

ENGINE MECHANICAL

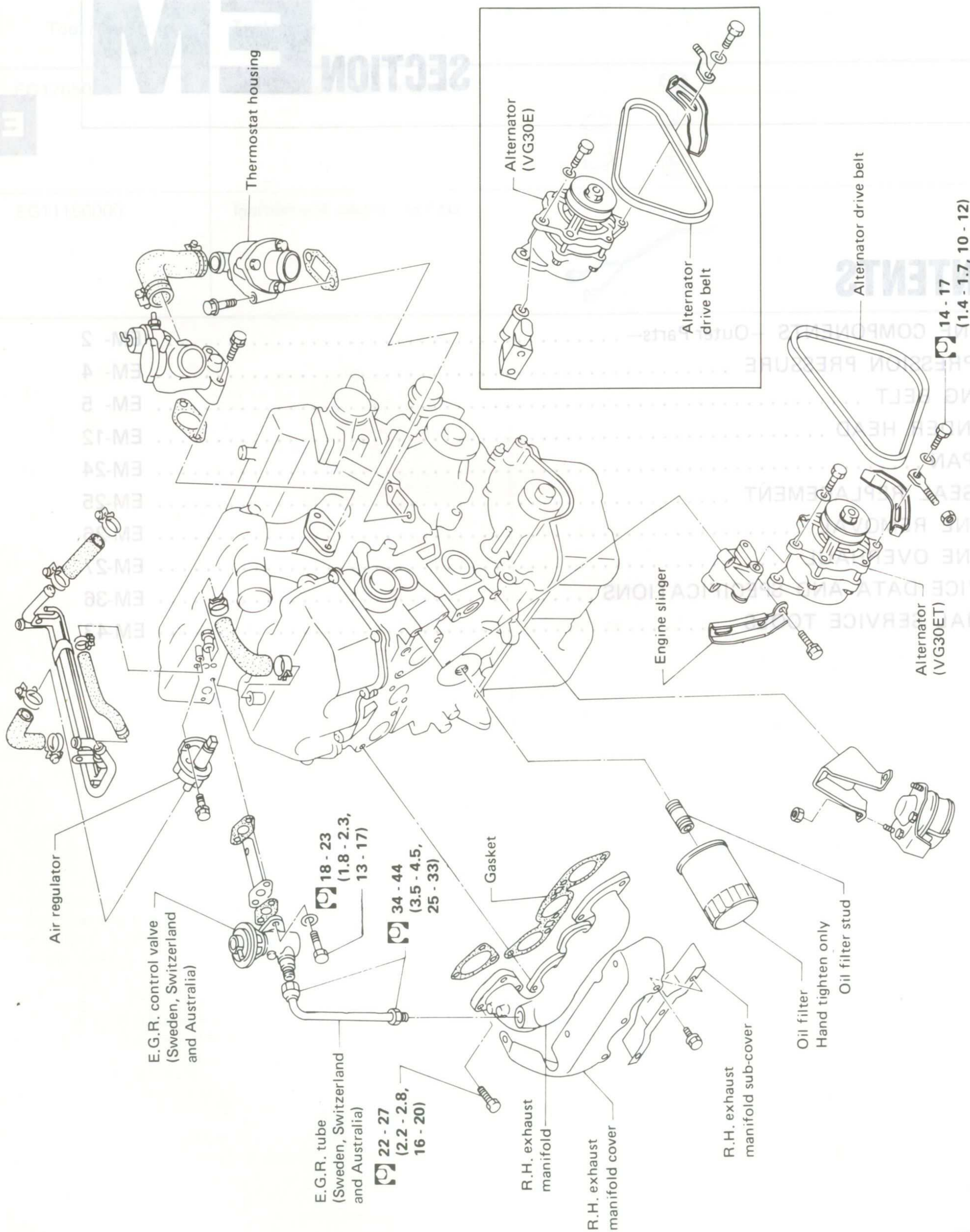
SECTION **EM**

EM

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ENGINE COMPONENTS —Outer Parts—

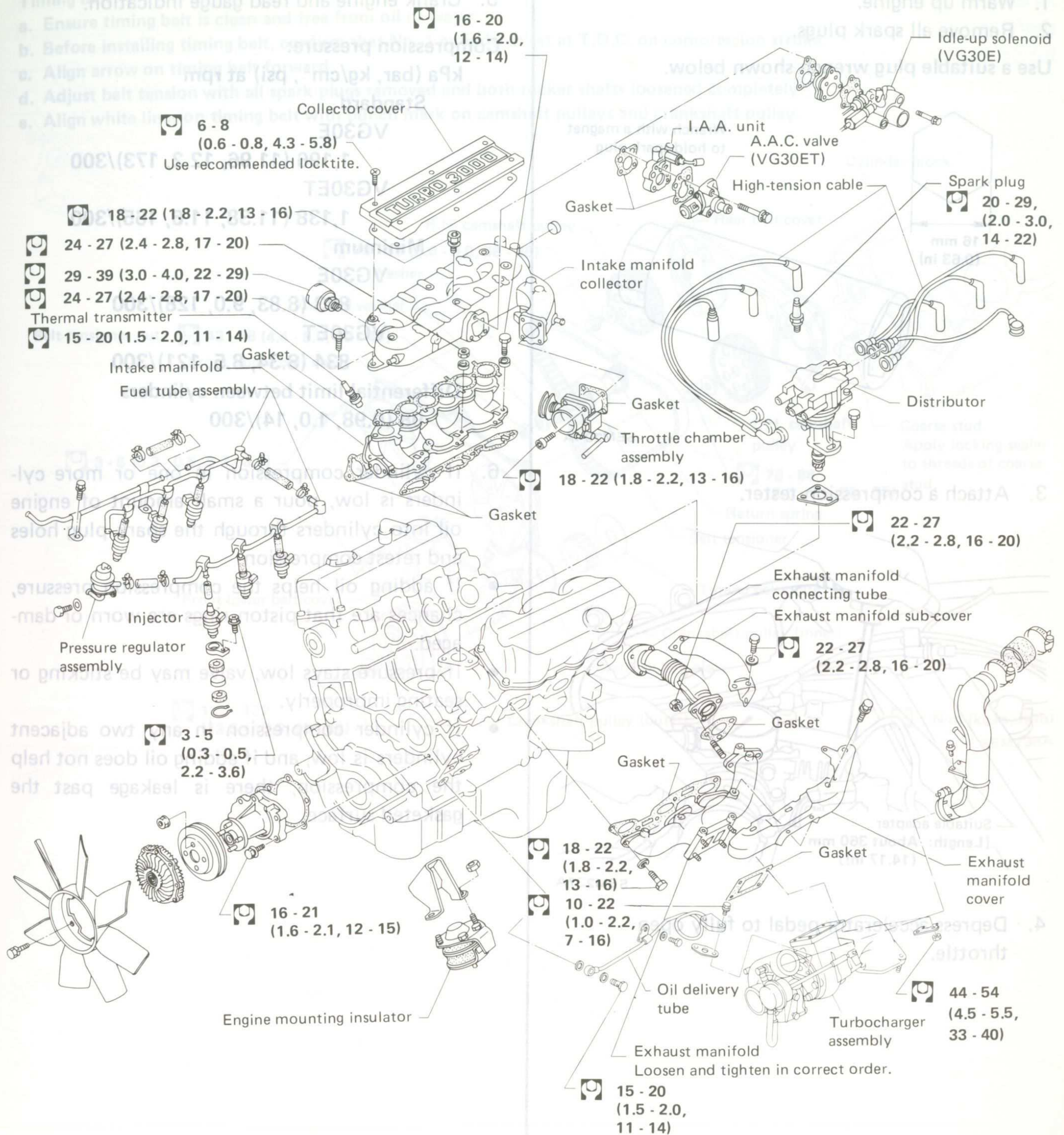


□ : N·m (kg-m, ft-lb)

14 - 17
(1.4 - 1.7, 10 - 12)

SEM234A

ENGINE COMPONENTS —Outer Parts—



- Use new gaskets, O-rings and bronze washers.
- As for tightening order of exhaust manifolds and collector, refer to Cylinder Head.

: N·m (kg-m, ft-lb)

SEM704A

COMPRESSION PRESSURE

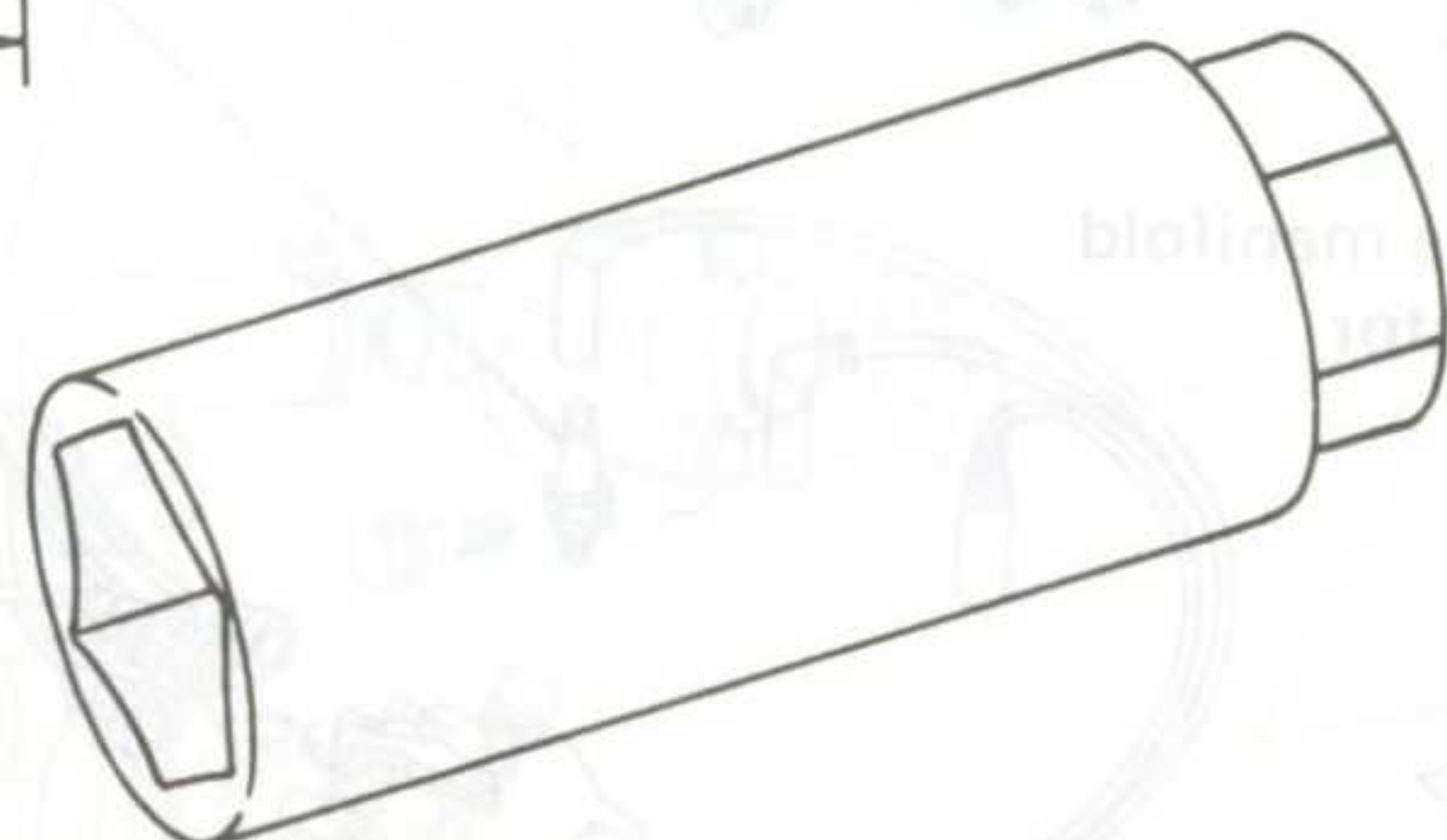
Measurement of Compression Pressure

1. Warm up engine.
2. Remove all spark plugs.

Use a suitable plug wrench shown below.

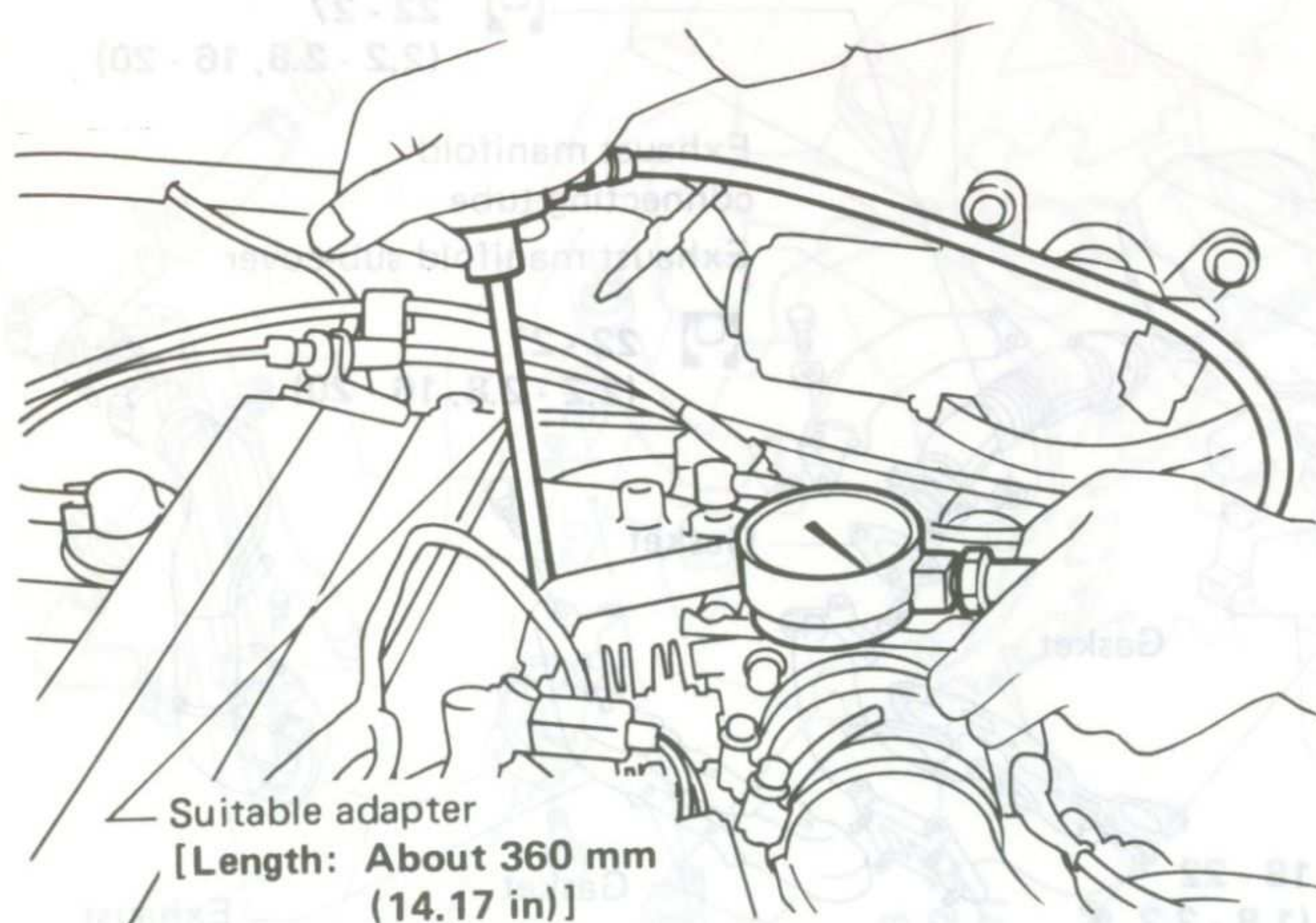


Wrench with a magnet to hold spark plug



SEM294A

3. Attach a compression tester.



SEM237A

4. Depress accelerator pedal to fully open throttle.

5. Crank engine and read gauge indication.

Compression pressure:

kPa (bar, kg/cm², psi) at rpm

Standard

VG30E

1,196 (11.96, 12.2, 173)/300

VG30ET

1,138 (11.38, 11.6, 165)/300

Minimum

VG30E

883 (8.83, 9.0, 128)/300

VG30ET

834 (8.34, 8.5, 121)/300

Differential limit between cylinders

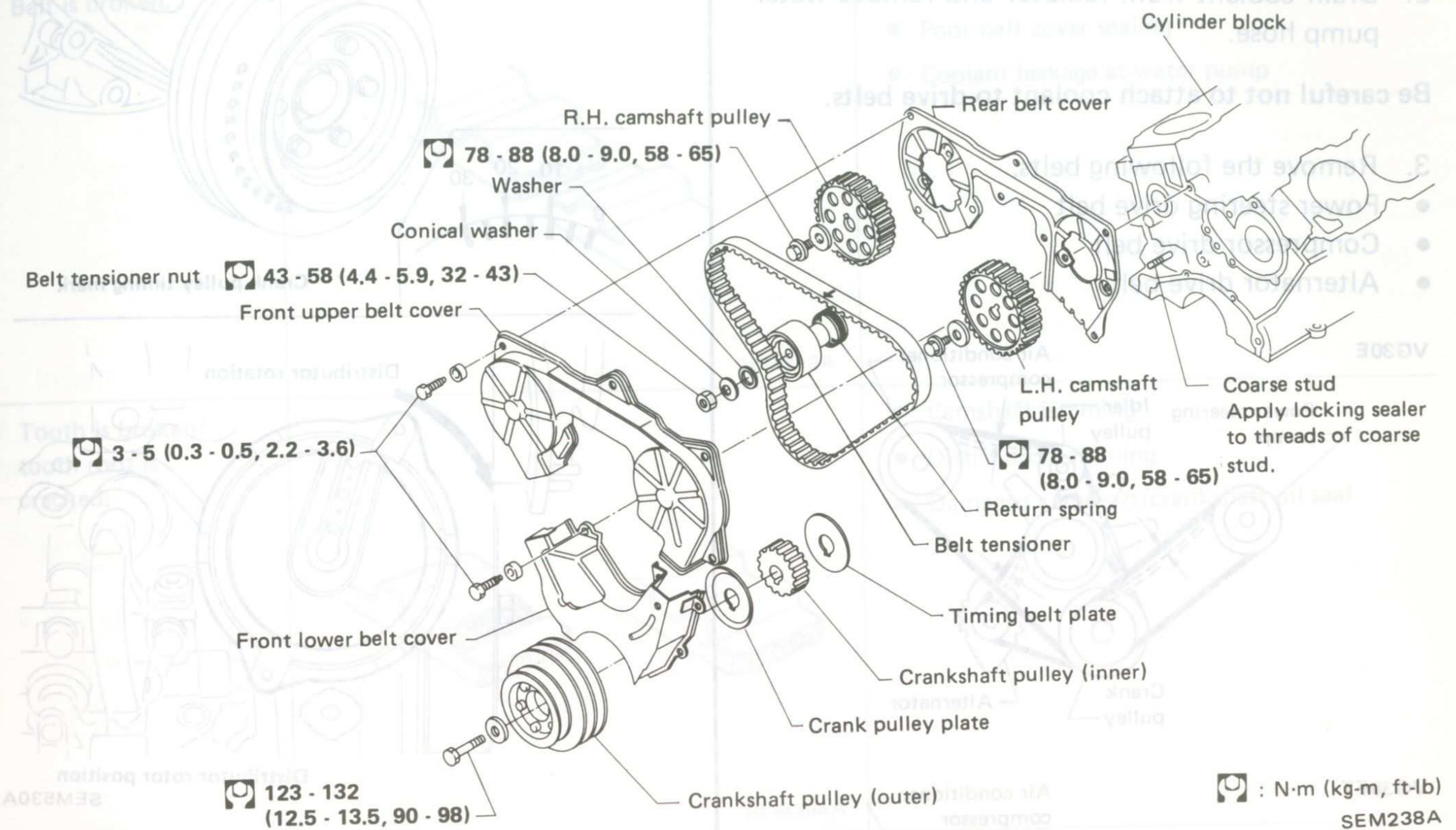
98 (0.98, 1.0, 14)/300

6. If cylinder compression in one or more cylinders is low, pour a small amount of engine oil into cylinders through the spark plug holes and retest compression.
 - If adding oil helps the compression pressure, chances are that piston rings are worn or damaged.
 - If pressure stays low, valve may be sticking or seating improperly.
 - If cylinder compression in any two adjacent cylinders is low, and if adding oil does not help the compression, there is leakage past the gasketed surface.

TIMING BELT

Timing belt

- Ensure timing belt is clean and free from oil or water.
- Before installing timing belt, confirm that No. 1 cylinder is set at T.D.C. on compression stroke.
- Align arrow on timing belt forward.
- Adjust belt tension with all spark plugs removed and both rocker shafts loosened completely.
- Align white lines on timing belt with punch mark on camshaft pulleys and crankshaft pulley.



TIMING BELT

Removal

After removing cylinder head, do not rotate crankshaft and camshaft separately, because valves will hit piston heads.

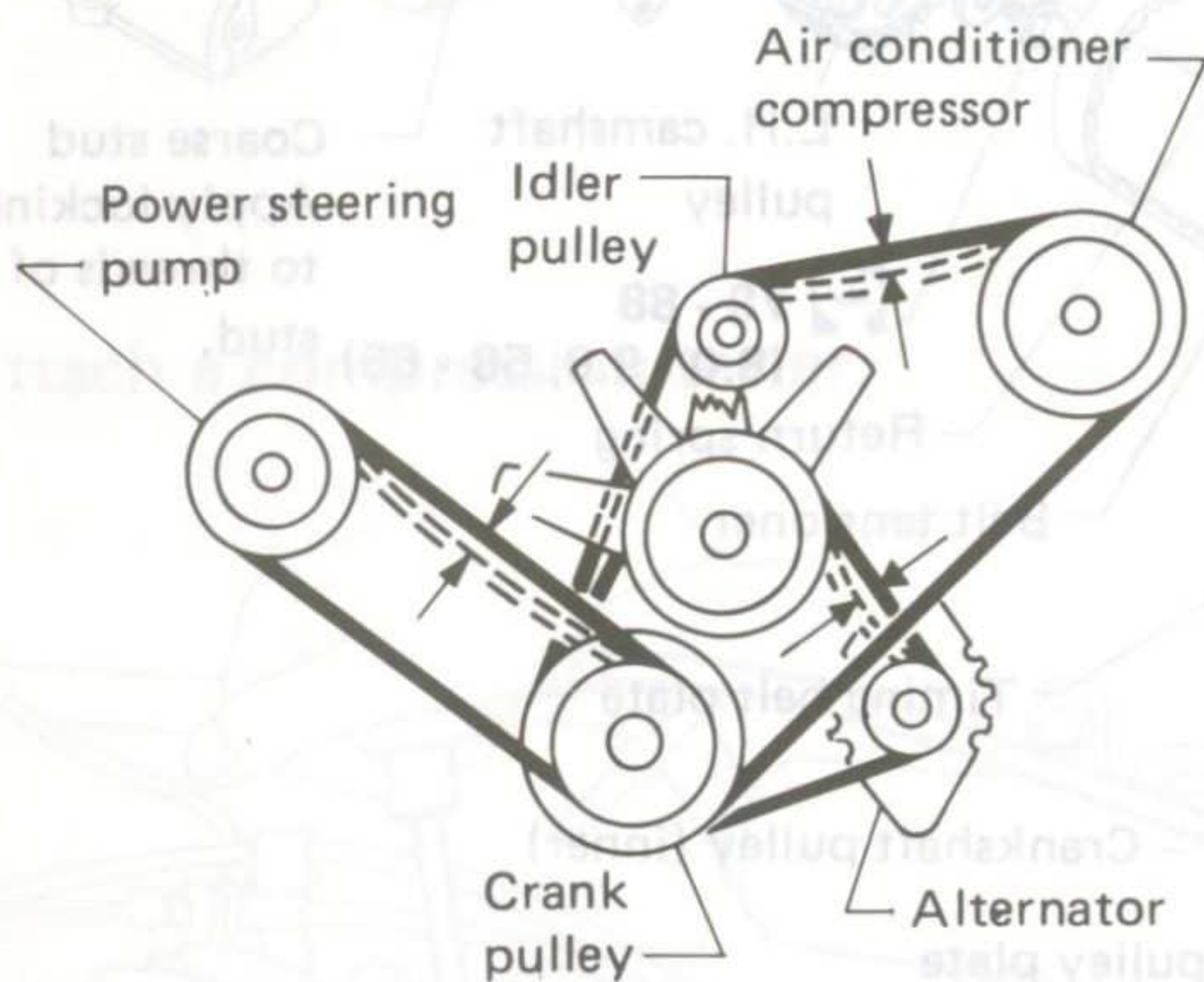
1. Remove radiator shroud, fan and pulleys (if equipped).
2. Drain coolant from radiator and remove water pump hose.

Be careful not to attach coolant to drive belts.

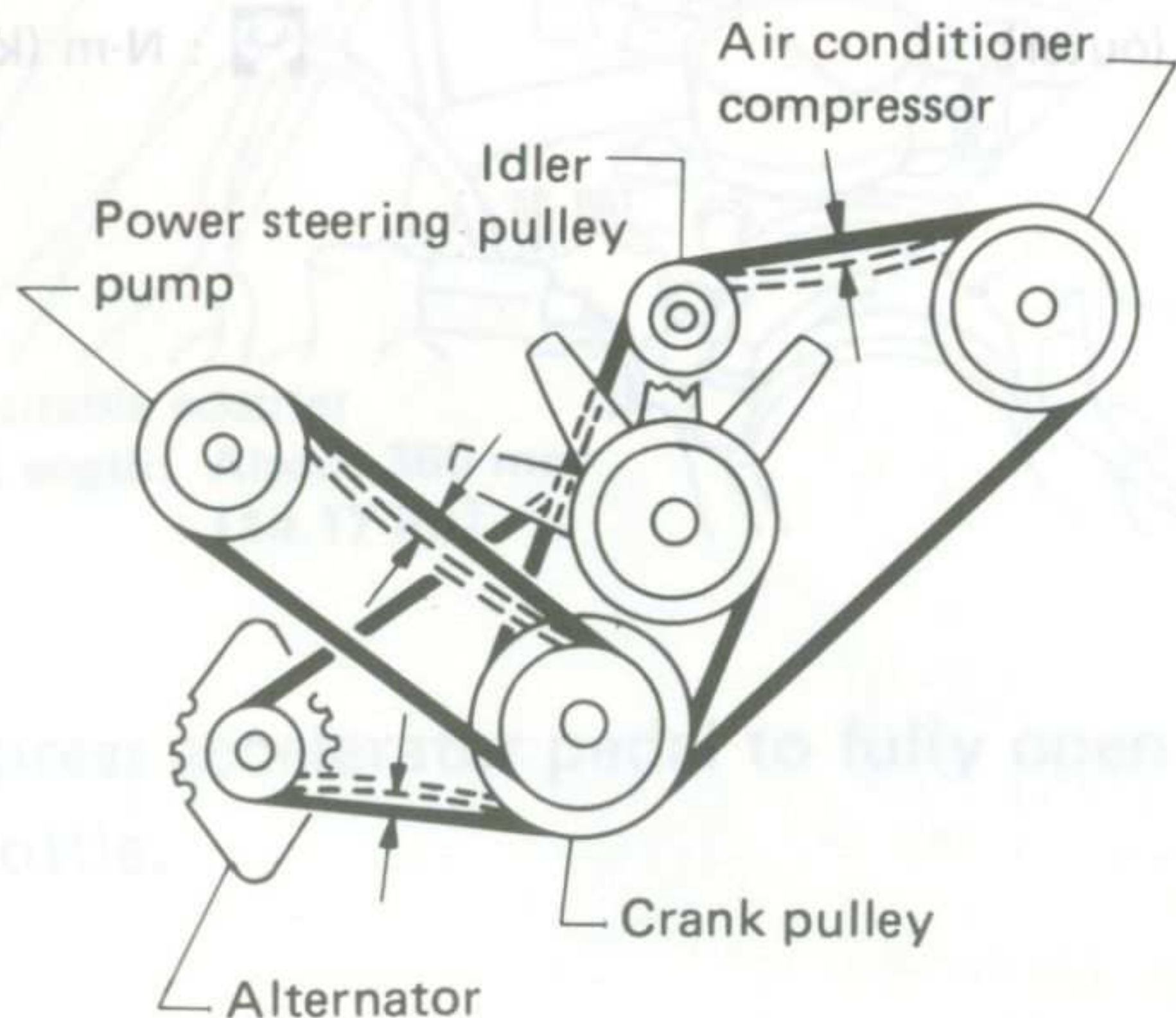
3. Remove the following belts.

- Power steering drive belt
- Compressor drive belt
- Alternator drive belt

VG30E

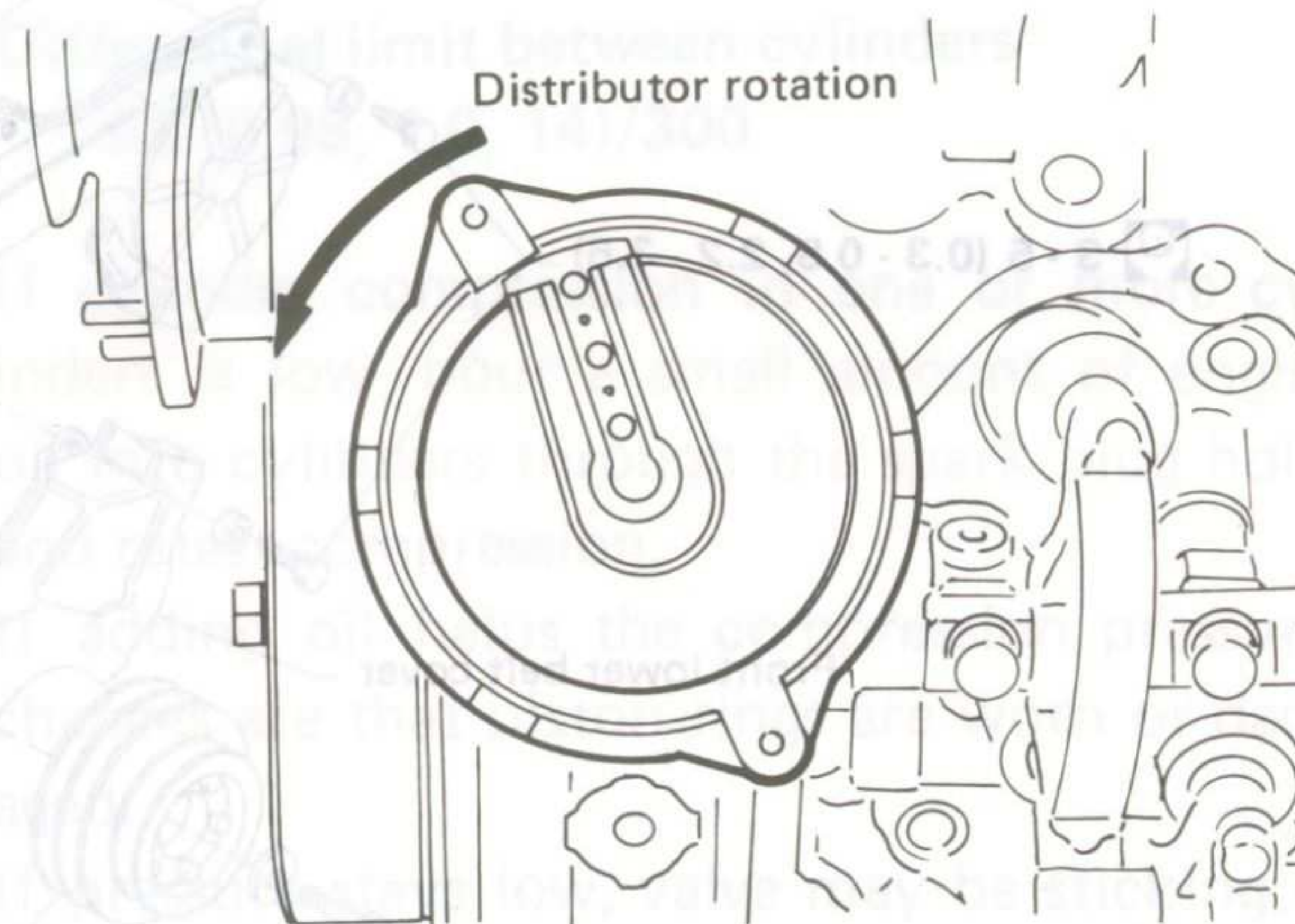
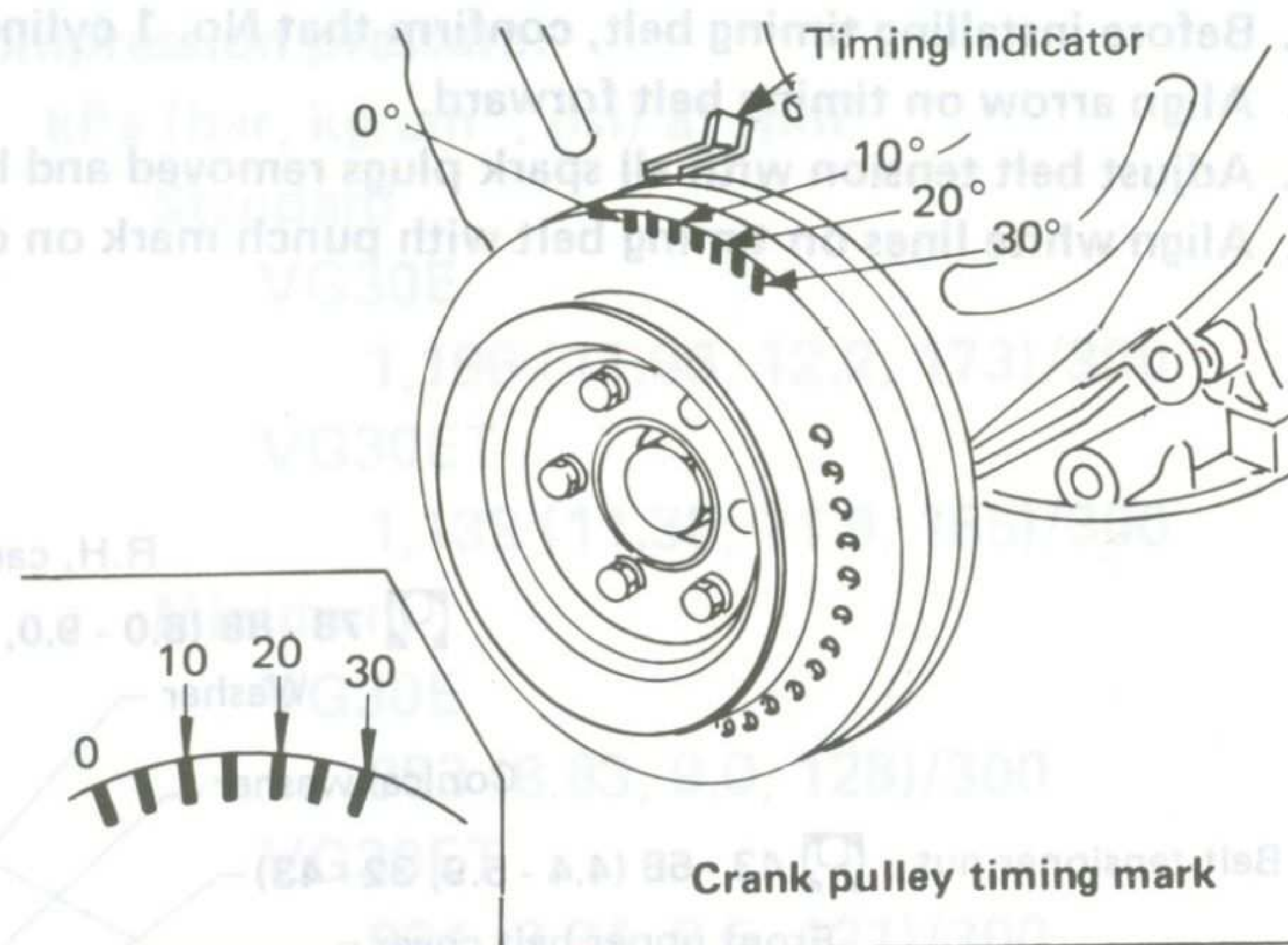


VG30ET



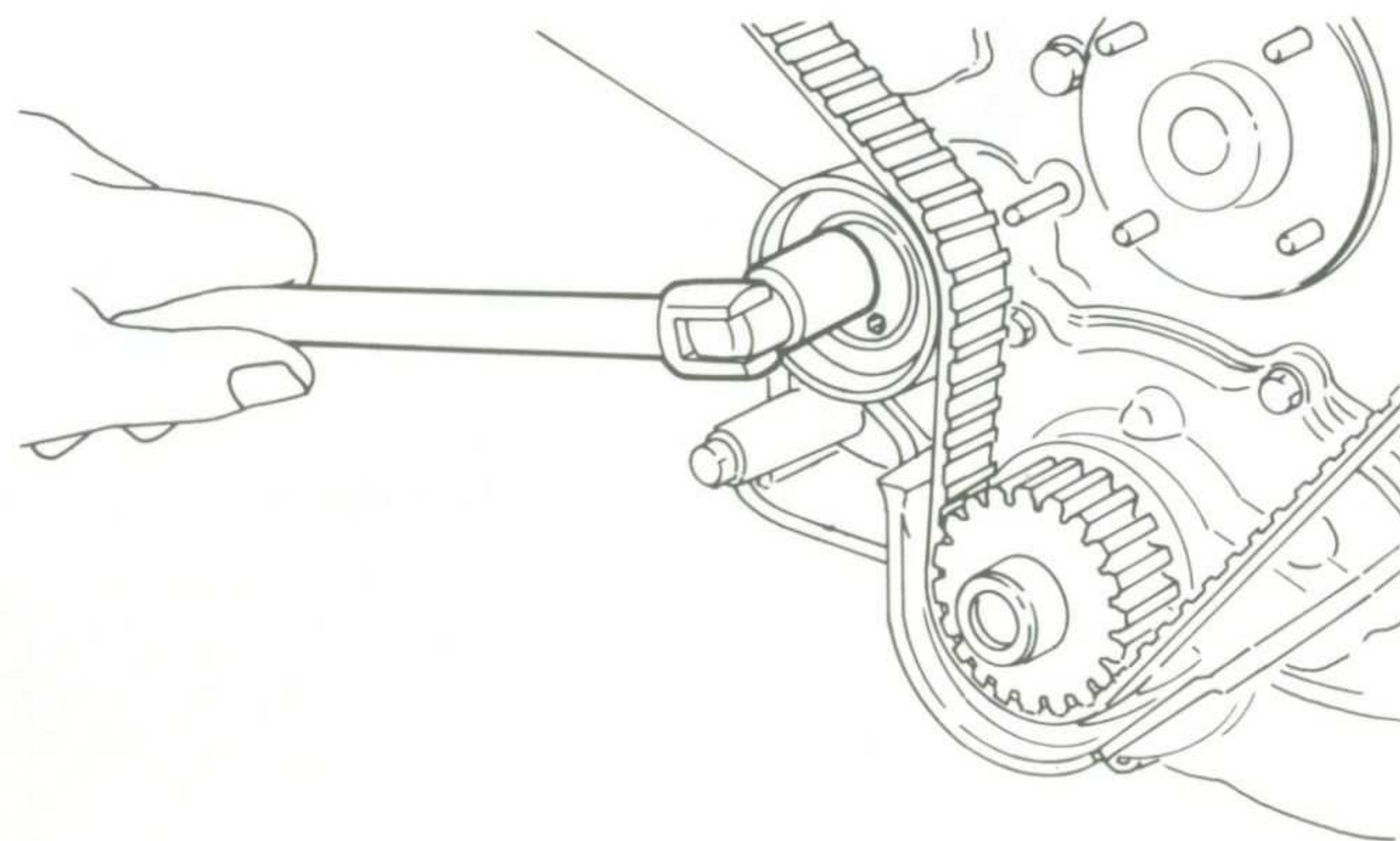
SEM239A

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



SEM530A

5. Remove front upper and lower belt covers.
6. Loosen timing belt tensioner and return spring then remove timing belt.

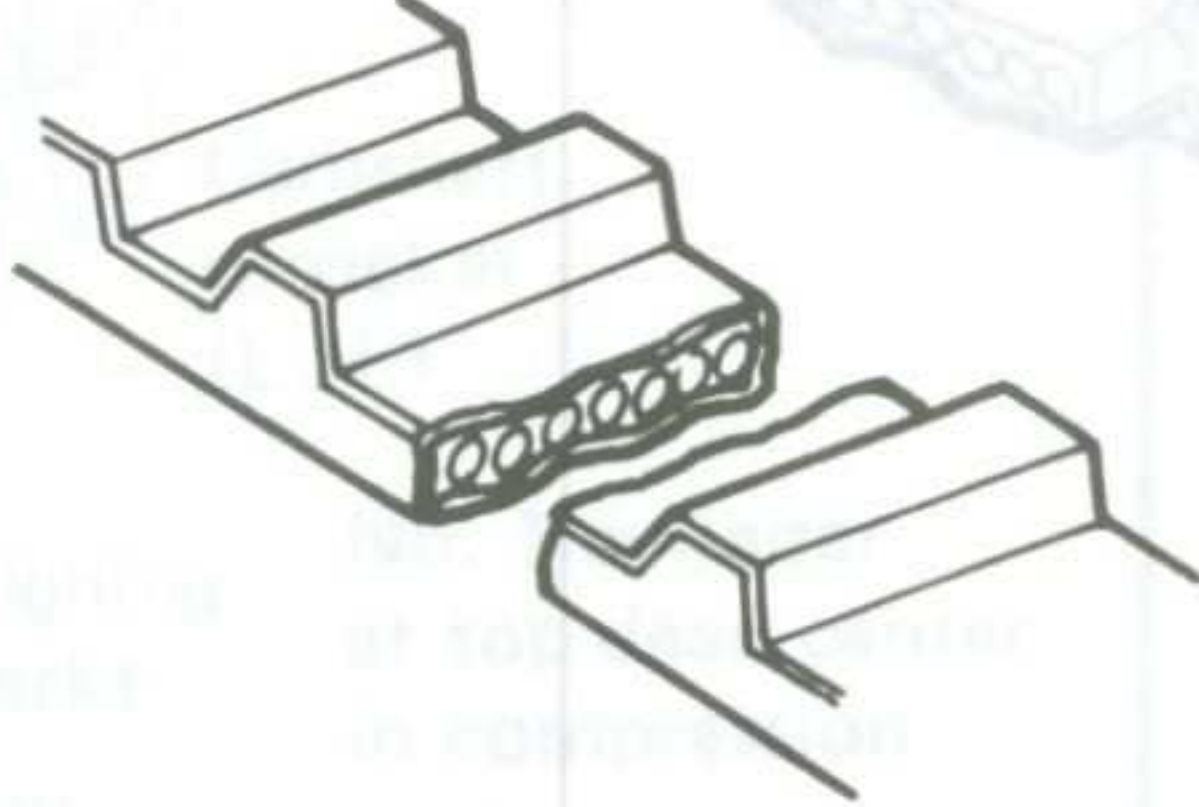
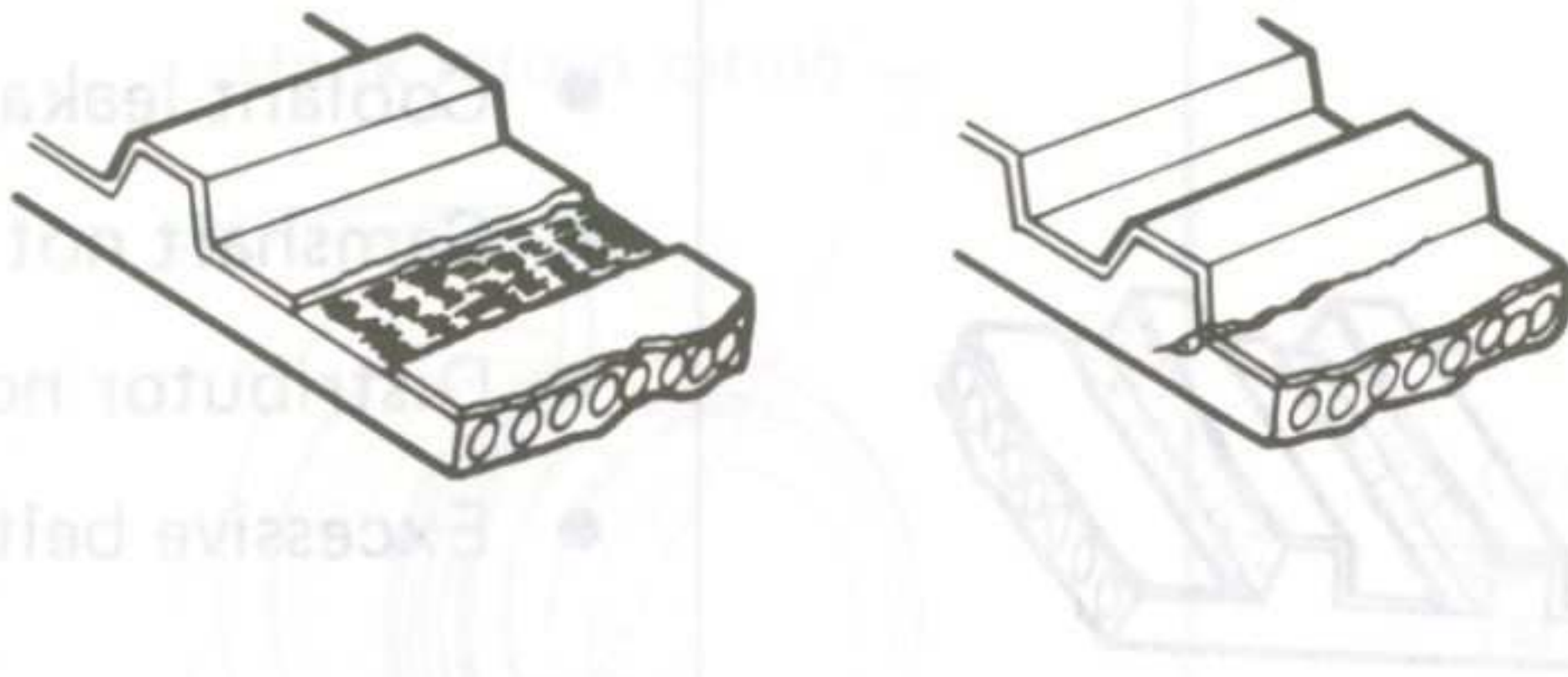
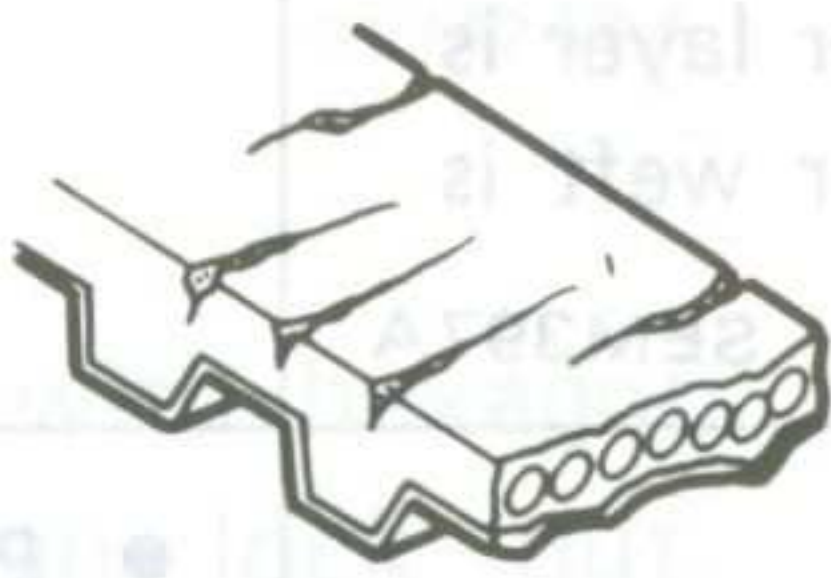


SEM240A

TIMING BELT

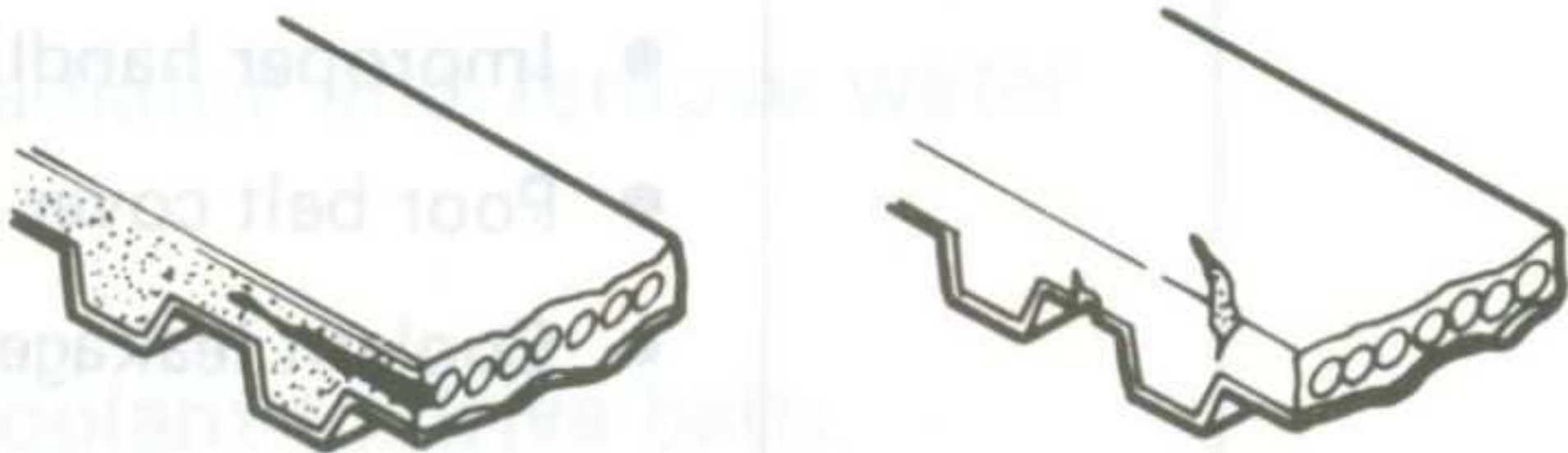
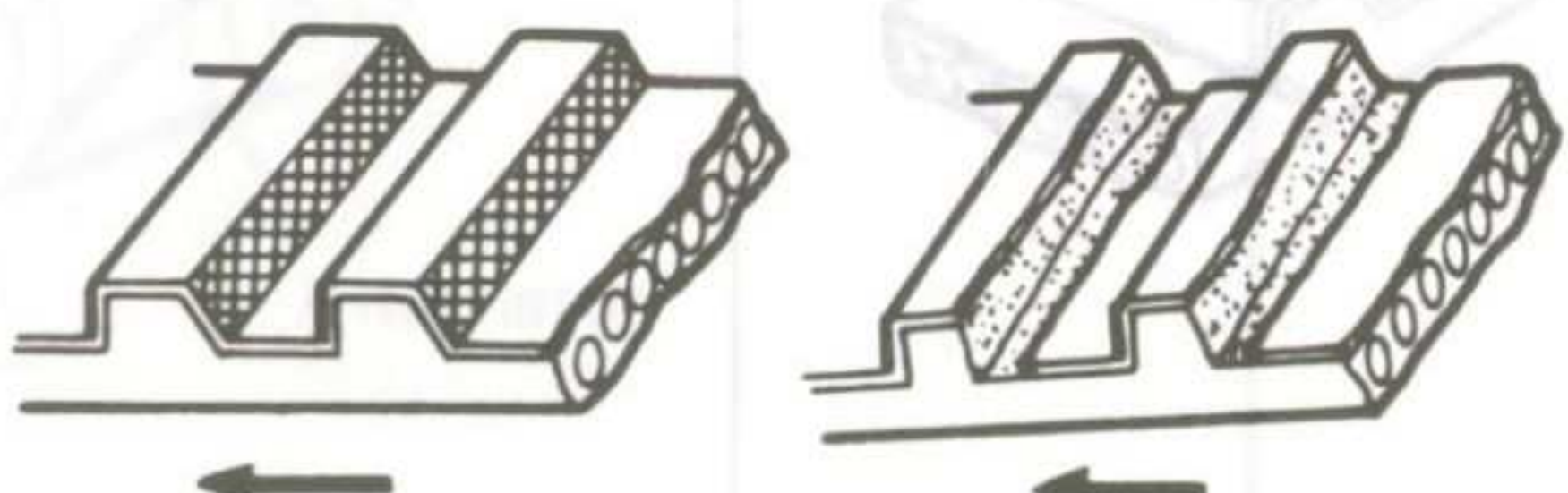
Inspection

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

Item to check	Problem	Cause
Belt is broken.	 SEM393A	- Improper handling - Poor belt cover sealing - Coolant leakage at water pump
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

TIMING BELT

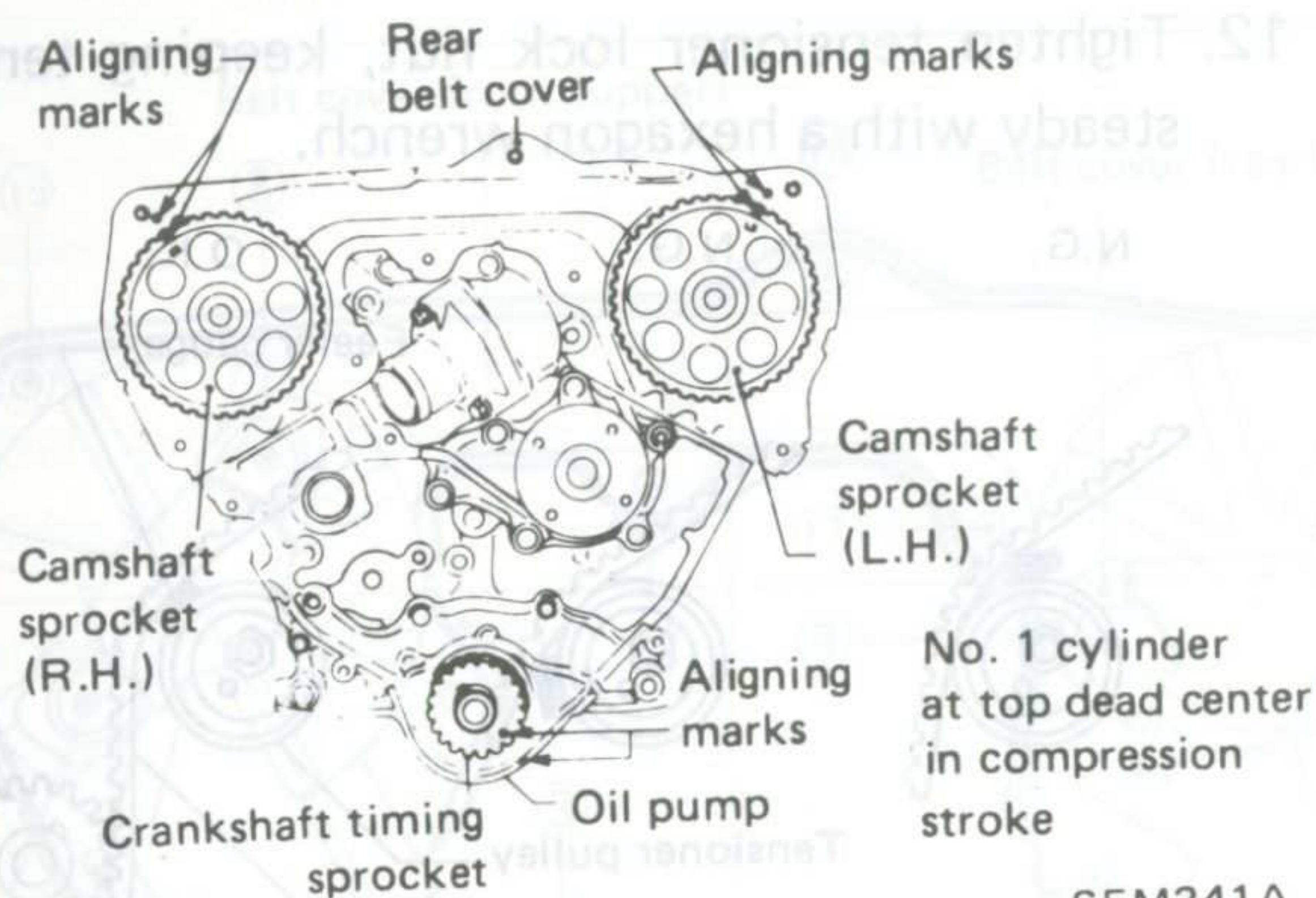
Inspection (Cont'd)

Item to check	Problem	Cause
Side surface is worn.	 - Side surface of belt is worn to such an extent that there is no trace of cutoff performed during manufacturing process. - Belt corners are worn and round. - Wicks are frayed and coming out.	- Improper installation of belt - Malfunctioning crank pulley plate/timing belt plate
Teeth are worn.	 - Canvas on tooth face is worn down. - Canvas on tooth is fluffy, rubber layer is worn down and faded white, or weft is worn down and invisible.	- Poor belt cover sealing - Coolant leakage at water pump - Camshaft not functioning properly - Distributor not functioning properly - Excessive belt tension
Oil/Coolant or water is stuck to belt.		- Poor oil sealing of each oil seal - Coolant leakage at water pump - Poor belt cover sealing

TIMING BELT

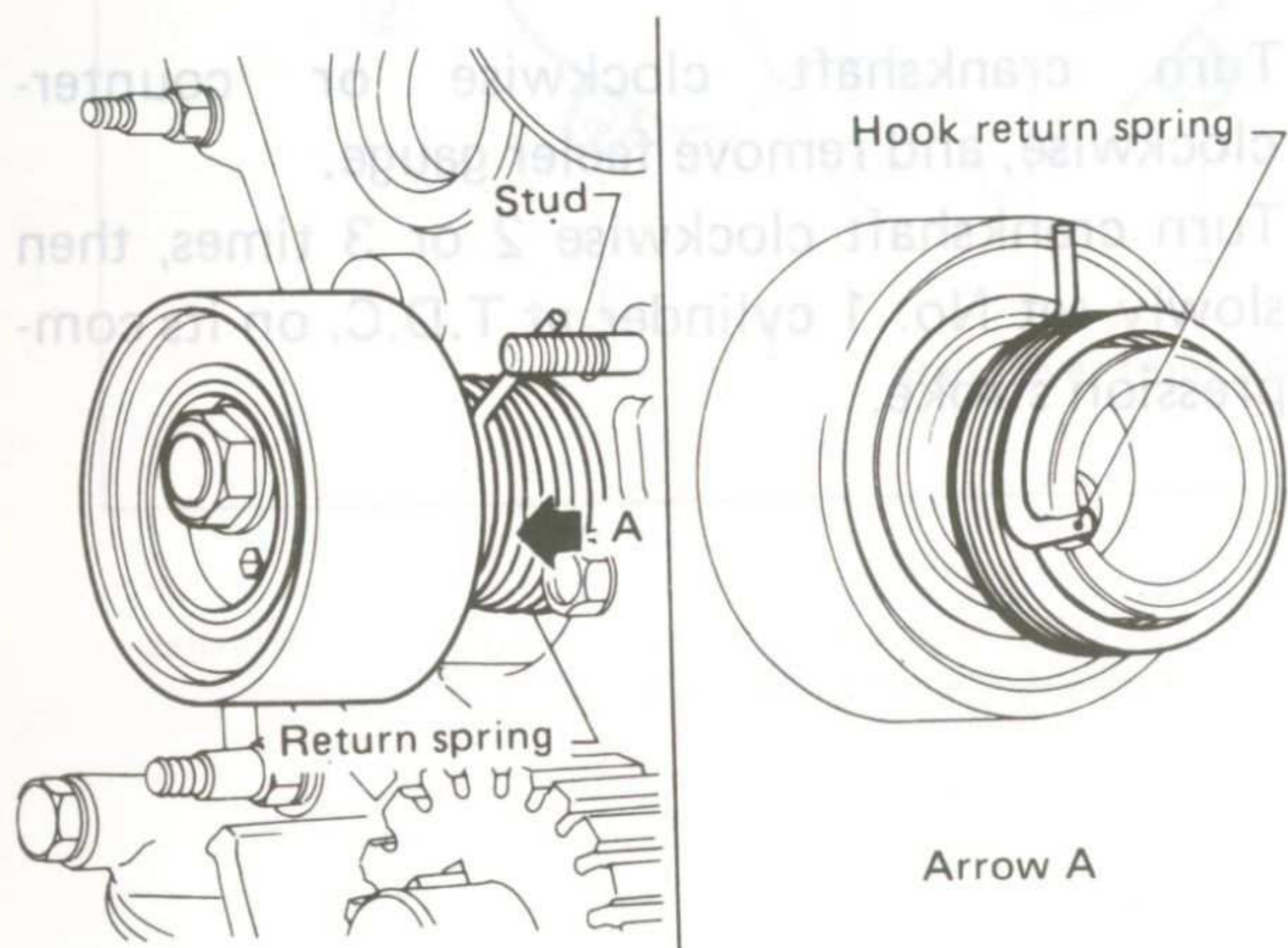
Installation

1. Confirm that No. 1 cylinder is set at T.D.C. on its compression stroke.

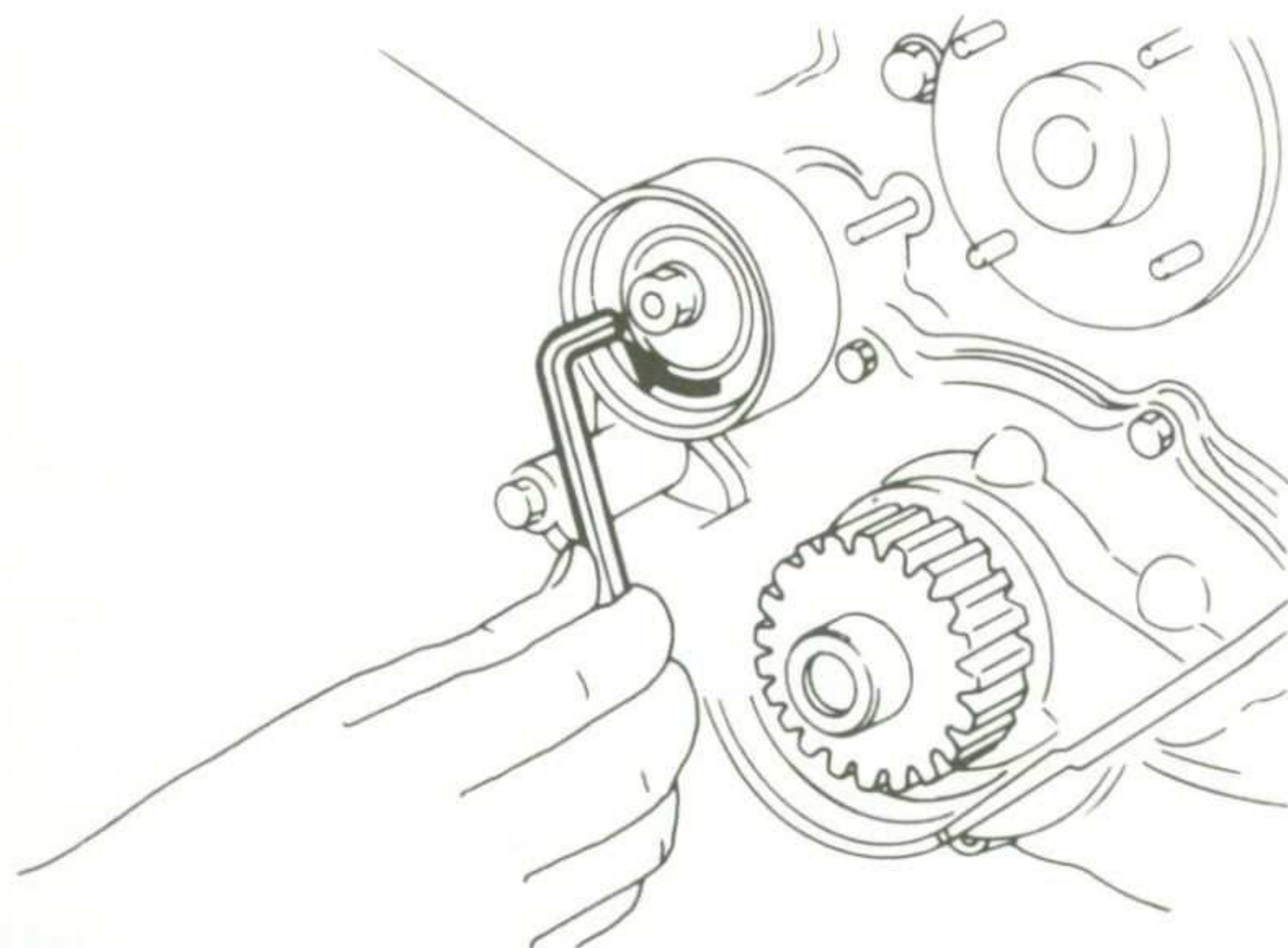


2. Install tensioner and tensioner spring.

If stud is once removed, apply locking sealant to threads of stud before installing.



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

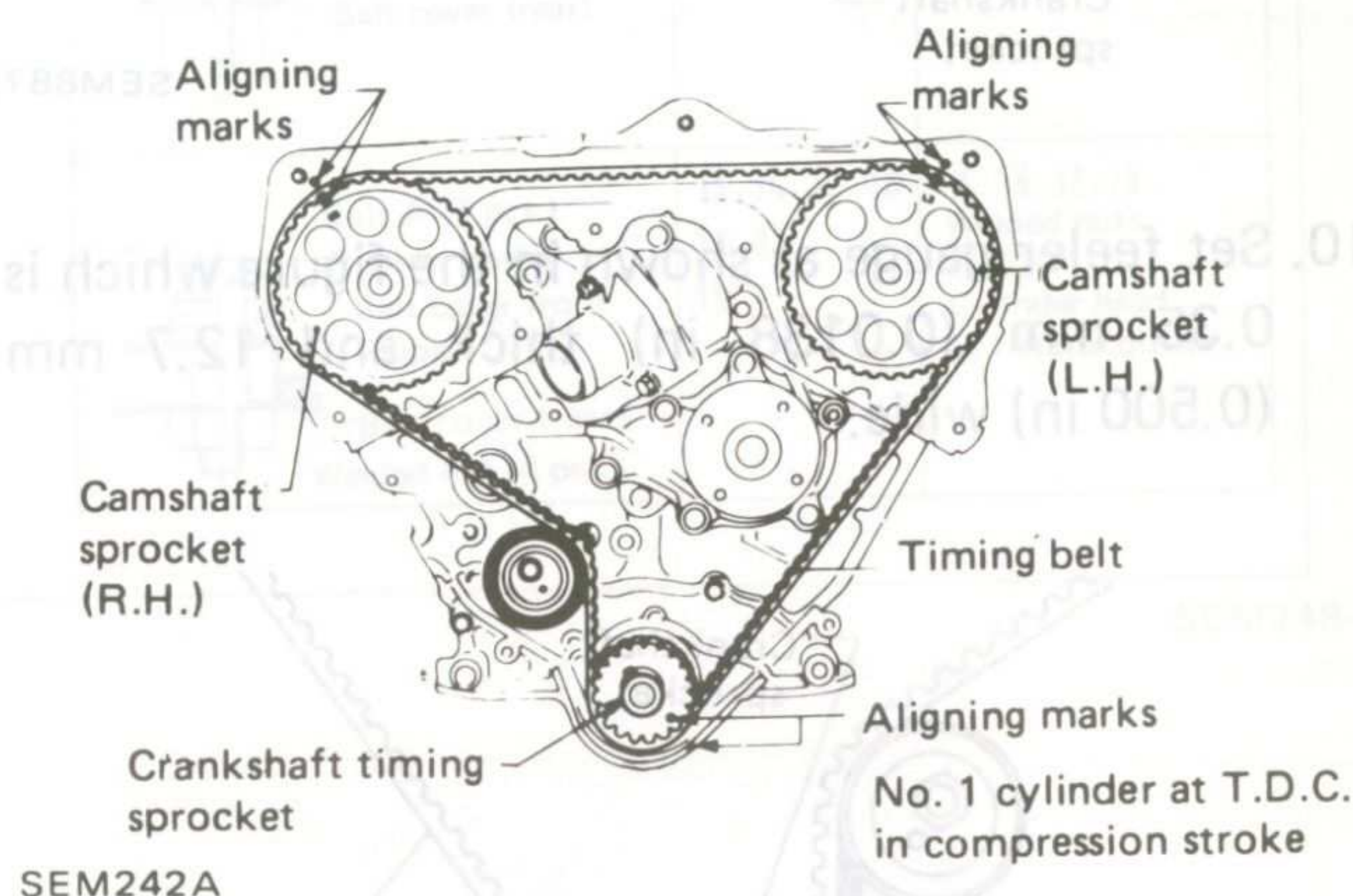


4. Set timing belt.
 - (1) Align white lines on timing belt with punch marks on camshaft sprockets and crankshaft sprocket.
 - (2) Point arrow on timing belt toward front belt cover.

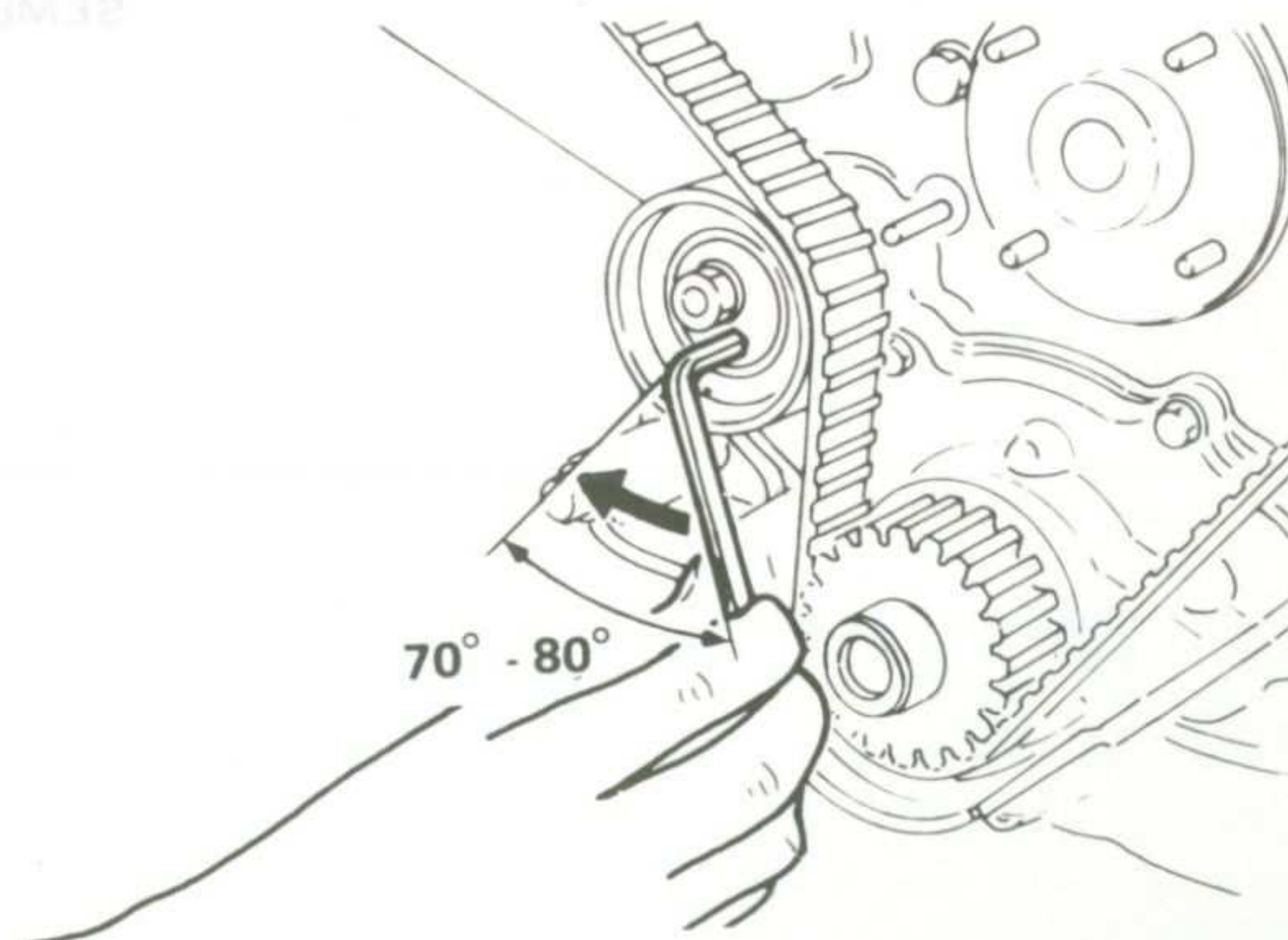
Number of teeth (reference):

Number of timing belt teeth		133
Number of teeth between timing marks	Between L.H. and R.H. camshaft sprockets	40
	Between L.H. camshaft sprocket and crankshaft timing sprocket	43

5. Loosen tensioner lock nut, keeping tensioner steady with a hexagon wrench.



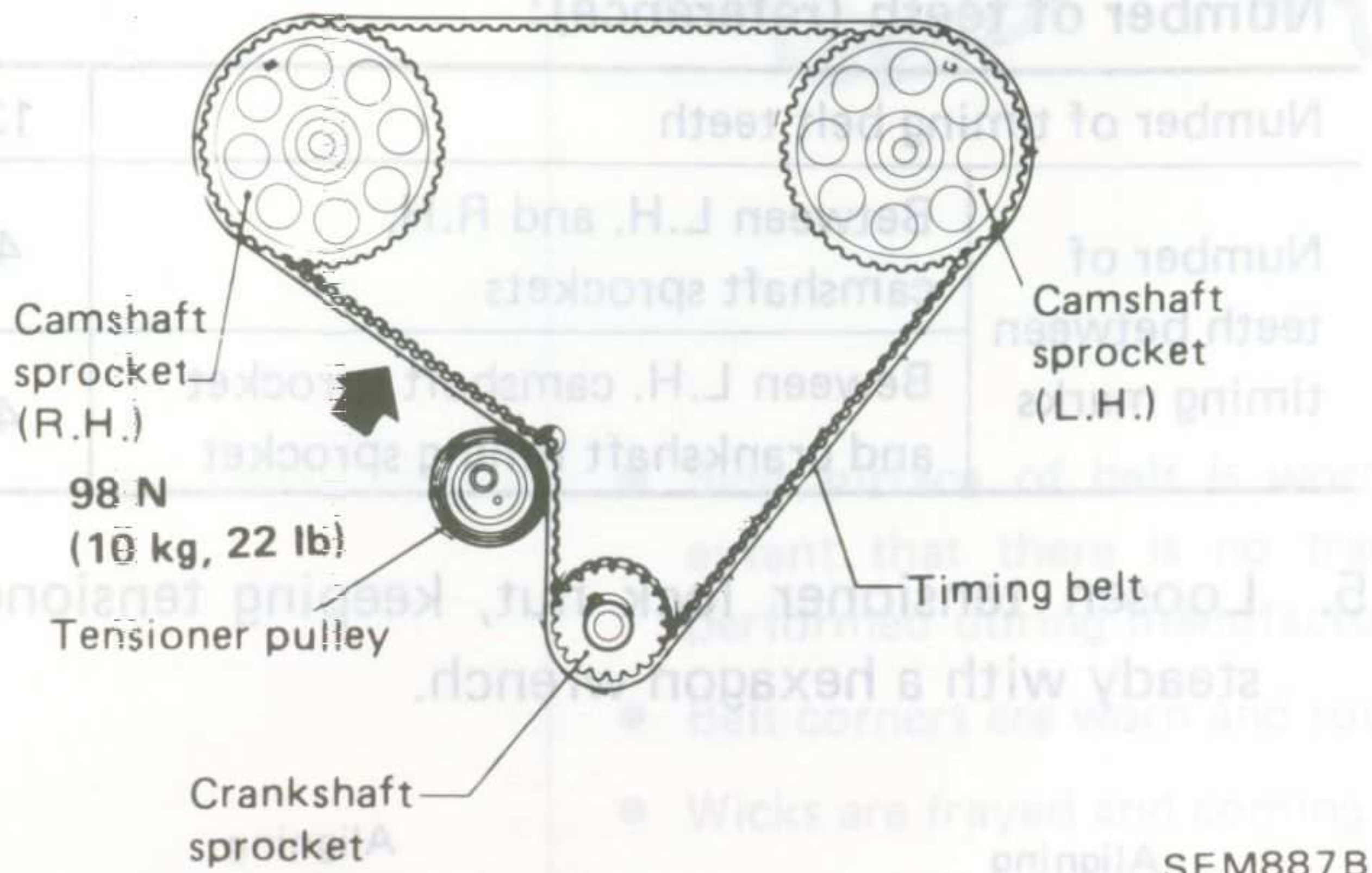
6. Turn tensioner 70 to 80 degrees clockwise with hexagon wrench, and temporarily tighten lock nut.
7. Turn crankshaft clockwise 2 or 3 times, then slowly set No. 1 cylinder at T.D.C. on its compression stroke.



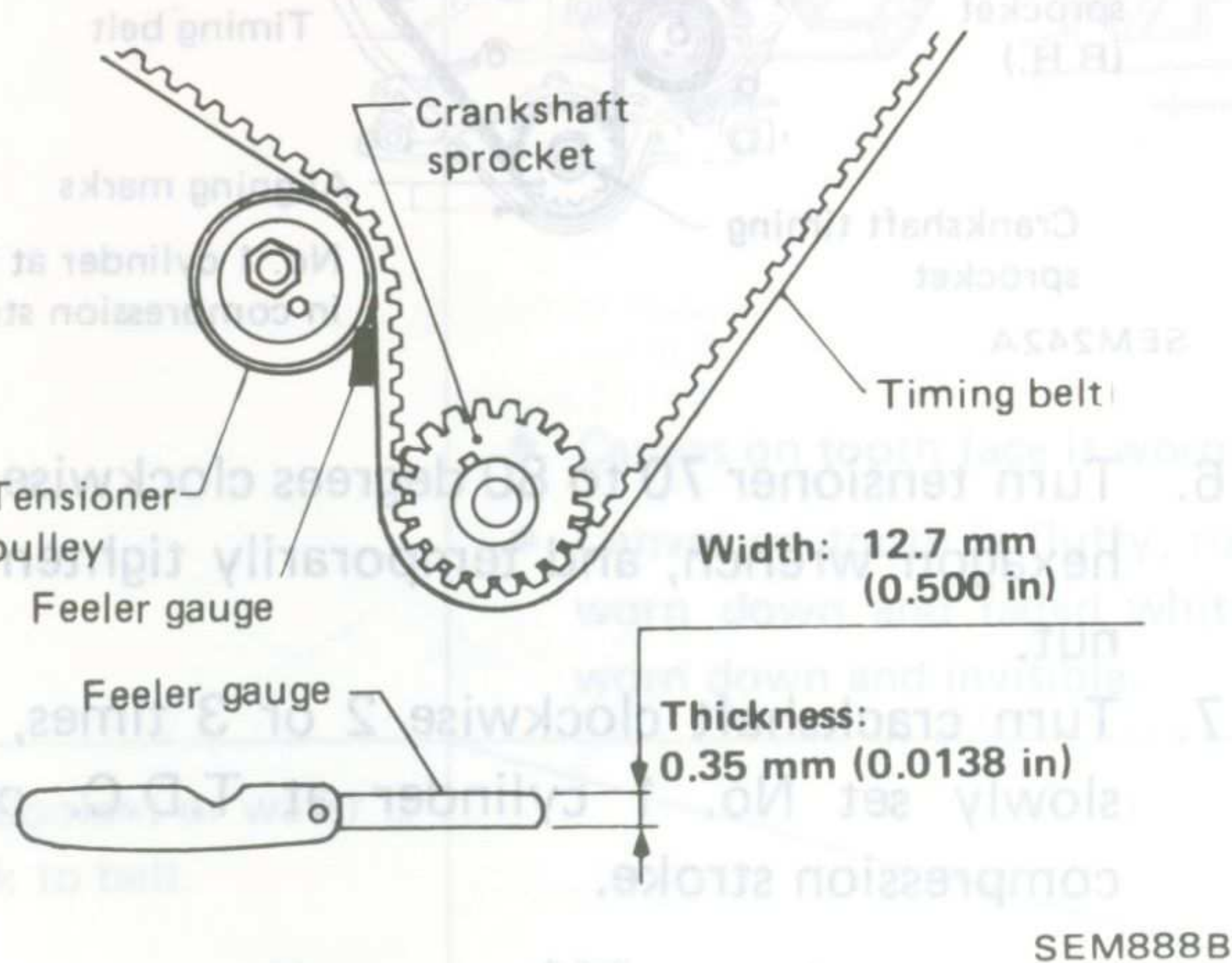
TIMING BELT

Installation (Cont'd)

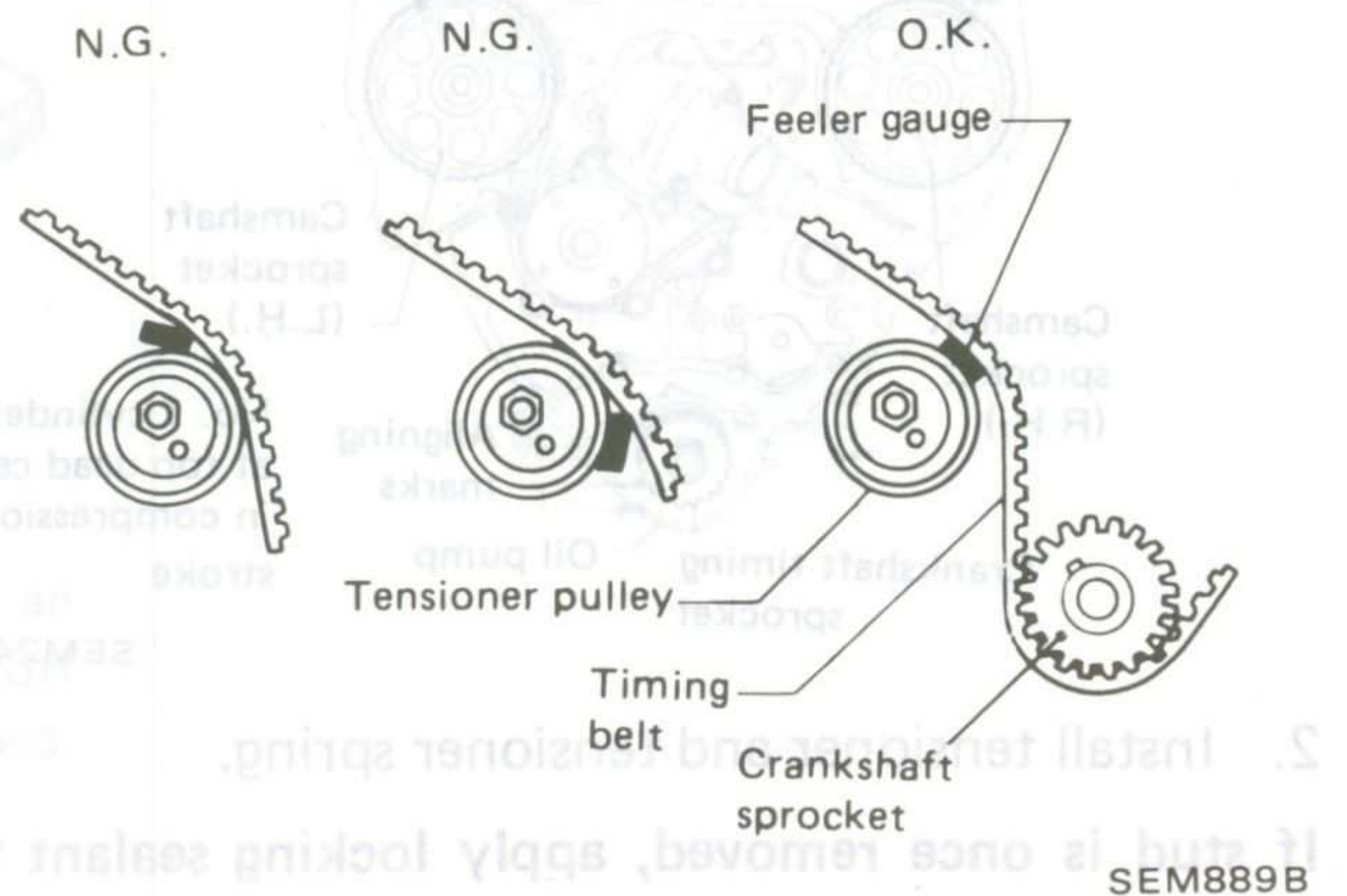
8. Push middle of timing belt between R.H. camshaft sprocket and tensioner pulley with force of 98 N (10 kg, 22 lb).
9. Loosen tensioner lock nut, keeping tensioner steady with a hexagon wrench.



10. Set feeler gauge as shown in the figure which is 0.35 mm (0.0138 in) thick and 12.7 mm (0.500 in) wide.



11. Turn crankshaft clockwise, and set feeler gauge as shown in the figure.
 - Timing belt will move about 2.5 teeth.
12. Tighten tensioner lock nut, keeping tensioner steady with a hexagon wrench.

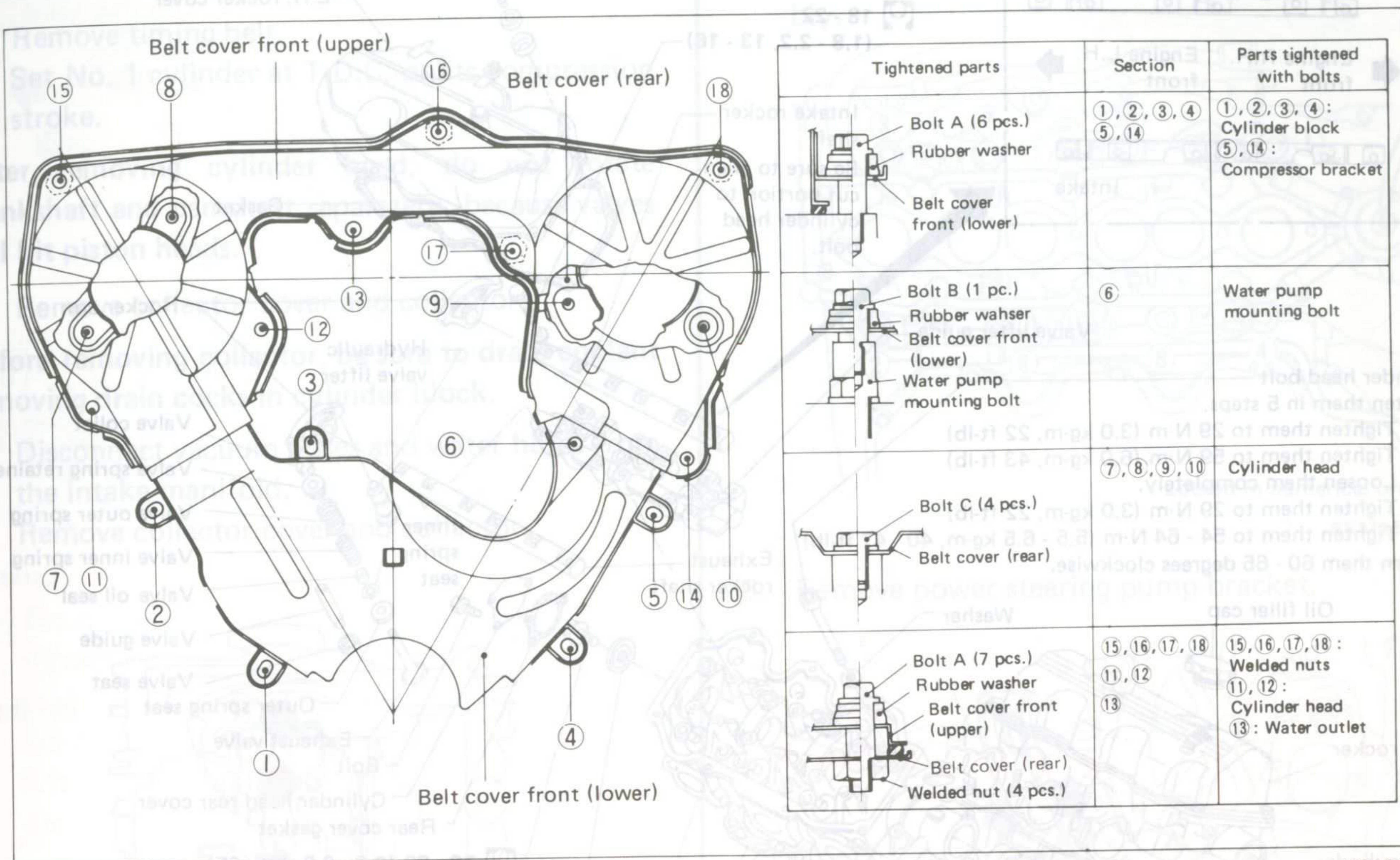


13. Turn crankshaft clockwise or counter-clockwise, and remove feeler gauge.
14. Turn crankshaft clockwise 2 or 3 times, then slowly set No. 1 cylinder at T.D.C. on its compression stroke.

TIMING BELT

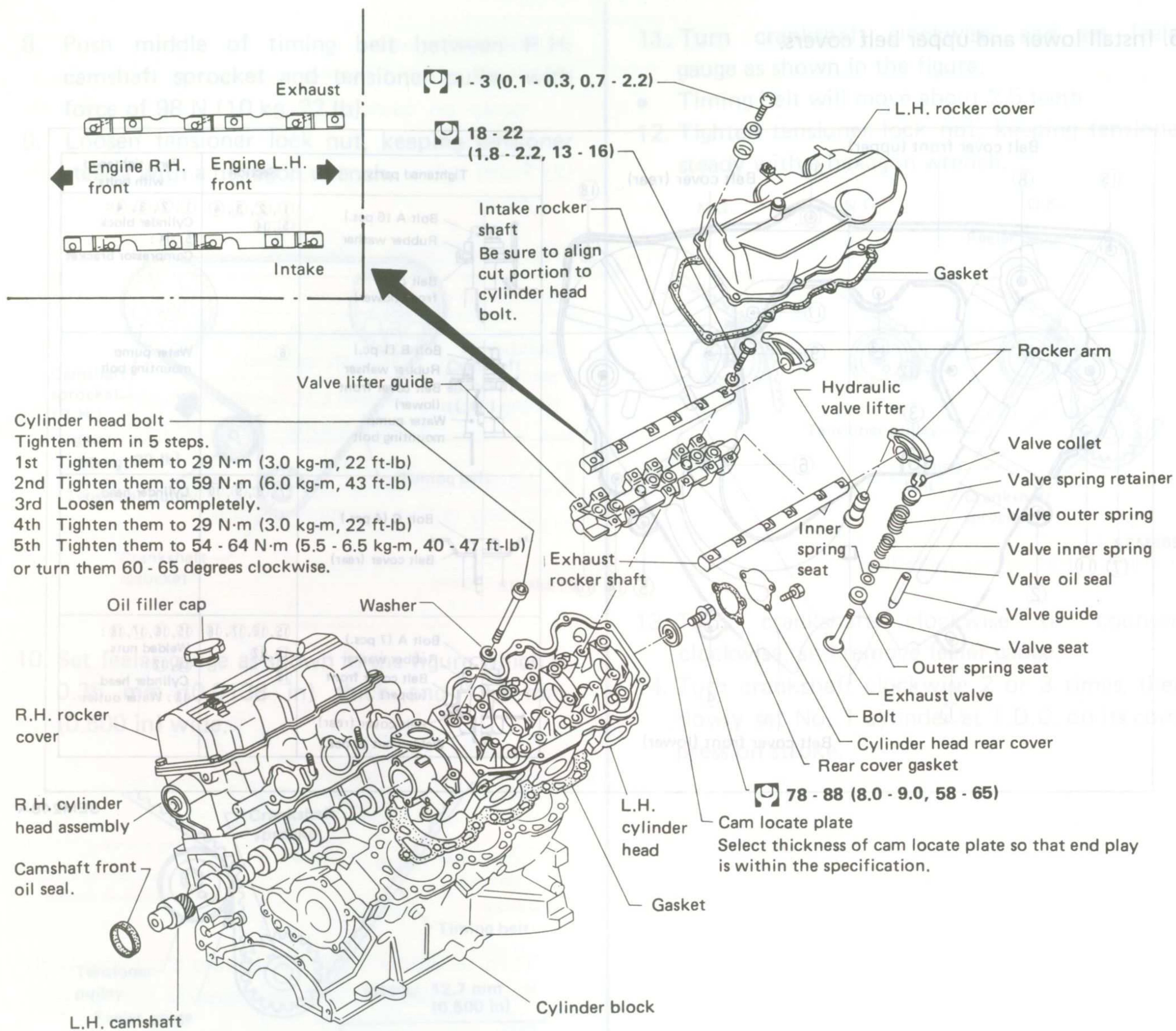
Installation (Cont'd)

15. Install lower and upper belt covers.



SEM248A

CYLINDER HEAD



- When installing sliding parts such as bearings, be sure to apply engine oil on the sliding surfaces.
- Use new gaskets and oil seals.

: N·m (kg-m, ft-lb)

SEM250A

CYLINDER HEAD

Removal

To facilitate removal of both cylinder heads, it is advisable to dismount the engine as a unit in advance.

1. Remove timing belt.

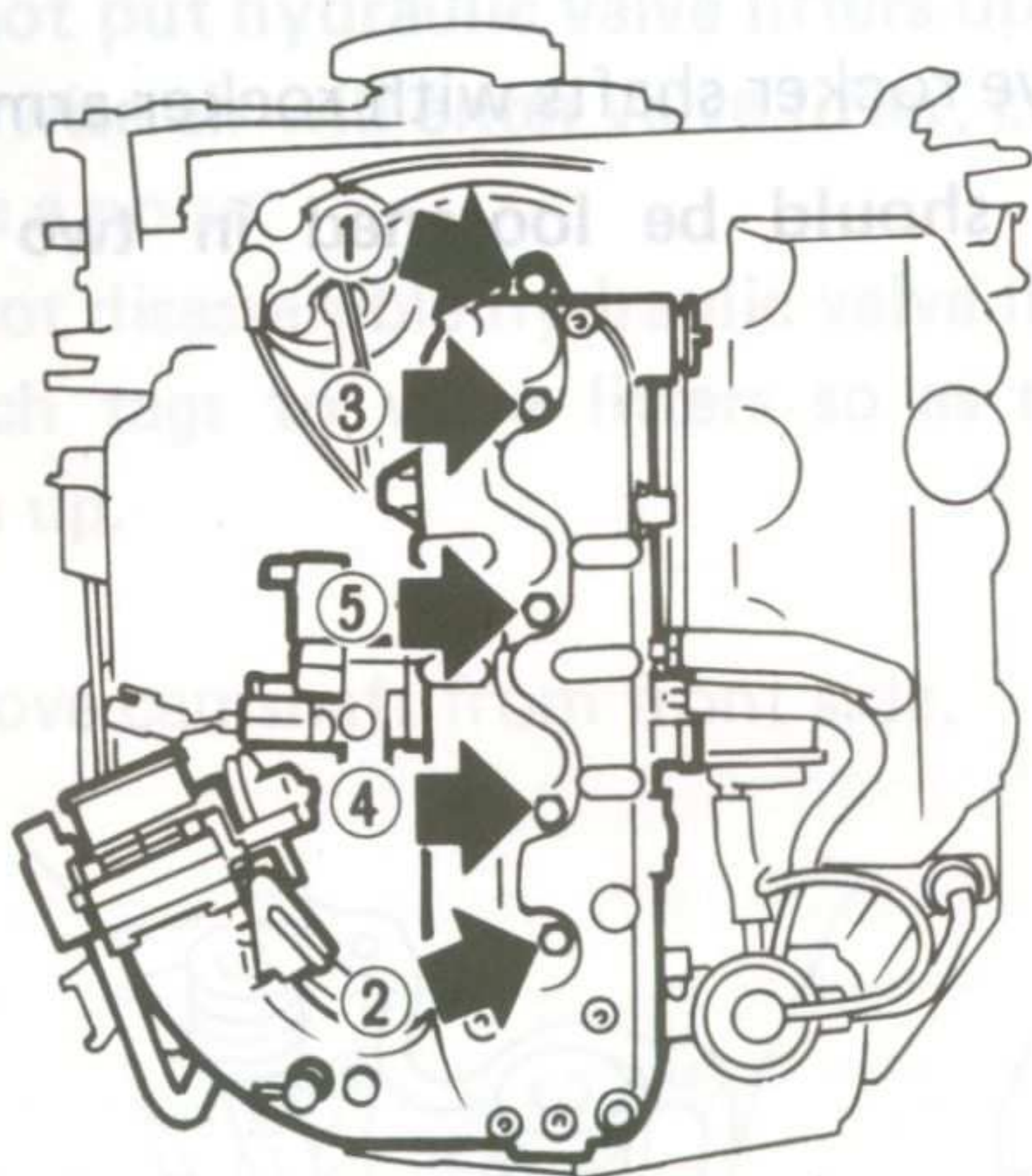
Set No. 1 cylinder at T.D.C. on its compression stroke.

After removing cylinder head, do not rotate crankshaft and camshaft separately, because valves will hit piston heads.

2. Remove collector cover and collector.

Before removing collector, be sure to drain coolant removing drain cocks in cylinder block.

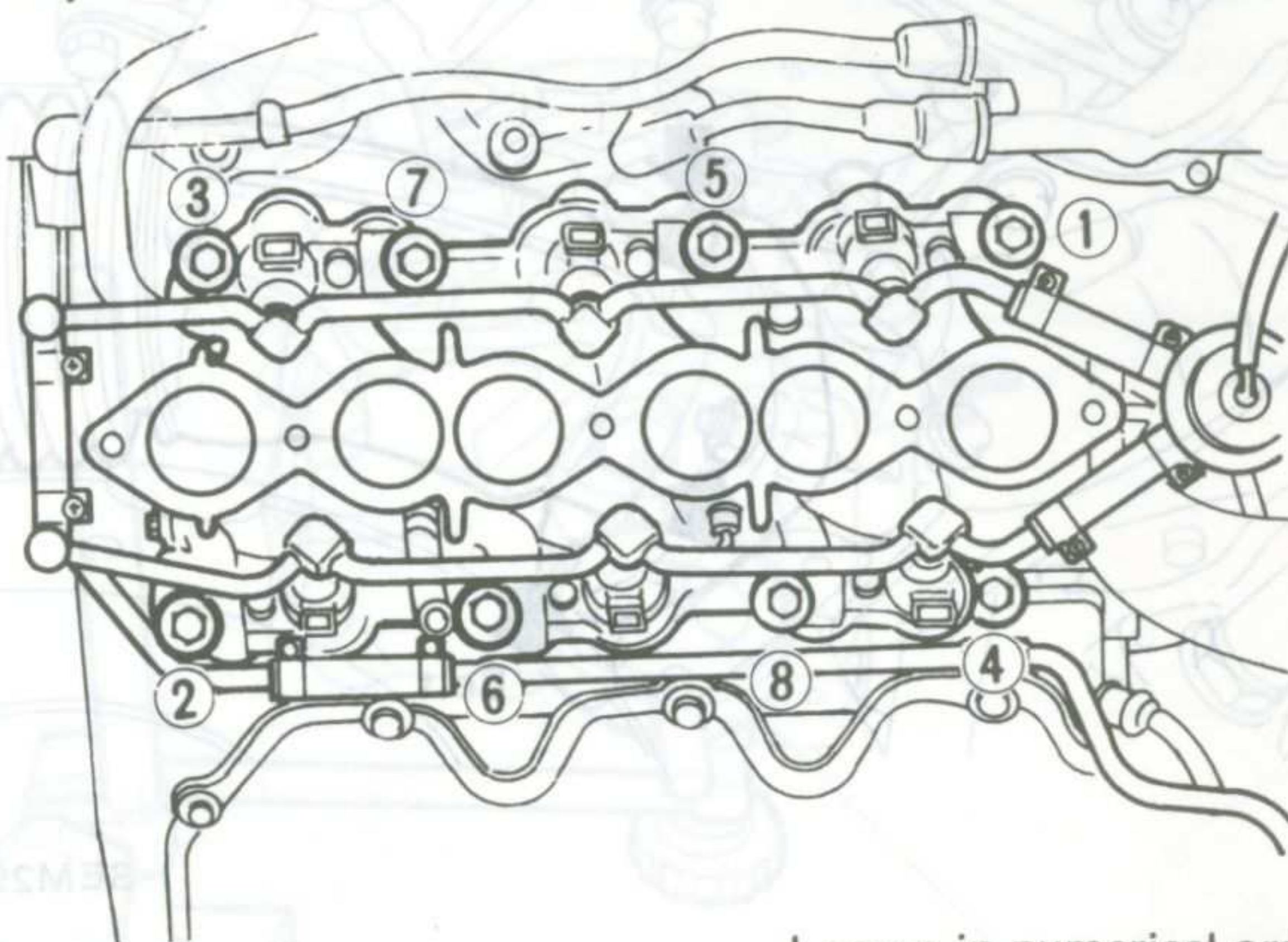
- 1) Disconnect vacuum hoses and water hoses from the intake manifold.
- 2) Remove collector cover and collector.



Loosen in numerical order and tighten in reverse order of removal.

SEM251A

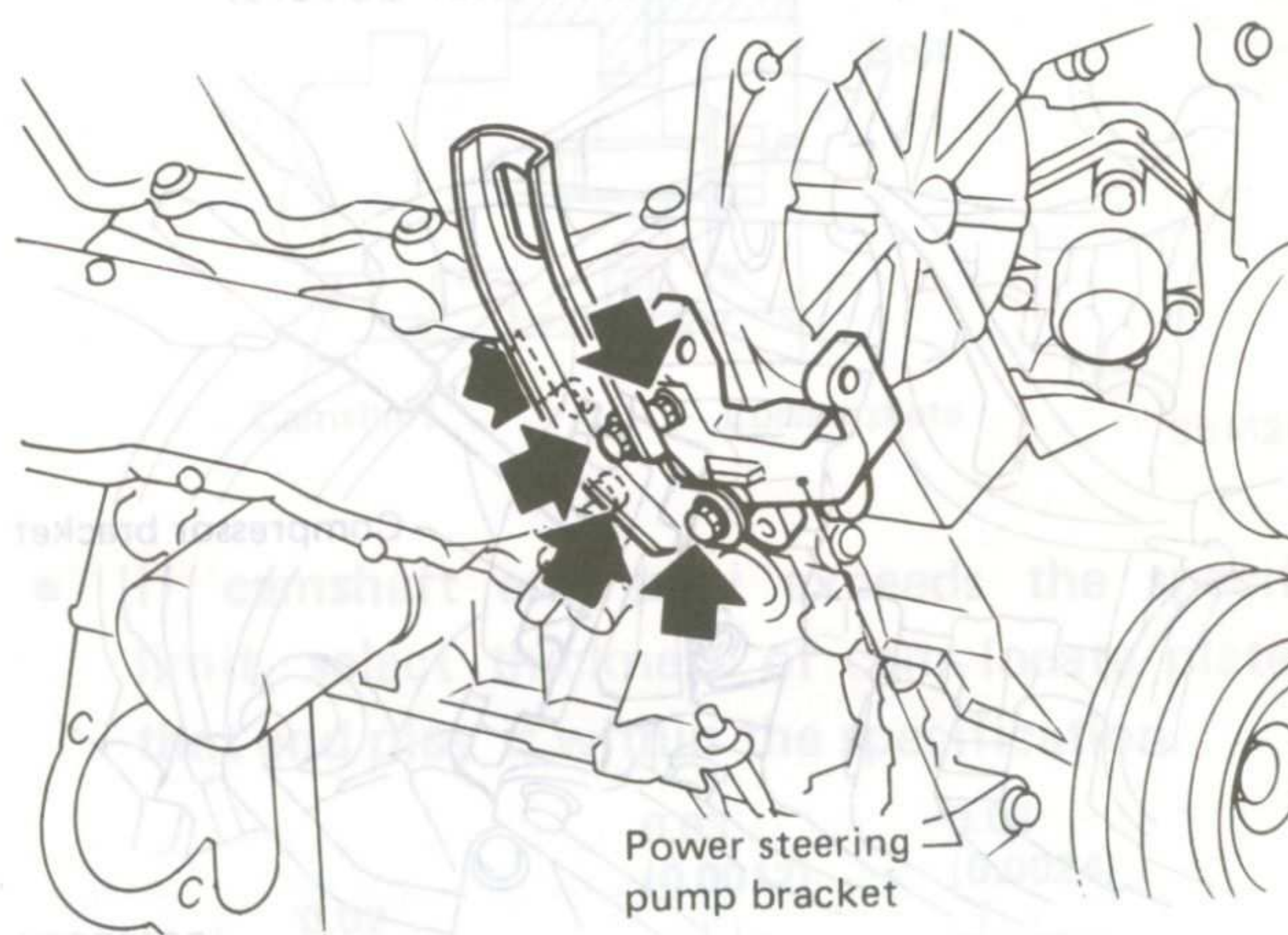
3. Disconnect vacuum hoses and water hoses from the intake manifold.
4. Remove intake manifold with fuel tube assembly.



Loosen in numerical order.

SEM252A

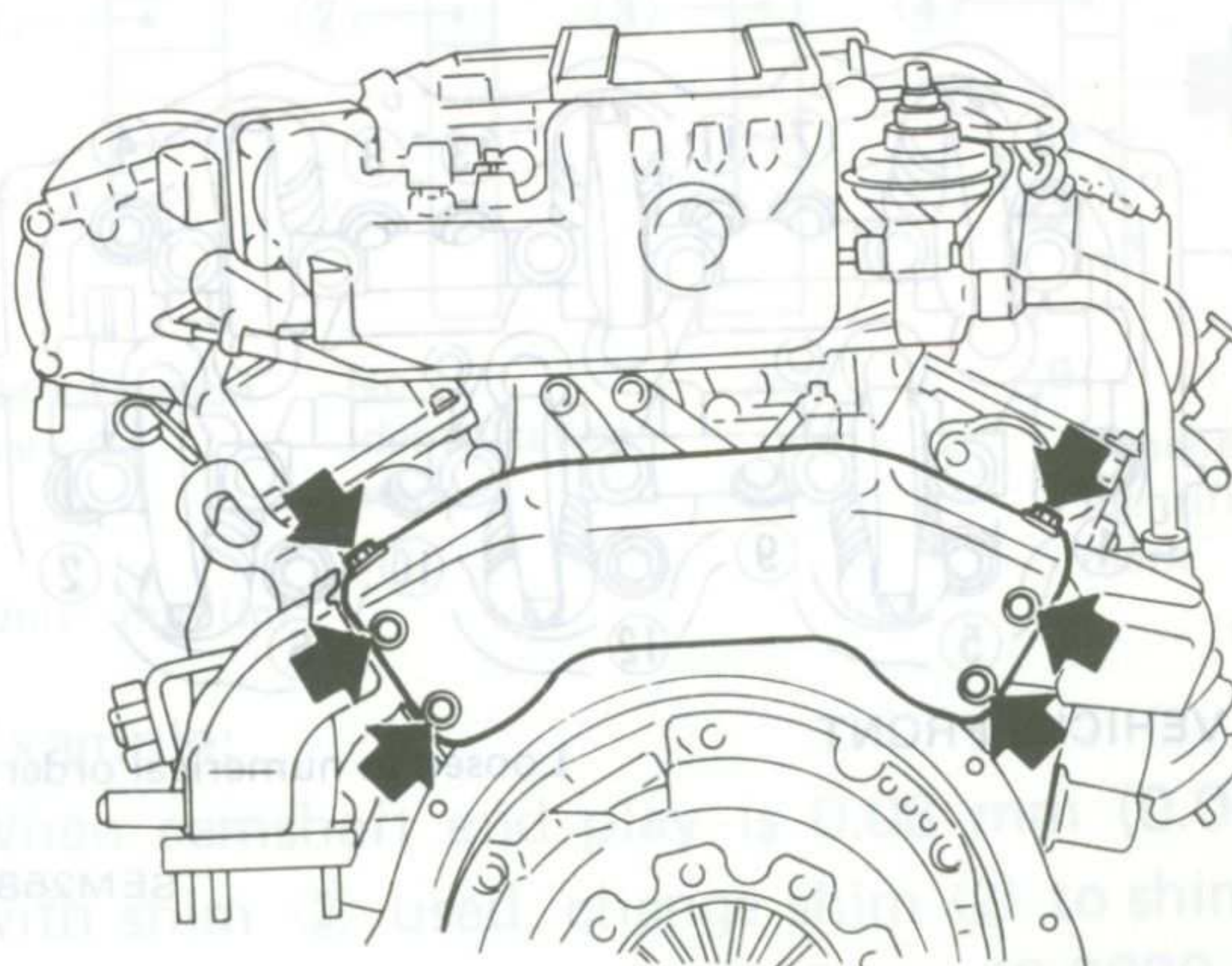
5. Remove power steering pump bracket.



Power steering pump bracket

SEM253A

6. Remove exhaust manifold covers.

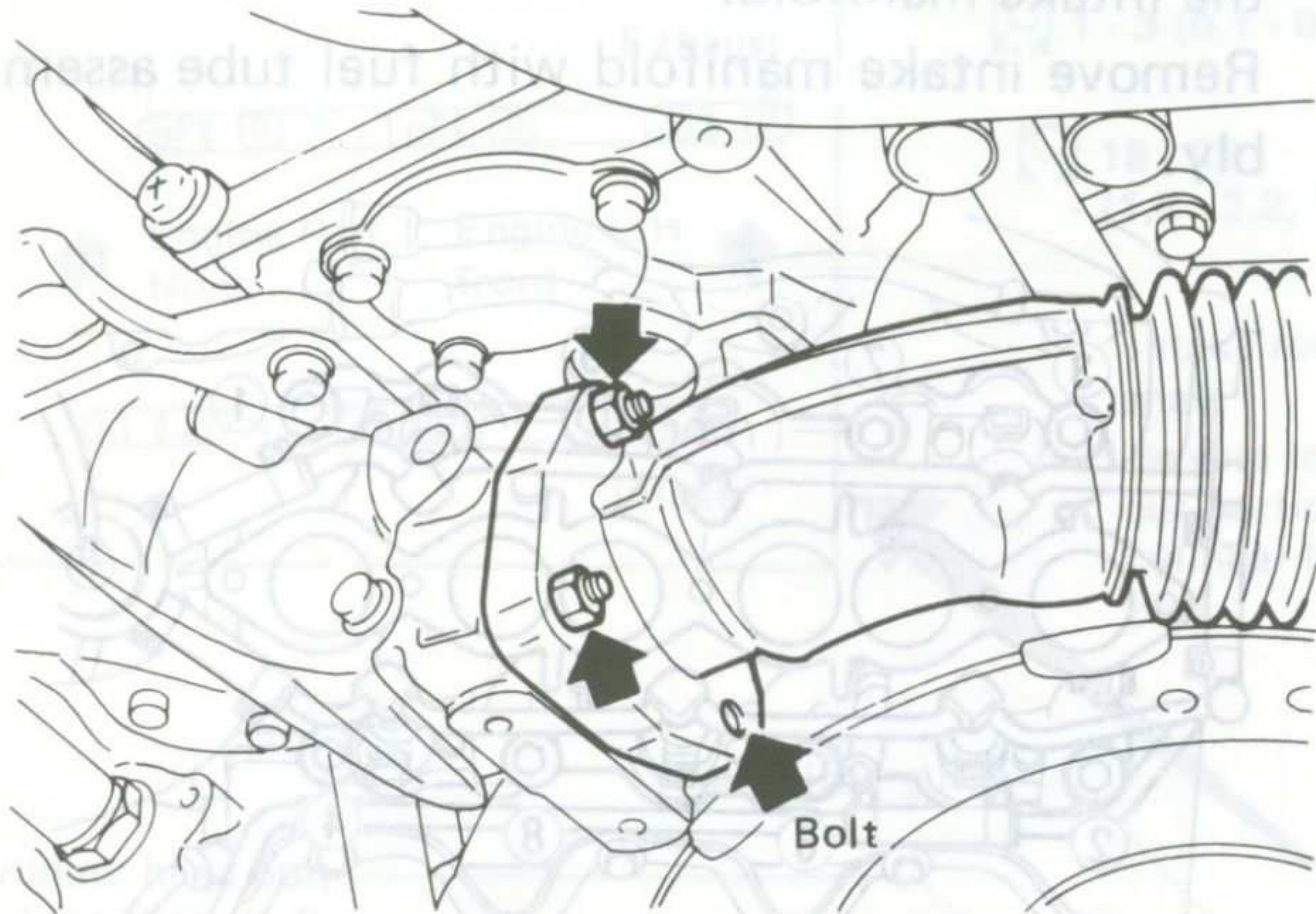


SEM297A

CYLINDER HEAD

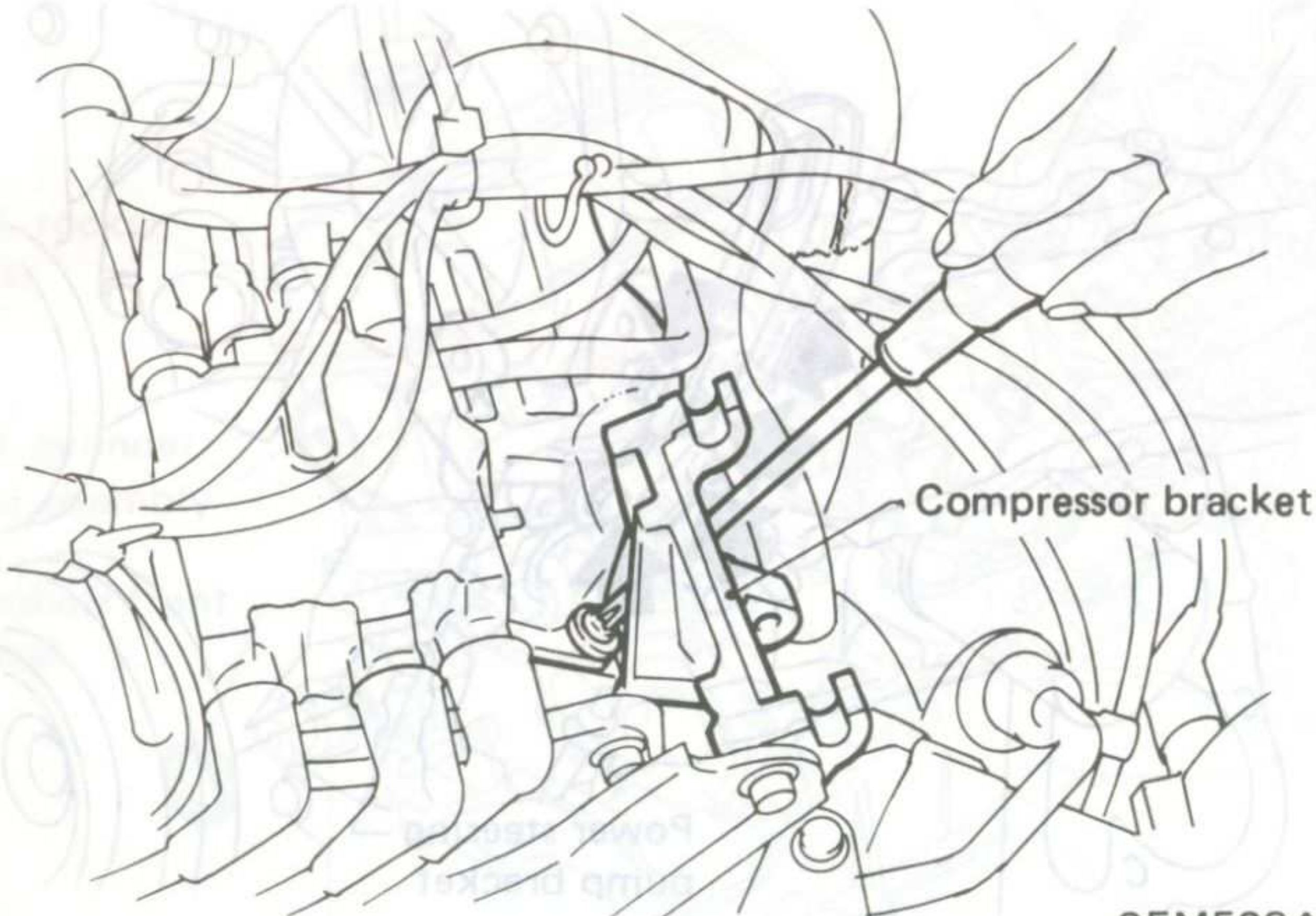
Removal (Cont'd)

7. Disconnect exhaust manifold connecting tube.



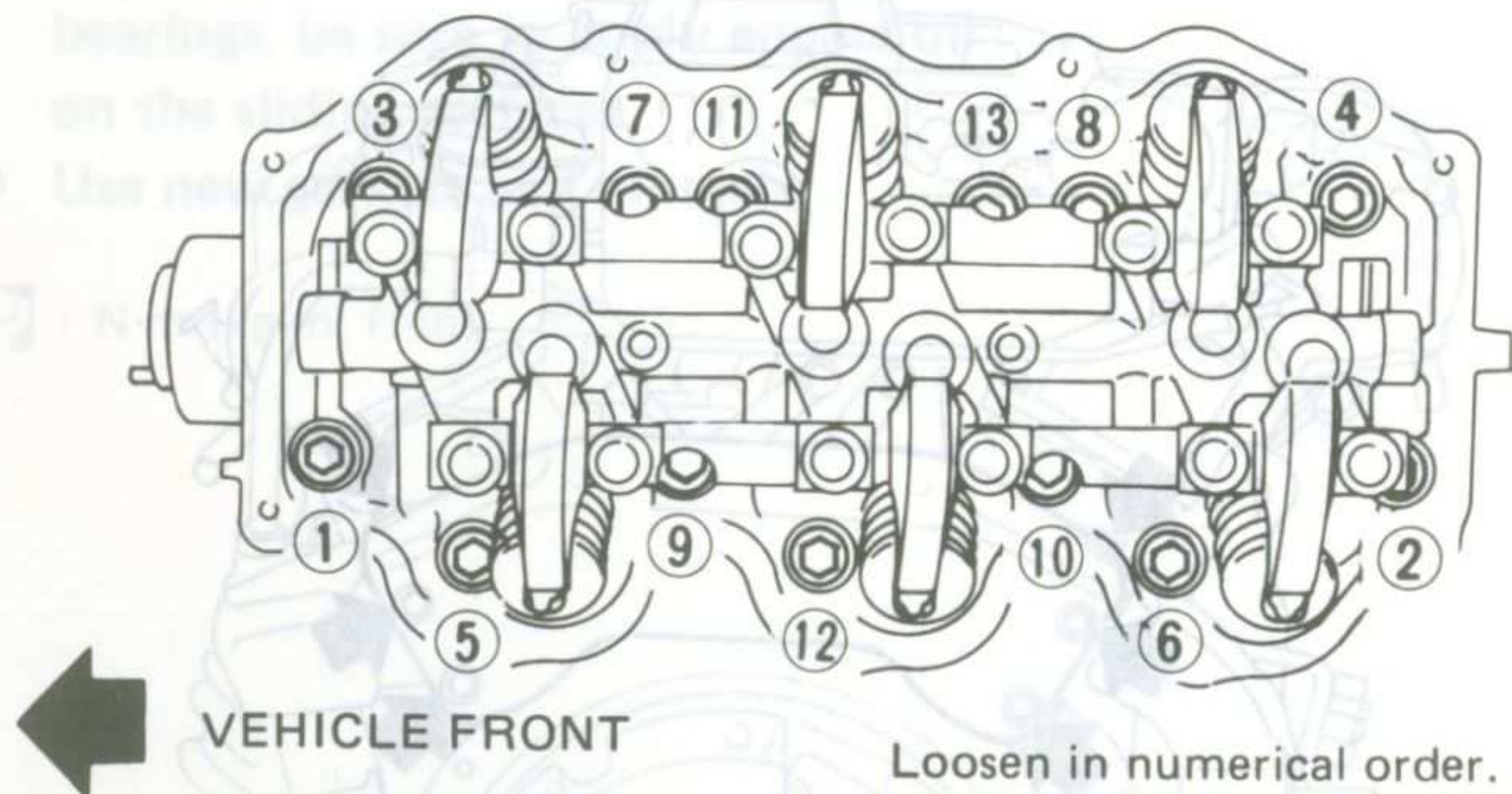
SEM298A

8. Remove camshaft pulleys and rear timing cover securing bolts.
9. Remove compressor and rocker covers.



SEM528A

10. Remove cylinder head with exhaust manifold.

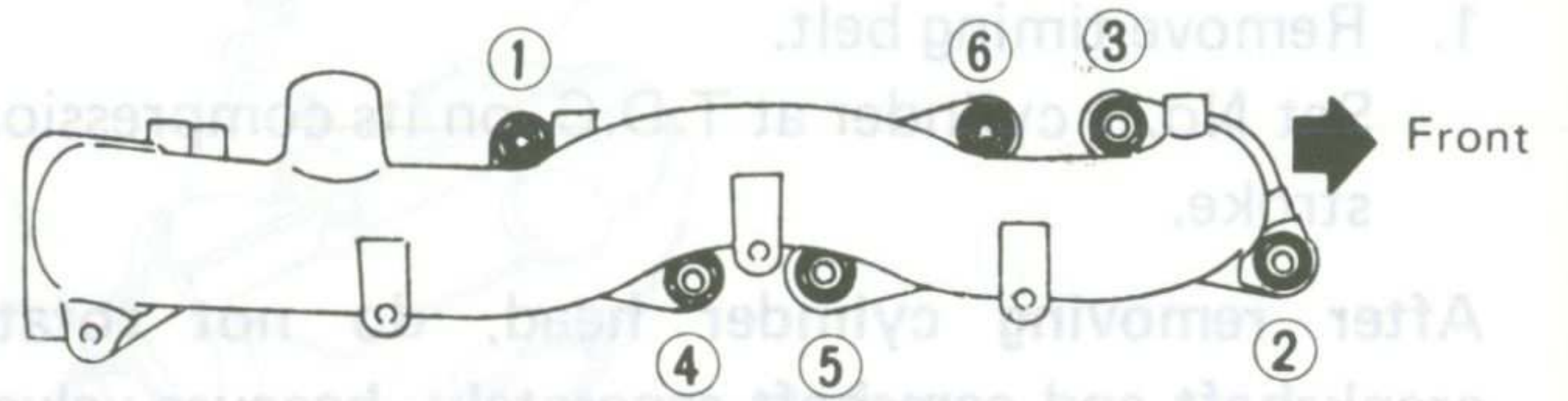


SEM258A

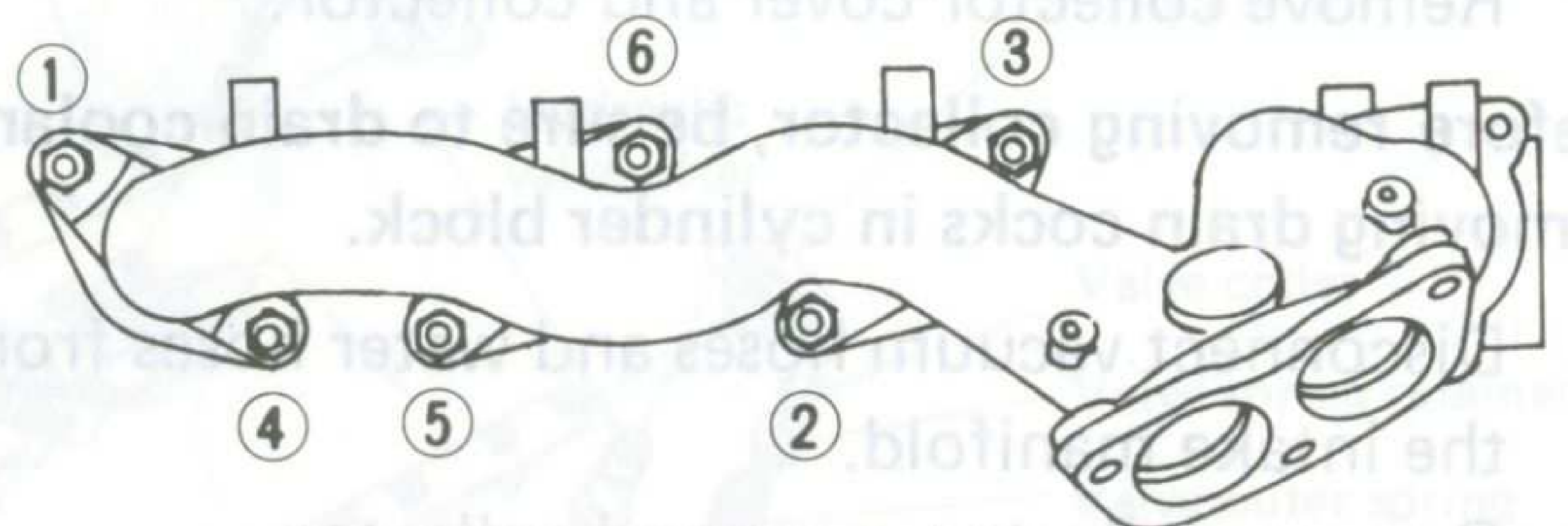
Disassembly

1. Remove exhaust manifold.

R.H. exhaust manifold



L.H. exhaust manifold



SEM662A

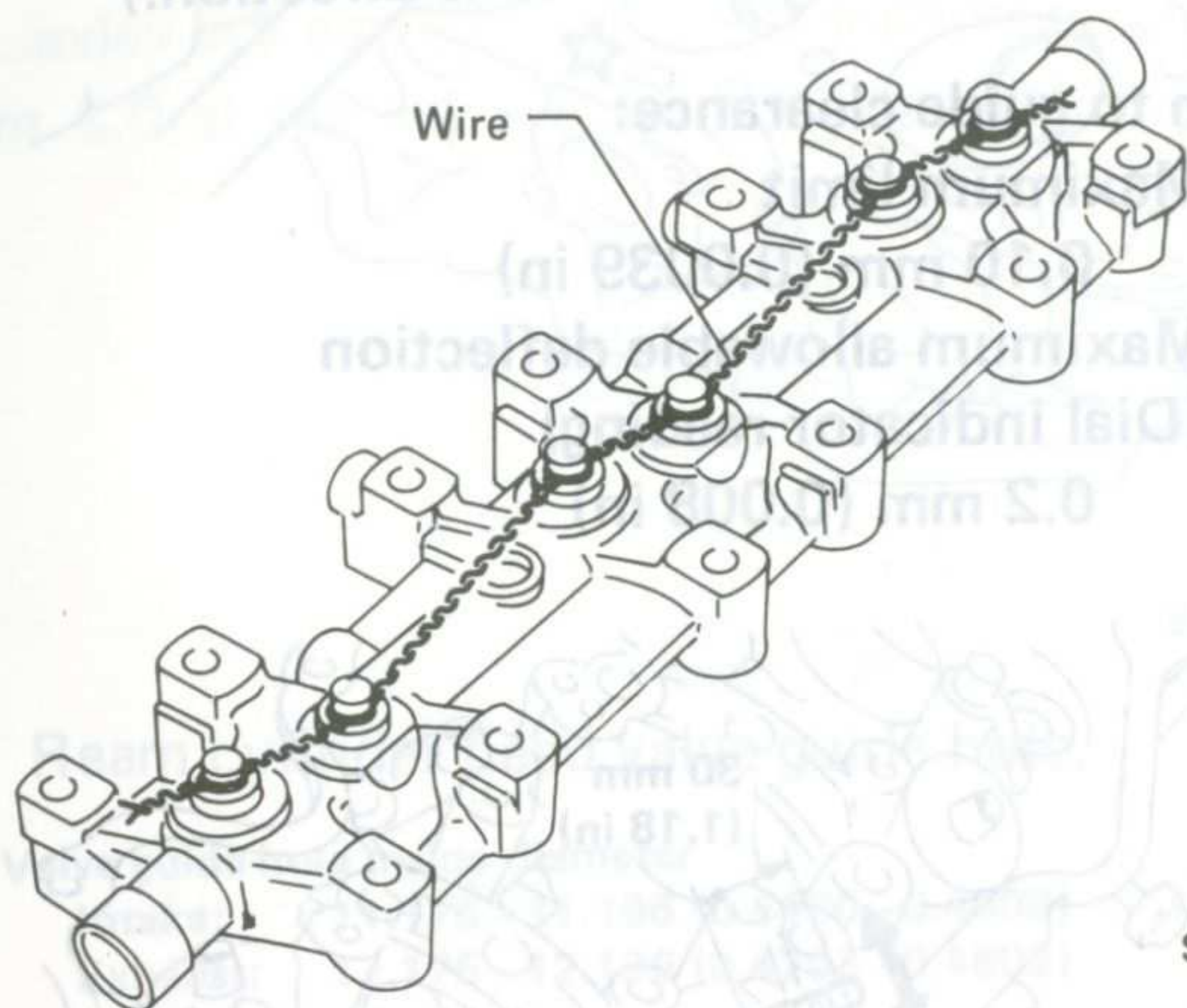
2. Remove rocker shafts with rocker arms.

The bolts should be loosened in two or three stages.

CYLINDER HEAD

Disassembly (Cont'd)

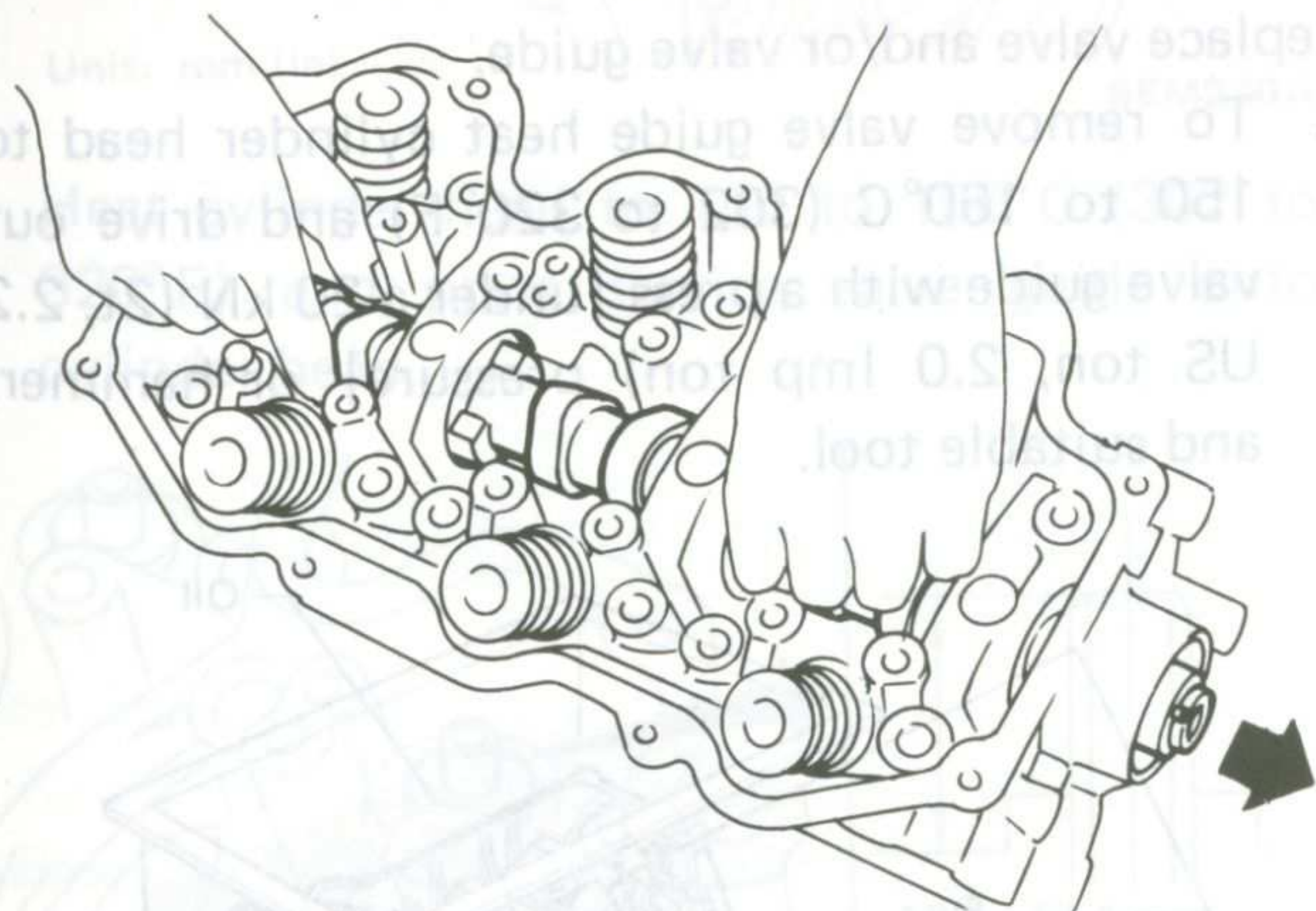
3. Remove hydraulic valve lifters and lifter guide.
 - a. Hold hydraulic valve lifters with wire so that they will not drop from lifter guide.



SEM304A

- b. Do not put hydraulic valve lifters upside down, otherwise air will enter valve lifter, causing it to make a noise.
 - c. Do not disassemble hydraulic valve lifter.
 - d. Attach tags to valve lifters so as not to mix them up.

4. Remove camshaft from front side.



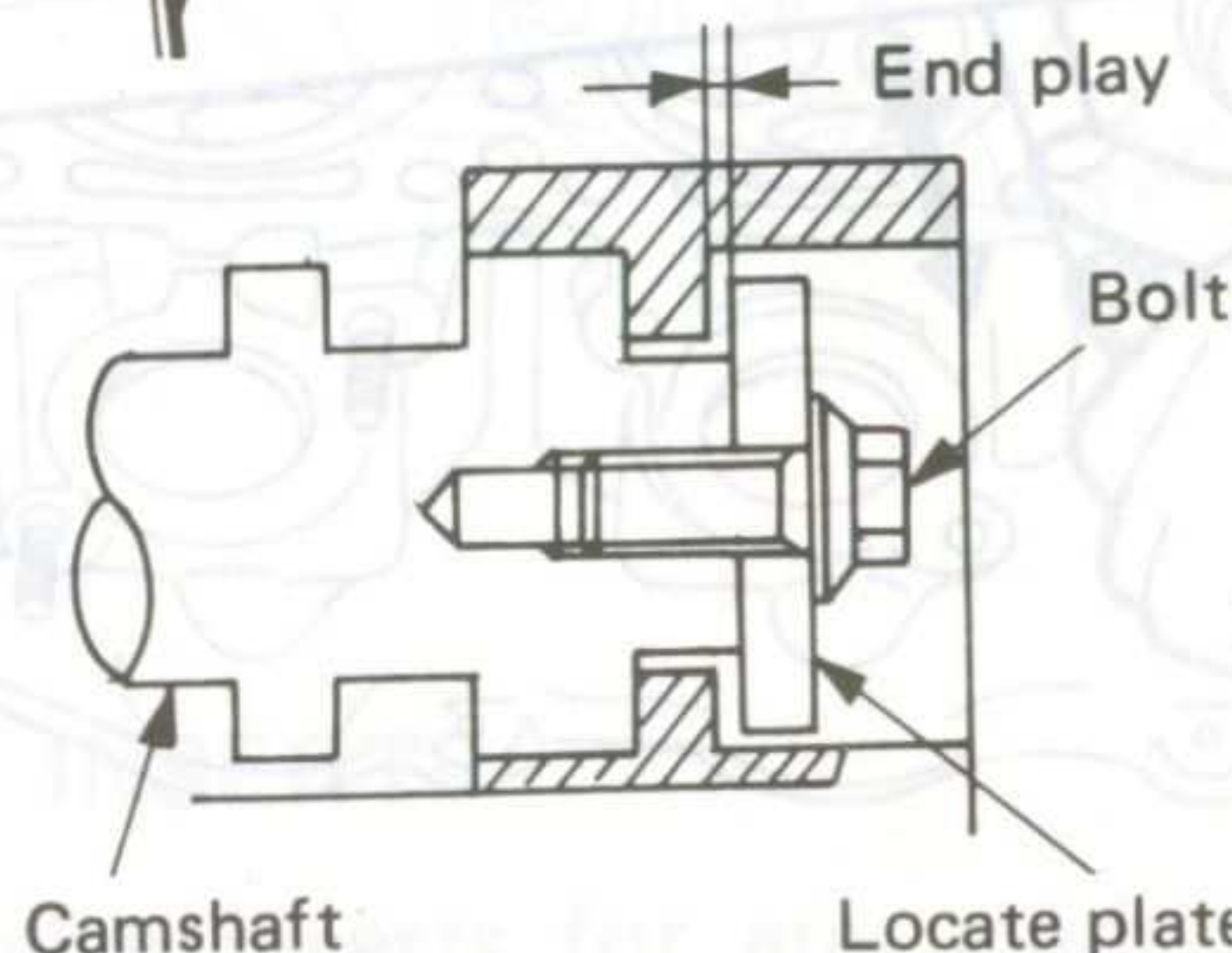
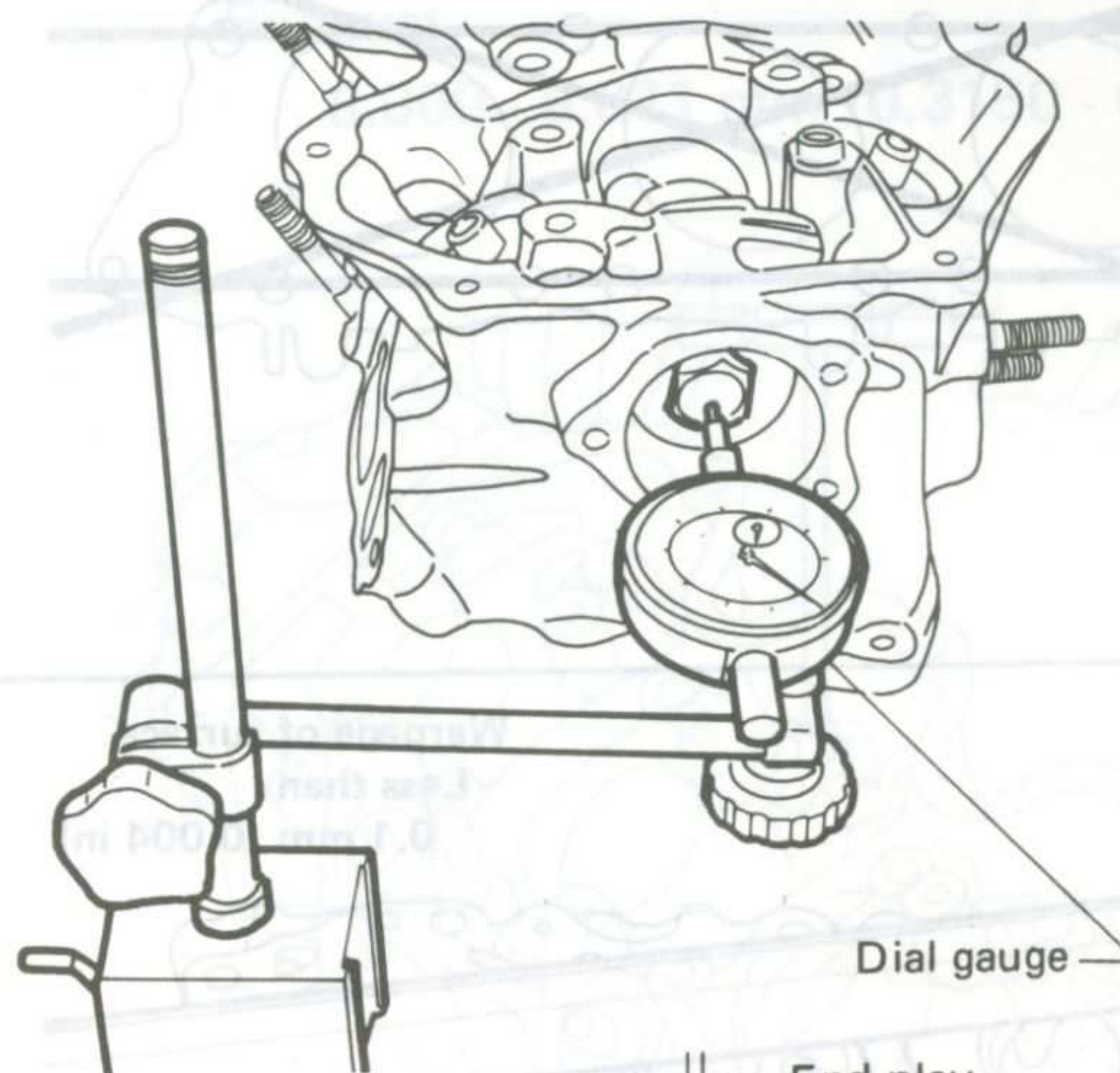
SEM259A

Inspection

CAMSHAFT END PLAY

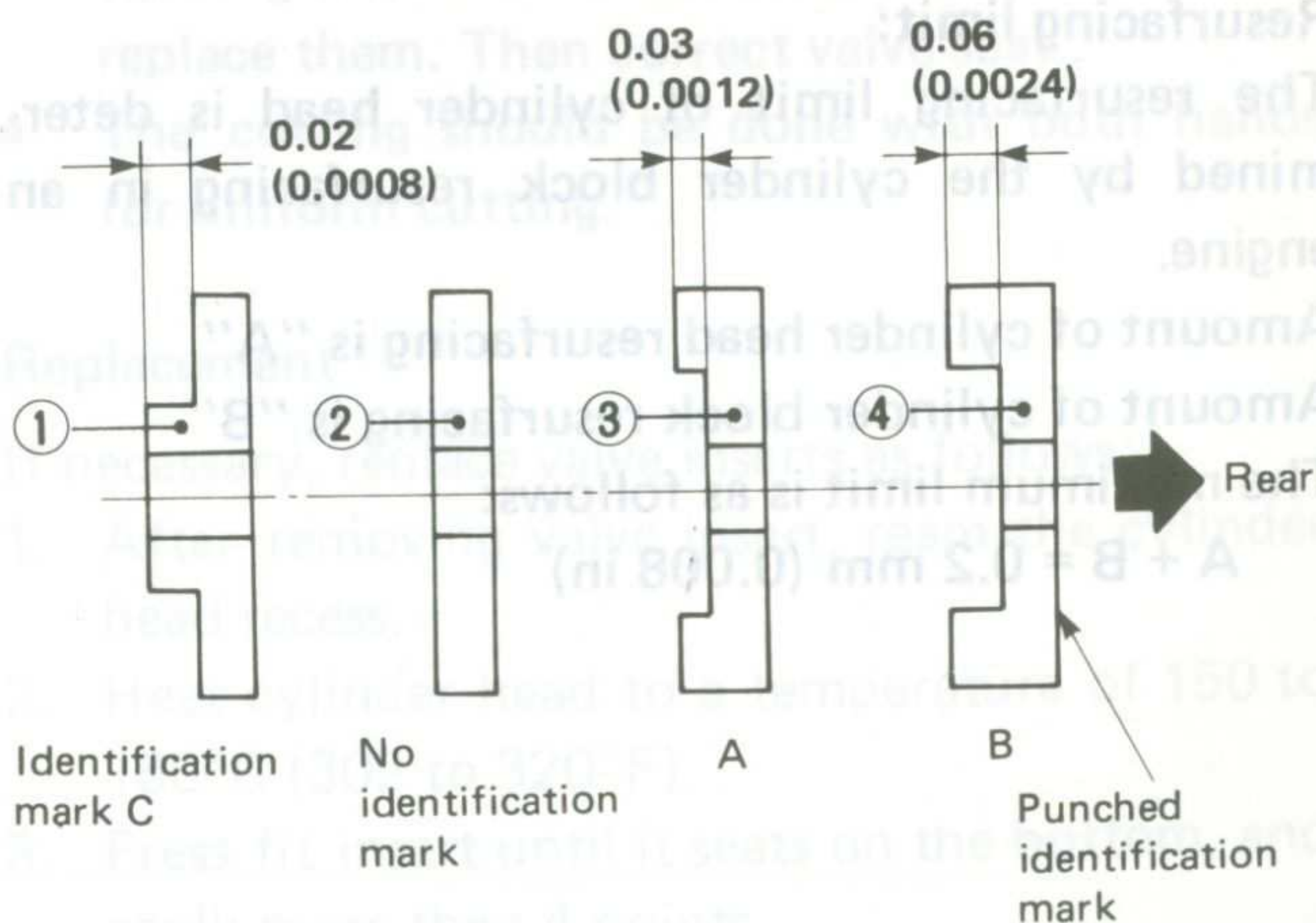
Camshaft end play:

0.03 - 0.06 mm (0.0012 - 0.0024 in)



SEM260A

- If camshaft end play exceeds the specified limit, select thickness of cam locate plate so that end play is within the specification.



Unit: mm (in)

SEM261A

Example:

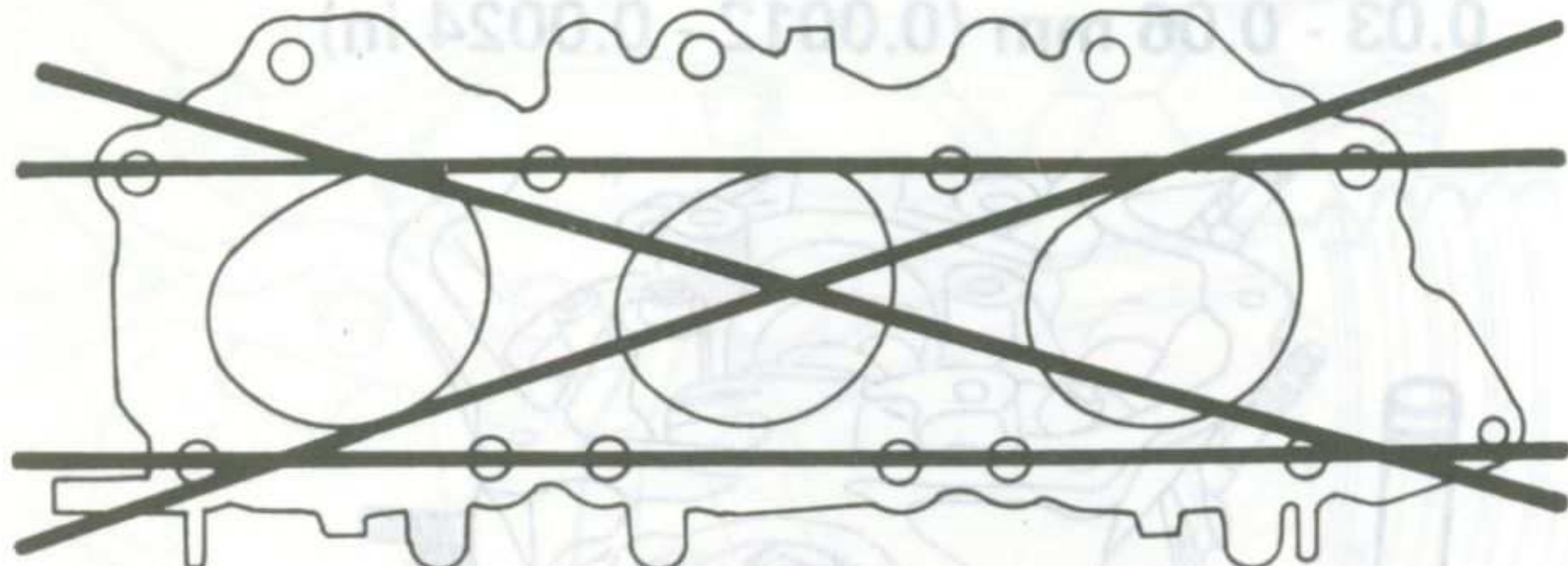
When camshaft end play is 0.08 mm (0.0031 in) with shim ② used, change shim ② to shim ③ so that camshaft end play is 0.05 mm (0.0020 in).

CYLINDER HEAD

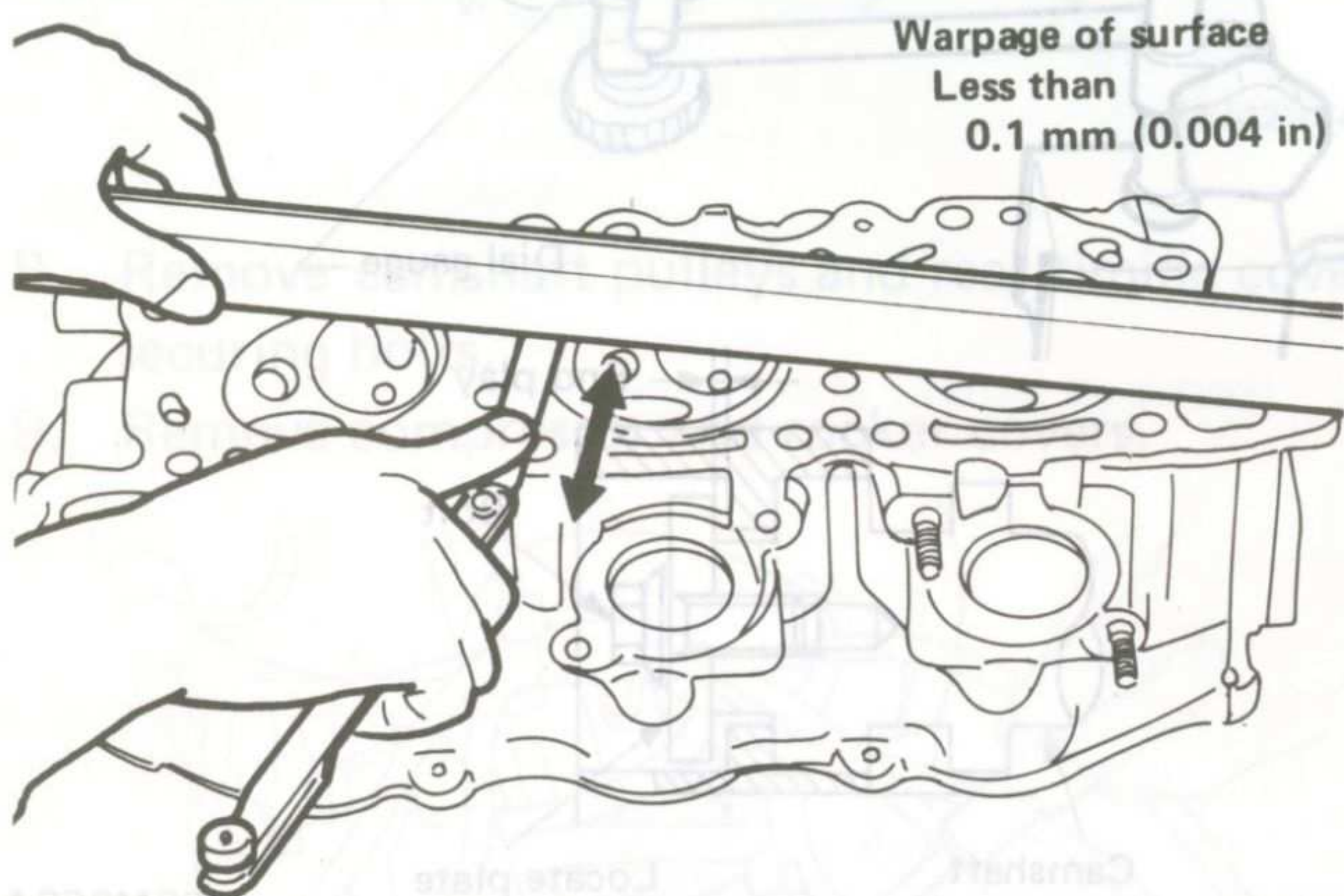
Inspection (Cont'd)

CYLINDER HEAD DISTORTION

Measuring points



Warpage of surface
Less than
0.1 mm (0.004 in)



SEM262A

If beyond the specified limit, 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:

$$A + B = 0.2 \text{ mm (0.008 in)}$$

VALVE GUIDE CLEARANCE

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

Stem to guide clearance:

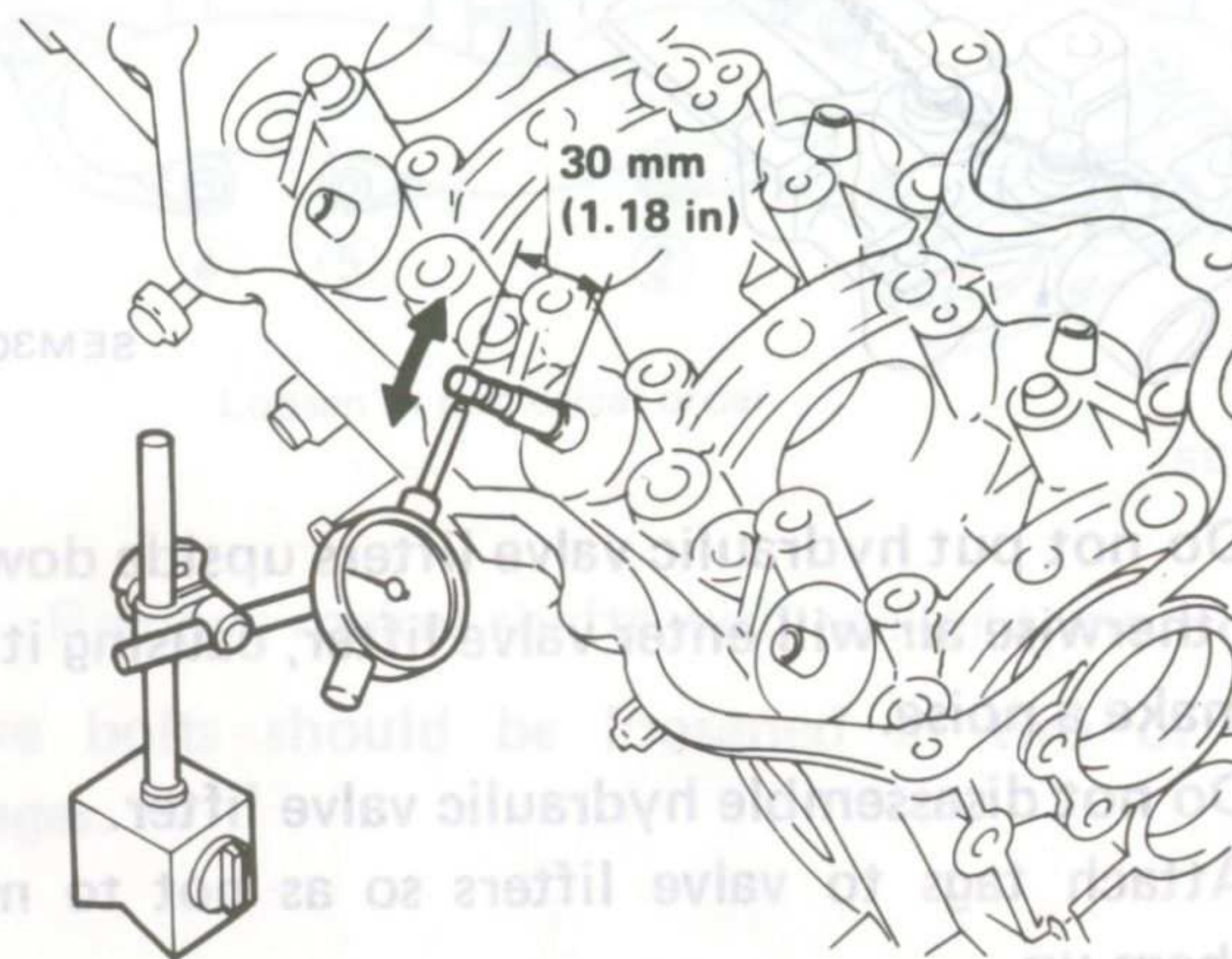
Maximum limit

0.10 mm (0.0039 in)

Maximum allowable deflection

(Dial indicator reading)

0.2 mm (0.008 in)

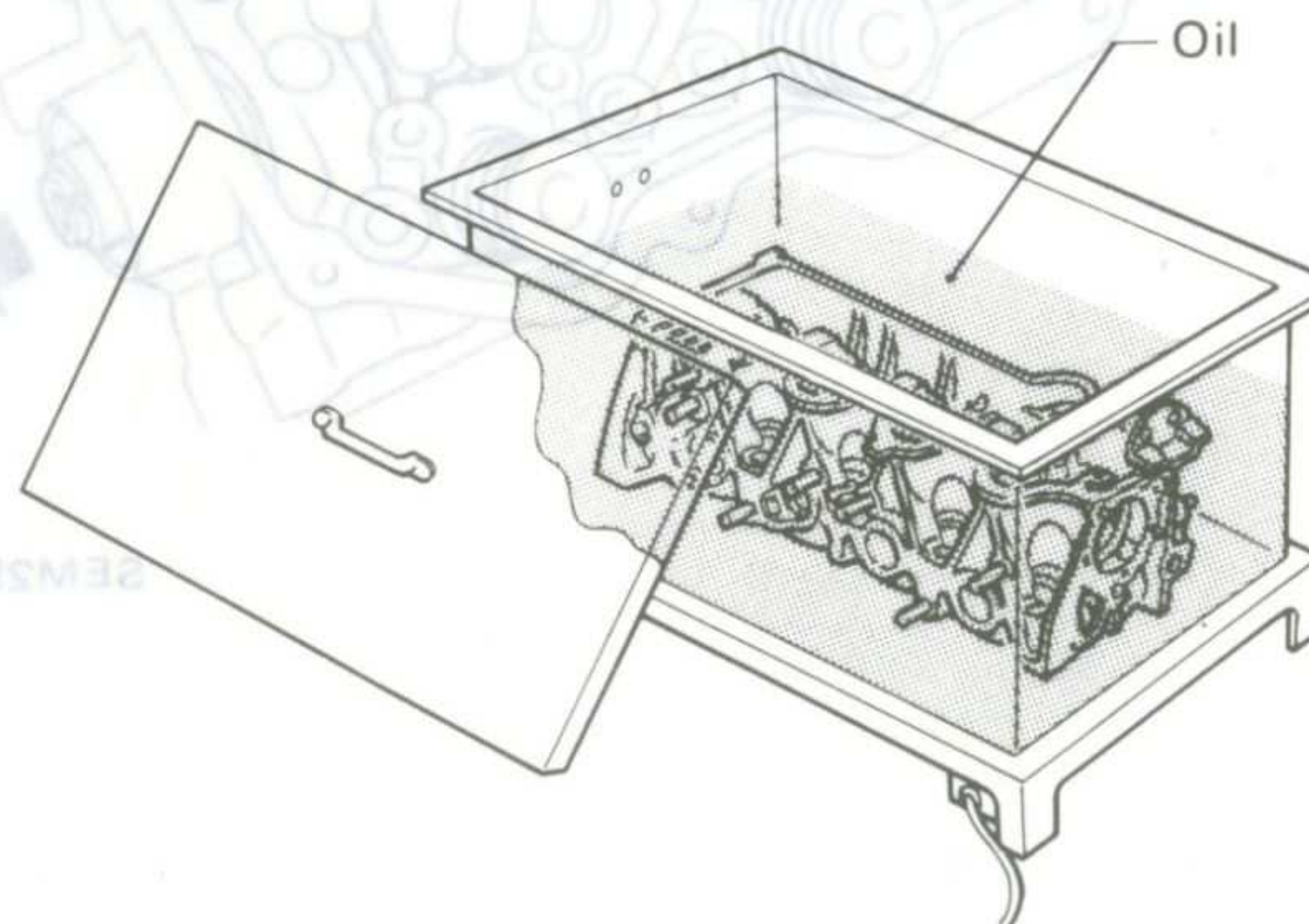


SEM263A

Replacement

Replace valve and/or valve guide.

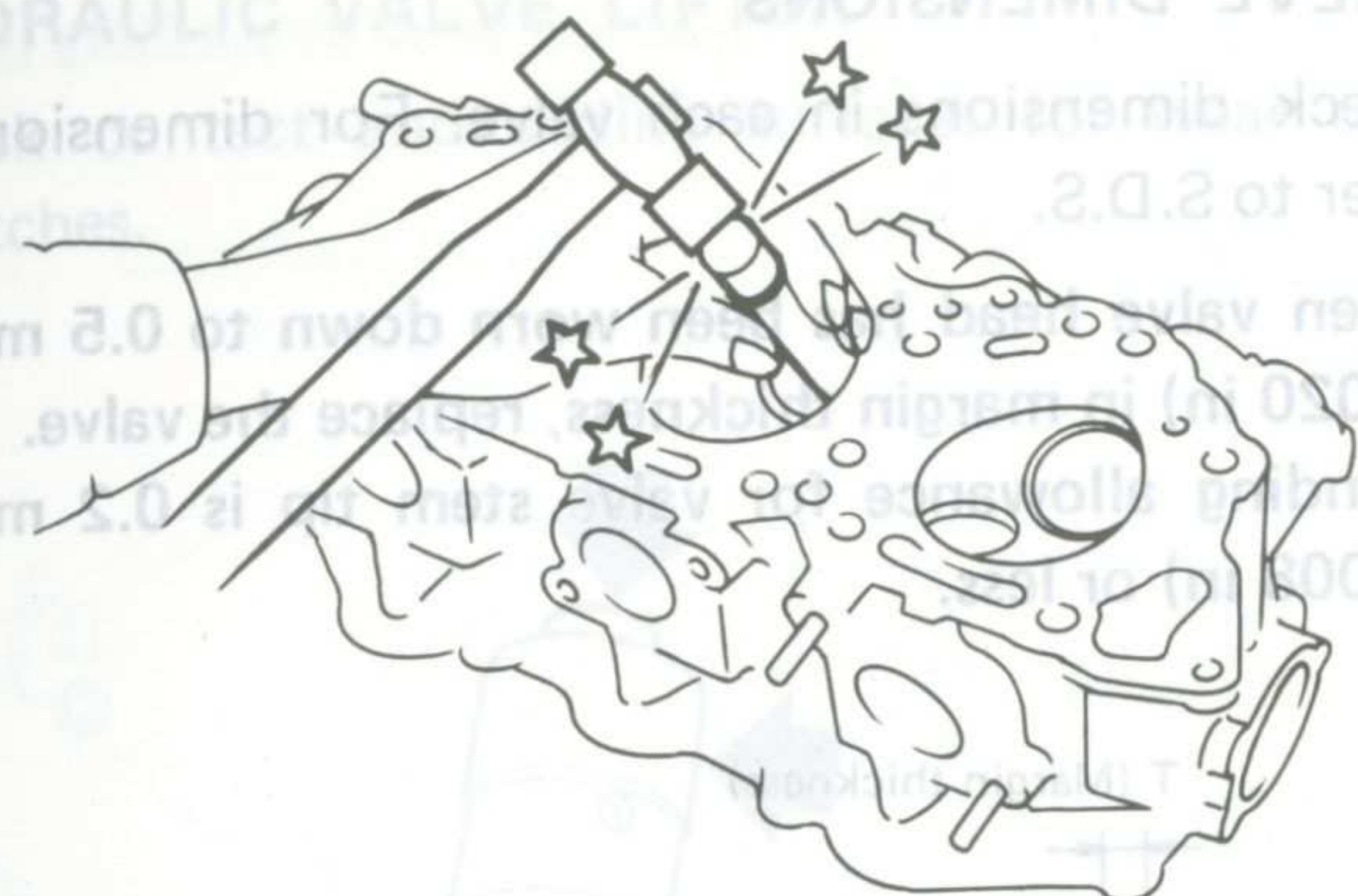
- To remove valve guide heat cylinder head to 150 to 160°C (302 to 320°F) and drive out valve guide with a press [under a 20 kN (2t, 2.2 US ton, 2.0 Imp ton) pressure] or hammer, and suitable tool.



SEM008A

CYLINDER HEAD

Inspection (Cont'd)



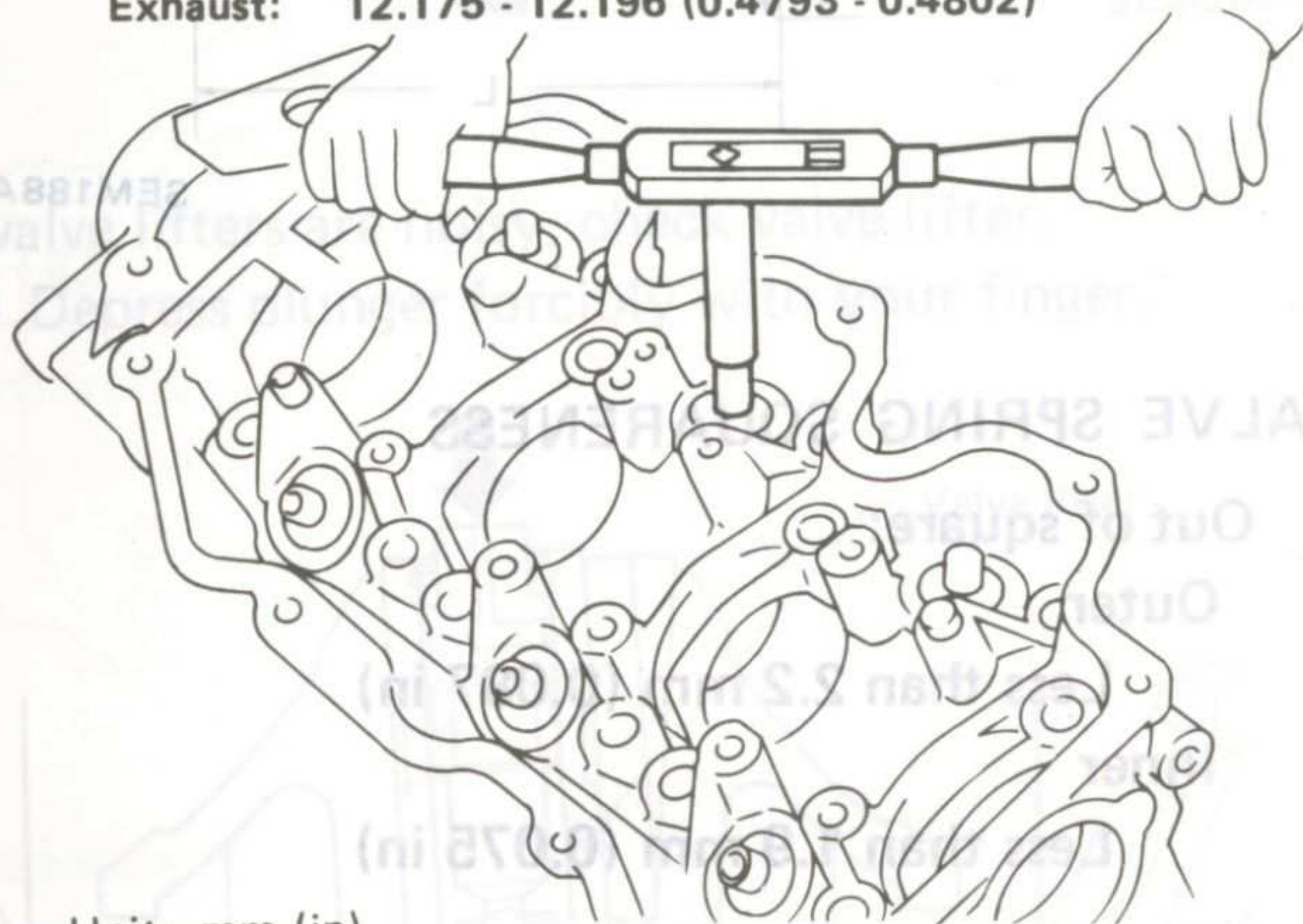
SEM264A

2. Ream cylinder head valve guide hole.

Valve guide hole inside diameter

Intake: 11.175 - 11.196 (0.4400 - 0.4408)

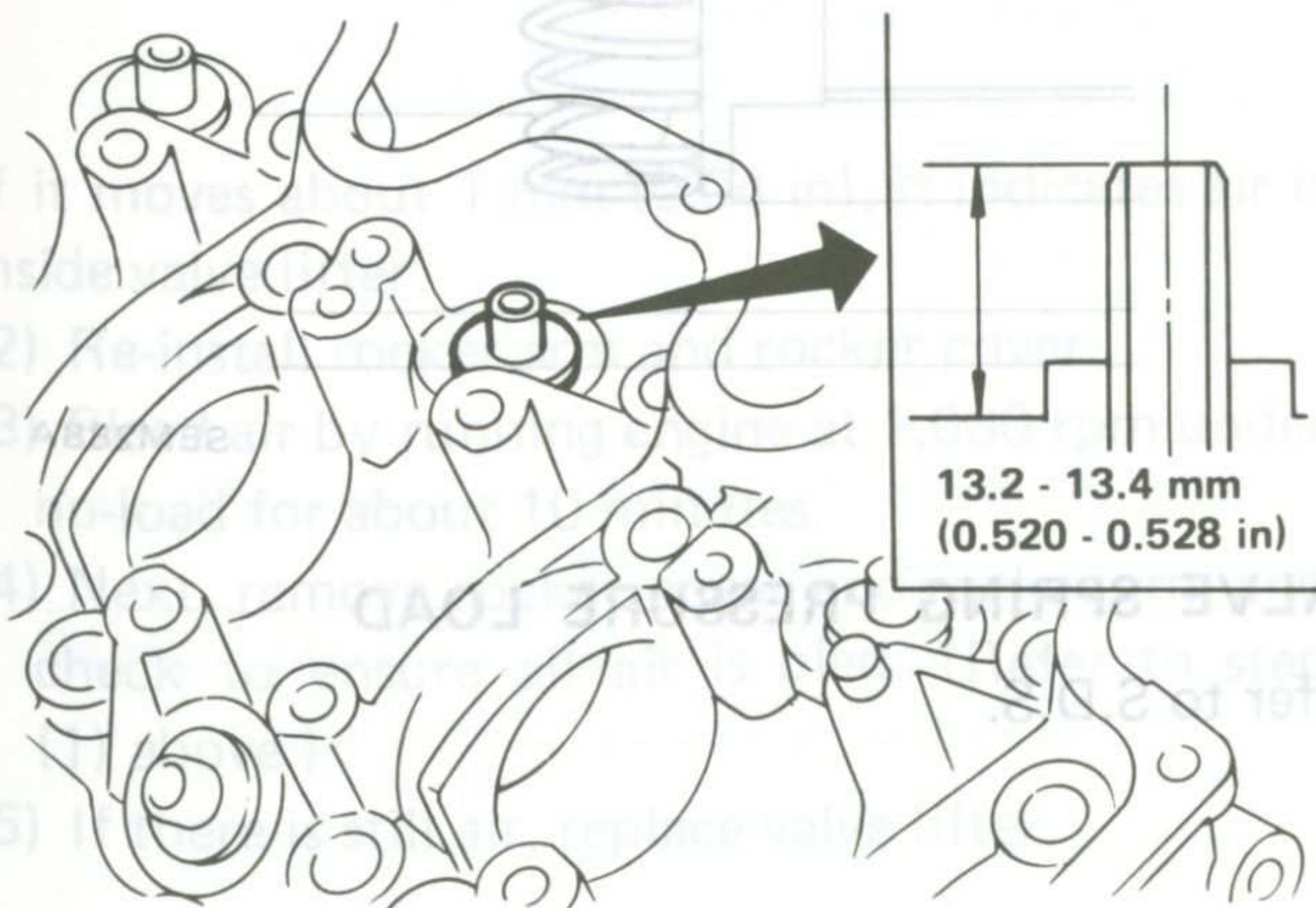
Exhaust: 12.175 - 12.196 (0.4793 - 0.4802)



Unit: mm (in)

SEM270A

3. Heat cylinder head to 150 to 160°C (302 to 320°F) and press service valve guide onto cylinder head.



SEM271A

4. Ream valve guide.

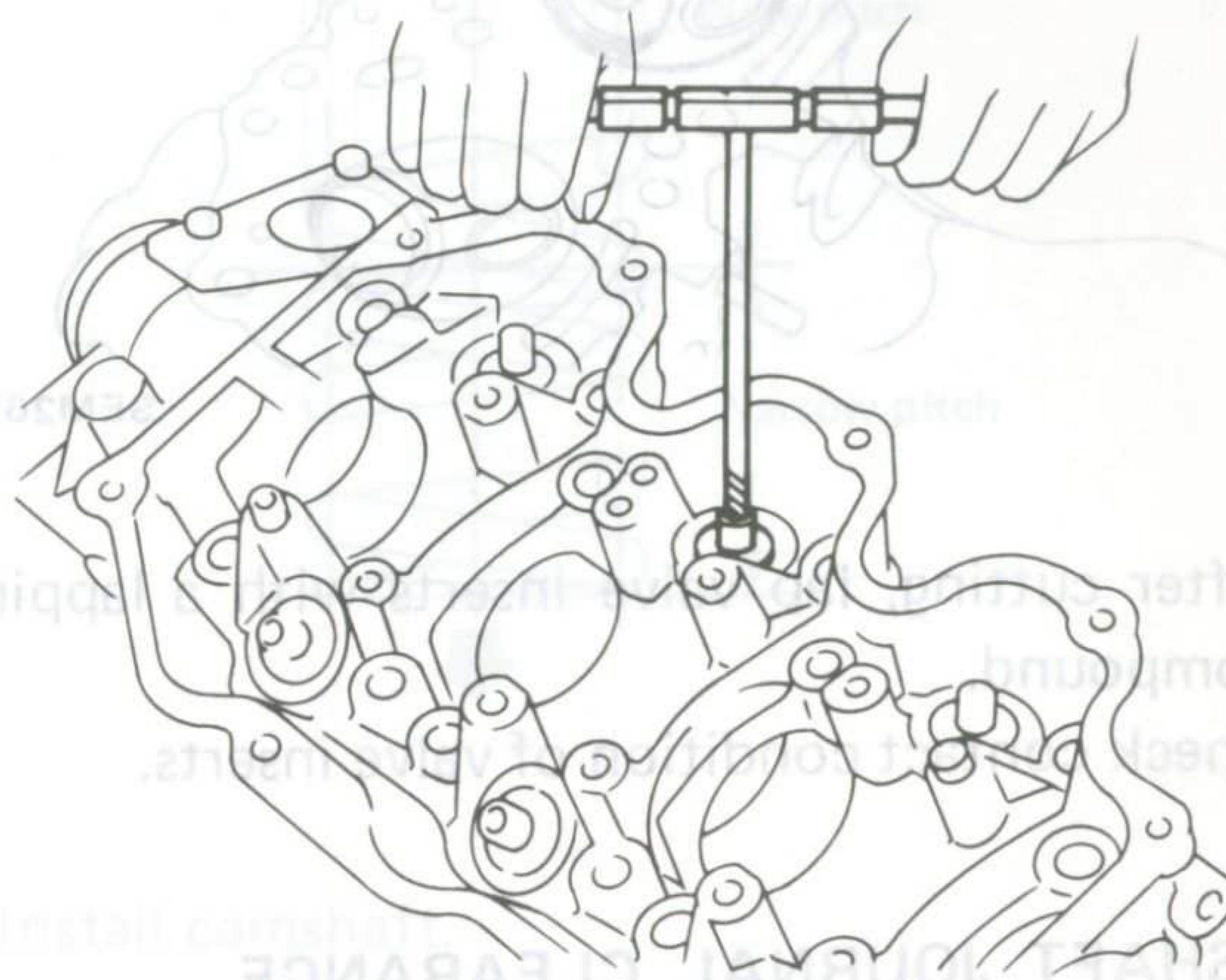
Finished size:

Intake

7.000 - 7.018 mm (0.2756 - 0.2763 in)

Exhaust

8.000 - 8.011 mm (0.3150 - 0.3154 in)



SEM272A

VALVE INSERTS

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

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

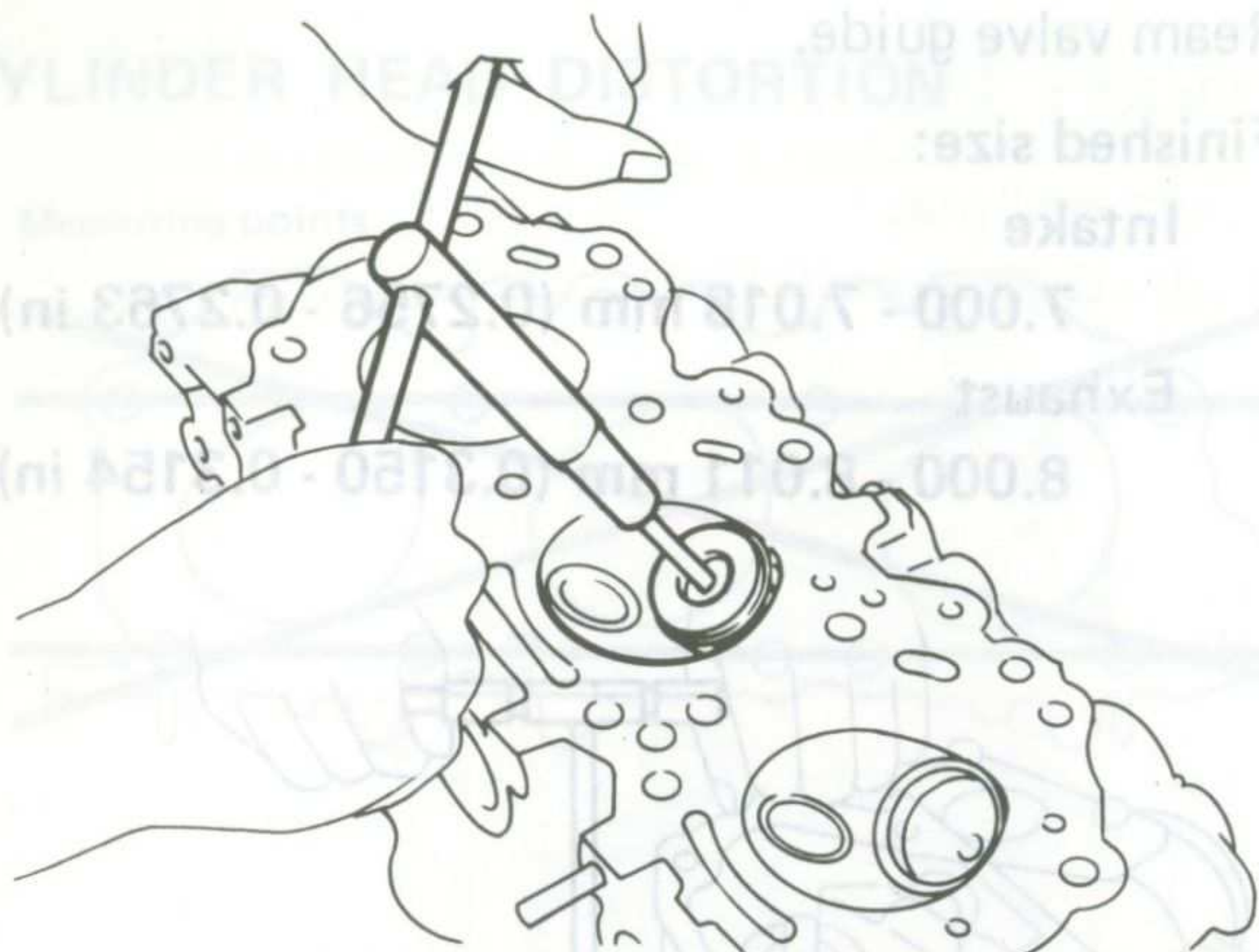
Replacement

If necessary, replace valve inserts as follows:

1. After removing valve insert, ream the cylinder head recess.
2. Heat cylinder head to a temperature of 150 to 160°C (302 to 320°F).
3. Press fit insert until it seats on the bottom, and caulk more than 4 points.
4. Cut or grind valve inserts using suitable tool at the specified dimensions as shown in S.D.S.

CYLINDER HEAD

Inspection (Cont'd)



SEM265A

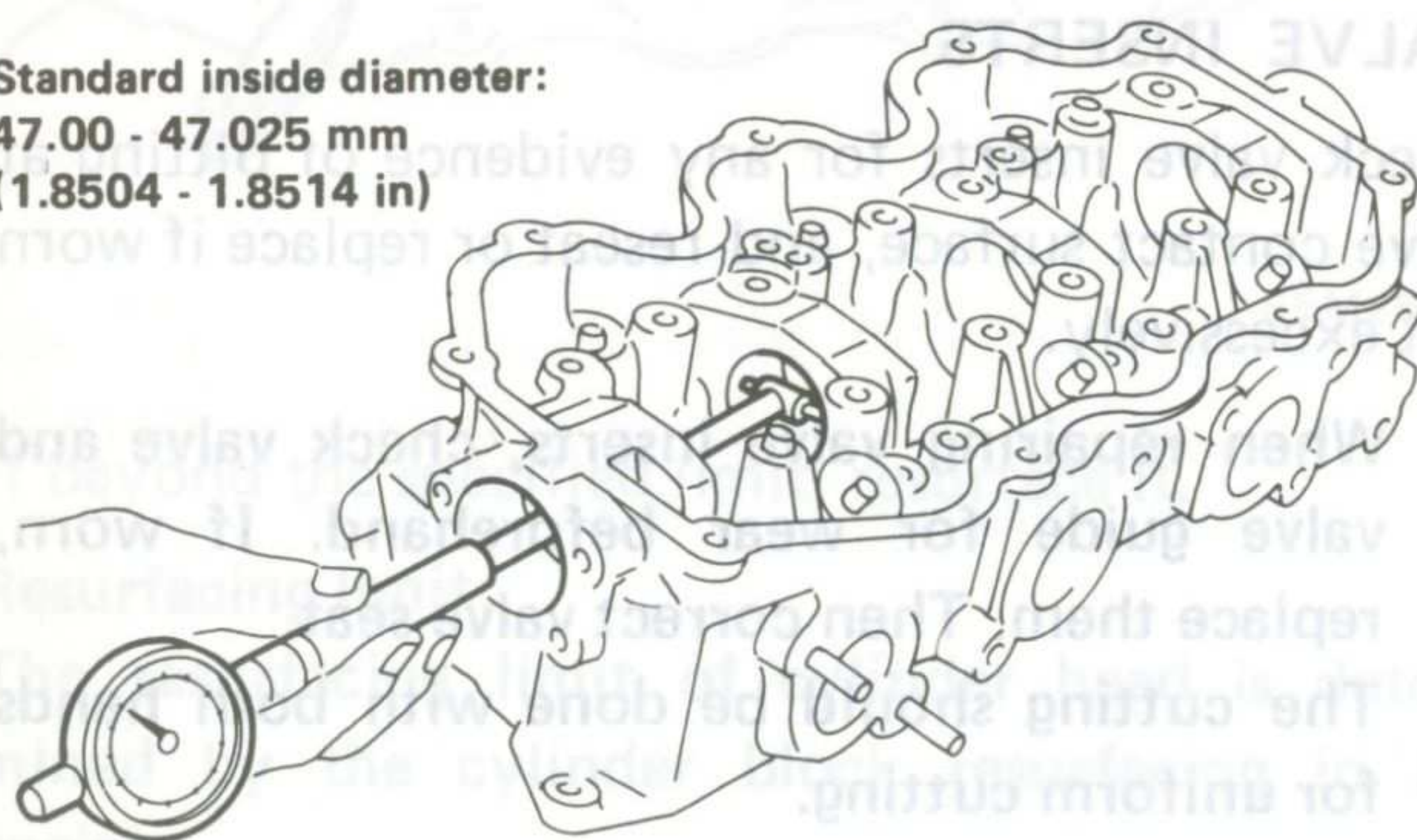
5. After cutting, lap valve inserts with a lapping compound.
6. Check contact condition of valve inserts.

CAMSHAFT JOURNAL CLEARANCE

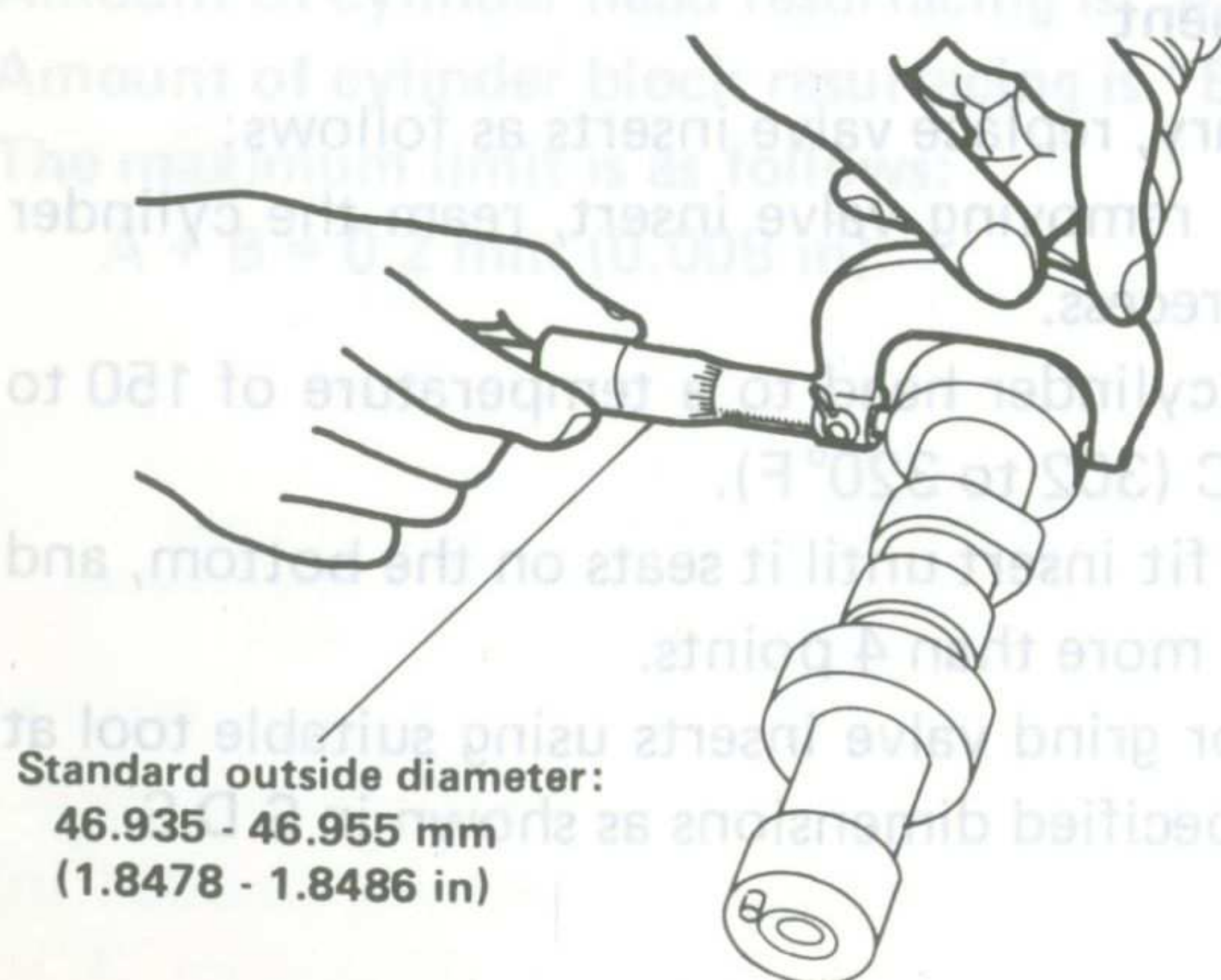
Wear limit

0.15 mm (0.0059 in)

Standard inside diameter:
47.00 - 47.025 mm
(1.8504 - 1.8514 in)



SEM266A



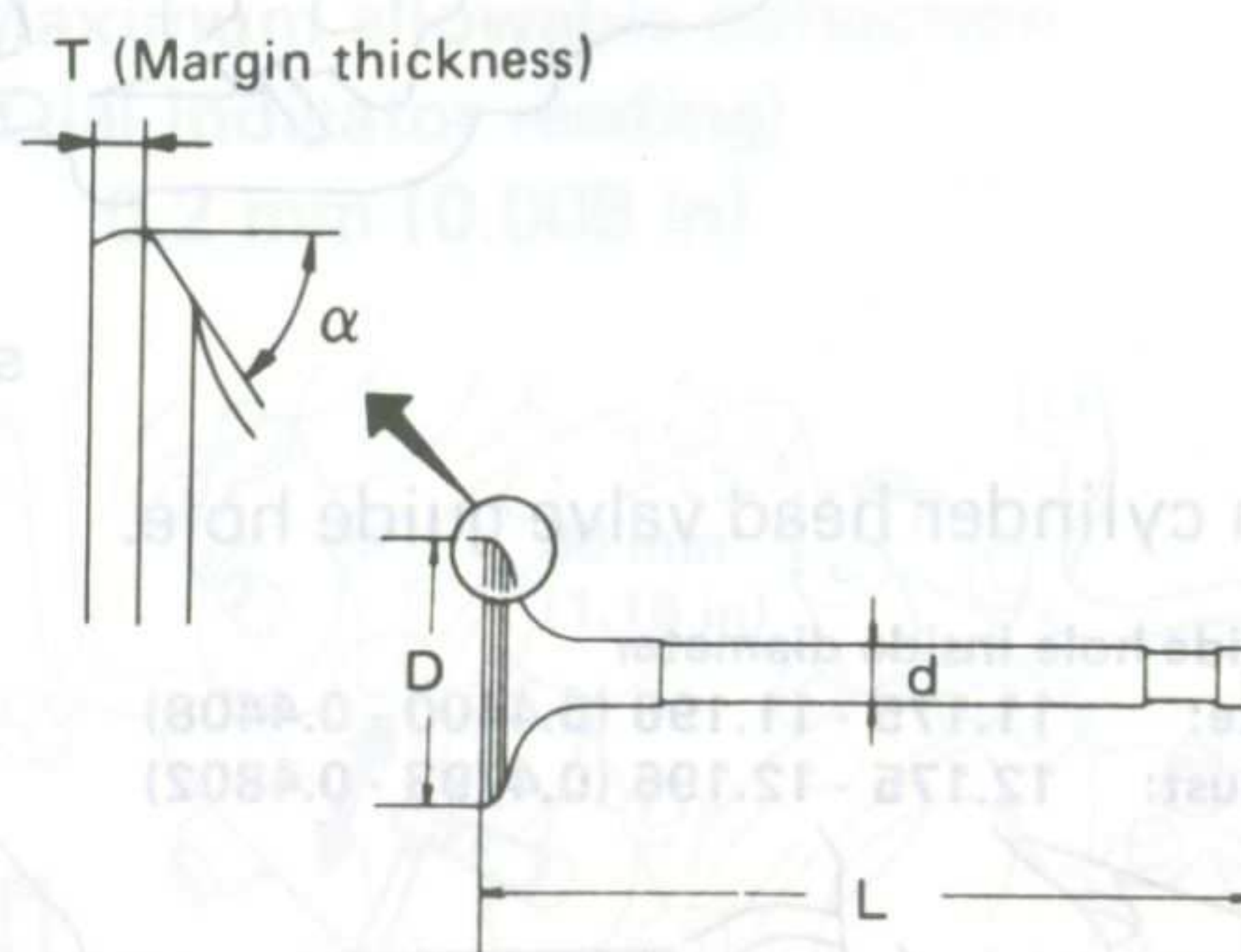
Standard outside diameter:
46.935 - 46.955 mm
(1.8478 - 1.8486 in)

SEM267A

VALVE DIMENSIONS

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

When valve head has been worn down to 0.5 mm (0.020 in) in margin thickness, replace the valve. Grinding allowance for valve stem tip is 0.2 mm (0.008 in) or less.



SEM188A

VALVE SPRING SQUARENESS

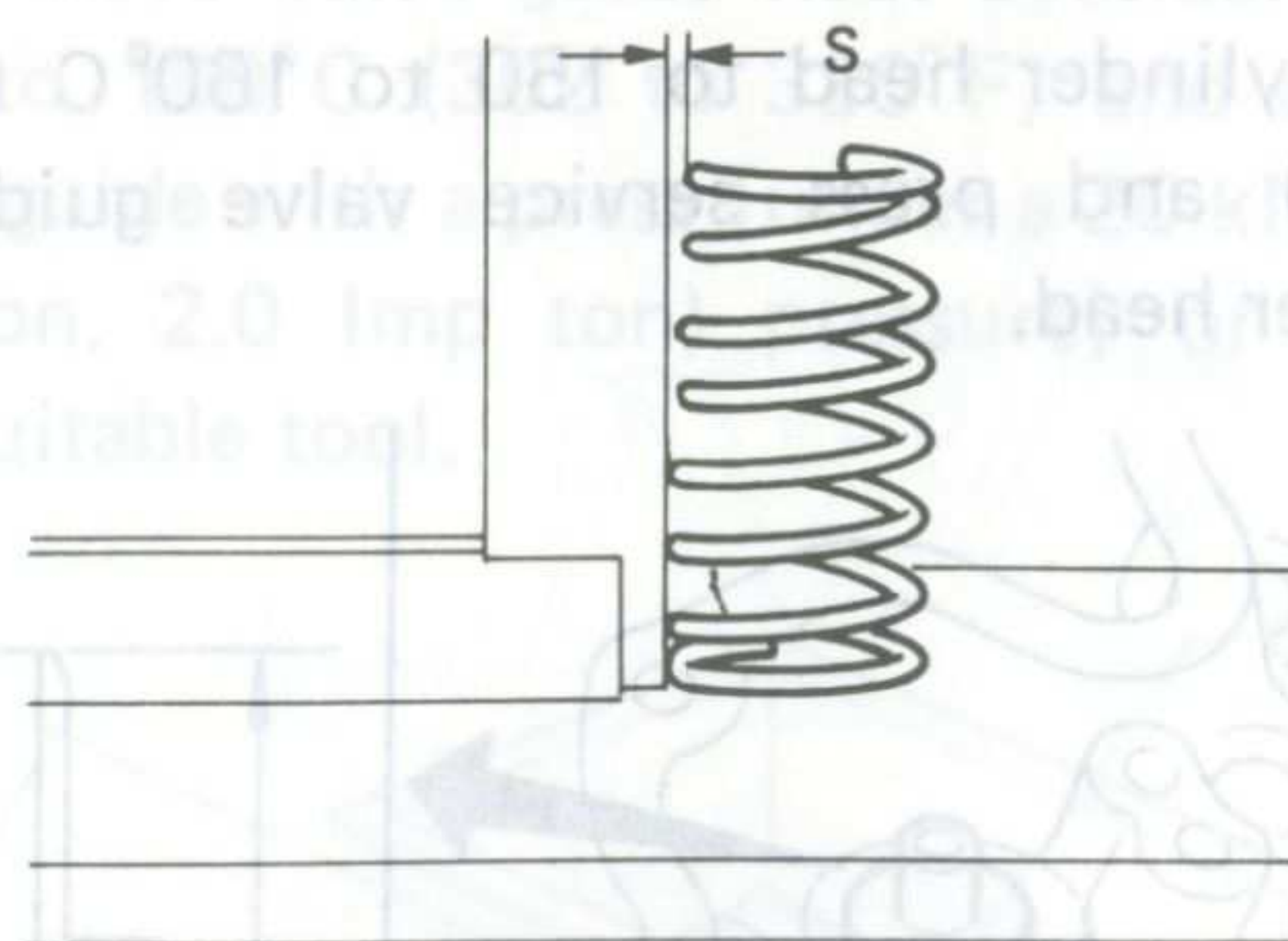
Out of square:

Outer

Less than 2.2 mm (0.087 in)

Inner

Less than 1.9 mm (0.075 in)



SEM288A

VALVE SPRING PRESSURE LOAD

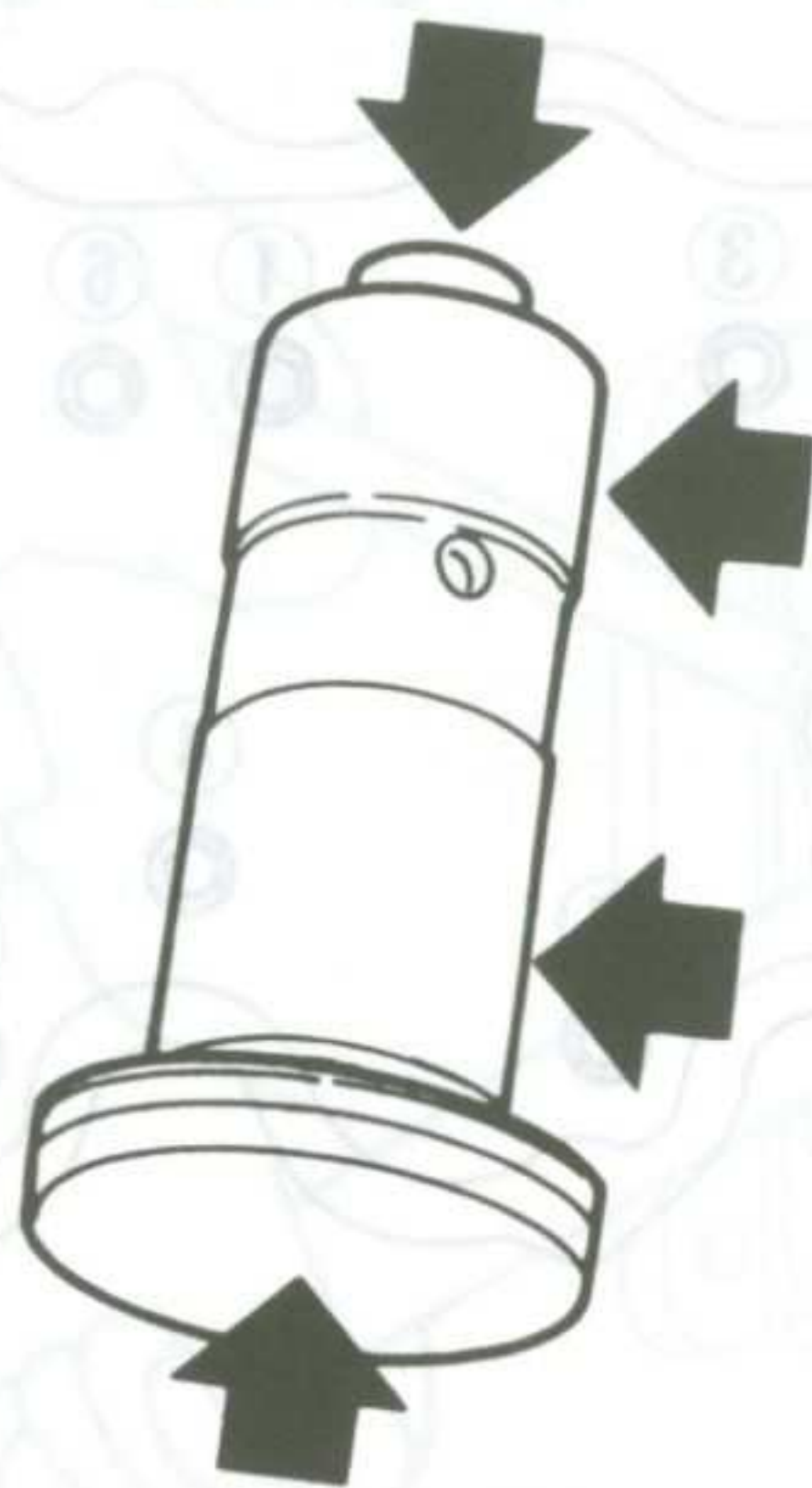
Refer to S.D.S.

CYLINDER HEAD

Inspection (Cont'd)

HYDRAULIC VALVE LIFTER

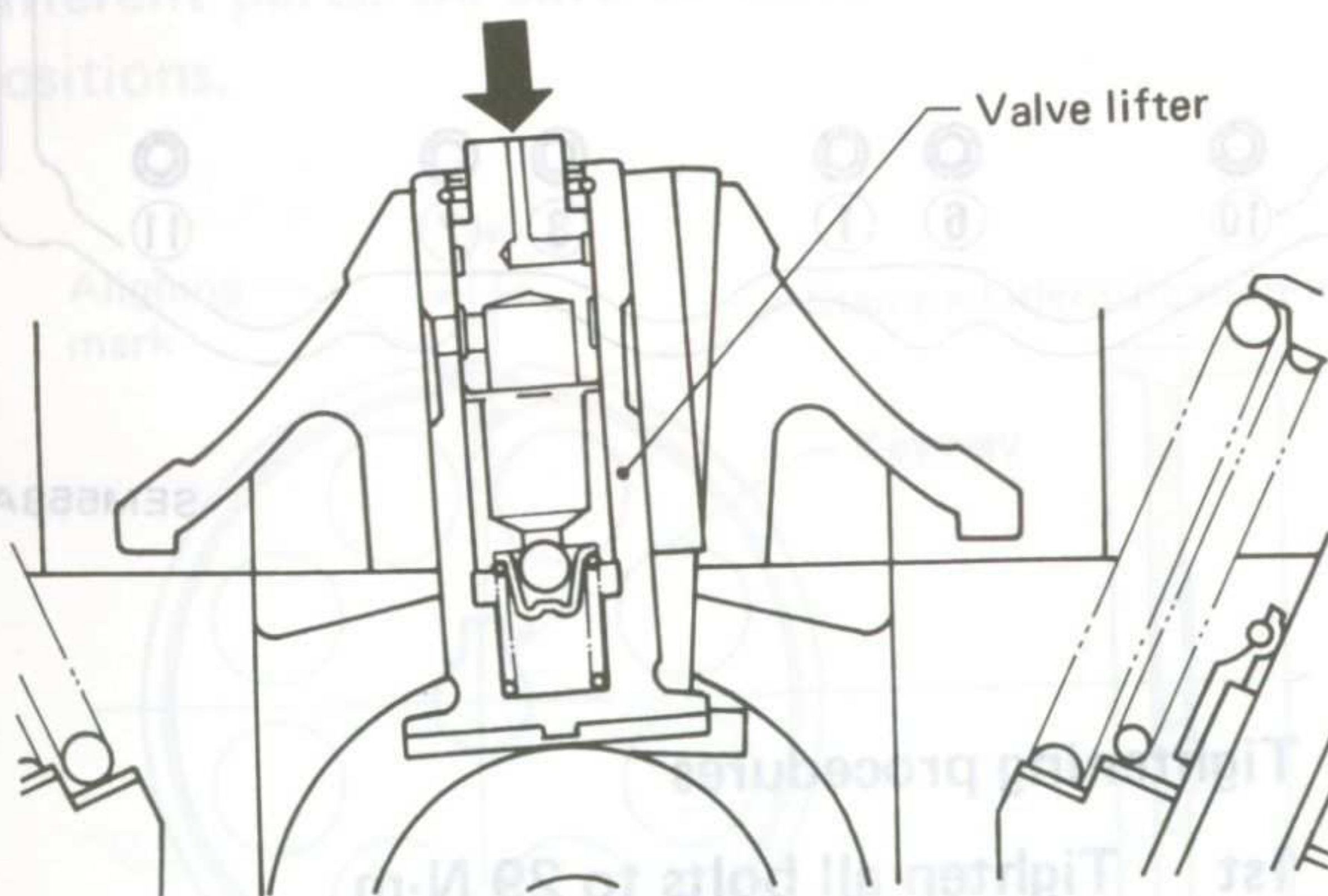
Check contact and sliding surfaces for wear or scratches.



SEM269A

If valve lifters are noisy, check valve lifter.

- (1) Depress plunger forcibly with your finger.



SEM531A

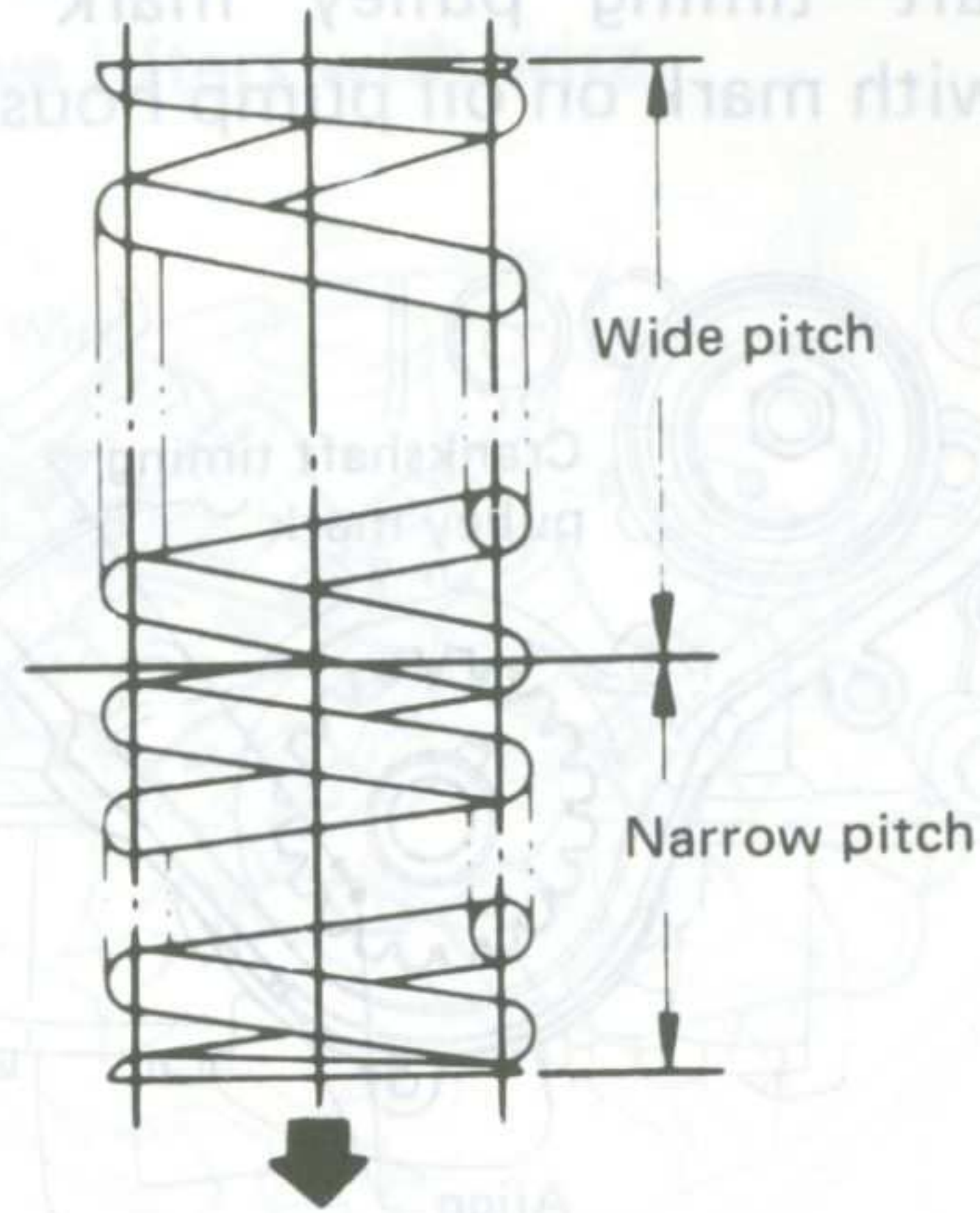
If it moves about 1 mm (0.04 in), it indicates air is inside valve lifter.

- (2) Re-install rocker arm and rocker cover.
- (3) Bleed air by running engine at 1,000 rpm under no-load for about 10 minutes.
- (4) Next, remove rocker cover and rocker arm and check to ensure all air is bled. (Refer to step (1) above.)
- (5) If there is still air, replace valve lifter.

Assembly

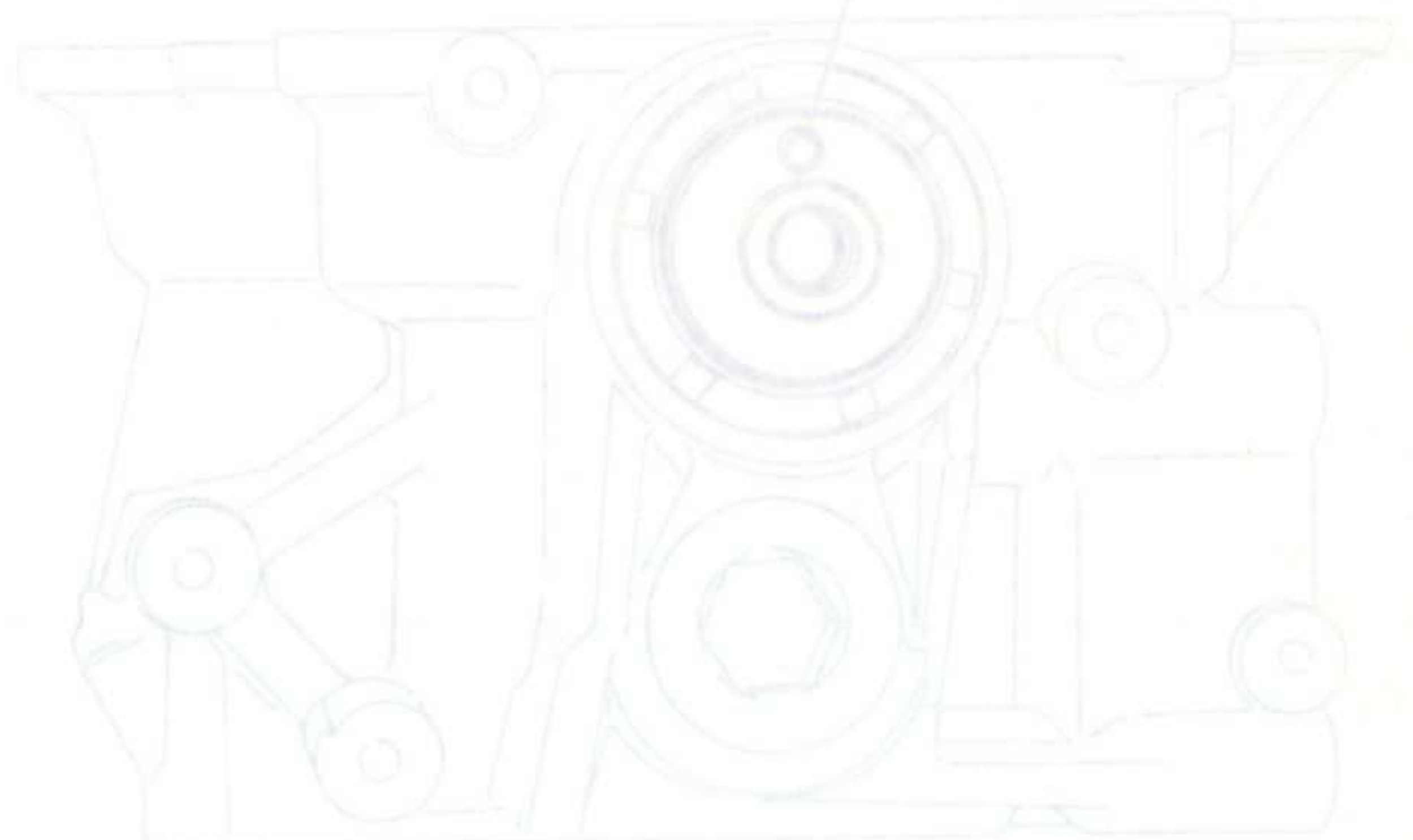
1. Install valve component parts.

Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.



SEM052

2. Install camshaft.
3. Apply engine oil to camshaft oil seal and install it in place.
4. Adjust camshaft end play with locate plate installed.

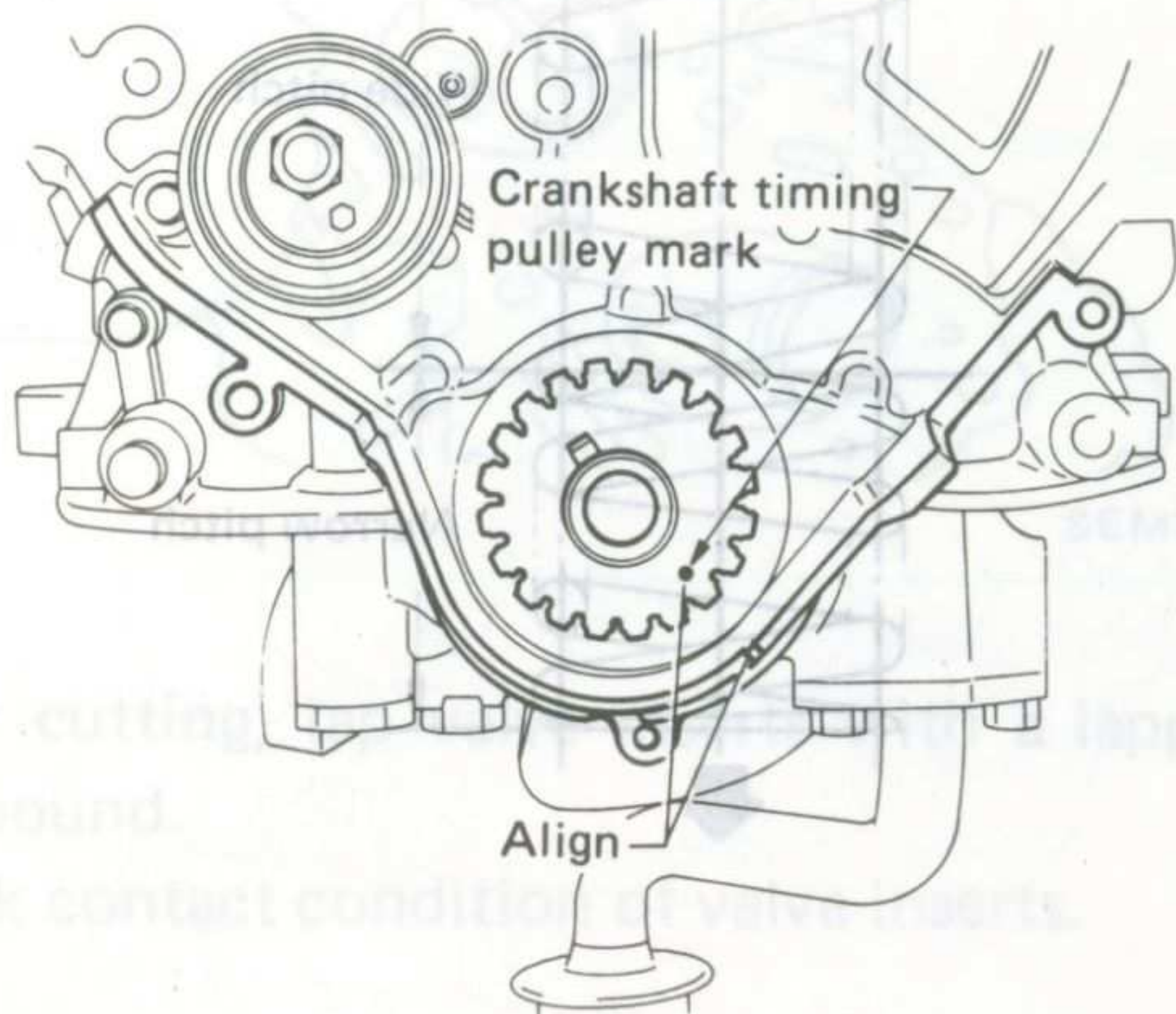


CYLINDER HEAD

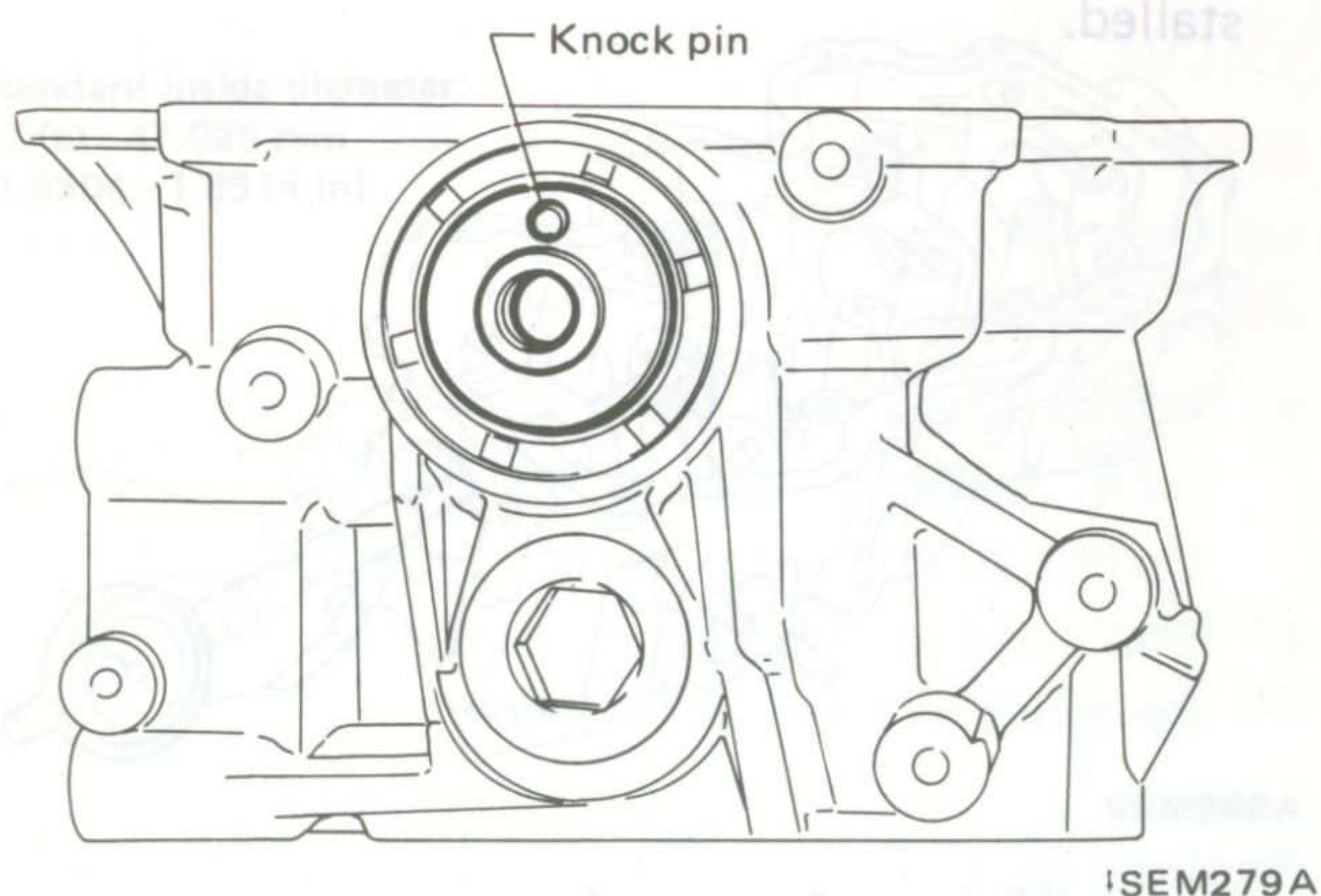
Installation

1. Before installing cylinder head, make sure that No. 1 cylinder is set at T.D.C. on its compression stroke as follows:

(1) Crankshaft timing pulley mark should be aligned with mark on oil pump housing.



(2) Have knock pin in front end of camshaft facing upward.



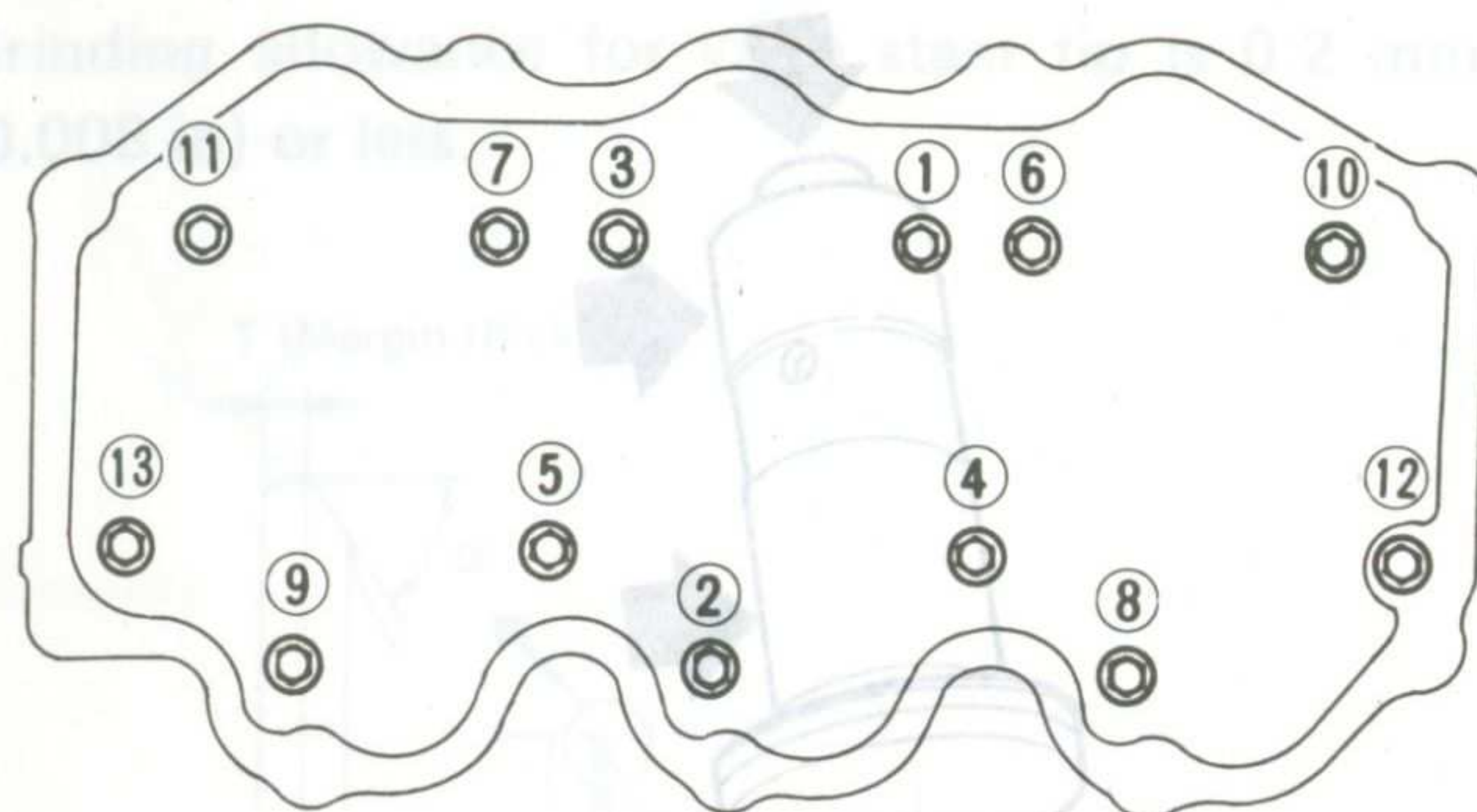
Do not rotate crankshaft and camshaft separately, because valves will hit piston heads.

2. Install cylinder head with new gasket.

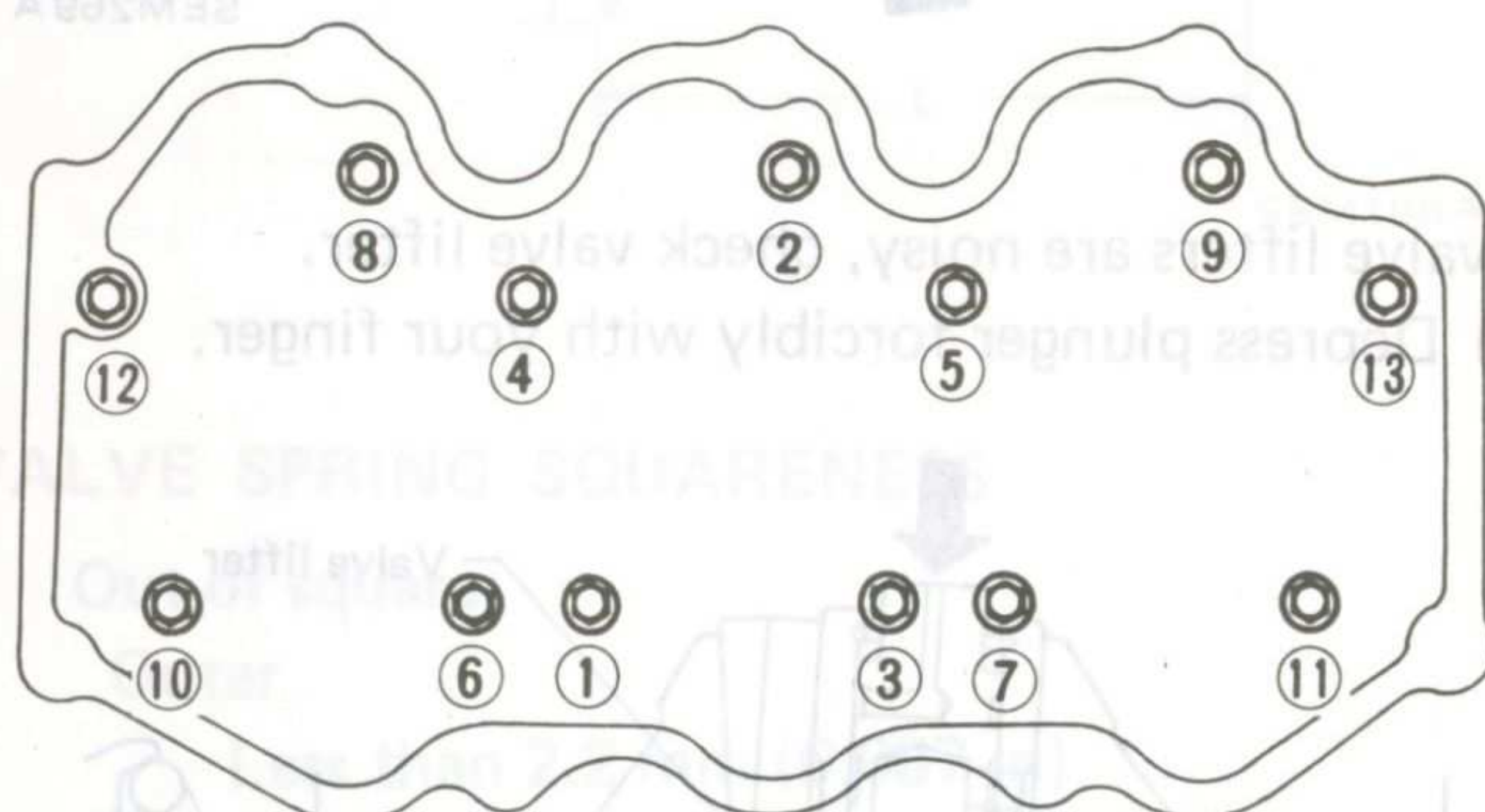
3. Tighten cylinder head bolts with washers using ST10120000.

• Tightening order

R.H. side



L.H. side



SEM558A

• Tightening procedures

1st Tighten all bolts to 29 N·m
(3.0 kg-m, 22 ft-lb)

2nd Tighten all bolts to 59 N·m
(6.0 kg-m, 43 ft-lb)

3rd Loosen all bolts completely.

4th Tighten all bolts to 29 N·m
(3.0 kg-m, 22 ft-lb)

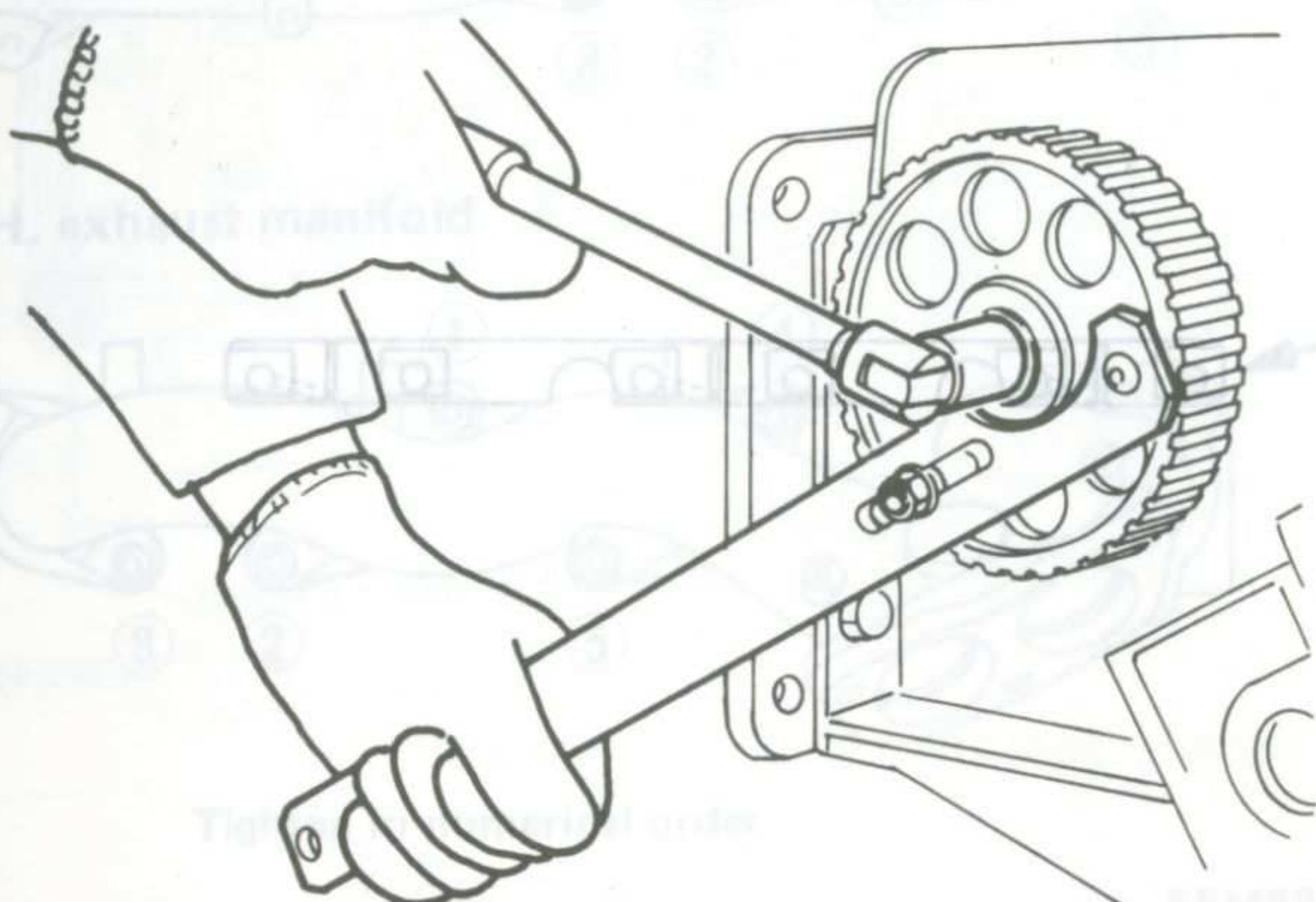
5th Tighten all bolts to 54 to 64 N·m
(5.5 to 6.5 kg-m, 40 to 47 ft-lb)
or if you have an angle wrench, turn all bolts 60 - 65 degrees clockwise.

CYLINDER HEAD

Installation (Cont'd)

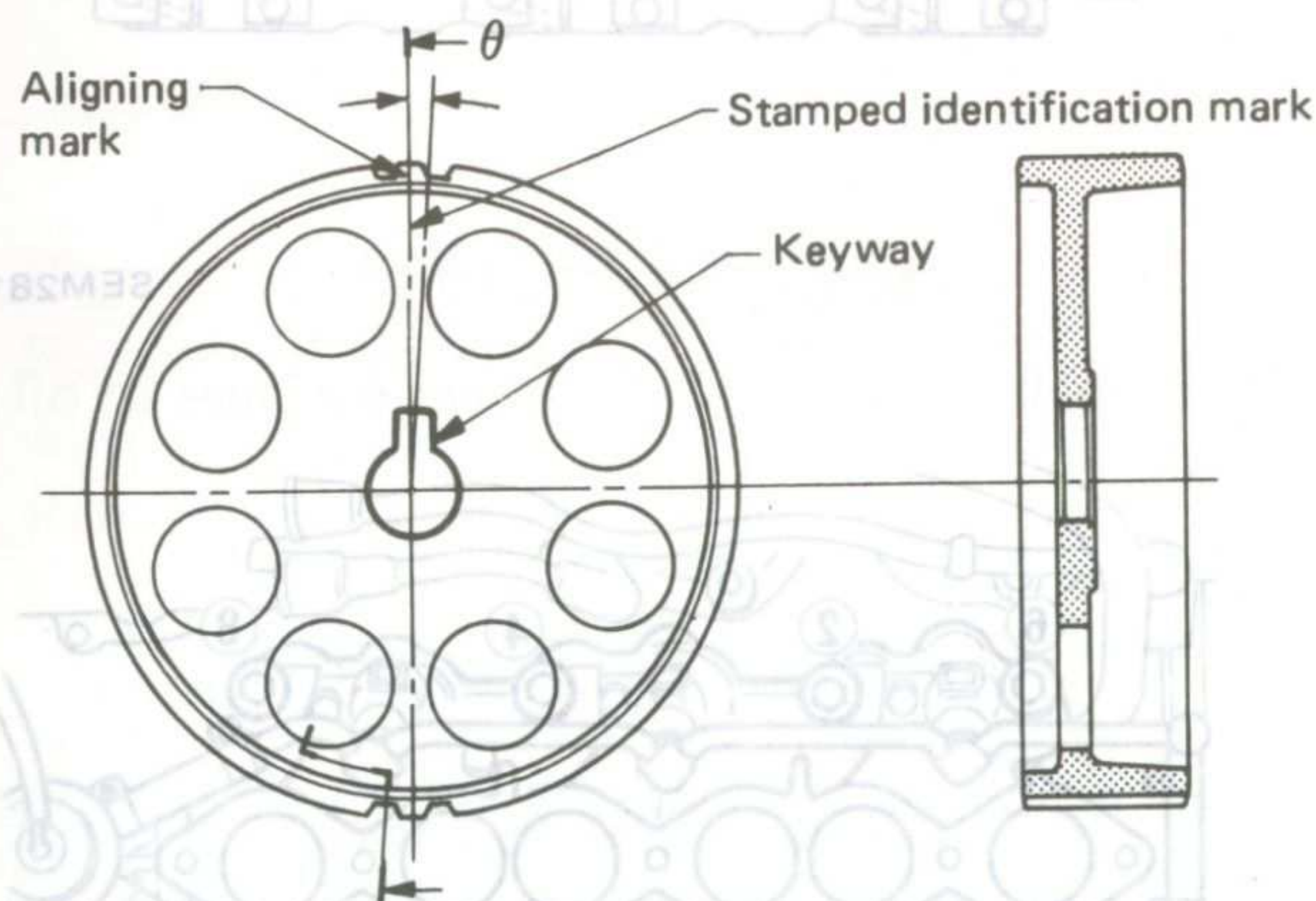
4. Tighten rear timing cover.
5. Install camshaft pulleys.

 : **Camshaft pulley:**
78 - 88 N·m
(8.0 - 9.0 kg-m, 58 - 65 ft-lb)



SEM305A

R.H. camshaft pulley and L.H. camshaft pulley are different parts. Be sure to install them in the right positions.

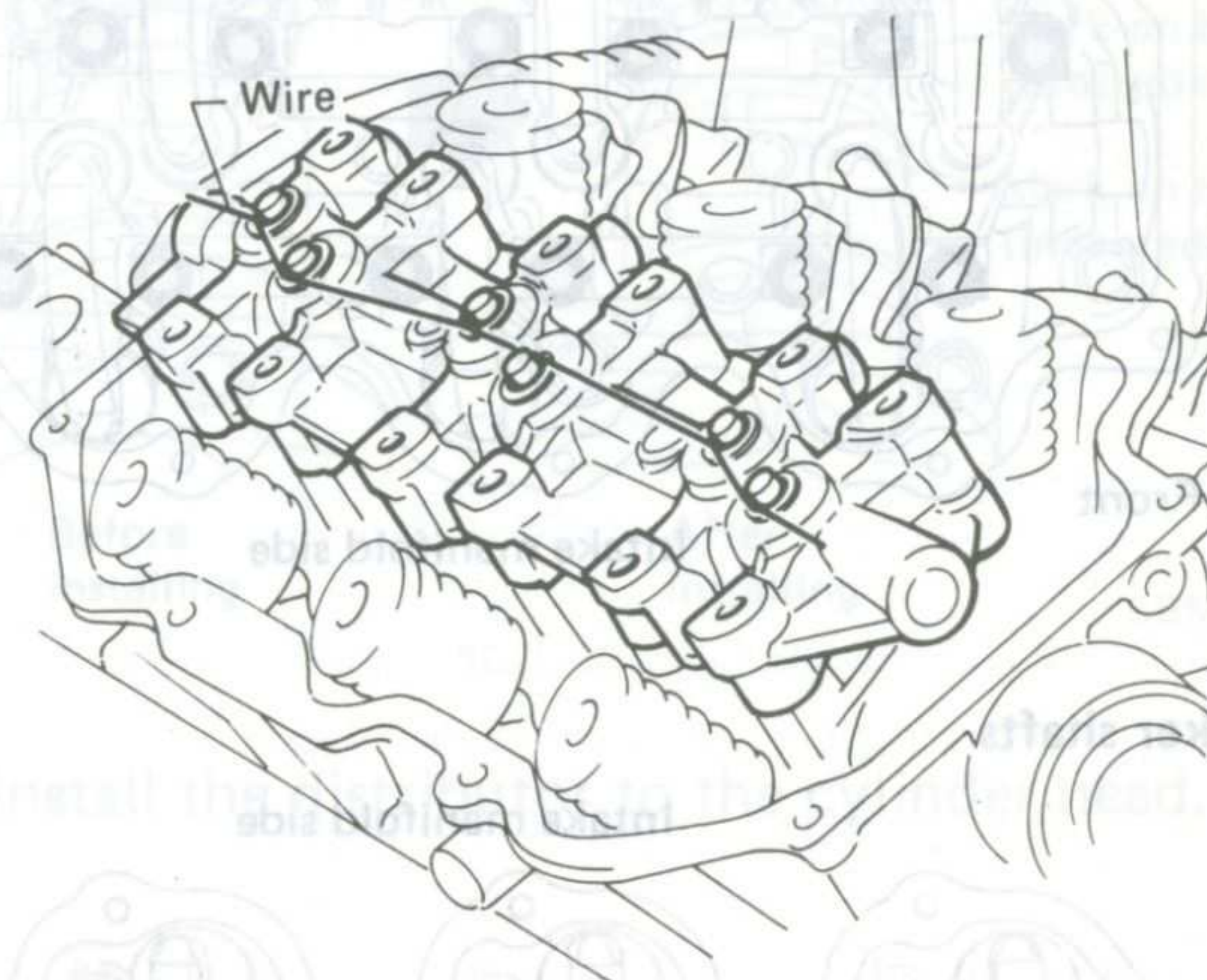


SEM303A

	Identification mark	θ
R.H. camshaft pulley	R3	0°53'
L.H. camshaft pulley	L3	-3°27'

6. Install timing belt and adjust belt tension.
7. Install front upper and lower belt covers.
8. Install valve lifters and lifter guide.

Assemble valve lifters to their original position and hold all valve lifters with wire.



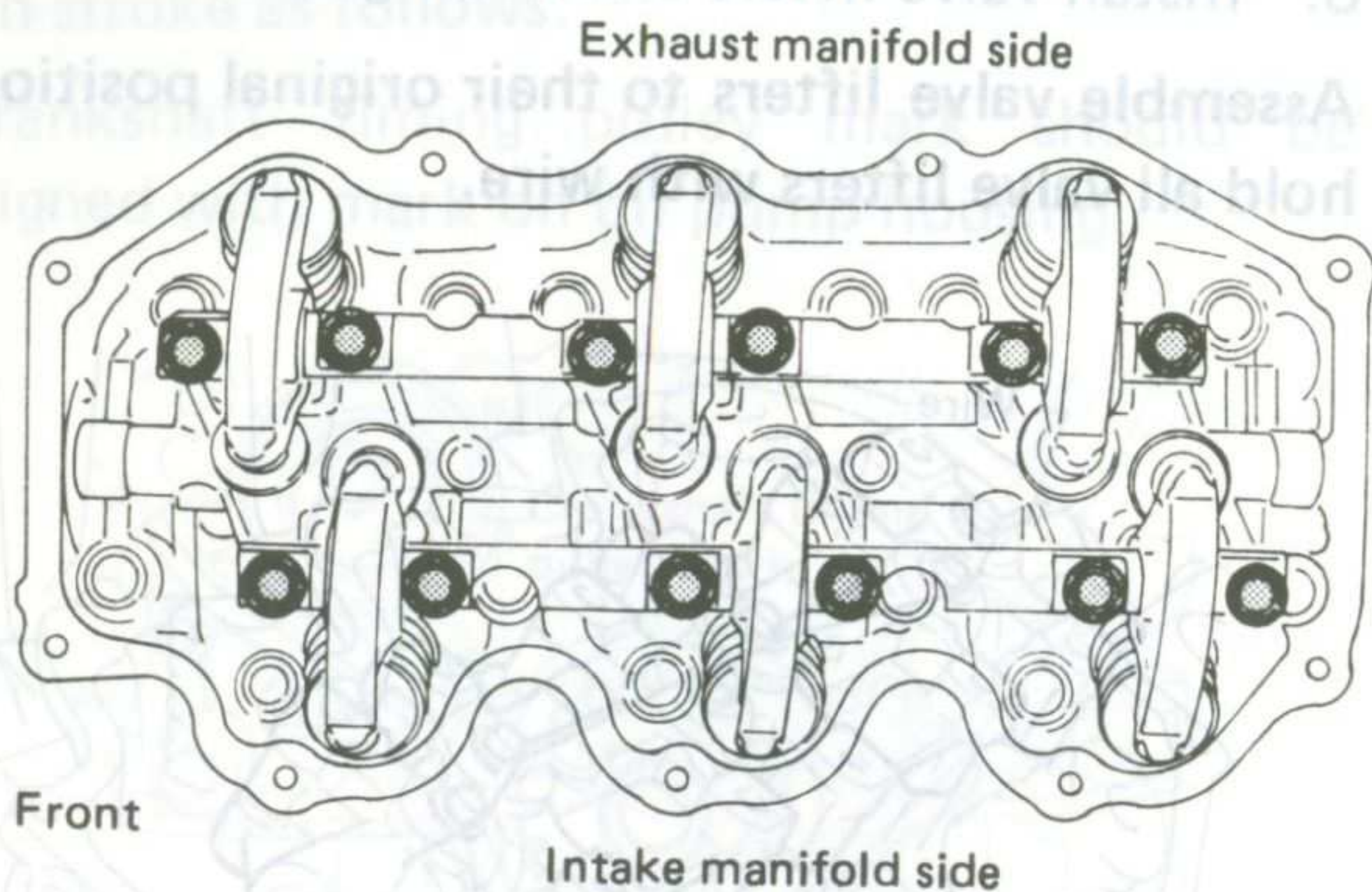
SEM280A

CYLINDER HEAD

Installation (Cont'd)

9. Install rocker shafts with rocker arms and tighten rocker shaft securing bolts in two or three stages.

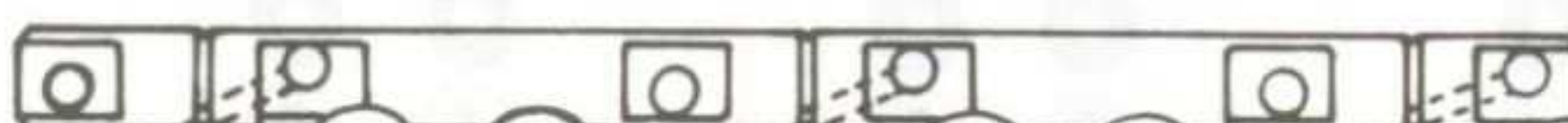
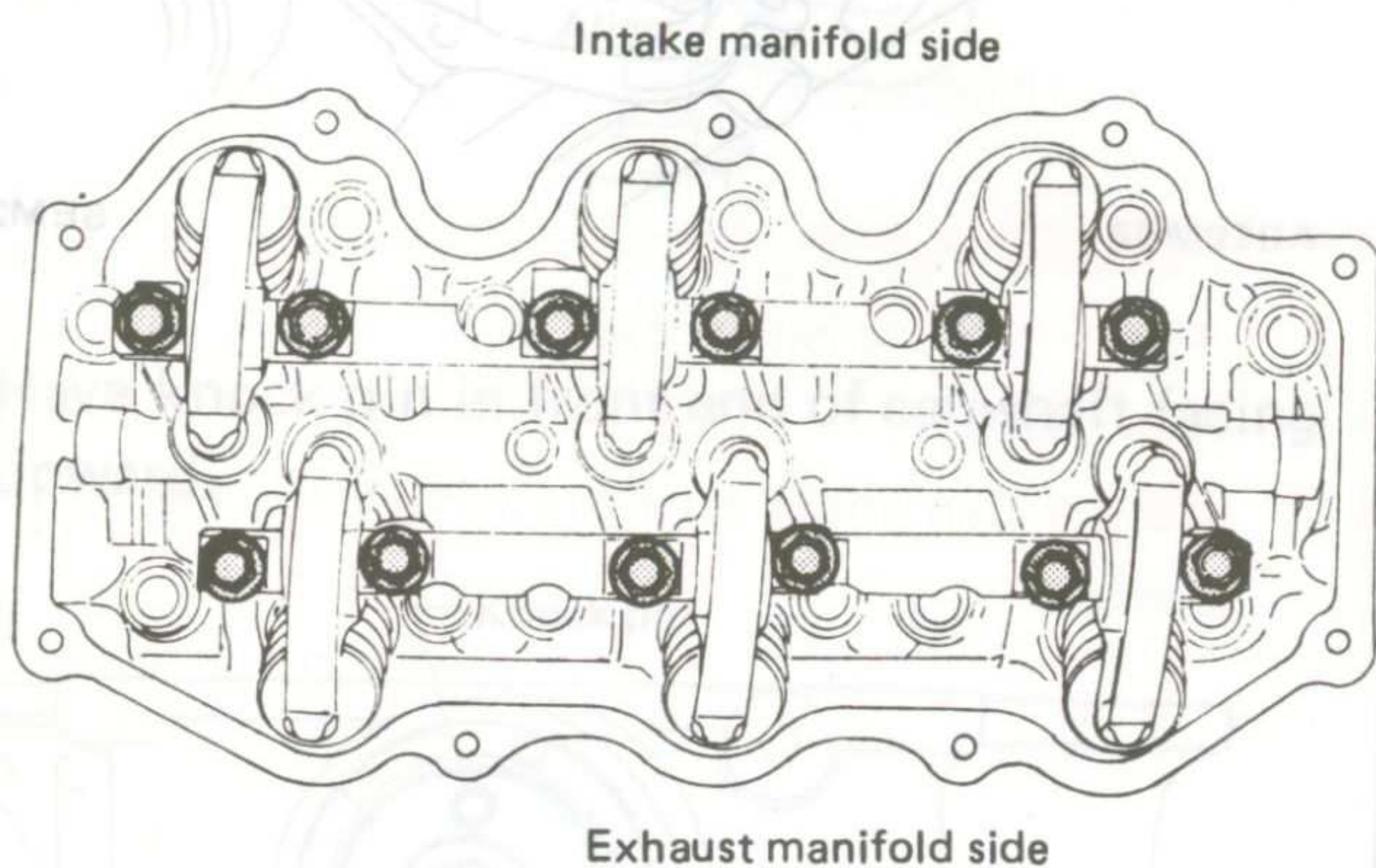
R.H. rocker shafts



Rocker shaft direction



L.H. rocker shafts



10. Install rocker cover.

Confirm rocker cover bolts, washers and trays are free from oil.

11. Install intake manifold and fuel tube.

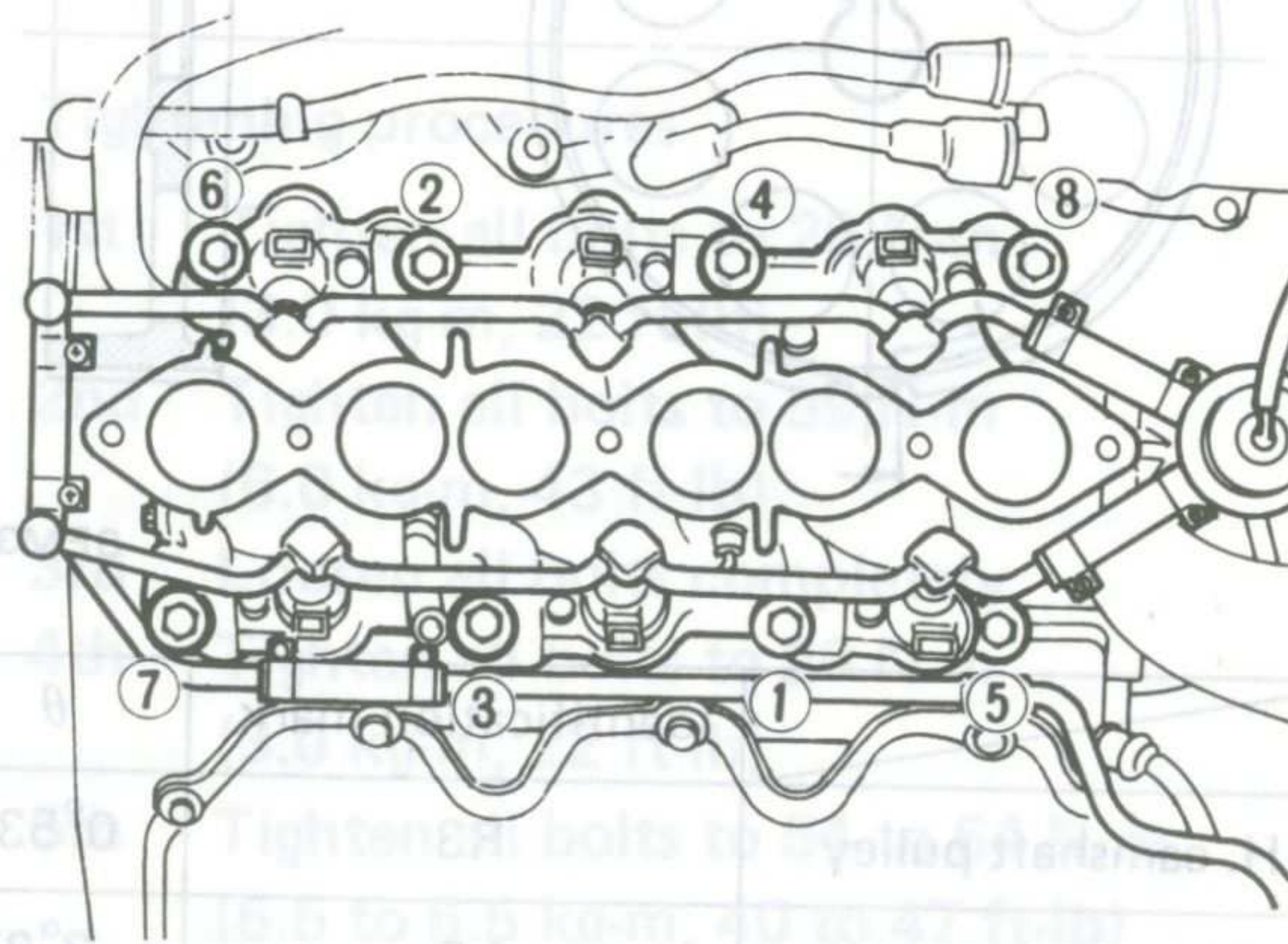
Tighten in two or three stages.

 : Nut

- 1st 3 - 5 N·m
(0.3 - 0.5 kg-m, 2.2 - 3.6 ft-lb)
- 2nd 24 - 27 N·m
(2.4 - 2.8 kg-m, 17 - 20 ft-lb)

Bolt

- 1st 3 - 5 N·m
(0.3 - 0.5 kg-m, 2.2 - 3.6 ft-lb)
- 2nd 24 - 27 N·m
(2.4 - 2.8 kg-m, 17 - 20 ft-lb)



Tighten in numerical order.

SEM529A

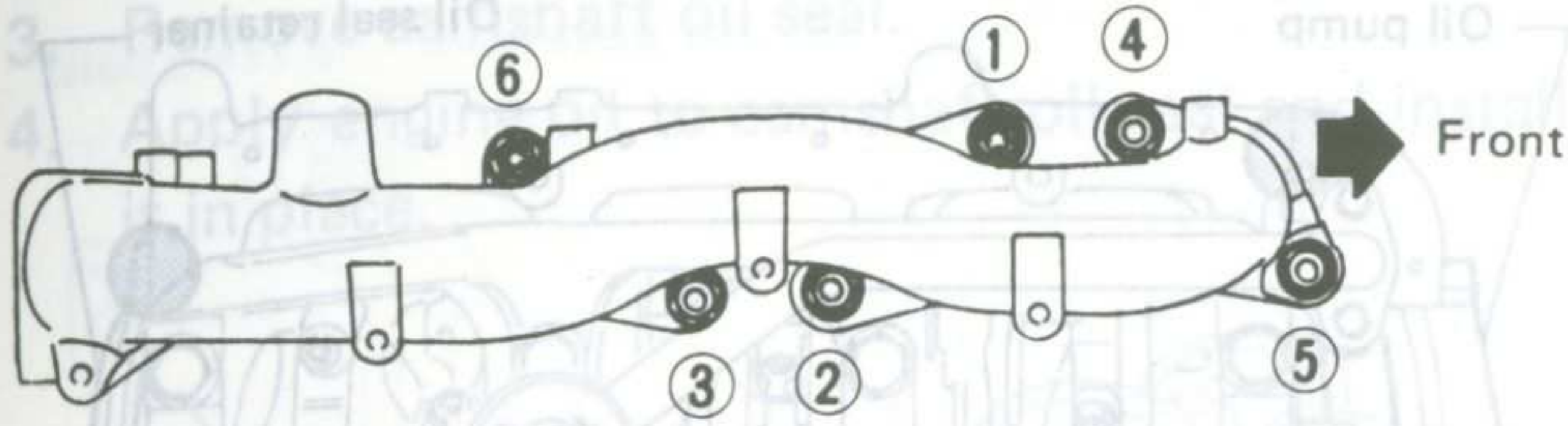
SEM281A

CYLINDER HEAD

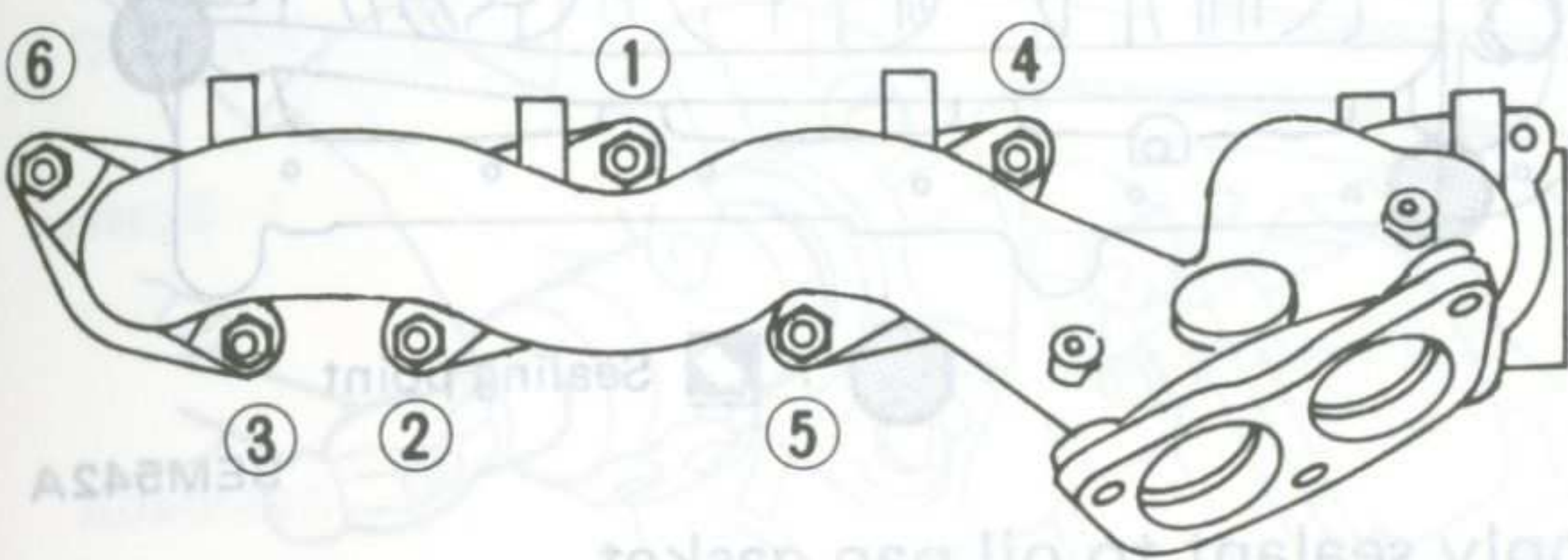
Installation (Cont'd)

12. Install exhaust manifolds and connecting tube.

R.H. exhaust manifold



L.H. exhaust manifold



Tighten in numerical order

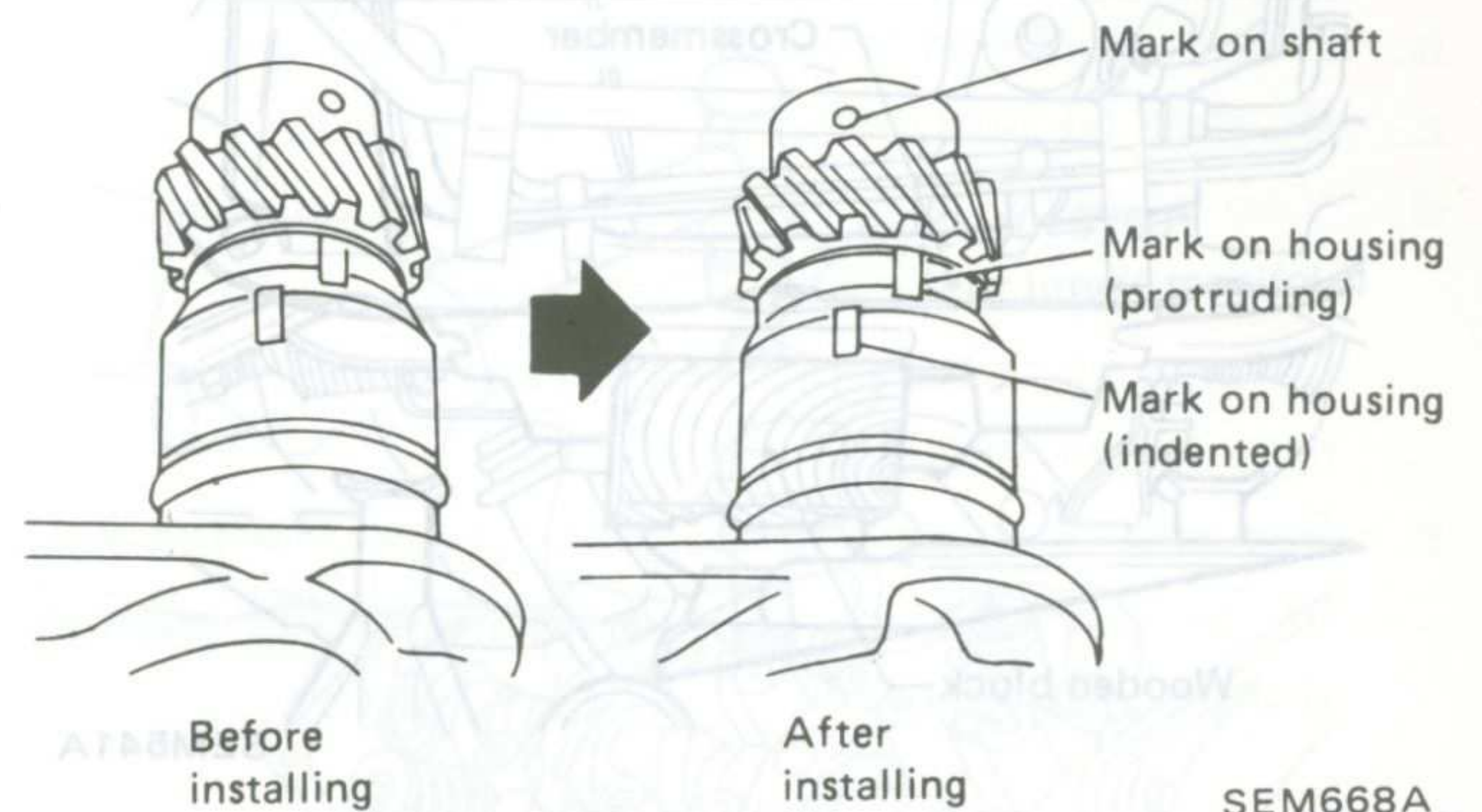
SEM663A

13. After assembling all disassembled parts, fill radiator with coolant up to the specified level. Refer to Changing Engine Coolant (Sections MA and LC).

Distributor Installation

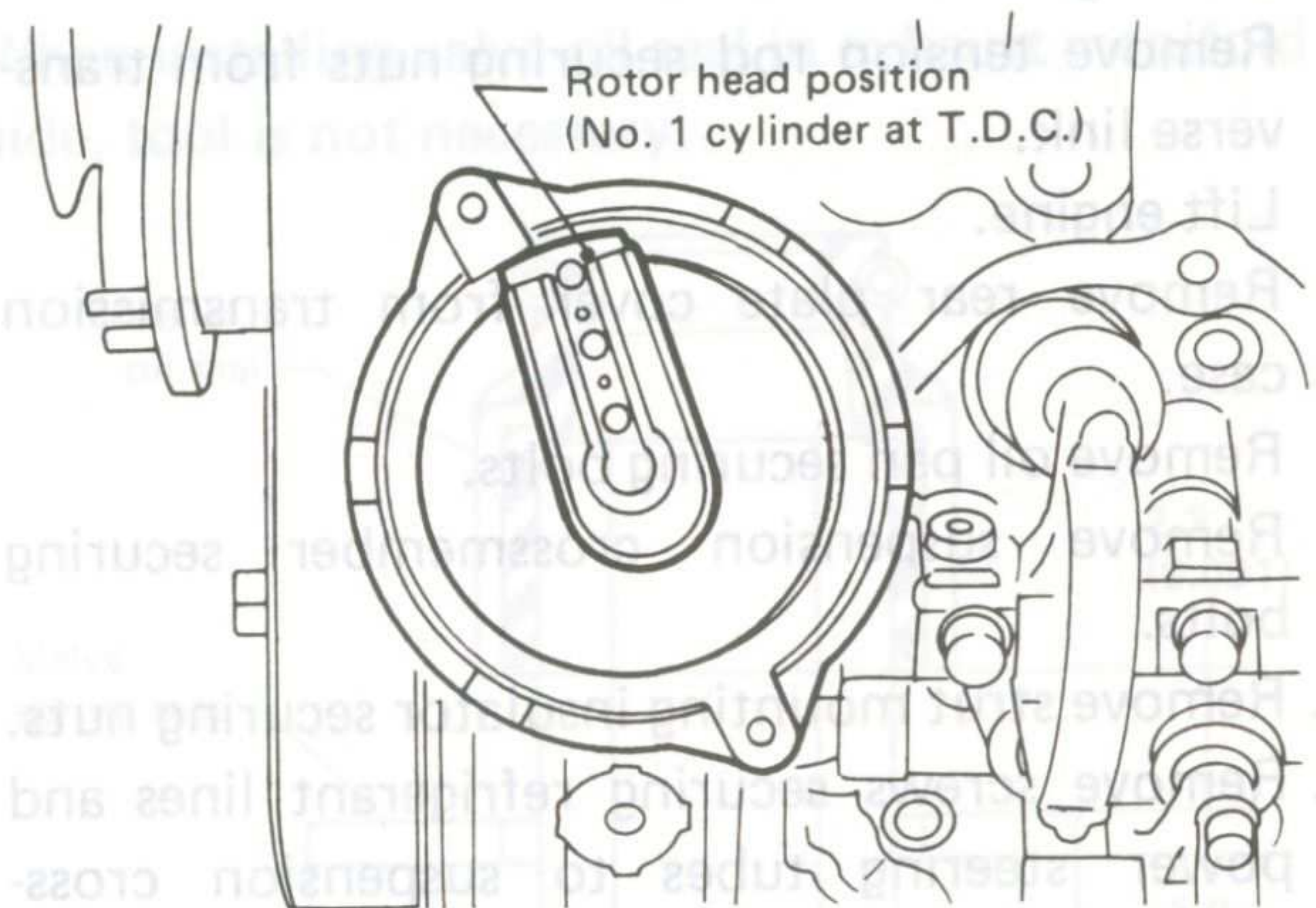
1. Set the distributor gear position.

Distributor gear position



SEM668A

2. Install the distributor to the cylinder head.

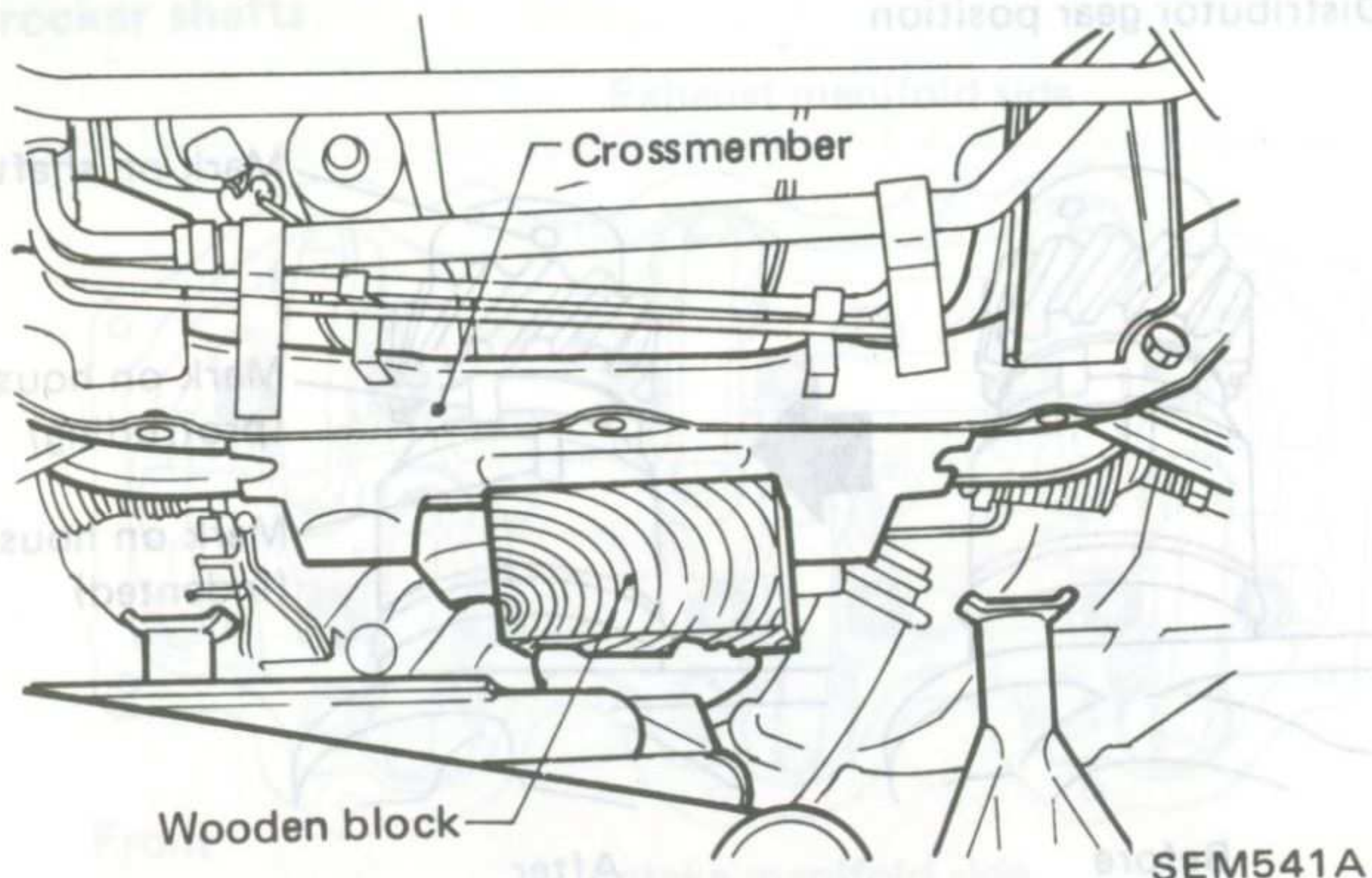


SEM669A

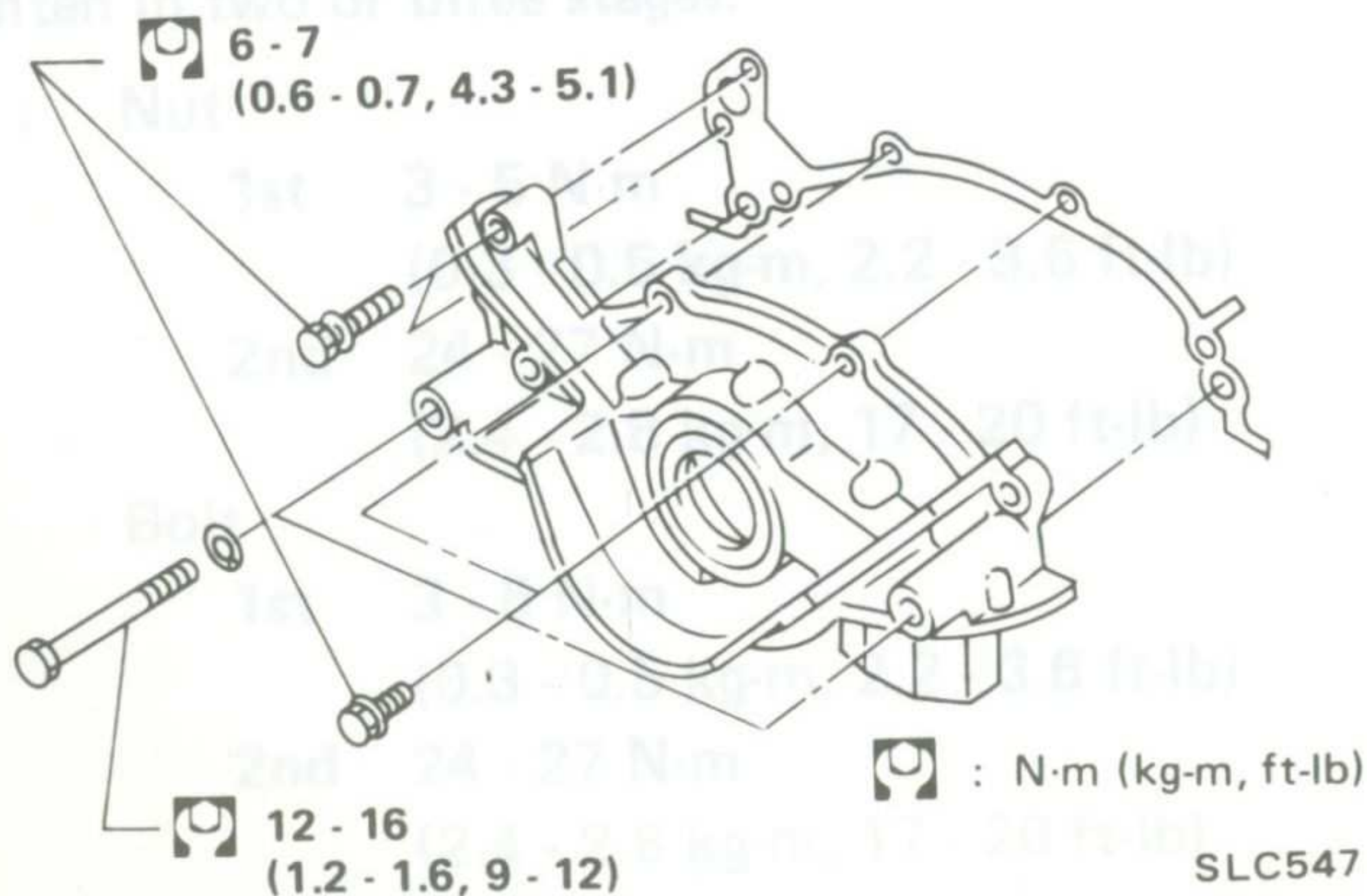
OIL PAN

Removal

1. Drain engine oil.
2. Raise vehicle and support it with safety stands.

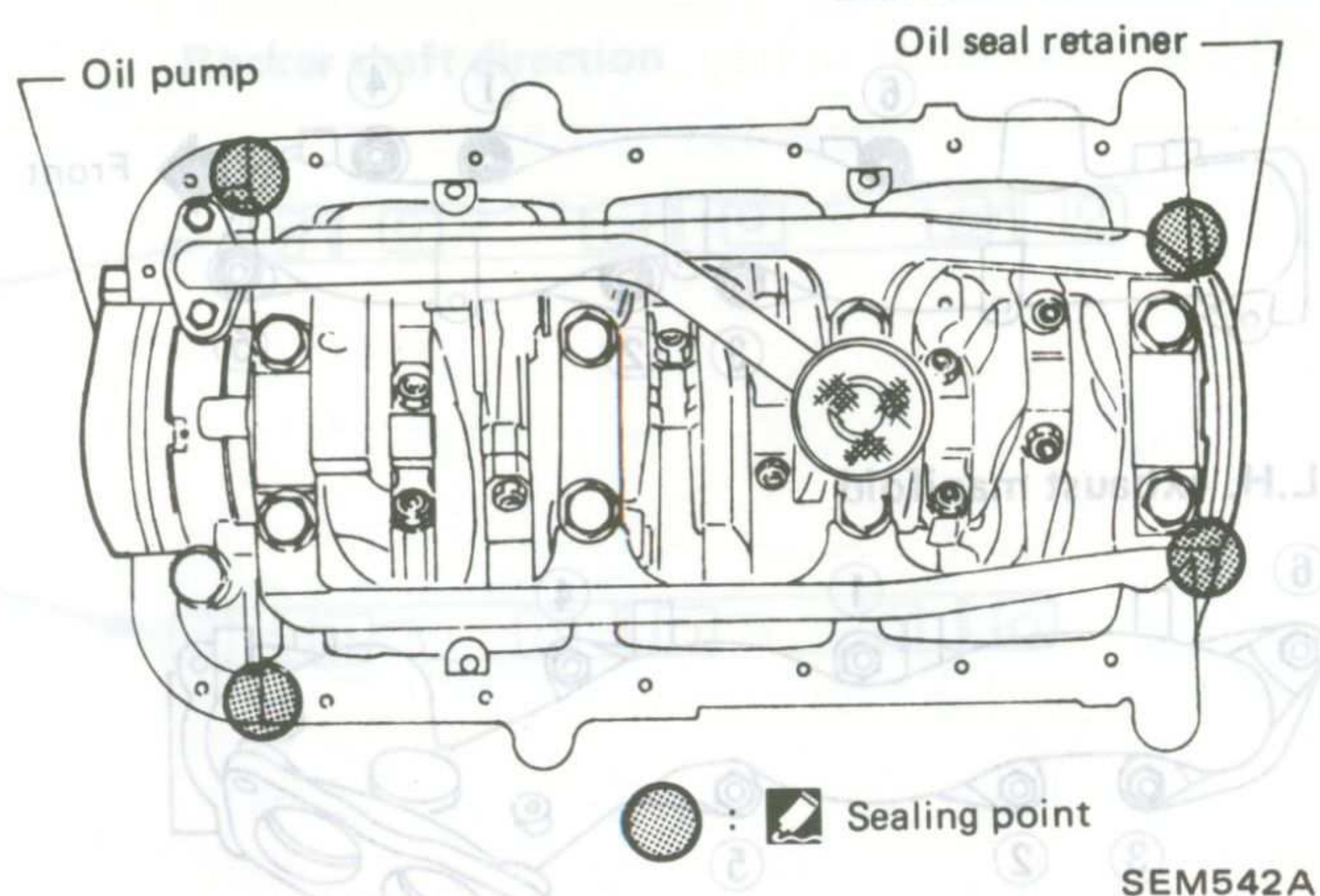


3. Remove front stabilizer bar securing bolts and nuts from suspension crossmember.
4. Remove steering column shaft from gear housing.
5. Remove tension rod securing nuts from transverse link.
6. Lift engine.
7. Remove rear plate cover from transmission case.
8. Remove oil pan securing bolts.
9. Remove suspension crossmember securing bolts.
10. Remove strut mounting insulator securing nuts.
11. Remove screws securing refrigerant lines and power steering tubes to suspension crossmember.
12. Lower suspension crossmember.
13. Remove oil pan from rear side.
14. Remove oil strainer from oil pump assembly and cylinder block.
15. Remove oil pump assembly.

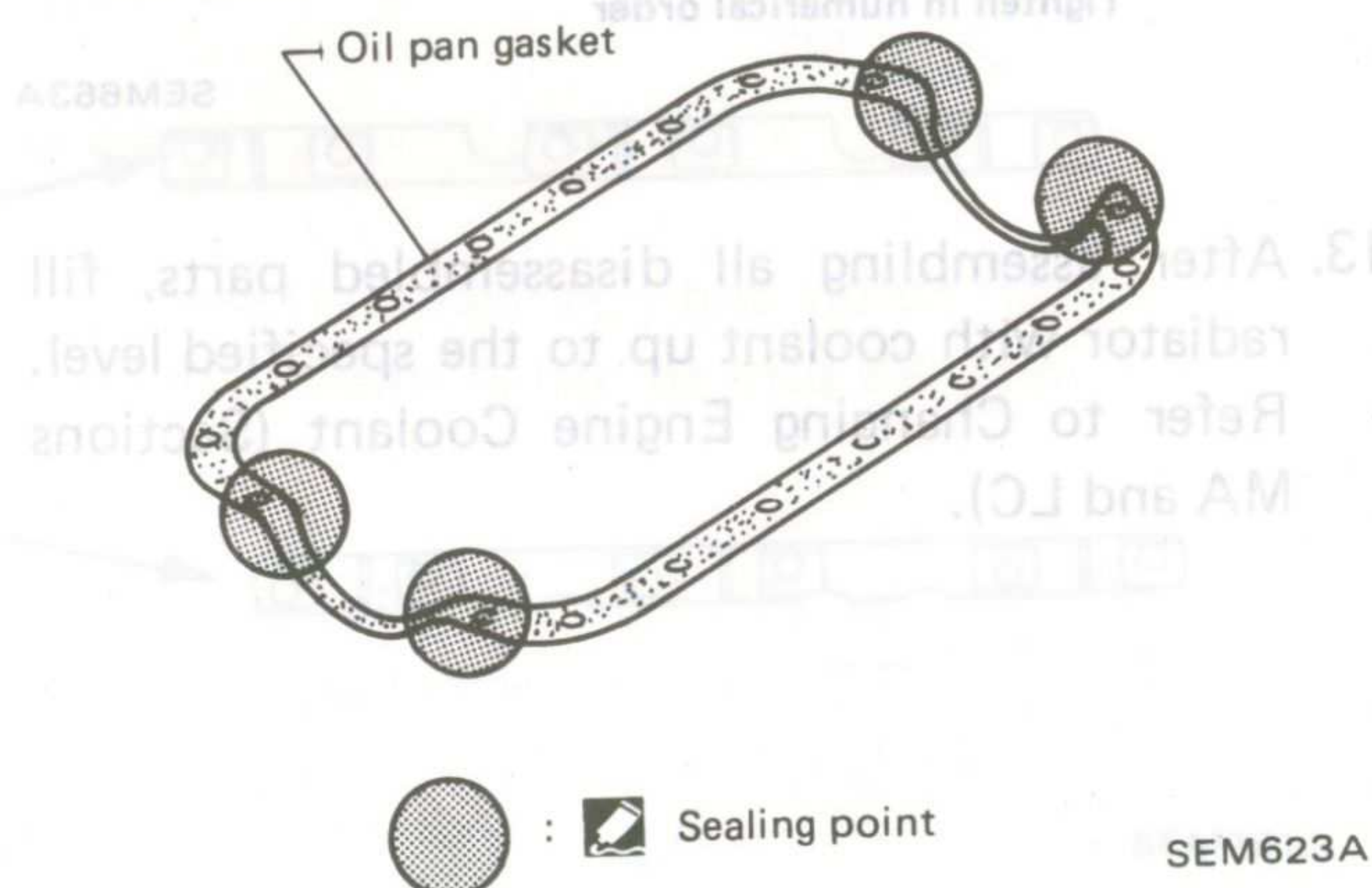


INSTALLATION

1. Apply sealant to cylinder block lower surface.



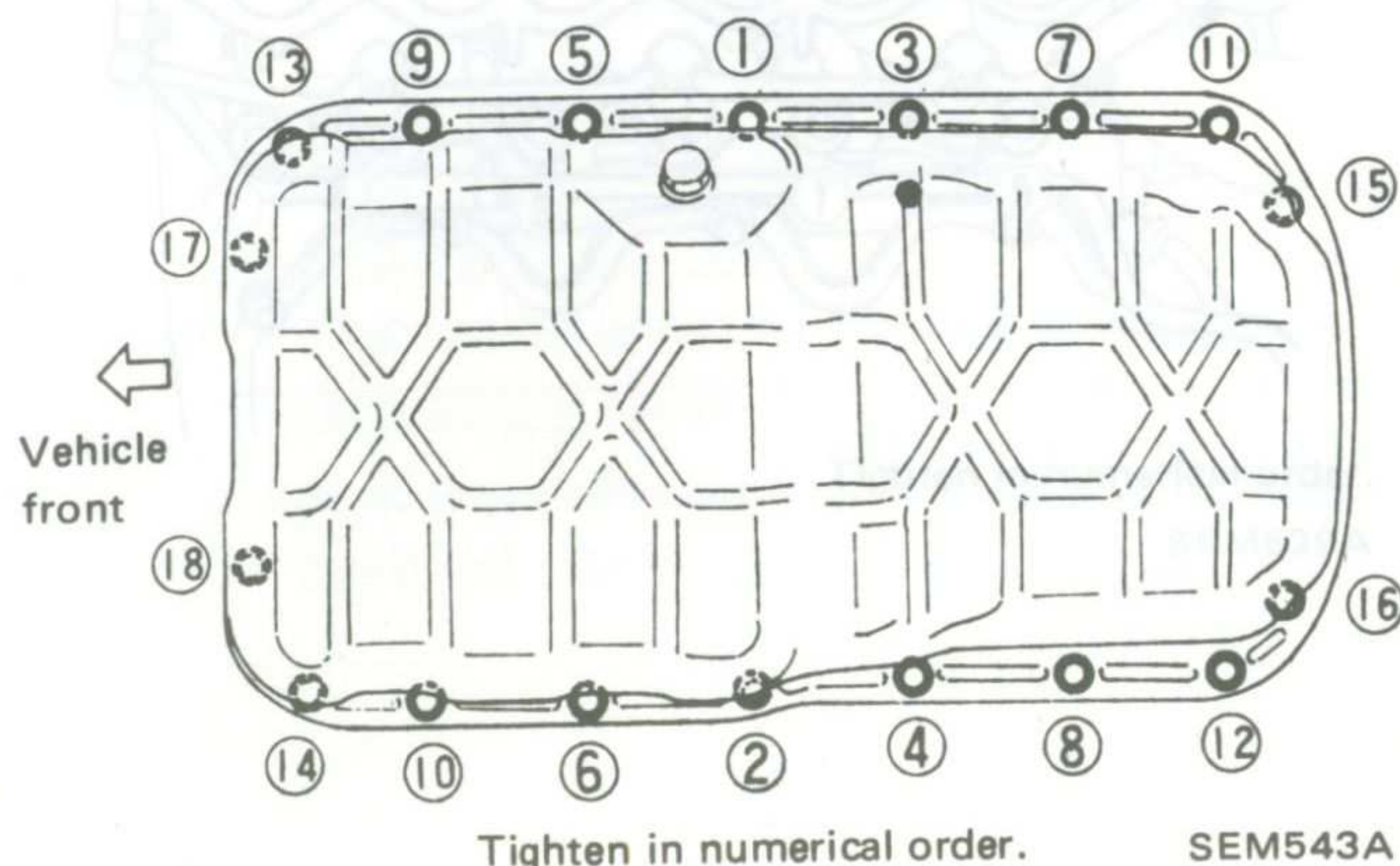
2. Apply sealant to oil pan gasket.



Apply sealant to upper and lower surfaces of oil pan gasket.

3. Install oil pan.

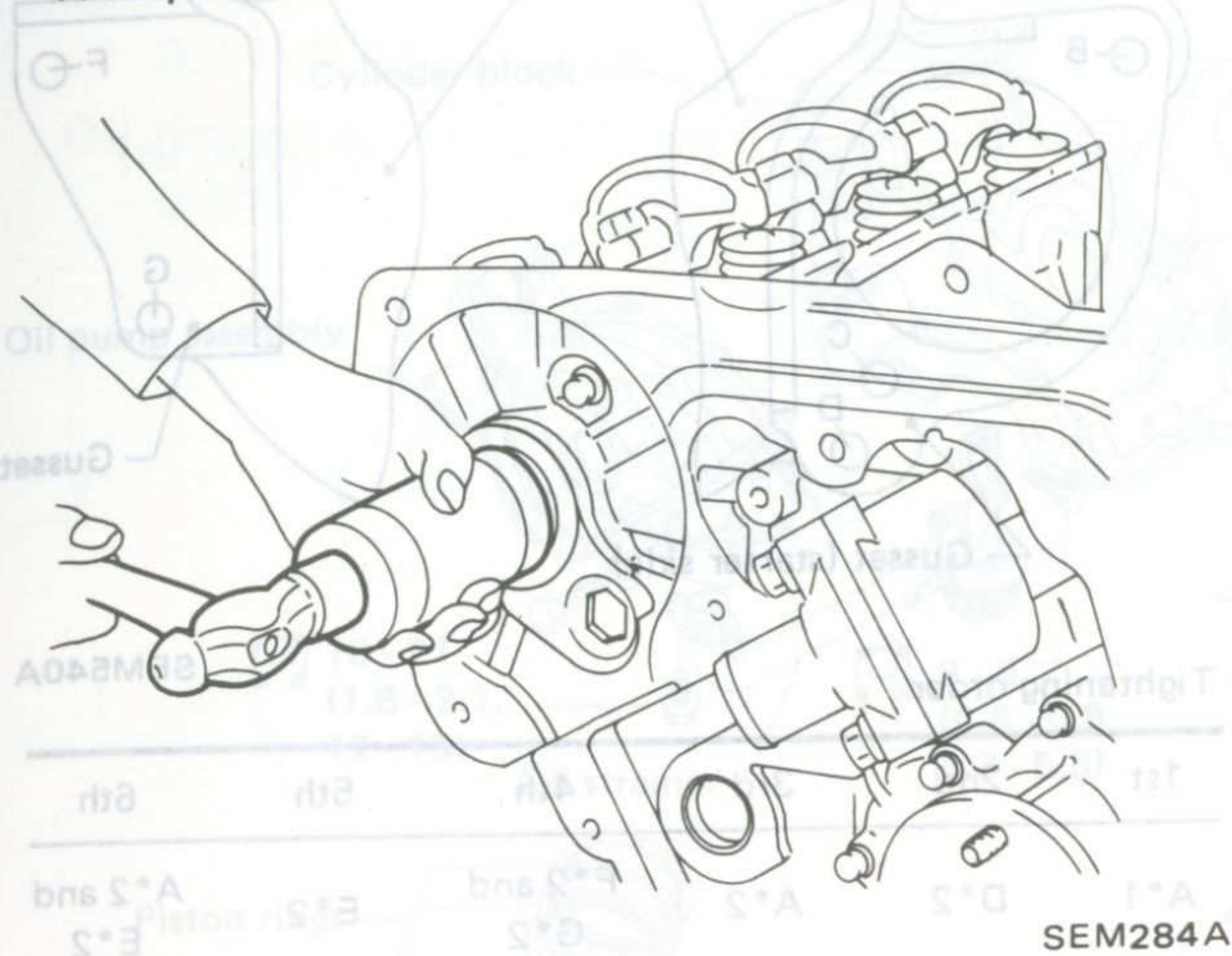
: 5 - 7 N·m
(0.5 - 0.7 kg-m, 3.6 - 5.1 ft-lb)



OIL SEAL REPLACEMENT

Replacement of Camshaft Oil Seal

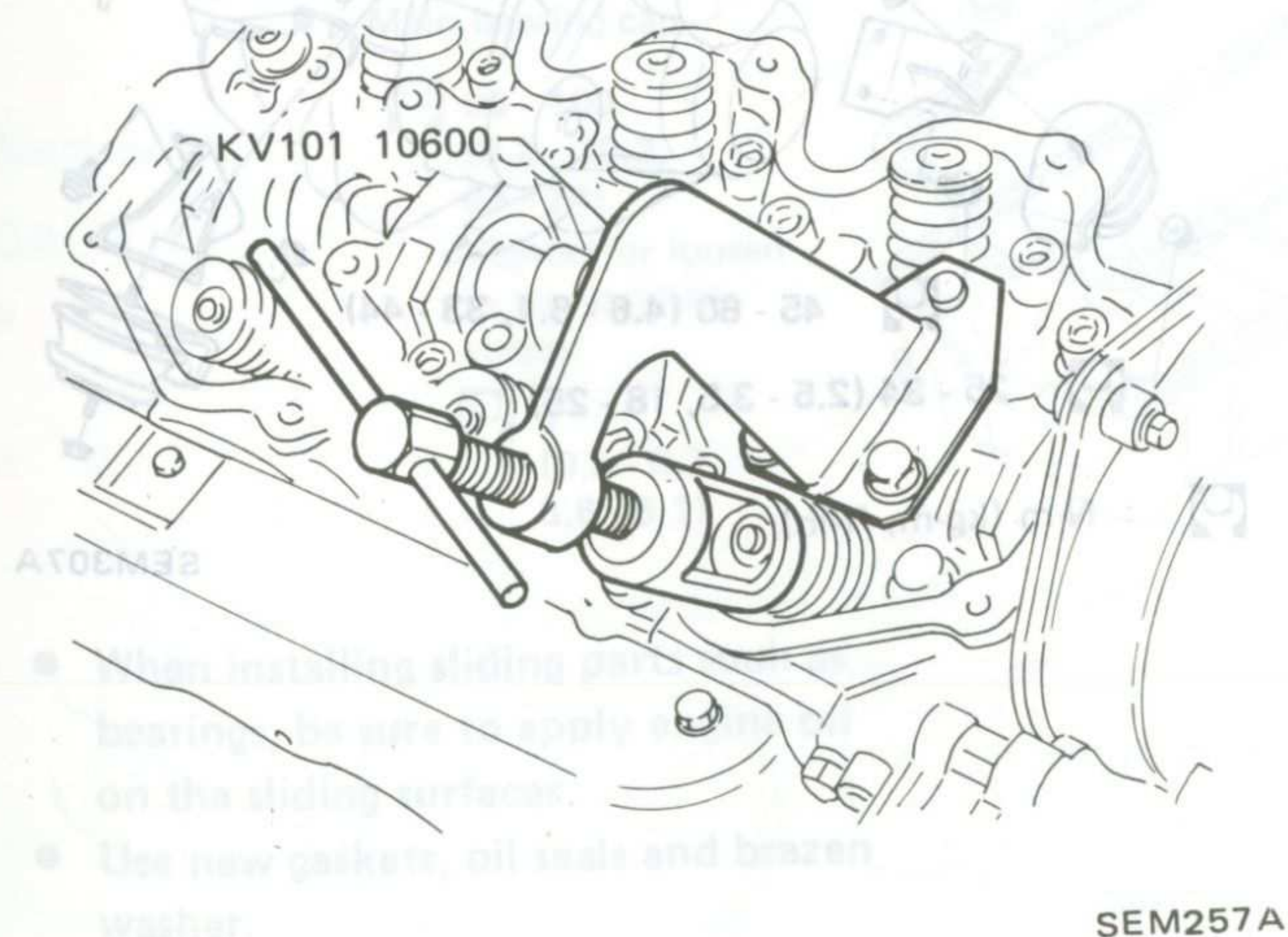
1. Remove timing belt.
2. Remove camshaft pulleys.
3. Remove camshaft oil seal.
4. Apply engine oil to camshaft oil seal and install it in place.



5. Install camshaft pulleys.
6. Install timing belt.

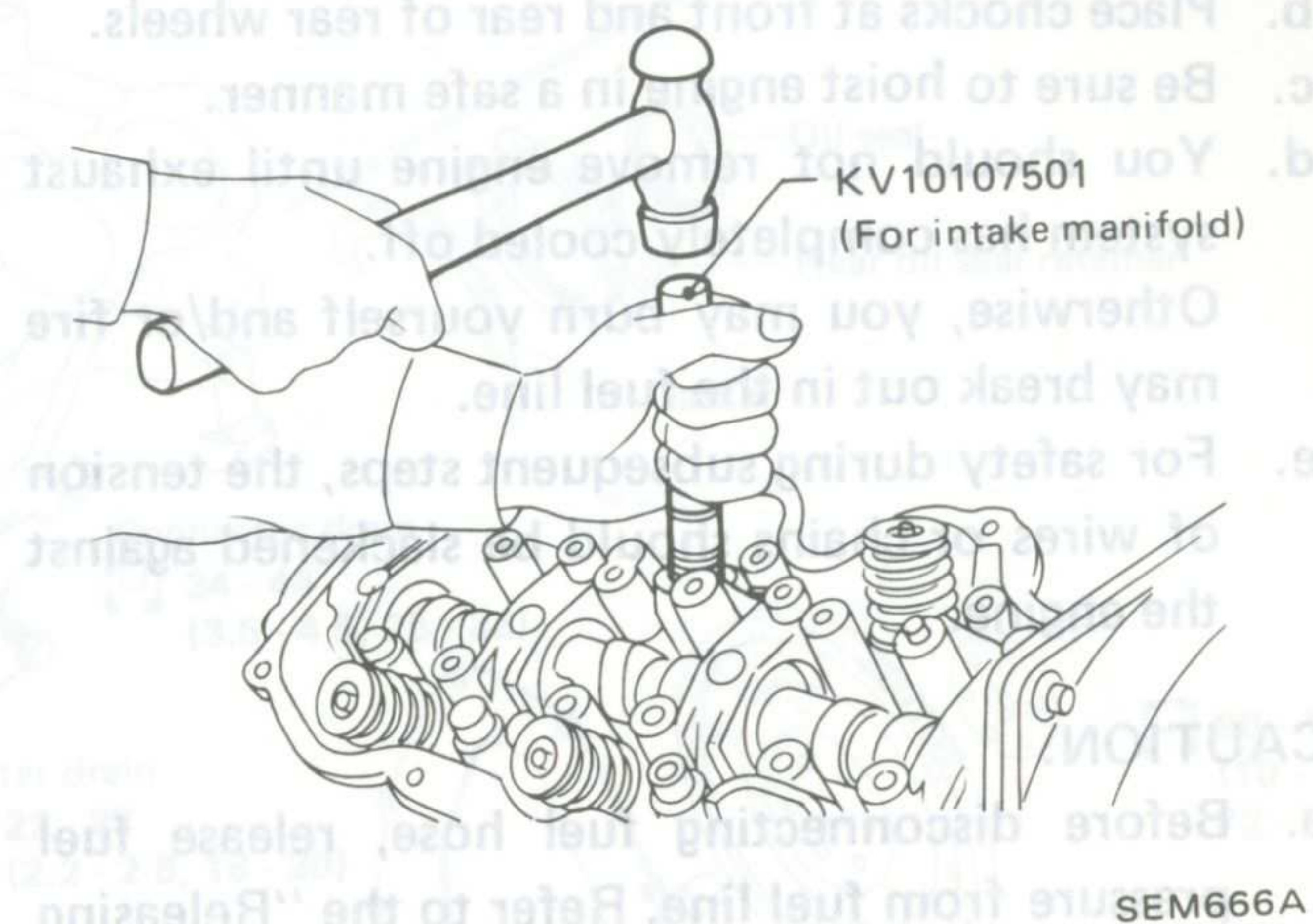
Replacement of Valve Oil Seal

1. Remove collector and rocker cover.
2. Remove rocker shaft assembly and valve lifters with valve guide.
3. Remove valve springs, retainer and collets.

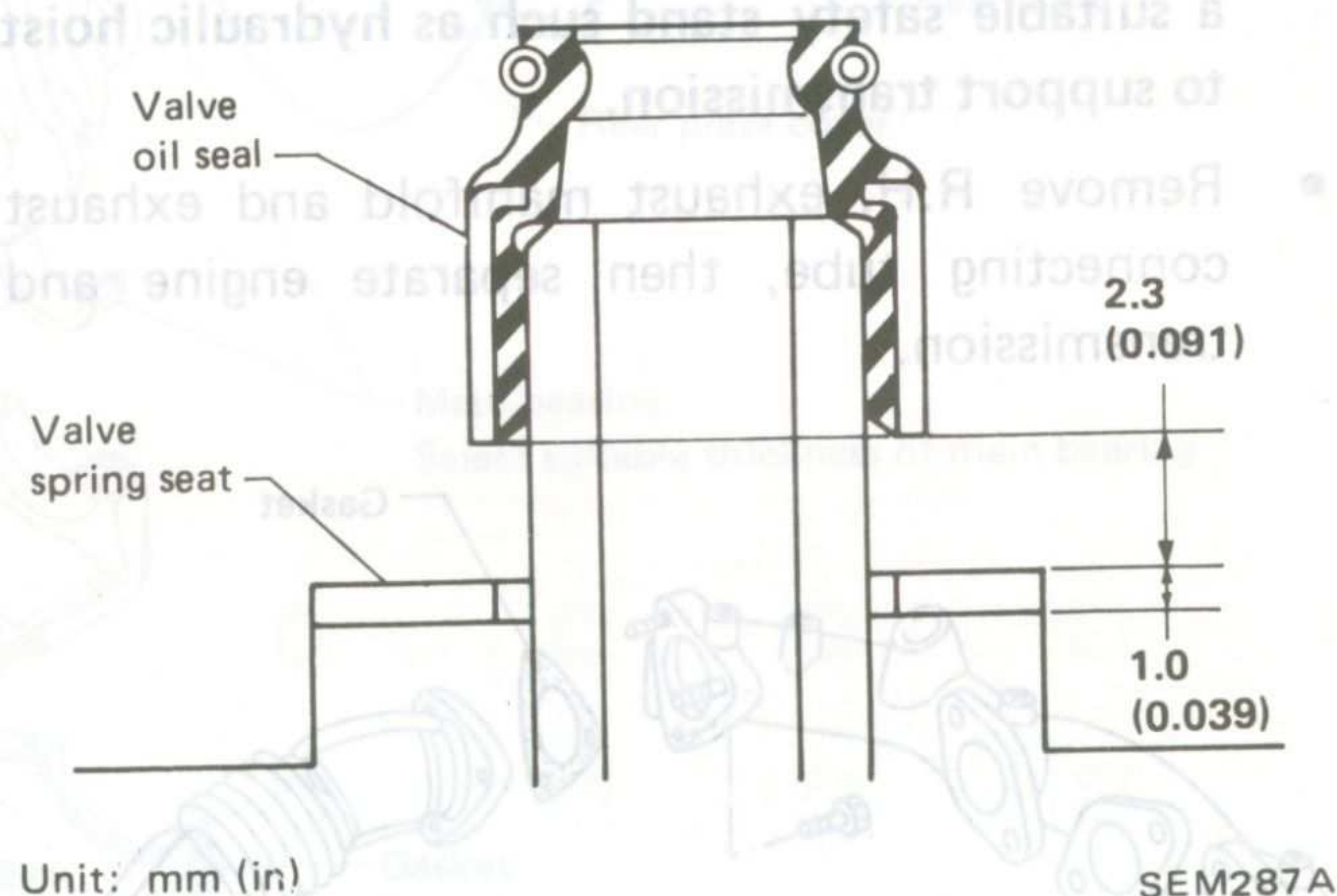


4. Remove valve oil seals.

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

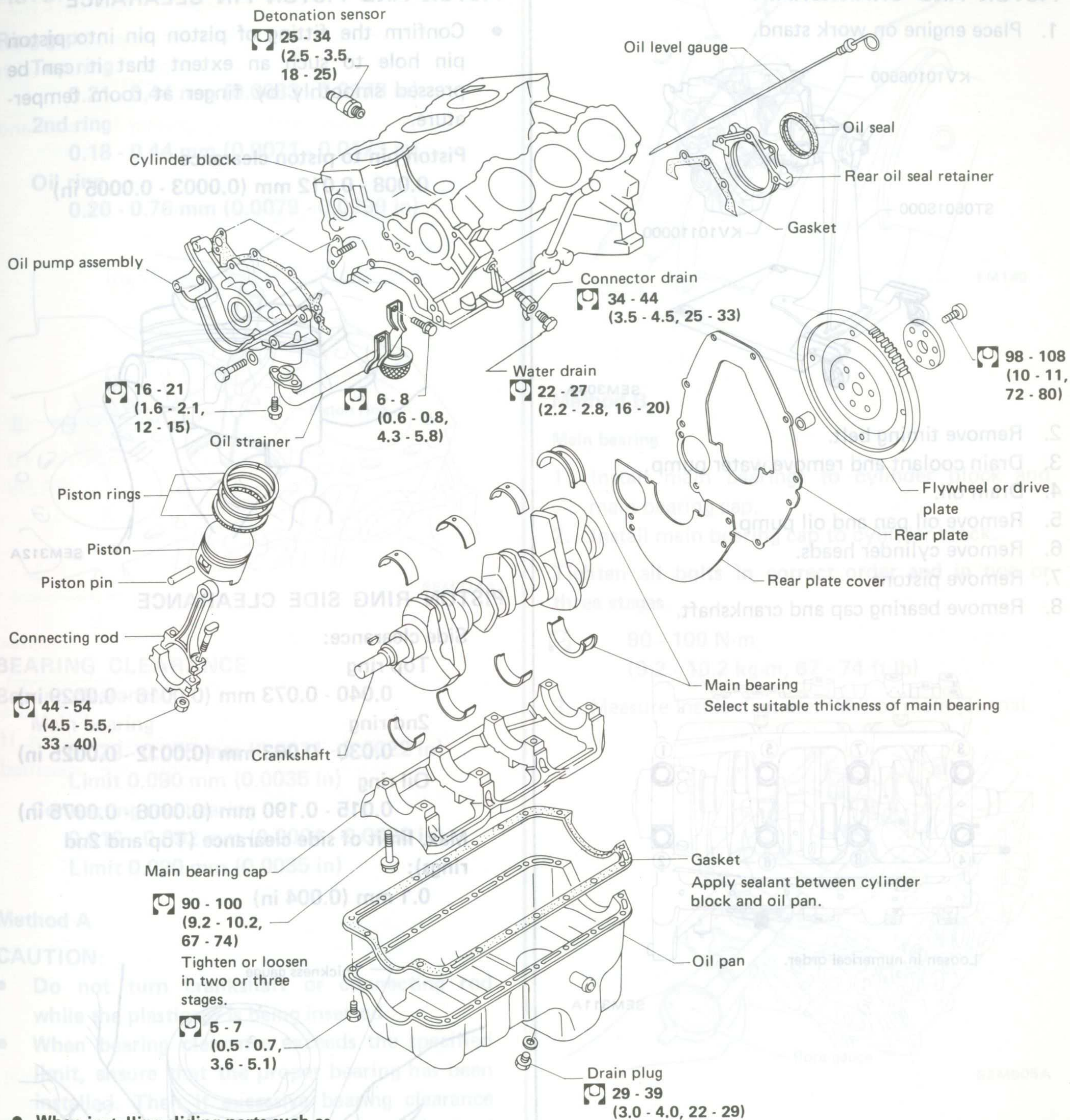


When installing valve oil seal in exhaust manifold side, tool is not necessary.



ENGINE OVERHAUL

Cylinder Block, Crankshaft and Piston



- When installing sliding parts such as bearings, be sure to apply engine oil on the sliding surfaces.
- Use new gaskets, oil seals and brazen washer.

□ : N·m (kg-m, ft-lb)

SEM504A

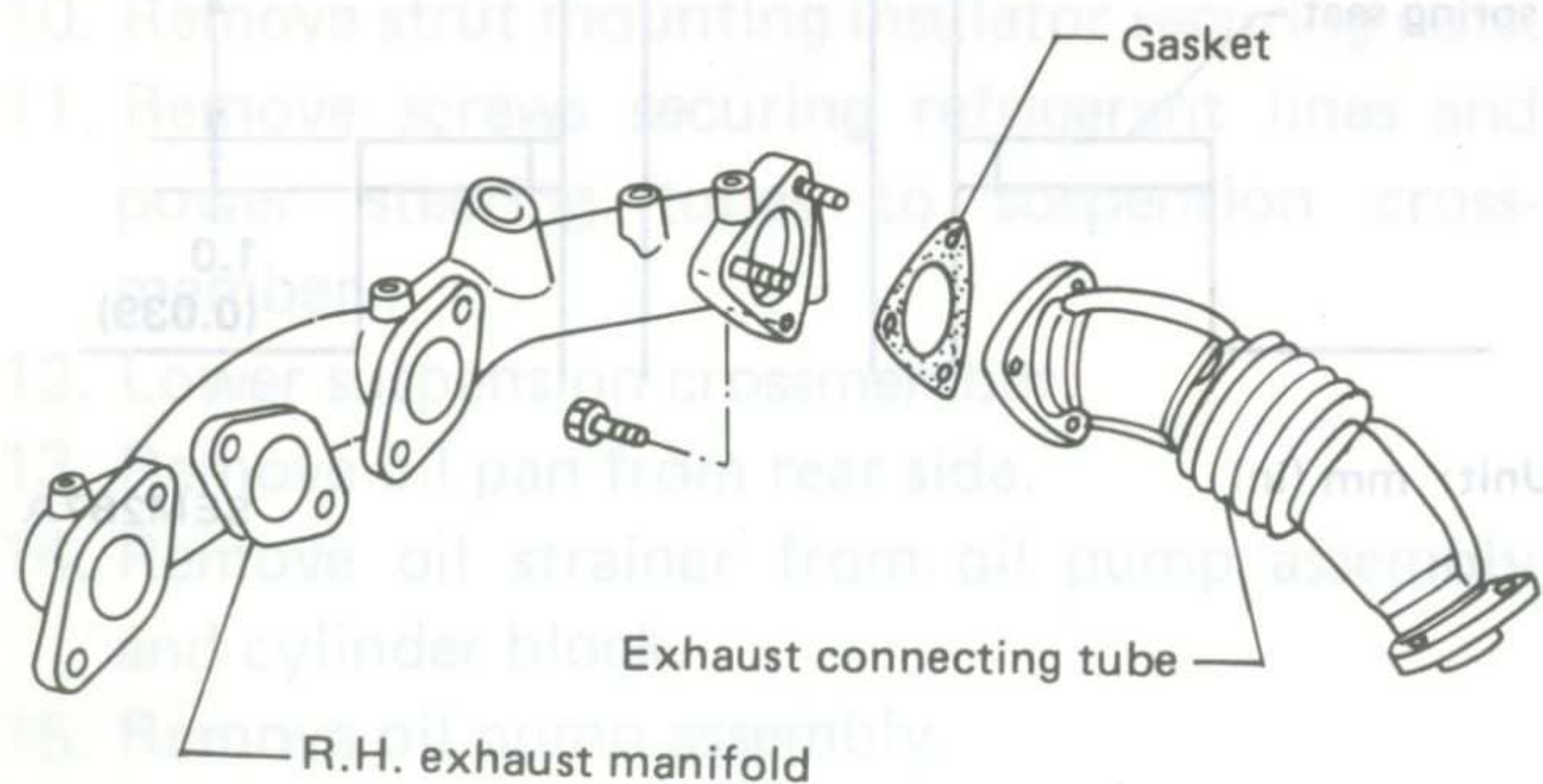
ENGINE REMOVAL

WARNING:

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

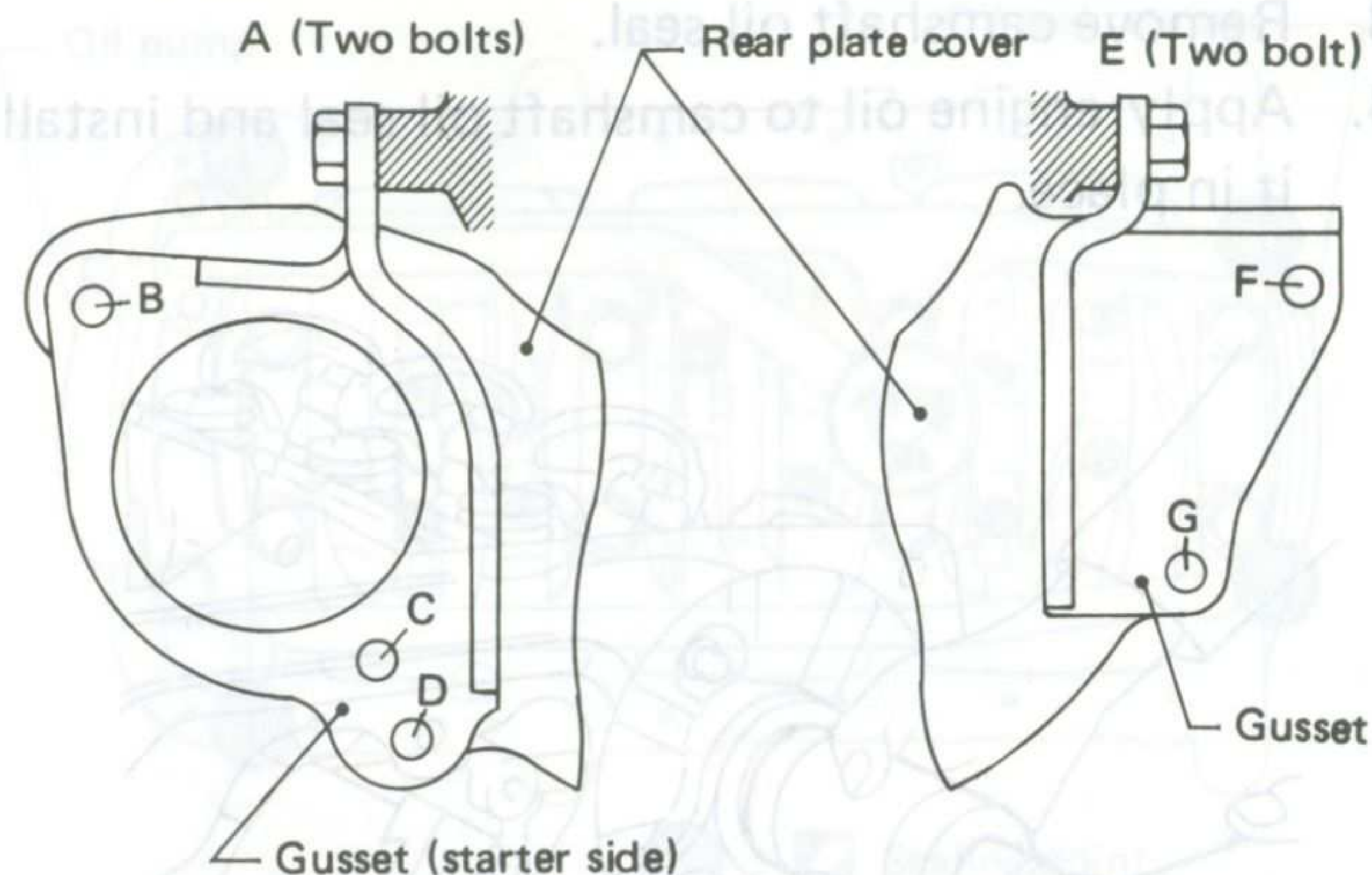
CAUTION:

- Before disconnecting fuel hose, release fuel pressure from fuel line. Refer to the "Releasing Fuel Pressure" in section EF.
 - After separating engine and transmission, remove engine from the vehicle. At this time use a suitable safety stand such as hydraulic hoist to support transmission.
- Remove R.H. exhaust manifold and exhaust connecting tube, then separate engine and transmission.



SEM526A

- When installing engine gussets, tighten bolts in 6 stages as shown below.



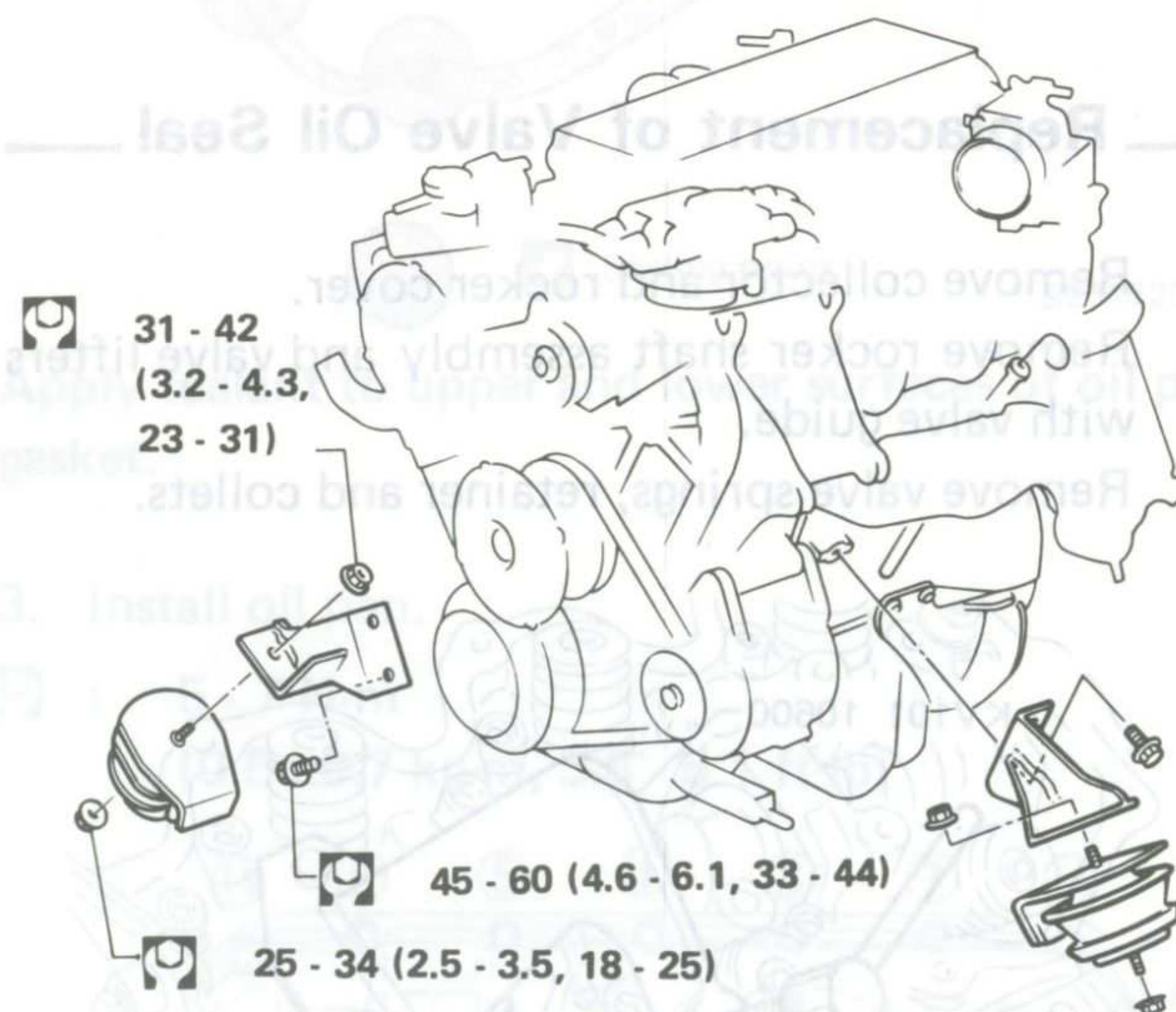
SEM540A

Tightening order

1st	2nd	3rd	4th	5th	6th
A*1	D*2	A*2	F*2 and G*2	E*2	A*2 and E*2

*1: Tighten temporarily.

*2: Tighten completely.



: N·m (kg-m, ft-lb)

SEM307A

ENGINE OVERHAUL

Disassembly

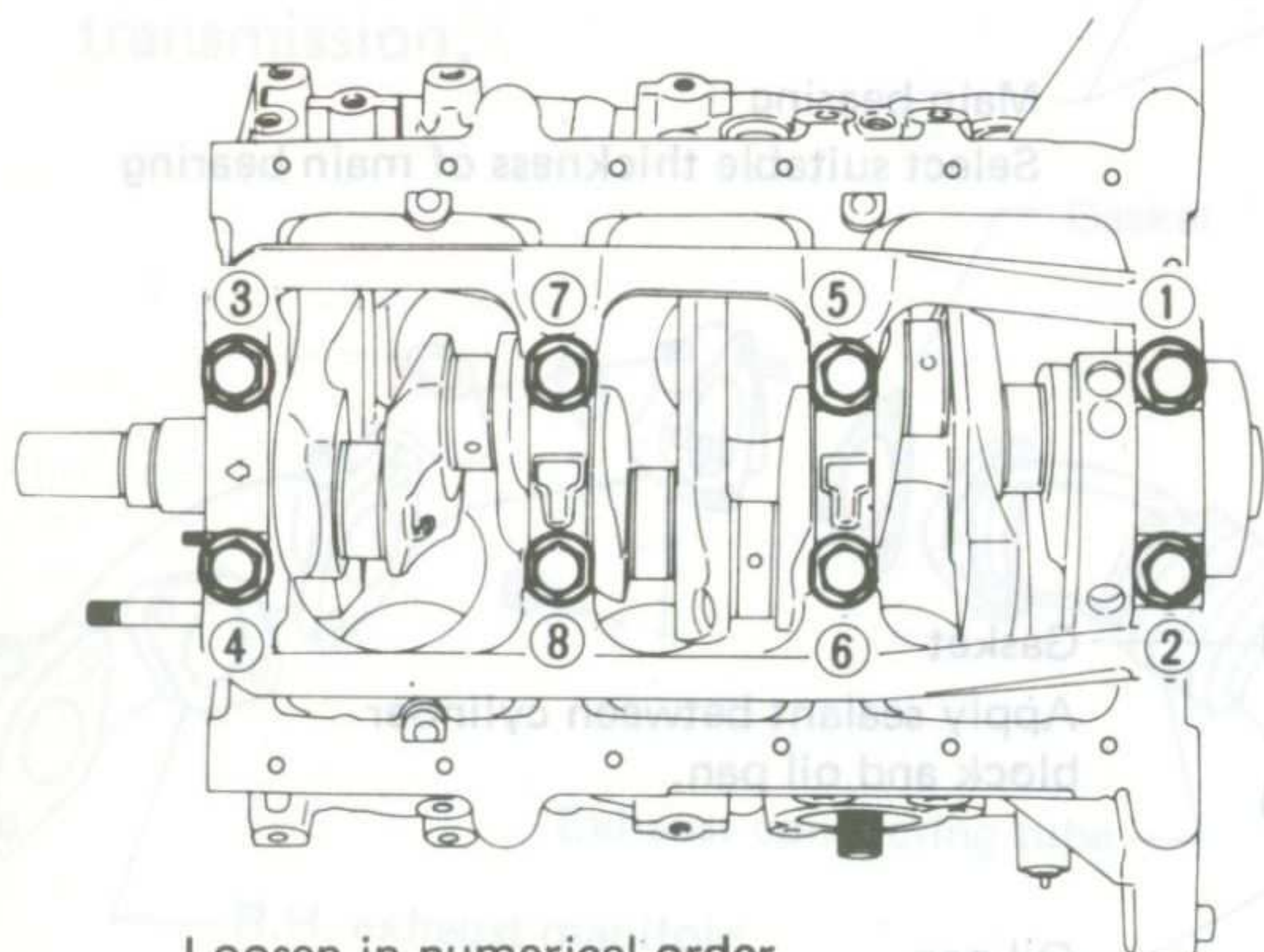
PISTON AND CRANKSHAFT

1. Place engine on work stand.



SEM308A

2. Remove timing belt.
3. Drain coolant and remove water pump.
4. Drain oil.
5. Remove oil pan and oil pump.
6. Remove cylinder heads.
7. Remove pistons.
8. Remove bearing cap and crankshaft.



Loosen in numerical order.

SEM311A

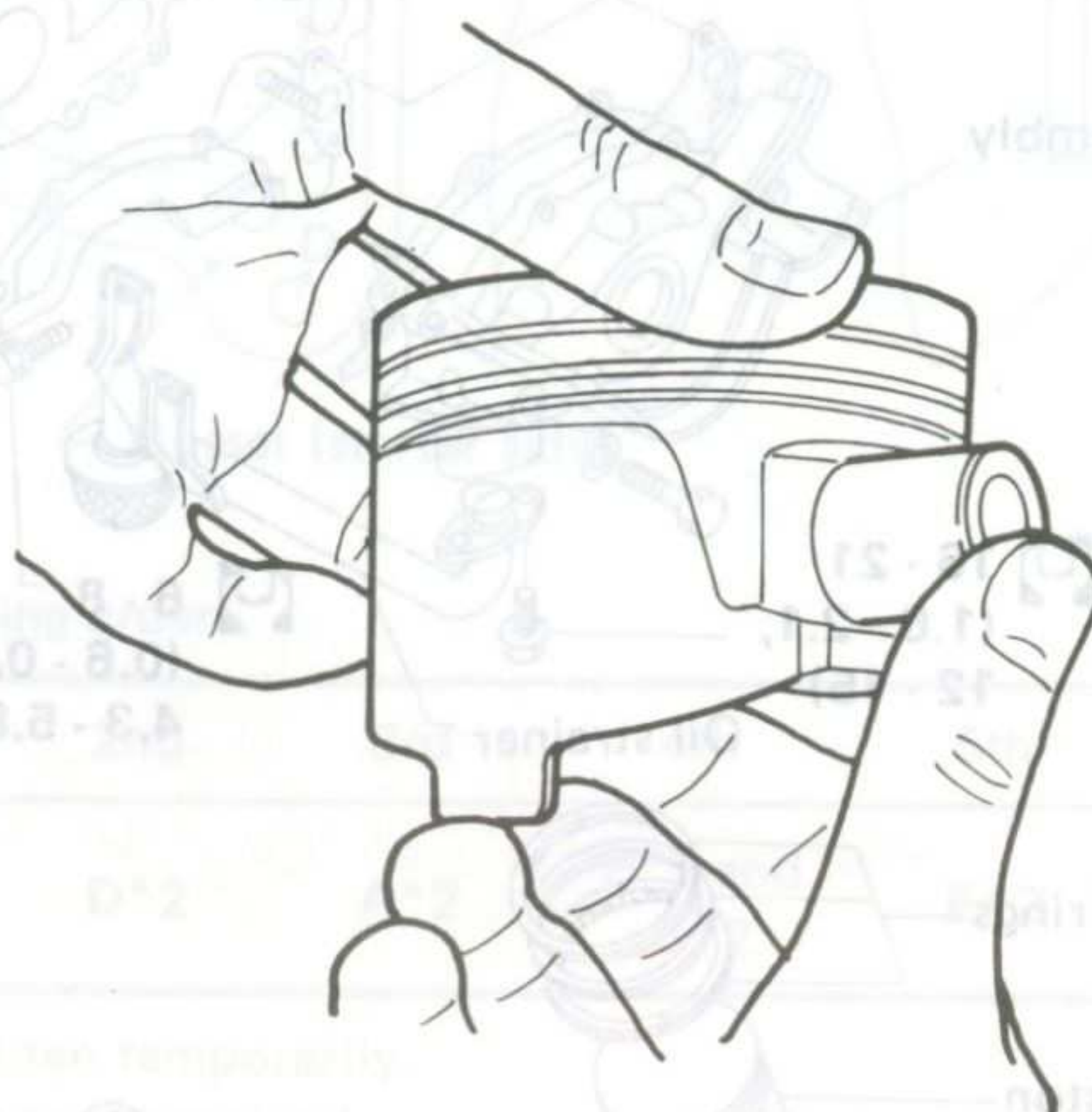
Inspection

PISTON AND PISTON PIN CLEARANCE

- Confirm the fitting of piston pin into piston pin hole to such an extent that it can be pressed smoothly by finger at room temperature.

Piston pin to piston clearance:

0.008 - 0.012 mm (0.0003 - 0.0005 in)



SEM312A

PISTON RING SIDE CLEARANCE

Side clearance:

Top ring

0.040 - 0.073 mm (0.0016 - 0.0029 in)

2nd ring

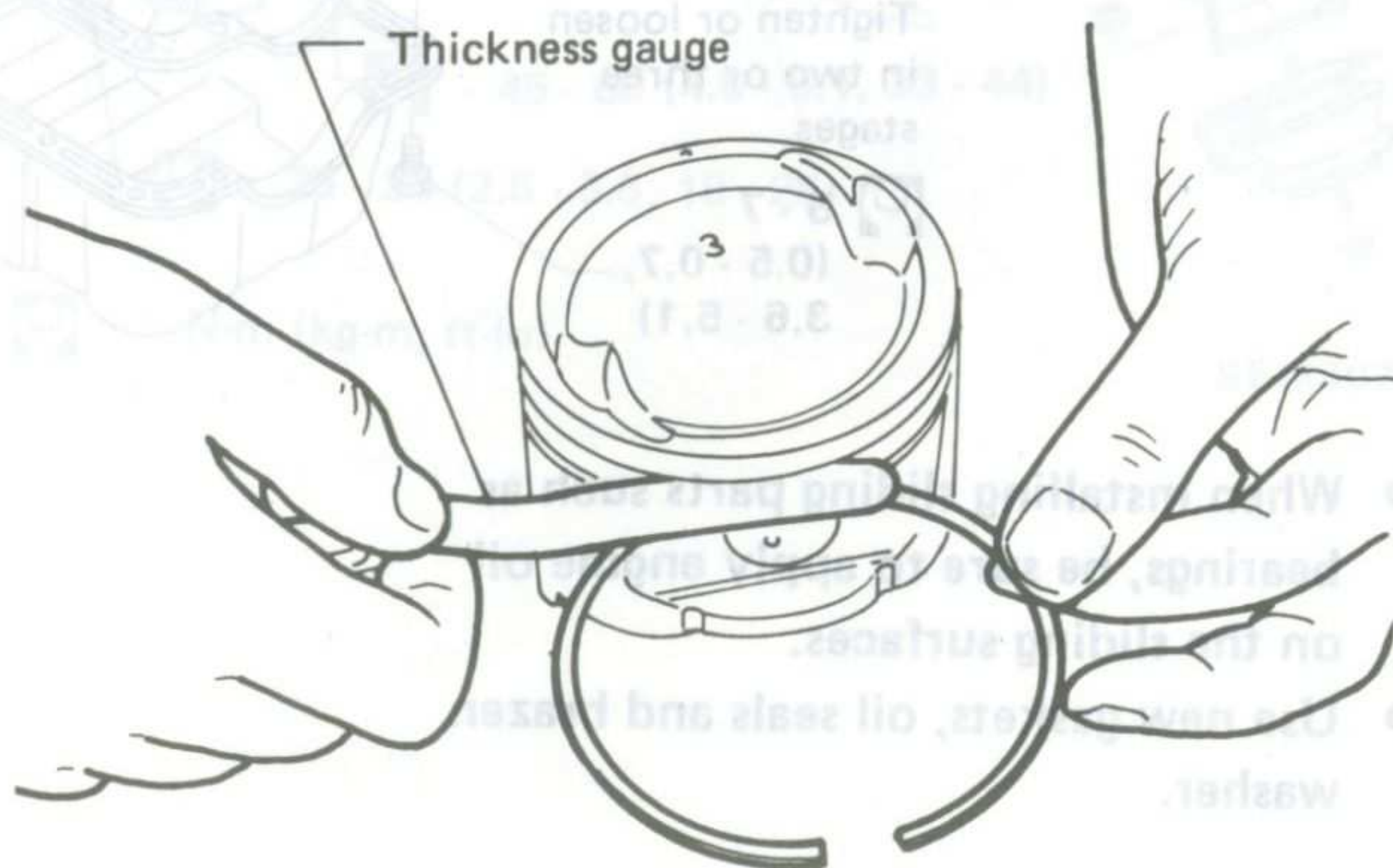
0.030 - 0.063 mm (0.0012 - 0.0025 in)

Oil ring

0.015 - 0.190 mm (0.0006 - 0.0075 in)

Max. limit of side clearance (Top and 2nd rings):

0.1 mm (0.004 in)



SEM313A

ENGINE OVERHAUL

Inspection (Cont'd)

PISTON RING GAP

Ring gap:

Top ring

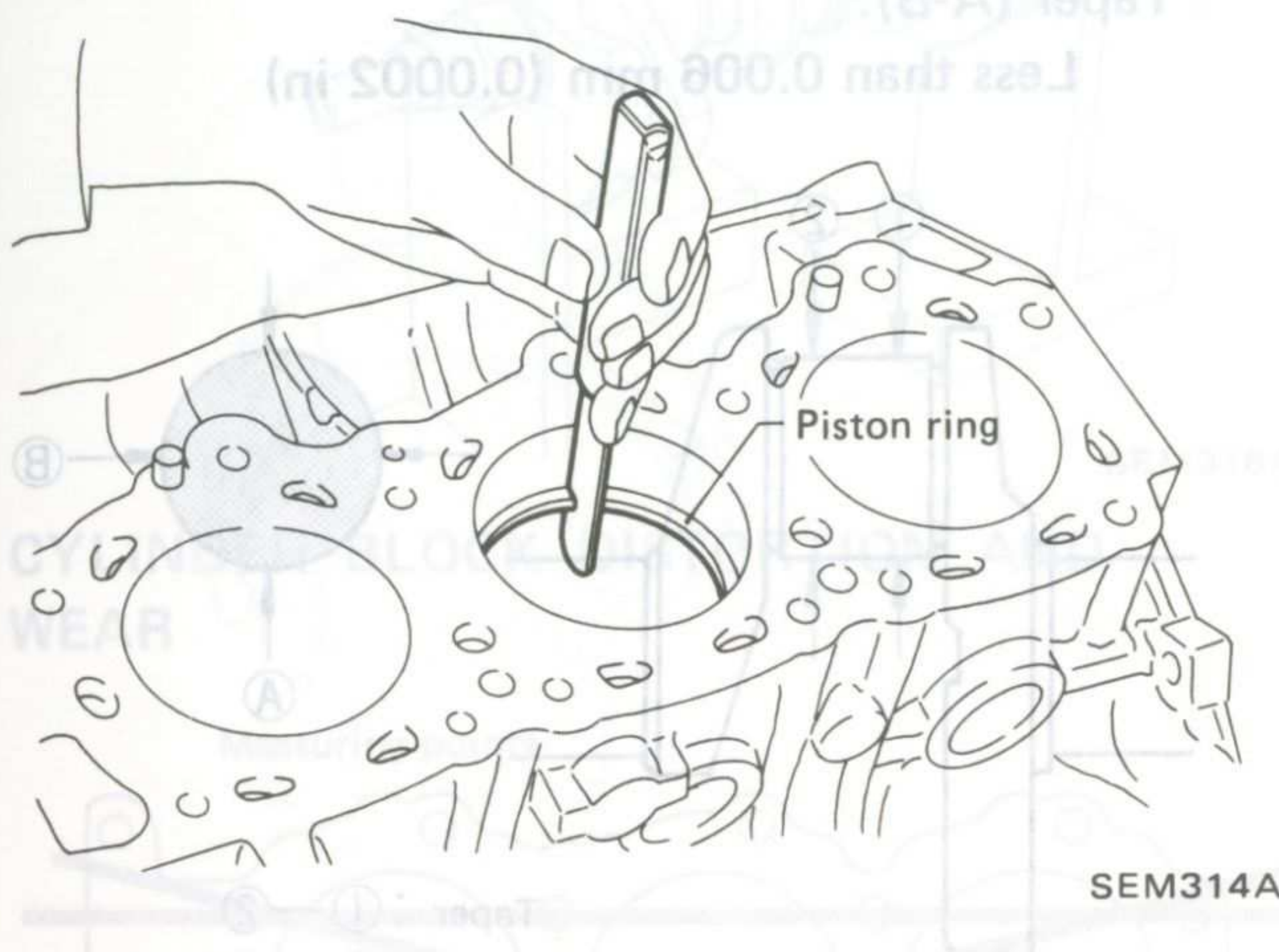
0.21 - 0.44 mm (0.0083 - 0.0173 in)

2nd ring

0.18 - 0.44 mm (0.0071 - 0.0173 in)

Oil ring

0.20 - 0.76 mm (0.0079 - 0.0299 in)



BEARING CLEARANCE

Bearing clearance:

Main bearing

0.028 - 0.055 mm (0.0011 - 0.0022 in)

Limit 0.090 mm (0.0035 in)

Connecting rod bearing

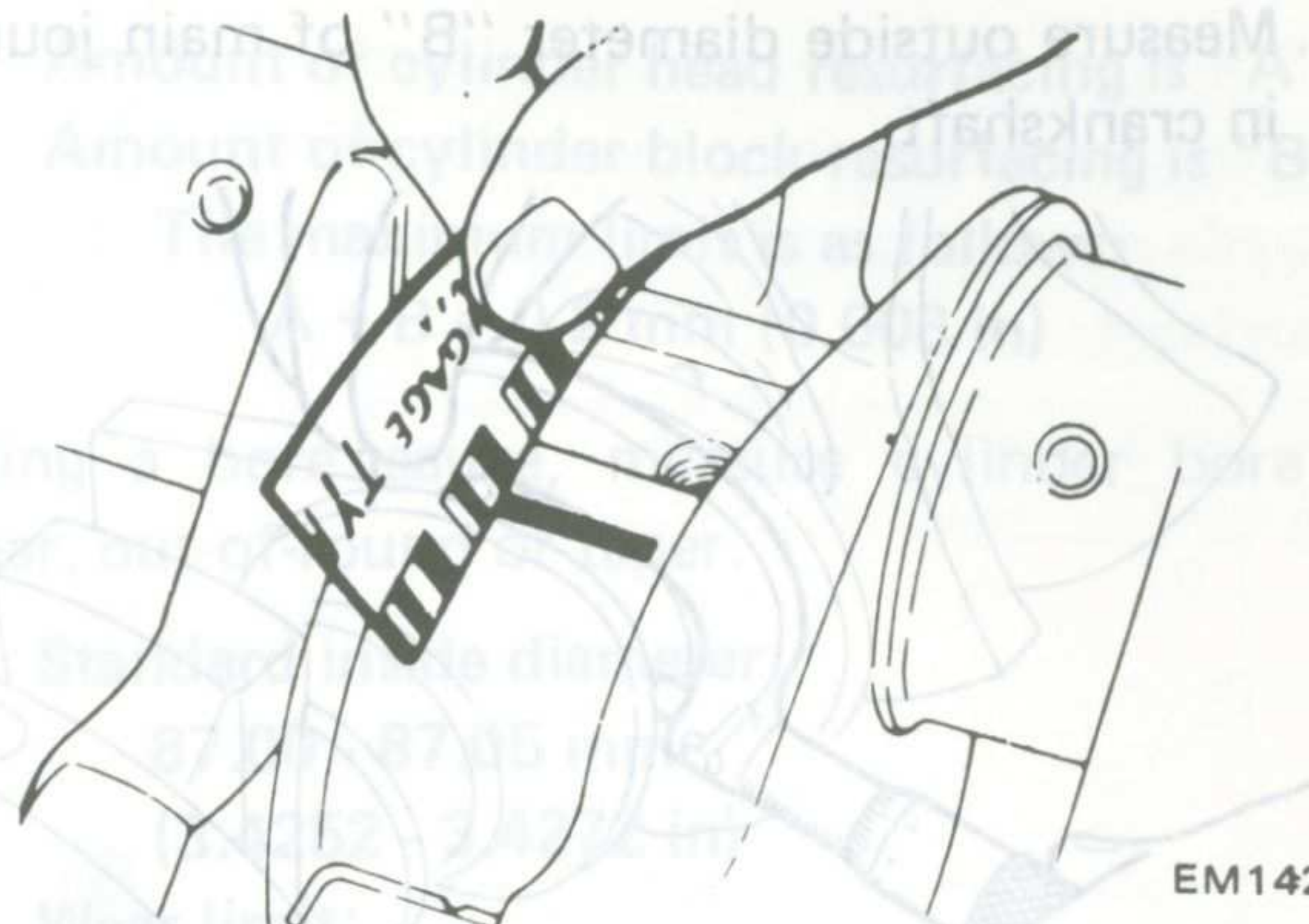
0.010 - 0.052 mm (0.0004 - 0.0020 in)

Limit 0.090 mm (0.0035 in)

Method A

CAUTION:

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



Method B

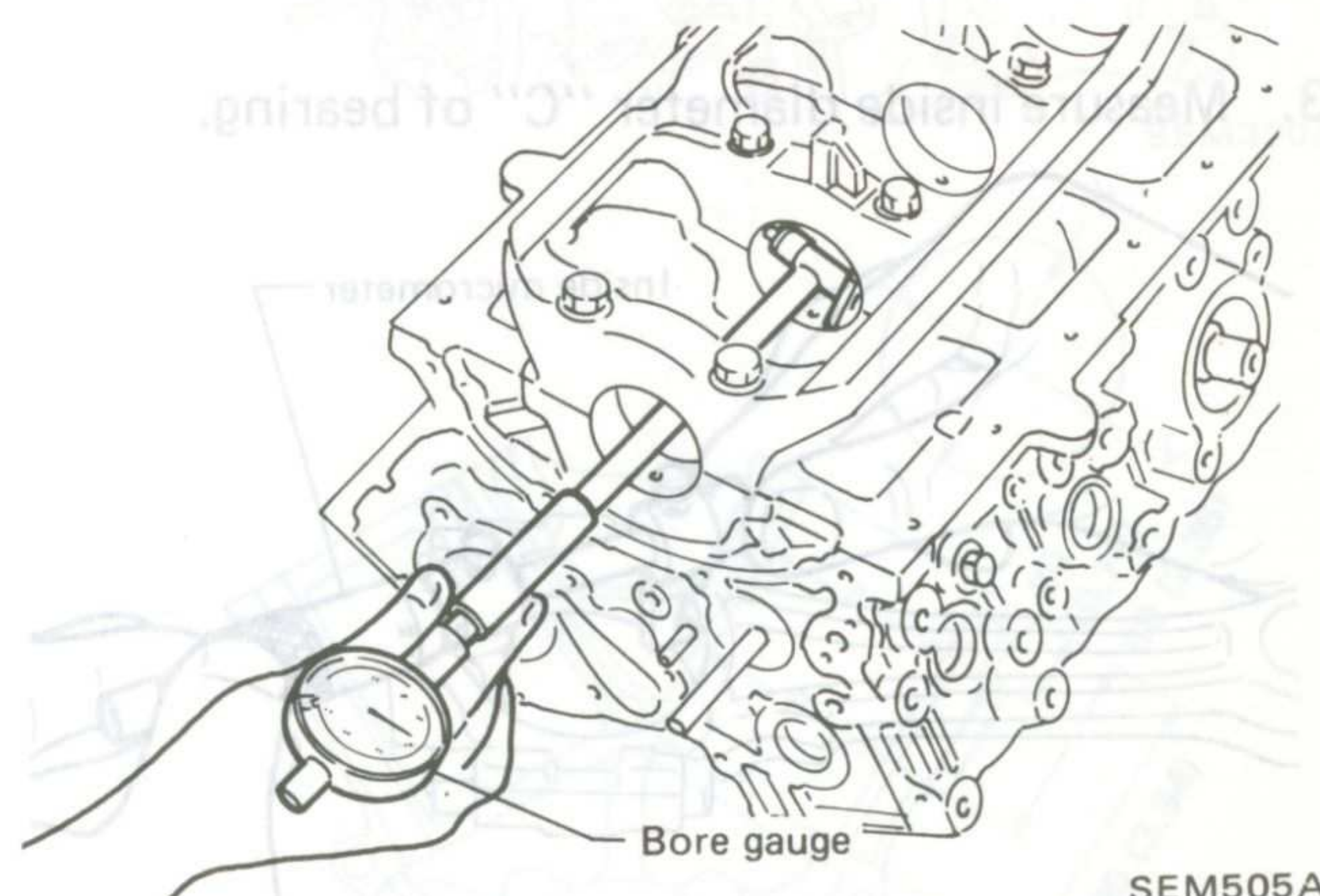
Main bearing

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

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

 : 90 - 100 N·m
(9.2 - 10.2 kg-m, 67 - 74 ft-lb)

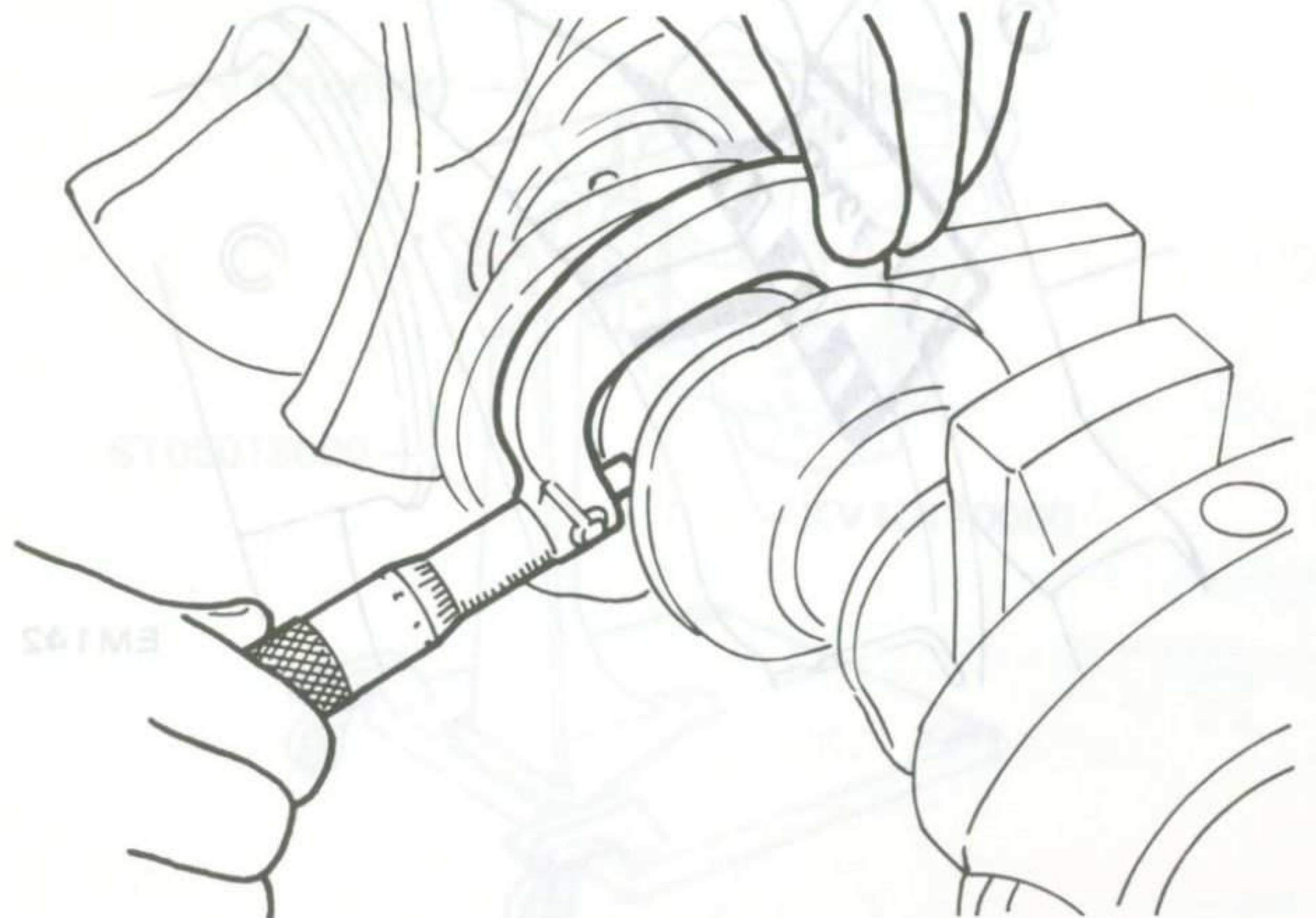
3. Measure inside diameter "A" of main journal.



ENGINE OVERHAUL

Inspection (Cont'd)

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



SEM506A

5. Calculate main bearing clearance.

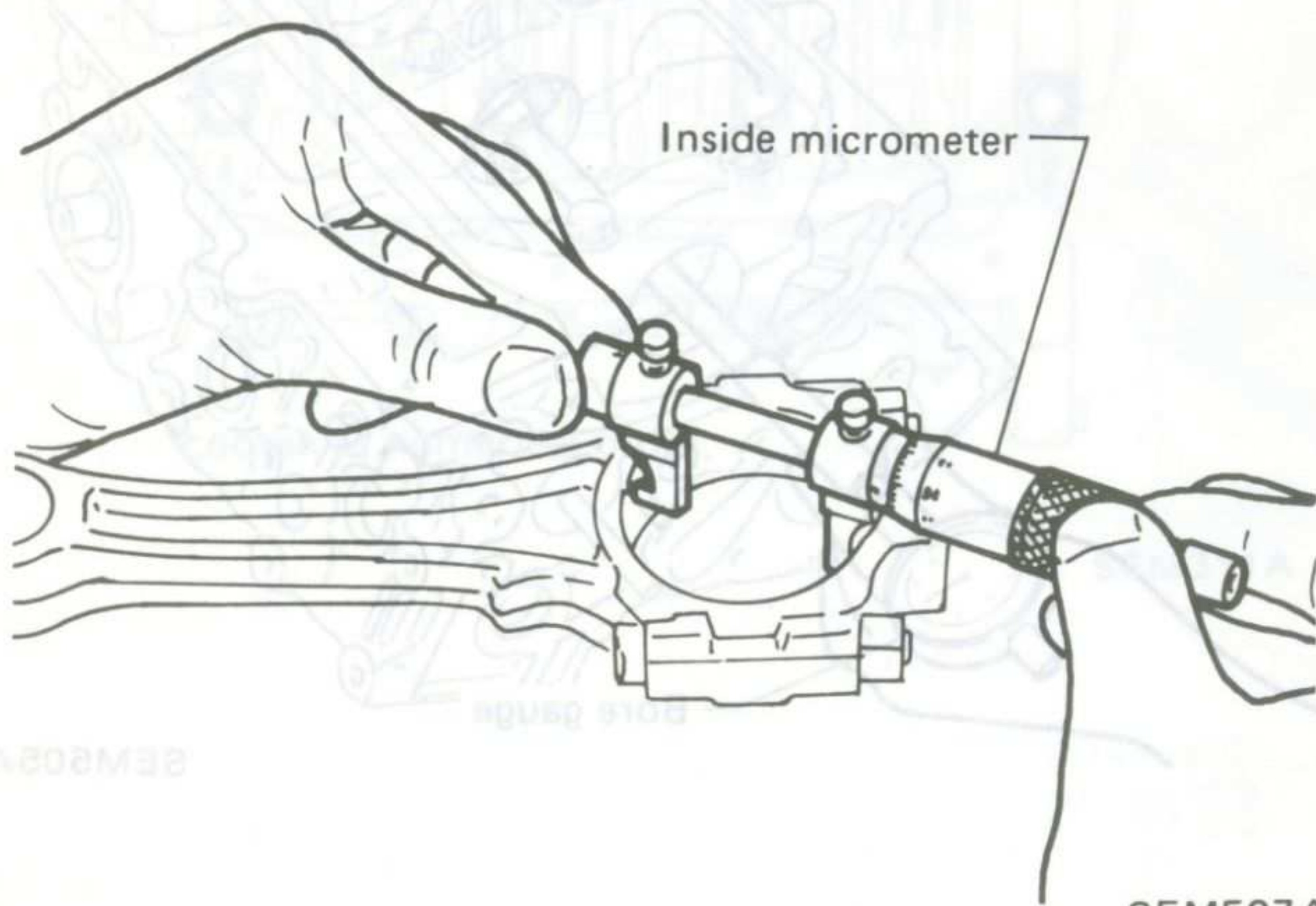
$$\text{Main bearing clearance} = A - B$$

Connecting rod bearing

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

Torque: 44 - 54 N·m
(4.5 - 5.5 kg-m, 33 - 40 ft-lb)

3. Measure inside diameter "C" of bearing.



SEM507A

4. Measure outside diameter "D" of pin journal in crankshaft.

5. Calculate connecting rod bearing clearance.

$$\text{Connecting rod bearing clearance} = C - D$$

CRANKSHAFT INSPECTION

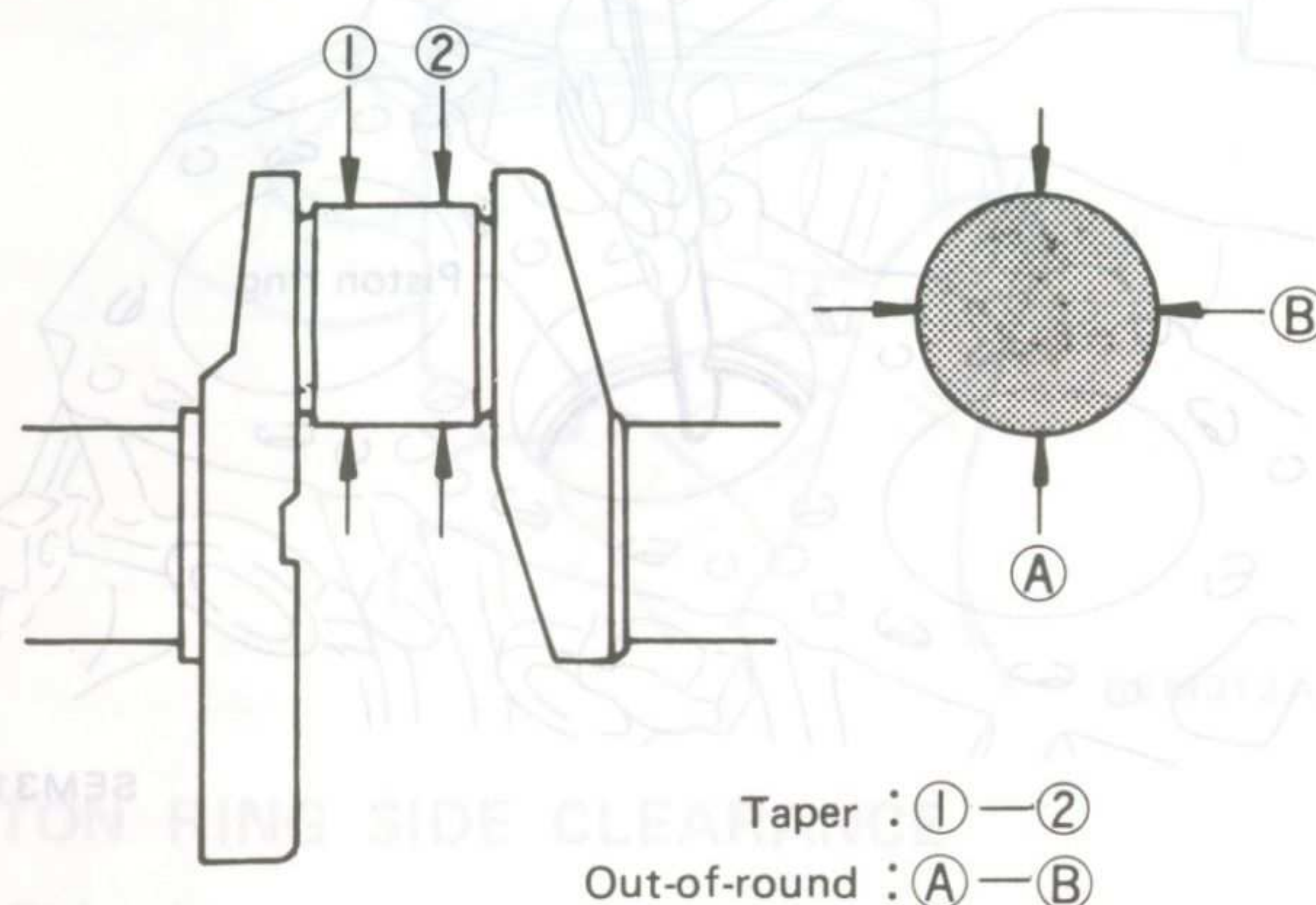
1. Check crankshaft journals for score, bias, wear or cracks. If faults are minor, correct with fine crocus cloth.
2. Check journals with a micrometer for taper and out-of-round.

Out-of-round (X-Y):

0.006 mm (0.0002 in)

Taper (A-B):

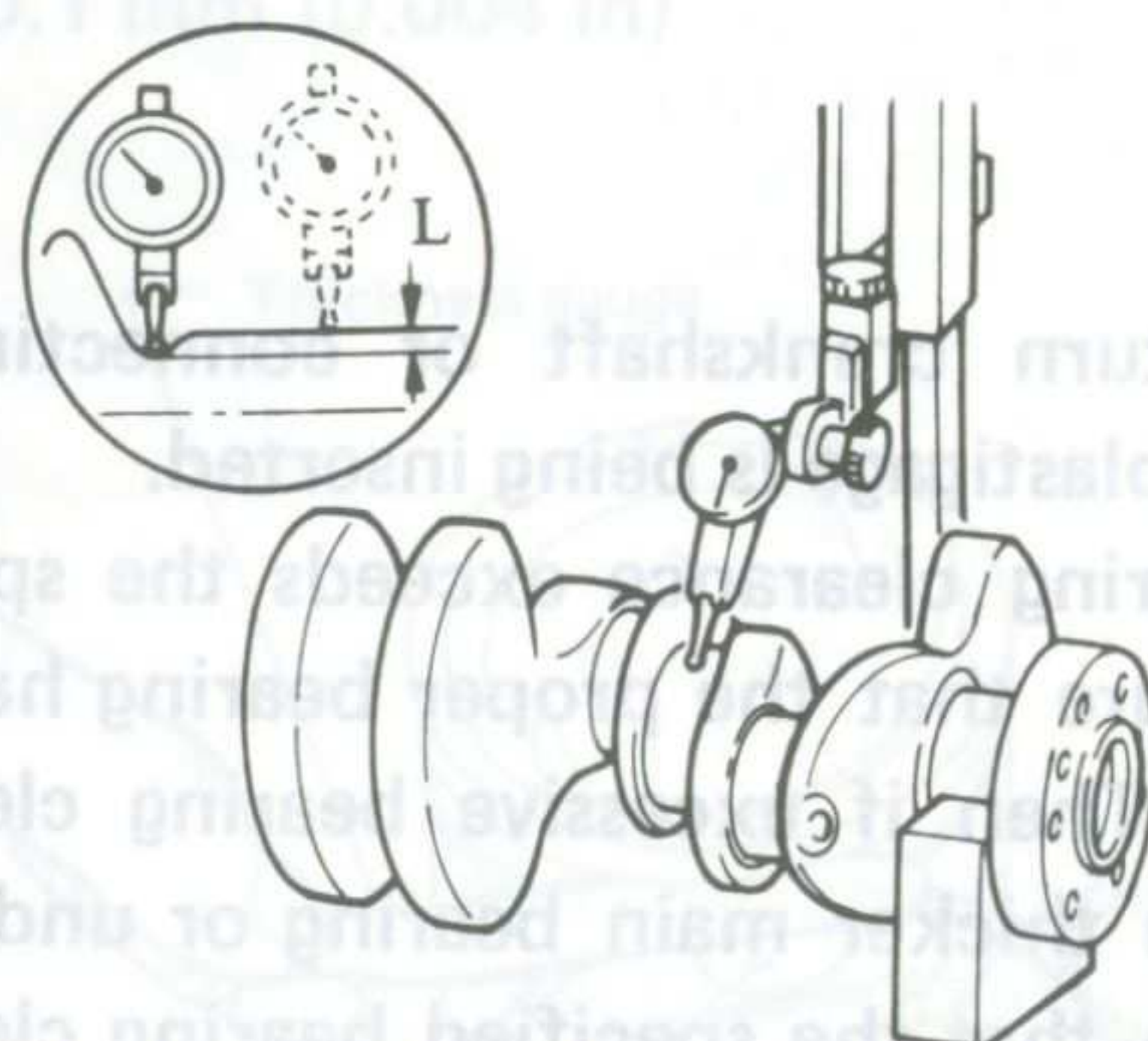
Less than 0.006 mm (0.0002 in)



SEM316A

- a. When regrinding crank pin and crank journal, measure "L" dimension in fillet roll. Make sure the measurements exceed the specified limit. If the measurements are within the specified limit, do not regrind.

L: More than 0.13 mm (0.0051 in)



SEM184A

- b. Do not grind off fillet roll.
- c. Refer to S.D.S. for regrinding crankshaft and available service parts.

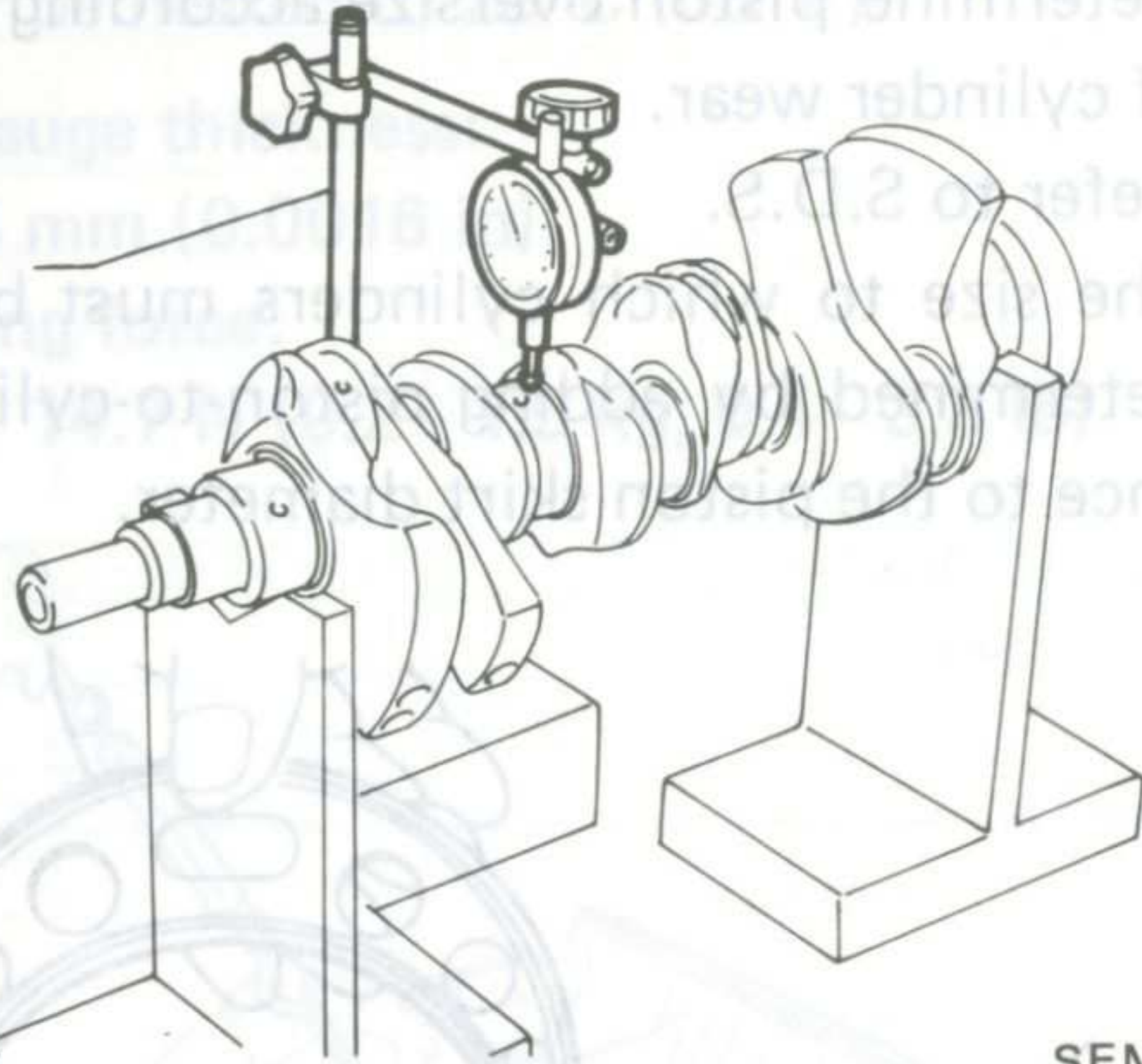
ENGINE OVERHAUL

Inspection (Cont'd)

CRANKSHAFT RUNOUT

Check crankshaft runout.

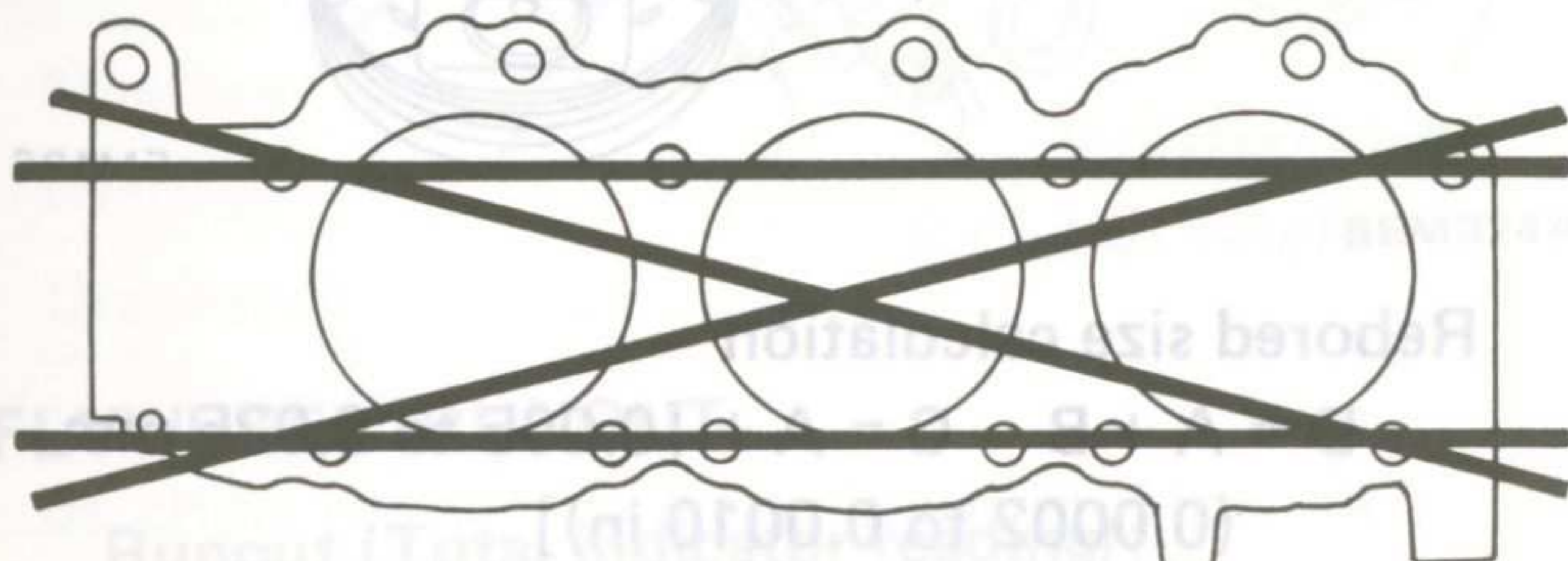
Runout [T.I.R. (Total Indicator Reading)]
Less than 0.10 mm (0.0039 in)



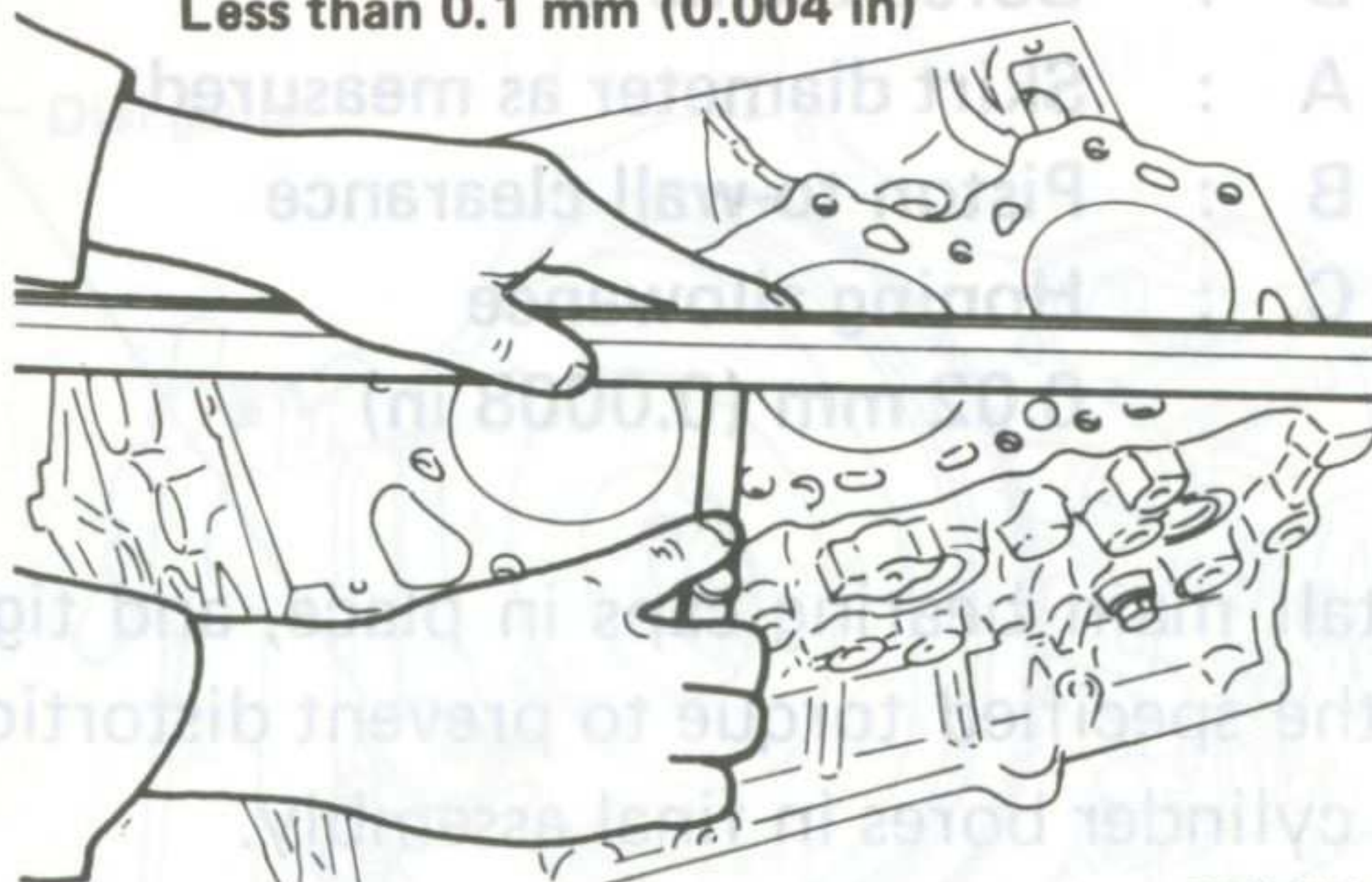
SEM318A

CYLINDER BLOCK DISTORTION AND WEAR

Measuring points



Warpage of surface:
Less than 0.1 mm (0.004 in)



SEM319A

If beyond the specified limit, resurface it.

Resurfacing limit:

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

Amount of cylinder head resurfacing is "A".

Amount of cylinder block resurfacing is "B".

The maximum limit is as follows:

$$A + B = 0.2 \text{ mm (0.008 in)}$$

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

Standard inside diameter:

87.00 - 87.05 mm
(3.4252 - 3.4272 in)

Wear limit:

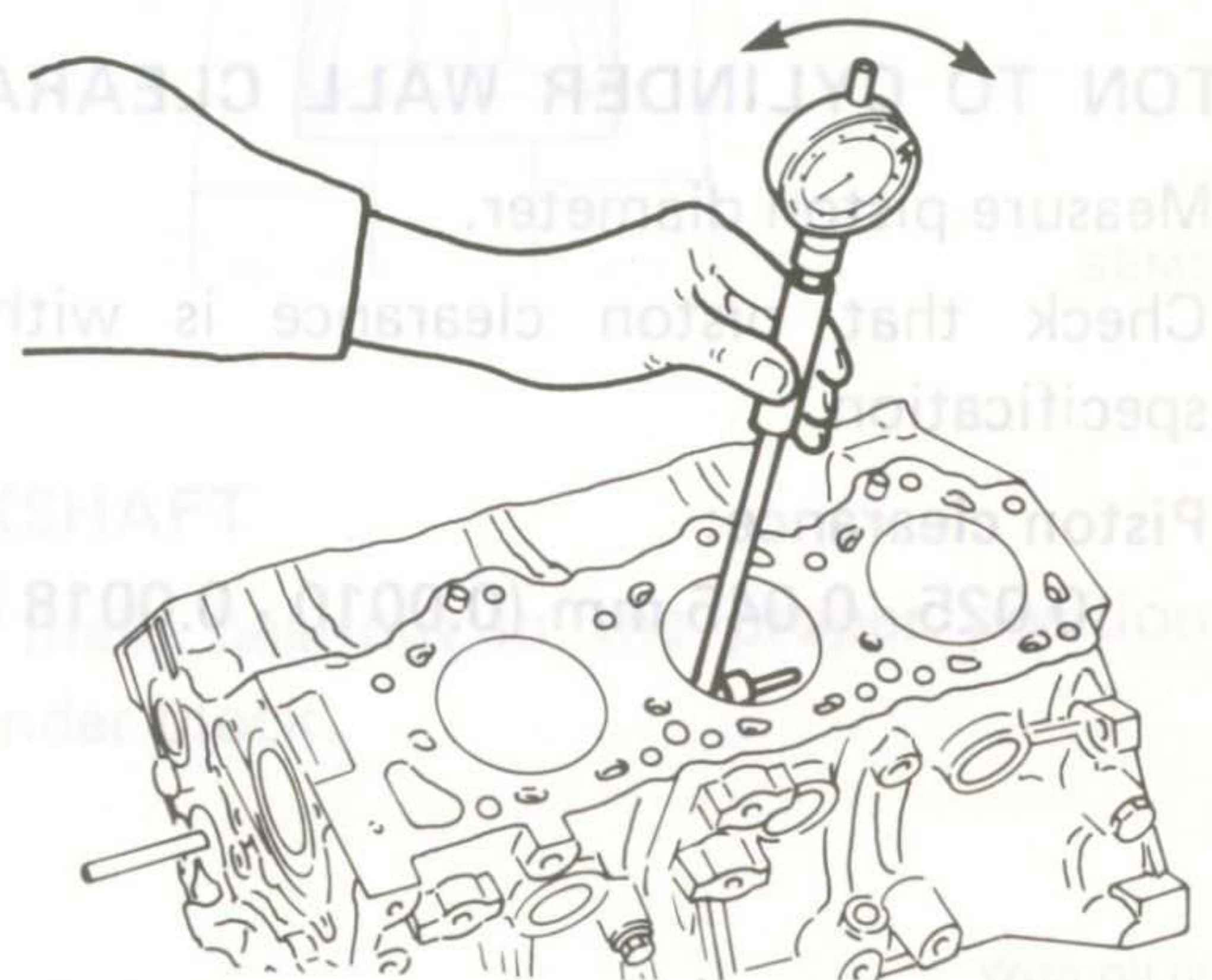
0.20 mm (0.0079 in)

Out-of-round (X-Y) limit:

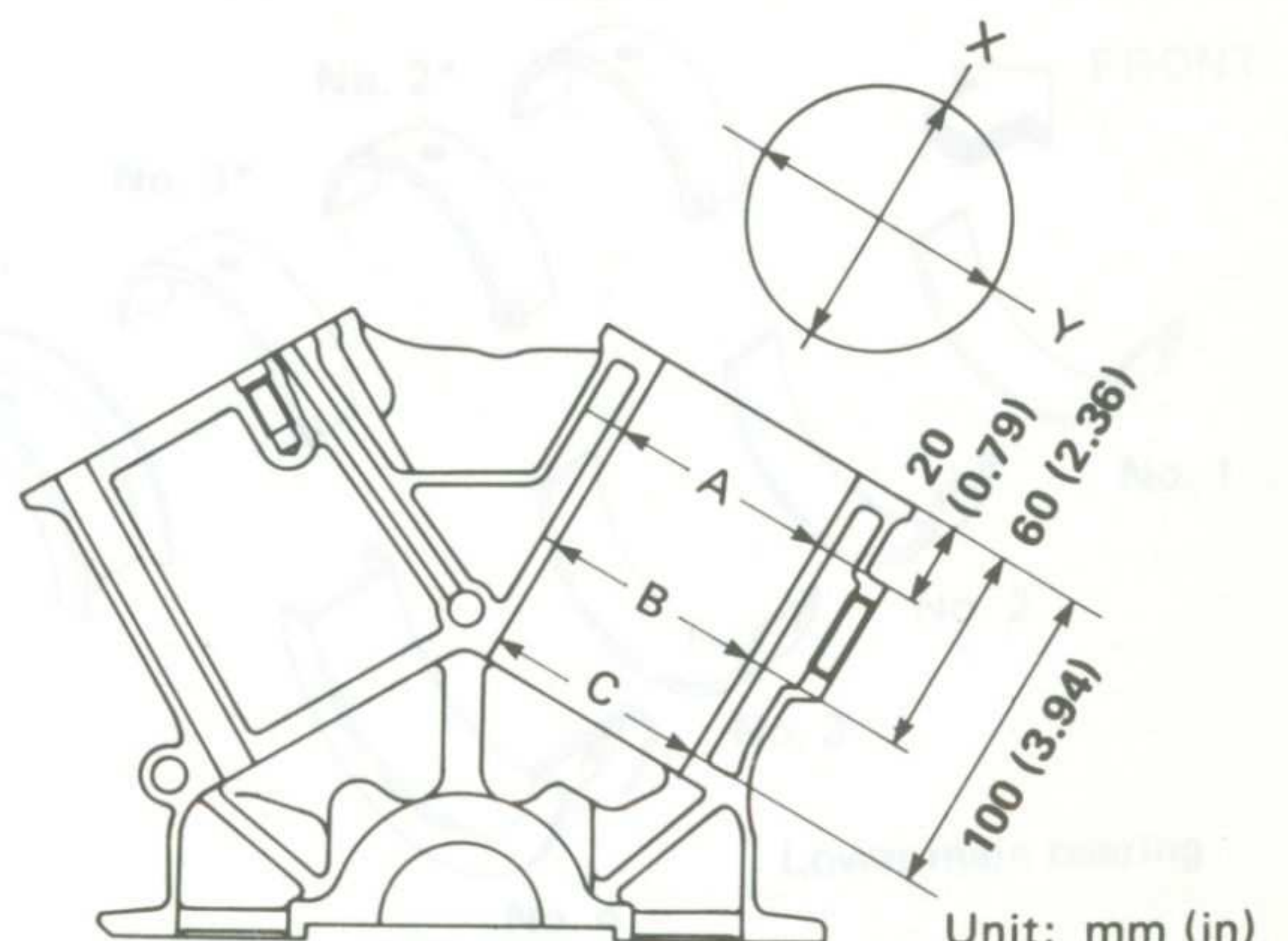
0.015 mm (0.0006 in)

Taper (A-B) limit:

0.015 mm (0.0006 in)



SEM320A



Unit: mm (in)

SEM321A

Check for scratches or seizure. If seizure is found, hone it.

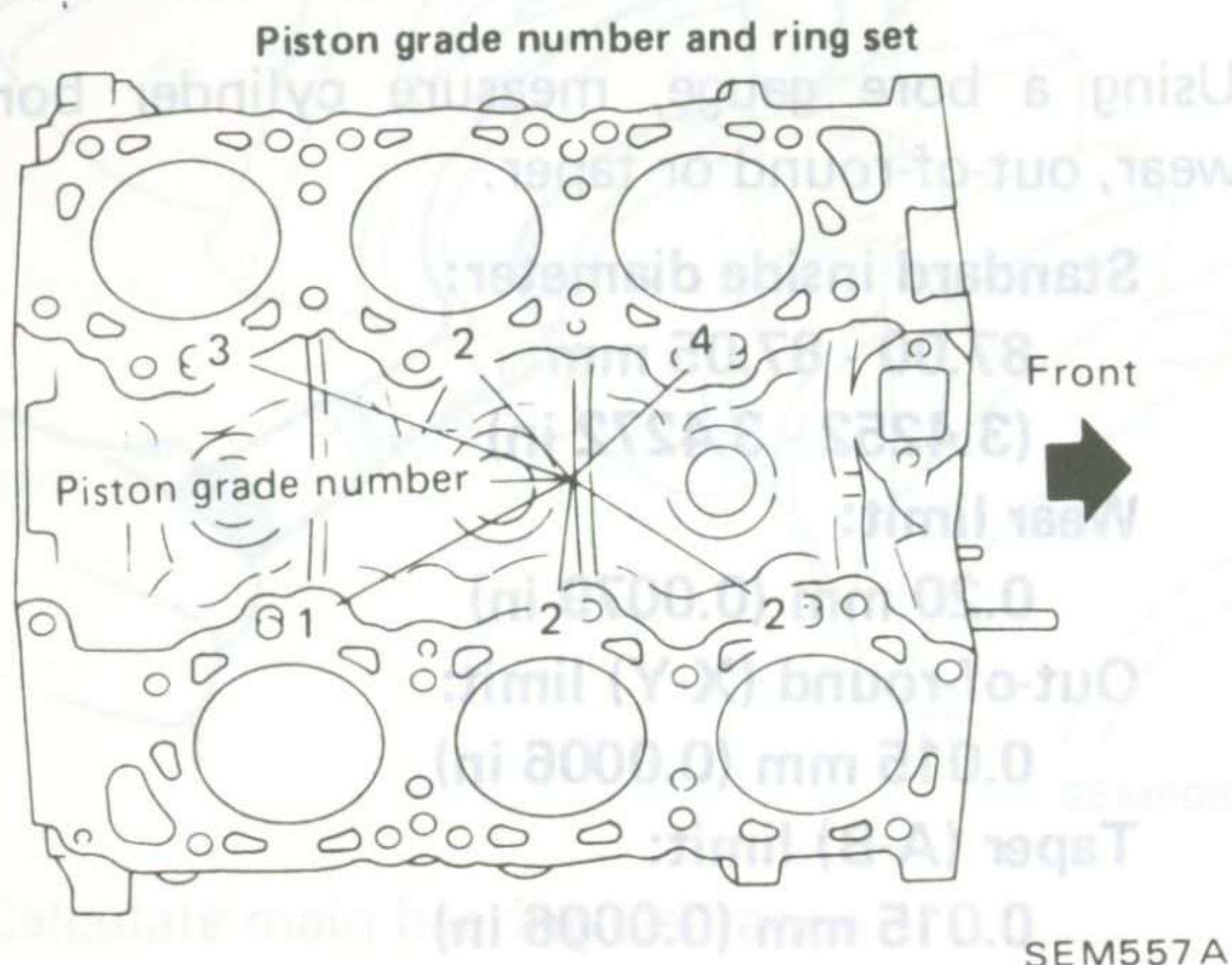
Never bore it.

If wear exceeds the specified limit, replace cylinder block.

ENGINE OVERHAUL

Inspection (Cont'd)

- If either cylinder block or piston is replaced with new one, select the same piston as piston grade number punched on cylinder block upper surfaces.



PISTON TO CYLINDER WALL CLEARANCE

1. Measure piston diameter.
2. Check that piston clearance is within the specification.

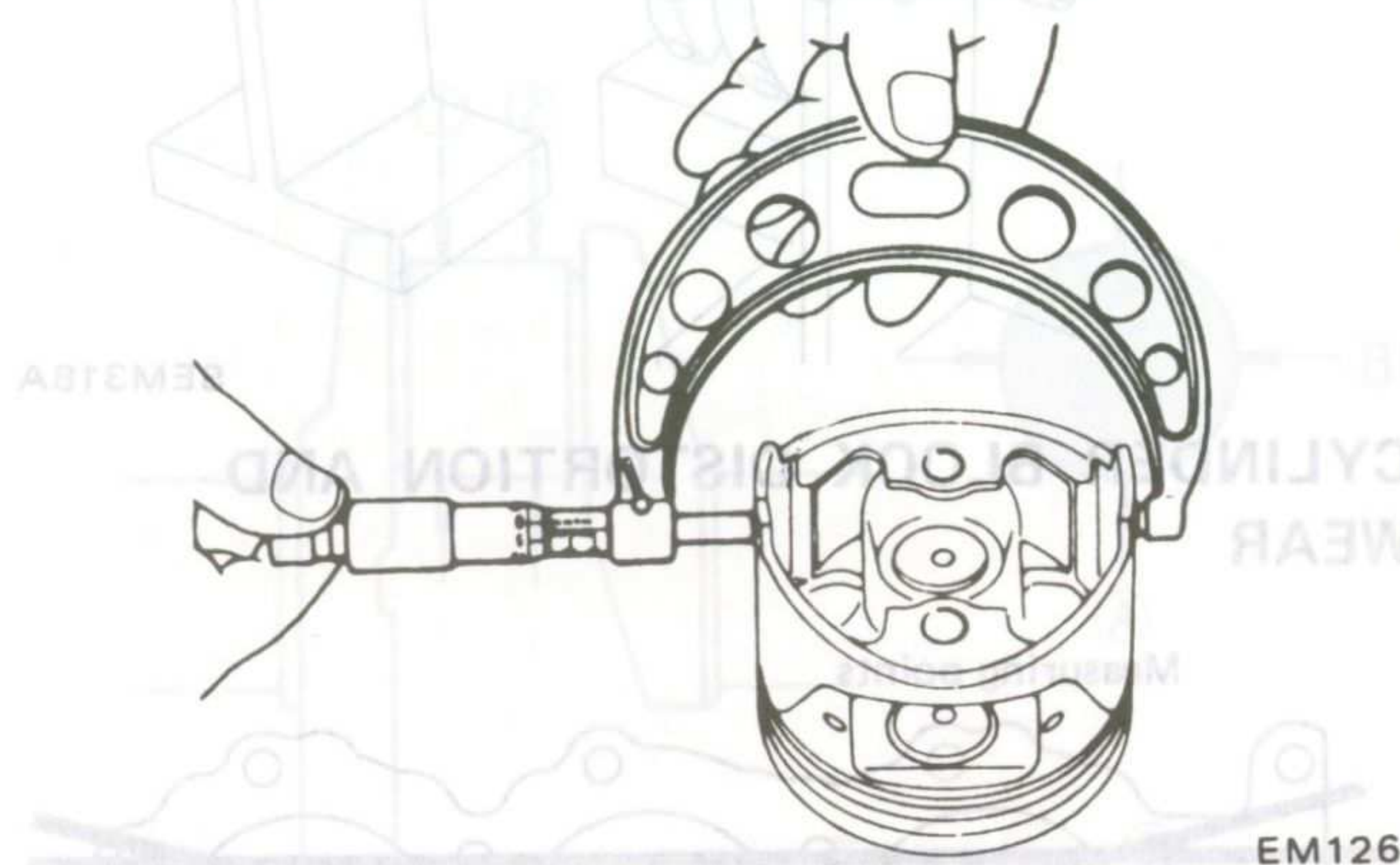
Piston clearance:

0.025 - 0.045 mm (0.0010 - 0.0018 in)

CYLINDER BORING

When any cylinder needs boring, all other cylinders must also be bored.

1. Determine piston oversize according to amount of cylinder wear. Refer to S.D.S.
2. The size to which cylinders must be honed is determined by adding piston-to-cylinder clearance to the piston skirt diameter.



Rebored size calculation

$$D = A + B - C = A + [0.005 \text{ to } 0.025 \text{ mm} (0.0002 \text{ to } 0.0010 \text{ in})]$$

where,

- D : Bored diameter
- A : Skirt diameter as measured
- B : Piston-to-wall clearance
- C : Honing allowance
0.02 mm (0.0008 in)

3. Install main bearing caps in place, and tighten to the specified torque to prevent distortion of the cylinder bores in final assembly.
4. Cut cylinder bores.
- Do not cut too much out of the cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.
5. Hone the cylinders to the required size referring to S.D.S.
6. Measure the finished cylinder bore for out-of-round and taper.

ENGINE OVERHAUL

Inspection (Cont'd)

PISTON-TO-CYLINDER CLEARANCE

(Using feeler gauge)

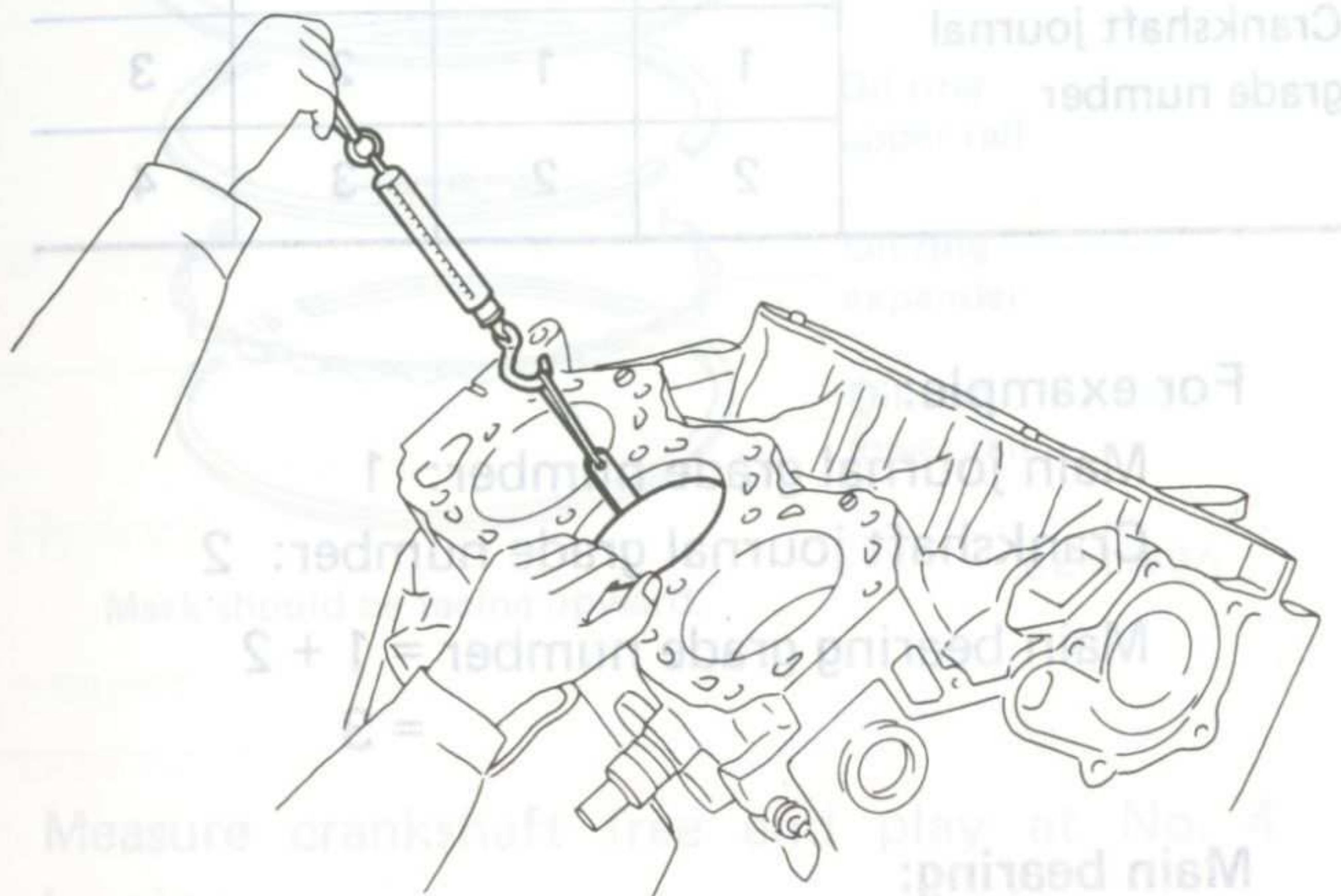
When pulling feeler gauge straight upward, measure the extracting force. It is recommended that piston and cylinder be heated to 20°C (68°F).

Feeler gauge thickness:

0.04 mm (0.0016 in)

Extracting force:

2.0 - 14.7 N (0.2 - 1.5 kg, 0.4 - 3.3 lb)

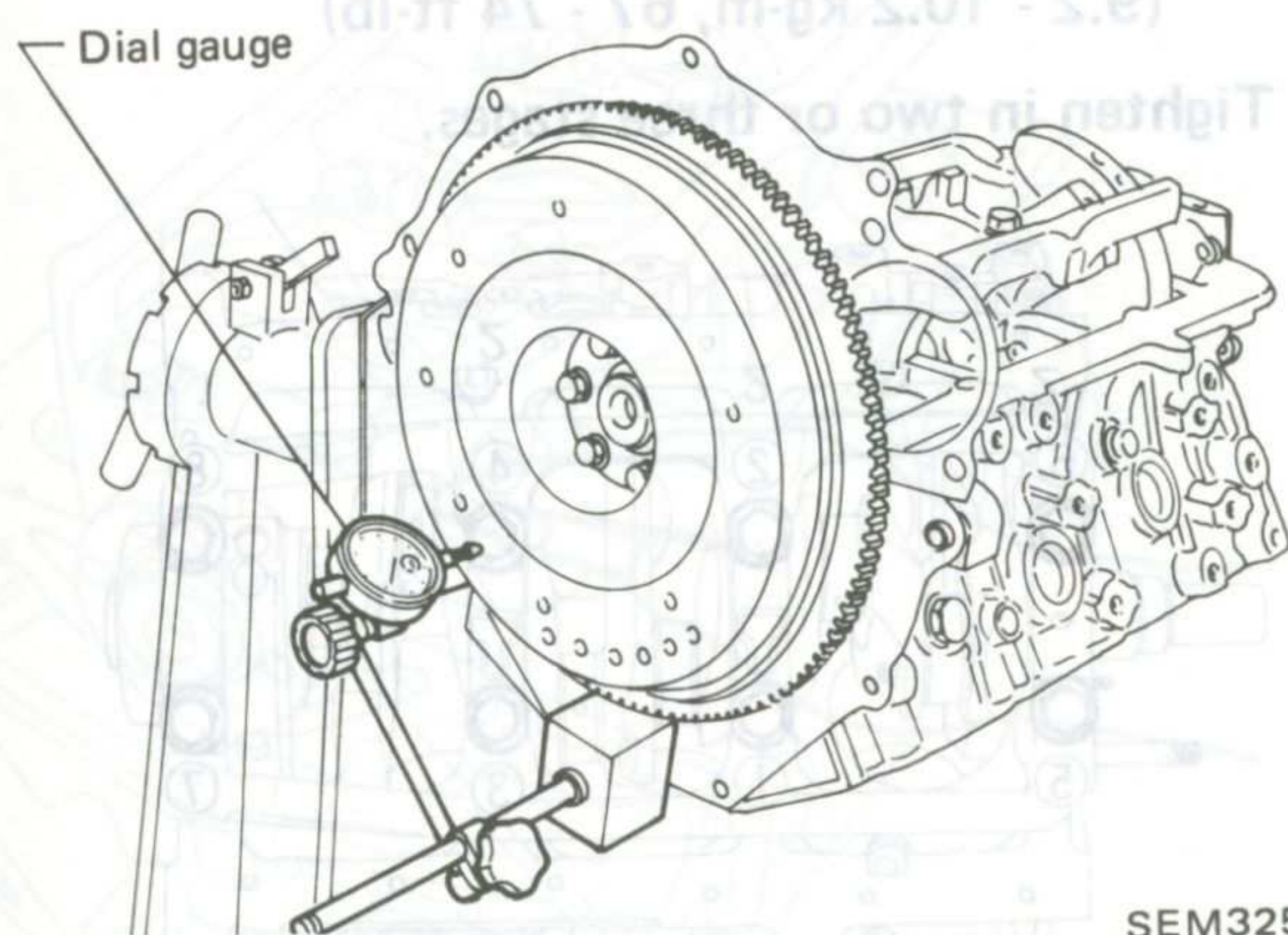


SEM324A

FLYWHEEL RUNOUT

Runout (Total indicator reading):

Less than 0.15 mm (0.0059 in)



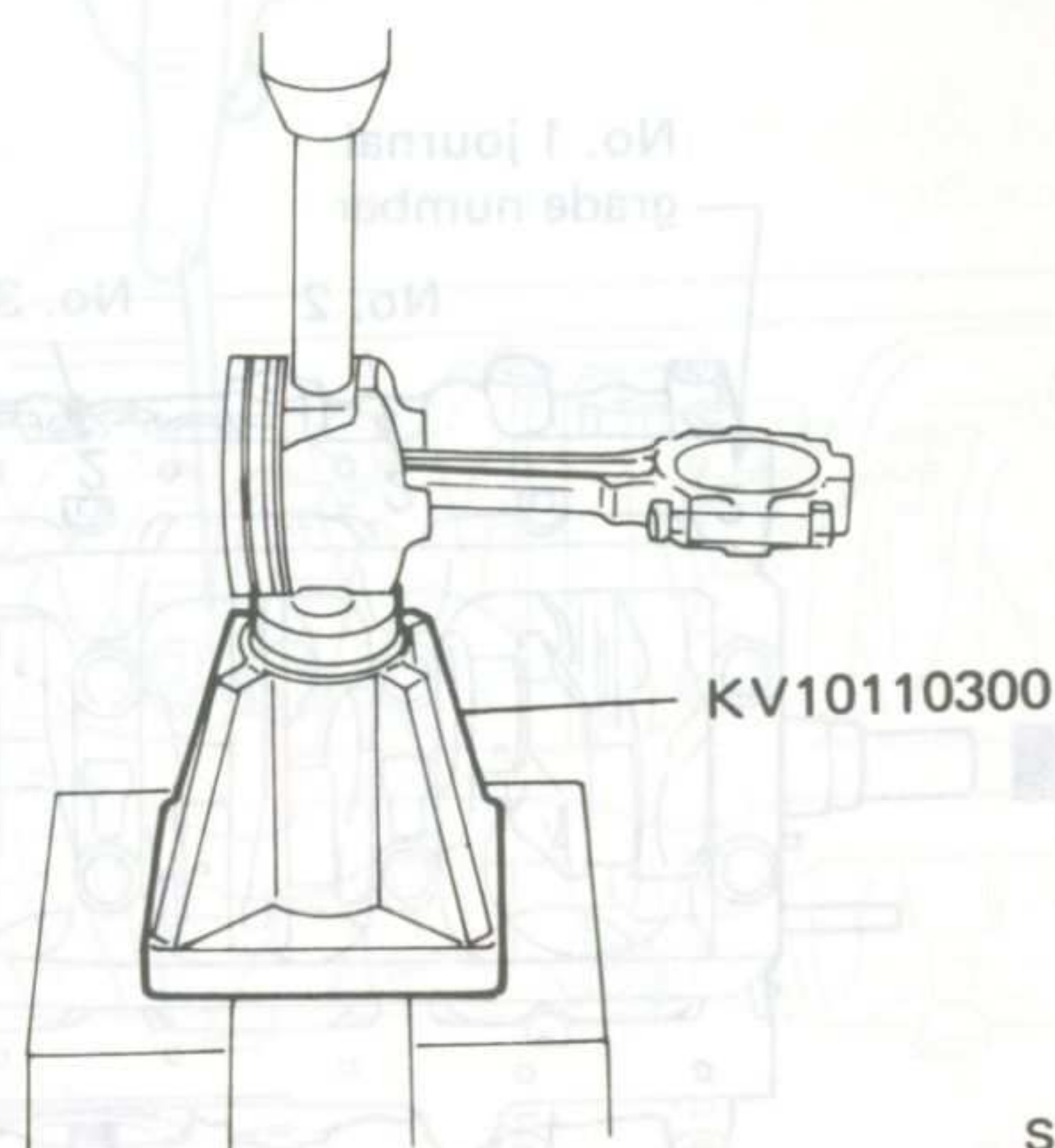
SEM325A

Install ring on flywheel, heating ring gear to about 180 to 220°C (356 to 428°F).

Assembly

PISTON

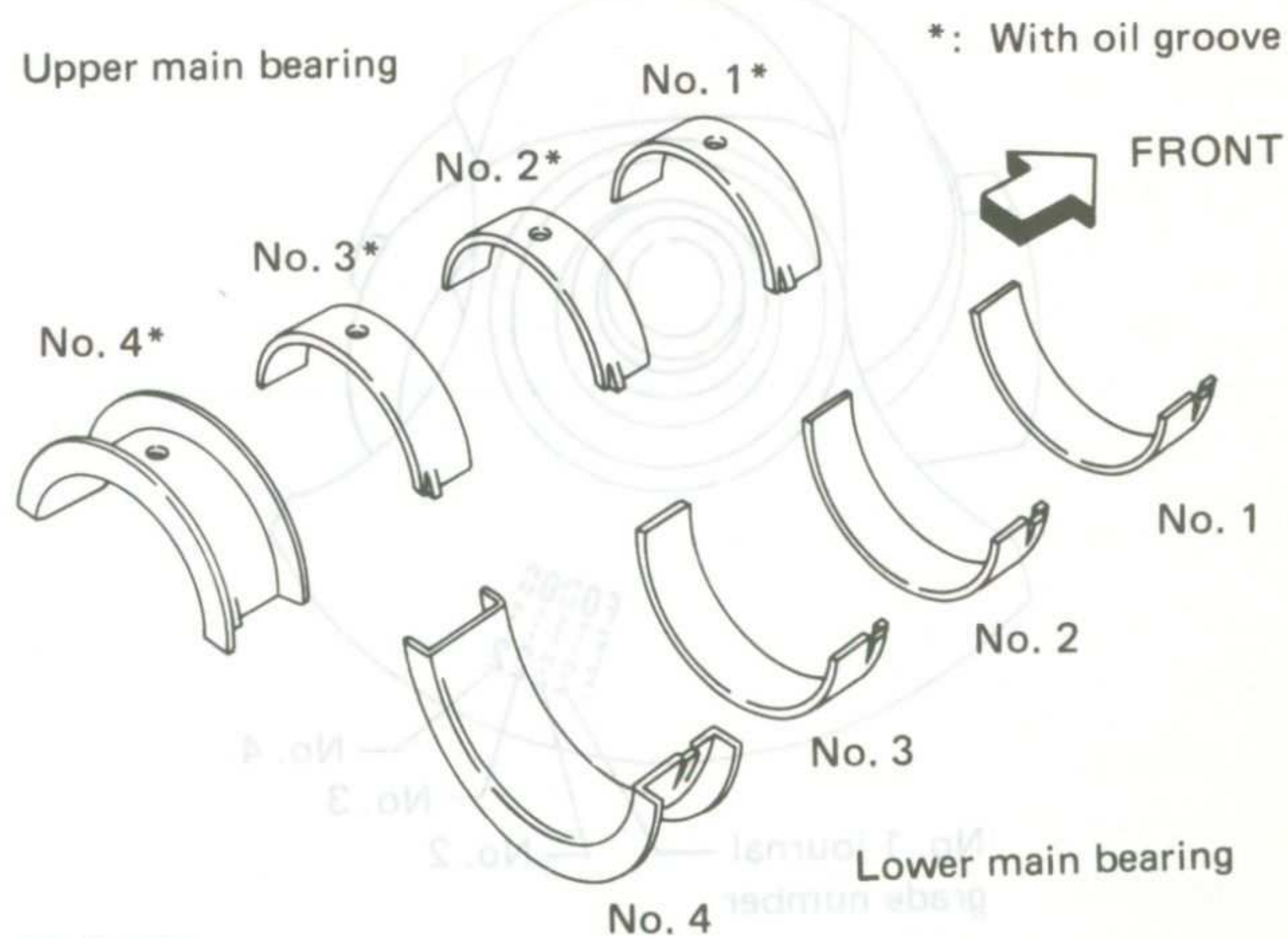
- Numbers are stamped on the connecting rod and cap corresponding to each cylinder. Care should be taken to avoid a wrong combination including bearing.
- When pressing piston pin in connecting rod, apply engine oil to pin and small end of connecting rod.



SEM326A

CRANKSHAFT

- Set main bearings in the proper position on cylinder block.



SEM327A

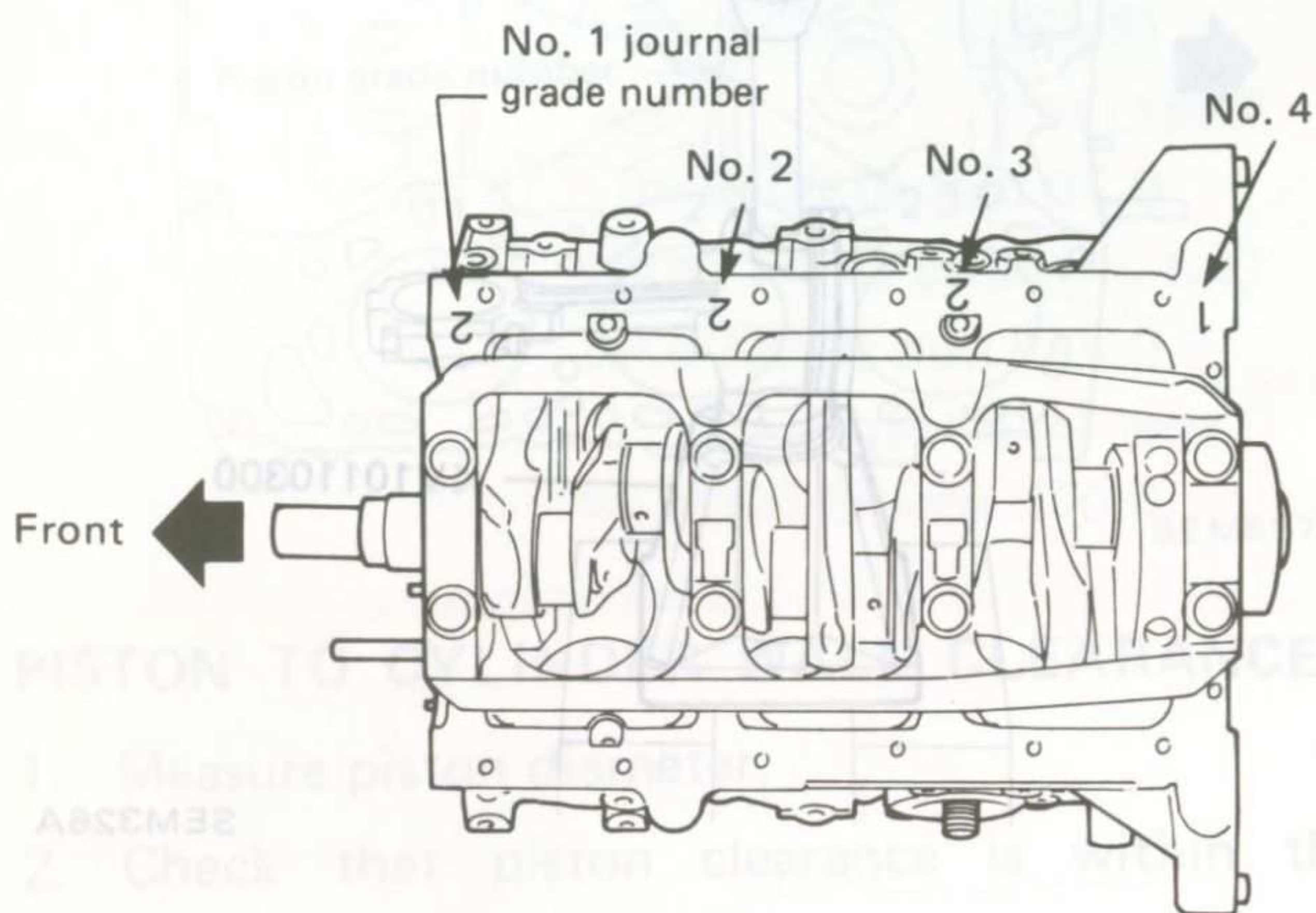
ENGINE OVERHAUL

Assembly (Cont'd)

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

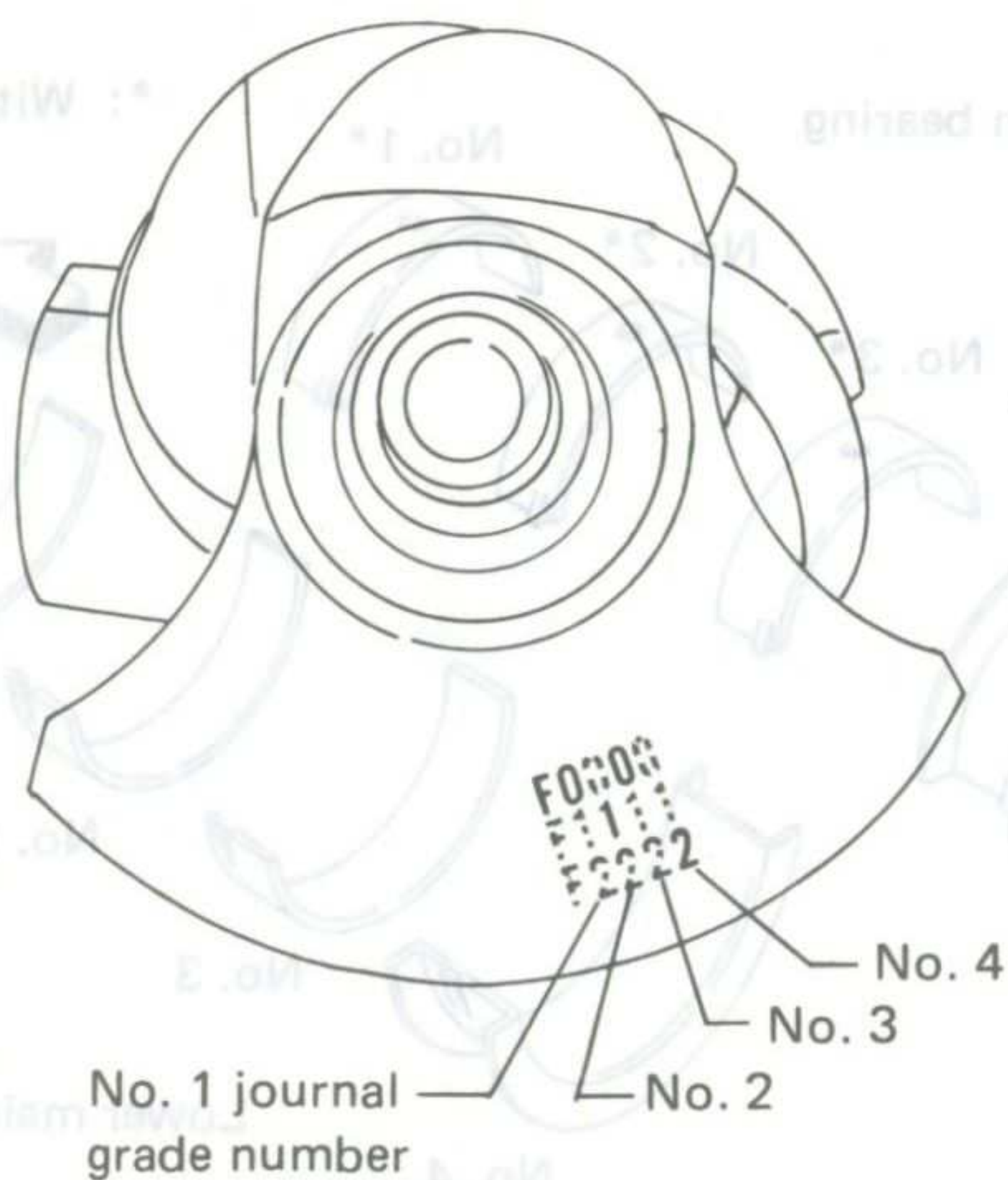
If all of crankshaft, cylinder block and main bearing are replaced with new ones, it is necessary to select thickness of main bearings as follows:

a. Grade number of each cylinder block main journal is punched on the respective cylinder block.



SEM508A

b. Grade number of each crankshaft main journal is punched on the respective crankshaft.



SEM167B

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

		Main journal grade number		
		0	1	2
Crankshaft journal grade number		Main bearing grade number		
	0	0	1	2
	1	1	2	3
	2	2	3	4

For example:

Main journal grade number: 1

Crankshaft journal grade number: 2

Main bearing grade number = 1 + 2
= 3

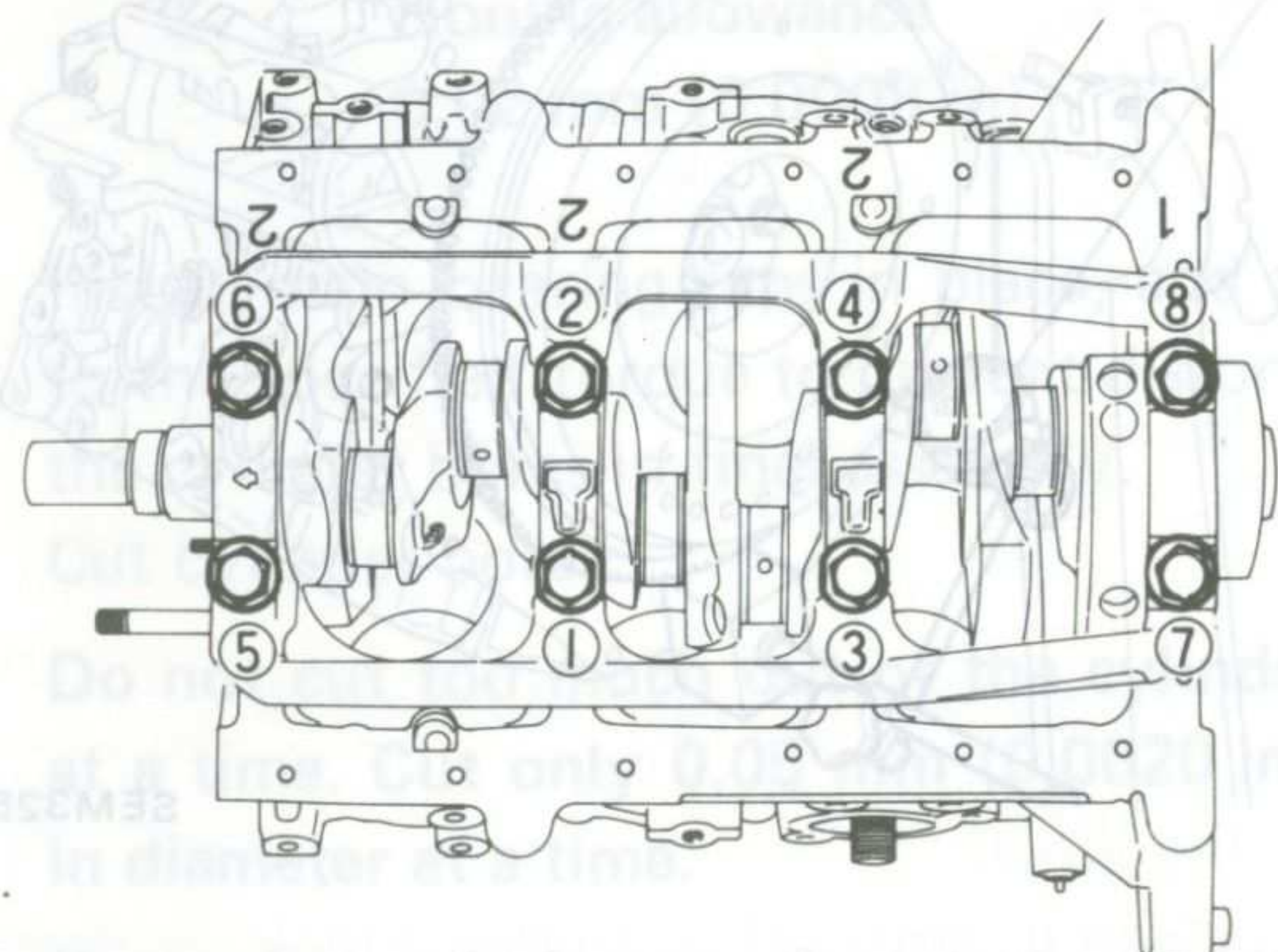
Main bearing:

Refer to S.D.S.

3. Install main bearing cap and tighten bolts to the specified torque.

 : 90 - 100 N·m
(9.2 - 10.2 kg-m, 67 - 74 ft-lb)

• Tighten in two or three stages.



SEM510A

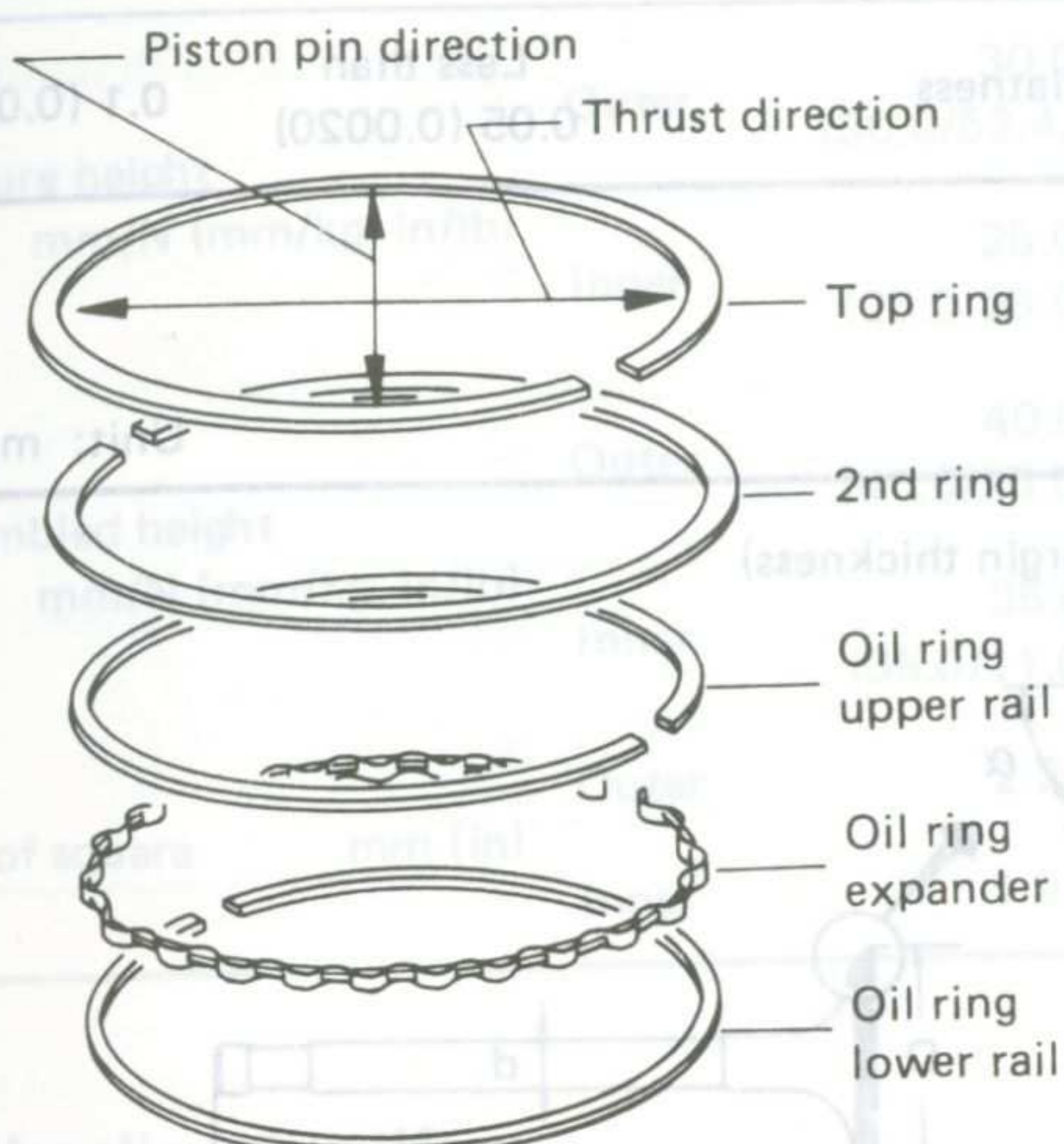
• After securing bearing cap bolts, ascertain that crankshaft turns smoothly by hand.

ENGINE OVERHAUL

Assembly (Cont'd)

4. Install piston assembly.

Set piston rings as shown below.



Mark should be facing upward.

SEM180A

5. Measure crankshaft free end play at No. 4 bearing.

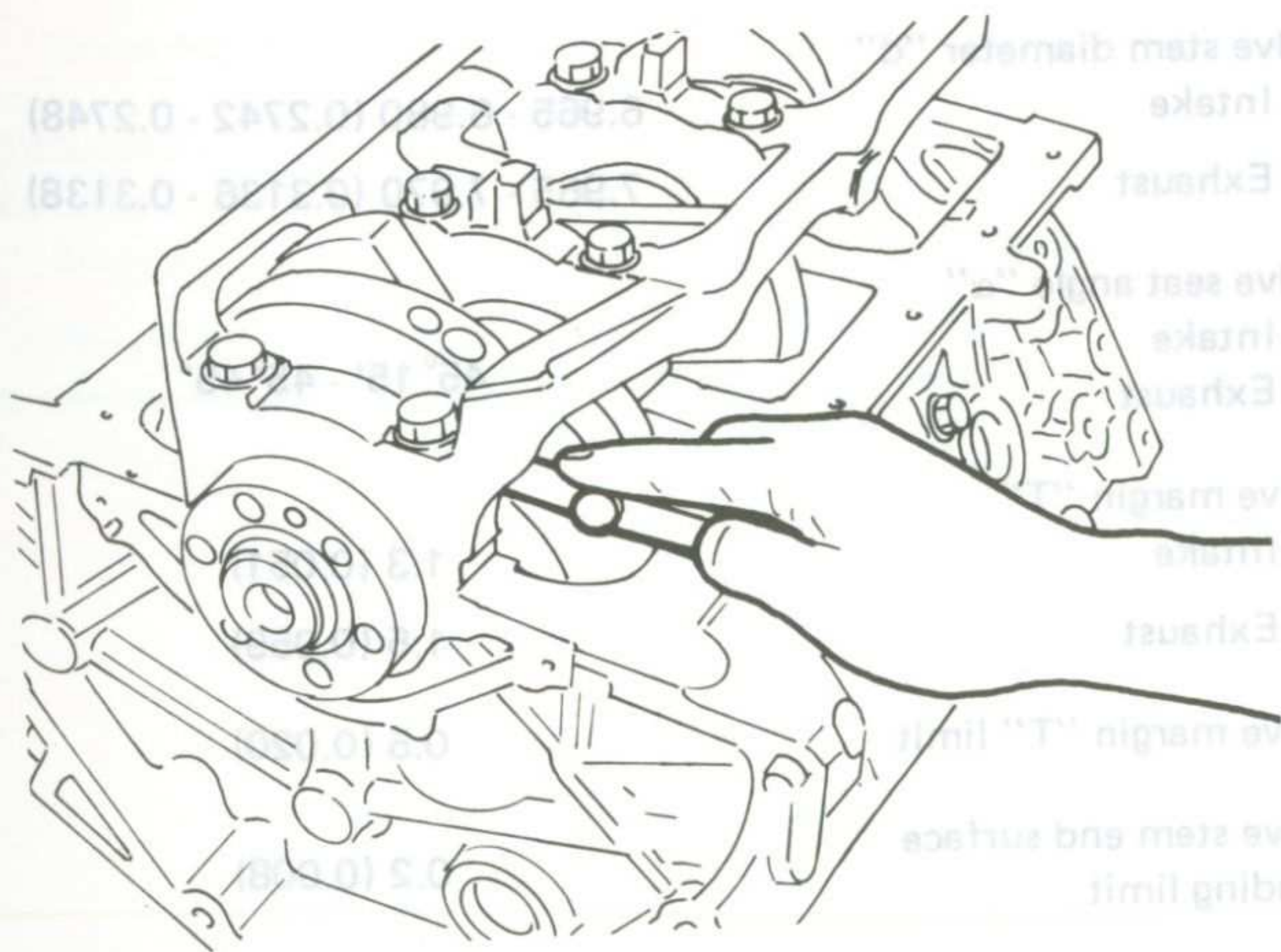
Crankshaft free end play:

Standard

0.05 - 0.17 mm (0.0020 - 0.0067 in)

Limit

0.30 mm (0.0118 in)



SEM511A

6. Measure connecting rod clearance.

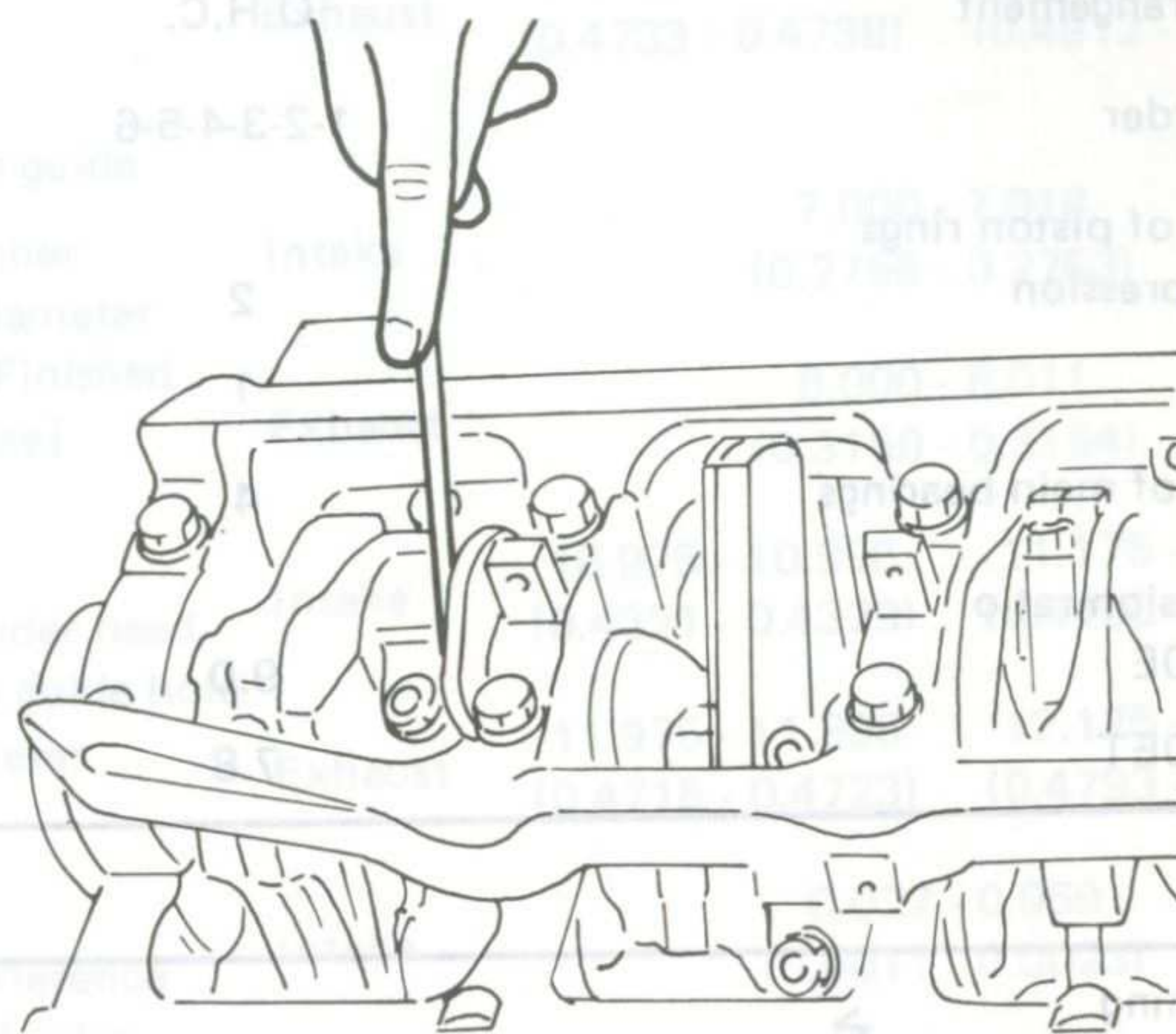
Connecting rod clearance:

Standard

0.20 - 0.35 mm (0.0079 - 0.0138 in)

Limit

0.40 mm (0.0157 in)



SEM512A

DIRECTION OF ROTATION			
EXHAUST			
INTAKE			
CLOSURE			
B.D.C.			
Unit: degree			
a	b	c	d
35°	35°	30°	35°
16°	16°	16°	16°
Unit: kPa (lb./sq. in.)			
Turbo			
Non-turbo			
Standard			
1.79 (1.79)	1.79 (1.79)	1.79 (1.79)	1.79 (1.79)
1.79 (1.79)	1.79 (1.79)	1.79 (1.79)	1.79 (1.79)
Minimum			
883 (8.83)	883 (8.83)	883 (8.83)	883 (8.83)
1.79 (1.79)	1.79 (1.79)	1.79 (1.79)	1.79 (1.79)
Differential limit between cylinders			
98 (0.98)	98 (0.98)	98 (0.98)	98 (0.98)
1.79 (1.79)	1.79 (1.79)	1.79 (1.79)	1.79 (1.79)

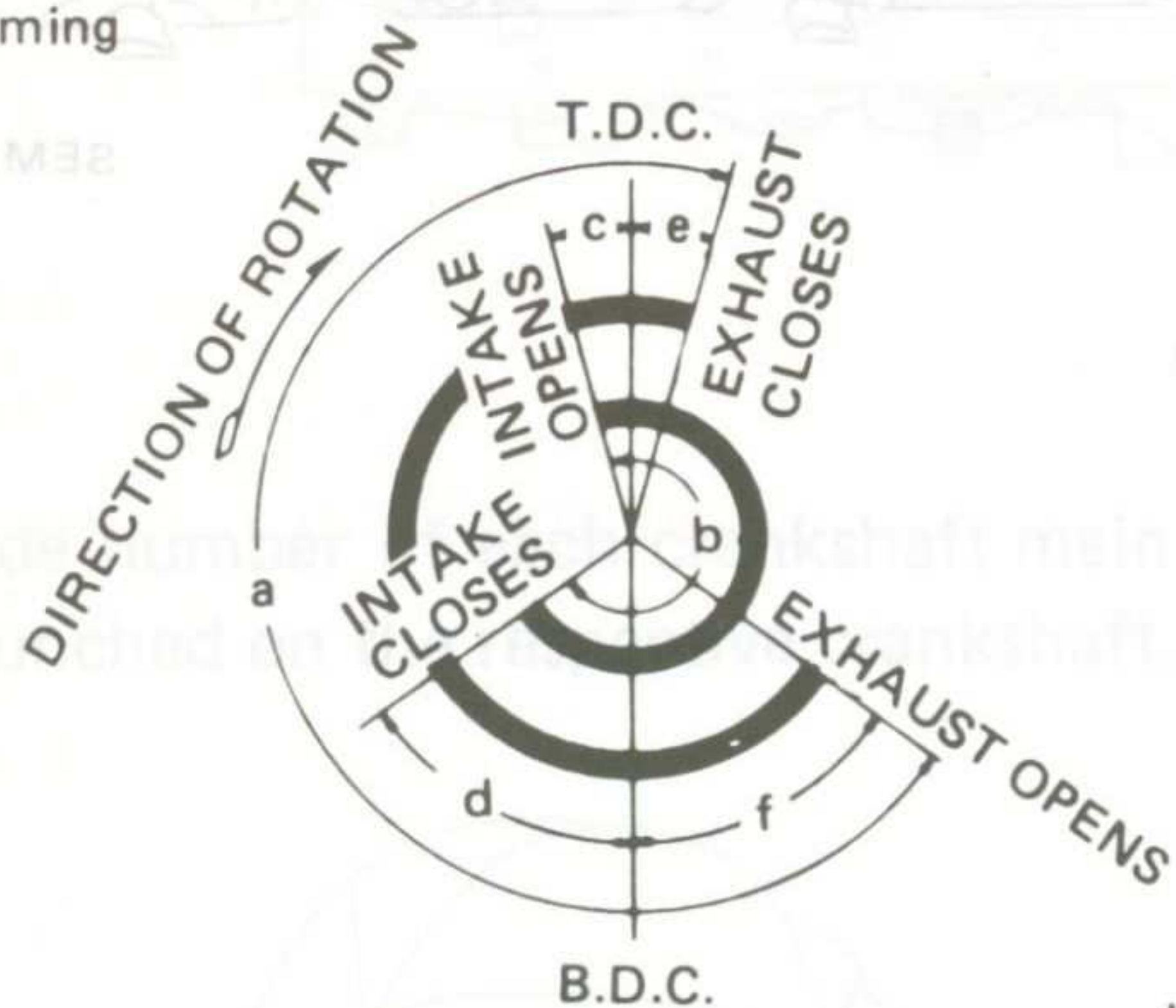
SERVICE DATA AND SPECIFICATIONS

General Specifications

Inspection and Adjustment

Engine		VG30E
Item		
Cylinder arrangement		V-6
Displacement	cm ³ (cu in)	2,960 (180.62)
Bore and Stroke	mm (in)	87 x 83 (3.43 x 3.27)
Valve arrangement		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		
VG30E		9.0
VG30ET		7.8

Valve timing



EM120

Unit: degree

a	b	c	d	e	f
252°	252°	20°	52°	16°	62°

Unit: kPa (bar, kg/cm², psi)/rpm

	Non-turbo	Turbo
Compression pressure		
Standard	1,196 (11.96, 12.2, 173)/300	1,138 (11.38, 11.6, 165)/300
Minimum	883 (8.83, 9.0, 128)/300	834 (8.34, 8.5, 121)/300
Differential limit between cylinders	98 (0.98, 1.0, 14)/300	98 (0.98, 1.0, 14)/300

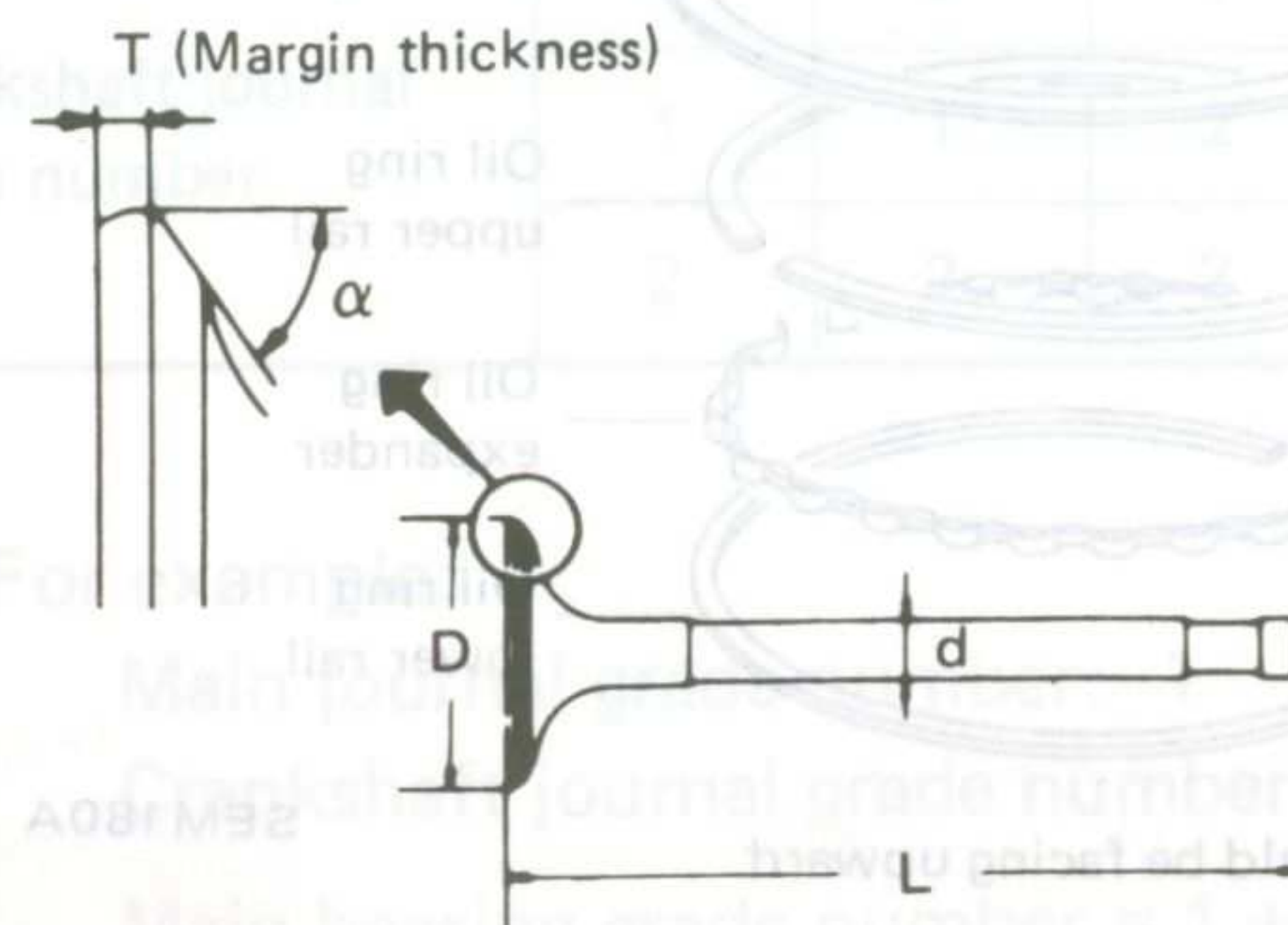
CYLINDER HEAD

Unit: mm (in)

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

VALVE

Unit: mm (in)



SEM188

Engine		VG30E
Item		
Valve head diameter "D"		
Intake		42.0 - 42.2 (1.654 - 1.661)
Exhaust		35.0 - 35.2 (1.378 - 1.386)
Valve length "L"		
Intake		125.3 - 125.9 (4.93 - 4.96)
Exhaust		124.2 - 124.8 (4.89 - 4.91)
Valve stem diameter "d"		
Intake		6.965 - 6.980 (0.2742 - 0.2748)
Exhaust		7.965 - 7.970 (0.3136 - 0.3138)
Valve seat angle "α"		
Intake		45° 15' - 45° 45'
Exhaust		
Valve margin "T"		
Intake		1.3 (0.051)
Exhaust		1.5 (0.059)
Valve margin "T" limit		0.5 (0.020)
Valve stem end surface grinding limit		0.2 (0.008)
Valve clearance		
Intake		0 (0)
Exhaust		0 (0)

SERVICE DATA AND SPECIFICATIONS

Inspection and Adjustment (Cont'd)

Valve spring

Free height	Outer	51.2 (2.016)
	Inner	44.1 (1.736)
Pressure height	Outer	30.0/523.7 (30.0/53.4, 1.181/117.7)
	Inner	25.0/255.0 (25.0/26.0, 0.984/57.3)
Assembled height	Outer	40.0/250.1 (40.0/25.5, 1.575/56.2)
	Inner	35.0/107.9 (35.0/11.0, 1.378/24.3)
Out of square	Outer	2.2 (0.087)
	Inner	1.9 (0.075)

Hydraulic valve lifter

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

Valve guide

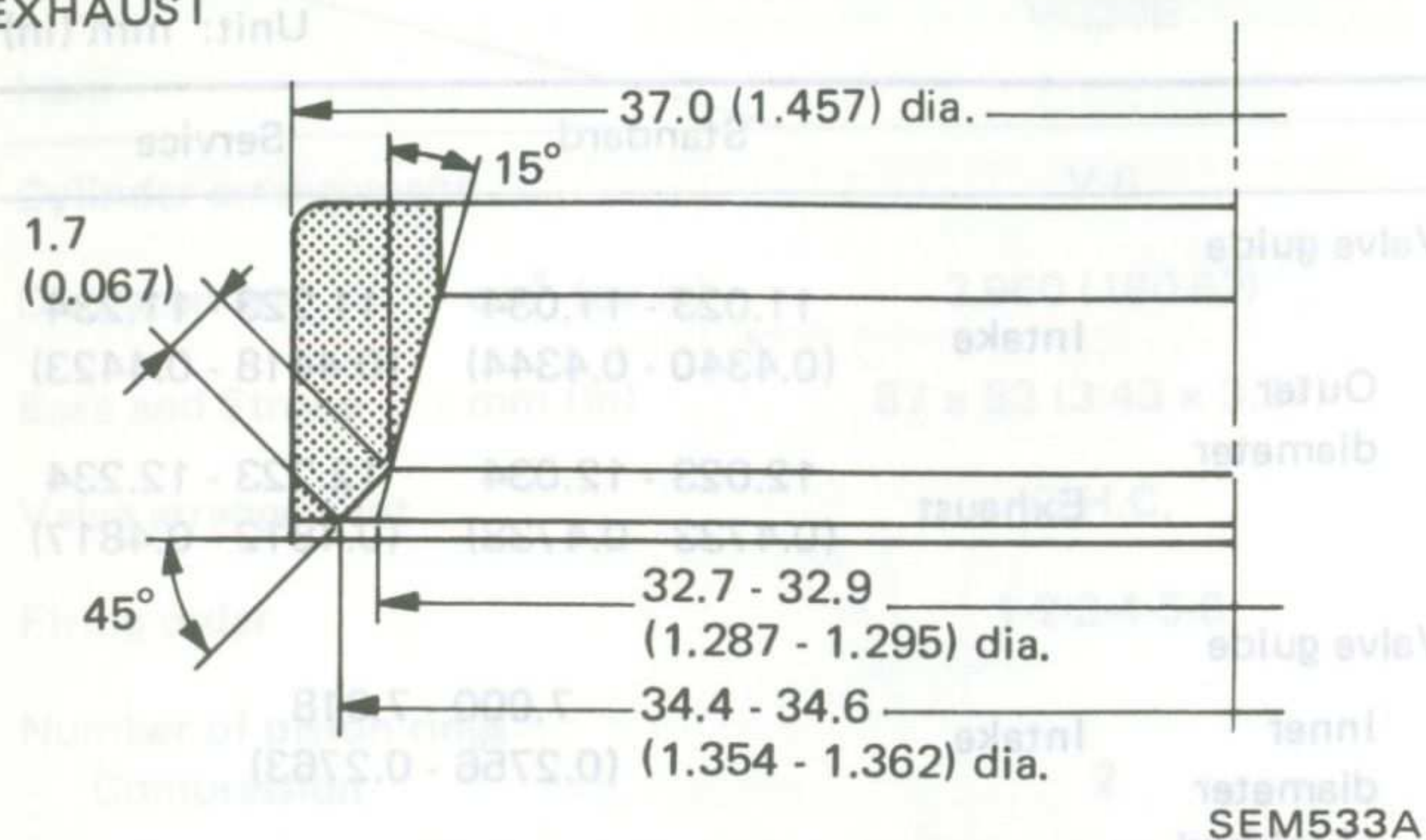
		Unit: mm (in)	
		Standard	Service
Valve guide	Intake	11.023 - 11.034 (0.4340 - 0.4344)	11.223 - 11.234 (0.4418 - 0.4423)
	Exhaust	12.023 - 12.034 (0.4733 - 0.4738)	12.223 - 12.234 (0.4812 - 0.4817)
Valve guide	Intake	7.000 - 7.018 (0.2756 - 0.2763)	
	Exhaust	8.000 - 8.011 (0.3150 - 0.3154)	
Cylinder head valve guide hole diameter	Intake	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
	Exhaust	11.975 - 11.996 (0.4715 - 0.4723)	12.175 - 12.196 (0.4793 - 0.4802)
Interference fit of valve guide	Intake	0.027 - 0.059 (0.0011 - 0.0023)	
	Exhaust	0.027 - 0.059 (0.0011 - 0.0023)	
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.1 (0.004)
	Exhaust	0.040 - 0.073 (0.0016 - 0.0029)	
Valve deflection limit		—	0.2 (0.008)

SERVICE DATA AND SPECIFICATIONS

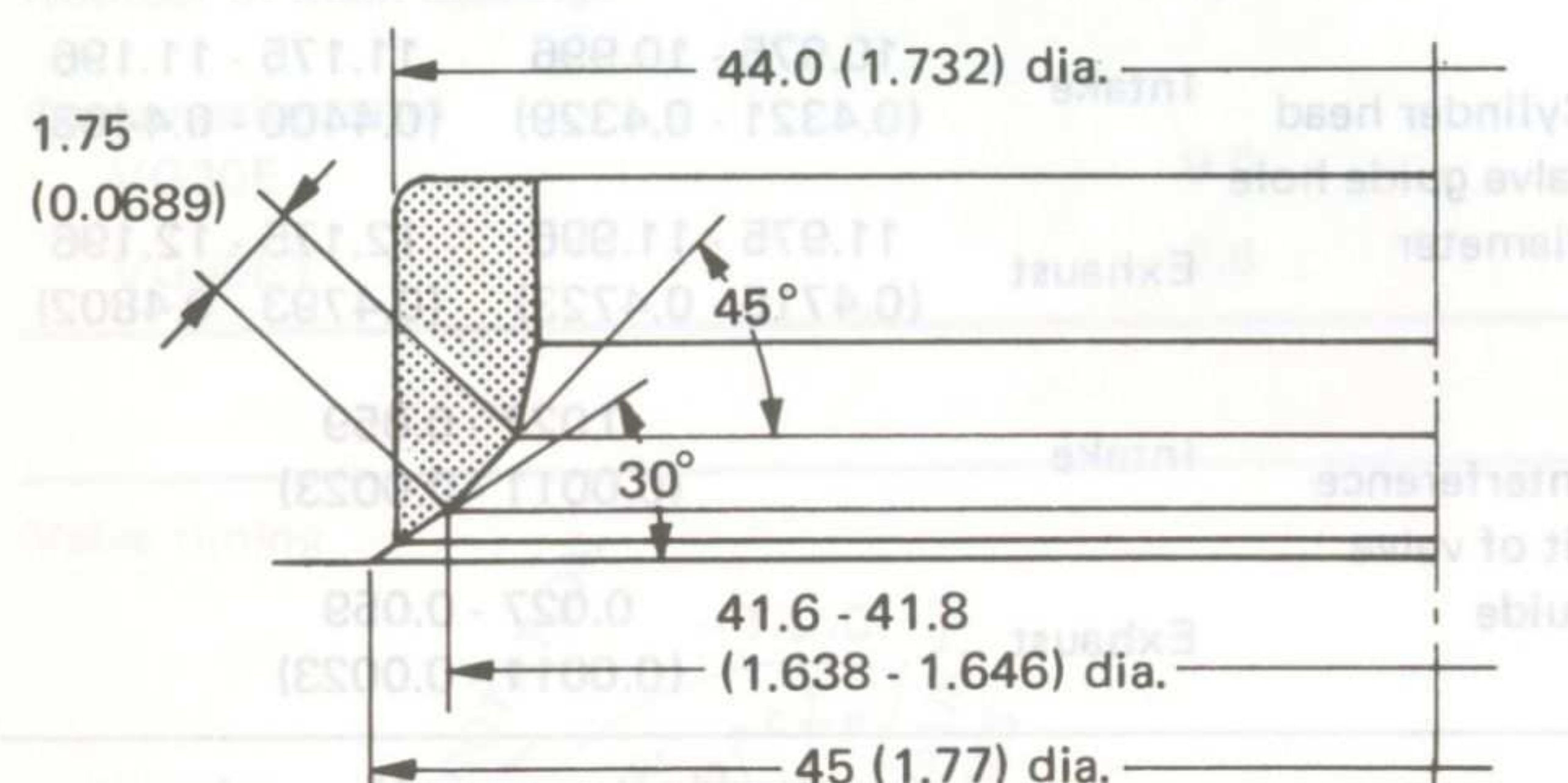
Inspection and Adjustment (Cont'd)

Valve seat

EXHAUST



INTAKE



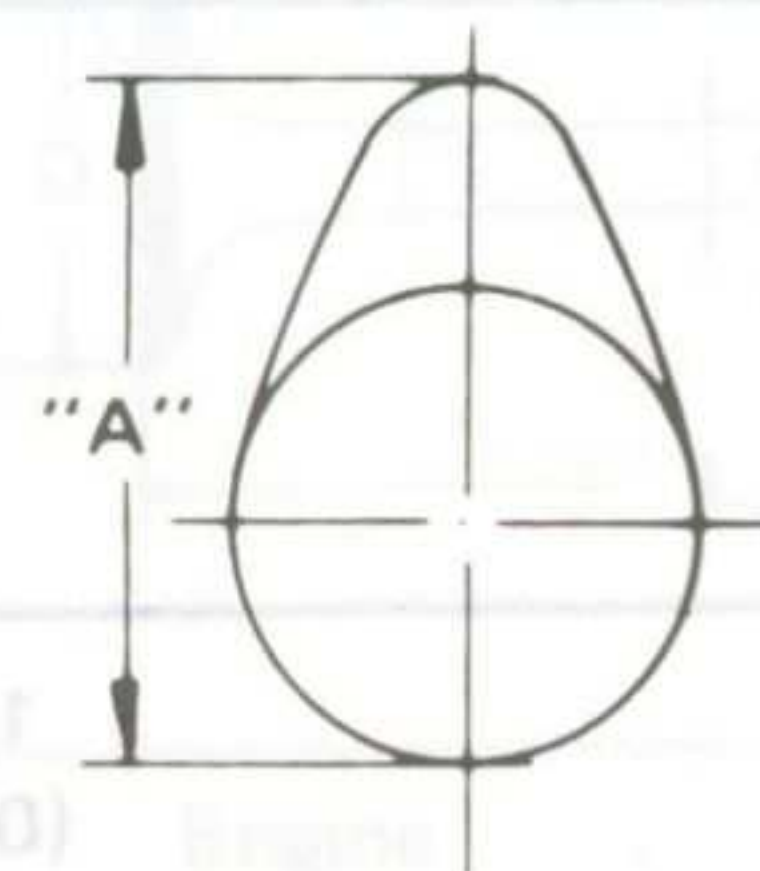
Unit: mm (in)

SEM534A

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

	Standard	Max. tolerance
Camshaft journal to bearing clearance	0.045 - 0.090 (0.0018 - 0.0035)	0.15 (0.0059)
Inner diameter of camshaft bearing	47.00 - 47.025 (1.8504 - 1.8514)	—
Outer diameter of camshaft journal	46.935 - 46.955 (1.8478 - 1.8486)	—
Camshaft runout [T.I.R.*]	Less than 0.02 (0.0008)	0.1 (0.004)
Camshaft end play	0.03 - 0.06 (0.0012 - 0.0024)	—



EM671

Cam height "A"

Intake	39.537 - 39.725 (1.5566 - 1.5640)
Exhaust	

Wear limit of cam height	0.15 (0.0059)
--------------------------	---------------

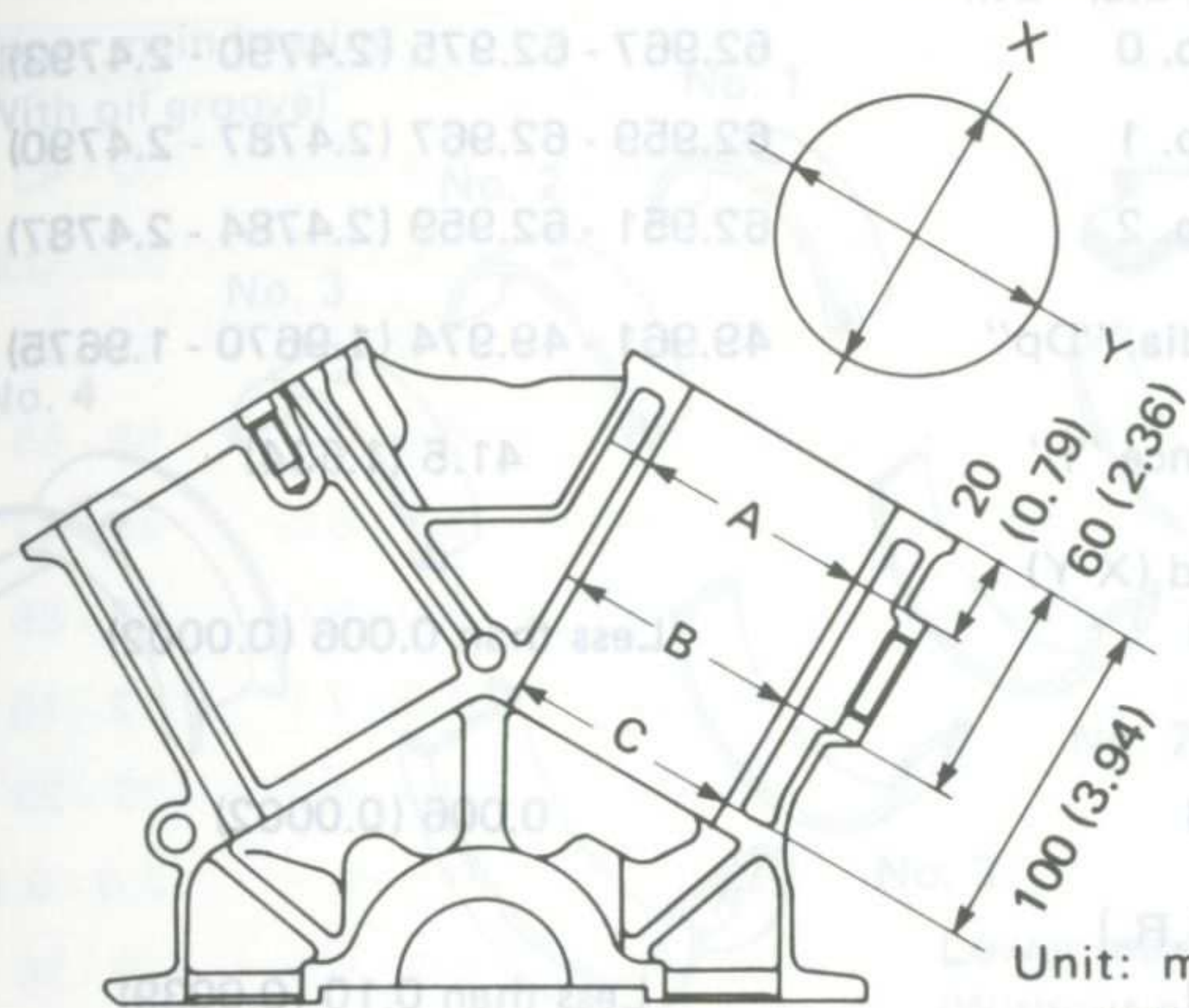
*Total indicator reading

SERVICE DATA AND SPECIFICATIONS

Inspection and Adjustment (Cont'd)

CYLINDER BLOCK

Unit: mm (in)



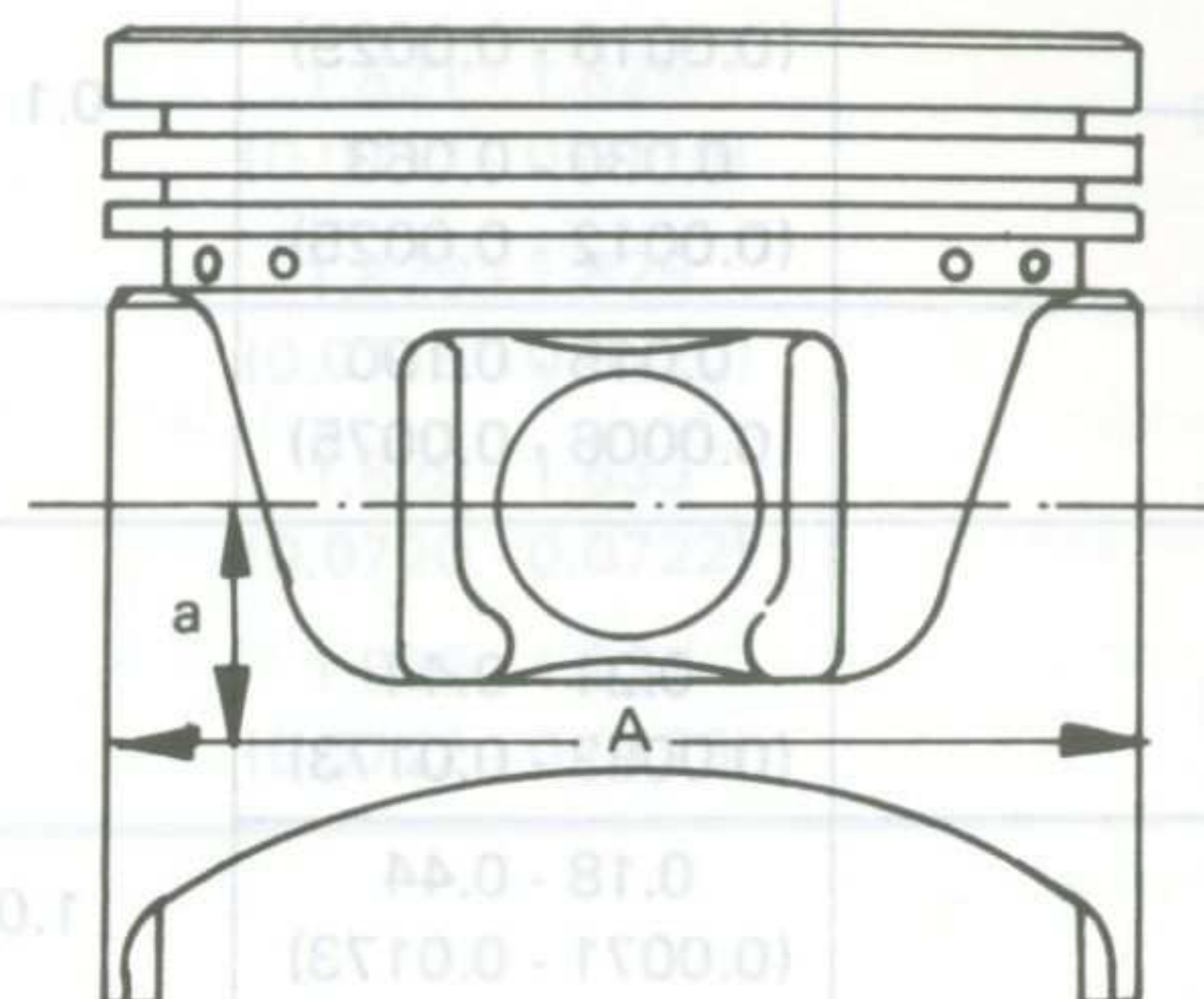
Unit: mm (in)
SEM321A

Surface flatness	
Standard	Less than 0.03 (0.0012)
Limit	0.10 (0.0039)
Cylinder bore	
Inner diameter	
Standard	87.000 - 87.050 (3.4252 - 3.4272)
Wear limit	0.20 (0.0079)
Out-of-round (X-Y)	Less than 0.015 (0.0006)
Taper (A-B-C)	Less than 0.015 (0.0006)
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)
Wear limit	0.20 (0.0079)

PISTON, PISTON RING AND PISTON PIN

Available piston

Unit: mm (in)



SEM624A

Model	Non-turbo	Turbo
Piston Standard	86.965 - 87.015 (3.4238 - 3.4258)	
skirt 0.02 (0.0008)	86.985 - 87.035 (3.4246 - 3.4266)	
diam- 0.25 (0.0098)	87.215 - 87.265 (3.4337 - 3.4356)	
eter "A" oversize (Service)		
"a" dimension	20.0 (0.787)	21.5 (0.846)
Piston pin hole diameter	21.001 - 21.008 (0.8268 - 0.8271)	
Piston clearance to cylinder block	0.025 - 0.045 (0.0010 - 0.0018)	

SERVICE DATA AND SPECIFICATIONS

Inspection and Adjustment (Cont'd)

Piston ring

Unit: mm (in)

	Standard	Limit
Side clearance		
Top	0.040 - 0.073 (0.0016 - 0.0029)	0.1 (0.004)
2nd	0.030 - 0.063 (0.0012 - 0.0025)	
Oil	0.015 - 0.190 (0.0006 - 0.0075)	—
Ring gap		
Top	0.21 - 0.44 (0.0083 - 0.0173)	1.0 (0.04)
2nd	0.18 - 0.44 (0.0071 - 0.0173)	
Oil (rail ring)	0.20 - 0.76 (0.0079 - 0.0299)	

Piston pin

Unit: mm (in)

Piston pin outer diameter	20.993 - 20.998 (0.8265 - 0.8267)
Piston pin to piston clearance	0.008 - 0.010 (0.0003 - 0.0004)
Interference fit of piston pin to connecting rod	0.022 - 0.040 (0.0009 - 0.0016)

CONNECTING ROD

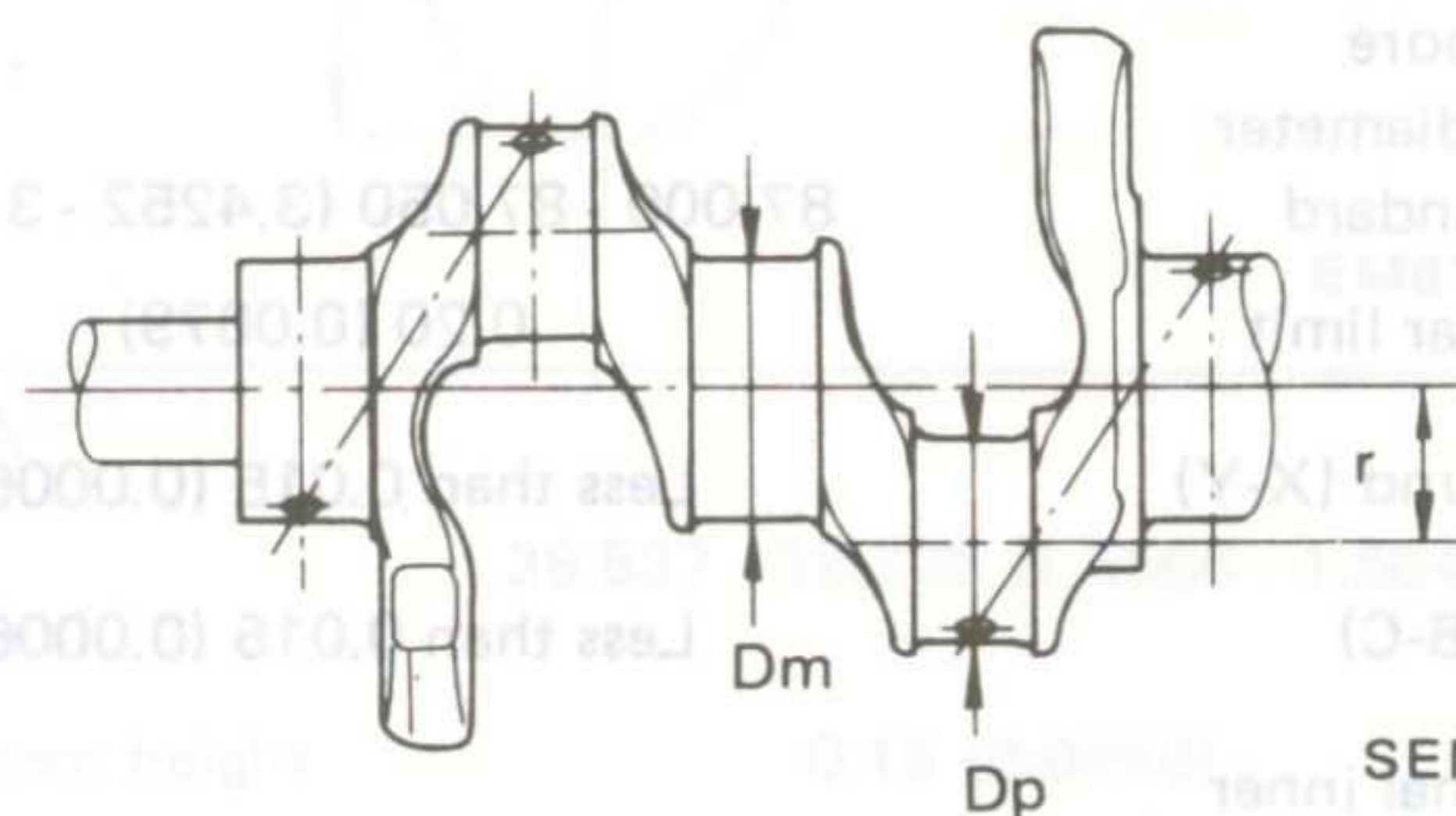
Unit: mm (in)

Center distance	154.10 - 154.20 (6.0669 - 6.0709)
Bend, torsion [per 100 (3.94)]	
Limit	0.10 (0.0039)
Piston pin bore dia.	20.958 - 20.971 (0.8251 - 0.8256)
Big end play	
Standard	0.20 - 0.35 (0.0079 - 0.0138)
Limit	0.6 (0.024)

CRANKSHAFT

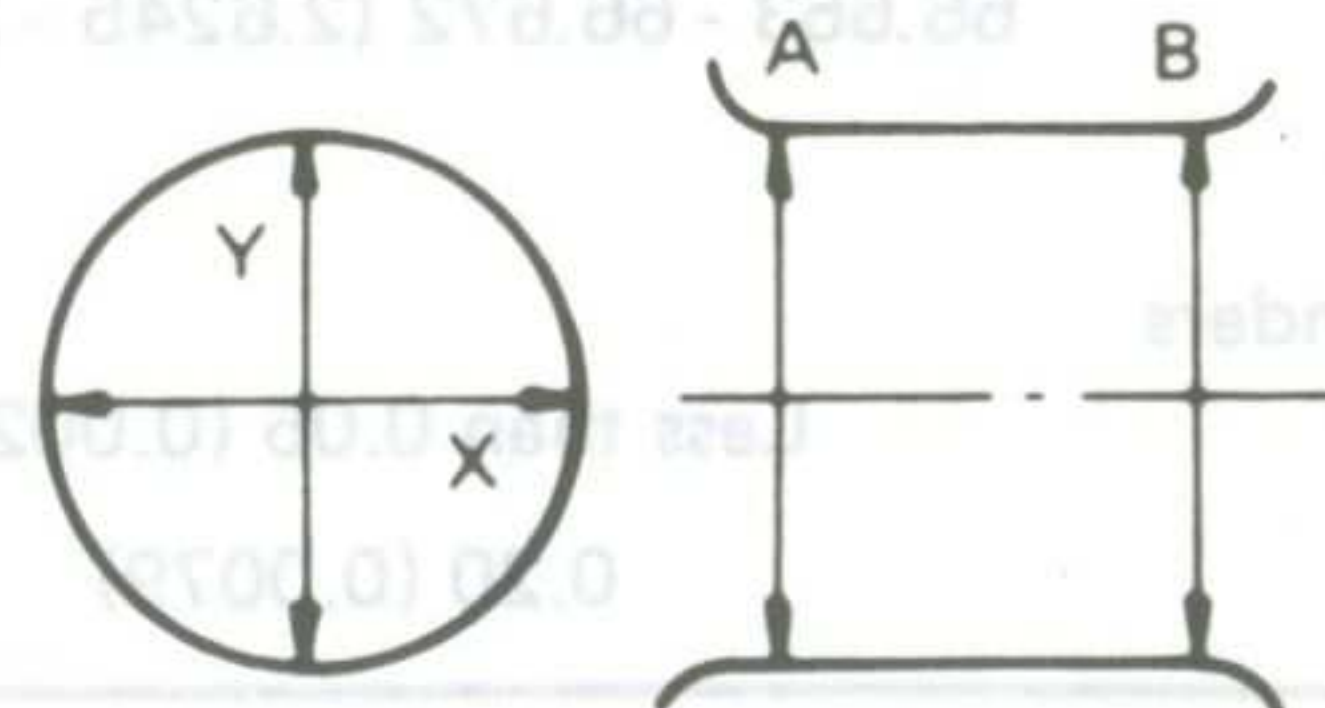
Unit: mm (in)

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"	49.961 - 49.974 (1.9670 - 1.9675)
Center distance "r"	41.5 (1.634)
Out-of-round (X-Y)	
Standard	Less than 0.006 (0.0002)
Taper (A-B)	
Standard	0.006 (0.0002)
Runout [T.I.R.]	
Standard	Less than 0.10 (0.0039)
Free end play	
Standard	0.05 - 0.17 (0.0020 - 0.0067)
Limit	0.30 (0.0118)



SEM645

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

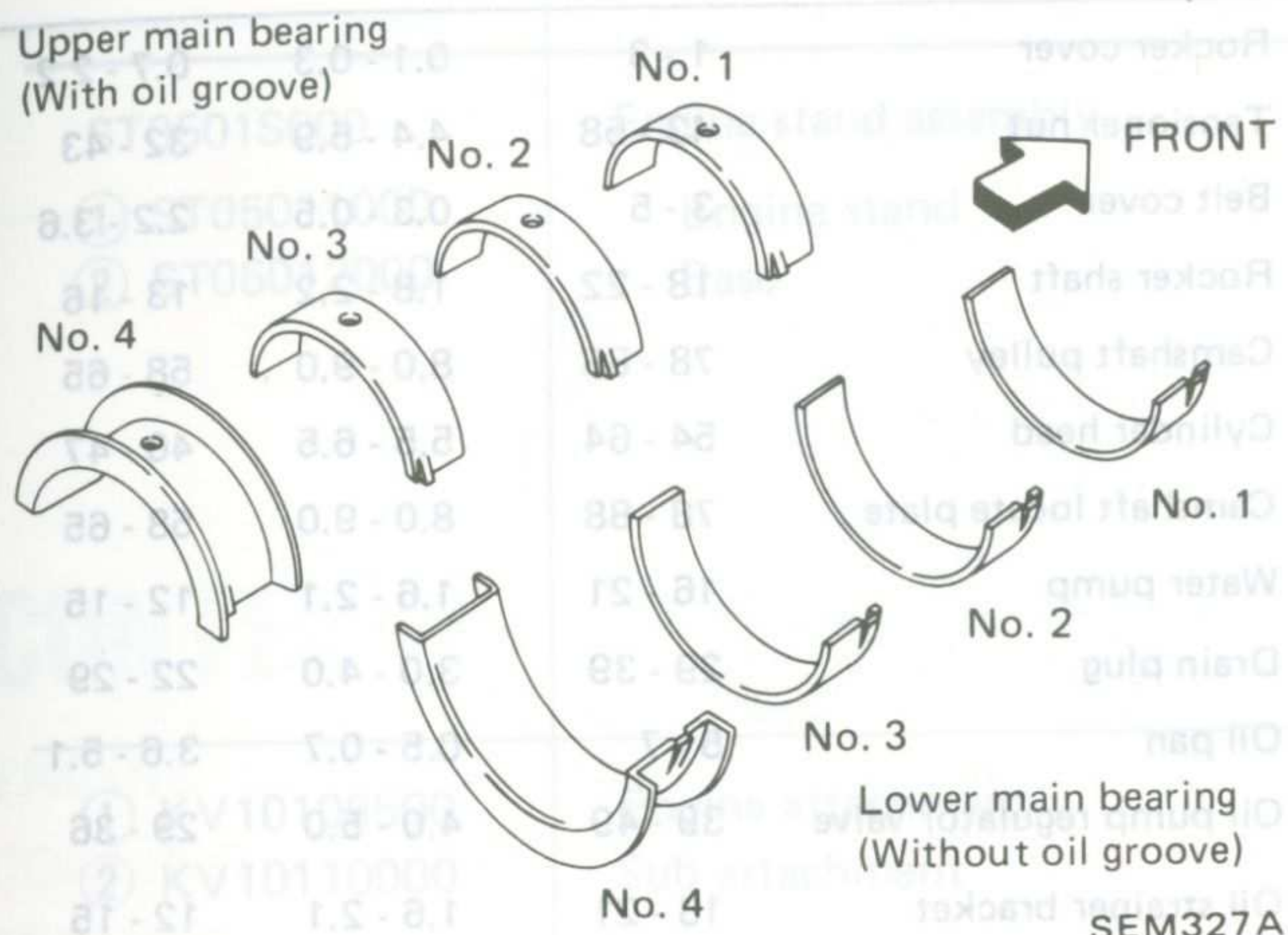


EM715

SERVICE DATA AND SPECIFICATIONS

Inspection and Adjustment (Cont'd)

AVAILABLE MAIN BEARING



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)		White
1	1.821 - 1.825 (0.0717 - 0.0719)		Brown
2	1.825 - 1.829 (0.0719 - 0.0720)	22.5 (0.886)	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)		White
1	1.821 - 1.825 (0.0717 - 0.0719)		Brown
2	1.825 - 1.829 (0.0719 - 0.0720)	19.0 (0.748)	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)	White
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

AVAILABLE CONNECTING ROD BEARING

Connecting rod bearing undersize

Unit: mm (in)	
Crank pin journal diameter "Dp"	
Standard	49.961 - 49.974 (1.9670 - 1.9675)
Undersize	
0.08 (0.0031)	49.881 - 49.894 (1.9638 - 1.9643)
0.12 (0.0047)	49.841 - 49.854 (1.9622 - 1.9628)
0.25 (0.0098)	49.711 - 49.724 (1.9571 - 1.9576)

MISCELLANEOUS COMPONENTS

Unit: mm (in)	
Flywheel	
Runout [T.I.R.]	Less than 0.15 (0.0059)

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	0.010 - 0.052 (0.0004 - 0.0020)
Limit	0.090 (0.0035)

SERVICE DATA AND SPECIFICATIONS

Tightening Torque

TIGHTENING TORQUE

Engine outer parts

	N·m	kg-m	ft-lb
Collector cover	6 - 8	0.6 - 0.8	4.3 - 5.8
Collector	18 - 22	1.8 - 2.2	13 - 16
Throttle chamber	18 - 22	1.8 - 2.2	13 - 16
E.G.R. control valve	18 - 22	1.8 - 2.2	13 - 16
Intake relief valve	29 - 39	3.0 - 4.0	22 - 29
Intake manifold bolt	16 - 20	1.6 - 2.0	12 - 14
Intake manifold nut	24 - 27	2.4 - 2.8	17 - 20
Injector holder	3 - 5	0.3 - 0.5	2.2 - 3.6
Cylinder head temperature sensor	15 - 20	1.5 - 2.0	11 - 14
Thermal transmitter	15 - 20	1.5 - 2.0	11 - 14
Exhaust manifold	18 - 22	1.8 - 2.2	13 - 16
Exhaust manifold stay	22 - 27	2.2 - 2.8	16 - 20
Exhaust outlet	25 - 29	2.5 - 3.0	18 - 22
E.G.R. tube	34 - 44	3.5 - 4.5	25 - 33
Exhaust connecting tube	22 - 27	2.2 - 2.8	16 - 20
Exhaust gas sensor	40 - 50	4.1 - 5.1	30 - 37
Crank pulley	123 - 132	12.5 - 13.5	90 - 98
Water inlet	16 - 21	1.6 - 2.1	12 - 15
Detonation sensor	25 - 34	2.5 - 3.5	18 - 25
P.C.V. valve	29 - 39	3.0 - 4.0	22 - 29
Distributor bolt	5 - 6	0.5 - 0.6	3.6 - 4.3
Alternator adjusting bar bolt	14 - 17	1.4 - 1.7	10 - 12
Air regulator	5 - 6	0.5 - 0.6	3.6 - 4.3

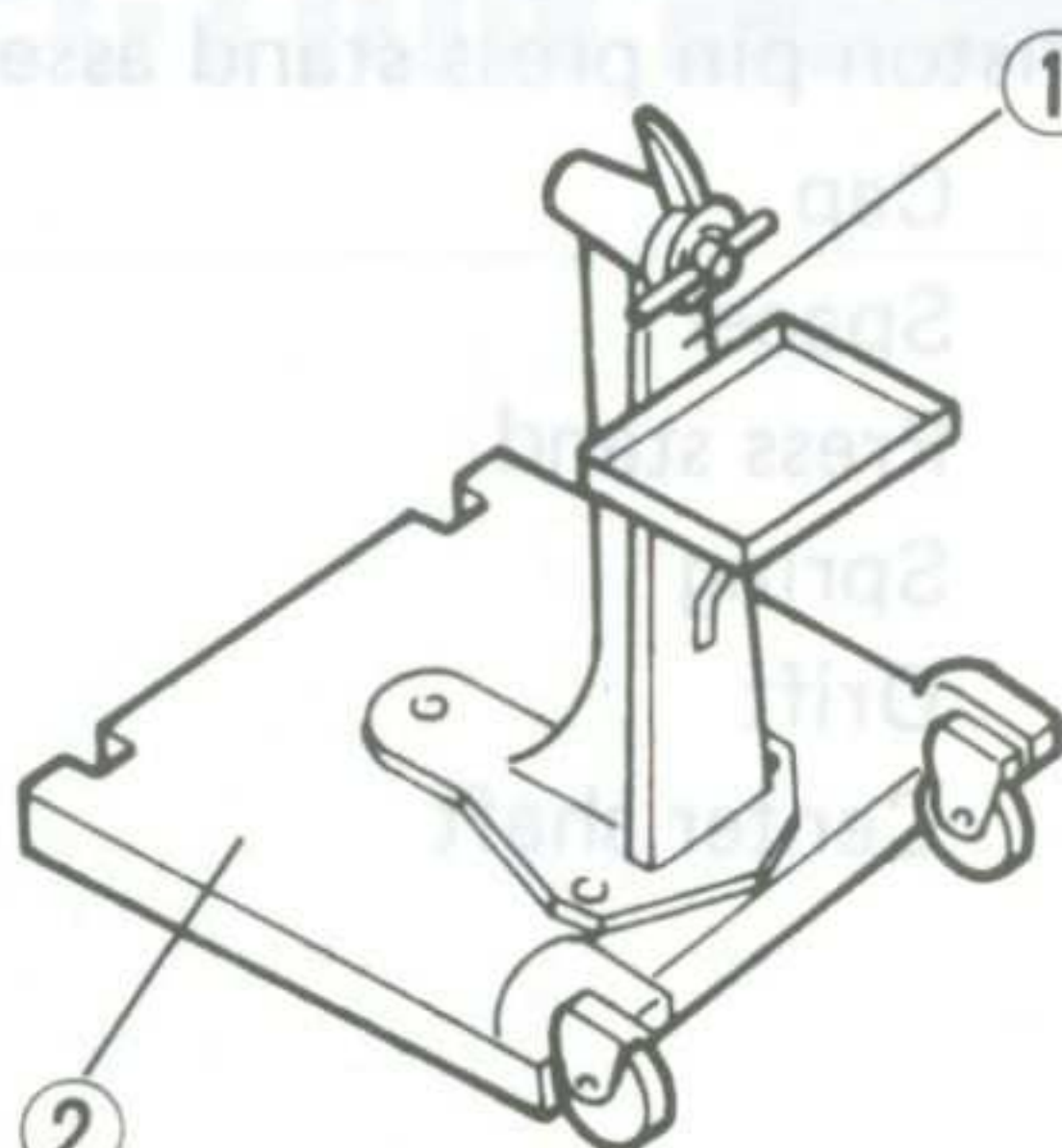
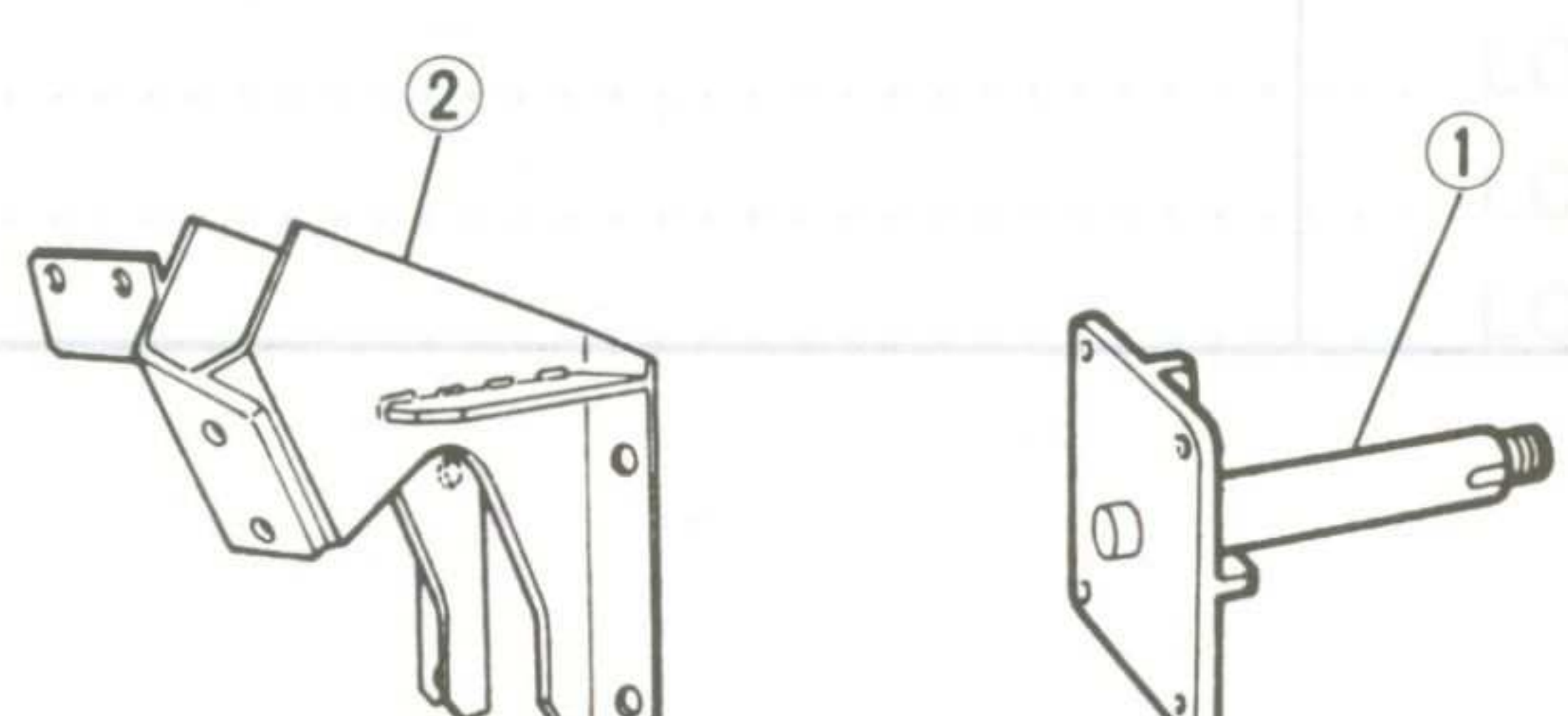
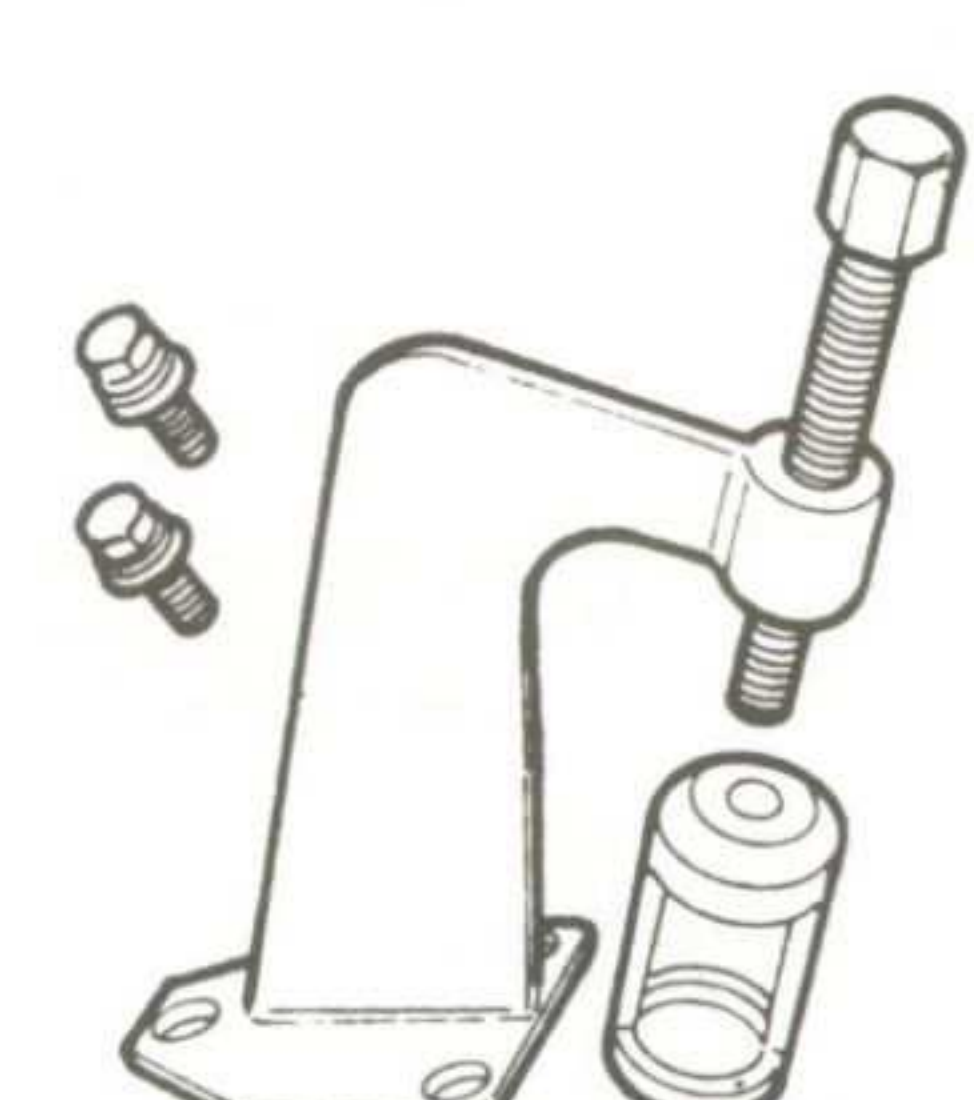
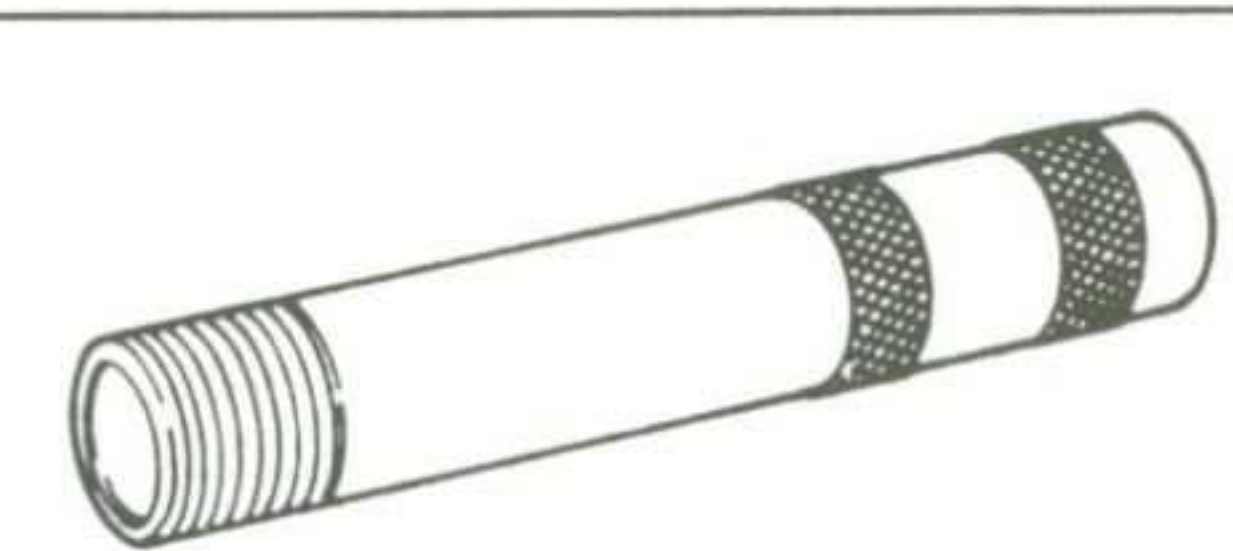
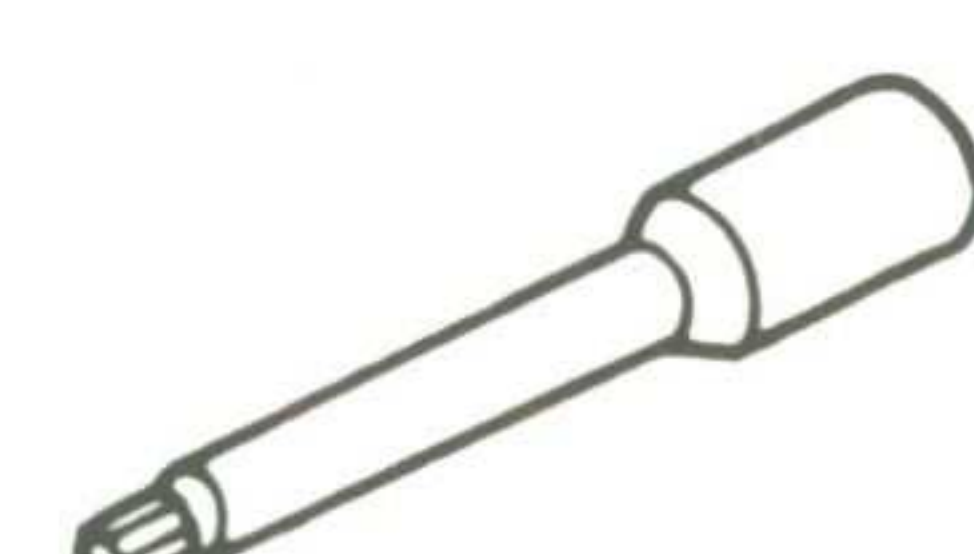
Engine internal parts

	N·m	kg-m	ft-lb
Rocker cover	1 - 3	0.1 - 0.3	0.7 - 2.2
Tensioner nut	43 - 58	4.4 - 5.9	32 - 43
Belt cover	3 - 5	0.3 - 0.5	2.2 - 3.6
Rocker shaft	18 - 22	1.8 - 2.2	13 - 16
Camshaft pulley	78 - 88	8.0 - 9.0	58 - 65
Cylinder head	54 - 64	5.5 - 6.5	40 - 47
Camshaft locate plate	78 - 88	8.0 - 9.0	58 - 65
Water pump	16 - 21	1.6 - 2.1	12 - 15
Drain plug	29 - 39	3.0 - 4.0	22 - 29
Oil pan	5 - 7	0.5 - 0.7	3.6 - 5.1
Oil pump regulator valve	39 - 49	4.0 - 5.0	29 - 36
Oil strainer bracket	16 - 21	1.6 - 2.1	12 - 15
Flywheel	98 - 108	10 - 11	72 - 80
Rear oil seal retainer	6 - 7	0.6 - 0.7	4.3 - 5.1
Connecting rod	44 - 54	4.5 - 5.5	33 - 40
Main bearing cap	90 - 100	9.2 - 10.2	67 - 74
Water drain connector	34 - 44	3.5 - 4.5	25 - 33
Water drain plug	22 - 27	2.2 - 2.8	16 - 20
Spark plug	20 - 29	2.0 - 3.0	14 - 22

Turbocharger related parts

	N·m	kg-m	ft-lb
Oil feed tube	15 - 20	1.5 - 2.0	11 - 14
Oil return tube	10 - 12	1.0 - 1.2	7 - 9
Turbocharger unit	44 - 54	4.5 - 5.5	33 - 40

SPECIAL SERVICE TOOLS

Tool number	Tool name	
ST0501S000 ① ST05011000 ② ST05012000	Engine stand assembly Engine stand Base	
① KV10106500 ② KV10110000	Engine attachment Sub attachment	
KV10110600	Valve spring compressor	
KV10107501	Valve oil seal drift	
ST10120000	Cylinder head bolt wrench	

SPECIAL SERVICE TOOLS

Tool number	Tool name
KV10110300	Piston pin press stand assembly
① KV10110310	Cap
② KV10110330	Spacer
③ ST13030020	Press stand
④ ST13030030	Spring
⑤ KV10110340	Drift
⑥ KV10110320	Center shaft