Chapter 2 Part C:
General engine overhaul procedures

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

Note: *At the time of writing, no manufacturer's specifications were available for the 2.0 litre turbo petrol engine. The petrol engine figures given here relate to the 2.0 fuel injected, non-turbo engines (XU10J2 series - see Chapter 2A for engine code details).*

Cylinder head

Maximum gasket face distortion:	
Petrol engines	0.05 mm
2.1 litre turbo diesel engines	0.05 mm
2.5 litre turbo diesel engines	0.03 mm
Swirl chamber protrusion - diesel engines only	0 to 0.03 mm

Valves

	Inlet	Exhaust
Valve head diameter:		
Petrol engines:		
2.0 litre engine	42.6 mm	34.5 mm
Diesel engines:		
2.1 litre turbo engine	33.9 mm	33.9 mm
2.5 litre engine	36.9 mm	36.9 mm
Valve stem diameter:		
Petrol engines:		
2.0 litre engines	7.984 +0 -0.015 mm	7.970 mm +0 -0.015 mm
Diesel engines:		
2.1 litre turbo engine	8.005 +0 -0.015 mm	7.975 +0 -0.015 mm
2.5 litre engine	6.990 +0 -0.015 mm	6.960 +0 -0.015 mm
Overall length:		
Petrol engines:		
2.0 litre engines	108.70 mm	108.25 mm
Diesel engines:		
2.1 litre turbo engine	122.30 mm	121.90 mm
2.5 litre engine	127.91 mm	127.51 mm

Cylinder block

Cylinder bore diameter:	
Petrol engines:	
2.0 litre engines:	
Standard	86.000 to 86.018 mm
Oversize R1	86.250 to 86.268 mm
Oversize R2	86.600 to 86.618 mm
Diesel engines:	
2.1 litre turbo engines:	
Standard	85.000 to 85.018 mm
Oversize A1	85.030 to 85.048 mm
Oversize R1	85.250 to 85.268 mm
Oversize R2	85.600 to 85.618 mm
2.5 litre engine:*	
Standard, cylinder No 1	92.020 to 92.038 mm
Oversize, cylinder No 1	92.520 to 92.538 mm
Standard, cylinder Nos 2 to 4	92.010 to 92.028 mm
Oversize, cylinder Nos 2 to 4	92.510 to 92.528 mm

***Note:** *The offset design of the cylinder block on the 2.5 litre engine is such that the machining tolerance for cylinder No 1 is different to that of cylinders No 2, 3 and 4.*

Pistons

Piston diameter:	
Petrol engines:	
2.0 litre engines:	
Standard	85.967 to 85.976 mm
Oversize R1	86.217 to 86.226 mm
Oversize R2	86.567 to 86.576 mm
Piston diameter:	
Diesel engines:	
2.1 litre engine:	
Standard	84.920 to 84.929 mm
1st oversize	84.950 to 84.959 mm
2nd oversize	85.170 to 85.179 mm
3rd oversize	85.520 to 85.529 mm
2.5 litre engine:	
Standard	91.911 to 91.929 mm
Oversize	92.411 to 92.429 mm

Crankshaft

Endfloat:	
2.5 litre turbo diesel engine	0.04 to 0.29 mm
All other engines	0.07 to 0.32 mm
Main bearing journal diameter:	
Petrol engines:	
2.0 litre engines:	
Standard	60.0 +0 -0.019 mm
Undersize	59.7 +0 -0.019 mm
Diesel engines:	
2.1 litre turbo engine:	
Standard	60.0 +0 -0.019 mm
Undersize	59.7 +0 -0.019 mm
2.5 litre turbo engine:	
Standard	64.0 +0 -0.019 mm
Undersize	63.7 +0 -0.019 mm
Big-end bearing journal diameter:	
Petrol engines:	
2.0 litre engines:	
Standard	50.0 +0 -0.016 mm
Undersize	49.7 +0 -0.016 mm
Diesel engines	
2.1 litre turbo engine:	
Standard	50.0 +0 -0.016 mm
Undersize	49.7 +0 -0.016 mm
2.5 litre engine:	
Standard	54.0 +0 -0.019 mm
Undersize	53.7 +0 -0.019 mm

Crankshaft (continued)

Maximum bearing journal out-of-round (all models)	0.007 mm
Main bearing running clearance:	
Petrol engines:	
2.0 litre engines:	
pre-1993	0.045 to 0.109 mm
1993 onwards	0.038 to 0.069 mm
Diesel engines*	0.025 to 0.050 mm
Big-end bearing running clearance - all models*	0.025 to 0.050 mm

These are suggested figures, typical for this type of engine - at the time of writing, no exact values were available from Citroën.

Piston rings

End gaps:	
Petrol engines:	
Top compression ring:	
2.0 litre engine	0.2 to 0.4 mm
Second compression ring:	
2.0 litre engine	0.15 to 0.35 mm
Oil control ring	n/a
Diesel engines:	
Top and second compression rings	0.30 to 0.50 mm
Oil control ring	0.25 to 0.50 mm

Torque wrench settings

	Nm	lbf ft
2.0 litre petrol engine		
Big-end bearing cap nuts:		
Stage 1	20	15
Stage 2	Angle-tighten through 70°	
Crankshaft pulley retaining bolt	120	88
Cylinder head bolts:		
Stage 1	35	26
Stage 2	70	52
Stage 3	Angle-tighten through 160°	
Engine-to-transmission fixing bolts	45	33
Flywheel/driveplate retaining bolts	50	37
Front oil seal carrier bolts	16	12
Left-hand engine/transmission mounting:		
Mounting bracket-to-body	30	22
Rubber mounting-to-bracket bolts	30	22
Mounting stud-to-transmission	60	44
Mounting stud bracket-to-transmission	60	44
Centre nut	65	48
Lower engine movement limiter-to-driveshaft intermediate bearing housing	50	37
Lower engine movement limiter-to-subframe	85	62
Main bearing cap bolts	70	52
Oil pump retaining bolts	16	12
Piston oil jet spray tube bolt	10	7
Right-hand engine/transmission mounting:		
Mounting bracket-to-engine nuts/bolts	80	59
Mounting bracket-to-rubber mounting nut	45	33
Rubber mounting-to-body nut	40	29
Upper engine movement limiter bolts	50	37
Sump retaining bolts	16	12
Timing belt cover bolts	8	6
Timing belt tensioner pulley bolt	20	15
2.1 litre turbo diesel engines		
Big-end bearing cap nuts:		
Stage 1	20	15
Stage 2	Tighten through a further 70°	
Camshaft carrier bolts	25	18
Camshaft sprocket bolt	50	37
Crankshaft front oil seal housing bolts	16	12
Crankshaft pulley bolt:		
Stage 1	40	30
Stage 2	Tighten through a further 60°	
Cylinder head cover bolts	8	6

Torque wrench settings	Nm	lbf ft
2.1 litre turbo diesel engines (continued)		
Cylinder head bolts (new bolts with guide bosses)*:		
Stage 1	20	15
Stage 2	60	44
Stage 3	Angle tighten through 180°	
Flywheel/driveplate bolts	50	37
Injection pump sprocket puller retaining screws	10	7
Injection pump sprocket nut	50	37
Left-hand engine/transmission mounting:		
Mounting bracket-to-body	30	22
Rubber mounting-to-bracket bolts	30	22
Mounting stud-to-transmission	60	44
Centre nut	65	48
Lower engine movement limiter-to-driveshaft intermediate bearing housing	50	37
Lower engine movement limiter-to-subframe	85	62
Main bearing cap bolts:		
Stage 1	15	11
Stage 2	Tighten through a further 60°	
Oil pump mounting bolts	13	10
Piston oil jet spray tube bolt	10	7
Right-hand engine/transmission mounting:		
Mounting bracket-to-engine nuts	45	33
Mounting bracket-to-rubber mounting nut	45	33
Rubber mounting-to-body nut	40	29
Upper engine movement limiter bolts	50	37
Sump bolts	16	12
Timing belt idler pulley	37	27
Timing belt tensioner nut/bolt	10	7
Transmission housing-to-engine bolts	55	40
2.5 litre turbo diesel engine		
Big-end bearing cap nuts:		
Stage 1	12	9
Stage 2	Angle tighten through 60°	
Crankshaft sprocket bolt:		
Stage 1	70	52
Stage 2	Angle tighten through 51°	
Cylinder head bolts:*		
M10 bolts:		
Stage 1	35	26
Stage 2	Angle tighten through 120°	
M12 bolts:		
Stage 1	50	37
Stage 2	Angle tighten through 120°	
Flywheel/driveplate bolts	50	37
Balance shaft housing bolts:		
High tensile bolts	34	25
All other bolts	25	18
Balance shaft sprocket nut:		
Rear balance shaft (LEFT HAND THREAD)	13	10
Front balance shaft	13	10
Balance shaft counter weight screws	12	9
Main bearing ladder inner bolts:		
Stage 1	20	15
Stage 2	Angle tighten through 60°	
Main bearing ladder outer bolts	10	7
Oil pump mounting bolts	9	7
Piston oil jet spray tube bolt	10	7
Sump bolts	8	6
Transmission housing-to-engine bolts	55	40

***Note:** *Where new cylinder head bolts are fitted, there is no requirement to re-tighten the bolts after the engine has been started and warmed u for the first time; see Chapter 2B for details.*

1 General information

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

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

3 After Section 7, all instructions are based on the assumption that the engine has been removed from the car. 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 (as applicable) and to Section 7. Ignore any preliminary dismantling operations described in Part A or B that are no longer relevant once the engine has been removed from the car.

4 Specifications relating to engine overhaul are at the beginning of this Part of Chapter 2.

2 Engine overhaul - general information

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

2 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.

3 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. Perform a compression test, as described in Part A (petrol engine) or B (Diesel engine) of this Chapter, to determine the likely cause of the problem.

4 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.

5 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.

6 An engine overhaul involves restoring all internal parts to the specification of a new engine. During an overhaul, the pistons and the piston rings are renewed. New main and big-end bearings are generally fitted; if necessary, the crankshaft may be renewed, to restore the journals. The valves are also serviced as well, since they are usually in less-than-perfect condition at this point. While the engine is being overhauled, other components, such as the starter and alternator, can be overhauled as well. The end result should be an as-new engine that will give many trouble-free miles.

Note: *Critical cooling system components such as the hoses, thermostat and water pump should be renewed when an engine is overhauled. The radiator should be checked carefully, to ensure that it is not clogged or leaking. Also, it is a good idea to renew the oil pump whenever the engine is overhauled.*

7 Before beginning the engine overhaul, read through the entire procedure, to familiarise yourself with the scope and requirements of the job. Overhauling an engine is not difficult if you follow carefully all of the instructions, have the necessary tools and equipment, and pay close attention to all specifications. It can, however, be time-consuming. Plan on the car being off the road for a minimum of two weeks, especially if parts must be taken to an engineering works for repair or reconditioning. 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. Often the engineering works will handle the inspection of parts and offer advice concerning reconditioning and renewal. **Note:** *Always wait until the engine has been completely dismantled, and until all components (especially the cylinder block 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.

8 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

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

2 Locating a suitable place to work is extremely important. Adequate work space, along with storage space for the car, will be needed. If a workshop or garage is not available, at the very least, a flat, level, clean work surface is required.

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

4 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 car.

5 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.

6 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 front 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.

7 Plan for the car 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.

8 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.

4 Petrol engine and manual transmission unit - removal, separation and refitting

Removal

1 Park the vehicle on firm, level ground. Chock the rear wheels, then firmly apply the parking brake. Jack up the front of the vehicle, and securely support it on axle stands. Remove both front roadwheels.

2 Set the ride height control to its lowest position, then depressurise the hydraulic system - refer to Chapter 9 for details.
3 Set the bonnet in the upright position or, to improve access, remove it completely as described in Chapter 11.
4 Undo the retaining screws and remove the plastic undercover from beneath the engine/transmission unit. Also remove the plastic covers from the left- and right-hand wheelarches.
5 If the engine is to be dismantled, working as described in Chapter 1, first drain the oil and remove the oil filter. Clean and refit the drain plug, tightening it securely.
6 Disconnect both cables from the battery terminals. Remove the battery from its holder then unbolt the battery holder from the bodywork and remove it from the engine compartment.
7 Refer to Chapter 3 and drain the cooling system.
8 Drain the transmission oil as described in Chapter 7A.
9 Remove both driveshafts, as described in Chapter 8.
10 Refer to Chapter 2A and unbolt the rear engine mounting from the suspension subframe.
11 Remove the bolt and detach the metal clip(s) that secures the hydraulic system pipework to the front of the pressure regulator, at the front of the transmission casing.
12 Unbolt the exhaust downpipe from the exhaust manifold/turbocharger flange (as applicable), with reference to Chapter 4A/C.
13 Slacken the clips and detach the hoses from the coolant pump inlet and outlet ports. Similarly, disconnect the throttle housing coolant hose, and the radiator top and bottom hoses at their respective ports.
14 Refer to Chapter 7A and detach the three gear change/shift control rods from their ball joint pivots.
15 With reference to Chapters 9 and 11 as applicable, slacken the unions and disconnect the hydraulic system feed pipe, the power steering system supply pipe, the pressure regulator return pipe and the flow distributor return pipe from the regulator/distributor assembly.
16 Slacken the large worm drive clips and disconnect the air intake ducting from the throttle body. Where applicable, unplug the wiring at the connector and detach the section of ducting that incorporates the air flow meter. Store the air flow meter in a safe place. On turbo models, remove the securing screws, slacken the hose clips and disconnect the air cleaner to turbocharger, turbocharger to intercooler and intercooler to inlet manifold ducting.
17 Refer to Chapter 9 and detach the hose manifold from the hydraulic system fluid reservoir from its casing. Cover the open reservoir to prevent dirt ingress. Slacken the clip and detach the hydraulic pump feed pipe from the hose manifold. Pad the exposed pipes on the underside of the manifold, to prevent damage and dirt ingress.
18 Working at the transmission, carry out the following:
a) Refer to Chapter 7A and disconnect the speedometer drive cable or the transducer wiring from the transmission.
b) Unbolt the earth cable from the transmission casing.
c) Disconnect the clutch cable from the transmission with reference to Chapter 6.
d) Unplug the wiring from the reversing lamp switch at the connector.
19 Disconnect the accelerator cable from throttle body as described in Chapter 4A.
20 Disconnect the main engine wiring harness at the connectors located on the top of the transmission casing.
21 Remove the electronic control unit(s) from the casing at the front right hand corner of the engine compartment. Slacken and withdraw the securing screws and detach the casing from the bodywork.
22 Slacken the hose clips and disconnect the fuel supply and return hoses from the fuel rail and pressure regulator - see Chapter 4A fro details.
23 Working at the engine compartment bulkhead, slacken the hose clips and detach the cabin heater supply and return hoses from their respective ports.
24 Support the engine securely on a hoist, or a lifting beam positioned across the engine compartment in line with the suspension mounting turrets.
25 Refer to Chapter 2A and carry out the following:
a) Remove the centre nut and unbolt the transmission casing from the engine/transmission mounting.
b) Unbolt the engine/transmission mounting bracket from the chassis rail and remove it from the engine compartment.
c) Slacken and withdraw the centre bolt, then separate the two halves of the upper engine mounting.
26 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 and driveshafts are secured so that they cannot be damaged on removal.
27 Lift the engine/transmission out of the car, ensuring that nothing is trapped or damaged. Enlist the help of an assistant during this procedure, as it will be necessary to tilt the assembly slightly to clear the body panels.
28 Once the engine is high enough, lift it out over the front of the body, and lower the unit to the ground.

Separation

29 With the engine/transmission assembly removed, support the assembly on suitable blocks of wood, on a workbench (or failing that, on a clean area of the workshop floor).
30 Undo the retaining bolts, and remove the flywheel lower cover plate from the transmission. On some models the plate has support struts attached to it, these will have to be unbolted from the side of the cylinder block.
31 Disconnect the wiring then undo the retaining bolts, and remove the starter motor from the transmission, noting the correct fitted position of the locating dowel (see Chapter 5A).
32 Ensure that both engine and transmission are adequately supported, then slacken and remove the remaining bolts securing the transmission housing to the engine. Note the correct fitted positions of each bolt (and the relevant brackets) as they are removed, to use as a reference on refitting.
33 With reference to Chapter 7A, carefully withdraw the transmission from the engine, ensuring that the weight of the transmission is not allowed to hang on the input shaft while it is engaged with the clutch friction disc.
34 If they are loose, remove the locating dowels from the engine or transmission (where applicable), and keep them in a safe place.

Refitting

35 If the engine and transmission have been separated, perform the operations described below in paragraphs 36 to 41. If not, proceed as described from paragraph 42 onwards.
36 Ensure the clutch plate and transmission input shaft splines are clean and dry. Do not apply grease to the splines as they have a special low-friction nickel coating.
37 Ensure the locating dowels are correctly positioned prior to installation and make sure the clutch release mechanism components are correctly fitted (see Chapter 6).
38 With reference to Chapter 7A, carefully offer the transmission to the engine, until the locating dowels are engaged. Ensure that the weight of the transmission is not allowed to hang on the input shaft as it is engaged with the clutch friction disc.
39 Refit the transmission housing-to-engine bolts, ensuring that all the necessary brackets are correctly positioned, and tighten them to the specified torque setting.
40 Refit the starter motor making sure the locating dowel is correctly positioned. Securely tighten its retaining bolts and reconnect the wiring (see Chapter 5A).
41 Refit the flywheel lower cover plate to the transmission, and tighten its retaining bolts to the specified torque.
42 Reconnect the hoist and lifting tackle to the engine lifting brackets. With the aid of an assistant, lift the assembly over the engine compartment.
43 The assembly should be tilted as necessary to clear the surrounding components, as during removal; lower the assembly into position in the engine compartment, manipulating the hoist and lifting tackle as necessary.

44 With the engine/transmission in position, refit the engine/transmission mounting bracket to the chassis rail and tighten the securing bolts to the specified torque. Pass the stud on the transmission casing through the engine/transmission mounting, then fit the nut to the stud and tighten it lightly by hand

45 Refit the right-hand engine mounting bolts and tighten them lightly by hand.

46 Rock the engine to settle it on its mountings. Centralise the right-hand mounting bracket in relation to the rubber mounting lug then tighten its retaining nut and bolts to their specified torque settings. Go around and tighten all the remaining mounting nuts and bolts to their specified torque settings and detach the hoist from the engine.

47 The remainder of the refitting procedure is a direct reversal of the removal sequence, noting the following points:

a) *Ensure that the wiring loom is correctly routed and retained by all the relevant retaining clips; all connectors should be correctly and securely reconnected.*
b) *Refit the cap and hose manifold to the hydraulic system fluid reservoir, then bleed the system as described in Chapter 9.*
c) *Prior to refitting the driveshafts to the transmission, the driveshaft oil seals should be renewed.*
d) *Ensure that all disturbed hoses are correctly reconnected, and securely retained by their retaining clips.*
e) *Adjust the clutch cable as described in Chapter 6.*
f) *Adjust the accelerator cable as described in Chapter 4A.*
g) *Refill the engine and transmission with correct quantity and type of oil, as described in Chapters 1A and 7A.*
h) *Refill the cooling system as described in Chapters 1A and 3.*
i) *Top up the fluid level in the hydraulic system as described in "Weekly checks".*

5 Petrol engine and automatic transmission unit - removal, separation and refitting

Removal

Note: *The engine can be removed from the car only as a complete unit with the transmission; the two are then separated for overhaul.*

1 The removal procedure is essentially the same as that described for the removal of the engine and manual transmission assembly, but note the following points:

a) *Where applicable, release the retaining clips and disconnect the coolant hoses from the transmission fluid cooler.*
b) *On models with electronic transmission control, release the retaining clips and disconnect the wiring connectors from the transmission electronic control unit (ECU).*
c) *Disconnect the selector cable from the transmission and position it clear of the unit as described in Chapter 7B.*
d) *Where applicable, disconnect the transmission kick-down cable at the throttle body.*
e) *Disconnect the earth cable from the stud on the transmission.*
f) *Remove the wiring harness bracket and the hose support bracket from the transmission.*
g) *Disconnect the wiring from the speedometer transducer (speedometer drive) and RPM sensor, then remove the RPM sensor from the bellhousing.*
h) *Remove the starter motor.*
i) *Label and disconnect any remaining wiring connectors and support brackets connected to the transmission.*

Separation

2 With the engine/transmission assembly removed, support the assembly on suitable blocks of wood, on a workbench (or failing that, on a clean area of the workshop floor).

3 Locate the access hole at the lower rear of the cylinder block, then turn the crankshaft, by means of a socket on the crankshaft pulley bolt, until one of the torque converter retaining bolts is accessible through the access hole.

4 Undo the accessible torque converter bolt then turn the crankshaft as necessary and undo the remaining two bolts.

5 Slacken and remove the bolts securing the transmission housing to the engine. Note the correct fitted positions of each bolt, and the necessary brackets, as they are removed, to use as a reference on refitting. Make a final check that all components have been disconnected, and are positioned clear of the transmission so that they will not hinder the removal procedure.

6 With the bolts removed, pull the transmission off the engine, to free it from its locating dowels. Once the transmission is free, and sufficient clearance exists, insert a bolt with a suitable washer, through the RPM sensor hole in the transmission bellhousing, to retain the torque converter on the transmission.

Preparation for reconnection

7 Prior to reconnection it is necessary to make a simple tool to align the torque converter with the driveplate as the transmission is refitted. To make the tool, obtain a bolt of the same size as the torque converter retaining bolts, but long enough to extend through the access hole in the cylinder block when the transmission is refitted.

8 Cut the head off the bolt and cut a slot (to enable it to be unscrewed) in the plain end. Check that the tool will slide easily through the torque converter retaining bolt hole in the driveplate.

9 Turn the engine crankshaft so that one of the torque converter retaining bolt holes in the driveplate, is aligned with the access hole in the cylinder block. Screw the alignment tool (finger tight only) into one of the retaining bolt holes in the torque converter. Turn the torque converter so that the alignment tool is in approximately the correct position, relative to the cylinder block access hole. As the transmission is refitted, the alignment tool will pass through the retaining bolt hole in the driveplate and through the access hole. It can then be unscrewed with a screwdriver and the first torque converter retaining bolt fitted in its place.

10 Check that the torque converter support bush fitted to the centre of the crankshaft is in good condition, and in place.

11 Ensure that the engine/transmission locating dowels are correctly positioned prior to installation.

Reconnection

12 The transmission is reconnected by a reversal of the removal procedure, bearing in mind the following points:

a) *Guide the transmission into position ensuring that the alignment tool passes through the driveplate and access hole.*
b) *Remove the bolt used to retain the torque converter in place, just before the transmission engages with the engine.*
c) *Once the transmission is bolted to the engine, remove the alignment tool and fit the first torque converter retaining bolt. Turn the crankshaft as necessary and fit the other two bolts.*

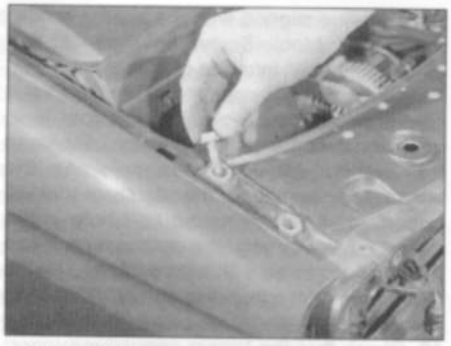
Refitting

13 Refit the starter motor, and securely tighten its retaining bolts.

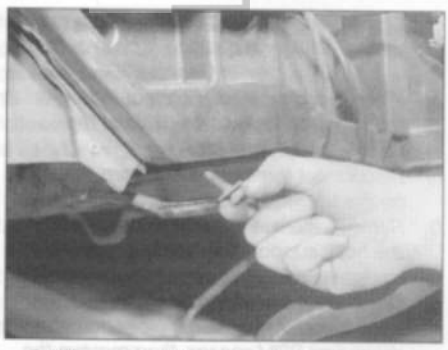
14 Refit the engine unit to the vehicle as described in the relevant refitting paragraphs of Section 4.

15 The remainder of the refitting procedure is a reversal of the removal sequence, noting the following points:

a) *Ensure that the wiring loom is correctly routed, and retained by all the relevant retaining clips; all connectors should be correctly and securely reconnected.*
b) *Prior to refitting the driveshafts to the transmission, renew the driveshaft oil seals as described in Chapter 7B.*
c) *Ensure that all coolant hoses are correctly reconnected, and securely retained by their retaining clips.*
d) *Adjust the accelerator cable as described in Chapter 4A.*
e) *Refill the engine and transmission with correct quantity and type of lubricant, as described in Chapter 1A and 7B.*
f) *Refill the cooling system (see Weekly Checks).*
g) *Top up the hydraulic system with the specified grade of fluid, as described in "Weekly checks"*



6.11a At the engine compartment front crossmember, remove the upper . . .



6.11b . . . and lower securing bolts . . .

6.11c . . . then lift the crossmember away from the front of the car

6 Diesel engine and manual transmission unit - removal, separation and refitting

Removal

1 Park the vehicle on firm, level ground. Chock the rear wheels, then firmly apply the parking brake. Jack up the front of the vehicle, and securely support it on axle stands. Remove both front roadwheels.

2 Set the ride height control to its lowest position, then depressurise the hydraulic system - refer to Chapter 9 for details.

3 Set the bonnet in the upright position or, to improve access, remove it completely as described in Chapter 12.

4 Undo the retaining screws and remove the plastic undertray from beneath the engine/transmission unit. Also remove the plastic covers from the left- and right-hand wheelarches.

5 If the engine is to be dismantled, working as described in Chapter 1B, first drain the engine oil and remove the oil filter. Clean the sump drain plug (fitting a new sealing washer where applicable), then fit and tighten it securely.

6 Disconnect both cables from the battery terminals. Slacken the clamp bar and remove the battery from its holder (see Chapter 5A).

7 Refer to Chapter 3 and drain the cooling system.

8 Drain the transmission oil as described in Chapter 7A.

9 Refer to Chapter 4B and carry out the following:

a) Remove the air cleaner and its associated intake air ducting. On 2.1 litre models, slacken the clips and disconnect the inlet air ducting from the upper inlet manifold and intercooler.

b) Disconnect the accelerator cable from the fuel injection pump (excluding models with 'drive by wire' electronic fuel injection).

c) Slacken the clips and disconnect the fuel supply and return hoses.

d) Unplug the fuel injection pump wiring at the connectors.

10 Refer to Chapter 9 and detach the cap and hose manifold from the hydraulic system fluid reservoir casing. Cover the open reservoir to prevent dirt ingress. Slacken the clip and detach the hydraulic pump feed pipe from the hose manifold. Place the exposed pipes on the underside of the cap/manifold in a suitable container to prevent damage and dirt ingress, and tie them back away from the work area.

11 Remove the front bumper with reference to Chapter 12, then remove the headlights with reference to Chapter 13. Disconnect the bonnet release cable at the joint block, located underneath and behind the battery holder. Slacken and withdraw the securing bolts, then carefully lift off the engine compartment front crossmember, together with the cooling fans **(see illustrations)**. Unplug the horn and cooling fan wiring as the connectors become accessible.

12 Unbolt the fuel filter/priming pump, glow plug control unit and power supply unit from the battery tray. Label the connectors to aid refitting then unplug the wiring from the underside of the glow plug control and power supply units. Remove the securing screws and lift the battery tray out of the engine compartment.

6.13 Remove the electronic control units from their plastic casing, then remove the casing from the bodywork

13 Remove the electronic control unit(s) fr their plastic casing, located at the front ri hand corner of the engine compartme Unplug each ECU from its respective wir connector and store it in a safe place - avo touching the connector pins. Slacken a withdraw the securing screws, then remo the ECU casing from the bodywork (se **illustration).**

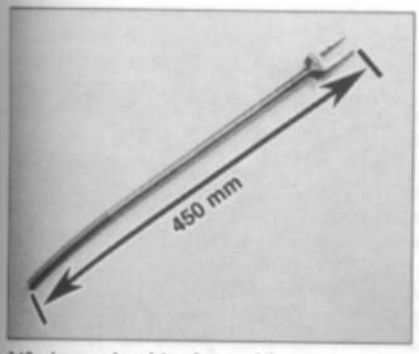
14 Refer to Chapter 3 and remove t radiator. Note that on 2.5 litre models, t intercooler cooling radiator is secured to t front of the main radiator; both units can b removed as an assembly.

15 Refer to Chapter 8 and remove the ri hand driveshaft and intermediate shaft. T left hand driveshaft must be withdrawn fr the differential, but it does not need to b removed from the hub; (refer to Chapter 8 f details). Secure the shaft away from t transmission using a length of wire to ensu that it does impede the engine remov process. Ensure that the shaft is secur horizontally, so that the CV joints are n strained.

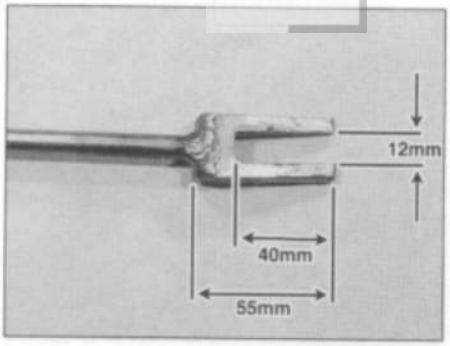
16 Unbolt the exhaust downpipe from t exhaust manifold/turbocharger flange (i applicable), with reference to Chapter 4C.

17 On 2.5 litre models, working underneat the car, unbolt the curved inlet air trunki from the turbocharger flange, and recover t O-ring seal **(see illustration)**. Slacken t

6.17 On 2.5 litre models, unbolt the inlet a trunking (arrowed) from the turbocharge flange (viewed through right hand wheel arch)



6.18a Improvised tool, used for separating the gear change cable ball joints on 2.5 litre models



6.18b Fabricate the tapered, forked end to the dimensions shown

6.18c Insert the tool between the two halves of the balljoint and tap the end with a mallet to separate the joint

hose clip and detach the other end of the trunking from the rigid duct/coolant pump pulley cover assembly. Remove the trunking from the engine bay.

18 Refer to Chapter 7A and detach the three gear change/shift control rods from their ball joint pivots. On 2.5 litre models, disconnect the gear change and shift cables from the transmission as described in Chapter 7A.

Note: *Access to the gear change and shift cable ball joints at the transmission is extremely limited on the 2.5 litre model. The fabrication of a special tool for this purpose is recommended* ***(see illustrations).***

19 Unplug the main engine wiring harness at the connectors, located above the transmission casing **(see illustration)**. Work around the engine and trace any remaining wiring that has not been isolated by the separation of the main wiring harness connectors. Unplug each section of wiring at its respective connector - label each connector carefully to aid reconnection later. Note that some (but not all) connectors are colour-coded.

20 Working at the transmission, carry out the following:

a) Refer to Chapter 7A and disconnect the speedometer drive cable (or transducer wiring) and the reversing lamp switch wiring from the transmission.

b) Unbolt the earth cable from the transmission casing.

c) Disconnect the clutch cable (or slave cylinder, as applicable) from the transmission with reference to Chapter 6.

d) Remove the securing screw and withdraw the TDC sensor from the top of the transmission bellhousing.

21 With reference to Chapters 9 and 11 as applicable, slacken the unions and disconnect the hydraulic system feed pipe, the power steering system supply pipe, the pressure regulator return pipe and the flow distributor return pipe from the regulator/distributor assembly (mounted on the front of the transmission assembly). It will be necessary to release the pipes from the metal clip(s) at the front of the pressure regulator.

22 Support the engine securely on a hoist. Attach the jib only to the lifting eyes provided, do not lift at any other point. Use all the available lifting eyes, to achieve even weight distribution and balance.

23 On 2.1 litre models, refer to Chapter 2B and carry out the following:

a) Remove the auxiliary drivebelt.

b) Unbolt the auxiliary drivebelt tensioner assembly from the engine (where applicable).

c) Unbolt the auxiliary drivebelt pulley from the crankshaft timing/balance shaft sprocket.

24 Ensure that the engine is securely supported on the hoist, then refer to Chapter 2B and unbolt and remove the engine mounting components.

25 Using the hoist, raise the engine slightly, then draw it away from the bulkhead slightly. Adjust the hoist so that the engine can be tilted towards the front of the car slightly.

26 Working at the engine compartment bulkhead, slacken the hose clips and detach the cabin heater supply and return hoses from their respective ports (see Chapter 3).

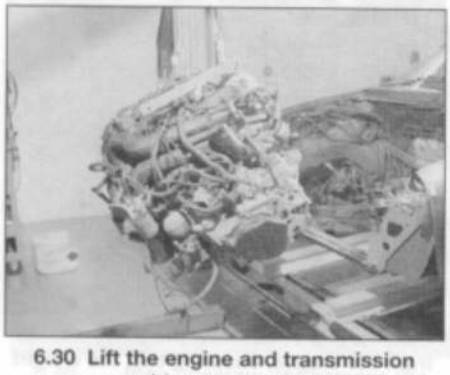
27 Make a final check that any components which would prevent the removal of the engine/transmission from the car have been removed or disconnected.

28 Ensure that components such as the gearchange selector rods/cables and hydraulic pipes are secured so that they cannot be damaged on removal.

29 Lift the engine/transmission upwards, until the bottom of the sump is just above the level of the suspension front crossmember. Check around the engine and ensure that nothing is trapped or damaged. Enlist the help of an assistant during this procedure, as it will be necessary to tilt the assembly slightly to clear the body panels.

30 Rotate the engine on the hoist, so that the timing belt end is furthest forward, allowing it to leave the engine compartment first. Manoeuvre the engine past the bodywork, taking great care to avoid the ABS hydraulic unit (where fitted). Lift the engine assembly out over the front crossmember using the hoist and lower the unit to a suitable work surface **(see illustration)**.

6.19 Unplug the main engine wiring harness at the connectors, located above the transmission casing



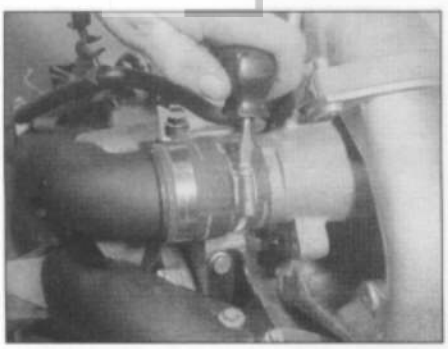
6.30 Lift the engine and transmission assembly out over the front crossmember

Separation

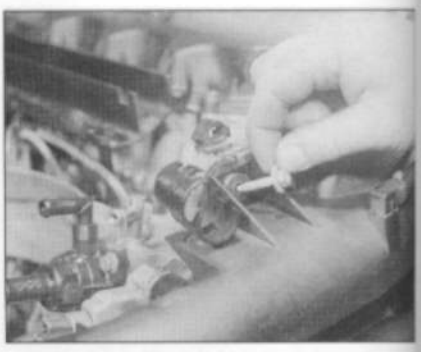
31 With the engine/transmission assembly removed, support the assembly on suitable blocks of wood, on a workbench (or failing that, on a clean area of the workshop floor).

32 Undo the retaining bolts, and remove the flywheel lower cover plate from the transmission. On some models the plate has support struts attached to it, these will have to be unbolted from the side of the cylinder block.

6.33a On 2.5 litre models, unbolt the intercooler mounting bracket from the engine block



6.33b On 2.5 litre models, slacken the hose clips . . .



6.33c . . . remove the securing screws . . .

33 On 2.5 litre models, carry out the following **(see illustrations)**:

a) Remove the intercooler, then unbolt the intercooler mounting bracket from the engine block (see Chapter 4B)

b) Slacken the hose clips, remove the securing screws, and lift off the combined coolant pump pulley cover/inlet air ducting assembly.

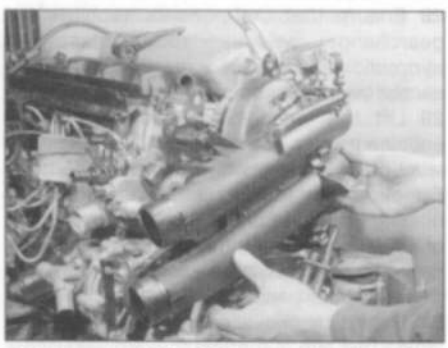
c) Remove the securing bolt and detach the fuel heater thermostat from the transmission bellhousing.

34 Disconnect the wiring then undo the retaining bolts, and remove the starter motor from the transmission, noting the correct fitted position of the locating dowel (see Chapter 5A).

35 Ensure that both engine and transmission are adequately supported, then slacken and remove the remaining bolts securing the transmission housing to the engine. Note the correct fitted positions of each bolt (and the relevant brackets) as they are removed, to use as a reference on refitting.

36 Carefully withdraw the transmission from the engine, ensuring that the weight of the transmission is not allowed to hang on the input shaft while it is disengaged from the clutch friction disc **(see illustration)**. Note that on 2.5 litre models, some resistance may be encountered as the release bearing disengages from the release shaft forks.

37 If they are loose, remove the locating dowels from the engine or transmission (where applicable), and keep them in a safe place.



6.33d . . . and lift off the combined coolant pump pulley cover/inlet air ducting assembly

Refitting

38 If the engine and transmission have been separated, perform the operations described below in paragraphs 39 to 44. If not, proceed as described from paragraph 45 onwards.

39 Ensure the clutch plate and transmission input shaft splines are clean and dry. Do not apply grease to the splines as they have a special low-friction nickel coating.

40 Ensure the locating dowels are correctly positioned prior to installation and make sure the clutch release mechanism components are correctly fitted (see Chapter 6). Note that on 2.5 litre models, the clutch release bearing must be separated from the pressure plate and fitted to the clutch release fork - see Chapter 6 for details.

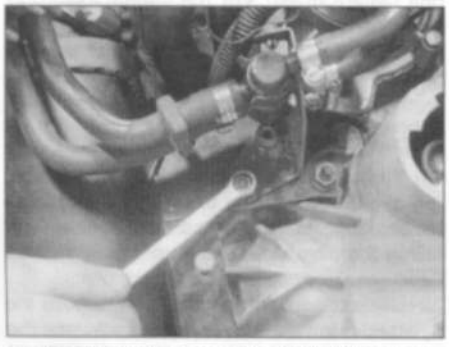
41 With reference to Chapter 7A, carefully offer the transmission to the engine, until the locating dowels are engaged. Ensure that the weight of the transmission is not allowed to hang on the input shaft as it is engaged with the clutch friction disc. On 2.5 models with a hydraulic clutch, refer to the information in Chapter 6 which describes how to reconnect the thrust bearing to the pressure plate.

42 Refit the transmission housing-to-engine bolts, ensuring that all the necessary brackets are correctly positioned, and tighten them to the specified torque setting **(see illustration)**.

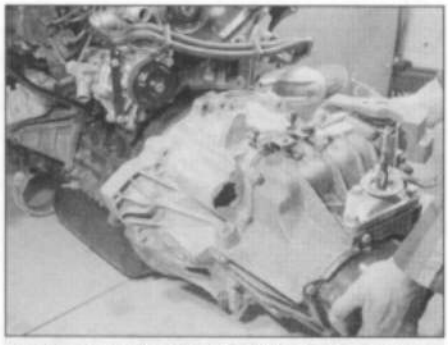
43 Refit the starter motor making sure the locating dowel is correctly positioned. Securely tighten its retaining bolts and reconnect the wiring (see Chapter 5A).

44 On 2.5 litre engines, carry out the following:

a) Refit the intercooler mounting bracket to the engine block, then refit the intercooler.



6.33e On 2.5 litre models, unbolt the fuel heater thermostat from the transmission bellhousing



6.36 Carefully withdraw the transmission from the engine, ensuring that the weight of the transmission is not allowed to hang on the input shaft

6.42 Refit the transmission bellhousing-to-engine bolts and tighten them to the specified torque setting

b) *Refit the combined coolant pump pulley cover/inlet air ducting assembly, and tighten the screws securely.*
c) *Refit the fuel heater thermostat.*

45 Refit the flywheel lower cover plate to the transmission, and tighten its retaining bolts to the specified torque.

46 Reconnect the hoist and lifting tackle to the engine lifting brackets. With the aid of an assistant, lift the assembly over the engine compartment.

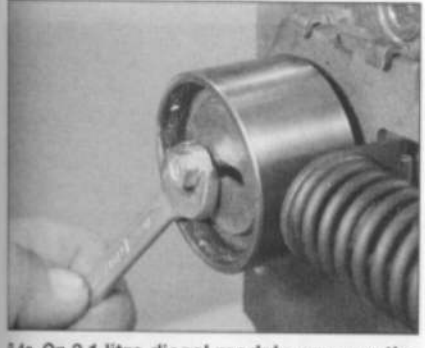
47 The assembly should be tilted as necessary to clear the surrounding components, as during removal; lower the assembly into position in the engine compartment, manipulating the hoist and lifting tackle as necessary.

48 With the engine/transmission in position, refit the engine/transmission mountings as described in Chapter 2B. Do not fully tighten the mounting bolts at this stage.

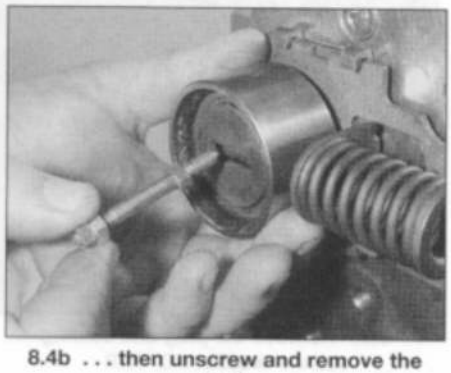
49 Rock the engine to settle it on its mountings. Centralise the right-hand mounting bracket in relation to the rubber mounting lug then tighten its retaining nut and bolts to their specified torque settings. Go around and tighten all the remaining mounting nuts and bolts to their specified torque settings and detach the hoist from the engine. Where applicable, adjust the torque control mechanisms as described in Chapter 2B to ensure minimal engine movement.

50 The remainder of the refitting procedure is a direct reversal of the removal sequence, noting the following points:

a) *Ensure that the wiring loom is correctly routed and retained by all the relevant retaining clips; all connectors should be correctly and securely reconnected. Pay particular attention to body earth points - ensure that the connections surfaces are clean and free from corrosion.*
b) *Refit the cap and hose manifold to the hydraulic system fluid reservoir, then bleed the system as described in Chapter 9.*
c) *Prior to refitting the driveshafts to the transmission, the driveshaft oil seals should be renewed.*
d) *Ensure that all disturbed hoses are correctly reconnected, and securely retained by their retaining clips.*
e) *Adjust the clutch cable as described in Chapter 6.*
f) *Adjust the accelerator cable as described in Chapter 4B (where applicable).*
g) *Refill the engine and transmission with correct quantity and type of oil, as described in Chapters 1 and 7.*
h) *Refill the cooling system as described in* Chapters 1B and 3.
i) *Top up the fluid level and bleed the hydraulic system as described in Chapter 9.*



8.4a On 2.1 litre diesel models, remove the timing belt tensioner centre retaining stud by screwing on a second nut and locking the two nuts together . . .



8.4b . . . then unscrew and remove the stud

7 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 ancillary equipment and external components must be removed first, to be transferred to the replacement engine (just as they will if you are doing a complete engine overhaul yourself).

Note: *When removing the external components from the engine, pay close attention to details that may be helpful or important during refitting. Note the fitted position of gaskets, seals, spacers, pins, washers, bolts, and other small items.*

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, sump, oil pump, and timing belt 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, referring to Part A or B of this Chapter unless otherwise stated.

a) *Inlet and exhaust manifolds (Chapter 4).*
b) *Timing belt, sprockets and tensioner(s).*
c) *Cylinder head.*
d) *Flywheel/driveplate.*
e) *Sump.*
f) Oil pump.
g) *Balance shafts and housings (where applicable).*
h) *Pistons/connecting rods.*
i) *Crankshaft.*

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

8 Cylinder head - dismantling

Note: *New and reconditioned cylinder heads are available from the manufacturer, and 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.*

1 Remove the cylinder head as described in Part A or B of this Chapter, or in this Part (as applicable).

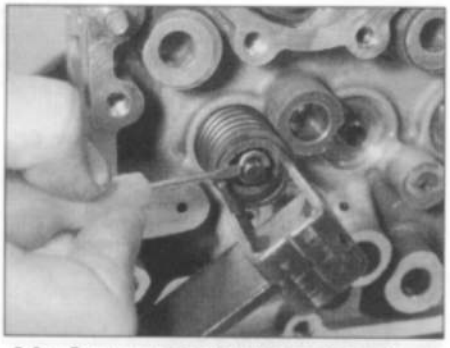
2 If not already done, remove the inlet and exhaust manifolds with reference to the relevant Part of Chapter 4. Remove any remaining brackets or housings as required.

3 Remove the camshaft, followers and shims (as applicable) as described in Part A or B of this Chapter.

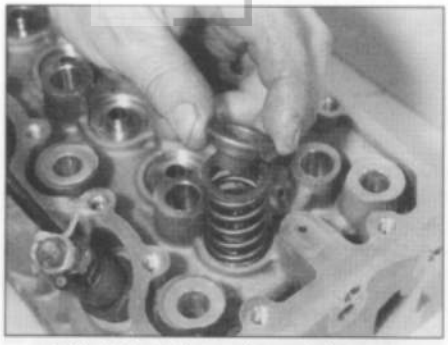
4 On diesel models, remove the glow plugs as described in Chapter 5C and the injectors as described in Chapter 4B. On 2.1 litre diesel models, remove the timing belt tensioner centre retaining stud by screwing on a second nut and locking the two nuts together. Unscrew the stud by means of the locked nuts. Undo the retracting cam retaining bolt and remove the tensioner assembly **(see illustrations)**.

5 On 2.5 litre diesel models, unbolt the camshaft timing belt and coolant pump drivebelt tensioner assemblies from either end of the cylinder head.

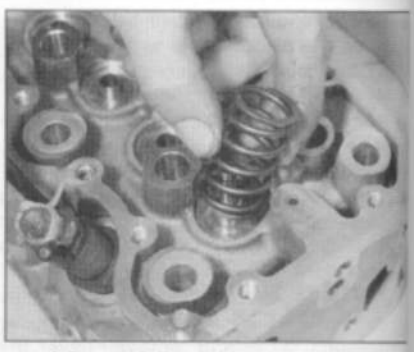
6 On all models, using a valve spring compressor, compress each valve spring in turn until the split collets can be removed. Release the compressor, and lift off the spring retainer, spring and spring seat. Using a pair of pliers, carefully extract the valve stem oil



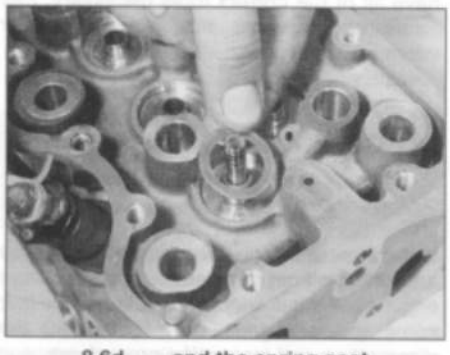
8.6a Compress each valve spring using a valve spring compressor and remove the split collets



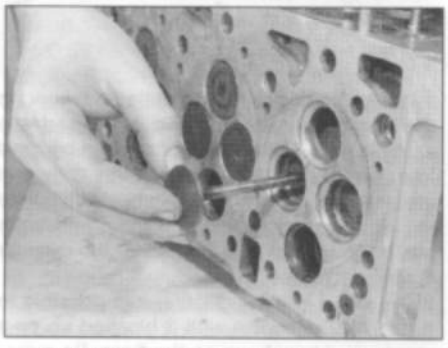
8.6b Lift off the spring retainer . . .



8.6c . . . followed by the spring . . .



8.6d . . . and the spring seat



8.8 Withdraw the valve through the combustion chamber

8.9 Keep each valve and its associated components together in a labelled bag

seal from the top of the guide **(see illustrations)**.

7 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 should free the retainer.

8 Withdraw the valve through the combustion chamber **(see illustration)**

9 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 illustration)**. Note that No 1 valve is nearest to the transmission (flywheel/driveplate) end of the engine.

9 Cylinder head and valves - cleaning and inspection

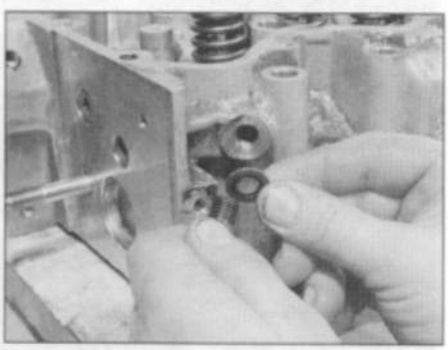
1 Thorough cleaning of the cylinder head and valve components, followed by a detailed inspection, will enable you to decide how much valve service work must be carried out during the engine overhaul. **Note:** *If the engine has been severely overheated, it is best to assume that the cylinder head is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

Cleaning

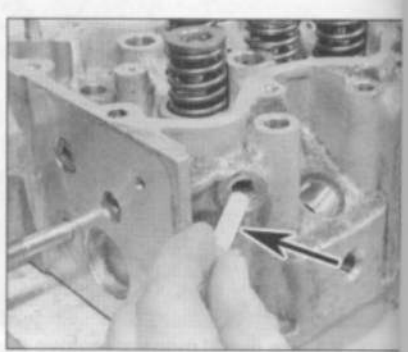
2 Scrape away all traces of old gasket material from the cylinder head.

3 Scrape away the carbon from the combustion chambers and ports, then wash the cylinder head thoroughly with paraffin or a suitable solvent. Similarly, scrape off any heavy carbon deposits that may have formed on the valves, then use a power-operated wire brush to remove deposits from the valve heads and stems.

4 Where applicable on 2.5 litre diesel engines, unscrew the plug together with it sealing washer and remove the oil filter cartridge from the cylinder head casting **(see illustrations)**.



9.4a Remove the plug and sealing washer . . .



9.4b . . . then withdraw the oil filter cartridge from the cylinder head casting - 2.5 litre diesel models

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.

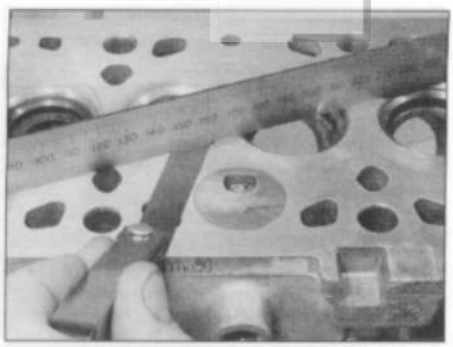
6 Use a straight-edge and feeler blade to check that the cylinder head gasket surface is not distorted **(see illustration)**. If it is, it may be possible to have it machined, provided that the cylinder head is not reduced to less than the specified height. **Note:** *On diesel engines, it will be necessary to recut the combustion chambers and valve seats if more than 0.1 mm has been machined off the cylinder head. This is necessary in order to maintain the correct dimensions between the valve heads, valve guides and cylinder head gasket face.*

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 re-cut by an engine overhaul specialist. If they are only slightly pitted, this can be removed by grinding-in the valve heads and seats with fine valve-grinding compound, as described below.

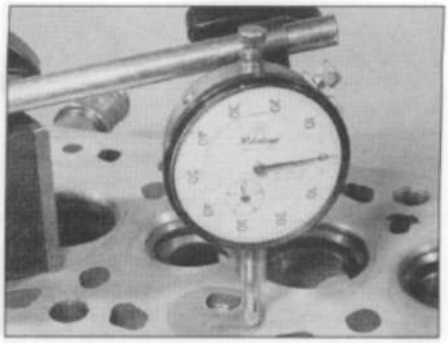
8 Check the valve guides for wear by inserting the relevant valve, and checking for side-to-side motion of the valve. A very small amount of movement is acceptable. If the movement seems excessive, remove the valve. Measure the valve stem diameter (see below), and renew the valve if it is worn. If the 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 Citroën dealer or engine overhaul specialist, who will have the necessary tools available. Where no valve stem diameter is specified, seek the advice of a Citroën dealer on the best course of action.

9 If renewing the valve guides, the valve seats should be re-cut or re-ground only *after* the guides have been fitted.

10 On diesel models, inspect the swirl chambers for burning or damage such as cracking. Small cracks in the chambers are acceptable; renewal of the chambers will only be required if chamber tracts are badly burned and disfigured, or if they are no longer a tight fit in the cylinder head. If there is any doubt as to the swirl chamber condition, seek the advice of a Citroën dealer or a suitable repairer who specialises in diesel engines. Swirl chamber renewal should be entrusted to a specialist. Using a dial test indicator, check that the swirl chamber protrusion is within the limits given in the Specifications **(see illustration)**. Zero the dial test indicator on the gasket surface of the cylinder head, then measure the protrusion of the swirl chamber. If the protrusion is not within the specified limits, the advice of a Citroën dealer or suitable repairer who specialises in diesel engines should be sought.



9.6 Use a straight-edge and feeler blade to check that the cylinder head gasket surface is not distorted



9.10 Using a dial test indicator, check that the swirl chamber protrusion is within the limits given in the Specifications

Valves

11 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 or excessive wear on the tip of each valve stem. Renew any valve that shows any such signs of wear or damage.

12 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.

13 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 re-cut, fine grinding compound *only* should be used to produce the required finish. Coarse 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 re-cutting, or even the renewal of the valve or seat insert (where possible) is required.

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

15 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 **(see illustration)**. 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.

16 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.

17 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.

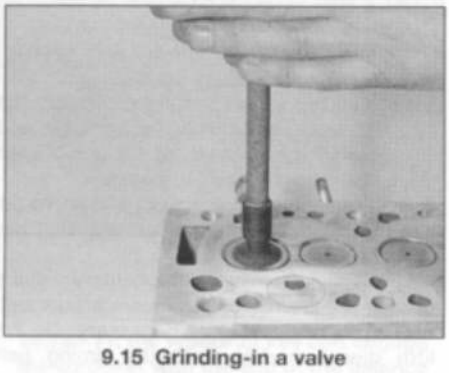
Valve components

18 Examine the valve springs for signs of damage and discoloration. No minimum free length is specified by Citroën, so the only way of judging valve spring wear is by comparison with a new component.

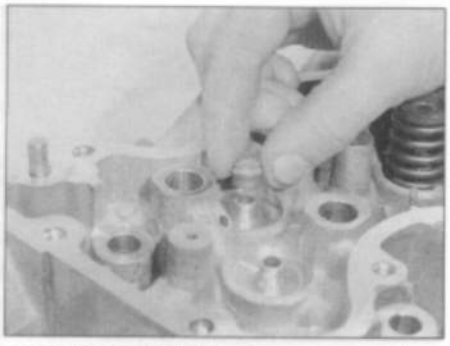
19 Stand each spring on a flat surface, and check it for squareness. If any of the springs are damaged, distorted or have lost their tension, obtain a complete new set of springs. It is normal to renew the valve springs as a matter of course if a major overhaul is being carried out.

20 Renew the valve stem oil seals regardless of their apparent condition.

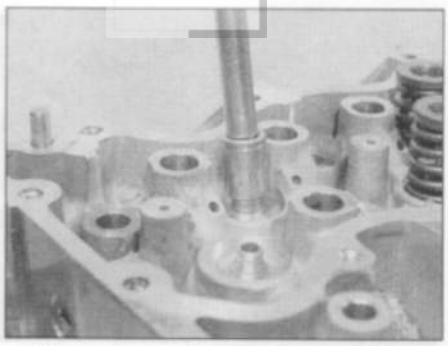
9.12 Measure the valve stem diameter at several points using a micrometer



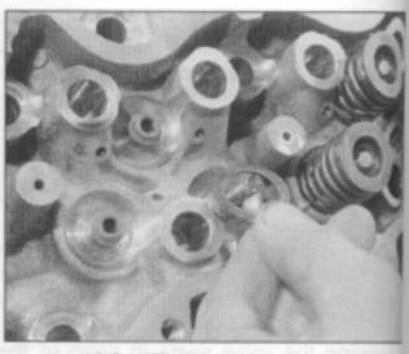
9.15 Grinding-in a valve



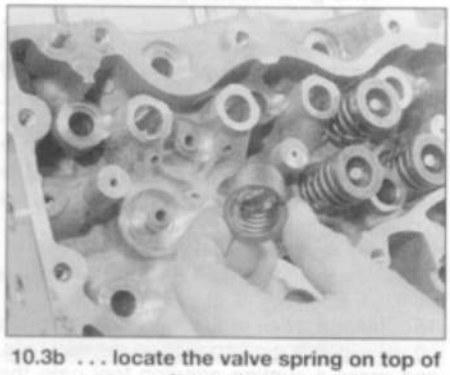
10.2a Carefully locate the new valve stem oil seal over the valve and onto the guide



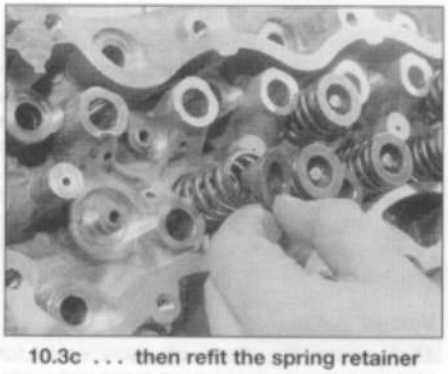
10.2b Use a suitable socket or metal tube to press the seal firmly onto the guide



10.3a Fit the spring seat . . .



10.3b . . . locate the valve spring on top of its seat . . .



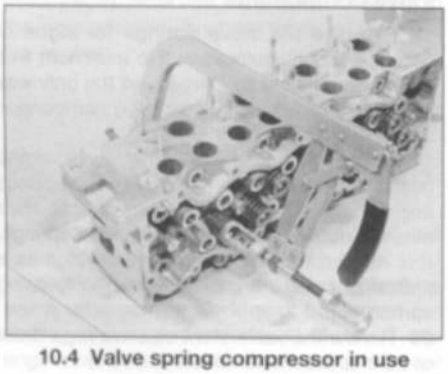
10.3c . . . then refit the spring retainer

10 Cylinder head - reassembly

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

2 Refit the spring seat then, 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 illustrations)**.

3 Fit the spring seat, locate the valve spring on top of its seat, then refit the spring retainer **(see illustrations)**



10.4 Valve spring compressor in use

4 Compress the valve spring, and locate the split collets in the recess in the valve stem. Release the compressor, then repeat the procedure on the remaining valves **(see illustration)**.

Use a little dab of grease to hold the collets in position on the valve stem while the spring compressor is released

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

6 Refit the camshaft, followers and shims (as applicable) as described in Part A or B of this Chapter.

7 Refit any remaining components using the reverse of the removal sequence and with new seals or gaskets as necessary. On 2.1 litre diesel models, refit the timing belt tensioner using thread locking compound on the centre stud. Tighten the stud using t locked nuts, then remove the second nut fr the end of the stud.

8 The cylinder head can then be refitted described in Part A or B of this Chapter applicable).

11 Balance shaft housings (2.5 litre Diesel engine)- removal and refitting

Removal

1 Brace the balance shaft timing belt sproc to prevent rotation **(see Tool Tip in Part B this chapter)**, then slacken and remove t sprocket securing nut. Note that on the r balance shaft (ie the one below the exha manifold), the nut has LEFT HAND THRE Slide the sprocket off the end of the shaft a recover the woodruff key.

2 Progressively slacken and withdraw t balance shaft housing bolts. Note that t bolts are of different sizes and tens strengths - make a note of their order fitment, to aid refitting.

3 Lift the housing away from the cylin block and recover the gasket.

4 Pull the balance shaft oil seal from t housing using a hooked instrum Alternatively, drill a small hole in the oil s and use a self-tapping screw and a pair pliers to remove it. Take great care to av drilling into the balance shaft or the oil s housing sealing surfaces.

5 Clean the oil seal housing and the balan shaft sealing surface.

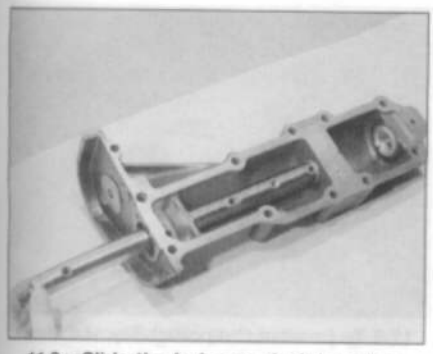
6 Slacken the securing screws, then lift t balance weights and plastic shields from t shaft. Make a note of their correct fit position, to aid refitting later.

7 Withdraw the balance shaft from t housing. Inspect the bearing and oil s mating surfaces for signs of wear.

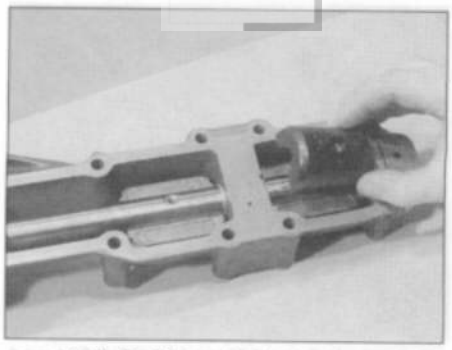
8 Clean the balance shaft housing-t crankcase sealing surface thorough removing any traces of the old gasket.

Refitting

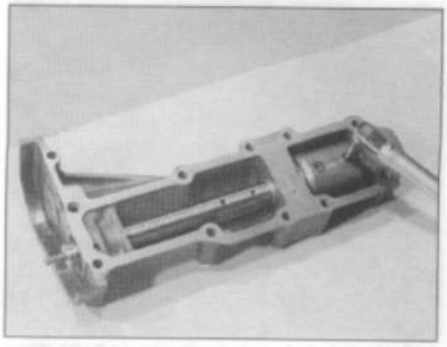
9 Lightly oil the bearing surfaces then sl the balance shaft into the housing. Refit t



11.9a Slide the balance shaft into the housing . . .



11.9b Refit the plastic covers . . .



11.9c . . . and balance weights and tighten the securing screws to the specified torque

balance weights and plastic covers, according to the notes made during removal. Tighten the securing screws to the specified torque **(see illustrations)**.

10 Fit a new balance shaft housing-to-crankcase gasket, then offer up the balance shaft housing to the cylinder block. Refit the balance shaft housing securing bolts, ensuring that they are refitted in the correct order, according to their length and size, then tighten them to the specified torque **(see illustrations)**.

11 Fit a new oil seal over the end of the balance shaft, open end first **(see illustration)**. A piece of thin plastic or tape wound around the front of the balance shaft is useful to prevent damage to the oil seal as it is fitted.

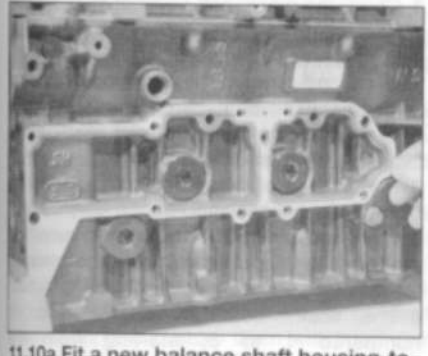
12 Press the seal into the housing until it is flush with the end face of the seal housing.

13 Fit the Woodruff key and engage the balance shaft sprocket with the end of the balance shaft. Brace the sprocket to prevent rotation, then tighten the sprocket securing nut to the specified torque **(see illustrations)**.

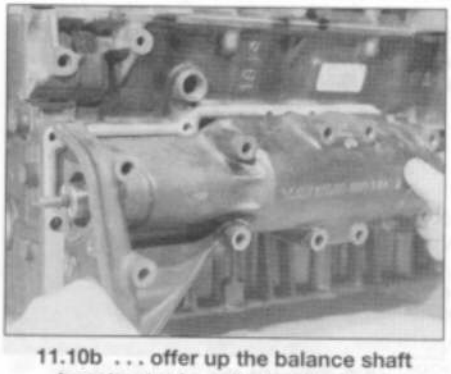
12 Piston/connecting rod assembly - removal

1 Remove the cylinder head, sump and oil pump as described in Part A or B of this Chapter (as applicable).

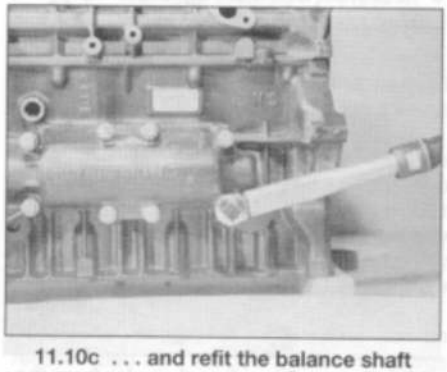
2 If there is a pronounced wear ridge at the top of any bore, it may be necessary to remove it with a scraper or ridge reamer, to avoid piston damage during removal. Such a ridge indicates excessive wear of the cylinder bore.



11.10a Fit a new balance shaft housing-to-crankcase gasket

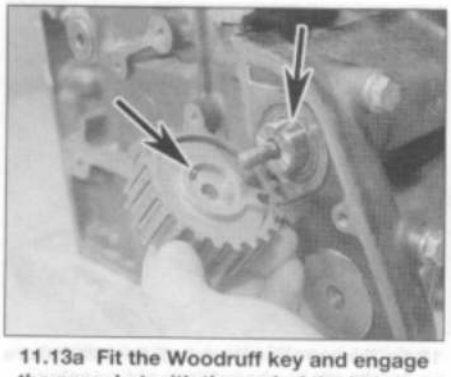


11.10b . . . offer up the balance shaft housing to the cylinder block . . .

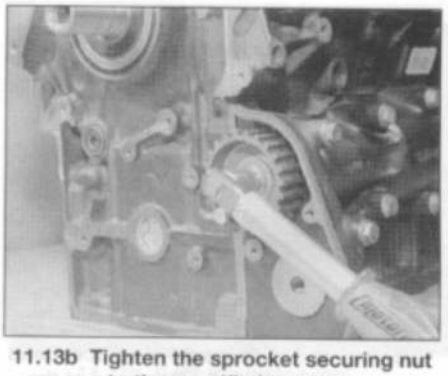


11.10c . . . and refit the balance shaft housing securing bolts and tighten them to the specified torque

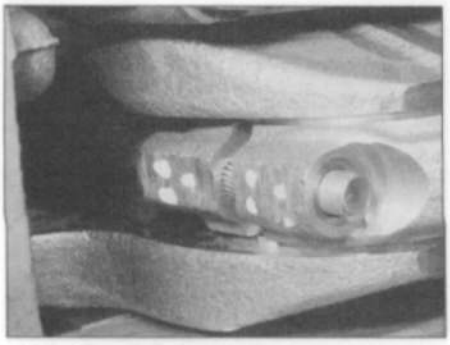
11.11 Fit a new oil seal over the end of the balance shaft



11.13a Fit the Woodruff key and engage the sprocket with the end of the balance shaft

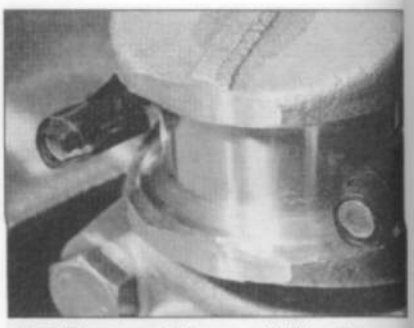


11.13b Tighten the sprocket securing nut to the specified torque



12.3 Connecting rod and big end bearing cap marked for identification

12.5 Removing a big-end bearing cap and shell



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

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 **(see illustration)**. Note that No 1 cylinder is at the transmission (flywheel) end of the engine.

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

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

6 To prevent the possibility of damage to the crankshaft bearing journals, tape over the connecting rod stud threads **(see illustration)**.

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 safe-keeping.

8 Loosely refit the big-end cap to the connecting rod, and secure with the nuts - 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.

13 Crankshaft - removal

1 Remove the crankshaft sprocket and the pump as described in Part A or B of th Chapter (as applicable).

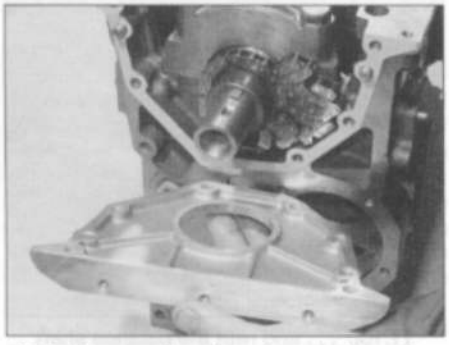
2 Remove the pistons and connecting rod as described in Section 12. If no work is to b done on the pistons and connecting rod there is no need to remove the cylinder hea or to push the pistons out of the cylinde bores. The pistons should just be pushed t enough up the bores so that they ar positioned clear of the crankshaft journals.

3 Check the crankshaft endfloat as describe in Section 16, then proceed as follows.

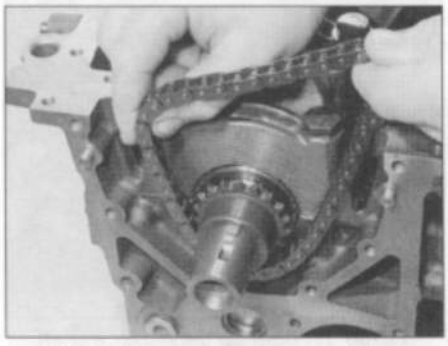
4 Where applicable on XU and XUD engine slacken and remove the retaining bolts, an remove the oil seal carrier from the fro (timing belt) end of the cylinder block, alon with its gasket **(see illustration)**.

5 Remove the oil pump drive chain, and sli the drive sprocket and spacer (where fitte off the end of the crankshaft. Remove th Woodruff key, and store it with the sprock for safe-keeping **(see illustrations)**.

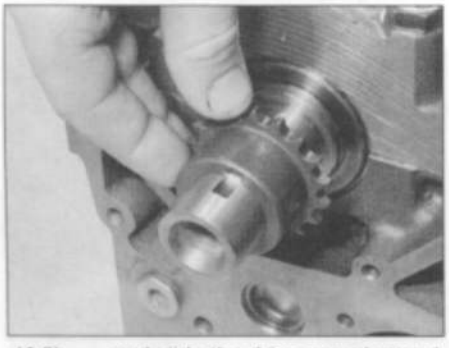
6 The main bearing caps should b numbered 1 to 5, starting from th transmission (flywheel/driveplate) end of th engine **(see illustration)**. If not, mark the accordingly using a centre-punch. Also no



13.4 Remove the oil seal carrier from the front (timing belt) end of the cylinder block - XU and XUD engines

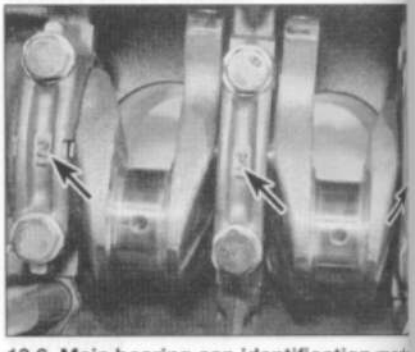


13.5a Remove the oil pump drive chain . . .

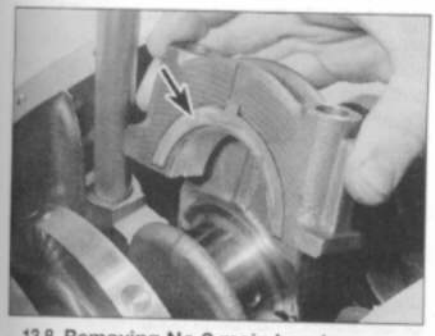


13.5b . . . and slide the drive sprocket and spacer (where fitted) off the end of the crankshaft

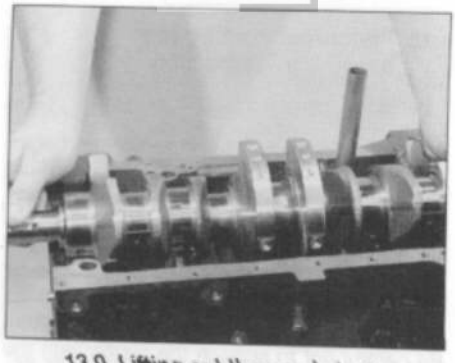
13.5c Remove the Woodruff key, and store it with the sprocket for safe-keeping



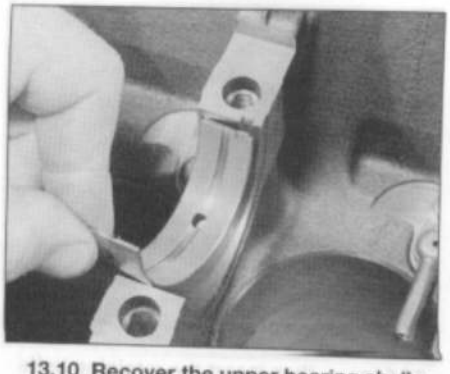
13.6 Main bearing cap identification mark (arrowed)



13.8 Removing No 2 main bearing cap; note the thrustwasher (arrowed) - XU and XUD engines



13.9 Lifting out the crankshaft - XU and XUD engines



13.10 Recover the upper bearing shells from the cylinder block

the correct fitted depth of the rear crankshaft oil seal in the bearing cap.

7 On 2.5 litre diesel engines, progressively slacken the bearing ladder retaining bolts, then lift the ladder away from the crankshaft. Hold the lower bearing shells as you do this, to prevent them falling out. Tape them to their respective housings in the bearing ladder for safe-keeping. Note that the lower thrustwashers are integral with the No 2 main bearing half shell.

8 On all engines (excluding the 2.5 litre diesel) slacken and remove the main bearing cap retaining bolts/nuts, and lift off each bearing cap. Recover the lower bearing shells, and tape them to their respective caps for safe-keeping. Also recover the lower thrustwasher halves from the side of No 2 main bearing cap **(see illustration)**. Remove the rubber sealing strips from the sides of No 1 main bearing cap, and discard them.

9 Lift out the crankshaft, and discard the oil seal(s) **(see illustration)**. Place it on a clean work surface and chock it with blocks of wood to prevent it rolling.

10 Recover the upper bearing shells from the cylinder block, and tape them to their respective caps/ladder housings for safe-keeping **(see illustration)**. Remove the upper thrustwasher halves from the side of No 2 main bearing, and store them with the lower halves. Note that on 2.5 litre engines, the thrustwashers are integral with the No 2 upper main bearing shell.

14 Cylinder block/crankcase - cleaning and inspection

Cleaning

1 Remove all external components and electrical switches/sensors from the block.

2 For complete cleaning, the core plugs should ideally be removed. Drill a small hole in the plugs, 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.

3 Where applicable, slacken and withdraw the retaining bolt, then remove the piston oil jets tube from inside the cylinder block.

4 Scrape all traces of gasket/sealant from the cylinder block/crankcase, and from the main bearing ladder (where fitted), taking care not to damage the gasket/sealing surfaces.

5 Remove all oil gallery plugs (where fitted). The plugs are usually very tight - they may have to be drilled out, and the holes re-tapped. Use new plugs when reassembling.

6 If any of the castings are extremely dirty, all should be steam-cleaned.

7 After the castings are returned, clean all oil holes and oil galleries one more time. 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. On cast-iron block engines, 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!

8 If the castings are not very dirty, you can do an adequate cleaning job with hot, 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 cast-iron block engines, protect the cylinder bores as described above, to prevent rusting.

9 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. If possible, use compressed air to clear the holes of debris produced by this operation.

> **HAYNES HINT** ***A good alternative is to inject water-dispersant lubricant into each hole, using the long spout usually supplied. However, if the hole is blind, ensure that the excess fluid is removed before reassembly.***

Warning: Wear eye protection when cleaning out these holes in this way!

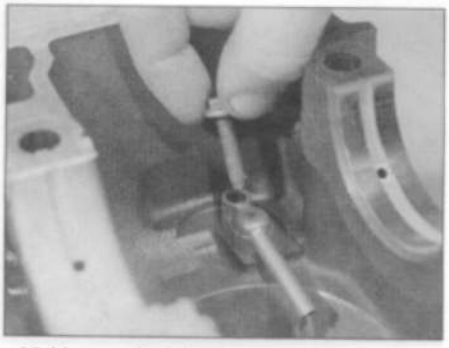
10 Apply suitable sealant to the new oil gallery plugs, and insert them into the holes in the block. Tighten them securely.

11 Where applicable, clean the threads of the piston oil jet retaining bolt, and apply a drop of thread-locking compound to the bolt threads. Refit the piston oil jet spray tube to the cylinder block, and tighten its retaining bolt to the specified torque setting **(see illustrations)**.

12 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.

14.11a Apply a drop of thread-locking compound to the threads of the piston oil jet retaining bolt

14.11b Refit the piston jets . . .



14.11c . . . then insert the retaining bolts and tighten them to the specified torque

Inspection

13 Visually check the castings 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, or renew the assembly.

14 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.

15 If the necessary measuring equipment is available, measure the bore diameter of each cylinder liner at the top (just under the wear ridge), centre, and bottom of the cylinder bore, parallel to the crankshaft axis.

16 Next, measure the bore diameter at the same three locations, at right-angles to the crankshaft axis. Compare the results with the figures given in the Specifications. Where no figures are stated by Citroën, if there is any doubt about the condition of the cylinder bores seek the advice of a Citroën dealer or suitable engine reconditioning specialist.

17 At the time of writing, it was not clear whether oversize pistons were available for all models. Consult your Citroën dealer for the latest information on piston availability. If oversize pistons are available, then it may be possible to have the cylinder bores rebored and fit the oversize pistons. If oversize pistons are not available, and the bores are worn, a new block seems to be the only option.

15 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.

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 illustration)**. 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 are also very sharp - protect your hands and fingers. Note that the third ring incorporates an expander. Always remove the 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.

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. New piston rings should always be used when the engine is reassembled.

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.

9 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/injection pump timing, or a faulty injector (as applicable).

10 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.

11 Examine each connecting rod carefully for signs of damage, such as cracks around the big-end and small-end bearings. Check that the rod is not bent or distorted. Damage is highly unlikely, unless the engine has been seized or badly overheated. Detailed checking of the connecting rod assembly can only be carried out by a Citroën dealer or engine repair specialist with the necessary equipment.

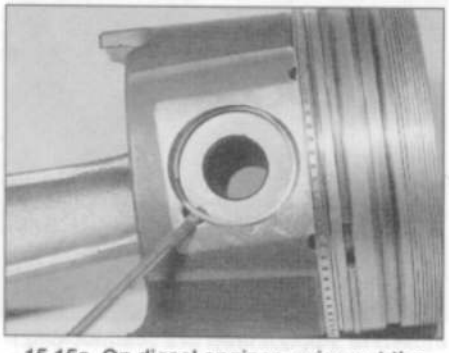
12 On all engines, due to the tightening procedure for the connecting rod big-end cap retaining nuts, it is highly recommended that the big-end cap nuts and bolts are renewed as a complete set prior to refitting.

13 On all petrol engines, the gudgeon pins are an interference fit in the connecting rod small-end bearing. Therefore, piston and/or connecting rod renewal should be entrusted to a Citroën dealer or engine repair specialist, who will have the necessary tooling to remove and install the gudgeon pins.

14 On diesel engines, the gudgeon pins are of the floating type, secured in position by two circlips. On these engines, the pistons and connecting rods can be separated as follows.

15 Using a small flat-bladed screwdriver, prise out the circlips, and push out the gudgeon pin **(see illustrations)**. Hand

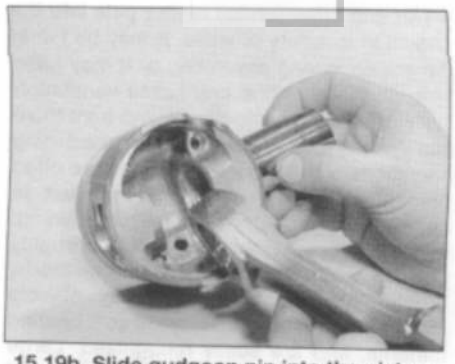
15.2 Using an old feeler blade to aid the removal of the piston rings



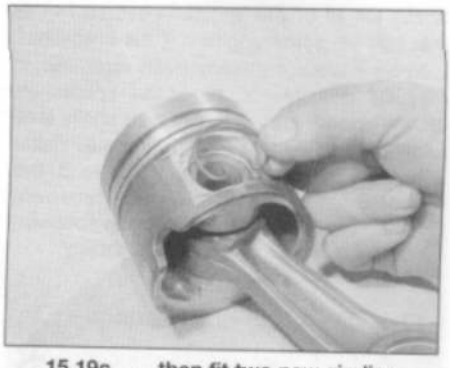
15.15a On diesel engines, prise out the circlips . . .

15.15b . . . and push out the gudgeon pin - 2.1 litre model shown

15.19a On diesel engines, the piston to connecting rod and bearing cap orientation is given by the inlet valve cut-outs on the piston crowns



15.19b Slide gudgeon pin into the piston, through the connecting rod small-end . . .



15.19c . . . then fit two new circlips

pressure should be sufficient to remove the pin. Identify the piston and rod to ensure correct reassembly. Discard the circlips - new ones *must* be used on refitting.

16 Examine the gudgeon pin and connecting rod small-end bearing for signs of wear or damage. Wear can be cured by renewing both the pin and bush. Bush renewal, however, is a specialist job - press facilities are required, and the new bush must be reamed accurately.

17 The connecting rods themselves should not be in need of renewal, unless seizure or some other major mechanical failure has occurred. Check the alignment of the connecting rods visually, and if the rods are not straight, take them to an engine overhaul specialist for a more detailed check.

18 Examine all components, and obtain any new parts from your Citroën dealer. If new pistons are purchased, they will be supplied complete with gudgeon pins and circlips. Circlips can also be purchased individually.

19 Position the piston so that the arrow on the piston crown is positioned as shown, in relation to the connecting rod big-end bearing shell cutouts. On 2.5 litre diesel engines, the orientation is given by the inlet valve cut-outs on the piston crowns. Apply a smear of clean engine oil to the gudgeon pin. Slide it into the piston and through the connecting rod small-end. Check that the piston pivots freely on the rod, then secure the gudgeon pin in position with two new circlips. Ensure that each circlip is correctly located in its groove in the piston **(see illustrations)**.

16 Crankshaft - inspection

Checking crankshaft 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.

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. The result can be compared with the specified amount, and will give an indication as to whether new thrustwashers are required **(see illustration)**.

3 If a dial gauge is not available, feeler gauges can be used. First push the crankshaft fully towards the flywheel end of the engine, then use feeler gauges to measure the gap between the web of No 2 crankpin and the thrustwasher.

Inspection

4 Clean the crankshaft using paraffin or a suitable solvent, and dry it, preferably with compressed air if available.

Warning: Wear eye protection when using compressed air! Be sure to clean the oil holes with a pipe cleaner or similar probe, to ensure that they are not obstructed.

5 Check the main and big-end bearing journals for evidence of 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 by 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.

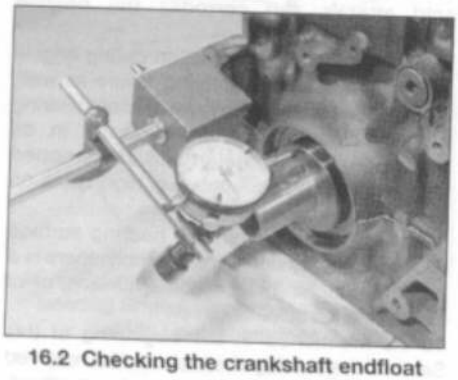
8 Check the bearing journal for roughness by running a finger lightly over the bearing surface. Any roughness (which will be accompanied by obvious bearing wear) indicates that the crankshaft requires regrinding (where possible) or renewal.

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. Where no specified journal diameters are quoted, seek the advice of a Citroën dealer.

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.

12 At the time of writing, it was not clear whether Citroën produce oversize bearing



16.2 Checking the crankshaft endfloat

16.10 Checking the diameter of a big-end journal

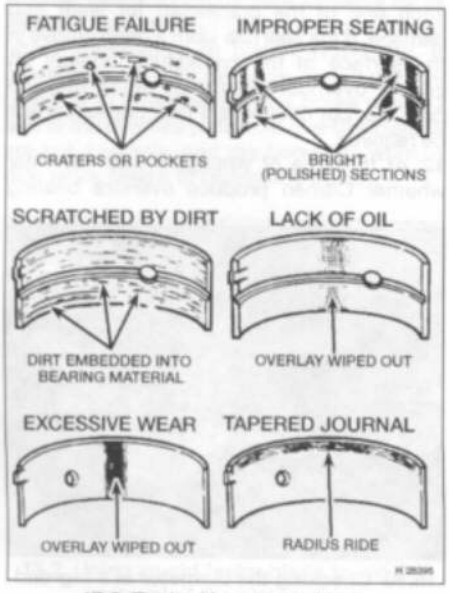
shells for all of the engines covered in this manual. On some engines, if the crankshaft journals have not already been reground, it may be possible to have the crankshaft reconditioned, and to fit oversize shells (see Section 20). If no oversize shells are available and the crankshaft has worn beyond the specified limits, it will have to be renewed. Consult your Citroën dealer or engine specialist for further information on parts availability.

17 Main and big-end bearings - inspection

1 Even though the main and big-end bearings should be 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. The bearing shells are graded by thickness, the grade of each shell being indicated by the colour code marked on it.

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 ladder/caps (as appropriate), the connecting rods and the connecting rod big-end bearing caps. 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.



17.2 Typical bearing failures

4 Dirt and other foreign matter gets 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. Refer to Sections 20 and 21 for details of bearing shell selection.

18 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 liquid sealant will also be required for the joint faces that are fitted without gaskets. It is recommended that Citroën's own product(s) are used, which are specially formulated for this purpose; the relevant product names are quoted in the text of each Section where they are required.

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

a) Crankshaft (Section 20).
b) Piston/connecting rod assemblies (Section 21).
c) Oil pump (See Chapters 2A or 2B - as applicable).
d) Sump (See Chapters 2A or 2B - as applicable).
e) Flywheel (See Chapters 2A or 2B - as applicable).
f) Cylinder head (See Chapters 2A or 2B, or this Part - as applicable).
g) Timing belt tensioner and sprockets, and timing belt (See Chapters 2A or 2B - as applicable).
h) Engine external components.

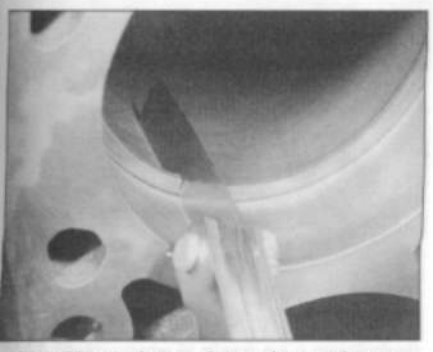
3 At this stage, all engine components should be absolutely clean and dry, with all faults repaired. The components should be laid out (or in individual containers) on a completely clean work surface.

19 Piston rings - refitting

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

2 Lay out the piston/connecting rod assemblies and the new piston ring sets, so that the ring sets will be matched with the same piston and 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. 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. The second ring is easily identified by the step



19.4 Measuring a piston ring end gap using a feeler blade

on its lower surface, and by the fact that its outer face is tapered.

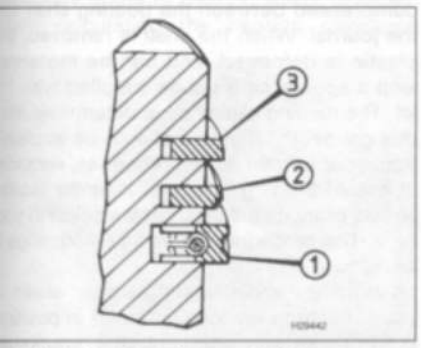
4 Measure the end gap using feeler gauges **(see illustration)**.

5 Repeat the procedure with the ring at the top of the cylinder bore, at the upper limit of its travel, and compare the measurements with the figures given in the Specifications. Where no figures are given, seek the advice of a Citroën dealer or engine reconditioning specialist.

6 If the gap is too small (unlikely if genuine Citroën 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 equipped 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.

7 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 engine and for the particular cylinder bore size.

8 Repeat the checking procedure for each ring in the first cylinder, and then for the rings



19.10c Sectional view of piston rings fitted to piston

Oil control ring and expander ring
Second compression ring
Top compression ring

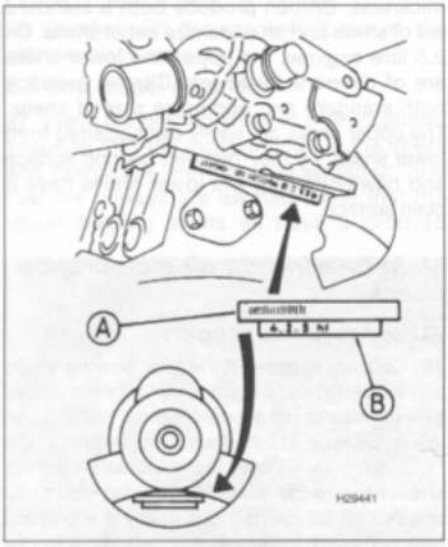
19.10a Fit the expander ring . . .

19.10b . . . then the oil control ring

in the remaining cylinders. Remember to keep rings, pistons and cylinders matched up.

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

10 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 (where fitted), then fit the ring with its gap positioned 180° from the expander gap. Ensure that the second compression ring is fitted the correct way up, with its identification mark (either a dot of paint or the word 'TOP' stamped on the ring surface) at the top, and the stepped surface at the bottom **(see illustrations)**. Arrange the gaps of the top and second compression rings 120° either side of the oil control ring gap. **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.*



20.4 Cylinder block and crankshaft main bearing reference marking locations - XU petrol engines

A Bar code (production use only)
B Reference markings

20 Crankshaft - refitting and main bearing running clearance check

Selection of new bearing shells

XU series (petrol) engine

1 On some early engines, both the upper and lower bearing shells were of the same thickness.

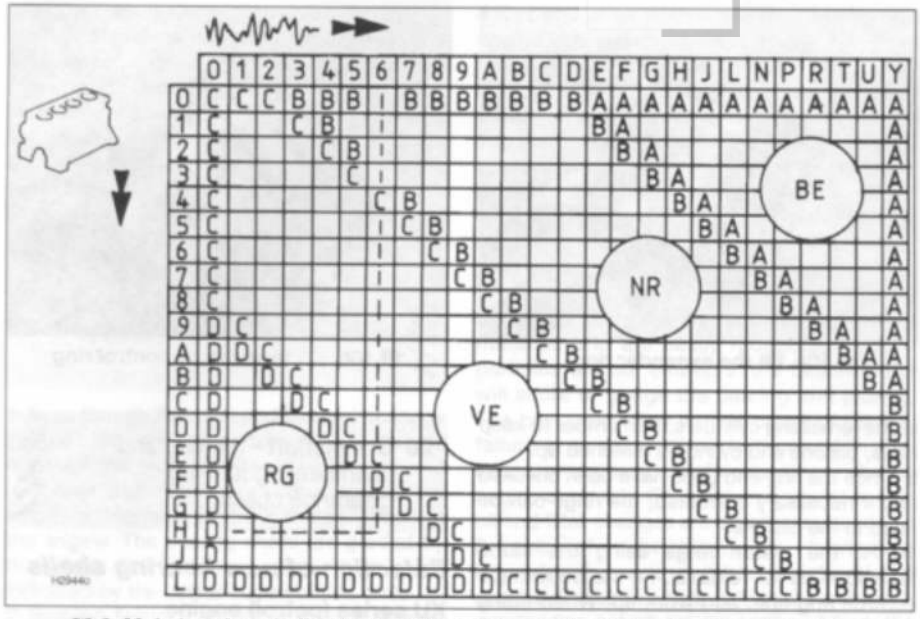
2 However, on later engines the main bearing running clearance was significantly reduced. To enable this to be done, four different grades of bearing shell were introduced. The grades are indicated by a colour-coding marked on the edge of each shell, which denotes the shell's thickness, as listed in the following table. The upper shell on all bearings is of the same size, and the running clearance is controlled by fitting a lower bearing shell of the required thickness.

Bearing colour code	Thickness (mm) Standard	Undersize
Upper bearing		
Black	1.847	N/A
Lower bearing		
Blue (Class A)	1.844	N/A
Black (Class B)	1.857	N/A
Green (Class C)	1.866	N/A
Red (Class D)	1.877	N/A

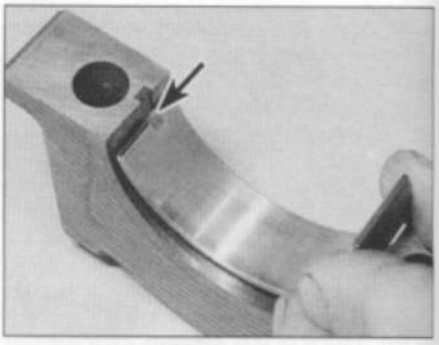
Note: *On all engines, upper shells are easily distinguished from lower shells, by their grooved bearing surface and oilway drilling; the lower shells have a plain surface. It was not clear at the time of writing whether undersize bearing shells were available for 1998 cc engine. Refer to your Citroën dealer for further information.*

3 On most later engines, new bearing shells can be selected using the reference marks on the cylinder block/crankcase. The cylinder block marks identify the diameter of the bearing bores and the crankshaft marks, the diameter of the crankshaft journals. Where no marks are present, the bearing shells can only be selected by checking the running clearance (see below).

4 The cylinder block reference marks are on the left-hand (flywheel/driveplate) end of the block, and the crankshaft reference marks are on the end web of the crankshaft **(see illustration)**. These marks can be used to



20.6 Main bearing shell selection chart for use with XU series petrol engines (see text for details)



20.12 Press the bearing shells into their locations, ensuring that the tab (arrowed) on each shell engages in the notch in the bearing cap

select bearing shells of the required thickness as follows.

5 On both the crankshaft and block there are two lines of identification: a bar code, which is used by Citroën during production, and a row of five letters. The first letter in the sequence refers to the size of No 1 bearing (at the flywheel/driveplate end). The last letter in the sequence (which is followed by an arrow) refers to the size of No 5 main bearing. These marks can be used to select the required bearing shell grade as follows.

6 Obtain the identification number/letter of both the relevant crankshaft journal and the cylinder block bearing bore. Noting that the crankshaft references are listed across the top of the chart, and the cylinder block references down the side, trace a vertical line down from the relevant crankshaft reference, and a horizontal line across from the relevant cylinder block reference, and find the point at which both lines cross. This crossover point will indicate the grade of lower bearing shell required to give the correct main bearing running clearance. For example, the illustration shows crankshaft reference 6, and cylinder block reference H, crossing at a point within the RED area, indicating that a Red-coded (Class D) lower bearing shell is required to give the correct main bearing running clearance **(see illustration)**.

7 Repeat this procedure so that the required bearing shell grade is obtained for each of the five main bearing journals.

8 Seek the advice of your Citroën dealer on parts availability, and on the best course of action when ordering new bearing shells.

Note: *On early models, at overhaul it is recommended that the later bearing shell arrangement is fitted. This, however, should only be done if the lubrication system components are upgraded (necessitating replacement of the oil pump relief valve piston and spring as well as the pump sprocket and drive chain) at the same time. If the new bearing arrangement is to be used without uprating the lubrication system, Blue (Class A) lower bearing shells should be fitted. Refer to your Citroën dealer for further information.*

Diesel engines

9 On 2.1 litre diesel engines both the upper and lower bearing shells are of the same thickness. Citroën produce both a standard set of shells and an undersize set of shells. On 2.5 litre engines, the upper and lower shells are of different thickness. Citroën produce both standard and undersize sets of shells. The upper shells are easily distinguished from lower shells, by their grooved bearing surface and oilway drilling; the lower shells have a plain surface.

Main bearing running clearance check

XU series (petrol) engine

10 On early engines, if the later bearing shells are to be fitted, obtain a set of new upper bearing shells, and new blue (as applicable) lower bearing shells (see paragraph 2). On later engines where the modified bearing shells are already fitted, the running clearance check can be carried out using the original bearing shells. However, it is preferable to use a new set, since the results obtained will be more conclusive.

11 Clean the backs of the bearing shells, and the bearing locations in both the crankcase and the main bearing caps/ladder.

12 Press the bearing shells into their locations, ensuring that the tab on each shell engages in the notch in the crankcase or bearing cap/ladder **(see illustration)**. Take care not to touch any shell's bearing surface with your fingers. Note that the upper bearing shells all have a grooved bearing surface, whereas the lower shells have a plain bearing surface. If the original bearing shells are being used for the check, ensure that they are refitted in their original locations.

13 The clearance can be checked in either of two ways.

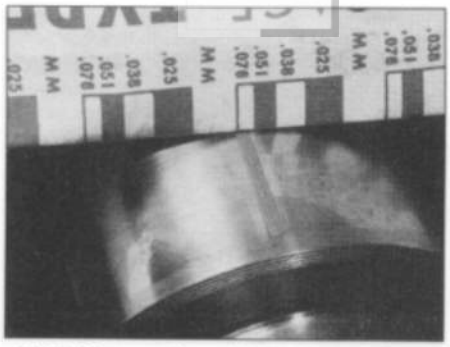
14 One method (which will be difficult to achieve without a range of internal micrometers or internal/external expanding calipers) is to refit the main bearing caps to the cylinder block/crankcase, with bearing shells in place. With the cap retaining bolts tightened to the specified torque, measure the 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 main bearing running clearance.

15 The second, and more accurate, method is to use Plastigauge. This consists of a fine thread of perfectly-round plastic, which is compressed between the bearing shell and the journal. When the shell is removed, the plastic is deformed, and can be measured with a special card gauge supplied with the kit. The running clearance is determined from this gauge. Plastigauge should be available from your Citroën dealer; otherwise, enquiries at one of the larger specialist motor factors should produce the name of a stockist in your area. The procedure for using Plastigauge is as follows.

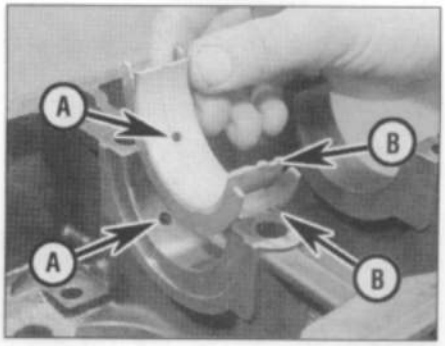
16 With the main bearing upper shells in place, carefully lay the crankshaft in position. Do not use any lubricant; the crankshaft journals and bearing shells must be perfectly clean and dry.

17 Cut several lengths of the appropriate-size Plastigauge (they should be slightly shorter than the width of the main bearings),

20.17 Plastigauge in place on a crankshaft main bearing journal



20.20 Measure the width of the deformed Plastigauge using the scale on the card provided



20.27a Place the bearing shells in their locations, ensuring that the location lugs in the shells and crankcase are correctly engaged, and that the oilways are aligned

A Oilways B Location lugs

and place one length on each crankshaft journal axis **(see illustration)**.

18 With the main bearing lower shells in position, refit the main bearing caps and tighten them as described later in this Section. Take care not to disturb the Plastigauge, and *do not* rotate the crankshaft at any time during this operation.

19 Remove the main bearing caps, again taking great care not to disturb the Plastigauge or rotate the crankshaft.

20 Compare the width of the crushed Plastigauge on each journal to the scale printed on the Plastigauge envelope, to obtain the main bearing running clearance **(see illustration)**. Compare the clearance measured with that given in the Specifications at the start of this Chapter.

21 If the clearance is significantly different from that expected, the bearing shells may be the wrong size (or excessively worn, if the original shells are being re-used). Before deciding that different-size shells are required, make sure that no dirt or oil was trapped between the bearing shells and the caps or block when the clearance was measured. If the Plastigauge was wider at one end than at the other, the crankshaft journal may be tapered.

22 If the clearance is not as specified, use the reading obtained, along with the shell thicknesses quoted above, to calculate the necessary grade of bearing shells required. When calculating the bearing clearance required, bear in mind that it is always better to have the running clearance towards the lower end of the specified range, to allow for wear in use.

23 Where necessary, obtain the required grades of bearing shell, and repeat the running clearance checking procedure as described above.

24 On completion, carefully scrape away all traces of the Plastigauge material from the crankshaft and bearing shells. Use your fingernail, or a wooden or plastic scraper which is unlikely to score the bearing surfaces.

Diesel engines

25 The running clearance check can be carried out using the original bearing shells. However, it is preferable to use a new set, since the results obtained will be more conclusive. Perform the check using the information given in the preceding paragraphs.

Final crankshaft refitting

26 Carefully lift the crankshaft out of the cylinder block once more.

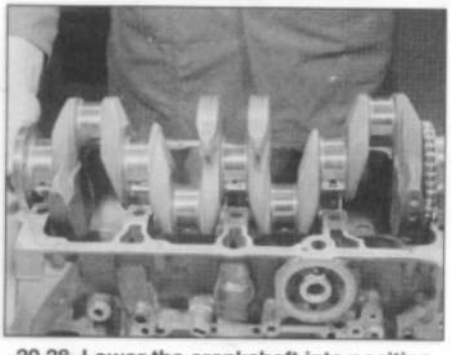
2.5 litre diesel engines

27 Place the bearing shells in their locations, ensuring that the location lugs in the shells and crankcase are correctly engaged, and that the oilways are aligned. Note that the upper bearing shells all have a grooved bearing surface, whereas the lower shells have a plain bearing surface. Note that the thrustwashers are integral with the No 2 main bearing half shell. If the original bearing shells are being used for the check, ensure that they are refitted in their original locations. 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 illustrations)**.

28 Lower the crankshaft into position so that Nos 2 and 3 cylinder crankpins are at TDC; Nos 1 and 4 cylinder crankpins will be at BDC, ready for fitting No 1 piston **(see illustration)**. Check the crankshaft endfloat, referring to Section 15. Ensure that the oil pump drive chain is not trapped between the crankshaft and the crankcase.

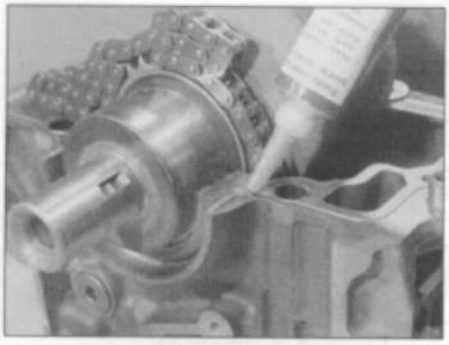
29 Place the lower bearing shells in the bearing ladder and lubricate them liberally with clean engine oil. Make sure that the locating lugs on the shells engage with the corresponding recesses in the ladder journals. Note that the thrustwashers are integral with the No 2 main bearing half shell **(see illustration)**.

20.27b Liberally lubricate each bearing shell in the cylinder block/ crankcase with clean engine oil

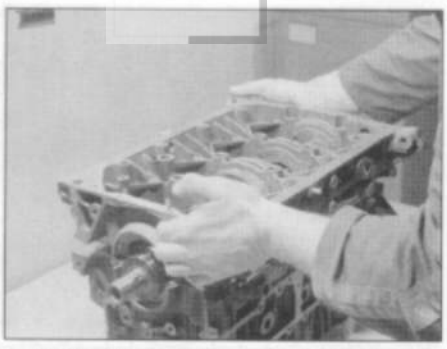


20.28 Lower the crankshaft into position so that Nos 2 and 3 cylinder crankpins are at TDC - 2.5 litre engine shown

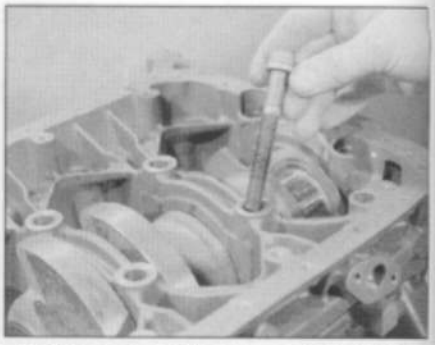
20.29 Place the lower bearing shells in the bearing ladder. Make sure that the locating lugs on the shells engage with the corresponding recesses in the bearing ladder (arrowed)



20.30a Apply a bead of suitable sealant to the recess in the bearing ladder/crankcase mating surface



20.30b Lower the bearing ladder into position over the crankshaft



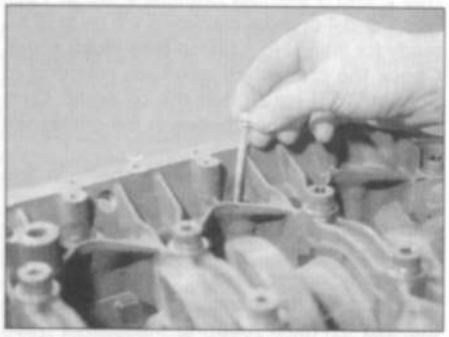
20.30c Insert and progressively tighten the bearing ladder inner . . .

30 Apply a bead of suitable sealant to the recess in the bearing ladder/crankcase mating surface. Lower the bearing ladder into position over the crankshaft, ensuring that the lower bearing shells stay in position. Progressively tighten the bearing ladder retaining bolts in the specified sequence as shown, and to the specified torque wrench settings **(see illustrations)**.

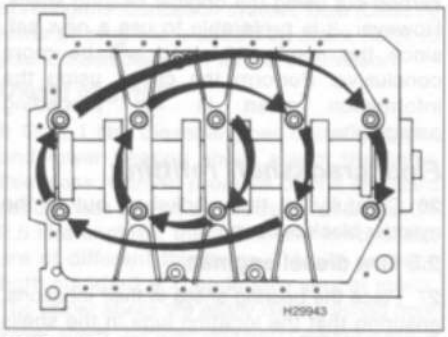
31 Fit new crankshaft front and rear oil seals as described in Part B of this Chapter.

32 Refit the piston/connecting rod assemblies to the crankshaft as described in Section 21.

33 Ensuring that the drive chain is correctly located on the sprocket, refit the oil pump and sump as described in Part A or B of this Chapter.



20.30d . . . and outer retaining bolts in the specified sequence, and to the specified torque wrench settings



20.30e Tightening sequence of the bearing ladder retaining bolts

Petrol and 2.1 litre diesel engines

34 Using a little grease, stick the upper thrustwashers to each side of the No 2 main bearing upper location. Ensure that the oilway grooves on each thrustwasher face outwards (away from the cylinder block) **(see illustration).**

35 Place the bearing shells in their locations, ensuring that the location lugs in the shells and crankcase are correctly aligned, as described earlier. If new shells are being fitted, ensure that all traces of protective grease are cleaned off using paraffin. Note that the upper bearing shells all have a grooved bearing surface, whereas the lower shells have a plain bearing surface. If the original bearing shells are being used for the check, ensure that they are refitted in their original locations. Wipe dry the shells and connecting rods with a lint-free cloth. Liberally lubricate each bearing shell in the cylinder block/crankcase and cap with clean engine oil.

36 Lower the crankshaft into position so that Nos 2 and 3 cylinder crankpins are at TDC, Nos 1 and 4 cylinder crankpins will be at BDC, ready for fitting No 1 piston. Check the crankshaft endfloat, referring to Section 15.

37 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.

38 Fit main bearing caps Nos 2 to 5 to their correct locations, ensuring that they are fitted the correct way round (the bearing shell tab recesses in the block and caps must be on the same side). Insert the bolts/nuts, tightening them only loosely at this stage.

39 Apply a small amount of sealant to the No 1 main bearing cap mating face on the cylinder block, around the sealing strip holes **(see illustration)**.

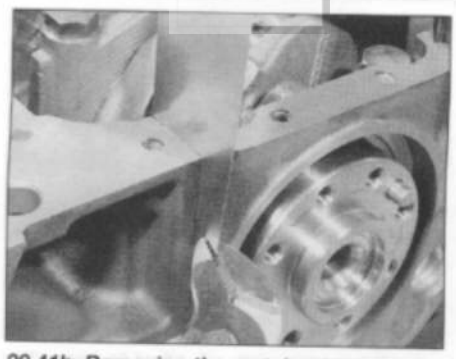
40 Locate the tab of each sealing strip over the pins on the base of No 1 bearing cap, and press the strips into the bearing cap grooves. It is now necessary to obtain two thin metal strips, of 0.25 mm thickness or less, in order to prevent the strips moving when the cap is being fitted. Citroën garages use the tool shown, which acts as a clamp. Metal strips (such as old feeler blades) can be used, provided all burrs which may damage the sealing strips are first removed **(see illustration)**.

20.34 Fitting a thrustwasher to No 2 main bearing upper location

20.39 Apply a small amount of sealant to the No 1 main bearing cap mating face on the cylinder block, around the sealing strip holes

20.40 Fitting a new sealing strip to No 1 main bearing cap

20.41a Fitting No 1 main bearing cap, using metal strips to retain the side seals



20.41b Removing the metal strips from No 1 main bearing cap

20.42a Tighten all the main bearing cap bolts/nuts evenly to the specified torque . . .

41 Where applicable, oil both sides of the metal strips, and hold them on the sealing strips. Fit the No 1 main bearing cap, insert the bolts loosely, then carefully pull out the metal strips in a horizontal direction, using a pair of pliers **(see illustrations)**.

42 Tighten all the main bearing cap bolts/nuts evenly to the specified torque. Using a sharp knife, trim off the ends of the No 1 bearing cap sealing strips (where applicable), so that they protrude above the cylinder block/crankcase mating surface by approximately 1 mm **(see illustrations)**.

43 Fit a new crankshaft rear oil seal as described in Part A or B of this Chapter (as applicable).

44 Refit the piston/connecting rod assemblies to the crankshaft as described in Section 21.

45 Refit the Woodruff key, then slide on the oil pump drive sprocket and spacer (where fitted), and locate the drive chain on the sprocket.

46 Where applicable, ensure that the mating surfaces of the front oil seal carrier and cylinder block are clean and dry. Note the correct fitted depth of the oil seal then, using a large flat-bladed screwdriver, lever the old seal out of the housing.

47 Where applicable, apply a smear of suitable sealant to the oil seal carrier mating surface. Ensure that the locating dowels are in position, then slide the carrier over the end of the crankshaft and into position on the cylinder block. Tighten the carrier retaining bolts to the specified torque.

48 Fit a new crankshaft front oil seal as described in Part A or B of this Chapter.

49 Ensuring that the drive chain is correctly located on the sprocket, refit the oil pump and sump as described in Part A or B of this Chapter.

50 Where removed, refit the cylinder head as described in Part A or B of this Chapter.

21 Pistons/connecting rods - refitting and big-end bearing running clearance check

Selection of bearing shells

1 On most engines, there are two sizes of big-end bearing shell produced by Citroën; a standard size for use with the standard crankshaft, and an oversize for use once the crankshaft journals have been reground.

2 Consult your Citroën dealer for the latest information on parts availability. To be safe, always quote the diameter of the crankshaft big-end crankpins when ordering bearing shells.

3 Prior to refitting the piston/connecting rod assemblies, it is recommended that the big-end bearing running clearance is checked as follows.

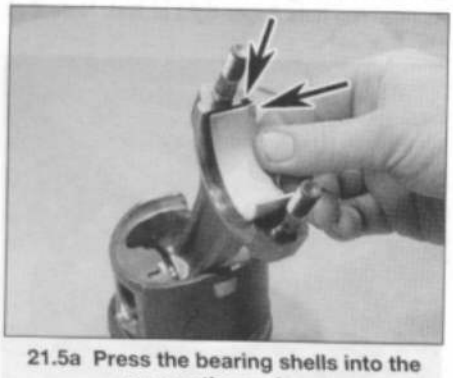
Big-end bearing running clearance check

4 Clean the backs of the bearing shells, and the bearing locations in both the connecting rod and bearing cap.

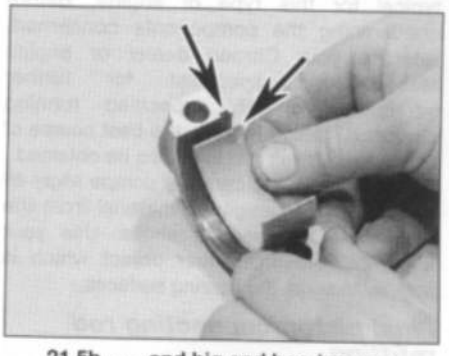
5 Press the bearing shells into their locations, ensuring that the tab on each shell engages in the notch in the connecting rod and cap. Take care not to touch any shell's bearing surface with your fingers **(see illustrations)**. If the original bearing shells are being used for the check, ensure they are refitted in their original locations. The clearance can be checked in either of two ways.

6 One method is to refit the big-end bearing cap to the connecting rod, ensuring they are fitted the correct way around (see paragraph 20), 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.

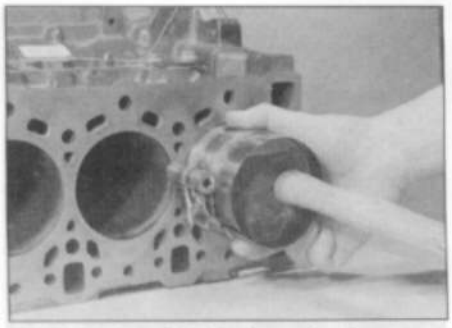
20.42b . . . Using a sharp knife, trim off the ends of the No 1 bearing cap sealing strips, so that they protrude above the cylinder block/crankcase mating surface by approximately 1 mm



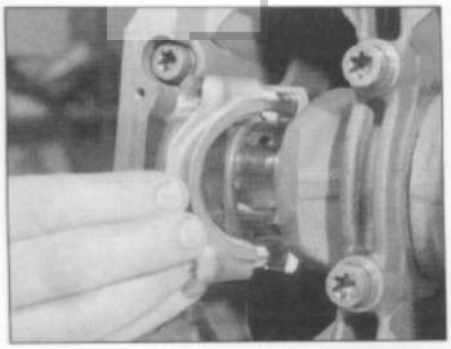
21.5a Press the bearing shells into the connecting rod . . .



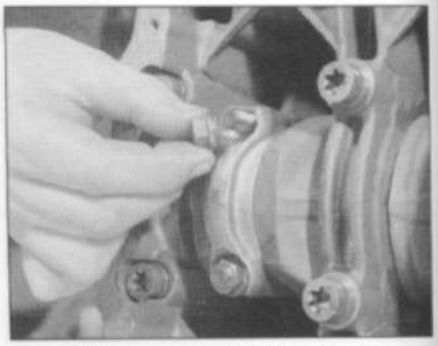
21.5b . . . and big end bearing cap, ensuring that the tabs (arrowed) on each shell engages in the notches in the connecting rod and cap



21.19 Using a block of wood or hammer handle against the piston crown, tap the assembly into the cylinder



21.21a Refit the big-end bearing cap . . .



21.21b . . . and retaining nuts

7 The second, and more accurate method is to use Plastigauge as follows.

8 Ensure that the bearing shells are correctly fitted. Place a strand of Plastigauge on each (cleaned) crankpin journal.

9 Refit the (clean) piston/connecting rod assemblies to the crankshaft, and refit the big-end bearing caps, using the marks made or noted on removal to ensure they are fitted the correct way around.

10 Tighten the bearing cap nuts as described below in paragraph 21 or 22 (as applicable). Take care not to disturb the Plastigauge or rotate the connecting rod during the tightening sequence.

11 Dismantle the assemblies without rotating the connecting rods. Use the scale printed on the Plastigauge envelope to obtain the big-end bearing running clearance.

12 If the clearance is significantly different from that expected, the bearing shells may be the wrong size (or excessively worn, if the original shells are being re-used). Make sure that no dirt or oil was trapped between the bearing shells and the caps or block when the clearance was measured. If the Plastigauge was wider at one end than at the other, the crankshaft journal may be tapered.

13 Note that Citroën do not specify a recommended big-end bearing running clearance. The figure given in the Specifications is a guide figure, which is typical for this type of engine. Before condemning the components concerned, refer to your Citroën dealer or engine reconditioning specialist for further information on the specified running clearance. Their advice on the best course of action to be taken can then also be obtained.

14 On completion, carefully scrape away all traces of the Plastigauge material from the crankshaft and bearing shells. Use your fingernail, or some other object which is unlikely to score the bearing surfaces.

Final piston/connecting rod refitting

15 Note that the following procedure assumes that the crankshaft and main bearing caps (or ladder) are in place (see Section 20).

16 Ensure that the bearing shells are correctly fitted to the connecting rods and big end bearing caps, as described earlier. If new shells are being fitted, ensure that all traces of the protective grease are cleaned off using paraffin. Wipe dry the shells and connecting rods with a lint-free cloth.

17 Lubricate the cylinder bores, the pistons, and piston rings, then lay out each piston/connecting rod assembly in its respective position.

18 Start with assembly No 1. Make sure that the piston rings are still spaced as described in Section 18, then clamp them in position with a piston ring compressor.

19 Insert the piston/connecting rod assembly into the top of cylinder/liner No 1. On petrol engines, ensure that the arrow on the piston crown is pointing towards the timing belt end of the engine and on diesel engines, ensure that the cloverleaf-shaped cut-out on the piston crown is towards the front (oil filter side) of the cylinder block. Using a block of wood or hammer handle against the piston crown, tap the assembly into the cylinder/liner until the piston crown is flush with the top of the cylinder/liner **(see illustration)**.

20 Ensure that the bearing shell is still correctly installed. Liberally lubricate the crankpin and both bearing shells. Taking care not to mark the cylinder/liner bores, pull the piston/connecting rod assembly down the bore and onto the crankpin.

21 Refit the big-end bearing cap, tightening its retaining nuts finger-tight at first. Note that the faces with the identification marks must match (which means that the bearing shell locating tabs abut each other) **(see illustrations)**.

22 Tighten the bearing cap retaining nuts evenly and progressively to the stage 1 torque setting. Once both nuts have been tightened to the stage 1 setting, angle-tighten them through the specified stage 2 angle, using a socket and extension bar **(see illustrations)**.

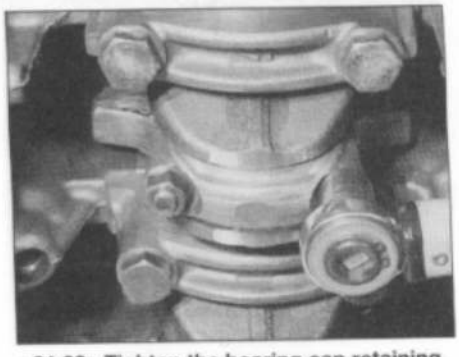
23 On all engines, once the bearing cap retaining nuts have been correctly tightened, rotate the crankshaft. Check that it turns freely; some stiffness is to be expected if new components have been fitted, but there should be no signs of binding or tight spots.

24 Refit the remaining three piston/connecting rod assemblies in the same way. Note that on 2.5 litre diesel engines, the cut-out in the lower edge of No 4 piston skirt must be oriented towards the oil filter housing flange, on the side of the cylinder block.

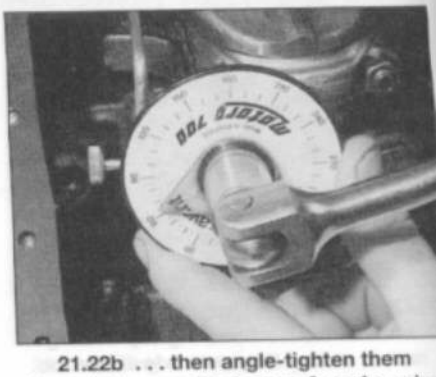
25 Refit the cylinder head and oil pump as described in Part A or B of this Chapter, or this Part (as applicable).

22 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



21.22a Tighten the bearing cap retaining nuts evenly and progressively to the stage 1 torque setting . . .



21.22b . . . then angle-tighten them through the specified stage 2 angle, using a socket and extension bar

been reconnected, and that there are no tools or rags left in the engine compartment.

Petrol engine models

2 Remove the spark plugs and disable the fuel system by disconnecting the wiring connectors from the fuel injectors, referring to Chapter 4A for further information. Disable the ignition system (see Chapter 2A, section 2).

3 Turn the engine on the starter until the oil pressure warning light goes out. Refit the spark plugs, and reconnect the ignition system components (see Chapter 2A, section 2)

Diesel engine models

4 To prevent the engine starting, disconnect the wiring from the stop solenoid on the injection pump or remove the fuel injection system relay (Chapter 4B), then turn the engine on the starter motor until the oil pressure warning light goes out. Reconnect the wire to the stop solenoid.

5 Prime the fuel system (refer to Chapter 4B).

6 Fully depress the accelerator pedal, turn the ignition key to position 'M', and wait for the preheating warning light to go out.

All models

7 Start the engine, noting that this may take a little longer than usual, due to the fuel system components having been disturbed.

8 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.

9 Assuming all is well, keep the engine idling until hot water is felt circulating through the top hose, then switch off the engine.

10 Check the ignition timing (petrol engines) or injection pump timing (diesel engines), and the idle speed settings (as appropriate), then switch the engine off.

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

12 If the cylinder head bolts were tightened as described, there is no need to re-tighten them once the engine has first run after reassembly.

13 If new pistons, rings or crankshaft bearings have been fitted, the engine must be treated as new, and run-in for the first 500 miles (800 km). *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.