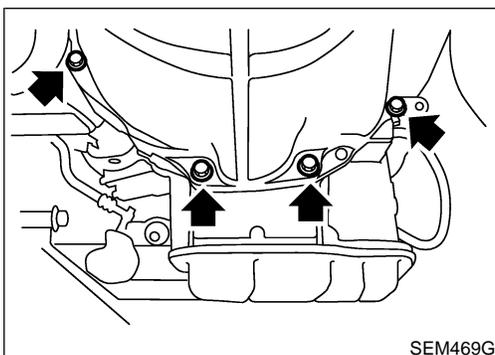
6. Install O-rings, cylinder block and oil pump body.



7. Install aluminum oil pan.

CAUTION:
Install avoiding misalignment of both oil pan gasket and O-rings.

- Tighten bolts in numerical order as shown in the figure.
 - Wait at least 30 minutes before refilling engine oil.
8. Install plug to rear right of aluminum oil pan.
 - Plug position is under No. 10 bolt in the figure.



9. Install the four engine-to-transmission bolts. For tightening torque, refer to AT-274 or MT-8, "Installation".
10. Reinstall in the reverse order of removal.

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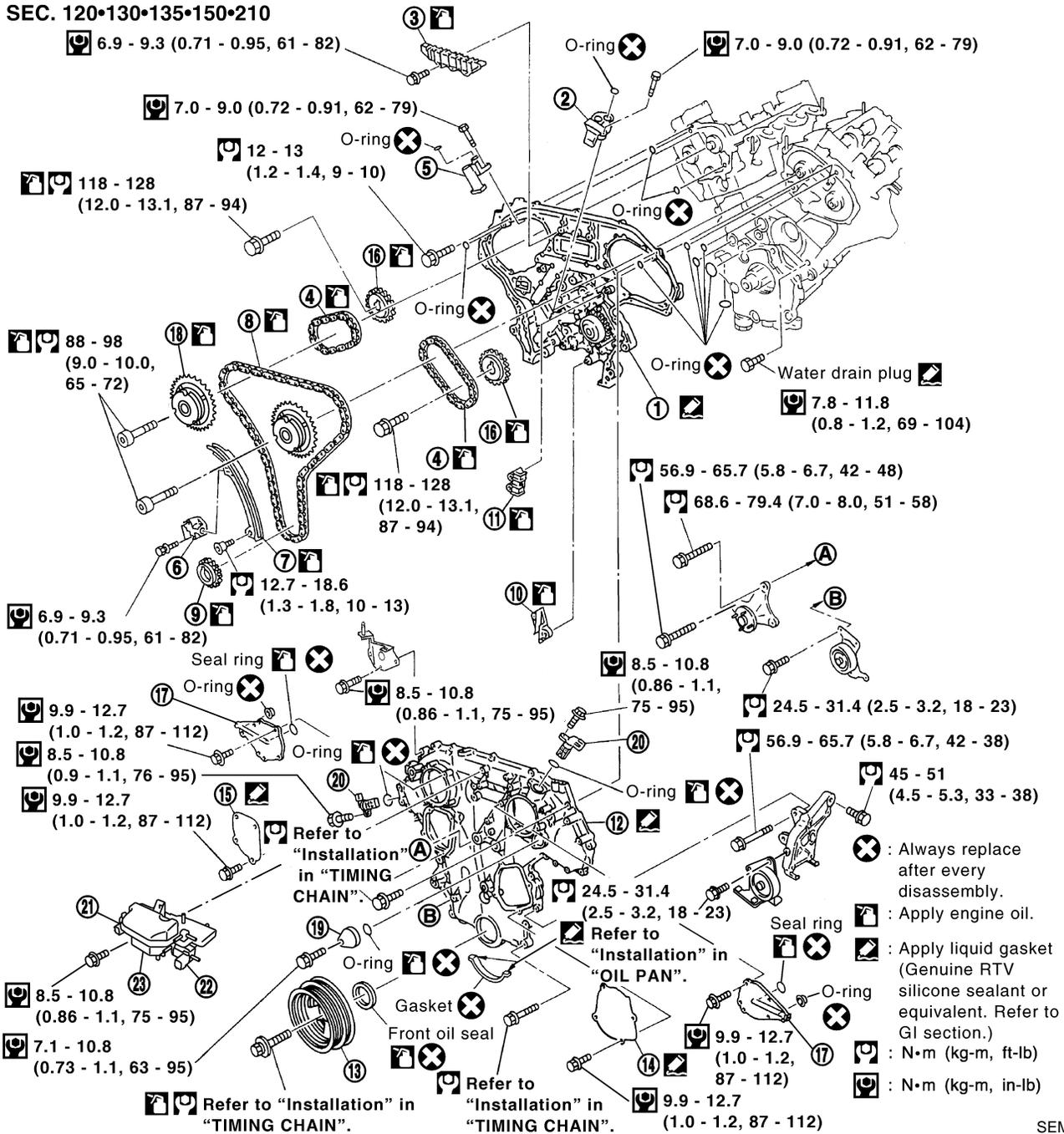
TIMING CHAIN

Components

NAEM0011

Components

SEC. 120•130•135•150•210



SEM930G

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|-----------------------------------|-------------------------------|--|
| 1. Rear timing chain case | 9. Crankshaft sprocket | 17. Intake valve timing control cover |
| 2. Left camshaft chain tensioner | 10. Lower chain guide | 18. Intake camshaft sprocket |
| 3. Internal guide | 11. Upper tension guide | 19. Cover |
| 4. Timing chain (Secondary) | 12. Front timing chain case | 20. Camshaft position sensor (PHASE) |
| 5. Right camshaft chain tensioner | 13. Crankshaft pulley | 21. VIAS control solenoid valve (A/T) |
| 6. Timing chain tensioner | 14. Water pump cover | 22. Swirl control valve control solenoid valve |
| 7. Slack guide | 15. Chain tensioner cover | 23. Vacuum tank |
| 8. Timing chain (Primary) | 16. Exhaust camshaft sprocket | |

POSITION FOR APPLYING LIQUID GASKET

Refer to "Liquid Gasket Application Procedure" in "PRECAUTION",
EM-3. =NAEM0011S01

- Before installation, wipe off the protruding sealant.

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CAUTION:

- After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.
- When installing camshafts, chain tensioners, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.
- Apply new engine oil to bolt threads and seat surfaces when installing camshaft sprockets and crankshaft pulley.
- Before disconnecting fuel hose, release fuel pressure. Refer to EC-56, "Fuel Pressure Release".
- Be careful not to damage sensor edges.
- Do not spill engine coolant on drive belts.

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Removal

NAEM0012

1. Release fuel pressure.
Refer to EC-56, "Fuel Pressure Release".
2. Remove battery.
3. Remove radiator.
Refer to LC-22, "REMOVAL AND INSTALLATION".
4. Drain engine oil.
5. Remove drive belts and idler pulley with brackets.
6. Remove cooling fan with bracket.
7. Remove engine cover.
8. Remove air duct with air cleaner case, collector, PCV hose, vacuum hoses, fuel hoses, water hoses, harnesses, connectors and so on.
9. Remove the air conditioner compressor, and tie it down using rope or the like to keep it from interfering.
10. Remove the power steering oil pump and reservoir tank. Tie them down using rope or the like to keep them from interfering.
11. Remove alternator.
12. Remove the following.
 - Vacuum tank
 - Water bypass pipe
 - Brackets

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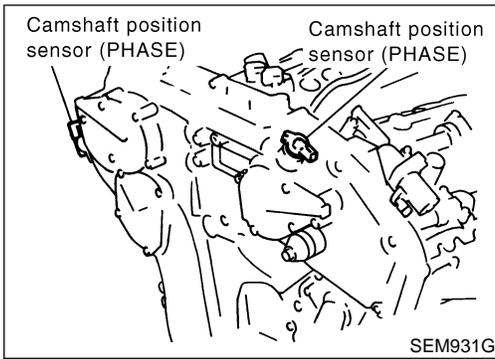
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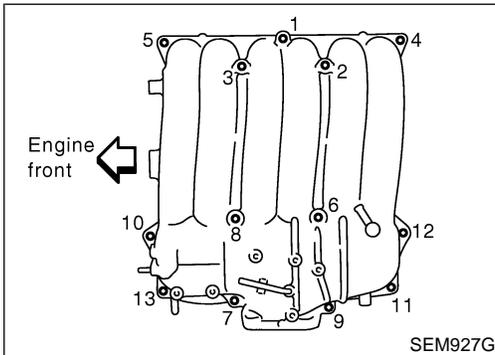
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TIMING CHAIN

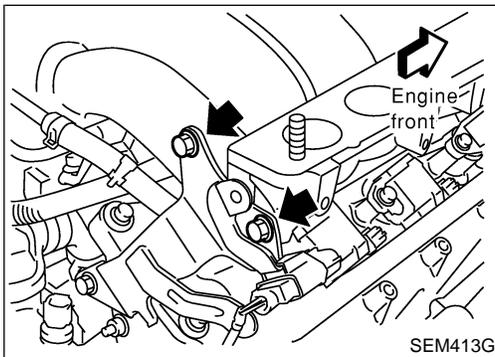
Removal (Cont'd)



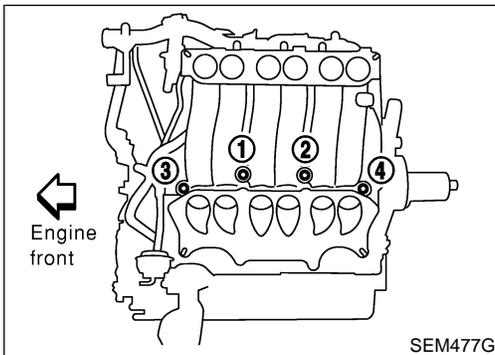
13. Remove camshaft position sensors (PHASE).
 - Avoid impact such as dropping.
 - Do not disassemble the components.
 - Do not place them on areas where iron powder may adhere.
 - Keep away from the objects susceptible to magnetism.



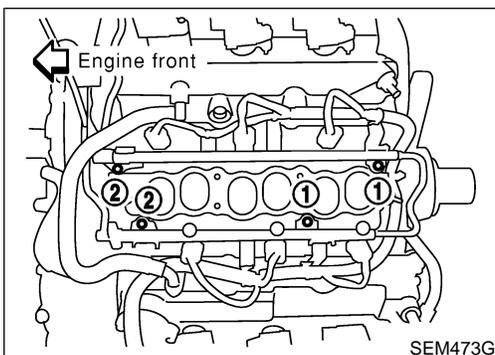
14. Remove upper intake manifold collector in reverse order of illustration.



15. Remove intake manifold collector support bolts.



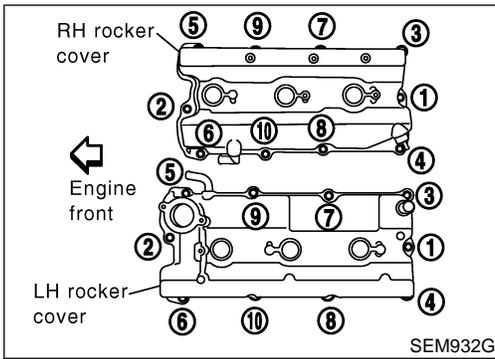
16. Remove lower intake manifold collector in reverse order of illustration.



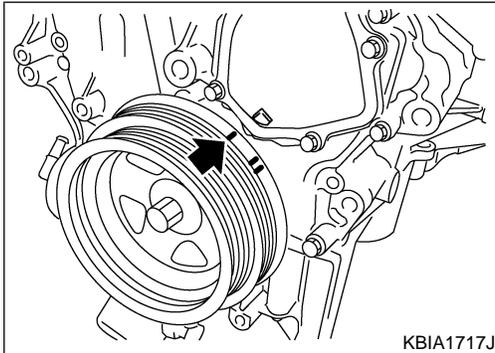
17. Disconnect injector harness connectors.
18. Remove fuel tube assembly in reverse order of illustration.

TIMING CHAIN

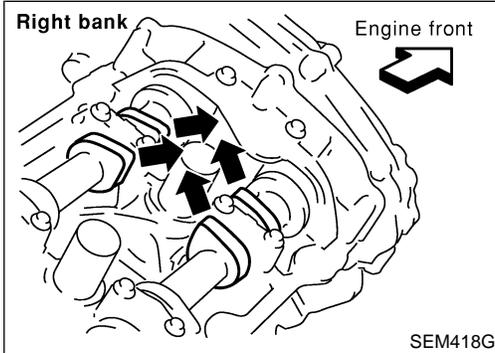
Removal (Cont'd)



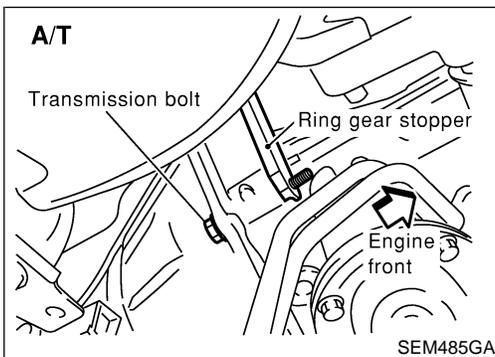
19. Remove ignition coils.
20. Remove RH and LH rocker covers from cylinder head.
 - Loosen bolts in numerical order shown in the figure.



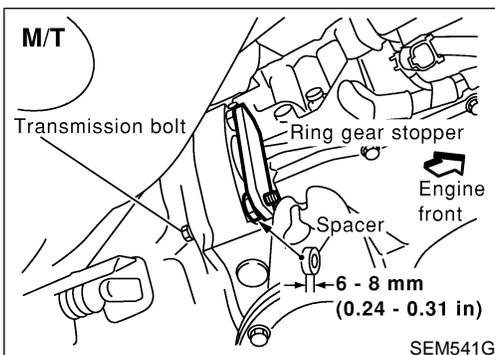
21. Set No. 1 piston at TDC on the compression stroke by rotating crankshaft.
 - Align pointer with TDC mark on crankshaft pulley.



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



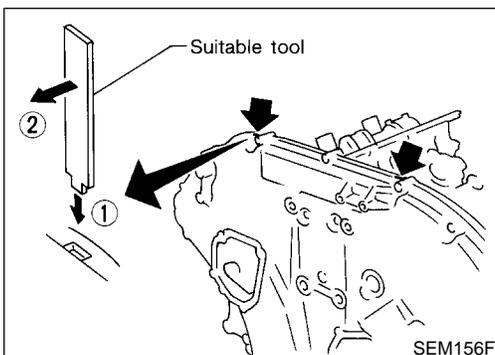
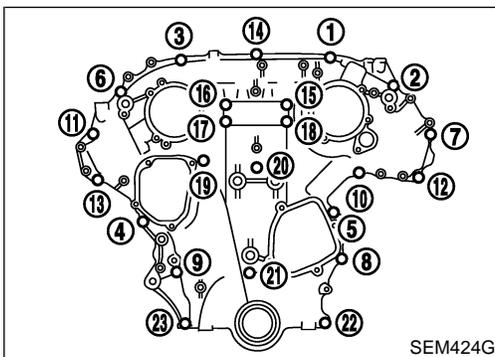
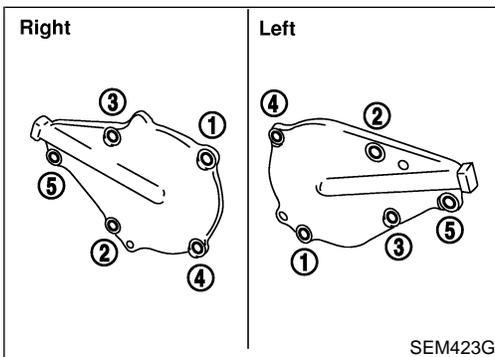
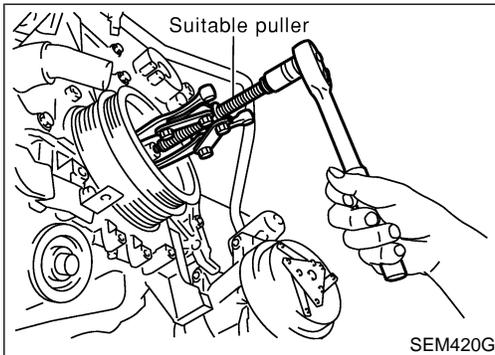
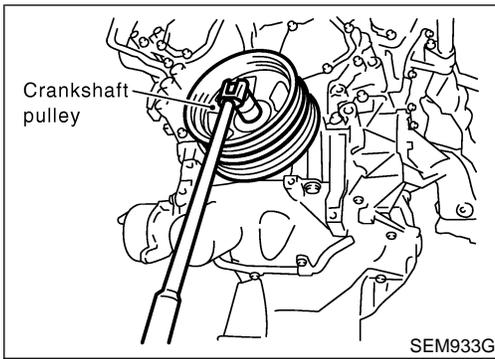
22. Remove starter motor, and set ring gear stopper using the mounting bolt hole.
 - **Be careful not to damage the signal plate teeth.**



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TIMING CHAIN

Removal (Cont'd)



23. Loosen the crankshaft pulley bolt.

24. Remove crankshaft pulley with a suitable puller.

25. Remove aluminum oil pan.
Refer to EM-19, "Removal".

26. Temporarily install the suspension member bolts and engine mounting nuts.

27. Remove intake valve timing control covers.

- **Loosen bolts in numerical order as shown in the figure.**
- In the cover, the shaft is engaged with the center hole of the intake camshaft sprocket. Remove it straight out until the engagement comes off.

28. Remove front timing chain case bolts.

- **Loosen bolts in numerical order as shown in the figure.**

29. Remove front timing chain case.

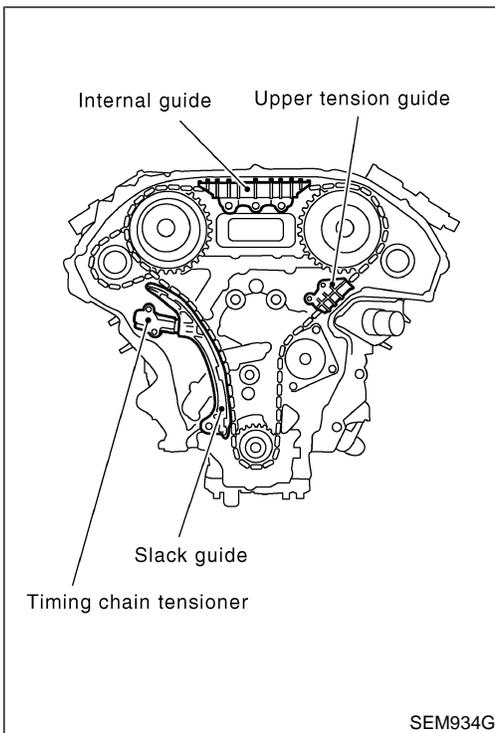
- Insert the appropriate size tool into the notch at the top of the front timing chain case as shown (1).
 - Pry off the case by moving the tool as shown (2).
- Use seal cutter (special service tool) or an equivalent tool to cut liquid gasket for removal.

CAUTION:

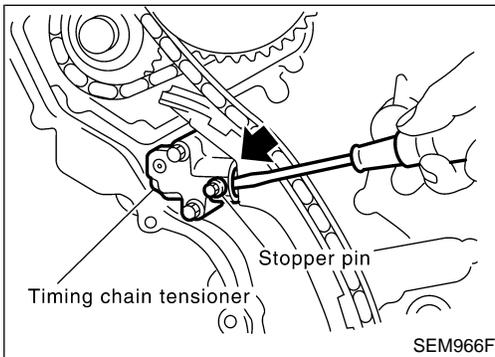
- **Do not use screwdrivers or something similar.**
- **After removal, handle it carefully so it does not tilt, cant, or warp under a load.**

TIMING CHAIN

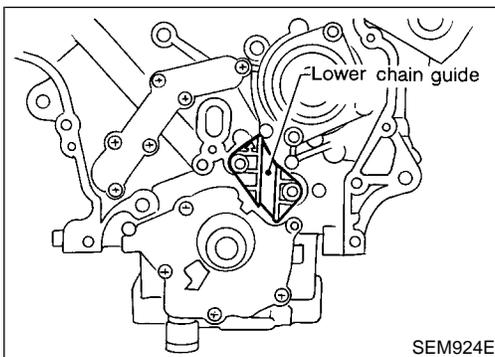
Removal (Cont'd)



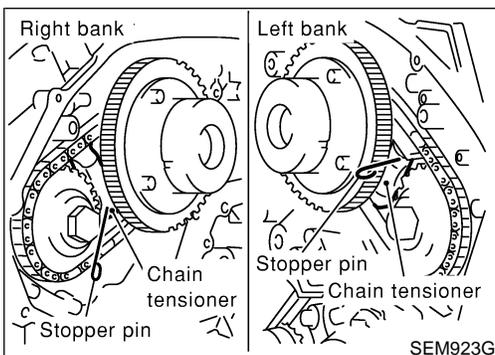
30. Remove internal guide.
31. Remove upper tension guide.
32. Remove timing chain tensioner and slack guide.



- Remove timing chain tensioner. (Push piston and insert a suitable pin into pinhole.)
33. Remove primary timing chain and crankshaft sprocket.



34. Remove lower chain guide.

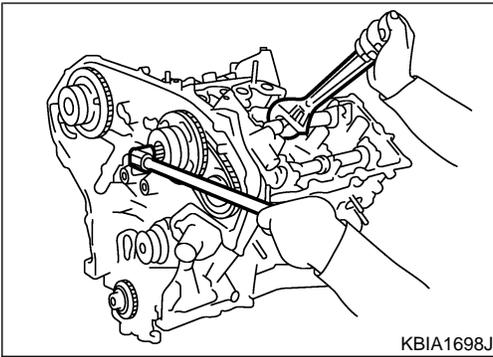


35. Attach a suitable stopper pin to RH and LH camshaft chain tensioners.

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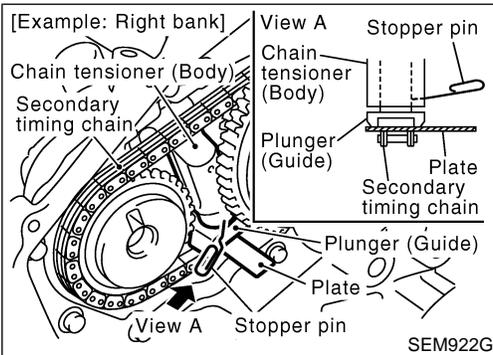
TIMING CHAIN

Removal (Cont'd)



36. Remove intake and exhaust camshaft sprocket bolts.

- Secure the hexagonal head of the camshaft using a spanner to loosen mounting bolts.

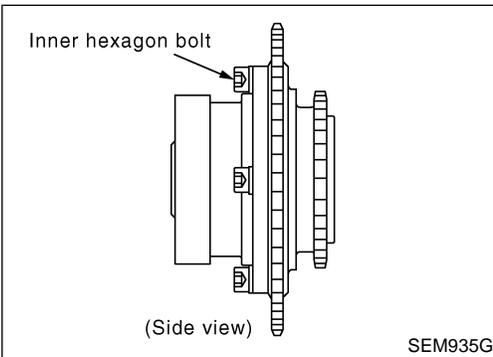


37. Remove secondary timing chains with camshaft sprockets.

- Rotate camshaft lightly, and slacken timing chain of timing chain tensioner-side.
- Insert metal or resin plate [thickness: 0.5 mm (0.020 in)] into guide between timing chain and chain tensioner plunger. Remove cam sprocket and secondary timing chain with timing chain floated from guide groove.

CAUTION:

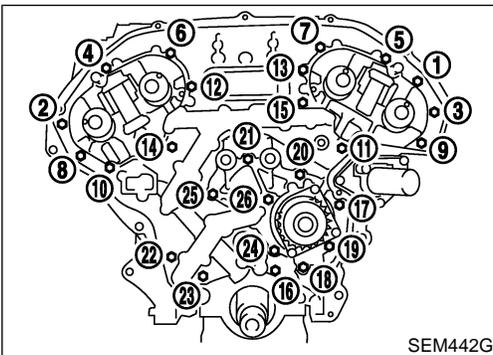
Chain tensioner plunger may move, while fixed stopper pin and plunger both come off when timing chain is removed. Use caution during removal.



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

CAUTION:

- Avoid impact.
- Do not disassemble (Never loosen inner hexagonal bolts).

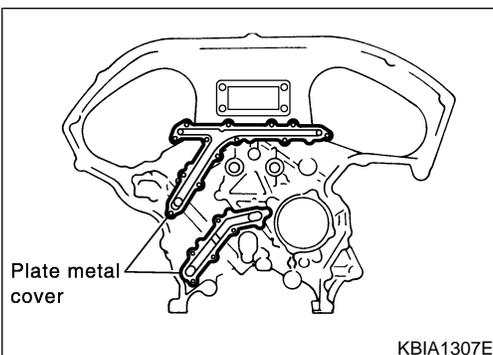


38. Remove rear timing chain case as follows if necessary.

- Loosen mounting bolts in numerical order shown in figure, and remove them.
- Disconnect liquid gasket applied portion using seal cutter (special service tool: KV10111100) or an equivalent tool. Then remove rear timing chain case.

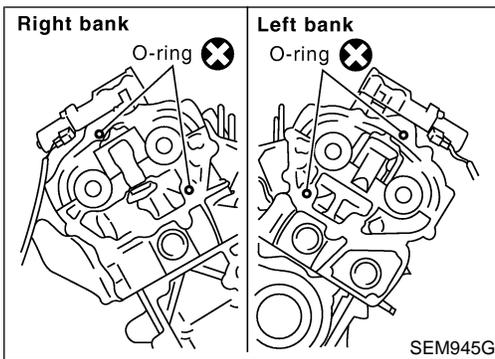
CAUTION:

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

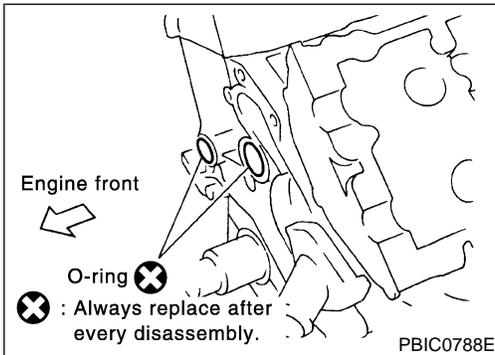


TIMING CHAIN

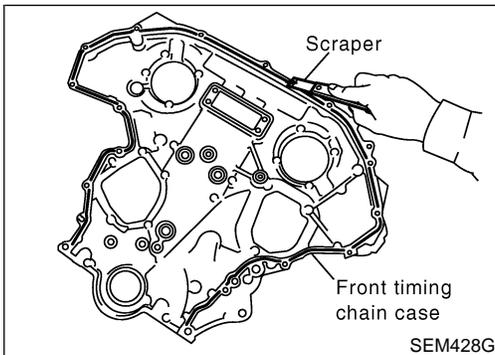
Removal (Cont'd)



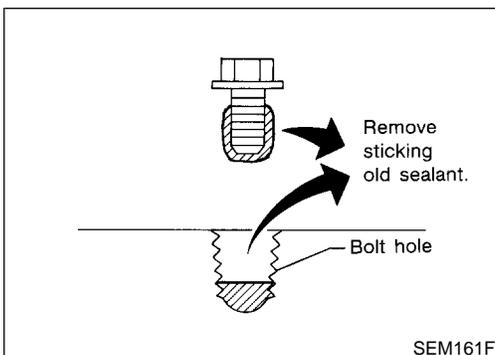
39. Remove O-rings from cylinder head.



40. Remove O-rings from cylinder block.



42. Use a scraper to remove all traces of liquid gasket from front and rear timing chain case, and opposite mating surfaces.



● Remove old liquid gasket from the bolt hole and thread.

43. Remove front oil seal from front timing chain case. Refer to EM-43, "FRONT OIL SEAL".

44. Remove water pump cover and chain tensioner cover from front timing chain case if necessary.

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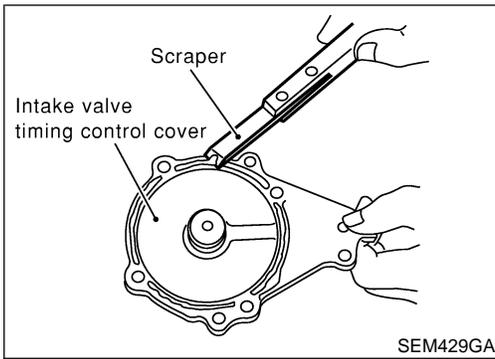
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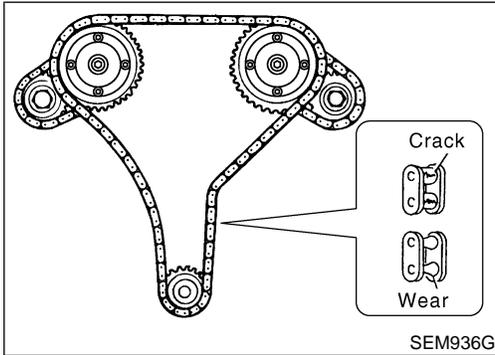
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TIMING CHAIN

Removal (Cont'd)

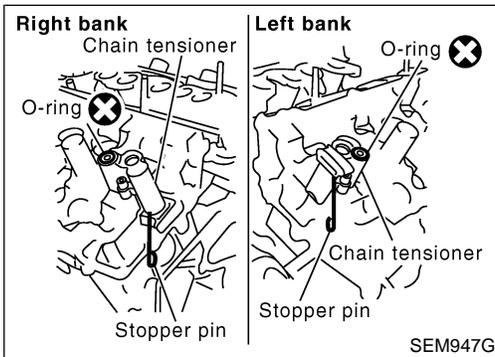


45. Use a scraper to remove all traces of liquid gasket from intake valve timing control cover, water pump cover and chain tensioner cover.



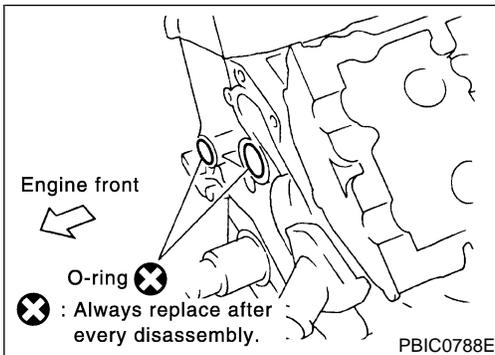
Inspection

Check for cracks and excessive wear at roller links. ^{NAEM0013} Replace chain if necessary.

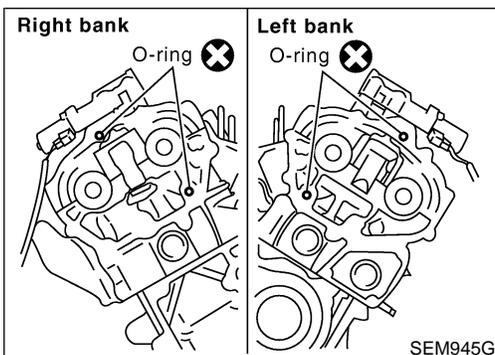


Installation

1. Install RH and LH camshaft chain tensioners to cylinder head as follows if removed. ^{NAEM0014}
 - a. Install chain tensioners with stopper pin attached and new O-ring.
 - b. Install No. 1 camshaft brackets.



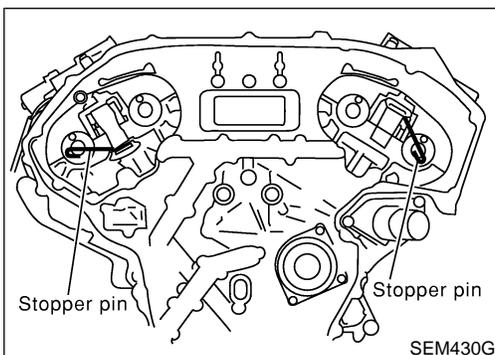
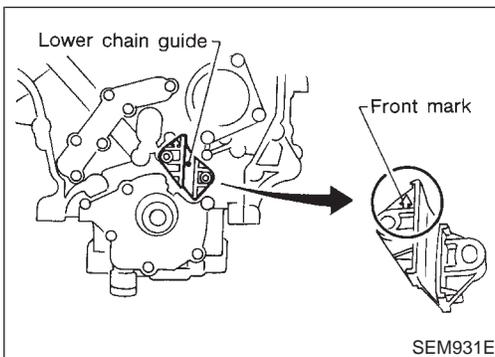
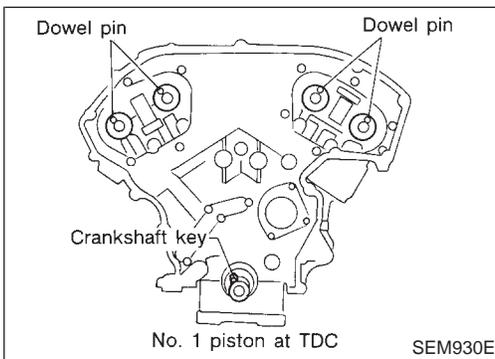
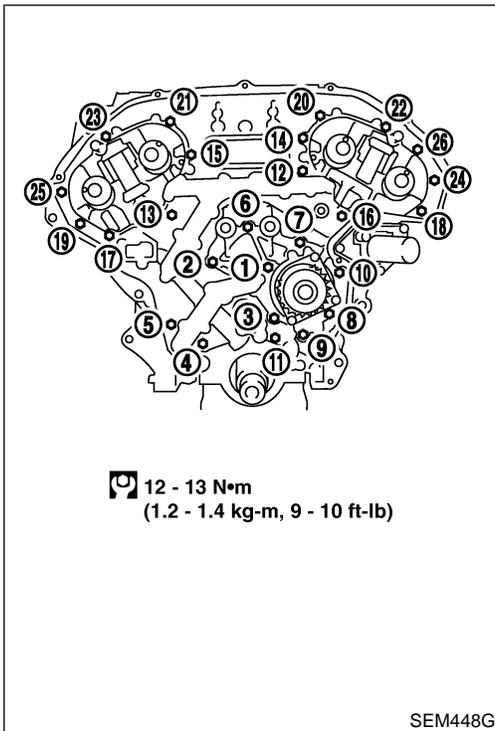
2. Install new O-rings to cylinder block if rear timing chain case is removed.



3. Install new O-rings to cylinder head if rear timing chain case is removed.
4. Apply liquid gasket to rear timing chain case. Refer to EM-25, "POSITION FOR APPLYING LIQUID GASKET".

TIMING CHAIN

Installation (Cont'd)



5. Align rear timing chain case, if removed, with dowel pins (RH and LH) on cylinder block. Then install it.
 - Do not allow O-ring to drop.
 - a. Tighten mounting bolts in order as shown in the figure.
 - Install two types of mounting bolts, referring to the following instructions and figure.

Bolt length:

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

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

- b. After all bolts are temporarily tightened, retighten them to specified torque in order shown in the figure.
6. After installing rear timing chain case, check surface height difference between following parts on oil pan mounting surface.

Standard

Rear timing chain case to cylinder block:

-0.24 to 0.14 mm (-0.0094 to 0.0055 in)

- If not within standard, repeat above installation procedure.

7. Make sure that camshaft and crankshaft are at TDC position of No. 1 cylinder.
 - Make sure that dowel pin and crankshaft key are located as shown in the figure.
Camshaft dowel pin: At cylinder head upper face side in each bank
Crankshaft key: At cylinder head side of RH bank

NOTE:

Though camshafts are not stopped at the positions as shown in the figure for the cam nose locations, it is appropriate in this step that camshafts are stopped at the basically same direction of the figure.

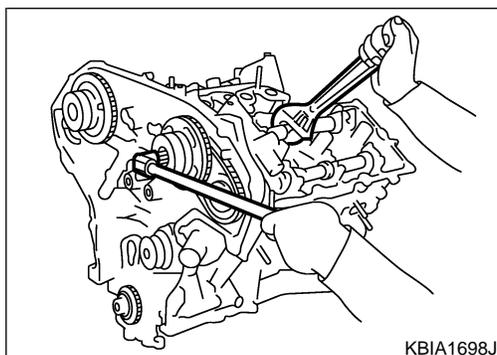
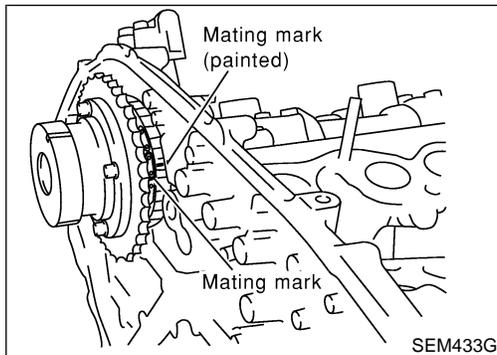
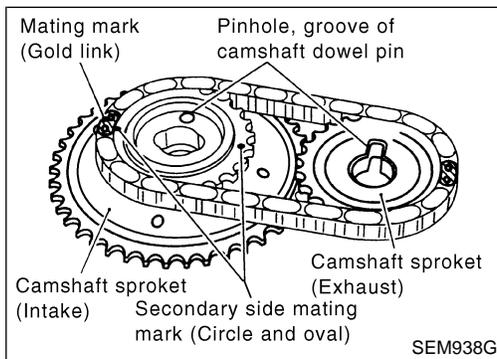
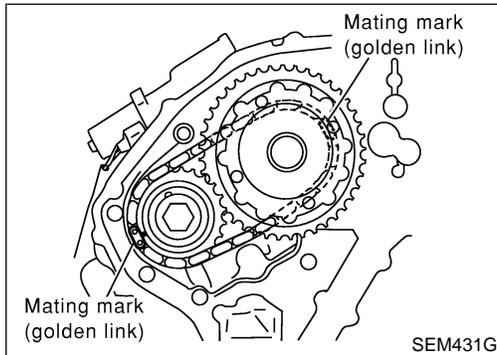
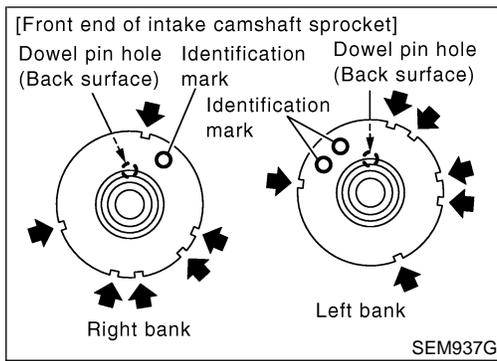
8. Install lower chain guide on dowel pin, with front mark on the guide facing upside.

9. Install secondary timing chain and camshaft sprockets.
 - a. Press and shrink the secondary chain tensioner sleeve, and fix it using stopper pins.
 - Lubricate threads and seat surfaces of camshaft sprocket bolts with new engine oil.

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TIMING CHAIN

Installation (Cont'd)



- b. Identify intake camshaft sprocket of the right and left bank.
 - Identify by front identification mark [10 mm (0.39 in) dia. recess] number and cutout position difference for signal detection of front end circumference.
 - Exhaust camshaft sprocket is a common part for both banks.

- c. Install secondary timing chain and sprocket.
 - Align mating marks (golden links) on secondary timing chain with those (punched marks) on the intake and exhaust sprockets.
 - Align camshaft dowel pins with the sprocket groove and hole.
 - Because camshaft sprocket mounting bolts are tightened in step 10, perform manual tightening to the extent necessary to keep camshaft dowel pin from dislocating.

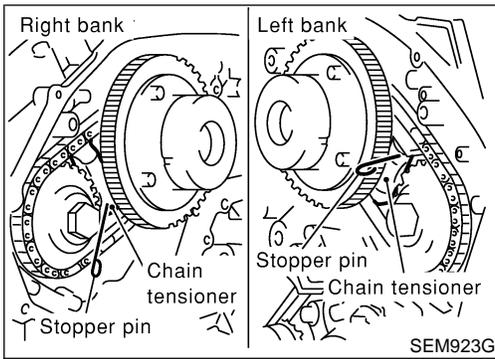
- Mating marks of the intake sprocket are on the back side of the secondary sprockets. There are two types of the marks; circle and oval types, which should be used for right and left banks respectively.
 - Right bank: Circle**
 - Left bank: Oval**
- In cases that positions of each mating mark and each dowel pin are not fit on mating parts, make fine adjustment to the position holding the hexagonal head of camshaft with a spanner or equivalent.

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

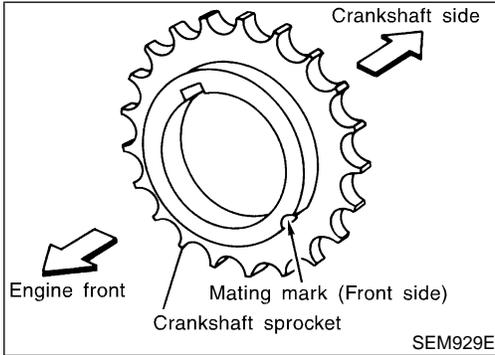
10. After confirming the mating marks are aligned, tighten the camshaft sprocket mounting bolts.
 - Secure the camshaft hexagonal head using a spanner to tighten mounting bolts.

TIMING CHAIN

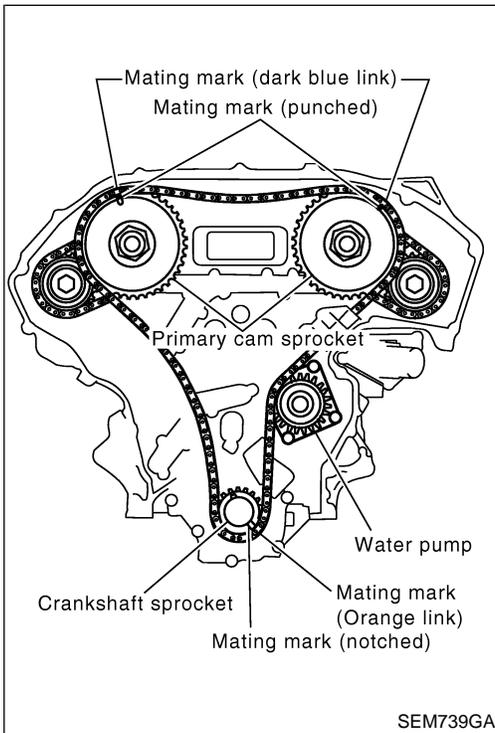
Installation (Cont'd)



SEM923G



SEM929E



SEM739GA

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

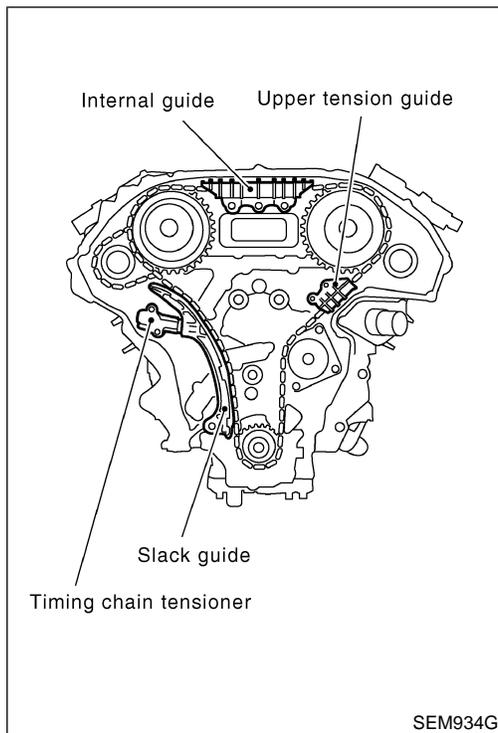
- Install crankshaft sprocket, with mating mark to timing chain facing front of engine.

- Install primary timing chain so that mating mark (punched) on camshaft sprocket is aligned with that (dark blue link) on the timing chain, and mating mark (notched) on crankshaft sprocket is aligned with that (orange link) on the timing chain, respectively.
- When it is difficult to align mating marks of the primary timing chain with each sprocket, gradually turn the camshaft hexagonal head using a spanner so it is aligned with the mating mark.
- During alignment, be careful to prevent dislocation of mating marks on the secondary timing chain.

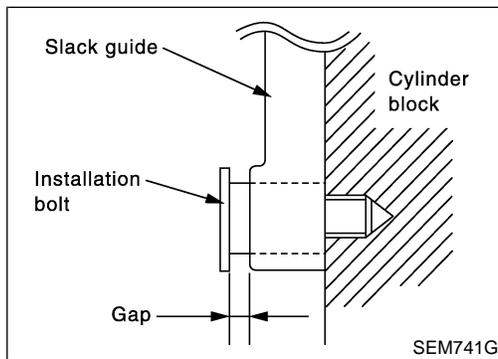
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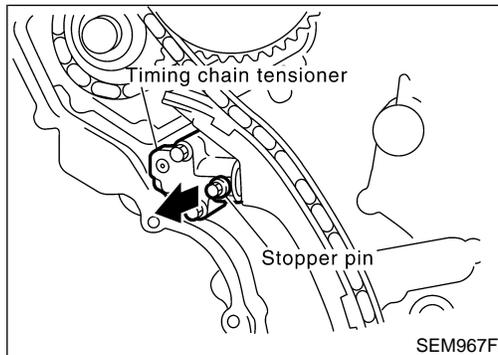
Installation (Cont'd)



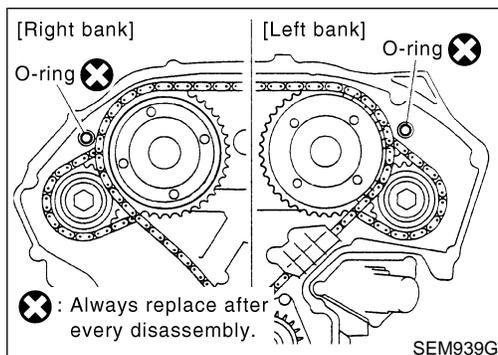
13. Install internal guide.
14. Install upper tension guide and slack guide.



- Do not overtighten the slack guide mounting bolts. It is normal for a gap to exist under the bolt seats when the mounting bolts are tightened to specification.



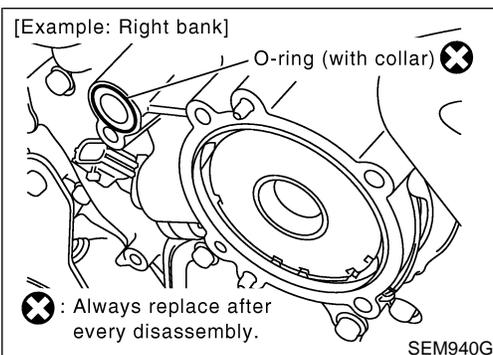
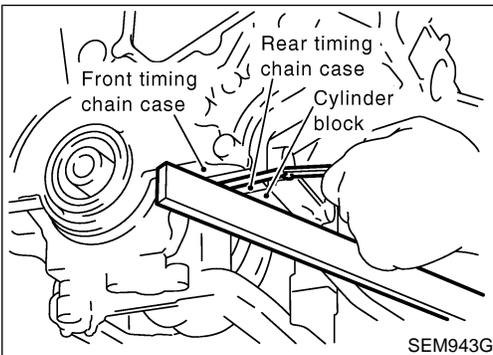
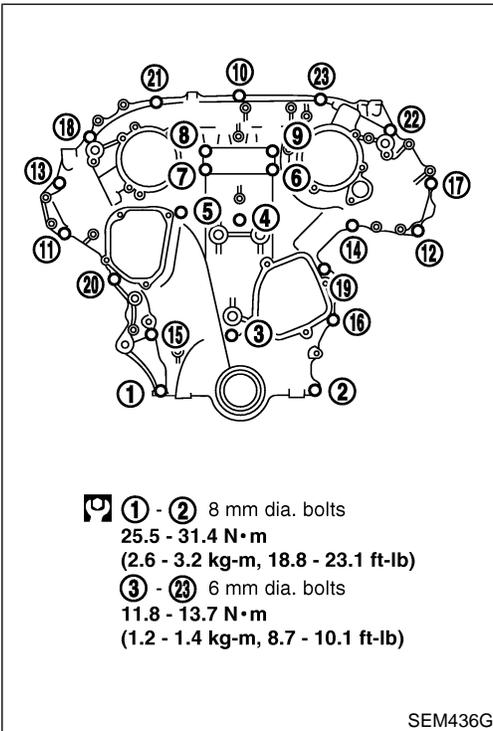
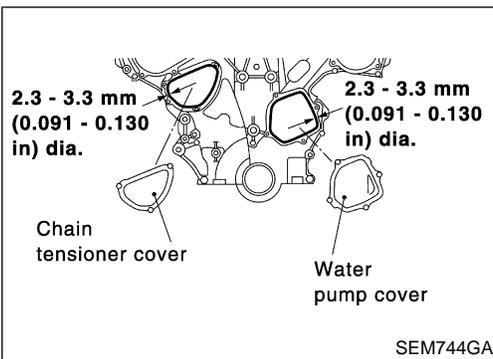
15. Install timing chain tensioner, then remove the stopper pin.
- **When installing the timing chain tensioner, engine oil should be applied to the oil hole and tensioner.**



16. Install O-rings on rear timing chain case.

TIMING CHAIN

Installation (Cont'd)



17. Install the water pump cover and the chain tensioner cover to front timing chain case if removed.

- Apply RTV silicone sealant or equivalent. Refer to GI-53, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS".

18. Install new front oil seal, then apply liquid gasket to front timing chain case.

- Refer to "OIL SEAL INSTALLATION DIRECTION", EM-43.
- Refer to "POSITION FOR APPLYING LIQUID GASKET", EM-25.

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

19. Install rear timing chain case pin into dowel pin hole on front timing chain case.

20. Tighten bolts to the specified torque in order shown in the figure.

- **Leave the bolts unattended for 30 minutes or more after tightening.**

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

Standard

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

- If not within standard, repeat above installation procedure.

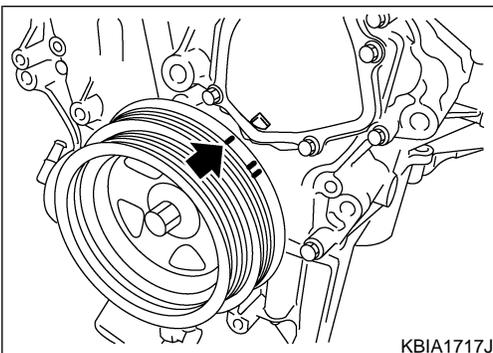
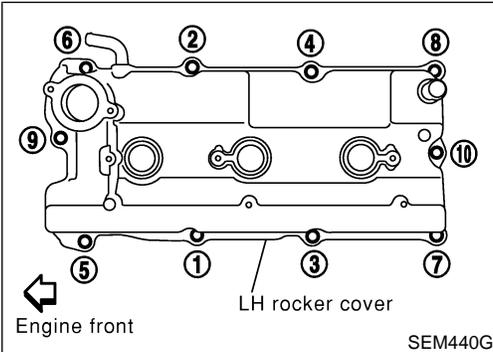
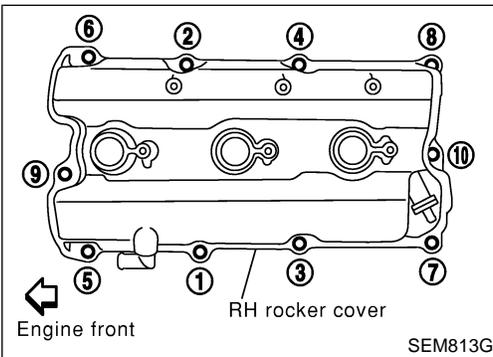
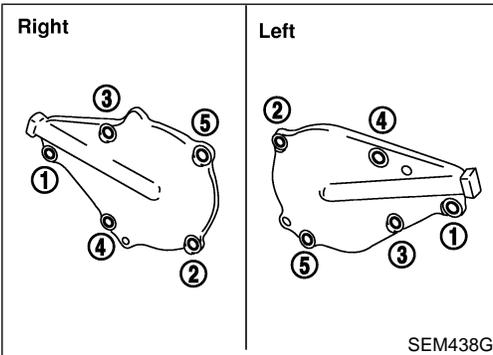
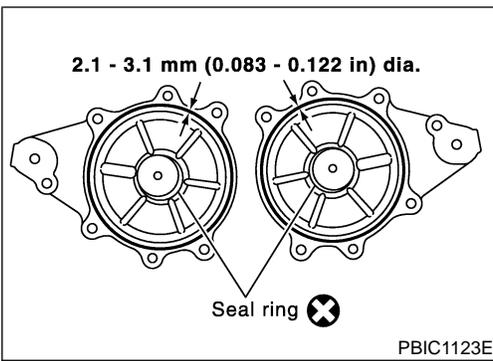
22. Install LH and RH intake valve timing control covers.

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

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TIMING CHAIN

Installation (Cont'd)



- b. Install seal ring at intake valve timing control covers.
- c. Apply liquid gasket to intake valve timing control covers. Use genuine RTV silicone sealant or equivalent. Refer to GI-53.
- d. Being careful not to move the seal ring from the installation groove, align the dowel pins on the chain case with the holes to install the intake valve timing control cover.

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

23. Install RH and LH rocker covers.

Rocker cover tightening procedure:

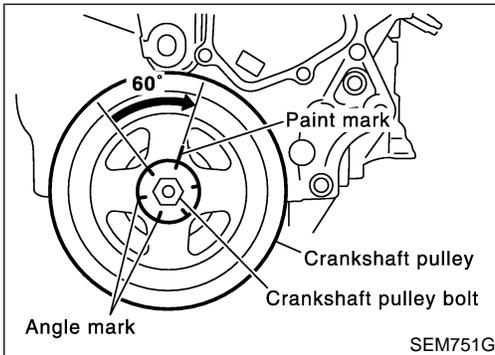
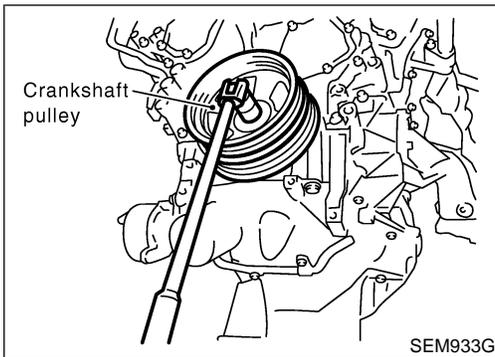
- **Tighten in numerical order as shown in the figure.**
 - a. Tighten bolts 1 to 10 in that order to 6.9 to 8.8 N·m (0.7 to 0.9 kg-m, 61 to 78 in-lb).
 - b. Then tighten bolts 1 to 10 as indicated in figure to 6.9 to 8.8 N·m (0.7 to 0.9 kg-m, 61 to 78 in-lb).
- 24. Hang engine using the right and left side engine slingers with a suitable hoist.
- 25. Set a suitable transmission jack under the suspension member.
- 26. Remove right and left side engine mounting nuts.
- 27. Remove right and left side suspension member bolts.
- 28. Install oil pan. Refer to EM-22, "Installation".
- 29. Set ring gear stopper using the mounting bolt hole.
 - Be careful not to damage the signal plate teeth.

30. Install crankshaft pulley to crankshaft.

- Align pointer with TDC mark on crankshaft pulley.

TIMING CHAIN

Installation (Cont'd)



31. Install crankshaft pulley bolt.
 - **Lubricate thread and seat surface of the bolt with new engine oil.**
 - a. Tighten to 39 to 49 N·m (4.0 to 5.0 kg·m, 29 to 36 ft·lb).
 - b. Put a paint mark on the crankshaft pulley.
- c. Again tighten by turning 60° to 66°, about the angle from one hexagon bolt head corner to another.
32. Install camshaft position sensors (PHASE), crankshaft position sensor (POS).
33. Reinstall removed parts in the reverse order of removal.
 - When installing fuel tube and intake manifold collectors, refer to EM-12, "TIGHTENING PROCEDURES".
 - **Check oil level. Refer to MA-18, "Changing Engine Oil".**
 - **After starting engine, keep idling for three minutes. Then rev engine up to 3,000 rpm under no load to purge air from the high-pressure chamber of the chain tensioners. The engine may produce a rattling noise. This indicates that air still remains in the chamber and is not a matter of concern.**

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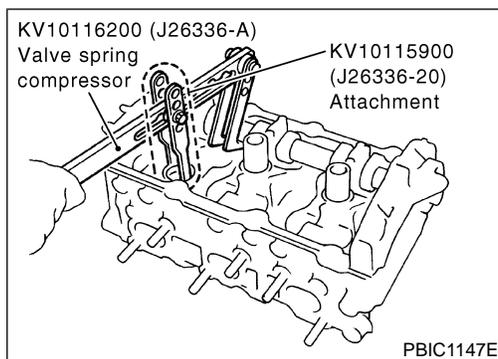
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OIL SEAL

Replacement



Replacement

NAEM0015

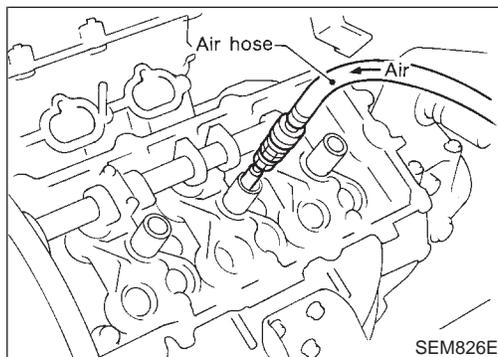
CAUTION:

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

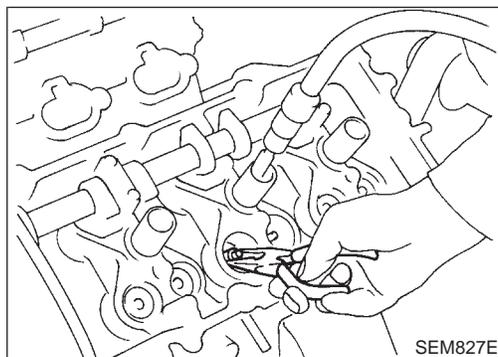
VALVE OIL SEAL

NAEM0015S01

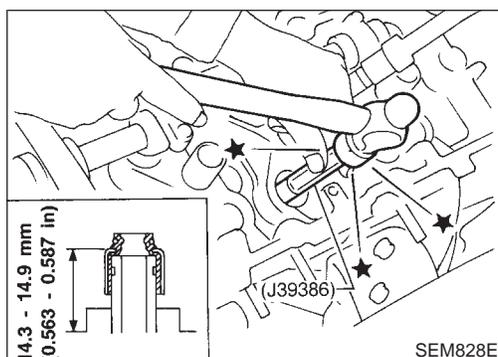
1. Remove timing chain. Refer to "Removal", EM-27.
2. Remove camshaft brackets and camshaft. Refer to "Removal", EM-45.
3. Remove valve lifters.
4. Remove valve spring with Tool.
Before removing valve spring, fix valve as follows.
Piston concerned should be set at TDC to prevent valve from falling.



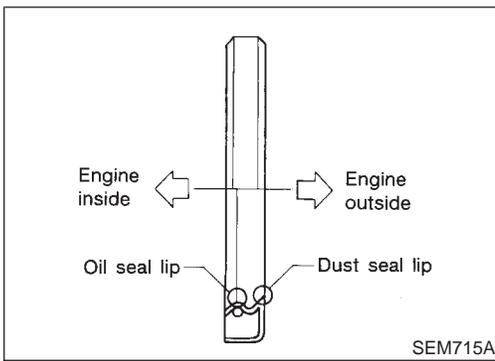
Remove spark plug, then install air hose adapter into spark plug hole and apply air pressure to hold valves in place. Apply a pressure of 490 kPa (5 kg/cm², 71 psi).



5. Remove valve oil seal.



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



OIL SEAL INSTALLATION DIRECTION

NAEM0015S02

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

GI

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NAEM0015S03

FRONT OIL SEAL

1. Remove the following parts:

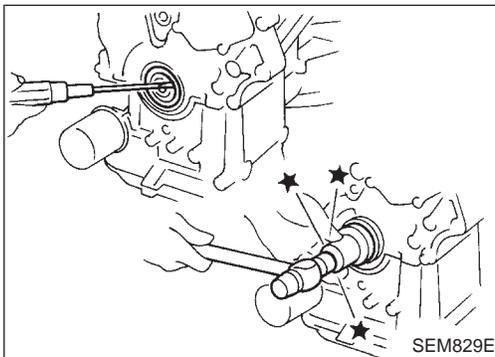
- Engine undercover
- Suspension member stay
- Drive belts
- Crankshaft pulley: Refer to EM-27, "Removal".
- Radiator: Refer to LC-22, "REMOVAL AND INSTALLATION".
- Cooling fan

FE

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2. Remove front oil seal using a suitable tool.

Be careful not to scratch front cover.

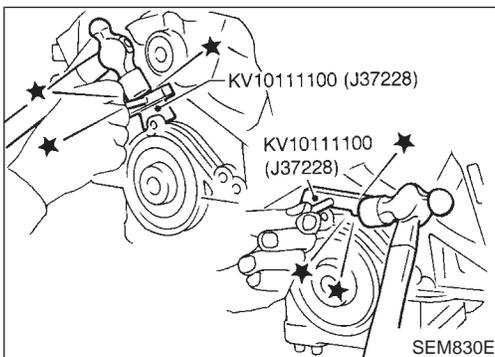
3. Apply engine oil to new oil seal and install it using a suitable tool until its front end is level with front end of front cover.

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SU



REAR OIL SEAL

NAEM0015S04

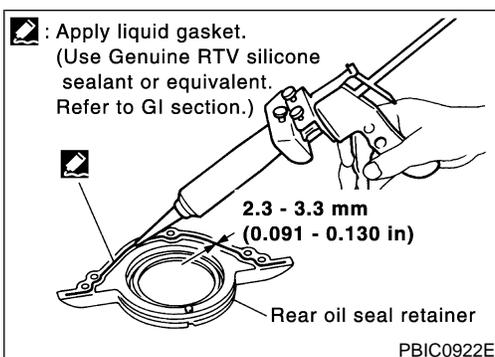
1. Remove transmission. Refer to MT-7 or AT-273, "Removal".
2. Remove flywheel or drive plate.
3. Remove oil pan. Refer to EM-19.
4. Remove rear oil seal retainer.

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5. Apply liquid gasket to rear oil seal retainer.

- Assembly should be done within 5 minutes after coating.

HA

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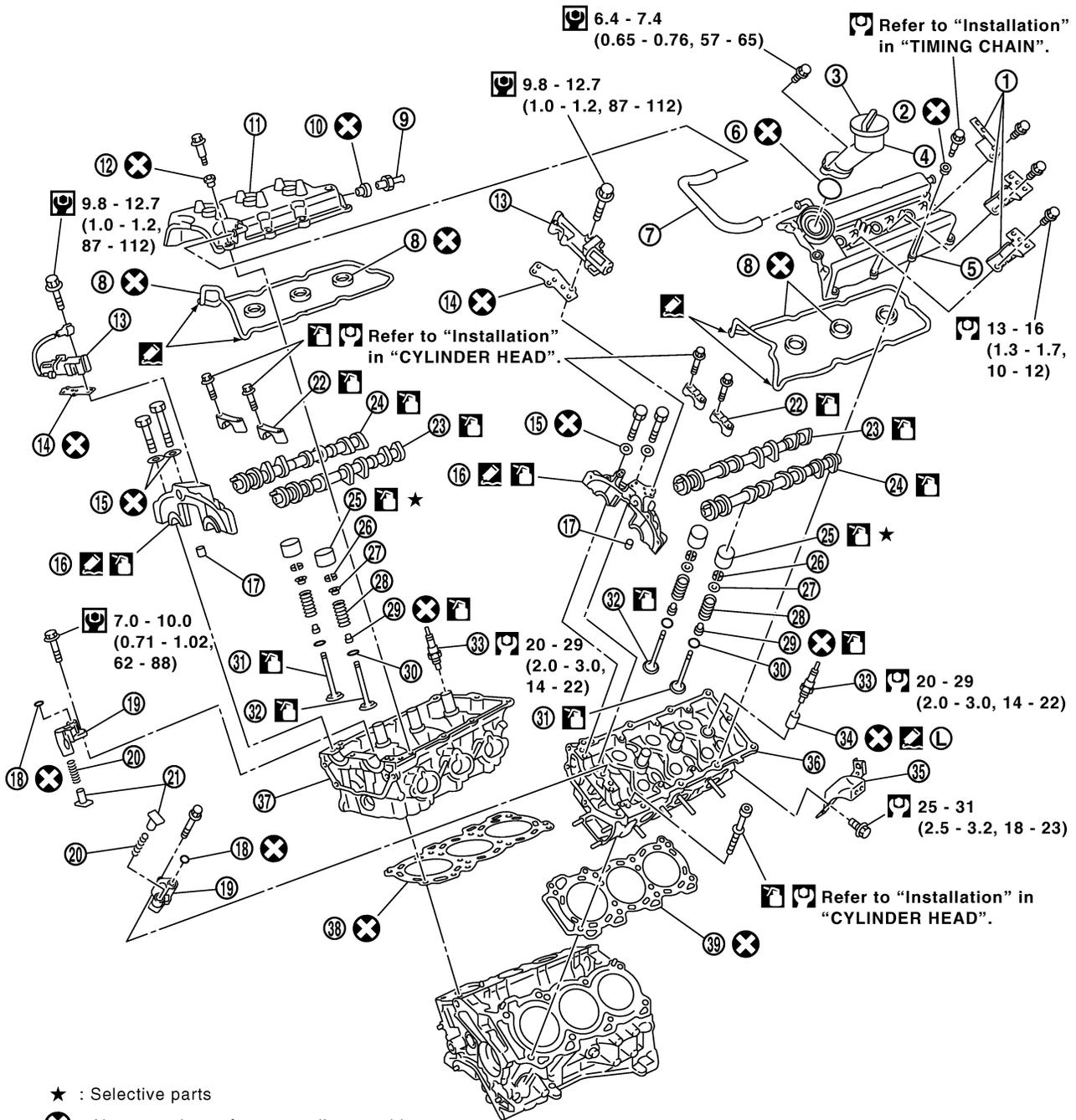
EL

IDX

CYLINDER HEAD

Components

SEC. 111•118•130•140•220



★ : Selective parts

⊗ : Always replace after every disassembly.

▣ : Apply Genuine RTV Silicone Sealant or equivalent. Refer to GI section.

▣ L : Apply Genuine High Strength Locking Sealant or equivalent. Refer to GI section.

▣ : Lubricate with new engine oil.

⊞ : N·m (kg-m, ft-lb)

⊞ : N·m (kg-m, in-lb)

CYLINDER HEAD

Components (Cont'd)

1. Bracket	14. Gasket	27. Valve spring retainer	GI
2. Washer	15. Seal washer	28. Valve spring	
3. Oil filler cap	16. Camshaft bracket (No. 1)	29. Valve oil seal	
4. Oil filler tube	17. Dowel pin	30. Valve spring seat	MA
5. LH rocker cover	18. O-ring	31. Valve (EXH)	
6. O-ring	19. Chain tensioner	32. Valve (INT)	
7. PCV hose	20. Spring	33. Spark plug	EM
8. Gasket	21. Tensioner sleeve	34. Spark plug tube	
9. PCV valve	22. Camshaft bracket (No. 2 to No. 4)	35. Engine rear lower slinger	
10. Gasket	23. Camshaft (INT)	36. Cylinder head (left bank)	LC
11. RH rocker cover	24. Camshaft (EXH)	37. Cylinder head (right bank)	
12. Washer	25. Valve lifter	38. Cylinder head gasket (right bank)	
13. Intake valve timing control solenoid valve	26. Valve collet	39. Cylinder head gasket (left bank)	EC

CAUTION:

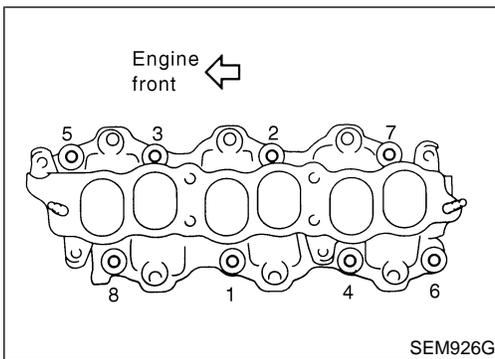
- When installing camshafts, chain tensioners, oil seals, or other sliding parts, lubricate contacting surfaces with new engine oil.
- Apply new engine oil to threads and seat surfaces when installing cylinder head, camshaft sprocket, crankshaft pulley, and camshaft bracket.
- Attach tags to valve lifters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

Removal

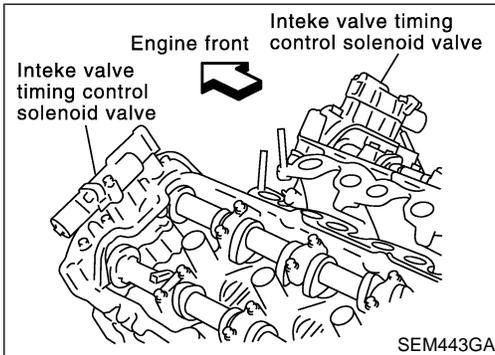
1. Release fuel pressure. Refer to EC-56, "Fuel pressure release".
2. Drain engine coolant and engine oil.
3. Remove the following parts.
 - Battery
 - Engine undercover
 - Radiator shroud
 - Radiator: Refer to LC-22, "REMOVAL AND INSTALLATION".
 - Cooling fan
 - Drive belts
4. Remove exhaust front tubes. Refer to FE-9, "EXHAUST SYSTEM".
5. Remove exhaust manifolds in reverse order of installation. Refer to EM-13, "Exhaust Manifold".
6. Remove aluminum oil pan. Refer to EM-19, "Removal".
7. Remove front timing chain case, timing chain and rear timing chain case. Refer to EM-27, "Removal".

CYLINDER HEAD

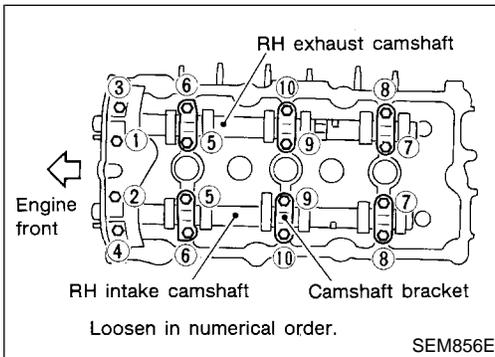
Removal (Cont'd)



8. Remove intake manifold in reverse order of illustration.
9. Remove water outlet.



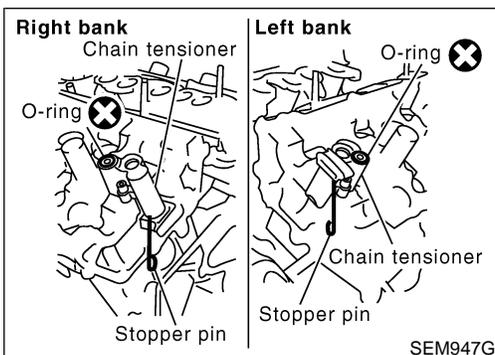
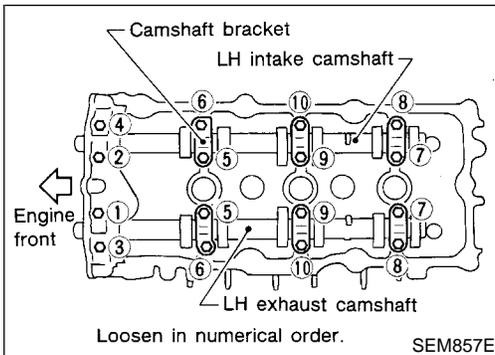
10. Remove intake valve timing control solenoid valves.



11. Remove intake and exhaust camshafts and camshaft brackets.
 - Equally loosen camshaft bracket bolts in several steps in the numerical order shown in the figure.

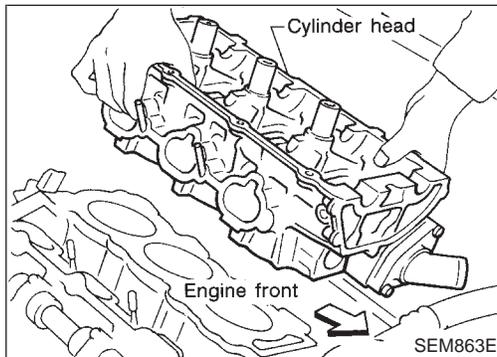
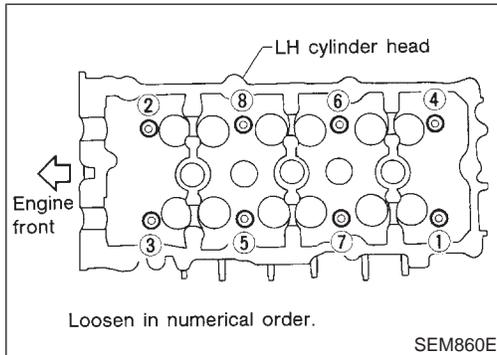
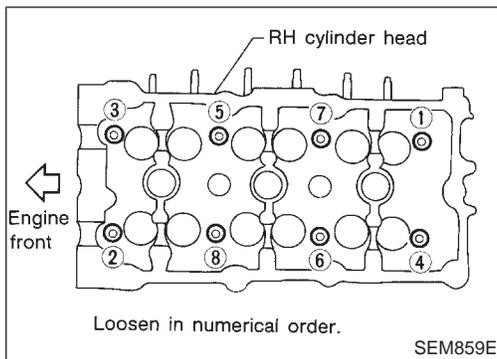
For reinstallation, be sure to put marks on camshaft bracket before removal.

12. Remove valve lifters.
 - Identify installation positions, and store them without mixing them up.



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

- Remove chain tensioner with its stopper pin attached.
- Stopper pin was attached when secondary timing chain was removed.



14. Remove cylinder head bolts.

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

15. Remove cylinder head.

Disassembly

1. Remove spark plug with spark plug wrench (commercial service tool).
2. Remove valve component parts. Refer to EM-42, "VALVE OIL SEAL".
 - Check the clearance before removing the valve guide. Refer to EM-50, "VALVE GUIDE CLEARANCE".
3. Remove spark plug tube, as necessary.
 - Using a pair of pliers, pull spark plug tube out of cylinder head.

CAUTION:

- Take care not to damage cylinder head.
- Once removed, a spark plug tube will be deformed and cannot be reused. Do not remove it unless absolutely necessary.

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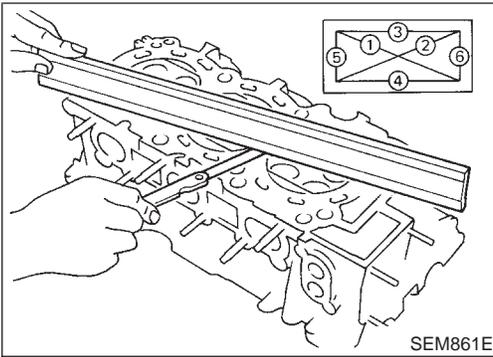
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CYLINDER HEAD

Inspection



Inspection

CYLINDER HEAD DISTORTION

NAEM0019

NAEM0019S01

Clean surface of cylinder head.

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

Check along six positions shown in the figure.

Head surface flatness: Limit 0.1 mm (0.004 in)

If beyond the specified limit, resurface or replace it.

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

Resurfacing limit:

Amount of cylinder head resurfacing is "A".

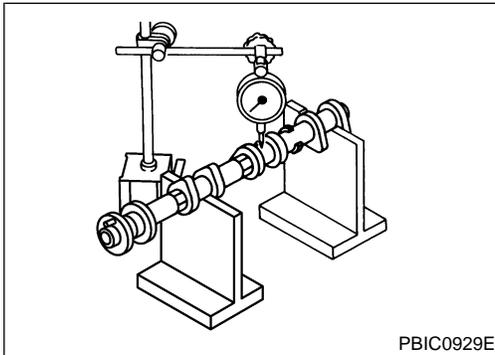
Amount of cylinder block resurfacing is "B".

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

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

Nominal cylinder head height:

126.3 - 126.5 mm (4.972 - 4.980 in)



CAMSHAFT VISUAL CHECK

NAEM0019S02

Check camshaft for scratches, seizure and wear.

CAMSHAFT RUNOUT

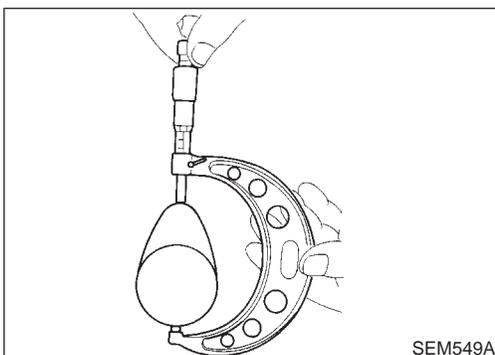
NAEM0019S03

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

Runout (Total indicator reading):

Limit 0.05 mm (0.0020 in)

4. If it exceeds the limit, replace camshaft.



CAMSHAFT CAM HEIGHT

NAEM0019S04

1. Measure camshaft cam height.

Standard cam height:

Intake and exhaust

44.465 - 44.655 mm (1.7506 - 1.7581 in)

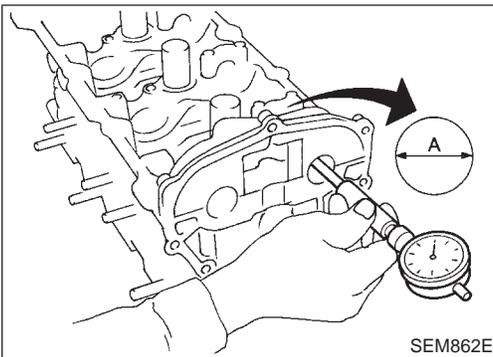
Cam wear limit:

0.2 mm (0.008 in)

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

CYLINDER HEAD

Inspection (Cont'd)



CAMSHAFT JOURNAL CLEARANCE

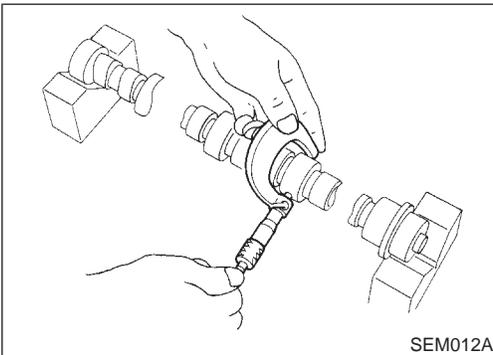
NAEM0019S05

1. Install camshaft bracket and tighten bolts to the specified torque.
2. Measure inner diameter "A" of camshaft bearing.

Standard inner diameter:

No. 1: 26.000 - 26.021 mm (1.0236 - 1.0244 in)

No. 2, 3, 4: 23.500 - 23.521 mm (0.9252 - 0.9260 in)



3. Measure outer diameter of camshaft journal.

Standard outer diameter:

No. 1: 25.935 - 25.955 mm (1.0211 - 1.0218 in)

No. 2, 3, 4: 23.445 - 23.465 mm (0.9230 - 0.9238 in)

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

Camshaft journal clearance:

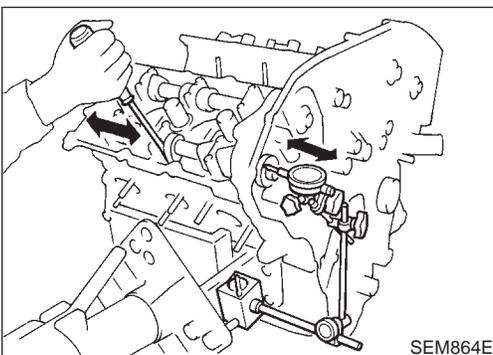
Standard

No. 1: 0.045 - 0.086 mm (0.0018 - 0.0034 in)

No. 2, 3, 4: 0.035 - 0.076 mm (0.0014 - 0.0030 in)

Limit

0.15 mm (0.0059 in)



CAMSHAFT END PLAY

NAEM0019S06

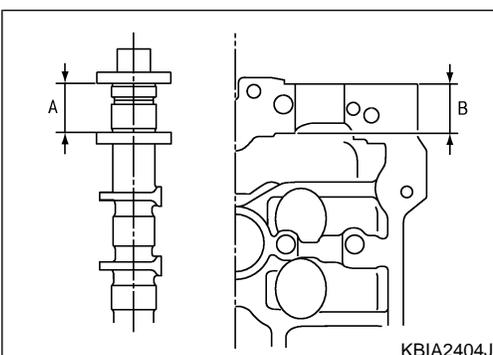
1. Install dial indicator in thrust direction on front end of camshaft. Measure the end play of dial indicator when camshaft is moved forward/backward (in direction to axis).

Standard

0.115 - 0.188 mm (0.0045 - 0.0074 in)

Limit

0.24 mm (0.0094 in)



2. Measure the following parts if out of the limit.

- Dimension "A" for camshaft No. 1 journal

Standard

27.500 - 27.548 mm (1.0827 - 1.0846 in)

- Dimension "B" for cylinder head No. 1 journal bearing

Standard

27.360 - 27.385 mm (1.0772 - 1.0781 in)

3. Refer to the standards above, and then replace camshaft and/or cylinder head.

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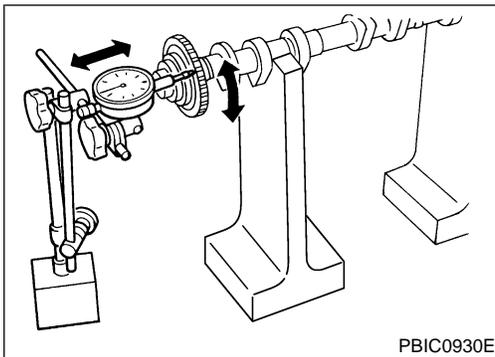
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CYLINDER HEAD

Inspection (Cont'd)



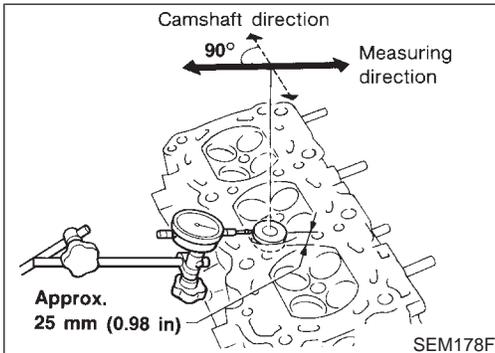
CAMSHAFT SPROCKET RUNOUT

NAEM0019S07

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

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

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

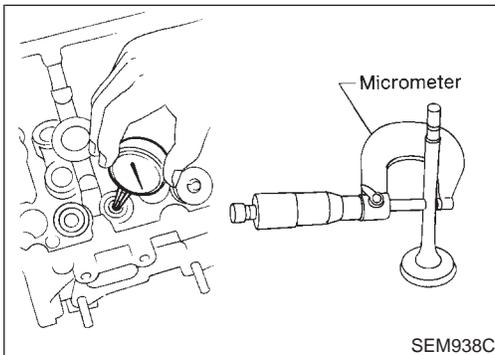


VALVE GUIDE CLEARANCE

NAEM0019S08

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

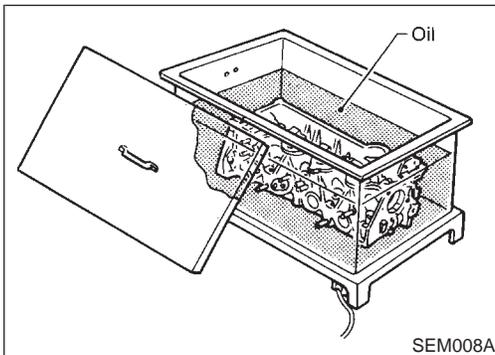
**Valve deflection limit (Dial gauge reading):
Intake 0.24 mm (0.0094 in)
Exhaust 0.28 mm (0.0110 in)**



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

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

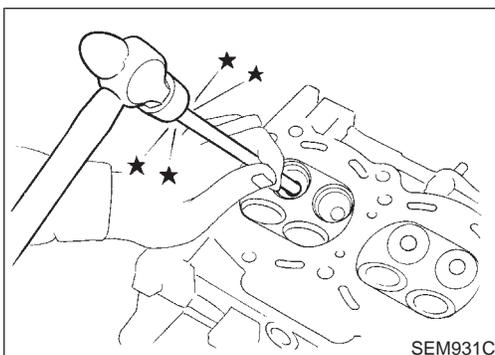
- c. If it exceeds the limit, replace valve or valve guide.



VALVE GUIDE REPLACEMENT

NAEM0019S09

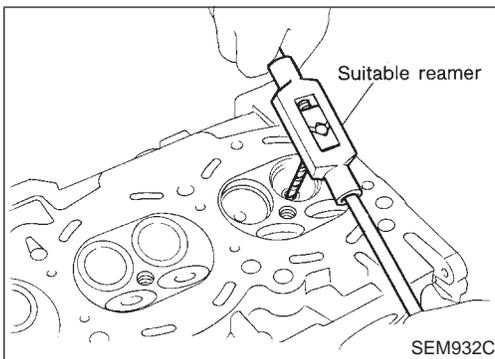
1. To remove valve guide, heat cylinder head to 110 to 130°C (230 to 266°F) by soaking in heated oil.



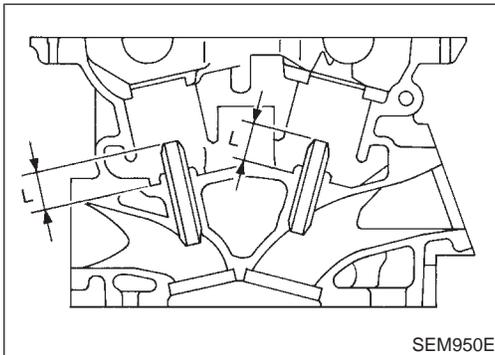
2. Drive out valve guide with a press [under a 20 kN (2 ton, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.

CAUTION:

Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.

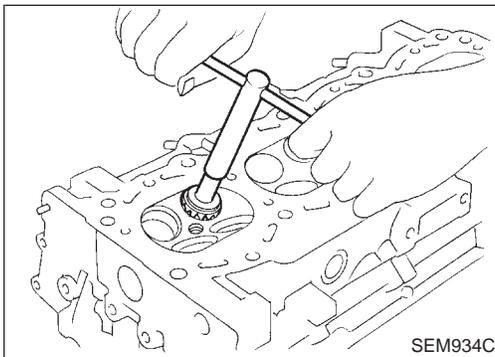


3. Ream cylinder head valve guide hole.
Valve guide hole diameter (for service parts):
10.175 - 10.196 mm (0.4006 - 0.4014 in)



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

CAUTION:
Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.

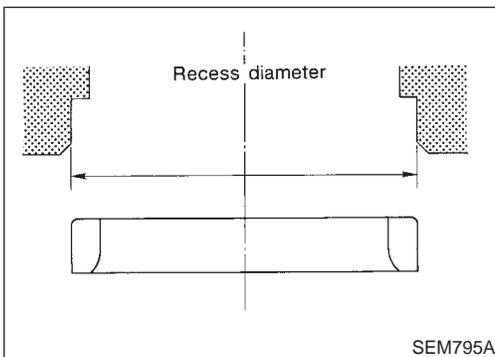


5. Ream valve guide.
Finished size:
6.000 - 6.018 mm (0.2362 - 0.2369 in)

VALVE SEATS

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

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



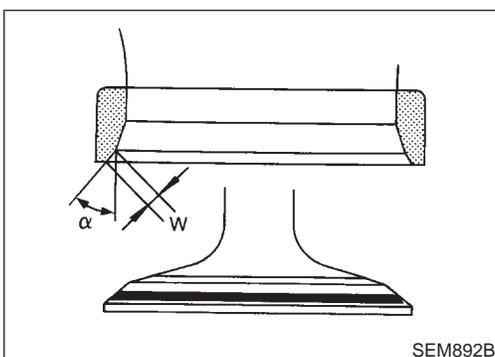
REPLACING VALVE SEAT FOR SERVICE PARTS

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 for service valve seat.

Upsize [0.5 mm (0.020 in)]:
Intake 38.500 - 38.516 mm (1.5157 - 1.5164 in)
Exhaust 32.700 - 32.716 mm (1.2874 - 1.2880 in)

Be sure to ream in circles concentric to the valve guide center.

This will enable valve seat to fit correctly.



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

CAUTION:
Cylinder head contains heat. When working, wear protective equipment to avoid getting burned.

5. Cut or grind valve seat using suitable tool to the specified dimensions as shown in SDS (EM-85).
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

Seat face angle "α": 45°

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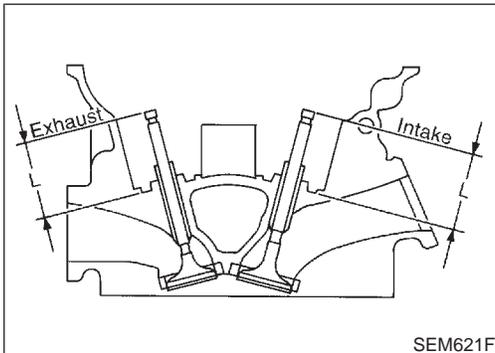
CYLINDER HEAD

Inspection (Cont'd)

Contacting width "W":

Intake 1.09 - 1.31 mm (0.0429 - 0.0516 in)

Exhaust 1.29 - 1.51 mm (0.0508 - 0.0594 in)

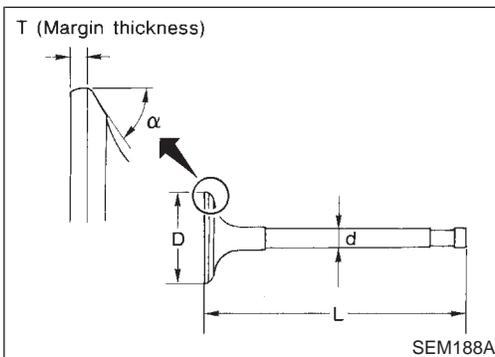


- Use a depth gauge to measure the distance between the mounting surface of the cylinder head spring seat and the valve stem end. If the distance is shorter than specified, repeat step 5 above to adjust it. If it is longer, replace the valve seat with a new one.

Valve seat resurface limit "L":

Intake 41.07 - 41.67 mm (1.6169 - 1.6405 in)

Exhaust 41.00 - 41.60 mm (1.6142 - 1.6378 in)



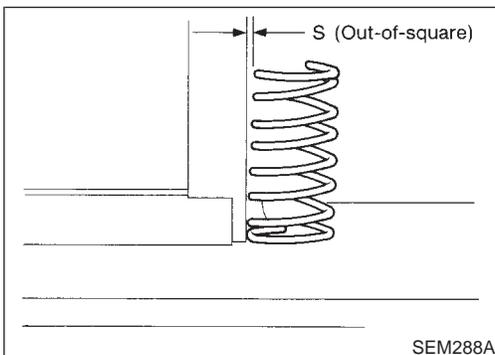
VALVE DIMENSIONS

Check dimensions of each valve. For dimensions, refer to SDS (EM-83).

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.

NAEM0019S12



VALVE SPRING

Squareness

- Measure dimension "S".

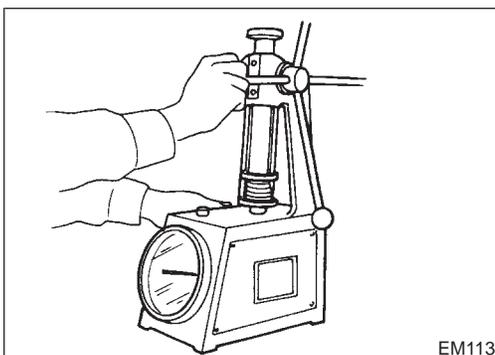
Out-of-square "S":

Less than 2.0 mm (0.079 in)

- If it exceeds the limit, replace spring.

NAEM0019S13

NAEM0019S1301



Pressure

Check valve spring pressure at specified spring height.

Pressure:

Installation

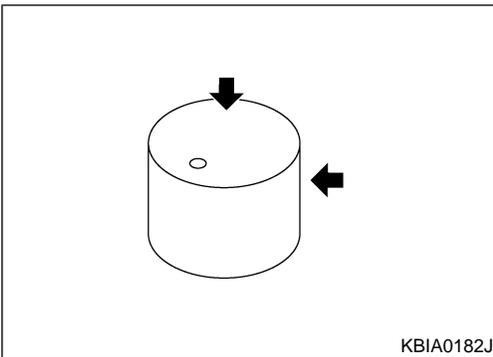
196 N (20.0 kg, 44.1 lb) at height 37.0 mm (1.457 in)

Valve open

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

If it exceeds the limit, replace spring.

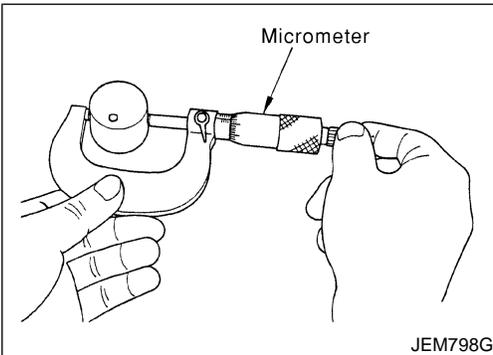
NAEM0019S1302



VALVE LIFTER

NAEM0019S14

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



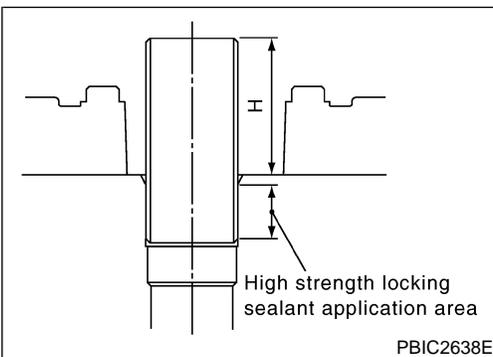
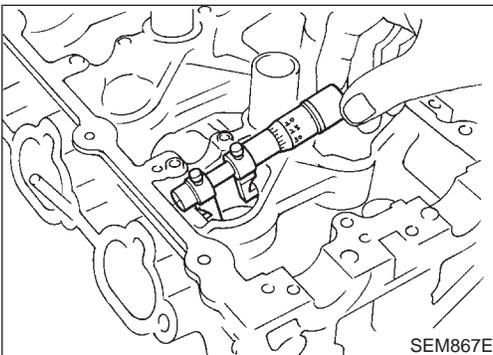
2. Check diameter of valve lifter and valve lifter guide bore.

Valve lifter outer diameter:

33.977 - 33.987 mm (1.3377 - 1.3381 in)

Lifter guide bore diameter:

34.000 - 34.016 mm (1.3386 - 1.3392 in)



Assembly

NAEM0020

1. Install spark plug tube.
 - Press-fit spark plug tube following procedure below.
 - a. Remove old liquid gasket adhering to cylinder-head mounting hole.
 - b. Apply liquid gasket to area within approximately 12 mm (0.47 in) from edge of spark plug tube press-fit side.
 - Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-53, "RECOMENDED CHEMICAL PRODUCTS AND SEALANTS".
- c. Using a drift, press-fit spark plug tube so that its height "H" is as specified in the figure.

Standard press-fit height "H":

38.1 - 39.1 mm (1.500 - 1.539 in)

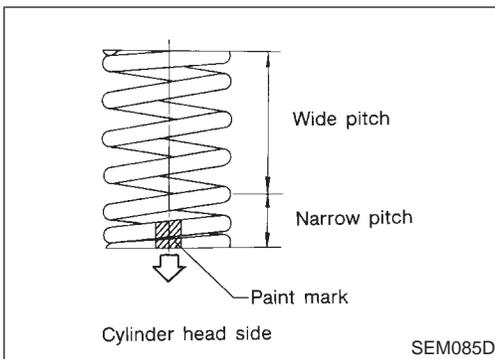
CAUTION:

- When press-fitting, take care not to deform spark plug tube.
- After press-fitting, wipe off liquid gasket protruding onto cylinder-head upper face.

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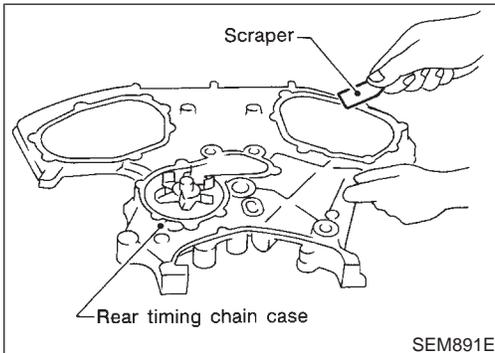
CYLINDER HEAD

Assembly (Cont'd)

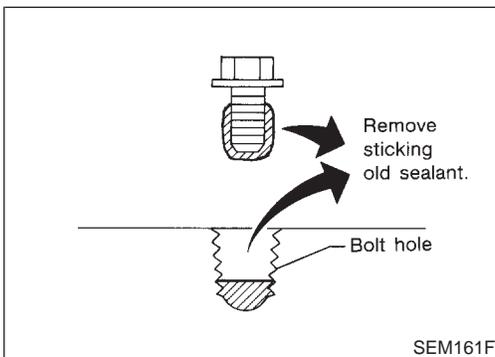


2. Install valve component parts.
 - **Always use new valve oil seal. Refer to "VALVE OIL SEAL", EM-42.**
 - **Before installing valve oil seal, install valve spring seat.**
 - **Install valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side (paint mark).**
 - After installing valve component parts, tap valve stem tip with plastic hammer to assure a proper fit.
3. Install spark plug.

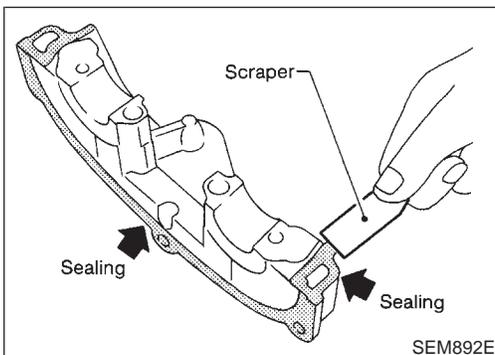
Installation



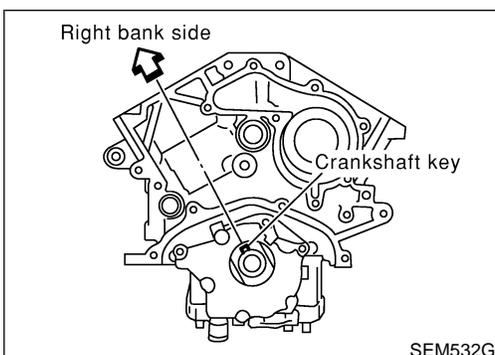
1. Before installing rear timing chain case, remove old liquid gasket from mating surface using a scraper.^{NAEM0021}
 - Also remove old liquid gasket from mating surface of cylinder block.



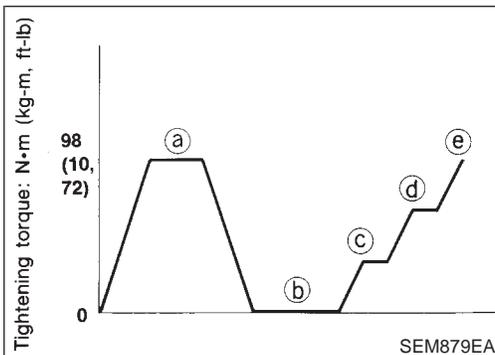
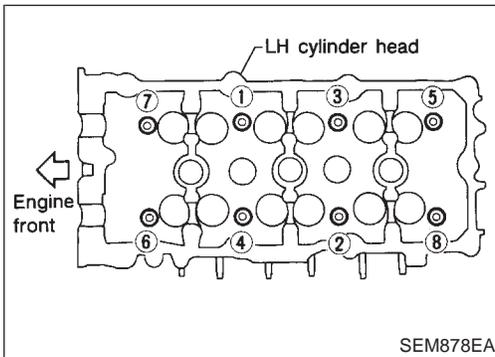
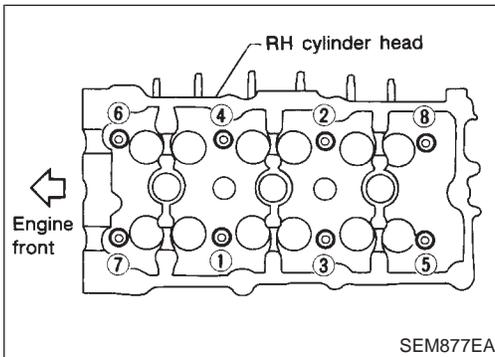
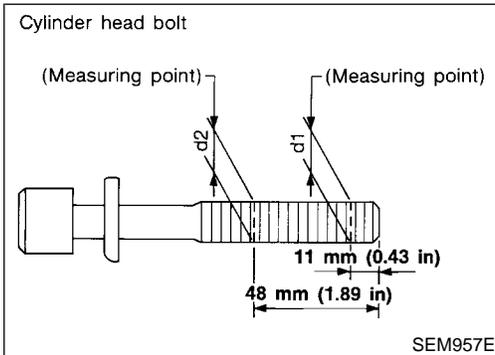
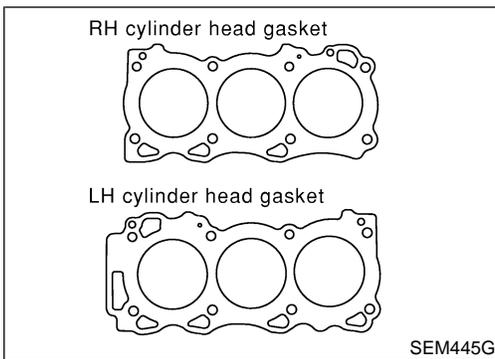
- **Remove old liquid gasket from the bolt hole and thread.**



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



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



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

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

Limit (d1 - d2):
0.11 mm (0.0043 in)

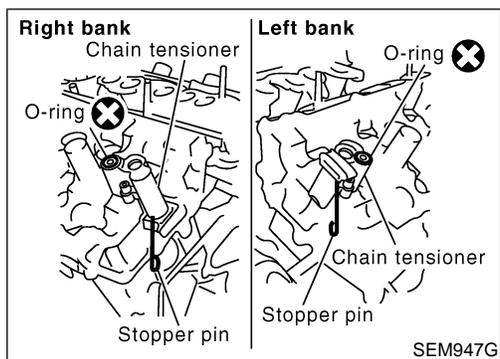
- Lubricate threads and seat surfaces of the bolts with new engine oil.
- If reduction of outer diameter appears in a position other than d2, use it as d2 point.

5. Install cylinder head outside bolts.
 - **Tightening procedure:**
 - a. Tighten all bolts to 98.1 N-m (10 kg-m, 72 ft-lb).
 - b. Completely loosen all bolts in reverse order shown.
 - c. Tighten all bolts to 34.3 to 44.1 N-m (3.5 to 4.4 kg-m, 25 to 33 ft-lb).
 - d. Turn all bolts 90 to 95 degrees clockwise [target: 90 degrees (angle tightening)].
 - e. Turn all bolts 90 to 95 degrees clockwise again [target: 90 degrees (angle tightening)].
 - Tighten in numerical order shown in the figure.

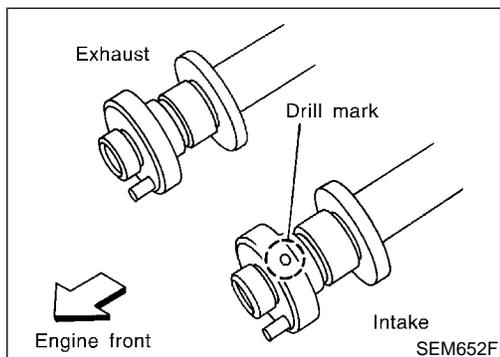
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CYLINDER HEAD

Installation (Cont'd)

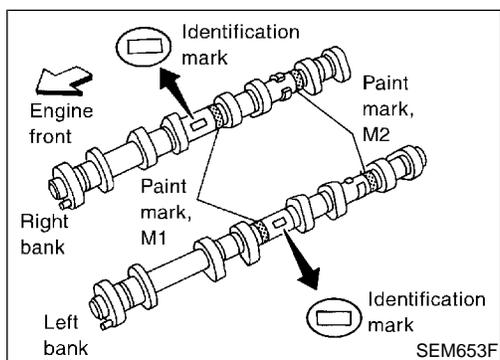


6. Install camshaft chain tensioners on both sides of cylinder head.



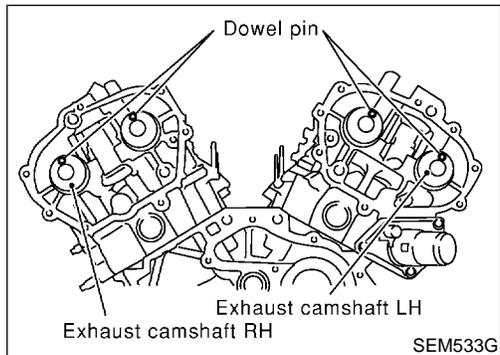
7. Install exhaust and intake camshafts and camshaft brackets.

- Intake camshaft has a drill mark on camshaft sprocket mounting flange. Install it on the intake side.



- Identification marks are present on camshafts.

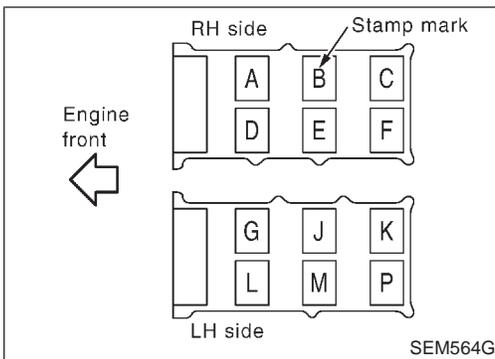
Bank	INT/EXH	ID mark	Drill mark	Paint mark	
				M1	M2
RH	INT	R3	Yes	Yes	No
	EXH	R3	No	No	Yes
LH	INT	L3	Yes	Yes	No
	EXH	L3	No	No	Yes



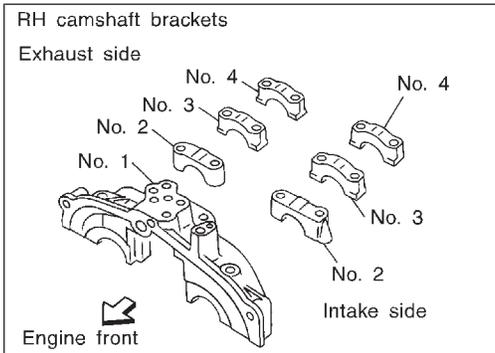
- Position camshaft
RH exhaust camshaft dowel pin at about 10 o'clock
LH exhaust camshaft dowel pin at about 2 o'clock

CYLINDER HEAD

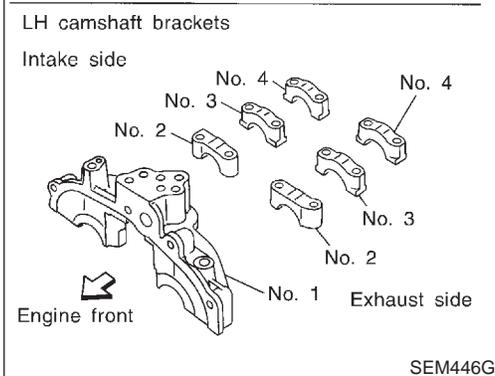
Installation (Cont'd)



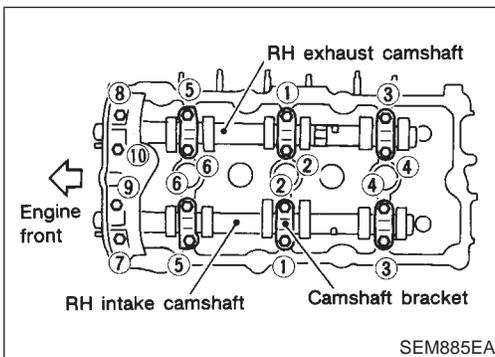
SEM564G



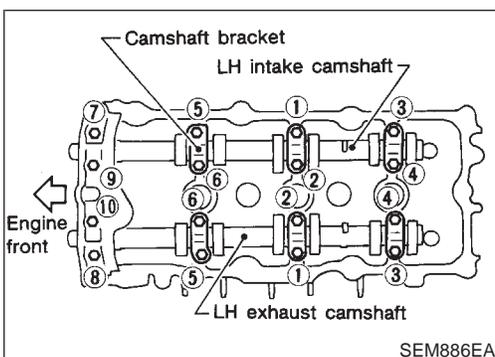
SEM446G



SEM446G



SEM885EA



SEM886EA

8. Before installing camshaft brackets, apply sealant to mating surface of No. 1 journal head.
 - Use Genuine RTV silicone sealant or equivalent. Refer to GI-53.
 - Refer to "POSITION FOR APPLYING LIQUID GASKET", EM-25.
 - Remove foreign material completely from camshaft bracket backside and from cylinder head installation face.
 - Install camshaft brackets in their original positions. Align stamp mark as shown in the figure.
 - If any part of valve assembly or camshaft is replaced, check valve clearance according to reference data. After completing assembly check valve clearance. Refer to "Checking" and "Adjusting" in "VALVE CLEARANCE", EM-58 and 60.

Reference data valve clearance (Cold):

Intake

0.26 - 0.34 mm (0.010 - 0.013 in)

Exhaust

0.29 - 0.37 mm (0.011 - 0.015 in)

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

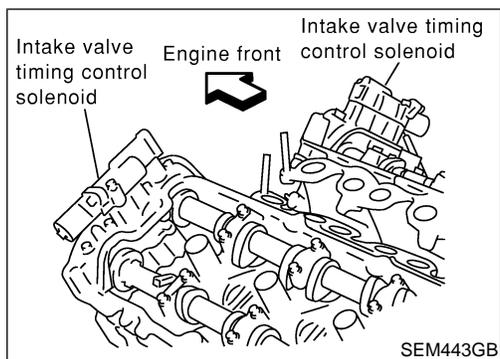
- Tighten the camshaft brackets in the following steps.

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

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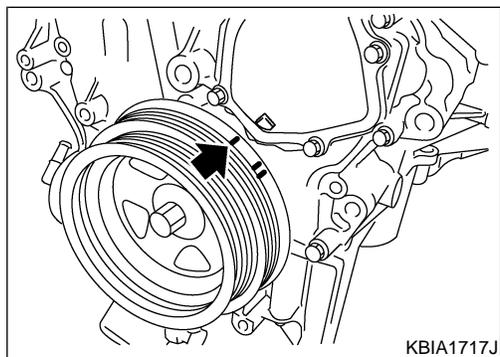
CYLINDER HEAD

Installation (Cont'd)



9. Install intake valve timing control solenoid valves.

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



Valve Clearance

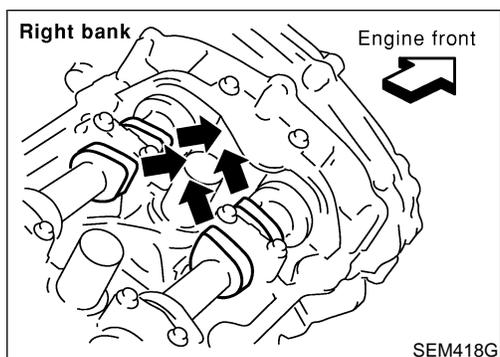
CHECKING

NAEM0022

NAEM0022S01

Check valve clearance while engine is cold and not running.

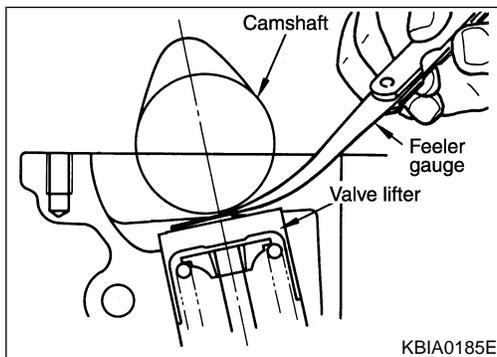
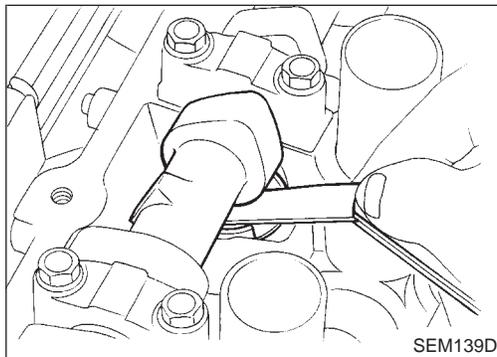
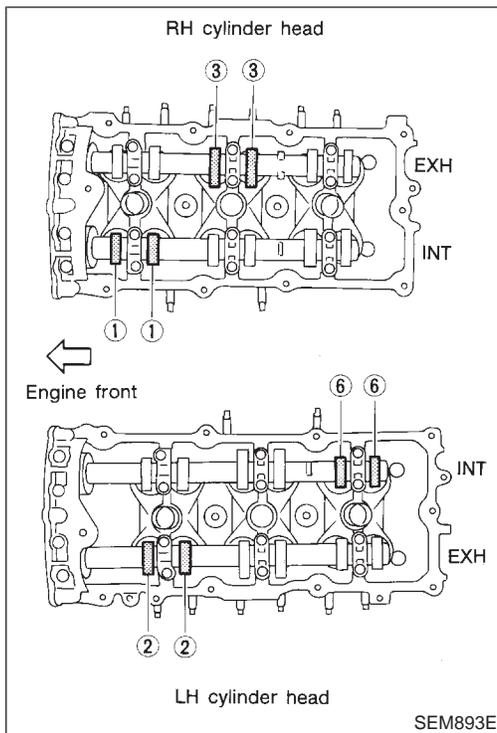
1. Remove engine cover.
2. Remove air duct with air cleaner case, collectors, hoses, harnesses, connectors and so on.
3. Remove upper intake manifold collector. Refer to EM-12, "Upper Intake Manifold Collector".
4. Remove lower intake manifold collector. Refer to EM-13, "Lower Intake Manifold Collector".
5. Remove ignition coils and spark plugs.
6. Remove RH and LH rocker covers.
7. 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.

CYLINDER HEAD

Valve Clearance (Cont'd)



8. Check only those valves shown in the figure.

Measuring position (RH bank)		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.
No. 1 CYL. at TDC	EXH		X	
	INT	X		
Measuring position (LH bank)		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.
No. 1 CYL. at TDC	INT			X
	EXH	X		

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

Valve clearance for checking:

Cold

Intake

0.26 - 0.34 mm (0.010 - 0.013 in)

Exhaust

0.29 - 0.37 mm (0.011 - 0.015 in)

Hot*

Intake

0.304 - 0.416 mm (0.012 - 0.016 in)

Exhaust

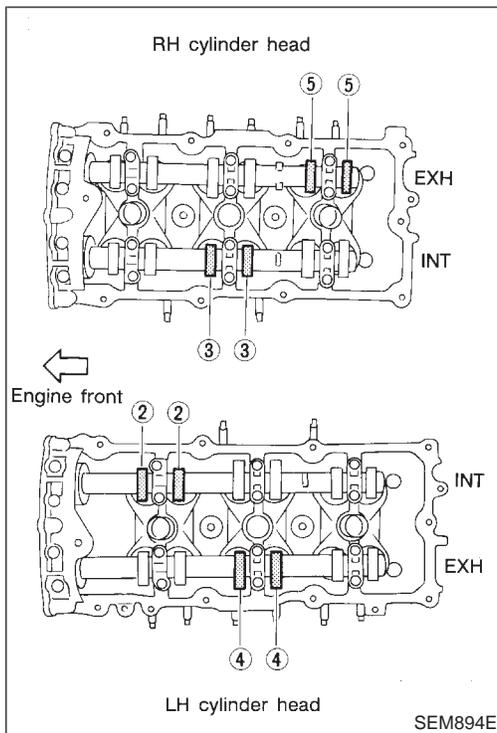
0.308 - 0.432 mm (0.012 - 0.017 in)

*: Approximately 80°C (176°F) (Reference data)

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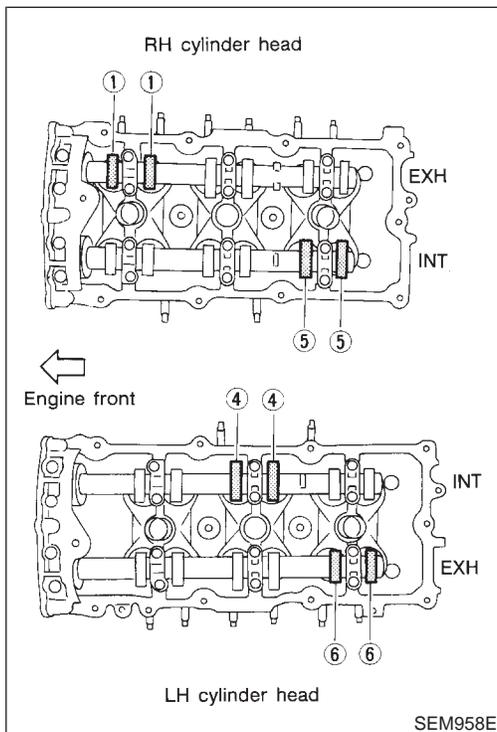
CYLINDER HEAD

Valve Clearance (Cont'd)



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

Measuring position (RH bank)		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.
No. 3 CYL. at TDC	EXH			X
	INT		X	
Measuring position (LH bank)		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.
No. 3 CYL. at TDC	INT	X		
	EXH		X	



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

Measuring position (RH bank)		No. 1 CYL.	No. 3 CYL.	No. 5 CYL.
No. 5 CYL. at TDC	EXH	X		
	INT			X
Measuring position (LH bank)		No. 2 CYL.	No. 4 CYL.	No. 6 CYL.
No. 5 CYL. at TDC	INT		X	
	EXH			X

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

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

ADJUSTING

Adjust valve clearance while engine is cold.

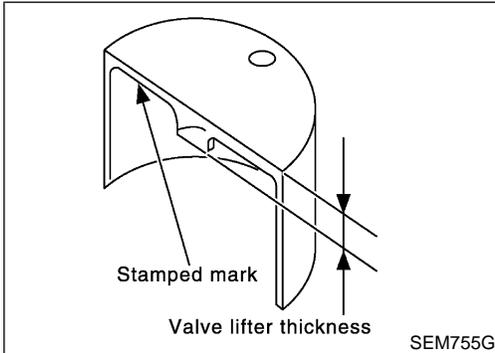
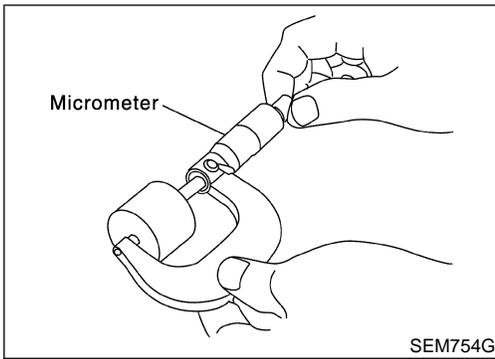
NAEM0022S02

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

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

CYLINDER HEAD

Valve Clearance (Cont'd)



3. Measure center thickness of removed valve lifter with micrometer.
4. Use equation below to calculate valve lifter thickness for replacement.

Valve lifter thickness calculation:

$$\text{Thickness of replacement valve lifter} = t1 + (C1 - C2)$$

t1 = Thickness of removed valve lifter

C1 = Measured valve clearance

C2 = Standard valve clearance:

Intake: 0.30 mm (0.012 in)

Exhaust: 0.33 mm (0.013 in)

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

Unit: mm (in)

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

- Available thickness of valve lifter (Factory setting): 7.88 - 8.40 mm (0.3102 - 0.3307 in) [in 0.02 mm (0.0008 in) step] in 27 sizes (Intake/Exhaust) Refer to EM-84.

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

Valve clearance:

Unit: mm (in)

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

*: Approximately 80°C (176°F)

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Removal and Installation

NAEM0042

WARNING:

- Situate vehicle on a flat and solid surface.
- Place chocks at front and back of rear wheels.
- Do not remove engine until exhaust system has completely cooled off. Otherwise, you may burn yourself and/or fire may break out in fuel line.
- For safety during subsequent steps, the tension of wires should be slackened against the engine.
- Before disconnecting fuel hose, release fuel pressure from fuel line.
Refer to EC-56, "Fuel Pressure Release".
- Before removing front axle from transmission, place safety stands under designated front supporting points. Refer to GI section for lifting points and towing.
- Be sure to hoist engine and transmission 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 brake lines, and brake master cylinder.
- In hoisting the engine, always use engine slingers in a safe manner.
- Before separating engine and transmission, remove crankshaft position sensor (POS) from the assembly.
- Always take extra care not to damage edge of crankshaft position sensor (POS), or ring gear teeth.

ENGINE ASSEMBLY

Removal and Installation (Cont'd)

REMOVAL Front Engine Mounting

NAEM0042S01

NAEM0042S0101

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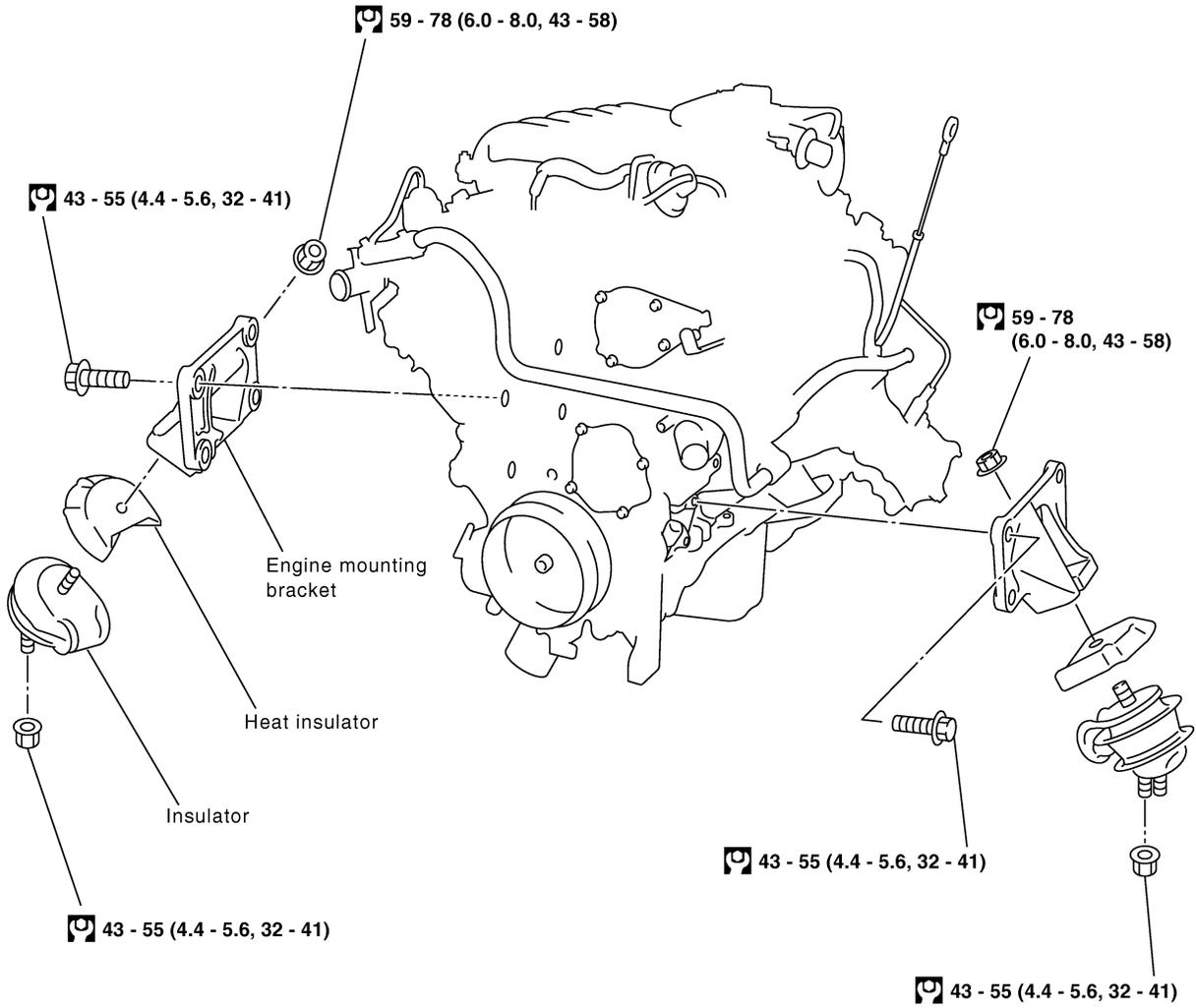
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SEC. 112



: N·m (kg-m, ft-lb)

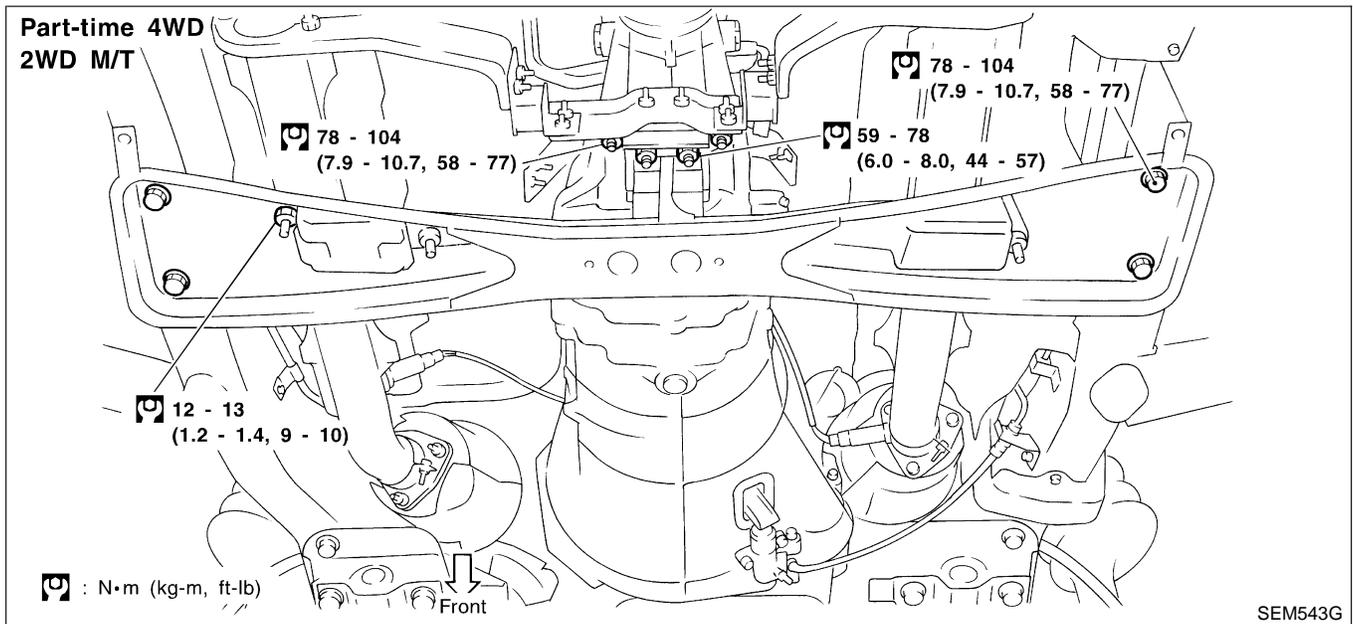
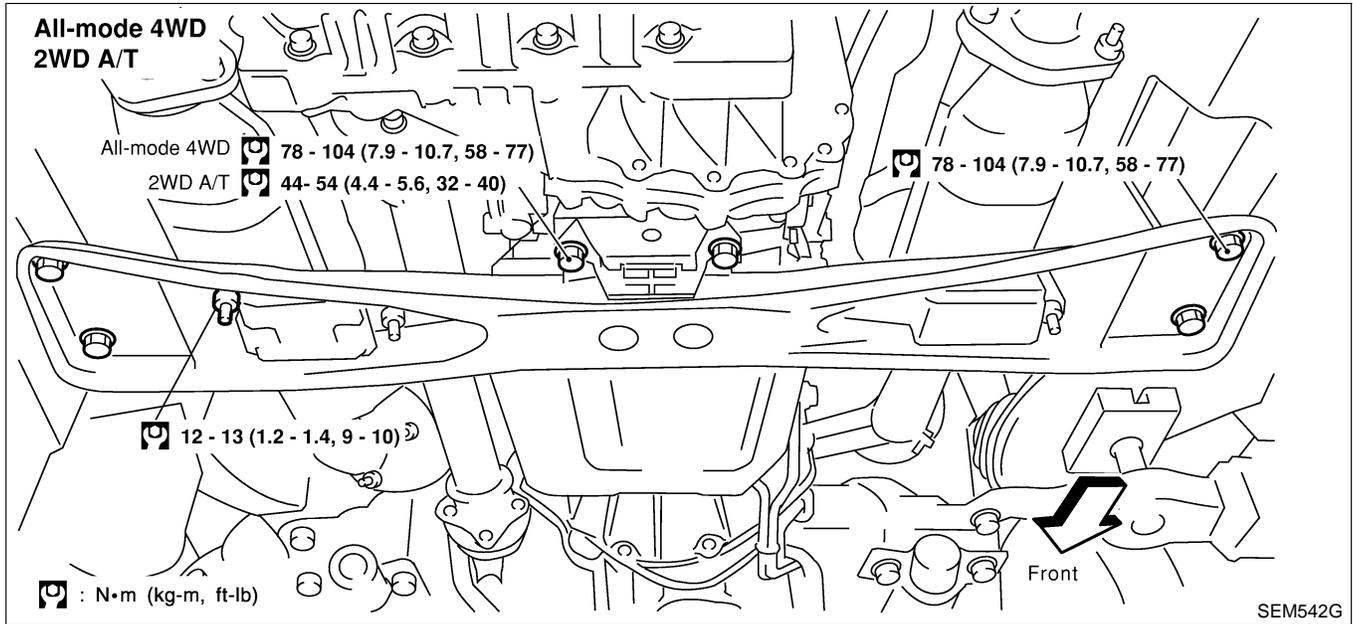
SEM458G

ENGINE ASSEMBLY

Removal and Installation (Cont'd)

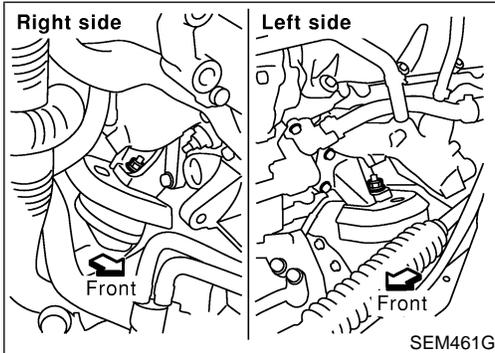
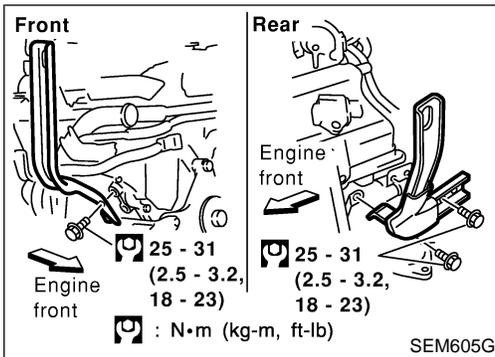
Rear Engine Mounting

NAEM0042S0102



ENGINE ASSEMBLY

Removal and Installation (Cont'd)



1. Release fuel pressure.
Refer to EC-56, "Fuel pressure release".
2. Remove engine hood and front RH and LH wheels.
3. Remove engine undercover and suspension member stay.
4. Drain coolant from radiator.
5. Remove the following parts.
 - Radiator shroud
 - Radiator: Refer to LC-22, "REMOVAL AND INSTALLATION".
 - Cooling fan
 - Drive belts
 - Battery
 - Engine cover
 - Air duct with air cleaner case
6. Disconnect vacuum hoses, fuel hoses, heater hoses, EVAP canister hoses, harnesses, connectors and so on.
7. Remove air conditioner compressor from bracket, then put it aside holding with a suitable wire.
8. Remove power steering oil pump and reservoir tank with bracket, then put it aside holding with a suitable wire.
9. Remove alternator.
10. Remove exhaust front tube heat insulators, then remove rear heated oxygen sensors.
11. Remove exhaust front and rear tubes.
Refer to FE-9, "Removal and Installation".
12. Remove transmission.
Refer to AT-273, MT-7, "Removal".
13. Remove TWC (manifold) heat insulators, then remove TWC (manifold).
14. Install engine slingers.
15. Hoist engine with engine slingers and remove front engine mounting nuts.
16. Remove engine from vehicle.

INSTALLATION

Installation is in the reverse order of removal.

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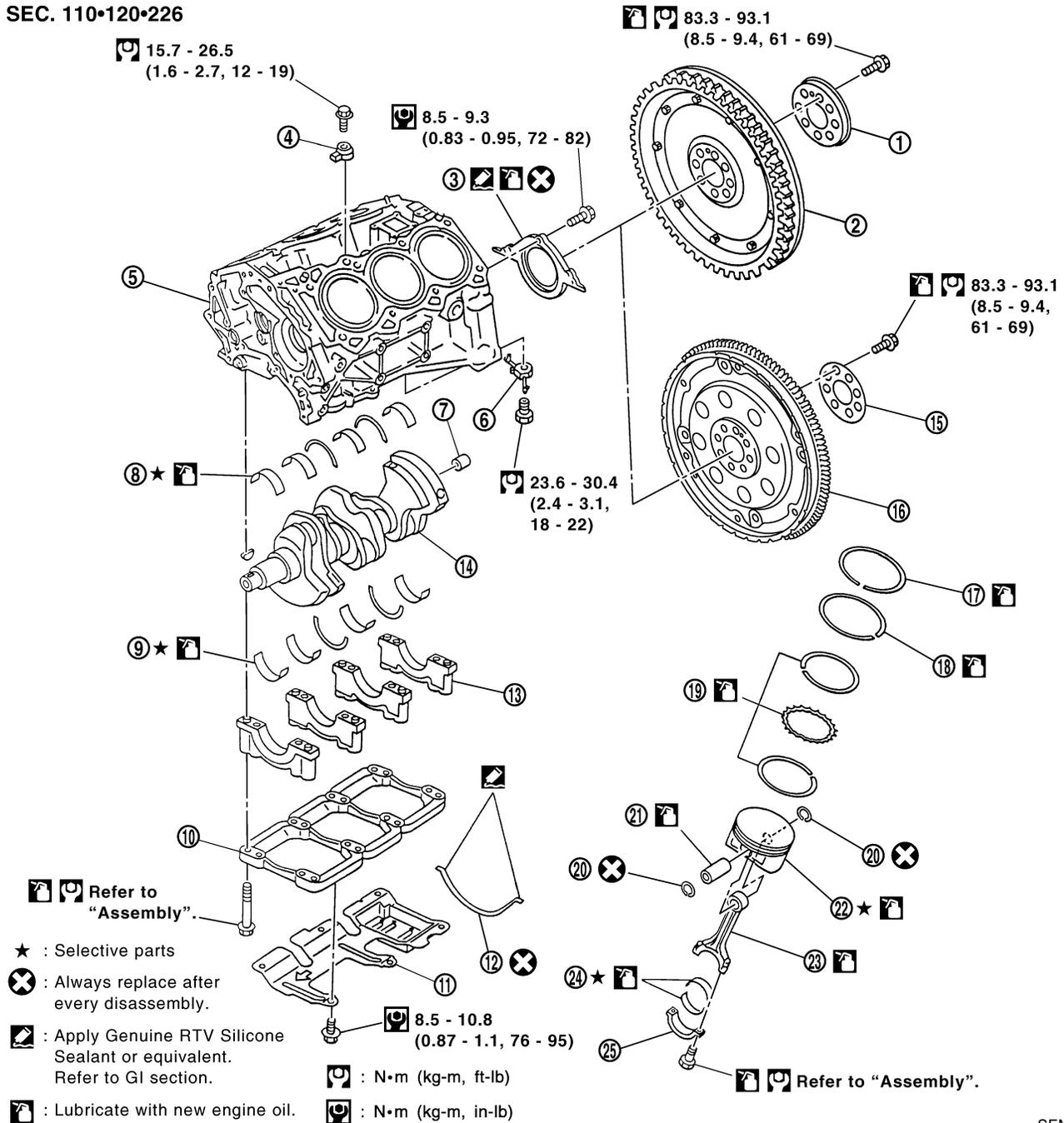
CYLINDER BLOCK

Components

Components

NAEM0024

SEC. 110•120•226



1. Flywheel reinforcement plate (M/T)
2. Flywheel with signal plate (M/T)
3. Rear oil seal retainer
4. Knock sensor
5. Cylinder block
6. Oil jet
7. Pilot bushing (M/T) or pilot converter (A/T)
8. Upper main bearing

9. Lower main bearing
10. Main bearing beam
11. Baffle plate
12. Gasket
13. Main bearing cap
14. Crankshaft
15. Drive plate reinforcement plate (A/T)
16. Drive plate with signal plate (A/T)

17. Top ring
18. 2nd ring
19. Oil ring
20. Snap ring
21. Piston pin
22. Piston
23. Connecting rod
24. Connecting rod bearing
25. Connecting rod bearing cap

SEM201H

CYLINDER BLOCK HEATER

NAEM0024S02

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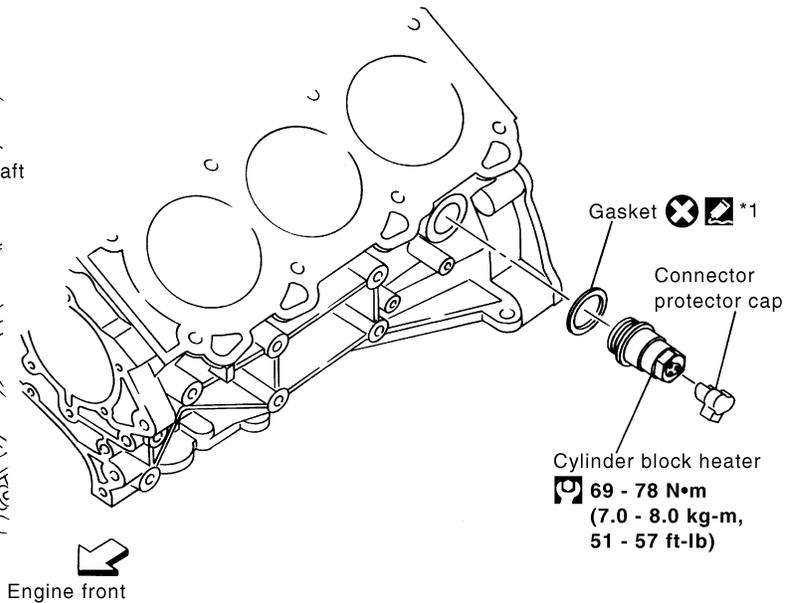
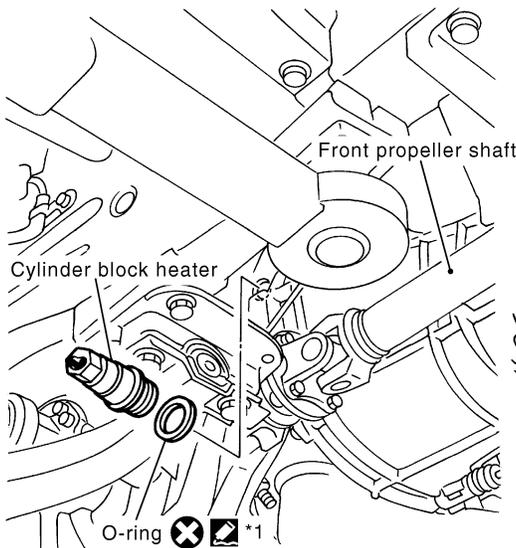
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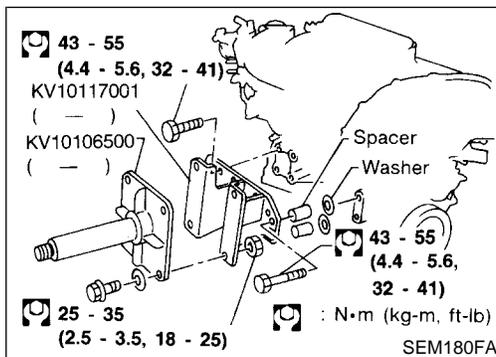
: Apply Anaerobic Liquid Gasket or equivalent. Refer to GI section.

*1 : Sealing point: Front and reverse side.

: Always replace after every disassembly.

• Remove old anaerobic liquid gasket completely after removing cylinder block heater.

SEM202H



SEM180FA

Removal and Installation

NAEM0025

CAUTION:

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

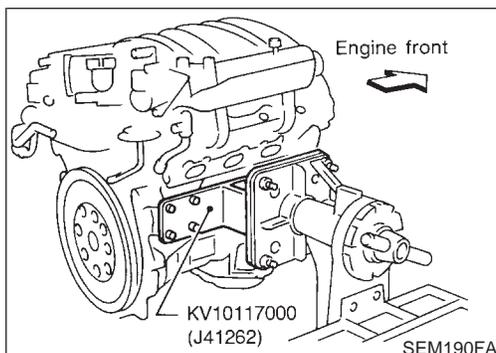
Disassembly

NAEM0026

PISTON, CRANKSHAFT AND OIL JET

NAEM0026S01

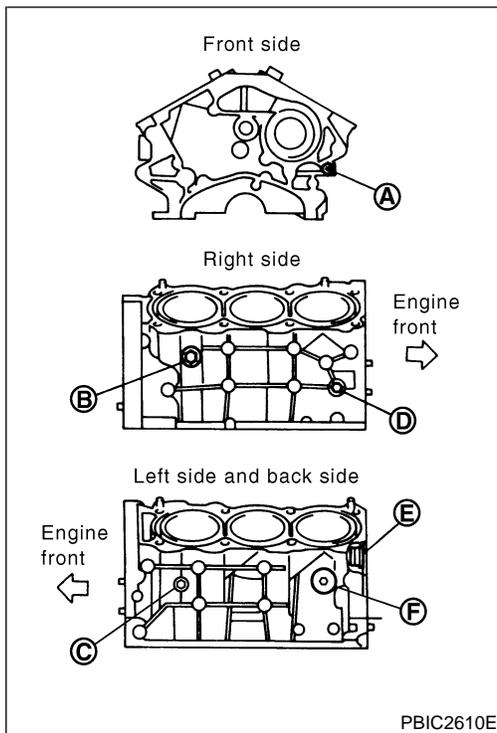
1. Remove engine. Refer to "Removal and Installation", EM-62.
2. Place engine on a work stand.
3. Drain engine oil. Refer to "Changing Engine Oil", MA-18.



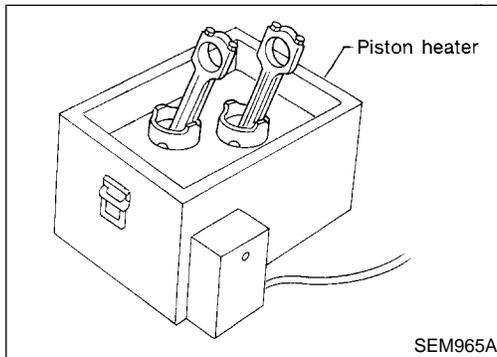
SEM190FA

CYLINDER BLOCK

Disassembly (Cont'd)



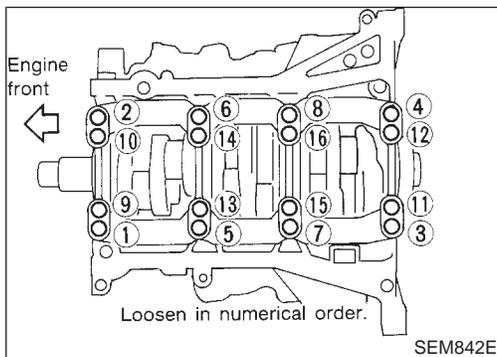
4. Drain engine coolant by removing water drain plugs from cylinder block both sides at "B" and "C" and cylinder block front side at "A" as shown in the figure.
5. Remove oil pan. Refer to "Removal", EM-19.
6. Remove timing chain. Refer to "Removal", EM-27.
7. Remove cylinder head. Refer to "Removal", EM-27.



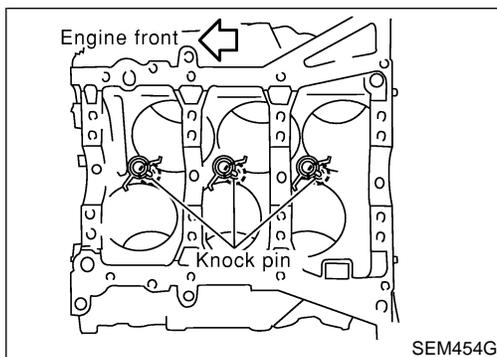
8. Remove baffle plate from main bearing beam.
9. Remove pistons with connecting rods.
 - When disassembling piston and connecting rod, remove snap ring first, then heat piston to 60 to 70°C (140 to 158°F).
10. Remove rear oil seal retainer.

CAUTION:

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



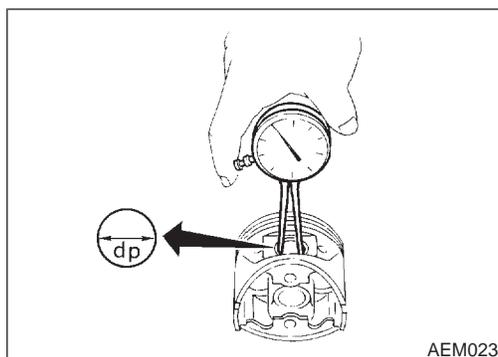
11. Loosen bolts in numerical order as shown and remove main bearing beam, bearing cap and crankshaft.
 - Before removing bearing beam and bearing cap, measure crankshaft end play. Refer to EM-78.
 - Bolts should be loosened in two or three steps.



12. Remove oil jets.
13. Remove knock sensor.

CAUTION:

Carefully handle the sensor and avoid impacts.



Inspection

PISTON AND PISTON PIN CLEARANCE

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

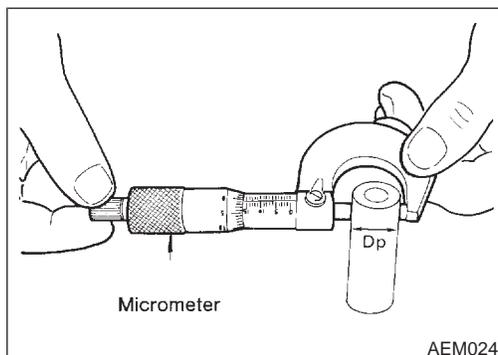
Standard diameter "dp":

Grade No. 0

21.993 - 21.999 mm (0.8659 - 0.8661 in)

Grade No. 1

21.999 - 22.005 mm (0.8661 - 0.8663 in)



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

Standard diameter "Dp":

Grade No. 0

21.989 - 21.995 mm (0.8657 - 0.8659 in)

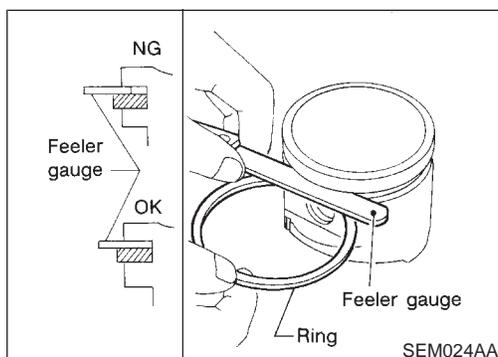
Grade No. 1

21.995 - 22.001 mm (0.8659 - 0.8662 in)

3. Calculate interference fit of piston pin to piston.

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

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



PISTON RING SIDE CLEARANCE

Side clearance:

Top ring

0.040 - 0.080 mm (0.0016 - 0.0031 in)

2nd ring

0.030 - 0.070 mm (0.0012 - 0.0028 in)

Oil ring

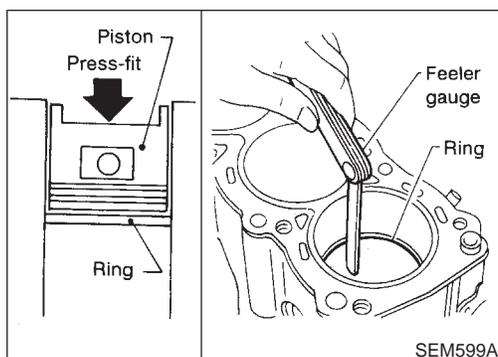
0.015 - 0.050 mm (0.0006 - 0.0020 in)

Max. limit of side clearance:

Top ring 0.11 mm (0.0043 in)

2nd ring 0.1 mm (0.004 in)

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



PISTON RING END GAP

End gap:

Top ring 0.23 - 0.33 mm (0.0091 - 0.0130 in)

2nd ring 0.33 - 0.48 mm (0.0130 - 0.0189 in)

Oil ring 0.20 - 0.60 mm (0.0079 - 0.0236 in)

Max. limit of ring gap:

Top ring 0.54 mm (0.0213 in)

2nd ring 0.80 mm (0.0315 in)

Oil ring 0.95 mm (0.0374 in)

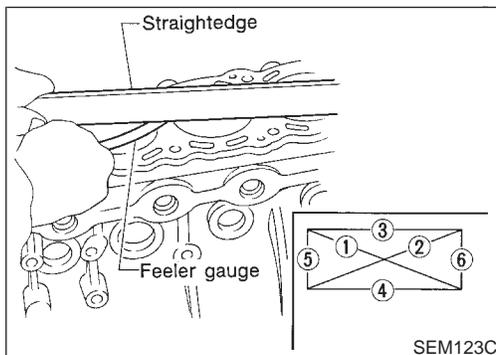
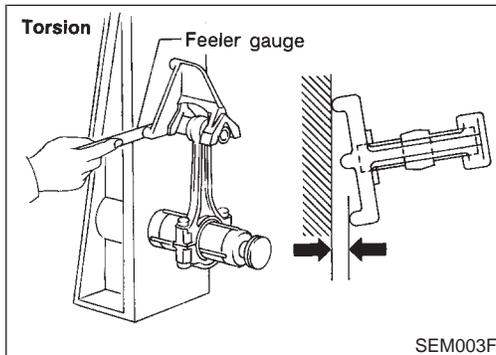
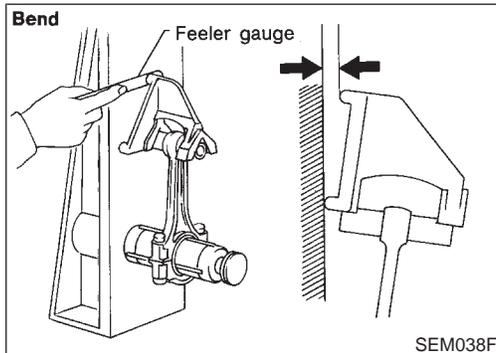
CYLINDER BLOCK

Inspection (Cont'd)

If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, do the following. Rebore cylinder and use oversized piston and piston rings.

Refer to SDS (EM-88).

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



CONNECTING ROD BEND AND TORSION

NAEM0027S04

Bend:

**Limit 0.15 mm (0.0059 in)
per 100 mm (3.94 in) length**

Torsion:

**Limit 0.30 mm (0.0118 in)
per 100 mm (3.94 in) length**

If it exceeds the limit, replace connecting rod assembly.

CYLINDER BLOCK DISTORTION AND WEAR

NAEM0027S05

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

Distortion limit: 0.10 mm (0.0039 in)

- If out of specification, resurface it. The limit for cylinder block resurfacing is determined by cylinder head resurfacing in engine.

Resurfacing limit:

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

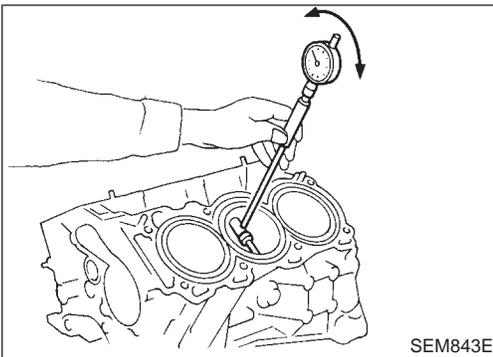
$A + B = 0.2 \text{ mm (0.008 in)}$

Nominal cylinder block height from crankshaft center:

214.95 - 215.05 mm (8.4626 - 8.4665 in)

Refer to SDS (EM-87).

- If necessary, replace cylinder block.



PISTON-TO-BORE CLEARANCE

NAEM0027S06

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

Cylinder bore inner diameter

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

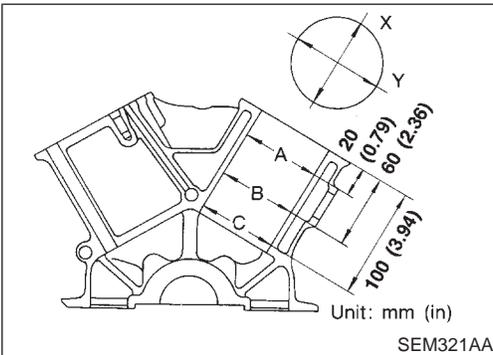
If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.

Out-of-round (Difference between X and Y):

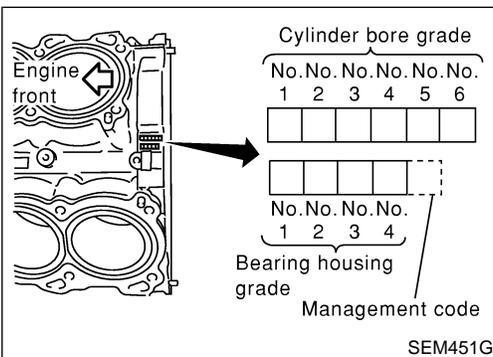
Limit 0.015 mm (0.0006 in)

Taper (Difference between A and C):

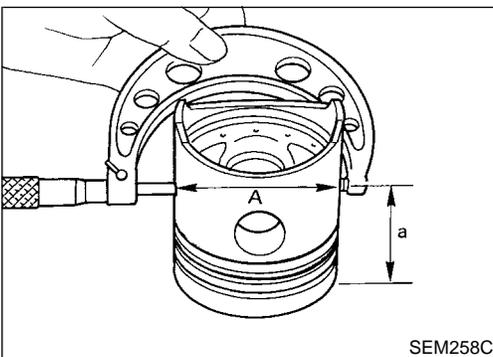
Limit 0.015 mm (0.0006 in)



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



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



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

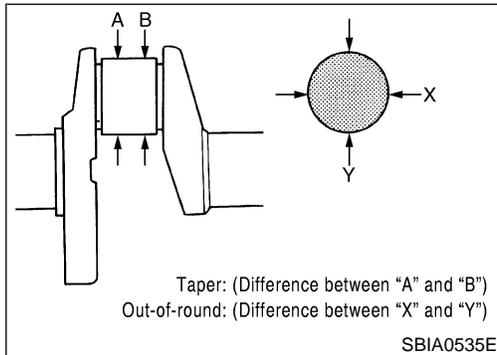
C: Honing allowance 0.02 mm (0.0008 in)

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CYLINDER BLOCK

Inspection (Cont'd)

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. NAEM0027S07
2. With a micrometer, measure journals for taper and out-of-round.

Out-of-round (Difference between "X" and "Y"):

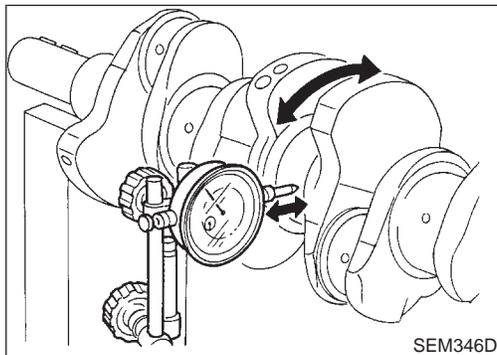
Standard

0.002 mm (0.0001 in)

Taper (Difference between "A" and "B"):

Standard

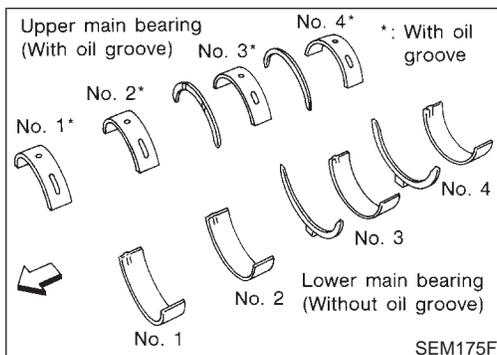
0.002 mm (0.0001 in)



3. Measure crankshaft runout.

Runout (Total indicator reading):

Limit 0.10 mm (0.0039 in)



BEARING CLEARANCE

- Use either of the following two methods, however, method "A" gives more reliable results and is preferable. NAEM0027S08

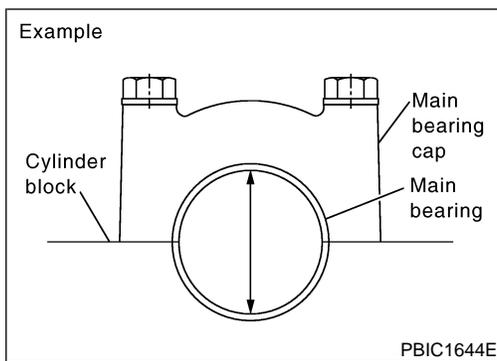
Method A (Using bore gauge & micrometer)

Main bearing

1. Set main bearings in their proper positions on cylinder block and main bearing cap. NAEM0027S0801

CYLINDER BLOCK

Inspection (Cont'd)



2. Install main bearing cap and bearing beam to cylinder block. **Tighten all bolts in correct order.**
3. Measure inner diameters of each main bearing.
4. Measure outer diameters of each crankshaft main journal.
5. Calculate main bearing clearance.

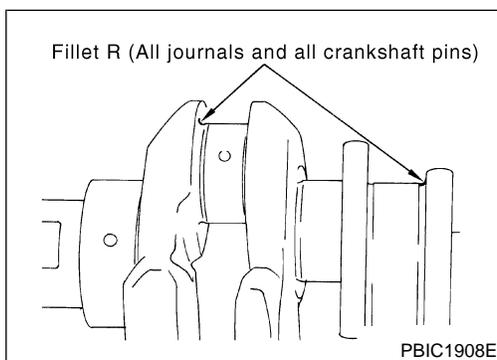
Main bearing clearance = Main bearing inner diameter – Crankshaft main journal diameter

Standard: 0.035 - 0.045 mm (0.0014 - 0.0018 in)

Limit: 0.065 mm (0.0026 in)

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

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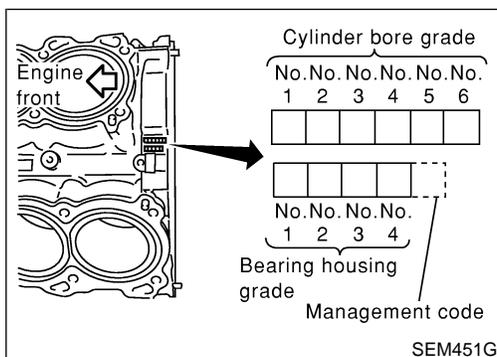


- When using undersize (US) bearing, measure the main bearing inner diameter with bearing installed, and grind main journal so that the main bearing oil clearance satisfies the standard.

CAUTION:

In grinding crankshaft main journal to use undersize bearings, keep the fillet R [1.5 mm (0.059 in)].

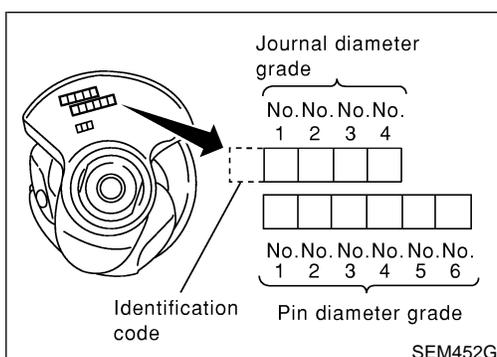
- Refer to SDS for grinding crankshaft and available service parts.



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

- a. Grade number of each cylinder block main journal is punched on the respective cylinder block. These numbers are punched in either Arabic or Alphabet. Refer to SDS, EM-87.

If measured diameter is out of grade punched, decide suitable grade using table in SDS.



- b. Grade number of each crankshaft main journal is punched on the respective crankshaft. These numbers are punched in either Arabic or Alphabet. Refer to SDS, EM-90.

If measured diameter is out of grade punched, decide suitable grade using table in SDS.

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

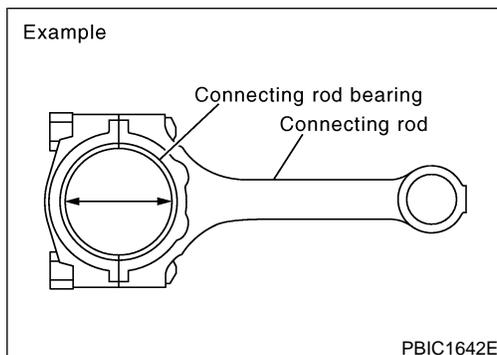
Refer to "SDS", EM-91, for available main bearings.

CYLINDER BLOCK

Inspection (Cont'd)

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

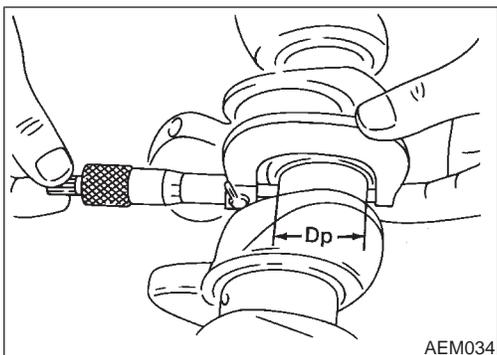
PBIC0814E



Connecting Rod Bearing (Big end)

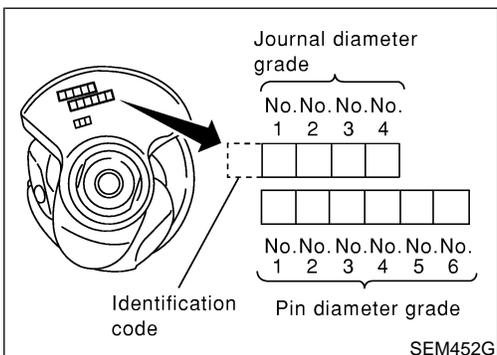
NAEM0027S0802

1. Install connecting rod bearing to connecting rod and cap.
2. Install connecting rod cap to connecting rod.
Tighten bolts to the specified torque.
3. Measure inner diameter "C" of connecting rod.



4. Measure outer diameter "Dp" of each crankshaft pin journal.
5. Calculate connecting rod bearing clearance.
Connecting rod bearing clearance = C - Dp
Standard: 0.034 - 0.059 mm (0.0013 - 0.0023 in)
Limit: 0.070 mm (0.0028 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to "BEARING CLEARANCE — Main bearing", EM-72.

GI
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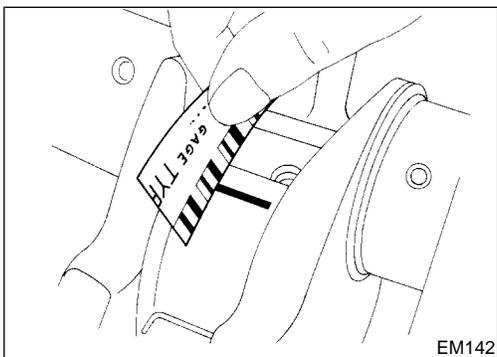


8. If crankshaft is replaced with a new one, select connecting rod bearing according to the following table.
Connecting rod bearing grade number (Identification color):
 These numbers are punched in either Arabic or Roman numerals.

EC
FE
CL

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

MT
AT

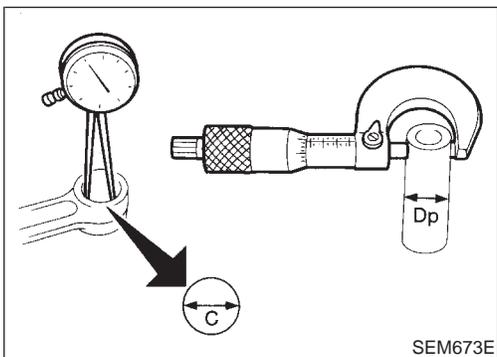


Method B (Using plastigage)

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.

TF
PD
AX
SU



CONNECTING ROD BUSHING CLEARANCE (SMALL END)

NAEM0027S09

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

BR
ST
RS

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

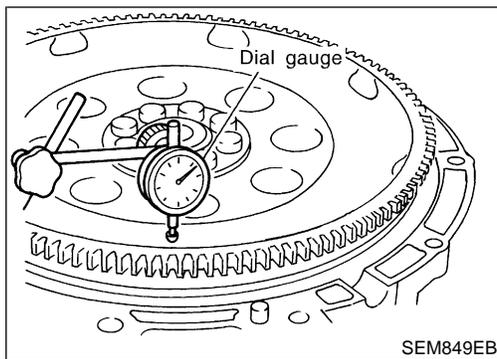
BT
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SC
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CYLINDER BLOCK

Inspection (Cont'd)



FLYWHEEL/DRIVE PLATE RUNOUT

NAEM0027S11

Runout (Total indicator reading):

Flywheel (M/T model)

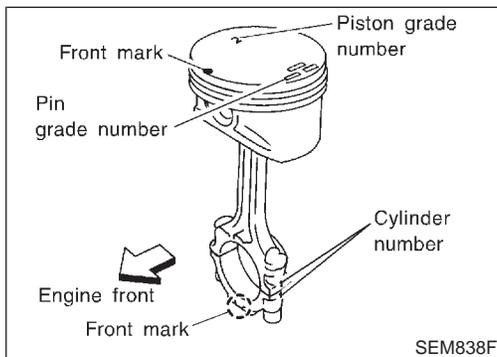
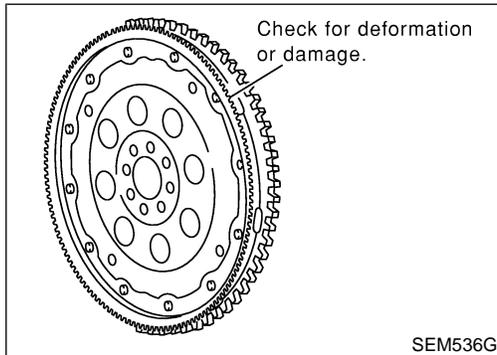
Less than 0.15 mm (0.0059 in)

Drive plate (A/T model)

Less than 0.15 mm (0.0059 in)

CAUTION:

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



Assembly

NAEM0028

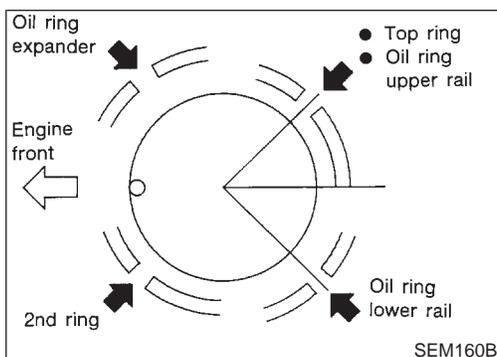
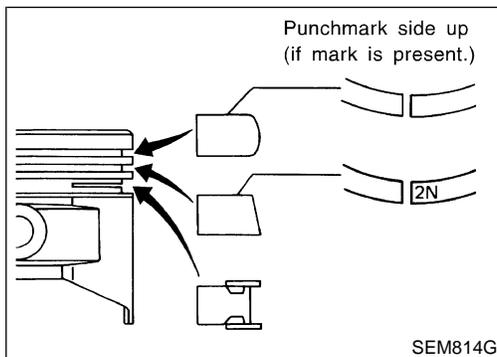
PISTON

NAEM0028S01

1. Install new snap ring on one side of piston pin hole.
2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.
 - Align the direction of piston and connecting rod.
 - Numbers stamped on connecting rod and cap correspond to each cylinder.
 - After assembly, make sure connecting rod swings smoothly.
3. Set piston rings as shown.

CAUTION:

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



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

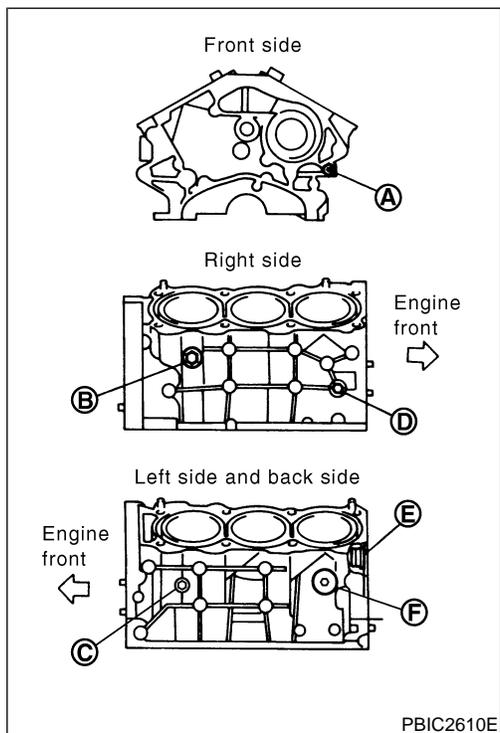
PLUG

NAEM0028S08

1. Fully air-blow engine coolant and engine oil passages in cylinder block, cylinder bore and crankcase to remove any foreign material.

CAUTION:

Use goggles to protect your eye.



2. Install each water drain plug to cylinder block as shown in the figure.

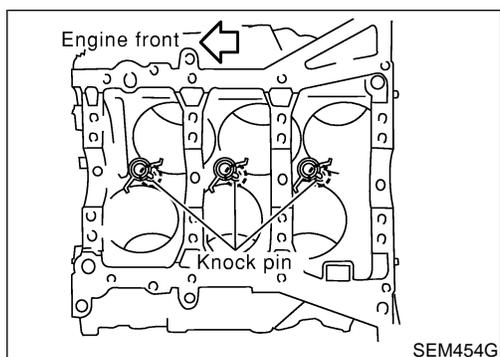
- Apply thread sealant to the thread of water drain plugs. **Use Genuine RTV Silicone Sealant or equivalent. Refer to GI-53, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS".**
- Tighten each water drain plug as specified below.

Part	Gasket	Tightening torque
A	No	7.8 - 11.8 N·m (0.8 - 1.2 kg-m, 69 - 104 in-lb)
B	No	17.6 - 21.6 N·m (1.8 - 2.2 kg-m, 13 - 15 ft-lb)
C	No	17.6 - 21.6 N·m (1.8 - 2.2 kg-m, 13 - 15 ft-lb)

3. Install each plug to cylinder block as shown in the figure if removed.

- Apply thread sealant to the thread of plugs "D" and "E". **Use Genuine High Strength Thread Locking Sealant or equivalent. Refer to GI-53, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS".**
- Apply thread sealant to the thread of plug "F". **Use Anaerobic Liquid Gasket or equivalent. Refer to GI-53, "RECOMMENDED CHEMICAL PRODUCTS AND SEALANTS".**
- Tighten each plug as specified below.

Part	Gasket	Tightening torque
D	Yes	9.8 - 14.8 N·m (1.0 - 1.5 kg-m, 87 - 130 in-lb)
E	Yes	59.0 - 65.0 N·m (6.1 - 6.5 kg-m, 44 - 47 ft-lb)
F	Yes	59.0 - 65.0 N·m (6.1 - 6.5 kg-m, 44 - 47 ft-lb)



OIL JET

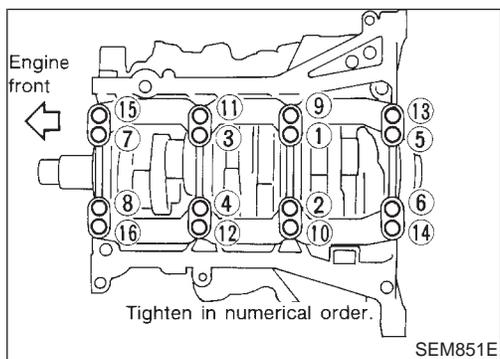
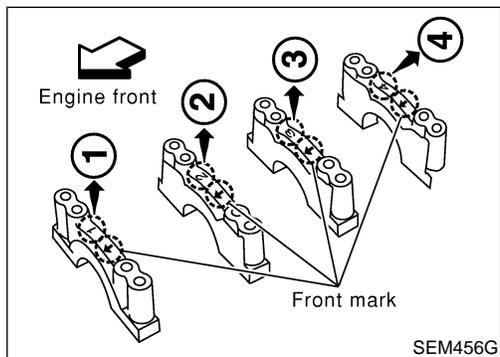
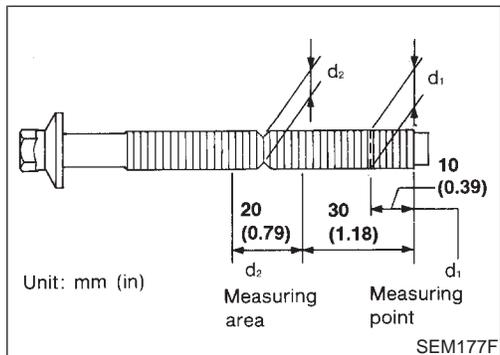
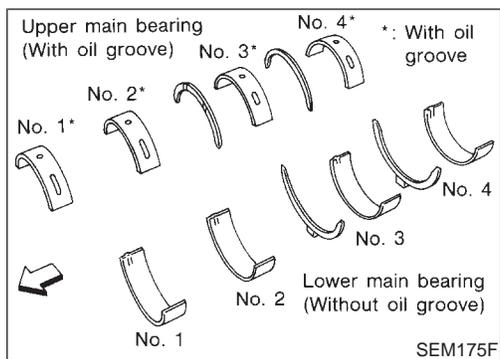
NAEM0028S05

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

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CYLINDER BLOCK

Assembly (Cont'd)



CRANKSHAFT

NAEM0028S02

1. Set main bearings in their proper positions on cylinder block and main bearing beam.
 - Confirm that correct main bearings are used. Refer to "Inspection" of this section.

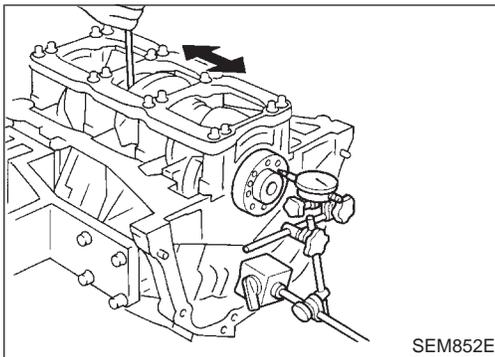
2. Instructions for re-use of main bearing cap bolts.
 - A plastic zone tightening method is used for tightening main bearing cap bolts. Measure d_1 and d_2 as shown in the figure.
 - d_2 : Select minimum diameter in the measuring area.
 - If the difference between d_1 and d_2 exceeds the limit, replace the bolts with new ones.

Limit ($d_1 - d_2$): 0.11 mm (0.0043 in)

3. After installing crankshaft, main bearing cap, main bearing beam and bearing cap bolts, tighten bearing cap bolts in numerical order as shown.
 - Make sure that the front mark on the main bearing beam faces the front of the engine.
 - Tightening procedure
 - a) Tighten all bolts to 32 to 38 N·m (3.3 to 3.9 kg·m, 24 to 28 ft·lb) in several different steps.
 - b) Turn all bolts 90 to 95 degrees clockwise with angle wrench.
 - Prior to tightening bearing cap bolts, place bearing beam in its proper position by shifting crankshaft in the axial direction.
 - After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.
 - Lubricate threads and seat surfaces of the bolts with new engine oil.

CYLINDER BLOCK

Assembly (Cont'd)



4. Measure crankshaft end play.

Crankshaft end play:

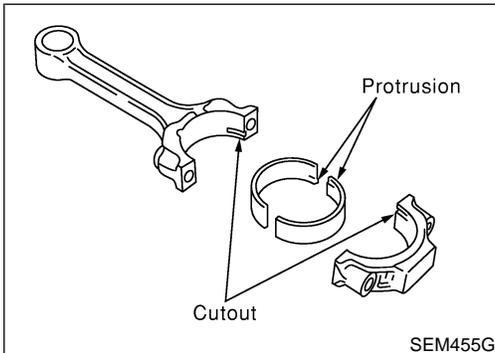
Standard

0.10 - 0.25 mm (0.0039 - 0.0098 in)

Limit

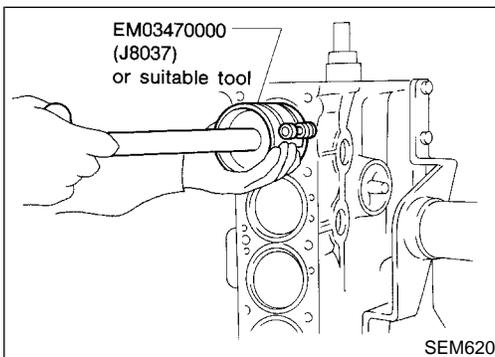
0.30 mm (0.0118 in)

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



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

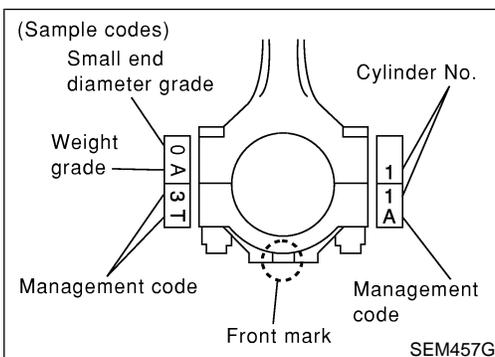
- **Confirm that correct bearings are used.**



6. Install pistons with connecting rods.

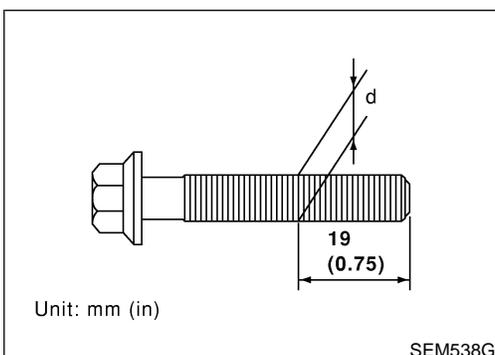
- a. Install them into corresponding cylinders with Tool.

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



- b. Install connecting rod caps.

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



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

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

Outer diameter "d" of connecting rod cap bolt:

Standard

7.90 - 8.00 mm (0.3110 - 0.3150 in)

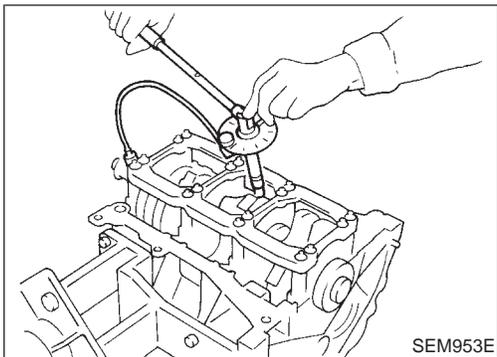
Limit

7.75 mm (0.3051 in)

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CYLINDER BLOCK

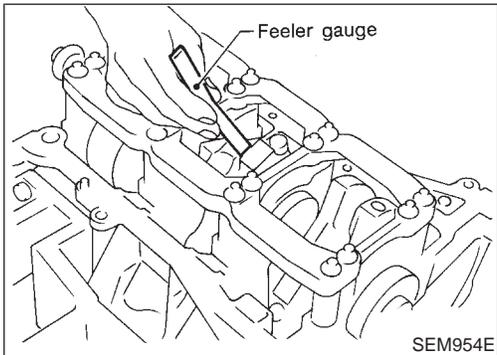
Assembly (Cont'd)



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

Connecting rod cap bolt:

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



7. Measure connecting rod side clearance.

Connecting rod side clearance:

Standard

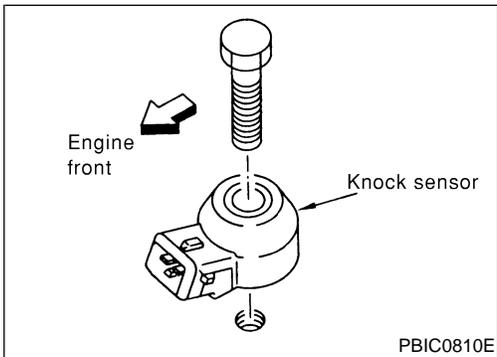
0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit

0.40 mm (0.0157 in)

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

8. Install baffle plate to main bearing beam.
9. Install rear oil seal retainer.



KNOCK SENSOR

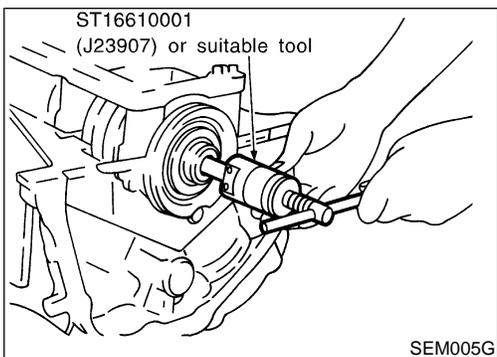
NAEM0028S07

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

CAUTION:

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

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



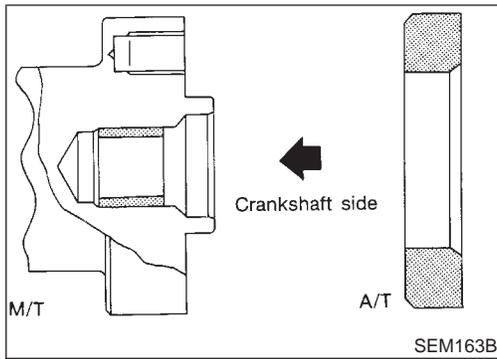
REPLACEMENT OF PILOT BUSHING (M/T) OR PILOT CONVERTER (A/T)

NAEM0028S04

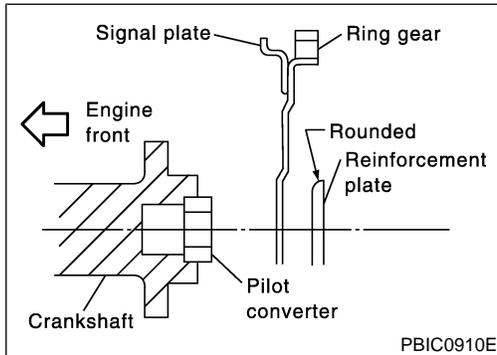
1. Remove pilot bushing or pilot converter using tool or suitable tool.

CYLINDER BLOCK

Assembly (Cont'd)



2. Install pilot bushing or pilot converter as shown.



FLYWHEEL/DRIVE PLATE

NAEM0028S06

Install drive plate.

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

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SERVICE DATA AND SPECIFICATIONS (SDS)

General Specifications

General Specifications

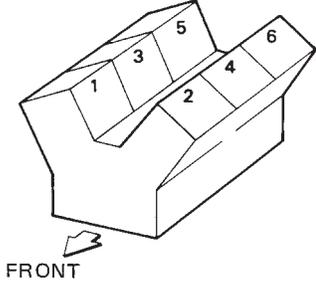
NAEM0029

Cylinder arrangement		V-6
Displacement cm ³ (cu in)		3,498 (213.45)
Bore and stroke mm (in)		95.5 x 81.4 (3.760 x 3.205)
Valve arrangement		DOHC
Firing order		1-2-3-4-5-6
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		4
Compression ratio		10.0

Compression Pressure

Unit: kPa (kg/cm², psi)/300 rpm ^{NAEM0030}

Compression pressure	Standard	1,270 (13.0, 184)
	Minimum	980 (10.0, 142)
	Differential limit between cylinders	100 (1.0, 15)

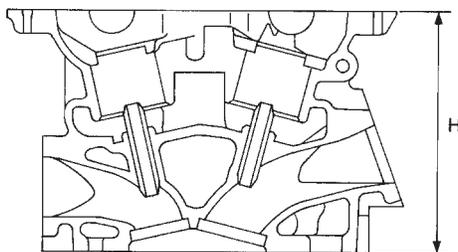
Cylinder number	 <p style="text-align: center;">FRONT</p>	
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SEM713A

Cylinder Head

Unit: mm (in) ^{NAEM0031}

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



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

SEM949E

SERVICE DATA AND SPECIFICATIONS (SDS)

Valve

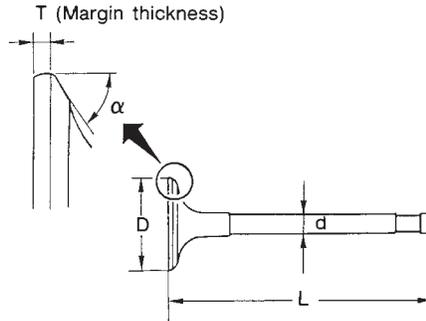
Valve

VALVE

NAEM0032

NAEM0032S01

Unit: mm (in)



SEM188

Valve head diameter "D"	Intake	37.0 - 37.3 (1.4567 - 1.4685)
	Exhaust	31.2 - 31.5 (1.228 - 1.240)
Valve length "L"	Intake	96.12 - 96.62 (3.7842 - 3.8039)
	Exhaust	93.65 - 94.15 (3.6870 - 3.7067)
Valve stem diameter "d"	Intake	5.965 - 5.980 (0.2348 - 0.2354)
	Exhaust	5.945 - 5.960 (0.2341 - 0.2346)
Valve seat angle "α"	Intake	45°15' - 45°45'
	Exhaust	
Valve margin "T"	Intake	1.1 (0.044)
	Exhaust	1.3 (0.051)
Valve margin "T" limit		More than 0.5 (0.020)
Valve stem end surface grinding limit		Less than 0.2 (0.008)

VALVE CLEARANCE

NAEM0032S02

Unit: mm (in)

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

*: Approximately 80°C (176°F)

VALVE SPRING

NAEM0032S04

Free height	mm (in)	46.52 (1.8315)
Pressure	N (kg, lb) at height mm (in)	196 (20.0, 44.1) at 37.0 (1.457)
	Valve open	433 (44.2, 97.3) at 27.8 (1.094)
Out-of-square	mm (in)	Less than 2.0 (0.079)

VALVE LIFTER

NAEM0032S05

Unit: mm (in)

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

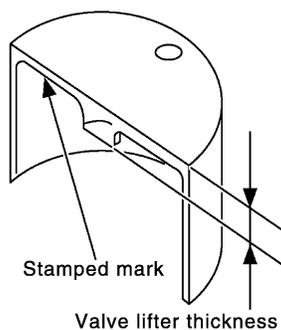
SERVICE DATA AND SPECIFICATIONS (SDS)

Valve (Cont'd)

AVAILABLE LIFTERS (SHIMLESS TYPE)

=NAEM0032S08

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



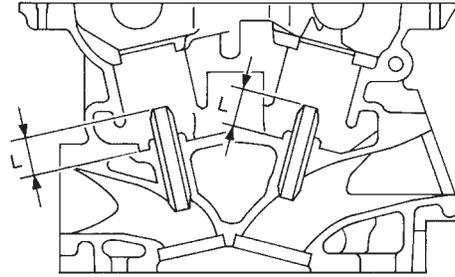
SEM758G

SERVICE DATA AND SPECIFICATIONS (SDS)

Valve (Cont'd)

VALVE GUIDE

NAEM0032S06
Unit: mm (in)

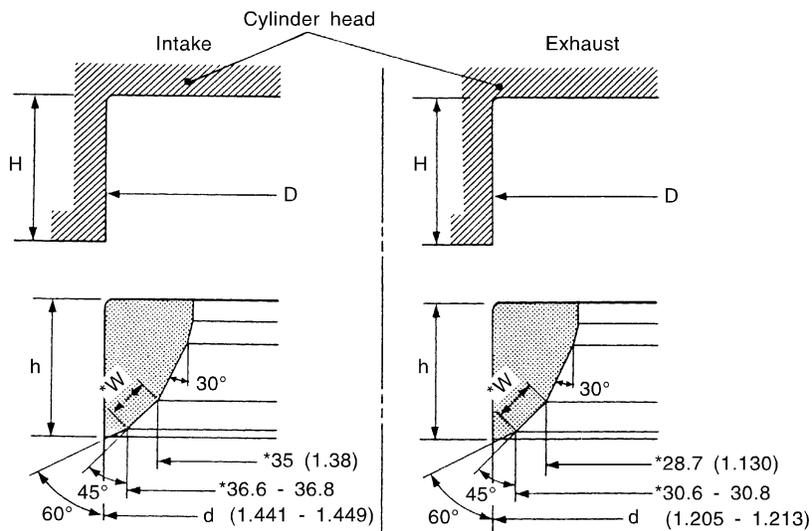


SEM950E

		Standard	Service
Valve guide	Outer diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
Valve guide	Inner diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter		9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)	
		Standard	Max. tolerance
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.08 (0.0031)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
Valve deflection limit	Intake	—	0.24 (0.0094)
	Exhaust	—	0.28 (0.0110)
Projection length "L"		12.6 - 12.8 (0.496 - 0.504)	

Valve Seat

NAEM0033
Unit: mm (in)



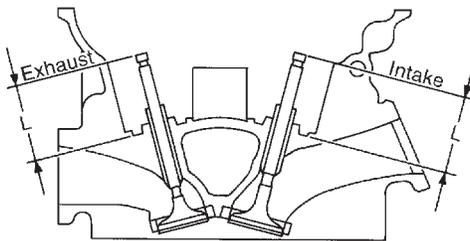
Contacting width (W); 1.09 - 1.31 (0.0429 - 0.0516)

Contacting width (W); 1.29 - 1.51 (0.0508 - 0.0594)

SEM021EB

SERVICE DATA AND SPECIFICATIONS (SDS)

Valve Seat (Cont'd)



SEM621F

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

Camshaft and Camshaft Bearing

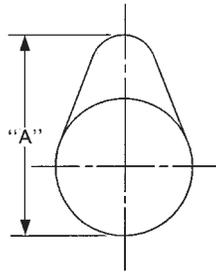
NAEM0034
Unit: mm (in)

	Standard	Limit
Camshaft journal to bearing clearance	No. 1 0.045 - 0.086 (0.0018 - 0.0034) No. 2, 3, 4 0.035 - 0.076 (0.0014 - 0.0030)	0.15 (0.0059)
Inner diameter of camshaft bearing	No. 1 26.000 - 26.021 (1.0236 - 1.0244) No. 2, 3, 4 23.500 - 23.521 (0.9252 - 0.9260)	—
Outer diameter of camshaft journal	No. 1 25.935 - 25.955 (1.0211 - 1.0218) No. 2, 3, 4 23.445 - 23.465 (0.9230 - 0.9238)	—
Camshaft runout [TIR*]	Less than 0.02 (0.0008)	0.05 (0.0020)
Camshaft sprocket runout [TIR*]	Less than 0.15 (0.0059)	—
Camshaft end play	0.115 - 0.188 (0.0045 - 0.0074)	0.24 (0.0094)

*: Total indicator reading

SERVICE DATA AND SPECIFICATIONS (SDS)

Camshaft and Camshaft Bearing (Cont'd)



EM671

Cam height "A"	Intake and exhaust	44.465 - 44.655 (1.7506 - 1.7581)
Wear limit of cam height		0.2 (0.008)

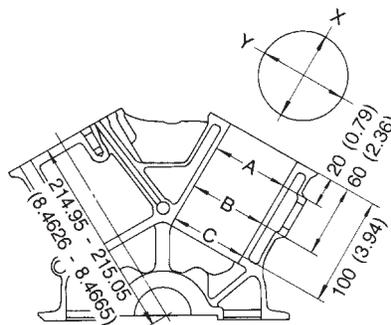
Valve timing					
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Unit: degree

a	b	c	d	e	f
232	230	-3	53	6	46

Cylinder Block

NAEM0035
Unit: mm (in)



SEM022EA

Surface flatness	Standard		Less than 0.03 (0.0012)
	Limit		0.10 (0.0039)
Cylinder bore	Inner diameter	Standard	Grade No. 1 95.500 - 95.510 (3.7598 - 3.7602)
			Grade No. 2 95.510 - 95.520 (3.7602 - 3.7606)
			Grade No. 3 95.520 - 95.530 (3.7606 - 3.7610)
		Wear limit	0.20 (0.0079)
Out-of-round (Difference between X and Y)			Less than 0.015 (0.0006)
Taper (Difference between A and C)			Less than 0.015 (0.0006)

SERVICE DATA AND SPECIFICATIONS (SDS)

Cylinder Block (Cont'd)

Main journal inner diameter grade (Without bearing)	Grade No. A	63.993 - 63.994 (2.5194 - 2.5194)
	Grade No. B	63.994 - 63.995 (2.5194 - 2.5195)
	Grade No. C	63.995 - 63.996 (2.5195 - 2.5195)
	Grade No. D	63.996 - 63.997 (2.5195 - 2.5196)
	Grade No. E	63.997 - 63.998 (2.5196 - 2.5196)
	Grade No. F	63.998 - 63.999 (2.5196 - 2.5196)
	Grade No. G	63.999 - 64.000 (2.5196 - 2.5197)
	Grade No. H	64.000 - 64.001 (2.5197 - 2.5197)
	Grade No. J	64.001 - 64.002 (2.5197 - 2.5198)
	Grade No. K	64.002 - 64.003 (2.5198 - 2.5198)
	Grade No. L	64.003 - 64.004 (2.5198 - 2.5198)
	Grade No. M	64.004 - 64.005 (2.5198 - 2.5199)
	Grade No. N	64.005 - 64.006 (2.5199 - 2.5199)
	Grade No. P	64.006 - 64.007 (2.5199 - 2.5200)
	Grade No. R	64.007 - 64.008 (2.5200 - 2.5200)
	Grade No. S	64.008 - 64.009 (2.5200 - 2.5200)
	Grade No. T	64.009 - 64.010 (2.5200 - 2.5201)
	Grade No. U	64.010 - 64.011 (2.5201 - 2.5201)
	Grade No. V	64.011 - 64.012 (2.5201 - 2.5202)
	Grade No. W	64.012 - 64.013 (2.5202 - 2.5202)
Grade No. X	64.013 - 64.014 (2.5202 - 2.5202)	
Grade No. Y	64.014 - 64.015 (2.5202 - 2.5203)	
Grade No. 4	64.015 - 64.016 (2.5203 - 2.5203)	
Grade No. 7	64.016 - 64.017 (2.5203 - 2.5203)	
Difference in inner diameter between cylinders	Standard	Less than 0.03 (0.0012)

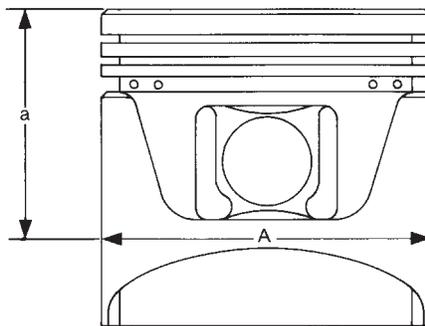
Piston, Piston Ring and Piston Pin

NAEM0036

AVAILABLE PISTON

NAEM0036S01

Unit: mm (in)



SEM882E

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

*: No grade No. is punched on piston.

SERVICE DATA AND SPECIFICATIONS (SDS)

Piston, Piston Ring and Piston Pin (Cont'd)

PISTON RING

^{NAEM0036S02}
Unit: mm (in)

		Standard	Limit
Side clearance	Top	0.040 - 0.080 (0.0016 - 0.0031)	0.11 (0.0043)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.1 (0.004)
	Oil ring	0.015 - 0.050 (0.0006 - 0.0020)	—
End gap	Top	0.23 - 0.33 (0.0091 - 0.0130)	0.54 (0.0213)
	2nd	0.33 - 0.48 (0.0130 - 0.0189)	0.80 (0.0315)
	Oil (rail ring)	0.20 - 0.60 (0.0079 - 0.0236)	0.95 (0.0374)

PISTON PIN

^{NAEM0036S03}
Unit: mm (in)

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

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

Connecting Rod

^{NAEM0037}
Unit: mm (in)

Center distance		144.15 - 144.25 (5.6752 - 5.6791)
Bend [per 100 (3.94)]	Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	Limit	0.30 (0.0118)
Connecting rod small end inner diameter		23.980 - 24.000 (0.9441 - 0.9449)
Piston pin bushing inner diameter*	Grade No. 0	22.000 - 22.006 (0.8661 - 0.8664)
	Grade No. 1	22.006 - 22.012 (0.8664 - 0.8666)
Connecting rod big end inner diameter		55.000 - 55.013 (2.1654 - 2.1659)
Side clearance	Standard	0.20 - 0.35 (0.0079 - 0.0138)
	Limit	0.40 (0.0157)

*: After installing in connecting rod

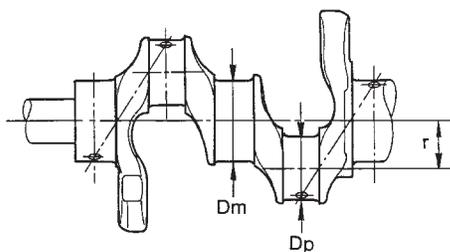
SERVICE DATA AND SPECIFICATIONS (SDS)

Crankshaft

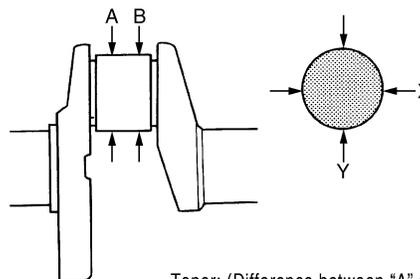
Crankshaft

Unit: mm (in) NAEM0038

Main journal dia. "Dm" grade	Grade No. A	59.975 - 59.974 (2.3612 - 2.3612)
	Grade No. B	59.974 - 59.973 (2.3612 - 2.3611)
	Grade No. C	59.973 - 59.972 (2.3611 - 2.3611)
	Grade No. D	59.972 - 59.971 (2.3611 - 2.3611)
	Grade No. E	59.971 - 59.970 (2.3611 - 2.3610)
	Grade No. F	59.970 - 59.969 (2.3610 - 2.3610)
	Grade No. G	59.969 - 59.968 (2.3610 - 2.3609)
	Grade No. H	59.968 - 59.967 (2.3609 - 2.3609)
	Grade No. J	59.967 - 59.966 (2.3609 - 2.3609)
	Grade No. K	59.966 - 59.965 (2.3609 - 2.3608)
	Grade No. L	59.965 - 59.964 (2.3608 - 2.3608)
	Grade No. M	59.964 - 59.963 (2.3608 - 2.3607)
	Grade No. N	59.963 - 59.962 (2.3607 - 2.3607)
	Grade No. P	59.962 - 59.961 (2.3607 - 2.3607)
	Grade No. R	59.961 - 59.960 (2.3607 - 2.3606)
	Grade No. S	59.960 - 59.959 (2.3606 - 2.3606)
	Grade No. T	59.959 - 59.958 (2.3606 - 2.3605)
	Grade No. U	59.958 - 59.957 (2.3605 - 2.3605)
	Grade No. V	59.957 - 59.956 (2.3605 - 2.3605)
Grade No. W	59.956 - 59.955 (2.3605 - 2.3604)	
Grade No. X	59.955 - 59.954 (2.3604 - 2.3604)	
Grade No. Y	59.954 - 59.953 (2.3604 - 2.3603)	
Grade No. 4	59.953 - 59.952 (2.3603 - 2.3603)	
Grade No. 7	59.952 - 59.951 (2.3603 - 2.3603)	
Pin journal dia. "Dp"	Grade No. 0	51.968 - 51.974 (2.0460 - 2.0462)
	Grade No. 1	51.962 - 51.968 (2.0457 - 2.0460)
	Grade No. 2	51.956 - 51.962 (2.0445 - 2.0457)
Center distance "r"		40.36 - 40.44 (1.5890 - 1.5921)
Out-of-round (Difference between "X" and "Y")	Standard	Less than 0.002 (0.0001)
Taper (Difference between "A" and "B")	Standard	Less than 0.002 (0.0001)
Runout [TIR*]	Limit	Less than 0.10 (0.0039)
Free end play	Standard	0.10 - 0.25 (0.0039 - 0.0098)
	Limit	0.30 (0.0118)



SEM645



Taper: (Difference between "A" and "B")
Out-of-round: (Difference between "X" and "Y")

SBIA0535E

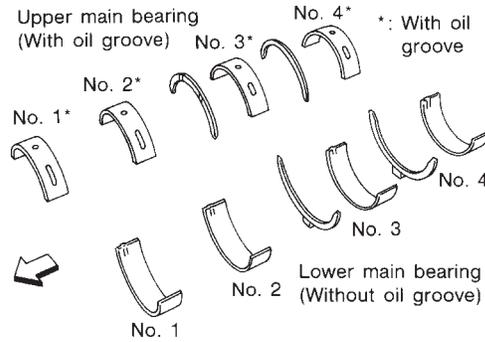
*: Total indicator reading

SERVICE DATA AND SPECIFICATIONS (SDS)

Available Main Bearing

Available Main Bearing

NAEM0039



SEM175F

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

UNDERSIZE

NAEM0039S01
Unit: mm (in)

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

SERVICE DATA AND SPECIFICATIONS (SDS)

Available Connecting Rod Bearing

Available Connecting Rod Bearing

NAEM0040

CONNECTING ROD BEARING

NAEM0040S01

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

UNDERSIZE

NAEM0040S02
Unit: mm (in)

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

Miscellaneous Components

NAEM0041
Unit: mm (in)

Flywheel runout [TIR]*	Less than 0.15 (0.0059)
Drive plate runout [TIR]*	Less than 0.15 (0.0059)

*: Total indicator reading

BEARING CLEARANCE

NAEM0041S01
Unit: mm (in)

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