

Chapter 2 Part A:






HCS engine - in-car engine repair procedures

Contents

Auxiliary drivebelt check and renewal	See Chapter 1	Flywheel - removal, inspection and refitting	19
Compression test - description and interpretation	3	General information	1
Crankshaft oil seals - renewal	17	Inlet manifold - removal and refitting	7
Crankshaft pulley - removal and refitting	11	Oil pump - dismantling, inspection and reassembly	16
Cylinder head - removal and refitting	10	Oil pump - removal and refitting	15
Cylinder head and valve components - cleaning and inspection	See Chapter 2D	Repair operations possible with the engine in the vehicle	2
Cylinder head rocker cover - removal and refitting	5	Spark plug renewal	See Chapter 1
Cylinder head rocker gear - removal, inspection and refitting	9	Sump - removal and refitting	14
Engine oil and filter change	See Chapter 1	Timing chain cover - removal and refitting	12
Engine oil level check	See Chapter 1	Timing chain, sprockets and tensioner - removal, inspection and refitting	13
Engine overhaul - general information	See Chapter 2D	Top Dead Centre (TDC) for No 1 piston - locating	4
Engine/transmission - removal and refitting	See Chapter 2D	Valve clearances - checking and adjustment	6
Engine/transmission mountings - inspection and renewal	18	Water pump - removal and refitting	See Chapter 3
Exhaust manifold - removal, inspection and refitting	8		

2A

Degrees of difficulty

Easy , suitable for novice with little experience		Fairly easy , suitable for beginner with some experience		Fairly difficult , suitable for competent DIY mechanic		Difficult , suitable for experienced DIY mechanic		Very difficult , suitable for expert DIY or professional	
--	--	---	--	---	--	--	--	---	--

Specifications

General

Engine type	Four-cylinder, in-line overhead valve
Engine code:	
Carburettor models	JBD
CFI fuel-injected models	J6A
Capacity	1297 cc
Bore	73.96 mm
Stroke	75.48 mm
Compression ratio:	
Carburettor models	9.5:1
CFI fuel-injected models	8.8:1
Firing order	1-2-4-3 (No 1 cylinder at timing chain end)
Direction of crankshaft rotation	Clockwise (seen from right-hand side of vehicle)

Valves

Valve clearance (cold):	
Inlet	0.20 mm
Exhaust	0.30 mm

Lubrication

Engine oil type/specification	See Chapter 1
Engine oil capacity	See Chapter 1
Oil pressure:	
At idle speed	0.60 bars
At 2000 rpm	1.50 bars
Oil pump clearances:	
Outer rotor-to-body	0.14 to 0.26 mm
Inner rotor-to-outer rotor	0.051 to 0.127 mm
Rotor endfloat	0.025 to 0.06 mm

Torque wrench settings

	Nm	lbf ft
Camshaft thrust plate bolts	4 to 5	3 to 4
Camshaft sprocket bolt	16 to 20	12 to 14
Crankshaft pulley bolt	110 to 120	81 to 88
Rocker gear pedestal bolts	40 to 46	30 to 34
Flywheel bolts	64 to 70	47 to 51
Exhaust manifold	21 to 25	15 to 18
Inlet manifold	16 to 20	12 to 15
Sump:		
Stage 1	6 to 8	4 to 6
Stage 2	8 to 11	6 to 8
Stage 3 (with engine warm)	8 to 11	6 to 8
Oil pressure switch	13 to 15	10 to 11
Cylinder head bolts (may be re-used once only):		
Stage 1	30	22
Stage 2	Angle-tighten a further 90°	
Stage 3	Angle-tighten a further 90°	
Timing chain tensioner	7 to 9	5 to 6
Timing chain cover	7 to 10	5 to 7
Crankshaft rear oil seal housing	16 to 20	12 to 14
Rocker cover bolts	4 to 5	3 to 4
Oil pump	16 to 20	12 to 14
Oil pump cover	8 to 12	6 to 9

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

1 General information

How to use this Chapter

This Part of Chapter 2 is devoted to repair procedures possible while the engine is still installed in the vehicle, and includes only the Specifications relevant to those procedures. Similar information concerning the 1.4 and 1.6 litre CVH engines, and the 1.6 and 1.8 litre

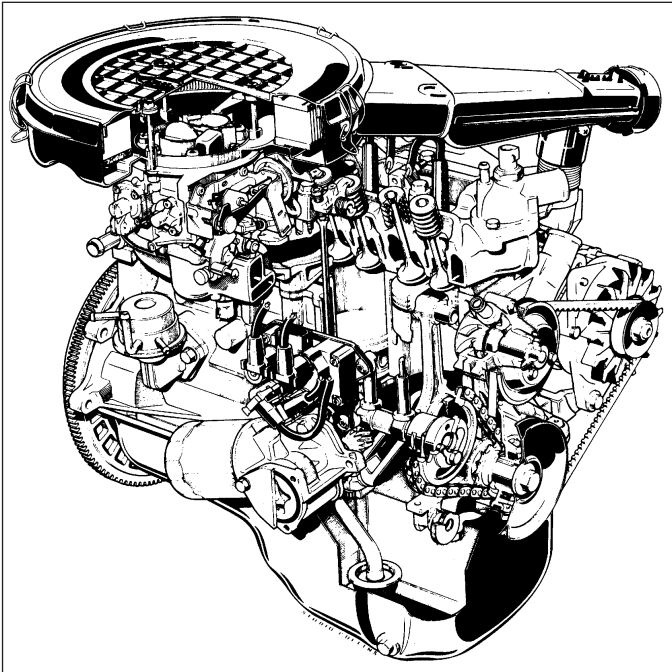
Zetec engines, will be found in Parts B and C of this Chapter respectively. Since these procedures are based on the assumption that the engine is installed in the vehicle, if the engine has been removed from the vehicle and mounted on a stand, some of the preliminary dismantling steps outlined will not apply.

Information concerning engine/transmission removal and refitting, and engine overhaul, can be found in Part D of this Chapter, which also includes the Specifications relevant to those procedures.

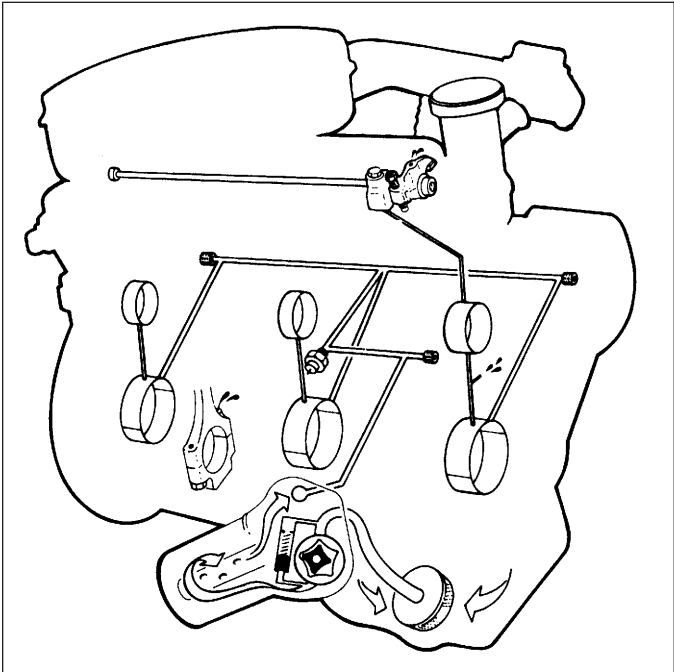
General description - HCS engine

The engine is an overhead valve, water-cooled, four cylinder in-line design, designated HCS (High Compression Swirl) (see illustration). It is mounted transversely at the front of the vehicle together with the transmission to form a combined power unit.

The crankshaft is supported in five shell-type main bearings. The connecting rod big-end bearings are also split shell-type, and are attached to the pistons by interference-fit



1.3 Cutaway view of the HCS engine



1.6 HCS engine lubrication circuit

gudgeon pins. Each piston is fitted with two compression rings and one oil control ring.

The camshaft, which runs on bearings within the cylinder block, is chain-driven from the crankshaft, and operates the valves via pushrods and rocker arms. The valves are each closed by a single valve spring, and operate in guides integral in the cylinder head.

The oil pump is mounted externally on the crankcase, incorporates a full-flow oil filter, and is driven by a skew gear on the camshaft (**see illustration**). On carburettor versions, the fuel pump is also driven from the camshaft, via an eccentric lobe.

2 Repair operations possible with the engine in the vehicle

The following major repair operations can be accomplished without removing the engine from the vehicle:

- a) *Compression pressure - testing.*
- b) *Cylinder head rocker cover - removal and refitting.*
- c) *Valve clearances - adjustment.*
- d) *Cylinder head and pistons - decarbonising.*
- e) *Rocker shaft assembly - removal and refitting.*
- f) *Crankshaft oil seals - renewal.*
- g) *Oil filter renewal.*
- h) *Oil pump - removal and refitting.*
- i) *Sump - removal and refitting.*
- j) *Piston/connecting rod assemblies - removal and refitting.*
- k) *Flywheel - removal, inspection and refitting.*
- l) *Engine/transmission mountings - removal and refitting.*

Clean the engine compartment and the exterior of the engine with some type of degreaser before any work is done. It will make the job easier, and will help to keep dirt out of the internal areas of the engine.

Depending on the components involved, it may be helpful to remove the bonnet, to improve access to the engine as repairs are performed (refer to Chapter 11 if necessary). Cover the wings to prevent damage to the paint; special covers are available, but an old bedspread or blanket will also work.

If vacuum, exhaust, oil or coolant leaks develop, indicating a need for component/gasket or seal replacement, the repairs can generally be made with the engine in the vehicle. The inlet and exhaust manifold gaskets, sump gasket, crankshaft oil seals and cylinder head gasket are all accessible with the engine in place.

Exterior components such as the inlet and exhaust manifolds, the sump, the oil pump, the water pump, the starter motor, the alternator and the fuel system components can be removed for repair with the engine in place.

Since the cylinder head can be removed without lifting out the engine, valve component servicing can also be accomplished with the engine in the vehicle.

In extreme cases caused by a lack of necessary equipment, repair or renewal of piston rings, pistons, connecting rods and big-end bearings is possible with the engine in the vehicle. However, this practice is not recommended, because of the cleaning and preparation work that must be done to the components involved, and because of the amount of preliminary dismantling work required - these operations are therefore covered in Part D of this Chapter.

3 Compression test - description and interpretation



1 When engine performance is down, or if misfiring occurs which cannot be attributed to the ignition or fuel systems, a compression test can provide diagnostic clues as to the engine's condition. If the test is performed regularly, it can give warning of trouble before any other symptoms become apparent.

2 The engine must be fully warmed-up to normal operating temperature, the oil level must be correct, the battery must be fully charged, and the spark plugs must be removed. The aid of an assistant will also be required.

3 Disconnect the 3-pin plug from the DIS ignition coil (under the inlet manifold).

4 Fit a compression tester to the No 1 cylinder spark plug hole - the type of tester which screws into the plug thread is to be preferred.

5 Arrange for an assistant to hold the accelerator pedal fully depressed to the floor, while at the same time cranking the engine over for several seconds on the starter motor. Observe the compression gauge reading. The compression will build up fairly quickly in a healthy engine. Low compression on the first stroke, followed by gradually-increasing pressure on successive strokes, indicates worn piston rings. A low compression on the first stroke which does not rise on successive strokes, indicates leaking valves or a blown head gasket (a cracked cylinder head could also be the cause). Deposits on the underside of the valve heads can also cause low compression. Record the highest gauge reading obtained, then repeat the procedure for the remaining cylinders.

6 Due to the variety of testers available, and the fluctuation in starter motor speed when cranking the engine, different readings are often obtained when carrying out the compression test. For this reason, actual compression pressure figures are not quoted by Ford. However, the most important factor is that the compression pressures are uniform in all cylinders, and that is what this test is mainly concerned with.

7 Add some engine oil (about three squirts from a plunger type oil can) to each cylinder through the spark plug holes, and then repeat the test.

8 If the compression increases after the oil is added, it is indicative that the piston rings are definitely worn. If the compression does not increase significantly, the leakage is occurring at the valves or the head gasket. Leakage past the valves may be caused by burned valve seats and/or faces, or warped, cracked or bent valves.

9 If two adjacent cylinders have equally low compressions, it is most likely that the head gasket has blown between them. The appearance of coolant in the combustion chambers or on the engine oil dipstick would verify this condition.

10 If one cylinder is about 20 percent lower than the other, and the engine has a slightly rough idle, a worn lobe on the camshaft could be the cause.

11 On completion of the checks, refit the spark plugs and reconnect the HT leads and the DIS ignition coil plug.

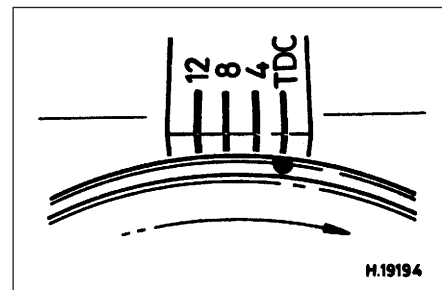
4 Top Dead Centre (TDC) for No 1 piston - locating



1 Top dead centre (TDC) is the highest point of the cylinder that each piston reaches as the crankshaft turns. Each piston reaches its TDC position at the end of its compression stroke, and then again at the end of its exhaust stroke. For the purpose of engine timing, TDC at the end of the compression stroke for No 1 piston is used. On the HCS engine, No 1 cylinder is at the crankshaft pulley/timing chain end of the engine. Proceed as follows.

2 Ensure that the ignition is switched off. Disconnect the HT leads from the spark plugs, then unscrew and remove the plugs as described in Chapter 1.

3 Turn the engine over by hand (using a spanner on the crankshaft pulley) to the point where the timing mark on the crankshaft pulley aligns with the TDC (0) mark on the timing cover (**see illustration**). As the pulley mark nears the timing mark, the No 1 piston is simultaneously approaching the top of its cylinder. To ensure that it is on its



4.3 Timing mark on the crankshaft pulley aligned with the TDC (0) mark on the timing cover



5.5A Engage tags of rocker cover gasket into the cut-outs in the cover



5.5B Refitting the rocker cover



6.5 Adjusting the valve clearances

compression stroke, place a finger over the No 1 cylinder plug hole, and feel to ensure that air pressure exits from the cylinder as the piston reaches the top of its stroke.

4 A further check to ensure that the piston is on its compression stroke can be made by first removing the air cleaner (see Chapter 4), then unbolting and removing the rocker cover, so that the movement of the valves and rockers can be observed.

5 With the TDC timing marks on the crankshaft pulley and timing cover in alignment, rock the crankshaft back and forth a few degrees each side of this position, and observe the action of the valves and rockers for No 1 cylinder. When No 1 piston is at the TDC firing position, the inlet and exhaust valve of No 1 cylinder will be fully closed, but the corresponding valves of No 4 cylinder will be seen to rock open and closed.

6 If the inlet and exhaust valves of No 1 cylinder are seen to rock whilst those of No 4 cylinder are shut, the crankshaft will need to be turned one full rotation to bring No 1 piston up to the top of its cylinder on the compression stroke.

7 Once No 1 cylinder has been positioned at TDC on the compression stroke, TDC for any of the other cylinders can then be located by rotating the crankshaft clockwise (in its normal direction of rotation), 180° at a time, and following the firing order (see Specifications).

5 Cylinder head rocker cover - removal and refitting



- 1 Remove the air cleaner as described in Chapter 4.
- 2 Detach the HT leads from the spark plugs. Pull on the connector of each lead (not the lead itself), and note the order of fitting.
- 3 Unscrew the four retaining bolts, and lift the rocker cover clear of the cylinder head. Remove the gasket.
- 4 Thoroughly clean the rocker cover, and scrape away any traces of old gasket remaining on the cover and cylinder head mating surfaces.
- 5 Fit a new gasket to the rocker cover, then

refit the rocker cover (see illustrations). Tighten the cover retaining bolts to the specified torque wrench setting, in a diagonal sequence.

6 Reconnect the HT leads, and refit the air cleaner as described in Chapter 4.

6 Valve clearances - checking and adjustment



1 This operation must be carried out with the engine cold. The air cleaner (see Chapter 4), the rocker cover and the spark plugs (see Chapter 1) must first be removed. As the plugs and their HT leads are removed, note their order of fitting, so that they may be refitted in their original locations.

2 Set the engine to TDC for No 1 piston, as described in Section 4.

3 Starting from the thermostat end of the cylinder head, the valves are numbered as follows:

Valve No	Cylinder No
1 - Exhaust	1
2 - Inlet	1
3 - Exhaust	2
4 - Inlet	2
5 - Inlet	3
6 - Exhaust	3
7 - Inlet	4
8 - Exhaust	4

4 Adjust the valve clearances following the sequence given in the following table. Turn the crankshaft pulley 180° (half a turn) after adjusting each pair of valve clearances.

Valves "rocking"	Valves to adjust
7 and 8	1 (exhaust), 2 (inlet)
5 and 6	3 (exhaust), 4 (inlet)
1 and 2	8 (exhaust), 7 (inlet)
3 and 4	6 (exhaust), 5 (inlet)

5 The clearances for the inlet and exhaust valves differ (refer to the Specifications). Use a feeler gauge of the appropriate thickness to check each clearance between the end of the valve stem and the rocker arm (see illustration). The gauge should be a firm sliding fit between the valve and rocker arm. Where adjustment is necessary, turn the adjuster bolt as required with a ring spanner to set the clearance to that specified. The

adjuster bolts are of stiff-thread type, and require no locking nut.

6 Refit the rocker cover, and tighten its retaining bolts to the specified torque setting in a diagonal sequence.

7 Refit the spark plugs, and reconnect the HT leads.

8 Refit the air cleaner as described in Chapter 4.

7 Inlet manifold - removal and refitting



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. 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.

Removal

- 1 Drain the cooling system as described in Chapter 1.
- 2 Remove the carburettor or CFI unit (as applicable) as described in Chapter 4.
- 3 Noting their locations, disconnect the coolant, vacuum and breather hoses from the manifold.
- 4 Disconnect the wiring multi-plugs from the engine sensors at the inlet manifold. Disconnect the radio earth lead at the inlet manifold connector.
- 5 Undo the retaining bolts, and withdraw the manifold from the cylinder head. Remove the gasket.
- 6 With the manifold removed, clean all traces of the old gasket from the mating surfaces of the manifold and the cylinder head.

Refitting

- 7 Refitting is the reversal of removal. Use a new gasket, and tighten the retaining bolts to the specified torque. Refit the remainder of the components with reference to the appropriate Chapters of this manual.



8.1 Exhaust manifold shroud/heat shield

8 Exhaust manifold - removal, inspection and refitting



Note: Never work on or near the exhaust system and in particular, the catalytic converter (where fitted), while it is still hot. If this is unavoidable, wear thick gloves, and protect yourself from burns should you accidentally touch a hot exhaust component.

Removal

1 The exhaust manifold is secured the cylinder head by studs and nuts, and is similarly attached to the exhaust downpipe. A shroud/heat shield is bolted to the manifold, to direct exhaust-heated air into the air inlet system when the engine is cold. Access to the exhaust manifold retaining nuts is gained by first removing this shroud (see illustration).

2 On vehicles equipped with a pulse-air system, remove the pulse-air piping as described in Chapter 6.

3 Support the exhaust downpipe on a jack or suitable blocks, and undo the downpipe-to-manifold retaining nuts. Separate the pipe from the manifold, and remove the gasket. On catalytic converter-equipped vehicles, take care not to stretch the oxygen sensor wiring, where applicable; if necessary, disconnect the sensor's multi-plug.

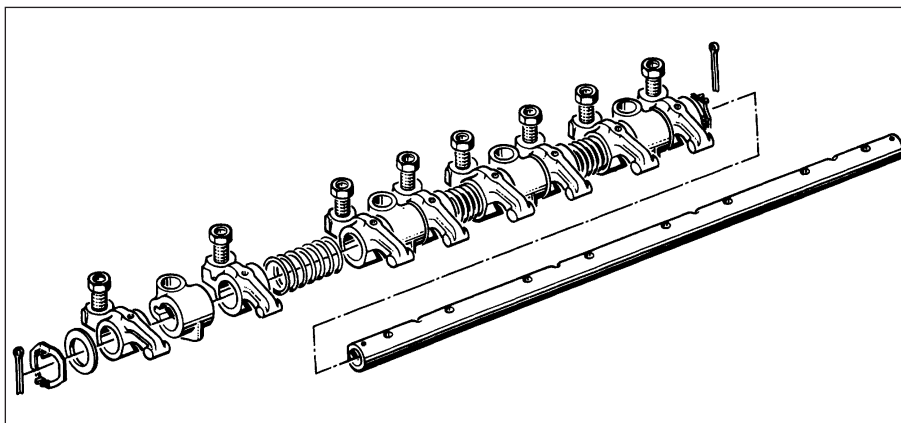
4 Undo the retaining nuts, and withdraw the manifold from the cylinder head studs. Remove the manifold gasket.

Inspection

5 Use a scraper to remove all traces of old gasket material and carbon deposits from the manifold and cylinder head mating surfaces. If the gasket was leaking, have the manifold checked for warpage at an automotive machine shop, and have it resurfaced if necessary.

6 Provided both mating surfaces are clean and flat, a new gasket will be sufficient to ensure the joint is gastight. *Do not* use any kind of exhaust sealant upstream of the catalytic converter, where fitted.

7 Note that on some models, the downpipe is secured to the manifold by two bolts, with a



9.4A Rocker shaft and associated components

coil spring, spring seat and self-locking nut on each. On refitting, tighten the nuts until they stop on the bolt shoulders; the pressure of the springs will then suffice to make a gastight joint.

8 Do not overtighten the nuts to cure a leak - the bolts will shear; renew the gasket and the springs if a leak is found. The bolts themselves are secured by spring clips to the manifold, and can be renewed easily if damaged.

Refitting

9 Refit the manifold in the reverse order of removal. Tighten the retaining bolts to the specified torque - see previous paragraph. Ensure that all adjacent wiring and hoses are clear of the exhaust system and manifold, and on completion check the system joints for any signs of leaks.

9 Cylinder head rocker gear - removal, inspection and refitting



Removal

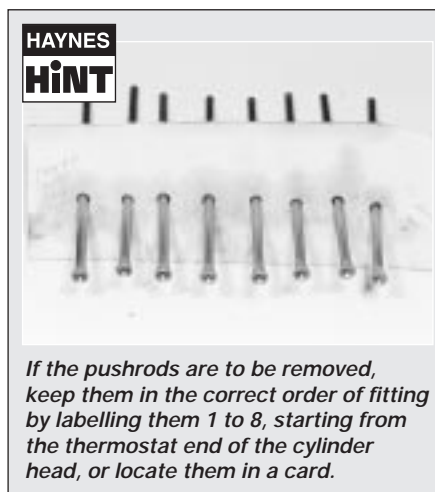
1 Remove the rocker cover as described in Section 5.

2 Unscrew the four retaining bolts, and lift the rocker gear assembly from the cylinder head.



9.4B Partially-dismantled rocker shaft

As the assembly is withdrawn, ensure that the pushrods remain seated in their positions in the engine.



If the pushrods are to be removed, keep them in the correct order of fitting by labelling them 1 to 8, starting from the thermostat end of the cylinder head, or locate them in a card.

Inspection

3 To dismantle the rocker shaft assembly, extract the split pin from one end of the shaft, then withdraw the spring and plain washers from the shaft.

4 Slide off the rocker arms, the support pedestals and coil springs from the shaft, but take care to keep them in their original order of fitting (see illustrations).

5 Clean the respective components, and inspect them for signs of excessive wear or damage. Check that the oil lubrication holes in the shaft are clear.

6 Check the rocker shaft and arm pads which bear on the valve stem end faces for wear and scoring, and check each rocker arm on the shaft for excessive wear. Renew any components as necessary.

Refitting

7 Apply clean engine oil to the rocker shaft prior to reassembling.

8 Reassemble in the reverse order of dismantling. Make sure that the "flat" on the



9.8 Flat on the rocker shaft (arrowed) to same side as rocker arm adjusting screws

rear end of the rocker shaft is to the same side as the rocker arm adjusting screws (closest to the thermostat end of the cylinder head when fitted) (see illustration). This is essential for the correct lubrication of the cylinder head components.

9 Refit the rocker shaft assembly. As it is fitted, ensure that the rocker adjuster screws engage with their corresponding pushrods.

10 Refit the rocker shaft retaining bolts, hand-tighten them and then tighten them to the specified torque wrench setting. As they are tightened, some of the rocker arms will apply pressure to the ends of the valve stems, and some of the rocker pedestals will not initially be in contact with the cylinder head - these should pull down as the bolts are tightened to their specified torque. If for any reason they do not, avoid the temptation to overtighten in order to pull them into position; loosen off the bolts, and check the cause of the problem. It may be that the rocker adjuster screws require loosening off in order to allow the assembly to be tightened down as required.

11 Adjust the valve clearances as described in Section 6.

10 Cylinder head - removal and refitting



Removal

1 On CFI-equipped engines, depressurise the fuel system as described in Chapter 4.

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

3 Whenever you disconnect any vacuum lines, coolant or 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. Masking tape and/or a touch-up paint applicator work well for marking items. Take instant photos, or sketch the locations of components and brackets.

4 Refer to Section 5 and remove the rocker cover.

5 Refer to Chapter 1 and drain the cooling system.

6 Disconnect the hoses from the thermostat housing.



10.17 Withdraw the pushrods

7 Disconnect the heater (coolant) hoses from the inlet manifold and CFI unit, where applicable.

8 Disconnect the accelerator and choke cables from the carburettor or CFI unit, as applicable (see Chapter 4).

9 Disconnect the fuel and vacuum hoses from the carburettor/CFI unit and inlet manifold.

10 Disconnect the HT leads from the spark plugs and the support bracket. Unscrew and remove the spark plugs.

11 Disconnect the electrical leads from the temperature gauge sender, radiator cooling fan, the engine coolant temperature sender (beneath the inlet manifold), the radio earth lead on the inlet manifold, and the anti-run-on (anti-dieselling) valve at the carburettor.

12 Remove the engine oil filler cap and breather hose.

13 On vehicles equipped with a pulse-air system, remove the pulse-air piping as described in Chapter 6.

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

15 Undo the retaining nuts and bolts, and disconnect the exhaust downpipe from the manifold. Remove the flange gasket. (Note that both the gasket and the joint self-locking nuts must be renewed.) To prevent the exhaust system from being strained, tie the downpipe up using strong wire or a length of cord to support it. On catalytic converter-equipped vehicles, take care not to stretch the oxygen sensor wiring, where applicable; if necessary, disconnect the sensor's multi-plug. Lower the vehicle.



10.22A Cylinder head gasket top-face marking ("OBEN")

16 Undo the four retaining bolts and lift clear the rocker gear assembly from the cylinder head.

17 Lift out the pushrods. Keep them in order of fitting by labelling them 1 to 8, starting from the thermostat end of the cylinder head. Alternatively, push them through a piece of card in their fitted sequence (see illustration).

18 Progressively unscrew and loosen off the cylinder head retaining bolts in the reverse sequence to that shown for tightening (see illustration 10.24A). When they are all loosened off, remove the bolts, then lift the cylinder head clear and remove the gasket. The gasket must always be renewed; it should be noted that the cylinder head retaining bolts may be re-used, but only once. They should be marked accordingly with a punch or paint mark. If there is any doubt as to how many times the bolts have been used, they must be renewed.

19 To dismantle/overhaul the cylinder head, refer to Part D of this Chapter. It is normal for the cylinder head to be decarbonised and the valves to be reground whenever the head is removed.

Refitting

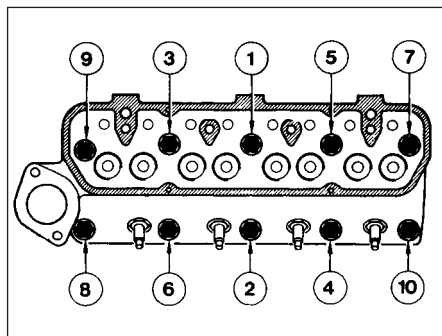
20 Prior to refitting the cylinder head, clean all carbon deposits, dirt and any traces of the old cylinder head gasket, from the mating faces of both the head and the cylinder block. Do not allow any dirt to drop into the cylinder bores, oil passages or waterways; if any does, remove it. Clean the threads of the cylinder head bolts or fit new ones (as applicable) and clean out the bolt holes in the block. Screwing a bolt into an oil-filled hole can (in extreme cases) cause the block to fracture, due to the hydraulic pressure.

21 If there is any doubt as to the condition of the exhaust and inlet manifold gaskets, the manifolds must be removed and the gaskets renewed, but ensure that the mating faces are clean before fitting new gaskets.

22 Check that the new cylinder head gasket is the same type as the original, and that the "TOP" (or "OBEN") marking is facing upwards. Locate the new cylinder head gasket onto the top face of the cylinder block and over the dowels. Ensure that it is correctly aligned with the coolant passages and oilways (see illustrations).



10.22B Cylinder head gasket in position on the top face of the cylinder block



10.24A Cylinder head bolt tightening sequence



10.24B Tightening the cylinder head bolts (Stage 1)



10.24C Cylinder head bolt tightening (Stages 2 and 3) using an angle gauge

23 Lower the cylinder head carefully into position, then insert the retaining bolts and hand-tighten them.

24 Tightening of the cylinder head bolts must done in three stages, and in the correct sequence (see illustration 10.18). First tighten all of the bolts in the sequence shown to the Stage 1 torque setting. When all of the bolts are tightened to the Stage 1 setting, further tighten each bolt (in sequence) through the Stage 2 specified angle of rotation. When the second stage tightening is completed on all of the bolts, further tighten them to the Stage 3 angle setting (in sequence) to complete. Where possible, use an angular torque setting gauge attachment tool for accurate tightening of stages two and three (see illustrations).

25 Lubricate the pushrods with clean engine oil, and then insert them into their original locations in the engine.

26 Refit the rocker shaft assembly. As it is fitted, ensure that the rocker adjuster screws engage with their corresponding pushrods.

27 Refit the rocker shaft retaining bolts, hand-tighten them and then tighten them to the specified torque wrench setting. As they are tightened, some of the rocker arms will apply pressure to the ends of the valve stems, and some of the rocker pedestals will not initially be in contact with the cylinder head - these should pull down as the bolts are tightened to their specified torque. If for any reason they do not, avoid the temptation to overtighten in order to pull them into position; loosen off the bolts, and check the cause of the problem. It may be that the rocker adjuster screws require loosening off in order to allow the assembly to be tightened down as required.

28 Adjust the valve clearances as described in Section 6.

29 Refit the spark plugs and tighten them to the specified torque (see Chapter 1).

30 Fit a new gasket to the rocker cover, then refit the rocker cover. Tighten the cover retaining bolts to the specified torque wrench setting.

31 The remainder of the refitting procedure is a reversal of the removal process. Tighten all fastenings to their specified torque setting

(where given). Refer to the appropriate Section in Chapter 4 for details on reconnecting the accelerator and choke cables. Ensure that all coolant, fuel, vacuum and electrical connections are securely made.

32 On completion, top-up the engine oil and coolant levels. When the engine is restarted, check for any sign of fuel, oil and/or coolant leakages from the various cylinder head joints.

11 Crankshaft pulley - removal and refitting

Removal

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

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

3 Undo the three retaining bolts and remove the plastic cover from the underside of the auxiliary drivebelt.

4 Loosen off the crankshaft pulley retaining bolt. To prevent the crankshaft from turning, unbolt and remove the clutch housing cover plate, and jam the starter ring gear on the flywheel.

5 Loosen off the alternator mounting/adjuster bolts, then pivot the alternator to slacken off the tension from the auxiliary drivebelt, and disengage the belt from the crankshaft pulley (see Chapter 1).

6 Unscrew and remove the crankshaft pulley bolt, and withdraw the pulley from the front end of the crankshaft. If it does not pull off by hand, lever it free using a pair of suitable levers positioned diagonally opposite each other behind the pulley.

7 If required, the crankshaft front oil seal can be renewed at this stage, as described in Section 17.

Refitting

8 Refitting is a reversal of the removal procedure. When the pulley is refitted, tighten the retaining bolt to the specified torque setting. Relocate the drivebelt over the pulley,

and adjust the tension as described in Chapter 1.

9 Refit the drivebelt plastic cover, and lower the vehicle to complete.

12 Timing chain cover - removal and refitting

Removal

1 Remove the crankshaft pulley as described in the previous Section.

2 A combined timing cover and water pump gasket is fitted during production; if this is still in position, it will be necessary to drain the cooling system and remove the water pump as described in Chapter 3. If the water pump and/or the timing cover have been removed at any time, the single gasket used originally will have been replaced by an individual item, in which case the water pump can remain in position.

3 Unscrew the retaining bolts, and carefully prise free the timing chain cover. Note that two of the retaining bolts also secure the sump at the front end. Remove the engine front face-to-cover gasket. If the sump-to-timing cover gasket is damaged during the removal of the cover, it will be necessary to drain and remove the sump in order to renew the gasket, in which case refer to Section 14 for details.

4 Clean the mating faces of the timing chain cover and the engine.

5 If necessary, renew the crankshaft front oil seal in the timing cover prior to refitting the cover (see Section 17).

Refitting

6 Before refitting the cover into position, clean the contact faces at the point where the timing chain cover meets the sump gasket each side. Smear the faces at this point with sealant; it is important that a good seal is made. As previously mentioned, if the sump gasket is damaged on either side at the front, it must be renewed (see Section 14) prior to refitting the timing chain cover.

7 Lightly lubricate the front end of the



12.7 Fitting the timing chain cover.
Crankshaft pulley used as aid to centring



13.4 Oil slinger removal from crankshaft



13.5 Chain tensioner arm removal from the pivot pin. Note tensioner retaining bolts (arrowed)

crankshaft and the radial lip of the timing chain cover oil seal (already installed in the cover). Using a new gasket, fit the timing chain cover, centring it with the aid of the crankshaft pulley (*see illustration*) - lubricate the seal contact surfaces beforehand. Where applicable, leave out the timing cover bolt which also secures the water pump at this stage.

8 Where applicable, refit the water pump as described in Chapter 3.

9 Refit the crankshaft pulley as described in the previous Section. Refer to Chapter 1 for details on refitting and adjusting the auxiliary drivebelt.

13 Timing chain, sprockets and tensioner - removal, inspection and refitting



Removal

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

2 Remove the timing chain cover as described in the previous Section.

3 Refer to Section 14 and remove the sump.

4 Remove the oil slinger from the front face of the crankshaft, noting its orientation (*see illustration*).

5 Retract the chain tensioner cam back against its spring pressure, then slide the chain tensioner arm from its pivot pin on the front main bearing cap (*see illustration*).

6 Unbolt and remove the chain tensioner.

7 Bend back the lockplate tabs from the camshaft sprocket bolts, then unscrew and remove the bolts.

8 Withdraw the sprocket complete with the timing chain.

Inspection

9 Examine the teeth on the timing sprockets for any signs of excessive wear or damage.

10 The timing chain should always be renewed during a major engine overhaul. Slack links and pins are indicative of a worn chain. Unless the chain is known to be relatively new, it should be renewed.

11 Examine the rubber cushion on the tensioner spring leaf. If grooved or deteriorated, it must be renewed.

Refitting

12 Commence reassembly by bolting the timing chain tensioner into position. Check that the face of the tensioner cam is parallel with the face of the cylinder block, ideally using a dial gauge. The maximum permissible error between the two measuring points is 0.2 mm. Release and turn the timing chain tensioner as required to achieve this (if necessary). Refer to the Specifications for the correct tightening torque.

13 Turn the crankshaft so that the timing mark on its sprocket is directly in line with the centre of the camshaft sprocket mounting flange.

14 Engage the camshaft sprocket with the timing chain, then engage the chain around

the teeth of the crankshaft sprocket. Push the camshaft sprocket onto its mounting flange, and check that the sprocket retaining bolt holes are in alignment. Also check that the timing marks of both sprockets face each other. If required, turn the camshaft/sprocket as required to achieve this. It may also be necessary to remove the camshaft from the chain in order to reposition it in the required location in the chain to align the timing marks. This is a "trial and error" procedure, which must be continued until the exact alignment of the bolt holes and the timing marks is made (*see illustrations*).

15 Insert and tighten the camshaft sprocket retaining bolts to the specified torque wrench setting. Bend up the tabs of the new lockplate to secure (*see illustration*).

16 Retract the timing chain tensioner cam, and then slide the tensioner arm onto its pivot pin. Release the cam so that it bears on the arm.

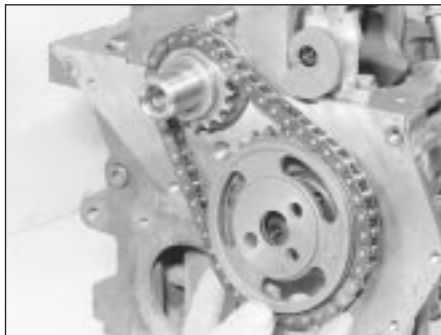
17 Refit the oil slinger to the front of the crankshaft sprocket so that its convex side faces the sprocket.

18 Refit the timing chain cover as described in the previous Section.

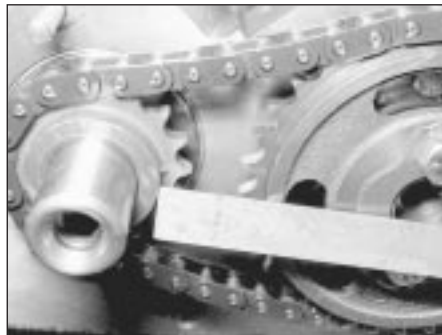
19 Refit the sump as described in Section 14. Top-up the engine oil level as described in Chapter 1.

20 Reconnect the battery.

21 When the engine is restarted, check for any sign of oil or coolant leaks from the sump and water pump (if disturbed).



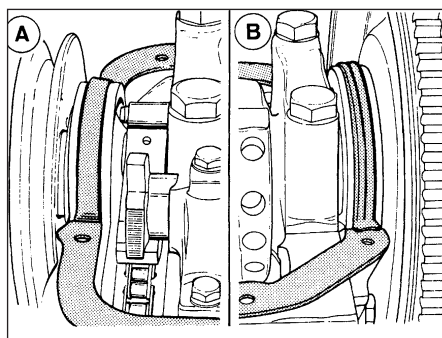
13.14A Fit the timing chain to the crankshaft and camshaft sprockets . . .



13.14B . . . and check that the timing marks on the sprockets are in alignment



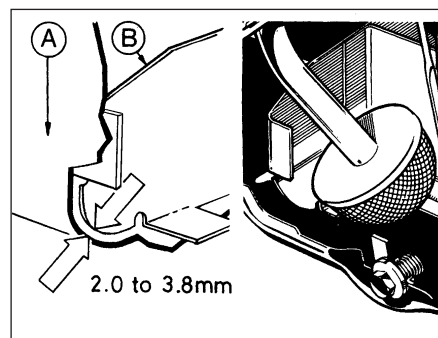
13.15 Bend locktabs against the camshaft retaining bolt heads to secure



14.8A Sump gasket fitting details at the timing chain cover end (A) and the flywheel end (B)



14.8B Lugs of cork gasket halves to fit under the cut-outs in the rubber gaskets



14.9 Sump (A) and oil baffle (B) clearance details

14 Sump - removal and refitting



Removal

- 1 Disconnect the battery negative (earth) lead (refer to Chapter 5, Section 1).
- 2 Refer Chapter 1 and drain the engine oil. Refit the sump drain plug.
- 3 Undo the retaining nuts and detach the exhaust downpipe from the manifold flange. Note that the flange gasket should be renewed on reassembly. Allowing sufficient clearance for sump removal, tie the exhaust downpipe up with a suitable length of wire or cord to prevent the system straining the insulators. On catalytic converter-equipped vehicles, avoid straining the oxygen sensor wiring, where applicable; if necessary, disconnect the sensor's multi-plug.
- 4 Remove the starter motor (see Chapter 5).
- 5 Undo the two retaining bolts and remove the clutch housing cover plate.
- 6 Undo the eighteen bolts securing the sump to the base of the engine crankcase, then prise free and lower the sump. If the sump is stuck tight to the engine, cut around the flange gasket with a sharp knife, then lightly tap and prise it free. Keep the sump upright as it is lowered, to prevent spillage of any remaining oil in it. Also be prepared for oil drips from the crankcase when the sump is removed.
- 7 Remove any dirt and old gasket from the contact faces of the sump and crankcase, and wash the sump out thoroughly before refitting. Check that the mating faces of the sump are not distorted. Check that the oil pick-up strainer is clear, cleaning it if necessary.

Refitting

- 8 Remove the old gaskets from the timing chain cover end, and from the flywheel end, and clean their location faces. Apply a dab of sealing compound to the mating faces where the ends of each cork half-gasket are to be fitted (see illustration). Stick the new cork gaskets into position on the block face, using clean thick grease to retain them, then locate

the new rubber gaskets into their slots in the timing chain cover and rear oil seal carrier. The lugs of the cork gasket halves fit under the cut-outs in the rubber gaskets (see illustration).

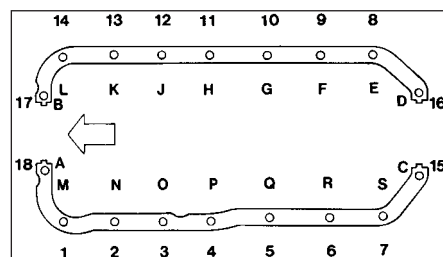
- 9 Before offering up the sump, check that the gap between the sump and the oil baffle is between 2.0 and 3.8 mm (see illustration). Do not use a dented or damaged sump, as the indicated dimension is important for correct engine lubrication.

- 10 Fit the sump into position, and fit the retaining bolts. Initially tighten them all finger-tight, then further tighten them in the sequence shown through Stages 1 and 2, to the torque wrench settings specified (see illustration). Note that different tightening sequences are specified for the tightening stages. Final (Stage 3) tightening is carried out after the engine has been started and warmed up.

- 11 Refit the lower plate to the front face of the clutch housing.
- 12 Refit the starter motor.

- 13 Check that the downpipe and manifold mating faces are clean, then locate a new gasket and reconnect the exhaust downpipe to the manifold. Where applicable, use new self-locking nuts, and tighten securely.

- 14 Check that the sump drain plug is fitted and tightened to the specified torque, then lower the vehicle to the ground.



14.10 Sump bolt tightening sequence - arrow indicates crankshaft pulley end of engine

Refer to Specifications for torque wrench settings

Stage 1 - Tighten in alphabetical order

Stage 2 - Tighten in numerical order

Stage 3 - Tighten in alphabetical order

- 15 Top-up the oil level in the sump as described in Chapter 1 (taking care not to over-fill).

- 16 Reconnect the battery, then start the engine and run it up to its normal operating temperature. Check that no oil leaks are evident around the sump joint.

- 17 After the engine has warmed up for approximately 15 minutes, switch it off. Tighten the sump bolts to the Stage 3 torque wrench setting given in the Specifications, in the sequence shown in illustration 14.10.

15 Oil pump - removal and refitting



Removal

- 1 The oil pump is externally-mounted, on the rear-facing side of the crankcase.
- 2 Apply the handbrake, then raise and support the vehicle at the front end on axle stands, allowing sufficient working clearance underneath.
- 3 Unscrew and remove the oil filter cartridge. It should unscrew by hand, but will probably be tight. Use a strap wrench to loosen it off, if required. Catch any oil spillage in a suitable container.
- 4 Undo the three retaining bolts and withdraw the oil pump from the engine (see illustration).



15.4 Unscrewing the oil pump retaining bolts



15.7 Refitting the oil pump. Note the new gasket

5 Clean all traces of the old gasket from the mating surfaces of the pump and engine.

Refitting

6 If the original oil pump has been dismantled and reassembled and is to be re-used, or if a new pump is to be fitted, it must first be primed with engine oil prior to fitting. To do this, turn its driveshaft and simultaneously inject clean engine oil into it.

7 Locate a new gasket into position on the pump mounting flange, then insert the pump, engaging the drivegear as it is fitted (see illustration). Fit the retaining bolts, and tighten to the specified torque wrench setting.

8 Fit a new oil filter into position on the oil pump body, as described in Chapter 1.

9 Lower the vehicle to the ground, and top-up the engine oil level to replenish that lost during the previous operations.

16 Oil pump - dismantling, inspection and reassembly



Dismantling

1 To inspect the oil pump components for excessive wear, undo the retaining bolts and remove the cover plate from the pump body. Remove the O-ring seal from the cover face (see illustration).

2 Wipe the exterior of the pump housing clean housing.



16.1 Extract the O-ring from the groove in the oil pump

Inspection

3 Noting their orientation, extract and clean the rotors and the inner body of the pump housing. Inspect them for signs of severe scoring or excessive wear, which if evident will necessitate renewal of the complete pump.

4 Using feeler gauges, check the clearances between the pump body and the outer rotor, the inner-to-outer rotor clearance, and the amount of rotor endfloat (see illustrations).

5 Check the drivegear for signs of excessive wear or damage.

6 If the clearances measured are outside the specified maximum clearances and/or the drivegear is in poor condition, the complete pump unit must be renewed.

Reassembly

7 Refit the rotors into the pump (in their original orientation), lubricate the rotors and the new O-ring seal with clean engine oil, and refit the cover. Tighten the retaining bolts to the specified torque wrench setting.

17 Crankshaft oil seals - renewal



Front oil seal

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

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

3 Refer to Section 11 for details and remove the crankshaft pulley.

4 Using a suitable claw tool, extract the oil seal from the timing chain cover, but take care not to damage the seal housing. As it is removed, note the fitted orientation of the seal in the cover.

5 Clean the oil seal housing in the timing chain cover. Lubricate the sealing lips of the new seal and the crankshaft stub with clean engine oil.

6 Locate the new seal into position so that it is squarely located on the crankshaft stub and in the housing, and is correctly orientated. Drift it initially into position by fitting a temporary distance piece against the seal, then draw it fully home by refitting the crankshaft pulley and retaining bolt.

7 When the seal is fully fitted, remove the crankshaft pulley bolt, pulley and distance piece.

8 Lightly lubricate the rubbing surface of the pulley, then refit the pulley as described in Section 11.

Rear oil seal

9 Remove the flywheel as described in Section 19.

10 Using a suitable claw tool, lever the seal from the rear seal housing (taking care not to damage the housing). As it is removed, note the fitted orientation of the seal.

11 Clean the seal housing, the crankshaft rear flange face and the flywheel mating surface.

12 One of two possible methods may be used to insert the new oil seal, depending on the tools available.

13 If Ford service tool No 21-011 is available, lubricate the crankshaft flange and the oil seal inner lip with clean engine oil. Position the seal onto the service tool (ensuring correct orientation), then press the seal into its housing.

14 If the service tool is not available, remove the engine sump (Section 14), then unscrew the Torx-head bolts retaining the rear seal housing in position, and remove the seal housing from the rear face of the cylinder block. New gaskets will be required for both the seal housing and the sump when refitting.



16.4A Checking the outer body-to-rotor clearance



16.4B Checking the inner rotor-to-outer rotor clearance



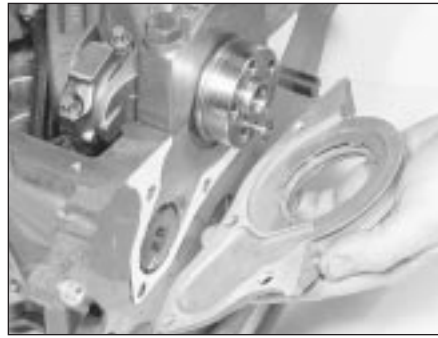
16.4C Checking the rotor endfloat



17.14A Positioning the crankshaft rear oil seal in its housing

Clean the seal housing seat and the mating surfaces of the sump and the crankcase. To fit the seal squarely into its housing without damaging either component, place a flat block of wood across the seal, then carefully tap the seal into position in the housing. Do not allow the seal to tilt as it is being fitted. Lubricate the crankshaft flange and the oil seal inner lip with clean engine oil, then with a new gasket located on the seal housing/crankcase face, fit the housing into position. Take care not damage the seal lips as it is passed over the crankshaft rear flange (see illustrations). Centralise the seal on the shaft, then insert and tighten the housing retaining bolts to the specified torque setting. Refit the sump with reference to Section 14.

15 Check that the crankshaft rear flange and the flywheel mating faces are clean, then refit the flywheel as described in Section 19.



17.14B Fitting the rear oil seal housing with a new gasket in position on the rear face of the cylinder block

or lever to attempt to move the mountings). If movement is noted, lower the engine and check-tighten the mounting fasteners.

Renewal

6 The engine mountings can be removed if the weight of the engine/transmission is

supported by one of the following alternative methods.

7 Either support the weight of the assembly from underneath using a jack and a suitable piece of wood between the jack saddle and the sump (to prevent damage), or from above by attaching a hoist to the engine. A third method is to use a suitable support bar with end pieces which will engage in the water channel each side of the bonnet lid aperture. Using an adjustable hook and chain connected to the engine, the weight of the engine and transmission can then be taken from the mountings.

8 Once the weight of the engine and transmission is suitably supported, any of the mountings can be unbolted and removed. The accompanying illustrations show the mountings and their attachments, and should be used for reference (see illustrations). As the mountings are disconnected and removed, note the location and orientation of the fixings and any associated fittings.

18 Engine/transmission mountings - inspection and renewal



Inspection

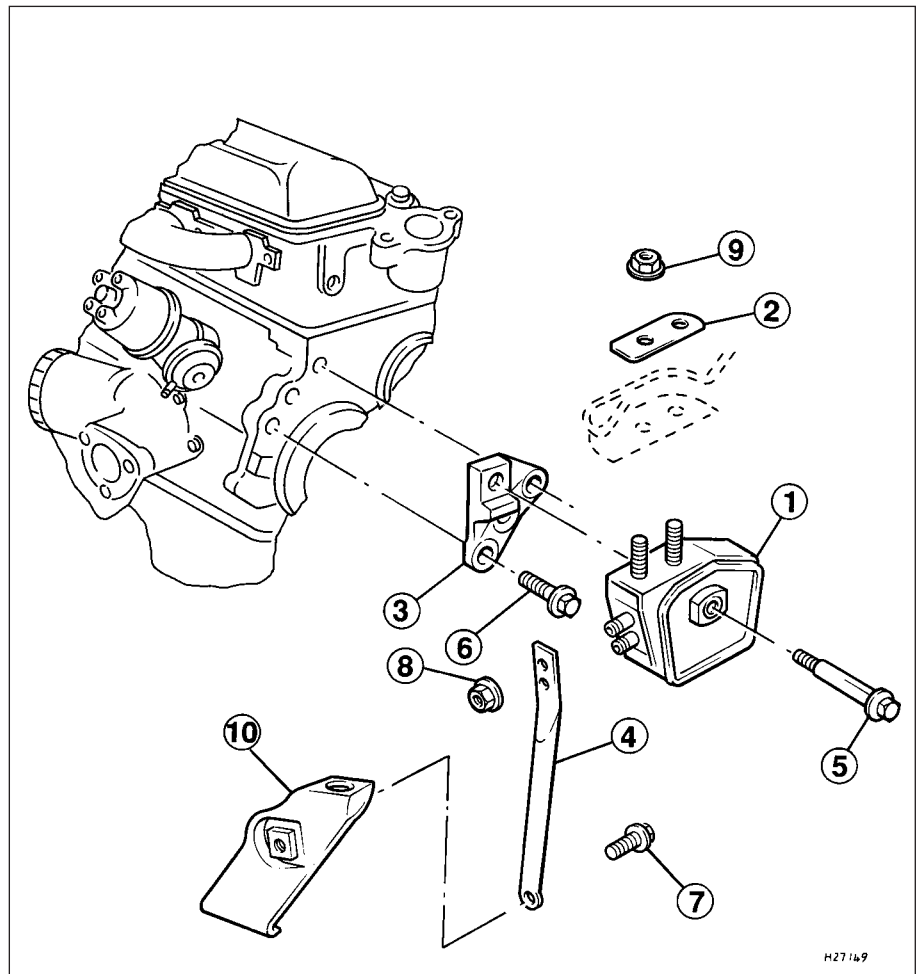
1 The engine/transmission mountings seldom require attention, but broken or deteriorated mountings should be renewed immediately, or the added strain placed on the driveline components may cause damage or wear.

2 During the check, the engine/transmission must be raised slightly, to remove its weight from the mountings.

3 Apply the handbrake, then raise the front of the vehicle, and support it securely on axle stands. Position a jack under the sump, with a large block of wood between the jack head and the sump, then carefully raise the engine/transmission just enough to take the weight off the mountings.

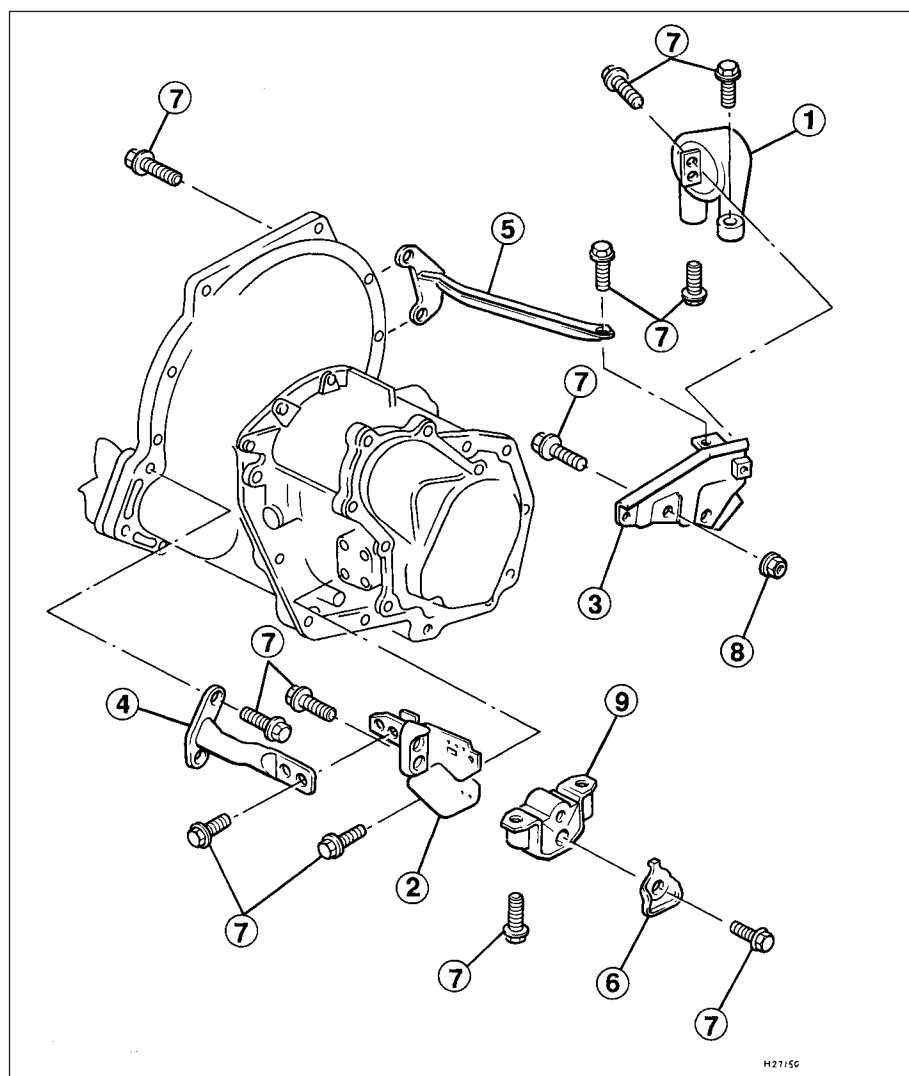
4 Check the mountings to see if the rubber is cracked, hardened or separated from the metal components. Sometimes, the rubber will split right down the centre.

5 Check for relative movement between each mounting's brackets and the engine/transmission or body (use a large screwdriver



18.8A Right-hand engine mounting components

- | | | | |
|-----------------------|--------------------|--------------------|--------------------|
| 1 Insulator | 3 Mounting bracket | 6 Bolt | 9 Self-locking nut |
| 2 Reinforcement plate | 4 Support | 7 Bolt | 10 Insulator |
| | 5 Bolt and washer | 8 Self-locking nut | |

**18.8B Left-hand engine/transmission mounting components**

- | | | | |
|----------------------------|----------------|--------------------|--------------------------|
| 1 Engine support insulator | 3 Bracket | 6 Retainer | 9 Engine support bracket |
| 2 Mounting bracket | 4 Support stay | 7 Bolt and washer | |
| | 5 Support stay | 8 Self-locking nut | |

9 Refitting of all mountings is a reversal of the removal procedure. Ensure that the original sequence of washers and associated fittings are correctly fitted.

10 Do not fully tighten the mounting fasteners until all of the mountings are in position. Check that the mounting rubbers do not twist or distort as the mounting bolts and nuts are tightened to their specified torque wrench settings.

19 Flywheel - removal, inspection and refitting

Refitting

1 Remove the transmission as described in Chapter 7A, then remove the clutch as described in Chapter 8.

2 Unscrew the six retaining bolts, and remove



19.5 Tightening the flywheel retaining bolts to the specified torque

Note the "peg" tool jamming the ring gear teeth to prevent the flywheel/crankshaft from rotating.

the flywheel from the rear end flange of the crankshaft - take care not to drop the flywheel, as it is heavy. A tool similar to that shown in illustration 19.5 can be fitted to prevent the flywheel/crankshaft from rotating as the bolts are removed. If on removal the retaining bolts are found to be in poor condition (stretched threads, etc) they must be renewed.

Inspection

3 Inspect the starter ring gear on the flywheel for any broken or excessively-worn teeth. If evident, the ring gear must be renewed; this is a task best entrusted to a Ford dealer or a competent garage. Alternatively, it may be cheaper to obtain a complete flywheel from a car breaker.

4 The clutch friction surface on the flywheel must be carefully inspected for grooving or hairline cracks (caused by overheating). If these conditions are evident, it may be possible to have the flywheel surface-ground to renovate it, providing that the balance is not upset. Regrinding is a task for an automotive engineer. If surface-grinding is not possible, the flywheel must be renewed.

Refitting

5 Check that the mating faces of the flywheel and the crankshaft are clean before refitting. Lubricate the threads of the retaining bolts with engine oil before they are screwed into position. Locate the flywheel onto the crankshaft, and insert the bolts. Hand-tighten them initially, then tighten them in a progressive sequence to the specified torque wrench setting (**see illustration**).

6 Refit the clutch as described in Chapter 6.