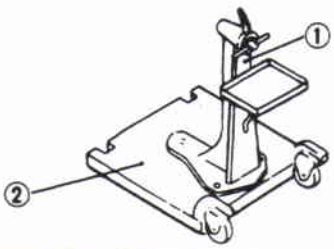
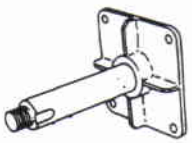
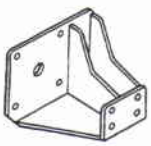
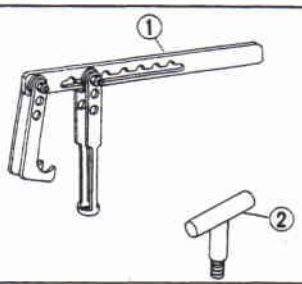
ENGINE MECHANICAL

SECTION EM

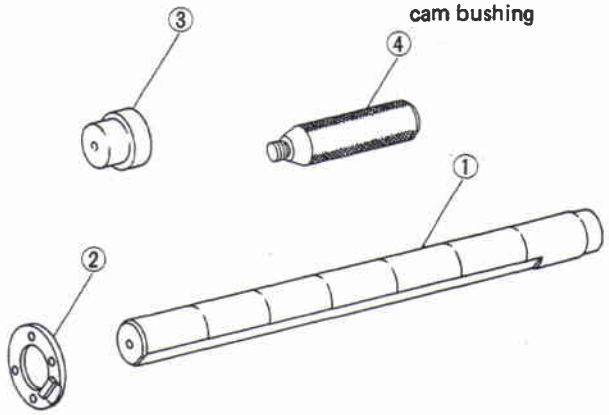
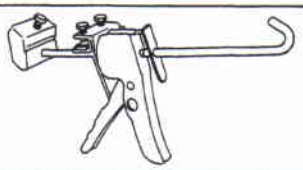
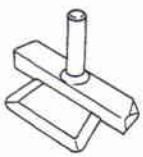
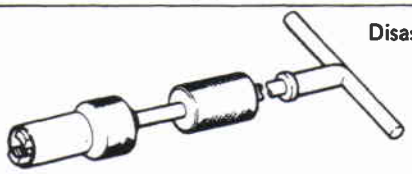
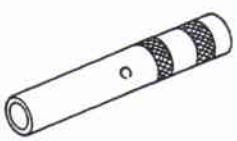
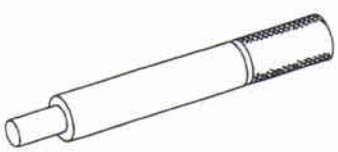
CONTENTS

SPECIAL SERVICE TOOLS

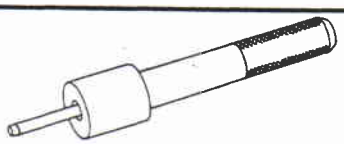
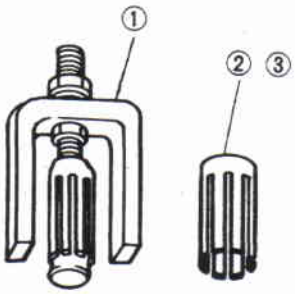
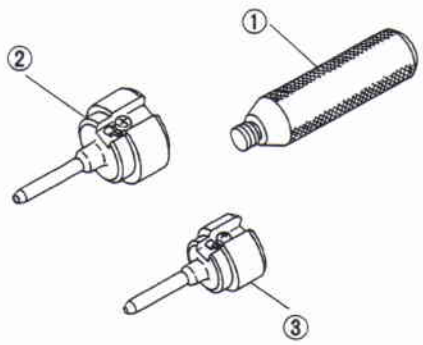
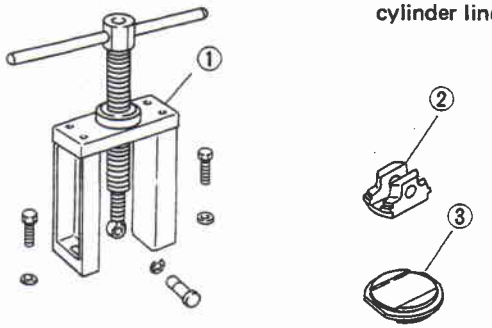
*: Special tool or commercial equivalent

Tool number Tool name	Description		Engine application	
			TB42	TD42
ST0501S000* Engine stand assembly ① ST05011000 Engine stand ② ST05012000 Base		Disassembling and assembling	X	X
KV10106500* Engine stand shaft			X	X
KV11104800* Engine sub-attachment			X	X
KV101092S0* Valve spring compressor ① KV10109210 Compressor ② KV10111200 Adapter		Disassembling and assembling valve components	X	X
EM03470000* Piston ring compressor		Installing piston assembly into cylinder bore	X	X
ST16610001* Pilot bushing puller		Removing crankshaft pilot bushing	X	X

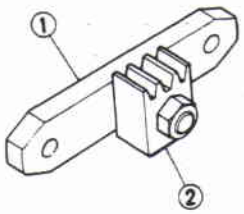
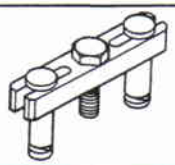
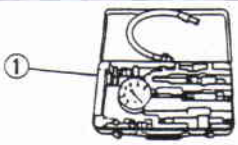
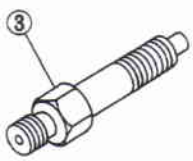
*: Special tool or commercial equivalent

Tool number Tool name	Description	Engine application	
		TB42	TD42
KV111045S0 Cam bushing replacer set ① KV11104510 Replacer bar ② KV11104520 Guide plate ③ KV11104530 Adapter (1st bushing) ④ ST15243000 Drift	Removing and installing cam bushing 	X	X
WS39930000* Tube presser	Pressing the tube of fluid gasket 	X	X
KV10111100 Seal cutter	Removing oil pan 	X	–
KV10107900* Valve oil seal puller	Disassembling valve oil seal 	–	X
KV11103400 Valve oil seal drift	Installing valve oil seal 	–	X
KV10113000 Valve oil seal drift	Installing valve oil seal 	X	–
ST11033000* Valve guide drift	Removing valve guide 	–	X

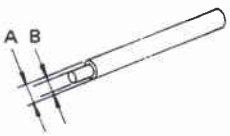
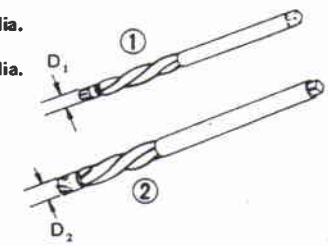
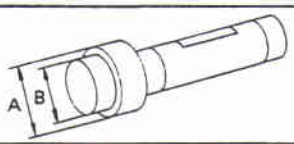
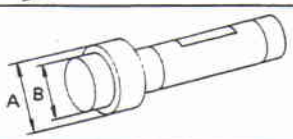
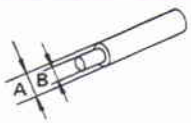
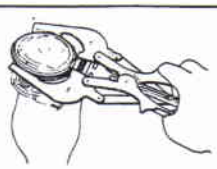
*: Special tool or commercial equivalent

Tool number Tool name	Description	Engine application	
		TB42	TD42
KV11103900* Valve guide drift	 Installing valve guide	–	X
ST11032000* Valve guide reamer 8.0 mm (0.315 in) dia.	 Reaming valve guide	–	X
① KV11101110 Valve seat remover ② KV11103610 Adapter (Intake) ③ KV11103620 Adapter (Exhaust)	Removing valve seat 	–	X
① ST15243000 Valve seat drift ② KV11103810 Adapter (Intake) ③ KV11103820 Adapter (Exhaust)	Installing valve seat 	–	X
① KV11104010 Cylinder liner tool ② KV11104110 Adapter for removing ③ KV11104030 Adapter for installing	Removing and installing cylinder liner 	–	X

*: Special tool or commercial equivalent

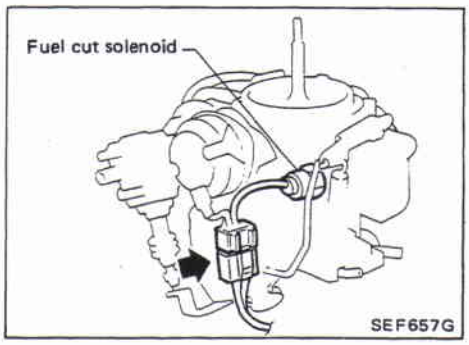
Tool number Tool name	Description		Engine application	
			TB42	TD42
KV111033S0 Engine stopper ① KV11103310 Stopper plate ② KV10105630 Stopper gear		Preventing crankshaft from rotating	–	X
KV10109300* Injection pump drive gear holder		Preventing drive gear from rotating (VE-type)	–	X
KV11103000* Injection pump drive gear puller		Removing drive gear (VE-type)	–	X
① ED19601000 Compression gauge ② ED19600600 Compression gauge adapter (for glow plug hole) ③ ED19600700 Compression gauge adapter (for injector hole)	  	Checking compression pressure	–	X

COMMERCIAL SERVICE TOOLS

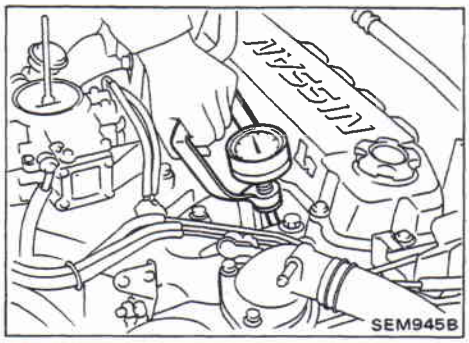
Tool name	Description		Engine application	
			TB42	TD42
Pulley holder		Holding camshaft pulley while tightening or loosening camshaft bolt	X	–
Valve guide drift	Intake: A = 11.5 mm (0.453 in) dia. Exhaust: B = 7.6 mm (0.299 in) dia. 	Removing and installing valve guide	X	–
Valve guide reamer	Intake: D_1 = 8.0 mm (0.315 in) dia. Exhaust: D_2 = 12.2 mm (0.480 in) dia. 	Reaming valve guide (①) or hole for oversize valve guide (②)	X	–
Valve seat cutter set		Finishing valve seat dimensions	X	X
Front oil seal drift	A = 90 mm (3.54 in) dia. B = 57 mm (2.24 in) dia. 	Installing front oil seal	X	–
Rear oil seal drift	A = 110 mm (4.33 in) dia. B = 85 mm (3.35 in) dia. 	Installing rear oil seal	X	–
Piston pin drift	A = 22.5 mm (0.886 in) dia. B = 12.5 mm (0.492 in) dia. 	Removing and installing piston pin	X	–
Piston ring expander		Removing and installing piston ring	X	X

Measurement of Compression Pressure (On-vehicle service)

1. Warm up engine.
2. Turn ignition switch off.
3. Remove air cleaner and all spark plugs.
4. Disconnect distributor center cable.



5. Disconnect fuel cut solenoid valve connector.



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

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

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

Standard

1,177 (11.77, 12.0, 171)/200

Minimum

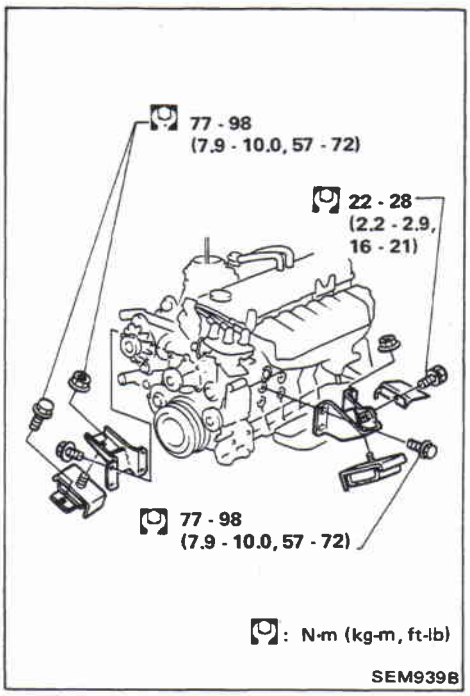
883 (8.83, 9.0, 128)/200

Difference limit between cylinders:

98 (0.98, 1.0, 14)/200

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

- **If adding oil helps the 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 S.D.S.). 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 help the compression, there is leakage past the gasket surface. If so, replace cylinder head gasket.**

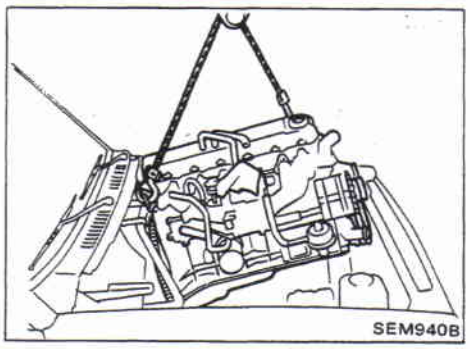


WARNING:

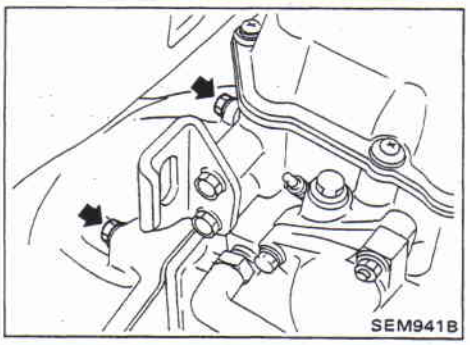
a. **Situate vehicle on a flat and solid surface.**
b. **Place chocks at front and back of rear wheels.**
c. **Do not remove engine until exhaust system has completely cooled off.**
   Otherwise, you may burn yourself and/or fire may break out in the fuel line.
d. **For safety during subsequent steps, the tension of wires should be slackened against the engine.**
e. **Be sure to hoist engine in a safe manner.**

CAUTION:

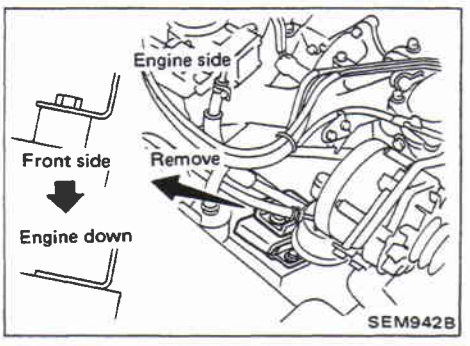
- **When lifting engine, be careful not to strike adjacent parts, especially accelerator wire casing, brake lines, and brake master cylinder.**
- **In hoisting the engine, always use engine slingers in a safe manner.**
- **For engines not equipped with engine slingers, attach proper slingers and bolts described in the PARTS CATALOG.**

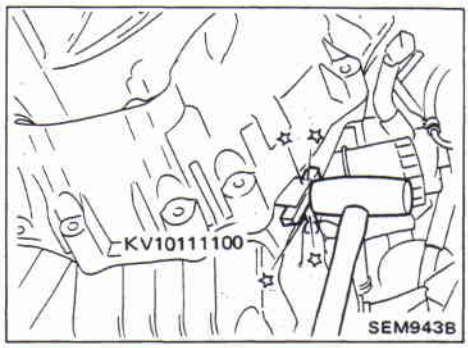


- Remove engine after disconnecting from transmission.

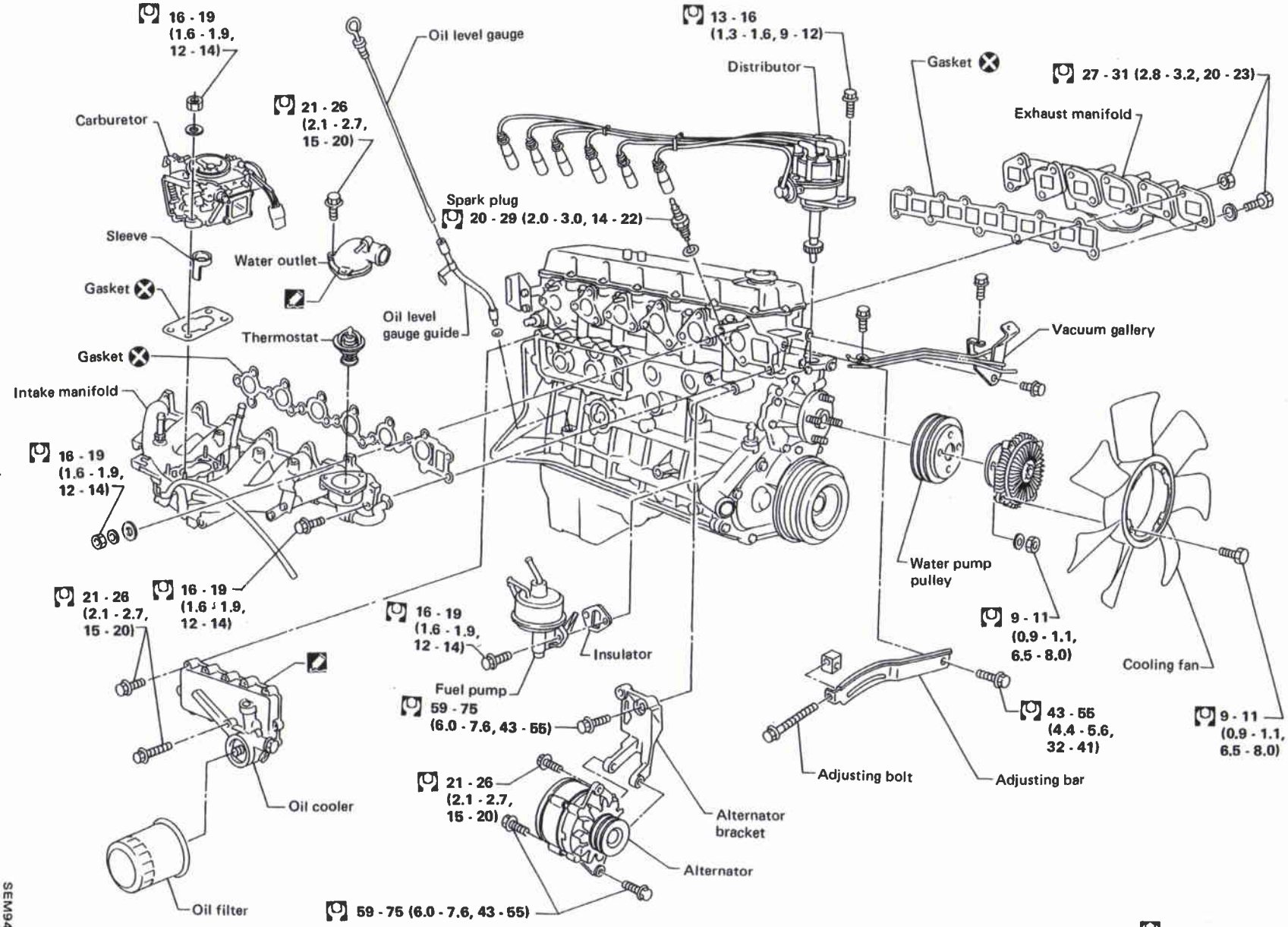


(1) Before removing two mounting bolts from upper side of transmission, remove front engine mounts and lower engine to the level of the front mount.

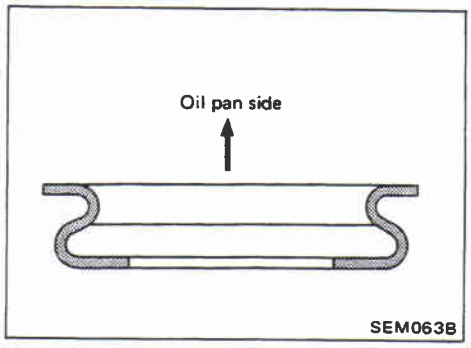




(2) Before separating transmission and rear plate, remove transmission mounting bolts. Position Tool into mating surface of transmission and rear plate, and slide it along mating surface.

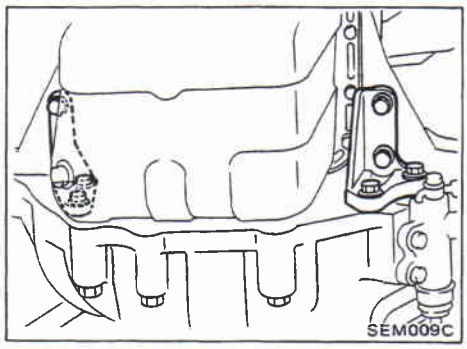

16 - 19 (1.6 - 1.9, 12 - 14)
Carburetor
21 - 26 (2.1 - 2.7, 15 - 20)
Oil level gauge
13 - 16 (1.3 - 1.6, 9 - 12)
Distributor
Gasket
27 - 31 (2.8 - 3.2, 20 - 23)
Exhaust manifold
Spark plug
20 - 29 (2.0 - 3.0, 14 - 22)
Sleeve
Water outlet
Gasket
Thermostat
Oil level gauge guide
Vacuum gallery
Gasket
Intake manifold
16 - 19 (1.6 - 1.9, 12 - 14)
Water pump pulley
9 - 11 (0.9 - 1.1, 6.5 - 8.0)
Cooling fan
21 - 26 (2.1 - 2.7, 15 - 20)
16 - 19 (1.6 - 1.9, 12 - 14)
16 - 19 (1.6 - 1.9, 12 - 14)
Insulator
Fuel pump
59 - 75 (6.0 - 7.6, 43 - 55)
43 - 55 (4.4 - 5.6, 32 - 41)
9 - 11 (0.9 - 1.1, 6.5 - 8.0)
Adjusting bolt
Adjusting bar
21 - 26 (2.1 - 2.7, 15 - 20)
Alternator bracket
Oil cooler
Alternator
Oil filter
59 - 75 (6.0 - 7.6, 43 - 55)
: N·m (kg-m, ft-lb)

SEM944B

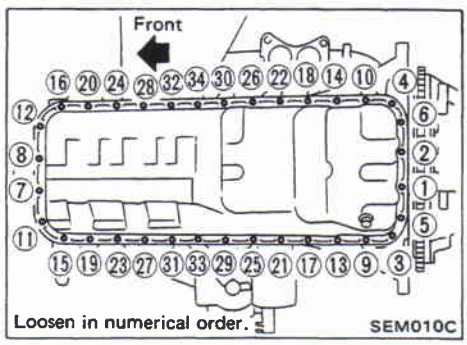


Removal (On-vehicle service)

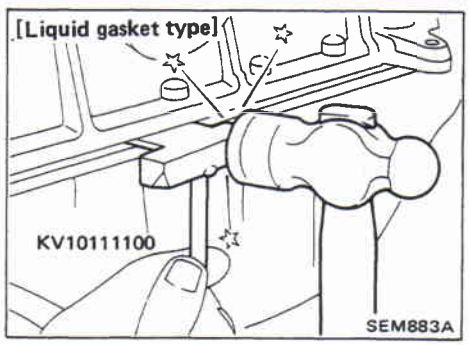
1. Drain engine oil.
- When installing drain plug washer, make sure it faces correct direction.
2. Remove engine gussets.



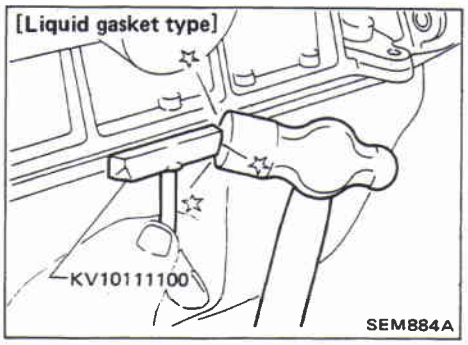
2. Remove engine gussets.



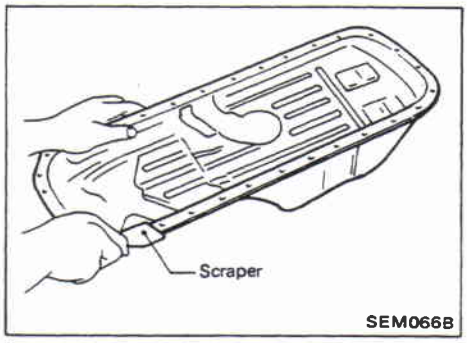
3. Remove oil pan.
(1) Remove oil pan bolts and nuts in numerical order.



The following operation is only for the liquid gasket type.
(2) Insert Tool between cylinder block and oil pan.
- **Do not insert screwdriver, or oil pan flange will be deformed.**
- **Do not insert Tool into rear oil seal retainer portion; otherwise, it will be damaged.**



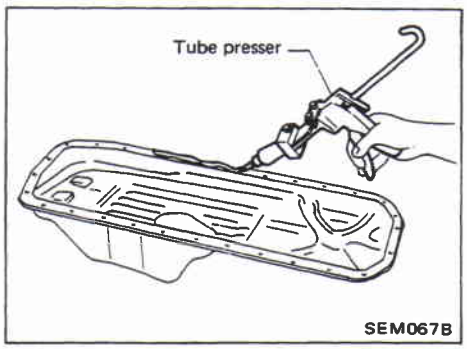
(3) Slide Tool by tapping its side with a hammer, and remove oil pan.



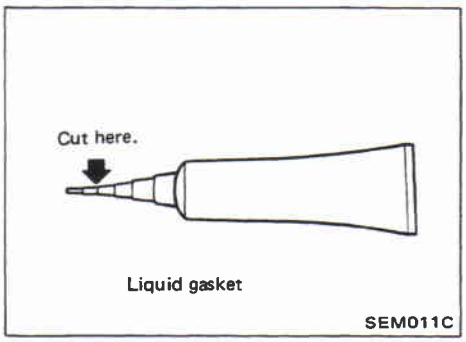
Installation (On-vehicle service)

LIQUID GASKET TYPE

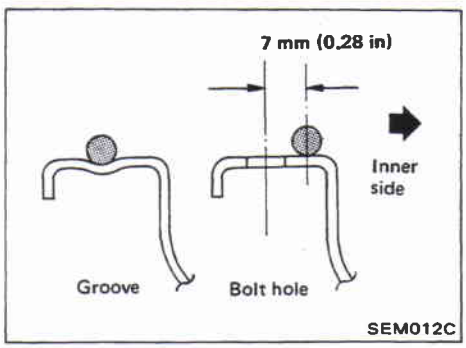
1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
- Also remove traces of liquid gasket from mating surface of cylinder block.



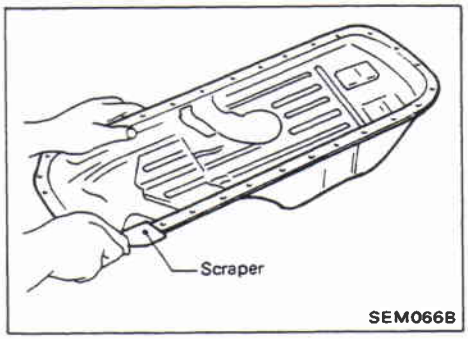
2. Apply a continuous bead of liquid gasket to mating surface of oil pan.
- **Use Genuine Liquid Gasket or equivalent.**



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



3. Apply liquid gasket to inner sealing surface instead of surface where there is no groove at bolt hole.
- Attaching should be done within 5 minutes after coating.
4. Install oil pan.
- Install bolts and nuts in reverse order of removal.
- Wait at least 30 minutes before refilling engine oil.

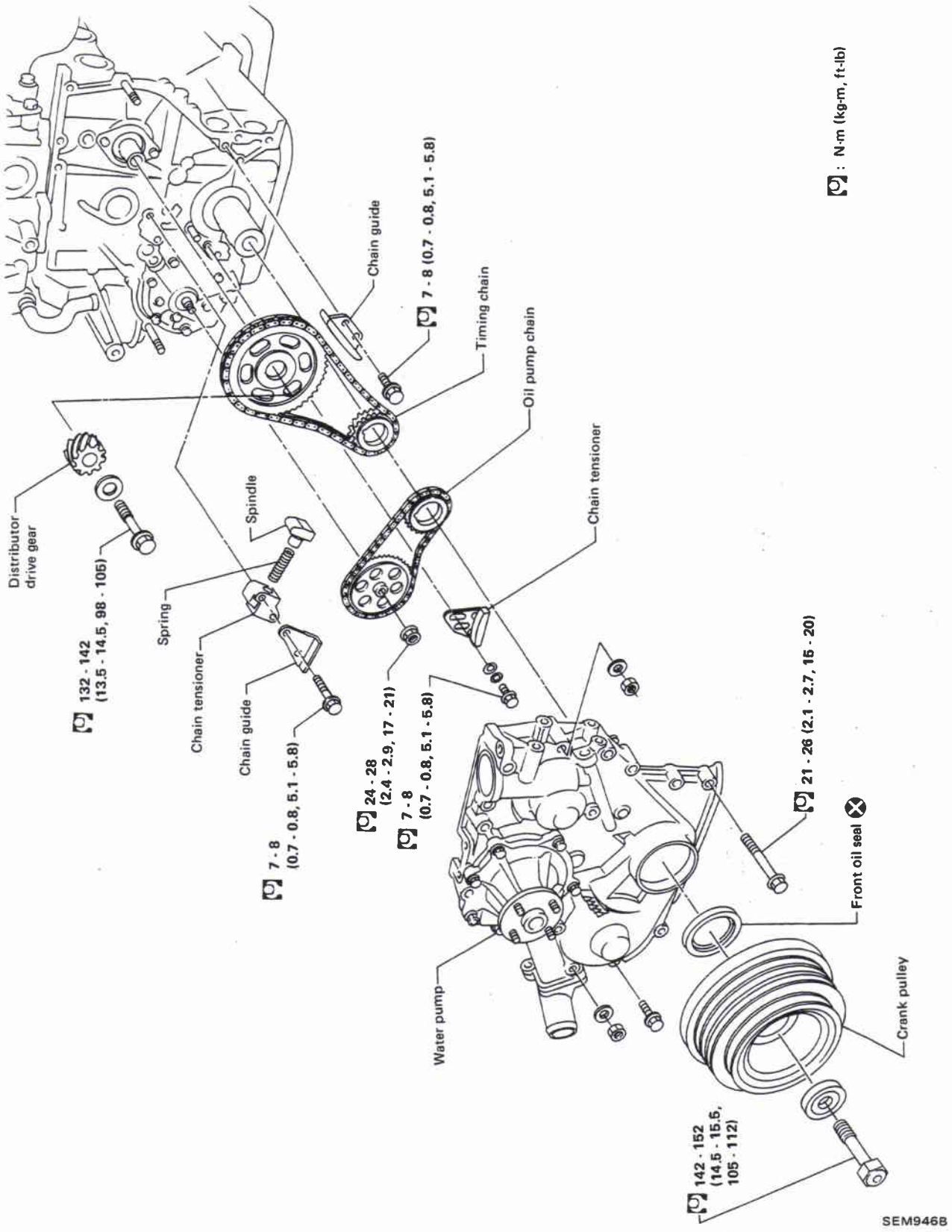


CONVENTIONAL GASKET TYPE

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.

Perform the above operation only when liquid gasket is used between oil pan and cylinder block.

2. Install gasket and oil pan.
- Install bolts and nuts in reverse order of removal.


Distributor drive gear
132 - 142 (13.5 - 14.5, 98 - 105)
Spring
Chain tensioner
Chain guide
7 - 8 (0.7 - 0.8, 5.1 - 5.8)
Spindle
24 - 28 (2.4 - 2.9, 17 - 21)
7 - 8 (0.7 - 0.8, 5.1 - 5.8)
Chain guide
7 - 8 (0.7 - 0.8, 5.1 - 5.8)
Timing chain
Oil pump chain
Chain tensioner
Water pump
21 - 26 (2.1 - 2.7, 15 - 20)
Front oil seal
Crank pulley
142 - 152 (14.5 - 15.5, 105 - 112)
: N·m (kg-m, ft-lb)
SEM9468

CAUTION:

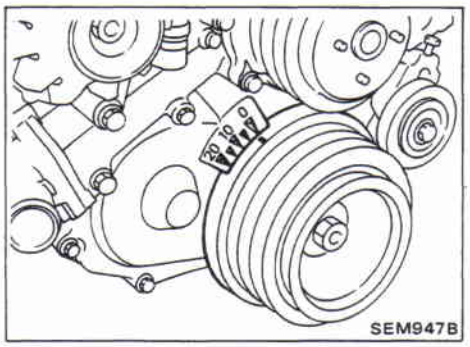
- **After removing timing chain, do not turn crankshaft and camshaft separately, or valves will strike piston heads.**
- **When tightening camshaft bolt, oil pump sprocket nuts and crank pulley bolt, apply new engine oil to the threaded portions and seat surfaces of bolts or nuts.**

Removal (On-vehicle service)

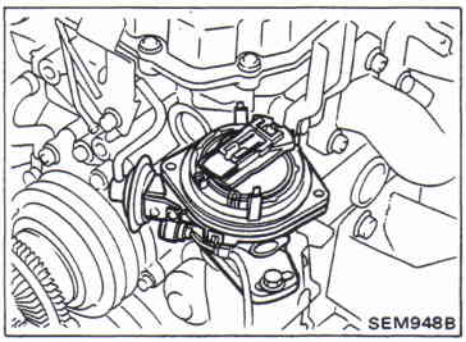
1. Drain coolant from radiator.

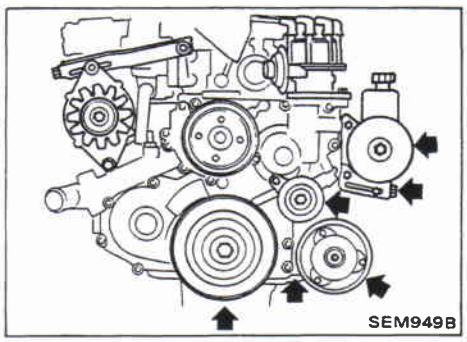
Be careful not to spill coolant on drive belts.

2. Remove radiator and cooling fan.
3. Remove the following belts.
- Power steering drive belt
- Alternator drive belts
- Compressor drive belt



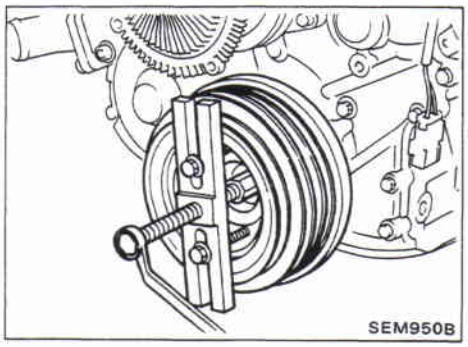
4. Set No. 1 piston at T.D.C. on its compression stroke.



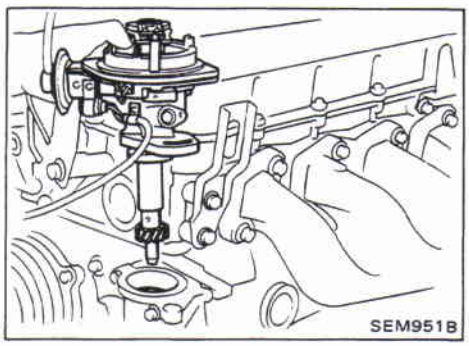


5. Remove the following parts.
- Power steering pump and power steering bracket
- A/C compressor, idler pulley and compressor bracket

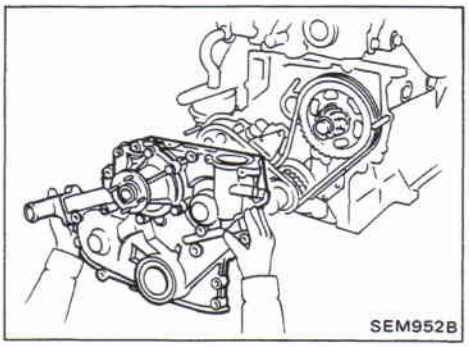
Removal (On-vehicle service) (Cont'd)



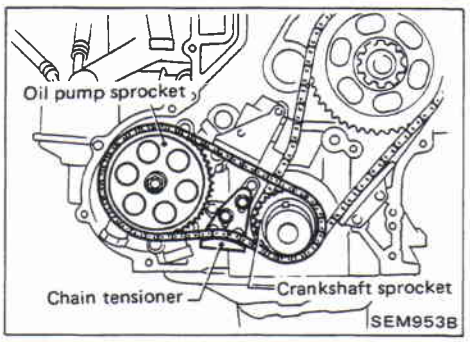
6. Remove crankshaft pulley.



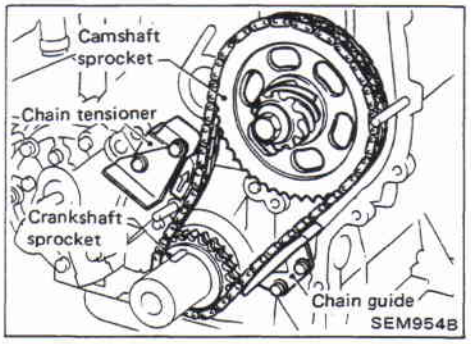
7. Remove distributor.



8. Remove oil pan.
9. Remove front cover.

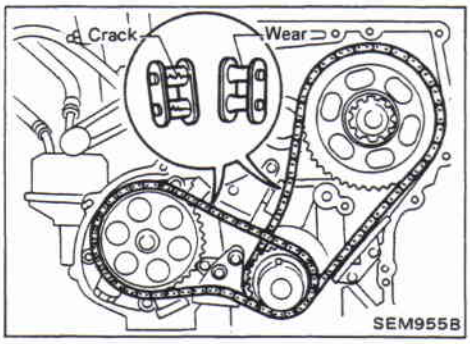


10. Remove the following parts.
- Chain tensioner
- Oil pump chain and sprocket



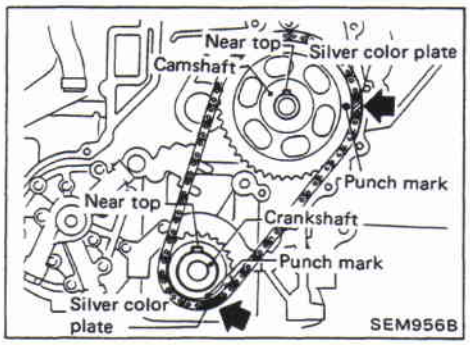
11. Remove the following parts.
- Chain tensioner
- Chain guides
- Timing chain and sprocket

Carefully remove chain tensioner. Otherwise, spring may fall.



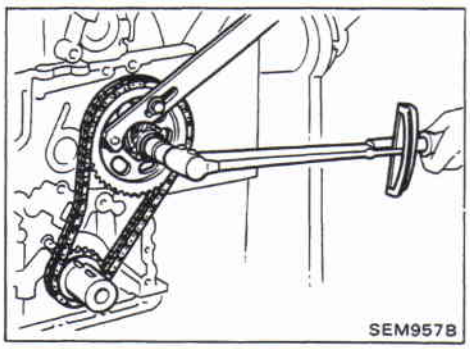
Inspection

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

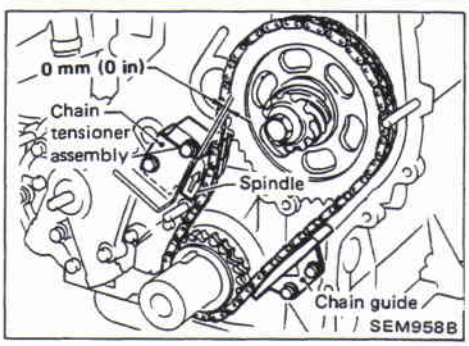


Installation (On-vehicle service)

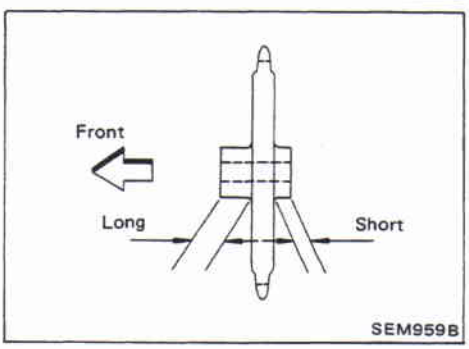
1. Install camshaft sprocket and timing chain.
- Confirm that No. 1 cylinder is set at T.D.C. on its compression stroke.
- **Set timing chain by aligning its mating marks with those of crankshaft sprocket and camshaft sprocket.**



2. Tighten camshaft sprocket bolt.

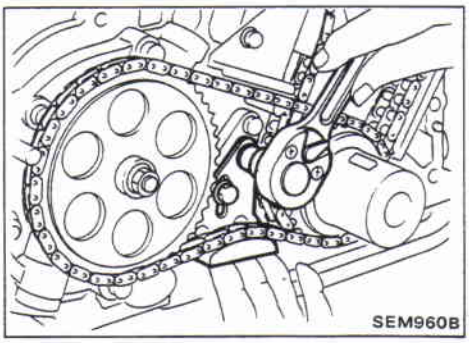


3. Install chain tensioner and chain guides.
- **Adjust protrusion of timing chain tensioner spindle to 0 mm (0 in) with slack chain guide.**

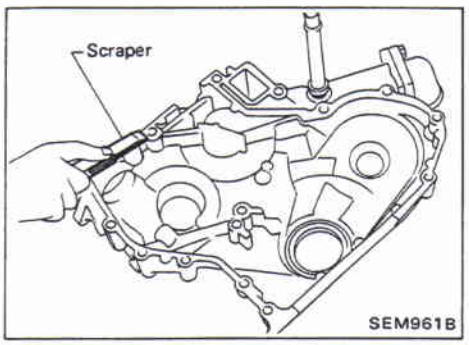


4. Install oil pump sprocket and oil pump chain.

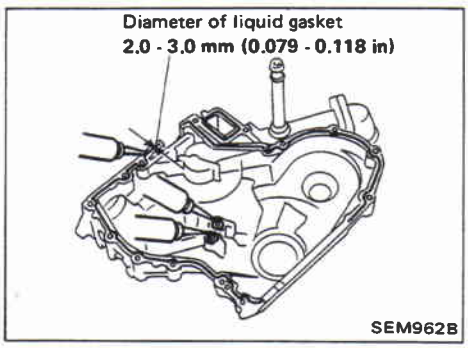
Installation (On-vehicle service) (Cont'd)



5. Install oil pump chain tensioner.
   Tighten bolts while applying pressure to oil pump chain with one hand.



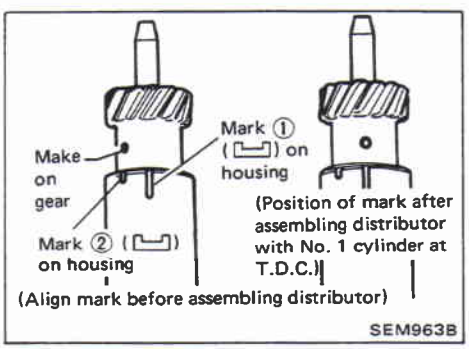
6. Before installing front cover, remove all traces of liquid gasket from mating surface using a scraper.



7. Apply a continuous bead of liquid gasket to front cover.
- **Use Genuine Liquid Gasket or equivalent.**

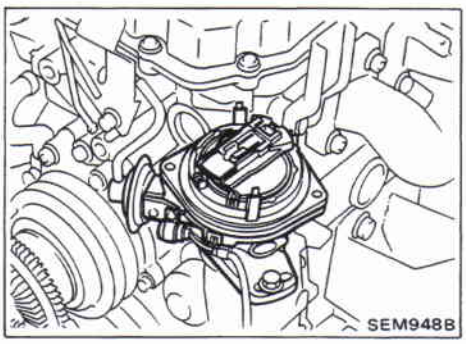
a. **Coat of liquid gasket should be maintained within 2.0 to 3.0 mm (0.079 to 0.118 in) dia. range.**
b. **Attach front cover to cylinder block within five minutes after coating.**
c. **Wait at least 30 minutes before refilling engine oil or starting engine.**

8. Install front cover.
Be careful not to damage cylinder head gasket.
9. Install oil pan.
Refer to Installation of OIL PAN.
10. Install crankshaft pulley.



11. Install distributor.
    Set the distributor gear position.
    [Be sure mark ② (⌐¬) on housing is aligned with mark on gear.]

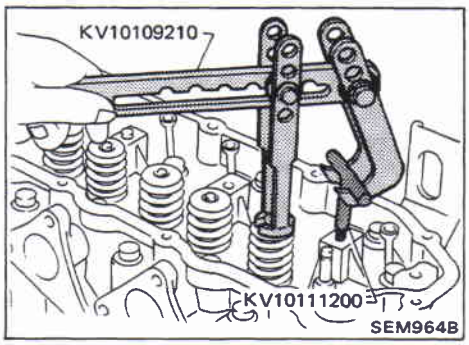
Installation (On-vehicle service) (Cont'd)



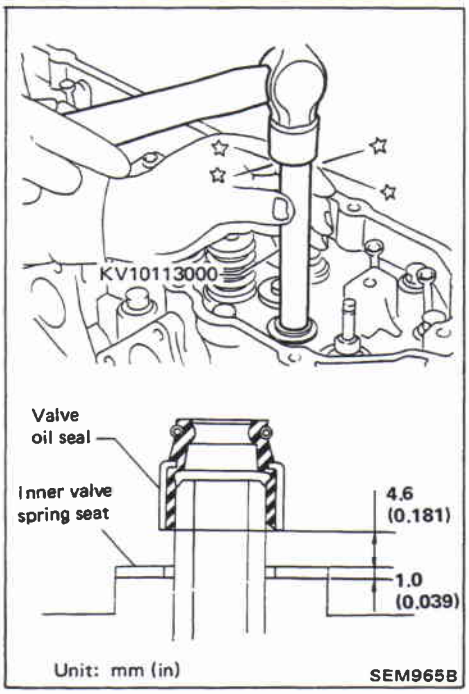
12. Make sure that No. 1 cylinder is set at T.D.C. and that distributor rotor is set at No. 1 cylinder spark position.

VALVE OIL SEAL (On-vehicle service)

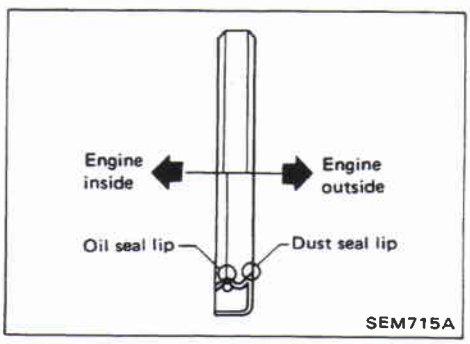
1. Remove air cleaner and air duct.
2. Remove rocker cover.
3. Remove rocker shaft assembly.



4. Remove valve springs and valve oil seals with Tool.
Piston concerned should be set at T.D.C. to prevent valve from falling off.

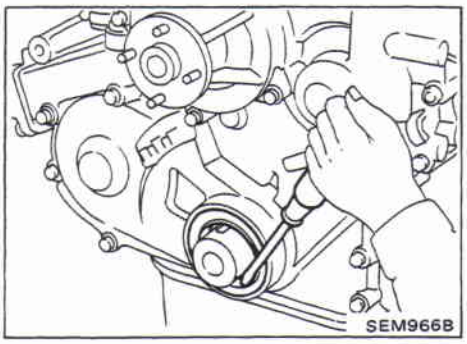


5. Apply engine oil to new valve oil seal and install it with Tool.
- **Before installing valve oil seal, install inner valve spring seat.**



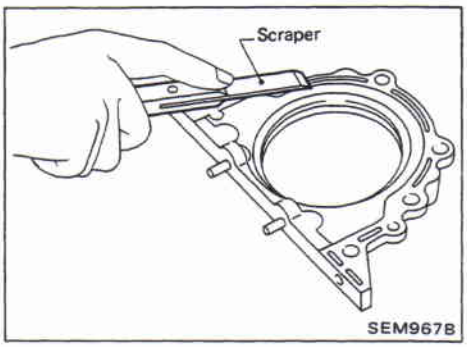
OIL SEAL INSTALLING DIRECTION

- When installing a new front or rear seal, make sure its mounting direction is correct.



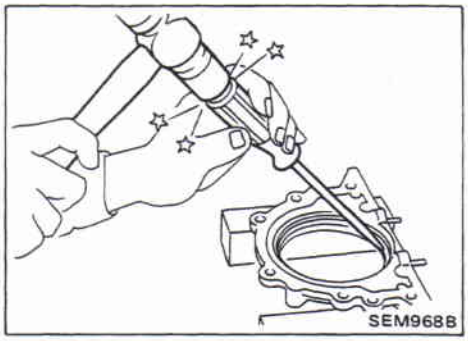
CRANKSHAFT FRONT OIL SEAL (On-vehicle service)

1. Remove radiator and radiator shroud.
2. Remove cooling fan.
3. Remove drive belts.
4. Remove crank pulley.
5. Remove crankshaft oil seal.
- Be careful not to damage sealing surfaces of crankshaft.
6. Apply engine oil to new oil seal and install it using suitable tool.

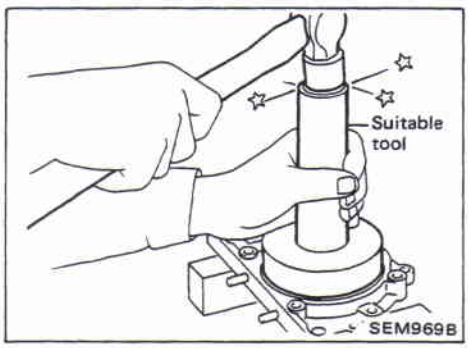


REAR OIL SEAL (On-vehicle service)

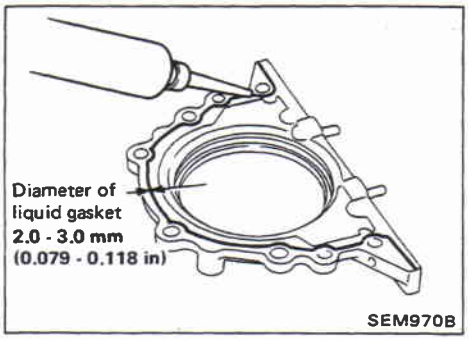
1. Remove flywheel or drive plate.
2. Remove oil pan.
3. Remove rear oil seal retainer.
4. Remove traces of liquid gasket using scraper.



5. Remove rear oil seal from retainer.



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

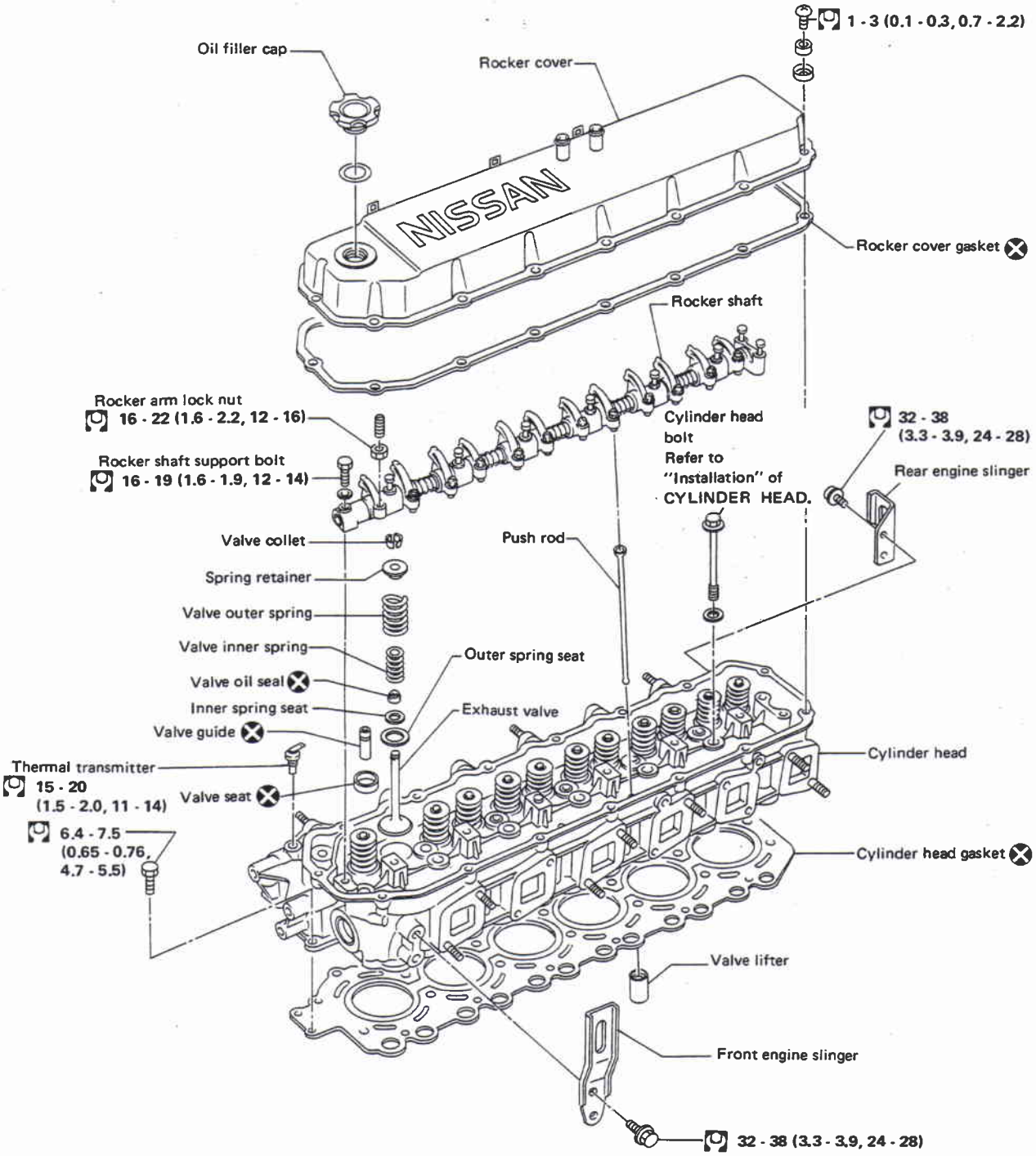


7. Apply a continuous bead of liquid gasket to rear oil seal retainer.
- **Use Genuine Liquid Gasket or equivalent.**

a. Coat of liquid gasket should be maintained within 2.0 to 3.0 mm (0.079 to 0.118 in) dia. range.

b. Attach oil seal retainer to cylinder block within five minutes after coating.

c. Wait at least 30 minutes before refilling engine oil or starting engine.



: N·m (kg-m, ft-lb)

SEM971B

CAUTION:

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

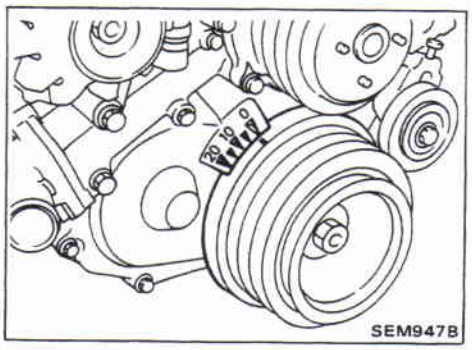
Removal (On-vehicle service)

1. Drain coolant from radiator.

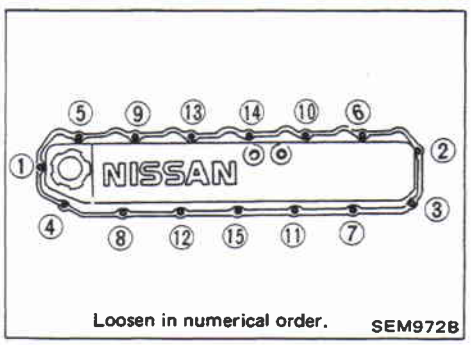
Be careful not to spill coolant on drive belts.

2. Remove the following parts.
- Air cleaner and duct
- Disconnect vacuum hoses, harness, water hoses and fuel hose
- Disconnect high tension wires from spark plugs
- Disconnect accelerator wire and choke wire
- Alternator adjusting bar

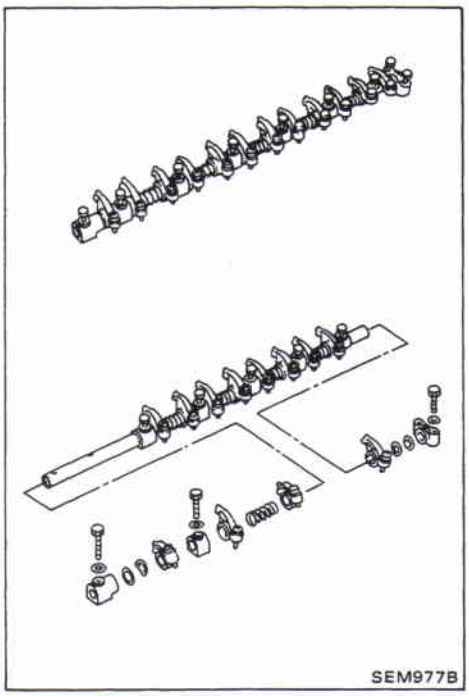
3. Disconnect front exhaust tube from exhaust manifold.
4. Set No. 1 piston at T.D.C. on its compression stroke.



5. Remove rocker cover.
- Loosen rocker cover bolts in numerical order.



Removal (On-vehicle service) (Cont'd)

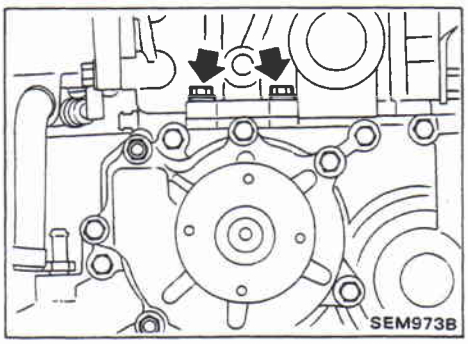

SEM977B

6. Remove rocker shaft with rocker arms.

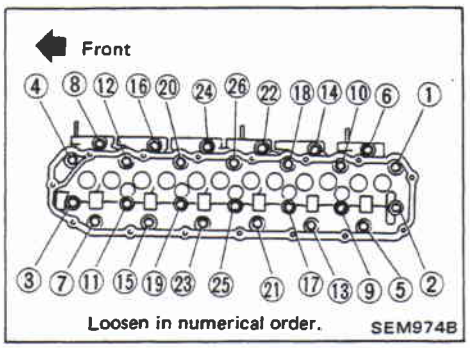
Before removal, fully loosen valve clearance adjusting screws.

The bolts should be loosened in two or three steps.

7. Remove push rods.


SEM973B

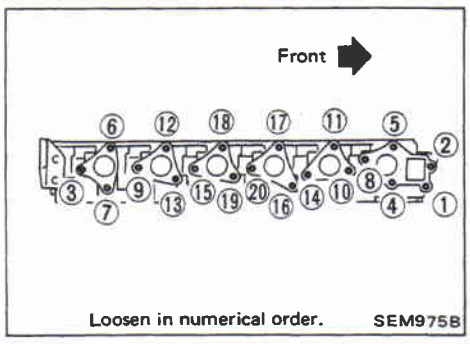
8. Remove front cover tightening bolts to cylinder head.



Loosen in numerical order. SEM974B

9. Remove cylinder head with manifolds.

- **Head warpage or cracking could result from removing in incorrect order.**
- **Cylinder head bolts should be loosened in two or three steps.**



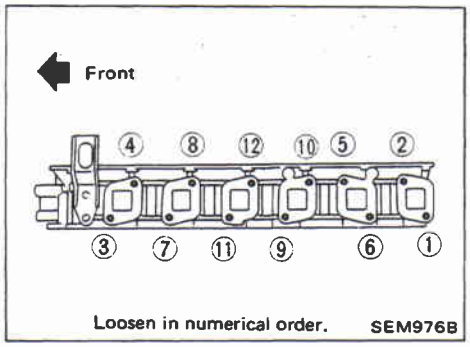
Loosen in numerical order. SEM975B

Disassembly

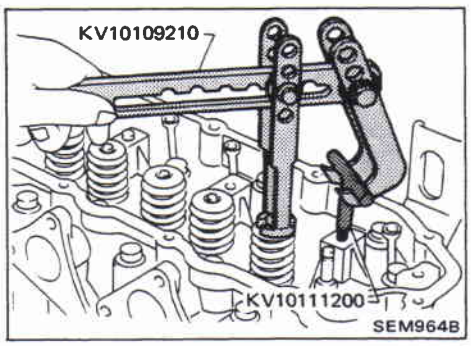
1. Remove intake manifold.

- Loosen intake manifold bolts in numerical order.

Disassembly (Cont'd)



2. Remove exhaust manifold.
- Loosen exhaust manifold bolts in numerical order.



3. Remove valve springs and valve oil seals with Tool.

Inspection

CYLINDER HEAD DISTORTION

Head surface flatness:

Less than 0.07 mm (0.0028 in)

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

Resurfacing limit:

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

Amount of cylinder head resurfacing is "A"

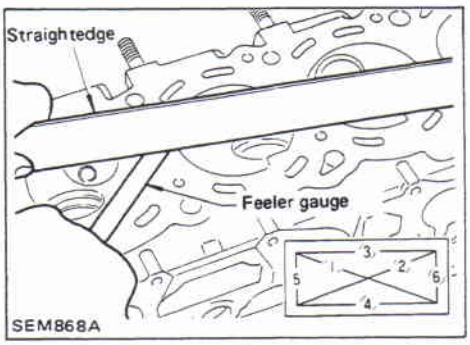
Amount of cylinder block resurfacing is "B"

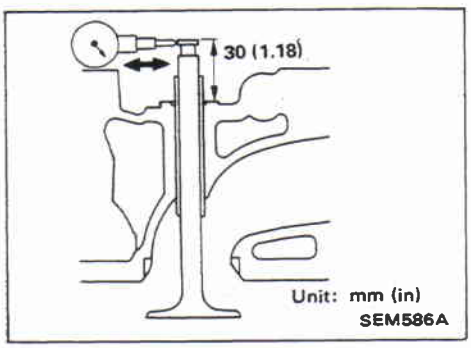
The maximum limit is as follows:

A + B = 0.2 mm (0.008 in)

Nominal cylinder head height:

117.19 - 117.59 mm (4.6138 - 4.6295 in)





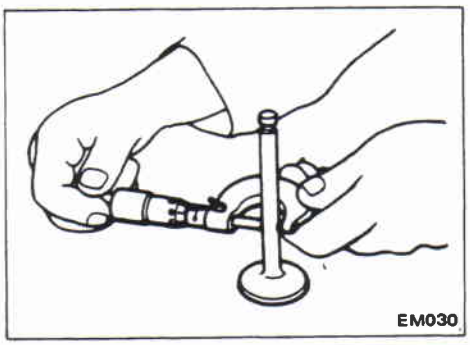
VALVE GUIDE CLEARANCE

1. Measure valve deflection in a parallel direction with rocker arm. (Valve and valve guide mostly wear in this direction.)

Valve deflection limit (Dial gauge reading):

0.2 mm (0.008 in)

Inspection (Cont'd)

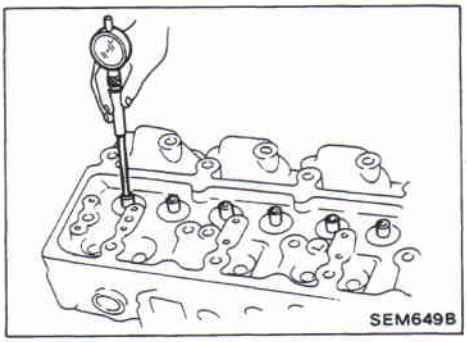


2. If it exceeds the limit, check valve to valve guide clearance.
(1) Measure valve stem diameter "d" and valve guide inner diameter.
(2) Check that clearance is within the specification.

Valve to valve guide clearance limit:

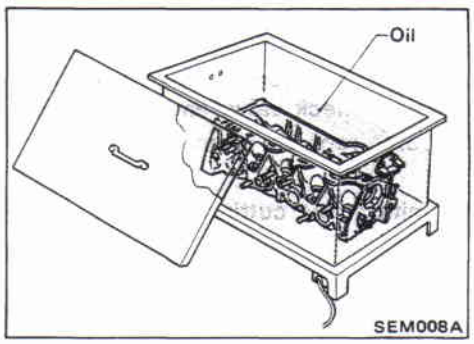
0.1 mm (0.004 in)

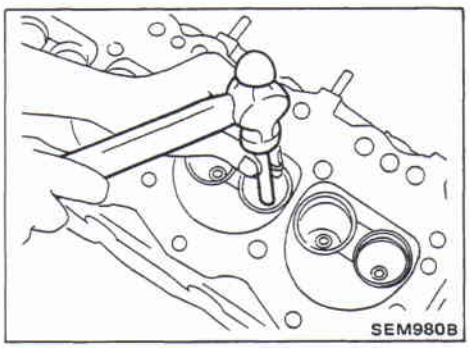
(3) If it exceeds the limit, replace valve or valve guide.



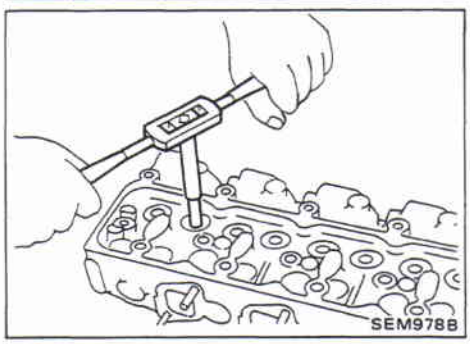
VALVE GUIDE REPLACEMENT

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





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



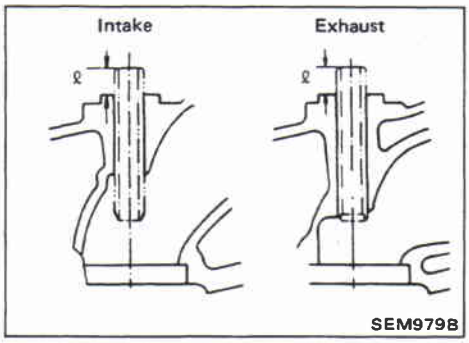
3. Ream cylinder head valve guide hole.

Valve guide hole diameter (for service parts):

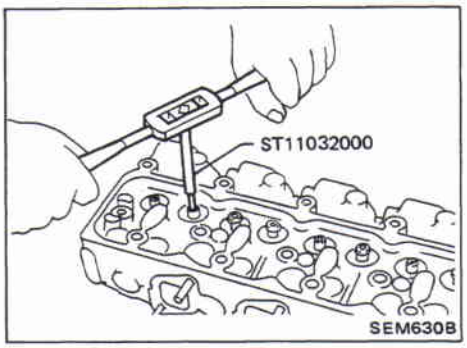
Intake and exhaust

12.233 - 12.244 mm (0.4816 - 0.4820 in)

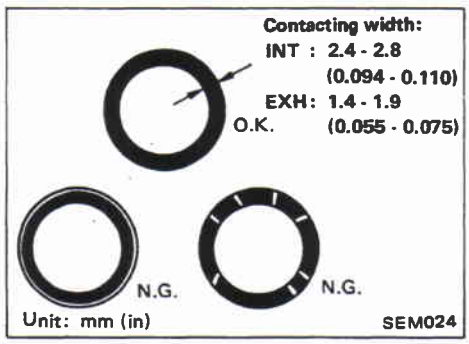
Inspection (Cont'd)



4. Heat cylinder head to 150 to 160°C (302 to 320°F) and press service valve guide onto cylinder head.
   Projection " ℓ ":
   11.7 - 12.3 mm (0.461 - 0.484 in)



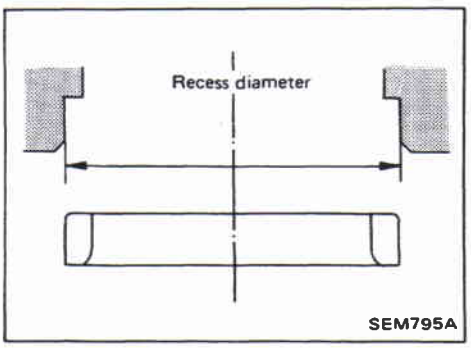
5. Ream valve guide.
   Finished size:
   Intake and exhaust
   8.000 - 8.018 mm (0.3150 - 0.3157 in)



VALVE SEATS

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

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

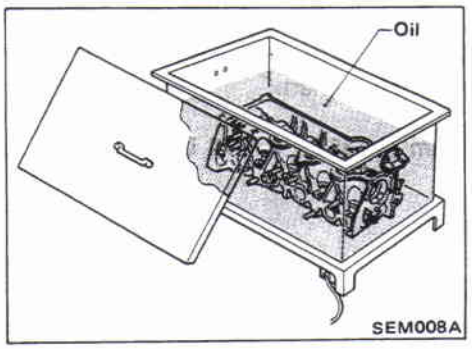


REPLACING VALVE SEAT FOR SERVICE PARTS

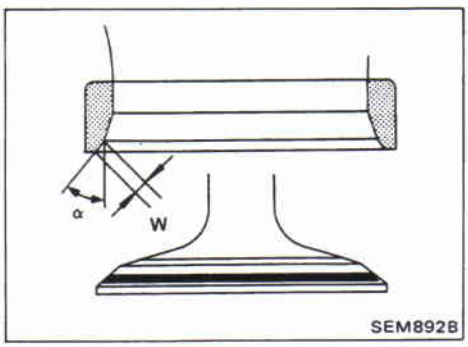
1. Bore out old seat until it collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the seat recess in cylinder head.
2. Ream cylinder head recess.
   Reaming bore for service valve seat
   Oversize [0.5 mm (0.020 in)]:
   Intake
   48.500 - 48.516 mm (1.9094 - 1.9101 in)
   Exhaust
   40.500 - 40.516 mm (1.5945 - 1.5951 in)

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

Inspection (Cont'd)

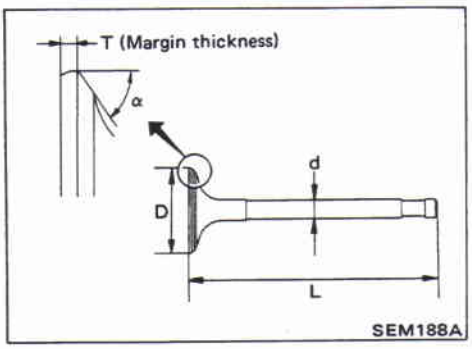


3. Heat cylinder head to 150 to 160°C (302 to 320°F).
4. Press fit valve seat until it seats on the bottom.



5. Cut or grind valve seat using suitable tool at the specified dimensions as shown in S.D.S.
6. After cutting, lap valve seat with an abrasive compound.
7. Check valve seating condition.

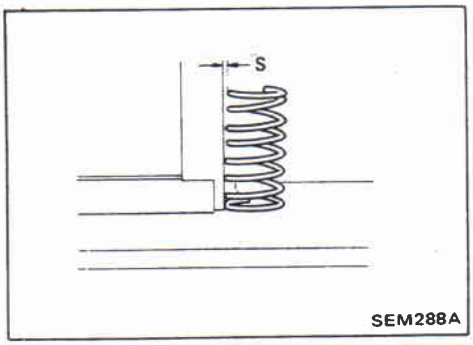
Seat face angle "α": 45 deg.
Contacting width "W":
Intake
2.4 - 2.8 mm (0.094 - 0.110 in)
Exhaust
1.4 - 1.9 mm (0.055 - 0.075 in)



VALVE DIMENSIONS

Check dimensions in each valve. For dimensions, refer to S.D.S. When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace the valve.

Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.

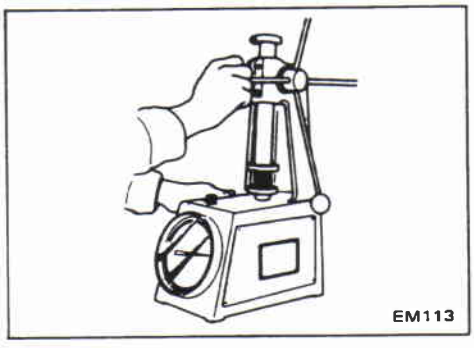


VALVE SPRING SQUARENESS

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 it exceeds the limit, replace spring.

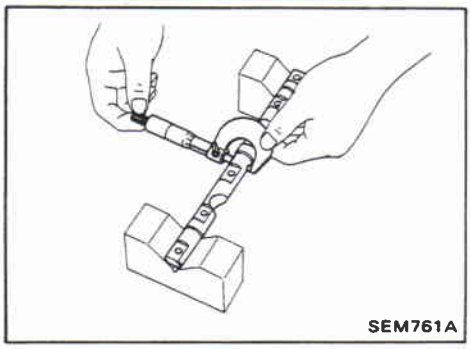


VALVE SPRING PRESSURE HEIGHT

Check valve spring pressure height.

Pressure height: mm/N (mm/kg, in/lb)
Outer
30.0/512.9 (30.0/52.3, 1.181/115.3)
Inner
25.0/255.0 (25.0/26.0, 0.984/57.3)

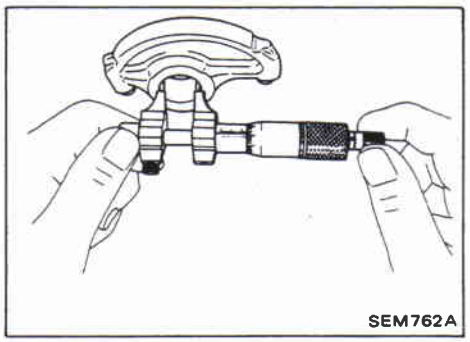
Inspection (Cont'd)


SEM761A

ROCKER SHAFT AND ROCKER ARM

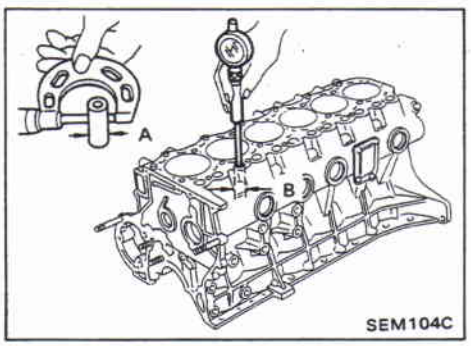
1. Check rocker shaft for scratches, seizure and wear.
2. Check outer diameter of rocker shaft.

Diameter:
19.979 - 20.000 mm (0.7866 - 0.7874 in)


SEM762A

3. Check inner diameter of rocker arm.

Diameter:
20.020 - 20.038 mm (0.7882 - 0.7889 in)
Rocker arm to shaft clearance:
0.020 - 0.059 mm (0.0008 - 0.0023 in)



SEM104C

VALVE LIFTER AND PUSH ROD

Valve lifter

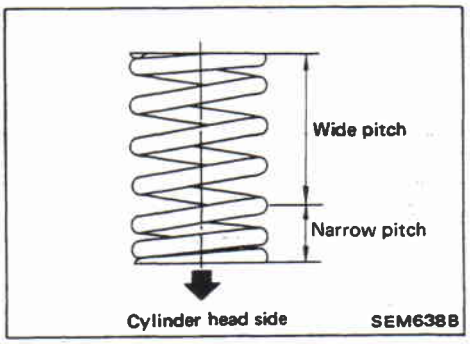
1. Check valve lifters for excessive wear on the face.
2. Replace with new ones if worn beyond repair.

a. Valve lifter end should be smooth.
b. Valve lifter to lifter hole clearance:
Standard
0.020 - 0.063 mm (0.0008 - 0.0025 in)
Limit
Less than 0.20 mm (0.0079 in)
Valve lifter outer diameter "A":
Standard
24.970 - 24.980 mm (0.9831 - 0.9835 in)
Cylinder block valve lifter hole diameter "B":
Standard
25.000 - 25.033 mm (0.9843 - 0.9855 in)

Push rod

1. Inspect push rod for excessive wear on the face.
2. Replace if worn or damaged beyond repair.
3. Check push rod for bend using a dial gauge.

Maximum allowable bend
(Total indicator reading):
Less than 0.5 mm (0.020 in)

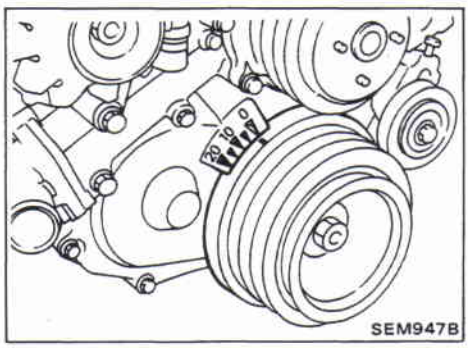


Assembly

1. Install valve component parts.
- **Always use new valve oil seal. Refer to OIL SEAL REPLACEMENT.**
- **Before installing valve oil seal, install inner spring seat.**
- **Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.**

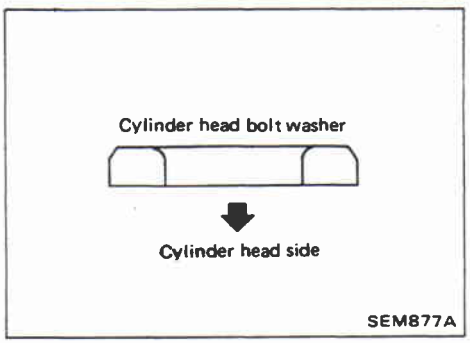
2. Install intake and exhaust manifolds.
Tighten manifold bolts and nuts in two or three steps in reverse order of removal.

Refer to "Removal" of CYLINDER HEAD.

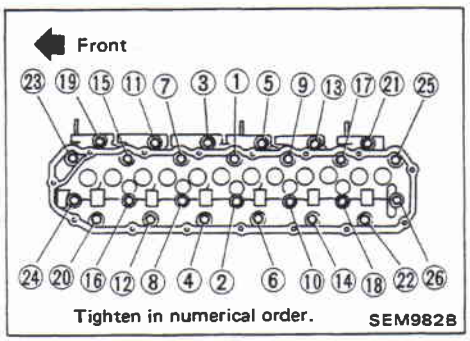


Installation (On-vehicle service)

1. Set No. 1 piston at T.D.C. on its compression stroke.

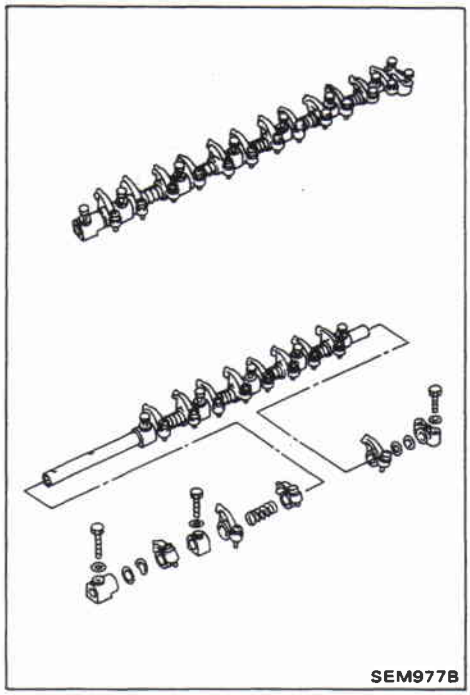


2. Install cylinder head with new gasket.
- **Be sure to install washers between bolts and cylinder head.**
- **Do not rotate crankshaft and camshaft separately, or valves will hit piston heads.**



3. Tighten cylinder head bolts in numerical order.
- **Tightening procedure.**

(1) Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
(2) Tighten all bolts from 57 to 67 N·m (5.8 to 6.8 kg-m, 42 to 49 ft-lb).
(3) Loosen all bolts completely.
(4) Tighten all bolts to 29 N·m (3.0 kg-m, 22 ft-lb).
(5) Tighten all bolts from 64 to 74 N·m (6.5 to 7.5 kg-m, 47 to 54 ft-lb) or if you have an angle wrench, turn all bolts 69 to 74 degrees clockwise.


SEM977B

Installation (On-vehicle service) (Cont'd)

4. Install push rods and rocker shaft with rocker arms.
5. Adjust valve clearance.

Valve clearance:

Unit: mm (in)

	*Cold	Hot
Intake	0.20 (0.008)	0.38 (0.015)
Exhaust	0.20 (0.008)	0.38 (0.015)

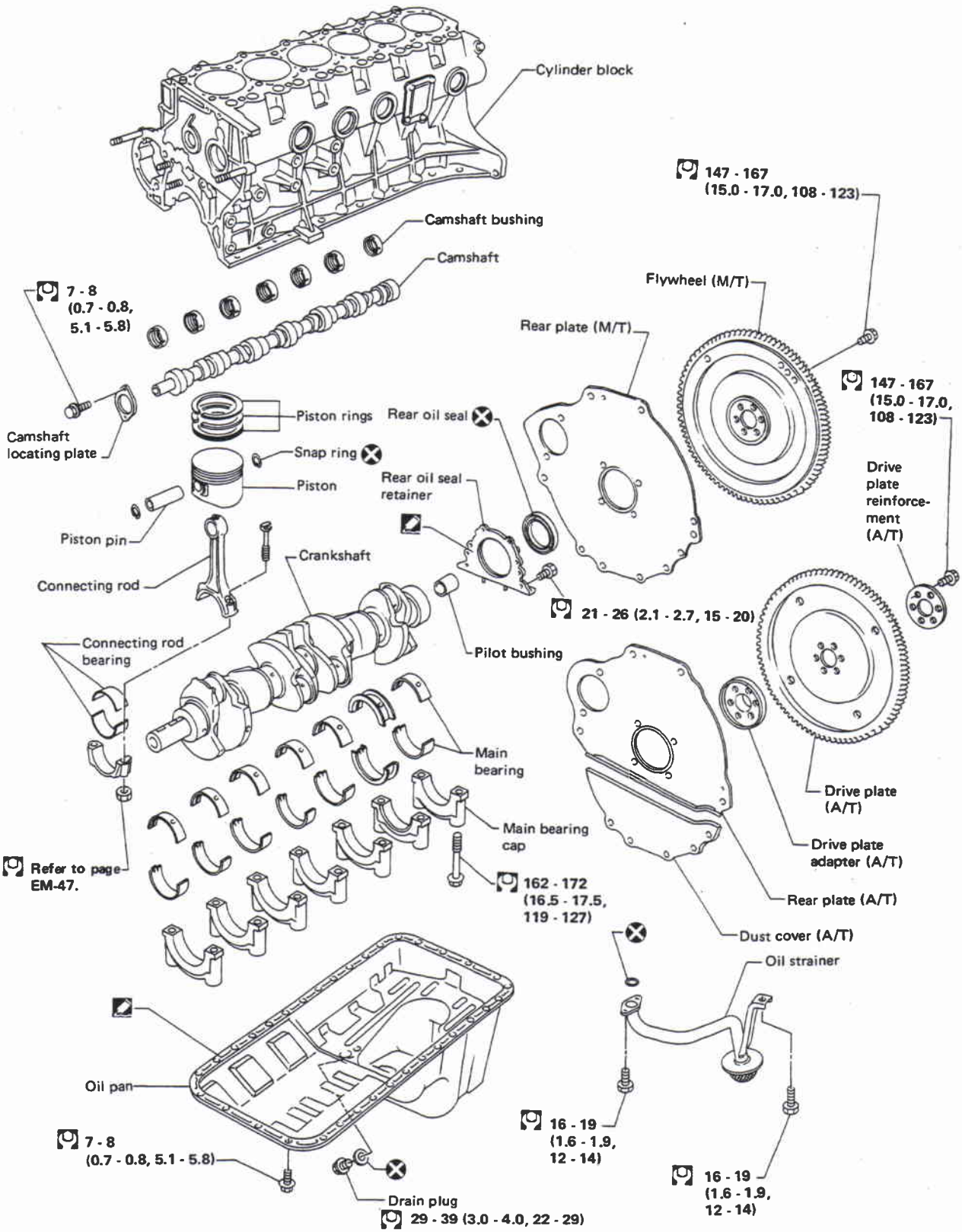
* At temperature of approximately 20°C (68°F)

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

Refer to MA section.

6. Install rocker cover.
   Tighten rocker cover bolts in reverse order of removal.

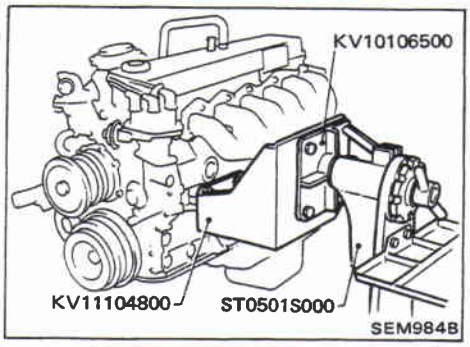
Refer to "Removal" of CYLINDER HEAD.



: N·m (kg-m, ft-lb)

SEM983B

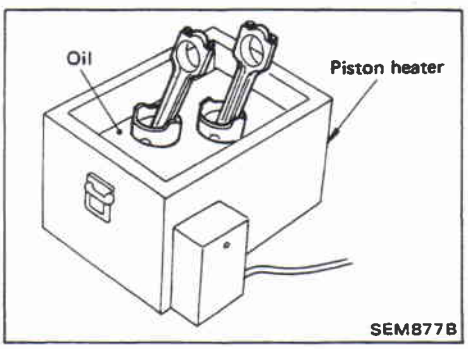
CAUTION:
- **When installing sliding parts such as bearings and pistons, be sure to apply engine oil on the sliding surfaces.**
- **Place the removed parts such as bearings and bearing caps in their proper order and direction.**
- **When tightening connecting rod bolts, main bearing cap bolts and flywheel bolts, apply engine oil to the thread portion of bolts and seating surface of nuts.**



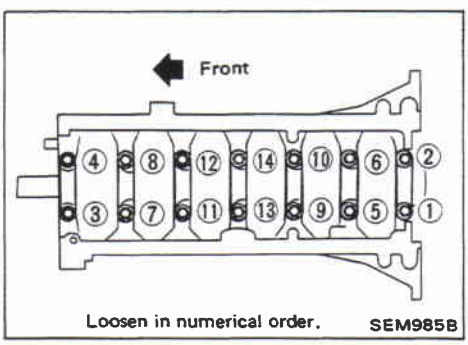
Disassembly

PISTON AND CRANKSHAFT

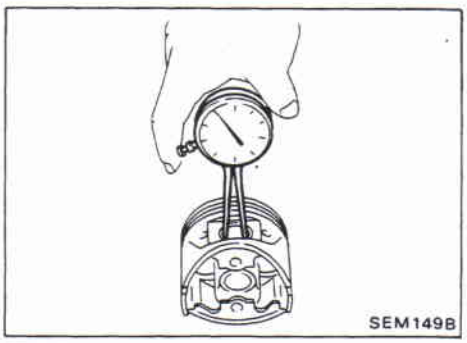
1. Place engine on work stand.
2. Drain coolant and remove water pump.
3. Drain oil.
4. Remove oil pan and oil strainer.
5. Remove distributor.
6. Remove front cover.
7. Remove oil pump chain.
8. Remove timing chain.
9. Remove rocker cover.
10. Remove rocker shaft with rocker arms and push rods.
11. Remove cylinder head.
12. Remove valve lifters and camshaft.



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



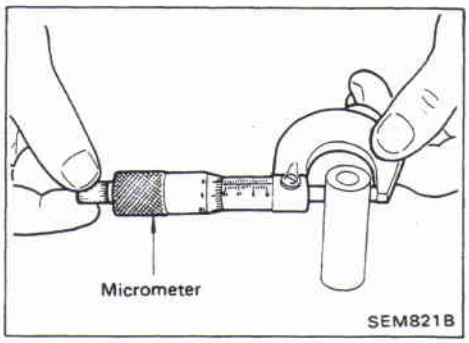
14. Remove bearing cap and crankshaft.
- **Before removing bearing cap, measure crankshaft end play.**



Inspection

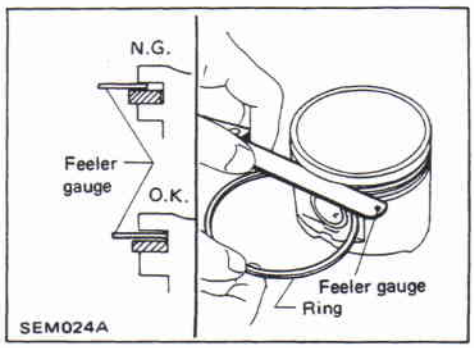
PISTON AND PISTON PIN CLEARANCE

1. Measure inner diameter of piston pin hole "dp".
   Standard diameter "dp":
   22.987 - 22.993 mm (0.9050 - 0.9052 in)



2. Measure outer diameter of piston pin "Dp".
   Standard diameter "Dp":
   22.989 - 22.995 mm (0.9051 - 0.9053 in)
3. Calculate piston pin clearance.
   –0.008 to 0.004 mm (–0.0003 to 0.0002 in)

If it exceeds the limit, replace piston assembly with pin.



PISTON RING SIDE CLEARANCE

Side clearance:

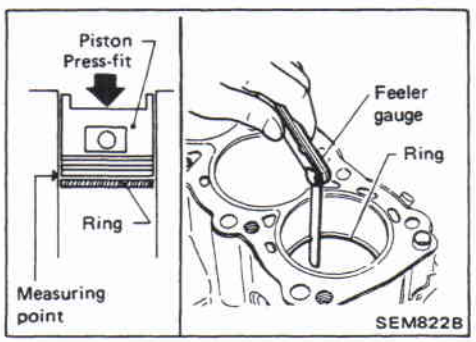
Top ring
0.040 - 0.073 mm (0.0016 - 0.0029 in)

2nd ring
0.030 - 0.063 mm (0.0012 - 0.0025 in)

Oil ring
0.015 - 0.185 mm (0.0006 - 0.0073 in)

Max. limit of side clearance (Top and 2nd rings):
0.1 mm (0.004 in)

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



PISTON RING GAP

Standard ring gap:

Top ring
0.30 - 0.45 mm (0.0118 - 0.0177 in)

2nd ring
0.30 - 0.45 mm (0.0118 - 0.0177 in)

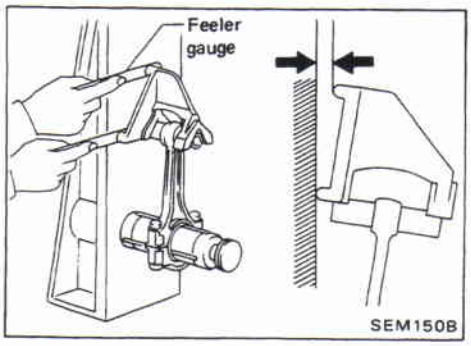
Oil ring
0.20 - 0.60 mm (0.0079 - 0.0236 in)

Max. limit of ring gap:
1.5 mm (0.059 in)

Inspection (Cont'd)

If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, rebore the cylinder and use oversized piston and piston ring assembly.

Refer to S.D.S.



CONNECTING ROD BEND AND TORSION

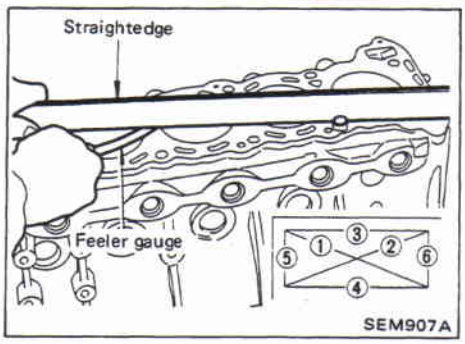
Bend:

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

Torsion:

Limit 0.3 mm (0.012 in)
per 100 mm (3.94 in) length

If it exceeds the limit, replace connecting rod assembly.



CYLINDER BLOCK DISTORTION AND WEAR

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

   Limit:

   0.10 mm (0.0039 in)

2. If out of specification, resurface it.
   The resurfacing limit is determined by the 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)

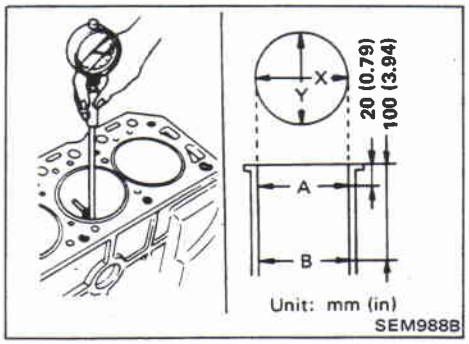
Nominal cylinder block height
from crankshaft center:

254.95 - 255.05 mm (10.0374 - 10.0413 in)

3. If necessary, replace cylinder block.

Inspection (Cont'd)

PISTON-TO-BORE CLEARANCE

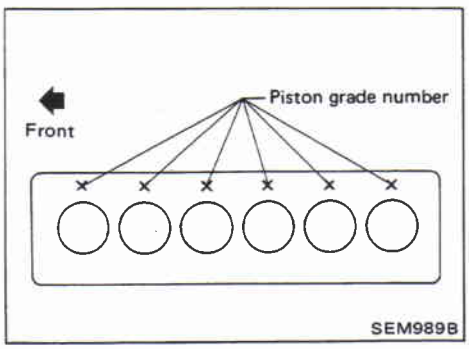


Method A (Using bore gauge and micrometer)

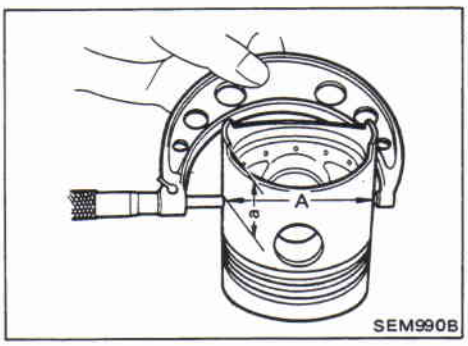
1. Using a bore gauge, measure cylinder bore for wear, out-of-round or taper.

   Standard inner diameter:
   96.000 - 96.050 mm (3.7795 - 3.7815 in)
   Wear limit:
   0.20 mm (0.0079 in)
   Out-of-round (X—Y) limit:
   0.015 mm (0.0006 in)
   Taper (A—B) limit:
   0.010 mm (0.0004 in)

   If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.
2. Check for scratches or seizure. If seizure is found, hone it.



- **If cylinder block or piston is replaced with a new one, select piston of the same grade number punched on cylinder block upper surface.**



3. Measure piston skirt diameter.
   Piston diameter "A":
   Refer to S.D.S.
   Measuring point "a" (Distance from the bottom):
   20 mm (0.79 in)
4. Check that piston-to-bore clearance is within the specification.
   Piston-to-bore clearance "B":
   0.015 - 0.035 mm (0.0006 - 0.0014 in)
5. Determine piston oversize according to amount of cylinder wear.

Oversize pistons are available for service. Refer to S.D.S.

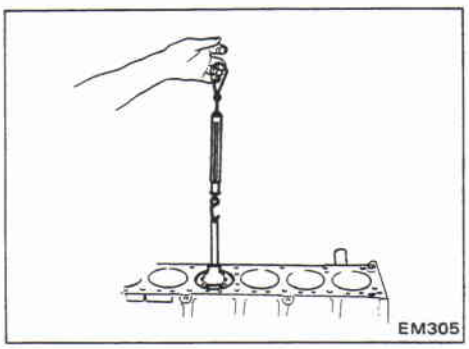
Inspection (Cont'd)

6. Cylinder 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 the cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.**

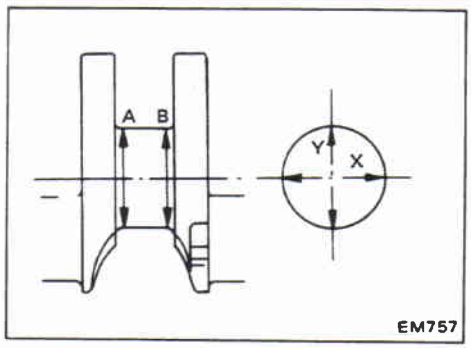
9. Hone the cylinders to obtain specified piston-to-bore clearance.
10. Measure the finished cylinder bore for out-of-round and taper.

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



Method B (Using feeler gauge)
Measure the extracting force by pulling feeler gauge straight upward.

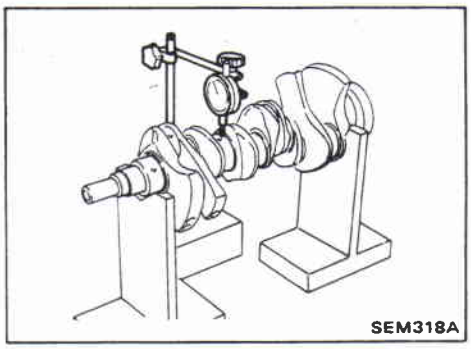
Feeler gauge thickness:
0.04 mm (0.0016 in)
Extracting force:
2.0 - 14.7 N (0.2 - 1.5 kg, 0.4 - 3.3 lb)



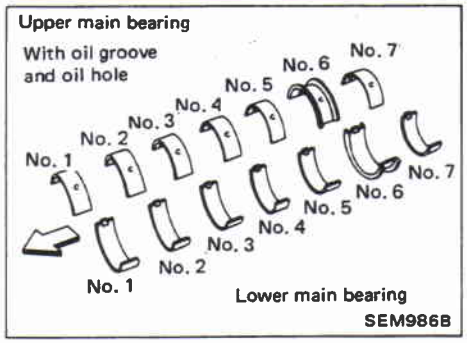
CRANKSHAFT

1. Check crankshaft main and pin journals for score, bias, wear or cracks.
2. With a micrometer, measure journals for taper and out-of-round.
   Out-of-round (X—Y):
   Less than 0.0025 mm (0.0001 in)
   Taper (A—B):
   Less than 0.0025 mm (0.0001 in)

Inspection (Cont'd)


SEM318A

3. Measure crankshaft runout.
   Runout (Total indicator reading):
   Less than 0.20 mm (0.0079 in)



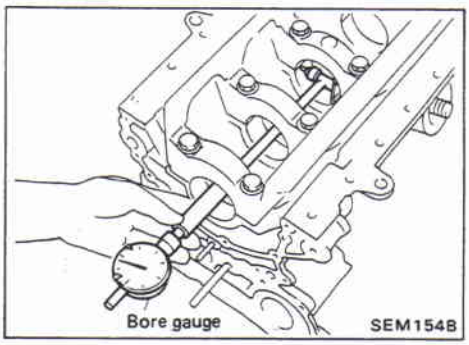
SEM986B

BEARING CLEARANCE

Method A (Using bore gauge and micrometer)

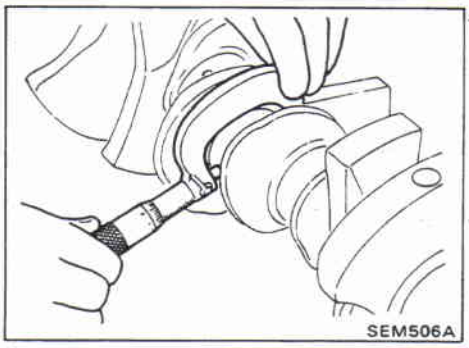
Main bearing clearance

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

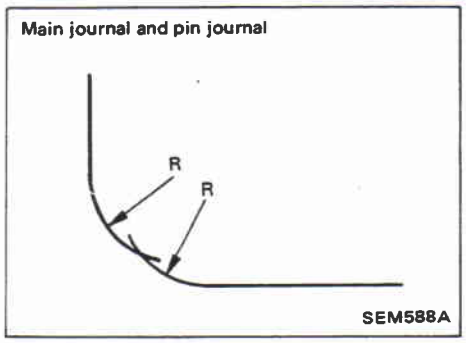


SEM154B

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 main bearing.


SEM506A

4. Measure outer diameter "Dm" of crankshaft main journal.
5. Calculate main bearing clearance.
   Main bearing clearance = A – Dm
   Standard:
   0.041 - 0.087 mm (0.0016 - 0.0034 in)
   Limit: 0.09 mm (0.0035 in)
6. If it exceeds the limit, replace bearing.
7. If the clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.

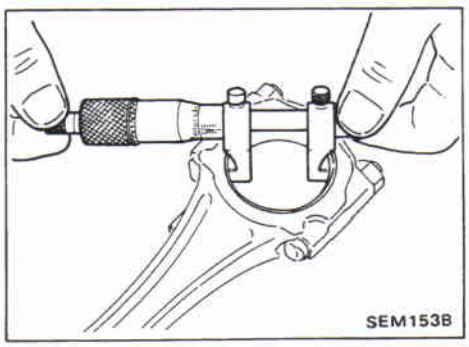


SEM588A

a. When grinding crank pin and crank journal, fillets should be finished as shown in the figure.
   R: Main journal
   2.5 - 2.6 mm (0.098 - 0.102 in)
   Pin journal
   3.0 - 3.1 mm (0.118 - 0.122 in)
b. Refer to S.D.S. for grinding crankshaft and available service parts.

Inspection (Cont'd)

8. If crankshaft, cylinder block and main bearings are replaced with new ones, check that the clearance of main bearing is within specifications.

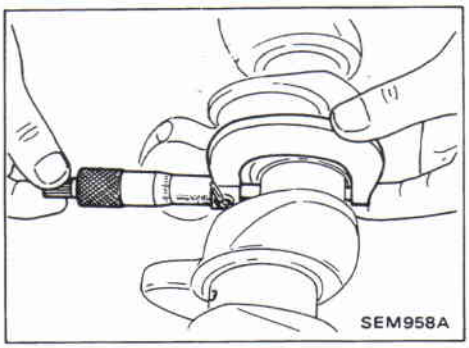


CONNECTING ROD BEARING CLEARANCE (Big end)

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 bearing.



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

   Connecting rod bearing clearance = C – Dp

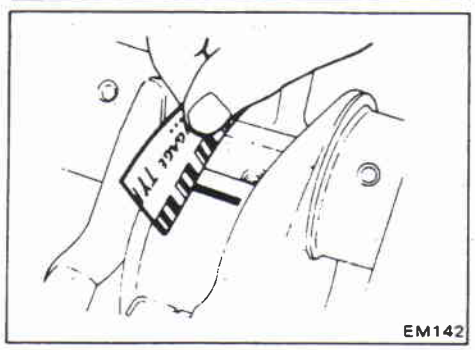
   Standard:

   0.027 - 0.061 mm (0.0011 - 0.0024 in)

   Limit: 0.09 mm (0.0035 in)

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

   Refer to step 7 of "MAIN BEARING CLEARANCE".



Method B (Using plastigage)

CAUTION:

- **Do not turn crankshaft or connecting rod while the 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 thicker main bearing or undersized bearing so that the specified bearing clearance is obtained.**

Main bearing clearance:

Standard

0.051 - 0.097 mm (0.0020 - 0.0038 in)

Limit

0.1 mm (0.004 in)

Connecting rod bearing clearance:

Standard

0.040 - 0.074 mm (0.0016 - 0.0029 in)

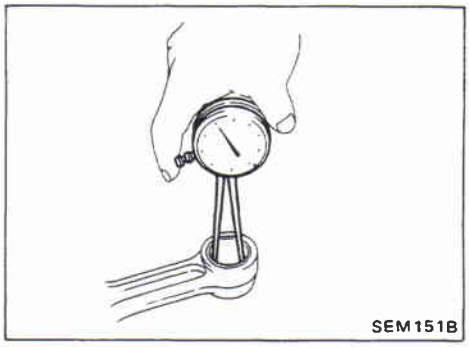
Limit

0.1 mm (0.004 in)

Inspection (Cont'd)

CONNECTING ROD BUSHING CLEARANCE (Small end)

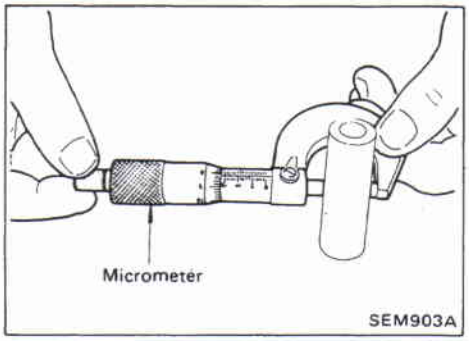
1. Measure inner diameter "C" of bushing.



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

C – Dp = 0.005 - 0.017 mm (0.0002 - 0.0007 in)

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



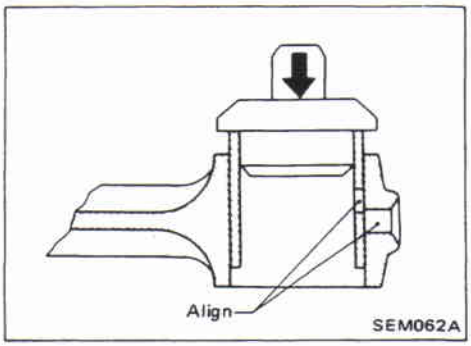
REPLACEMENT OF CONNECTING ROD SMALL END BUSHING

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

Be sure to align the oil holes.

2. After driving in the small end bushing, ream the bushing.

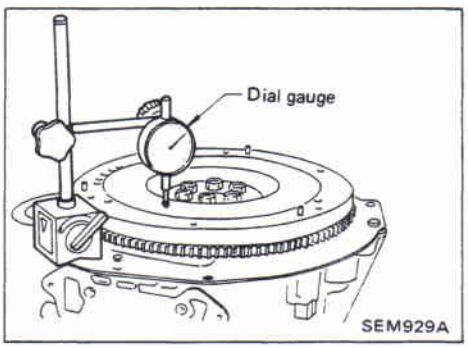
Small end bushing inside diameter:
Finished size
23.000 - 23.006 mm (0.9055 - 0.9057 in)



FLYWHEEL OR DRIVE PLATE RUNOUT

Runout (Total indicator reading):
Flywheel (M/T model)
0.1 mm (0.004 in) or less
Drive plate (A/T model)
0.1 mm (0.004 in) or less

If runout exceeds the limit, replace flywheel or drive plate.

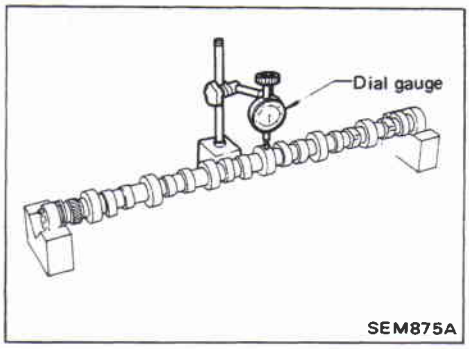


CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.

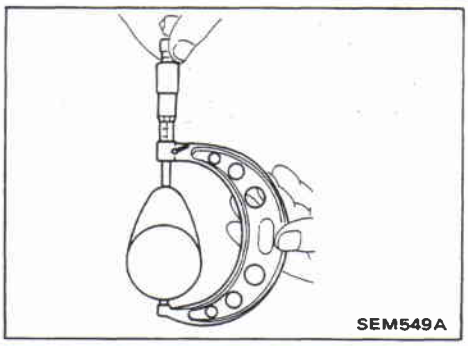
Inspection (Cont'd)

CAMSHAFT RUNOUT



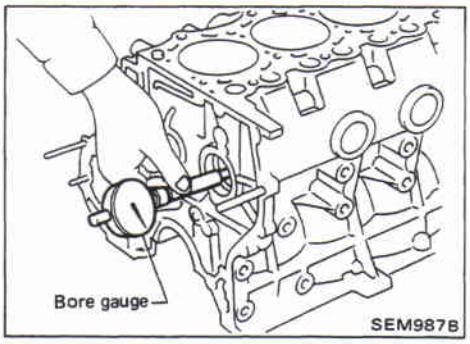
1. Measure camshaft runout at the center journal.
   Runout (Total indicator reading):
   Limit 0.06 mm (0.0024 in)
2. If it exceeds the limit, replace camshaft.

CAMSHAFT CAM HEIGHT

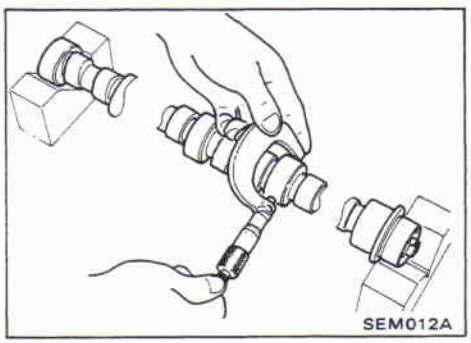


1. Measure camshaft cam height.
   Standard cam height:
   42.311 - 42.561 mm (1.6658 - 1.6756 in)
   Cam wear limit:
   0.15 mm (0.0059 in)
2. If wear is beyond the limit, replace camshaft.

CAMSHAFT JOURNAL CLEARANCE



1. Measure the inner diameter of camshaft bushings.
   Standard inner diameter:
   Front
   50.76 - 50.83 mm (1.9984 - 2.0012 in)
   2nd
   50.56 - 50.63 mm (1.9905 - 1.9933 in)
   3rd
   50.36 - 50.43 mm (1.9827 - 1.9854 in)
   4th
   50.16 - 50.23 mm (1.9748 - 1.9776 in)
   5th
   49.96 - 50.03 mm (1.9669 - 1.9697 in)
   6th
   49.76 - 49.83 mm (1.9591 - 1.9618 in)
   Rear
   49.56 - 49.63 mm (1.9512 - 1.9539 in)



2. Measure the outer diameter of camshaft journal.
   Standard outer diameter:
   Front
   50.721 - 50.740 mm (1.9969 - 1.9976 in)
   2nd
   50.521 - 50.540 mm (1.9890 - 1.9898 in)
   3rd
   50.321 - 50.340 mm (1.9811 - 1.9819 in)
   4th
   50.121 - 50.140 mm (1.9733 - 1.9740 in)

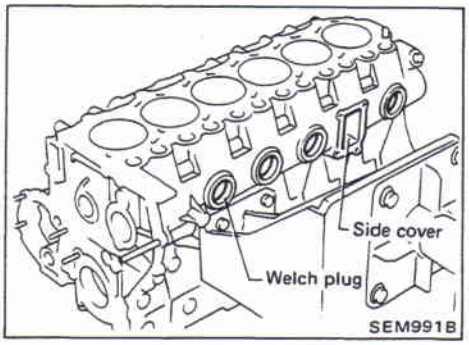
Inspection (Cont'd)

5th
49.921 - 49.940 mm (1.9654 - 1.9661 in)
6th
49.721 - 49.740 mm (1.9575 - 1.9583 in)
Rear
49.521 - 49.540 mm (1.9496 - 1.9504 in)

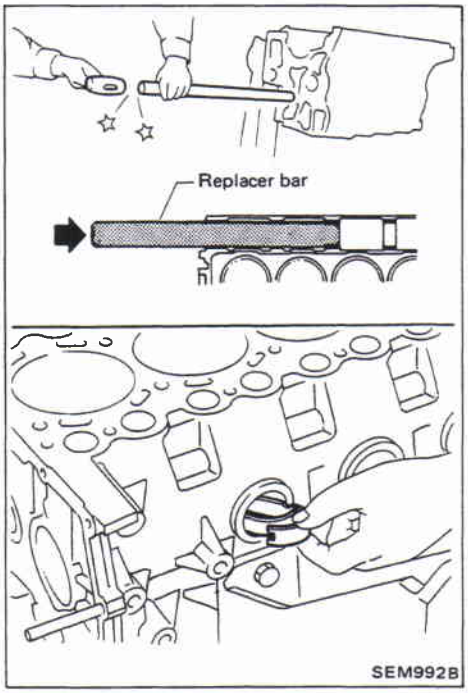
3. If the clearance exceeds the limit, replace camshaft and/or camshaft bushings.
   Camshaft journal clearance limit:
   0.15 mm (0.0059 in)

REPLACING CAMSHAFT BUSHING

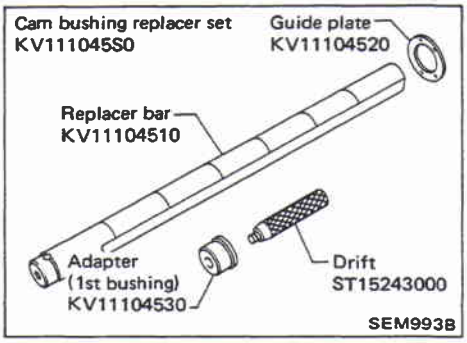
1. Remove welch plugs and side cover.



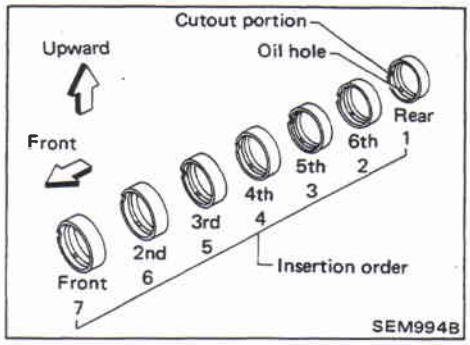
2. Using Tool, remove camshaft bushings from engine. Some bushings must be broken in order to remove.



3. Using Tool, install camshaft bushings as follows:

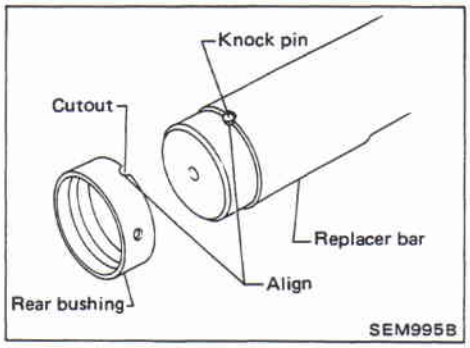


Inspection (Cont'd)

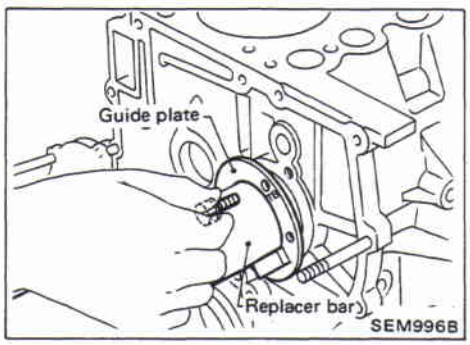


(1) Install camshaft bushings in the order of "rear", "6th", "5th", "4th", "3rd", "2nd" and "front". All bushings must be installed from the front.

(2) Face the cutout rightward and toward the front of engine during installation.



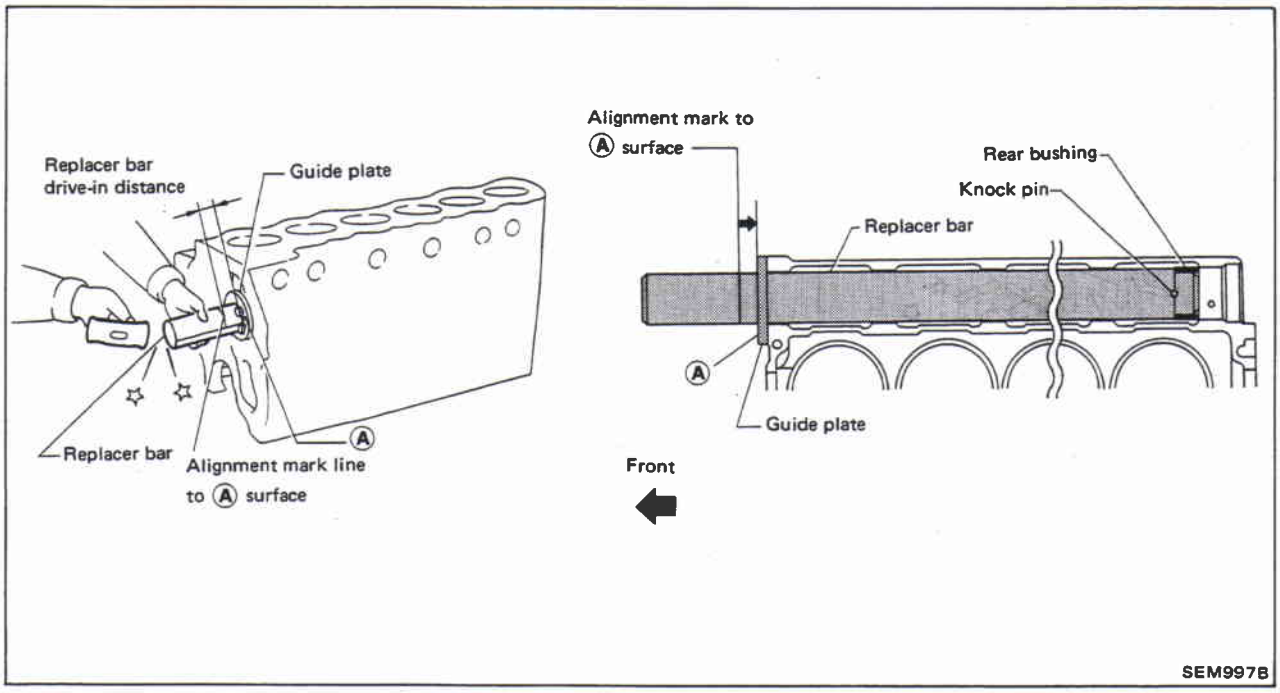
(3) Rear camshaft bushing
Align the cutout of rear bushing with knock pin of replacer bar before installation.



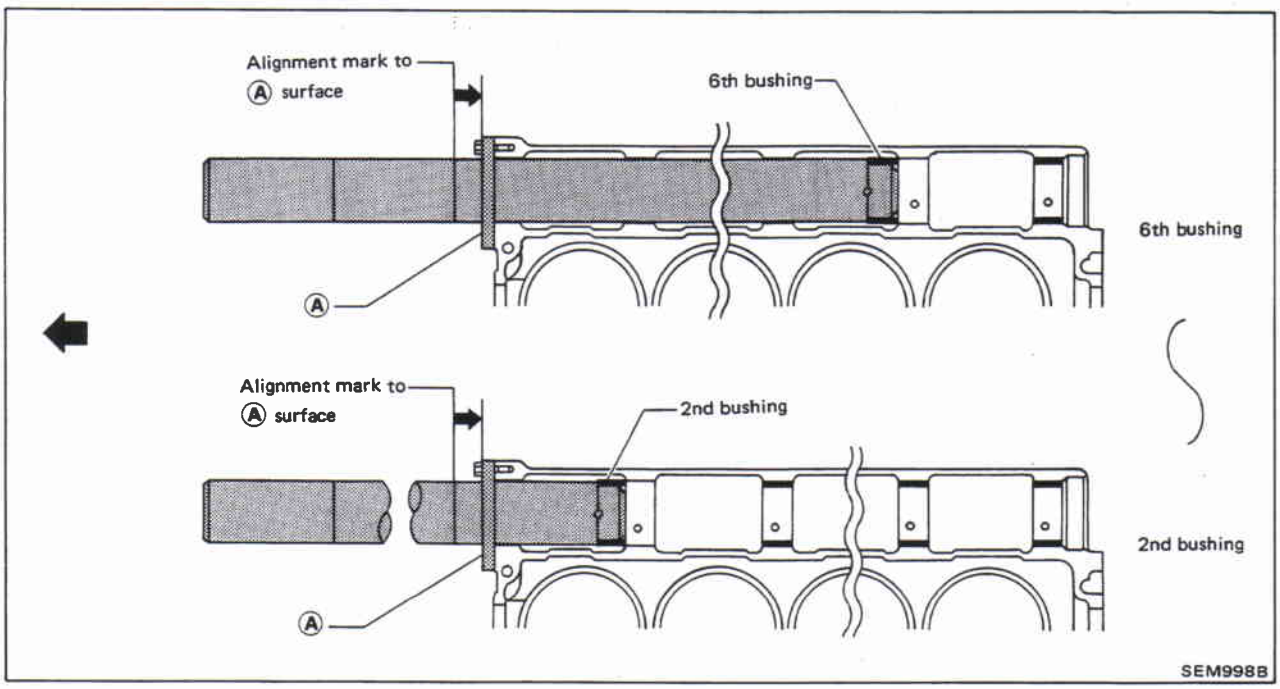
Insert rear bushing with replacer bar into cylinder block.
Install guide plate with bolt holes (on the "TB" mark side) facing upper side of cylinder block. Tighten bolts.

Inspection (Cont'd)

Drive replacer bar until the alignment mark on replacer bar is aligned with the end of guide plate.
Remove replacer set.
After installation, check that oil holes 4.3 mm (0.169 in) dia. in camshaft bushings are aligned with oil holes 6 mm (0.24 in) dia. in the cylinder block.

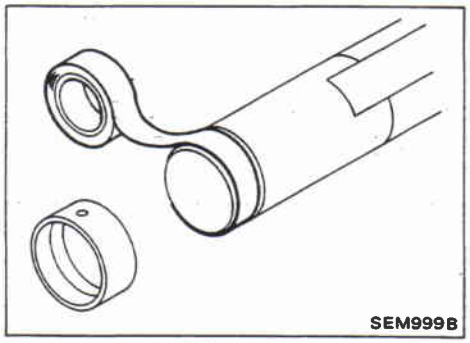


(4) 6th, 5th, 4th, 3rd and 2nd camshaft bushings
Install in the same manner as rear camshaft bushing.

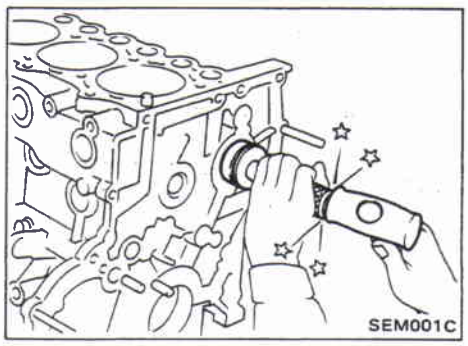


Inspection (Cont'd)

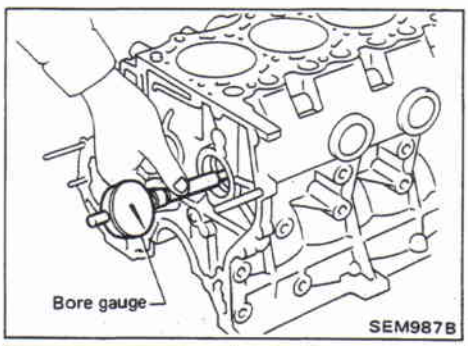
When setting 6th through 2nd bushings on replacer bar, tape the bar to prevent movement.



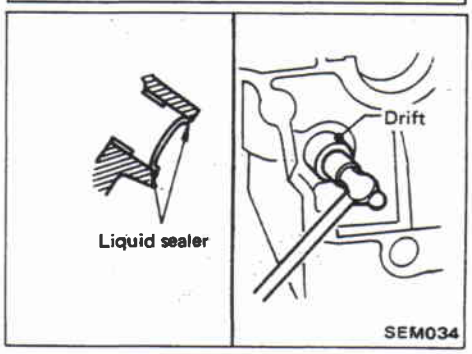
(5) Front camshaft bushing
Using 1st bushing adapter, position front camshaft bushing so that oil hole in cylinder block is aligned with oil hole in bushing.



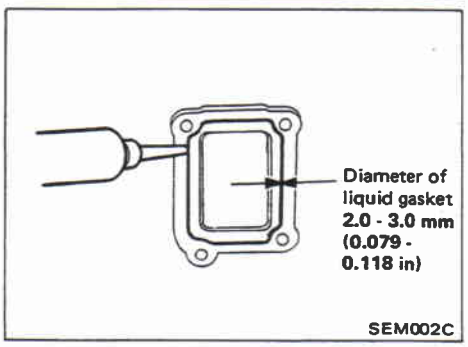
4. Check camshaft bushing inner diameter.



5. Install new welch plugs with a drift.
Apply liquid sealer.

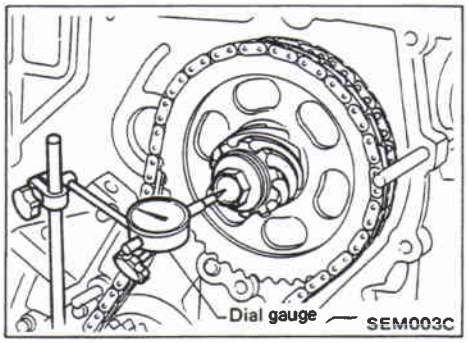


6. Install side cover.
Apply liquid gasket.
- **Use Genuine Liquid Gasket or equivalent.**



Inspection (Cont'd)

CAMSHAFT END PLAY



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

Camshaft end play:

Standard

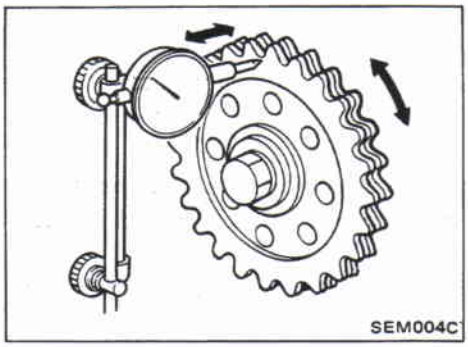
0.08 - 0.28 mm (0.0031 - 0.0110 in)

Limit

0.05 mm (0.0020 in)

3. If end play exceeds the limit, replace locating plate.

CAMSHAFT SPROCKET RUNOUT



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

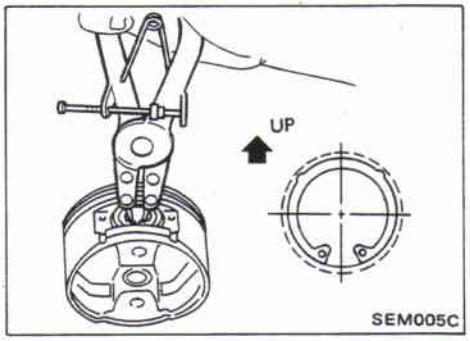
Runout (Total indicator reading):

Limit 0.1 mm (0.004 in)

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

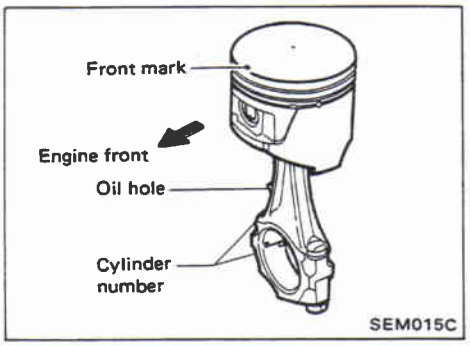
Assembly

PISTON



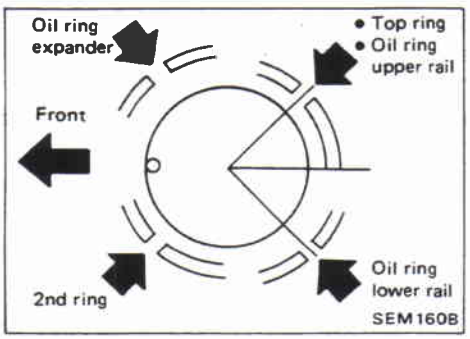
1. Install a new snap ring on one side of the piston pin hole.

Ensure that ends of snap ring face down and fit properly into groove.



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.**

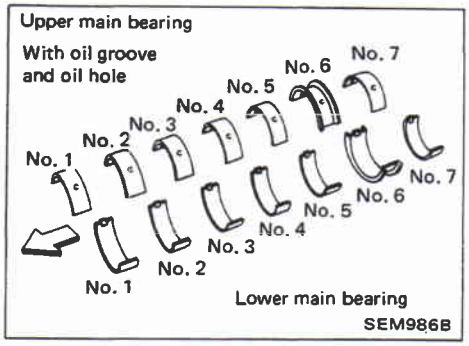


- **After assembly, make sure piston swings smoothly.**

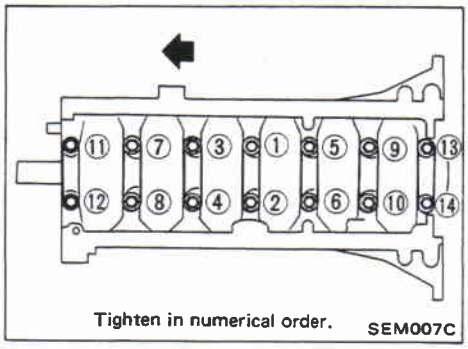
3. Set piston rings as shown.

Assembly (Cont'd)

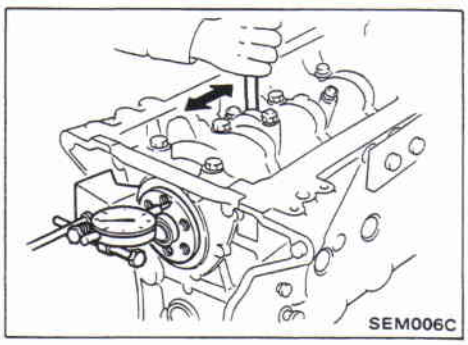
CRANKSHAFT



1. Set main bearings in their proper positions on cylinder block and main bearing cap.
- **Do not confuse upper and lower sides of main bearings.**



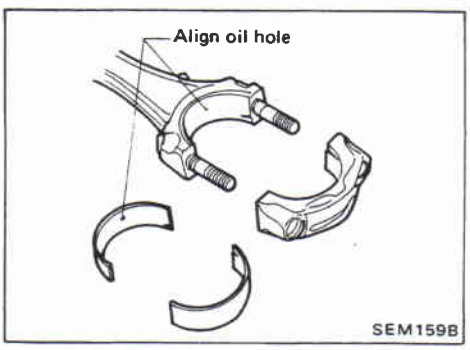
2. Install crankshaft and main bearing caps and tighten bolts to the specified torque.
- **Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting crankshaft in the axial direction.**
- **Tighten bearing cap bolts gradually in two or three stages start with the center bearing and move outward sequentially.**
- **After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.**



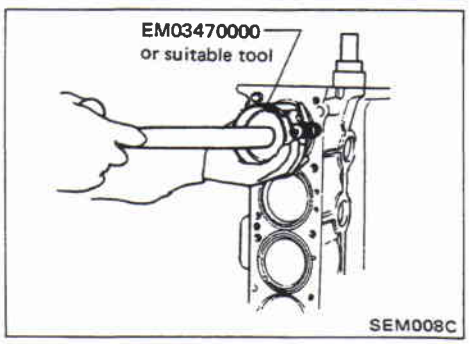
3. Measure crankshaft end play.

Crankshaft end play:
Standard
0.05 - 0.17 mm (0.0020 - 0.0067 in)
Limit
0.3 mm (0.012 in)

If end play exceeds the limit, replace No. 6 bearing.



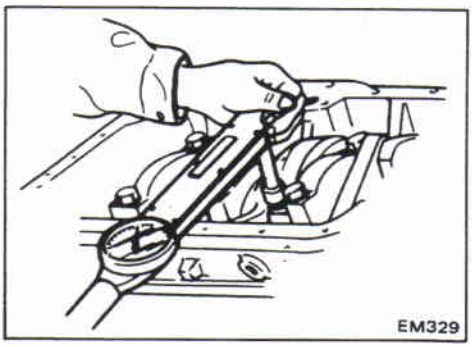
4. Install connecting rod bearings in connecting rods and connecting rod caps.
- Confirm that correct bearings are used. **Refer to "Inspection".**
- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.



5. Install pistons with connecting rods.

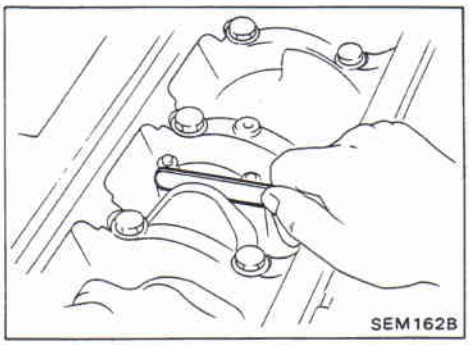
(1) Install them into corresponding cylinders with Tool.
- **Be careful not to scratch cylinder wall by connecting rod.**
- **Arrange so that front mark on piston head faces toward front of engine.**

Assembly (Cont'd)



(2) Install connecting rod bearing caps.
Tighten connecting rod bearing cap nuts to the specified torque.

: Connecting rod bearing nut
(1) Tighten to 38 to 40 N·m (3.9 to 4.1 kg-m, 28 to 30 ft-lb).
(2) Tighten to 67 to 71 N·m (6.8 to 7.2 kg-m, 49 to 52 ft-lb) or if you have an angle wrench, tighten bolts 40 to 45 degrees clockwise.



6. Measure connecting rod side clearance.

Connecting rod side clearance:

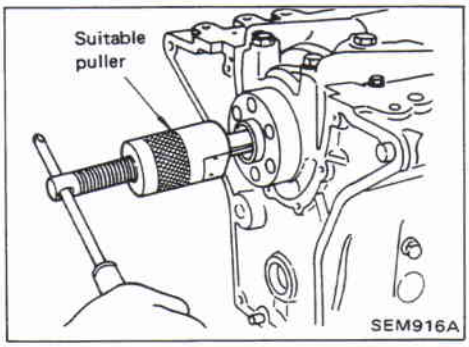
Standard

0.2 - 0.3 mm (0.008 - 0.012 in)

Limit

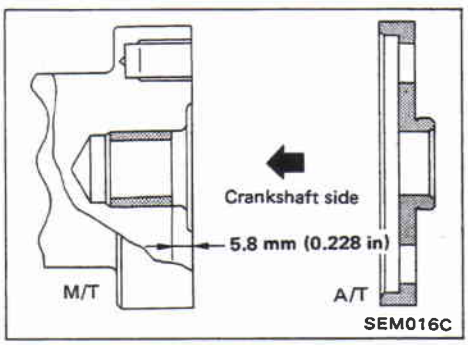
0.4 mm (0.016 in)

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

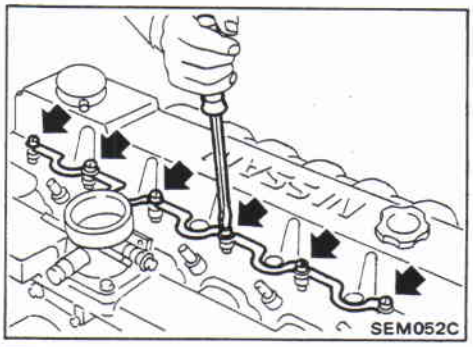


REPLACING PILOT BUSHING

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

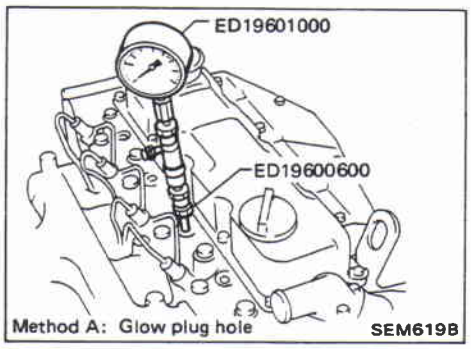


2. Install pilot bushing (M/T) or pilot converter (A/T).

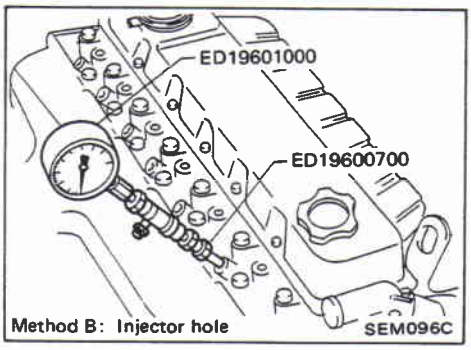

SEM052C

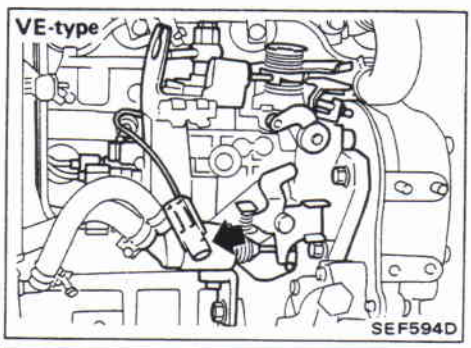
Measurement of Compression Pressure (On-vehicle service)

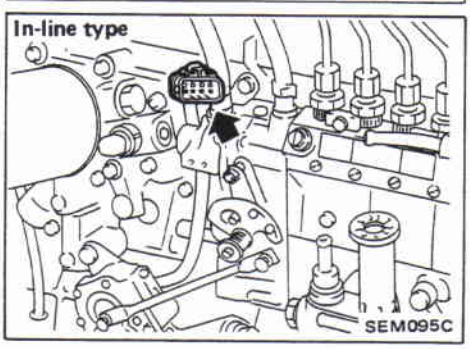
1. Warm up engine.
2. Remove glow plate or injector.



3. Fit compression gauge adapter to cylinder head.
   Compression gauge adapter:
   [Ⓣ]: 15 - 20 N·m (1.5 - 2.0 kg-m, 11 - 14 ft-lb)
   (For glow plug hole)
   54 - 64 N·m (5.5 - 6.5 kg-m, 40 - 47 ft-lb)
   (For injector hole)







4. Set no fuel injected condition.
- VE-type
  Disconnect fuel cut solenoid wire.
- In-line type
  Disconnect injection pump controller harness connector.

5. Crank engine, then read gauge indication.
- **In case of engine equipped with in-line type, depress accelerator pedal fully and crank engine.**
- **Engine compression measurement should be made as quickly as possible.**

Compression pressure:

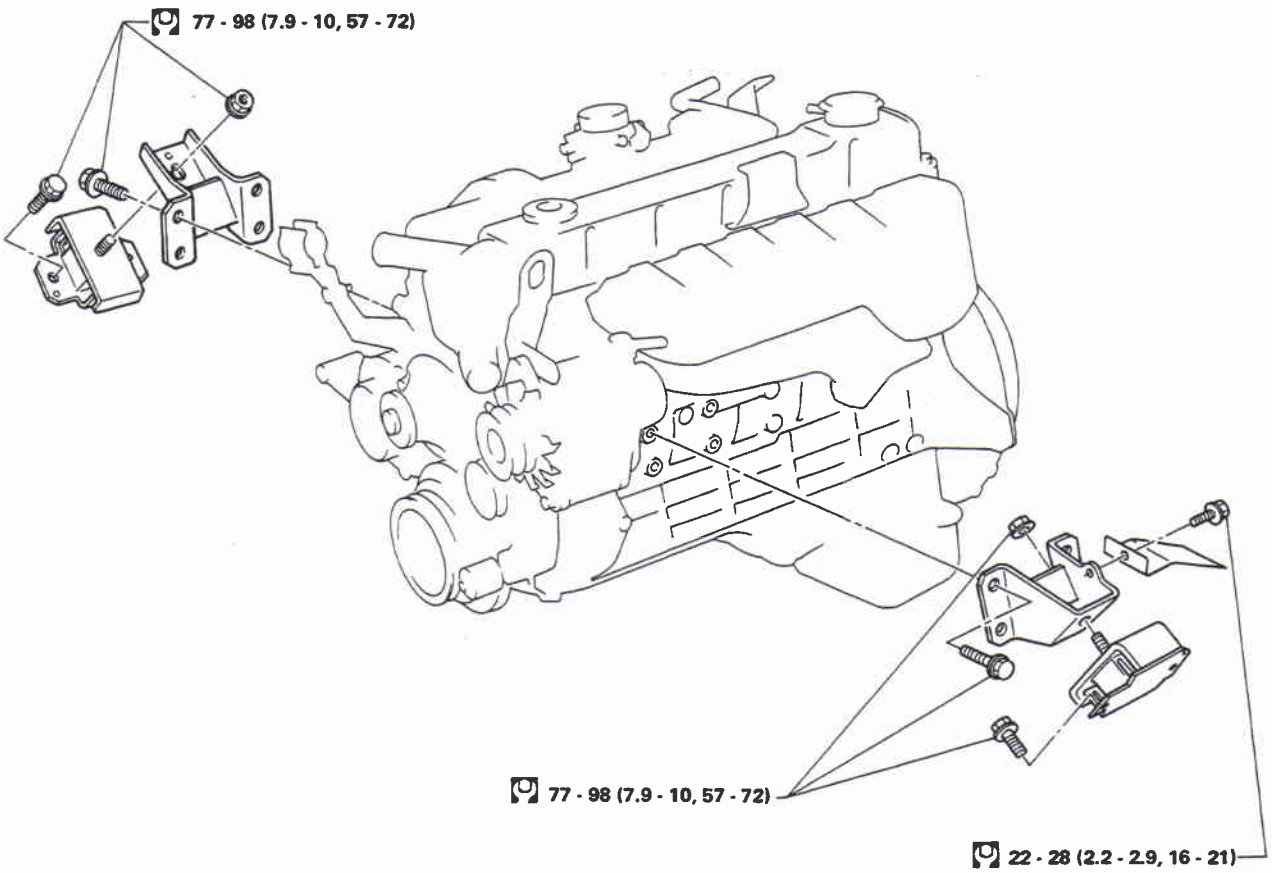
Unit: kPa (bar, kg/cm^2, psi)/200 rpm

Standard	2,942 (29.4, 30, 427)
Minimum	2,452 (24.5, 25, 356)
Differential limit between cylinders	294 (2.9, 3, 43)

6. If cylinder compression in one or more cylinders is low, pour a small quantity of engine oil into cylinders through the glow holes and retest compression.

Measurement of Compression Pressure (On-vehicle service) (Cont'd)

- If adding oil helps the compression pressure, chances are that piston rings are worn or damaged.
- If pressure stays low, valve may be sticking or seating improperly.
- If cylinder compression in any two adjacent cylinders is low, and if adding oil does not help the compression, there is leakage past the gasket surface.
  Oil and water in combustion chambers can result from this problem.



: N·m (kg-m, ft-lb)

SEM105C

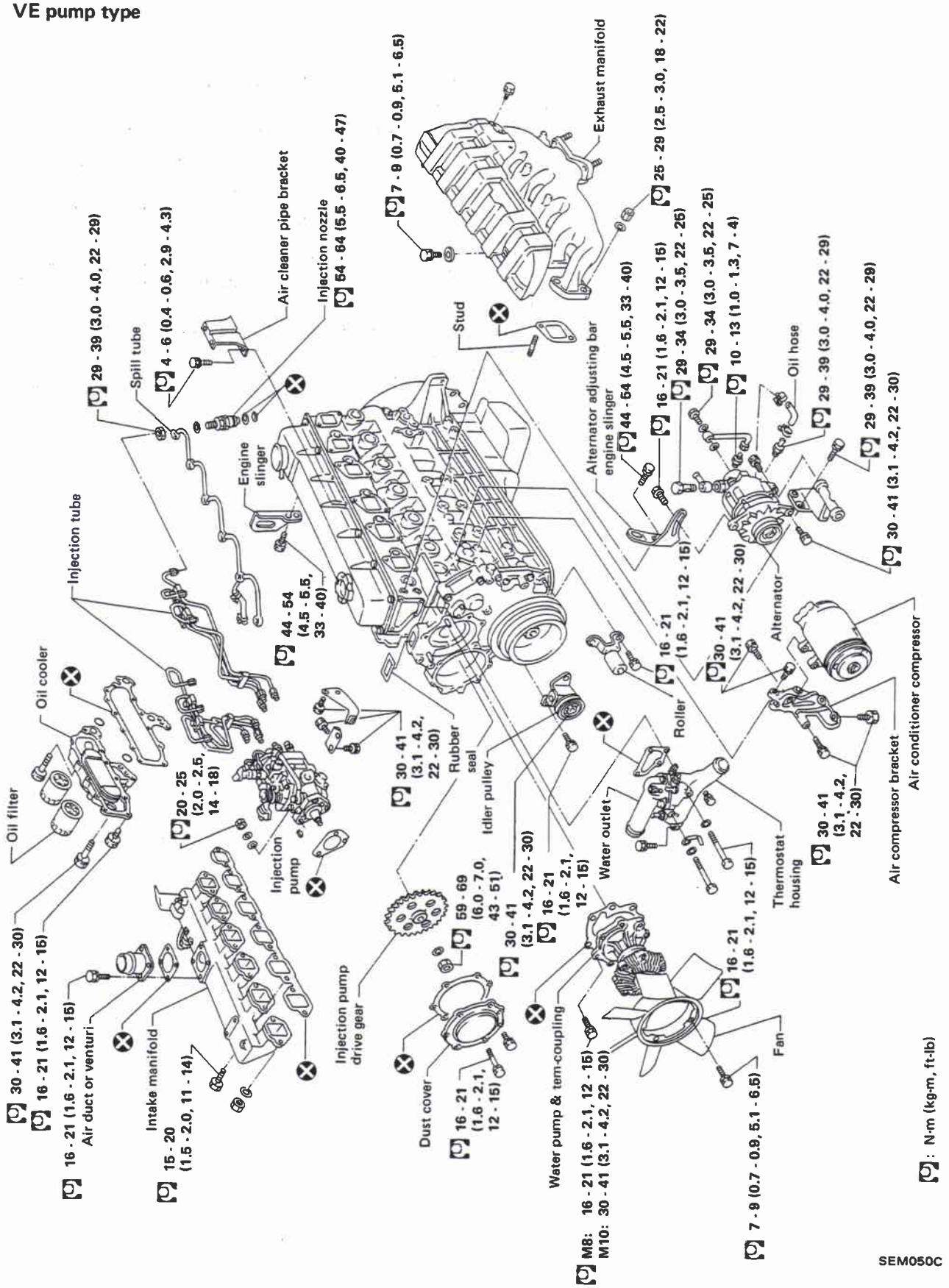
WARNING:

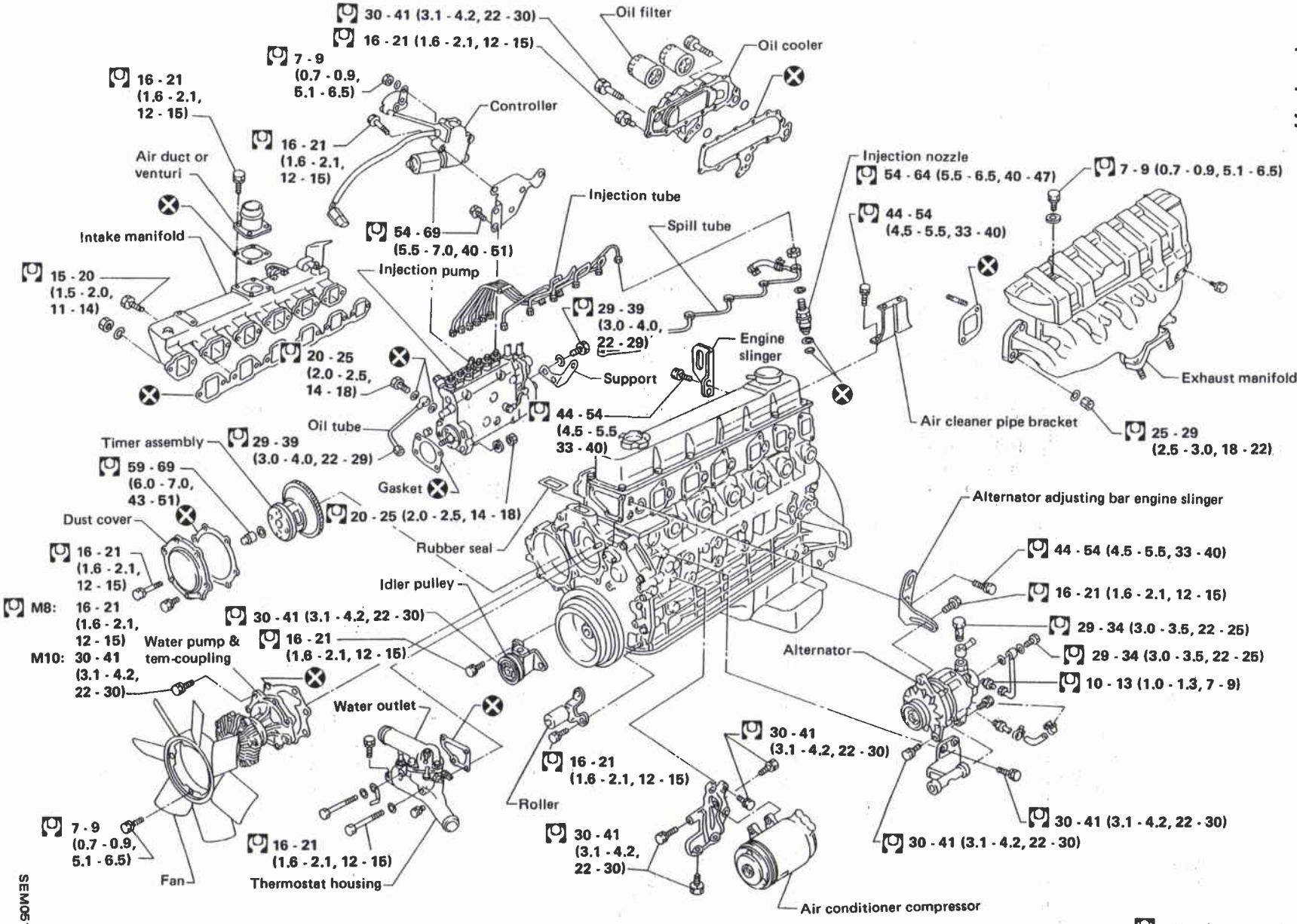
a. Place vehicle on a flat and solid surface.
b. Place chocks at front and back of rear wheels.
c. Do not remove engine until exhaust system has completely cooled off.
   Otherwise, you may burn yourself and/or fire may break out in the fuel line.
d. For safety during subsequent steps, the tension of wires should be slackened against the engine.
e. Be sure to hoist engine and transmission in a safe manner.

CAUTION:

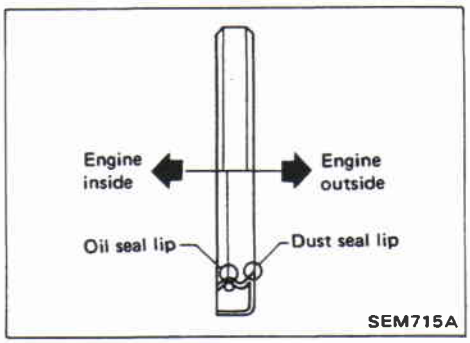
- When lifting engine, be careful not to strike adjacent parts, especially the accelerator wire casing, brake lines, and brake master cylinder.
- In hoisting the engine, always use engine slingers in a safe manner.
- For engines not equipped with engine slingers, attach proper slingers and bolts described in the PARTS CATALOG.

VE pump type


Oil filter
Oil cooler
Injection tube
Spill tube
Air cleaner pipe bracket
Injection nozzle
Exhaust manifold
Stud
Engine slinger
Alternator adjusting bar
Oil hose
Alternator
Roller
Rubber seal
Idler pulley
Injection pump
Injection pump drive gear
Water outlet
Thermostat housing
Air compressor bracket
Air conditioner compressor
Dust cover
Water pump & fan-coupling
Fan
Intake manifold
Air duct or venturi
30 - 41 (3.1 - 4.2, 22 - 30)
16 - 21 (1.6 - 2.1, 12 - 15)
29 - 39 (3.0 - 4.0, 22 - 29)
4 - 6 (0.4 - 0.6, 2.9 - 4.3)
54 - 64 (5.5 - 6.5, 40 - 47)
7 - 9 (0.7 - 0.9, 5.1 - 6.5)
25 - 29 (2.5 - 3.0, 18 - 22)
29 - 34 (3.0 - 3.5, 22 - 25)
10 - 13 (1.0 - 1.3, 7 - 4)
44 - 54 (4.5 - 5.5, 33 - 40)
20 - 25 (2.0 - 2.5, 14 - 18)
59 - 69 (6.0 - 7.0, 43 - 51)
15 - 20 (1.5 - 2.0, 11 - 14)
M8: 16 - 21 (1.6 - 2.1, 12 - 15)
M10: 30 - 41 (3.1 - 4.2, 22 - 30)
: N·m (kg-m, ft-lb)
SEM050C

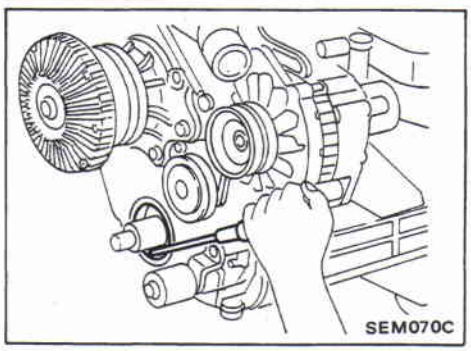

30 - 41 (3.1 - 4.2, 22 - 30)
16 - 21 (1.6 - 2.1, 12 - 15)
Oil filter
Oil cooler
7 - 9 (0.7 - 0.9, 5.1 - 6.5)
Controller
16 - 21 (1.6 - 2.1, 12 - 15)
16 - 21 (1.6 - 2.1, 12 - 15)
Air duct or venturi
Injection tube
Spill tube
Injection nozzle
54 - 64 (5.5 - 6.5, 40 - 47)
7 - 9 (0.7 - 0.9, 5.1 - 6.5)
44 - 54 (4.5 - 5.5, 33 - 40)
Intake manifold
54 - 69 (5.5 - 7.0, 40 - 51)
Injection pump
15 - 20 (1.5 - 2.0, 11 - 14)
29 - 39 (3.0 - 4.0, 22 - 29)
Engine slinger
20 - 25 (2.0 - 2.5, 14 - 18)
Support
Exhaust manifold
Oil tube
44 - 54 (4.5 - 5.5 33 - 40)
Air cleaner pipe bracket
25 - 29 (2.5 - 3.0, 18 - 22)
Timer assembly
29 - 39 (3.0 - 4.0, 22 - 29)
59 - 69 (6.0 - 7.0, 43 - 51)
Gasket
20 - 25 (2.0 - 2.5, 14 - 18)
Alternator adjusting bar engine slinger
Dust cover
Rubber seal
44 - 54 (4.5 - 5.5, 33 - 40)
16 - 21 (1.6 - 2.1, 12 - 15)
Idler pulley
M8: 16 - 21 (1.6 - 2.1, 12 - 15)
30 - 41 (3.1 - 4.2, 22 - 30)
16 - 21 (1.6 - 2.1, 12 - 15)
29 - 34 (3.0 - 3.5, 22 - 25)
Water pump & tem-coupling
Alternator
29 - 34 (3.0 - 3.5, 22 - 25)
M10: 30 - 41 (3.1 - 4.2, 22 - 30)
10 - 13 (1.0 - 1.3, 7 - 9)
Water outlet
30 - 41 (3.1 - 4.2, 22 - 30)
16 - 21 (1.6 - 2.1, 12 - 15)
Roller
30 - 41 (3.1 - 4.2, 22 - 30)
30 - 41 (3.1 - 4.2, 22 - 30)
7 - 9 (0.7 - 0.9, 5.1 - 6.5)
16 - 21 (1.6 - 2.1, 12 - 15)
Fan
Thermostat housing
Air conditioner compressor
: N·m (kg-m, ft-lb)

SEM051C



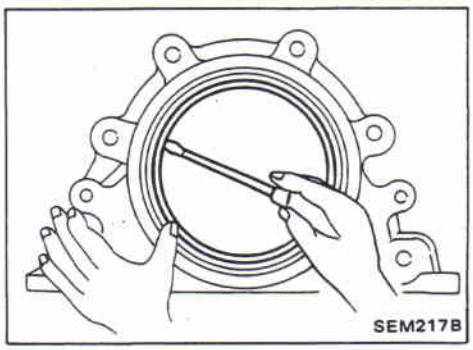
OIL SEAL INSTALLING DIRECTION

- When installing a new front or rear seal, make sure its mounting direction is correct.



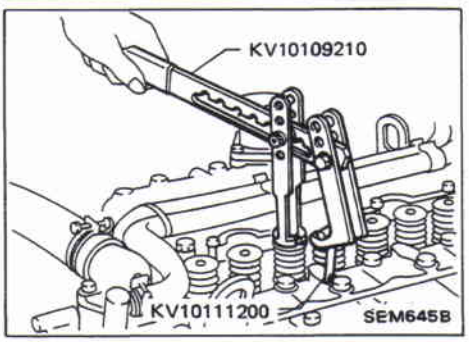
CRANKSHAFT FRONT OIL SEAL (On-vehicle service)

1. Remove radiator shroud.
2. Remove cooling fan.
3. Remove drive belts.
4. Remove crank pulley.
5. Remove crankshaft oil seal.
   - Be careful not to damage sealing surfaces of crankshaft.
6. Coat new oil seal with engine oil and install it in place.



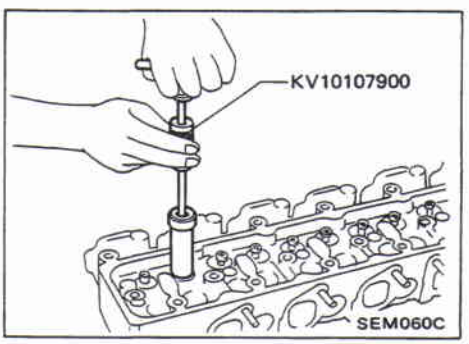
CRANKSHAFT REAR OIL SEAL (On-vehicle service)

1. Dismount transmission.
2. Remove clutch cover assembly.
3. Remove flywheel and rear plate.
4. Remove engine gusset and oil pan.
5. Remove oil seal retainer assembly, then remove oil seal.
   - Be careful not to damage sealing surfaces of crankshaft.
6. Coat new oil seal with engine oil and install it in place.

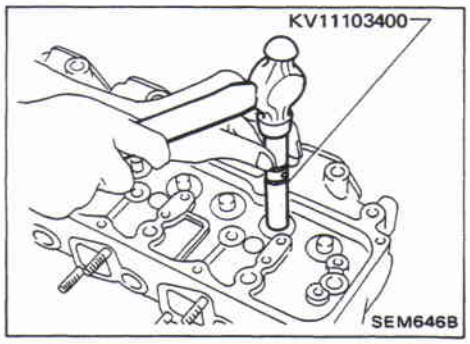


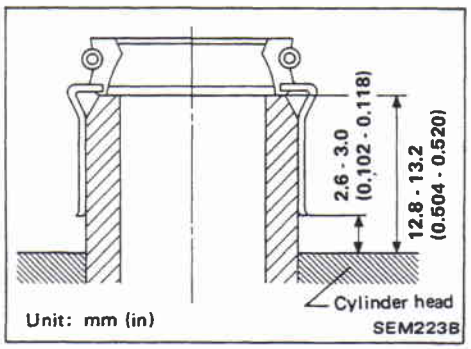
VALVE OIL SEAL (On-vehicle service)

1. Remove rocker cover.
2. Remove rocker shaft assembly.
3. Remove valve spring.

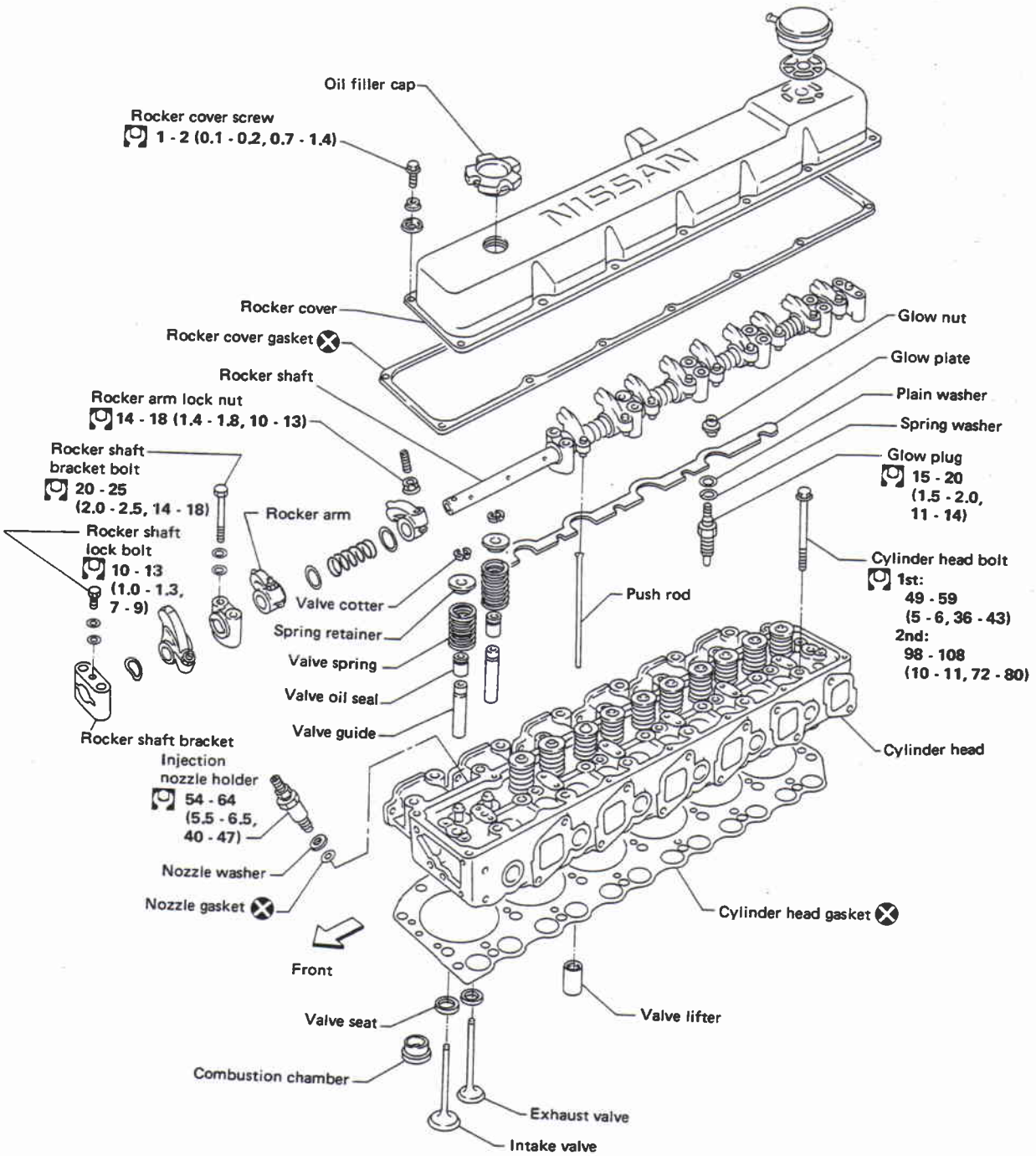


4. Remove valve oil seals.



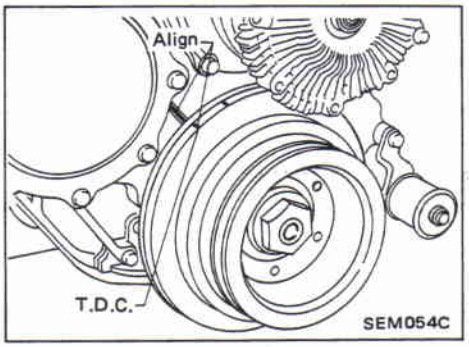


5. Apply engine oil to valve oil seal and install it in place.



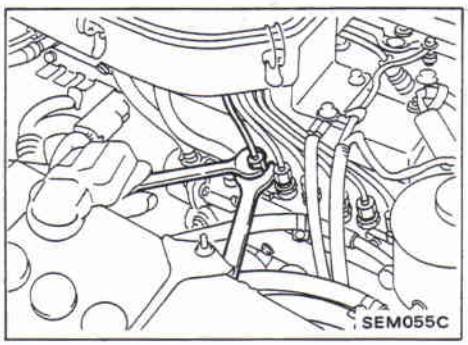
: N·m (kg-m, ft-lb)

SEM053C

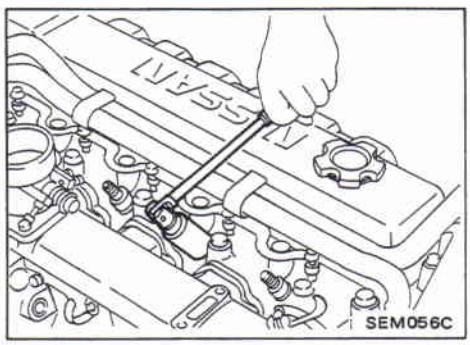


Removal (On-vehicle service)

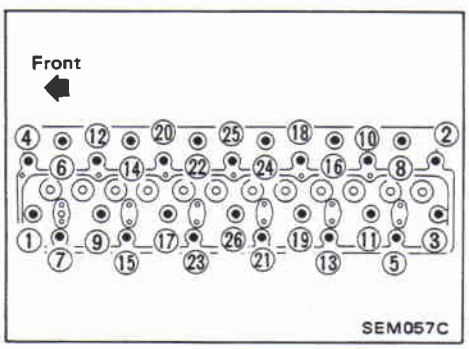
1. Set No. 1 cylinder at T.D.C. on its compression stroke.
2. Drain engine coolant from drain plugs on cylinder block and radiator.
3. Remove air cleaner and/or air duct.
4. Remove alternator adjusting bolt.
5. Disconnect exhaust manifold from front exhaust tube.
6. Disconnect radiator outlet hose and thermostat housing water inlet hose.



7. Remove fuel injection tube assembly and spill tube.

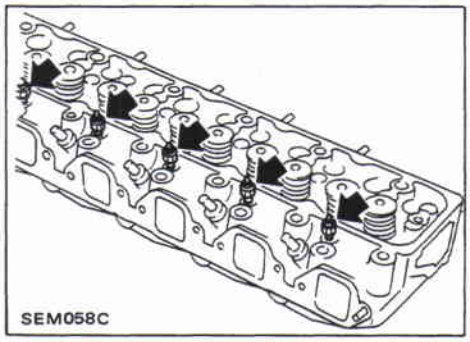


8. Remove injection nozzle holder and top nozzle gasket using deep socket wrench.
9. Remove rocker cover.
10. Remove rocker shaft with rocker arms.
11. Remove push rods.



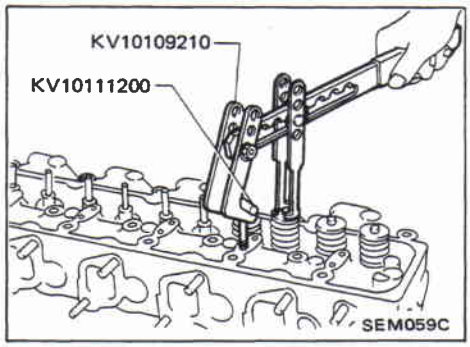
12. Remove cylinder head bolts in numerical order and remove cylinder head.

Head warpage or cracking could result from removing in incorrect order.

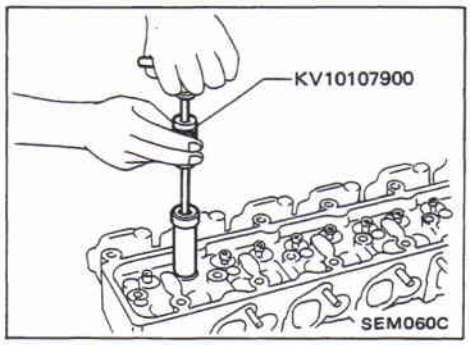


Disassembly

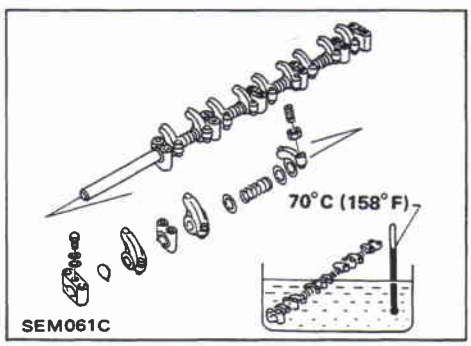
1. Remove the following parts:
- Intake manifold
- Exhaust manifold
- Thermostat housing
- Alternator adjusting bar & engine slinger
- Glow plate and glow plugs



2. Remove valve component parts with Tool.

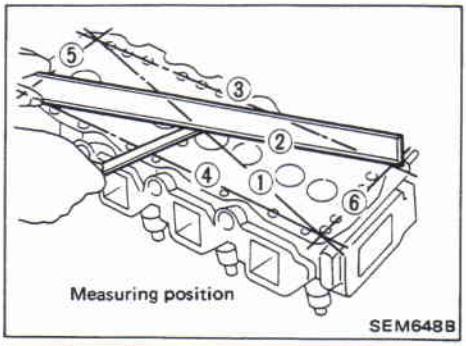


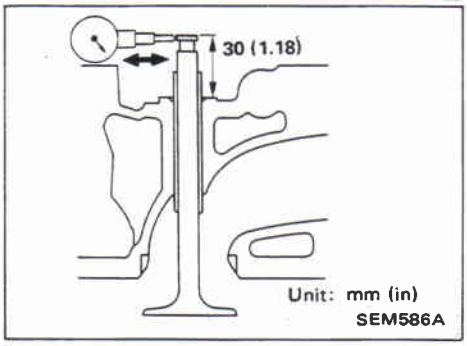
3. Remove valve oil seals with Tool.

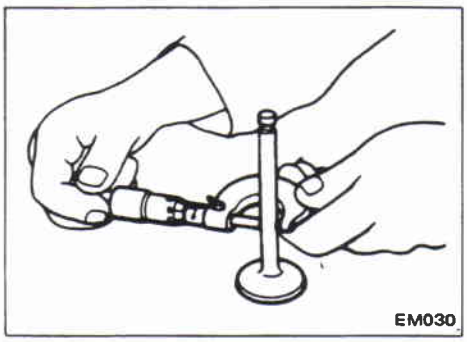


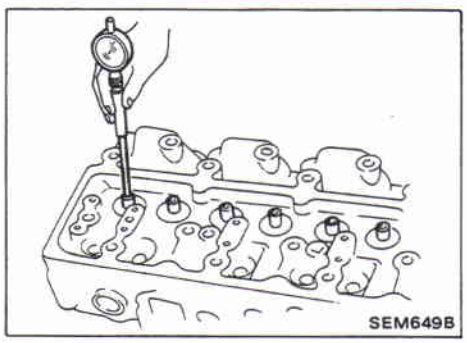
4. Disassemble rocker shaft assembly.
a. Remove rocker shaft lock bolt.
b. Remove valve rocker and rocker shaft bracket.

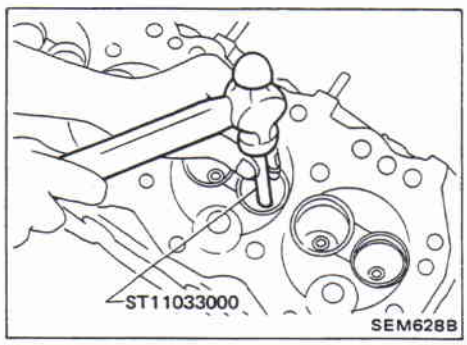
If it is difficult to remove rocker shaft bracket, immerse rocker shaft assembly in oil of 70°C (158°F) for a few minutes and then remove bracket.











Inspection

CYLINDER HEAD DISTORTION

Cylinder head distortion:
Standard
Less than 0.07 mm (0.0028 in)
Limit
0.2 mm (0.008 in)

If beyond the specified limit, correct with a surface grinder. Cylinder head height should be greater than 89.7 mm (3.531 in) after surface has been ground.

VALVE GUIDE CLEARANCE

- **Valve guide clearance should be measured parallel with rocker arm. (Generally, a large amount of wear occurs in this direction.)**

Stem to guide clearance:
Limit
Intake 0.15 mm (0.0059 in)
Exhaust 0.20 mm (0.0079 in)
Maximum allowable deflection
(Dial indicator reading)
Intake 0.30 mm (0.0118 in)
Exhaust 0.40 mm (0.0157 in)

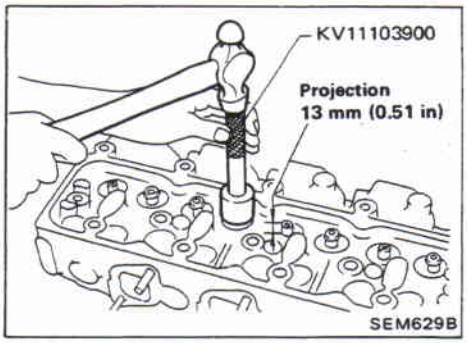
- **To determine the correct replacement part, measure valve stem diameter and valve guide inner diameter.**

Valve stem diameter:
Standard
Intake
7.962 - 7.977 mm (0.3135 - 0.3141 in)
Exhaust
7.945 - 7.960 mm (0.3128 - 0.3134 in)
Valve guide inner diameter:
8.00 - 8.015 mm (0.3150 - 0.3156 in)

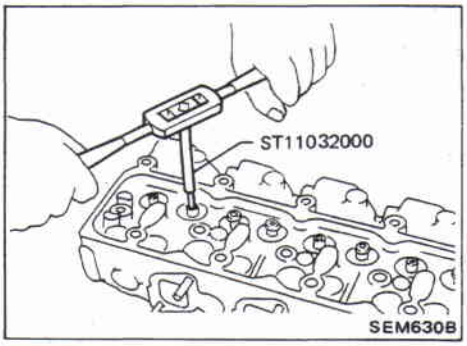
VALVE GUIDE REPLACEMENT

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

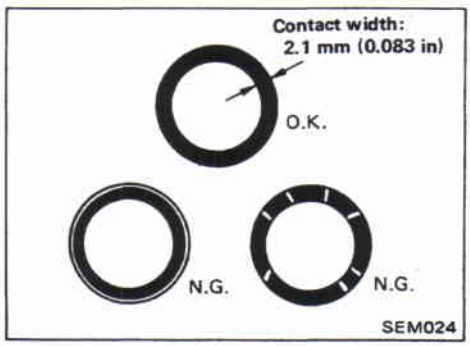
Inspection (Cont'd)



2. Press service valve guide onto cylinder head using suitable tool until the guide projects out 13 mm (0.51 in).



3. Ream valve guide.
   Finished size:
   8.000 - 8.015 mm (0.3150 - 0.3156 in)



VALVE SEATS

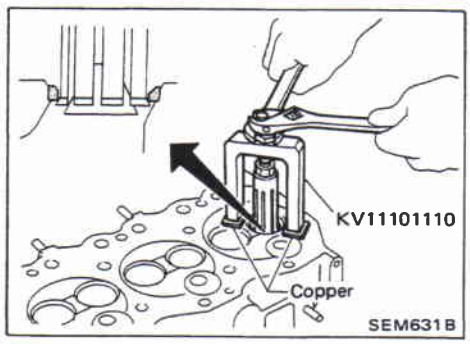
Check valve for any evidence of pitting at valve contact surface, and reseat or replace if worn out excessively.

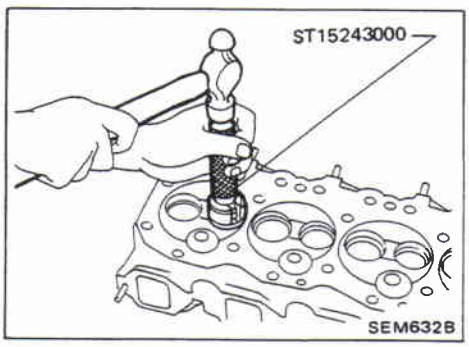
- **When repairing valve seats, check valve and valve guide for wear beforehand. If worn, replace them. Then correct valve seat.**
- **The cutting should be done with both hands for uniform cutting.**

REPLACING VALVE SEAT FOR SERVICE PARTS

1. Bore out old seat until it collapses or remove valve seats with Tool.

Place a copper seat between contact surface of Tool and cylinder head.





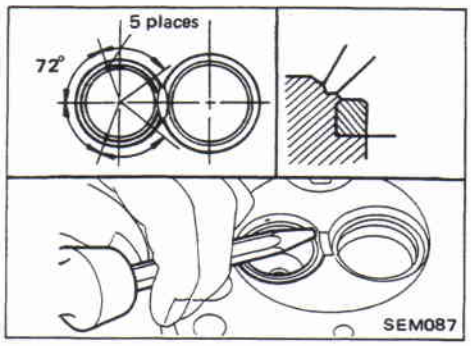
2. Place new valve seats on dry ice and allow them to cool for five minutes.

WARNING:

Do not touch cooled valve seats with bare hand.

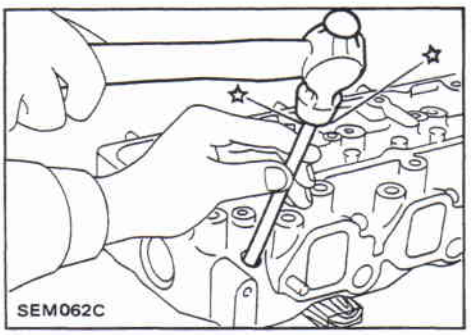
3. Heat cylinder head to 80°C (176°F).
4. Install cooled valve seats on cylinder head with Tool.

Inspection (Cont'd)



5. Stake exhaust valve seat at five places with punch.
When staking valve seat, select different places than those staked before.

6. Cut or grind valve seat using suitable tool at the specified dimensions as shown in S.D.S.
7. After cutting, lap valve seat with a lapping compound.
8. Check contact condition of valve seat.



COMBUSTION CHAMBER

Check combustion chamber for cracks and other damage. If necessary, replace.

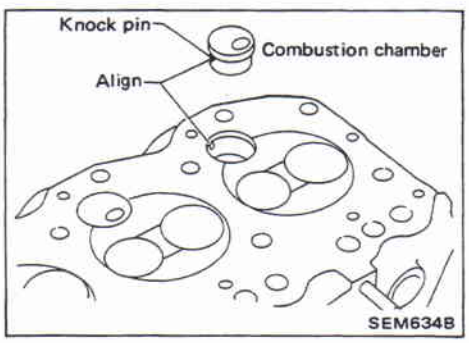
REPLACING COMBUSTION CHAMBER

Usually combustion chamber should not be removed.

1. Remove combustion chamber so that cylinder head cannot be damaged.
2. Install combustion chamber.

(1) Cool combustion chamber with dry ice for approximately 5 to 10 minutes.

WARNING:
Do not touch cooled combustion chamber with bare hand.



(2) Align combustion chamber knock pin with cylinder head notch, and drive in combustion chamber with a soft hammer.

3. Check amount of protrusion of combustion chamber.

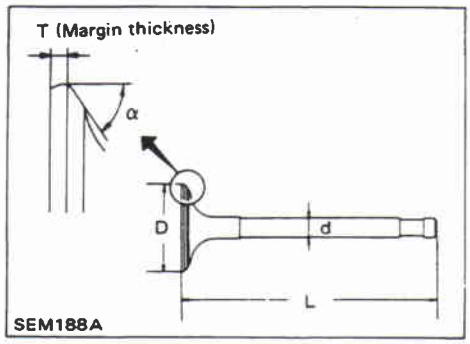
Protrusion:

Standard

–0.05 to 0.10 mm (–0.0020 to 0.0039 in)

Inspection (Cont'd)

VALVE DIMENSIONS

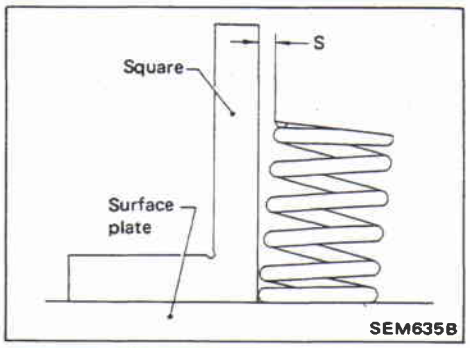


Check dimensions in each valve. For dimensions, refer to S.D.S.

When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace the valve.

Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.

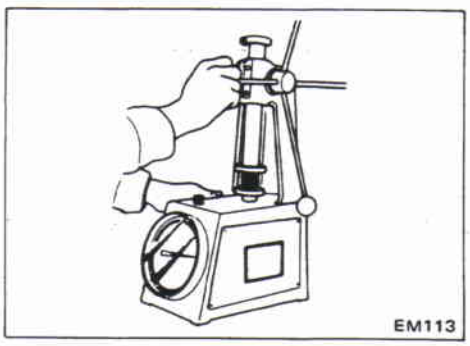
VALVE SPRING SQUARENESS



Out of square "S":

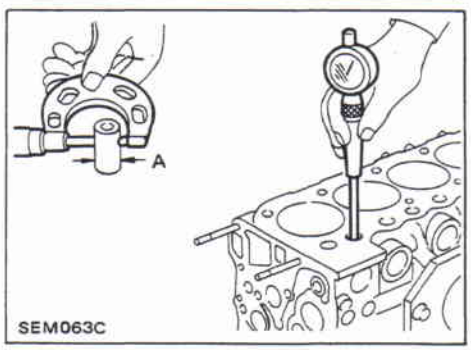
Less than 2.0 mm (0.079 in)

VALVE SPRING PRESSURE LOAD



Refer to S.D.S.

VALVE LIFTER AND PUSH ROD



Valve lifter

1. Check valve lifters for excessive wear on the face.
2. Replace with new ones if worn beyond repair.

a. Valve lifter end should be smooth.

b. Valve lifter to lifter hole clearance:

Standard

0.030 - 0.073 mm (0.0012 - 0.0029 in)

Limit

Less than 0.20 mm (0.0079 in)

Valve lifter outer diameter "A":

Standard

24.960 - 24.970 mm (0.9827 - 0.9831 in)

Cylinder block valve lifter hole diameter "B":

Standard

25.000 - 25.033 mm (0.9843 - 0.9855 in)

Inspection (Cont'd)

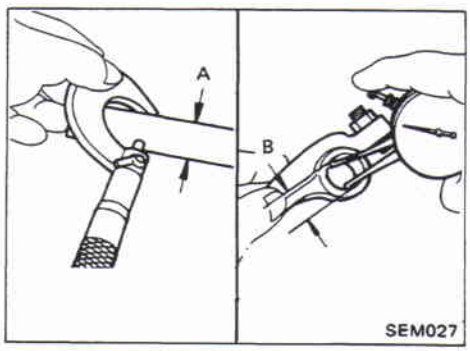
Push rod

1. Inspect push rod for excessive wear on the face.
2. Replace if worn or damaged beyond repair.
3. Check push rod for bend using a dial gauge.

Maximum allowable bend
(Total indicator reading):
Less than 0.5 mm (0.020 in)

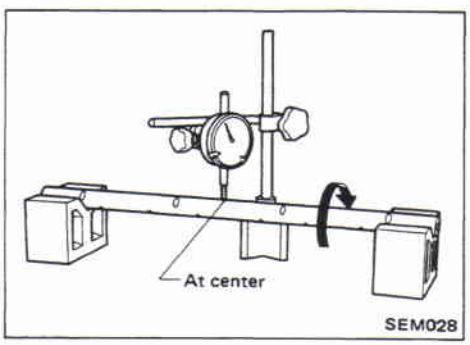
ROCKER SHAFT AND ROCKER ARM

1. Check valve rockers, brackets and rocker shafts for scoring, wear or distortion. Replace if necessary.



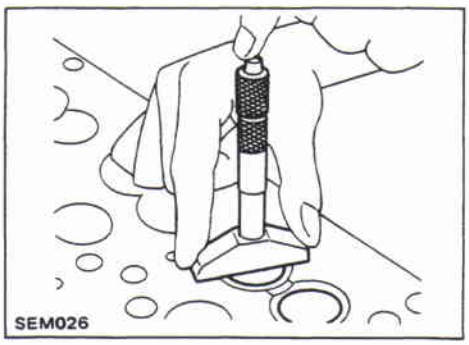
2. Check clearance between valve rockers and rocker shaft. If specified clearance is exceeded, replace affected valve rockers or shafts.

Specified clearance:
Limit
Less than 0.15 mm (0.0059 in)
Rocker shaft outer diameter "A":
Standard
19.979 - 20.000 mm (0.7866 - 0.7874 in)
Rocker arm inner diameter "B":
Standard
20.014 - 20.035 mm (0.7880 - 0.7888 in)



3. Check rocker shaft bend at its center. If bend is within specified limit, straighten it; and if it is greater than specified limit, replace rocker shaft.

Rocker shaft bend
(Total indicator reading):
Limit
Less than 0.3 mm (0.012 in)


SEM026

Inspection (Cont'd)

MEASURING CYLINDER HEAD TO VALVE DISTANCE

Measure distance from cylinder head surface to intake and exhaust valves. If specified distance is exceeded, replace valve(s) or valve seat(s).

Specified distance:

Standard

Intake

0.275 - 0.675 mm (0.0108 - 0.0266 in)

Exhaust

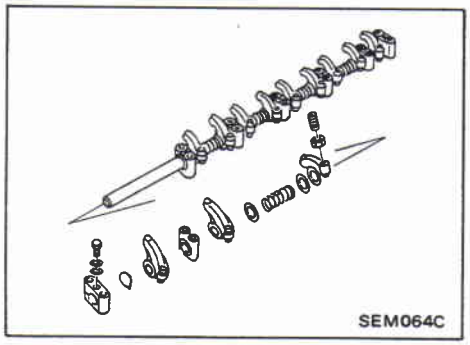
0.305 - 0.695 mm (0.0120 - 0.0274 in)

Limit

Less than

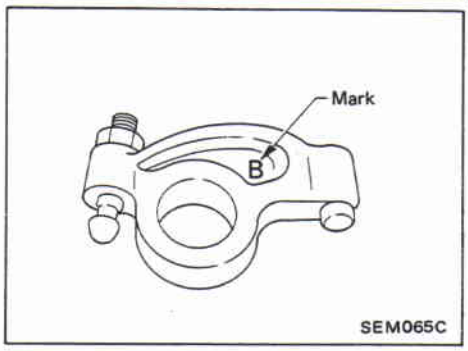
1.25 mm (0.0492 in)

for intake and exhaust valves


SEM064C

Assembly

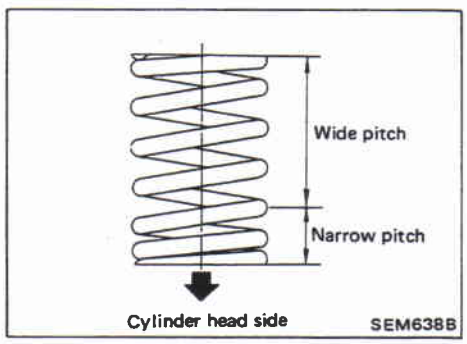
1. Assemble rocker shaft component parts.



SEM065C

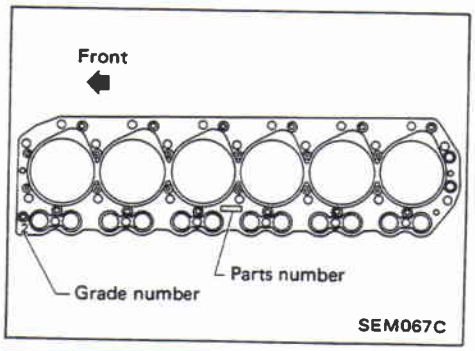
- Identification of rocker arms

Identification mark (on rocker arm)	For use with
B	Intake
C	Exhaust



SEM638B

2. Install valve component parts.
- **Always use new valve oil seal. (Refer to OIL SEAL REPLACEMENT.)**
- **Install valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.**

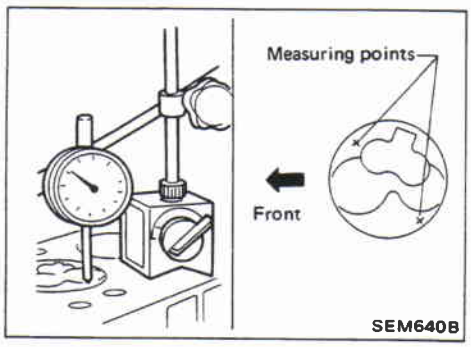


Installation (On-vehicle service)

1. Install cylinder head gasket.

a. When replacing only cylinder head gasket, install same grade gasket as the one formerly used.

b. When replacing or repairing cylinder block, cylinder head, piston, connecting rod and crankshaft, select gasket as follows:



(1) Measure piston projection.

- Set each piston at its top dead center. With piston held in that position, measure its projections at two points.
- Calculate the average value of the two measurements.
- Determine the amount of projection of the other three pistons.

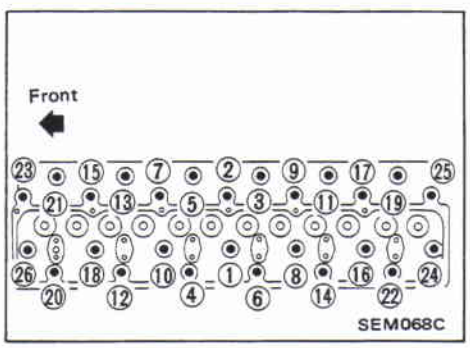
(2) Select suitable cylinder head gasket which conforms to the largest amount of projection of the four pistons.

Unit: mm (in)

Average values piston projections	Gasket thickness	Gasket grade number
Less than 0.118 (0.0046)	1.15 (0.0453)	1
0.118 - 0.168 (0.0046 - 0.0066)	1.20 (0.0472)	2
More than 0.168 (0.0066)	1.25 (0.0492)	3

Make sure that No. 1 piston is at T.D.C. on its compression stroke.

2. Install cylinder head.



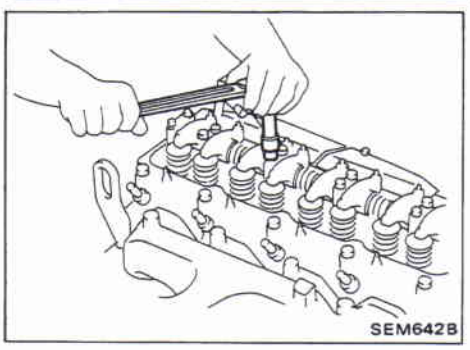
3. Apply oil to the thread portion and seat surface of bolts and tighten cylinder head bolts using Tool.

CAUTION:

- **Tightening procedure:**

1st **Tighten bolts to 49 - 59 N·m (5.0 - 6.0 kg-m, 36 - 43 ft-lb)**

2nd **Tighten bolts to 98 - 108 N·m (10.0 - 11.0 kg-m, 72 - 80 ft-lb)**



4. Apply engine oil and install push rods.
5. Install rocker shaft assembly.

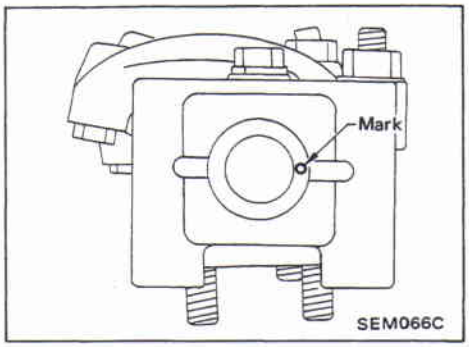
Rocker shaft bracket bolt:

20 - 25 N·m

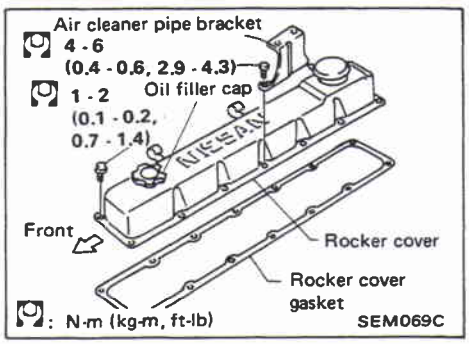
(2.0 - 2.5 kg-m, 14 - 18 ft-lb)

Adjusting intake and exhaust valve clearance tentatively. Refer to section MA.

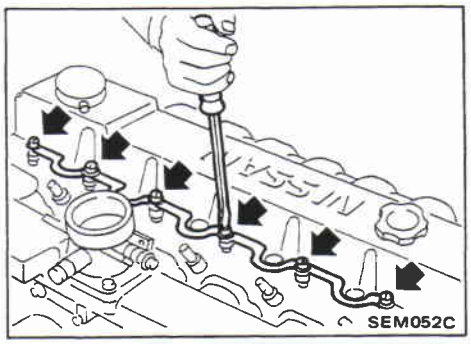
Installation (On-vehicle service) (Cont'd)



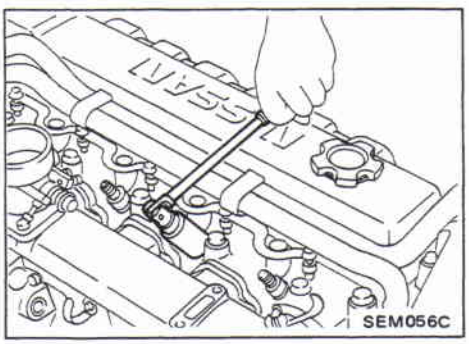
- **Face punch mark toward the front of the engine.**



6. Install rocker cover with air cleaner pipe bracket.

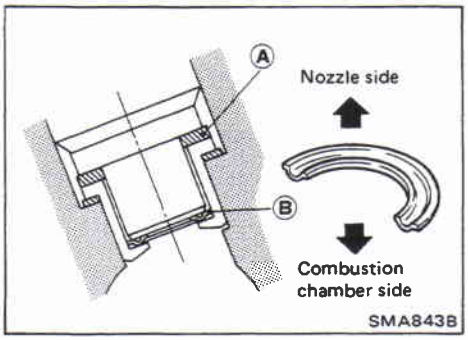


7. Install glow plugs and glow plate.
   Glow plug:
   : 15 - 20 N·m (1.5 - 2.0 kg-m, 11 - 14 ft-lb)

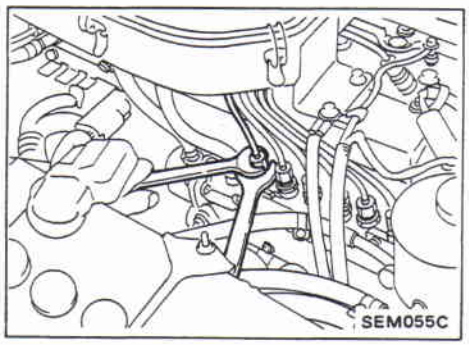


8. Install top nozzle gasket, nozzle washer and injection nozzle.
   Injection nozzle:
   : 54 - 64 N·m (5.5 - 6.5 kg-m, 40 - 47 ft-lb)

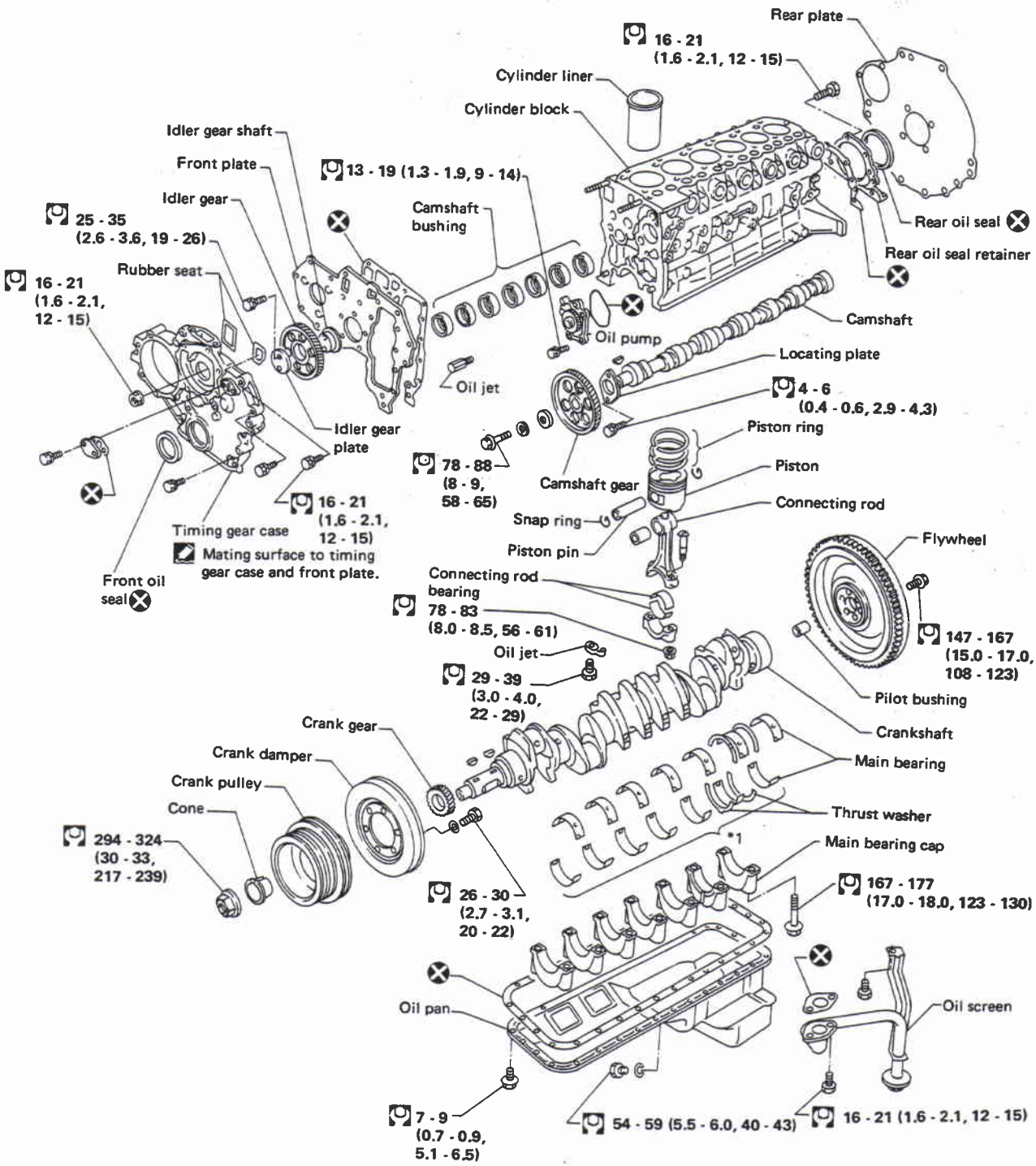
- **Always replace nozzle gasket and washer.**



Installation (On-vehicle service) (Cont'd)

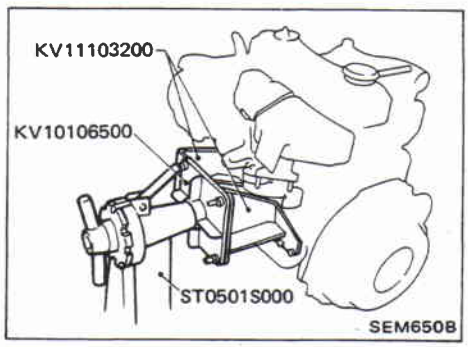


9. Install spill tube and injection tube.
   Spill tube fixing nut:
   : 29 - 39 N·m (3.0 - 4.0 kg-m, 22 - 29 ft-lb)
   Injection tube flared nut:
   : 20 - 25 N·m (2.0 - 2.5 kg-m, 14 - 18 ft-lb)
10. Connect thermostat housing water inlet hose and radiator hose.
11. After assembling all disassembled parts, fill radiator and engine with new coolant up to filler opening.



: N·m (kg-m, ft-lb)
: Apply liquid gasket.
*1 : Keep in correct order.

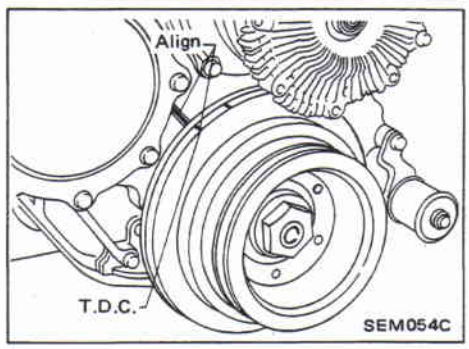
SEM071C



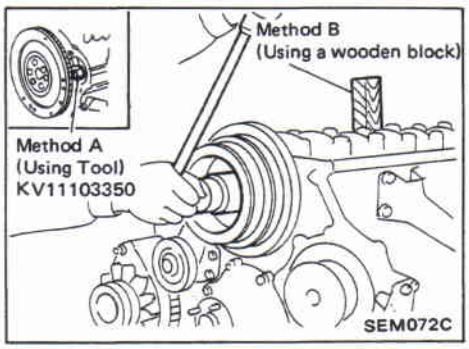
Disassembly

PISTON AND CRANKSHAFT

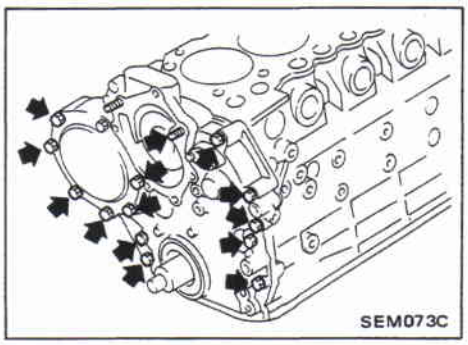
1. Remove exhaust manifold cover and manifold.
2. Remove drive belts.
3. Remove alternator, air conditioner and power steering bracket.
4. Place engine on work stand.
5. Drain coolant and oil.
6. Remove cylinder head.
7. Remove oil pan and oil strainer.



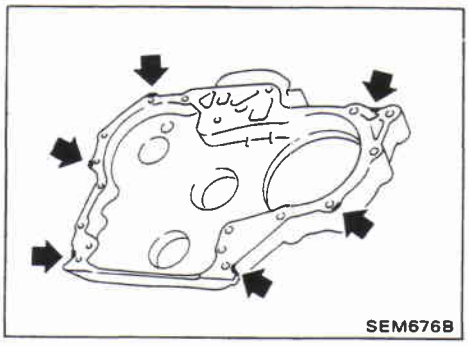
8. Align crank pulley and timing gear case mark so that No. 1 piston is at top dead center on its compression stroke.



9. Remove crank pulley.
(1) Remove crank pulley nut and install it in reverse.
(2) Remove cone bushing by tapping crank pulley nut end.
(3) Remove crank pulley nut and crank pulley.

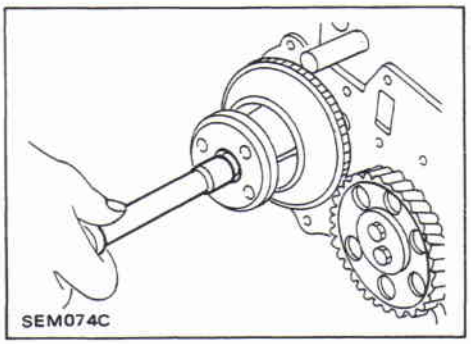


10. Remove thermostat housing.
11. Remove water pump.
12. Remove timing gear case.

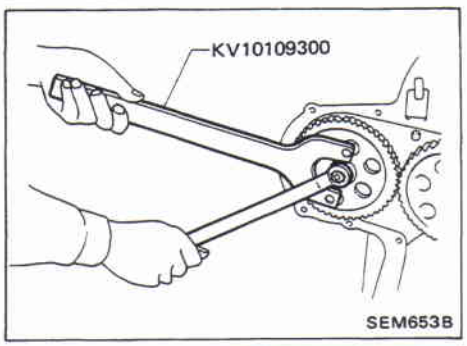


If the timing case is hard to remove due to liquid gasket, pry it off with a suitable tool at the cutout section.

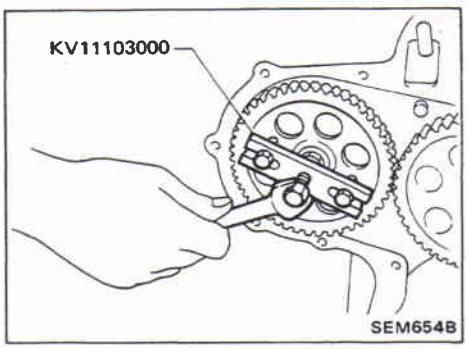
Disassembly (Cont'd)

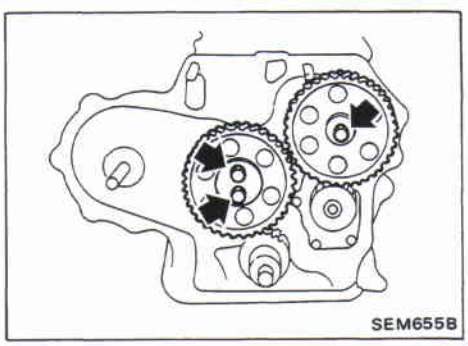


13.
- In-line pump
  Remove timer cover and timer.

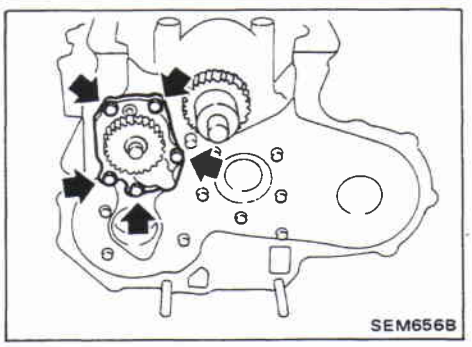


- VE-pump
  Remove injection pump gear.



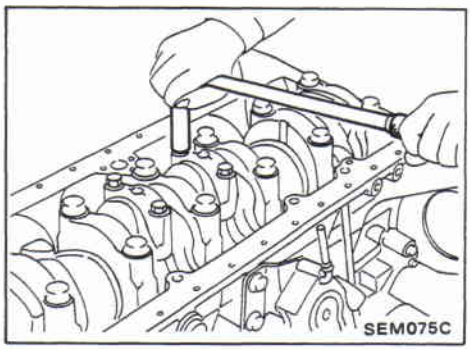


14. Remove idler gear and idler gear shaft.
15. Remove camshaft gear, camshaft and valve lifters.

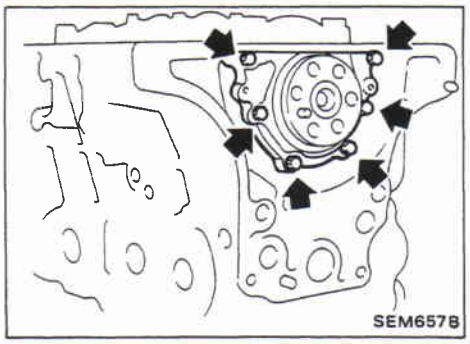


16. Remove oil pump assembly.

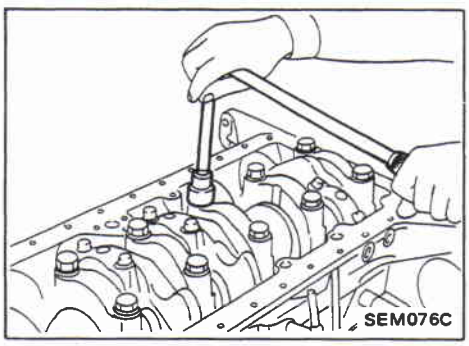
Disassembly (Cont'd)



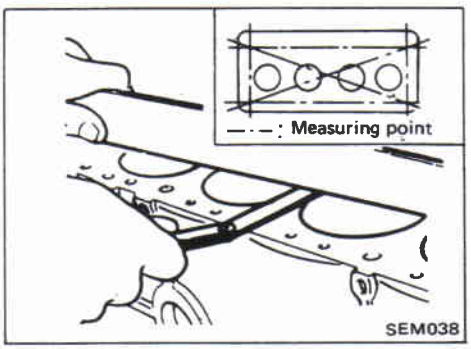
17. Remove crankshaft gear.
18. Remove flywheel and rear plate.
19. Remove oil jets.
20. Remove connecting rod caps.
21. Remove pistons.



22. Remove rear oil seal retainer.



23. Remove main bearing cap and crankshaft.
Place the bearings and caps in their proper order.

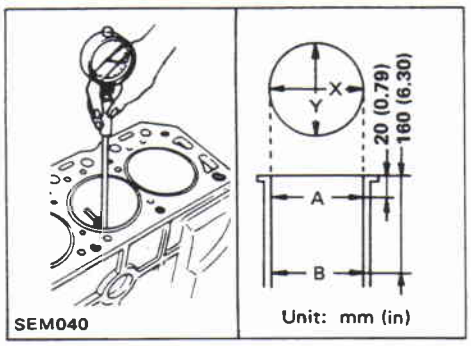


Inspection and Replacement

CYLINDER BLOCK DISTORTION

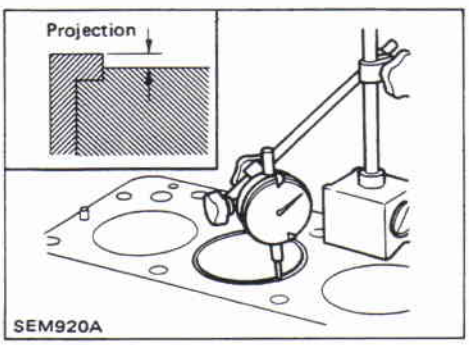
If beyond the specified limit, replace it.

Cylinder block distortion:
Standard
Less than 0.05 mm (0.0020 in)
Limit
0.2 mm (0.008 in)

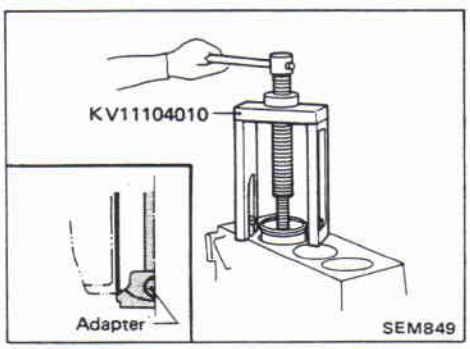


CYLINDER LINER WEAR

1. Measure cylinder liner bore for out-of-round and taper with a bore gauge. If beyond the limit, replace cylinder liner.
   Standard inside diameter:
   96.000 - 96.030 mm (3.7795 - 3.7807 in)
   Refer to S.D.S.
   Wear limit:
   0.20 mm (0.0079 in)
   Out-of-round (X—Y) limit:
   0.020 mm (0.0008 in)
   Taper (A—B) limit:
   0.20 mm (0.0079 in)
2. Check for scratches or seizure. If seizure is found, replace cylinder liner.



3. Check amount of projection of cylinder liner.
   Cylinder liner projection:
   Standard
   0.02 - 0.09 mm (0.0008 - 0.0035 in)
   Deviation of each cylinder:
   Less than 0.05 mm (0.0020 in)

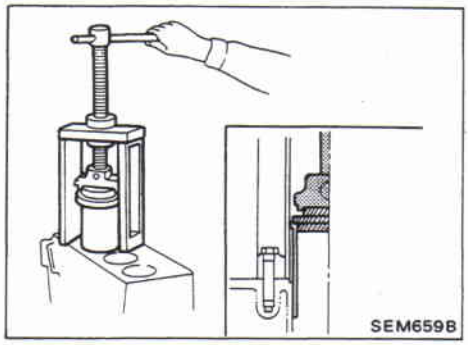


CYLINDER LINER

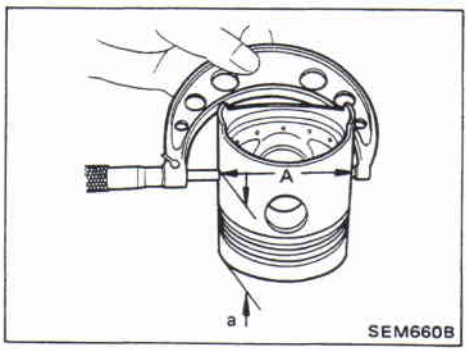
Replacement

1. Remove cylinder liner with Tool.

Inspection and Replacement (Cont'd)



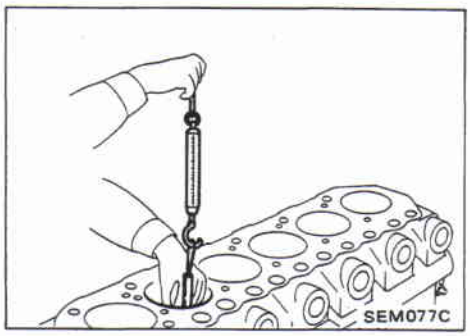
2. Install cylinder liner with Tool.
3. Check amount of projection of cylinder liner.



PISTON TO CYLINDER WALL CLEARANCE

Method A (Using micrometer)

1. Measure piston and cylinder bore diameter.
   Piston diameter "A":
   Refer to S.D.S.
   Measuring point "a" (Distance from the top):
   70 mm (2.76 in)
2. Check that piston clearance is within the specification.
   Piston clearance:
   0.05 - 0.07 mm (0.0020 - 0.0028 in)

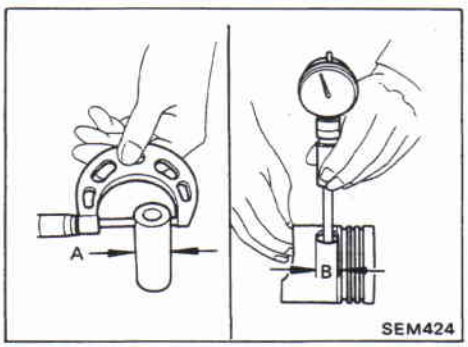


Method B (Using feeler gauge)

Measure the extracting force, and pull feeler gauge straight upward.

It is recommended that piston and cylinder be heated to 20°C (68°F).

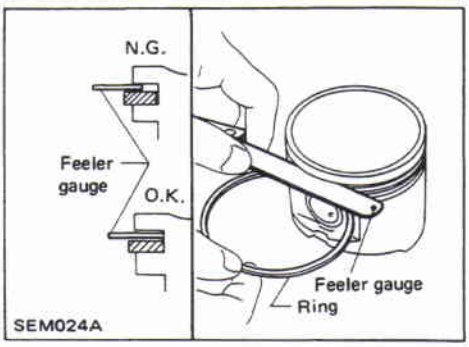
Feeler gauge thickness:
0.06 mm (0.0024 in)
Extracting force:
5.9 - 11.8 N (0.6 - 1.2 kg, 1.3 - 2.6 lb)



PISTON AND PISTON PIN CLEARANCE

Check clearance between pistons and piston pins.

Clearance (A—B):
Standard
–0.008 to 0.007 mm (–0.0003 to 0.0003 in)
Limit
Less than 0.1 mm (0.004 in)



PISTON RING SIDE CLEARANCE

Side clearance:
Top ring
0.06 - 0.10 mm (0.0024 - 0.0039 in)
2nd ring
0.04 - 0.08 mm (0.0016 - 0.0031 in)
Oil ring
0.02 - 0.06 mm (0.0008 - 0.0024 in)

Inspection and Replacement (Cont'd)

Max. limit of side clearance:

Top

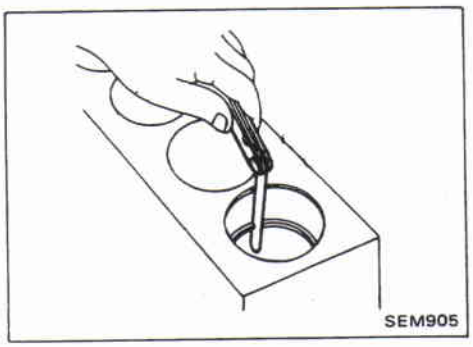
0.50 mm (0.0197 in)

2nd

0.30 mm (0.0118 in)

Oil

0.15 mm (0.0059 in)



PISTON RING GAP

Standard ring gap:

Top ring

0.30 - 0.45 mm (0.0118 - 0.0177 in)

2nd ring

0.20 - 0.35 mm (0.0079 - 0.0138 in)

Oil ring

0.30 - 0.50 mm (0.0118 - 0.0197 in)

Max. limit of ring gap:

1.5 mm (0.059 in)

MAIN BEARING CLEARANCE

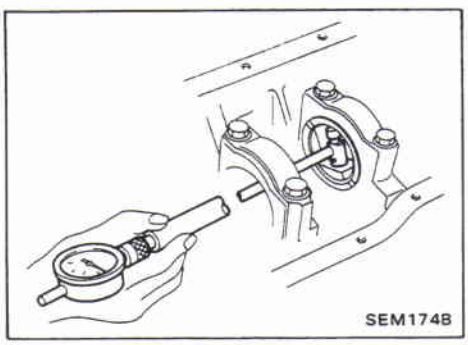
Main bearing clearance:

Standard

0.035 - 0.087 mm (0.0014 - 0.0034 in)

Limit

Less than 0.15 mm (0.0059 in)



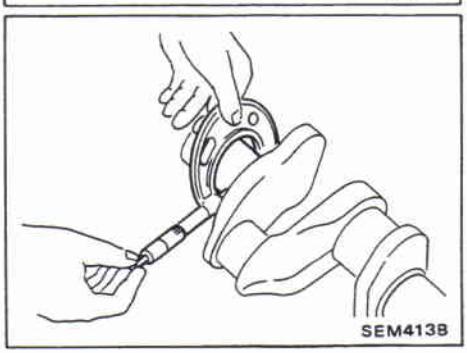
1. Install main bearings to cylinder block and main bearing cap.
2. Install main bearing cap to cylinder block.

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

: 167 - 177 N·m

(17.0 - 18.0 kg-m, 123 - 130 ft-lb)

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



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

Inspection and Replacement (Cont'd)

5. Calculate main bearing clearance:
   Main bearing clearance = A – Dm

CONNECTING ROD BEARING CLEARANCE

Connecting rod bearing clearance:

Standard

0.035 - 0.081 mm (0.0014 - 0.0032 in)

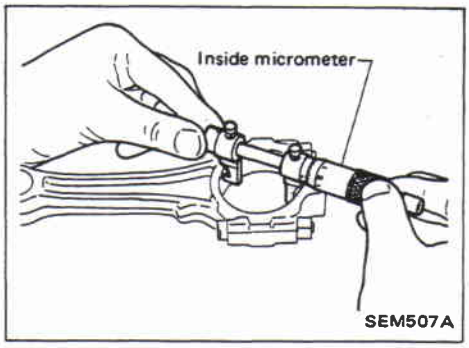
Limit

Less than 0.15 mm (0.0059 in)

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

Apply oil to the thread portion of bolts and seating surface of nuts.

: 78 - 83 N·m (8.0 - 8.5 kg-m, 58 - 61 ft-lb)



3. Measure inside diameter "A" of bearing.
4. Measure outside diameter "Dp" of pin journal in crankshaft.
5. Calculate connecting rod bearing clearance.
   Connecting rod bearing clearance = A – Dp

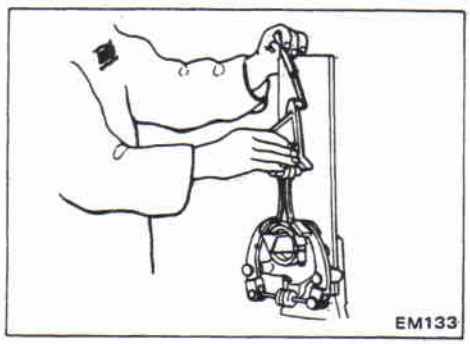
CONNECTING ROD BEND AND TORSION

Bend and torsion:

Limit

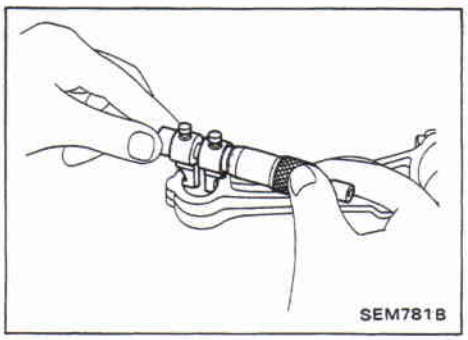
0.05 mm (0.0020 in)

per 100 mm (3.94 in) length

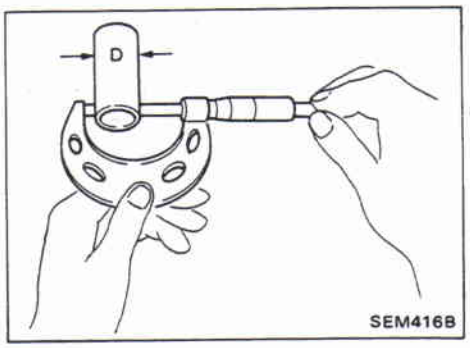


CONNECTING ROD SMALL END BUSHING CLEARANCE

1. Measure inside diameter "A" of connecting rod small end bushings.



Inspection and Replacement (Cont'd)



2. Measure outside diameter "D" of piston pin.
3. Calculate connecting rod small end bushing clearance.
   Connecting rod small end bushing clearance = A – D

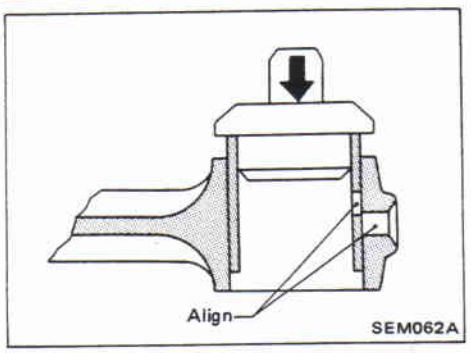
Bushing clearance:

Standard

0.025 - 0.045 mm (0.0010 - 0.0018 in)

Limit

0.15 mm (0.0059 in)



REPLACEMENT OF CONNECTING ROD SMALL END BUSHING

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

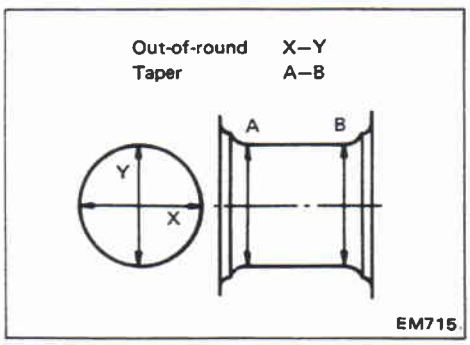
Be sure to align the oil holes.

2. After driving in the small end bushing, ream the bushing.

Small end bushing inside diameter:

Finished size

28.025 - 28.038 mm (1.1033 - 1.1039 in)



CRANKSHAFT

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

Out-of-round (X—Y):

Standard

Less than 0.01 mm (0.0004 in)

Limit

0.02 mm (0.0008 in)

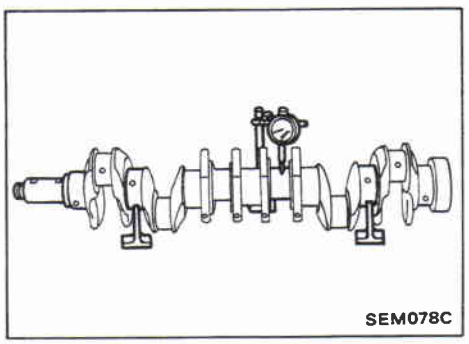
Taper (A—B):

Standard

Less than 0.01 mm (0.0004 in)

Limit

0.02 mm (0.0008 in)



3. Check crankshaft runout.

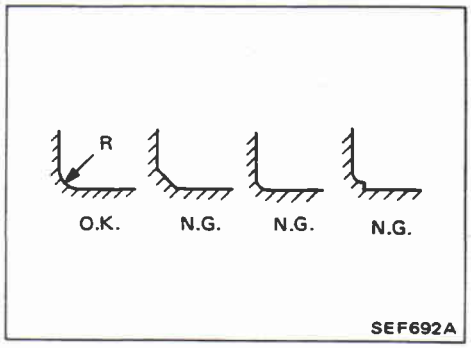
Runout [T.I.R. (Total Indicator Reading)]:

Standard

0 - 0.03 mm (0 - 0.0012 in)

Limit

0.10 mm (0.0039 in)



Inspection and Replacement (Cont'd)

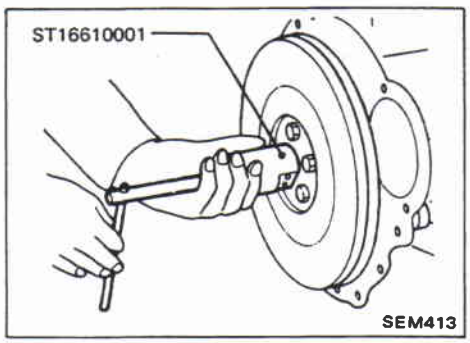
RESURFACING OF CRANKSHAFT JOURNAL AND CRANK PIN

When using undersize main bearings and connecting rod bearings, the crankshaft journals or crank pins must be finished to match the bearings.

R: Crank journal:
3.0 mm (0.118 in)
Crank pin:
3.5 mm (0.138 in)

CAUTION:

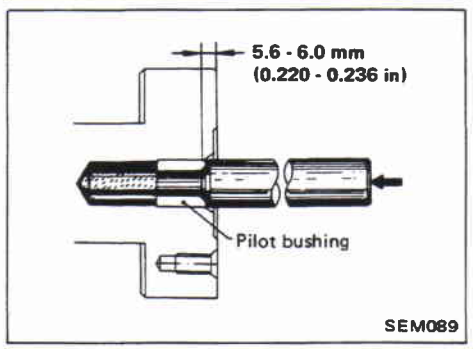
- **At the same time make sure that the surface width does not increase.**
- **Do not attempt to cut counterweight of crankshaft.**



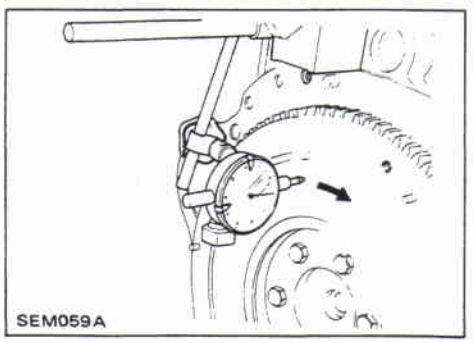
CRANKSHAFT PILOT BUSHING

Crankshaft pilot bushing replacement

1. Pull out bushing with Tool.



2. Insert pilot bushing until distance between flange end and bushing is specified value.
   Distance:
   Approx. 5.6 - 6.0 mm (0.220 - 0.236 in)

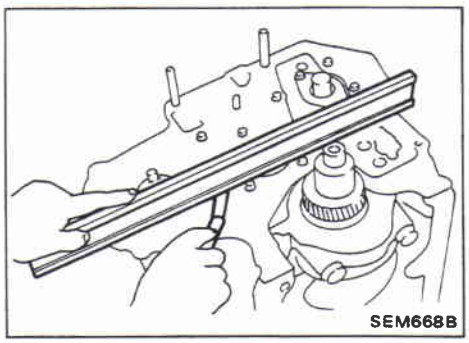


FLYWHEEL RUNOUT

Runout (Total indicator reading):
0.15 mm (0.0059 in) or less

Inspection and Replacement (Cont'd)

FRONT PLATE

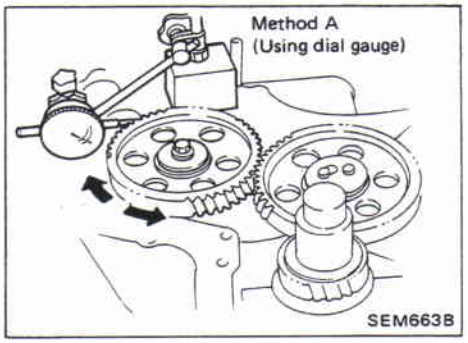

SEM668B

Check front plate for warpage. If not within the limit, make flat or replace front plate.

Warpage limit:

0.2 mm (0.008 in)

GEAR TRAIN



SEM663B

Camshaft drive gear, injection pump drive gear, oil pump gear, idler gear and crankshaft gear

1. If gear tooth and key have scratches or are excessively worn, replace gear and key.
2. Check gear train backlash before disassembling and after assembling.
   Method A (Using dial gauge)
   Method B (Using fuse wire)
   If beyond the limit, replace gear.

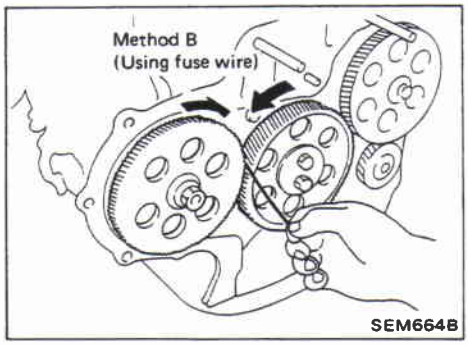
Backlash:

Standard

0.06 - 0.12 mm (0.0024 - 0.0047 in)

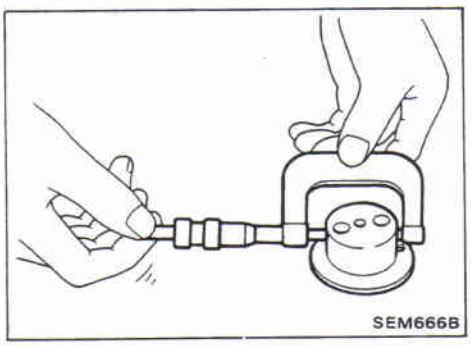
Limit

0.20 mm (0.0079 in)

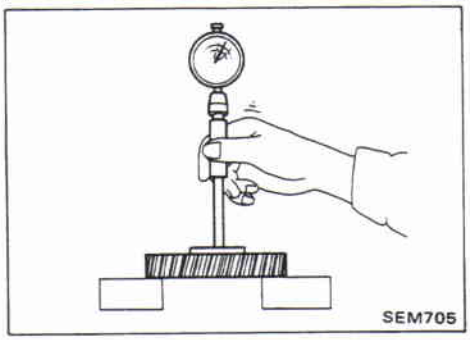


SEM664B

IDLER GEAR BUSHING CLEARANCE


SEM666B

1. Measure idler gear shaft outer diameter.


SEM705

2. Measure idler gear bushing inner diameter.
3. Calculate idler gear bushing clearance.

Bushing oil clearance:

Standard

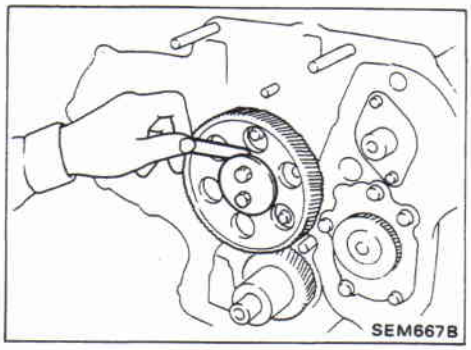
0.025 - 0.061 mm (0.0010 - 0.0024 in)

Limit

0.20 mm (0.0079 in)

Inspection and Replacement (Cont'd)

IDLER GEAR END PLAY

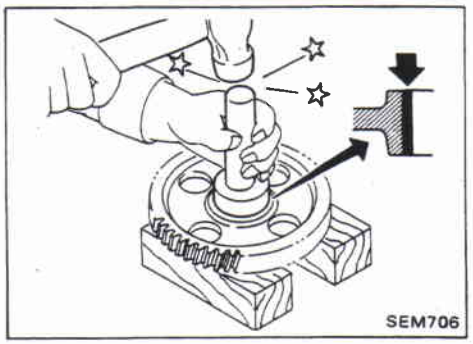

SEM667B

Measure idler gear end play between gear plate and gear.

Idler gear end play:
Standard
0.03 - 0.14 mm (0.0012 - 0.0055 in)
Limit
Less than 0.3 mm (0.012 in)

Idler gear shaft bolt:
[O]: 25 - 35 N·m (2.6 - 3.6 kg-m, 19 - 26 ft-lb)

REPLACEMENT OF IDLER GEAR BUSHING


SEM706

1. Use a suitable tool to replace bushing.
2. Ream idler gear bushing.

Finished size:
42.00 - 42.02 mm (1.6535 - 1.6543 in)

Idler gear shaft

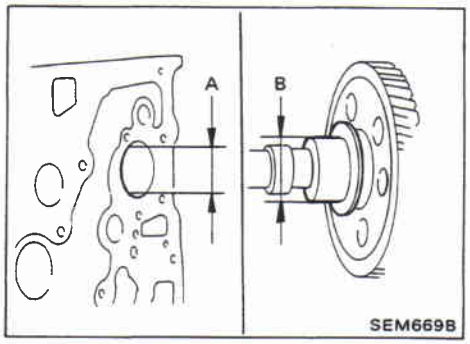
Install idler gear shaft so that oil hole of shaft faces upward.

CAMSHAFT AND CAMSHAFT BUSHING

Camshaft bushing clearance

Measure inside diameter of camshaft bushing and outside diameter of camshaft journal with a suitable gauge.

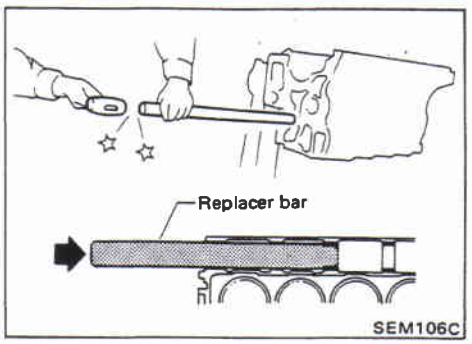
Clearance between camshaft and bushing (A—B):
Standard
0.020 - 0.109 mm (0.0008 - 0.0043 in)
Limit
Less than 0.15 mm (0.0059 in)



SEM669B

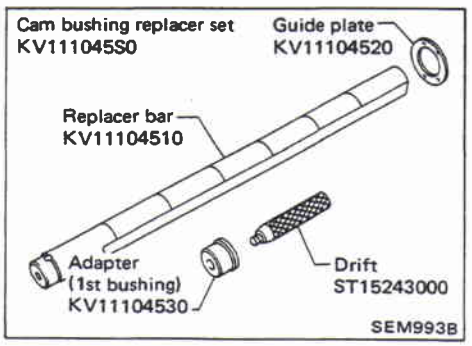
REPLACING CAMSHAFT BUSHING

1. Using Tool, remove camshaft bushings from the engine. Some bushings must be broken in order to remove.



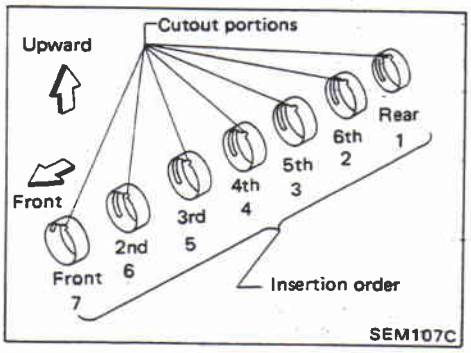
SEM106C

2. Using Tool, install camshaft bushings as follows:

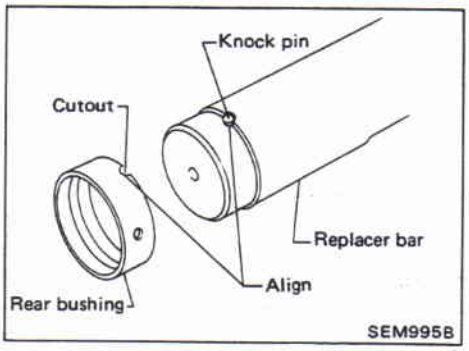


SEM993B

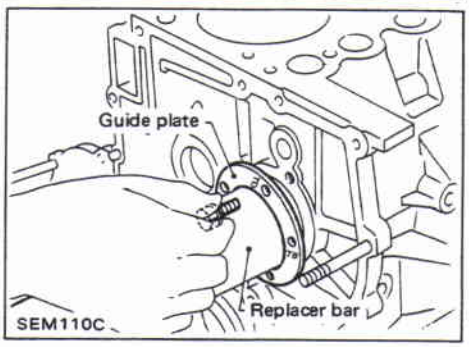
Inspection and Replacement (Cont'd)



(1) Install camshaft bushings in the order of "rear", "6th", "5th", "4th", "3rd", "2nd" and "front". All bushings must be installed from the front.
(2) Face the cutout upward during installation.

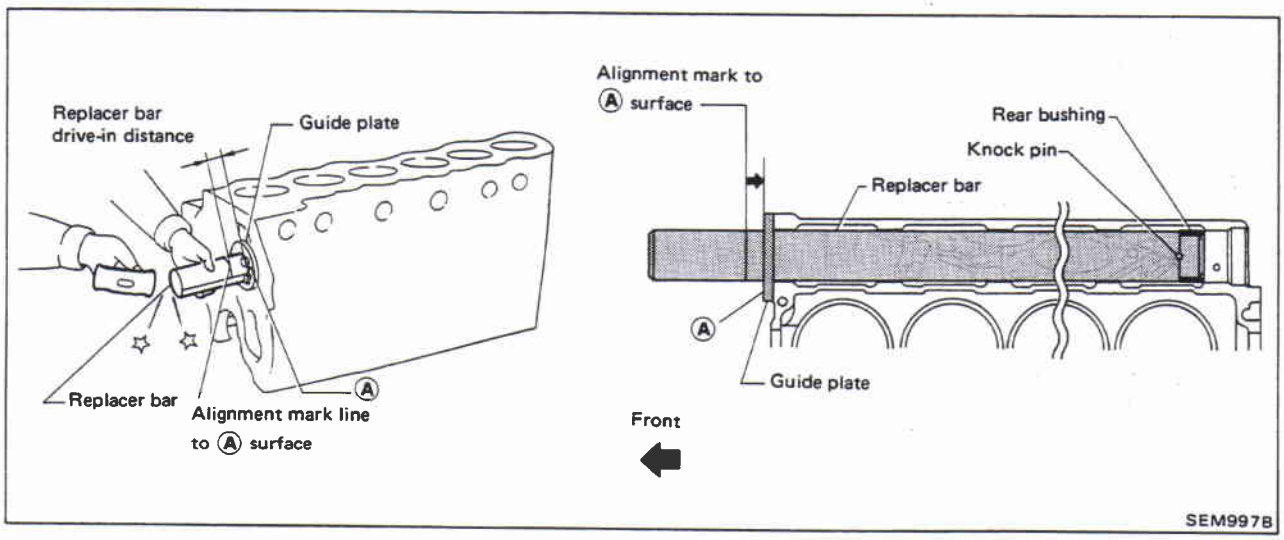


(3) Rear camshaft bushing
Align the cutout of rear bushing with knock pin of replacer bar before installation.



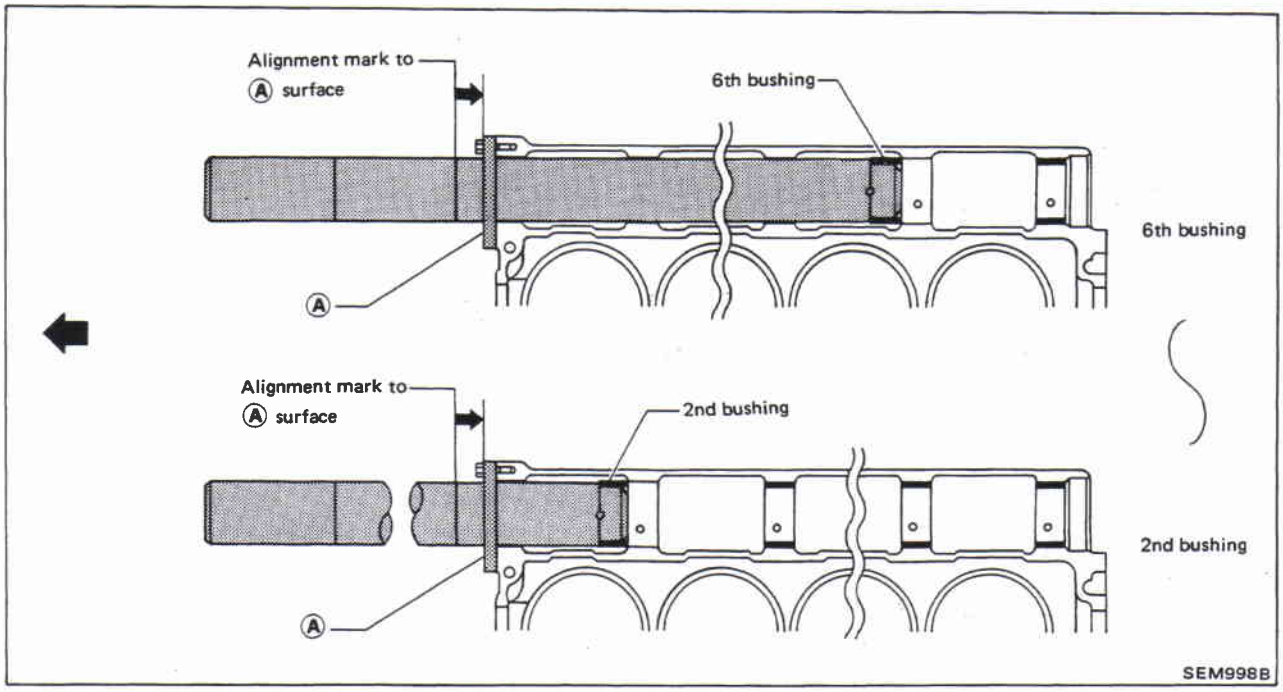
Insert rear bushing with replacer bar into the engine.
Install guide plate with bolt holes (on the "TD" mark side) facing upper side of cylinder block. Tighten bolts.

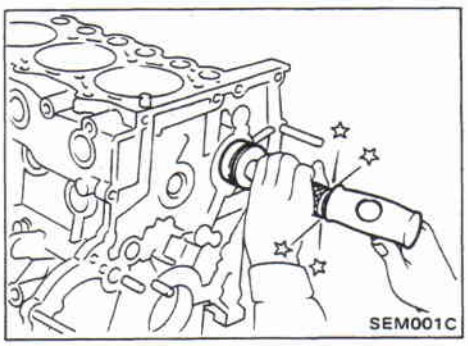
Drive replacer bar until the alignment mark on replacer bar is aligned with the end of replacer guide.
Remove replacer set.
After installation, check that oil holes in camshaft bushings are aligned with oil holes in cylinder block.



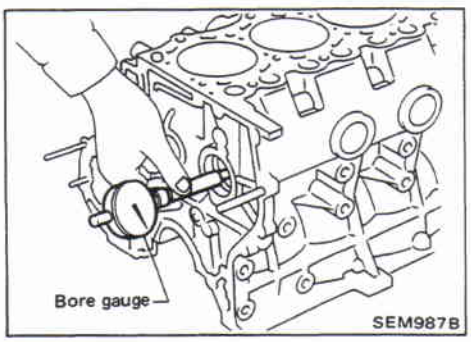
Inspection and Replacement (Cont'd)

(4) 6th, 5th, 4th, 3rd and 2nd camshaft bushings
Install in the same manner as rear camshaft bushing.





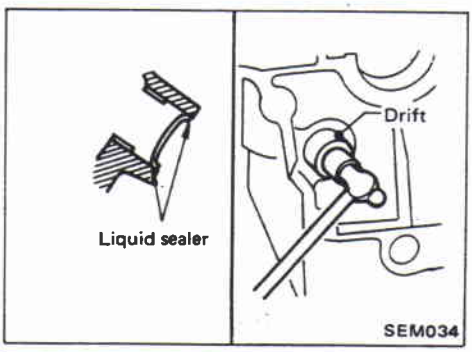
(5) Front camshaft bushing
Using 1st bushing adapter, position front camshaft bushing so that oil hole in cylinder block is aligned with oil hole in bushing.

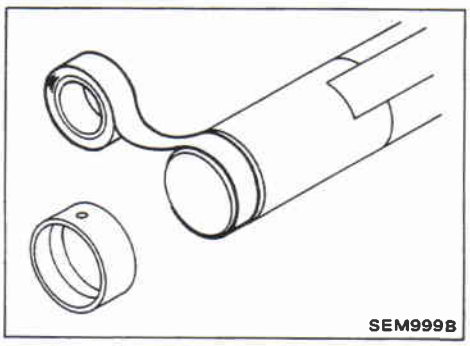


3. Check camshaft bushing clearance.

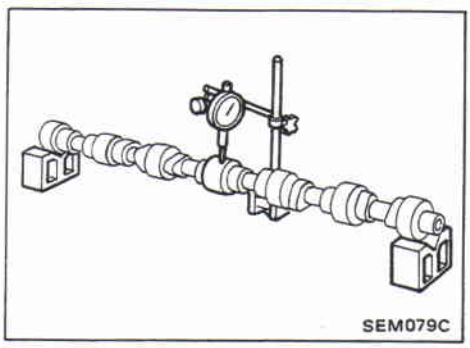
Inspection and Replacement (Cont'd)

4. Install new welch plug with a drift.
Apply liquid sealer.



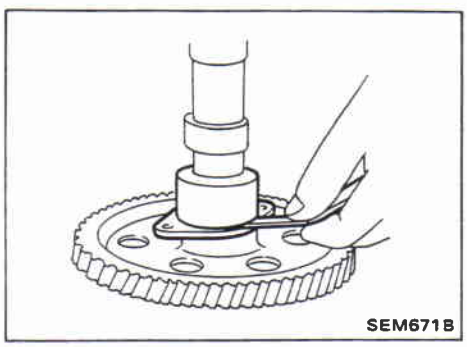


When setting 6th through 2nd bushings on replacer bar, tape the bar to prevent movement.

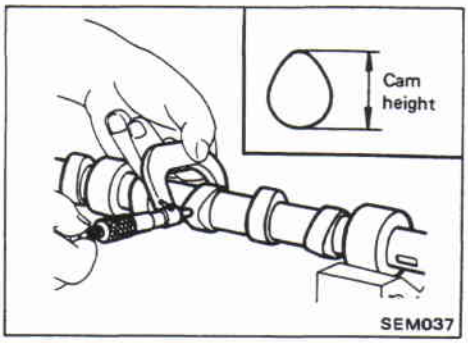


CAMSHAFT ALIGNMENT

1. Check camshaft journal and cam surface for bend, wear or damage.
   If fault is beyond limit, replace.
2. Check camshaft bend at center journal.
   If bend is greater than specified limit, repair or replace camshaft.
   Camshaft bend (Total indicator reading):
   Standard
   Less than 0.02 mm (0.0008 in)
   Limit
   Less than 0.06 mm (0.0024 in)



3. Measure camshaft end play between locating plate and gear.
   If beyond the specified limit, replace camshaft locating plate.
   Camshaft end play:
   Standard
   0.08 - 0.28 mm (0.0031 - 0.0110 in)
   Limit
   Less than 0.5 mm (0.020 in)



Inspection and Replacement (Cont'd)

4. Measure camshaft cam height. If beyond the specified limit, replace camshaft.

Cam height:

Standard

Intake

41.71 - 41.75 mm (1.6421 - 1.6437 in)

Exhaust

41.88 - 41.92 mm (1.6488 - 1.6504 in)

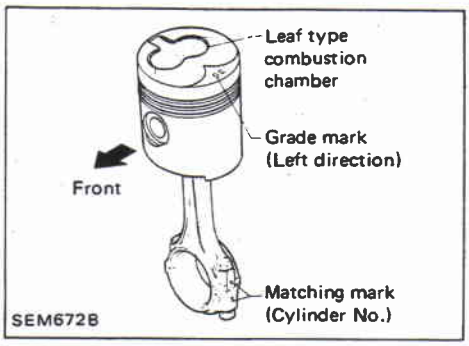
Limit

Intake

Less than 41.20 mm (1.6220 in)

Exhaust

Less than 41.30 mm (1.6260 in)

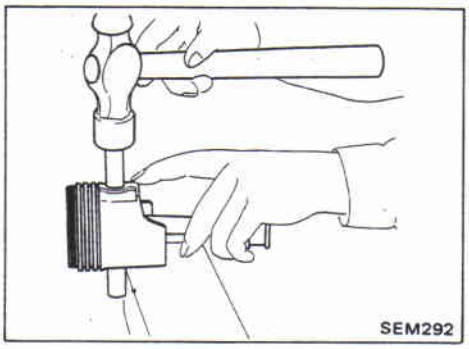


Assembly

PISTON

Assemble pistons, piston pins, snap rings and connecting rods.

a. Numbers are stamped on the connecting rod and cap corresponding to each cylinder. Care should be taken to avoid a wrong combination including bearing.



b. When inserting piston pin in connecting rod, heat piston with a heater or hot water [approximately 60 to 70°C (140 to 158°F)] and apply engine oil to pin and small end of connecting rod.

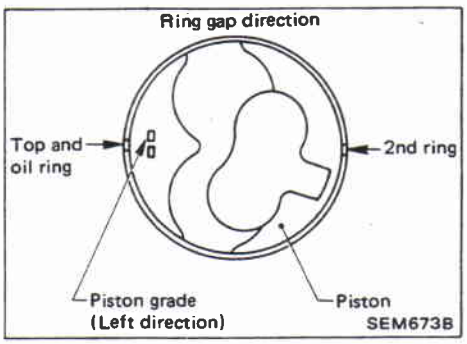
c. After assembling, ascertain that piston swings smoothly.

Install piston assembly.

CAUTION:

a. Stretch the piston rings only enough to fit them in the piston grooves.

b. Be sure the manufacturer's mark faces upward.



c. Install No. 1 piston ring in such a way that its gap faces the direction of the piston pin; and then install piston rings so that their gap positioned at 180° to one another.

CRANKSHAFT

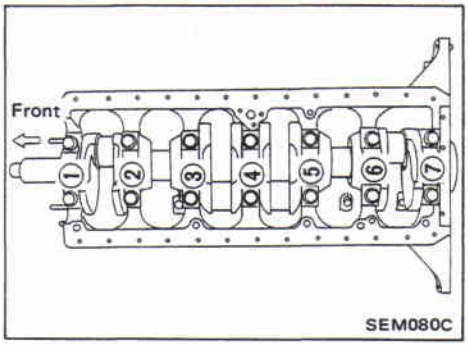
1. Install crankshaft.

(1) Set main bearings in the proper position on cylinder block.

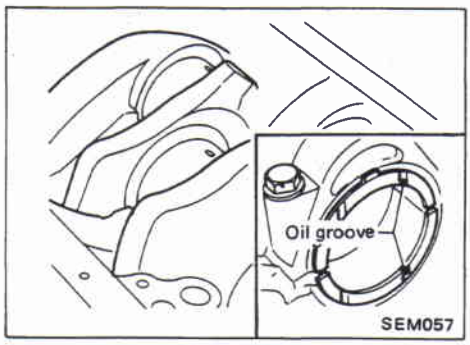
a. If either crankshaft, cylinder block or main bearing is reused again, it is necessary to measure main bearing clearance.

b. Upper bearings have oil hole and oil groove, however lower bearings do not.

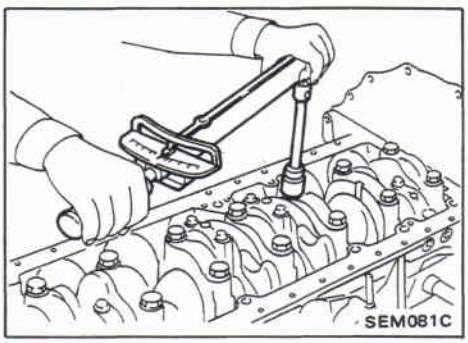
Assembly (Cont'd)



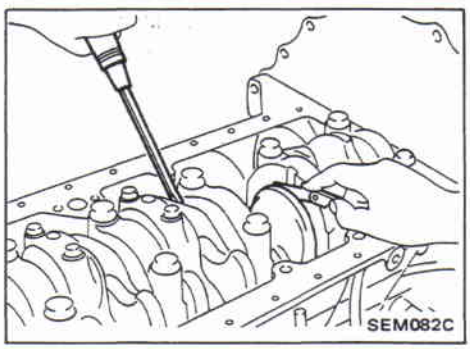
(2) Apply engine oil to crankshaft journal and pin and install crankshaft.
(3) Install main bearing caps.
a) Install main bearing cap with the number facing the front of vehicle.
b) Apply engine oil to main bearing cap and cylinder block contact surfaces.
c) Install rear oil seal assembly. Apply engine oil to contact surface of rear end oil seal and crankshaft.



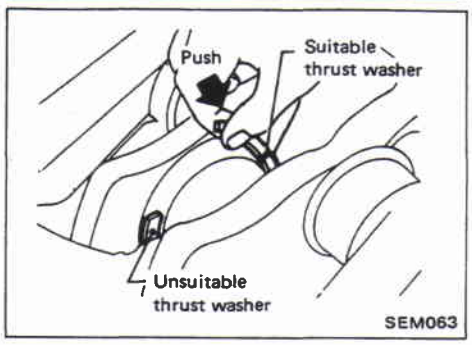
(4) Install crankshaft thrust washer at the 6th journal from front.
Install thrust washer so that oil groove can face crankshaft.



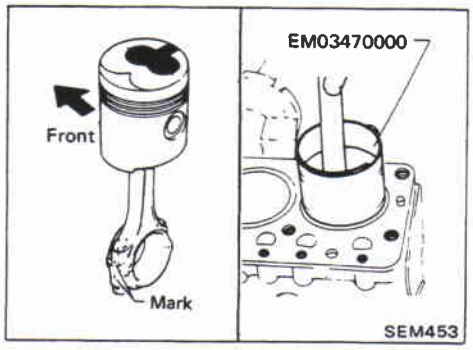
(5) Tighten main bearing cap bolts gradually in stages, starting from two to three separate stages, from center bearing and moving outward in sequence.
Main bearing cap bolt:
: 167 - 177 N·m
(17.0 - 18.0 kg-m, 123 - 130 ft-lb)



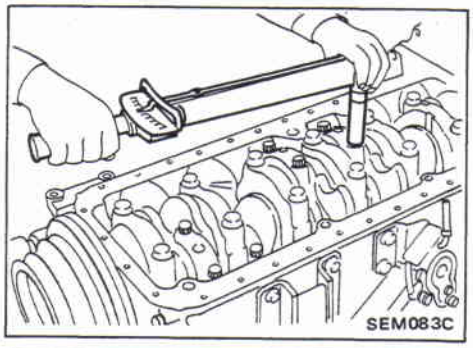
(6) Measure crankshaft free end play at No. 6 bearing.
Crankshaft free end play:
Standard
0.055 - 0.140 mm (0.0022 - 0.0055 in)
Limit
0.4 mm (0.016 in)
If beyond the limit, replace No. 6 main bearing thrust washer.
Refer to S.D.S.



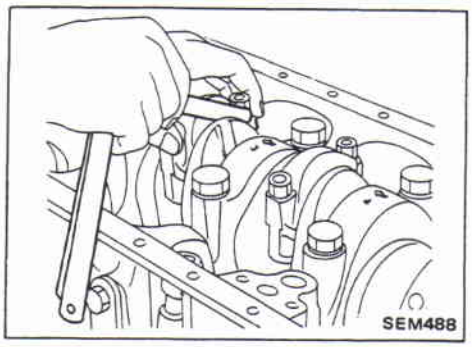
Assembly (Cont'd)



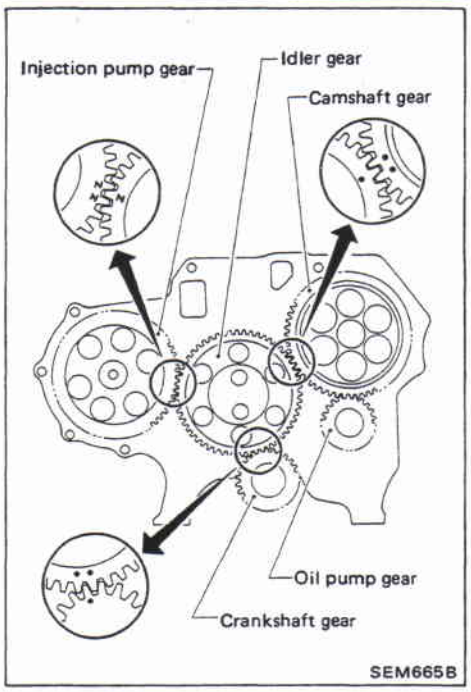
2. Install pistons with connecting rods.
(1) Install them into corresponding cylinder using Tool.
- **Be careful not to scratch cylinder wall with connecting rod.**
- **Apply engine oil to cylinder wall, piston and bearing.**
- **The leaf type combustion chamber on piston head must be at right side of engine.**



(2) Install connecting rod bearing caps.
Connecting rod bearing nut:
:78 - 83 N·m (8.0 - 8.5 kg-m, 58 - 61 ft-lb)



3. Measure connecting rod side clearance.
Connecting rod side clearance:
Standard
0.10 - 0.22 mm (0.0039 - 0.0087 in)
Limit
0.22 mm (0.0087 in)
If beyond the limit, replace connecting rod and/or crankshaft.



GEAR TRAIN

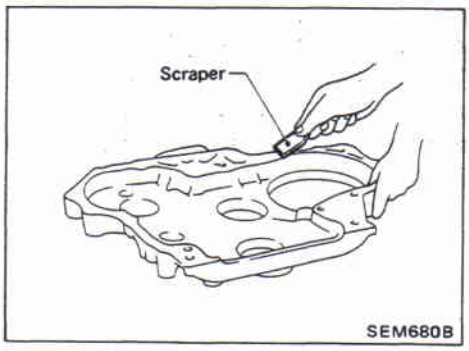
1. Set No. 1 piston at its top dead center.
2. Align each gear mark and install gears.

Assembly (Cont'd)

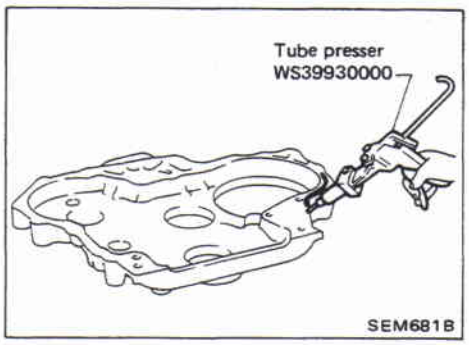
TIMING GEAR CASE

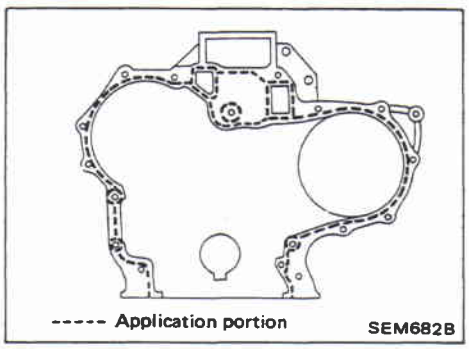
Installation

1. Before installing timing gear case, remove all traces of liquid gasket from mating surface using a scraper.
   Also remove traces of liquid gasket from mating surface of front plate.

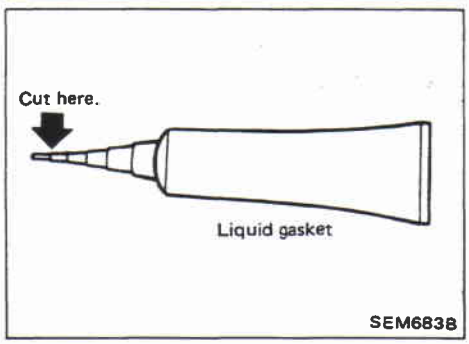


2. Apply a continuous bead of liquid gasket to mating surface of timing gear case.





- **Be sure liquid gasket is 2.5 to 3.5 mm (0.098 to 0.138 in) wide.**
- **Attach timing gear case to front plate within 10 minutes after coating.**
- **Wait at least 30 minutes before refilling engine coolant or starting engine.**
- **Use Genuine Liquid Gasket or equivalent.**



General Specifications

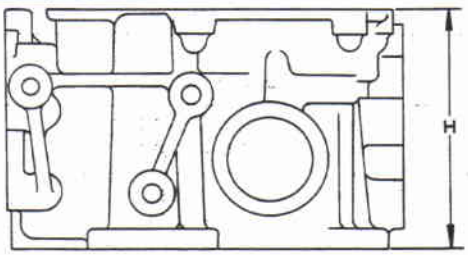
Cylinder arrangement		6, in-line
Displacement	cm^3 (cu in)	4,169 (254.39)
Bore and stroke	mm (in)	96 x 96 (3.78 x 3.78)
Valve arrangement		O.H.V.
Firing order		1-5-3-6-2-4
Number of piston rings		
Compression		2
Oil		1
Number of main bearings		7
Compression ratio		8.3

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

Compression pressure	
Standard	1,177 (11.77, 12.0, 171)/200
Minimum	883 (8.83, 9.0, 128)/200
Differential limit between cylinders	98 (0.98, 1.0, 14)/200

Inspection and Adjustment

CYLINDER HEAD



SEM013C

Unit: mm (in)

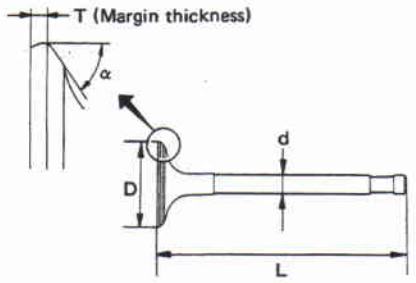
	Standard	Limit
Height (H)	117.19 - 117.59 (4.6138 - 4.6295)	0.2 (0.008)*
Surface distortion	Less than 0.07 (0.0028)	0.2 (0.008)

*: Total amount of cylinder head resurfacing and cylinder block resurfacing

Inspection and Adjustment (Cont'd)

VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	
Intake	47.0 - 47.2 (1.850 - 1.858)
Exhaust	38.0 - 38.2 (1.496 - 1.504)
Valve length "L"	
Intake	116.7 - 117.0 (4.594 - 4.606)
Exhaust	117.0 - 117.3 (4.606 - 4.618)
Valve stem diameter "d"	
Intake	7.965 - 7.980 (0.3136 - 0.3142)
Exhaust	7.945 - 7.960 (0.3128 - 0.3134)
Valve seat angle "α"	
Intake Exhaust	45°30′
Valve margin "T"	
Intake	1.3 (0.051)
Exhaust	1.5 (0.059)
Valve margin "T" limit	More than 0.5 (0.020)
Valve stem end surface grinding limit	Less than 0.2 (0.008)

Valve clearance

Unit: mm (in)

	*Cold	Hot
Intake	0.20 (0.008)	0.38 (0.015)
Exhaust	0.20 (0.008)	0.38 (0.015)

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

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

Valve spring

Free height mm (in)	
Outer	49.77 (1.9594)
Inner	44.10 (1.7362)
Pressure height mm/N (mm/kg, in/lb)	
Outer	30.0/512.9 (30.0/52.3, 1.181/115.3)
Inner	25.0/255.0 (25.0/26.0, 0.984/57.3)
Assembled height mm/N (mm/kg, in/lb)	
Outer	40.0/225.6 (40.0/23.0, 1.575/50.7)
Inner	35.0/107.9 (35.0/11.0, 1.378/24.3)
Out-of-square mm (in)	
Outer	2.2 (0.087)
Inner	1.9 (0.075)

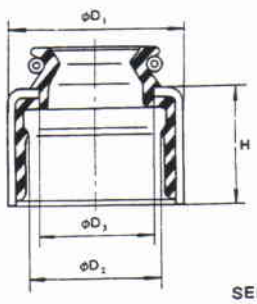
Valve lifter and push rod

Unit: mm (in)

	Standard	Limit
Valve lifter outer diameter	24.970 - 24.980 (0.9831 - 0.9835)	–
Cylinder block valve lifter hole diameter	25.000 - 25.033 (0.9843 - 0.9855)	–
Valve lifter to lifter hole clearance	0.020 - 0.063 (0.0008 - 0.0025)	0.1 (0.004)
Push rod bend (T.I.R.)*	Less than 0.2 (0.008)	0.5 (0.020)

*: Total indicator reading

Valve oil seal



SEM892A

		φD1	φD2	φD3	H
Intake side Exhaust side	mm (in)	15.0 (0.591)	11.68 - 11.78 (0.4598 - 0.4638)	10.2 (0.402)	8.5 (0.335)

Inspection and Adjustment (Cont'd)

Valve guide

Unit: mm (in)

	Standard	Oversize
Valve guide Outer diameter Intake Exhaust	12.033 - 12.044 (0.4737 - 0.4742)	12.233 - 12.244 (0.4816 - 0.4820)
Valve guide Inner diameter [Finished size] Intake Exhaust	8.000 - 8.018 (0.3150 - 0.3157)	
Cylinder head valve guide hole diameter Intake Exhaust	11.970 - 11.988 (0.4713 - 0.4720)	12.170 - 12.188 (0.4791 - 0.4798)
Interference fit of valve guide Intake Exhaust	0.045 - 0.074 (0.0018 - 0.0029)	

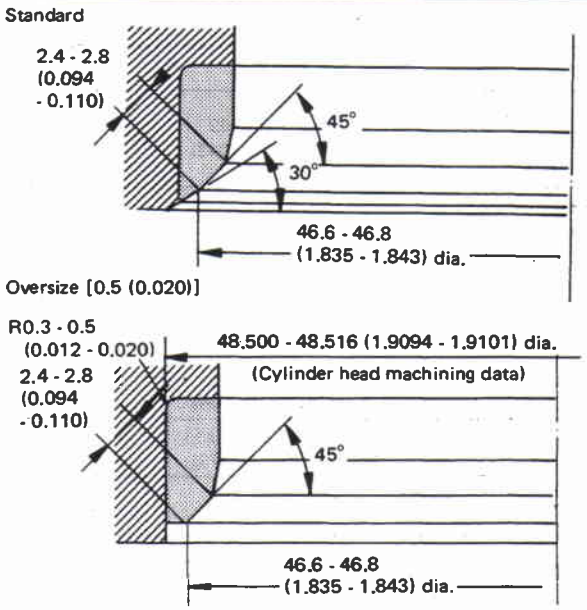
	Standard	Max. tolerance
Stem to guide clearance Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.1 (0.004)
Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	
Valve deflection limit	–	0.2 (0.008)

Rocker shaft and rocker arm

Unit: mm (in)

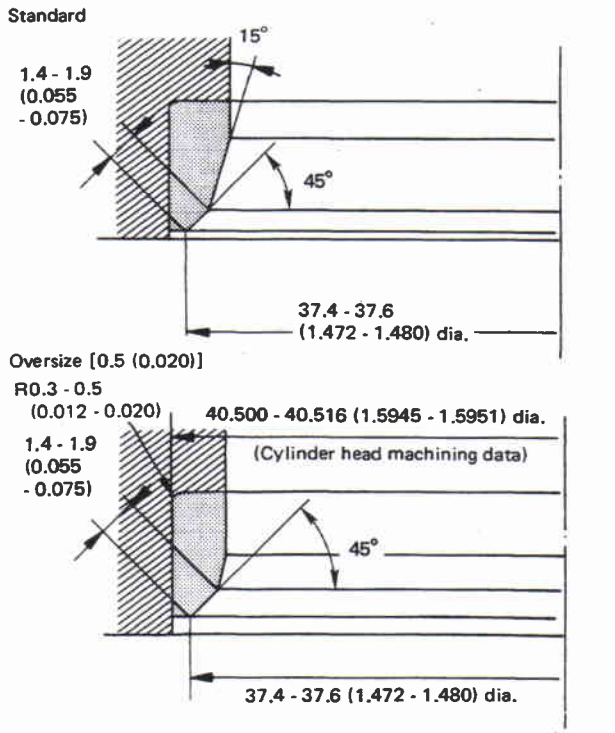
Rocker shaft Outer diameter	19.979 - 20.000 (0.7866 - 0.7874)
Rocker arm Inner diameter	20.020 - 20.038 (0.7882 - 0.7889)
Clearance between rocker arm and rocker shaft	0.020 - 0.059 (0.0008 - 0.0023)

Intake valve seat



Unit: mm (in) SEM755A

Exhaust valve seat



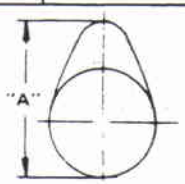
Unit: mm (in) SEM108C

Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BUSHING

Unit: mm (in)

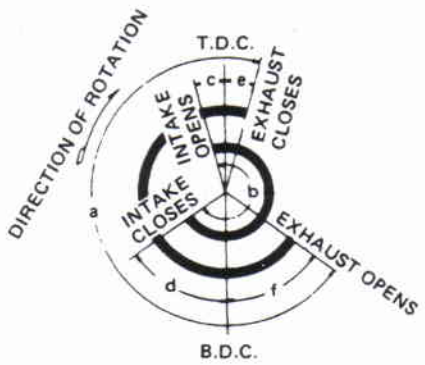
	Standard	Limit
Camshaft journal to bushing clearance [Oil clearance]	0.020 - 0.109 (0.0008 - 0.0043)	0.15 (0.0059)
Inner diameter of camshaft bushing		
Front	50.76 - 50.83 (1.9984 - 2.0012)	–
2nd	50.56 - 50.63 (1.9905 - 1.9933)	–
3rd	50.36 - 50.43 (1.9827 - 1.9854)	–
4th	50.16 - 50.23 (1.9748 - 1.9776)	–
5th	49.96 - 50.03 (1.9669 - 1.9697)	–
6th	49.76 - 49.83 (1.9591 - 1.9618)	–
Rear	49.56 - 49.63 (1.9512 - 1.9539)	–
Outer diameter of camshaft journal		
Front	50.721 - 50.740 (1.9969 - 1.9976)	–
2nd	50.521 - 50.540 (1.9890 - 1.9898)	–
3rd	50.321 - 50.340 (1.9811 - 1.9819)	–
4th	50.121 - 50.140 (1.9733 - 1.9740)	–
5th	49.921 - 49.940 (1.9654 - 1.9661)	–
6th	49.721 - 49.740 (1.9575 - 1.9583)	–
Rear	49.521 - 49.540 (1.9496 - 1.9504)	–
Camshaft bend (Total indicator reading)	Less than 0.02 (0.0008)	0.06 (0.0024)
Camshaft end play	0.08 - 0.28 (0.0031 - 0.0110)	0.5 (0.020)



EM671

Cam height "A"	
Intake Exhaust	42.311 - 42.561 (1.6658 - 1.6756)
Wear limit of cam height	0.15 (0.0059)

Valve timing



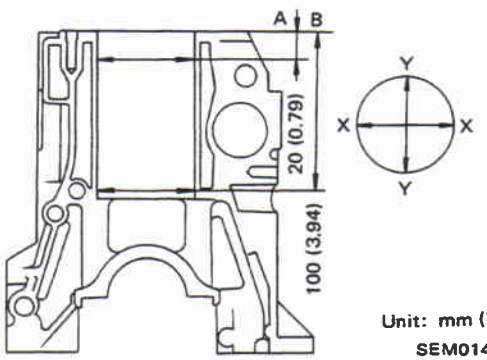
EM120

Unit: degree

a	b	c	d	e	f
248	248	16	52	6	62

CYLINDER BLOCK

Unit: mm (in)



Unit: mm (in)

SEM014C

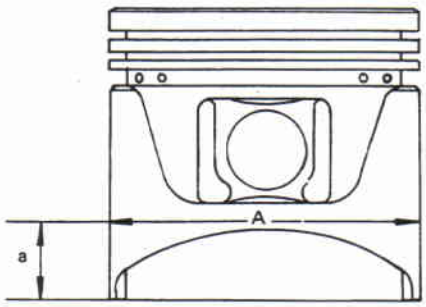
Surface flatness	
Standard	Less than 0.03 (0.0012)
Limit	0.10 (0.0039)
Cylinder bore	
Inner diameter	
Standard	
Grade No. 1	96.000 - 96.010 (3.7795 - 3.7799)
Grade No. 2	96.010 - 96.020 (3.7799 - 3.7803)
Grade No. 3	96.020 - 96.030 (3.7803 - 3.7807)
Grade No. 4	96.030 - 96.040 (3.7807 - 3.7811)
Grade No. 5	96.040 - 96.050 (3.7811 - 3.7815)
Wear limit	0.20 (0.0079)
Out-of-round (X–Y)	Less than 0.015 (0.0006)
Taper (A–B)	Less than 0.010 (0.0004)
Difference in inner diameter between cylinders	
Standard	Less than 0.05 (0.0020)
Wear limit	0.20 (0.0079)

Inspection and Adjustment (Cont'd)

PISTON, PISTON RING AND PISTON PIN

Available piston

Unit: mm (in)



SEM891B

Piston skirt diameter "A"	
Standard	
Grade No. 1	95.975 - 95.985 (3.7785 - 3.7789)
Grade No. 2	95.985 - 95.995 (3.7789 - 3.7793)
Grade No. 3	95.995 - 96.005 (3.7793 - 3.7797)
Grade No. 4	96.005 - 96.015 (3.7797 - 3.7801)
Grade No. 5	96.015 - 96.025 (3.7801 - 3.7805)
Oversize	
0.50 (0.0197) (mark: "50")	96.475 - 96.525 (3.7982 - 3.8002)
1.00 (0.0394) (mark: "100")	96.975 - 97.025 (3.8179 - 3.8199)
"a" dimension	20 (0.79)
Piston pin hole diameter	22.987 - 22.993 (0.9050 - 0.9052)
Piston clearance to cylinder block	0.015 - 0.035 (0.0006 - 0.0014)

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

Piston ring

Unit: mm (in)

	Standard	Limit
Side clearance		
Top	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
2nd	0.030 - 0.063 (0.0012 - 0.0025)	
Oil	0.015 - 0.185 (0.0006 - 0.0073)	
Ring gap (at master bore D = 96.000 (3.7795))		
Top	0.30 - 0.45 (0.0118 - 0.0177)	1.5 (0.059)
2nd	0.30 - 0.45 (0.0118 - 0.0177)	
Oil	0.20 - 0.60 (0.0079 - 0.0236)	

Piston pin

Unit: mm (in)

Piston pin outer diameter	22.989 - 22.995 (0.9051 - 0.9053)
Interference fit of piston pin to piston	−0.008 to 0.004 (−0.0003 to 0.0002)
Piston pin to connecting rod bush clearance	0.005 - 0.017 (0.0002 - 0.0007)

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

CONNECTING ROD

Unit: mm (in)

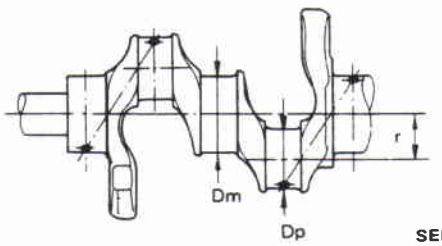
Center distance	166.45 - 166.55 (6.5531 - 6.5571)
Bend, torsion [per 100]	
Limit	Bend 0.15 (0.0059) Torsion 0.3 (0.012)
Piston pin bushing inner diameter	23.000 - 23.006 (0.9055 - 0.9057)
Connecting rod big end inner diameter	59.987 - 60.000 (2.3617 - 2.3622)
Side clearance	
Standard	0.20 - 0.30 (0.0079 - 0.0118)
Limit	0.40 (0.0157)

Inspection and Adjustment (Cont'd)

CRANKSHAFT

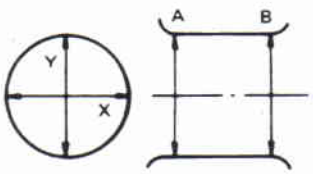
Unit: mm (in)

Main journal dia. "Dm"	70.907 - 70.920 (2.7916 - 2.7921)
Pin journal dia. "Dp"	56.913 - 56.926 (2.2407 - 2.2412)
Center distance "r"	48 (1.89)
Out-of-round (X–Y)	
Standard	Less than 0.0025 (0.0001)
Taper (A–B)	
Standard	Less than 0.0025 (0.0001)
Runout [T.I.R.]	
Standard	Less than 0.20 (0.0079)
Free end play	
Standard	0.05 - 0.17 (0.0020 - 0.0067)
Limit	0.30 (0.0118)



SEM645

Out-of-round X–Y
Taper A–B



EM715

AVAILABLE MAIN BEARING

Unit: mm (in)

	Thickness "T"	Main journal diameter "Dm"
Standard	2.003 - 2.007 (0.0789 - 0.0790)	–
Undersize 0.25 (0.0098)	2.128 - 2.132 (0.0838 - 0.0839)	Grind so that bearing clearance is the specified value.
0.50 (0.0197)	2.253 - 2.257 (0.0887 - 0.0889)	
0.75 (0.0295)	2.378 - 2.382 (0.0936 - 0.0938)	
1.00 (0.0394)	2.503 - 2.507 (0.0985 - 0.0987)	

AVAILABLE CONNECTING ROD BEARING

Unit: mm (in)

	Thickness "T"	Crank pin journal diameter "Dp"
Standard	1.513 - 1.517 (0.0596 - 0.0597)	–
Undersize 0.25 (0.0098)	1.638 - 1.642 (0.0645 - 0.0646)	Grind so that bearing clearance is the specified value.
0.50 (0.0197)	1.763 - 1.767 (0.0694 - 0.0696)	
0.75 (0.0295)	1.888 - 1.892 (0.0743 - 0.0745)	
1.00 (0.0394)	2.013 - 2.017 (0.0793 - 0.0794)	

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Flywheel & drive plate	
Runout [T.I.R.]	Less than 0.1 (0.004)

Bearing clearance

Unit: mm (in)

Main bearing clearance	
Standard	0.041 - 0.087 (0.0016 - 0.0034)
Limit	0.09 (0.0035)
Connecting rod bearing clearance	
Standard	0.027 - 0.061 (0.0011 - 0.0024)
Limit	0.09 (0.035)

General Specifications

Cylinder arrangement		6, in-line
Displacement	cm^3 (cu in)	4,169 (254.39)
Bore and stroke	mm (in)	96 x 96 (3.78 x 3.78)
Valve arrangement		O.H.V.
Firing order		1-4-2-6-3-5
Number of piston rings		
Compression		2
Oil		1
Number of main bearings		7
Compression ratio		22.7

Inspection and Adjustment

COMPRESSION PRESSURE

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

Standard	2,942 (29.4, 30, 427)/200
Minimum	2,452 (24.5, 25, 356)/200
Differential limit between cylinders	294 (2.9, 3, 43)/200

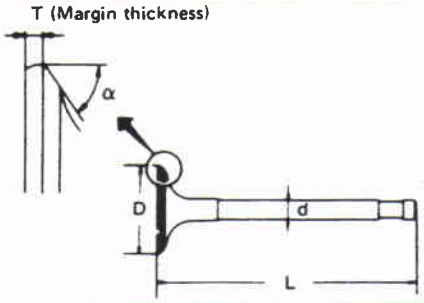
CYLINDER HEAD

Unit: mm (in)

	Standard	Limit
Head surface distortion	Less than 0.07 (0.0028)	0.2 (0.008)

VALVE

Unit: mm (in)



SEM188

	Standard
Valve head diameter "D"	
Intake	43.4 - 43.6 (1.709 - 1.717)
Exhaust	37.9 - 38.1 (1.492 - 1.500)
Valve length "L"	
Intake	117 (4.61)
Exhaust	
Valve stem diameter "d"	
Intake	7.962 - 7.977 (0.3135 - 0.3141)
Exhaust	7.945 - 7.960 (0.3128 - 0.3134)
Valve seat angle "α"	
Intake	45° - 45°30'
Exhaust	
Valve margin "T" limit	1.0 (0.039)
Valve stem end surface grinding limit	0.2 (0.008)
Valve clearance (Hot)	
Intake	0.35 (0.0138)
Exhaust	

Inspection and Adjustment (Cont'd)

Valve guide

Unit: mm (in)

	Standard	Service
Valve guide outside diameter	12.033 - 12.044 (0.4737 - 0.4742)	–
Valve guide inner diameter (Finished size)	8.00 - 8.015 (0.3150 - 0.3156)	
Cylinder head valve guide hole diameter	12.00 - 12.011 (0.4724 - 0.4729)	–
Interference fit of valve guide	0.022 - 0.044 (0.0009 - 0.0017)	

	Standard	Max. tolerance
Stem to guide clearance		
Intake	0.023 - 0.053 (0.0009 - 0.0021)	0.15 (0.0059)
Exhaust	0.04 - 0.07 (0.0016 - 0.0028)	0.20 (0.0079)
Valve deflection limit		
Intake	0.30 (0.0118)	
Exhaust	0.40 (0.0157)	

Valve spring

Free length mm (in)	
Painted red	52.15 (2.0531)
Painted yellow	53.0 (2.087)
Pressure height mm/N (mm/kg, in/lb)	
Painted red	32.3/672.8 - 759.1 (32.3/68.6 - 77.4, 1.272/151.3 - 170.7)
Painted yellow	31.8/697.3 - 779.7 (31.8/71.1 - 79.5, 1.252/156.8 - 175.3)
Assembled height mm/N (mm/kg, in/lb)	
Standard	42.3/287.3 - 330.5 (42.3/29.3 - 33.7, 1.665/64.6 - 74.3)
Limit	42.3/270.7 (42.3/27.6, 1.665/60.9)
Out-of-square mm (in)	2.0 (0.079)

VALVE LIFTER AND PUSH ROD

Unit: mm (in)

	Standard	Limit
Valve lifter outer diameter	24.960 - 24.970 (0.9827 - 0.9831)	–
Cylinder block valve lifter hole diameter	25.000 - 25.033 (0.9843 - 0.9855)	–
Valve lifter to lifter hole clearance	0.030 - 0.073 (0.0012 - 0.0029)	0.20 (0.0079)
Push rod bend (T.I.R.)*	Less than 0.3 (0.012)	0.5 (0.020)

*: Total indicator reading

Rocker shaft and rocker arm

Unit: mm (in)

	Standard	Limit
Rocker shaft		
Outer diameter	19.979 - 20.00 (0.7866 - 0.7874)	–
Rocker shaft bend (T.I.R.)	0 - 0.10 (0 - 0.0039)	Less than 0.30 (0.0118)
Rocker arm		
Inner diameter	20.014 - 20.035 (0.7880 - 0.7888)	–
Clearance between rocker arm and rocker shaft	0.014 - 0.056 (0.0006 - 0.0022)	0.15 (0.0059)

CYLINDER HEAD TO VALVE DISTANCE

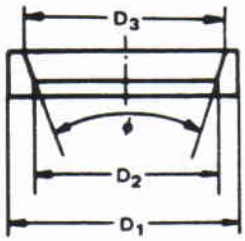
Unit: mm (in)

	Standard	Limit
Intake	0.275 - 0.675 (0.0108 - 0.0266)	1.25 (0.0492)
Exhaust	0.305 - 0.695 (0.0120 - 0.0274)	1.25 (0.0492)

Inspection and Adjustment (Cont'd)

Valve seat

Unit: mm (in)



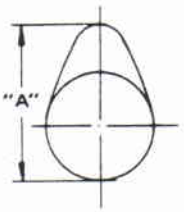
EM733

Intake	
Outer diameter "D_1"	44.535 - 44.545 (1.7533 - 1.7537)
Inner diameter "D_2"	38.4 - 38.6 (1.512 - 1.520)
Diameter of seat "D_3"	41.7 - 41.9 (1.642 - 1.650)
Cylinder head valve seat diameter	44.500 - 44.515 (1.7520 - 1.7526)
Valve seat face angle "ϕ"	89° - 91°
Exhaust	
Outer diameter "D_1"	
Standard	39.535 - 39.545 (1.5565 - 1.5569)
0.2 (0.008) Oversize (Service)	39.735 - 39.745 (1.5644 - 1.5648)
0.4 (0.016) Oversize (Service)	39.935 - 39.945 (1.5722 - 1.5726)
Inner diameter "D_2"	32.9 - 33.1 (1.295 - 1.303)
Diameter of seat "D_3"	36.95 - 37.05 (1.4547 - 1.4587)
Cylinder head valve seat diameter	
Standard	39.495 - 39.510 (1.5549 - 1.5555)
0.2 (0.008) Oversize	36.695 - 39.710 (1.5628 - 1.5634)
0.4 (0.016) Oversize	39.895 - 39.910 (1.5707 - 1.5713)
Valve seat face angle "ϕ"	89° - 90°

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

	Standard	Limit
Camshaft journal to bushing clearance [Oil clearance]	0.020 - 0.109 (0.0008 - 0.0043)	0.15 (0.0059)
Camshaft journal diameter		
Front	50.721 - 50.740 (1.9969 - 1.9976)	–
2nd	50.521 - 50.540 (1.9890 - 1.9898)	–
3rd	50.321 - 50.340 (1.9811 - 1.9819)	–
4th	50.121 - 50.140 (1.9733 - 1.9740)	–
Rear	49.921 - 49.940 (1.9654 - 1.9661)	–
Camshaft bend (Total indicator reading)	Less than 0.02 (0.0008)	0.06 (0.0024)
Camshaft end play	0.08 - 0.28 (0.0031 - 0.0110)	0.50 (0.0197)



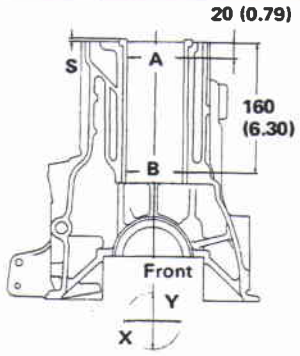
EM671

	Standard	Limit
Cam height "A"		
Intake	41.71 - 41.75 (1.6421 - 1.6437)	41.20 (1.6220)
Exhaust	41.88 - 41.92 (1.6488 - 1.6504)	41.30 (1.6260)

Inspection and Adjustment (Cont'd)

CYLINDER BLOCK AND CYLINDER LINER

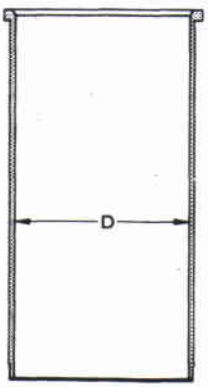
Unit: mm (in)



SEM679B

Surface flatness (Without cylinder liner) Standard	Less than 0.05 (0.0020)
Limit	0.2 (0.008)
Cylinder bore Inner diameter Standard	99.000 - 99.020 (3.8976 - 3.8984)
Cylinder bore (With cylinder liner) Inner diameter Standard Grade No. 1	96.000 - 96.010 (3.7795 - 3.7799)
Grade No. 2	96.010 - 96.020 (3.7799 - 3.7803)
Grade No. 3	96.020 - 96.030 (3.7803 - 3.7807)
Wear limit	0.20 (0.0079)
Out-of-round (X–Y)	Less than 0.020 (0.0008)
Taper (A–B)	Less than 0.20 (0.0079)
Projection "S"	0.02 - 0.09 (0.0008 - 0.0035)
Division of each cylinder "S"	Less than 0.05 (0.0020)
Interference fit cylinder liner to block	–0.01 to 0.03 (–0.0004 to 0.0012)

Unit: mm (in)



SEM427

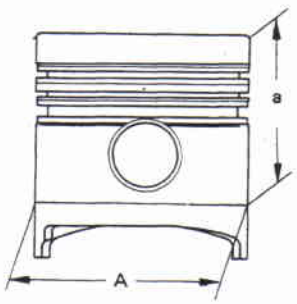
Cylinder liner diameter "D" (service)**	96.050 - 96.070 (3.7815 - 3.7823)

** Before installing in cylinder block

PISTON, PISTON RING AND PISTON PIN

Available piston

Unit: mm (in)



SEM778A

Piston skirt diameter "A" Standard Grade No. 1	95.940 - 95.950 (3.7772 - 3.7776)
Grade No. 2	95.950 - 95.960 (3.7776 - 3.7779)
Grade No. 3*	95.960 - 95.970 (3.7779 - 3.7783)
"a" dimension	70 (2.76)
Piston pin hole diameter	27.992 - 28.000 (1.1020 - 1.1024)
Piston to cylinder liner clearance	0.05 - 0.07 (0.0020 - 0.0028)

* Grade No. 3 piston is not provided as a service part

Inspection and Adjustment (Cont'd)

Piston ring

Unit: mm (in)

	Standard	Limit
Side clearance		
Top	0.06 - 0.10 (0.0024 - 0.0039)	0.50 (0.0197)
2nd	0.04 - 0.08 (0.0016 - 0.0031)	0.30 (0.0118)
Oil	0.02 - 0.06 (0.0008 - 0.0024)	0.15 (0.0059)
Ring gap		
Top	0.30 - 0.45 (0.0118 - 0.0177)	1.5 (0.059)
2nd	0.20 - 0.35 (0.0079 - 0.0138)	
Oil (rail ring)	0.30 - 0.50 (0.0118 - 0.0197)	

Piston pin

Unit: mm (in)

Piston pin outer diameter	27.993 - 28.000 (1.1021 - 1.1024)
Piston pin to piston clearance	−0.008 to 0.007 (−0.0003 to 0.0003)
Piston pin to connecting rod clearance	
Standard	0.025 - 0.045 (0.0010 - 0.0018)
Limit	0.15 (0.0059)

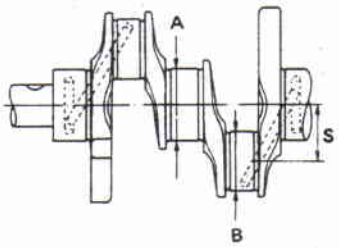
CONNECTING ROD

Unit: mm (in)

Center distance	156.975 - 157.025 (6.1801 - 6.1821)
Bend, torsion [per 100 (3.94)]	
Limit	0.05 (0.0020)
Piston pin bore dia.	28.025 - 28.038 (1.1033 - 1.1039)
Side clearance	
Standard	0.10 - 0.22 (0.0039 - 0.0087)
Limit	0.22 (0.0087)

CRANKSHAFT

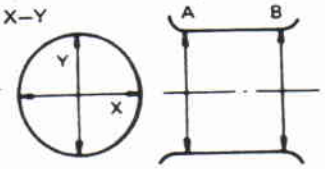
Unit: mm (in)



SEM100A

Journal diameter "A"	70.907 - 70.920 (2.7916 - 2.7921)
Pin diameter "B"	56.919 - 56.926 (2.2409 - 2.2412)
Center distance "S"	48.00 (1.8898)

Out-of-round X–Y
Taper A–B



EM715

Taper of journal and pin "A–B"	
Standard	0.01 (0.0004)
Limit	0.02 (0.0008)
Out-of-round of journal and pin "X–Y"	
Standard	0.01 (0.0004)
Limit	0.02 (0.0008)
Crankshaft bend	
Standard	0 - 0.03 (0 - 0.0012)
Limit	0.10 (0.0039)
Crankshaft end play	
Standard	0.055 - 0.14 (0.0022 - 0.0055)
Limit	0.40 (0.0157)

Inspection and Adjustment (Cont'd)

AVAILABLE MAIN BEARING

Bearing clearance

Unit: mm (in)

Main bearing clearance Standard	0.035 - 0.087 (0.0014 - 0.0034)
Limit	0.15 (0.0059)
Connecting rod bearing clearance Standard	0.035 - 0.081 (0.0014 - 0.0032)
Limit	0.15 (0.0059)

Main bearing undersize

Unit: mm (in)

	Crank journal diameter
Standard	70.907 - 70.920 (2.7916 - 2.7921)
Undersize 0.25 (0.0098)	70.657 - 70.670 (2.7818 - 2.7823)
0.50 (0.0197)	70.407 - 70.420 (2.7719 - 2.7724)
0.75 (0.0295)	70.157 - 70.170 (2.7621 - 2.7626)
1.00 (0.0394)	69.907 - 69.920 (2.7522 - 2.7528)

AVAILABLE CONNECTING ROD BEARING

Connecting rod bearing undersize

Unit: mm (in)

	Crank pin journal diameter
Standard	56.919 - 56.926 (2.2409 - 2.2412)
Undersize 0.25 (0.0098)	56.669 - 56.676 (2.2311 - 2.2313)
0.50 (0.0197)	56.419 - 56.676 (2.2212 - 2.2313)
0.75 (0.0295)	56.169 - 56.176 (2.2114 - 2.2116)
1.00 (0.0394)	55.919 - 55.926 (2.2015 - 2.2018)

AVAILABLE THRUST WASHER

Thrust washer undersize

Unit: mm (in)

		Thrust washer thickness
Standard Standard mark	A	2.275 - 2.325 (0.0896 - 0.0915)
	B	2.300 - 2.350 (0.0906 - 0.0925)
	C	2.325 - 2.375 (0.0915 - 0.0935)
Oversize 0.20 (0.0079)		2.475 - 2.525 (0.0974 - 0.0994)
0.40 (0.0157)		2.675 - 2.725 (0.1053 - 0.1073)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Gear train Backlash of each gear	0.06 - 0.12 (0.0024 - 0.0047)
Limit	0.20 (0.0079)
Flywheel Runout (Total indicator reading)	Less than 0.15 (0.0059)
Front plate Warpage limit	0.2 (0.008)