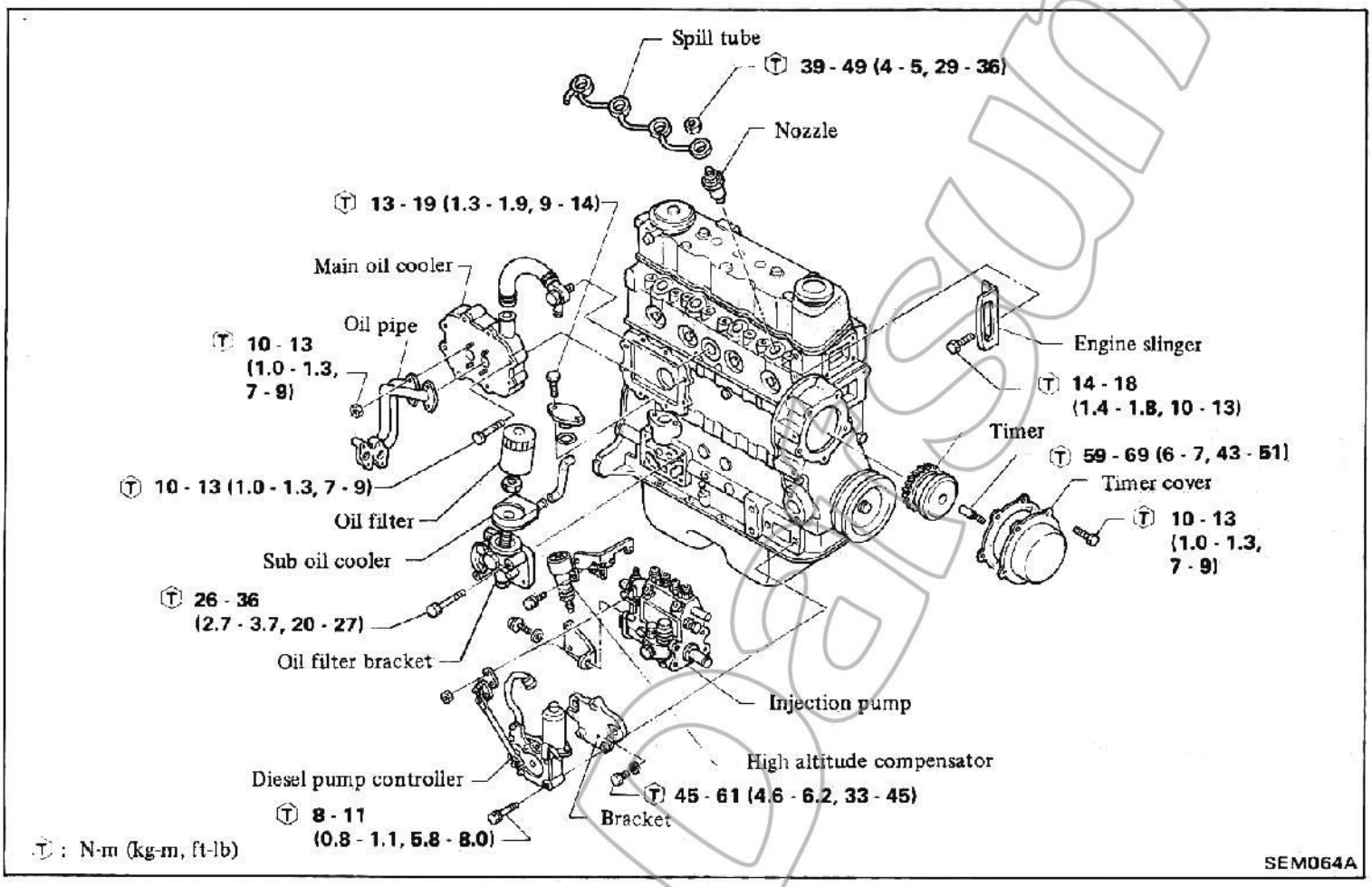
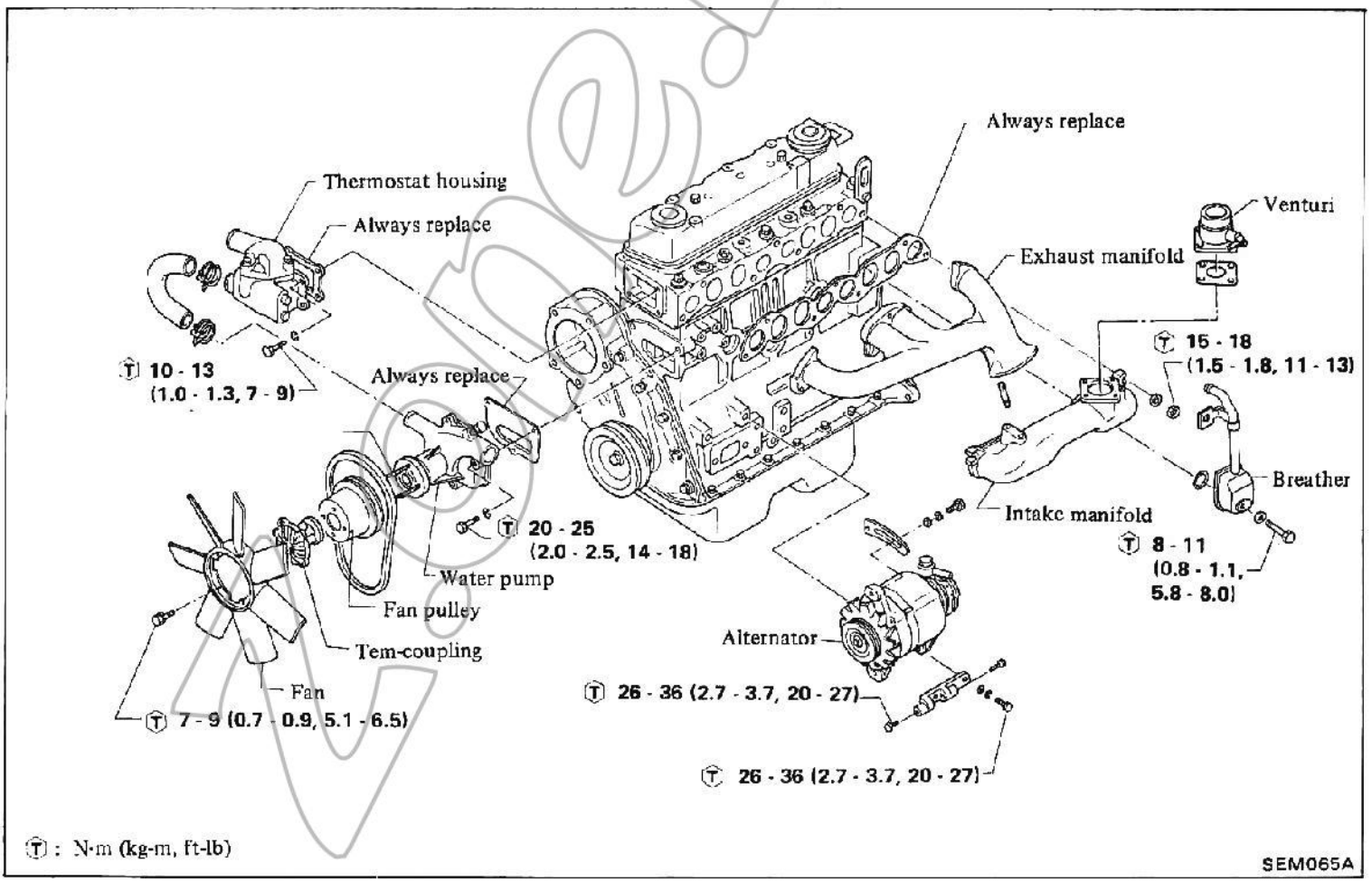
ENGINE MECHANICAL

SECTION EM

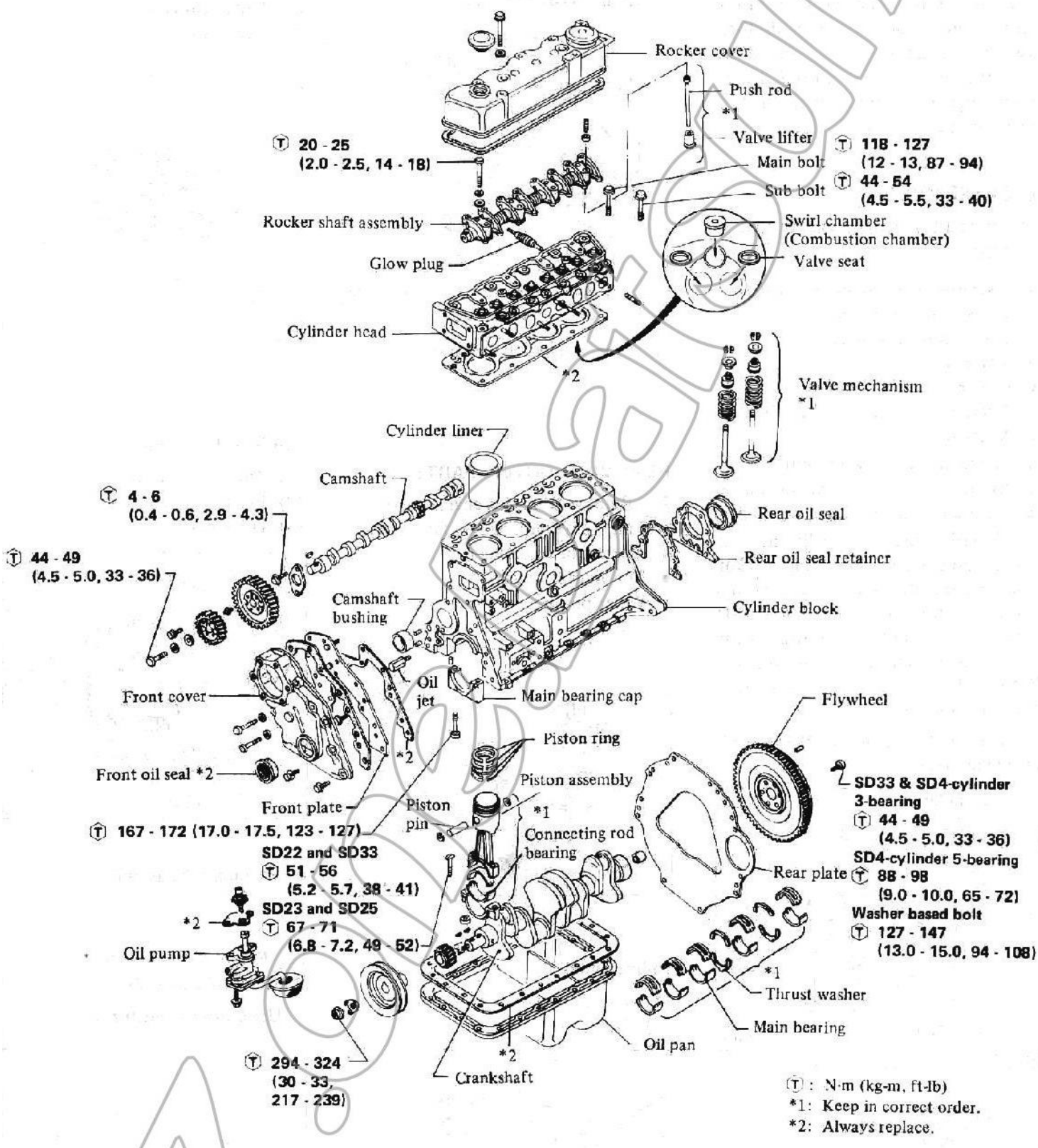
CONTENTS

ENGINE COMPONENTS (Outer parts)





ENGINE COMPONENTS (Internal parts)



SEM048A

ENGINE DISASSEMBLY

PRECAUTIONS

Arrange the disassembled parts on the parts stand in accordance with their assembled locations, sequence, etc., so that the parts will be reassembled in their original locations. Place mating marks on the parts if necessary.

DISASSEMBLY

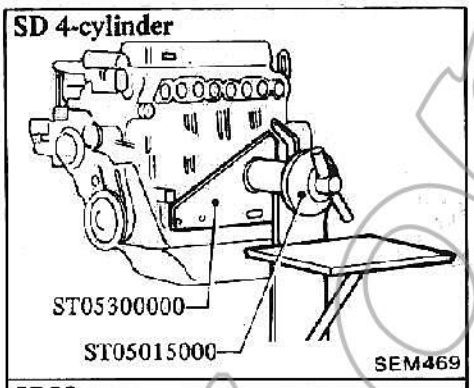
MOUNTING ENGINE ON WORK STAND

1. Remove rear and left side parts.
- Transmission assembly
- Clutch cover assembly
- Starter motor
- Engine mounting bracket
- Alternator assembly and fan belt
- Alternator bracket
- Intake manifold with venturi
- Exhaust manifold & engine slinger
- Breather assembly (SD 4-cylinder)

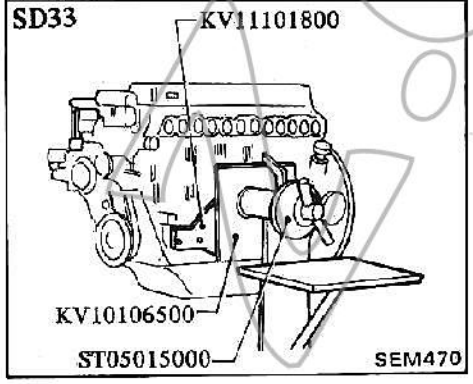
2. Install engine attachment on engine, using engine mounting bracket holes, air breather mounting hole and starter motor mounting holes (SD 4-cylinder). Install engine attachment on engine, using mounting bracket holes and cylinder block water drain cock hole (SD33).

3. Place both engine and attachment on engine stand.

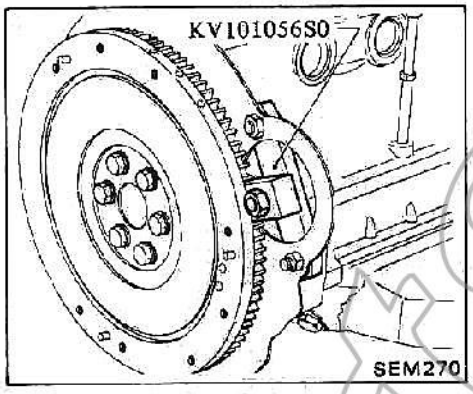
SD 4-cylinder



SD33



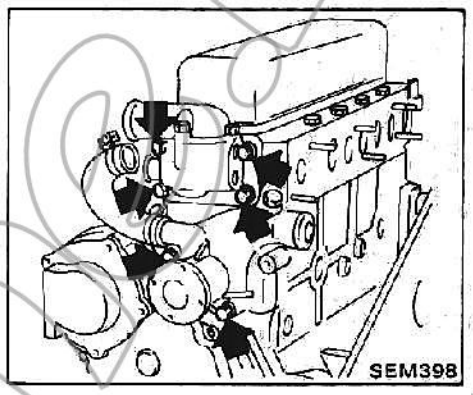
4. Install Tool to prevent crankshaft rotation (SD 4-cylinder).



5. Drain engine oil and coolant.

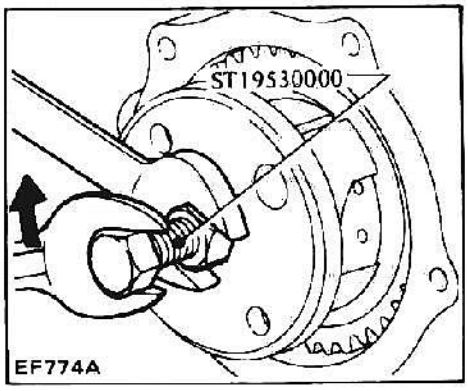
REMOVING OUTER PARTS

1. Remove front side engine parts.
- Fan, Tem-coupling and fan pulley
- Alternator adjusting bar
- Thermostat housing
- Water pump



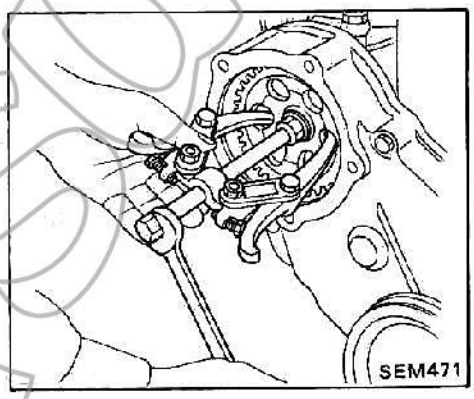
In-line pump

(1) Timer cover
(2) Timer



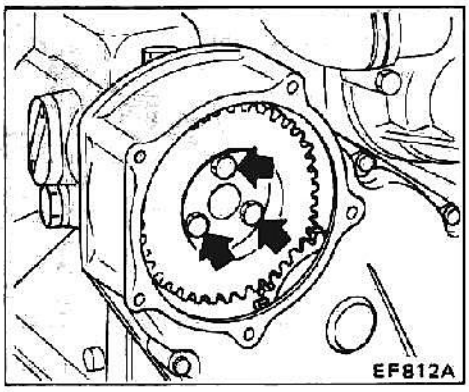
VE pump

(1) Drive gear cover
(2) Drive gear



C.A.V.-D.P.A. pump

(1) Timing gear cover
(2) Feed pump camshaft
(3) Drive gear

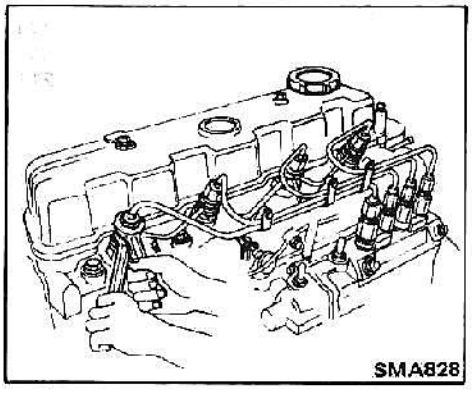


- Vacuum tube assembly

2. Remove right side parts.

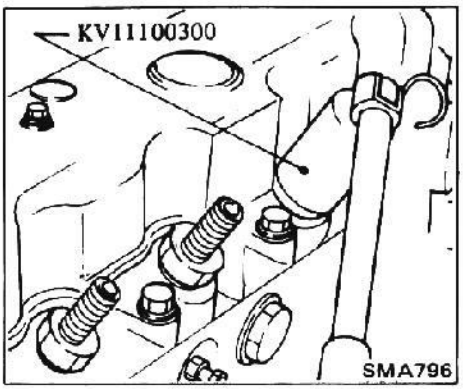
(1) Fuel tube assembly

Use double wrench action.



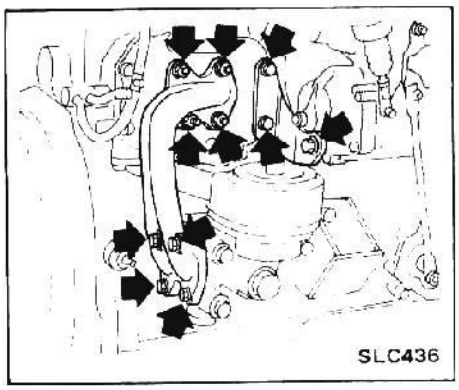
(2) Spill tube
(3) Injection nozzles
(4) Nozzle washers

Plug nozzle holes to prevent entry of dust and dirt.

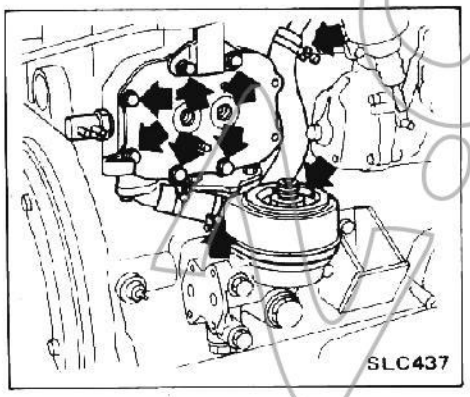


(5) Oil cooler
(a) SD 4-cylinder

- Oil filter using Tool.
- Remove injection pump rear bracket (if equipped) and oil pipe.



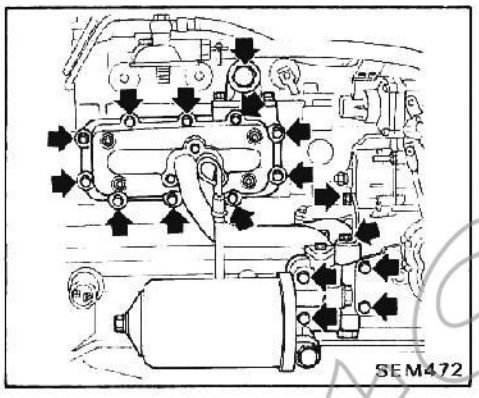
- Remove main and sub oil cooler (if equipped) assembly.



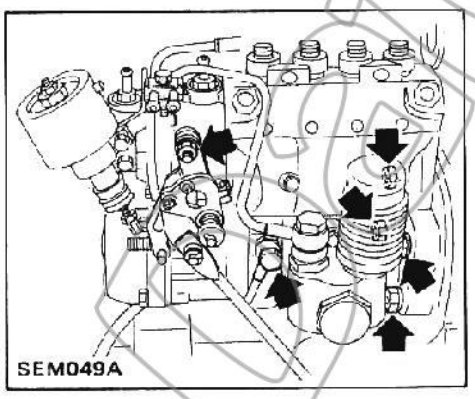
- Remove oil filter bracket.

(b) SD33

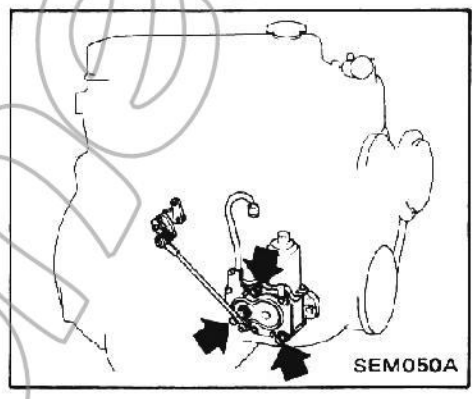
- Fuel filter using Tool
- Oil cooler and oil filter bracket with oil filter



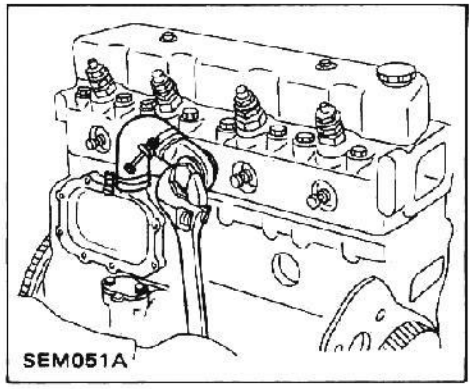
(6) Injection pump assembly



(7) Diesel pump controller assembly (In-line type only)

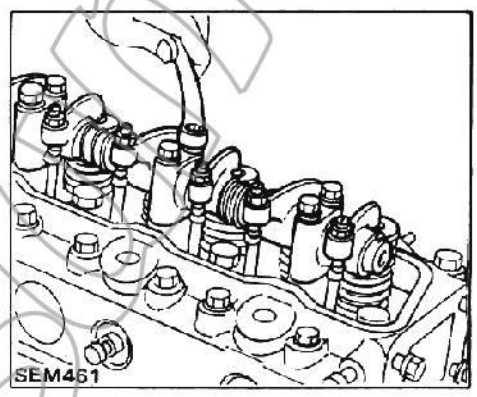


(8) Glow plug harness and oil cooler hose.

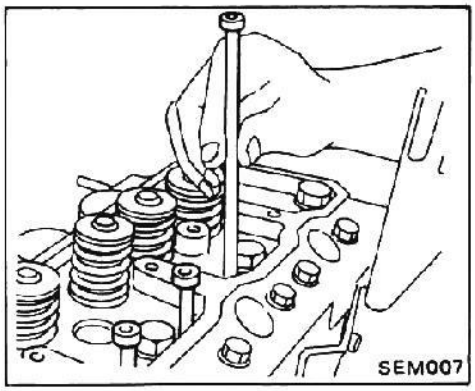


REMOVING INTERNAL PARTS

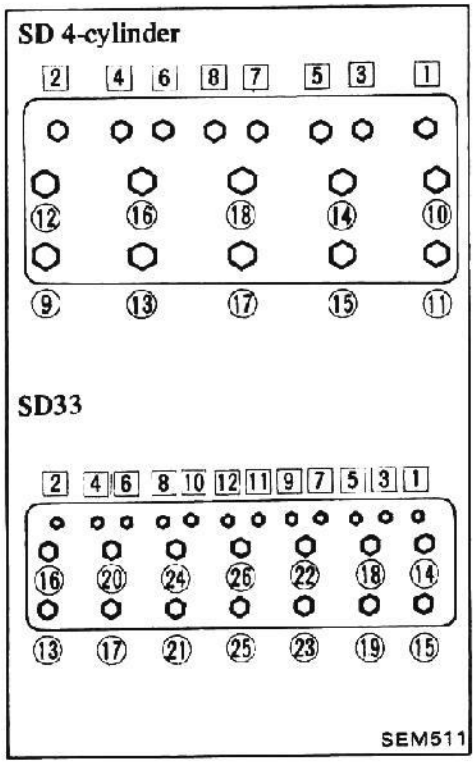
1. Remove rocker cover.
2. Remove rocker shaft assembly.



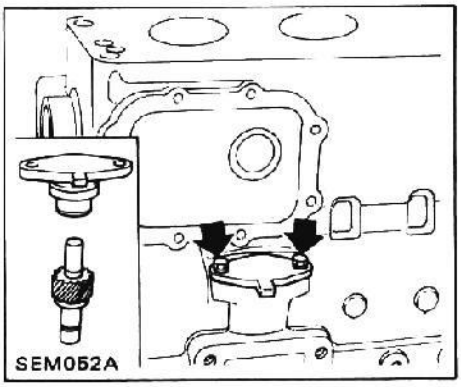
3. Remove push rods and keep them in correct order.



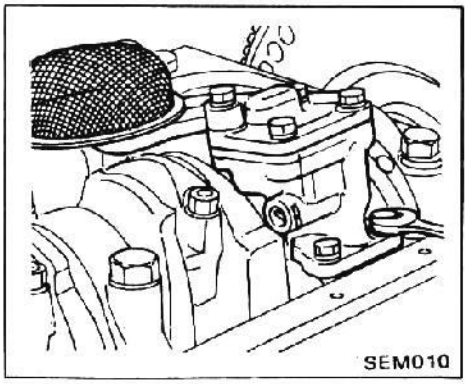
4. Remove cylinder head bolts in the sequence shown below and then remove cylinder head assembly and cylinder head gasket assembly.



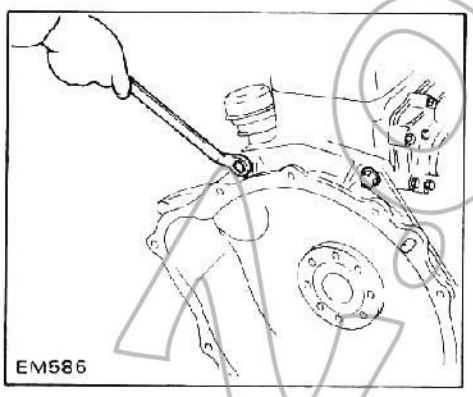
5. Remove oil pump.
(1) Remove spindle support and drive spindle.



(2) Remove oil pan.
(3) Remove oil pump assembly.

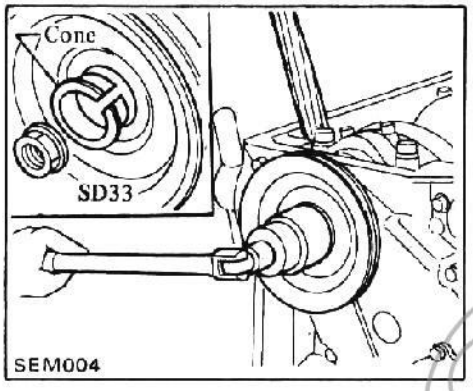


6. Remove flywheel.
(1) Straighten lock plates (if equipped).
(2) Place a wooden block between cylinder block and flywheel to prevent crankshaft from turning (SD33).
(3) Remove flywheel.
(4) Remove flywheel housing (SD33).



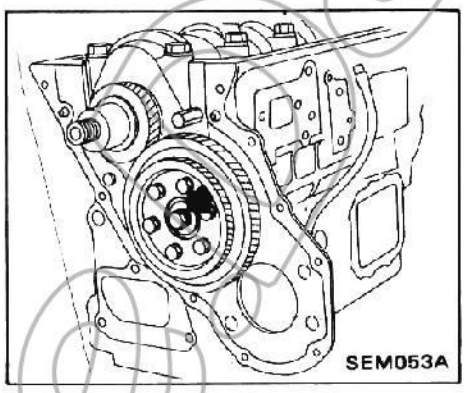
WARNING:
When removing flywheel, be careful not to drop it.

7. Crank pulley

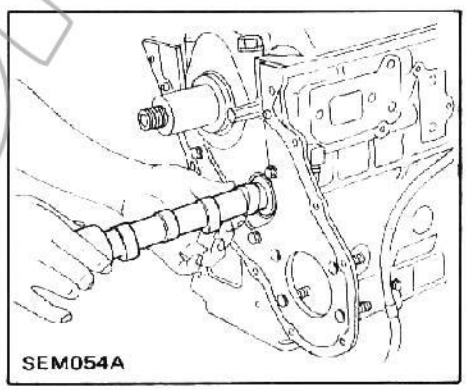


If it is difficult to remove cone, tap evenly around the periphery of the crankshaft pulley (with a brass rod and hammer), causing the cone to protrude beyond the pulley (SD33).

8. Remove front cover.
9. Remove camshaft gear.

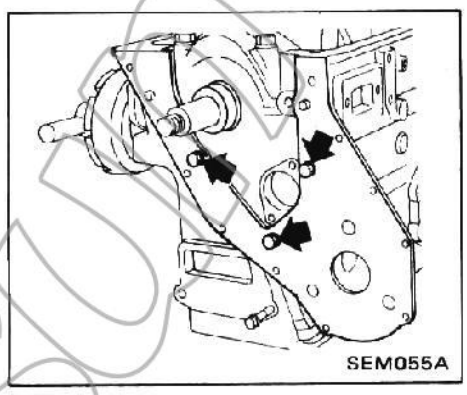


10. Remove camshaft.
(1) Remove camshaft locating plate.
(2) Bring crankshaft to upper side as shown below and remove camshaft.

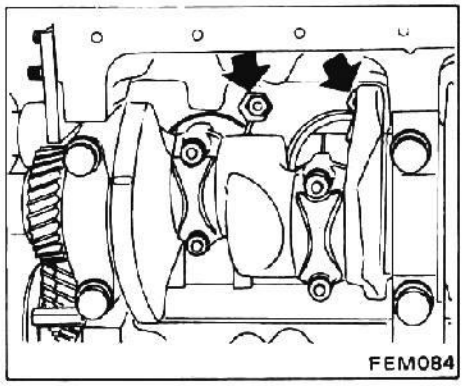


11. Remove valve lifters and **keep them in correct order.**
12. Remove crankshaft gear.
If it is difficult to extract crankshaft gear, use a suitable puller.

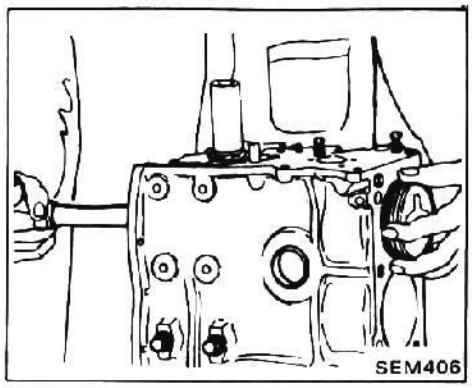
13. Remove front plate.



14. Remove oil jet bolts and then remove oil jet.

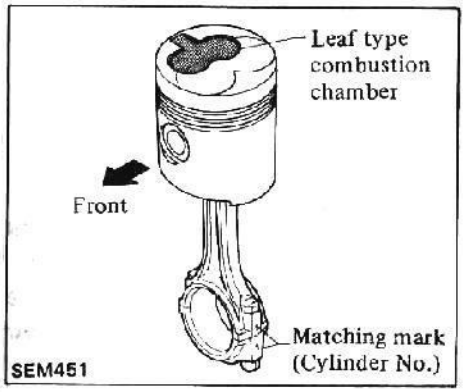


15. Pistons and connecting rod assembly
(1) Remove connecting rod caps and connecting rod bearings.
(2) Take pistons and connecting rods out of cylinder head side.



a. Piston can be easily removed by scraping carbon off top face of cylinder with a scraper.

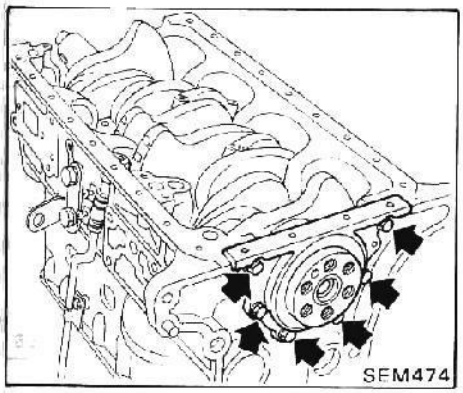
b. Numbers are stamped on connecting rod and cap corresponding to each cylinder. Care should be taken to avoid a wrong combination including bearing.



16. Crankshaft

(1) 5 bearings (SD 4-cylinder)

a) Remove rear oil seal assembly.



b) Remove main bearing cap with bearing.

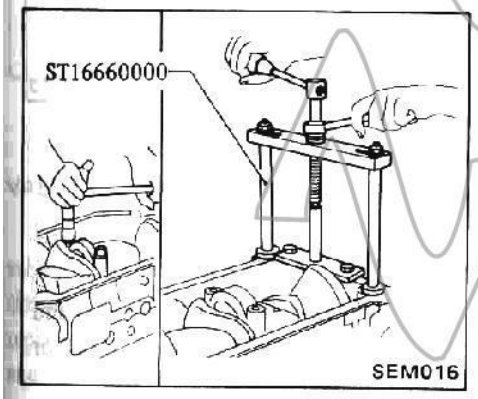
c) Remove crankshaft and main bearings.

Keep main bearing in correct order.

(2) 3 bearings (SD22) & 4 bearings (SD33).

a) Remove main bearing cap with bearing.

Remove rear main bearing cap with Tool.



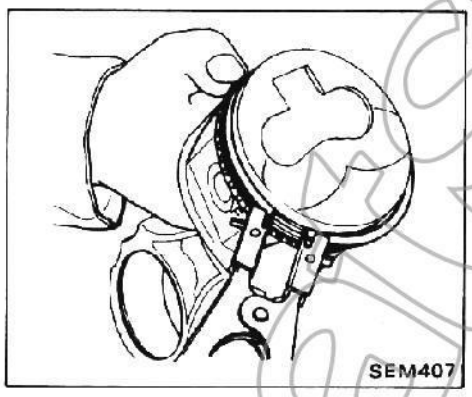
b) Remove crankshaft and main bearings.

Keep main bearing in correct order.

c) Remove oil seal from crankshaft and rear main cap.

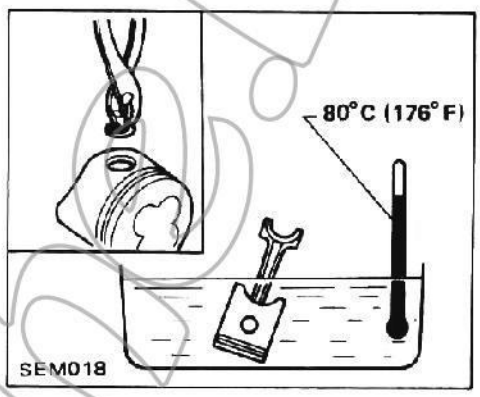
DISASSEMBLING PISTON AND CONNECTING ROD

1. Remove piston ring with a ring remover.



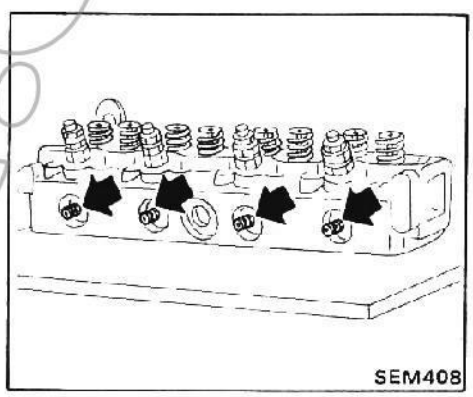
When removing piston rings, be careful not to scratch piston.

2. Remove piston snap rings, and immerse piston in oil of 80°C (176°F), and push out piston pin.

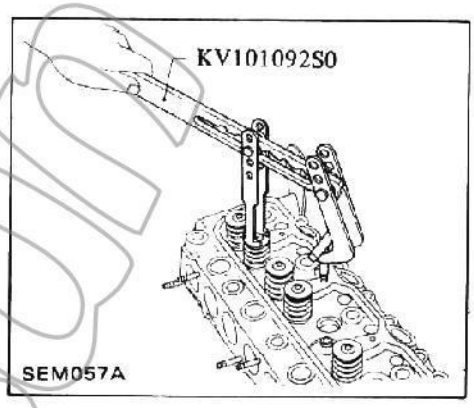


DISASSEMBLING CYLINDER HEAD

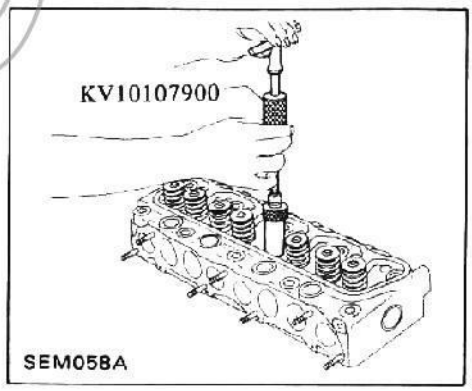
1. Remove glow plugs.



2. Remove valves, valve springs and relating parts using Tool.



3. Remove valve stem seals.



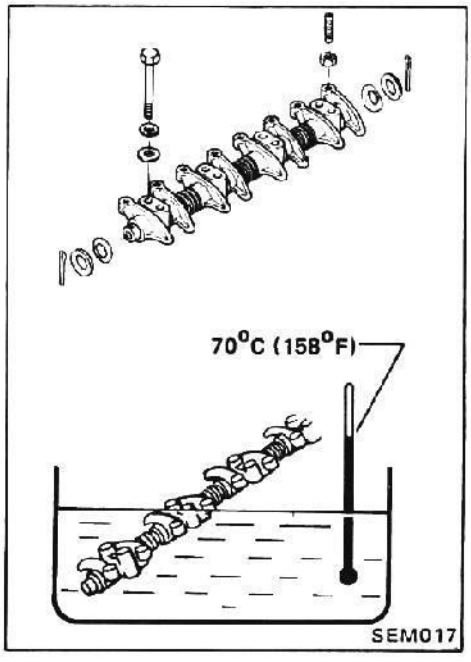
Keep valve spring and valves in correct order.

DISASSEMBLING ROCKER SHAFT

1. Remove cotter pin, washer and outer spring.

2. Remove valve rocker and rocker shaft bracket.

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



INSPECTION AND REPAIR

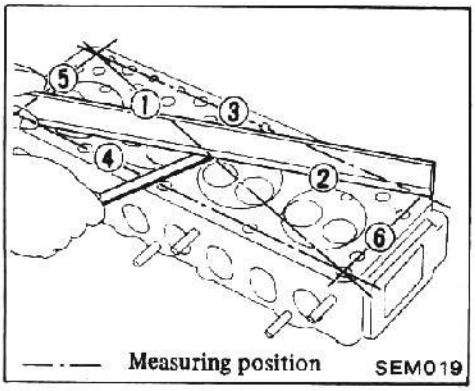
Clean all removed parts in cleaning oil, eliminating obstacles or dust/dirt from passages or holes. Also check these parts to make sure they are free from cracks or flaws.

CYLINDER HEAD AND VALVE

CHECKING CYLINDER HEAD MATING FACE

Measure the surface of cylinder head (on cylinder block side) for warpage.

Warpage of surface:
Less than
0.2 mm (0.008 in)



If beyond the specified limit, correct with a surface grinder.

Cylinder head height should be greater than 89.7 mm (3.531 in) after surface has been ground.

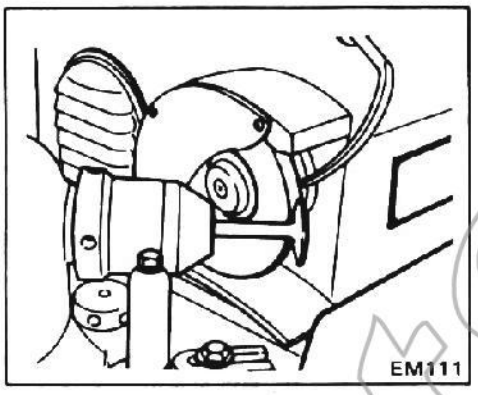
VALVE

1. Check each of the intake and exhaust valve for worn, damaged or deformed valve stems. Correct or replace the valve that is faulty.

For standard size of valve, refer to S.D.S.

2. Valve face or valve stem end surface should be refaced by using a valve grinder.

Valve face angle:
45° - 45°30'



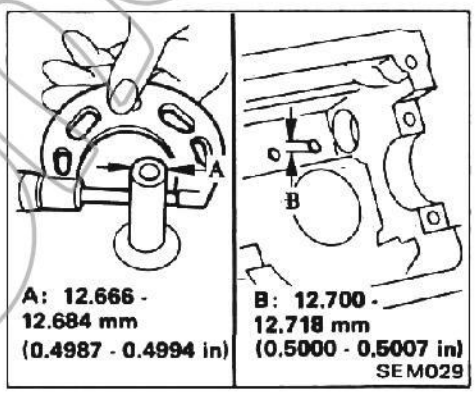
VALVE LIFTER AND PUSH ROD

Valve lifter

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

a. Valve lifter end should be smooth.
b. Valve lifter to lifter hole clearance:

Standard
0.016 - 0.052 mm
(0.0006 - 0.0020 in)
Limit
Less than
0.10 mm (0.0039 in)



Push rod

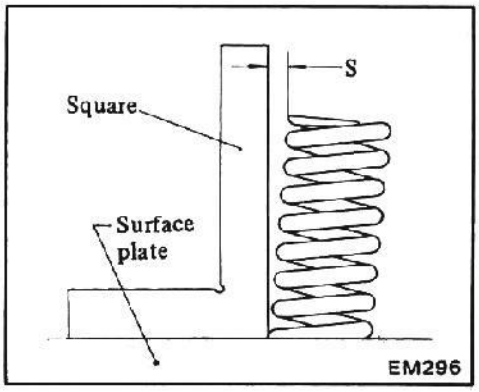
1. Inspect push rod for excessive wear on the face.
2. Replace if worn or damaged beyond repair.
3. Check push rod for bend using a dial gauge.

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

VALVE SPRING

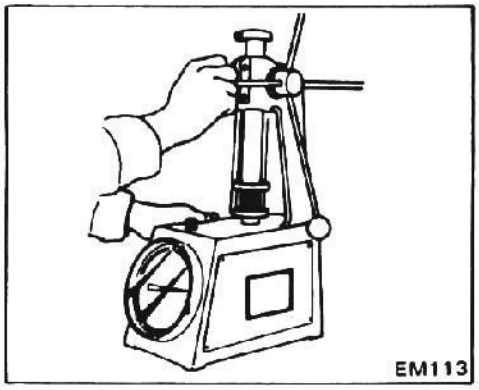
1. Check valve spring for squareness using a steel square and surface plate. If spring is out of square "S" more than specified limit, replace with new ones.

Out of square ("S"):
Less than
1.3 mm (0.051 in)



2. Measure free length and tension of spring. If measured value exceeds specified limit, replace spring.

Refer to S.D.S.

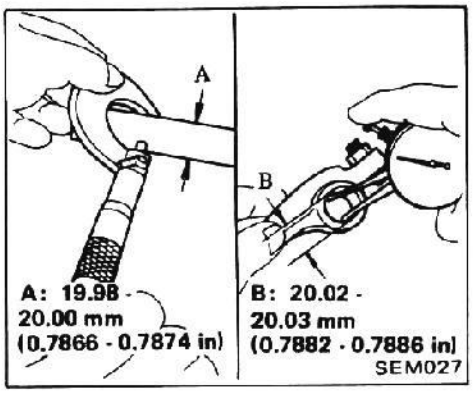


VALVE ROCKER ASSEMBLY

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

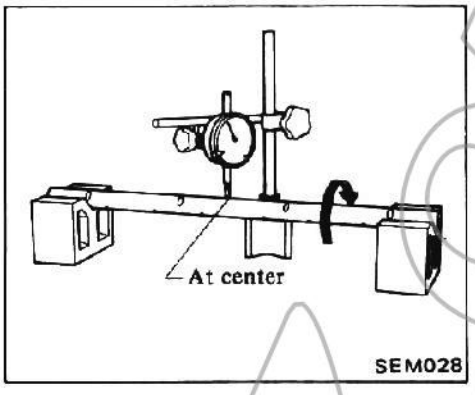
2. Check clearance between valve rockers and rocker shaft. If specified clearance is exceeded, replace affected valve rockers or shafts.

Specified clearance:
Standard
0.02 - 0.05 mm
(0.0008 - 0.0020 in)
Limit
Less than
0.15 mm (0.0059 in)



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

Rocker shaft bend
(Total indicator reading):
Standard
0 - 0.1 mm (0 - 0.004 in)
Limit
Less than
0.3 mm (0.012 in)

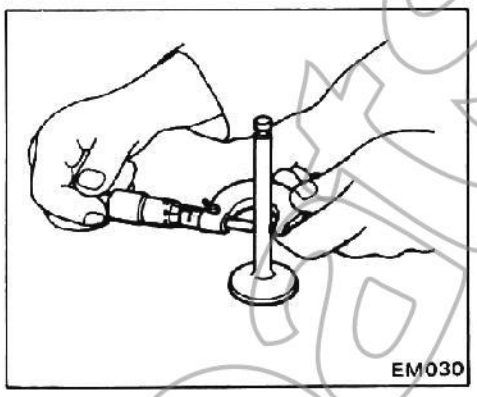


VALVE GUIDE (SD23 and SD25)

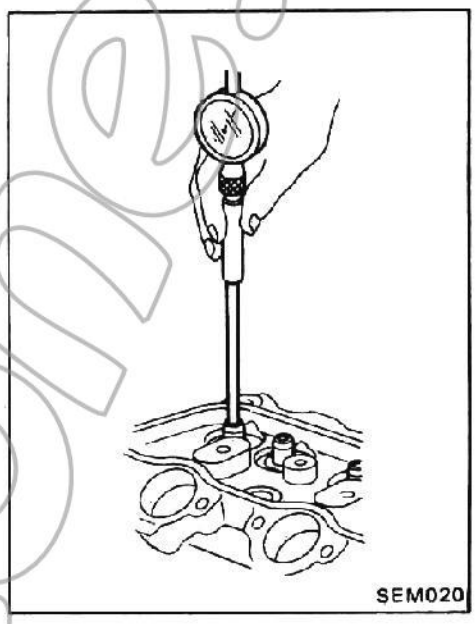
Measure the clearance between valve guide and valve stem. If the clearance exceeds the specified limit, replace the worn parts or both valve and valve guide. In this case, it is essential to determine if such a clearance has been caused by a worn or bend valve stem or by a worn valve guide.

Determining clearance

1. Precise method
(1) Measure diameter of valve stem in three places: top, center, and bottom.
Refer to S.D.S.



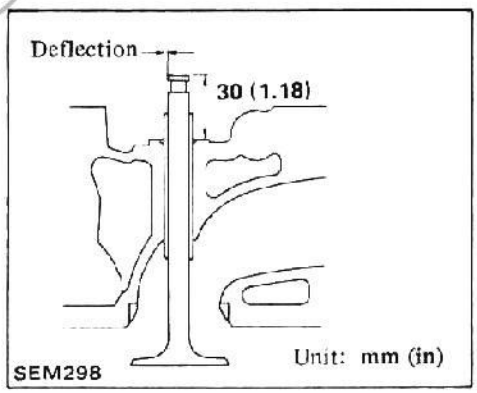
(2) Measure valve guide bore at center using telescope hole gauge.
(3) Subtract the highest reading of valve stem diameter from valve guide bore to obtain the stem to guide clearance.



Stem to guide clearance:
Standard
Intake
0.015 - 0.045 mm
(0.0006 - 0.0018 in)
Exhaust
0.04 - 0.07 mm
(0.0016 - 0.0028 in)
Max. tolerance
Intake
Less than
0.15 mm (0.0059 in)
Exhaust
Less than
0.20 mm (0.0079 in)

2. Expedient method
Pry the valve in a lateral direction, and measure the deflection at stem tip with dial gauge.

Stem to guide clearance is 1/2 of measured value.

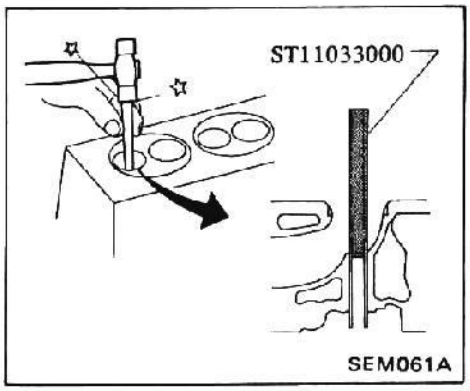


Valve should be moved in parallel with rocker arm. (Generally, a large amount of wear occurs in this direction.)

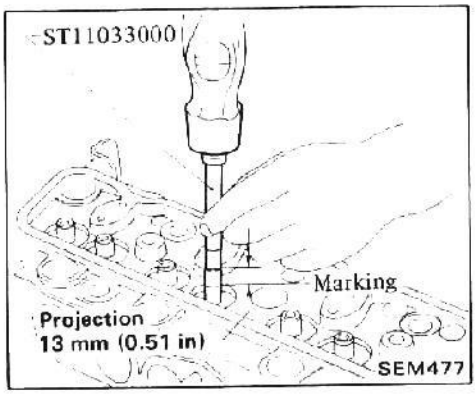
Replacement of valve guide

To remove old guides, use a press (under a 2-ton pressure) or a hammer, and Tool.
1. Drive them out toward rocker cover side using Tool.

Heating the cylinder head will facilitate the operation.



2. Install new guide onto cylinder head until the guide projects out 13 mm (0.51 in).



3. Ream the bore using Tool ST11032000.

Reaming bore:
8.000 - 8.015 mm
(0.3150 - 0.3156 in)

VALVE STEM HOLE (SD22 and SD33)
(Cylinder head)

Measure clearance between valve stem hole (cylinder head) and valve stem. If clearance exceeds specified limit, replace worn parts.

Determining clearance

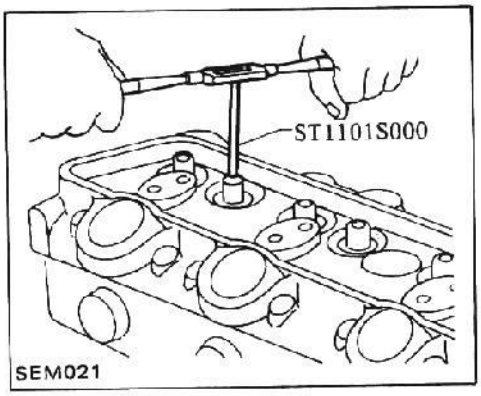
Refer to Valve Guide for determining clearance check method.

1. If valve stem clearance exceeds limit, grind valve stem hole and use oversize intake and exhaust valves.

Select oversize valve stem so that clearance between valve stem hole and stem is less than 0.15 mm (0.0059 in) at intake side and less than 0.20 mm (0.0079 in) at exhaust side.

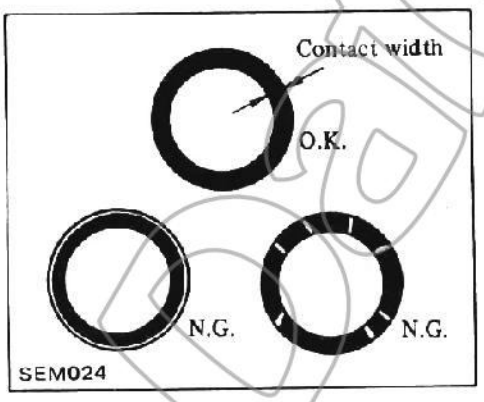
Unit: mm (in)

Grinding valve stem hole diameter	Diameter of oversize valve stem to be used
8.200 - 8.215 (0.3228 - 0.3234)	8.2 (0.323)
8.400 - 8.415 (0.3307 - 0.3313)	8.4 (0.331)



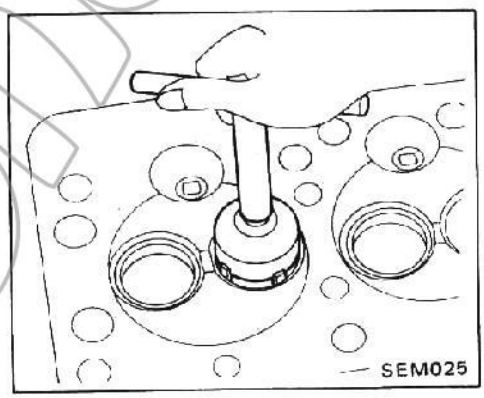
VALVE SEAT INSERTS

1. Check contact width and state of contact between valve and valve seat.



2. Reface valve seat with valve seat cutter.

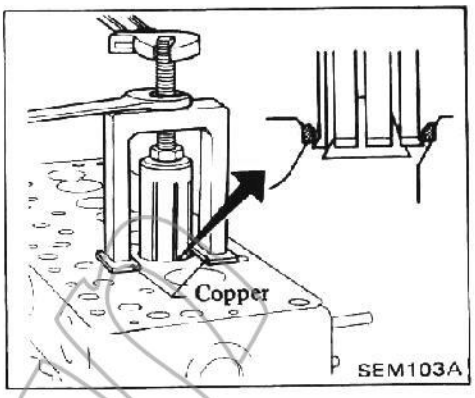
Valve seat surface:
Refer to S.D.S.



Valve seat insert replacement

1. Remove valve seats with Tool.

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



2. Install new valve seats.

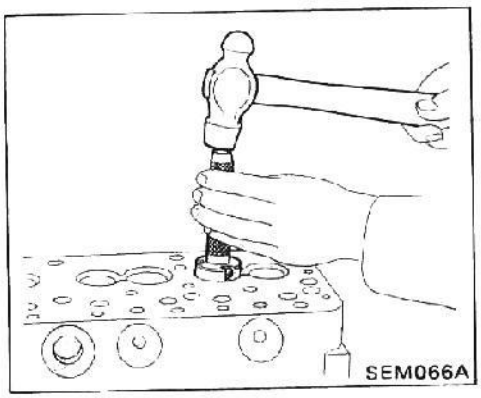
a. Eliminate the old staked lugs (Exhaust side).

b. Oversize exhaust valve seats are available as 0.2 and 0.4 mm (0.008 and 0.016 in).

(1) Place new valve seats dry ice and allow it to cool for five minutes.

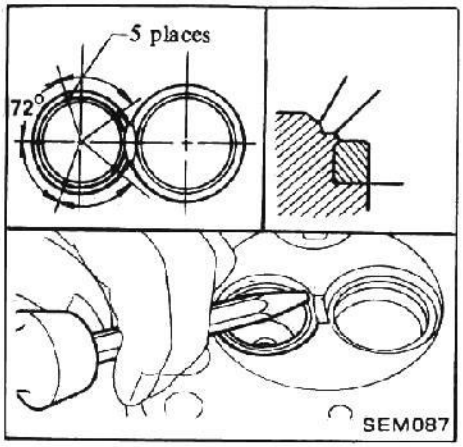
WARNING:
Do not touch cooled valve seats with bare hand.

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



(4) Stake exhaust valve seat at five places with punch.

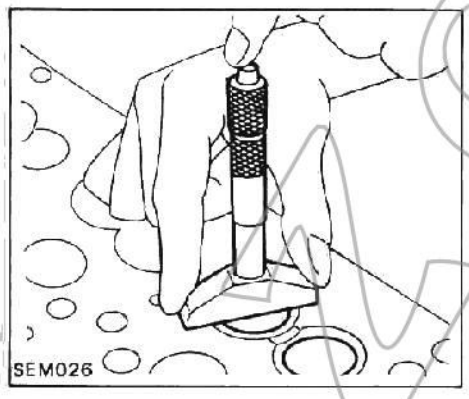
When staking valve seat, select different places than those staked before.



MEASURING CYLINDER HEAD-TO-VALVE DISTANCE

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

Specified distance:
Standard
Intake
0.275 - 0.675 mm
(0.0108 - 0.0266 in)
Exhaust
0.305 - 0.695 mm
(0.0120 - 0.0274 in)
Limit
Less than
1.25 mm (0.0492 in)
for intake and exhaust valves



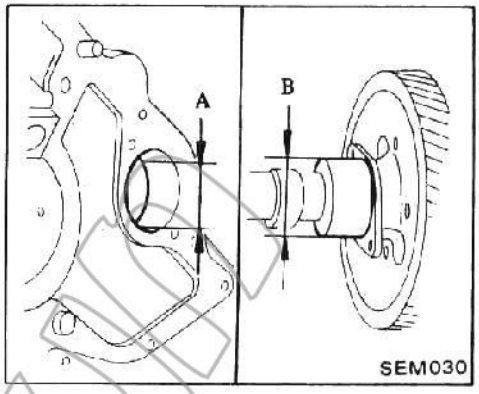
CAMSHAFT AND CAMSHAFT BUSHING

CAMSHAFT BUSHING CLEARANCE

Measure inside diameter of camshaft bushing with an inside dial gauge and outside diameter of camshaft journal with a micrometer.

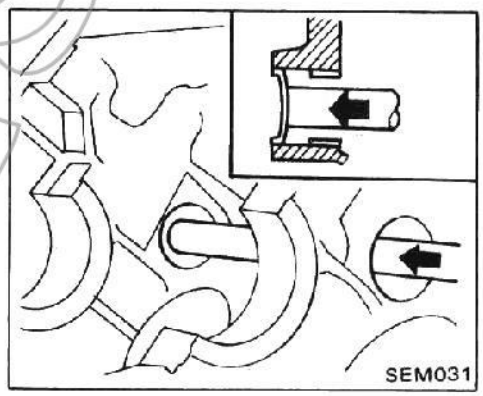
Clearance between camshaft and bushing (A–B):
Standard
Front
0.024 - 0.102 mm
(0.0009 - 0.0040 in)
Center (SD 4-cylinder), Nos. 2 and 3 (SD33)
0.037 - 0.115 mm
(0.0015 - 0.0045 in)
Rear
0.024 - 0.102 mm
(0.0009 - 0.0040 in)
Limit
Less than
0.15 mm (0.0059 in)

Camshaft bushing undersize:
0.25 mm (0.0098 in),
0.50 mm (0.0197 in),
0.75 mm (0.0295 in)



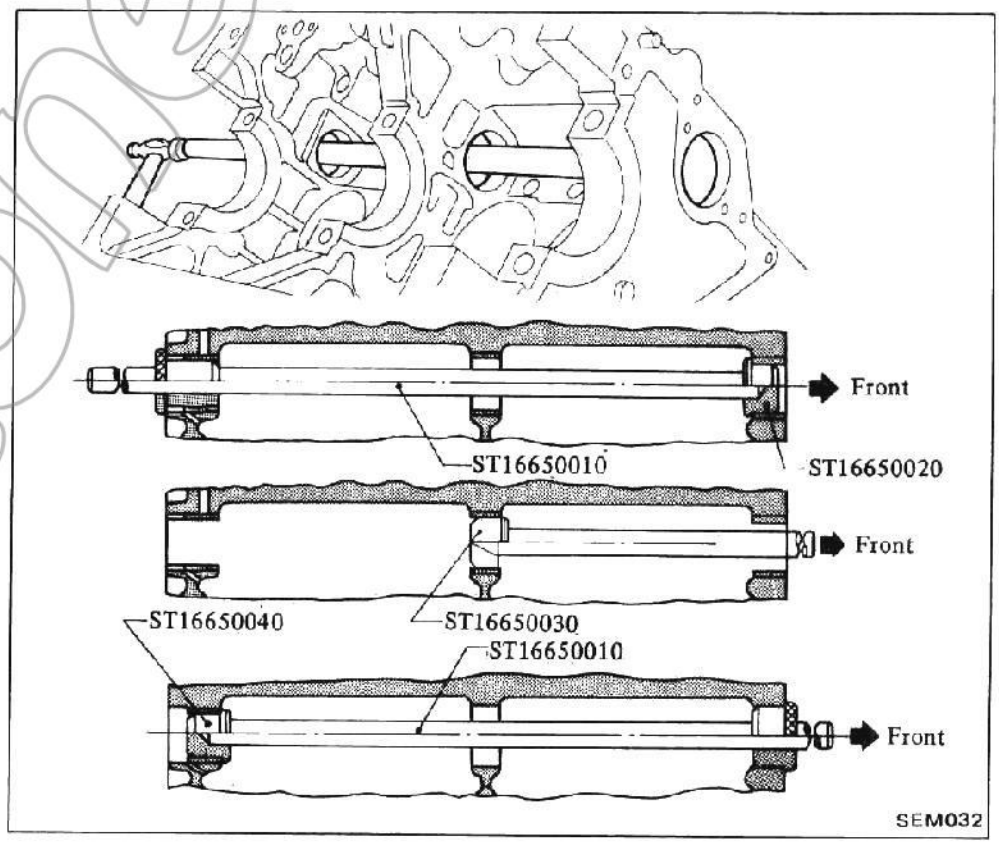
REPLACING CAMSHAFT BUSHING

1. Remove rear plug.



2. Remove camshaft bushing with Tool.

Remove bushing from front side of engine.

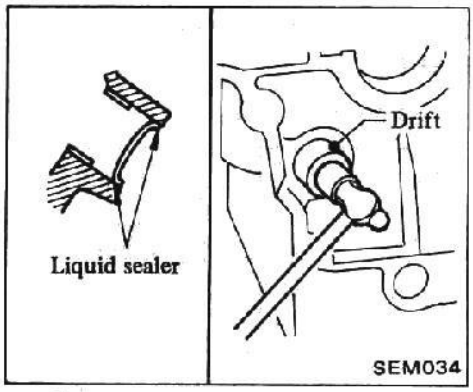


3. Install new bushing with Tool, following in the reverse order of removal.

a. Align cylinder block oil passage hole and bushing oil hole.
b. Install bushing with beveled end facing front.

4. Check camshaft bushing clearance.
5. Install new rear plug with a drift.

Apply liquid sealer.

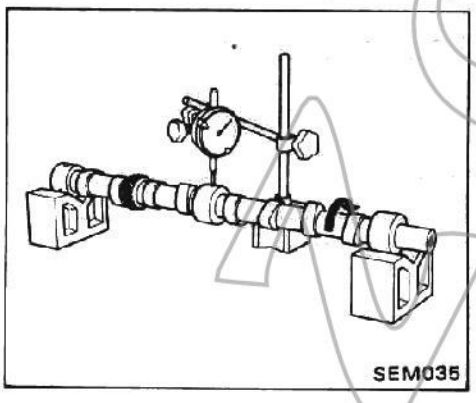


CAMSHAFT ALIGNMENT

1. Check camshaft journal and cam surface for bend, wear or damage.
If fault is beyond limit, replace.
2. Check camshaft bend **at center journal.**

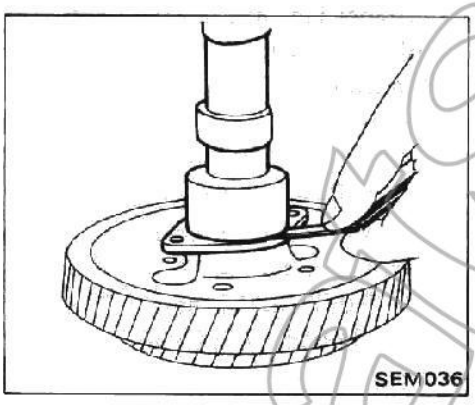
If bend is greater than specified limit, repair or replace camshaft.

Camshaft bend
(Total indicator reading):
Standard
0 - 0.03 mm (0 - 0.0012 in)
Limit
Less than 0.06 mm (0.0024 in)



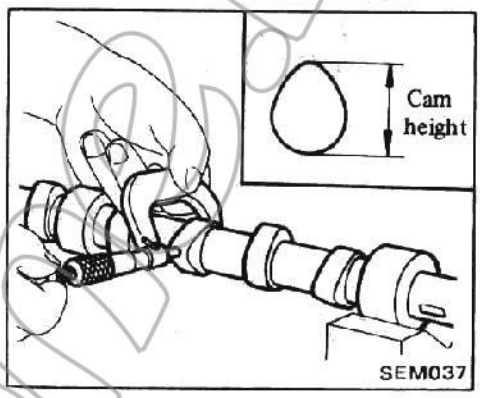
3. Measure camshaft end play between locating plate and gear. If beyond the specified limit, replace camshaft locating plate.

Camshaft end play:
Standard
0.08 - 0.28 mm
(0.0031 - 0.0110 in)
Limit
Less than 0.5 mm (0.020 in)



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

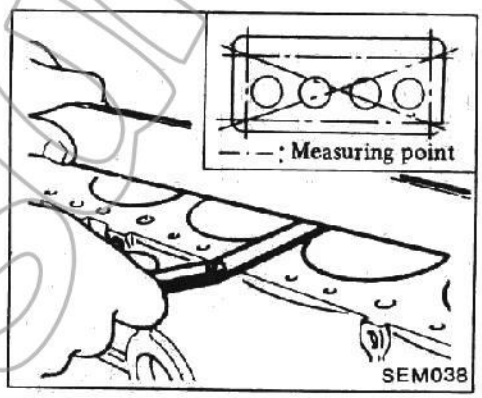
Cam height limit:
36.8 mm (1.449 in)



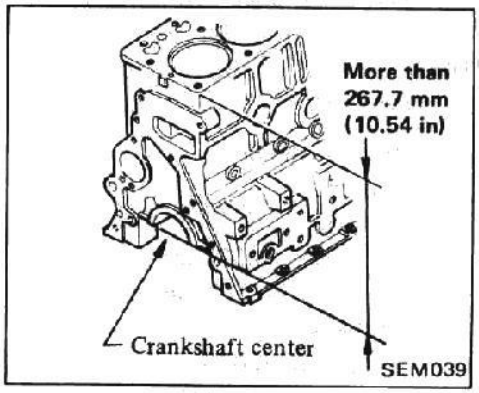
CYLINDER BLOCK

1. Check cylinder block for cracks or flaws.
2. Check cylinder block warpage with cylinder liner removed. If beyond the limit, correct with a surface grinder.

Warpage of cylinder block surface (Without cylinder liner):
Longitudinal
Less than 0.10 mm (0.0039 in)
Transverse direction
Less than 0.02 mm (0.0008 in)



Surface grinding limit:
Height from upper face of cylinder block to crankshaft centerline should be greater than specified limit.



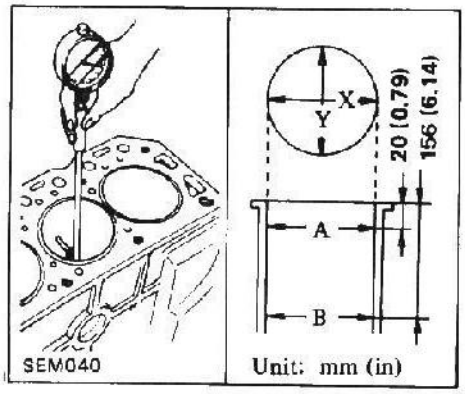
CYLINDER LINER

1. Check cylinder liner wear by means of bore diameter.

Cylinder liner bore wear limit:
Less than 0.3 mm (0.012 in)
Bore standard:
SD22 and SD33
82.995 - 83.025 mm
(3.2675 - 3.2687 in)
SD23 and SD25
89.000 - 89.035 mm
(3.5039 - 3.5053 in)

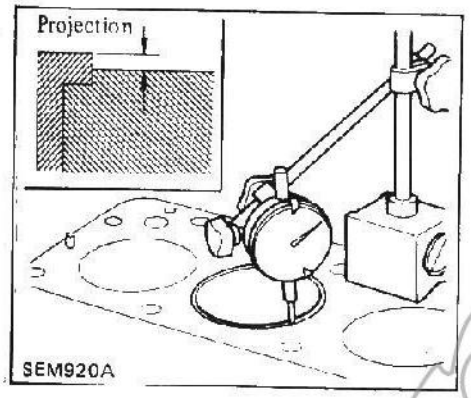
2. Measure cylinder liner bore for out-of-round and taper with a bore gauge. If beyond the limit, replace cylinder liner.

Out-of-round (X–Y):
Standard
0.02 mm (0.0008 in)
Taper (A–B):
Standard
0.02 mm (0.0008 in)



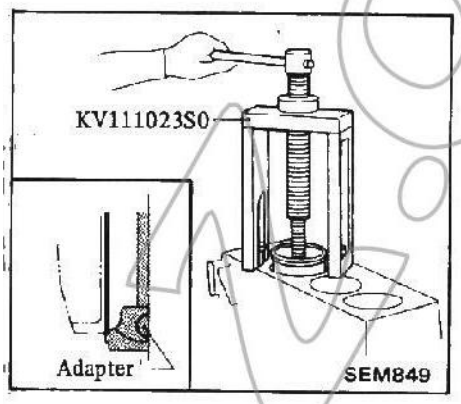
3. Check amount of projection of cylinder liner.

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

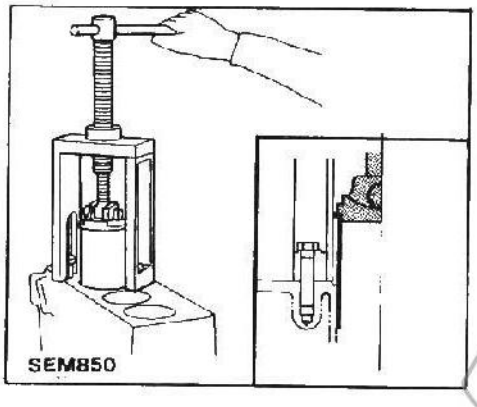


CYLINDER LINER REPLACEMENT

1. Remove cylinder liner with Tool.



2. Install cylinder liner with Tool or press stand.



3. Check amount of projection of cylinder liner.

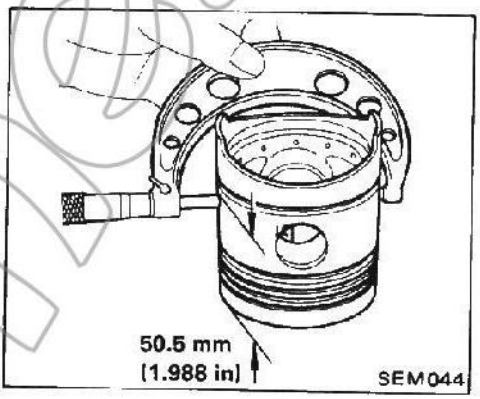
PISTON, PISTON PIN AND PISTON RINGS

1. Check for damage, scratches and wear. Replace if such a fault is detected.
2. Check piston outside diameter.

- 5-ring piston

Measure piston outside diameter at 50.5 mm (1.988 in) from piston head. If beyond the limit, replace piston.

Piston wear limit:
Less than 0.15 mm (0.0059 in)
Piston outside diameter:
Standard
82.845 - 82.885 mm
(3.2616 - 3.2632 in)

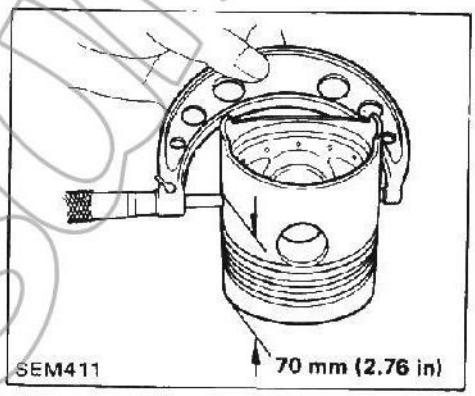


- 3-ring piston

Measure piston outside diameter at 70.0 mm (2.756 in) from piston head. If beyond the limit, replace piston.

Piston wear limit:
Less than 0.15 mm (0.0059 in)

Piston outside diameter:
Standard
SD22 and SD33
3 rings
82.905 - 82.945 mm
(3.4998 - 3.5014 in)
5 rings
82.845 - 82.885 mm
(3.2616 - 3.2632 in)
SD23 and SD25
88.895 - 88.935 mm
(3.4998 - 3.5014 in)

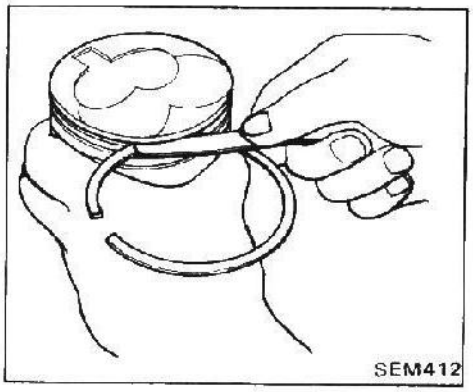


3. Measure Piston ring to ring groove clearance. If beyond the limit, replace piston rings or piston.

Piston ring to groove clearance (side clearance):
Limit

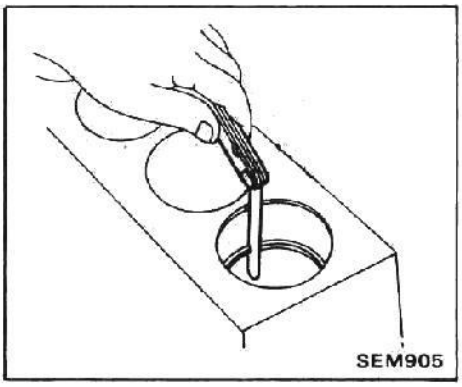
Unit: mm (in)

Ring No.	5 rings	3 rings
1	Less than 0.5 (0.020)	Less than 0.5 (0.020)
2	Less than 0.3 (0.012)	Less than 0.3 (0.012)
3		Less than 0.15 (0.0059)
4	Less than 0.15 (0.0059)	–
5		



4. Measure piston ring end gap by securely placing piston ring in cylinder liner at position where cylinder bore wear is least. If beyond the maximum limit, replace piston ring.

Maximum ring gap:
1.5 mm (0.059 in)

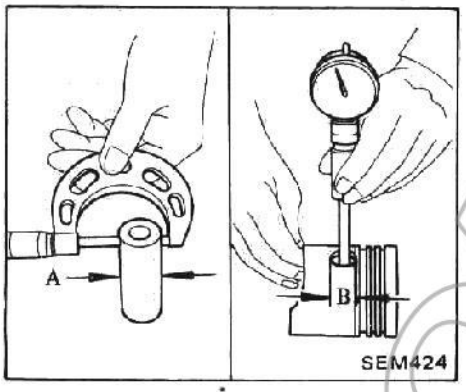


5. Measure piston pin to piston clearance. If beyond the limit, replace piston pin and piston.

Piston pin to piston clearance (A–B):
Limit

Unit: mm (in)

5 rings & 3 rings
Less than 0.003 (0.0001)

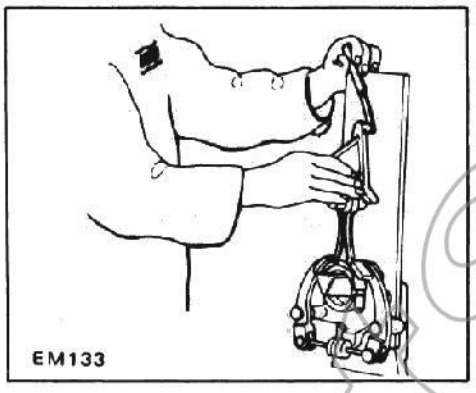


CONNECTING ROD

1. If a connecting rod has any flaw on both slides of the thrust face and the large end, correct or replace it.
2. Check connecting rod for bend or torsion using a connecting rod aligner. If bend or torsion exceeds the limit, correct or replace.

Bend and torsion
[per 100 mm (3.94 in) length]:
Standard

Bend
Less than 0.05 mm
(0.0020 in)
Torsion
Less than 0.05 mm
(0.0020 in)



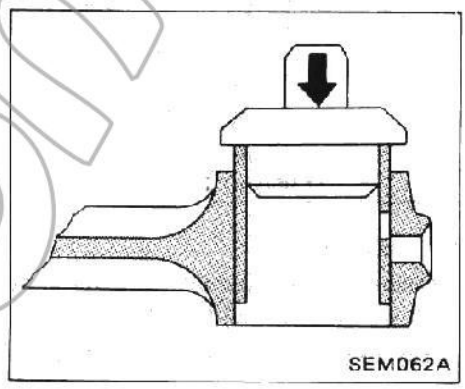
REPLACEMENT OF CONNECTING ROD SMALL END BUSHING

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

Be sure to align the oil holes.

2. After driving in the small end bushing, finish the bushing to the inside diameter specified by maintenance standard.

Small end bushing inside diameter
Maintenance standard:
26.025 - 26.038 mm
(1.0246 - 1.0251 in)



CRANKSHAFT

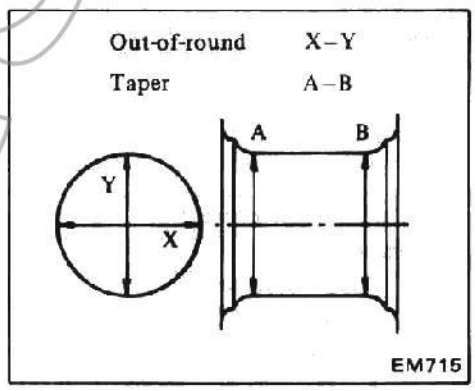
1. Check journal and crank pin for flaws or clogged oil passage. If necessary, replace crankshaft.

2. Check journal and crank pin for out-of-round and taper with a micrometer.

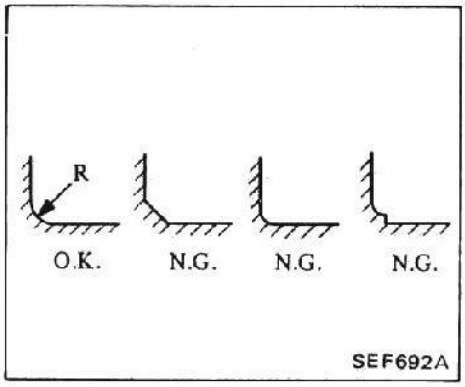
If beyond the specified value, replace or regrind crankshaft.

After regrinding crankshaft, use suitable undersize main bearing.

Out-of-round (X-Y):
Less than
0.02 mm (0.0008 in)
Taper (A-B):
Less than
0.02 mm (0.0008 in)



When regrinding crankshaft, finish fillets as follows:



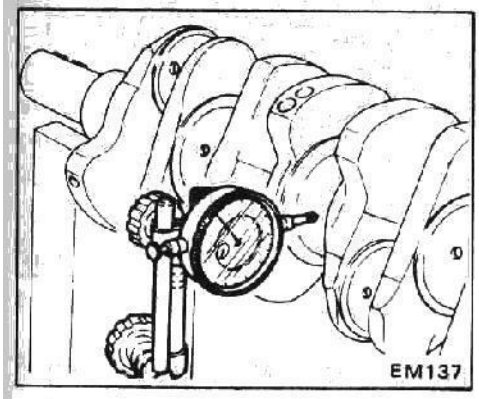
R Crank journal: 3.0 mm (0.118 in)
Crank pin: 3.5 mm (0.138 in)

Do not attempt to cut counterweight of crankshaft.

3. Check crankshaft bend **on center journal.** If beyond the specified value, replace or repair.

Crankshaft bend
(Total indicator reading):
Standard
0 - 0.06 mm
(0 - 0.0024 in)

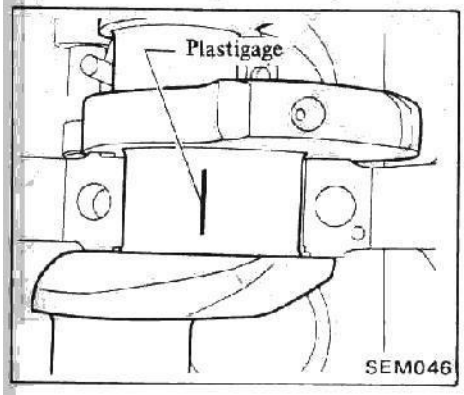
Limit
Less than
0.2 mm (0.008 in)



BEARINGS

MAIN BEARING OIL CLEARANCE

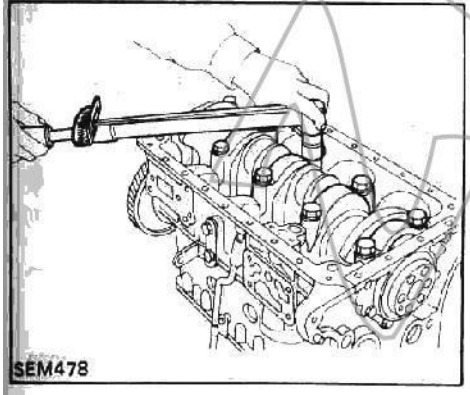
1. Thoroughly clean all bearings, journal and caps, and check for scratches, melt, scores or wear. Replace bearings, if any fault is detected.
2. Set main bearings on cylinder block and install crankshaft.
3. Set plastigage at each journal.



4. Install main bearing caps with main bearings and tighten.

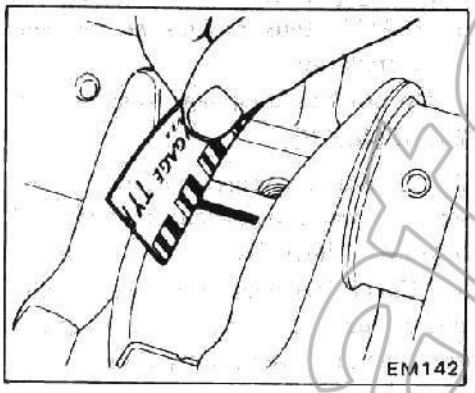
Do not turn crankshaft.

Ⓣ : **Main bearing cap bolt:**
167 - 172 N·m
(17.0 - 17.5 kg-m,
123 - 127 ft-lb)



5. Remove cap and measure main bearing oil clearance with plastigage. If clearance is not within specification, replace bearings.

Main bearing oil clearance:
Standard
0.035 - 0.093 mm
(0.0014 - 0.0037 in)
Limit
Less than
0.15 mm (0.0059 in)



CONNECTING ROD BEARING OIL CLEARANCE

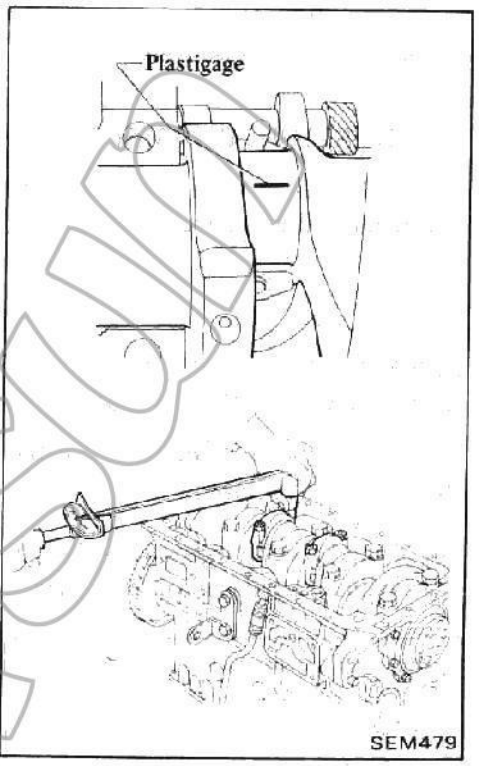
Measure connecting rod bearing oil clearance in same manner as main bearing oil clearance.

If clearance is not within specification, replace bearings.

Do not turn connecting rod or crankshaft.

Ⓣ : **Connecting rod cap:**
SD22 and SD33
51- 56 N·m
(5.2 - 5.7 kg-m,
38 - 41 ft-lb)
SD23 and SD25
67 - 71 N·m
(6.8 - 7.2 kg-m,
49 - 52 ft-lb)

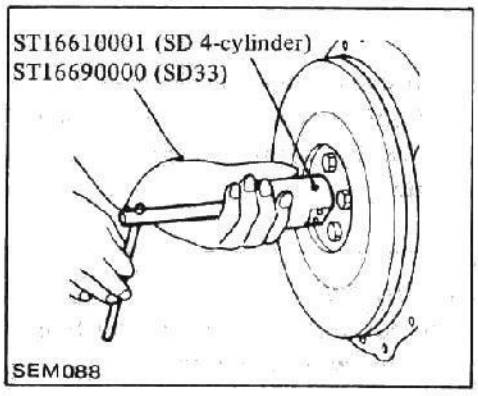
Connecting rod bearing oil clearance:
Standard
0.035 - 0.087 mm
(0.0014 - 0.0034 in)
Limit
Less than
0.15 mm (0.0059 in)



CRANKSHAFT PILOT BUSHING

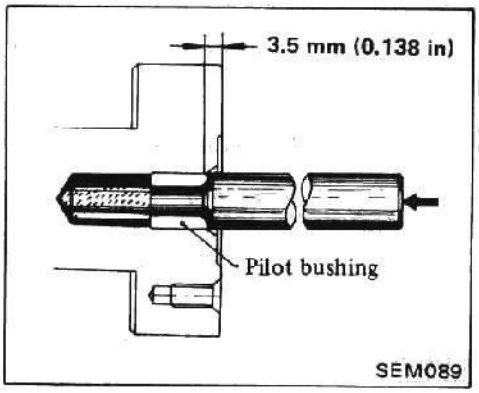
CRANKSHAFT PILOT BUSHING REPLACEMENT

1. Pull out bushing with Tool.



2. Insert pilot bushing until distance between flange end and bushing is specified value.

Distance "A":
Approx. 3.5 mm (0.138 in)



a. Do not oil bushing.
b. Do not insert excessively.

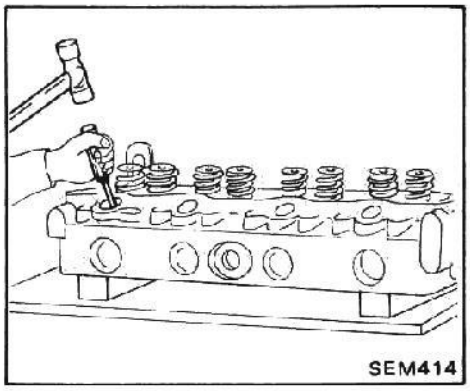
COMBUSTION CHAMBER

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

COMBUSTION CHAMBER REPLACEMENT

Usually combustion chamber should not be removed.

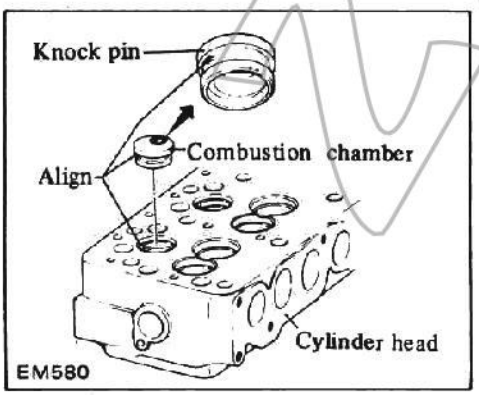
1. Remove combustion chamber so that cylinder head cannot be damaged.



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

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

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



3. Check amount of protrusion of combustion chamber.

FLYWHEEL

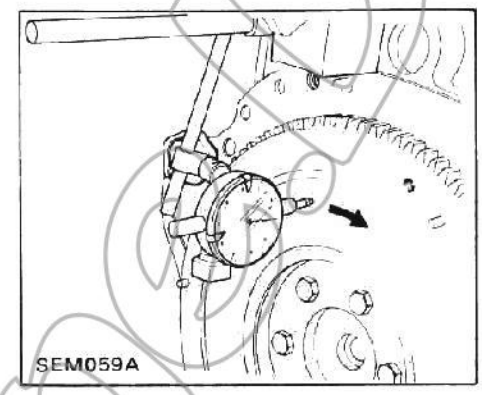
1. Check ring gear for wear or damage. If worn or damaged excessively, replace.

Removal and installation of ring gear requires use of hydraulic press. Heat ring gear to 180 to 200°C (356 to 392°F), thus facilitating removal and installation.

Do not heat ring gear to more than 250°C (482°F).

2. If clutch contact surface of flywheel is worn, damaged or roughened beyond limit, replace.
3. Check flywheel runout before disassembling and after assembling. If beyond the limit, replace flywheel.

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

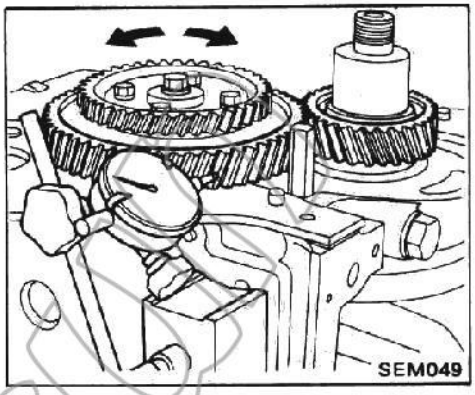


GEAR TRAIN

CAMSHAFT DRIVE GEAR

1. If gear tooth and key have scratches or are excessively worn, replace gear and key.
2. Check gear train backlash before disassembling and after assembling. If beyond the limit, replace gear.

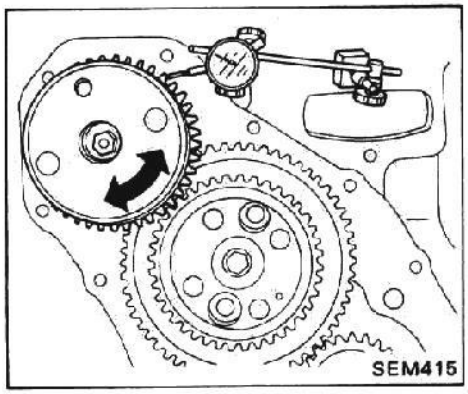
Backlash:
Standard
0.07 - 0.20 mm
(0.0028 - 0.0079 in)
Limit
0.30 mm (0.0118 in)



INJECTION PUMP DRIVE GEAR

Check gear backlash before disassembling and after assembling. If beyond the limit, replace idler gear or injection pump drive gear.

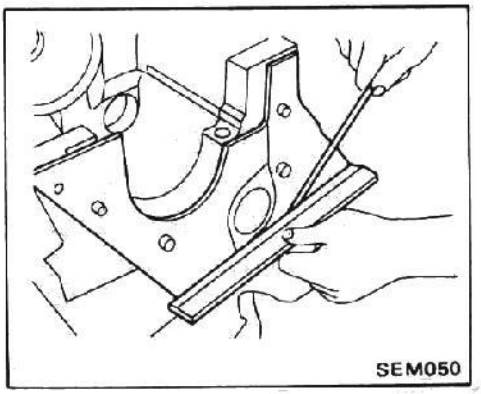
Gear backlash:
Standard
0.07 - 0.20 mm
(0.0028 - 0.0079 in)
Limit
0.30 mm (0.0118 in)



FRONT PLATE

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

Warpage limit:
0.2 mm (0.008 in)



ENGINE ASSEMBLY

PRECAUTIONS

1. When installing sliding parts such as bearings, be sure to apply engine oil on the sliding surfaces.
2. Use new packing and oil seals.
3. Be sure to follow the specified order and tightening torque.

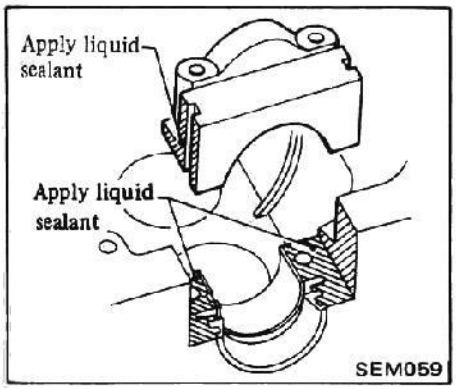
4 bearings (SD33) & 3 bearings (SD22)

4. Applying sealant

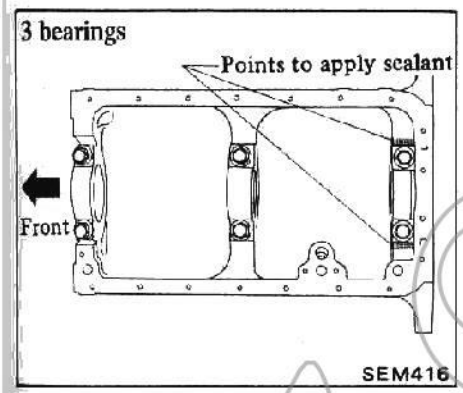
Use sealant to eliminate water and oil leaks.

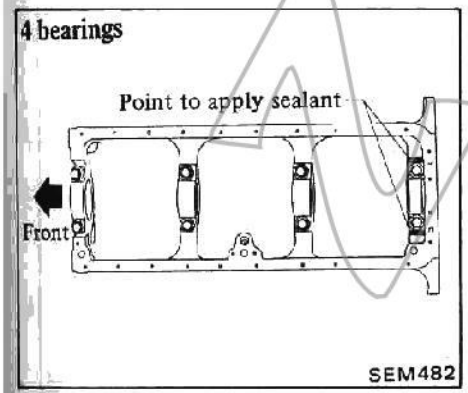
Do not apply too much sealant. Parts requiring sealant are:

(1) Main bearing cap and cylinder block



(2) Cylinder block





After inserting rear bearing cap side seals, apply sealant to rear main bearing cap.

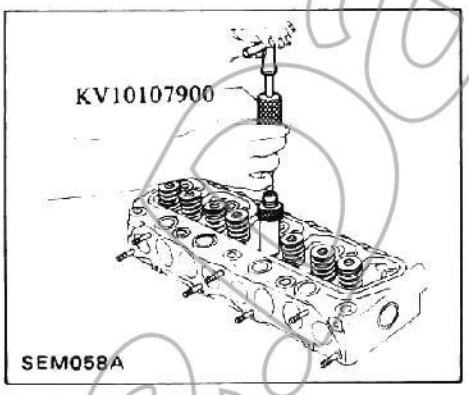
ASSEMBLING CYLINDER HEAD

1. Install glow plugs.

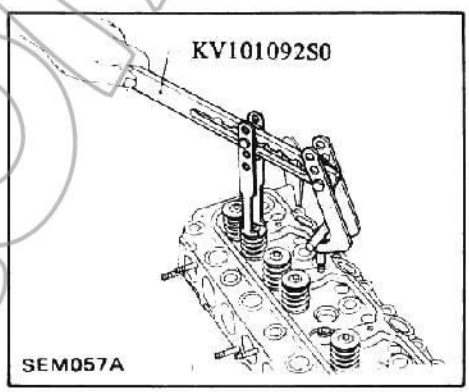
Ⓣ : **Glow plug**
15 - 20 N·m
(1.5 - 2.0 kg-m,
11 - 14 ft-lb)

2. Install valve and valve spring.

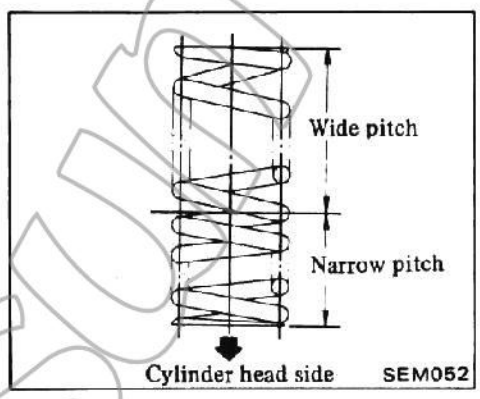
(1) Install new valve stem seal with Tool.



(2) Install valve, valve spring, valve spring retainer and valve spring collet by using Tool.



a. Install valve spring (uneven pitch type) with its narrow pitch side (yellow or red painted) at cylinder head side.



b. When installing valve, apply engine oil on the valve stem and lip of valve stem oil seal.

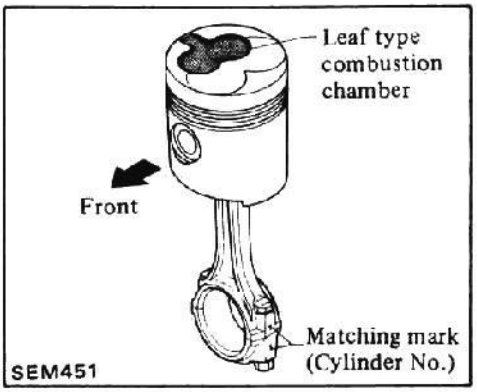
c. Check whether the valve face is free of foreign matter.

ASSEMBLING PISTON AND CONNECTING ROD

Assemble pistons, piston pins and connecting rods of the designated cylinders.

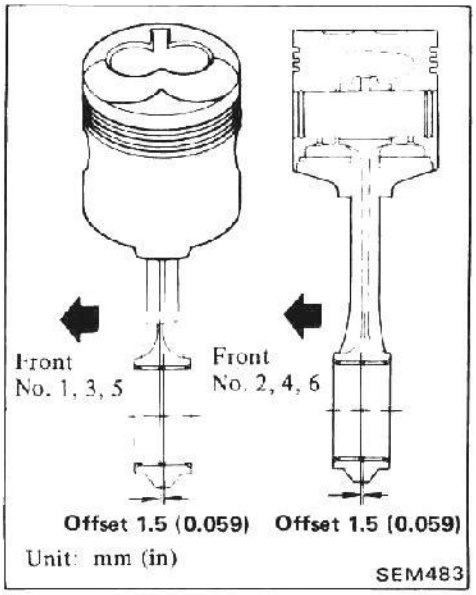
a. Immerse piston in oil of 80°C (176°F), and push in piston pin. Install snap ring.

b. Install connecting rod and piston so that leaf type combustion chamber on piston head is opposite the matching marks on connecting rod and cap.



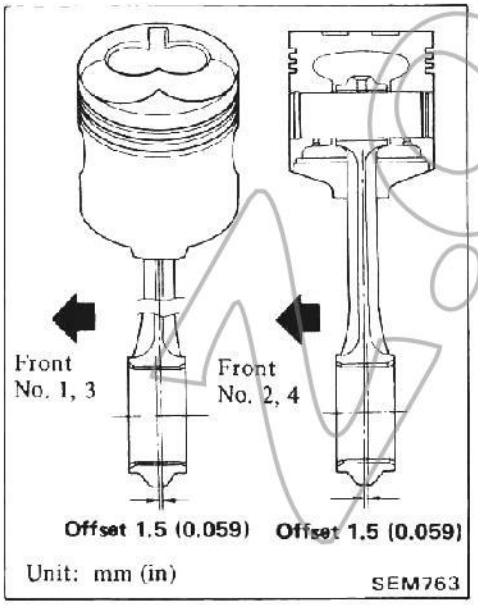
SD22-3 bearing & SD33

No matching marks are stamped on service parts of connecting rod. Install so that connecting rod big end is offset with respect to piston, so that on No. 1, No. 3 and No. 5 cylinders this offset is rearward with respect to engine and on No. 2, No. 4 and No. 6 cylinders this offset is forward with respect to engine and so that leaf type combustion chamber on piston head is at right side of engine.

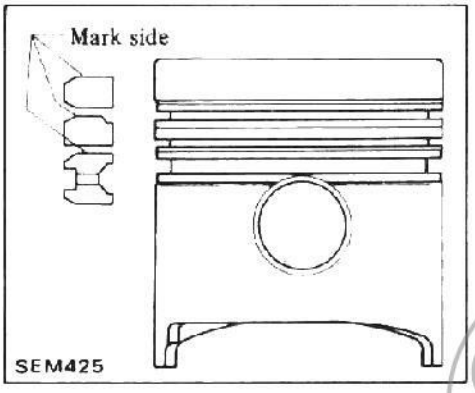


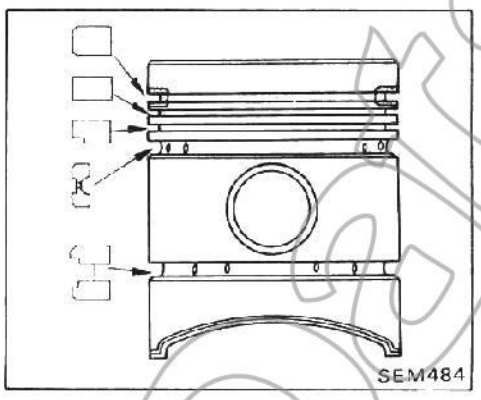
SD series 5-bearing engine

Install so that connecting rod big end is offset with respect to piston, and that this offset is forward on No. 1 and No. 3 cylinders with respect to engine and rearward on No. 2 and No. 4 cylinders.
Additionally, the leaf type combustion chamber on piston head must be at right side of engine.



Install piston ring so that mark stamped on ring faces upward.





ASSEMBLING ENGINE OVERALL

INSTALLING INTERNAL PARTS

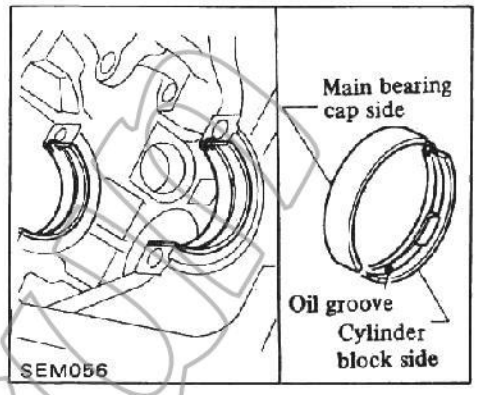
First, mount cylinder block on work stand (refer to Engine Disassembly).

Then install following parts:

1. Install front plate, and measure front plate warpage.
2. Install valve lifter with engine oil coated.
3. Install camshaft assembly with engine oil applied to bushing.
4. Crankshaft

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

a. Install bearing so that side with oil groove is on cylinder block side and side without oil groove is on cap side.

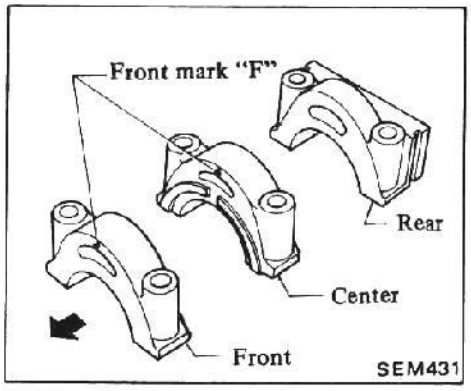


b. Only apply engine oil to inside of bearing.

(2) Apply engine oil to crankshaft journal and pin and install crankshaft.
(3) Install main bearing caps.

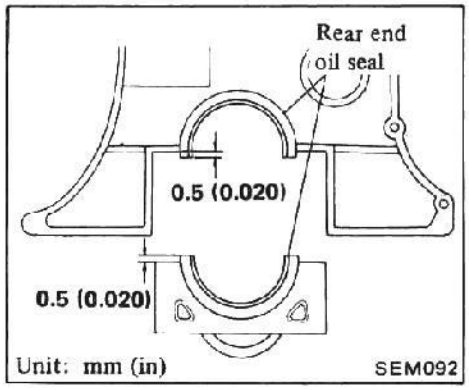
3 bearings (SD22) & 4 bearings (SD33)

a) Install main bearing cap so that embossed "F" mark is at front side of vehicle.

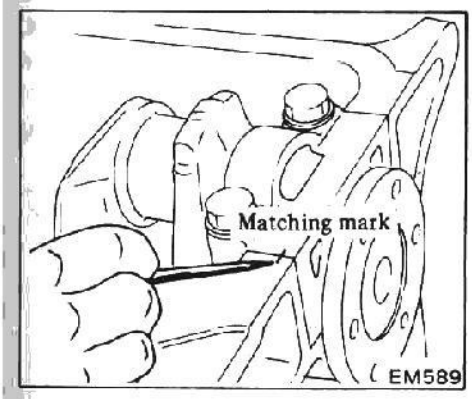


b) Apply engine oil to main bearing cap and cylinder block contact surfaces.
c) Install rear end oil seals to main bearing cap and cylinder block by hand so that they are protruded by 0.5 mm (0.020 in) from end surface.
Apply grease to contact surface of rear end oil seal and crankshaft.

Do not depress oil seal at middle portion.



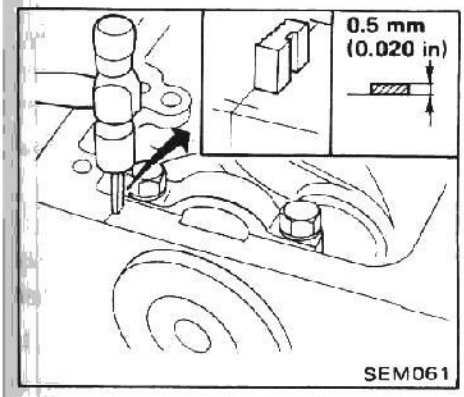
d) Install rear main bearing cap by aligning marks on cylinder block and cap.



e) Install new rear main bearing cap side seal with liquid sealant.

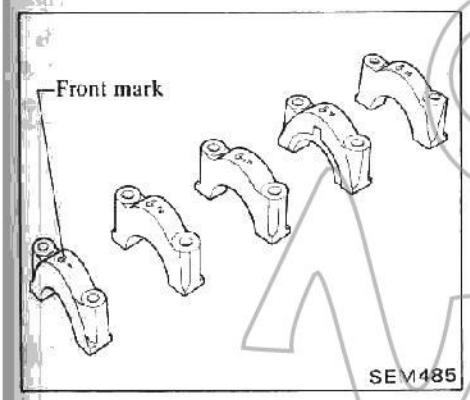
a. Face groove of side oil seal toward cap and block.

b. Make sure that side oil seal end protrudes by 0.5 mm (0.020 in) from cylinder block.



5 bearings (SD 4-cylinder)

a) Install main bearing cap so that "F" mark is at front side of vehicle.

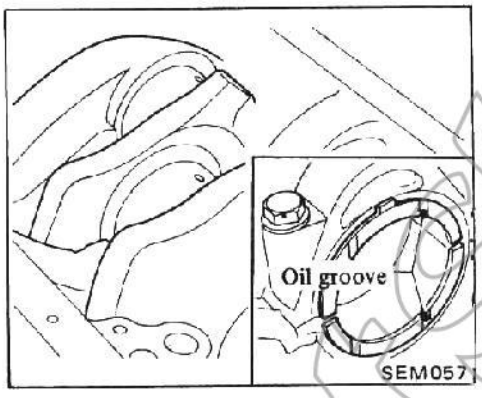


b) Apply engine oil to main bearing cap and cylinder block contact surfaces.

c) Install oil seal assembly. Apply grease to contact surface of rear end oil seal and crankshaft.

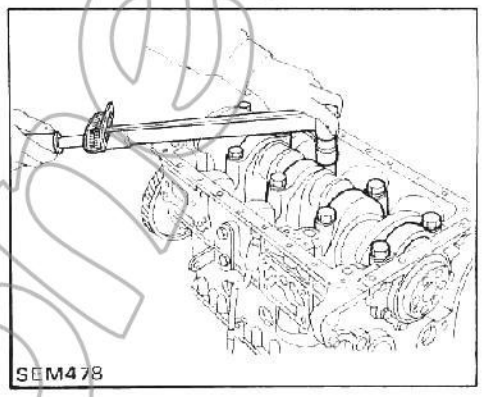
(4) Install crankshaft thrust washer at the 4th journal from front.

Install thrust washer so that oil groove can face crankshaft.



(5) Tighten bearing cap bolts gradually in stages, starting from two to three separate stages, from center bearing and moving outward in sequence.

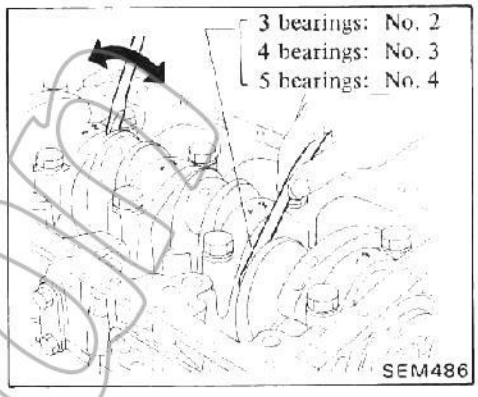
Ⓣ : Main bearing cap bolt:
167 - 172 N·m
(17.0 - 17.5 kg-m,
123 - 127 ft-lb)

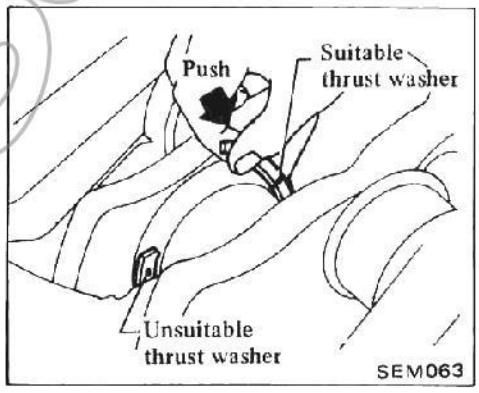


(6) Measure crankshaft end play.

If not within specification, replace with proper thrust washer.

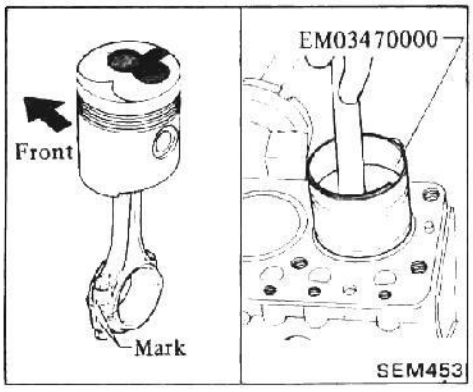
Crankshaft end play:
Standard
0.06 - 0.14 mm
(0.0024 - 0.0055 in)
Limit
Less than 0.4 mm (0.016 in)
Thrust washer oversize:
0.2 mm (0.008 in) and
0.4 mm (0.016 in) oversize





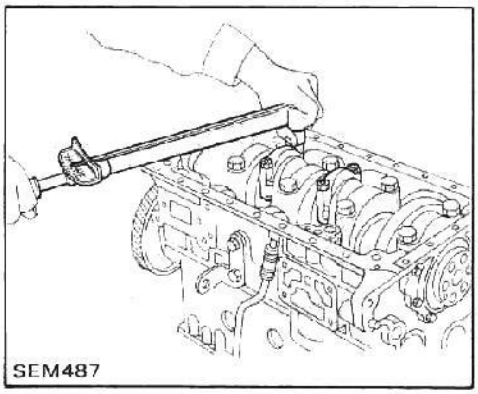
5. Install piston assembly with Tool.

(1) Install piston assembly by aligning matching mark on connecting rod big end.



(2) Tighten connecting rod bearing cap nut.

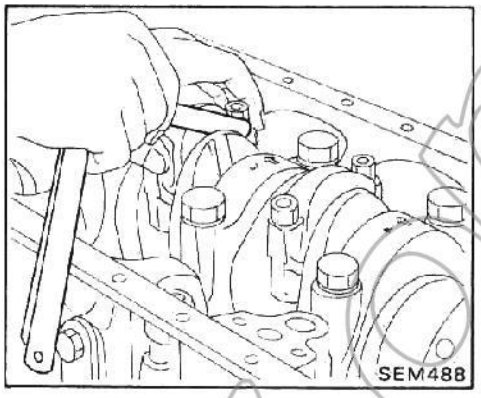
Ⓣ : **Connecting rod bearing cap:**
SD22 and SD33
51 - 56 N·m
(5.2 - 5.7 kg-m,
38 - 41 ft-lb)
SD23 and SD25
67 - 71 N·m
(6.8 - 7.2 kg-m,
49 - 52 ft-lb)


SEM487

(3) Measure clearance between connecting rod big end and web of crankshaft.

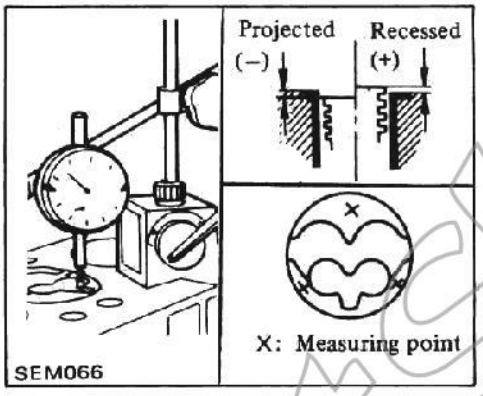
If beyond the specified value, replace connecting rod.

Connecting rod thrust clearance:
0.1 - 0.2 mm
(0.004 - 0.008 in)

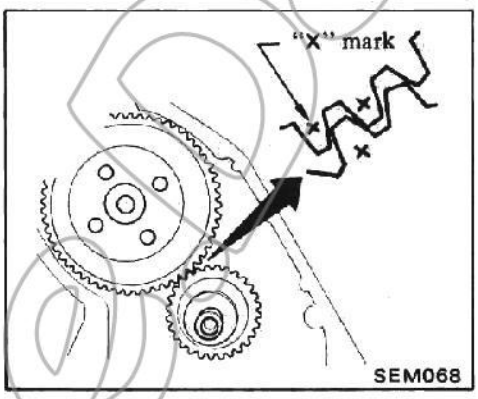

SEM488

6. Install oil pump assembly.
7. Measure piston top clearance.
(1) Set piston to T.D.C.
(2) Measure clearance between top of piston and cylinder block with dial gauge. Measure clearance at front and rear of each piston.

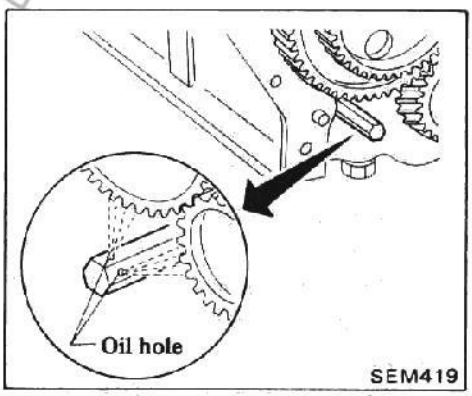
Piston top clearance:
Standard
–0.27 - +0.08 mm
(–0.0106 - +0.0031 in)
Limit
–0.4 - +0.3 mm
(–0.016 - +0.012 in)



8. Install crankshaft gear.
(1) Install crankshaft gear through key by aligning crank gear and camshaft gear matching marks.



(2) Measure gear backlash. Refer to Inspection and Repair.
9. Install oil jet so that it can face each gear.



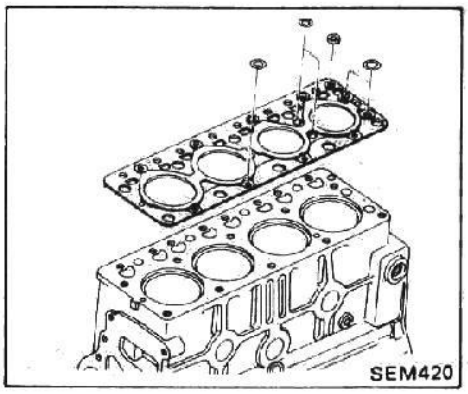
10. Install rear engine plate (SD 4-cylinder)/flywheel housing (SD33) and flywheel and then bend lock plate (if equipped).

Ⓣ : **Flywheel bolt**
3 bearings & 4 bearings
44 - 49 N·m
(4.5 - 5.0 kg-m,
33 - 36 ft-lb)
5 bearings
88 - 98 N·m
(9.0 - 10.0 kg-m,
65 - 72 ft-lb)
Washer based bolt
127 - 147 N·m
(13.0 - 15.0 kg-m,
94 - 108 ft-lb)

INSTALLING CYLINDER HEAD

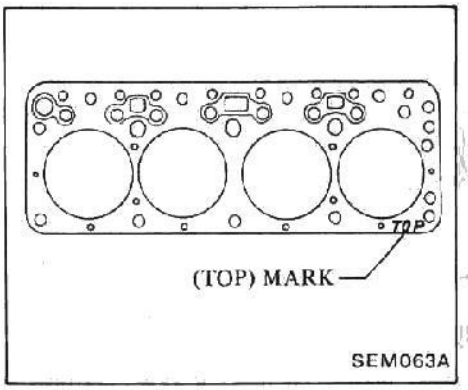
1. Install new cylinder head gasket.

Securely install rubber rings into water and oil holes.


SEM420

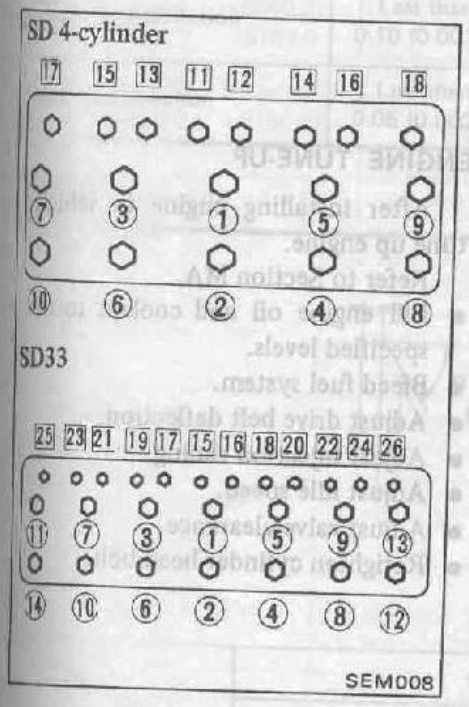
2. Install cylinder head by accommodating knock pin of cylinder block.

Be sure to install gasket with TOP mark facing upward if that mark is stamped.



3. Tighten cylinder head bolts in the sequence shown below. Install cylinder head.

(1) Tighten main bolts to 59 - 78 N·m (6 - 8 kg-m, 43 - 58 ft-lb).
(2) Tighten sub bolts to 20 - 29 N·m (2 - 3 kg-m, 14 - 22 ft-lb).
(3) Tighten main bolts to 118 - 127 N·m (12 - 13 kg-m, 87 - 94 ft-lb).
(4) Tighten sub bolts to 44 - 54 N·m (4.5 - 5.5 kg-m, 33 - 40 ft-lb).



After installing engine in the vehicle, warm up engine and retighten cylinder head bolts.

4. Install push rod.

Turn push rod and make sure that it is within spherical area of valve lifter.

5. Install rocker shaft assembly.

a. **Tighten in two or three stages outwardly from center bracket.**
b. **Fully loosen rocker arm screws.**

Ⓣ: **Rocker shaft bolt**
20 - 25 N·m
(2.0 - 2.5 kg-m,
14 - 18 ft-lb)

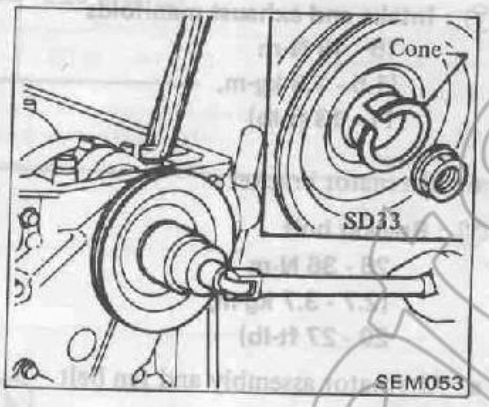
INSTALLING FRONT PARTS

1. Install front cover with new gasket and new front oil seal.

Ⓣ: **Front cover fixing bolt**
M6
4 - 6 N·m
(0.4 - 0.6 kg-m,
2.9 - 4.3 ft-lb)
M8
10 - 13 N·m
(1.0 - 1.3 kg-m,
7 - 9 ft-lb)

2. Install crank pulley.

Ⓣ: **Crank pulley**
294 - 324 N·m
(30 - 33 kg-m,
217 - 239 ft-lb)

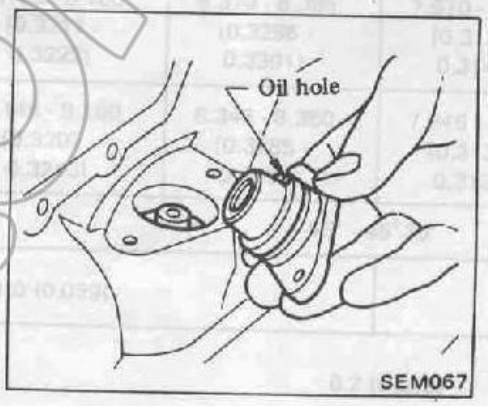


3. Install oil pan with new gasket coated with liquid sealant.
4. Install water pump with new gasket.
5. Install thermostat housing with new gasket.

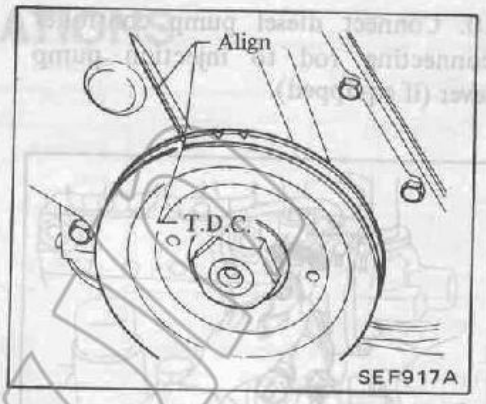
INSTALLING SIDE PARTS

1. Install oil pump spindle by aligning grooves of camshaft, oil pump, drive gear and oil pump drive shaft.

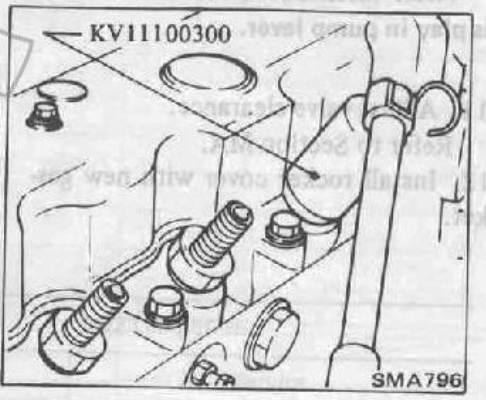
Face oil hole in support toward cylinder block side and install support with new O-ring (SD 4-cylinder)/ gasket (SD33).



2. Connect oil cooler hose to cylinder head.
3. Install glow plug harness.
4. Align front cover and crank pulley mark for setting No. 1 piston at T.D.C.



5. Install injection pump assembly. Refer to Section EF.
6. Injection nozzle and tube.
(1) Install new washer and injection nozzle.



(2) Install spill tube.

Ⓣ: **Spill tube fixing nut**
39 - 49 N·m
(4 - 5 kg-m,
29 - 36 ft-lb)

(3) Install injection tube.

Ⓣ: **Injection tube flare nut**
29 - 34 N·m
(3.0 - 3.5 kg-m,
22 - 25 ft-lb)

7. Temporarily install oil cooler, oil filter bracket and oil pipe, and then gradually tighten them.
8. Vacuum tube assembly.
9. Install diesel pump controller.

10. Connect diesel pump controller connecting rod to injection pump lever (if equipped).

After installation, make sure there is play in pump lever.

11. Adjust valve clearance.
Refer to Section MA.
12. Install rocker cover with new gasket.

Ⓣ : **Rocker cover bolt**
10 - 13 N·m
(1.0 - 1.3 kg-m,
7 - 9 ft-lb)

13. Dismount engine from work stand and remove engine attachment.
14. Install rear and left side parts.
- Breather assembly
- Intake and Exhaust manifold

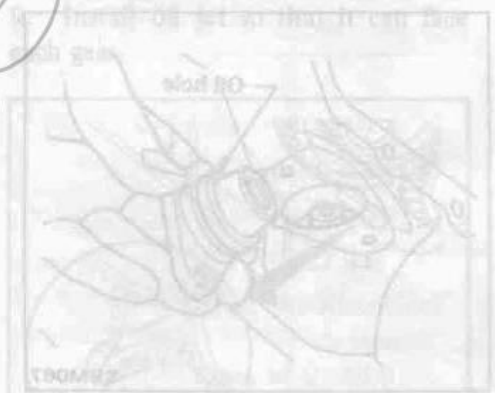
Ⓣ : **Intake and exhaust manifolds**
15 - 18 N·m
(1.5 - 1.8 kg-m,
11 - 13 ft-lb)

- Alternator bracket

Ⓣ : **Bracket bolt**
26 - 36 N·m
(2.7 - 3.7 kg-m,
20 - 27 ft-lb)

- Alternator assembly and fan belt

Ⓣ : **11 - 14 N·m**
(1.1 - 1.4 kg-m,
8 - 10 ft-lb)



- Engine mountings
- Starter motor
- Clutch cover assembly
Refer to Section CL.
- Transmission assembly
Refer to Section MT.

ENGINE TUNE-UP

After installing engine in vehicle, tune up engine.
Refer to Section MA.
- Fill engine oil and coolant to the specified levels.
- Bleed fuel system.
- Adjust drive belt deflection.
- Adjust injection timing.
- Adjust idle speed.
- Adjust valve clearance.
- Retighten cylinder head bolt.

SERVICE DATA AND SPECIFICATIONS

INSPECTION AND ADJUSTMENT

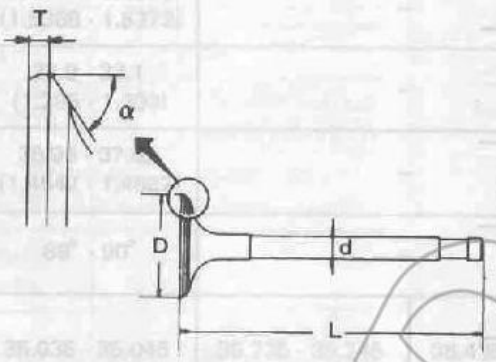
CYLINDER HEAD

Unit: mm (in)

	Standard	Limit
Longitudinal direction	Less than 0.10 (0.0039)	0.20 (0.0079)
Transverse direction	Less than 0.05 (0.0020)	

VALVE

Unit: mm (in)



SEM188

	SD22 and SD33			SD23 and SD25	
	Standard	Service		Standard	Service
Valve head diameter "D"					
Intake	38.0 (1.496)			40.0 (1.575)	
Exhaust	32.0 (1.260)			34.0 (1.339)	
Valve length "L"					
Intake	117 (4.61)				
Exhaust					
Valve stem diameter "d"					
Intake	7.970 - 7.985 (0.3138 - 0.3144)	8.170 - 8.185 (0.3217 - 0.3222)	8.370 - 8.385 (0.3295 - 0.3301)	7.970 - 7.985 (0.3138 - 0.3144)	–
Exhaust	7.945 - 7.960 (0.3128 - 0.3134)	8.145 - 8.160 (0.3207 - 0.3213)	8.345 - 8.360 (0.3285 - 0.3291)	7.945 - 7.960 (0.3128 - 0.3134)	–
Valve seat angle "α"	45° - 45°30′				
Valve margin "T" limit	1.0 (0.039)			1.5 (0.059)	
Valve stem and surface grinding limit	0.2 (0.008)				
Valve clearance (Hot)					
Intake	0.35 (0.014)				
Exhaust					

Valve spring

Free length mm (in)	Painted yellow	50.20 (1.976)
	Painted red	50.35 (1.982)
Pressure height mm/N (mm/kg, in/lb)	30.4/599.2 (30.4/61.1, 1.197/134.7)	
Assembled height mm/N (mm/kg, in/lb)	39/294 (39/30, 1.54/66)	
Out of square mm (in)	1.3 (0.051)	

Valve guide (SD23 and SD25)

Unit: mm (in)

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

	Standard	Max. tolerance
Stem to guide clearance Intake	0.015 - 0.045 (0.0006 - 0.0018)	0.15 (0.0059)
Exhaust	0.04 - 0.07 (0.0016 - 0.0028)	0.20 (0.0079)
Valve deflection limit	0.15 (0.0059)	

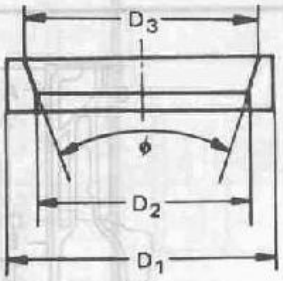
Valve stem hole (Cylinder head) (SD22 and SD33)

Unit: mm (in)

Valve stem hole inner diameter	8.000 - 8.015 (0.3150 - 0.3156)	
	Standard	Max. tolerance
Stem to stem hole clearance Intake	0.015 - 0.045 (0.0006 - 0.0018)	0.15 (0.0059)
Exhaust	0.04 - 0.07 (0.0016 - 0.0028)	0.20 (0.0079)
Valve deflection limit	0.15 (0.0059)	

Valve seat

Unit mm (in)



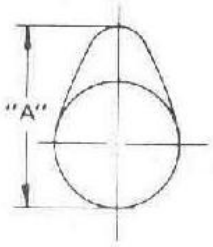
EM733

	SD22 and SD33			SD23 and SD25		
	Standard	Service		Standard	Service	
Intake						
Outer diameter "D1"	39.035 - 39.045 (1.5368 - 1.5372)	–		41.035 - 41.045 (1.6155 - 1.6159)	–	
Inner diameter "D2"	32.9 - 33.1 (1.295 - 1.303)	–		34.9 - 35.1 (1.374 - 1.382)	–	
Diameter of seat "D3"	36.95 - 37.05 (1.4547 - 1.4587)	–		38.95 - 39.05 (1.5335 - 1.5374)	–	
Valve seat face angle "φ"	89° - 90°	–		89° - 90°	–	
Exhaust						
Outer diameter "D1"	35.035 - 35.045 (1.3793 - 1.3797)	35.235 - 35.245 (1.3872 - 1.3876)	35.435 - 35.445 (1.3951 - 1.3955)	37.035 - 37.045 (1.4581 - 1.4585)	37.235 - 37.245 (1.4659 - 1.4663)	37.435 - 37.445 (1.4738 - 1.4742)
Inner diameter "D2"	28.4 - 28.6 (1.118 - 1.126)	28.4 - 28.6 (1.118 - 1.126)	28.4 - 28.6 (1.118 - 1.126)	30.4 - 30.6 (1.197 - 1.205)		
Diameter of seat "D3"	30.95 - 31.05 (1.2185 - 1.2224)	30.95 - 31.05 (1.2185 - 1.2224)	30.95 - 31.05 (1.2185 - 1.2224)	32.950 - 33.050 (1.2972 - 1.3012)		
Cylinder head valve seat diameter	34.995 - 35.01 (1.3778 - 1.3783)	35.195 - 35.21 (1.3856 - 1.3862)	35.395 - 35.41 (1.3935 - 1.3941)	36.995 - 37.010 (1.4565 - 1.4571)	–	–
Valve seat face angle "φ"	89° - 90°	–		89° - 90°		

CAMSHAFT AND CAMSHAFT BUSHING

Unit: mm (in)

	Standard	Limit
Camshaft journal to bushing clearance [Oil clearance]		
Front	0.024 - 0.102 (0.0009 - 0.0040)	0.15 (0.0059)
Center	0.037 - 0.115 (0.0015 - 0.0045)	
Rear	0.024 - 0.102 (0.0009 - 0.0040)	
Camshaft journal diameter		
Front	45.434 - 45.447 (1.7887 - 1.7892)	—
Center	43.897 - 43.910 (1.7282 - 1.7287)	—
Rear	41.218 - 41.231 (1.6228 - 1.6233)	—
Camshaft bend (Total indicator reading)	Less than 0.03 (0.0012)	0.06 (0.0024)
Camshaft end play	0.08 - 0.28 (0.0031 - 0.0110)	0.50 (0.0197)

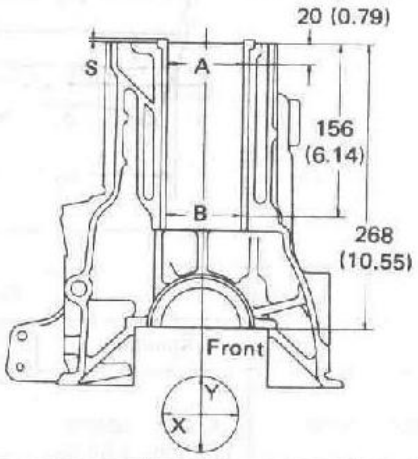


EM671

Cam height "A"	37.28 - 37.32 (1.4677 - 1.4693)
Cam height limit	36.8 (1.449)

CYLINDER BLOCK AND CYLINDER LINER

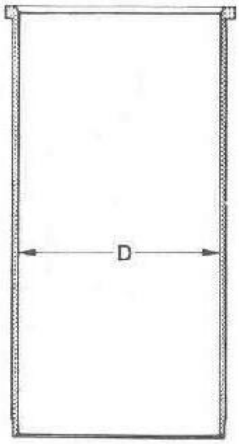
Unit: mm (in)



SEM251

	Standard	Wear limit
Surface flatness (Without cylinder liner)	Less than 0.10 (0.0039) (Shaft direction) Less than 0.02 (0.0008) (Right angle direction)	0.3 (0.012)
Cylinder bore (With cylinder liner) Inner diameter		
SD22 and SD33	82.985 - 83.020 (3.2671 - 3.2685)	0.3 (0.012)
SD23 and SD25	89.000 - 89.030 (3.5039 - 3.5051)	
Out-of-round (X-Y)	Less than 0.02 (0.0008)	—
Taper (A-B)	Less than 0.02 (0.0008)	—
Projection "S"	0.02 - 0.09 (0.0008 - 0.0035)	—
Division of each cylinder "S"	Less than 0.05 (0.0020)	—
Piston to cylinder liner clearance		
SD22 and SD33	0.04 - 0.11 (0.0016 - 0.0043)	
SD23 and SD25	0.09 - 0.115 (0.0035 - 0.0045)	
Interference fit cylinder liner to block		
SD22 and33	0.01 - 0.03 (0.0004 - 0.0012)	
SD23 and SD25	0.02 - 0.09 (0.0008 - 0.0035)	

Unit: mm (in)



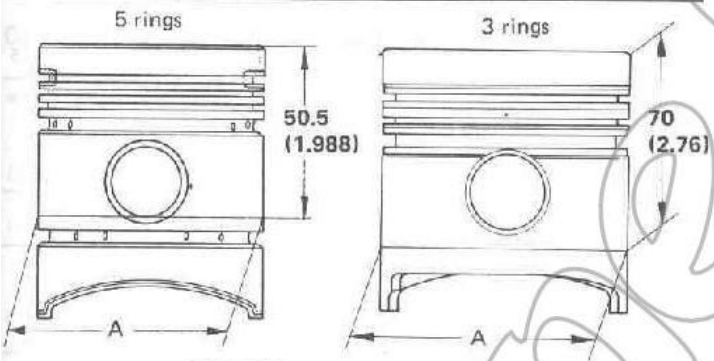
SEM427

	Standard	Service
Cylinder liner inner diameter "D"		
SD22 and SD33	82.995 - 83.025 (3.2675 - 3.2687)	83.03 - 83.05 (3.2689 - 3.2697)
SD23 and SD25	89.000 - 89.035 (3.5039 - 3.5053)	89.050 - 89.070 (3.5059 - 3.5067)

PISTON, PISTON RING AND PISTON PIN

Piston

Unit: mm (in)



SEM105A SEM778A

	SD22 and SD33	SD23 and SD25
Piston skirt diameter "A" 3 rings	82.905 - 82.945 (3.2640 - 3.2655)	88.895 - 88.935 (3.4998 - 3.5014)
5 rings	82.845 - 82.885 (3.2616 - 3.2632)	—
Piston pin hole diameter	25.99 - 26.00 (1.0232 - 1.0236)	

Piston ring

Unit: mm (in)

	Standard		Limit	
	5 rings	3 rings	5 rings	3 rings
Side clearance No. 1	0.06 - 0.10 (0.0024 - 0.0039)		0.5 (0.020)	
No. 2	0.04 - 0.08 (0.0016 - 0.0031)		0.3 (0.012)	
No. 3	0.04 - 0.08 (0.0016 - 0.0031)	0.02 - 0.06 (0.0008 - 0.0024)	0.3 (0.012)	0.15 (0.0059)
No. 4	0.02 - 0.06 (0.0008 - 0.0024)	—	0.15 (0.0059)	—
No. 5			0.15 (0.0059)	—
Ring gap No. 1	0.30 - 0.45 (0.0118 - 0.0177)		1.5 (0.059)	
No. 2	0.20 - 0.35 (0.0079 - 0.0138)			
No. 3	0.20 - 0.35 (0.0079 - 0.0138)	0.15 - 0.30 (0.0059 - 0.0118)		
No. 4 & No. 5	0.15 - 0.30 (0.0059 - 0.0118)	—		

Piston pin

Unit: mm (in)

	SD22 and SD33	SD23 and SD25
Piston pin outer diameter	25.993 - 26.000 (1.0233 - 1.0236)	
Interference fit of piston pin to piston	0 - 0.003 (0 - 0.0001)	−0.007 - 0.010 (−0.0003 - 0.0004)
Piston pin to connecting rod clearance	0.025 - 0.045 (0.0010 - 0.0018)	

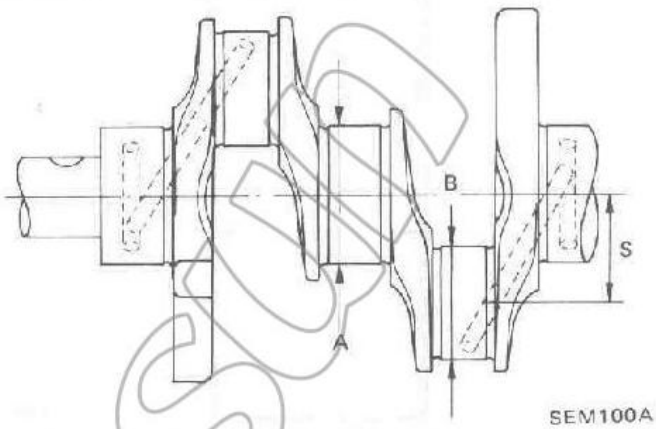
CONNECTING ROD

Unit: mm (in)

Center distance SD22, SD25 and SD33	170.0 (6.69)
SD23	174.2 (6.86)
Connecting rod bend or torsion [Per 100 mm (3.94 in) length] Standard	0 - 0.05 (0 - 0.0020)
Limit	0.05 (0.0020)
Piston pin bore diameter	26.025 - 26.038 (1.0246 - 1.0251)
Big end play Standard	0.1 - 0.2 (0.004 - 0.008)
Limit	0.2 (0.008)

CRANKSHAFT

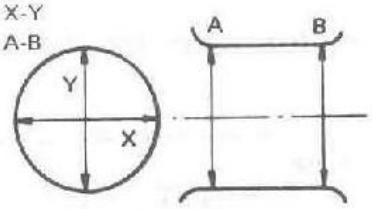
Unit: mm (in)



SEM100A

Journal diameter "A"	70.907 - 70.920 (2.7916 - 2.7921)
Pin diameter "B"	52.913 - 52.926 (2.0832 - 2.0837)
"S" SD22, SD25 and SD33	50.00 (1.9685)
SD23	46.00 (1.8110)

Out-of-round X-Y
Taper A-B



EM715

Taper of journal and pin "A-B" Standard	0.01 (0.0004)
Limit	0.02 (0.0008)
Out-of-round of journal and pin "X-Y" Standard	0.01 (0.0004)
Limit	0.02 (0.0008)
Crankshaft bend Standard	0 - 0.03 (0 - 0.0012)
Limit	0.10 (0.0039)
Crankshaft end play Standard	0.06 - 0.14 (0.0024 - 0.0055)
Limit	0.40 (0.0157)

BEARING

Bearing clearance

Unit: mm (in)

	Standard	Limit
Main bearing clearance		
3 or 4 bearings	0.035 - 0.093 (0.0014 - 0.0037)	0.15 (0.0059)
5 bearings	0.035 - 0.087 (0.0014 - 0.0034)	
Connecting rod bearing clearance	0.035 - 0.081 (0.0014 - 0.0032)	0.15 (0.0059)

Main bearing undersize

Unit: mm (in)

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

Connecting rod bearing undersize

Unit: mm (in)

	Crank pin diameter
Standard	52.913 - 52.926 (2.0832 - 2.0837)
Undersize	
0.25 (0.0098)	52.663 - 52.676 (2.0733 - 2.0738)
0.50 (0.0197)	52.413 - 52.426 (2.0635 - 2.0640)
0.75 (0.0295)	52.163 - 52.176 (2.0537 - 2.0542)
1.00 (0.0394)	51.913 - 51.926 (2.0438 - 2.0443)

MISCELLANEOUS COMPONENTS

Unit: mm (in)

Gear train Backlash of each gear	0.07 - 0.20 (0.0028 - 0.0079)
Flywheel Runout (Total indicator reading)	Less than 0.15 (0.0059)

TIGHTENING TORQUE

Engine outer parts

		N·m	kg-m	ft-lb
Water outlet bolt		10 - 13	1.0 - 1.3	7 - 9
Water pump bolt	M8	10 - 13	1.0 - 1.3	7 - 9
	M10	20 - 25	2.0 - 2.5	14 - 18
Manifold bolt and nut		15 - 18	1.5 - 1.8	11 - 13
Injection pump nut (In-line)		20 - 25	2.0 - 2.5	14 - 18
Injection pump (VE type)	nut	20 - 25	2.0 - 2.5	14 - 18
	bolt	16 - 22	1.6 - 2.2	12 - 16
Injection pump (C.A.V.-D.P.A.)		15 - 20	1.5 - 2.0	11 - 14
Injection nozzle to cylinder head	*1	59 - 69	6.0 - 7.0	43 - 51
	*2	69 - 78	7.0 - 8.0	51 - 58
Oil cooler bolt		10 - 13	1.0 - 1.3	7 - 9
Oil cooler pipe nut		10 - 13	1.0 - 1.3	7 - 9
Timing gear cover bolt		10 - 13	1.0 - 1.3	7 - 9
Injection pump timer nut		59 - 69	6 - 7	43 - 51
Injection pump drive gear nut (VE type)		59 - 69	6.0 - 7.0	43 - 51
Injection pump drive gear (C.A.V.-D.P.A.)		15 - 20	1.5 - 2.0	11 - 14
Feed pump gear (C.A.V.-D.P.A.)		15 - 20	1.5 - 2.0	11 - 14
Injection tube flare nut		29 - 34	3.0 - 3.5	22 - 25
Spill tube with cap nut		39 - 49	4 - 5	29 - 36
Oil filter bracket bolt		26 - 36	2.7 - 3.7	20 - 27
Alternator bracket bolt		26 - 36	2.7 - 3.7	20 - 27
Alternator to adjusting bar bolt		11 - 14	1.1 - 1.4	8 - 10
Diesel pump controller bolt		10 - 13	1.0 - 1.3	7 - 9
Diesel pump controller bracket bolt		45 - 61	4.6 - 6.2	33 - 45
Thermostat housing		10 - 13	1.0 - 1.3	7 - 9

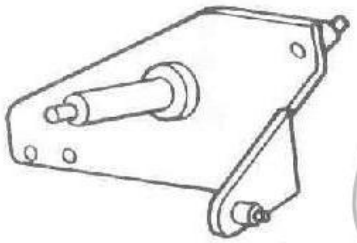
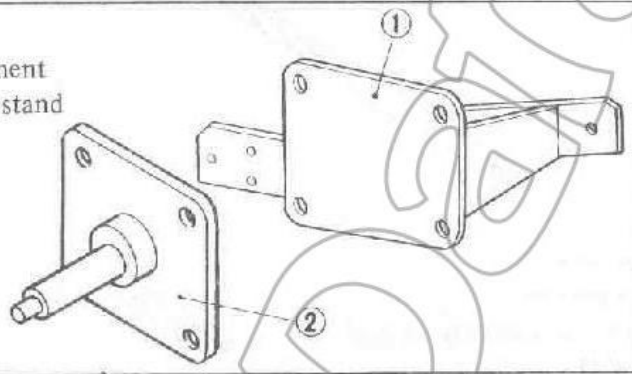
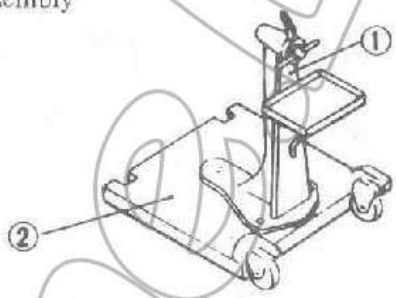
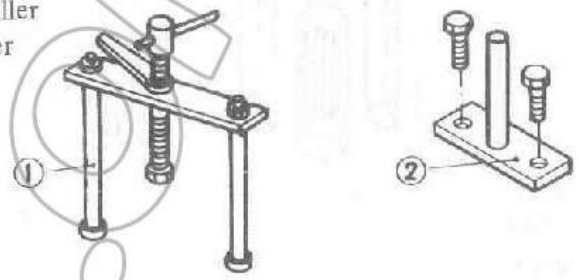
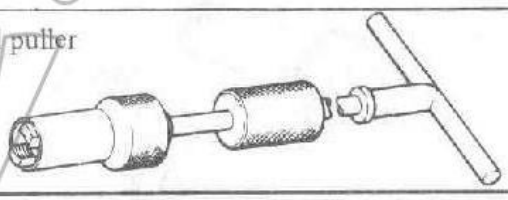
*1: Part No. of injection nozzle
16600-90060, 16600-36W00, 16600-T9000

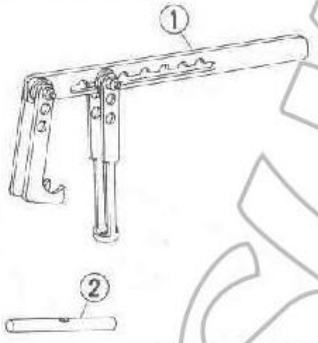
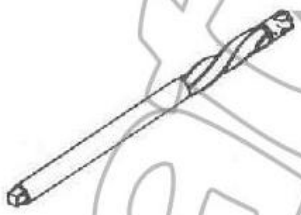
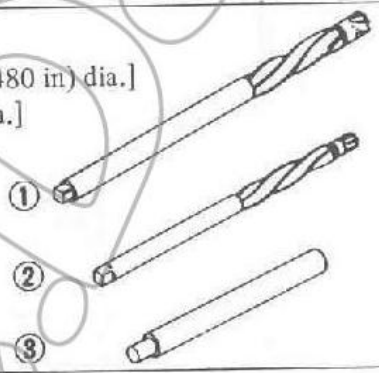
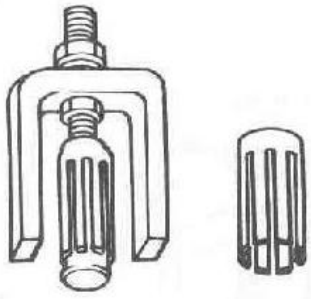
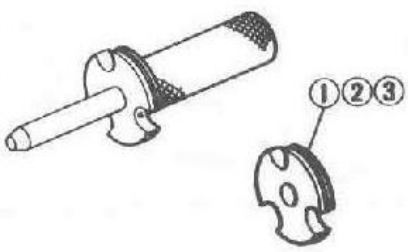
*2: Part No. of injection nozzle
16600-37502, 16600-90012, 16600-90019, 16600-J5571, 16600-T3401, 16600-T3470, 16600-T6200, 16600-T6201, 16600-Y8400, 16600-Y8401.

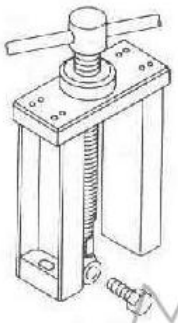
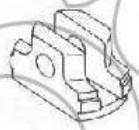
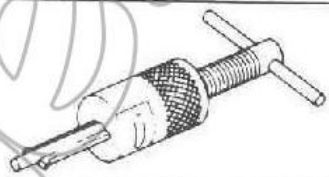
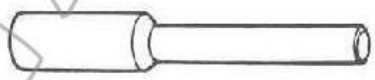
Engine internal parts

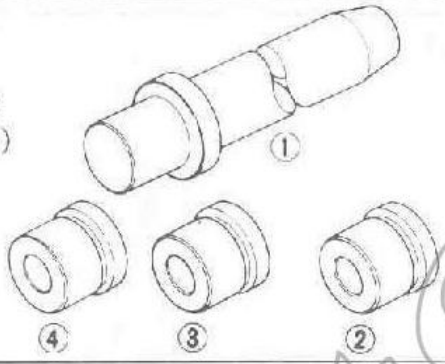
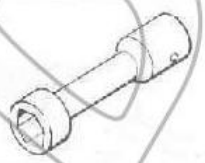
	N·m	kg-m	ft-lb
Main bearing cap bolt	167 - 172	17.0 - 17.5	123 - 127
Crank pulley nut	294 - 324	30 - 33	217 - 239
Flywheel bolt			
3 bearings & 4 bearings	44 - 49	4.5 - 5.0	33 - 36
5 bearings	88 - 98	9.0 - 10.0	65 - 72
Bolt w/washer	127 - 147	13 - 15	94 - 108
Front cover bolt			
M6	4 - 6	0.4 - 0.6	2.9 - 4.3
M8	10 - 13	1.0 - 1.3	7 - 9
Front end plate bolt	10 - 13	1.0 - 1.3	7 - 9
Camshaft gear bolt	44 - 49	4.5 - 5.0	33 - 36
Oil pump bolt	13 - 19	1.3 - 1.9	9 - 14
Oil pan bolt	7 - 10	0.7 - 1.0	5.1 - 7.2
Cylinder head bolt			
Sub	44 - 54	4.5 - 5.5	33 - 40
Main	118 - 127	12 - 13	87 - 94
Rocker arm shaft bolt	20 - 25	2.0 - 2.5	14 - 18
Rocker arm lock nut	20 - 25	2.0 - 2.5	14 - 18
Camshaft thrust plate bolt	4 - 6	0.4 - 0.6	2.9 - 4.3
Connecting rod big end nut			
SD22 and SD33	51 - 56	5.2 - 5.7	38 - 41
SD23 and SD25	67 - 71	6.8 - 7.2	49 - 52
Rocker cover bolt	10 - 13	1.0 - 1.3	7 - 9
Oil jet (for piston)	29 - 39	3 - 4	22 - 29

SPECIAL SERVICE TOOLS

Tool number	Tool name	Engine application			
		SD22	SD23	SD25	SD33
ST05300000	Engine attachment 	X	X	X	–
① KV11101800 ② KV10106500	Engine attachment Engine stand shaft 	–	–	–	X
ST0501S000 ① ST05011000 ② ST05012000	Engine stand assembly Engine stand Base 	X	X	X	X
KV111021S0 ① ST16660000 ② KV11101300	Crankshaft main bearing Cap puller Adapter 	X	–	–	X
KV10107900	Valve lip seal puller 	X	X	X	X

Tool number	Tool name	Engine application			
		SD22	SD23	SD25	SD33
KV101092S0 ① KV10109210 ② KV10109220	Valve spring compressor Compressor Adapter 	X	X	X	X
ST1101S000	Valve guide reamer 	X	–	–	X
KV101039S0 ① ST11081000 ② ST11032000 ③ ST11033000	Valve guide reamer set Reamer [12.2 mm (0.480 in) dia.] [8.0 mm (0.315 in) dia.] Valve guide drift 	–	X	X	–
KV111011S0 ① KV11101120 ② KV11101130	Valve seat remover Adapter (Exhaust) Adapter (Intake) 	X	–	–	X
KV111012S0 ① KV11101220 ② KV11101230 ③ KV11101240	Valve seat insert tool Adapter (Intake) Adapter (Exhaust) Adapter (Exhaust) 	X	–	–	X

Tool number	Tool name	Engine application			
		SD22	SD23	SD25	SD33
KV111023S0	Cylinder liner tool 	X	X	X	X
└KV11102320	Cylinder liner tool adapter 	–	X	X	–
KV11102500	Cylinder liner tool adapter 	X	–	–	X
ST16610001	Pilot bushing puller 	X	X	X	–
ST16690000	Pilot bushing puller 	–	–	–	X
KV11101000	Valve oil seal drift 	X	X	X	X
EM03470000	Piston ring compressor 	X	X	X	X
KV11100300	Nozzle holder socket 	X	X	X	X

Tool number	Tool name	Engine application			
		SD22	SD23	SD25	SD33
ST16650000 ① ST16650010 ② ST16650020 ③ ST16650030 ④ ST16650040	Cam bush replacer Bar Adapter (Front) Adapter (Center) Adapter (Rear) 	X	X	X	X
ST19530000	Injection pump timer puller 	X	X	X	X
ST19320000	Oil filter wrench 	X	X	X	X
KV11100400	Socket wrench 	X	X	X	X