ENGINE MECHANICAL

SECTION EM

MODIFICATION NOTICE:

ZD engine

- ZD30DDTi engine has newly been added.

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ZD

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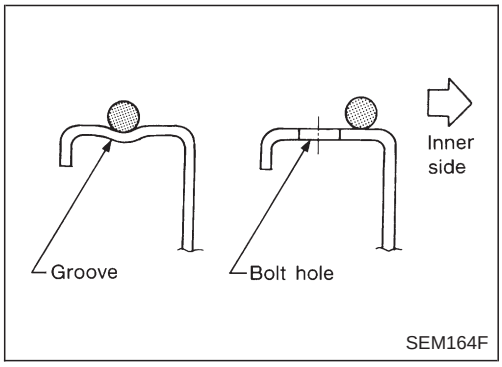
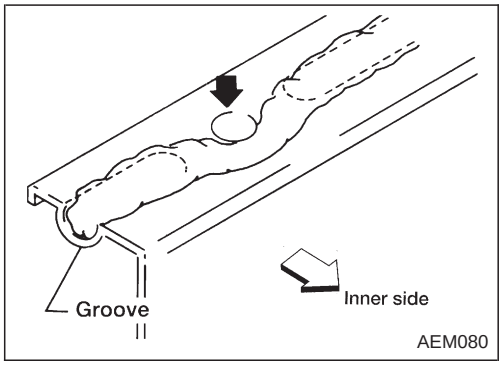
Parts Requiring Angular Tightening

- Use an angle wrench for the final tightening of the cylinder head bolts.
- Do not use a torque value for final tightening.
- The torque value for these parts are for a preliminary step.
- Ensure thread and seat surfaces are clean and coated with engine oil.



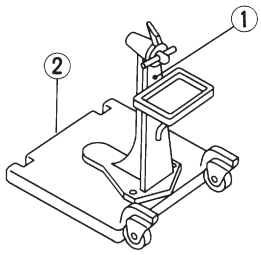
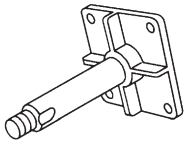
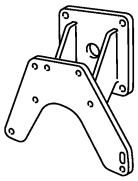
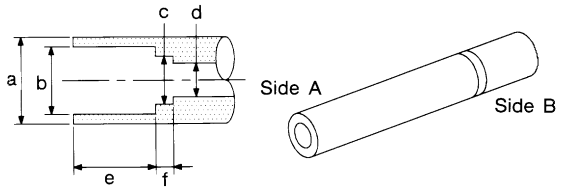
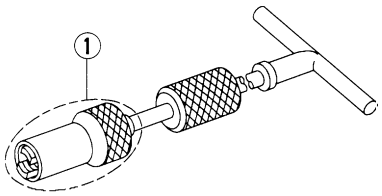
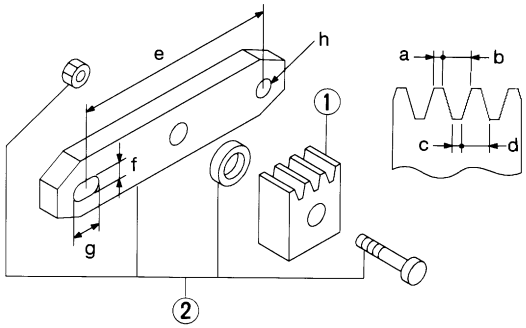
Liquid Gasket Application Procedure

1. **Use a scraper to remove 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 Liquid Gasket or equivalent.)**
   - Be sure liquid gasket diameter is as specified.

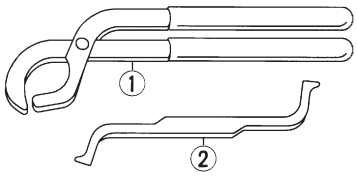
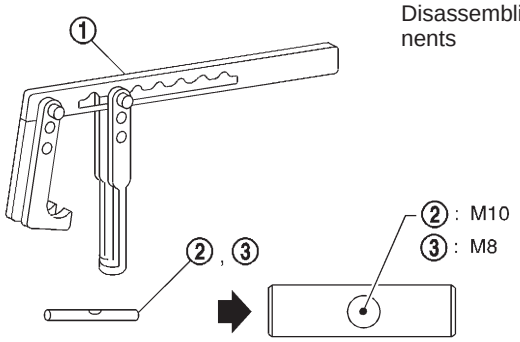
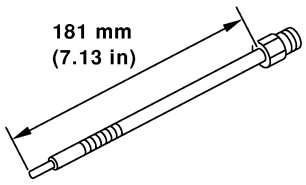
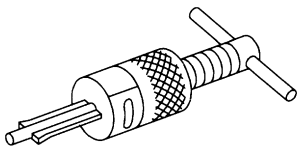
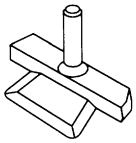
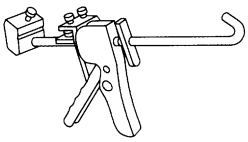
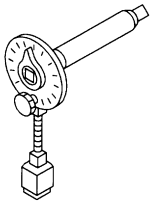


3. **Apply liquid gasket around the inner side of bolt holes (unless otherwise specified).**
4. **Assembly should be done within 5 minutes after coating.**
5. **Wait at least 30 minutes before refilling engine oil and engine coolant.**

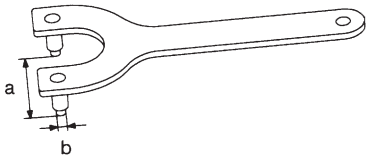
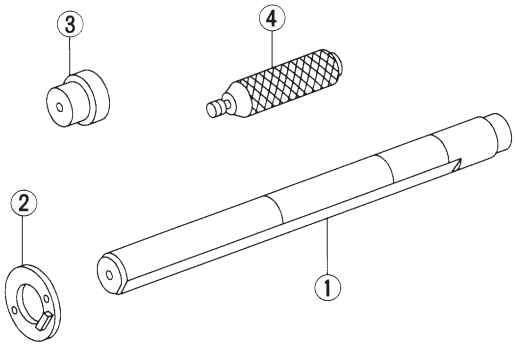
Special Service Tools

Tool number Tool name	Description
ST0501S000 Engine stand assembly ① ST05011000 Engine stand ② ST05012000 Base	 NT042 Disassembling and assembling
KV10106500 Engine stand shaft	 NT028
KV11106101 Engine sub-attachment	 NT819
KV10115600 Valve oil seal drift	 NT603 Installing valve oil seal **Use side A.** **Side A** **a: 20 (0.79) dia.** **b: 13 (0.51) dia.** **c: 10.3 (0.406) dia.** **d: 8 (0.31) dia.** **e: 10.7 (0.421)** **f: 5 (0.20)** Unit: mm (in)
KV10107902 Valve oil seal puller ① KV10116100 Valve oil seal puller adapter	 NT605 Removing valve oil seal
KV101056S0 Ring gear stopper ① KV10105630 Adapter ② KV10105610 Plate	 NT617 Preventing crankshaft from rotating **a: 3 (0.12)** **b: 6.4 (0.252)** **c: 2.8 (0.110)** **d: 6.6 (0.260)** **e: 107 (4.21)** **f: 14 (0.55)** **g: 20 (0.79)** **h: 14 (0.55) dia.** Unit: mm (in)

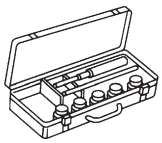
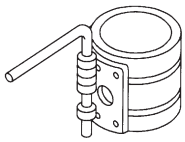
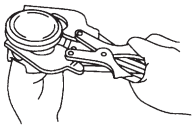
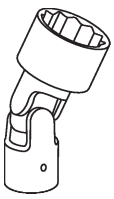
Special Service Tools (Cont'd)

Tool number Tool name	Description	
KV101151S0 Lifter stopper set ① KV10115110 Camshaft pliers ② KV10115120 Lifter stopper	 NT041	Changing shims
KV101092S0 Valve spring compressor ① KV10109210 Compressor ② KV10109220 Adapter	 NT718	Disassembling and assembling valve components
ED19600620 Compression gauge adapter	 NT820	Checking compression pressure
ST16610000 Pilot bushing puller	 NT045	Removing crankshaft pilot bushing
KV10111100 Seal cutter	 NT046	Removing steel oil pan and rear timing chain case
WS39930000 Tube presser	 NT052	Pressing the tube of liquid gasket
KV10112100 Angle wrench	 NT014	Tightening bolts for bearing cap, cylinder head, etc.

Special Service Tools (Cont'd)

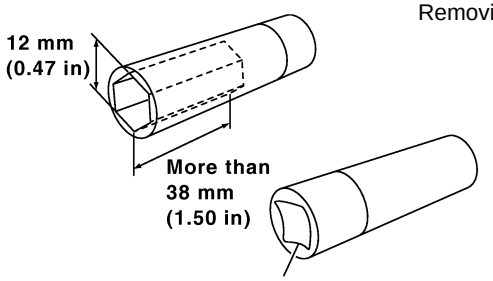
Tool number Tool name	Description	
KV10109300 Pulley holder	 NT628	**a: 68 mm (2.68 in)** **b: 8 mm (0.31 in) dia.**
KV111045S1 Balancer shaft bearing replacer set ① KV11104510 Replacer bar ② KV11104521 Guide plate ③ KV11104530 Adapter (Front bearing) ④ ST15243000 Drift	 NT258	Removing and installing balancer shaft bearing

Commercial Service Tools

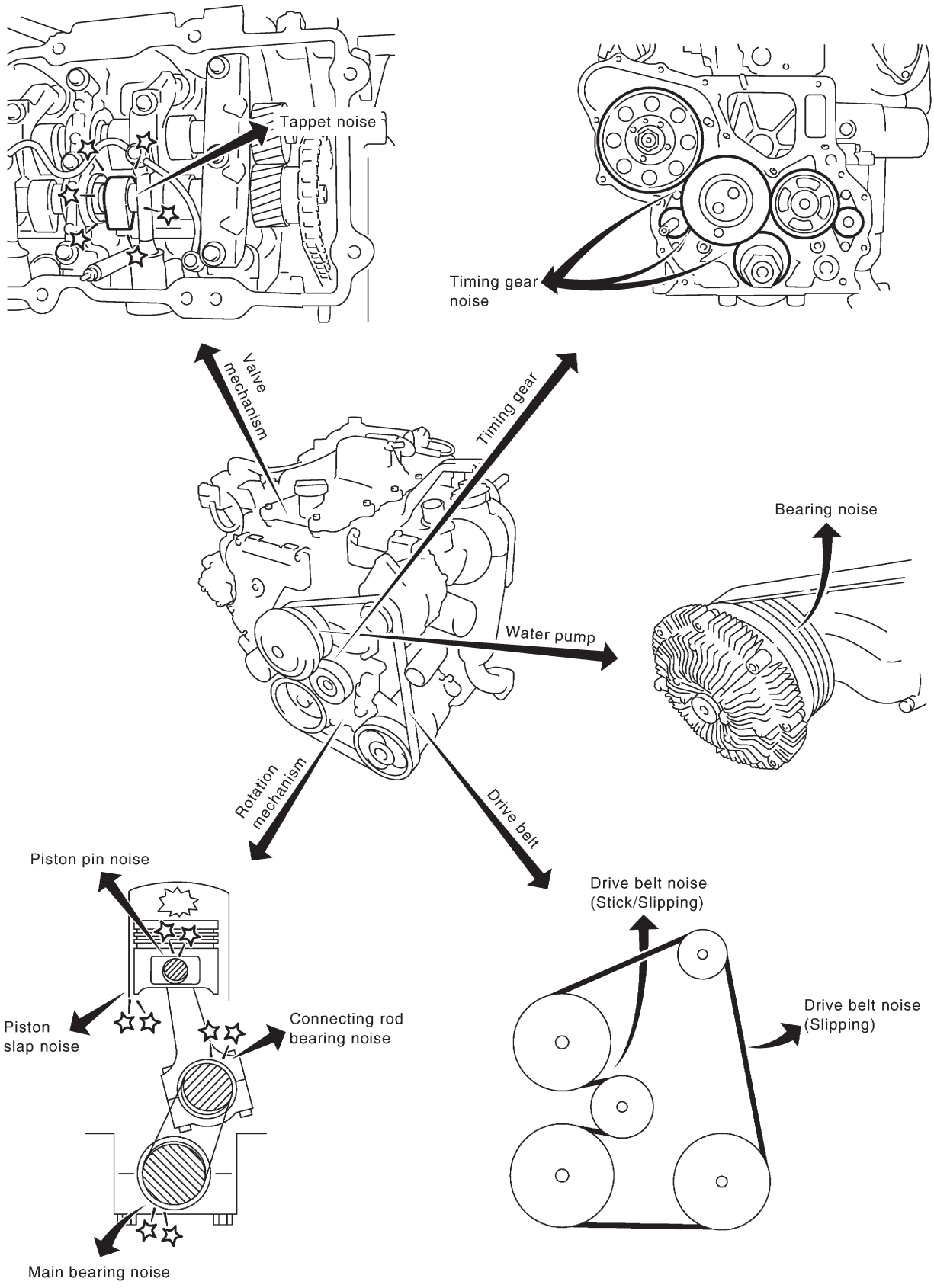
Tool name	Description	
Valve seat cutter set	 NT048	Finishing valve seat dimensions
Piston ring compressor	 NT044	Installing piston assembly into cylinder bore
Piston ring expander	 NT030	Removing and installing piston ring
Standard Universal	 NT808	Removing and installing transmission mount

Commercial Service Tools (Cont'd)

Tool name	Description
Deep socket (12 mm)	Removing and installing glow plugs



NT821


Tappet noise
Timing gear noise
Valve mechanism
Timing gear
Water pump
Bearing noise
Rotation mechanism
Drive belt
Piston pin noise
Piston slap noise
Connecting rod bearing noise
Main bearing noise
Drive belt noise (Stick/Slipping)
Drive belt noise (Slipping)

SEM290G

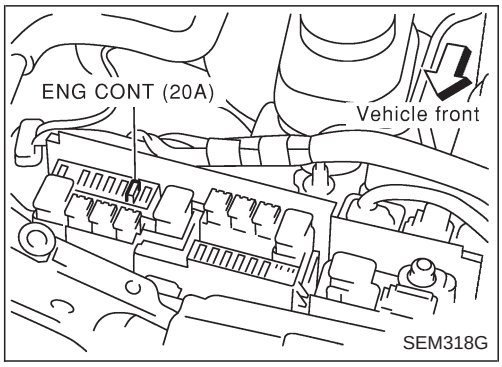
NVH Troubleshooting Chart — Engine Noise

Use the chart below to help you find the cause of the symptom.
1. Locate the area where noise occurs.
2. Confirm the type of noise.
3. Specify the operating condition of engine.
4. Check specified noise source.

If necessary, repair or replace these parts.

Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When 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	MA section (“Adjusting Intake & Exhaust Valve Clearance”, “ENGINE MAINTE-NANCE”)
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft bushing clearance Camshaft runout	EM-1032, 1032
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clear-ance Connecting rod bushing clearance	EM-1072, 1074
	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-1076, 1073, 1073, 1074
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing clearance (Small end) Connecting rod bearing clearance (Big end)	EM-1074, 1078
	Knock	A	B	—	A	B	C	Main bear-ing noise	Main bearing oil clearance Crankshaft runout	EM-1079, 1077
Front of engine Timing gear cover	Tapping or ticking	A	A	—	B	B	B	Timing gear noise	Timing gear backlash	EM-1042
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Other drive belts (Stick-ing or slip-ping)	Drive belts deflection	MA section (“Checking Drive Belts”, “ENGINE MAINTE-NANCE”)
	Creaking	A	B	A	B	A	B	Other drive belts (Slip-ping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump bearing noise	Water pump bearing opera-tion	LC section (“Water Pump Inspection”, “ENGINE COOLING SYSTEM”)

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



1. Warm up engine.
2. Turn ignition switch OFF.
3. Using CONSULT-II, make sure no error codes are indicated for self-diagnosis items. Refer to EC section, “Fuel Pressure Release”.

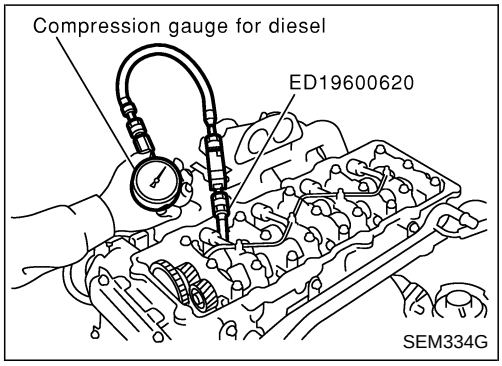
- Do not disconnect CONSULT-II until the end of this operation; it will be used to check engine rpm and for error detection at the end of this operation.

4. Disconnect the negative battery terminal.
5. Remove the following parts.

- Intercooler cover
- Intercooler
- Throttle body
- Rocker cover

6. To prevent fuel from being injected during inspection, remove fuel injection pump fuse [ENG CONT (20A)] from fuse box on the right side of engine compartment.
7. Remove glow plugs from all the cylinders.

- **Before removal, clean the surrounding area to prevent entry of any foreign materials into the engine.**
- **Carefully remove glow plugs to prevent any damage or breakage.**
- **Handle with care to avoid applying any shock to glow plugs.**



8. Install adapter (SST) to installation holes of glow plugs and connect compression gauge for diesel engine.
   : 15 - 19 N·m (1.5 - 2.0 kg-m, 11 - 14 ft-lb)
9. Connect battery negative terminal.
10. Set the ignition switch to “START” and crank. When gauge pointer stabilizes, read compression pressure and engine rpm. Repeat the above steps for each cylinder.

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

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

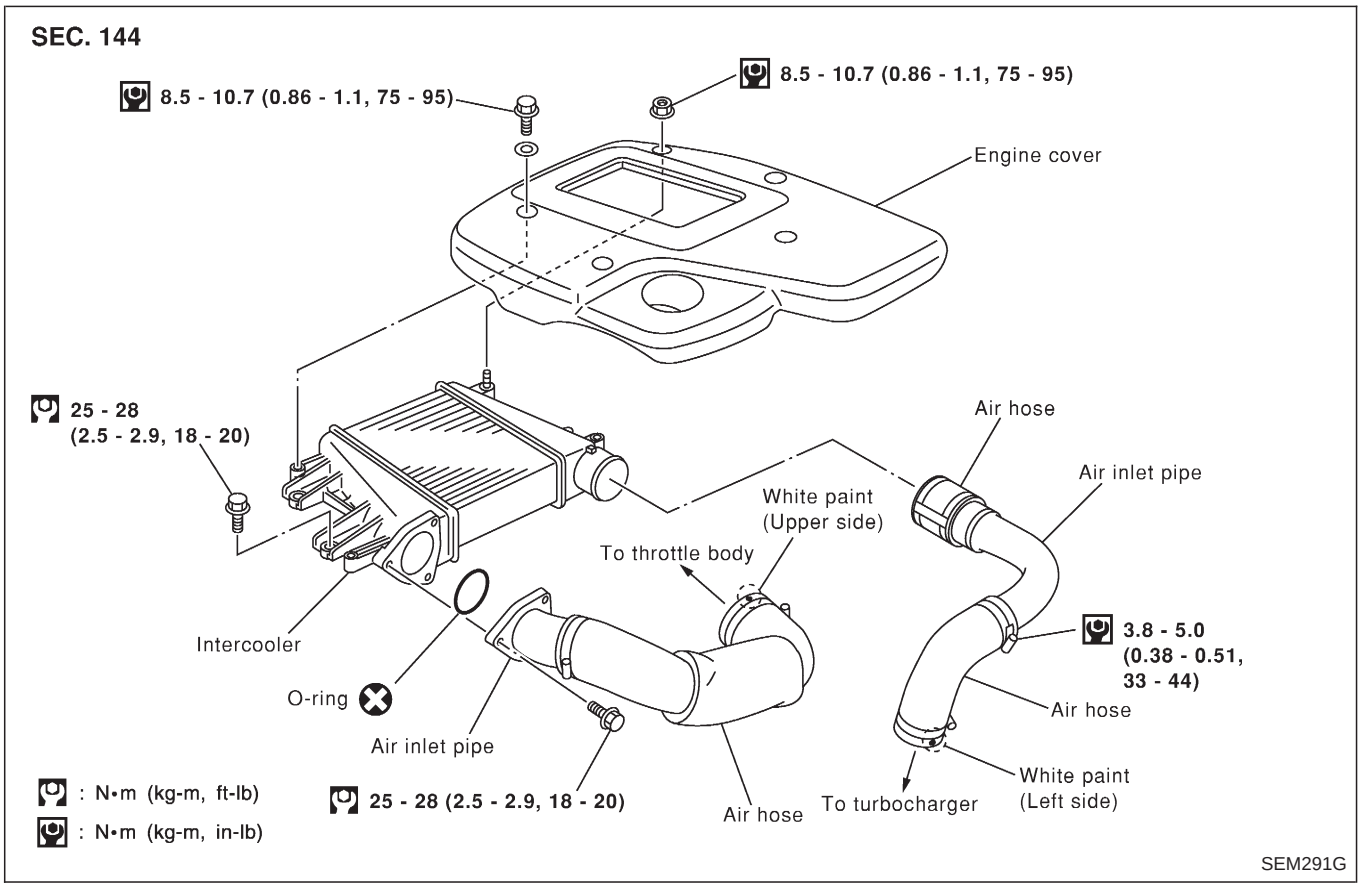
Standard	Minimum	Difference limit between cylinders
2,942 (29.42, 30.0, 427)/200	2,452 (24.52, 25.0, 356)/200	294 (2.94, 3.0, 43)/200

- When engine rpm is out of the specified range, check the specific gravity of battery liquid. Measure again under corrected conditions.
- If engine rpm exceeds the limit, check valve clearance and combustion chamber components (valves, valve seats, cylinder head gaskets, piston rings, pistons, cylinder bores, cylinder block upper and lower surfaces) and measure again.

11. Complete this operation as follows:

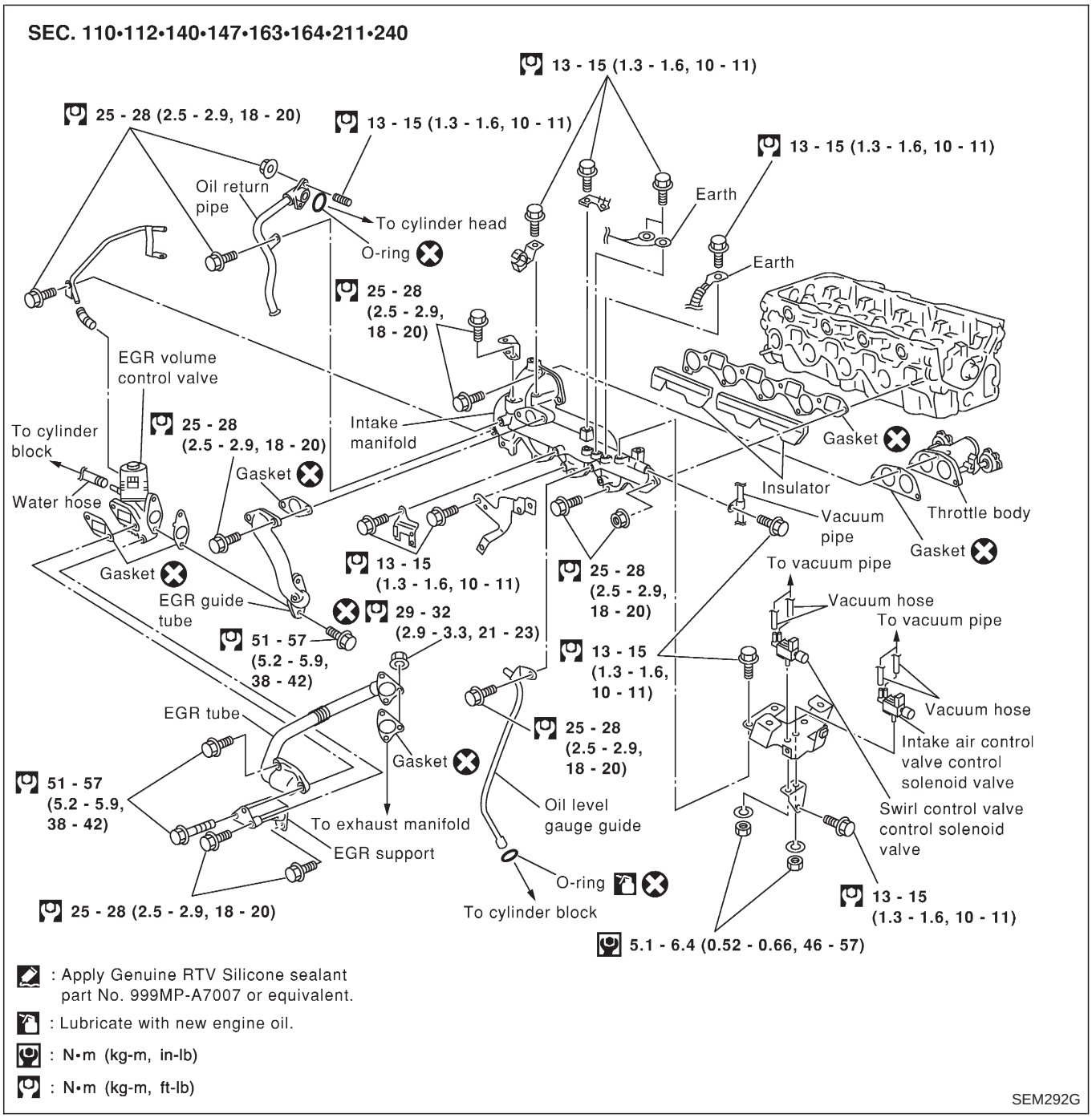
a. Turn the ignition switch to “OFF”.
b. Disconnect battery negative terminal.
c. Replace glow plug oil seals and install glow plugs.
d. Install fuel injection pump fuse [ENG CONT (20A)].
e. Connect battery negative terminal.
f. Using CONSULT-II make sure no error code is indicated for items of self-diagnosis. Refer to EC section, “Trouble Diagnosis — Index”.

Removal and Installation



CAUTION:
To avoid damaging intercooler core when flushing intercooler with high pressure water, apply water straight to the core face.

Removal and Installation

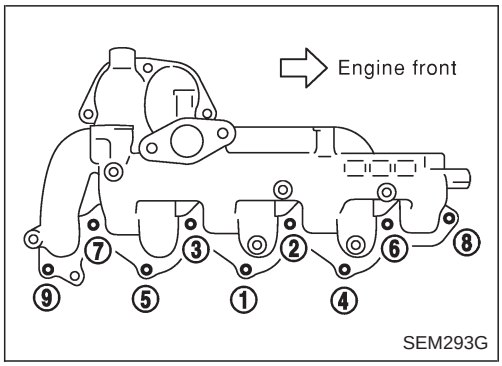


REMOVAL

1. Remove the following parts.

- Drain engine coolant. Refer to MA section, “Changing Engine Coolant”.
- Remove engine cover. Refer to the figure at left.
- Remove intercooler.
- Remove air hose (on throttle body side).
- Remove injection tube.
- Remove or relocate wires/harnesses and tubes/pipes.

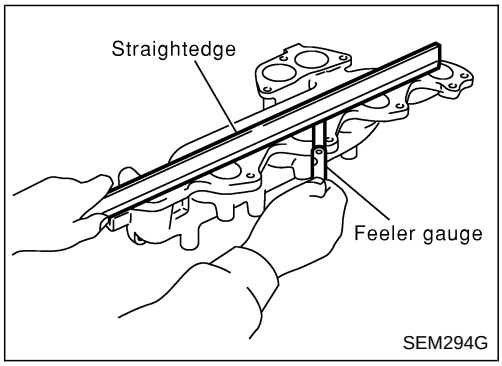
Removal and Installation (Cont'd)



SEM293G

2. Remove intake manifold in the reverse order of that shown in the figure.

Inspection



SEM294G

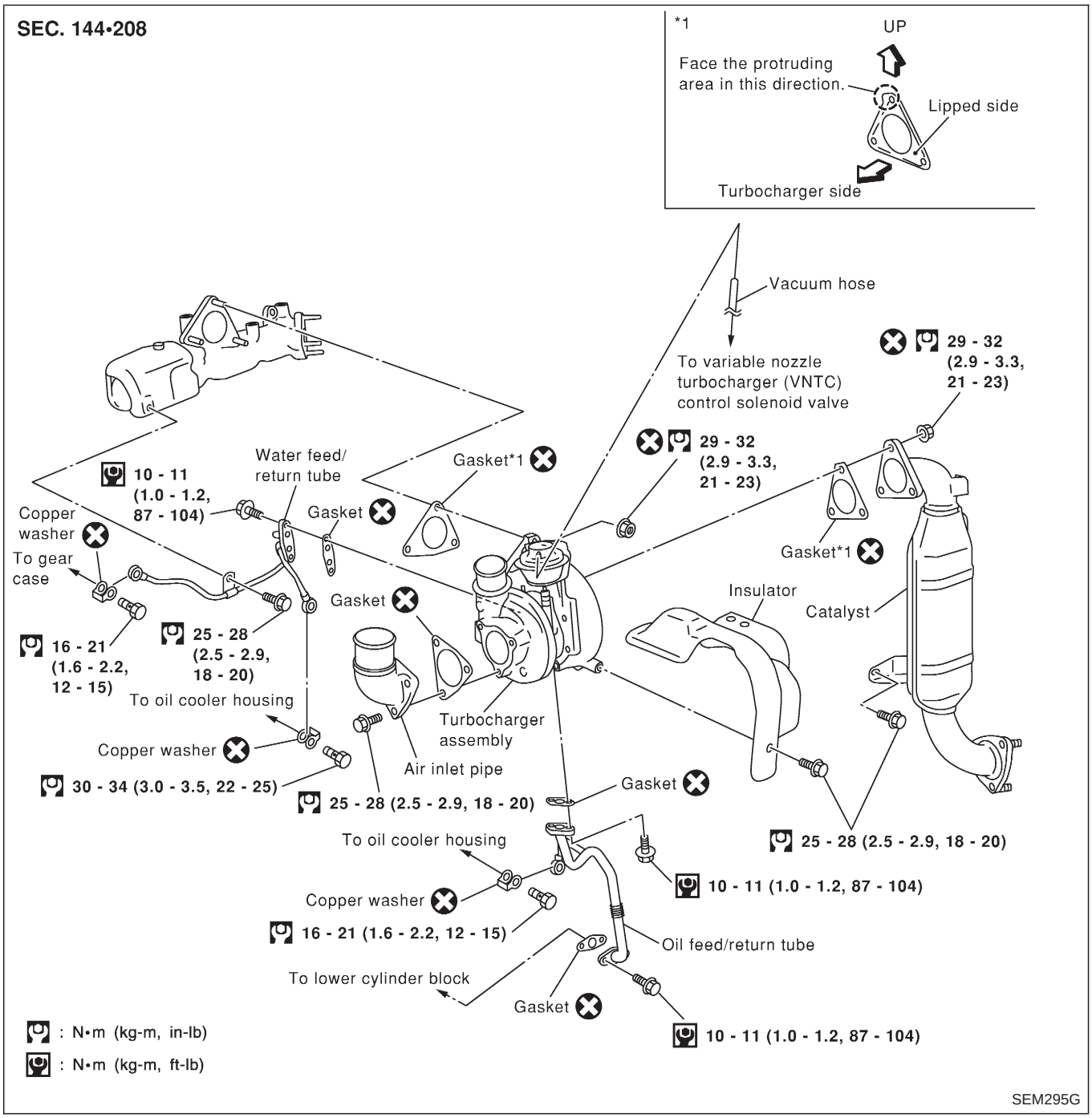
Clean surface of intake manifold.
Use a reliable straightedge and feeler gauge to check the flatness of intake manifold surface.

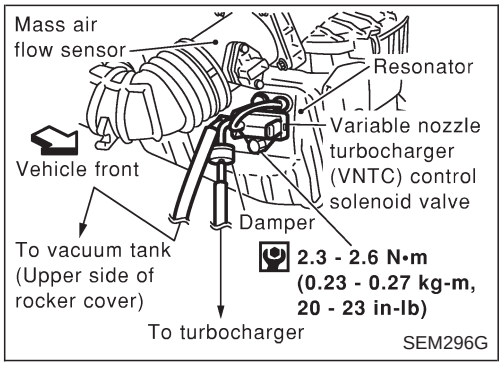
Intake manifold surface flatness:
Limit 0.2 mm (0.008 in)

INSTALLATION

1. Tighten intake manifold in the numerical order shown in the figure.
   : 25 - 28 N·m (2.5 - 2.9 kg-m, 18 - 20 ft-lb)
2. Install in the reverse order of removal.

Removal and Installation





REMOVAL

1. Remove the following parts.
- Undercover
- Under guard
- Engine coolant (drain)
  Refer to MA section, “Changing Engine Coolant”.
- Battery (on left side) (for cold areas)
- Exhaust front tube
  Refer to FE section, “Removal and Installation”, “EXHAUST SYSTEM”.
- Remove wires, harnesses, tubes and pipes.

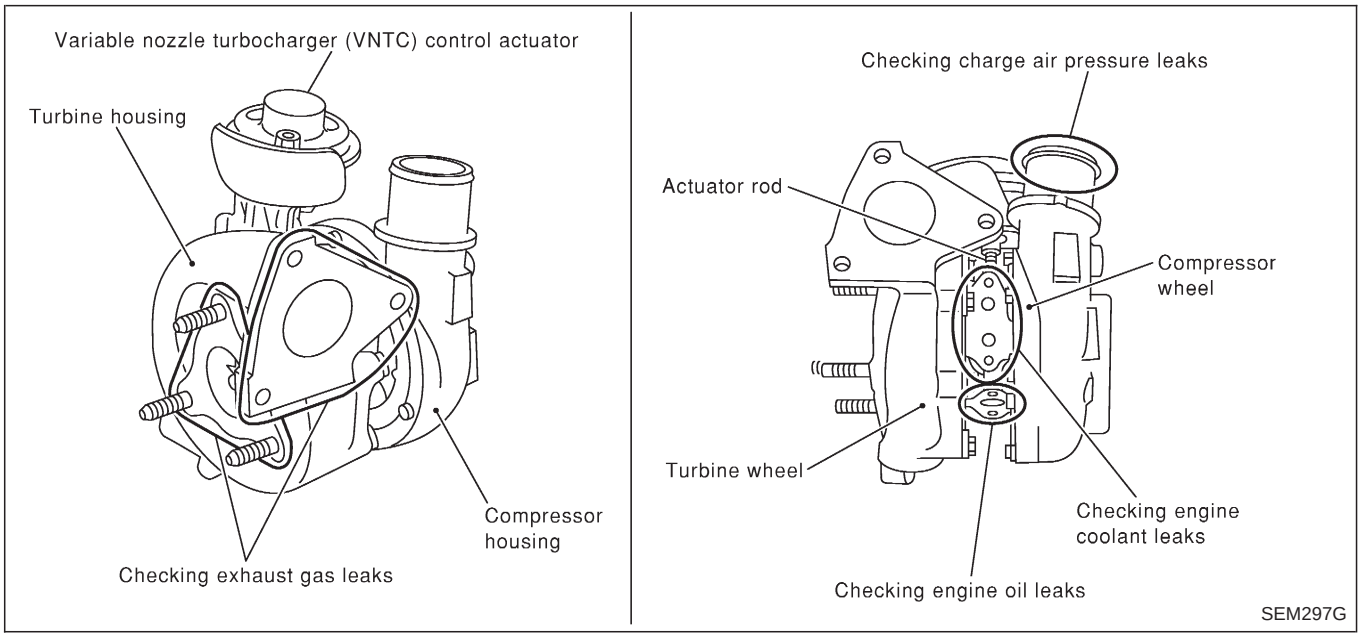
Removal and Installation (Cont'd)

2. Remove catalyst.

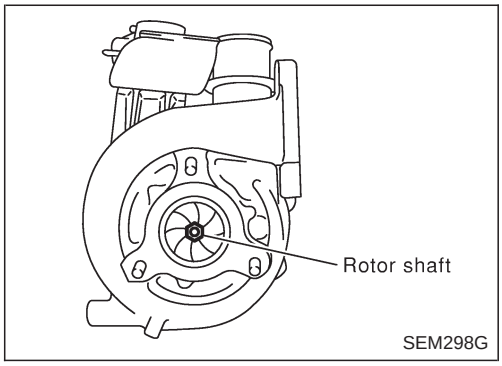
CAUTION:
Do not disassemble catalyst.

Inspection

TURBOCHARGER



CAUTION:
When the compressor wheel, turbine wheel, or rotor shaft is damaged, remove all the fragments and foreign matter left in the following passages in order to prevent a secondary failure:
Suction side: Between turbocharger and intercooler
Exhaust side: Between turbocharger and catalytic converter

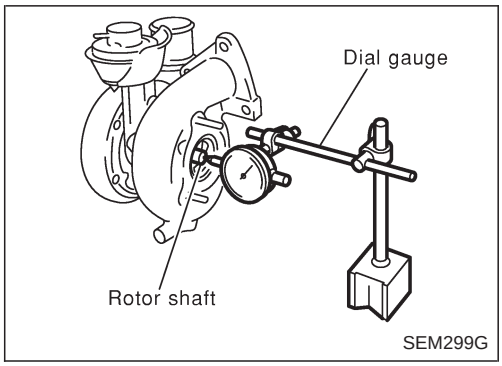


Rotor shaft

- Check that the rotor shaft rotates smoothly without any resistance when it is rotated by your fingertips.
- Check that the rotor shaft is not loose when it is moved vertically or horizontally.

Standard value for rotor shaft oil clearance:
0.086 - 0.177 mm (0.0034 - 0.0070 in)

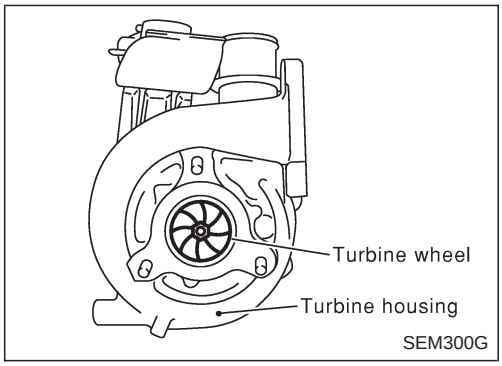
Inspection (Cont'd)



Rotor shaft end play

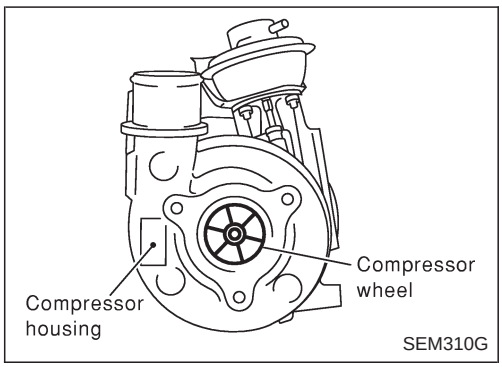
Place a dial gauge at the rotor shaft end in the axial direction to measure the end play.

Standard: 0.044 - 0.083 mm (0.0017 - 0.0033 in)



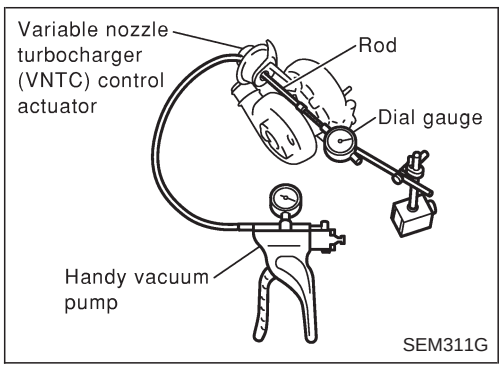
Turbine wheel

- Check that there is no oil adhesion.
- Check that there is no carbon accumulation.
- Check that blades of the turbine wheel are not bent or broken.
- Check that the turbine wheel does not interfere with the turbine housing.



Compressor wheel

- Check that there is no oil adhesion inside the air inlet.
- Check that the compressor wheel does not interfere with the compressor housing.
- Check that the wheel is not bent or broken.



VNT control actuator

- Connect the handy pump to the actuator, and check that the rod strokes smoothly in compliance with the following pressure.
- First, apply the inspection negative pressure of about −66.7 kPa (−667 mbar, −500 mmHg, 19.69 inHg), and then measure the values while reducing the negative pressure to 0.

  Standard (Vacuum pressure/rod stroke amount):
  −46.9±1.3 kPa (−469±13 mbar, −352±10 mmHg, −13.86±0.39 inHg)/0.2 mm (0.008 in)
  −30.8±0.7 kPa (−308±7 mbar, −231±5 mmHg, −9.09±0.20 inHg)/5.0 mm (0.197 in)
  Approximately −22.7 kPa (−227 mbar, −170 mmHg, −6.69 inHg)/Rod stroke end

Inspection (Cont'd)

Trouble diagnosis of turbocharger

Preliminary check:
Check that the VNT control valve system has no malfunction. Refer to EC section, "ECM Terminals and Reference Value" in "TROUBLE DIAGNOSIS — GENERAL DESCRIPTION".

- Check that the engine oil level is between MIN and MAX of the dipstick. (When the engine oil amount is more than MAX, the oil flows into the inlet duct through the blow-by gas passage, and the turbocharger is misjudged failure.)
- Ask the customer if he/she always runs the vehicle in idle engine speed to cool the oil down after driving.
- Replace the turbocharger assembly when any malfunction is found after unit inspections specified in the table below.
- If no malfunction is found after the unit inspections, judge that the turbocharger body has no failure. Check the other parts again.

Inspection item	Inspection result	Symptom (when each inspection item meets each inspection result)			
		Oil leakage	Smoke	Noise	Insufficient power/ acceleration failure
Turbine wheel	Oil leaks.	△	◎	△	△
	Carbon is accumulated.	△	◎	○	○
	Friction with housing.	△	○	◎	○
	Blades are bent or broken.			◎	◎
Compressor wheel	Inside the air inlet is seriously contaminated by oil.	○	○		
	Friction with housing.	△	○	◎	○
	Blades are bent or broken.			◎	◎
After checking both turbine and compressor, inspect rotor shaft end play.	There is resistance when the rotor shaft is rotated by your fingertips.		△	△	○
	The rotor shaft sometimes does not rotate by your fingertips.				◎
	There is too much play in the bearing.	△	△	○	△
Oil return port	Carbon or sludge is accumulated in the waste oil hole.	△	◎	△	△
Operation of VNT control actuator	● The actuator does not operate smoothly when vacuum pressure is gradually applied. ● Stroke amount is not in compliance with the vacuum pressure.		○		◎

◎: Large possibility
○: Medium possibility
△: Small possibility

INSTALLATION

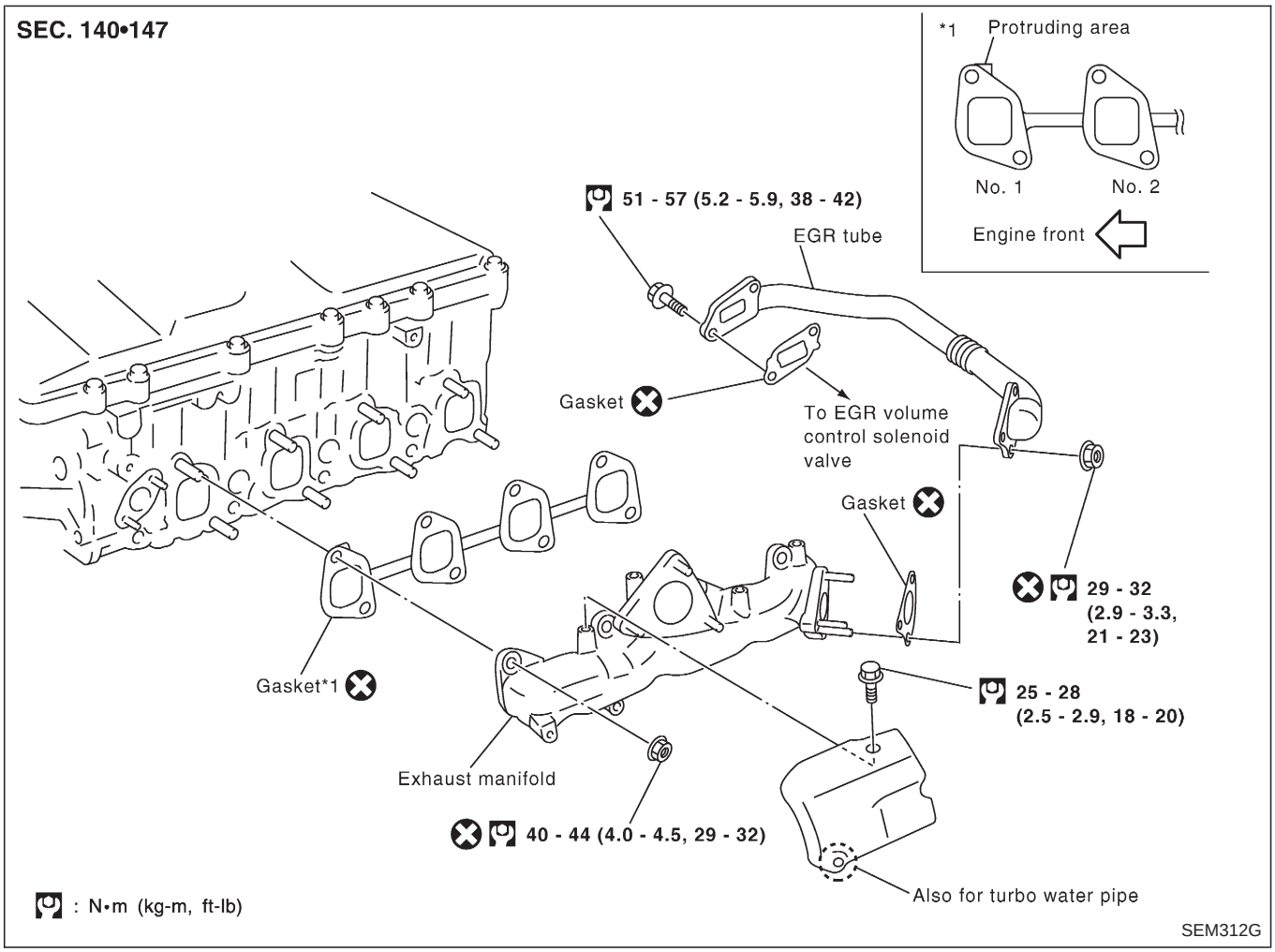
1. Install catalyst.

: 29 - 39 N·m (2.9 - 3.3 kg-m, 21 - 23 ft-lb)

Place the protruding area of the gasket between the turbocharger and the exhaust outlet upwards, and install the lipped side to the turbocharger side. Refer to the figure, EM-1014.

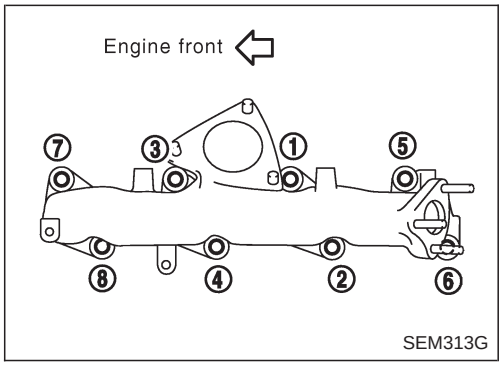
2. Install in the reverse order of removal.

Removal and Installation

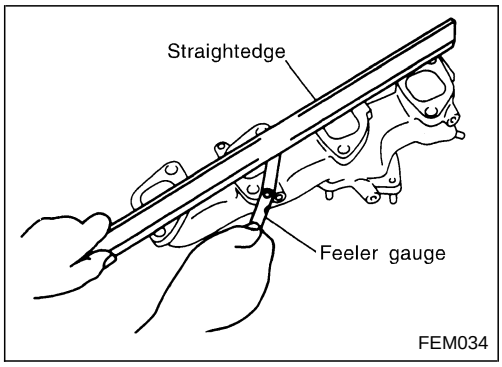


REMOVAL

1. Remove the following parts.
- Refer to “PREPARATIVE WORK” in “CATALYST AND TURBOCHARGER”, EM-1014.
- Remove catalytic converter.
- Remove turbocharger.



2. Loosen nuts holding the exhaust manifold in the reverse order of that shown in the figure.



Inspection

EXHAUST MANIFOLD

Check distortion on mounting surface with straightedge and feeler gauge.

Limit: 0.2 mm (0.008 in)

INSTALLATION

1. Tighten exhaust manifold holding nuts in the numerical order shown in the figure.

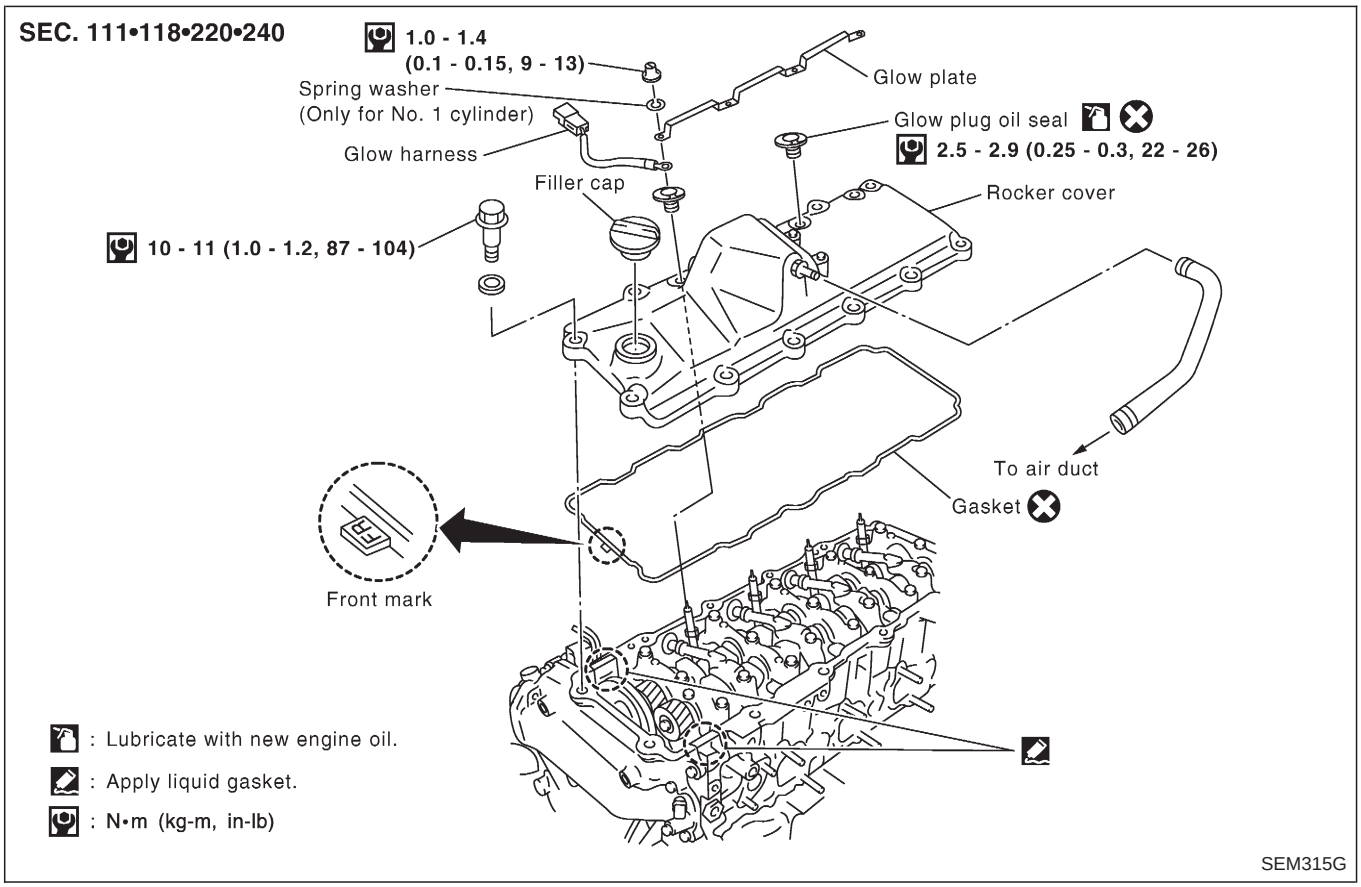
   : 40 - 44 N·m (4.0 - 4.5 kg-m, 29 - 32 ft-lb)

NOTE:

Install gasket so that the protruding tab (mark for correct installation) is positioned on the side of No. 1 port (front side). Refer to component structure diagram on the previous page.

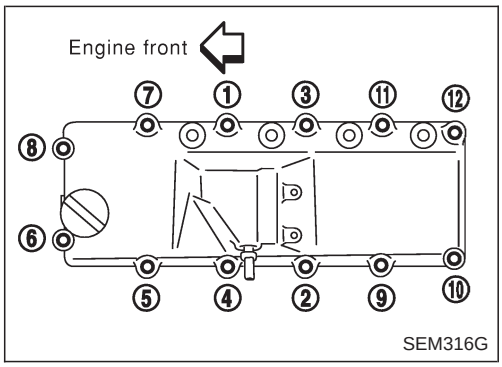
2. Install in the reverse order of removal.

Removal and Installation



REMOVAL

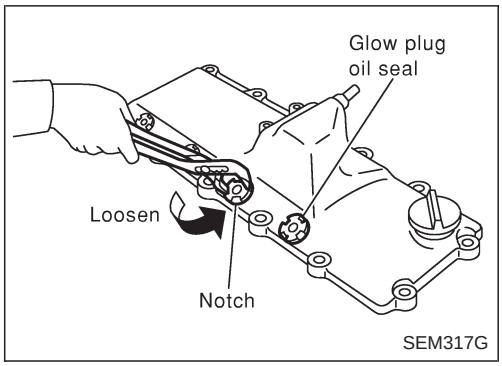
1. Remove the following parts.
- Engine cover
- Intercooler
- Air inlet pipe
- Throttle body
- Wires, harnesses, tubes and pipes



2. Loosen holding bolts in the reverse order of that shown in the figure and remove.
3. Remove rocker cover to the direction of glow plug tilt.
4. Remove glow plug oil seals.

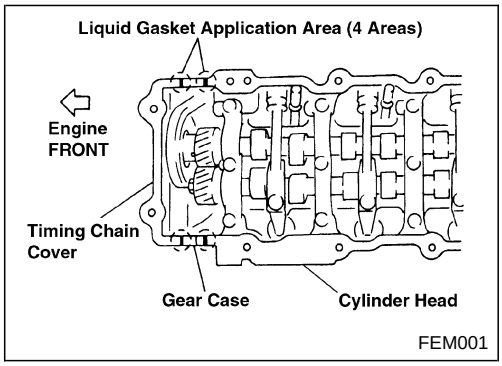
Removal and Installation (Cont'd)

INSTALLATION



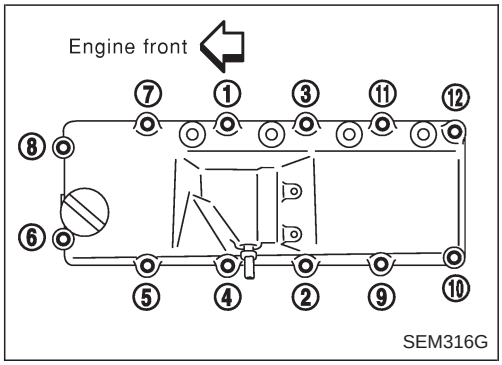
SEM317G

1. Temporarily tighten holding bolts in the numerical order shown in the figure.



FEM001

2. Apply Three Bond 1207C (KP510 00150) to the area shown in the figure.
3. Use a scraper to remove old liquid gasket.
4. Apply once more.
5. Apply engine oil to glow plug oil seals and install them.

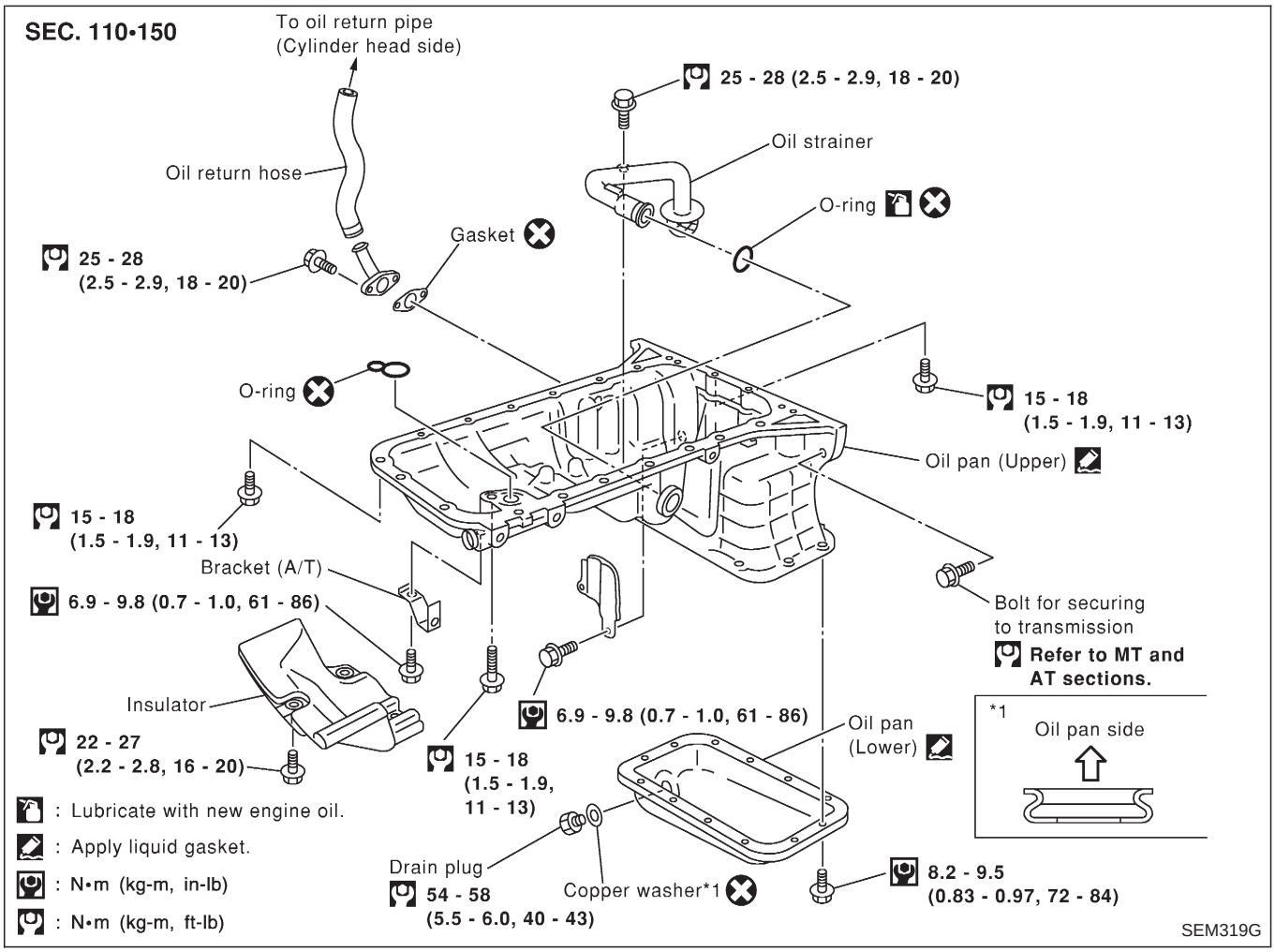


SEM316G

6. Tighten holding bolts in the numerical order shown in the figure.
7. Re-tighten to the same torque in the same order as above.

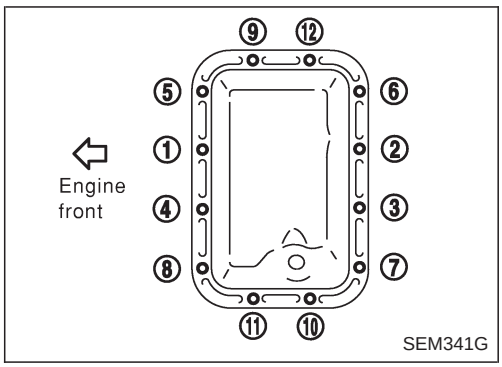
8. Install in the reverse order of removal.

Removal and Installation



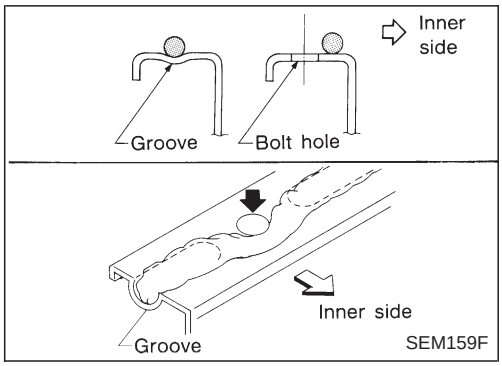
REMOVAL [OIL PAN (LOWER)]

1. Remove the following parts.
- Remove undercover.
- Extract the engine oil.



2. Loosen the installation bolts in the reverse order of that shown in the figure and then remove.
3. Using a seal cutter (SST), cut the liquid gasket to separate it.

Removal and Installation (Cont'd)



INSTALLATION [OIL PAN (LOWER)]

1. Install oil pan (Lower).

a. Use a scraper to remove all traces of liquid gasket from mating surfaces.

- Also remove traces of liquid gasket from mating surface of oil pan (Upper).
- **Remove old liquid gasket from the bolt hole and thread.**

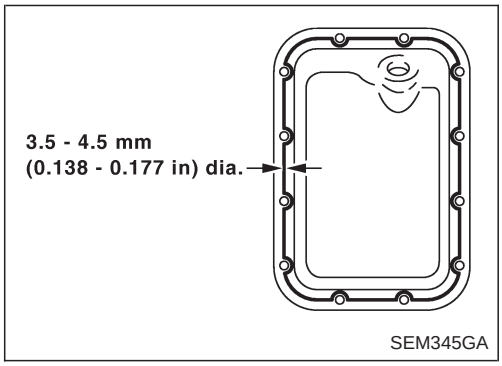
b. Apply a continuous bead of liquid gasket to mating surface of oil pan (Lower).

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

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

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

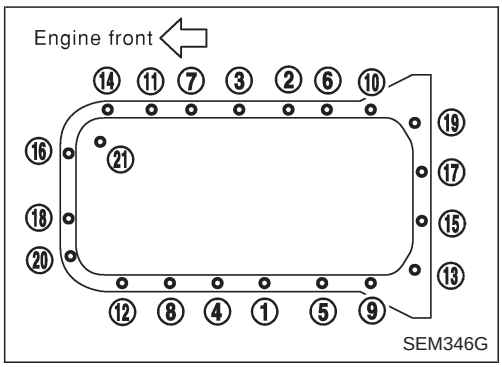
2. Tighten the installation bolts in the order shown in the figure.
3. Install in the reverse order of removal.



REMOVAL [OIL PAN (UPPER) AND OIL STRAINER]

1. Remove the following parts.

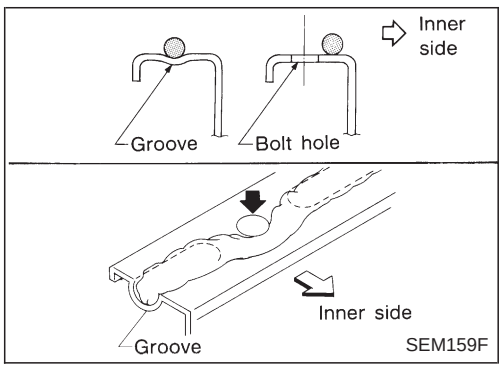
- Engine cover
- Under covers
- Stabilizer; Refer to FA section in original Service Manual.
- Exhaust front tube and its bracket; Refer to FE section in original Service Manual.
- Front propeller shaft and rear propeller shaft; Refer to PD section in original Service Manual.
- Starter motor; Refer to EL section in original Service Manual.
- A/T or M/T assembly with transfer; Refer to AT section or MT section in original Service Manual.



NOTE:

As there is a converter/clutch housing side oil pan (upper) installation bolt as well, the transmission will also need to be removed.

2. Loosen the installation bolts in the reverse order of that shown in the figure and then remove.
3. Using a seal cutter (SST), cut the liquid gasket to separate it.
4. Remove oil strainer



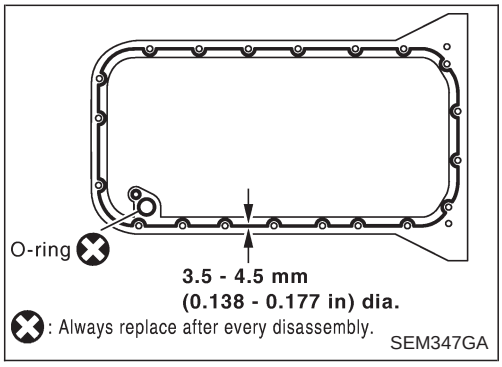
INSTALLATION [OIL PAN (UPPER) AND OIL STRAINER]

1. Clean oil strainer if any object is attached, and install oil strainer.
2. Install oil pan (Upper).

a. Use a scraper to remove all traces of liquid gasket from mating surfaces.

- Also remove traces of liquid gasket from mating surface of cylinder block, front cover and oil pan (Lower).
- **Remove old liquid gasket from the bolt hole and thread.**

b. Apply a continuous bead of liquid gasket to mating surface of oil pan (Upper).



Removal and Installation (Cont'd)

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

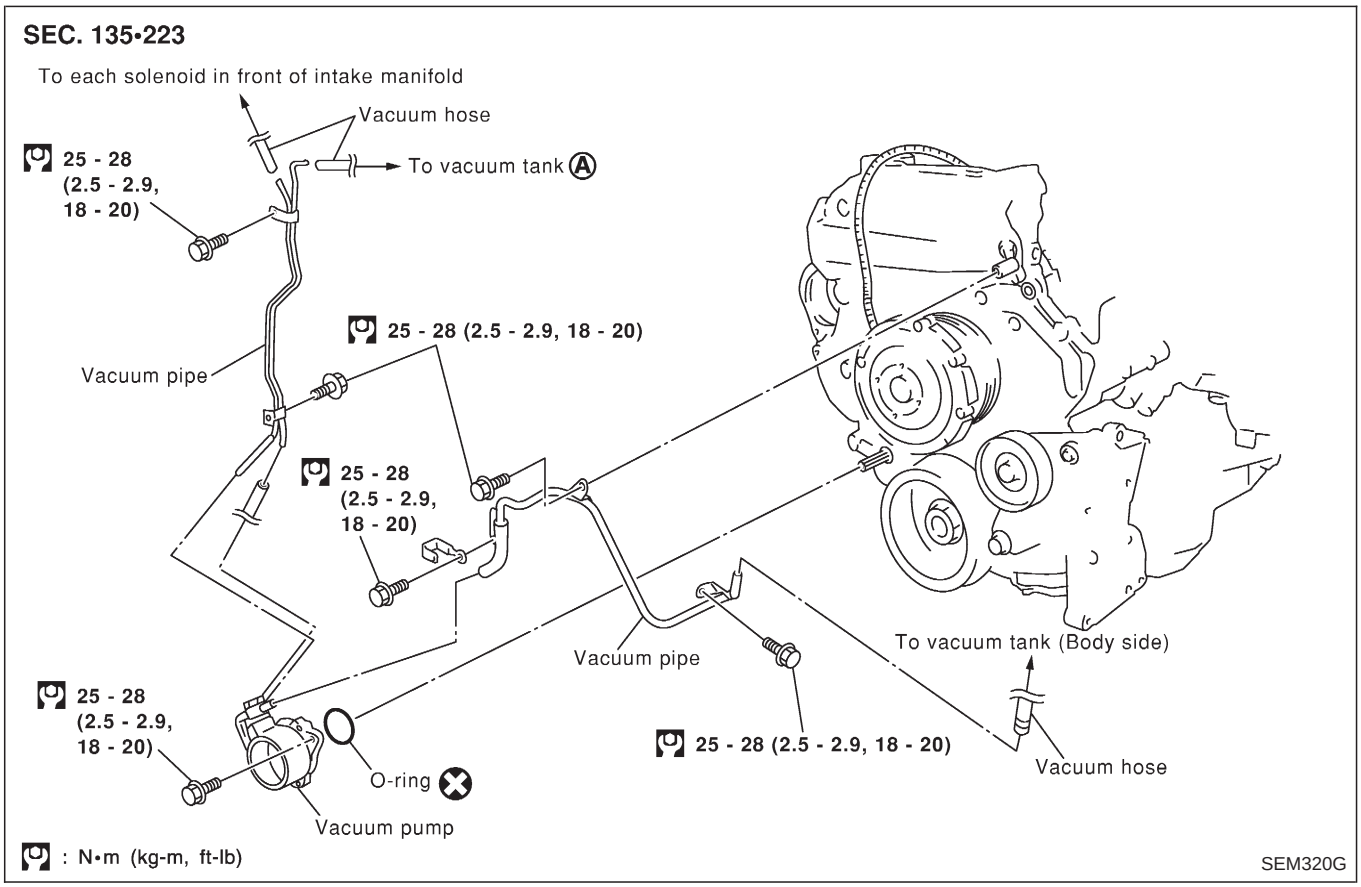
c. Apply liquid gasket to inner sealing surface as shown in figure.

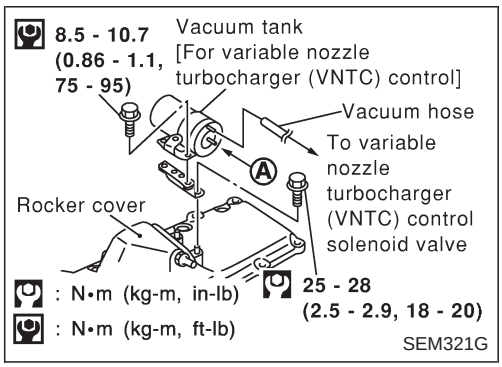
- **Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in).**
- **Attaching should be done within 5 minutes after coating.**

3. Tighten the installation bolts in the order shown in the figure. Then tighten in the same order to the torque stated.
4. The torque of the installation bolts will differ depending on position.

   Measurement below the neck of the installation bolt:
   40 mm (1.57 in) (Bolt No. 15, 17 in the figure)
   50 mm (1.97 in) (Bolt No. 21 in the figure)
   20 mm (Others)
5. Install in the reverse order of removal.

Removal and Installation



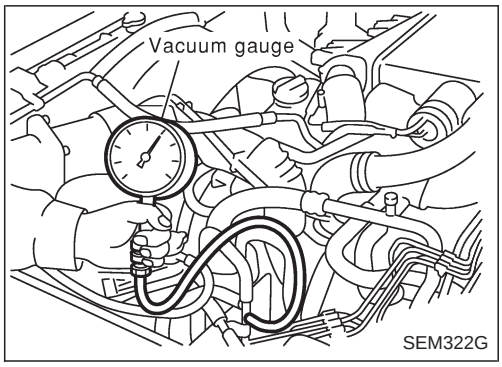


REMOVAL

1. Remove the following parts.
- Radiator under side
- Radiator shroud
- Cooling fan
- Chain cover front side
- A/T cooler hose (Disconnect)
- Vacuum hose
- Intercooler cover (When removing vacuum tank)

2. Remove the installation bolts and pull the vacuum pump from the engine front directly.
3. If it is difficult to remove from the spline shaft connection, tap lightly with a plastic hammer.

Removal and Installation (Cont'd)



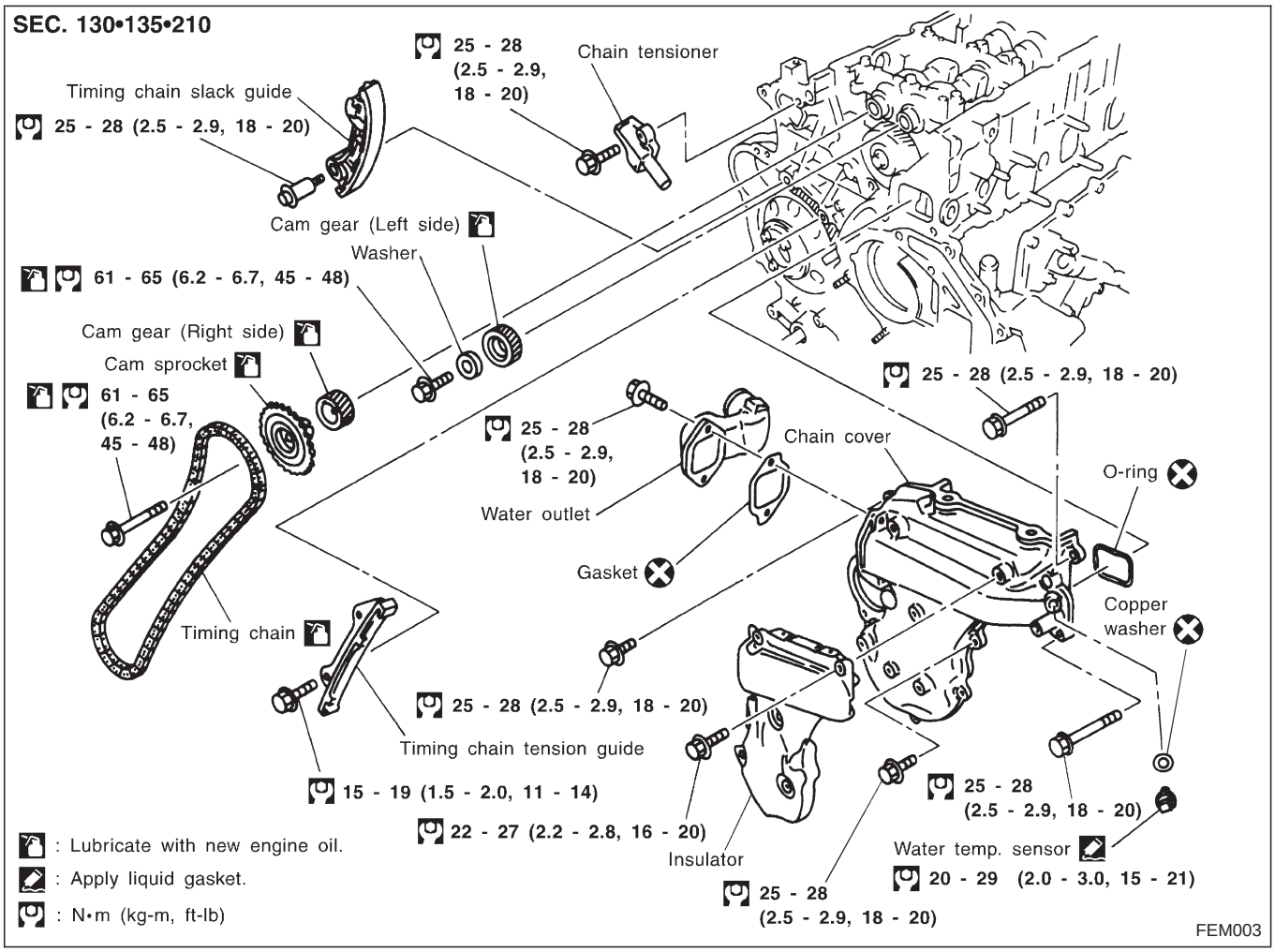
INSPECTION

1. Remove the vacuum hose. Connect the vacuum gauge through the 3-way connector. Otherwise, remove the welch valve of the vacuum pipe and attach the vacuum gauge directly. (The illustration shows the second method.)
- Remove an appropriate part to measure the vacuum pump load pressure directly and install the vacuum gauge. Refer to the figure.
2. Start the engine, and measure the load pressure with the engine idling.
   Vacuum pressure:
   Standard
   −93.3 to −101.3 kPa (−933 to −1,013 mbar, −700 to −760 mmHg, −27.56 to −29.92 inHg)
3. If outside the standard value, make sure that there is no intake of air within the circuit and measure again.
4. Replace the vacuum pump if still outside the standard value.

INSTALLATION

- Install in the reverse order of removal.

Removal and Installation



CAUTION:
As the internal mechanism of the idler gear must first of all, and always, be set by a bolt when removing the timing chain before removing the fuel injection pump and timing gear, follow the procedures on EM-1039, "Removal of timing chain after setting idler gear", "Electronic controlled fuel injection pump".

- This chapter will deal with the summary of removing the timing chain before removing the camshaft and cylinder head.

Removal

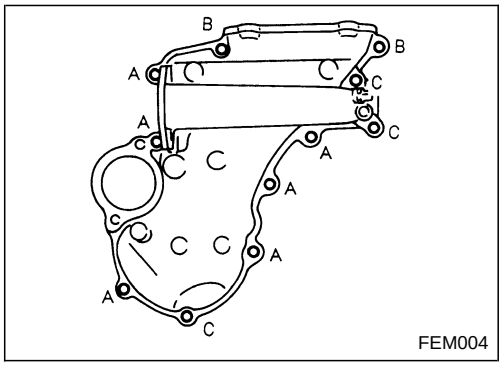
1. Remove the following parts.

- Engine cover
- Intercooler
- Air inlet pipe
- Throttle body
- Rocker cover
- Spill tube
- Coolant (Drain)
- Radiator upper hose
- Water outlet
- Radiator shroud
- Cooling fan
- Auxilary belt

Removal (Cont'd)

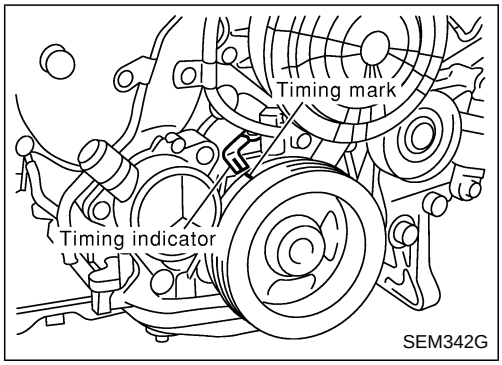
- Vacuum pipe
- Vacuum pump

2. Move the following parts.
- TDC sensor harness
- Power steering oil pump



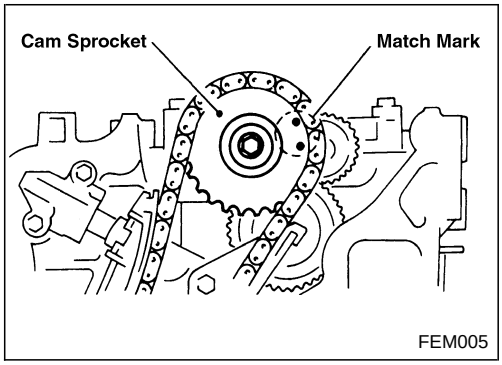
3. Remove the chain cover.
- Remove the holding bolts A to C shown in the figure.

CAUTION:
While the chain cover is removed, be careful not to allow entry of dust or foreign objects.

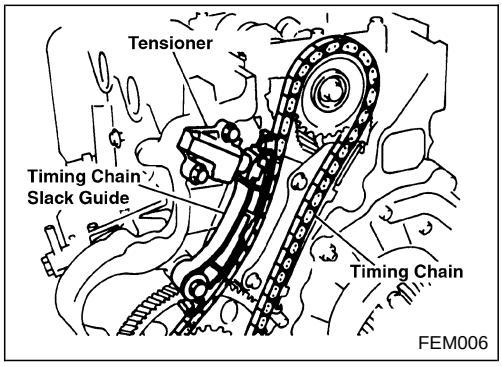


4. Set the No. 1 cylinder to the TDC.

1) Turn the crankshaft pulley clockwise, and match the timing indicator of the gear case to the timing mark of the crankshaft pulley.



2) Make sure that the cam sprocket match mark is in the position shown in the figure.
- If the match mark is not in position, turn the crankshaft pulley once more and position it.
- When removing at No. 1 cylinder TDC, each sprocket and chain is fitted using the match mark, therefore there is no need to apply any match marks beforehand.

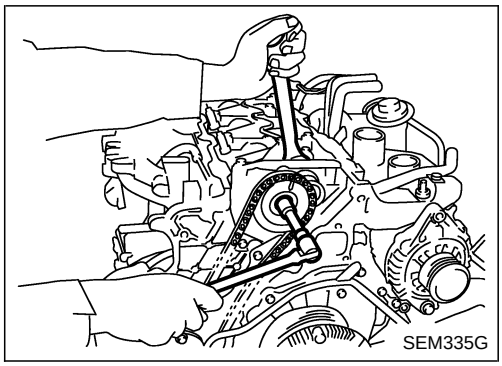


5. Remove the chain tensioner.

1) Loosen upper and lower holding bolts.
2) Holding the chain tensioner in your hand, remove the upper holding bolt and release the spring tension.
3) Remove the lower holding bolt, then remove the chain tensioner.
- The chain tensioner does not have a mechanism which prevents the ejection of the plunger. (It does have a mechanism which prevents the plunger from returning.)

CAUTION:
Be careful not to drop the plunger and spring.

Removal (Cont'd)


SEM335G

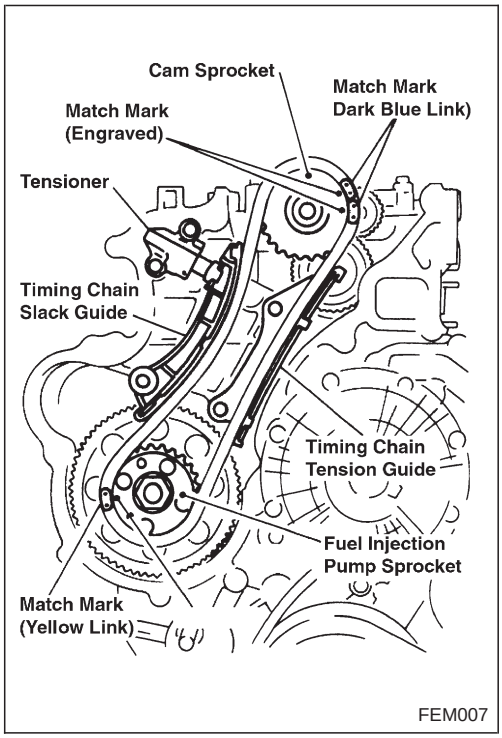
6. Remove the timing chain slack guide.
7. Remove the timing chain with cam sprocket.

- Loosen the cam sprocket holding bolt by fixing the hexagonal portion of the intake manifold side camshaft with a spanner, etc.
- If the spill tube is not removed, fix the hexagonal portion of the exhaust manifold side camshaft.

CAUTION:
Do not loosen the holding bolt by using the tension of the chain.

8. Remove the timing chain tension guide.

Installation



FEM007

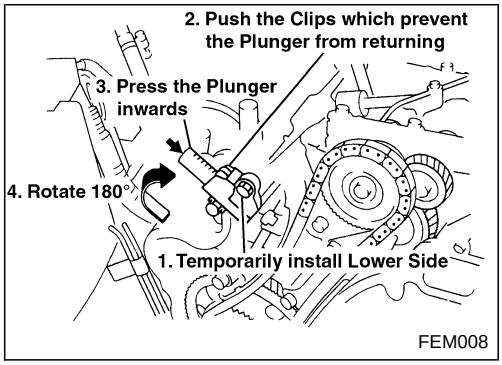
1. Install the timing chain tension guide.
2. Install the cam sprocket and the timing chain together.

- Install by aligning the sprocket and timing chain match marks.
- Tighten the cam sprocket holding bolt by fixing the hexagonal portion of the camshaft.

CAUTION:
Do not tighten in the holding bolt using the tension of the chain.

3. Install the timing chain slack guide.

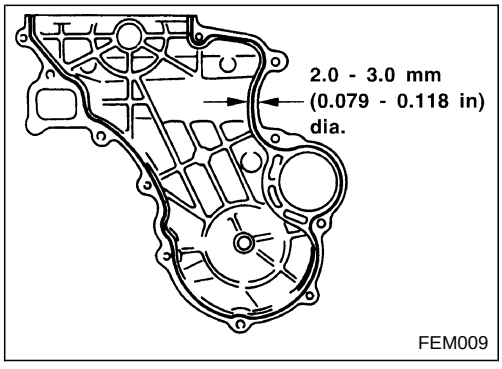
CAUTION:
When the holding bolt is tightened to the specified torque, there is a gap between the guide and bolt. Do not overtighten.



FEM008

4. Install the chain tensioner.

1) With the chain tensioner in the position shown in the figure (with the plunger on the outer side), temporarily tighten the holding bolt.
2) Press the plunger into the tensioner body while pressing on the clips which prevent the plunger from returning.
3) Install the upper side holding bolt while holding the plunger down with your finger and rotating it 180 degrees.
4) Tighten the holding bolt to the specified torque.



FEM009

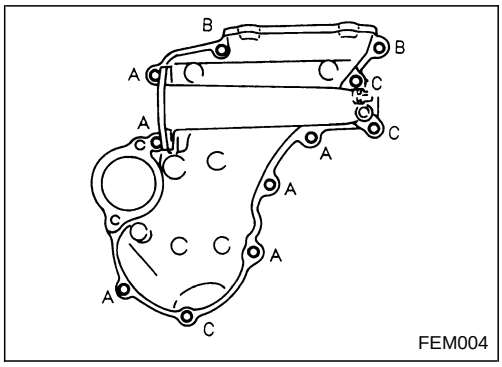
5. Install the chain cover.

1) Before installing chain cover, remove all traces of liquid gasket from mating surface using a scraper.
2) Apply a continuous bead of liquid gasket to chain cover.

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

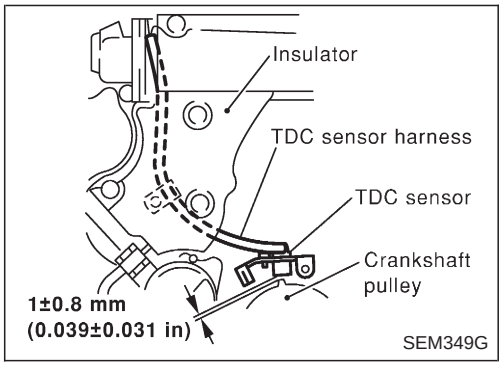
a. Coat of liquid gasket should be maintained within 2.0 to 3.0 mm (0.079 to 0.118 in) dia. range.
b. Attach chain cover to gear case within 5 minutes after coating.
c. Wait at least 30 minutes before refilling engine oil or starting engine.

Installation (Cont'd)



3) Install the chain cover.
- The dimension below the neck of the holding bolt will vary depending on the part.

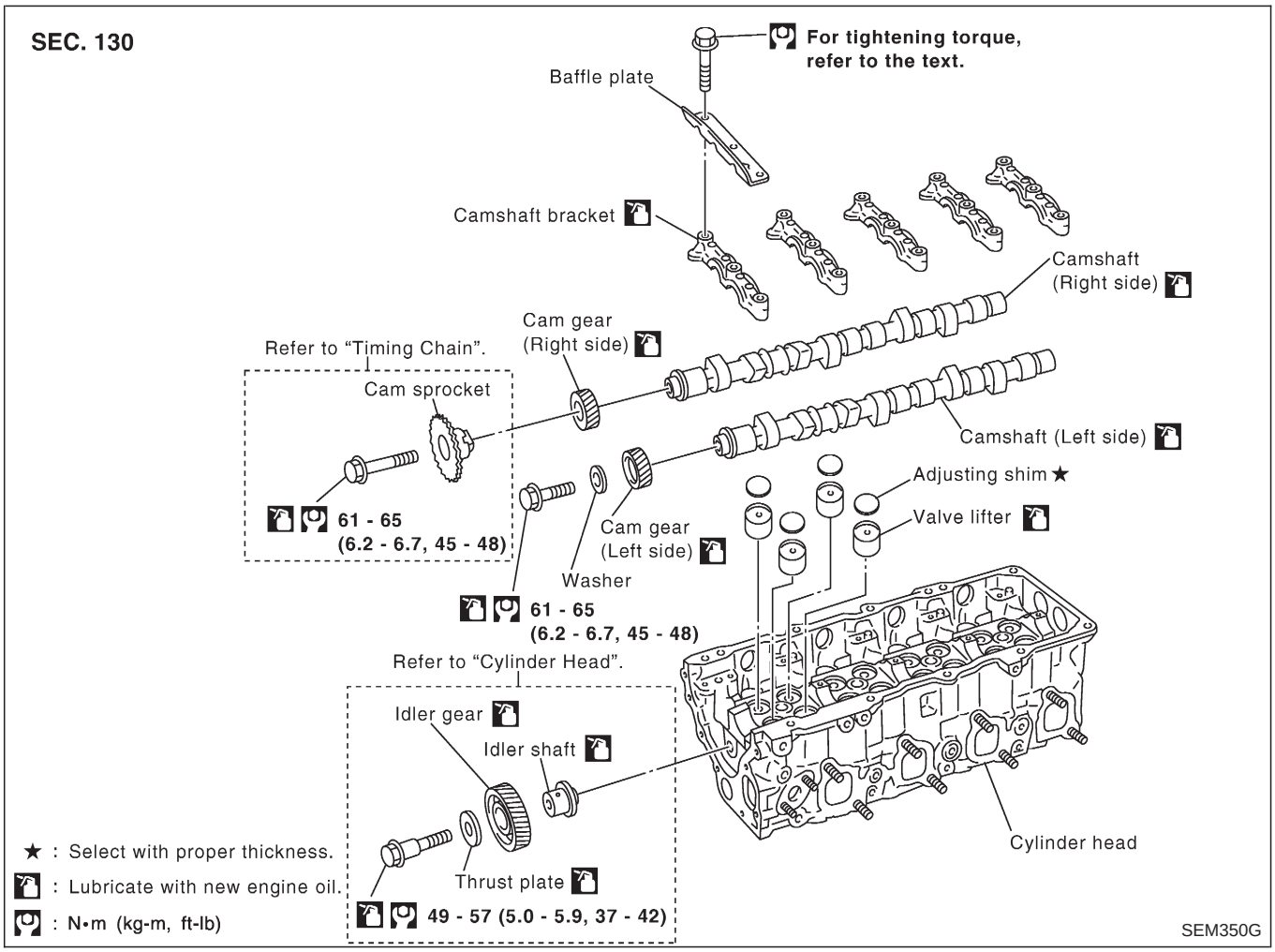
Dimension below the neck:
A: 20 mm (0.79 in)
B: 50 mm (1.97 in)
C: 60 mm (2.36 in)

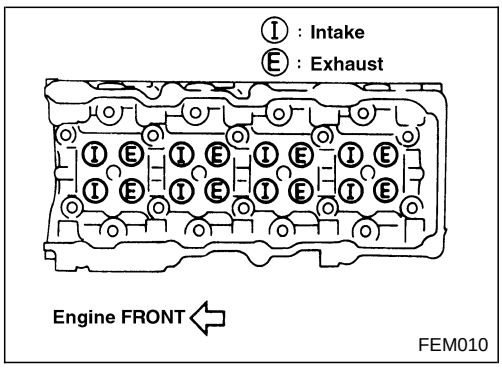


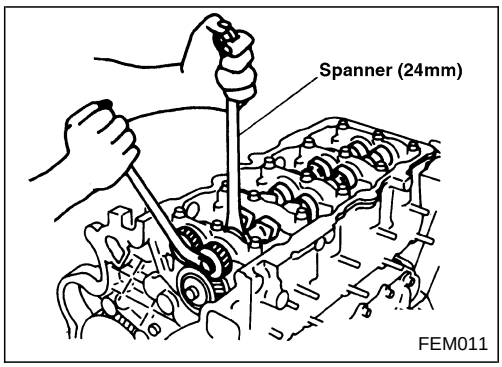
6. Install by following all removal procedures in reverse.

CAUTION:
- **Arrange the TDC sensor harness in the position shown in the figure.**
- **Make sure that the harness has no deflection around the vicinity of the crankshaft pulley when installing the clamp.**

Removal and Installation







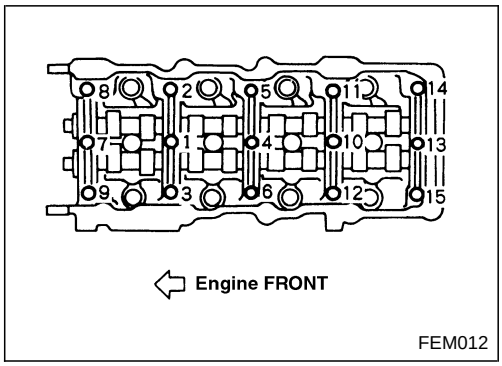
- This engine will have a different valve arrangement from normal DOHC 4-valve type engines. As both camshafts on this engine have intake and exhaust cams, in this chapter they are named as follows:
  Camshaft (Right side): Intake manifold side camshaft
  Camshaft (Left side): Exhaust manifold side camshaft
- The same parts are used for the right and left sides.
- Refer to the figure for intake and exhaust valve arrangement. (The camshafts have, alternately, either an intake valve or an exhaust valve.)

Removal

1. Set the No. 1 cylinder at TDC, then remove the chain case, timing chain and other parts in connection. Refer to "TIMING CHAIN", EM-1027.
2. Remove the cam gear.

- Loosen the cam gear installation bolt by fixing the hexagonal portion of the camshaft.
- The idler gear cannot be removed at this point as the gear case is in the way. (The cylinder head can be removed as a single unit.)

Removal (Cont'd)

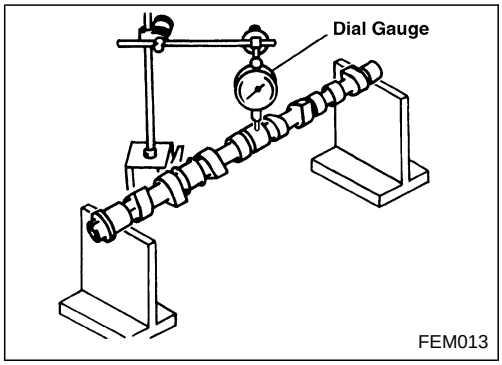


3. Remove injection tube and injection nozzle assembly. Refer to EC section, "Injection Tube and Injection Nozzle" in "BASIC SERVICE PROCEDURE".
4. Remove the camshaft.
- Place distinguishing marks on the right and left sides with paint.
- Loosen and remove the installation bolt in reverse order shown in the figure.
5. Remove the adjusting shim and valve lifter.
- Remove by taking notice of the installation position, and place outside engine in order to prevent confusion.

Inspection

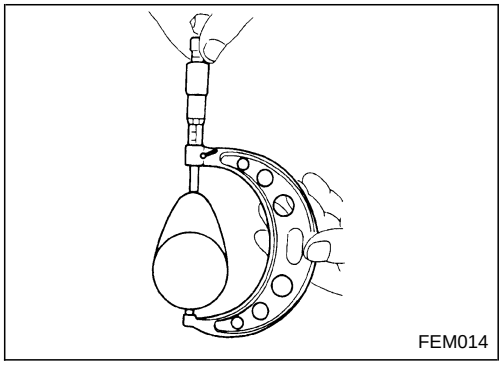
VISUAL CHECK OF CAMSHAFT

- Check the camshaft for one sided wear or scratches.
- Replace the camshaft if there are abnormalities.



CAMSHAFT RUNOUT

- Prepare V-block on a flat surface and secure camshaft journals No. 1 and No. 5.
- Set the dial gauge vertically on journal No. 3.
- Rotate camshaft in one direction by hand, then read needle movement on dial indicator.
  Camshaft bend value is 1/2 of needle movement.
  Limit: 0.02 mm (0.0008 in)



HEIGHT OF CAM NOSE

Measure by using a micrometer.

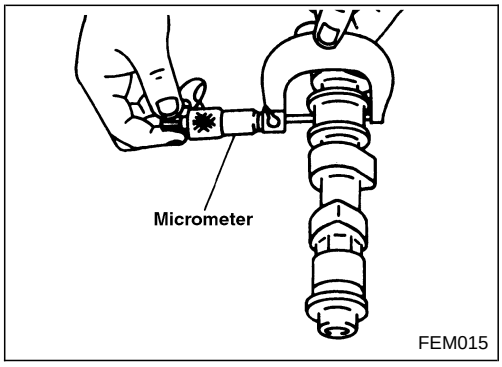
Standard:

Intake

40.488±0.02 mm (1.5940±0.0008 in)

Exhaust

40.850±0.02 mm (1.6083±0.0008 in)



CAMSHAFT OIL CLEARANCE

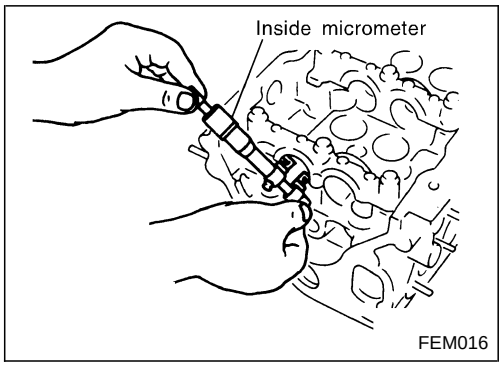
Measure by using a micrometer.

Cam journal outer diameter:

Standard

29.931 - 29.955 mm (1.1784 - 1.1793 in) dia.

Inspection (Cont'd)



CAMSHAFT BRACKET INNER DIAMETER

- Install camshaft bracket and tighten bolts to the specified torque.
- Measure inner diameter of camshaft bracket using an inside micrometer.

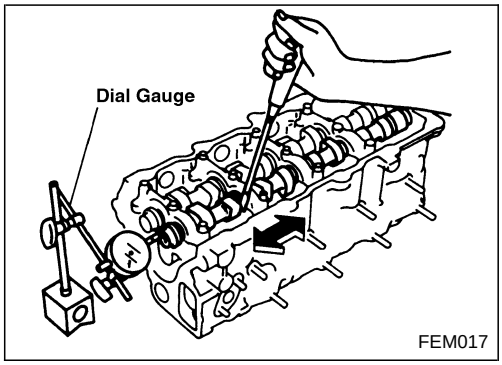
Standard: 30.000 - 30.021 mm (1.1811 - 1.1819 in) dia.

CAMSHAFT OIL CLEARANCE CALCULATIONS

Oil clearance = Cam bracket inner diameter − Cam journal outer diameter

Standard: 0.045 - 0.090 mm (0.0018 - 0.0035 in) dia.

- If it exceeds the standard value, refer to the standard value of each unit, then replace the camshaft and/or cylinder head.
- As the camshaft bracket is manufactured with the cylinder head, it is impossible to replace only the camshaft bracket.



CAMSHAFT END PLAY

- Set the dial gauge to the front end of the camshaft. Measure the end play by moving the camshaft in the direction of the axle.

Standard: 0.065 - 0.169 mm (0.0026 - 0.0067 in)
Limit: 0.2 mm (0.0079 in)

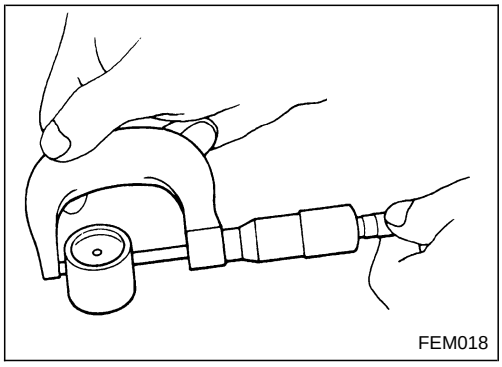
- If end play exceeds the limit, replace camshaft and measure camshaft end play again.
- If end play still exceeds the limit after replacing camshaft, replace cylinder head.

VISUAL INSPECTION OF VALVE LIFTER

Check lifter side for any signs of wear or damage. Replace if there are any abnormalities.

VISUAL INSPECTION OF ADJUSTING SHIM

Check cam nose contact and sliding surfaces for wear and scratches. Replace if there are any abnormalities.

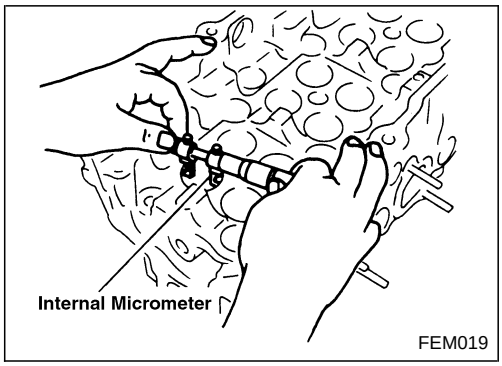


VALVE LIFTER CLEARANCE

Measure the outer diameter of the valve lifter with a micrometer.

Standard: 34.450 - 34.465 mm (1.3563 - 1.3569 in) dia.

Inspection (Cont'd)



VALVE LIFTER BORE DIAMETER

Measure the bore diameter of the cylinder head valve lifter with an inside micrometer.

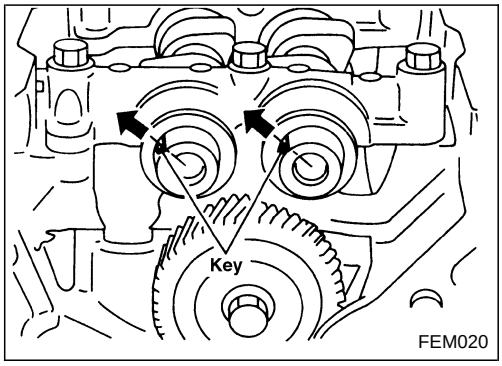
Standard: 34.495 - 34.515 mm (1.3581 - 1.3589 in) dia.

VALVE LIFTER CLEARANCE CALCULATIONS

Clearance = Valve lifter bore diameter − Valve lifter outer diameter

Standard: 0.030 - 0.065 mm (0.0012 - 0.0026 in)

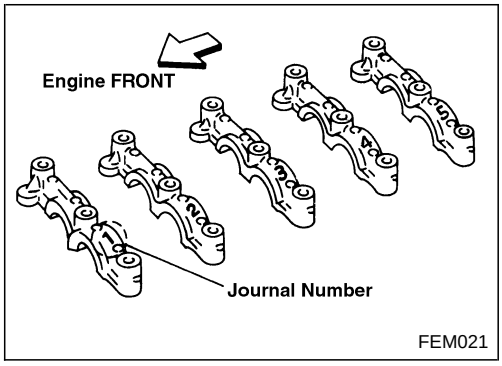
If it exceeds the standard value, refer to the outer diameter and bore diameter standard values and replace valve lifter and/or cylinder head.



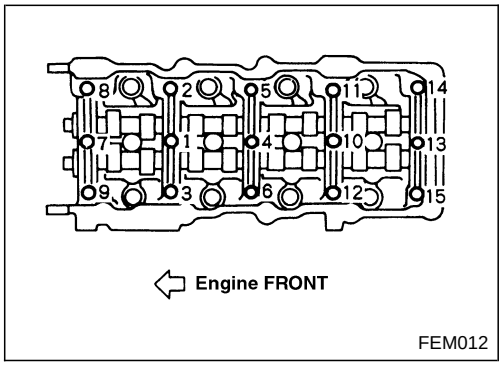
Installation

1. Install the valve lifter and adjusting shim.
- Make sure that these are installed in the same position as before the removal process.

2. Install the camshaft.
- Follow the distinguishing marks that were placed on in the removal process.
- Face the key in the direction shown in the figure.



3. Install the camshaft bracket.
- Refer to the camshaft bracket upper side journal No. and install.
- Looking from the exhaust manifold side (left side of engine), install in the direction that the journal number can be read correctly.
- Place baffle plate onto upper face of No. 1 camshaft bracket, and tighten together.

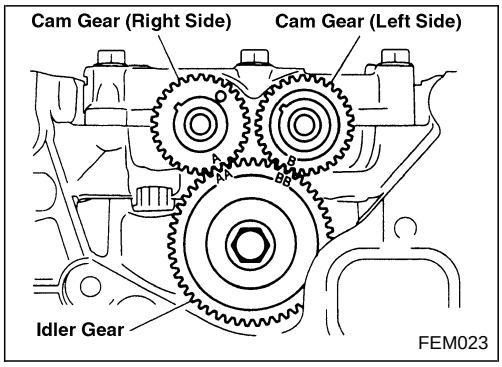


4. Tighten the installation bolts in numerical order in the figure.

1) Tighten to 10 to 14 N·m (1.0 to 1.5 kg-m, 8 to 10 ft-lb).
- Make sure that the thrust portion of the camshaft is fitted properly in the head installation side.

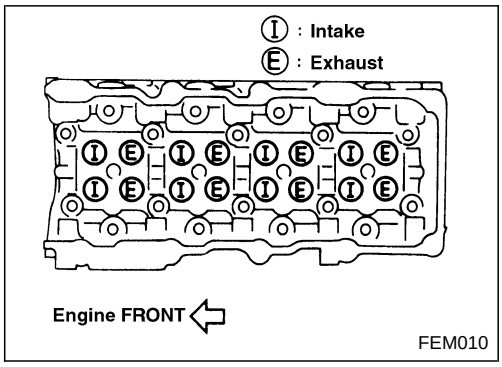
2) Tighten to 20 to 23 N·m (2.0 to 2.4 kg-m, 15 to 17 ft-lb).

Installation (Cont'd)



5. Install the cam gear.
- Align the match marks, and install the idler gear and each cam gear to the position shown in the figure.
- Tighten the cam gear installation bolt by fixing the hexagonal portion of the camshaft.

6. Install the timing chain, all other related parts and chain cover.
   Refer to "TIMING CHAIN", EM-1027.
7. After installing the timing chain, check and adjust the valve clearance before installing the spill tube.
   Refer to "VALVE CLEARANCE", EM-1036.
8. Install in the reverse order of removal.



FEM010

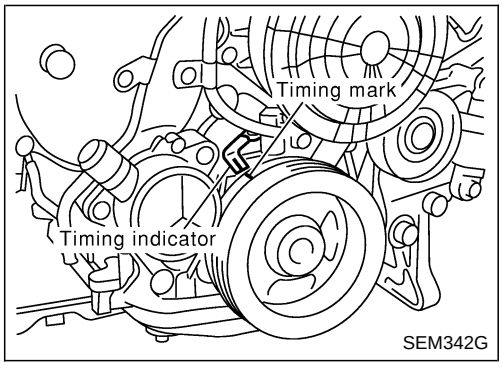
Inspection

- When the camshaft or parts in connection with valves are removed or replaced, and a fault has occurred (poor starting, idling, or other faults) due to the misadjustment of the valve clearance, inspect as follows.
- Inspect and adjust when the engine is cool (at normal temperature).
- Be careful of the intake and exhaust valve arrangement. (The valve arrangement is different from that in a normal engine.) (The camshafts have, alternately, either an intake valve or an exhaust valve.)

1. Remove the following parts.
- Intercooler cover
- Intercooler
- Rocker cover

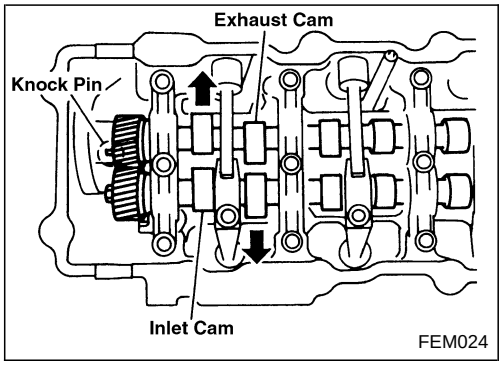
2. Set the No. 1 cylinder at TDC.

1) Rotate the crankshaft pulley clockwise, and align the TDC mark of the crankshaft pulley with the timing indicator of the TDC sensor bracket.



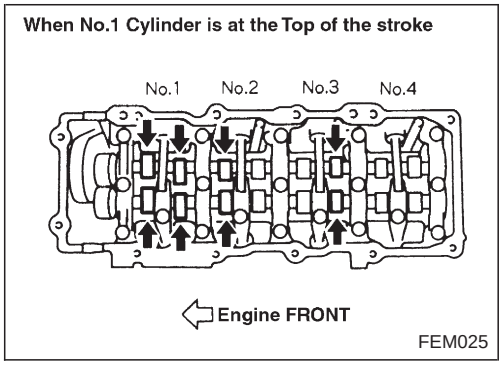
SEM342G

2) Confirm that the cam nose of the No. 1 cylinder and the knock pin of the cam sprocket is in the position shown in the figure.
- Rotate the crankshaft pulley again if not in the position shown in the figure.



FEM024

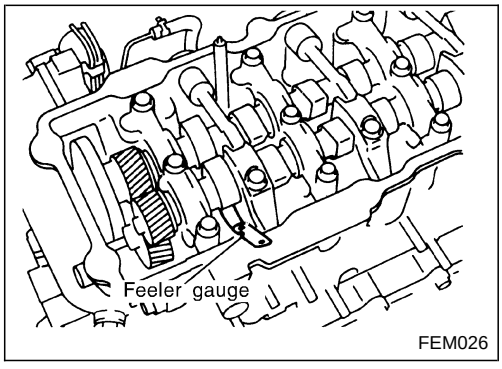
3. While referring to the figure, measure the valve clearance in the circled area of the table below.



FEM025

Measuring point	No. 1		No. 2		No. 3		No. 4	
	INT	EXH	INT	EXH	INT	EXH	INT	EXH
When the No. 1 cylinder is in the TDC	○	○	○			○		

- The injection order is 1-3-4-2.



FEM026

- Measure the valve clearance using a JIS high grade feeler gauge when the engine is cool (at normal temperature).

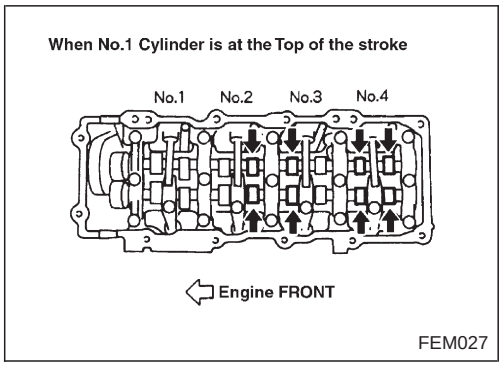
Standard:

Intake and exhaust

0.35±0.05 mm (0.0138±0.0020 in)

4. Set the No. 4 cylinder at TDC by rotating the crankshaft clockwise once.

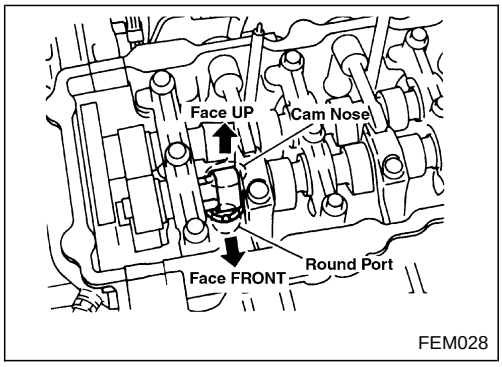
Inspection (Cont'd)



5. While referring to the figure, measure the valve clearance in the circled area of the table below.

Measuring point	No. 1		No. 2		No. 3		No. 4	
	INT	EXH	INT	EXH	INT	EXH	INT	EXH
When the No. 4 cylinder is in the TDC				○	○		○	○

6. If the valve clearance is outside the specification, adjust as follows.

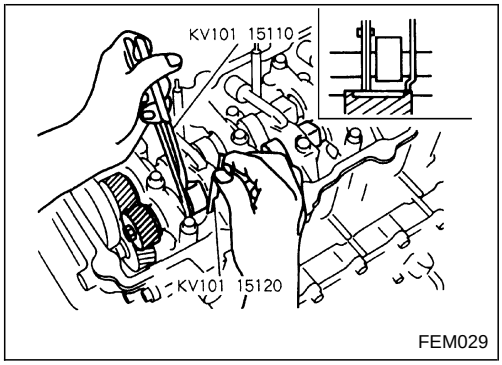


Adjustments

- Remove the adjusting shim for parts which are outside the specified valve clearance.

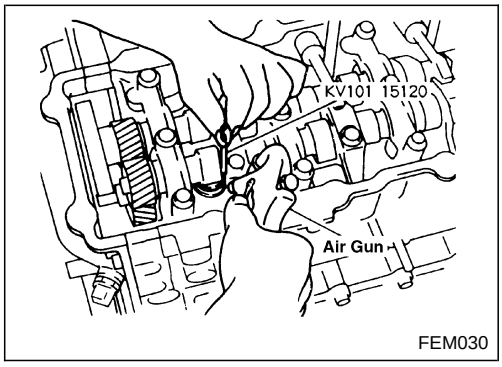
1. Remove the spill tube.
2. Extract the engine oil on the upper side of the cylinder head (for the air gun used in step 7).
3. Rotate the crankshaft to face the cam for adjusting shims that are to be removed upward.
4. Grip the camshaft with camshaft pliers (SST), the using the camshaft as a support point, push the adjusting shim downward to compress the valve spring.

CAUTION:
Do not damage the camshaft, cylinder head, or the outer circumference of the valve lifter.



5. With the valve spring in a compressed state, remove the camshaft pliers (SST) by securely setting the outer circumference of the valve lifter with the end of the lifter stopper (SST).
- Hold the lifter stopper by hand until the shim is removed.

CAUTION:
Do not retrieve the camshaft pliers forcefully, as the camshaft will be damaged.

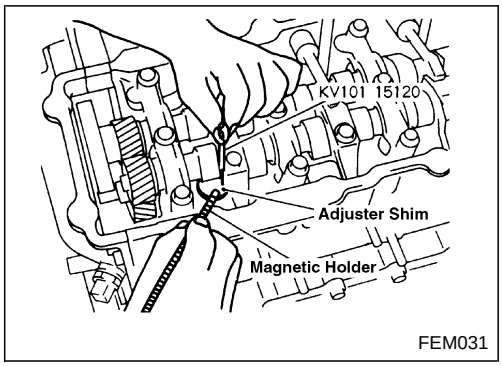


6. Move the rounded hole of the adjusting shim to the front with a very thin screwdriver.
- When the adjusting shim on the valve lifter will not rotate smoothly, restart from step 4 with the end of the lifter stopper (SST) touching the adjusting shim.

7. Remove the adjusting shim from the valve lifter by blowing air through the rounded hole of the shim with an air gun.

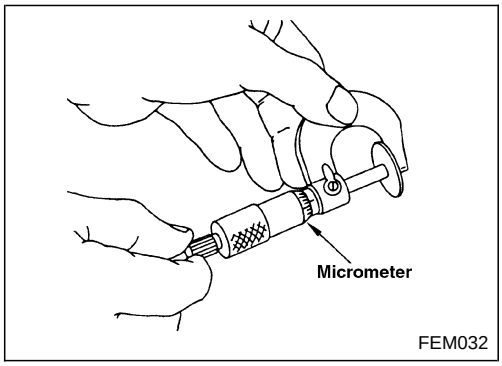
CAUTION:
To prevent any remaining oil from being blown around, thoroughly wipe the area clean and wear protective goggles.

Adjustments (Cont'd)



FEM031

8. Remove the adjusting shim by using a magnetic hand.



FEM032

9. Measure the thickness of the adjusting shim using a micrometer.
- Measure near the center of the shim (the part that touches the cam).

10. Select the new adjusting shim from the following methods.

Calculation method of the adjusting shim thickness:

$t = t_1 + (C_1 - C_2)$

t = Adjusting shim thickness

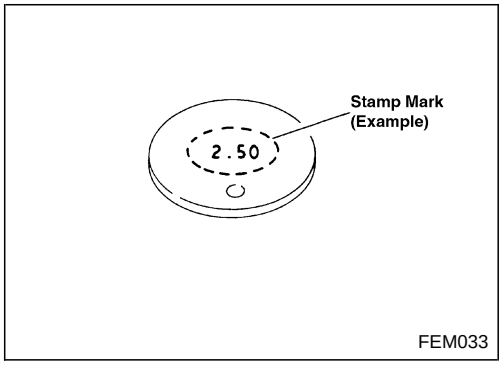
t_1 = Thickness of the removed shim

C_1 = Measured valve clearance

C_2 = Specified valve clearance

[when the engine is cool (at normal temperature)]

0.35 mm (0.0138 in)



FEM033

- New adjusting shims have the thickness stamped on the rear side.

Stamped	Shim thickness mm (in)
2.35	2.35 (0.0925)
2.40	2.40 (0.0945)
.	.
.	.
.	.
3.05	3.05 (0.1201)

- The thickness of the adjusting shim ranges from 2.35 to 3.05 mm (0.0925 to 0.1201 in), where in the space of 0.05 mm (0.0020 in). There are 15 types of shims available.

11. Fix the selected adjusting shim to the valve lifter.

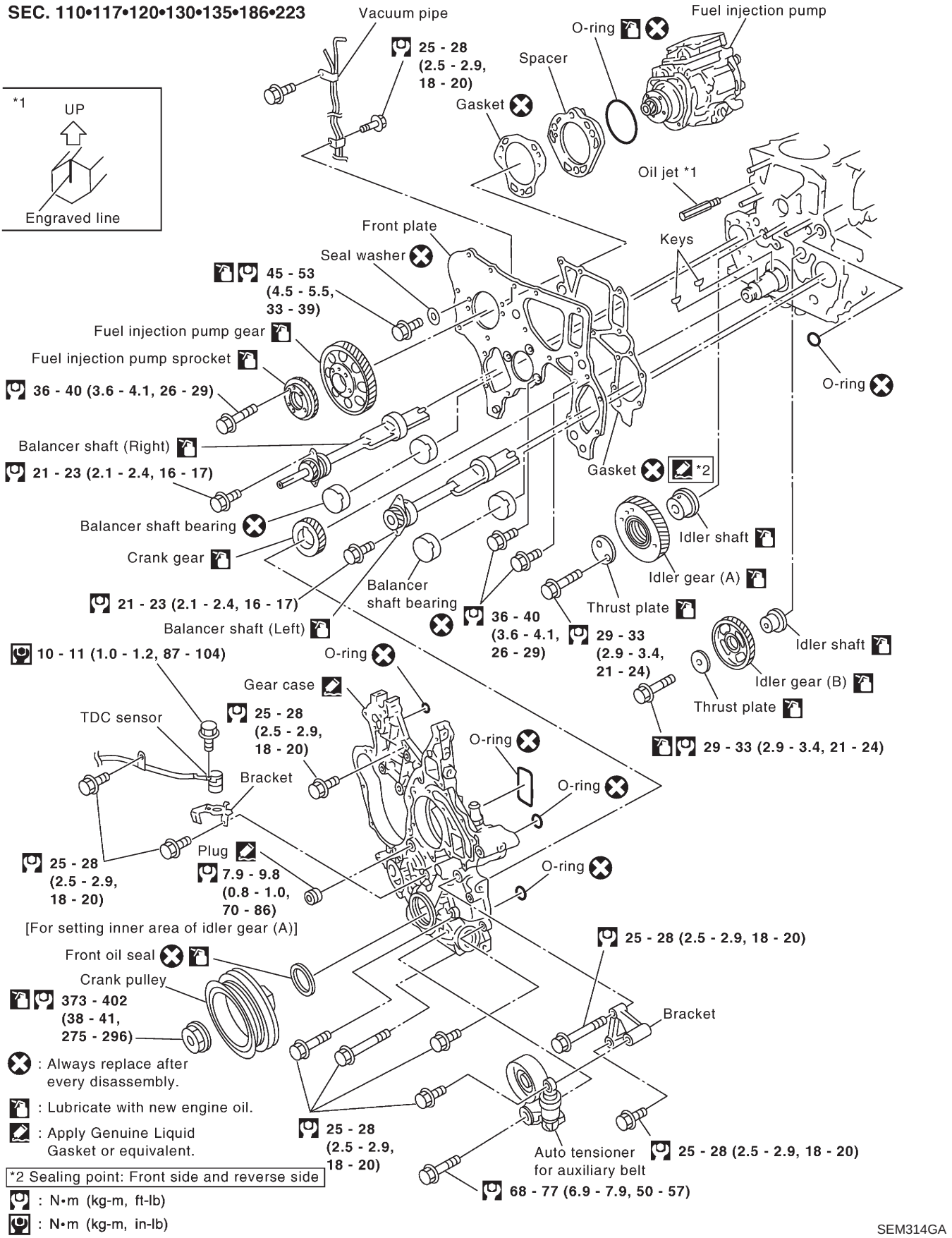
CAUTION:

Place the stamped side of the adjusting shim to the valve lifter.

12. Compress the valve spring using the camshaft pliers and remove the lifter stopper (SST).
13. Rotate the crankshaft 2 to 3 times by hand.
14. Confirm that the valve clearance is within the specification.

Removal and Installation

2 idler gears are shown in this chapter. Idler gear (A) has scissors gear, and idler gear (B) does not.

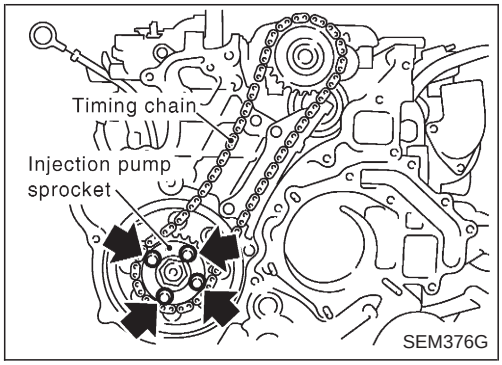


SEM314GA

Removal

1. Remove the following parts.
- Undercover
- Engine oil (Drain)
- Engine coolant (Drain)
- Engine cover
- Intercooler
- Air inlet pipe
- Air cleaner case
- Throttle body
- Swirl and intake air control valve control solenoid valve and bracket
- Vacuum tank
- Glow plate
- Rocker cover
- Spill tube
- Radiator shrouds (Rear and Lower)
- Cooling fan
- Radiator hose (Upper and Lower)
- Auxiliary belt and auto tensioner.

2. Remove the alternator.
3. Remove the A/C compressor and bracket with piping connected. Move and support it at the LH side of engine bay with a rope to avoid putting load on piping.
   Refer to HA section in Nissan Service Manual (Supplement I: Publication No. SM0E-Y61AE0E.)



4. Remove the chain cover, timing chain and other parts in connection.
   Before removing timing chain, remove injection pump sprocket with No.1 cylinder being positioned at TDC. Refer to the figure.
   Refer to “TIMING CHAIN”, EM-1027.

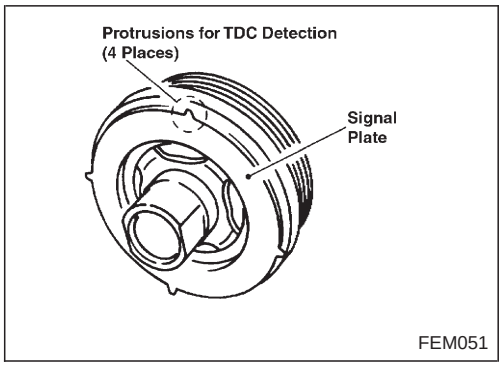
CAUTION:
After removing timing chain, never rotate crankshaft, or the piston will push the valve up and damage the valve.
- Do not paint the match mark on the timing chain beforehand as the No. 1 cylinder is set at the TDC during assembly.

5. Remove the TDC sensor.

CAUTION:
- **Do not drop or hit the sensor.**
- **Store in a clean place free of iron filings, etc.**
- **Do not place near any magnetic equipment.**

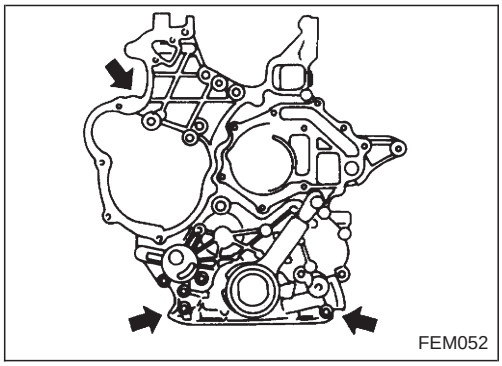
6. Remove the water pump and its stud bolts.
   Refer to “WATER PUMP” in LC section.
7. Remove the water inlet.

Removal (Cont'd)



8. Remove the crankshaft pulley.
- To fix the crankshaft, remove the starter motor and set ring gear stopper (SST).

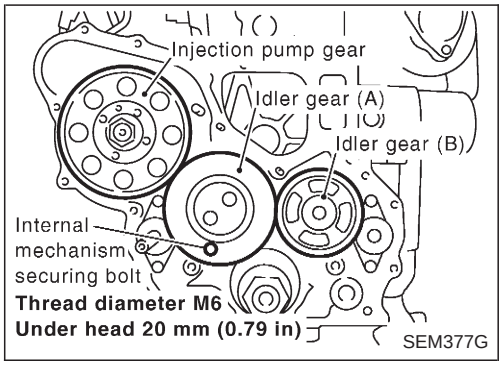
CAUTION:
- **Do not damage or magnetize the signal detection protrusions of the crankshaft pulley.**
- **After removing timing chain, never rotate crankshaft, or the piston will push the valve up and damage the valve.**



9. Remove the gear case.
- Using the grooved places shown in the figure, remove the gear case by using a screwdriver and a seal cutter (SST).

10. Remove the front oil seal from the gear case by using a screwdriver.

CAUTION:
Do not damage the gear case.

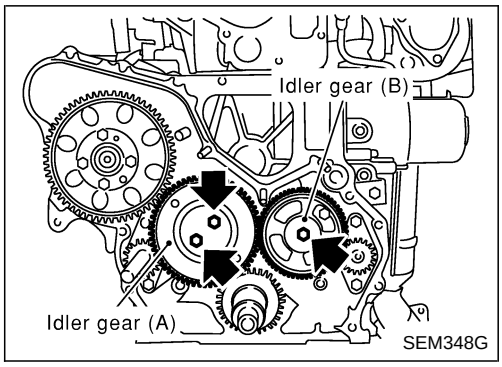


11. Fix the internal mechanism setting bolt [part No.: 81-20620-28, screw dia.: M6, dimension below neck: 20 mm (0.79 in)] to the bolt hole of the idler gear (A) and tighten to the specification.

: 2.5 - 3.4 N·m (0.25 - 0.35 kg-m, 22 - 30 in-lb)

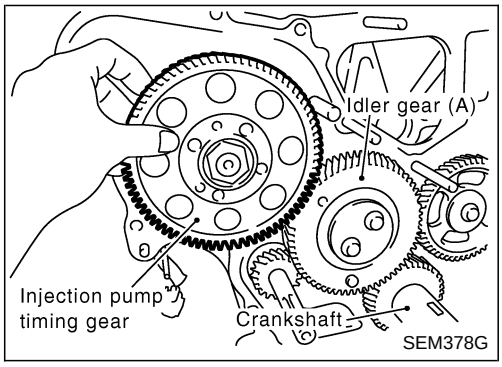
CAUTION:
- **Only use the genuine setting bolt, or the idler gear (A) will be damaged.**
- **Do not rotate the crankshaft as the head of the setting bolts interferes with the gear case.**
- **Do not remove the setting bolt from the idler gear (A) until the timing chain and all of the parts in connection have been installed.**
- **If these bolts are not installed, internal mechanism will disengage after the idler gear is removed. This will prohibit the idler gear from being reusable.**

Removal (Cont'd)

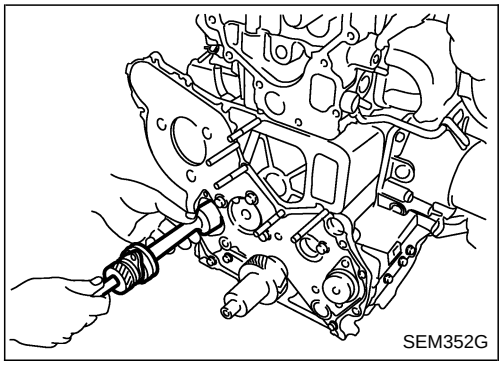


12. Remove the idler gears (A) and (B).
- Check the backlash of each gear before removing. Refer to "BACKLASH OF EACH GEAR", "Inspection".

CAUTION:
- **Do not loosen the internal mechanism setting bolt of the idler gear (A). (The idler gear cannot be reused when the internal mechanism is released.)**
- **During removal of the idler gears (A) and (B), do not face the rear side downward as the idler shaft will drop.**



13. Set the fuel injection timing gear with the pulley holder (SST).
14. Remove injection pump timing gear.

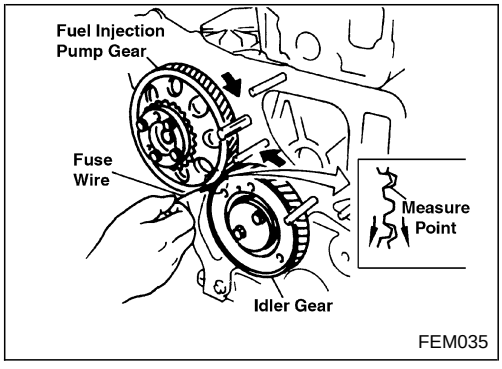


15. Extract the balancer shaft taking care not to damage the inner bushes of the cylinder block.
16. Remove the fuel injection pump.
17. Remove the front plate.

Inspection

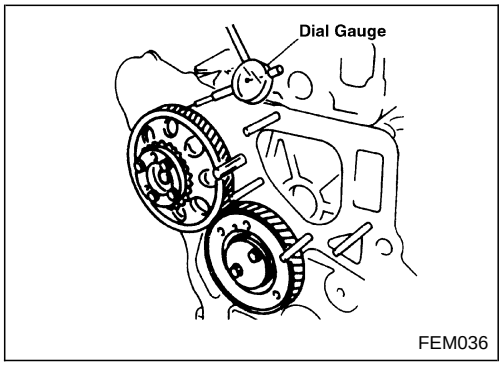
BACKLASH OF EACH GEAR

Method using a fuse wire



- Tighten the holding bolts of each gear to specification.
- Place a wire in the biting area of the teeth between the gears to be checked, rotate the crankshaft in the operating direction so that the wire is taken inwards.
- Measure the crushed area of the wire with a micrometer.

Method using dial gauge



- Tighten the holding bolts of each gear to specification.
- Place the dial gauge on the tooth surface area of the gear to be checked.
- With the other gear in a set position, measure the dial gauge value while moving the gear left and right.
  Standard: 0.07 - 0.11 mm (0.0028 - 0.0043 in)
  Limit: 0.20 mm (0.0079 in)
- If it exceeds the limit, replace the gear and measure again.
- If it exceeds the limit again, check for the installation condition of the gear driving parts, wear of shaft and gear, and oil clearance.

Inspection (Cont'd)

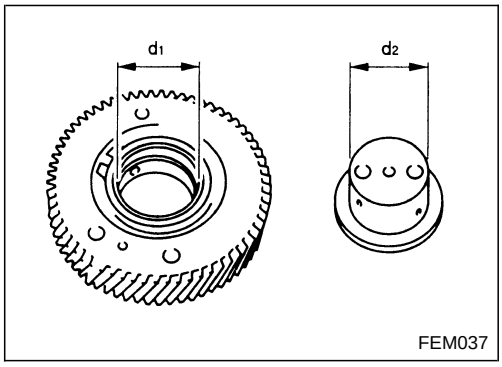
IDLER GEAR END PLAY

- Tighten the holding bolts to the specification.
- Measure the clearance between the gear plate and idler gear using a feeler gauge.

Unit: mm (in)

	Standard	Limit
Idler gear (A)	0.06 - 0.12 (0.0024 - 0.0047)	0.15 (0.0059)
Idler gear (B)		

- If it exceeds the limit, replace the idler gear, shaft, and gear plate.



IDLER GEAR OIL CLEARANCE

- Measure the inner diameter (d1) of the idler gear shaft.
  Standard:
  Idler gear (A)
  43.000 - 43.020 mm (1.6929 - 1.6937 in) dia.
  Idler gear (B)
  28.600 - 28.620 mm (1.1260 - 1.1268 in) dia.
- Measure the outer diameter (d2) of the idler shaft.
  Standard:
  Idler gear (A)
  42.959 - 42.975 mm (1.6913 - 1.6919 in) dia.
  Idler gear (B)
  28.567 - 28.580 mm (1.1247 - 1.1252 in) dia.
- Calculate the oil clearance.
  Clearance = d1 − d2

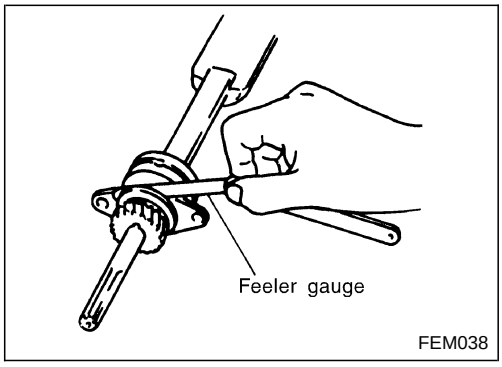
Unit: mm (in)

	Standard	Limit
Idler gear (A)	0.025 - 0.061 (0.0010 - 0.0024)	0.2 (0.0079)
Idler gear (B)	0.020 - 0.053 (0.0008 - 0.0021)	

- If it exceeds the limit, refer to each standard specification and replace the idler gear and/or shaft.

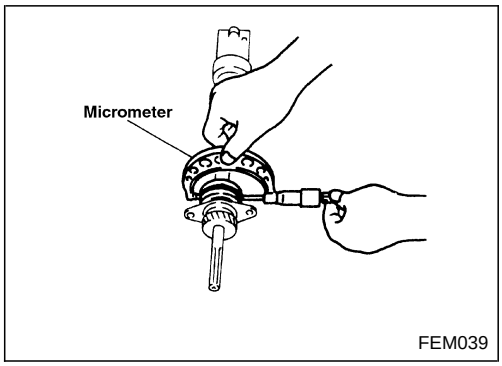
BALANCER SHAFT END PLAY

- Measure the clearance between the plate and gear using a feeler gauge.
  Standard: 0.07 - 0.22 mm (0.0028 - 0.0087 in)
- If it exceeds the specification, replace the balancer shaft assembly.
- As the gears are press-fitted, there are no setting for individual parts.



Inspection (Cont'd)

BALANCER SHAFT OIL CLEARANCE



Outer diameter of balancer shaft journal

Measure the outer diameter of the balancer shaft journal with a micrometer.

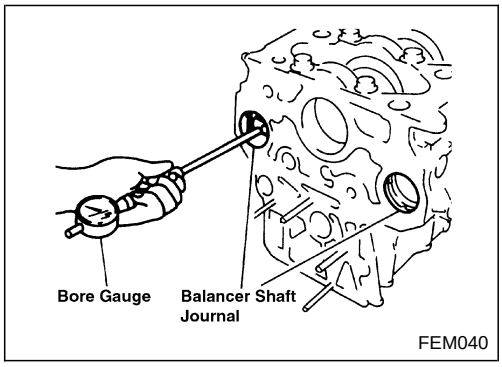
Standard:

Front side

50.875 - 50.895 mm (2.0029 - 2.0037 in) dia.

Rear side

50.675 - 50.695 mm (1.9951 - 1.9959 in) dia.



Inner diameter of balancer shaft bearing

Measure the inner diameter of the balancer shaft bearing using a bore gauge.

Standard:

Front side

50.940 - 51.010 mm (2.0055 - 2.0083 in) dia.

Rear side

50.740 - 50.810 mm (1.9976 - 2.0004 in) dia.

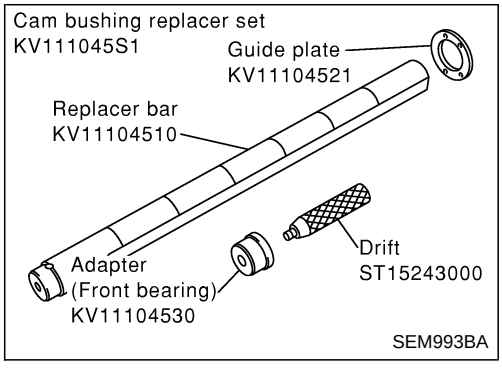
Oil clearance calculations

Oil clearance = Bearing inner diameter − Journal outer diameter

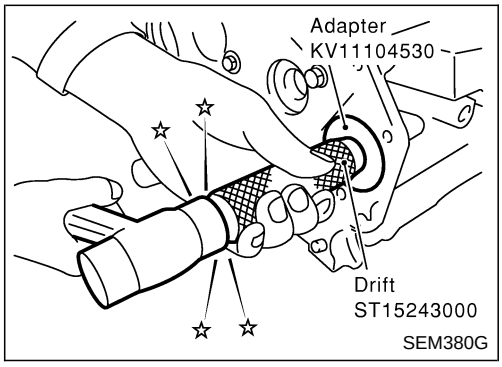
Standard: 0.045 - 0.135 mm (0.0018 - 0.0053 in)

Limit: 0.180 mm (0.0071 in)

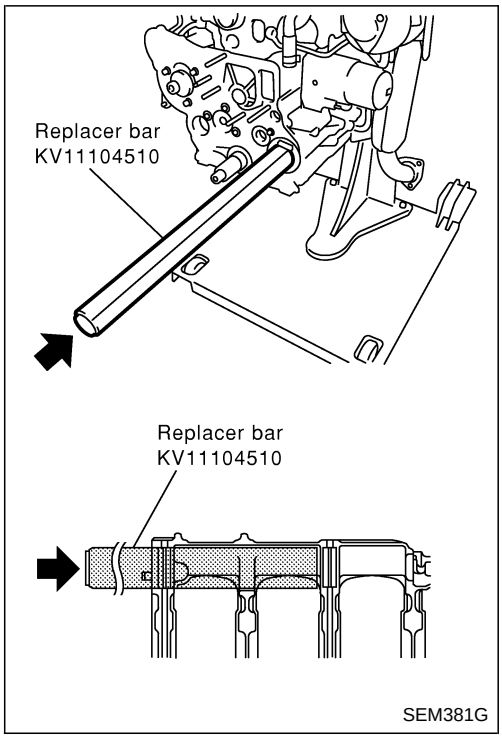
BALANCER SHAFT BEARING REMOVAL AND INSTALLATION



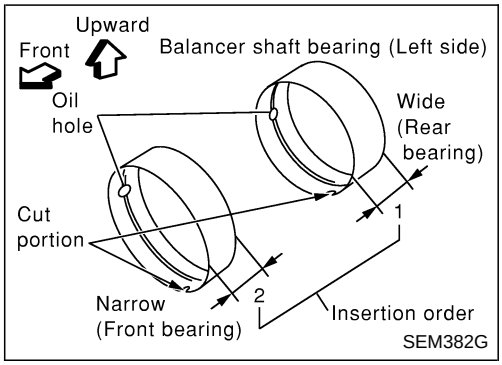
1. Remove balancer shaft front bearing.



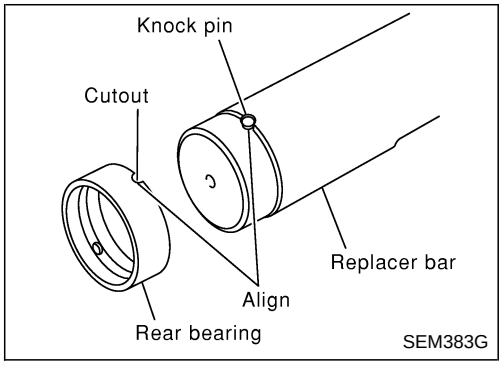
Inspection (Cont'd)



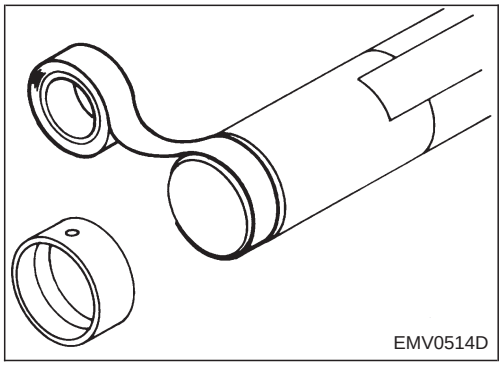
2. Using Tool, remove balancer shaft rear bearing from engine.



3. Install the rear and front balancer shaft bearings.
- Install from the cylinder block hole to the rear journal and then the front journal.
- Install the groove of the balancer shaft bearing facing the front and the under right direction.
  (Align the guide plate and bar knock pin and then force in the balancer shaft bearing.)

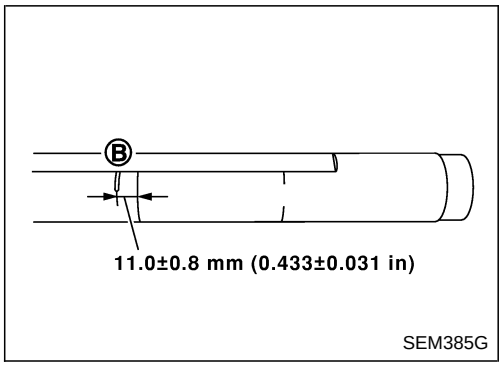


- Align the balancer shaft bearing groove with the knock pin of the bar (SST) and install the balancer shaft bearing.)

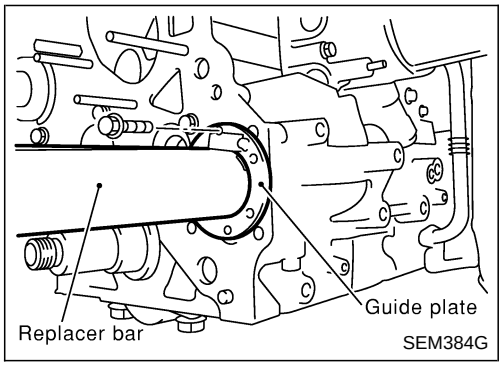


- On rear journals, so the bearing does not get out of position, wrap tape around the bar.

Inspection (Cont'd)

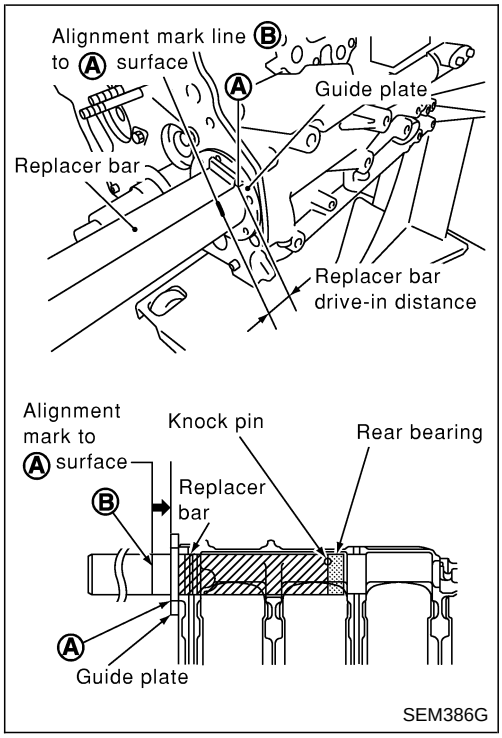


- Make an alignment mark 11.0±0.8 mm (0.433±0.031 in) from the bar No. 2 engraved line with a marker pen. This alignment mark Ⓑ will be the point to where the rear bearing is pushed.

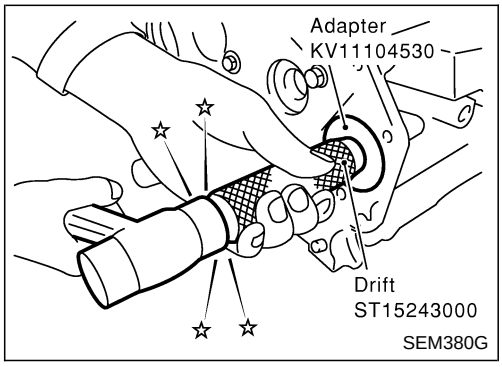


- Insert the bar with the bearing installed into the cylinder block and install the guide plate (SST).
- Align the guide plate with the ZD engraving and install the bolts.

CAUTION:
Use a washer of the same thickness used on the front plate to prevent the guide plate from bending.

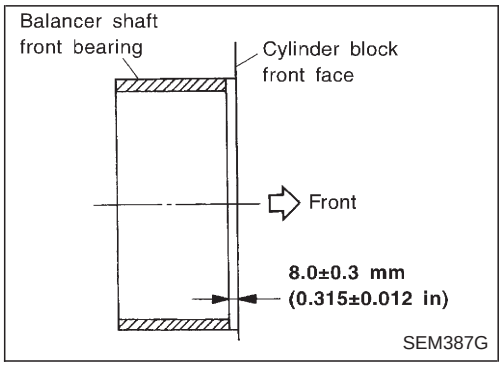


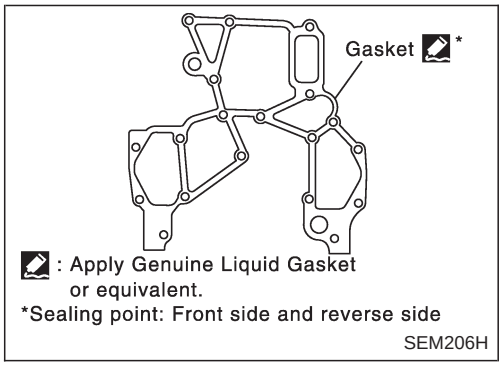
- Push the engraved bar alignment mark Ⓑ to the same position of the guide plate tip Ⓐ.
- After all the journals have been installed, make sure that all the journal and cylinder block oil holes are aligned.

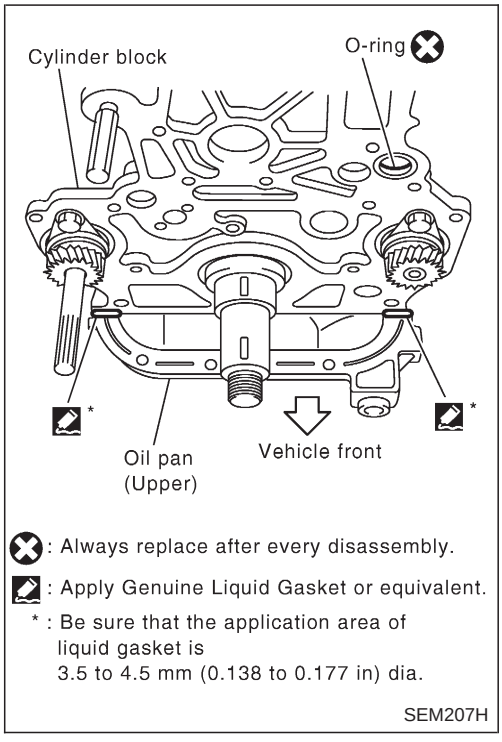


4. Install the front balancer shaft bearing.

- Align the journal and cylinder block oil holes.
- Use a drift (SST) to force in the tip of the journal to 8.0±0.3 mm (0.315±0.012 in) inside the cylinder block.
- After installing the journal, make sure that the journal and cylinder block oil holes are aligned.







Installation

1. Install the front plate.

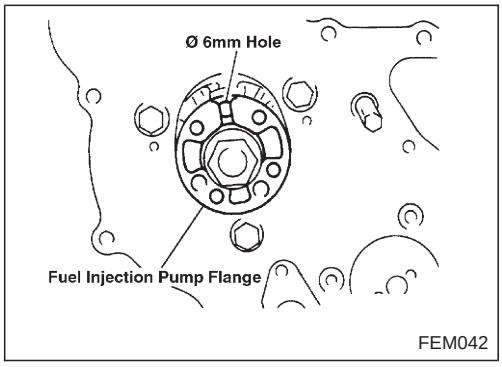
1) Install the O-ring and gasket to the cylinder block.

- Apply liquid gasket uniformly and thinly to the front and reverse sides of gasket.
  Use Genuine Liquid Gasket or equivalent.

2) Install the front plate.

- Before installing, apply liquid gasket to the mating surfaces of the cylinder block and the oil pan (upper).
  Use Genuine Liquid Gasket or equivalent.
- Lightly tap with a hammer if the dowel pin cannot be inserted easily.

CAUTION:
Make sure that the O-ring does not pop out.



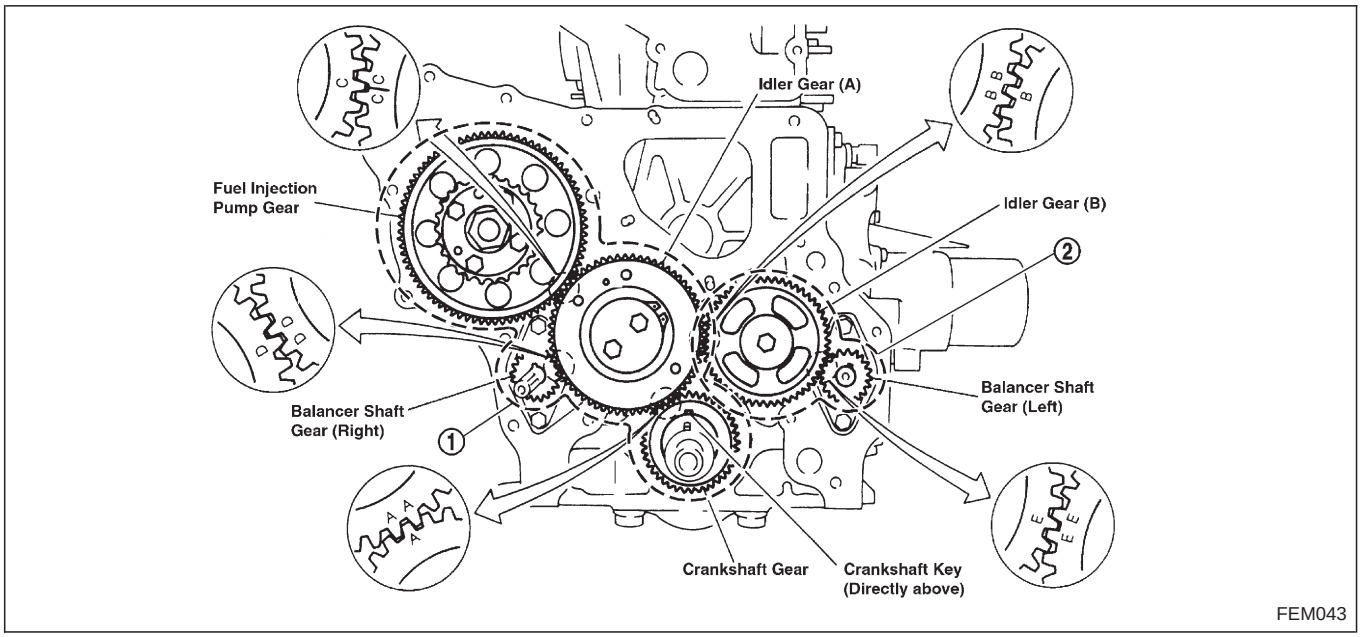
2. Install the fuel injection pump.

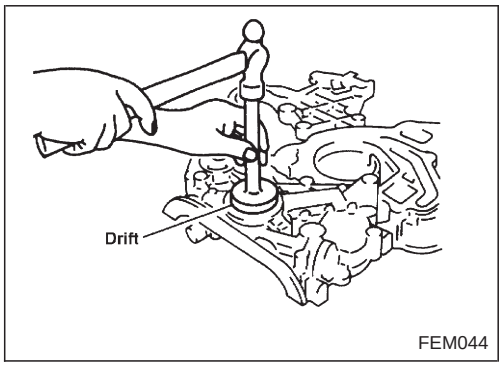
- After installing the front plate, align the 6 mm (0.24 in) dia. hole of the pump flange and the 6 mm (0.24 in) dia. hole position of the pump body.

3. Install each timing gear.

- Align the match marks of the timing gears by referring to the figure below.
- When installing timing gear, follow the order (①, ②) shown in the dotted box in the figure below to facilitate installation.

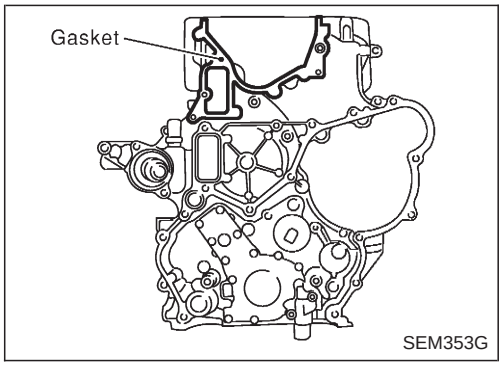
Installation (Cont'd)



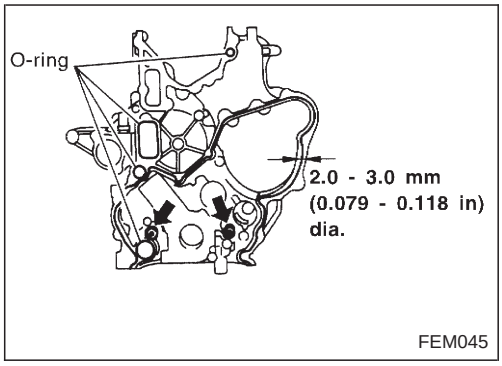


4. Install the front oil seal to the gear case.
- Apply engine oil to the fitting side.
- Evenly insert the front oil seal using a drift [outer dia.: approx. 64 mm (2.52 in)] completely.

CAUTION:
Make sure the oil seal does not spill off the end side of the gear case.



5. Install the gear case.
1) Before installing gear case, remove all traces of liquid gasket from mating surface using a scraper.
2) Align gasket with dowel and install.

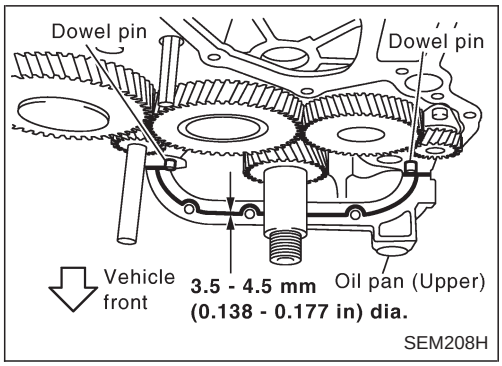


3) Install the O-rings to the gear case.
- The O-ring at the top position shown in the figure can be installed in during cylinder head installation.

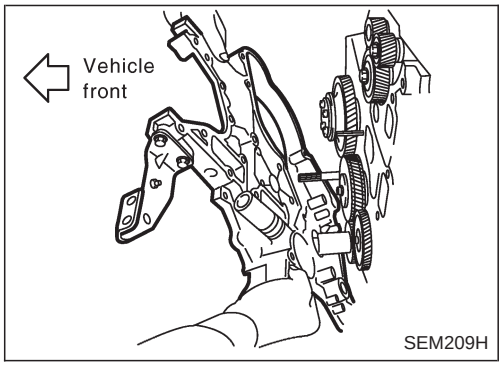
4) Apply a continuous bead of liquid gasket to gear case and oil pan (upper).
- **Use Genuine Liquid Gasket or equivalent.**

a. Coat of liquid gasket should be maintained within the specified range as shown in the figure.
b. Attach gear case to cylinder block within 5 minutes after coating.
c. Wait at least 30 minutes before refilling engine oil or starting engine.

Installation (Cont'd)

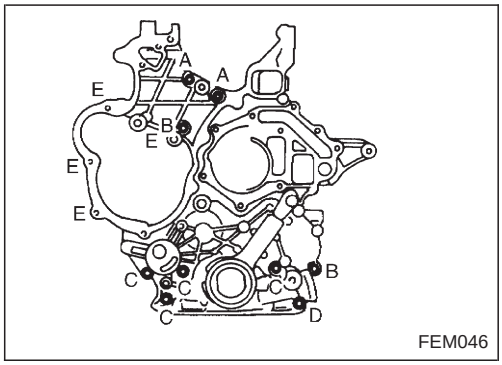


CAUTION:
Apply the liquid gasket around the bolt holes shown by the arrows in the figure.



5) Install the gear case.
- Insert the gear case diagonally to prevent it from dragging over the liquid gasket applied on the timing gear case and the oil pan (upper).
- Align the dowel pin at the lower position of cylinder block with the hole on the gear case side.
- Tap the area around the dowel pin with a plastic hammer if it cannot be inserted easily.

CAUTION:
Do not pop out the O-rings.



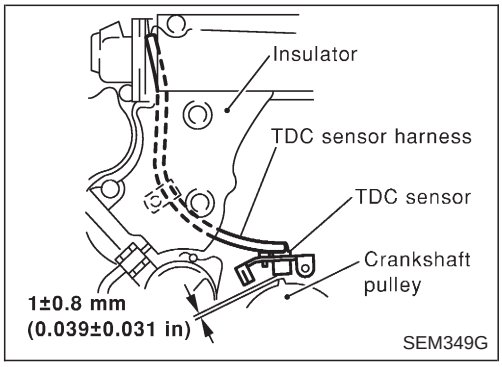
6) Install the holding bolt referring to the figure.
Dimension below neck:
A: 25 mm (0.98 in)
B: 30 mm (1.18 in)
C: 50 mm (1.97 in)
D: 80 mm (3.15 in)
E: 20 mm (0.79 in)

7) Install the holding bolts from the rear side of the front plate.

6. Install the crankshaft pulley.
- Insert by aligning the 2 sides of the oil pump with the 2 sides of the shaft on the rear side of the crankshaft pulley.

CAUTION:
Do not damage the oil seal lip when inserting.
- Refer to EM-1041, "Removal" for the crankshaft setting procedures when tightening the holding nut.

7. Install the water pump.
- Install it before installing the TDC sensor. Refer to "Water Pump" in LC section.

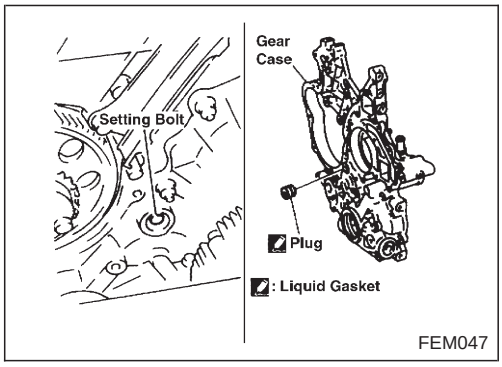


8. Install the TDC sensor.
- Align the bracket knock pin with the hole on the gear case side and tighten the holding bolt.
- Confirm that the clearance between the end of the sensor and the signal detection protrusion of the crankshaft pulley is within the specification.
  Standard: 1±0.8 mm (0.039±0.031 in)
- Arrange the TDC sensor harness to the position shown in the figure.

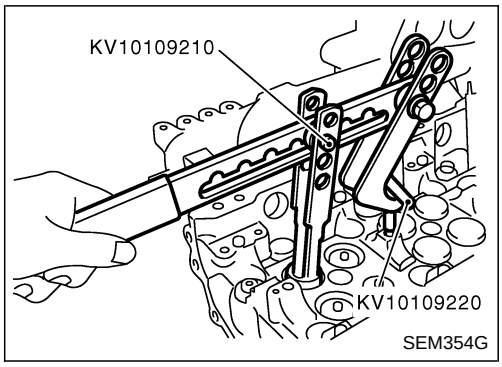
CAUTION:
Confirm that the harness has no deflection around the crankshaft pulley when installing the clamp.

Installation (Cont'd)

9. Install the timing chain, other parts in connection with the timing chain, and the chain cover. Refer to EM-1027, "TIMING CHAIN".

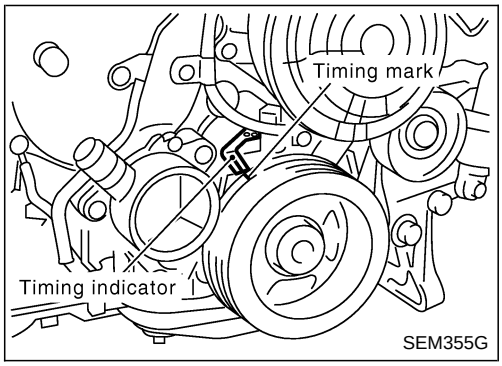


10. Remove the internal mechanism setting bolt of the idler gear (A).
11. Apply liquid gasket to the plug thread.
12. Install in the reverse order of removal.



VALVE OIL SEAL

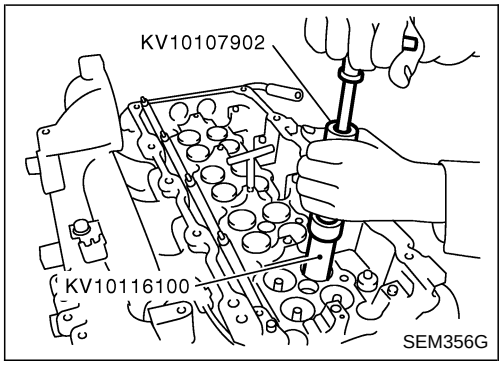
1. Remove timing chain. Refer to EM-1027, “TIMING CHAIN”.
2. Remove injection nozzle assembly. Refer to “Injection Tube and Injection Nozzle” in “BASIC SERVICE PROCEDURE” in EC section.
3. Remove camshaft. Refer to EM-1031, “CAMSHAFT”.



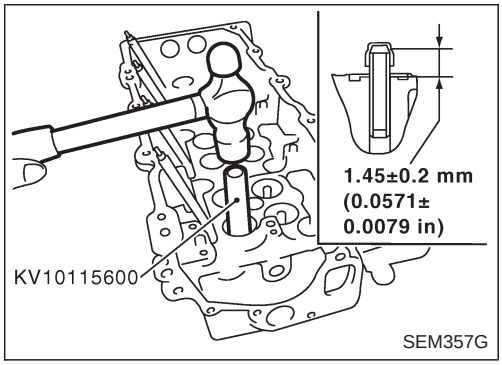
4. Remove valve lifters and mark order No. on each lifter.
5. Replace valve oil seal according to the following procedure.

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

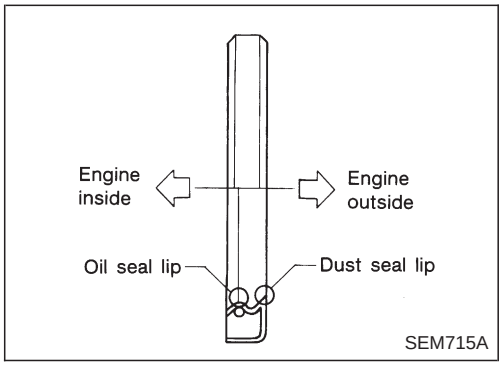
1) Set No. 1 cylinder at TDC.



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

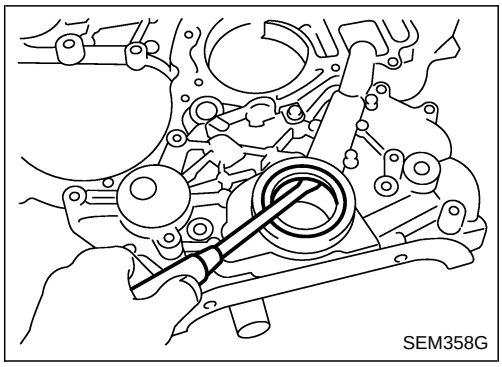


3) Install new valve oil seals for No. 1 and No. 4 cylinders as illustrated. Reinstall valve springs. (pink paint side toward cylinder head)
4) Install valve spring retainers on intake valves and valve rotators on exhaust valves, and remount valve assembly.
5) Set No. 2 cylinder at TDC.
6) Replace valve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



CRANKSHAFT OIL SEAL INSTALLING DIRECTION AND MANNER

- **When installing crankshaft oil seals, be careful to install them correctly, as shown in the figure.**
- **Wipe off excess oil after installing oil seal.**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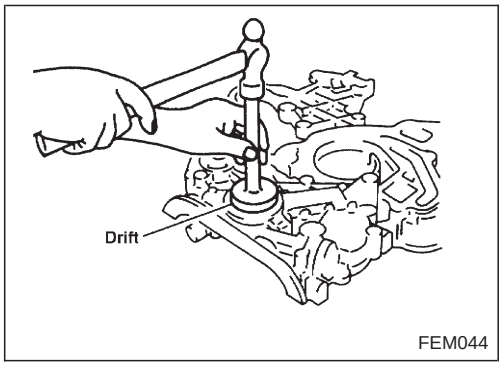
CRANKSHAFT FRONT OIL SEAL

1. Remove the front cover. Refer to “TIMING GEAR”.
2. Remove front oil seal with a suitable tool.



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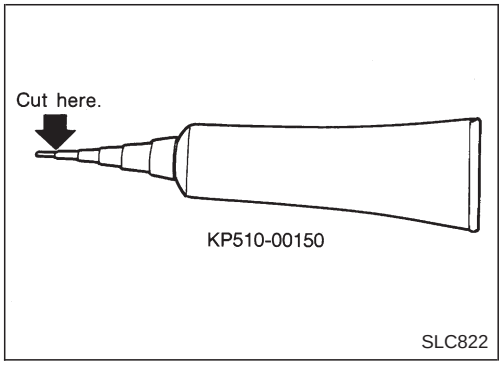
3. Apply engine oil to new oil seal and install oil seal using a suitable tool.

CRANKSHAFT REAR OIL SEAL

1. Remove oil pan assembly. Refer to EM-1022, “OIL PAN”.
2. Remove clutch cover assembly.
3. Remove flywheel and rear plate.
4. Remove oil seal retainer assembly.



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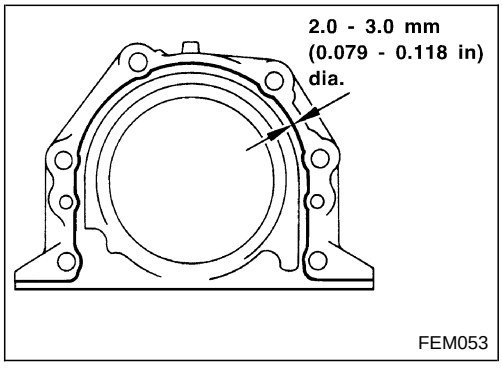
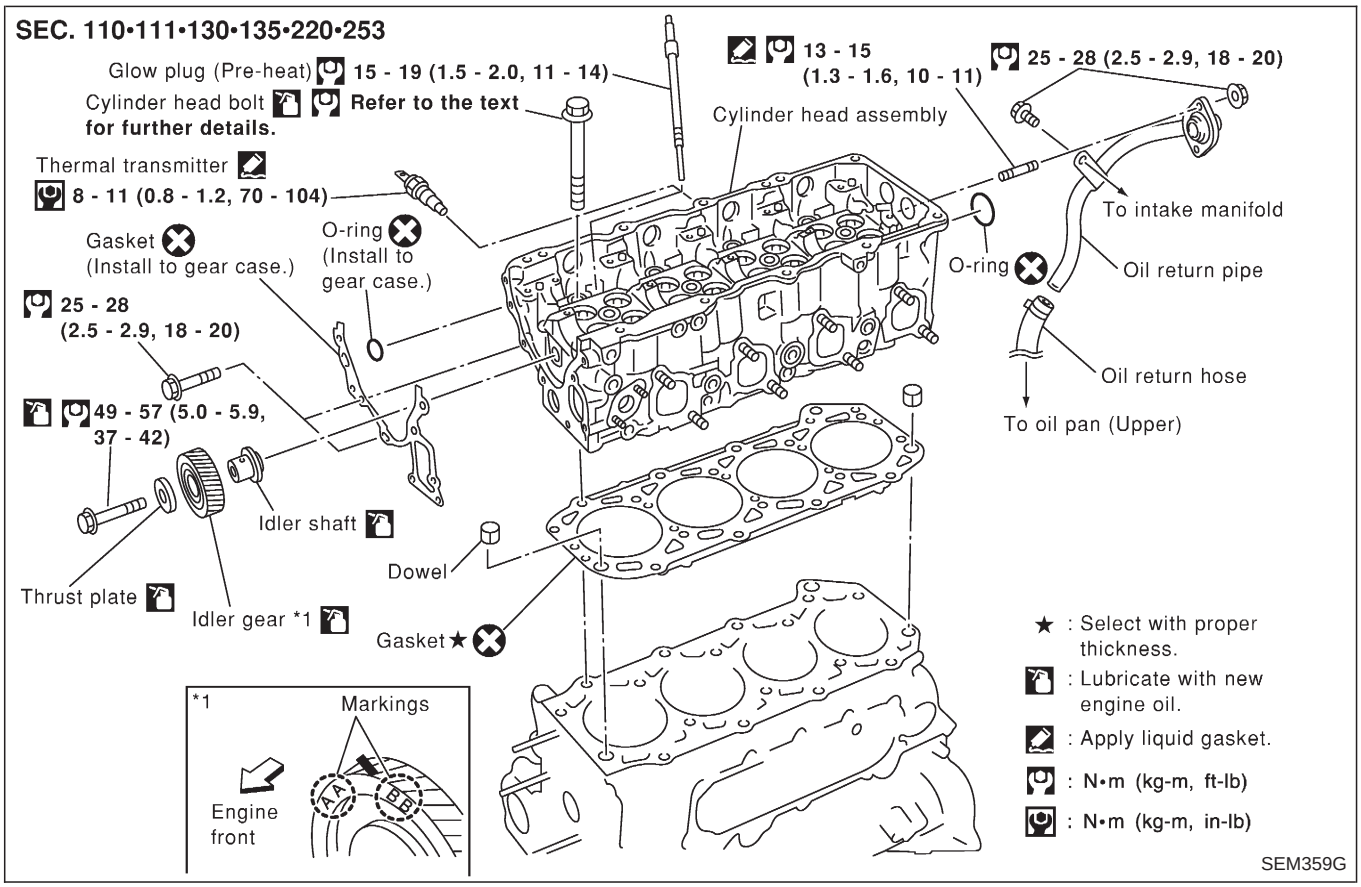
5. Apply a continuous bead of liquid gasket to rear oil seal retainer.

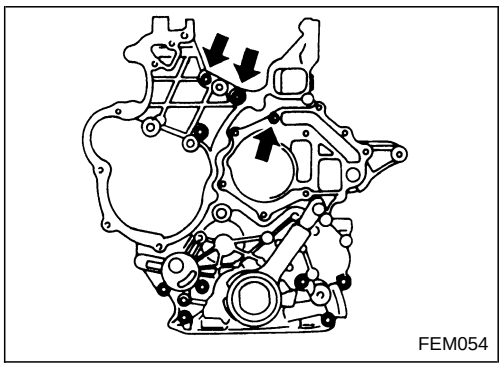
a. Coat of liquid gasket should be maintained within 2.0 to 3.0 mm (0.079 to 0.118 in) dia. range.
b. Attach oil seal retainer to cylinder block within five minutes after coating.
c. Wait at least 30 minutes before refilling engine oil or starting engine.
d. Use Genuine Liquid Gasket or equivalent.



FEM053

Removal and Installation



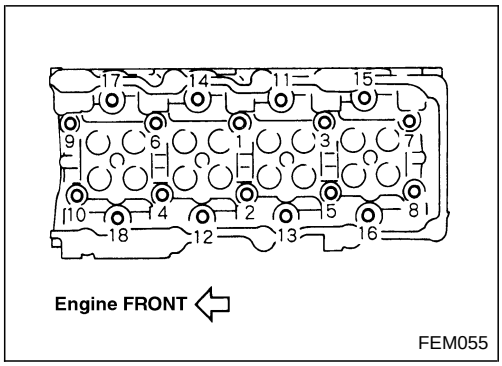


Removal

1. Remove the following. (Refer to corresponding chapter for detailed auxiliary work.)
- Drain coolant
- Rocker cover
- Injection tube
- Spill tube
- High pressure injection nozzle assembly
- Timing chain
- Camshaft
- Catalytic converter
- Turbocharger assembly
- Exhaust manifold

2. Remove mounting bolts of the gear case and water pump as shown by arrows in the figure.
3. Remove oil return pipe from the rear side of cylinder head.
4. Remove intake manifold.

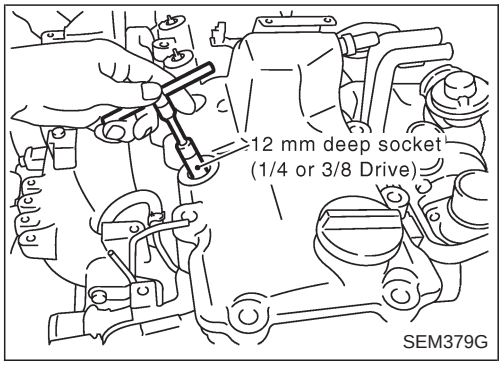
Removal (Cont'd)



FEM055

5. Remove cylinder head assembly.
- Loosen and remove mounting bolts in the reverse order shown in the figure.
- Lift up the cylinder head assembly to avoid interference with dowel pins located between the block and head, and remove cylinder head assembly.

CAUTION:
- **Do not drop the O-ring located between the front of cylinder head and the rear of gear case into the engine.**
- **Remove glow plug in advance to avoid damage as the tip of the glow plug projects from the bottom of the cylinder head, or, place wood blocks beneath both ends of the cylinder head to keep the cylinder bottom from any contact.**



SEM379G

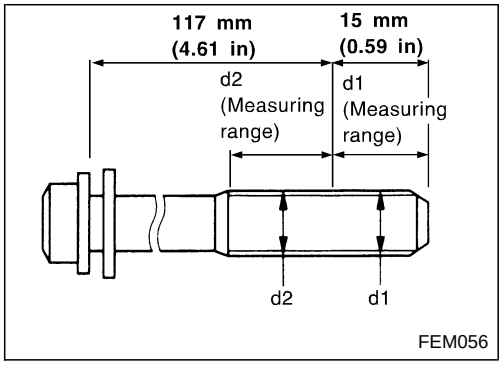
- For glow plug removal, the following shall be noted.

CAUTION:
- **To avoid breakage, do not remove glow plug unless necessary.**
- **Perform continuity test with glow plug installed.**
- **Keep glow plug from any impact. (Replace if dropped from a height 10 cm (3.94 in) or higher.)**
- **Do not use air impact wrench.**

6. Remove idler gear.

CAUTION:
While removing idler gear, keep the rear of idler gear facing up to prevent idler shaft from falling.

Inspection



FEM056

CYLINDER HEAD BOLT DEFORMATION (ELONGATION)

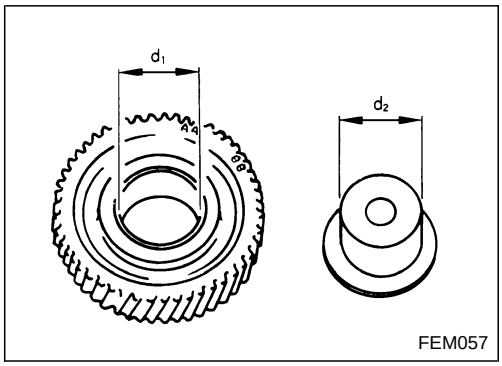
- Using micrometer, measure the outer diameters d1 and d2 of bolt thread as shown in the figure.
- If the necking point can be identified, set it as measuring point d2.
- Calculate the difference between d1 and d2.
  Limit: 0.15 mm (0.0059 in)

IDLER GEAR END PLAY

- Tighten mounting bolts to the specified torque.
- Using feeler gauge, measure the clearance between gear plate and idler gear.
  Standard: 0.07 - 0.14 mm (0.0028 - 0.0055 in)
  Limit: 0.2 mm (0.0079 in)
- If the measured value exceeds the limit value, replace idler gear, shaft, and gear plate.

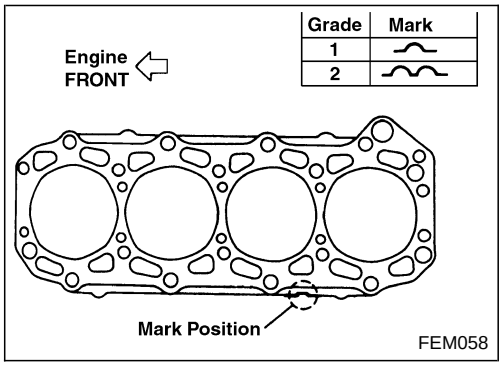
Inspection (Cont'd)

IDLER GEAR OIL CLEARANCE



FEM057

- Measure the inner diameter (d_1) of idler gear shaft hole.
  Standard: 26.000 - 26.020 mm (1.0236 - 1.0244 in)
- Measure the outer diameter (d_2) of idler shaft.
  Standard: 25.967 - 25.980 mm (1.0223 - 1.0228 in)
- Calculate gear clearance.
  Clearance = $d_1 - d_2$
  Standard: 0.023 - 0.053 mm (0.0009 - 0.0021 in)



FEM058

Installation

1. Install cylinder head gasket.

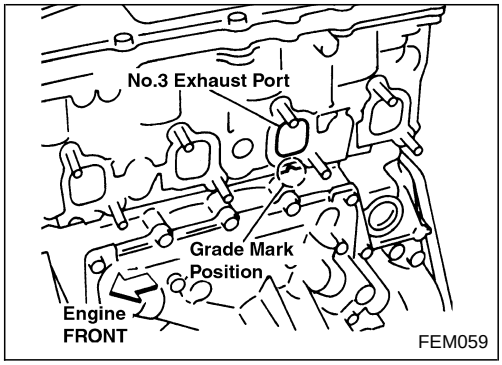
- Cylinder head gasket to be installed is selected by its thickness through the following procedure.

When replacing gasket only

- Install gasket with same thickness as the one removed.
- Gasket thickness is identified by the number of notches located on rear-left side.

Grade	Gasket thickness* mm (in)	No. of notches
1	0.65 (0.0256)	1
2	0.70 (0.0276)	2

*: Thickness of gasket tightened with head bolts



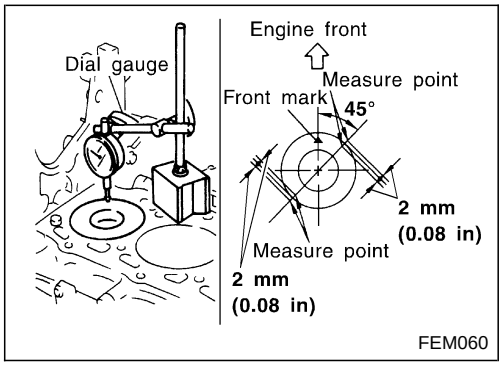
FEM059

- The number of notches can be checked at the position shown in the figure before cylinder head is removed. (It is necessary to remove exhaust manifold.)

When repairing/replacing the following

- When the top of cylinder block or crankshaft pin/journal is ground, or
- When cylinder block, piston, connecting rod, or crankshaft is replaced

1) Move piston toward TDC.
2) Position dial indicator on cylinder block as shown in the figure, and adjust the needle to "0".
3) Move dial indicator stand aside, and position the dial indicator to the measuring point as shown in the figure.
4) Rotate crankshaft slowly, and read the value on dial indicator at piston's maximum height.
5) Repeat above procedure at 2 positions of each cylinder (8 positions in total for 4 cylinders), and select the appropriate gasket by comparing the maximum crown depression with the table.



FEM060

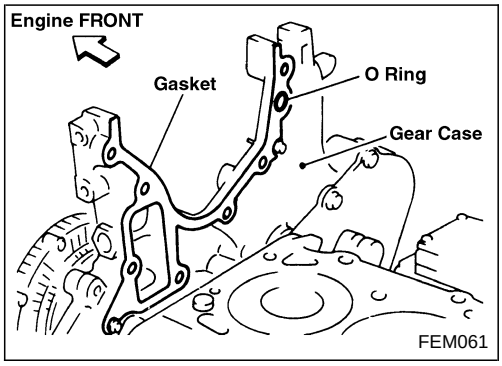
Installation (Cont'd)

Grade	Piston crown depression	Gasket thickness*1	No. of notches
1	Less than −0.078 (−0.0031)*2	0.65 (0.0256)	1
2	More than −0.078 (−0.0031)*3	0.70 (0.0276)	2

*1: Thickness of gasket tightened with head bolts
*2: Indicates values such as −0.080 mm (−0.0031 in).
*3: Indicates values such as −0.075 mm (−0.0030 in).

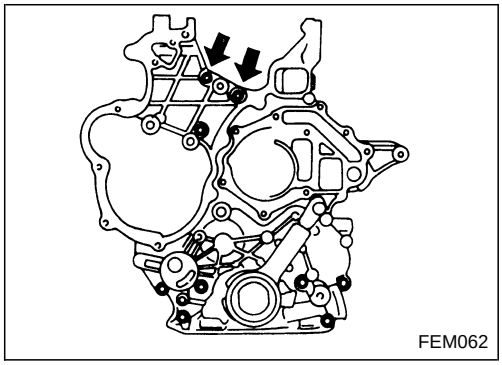
2. Install idler gear and idler shaft.
- Check that the counter marks with cam gear, "AA" and "BB", are located on the front side of the engine.
  Refer to EM- 1053.

CAUTION:
Since idler gear cannot be installed or removed with cylinder head assembly mounted on the engine because of interference with gear case, make sure that there are no reverse installations or uninstalled parts.

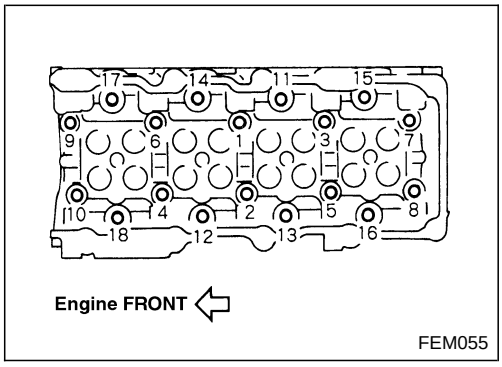


3. Install cylinder head assembly.
1) Attach gasket onto the rear of gear case.
2) Install O-ring to the rear of gear case.
3) Align cylinder head assembly with dowel pin of cylinder block and install.

CAUTION:
- **Make sure the O-ring does not fall off. Be careful not to drop the O-ring.**
- **Do not damage gasket located at the front.**



4. Position cylinder head assembly close to the rear of the gear case.
1) Install cylinder head bolts to the front and rear of cylinder head respectively, and tighten to the specified torque.
   : 40 - 49 N·m (4.0 - 5.0 kg-m, 29 - 36 ft-lb)
2) Loosen cylinder head bolts completely.
3) Install gear case mounting bolts to 2 positions shown by arrows in the figure, and tighten to the specified torque.
   : Less than 9.8 N·m (1.0 kg-m, 7 in-lb)



5. Tighten cylinder head bolts in the order indicated in the figure.
1) Apply engine oil to installation bolt threads and washers.
2) Tighten bolts to 98 to 102 N·m (10.0 to 10.5 kg-m, 73 to 75 ft-lb).
3) Loosen bolts completely until the torque becomes 0 N·m (0 kg-m, 0 in-lb).

CAUTION:
For procedure 3), loosen bolts in the reverse order as indicated in the figure.

4) Tighten bolts to 40 to 44 N·m (4.0 to 4.5 kg-m, 29 to 32 ft-lb).

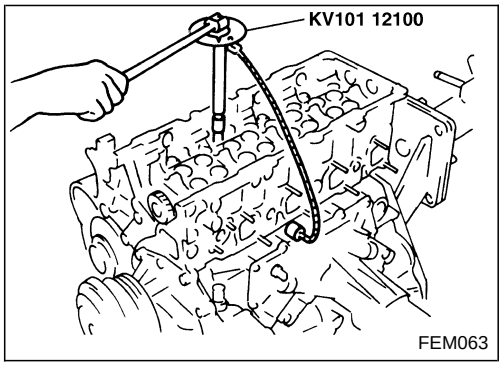
Installation (Cont'd)

5)Tighten bolts at the angle of 90 to 95° (target is 95°). (Angle tightening)

6) Once again, tighten bolts at the angle of 90 to 95° (target is 95°). (Angle tightening)

CAUTION:

Perform the following procedure to check turning angle of angle tightening, and do not judge by visual check.



ANGLE TIGHTENING PROCEDURE

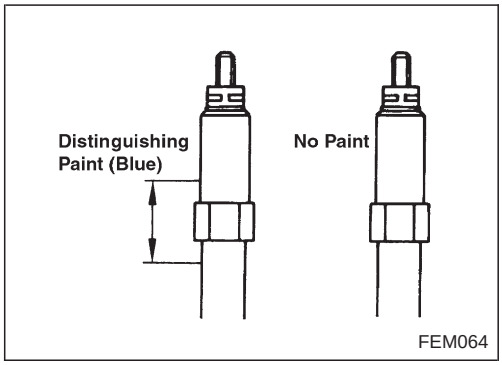
With protractor

- Make counter marks on the bolt head of cylinder head and cylinder head surface with paint, and check the turning angle.

With angle wrench (SST)

- Check the turning angle using angle indicator of angle wrench.

6. Loosen gear case mounting bolts which were tightened in 3) of procedure 4, retighten them to the specified torque.

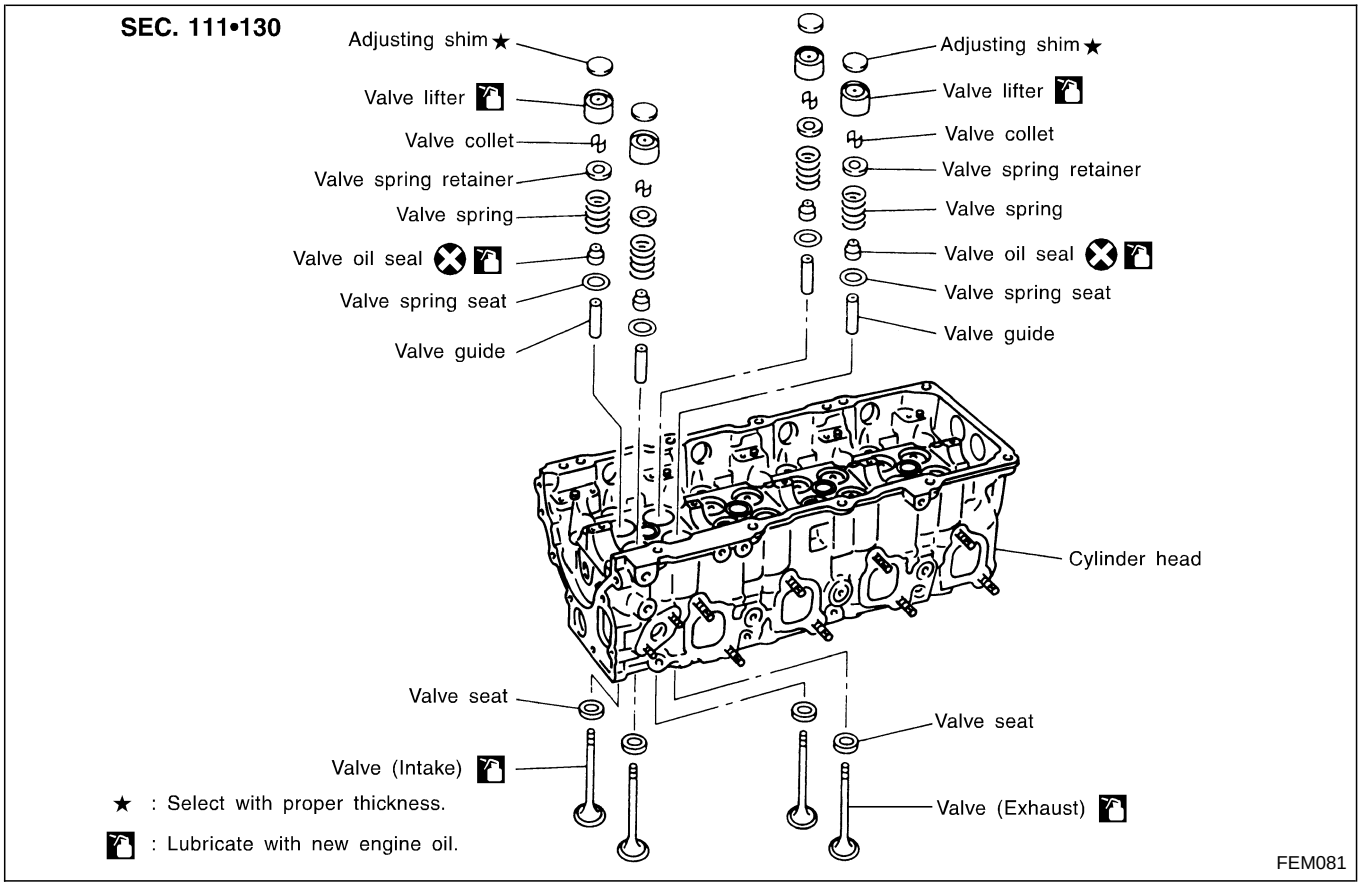


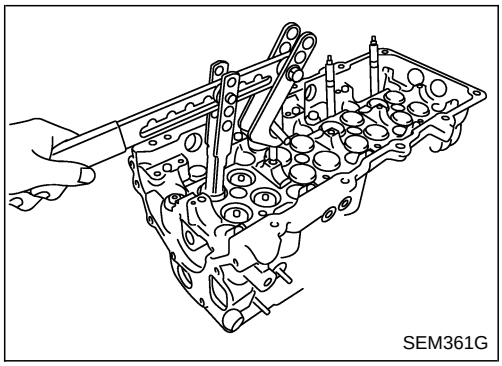
7. Install glow plug.

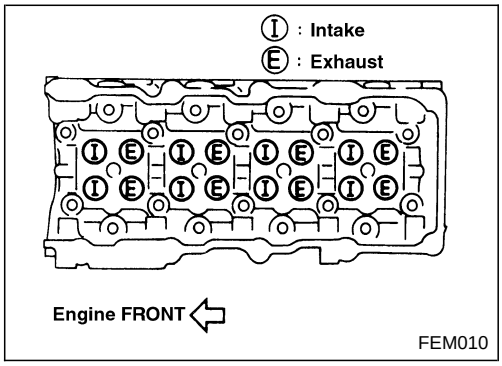
- 2 different types (manufacturers) of glow plugs are provided in parallel. (Refer to the figure for identification.)
- Do not install 2 different types of glow plugs in the engine. Make sure that the same glow plugs are installed.
- Using reamer, remove the carbon adhering to the installation hole of glow plug, and install glow plug.

Installation (Cont'd)

8. Install oil return pipe to the rear side of the cylinder head.
- When reinstalling a stud bolt, apply Three Bond 1207C (KP510 00150) to the thread of the bolt.





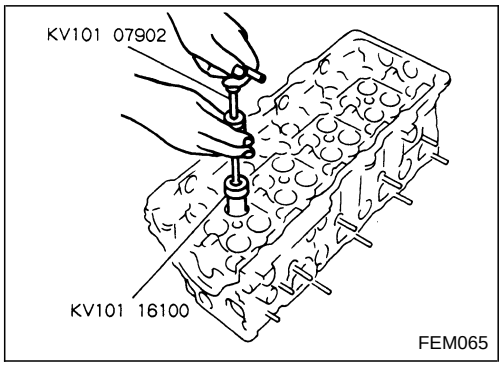


Disassembly

1. Remove adjusting shims and valve lifters.
   Check the installation positions, and keep them to avoid being confused.
2. Using valve spring compressor (SST), compress valve spring. Using magnetic hand, remove valve collets.
3. Remove valve spring retainers and valve springs.
4. Remove valves as pressing valve stems toward combustion chamber.

- Before removing the valve, check the valve guide clearance. (Refer to next page.)
- Check installation positions, and keep them to avoid being confused.
- Refer to the figure for intake/exhaust valve positions. (Intake and exhaust valve driving cams are provided alternately for each camshaft.)

Disassembly (Cont'd)



FEM065

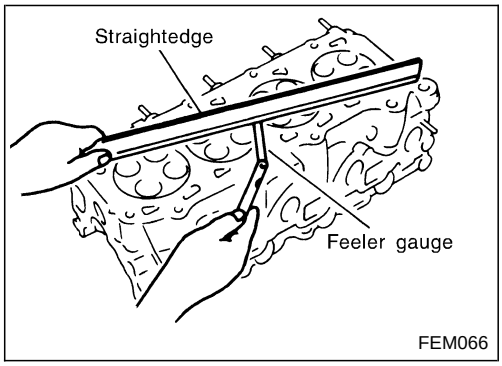
5. Remove valve oil seals using valve oil seal puller (SST).
6. Remove valve spring seats.
7. Before removing valve spring seats, perform valve seat contact check. (Refer to EM-1061.)
8. Before removing valve guides, perform valve guide clearance check. (Refer to below.)

Inspection

CYLINDER HEAD DISTORTION

Using straightedge and feeler gauge, check the bottom of the cylinder head for distortion.

Limit: 0.2 mm (0.008 in)



FEM066

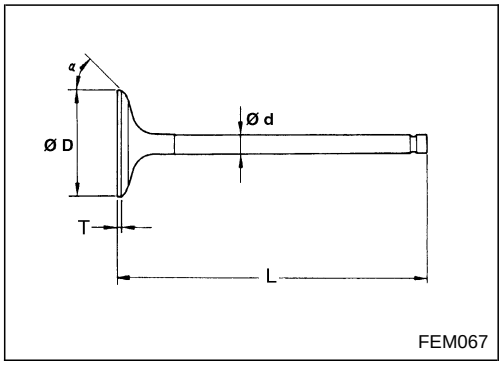
VALVE DIMENSION

Using micrometer, measure the dimensions of each part.

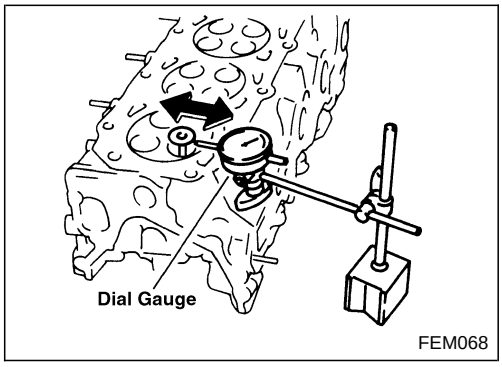
Standard

Unit: mm (in)

	Intake valve	Exhaust valve
L	113.5 (4.4685)	113.5 (4.4685)
T	1.5 (0.0591)	1.5 (0.0591)
ϕd	6.962 - 6.977 (0.2741 - 0.2747)	6.945 - 6.960 (0.2734 - 0.2740)
ϕD	31.9 - 32.1 (1.2559 - 1.2638)	29.9 - 30.1 (1.1772 - 1.1850)
α (degree)	45°00′ - 45°30′	45°00′ - 45°30′



FEM067



FEM068

VALVE GUIDE CLEARANCE

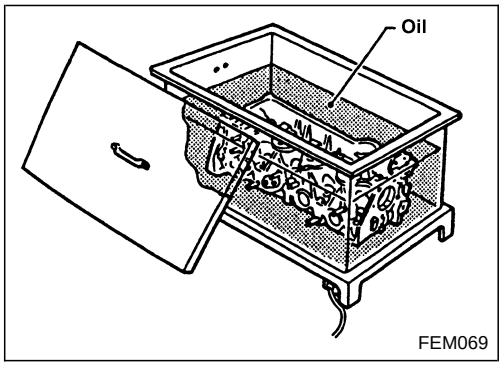
- Perform the inspection before removing valve guides.
- Check that the valve stem diameter is within specifications.
- Push valve approximately 25 mm (0.98 in) toward combustion chamber, move valve toward dial indicator to measure valve movement.
- Valve guide clearance is 1/2 of movement on dial indicator.

Inspection (Cont'd)

Unit: mm (in)

	Standard	Limit
Intake	0.023 - 0.053 (0.0009 - 0.0021)	0.18 (0.0071)
Exhaust	0.040 - 0.070 (0.0016 - 0.0028)	0.10 (0.0039)

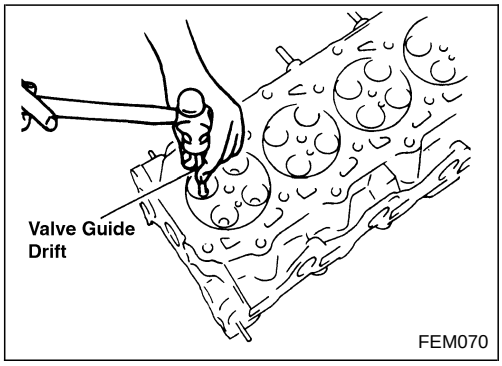
- If the measured value exceeds the limit, replace valve guide.



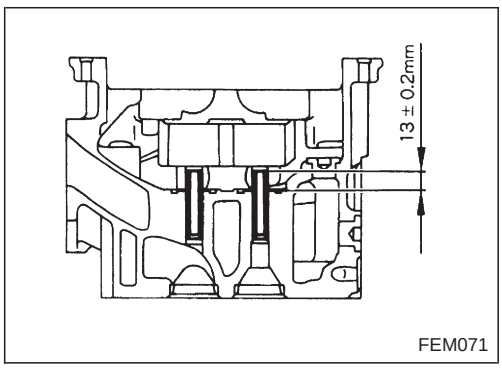
VALVE GUIDE REPLACEMENT

- There is no setup for oversized valve guide.

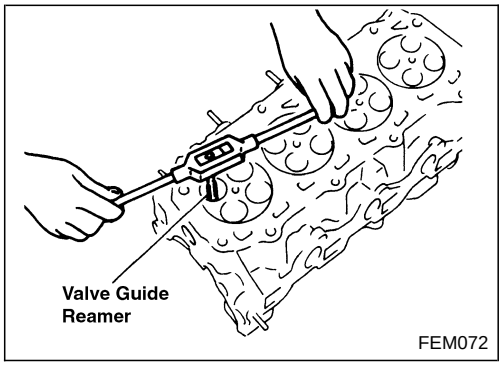
1. Heat cylinder head to 110 to 130°C (230 to 266°F) in oil bath.



2. Using valve guide drift (multi-purpose tool: for 7.0 mm dia.), tap valve guides out from the combustion chamber side.

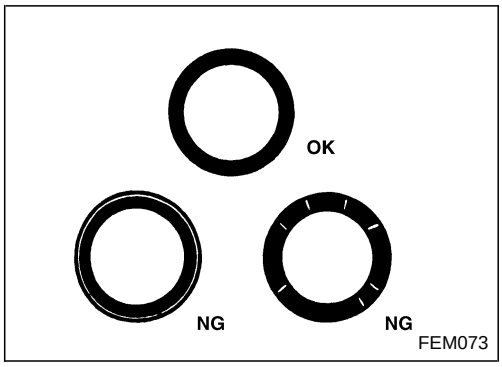


3. Heat cylinder head to 110 to 130°C (230 to 266°F) in oil bath.
4. Using valve guide drift (multi-purpose tool: for 7.0 mm dia.), press fit valve guides from camshaft side, referring to the dimension shown in the figure.



5. Using valve guide reamer (multi-purpose tool), perform reaming to the press-fitted valve guides.
   Reaming specifications:
   Intake/Exhaust
   7.000 - 7.015 mm (0.2756 - 0.2762 in)

Inspection (Cont'd)



VALVE SEAT CONTACT

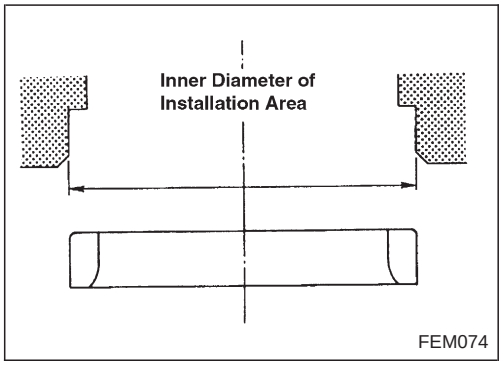
Check valve for any evidence of pitting at valve contact surface, and reseat or replace if worn out excessively.

- **When repairing valve seats, check valve and valve guide for wear beforehand. If worn, replace them. Then correct valve seat.**
- **The cutting should be done with both hands for uniform cutting.**

VALVE SEAT REPLACEMENT

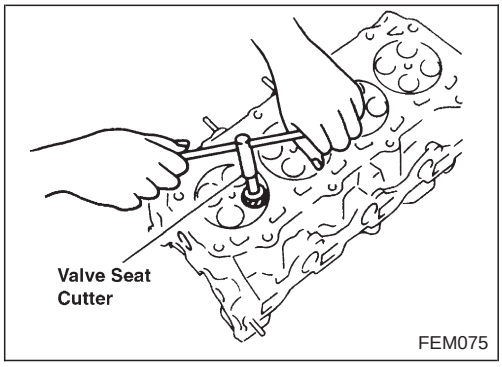
- When removing valve seat, replace it with oversized [0.5 mm (0.0020 in)] valve seat.

1. Cut valve seat to make it thin, and pull it out.



2. Machine cylinder head inner diameter at valve seat installation position.
   Machining dimension:
   Intake
   33.500 - 33.515 mm (1.3189 - 1.3195 in) dia.
   Exhaust
   31.995 - 32.010 mm (1.2596 - 1.2602 in) dia.
3. Heat cylinder head to approximately 110 to 130°C (230 to 266°F) in oil bath.
4. After cooling valve seats sufficiently with dry ice, press fit it to cylinder head.

CAUTION:
Do not touch the cooled valve seats directly by hand.

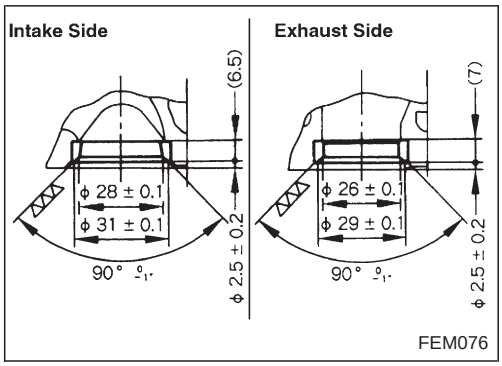


5. Using valve seat cutter (multi-purpose tool), finish processing referring to the dimensions shown in the figure.

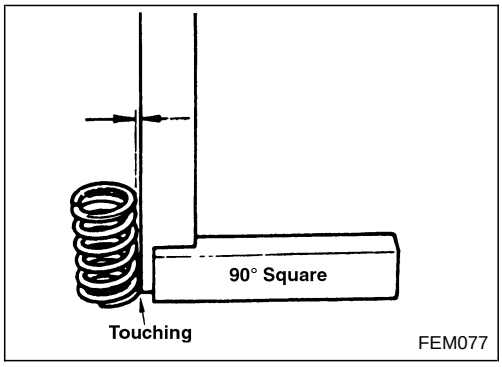
CAUTION:
When using valve seat cutter, grasp cutter handle with both hands, press cutter onto contacting face all around, and cut thoroughly. If cutter is pressed unevenly or repeatedly, the valve seat surface may be damaged.

6. Using compound, perform valve fitting.
7. Check again to make sure that contacting status is satisfactory.

Inspection (Cont'd)



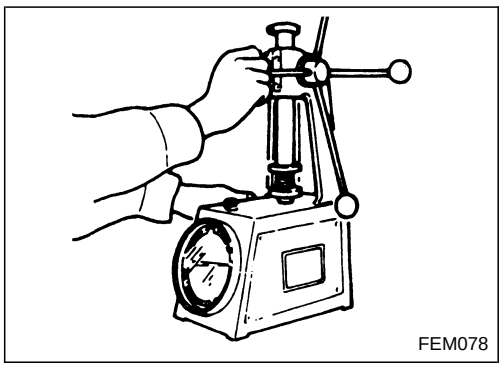
For details, Refer to EM-1088, "Valve Seat" in "SERVICE DATA AND SPECIFICATIONS (SDS)".



VALVE SPRING RIGHT ANGLE

Position a straightedge to valve spring, turn the spring, and measure the maximum clearance value between top surface of spring and the straightedge

Limit: 2.4 mm (0.0945 in)



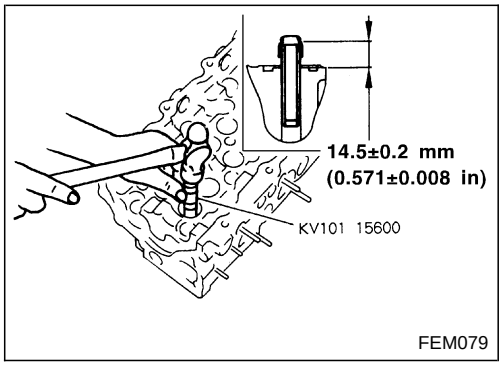
VALVE SPRING FREE LENGTH AND COMPRESSIVE LOAD

Using valve spring tester, check the following.

Free length: 55.43 mm (2.1823 in)
Installation height: 40.8 mm (1.6063 in)
Installation load: 180 - 206 N (18.4 - 21.0 kg, 40.6 - 46.3 lb)
Height at valve open: 32.3 mm (1.2717 in)
Load at valve open: 336 - 372 N (34.3 - 37.9 kg, 75.6 - 83.6 lb)

Assembly

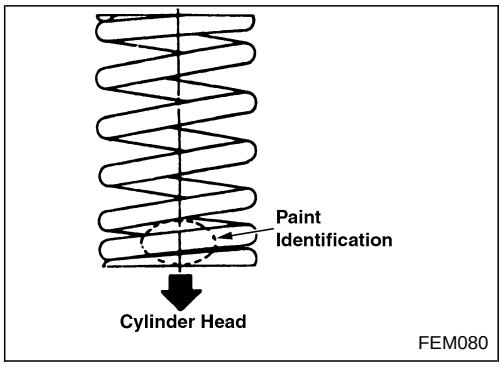
1. Install valve guides, referring to EM-1061, "VALVE SEAT REPLACEMENT".
2. Install valve seats, referring to EM-1061, "VALVE SEAT CONTACT".



3. Using valve oil seal drift (SST), install valve oil seals referring to the dimension shown in the figure.
- The figure shows the dimension before valve spring seats are installed.

4. Install valve spring seats.
5. Install valves.
- Install the valves with bigger openings to intake valve side.
- Note that valve layout here is different from that of conventional the engine.

Assembly (Cont'd)



6. Install valve spring.
- When installing valve spring, make sure that a smaller pitch side (identification paint-applied side) faces the cylinder head.

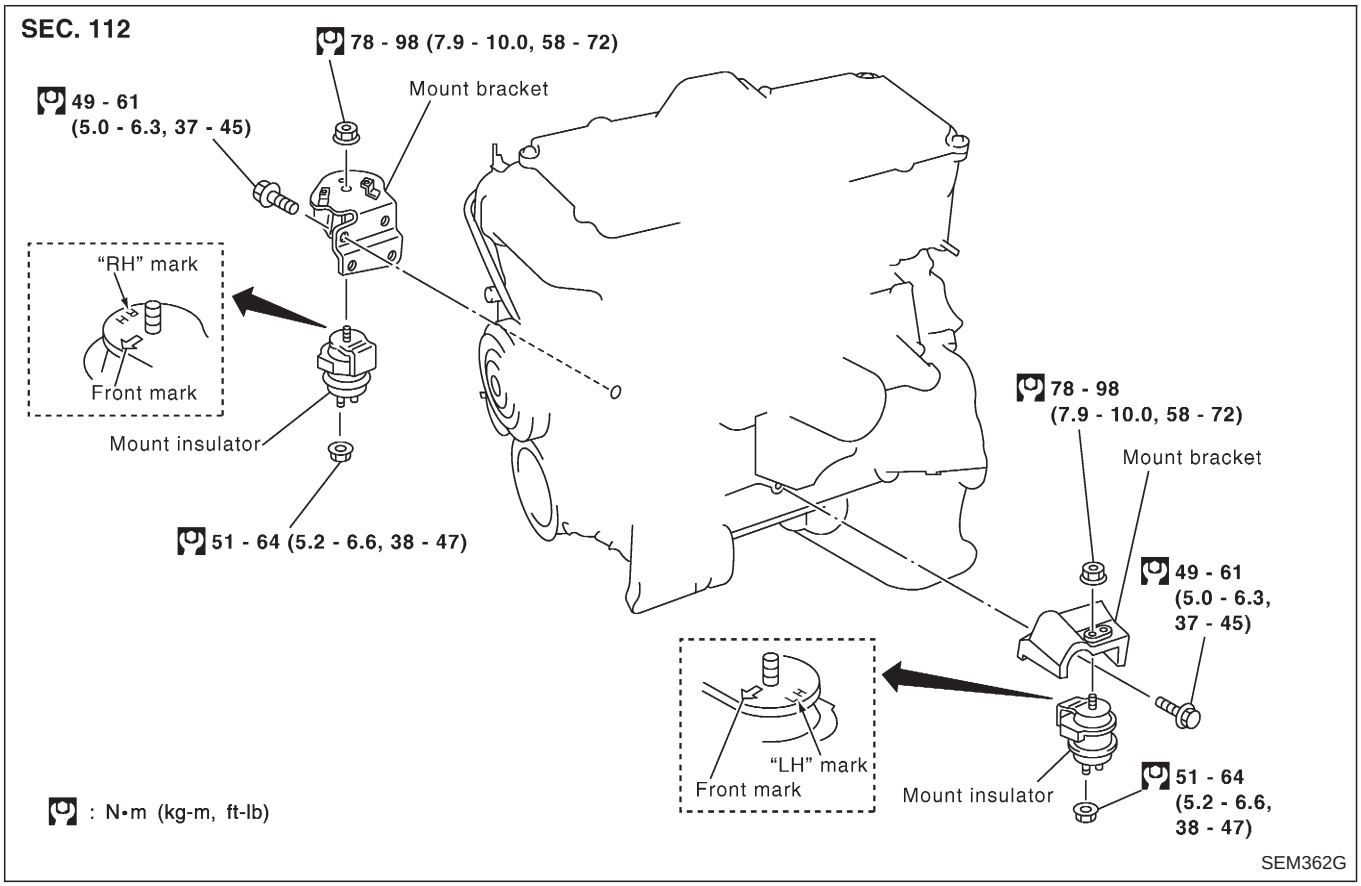
  Identification color: pink

7. Install valve spring retainers.
8. Using valve spring compressor (SST), compress valve springs. Using magnetic hand, install valve collets.
- After installing valve collets, tap the stem end using a plastic hammer, and check the installation status.

9. Install valve lifters and adjusting shims to the same positions as before.

Precautions

- Do not perform operation unless it is perfectly safe.
- Do not start operation unless the exhaust system and coolant are cooled down.
- Lift the engine at the designated support points only.
- Perform operations for the items other than the engine body, referring to the applicable sections.



- Refer to MT section and AT section for rear mount.

Removal

- After removing transmission, hoist the engine and remove it.

Preparation

1. Drain coolant from radiator drain plugs.
2. Remove the following parts.

- Engine hood
- Undercover
- Under protector
- Battery
- Intercooler cover
- Intercooler
- Radiator shroud
- Radiator
- Accessory belt
- Cooling fan
- Exhaust front tube

Engine room (Left)

3. Remove air duct and air cleaner case.
4. Disconnect vacuum hose to the vehicle on the engine.

Removal (Cont'd)

5. Disconnect harness connectors from alternator and air compressor.
6. Remove alternator.
7. After removing refrigerant, remove pipes of air compressor and inlet/outlet.
8. Disconnect heating hose, install blank cap to hose to prevent coolant from leaking.
9. Remove heating pipe.
10. Remove heat insulator.
11. Remove catalytic converter.

Engine room (Right)

12. Remove power steering reservoir tank from bracket, and fix it to the vehicle with a rope.

CAUTION:
Keep the reservoir tank level when fixing to prevent oil leak.

13. Remove fuel feed and return hoses.

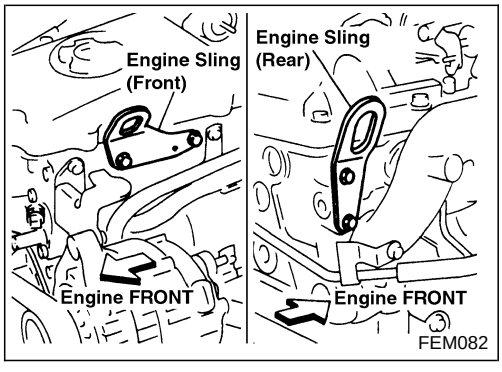
CAUTION:
Install blank caps immediately to avoid fuel leakage.

14. Remove all harness connectors on the engine, and move harnesses to the side of the vehicle.

Vehicle underfloor

15. Remove starter motor.
16. Detach A/T oil cooler pipes from oil pan. (A/T model)
17. Remove rear propeller shaft.
18. Remove mounting bolts to secure the engine to transmission.

1) Remove torque converter installation bolt. (A/T model)
2) Lift transmission bottom with transmission jack, and remove rear mount members from the vehicle.
3) Lower transmission with the jack, and remove upper mounting bolts securing the engine to transmission.
4) Lift transmission with the jack, and reinstall rear mount members to the vehicle.
5) Position the jack to the front side of transmission.
6) Remove remaining mounting bolts securing the engine to transmission.



Removal operation

19. Remove air conditioner high pressure pipes at the rear of the engine room.

- This is due to some inconvenience in the rear slinger installation.

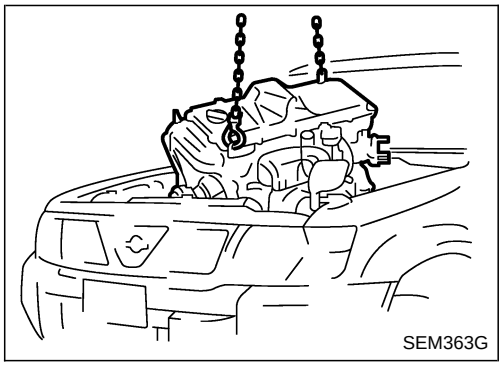
20. Install the engine slingers (standard service part) to front-left and rear-right.

: 25 - 28 N·m (2.5 - 2.9 kg-m, 18 - 20 ft-lb)

WARNING:
For engines without engine slingers, attach proper slingers and bolts described in the PARTS CATALOG.

Removal (Cont'd)

21. Hook hoists to slingers to secure the position.
22. Remove installation nuts for left and right engine mount insulators.


SEM363G

23. While adjusting position frequently, hoist and remove the engine.

CAUTION:

- **While performing operation, check that all necessary wires and pipes are disconnected.**
- **Avoid interference with parts on the vehicle.**

Installation

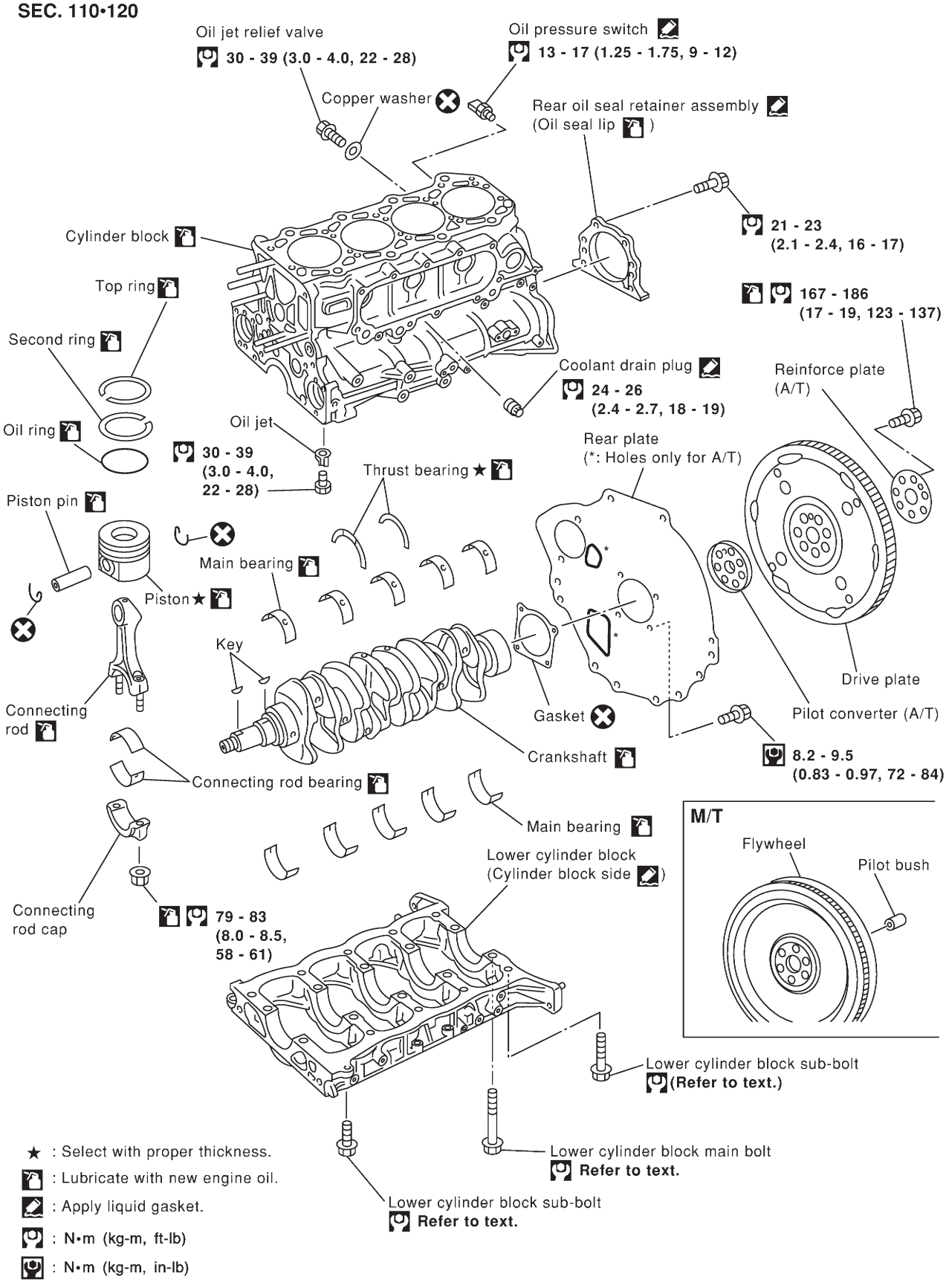
Install the engine in the reverse order of the removal procedure.

- Keep each mount insulator from oil adherence and damage.
- As for identification and installation direction of left and right insulators, refer to stamping on the top surface. Refer to EM-1064.
- As for a location with positioning pin, insert the pin correctly to the hole of mating part.
- While keeping each mount insulator free from twisting, tighten mounting bolts and nuts for the engine mount.

Inspection

- Before starting the engine, check coolant level and grease amount, and if necessary, refill them to the specified level.
- Start the engine, and check that there is no abnormal noise or vibration.
- Warm up the engine to the sufficient temperature, and check that there is no leakage of coolant, greases, fuel, or exhaust gas.

SEC. 110•120



SEM360G

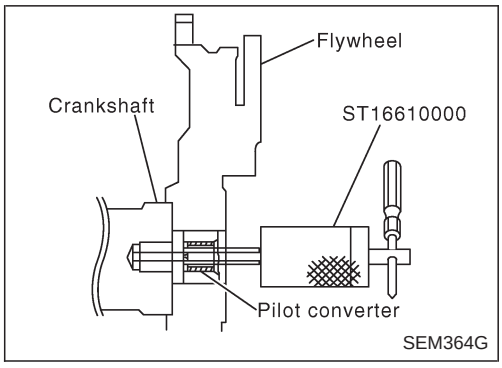
Selection Procedure for Selective Part Combination

Location	Selective part combination	Item	Method
Cylinder block - piston	Piston and piston assembly (Part No. is given to a piston and piston pin as a set.)	Piston grade (Piston outer diameter)	Refer to “Selective combination chart”.

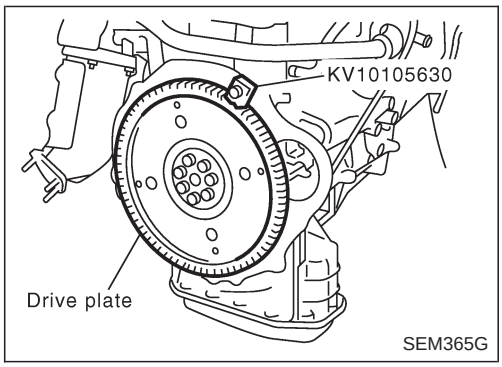
- Identification grade stamped on each part represents initial dimension of new part. This grade will not be applied to a reused part.
- Measure correct dimensions of a reused or modified part, then refer to “Selective combination chart” in this manual to identify the grade.
- Refer to the applicable pages for measurement method for each part, standards for reuse, and selecting method for selective part combination.

Disassembly

1. Remove engine assembly from vehicle.
   Refer to EM-1064, “ENGINE REMOVAL”.



2. Remove pilot bushing from flywheel using pilot bearing puller (SST), if necessary (M/T model).
3. Install engine to engine stand (SST).



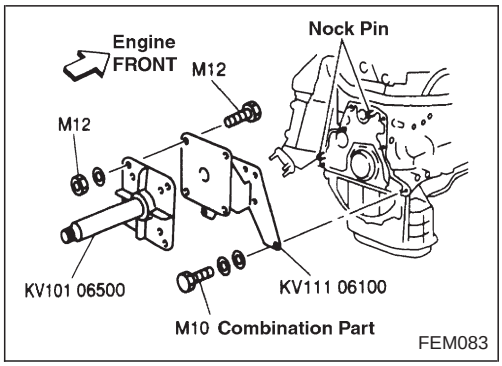
1) Remove flywheel (M/T model) or drive plate (A/T model).
- Using ring gear stopper (SST), secure ring gear, and remove mounting bolts.

CAUTION:
Do not disassemble flywheel.

- Flywheel has a two-piece structure. When being pressed forward/backward, or twisted in rotating direction, transmission-side mass will be moved with audible sound. This is not a problem.

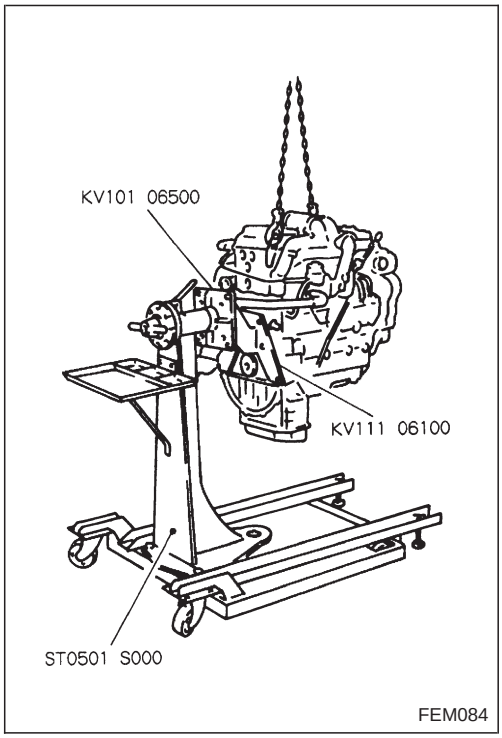
2) Remove pilot converter (A/T model) and rear plate.

Disassembly (Cont'd)



3) Install engine sub-attachment (SST) to the rear side of cylinder block.
- Align knock pin on cylinder block with pin hole on attachment to install engine sub-attachment.
- Mounting bolts are provided with engine sub-attachment.

4) Install engine attachment (SST).
- Use commercially available M12 mounting bolts and nuts (4 sets) with strength grade of 9T (minimum).

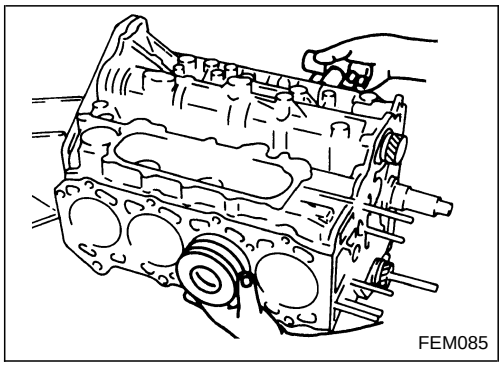


5) Hoist engine and install it to the engine stand (SST).
- Engine attachment and engine sub-attachment can be installed to engine stand before engine installation.

4. Drain engine oil and coolant from engine.
5. Remove the following parts and related parts. (Only major parts are listed.)
- Accessory belt
- Catalytic converter
- Turbocharger
- Exhaust manifold
- Injection tube
- Intake manifold
- Rocker cover
- Oil pan (upper/lower)
- Water pump
- Thermostat and water pipes
- Vacuum pump
- Injection tube
- Timing chain
- Electronic high pressure fuel injection pump
- Timing gear
- High pressure injection nozzle assembly
- Camshaft
- Cylinder head
- Oil cooler
- Accessory and accessory brackets

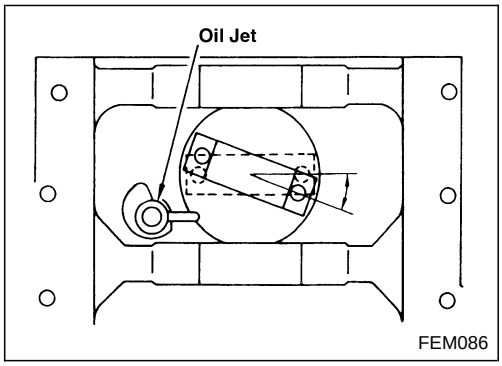
6. Remove rear oil seal and retainer assembly.
- Insert flat-bladed screwdriver between lower cylinder block and rear oil seal retainer to remove the assembly.
- No part No. is given to oil seal.

Disassembly (Cont'd)


FEM085

7. Remove piston and connecting rod assembly.
- Before removing piston and connecting rod assembly, check connecting rod side clearance.
  Refer to EM-1072,"CONNECTING ROD SIDE CLEARANCE".

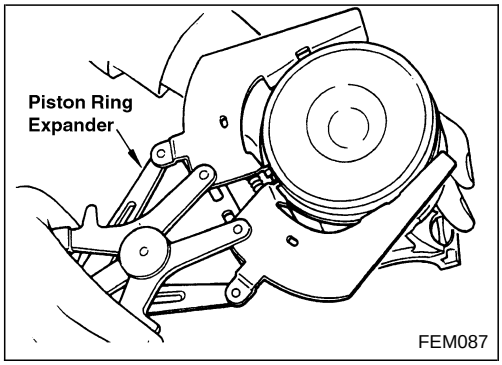
1) Move crankshaft pin to be removed to approximately BDC.
2) Remove connecting rod caps.
3) Using the grip of a hammer, press the piston and connecting rod assembly out to cylinder head side.



FEM086

CAUTION:
When removing the piston and connecting rod assembly, prevent the big end of the connecting rod from interfering with the oil jet.

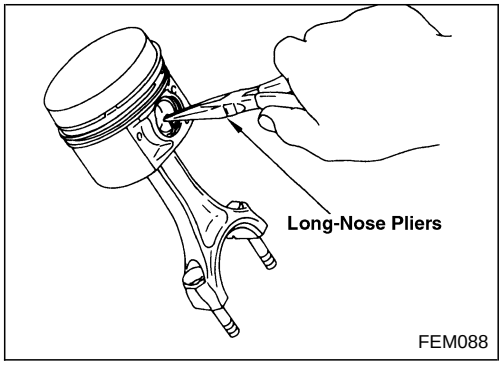
8. Remove connecting rod bearings from connecting rods and caps.
- Keep them by cylinder to avoid confusion.



FEM087

9. Remove piston rings from pistons using piston ring expander (multi-purpose tool).

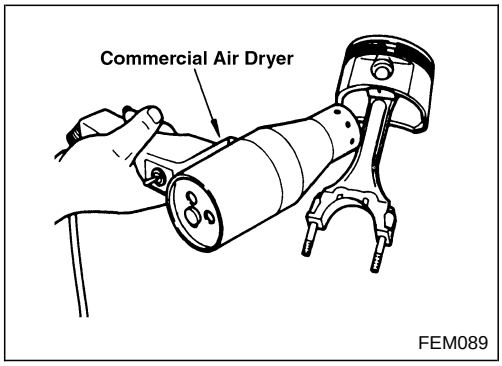
CAUTION:
- **When removing, prevent pistons from being damaged.**
- **Do not expand piston rings excessively. This may damage the piston rings.**



FEM088

10. Remove pistons from connecting rods.

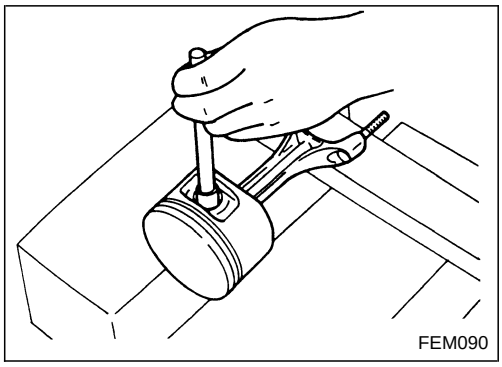
1) Using long nose pliers, remove snap rings.



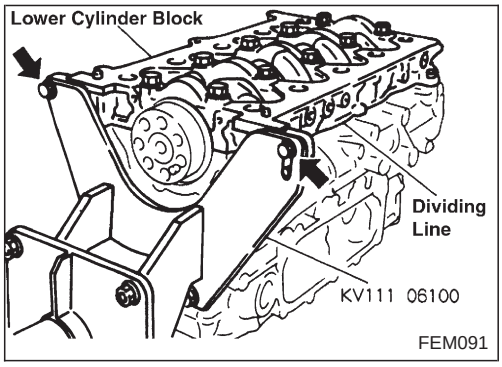
FEM089

2) Using industrial dryer, heat pistons up to 60 to 70°C (140 to 158°F).

Disassembly (Cont'd)


FEM090

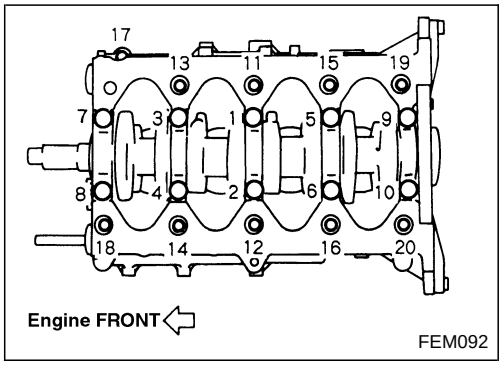
3) Using rod with outer diameter of 30 mm (1.18 in), press piston pins out.



FEM091

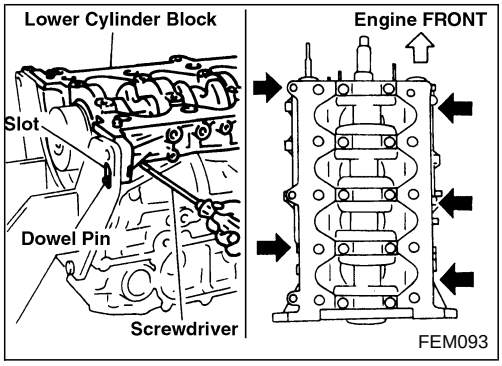
11. Remove lower cylinder block.
- The lower cylinder block is the lower part of the cylinder block, which works as the main bearing cap (beam) and oil pan mounting face.

1) Remove mounting bolts for engine sub-attachment shown by arrows in the figure.



FEM092

2) Loosen and remove mounting bolts in the reverse order shown in the figure.



FEM093

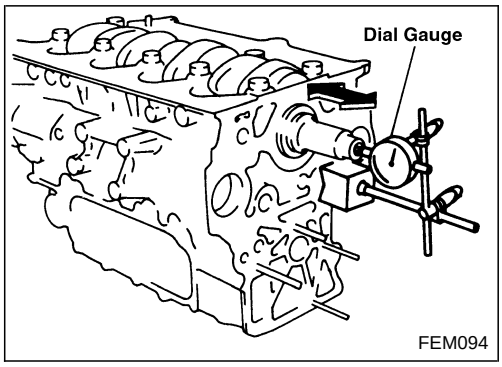
3) Insert flat-bladed screwdriver into 5 locations shown by arrows in the figure. Lift lower cylinder block evenly, and remove liquid gasket.

CAUTION:
Prevent mating faces from being damaged.

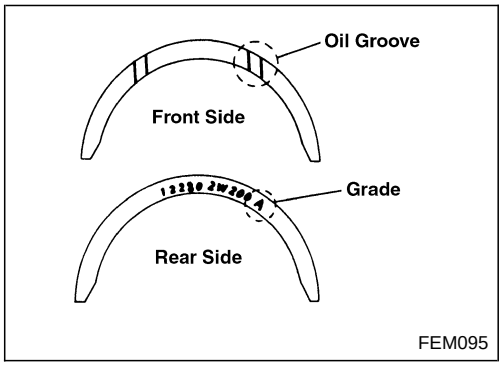
4) When removing lower cylinder block, use slot to prevent dowel pin from interfering with engine sub-attachment.
- No part No. is given to lower cylinder block, because it is machined with the cylinder block.

12. Remove crankshaft.
13. Remove main bearings and thrust bearings from cylinder block and lower cylinder block.

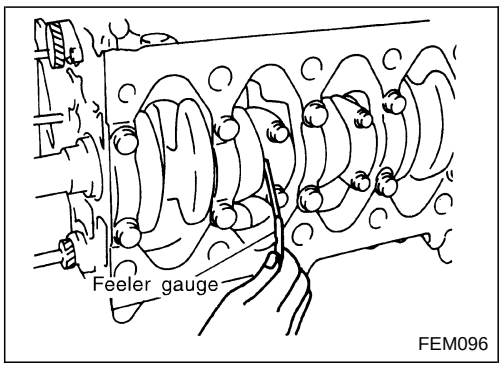
CAUTION:
Check mounting positions. Keep them to avoid confusion.



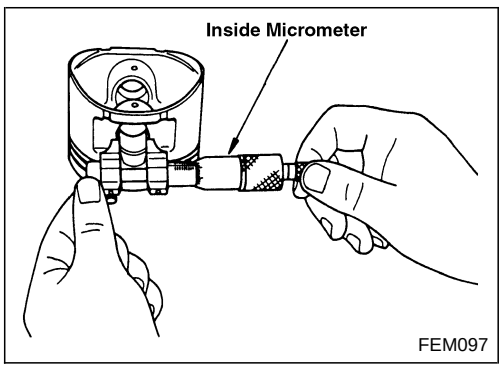
FEM094



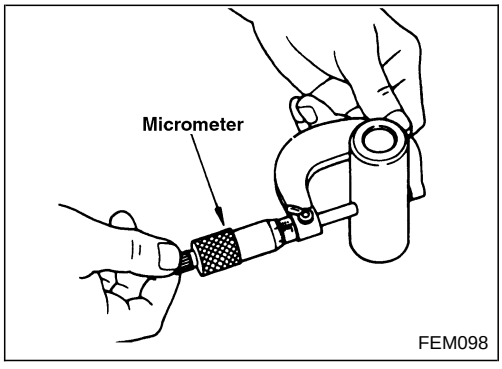
FEM095



FEM096



FEM097



FEM098

Inspection

CRANKSHAFT END PLAY

- Using dial indicator, measure crankshaft travel amount by moving the crankshaft forward or backward, or
- Using feeler gauge, measure crankshaft travel amount with the lower cylinder block removed.

Standard: 0.055 - 0.140 mm (0.0022 - 0.0055 in)
Limit: 0.250 mm (0.0098 in)

- If measured value exceeds the limit, select appropriate thrust bearings.

Unit: mm (in)

Grade symbol	Thickness of thrust bearing
A	2.275 - 2.325 (0.0896 - 0.0915)
B	2.300 - 2.350 (0.0906 - 0.0925)
C	2.325 - 2.375 (0.0915 - 0.0935)
OS 020	2.475 - 2.525 (0.0974 - 0.0994)

- OS 020 has part No. of 12280 2W215 and OS 0.20 marked on bearing surface.

CONNECTING ROD SIDE CLEARANCE

- Using feeler gauge, measure side clearance between connecting rod and crank arm.

Standard: 0.10 - 0.22 (0.0039 - 0.0087 in)
Limit: 0.22 mm (0.0087 in)

- If measured value exceeds the limit, replace connecting rod and repeat measurement.
  If measured value still exceeds the limit, replace crankshaft.

PISTON TO PISTON PIN CLEARANCE

Piston pin hole inner diameter

Using inside micrometer, measure piston pin hole inner diameter.

Standard: 32.997 - 33.005 mm (1.2991 - 1.2994 in) dia.

Piston pin outer diameter

Using micrometer, measure piston pin outer diameter.

Standard: 32.993 - 33.000 mm (1.2989 - 1.2992 in) dia.

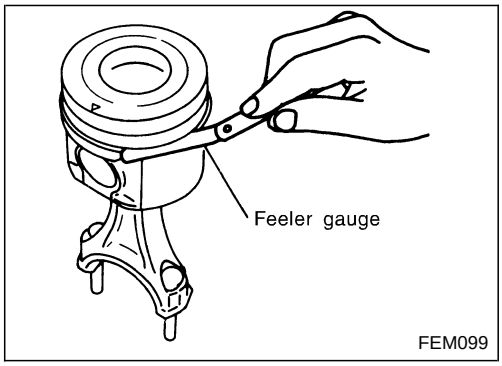
Inspection (Cont'd)

Calculation of piston to piston pin clearance

Piston pin clearance = Piston pin hole inner diameter − Piston pin outer diameter

Standard: −0.003 (Tightening clearance) to 0.012 mm (−0.0001 to 0.0005 in)

If out of specifications, replace piston and piston pin assembly.

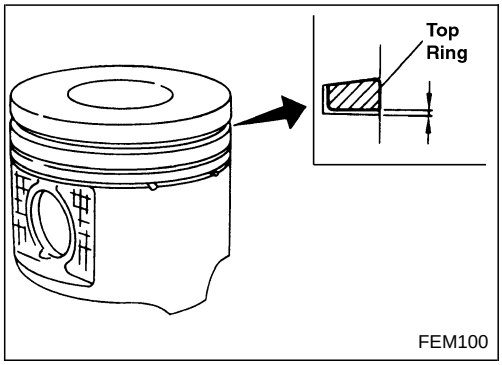


PISTON RING SIDE CLEARANCE

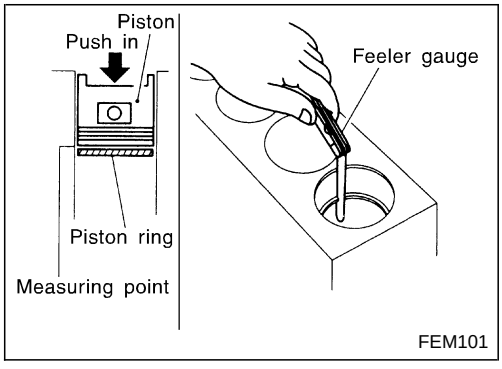
- Using feeler gauge, measure clearance between piston ring and piston ring groove.

Unit: mm (in)

	Standard	Limit
Top ring	0.05 - 0.07 (0.0020 - 0.0028)	0.5 (0.020)
Second ring	0.04 - 0.08 (0.0016 - 0.0031)	0.3 (0.012)
Oil ring	0.02 - 0.06 (0.0008 - 0.0024)	0.15 (0.0059)



- Align top ring and external surface of piston. Measure lower side clearance of top ring with top ring pressed onto upper side of ring groove.
- If side clearance exceeds the limit, replace piston ring.
- Check clearance again. If side clearance still exceeds the limit, replace piston.



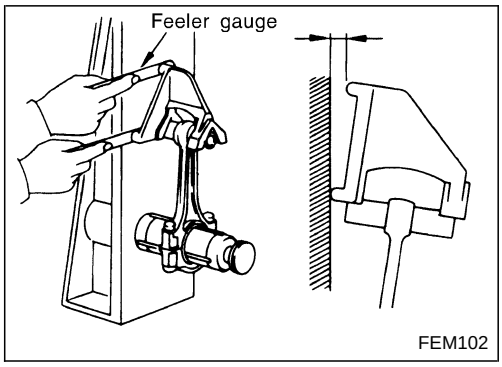
PISTON RING END GAP

- Check that cylinder bore diameter is within specifications. Refer to EM-1075, "PISTON TO CYLINDER BORE CLEARANCE".
- Using piston, press piston ring to cylinder mid point, and measure end gap.

Unit: mm (in)

	Standard	Limit
Top ring	0.3 - 0.45 (0.0118 - 0.0177)	1.5 (0.059)
Second ring	0.5 - 0.65 (0.0197 - 0.0256)	
Oil ring	0.25 - 0.45 (0.0098 - 0.0177)	

Inspection (Cont'd)



CONNECTING ROD BEND AND TORSION

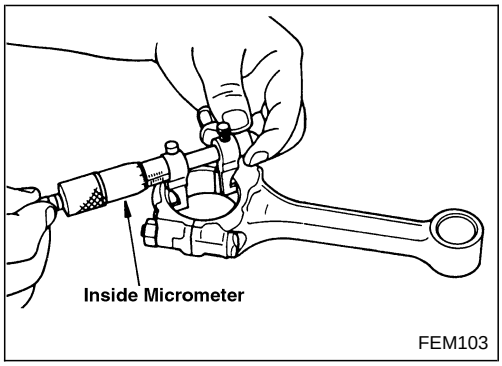
Use connecting rod aligner to check bend and torsion.

Bend limit:

0.05 mm (0.0020 in)/100 mm (3.94 in)

Torsion limit:

0.05 mm (0.0020 in)/100 mm (3.94 in)

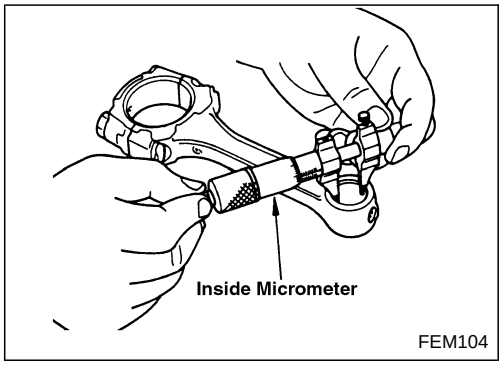


Connecting rod big end inner diameter

Install connecting rod caps without connecting rod bearings and tighten connecting rod nuts to the specified torque. Using inside micrometer, measure connecting rod big end inner diameter.

Standard:

59.987 - 60.000 mm (2.3617 - 2.3622 in) dia.



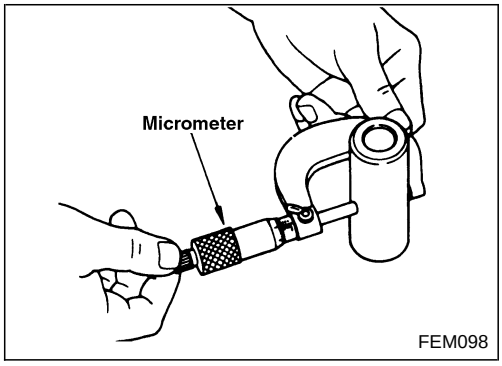
CONNECTING ROD BUSHING OIL CLEARANCE (SMALL END)

Connecting rod small end inner diameter

Use inside micrometer to measure small end inner diameter.

Standard:

33.025 - 33.038 mm (1.3002 - 1.3007 in) dia.



Piston pin outer diameter

Use micrometer to measure piston pin outer diameter.

Standard:

32.993 - 33.000 mm (1.2989 - 1.2992 in) dia.

Calculation of connecting rod bushing clearance

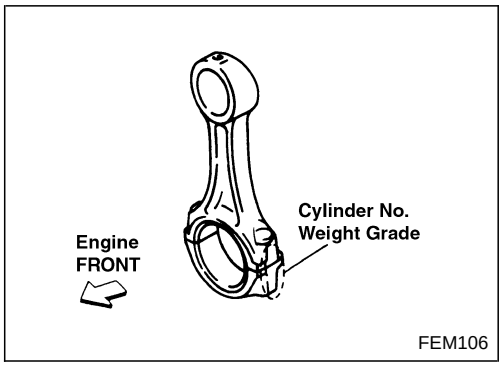
Connecting rod small end bushing clearance = Connecting rod small end inner diameter − Piston pin outer diameter

Standard:

0.025 - 0.045 mm (0.0010 - 0.0018 in)

- If out of specifications, replace connecting rod and/or piston and piston pin assembly.

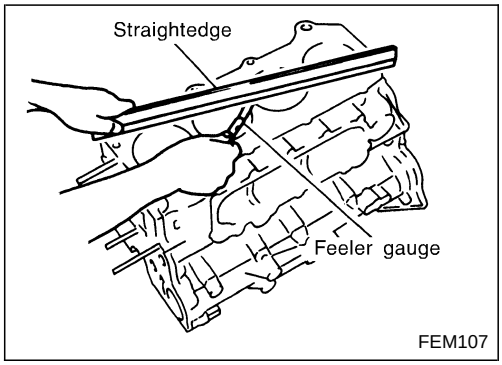
Inspection (Cont'd)



FEM106

- New connecting rods are classified into 8 weight classes at factory. The same class connecting rods are used on a engine.

Weight grade symbol	Weight class g (oz)
H	1,261 - 1,264 (44.5 - 44.6)
I	1,264 - 1,267 (44.6 - 44.7)
K	1,267 - 1,270 (44.7 - 44.8)
L	1,270 - 1,273 (44.8 - 44.9)
M	1,273 - 1,276 (44.9 - 45.0)
O	1,276 - 1,279 (45.0 - 45.1)
P	1,279 - 1,282 (45.1 - 45.2)
S	1,282 - 1,285 (45.2 - 45.3)



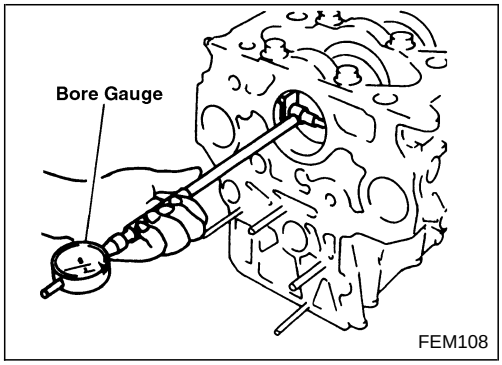
FEM107

CYLINDER BLOCK TOP SURFACE DISTORTION

- Using scraper, remove gasket installed onto cylinder block surface. Remove contamination such as oil, scale, and carbon.

CAUTION:
Keep broken pieces of gasket clear of oil and coolant passages.

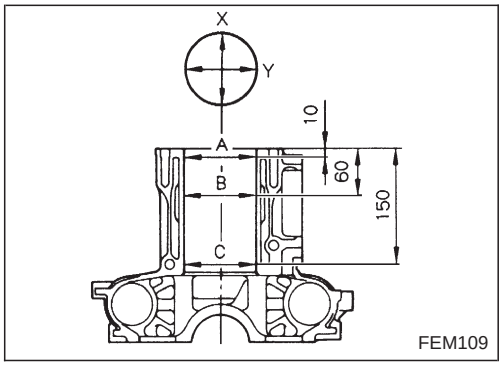
- Use straightedge and feeler gauge to check block upper surface for distortion.
  Limit: 0.1 mm (0.004 in)



FEM108

MAIN BEARING HOUSING INNER DIAMETER

- Install main bearing caps without main bearings. Tighten mounting bolts to the specified torque.
- Use bore gauge to measure main bearing housing inner diameter.
  Standard:
  74.981 - 75.000 mm (2.9520 - 2.9528 in) dia.
- If out of specification, replace cylinder block and lower cylinder block.



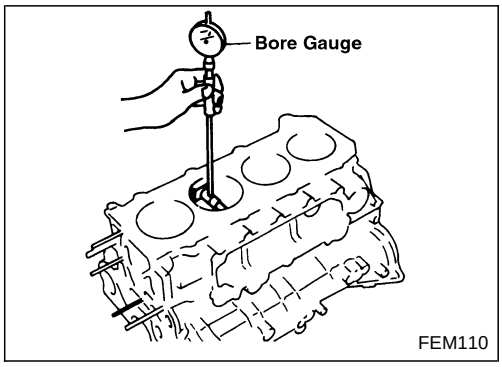
FEM109

PISTON TO CYLINDER BORE CLEARANCE

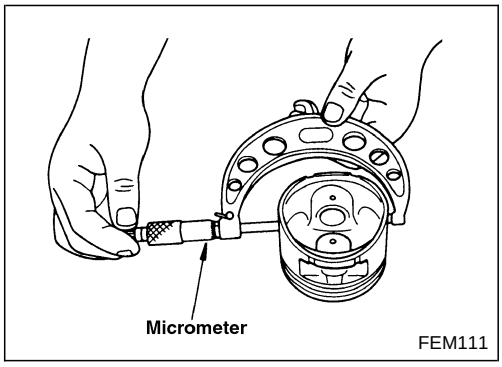
Cylinder bore inner diameter

- Using bore gauge, measure cylinder inner diameters at 6 positions; top, middle, and bottom (A, B, C) in 2 directions (X, Y).
  Cylinder inner diameter (Standard):
  96.000 - 96.030 mm (3.7795 - 3.7807 in) dia.
  Wear limit: 0.2 mm (0.008 in)
  Out-of-round limit (X - Y): 0.02 mm (0.0008 in)
  Taper limit (A - C): 0.02 mm (0.0008 in)

Inspection (Cont'd)



- If clearance exceeds the limit, or any flaws or seizures are found on inner surface of cylinder, horn or bore the applicable cylinder.



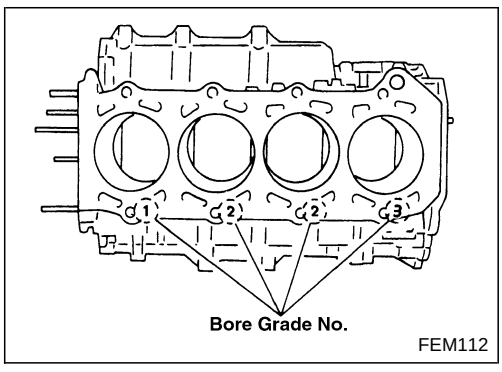
Piston outer diameter

Use micrometer to measure piston skirt outer diameter.

Measurement position:
10 mm (0.39 in) upper from the lower end of piston
Standard:
95.950 - 95.980 mm (3.7776 - 3.7787 in) dia.

Calculation of piston to piston bore clearance

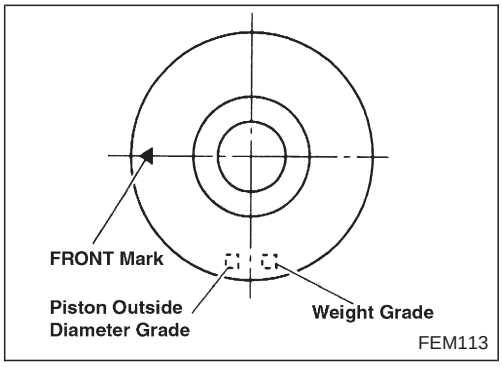
- Calculate using piston skirt outer diameter and cylinder inner diameter (direction X, position B).
  Clearance = Cylinder inner diameter − Piston skirt outer diameter
  Specifications at room temperature [20°C (68°F)]:
  0.040 - 0.060 mm (0.0016 - 0.0024 in)
- If out of specification, replace piston and piston pin assembly.



SELECTIVE PISTON COMBINATION

When using new cylinder block

- Confirm cylinder bore grade (1, 2, 3) on left upper surface of cylinder block, and refer to "Selective combination chart" below to select appropriate piston.
- Part No. is given to a piston and piston pin as a set.



When re-using an old cylinder block

1. Measure cylinder block bore inner diameter.
2. Referring to "Cylinder block bore inner diameter" in "Selective combination chart", select appropriate piston according to cylinder bore grade.

Inspection (Cont'd)

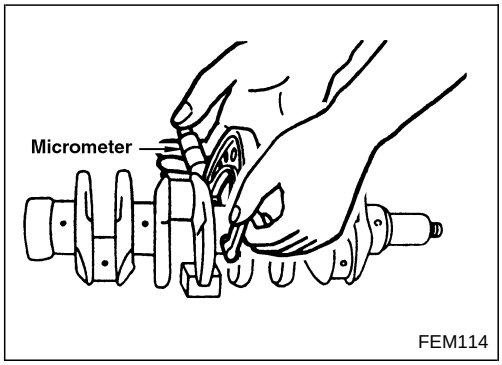
Selective combination chart

Unit: mm (in)

○: Preferable combination △: Allowable combination X: NG combination			Piston grade	
			1	2
			95.950 - 95.960 (3.7776 - 3.7779)	95.960 - 95.970 (3.7779 - 3.7783)
Cylinder bore grade (Cylinder block bore inner diameter)	1	96.000 - 96.010 (3.7795 - 3.7799)	○	X
	2	96.010 - 96.020 (3.7799 - 3.7803)	△	○
	3	96.020 - 96.030 (3.7803 - 3.7807)	△	○

- Piston grade 3 (95.980/95.970) is applicable at factory only.
- New pistons are classified into 4 weight classes at factory. The same class pistons are used on a engine.

Weight grade symbol	Weight class g (oz)
E	600 - 605 (21.2 - 21.3)
F	605 - 610 (21.3 - 21.5)
G	610 - 615 (21.5 - 21.7)
H	615 - 620 (21.7 - 21.9)



FEM114

CRANKSHAFT JOURNAL OUTER DIAMETER

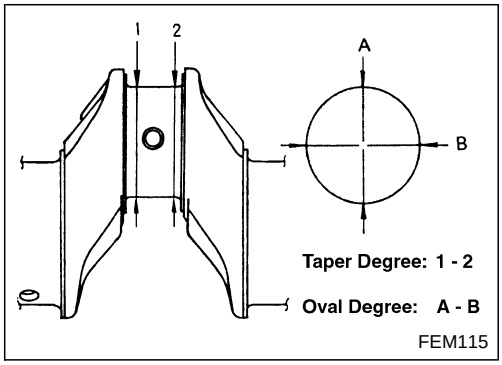
Use micrometer to measure journal outer diameter.

Standard: 70.907 - 70.920 mm (2.7916 - 2.7921 in) dia.

CRANKSHAFT PIN OUTER DIAMETER

Use micrometer to measure pin outer diameter.

Standard: 56.913 - 56.926 mm (2.2407 - 2.2412 in) dia.

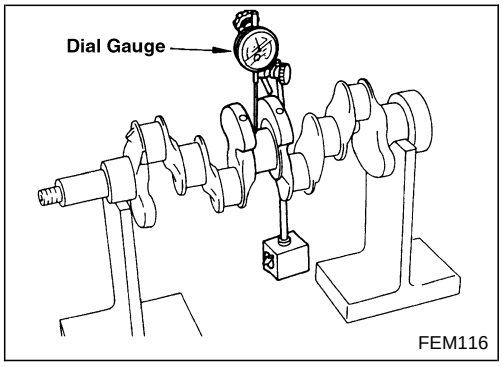


FEM115

CRANKSHAFT OUT-OF-ROUND AND TAPER

- Using micrometer, measure each journal and pin at 4 points shown in the figure.
- Out-of-round value is indicated by difference in dimensions between directions A and B at points 1 and 2.
- Taper value is indicated by difference in dimensions between points 1 and 2 in directions A and B.

Out-of-round limit: 0.01 mm (0.0004 in)
Taper limit: 0.01 mm (0.0004 in)



FEM116

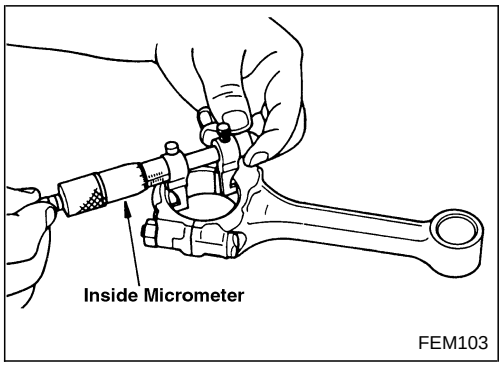
CRANKSHAFT RUNOUT

- Place V-block onto surface plate to support journals at both ends of crankshaft.
- Position dial indicator vertically onto No. 3 journal.
- Rotate crankshaft to read needle movement on dial indicator.
- Crankshaft bend value is 1/2 of needle movement.

Limit: 0.03 mm (0.0012 in)

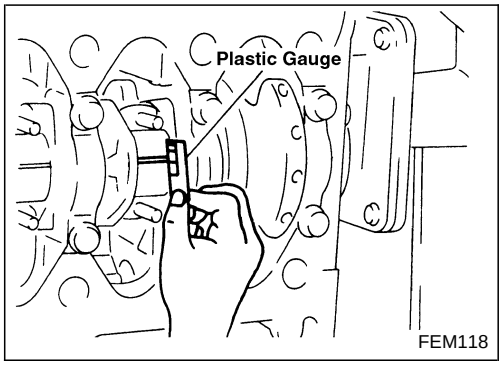
Inspection (Cont'd)

CONNECTING ROD BEARING OIL CLEARANCE



Method by measurement

- Install connecting rod bearings to connecting rods and caps, and tighten connecting nuts to the specified torque. Use inside micrometer to measure connecting rod bearing inner diameter.
  Bearing clearance = Connecting rod bearing inner diameter − Crankshaft pin outer diameter
  Standard: 0.035 - 0.077 mm (0.0014 - 0.0030 in)
- If out of specifications, check connecting rod big end inner diameter and crankshaft pin outer diameter, and select appropriate connecting rod bearing to adjust clearance to specifications.
  Refer to "Connecting rod bearing undersize list" on the next page.



Method using plastigage

- Remove contamination such as oil, dust completely from crankshaft pins and each bearing surface.
- Cut plastigage slightly shorter than bearing width, place it in crankshaft direction, avoiding oil holes.
- Install connecting rod bearings to caps, and tighten connecting rod nuts to the specified torque.

CAUTION:
Never rotate crankshaft.

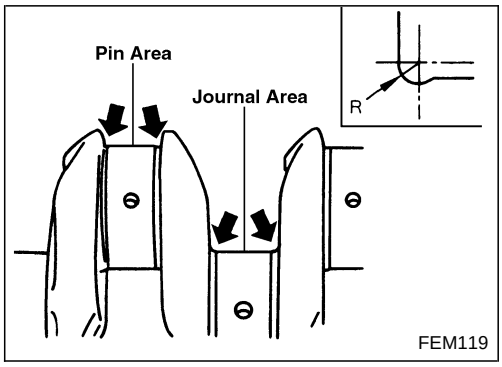
- Remove connecting rod caps and bearings, and measure plastigage width using scale on plastigage bag.

CAUTION:
If out of specification, take same action mentioned in "Method by measurement".

Undersize bearing usage

- If bearing clearance is out of specifications for connecting rod bearings in standard size, use undersize bearings.
- When using undersize bearings, measure bearing inner diameter with bearing installed, and grind pins to adjust clearance to specification.

Inspection (Cont'd)



Connecting rod bearing undersize list

Unit: mm (in)

Size	Thickness
US 025	1.630 - 1.638 (0.0642 - 0.0645)
US 050	1.755 - 1.763 (0.0691 - 0.0694)
US 075	1.880 - 1.888 (0.0740 - 0.0743)
US 100	2.005 - 2.013 (0.0789 - 0.0793)

CAUTION:
When grinding crank pins to use undersize bearings, avoid damaging corners of fillet.

Corner dimension (Standard):

Pin

3.3 - 3.7 mm (0.130 - 0.146 in)

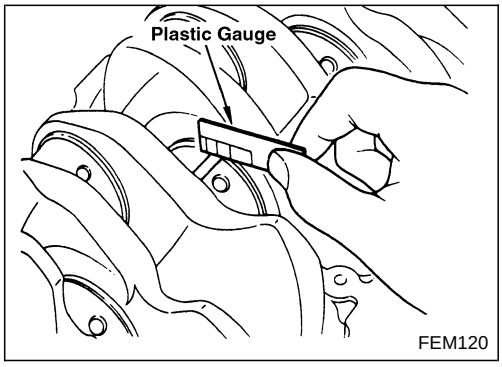
Journal

2.8 - 3.2 mm (0.110 - 0.126 in)

MAIN BEARING OIL CLEARANCE

Method by measurement

- Install main bearings to cylinder block and bearing caps, and tighten bearing cap bolts to the specified torque. Measure main bearing inner diameter.
  Bearing clearance = Bearing inner diameter − Crankshaft journal outer diameter
  Standard: 0.035 - 0.083 mm (0.0014 - 0.0033 in)
- If out of specification, check main bearing housing inner diameter and crankshaft journal outer diameter, and select appropriate main bearing to adjust clearance to specifications.
  Refer to "Main bearing undersize list" on the next page.



Method using plastigage

- Remove contamination such as oil, dust completely from crankshaft journals and each bearing surface.
- Cut plastigage slightly shorter than bearing width, place it in crankshaft direction, avoiding oil holes.
- Install main bearings to caps, and tighten connecting rod nuts to the specified torque.

CAUTION:
Never rotate crankshaft.

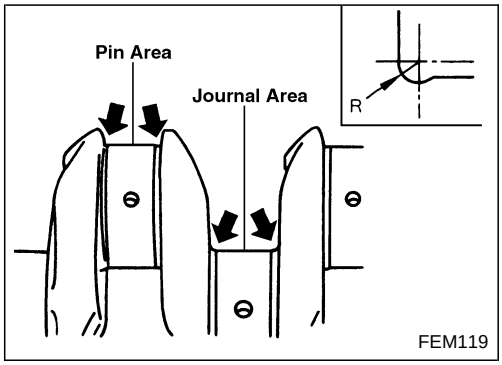
- Remove bearing caps and bearings, and measure plastigage width using scale on plastigage bag.

Inspection (Cont'd)

CAUTION:
If out of specification, take same action mentioned in "Method by measurement".

Undersize bearing usage

- If bearing clearance is out of specifications for main bearings in standard size, use undersize bearings.
- When using undersize bearings, measure bearing inner diameter with bearing installed, and grind crank journals to adjust clearance to specification.



Main bearing undersize list

Unit: mm (in)

Size	Thickness
US 025	2.130 - 2.138 (0.0839 - 0.0842)
US 050	2.255 - 2.263 (0.0888 - 0.0891)
US 075	2.380 - 2.388 (0.0937 - 0.0940)
US 100	2.505 - 2.513 (0.0986 - 0.0989)

CAUTION:
When grinding crank journals to use undersize bearings, avoid damaging corners of fillet.

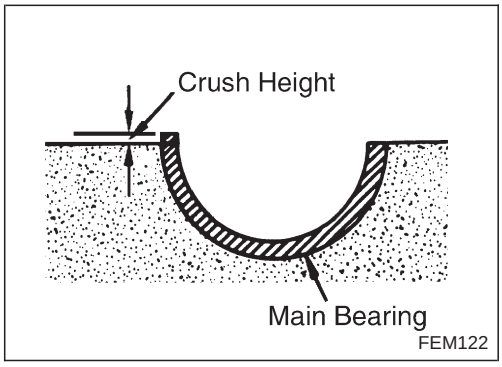
Corner dimension (Standard):

Pin

3.3 - 3.7 mm (0.130 - 0.146 in)

Journal

2.8 - 3.2 mm (0.110 - 0.126 in)



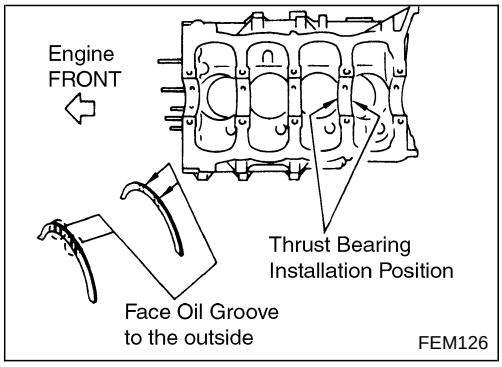
MAIN BEARING CRUSH HEIGHT

- Tighten bearing caps to the specified torque with main bearings installed, and remove caps. The bearing end must then be higher than the flat surface.

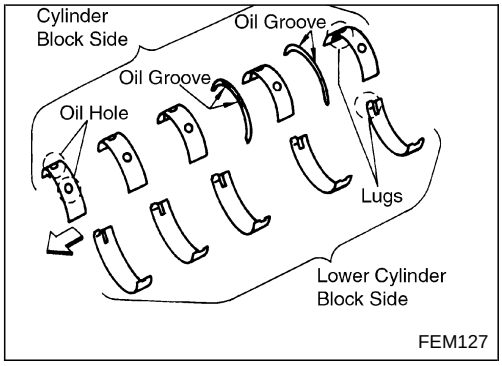
  Standard: Crush height must exist.
- If out of specification, replace main bearings.

Assembly

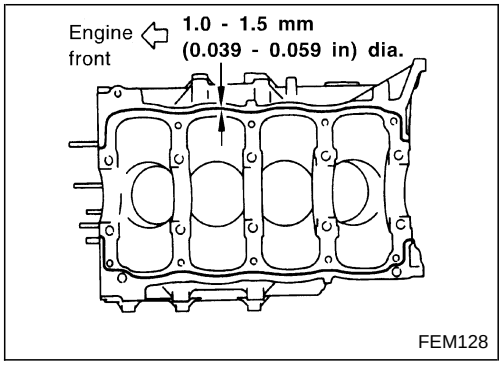
1. Blow air sufficiently to inside coolant passage, oil passage, crankcase, and cylinder bore to remove foreign matter.



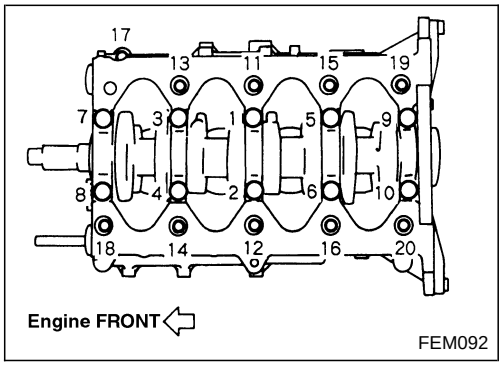
2. Install main bearings and thrust bearings.
1) Remove contamination, dust and oil from bearing mounting positions on cylinder block and main bearing caps.
2) Install thrust bearings on both sides of No. 4 housing on cylinder block.
- Install thrust bearings with oil groove facing to crankshaft arm (outside).



3) Being careful with the direction, install main bearings.
- Install main bearings with the oil holes and grooves onto the cylinder block side, and those without oil holes and grooves onto the lower cylinder block side.
- While installing bearings, apply engine oil to bearing surfaces (inside). Do not apply oil to rear surfaces, but clean them completely.
- Align stopper notches on bearings to install them.
- Check that the oil holes on the cylinder block body are mated with the oil hole positions on the bearings.



3. Install crankshaft to cylinder block.
- While rotating crankshaft by hand, check for smooth rotation.
4. Install lower cylinder block.
- Apply a continuous bead of liquid gasket to lower cylinder block as shown in the figure.
- Using slots on engine sub-attachment, install the lower cylinder block to the cylinder block, avoiding interference of dowel pins.



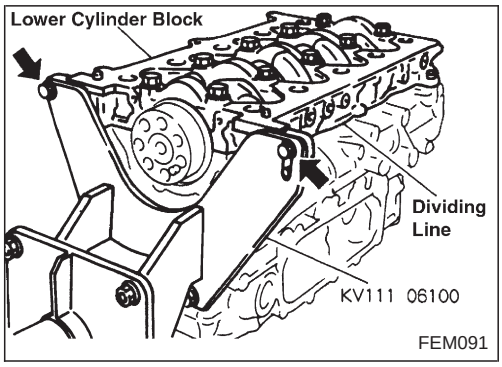
5. Tighten lower cylinder mounting bolts to the torque shown below in 3 consecutive steps in the order shown in the figure.

Unit: N·m (kg-m, ft-lb)

	Main bolt (Nos. 1 - 10)	Sub-bolt (Nos. 11 - 20)
1st	20 (2.0, 14)	98 (10, 72)
2nd	98 (10, 72)	20 (2.0, 14)
3rd	167 - 176 (17 - 18, 123 - 130)	40 - 46 (4.0 - 4.7, 29 - 33)

- Sub-bolt No. 17 has shorter length than that of other sub-bolts.

Assembly (Cont'd)

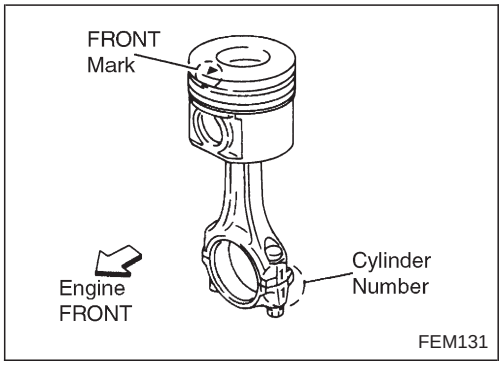


6. Install mounting bolts for engine sub-attachment shown by arrows in the figure.
- After tightening bolts to the specified torque, check crankshaft for smooth rotation.
- Check crankshaft end play.
  Refer to EM-1072, "CRANKSHAFT END PLAY".

7. Install pistons to connecting rod.

1) Using long nose pliers, install snap rings to grooves on piston rear side.
- Fit snap rings correctly into grooves.

2) Install pistons to connecting rods.
- Using industrial dryer, heat pistons up to approx. 60 to 70°C (140 to 158°F) until piston pin can be pressed down by finger touch. Then insert piston pins into piston and connecting rod from front side of piston toward rear.

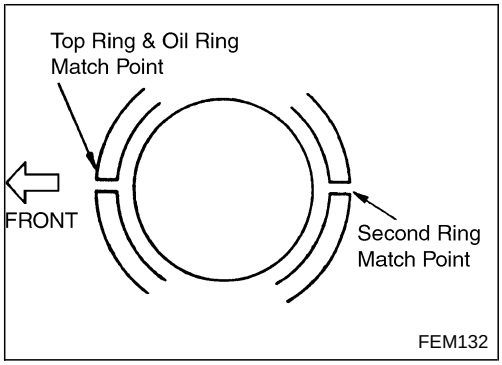


- Assemble piston and connecting rod with front mark of piston crown and cylinder No. stamped on connecting rod being positioned as shown in the figure.

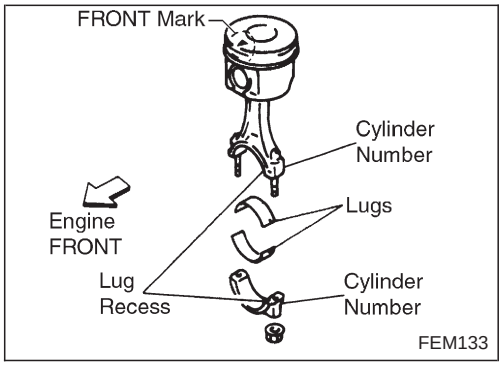
3) Install snap rings to front side of pistons.
- Refer to above 1) for precaution on snap ring installation.
- After installation, check connecting rods for smooth movement.

8. Use piston ring expander (multi-purpose tool) to install piston rings.

CAUTION:
When installing, prevent piston from being damaged.

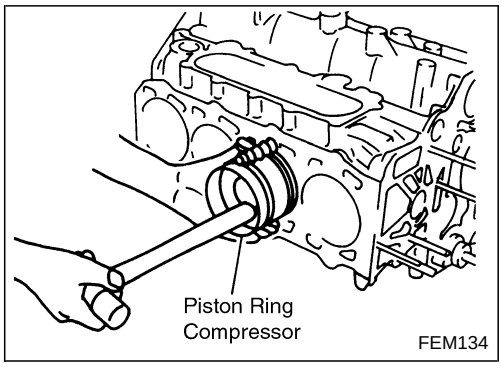


- Install top ring and second ring with stamped surfaces facing upward.
  Identification stamp:
  Top ring: R
  Second ring: RN



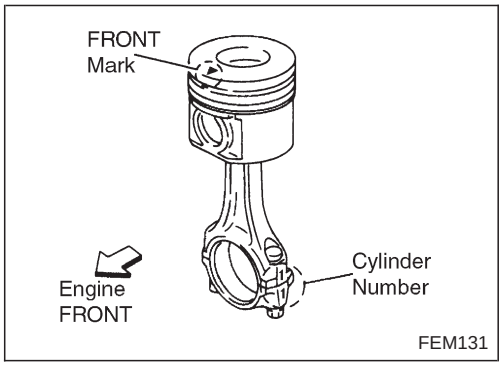
9. Install connecting rod bearings to connecting rods and caps.
- While installing connecting rod bearings, apply engine oil to bearing surfaces (inside). Do not apply oil to rear surfaces, but clean them completely.
- Align stoppers on connecting rod bearings with connecting rod stopper notches to install connecting rod bearings.

Assembly (Cont'd)

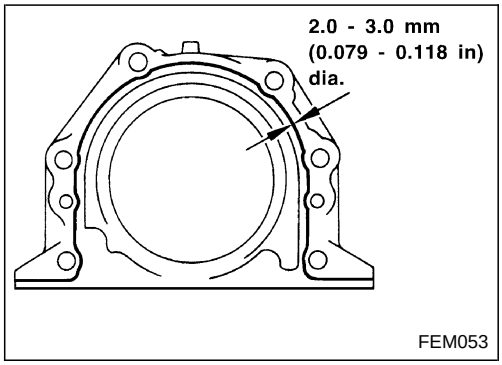


10. Install piston and connecting rod assembly to crankshaft.
- Move crankshaft pin to be removed to BDC.
- Align cylinder position with cylinder No. on connecting rod to install piston and connecting rod assembly.
- Using piston ring compressor (multi-purpose tool), install piston and connecting rod assembly with front mark on piston crown facing toward the front side of engine.

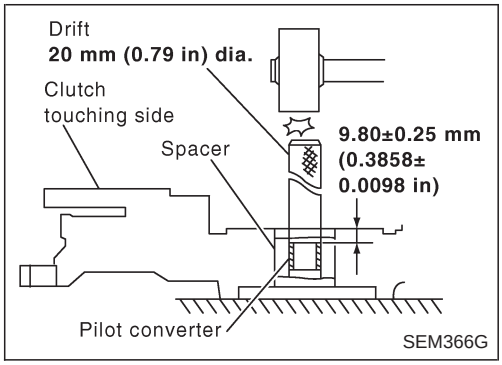
CAUTION:
When installing piston and connecting rod assembly, prevent the big end of connecting rod from interfering with oil jet.



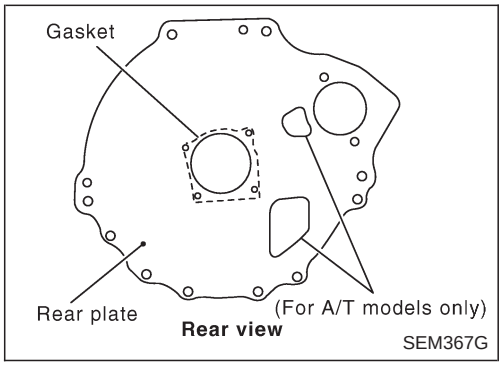
11. Install connecting rod caps and mounting nuts.
- Align cylinder No. stamped on connecting rod with that on cap to install connecting rod cap.
- After tightening nuts, check crankshaft for smooth rotation.
- Check connecting rod side clearance.
  Refer to EM-1072, "CONNECTING ROD SIDE CLEARANCE".



12. Install rear oil seal and retainer assembly.
- Apply a continuous bead of liquid gasket to rear oil seal and retainer assembly as shown in the figure.



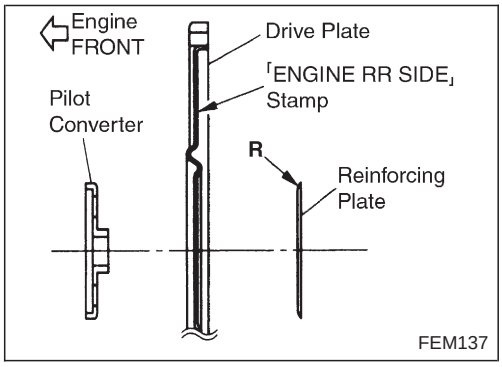
13. Press fit pilot bushing into flywheel (M/T model).
1) Using drift with outer diameter of 35 mm, press fit spacer until it is in contact with the flywheel to prevent displacement at removal.
2) Using drift with outer diameter of 20 mm, press fit pilot bushing by the length shown in the figure.



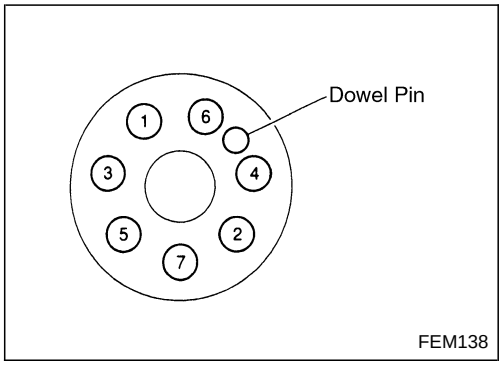
14. Install rear plate.
- Refer to the figure for gasket installation direction.

Assembly (Cont'd)

15. Install removed parts to engine in the reverse order of disassembly.
16. Remove engine from engine stand.



17. Install flywheel (M/T model) or drive plate (A/T model).
- Install pilot converter, drive plate, and reinforcing plate in direction shown in the figure.
- Using the same method as disassembly, secure crankshaft and tighten mounting bolts.



- Tighten mounting bolts for flywheel or drive plate in order shown in the figure.

General Specifications

Cylinder arrangement		In-line 4
Displacement	cm^3 (cu in)	2,953 (180.19)
Bore and stroke	mm (in)	96 x 102 (3.78 x 4.02)
Valve arrangement		DOHC
Firing order		1-3-4-2
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		5
Compression ratio		17.9

Compression Pressure

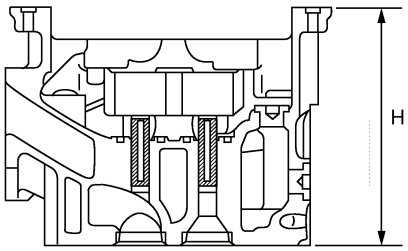
Unit: kPa (bar, kg/cm^2, psi)/200 rpm

Compression pressure	Standard	2,942 (29.4, 30.0, 427)
	Minimum	2,452 (24.5, 25.0, 356)
	Differential limit between cylinders	294 (2.94, 3.0, 43)

Cylinder Head

Unit: mm (in)

	Standard	Limit
Head surface distortion	Less than 0.03 (0.0012)	0.2 (0.008)



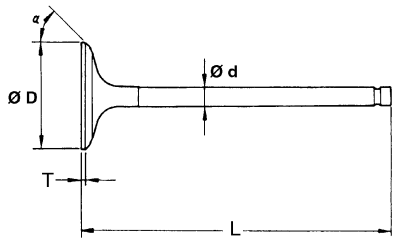
Nominal cylinder head height:
H = 156.9 - 157.1 mm (6.177 - 6.185 in)

SEM368G

Valve

VALVE

Unit: mm (in)



FEM067

Valve (Cont'd)

Valve head diameter "D"	Intake	31.9 - 32.1 (1.256 - 1.264)
	Exhaust	29.9 - 30.1 (1.177 - 1.185)
Valve length "L"	Intake	113.5 (4.4685)
	Exhaust	113.5 (4.4685)
Valve stem diameter "d"	Intake	6.962 - 6.977 (0.2741 - 0.2747)
	Exhaust	6.945 - 6.960 (0.2734 - 0.2740)
Valve seat angle "α"	Intake	45°00′ - 45°30′
	Exhaust	
Valve margin "T"	Intake	1.5 (0.059)
	Exhaust	1.5 (0.059)
Valve stem end surface grinding limit		Less than 0.2 (0.008)

VALVE CLEARANCE

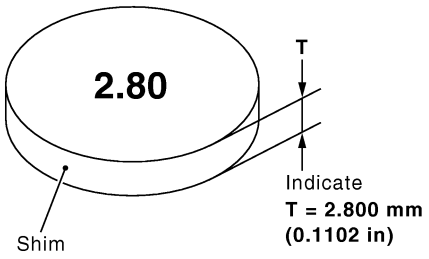
Unit: mm (in)

	Cold
Intake	0.30 - 0.40 (0.0118 - 0.0157)
Exhaust	0.30 - 0.40 (0.0118 - 0.0157)

*: Approximately 80°C (176°F)

AVAILABLE SHIMS

Thickness mm (in)	Identification mark
2.35 (0.0925)	2.35
2.40 (0.0945)	2.40
2.45 (0.0965)	2.45
2.50 (0.0984)	2.50
2.55 (0.1004)	2.55
2.60 (0.1024)	2.60
2.65 (0.1043)	2.65
2.70 (0.1063)	2.70
2.75 (0.1083)	2.75
2.80 (0.1102)	2.80
2.85 (0.1122)	2.85
2.90 (0.1142)	2.90
2.95 (0.1161)	2.95
3.00 (0.1181)	3.00
3.05 (0.1201)	3.05



SEM252G

Valve (Cont'd)

VALVE SPRING

Free height	mm (in)	55.43 (2.1823)
Pressure	N (kg, lb) at height mm (in)	354 (36.1, 79.6) at 32.3 (1.2717)
Out-of-square	mm (in)	2.4 (0.094)

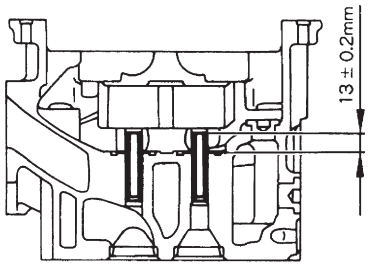
VALVE LIFTER

Unit: mm (in)

Valve lifter outer diameter	34.450 - 34.465 (1.3563 - 1.3569)
Lifter guide inner diameter	34.495 - 34.515 (1.3581 - 1.3589)
Clearance between lifter and lifter guide	0.030 - 0.065 (0.0012 - 0.0026)

VALVE GUIDE

Unit: mm (in)

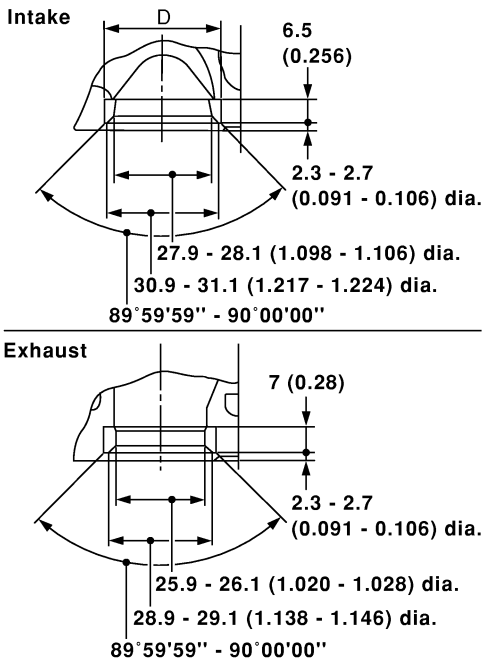


FEM071

		Standard
Valve guide	Outer diameter	11.023 - 11.034 (0.4340 - 0.4344)
	Inner diameter (Finished size)	7.000 - 7.015 (0.2756 - 0.2762)
Cylinder head valve guide hole diameter		10.996 - 10.975 (0.4329 - 0.4321)
Interference fit of valve guide		0.027 - 0.059 (0.0011 - 0.0023)
		Standard
Stem to guide clearance	Intake	0.023 - 0.053 (0.0009 - 0.0021)
	Exhaust	0.040 - 0.070 (0.0016 - 0.0028)
Valve deflection limit		0.2 (0.0079)
Projection length		12.8 - 13.2 (0.5309 - 0.5197)

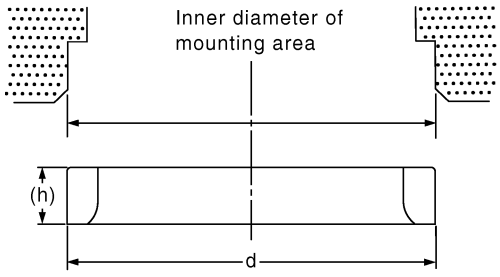
Valve Seat

Unit: mm (in)

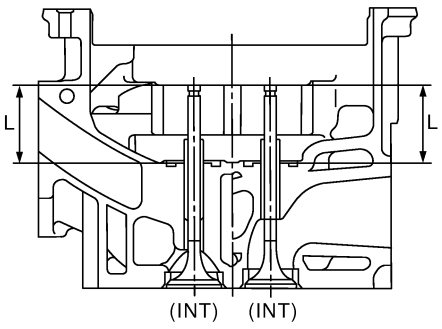


Unit: mm (in)

SEM374G



SEM373G



SEM375G

		Standard	Service
Cylinder head seat recess diameter (D)	Intake	33.000 - 33.015 (1.2992 - 1.2998)	33.500 - 33.515 (1.3189 - 1.3195)
	Exhaust	31.495 - 31.510 (1.2400 - 1.2405)	31.995 - 32.010 (1.2596 - 1.2602)
Valve seat interference fit	Intake	0.050 - 0.078 (0.0020 - 0.0031)	
	Exhaust	0.040 - 0.066 (0.0016 - 0.0026)	

Valve Seat (Cont'd)

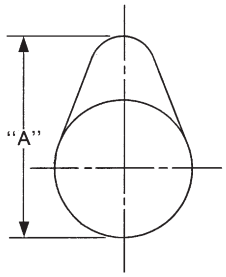
Valve seat outer diameter (d)	Intake	33.065 - 33.078 (1.3018 - 1.3023)	33.565 - 33.578 (1.3215 - 1.3220)
	Exhaust	31.550 - 31.561 (1.2421 - 1.2426)	32.050 - 32.061 (1.2618 - 1.2622)
Height (h)	Intake	6.75 - 6.85 (0.2657 - 0.2697)	6.75 - 6.85 (0.2657 - 0.2697)
	Exhaust	7.35 - 7.45 (0.2894 - 0.2933)	7.35 - 7.45 (0.2894 - 0.2933)
Depth (L)	Intake	43.65 - 44.35 (1.7185 - 1.7461)	
	Exhaust	43.65 - 44.35 (1.7185 - 1.7461)	

Camshaft and Camshaft Bearing

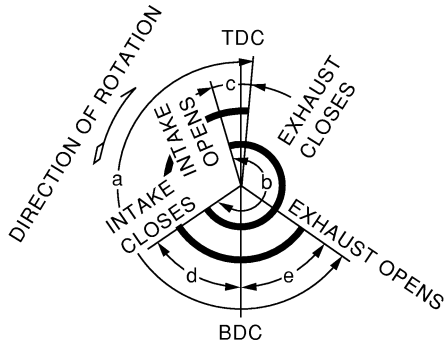
Unit: mm (in)

	Standard	Limit
Camshaft journal to bearing clearance	0.045 - 0.090 (0.0018 - 0.0035)	0.09 (0.0035)
Inner diameter of camshaft bearing	30.000 - 30.021 (1.1811 - 1.1819)	—
Outer diameter of camshaft journal	29.931 - 29.955 (1.1784 - 1.1793)	—
Camshaft runout [TIR*]	—	0.02 (0.0008)
Camshaft sprocket runout [TIR*]	Less than 0.15 (0.0059)	—
Camshaft end play	0.065 - 0.169 (0.0026 - 0.0067)	0.2 (0.008)

*: Total indicator reading



EM671

Cam height "A"	Intake	40.468 - 40.508 (1.5932 - 1.5948)
	Exhaust	40.830 - 40.870 (1.6075 - 1.6091)
Wear limit of cam height		0.15 (0.0059)
Valve timing		

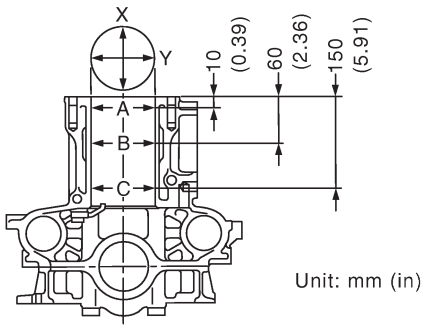
SEM372G

Unit: degree

a	b	c	d	e
234	220	10	34	50

Cylinder Block

Unit: mm (in)



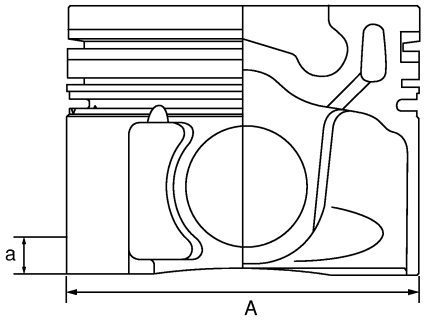
SEM370G

Surface flatness	Standard			Less than 0.03 (0.0012)
	Limit			0.10 (0.0039)
Cylinder bore	Inner diameter	Standard	Grade No. 1	96.000 - 96.010 (3.7795 - 3.7799)
			Grade No. 2	96.010 - 96.020 (3.7799 - 3.7803)
			Grade No. 3	96.020 - 96.030 (3.7803 - 3.7807)
		Wear limit		0.20 (0.0079)
Out-of-round (X − Y)				Less than 0.02 (0.0008)
Taper (A − B − C)				Less than 0.02 (0.0008)
Main journal inner diameter (Without bearing)				74.981 - 75.000 (2.9520 - 2.9528)
Difference in inner diameter between cylinders	Limit			Less than 0.05 (0.0020)

Piston, Piston Ring and Piston Pin

AVAILABLE PISTON

Unit: mm (in)



SEM369G

Piston skirt diameter “A”	Standard	Grade No. 1	95.950 - 95.960 (3.7776 - 3.7779)
		Grade No. 2	95.960 - 95.970 (3.7779 - 3.7783)
		Grade No. 3	95.970 - 95.980 (3.7783 - 3.7787)
“a” dimension			10 (0.39)
Piston pin hole diameter			32.997 - 33.005 (1.2991 - 1.2994)
Piston clearance to cylinder block			0.040 - 0.060 (0.0016 - 0.0024)

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

PISTON RING

Unit: mm (in)

		Standard	Limit
Side clearance	Top	0.05 - 0.07 (0.0020 - 0.0028)	0.5 (0.020)
	2nd	0.04 - 0.08 (0.0016 - 0.0031)	0.3 (0.012)
	Oil ring	0.02 - 0.06 (0.0008 - 0.0024)	0.15 (0.0059)
End gap	Top	0.30 - 0.45 (0.0118 - 0.0177)	1.5 (0.059)
	2nd	0.50 - 0.65 (0.0197 - 0.0256)	1.5 (0.059)
	Oil (rail ring)	0.25 - 0.45 (0.0098 - 0.0177)	1.5 (0.059)

PISTON PIN

Unit: mm (in)

Piston pin outer diameter		32.993 - 33.000 (1.2989 - 1.2992)
Interference fit of piston pin to piston		−0.003 to 0.012 (−0.0001 to 0.0005)
Piston pin to connecting rod bushing clearance	Standard	0.025 - 0.045 (0.0010 - 0.0018)
	Limit	0.045 (0.0018)

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

Connecting Rod

Unit: mm (in)

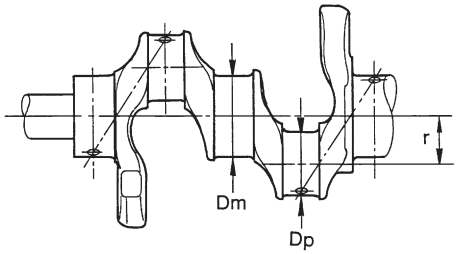
Center distance		154.5 (6.083)
Bend [per 100 (3.94)]	Limit	0.05 (0.0020)
Torsion [per 100 (3.94)]	Limit	0.05 (0.0020)
Connecting rod small end inner diameter		35.087 - 36.000 (1.3814 - 1.4173)
Piston pin bushing inner diameter*		33.025 - 33.038 (1.3002 - 1.3007)
Connecting rod big end inner diameter		59.987 - 60.000 (2.3617 - 2.3622)
Crankshaft journal bearing inner diameter*		70.955 - 70.990 (2.7935 - 2.7949)
Side clearance	Standard	0.10 - 0.22 (0.0039 - 0.0087)
	Limit	0.22 (0.0087)

*: After installing in connecting rod

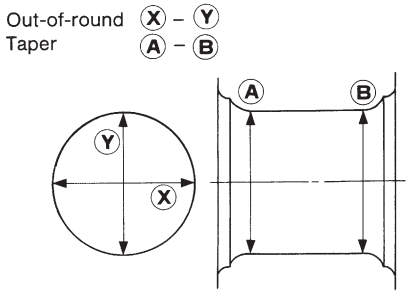
Crankshaft

Unit: mm (in)

Main journal dia. “Dm”		70.907 - 70.920 (2.7916 - 2.7921)
Pin journal dia. “Dp”	Grade No. 0	56.913 - 56.926 (2.2407 - 2.2412)
Center distance “r”		50.95 - 51.05 (2.0059 - 2.0098)
Out-of-round (X − Y)	Standard	Less than 0.01 (0.0004)
Taper (A − B)	Standard	Less than 0.01 (0.0004)
Runout [TIR*]	Standard	Less than 0.01 (0.0004)
	Limit	Less than 0.03 (0.0012)
Free end play	Standard	0.055 - 0.140 (0.0022 - 0.0055)
	Limit	0.25 (0.0098)



SEM645

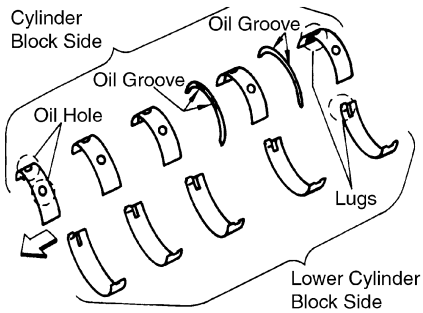


EM715

*: Total indicator reading

Available Main Bearing

UNDERSIZE



FEM127

Size	Thickness “T” mm (in)	Width “W” mm (in)	Main journal diameter “Dm”
Standard	2.005 - 2.013 (0.0789 - 0.0793)	25.74 - 26.00 (1.0134 - 1.0236)	Grind so that bearing clearance is the specified value.
US 025	2.130 - 2.138 (0.0839 - 0.0842)		
US 050	2.255 - 2.263 (0.0888 - 0.0891)		
US 075	2.380 - 2.388 (0.0937 - 0.0940)		
US 100	2.505 - 2.513 (0.0986 - 0.0989)		

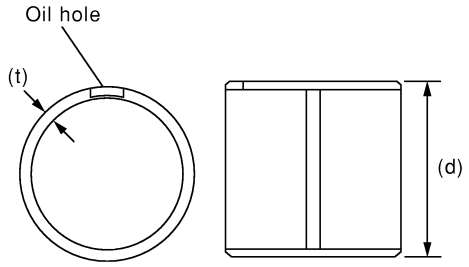
Available Connecting Rod Bearing

CONNECTING ROD BEARING

Grade number	Thickness “T” mm (in)	Width “W” mm (in)
Standard	1.505 - 1.513 (0.0593 - 0.0596)	25.9 - 26.1 (1.020 - 1.028)
US 025	1.630 - 1.638 (0.0642 - 0.0645)	
US 050	1.755 - 1.763 (0.0691 - 0.0694)	
US 075	1.880 - 1.888 (0.0740 - 0.0743)	
US 100	2.005 - 2.013 (0.0789 - 0.0793)	

BALANCER SHAFT BUSH

Unit: mm (in)



SEM371G

Balancer shaft bearing journal diameter	Front	50.940 - 51.010 (2.0055 - 2.0083)
	Rear	50.740 - 50.810 (1.9976 - 2.0004)
Balancer shaft journal outer diameter	Front	53.980 - 54.010 (2.1252 - 2.1264)
	Rear	53.780 - 53.810 (2.1173 - 2.1185)
Balancer shaft journal oil clearance	Standard	0.045 - 0.135 (0.0018 - 0.0053)
	Limit	0.180 (0.0071)
Balancer shaft bush outer diameter (d)	Front	54.090 - 54.130 (2.1295 - 2.1311)
	Rear	53.890 - 53.930 (2.1216 - 2.1232)
Thickness (t)	Front	0.2 - 0.4 (0.008 - 0.016)
	Rear	0.2 - 0.4 (0.008 - 0.016)

Miscellaneous Components

Unit: mm (in)

Flywheel runout [TIR]*	Less than 0.15 (0.0059)
Drive plate runout [TIR]*	Less than 0.1 (0.0039)

*: Total indicator reading

BEARING CLEARANCE

Unit: mm (in)

Main bearing clearance	Standard	0.035 - 0.083 (0.0014 - 0.0033)
Connecting rod bearing clearance	Standard	0.035 - 0.077 (0.0014 - 0.0030)