

GROUP 21 ENGINE ASSEMBLY

Description

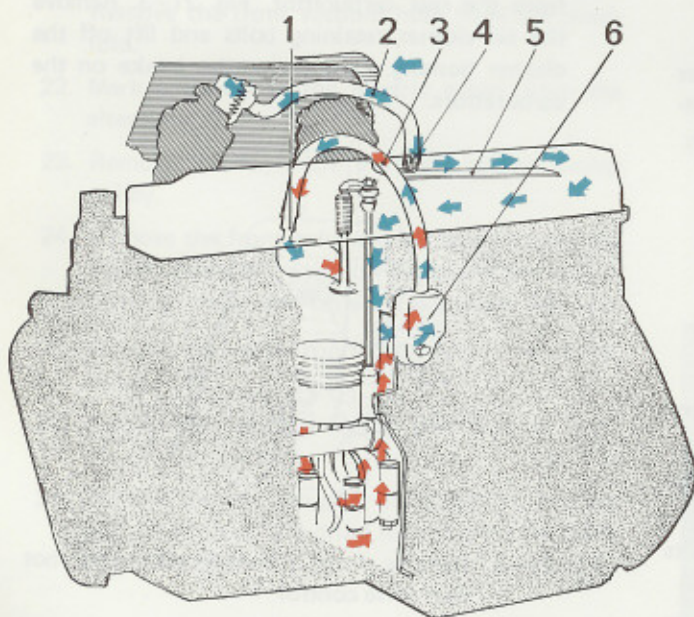
The cylinder head is bolted to the top of the block with head bolts. All combustion chambers are fully machined and have separate intake and exhaust ports, one for each valve. The cooling jackets are so designed that even the areas next to the spark plugs are cooled. The coolant otherwise is distributed to the warmest parts by piping.

The cylinder block is made of special cast iron and is cast in one piece. The cylinder liners, which are surrounded by cooling jackets, are machined directly in the block. The oilways in the block are arranged so that the oil cooler is directly connected to the right-hand side of the block and the oil filter, which is of the full-flow type, is directly connected to the oil cooler.

The pistons are made of light alloy and have two compression rings and one oil scraper ring. The upper compression ring is chromed, and this reduces the wear on the cylinders. The gudgeon pin has a floating fit in piston and connecting rod. The movement of the pin axially is limited by circlips in the gudgeon pin hole.

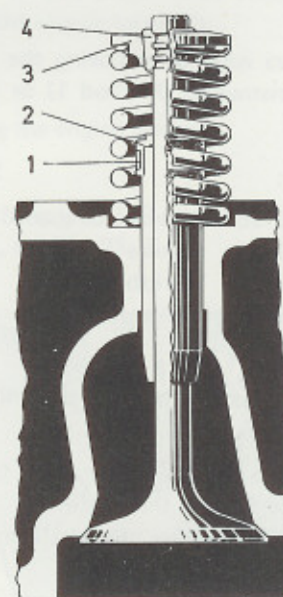
The engine has so-called "positive crankcase ventilation", that is, it is vented in an enclosed system. This is in order to prevent crankcase gases being released into the atmosphere and to prevent gas forming in the engine compartment. Fresh air is supplied via the air filters on the carburettors, and from there through a hose (2, Fig. 21-1) to the rocker arm casing. Fresh air is sucked through a metal filter (flame arrester, 4), is distributed by a plate (5) and mixed with the crankcase gases. The crankcase gases are sucked through an oil trap (6), through a hose (3) and a calibrated nipple (1) to the intake manifold. With this arrangement the exhaust gases take part in the combustion process. Residues are blown out through the exhaust pipe together with the other combustion residues.

The valves, which are fitted suspended in the cylinder head, are made of special steel and are carried in replaceable guides. The valve stems are chromed. The valve collet is provided with three lands and the valve with corresponding grooves, which hold the valve but also make suitable rotation possible, see Fig. 21-2. The valves are provided with valve guide rubber seals. Viewed in order from the front, the valves are placed: intake, exhaust, intake, exhaust, and so on.



- | | |
|------------------------------|-------------------|
| 1. Nipple | 4. Flame arrester |
| 2. Hose for fresh air supply | 5. Plate |
| 3. Hose for crankcase gases | 6. Oil trap |

Fig. 21-1. Positive crankcase ventilation



- | | |
|----------------|-----------------|
| 1. Metal ring | 3. Washer |
| 2. Rubber seal | 4. Valve collet |

Fig. 21-2. Valve collet and valve guide seal

The camshaft is made of special-alloy cast iron and has case-hardened cams. It is driven from the crankshaft through a gear train which has a ratio of 1:2. Camshaft axial location is maintained by means of a bronze axial washer located at the front end of the camshaft. Axial play is determined by a spacer ring behind the camshaft gear. The camshaft is carried in four bearings.

The valve tappets are actuated directly by the camshaft. They are located in holes in the block above the camshaft and transfer movement to the valves by means of push rods and rocker arms. There are no inspection covers for the valve tappets since these are accessible after the cylinder head has been removed.

The crankshaft is made of steel and has ground, case-hardened bearing journals. It is carried in seven main bearings, the rear flange bearing of which also functions as a pilot bearing axially. There are drilled oilways in the crankshaft for the lubricating oil.

The bearing shells, which are replaceable, consist of a steel backing with lining of indium, lead-bronze bearing metal.

The connecting rods are made of drop-forged steel and are provided with a precision-machined bushing which acts as a bearing for the gudgeon pin. The big-end bearing shells are precision-manufactured and are replaceable.

The front end of the camshaft is in the shape of a polygon. On this sits the hub (polygon hub) for the flywheel damper.

The flywheel damper is of the rubber type. The hub is jointed to the crankshaft by means of a polygon joint. The flywheel mass is journalled on the hub through a rubber suspension. The graduation for the ignition setting is marked on the flywheel damper.

Service Procedures

(Concerns the engine in the vehicle, unless otherwise indicated)

ENGINE

Removing the engine

There are two ways of removing the engine. Either remove it downwards (Method 1) or upwards (Method 2).

Special tools:

Method 1	6128	Spanner for speedometer wire
	9916	Fixture
	9809	Workshop lift
Method 2	6129	Lifting lug

1. Open the battery box and disconnect the battery earth cable.
2. **Method 1:** Remove the retaining bolts and lift off the floor cover in the platform.
Method 2: Remove the platform retaining bolts and lift off the platform.
3. Drain the coolant by disconnecting the lower radiator hose from the engine and remove the drain plug in the oil cooler.
4. Drain the engine oil.
5. Remove the inspection cover on the front engine casing.

6. Remove the upper part of the air cleaner and lift out the insert. Remove the hot-start valve control from the rear carburettor, Fig. 21-3. Remove the air cleaner retaining bolts and lift off the cleaner housing. Cover over the intake on the carburettors.

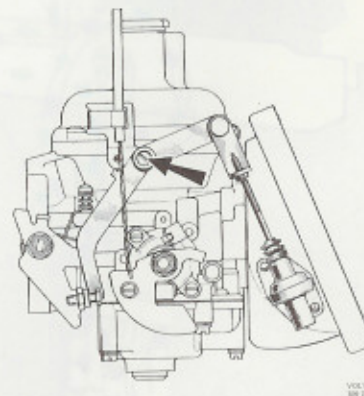


Fig. 21-3. Remove from the carburettor the hot start valve control

7. Remove the choke wire from the rear carburettor and the rear vacuum hose from the intake manifold.
8. Remove the coolant hose from the coolant pipe under the manifold.

9. Remove the hose for the oil pressure gauge from the nipple in the cylinder block.
10. Disconnect the electric cables from the temperature sender and the gearbox and distribution box.
11. Remove the vacuum hose from the vacuum box on the distribution box.
12. Remove the speedometer wire from the gearbox, using spanner 6128.
13. Remove the ignition cable and electric cable to the ignition distributor from the ignition coil.
14. Remove the ventilation hoses (3) from the clutch casing, gearbox and distribution box.
15. Remove the shift controls from the gearbox.
16. Remove the clutch wire from the throw-out clutch lever and from the clutch casing.
17. Disconnect the electric cables from the starter motor.
18. Remove the fuel hose from the fuel pump.
19. Pull loose the lock clip for the parking brake wire sleeve, front end. Remove the lock nut and the adjuster sleeve. Remove the rubber bellows and the wire through the body attachment.
20. Remove lock clip and disconnect link rods of carburettors from throttle control shaft. Remove shaft's lock clip and then the shaft from the manifold bracket. Hang up the shaft.
21. Remove the upper radiator hose from the engine. Remove the front vacuum hose from the manifold.
22. Mark and remove the electric cables from the alternator.
23. Remove the fan shaft from the coolant pump pulley.
24. Remove the front exhaust pipe section from the manifold flange, the silencer flange and the attachment on the clutch casing. Take down the pipe.
25. Remove the earth connection from the clutch casing.
26. Remove the front propeller shaft section from the distribution box.
27. Remove the rear propeller shaft section. Fit two nuts which hold the drum for the propeller shaft brake in position.

28. Removing the engine downwards

Method 1

- a. Remove the reinforcing bracket between the engine and clutch casing. Take care not to deform the sealing plate.
- b. Place engine fixture 9916 on workshop lift 9809. Run the jack in under the engine, jack up and screw tight the fixture, see Fig. 21-4.

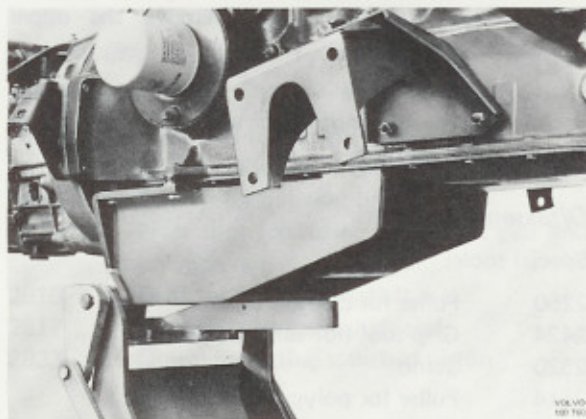


Fig. 21-4. Fixing the engine in fixture 9916

- c. Remove the engine mounts (4) from the frame members.
- d. Lower the engine.
- e. Jack up and place stands under the vehicle. Pull the engine forwards.

29. Removing the engine upwards

Method 2

- a. Fit lifting lug 6129 on the rear cylinder head bolts, see Fig. 21-5.

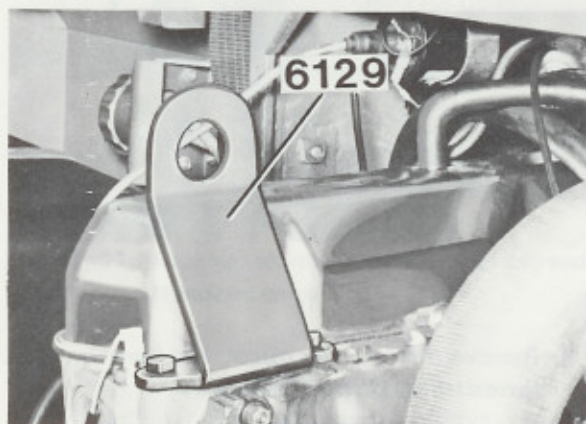


Fig. 21-5. Attaching the lifting lug 6129

- b. Run the engine jack in under the engine. Swing in hoist over the engine and secure its lifting hook to the lifting lug 6129.
- c. Remove the lower retaining bolts (in the frame members) for the rear engine mounts.
- d. Raise the engine jack so as to off-load the front engine mounts. Remove the retaining bolts in the frame members (4 per side) for the engine mounts.
- e. Lower the engine jack so as to off-load the rear engine mounts. Remove the upper retaining bolts.
- f. Lift out the engine. Take care that the engine does not knock against brake pipes or the fuel pipe.

Disassembling

Special tools:

2250	Puller for camshaft gear
2424	Grip tool (for valve tappets)
2520	Stand
2814	Puller for polygon hub
2820	Fixture
2822	Puller for crankshaft gear

After the engine has been lifted out of the vehicle, it should be disassembled more or less according to below. (For the instructions concerning the individual parts, see under their respective headings.)

1. Remove the oil trap, fuel pump and left engine mount. Mount the engine on stand 2520 with fixture 2820, Fig. 21-6.

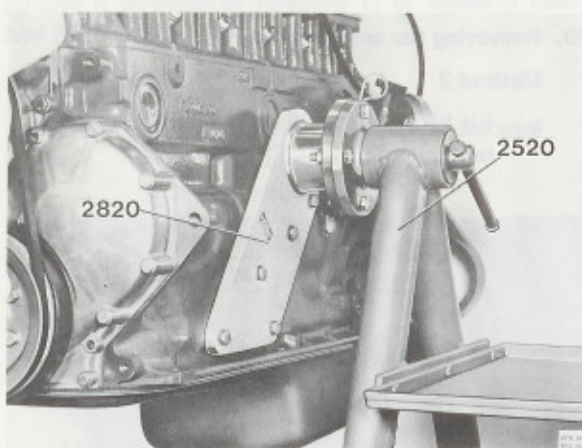


Fig. 21-6. Engine on stand

2. Remove the starter motor and gearbox and thereafter the clutch and flywheel.
3. Remove fixture 9916 (reinforcing bracket) from the engine.

4. Remove the alternator, coolant pump, distributor, rocker arm casing, rocker arm mechanism, push rods, oil filter and oil cooler. Remove the manifold and carburetors. Remove the cylinder head. Remove the valve tappets with tool 2424, Fig. 21-7.

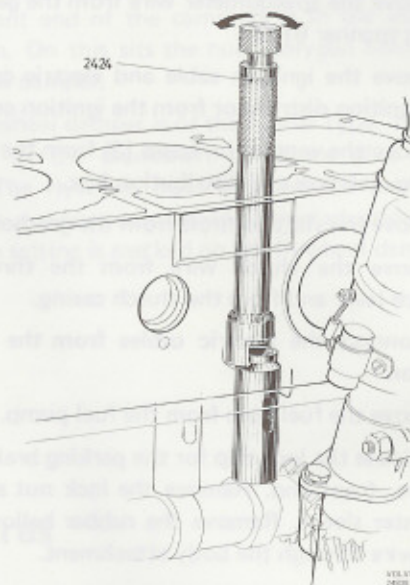


Fig. 21-7. Lifting out valve tappets

5. Remove the crankshaft pulley and vibration damper.
6. Remove the centre bolt and pull off the polygon hub with puller 2814, Fig. 21-8. (First test to see whether the polygon hub can be pulled off by hand.)

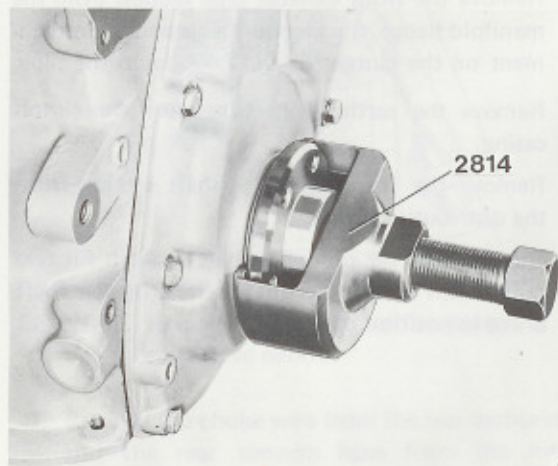


Fig. 21-8. Removing the polygon hub

7. Remove the timing gear casing.
8. Remove the camshaft nut and pull off the gear with puller 2250, Fig. 21-9.

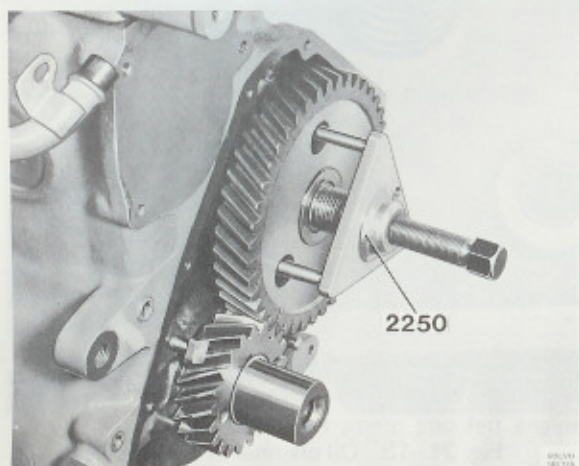


Fig. 21-9. Removing the camshaft gear

9. Pull off the crankshaft gear with puller 2822, Fig. 21-10.

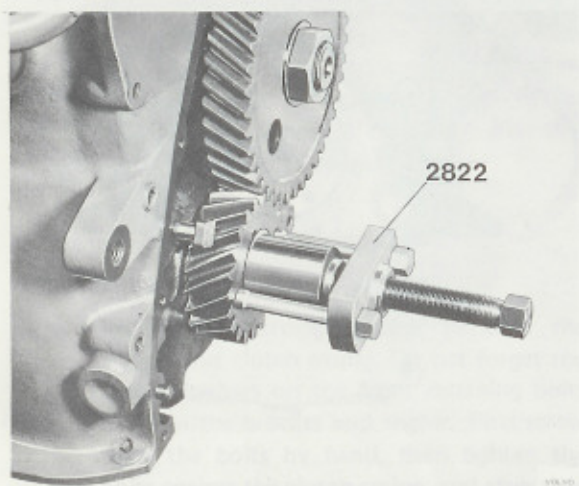


Fig. 21-10. Removing the crankshaft gear

10. Remove the camshaft and oil nozzle.
11. Remove the carbon border on the cylinder liners.
12. Turn over the engine so that the underside is up.
13. Remove the oil sump, rear sealing flange, oil pump and pistons with connecting rods. Put back the caps correctly on their respective rods.
14. Remove the crankshaft. Place the caps properly in their respective positions.

Cleaning

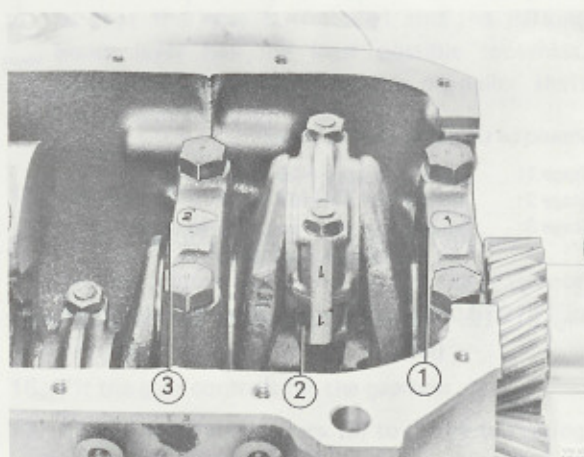
After disassembling the parts, wash them thoroughly. Parts made of steel or cast iron can be washed in a degreasing tank with a caustic soda solution. Light-alloy parts can, however, be damaged by caustic soda so that they should preferably be cleaned in white spirit. Rinse the parts with warm water and blow them dry with compressed air after washing. Clean the oilways with particular thoroughness. All sealing plugs at the oilway openings in the cylinder block must be removed during the cleaning process.

Assembling

Special tools:

2408	Press tool for fitting camshaft gear
2424	Grip tools for valve tappets
2435	Dowels for cylinder head
2815	Press tool for fitting crankshaft gear and polygon hub
2816	Drift for front crankshaft seal
2817	Drift for rear crankshaft seal
2823	Dowel for fitting standard piston

When assembling the engine, follow the instructions for the components concerned. Check the marking of the bearings according to Fig. 21-11. The main bearings are marked 1-7, and the big-end bearings 1-6, counting from the front.



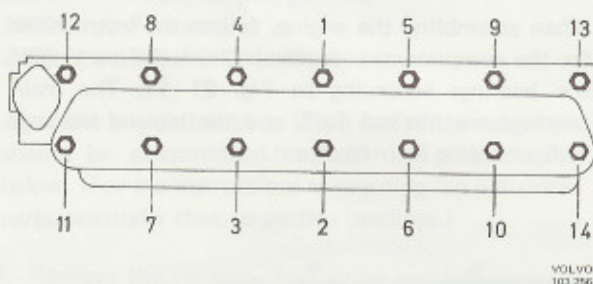
1. Main bearing No. 1
2. Big-end bearing No. 1
3. Main bearing No. 2

Fig. 21-11. Marking of main bearings and big-end bearings

Check that all parts are clean and lubricate sliding surfaces with oil before assembling. Always use new gaskets, split pins and lock washers. No adhesive should be used on the gaskets. Sealing at the ends of

both the oil pump delivery pipe and the water pumps is provided with rubber rings. These rings, which seal radially, are made of special rubber with very close tolerances. Only genuine Volvo parts should be used. Fitting is made easier by coating the rings with soapy water. Slip the rings on the pipes and then press them into their respective positions before finally tightening the attaching screws. The oil pump flange should lie flush against cylinder block before tightening.

Crankshaft seals at the front and rear ends respectively are installed according to the instructions given on pages 21:16 and 21:20. When reconditioning, replace the connecting rod, bolts and nuts with new ones. Use dowels 2435 for fitting the cylinder head. The bolts must be tightened in a certain sequence, see Fig. 21-12, in order to avoid unnecessary stresses. The bolts should be tightened in two stages and final-tightened after the engine has been run warm and allowed to cool.



Should be tightened in three stages

- Stage 1: 40 Nm (4 kpm = 29 lbftf)
- Stage 2: 80 Nm (8 kpm = 58 lbftf)
- Stage 3: engine run warm and allowed to cool
90 Nm (9 kpm = 65 lbftf)

Fig. 21-12. Tightening sequence for cylinder head bolts

Check that the oil hole (Fig. 21-13) for lubricating the rocker arms is not blocked.

The pilot bearing (5, Fig. 21-14) should be lubricated before being fitted with heat-resistant ball bearing grease. The bearing and protecting washer are held in position by a circlip (6).

Fit the flywheel and clutch and then the gearbox and starter motor.

The most important bolts and nuts should be tightened with a torque wrench, see "Tightening Torques" in the data section, page 20:6.

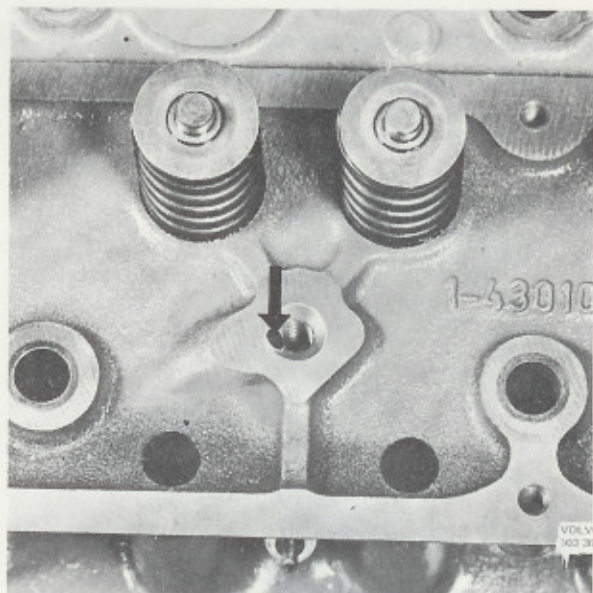
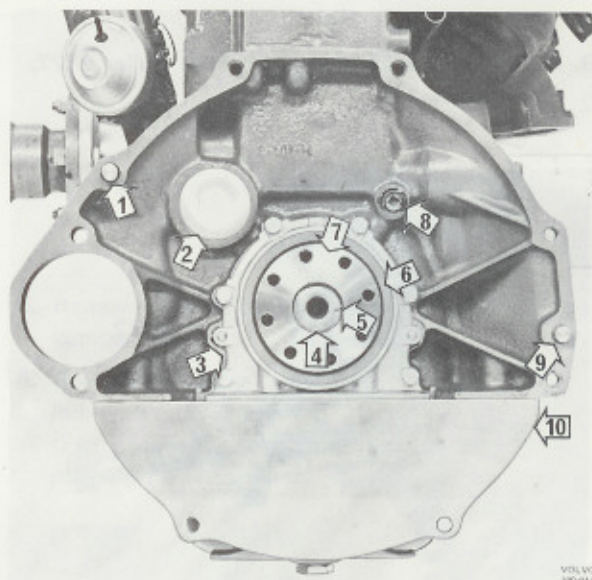


Fig. 21-13. Oil channel in cylinder head



- | | |
|-------------------|-------------------|
| 1. Dowel | 6. Sealing ring |
| 2. Sealing washer | 7. Crankshaft |
| 3. Sealing flange | 8. Plug |
| 4. Circlip | 9. Dowel |
| 5. Pilot bearing | 10. Sealing plate |

Fig. 21-14. Rear end of engine

Installing the engine

The engine can be installed in two ways. Either from underneath (Method 1) or it can be lifted into position from the top (Method 2).

Special tools:

	6128	Spanner for speedometer wire
Method 1	9916	Fixture
	9809	Workshop lift
Method 2	6129	Lifting lug

1. Installing the engine from underneath

Method 1

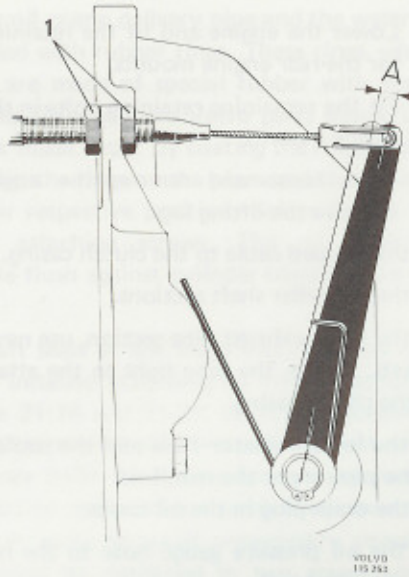
- Remove the engine from fixture 2820 and place it in engine fixture 9916, Fig. 21-4. Fit the oil trap, fuel pump and left engine mount.
- Run the engine into position under the vehicle. Lower the vehicle and make sure that the engine does not catch on anything.
- Raise the engine and screw tight the engine mounts (4).
- Remove fixture 9916 from the engine.
- Fit the reinforcing bracket between the engine and clutch casing. Do not forget the spacer washers on the front retaining bolts between the bracket and engine. First screw the bolts tight by hand, then tighten the bolts against the clutch casing and after that the bolts against the engine.

2. Installing the engine from above

Method 2

- Fit the reinforcing bracket between the engine and clutch casing. Do not forget the spacer washers on the front retaining bolts between the bracket and engine. First screw tight the bolts by hand, then tighten the bolts against the clutch casing, and after that the bolts against the engine.
- Fit lifting lug 6129 on the rear cylinder head bolts.
- Secure the engine lift to the lifting lug and remove the engine from fixture 2820.
- Fit the oil trap, fuel pump and left engine mount.
- Lift the engine into position taking care to make sure that the brake pipes and fuel pipe do not get jammed.
- Fit the upper front retaining bolts to the front engine mounts.

- Lower the engine and fit the retaining bolts for the rear engine mounts.
 - Fit the remaining retaining bolts in the front engine mounts.
 - Hook loose and remove the engine lift. Remove the lifting lug.
- Fit the braided cable to the clutch casing.
 - Fit the propeller shaft sections.
 - Fit the front exhaust pipe section, use new flange gaskets. Clamp the pipe tight to the attachment on the clutch casing.
 - Fit the lower radiator hose and the coolant hose to the pipe under the manifold. Fit the drain plug in the oil cooler.
 - Fit the oil pressure gauge hose to the nipple in the cylinder block.
 - Fit the fan shaft to the coolant pump pulley.
 - Connect the electric cables to the alternator.
 - Fit the throttle control shaft to the manifold bracket. Fit the lock clip. Fit the link rods to the shaft. Fit the shaft lock clip.
 - Fit the upper radiator hose and connect the front vacuum hose to the manifold.
 - Insert the wire for the parking brake through the body attachment. Fit the rubber bellows and the sleeve lock clips. Fit the adjuster nut and adjust so that the wire is stretched and the parking brake lever has the least possible looseness. Concerning adjustment of the propeller shaft brake, see Part 5. Fit the lock nut.
 - Fit the fuel hose to the fuel pump.
 - Fit the electric cables to the starter motor.
 - Fit the clutch wire and adjust the clearance, which should be 4-5 mm (0.016-0.020"), Fig. 21-15.
 - Fit the gear controls for the gearbox.
 - Fit the ventilation hoses (3) to the clutch casing, gearbox and distribution gear.
 - Fit the ignition cable and electric cable to the ignition coil and the electric cable to the temperature sender.
 - Fit the speedometer wire to the gearbox, using spanner 6128 tightening.
 - Fit the electric cables to the gearbox and the distribution gear.
 - Fit the vacuum hose to the distribution gear vacuum box.
 - Connect the rear vacuum hose to the manifold.



A = 4–5 mm (0.16–0.20")

1. Adjuster nut

Fig. 21–15. Throw-out lever travel

23. Fit the air cleaner housing. Fit the hot start valve control to the rear carburettor. At idle position, the valve control should be against the throttle control lever. Fit the air cleaner insert and put on the upper part of the air cleaner.
 24. Fit the choke wire to the rear carburettor.
 25. Fill with coolant through the opening in the radiator, the heater control should be at max. heat. Fill the radiator fully and put on the cap. Also fill the expansion tank to the MAX mark.
 26. Fill with engine oil.
 27. Connect the battery earth cable and close the battery box.
 28. Start the engine and carry out a function check.
 29. Fit the inspection cover on the front engine casing.
 30. **Method 1:** Fit the roof cover in the platform.
Method 2: Fit the platform.
3. Drain the coolant by opening the drain cock on the lower radiator pipe.
 4. Remove the inspection cover on the front engine casing and the floor cover in the platform.
 5. Remove the upper radiator hose from the engine.
 6. Remove the fuel hose from the distribution pipe at the carburettors and from the clamp at the thermostat housing. Bend the hose to the one side.

Remove the vacuum hose from the front carburettor and the hoses for the crankcase ventilation from the manifold and air cleaner.
 7. Remove the alternator tensioning bar from the cylinder head.
 8. Remove the clasps and take off the upper part of the air cleaner housing.
 9. Disconnect the electric cable from the temperature sender and the choke wire from the rear carburettor.
 10. Remove the front exhaust pipe section from the silencers and the attachment on the clutch casing.
 11. Remove the flange nuts "manifold – cylinder head" and move the manifold to the one side.
 12. Disconnect the spark plug cables from the spark plugs.
 13. Remove the rocker arm cover and the rocker arm mechanism and push rods.
 14. Remove the cylinder head bolts and lift off the head.
 15. Remove the cylinder head gasket, the manifold gasket and the sealing rings for the coolant pump. Clean the contact surfaces.

CYLINDER HEAD

Special tools:

2435	Dowels
2898	Spanner for final-tightening cylinder head bolts

Removing

1. Open the battery lid and disconnect the battery earth cable.
2. Remove the platform.

Checking surface unevenness (Grinding even)

Deviations in the cylinder head surface unevenness may amount to max. 0.05 mm (0.002") per 100 mm (4") length. Check the surface evenness with a surface gauge. If the cover has to be ground smooth, grind off as little as possible.

Fitting the cylinder head

1. Check to make sure that the sealing surfaces on the cylinder block and head are clean, even and undamaged, also that the oil channel in the cylinder head (Fig. 21–16) for the rocker arm mechanism is clean.

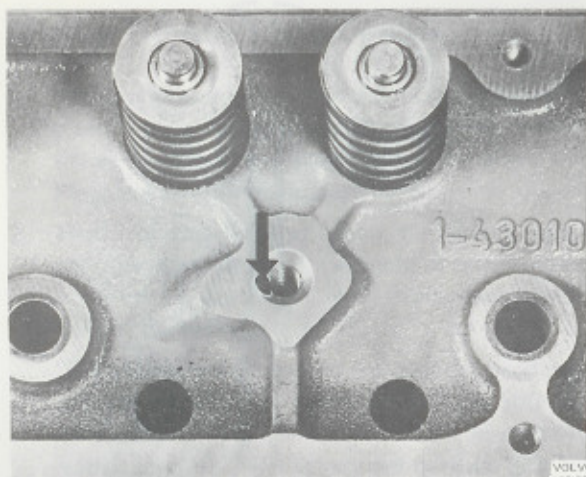


Fig. 21-16. Oil channel in cylinder head

2. Place the cylinder head gasket with TOP facing upwards (wide edge facing upwards) on the cylinder block.
Fit the coolant pump sealing rings.
Screw dowels 2435 into the cylinder block, one at the rear left and one at the front right screw hole.
3. Fit the cylinder head and the retaining bolts. Tighten in the sequence shown in Fig. 21-17 and in two stages: 1-40 Nm (4 kpm = 29 lbftf), stage 2-80 Nm (8 kpm = 57 lbftf).

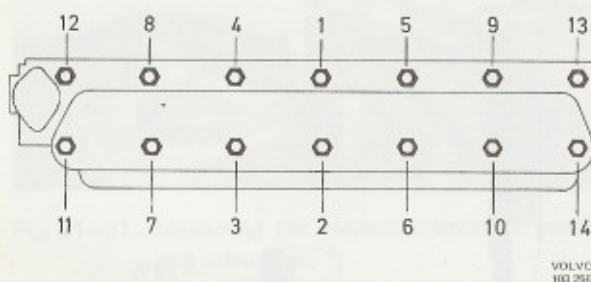


Fig. 21-17. Tightening sequence for cylinder head bolts

4. Fit the push rods in position and mount the rocker arm mechanism.
5. Adjust the valve clearance to 0.45-0.50 mm (0.018-0.020"). NOTE! These values are not the final ones.
6. Fit the rocker arm cover.
7. Connect the spark plug cables to the spark plugs.

8. Fit the new manifold gasket to the cylinder head and lift the manifold into position.
Fit the washers and flange nuts.
9. Fit the front exhaust pipe section to the silencer and to the attachment on the clutch casing.
10. Fit the electric cable to the temperature sender and choke wire to the rear carburettor.
11. Fit the air cleaner housing upper part.
12. Fit the alternator tensioning bar and adjust the belt tension.
13. Fit the fuel hose to the clamp at the thermostat housing and the branch pipe at the carburettors.
Fit the vacuum hose to the front carburettor and the hoses for the crankcase ventilation to the manifold and air cleaner.
14. Fit the radiator hose.
15. Close the drain cock on the lower radiator pipe.
16. Fill with coolant through the radiator opening, the heater control should be at MAX heat. Fill the radiator fully and fit the cap. Also fill the expansion tank to the MAX mark.
17. Connect the battery earth cable to the battery and close the battery box.
18. Start the engine and carry out a function check. Run the engine for about 10 minutes (preferably under load).
19. Remove the rocker arm cover.
20. Check-tighten the cylinder head bolts, after the engine has cooled, in correct sequence to 90 Nm (9 kpm = 65 lbftf). Use spanner 2898 for this purpose, see Fig. 21-18.

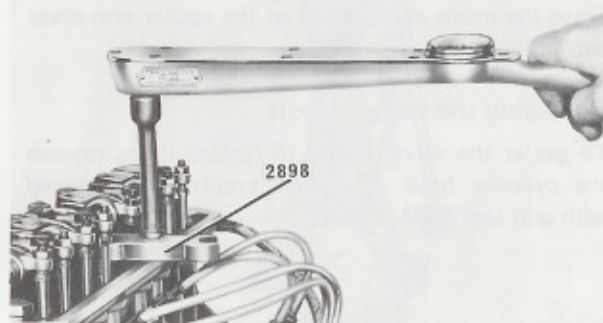


Fig. 21-18. Check-tightening cylinder head bolts

21. Check and if necessary adjust the valve clearance to 0.40-0.45 mm (0.016-0.018").
22. Fit the rocker arm cover.
23. Fit the inspection cover on the front engine casing.
24. Fit the platform.

VALVE MECHANISM

Special tools:

1867	Drift
2425	Grip tool
2818	Drift
2819	Drift

Adjusting the valve clearance

It is an advantage to adjust the valve clearance with the engine switched off, either cold or hot. The clearance is the same for both inlet and exhaust valves (0.40–0.45 mm = 0.016–0.018"). When adjusting, use two feeler gauges, one "Go" 0.40 mm (0.016") thick and the other "No-Go" 0.45 mm (0.018") thick.

The clearance is adjusted so that the thinnest gauge can be inserted easily while the thicker one must not enter.

Remove the rocker arm cover. Turn over the crankshaft until No. 1 is at firing position. The rocker arms for No. 6 "rock". The marking on the pulley is at 0. Adjust the valve clearance for No. 1.

Turn over the crankshaft until No. 2 rocker arms "rock" -adjust the clearance for No. 5.

When No. 4 rocker arms "rock" - adjust No. 3 clearance.

When No. 1 rocker arms "rock" - adjust No. 6 clearance.

When No. 5 rocker arms "rock" - adjust No. 2 clearance.

When No. 3 rocker arms "rock" - adjust No. 4 clearance.

Clean the inside and outside of the rocker arm cover and fit it.

Replacing the valve tappets

To get at the valve tappets to replace them, remove the cylinder head. The valve tappets are removed with grip tool 2424, Fig. 21-19.

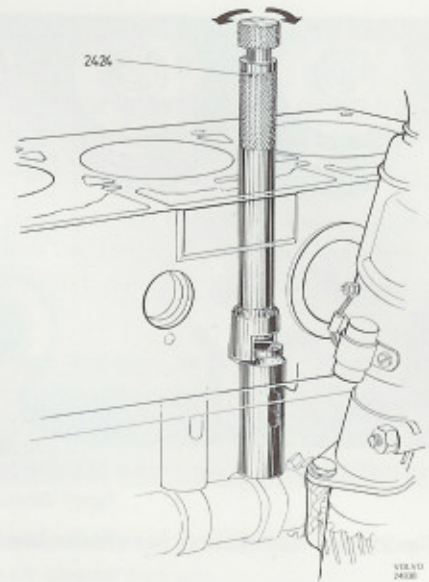
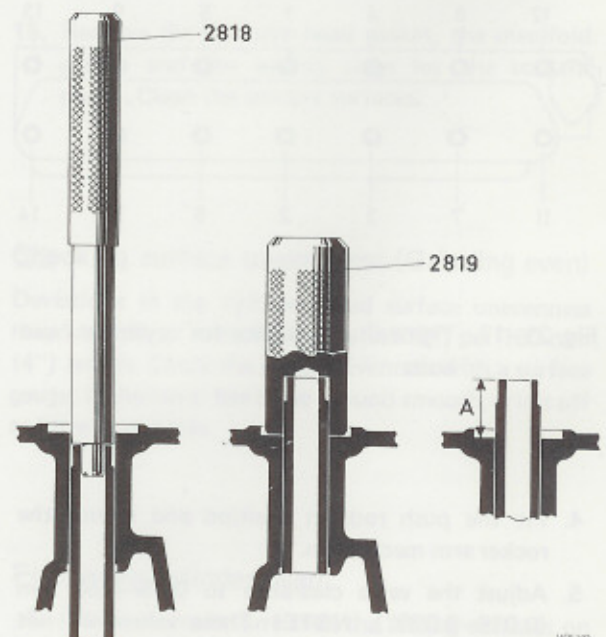


Fig. 21-19. Removing and installing valve tappets

Replacing the valve guides

1. Press out the old guides with drift 2818.
2. Press in the new guides with drift 2819, which gives the correct pressing-in depth, Fig. 21-20.
3. Check that the guides are free from burr and that the valves move easily in them.



A = 17.5 mm (0.69")

Fig. 21-20. Replacing valve guides

Grinding the valves and valve seats

1. Remove the valve springs by first compressing them with valve spring pliers and then remove the valve collets after which release the pliers. Place the valves in order on a rack.
2. With rotating brushes clean the valves, combustion chambers and channels of carbon and combustion deposits. Check the surface condition of the cylinder head.

The surface unevenness of the cylinder head may amount to max. 0.05 mm (0.0020") per 100 mm (4") length. The surface condition is checked with a level disc. If the cylinder head surface has to be machined level, remove as little material as possible.

3. Measure the clearance between the stem and guide, Fig. 21-21. With a new valve the clearance should not exceed 0.15 mm (0.0060") Also check to make sure the valves are not excessively worn. Wear on the valve stems may amount to max. 0.02 mm (0.0008").

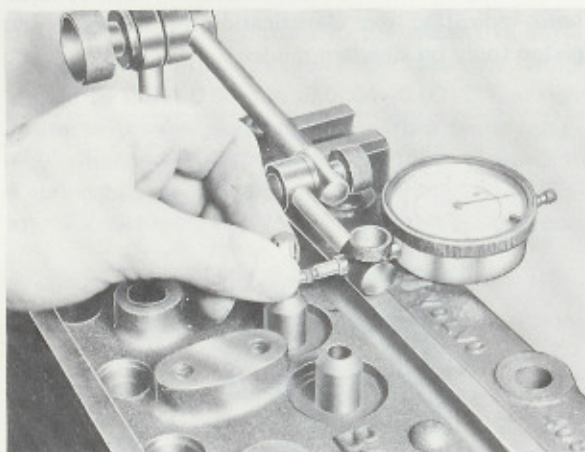
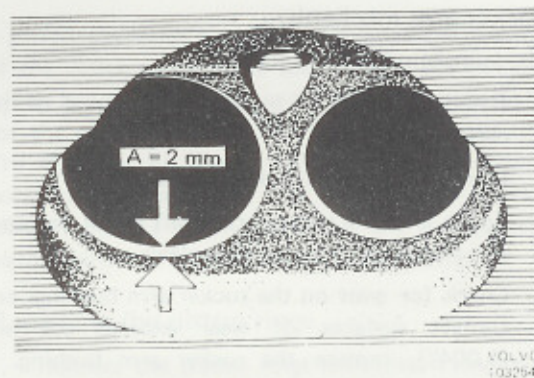


Fig. 21-21. Measuring the clearance between guide and valve stem

4. Grind the valves in a valve grinding machine after cleaning them. The valve seat angle should be 44.5° . Replace valves if excessively worn.
5. Grind the valve seats in the cylinder head. Use an electrically driven grinder or a hand milling cutter. A pilot spindle must be carefully fitted before work is started and any worn guides must be replaced by new ones. The seat should be ground until a good sealing surface is obtained. The angle is 45.25° and the width of the sealing surfaces approx. 2 mm (0.08"), see "A", Fig. 21-22.



A = 2 mm (0.08")

Fig. 21-22. Valve seat width

If the sealing surface is too wide after grinding, it can be reduced by using a 70° grinding stone from the inside and a 20° grinding stone from the outside.

6. Check the sealing with marking colour and if necessary grind the valves with fine grinding paste.
7. Check the valve springs with a spring tester, Fig. 21-23. If the springs are not according to the values given in the data for springs, see page 20:3, they should be scrapped.

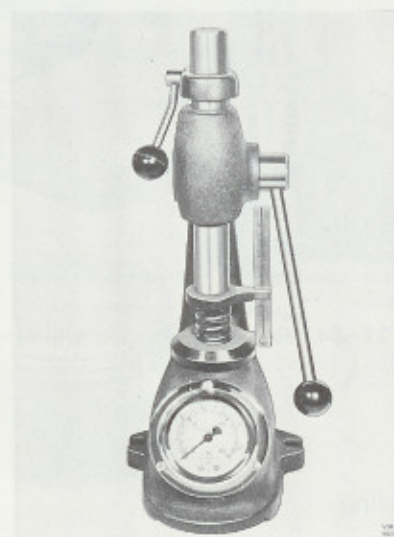


Fig. 21-23. Testing a valve spring

8. Oil the valve stems and place the valves in their guides. Fit the valve guide seals, valve springs, washers and locks.

Rocker arm mechanism

Disassembling and checking

1. Remove the lock rings on both ends of the rocker arm shaft.
2. Dismantle the rocker arm mechanism.
3. Check that the rocker arm shaft is not damaged and that the oil channels are clean.
4. Check for wear on the rocker arm bushings and contact surfaces. If wear exceeds 0.1 mm (0.004"), replace the rocker arm bushing. If necessary grind the thrust area against the valve in a special grinding machine.
5. If the bushings are to be replaced, use drift 1867 for pressing them out and in, Fig. 21-24. Then ream the bushing with a suitable reamer to an accurate fit on the shaft. The hole in the bushing should be opposite the hole in the rocker arm.

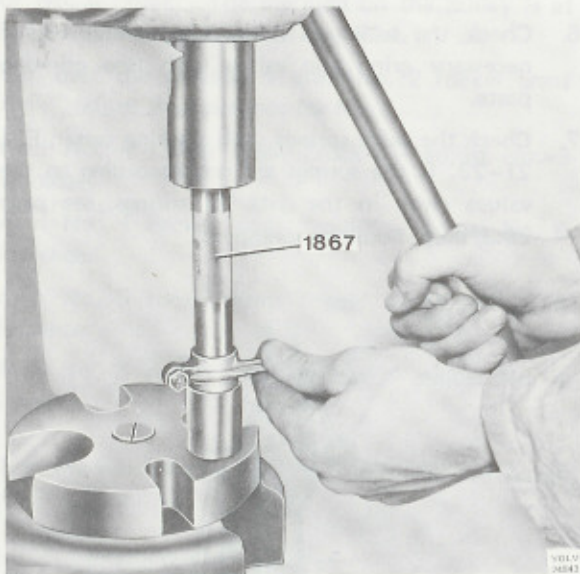


Fig. 21-24. Replacing a rocker arm bushing

Assembling

1. Before assembling the rocker arm mechanism clean all parts thoroughly and check them.
2. Assemble the bearing brackets, springs, rocker arms and shaft according to Fig. 21-25. Lock the parts with new lock rings. Note that the rocker arms are of two types, left and right.

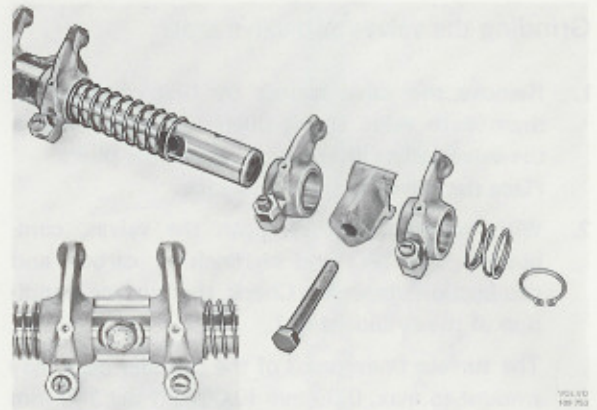


Fig. 21-25. Rocker arm mechanism

CYLINDER BLOCK

Measuring the cylinder bores

The cylinder bores are measured with a special dial indicator, Fig. 21-26.

The measuring should be carried out just below the top edge of the bore only in the transverse direction of the engine. A letter is stamped on each cylinder bore indicating the classification of the bore and piston (only on standard models).

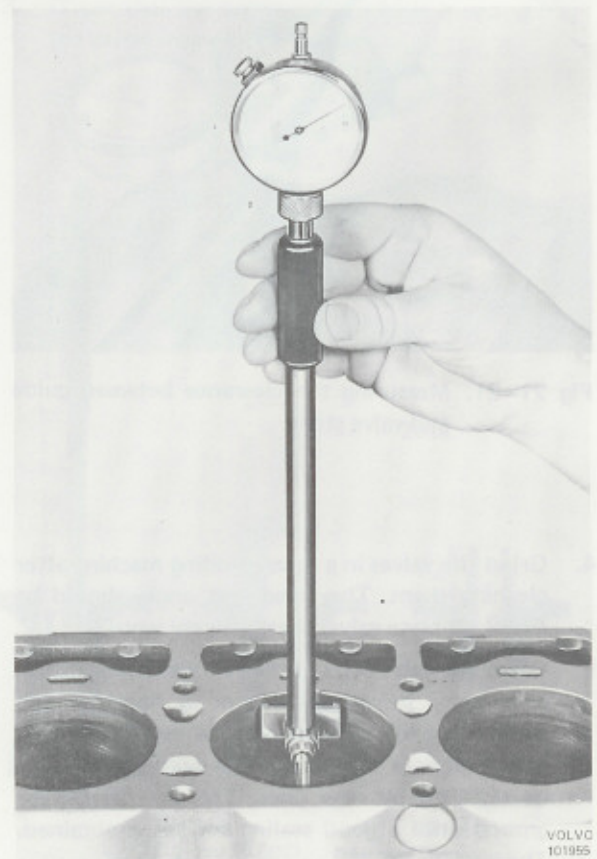


Fig. 21-26. Measuring a cylinder bore

PISTONS AND CONNECTING RODS

Special tools:

5017	Drift
2873	Installation ring

Removing

1. Remove the cylinder head. See under "Removing the cylinder head", page 21-8.
2. Drain the engine oil.
3. Remove the reinforcing bracket between the cylinder block and the clutch casing. Remove the oil sump.
4. Remove the big-end bearing caps and move up the pistons and connecting rods through the cylinder bores. Put back the caps properly on their respective connecting rods. Hang up the pistons and connecting rods on a special rack or place them on a clean, soft base.

Measuring the pistons and piston fit

Measure the piston diameter with a micrometer, at right angles to the gudgeon pin hole and 7 mm (0.28") from the lower edge.

Test the fit of the pistons in the respective bores, without piston rings. Measure the clearance, which should be 0.01-0.03 mm (0.0004-0.0012"), at right angles to the gudgeon pin hole with a feeler gauge, 1/2" wide and 0.02 mm (0.0008") thick, attached to a spring balance. The pulling force should be 10 N (1 kp = 2.2 lbf.), see Fig. 21-27. With this pulling force



Fig. 21-27. Measuring the piston clearance

a piston clearance is obtained equal to the thickness of the feeler gauge blade used. The blade thickness which is equally as thick as the indicated outer values for the piston clearance can, therefore, also be used. Try this out at several different depths. Cylinder bores of standard bore size have a letter marking which indicates the measurement and the respective piston should be marked with the same letter.

Replacing the piston rings

1. Remove the piston rings with piston ring pliers.
2. Clean the pistons, taking particular care with the piston ring grooves.
3. Fit the piston rings, one after the other, down into the cylinder bore. Use an inverted piston to ensure that the rings are fitted properly.
4. Measure the ring gap with a feeler gauge. The gap should be 0.40-0.55 mm (0.016-0.022"). If necessary, the gap can be increased with the help of a special file.

NOTE! When checking the fit in a worn cylinder bore, the rings must be checked at the bottom dead centre position where the diameter of the bore is smallest.

5. Check the piston rings in the respective ring grooves by rolling them in the groove. Also measure the clearance at several points, Fig. 21-28. This clearance should be 0.040-0.072 mm (0.0016-0.0028") for both compression rings and the oil scraper ring.

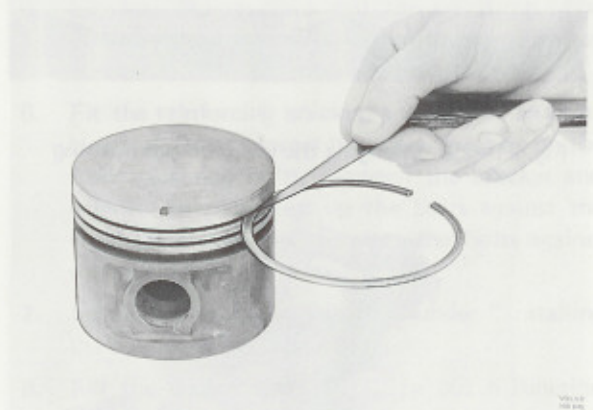


Fig. 21-28. Measuring the piston ring clearance in groove

6. Fit the piston rings with piston ring pliers. The chromed compression ring should be at the top. Turn the rings so that their gaps are apart from each other.

Replacing the gudgeon pins and gudgeon pin bushings

1. Remove the piston rings with piston ring pliers.
2. Remove the circlips and pull out the gudgeon pin.
3. Check the gudgeon pin hole in the piston. If the gudgeon pin hole in the piston is worn so that the oversize (+0.05 mm = 0.002") is required, first ream up the hole to the correct measurement. Use a reamer fitted with pilot guide and take only small cuts at a time.
The fit is correct when the gudgeon pin can be pushed through the hole by hand with light resistance.
4. If the gudgeon pin bushing is too worn, press it out with drift 5017, Fig. 21-29. A new bushing is pressed in with the same tool, the other end of which is now used. Make sure that the lubricating holes are opposite the holes in the connecting rods. Then ream the bushing to the correct fit.

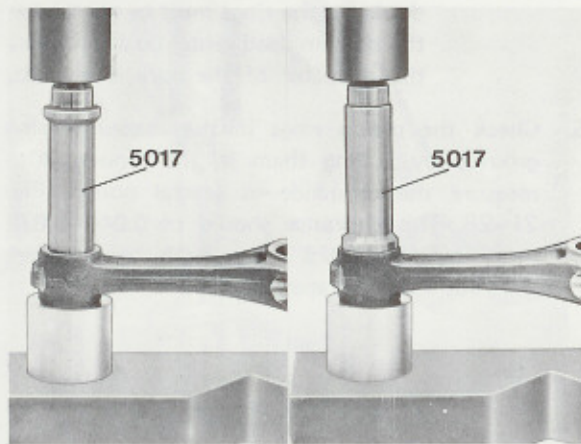


Fig. 21-29. Changing the gudgeon pin bushing



Fig. 21-30. Gudgeon pin fit

The gudgeon pin should glide through the hole under light thumb pressure but without any noticeable looseness, Fig. 21-30.

5. If necessary check the connecting rods for straightness and warp, Fig. 21-31.

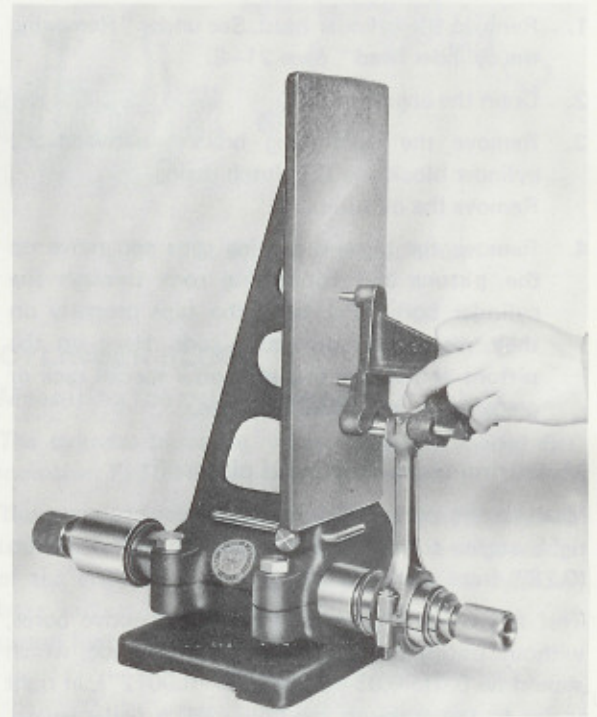


Fig. 21-31. Checking the connecting rod

6. If necessary check the connecting rods for any S-distortion. Let the transverse areas at the connecting rod big end rest against the pulled out support on the measuring apparatus. Measure the distance between the indicating plate and the transverse area at the little end of the connecting rod, and then turn the connecting rod and carry out the same measurement for the other side. The results should agree with a permitted deviation of 0.5 mm (0.020").
7. If the connecting rod is bent or twisted it can be straightened with the straightening tools which belong to the checking and straightening apparatus. The straightening must be carried out with great care.
8. Assemble the piston and connecting rod, using new circlips. NOTE! The groove on the top of the piston should point forwards and the number marking on the connecting rod should face away from the camshaft side, Figs. 21-32 and 21-33.
9. Replace the connecting rod bolts and nuts with new ones.

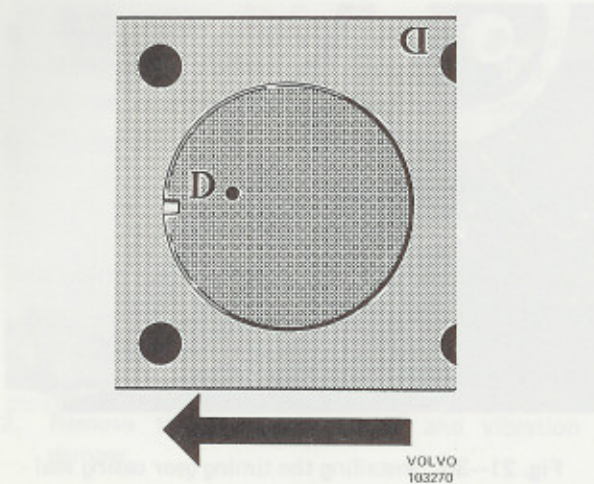
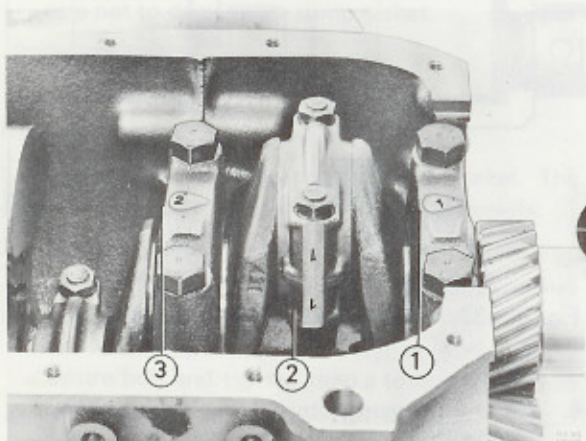


Fig. 21-32. Marking on piston and block



1. Main bearing No. 1
2. Big-end bearing No. 1
3. Main bearing No. 2

Fig. 21-33. Marking the main and big-end bearings

Installing

1. Check that pistons and connecting rods are properly located in relation to each other and to the cylinder block, Figs. 21-32 and 21-33.
2. Turn the piston rings so that their gaps are apart from each other. Oil pistons and bearing surfaces.
3. Fit the pistons with connecting rods in the cylinder bores. Use installation ring 2823, Fig. 21-34. Make sure that the number markings on the connecting rods are facing away from the camshaft side and that the groove in the gudgeon pin points forwards, Figs. 21-32 and 21-33.

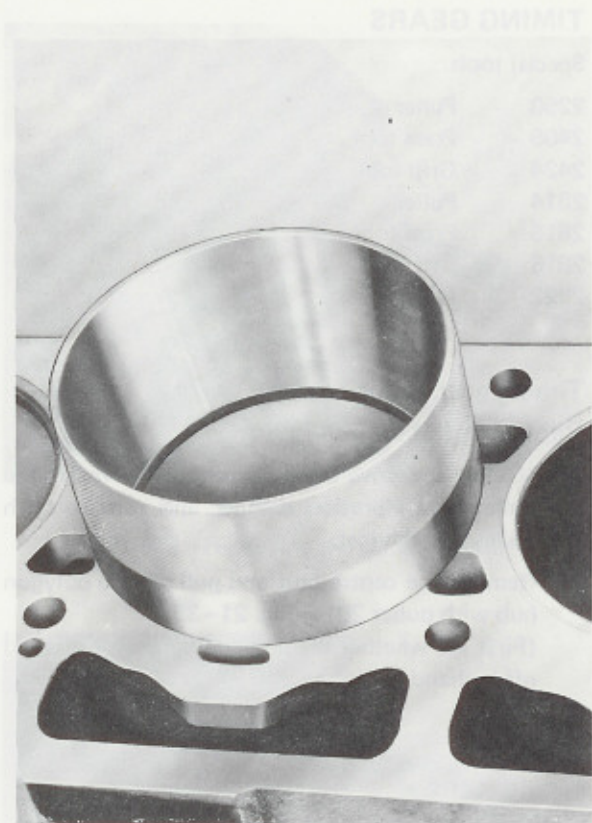


Fig. 21-34. Installing a piston

4. Fit the connecting rod caps. Fit and tighten up the connecting rod nuts to a torque of 63-70 Nm (6.3-7.0 kpm = 45-50 lbftf).
5. Fit the sealing plate and the oil sump. The "tongue" on the oil sump gasket should face towards the starter motor flange.
6. Fit the reinforcing bracket, and tighten all bolts by hand. Do not forget the spacer washers on the front retaining bolts, between the bracket and engine. Then tighten up the bolts against the flywheel casing and thereafter the bolts against the cylinder block.
7. Install the cylinder head. See under "Installing the cylinder head", page 21:8.
8. Fill the engine with oil. Carry out a function check.

CRANKCASE VENTILATION (inspection)

Remove the nipple in the intake manifold, hoses and flame arrester (metal filter) and clean them. If necessary replace the flame arrester. At the same time check the hoses and replace them if in poor condition.

TIMING GEARS

Special tools:

2250	Puller
2408	Press tool
2424	Grip tool
2814	Puller
2815	Press tool
2816	Drift
2822	Puller

Timing gear casing

Replacing the sealing ring

1. Slacken the drive belts. Remove the bolts for the pulley and vibration damper and remove both pulley and damper.
2. Remove the centre bolt and pull off the polygon hub with puller 2814, Fig. 21-35.
(First see whether the polygon hub can be pulled off by hand.)

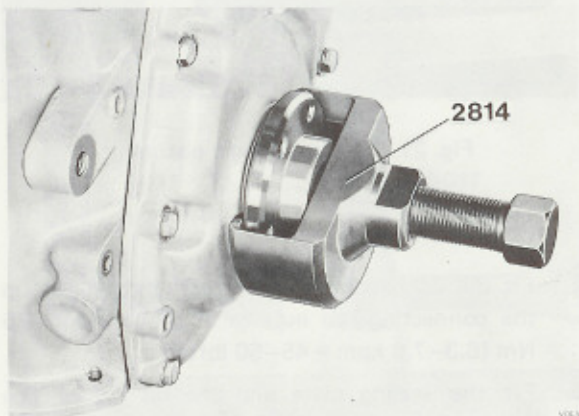


Fig. 21-35. Removing the polygon hub

3. Lever out the sealing ring. Oil the sealing lip on the new sealing ring and fit the ring with drift 2816, Fig. 21-36.

NOTE! First inspect the wear surface on the polygon hub. The sealing ring can be fitted in three positions with drift 2816. With a new polygon hub the tool centre bolt should be screwed in fully, Fig. 21-37. In this position, the sealing ring will be placed in its outer position (position 1). With a wear mark on the polygon hub place the sealing ring in position 2 (centre bolt screwed out 1 1/4 threads). With two wear marks place the sealing ring in position 3 (centre bolt screwed out fully). With three wear marks the polygon hub should be replaced with a new one.

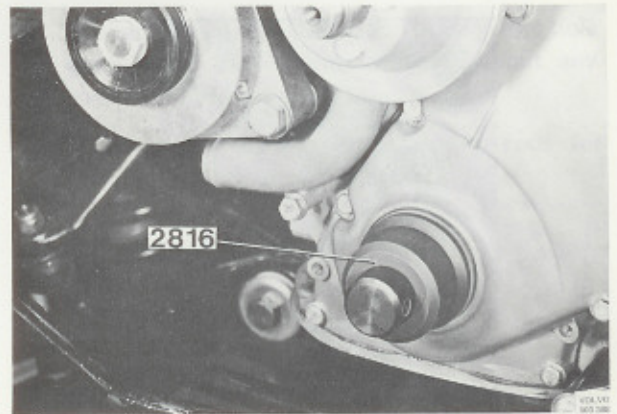


Fig. 21-36. Installing the timing gear casing seal

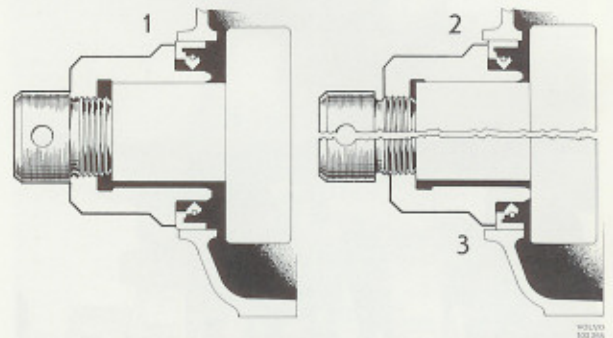


Fig. 21-37. Locations of centre bolt on tool 2816

4. Fit the polygon hub with press tool 2815, Fig. 21-38. Before fitting it, grease the slide surfaces of the hub. **Note the marking, punch pops on the end of the crankshaft and polygon hub.** Fit the centre bolt and tighten it to a torque of 95-105 Nm (9.5-10.5 kpm = 69-76 lbftf).

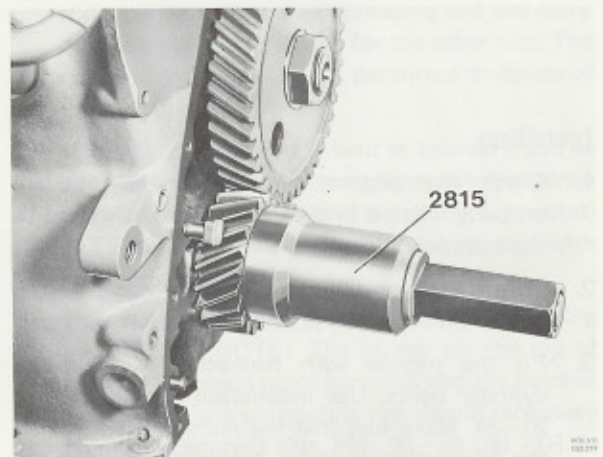


Fig. 21-38. Installing the polygon hub

5. Fit the vibration damper and pulley. The bolt holes are asymmetrically placed so that these components can only be fitted in one position.
6. Fit the drive belts and adjust the belt tension.

Removing the timing gear casing

1. Remove the fan shaft from the coolant pump pulley. Slacken the drive belts and remove the pump pulley.
2. Remove the crankshaft pulley and vibration damper.
3. Remove the centre bolt and pull off the polygon hub with puller 2814, Fig. 21-35. (But first try to see whether the polygon hub can be pulled off by hand.)
4. Remove the timing gear casing. Slacken a couple of bolts extra for the oil sump and observe due care not to damage the sump gasket.

Installing

1. Install the timing gear casing with gasket. The casing is located properly by means of dowels.
2. Fit the polygon hub with press tool 2815, Fig. 21-38. Before installing the hub, grease the hub slide surfaces. **Note the marking**, punch pops on the crankshaft end and polygon hub, fit the centre bolt and tighten it to a torque of 95-105 Nm (9.5-10.5 kpm = 69-76 lbftf).
3. Fit the vibration damper and pulley. The bolt holes are asymmetrically placed so damper and pulley can be fitted in one position.
4. Fit the coolant pump pulley and drive belts, and adjust the belt tension.
5. Install the fan shaft.

Timing gears

Replacing

1. Remove the timing gear casing. See under "Removing the timing gear casing", above.
2. Remove the camshaft nut and pull the gear off with puller 2250, Fig. 21-39.
3. Pull off the crankshaft with puller 2822, Fig. 21-40.
4. Screw out the oil nozzle, blow it clean and re-fit it according to Fig. 21-41. The gears are lubricated by oil from the nozzle.

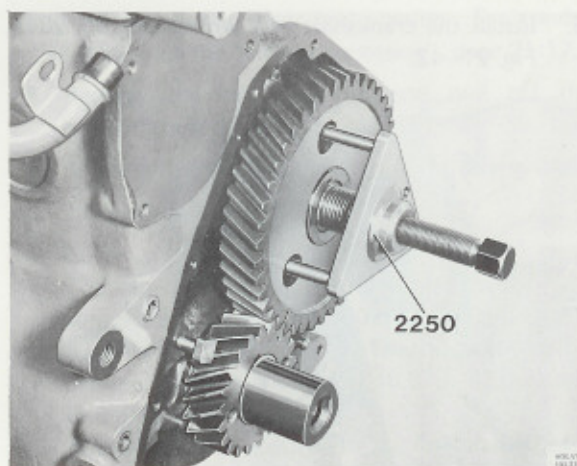


Fig. 21-39. Removing the camshaft gear

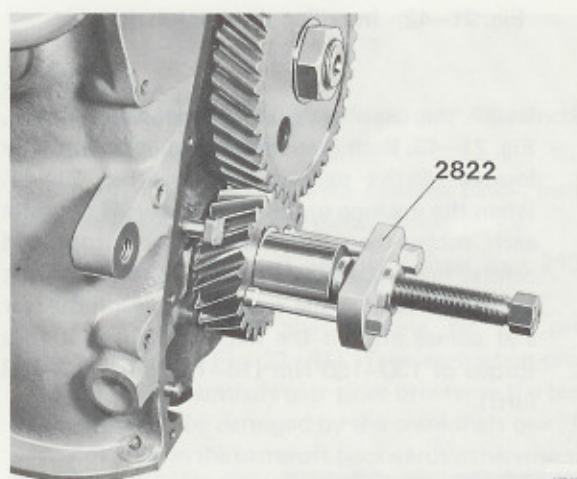
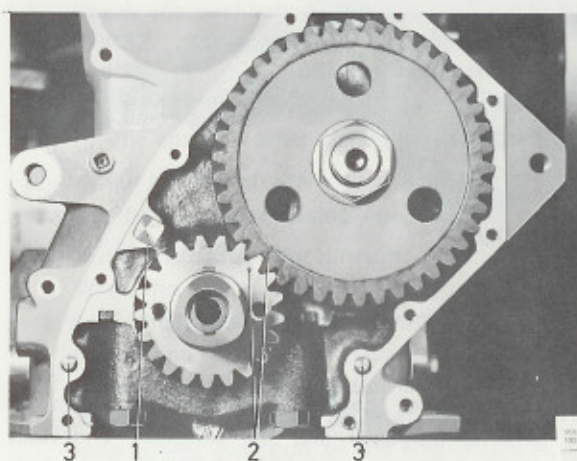


Fig. 21-40. Removing the crankshaft gear



1. Oil nozzle
2. Line-up marks
3. Dowels

Fig. 21-41. Timing gears

5. Install the crankshaft gear with press tool 2815, Fig. 21-42.

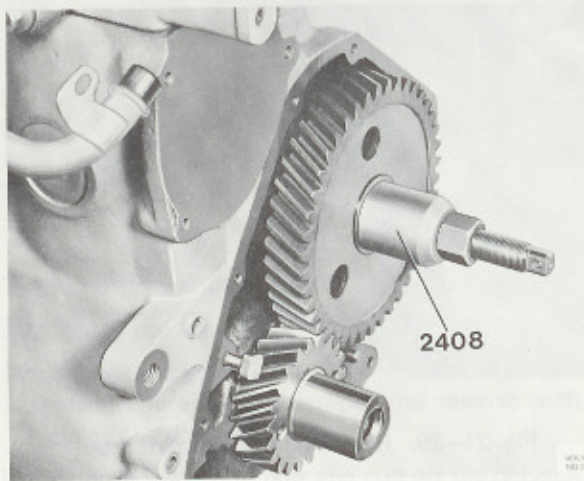


Fig. 21-42. Installing the crankshaft gear

6. Install the camshaft gear with press tool 2408, Fig. 21-43. Both gear wheels should be correctly located relative to each other, see Fig. 21-41. When the marking on the timing gears is opposite each other, then No. 6 piston is at top dead centre, firing position. Do not press the camshaft backwards so that the sealing washer on the rear end comes off. Fit the nut and tighten it to a torque of 130-150 Nm (13-15 kpm = 94-108 lbftf).

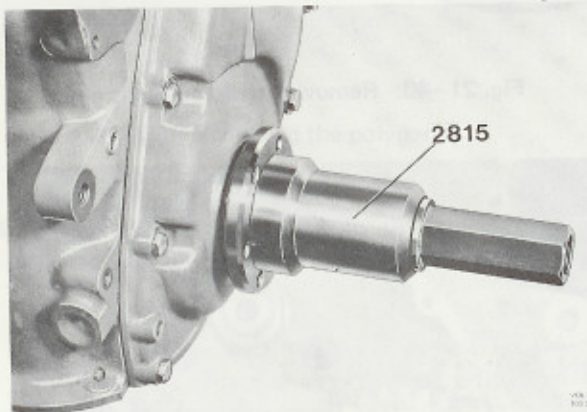


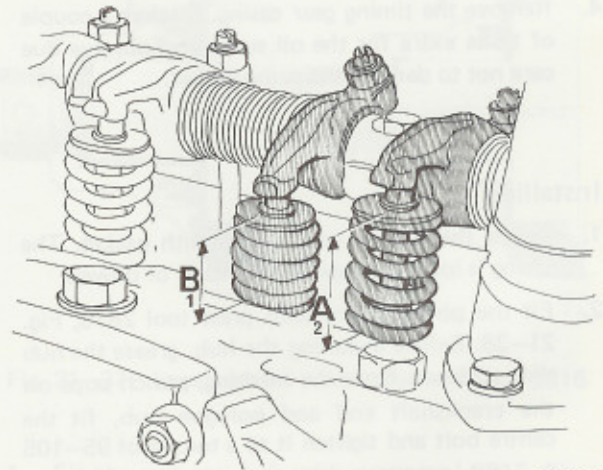
Fig. 21-43. Installing the camshaft gear

7. Check the backlash (0.04-0.08 mm = 0.0016-0.0032") and the camshaft end float (0.02-0.06 mm = 0.0008-0.0024"), which is determined by the spacer washer behind the camshaft gear.
8. Install the timing gear casing. See under "Installing the timing gear casing", page 21:17.

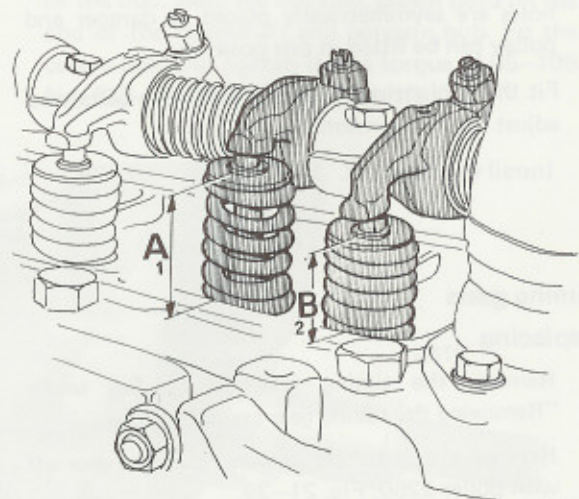
Camshaft

Checking camshaft wear, engine in vehicle

1. Remove the rocker arm casing.
2. Clean the rocker arm casing contact surface against the cylinder head.
3. Zero-set the valve clearance.
4. Turn over the engine until No. 1 cylinder intake valve is fully open and the exhaust valve fully closed.
5. With slide calipers measure the distance between the valve spring washer and the contact surface of the timing gear casing against the cylinder head for both the No. 1 cylinder intake and exhaust valves, Fig. 21-44. Note the measurements.



VOLVO
108050



VOLVO
108 049

Valve lift height:
 $A_1 - B_1$ and $A_2 - B_2$

Fig. 21-44. Checking the camshaft lift height

6. Turn over the engine so that the exhaust valve is fully open and the intake valve fully closed.
7. Measure the distance again between the valve spring washer and the contact surface of the rocker arm cover, for both the valves, Fig. 21-44. Note the measurements.
8. Calculate the lifting height of the valves deducting the measurement for the open valve from the measurement for the closed valve.
9. Measure and calculate correspondingly for the other cylinders. The difference between the maximum and minimum lifting height should not exceed 0.7 mm (0.028").
10. If necessary replace the camshaft.
11. Adjust the valve clearance, which should be 0.40-0.45 mm (0.016-0.018").
12. Install the rocker arm cover.

Removing and checking

1. Remove the cylinder head. See under "Removing the cylinder head", page 21:8.
2. Lift up the valve tappets with tool 2424, Fig. 21-45.

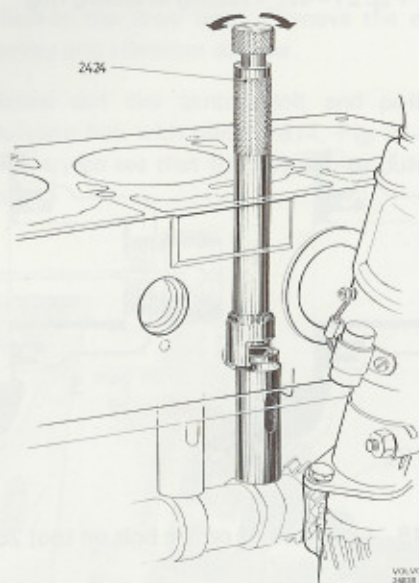


Fig. 21-45. Lifting out valve tappets

3. Remove the fuel pump.
4. Remove the ignition distributor and the distributor pinion.

5. Remove the timing gear casing. See under "Removing the timing gear casing", page 21:17.
6. Remove the camshaft nut and pull off the camshaft gear with puller 2250, Fig. 21-39.
7. Remove the thrust flange and the spacer washer.
8. Take out the camshaft.
9. Check the camshaft for straightness and wear. The out-of-round on the bearing journals may amount to 0.07 mm (0.0028"), providing that the bushings are replaced. The diameter of the bearing journals should be 46.975-47.000 mm (1.8494-1.8504"). If the indicated values are not maintained or if the cams are worn, replace the camshaft.
10. Also check that the camshaft bearings are not excessively worn. Permissible wear up to 0.02 mm (0.0008").

Installing

1. Check that the camshaft has an "A" punched onto the front end.
2. Insert the camshaft in the cylinder block. Install the spacer washer and thrust flange.
3. Install the camshaft gear with press tool 2408, Fig. 21-43. Make sure that the marking on the gears coincide (2, Fig. 21-41). Take care when pressing in the camshaft gear since otherwise the teeth can easily be damaged by the crankshaft gear. Do not press in the camshaft backwards otherwise the sealing washer at the rear camshaft bearing will fall off. Install and tighten up the camshaft nut to a torque of 130-150 Nm (13-15 kpm = 94-108 lbftf).
4. Check the backlash (0.04-0.08 mm = 0.0016-0.0032", max. permitted 0.12 mm = 0.0048") and the camshaft end float (0.02-0.06 mm = 0.0008-0.0024"). The end float is determined by the spacer washer behind the camshaft gear.
5. Install the timing gear cover. See under "Installing the timing gear casing", page 21:17.
6. Install the distributor pinnion. When the engine is at top dead centre and firing on No. 1 cylinder, install the pinnion for the oil pump and distributor. The small end of the groove is faced obliquely upwards-backwards and the groove is set at an angle of about 35° to the longitudinal direction of the engine (see A, Fig. 21-46). Make sure that the shaft goes down into its groove in the pump shaft. (NOTE! When the marking on the timing gears are opposite each other then the No. 6 piston is at top dead centre, firing position.)

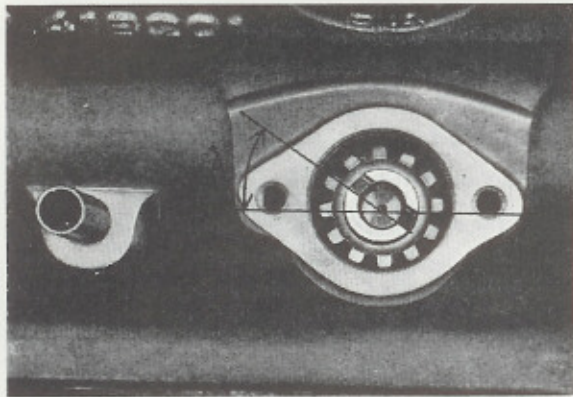


Fig. 21-46. Location of distributor pinion

A = approx 35°

7. Install the valve tappets, with grip tool 2424.
8. Install the distributor and fuel pump.
9. Install the cylinder head. See under "Installing the cylinder head", page 21:8.

Camshaft bearings

Replacing (engine removed)

When the camshaft bearings are worn more than 0.02 mm (0.0008") they should be replaced with new ones. If this work is to be done fully satisfactorily, a drilling machine must be available. When pressing in the new bearings make sure that the lubricating holes are opposite the oil channels in the block.

CRANK MECHANISM

Special tools

1426	Drift
2814	Puller
2815	Press tool
2816	Drift
2817	Tool for pressing sealing ring in and out
4090	Extractor

Crankshaft

Replacing rear crankshaft seal (gearbox removed)

1. Remove the reinforcing bracket.
2. Line-up mark and remove the clutch and fly-wheel.
3. Remove the two oil sump bolts fixed to the sealing flange. Slacken a couple of the oil sump bolts so that the sump does not press against the sealing flange.
4. Remove the sealing flange.

5. Press out the old seal with the drift for tool 2817. Use a suitable cushion for the sealing flange in order not to damage it.
6. Press in the sealing ring with tool 2817, Fig. 21-47. **NOTE!** First inspect the wear surface of the crankshaft. The sealing ring can be installed in three positions with 2817, see Fig. 21-48. With a new crankshaft or with a crankshaft without noticeable wear on the surface, place the sealing in its outer position (centre bolt screwed in fully). With wear marks on the crankshaft, place it with the centre bolt screwed out two threads or screwed out fully.

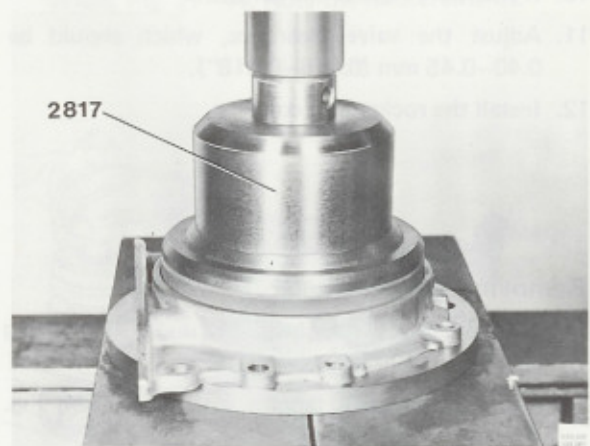


Fig. 21-47. Pressing in sealing ring

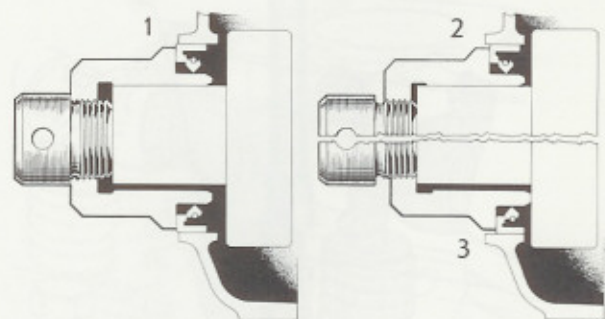


Fig. 21-48. Locations of centre bolt on tool 2817

7. Install the sealing flange with a well-cleaned sealing surface and new gasket. (Oil first the sealing lip.) The sealing flange should be fitted on the crankshaft with due care, see Fig. 21-49. Fit on the sealing lip with a finger.

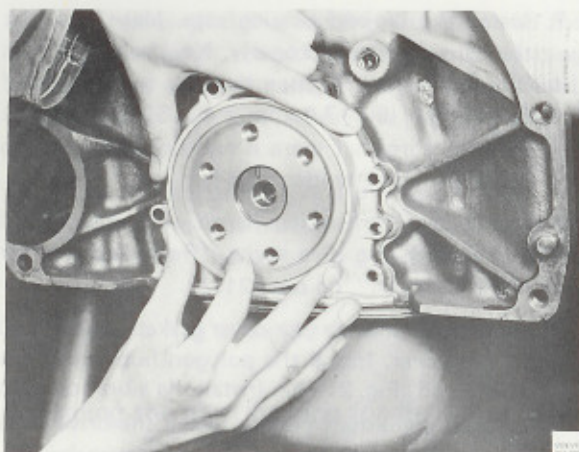


Fig. 21-49. Installing the sealing flange

8. Install the oil sump bolts.
9. Install the flywheel and clutch. Note the line-up marks, see point 1.
10. Install the reinforcing bracket.

Removing the crankshaft (engine removed)

1. Line-up mark and remove the clutch and flywheel.
2. Remove the oil sump, sealing plate and oil pump.
3. Slacken the drive belts. Remove the crankshaft pulley and vibration damper.
4. Screw out the centre bolt and pull off the polygon hub with puller 2814, Fig. 21-50. (But first try to see that the hub can be pulled off by hand.)

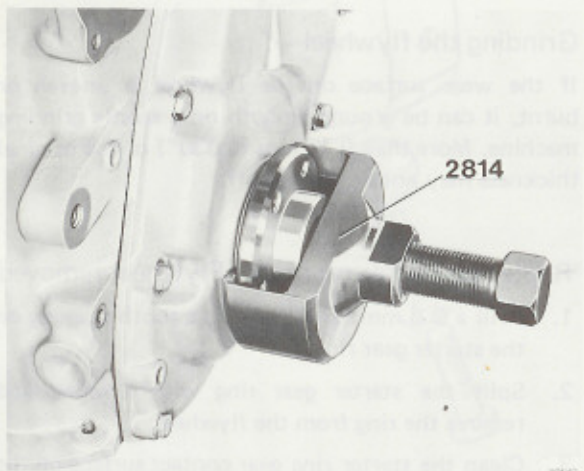


Fig. 21-50. Removing the polygon hub

5. Remove the timing gear casing and the rear sealing flange.
6. Remove the caps for the big-end and main bearings.
7. Lift out the crankshaft.

Checking

After cleaning the crankshaft measure its journals with a micrometer. Measure at different points round the circumference and on the length. Out-of-roundness on the main bearing journals may not exceed 0.05 mm (0.0020"), and that on the connecting rod journals 0.07 mm (0.0028"). Taper may not be greater than 0.05 mm (0.0020") for any of the journals.

If the measurements are close to or exceed the wear indicated above, grind the crankshaft to undersize. Suitable bearing shells are available in 2 undersizes. Concerning measurements, see the data on page 20:4.

Check that the shaft is straight within 0.05 mm (0.0020") by means of a dial indicator. Place the shaft in two V-blocks and place a dial indicator on the centre journal and then rotate the shaft. If necessary straighten the shaft in a press.

Grinding

Before being ground, the crankshaft must be straight. This should be checked according to the previous paragraph. Grinding is carried out in a special machine and the main bearing and big-end bearing journals are ground to similar measurements. These measurements, which are indicated in the data given on page 20:4, must be accurately followed in order to get the correct bearing clearance with the ready-machined bearing shells.

Under no circumstances whatsoever may the bearing shells be shaved or the caps filed.

The journal fillets should be 2.0-2.5 mm (0.08-0.10") for all journals, Fig. 21-51. The width measurement (A) for the pilot bearing will depend on the size of the journal and should be ground so that the correct measurement is obtained. After the grinding the oil channel openings should be carefully cleaned and all journals lapped with a fine lapping paste to best surface finish, after which the shaft is washed. Clean all oil channels with particular thoroughness in order to remove all residues of filings and grinding paste.

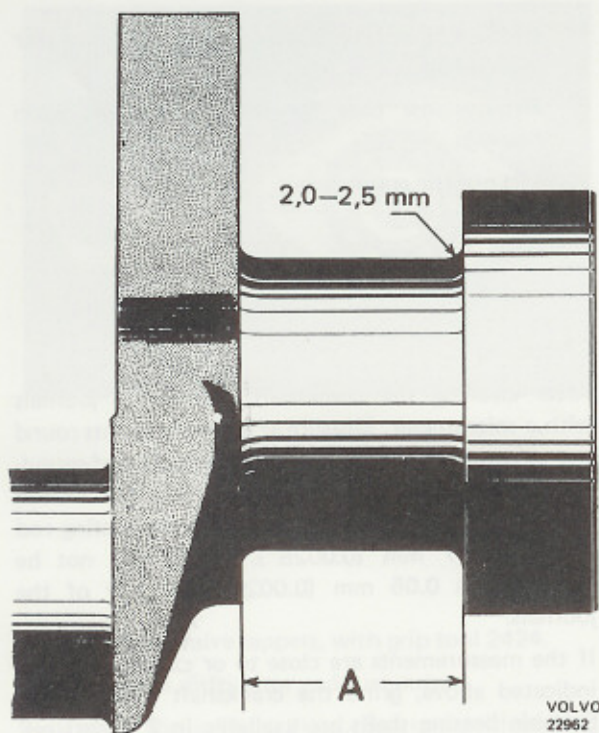


Fig. 21-51. Bearing journal

Installing

1. Clean all the bearing seats and fit bearing shells with the correct size.
In addition to the standard size, there are bearing shells available with undersizes 0.010" and 0.020". The rear main bearing shells are provided with flanges and have a wider width in relation to the size. If the crankshaft has been ground to the correct measurement, the correct bearing clearance will be obtained when the corresponding bearing shell is fitted. The bearing shells must not be shaved and the caps must never be filed in order to get a tighter fit for the bearings.
2. Oil the bearing shells and carefully install the crankshaft in position.
Note the line-up marks on the timing gears.
3. Install the lower main bearing shells in the caps and oil them.
4. Install the main bearing caps. Tighten the bolts in stages to a torque of 120-130 Nm (12-13 kpm = 87-94 lbftf). Between tightenings turn over the crankshaft and check that it does not jam.
5. Measure the crankshaft end float which should be 0.037-0.147 mm (0.0015-0.0058").
6. Install the big-end bearings in the caps and oil them.

7. Install the big-end bearing caps. Make sure that the caps are fitted properly. New bolts and nuts should be used. Tighten the nuts to a torque of 63-70 Nm (6.3-7.0 kpm = 45-51 lbftf). Check to make sure that there is end float and that no bearing shows a tendency to jam.
8. Install the rear sealing flange, with new gasket and sealing ring. See under "Replacing the rear crankshaft seal", on page 21:20.
9. Replace the timing gear cover gasket and seal and fit the cover. Install the polygon hub with press tool 2815, Fig. 21-52. Install the vibration damper and crankshaft pulley. Install the drive belts and the adjust the belt tension.

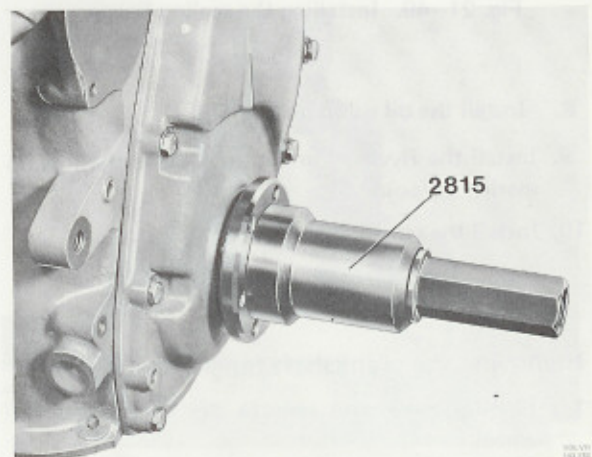


Fig. 21-52. Installing the polygon hub

10. Install the oil pump, sealing plate and oil sump with new gasket. The "tongue" on the oil sump gasket should face the starter motor flange.
11. Install the flywheel and clutch. Note the line-up marks for these components, see point 1 "Removing".

Grinding the flywheel

If the wear surface on the flywheel is uneven or burnt, it can be ground smooth on a saddle grinding machine. More than 0.75 mm (0.030") of the original thickness may not be ground off.

Replacing starter gear ring (Flywheel removed)

1. Drill a \varnothing 6 mm (1/4") hole in a tooth opening on the starter gear ring.
2. Split the starter gear ring with a chisel and remove the ring from the flywheel.
3. Clean the starter ring gear contact surface on the flywheel.
4. Polish the starter gear ring at three points.

5. Heat the ring with a welding flame. Spread the heat evenly all round. Discontinue the heating when the polished surfaces become blue. **Note!** Be careful not to overheat the ring otherwise it might warp.
6. Place the starter gear ring on the flywheel and drive it into position with a copper drift or similar tool. The bevel on the ring should face forwards.
7. Allow the ring to cool in the open air.

**Replacing the pilot bearing for the input shaft
(Gearbox removed)**

1. Make line-up marks on the clutch and remove the clutch.
2. Remove the bearing circlip and protective washer and pull out the bearing with puller 4090.
3. Check the bearing after having cleaned it in white spirit. Replace it if it is worn.
4. Pack the bearing with heat-resistant ball bearing grease.
5. Install the bearing with drift 1426.
6. Install the protective washer and circlip.
7. Install the clutch. Note the line-up marks, see point 1.

Replacing the rear engine mount

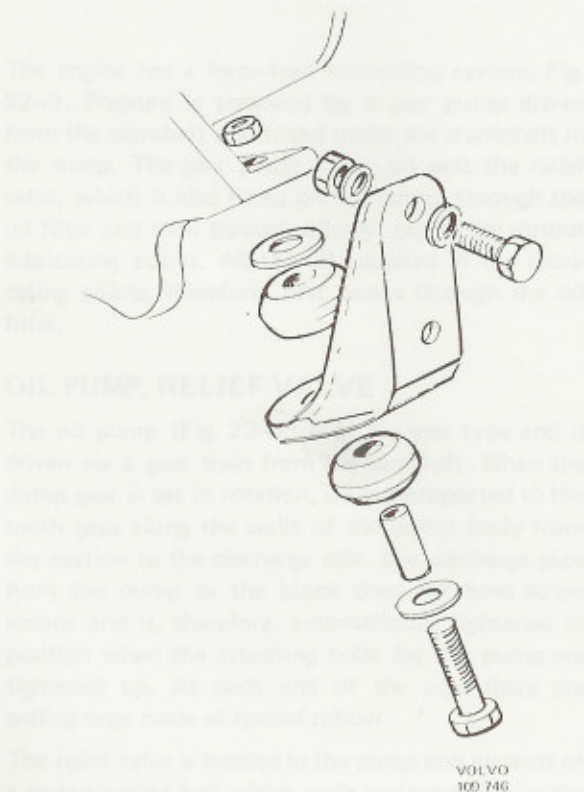


Fig. 21-53 Rear engine mount

Replacing the front engine mount

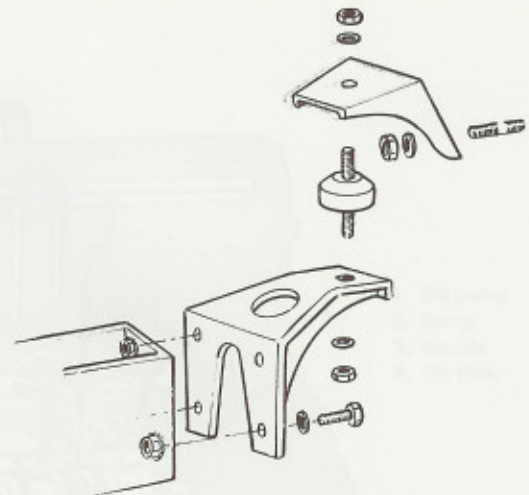


Fig. 21-54. Front engine mount

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