ENGINE MECHANICAL

SECTION EM

CONTENTS

CONTENTS (Cont'd)

Supplemental Restraint System (SRS) “AIR BAG” and “SEAT BELT PRE-TENSIONER”

NDEM0041

The Supplemental Restraint System such as “AIR BAG” and “SEAT BELT PRE-TENSIONER” used along with a seat belt, helps to reduce the risk or severity of injury to the driver and front passenger for certain types of collision. The Supplemental Restraint System consists of driver air bag module (located in the center of the steering wheel), front passenger air bag module (located on the instrument panel on passenger side), seat belt pre-tensioners, a diagnosis sensor unit, warning lamp, wiring harness, and spiral cable.
Information necessary to service the system safely is included in the **RS section** of this Service Manual.

WARNING:

- **To avoid rendering the SRS inoperative, which could increase the risk of personal injury or death in the event of a collision which would result in air bag inflation, all maintenance should be performed by an authorized NISSAN dealer.**
- **Improper maintenance, including incorrect removal and installation of the SRS, can lead to personal injury caused by unintentional activation of the system. For removal of Spiral Cable and Air Bag Module, see the RS section.**
- **Do not use electrical test equipment on any circuit related to the SRS unless instructed to in this Service Manual. Spiral cable and wiring harnesses (except “SEAT BELT PRE-TENSIONER”) are covered with yellow insulation either just before the harness connectors or for the complete harness are related to the SRS.**

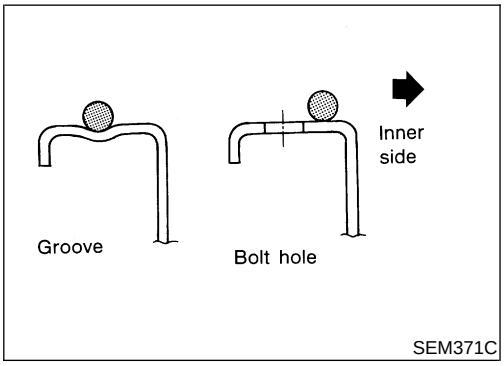
Parts Requiring Angular Tightening

NDEM0001

- Use an angle wrench for the final tightening of the following engine parts:

a) Cylinder head bolts
b) Connecting rod cap nuts

- 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.



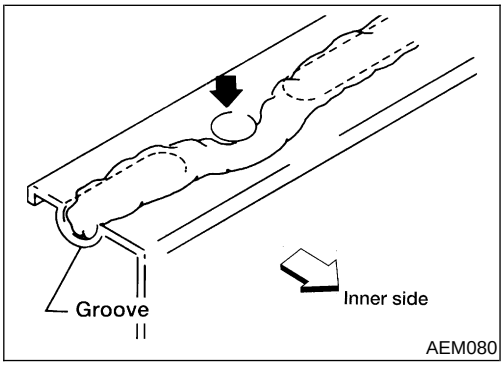
Liquid Gasket Application Procedure

NDEM0002

1) Use a scraper to remove all traces of old liquid gasket from mating surfaces and grooves. Also completely clean any oil stains from these portions.
2) Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine RTV Silicone Sealant Part No. 999MP-A7007 or equivalent).

- Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) dia. (for oil pan).
- Be sure liquid gasket is 2.0 to 3.0 mm (0.079 to 0.118 in) dia. (in areas except oil pan).

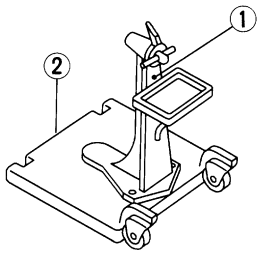
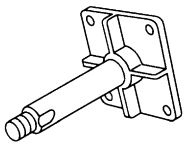
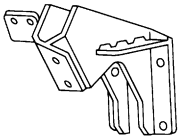
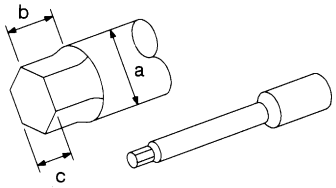
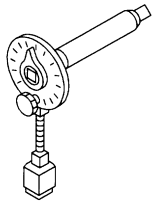
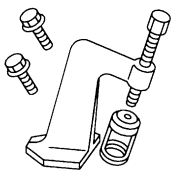
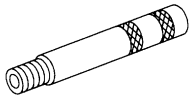
3) Apply liquid gasket to inner surface around hole perimeter area (unless otherwise specified).
4) Assembly should be done within 5 minutes after coating.
5) Wait at least 30 minutes before refilling engine oil and engine coolant.

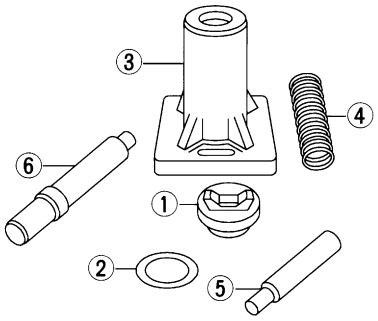
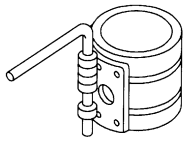
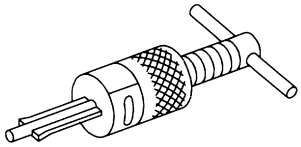
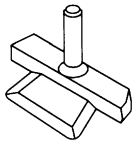
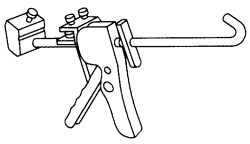
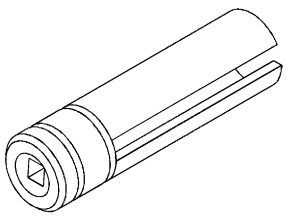


Special Service Tools

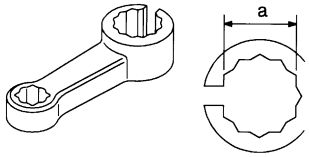
NDEM0003

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
KV10106500 (—) Engine stand shaft	 NT028	
KV10110001 (—) Engine sub-attachment	 NT032	
ST10120000 (J24239-01) Cylinder head bolt wrench	 NT583	Loosening and tightening cylinder head bolt **a: 13 mm (0.51 in) dia.** **b: 12 mm (0.47 in)** **c: 10 mm (0.39 in)**
KV10112100 (BT8653-A) Angle wrench	 NT014	Tightening bearing cap, cylinder head bolts, etc.
KV10110600 (J33986) Valve spring compressor	 NT033	Disassembling and assembling valve components
KV10107501 (—) Valve oil seal drift	 NT025	Installing valve oil seal

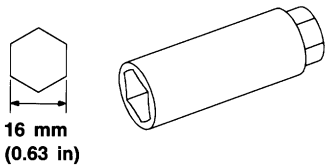
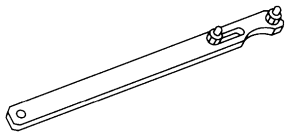
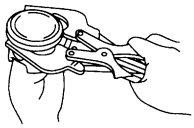
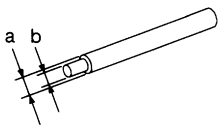
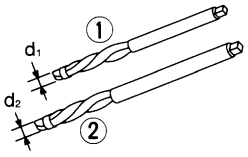
Tool number (Kent-Moore No.) Tool name	Description	
KV10110300 (—) Piston pin press stand assembly 1 KV10110310 (—) Cap 2 KV10110330 (—) Spacer 3 ST13030020 (—) Press stand 4 ST13030030 (—) Spring 5 KV10110340 (—) Drift 6 KV10110320 (—) Center shaft	 NT036	Disassembling and assembling piston with connecting rod
EM03470000 (J8037) Piston ring compressor	 NT044	Installing piston assembly into cylinder bore
ST16610001 (J23907) Pilot bushing puller	 NT045	Removing crankshaft pilot bushing
KV10111100 (J37228) Seal cutter	 NT046	Removing oil pan
WS39930000 (—) Tube presser	 NT052	Pressing the tube of liquid gasket
KV10117100 (J3647-A) Heated oxygen sensor wrench	 NT379	Loosening or tightening heated oxygen sensor **For 22 mm (0.87 in) hexagon nut**

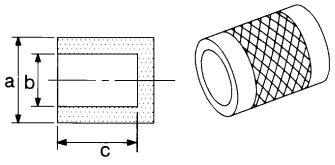
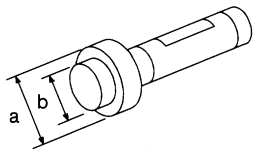
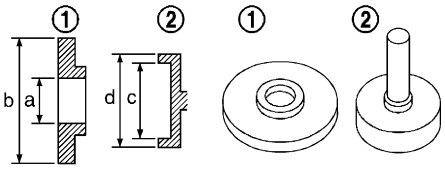
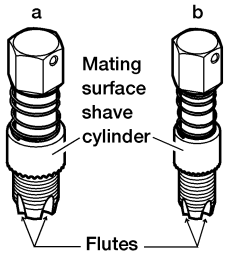
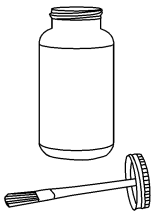
Special Service Tools (Cont'd)

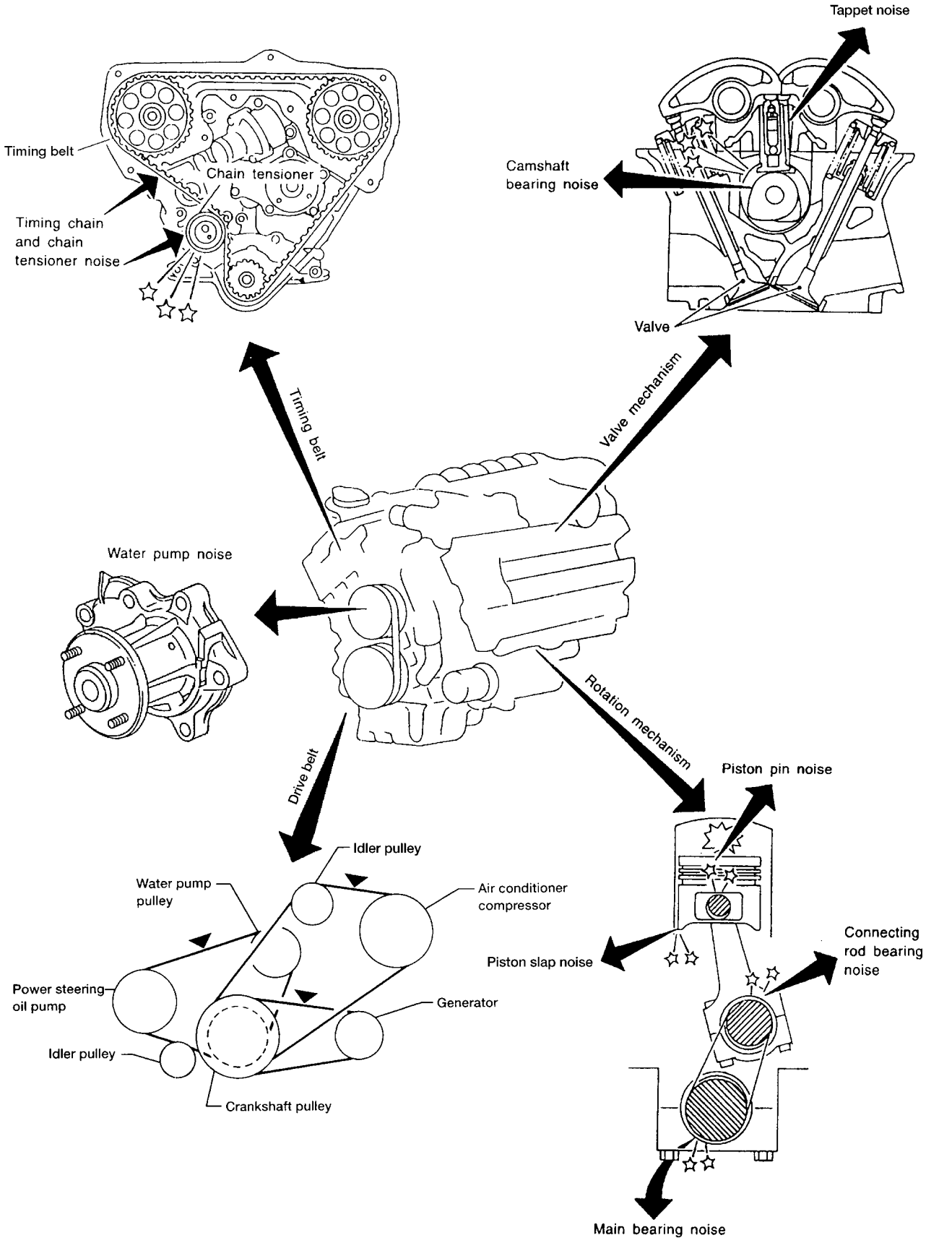
Tool number (Kent-Moore No.) Tool name	Description	
KV10114400 (J38365) Heated oxygen sensor wrench	 NT636	Loosening or tightening rear heated oxygen sensor (For right bank) **a: 22 mm (0.87 in)**

Commercial Service Tools

NDEM0004

Tool number (Kent-Moore No.) Tool name	Description	
Spark plug wrench	 NT047	Removing and installing spark plug
Pulley holder	 NT035	Holding camshaft pulley while tightening or loosening camshaft bolt
Valve seat cutter set	 NT048	Finishing valve seat dimensions
Piston ring expander	 NT030	Removing and installing piston ring
Valve guide drift	 NT015	Removing and installing valve guide **Intake & Exhaust:** **a = 10.5 mm (0.413 in) dia.** **b = 6.6 mm (0.260 in) dia.**
Valve guide reamer	 NT016	Reaming valve guide 1 or hole for oversize valve guide 2 **Intake:** **d_1 = 7.0 mm (0.276 in) dia.** **d_2 = 11.2 mm (0.441 in) dia.** **Exhaust:** **d_1 = 8.0 mm (0.315 in) dia.** **d_2 = 12.2 mm (0.480 in) dia.**

Tool number (Kent-Moore No.) Tool name	Description	
Camshaft oil seal drift	 NT613	Installing camshaft oil seal **a: 60 mm (2.36 in) dia.** **b: 44.5 mm (1.752 in) dia.** **c: 75 mm (2.95 in)**
Front oil seal drift	 NT049	Installing front oil seal **a: 52 mm (2.05 in) dia.** **b: 44 mm (1.73 in) dia.**
Rear oil seal drift	 NT719	Installing rear oil seal **a: 46 mm (1.81 in)** **b: 110 mm (4.33 in)** **c: 84 mm (3.31 in)** **d: 96 mm (3.78 in)**
(J-43897–18) (J-43897–12) Oxygen Sensor Thread Cleaner	 AEM488	Reconditioning the exhaust system threads before installing a new oxygen sensor. Use with anti-seize lubricant shown below **a: J-43897–18 18mm diameter, for Zirconia oxygen sensor** **a: J-43897–12 12mm diameter, for Titania oxygen sensor**
Anti-seize lubricant (Permatex™ 133AR or equivalent meeting MIL specification MIL-A-907)	 AEM489	Lubricating oxygen sensor thread cleaning tool when reconditioning exhaust system threads


Tappet noise
Timing belt
Chain tensioner
Timing chain and chain tensioner noise
Camshaft bearing noise
Valve
Timing belt
Valve mechanism
Water pump noise
Drive belt
Rotation mechanism
Piston pin noise
Idler pulley
Water pump pulley
Air conditioner compressor
Power steering oil pump
Generator
Idler pulley
Crankshaft pulley
Piston slap noise
Connecting rod bearing noise
Main bearing noise

AEM413

NVH Troubleshooting Chart — Engine Noise

NDEM0039S01

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.

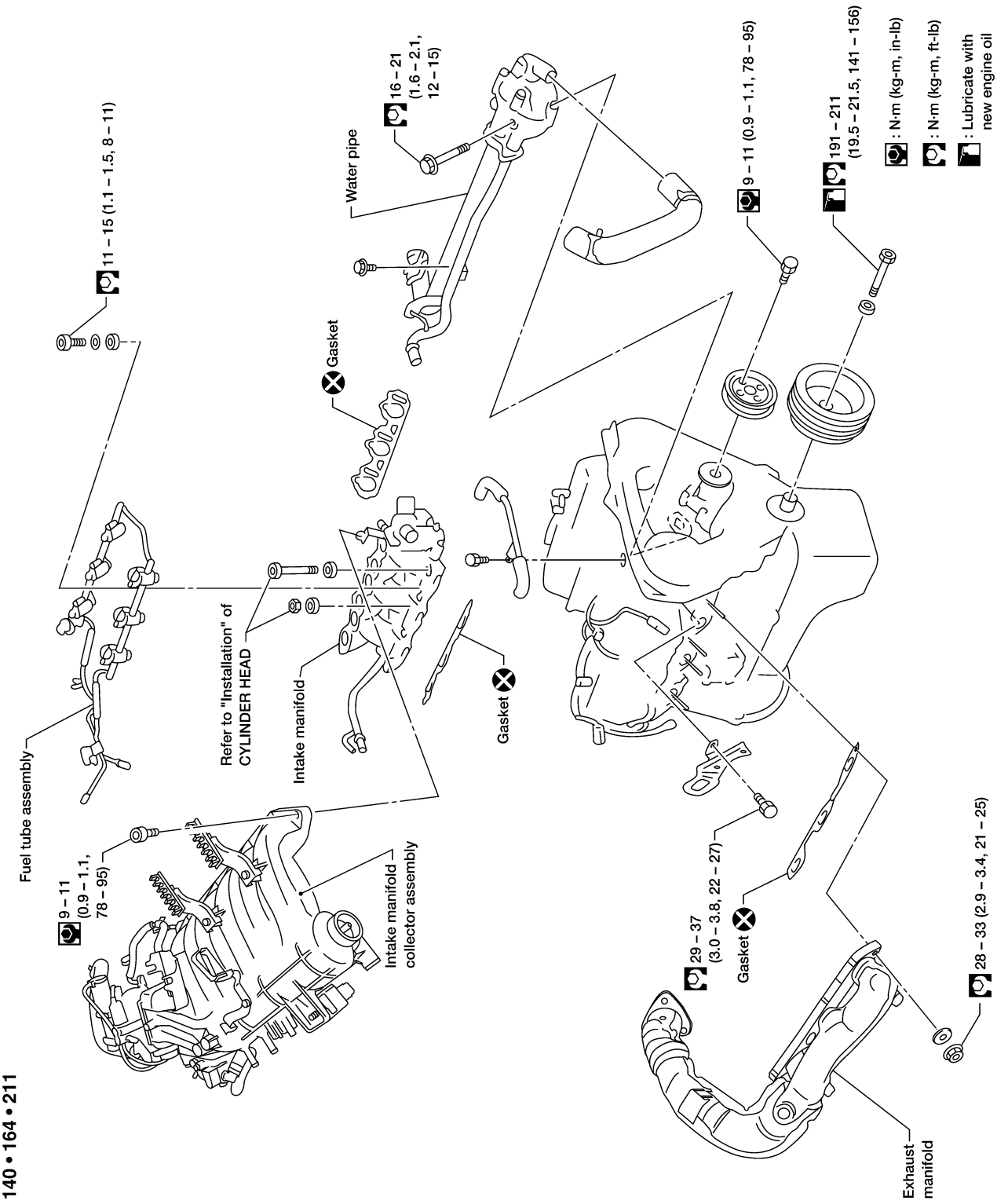
Location of noise	Type of noise	Operating condition of engine						Source of noise	Check item	Reference page
		Before warm-up	After warm-up	When starting	When idling	When racing	While driving			
Top of engine Rocker cover Cylinder head	Ticking or clicking	C	A	—	A	B	—	Tappet noise	Hydraulic valve lifter	EM-39 *1
	Rattle	C	A	—	A	B	C	Camshaft bearing noise	Camshaft journal clearance Camshaft runout	EM-32, EM-32
Crankshaft pulley Cylinder block (Side of engine) Oil pan	Slap or knock	—	A	—	B	B	—	Piston pin noise	Piston and piston pin clearance Connecting rod bushing clearance	EM-49, EM-55
	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-51, EM-49, EM-49, EM-50
	Knock	A	B	C	B	B	B	Connecting rod bearing noise	Connecting rod bushing clearance (Small end) Connecting rod bearing clearance (Big end)	EM-55, EM-54
	Knock	A	B	—	A	B	C	Main bearing noise	Main bearing oil clearance Crankshaft runout	EM-53, EM-52
Timing belt cover	Whine or hissing	C	A	—	A	A	—	Timing belt noise (too tight)	Loose timing belt Belt contacting case	EM-17
	Clatter	A	B	—	C	A	—	Timing belt noise (too loose)		
Front of engine	Squeaking or fizzing	A	B	—	B	—	C	Other drive belts (Sticking or slipping)	Drive belts deflection	***MA-13***
	Creaking	A	B	A	B	A	B	Other drive belts (Slipping)	Idler pulley bearing operation	
	Squall Creak	A	B	—	B	A	B	Water pump noise	Water pump operation	***LC-10***

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

*1: Step 19 in “Installation”, “CYLINDER HEAD”

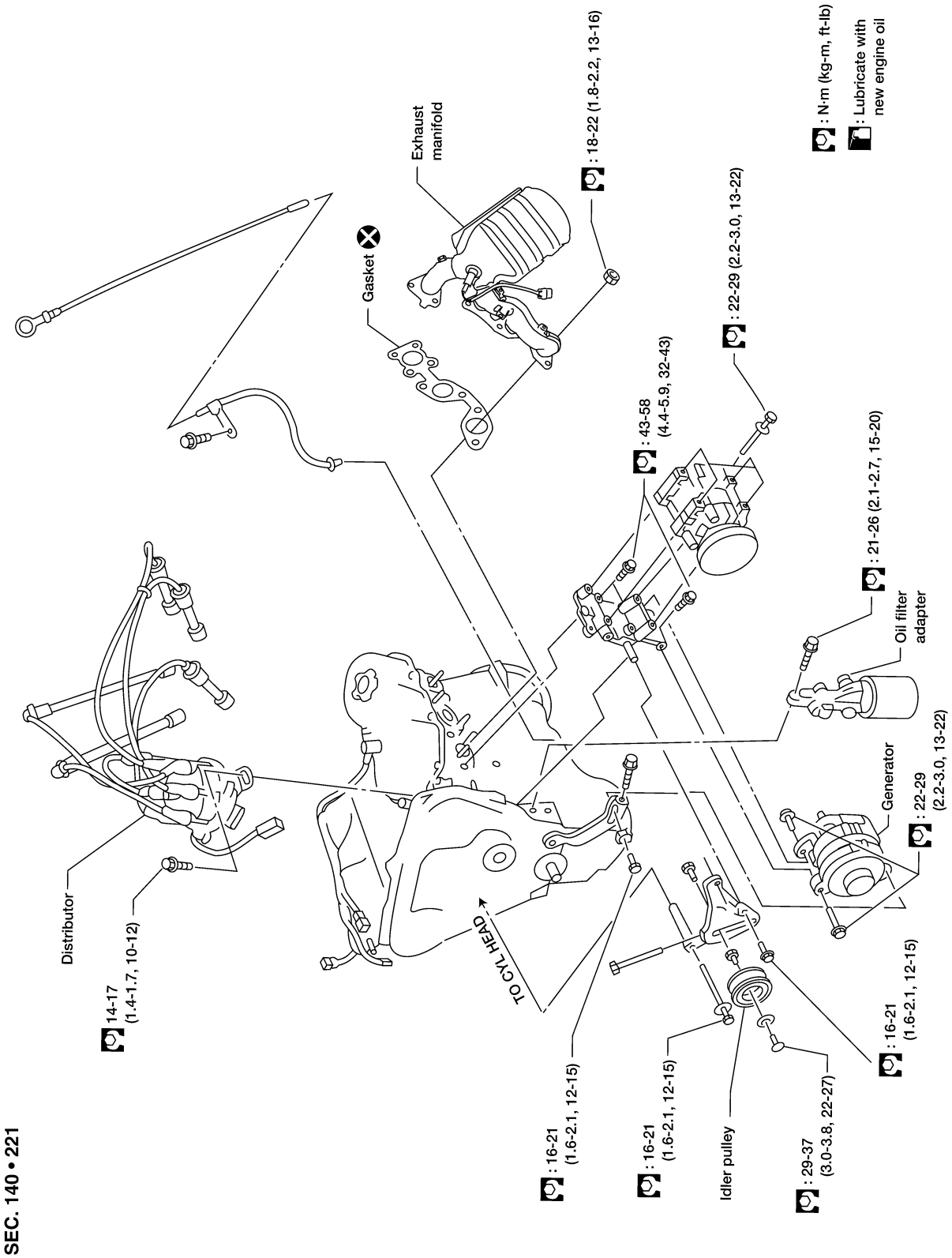
Removal and Installation

NDEM0005



SEC. 120 • 140 • 164 • 211

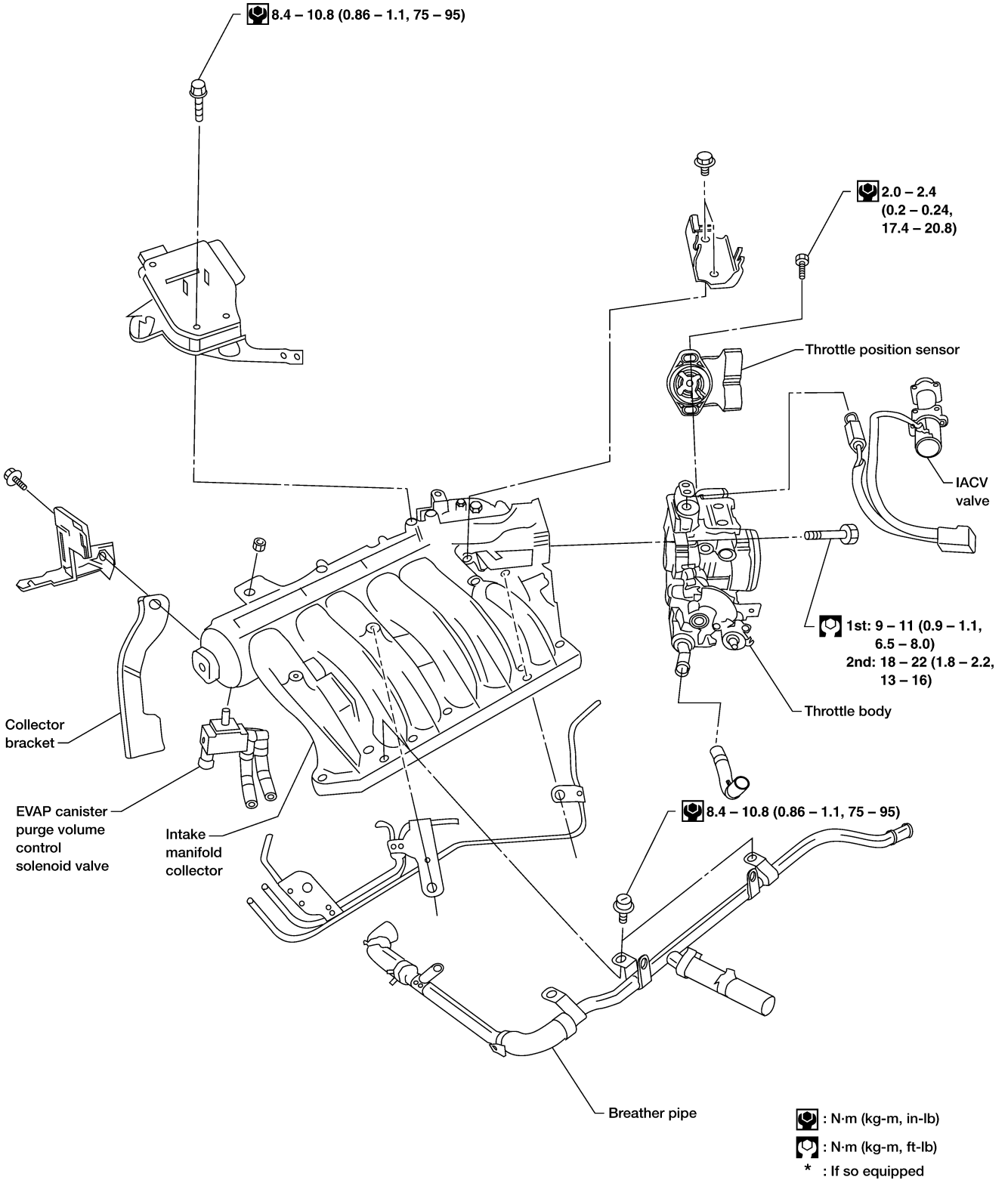
WEM084



SEC. 140 • 221

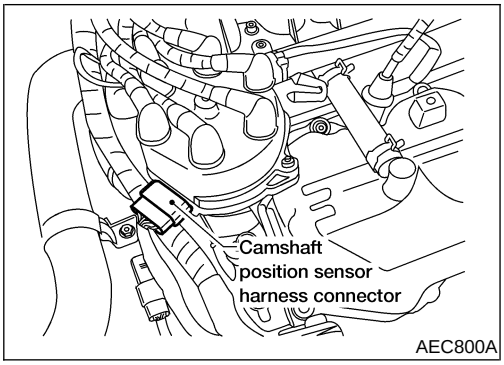
WEM086

SEC. 140 • 147 • 148 • 163 • 223

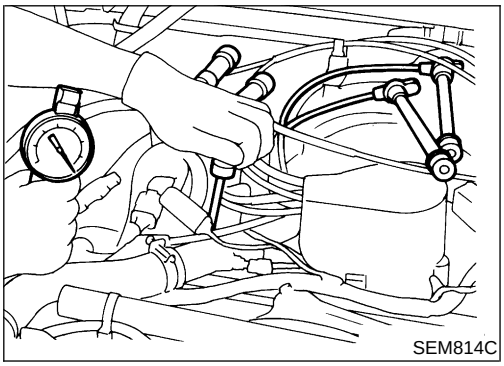


WEM085

MEASUREMENT OF COMPRESSION PRESSURE



AEC800A


SEM814C


20 mm (0.79 in) dia.

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

SEM387C

1. Warm up engine.
2. Turn ignition switch OFF.
3. Release fuel pressure.
   Refer to ***EC-35***, “Releasing Fuel Pressure”.
4. Remove all spark plugs.

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

5. Disconnect the camshaft position sensor harness connector at the distributor.
6. Remove fuel injector fuse 33 located in engine room.
   Refer to “Terminal Arrangement”.
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

1,196 (12.2, 173)

Minimum

883 (9.0, 128)

Difference limit 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 cylinders through spark plug holes 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 “Valve”, EM-60. 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 *EC-61*, “How to Erase Emission-Related Diagnostic Information”.

Removal

NDEM0007

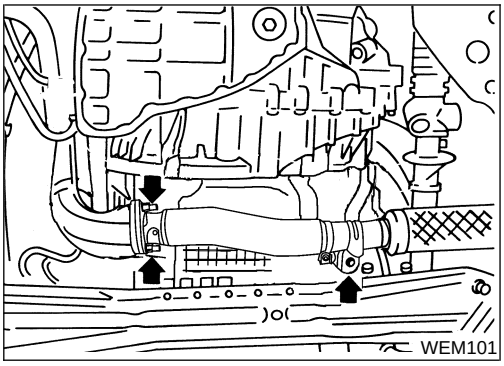
WARNING:

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

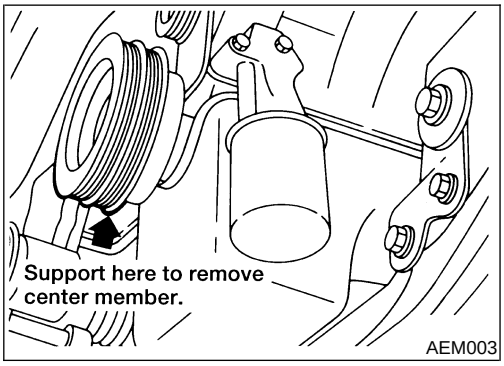
CAUTION:

- **In lifting engine, be careful not to hit against adjacent parts, especially against accelerator wire casing end, brake tube and brake master cylinder.**

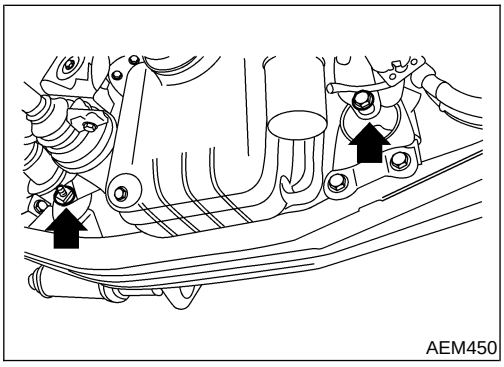
1. Drain engine oil.
2. Remove engine lower covers.



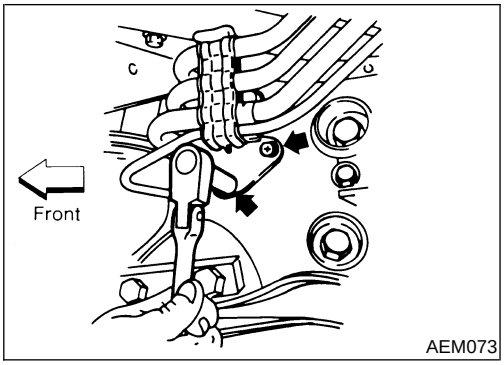
3. Remove exhaust tube fixing nuts and exhaust tube.



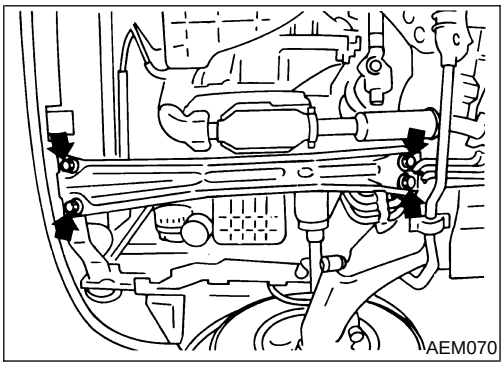
4. Support engine at crankshaft pulley with a suitable jack and block or from above with a suitable support bar or hoist.



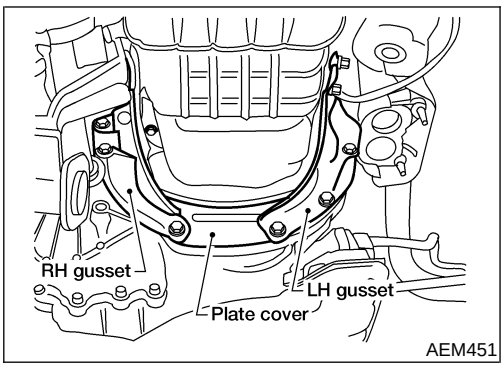
5. Remove engine mounting insulator bolts and nuts.



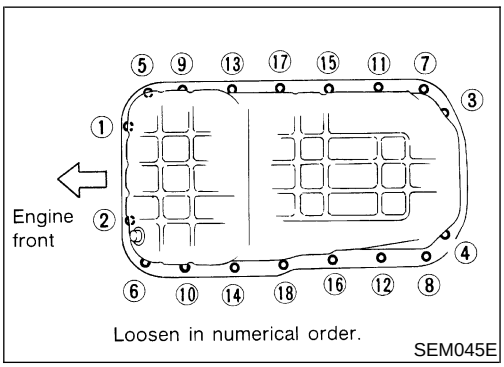
6. Remove the rear A/C refrigerant lines support bracket bolts, if so equipped.



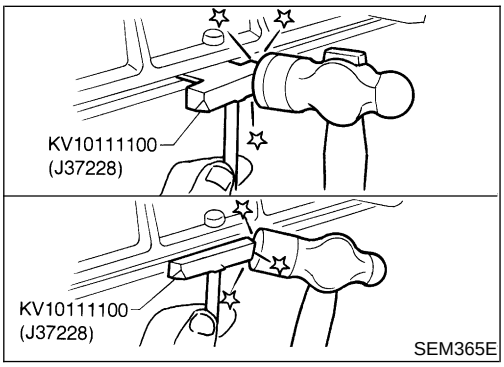
7. Remove center member.



8. Remove LH and RH gusset from engine block and transmission.
9. Remove plate cover.



10. Remove oil pan bolts in numerical order.



11. Remove oil pan.

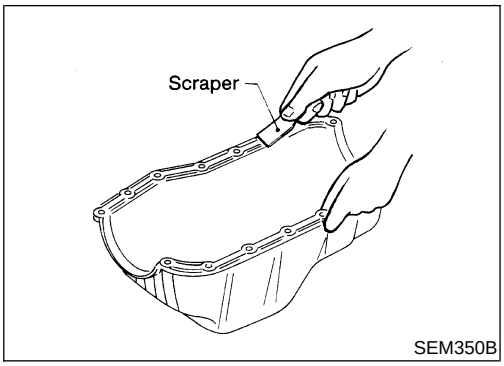
a. Insert Tool between cylinder block and oil pan.

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

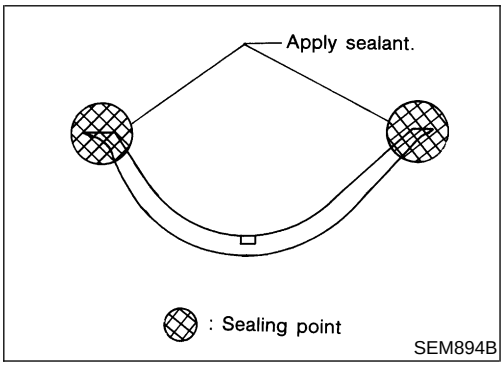
b. Slide Tool by tapping its side with a hammer, and remove oil pan.

Installation

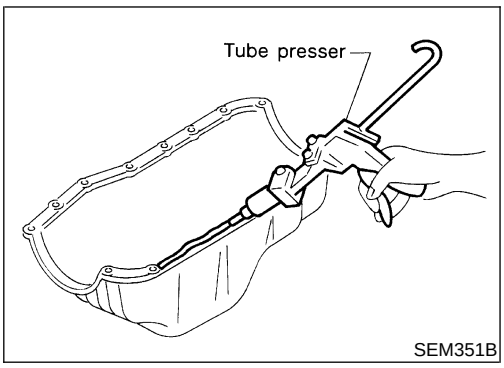
NDEM0008



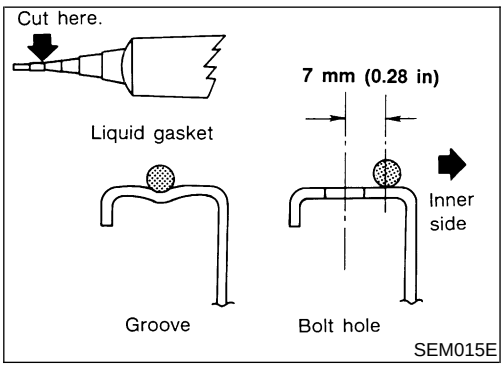
1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
- Also remove traces of liquid gasket from mating surface of cylinder block.



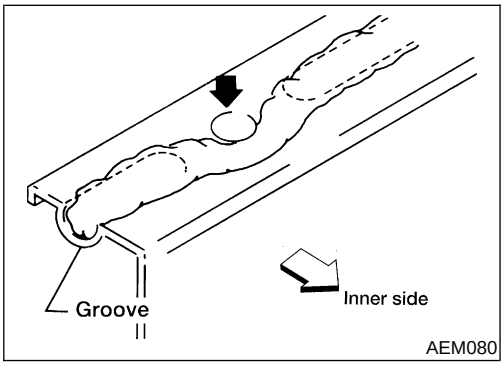
2. Apply sealant to oil pump gasket and rear oil seal retainer gasket.



3. Apply a continuous bead of liquid gasket to mating surface of oil pan.
- **Use Genuine RTV Silicone Sealant Part No. 999MP-A7007 or equivalent.**



- **Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide.**
4. Apply liquid gasket to inner sealing surface as shown in figure.
- **Attaching should be done within 5 minutes after coating.**
5. Install oil pan.
- **Install bolts/nuts in their reverse order of removal.**
- **Wait at least 30 minutes before refilling engine oil.**



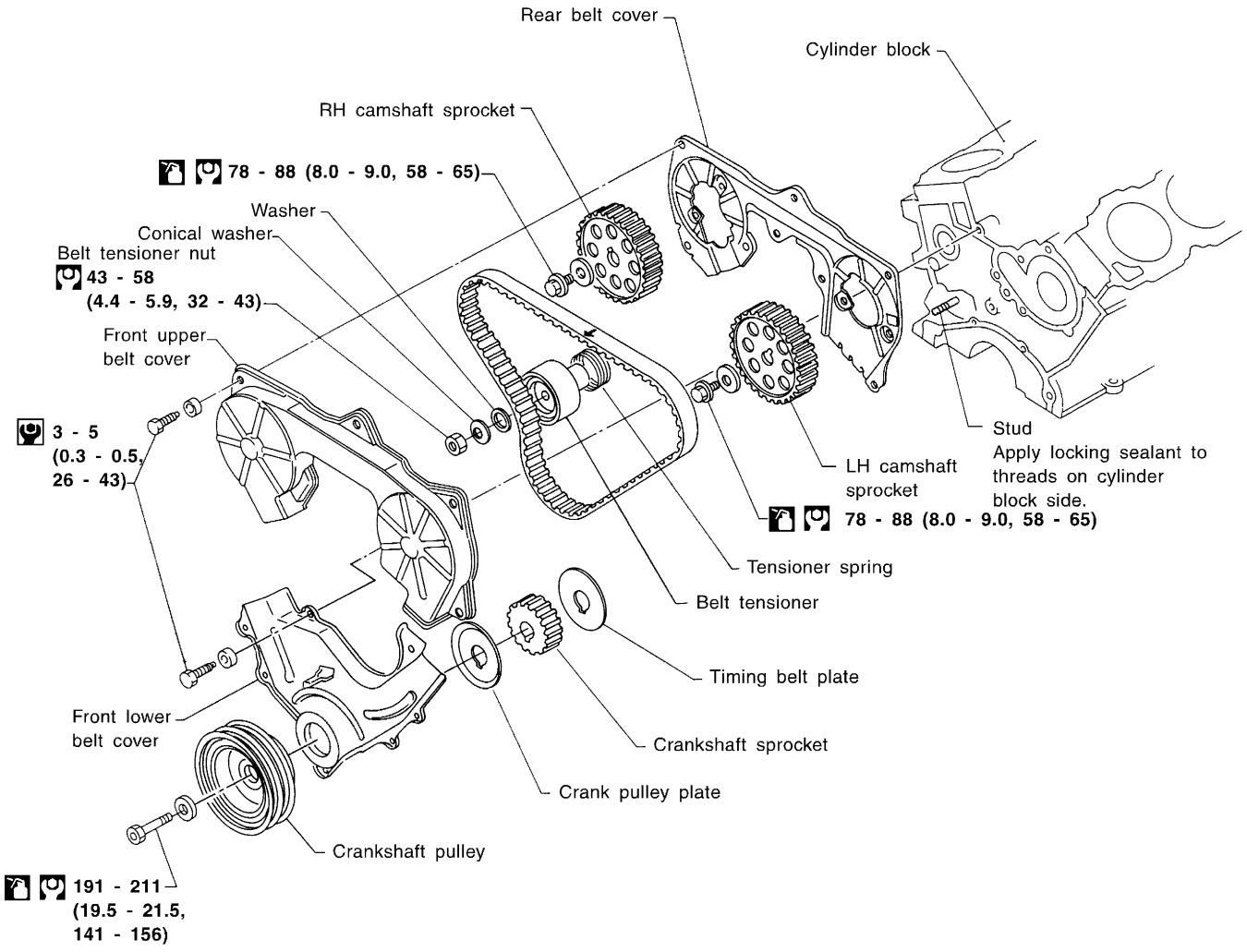
Components

NDEM0009

CAUTION:

- **Do not bend or twist timing belt.**
- **After removing timing belt, do not turn crankshaft and camshaft separately because valves will strike piston heads.**
- **Make sure that timing belt, camshaft sprocket, crankshaft sprocket and belt tensioner are clean and free from oil and water.**
- **Installation should be carried out when engine is cold.**

SEC. 120•130•135



: N•m (kg-m, in-lb)

: N•m (kg-m, ft-lb)

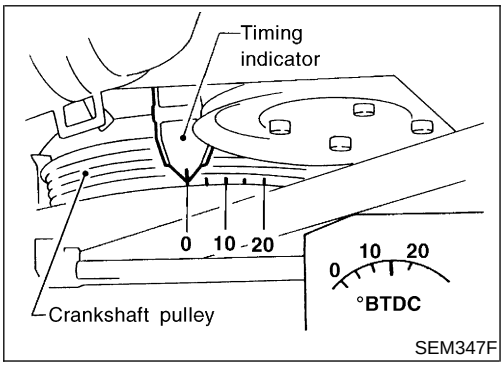
: Lubricate with new engine oil

SEM311FA

Removal

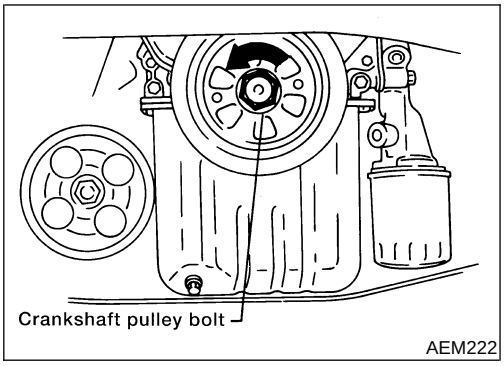
NDEM0010

1. Jack up the vehicle front and support with safety stand.
2. Remove engine under cover.
3. Remove front RH wheel and engine side cover.
4. Drain engine coolant from radiator. Refer to ***MA-14***, “Changing Engine Coolant”.
5. Remove the following belts.
- Compressor drive belt
- Generator drive belt
- Power steering pump drive belt
6. Set No. 1 piston at TDC of its compression stroke.



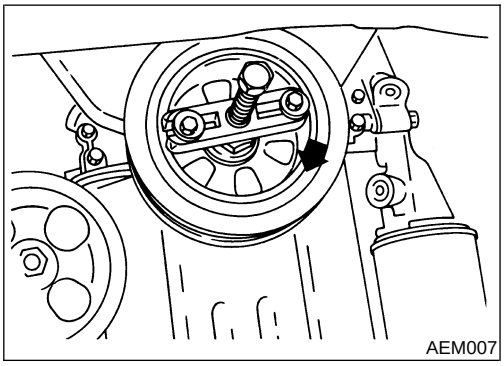
SEM347F

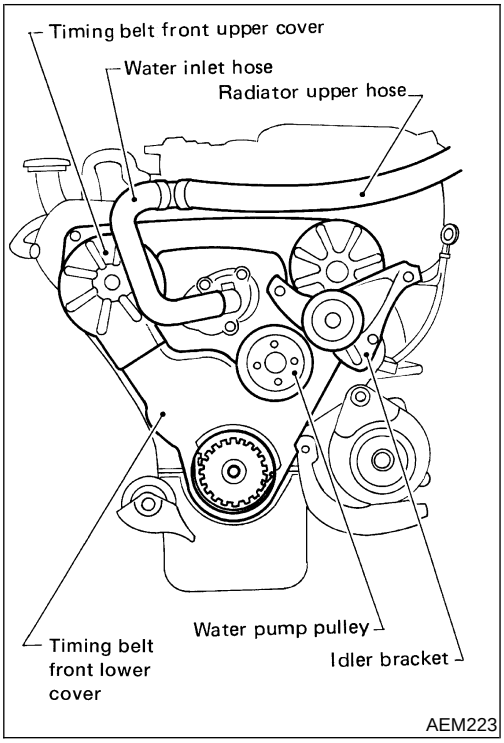
7. Loosen crankshaft pulley bolt.



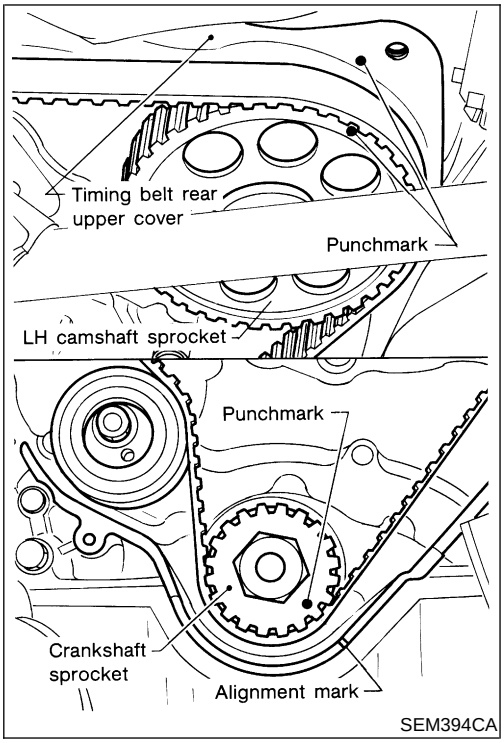
AEM222

8. Remove crankshaft pulley using a suitable puller.

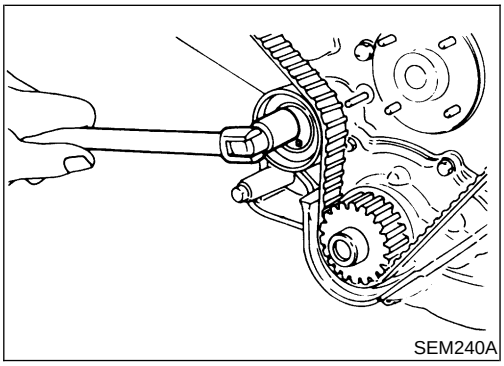

AEM007



9. Remove radiator upper hose and water inlet hose.
10. Remove compressor drive belt idler bracket.
11. Remove water pump pulley.
12. Remove breather pipe from timing belt front upper cover.
13. Remove timing belt front covers.



- **Align punchmark on LH camshaft sprocket with punchmark on timing belt rear cover.**
- **Align punchmark on crankshaft sprocket with alignment mark on oil pump housing.**
- **Temporarily install crankshaft pulley bolt on crankshaft so the crankshaft can be rotated.**

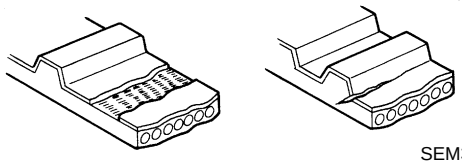
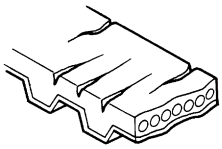
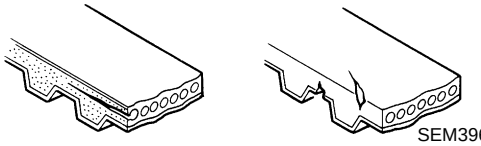
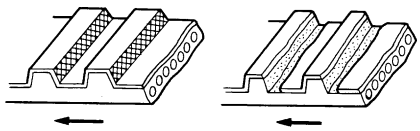


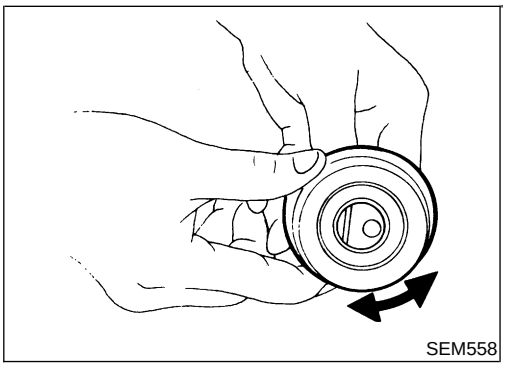
14. Loosen timing belt tensioner nut, rotate tensioner, then remove timing belt.

Inspection

NDEM0011

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

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


SEM558

BELT TENSIONER AND TENSIONER SPRING

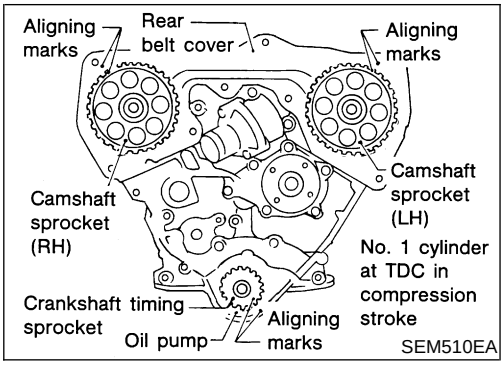
NDEM0011S01

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

Installation

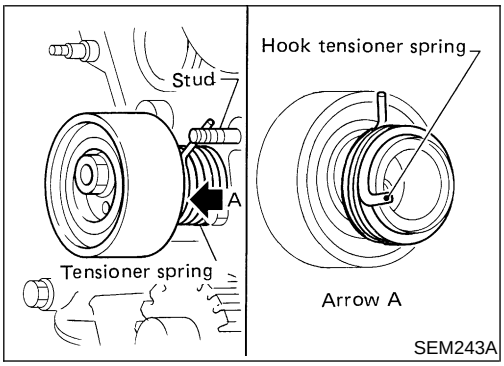
NDEM0012

1. Confirm that No. 1 piston is set at TDC on its compression stroke.

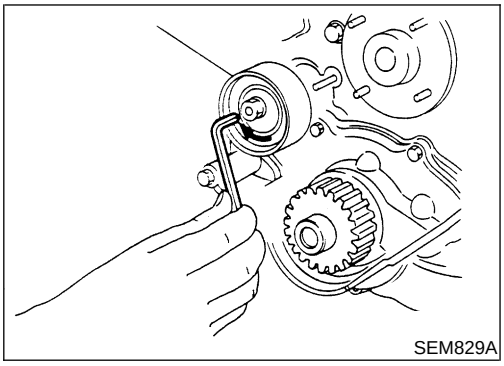


2. Install tensioner and tensioner spring.

Once stud is removed, apply locking sealant to threads of stud on cylinder block side before installing.



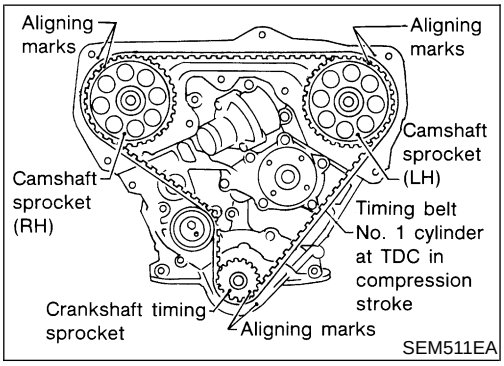
3. Turn tensioner fully outward with hexagon wrench, and temporarily tighten lock nut.

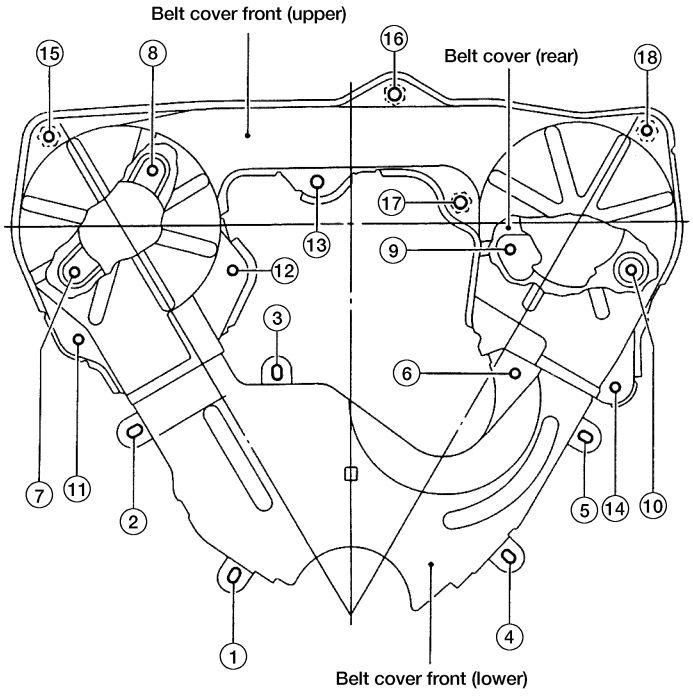


4. Set timing belt when engine is cold.
1) Align white lines on timing belt with punchmarks on camshaft sprockets and crankshaft sprocket.
2) Point arrow on timing belt toward front belt cover.

Number of teeth (reference):

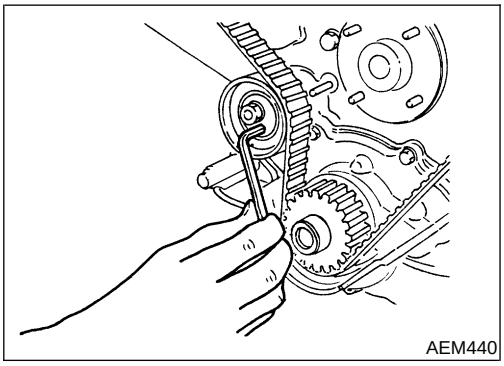
Number of timing belt teeth		133
Number of teeth between timing marks	Between LH and RH camshaft sprockets	40
	Between LH camshaft sprocket and crankshaft timing sprocket	43



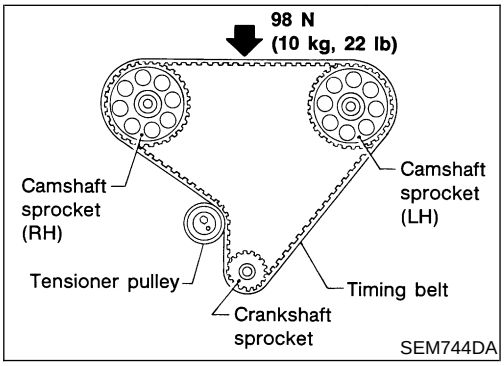


Tightened parts	Section	Parts tightened with bolts
Bolt (4 pcs.) Rubber washer Belt cover front (lower)	①,②,③ ⑤	①,②,③: Cylinder block ⑤: Compressor bracket
Bolt (2 pcs.) Belt cover front (lower)	④ ⑥	④: Oil pump ⑥: Water pump mounting bolt
Bolt (4 pcs.) Belt cover (rear)	⑦,⑧,⑨ ⑩	Cylinder head
Bolt (8 pcs.) Rubber washer Belt cover front (upper) Belt cover (rear) Welded nut (4 pcs.)	⑮,⑯,⑰ ⑱,⑪,⑫ ⑬,⑭	⑮,⑯,⑰,⑱: Welded nuts ⑪,⑫: Cylinder head ⑬: Water outlet ⑭: Compressor bracket

AEM418



AEM440



SEM744DA

Tension Adjustment

NDEM0040

AFTER BELT REPLACEMENT

NDEM0040S01

If the timing belt was replaced (or to adjust tension on a used belt), follow the steps below.

1. Loosen tensioner lock nut, then turn tensioner clockwise and counterclockwise with hexagon wrench at least 2 times.
2. Tighten tensioner lock nut.
3. Turn crankshaft clockwise at least 2 times, then slowly set No. 1 piston at TDC on its compression stroke.
4. Measure deflection of timing belt midway between camshaft pulleys while pushing with 98 N (10 kg, 22 lb) force.

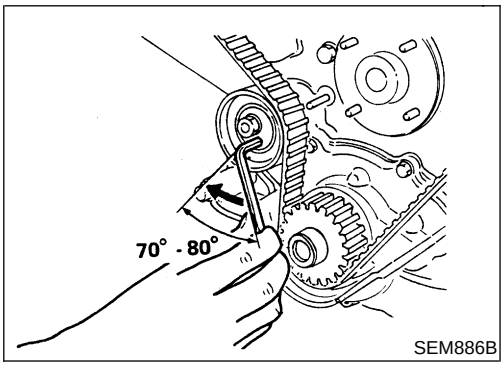
   Belt deflection when engine is cold (Reference value):
   13 - 15 mm (0.51 - 0.59 in)/98 N (10 kg, 22 lb)
5. If NG, return to step 1.

AFTER ENGINE OVERHAUL OR ENGINE REASSEMBLY (WITH ROCKER COVERS REMOVED)

NDEM0040S02

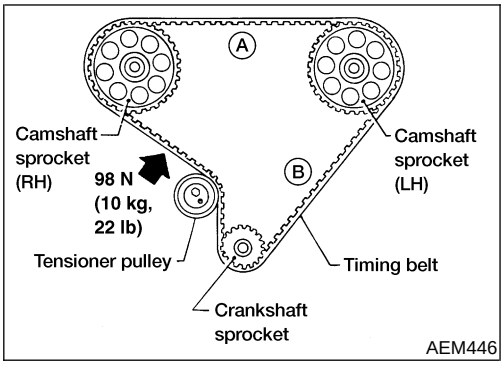
If the engine was overhauled or previously disassembled (i.e. intake manifold and/or cylinder head were removed), follow the steps below.

1. Loosen rocker shaft bolts to relieve belt tension caused by the cam shafts.



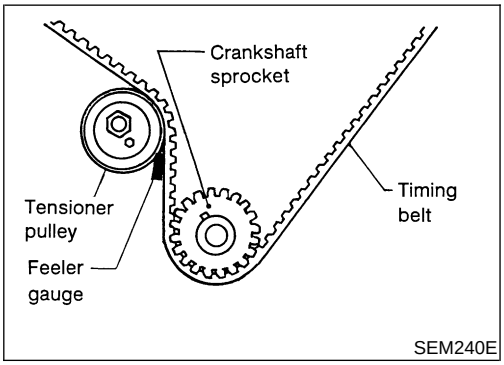
SEM886B

2. Loosen tensioner lock nut, keeping tensioner steady with hexagon wrench.
3. Turn tensioner 70 to 80 degrees clockwise with hexagon wrench to release belt tension, and temporarily tighten lock nut.
4. Turn crankshaft clockwise at least two times, then slowly set No. 1 piston at TDC on its compression stroke.



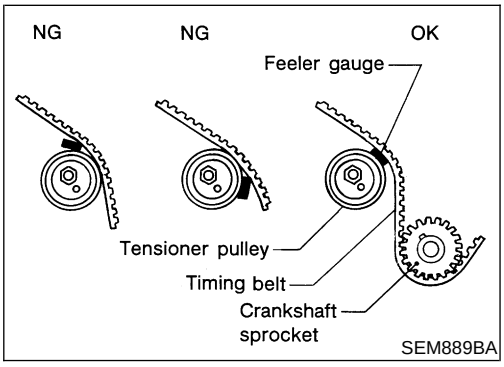
AEM446

5. Push middle of timing belt between RH camshaft sprocket and tensioner pulley with force of 98 N (10 kg, 22 lb) to apply tensions on part A and part B.
6. Loosen tensioner lock nut, keeping tensioner steady with hexagon wrench.



SEM240E

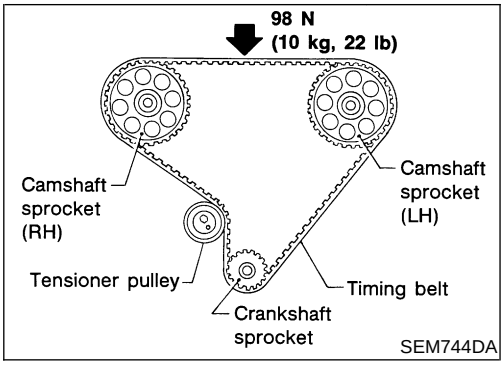
7. Set feeler gauge as shown in figure which is 0.5 mm (0.0206 in) thick and 12.7 mm (0.500 in) wide.



SEM889BA

8. Turn crankshaft clockwise until feeler gauge is positioned as shown in figure.
   - Timing belt will move about 2.5 teeth.
9. Tighten tensioner lock nut, keeping tensioner steady with hexagon wrench.
10. Turn crankshaft clockwise or counterclockwise, and remove feeler gauge.
11. Turn crankshaft clockwise at least two times, then slowly set No. 1 piston at TDC on its compression stroke.

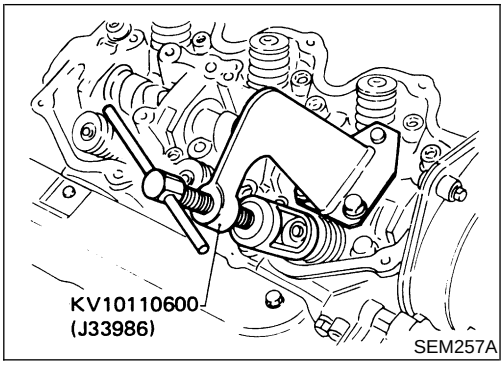
Tension Adjustment (Cont'd)



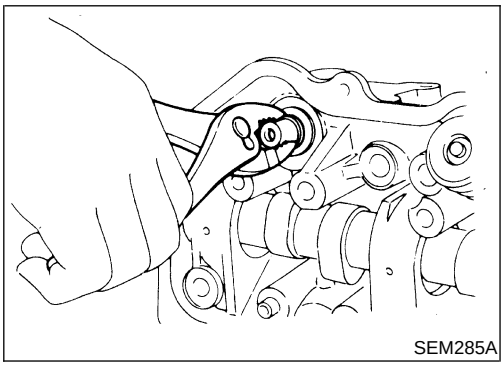
12. Measure deflection of timing belt midway between camshaft pulleys while pushing with 98 N (10 kg, 22 lb) force.

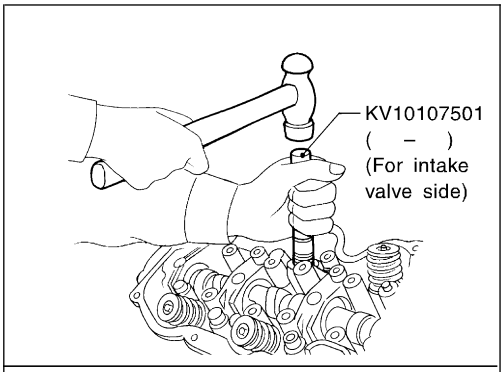
    Belt deflection when engine is cold (Reference value):
    13 - 15 mm (0.51 - 0.59 in)/98 N (10 kg, 22 lb)

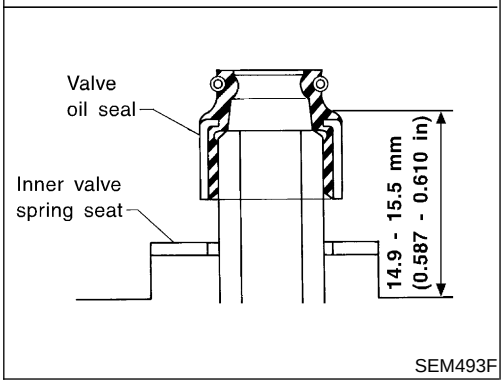
13. Install lower and upper belt covers.



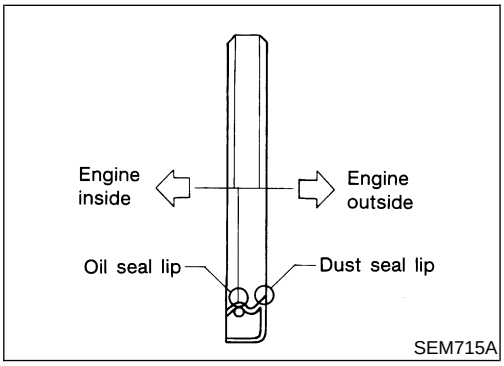
SEM257A


SEM285A





SEM493F



SEM715A

Replacement

NDEM0013

VALVE OIL SEAL

NDEM0013S01

1. Remove rocker cover.
2. Remove rocker shaft assembly and valve lifters with valve lifter guide.
3. Remove valve springs and valve oil seal.

- Piston concerned should be set at TDC to prevent valve from falling.
- When removing intake side valve oil seal, use Tool or suitable tool.
- When removing exhaust side valve oil seal, pull it out with suitable tool.

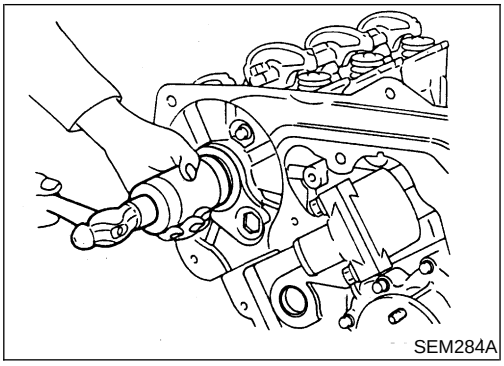
4. Apply engine oil to new valve oil seal and install it.

- Before installing valve oil seal, install inner valve spring seat.
- When installing intake side valve oil seal, use Tool.
- When installing exhaust side valve oil seal, set it by hand.

OIL SEAL INSTALLING DIRECTION

NDEM0013S02

Replacement (Cont'd)


SEM284A

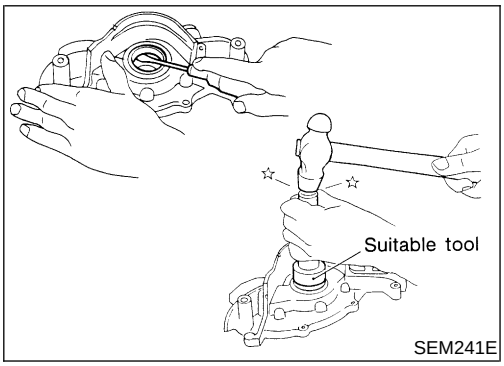
CAMSHAFT OIL SEAL

NDEM0013S03

1. Remove timing belt.
2. Remove camshaft sprocket.
3. Remove camshaft.
4. Remove camshaft oil seal.

Be careful not to scratch camshaft.

5. Apply engine oil to new camshaft oil seal.

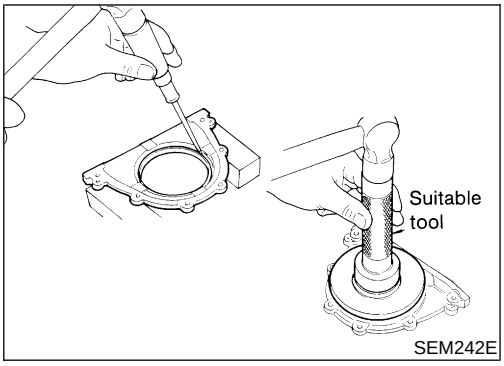


SEM241E

FRONT OIL SEAL

NDEM0013S04

1. Remove timing belt and crankshaft sprocket.
2. Remove oil pump assembly.
3. Remove front oil seal from oil pump body.
4. Apply engine oil to new oil seal and install it using suitable tool.



SEM242E

REAR OIL SEAL

NDEM0013S05

1. Remove drive plate.
2. Remove rear oil seal retainer.
3. Remove rear oil seal from retainer.

- Be careful not to scratch rear oil seal retainer.

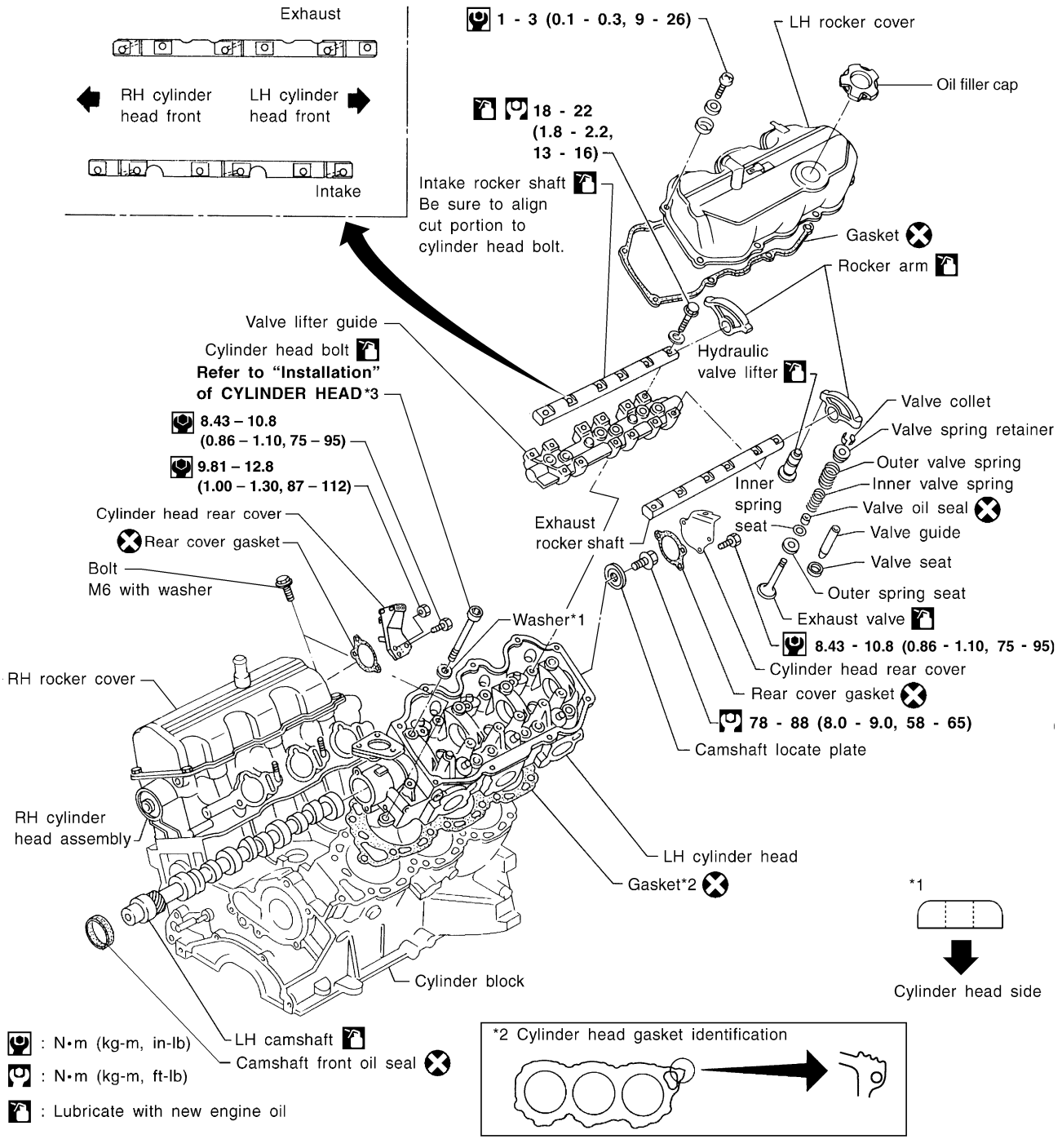
4. Apply engine oil to new oil seal and install it using suitable tool.
5. Install rear oil seal retainer with a new gasket to cylinder block.

- Always use a new oil seal retainer to cylinder block gasket.

Components

NDEM0014

SEC. 102•111•130



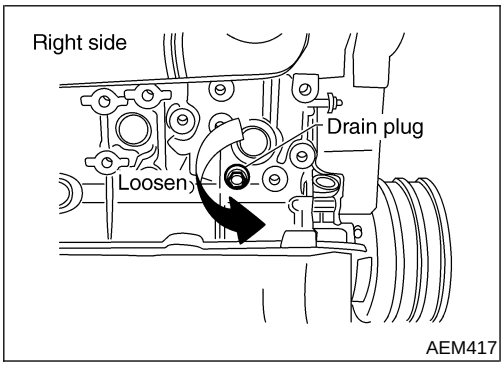
WEM097

*3 EM-39

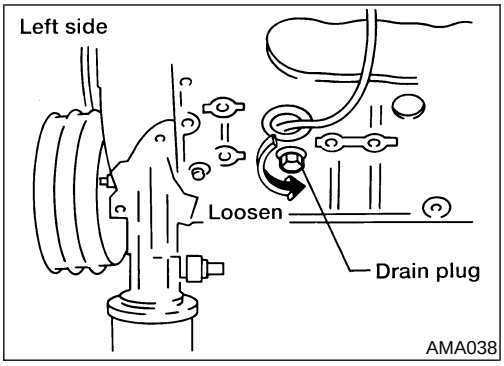
Removal

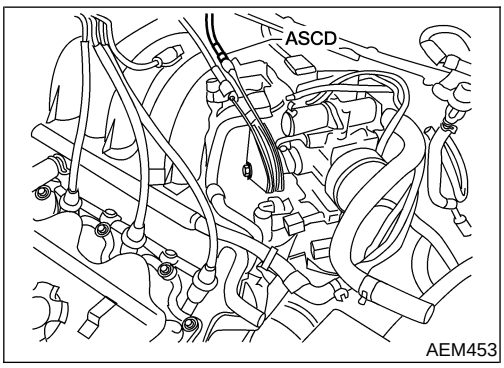
NDEM0015

1. Release fuel pressure.
   Refer to ***EC-35***, “Releasing Fuel Pressure”.
2. Remove timing belt.
   Refer to “Removal”, EM-18.



3. Drain coolant by removing drain plugs from both sides of cylinder block.





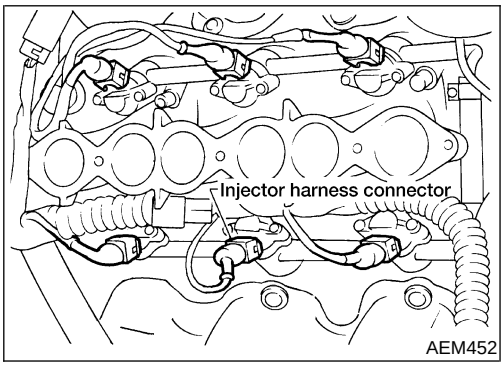
4. Disconnect air duct hose.
5. Separate ASCD and accelerator control wire from intake manifold collector.
6. Remove intake manifold collector from engine. The following parts should be disconnected to remove intake manifold collector.

a. Harness connectors for:
- IACV-AAC valve
- Throttle position sensor
- Throttle position switch
- Distributor (ignition coil)
- Distributor
- IACV-FICD solenoid valve

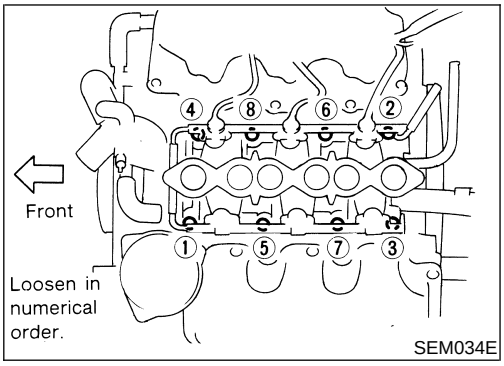
b. Water hoses from collector
c. Heater hoses
d. PCV hose from RH/LH rocker cover
e. Vacuum hoses for:
- EVAP canister
- Master brake cylinder
- Pressure regulator

f. Purge hose from purge control valve

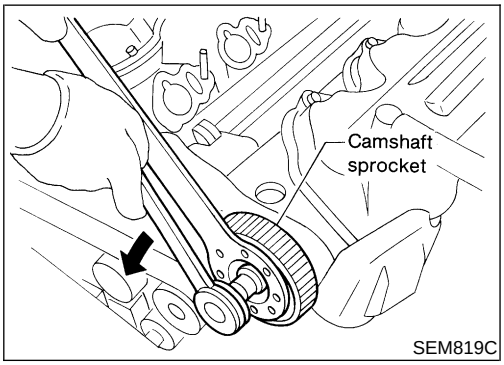
g. Spark plug wires
h. Distributor assembly
i. 3 left/right bank injector connectors
j. Ground harness



7. Remove fuel feed and fuel return hoses from injector fuel tube assembly.
8. Disconnect the right injector harness connectors.
9. Remove injector fuel tube assembly.



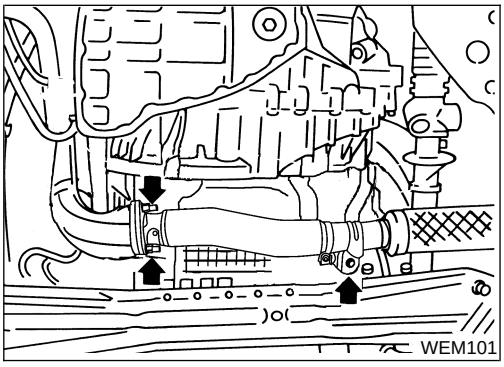
10. Remove intake manifold from engine. The following parts should be disconnected to remove intake manifold.
a. Engine coolant temperature switch harness connector
b. Water hose from thermostat housing



11. Remove both camshaft sprockets.
12. Remove rear timing belt cover.
13. Remove distributor.

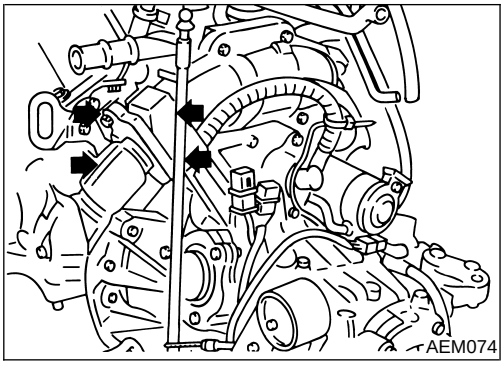
After pulling out distributor from cylinder head, do not rotate distributor rotor.

14. Remove harness clamp from RH rocker cover.

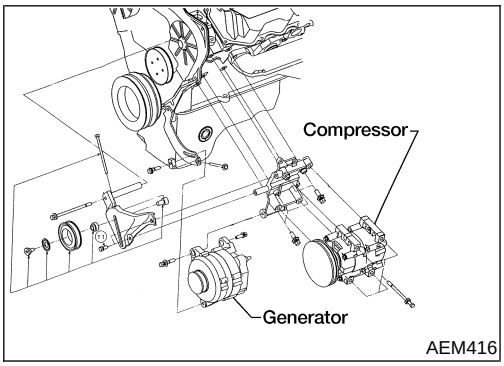


15. Remove exhaust tube from LH exhaust manifold.

Removal (Cont'd)

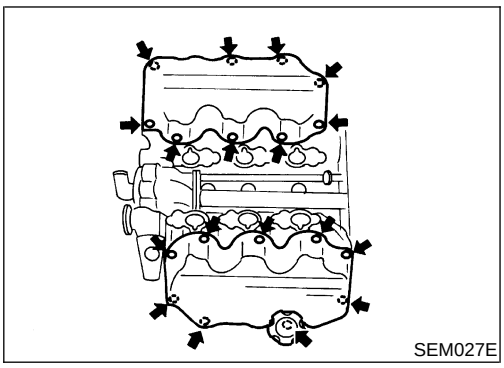

AEM074

16. Remove the nuts and bolt, then separate the LH exhaust manifold from the RH exhaust manifold.
17. Remove the LH exhaust manifold-to-support bracket bolt.

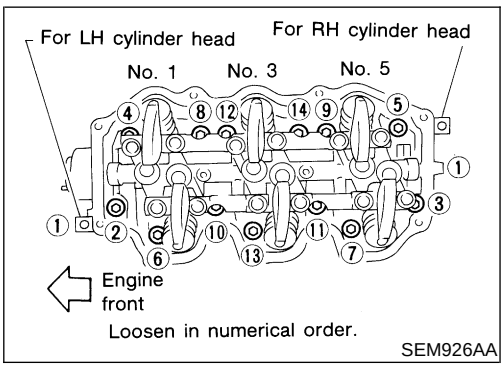


AEM416

18. Remove compressor from bracket.
19. Remove generator from bracket.
20. Remove compressor and bracket.


SEM027E

21. Remove both rocker covers.



SEM926AA

22. Remove cylinder head with exhaust manifold.

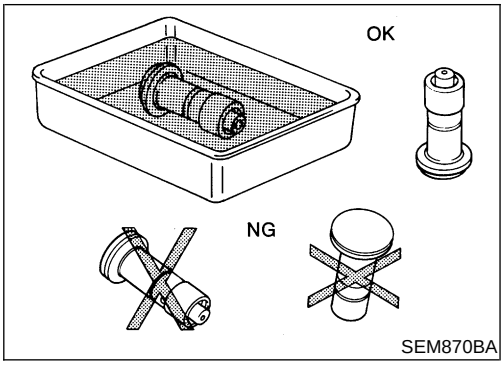
- **A warped or cracked cylinder head could result from removing in incorrect order.**
- **Cylinder head bolts should be loosened in two or three steps.**

Disassembly

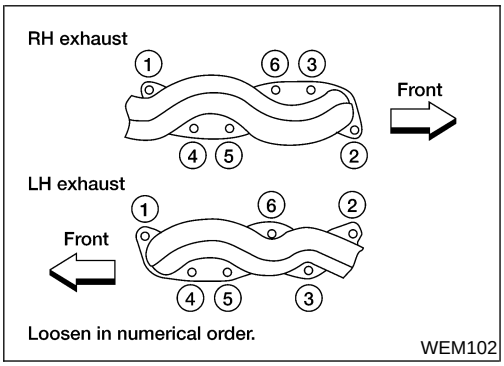
NDEM0016

CAUTION:

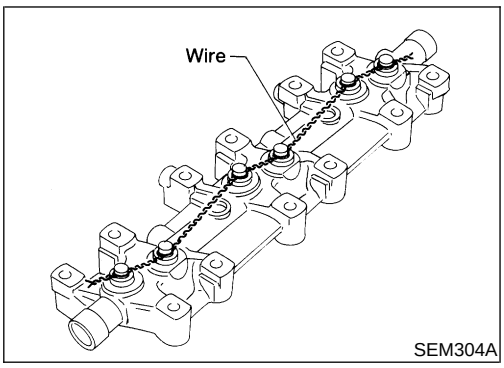
- **When installing sliding parts such as rocker arms, camshaft and oil seal, be sure to apply new engine oil on their sliding surfaces.**
- **When tightening cylinder head bolts and rocker shaft bolts, apply new engine oil to thread portions and seat surfaces of bolts.**



- **If hydraulic valve lifter is kept on its side, there is a risk of air entering it. After removal, always set hydraulic valve lifter straight up, or when laying it on its side, have it soak in new engine oil.**
- **Do not disassemble hydraulic valve lifter.**
- **Attach tags to valve lifters so as not to mix them up.**



1. Remove exhaust manifolds from cylinder head.



2. Remove rocker shafts with rocker arms.

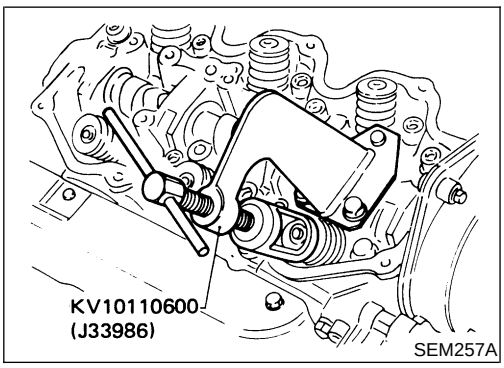
Bolts should be loosened in two or three steps.

3. Remove hydraulic valve lifters and lifter guide.

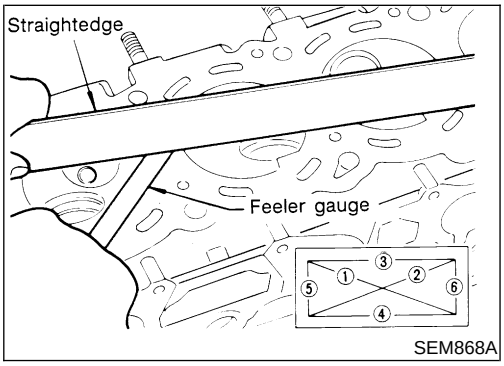
- **Hold hydraulic valve lifters with wire so that they will not drop from lifter guide.**

4. Remove oil seal and camshaft.

- **Before removing camshaft, measure camshaft end play.**



5. Remove valve components with Tool.
6. Remove valve oil seals with Tool or suitable tool.



Inspection

NDEM0017

CYLINDER HEAD DISTORTION

NDEM0017S01

Head surface flatness:

Less than 0.1 mm (0.004 in)

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

Resurfacing limit:

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

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

A + B = 0.2 mm (0.008 in)

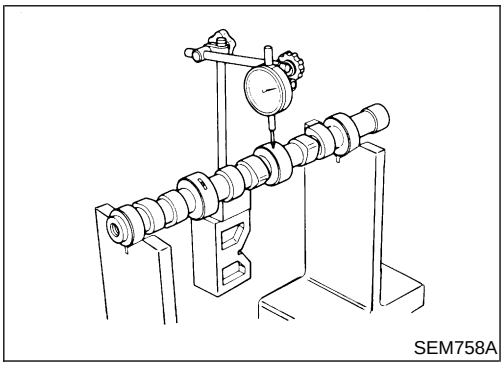
After resurfacing cylinder head, check that camshaft rotates freely by hand. If resistance is felt, cylinder head must be replaced.

Nominal cylinder head height:
106.8 - 107.2 mm (4.205 - 4.220 in)

CAMSHAFT VISUAL CHECK

NDEM0017S02

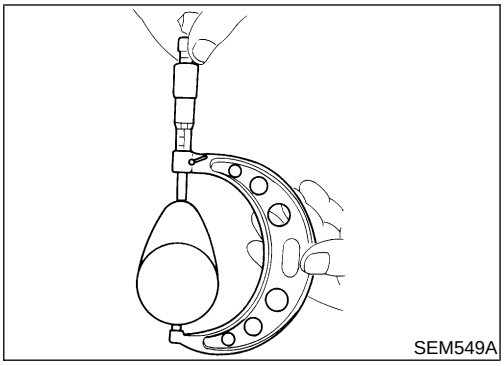
Check camshaft for scratches, seizure and wear.


SEM758A

CAMSHAFT RUNOUT

NDEM0017S03

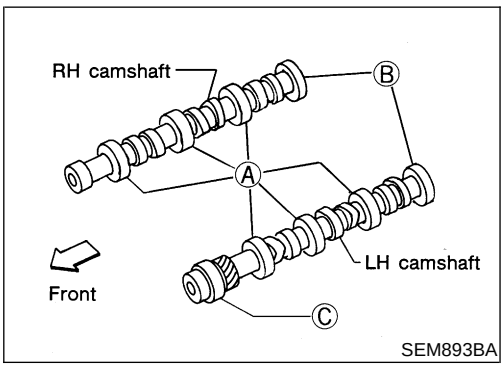
1. Measure camshaft runout at the center journal.
   Runout (Total indicator reading):
   Limit 0.1 mm (0.004 in)
2. If it exceeds the limit, replace camshaft.


SEM549A

CAMSHAFT CAM HEIGHT

NDEM0017S04

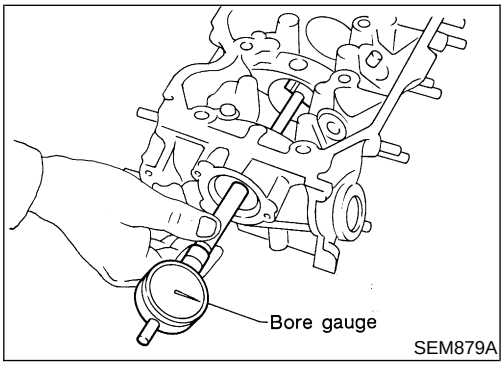
1. Measure camshaft cam height.
   Standard cam height:
   Intake and exhaust:
   38.943 - 39.133 mm (1.5332 - 1.5407 in)
   Cam wear limit:
   0.15 mm (0.0059 in)
2. If wear is beyond the limit, replace camshaft.



SEM893BA

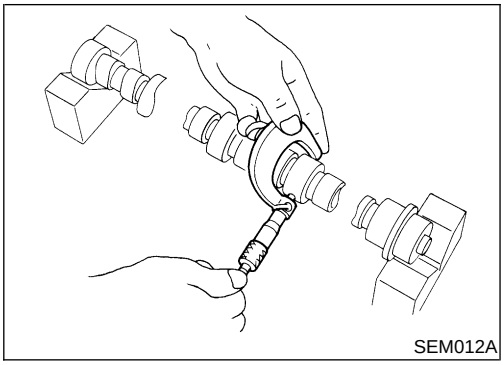
CAMSHAFT JOURNAL CLEARANCE

NDEM0017S05

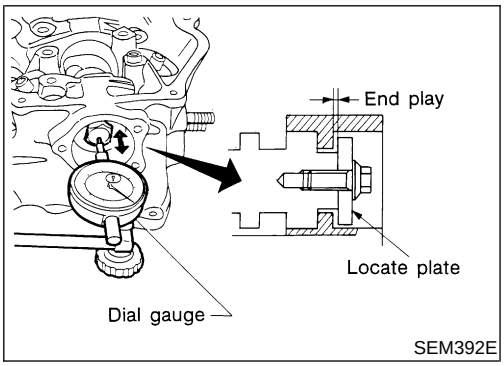


SEM879A

1. Measure inner diameter of camshaft bearing.
   Standard inner diameter:
   A 47.000 - 47.025 mm (1.8504 - 1.8514 in)
   B 42.500 - 42.525 mm (1.6732 - 1.6742 in)
   C 48.000 - 48.025 mm (1.8898 - 1.8907 in)


SEM012A

2. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   A 46.920 - 46.940 mm (1.8472 - 1.8480 in)
   B 42.420 - 42.440 mm (1.6701 - 1.6709 in)
   C 47.920 - 47.940 mm (1.8866 - 1.8874 in)
3. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance limit:
   0.15 mm (0.0059 in)

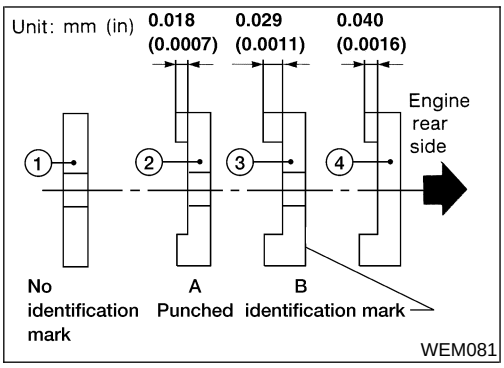


SEM392E

CAMSHAFT END PLAY

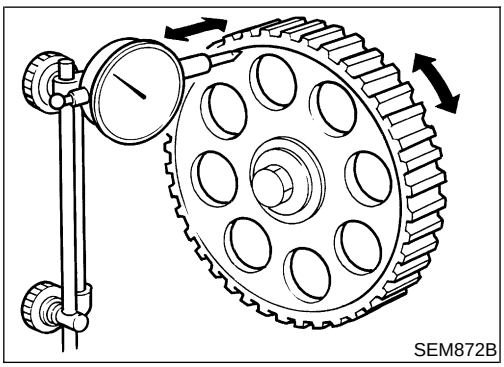
NDEM0017S06

1. Install camshaft and locate plate in cylinder head.
2. Measure camshaft end play.
   Camshaft end play:
   Standard:
   0.03 - 0.06 mm (0.0012 - 0.0024 in)



WEM081

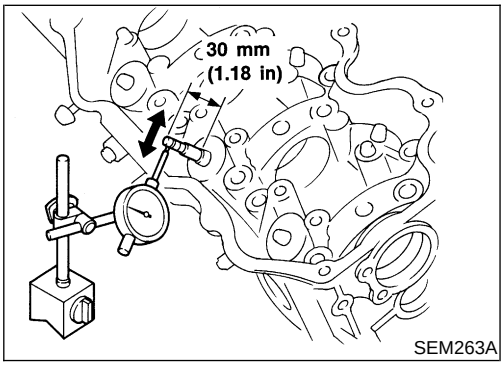
3. If it is out of the specified range, select thickness of camshaft locate plate to obtain standard specified end play.
   Example:
   When camshaft end play is 0.08 mm (0.0031 in) with camshaft locate plate 1, replace camshaft locate plate 1 with camshaft locate plate 4 to set the end play at 0.04 mm (0.0016 in).


SEM872B

CAMSHAFT SPROCKET RUNOUT

NDEM0017S07

1. Install sprocket on camshaft.
2. Measure camshaft sprocket runout.
   Runout (Total indicator reading):
   Limit:
   0.1 mm (0.004 in)
3. If it exceeds the limit, replace camshaft sprocket.

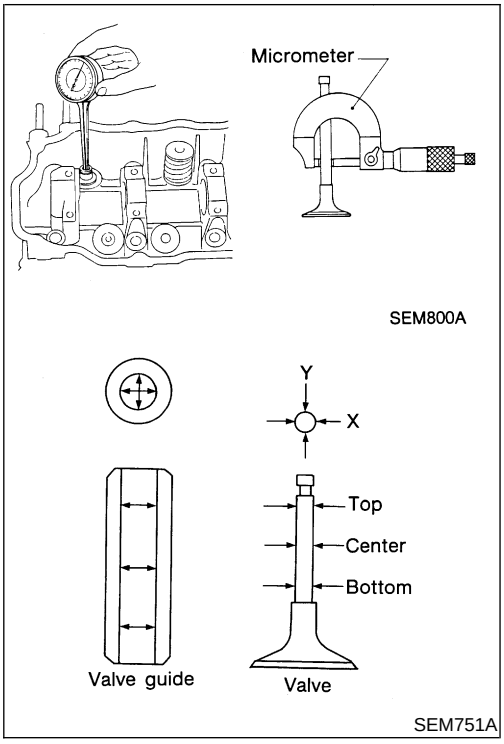


SEM263A

VALVE GUIDE CLEARANCE

NDEM0017S08

1. Measure valve deflection in a right-angled direction with camshaft. (Valve and valve guide mostly wear in this direction.)
   Valve deflection limit (Dial gauge reading):
   0.20 mm (0.0079 in)



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

Valve to valve guide clearance:

Intake:

0.020 - 0.053 mm (0.0008 - 0.0021 in)

Exhaust:

0.030 - 0.049 mm (0.0012 - 0.0019 in)

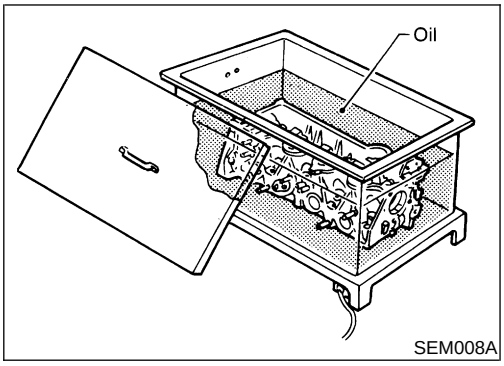
Limit:

0.10 mm (0.0039 in)

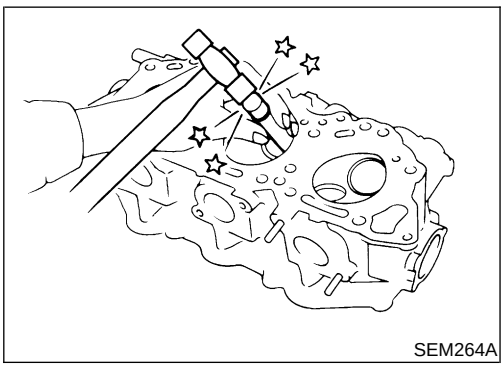
c. If it exceeds the limit, replace valve or valve guide.

VALVE GUIDE REPLACEMENT

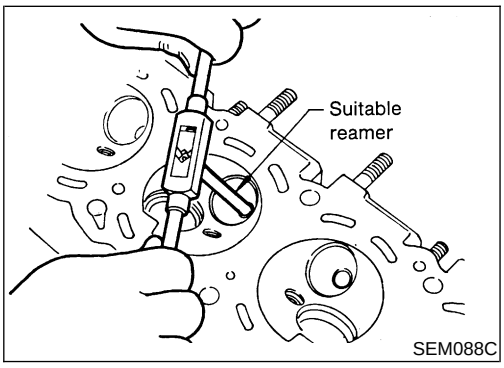
NDEM0017S09



1. To remove valve guide, heat cylinder head to 150 to 160°C (302 to 320°F) by soaking in heated oil.



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



3. Ream cylinder head valve guide hole.

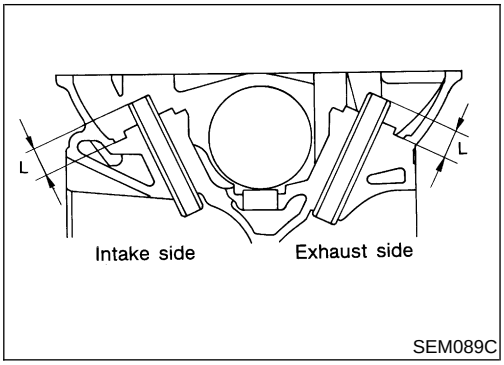
Valve guide hole diameter (for service parts):

Intake:

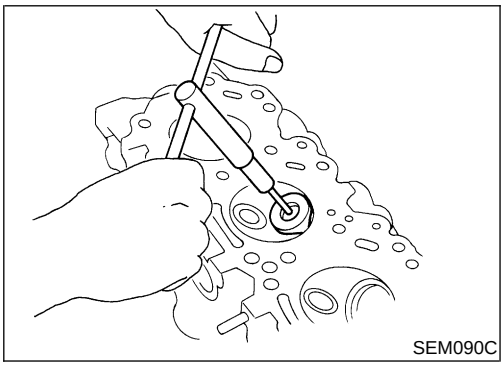
11.175 - 11.196 mm (0.4400 - 0.4408 in)

Exhaust:

12.175 - 12.196 mm (0.4793 - 0.4802 in)



SEM089C


SEM090C

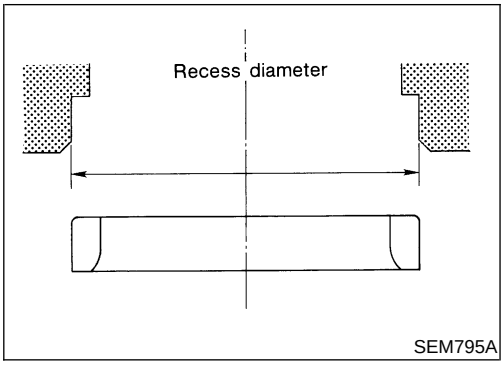
4. Heat cylinder head to 150 to 160°C (302 to 320°F) by soaking in heated oil and press service valve guide onto cylinder head.
   Projection "L":
   13.2 - 13.4 mm (0.520 - 0.528 in)
5. Ream valve guide.
   Finished size:
   Intake:
   7.000 - 7.018 mm (0.2756 - 0.2763 in)
   Exhaust:
   8.000 - 8.011 mm (0.3150 - 0.3154 in)

VALVE SEATS

NDEM0017S10

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

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



REPLACING VALVE SEAT FOR SERVICE PARTS

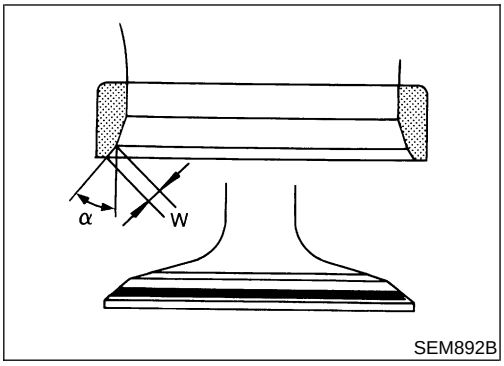
=NDEM0017S11

1. Bore out old seat until it collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the seat recess in cylinder head.
2. Ream cylinder head recess.

Reaming bore for service valve seat:
Oversize [0.5 mm (0.020 in)]:
Intake:
44.500 - 44.516 mm (1.7520 - 1.7526 in)
Exhaust:
37.500 - 37.516 mm (1.4764 - 1.4770 in)

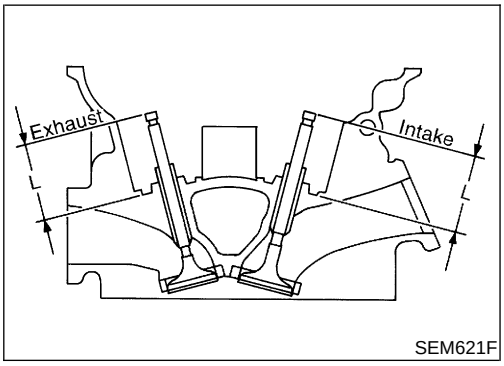
Reaming should be done in circles concentric to the valve guide center so that valve seat will have the correct fit.

3. Heat cylinder head to 150 to 160°C (302 to 320°F) by soaking in heated oil.
4. Press fit valve seat until it seats on the bottom.



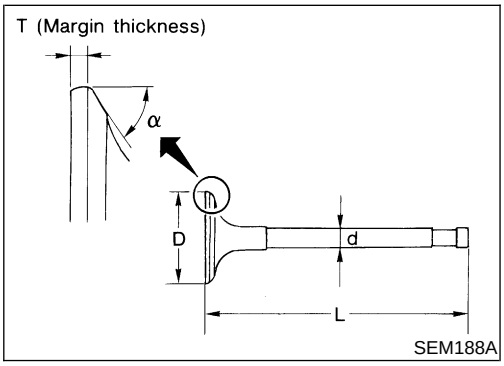
5. Cut or grind valve seat using suitable tool at the specified dimensions. Refer to "Valve", EM-60.
6. After cutting, lap valve seat with abrasive compound.
7. Check valve seating condition.

	Intake	Exhaust
Seat face angle "α" degree	45	45
Contacting width "W" mm (in)	1.75 (0.0689)	1.7 (0.067)



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

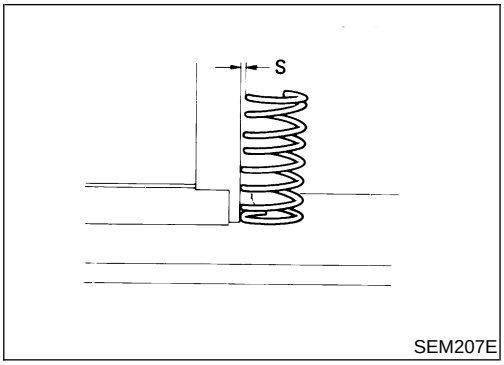
Intake:
44.7 - 44.9 mm (1.760 - 1.768 in)
Exhaust:
45.4 - 45.6 mm (1.787 - 1.795 in)



VALVE DIMENSIONS

NDEM0017S12

Check dimensions in each valve. For dimensions, refer to "Valve", EM-60.
When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace valve.
Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.



SEM207E

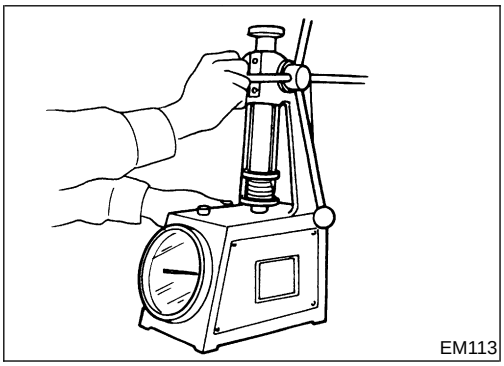
VALVE SPRING

NDEM0017S13

Squareness

NDEM0017S1301

1. Measure "S" dimension.
   Out-of-square:
   Outer:
   Less than 2.2 mm (0.087 in)
   Inner:
   Less than 1.9 mm (0.075 in)
2. If not within specification, replace spring.


EM113

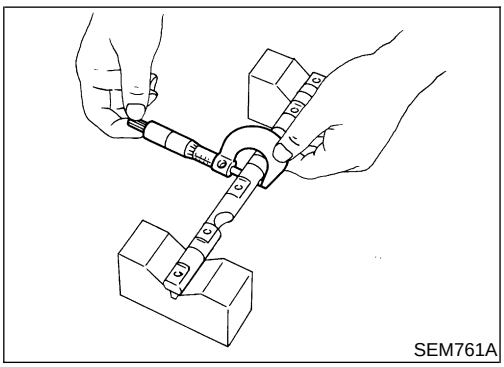
Pressure

NDEM0017S1302

Check valve spring pressure.

Standard pressure: N (kg, lb) at height mm (in)
Outer:
523.7 (53.4, 117.7) at 30.0 (1.181)
Inner:
255.0 (26.0, 57.3) at 25.0 (0.984)
Limit pressure: N (kg, lb) at height mm (in)
Outer:
More than 228.5 (23.3, 51.4) at 25.0 (0.984)
Inner:
More than 225.6 (23.0, 50.7) at 25.0 (0.984)

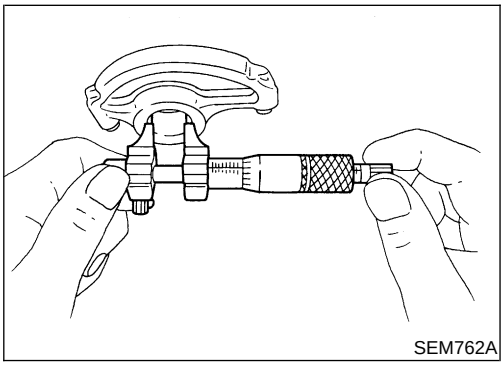
If not within specification, replace spring.


SEM761A

ROCKER SHAFT AND ROCKER ARM

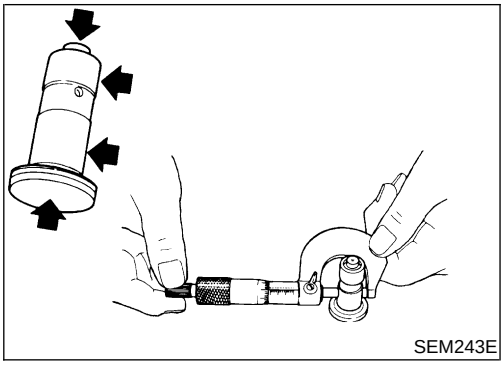
NDEM0017S14

1. Check rocker shafts for scratches, seizure and wear.
2. Check outer diameter of rocker shaft.
   Diameter:
   17.979 - 18.000 mm (0.7078 - 0.7087 in)


SEM762A

3. Check inner diameter of rocker arm.
   Diameter:
   18.007 - 18.028 mm (0.7089 - 0.7098 in)
   Rocker arm to shaft clearance:
   0.007 - 0.049 mm (0.0003 - 0.0019 in)

- **Keep rocker arm with hydraulic valve lifter standing to prevent air from entering hydraulic valve lifter when checking.**


SEM243E

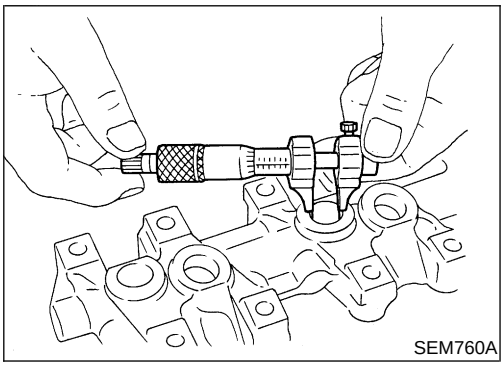
HYDRAULIC VALVE LIFTER

NDEM0017S15

1. Check contact and sliding surfaces for wear or scratches.
2. Check diameter of valve lifter.

Outer diameter:

15.947 - 15.957 mm (0.6278 - 0.6282 in)


SEM760A

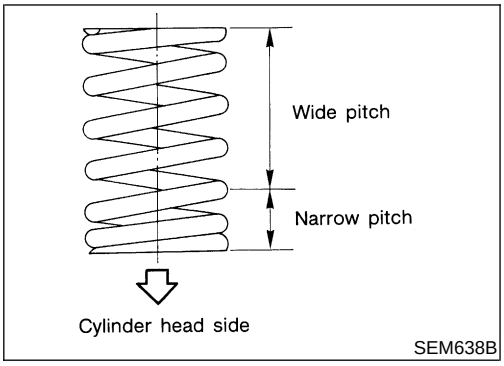
3. Check valve lifter guide inner diameter.

Inner diameter:

16.000 - 16.013 mm (0.6299 - 0.6304 in)

Standard clearance between valve lifter and lifter guide:

0.043 - 0.066 mm (0.0017 - 0.0026 in)



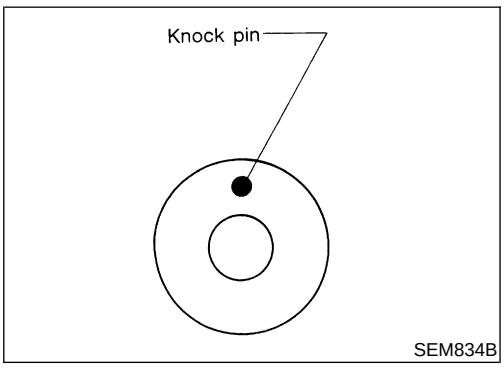
SEM638B

Assembly

NDEM0018

1. Install valve component parts.

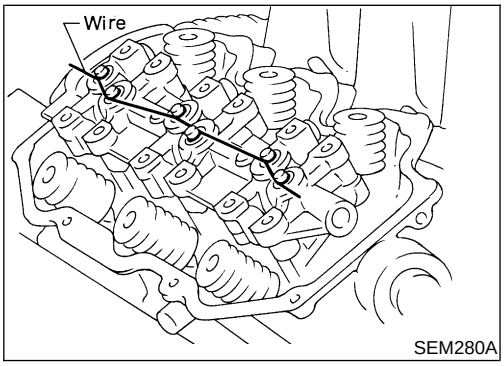
- **Always use new valve oil seal. Refer to "OIL SEAL", EM-25.**
- **Before installing valve oil seal, install inner valve spring seat.**
- **Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.**
- **After installing valve component parts, use plastic hammer to lightly tap valve stem tip to assure a proper fit.**



SEM834B

2. Install camshafts, locate plates and cylinder head rear covers.

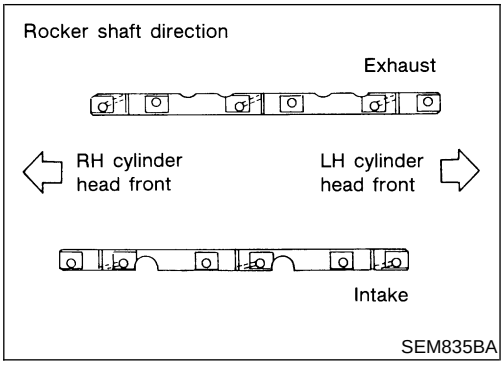
- **Set knock pin of camshaft at the top.**



SEM280A

3. Install valve lifters into valve lifter guide.

- **Assemble valve lifters to their original position and hold all valve lifters with wire to prevent lifters from falling off.**
- **After installing, remove the wire.**



4. Install rocker shafts with rocker arms.
- **Tighten bolts gradually in two or three stages.**
- **Before tightening, be sure to set camshaft lobe at the position where lobe is not lifted.**

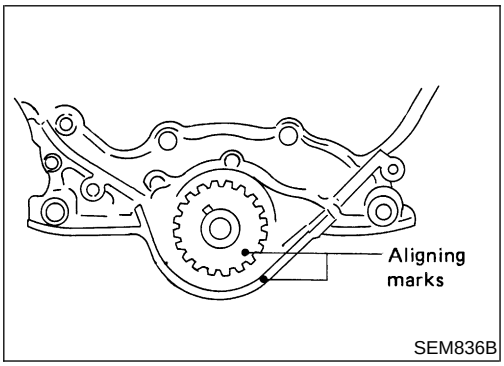
a. Set No. 1 piston at TDC on its compression stroke and tighten rocker shaft bolts for No. 2, No. 4 and No. 6 cylinders.

b. Set No. 4 piston at TDC on its compression stroke and tighten rocker shaft bolts for No. 1, No. 3 and No. 5 cylinders.

5. Install exhaust manifold to cylinder head in reverse order of removal.

Installation

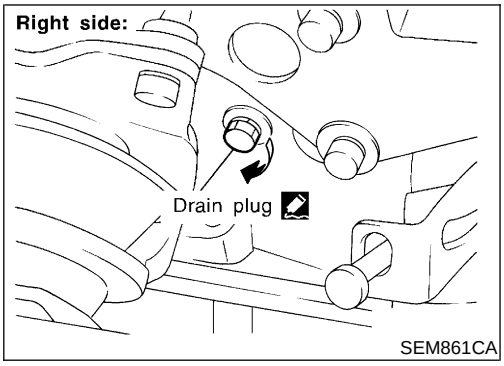
NDEM0019



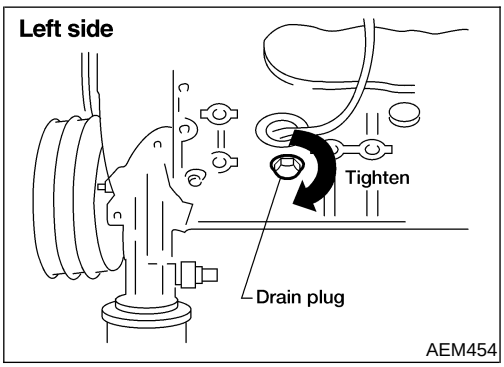
1. Set No. 1 piston at TDC on its compression stroke as follows:

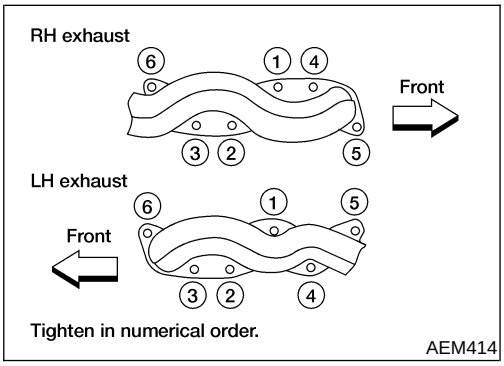
a. Align crankshaft sprocket aligning mark with mark on oil pump body.

b. Confirm that knock pin on camshaft is set at the top.

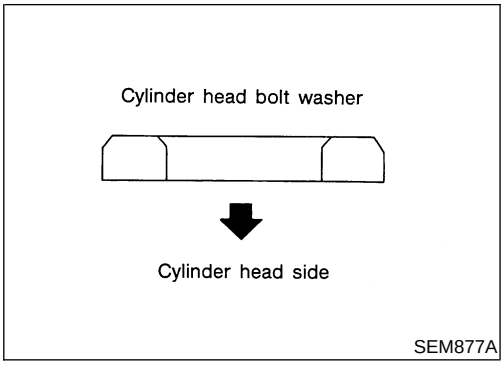


2. Install both drain plugs.
- Use Genuine RTV Silicone Sealant Part No. 999MP-A7007 or equivalent.



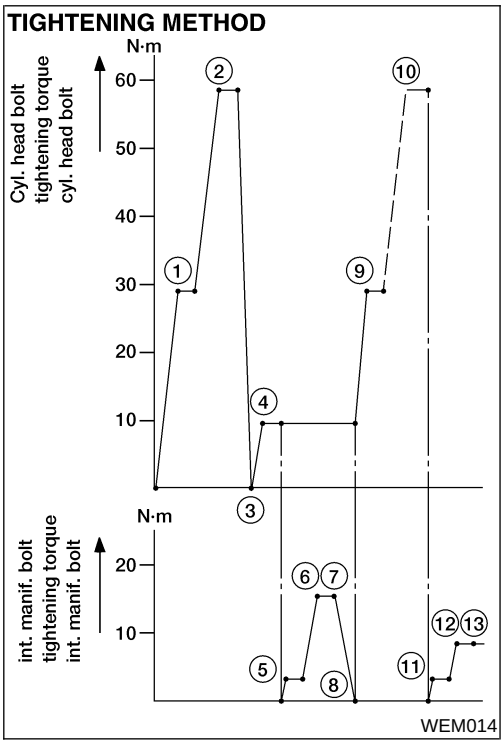


3. Install exhaust manifolds to cylinder head.



4. Install cylinder head with new gasket.

- **Be sure to install washers between bolts and cylinder head.**
- **Do not rotate crankshaft and camshaft separately, or valves will hit piston heads.**



5. Tighten cylinder head bolts in numerical order using angle wrench [ST10120000 (J24239-01)].

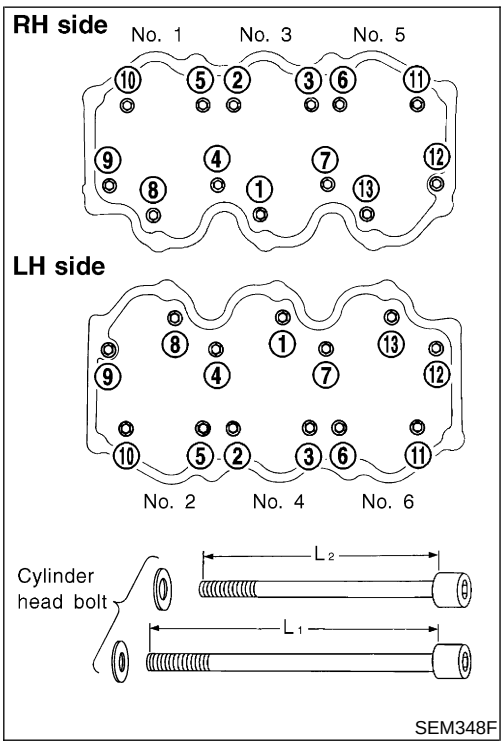
Apply engine oil to threads and seating surfaces of cylinder head bolts before installing them.

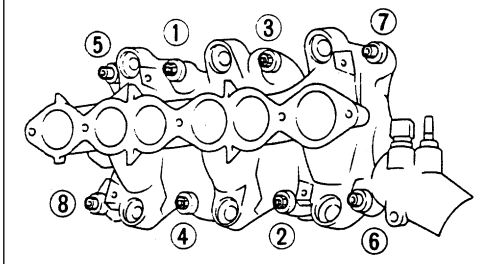
- **Cylinder head bolts for 4, 7, 9 and 12 are longer than the others.**

  L_1: 127 mm (5.00 in) for 4, 7, 9 and 12

  L_2: 106 mm (4.17 in) for others
- **Install intake manifold and cylinder head at the same time using the following procedure:**

1) Tighten cylinder head bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
2) Tighten cylinder head bolts to 59 N·m (6.0 kg-m, 43 ft-lb).
3) Loosen cylinder head bolts completely.
4) Tighten cylinder head bolts to 10 N·m (1.0 kg-m, 7 ft-lb).
5) Tighten intake manifold bolts and nuts to 4 N·m (0.4 kg-m, 2.9 ft-lb).
6) Tighten intake manifold bolts and nuts to 18 N·m (1.8 kg-m, 13 ft-lb).
7) Tighten intake manifold bolts and nuts to 16 to 20 N·m (1.6 to 2.0 kg-m, 12 to 14 ft-lb).
8) Loosen intake manifold bolts and nuts completely.
9) Tighten cylinder head bolts to 29 N·m (3.0 kg-m, 2.2 ft-lb).
10) Turn cylinder head bolts to 60 to 65 degrees clockwise. If an angle wrench is not available, tighten cylinder head bolts to 54 to 64 N·m (5.5 to 6.5 kg-m, 40 to 47 ft-lb).
11) Tighten cylinder head sub-bolts to 9.0 to 11.8 N·m (0.92 to 1.20 kg-m, 6.7 to 8.7 ft-lb).
12) Tighten intake manifold bolts and nuts to 4 N·m (0.4 kg-m, 2.9 ft-lb).
13) Tighten intake manifold bolts and nuts to 9 N·m (0.9 kg-m, 6.5 ft-lb).
14) Tighten intake manifold bolts and nuts to 8 to 10 N·m (0.8 to 1.0 kg-m, 5.8 to 7 ft-lb).





Tighten bolts in numerical order.

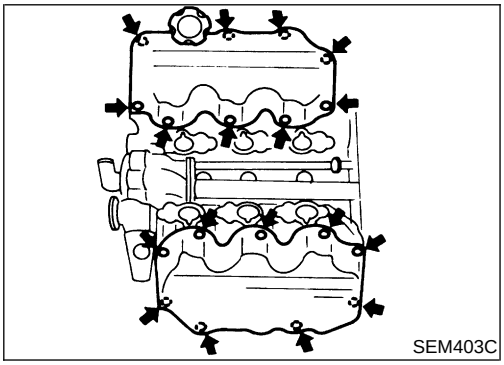
SEM825C

- **If only intake manifold is removed and to be used again, install it using the following procedure:**

1) Tighten all bolts and nuts to 4 N·m (0.4 kg-m, 2.9 ft-lb).
2) Tighten all bolts and nuts to 9 N·m (0.9 kg-m, 6.5 ft-lb).
3) Tighten all bolts and nuts to 8 to 10 N·m (0.8 to 1.0 kg-m, 5.8 to 7 ft-lb).

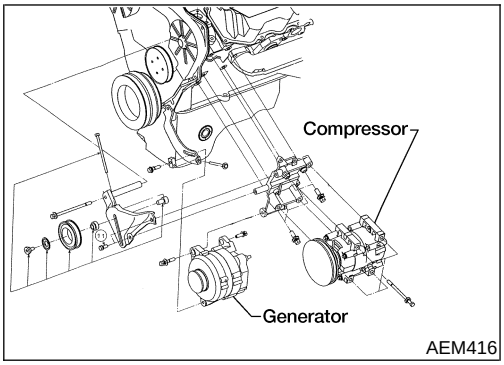
CAUTION:

If replacing intake manifold with a new one, cylinder head gasket must also be replaced with a new one. Refer to step 4.



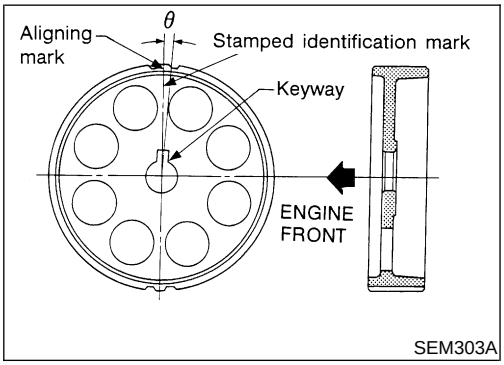
SEM403C

6. Install both rocker covers.



AEM416

7. Install compressor and generator bracket.
8. Install generator.
9. Install compressor.
10. Install exhaust front tube to exhaust manifold.



SEM303A

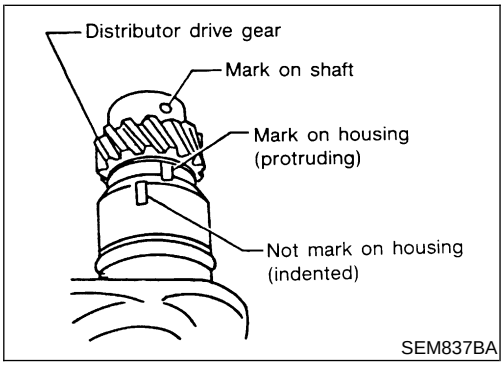
11. Install rear belt cover and camshaft sprocket.

- **RH camshaft sprocket and LH camshaft sprocket are different parts. Be sure to install them in the correct location.**

	Identification mark	θ
RH camshaft sprocket	R3	0°53′
LH camshaft sprocket	L3	−3°27′

12. Install timing belt and adjust belt tension.

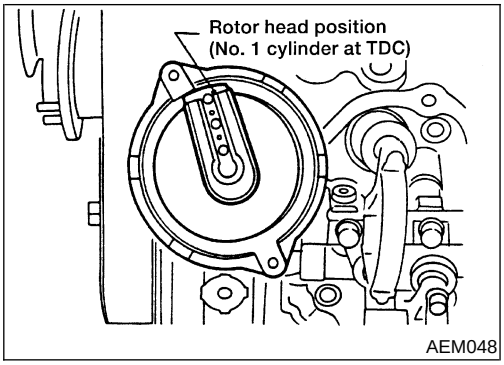
Refer to "Installation", EM-21.



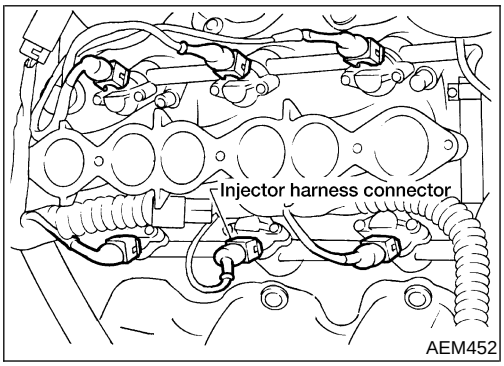
SEM837BA

13. Install distributor.

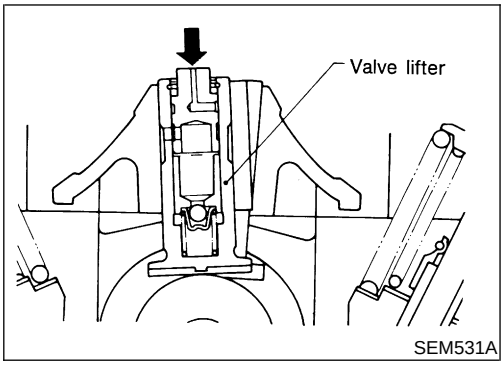
1) Align mark on shaft with protruding mark on housing.



2) After installing, confirm that distributor rotor head is set as shown in figure.



14. Install injector fuel tube assembly.
15. Connect all injector harness connectors.
16. Install fuel feed and fuel return hoses to injector fuel tube assembly.
17. Install intake manifold collector. Install all parts which were removed in step 6 under "Removal", EM-28.
18. Install ASCD and accelerator control wire.



19. Check hydraulic valve lifter.

a. Push plunger forcefully with your finger.

- **Be sure to check it with rocker arm in its free position (not on the lobe).**

b. If valve lifter moves more than 1 mm (0.04 in), air may be inside it.

c. Bleed air off by running engine at 1,000 rpm under no load for about 10 minutes.

d. If hydraulic valve lifters are still noisy, replace them and bleed air off again in the same manner as in step 19 (c).

Removal and Installation

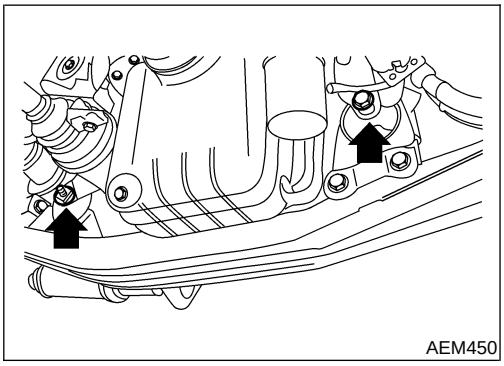
NDEM0020

WARNING:

- **Situate vehicle on a flat and solid surface.**
- **Place chocks at front and back of rear wheels.**
- **Do not remove engine until exhaust system has completely cooled off. Otherwise, you may burn yourself and/or fire may break out in fuel line.**
- **For safety during subsequent steps, the tension of wires should be slackened against the engine.**
- **Before disconnecting fuel hose, release fuel pressure from fuel line.**
  Refer to *EC-35*, "Releasing Fuel Pressure".
- **Before removing front axle from transmission, place safety stands under designated front supporting points. Refer to GI section for lifting points and towing.**
- **Be sure to hoist engine and transmission in a safe manner.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.**

CAUTION:

- **When lifting engine, be careful not to strike adjacent parts, especially 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 crankshaft position sensor (OBD) from the assembly.**
- **Always take extra care not to damage edge of crankshaft position sensor (OBD), or ring gear teeth.**



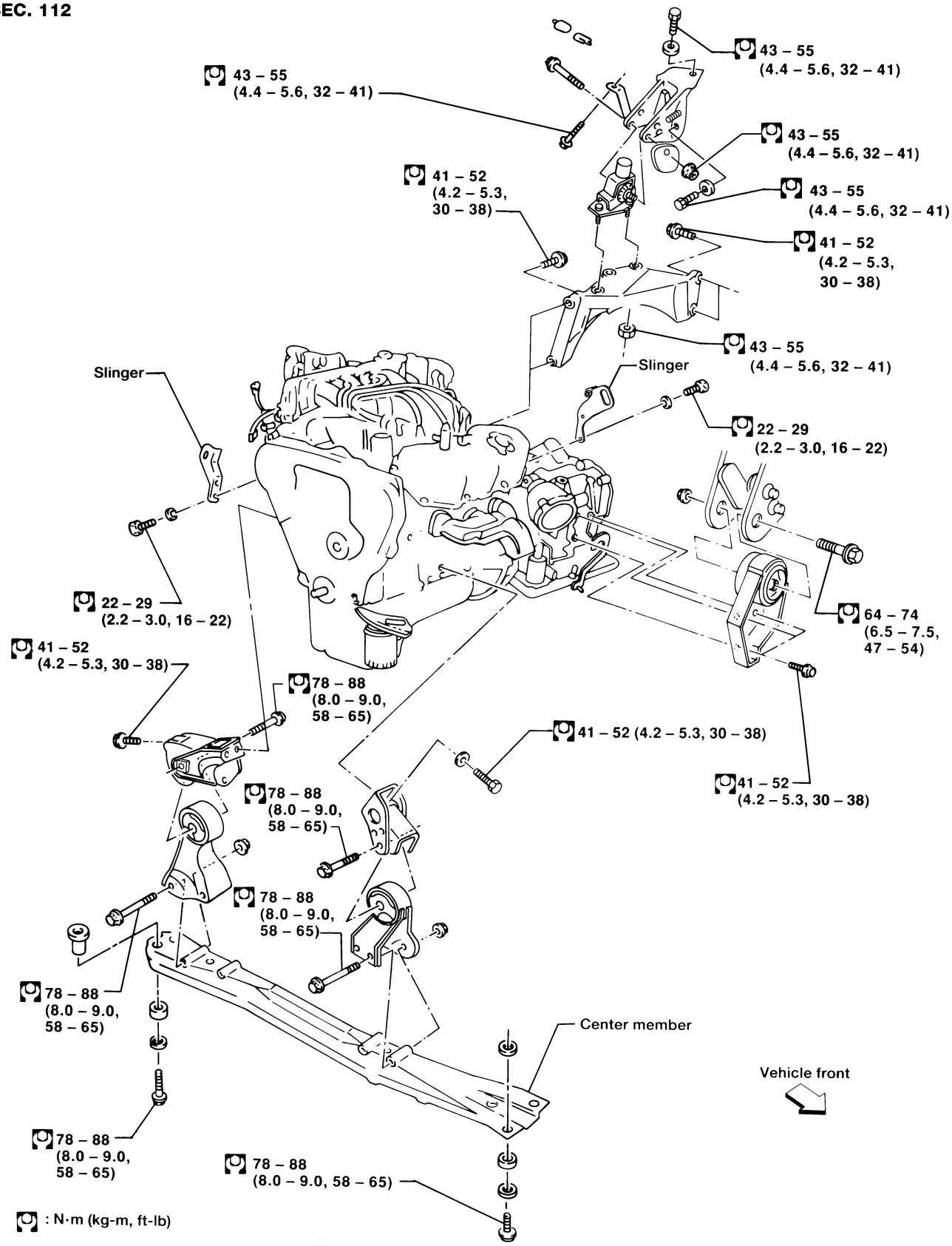
AEM450

- **Do not loosen front engine mounting insulator cover securing bolts.**
  When cover is removed, damper oil flows out and mounting insulator will not function.

ENGINE MOUNTING

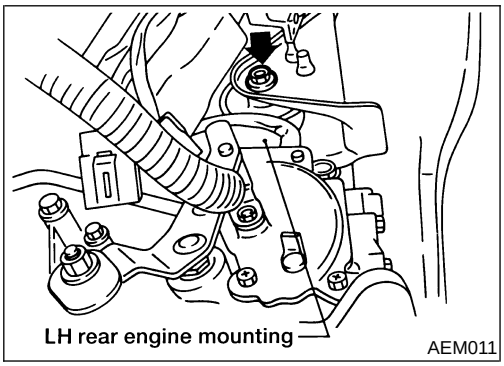
NDEM0020S01

SEC. 112

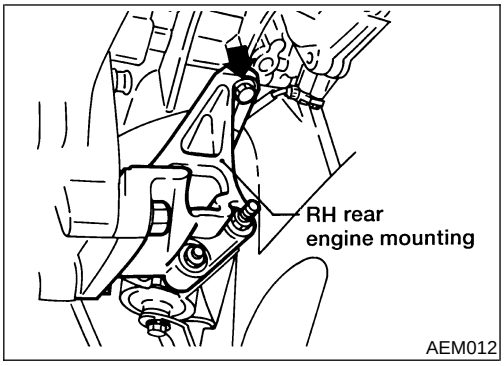


WEM087

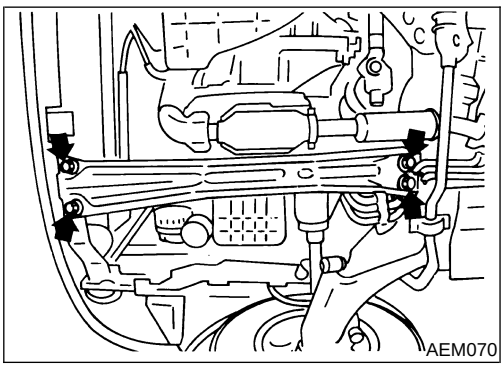
1. Remove front wheels, engine under covers and side cover.
2. Drain coolant from cylinder block and radiator. Refer to ***MA-14***, "Changing Engine Coolant".
3. Remove vacuum hoses, fuel tubes, wires, harnesses and connectors.
4. Remove exhaust tube, ball joints and drive shafts.
5. Remove drive belts.
6. Discharge refrigerant, refer to ***HA-122***, "HFC-134a (R-134a) Service Procedures".
7. Remove A/C compressor manifold.
8. Remove power steering oil pump from engine.
9. Set a powertrain lift under engine and transaxle.
10. Remove LH rear engine mounting bolts.



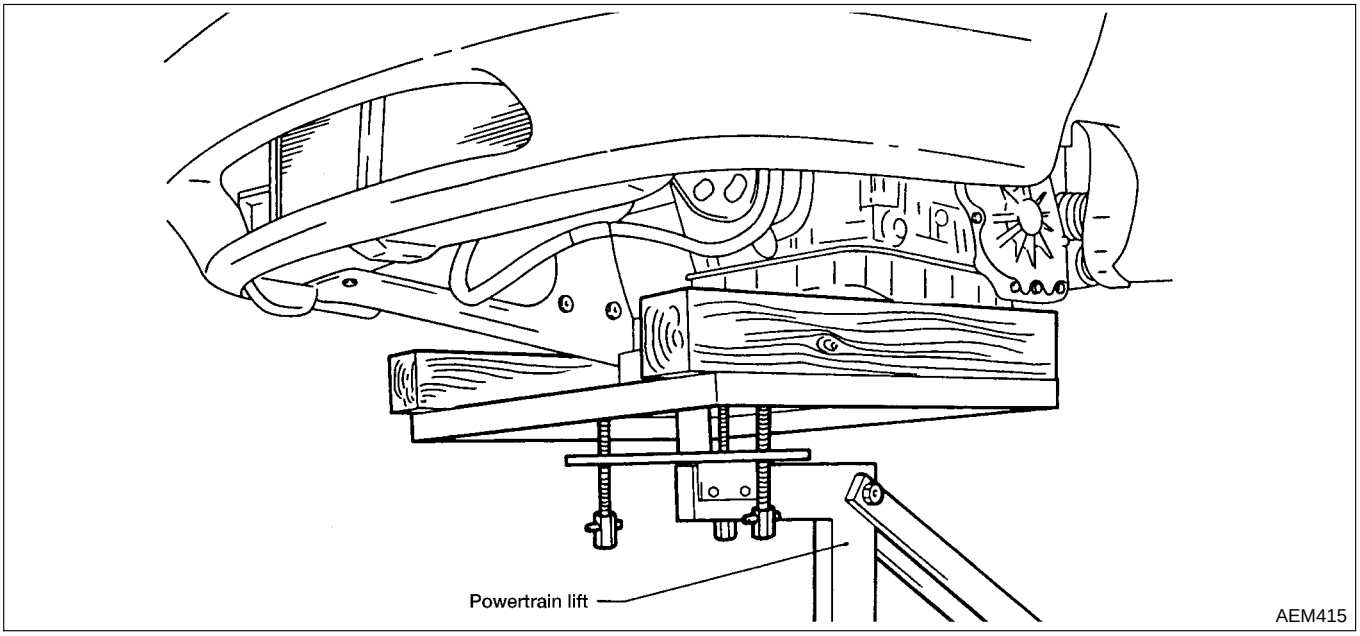
11. Remove RH rear engine mounting.
12. If equipped, remove the rear A/C refrigerant lines support bracket bolts.



13. Remove center member bolts, then slowly lower powertrain lift.



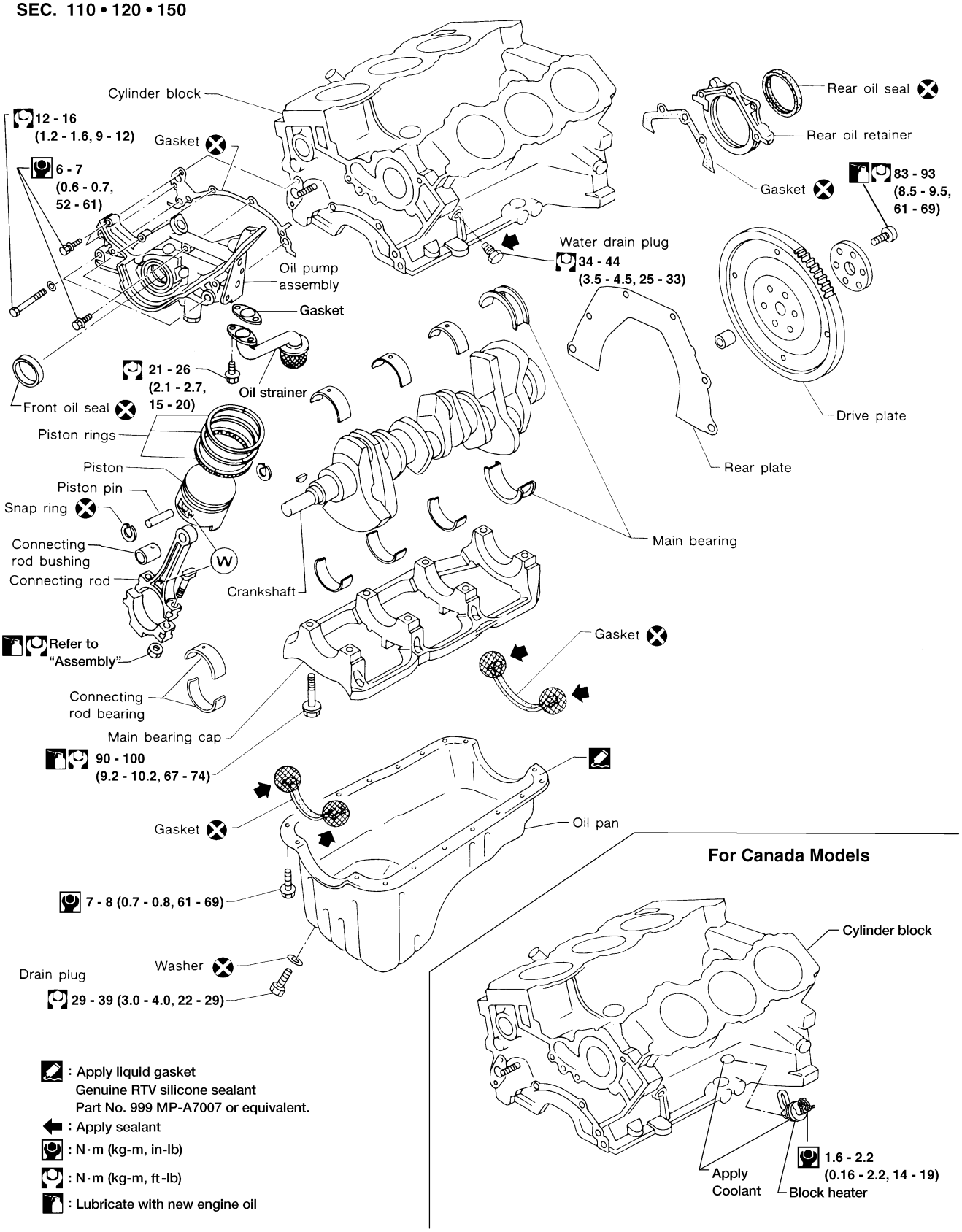
14. Remove engine with transaxle as shown.



Components

NDEM0021

SEC. 110 • 120 • 150



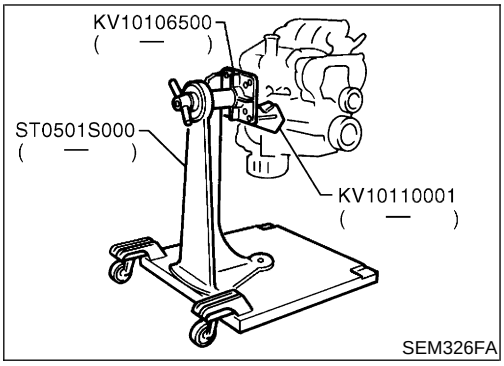
WEM103

Removal and Installation

NDEM0022

CAUTION:

- **When installing sliding parts such as bearings and pistons, be sure to apply engine oil on the sliding surfaces.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When installing connecting rod bolts and main bearing cap bolts, apply new engine oil to threads and seating surfaces.**
- **Do not allow any magnetic materials to contact the ring gear teeth on drive plate and rear plate.**



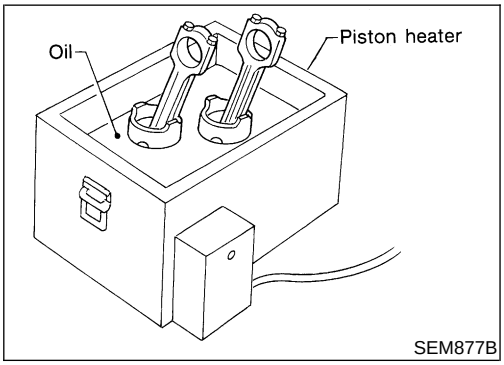
Disassembly

NDEM0023

PISTON AND CRANKSHAFT

NDEM0023S01

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

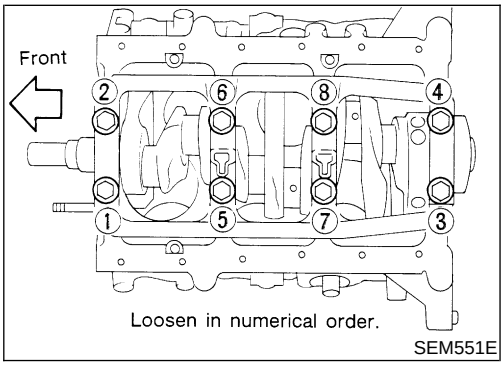


7. Remove pistons with connecting rods.

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

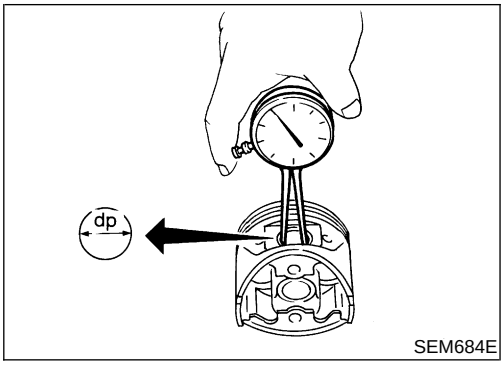
CAUTION:

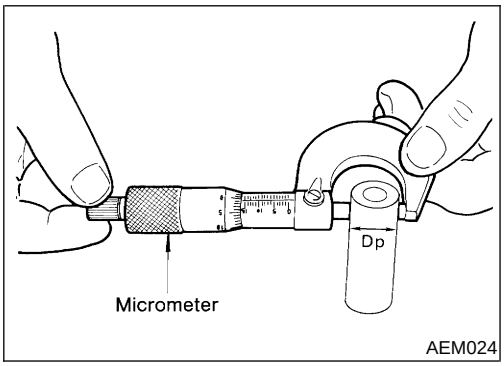
- **When piston rings are not replaced, make sure that piston rings are mounted in their original positions.**
- **When replacing piston rings, if there is no punchmark, install with either side up.**

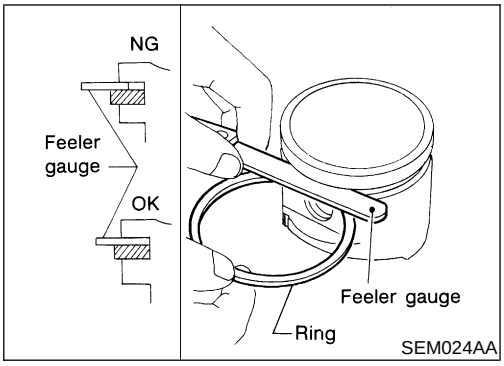


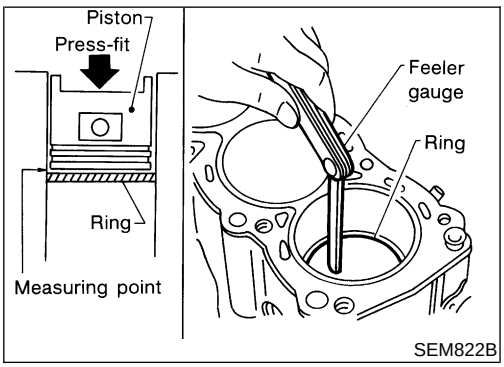
8. Remove bearing cap and crankshaft.

- **Before removing bearing cap, measure crankshaft end play.**
- **Bolts should be loosened in two or three steps.**









Inspection

NDEM0024

PISTON AND PISTON PIN CLEARANCE

NDEM0024S01

1. Measure inner diameter of piston pin hole “dp”.
   Standard diameter “dp”:
   20.969 - 20.981 mm (0.8255 - 0.8260 in)
2. Measure outer diameter of piston pin “Dp”.
   Standard diameter “Dp”:
   20.971 - 20.983 mm (0.8256 - 0.8261 in)
3. Calculate piston pin clearance.
   dp − Dp = 0 to -0.004 mm (0 to -0.0002 in)

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

PISTON RING SIDE CLEARANCE

NDEM0024S02

Side clearance:
Top ring: 0.040 - 0.080 mm (0.0016 - 0.0031 in)
2nd ring: 0.030 - 0.070 mm (0.0012 - 0.0028 in)
Oil ring: 0.015 - 0.185 mm (0.0006 - 0.0073 in)
Max. limit of side clearance:
Top ring: 0.11 mm (0.0043 in)
2nd ring: 0.1 mm (0.004 in)

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

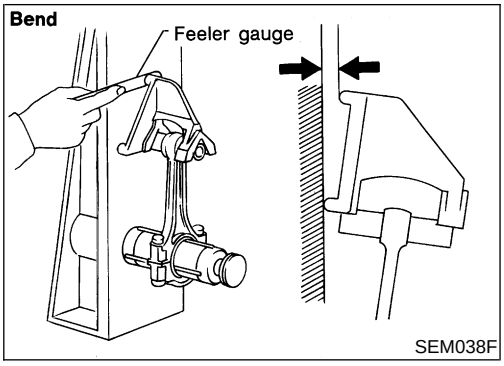
PISTON RING END GAP

NDEM0024S03

End gap:
Top ring: 0.21 - 0.31 mm (0.0083 - 0.0122 in)
2nd ring: 0.50 - 0.60 mm (0.0197 - 0.0236 in)
Oil ring: 0.20 - 0.60 mm (0.0079 - 0.0236 in)
Max. limit of ring gap:
Top ring: 0.43 mm (0.0169 in)
2nd ring: 0.69 mm (0.0272 in)
Oil ring: 0.84 mm (0.0331 in)

If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, rebore cylinder and use oversized piston and piston rings.
Refer to “PISTON RING”, EM-66.

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



CONNECTING ROD BEND AND TORSION

NDEM0024S04

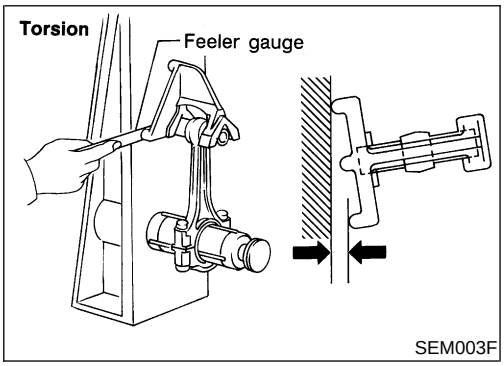
Bend:

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

Torsion:

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

If it exceeds the limit, replace connecting rod assembly.



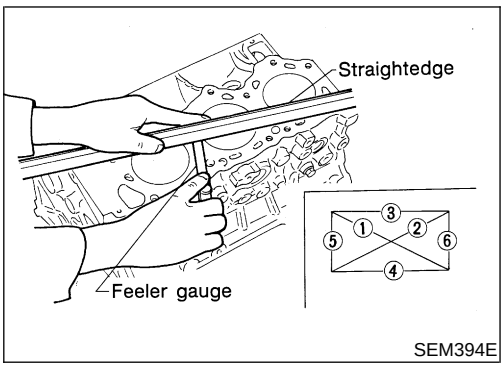
CYLINDER BLOCK DISTORTION AND WEAR

NDEM0024S05

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

Limit:

0.10 mm (0.0039 in)



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

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

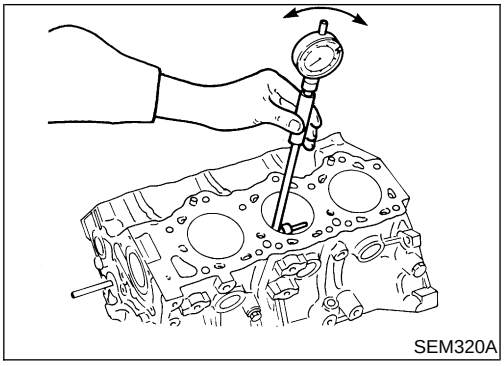
The maximum limit is as follows:

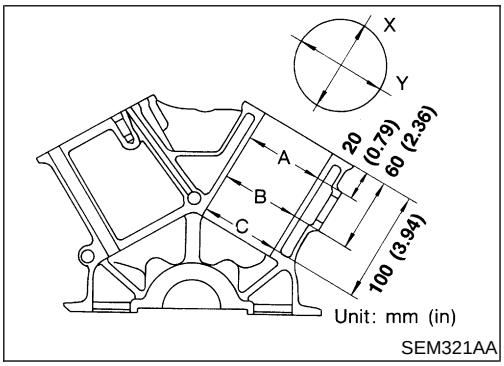
A + B = 0.2 mm (0.008 in)

Nominal cylinder block height from crankshaft center:

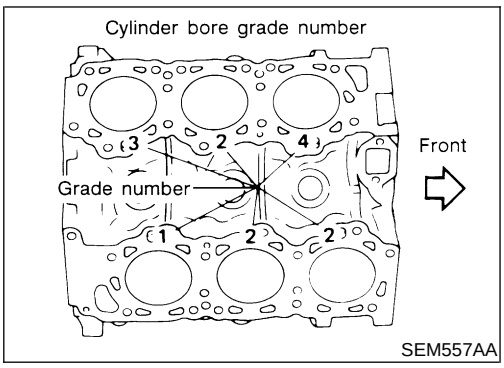
227.60 - 227.70 mm (8.9606 - 8.9645 in)

3. If necessary, replace cylinder block.

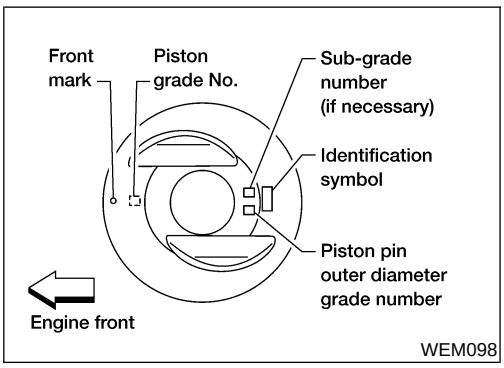

SEM320A



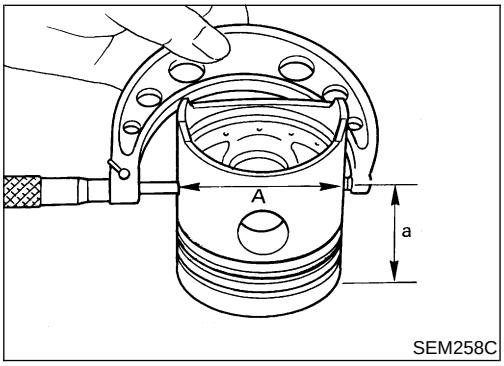
SEM321AA



SEM557AA



WEM098



SEM258C

PISTON-TO-BORE CLEARANCE

NDEM0024S06

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

Standard inner diameter:

Except for No. 5 cylinder

91.500 - 91.530 mm (3.6024 - 3.6035 in)

For No. 5 cylinder

91.515 – 91.545 mm (3.6029 – 3.6041 in)

Refer to "Cylinder Block", EM-65.

Wear limit:

0.20 mm (0.0079 in)

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

Out-of-round (X − Y) standard:

0.015 mm (0.0006 in)

Taper (A − B or A − C) standard:

0.015 mm (0.0006 in)

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

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

Combination of grade number for cylinder bore and piston

	For No. 3, 4 and 5 cylinders						For No. 1, 2 and 6 cylinders		
Cylinder bore grade No.	1	2	3	4	5	6	1	2	3
Piston grade No.	2-1	3-2	3-3	4-4	4-5	5-6	1	2	3

3. Measure piston skirt diameter.

Piston diameter "A":

Refer to "AVAILABLE PISTON", EM-66.

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

49.0 mm (1.929 in)

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

Piston-to-bore clearance "B":

0.025 - 0.045 mm (0.0010 - 0.0018 in) for No. 1, 2 and 6 cylinders

0.015 - 0.025 mm (0.0006 - 0.0010 in) for No. 3 and 4 cylinders

0.030 - 0.040 mm (0.0012 - 0.0016 in) for No. 5 cylinder

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

Oversize pistons are available for service. Refer to "AVAILABLE PISTON", EM-66.

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

Rebored size calculation:

D = A + B − C

where,

D: Bored diameter

A: Piston diameter as measured

B: Piston-to-bore clearance

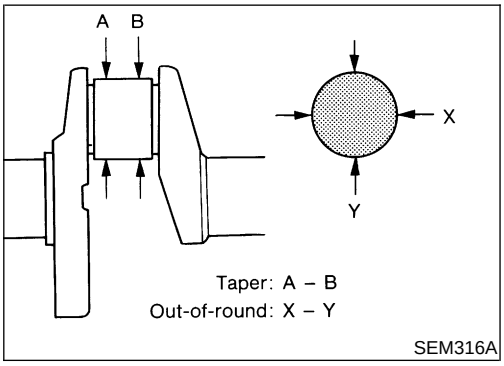
C: Honing allowance 0.02 mm (0.0008 in)

7. Install main bearing caps, and tighten to the specified torque to prevent distortion of cylinder bores in final assembly.
8. Cut cylinder bores.

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

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

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



CRANKSHAFT

NDEM0024S07

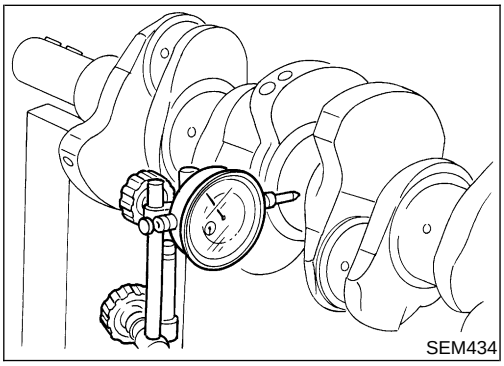
1. Check crankshaft main and pin journals for score, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.

Out-of-round (X − Y):

Less than 0.005 mm (0.0002 in)

Taper (A − B):

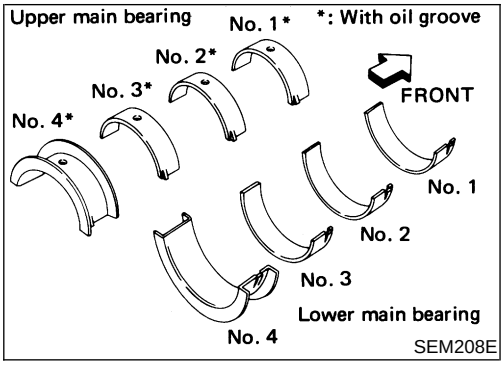
Less than 0.005 mm (0.0002 in)



3. Measure crankshaft runout.

Runout (Total indicator reading):

Less than 0.10 mm (0.0039 in)



SEM208E

BEARING CLEARANCE

NDEM0024S08

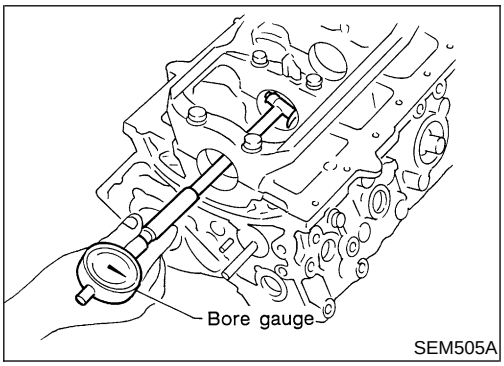
- Either of the following two methods may be used, however, method A gives more reliable results and is preferable.

Method A (Using bore gauge & micrometer)

Main Bearing

NDEM0024S0801

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

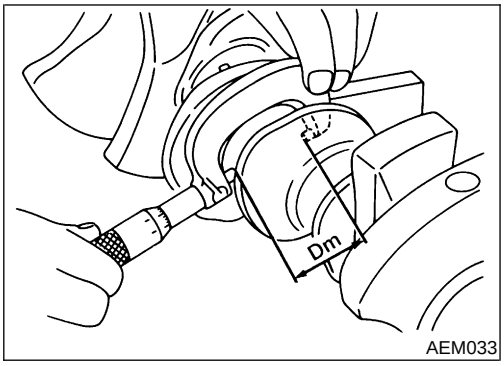


SEM505A

2. Install main bearing cap to cylinder block.

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

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



AEM033

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

No. 1 Main bearing clearance (A - Dm)

Standard

0.030 - 0.048 mm (0.0012 - 0.0019 in)

Limit

0.060 mm (0.0024 in)

No. 2, 3 and No. 4 Main bearing clearance (A − Dm):

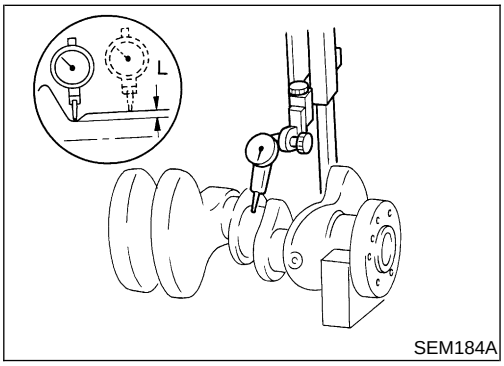
Standard

0.038 - 0.065 mm (0.0015 - 0.0026 in)

Limit

0.080 mm (0.0031 in)

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

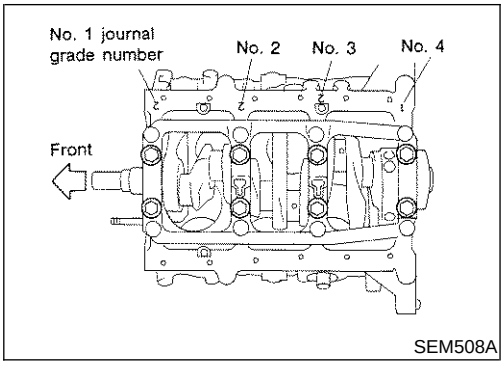


SEM184A

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

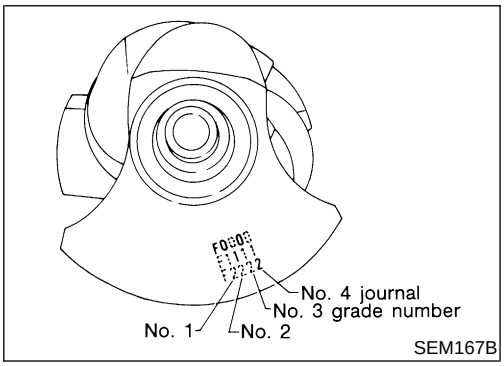
"L": 0.1 mm (0.004 in)

b. Refer to "Crankshaft", EM-67 and "UNDER SIZE", EM-68 for grinding crankshaft and available service parts.



8. If crankshaft is reused, measure main bearing clearances and select thickness of main bearings.
   If crankshaft is replaced with a new one, it is necessary to select thickness of main bearings as follows:

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



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

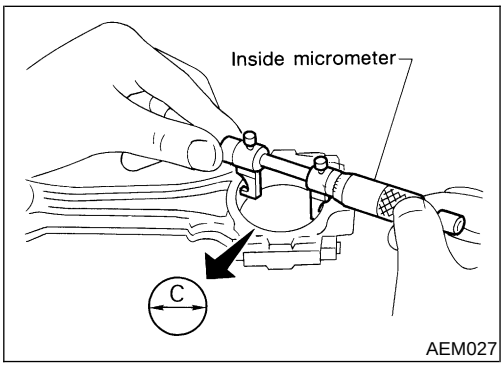
c. Select main bearing with suitable thickness according to the following example or table.

Main bearing grade number
No. 1 main bearing
(Identification color):

Crankshaft main journal grade number	Cylinder block main journal grade number			
	3	4	5	6
3	0 (Black)	1 (Brown)	2 (Green)	3 (Yellow)
4	1 (Brown)	2 (Green)	3 (Yellow)	4 (Blue)
5	2 (Green)	3 (Yellow)	4 (Blue)	5 (Pink)
6	3 (Yellow)	4 (Blue)	5 (Pink)	6 (Purple)

No. 2, 3 and No. 4 main bearings
(Identification color):

Crankshaft journal grade number	Main journal grade number		
	0	1	2
0	0 (Black)	1 (Brown)	2 (Green)
1	1 (Brown)	2 (Green)	3 (Yellow)
2	2 (Green)	3 (Yellow)	4 (Blue)



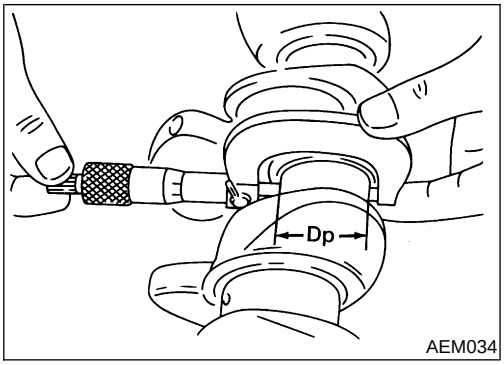
Connecting Rod Bearing (Big end)

NDEM0024S0802

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

Tighten bolts to the specified torque.

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



AEM034

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

Connecting rod bearing clearance (C − Dp):

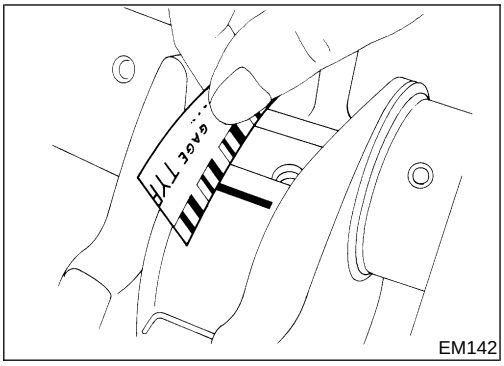
Standard

0.024 - 0.064 mm (0.0009 - 0.0025 in)

Limit

0.090 mm (0.0035 in)

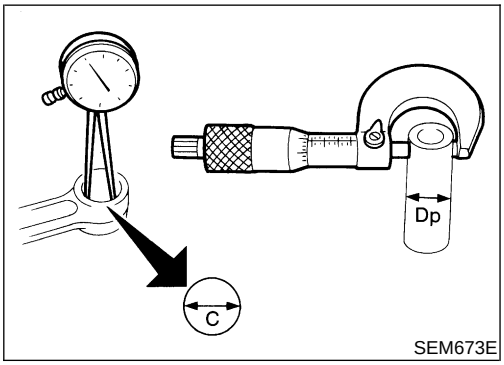
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing. Refer to step 7 of "Main Bearing", EM-53.


EM142

Method B (Using plastigage)

CAUTION:

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



SEM673E

CONNECTING ROD BUSHING CLEARANCE (SMALL END)

NDEM0024S09

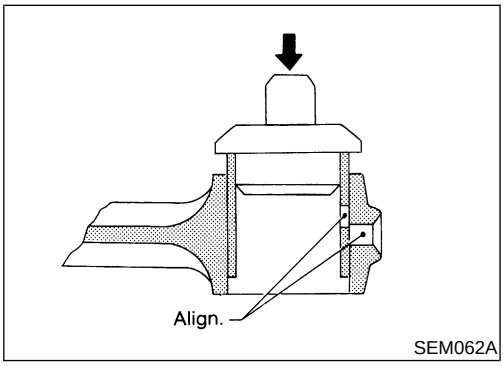
1. Measure inner diameter "C" of bushing.
2. Measure outer diameter "Dp" of piston pin.
3. Calculate connecting rod bushing clearance.

Connecting rod bushing clearance = C − Dp

Standard: 0.005 - 0.017 mm (0.0002 - 0.0007 in)

Limit: 0.023 mm (0.0009 in)

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



SEM062A

REPLACEMENT OF CONNECTING ROD BUSHING (SMALL END)

NDEM0024S10

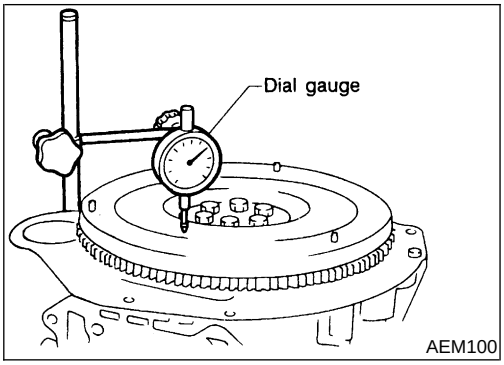
1. Drive in small end bushing until it is flush with end surface of rod.

Be sure to align the oil holes.

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

Clearance between connecting rod bushing and piston pin:

0.005 - 0.017 mm (0.0002 - 0.0007 in)



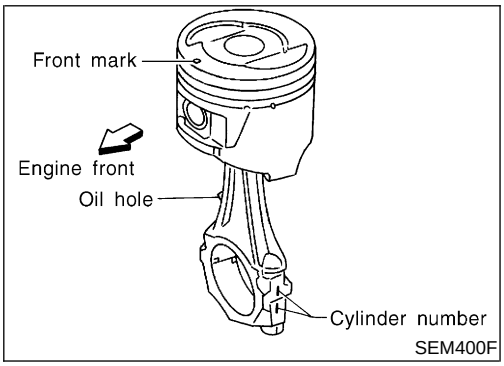
DRIVE PLATE RUNOUT

NDEM0024S11

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

CAUTION:

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



Assembly

NDEM0025

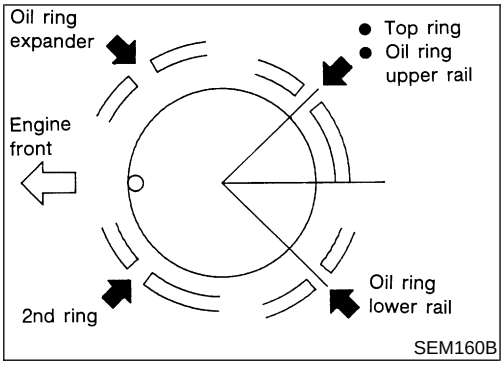
PISTON

NDEM0025S01

1. Install new snap ring on one side of piston pin hole.
2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.

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

3. Set piston rings as shown.



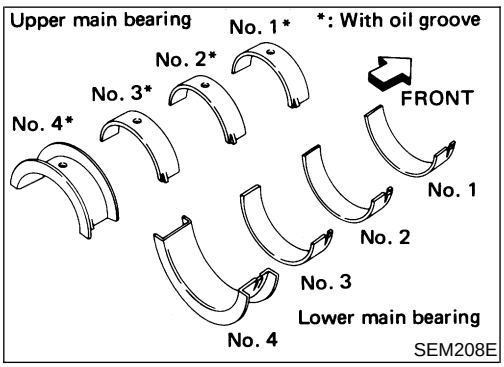
CRANKSHAFT

NDEM0025S02

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

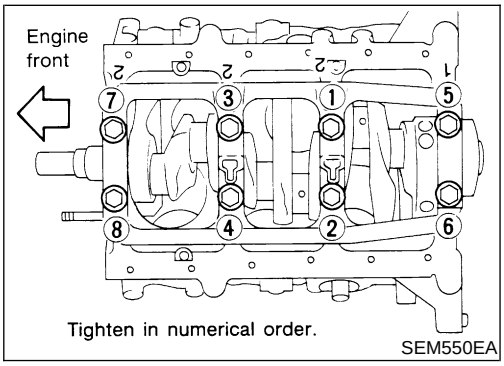
- **Confirm that correct main bearings are used.**
- **Apply new engine oil to bearing surfaces.**

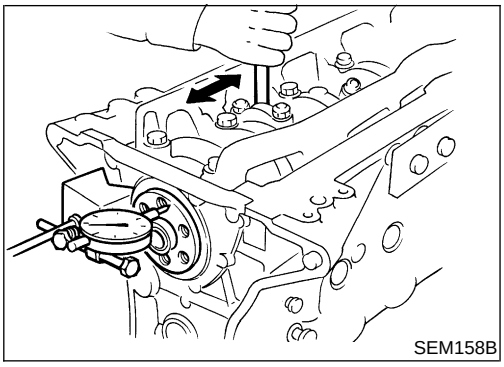
Refer to "BEARING CLEARANCE", EM-53.



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

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




SEM158B

3. Measure crankshaft end play.

Crankshaft end play:

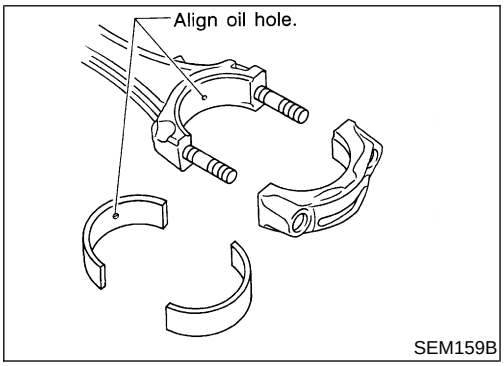
Standard

0.050 - 0.170 mm (0.0020 - 0.0067 in)

Limit

0.30 mm (0.0118 in)

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



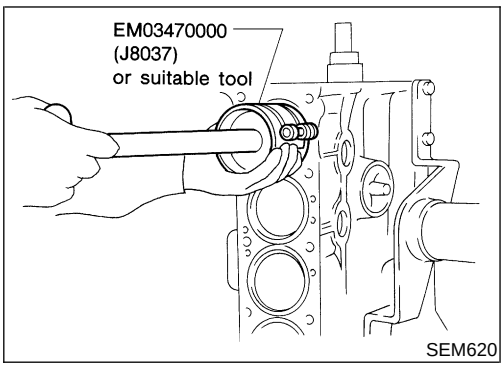
SEM159B

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

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

Refer to "Connecting Rod Bearing (Big End)", EM-54.

- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.

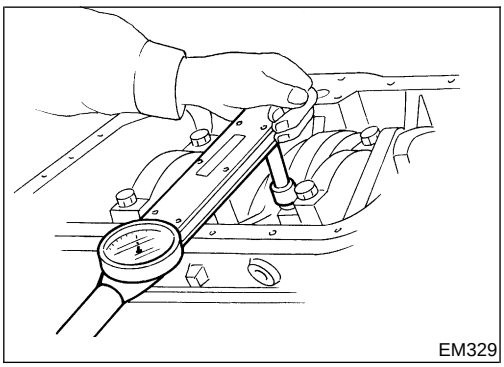


SEM620

5. Install pistons with connecting rods.

a. Install them into corresponding cylinders with Tool.

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


EM329

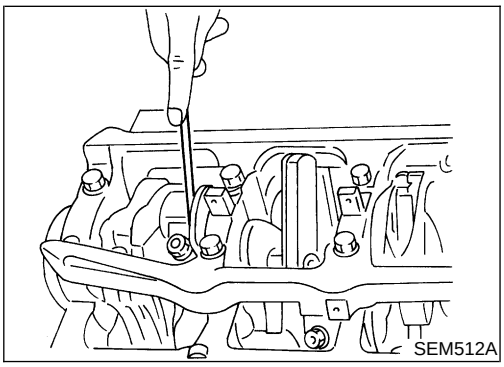
b. Install connecting rod bearing caps.

- **Lubricate threads and seat surfaces with new engine oil.** Tighten connecting rod bearing cap nuts to the specified torque.

: Connecting rod bearing nut

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

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


SEM512A

6. Measure connecting rod side clearance.

Connecting rod side clearance:

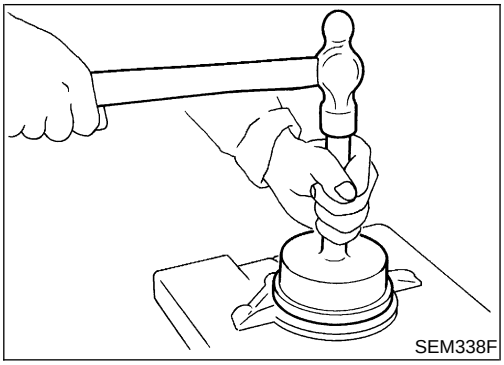
Standard

0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit

0.40 mm (0.0157 in)

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

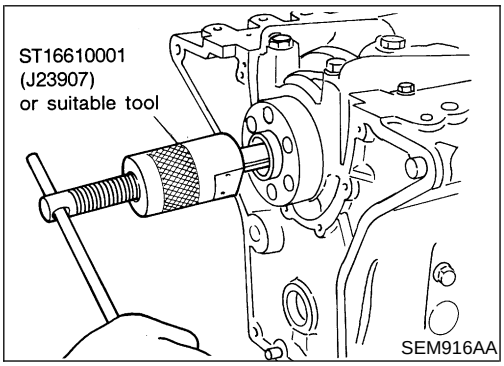


7. Install rear oil seal retainer.

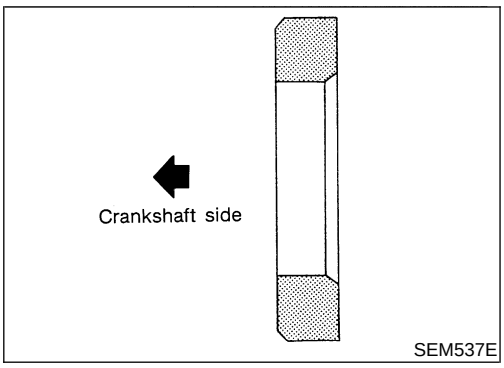
REPLACING PILOT CONVERTER

NDEM0025S03

1. Remove pilot converter.



2. Install pilot converter.

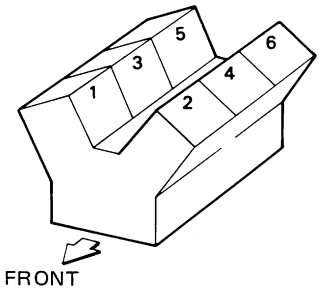


General Specifications

NDEM0026

Cylinder arrangement		V-6
Displacement		3,275 cm^3 (199.84 cu in)
Bore and stroke		91.5 x 83 mm (3.602 x 3.27 in)
Valve arrangement		OHC
Firing order		1-2-3-4-5-6
Number of piston rings	Compression	2
	Oil	1
Number of main bearings		4
Compression ratio		8.9

Cylinder number



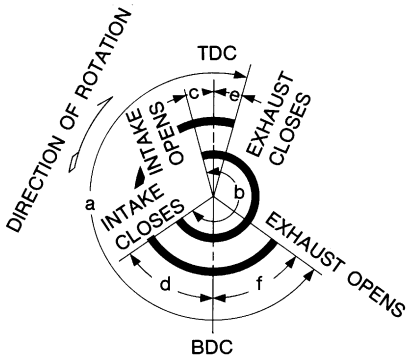
SEM713A

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

Compression pressure	Standard	1,196 (12.2, 173)
	Minimum	883 (9.0, 128)
	Differential limit between cylinders	98 (1.0, 14)

Unit: degree

Valve timing



EM120

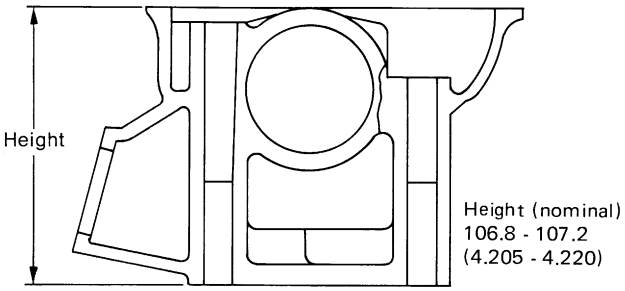
a	b	c	d	e	f
240	244	4	60	9	51

Cylinder Head

NDEM0027

Unit: mm (in)

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



SEM082B

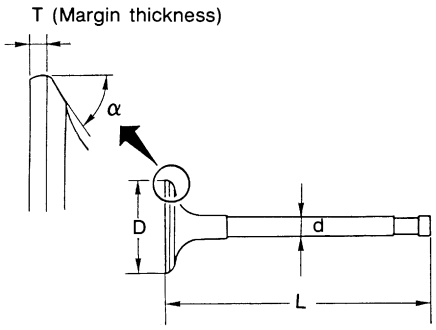
Valve

VALVE

NDEM0028

NDEM0028S01

Unit: mm (in)



SEM188

Valve head diameter “D”	Intake	42.0 - 42.2 (1.654 - 1.661)
	Exhaust	35.0 - 35.2 (1.378 - 1.386)
Valve length “L”	Intake	125.3 - 125.9 (4.933 - 4.957)
	Exhaust	124.2 - 124.8 (4.890 - 4.913)
Valve stem diameter “d”	Intake	6.965 - 6.980 (0.2742 - 0.2748)
	Exhaust	7.965 - 7.970 (0.3136 - 0.3138)
Valve seat angle “α”	Intake	45°15′ - 45°45′
	Exhaust	
Valve margin “T”	Intake	1.15 - 1.45 (0.0453 - 0.0571)
	Exhaust	1.35 - 1.65 (0.0531 - 0.0650)
Valve margin “T” limit		More than 0.5 (0.020)
Valve stem end surface grinding limit		Less than 0.2 (0.008)
Valve clearance	Intake	0 (0)
	Exhaust	0 (0)

VALVE SPRING

NDEM0028S02

Free height	Outer	51.2 mm (2.016 in)
	Inner	44.1 mm (1.736 in)
Pressure	Outer	523.7 N (53.4 kg, 117.7 lb) at 30.0 mm (1.181 in)
	Inner	255.0 N (26.0 kg, 57.3 lb) at 25.0 mm (0.984 in)
Out-of-square	Outer	2.2 mm (0.087 in)
	Inner	1.9 mm (0.075 in)

HYDRAULIC VALVE LIFTER

NDEM0028S03

Unit: mm (in)

Lifter outside diameter	15.947 - 15.957 (0.6278 - 0.6282)
Lifter guide inside diameter	16.000 - 16.013 (0.6299 - 0.6304)
Clearance between lifter and lifter guide	0.043 - 0.066 (0.0017 - 0.0026)

VALVE GUIDE

NDEM0028S04

Unit: mm (in)

			Standard	Service
Valve guide	Outer diameter	Intake	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
		Exhaust	12.023 - 12.034 (0.4733 - 0.4738)	12.223 - 12.234 (0.4812 - 0.4817)
	Inner diameter (Finished size)	Intake	7.000 - 7.018 (0.2756 - 0.2763)	
		Exhaust	8.000 - 8.011 (0.3150 - 0.3154)	
Cylinder head valve guide hole diameter		Intake	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
		Exhaust	11.975 - 11.996 (0.4715 - 0.4723)	12.175 - 12.196 (0.4793 - 0.4802)
Interference fit of valve guide		Intake	0.027 - 0.059 (0.0011 - 0.0023)	
		Exhaust		
			Standard	Max. tolerance
Stem to guide clearance		Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.10 (0.0039)
		Exhaust	0.030 - 0.049 (0.0012 - 0.0019)	
Valve deflection limit			—	0.20 (0.0079)

ROCKER SHAFT AND ROCKER ARM

NDEM0028S05

Unit: mm (in)

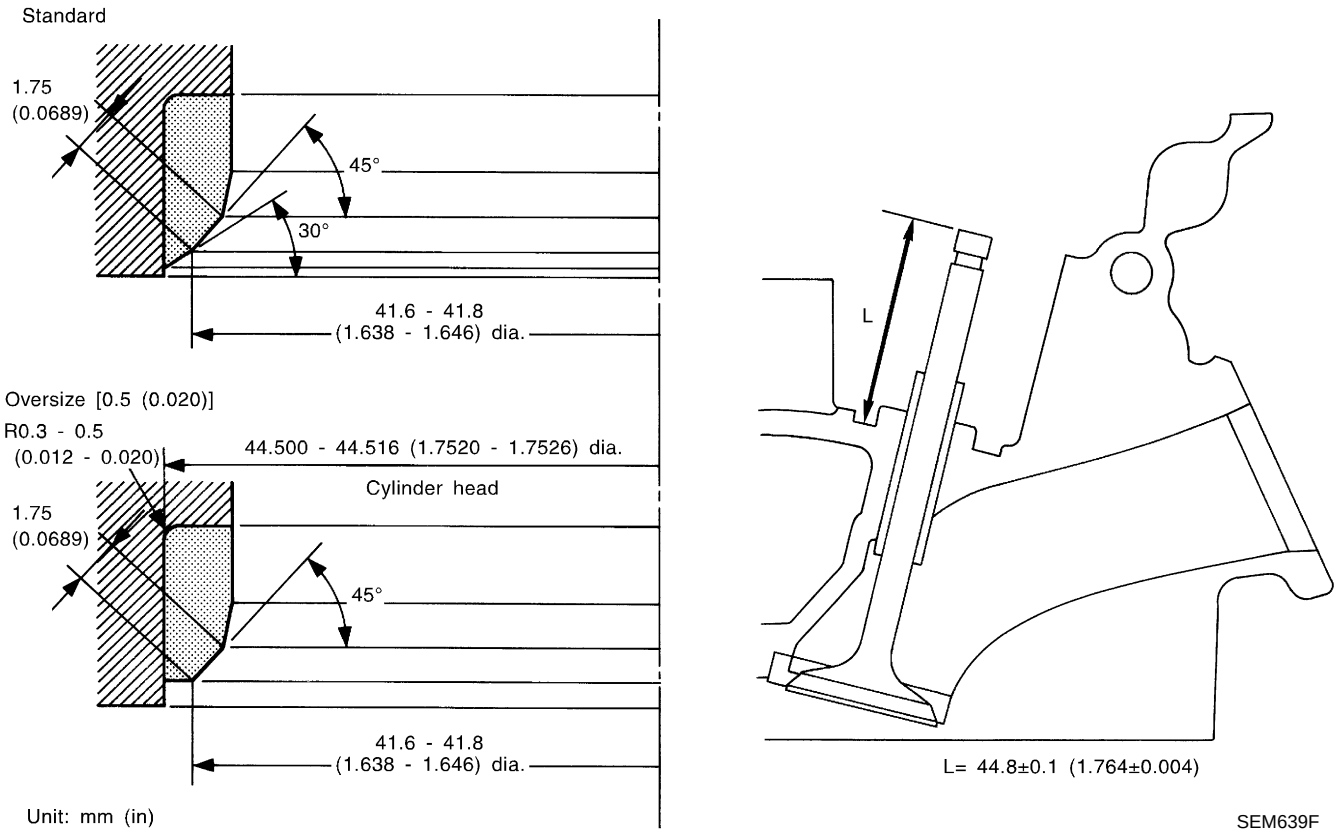
Rocker shaft	Outer diameter	17.979 - 18.000 (0.7078 - 0.7087)
Rocker arm	Inner diameter	18.007 - 18.028 (0.7089 - 0.7098)
Clearance between rocker arm and rocker shaft		0.007 - 0.049 (0.0003 - 0.0019)

Valve Seat

NDEM0029

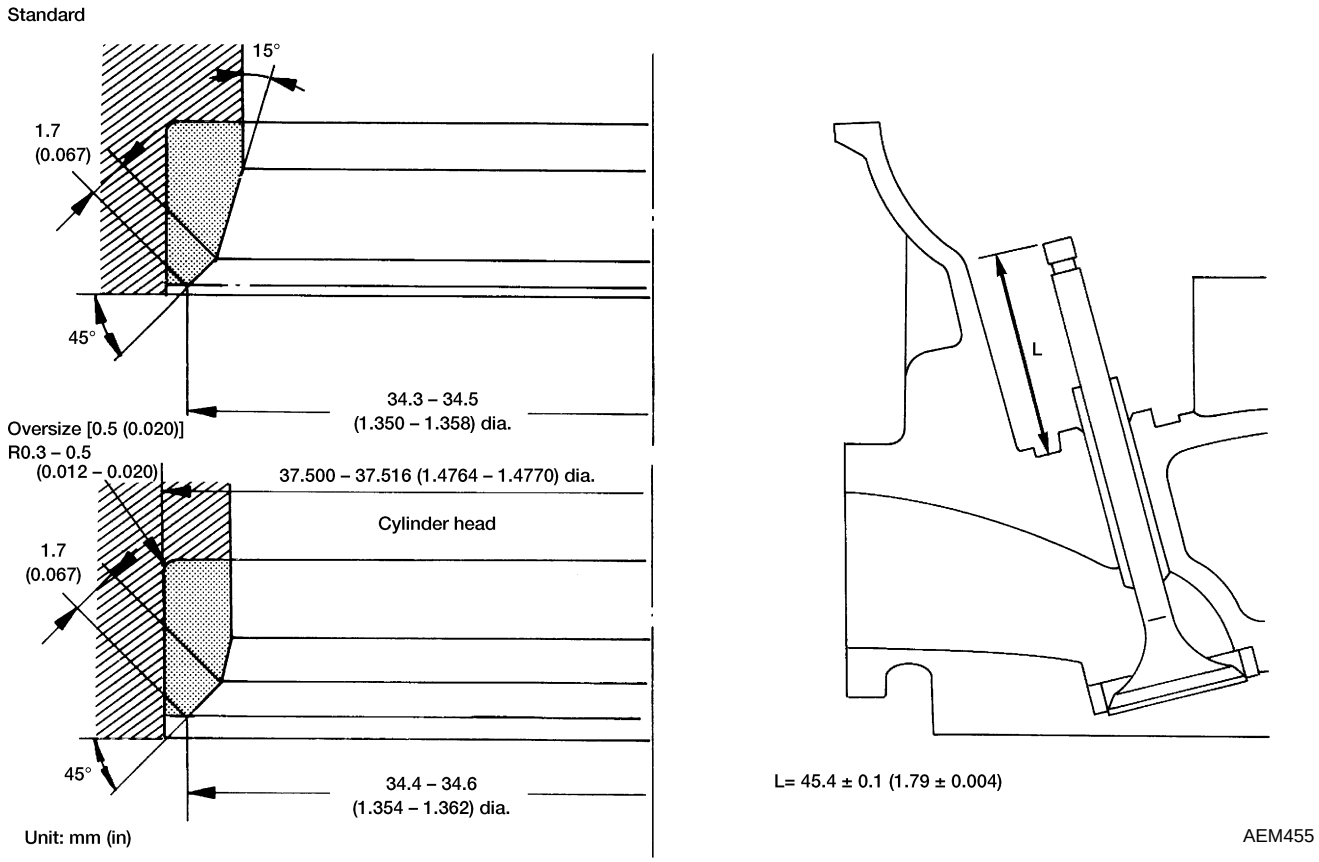
INTAKE VALVE SEAT

NDEM0029S01



EXHAUST VALVE SEAT

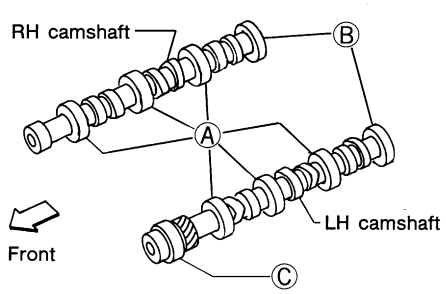
NDEM0029S02



Camshaft and Camshaft Bearing

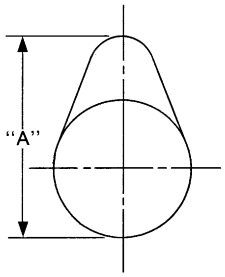
NDEM0030

Unit: mm (in)



SEM893BA

	Standard	Max. tolerance
Camshaft journal to bearing clearance	0.060 - 0.105 (0.0024 - 0.0041)	0.15 (0.0059)
Inner diameter of camshaft bearing	A: 47.000 - 47.025 (1.8504 - 1.8514)	—
	B: 42.500 - 42.525 (1.6732 - 1.6742)	—
	C: 48.000 - 48.025 (1.8898 - 1.8907)	—
Outer diameter of camshaft journal	A: 46.920 - 46.940 (1.8472 - 1.8480)	—
	B: 42.420 - 42.440 (1.6701 - 1.6709)	—
	C: 47.920 - 47.940 (1.8866 - 1.8874)	—
Camshaft runout [TIR*]	Less than 0.04 (0.0016)	0.1 (0.004)
Camshaft end play	0.03 - 0.06 (0.0012 - 0.0024)	—



EM671

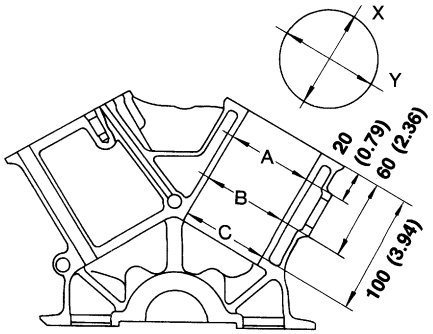
Cam height "A"	Intake	38.943 - 39.133 (1.5332 - 1.5407)
	Exhaust	38.943 - 39.133 (1.5332 - 1.5407)
Wear limit of cam height		0.15 (0.0059)

*Total indicator reading

Cylinder Block

NDEM0031

Unit: mm (in)



SEM321A

Surface flatness		Standard		Less than 0.03 (0.0012)
		Limit		0.10 (0.0039)
Cylinder bore	Inner diameter	Standard (for No. 1, 2 and 6 cylinders)	Grade No. 1	91.500 - 91.510 (3.6024 - 3.6027)
			Grade No. 2	91.510 - 91.520 (3.6027 - 3.6031)
			Grade No. 3	91.520 - 91.530 (3.6031 - 3.6035)
		Standard (for No. 3 and 4 cylinders)	Grade No. 1	91.500 - 91.505 (3.6024 - 3.6026)
			Grade No. 2	91.505 - 91.510 (3.6026 - 3.6027)
			Grade No. 3	91.510 - 91.515 (3.6027 - 3.6029)
			Grade No. 4	91.515 - 91.520 (3.6029 - 3.6031)
			Grade No. 5	91.520 - 91.525 (3.6031 - 3.6033)
			Grade No. 6	91.525 - 91.530 (3.6033 - 3.6035)
		Standard (for No. 5 cylinder)	Grade No. 1	91.515 - 91.520 (3.6029 - 3.6031)
			Grade No. 2	91.520 - 91.525 (3.6031 - 3.6033)
			Grade No. 3	91.525 - 91.530 (3.6033 - 3.6035)
			Grade No. 4	91.530 - 91.535 (3.6035 - 3.6037)
			Grade No. 5	91.535 - 91.540 (3.6037 - 3.6039)
			Grade No. 6	91.540 - 91.545 (3.6039 - 3.6041)
		Wear limit		0.20 (0.0079)
Out-of-round (X − Y)				Less than 0.015 (0.0006)
Taper (A − B or A − C)				Less than 0.015 (0.0006)
Main journal inner diameter		No. 1 main journal	Grade No. 3	66.645 - 66.651 (2.6238 - 2.6240)
			Grade No. 4	66.651 - 66.657 (2.6240 - 2.6243)
			Grade No. 5	66.657 - 66.663 (2.6243 - 2.6245)
			Grade No. 6	66.663 - 66.669 (2.6245 - 2.6248)
		No. 2, 3 and 4 main journals	Grade No. 0	66.645 - 66.654 (2.6238 - 2.6242)
			Grade No. 1	66.654 - 66.663 (2.6242 - 2.6245)
			Grade No. 2	66.663 - 66.672 (2.6245 - 2.6249)
Difference in inner diameter between cylinders		Standard		Less than 0.05 (0.0020)

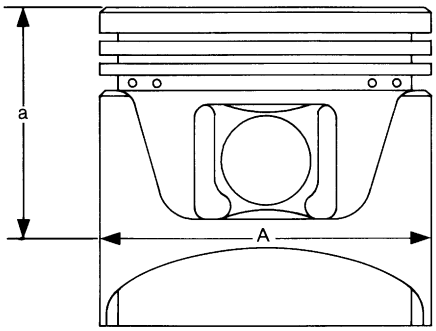
Piston, Piston Ring and Piston Pin

NDEM0032

AVAILABLE PISTON

NDEM0032S01

Unit: mm (in)



SEM882E

Piston skirt diameter “A”	Standard (for No. 3, 4 and 5 cylinders)	Grade No. 2-1	91.480 - 91.485 (3.6016 - 3.6018)
		Grade No. 3-2	91.485 - 91.490 (3.6018 - 3.6020)
		Grade No. 3-3	91.490 - 91.495 (3.6020 - 3.6022)
		Grade No. 4-4	91.495 - 91.500 (3.6022 - 3.6024)
		Grade No. 4-5	91.500 - 91.505 (3.6024 - 3.6026)
		Grade No. 5-6	91.505 - 91.510 (3.6026 - 3.6027)
	Standard (for No. 1, 2 and 6 cylinders)	Grade No. 1	91.465 - 91.475 (3.6010 - 3.6014)
		Grade No. 2	91.475 - 91.485 (3.6014 - 3.6018)
		Grade No. 3	91.485 - 91.495 (3.6018 - 3.6022)
	0.25 (0.0098) oversize (Service)		91.715 - 91.745 (3.6108 - 3.6120)
	0.50 (0.0197) oversize (Service)		91.965 - 91.995 (3.6207 - 3.6218)
“a” dimension			49.0 (1.929)
Piston pin hole diameter	Grade No. 0		20.969 - 20.975 (0.8255 - 0.8258)
	Grade No. 1		20.975 - 20.981 (0.8258 - 0.8260)
Piston clearance to cylinder block	Standard	For No. 1, 2 and 6 cylinders	0.025 - 0.045 (0.0010 - 0.0018)
		For No. 3 and 4 cylinders	0.015 - 0.025 (0.0006 - 0.0010)
		For No. 5 cylinder	0.030 - 0.040 (0.0012 - 0.0016)

PISTON RING

NDEM0032S02

Unit: mm (in)

		Standard	Limit
Side clearance	Top	0.040 - 0.080 (0.0016 - 0.0031)	0.11 (0.0043)
	2nd	0.030 - 0.070 (0.0012 - 0.0028)	0.10 (0.004)
	Oil	0.015 - 0.185 (0.0006 - 0.0073)	—
Ring gap	Top	0.21 - 0.31 (0.0083 - 0.0122)	0.43 (0.0169)
	2nd	0.50 - 0.60 (0.0197 - 0.0236)	0.69 (0.0272)
	Oil (rail ring)	0.20 - 0.60 (0.0079 - 0.0236)	0.84 (0.0331)

PISTON PIN

NDEM0032S03
Unit: mm (in)

Piston pin outer diameter	20.971 - 20.983 (0.8256 - 0.8261)
Interference fit of piston pin to piston	0 to -0.004 (0 to -0.0002)
Piston pin to connecting rod bushing clearance	0.005 - 0.017 (0.0002 - 0.0007)

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

Connecting Rod

NDEM0033
Unit: mm (in)

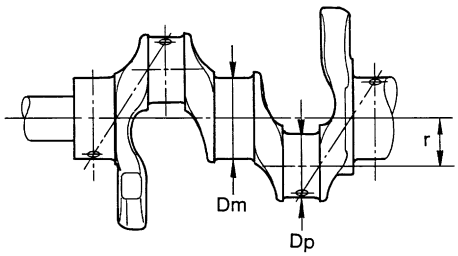
Center distance		154.1 - 154.2 (6.067 - 6.071)
Bend, torsion [per 100 (3.94)]	Limit	Bend: 0.15 (0.0059) Torsion: 0.30 (0.0118)
Piston pin bushing inner diameter*		20.982 - 20.994 (0.8261 - 0.8265)
Connecting rod big end inner diameter		53.000 - 53.013 (2.0866 - 2.0871)
Side clearance	Standard	0.20 - 0.35 (0.0079 - 0.0138)
	Limit	0.40 (0.0157)

*After installing in connecting rod

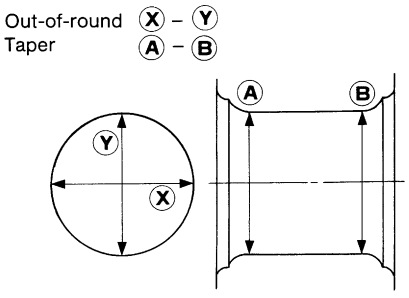
Crankshaft

NDEM0034
Unit: mm (in)

Main journal dia. "Dm"	No. 1 main journal	Grade No. 3	62.969 - 62.975 (2.4791 - 2.4793)
		Grade No. 4	62.963 - 62.969 (2.4789 - 2.4791)
		Grade No. 5	62.957 - 62.963 (2.4786 - 2.4789)
		Grade No. 6	62.951 - 62.957 (2.4784 - 2.4786)
	No. 2, 3 and 4 main journals	Grade No. 0	62.967 - 62.975 (2.4790 - 2.4793)
		Grade No. 1	62.959 - 62.967 (2.4787 - 2.4790)
		Grade No. 2	62.951 - 62.959 (2.4784 - 2.4787)
Pin journal dia. "Dp"			49.955 - 49.974 (1.9667 - 1.9675)
Center distance "r"			41.5 (1.634)
Out-of-round (X − Y)		Standard	Less than 0.005 (0.0002)
Taper (A − B)		Standard	Less than 0.005 (0.0002)
Runout [TIR]		Standard	Less than 0.025 (0.0010)
		Limit	Less than 0.10 (0.0039)
Free end play		Standard	0.050 - 0.170 (0.0020 - 0.0067)
		Limit	0.30 (0.0118)



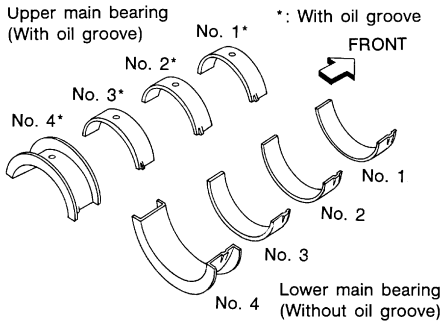
SEM645



EM715

Available Main Bearing

NDEM0035



SEM327A

NO. 1 MAIN BEARING

NDEM0035S01

Grade number	Thickness “T” mm (in)	Width “W” mm (in)	Identification color
0	1.822 - 1.825 (0.0717 - 0.0719)	22.4 - 22.6 (0.882 - 0.890)	Black (A)
1	1.825 - 1.828 (0.0719 - 0.0720)		Brown (B)
2	1.828 - 1.831 (0.0720 - 0.0721)		Green (C)
3	1.831 - 1.834 (0.0721 - 0.0722)		Yellow (D)
4	1.834 - 1.837 (0.0722 - 0.0723)		Blue (E)
5	1.837 - 1.840 (0.0723 - 0.0724)		Pink (F)
6	1.840 - 1.843 (0.0724 - 0.0726)		Purple (G)

NO. 2 AND 3 MAIN BEARING

NDEM0035S02

Grade number	Thickness “T” mm (in)	Width “W” mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)	18.9 - 19.1 (0.744 - 0.752)	Black
1	1.821 - 1.825 (0.0717 - 0.0719)		Brown
2	1.825 - 1.829 (0.0719 - 0.0720)		Green
3	1.829 - 1.833 (0.0720 - 0.0722)		Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)		Blue

NO. 4 MAIN BEARING

NDEM0035S03

Grade number	Thickness “T” mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)	Black
1	1.821 - 1.825 (0.0717 - 0.0719)	Brown
2	1.825 - 1.829 (0.0719 - 0.0720)	Green
3	1.829 - 1.833 (0.0720 - 0.0722)	Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)	Blue

UNDER SIZE

NDEM0035S04

Unit: mm (in)

		Thickness “T”	Main journal diameter “Dm”
0.25 (0.0098)	No. 1 main bearing	1.956 - 1.962 (0.0770 - 0.0772)	Grind so that bearing clearance is the specified value.
	No. 2, 3 and No. 4 main bearing	1.948 - 1.956 (0.0767 - 0.0770)	

Available Connecting Rod Bearing

NDEM0036

CONNECTING ROD BEARING UNDERSIZE

NDEM0036S01

Unit: mm (in)

		Thickness	Crank pin journal diameter "Dp"
Standard		1.502 - 1.506 (0.0591 - 0.0593)	49.955 - 49.974 (1.9667 - 1.9675)
Undersize	0.08 (0.0031)	1.542 - 1.546 (0.0607 - 0.0609)	Grind so that bearing clearance is the specified value.
	0.12 (0.0047)	1.562 - 1.566 (0.0615 - 0.0617)	
	0.25 (0.0098)	1.627 - 1.631 (0.0641 - 0.0642)	

Miscellaneous Components

NDEM0037

Unit: mm (in)

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

BEARING CLEARANCE

NDEM0037S01

Unit: mm (in)

Main bearing clearance	No. 1 main bearing	Standard	0.030 - 0.048 (0.0012 - 0.0019)
		Limit	0.060 (0.0024)
	No. 2, 3, and No.4 main bearing	Standard	0.038 – 0.065 (0.0015 – 0.0026)
		Limit	0.080 (0.0031)
Connecting rod bearing clearance		Standard	0.024 - 0.064 (0.0009 - 0.0025)
		Limit	0.090 (0.0035)

NOTES