Chapter 2 Part D: Engine removal and general engine overhaul procedures

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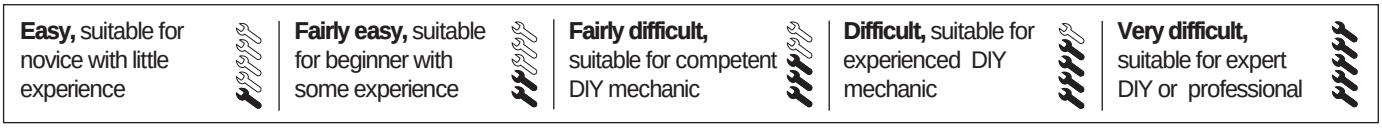
Degrees of difficulty



Specifications

HCS engine

Cylinder head

Maximum permissible gasket surface distortion (measured over full length)	0.15 mm
Valve seat angle (inlet and exhaust)	45º
Valve seat width (inlet and exhaust)	1.18 to 1.75 mm*

**The inlet and exhaust valves have special inserts which cannot be recut using conventional tools.*

Valves - general

	Inlet	Exhaust
Valve lift	8.86 to 9.26 mm	8.96 to 9.36 mm
Valve length	103.7 to 104.4 mm	104.2 to 104.7 mm
Valve head diameter	34.40 to 34.60 mm	28.90 to 29.10 mm
Valve stem diameter	7.0 mm	7.0 mm
Valve stem-to-guide clearance	0.020 to 0.069	0.046 to 0.095

Pistons and piston rings

Piston diameter:	
Standard 1	73.91 to 73.92 mm
Standard 2	73.92 to 73.93 mm
Standard 3	73.93 to 73.94 mm
Oversize 0.5 mm	74.46 to 74.49 mm
Oversize 1.0 mm	74.96 to 74.99 mm
Piston-to-cylinder bore clearance	0.015 to 0.050 mm
Piston ring end gap - installed:	
Compression rings	0.25 to 0.45 mm
Oil control ring	0.20 to 0.40 mm
Ring gap position:	
Top compression ring	Offset 180º from oil control ring gap
Second compression ring	Offset 90º from oil control ring gap
Oil control ring	Aligned with gudgeon pin

Cylinder block

Cylinder bore diameter:	
Standard 1	73.94 to 73.95 mm
Standard 2	73.50 to 73.96 mm
Standard 3	73.96 to 73.97 mm
Oversize 0.5 mm	74.50 to 74.51 mm
Oversize 1.0 mm	75.00 to 75.01 mm

Gudgeon pin

Length	63.3 to 64.6 mm
Diameter:	
White colour code	18.026 to 18.029 mm
Red colour code	18.029 to 18.032 mm
Blue colour code	18.032 to 18.035 mm
Yellow colour code	18.035 to 18.038 mm
Clearance in piston	0.008 to 0.014 mm
Interference fit in connecting rod	0.016 to 0.048 mm

Crankshaft and bearings

Main bearing journal diameter:	
Standard	56.990 to 57.000 mm
0.254 mm undersize	56.726 to 56.746 mm
0.508 mm undersize	56.472 to 56.492 mm
0.762 mm undersize	56.218 to 56.238 mm
Main bearing journal-to-shell running clearance	0.009 to 0.056 mm
Crankpin (big-end) bearing journal diameter:	
Standard	40.99 to 41.01 mm
0.254 mm undersize	40.74 to 40.76 mm
0.508 mm undersize	40.49 to 40.51 mm
0.762 mm undersize	40.24 to 40.26 mm
Crankpin (big-end) bearing journal-to-shell running clearance	0.006 to 0.060 mm
Crankshaft endfloat	0.075 to 0.285 mm
Thrustwasher thickness:	
Standard	2.80 to 2.85 mm
Oversize	2.99 to 3.04 mm

Torque wrench settings

	Nm	lbf ft
Main bearing cap	88 to 102	65 to 72
*****Crankpin (big-end) bearing cap bolts:		
Stage 1	43	32
Stage 2	Angle-tighten a further 90º	
Engine-to-transmission bolts	35 to 45	26 to 33
Engine/transmission mountings:		
Right-hand mounting-to-cylinder block bracket	102 to 138	75 to 102
Right-hand mounting bracket-to-cylinder block	58 to 79	43 to 58
Right-hand mounting brace	58 to 79	43 to 58
Right-hand mounting-to-body	70 to 97	51 to 71
Left-hand rear mounting bracket-to-transmission	41 to 58	30 to 43
Left-hand rear mounting bracket-to-mounting	58 to 79	43 to 58
Left-hand front mounting bracket-to-mounting	58 to 79	43 to 58
Left-hand front mounting bracket brace	41 to 58	30 to 43

*****_New bolts must be used_

Note: _Refer to Part A of this Chapter for remaining torque wrench settings._

CVH engine

Valves - general

	Inlet	Exhaust
Valve lift:		
1.4 litre engine	9.3 to 9.7 mm	9.3 to 9.7 mm
1.6 litre engine: Carburettor models	9.5 to 9.9 mm	9.5 to 9.9 mm
EFi fuel-injected models	10.3 to 10.7 mm	10.3 to 10.7 mm
Valve length:		
1.4 litre engine	136.29 to 136.75 mm	132.97 to 133.43 mm
1.6 litre engine	134.54 to 135.00 mm	131.57 to 132.03 mm
Valve head diameter:		
1.4 litre engine	39.90 to 40.10 mm	33.90 to 34 10 mm
1.6 litre engine	41.90 to 42.10 mm	36.90 to 37.10 mm
Valve stem diameter (standard)	8.025 to 8.043 mm	7.999 to 8.017 mm
Valve stem diameter (0.2 mm oversize)	8.225 to 8.243 mm	8.199 to 8.217 mm
Valve stem diameter (0.4 mm oversize)	8.425 to 8.443 mm	8.399 to 8.417 mm
Valve stem-to-guide clearance	0.020 to 0.063 mm	0.046 to 0.089 mm

Cylinder head

Maximum permissible gasket surface distortion (measured over full length)	0.15 mm
Camshaft bearing bore diameters in cylinder head (standard):	
Bearing 1	44.783 to 44.808 mm
Bearing 2	45.033 to 45.058 mm
Bearing 3	45.283 to 45.308 mm
Bearing 4	45.533 to 45.558 mm
Bearing 5	45.783 to 45.808 mm
Camshaft bearing bore diameters in cylinder head (oversize):	
Bearing 1	45.188 to 45.163 mm
Bearing 2	45.438 to 45.413 mm
Bearing 3	45.668 to 45.663 mm
Bearing 4	45.983 to 45.913 mm
Bearing 5	46.188 to 46.163 mm
Valve tappet bore diameter (standard)	22.235 to 22.265 mm
Valve tappet bore diameter (oversize)	22.489 to 22.519 mm
Valve seat angle (inlet and exhaust)	44º30' to 45º30'
Valve seat width (inlet and exhaust)	1.75 to 2.32 mm*

**The cylinder head has valve seat rings on the exhaust side. These valve seats cannot be recut with conventional tools.*

Cylinder block

Cylinder bore diameter:	
1.4 litre engine:	
Standard 1	77.22 to 77.23 mm
Standard 2	77.23 to 77.24 mm
Standard 3	77.24 to 77.25 mm
Standard 4	77.25 to 77.26 mm
Oversize A	77.51 to 77.52 mm
Oversize B	77.52 to 77.53 mm
Oversize C	77.53 to 77.54 mm
1.6 litre engine:	
Standard 1	79.94 to 79.95 mm
Standard 2	79.95 to 79.96 mm
Standard 3	79.96 to 79.97 mm
Standard 4	79.97 to 79.98 mm
Oversize A	80.23 to 80.24 mm
Oversize B	80.24 to 80.25 mm
Oversize C	80.25 to 80.26 mm

Crankshaft and bearings

Main bearing shell inside diameter - installed:	
Standard	58.011 to 58.038 mm
0.25 mm undersize	57.761 to 57.788 mm
0.50 mm undersize	57.511 to 57.538 mm
0.75 mm undersize	57.261 to 57.288 mm
Main bearing journal diameter:	
Standard	57.98 to 58.00 mm
0.25 mm undersize	57.73 to 57.75 mm
0.50 mm undersize	57.48 to 57.50 mm
0.75 mm undersize	57.23 to 57.25 mm
Main bearing journal-to-shell running clearance	0.011 to 0.058 mm
Big-end bearing shell inside diameter - installed:	
Standard	47.916 to 47.950 mm
0.25 mm undersize	47.666 to 47.700 mm
0.50 mm undersize	47.416 to 47.450 mm
0.75 mm undersize	47.166 to 47.200 mm
1.00 mm undersize	46.916 to 46.950 mm
Crankpin (big-end) bearing journal diameter:	
Standard	47.89 to 47.91 mm
0.25 mm undersize	47.64 to 47.66 mm
0.50 mm undersize	47.39 to 47.41 mm
0.75 mm undersize	47.14 to 47.16 mm
1.00 mm undersize	46.89 to 46.91 mm
Crankpin (big-end) bearing journal-to-shell running clearance	0.006 to 0.060 mm
Crankshaft endfloat	0.09 to 0.30 mm
Thrustwasher thickness:	
Standard	2.301 to 2.351 mm
Oversize	2.491 to 2.541 mm

Pistons and piston rings

Piston diameter (production):	
1.4 litre engine:	
Standard 1	77.190 to 77.200 mm
Standard 2	77.200 to 77.210 mm
Standard 3	77.210 to 77.220 mm
Standard 4	77.220 to 77.230 mm
Oversize A	77.480 to 77.490 mm
Oversize B	77.490 to 77.500 mm
Oversize C	77.500 to 77.510 mm
1.6 litre carburettor engine:	
Standard 1	79.910 to 79.920 mm
Standard 2	79.920 to 79.930 mm
Standard 3	79.930 to 79.940 mm
Standard 4	79.940 to 79.950 mm
Oversize A	80.200 to 80.210 mm
Oversize B	80.210 to 80.220 mm
Oversize C	80.220 to 80.230 mm
1.6 litre EFi fuel-injected engine:	
Standard 1	79.915 to 79.925 mm
Standard 2	79.925 to 79.935 mm
Standard 3	79.935 to 79.945 mm
Standard 4	79.945 to 79.955 mm
Oversize A	80.205 to 80.215 mm
Oversize B	80.215 to 80.225 mm
Oversize C	80.225 to 80.235 mm
Piston-to-cylinder bore clearance:	
1.4 litre engine	0.020 to 0.040 mm
1.6 litre carburettor engine	0.020 to 0.040 mm
1.6 litre EFi fuel-injected engine	0.015 to 0.035 mm
Piston ring end gaps - installed:	
Compression rings	0.30 to 0.50 mm
Oil control rings:	
1.4 litre engine	0.40 to 1.40 mm
1.6 litre carburettor engine	0.40 to 1.40 mm
1.6 litre EFi fuel-injected engine	0.25 to 0.40 mm

Gudgeon pins

Length:	
1.4 litre engine	63.000 to 63.800 mm
1.6 litre carburettor engine	66.200 to 67.000 mm
1.6 litre EFi fuel-injected engine	63.000 to 63.800 mm
Diameter:	
White colour code	20.622 to 20.625 mm
Red colour code	20.625 to 20.628 mm
Blue colour code	20.628 to 20.631 mm
Yellow colour code	20.631 to 20.634 mm
Clearance in piston	0.005 to 0.011 mm
Interference fit in connecting rod	0.013 to 0.045 mm

Torque wrench settings

	Nm	lbf ft
Main bearing caps	90 to 100	66 to 74
Big-end bearing caps	30 to 36	22 to 26
Engine-to-transmission bolts	35 to 45	26 to 33
Engine/transmission mountings:		
Right-hand mounting-to-cylinder block bracket	102 to 138	75 to 102
Right-hand mounting bracket-to-cylinder block	76 to 104	56 to 76
Right-hand mounting brace	58 to 79	43 to 58
Right-hand mounting-to-body	70 to 79	51 to 71
Left-hand rear mounting bracket-to-transmission	41 to 58	30 to 43
Left-hand rear mounting bracket-to-mounting	58 to 79	43 to 58
Left-hand front mounting bracket-to-mounting	58 to 79	43 to 58
Left-hand front mounting-to-bracket	41 to 58	30 to 43

Note: *Refer to Part B of this Chapter for remaining torque wrench settings.*

Zetec engine

Cylinder head

Maximum permissible gasket surface distortion	0.10 mm
Valve seat included angle	90º
Valve guide bore	6.060 to 6.091 mm

Valves - general

	Inlet	Exhaust
Valve lift	7.500 to 7.685 mm	7.610 to 7.765 mm
Valve length	96.870 to 97.330 mm	96.470 to 96.930 mm
Valve head diameter:		
1.6 litre engine	26.0 mm	24.5 mm
1.8 litre engine	32.0 mm	28.0 mm
Valve stem diameter	6.028 to 6.043 mm	6.010 to 6.025 mm
Valve stem-to-guide clearance	0.017 to 0.064 mm	0.035 to 0.081 mm

Cylinder block

Cylinder bore diameter:	
1.6 litre engine:	
Class 1	76.000 to 76.010 mm
Class 2	76.010 to 76.020 mm
Class 3	76.020 to 76.030 mm
1.8 litre engine:	
Class 1	80.600 to 80.610 mm
Class 2	80.610 to 80.620 mm
Class 3	80.620 to 80.630 mm

Pistons and piston rings

Piston diameter	
1.6 litre engine:	
Class 1	75.975 to 75.985 mm
Class 2	75.985 to 75.995 mm
Class 3	75.995 to 76.005 mm
1.8 litre engine:	
Class 1	80.570 to 80.580 mm
Class 2	80.580 to 80.590 mm
Class 3	80.590 to 80.600 mm
Oversizes - all engines	None available
Piston-to-cylinder bore clearance	No information available at time of writing
Piston ring end gaps - installed:	
Compression rings	0.30 to 0.50 mm
Oil control ring:	
1.6 litre engine	0.25 to 1.00 mm
1.8 litre engine	0.38 to 1.14 mm

Gudgeon pin

Diameter:	
White colour code/piston crown marked “A”	20.622 to 20.625 mm
Red colour code/piston crown marked “B”	20.625 to 20.628 mm
Blue colour code/piston crown marked “C”	20.628 to 20.631 mm
Clearance in piston	0.010 to 0.016 mm
Connecting rod small-end eye internal diameter	20.589 to 20.609 mm
Interference fit in connecting rod	0.011 to 0.042 mm

Crankshaft and bearings

Main bearing shell standard inside diameter - installed	58.011 to 58.038 mm
Main bearing journal standard diameter	57.980 to 58.000 mm
Main bearing journal-to-shell running clearance	0.011 to 0.058 mm
Main bearing shell undersizes available	0.02 mm, 0.25 mm
Big-end bearing shell standard inside diameter - installed	46.926 to 46.960 mm
Crankpin (big-end) bearing journal standard diameter	46.890 to 46.910 mm
Crankpin (big-end) bearing journal-to-shell running clearance	0.016 to 0.070 mm
Big-end bearing shell undersizes available	0.02 mm, 0.25 mm
Crankshaft endfloat	0.090 to 0.310 mm

Torque wrench settings	Nm	lbf ft
Main bearing cap bolts and nuts	80	59
Big-end bearing cap bolts:		
Stage 1	18	13
Stage 2	Angle-tighten a further 90º	
Piston-cooling oil jet/blanking plug Torx screws	10	7
Cylinder block and head oilway blanking plugs:		
M6 x 10	8 to 11	6 to 8
M10 x 11.5 - in block	24	17
1/4 PTF plug - in block	25	18
Power steering pump/air conditioning compressor mounting bracket-to-cylinder block bolts	47	35
Exhaust manifold heat shield mounting bracket-to-cylinder block bolts	32	24
Crankcase breather system:		
Oil separator-to-cylinder block bolts	10	7
Pipe-to-cylinder head bolt	23	17
Transmission-to-engine bolts	40	30
Engine/transmission mountings:		
Right-hand mounting-to-cylinder block bracket	102 to 138	75 to 102
Right-hand mounting bracket-to-cylinder block	76 to 104	56 to 77
Right-hand mounting brace	58 to 79	43 to 58
Right-hand mounting-to-body	70 to 97	51 to 71
Left-hand rear mounting bracket-to-transmission	41 to 58	30 to 43
Left-hand rear mounting bracket-to-mounting	58 to 79	43 to 58
Left-hand front mounting bracket-to-mounting	58 to 79	43 to 58
Left-hand front mounting-to-bracket	41 to 58	30 to 43

Note: *Refer to Part C of this Chapter for remaining torque wrench settings.*

1 General information

How to use this Chapter

This Part of Chapter 2 is devoted to engine/transmission removal and refitting, to those repair procedures requiring the removal of the engine/transmission from the vehicle, and to the overhaul of engine components. It includes only the Specifications relevant to those procedures. Refer to Parts A, B and C for additional Specifications, if required.

General information

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

The following Sections have been written based on the assumption that the engine has been removed from the vehicle. For information concerning in-vehicle engine repair, as well as removal and installation of the external components necessary for the overhaul, see Parts A, B and C of this Chapter, and Section 7 of this Part.

When overhauling the engine, it is essential to establish first exactly what replacement parts are available. On some of the engines covered in this Chapter, components such as the piston rings are not available separately from the piston/connecting rod assemblies; pistons, gudgeon pins and valve guides may also not be available separately, as may some under- or oversized components. In some cases, depending on the extent of engine wear, it would appear that the easiest and most economically-sensible course of action is to replace a worn or damaged engine with an exchange unit.

2 Engine overhaul - general information

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

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

Excessive oil consumption is an indication that piston rings, valve seals and/or valve guides are in need of attention. Make sure that oil leaks aren't responsible before deciding that the rings and/or guides are worn. Perform a cylinder compression check to determine the extent of the work required.

Loss of power, rough running, knocking or metallic engine noises, excessive valve train noise and high fuel consumption rates may also point to the need for an overhaul, especially if they're all present at the same time. If a full service doesn't remedy the situation, major mechanical work is the only solution.

An engine overhaul involves restoring all internal parts to the specification of a new engine. **Note:** *Always check first what replacement parts are available before planning any overhaul operation; refer to Section 1. Ford dealers, or a good engine reconditioning specialist/automotive parts supplier may be able to suggest alternatives which will enable you to overcome the lack of replacement parts.*

During an overhaul, it is usual to renew the piston rings, and to rebore and/or hone the cylinder bores; where the rebore is done by an automotive machine shop, new oversize pistons and rings will also be installed - all these operations, of course, assume the availability of suitable replacement parts. The main and big-end bearings are generally renewed and, if necessary, the crankshaft may be reground to restore the journals. Generally, the valves are serviced as well, since they're 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 renewed as well, or rebuilt, if the necessary parts can be found. 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, drivebelt, thermostat and water pump MUST be replaced with new parts when an engine is overhauled. The radiator should be checked carefully, to ensure that it isn't clogged or leaking (see Chapter 3). Also, as a general rule, the oil pump should be renewed when an engine is rebuilt.*

Before beginning the engine overhaul, read through the entire procedure to familiarise yourself with the scope and requirements of the job. Overhauling an engine isn't difficult, but it is time-consuming. Plan on the vehicle being off the road for a minimum of two weeks, especially if parts must be taken to an automotive machine shop for repair or reconditioning. Check on 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 replaced. Often, an automotive machine shop will handle the inspection of parts, and will offer advice concerning reconditioning and replacement. **Note:** *Always wait until the engine has been completely dismantled, and all components, especially the cylinder block/crankcase, have been inspected, before deciding what service and repair operations must be performed by an automotive machine shop. Since the block's condition will be the major factor to consider when determining whether to overhaul the original engine or buy a rebuilt one, never purchase parts or have machine work done on other components until the cylinder block/crankcase has been thoroughly inspected.* As a general rule, time is the primary cost of an overhaul, so it doesn't pay to install worn or sub-standard parts.

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

3 Engine removal - methods and precautions

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

Locating a suitable place to work is extremely important. Adequate work space, along with storage space for the vehicle, will be needed. If a workshop or garage isn't available, at the very least, a flat, level, clean work surface made of concrete or asphalt is required.

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

On two of the engines covered in this manual, the unit can only be withdrawn by removing it complete with the transmission; the vehicle's body must be raised and supported securely, sufficiently high that the engine/transmission can be unbolted as a single unit and lowered to the ground; the engine/transmission unit can then be withdrawn from under the vehicle and separated. On all engines, an engine hoist or A-frame will 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 removing the engine/transmission from the vehicle.

If this is the first time you have removed an engine, a helper 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 removing the engine/transmission from the vehicle.

Plan the operation ahead of time. Arrange for, or obtain, all of the tools and equipment you'll need prior to beginning the job. Some of the equipment necessary to perform engine/transmission removal and installation safely and with relative ease, and which may have to be hired or borrowed, includes (in addition to the engine hoist) a heavy-duty trolley jack, a strong pair of axle stands, some wooden blocks, and an engine dolly (a low, wheeled platform capable of taking the weight of the engine/transmission, so that it can be moved easily when on the ground). A complete set of spanners and sockets (as described in *"Tools and working facilities"* at the rear of this manual) will obviously be needed, together with plenty of rags and cleaning solvent for mopping-up spilled oil, coolant and fuel. If the hoist is to 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.

Plan for the vehicle to be out of use for quite a while. A machine shop will be required to perform some of the work which the do-it-yourselfer can't accomplish without special equipment. These establishments often have a busy schedule, so it would be a good idea to consult them before removing the engine, to accurately estimate the amount of time required to rebuild or repair components that may need work.

Always be extremely careful when removing and installing the engine/transmission. Serious injury can result from careless actions. By planning ahead and taking your time, the job (although a major task) can be accomplished successfully.

4 Engine - removal and refitting (HCS engine)

Warning: Petrol is extremely flammable, so take extra precautions when disconnecting any part of the fuel system. Don't smoke, or allow naked flames or bare light bulbs, in or near the work area, and don't work in a garage where a natural-gas appliance (such as a clothes dryer or water heater) is installed. If you spill petrol on your skin, rinse it off immediately. Have a fire extinguisher rated for petrol fires handy, and know how to use it.

Note: *Read through the entire Section, as well as reading the advice in the preceding Section, before beginning this procedure. The engine is removed separately from the transmission and is lifted upwards and out of the engine compartment.*

Removal

1 On fuel-injected engines, refer to Chapter 4B and depressurise the fuel system.

2 Disconnect the battery negative (earth) lead (refer to Chapter 5, Section 1).

3 Referring to Chapter 1 for details, drain the coolant and engine oil. Refit the drain plug to the sump on completion.

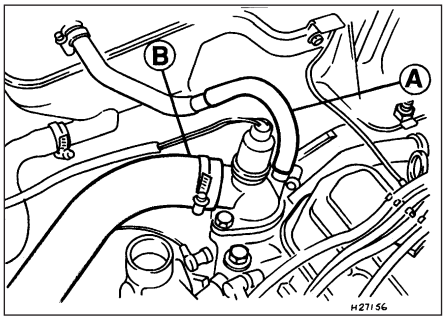
4 Remove the bonnet as described in Chapter 11. Position it out of the way in a safe place where it will not get damaged.

5 Remove the air cleaner unit as described in Chapter 4.

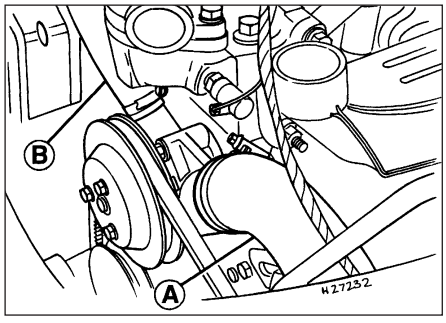
6 Release the retaining clips and detach the following coolant hoses. Allow for coolant spillage as the hoses are detached, note their routing, and position them out of the way **(see illustrations)**:

a) All hoses at the thermostat housing.
b) Bottom hose from the radiator to the water pump.
c) Heater hoses at the bulkhead and water pump.
d) Inlet manifold coolant supply hose (where applicable).

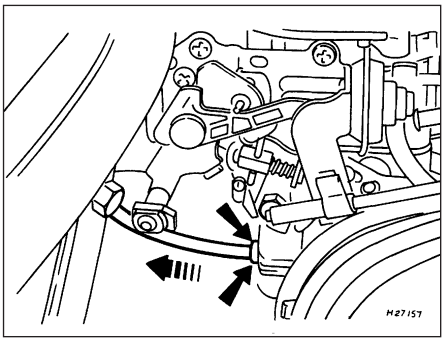
7 Disconnect the fuel trap vacuum hose from the inlet manifold.



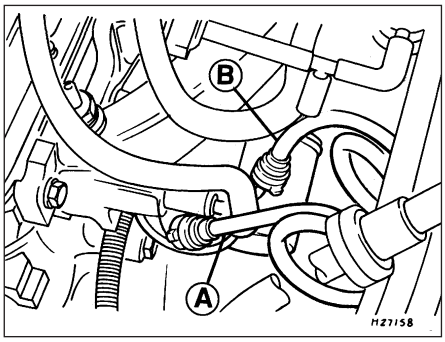
4.6A Disconnect the overflow hose (A) and the top hose (B) from the thermostat housing



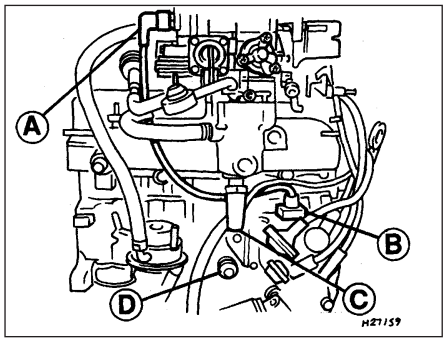
4.6B Disconnect the bottom hose (A) and the heater hose (B) from the water pump



4.8 Detach the servo vacuum hose from the manifold



4.10 Fuel supply (A) and return (B) hose connections at the fuel pump



4.11A Wiring connections to the HCS engine

A Idle cut-off valve
B DIS ignition coil
C Engine coolant temperature sensor
D Oil pressure switch

8 Disconnect the brake servo unit vacuum hose from the inlet manifold, by pushing the hose retainer in towards the manifold and simultaneously pulling free the hose **(see illustration)**.

9 Refer to Chapter 4 for details, and detach the accelerator cable. Where applicable, detach the choke cable from the carburettor.

10 Compress the quick-release couplings at the sides, and detach the fuel supply hose and return hose from the fuel pump or CFi unit **(see illustration)**. Allow for fuel spillage as the hoses are disconnected, and plug the exposed ends to prevent further spillage and the ingress of dirt. Position the hoses out of the way.

11 Note their locations and disconnect the wiring connectors from the following **(see illustrations)**:

a) Coolant temperature gauge sender unit.
b) The oil pressure switch.
c) The radio earth lead.
d) The cooling fan thermostatic switch.
e) The DIS ignition coil.
f) The crankshaft speed/position sensor.
g) The engine coolant temperature sensor.
h) The idle cut-off valve.

12 Apply the handbrake, then raise the vehicle at the front end and support it on axle stands.

13 Unscrew the retaining nuts, and detach the exhaust downpipe from the exhaust manifold. Remove the seal from the joint flange.

14 Refer to Chapter 5 for details, and remove the starter motor.

15 Undo the two retaining bolts, and remove the clutch lower cover plate.

16 Unscrew the retaining bolt, and detach the gearshift stabiliser from the transmission.

17 Unscrew and remove the engine/transmission flange attachment bolts and also the bolt fitted from the front, securing the earth lead (from the underside) **(see illustration)**.

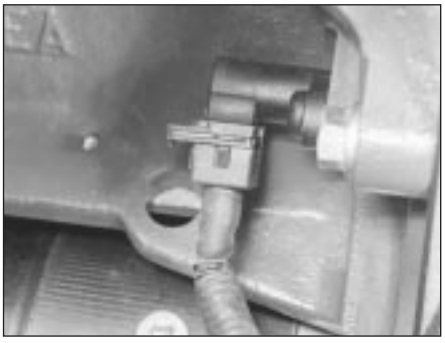
18 Unscrew and remove the single bolt securing the engine mounting brace to the crossmember **(see illustration)**.

19 Check that the appropriate underside attachments are disconnected and out of the way, then lower the vehicle to the ground.

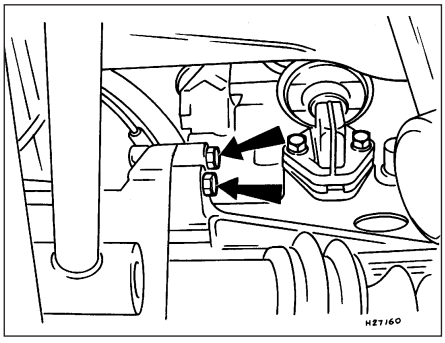
20 Unbolt and remove the heat shield from the exhaust manifold.

21 Attach a suitable hoist to the engine. It is possible to fabricate lifting eyes to connect the hoist to the engine, but make sure that they are strong enough, and connect them to the inlet and exhaust manifold at diagonally-opposite ends of the engine **(see illustration)**.

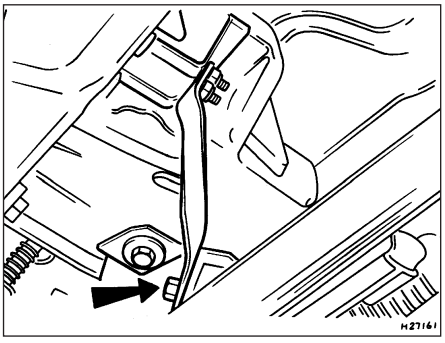
22 With the hoist securely connected, take the weight of the engine, then unscrew the two retaining nuts to detach the engine mounting from the apron panel, and the single bolt to disconnect it at the mounting bracket **(see illustration)**.



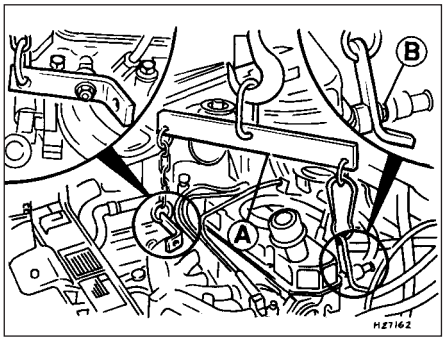
4.11B Engine crankshaft speed/position sensor and multi-plug



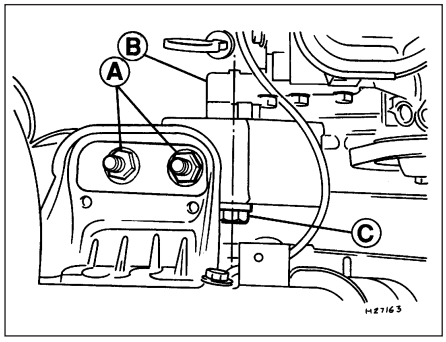
4.17 Engine-to-transmission flange attachment bolts (arrowed)



4.18 Mounting brace-to-crossmember bolt (arrowed)



4.21 Engine lifter and attachment points (A) and M8 x 35 bolt location (B)



4.22 Detach the engine mounting fixing at the points indicated

A Front apron panel bracket nuts
B Mounting bracket
C Bolt-to-engine bracket

23 Locate a jack under the transmission, and raise it to take the weight of the transmission.
24 Unscrew and remove the remaining engine-to-transmission retaining bolts on the upper flange.
25 Check around the engine to ensure that all of the relevant fixings and attachments are disconnected and out of the way for the removal.
26 Enlist the aid of an assistant, then move the engine forwards and away from the transmission, whilst simultaneously raising the transmission. When the engine is separated from the transmission, carefully guide it up and out of the engine compartment. Do not allow the weight of the engine to hang on the transmission input shaft at any point during the removal (or refitting) of the engine. When the engine sump is clear of the vehicle, swing the power unit out of the way, and lower it onto a trolley (if available). Unless a mobile hoist is being used, it will be necessary to move the vehicle rearwards and out of the way in order to allow the engine to be lowered for removal. In this instance, ensure that the weight of the transmission is well supported as the vehicle is moved.
27 While the engine is removed, check the mountings; renew them if they are worn or damaged. Similarly, check the condition of all coolant and vacuum hoses and pipes (see Chapter 1); components that are normally hidden can now be checked properly, and should be renewed if there is any doubt at all about their condition. Also, take the opportunity to overhaul the clutch components (see Chapter 8). It is regarded by many as good working practice to renew the clutch assembly as a matter of course, whenever major engine overhaul work is carried out. Check also the condition of all components (such as the transmission oil seals) disturbed on removal, and renew any that are damaged or worn.

Refitting

28 Refitting is in general, a reversal of the removal procedure, but the following special points should be noted.
29 Before coupling the engine to the transmission, apply a thin smear of high-melting-point grease onto the transmission input shaft splines. If the clutch has been removed, ensure that the clutch disc is centralised, and disconnect the clutch cable from the release lever on the transmission casing.
30 Tighten all fixings to their recommended torque wrench settings.
31 Check that the mating faces are clean, and fit a new exhaust downpipe-to-manifold gasket and self-locking nuts when reconnecting this joint.
32 Ensure that all wiring connections are correctly and securely made.
33 Remove the plugs from the fuel lines before reconnecting them correctly and securely.
34 Reconnect and adjust the accelerator and choke cables as described in Chapter 4. The refitting details for the air cleaner unit are also given in that Chapter.
35 Renew any coolant hoses (and/or retaining clips) that are not in good condition.
36 Refer to Chapter 8 for details on reconnecting the clutch cable.
37 When the engine is fully refitted, check that the various hoses are connected, and then top-up the engine oil and coolant levels as described in Chapter 1.
38 When engine refitting is completed, refer to Section 22 for the engine start-up procedures.

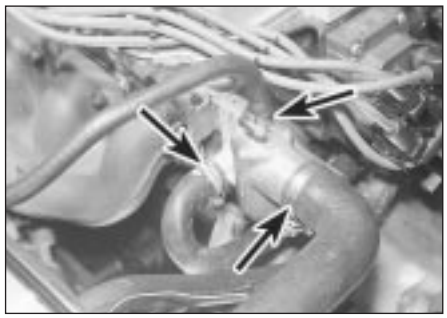
5 Engine/transmission - removal and refitting (CVH engine)

Warning: Petrol is extremely flammable, so take extra precautions when disconnecting any part of the fuel system. Don't smoke, or allow naked flames or bare light bulbs, in or near the work area, and don't work in a garage where a natural-gas appliance (such as a clothes dryer or water heater) is installed. If you spill petrol on your skin, rinse it off immediately. Have a fire extinguisher rated for petrol fires handy, and know how to use it.

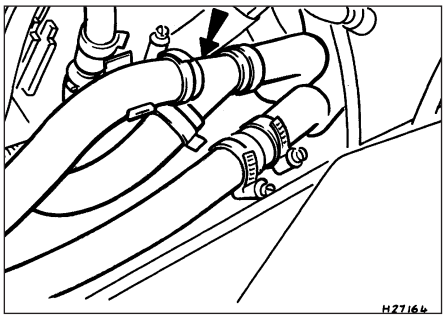
Note: *Read through the entire Section, as well as reading the advice in the preceding Section, before beginning this procedure. The engine and transmission are removed as a unit, lowered to the ground and removed from underneath, then separated outside the vehicle.*

Removal

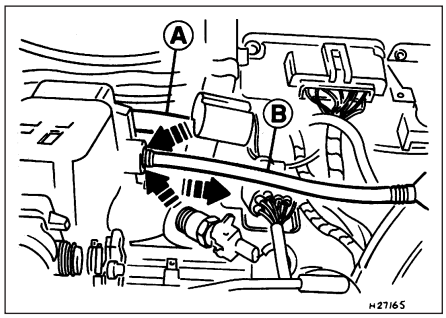
1 On all fuel-injected engines, refer to Chapter 4B and depressurise the fuel system.
2 Disconnect the battery negative (earth) lead (refer to Chapter 5, Section 1).
2 Referring to Chapter 1 for details, drain the coolant and the engine oil. Refit the drain plug to the sump on completion.
4 Refer to Chapter 11 for details, and remove the bonnet. Store it in a safe area where it will not get damaged.
5 Remove the air cleaner unit as described in Chapter 4. On 1.6 litre EFi fuel-injected models, remove the air inlet components and the complete air cleaner unit.
6 Release the retaining clips and detach the coolant top hose, the heater hose and the radiator overflow hose from the thermostat housing. Disconnect the coolant hose from the inlet manifold, and the bottom hose from the water pump and/or the radiator **(see illustrations)**. On 1.4 litre CFi fuel-injected models, also disconnect the coolant hose from the injection unit. On 1.6 EFi models, detach the heater hose Y-connector. Allow for coolant spillage as the hoses are detached, note their routing, and position them out of the way.
7 Refer to Chapter 4 for details, and disconnect the accelerator cable from the throttle linkage and support/adjuster bracket. Where applicable, also disconnect the choke cable. Position the cable(s) out of the way.
8 On carburettor models, disconnect the fuel supply hose from the fuel pump, and the return hose from the carburettor.
9 On CFi models, detach the fuel hose at the injector/pressure regulator unit, and the return line, by compressing the couplings whilst pulling the hoses free from their connections. On EFi models, unscrew the union nut to detach the fuel line from the fuel rail; release the retaining clip to detach the return pipe from the pressure regulator. Plug the exposed ends of the hoses and connections, to prevent fuel spillage and the ingress of dirt. Position the hoses out of the way.
10 Press the clamp ring inwards, and simultaneously pull free the brake servo hose from the inlet manifold. Position it out of the way.
11 On CFi and EFi models, detach the vacuum hose from the MAP sensor, and the hose between the carbon canister and the fuel injection unit **(see illustration)**.



5.6A Coolant hose connections to the thermostat (arrowed)



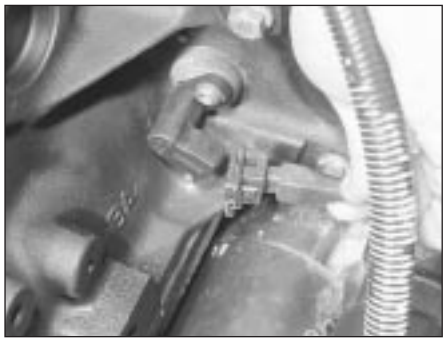
5.6B Heater coolant hoses and Y-connector on 1.6 litre EFi fuel-injected models



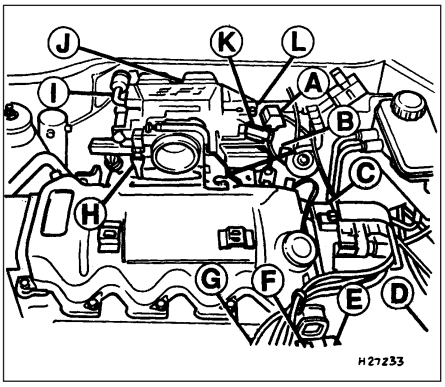
5.11 Vacuum hose to MAP sensor (A) and brake servo (B)

5.12A Disconnect the wiring at the temperature gauge sender unit . . .

5.12B . . . the oil pressure switch . . .

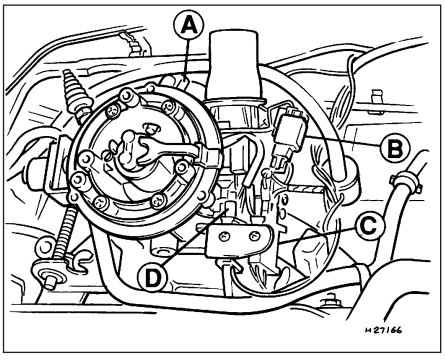


5.12C . . . and the crankshaft speed/position sensor



5.12D Engine and associated component wiring plug connections

A Main wiring loom
B Road speed sensor unit
C DIS ignition coil
D Reversing light switch
E Cooling fan temperature sensor
F Temperature gauge sender
G Engine speed/crankshaft position sensor
H Throttle position sensor
I Idle speed control valve
J Coolant temperature sensor
K Intake air temperature sensor
L Oil pressure switch



5.12E Wiring connections to the CFi unit on the 1.4 litre engine

A Coolant temperature sensor
B Throttle plate control motor
C Throttle position sensor
D Injector

12 Note their connections and routings, and detach the following wiring connections, according to model:

a) Coolant temperature sender unit ***(see illustration)****.*
b) Oil pressure switch ***(see illustration)****.*
c) DIS ignition coil unit.
d) Coolant temperature sensor.
e) Cooling fan thermostatic switch.
f) Carburettor.
g) Earth lead (radio).
h) Reversing light switch (from transmission).
i) Crankshaft speed/position sensor ***(see illustration)****.*
j) Earth leads from the transmission and engine.

Additional items specific to CFi and EFi models only **(see illustrations)**.

a) Inlet air temperature sensor.
b) Vehicle speed sensor.
c) Throttle plate control motor (CFi models).
d) Throttle position sensor.
e) Injector harness connector.
f) Idle speed control valve (EFi models).

13 Unscrew the retaining bolt and detach the bracket locating the wiring and coolant hoses above the transmission.

14 Disconnect the speedometer drive cable from the transmission.

15 On manual transmission models, disconnect the clutch cable from the release lever at the transmission (see Chapter 8 for details). Position the cable out of the way.

16 Unscrew the two retaining bolts, and detach the engine/transmission mounting from the mounting bracket **(see illustration)**.

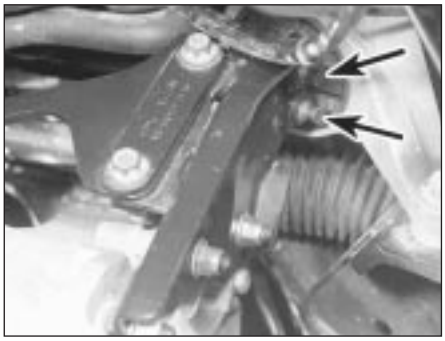
17 Apply the handbrake, then raise and support the vehicle at the front end on axle stands. Allow sufficient clearance under the vehicle to withdraw the engine and transmission units from under the front end.

18 Where applicable on catalytic converter-equipped vehicles, release the multi-plug from the bracket and disconnect the wiring connector from the oxygen sensor in the exhaust downpipe **(see illustration)**.

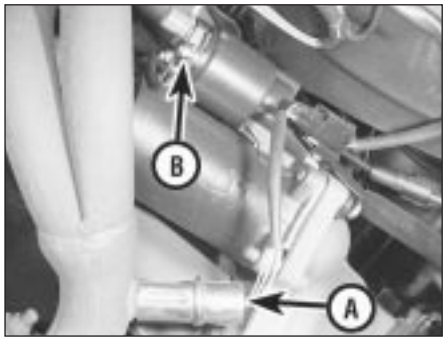
19 Undo the three retaining bolts, detach the exhaust downpipe from the manifold, and collect the gasket from the flange joint **(see illustration)**. Now disconnect the exhaust downpipe from the rest of the system, and remove it from the vehicle. Where applicable, disconnect the pulse-air supply hose from the check valve. Noting their connections (to ensure correct reassembly), detach the appropriate system vacuum hoses at the PVS (three-port vacuum switch) under the inlet manifold.

20 Where fitted, undo the four retaining nuts and two bolts securing the front part of the exhaust heat shield to the floor, then remove the heat shield **(see illustration)**.

21 Note their connections, and detach the wiring from the starter motor and the alternator. Unbolt and remove the starter motor.

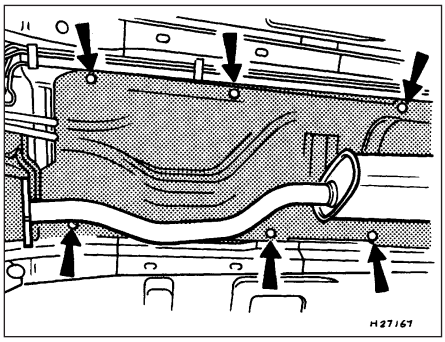


5.16 Engine/transmission mounting bracket bolts (arrowed)

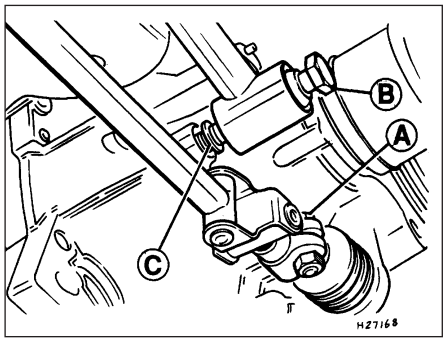


5.18 Wiring connections to the oxygen sensor (A) and starter motor (B)

5.19 Exhaust downpipe-to-manifold flange and securing bolts



5.20 Exhaust system heat shield, showing securing nut and bolt locations



5.22 Manual transmission shift rod clamp bolt (A), stabiliser-to-transmission bolt (B) and washer (C)

Manual transmission models

22 Select fourth gear, to assist in correct adjustment of the gearchange during reassembly. If it is likely that the gear lever will be moved from this position before refitting, mark the relative position of the transmission shift rod and the selector shaft before separating them. Undo the clamp bolt, and then pull free and detach the shift rod from the selector shaft **(see illustration)**.

23 Unscrew the retaining bolt, and detach the shift rod stabiliser from the transmission. As it is detached, note the washer located between the stabiliser and the transmission. Tie the stabiliser and the shift rod up out of the way.

Automatic transmission models

24 Unclip and detach the wiring connector from the starter inhibitor switch (on the transmission housing).

25 Referring to Chapter 4 for details, unhook the accelerator (cam plate) cable from the carburettor or fuel injection unit (as applicable) at the transmission end of the cable. Undo the retaining bolt and detach the cable sheath bracket from the transmission. Detach the cam plate cable from the link.

26 Undo the two nuts from the selector cable bracket which connects it to the lever on the selector shaft. Disconnect the yoke from the lever on the selector shaft and the cable from the lever.

27 Unscrew the union nuts, and disconnect the oil cooler feed and return pipes from the transmission. Allow for a certain amount of spillage, and plug the connections to prevent the ingress of dirt.

All models

28 Note the direction of fitting, unscrew the retaining nut and withdraw the Torx-type clamp bolt securing the lower suspension arm to the spindle carrier on each side.

29 Refer to Chapter 10 for details, and detach the right-hand track rod end balljoint from the spindle carrier.

30 Insert a suitable lever between the right-hand driveshaft inner joint and the transmission housing, and prise free the driveshaft from the transmission; be prepared for oil spillage from the transmission case through the vacated driveshaft aperture. As it is being prised free, simultaneously pull the roadwheel outwards on that side, to enable the driveshaft inboard end to separate from the transmission. Once it is free, suspend and support the driveshaft from the steering gear, to prevent unnecessary strain being placed on the driveshaft joints. The outer joint must not be angled in excess of 45º, the inner joint no more than 20º, or the joints may be damaged. Refer to Chapter 8 for further details if necessary.

31 Insert a suitable plastic plug (or if available, an old driveshaft joint), into the transmission driveshaft aperture, to immobilise the gears of the differential unit.

32 Proceed as described above in paragraphs 29 to 31, and disconnect the left-hand driveshaft from the transmission.

33 Unscrew the retaining bolts, and remove the brace between the transmission left front mounting bracket and the transmission flange **(see illustration)**.

34 Connect a suitable lift hoist and sling to the engine, connecting to the lifting eyes **(see illustration)**. When securely connected, take the weight of the engine/transmission unit so that the tension is relieved from the mountings.

35 Unscrew the two retaining bolts, and detach the transmission front mounting from the side member.

36 Unscrew the three retaining bolts, and remove the auxiliary drivebelt cover from under the crankshaft pulley.

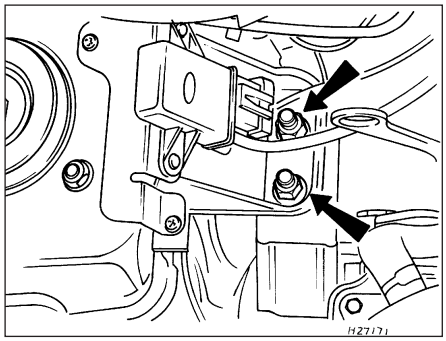
37 Unscrew the two retaining nuts, and detach the right-hand engine mounting from the suspension strut mounting. On EFi engines, remove the MAP sensor **(see illustration)**.

38 The engine/transmission unit should now be ready for removal from the vehicle. Check that all of the associated connections and fittings are disconnected from the engine and transmission, and positioned out of the way.

39 Enlist the aid of an assistant to help steady and guide the power unit down

5.33 Remove the brace between the transmission left front mounting bracket and the transmission flange

5.34 Connect a suitable lift hoist and sling to the engine, connecting to the lifting eyes



5.37 Right-hand engine mounting bracket and MAP sensor on EFi models

5.40 Removing the engine/transmission from under the vehicle

through the engine compartment as it is removed. If available, position a suitable engine trolley or crawler board under the engine/transmission so that when lowered, the power unit can be withdrawn from the front end of the vehicle, and then moved to the area where it is to be cleaned and dismantled. On automatic transmission models, particular care must be taken not to damage the transmission fluid pan (sump) during the removal and subsequent refitting processes.

40 Carefully lower the engine and transmission unit, ensuring that no fittings become snagged. Detach the hoist and remove the power unit from under the vehicle **(see illustration)**.

41 Referring to the relevant Part of Chapter 7, separate the transmission from the engine.

42 While the engine/transmission is removed, check the mountings; renew them if they are worn or damaged. Similarly, check the condition of all coolant and vacuum hoses and pipes (see Chapter 1). Components that are normally hidden can now be checked properly, and should be renewed if there is any doubt at all about their condition. Where the vehicle is fitted with manual transmission, take the opportunity to inspect the clutch components (see Chapter 8). It is regarded by many as good working practice to renew the clutch assembly as a matter of course, whenever major engine overhaul work is carried out. Check also the condition of all components (such as the transmission oil seals) disturbed on removal, and renew any that are damaged or worn.

Refitting

43 Refitting is a reversal of removal, however note the following additional points:

a) Refer to the applicable Chapters and Sections as for removal.

b) Fit new spring clips to the grooves in the inboard end of the right- and left-hand driveshaft joints. Lubricate the splines with transmission oil prior to fitting.

c) Renew the exhaust flange gasket when reconnecting the exhaust. Ensure that all wires are routed clear of the exhaust system and, on catalytic converter models, ensure that the heat shields are securely and correctly fitted.

d) Ensure that all earth lead connections are clean and securely made.

e) Tighten all nuts and bolts to the specified torque.

f) Fit a new oil filter, and refill the engine and transmission with oil, with reference to Chapter 1.

g) Refill the cooling system with reference to Chapter 1.

44 When engine and transmission refitting is complete, refer to the procedures described in Section 22 before restarting the engine.

6 Engine/transmission - removal and refitting (Zetec engine)

Warning: Petrol is extremely flammable, so take extra precautions when disconnecting any part of the fuel system. Don't smoke, or allow naked flames or bare light bulbs, in or near the work area, and don't work in a garage where a natural-gas appliance (such as a clothes dryer or water heater) is installed. If you spill petrol on your skin, rinse it off immediately. Have a fire extinguisher rated for petrol fires handy, and know how to use it.

Note: *Read through the entire Section, as well as reading the advice in the preceding Section, before beginning this procedure. The engine and transmission are removed as a unit, lowered to the ground and removed from underneath, then separated outside the vehicle.*

Removal

1 Park the vehicle on firm, level ground, apply the handbrake firmly, and slacken the nuts securing both front roadwheels.

2 Depressurise the fuel system as described in Chapter 4B.

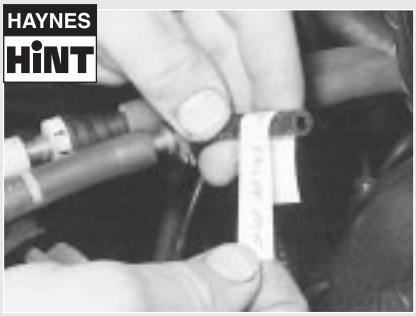
3 Disconnect the battery negative (earth) lead (refer to Chapter 5, Section 1).

4 Place protective covers on the wings, then remove the bonnet (see Chapter 11).

5 Drain the cooling system and the engine oil (see Chapter 1). Also drain the transmission (MTX-75 type only) as described in the relevant Part of Chapter 7.

6.12 Unbolt the engine/transmission-to-body earth lead from the transmission

6 Whenever you disconnect any vacuum lines, coolant and emissions hoses, wiring loom connectors, earth straps and fuel lines as part of the following procedure, always label them clearly, so that they can be correctly reassembled. Take instant photos, or sketch the locations of components and brackets.



Masking tape and/or a touch-up paint applicator work well for marking items.

7 Remove the air inlet components and the complete air cleaner unit as described in Chapter 4B.

8 Equalise the pressure in the fuel tank by removing the filler cap, then release the fuel feed and return quick-release couplings, and pull the hoses off the fuel pipes. Plug or cap all open fittings.

9 Disconnect the accelerator cable from the throttle linkage as described in Chapter 4B. Secure the cable clear of the engine/transmission.

10 Releasing its wire clip, unplug the power steering pressure switch electrical connector, then disconnect the earth cable from the engine lifting eye. Refit the bolt after disconnecting the cable.

11 Marking or labelling all components as they are disconnected (see paragraph 6 above), disconnect the vacuum hoses as follows:

a) From the rear of the inlet manifold.

b) The braking system vacuum servo unit hose - from the inlet manifold (see Chapter 9 for details).

c) While you are there, trace the vacuum line from the pulse-air filter housing, and disconnect it from the pulse-air solenoid valve.

d) Secure all these hoses so that they won't get damaged as the engine/transmission is removed.

12 Unbolt the engine/transmission-to-body earth lead from the transmission **(see illustration)**. Disconnect the speedometer drive cable (see Chapter 12) and secure it clear of the engine/transmission.

13 Disconnect the earth strap at the top of the engine/transmission flange, and the adjacent bolt securing the wiring harness clip.

6.15A Disconnect the wiring multi-plug (arrowed) from the ignition coil ..

6.15B . . . the radio interference suppressor . . .

6.15C . . . and the reversing light switch

14 Where the vehicle is fitted with manual transmission, disconnect the clutch cable (see Chapter 8).

15 Marking or labelling all components as they are disconnected (see paragraph 5 above), disconnect the engine wiring connectors as follows:

*a) The multi-plug from the DIS ignition coil **(see illustration)**.*
*b) The radio interference suppressor from the DIS ignition coil **(see illustration)**.*
*c) The reversing light switch multi-plug **(see illustration)**.*
d) The engine main wiring loom multi-plug behind the DIS ignition coil.
e) The crankshaft speed/position sensor and vehicle speed sensor multi-plugs.
f) The oxygen sensor multi-plug.

16 Unbolt the exhaust manifold heat shield, and lift it clear.

17 Remove the auxiliary drivebelt (see Chapter 1).

18 Marking or labelling all components as they are disconnected (see paragraph 6 above) and catching as much as possible of the escaping coolant in the drain tray, disconnect the cooling system hoses and pipes as follows - refer to Chapter 3 for further details, if required:

a) The coolant hoses at the thermostat housing.
b) The coolant hose at the metal cross pipe lower connection.
c) The radiator top and bottom hoses.

19 Undo the nut securing the power steering pump pressure pipe clip to the timing belt cover. Release the unions and clips, and disconnect the pump pressure and return lines. Collect the fluid in a suitable container, and plug the disconnected unions. Lift the power steering fluid reservoir out of its bracket, and move it clear of the engine.

20 Apply the handbrake, then raise the vehicle and support it securely on axle stands, then remove the front roadwheels.

21 Refer to Chapter 5 if necessary, and disconnect the wiring from the starter motor and alternator.

22 Disconnect the oil pressure switch wiring connector.

23 On automatic transmission models, disconnect the starter inhibitor switch wiring and disconnect the selector cable (see Chapter 7B). Secure the cable clear of the engine/transmission.

24 Where the vehicle is fitted with manual transmission, disconnect the gearchange linkage and transmission support rod from the rear of the transmission - make alignment marks as they are disconnected **(see illustrations)**.

25 On automatic transmission models, clean around the unions, then disconnect the fluid pipes from the transmission. Plug the openings in the transmission and the pipe unions after removal.

26 Unscrew the nuts to disconnect the exhaust system front downpipe from the manifold **(see illustration)**. Undo the nuts securing the catalytic converter to the rear part of the exhaust system, and remove the converter and downpipe assembly.

27 Where the vehicle is fitted with air conditioning, refer to Chapter 3 and disconnect any components that are likely to impede removal of the engine/transmission from below.

Warning: Do not disconnect the refrigerant hoses.

28 Disconnect both anti-roll bar links from their respective suspension struts, and both track rod end ball joints from their spindle carriers (see Chapter 10).

29 Noting the direction of fitting, unscrew the retaining nut and withdraw the Torx-type clamp bolt securing the lower suspension arm to the spindle carrier on each side.

30 Insert a suitable lever between the right-hand driveshaft inner joint and the transmission housing, and prise free the driveshaft from the transmission; be prepared for oil spillage from the transmission case through the vacated driveshaft aperture. As it is being prised free, simultaneously pull the roadwheel outwards on that side to enable the driveshaft inboard end to separate from the transmission. Once it is free, suspend and support the driveshaft from the steering gear, to prevent unnecessary strain being placed on the driveshaft joints. The outer joint must not be angled in excess of 45∞, the inner joint no

6.24A Disconnect the gearchange linkage . . .

6.24B . . . and transmission support rod

6.26 Disconnect the exhaust system front downpipe from the manifold

6.40 Removing the engine/transmission unit from under the car

more than 20º. Refer to Chapter 8 for further details if necessary.

31 Insert a suitable plastic plug (or if available, an old driveshaft joint), into the transmission driveshaft aperture, to immobilise the gears of the differential unit.

32 Proceed as described above in paragraphs 30 and 31, and disconnect the left-hand driveshaft from the transmission.

33 Remove the oil filter, referring to Chapter 1 if necessary.

34 Undo the two upper bolts and one lower bolt, and remove the right-hand engine mounting support brace.

35 Connect a suitable lift hoist and sling to the engine, connecting to the lift eyes. When securely connected, take the weight of the engine/transmission unit so that the tension is relieved from the mountings.

36 From above, undo the two bolts securing the left-hand rear mounting to the transmission bracket.

37 Undo the two nuts securing the right-hand mounting to the body adjacent to the suspension strut tower.

38 Undo the two bolts securing the left-hand front mounting to the body side member.

39 The engine/transmission unit should now be hanging on the hoist only, with all components which connect it to the rest of the vehicle disconnected or removed, and secured well clear of the unit. Make a final check that this is the case.

40 Lower the engine/transmission to the ground, and withdraw it from under the vehicle **(see illustration)**.

41 Referring to the relevant Part of Chapter 7, separate the transmission from the engine.

42 While the engine/transmission is removed, check the mountings; renew them if they are worn or damaged. Similarly, check the condition of all coolant and vacuum hoses and pipes (see Chapter 1); components that are normally hidden can now be checked properly, and should be renewed if there is any doubt at all about their condition. Where the vehicle is fitted with manual transmission, take the opportunity to overhaul the clutch components (see Chapter 8). It is regarded by many as good working practice to renew the clutch assembly as a matter of course, whenever major engine overhaul work is carried out. Check also the condition of all components (such as the transmission oil seals) disturbed on removal, and renew any that are damaged or worn.

Refitting

43 Refitting is a reversal of removal, however note the following additional points:

a) Refer to the applicable Chapters and Sections as for removal.
b) Fit new spring clips to the grooves in the inboard end of the right- and left-hand driveshaft joints. Lubricate the splines with transmission oil prior to fitting.
c) Renew the exhaust flange gaskets when reconnecting the exhaust. Ensure that all wires are routed clear of the exhaust system, and that the heat shields are securely and correctly fitted.
d) Ensure that all earth lead connections are clean and securely made.
e) Tighten all nuts and bolts to the specified torque.
f) Fit a new oil filter, and refill the engine and transmission with oil, with reference to Chapter 1.
g) Refill the cooling system with reference to Chapter 1.
h) Bleed the power steering system with reference to Chapter 10.

44 When engine and transmission refitting is complete, refer to the procedures described in Section 22 before restarting the engine.

7 **Engine overhaul** - dismantling sequence

1 The engine dismantling and reassembly tasks are made easier if the engine is mounted on a portable engine stand. These stands can be hired from a tool hire shop. Before mounting the engine on a stand, the flywheel/driveplate must first be removed, to enable the engine-to-stand fixing bolts to be fitted.

2 If a stand is not available, it is possible to dismantle the engine with it suitably supported on a strong workbench or on the floor. Be careful not to tip or drop the engine when working without a stand.

3 If a reconditioned engine is to be fitted, all external components of the original engine must be removed in order to transfer them to the replacement unit (just as they will if you are doing a complete engine rebuild). These components include the following:

a) Alternator and mounting brackets.
b) DIS ignition coil unit (and mounting bracket), HT leads and spark plugs.
c) The thermostat and housing cover.
d) Carburettor/fuel injection system components.
e) Inlet and exhaust manifolds.
f) Oil filter.
g) Fuel pump.
h) Engine mountings.
i) Flywheel/driveplate.
j) Water pump.

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 positions of gaskets, seals, washers, bolts and other small items.*

4 If you are obtaining a short motor (which consists of the cylinder block, crankshaft, pistons and connecting rods all assembled), the cylinder head, sump, oil pump and timing chain/belt will have to be removed also.

5 If a complete overhaul is planned, the engine can be dismantled and the internal components removed in the following order:

a) Inlet and exhaust manifolds.
b) Timing chain/belt, tensioner and sprockets.
c) Cylinder head.
d) Flywheel/driveplate.
e) Sump.
f) Oil pump.
g) Pistons (with connecting rods).
h) Crankshaft.
i) Camshaft and tappets (HCS engine).

6 Before starting the dismantling and overhaul procedures, make sure that you have all of the correct tools for the jobs to tackled. Refer to the introductory pages at the start of this manual for further information.

8 **Cylinder head** - dismantling

Note: *New and reconditioned cylinder heads are available from the manufacturers, and from engine overhaul specialists. Due to the fact that some specialist tools are required for the dismantling and inspection procedures, and new components may not be readily available (refer to Section 1), it may be more practical and economical for the home mechanic to purchase a reconditioned head, rather than to dismantle, inspect and recondition the original head.*

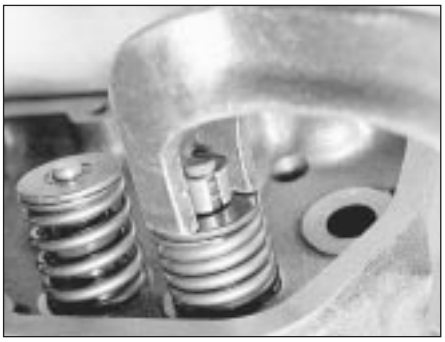
HCS engine

1 Unscrew and remove the five retaining bolts, and lift off the inlet manifold (complete with carburettor). Remove the inlet manifold-to-cylinder head gasket.

2 Unscrew and remove the eight retaining nuts, and lift off the exhaust manifold from the cylinder head. Remove the exhaust manifold-to-cylinder head gasket.

3 Unscrew and remove the temperature gauge sender unit.

4 To remove the valve springs and valves from the cylinder head, a standard valve spring compressor will required. Fit the spring compressor to the first valve and spring to be removed. Assuming that all of the valves and springs are to be removed, start by compressing the No 1 valve (nearest the timing cover end) spring. Take care not to



8.5 Compress the valve spring to remove the collets

8.6A Remove the valve spring retainer and spring . . .

8.6B . . . followed by the valve

damage the valve stem with the compressor, and do not over-compress the spring, or the valve stem may bend. When tightening the compressor, it may be found that the spring retainer does not release and the collets are then difficult to remove. In this instance, remove the compressor, then press a piece of tube (or a socket of suitable diameter) so that it does not interfere with the removal of the collets, against the retainer's outer rim. Tap the tube (or socket) with a hammer to unsettle the components.

5 Refit the compressor, and wind it in to enable the collets to be extracted **(see illustration)**.

6 Loosen off the compressor, and remove the retainer and spring. Withdraw the valve from the cylinder head **(see illustrations)**.

7 Prise up and remove the valve stem seal **(see illustration)**.

8 Repeat the removal procedure with each of the remaining seven valve assemblies in turn. As they are removed, keep the individual valves and their components together, and in their respective order of fitting, by placing them in a separate labelled bag **(see illustration)**.

CVH engine

9 Remove the camshaft, rocker arms and tappets as described in Part B of this Chapter, being careful to store the hydraulic tappets as described.

10 Valve removal should commence with No 1 valve (nearest the timing belt end).

11 Compress the valve spring of the No 1 valve using a suitable valve compressor. A conventional valve spring compressor will be ideal, but if preferred, a forked tool (Part No 21-097) can be purchased or fabricated. The tool engages on the rocker stud, and a nut and distance piece are used to compress it and the valve spring **(see illustration)**.

12 Compress the valve spring (and upper retainer) just enough to enable the split collets to be released from the groove in the top of the valve stem, then separate and extract the split collets from the valve. Do not compress the spring any further than is necessary, or the valve stem may bend. If the valve spring retainer does not release from the collets as the spring is compressed, remove the compressor, and position a piece of suitable tube over the end of the retainer, so that it does not impinge on the collets. Place a small block of wood under the valve head (with the head resting face down on the workbench), then tap the end of the tube with a hammer. Now refit the compressor tool, and compress the valve spring. The collets should release.

13 Extract the split collets, then slowly unscrew, release and remove the compressor.

14 Withdraw the upper retainer and the valve spring from the valve stem, then remove the valve from the underside of the cylinder head. Use a suitable screwdriver to prise free and remove the valve stem oil seal from the guide.

15 Remove the lower retainer.

16 Repeat the removal procedure with each of the remaining valve assemblies in turn. As they are removed, keep the valves and their associated components together, and in the originally-installed order, by placing them in a separate labelled bag **(see illustration 8.8).**

Zetec engine

17 Remove the camshafts and hydraulic tappets (Part C of this Chapter, Section 13), being careful to store the hydraulic tappets as described.

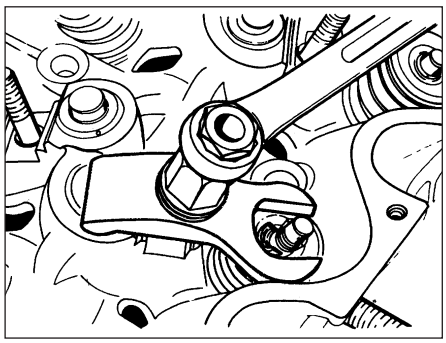
18 Remove the cylinder head (Part C of this Chapter, Section 14).

19 Using a valve spring compressor, compress each valve spring in turn until the split collets can be removed. A special valve spring compressor will be required, to reach into the deep wells in the cylinder head without risk of damaging the hydraulic tappet bores; such compressors are now widely available from most good motor accessory shops. Release the compressor, and lift off the spring upper seat and spring **(see illustrations)**.

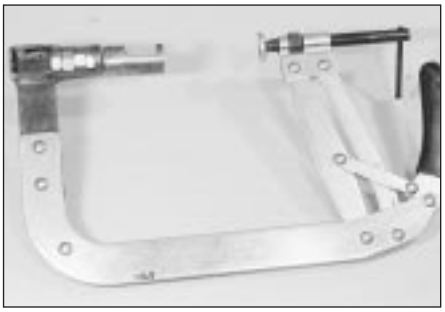
20 If, when the valve spring compressor is screwed down, the spring upper seat refuses to free and expose the split collets, gently tap the top of the tool, directly over the upper seat, with a light hammer. This will free the seat.

8.7 Prise off the valve stem oil seal

8.8 Use a labelled plastic bag to store and identify valve components



8.11 Compressing a valve spring using a forked type compressor



8.19A Standard valve spring compressor modified as shown . . .

8.19B . . . or purpose-built special version, is required to compress valve springs without damaging cylinder head . . .

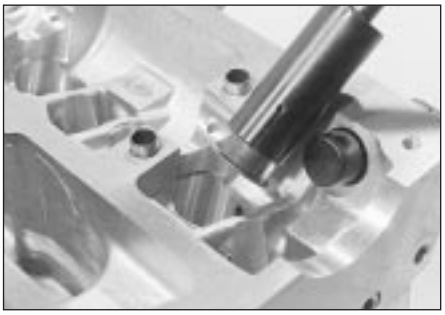
8.19C . . . so that both valve split collets can be removed from the valve's stem - small magnetic pick-up tool prevents loss of small metal components on removal and refitting

21 Withdraw the valve through the combustion chamber. If it binds in the guide (won't pull through), push it back in, and deburr the area around the collet groove with a fine file or whetstone; take care not to mark the hydraulic tappet bores.

22 Ford recommend the use of their service tool 21-160 to extract the valve spring lower seat/stem oil seals; while this is almost indispensable if the seals are to be removed without risk of (extremely expensive) damage to the cylinder head, we found that a serviceable substitute can be made from a strong spring of suitable size. Screw on the tool or spring so that it bites into the seal, then draw the seal off the valve guide **(see illustrations)**.

23 It is essential that the valves are kept together with their collets, spring seats and springs, and 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 them in a labelled polythene bag or similar small container **(see illustration 8.8).** Note that No 1 valve is nearest to the timing belt end of the engine.

24 If the oil-retaining valve is to be removed (to flush out the cylinder head oil galleries thoroughly), seek the advice of a Ford dealer as to how it can be extracted; it may be that the only course of action involves destroying the valve as follows. Screw a self-tapping screw into its ventilation hole, and use the screw to provide purchase with which the valve can be drawn out; a new valve must be purchased and pressed into place on reassembly **(see illustration)**.



8.22A Ford service tool in use to remove valve spring lower seat/stem oil seals . . .

8.22B . . . can be replaced by home-made tool if suitable spring can be found

8.24 Cylinder head oil-retaining valve (arrowed)

9 Cylinder head and valve components - cleaning and inspection

Note: *Always check first what replacement parts are available before planning any overhaul operation; refer to Section 1. A Ford dealer, or a good engine reconditioning specialist/automotive parts supplier, may be able to suggest alternatives which will enable you to overcome the lack of replacement parts.*

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, and to check carefully for signs of this.*

Cleaning

2 Scrape away all traces of old gasket material and sealing compound 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.

4 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.

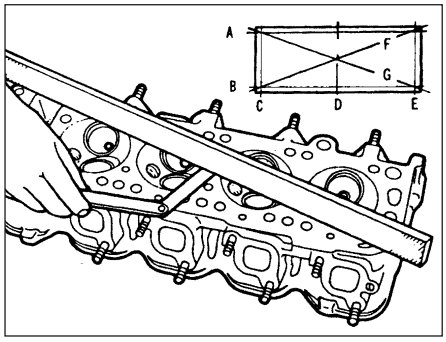
Inspection

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.*

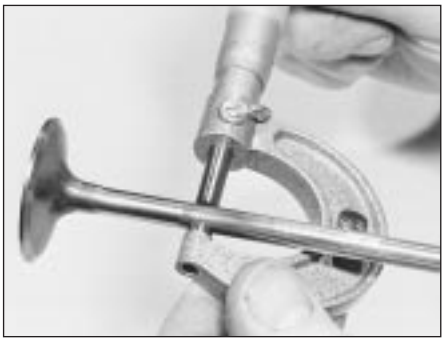
Cylinder head

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.

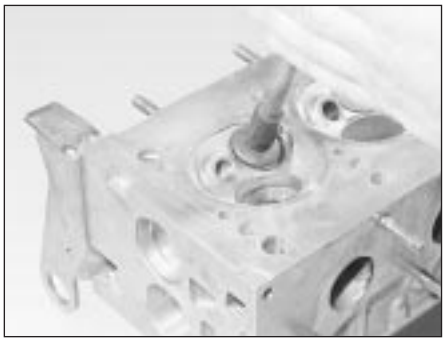
6 Use a straight edge and feeler blade to check that the cylinder head gasket surface is not distorted **(see illustration)**. If it is, it may be possible to re-surface it.



9.6 Check the cylinder head gasket surfaces for warpage, in the planes indicated (A to G). Try to slip a feeler gauge under the precision straight edge (see the Specifications for the maximum distortion allowed, and use a feeler blade of that thickness)



9.12 Measuring the diameter of a valve stem - if any significant difference is found in the readings obtained, excessive valve stem wear is indicated



9.15 Grinding-in a valve seat - do not grind in the valves any more than absolutely necessary, or their seats will be prematurely sunk into the cylinder head

7 Examine the valve seats in each of the combustion chambers. If they are severely pitted, cracked or burned, then 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 If the valve guides are worn, indicated by a side-to-side motion of the valve, new guides must be fitted. Measure the diameter of the existing valve stems (see below) and the bore of the guides, then calculate the clearance, and compare the result with the specified value; if the clearance is excessive, renew the valves or guides as necessary.

9 The renewal of valve guides is best carried out by an engine overhaul specialist.

10 If the valve seats are to be re-cut, this must be done *only after* the guides have been renewed.

Valves

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

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, is required.

14 Valve grinding is carried out as follows. Place the cylinder head upside-down on a bench, with a block of wood at each end to give clearance for the valve stems.

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. With a semi-rotary action, grind the valve head to its seat, lifting the valve occasionally to redistribute the grinding compound **(see illustration)**. 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 reassembly of the cylinder head.

Valve components

18 Examine the valve springs for signs of damage and discolouration, and also measure their free length **(see illustration)**. If possible, compare each of the existing springs 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 set of new springs.

20 Check the spring upper seats and collets for obvious wear and cracks. Any questionable parts should be renewed, as extensive damage will occur if they fail during engine operation. Any damaged or excessively-worn parts must be renewed; the valve spring lower seat/stem oil seals must be renewed as a matter of course whenever they are disturbed.

21 Check the rocker gear components and hydraulic tappets as described in earlier parts of this Chapter according to engine type.

10 Cylinder head - reassembly

1 Before reassembling the cylinder head, ensure that it is perfectly clean, and no traces of grinding paste are left in the head or on the valves and guides. Use compressed air, if available, to blow out all the oil holes and passages.

2 Commence reassembly of the cylinder head by lubricating the valve stems and guides with clean engine oil.

HCS engine

3 Insert the first valve into its guide. Wipe the oil from the top of the valve stem, then wind some insulation tape over the split collet location groove, to protect the new valve stem seal as it is fitted over the valve and into position. As the seal is fitted, support the valve to prevent it from falling out; push the seal down the valve, and locate it flush to the valve guide. Press the seal down firmly and evenly using a suitable diameter tube or socket, and take care not to distort the seal as it is located. Check that the seal spring is correctly located to ensure that it seals correctly, then remove the tape from the valve stem **(see illustrations)**.

4 Locate the valve spring and its retainer over the valve stem, and engage the valve spring

9.18 Checking the valve spring free length

10.3A Tape the end of the valve stem before fitting the valve stem seal

10.3B Press the seal into position using a suitable socket

10.7 Fit the lower retainer

10.8 Locate the seal, and tap it into position over the guide

compressor. Compress the spring and retainer just enough to allow the split collets to be inserted in the location groove in the valve stem. Holding the collets in position, slowly release and remove the valve spring compressor.

> **HAYNES HiNT** ***A little grease applied to the collet groove will help retain them in position.***

5 Repeat the operation on the remaining valves, ensuring that each valve is fitted in its appropriate location.

6 On completion, support the cylinder head on a suitable piece of wood, and lightly strike the end of each valve stem in turn with a plastic- or copper-faced hammer to fractionally open the valve and seat the valve components.

10.9 Insert the valve . . .

CVH engine

7 Working on one valve at a time, fit the lower retainer into position **(see illustration)**.

8 Check for correct orientation, then fit the new oil seal into position over the guide. Drive or press the seal squarely into place, using a suitable tube or socket **(see illustration)**.

9 To protect the seal lips from being damaged by the collet grooves in the valve stem as it is passed through the seal, wipe any oil from the stem at the top, and mask the split collet groove on the stem with insulating tape. Lubricate the lips of the valve stem seal, and insert the valve **(see illustration)**.

10 Remove the tape from the grooved section of the valve stem, then locate the spring and the upper retainer over the valve **(see illustrations)**.

11 Locate the valve spring compressor into position, and compress the spring and cup down the valve stem so that the collet's groove is exposed above the upper retainer. Lightly grease the collet's groove in the stem, (to retain the collets in position) then locate the split collets into the groove in the stem. Slowly release and remove the valve spring compressor. As the compressor is released, ensure that the collets remain fully seated in the groove, and the upper retainer rides up over them to secure them in position **(see illustration)**.

12 Repeat the above operations on the remaining valves, ensuring that each valve assembly is returned to its original position, or where new valves have been fitted, onto the seat to which it was ground.

13 When all of the valves have been fitted, support the cylinder head on a wooden block, and using a plastic or copper-faced hammer, lightly tap the end of each valve stem in turn to seat the respective valve assemblies.

14 Refit the camshaft, tappets and rocker arms to the cylinder head as described in Section 13 of Part B.

Zetec engine

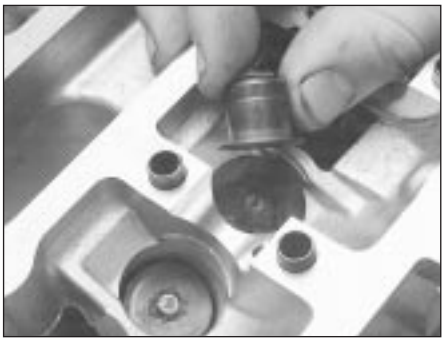
15 Beginning at one end of the head, lubricate and install the first valve. Apply molybdenum disulphide-based grease or clean engine oil to the valve stem, and refit the valve. Where the original valves are being re-used, ensure that each is refitted in its original guide. If new valves are being fitted, insert them into the locations to which they have been ground.

16 Fit the plastic protector supplied with new valve spring lower seat/stem oil seals to the end of the valve stem, then put the new seal squarely on top of the guide, and leave it there; the action of refitting the valve spring

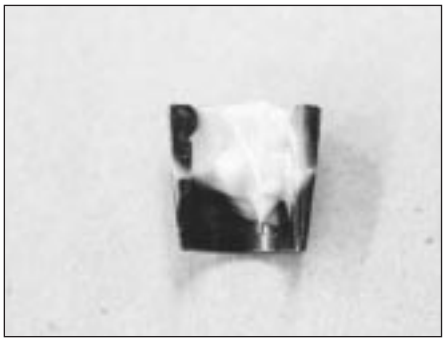
10.10A Fit the spring . . .

10.10B . . . and the retainer

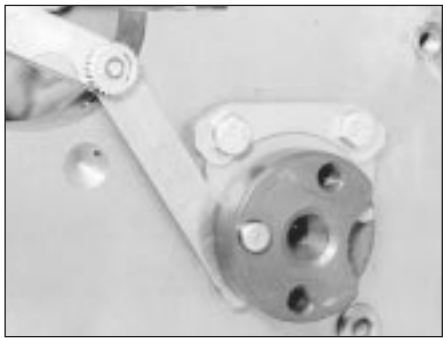
10.11 Insert the split collets into the groove in the valve stem



10.16 Valve spring pressure is sufficient to seat lower seat/stem oil seals on reassembly



10.18 Apply a small dab of grease to each collet before installation - it will hold them in place on the valve stem until the spring is released



11.5 Checking the camshaft endfloat

presses the lower seat/stem oil seal into place **(see illustration)**.

17 Refit the valve spring and upper seat.

18 Compress the spring with a valve spring compressor, and carefully install the collets in the stem groove. Apply a small dab of grease to each collet to hold it in place if necessary **(see illustration)**. Slowly release the compressor, and make sure the collets seat properly.

19 When the valve is installed, place the cylinder head flat on the bench and, using a hammer and interposed block of wood, tap the end of the valve stem gently, to settle the components.

20 Repeat the procedure for the remaining valves. Be sure to return the components to their original locations - don't mix them up!

21 Refit the hydraulic tappets (Part C of this Chapter, Section 13).

11 Camshaft and tappets - removal, inspection and refitting (HCS engine)

Removal

1 Remove the cylinder head as described in Part A, Section 10.

2 Remove the timing chain and the camshaft sprocket as described in Part A, Section 13.

3 Remove the sump as described in Part A, Section 14.

4 Invert the engine so that it is supported on its cylinder head face (on a clean work area). This is necessary to make all of the tappets slide to the top of their stroke, thus allowing the camshaft to be withdrawn. Rotate the camshaft through a full turn, to ensure that all of the tappets slide up their bores, clear of the camshaft.

5 Before removing the camshaft, check its endfloat using a dial gauge mounted on the front face of the engine or feeler gauges. Pull the camshaft fully towards the front (timing case) end of the engine, then insert feeler gauges between the camshaft sprocket flange and the camshaft thrust plate to assess the endfloat clearance **(see illustration)**. The camshaft endfloat must be as specified.

6 Undo the two retaining bolts, and remove the camshaft thrust plate.

7 Carefully withdraw the camshaft from the front end of the engine **(see illustration)**.

8 Extract each tappet in turn. Keep them in order of fitting by inserting them in a card with eight holes in it, numbered 1 to 8 (from the timing case end of the engine). A valve grinding tool will be found to be useful for the removal of tappets **(see illustration)**.

Inspection

9 Examine the camshaft bearing journals and lobes for damage or excessive wear. If evident, the camshaft must be renewed.

10 Examine the camshaft bearing internal diameters for signs of damage or excessive wear. If evident, the bearings must be renewed by a Ford dealer.

11 If not carried out on removal, check the camshaft endfloat as described in paragraph 5. If the endfloat is exceeds the specified tolerance, renew the thrust plate.

12 It is seldom that the tappets wear excessively in their bores, but it is likely that after a high mileage, the cam lobe contact surfaces will show signs of depression or grooving.

13 Where this condition is evident, renew the tappets. Grinding out the grooves and wear marks will reduce the thickness of the surface hardening, and will accelerate further wear.

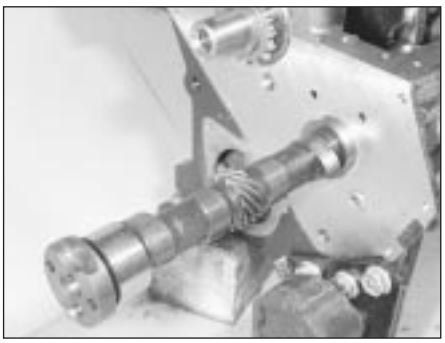
Refitting

14 To refit the tappets and the camshaft, it is essential that the crankcase is inverted.

15 Lubricate their bores and the tappets. Insert each tappet fully into its original bore in the cylinder block.

16 Lubricate the camshaft bearings, camshaft and thrust plate, then insert the camshaft into the crankcase from the timing case end.

17 Fit the thrust plate and tighten the retaining bolts to the specified torque setting **(see illustration)**. Check that the camshaft is able to rotate freely, and that the endfloat is as specified.



11.7 Withdrawing the camshaft from the front of the engine

11.8 Tappet withdrawal using a valve grinding tool suction cup

11.17 Refitting the camshaft thrust plate

12 Piston/connecting rod assemblies - removal

Note: *Always check first what replacement parts are available before planning any overhaul operation; refer to Section 1. A Ford dealer, or a good engine reconditioning specialist/automotive parts supplier, may be able to suggest alternatives which will enable you to overcome the lack of replacement parts.*

HCS engine

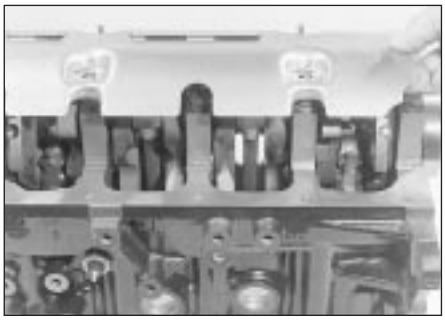
1 Remove the cylinder head as described in Part A, Section 10.
2 Remove the sump as described in Part A, Section 14, then remove the oil pick-up pipe and strainer.
3 Temporarily refit the crankshaft pulley, so that the crankshaft can be rotated. Check that the connecting rod big-end caps have adjacent matching numbers facing towards the camshaft side of the engine. If no marks can be seen, make your own before disturbing any of the components, so that you can be certain of refitting each piston/connecting rod assembly the right way round, to its correct (original) bore, with the cap also the right way round.

CVH engine

4 Remove the cylinder head as described in Part B, Section 14.
5 Remove the sump as described in Part B, Section 15, then remove the oil pick-up pipe and strainer.
6 Temporarily refit the crankshaft pulley, so that the crankshaft can be rotated. Check that the connecting rods have identification numbers - these should be found on the exhaust side of the big-ends. No 1 assembly is at the timing belt end of the engine. If no marks can be seen, make your own before disturbing any of the components, so that you can be certain of refitting each piston/connecting rod assembly the right way round, to its correct (original) bore, with the cap also the right way round.

Zetec engine

Note: *While this task is theoretically possible when the engine is in place in the vehicle, in practice, it requires so much preliminary dismantling, and is so difficult to carry out due to the restricted access, that owners are advised to remove the engine from the vehicle first. In addition to the new gaskets and other replacement parts required, a hoist will be needed. Alternatively, an adjustable engine support bar, fitting into the water drain channels on each side of the bonnet aperture, and having a hook which will engage the engine lifting eyes and allow the height of the engine to be adjusted, could be used. Lifting equipment such as this can be hired from most tool hire shops - be sure that any such equipment is rated well in excess of the combined weight of the engine/transmission unit.*

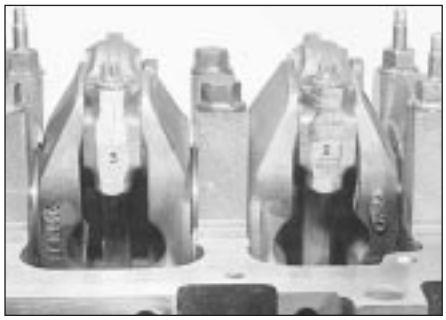


12.10 Removing the oil baffle to provide access to crankshaft and bearings

7 Remove the cylinder head as described in Part C, Section 14.
8 Bolt lifting eyes to suitable points on the engine and transmission, then attach the lifting equipment so that the engine/transmission unit is supported securely.
9 Remove the sump as described in Part C, Section 15.
10 Undo the screws securing the oil pump pick-up/strainer pipe to the pump, then unscrew the four nuts, and withdraw the oil pump pick-up/strainer pipe and oil baffle **(see illustration)**.
11 Temporarily refit the crankshaft pulley, so that the crankshaft can be rotated. Note that each piston/connecting rod assembly can be identified by its cylinder number (counting from the timing belt end of the engine) etched into the flat-machined surface of both the connecting rod and its cap. The numbers are visible from the front (exhaust side) of the engine **(see illustration)**. Furthermore, each piston has an arrow stamped into its crown, pointing towards the timing belt end of the engine. If no marks can be seen, make your own before disturbing any of the components, so that you can be certain of refitting each piston/connecting rod assembly the right way round, to its correct (original) bore, with the cap also the right way round.

All engines

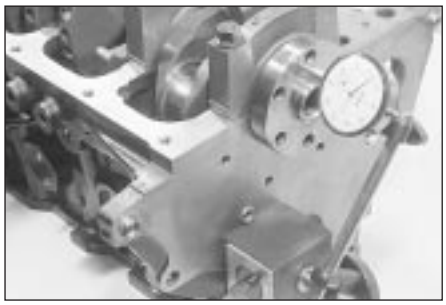
12 Use your fingernail to feel if a ridge has formed at the upper limit of ring travel (about a quarter-inch down from the top of each cylinder). If carbon deposits or cylinder wear have produced ridges, they must be completely removed with a special tool. Follow the tool manufacturer's instructions provided. Failure to remove the ridges before attempting to remove the piston/connecting rod assemblies may result in piston ring breakage.
13 Slacken each of the big-end bearing cap bolts half a turn at a time, until they can be removed by hand. Remove the No 1 cap and bearing shell. Don't drop the shell out of the cap.
14 Remove the upper bearing shell, and push the connecting rod/piston assembly out through the top of the engine. Use a wooden hammer handle to push on the connecting rod's bearing recess. If resistance is felt, double-check that all of the ridge was removed from the cylinder.
15 Repeat the procedure for the remaining cylinders.
16 After removal, reassemble the big-end bearing caps and shells on their respective connecting rods, and refit the bolts finger-tight. Leaving the old shells in place until reassembly will help prevent the bearing recesses from being accidentally nicked or gouged. New shells should be used on reassembly.



12.11 Each connecting rod and big-end bearing cap will have a flat-machined surface visible from the front (exhaust) side of the engine, with the cylinder number etched in it

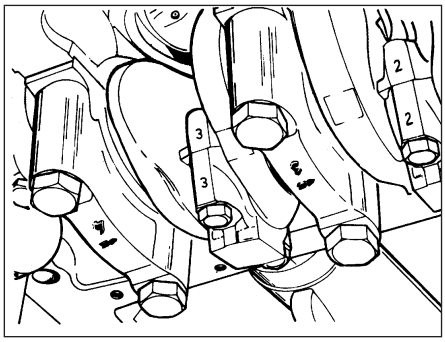
13 Crankshaft - removal

Note: *The crankshaft can be removed only after the engine has been removed from the vehicle. It is assumed that the transmission, flywheel/driveplate, timing belt/chain, cylinder head, sump, oil pump pick-up/strainer, oil baffle, oil pump, and piston/connecting rod assemblies, have already been removed. The crankshaft left-hand oil seal carrier/housing must be unbolted from the cylinder block/crankcase before proceeding with crankshaft removal.*
1 Before the crankshaft is removed, check the endfloat. Mount a DTI (Dial Test Indicator, or dial gauge) with the stem in line with the crankshaft and just touching the crankshaft **(see illustration)**.

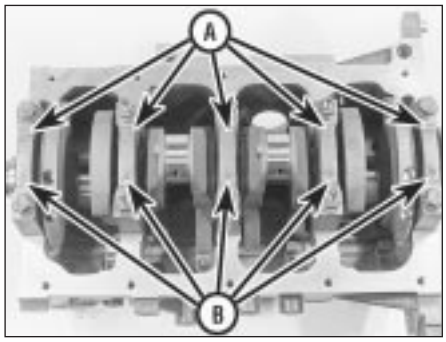


13.1 Checking crankshaft endfloat with a dial gauge

13.3 Checking crankshaft endfloat with a feeler gauge



13.4 Connecting rod big-end bearing cap and main bearing cap markings



13.12 Before unbolting crankshaft main bearing caps, note arrows pointing to timing belt end of engine (A), and bearing numbers (B) consecutive from timing belt end

2 Push the crankshaft fully away from the gauge, and zero it. Next, lever the crankshaft towards the gauge as far as possible, and check the reading obtained. The distance that the crankshaft moved is its endfloat; if it is greater than specified, check the crankshaft thrust surfaces for wear. If no wear is evident, new thrustwashers should correct the endfloat.
3 If no dial gauge is available, feeler gauges can be used. Gently lever or push the crankshaft all the way towards the right-hand end of the engine. Slip feeler gauges between the crankshaft and the main bearing incorporating the thrustwashers to determine the clearance **(see illustration)**.

HCS engine

4 Check that the main bearing caps have marks to indicate their respective fitted positions in the block. They also have arrow marks pointing towards the timing chain cover end of the engine to indicate correct orientation **(see illustration)**.
5 Unscrew the retaining bolts, and remove the main bearing caps. If the caps are reluctant to separate from the block face, lightly tap them free using a plastic- or copper-faced hammer. If the bearing shells are likely to be used again, keep them with their bearing caps for safekeeping. However, unless the engine is known to be of low mileage, it is recommended that they be renewed.
6 Lift the crankshaft out from the crankcase, then extract the upper bearing shells and side thrustwashers. Keep them with their respective caps for correct repositioning if they are to be used again.
7 Remove the crankshaft oil seals from the timing cover and the rear oil seal housing.

CVH engine

8 Check that each main bearing cap is numerically marked for position. Each cap should also have an arrow marking to indicate its direction of fitting (arrow points to the timing belt end).
9 Unscrew the retaining bolts, and remove the main bearing caps. As they are removed, keep each bearing shell with its cap (in case they are to used again). Note that the bearing shells in the main bearing caps are plain (no groove). It is recommended that the shells be renewed, unless the engine is known to be of low mileage.
10 Lift out the crankshaft from the crankcase.
11 Remove each bearing shell in turn from the crankcase, and keep them in order of fitting. Note that the upper shell halves are grooved. Also remove the semi-circular thrustwasher from each side of the central main bearing web, and keep them in their order of fitting.

Zetec engine

12 Check the main bearing caps, to see if they are marked to indicate their locations **(see illustration)**. They should be numbered consecutively from the timing belt end of the engine - if not, mark them with number-stamping dies or a centre-punch. The caps will also have an embossed arrow pointing to the timing belt end of the engine. Noting the different fasteners (for the oil baffle nuts) used on caps 2 and 4, slacken the cap bolts a quarter-turn at a time each, starting with the left- and right-hand end caps and working toward the centre, until they can be removed by hand.
13 Gently tap the caps with a soft-faced hammer, then separate them from the cylinder block/crankcase. If necessary, use the bolts as levers to remove the caps. Try not to drop the bearing shells if they come out with the caps.
14 Carefully lift the crankshaft out of the engine.
15 Remove each bearing shell in turn from the cylinder block/crankcase, and keep them in order of fitting.

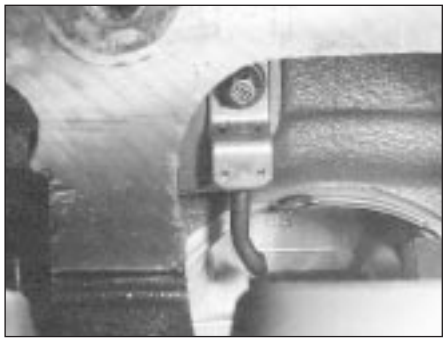
14.1A Unbolt blanking plugs (where fitted) to clean out oilways . . .

14 Cylinder block/crankcase - cleaning and inspection

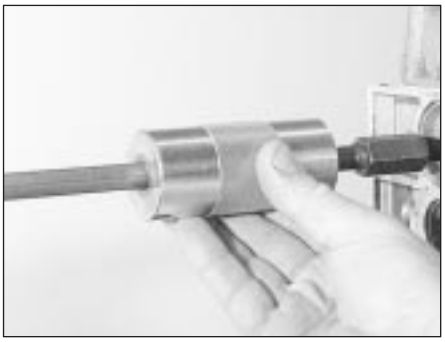
Note: *Always check first what replacement parts are available before planning any overhaul operation; refer to Section 1. A Ford dealer, or a good engine reconditioning specialist/automotive parts supplier, may be able to suggest alternatives which will enable you to overcome the lack of replacement parts.*

Cleaning

1 Prior to cleaning, remove all external components and senders. On the HCS engine, make sure that the camshaft and tappets are removed before carrying out thorough cleaning of the block (see Section 11). On the CVH engine, remove the engine ventilation cap from the recess in the rear corner of the cylinder block and if still fitted, undo the retaining screw and withdraw the engine speed sensor from the bellhousing face. On the Zetec engine, unbolt the piston-cooling oil jets or blanking plugs (as applicable); note that Ford state that the piston-cooling oil jets (where fitted) must be renewed whenever the engine is dismantled for full overhaul **(see illustrations)**.
2 Remove all oil gallery plugs (where fitted). The plugs are usually very tight - they may

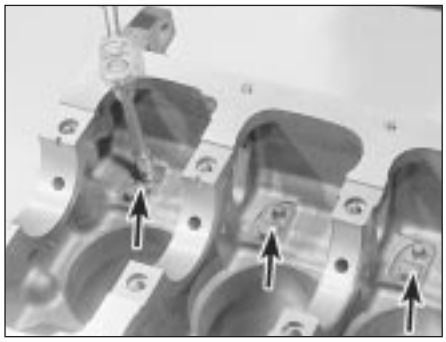


14.1B . . . but note that piston-cooling oil jets (where fitted) must be renewed as a matter of course whenever engine is overhauled - Zetec engine



14.2 The core plugs should be removed with a puller - if they're driven into the block, they may be impossible to retrieve

14.6 All bolt holes in the block - particularly the main bearing cap and head bolt holes - should be cleaned and restored with a tap (be sure to remove debris from the holes after this is done)



14.8 Do not forget to refit all components - such as oilway blanking plugs (three of four arrowed) - tighten fasteners to torque wrench settings specified

have to be drilled out, and the holes re-tapped. Use new plugs when the engine is reassembled. Drill a small hole in the centre of each core plug, and pull them out with a car bodywork dent puller **(see illustration)**.

Caution: The core plugs (also known as freeze or soft plugs) may be difficult or impossible to retrieve if they are driven into the block coolant passages.

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

4 After the castings are returned from steam-cleaning, clean all oil holes and oil galleries one more time. Flush all internal passages with warm water until the water runs clear, then dry thoroughly, and apply a light film of oil to all machined surfaces, to prevent rusting. If you have access to compressed air, use it to speed the drying process, and to blow out all the oil holes and galleries.

Warning: Wear eye protection when using compressed air!

5 If the castings are not very dirty, you can do an adequate cleaning job with hot soapy water (as hot as you can stand!) 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 completely; protect the machined surfaces as described above, to prevent rusting.

6 All threaded holes must be clean and dry, to ensure accurate torque readings during reassembly; now is also a good time to clean and check the threads of all principal bolts - however, note that some, such as the cylinder head and flywheel/driveplate bolts, are to be renewed as a matter of course whenever they are disturbed. Run the proper-size tap into each of the holes, to remove rust, corrosion, thread sealant or sludge, and to restore damaged threads **(see illustration)**. If possible, use compressed air to clear the holes of debris produced by this operation; a good alternative is to inject aerosol-applied water-dispersant lubricant into each hole, using the long spout usually supplied.

Warning: Wear eye protection when cleaning out these holes in this way, and be sure to dry out any excess liquid left in the holes.

7 When all inspection and repair procedures are complete (see below) and the block is ready for reassembly, apply suitable sealant to the new oil gallery plugs, and insert them into the holes in the block. Tighten them securely. After coating the sealing surfaces of the new core plugs with suitable sealant, install them in the cylinder block/crankcase. Make sure they are driven in straight and seated properly, or leakage could result. Special tools are available for this purpose, but a large socket with an outside diameter that will just slip into the core plug, used with an extension and hammer, will work just as well.

8 On the Zetec engine, refit the blanking plugs or (new) piston-cooling oil jets (as applicable), tightening their Torx screws to the torque wrench setting specified **(see illustration)**. On all engines, refit all other external components removed, referring to the relevant Chapter of this manual for further details where required. Refit the main bearing caps, and tighten the bolts finger-tight.

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

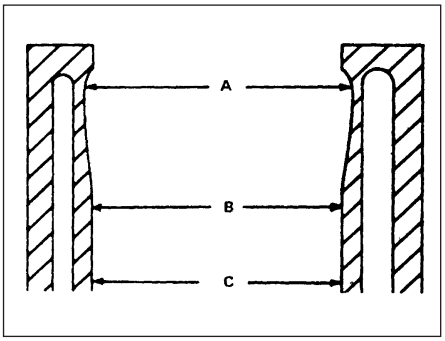
Inspection

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

11 Check each cylinder bore for scuffing and scoring.

12 The cylinder bores must be measured with all the crankshaft main bearing caps bolted in place (without the crankshaft and bearing shells), and tightened to the specified torque wrench settings. Measure the diameter of each cylinder at the top (just under the ridge area), centre and bottom of the cylinder bore, parallel to the crankshaft axis. Next, measure each cylinder's diameter at the same three locations across the crankshaft axis **(see illustrations)**. Note the measurements obtained.

13 Measure the piston diameter at right-angles to the gudgeon pin axis, just above the bottom of the skirt; again, note the results **(see illustration)**.



14.12 Measure the diameter of each cylinder just under the wear ridge (A), at the centre (B) and at the bottom (C)

14.13 Measure the piston skirt diameter at right-angles to the gudgeon pin axis, just above the base of the skirt

14 If it is wished to obtain the piston-to-bore clearance, measure the bore and piston skirt as described above, and subtract the skirt diameter from the bore measurement. If the precision measuring tools shown are not available, the condition of the pistons and bores can be assessed, though not quite as accurately, by using feeler gauges as follows. Select a feeler gauge of thickness equal to the specified piston-to-bore clearance, and slip it into the cylinder along with the matching piston. The piston must be positioned exactly as it normally would be. The feeler gauge must be between the piston and cylinder on one of the thrust faces (at right-angles to the gudgeon pin bore). The piston should slip through the cylinder (with the feeler gauge in place) with moderate pressure; if it falls through or slides through easily, the clearance is excessive, and a new piston will be required. If the piston binds at the lower end of the cylinder, and is loose toward the top, the cylinder is tapered. If tight spots are encountered as the piston/feeler gauge is rotated in the cylinder, the cylinder is out-of-round (oval).

15 Repeat these procedures for the remaining pistons and cylinder bores.

16 Compare the results with the Specifications at the beginning of this Chapter; if any measurement is beyond the dimensions specified for that class (check the piston crown marking to establish the class of piston fitted), or if any bore measurement is significantly different from the others (indicating that the bore is tapered or oval), the piston or bore is excessively-worn.

17 Worn pistons must be renewed; on some engines, the pistons are available as Ford replacement parts only as part of the complete piston/connecting rod assembly. See a Ford dealer or engine reconditioning specialist for advice.

18 If any of the cylinder bores are badly scuffed or scored, or if they are excessively-worn, out-of-round or tapered, the usual course of action would be to have the cylinder block/crankcase rebored, and to fit new, oversized, pistons on reassembly. See a Ford dealer or engine reconditioning specialist for advice.

19 If the bores are in reasonably good condition and not excessively-worn, then it may only be necessary to renew the piston rings.

20 If this is the case, the bores should be honed, to allow the new rings to bed in correctly and provide the best possible seal; before honing the bores, refit the main bearing caps (without the bearing shells), and tighten the bolts to the specified torque wrench setting. **Note:** *If you don't have the tools, or don't want to tackle the honing operation, most engine reconditioning specialists will do it for a reasonable fee.*

21 Two types of cylinder hones are commonly available - the flex hone or "bottle-brush" type, and the more traditional surfacing hone with spring-loaded stones. Both will do the job, and are used with a power drill, but for the less-experienced mechanic, the "bottle-brush" hone will probably be easier to use. You will also need some paraffin or honing oil, and rags. Proceed as follows:

a) Mount the hone in the drill, compress the stones, and slip it into the first bore. Be sure to wear safety goggles or a face shield!

*b) Lubricate the bore with plenty of honing oil, switch on the drill, and move the hone up and down the bore, at a pace that will produce a fine cross-hatch pattern on the cylinder walls. Ideally, the cross-hatch lines should intersect at approximately a 60º angle **(see illustration)**. Be sure to use plenty of lubricant, and don't take off any more material than is absolutely necessary to produce the desired finish. **Note:** Piston ring manufacturers may specify a different cross-hatch angle - read and follow any instructions included with the new rings.*

c) Don't withdraw the hone from the bore while it's running. Instead, switch off the drill, and continue moving the hone up and down the bore until it comes to a complete stop, then compress the stones and withdraw the hone. If you're using a "bottle-brush" hone, switch off the drill, then turn the chuck in the normal direction of rotation while withdrawing the hone from the bore.

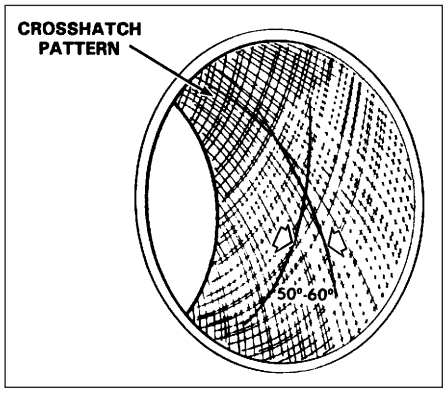
d) Wipe the oil out of the bore, and repeat the procedure for the remaining cylinders.

e) When all the cylinder bores are honed, chamfer the top edges of the bores with a small file, so the rings won't catch when the pistons are installed. Be very careful not to nick the cylinder walls with the end of the file.

*f) The entire cylinder block/crankcase must be washed very thoroughly with warm, soapy water, to remove all traces of the abrasive grit produced during the honing operation. **Note:** The bores can be considered clean when a lint-free white cloth - dampened with clean engine oil - used to wipe them out doesn't pick up any more honing residue, which will show up as grey areas on the cloth. Be sure to run a brush through all oil holes and galleries, and flush them with running water.*

g) When the cylinder block/crankcase is completely clean, rinse it thoroughly and dry it, then lightly oil all exposed machined surfaces, to prevent rusting.

22 The cylinder block/crankcase should now be completely clean and dry, with all components checked for wear or damage, and repaired or overhauled as necessary. Refit as many ancillary components as possible, for safekeeping (see paragraphs 7 and 8 above). If reassembly is not to start immediately, cover the block with a large plastic bag to keep it clean, and protect the machined surfaces as described above to prevent rusting.



14.21 The cylinder hone should leave a smooth, cross-hatch pattern with the lines intersecting at approximately a 60º angle

15 Piston/connecting rod assemblies - inspection

Note: *Always check first what replacement parts are available before planning any overhaul operation; refer to Section 1. A Ford dealer, or a good engine reconditioning specialist/automotive parts supplier, may be able to suggest alternatives which will enable you to overcome the lack of replacement parts.*

1 Before the inspection process can be carried out, the piston/connecting rod assemblies must be cleaned, and the original piston rings removed from the pistons. The rings should have smooth, polished working surfaces, with no dull or carbon-coated sections (showing that the ring is not sealing correctly against the bore wall, so allowing combustion gases to blow by) and no traces of wear on their top and bottom surfaces. The end gaps should be clear of carbon, but not polished (indicating a too-small end gap), and all the rings (including the elements of the oil control ring) should be free to rotate in their grooves, but without excessive up-and-down movement. If the rings appear to be in good condition, they are probably fit for further use; check the end gaps (in an unworn part of the bore) as described in Section 19. If any of the rings appears to be worn or damaged, or has an end gap significantly different from the specified value, the usual course of action is to renew all of them as a set. **Note:** *While it is usual always to renew piston rings when an engine is overhauled, this of course assumes that rings are available separately - if not, it follows that great care must be taken not to break or damage any of the rings during the following procedures, and to ensure that each ring is marked on removal so that it is refitted **only** the original way up, and **only** to the same groove.*

15.2 Using feeler gauge blades to remove piston rings

15.12 Check that the connecting rod oilway on CVH engines is clear

2 Using a piston ring installation tool, carefully remove the rings from the pistons. If such a tool is not available, the rings can be removed by hand, expanding them 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 nick or gouge the pistons in the process, and mark or label each ring as it is removed, so that its original top surface can be identified on reassembly, and so that it can be returned to its original groove. Take care also with your hands - piston rings are sharp!

3 Scrape 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. *Do not*, under any circumstances, use a wire brush mounted in a drill motor to remove deposits from the pistons - the piston material is soft, and may be eroded away by the wire brush.

4 Use a piston ring groove-cleaning tool to remove carbon deposits from the ring grooves. If a tool isn't available, but replacement rings have been found, a piece broken off the old ring will do the job. Be very careful to remove only the carbon deposits - don't remove any metal, and do not nick or scratch the sides of the ring grooves. Protect your fingers - piston rings are sharp!

5 Once the deposits have been removed, clean the piston/rod assemblies with solvent, and dry them with compressed air (if available). Make sure that the oil return holes in the back sides of the ring grooves, and the oil hole in the lower end of each rod, are clear.

6 If the pistons and cylinder walls aren't damaged or worn excessively - refer to Section 14 for details of inspection and measurement procedures - and if the cylinder block/crankcase is not rebored, new pistons won't be necessary. Normal piston wear appears as even vertical wear on the piston thrust surfaces, and slight looseness of the top ring in its groove.

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

8 Look for scoring and scuffing on the thrust faces of the 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. A hole in the piston crown is an indication that abnormal combustion (pre-ignition) was occurring. Burned areas at the edge of the piston crown are usually evidence of spark knock (detonation). If any of the above problems exist, the causes must be corrected, or the damage will occur again. The causes may include inlet air leaks, incorrect fuel/air mixture or incorrect ignition timing.

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

10 Check the piston-to-rod clearance by twisting the piston and rod in opposite directions. Any noticeable play indicates excessive wear, which must be corrected. The piston/connecting rod assemblies should be taken to a Ford dealer or engine reconditioning specialist to have the pistons, gudgeon pins and rods checked, and new components fitted as required.

11 *Don't* attempt to separate the pistons from the connecting rods (even if non-genuine replacements are found elsewhere). This is a task for a Ford dealer or similar engine reconditioning specialist, due to the special heating equipment, press, mandrels and supports required to do the job. If the piston/connecting rod assemblies do require this sort of work, have the connecting rods checked for bend and twist, since only such engine repair specialists will have the facilities for this purpose.

12 Check the connecting rods for cracks and other damage. Also on CVH engines, check that the oilway in the base of the connecting rod is clear by probing with a piece of wire **(see illustration)**. Temporarily remove the big-end bearing caps and the old bearing shells, wipe clean the rod and cap bearing recesses, and inspect them for nicks, gouges and scratches. After checking the rods, replace the old shells, slip the caps into place, and tighten the bolts finger-tight.

16 Crankshaft - inspection

Note: *Always check first what replacement parts are available before planning any overhaul operation; refer to Section 1. A Ford dealer, or a good engine reconditioning specialist/automotive parts supplier, may be able to suggest alternatives which will enable you to overcome the lack of replacement parts.*

1 Clean the crankshaft, and dry it 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.

2 Check the main and crankpin (big-end) bearing journals for uneven wear, scoring, pitting and cracking.

3 Rub a penny across each journal several times **(see illustration)**. If a journal picks up copper from the penny, it is too rough.

4 Remove all burrs from the crankshaft oil holes with a stone, file or scraper.

5 Using a micrometer, measure the diameter of the main bearing and crankpin (big-end) journals, and compare the results with the Specifications at the beginning of this Chapter **(see illustration)**.

16.3 Rubbing a penny lengthwise along each journal will reveal its condition - if copper rubs off and is embedded in the crankshaft, the journals should be reground

16.5 Measure the diameter of each crankshaft journal at several points, to detect taper and out-of-round conditions

6 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.

7 If the crankshaft journals are damaged, tapered, out-of-round, or worn beyond the limits specified in this Chapter, the crankshaft must be taken to an engine overhaul specialist, who will regrind it, and who can supply the necessary undersize bearing shells.

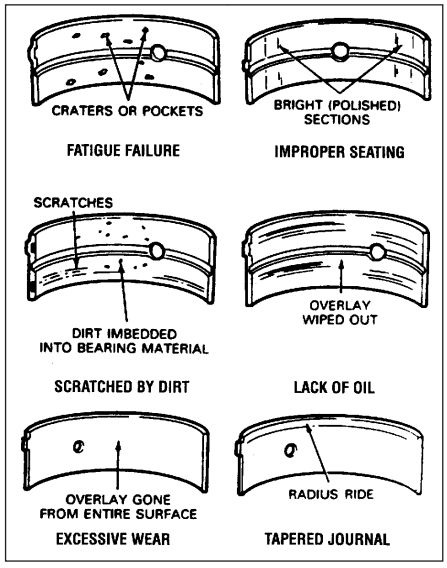
8 Check the oil seal journals at each end of the crankshaft for wear and damage. If either seal has worn an excessive groove in its journal, consult an engine overhaul specialist, who will be able to advise whether a repair is possible, or whether a new crankshaft is necessary.

17 Main and big-end bearings - inspection

Note: *Always check first what replacement parts are available before planning any overhaul operation; refer to Section 1. A Ford dealer, or a good engine reconditioning specialist/automotive parts supplier, may be able to suggest alternatives which will enable you to overcome the lack of replacement parts.*

1 Even though the main and big-end bearing shells should be renewed during the engine overhaul, the old shells should be retained for close examination, as they may reveal valuable information about the condition of the engine **(see illustration)**.

2 Bearing failure occurs because of lack of lubrication, the presence of dirt or other foreign particles, overloading the engine, and corrosion. Regardless of the cause of bearing failure, it must be corrected before the engine is reassembled, to prevent it from happening again.



17.1 When inspecting the main and big-end bearings, look for these problems

3 When examining the bearing shells, remove them from the cylinder block/crankcase and main bearing caps, and from the connecting rods and the big-end bearing caps, then lay them out on a clean surface in the same general position as their location in the engine. This will enable you to match any bearing problems with the corresponding crankshaft journal. *Do not* touch any shell's bearing surface with your fingers while checking it, or the delicate surface may be scratched.

4 Dirt or 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 material, and will score or gouge the shell and journal. The best prevention for this cause of bearing failure is to clean all parts thoroughly, and to 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 inter-related 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 starve a bearing of oil, and destroy it. When lack of lubrication is the cause of bearing failure, the bearing material is wiped or extruded from the shell's steel backing. 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, which tends to squeeze out the oil film. These loads cause the shells 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. Short-distance driving leads to corrosion of bearings, because insufficient engine heat is produced to drive off 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.

7 Incorrect shell refitting during engine assembly will lead to bearing failure as well. Tight-fitting shells 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. *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.

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, jointing and thread locking compound will be needed during engine reassembly. For general-purpose applications, it is recommended that Loctite 275 setting sealer or Hylomar PL32M non-setting sealer be used for joints where required, and Loctite 270 for stud and bolt thread-locking. For specific applications on the Zetec engine, Hylosil 102 for the cylinder block/crankcase-to-sump/oil pump/oil seal carrier joints, and Loctite 518 for the camshaft right-hand bearing caps should be used. These are recommended by, and obtained from, Ford dealers. In all other cases, provided the relevant mating surfaces are clean and flat, new gaskets will be sufficient to ensure joints are oil-tight. *Do not* use any kind of silicone-based sealant on any part of the fuel system or inlet manifold, and *never* use exhaust sealants upstream of the catalytic converter.

2 In order to save time and avoid problems, engine reassembly can be carried out in the following order (as applicable).

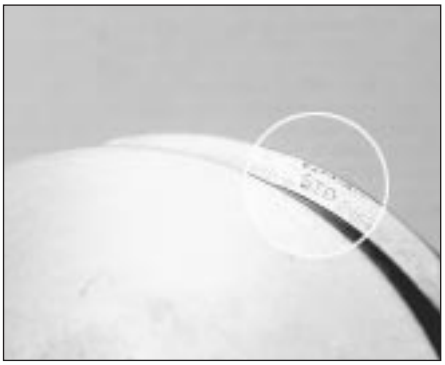
a) Engine ventilation cap (CVH engine).
b) Tappets and camshaft (HCS engine).
c) Crankshaft and main bearings.
d) Pistons and connecting rods.
e) Oil pump.
f) Sump.
g) Flywheel/driveplate.
h) Cylinder head.
i) Timing sprockets and chain/belt.
j) Engine external components.

3 Ensure that everything is clean prior to reassembly. As mentioned previously, dirt and metal particles can quickly destroy bearings and result in major engine damage. Use clean engine oil to lubricate during reassembly.

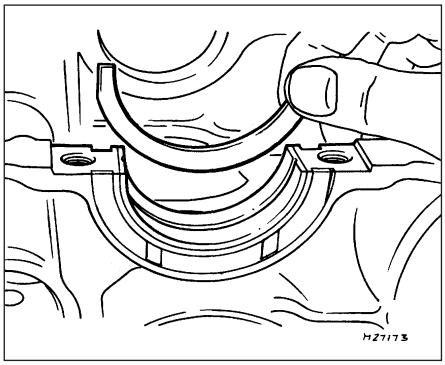
19 Piston rings - refitting

1 Before installing new piston rings, check the end gaps. Lay out each piston set with a piston/connecting rod assembly, and keep them together as a matched set from now on.
2 Insert the top compression ring into the first cylinder, and square it up with the cylinder walls by pushing it in with the top of the piston. The ring should be near the bottom of the cylinder, at the lower limit of ring travel.
3 To measure the end gap, slip feeler gauges between the ends of the ring, until a gauge equal to the gap width is found. The feeler gauge should slide between the ring ends with a slight amount of drag. Compare the measurement to the value given in the Specifications in this Chapter; if the gap is larger or smaller than specified, double-check to make sure you have the correct rings before proceeding. If you are assessing the condition of used rings, have the cylinder bores checked and measured by a Ford dealer or similar engine reconditioning specialist, so that you can be sure of exactly which component is worn, and seek advice as to the best course of action to take.
4 If the end gap is still too small, it must be opened up by careful filing of the ring ends using a fine file. If it is too large, this is not as serious, unless the specified limit is exceeded, in which case very careful checking is required of the dimensions of all components, as well as of the new parts.
5 Repeat the procedure for each ring that will be installed in the first cylinder, and for each ring in the remaining cylinders. Remember to keep rings, pistons and cylinders matched up.
6 Refit the piston rings as follows. Where the original rings are being refitted, use the marks or notes made on removal, to ensure that each ring is refitted to its original groove and the same way up. New rings generally have their top surfaces identified by markings (often an indication of size, such as "STD", or the word "TOP") - the rings must be fitted with such markings uppermost **(see illustration)**.
Note: *Always follow the instructions printed on the ring package or box - different manufacturers may require different approaches. Do not mix up the top and second compression rings, as they usually have different cross-sections.*
7 The oil control ring (lowest one on the piston) is usually installed first. It is composed of three separate elements. Slip the spacer/expander into the groove. If an anti-rotation tang is used, make sure it is inserted into the drilled hole in the ring groove. Next, install the lower side rail. Don't use a piston ring installation tool on the oil ring side rails, as they may be damaged. Instead, place one end of the side rail into the groove between the spacer/expander and the ring land, hold it firmly in place, and slide a finger around the piston while pushing the rail into the groove. Next, install the upper side rail in the same manner.
8 After the three oil ring components have been installed, check that both the upper and lower side rails can be turned smoothly in the ring groove.
9 The second compression (middle) ring is installed next, followed by the top compression ring - ensure their marks are uppermost, and be careful not to confuse them. Don't expand either ring any more than necessary to slide it over the top of the piston.
10 On the HCS engine, when all of the rings are fitted to each piston, arrange them so that the gaps are positioned as specified.
11 On the CVH engine, when all of the rings are fitted to each piston, arrange them so that the gaps are spaced at 120º intervals, with no gaps positioned above the gudgeon pin hole.
12 On the Zetec engine, when all the rings are fitted to each piston, space the ring gaps (including the elements of the oil control ring) uniformly around the piston at 120º intervals.

19.3 With the ring square in the bore, measure the end gap with a feeler gauge



19.6 Look for etched markings ("STD" - indicating a standard-sized ring - shown here) identifying piston ring top surface



20.5 Place the crankshaft thrustwashers into position in the crankcase so that their oil grooves are facing outwards

20 Crankshaft - refitting and main bearing running clearance check

1 It is assumed at this point that the cylinder block/crankcase and crankshaft have been cleaned, inspected and repaired or reconditioned as necessary. Position the engine upside-down.
2 Remove the main bearing cap bolts, and lift out the caps. Lay the caps out in the proper order, to ensure correct installation.
3 If they're still in place, remove the old bearing shells from the block and the main bearing caps. Wipe the bearing recesses of the block and caps with a clean, lint-free cloth. They must be kept spotlessly-clean!

Main bearing running clearance check

HCS engine

4 Wipe clean the main bearing shell seats in the crankcase, and clean the backs of the bearing shells. Insert the respective upper shells (dry) into position in the crankcase. Note that the upper shells have grooves in them (the lower shells are plain, and have a wider location lug). Where the old main bearings are being refitted, ensure that they are located in their original positions. Make sure that the tab on each bearing shell fits into the notch in the block or cap.

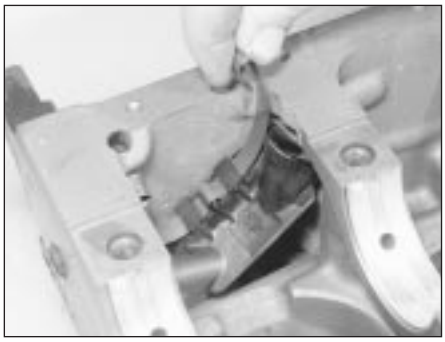
Caution: Don't hammer the shells into place, and don't nick or gouge the bearing faces. No lubrication should be used at this time.

5 Place the crankshaft thrustwashers into position in the crankcase, so that their oil grooves are facing outwards (away from the central web) **(see illustration)**.

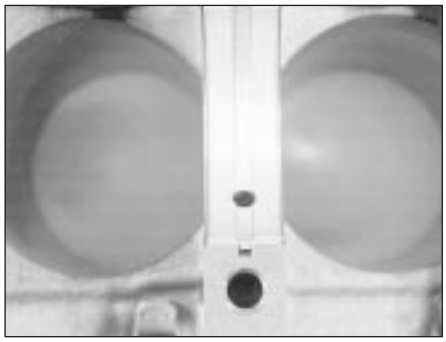
CVH engine

6 Wipe clean the main bearing shell seats in the crankcase, and clean the backs of the bearing shells. Insert the respective upper shells (dry) into position in the crankcase. Note that with the exception of the front main bearing, the upper shells have grooves in them (the lower half bearings are plain). The upper and lower front shells are narrower in section, and both have an oil groove in them. Where the old main bearings are being refitted, ensure that they are located in their

20.6 Fit the bearing shells to the main bearing housings in the crankcase



20.7 Fit the crankcase ventilation cap and its retaining spring



20.9 Tab on each bearing shell must engage with notch in block or cap, and oil holes in upper shells must align with block oilways

original positions **(see illustration)**. Make sure that the tab on each bearing shell fits into the notch in the block or cap.

Caution: Don't hammer the shells into place, and don't nick or gouge the bearing faces. No lubrication should be used at this time.

7 Relocate the crankcase ventilation cap and its retaining spring into position in the crankcase **(see illustration)**.

8 Place the crankshaft thrustwashers into position in the crankcase so that their oil grooves are facing outwards (away from the central web).

Zetec engine

9 Wipe clean the main bearing shell seats in the crankcase, and clean the backs of the new main bearing shells. Fit the shells with an oil groove in each main bearing location in the block; note the thrustwashers integral with the No 3 (centre) main bearing upper shell. Fit the other shell from each bearing set in the corresponding main bearing cap. Make sure the tab on each bearing shell fits into the notch in the block or cap. Also, the oil holes in the block must line up with the oil holes in the bearing shell **(see illustration)**.

Caution: Don't hammer the shells into place, and don't nick or gouge the bearing faces. No lubrication should be used at this time.

All engines

10 Clean the bearing surfaces of the shells in the block, and the crankshaft main bearing journals with a clean, lint-free cloth. Check or clean the oil holes in the crankshaft, as any dirt here can go only one way - straight through the new bearings.

11 Once you're certain the crankshaft is clean, carefully lay it in position in the main bearings. Trim several pieces of the appropriate-size Plastigage (they must be slightly shorter than the width of the main bearings), and place one piece on each crankshaft main bearing journal, parallel with the crankshaft centre-line **(see illustration)**.

12 Clean the bearing surfaces of the cap shells, and install the caps in their respective positions (don't mix them up) with the arrows pointing to the timing belt end of the engine **(see illustration)**. Don't disturb the Plastigage.

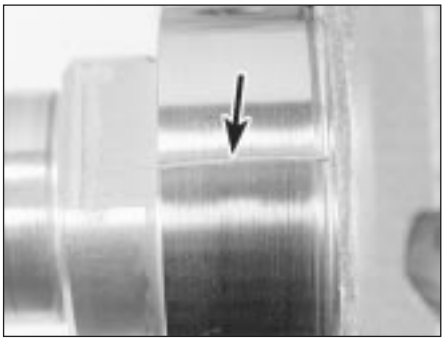
13 Working on one cap at a time, from the centre main bearing outwards (and ensuring that each cap is tightened down squarely and evenly onto the block), tighten the main bearing cap bolts to the specified torque wrench setting. Don't rotate the crankshaft at any time during this operation!

14 Remove the bolts, and carefully lift off the main bearing caps. Keep them in order. Don't disturb the Plastigage or rotate the crankshaft. If any of the main bearing caps are difficult to remove, tap them gently from side-to-side with a soft-faced mallet to loosen them.

15 Compare the width of the crushed Plastigage on each journal with the scale printed on the Plastigage envelope to obtain the main bearing running clearance **(see illustration)**. Check the Specifications to make sure that the clearance is correct.

16 If the clearance is not as specified, seek the advice of a Ford dealer or similar engine reconditioning specialist - if the crankshaft journals are in good condition (see Section 16), it may be possible simply to renew the shells to achieve the correct clearance. If this is not possible, the crankshaft must be reground by a specialist who can supply the necessary undersized shells. First though, make sure that no dirt or oil was between the bearing shells and the caps or block when the clearance was measured. If the Plastigage is noticeably wider at one end than the other, the journal may be tapered (see Section 16).

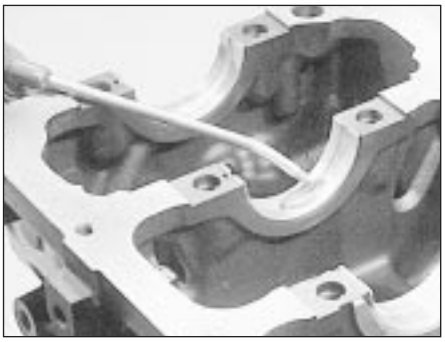
17 Carefully scrape all traces of the Plastigage material off the main bearing journals and the bearing surfaces. Be very careful not to scratch the bearing - use your fingernail or the edge of a credit card.



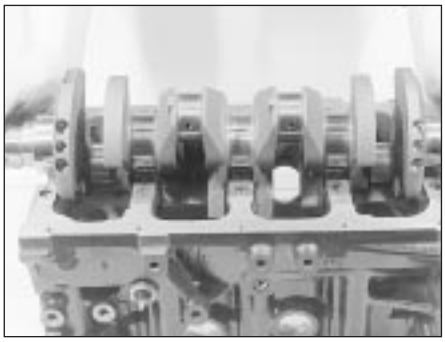
20.11 Lay the Plastigage strips (arrowed) on the main bearing journals, parallel to the crankshaft centre-line

20.12 Refit the main bearing caps and tighten the bolts as specified

20.15 Compare the width of the crushed Plastigage to the scale on the envelope to determine the main bearing oil clearance (always take the measurement at the widest point of the Plastigage). Be sure to use the correct scale; Imperial and metric scales are included



20.18 Ensure bearing shells are absolutely clean, lubricate liberally . . .



20.20 . . . and refit the crankshaft

Final refitting

18 Carefully lift the crankshaft out of the engine. Clean the bearing surfaces of the shells in the block, then apply a thin, uniform layer of clean molybdenum disulphide-based grease, engine assembly lubricant, or clean engine oil to each surface **(see illustration)**. Coat the thrustwasher surfaces as well.

19 Lubricate the crankshaft oil seal journals with molybdenum disulphide-based grease, engine assembly lubricant, or clean engine oil.

20 Make sure the crankshaft journals are clean, then lay the crankshaft back in place in the block **(see illustration)**. Clean the bearing surfaces of the shells in the caps, then lubricate them. Install the caps in their respective positions, with the arrows pointing to the timing belt/chain end of the engine.

21 Working on one cap at a time, from the centre main bearing outwards (and ensuring that each cap is tightened down squarely and evenly onto the block), tighten the main bearing cap bolts to the specified torque wrench setting.

22 Rotate the crankshaft a number of times by hand, to check for any obvious binding.

23 Check the crankshaft endfloat (see Section 13). It should be correct if the crankshaft thrust faces aren't worn or damaged.

24 Refit the crankshaft left-hand oil seal carrier, and install a new seal (see Part A, B or C of this Chapter according to engine type).

21 Piston/connecting rod assemblies - refitting and big-end bearing clearance check

Note: *On the HCS engine,* ***new*** *big-end bearing cap retaining bolts will be required for reassembly.*

1 Before refitting the piston/connecting rod assemblies, the cylinder bores must be perfectly clean, the top edge of each cylinder must be chamfered, and the crankshaft must be in place.

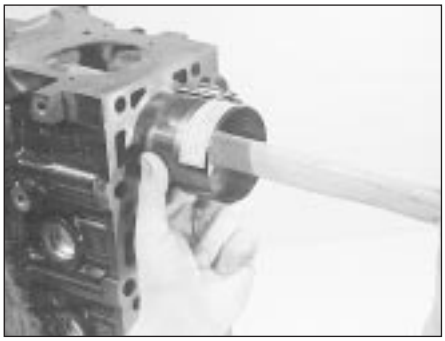
2 Remove the big-end bearing cap from No 1 cylinder connecting rod (refer to the marks noted or made on removal). Remove the original bearing shells, and wipe the bearing recesses of the connecting rod and cap with a clean, lint-free cloth. They must be kept spotlessly-clean!

Big-end bearing clearance check

3 Clean the back of the new upper bearing shell, fit it to the connecting rod, then fit the other shell of the bearing set to the big-end bearing cap. Make sure that the tab on each shell fits into the notch in the rod or cap recess **(see illustration)**.

Caution: Don't hammer the shells into place, and don't nick or gouge the bearing face. Don't lubricate the bearing at this time.

21.3 Tab on each big-end bearing shell must engage with notch in connecting rod or cap



21.9 The piston can be driven gently into the cylinder bore with the end of a wooden or plastic hammer handle

4 It's critically important that all mating surfaces of the bearing components are perfectly clean and oil-free when they're assembled.

5 Position the piston ring gaps as described in Section 19, lubricate the piston and rings with clean engine oil, and attach a piston ring compressor to the piston. Leave the skirt protruding about a quarter-inch, to guide the piston into the cylinder bore. The rings must be compressed until they're flush with the piston.

6 Rotate the crankshaft until No 1 crankpin (big-end) journal is at BDC (Bottom Dead Centre), and apply a coat of engine oil to the cylinder walls.

7 Arrange the No 1 piston/connecting rod assembly so that the arrow on the piston crown points to the timing belt/chain end of the engine. Gently insert the assembly into the No 1 cylinder bore, and rest the bottom edge of the ring compressor on the engine block.

8 Tap the top edge of the ring compressor to make sure it's contacting the block around its entire circumference.

9 Gently tap on the top of the piston with the end of a wooden hammer handle **(see illustration)**, while guiding the connecting rod's big-end onto the crankpin. The piston rings may try to pop out of the ring compressor just before entering the cylinder bore, so keep some pressure on the ring compressor. Work slowly, and if any resistance is felt as the piston enters the cylinder, stop immediately. Find out what's binding, and fix it before proceeding. *Do not*, for any reason, force the piston into the cylinder - you might break a ring and/or the piston.

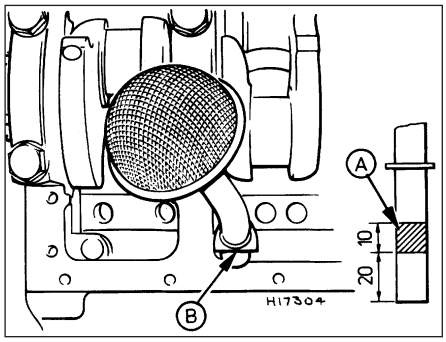
10 To check the big-end bearing running clearance, cut a piece of the appropriate-size Plastigage slightly shorter than the width of the connecting rod bearing, and lay it in place on the No 1 crankpin (big-end) journal, parallel with the crankshaft centre-line **(see illustration 20.11).**

11 Clean the connecting rod-to-cap mating surfaces, and refit the big-end bearing cap. Tighten the cap bolts evenly - on the HCS and Zetec engines, first use a torque wrench to tighten the bolts to the Stage 1 torque setting, then use an ordinary socket extension bar and an angle gauge to tighten the bolts further through the Stage 2 angle **(see illustrations)**. On the CVH engine, tighten the bolts progressively to the specified torque; further angle-tightening is not required on these engines. Use a thin-wall socket, to avoid erroneous torque readings that can result if the socket is wedged between the cap and nut. If the socket tends to wedge itself between the nut and the cap, lift up on it slightly until it no longer contacts the cap. Don't rotate the crankshaft at any time during this operation!

12 Unscrew the bolts and detach the cap, being very careful not to disturb the Plastigage.

21.11A Angle-tightening the big-end bolts using the correct tool . . .

21.11B . . . or a fabricated type as shown



21.21 Oil inlet pipe refitting details on the HCS engine

A Area of sealant application - dimensions in mm
B Edge must be parallel with engine longitudinal axis

13 Compare the width of the crushed Plastigage to the scale printed on the Plastigage envelope, to obtain the running clearance **(see illustration 20.15)**. Compare it to the Specifications, to make sure the clearance is correct.

14 If the clearance is not as specified, seek the advice of a Ford dealer or similar engine reconditioning specialist - if the crankshaft journals are in good condition (see Section 16), it may be possible simply to renew the shells to achieve the correct clearance. If this is not possible, the crankshaft must be reground by a specialist, who can also supply the necessary undersized shells. First though, make sure that no dirt or oil was trapped between the bearing shells and the connecting rod or cap when the clearance was measured. Also, recheck the crankpin diameter. If the Plastigage was wider at one end than the other, the crankpin journal may be tapered (see Section 16).

15 Carefully scrape all traces of the Plastigage material off the journal and the bearing surface. Be very careful not to scratch the bearing - use your fingernail or the edge of a credit card.

Final piston/connecting rod refitting

16 Make sure the bearing surfaces are perfectly clean, then apply a uniform layer of clean molybdenum disulphide-based grease, engine assembly lubricant, or clean engine oil, to both of them. You'll have to push the piston into the cylinder to expose the bearing surface of the shell in the connecting rod.

17 Slide the connecting rod back into place on the crankpin (big-end) journal, refit the big-end bearing cap, and then tighten the bolts as described above.

18 Repeat the entire procedure for the remaining piston/connecting rod assemblies.

19 The important points to remember are:

a) Keep the backs of the bearing shells and the recesses of the connecting rods and caps perfectly clean when assembling them.
b) Make sure you have the correct piston/rod assembly for each cylinder - use the etched cylinder numbers to identify the front-facing side of both the rod and its cap.
c) The arrow on the piston crown must face the timing belt/chain end of the engine.
d) Lubricate the cylinder bores with clean engine oil.
e) Lubricate the bearing surfaces when refitting the big-end bearing caps after the running clearance has been checked.

20 After all the piston/connecting rod assemblies have been properly installed, rotate the crankshaft a number of times by hand, to check for any obvious binding.

21 On the HCS engine, if the oil pick-up pipe and strainer was removed, this is a good time to refit it. First clean the joint area, then coat the area indicated with the specified activator (available from Ford dealers) **(see illustration)**. Wait for a period of ten minutes, then smear the shaded area with the specified adhesive and immediately press the inlet pipe into position in the crankcase.

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

2 With the spark plugs removed and the ignition system disabled by unplugging the ignition coil's electrical connector, remove fuse 5 (fuel-injected engines) to disconnect the fuel pump. Turn the engine on the starter until the oil pressure warning light goes out.

3 Refit the spark plugs, and connect all the spark plug (HT) leads (Chapter 1). Reconnect the ignition coil. On fuel-injected engines, refit the fuel pump fuse, switch on the ignition and listen for the fuel pump; it will run for a little longer than usual, due to the lack of pressure in the system.

4 Start the engine, noting that this also may take a little longer than usual, due to the fuel system components being empty.

5 While the engine is idling, check for fuel, coolant and oil leaks. Don't be alarmed if there are some odd smells and smoke from parts getting hot and burning off oil deposits. If the hydraulic tappets (where applicable) have been disturbed, some valve gear noise may be heard at first; this should disappear as the oil circulates fully around the engine, and normal pressure is restored in the tappets.

6 Keep the engine idling until hot water is felt circulating through the top hose, check that it idles reasonably smoothly and at the usual speed, then switch it off.

7 After a few minutes, recheck the oil and coolant levels, and top-up as necessary (Chapter 1).

8 If they were tightened as described, there is no need to re-tighten the cylinder head bolts once the engine has first run after reassembly - in fact, Ford state that the bolts *must not* be re-tightened.

9 If new components such as pistons, rings or crankshaft bearings have been fitted, the engine must be run-in for the first 500 miles (800 km). Do not operate the engine at full-throttle, or allow it to labour in any gear during this period. It is recommended that the oil and filter be changed at the end of this period.