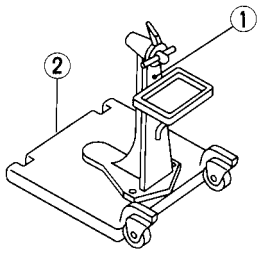
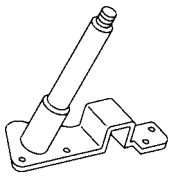
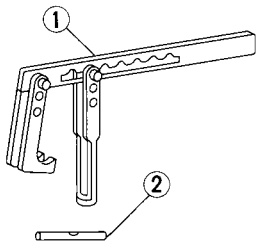
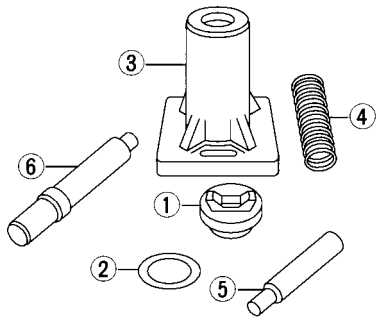
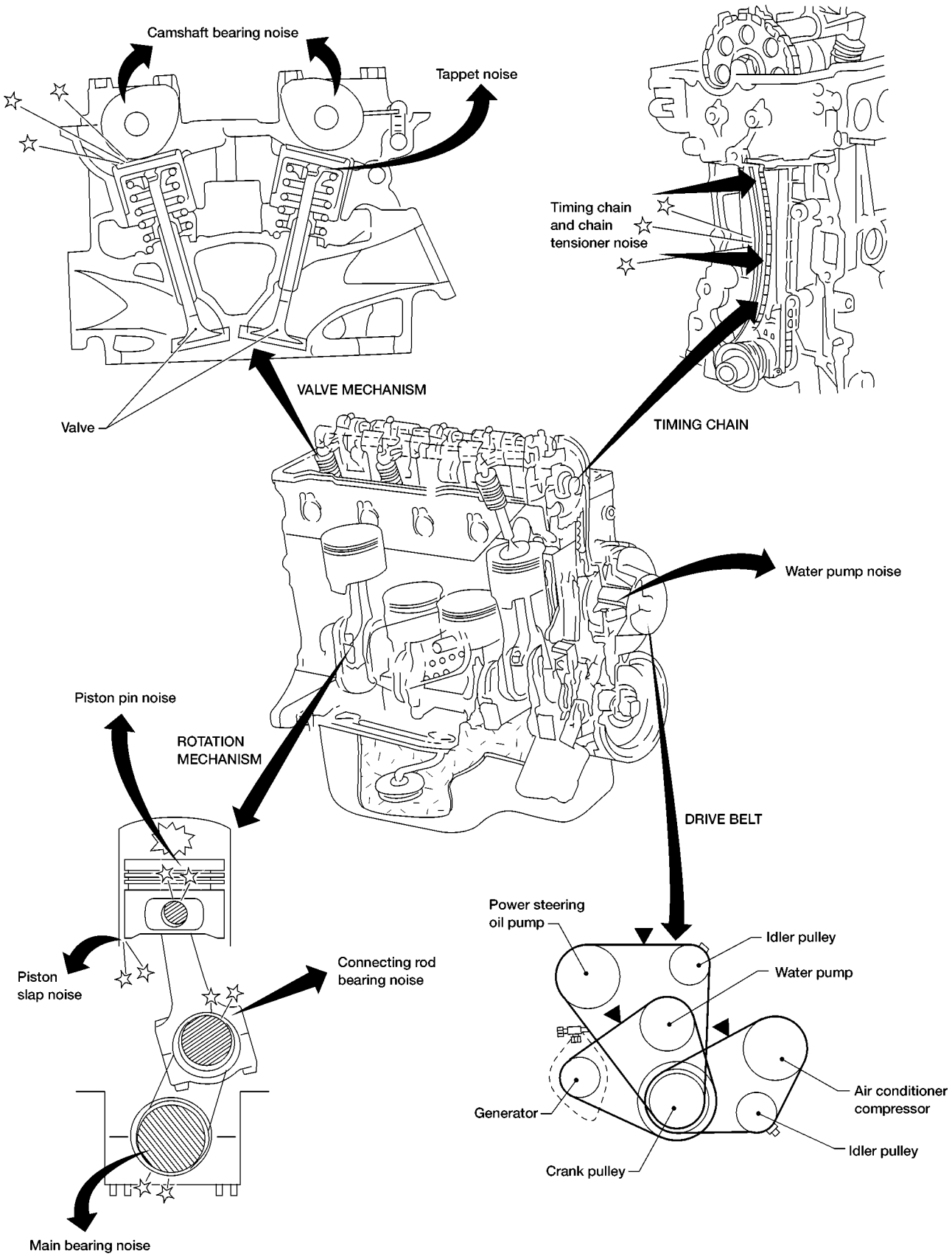
SECTION EM

CONTENTS

Special Service Tools

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

Tool number (Kent-Moore No.) Tool name	Description	
ST0501S000 (—) Engine stand assembly ① ST05011000 (—) Engine stand ② ST05012000 (—) Base	 NT042	Disassembling and assembling
KV10105001 (—) Engine attachment	 NT031	
KV101092S0 (J26336-B) Valve spring compressor ① KV10109210 (—) Compressor ② KV10109220 (—) Adapter	 NT021	Disassembling and assembling valve components)
KV10110300 (—) Piston pin press stand assembly ① KV10110310 (—) Cap ② KV10110330 (—) Spacer ③ ST13030020 (—) Press stand ④ ST13030030 (—) Spring ⑤ KV10110340 (—) Drift ⑥ KV10110320 (—) Center shaft	 NT036	Disassembling and assembling piston with connecting rod


Camshaft bearing noise
Tappet noise
Timing chain
and chain
tensioner noise
VALVE MECHANISM
Valve
TIMING CHAIN
Water pump noise
Piston pin noise
ROTATION
MECHANISM
DRIVE BELT
Power steering
oil pump
Idler pulley
Water pump
Piston
slap noise
Connecting rod
bearing noise
Air conditioner
compressor
Generator
Idler pulley
Crank pulley
Main bearing noise

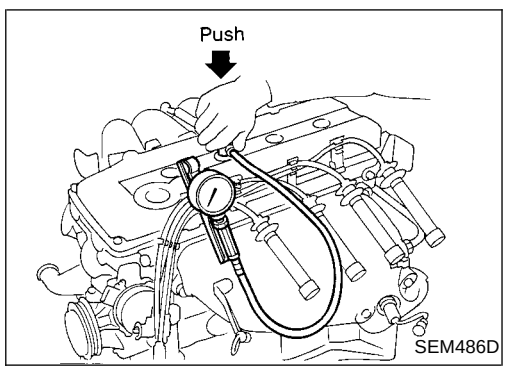
AEM399

Measurement of Compression Pressure

1. Warm up engine.
2. Turn ignition switch off.
3. Release fuel pressure.
   Refer to "Releasing Fuel Pressure" in EC section.
4. Remove all spark plugs.

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

5. Disconnect camshaft position sensor harness connector at the distributor.
6. Remove fuel injector fuse ③ on FUSE BLOCK (J/B) behind the instrument lower panel driver side.
   Refer to "Terminal Arrangement" "FUSE BLOCK - Junction Box (J/B)" on the Foldout page.



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

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

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

Standard

1,226 (12.5, 178)

Minimum

1,030 (10.5, 149)

Maximum allowable difference between cylinders

98 (1.0, 14)

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

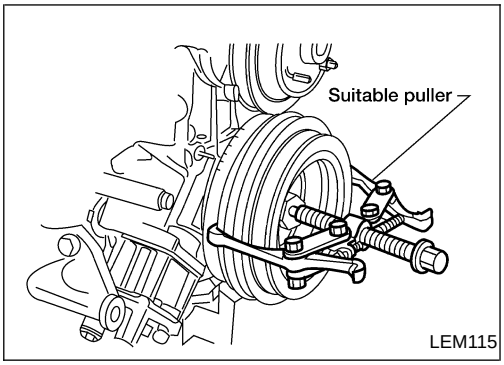
- **If adding oil improves cylinder compression, piston rings may be worn or damaged. If so, replace piston rings after checking piston.**
- **If pressure stays low, a valve may be sticking or seating improperly. Inspect and repair valve and valve seat. (Refer to SDS, EM-53 and EM-55.) If valve or valve seat is damaged excessively, replace them.**
- **If compression in any two adjacent cylinders is low and if adding oil does not improve compression, there is leakage past the gasket surface. If so, replace cylinder head gasket.**

12. Reinstall spark plugs fuel injector fuse, fuel pump fuse, and reconnect camshaft position sensor harness connector at the distributor.
13. Erase the DTC stored in ECM.

CAUTION:

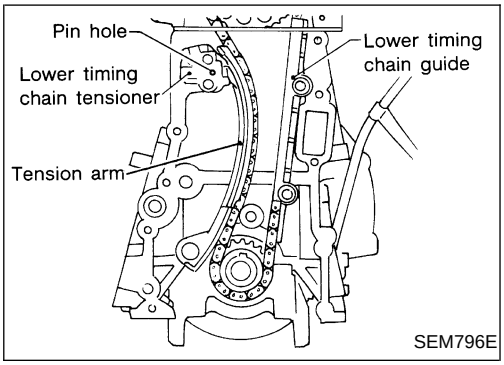
Always erase the DTC after checking compression.
Refer to "HOW TO ERASE EMISSION-RELATED DIAGNOSTIC INFORMATION" in EC section.

Removal (Cont'd)



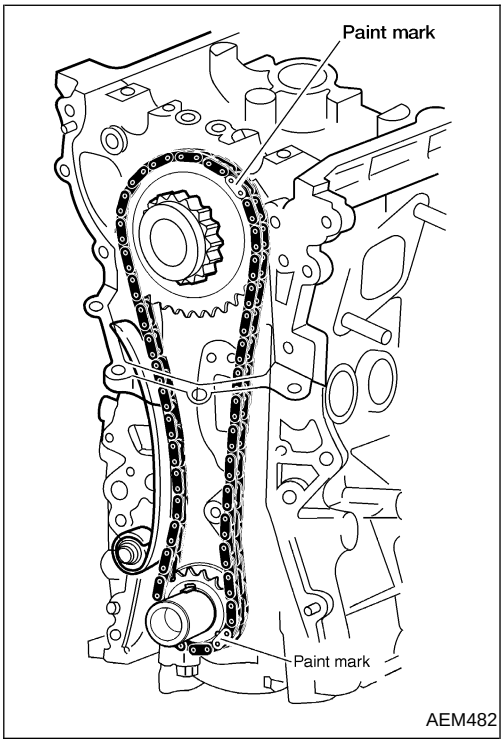
8. Remove oil pan.
   Refer to "Removal" in "OIL PAN" (EM-15).
9. Remove the oil pump and distributor drive shaft, the the oil pickup strainer.
10. Remove the front cover.

CAUTION:
Be careful not to tear or damage the cylinder head gasket.



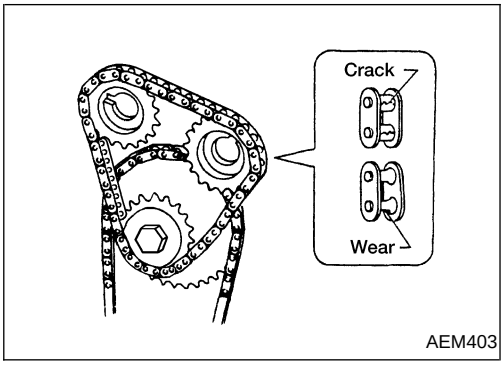
11. Remove the following parts.
- Lower timing chain tensioner (Push piston and insert a suitable pin into pin hole.)
- Chain tension arm
- Lower timing chain guide

12. Remove the upper timing chain and idler sprocket. **Refer to "Removal" "UPPER TIMING CHAIN" (EM-19) and "IDLER SPROCKET" (EM-20).**



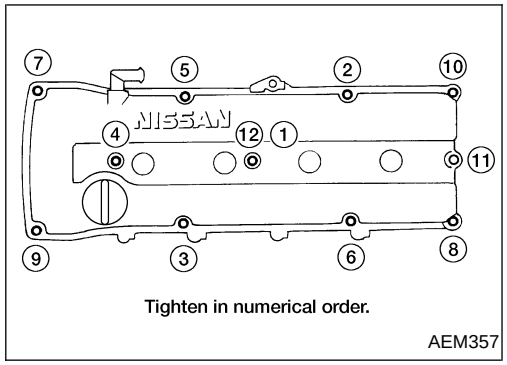
13. Wipe off the links of the timing chain next to the timing marks on the sprockets. Put paint marks on the timing chain, matching them with the timing marks on the crankshaft sprocket and idler sprocket.
14. Remove the lower timing chain and sprocket.

Inspection



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

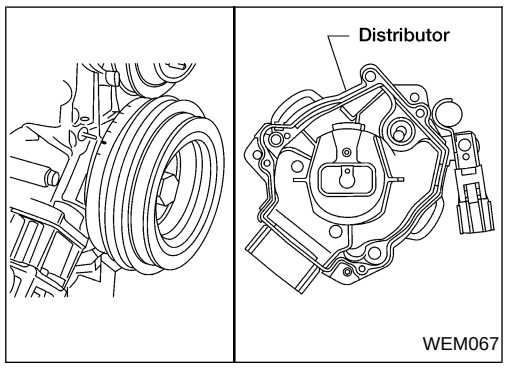
Installation (Cont'd)



Tighten in numerical order.

AEM357

6. Install rocker cover. Tighten bolts in numerical order.
   : 8 - 11 N·m (0.8 - 1.1 kg-m, 69 - 95 in-lb).



WEM067

7. Install distributor, aligning as shown.
8. Install vacuum hoses, electrical harnesses, connectors and harness clamps.

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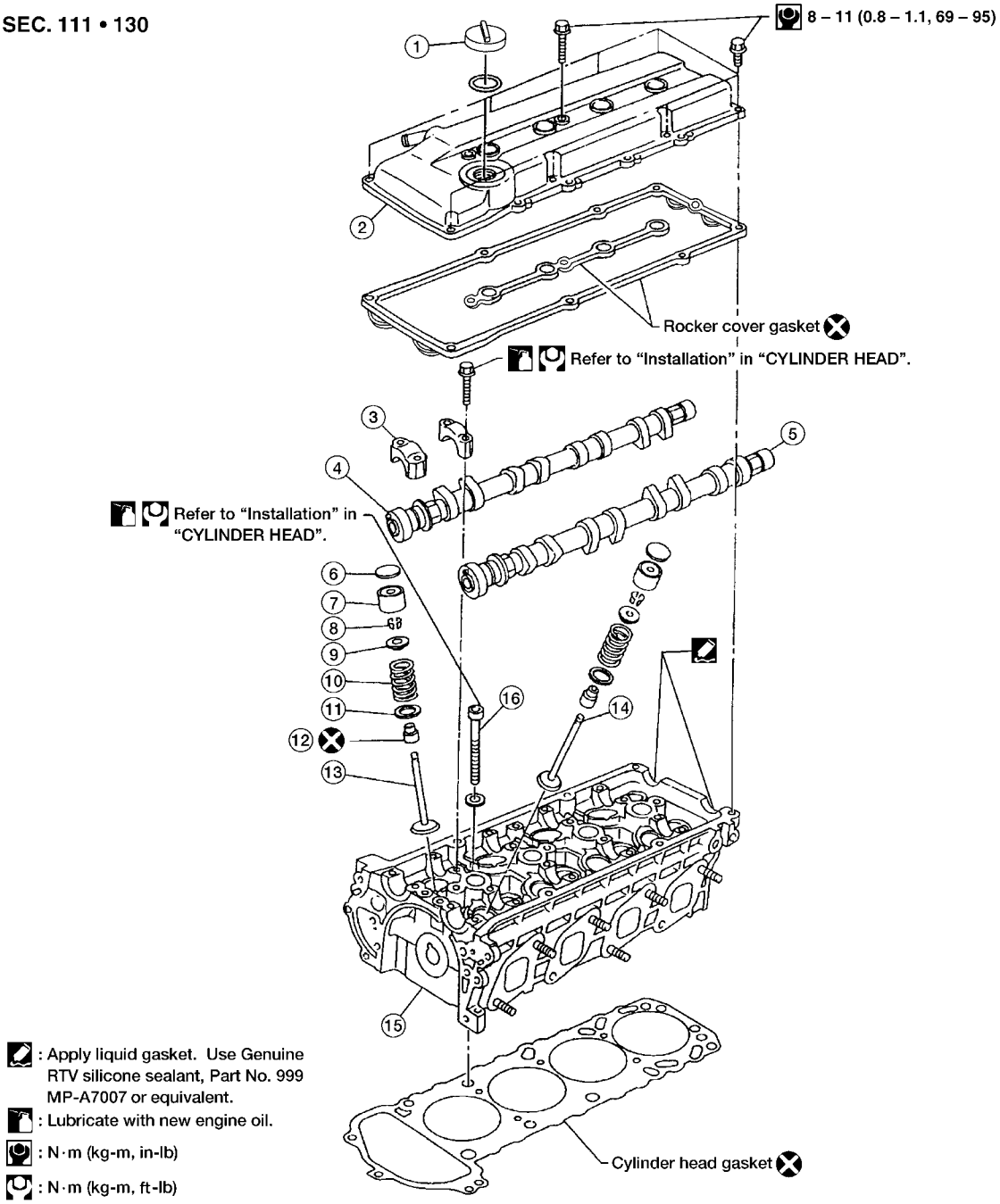
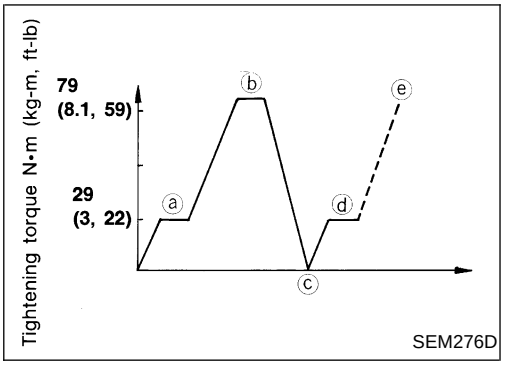


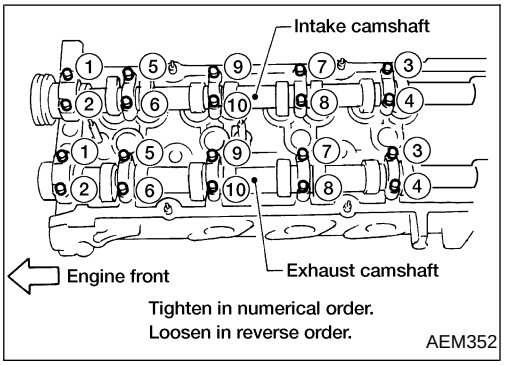
AEM485

① Oil filler cap
② Rocker cover
③ Camshaft bracket
④ Intake camshaft
⑤ Exhaust camshaft
⑥ Shim
⑦ Valve lifter
⑧ Valve cotter
⑨ Spring retainer
⑩ Valve spring
⑪ Spring seat
⑫ Valve oil seal
⑬ Intake valve
⑭ Exhaust valve
⑮ Cylinder head
⑯ Cylinder head bolt

Installation (Cont'd)



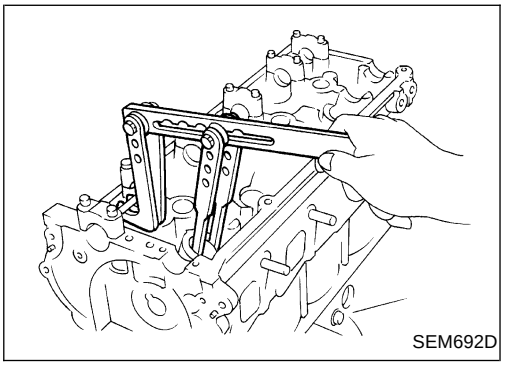
c. Loosen all bolts completely.
d. Tighten all bolts to 25 to 34 N·m (2.5 to 3.5 kg-m, 18 to 25 ft-lb).
e. Turn all bolts 86 to 91 degrees clockwise. If angle wrench is not available, mark all cylinder head bolts on the side facing engine front. Then, turn each cylinder head bolt 86 to 91 degrees clockwise.



2. Install camshafts and camshaft brackets in the order shown using the following procedure.
a. Set camshafts and camshaft brackets.
- Dowel pins of both intake and exhaust camshafts should be at 12 o'clock positions when installing the camshafts.

b. Tighten all bolts to 2 N·m (0.2 kg-m, 17 in-lb).
c. Tighten all bolts to 9.0 to 11.8 N·m (0.92 to 1.2 kg-m, 79.9 to 104.2 in-lb).
- **Apply new engine oil to bolt threads and seat surfaces.**

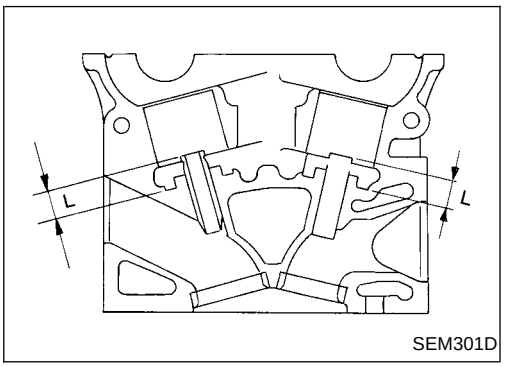
3. Install upper timing chain and idler sprocket.
Refer to "TIMING CHAIN", "Installation", "UPPER TIMING CHAIN" (EM-23) and "IDLER SPROCKET" (EM-23).



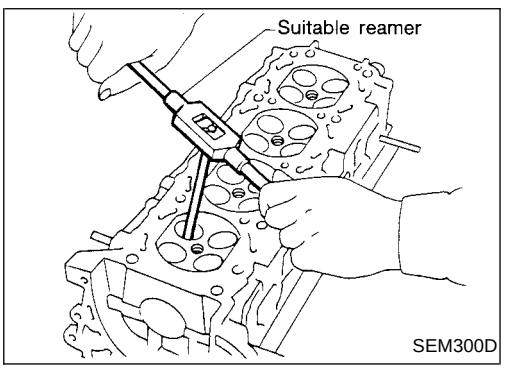
Disassembly

1. Remove intake manifold and exhaust manifold. Refer to "OUTER COMPONENT PARTS" (EM-11).
2. Remove valve components.
3. Remove valve oil seal with a suitable tool.

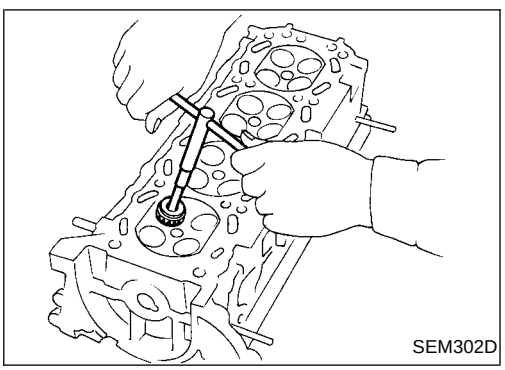
Inspection (Cont'd)



4. Heat cylinder head to 120 to 140°C (248 to 284°F) and press service valve guide onto cylinder head.
   Projection "L":
   13.3 - 13.9 mm (0.524 - 0.547 in)



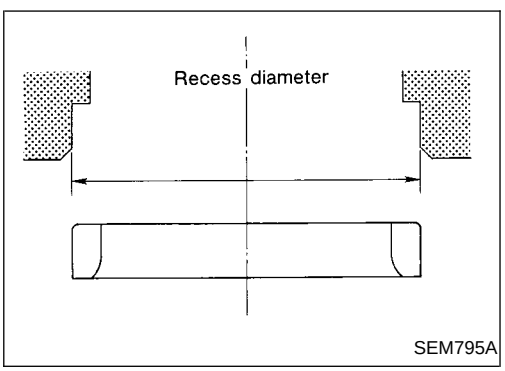
5. Ream valve guide.
   Finished size:
   Intake & Exhaust
   7.000 - 7.018 mm (0.2756 - 0.2763 in)



VALVE SEATS

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

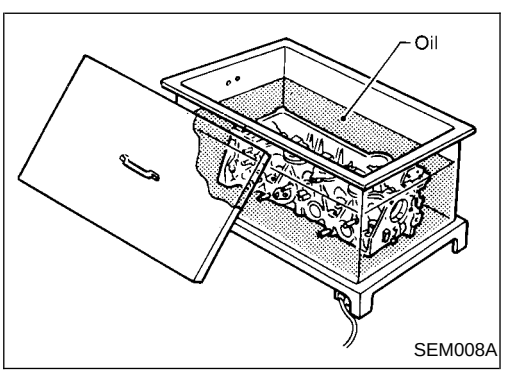
- **Before repairing valve seats, check valve and valve guide for wear. If they have worn, replace them. Then correct valve seat.**
- **Use both hands to cut uniformly.**



REPLACING VALVE SEAT FOR SERVICE PARTS

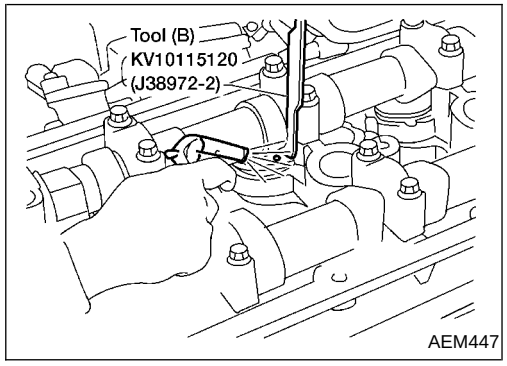
1. Bore out old seat until it collapses. Boring should not continue beyond the bottom face of the seat recess in cylinder head. Set the machine depth stop to ensure this.
2. Ream cylinder head recess.
   Reaming bore for service valve seat
   Oversize [0.5 mm (0.020 in)]:
   Intake 38.000 - 38.016 mm (1.4961 - 1.4967 in)
   Exhaust 32.700 - 32.716 mm (1.2874 - 1.2880 in)

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

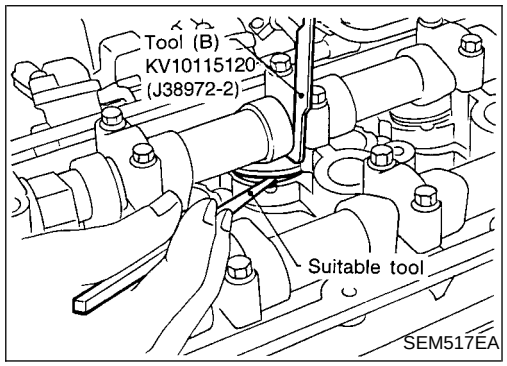


3. Heat cylinder head to 120 to 140°C (248 to 284°F).
4. Press fit valve seat until it seats on the bottom.

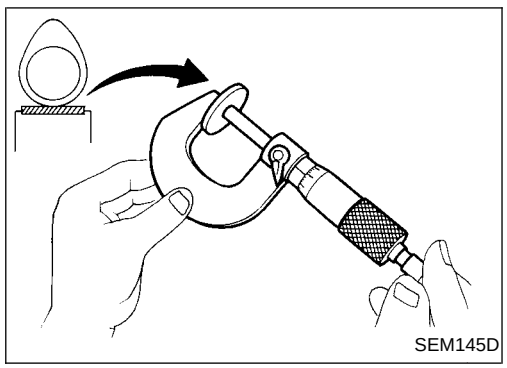
Valve Clearance (Cont'd)



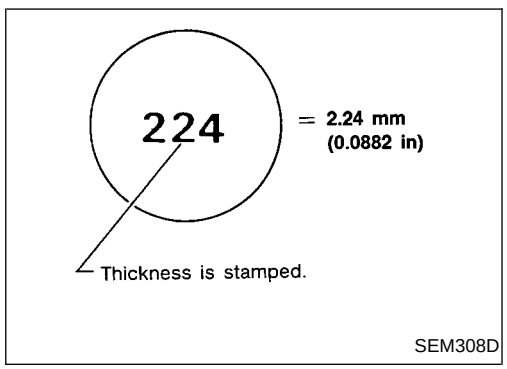
6. Rotate adjusting shim until hole is visible. Blow air into the hole to separate adjusting shim from valve lifter.



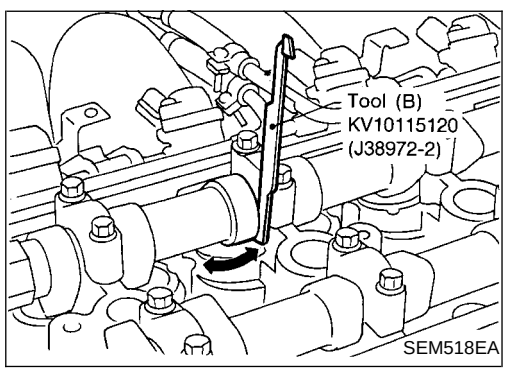
7. Remove adjusting shim using a small screwdriver and a magnetic finger.



8. Determine replacement adjusting shim size as follows.
a. Using a micrometer determine thickness of removed shim.
b. Calculate thickness of new adjusting shim so valve clearance comes within specified values.
   R = Thickness of removed shim
   N = Thickness of new shim
   M = Measured valve clearance
   Intake & Exhaust:
   N = R + [M − 0.37 mm (0.0146 in)]



Shims are available in thicknesses from 1.96 mm (0.0772 in) to 2.68 mm (0.1055 in), in steps of 0.02 mm (0.0008 in).
c. Select new shim with thickness as close as possible to calculated value.
   Refer to SDS, EM-54.



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

10. Place Tool (A) as mentioned in steps 2 and 3.
11. Remove Tool (B).
12. Remove Tool (A).
13. Recheck valve clearance.
    Refer to ''CHECKING'' (EM-36).

WARNING:

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

CAUTION:

- **When lifting engine, be sure to clear surrounding parts. Take special care near accelerator wire casing, brake lines and brake master cylinder.**
- **In hoisting the engine, always use engine slingers in a safe manner.**
- **Before separating engine and transmission, remove the crankshaft position sensor (OBD) from the assembly.**
- **Always take extra care not to damage edge of crankshaft position sensor (OBD) or ring gear teeth.**

Removal

1. Drain coolant from engine block and radiator. Refer to MA section (“Changing Engine Coolant”, “ENGINE MAINTENANCE”).
2. Release fuel pressure. Refer to EC section (“Fuel Pressure Release”, “BASIC SERVICE PROCEDURE”).
3. Remove negative battery cable.
4. Remove hood. Refer to BT section.
5. Remove air cleaner.
6. Remove power steering drive belt, generator drive belt and A/C compressor drive belt.
7. Remove radiator. Refer to LC section (“Radiator”, “ENGINE COOLING SYSTEM”).
8. Remove exhaust manifold heat shield.
9. Disconnect exhaust system from #1 catalytic converter.
10. Remove A/C compressor from bracket. Refer to HA section (“Compressor Mounting”, “SERVICE PROCEDURES”).
11. Disconnect accelerator wire, vacuum hoses, electrical connectors, heater hoses and vacuum booster hose.

Inspection (Cont'd)

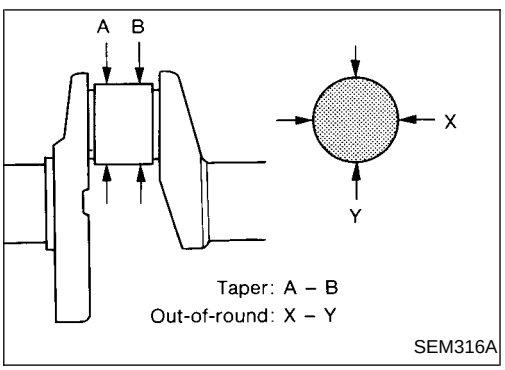
Oversize pistons are available for service. Refer to SDS, EM-58.

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

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

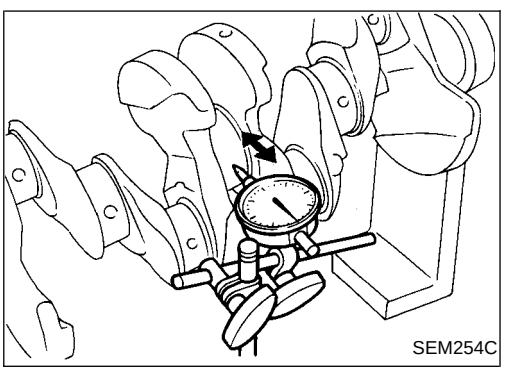
9. Hone cylinders to obtain specified piston-to-bore clearance.
10. Measure finished cylinder bore for out-of-round and taper.

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



CRANKSHAFT

1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.
   Out-of-round (X − Y):
   Main journal Less than 0.01 mm (0.0004 in)
   Crank pin Less than 0.005 mm (0.0002 in)
   Taper (A − B):
   Main journal Less than 0.01 mm (0.0004 in)
   Crank pin Less than 0.005 mm (0.0002 in)



3. Measure crankshaft runout.
   Runout (Total indicator reading):
   Less than 0.10 mm (0.0039 in)

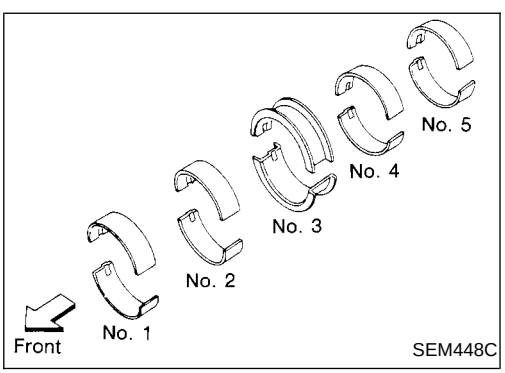
BEARING CLEARANCE

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

Method A (Using bore gauge and micrometer)

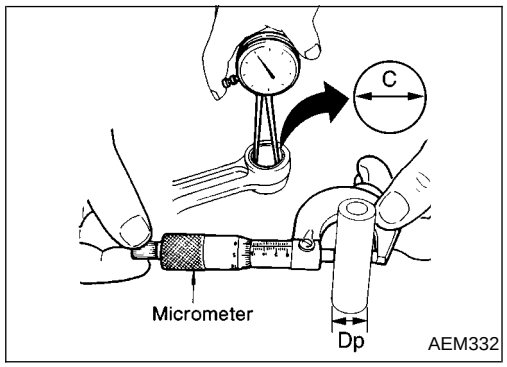
Main bearing

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



Inspection (Cont'd)

CONNECTING ROD BUSHING CLEARANCE (Small end)

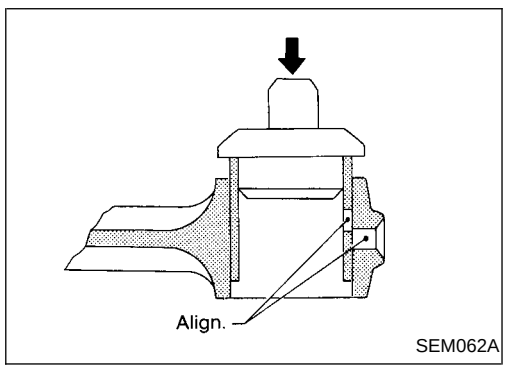


1. Measure inner diameter "C" of bushing.
2. Measure outer diameter "Dp" of piston pin.
3. Calculate connecting rod bushing clearance.

C − Dp =
0.005 - 0.017 mm (0.0002 - 0.0007 in) (Standard)
0.023 mm (0.0009 in) (Limit)

If out of specification, replace connecting rod assembly and/or piston set with pin.

REPLACEMENT OF CONNECTING ROD BUSHING (Small end)



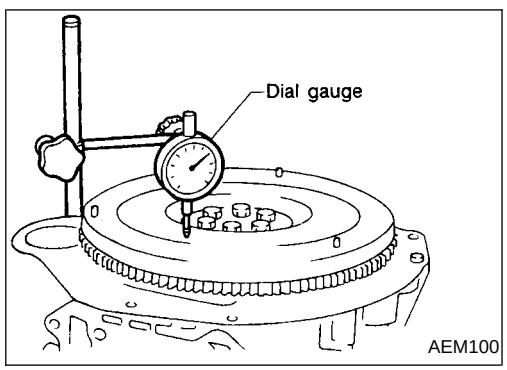
1. Drive in small end bushing until it is flush with end surface of rod.

Be sure to align the oil holes.

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

Clearance between connecting rod bushing and piston pin:
0.005 - 0.017 mm (0.0002 - 0.0007 in)

FLYWHEEL/DRIVE PLATE RUNOUT



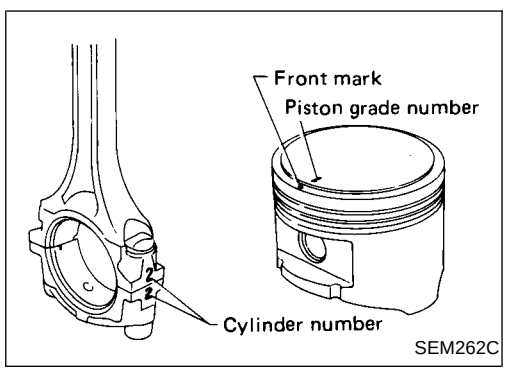
Runout (Total indicator reading):
Flywheel (M/T model)
Less than 0.15 mm (0.006 in)
Drive plate (A/T model)
Less than 0.15 mm (0.006 in)

CAUTION:

- **Be careful not to damage the ring gear teeth.**
- **Check the drive plate for deformation and cracks.**
- **Do not allow any magnetic materials to contact the ring gear teeth.**
- **Do not resurface the flywheel. Replace as necessary.**

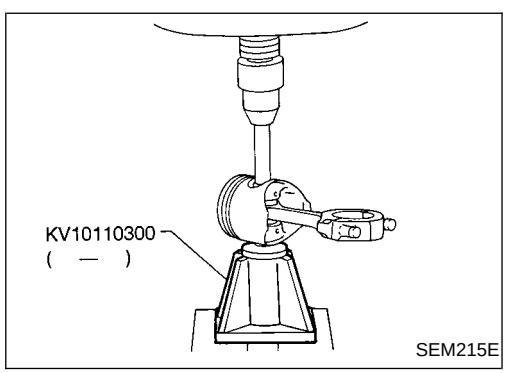
Assembly

PISTON

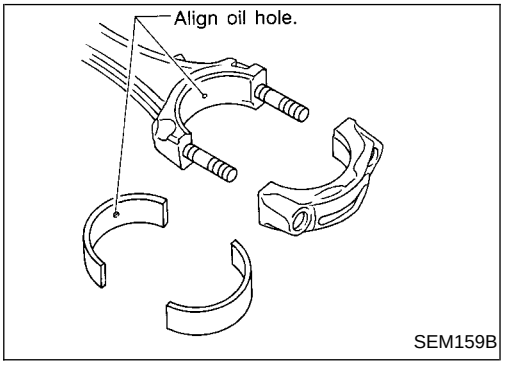


1. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin and connecting rod.

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

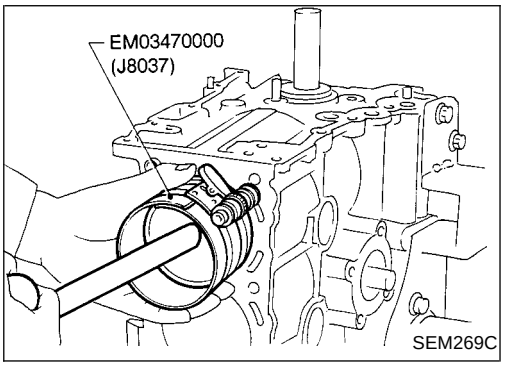


Assembly (Cont'd)



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

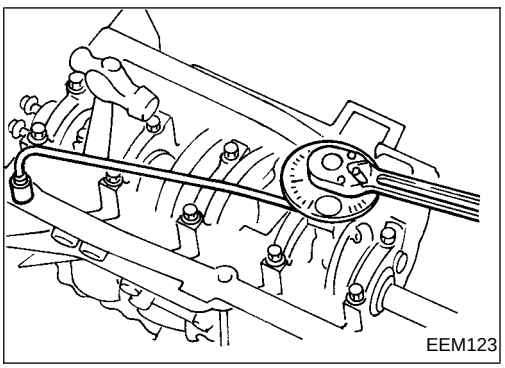
- **Confirm that correct bearings are used.**
  Refer to EM-48.
- **Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.**
- **Apply new engine oil to bearing surfaces, bolt threads and seating surfaces.**



5. Install pistons with connecting rods.

a. Install them into corresponding cylinders with Tool.

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

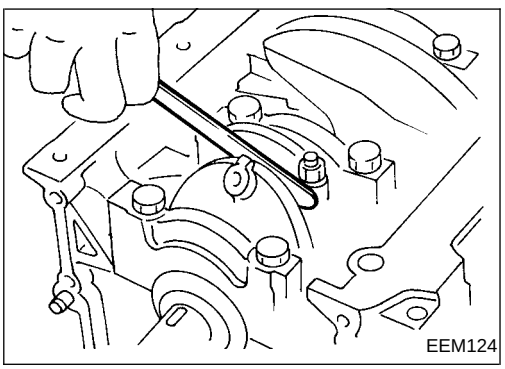


b. Install connecting rod bearing caps.
Tighten connecting rod bearing cap nuts using the following procedure.

Connecting rod bearing nut:

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

(2) Tighten bolts 60^{+5}_{-0} degrees clockwise with an angle wrench.
If an angle wrench is not available, tighten them to 38 - 44 N·m (3.9 - 4.5 kg-m, 28 - 33 ft-lb).



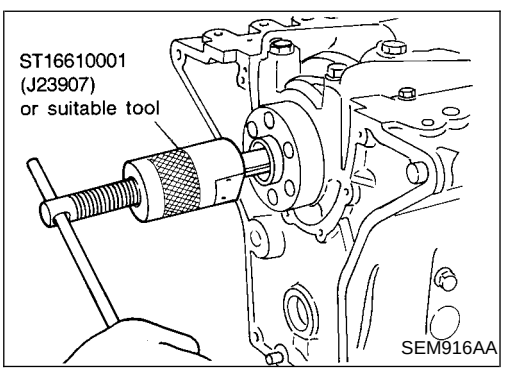
6. Measure connecting rod side clearance.

Connecting rod side clearance:

Standard
0.2 - 0.4 mm (0.008 - 0.016 in)

Limit
0.6 mm (0.024 in)

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

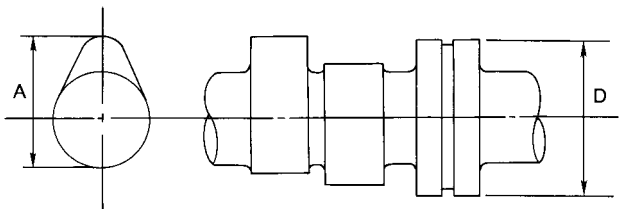


REPLACING PILOT BUSHING

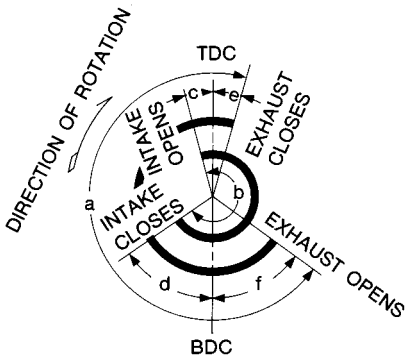
1. Remove pilot bushing (M/T) or pilot convertor (A/T).

Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BEARING



SEM568A



EM120

Unit: mm (in)

		Standard	Limit
Cam height (A)	Intake	42.505 - 42.695 (1.673 - 1.681)	—
	Exhaust	40.905 - 41.095 (1.610 - 1.618)	—
Wear limit of cam height		—	0.2 (0.008)
Camshaft journal to bearing clearance		0.045 - 0.090 (0.0018 - 0.0035)	0.12 (0.0047)
Inner diameter of camshaft bearing	#1 to #5 journals	28.000 - 28.025 (1.1024 - 1.1033)	—
Outer diameter of camshaft journal (D)	#1 to #5 journals	27.935 - 27.955 (1.0998 - 1.1006)	—
Camshaft runout*		Less than 0.02 (0.0008)	0.04 (0.0016)
Camshaft end play		0.070 - 0.148 (0.0028 - 0.0058)	0.2 (0.008)
Valve timing (Degree on crankshaft)	a	216	—
	b	232	—
	c	−1	—
	d	53	—
	e	4	—
	f	32	—

* Total indicator reading