Petrol engines (continued)

Pistons

Note: *Piston diameter is measured at right angles to the gudgeon pin holes, 11mm from the bottom of the piston skirt. The piston classification is stamped on the crown.*

Piston diameter:	
AB	89.964 to 89.975 mm
B	89.975 to 89.982 mm
First oversize (+0.5 mm)	90.457 to 90.475 mm
Second oversize (+1.0 mm)	90.957 to 90.975 mm
Nominal piston clearance (new)	0.025 to 0.056 mm

Connecting rods

Length (centre to centre):	
2.0 litre engine	159 mm
2.3 litre engine	153 mm

Crankshaft

Endfloat	0.08 to 0.34 mm
Maximum bearing journal out-of-round	0.005 mm
Main bearing journal diameter:	
Standard	57.981 to 58.000 mm
First undersize	57.731 to 57.750 mm
Second undersize	57.481 to 57.500 mm
Main bearing running clearance	0.014 to 0.062 mm
Big-end bearing journal diameter:	
Standard	51.981 to 52.000 mm
First undersize	51.731 to 51.750 mm
Second undersize	51.481 to 51.500 mm
Big-end bearing running clearance	0.020 to 0.068 mm

Piston rings

End gaps in cylinder:	
Upper compression ring	0.30 to 0.50 mm
Lower compression ring	0.30 to 0.50 mm
Scraper ring	0.75 to 1.00 mm
Side clearance in groove:	
Top compression ring	0.035 to 0.080 mm
Second compression ring	0.040 to 0.075 mm
Oil control ring	N/A

Torque wrench settings

Refer to Chapter 2A Specifications

Diesel engines

Cylinder head

Maximum gasket face distortion	0.10 mm
Cylinder head height	105.95 to 107.05 mm

Valves and guides

Valve stem diameter:	
Intake valve	5.982 to 6.000 mm
Exhaust valve	5.972 to 5.990 mm
Valve head diameter:	
Intake	29.489 mm
Exhaust	27.491 mm
Valve length:	
Intake	107.95 mm
Exhaust	107.95 mm
Maximum permissible valve stem play in guide	N/A
Valve spring free length (intake and exhaust)	43.1 mm

Cylinder block

Maximum gasket face distortion	0.15 mm
Cylinder bore diameter	82.000 to 82.030 mm
Maximum cylinder bore ovality	0.050 mm
Maximum cylinder bore taper	0.005 mm

Diesel engines (continued)	
Crankshaft and bearings	
Number of main bearings	5
Main bearing journal diameter	59.855 to 60.000 mm
Big-end bearing journal diameter	50.660 to 50.805 mm
Big-end bearing running clearance	N/A
Crankshaft endfloat	0.049 to 0.211 mm
Pistons	
Piston diameter	81.920 to 81.950 mm
Piston rings	
Number of rings (per piston)	2 compression, 1 oil control
Ring end gap:	
Top compression	0.20 to 0.35 mm
Second compression	0.60 to 0.80 mm
Oil control	0.25 to 0.50 mm
Torque wrench settings	
Refer to Chapter 2B Specifications	

1 General information

Included in this Part of Chapter 2 are details of removing the engine from the vehicle, and general overhaul procedures for the cylinder head, cylinder block/crankcase, and all engine internal components.

The information given ranges from advice concerning preparation for an overhaul and the purchase of new parts, to detailed step-by-step procedures covering removal, inspection, renovation and refitting of engine internal components.

After Section 8, all instructions are based on the assumption that the engine has been removed from the vehicle. For information concerning in-car engine repair, as well as the removal and refitting of those external components necessary for full overhaul, refer to Part A or B of this Chapter. Ignore any preliminary dismantling operations described in Part A or B that are no longer relevant once the engine has been removed from the vehicle.

2 Engine overhaul – general information

It is not always easy to determine when, or if, an engine should be completely overhauled, as a number of factors must be considered.

High mileage is not necessarily an indication that an overhaul is needed, while low mileage does not preclude the need for an overhaul. Frequency of servicing is probably the most important consideration. An engine which has had regular and frequent oil and filter changes, as well as other required maintenance, should give many thousands of miles of reliable service. Conversely, a neglected engine may require an overhaul very early in its life.

Excessive oil consumption is an indication that piston rings, valve seals and/or valve guides are in need of attention. Make sure that oil leaks are not responsible before deciding that the rings and/or guides are worn. Have a compression test performed (refer to Part A of this Chapter for petrol engines and to Part B for diesel engines), to determine the likely cause of the problem.

Check the oil pressure with a gauge fitted in place of the oil pressure switch, and compare it with that specified. If it is extremely low, the main and big-end bearings, and/or the oil pump, are probably worn out.

Loss of power, rough running, knocking or metallic engine noises, excessive valve gear noise, and high fuel consumption may also point to the need for an overhaul, especially if they are all present at the same time. If a complete service does not remedy the situation, major mechanical work is the only solution.

A full engine overhaul involves restoring all internal parts to the specification of a new engine. During a complete overhaul, the pistons and the piston rings are renewed, and the cylinder bores are reconditioned. New main and big-end bearings are generally fitted; if necessary, the crankshaft may be reground, to compensate for wear in the journals. The valves are also serviced as well, since they are usually in less-than-perfect condition at this point. Always pay careful attention to the condition of the oil pump when overhauling the engine, and renew it if there is any doubt as to its serviceability. The end result should be an as-new engine that will give many trouble-free miles.

Critical cooling system components such as the hoses, thermostat and coolant pump should be renewed when an engine is overhauled. The radiator should also be checked carefully, to ensure that it is not clogged or leaking.

Before beginning the engine overhaul, read through the entire procedure, to familiarise yourself with the scope and requirements of the job. Check on the availability of parts and make sure that any necessary special tools and equipment are obtained in advance. Most work can be done with typical hand tools, although a number of precision measuring tools are required for inspecting parts to determine if they must be renewed.

The services provided by an engineering machine shop or engine reconditioning specialist will almost certainly be required, particularly if major repairs such as crankshaft regrinding or cylinder reboring are necessary. Apart from carrying out machining operations, these establishments will normally handle the inspection of parts; offer advice concerning reconditioning or renewal and supply new components such as pistons, piston rings and bearing shells. It is recommended that the establishment used is a member of the Federation of Engine Re-Manufacturers, or a similar society.

Always wait until the engine has been completely dismantled, and until all components (especially the cylinder block/crankcase and the crankshaft) have been inspected, before deciding what service and repair operations must be performed by an engineering works. The condition of these components will be the major factor to consider when determining whether to overhaul the original engine, or to buy a reconditioned unit. Do not, therefore, purchase parts or have overhaul work done on other components until they have been thoroughly inspected. As a general rule, time is the primary cost of an overhaul, so it does not pay to fit worn or sub-standard parts.

As a final note, to ensure maximum life and minimum trouble from a reconditioned engine, everything must be assembled with care, in a spotlessly clean environment.

3 Engine removal – methods and precautions

If you have decided that the engine must be removed for overhaul or major repair work, several preliminary steps should be taken.

Locating a suitable place to work is extremely important. Adequate workspace,

4.9 Disconnecting the breather hose from the top of the automatic transmission

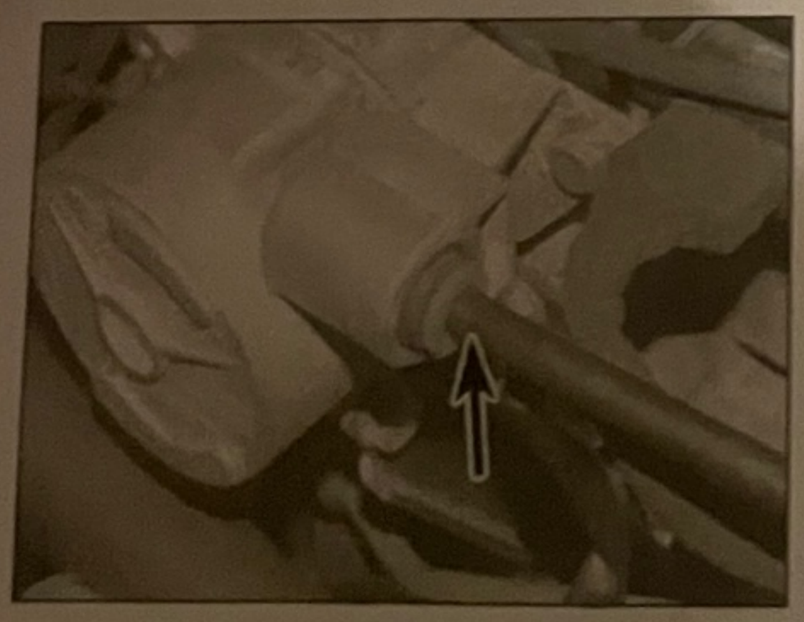
along with storage space for the vehicle, will be needed. If a workshop or garage is not available, at the very least, a flat, level, clean work surface is required.

Cleaning the engine compartment and engine/transmission before beginning the removal procedure will help keep tools clean and organised.

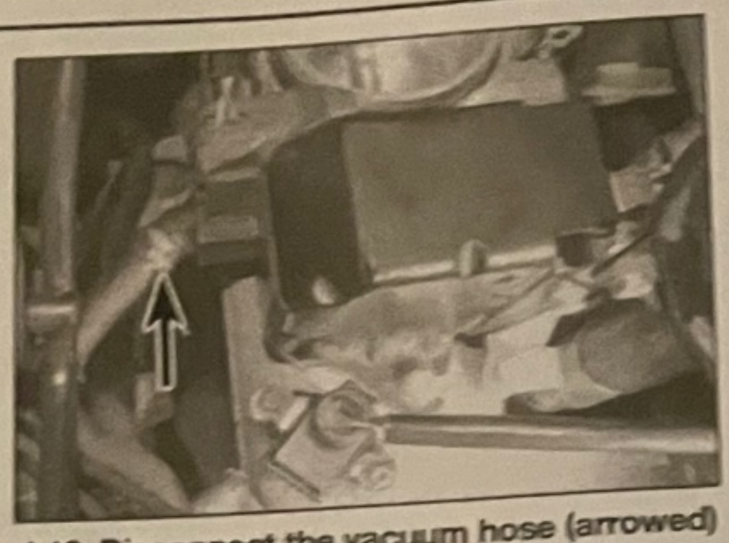
An engine hoist or A-frame will also be necessary. Make sure the equipment is rated in excess of the combined weight of the engine and transmission. Safety is of primary importance, considering the potential hazards involved in lifting the engine/transmission out of the vehicle.

If this is the first time you have removed an engine, an assistant should ideally be available. Advice and aid from someone more experienced would also be helpful. There are many instances when one person cannot simultaneously perform all of the operations required when lifting the engine out of the vehicle.

Plan the operation ahead of time. Before starting work, arrange for the hire of, or obtain, all of the tools and equipment you will need. Some of the equipment necessary to perform engine/transmission removal and installation safely and with relative ease (in addition to an engine hoist) is as follows: a heavy-duty trolley jack, complete sets of spanners and sockets as described in the back of this manual, wooden blocks, and plenty of rags and cleaning solvent for mopping-up spilled oil, coolant and fuel. If the hoist must be hired, make sure that you arrange for it in advance, and perform all of the operations possible without it beforehand. This will save you money and time.



4.13a Press the red sleeve in and pull the vacuum hose (arrowed) from the pump . . .



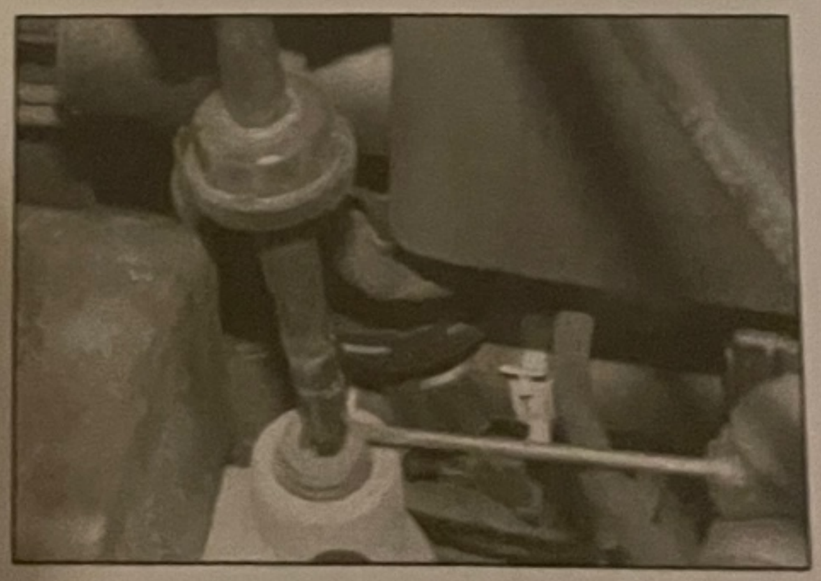
4.12 Disconnect the vacuum hose (arrowed) from the rear of the intake manifold

Plan for the vehicle to be out of use for quite a while. An engineering works will be required to perform some of the work, which the do-it-yourselfer cannot accomplish without special equipment. These places often have a busy schedule, so it would be a good idea to consult them before removing the engine, in order to accurately estimate the amount of time required to rebuild or repair components that may need work.

During the engine/transmission removal procedure, it is advisable to make notes of the locations of all brackets, cable-ties, earthing points, etc, as well as how the wiring harnesses, hoses and electrical connections are attached and routed around the engine and engine compartment. An effective way of doing this is to take a series of photographs of the various components before they are disconnected or removed; the resulting photographs will prove invaluable when the engine/transmission is refitted.

Always be extremely careful when removing and refitting the engine/transmission. Serious injury can result from careless actions. Plan ahead and take your time, and a job of this nature, although major, can be accomplished successfully.

On all 9-5 models, the engine must be removed complete with the transmission as an assembly. There is insufficient clearance in the engine compartment to remove the engine leaving the transmission in the vehicle. The engine/transmission unit is removed by raising the front of the vehicle, and lowering the complete assembly from the engine compartment.



4.13b . . . then press the red sleeve down and pull the vacuum hose from the intake manifold

4 Engine and transmission - removal, separation and refitting

Note: *The engine is removed from the vehicle unit complete with the transmission. The engine and transmission can then be separated for overhaul. The engine/transmission is then lifted and removed from the underside of the engine compartment. Note that it is possible to remove the transmission, leaving the engine in position – refer to Chapter 7A or 7B (as applicable) for details.*

Removal

1 Park the vehicle on firm, level ground. Chock the rear wheels, then firmly apply the handbrake. It may be useful at this point to slacken the front wheel bolts. Jack up the front of the vehicle, and securely support on axle stands (see *Jacking and vehicle support*).

2 Remove both front wheels, and then remove both wing mouldings and front wheel arch liners, for access to either side of the engine bay.

3 Unbolt and remove the lower cover panel under the engine and radiator.

4 Drain the coolant with reference to Chapter 1A or 1B. Save the coolant in a clean container if it is fit for re-use.

Warning: The engine should be cold before draining the cooling system.

5 With the coolant drained, tighten the drain plug on the left-hand bottom of the radiator.

6 If required, remove the bonnet as described in Chapter 11. Alternatively, disconnect the support struts from the bonnet, and support it in the fully open position.

7 Remove the covers from the top of the engine, intake manifold and battery, then remove the battery with reference to Chapter 5A.

8 Unbolt the battery tray from the side of the engine bay, and disconnect the earth cable between the transmission and the vehicle body.

9 On models with automatic transmission, disconnect the breather hose from the top of the transmission **(see illustration)**; plug the open port to prevent the ingress of foreign material.

10 On manual models, unplug the wiring from the reversing lamp switch at the connector on the top of the transmission casing.

11 Detach the throttle cable (where applicable) from the throttle body with reference to Chapter 4A or 4B.

12 On petrol models, release the retaining clip and disconnect the EVAP canister purge valve's vacuum hose from the intake manifold **(see illustration)**.

13 Press the red sleeve inwards and pull the braking system vacuum hose to disconnect it from the vacuum pump and intake manifold **(see illustrations)**; see Chapter 9 for details.

14 Disconnect the fuel supply and return hoses at the quick-release unions as described in Chapter 4A or 4B. Plug both sides of the open fuel lines to minimise leakage and to prevent the ingress of foreign material.

15 On manual models, release the securing clip and disconnect the connection for the clutch fluid delivery at the top of the transmission. Refit the securing clip to the connector after it has been disconnected for safekeeping. Plug both sides of the open clutch fluid lines to minimise leakage and to prevent the ingress of foreign material.

16 Disconnect the gear selector cable (automatic models) or shaft (manual models) at the rear of the transmission casing; refer to Chapter 7A or 7B for details. On automatic models, also unplug the transmission control system wiring harness, at the two multiway connectors located to the front of the battery tray **(see illustration)**.

17 Slacken the hose clip and disconnect the cooling system top hose from the thermostat housing and the expansion tank hose on the end of the cylinder head. Also disconnect the heater hoses from the rear of the engine; refer to Chapter 3 for further information.

18 Disconnect the vacuum hose from the bypass valve, and then disconnect the wiring connector from the pressure/temperature sensor **(see illustration)**.

19 Undo the retaining clips and securing bolt, then remove the air intake pipe to the throttle body. Undo the securing bolt from the air bypass pipe and withdraw from the vehicle **(see illustrations)**.

20 On petrol models, remove the mass airflow sensor and air intake hose from the vehicle as described in Chapter 4A, Section 14.

21 Slacken the hose clip and disconnect the radiator bottom hose from the coolant pump; refer to Chapter 3 for further information.

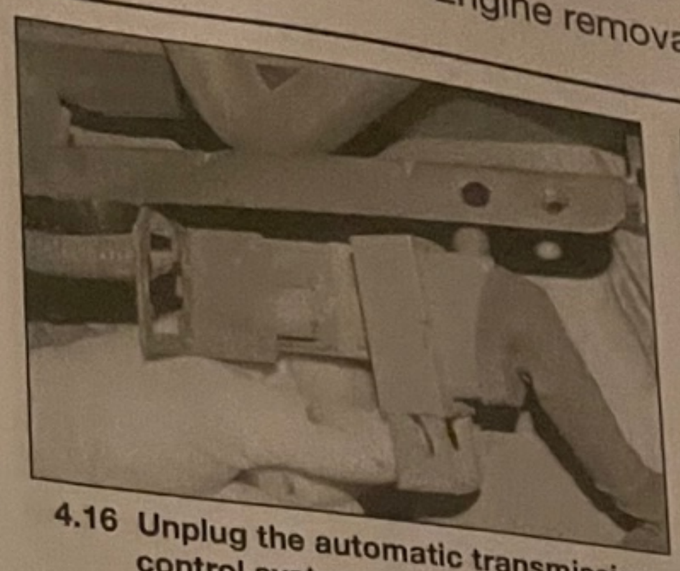
22 Remove the wiper arms and windscreen lower trim panel which covers the wiper motor, as described in Chapter 12.

23 Undo the four retaining nuts and withdraw the rubber cover, then disconnect the wiring connector from the electronic control module. Pull the rubber grommet from the bulkhead and rest the wiring harness on the top of the engine. Remove the wiring connection cover on the rear of the bulkhead and release any retaining clips/cable-ties as required **(see illustrations)**.

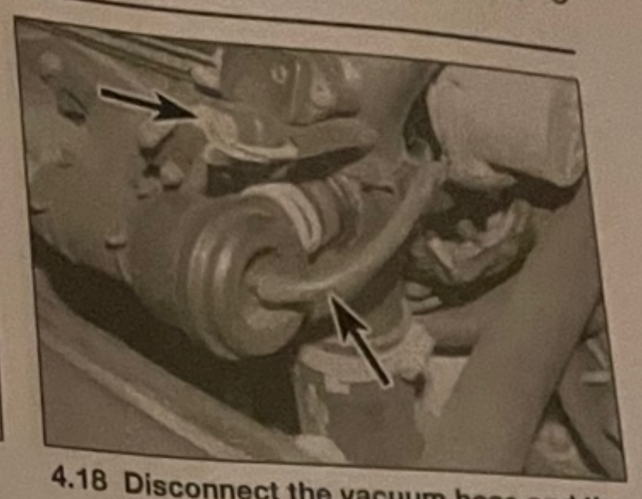
24 Release the tension on the auxiliary belt and remove it from the pulleys. Refer to Chapter 1A or 1B for further information.

25 Disconnect the power steering pump from the engine mounting bracket, then using suitable straps/cable-ties suspend it from the radiator upper crossmember.

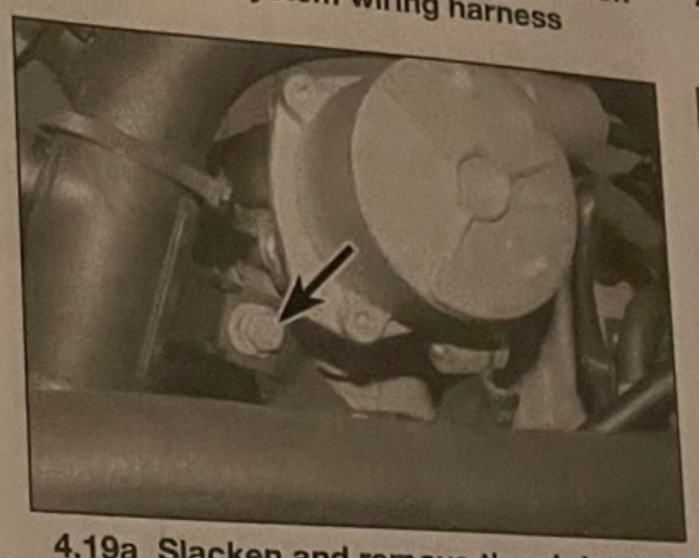
26 Slacken and remove the air conditioning compressor retaining bolts, then using suitable straps/cable-ties suspend the compressor, condenser cooler and charge air cooler from the radiator upper crossmember. Note that the engine oil cooler will be removed with the engine.



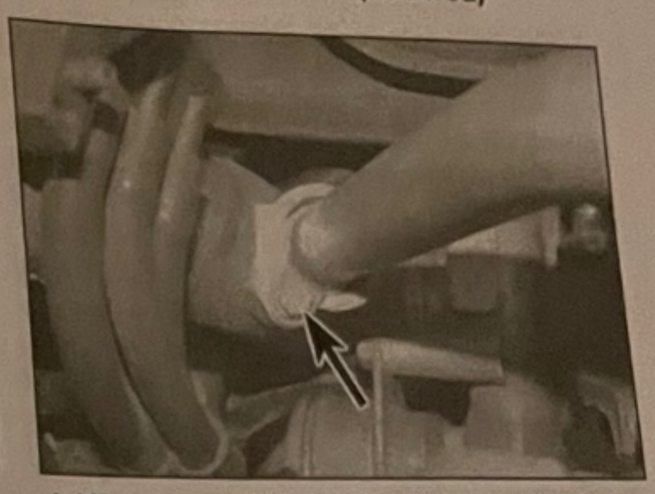
4.16 Unplug the automatic transmission control system wiring harness



4.18 Disconnect the vacuum hose and the wiring connector (arrowed)



4.19a Slacken and remove the air intake pipe retaining bolt (arrowed) . . .

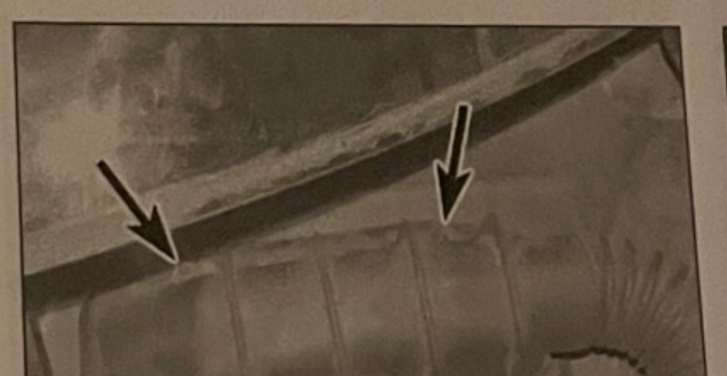


4.19b . . . and the air bypass pipe retaining bolt (arrowed)

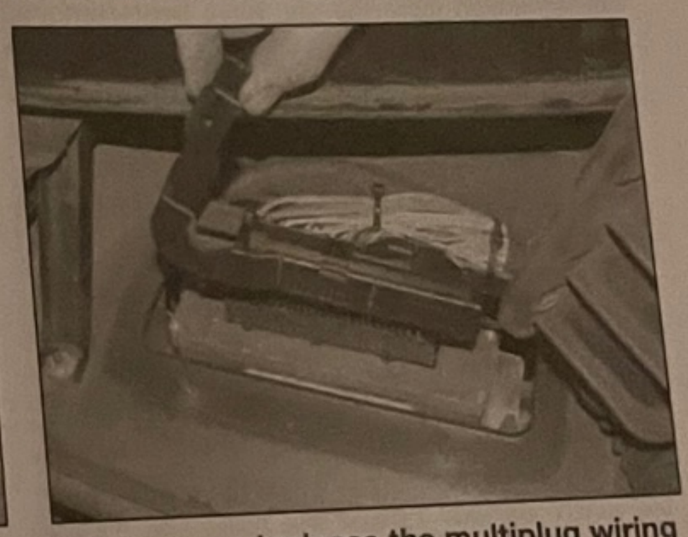
27 Disconnect the wiring connector to the air conditioning compressor and release the coupling on the vacuum hose connected to the wastegate.

28 Undo the retaining nut and disconnect the oil cooler pipes from the oil filter housing, then undo the retaining bolts and remove the engine oil cooler, complete with cooler pipes from the vehicle **(see illustrations)**.

29 On models with automatic transmission,

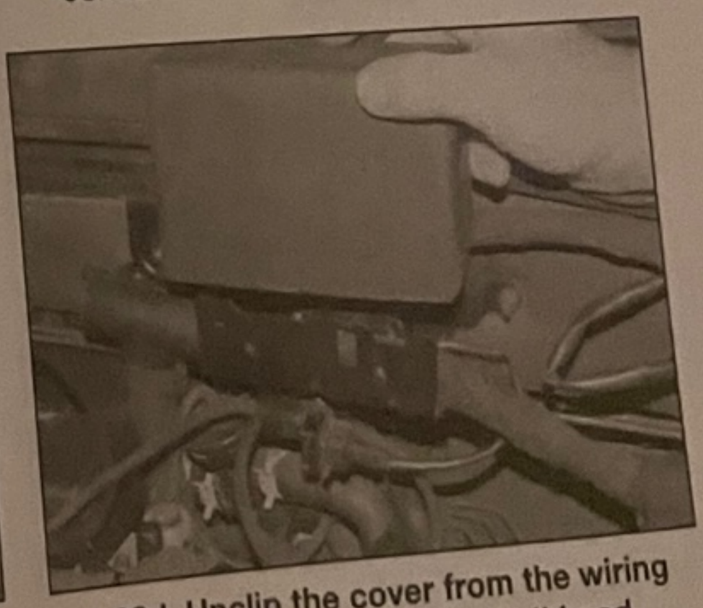


4.23a Remove the four retaining nuts (arrowed) . . .

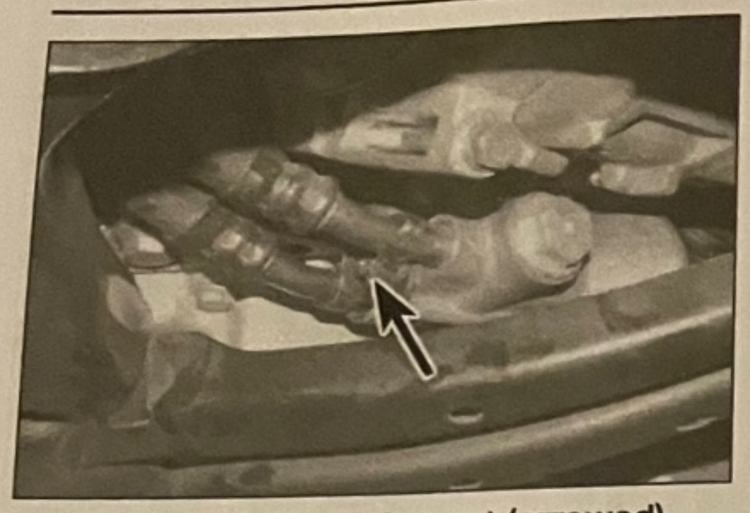


4.23b . . . and release the multiplug wiring connector from the control module

4.23c Withdraw the rubber wiring grommet from the bulkhead panel

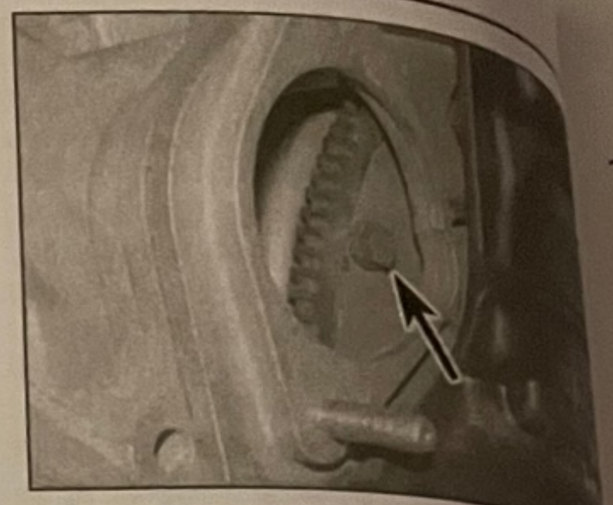


4.23d Unclip the cover from the wiring block connector on the bulkhead



4.28a Undo the retaining nut (arrowed) . . .

4.28b . . . and the retaining bolts (arrowed)



4.42 Undo the bolts (one shown) se... the torque converter to the flywh...

disconnect the quick-release connectors to the transmission oil cooler. Plug ends of the open fluid lines to minimise leakage and to prevent the ingress of foreign material.

30 Position an engine-lifting hoist over the engine compartment. Attach the lifting jib to the eyelets at either end of the cylinder head. It may be necessary to attach an extra lifting eye to the transmission to allow the engine/transmission to be kept level for removal. Raise the hoist until it is just taking the weight of the engine/transmission.

31 Referring to Chapter 8, unbolt and remove the both driveshafts.

32 Referring to Chapter 10, unbolt and remove the front subframe.

33 Unbolt and remove the right- and left-hand engine/transmission mountings, with reference to Chapter 2A, Section 13.

34 Make a final check that any components, which would prevent the removal of the engine/transmission from the car, have been removed or disconnected. Ensure that components such as the gearchange selector rod, clutch cable and accelerator cable are secured so that they cannot be damaged on removal.

35 Slowly lower the engine/transmission assembly from the engine compartment, making sure that it clears the components on the surrounding panels. In particular, make sure that it clears the ABS unit and the radiator. Enlist the help of an assistant during this procedure, as it may be necessary to tilt and twist the assembly slightly to clear the body panels. Lower the assembly to the ground and remove it from the underside of the engine compartment.

Separation from transmission

36 If the engine is to be dismantled, working as described in Chapter 1A or 1B, drain the oil and if required remove the oil filter. Clean and refit the drain plug, tightening it securely.

37 Support the engine/transmission assembly on suitable blocks of wood, on a workbench (or failing that, on a clean area of the workshop floor).

38 Remove the starter motor with reference to Chapter 5A.

Manual transmission models

39 Unscrew the bolt securing the turbo oil pipe bracket to the transmission.

40 Unbolt and remove the flywheel protection plate from the underside of the transmission bellhousing.

41 Ensure that both engine and transmission are adequately supported, then with reference to Chapter 7A, unscrew the bolts securing the transmission housing to the engine. Note the correct fitted positions of each bolt as they are removed, to use as a reference on refitting. Withdraw the transmission directly from the engine. Take care not to allow the weight of the transmission to bear on the input shaft and clutch friction plate.

Automatic transmission models

42 Working through the aperture exposed by the removal of the starter motor, unscrew the bolts securing the flywheel to the torque converter **(see illustration)**. To bring each bolt into view, turn the engine using a socket on the crankshaft pulley bolt.

43 Saab technicians use a special tool to hold the torque converter inside the transmission while the transmission is separated from the engine. The tool is quite basic, and consists of a plate which engages the torque converter through the timing hole in the top of the transmission.

44 Support the weight of the transmission, preferably using a hoist.

45 Ensure that both engine and transmission are adequately supported, then unscrew the bolts securing the transmission housing to the engine. Note the correct fitted positions of each bolt as they are removed, to use as a reference on refitting. Withdraw the transmission directly from the engine (see Chapter 7B for details). Make sure that the torque converter stays inside the transmission bellhousing, otherwise it may fall out and be damaged.

Reconnection to transmission

Automatic transmission models

46 Carefully offer the transmission to the engine. Make sure that the torque converter is held fully engaged with the transmission, using the special tool described earlier in this procedure (refer to Chapter 7B for settings and further details).

47 Insert and tighten the bolts securing the transmission to the engine to the specified torque.

48 Remove the special tool, then inser... tighten the bolts securing the drivepl... the torque converter to the specified to... Turn the engine by means of a socket o... crankshaft pulley.

Manual transmission models

Caution: If a new clutch slave cylinder... been fitted, or if any hydraulic fluid... been allowed to drain from the exis... slave cylinder, the cylinder must be pri... and bled BEFORE the transmissio... refitted; see Chapter 6 for details.

49 Apply a smear of high melting-p... grease to the splines of the transmission ... shaft. Do not apply too much; otherwise t... is a possibility of the grease contaminating ... clutch friction plate.

50 Carefully offer the transmission to the eng... Ensure that the weight of the transmissio... not allowed to hang on the input shaft as ... engaged with the clutch friction plate. Insert ... tighten the bolts securing the transmissio... the engine to the specified torque.

51 Where applicable, insert and tighten ... bolts securing the turbo oil pipe bracket t... transmission.

All models

52 Refit the lower cover plate to the tra... mission bellhousing, and tighten the bolts.

53 Refit the starter motor with reference ... Chapter 5A.

Refitting

54 Refit the engine and transmission ... following the removal procedure in reve... noting the following points:

a) Hoist the engine and transmission int... position in the engine compartment, ... then refit the right- and left-hand engi... mountings as described in Chapter 2... or 2B.

b) Refit the front subframe with reference ... to Chapter 10, refit the driveshafts with ... reference to Chapter 8.

c) Tighten all nuts and bolts to the specifi... torque.

d) Renew all copper sealing washers on ... unions, as applicable.

e) Where applicable, reconnect the ... accelerator cable with reference to ... Chapter 4A or 4B.

f) With reference to Chapter 6, reconn...

the fluid supply pipe to the slave cylinder, and then bleed the clutch hydraulic system.

g) Ensure that all wiring has been securely reconnected, and all nuts and bolts have been tightened.

h) Refill the engine and transmission with the correct quantity and grade of oil/fluid, with reference to Chapter 1A or 1B.

i) Refill the cooling system with reference to Chapter 1A or 1B.

j) Check and if necessary top-up the power steering fluid, with reference to Chapter 1A or 1B.

5 Engine overhaul – dismantling sequence

1 It is much easier to dismantle and work on the engine if it is mounted on a portable engine stand. These stands can often be hired from a tool hire shop. Before the engine is mounted on a stand, the flywheel/driveplate should be removed, so that the stand bolts can be tightened into the end of the cylinder block/crankcase.

2 If a stand is not available, it is possible to dismantle the engine with it blocked up on a sturdy workbench, or on the floor. Be extra careful not to tip or drop the engine when working without a stand.

3 If you are going to obtain a reconditioned engine, all the external components must be removed from the old engine first, to be transferred to the new engine (just as they will if you are doing a complete engine overhaul yourself). These components normally include the following, but check with your engine supplier first:

a) Engine wiring harness and supports.
b) Alternator and air conditioning compressor mounting brackets (as applicable).
c) Coolant pump (where applicable) and inlet/outlet housings.
d) Dipstick tube.
e) Fuel system components.
f) All electrical switches and sensors.
g) Intake and exhaust manifolds, and the turbocharger.
h) Oil filter and oil cooler/heat exchanger.
i) Flywheel/driveplate.
j) The Direct Ignition cartridge and spark plugs – petrol engines.
k) Engine mounting brackets.

4 If you are obtaining a 'short' engine (which consists of the engine cylinder block/crankcase, crankshaft, pistons and connecting rods all assembled), then the cylinder head and sump will have to be removed also.

5 If you are planning a complete overhaul, the engine can be dismantled, and the internal components removed, in the order given below:

Petrol engines

a) Intake and exhaust manifolds (Chapter 4A).
b) Cylinder head (Chapter 2A).
c) Timing chain and balance shaft chain, sprockets and tensioner (Sections 10 and 11).
d) Flywheel/driveplate (Chapter 2A).
e) Balance shafts (Section 12).
f) Sump (Chapter 2A).
g) Piston/connecting rod assemblies (Section 13).
h) Crankshaft (Section 14).

Diesel engines

a) Intake and exhaust manifolds (see Chapter 4B).
b) Timing belt, sprockets, tensioner and idler pulleys (see Chapter 2B).
c) Coolant pump (see Chapter 3).
d) Cylinder head (see Chapter 2B).
e) Flywheel/driveplate (see Chapter 2B).
f) Sump (see Chapter 2B).
g) Oil pump (see Chapter 2B).
h) Piston/connecting rod assemblies (see Section 13).
i) Crankshaft (see Section 14).

6 Before beginning the dismantling and overhaul procedures, make sure that you have all of the correct tools necessary. Refer to *Tools and working facilities* for further information.

6 Cylinder head – dismantling

Note: *New/reconditioned cylinder heads are obtainable from Saab, or from engine overhaul specialists. Be aware that some specialist tools are required for the dismantling and inspection procedures, and new components may not be readily available. It may therefore be more practical and economical for the home mechanic to purchase a reconditioned head, rather than dismantle, inspect and recondition the original head. A valve spring compressor tool will be required for this operation.*

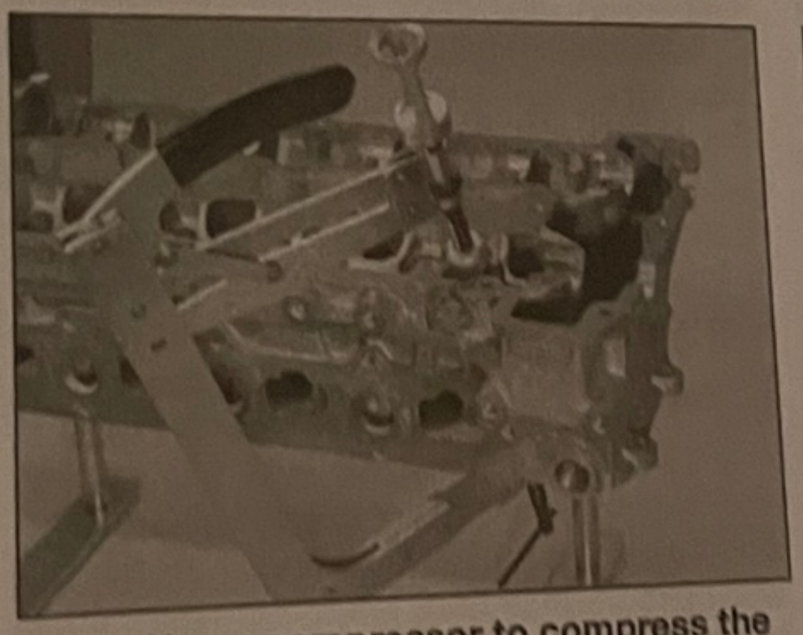
1 With the cylinder head removed as described in the relevant Part of this Chapter, clean away all external dirt, and remove the following components as applicable, if not already done:

a) Manifolds (see Chapter 4A or 4B).
b) Spark plugs (petrol engines – see Chapter 1A).
c) Glow plugs (diesel engines – see Chapter 5A).
d) Camshafts and associated valve train components (see Chapter 2A or 2B).
e) Fuel injectors (diesel engines – see Chapter 4B).
f) Engine lifting brackets.

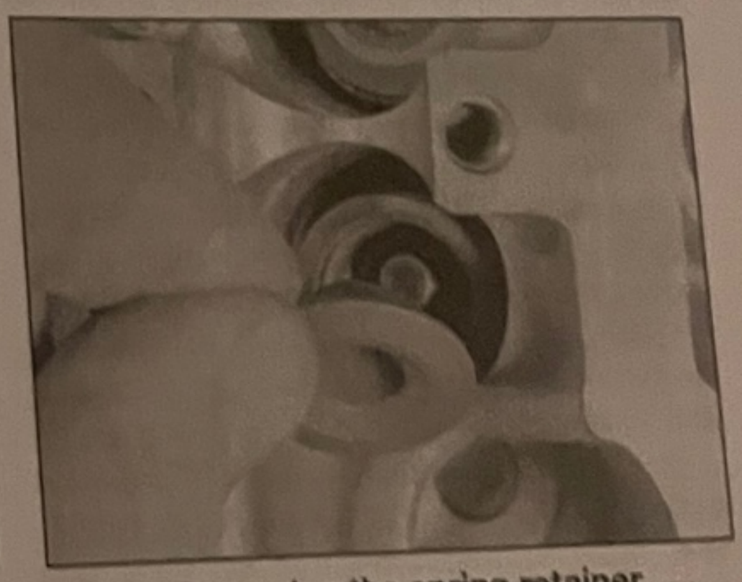
2 Remove the camshafts and hydraulic cam followers, with reference to Chapter 2A or 2B.

3 Before removing the valves, consider obtaining plastic protectors for the hydraulic cam follower bores. When using certain valve spring compressors, the bores can easily be damaged should the compressor slip off the end of the valve.

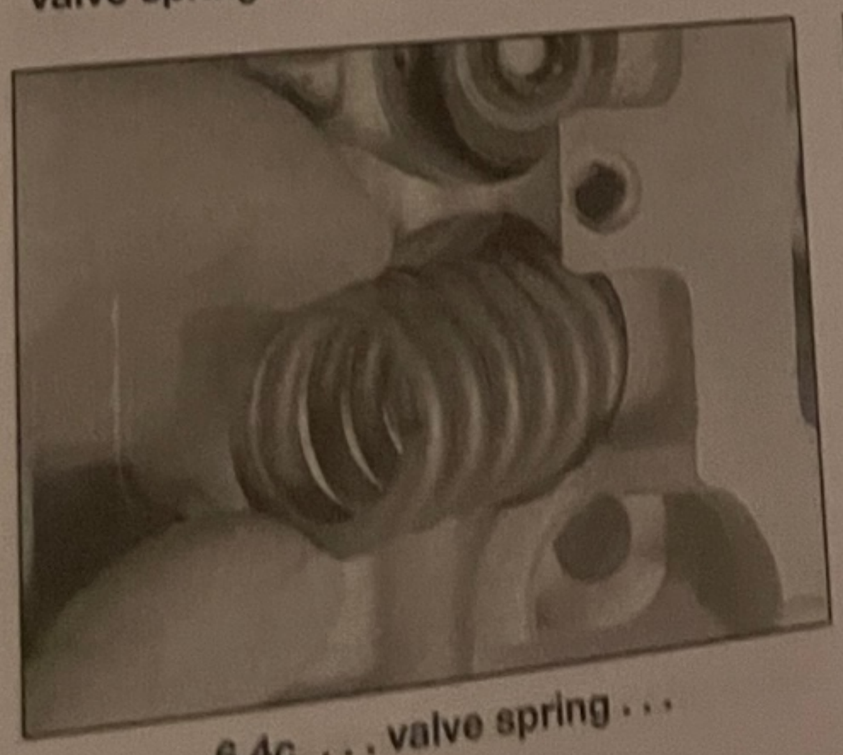
4 Position the protector in the cam follower bore then; using a valve spring compressor, compress the valve spring until the split collets can be removed. Release the compressor, and lift off the spring retainer, spring and seat.



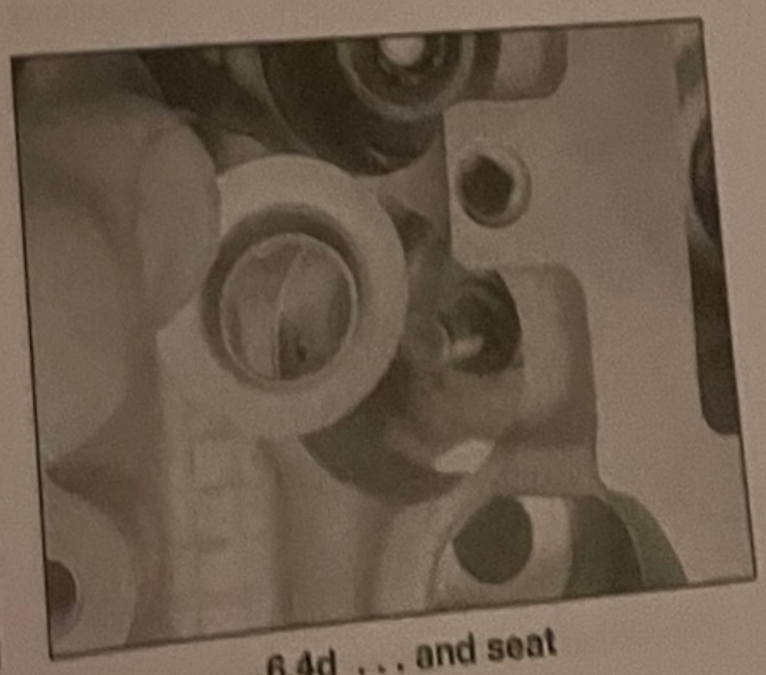
6.4a Use a compressor to compress the valve springs and remove the split collets



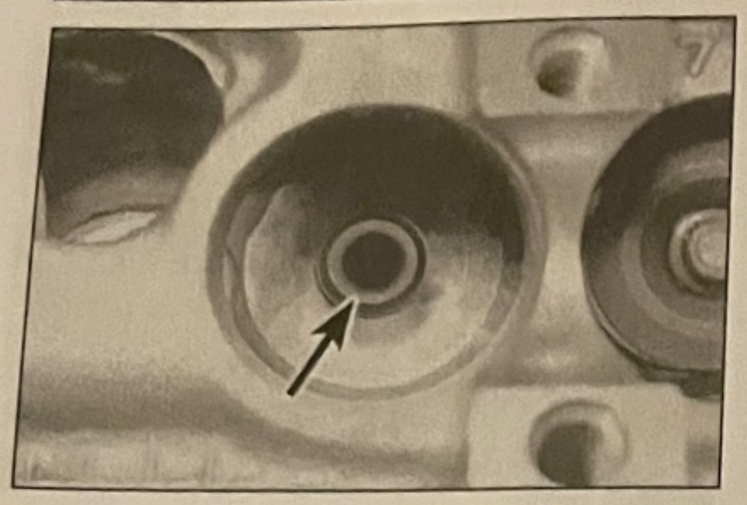
6.4b Removing the spring retainer . . .



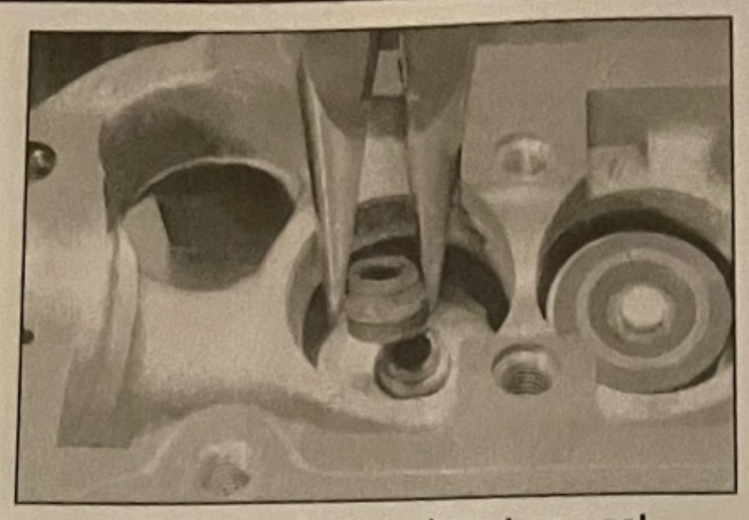
6.4c . . . valve spring . . .



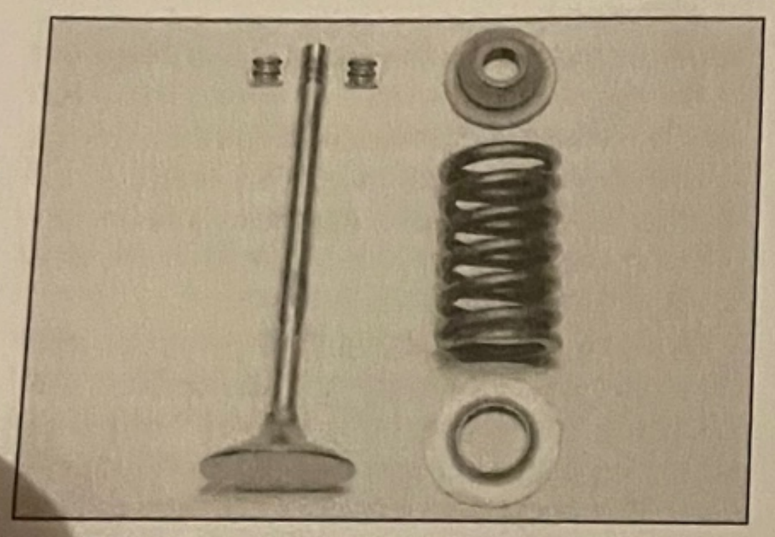
6.4d . . . and seat



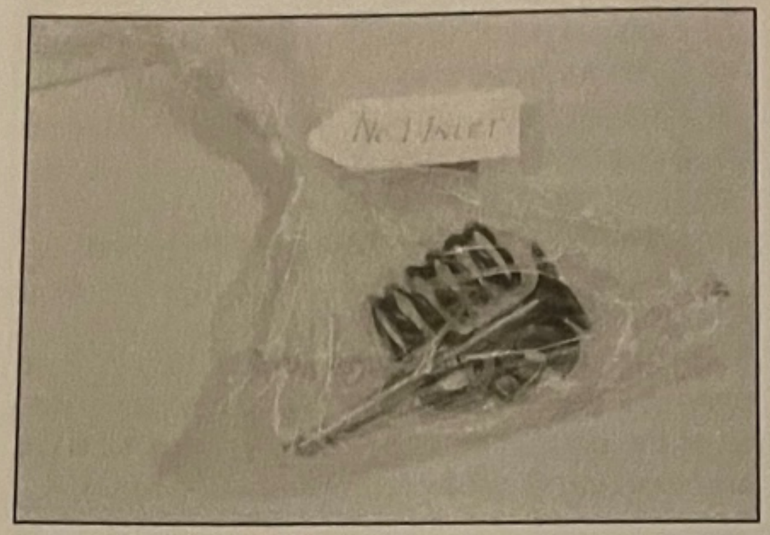
6.4e Valve stem seal location



6.4f Removing a valve stem seal



6.7a The valve spring components



6.7b Place each valve and its associated components in a labelled polythene bag

Using a pair of pliers, carefully extract the valve stem seal from the top of the guide **(see illustrations)**.

5 If, when the valve spring compressor is screwed down, the spring retainer refuses to free and expose the split collets, gently tap the top of the tool, directly over the retainer, with a light hammer. This will free the retainer.

6 Withdraw the valve through the combustion chamber.

7 It is essential that each valve is stored together with its collets, retainer, spring, and spring seat. The valves should also be kept in their correct sequence, unless they are so badly worn that they are to be renewed. If they are going to be kept and used again, place each valve assembly in a labelled polythene bag or similar small container **(see illustrations)**. Note that No 1 cylinder is nearest to the timing chain/belt end of the engine.

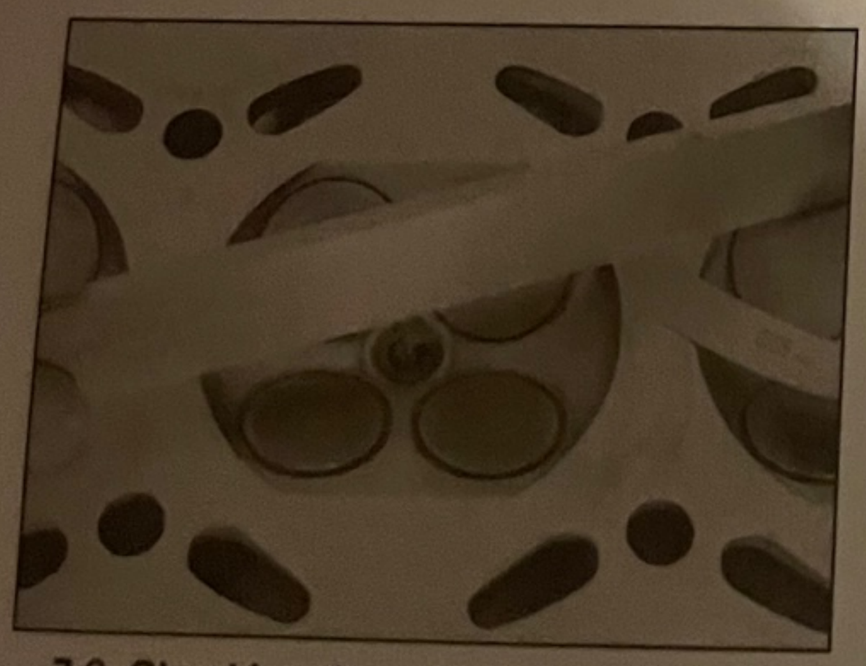
7 Cylinder head and valves – cleaning and inspection

1 Thorough cleaning of the cylinder head and valve components, followed by a detailed inspection, will enable you to decide how much valve service work must be carried out during the engine overhaul. **Note:** *If the engine has been severely overheated, it is best to assume that the cylinder head is warped – check carefully for signs of this.*

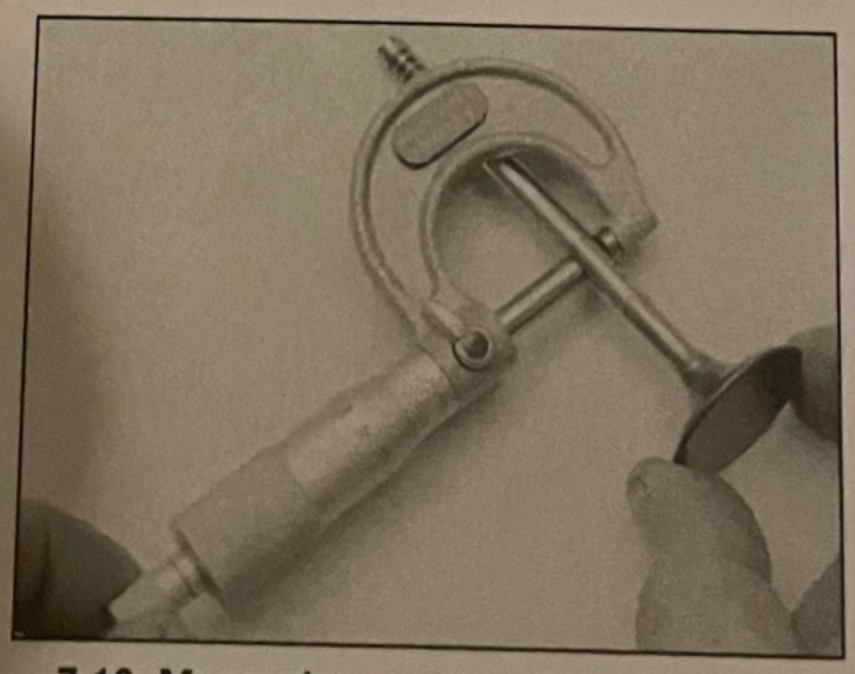
Cleaning

2 Scrape away all traces of old gasket material from the cylinder head.

3 Scrape away the carbon from the combustion chambers and ports, then wash the cylinder head thoroughly with paraffin or a suitable solvent.



7.6 Checking the cylinder head gasket face for distortion



7.10 Measuring a valve stem diameter

4 Scrape off any heavy carbon deposits that may have formed on the valves, and use a power-operated wire brush to remove deposits from the valve heads and stems.

Inspection

Note: *Be sure to perform all the following inspection procedures before concluding that the services of a machine shop or engine overhaul specialist are required. Make a list of all items that require attention.*

Cylinder head

5 Inspect the head very carefully for cracks, evidence of coolant leakage, and other damage. If cracks are found, a new cylinder head should be obtained.

6 Use a straight-edge and feeler blade to check that the cylinder head surface is not distorted **(see illustration)**. If it is, it may be possible to have it machined, provided that the cylinder head is not reduced to less than the specified height.

7 Examine the valve seats in each of the combustion chambers. If they are severely pitted, cracked, or burned, they will need to be renewed or recut by an engine overhaul specialist. If they are only slightly pitted, this can be removed by grinding-in the valves and seats with fine valve-grinding compound as described below. Note that the exhaust valves have a hardened coating and, although they may be ground-in with paste, they must not be machined.

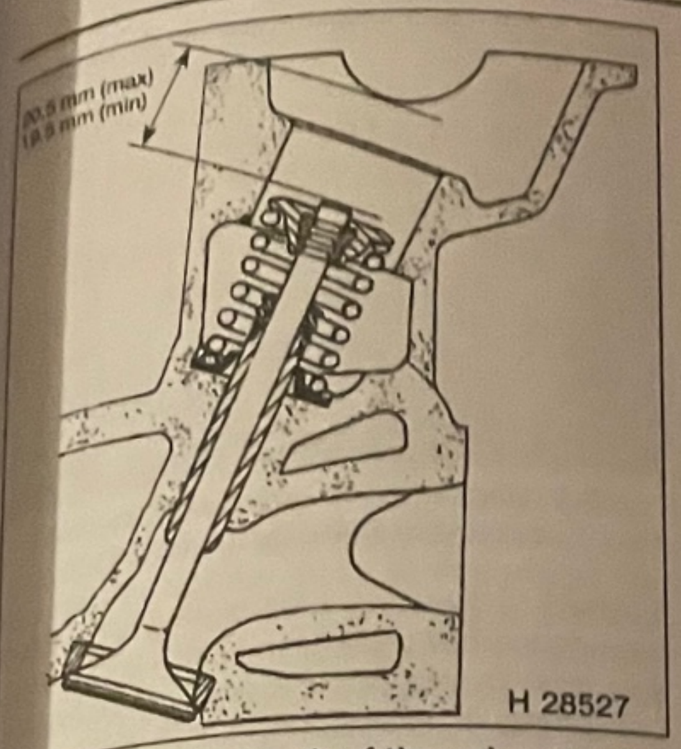
8 Check the valve guides for wear by inserting the relevant valve, and checking for side-to-side motion of the valve. A small amount of movement is acceptable, but if the movement seems excessive, remove the valve. Measure the valve stem diameter (see below), and renew the valve if it is worn. If the valve stem is not worn, the wear must be in the valve guide, and the guide must be renewed. The renewal of valve guides is best carried out by a Saab dealer or engine overhaul specialist who will have the necessary tools available.

Valves

9 Examine the head of each valve for pitting, burning, cracks, and general wear. Check the valve stem for scoring and wear ridges. Rotate the valve, and check for any obvious indication that it is bent. Look for pits and excessive wear on the tip of each valve stem. Renew any valve that shows any such signs of wear or damage.

10 If the valve appears satisfactory at this stage, measure the valve stem diameter at several points using a micrometer (see **illustration)**. Any significant difference in the readings obtained indicates wear of the valve stem. Should any of these conditions be apparent, the valve(s) must be renewed.

11 If the valves are in satisfactory condition, they should be ground (lapped) into their respective seats, to ensure a smooth, gas-tight seal. If the seat is only lightly pitted, or if it has been recut, fine grinding compound should be used to produce the required finish. Coarse



7.16 Check the depth of the valve stems below the camshaft bearing surface

valve-grinding compound should *not* be used, unless a seat is badly burned or deeply pitted. If this is the case, the cylinder head and valves should be inspected by an expert, to decide whether seat recutting, or even the renewal of the valve or seat insert (where possible) is required.

12 Valve grinding is carried out as follows. Place the cylinder head upside-down on a bench.

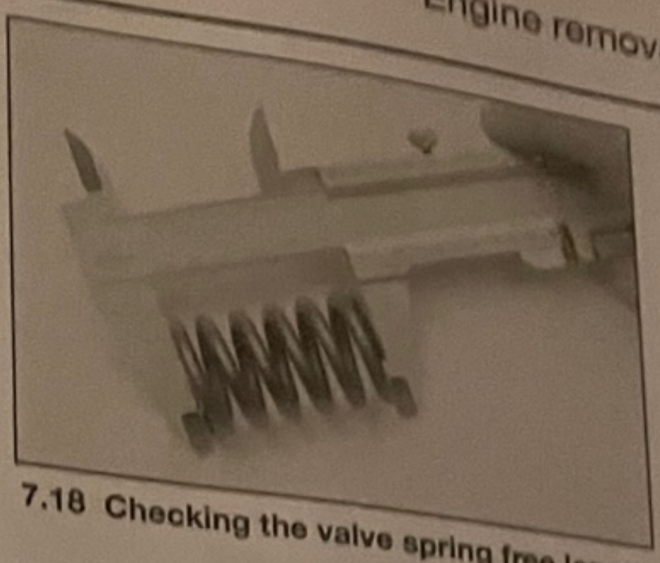
13 Smear a trace of (the appropriate grade of) valve-grinding compound on the seat face, and press a suction grinding tool onto the valve head. With a semi-rotary action, grind the valve head to its seat, lifting the valve occasionally to redistribute the grinding compound. A light spring placed under the valve head will greatly ease this operation.

14 If coarse grinding compound is being used, work only until a dull, matt even surface is produced on both the valve seat and the valve, then wipe off the used compound, and repeat the process with fine compound. When a smooth unbroken ring of light grey matt finish is produced on both the valve and seat, the grinding operation is complete. *Do not* grind-in the valves any further than absolutely necessary, or the seat will be prematurely sunk into the cylinder head.

15 When all the valves have been ground-in, carefully wash off *all* traces of grinding compound using paraffin or a suitable solvent, before reassembling the cylinder head.

16 To ensure that the hydraulic cam followers operate correctly, the depth of the valve stems below the camshaft bearing surface must be within certain limits. It may be possible to obtain a Saab checking tool from a dealer, but if not, the check may be made using a steel rule and straight-edge. Check that the dimension is within the limits given in the illustration by inserting each valve it its guide in turn, and measuring the dimension between the end of the valve stem and the camshaft bearing surface **(see illustration)**.

17 If the dimension is not within the specified



7.18 Checking the valve spring free length

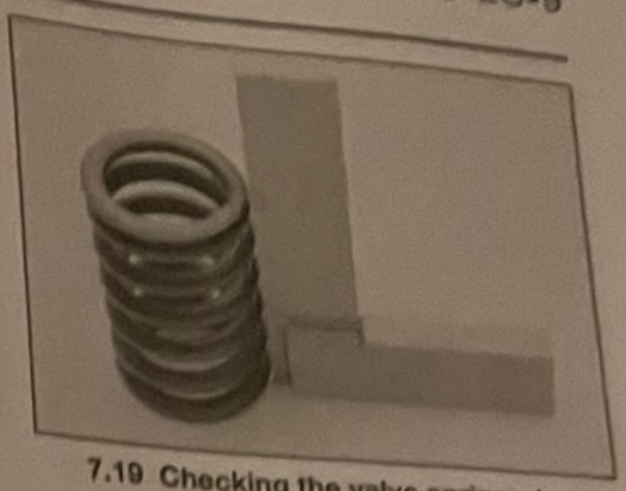
limits, adjustment must be made either to the end of the valve stem or to the valve seat height. If lower than the minimum amount, the length of the valve stem must be reduced, and if more than the maximum amount, the valve seat must be milled. Seek the advice of a Saab dealer or engine reconditioning specialist.

Valve components

18 Examine the valve springs for signs of damage and discoloration, and measure their free length **(see illustration)**.

19 Stand each spring on a flat surface, and check it for squareness **(see illustration)**. If any of the springs are less than the minimum free length, or are damaged, distorted or have lost their tension, obtain a complete new set of springs.

20 Obtain new valve stem oil seals, regardless of their apparent condition.



7.19 Checking the valve springs for squareness

3 Refit the valve spring followed by the spring retainer, then locate the plastic protector in the hydraulic cam follower bore.

4 Compress the valve spring, and locate the split collets in the recess in the valve stem. Release the compressor and remove the protector, then repeat the procedure on the remaining valves.

5 With all the valves installed, place the cylinder head flat on the bench and, using a hammer and interposed block of wood, tap the end of each valve stem to settle the components.

6 Refit the hydraulic cam followers and camshafts with reference to Chapter 2A or 2B.

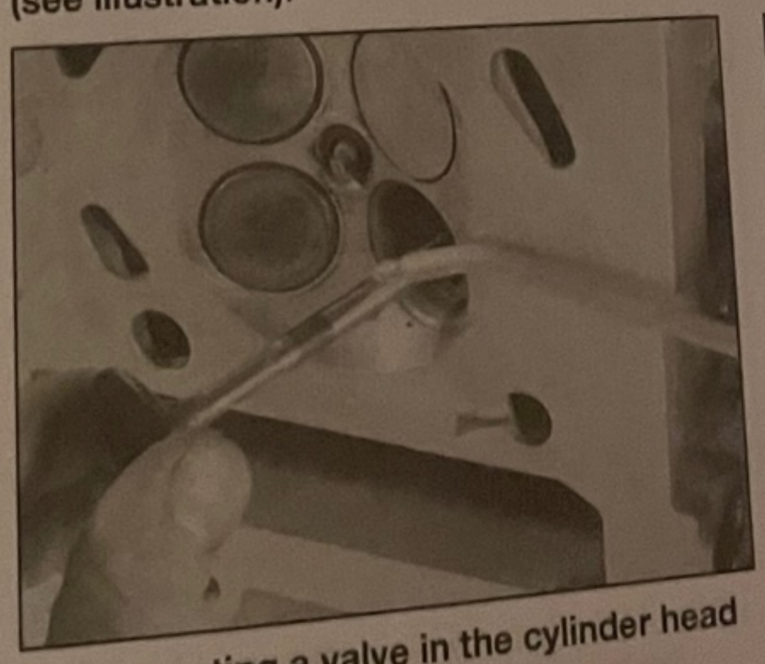
7 Refit the external components removed in Section 6.

8 The cylinder head may now be refitted as described in Chapter 2A or 2B.

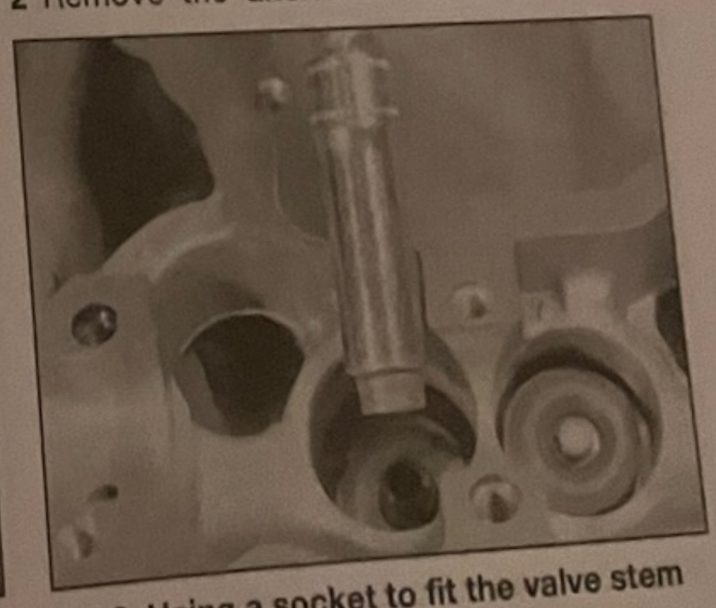
8 Cylinder head – reassembly

1 Lubricate the stems of the valves, and insert the valves into their original locations **(see illustration)**. If new valves are being fitted, insert them into the locations to which they have been ground.

2 Working on the first valve, dip the new valve stem seal in fresh engine oil. Carefully locate it over the valve and onto the guide. Take care not to damage the seal as it is passed over the valve stem. Use a suitable socket or metal tube to press the seal firmly onto the guide **(see illustration)**.



8.1 Inserting a valve in the cylinder head



8.2 Using a socket to fit the valve stem seals

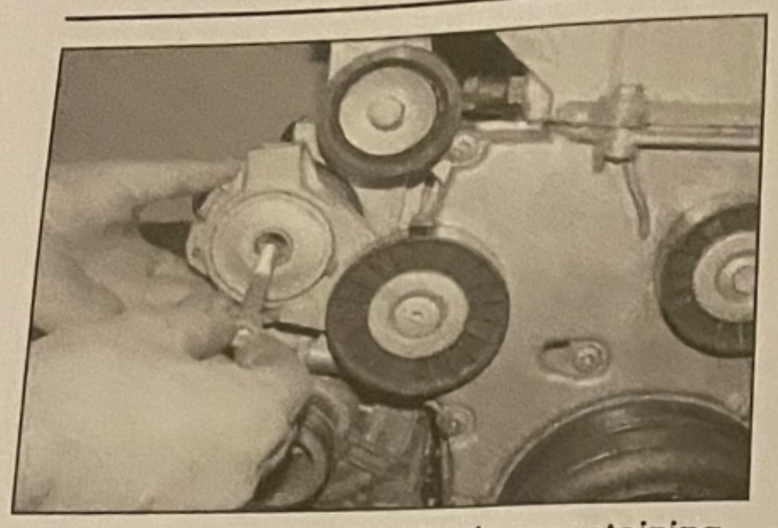
9 Timing cover (petrol engines) – removal and refitting

Note: *This procedure describes removal of the timing cover, leaving the cylinder head in position. The alternative method (which is less likely to damage the cylinder head gasket) is to remove the cylinder head first, as described in Chapter 2A.*

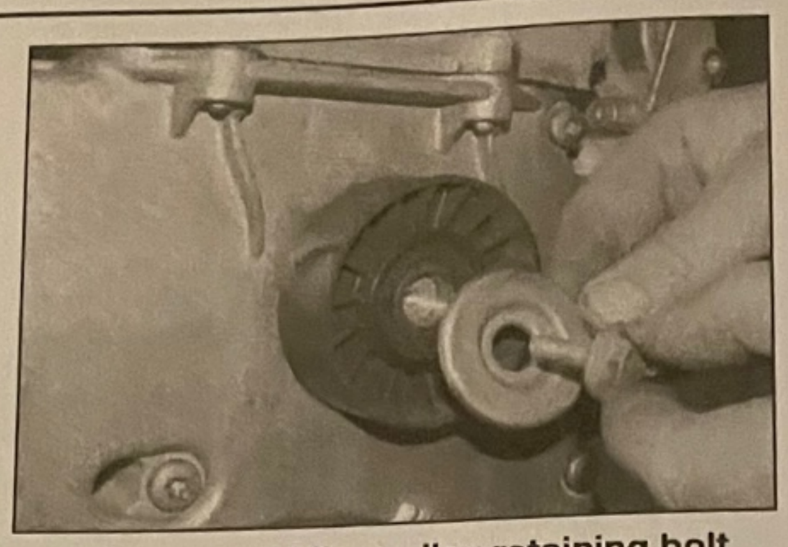
Removal

1 Unbolt and remove the auxiliary drivebelt tensioner unit and idler pulley **(see illustrations)**.

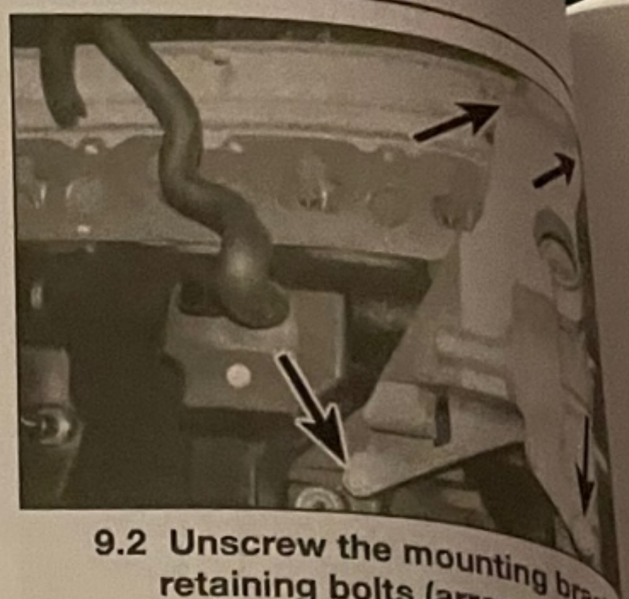
2 Remove the alternator as described in



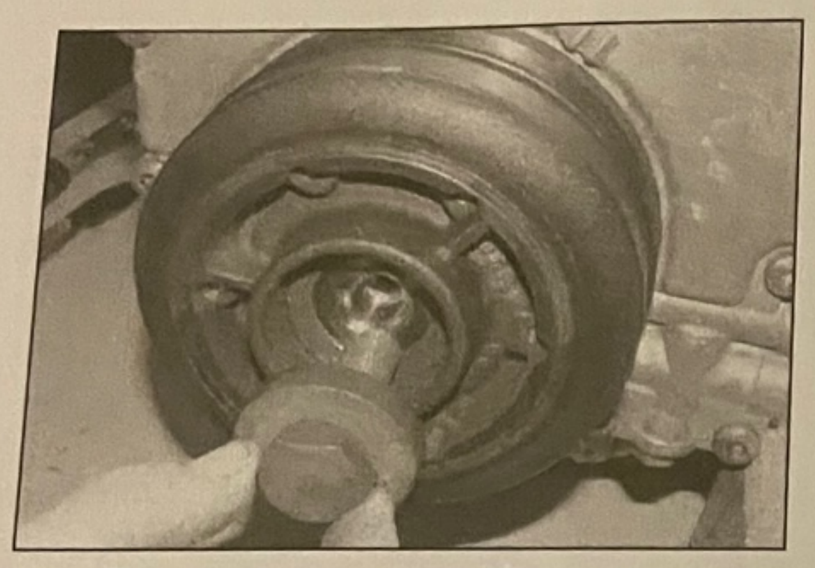
9.1a Unscrewing the tensioner retaining bolt . . .



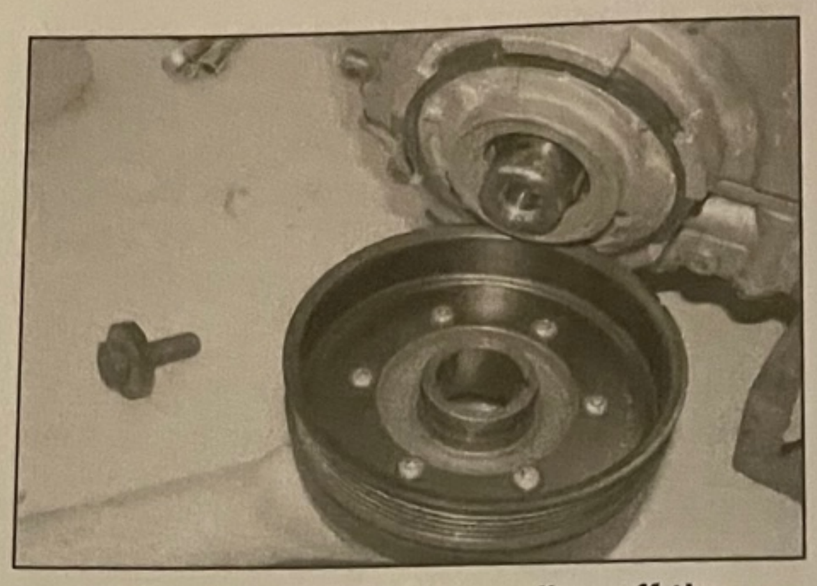
9.1b . . . and idler pulley retaining bolt



9.2 Unscrew the mounting bracket retaining bolts (arrowed) . . .



9.6a Remove the crankshaft pulley bolt . . .



9.6b . . . and slide the pulley off the crankshaft

Chapter 5A, then undo the retaining bolts and remove the mounting bracket from the rear of the cylinder block **(see illustration)**.

3 Undo the retaining bolts and remove the power steering pump mounting bracket, including the lifting eye, from the front of the cylinder head.

4 Remove the water pump as described in Chapter 3.

5 Have an assistant hold the crankshaft/flywheel by inserting a flat-bladed screw through the bellhousing and locking the ring gear to prevent the crankshaft Loosen the crankshaft pulley bolt using socket bar. Note that the bolt is tightened very high torque.

6 Fully unscrew the crankshaft pulley bo slide the pulley off the end of the cran **(see illustrations)**.

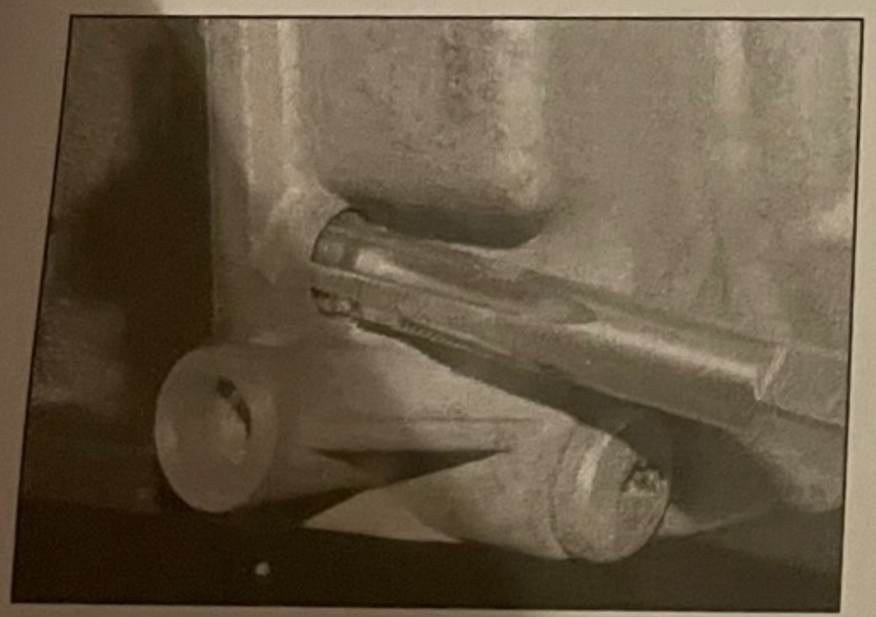
7 Remove the sump as described in C ter 2A, Section 7.

8 Remove the two locating dowels fo the left-hand bottom corner and one top right-hand corner) in the timing co cutting an internal thread in them us 3/8 in UNC thread tap and withdraw the sliding hammer. A bolt can be threaded the locating dowels, and then attached end of the slide hammer **(see illustrations)**.

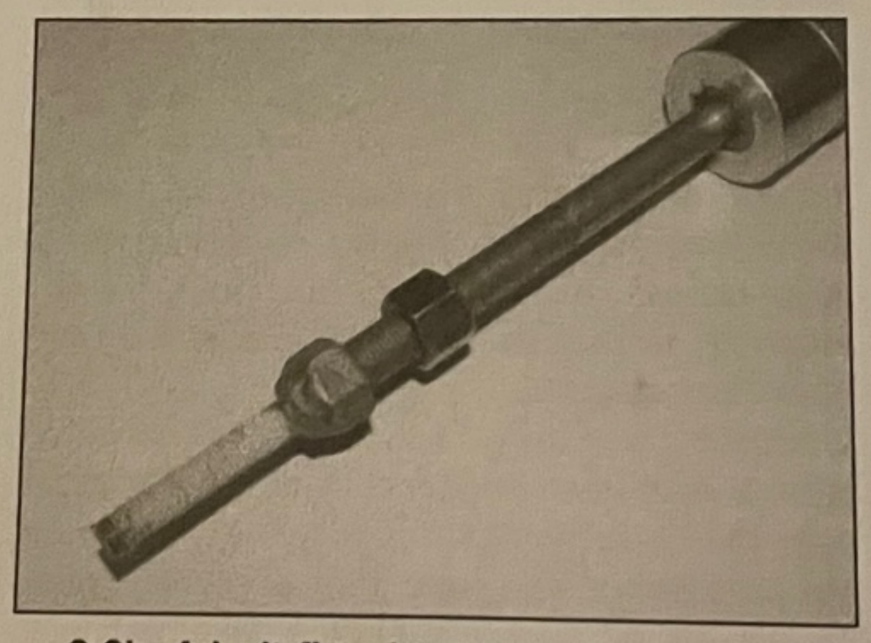
9 Unscrew and remove the bolts securing timing cover to the cylinder block and cyl head. Note the fitted position of the bolts two upper bolts on the cylinder head and two lower bolts in the sump are different **illustrations)**.

10 Taking care not to damage the cyl head gasket, withdraw the timing co complete with the oil pump, from the en the crankshaft. Carefully move the ti cover down and outwards, away from cylinder block.

11 Thoroughly clean all traces of sealant f the contact faces of the timing cover, su cylinder head and block. **Note:** Check *condition of the cylinder head gasket; if th is any damage to the gasket, then the cyl*

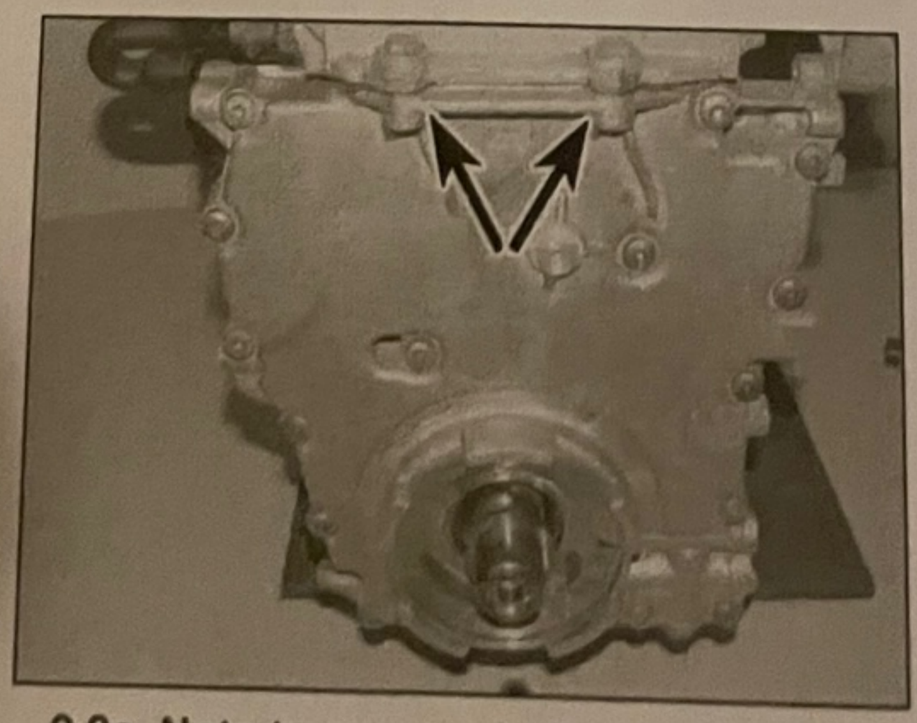


9.8a Cutting an internal thread in the dowel using a thread tap

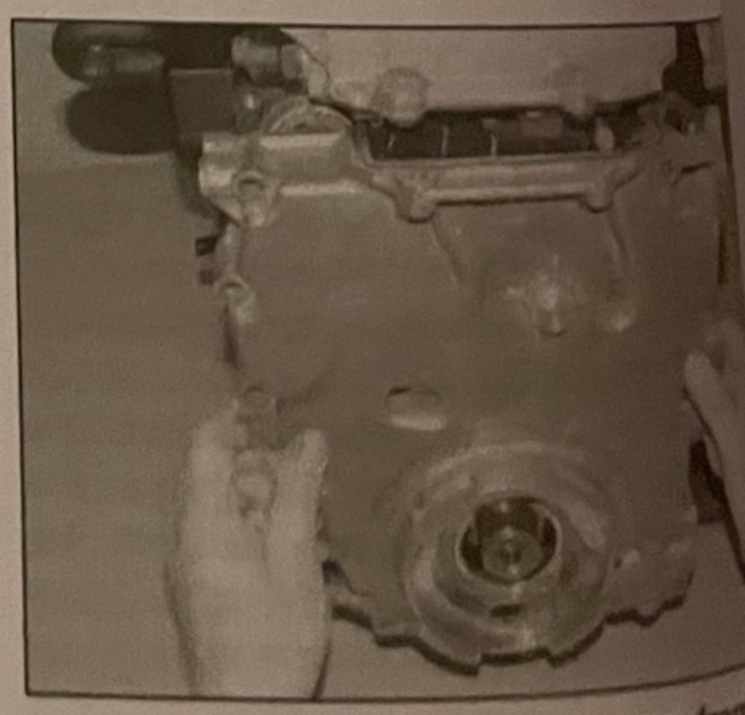


9.8b A bolt fitted to the end of a slide hammer

9.8c Using the slide hammer to withdraw the dowels from the timing cover



9.9a Note two upper bolts securing the timing cover to the cylinder head



9.9b Removing the timing cover from engine

head will need to be removed to renew the gasket.

12 If required, remove the oil pump from the timing cover, with reference to Chapter 2A, Section 8.

Refitting

13 Where applicable, refit the oil pump with reference to Chapter 2A, Section 8.

14 Apply a bead of sealant (Loctite 518 or similar) about 1 mm thick to the timing cover flanges, then carefully locate the timing cover on the cylinder block **(see illustration)**.

15 Insert the timing cover retaining bolts including the two upper cylinder head bolts but do not tighten them at this stage. Tap the locating dowels back into place **(see illustration)**, and then tighten the cover retaining bolts to the specified torque, including the two upper cylinder head bolts.

16 Refit the sump as described in Chapter 2A, Section 7.

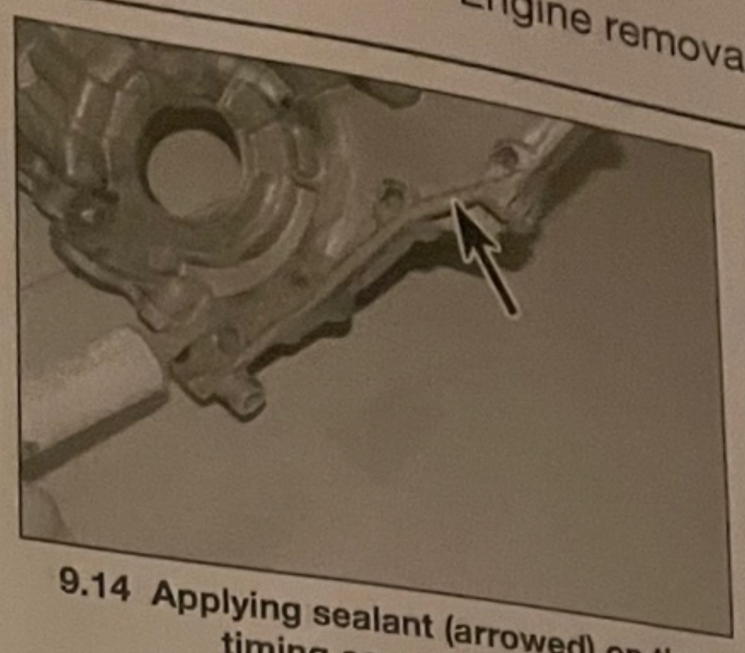
17 Slide the crankshaft pulley onto the crankshaft, then insert the pulley bolt. Tighten the bolt to the specified torque, while an assistant holds the crankshaft stationary using a wide-bladed screwdriver inserted in the starter ring gear.

18 Refit the water pump, with reference to Chapter 3.

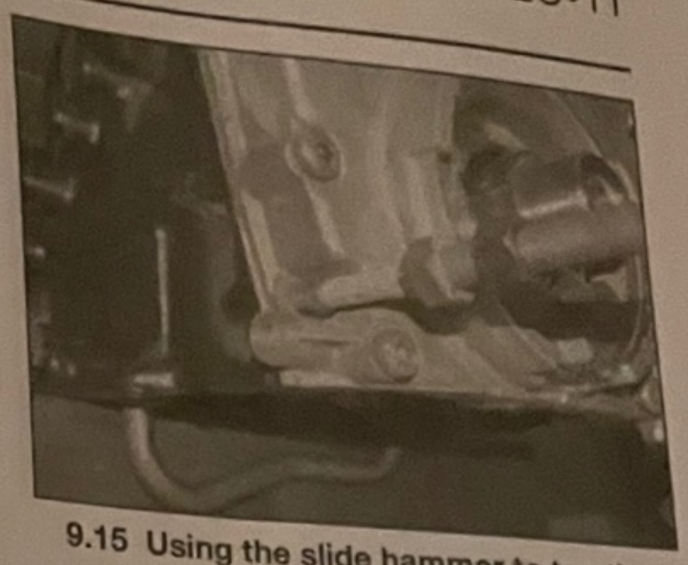
19 Refit the alternator and power steering pump mounting brackets, and tighten the retaining bolts.

20 Refit the alternator with reference to Chapter 5A.

21 Refit the drivebelt tensioner assembly and idler pulley, and tighten the bolts.



9.14 Applying sealant (arrowed) on the timing cover flanges



9.15 Using the slide hammer to tap the dowels back into the timing cover

10 Timing chain and sprockets (petrol engines) – removal, inspection and refitting

Removal

1 Position the crankshaft at TDC compression for No 1 piston (timing chain end of the engine) as described in Chapter 2A, Section 3.

2 Remove the timing cover as described in Section 9. Also remove the oil pump drive dog from the crankshaft **(see illustration)**.

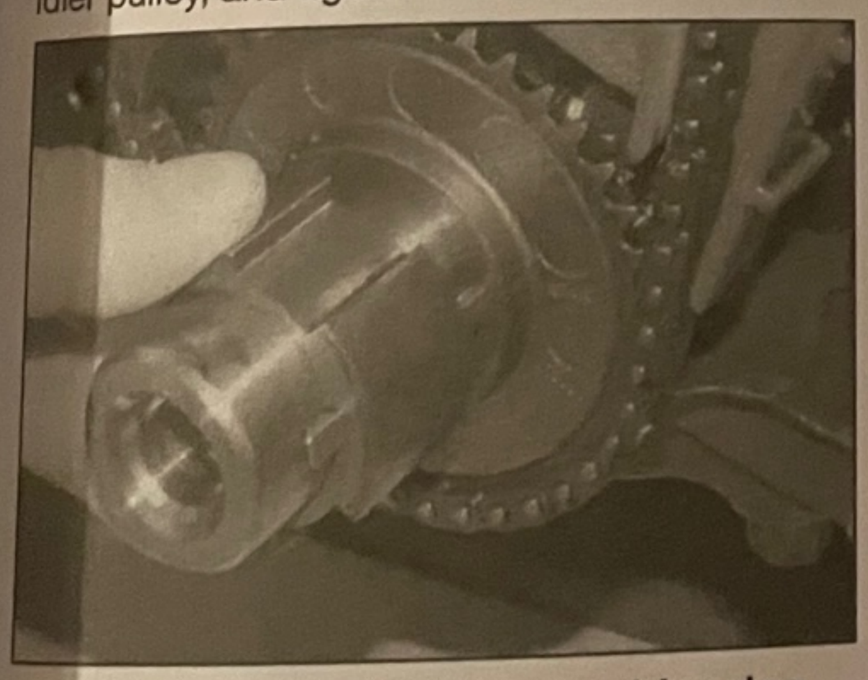
3 The balance shafts are 'timed' at TDC, but since they rotate at twice the speed of the crankshaft, they may also be correctly 'timed' at BDC. Check that the timing marks on the shafts are correctly aligned with the marks on the front of the cylinder block/bearing housing. Note that the balance shaft sprockets are marked 'intake' and 'exhaust' for their positions, but both front bearings are marked identically. However, as the bearings are located with single bolts, the 'intake' and 'exhaust' marks will always be correctly located at the top of the bearings **(see illustrations)**.

4 Unbolt the balance shaft chain upper guide, then remove the tensioner and side guide **(see illustrations)**.

5 Unbolt the idler from the block, then release the chain from the balance shaft sprockets and crankshaft sprocket. Note that the idler is in two parts **(see illustrations)**.

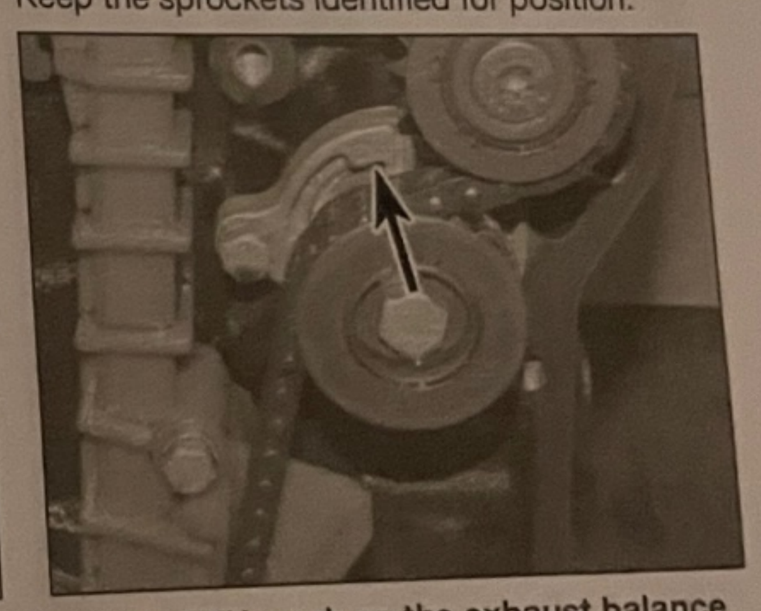
6 Slide the balance shaft chain sprocket from the front of the crankshaft **(see illustration)**. Note that the word 'Saab' is facing outwards.

7 Unscrew the retaining bolts, and remove the sprockets from the ends of the balance shafts. To do this, hold the sprockets stationary with a chain-type oil filter removal tool or similar. Keep the sprockets identified for position.

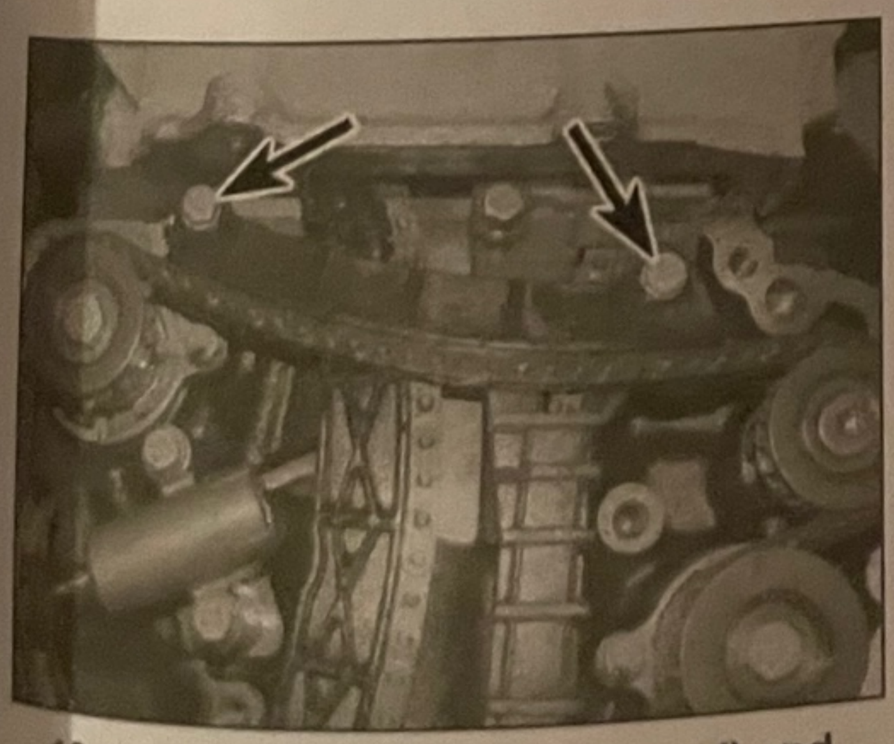


10.2 Removing the oil pump drive dog from the crankshaft

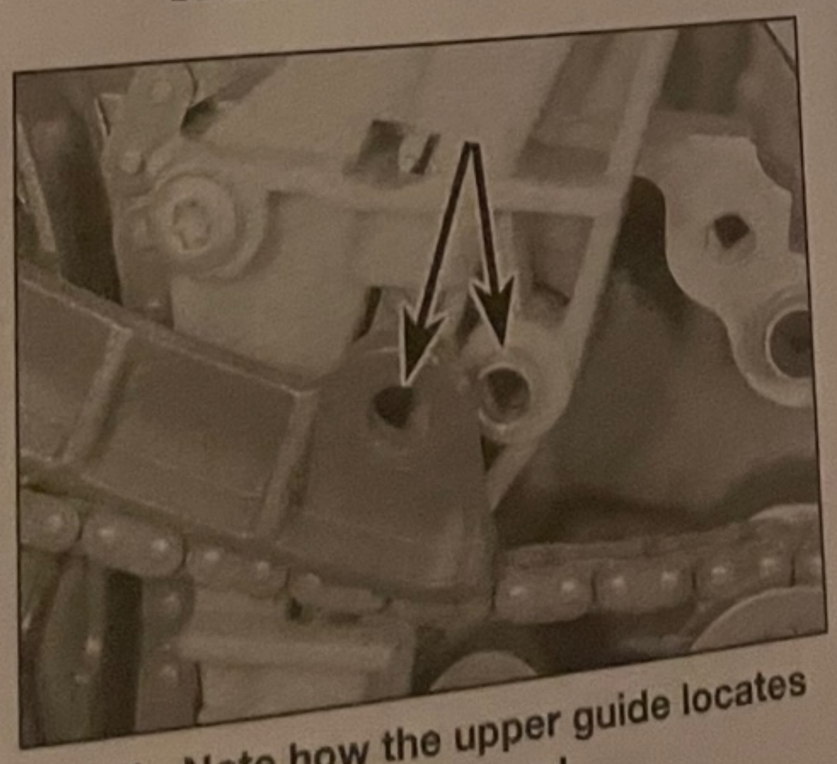
10.3a INL mark on the intake (inlet) balance shaft front bearing



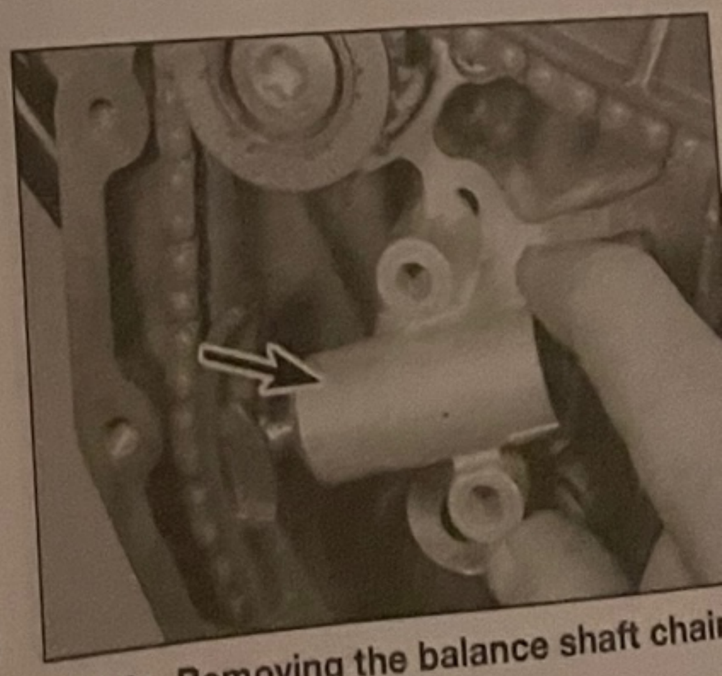
10.3b EXH mark on the exhaust balance shaft front bearing



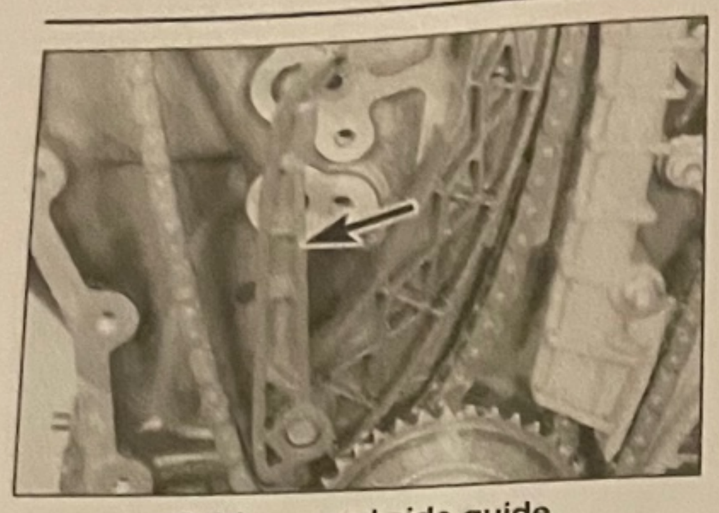
10.4a Unscrew the bolts (arrowed) and remove the balance shaft chain upper guide



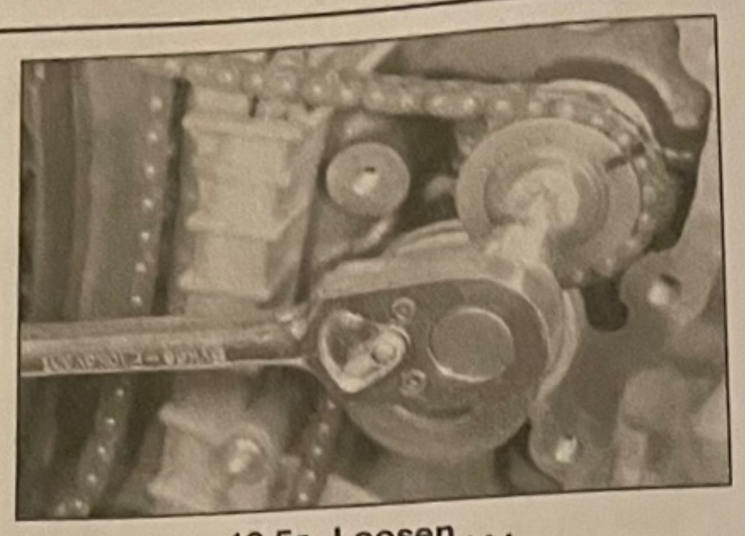
10.4b Note how the upper guide locates on the dowel



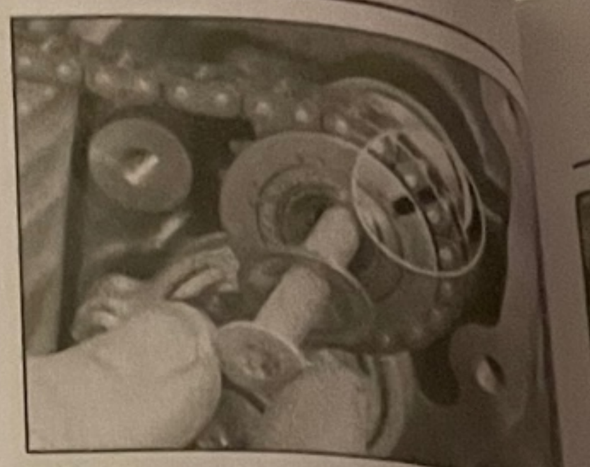
10.4c Removing the balance shaft chain tensioner . . .



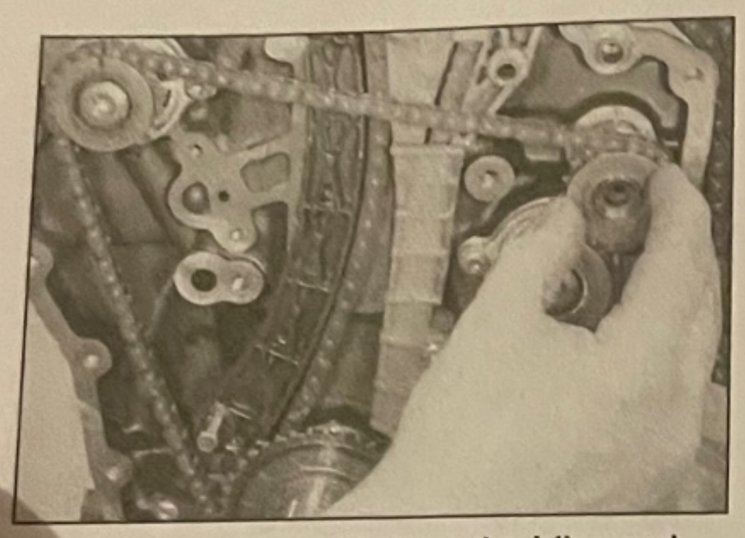
10.4d . . . and side guide



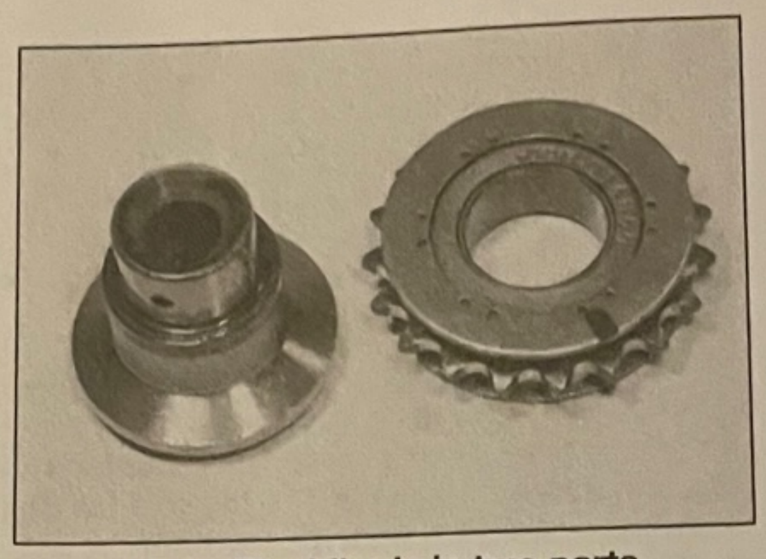
10.5a Loosen . . .



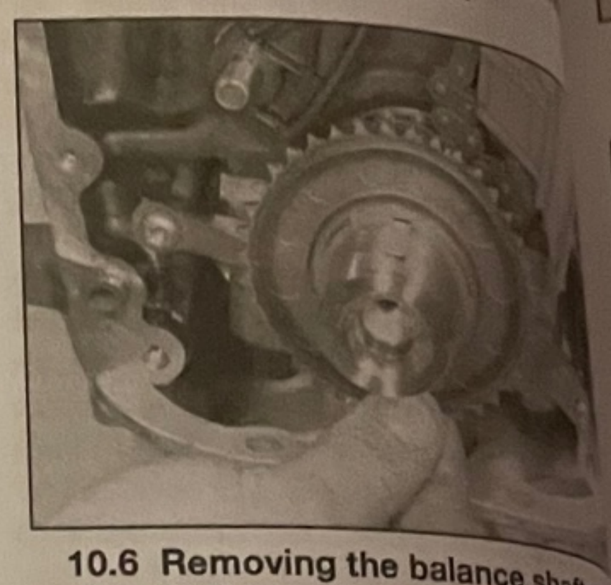
10.5b . . . and remove the idler r bolt (note alignment marks betwe and chain) . . .



10.5c . . . then withdraw the idler and remove the balance shaft chain



10.5d The idler is in two parts



10.6 Removing the balance shaft ch sprocket from the front of the crank

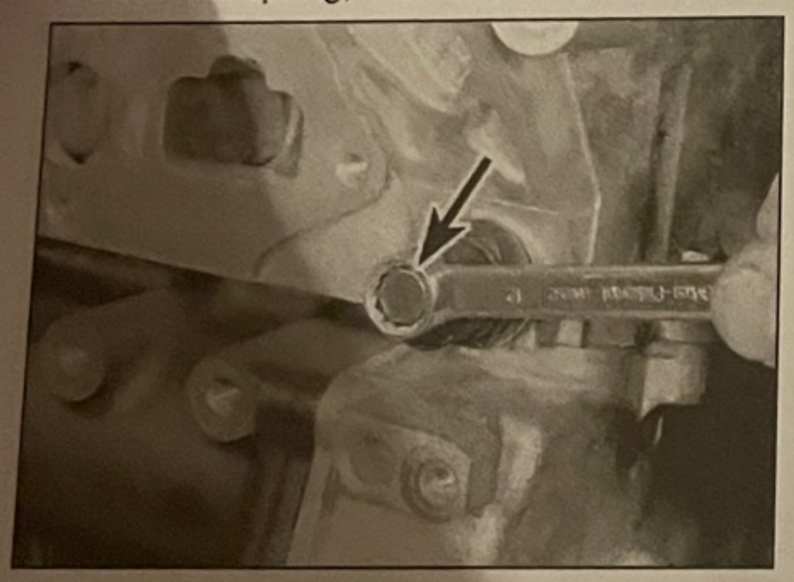
8 Remove the cylinder head cover as described in Chapter 2A.

9 Unscrew and remove the timing chain tensioner from the rear of the cylinder head. To do this, first unscrew the centre bolt and remove the spring, then unscrew and remove the tensioner from the cylinder head **(see illustrations)**.

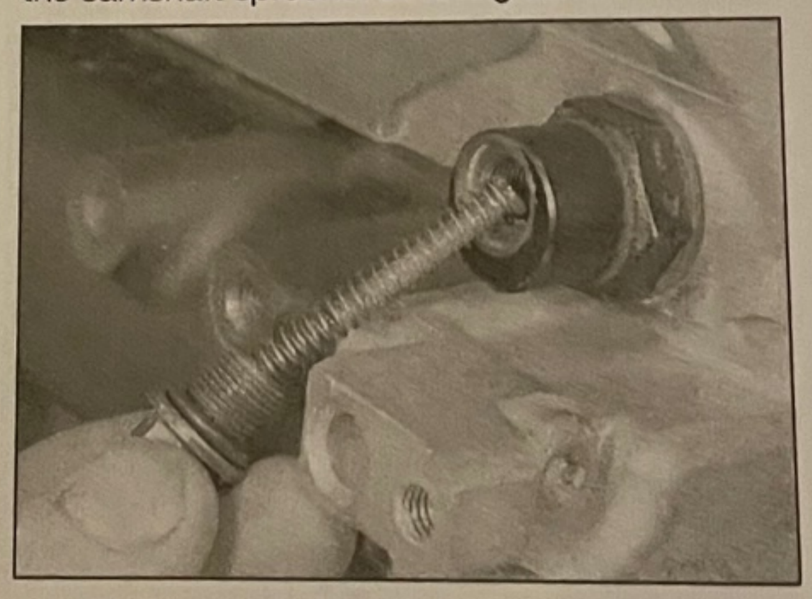
10 While holding each camshaft stationary with a spanner on the flats at the flywheel/driveplate end of the camshaft, loosen (but do not remove) the camshaft sprocket securing bolts.

11 Unscrew and remove the bolt, withdraw the sprocket from the end o intake camshaft **(see illustration)**. Ho timing chain with one hand, and releas sprocket from it with the other hand.

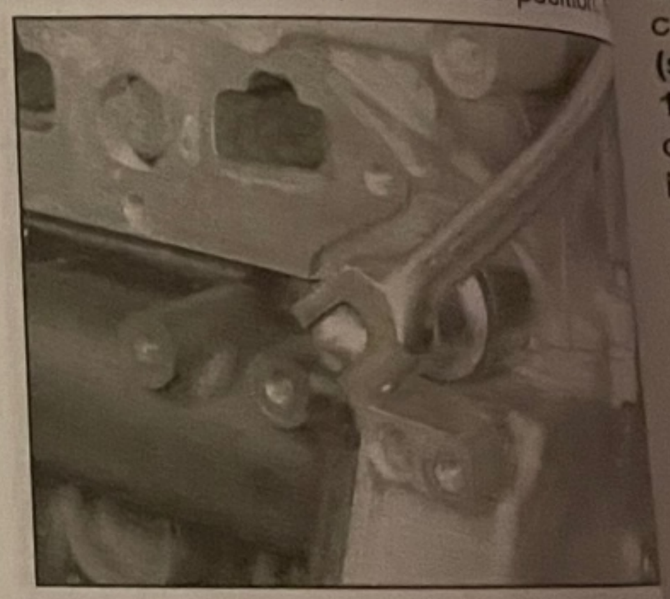
12 Identify each sprocket for position



10.9a Unscrew the centre bolt . . .

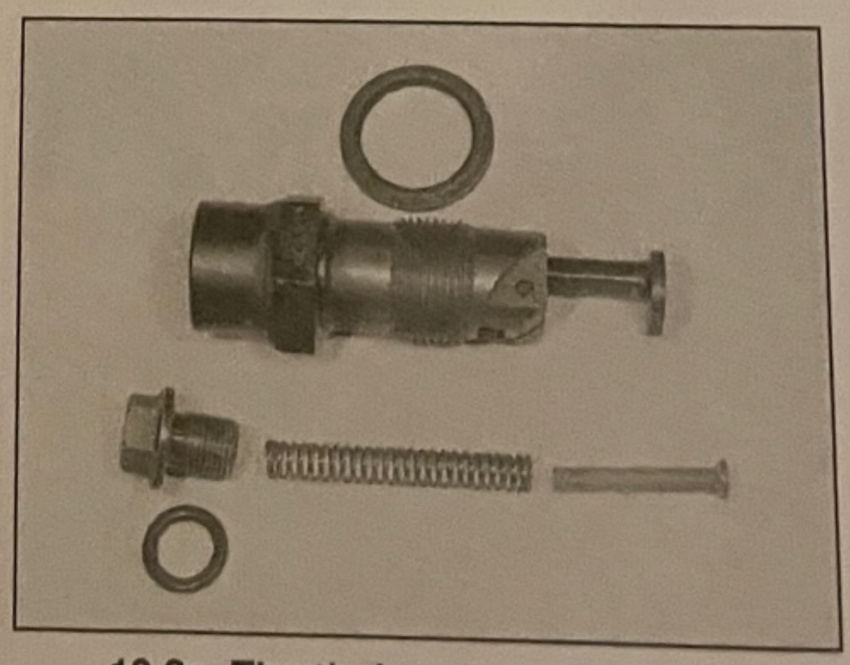


10.9b . . . and remove the spring . . .

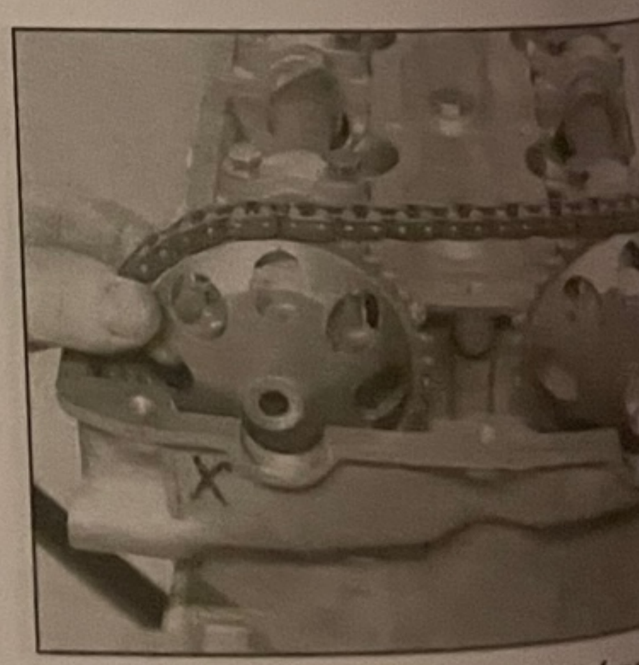


10.9c . . . then unscrew the tensioner

10.9d . . . and remove it from the cylinder head

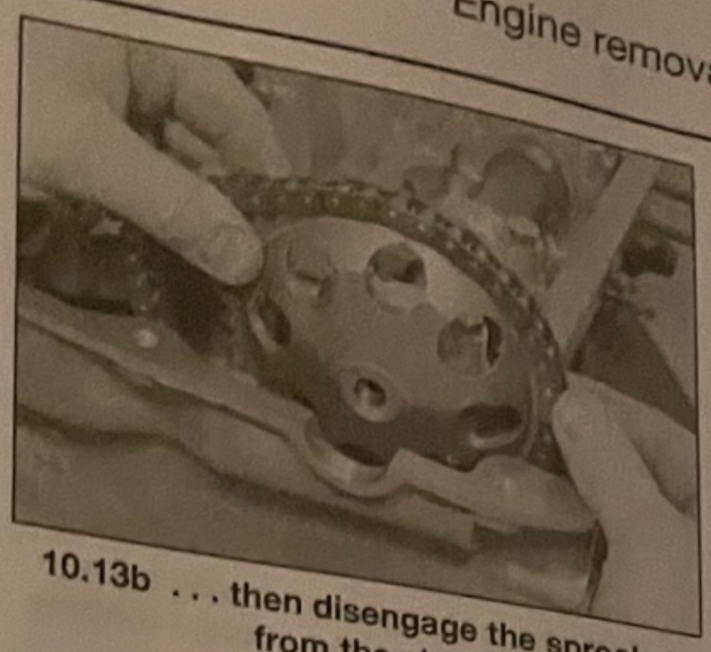


10.9e The timing chain tensioner components

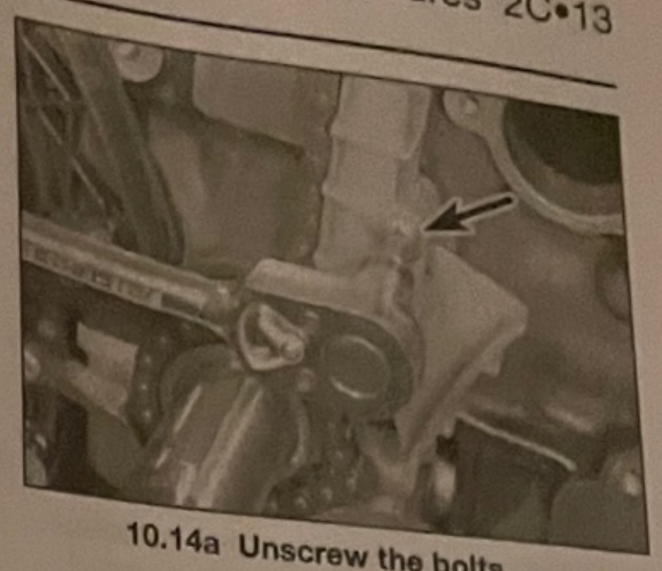


10.11 Removing the sprocket fro of the intake camshaft

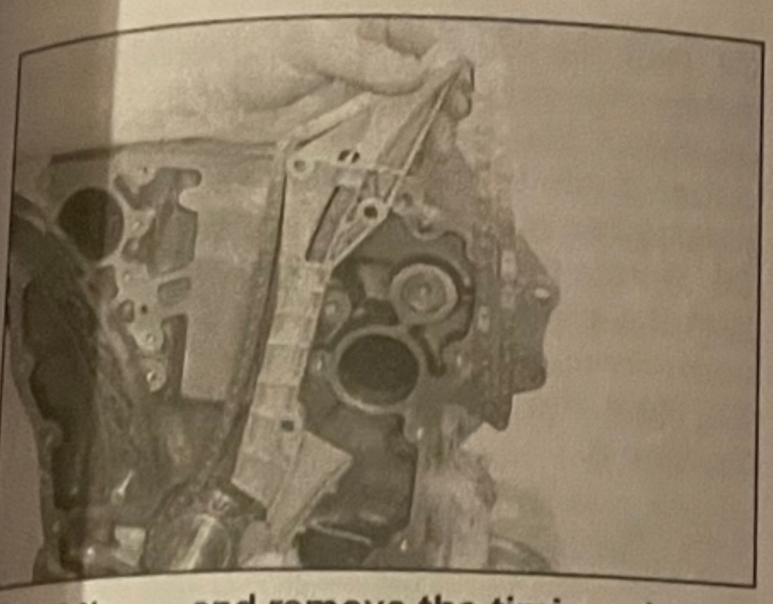
10.13a Remove the retaining bolt . . .



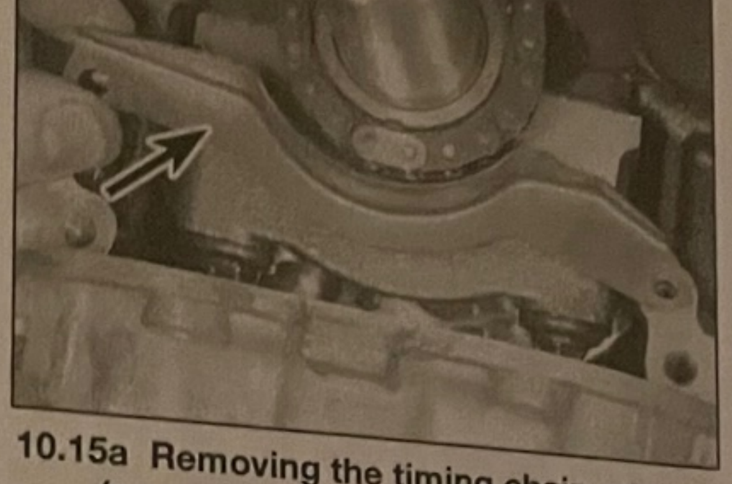
10.13b . . . then disengage the sprocket from the chain



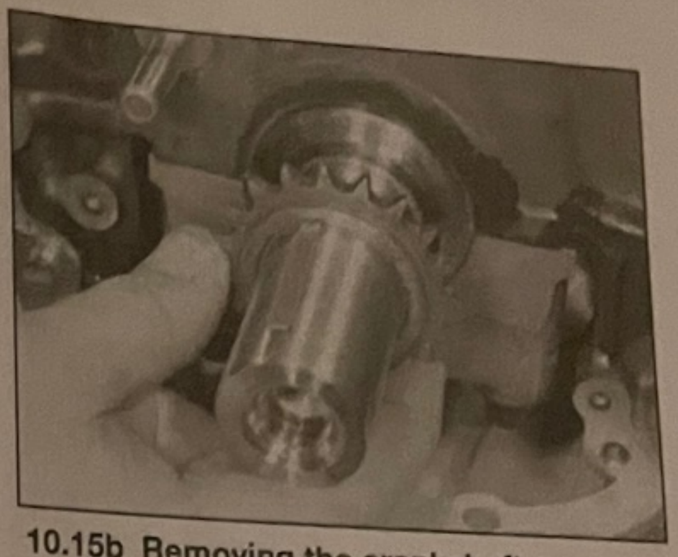
10.14a Unscrew the bolts . . .



10.14b . . . and remove the timing chain fixed guide



10.15a Removing the timing chain retainer (arrowed) from the cylinder block



10.15b Removing the crankshaft sprocket from the end of the crankshaft

that each sprocket has a projection, which engages with a cut-out in the end of the camshaft.

13 Unscrew the bolt and withdraw the sprocket from the end of the exhaust camshaft, then disengage it from the chain **(see illustrations)**.

14 Unscrew the bolts, and remove the timing chain fixed guide from the cylinder block **(see illustrations)**.

15 Unbolt the chain retainer from the cylinder block, then disengage the timing chain and remove the sprocket from the end of the crankshaft **(see illustrations)**. If necessary, remove the Woodruff key from the groove in the crankshaft using a screwdriver.

Inspection

16 The timing chain **(see illustration)** and the balance shaft chain should be renewed if the sprockets are worn, or if the chain is loose and noisy in operation. It's a good idea to renew the chains as a matter of course if the engine is stripped down for overhaul. The rollers on a very badly worn chain may be slightly grooved. To avoid future problems, if there's any doubt at all about the chain's condition, renew it. The chain tensioner and guides should be examined and if necessary renewed at the same time (refer to Section 11).

17 Examine the teeth on the crankshaft sprocket, camshaft sprockets and the balance shaft sprockets for wear. Each tooth forms an inverted V. If worn, the side of each tooth under tension will be slightly concave (hooked) in shape, when compared with the other side of the tooth (ie, one side of the inverted V will be concave when compared with the other). If the teeth appear to be worn, the sprockets must be renewed.

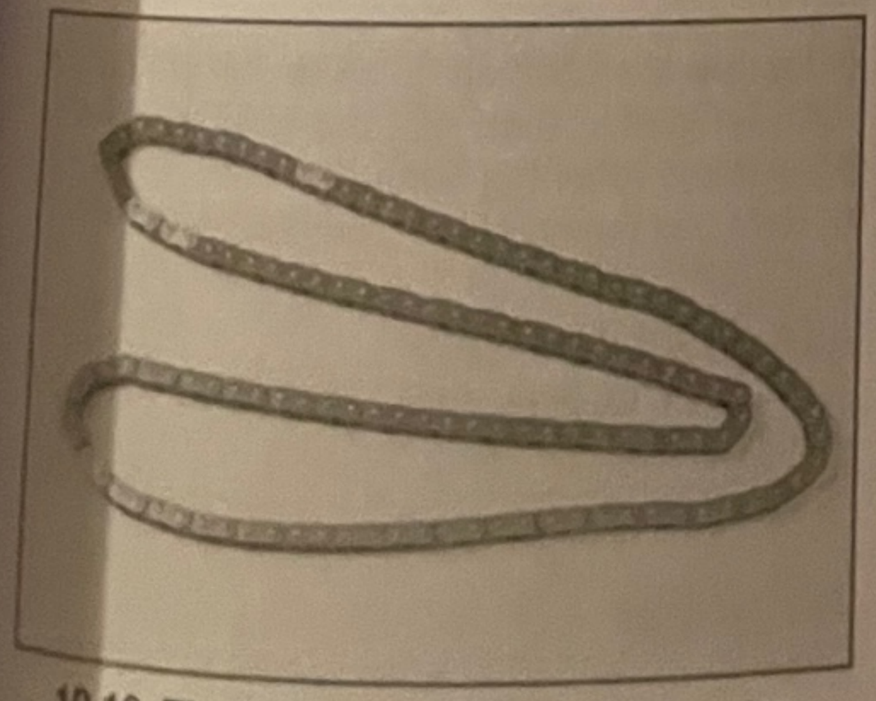
Refitting

18 Locate the Woodruff key in the groove in the crankshaft. Tap it fully into the groove, making sure that its plane surface is parallel to the crankshaft.

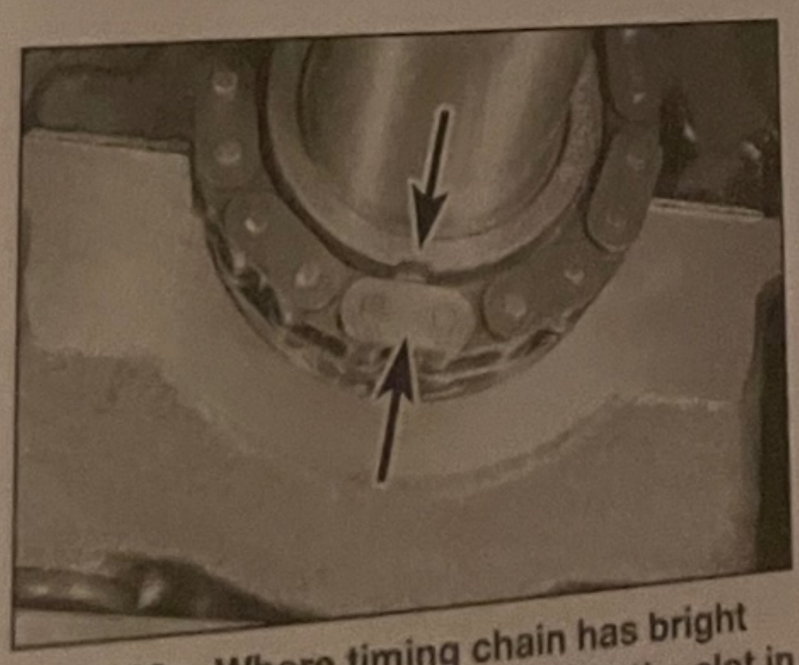
19 Engage the timing chain with the crankshaft sprocket, then locate the crankshaft sprocket on the end of the crankshaft, making sure that it locates correctly on the Woodruff key. Where the timing chain has bright links, locate the single bright link at the bottom of the sprocket, aligned with the slot in the sprocket. Refit the chain retainer and tighten the bolts **(see illustrations)**.

20 Locate the timing chain in the fixed guide, then refit the guide and tighten the bolts.

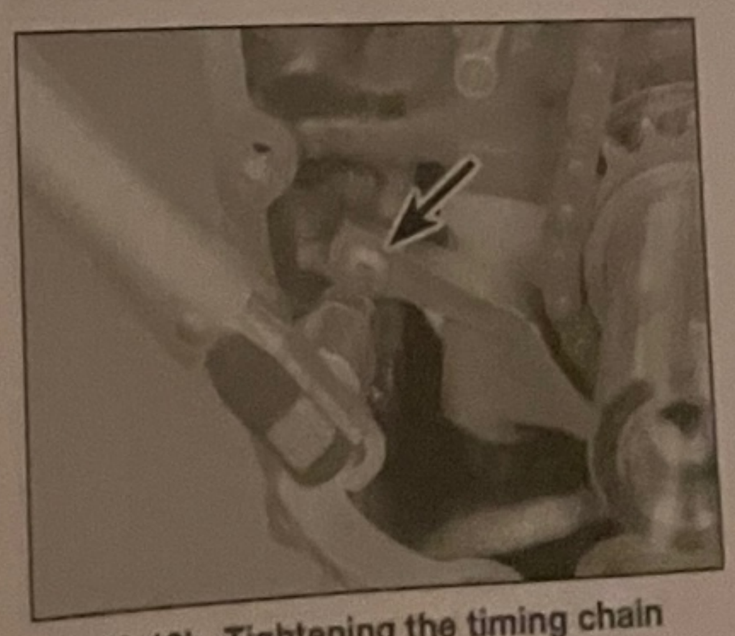
21 Refit the sprocket to the end of the exhaust camshaft, insert the bolt and finger-tighten it at this stage. **Do not** apply thread-locking fluid to the threads of the bolt.



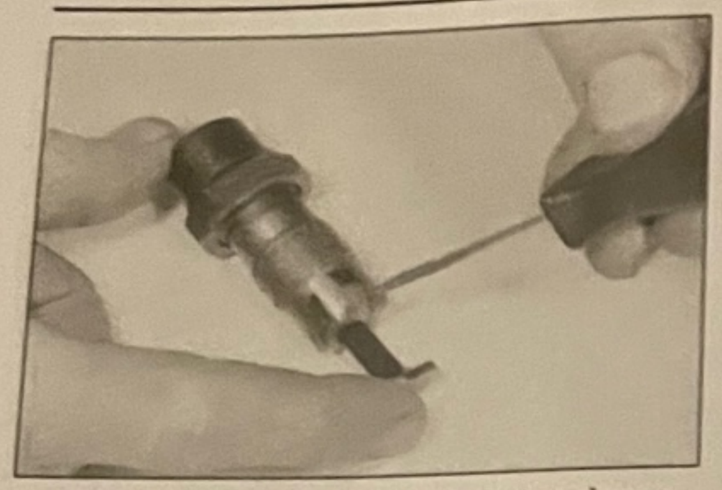
10.16 Timing chain removed from the engine



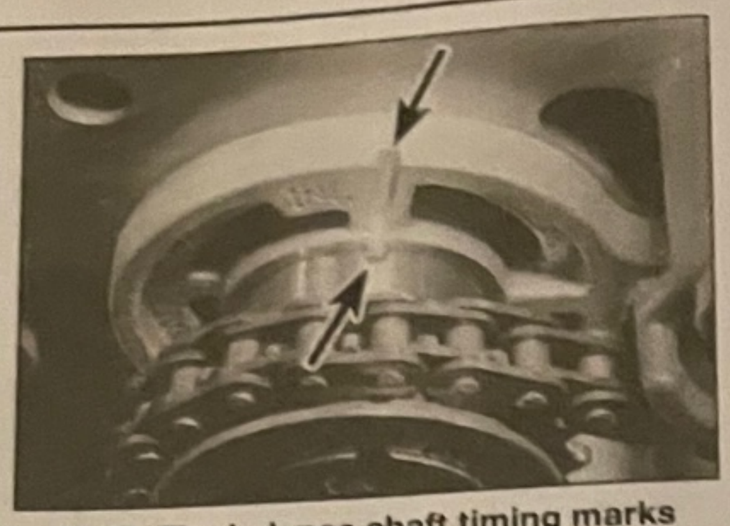
10.19a Where timing chain has bright links, these must be aligned with the slot in the sprocket (arrowed)



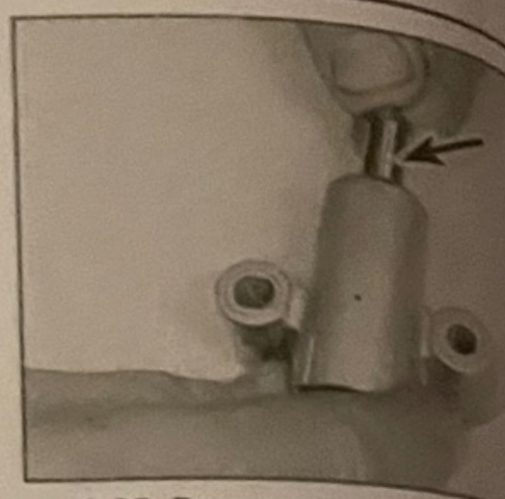
10.19b Tightening the timing chain retainer bolts



10.25 Setting the timing chain tensioner

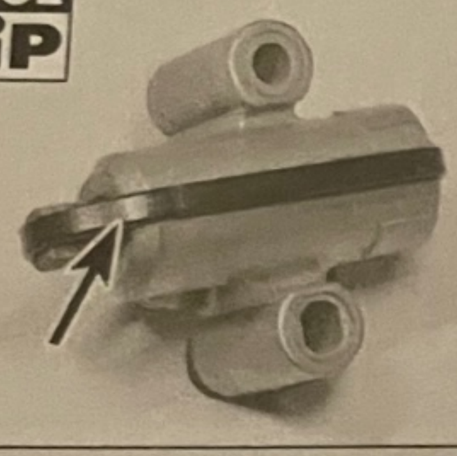


10.33 The balance shaft timing marks must be correctly aligned before refitting the chain



10.35 Depress the balance shaft chain tensioner plunger (arrowed) and retain it with a plastic cable-tie

TOOL TiP



Before refitting the tensioner, hold its plunger depressed by fitting a plastic cable-tie around it. Cut the tie after refitting.

22 Check that the crankshaft and camshafts are still aligned at their TDC positions.

23 Feed the timing chain up through the cylinder head aperture, and locate it on the exhaust camshaft sprocket, making sure that it is taut between the two sprockets. Check that it is correctly located on the guides. Where the chain has a bright link, make sure that it is aligned with the timing mark.

24 Engage the intake sprocket with the timing chain so that the engagement cut-out and projection are in alignment, then locate the sprocket on the intake camshaft, and insert the bolt. Finger-tighten the bolt at this stage. **Do not** apply thread-locking fluid to the threads of the bolt. Where the chain has a bright link, make sure that it is aligned with the timing mark.

25 Set the timing chain tensioner by pressing down on the ratchet with a screwdriver, then push the plunger fully into the tensioner, and release the ratchet **(see illustration)**. Check the tensioner washer for condition and renew it if necessary.

26 Insert the tensioner body in the cylinder head, and tighten to the specified torque.

27 Insert the spring and plastic guide pin in the tensioner, then fit the plug together with a new O-ring, and tighten it to the specified torque. **Note:** *New tensioners are supplied with the tensioner spring held pretensioned with a pin.* ***Do not*** *remove this pin until after the tensioner has been tightened into the cylinder head.* When the engine is started, hydraulic pressure will take up any remaining slack.

28 Temporarily refit the crankshaft pulley bolt, and rotate the engine two complete turns clockwise. Check that the timing marks still align correctly. Remove the pulley bolt. Where the chain has bright links, note that these will not now be aligned with the timing marks.

29 Fully tighten the camshaft sprocket bolts to the specified torque, while holding the camshafts with a spanner on the flats.

30 Refit the cylinder head cover with reference to Chapter 2A.

31 Refit the sprockets to the ends of the balance shafts, and tighten the retaining bolts.

32 Locate the balance shaft chain sprocket on the front of the crankshaft, with the word 'Saab' facing outwards.

33 Fit the chain to the sprockets, making sure that the timing marks are aligned correctly **(see illustration)**.

34 Refit the idler to the front of the block, and tighten the retaining bolt.

35 Refit the side guide, tensioner and upper guide to the balance shaft chain **(see illustration and Tool Tip)**.

36 Rotate the crankshaft one turn, and check that the balance shaft timing marks are correctly aligned.

37 Refit the timing cover with reference to Section 5.

11 Timing chain guides and tensioner (petrol engines) – removal, inspection and refitting

Removal

1 Remove the timing chain as described in Section 10; note that this procedure includes removal of the fixed guide and balance shaft chain guides. The timing chain need not be removed from the crankshaft sprocket.

2 Unbolt and remove the fixed timing chain guide and release the pivoting guide from the pin on the cylinder block **(see illustration)**.

Inspection

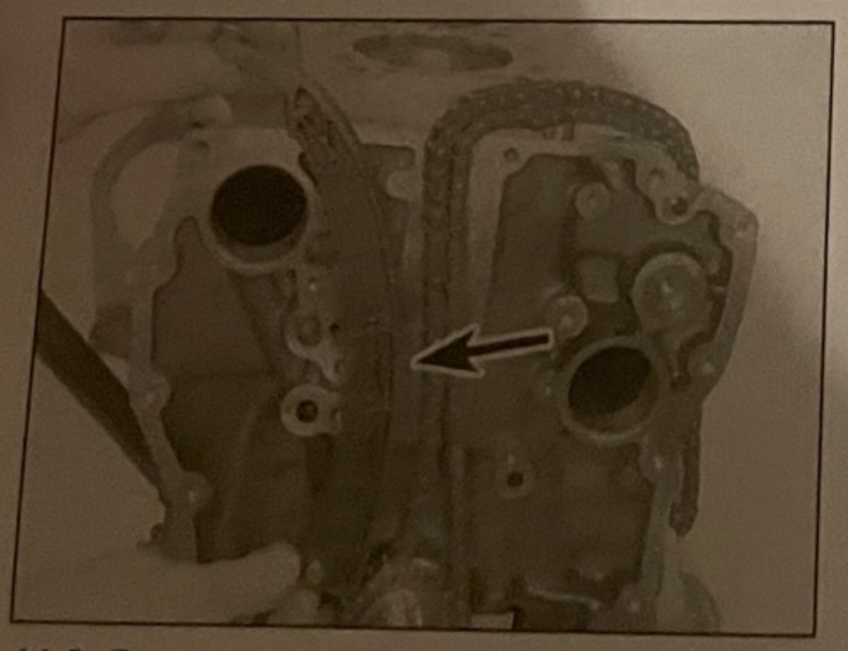
3 Inspect the chain guides for damage and excessive wear, and renew them if necessary.

4 Clean the tensioner plunger and body, and examine them for damage and wear **(see illustration)**. The plunger may be removed by depressing the ratchet against the spring. If the plunger or body is excessively scored, the complete tensioner should be renewed.

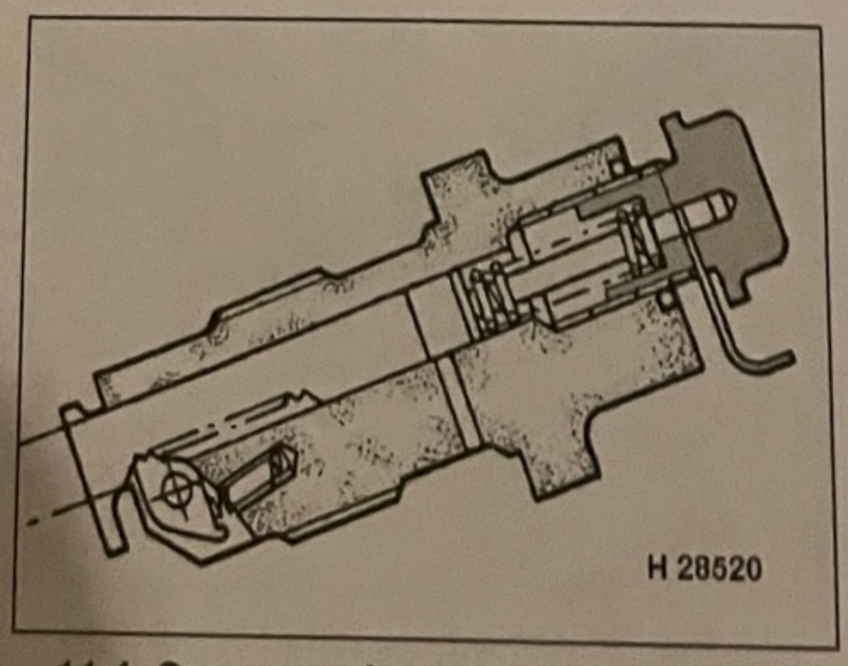
Refitting

5 Locate the pivoting guide on the pin on the cylinder block, then refit the fixed guide and tighten the retaining bolts.

6 Refit the timing chain (see Section 10).



11.2 Removing the pivoting guide from the pin on the cylinder block



11.4 Cross-section of the timing chain tensioner

12 Balance shafts (petrol engines) – removal, inspection and refitting

Removal

1 Position the crankshaft at TDC compression for No 1 piston (timing chain end of the engine) as described in Chapter 2A, Section 3.

2 Remove the timing cover as described in Section 9.

3 The balance shafts are 'timed' at TDC, but since they rotate at twice the speed of the crankshaft, they may also be correctly 'timed' at BDC. Check that the timing marks on the shafts are correctly aligned with the marks on the bearing brackets. As an extra precaution, apply dabs of paint to the chain and sprockets, to ensure correct refitting. Note that the balance shaft sprockets are marked 'intake' and 'exhaust' for position, but the front bearings are marked identically. However, as the bearings are located with single bolts, the 'intake' and 'exhaust' marks will always be correctly located at the top of the bearings – refer to Section 10 for further information.

4 Unbolt the balance shaft chain upper guide, then remove the tensioner and side guide **(see illustrations in Section 10)**.

5 Unscrew the retaining bolt and remove the idler from the block.

6 Release the chain from the balance shaft sprockets and crankshaft sprocket.

7 Unscrew the bearing retaining bolts, and withdraw the balance shafts from the cylinder block **(see illustrations)**. Keep the shafts identified for position.

8 Unscrew the retaining bolts, and remove the sprockets from the ends of the balance shafts, while holding each shaft in a soft-jawed vice.

Inspection

9 Clean the balance shafts and examine the bearing journals for wear and damage. The bearings inside the cylinder block should also be examined. If these are excessively worn or damaged, get advice from a Saab dealer or engine reconditioner.

Refitting

10 Fit the sprockets to the ends of the balance shafts, and tighten the retaining bolts.

11 Lubricate the bearing journals with clean engine oil, then insert the balance shafts in the cylinder block in their correct positions.

12 Locate the balance shaft chain sprocket on the front of the crankshaft, with the word 'Saab' facing outwards.

13 Fit the chain to the sprockets, and refit the idler to the front of the block, making sure that the timing marks remain aligned correctly.

14 Refit the side guide, tensioner and upper guide to the balance shaft chain.

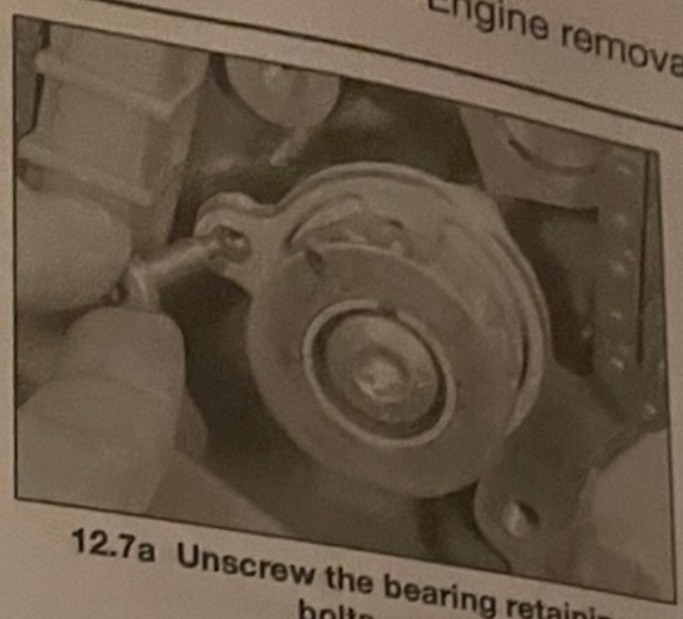
15 Rotate the crankshaft one turn, and check that the balance shaft sprockets are still correctly aligned.

16 Refit the timing cover with reference to Section 9.

13 Piston/connecting rod assembly – removal

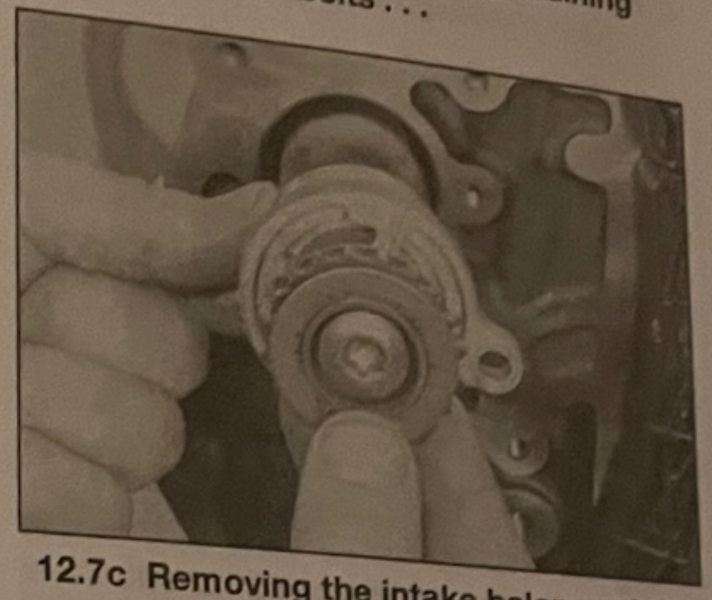
Note: *New connecting rod big-end cap bolts will be needed on refitting.*

1 Remove the cylinder head, sump and oil pump pick-up/strainer as described in Part A or Part B of this Chapter.

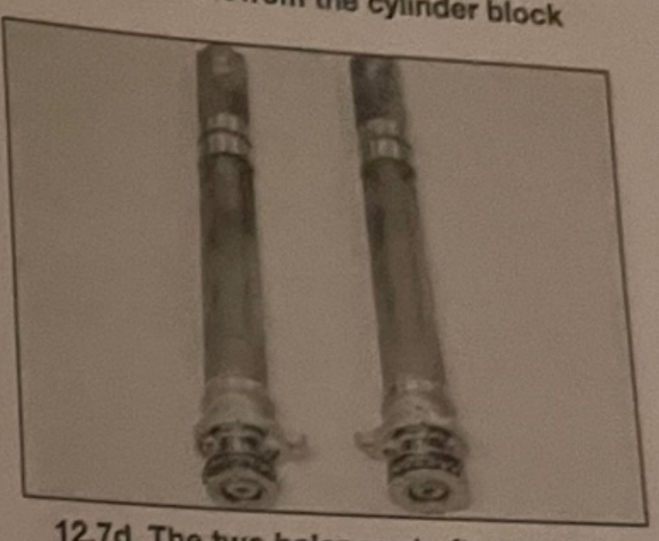


12.7a Unscrew the bearing retaining bolts . . .

12.7b . . . and withdraw the exhaust balance shaft from the cylinder block



12.7c Removing the intake balance shaft from the cylinder block



12.7d The two balance shafts removed from the engine

Caution: On some engines, the connecting rod/bearing cap mating surfaces are not machined flat; the big-end bearing caps are 'cracked' off from the rod during production and left untouched to ensure the cap and rod mate perfectly. Where this type of connecting rod is fitted, great care must be taken to ensure the mating surfaces of the cap and rod are not marked or damaged in anyway. Any damage to the mating surfaces will adversely affect the strength of the connecting rod and could lead to premature failure.

2 If there is a pronounced wear ridge at the top of any bore, it may be necessary to remove it with a scraper or ridge reamer, to avoid piston damage during removal. Such a ridge indicates excessive wear of the cylinder bore.

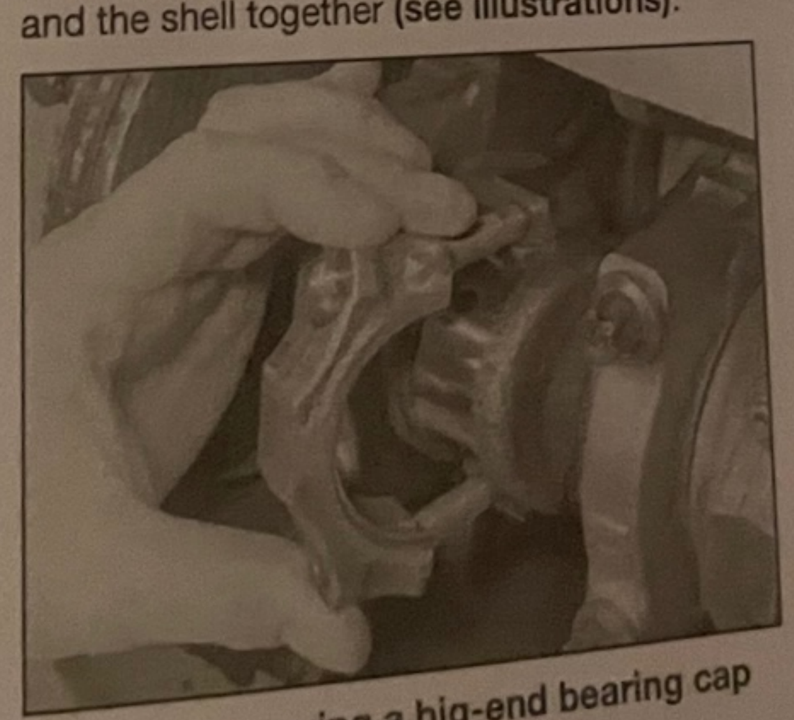
3 Using a hammer and centre-punch, paint or similar, mark each connecting rod big-end bearing cap with its respective cylinder number on the flat machined surface provided; if the engine has been dismantled before, note carefully any identifying marks made previously.

4 Turn the crankshaft to bring pistons 1 and 4 to BDC (bottom dead centre).

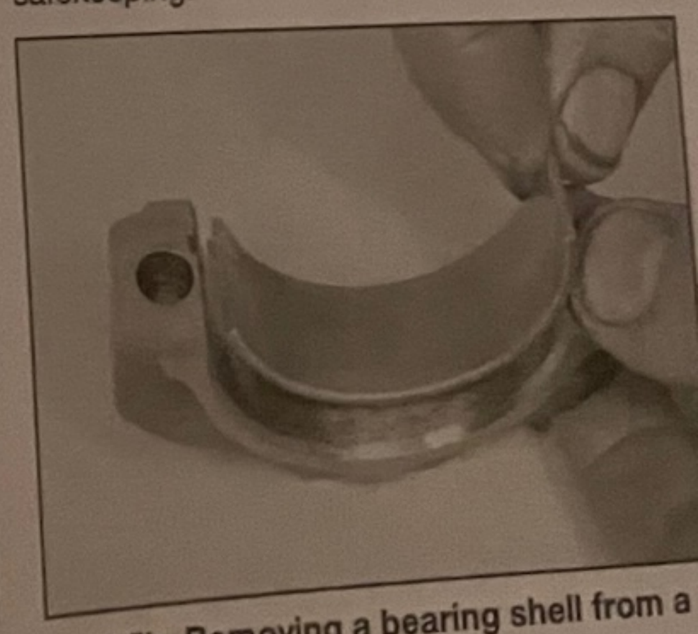
5 Unscrew the nuts/bolts from No 1 piston big-end bearing cap. Take off the cap, and recover the bottom half bearing shell. If the bearing shells are to be re-used, tape the cap and the shell together **(see illustrations)**.

6 To prevent the possibility of damage to the crankshaft bearing journals, tape over the connecting rod stud threads.

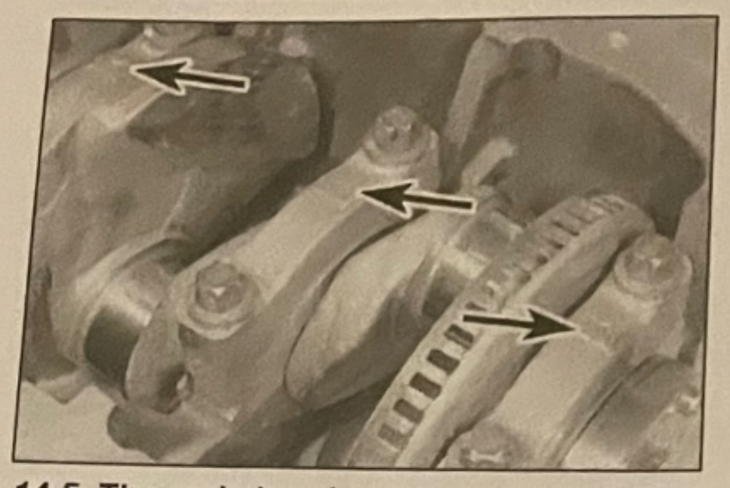
7 Using a hammer handle, push the piston up through the bore, and remove it from the top of the cylinder block. Recover the bearing shell, and tape it to the connecting rod for safekeeping.



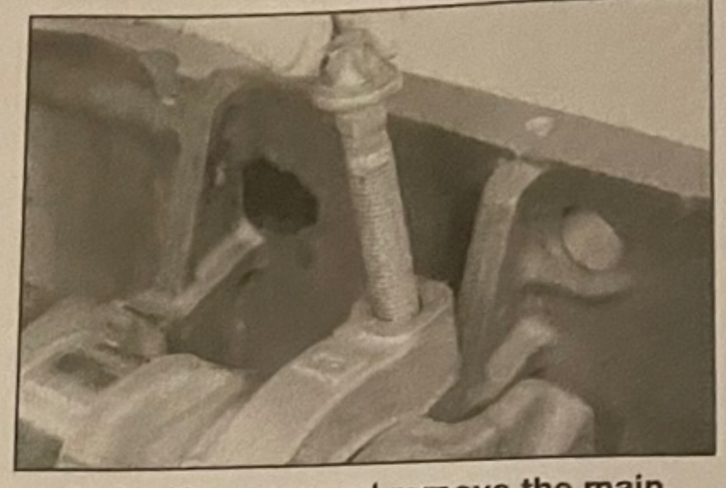
13.5a Removing a big-end bearing cap



13.5b Removing a bearing shell from a big-end bearing cap



14.5 The main bearing caps are numbered from the timing chain end of the engine



14.6a Unscrew and remove the main bearing cap bolts . . .

14.6b . . . and remove the main bearing caps

8 Loosely refit the big-end cap to the connecting rod, and secure with the nuts/bolts – this will help to keep the components in their correct order.

9 Remove No 4 piston assembly in the same way.

10 Turn the crankshaft through 180° to bring pistons 2 and 3 to BDC (bottom dead centre), and remove them in the same way.

14 Crankshaft – removal

Note: *New main bearing bolts will be required on refitting.*

1 Remove the timing chain and sprocket (petrol engines), the sump and oil pump pick-up/strainer/transfer tube, and the flywheel/driveplate.

2 Remove the pistons and connecting rods, as described in Section 13. **Note:** *If no work is to be done on the pistons and connecting rods, there is no need to remove the cylinder head, or to push the pistons out of the cylinder bores. The pistons should just be pushed far enough up the bores that they are positioned clear of the crankshaft journals.*

3 Check the crankshaft endfloat with reference to Section 17, then proceed as follows.

4 Unbolt and remove the crankshaft oil seal housing from the end of the cylinder block, noting the correct fitted locations of the locating dowels. If the locating dowels are a loose fit, remove them and store them with the housing for safe-keeping. Remove the gasket.

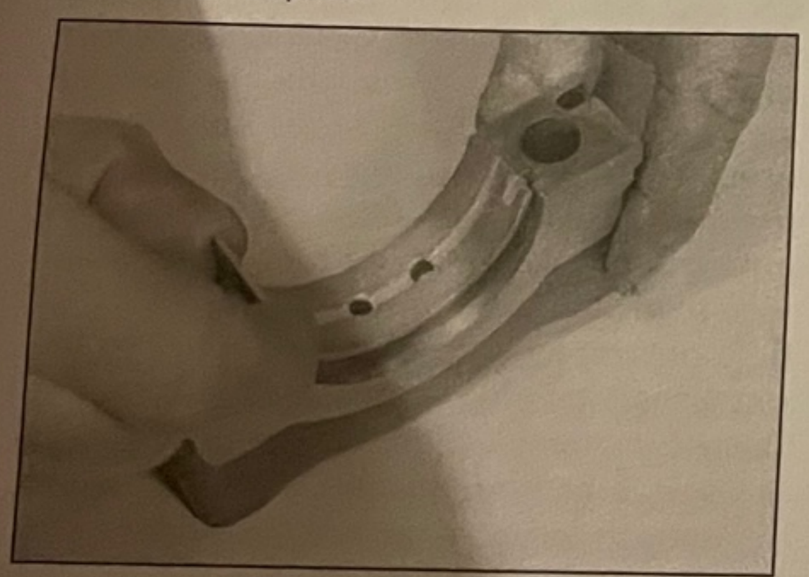
5 Identification numbers should already be cast onto the base of each main bearing cap **(see illustration)**. If not, number the cap and crankcase using a centre-punch, as was done for the connecting rods and caps.

6 Working in a diagonal sequence, e progressively slacken the ten main cap retaining bolts by half a turn at a all bolts are loose. Remove all the withdraw the caps, complete with shells **(see illustrations)**. Tap the caps wooden or copper mallet if they are **7** Remove the bearing shells from the but keep them with their relevant identified for position to ensure correct **(see illustration)**.

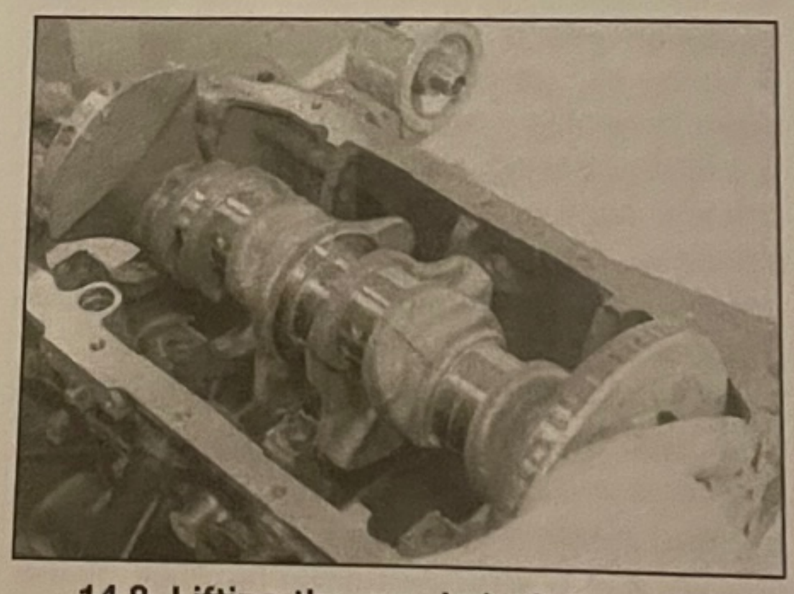
8 Carefully lift out the crankshaft, taki not to displace the upper main bearing **(see illustration)**.

9 Remove the upper bearing shells the crankcase, keeping them identifi position. Also remove the thrustwash each side of the centre main bearing, and them with the bearing cap **(see illustrat**

10 With the crankshaft removed crankshaft position sensor reluctor applicable) may be removed if nece by unscrewing the screws and withdr the reluctor over the end of the cran **(see illustration)**. Note that the screw arranged so that it is only possible to re reluctor in one position.



14.7 Removing a main bearing shell from its cap

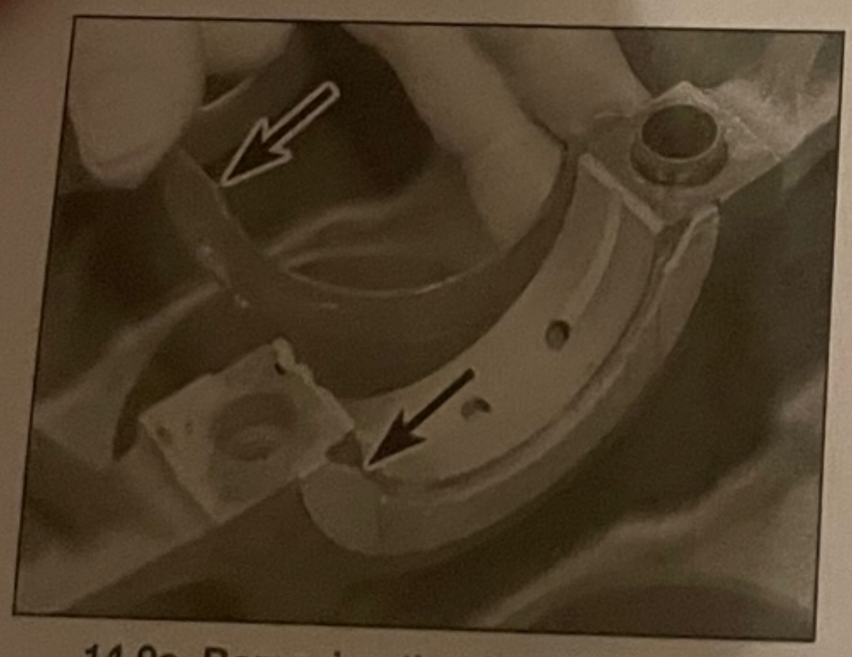


14.8 Lifting the crankshaft from the crankcase

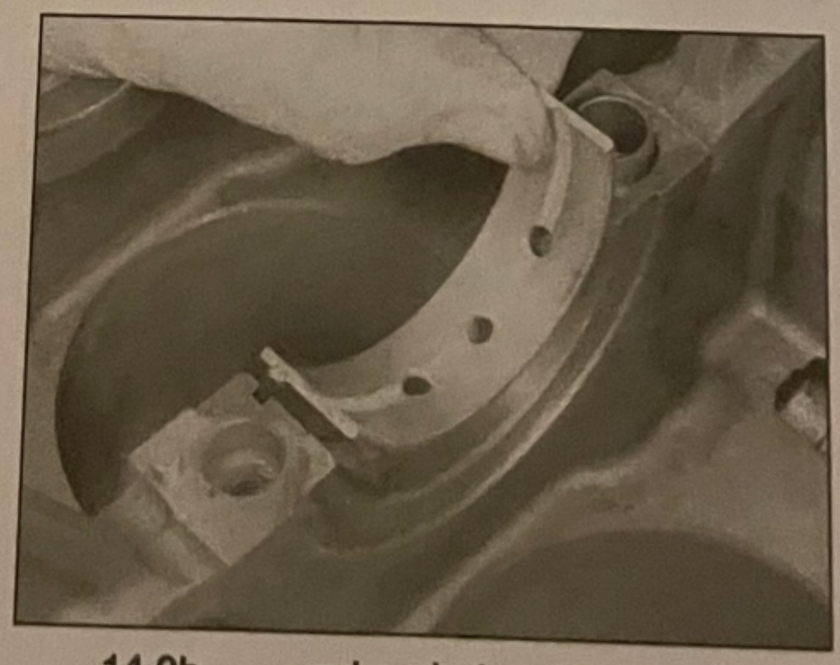
15 Cylinder block/crankcase – cleaning and inspection

Cleaning

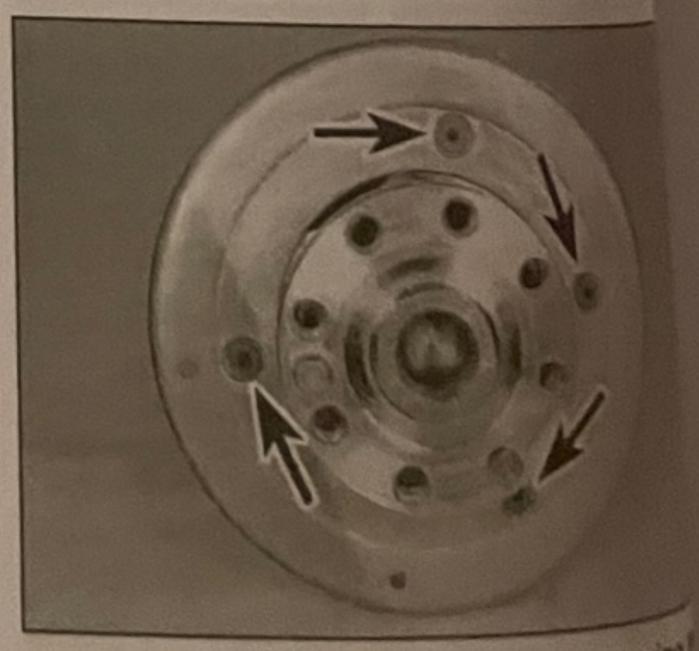
1 Remove all external components electrical switches/sensors from the b



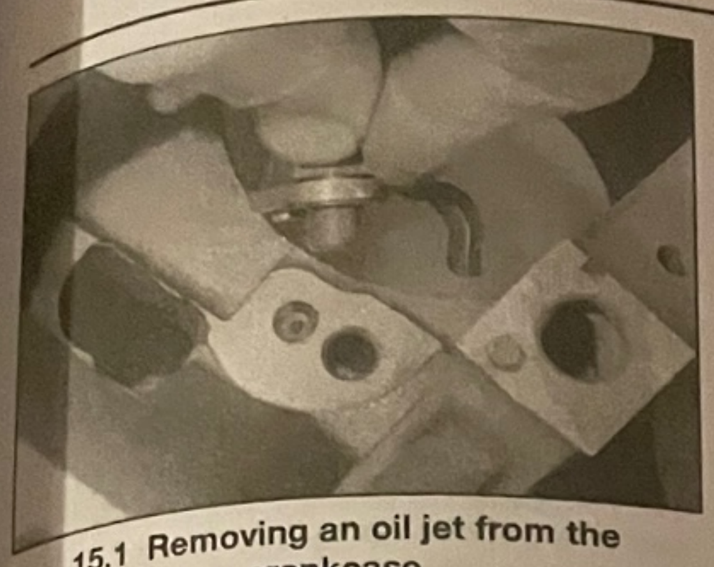
14.9a Removing the thrustwashers (arrowed) . . .



14.9b . . . and main bearing shells



14.10 Location of the screws securing crankshaft position sensor reluctor



15.1 Removing an oil jet from the crankcase

For complete cleaning, the core plugs should ideally be removed, as follows. Drill a small hole in the plugs, and then insert a self-tapping screw into the hole. Pull out the plugs by pulling on the screw with a pair of grips, or by using a slide hammer. Also unbolt the four oil jets (where fitted) from the lower part of the crankcase **(see illustration)**.

2 Scrape all traces of sealant from the cylinder block/crankcase, taking care not to damage the gasket/sealing surfaces.

3 Remove all oil gallery plugs (where fitted). The plugs are usually very tight – they may have to be drilled out, and the holes retapped. Use new plugs when the engine is reassembled.

4 If the cylinder block/crankcase is extremely dirty, it should be steam-cleaned.

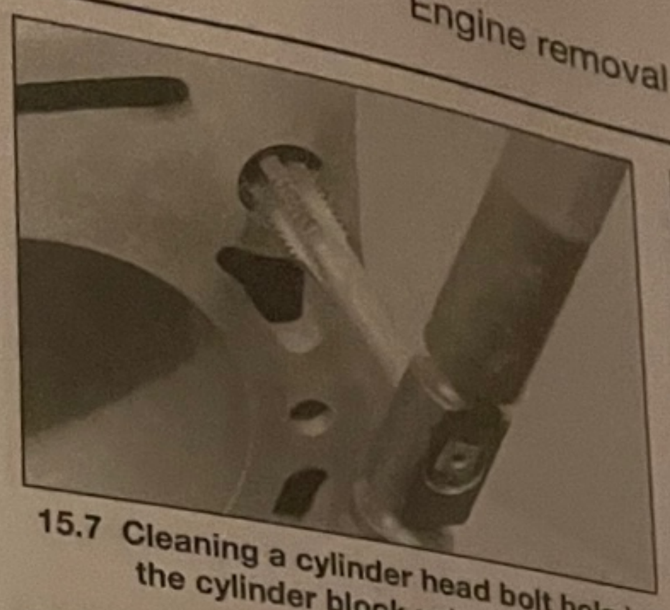
5 Clean all oil holes and oil galleries, and flush all internal passages with warm water until the water runs clear. Dry thoroughly, and apply a light film of oil to all mating surfaces, to prevent rusting. Also oil the cylinder bores. If you have access to compressed air, use it to speed up the drying process, and to blow out all the oil holes and galleries.

Warning: Wear eye protection when using compressed air.

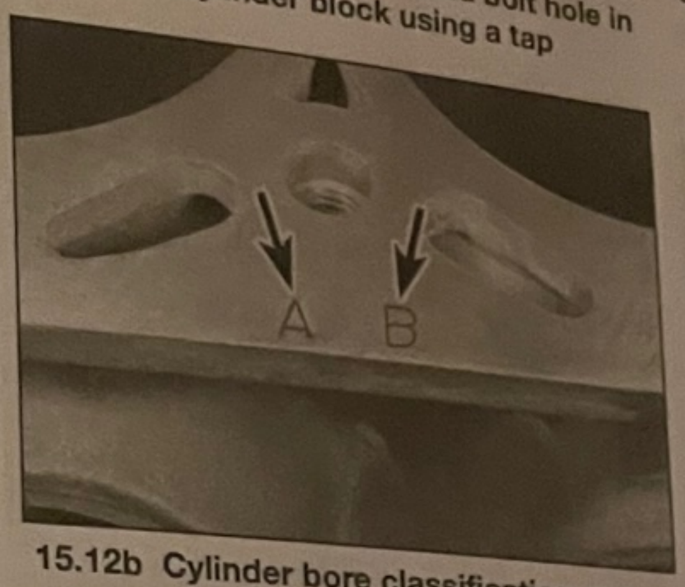
6 If the cylinder block is not very dirty, you can do an adequate cleaning job with hot (as hot as you can stand!), soapy water and a stiff brush. Take plenty of time, and do a thorough job. Regardless of the cleaning method used, be sure to clean all oil holes and galleries very thoroughly, and to dry all components well. On completion, protect the cylinder bores as described above, to prevent rusting.

7 All threaded holes must be clean, to ensure accurate torque readings during reassembly. To clean the threads, run the correct-size tap into each of the holes to remove rust, corrosion, thread sealant or sludge, and to restore damaged threads **(see illustration)**. If possible, use compressed air to clear the holes of debris produced by this operation.

8 Apply suitable sealant to the new oil gallery plugs, and insert them into the holes in the block. Tighten them securely. Apply suitable sealant to new core plugs and tap them into place with a socket or tube. Refit and tighten the oil jets to the bottom of the crankcase where applicable.



15.7 Cleaning a cylinder head bolt hole in the cylinder block using a tap



15.12b Cylinder bore classification on the front of the block

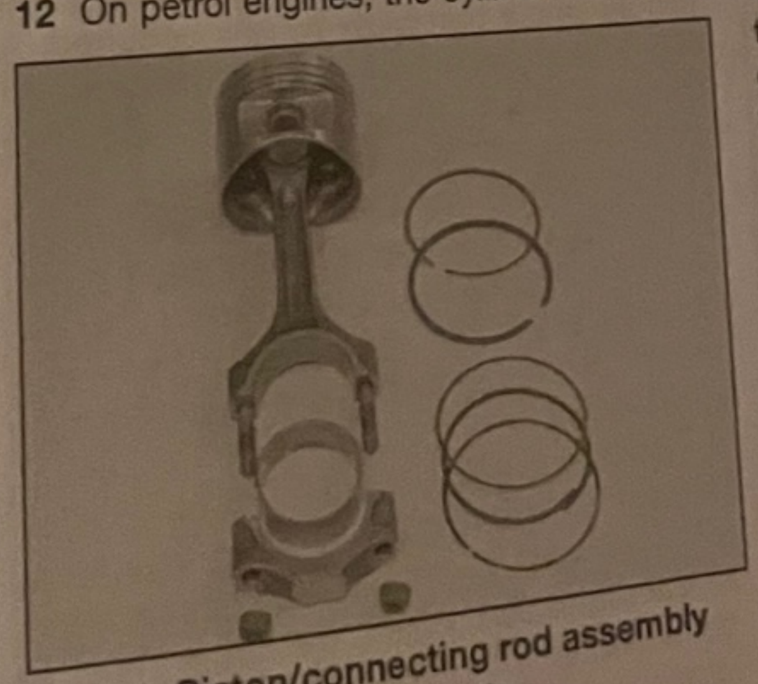
9 If the engine is not going to be reassembled right away, cover it with a large plastic bag to keep it clean; protect all mating surfaces and the cylinder bores as described above, to prevent rusting.

Inspection

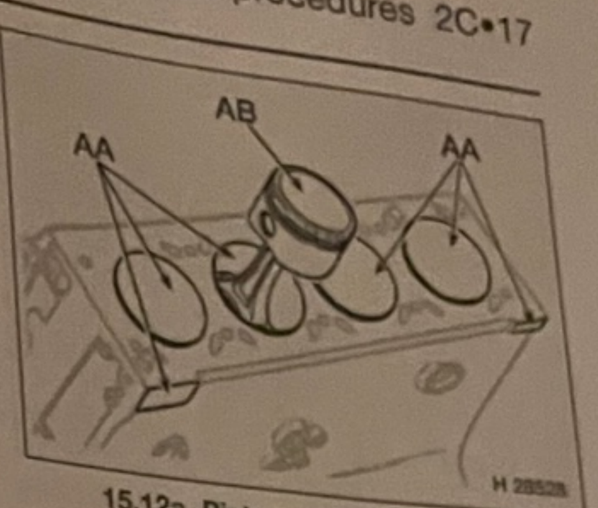
10 Visually check the cylinder block for cracks and corrosion. Look for stripped threads in the threaded holes. If there has been any history of internal water leakage, it may be worthwhile having an engine overhaul specialist check the cylinder block/crankcase with special equipment. If defects are found, have them repaired if possible; otherwise, a new block will be needed.

11 Check each cylinder bore for scuffing and scoring. Check for signs of a wear ridge at the top of the cylinder, indicating that the bore is excessively worn.

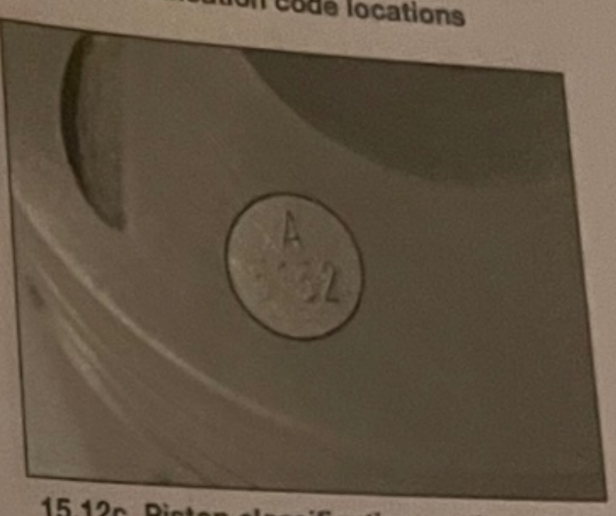
12 On petrol engines, the cylinder bores and



16.1 Piston/connecting rod assembly components



15.12a Piston and cylinder bore classification code locations



15.12c Piston classification on the piston crown

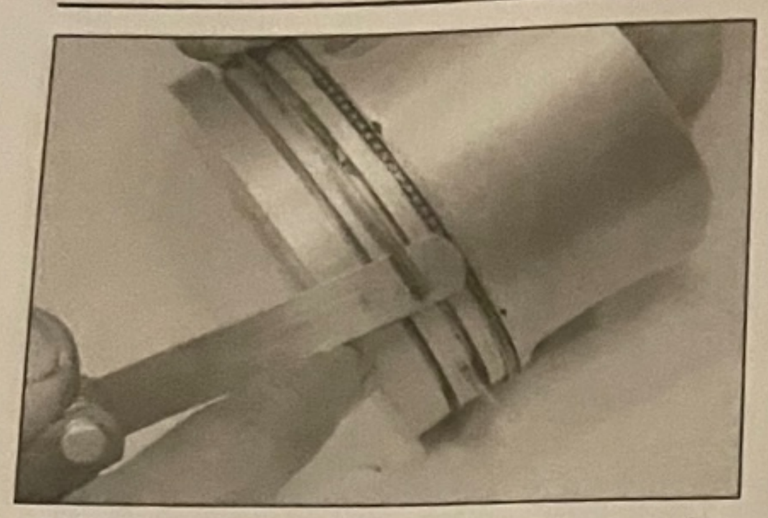
pistons are matched and classified according to four codes – AB, B, 1 (0.5 mm oversize), and 2 (1.0 mm oversize). The code is stamped on the piston crowns, and on the front of the cylinder block **(see illustrations)**. **Note:** *At the time of writing, no figures where given for the diesel engine. Refer to manufacturer or engine reconditioning specialist.*

13 If in any doubt as to the condition of the cylinder block, have it inspected and measured by an engine-reconditioning specialist. If the bores are worn or damaged, they will be able to carry out any necessary reboring (where possible), and supply appropriate oversized pistons, etc.

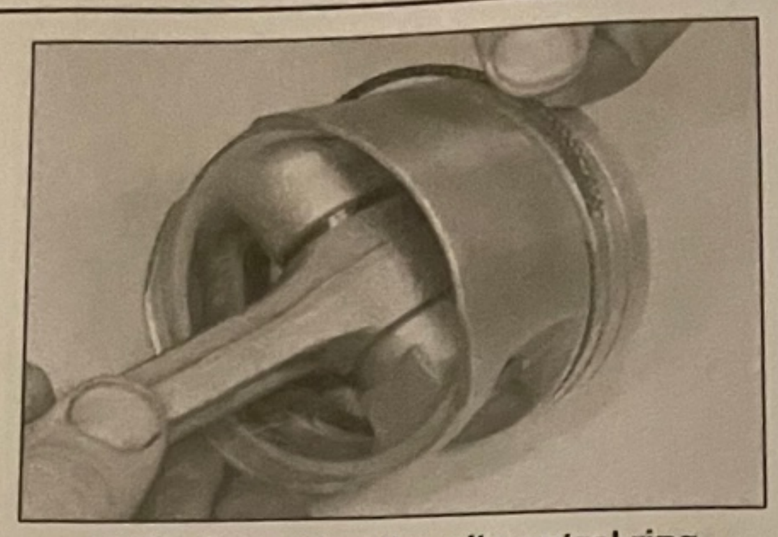
16 Piston/connecting rod assembly – inspection

1 Before the inspection process can begin, the piston/connecting rod assemblies must be cleaned, and the original piston rings removed from the pistons **(see illustration)**. **Note:** *Always use new piston rings when the engine is reassembled.*

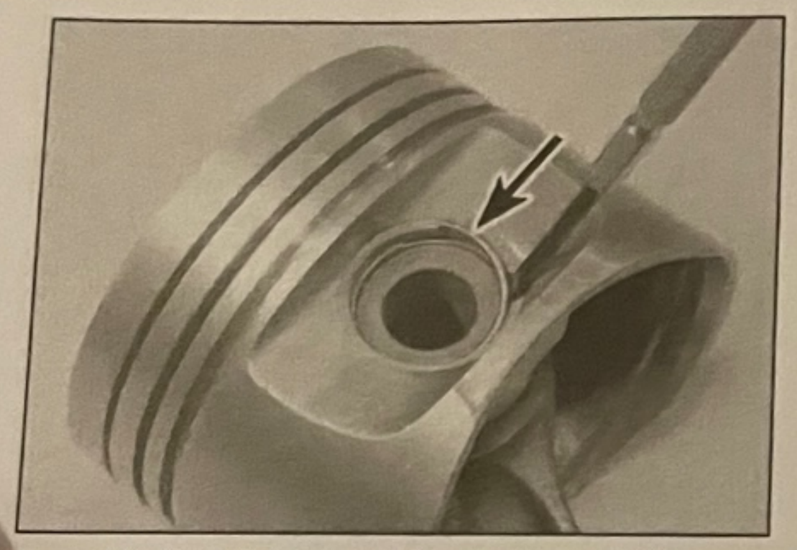
2 Carefully expand the old rings over the top of the pistons. The use of two or three old feeler blades will be helpful in preventing the rings dropping into empty grooves **(see illustrations)**. Be careful not to scratch the piston with the ends of the ring. The rings are brittle, and will snap if they are spread too far. They're also very sharp – protect your hands and fingers. Note that the third ring incorporates an expander. Always remove the



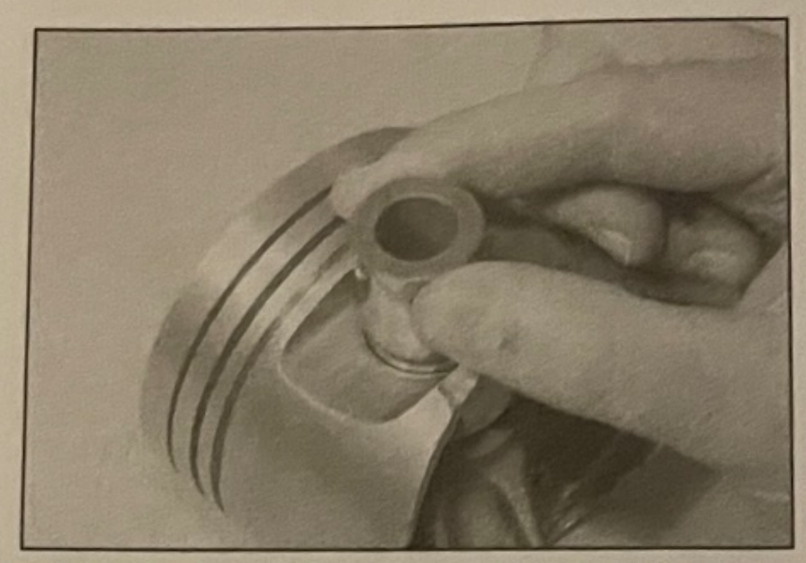
16.2a Removing a piston compression ring with the aid of a feeler blade



16.2b Removing the oil control ring



16.13a Prise out the gudgeon pin circlip . . .



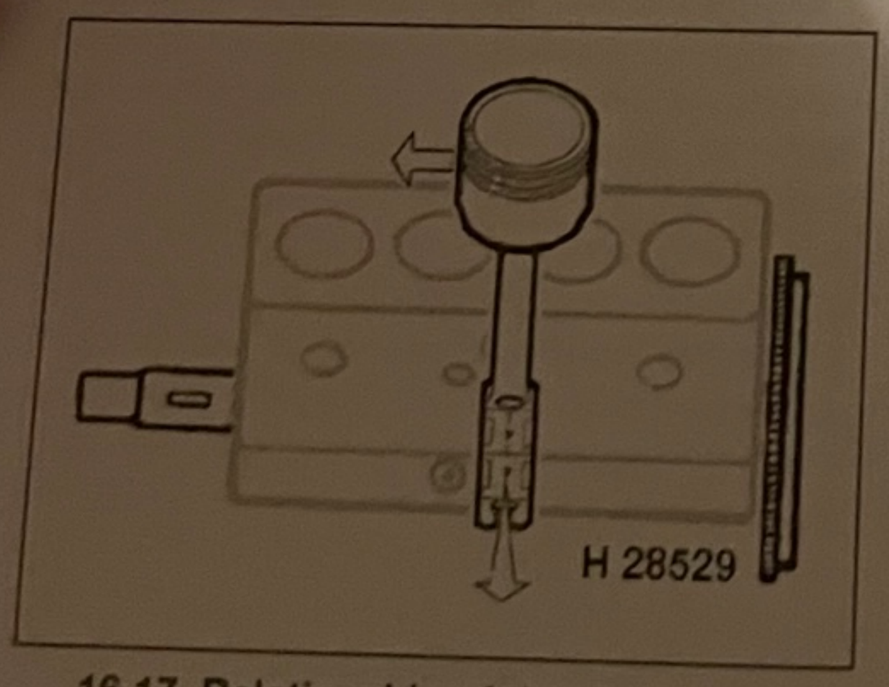
16.13b . . . then withdraw the gudgeon pin, and separate the piston from the connecting rod

rings from the top of the piston. Keep each set of rings with its piston, if the old rings are to be re-used.

3 Scrape away all traces of carbon from the top of the piston. A hand-held wire brush (or a piece of fine emery cloth) can be used, once the majority of the deposits have been scraped away.

4 Remove the carbon from the ring grooves in the piston, using an old ring. Break the ring in half to do this (be careful not to cut your fingers – piston rings are sharp). Be careful to remove only the carbon deposits – do not remove any metal, and do not nick or scratch the sides of the ring grooves.

5 Once the deposits have been removed, clean the piston/connecting rod assembly with paraffin or a suitable solvent, and dry thoroughly. Make sure that the oil return holes in the ring grooves are clear.



16.17 Relationship of the piston and connecting rod

6 If the pistons and cylinder bores are not damaged or worn excessively, and if the cylinder block does not need to be rebored, the original pistons can be refitted. Normal piston wear shows up as even vertical wear on the piston thrust surfaces, and slight looseness of the top ring in its groove.

7 Carefully inspect each piston for cracks around the skirt, around the gudgeon pin holes, and at the piston ring 'lands' (between the ring grooves).

8 Look for scoring and scuffing on the piston skirt, holes in the piston crown, and burned areas at the edge of the crown. If the skirt is scored or scuffed, the engine may have been suffering from overheating, and/or abnormal combustion, which caused excessively high operating temperatures. The cooling and lubrication systems should be checked thoroughly. Scorch marks on the sides of the pistons show that blow-by has occurred. A hole in the piston crown, or burned areas at the edge of the piston crown, indicates that abnormal combustion (pre-ignition, knocking, or detonation) has been occurring. If any of the above problems exist, the causes must be investigated and corrected, or the damage will occur again. The causes may include incorrect ignition timing and/or fuel/air mixture.

9 Corrosion of the piston, in the form of pitting, indicates that coolant has been leaking into the combustion chamber and/or the crankcase. Again, the cause must be corrected, or the problem may persist in the rebuilt engine.

10 Where needed, pistons can be pu from a Saab dealer.

11 Examine each connecting rod for signs of damage, such as cracks the big-end and small-end bearings that the rod is not bent or distorted is highly unlikely, unless the engi been seized or badly overheated checking of the connecting rod can only be carried out by a Saab engine repair specialist with the equipment.

12 The gudgeon pins are of the floati secured in position by two circlips, pistons and connecting rods can be and reassembled as follows.

13 Using a small flat-bladed screwdri out the circlips, and push out the pin **(see illustrations)**. Hand pressure be sufficient to remove the pin. Ident piston, gudgeon pin and rod to ensure reassembly.

14 Examine the gudgeon pin and conn rod small-end bearing for signs of w damage. Wear can be cured by ren both the pin and bush. Bush re however, is a specialist job – press fa are required, and the new bush mu reamed accurately.

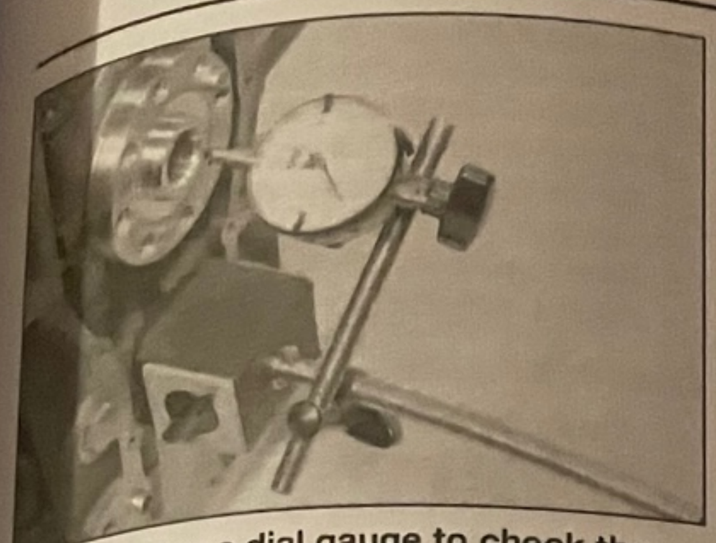
15 The connecting rods themselves sh not be in need of renewal, unless se or some other major mechanical fa has occurred. Check the alignment o connecting rods visually, and if the rod not straight, take them to an engine ove specialist for a more detailed check.

16 Examine all components, and o any new parts from your Saab dealer. I pistons are purchased, they will be sup complete with gudgeon pins and circ Circlips can also be purchased individual

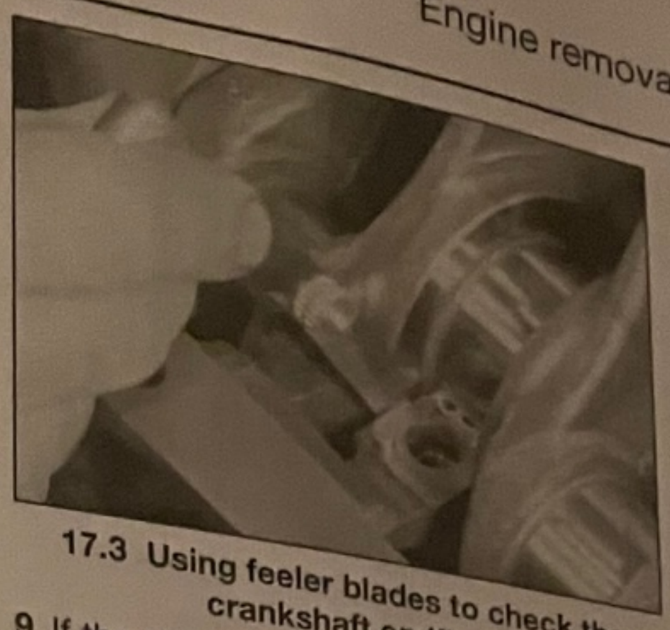
17 Position the piston so that the notch edge of the crown faces the timing end engine, and the numbers on the conne rod and big-end cap face the exhaust of the cylinder block. With the piston in your hand and the notch facing th the connecting rod numbering should towards you **(see illustration)**. Apply a of clean engine oil to the gudgeon pi it into the piston and through the con rod small-end. Check that the piston freely on the rod, then secure the gudg in position with the circlips. Ensure th circlip is correctly located in its groo piston.

18 Measure the piston diameters, a that they are within limits for the corre bore diameters. If the piston-to-bore is excessive, the block will have to be and new pistons and rings fitted.

19 Examine the mating surface big-end caps and connecting rod if they have ever been filed in a attempt to take up bearing w is extremely unlikely, but if ev offending connecting rods and cap renewed.



17.2 Using a dial gauge to check the crankshaft endfloat



17.3 Using feeler blades to check the crankshaft endfloat

17.10 Measuring a crankshaft big-end bearing journal diameter

17 Crankshaft – inspection

Checking endfloat

1 If the crankshaft endfloat is to be checked, this must be done when the crankshaft is still installed in the cylinder block/crankcase, but is free to move (see Section 14).

2 Check the endfloat using a dial gauge in contact with the end of the crankshaft. Push the crankshaft fully one way, and then zero the gauge. Push the crankshaft fully the other way, and check the endfloat **(see illustration)**. The result can be compared with the specified amount, and will give an indication as to whether new thrustwashers are required.

3 If a dial gauge is not available, feeler blades can be used. First push the crankshaft fully towards the flywheel end of the engine, then use feeler blades to measure the gap between the No 3 crankpin web and the centre main bearing thrustwasher **(see illustration)**.

Inspection

4 Clean the crankshaft using paraffin or a suitable solvent, and dry it, preferably with compressed air if available. Be sure to clean the oil holes with a pipe cleaner or similar probe, to ensure that they are not obstructed.

Warning: Wear eye protection when using compressed air.

5 Check the main and big-end bearing journals for uneven wear, scoring, pitting and cracking.

6 Big-end bearing wear is accompanied by distinct metallic knocking when the engine is running (particularly noticeable when the engine is pulling from low speed), and some loss of oil pressure.

7 Main bearing wear is accompanied by severe engine vibration and rumble – getting progressively worse as engine speed increases – and again by loss of oil pressure.

8 If there are any signs of wear, take the crankshaft to your local engine reconditioning specialist, where they will check the bearing journals. Any roughness (which will be accompanied by obvious bearing wear) indicates that the crankshaft requires regrinding (where possible) or renewal.

9 If the crankshaft has been reground, check for burrs around the crankshaft oil holes (the holes are usually chamfered, so burrs should not be a problem, unless regrinding has been carried out carelessly). Remove any burrs with a fine file or scraper, and thoroughly clean the oil holes as described previously.

10 Using a micrometer, measure the diameter of the main and big-end bearing journals, and compare the results with the Specifications **(see illustration)**. By measuring the diameter at a number of points around each journal's circumference, you will be able to determine whether or not the journal is out-of-round. Take the measurement at each end of the journal, near the webs, to determine if the journal is tapered. Compare the results obtained with those given in the Specifications.

11 Check the oil seal contact surfaces at each end of the crankshaft for wear and damage. If the seal has worn a deep groove in the surface of the crankshaft, consult an engine overhaul specialist; repair may be possible, but otherwise a new crankshaft will be required.

18 Main and big-end bearings – inspection

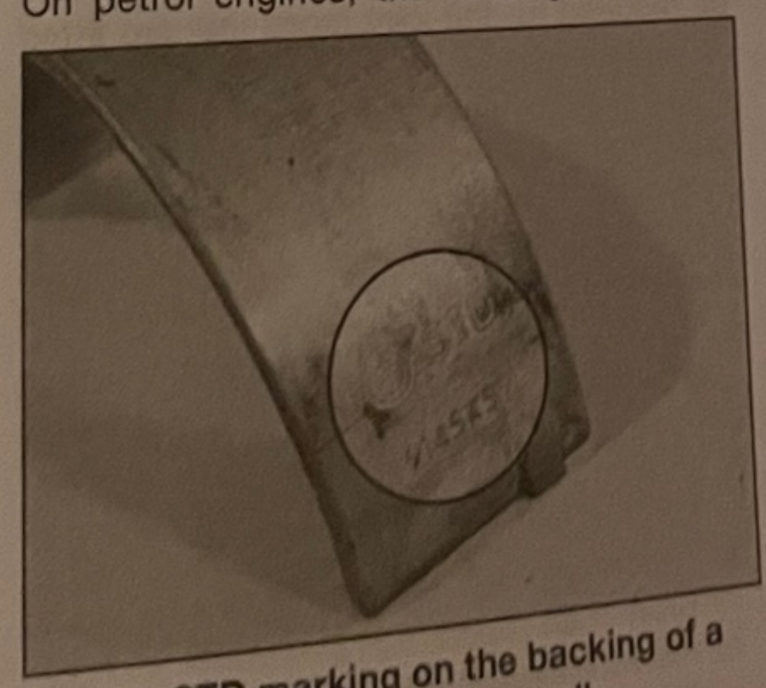
1 Even though the main and big-end bearings are renewed during the engine overhaul, the old bearings should be retained for close examination, as they may reveal valuable information about the condition of the engine. On petrol engines, the bearing shells are graded by thickness, the grade of each shell being indicated by the colour code marked on it – they may also have markings on their backing faces **(see illustration)**.

- *The thinnest shells are red – 0.005mm thinner than yellow.*
- *The standard shells are yellow (only size stocked as spare part).*
- *The first undersize shells are blue – 0.005mm thicker than yellow.*

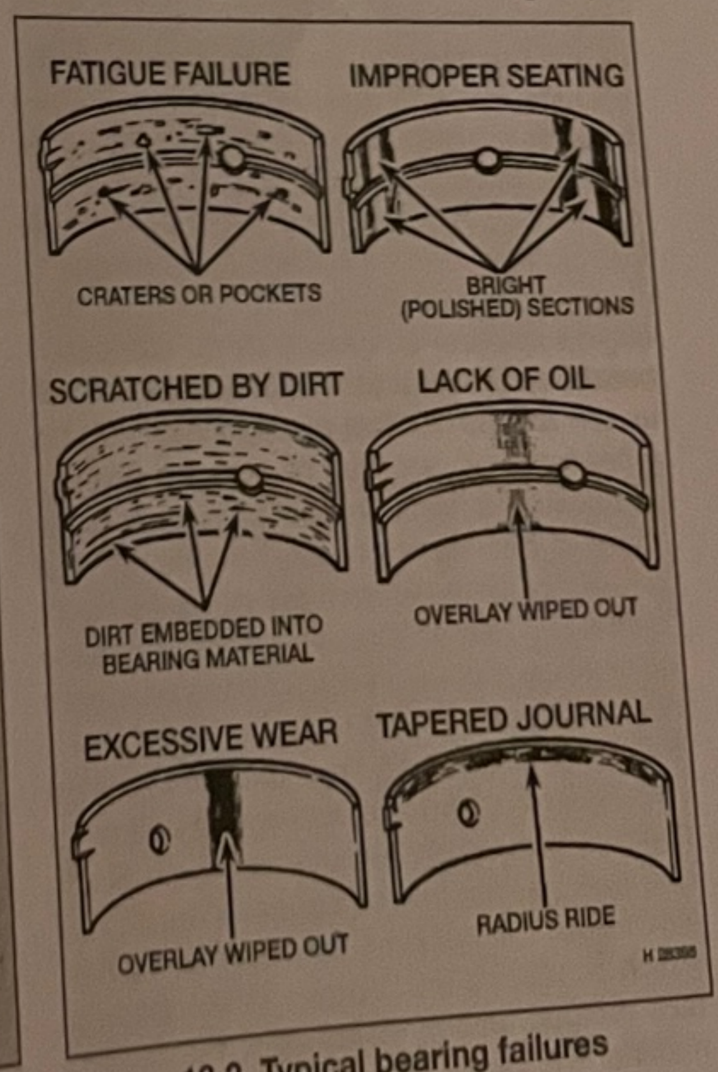
Note: *At the time of writing, no figures where given for the diesel engine. Refer to manufacturer or engine reconditioning specialist for more information.*

2 Bearing failure can occur due to lack of lubrication, the presence of dirt or other foreign particles, overloading the engine, or corrosion **(see illustration)**. Regardless of the cause of bearing failure, the cause must be corrected (where applicable) before the engine is reassembled, to prevent it from happening again.

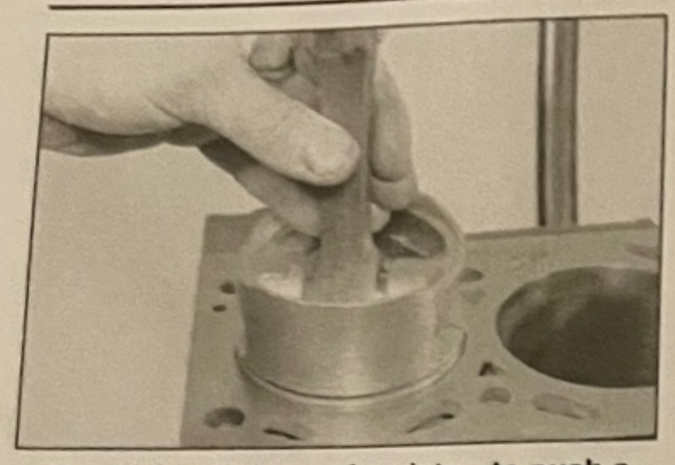
3 When examining the bearing shells, remove them from the cylinder block/crankcase, the main bearing caps, the connecting rods and the connecting rod big-end bearing caps.



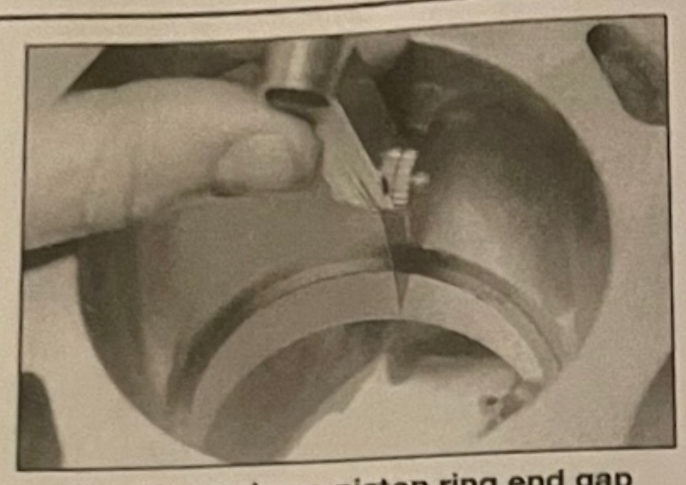
18.1 STD marking on the backing of a big-end bearing shell



18.2 Typical bearing failures



20.3 Using the top of a piston to push a piston ring into the bore



20.4 Measuring a piston ring end gap

Lay them out on a clean surface in the same general position as their location in the engine. This will enable you to match any bearing problems with the corresponding crankshaft journal. *Do not* touch any shell's bearing surface with your fingers while checking it, or the delicate surface may be scratched.

4 Dirt and other foreign matter could get into the engine in a variety of ways. It may be left in the engine during assembly, or it may pass through filters or the crankcase ventilation system. It may get into the oil, and from there into the bearings. Metal chips from machining operations and normal engine wear are often present. Abrasives are sometimes left in engine components after reconditioning, especially when parts are not thoroughly cleaned using the proper cleaning methods. Whatever the source, these foreign objects often end up embedded in the soft bearing material, and are easily recognised. Large particles will not embed in the bearing, and will score or gouge the bearing and journal. The best prevention for this cause of bearing failure is to clean all parts thoroughly, and keep everything spotlessly clean during engine assembly. Frequent and regular engine oil and filter changes are also recommended.

5 Lack of lubrication (or lubrication breakdown) has a number of interrelated causes. Excessive heat (which thins the oil), overloading (which squeezes the oil from the bearing face) and oil leakage (from excessive bearing clearances, worn oil pump or high engine speeds) all contribute to lubrication breakdown. Blocked oil passages, which usually are the result of misaligned oil holes in a bearing shell, will also oil-starve a bearing, and destroy it. When lack of lubrication is the cause of bearing failure, the bearing material is wiped or extruded from the steel backing of the bearing. Temperatures may increase to the point where the steel backing turns blue from overheating.

6 Driving habits can have a definite effect on bearing life. Full-throttle, low-speed operation (labouring the engine) puts very high loads on bearings, tending to squeeze out the oil film. These loads cause the bearings to flex, which produces fine cracks in the bearing face (fatigue failure). Eventually, the bearing material will loosen in pieces, and tear away from the steel backing.

7 Short-distance driving leads to corrosion of bearings, because insufficient engine heat is produced to drive off the condensed water and corrosive gases. These products collect in the engine oil, forming acid and sludge. As the oil is carried to the engine bearings, the acid attacks and corrodes the bearing material.

8 Incorrect bearing installation during engine assembly will lead to bearing failure as well. Tight-fitting bearings leave insufficient bearing running clearance, and will result in oil starvation. Dirt or foreign particles trapped behind a bearing shell result in high spots on the bearing, which lead to failure.

9 *Do not* touch any shell's bearing surface with your fingers during reassembly; there is a risk of scratching the delicate surface, or of depositing particles of dirt on it.

10 As mentioned at the beginning of this Section, the bearing shells should be renewed as a matter of course during engine overhaul; to do otherwise is false economy.

19 Engine overhaul – reassembly sequence

1 Before reassembly begins, ensure that all new parts have been obtained, and that all necessary tools are available. Read through the entire procedure, to familiarise yourself with the work involved, and to ensure that all items necessary for reassembly of the engine are at hand. In addition to all normal tools and materials, thread-locking compound will be needed. A suitable tube of sealant will also be required for the joint faces that are fitted without gaskets.

2 At this stage, all engine components should be absolutely clean and dry, with all faults repaired. The components should be laid out (or in individual containers) on a completely clean work surface.

3 In order to save time and avoid problems, engine reassembly can be carried out in the following order:

Petrol engines

a) Piston rings (see Section 20).
b) Crankshaft (Section 21).
c) Piston/connecting rod assemblies (Section 22).
d) Sump (Chapter 2A).
e) Balance shafts (Section 12).
f) Flywheel/driveplate (Chapter 2A).
g) Timing chain and balance shaft drive sprockets and tensioner (Section 10).
h) Cylinder head (Chapter 2A).
i) Intake and exhaust manifolds (Chapter 4A).
j) Engine external components.

Diesel engines

a) Piston rings (see Section 20).
b) Crankshaft (see Section 21).
c) Pistons/connecting rod assemblies (see Section 22).
d) Cylinder head (see Chapter 2B).
e) Oil pump (see Chapter 2B).
f) Sump (see Chapter 2B).
g) Flywheel/driveplate (see Chapter 2B).
h) Coolant pump (see Chapter 3).
i) Timing belt, sprockets, tensioner and pulleys (see Chapter 2B).
j) Intake and exhaust manifolds (see Chapter 4B).

20 Piston rings – refitting

1 Before fitting new piston rings, the ring gaps must be checked as follows.

2 Lay out the piston/connecting rod assembly and the new piston ring sets, so that the sets will be matched with the same piston/cylinder during the end gap measurement and subsequent engine reassembly.

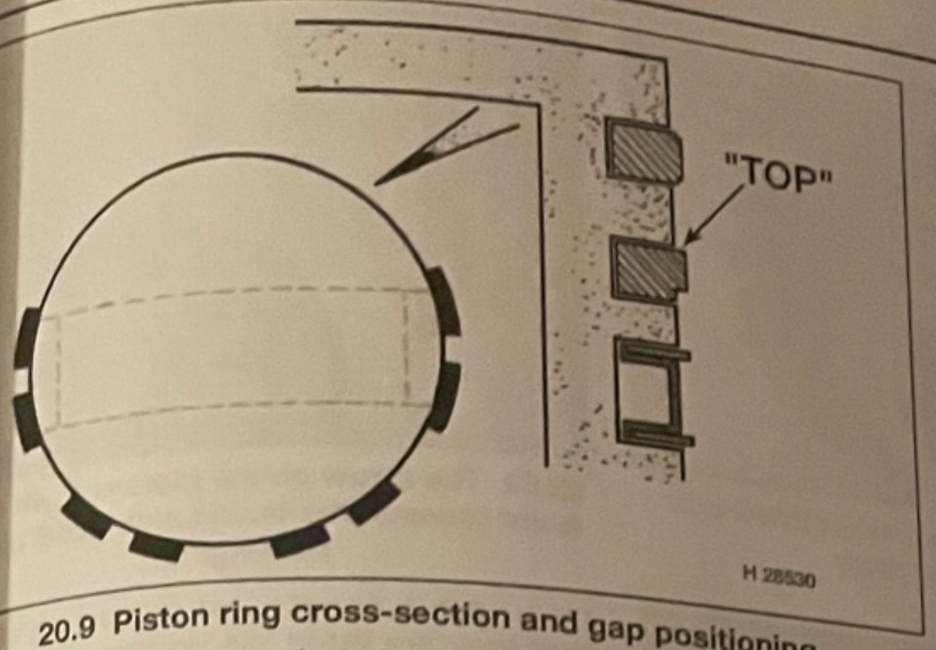
3 Insert the top ring into the first cylinder and push it down the bore using the top of the piston **(see illustration)**. This will ensure that the ring remains square with the cylinder walls. Position the ring near the bottom of the cylinder bore, at the lower limit of ring travel. Note that the top and second compression rings are different.

4 Measure the end gap using feeler blades and compare the measurements with the figures given in the Specifications **(see illustration)**.

5 If the gap is too small (unlikely if genuine Saab parts are used), it must be enlarged, or the ring ends may contact each other during engine operation, causing serious damage. Ideally, new piston rings providing the correct end gap should be fitted. As a last resort, the end gap can be increased by filing the ring ends very carefully with a fine file. Mount the file in a vice with soft jaws, slip the ring over the file with the ends contacting the file face, and slowly move the ring to remove material from the ends. Take care, as piston rings are sharp, and are easily broken.

6 With new piston rings, it is unlikely that the end gap will be too large. If the gaps are too large, check that you have the correct rings for your particular engine.

7 Repeat the checking procedure for each ring in the first cylinder, and then for the rings in the remaining cylinders. Remember to keep rings, pistons and cylinders matched up



20.9 Piston ring cross-section and gap positioning

8 Once the ring end gaps have been checked and if necessary corrected, the rings can be fitted to the pistons.

9 Fit the piston rings using the same technique as for removal. Fit the bottom (oil control) ring first, and work up. When fitting the oil control ring, first insert the expander, and then fit the lower and upper rings with the ring gaps both on the non-thrust side of the piston, with approximately 60° between them. Ensure that the second compression ring is fitted the correct way up, with the word TOP uppermost. Arrange the gaps of the top and second compression rings on opposite sides of the piston, above the ends of the gudgeon pin **(see illustration)**. **Note:** *Always follow any instructions supplied with the new piston ring sets – different manufacturers may specify different procedures. Do not mix up the top and second compression rings, as they have different cross-sections.*

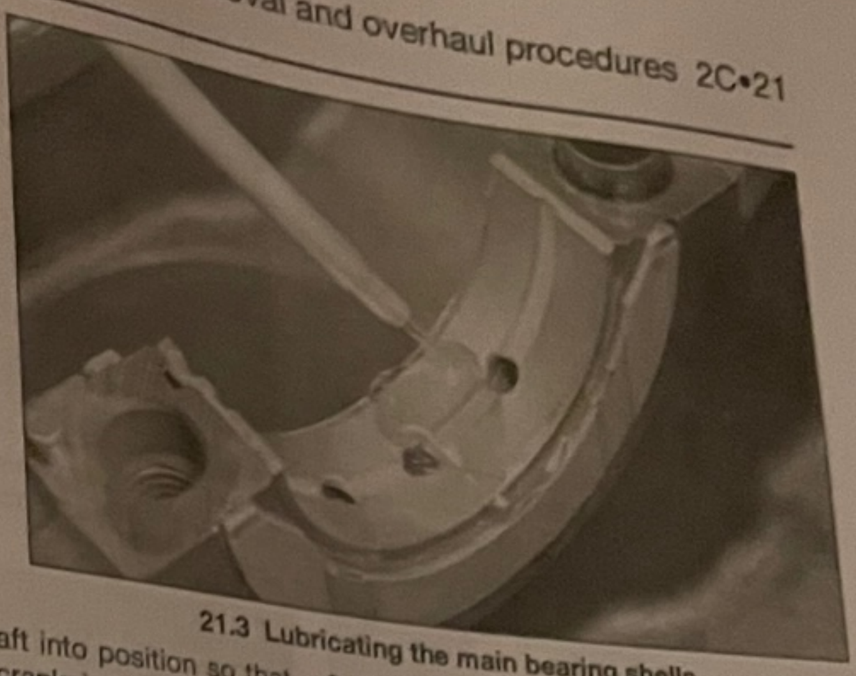
21 Crankshaft – refitting

Note: *It is recommended that new main bearing shells be fitted regardless of the condition of the original ones.*

1 Refit the crankshaft position sensor reluctor (where applicable) if removed and tighten the screws, with reference to Section 14.

2 Using a little grease, stick the upper thrustwashers to each side of the centre main bearing upper location; ensure that the oilway grooves on each thrustwasher face outwards (away from the cylinder block).

3 Place the bearing shells in their locations in the caps, ensuring that the tab on each shell engages in the notch in the cylinder block or main bearing cap location. Take care not to touch any shell's bearing surface with your fingers. If new shells are being fitted, ensure that all traces of protective grease are cleaned off, using paraffin. Wipe dry the shells and connecting rods with a lint-free cloth. Liberally lubricate each bearing shell in the cylinder block/crankcase with clean engine oil **(see illustration)**.



21.3 Lubricating the main bearing shells

4 Lower the crankshaft into position so that Nos 2 and 3 cylinder crankpins are at TDC. In this position, Nos 1 and 4 cylinder crankpins will be at BDC, ready for fitting No 1 piston. Check the crankshaft endfloat as described in Section 17.

5 Lubricate the lower bearing shells in the main bearing caps with clean engine oil. Make sure that the locating lugs on the shells engage with the corresponding recesses in the caps.

6 Fit the main bearing caps to their correct locations, ensuring that they are fitted the correct way round (the bearing shell lug recesses in the block and caps must be on the same side). Insert the bolts loosely.

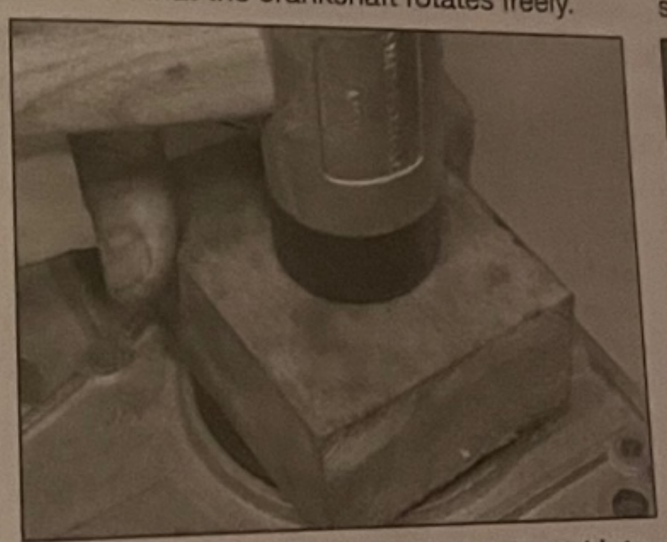
7 Progressively tighten the main bearing cap bolts to the specified torque wrench setting.

8 Check that the crankshaft rotates freely.

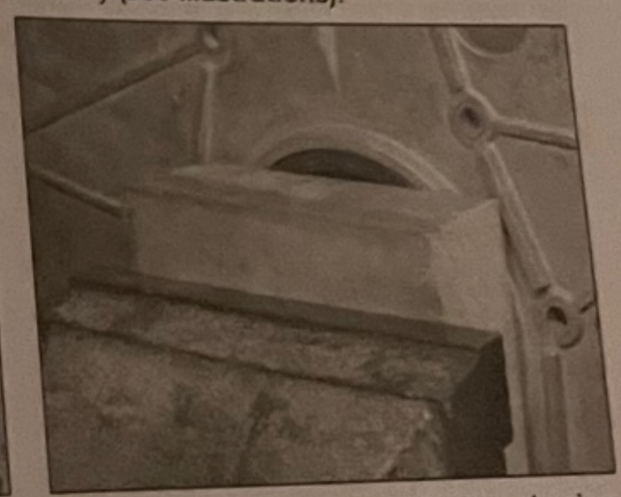
9 Refit the piston/connecting rod assemblies to the crankshaft, as described in Section 22.

10 Before refitting the crankshaft oil seal housing, fit a new oil seal in the housing, with reference to Chapter 2A or 2B. Use a mallet and block of wood to drive it into the housing, or alternatively, use the block of wood in a vice **(see illustrations)**.

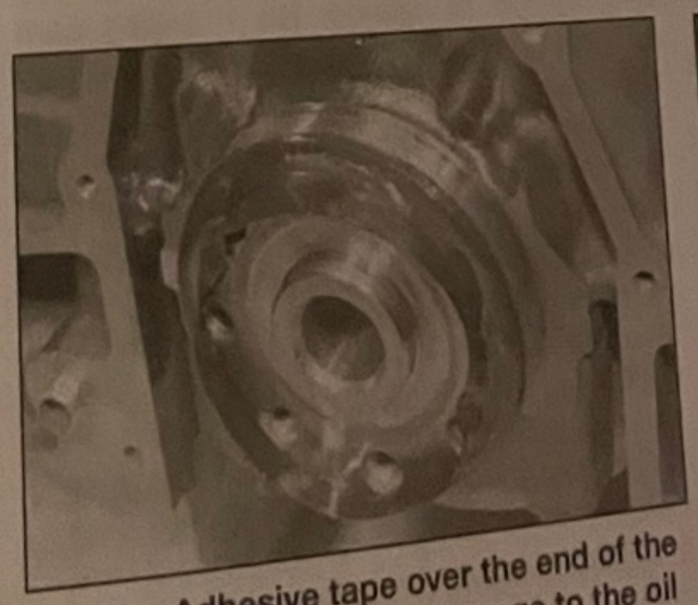
11 Apply suitable sealant to the contact faces of the oil seal housing, then smear a little oil on the oil seal lips, and refit the locating dowels where necessary. Locate the housing on the cylinder block. To prevent damage to the oil seal as it locates over the crankshaft, make up a guide out of a plastic container, or alternatively use adhesive tape. Once the housing is in position, remove the guide or tape, then insert the bolts and tighten them securely **(see illustrations)**.



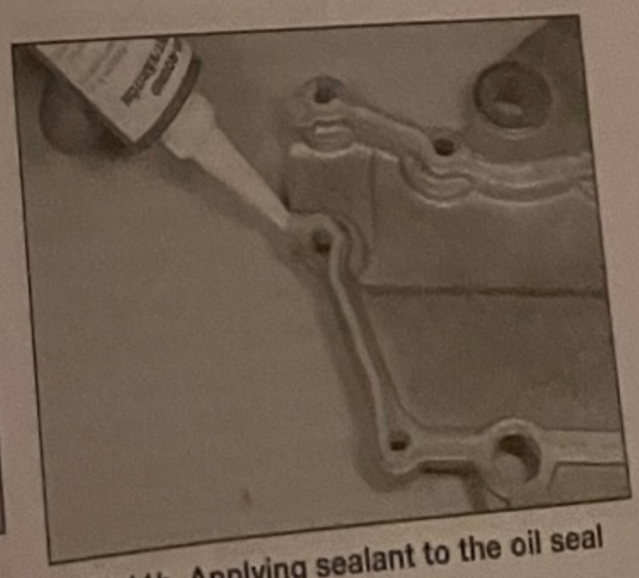
21.10a Driving the crankshaft oil seal into the housing



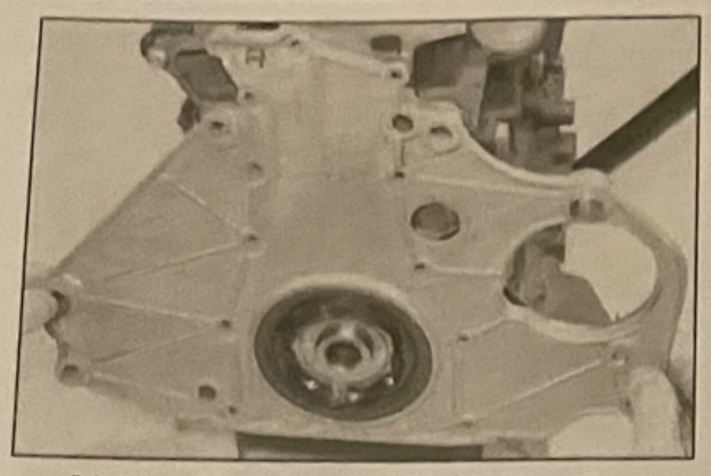
21.10b Fitting the crankshaft oil seal using a block of wood in a vice



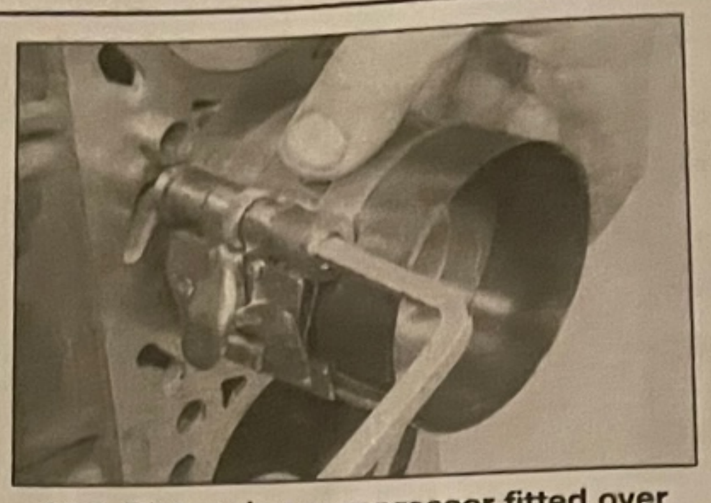
21.11a Adhesive tape over the end of the crankshaft will prevent damage to the oil seal when refitting



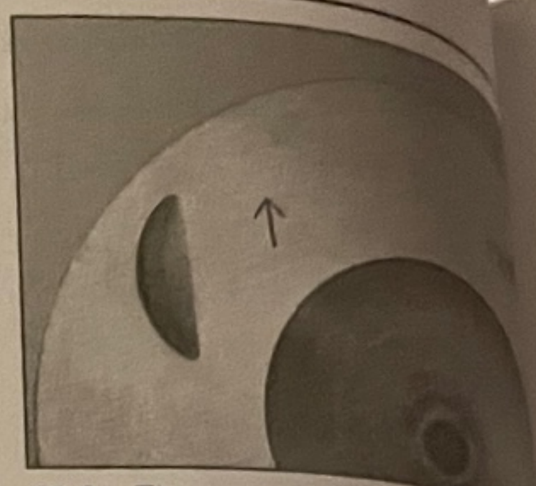
21.11b Applying sealant to the oil seal housing



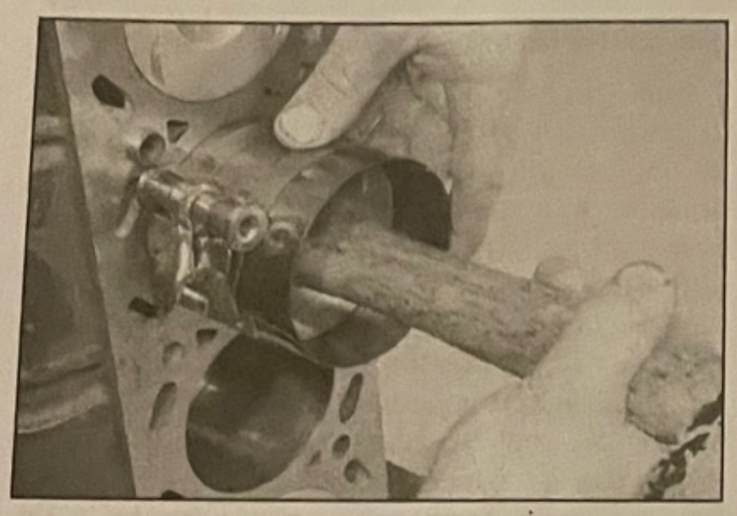
21.11c Refitting the oil seal housing (engine backplate)



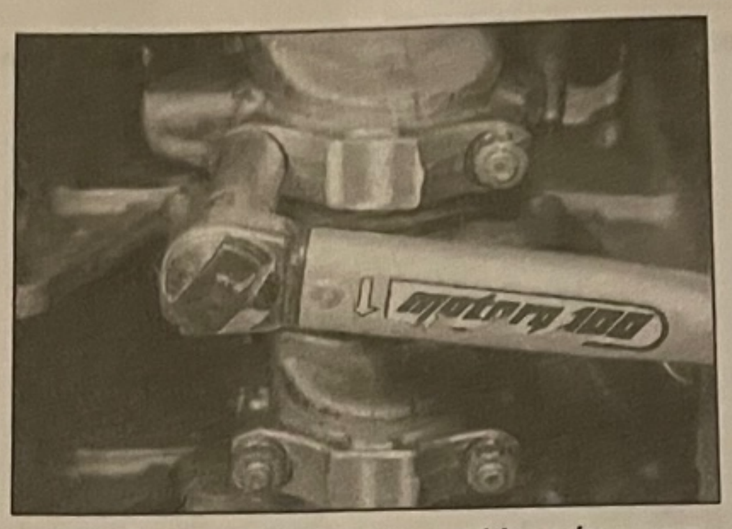
22.5 Piston ring compressor fitted over the piston rings



22.6a The arrow on the piston crown point towards the timing chain/belt the engine



22.6b Using a hammer handle to tap the piston down the cylinder bore



22.8 Tightening the big-end bearing cap nuts

12 Refit the flywheel/driveplate, oil pick-up/strainer/transfer tube and sump, with reference to Chapter 2A or 2B.

13 Where removed, refit the cylinder head as described in Chapter 2A or 2B.

14 Refit the timing chain and sprocket (petrol engines).

22 Piston/connecting rod assembly – refitting and big-end bearing clearance check

Note: *It is recommended that new bearing shells be fitted regardless of the condition of the original ones.*

Running clearance check

1 One method of checking the clearance is to refit the big-end bearing cap to the connecting rod before refitting the pistons to the cylinder block, ensuring that they are fitted the correct way round, with the bearing shells in place. With the cap retaining nuts correctly tightened, use an internal micrometer or vernier caliper to measure the internal diameter of each assembled pair of bearing shells. If the diameter of each corresponding crankshaft journal is measured and then subtracted from the bearing internal diameter, the result will be the big-end bearing running clearance.

2 The second, and more accurate, method is to take the components to your local engine reconditioning specialist, where they will be able to do a more comprehensive check.

Refitting

3 Lubricate the cylinder bores, pistons, piston rings and bearing shells with clean engine oil, then lay out each piston/connecting rod assembly in its respective position on a clean dust free surface.

4 Press the bearing shells into their locations, ensuring that the tab on each shell engages in the notch in the connecting rod and cap. Take care not to touch any shell's bearing surface with your fingers. If the original bearing shells are being used for the check, ensure that they are refitted in their original locations.

5 Start with assembly No 1. Position No 1 crankpin at the bottom of its stroke. Make sure that the piston rings are still spaced as described in Section 20, and then clamp them in position with a piston ring compressor **(see illustration)**.

6 Insert the piston/connecting rod assembly into the top of cylinder No 1; taking care not to mark the cylinder bores. Ensure that the notch or arrow on the piston crown is pointing towards the timing chain/belt end of the engine. Using a block of wood or hammer handle against the piston crown, tap the assembly into the cylinder bore until the piston crown is flush with the top of the cylinder **(see illustrations)**.

7 With the No 1 crankpin at the bottom of its stroke, guide the connecting rod onto it while tapping the top of the piston with the hammer handle.

8 Refit the big-end bearing cap, using the marks made or noted on removal to ensure that they are fitted the correct way. Tighten the bearing cap nuts/bolts to the specified torque **(see illustration)**.

9 Rotate the crankshaft. Check that it turns freely; some stiffness is to be expected if new components have been fitted, but there should be no signs of binding or tight spots.

10 Refit the remaining piston/connecting rod assemblies to their crankpins in the same way.

11 Refit the oil pump pick-up/strainer and cylinder head with reference to Chapter 2A or 2B.

23 Engine – initial start-up after overhaul

1 With the engine refitted in the vehicle, double-check the engine oil and coolant levels. Make a final check that everything has been reconnected, and that there are no tools or rags left in the engine compartment.

2 Start the engine, noting that this may take a little longer than usual. Make sure that the oil pressure warning light goes out.

3 While the engine is idling, check for fuel, water and oil leaks. Don't be alarmed if there are some odd smells and smoke from parts getting hot and burning off oil deposits.

4 Assuming all is well, run the engine until it reaches normal operating temperature, then switch off the engine.

5 After a few minutes, recheck the oil and coolant levels as described in Weekly checks and top-up as necessary.

6 Note that there is no need to retighten the cylinder head bolts once the engine has been run after reassembly.

7 If new pistons, rings or crankshaft bearings have been fitted, the engine must be treated as new, and run-in for the first 600 miles. Do not operate the engine at full-throttle, or allow it to labour at low engine speeds in any gear. It is recommended that the oil and filter be changed at the end of this period.