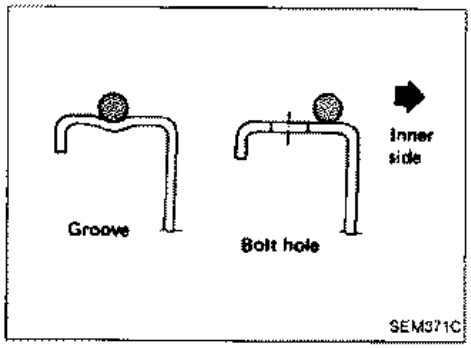
ENGINE MECHANICAL

SECTION EM

EM

CONTENTS



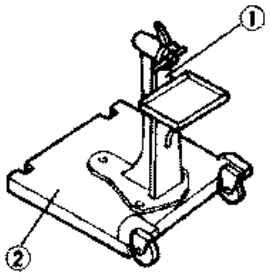
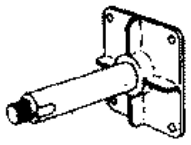
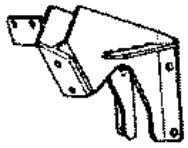
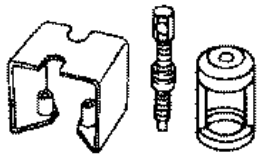
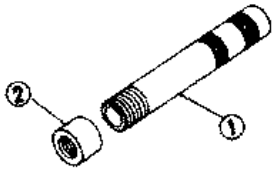
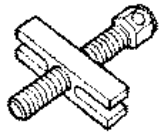
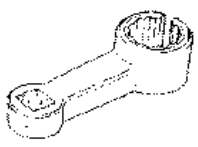
Liquid Gasket Application Procedure

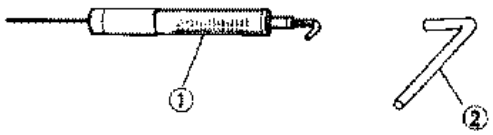
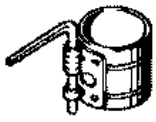
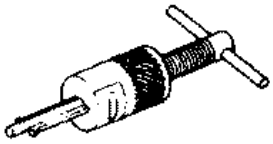
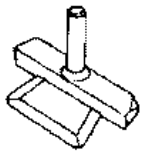
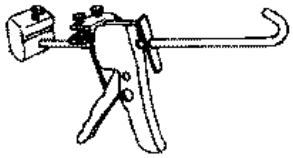
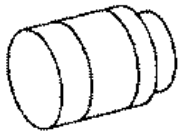
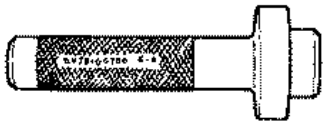
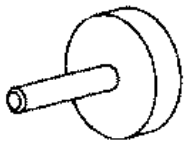
a. **Before applying liquid gasket, use a scraper to remove all traces of old liquid gasket from mating surface.**
b. **Apply a continuous bead of liquid gasket to mating surfaces. (Use Genuine Liquid Gasket or equivalent.)**
   - **Be sure liquid gasket is 3.5 to 4.5 mm (0.138 to 0.177 in) wide (for oil pan).**
   - **Be sure liquid gasket is 2.0 to 3.0 mm (0.079 to 0.118 in) wide (in areas except oil pan).**
c. **Apply liquid gasket to inner sealing surface around entire perimeter area.**
   (Assembly should be done within 5 minutes after coating.)
d. **Wait at least 30 minutes before refilling engine oil and engine coolant.**

Parts Requiring Angular Tightening

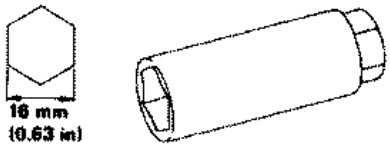
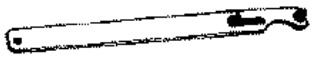
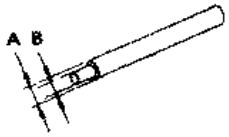
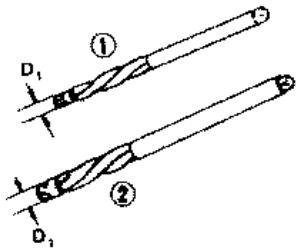
- Some important engine parts are tightened using an angular-tightening method rather than a torque setting method.
- If these parts are tightened using a torque setting method, dispersal of the tightening force (axial bolt force) will be two or three times that of the dispersal produced by using the correct angular-tightening method.
- Although the torque setting values (described in this manual) are equivalent to those used when bolts and nuts are tightened with an angular-tightening method, they should be used for reference only.
- To assure the satisfactory maintenance of the engine, bolts and nuts must be tightened using an angular-tightening method.
- Before tightening the bolts and nuts, ensure that the thread and seating surfaces are clean and then coated with engine oil.
- The bolts and nuts which require the angular-tightening method are as follows:
  (1) Cylinder head bolts
  (2) Connecting rod cap nuts

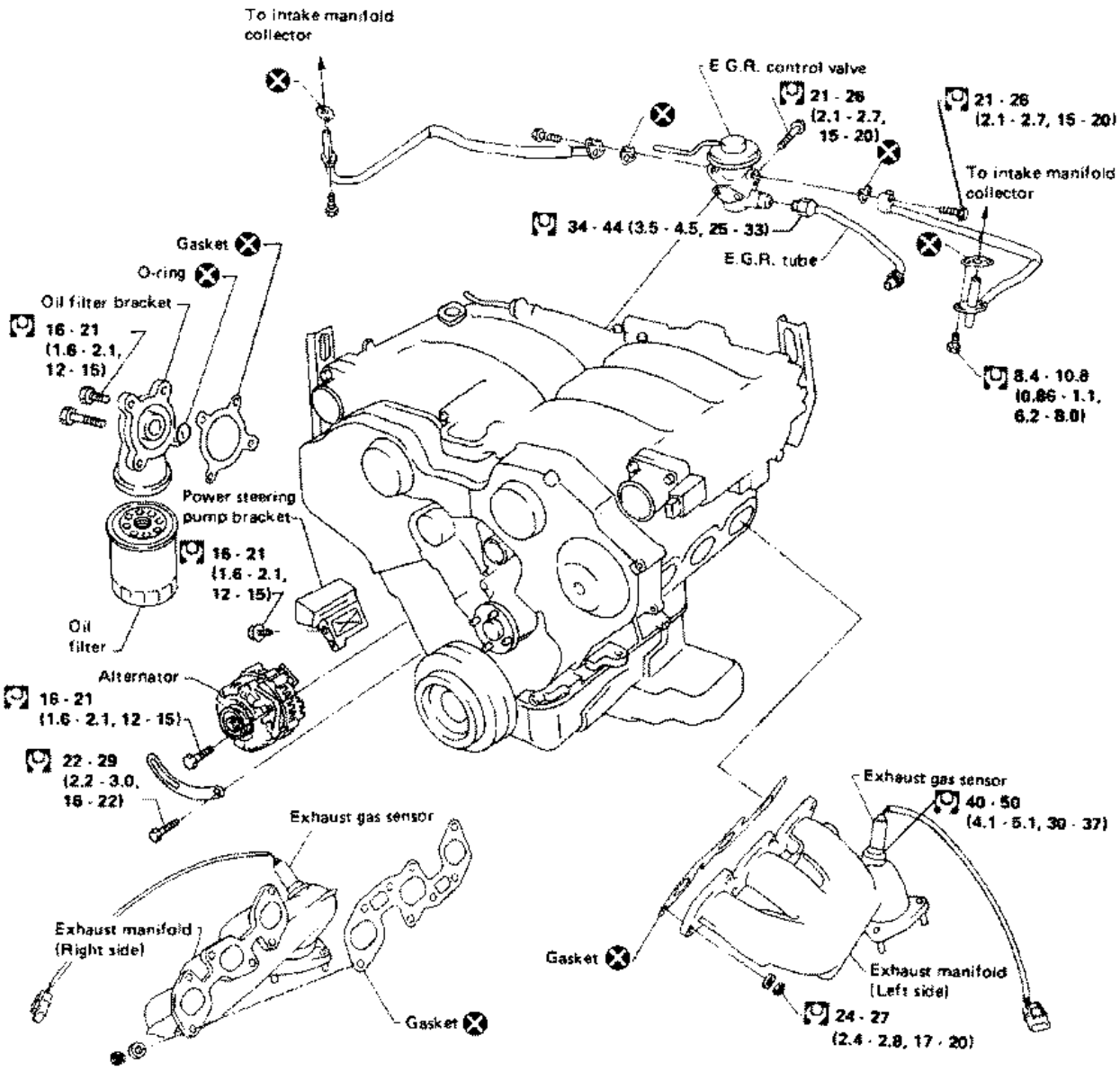
SPECIAL SERVICE TOOLS

Tool number Tool name	Description
ST0501S000 Engine stand assembly ①ST05011000 Engine stand ②ST05012000 Base	Disassembling and assembling 
KV10106500 Engine stand shaft	
KV10110001 Engine sub-attachment	
ST10120000 Cylinder head bolt wrench	Loosening and tightening cylinder head bolt 
KV10111300 Valve spring compressor	Disassembling and assembling valve components 
①KV10107501 Valve oil seal drift ②KV10111400 Attachment	Installing valve oil seal 
ST27180001 Steering wheel puller	Removing crankshaft pulley 
KV10114400 Exhaust gas sensor wrench	Loosening or tightening exhaust gas sensor 

Tool number Tool name	Description
①EG14860000 Push-pull gauge ②KV10112000 Hook	Adjusting timing belt tension 
EM03470000 Piston ring compressor	Installing piston assembly into cylinder bore 
ST16610001 Pilot bushing puller	Removing crankshaft pilot bushing 
KV10111100 Seal cutter	Removing oil pan 
WS39930000 Tube presser	Pressing the tube of liquid gasket 
ST33200000 Drift	Installing camshaft oil seal 
KV38100300 Drift	Installing front oil seal 
ST15310000 Drift	Installing rear oil seal 

COMMERCIAL SERVICE TOOLS

Tool name	Description
Spark plug wrench	Removing and installing spark plug 
Pulley holder	Holding camshaft pulley while tightening or loosening camshaft bolt 
Valve seat cutter set	Finishing valve seat dimensions 
Piston ring expander	Removing and installing piston ring 
Valve guide drift	Removing and installing valve guide  Intake & Exhaust: A = 9.5 mm (0.374 in) dia. B = 5.5 mm (0.217 in) dia.
Valve guide reamer	Reaming valve guide ① or hole for oversize valve guide ②  D_1 = 6.0 mm (0.236 in) dia. D_2 = 10.2 mm (0.402 in) dia.
Valve oil seal remover	Removing valve oil seals 



: N·m (kg-m, ft-lb)

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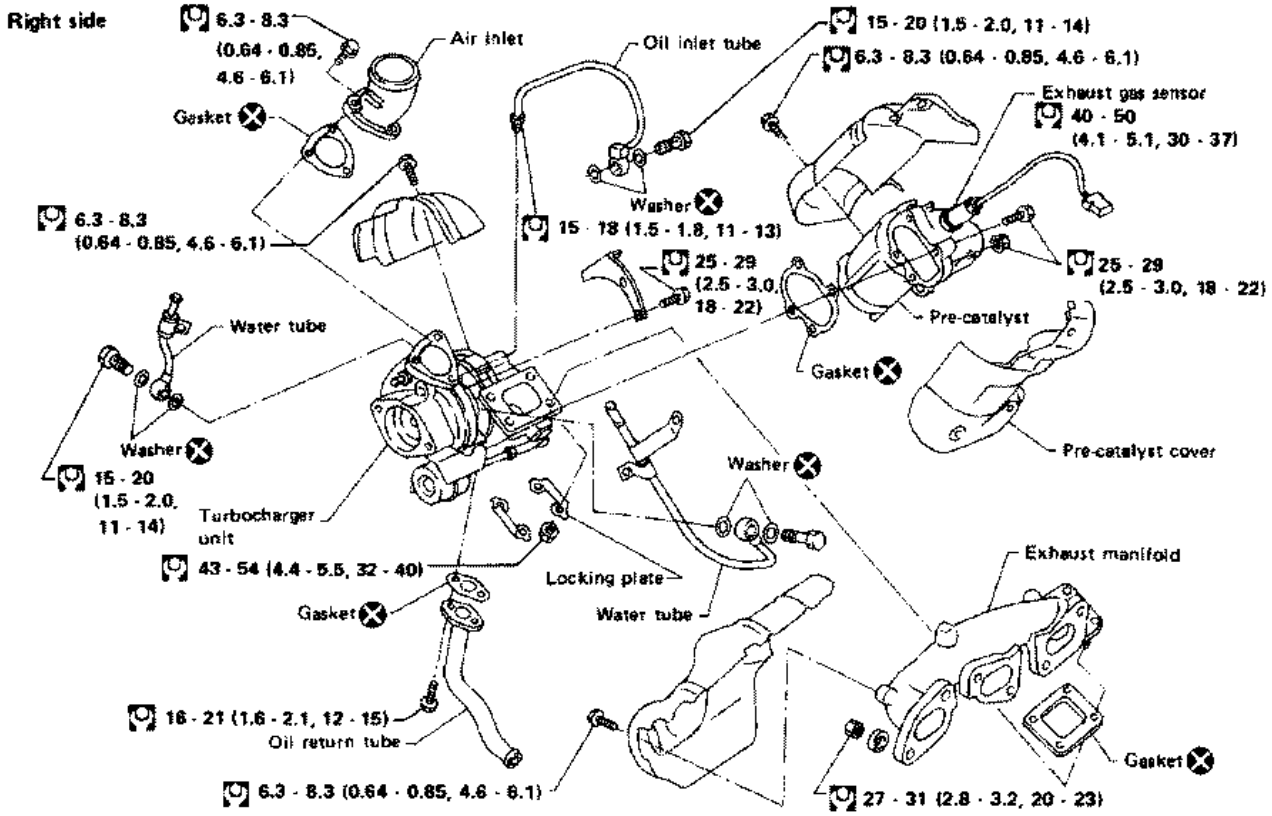
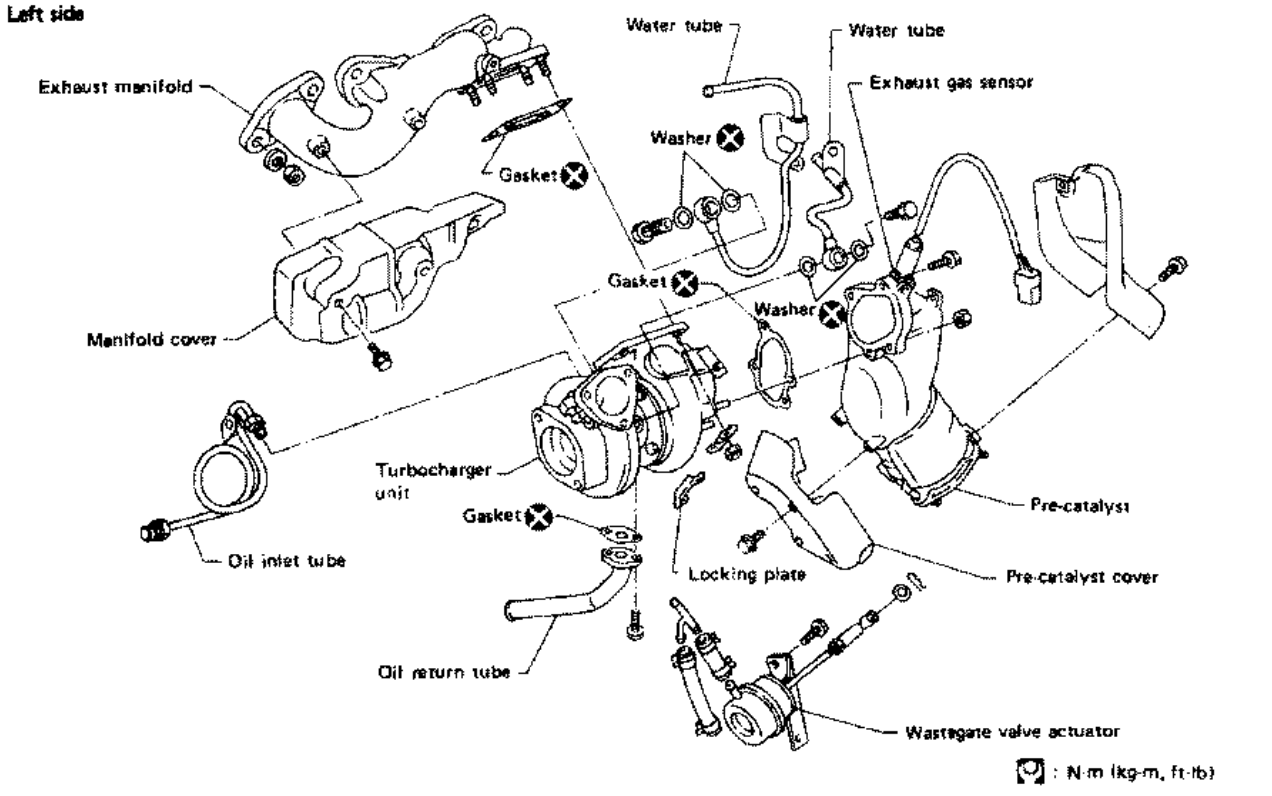
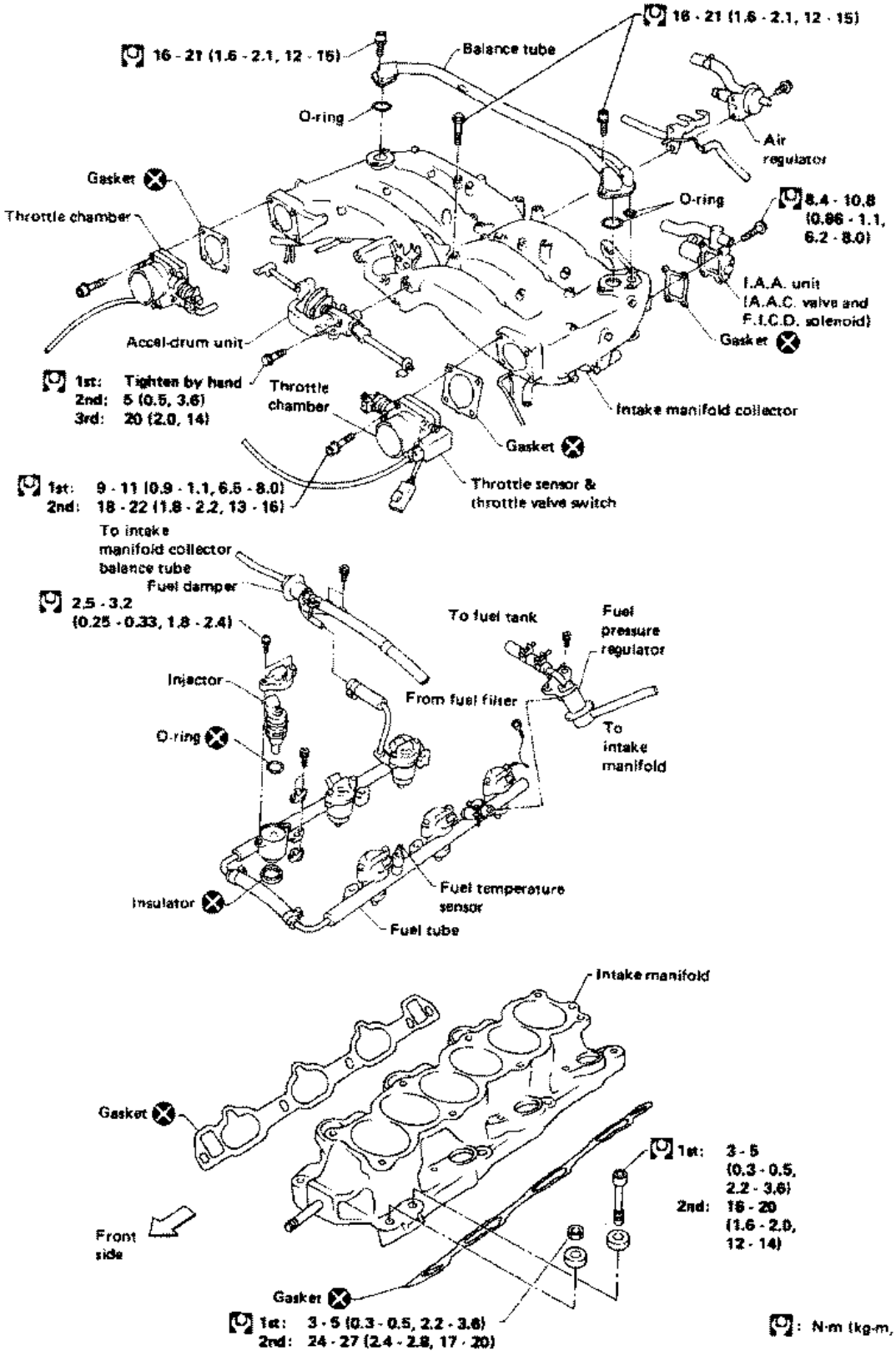
Turbo model





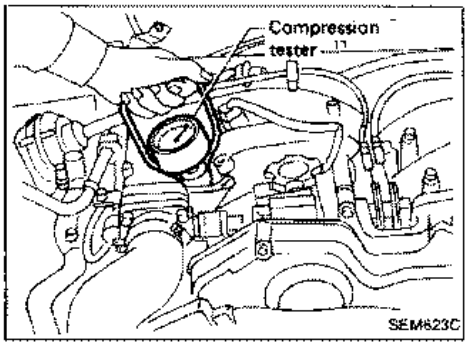
SEM773C


16 - 21 (1.6 - 2.1, 12 - 15)
16 - 21 (1.6 - 2.1, 12 - 15)
Balance tube
O-ring
Air regulator
Gasket
Throttle chamber
O-ring
8.4 - 10.8 (0.86 - 1.1, 6.2 - 8.0)
I.A.A. unit (A.A.C. valve and F.I.C.D. solenoid)
Gasket
Accel-drum unit
1st: Tighten by hand
2nd: 5 (0.5, 3.6)
3rd: 20 (2.0, 14)
Throttle chamber
Intake manifold collector
Gasket
1st: 9 - 11 (0.9 - 1.1, 6.5 - 8.0)
2nd: 18 - 22 (1.8 - 2.2, 13 - 16)
Throttle sensor & throttle valve switch
To intake manifold collector balance tube
Fuel damper
2.5 - 3.2 (0.25 - 0.33, 1.8 - 2.4)
To fuel tank
Fuel pressure regulator
Injector
From fuel filter
To intake manifold
O-ring
Insulator
Fuel temperature sensor
Fuel tube
Intake manifold
Gasket
1st: 3 - 5 (0.3 - 0.5, 2.2 - 3.6)
2nd: 16 - 20 (1.6 - 2.0, 12 - 14)
Front side
Gasket
1st: 3 - 5 (0.3 - 0.5, 2.2 - 3.6)
2nd: 24 - 27 (2.4 - 2.8, 17 - 20)
: N·m (kg-m, ft-lb)

SEM618C

Measurement of Compression Pressure

1. Warm up engine.
2. Turn ignition switch off.
3. Release fuel pressure.
   Refer to "Releasing Fuel Pressure" in section EF & EC.
4. Remove all spark plugs.
5. Disconnect crank angle sensor harness connector.



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

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

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

Standard

1,285 (12.85, 13.1, 186)

Minimum

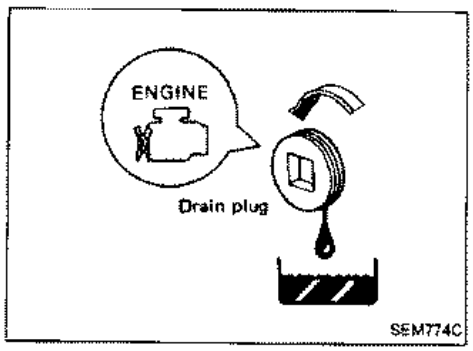
981 (9.81, 10.0, 142)

Difference limit between cylinders

98 (0.98, 1.0, 14)

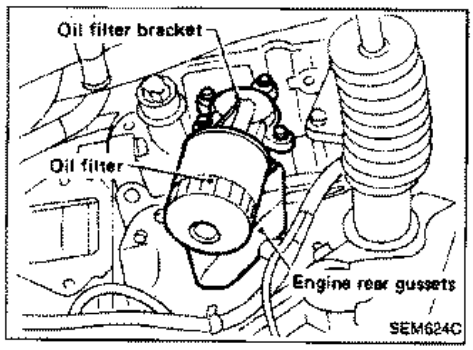
10. If cylinder compression in one or more cylinders is low, pour a small amount of engine oil into cylinders through the spark plug holes and retest compression.

- **If adding oil helps 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 valves and valve seats. (Refer to S.D.S.) If valves or valve seats are damaged excessively, replace them.**
- **If compression in any two adjacent cylinders is low and if adding oil does not help compression, there may be leakage past gasket surface. If so, replace cylinder head gasket.**

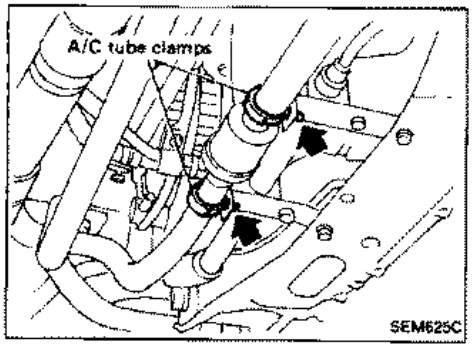


Removal

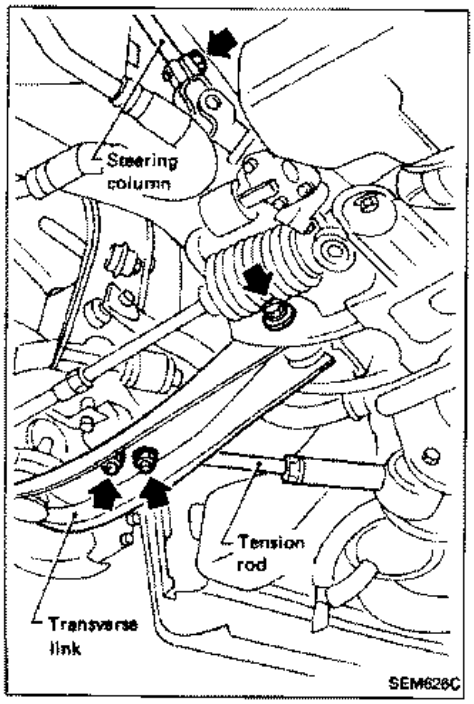
1. Drain engine oil.
2. Remove engine under cover.



3. Remove oil filter and bracket.
4. Remove engine rear gussets from both sides.

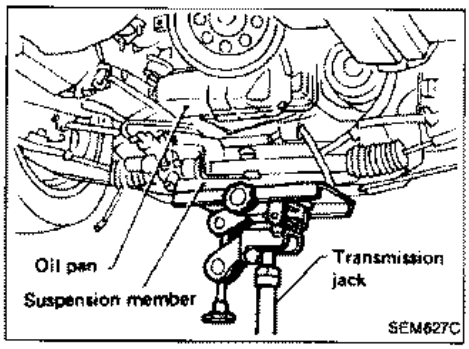


5. Disconnect A/C tube clamps as shown.



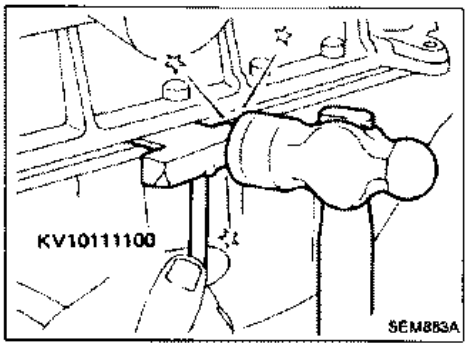
6. Disconnect steering column lower joint.
7. Remove tension rod fixing bolts from both sides.
8. Loosen transverse link bolts on both sides.

Removal (Cont'd)



9. Set a suitable transmission jack under the suspension member.
- At this time, hoist engine with engine slingers.

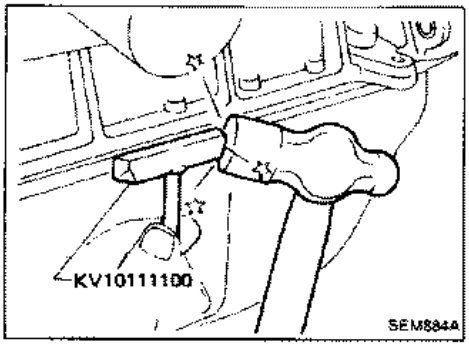
10. Remove suspension member fixing bolts.
11. Remove engine mounting bolts from both sides and then slowly lower transmission jack.
12. Remove oil pan bolts.



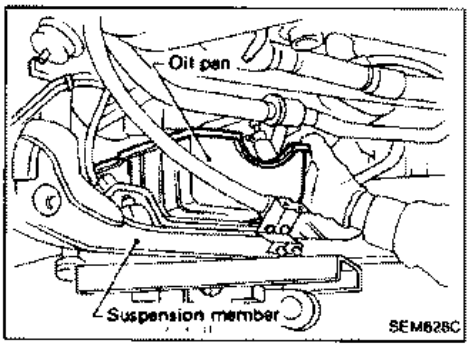
13. Remove oil pan.

(1) Insert Tool between cylinder block and oil pan.

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

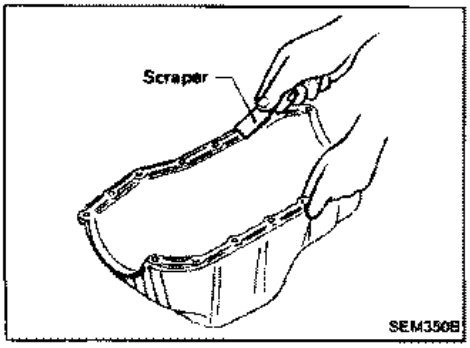


(2) Slide Tool by tapping its side with a hammer, and remove oil pan.



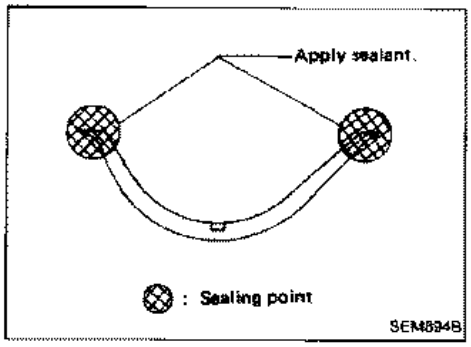
(3) Remove oil pan.

Installation

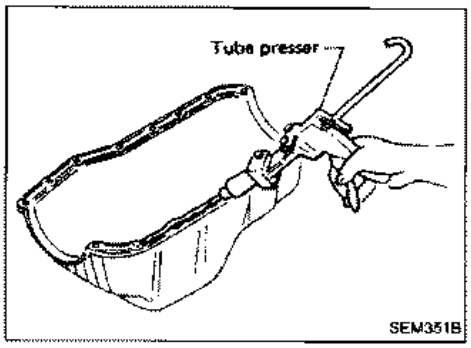


1. Before installing oil pan, remove all traces of liquid gasket from mating surface using a scraper.
- Also remove traces of liquid gasket from cylinder block mating surface.

Installation (Cont'd)

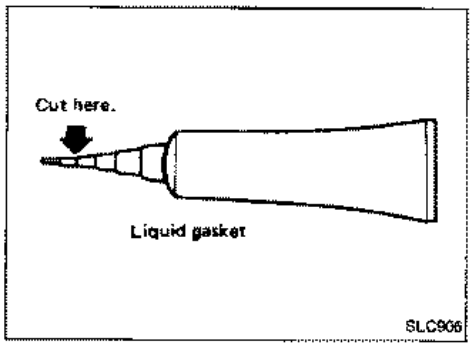


2. Apply sealant to oil pump gasket and rear oil seal retainer gasket.

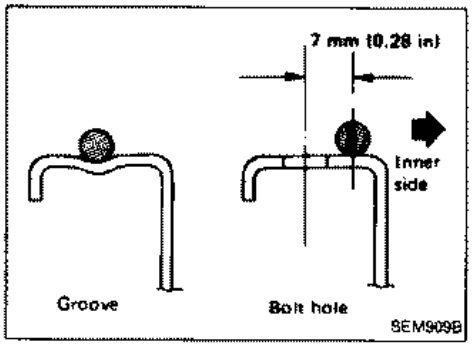


3. Apply a continuous bead of liquid gasket to oil pan mating surface.

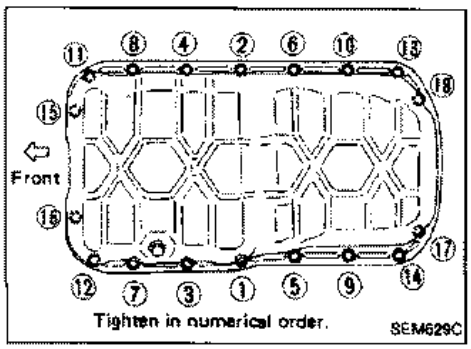
Use Genuine Liquid Gasket or equivalent.



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



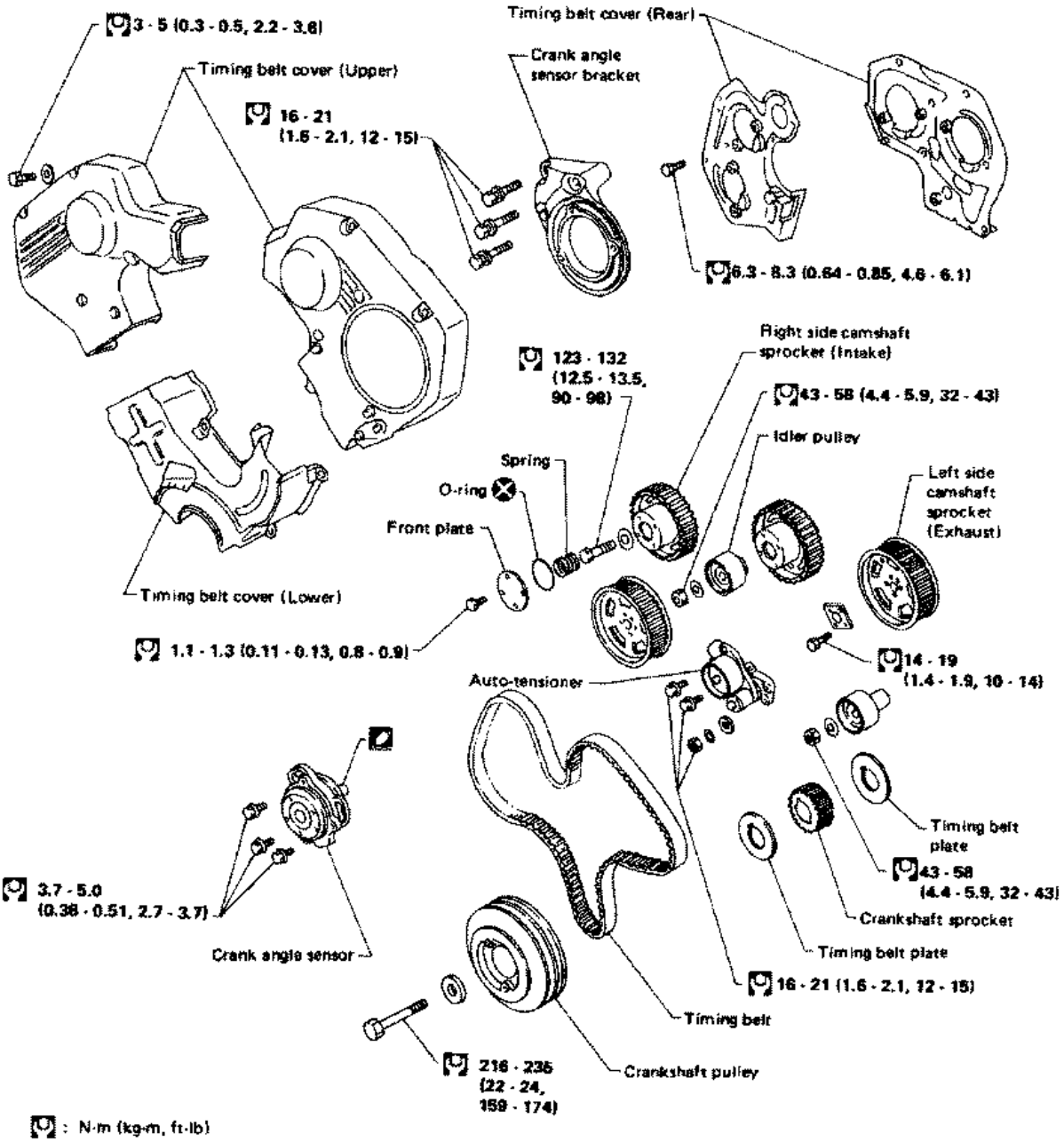
4. Apply liquid gasket to inner sealing surface as shown in figure.
- Attaching should be done within 5 minutes after coating.



5. Install oil pan.
- **Install bolts/nuts in their reverse order of removal.**
- **Wait at least 30 minutes before refilling engine oil.**

CAUTION:

a. **Do not bend or twist timing belt.**
b. **After removing timing belt, do not turn crankshaft and camshaft separately because valves will strike piston heads.**
c. **Make sure that timing belt, camshaft sprocket, crankshaft sprocket, idler pulley and auto-tensioner are clean and free of oil and water.**



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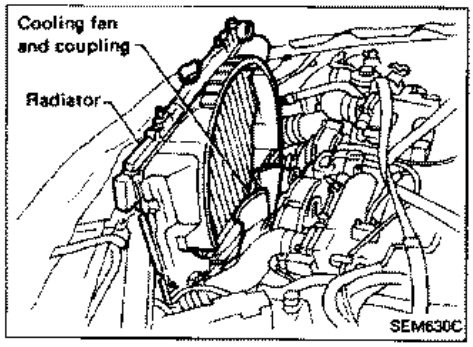
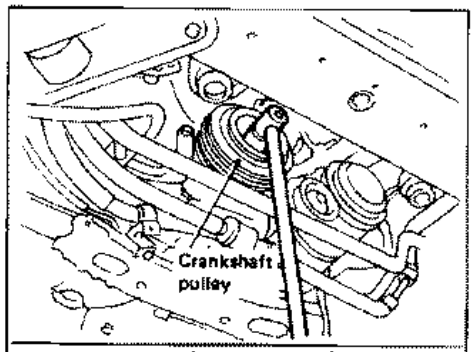
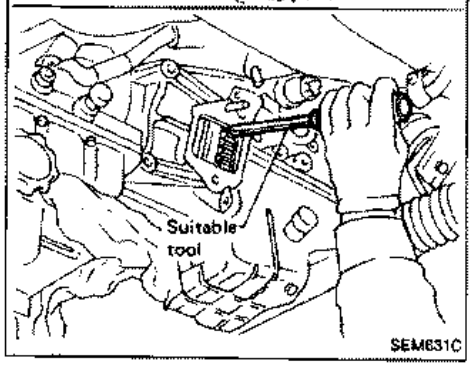
Removal

1. Remove engine under cover.
2. Drain coolant from both cylinder block drain plugs, and radiator drain cock.

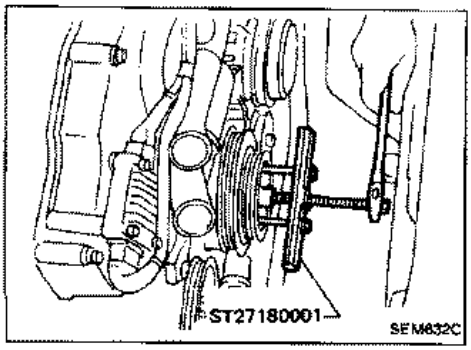


3. Remove radiator.
4. Remove drive belts, cooling fan and coupling.



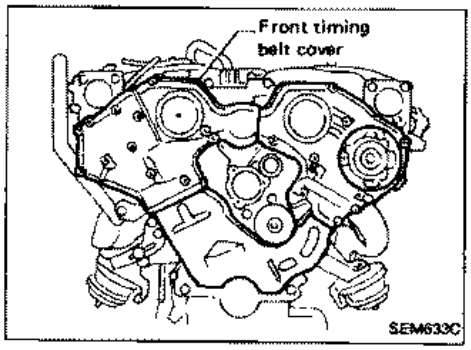


5. Remove crankshaft pulley bolt.
   (At this time, remove starter motor and set a suitable tool to ring gear so that crankshaft cannot rotate.)

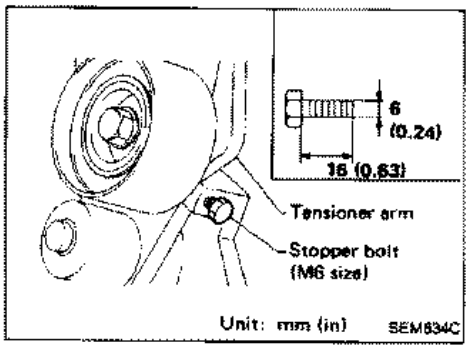


6. Remove crankshaft pulley using Tool.

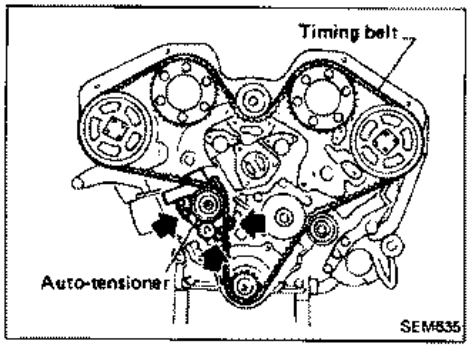
Removal (Cont'd)



7. Remove water inlet and outlet.
8. Remove front timing belt covers.



9. Install a suitable stopper bolt into tensioner arm of auto-tensioner so that projection of auto-tensioner pusher does not change.



10. Set No. 1 cylinder at T.D.C. on its compression stroke.
11. Remove auto-tensioner and timing belt.

Inspection

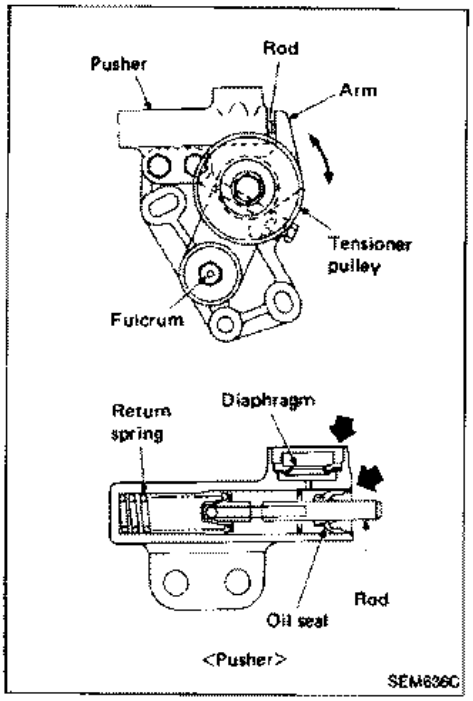
Visually check the condition of timing belt.
Replace if any abnormality is found.

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

Inspection (Cont'd)

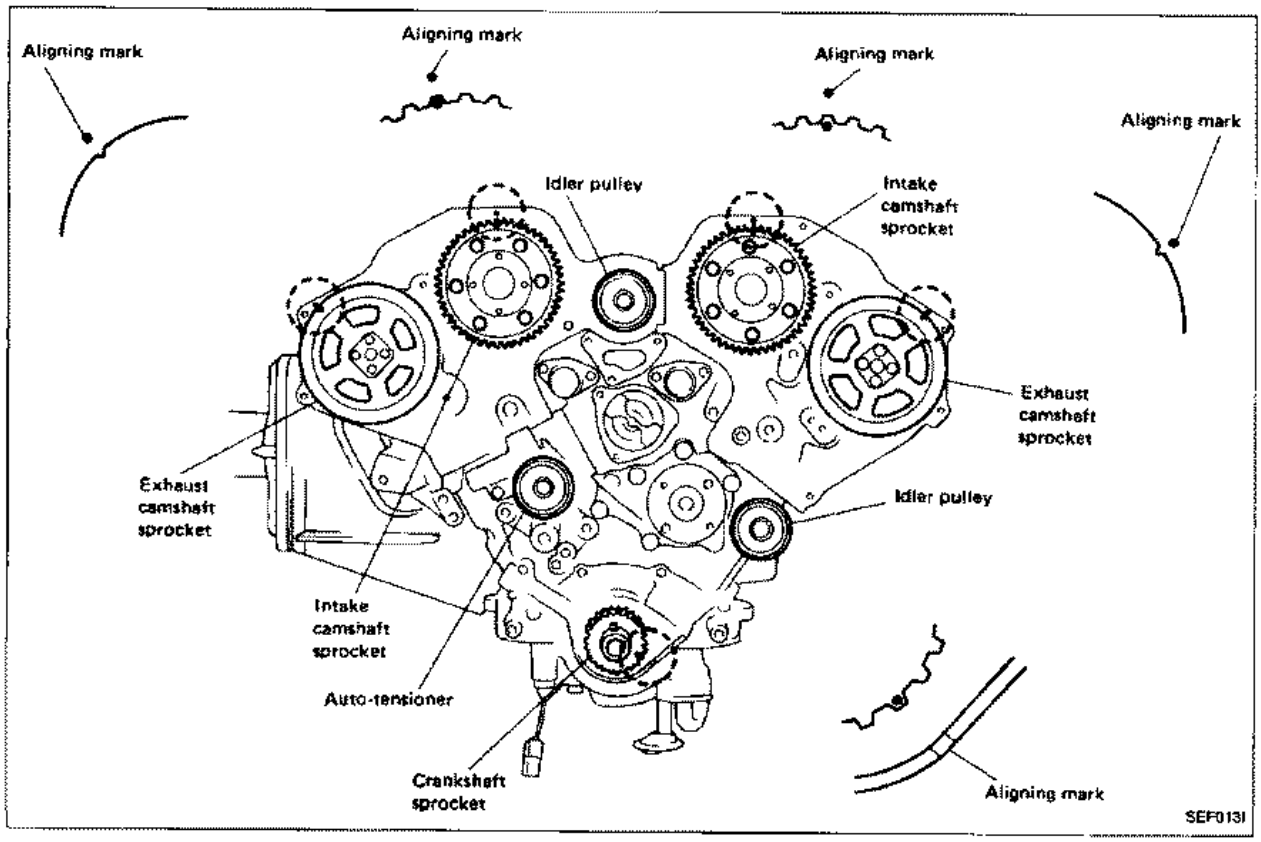
AUTO-TENSIONER

Check for oil leaks from pusher rod and diaphragm.

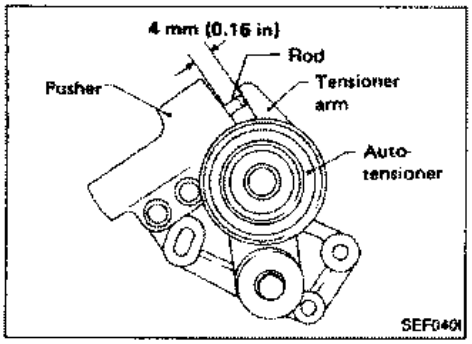


Installation

1. Confirm that No. 1 cylinder is set at T.D.C. on its compression stroke.
2. Align matching marks on camshaft and crankshaft sprockets with aligning marks on rear belt cover and oil pump housing.
3. Remove all spark plugs.

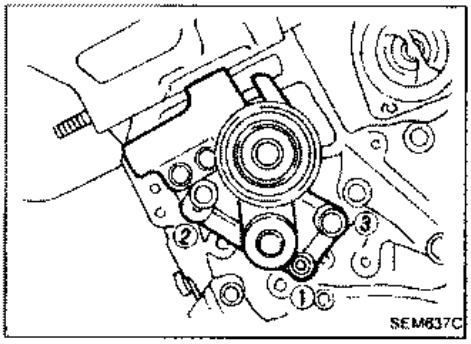


Installation (Cont'd)



4. Check clearance between tensioner arm and pusher of auto-tensioner is 4 mm (0.16 in).
   If not, adjust it in a suitable vise, and then insert stopper bolt into tensioner arm in order that clearance does not change.

When adjusting clearance, do not push tensioner arm with stopper bolt fitted because it will damage thread portion of stopper bolt.



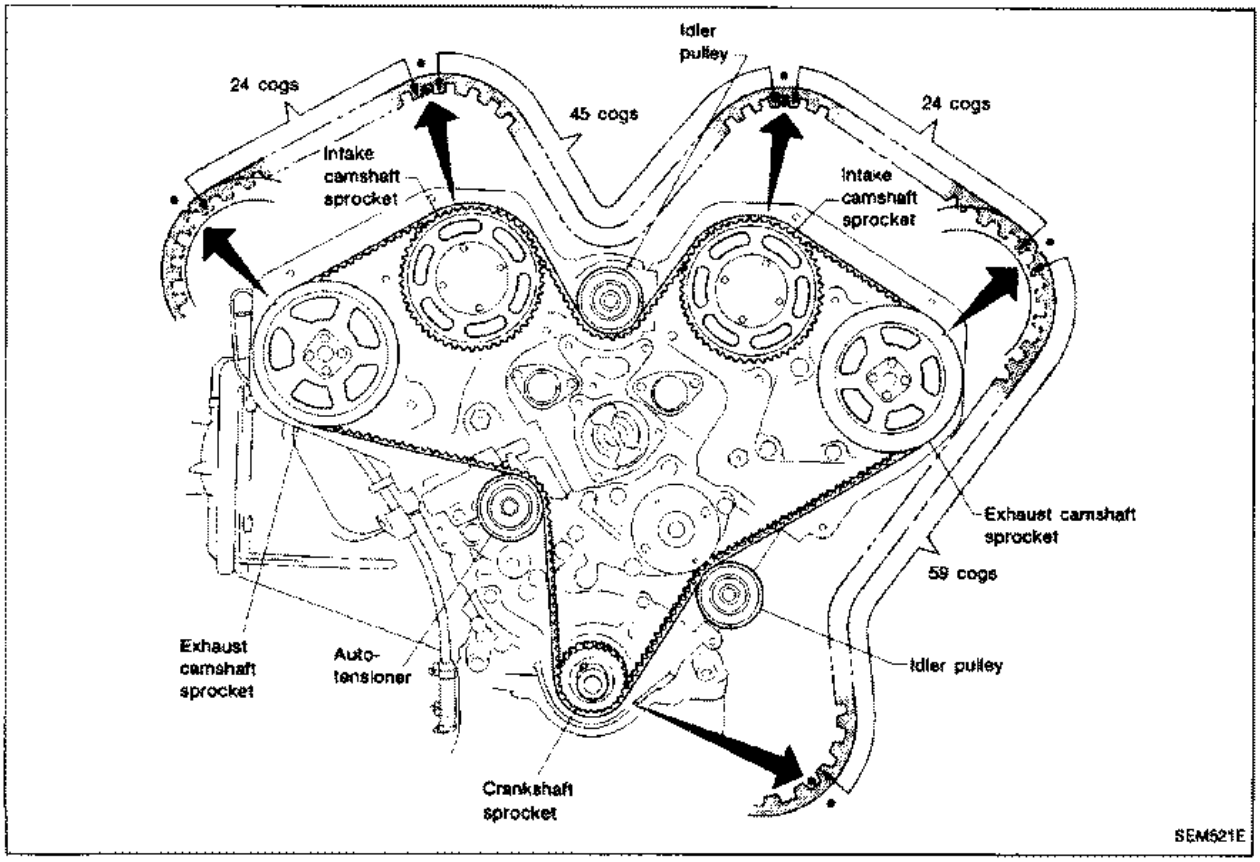
5. Install auto-tensioner and tighten nut (①) and bolts (②, ③) slightly by hand.

6. Set timing belt.

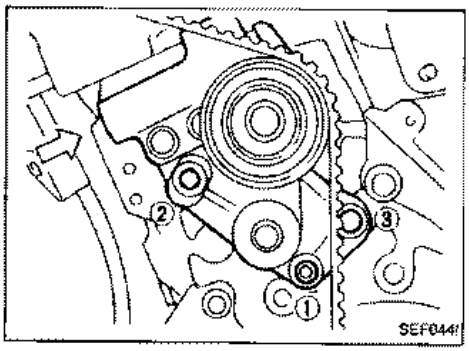
a. Ensure timing belt and sprockets are clean and free from oil or water. Do not bend or twist timing belt.

b. Align white lines on timing belt with matching mark on camshaft sprocket and crankshaft sprocket.

c. Point arrow on timing belt towards the front.

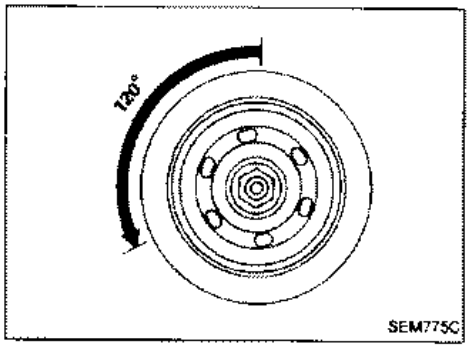


Installation (Cont'd)

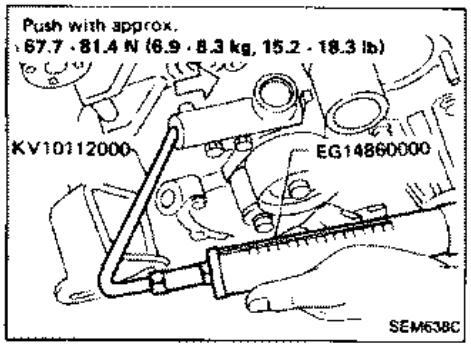


7. Push auto-tensioner slightly towards timing belt to prevent belt from slipping.
   While pushing, turn crankshaft 10 degrees clockwise and tighten nut (①) and bolts (②, ③) to 16 to 21 N·m (1.6 to 2.1 kg-m, 12 to 15 ft-lb).

At this time, do not push auto-tensioner hard or belt will be adjusted too tightly.

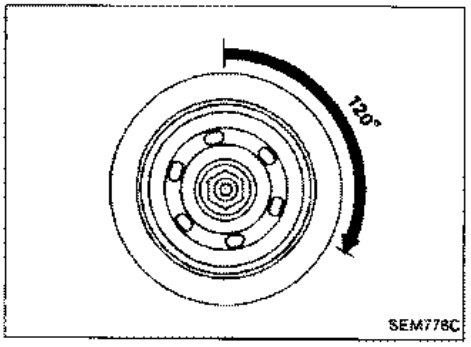


8. Turn crankshaft 120 degrees counterclockwise.
9. Turn crankshaft clockwise and set No. 1 cylinder at T.D.C. on its compression stroke.
10. Loosen nut (①) and bolts (②, ③) 1/2 turn.

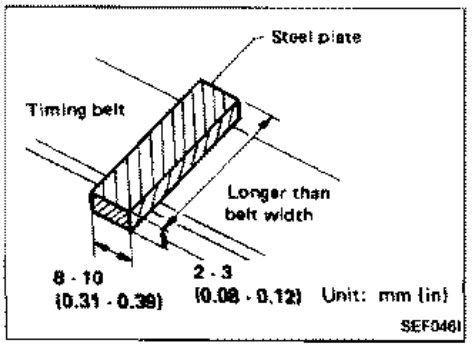


11. Push the end of pusher with approx. 67.7 to 81.4 N (6.9 to 8.3 kg, 15.2 to 18.3 lb) force using Tool (push-pull gauge) and tighten nut (①) and bolts (②, ③) to 16 to 21 N·m (1.6 to 2.1 kg-m, 12 to 15 ft-lb).

If deflection of timing belt exceeds specification in procedure 15., change applied pushing force.

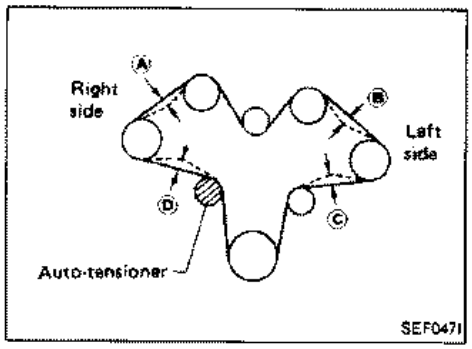


12. Turn crankshaft 120 degrees clockwise.
13. Turn crankshaft 120 degrees counterclockwise and set No. 1 cylinder at T.D.C. on its compression stroke.



14. Prepare a suitable steel plate as shown.

Installation (Cont'd)



15.
(1) Set plate on each position of timing belt mid-way between pulleys as shown.
(2) Push it with 49 N (5 kg, 11 lb) force using Tool (push-pull gauge) and check deflections.

Deflection:

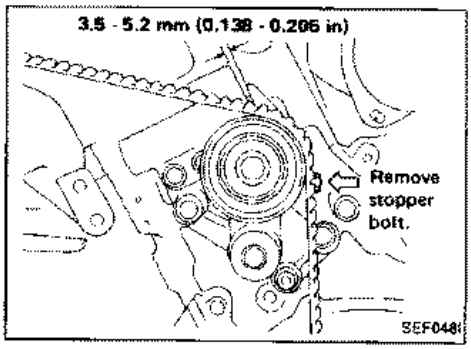
5.5 - 6.5 mm (0.217 - 0.256 in) or the average of each portion

$$\frac{Ⓐ + Ⓑ + Ⓒ + Ⓓ}{4}$$

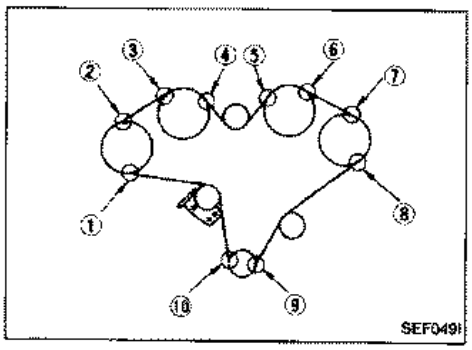
is 5.5 - 6.5 mm (0.217 - 0.256 in)

If not within specification, repeat procedure from step 7 through step 15.

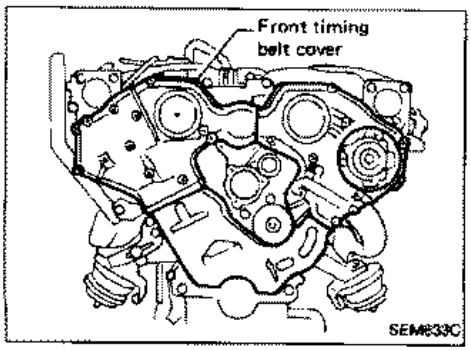
16. Confirm auto-tensioner fixing nuts and bolts are tightened to 16 to 21 N·m (1.6 to 2.1 kg-m, 12 to 15 ft-lb).



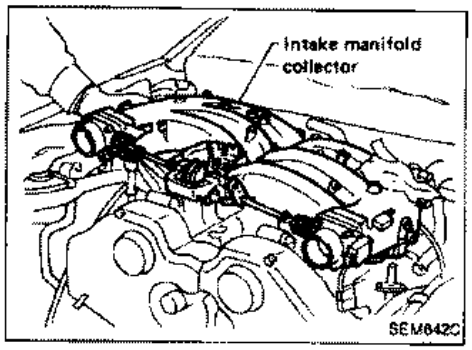
17.
- Remove the auto-tensioner stopper bolt.
- After 5 minutes check the projection of the rod (clearance between tensioner arm and pusher) stays at 3.5 to 5.2 mm (0.138 to 0.205 in).



18. Check the proper installation (no slip or misplacement) of timing belt at each position as shown.

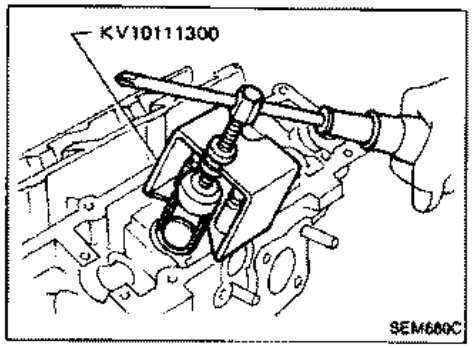


19. Install timing belt covers.

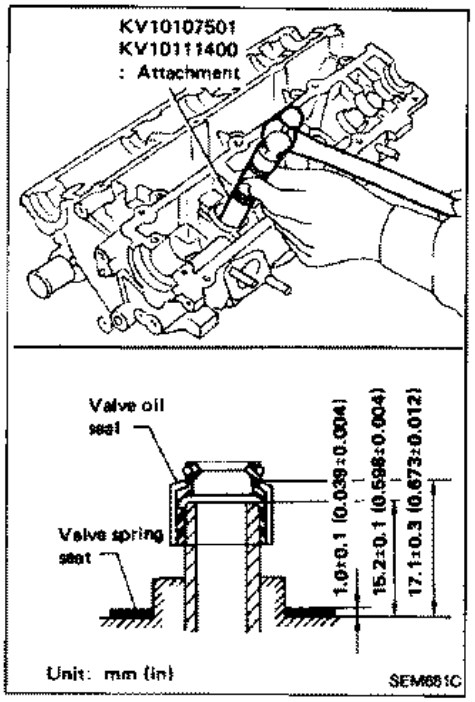


VALVE OIL SEAL

1. Remove intake manifold collector and valve cover.
2. Remove timing belt, camshaft sprocket and rear belt cover.
3. Remove camshaft brackets, camshaft and valve lifter.

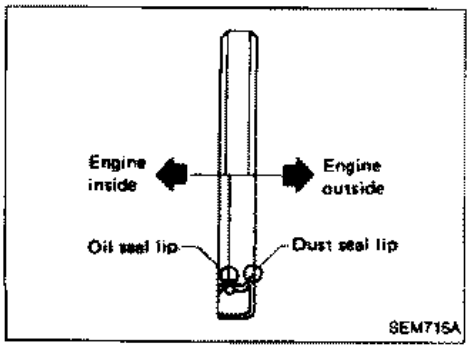


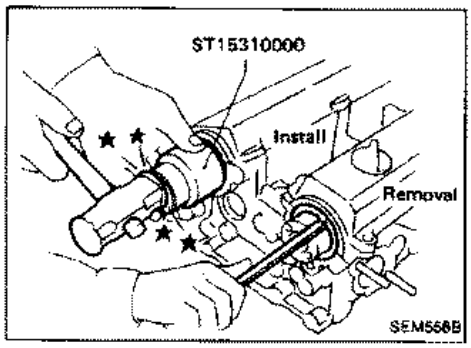
4. Remove valve spring using Tool or a suitable tool.
- Piston concerned should be set at T.D.C. to prevent valve from falling.
5. Pry out valve oil seal.



6. Apply engine oil to new valve oil seal and install it.
- Before installing valve oil seal, install inner valve spring seat.

OIL SEAL INSTALLATION DIRECTION



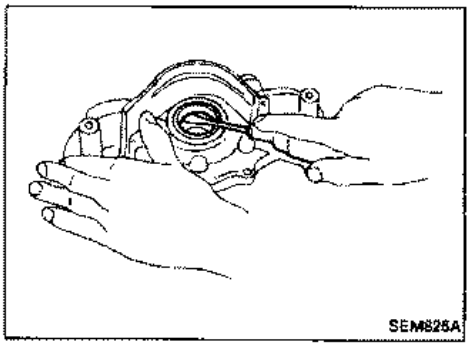


CAMSHAFT OIL SEAL

1. Remove timing belt and camshaft sprocket.
2. Remove rear belt cover and camshaft oil seal.

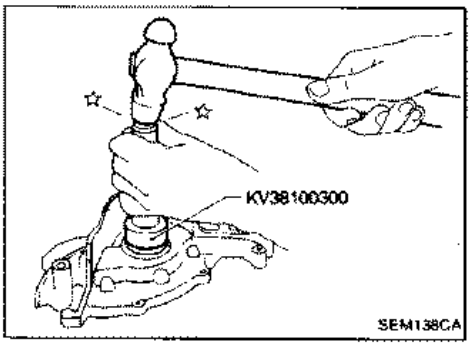
Be careful not to scratch camshaft.

3. Apply engine oil to new camshaft oil seal and install it using Tool or a suitable tool.

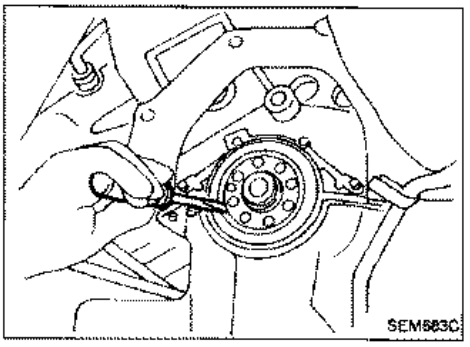


FRONT OIL SEAL

1. Remove timing belt and crankshaft sprocket.
2. Remove oil pan and oil pump assembly.
3. Remove front oil seal from oil pump body.



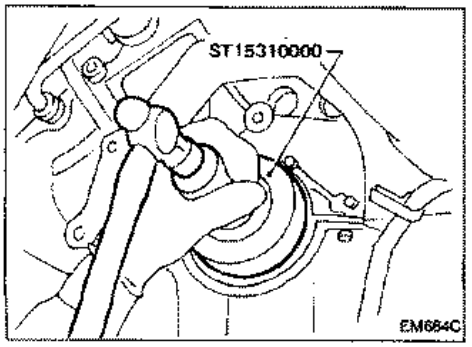
4. Apply engine oil to new oil seal and install it using Tool or a suitable tool.



REAR OIL SEAL

1. Remove flywheel or drive plate.
2. Remove rear oil seal from retainer.

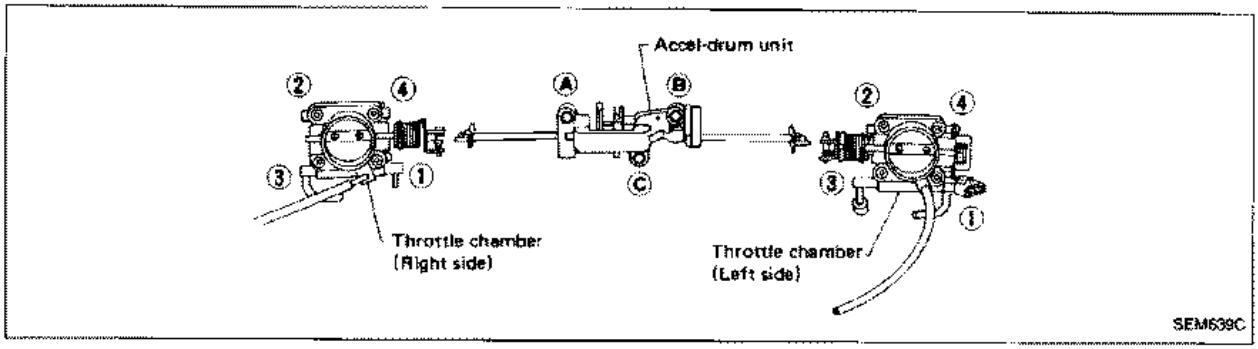
Be careful not to scratch crankshaft.



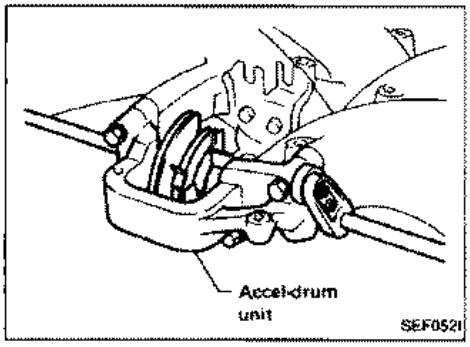
3. Apply engine oil to new oil seal and install it using Tool or a suitable tool.

Installation

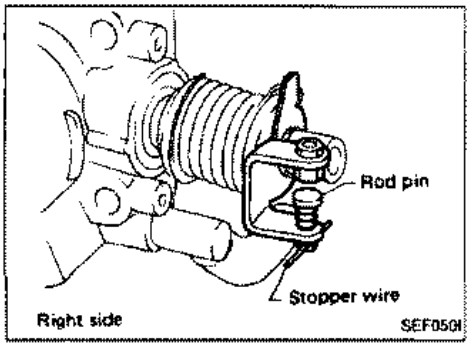
The intention of this installation and adjustment procedure is to assure accurate synchronization of the throttle chamber opening points.



1. Install accel-drum unit and throttle chambers (right side and left side).
   Tightening order:
   (1) ① → ② → ③ → ④:
   9 - 11 N·m (0.9 - 1.1 kg-m, 6.5 - 8.0 ft-lb)
   (2) ① → ② → ③ → ④:
   18 - 22 N·m (1.8 - 2.2 kg-m, 13 - 16 ft-lb)
   (3) Ⓐ → Ⓑ → Ⓒ: Tighten by hand
   (4) Ⓐ → Ⓑ → Ⓒ:
   5 N·m (0.5 kg-m, 3.6 ft-lb)
   (5) Ⓐ → Ⓑ → Ⓒ:
   20 N·m (2.0 kg-m, 14 ft-lb)

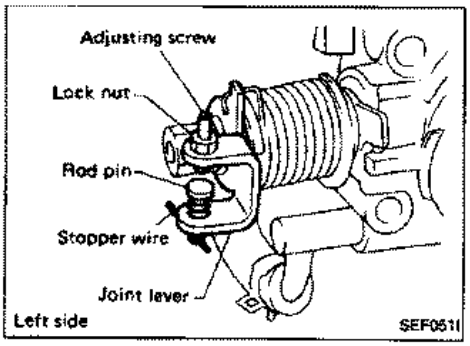


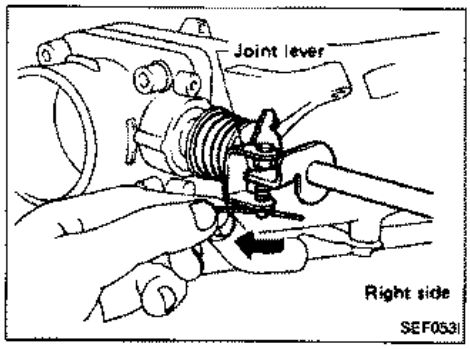
- **When tightening bolts, free accel-drum unit so that drum unit is left under its own weight. Do not apply external force to accel-drum unit.**
- **When replacing throttle chambers only, you need not perform procedures (3), (4) and (5).**



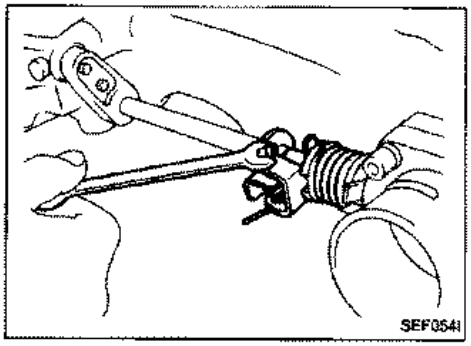
- **Before installing each throttle chamber, confirm that stopper wire is installed in hole of rod pin.**
  If not, install suitable wire.

Installation (Cont'd)

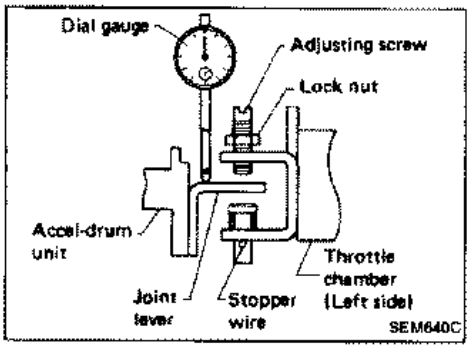




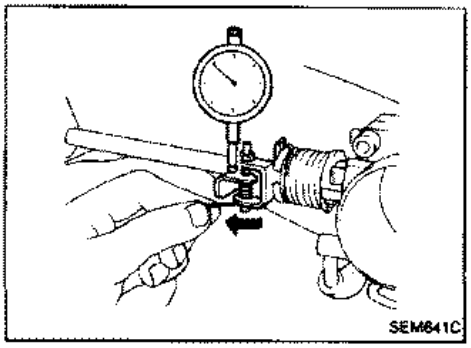
2. Pull out stopper wire of right side throttle chamber in order to secure right side joint lever.



3. Loosen left side throttle chamber lock nut and back off adjusting screw until there is clearance between the screw and joint lever.

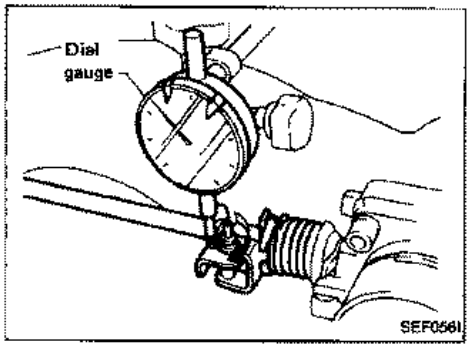


4. Set dial gauge on joint lever and set indicator to zero. Confirm that bottom end of adjusting screw is not in contact with joint lever of accelerator drum unit.



5. Pull out left side throttle chamber stopper wire from rod pin.

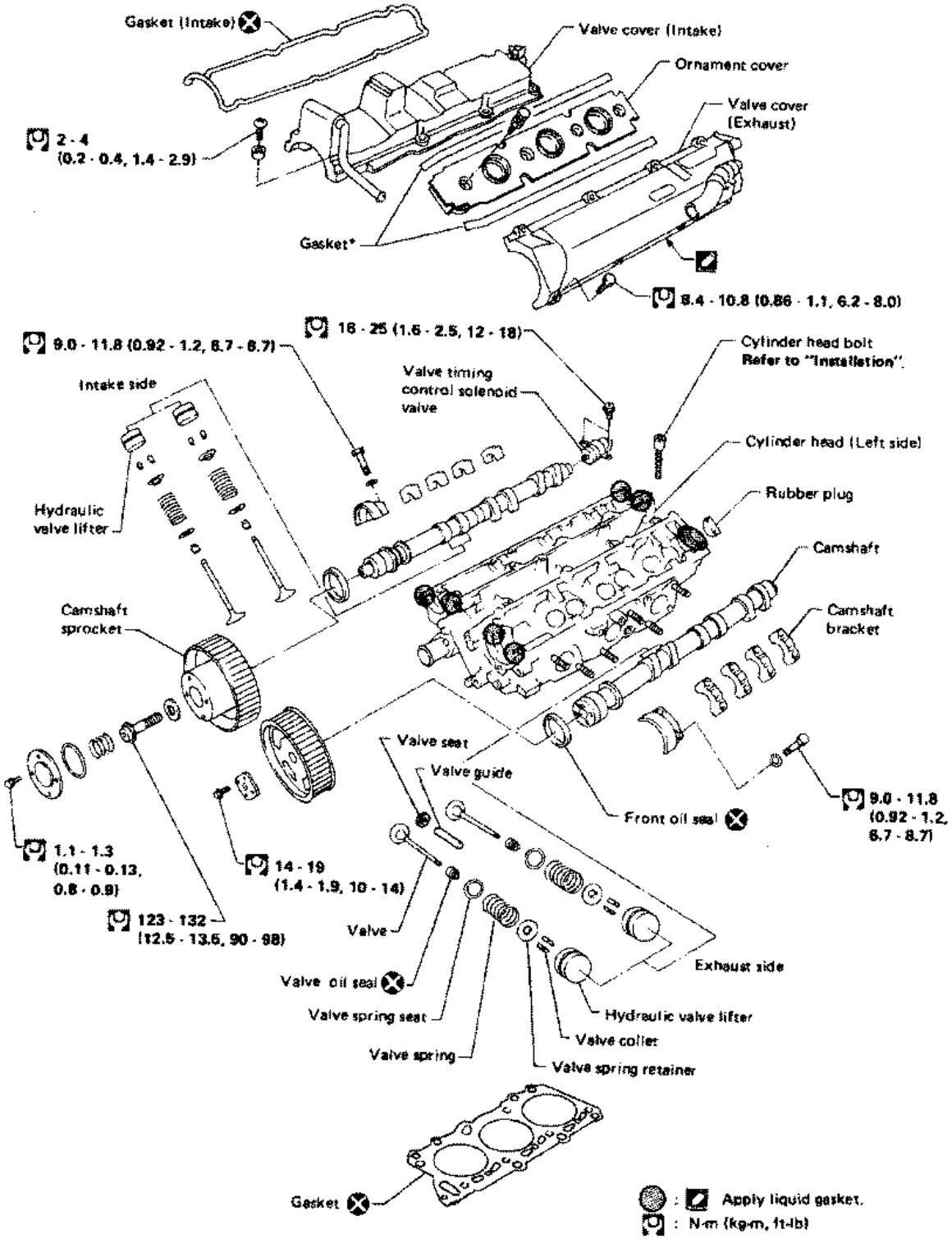
Installation (Cont'd)



6. Turn adjusting screw until dial gauge indicator is within the following range.
   Range: 0.07 - 0.13 mm (0.0028 - 0.0051 in)

Then tighten lock nut.

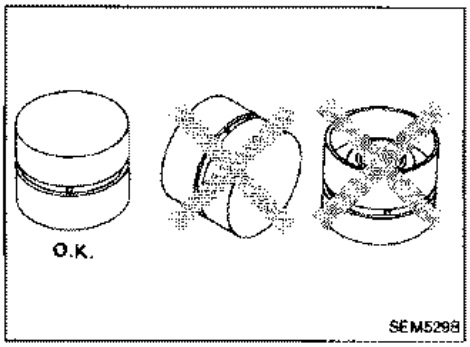
7. Confirm that the dial gauge indicator is still within the above range.


Gasket (Intake)
Valve cover (Intake)
Ornament cover
Valve cover (Exhaust)
2 - 4 (0.2 - 0.4, 1.4 - 2.9)
Gasket*
8.4 - 10.8 (0.86 - 1.1, 6.2 - 8.0)
9.0 - 11.8 (0.92 - 1.2, 6.7 - 8.7)
16 - 25 (1.6 - 2.5, 12 - 18)
Cylinder head bolt
Refer to "Installation".
Intake side
Valve timing control solenoid valve
Cylinder head (Left side)
Hydraulic valve lifter
Rubber plug
Camshaft
Camshaft sprocket
Camshaft bracket
Valve seat
Valve guide
Front oil seal
9.0 - 11.8 (0.92 - 1.2, 6.7 - 8.7)
1.1 - 1.3 (0.11 - 0.13, 0.8 - 0.9)
14 - 19 (1.4 - 1.9, 10 - 14)
123 - 132 (12.5 - 13.5, 90 - 98)
Valve
Valve oil seal
Valve spring seat
Valve spring
Exhaust side
Hydraulic valve lifter
Valve collet
Valve spring retainer
Gasket
: Apply liquid gasket.
: N·m (kg-m, ft-lb)
* : After installing gasket, cut off any loose ends.

SEM620C

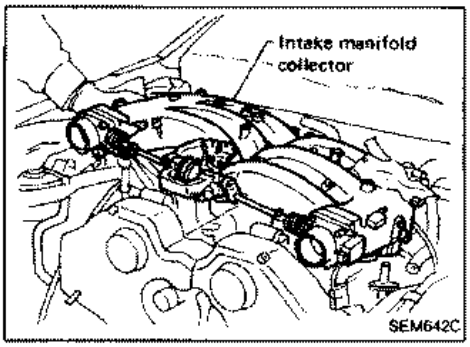
CAUTION:

- **When installing sliding parts such as camshaft, camshaft bracket and oil seal, be sure to apply new engine oil on their sliding surfaces.**
- **When tightening cylinder head bolts, intake camshaft sprocket bolts and camshaft bracket bolts, apply new engine oil to thread portions and seat surfaces of bolts.**
- **Before removing camshaft brackets, identify each one with a punch mark so that they may be reinstalled in their original positions.**

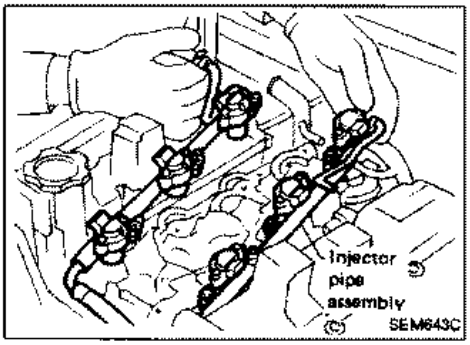


- **Do not put hydraulic valve lifters upside down, otherwise air will enter valve lifter, causing it to make a noise.**
- **Do not disassemble hydraulic valve lifter.**
- **Attach tags to valve lifters so as not to mix them up.**
- **Valve lifters should be immersed in engine oil.**

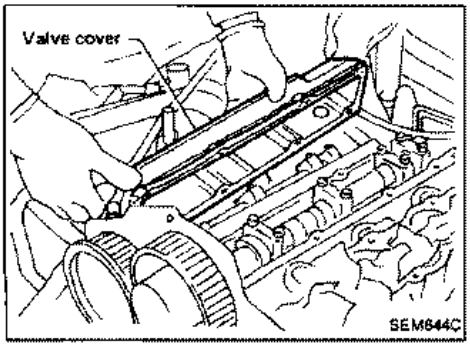
Removal



1. Remove intake manifold collector.

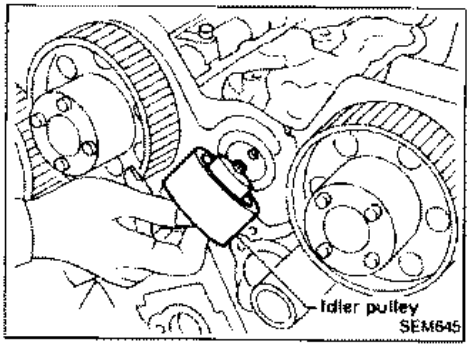


2. Remove injector pipe assembly.



3. Remove valve covers.

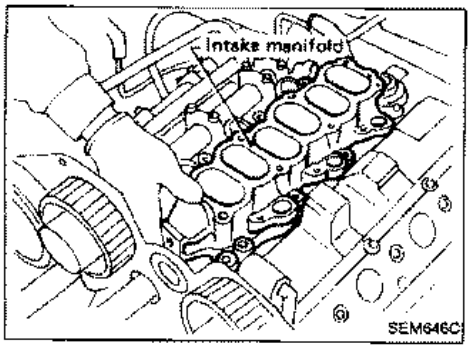
Removal (Cont'd)



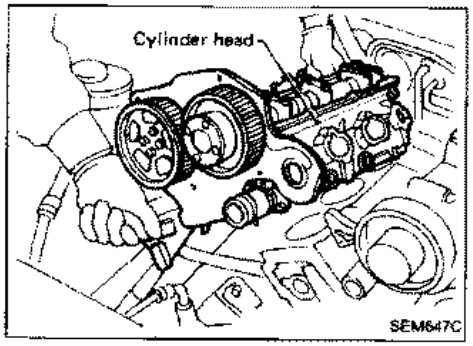
4. Remove timing belt.

Refer to "Removal" of TIMING BELT.

5. Remove idler pulley and its stud bolt.

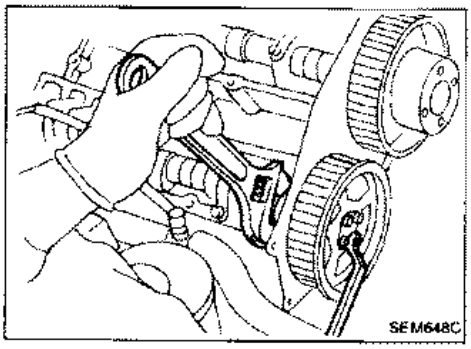


6. Remove intake manifold.



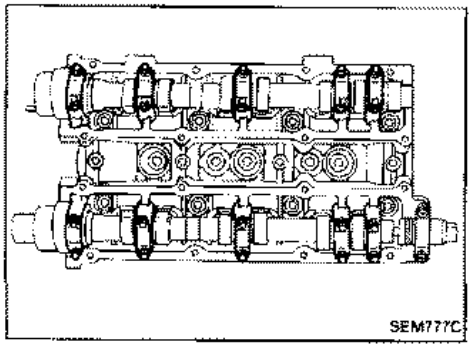
7. Disconnect front exhaust tube from exhaust manifold.
8. Remove cylinder head with exhaust manifold.

Cylinder head bolts should be loosened in two or three steps.



Disassembly

1. Remove exhaust manifold from cylinder head.
2. Remove camshaft sprockets.
3. Remove timing belt rear cover.



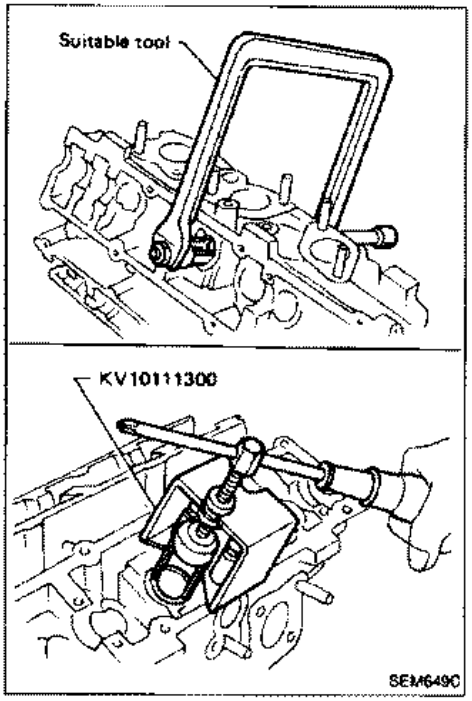
4. Punch an identification mark on each camshaft bracket.
5. Remove camshaft brackets.

Bolts should be loosened in two or three steps.

Before removing camshaft, measure camshaft end play.

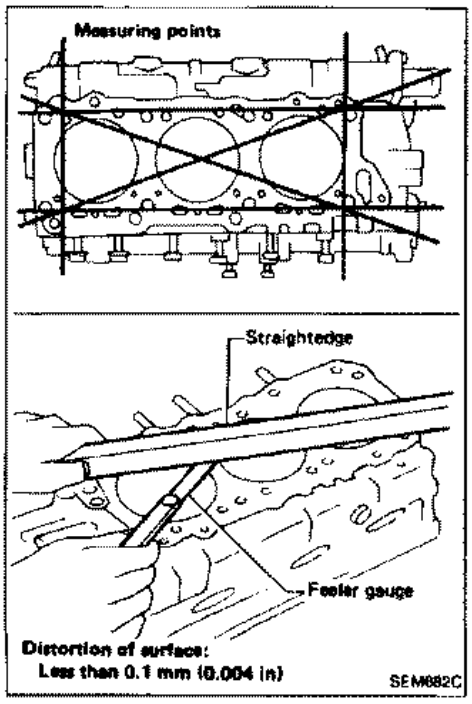
6. Remove oil seals, camshafts and hydraulic valve lifters.

Disassembly (Cont'd)



7. Remove valve springs with Tool or a suitable tool.

8. Pry out valve oil seals.



Inspection

CYLINDER HEAD DISTORTION

Head surface flatness:

Less than 0.1 mm (0.004 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)

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

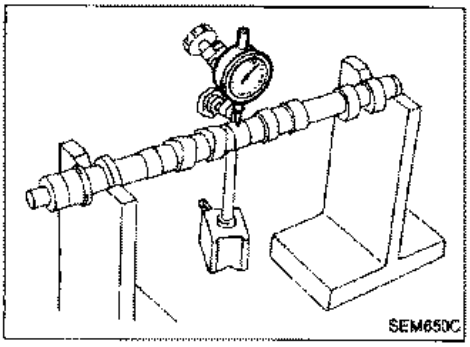
Nominal cylinder head height from camshaft center:

169.5 - 169.7 mm (6.673 - 6.681 in)

Inspection (Cont'd)

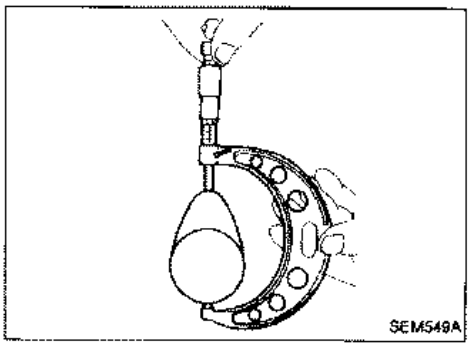
CAMSHAFT VISUAL CHECK

Check camshaft for scratches, seizure and wear.



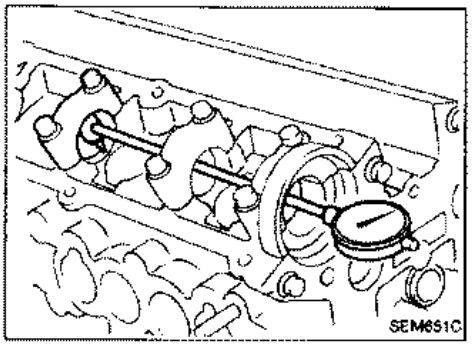
CAMSHAFT RUNOUT

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



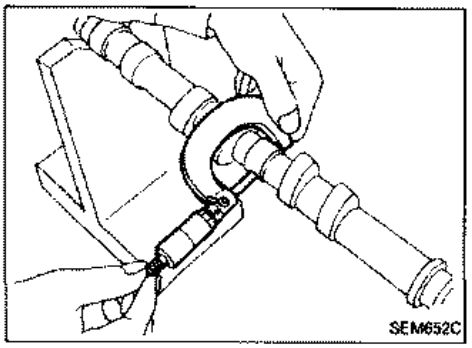
CAMSHAFT CAM HEIGHT

1. Measure camshaft cam height.
   Standard cam height:
   40.405 - 40.595 mm (1.5907 - 1.5982 in)
   Cam wear limit:
   0.15 mm (0.0059 in)
2. If wear is beyond the limit, replace camshaft.



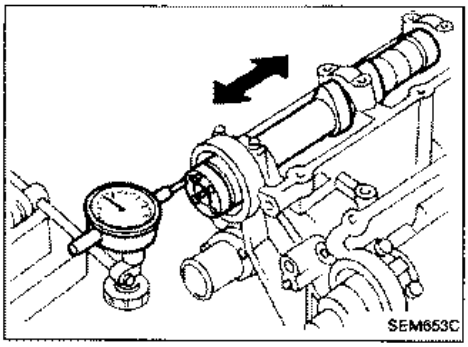
CAMSHAFT JOURNAL CLEARANCE

1. Install camshaft bracket and tighten bolts to the specified torque.
2. Measure inner diameter of camshaft bearing.
   Standard inner diameter:
   28.000 - 28.021 mm (1.1024 - 1.1032 in)



3. Measure outer diameter of camshaft journal.
   Standard outer diameter:
   27.935 - 27.955 mm (1.0998 - 1.1006 in)
4. If clearance exceeds the limit, replace camshaft and/or cylinder head.
   Camshaft journal clearance limit:
   0.15 mm (0.0059 in)

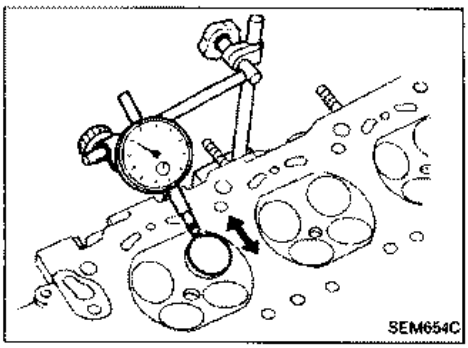
Inspection (Cont'd)



CAMSHAFT END PLAY

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

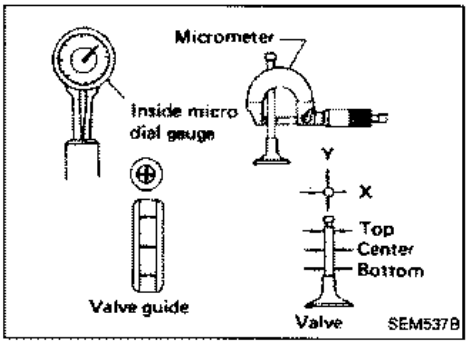
Camshaft end play:
Standard
0.03 - 0.08 mm (0.0012 - 0.0031 in)



VALVE GUIDE CLEARANCE

1. Push valve stem out so that its end is even with valve guide height. Measure valve runout by moving valve.

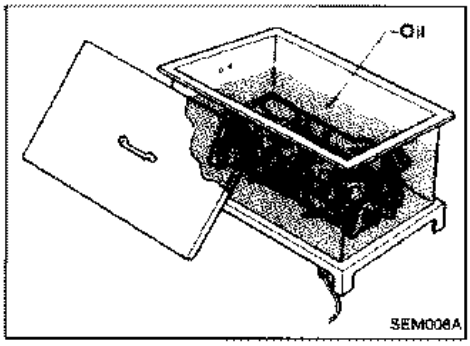
Valve deflection limit (Dial gauge reading):
0.2 mm (0.008 in)



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

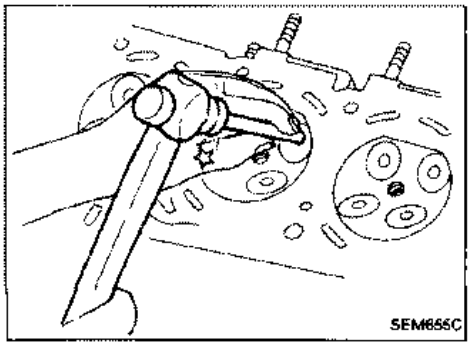
Valve to valve guide clearance limit:
0.10 mm (0.0039 in)

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



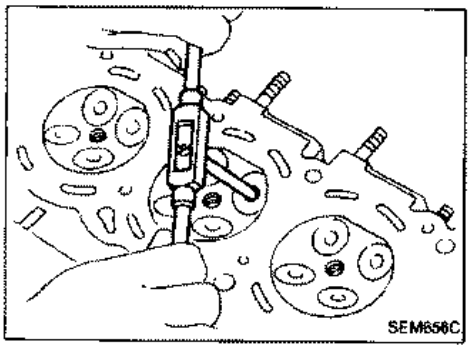
VALVE GUIDE REPLACEMENT

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

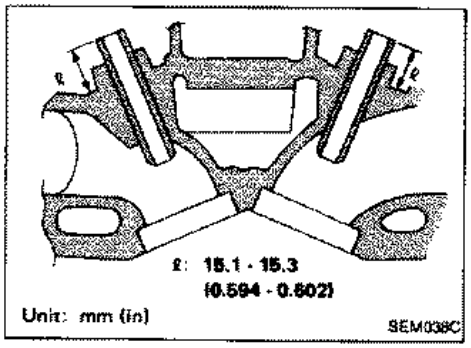


2. Drive out valve guide with a press [under a 20 kN (2 t, 2.2 US ton, 2.0 Imp ton) pressure] or hammer and suitable tool.

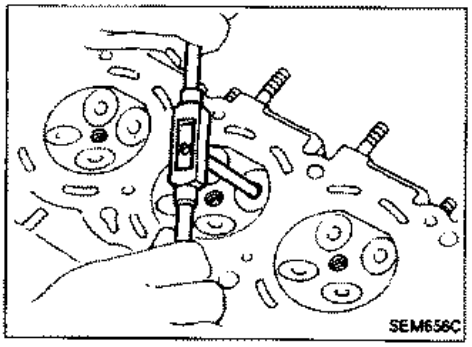
Inspection (Cont'd)



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



4. Heat cylinder head to 150 to 160°C (302 to 320°F) and press service valve guide onto cylinder head.
   Projection "ℓ":
   15.1 - 15.3 mm (0.594 - 0.602 in)



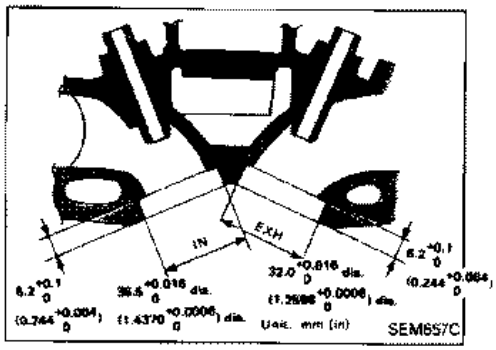
5. Ream valve guide.
   Finished size:
   Intake and Exhaust
   6.000 - 6.018 mm (0.2362 - 0.2369 in)

VALVE SEATS

Check valve seats for evidence of pitting at valve contact surface, and reseat or replace if it is worn 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 assure a uniform surface.**

Inspection (Cont'd)

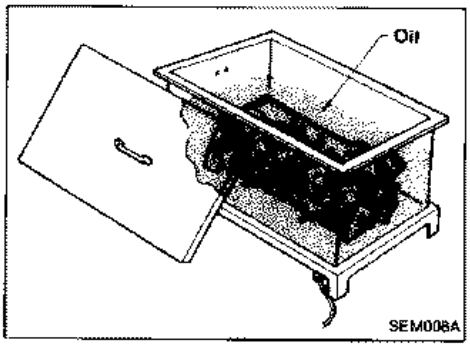


REPLACING VALVE SEAT FOR SERVICE PARTS

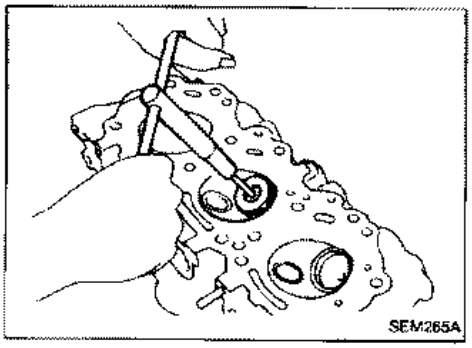
1. Bore out old seat until it collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the seat recess in cylinder head.
2. Ream cylinder head recess.

Reaming bore for service valve seat
Oversize [0.5 mm (0.020 in)]:
Intake
36.500 - 36.516 mm (1.4370 - 1.4376 in)
Exhaust
32.000 - 32.016 mm (1.2598 - 1.2605 in)

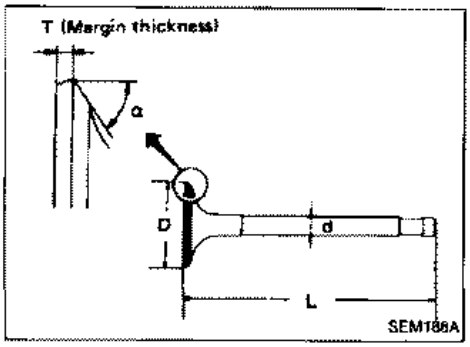
Reaming should be done to the concentric circles to valve guide center so that valve seat will have the correct fit.



3. Heat cylinder head to 150 to 160°C (302 to 320°F).
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 abrasive compound.
7. Check valve seat contact condition.

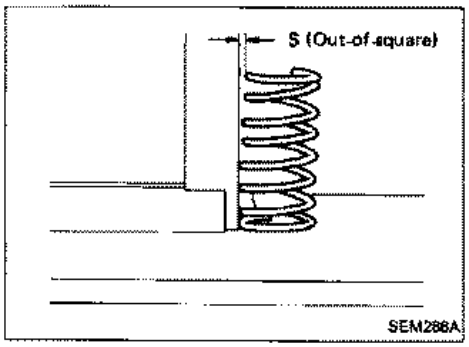


VALVE DIMENSIONS

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 valve.

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

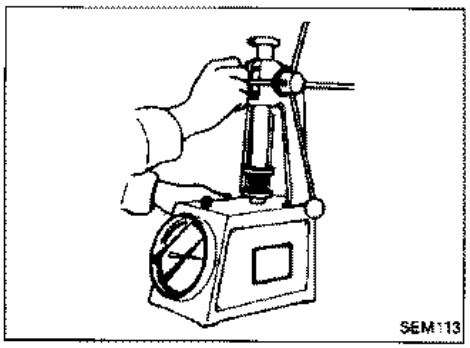
Inspection (Cont'd)



VALVE SPRING

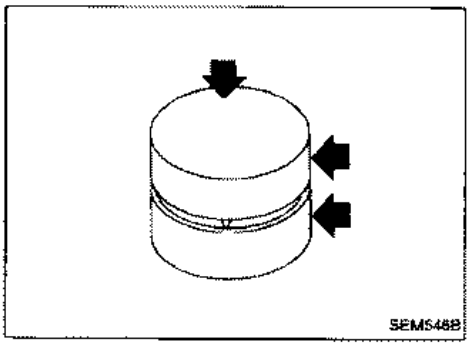
Squareness

1. Measure "S" dimension.
   Out-of-square:
   Less than 1.8 mm (0.071 in)
2. If it exceeds the limit, replace spring.



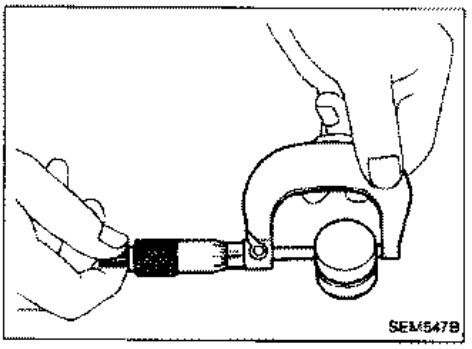
Pressure

Check valve spring pressure.
Pressure: N (kg, lb) at height mm (in)
Standard
536.4 (54.7, 120.6) at 26.5 (1.043)
Limit
More than 452.79 (46.17, 101.80) at 26.5 (1.043)
If it exceeds the limit, replace spring.

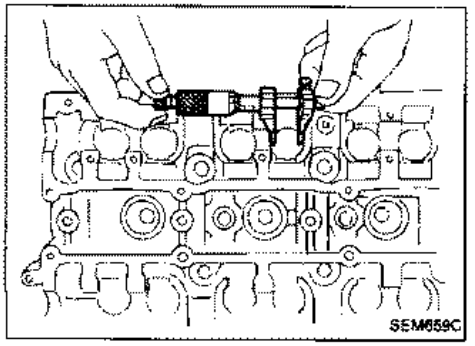


HYDRAULIC VALVE LIFTER

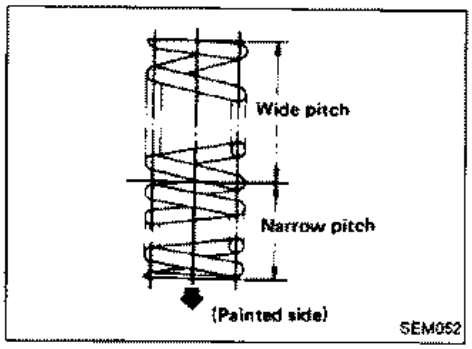
1. Check contact and sliding surfaces for wear or scratches.



2. Check diameter of valve lifter.
   Outer diameter:
   30.955 - 30.965 mm (1.2187 - 1.2191 in)



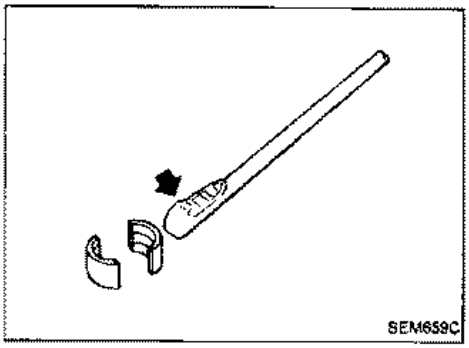
3. Check valve lifter guide inner diameter.
   Inner diameter:
   31.000 - 31.020 mm (1.2205 - 1.2213 in)
   Standard clearance between valve lifter and lifter guide:
   0.035 - 0.065 mm (0.0014 - 0.0026 in)



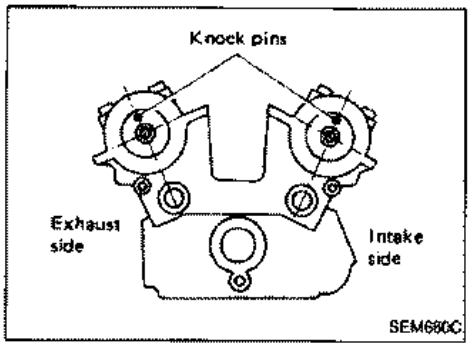
Assembly

1. Install valve component parts.

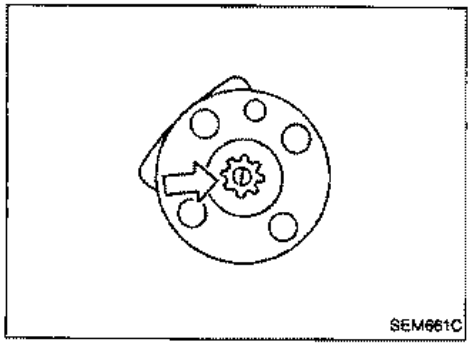
- **Always use new valve oil seal. (Refer to OIL SEAL REPLACEMENT.)**
- **Install valve spring (uneven pitch type) with its narrow pitch side (painted side) toward cylinder head side.**



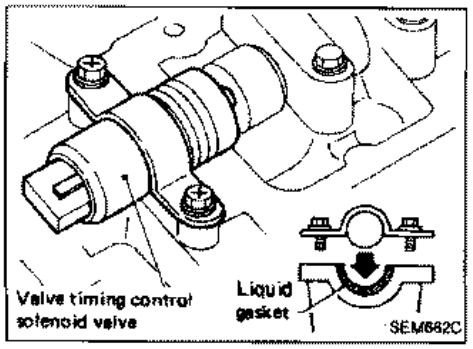
- To facilitate installation of collet, apply a small amount of grease to a piece of wire or a pencil and attach collet to wire or pencil, as shown.



2. Install camshafts as shown.

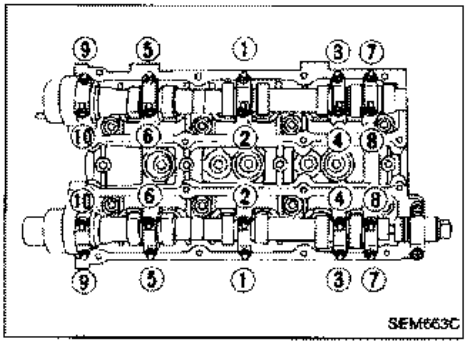


- Exhaust camshaft (left side) has spline for crank angle sensor.



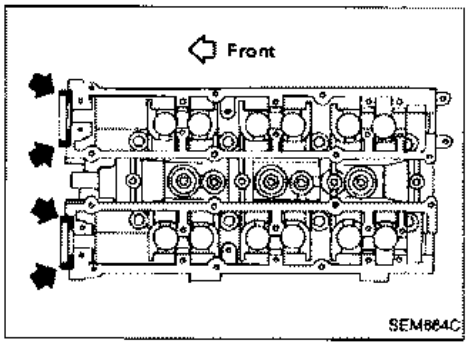
- When installing valve timing control solenoid valves, apply liquid gasket as shown.

Assembly (Cont'd)



3. Install camshaft brackets.

Tighten camshaft bracket bolts gradually in two or three stages.



When installing front side camshaft brackets, apply liquid gasket as shown.

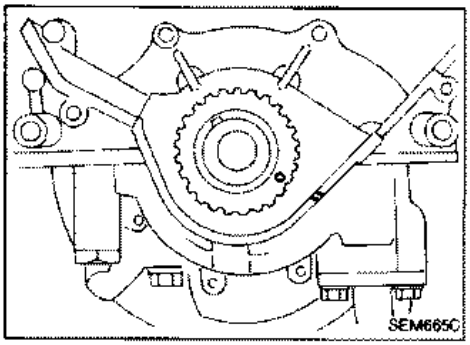
4. Apply engine oil to camshaft oil seal lip and install it in place.

Always use new camshaft oil seal.

5. Install rear timing belt cover.
6. Install camshaft sprockets.

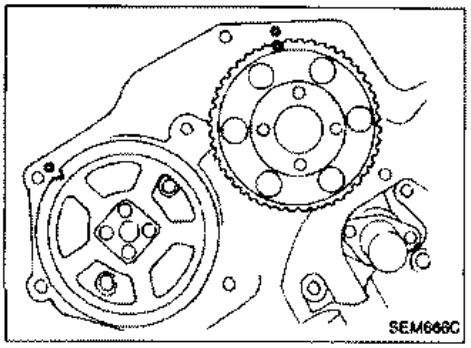
When tightening bolts, fix camshaft to prevent it from rotating.

Installation



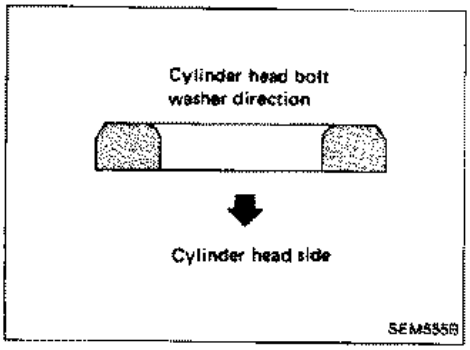
1. Set No. 1 piston at T.D.C. on its compression stroke as follows:

(1) Align crankshaft sprocket aligning mark with mark on oil pump body.



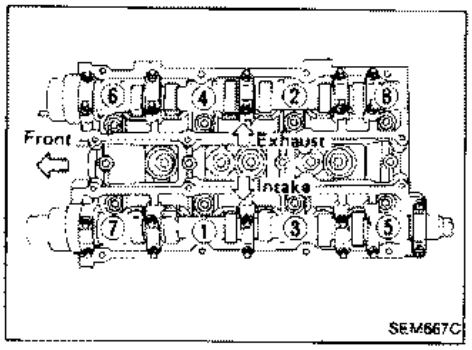
(2) Align camshaft sprocket aligning mark with mark on timing belt rear cover.

Installation (Cont'd)



2. Install cylinder head with new gasket.

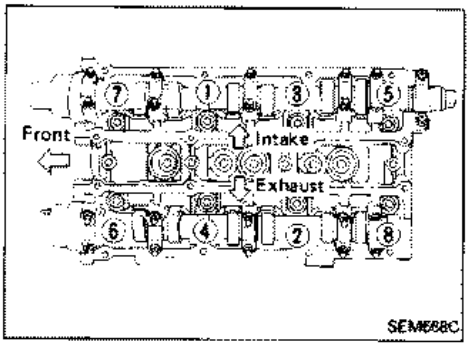
- **Be sure to install washers between bolts and cylinder head.**
- **Do not rotate crankshaft and camshaft separately, or valves will hit piston heads.**

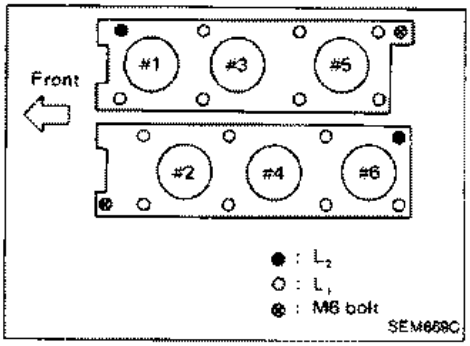


3. Tighten cylinder head bolts in numerical order.

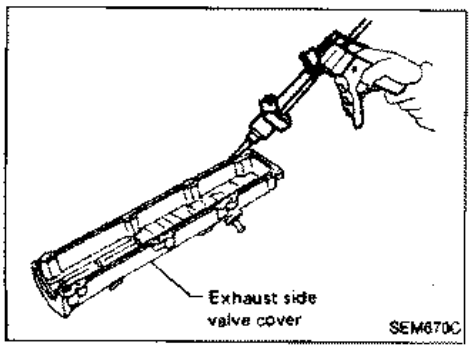
- **Tightening procedure**

(1) Tighten all bolts to 39 N·m (4.0 kg-m, 29 ft-lb).
(2) Tighten all bolts to 123 N·m (12.5 kg-m, 90 ft-lb).
(3) Loosen all bolts completely.
(4) Tighten all bolts to 34 to 44 N·m (3.5 to 4.5 kg-m, 25 to 33 ft-lb).
(5) Turn bolts 65 to 75 degrees (L_1), 60 to 70 degrees (L_2) clockwise or, if an angle wrench is not available, tighten all bolts to 123 N·m (12.5 kg-m, 90 ft-lb).

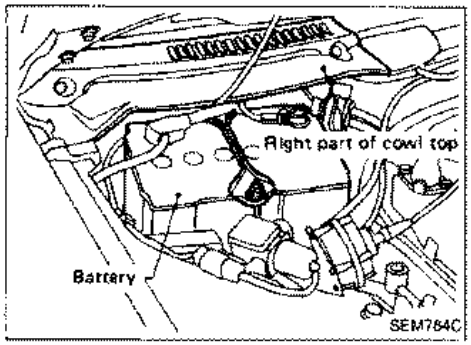




(6) Tighten bolts (⊗) as shown to 10 to 12 N·m (1.0 to 1.2 kg-m, 7 to 9 ft-lb).



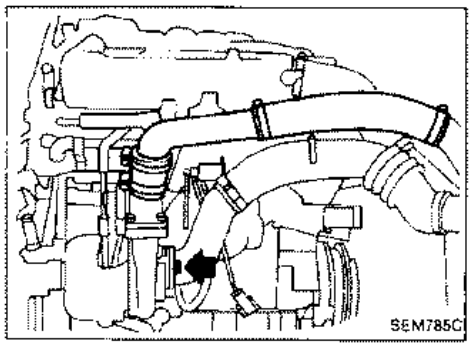
4. Install valve covers.
   When installing exhaust side valve covers, apply liquid gasket as shown.
5. Install remaining parts.



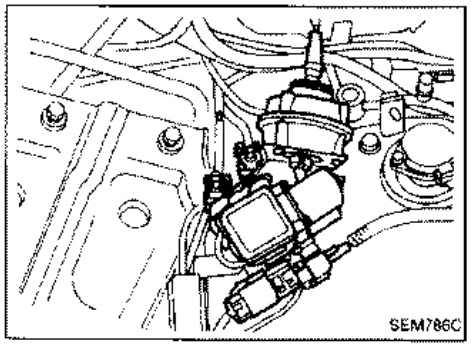
Removal

RIGHT SIDE UNIT

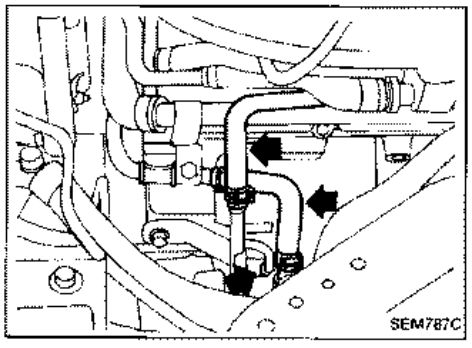
1. Remove right part of cowl top.
2. Remove battery.



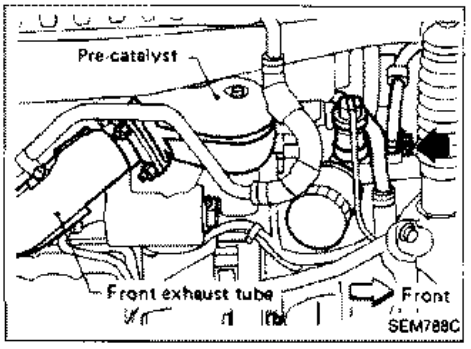
3. Remove air inlet hose and pipe.
4. Disconnect lower pipe from turbocharger unit.



5. Remove A.S.C.D. bracket with wiper motor and solenoid valves.
6. Disconnect exhaust gas sensor harness connector.

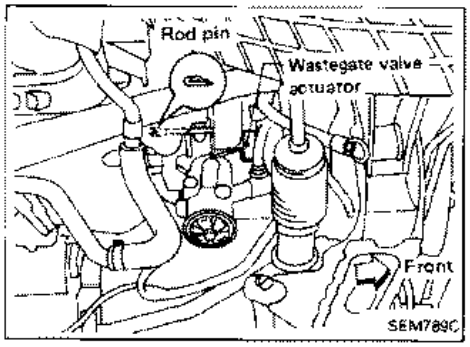


7. Remove turbocharger water hoses, and disconnect turbocharger oil inlet tube.
8. Remove two bolts fastening pre-catalyst to turbocharger unit.

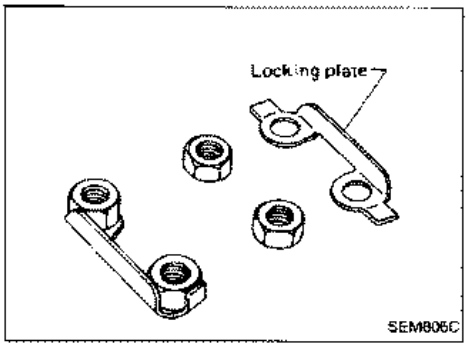


9. Remove the following parts;
   - oil pressure switch,
   - oil filter,
   - turbocharger oil return tube,
   - front exhaust tube,
   - pre-catalyst
10. Disconnect oil hose from oil filter bracket, and turbocharger water tubes from turbocharger unit.

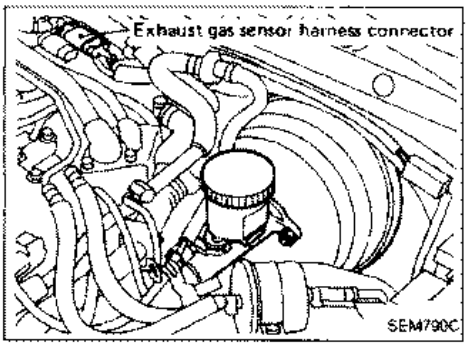
Removal (Cont'd)



11. Remove rod pin of wastegate valve actuator.
12. Remove oil filter bracket.

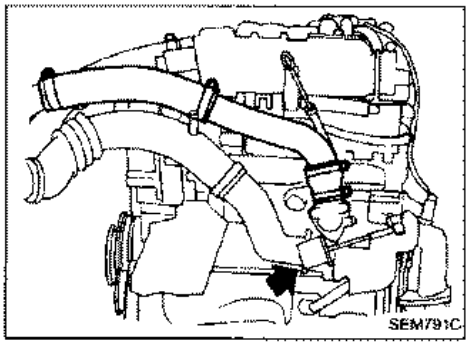


13. Unbend locking plates for fastening nuts of turbocharger unit.
14. Remove turbocharger unit.

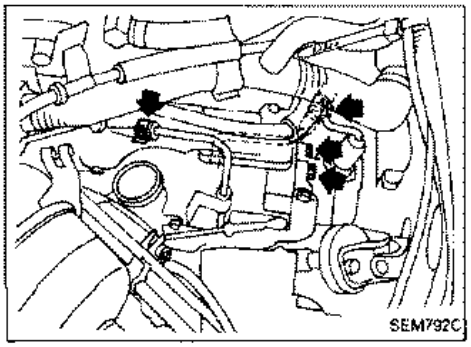


LEFT SIDE UNIT

1. Remove brake master cylinder and brake booster.
2. Disconnect exhaust gas sensor harness connector.

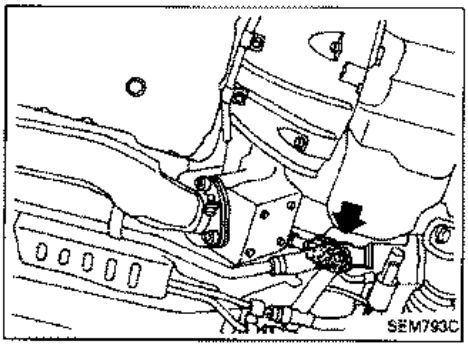


3. Remove air inlet hose and pipe.
4. Disconnect lower pipe from turbocharger unit.

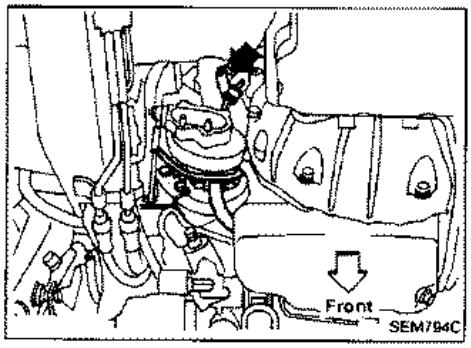


5. Disconnect water tubes.
6. Remove two bolts fastening pre-catalyst to turbocharger unit.

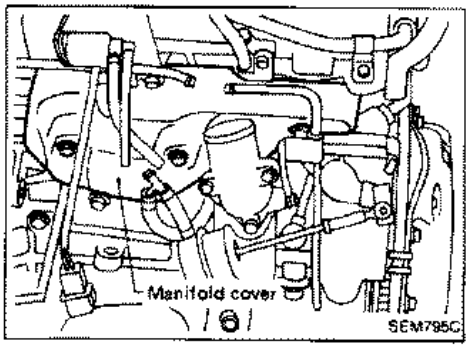
Removal (Cont'd)



7. Remove front exhaust tube and pre-catalyst.
8. Disconnect steering lower joint.



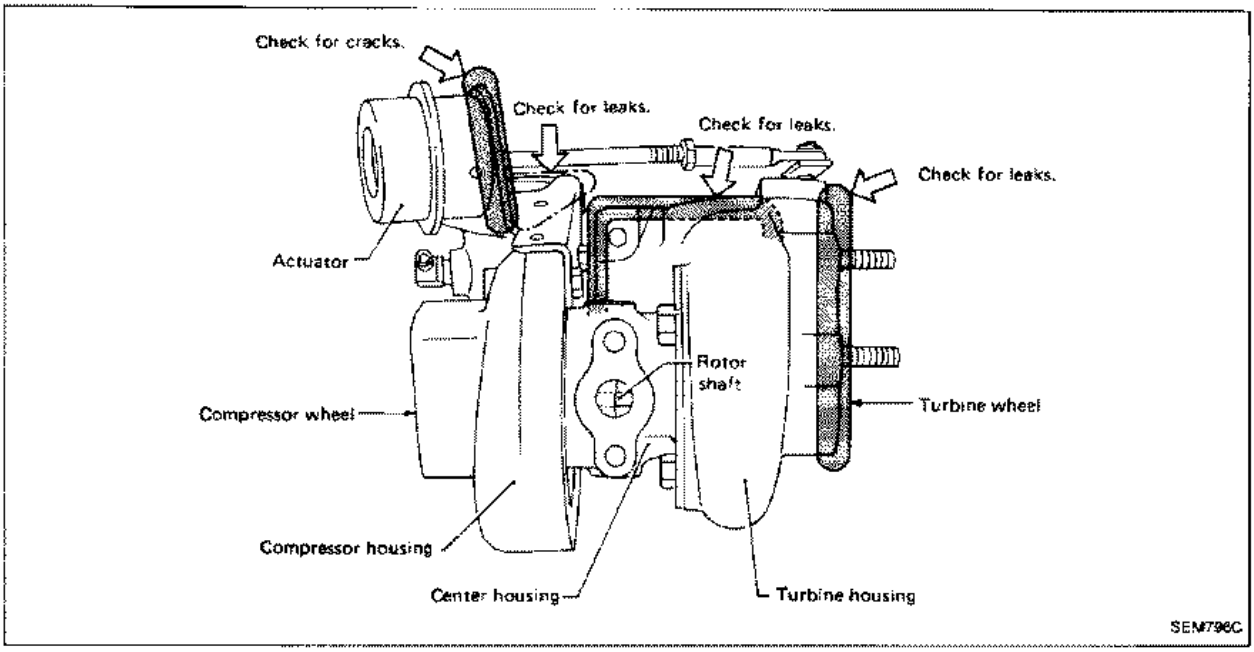
9. Remove turbocharger oil return tube and water tubes.
10. Disconnect E.G.R. tube and actuator bracket of turbocharger wastegate valve.

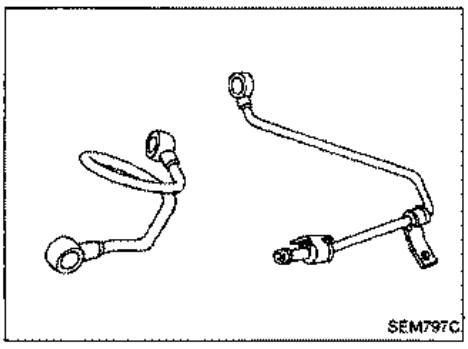


11. Remove manifold cover and fastening nuts.
12. Remove turbocharger unit with exhaust manifold.

Inspection

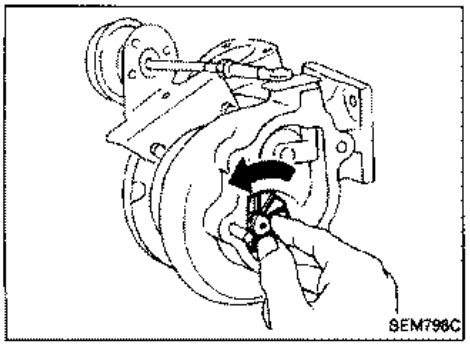
Proceed the following checks. If N.G., replace turbocharger units.





OIL AND WATER TUBES

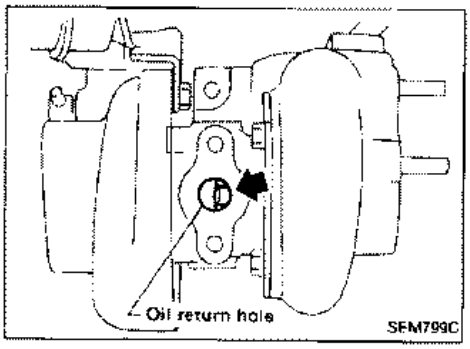
Check tubes for clogging.



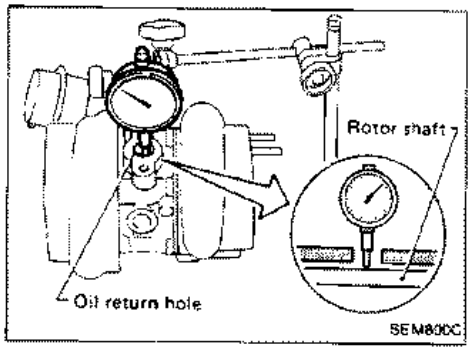
ROTOR SHAFT

1. Check rotor shaft for smooth rotating.

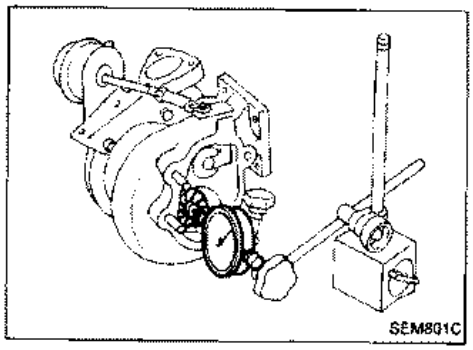
Inspection (Cont'd)



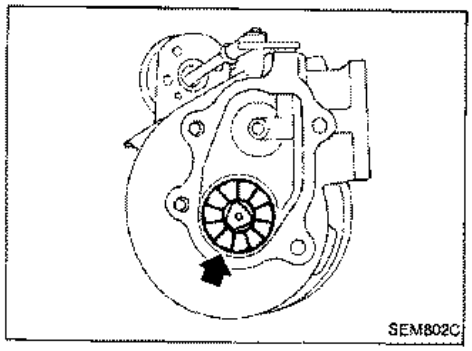
2. Check rotor shaft for carbon deposits.



3. Measure runout of rotor shaft.
   Runout (Total indicator reading):
   0.056 - 0.127 mm (0.0022 - 0.0050 in)



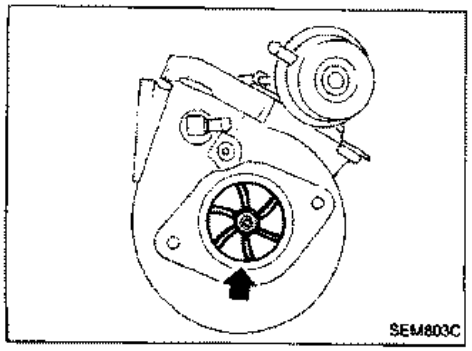
4. Measure end play of rotor shaft.
   End play:
   0.013 - 0.096 mm (0.0005 - 0.0038 in)



TURBINE WHEEL

Check turbine wheel for the following:

- Oil
- Carbon deposits
- Deformed fins
- Contact with turbine housing

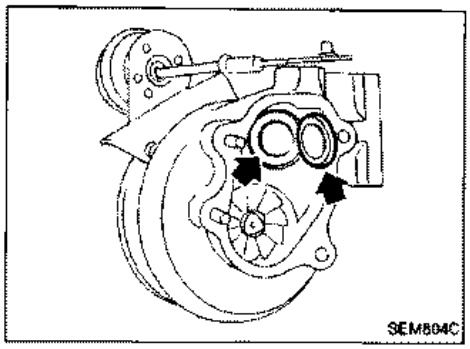


COMPRESSOR WHEEL

Check compressor wheel for the following:

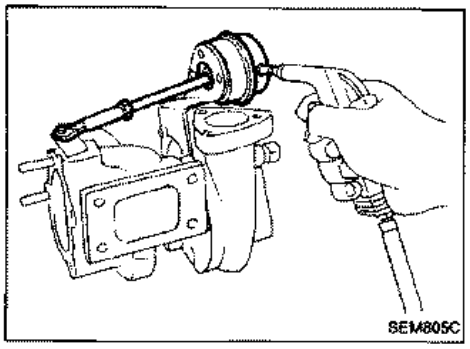
- Oil
- Deformed fins
- Contact with compressor housing

Inspection (Cont'd)



WASTEGATE VALVE

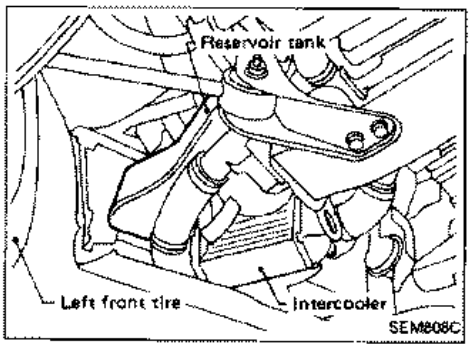
Remove rod pin and check wastegate valve for cracks, deformation and smooth movement.
Check valve seat surface for smoothness.



WASTEGATE VALVE ACTUATOR

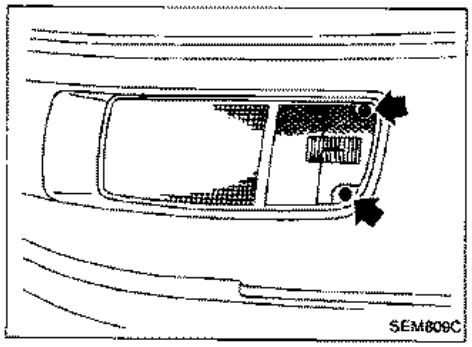
Apply air pressure to wastegate valve actuator and check it for smooth movement.

- **Do not keep applying air pressure to the actuator.**
- **The air pressure should be in the range of 78 to 88 kPa (0.78 to 0.88 bar, 0.8 to 0.9 kg/cm^2, 11 to 13 psi).**

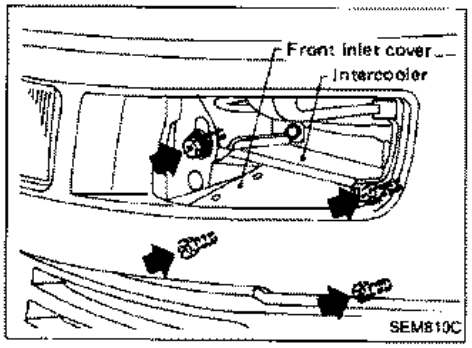


Removal

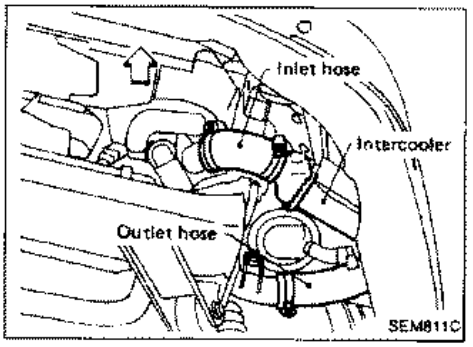
1. Remove front part of front fender protector.
2. Remove reservoir tank (left intercooler service only).



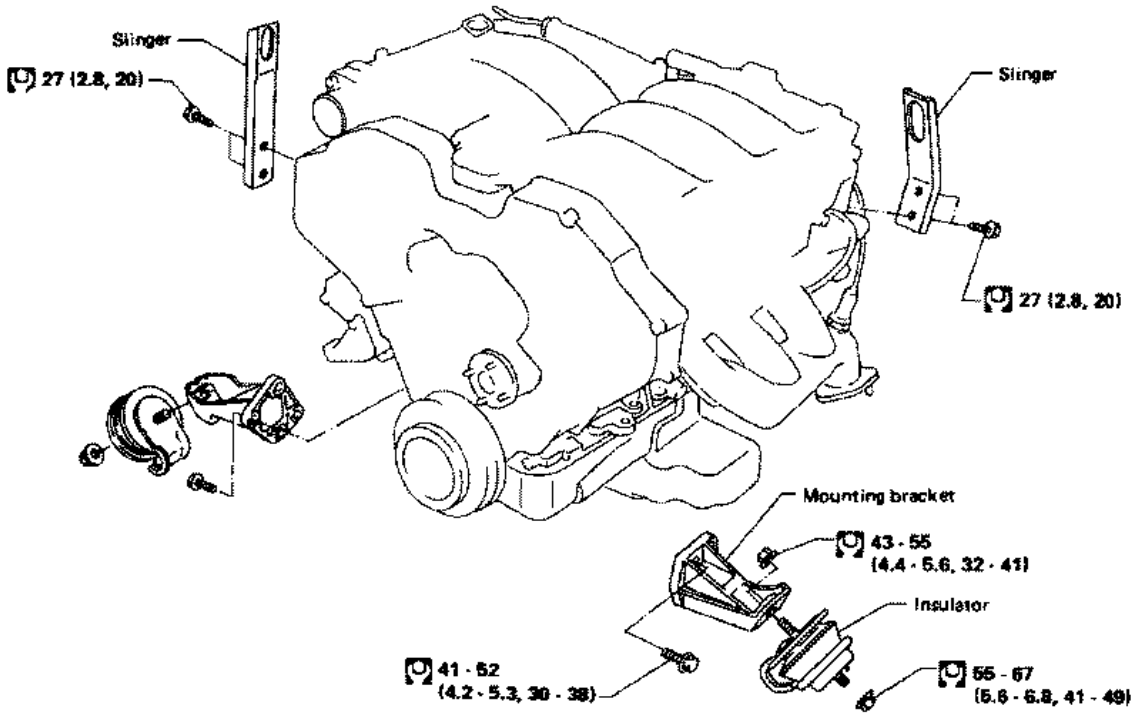
3. Remove front combination lamp.

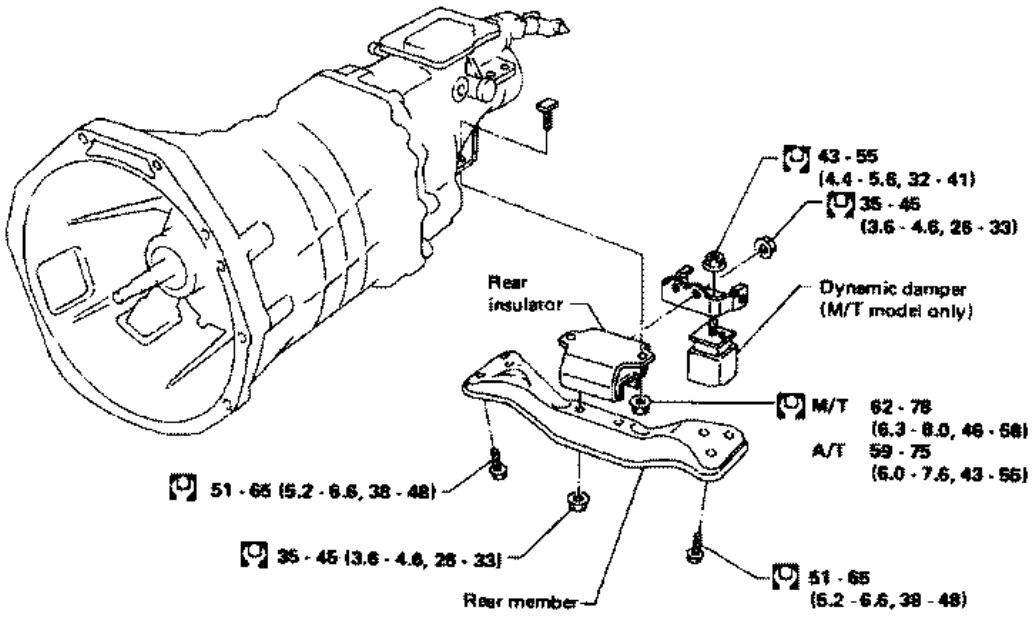


4. Remove bolts fastening intercooler and front inlet cover.



5. Remove inlet and outlet hoses.
6. Remove intercooler unit.





: N·m (kg-m, ft-lb)

SEM621C

WARNING:

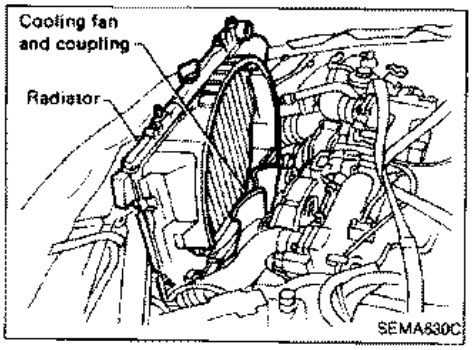
a. **Situate vehicle on a flat and solid surface.**
b. **Place chocks at front and back of rear wheels.**
c. **Do not remove engine until exhaust system has completely cooled off. Otherwise, you may burn yourself and/or fire may break out in fuel line.**
d. **For safety during subsequent steps, the tension of wires should be slackened against the engine.**
e. **Before disconnecting fuel hose, release fuel pressure from fuel line.**
   Refer to "Releasing Fuel Pressure" in section EF & EC.
f. **Be sure to hoist engine and transmission in a safe manner.**
g. **For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.**

CAUTION:

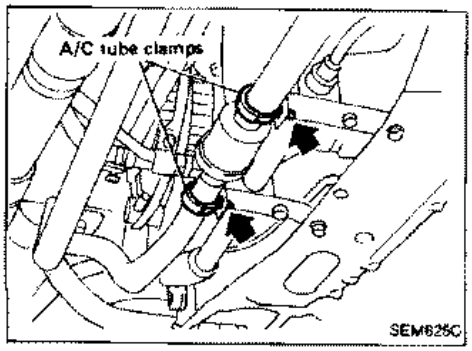
- **When lifting engine, be careful not to strike adjacent parts, especially accelerator wire casing, brake lines, and brake master cylinder.**
- **In hoisting the engine, always use engine slingers in a safe manner.**

M/T model

1. Remove engine under cover and hood.
2. Drain coolant from both cylinder block drain plugs, and radiator drain cock.
3. Drain engine oil from drain plug of oil pan.
4. Remove vacuum hoses, fuel tubes, wires, harnesses and connectors and so on.
5. Remove front exhaust tubes and propeller shaft.

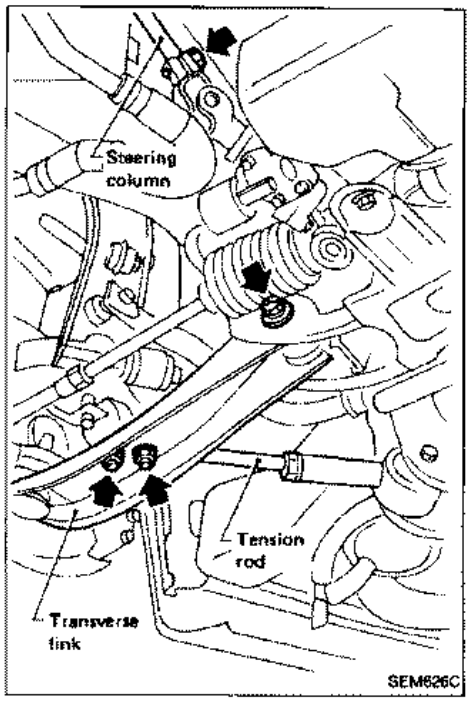


6. Remove radiator.
7. Remove drive belts, cooling fan and coupling.
8. Remove P/S oil pump, alternator, A/C pump from engine, and starter motor, and clutch operating cylinder.

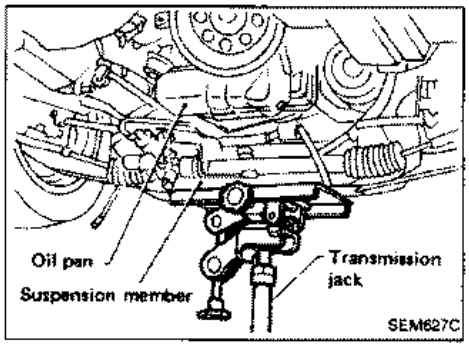


9. Disconnect A/C tube clamps as shown.

M/T model (Cont'd)



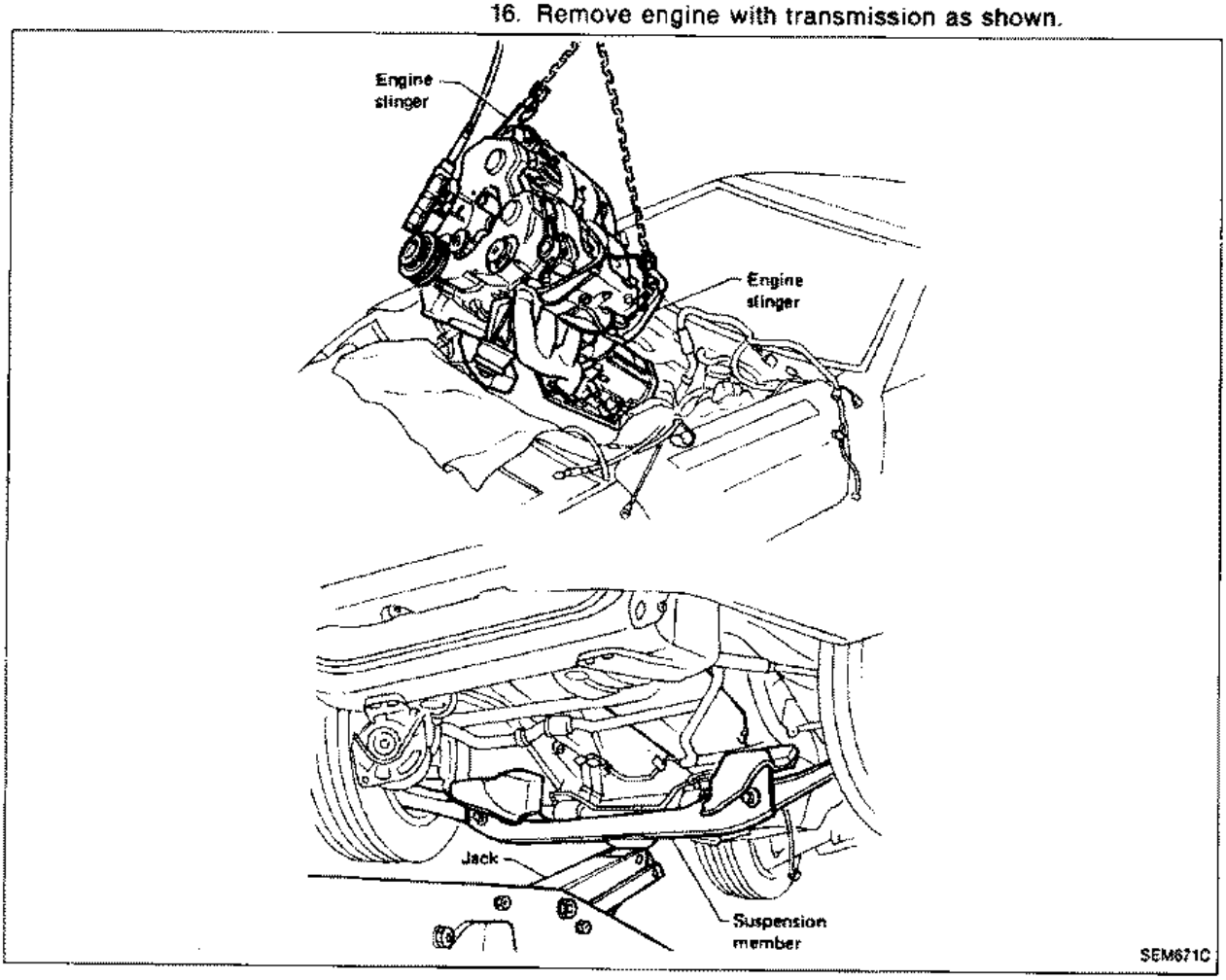
10. Disconnect steering column lower joint.
11. Remove tension rod fixing bolts from both sides.
12. Loosen transverse link bolts on both sides.



13. Set a suitable transmission jack under suspension member.
    - At this time, hoist engine with engine slinger.
14. Remove suspension member fixing bolts.
15. Remove engine mounting bolts from both sides and then slowly lower transmission jack.

M/T model (Cont'd)

16. Remove engine with transmission as shown.

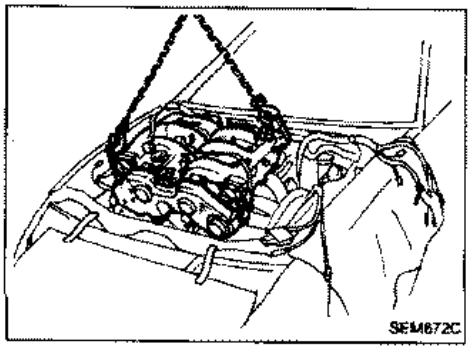


A/T model

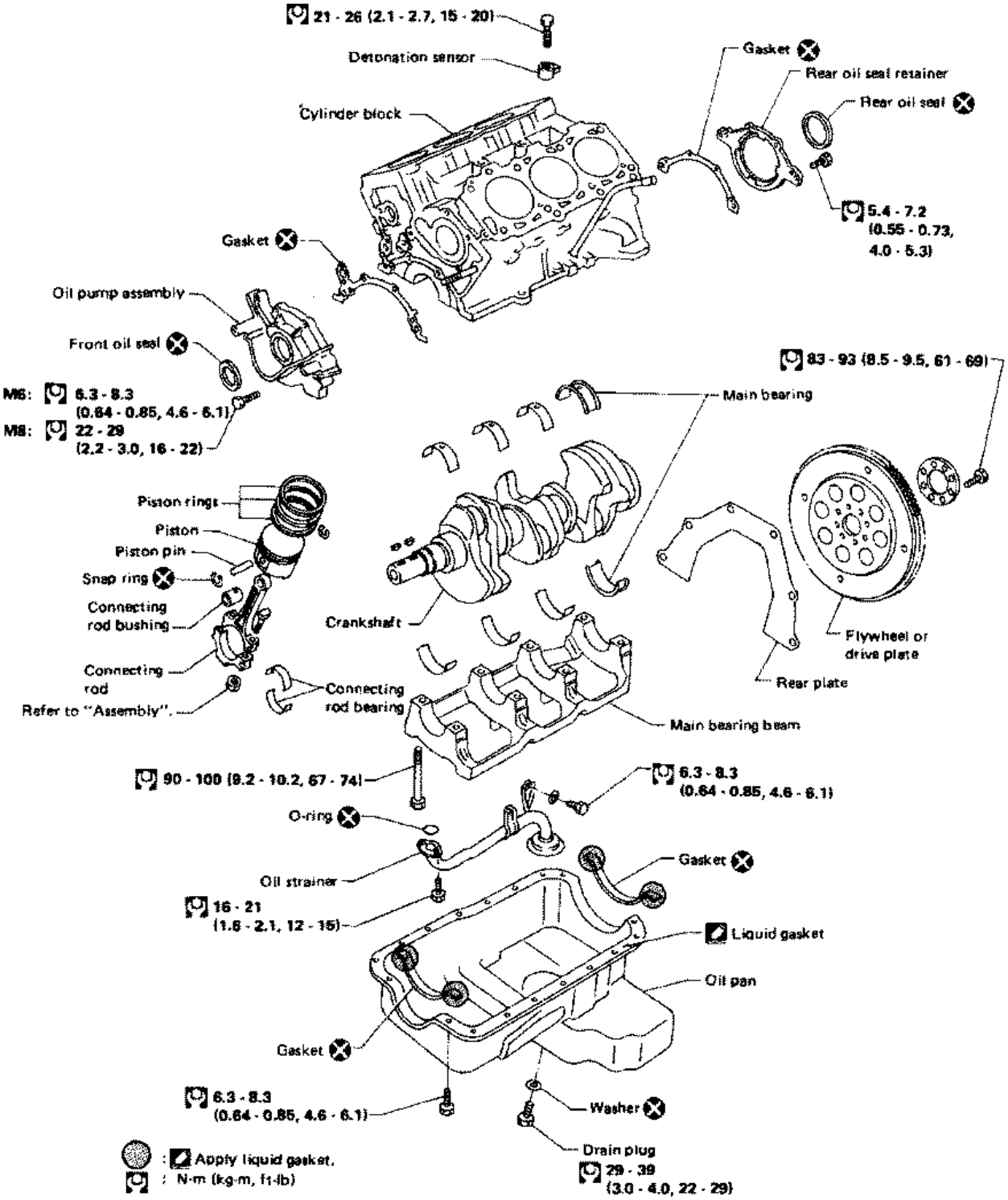
1. Perform the same procedures (1 to 8) as for M/T model.
2. Remove transmission from vehicle.

Refer to AT section.

3. Hoist engine with engine slingers and remove engine mounting bolts from both sides.



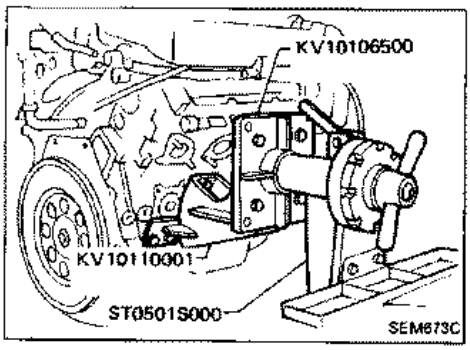
4. Remove engine from vehicle as shown.


21 - 26 (2.1 - 2.7, 15 - 20)
Detonation sensor
Cylinder block
Gasket
Rear oil seal retainer
Rear oil seal
5.4 - 7.2 (0.55 - 0.73, 4.0 - 5.3)
Gasket
Oil pump assembly
Front oil seal
M6: 6.3 - 8.3 (0.64 - 0.85, 4.6 - 6.1)
M8: 22 - 29 (2.2 - 3.0, 16 - 22)
83 - 93 (8.5 - 9.5, 61 - 69)
Main bearing
Piston rings
Piston
Piston pin
Snap ring
Connecting rod bushing
Connecting rod
Refer to "Assembly".
Crankshaft
Connecting rod bearing
Flywheel or drive plate
Rear plate
Main bearing beam
90 - 100 (9.2 - 10.2, 67 - 74)
6.3 - 8.3 (0.64 - 0.85, 4.6 - 6.1)
O-ring
Gasket
Oil strainer
16 - 21 (1.6 - 2.1, 12 - 15)
Liquid gasket
Oil pan
Gasket
6.3 - 8.3 (0.64 - 0.85, 4.6 - 6.1)
Washer
Drain plug
29 - 39 (3.0 - 4.0, 22 - 29)
: Apply liquid gasket.
: N·m (kg-m, ft-lb)

SEM622C

CAUTION:

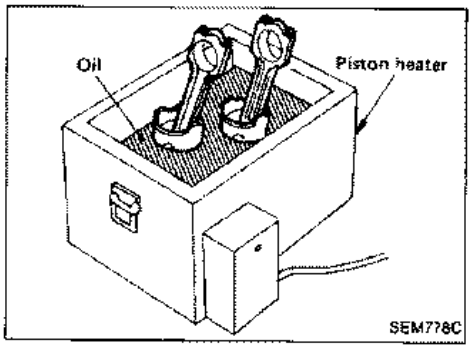
- **When installing sliding parts such as bearings and pistons, be sure to apply engine oil on the sliding surfaces.**
- **Place removed parts such as bearings and bearing caps in their proper order and direction.**
- **When tightening connecting rod bolts and main bearing cap bolts, apply engine oil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



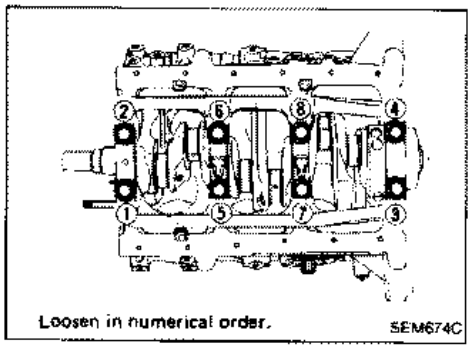
Disassembly

PISTON AND CRANKSHAFT

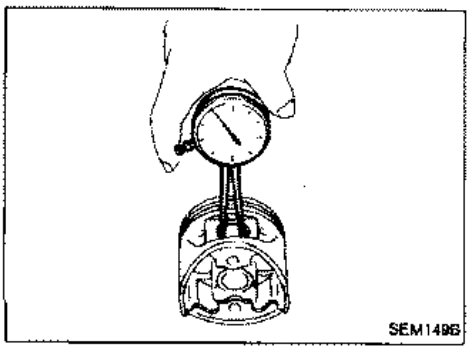
1. Place engine on a work stand.
2. Remove timing belt.
3. Drain coolant and remove water pump.
4. Drain oil.
5. Remove oil pan, oil pump and rear oil seal retainer.
6. Remove intake manifold collector, intake manifold and cylinder head.



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



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



Inspection

PISTON AND PISTON PIN CLEARANCE

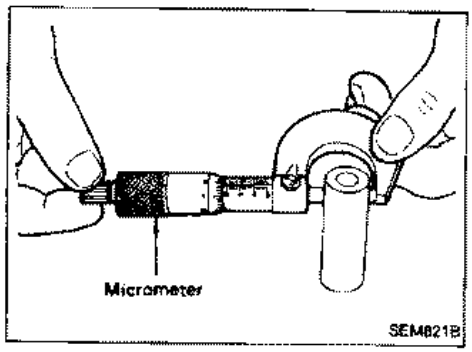
- Confirm the fitting of piston pin into piston pin hole by checking if it can be pressed in smoothly by finger pressure at room temperature.

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

Standard diameter "dp":

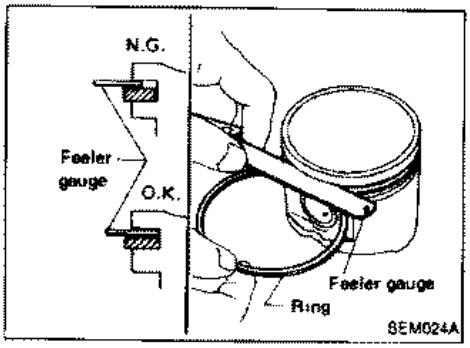
21.987 - 21.999 mm (0.8656 - 0.8661 in)

Inspection (Cont'd)



2. Measure outer diameter of piston pin "Dp".
   Standard diameter "Dp":
   21.989 - 22.001 mm (0.8657 - 0.8662 in)
3. Calculate piston pin clearance.
   dp - Dp = -0.004 to 0 mm (-0.0002 to 0 in)

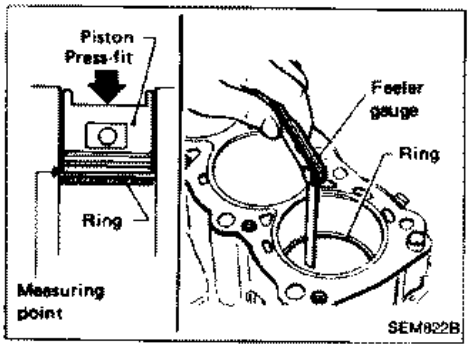
If it exceeds the above value, replace piston assembly with pin.



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)
Max. limit of side clearance:
0.1 mm (0.004 in)

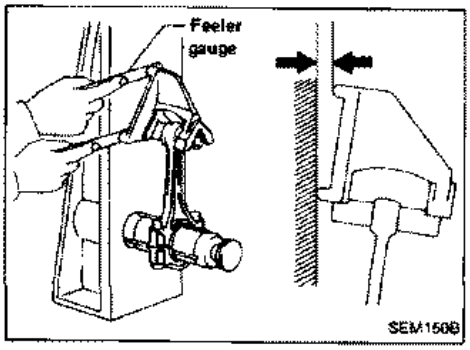
If out of specification, replace piston and/or piston ring assembly.



PISTON RING END GAP

End gap:
Top ring
0.21 - 0.40 mm (0.0083 - 0.0157 in)
2nd ring
0.50 - 0.76 mm (0.0197 - 0.0299 in)
Oil ring
0.20 - 0.76 mm (0.0079 - 0.0299 in)
Max. limit of end gap:
1.0 mm (0.039 in)

If out of specification, replace piston ring. If gap still exceeds the limit even with a new ring, rebore cylinder and use oversized piston and piston rings.
Refer to S.D.S.



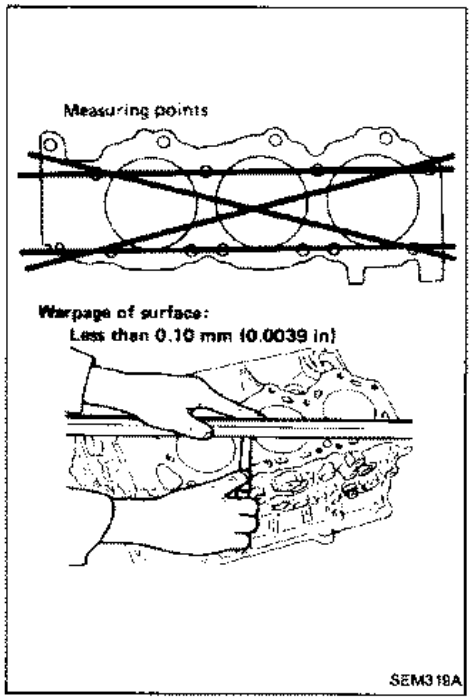
CONNECTING ROD BEND AND TORSION

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.

Inspection (Cont'd)

CYLINDER BLOCK DISTORTION AND WEAR



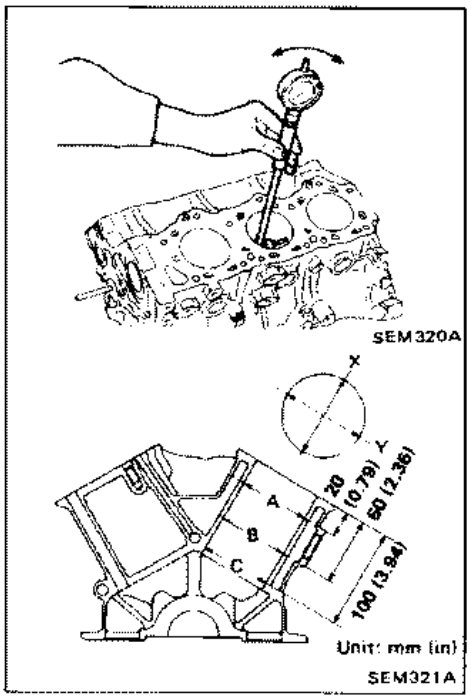
1. Clean upper face of cylinder block and measure the distortion.
   Limit:
   0.10 mm (0.0039 in)
2. If out of specification, resurface it.
   The resurfacing limit is determined by cylinder head resurfacing in engine.

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)

3. If necessary, replace cylinder block.

PISTON-TO-BORE CLEARANCE

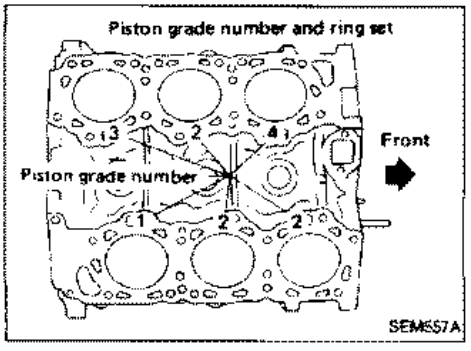
Method A (Using bore gauge and micrometer)



1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.
   Standard inner diameter:
   87.000 - 87.030 mm (3.4252 - 3.4264 in)
   Wear limit:
   0.20 mm (0.0079 in)
   Out-of-round (X - Y) limit:
   0.015 mm (0.0006 in)
   Taper (A - B - C) limit:
   0.010 mm (0.0004 in)

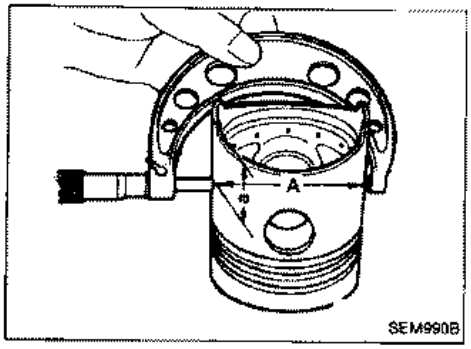
If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.

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

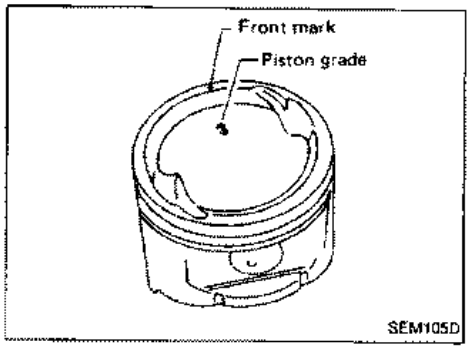


- **If both cylinder block and piston are replaced with new ones, select piston of the same grade number punched on cylinder block upper surface.**

Inspection (Cont'd)



3. Measure piston skirt diameter.
   Piston diameter "A":
   Refer to S.D.S.
   Measuring point "a" (Distance from the bottom):
   11.5 mm (0.453 in)
4. Check that piston-to-bore clearance is within specification.
   Piston-to-bore clearance "B":
   Non-turbo
   0.015 - 0.035 mm (0.0006 - 0.0014 in)
   Turbo
   0.025 - 0.045 mm (0.0010 - 0.0018 in)



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

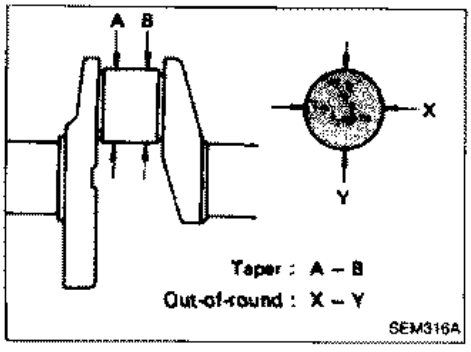
Oversize pistons are available for service. Refer to S.D.S.

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

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

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

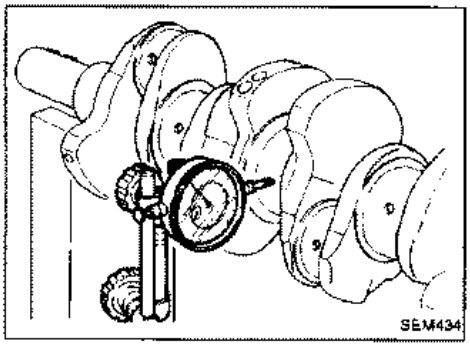
- **Measurement should be done after cylinder bore cools down.**



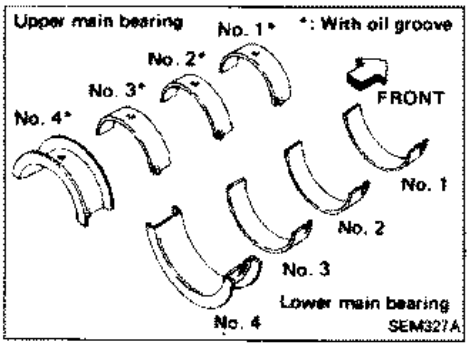
CRANKSHAFT

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

Inspection (Cont'd)



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



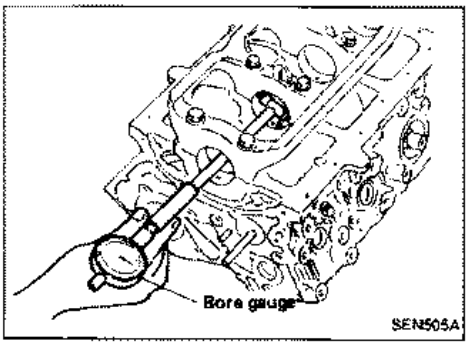
BEARING CLEARANCE

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

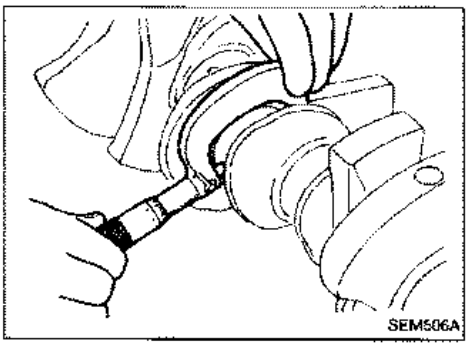
Method A (Using bore gauge & micrometer)

Main bearing

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

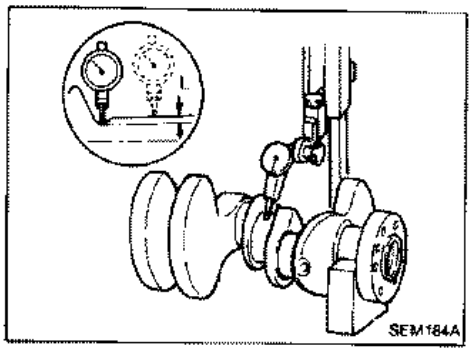


2. Install main bearing cap to cylinder block.
   Tighten all bolts in correct order in two or three stages.
3. Measure inner diameter "A" of each main bearing.

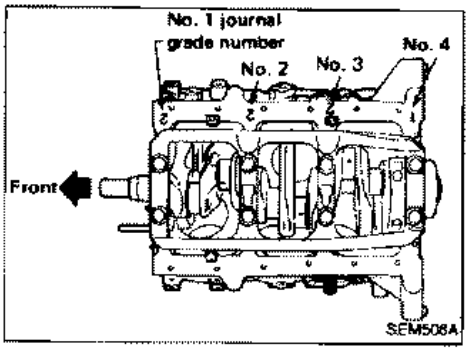


4. Measure outer diameter "Dm" of each crankshaft main journal.
5. Calculate main bearing clearance.
   Main bearing clearance (A - Dm):
   Standard
   0.028 - 0.055 mm (0.0011 - 0.0022 in)
   Limit
   0.090 mm (0.0035 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.

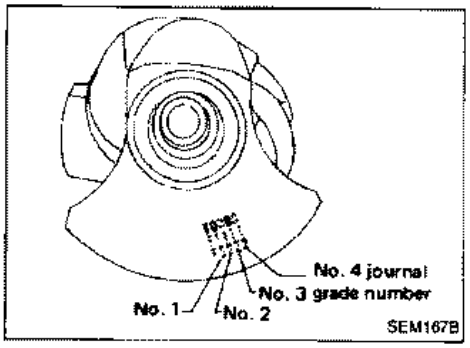
Inspection (Cont'd)



a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.
"L": 0.1 mm (0.004 in)
b. Refer to S.D.S. for grinding crankshaft and available service parts.



8. If crankshaft, cylinder block or main bearing is reused again, measure main bearing clearance.
If crankshaft, cylinder block and main bearings are replaced with new ones, it is necessary to select thickness of main bearings as follows:
a. Grade number of each cylinder block main journal is punched on the respective cylinder block.



b. Grade number of each crankshaft main journal is punched on the No. 1 counter weight of crankshaft.

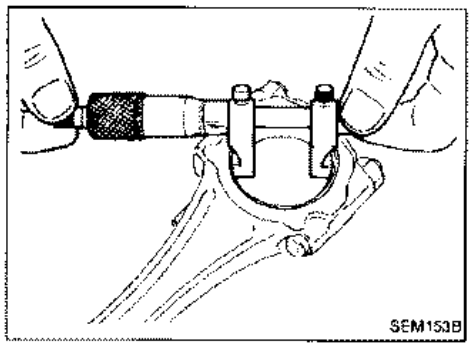
c. Select main bearing with suitable thickness according to the following table.

Main bearing grade number:

Crankshaft journal grade number \ Main journal grade number	0	1 (I)	2 (II)
0	0	1	2
1 (I)	1	2	3
2 (II)	2	3	4

For example:
Main journal grade number: 1
Crankshaft journal grade number: 2
Main bearing grade number = 1 + 2
= 3

Inspection (Cont'd)

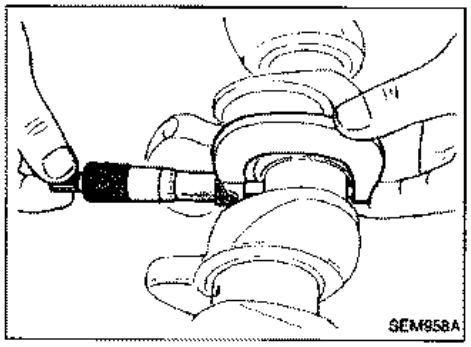


Connecting rod bearing (Big end)

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 each bearing.



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

   Connecting rod bearing clearance (C - Dp):

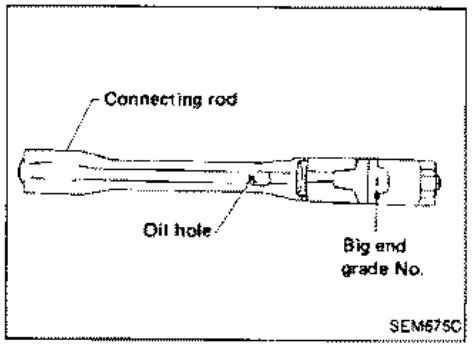
   Standard

   0.028 - 0.048 mm (0.0011 - 0.0019 in)

   Limit

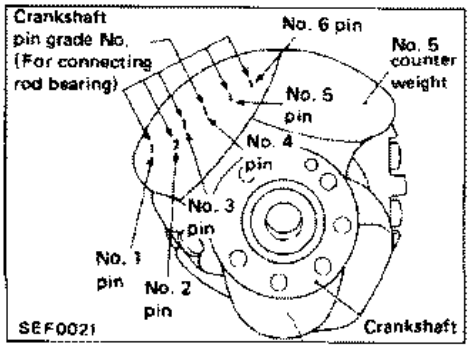
   0.090 mm (0.0035 in)
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.

   Refer to step 7 of "BEARING CLEARANCE — Main bearing".



8. If crankshaft, connecting rods or bearings are replaced with new ones, it is necessary to select thickness of connecting rod bearings as follows:

a. Grade number of each connecting rod big end is punched on the respective connecting rod.



b. Grade number of each crankshaft pin journal is punched on the No. 5 counter weight of crankshaft.

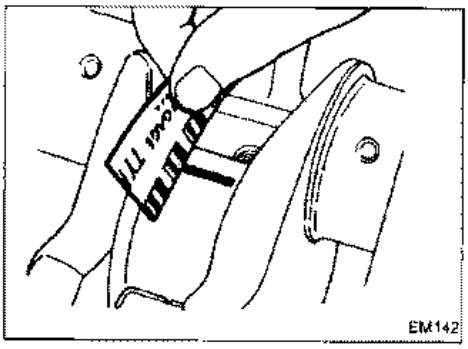
Inspection (Cont'd)

c. Select connecting rod bearing with suitable thickness according to the following table.

Connecting rod bearing grade number:

Crankshaft pin grade number \ Connecting rod big end grade number	0	1 (I)
0	0	1
1 (I)	1	2
2 (II)	2	3

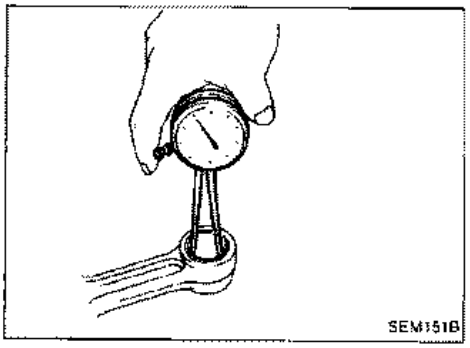
For example:
Connecting rod big end grade number: 1
Crankshaft pin grade number: 2
Connecting rod bearing grade number = 1 + 2
= 3


EM142

Method B (Using "plastigage")

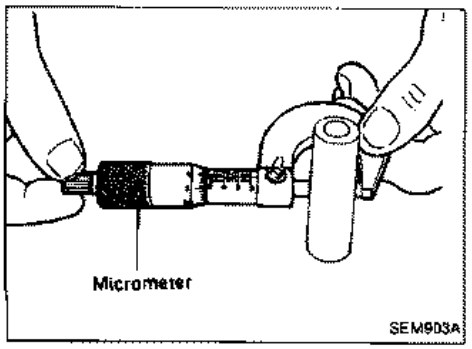
CAUTION:

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


SEM151B

CONNECTING ROD BUSHING CLEARANCE (Small end)

1. Measure inner diameter "C" of bushing.

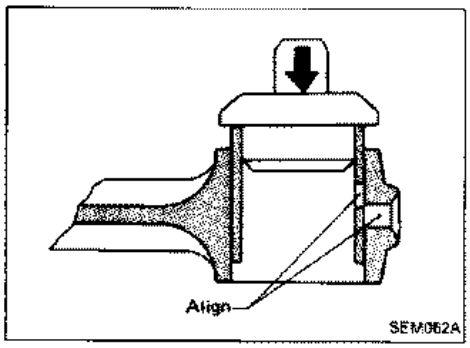


SEM903A

2. Measure outer diameter "Dp" of piston pin.
3. Calculate connecting rod bushing clearance.
   C – Dp = 0.005 - 0.017 mm (0.0002 - 0.0007 in)
   Limit: 0.023 mm (0.0009 in)

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

Inspection (Cont'd)



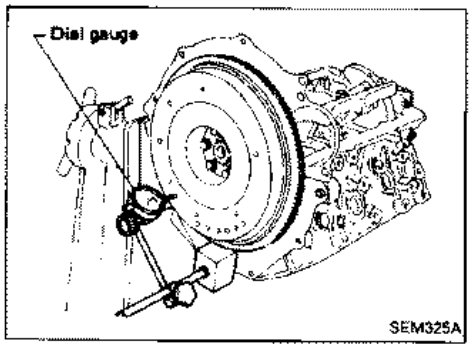
REPLACEMENT OF CONNECTING ROD BUSHING (Small end)

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

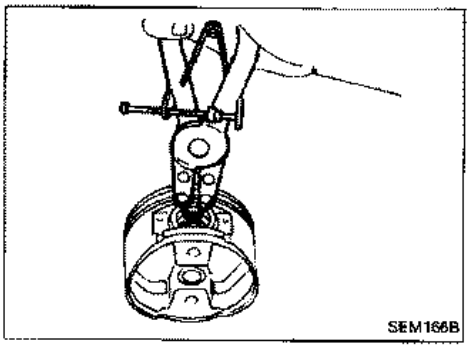
Be sure to align the oil holes.

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

Small end bushing inside diameter:
Finished size
22.000 - 22.012 mm (0.8661 - 0.8666 in)



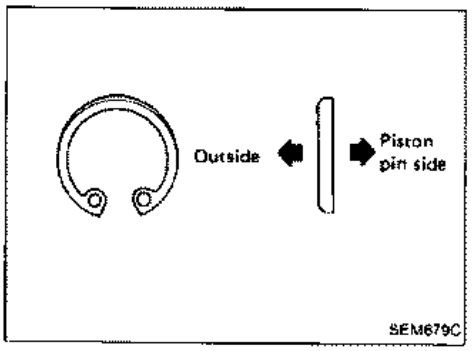
FLYWHEEL/DRIVE PLATE RUNOUT
Runout (Total indicator reading):
Flywheel (M/T model)
Less than 0.15 mm (0.0059 in)
Drive plate (A/T model)
Less than 0.15 mm (0.0059 in)

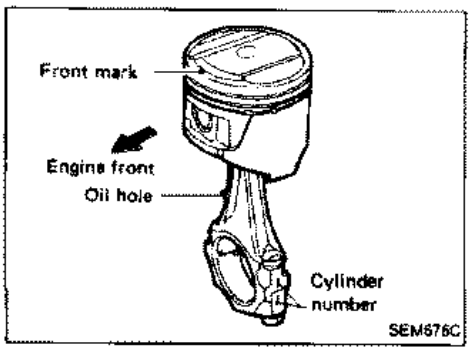


Assembly

PISTON

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

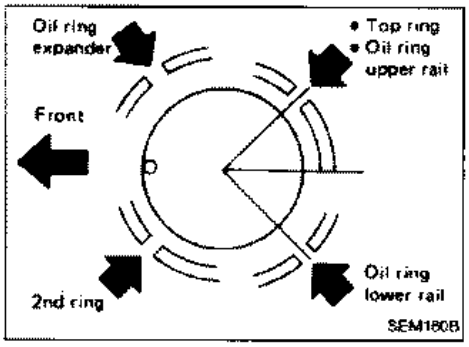




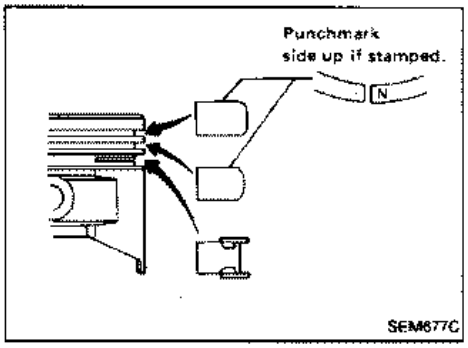
2. Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin, connecting rod and new snap ring.

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

Assembly (Cont'd)



3. Set piston rings as shown.

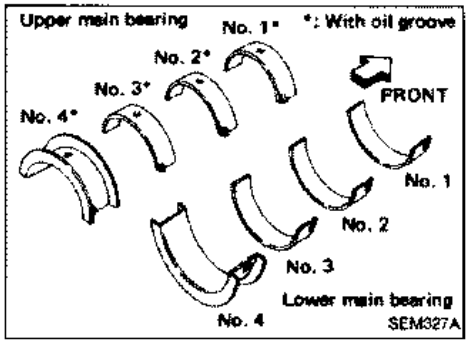


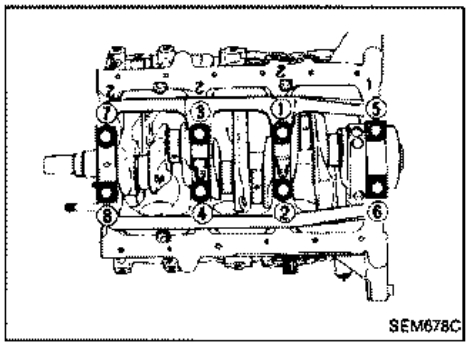
CRANKSHAFT

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

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

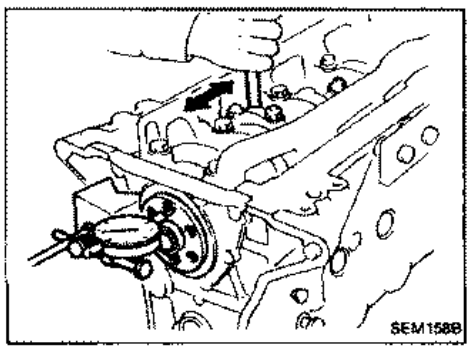
Refer to "Inspection".





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

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



3. Measure crankshaft end play.

Crankshaft end play:

Standard

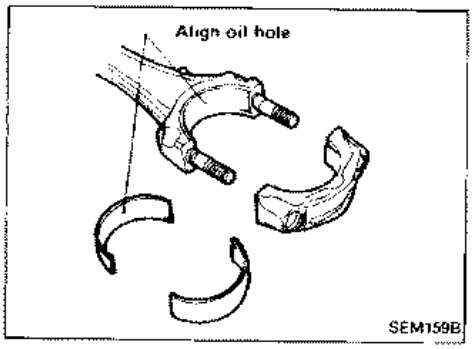
0.05 - 0.18 mm (0.0020 - 0.0071 in)

Limit

0.30 mm (0.0118 in)

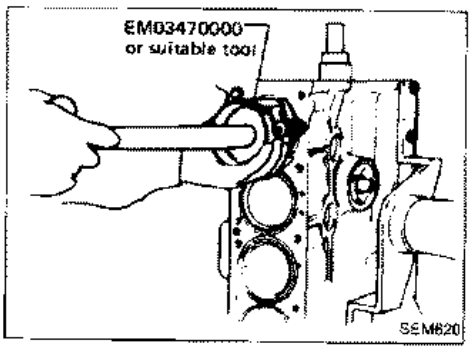
If beyond the limit, replace bearing with a new one.

Assembly (Cont'd)

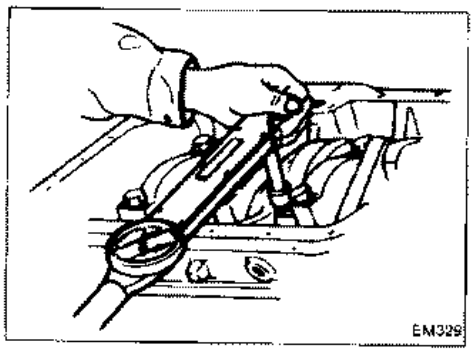


4. Install connecting rod bearings in connecting rods and connecting rod caps.
- **Confirm that correct bearings are used.**

Refer to "Inspection".
- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.



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

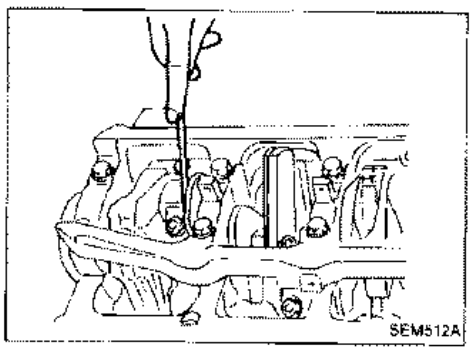


b. Install connecting rod bearing caps.
Tighten connecting rod bearingcap nuts to the specified torque.

: Connecting rod bearing nut

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

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



6. Measure connecting rod side clearance.

Connecting rod side clearance:

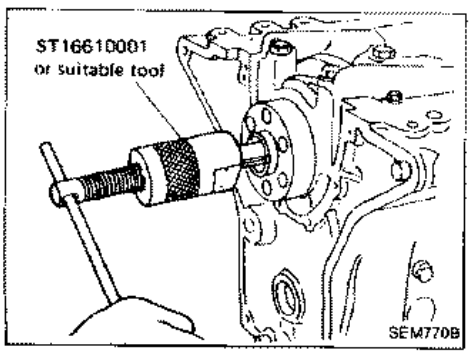
Standard

0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit

0.40 mm (0.0157 in)

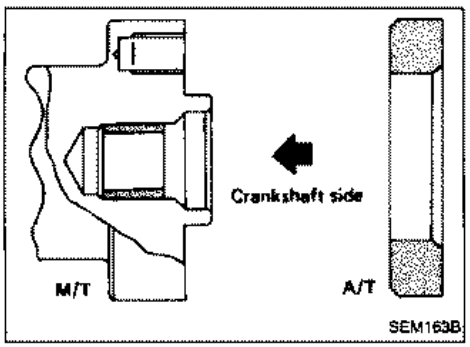
If beyond the limit, replace connecting rod and/or crankshaft.



REPLACING PILOT BUSHING

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

Assembly (Cont'd)

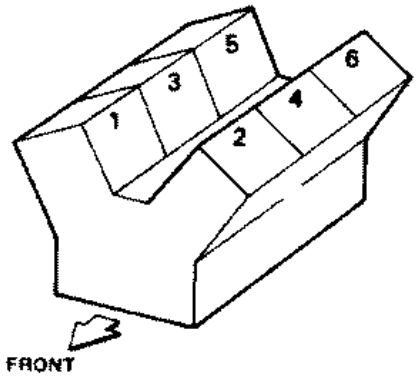


2. Install pilot bushing (M/T)/pilot converter (A/T).

General Specifications

Cylinder arrangement		V-6
Displacement	cm^3 (cu in)	2,960 (180.62)
Bore and stroke	mm (in)	87 × 83 (3.43 × 3.27)
Valve arrangement		D.O.H.C.
Firing order		1-2-3-4-5-6
Number of piston rings		
Compression		2
Oil		1
Number of main bearings		4
Compression ratio (Non-turbo/Turbo)		10.5/8.5

Cylinder number



SEM713A

COMPRESSION PRESSURE

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

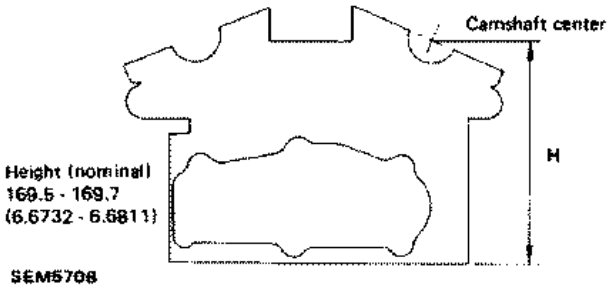
Compression pressure	
Standard	1,285 (12.85, 13.1, 186)
Minimum	981 (9.81, 10.0, 142)
Differential limit between cylinders	98 (0.98, 1.0, 14)

Inspection and Adjustment

CYLINDER HEAD

Unit: mm (in)

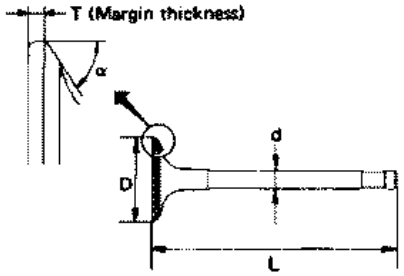
	Standard	Limit
Head surface distortion	Less than 0.05 (0.0020)	0.1 (0.004)



SEM570B

VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"	
Intake	34.0 - 34.2 (1.339 - 1.346)
Exhaust	29.5 - 29.7 (1.161 - 1.169)
Valve length "L"	
Intake	103.1 -103.3 (4.059 - 4.067)
Exhaust	103.6 - 103.8 (4.079 - 4.087)
Valve stem diameter "d"	
Intake	5.965 - 5.980 (0.2348 - 0.2354)
Exhaust	5.945 - 5.960 (0.2341 - 0.2346)
Valve seat angle "α"	
Intake	45°15' - 45°45'
Exhaust	
Valve margin "T"	
Intake	1.15 - 1.45 (0.0453 - 0.0571)
Exhaust	1.35 - 1.65 (0.0531 - 0.0650)
Valve margin "T" limit	More than 0.5 (0.020)
Valve stem end surface grinding limit	Less than 0.2 (0.008)
Valve clearance	
Intake	0 (0)
Exhaust	0 (0)

Valve spring

Free height	mm (in)		43.1 (1.697)
Pressure N (kg, lb) at height mm (in)		Standard	536.4 (54.7, 120.6) at 26.5 (1.043)
		Limit	452.79 (46.17, 101.80) at 26.5 (1.043)
Out-of square	mm (in)		Less than 1.8 (0.071)

Hydraulic valve lifter

Unit: mm (in)

Lifter outer diameter	30.955 - 30.965 (1.2187 - 1.2191)
Lifter guide inner diameter	31.000 - 31.020 (1.2205 - 1.2213)
Clearance between lifter and lifter guide	0.035 - 0.065 (0.0014 - 0.0026)

Valve guide

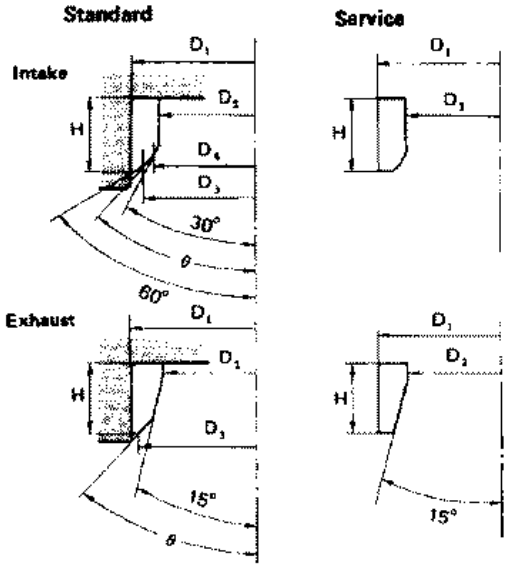
Unit: mm (in)

	Standard	Service
Valve guide Outer diameter	10.023 - 10.034 (0.3946 - 0.3950)	10.223 - 10.234 (0.4025 - 0.4029)
Valve guide Inner diameter (Finished size)	6.000 - 6.018 (0.2362 - 0.2369)	
Cylinder head valve guide hole diameter	9.975 - 9.996 (0.3927 - 0.3935)	10.175 - 10.196 (0.4006 - 0.4014)
Interference fit of valve guide	0.027 - 0.059 (0.0011 - 0.0023)	

	Standard	Max. tolerance
Stem to guide clearance Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.10 (0.0039)
Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	
Valve deflection limit	—	0.20 (0.0079)

Inspection and Adjustment (Cont'd)

VALVE SEAT



SEM529C

Unit: mm (in)

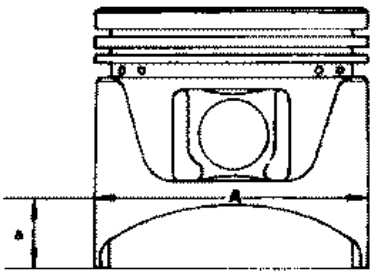
		Standard	Service*
Cylinder head seat recess diameter (D_c)	In.	36.000 - 36.016 (1.4173 - 1.4179)	36.500 - 36.516 (1.4370 - 1.4376)
	Ex.	31.500 - 31.516 (1.2402 - 1.2408)	32.000 - 32.016 (1.2598 - 1.2605)
Valve seat interference fit	In.	0.081 - 0.113 (0.0032 - 0.0044)	
	Ex.	0.054 - 0.096 (0.0025 - 0.0038)	
Valve seat outer diameter (D_1)	In.	36.097 - 36.113 (1.4211 - 1.4218)	36.597 - 36.613 (1.4408 - 1.4415)
	Ex.	31.580 - 31.596 (1.2433 - 1.2439)	32.080 - 32.096 (1.2630 - 1.2636)
Valve seat inner diameter (D_2)	In.	29.85 - 30.15 (1.1752 - 1.1870)	
	Ex.	24.35 - 24.65 (0.9587 - 0.9705)	
Height (H)	In.	5.9 - 6.0 (0.232 - 0.236)	5.35 - 5.45 (0.2106 - 0.2146)
	Ex.	5.9 - 6.0 (0.232 - 0.236)	5.9 - 6.0 (0.232 - 0.236)
Face angle (θ)	In.	45°	
	Ex.	45°	
Face inner diameter (D_4)	In.	31.5 (1.240)	*: Valve seat surface must be corrected to specified value.
Face outer diameter (D_3)	In.	33.6 - 33.8 (1.323 - 1.331)	
	Ex.	28.9 - 29.1 (1.138 - 1.146)	

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	86.975 - 86.985 (3.4242 - 3.4246)
Grade No. 2	86.985 - 86.995 (3.4246 - 3.4250)
Grade No. 3	86.995 - 87.005 (3.4250 - 3.4254)
0.25 (0.0098) oversize (Service)	87.225 - 87.275 (3.4340 - 3.4360)
0.50 (0.0197) oversize (Service)	87.475 - 87.525 (3.4439 - 3.4459)
"a" dimension	11.5 (0.453)
Piston pin hole diameter	21.987 - 21.999 (0.8656 - 0.8661)
Piston clearance to cylinder block	
Non-turbo	0.015 - 0.035 (0.0006 - 0.0014)
Turbo	0.025 - 0.045 (0.0010 - 0.0018)

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)	
End gap		
Top	0.21 - 0.40 (0.0083 - 0.0157)	1.0 (0.039)
2nd	0.50 - 0.76 (0.0197 - 0.0299)	
Oil (rail ring)	0.20 - 0.76 (0.0079 - 0.0299)	

Piston pin

Unit: mm (in)

Piston pin outer diameter	21.989 - 22.001 (0.8657 - 0.8662)
Interference fit of piston pin to piston	0 - 0.004 (0 - 0.0002)
Piston pin to connecting rod bushing clearance	0.005 - 0.017 (0.0002 - 0.0007)

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

CONNECTING ROD

Unit: mm (in)

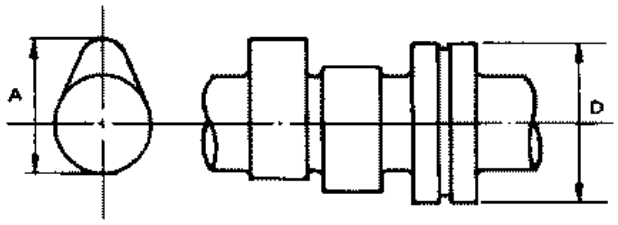
Center distance	154.1 - 154.2 (6.067 - 6.071)
Bend [per 100 (3.94)]	
Limit	0.15 (0.0059)
Torsion [per 100 (3.94)]	
Limit	0.3 (0.012)
Piston pin bushing inner diameter*	22.000 - 22.012 (0.8661 - 0.8666)
Connecting rod big end inner diameter	53.000 - 53.013 (2.0866 - 2.0871)
Side clearance	
Standard	0.20 - 0.35 (0.0079 - 0.0138)
Limit	0.40 (0.0157)

*After installing in connecting rod

Inspection and Adjustment (Cont'd)

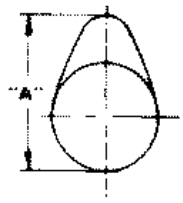
CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)



SEM568M

	Standard	Max. tolerance
Camshaft journal to bearing clearance	0.045 - 0.086 (0.0018 - 0.0034)	0.15 (0.0059)
Inner diameter of camshaft bearing	28.000 - 28.021 (1.1024 - 1.1032)	—
Outer diameter of camshaft journal	27.935 - 27.955 (1.0998 - 1.1006)	—
Camshaft runout [T.I.R.]*	Less than 0.04 (0.0016)	0.1 (0.004)
Camshaft end play	0.03 - 0.08 (0.0012 - 0.0031)	—

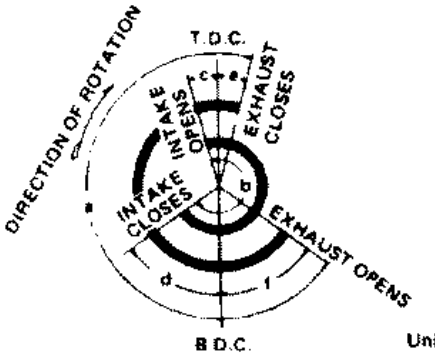


EM671

Cam height "A"	
Intake Exhaust	40.405 - 40.595 (1.5907 - 1.5982)
Wear limit of cam height	0.15 (0.0059)

*Total indicator reading

Valve timing



EM120

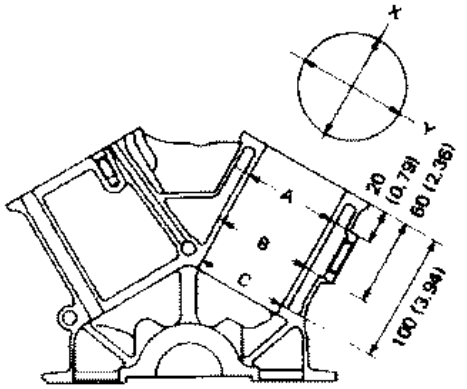
Unit: degree

Model	a	b	c	d	e	f
VG30DETT A/T	248	240	0	60	9	59
Others	248	248	−1	69	9	58

Inspection and Adjustment (Cont'd)

CYLINDER BLOCK

Unit: mm (in)



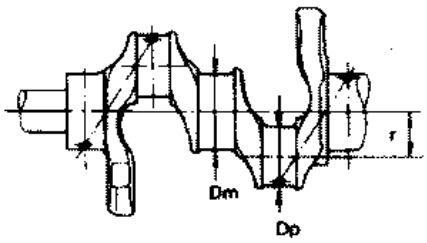
SEM321A

Surface flatness	
Standard	Less than 0.03 (0.0012)
Limit	0.10 (0.0039)
Cylinder bore	
Inner diameter	
Standard	
Grade No. 1	87.000 - 87.010 (3.4252 - 3.4256)
Grade No. 2	87.010 - 87.020 (3.4256 - 3.4260)
Grade No. 3	87.020 - 87.030 (3.4260 - 3.4264)
Wear limit	0.20 (0.0079)
Out-of-round (X – Y)	Less than 0.015 (0.0006)
Taper (A – B – C)	Less than 0.010 (0.0004)
Main journal inner diameter	
Grade No. 0	66.645 - 66.654 (2.6238 - 2.6242)
Grade No. 1	66.654 - 66.663 (2.6242 - 2.6245)
Grade No. 2	66.663 - 66.672 (2.6245 - 2.6249)
Difference in inner diameter between cylinders	
Standard	Less than 0.05 (0.0020)

CRANKSHAFT

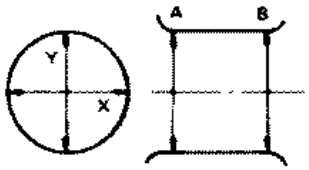
Unit: mm (in)

Main journal dia. "Dm"	
Grade No. 0	62.967 - 62.975 (2.4790 - 2.4793)
Grade No. 1	62.959 - 62.967 (2.4787 - 2.4790)
Grade No. 2	62.951 - 62.959 (2.4784 - 2.4787)
Pin journal dia. "Dp"	
Grade No. 0	49.968 - 49.974 (1.9672 - 1.9675)
Grade No. 1	49.962 - 49.968 (1.9670 - 1.9672)
Grade No. 2	49.955 - 49.962 (1.9667 - 1.9670)
Center distance "r"	41.47 - 41.53 (1.6327 - 1.6350)
Out-of-round (X – Y)	
Standard	Less than 0.005 (0.0002)
Taper (A – B)	
Standard	Less than 0.005 (0.0002)
Runout [T.I.R.]	
Standard	Less than 0.10 (0.0039)
Free end play	
Standard	0.05 - 0.18 (0.0020 - 0.0071)
Limit	0.30 (0.0118)



SEM845

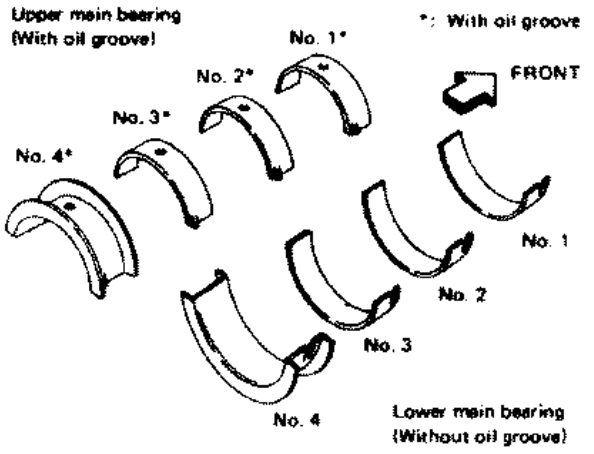
Out-of-round X – Y
Taper A – B



EM715

Inspection and Adjustment (Cont'd)

AVAILABLE MAIN BEARING



SEM327A

No. 1 main bearing

Grade number	Thickness "T" mm (in)	Width "W" mm (in)	Identification color
0	1.817 - 1.821 (0.0715 - 0.0717)		Black
1	1.821 - 1.825 (0.0717 - 0.0719)		Brown
2	1.825 - 1.829 (0.0719 - 0.0720)	22.4 - 22.6 (0.882 - 0.890)	Green
3	1.829 - 1.833 (0.0720 - 0.0722)		Yellow
4	1.833 - 1.837 (0.0722 - 0.0723)		Blue

No. 2 and 3 main bearing

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

No. 4 main bearing

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

Undersize

Unit: mm (in)

	Thickness	Main journal diameter "Dm"
0.25 (0.0098)	1.948 - 1.956 (0.0767 - 0.0770)	Grind so that bearing clearance is the specified value.

AVAILABLE CONNECTING ROD BEARING

Connecting rod bearing

Grade number	Thickness "T" mm (in)	Identification color
0	1.496 - 1.499 (0.0589 - 0.0590)	No paint
1	1.499 - 1.502 (0.0590 - 0.0591)	Brown
2	1.502 - 1.505 (0.0591 - 0.0593)	Green
3	1.505 - 1.508 (0.0593 - 0.0594)	Yellow

Undersize

Unit: mm (in)

	Thickness	Crank pin journal diameter "Dp"
0.08 (0.0031)	1.540 - 1.548 (0.0606 - 0.0609)	Grind so that bearing clearance is the specified value.
0.12 (0.0047)	1.560 - 1.568 (0.0614 - 0.0617)	
0.25 (0.0098)	1.625 - 1.633 (0.0640 - 0.0643)	

Inspection and Adjustment (Cont'd)

TURBOCHARGER

Unit: mm (in)

Rotor shaft	
Runout [T.I.R.]*	0.056 - 0.127 (0.0022 - 0.0050)
End play	0.013 - 0.096 (0.0005 - 0.0038)

*Total indicator reading

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Flywheel	
Runout [T.I.R.]*	Less than 0.15 (0.0059)

*Total indicator reading

Bearing clearance

Unit: mm (in)

Main bearing clearance	
Standard	0.028 - 0.055 (0.0011 - 0.0022)
Limit	0.090 (0.0035)
Connecting rod bearing clearance	
Standard	0.028 - 0.048 (0.0011 - 0.0019)
Limit	0.090 (0.0035)