

Chapter 2 Part C: Zetec engine in-car repair procedures

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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

2C

General

| | |
|----------------------------------|---|
| Engine type | Four-cylinder, in-line, double overhead camshafts |
| Engine code: | |
| 1.6 litre models | L1G |
| 1.8 litre models | RDB or RQC |
| Capacity: | |
| 1.6 litre models | 1597 cc |
| 1.8 litre models | 1796 cc |
| Bore: | |
| 1.6 litre models | 76.0 mm |
| 1.8 litre models | 80.6 mm |
| Stroke - all models | 88.0 mm |
| Compression ratio: | |
| 1.6 litre models | 10.3:1 |
| 1.8 litre models | 10.0:1 |
| Firing order | 1-3-4-2 (No 1 cylinder at timing belt end) |
| Direction of crankshaft rotation | Clockwise (seen from right-hand side of vehicle) |

Cylinder head

| | |
|---------------------------------------|---------------------|
| Hydraulic tappet bore inside diameter | 28.395 to 28.425 mm |
|---------------------------------------|---------------------|

Camshafts and hydraulic tappets

| | |
|---|---------------------|
| Camshaft bearing journal diameter | 25.960 to 25.980 mm |
| Camshaft bearing journal-to-cylinder head running clearance | 0.020 to 0.070 mm |
| Camshaft endfloat | 0.080 to 0.220 mm |

Lubrication

| | |
|-------------------------------|---|
| Engine oil type/specification | See "Lubricants, fluids and tyre pressures" |
| Engine oil capacity | See "Lubricants, fluids and tyre pressures" |
| Oil pressure: | |
| Idling | 1.3 to 2.5 bar |
| At 4000 rpm | 3.7 to 5.5 bars |
| Oil pump clearances | Not specified |

| Torque wrench settings | Nm | lbf ft |
|---|------------------------------|---------------|
| Cylinder head cover bolts: | | |
| Stage 1 | 2 | 1.5 |
| Stage 2 | 7 | 5 |
| Camshaft sprocket bolts | 68 | 50 |
| Camshaft bearing cap bolts: | | |
| Stage 1 | 9 | 7 |
| Stage 2 | 19 | 14 |
| Cylinder head bolts: | | |
| Stage 1 | 24 | 18 |
| Stage 2 | 45 | 33 |
| Stage 3 | Angle-tighten a further 105° | |
| Timing belt cover fasteners: | | |
| Upper-to-middle (outer) cover bolts | 4 | 3 |
| Cover-to-cylinder head or block bolts | 7 | 5 |
| Cover studs-to-cylinder head or block | 9 | 7 |
| Timing belt tensioner bolt | 38 | 28 |
| Timing belt tensioner backplate locating peg | 9 | 7 |
| Timing belt tensioner spring retaining pin | 9 | 7 |
| Timing belt guide pulley bolts | 38 | 28 |
| Water pump pulley bolts | 9 | 7 |
| Auxiliary drivebelt idler pulley | 47 | 35 |
| Front engine lifting eye bolt | 16 | 12 |
| Exhaust manifold heat shield bolts: | | |
| Shield-to-cylinder head | 7 | 5 |
| Shield/dipstick tube | 9 | 7 |
| Shield/coolant pipe-to-manifold | 23 | 17 |
| Crankshaft pulley bolt | 115 | 85 |
| Oil pump-to-cylinder block bolts | 10 | 7 |
| Oil pick-up pipe-to-pump screws | 10 | 7 |
| Oil baffle/pump pick-up pipe nuts | 19 | 14 |
| Oil filter adapter-to-pump | 22 | 16 |
| Oil pressure warning light switch | 27 | 20 |
| Sump bolts | 20 | 15 |
| Coolant pipe-to-sump bolt | 9 | 7 |
| Flywheel/driveplate bolts | 110 | 81 |
| Crankshaft left-hand oil seal carrier bolts | 22 | 16 |
| Engine mountings: | | |
| Engine front right-hand mounting: | | |
| Alternator mounting bracket-to-cylinder block bolts | 41 to 58 | 30 to 43 |
| Mounting bracket-to-alternator mounting bracket bolts | Not available | Not available |
| Mounting through-bolt | Not available | Not available |
| Outer bracket-to-mounting bolts | 58 to 79 | 43 to 58 |
| Inner bracket-to-body bolts | 58 to 79 | 43 to 58 |
| Outer bracket-to-body bolts | 58 to 79 | 43 to 58 |
| Engine rear right-hand mounting: | | |
| Bracket-to-cylinder block bolts | 76 to 104 | 56 to 77 |
| Mounting-to-(cylinder block) bracket bolts | 71 to 98 | 52 to 72 |
| Mounting-to-body bolt and nut | 102 to 138 | 75 to 102 |
| Transmission mounting fasteners | Refer to Chapter 7A or 7B | |

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 1.3 litre HCS engines, and the 1.4 and 1.6 litre CVH and PTE engines, will be found in Parts A and B 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.

Engine description

The Zetec engine, (formerly Zeta), is of sixteen-valve, double overhead camshaft

(DOHC), four-cylinder, in-line type, mounted transversely at the front of the vehicle, with the transmission on its left-hand end.

Apart from the plastic timing belt covers and the cast-iron cylinder block/crankcase, all major engine castings are of aluminium alloy.

The crankshaft runs in five main bearings, the centre main bearing's upper half incorporating thrustwashers to control crankshaft endfloat. The connecting rods rotate on horizontally-split bearing shells at their big-ends. The pistons are attached to the connecting rods by gudgeon pins which are an interference fit in the connecting rod small-end eyes. The aluminium alloy pistons are

fitted with three piston rings: two compression rings and an oil control ring. After manufacture, the cylinder bores and piston skirts are measured and classified into three grades, which must be carefully matched together, to ensure the correct piston/cylinder clearance; no oversizes are available to permit reboring.

The inlet and exhaust valves are each closed by coil springs; they operate in guides which are shrink-fitted into the cylinder head, as are the valve seat inserts.

Both camshafts are driven by the same toothed timing belt, each operating eight valves via self-adjusting hydraulic tappets, thus eliminating the need for routine checking and adjustment of the valve clearances. Each camshaft rotates in five bearings that are line-bored directly in the cylinder head and the (bolted-on) bearing caps; this means that the bearing caps are not available separately from the cylinder head, and must not be interchanged with caps from another engine.

The water pump is bolted to the right-hand end of the cylinder block, inboard of the timing belt, and is driven with the power steering pump and alternator by a flat "polyvee"-type auxiliary drivebelt from the crankshaft pulley.

When working on this engine, note that Torx-type (both male and female heads) and hexagon socket (Allen head) fasteners are widely used; a good selection of bits, with the necessary adapters, will be required, so that these can be unscrewed without damage and, on reassembly, tightened to the torque wrench settings specified.

Lubrication is by means of an eccentric-rotor trochoidal pump, which is mounted on the crankshaft right-hand end, and draws oil through a strainer located in the sump. The pump forces oil through an externally-mounted full-flow cartridge-type filter - on some versions of the engine, an oil cooler is fitted to the oil filter mounting, so that clean oil entering the engine's galleries is cooled by the main engine cooling system.

Repair operations possible with the engine in the car

The following work can be carried out with the engine in the car:

- a) Compression pressure - testing.
- b) Cylinder head cover - removal and refitting.
- c) Timing belt covers - removal and refitting.
- d) Timing belt - renewal.
- e) Timing belt tensioner and sprockets - removal and refitting.
- f) Camshaft oil seals - renewal.
- g) Camshafts and hydraulic tappets - removal and refitting.
- h) Cylinder head - removal and refitting.
- i) Cylinder head and pistons - decarbonising.
- j) Sump - removal and refitting.
- k) Crankshaft oil seals - renewal.
- l) Oil pump - removal and refitting.

m) Flywheel/driveplate - removal and refitting.

n) Engine/transmission mountings - removal and refitting.

Note: It is possible to remove the pistons and connecting rods (after removing the cylinder head and sump) without removing the engine. However, this is not recommended. Work of this nature is more easily and thoroughly completed with the engine on the bench, as described in Chapter 2D.

2 Compression test - description and interpretation

Refer to Section 2 in Part A of this Chapter.

3 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 on the compression stroke for No 1 piston is used. No 1 cylinder is at the timing belt end of the engine. Proceed as follows.

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

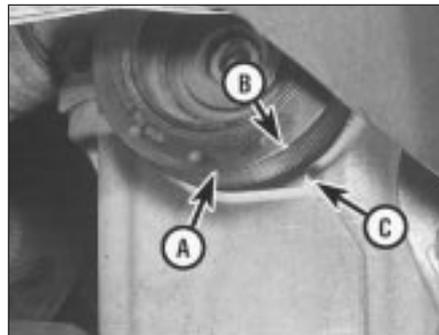
3 Chock the rear wheels then jack up the front of the car and support it on axle stands (see "Jacking and Vehicle Support"). Remove the right-hand roadwheel.

4 Remove the auxiliary drivebelt cover (see Chapter 1) to expose the crankshaft pulley and timing marks.

5 Fit a spanner onto the crankshaft pulley bolt, and turn the crankshaft in its normal direction of rotation (clockwise, viewed from the pulley end).



Turning the engine will be easier if the spark plugs are removed first - see Chapter 1.



3.6a Do not use crankshaft pulley's first pair of notches "A" - align second pair of notches "B" with raised rib on sump "C" . . .

6 Note the two pairs of notches in the inner and outer rims of the crankshaft pulley. In the normal direction of crankshaft rotation the first pair of notches are irrelevant to the vehicles covered in this manual, while the second pair indicate TDC when aligned with the rear edge of the raised mark on the sump. Rotate the crankshaft clockwise until the second pair of notches align with the edge of the sump mark; use a straight edge extended out from the sump if greater accuracy is required (see illustrations).

7 Nos 1 and 4 cylinders are now at TDC, one of them on the compression stroke. Remove the oil filler cap; if No 4 cylinder exhaust cam lobe is pointing to the rear of the vehicle and slightly downwards, it is No 1 cylinder that is correctly positioned. If the lobe is pointing horizontally forwards, rotate the crankshaft one full turn (360°) clockwise until the pulley notches align again, and the lobe is pointing to the rear and slightly down. No 1 cylinder will then be at TDC on the compression stroke.

8 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 180° at a time and following the firing order (see Specifications).

9 With the engine set at No 1 piston on TDC compression, refit the drivebelt cover and the roadwheel, then lower the vehicle and refit the spark plugs.

4 Cylinder head cover - removal and refitting

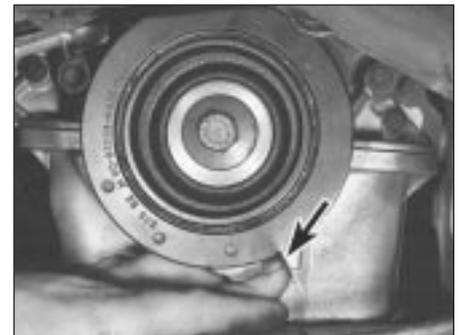
Removal

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

2 Remove the air inlet components as necessary for access as described in the Chapter 4D.

3 Disconnect the accelerator cable from the throttle linkage as described in Chapter 4D.

4 On models equipped with power steering, release the high pressure fluid pipe from the



3.6b . . . use a straight edge extended out from the sump (arrowed) if greater accuracy is required



4.6 Disconnecting crankcase breather hose from cylinder head cover union



4.8 Removing cylinder head cover



4.10 Ensure gasket is located correctly in cover groove

clamp brackets and disconnect the pipe joint union over the top of the cylinder head cover. Place absorbent rags beneath the union as it is disconnected to soak up escaping fluid and plug the open unions to prevent dirt entry and further fluid loss. Move the pipe(s) clear just sufficiently to allow removal of the cylinder head cover.

5 Remove the timing belt upper cover (see Section 7).

6 Disconnect the crankcase breather hose from the cylinder head cover union (see illustration).

7 Unplug the HT leads from the spark plugs and withdraw them, unclipping the leads from the cover.

8 Working progressively, unscrew the cylinder head cover retaining bolts, noting the spacer sleeve and rubber seal at each, then withdraw the cover (see illustration).

9 Discard the cover gasket; this *must* be renewed whenever it is disturbed. Check that the sealing faces are undamaged, and that the rubber seal at each retaining bolt is serviceable; renew any worn or damaged seals.

Refitting

10 On refitting, clean the cover and cylinder head gasket faces carefully, then fit a new gasket to the cover, ensuring that it locates correctly in the cover grooves (see illustration).

11 Refit the cover to the cylinder head, then insert the rubber seal and spacer sleeve at each bolt location (see illustration). Start all

bolts finger-tight, ensuring that the gasket remains seated in its groove.

12 Working in a diagonal sequence from the centre outwards, and in two stages (see Specifications), tighten the cover bolts to the specified torque wrench setting.

13 Refit the HT leads, clipping them into place so that they are correctly routed; each is numbered, and can also be identified by the numbering on its respective coil terminal.

14 Reconnect the crankcase breather hose, and refit the timing belt upper cover. Reconnect and adjust the accelerator cable, then refit the air inlet components (see Chapter 4B).

15 On models with power steering, reconnect the high pressure fluid pipe then bleed the system as described in Chapter 10.

5 Valve clearances - general information

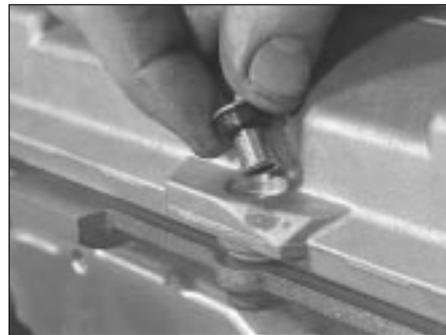
Refer to Section 5 in Part B of this Chapter.

6 Crankshaft pulley - removal and refitting



Removal

1 Remove the auxiliary drivebelt - either remove the drivebelt completely, or just



4.11 Ensure rubber seal is fitted to each cover bolt spacer, as shown



6.9 Unscrew pulley bolt to release crankshaft pulley

secure it clear of the crankshaft pulley, depending on the work to be carried out (see Chapter 1).

2 If necessary, rotate the crankshaft until the timing marks align (see Section 3).

3 The crankshaft must now be locked to prevent its rotation while the pulley bolt is unscrewed. To do this, remove the starter motor (Chapter 5A) and lock the starter ring gear teeth using a suitable screwdriver.

4 It should now just be possible to reach between the crankshaft pulley and the body side member to undo and remove the pulley bolt and withdraw the pulley. However, if additional working clearance is needed, proceed as follows.

5 If not already done, chock the rear wheels then jack up the front of the car and support it on axle stands (see "Jacking and Vehicle Support"). Remove the front right-hand roadwheel.

6 Support the weight of the engine/transmission using a trolley jack, with a wooden spacer to prevent damage to the sump.

7 From above, unscrew the three bolts securing the engine's front right-hand (Y-shaped) mounting bracket to the alternator mounting bracket. Unfasten the engine's rear right-hand mounting from the body by unscrewing first the single nut (and washer) immediately to the rear of the timing belt cover, then the bolt in the wheel arch

8 With the engine's right-hand mountings unfastened from the body, lower the engine/transmission on the jack until a socket spanner can be fitted to the crankshaft pulley bolt.

9 With the starter ring gear teeth locked, unscrew the crankshaft pulley bolt and withdraw the pulley (see illustration).

Refitting

10 Refitting is the reverse of the removal procedure; ensure that the pulley's keyway is aligned with the crankshaft's locating key, and tighten the pulley bolt to the specified torque wrench setting. If the engine mountings were disturbed, use the jack to adjust the height of the engine/transmission until the bolts (and nut, with washer) can be refitted and screwed

home by hand, then tighten them securely, to the specified torque wrench settings, where given.

11 Refit the auxiliary drivebelt as described in Chapter 1 on completion.

7 Timing belt covers - removal and refitting



Upper cover

1 Unscrew the cover's two mounting bolts and withdraw it (see illustration).

2 Refitting is the reverse of the removal procedure; ensure that the cover edges engage correctly with each other, and note the torque wrench setting specified for the bolts.

Middle cover

3 Slacken the water pump pulley bolts.

4 Remove the timing belt upper cover.

5 Remove the auxiliary drivebelt (see Chapter 1).

6 Unbolt and remove the water pump pulley.

7 Unscrew the middle cover fasteners (one bolt at the front, one at the lower rear, one stud at the top rear) and withdraw the cover.

8 Refitting is the reverse of the removal procedure. Ensure that the cover edges engage correctly with each other, and note the torque wrench settings specified for the various fasteners.

Lower cover

9 Slacken the water pump pulley bolts.

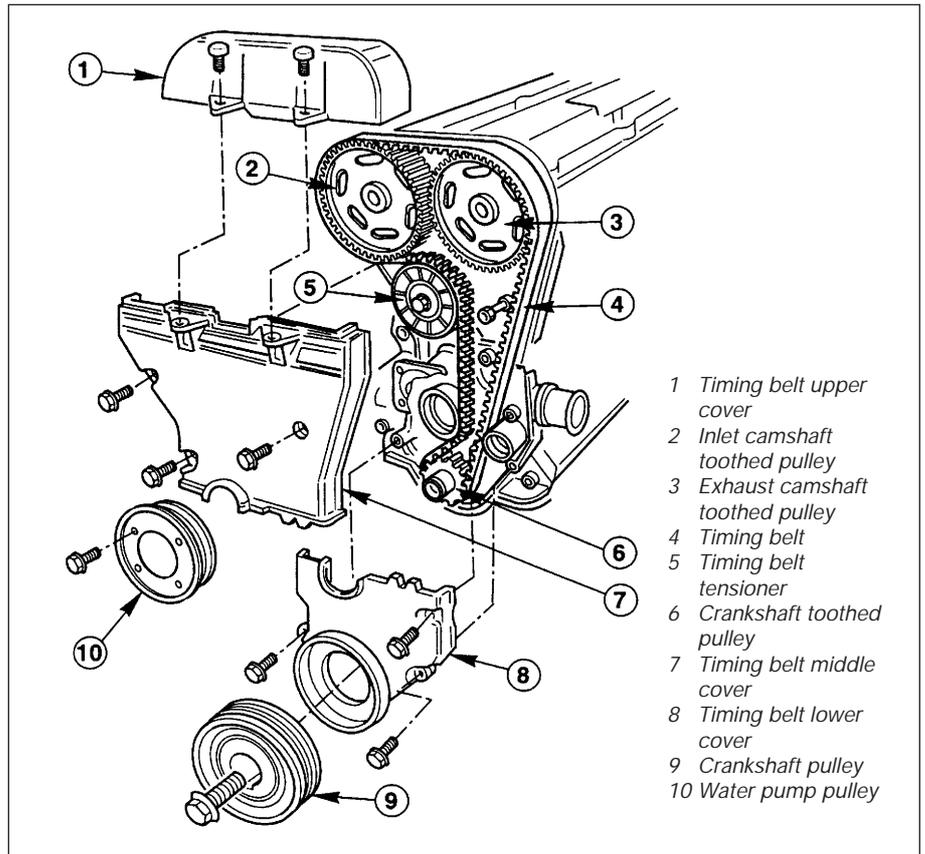
10 Remove the crankshaft pulley (see Section 6) then unbolt and remove the water pump pulley.

11 Unscrew the three cover securing bolts, and withdraw it (see illustration).

12 Refitting is the reverse of the removal procedure; ensure the cover edges engage correctly with each other, and note the torque wrench settings specified for the various fasteners.

Inner shield

13 Remove the timing belt, its tensioner components and the camshaft sprockets (see Sections 8 and 9).



7.1 Timing belt and cover details

14 The shield is secured to the cylinder head by two bolts at the top, and by two studs lower down; unscrew these and withdraw the shield (see illustration).

15 Refitting is the reverse of the removal procedure; note the torque wrench settings specified for the various fasteners.

8 Timing belt - removal, refitting and adjustment



Note: To carry out this operation, a new timing belt (where applicable), a new cylinder head cover gasket, and some special tools (see text)

will be required. If the timing belt is being removed for the first time since the vehicle left the factory, a tensioner spring and retaining pin must be obtained for fitting on reassembly.

Removal

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

2 Slacken the water pump pulley bolts.

3 Remove the cylinder head cover (see Section 4).

4 Remove the spark plugs, covering their holes with clean rag, to prevent dirt or other foreign bodies from dropping in (see Chapter 1).

5 Remove the auxiliary drivebelt (see Chapter 1).

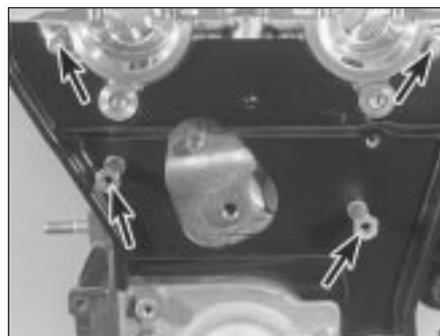
6 Position the engine with No 1 piston at TDC on compression as described in Section 3.

7 Unbolt and remove the water pump pulley and, where fitted, the auxiliary drivebelt idler pulley.

8 Obtain Ford service tool 21-162, or fabricate a substitute alternative from a strip of metal 5 mm thick (while the strip's thickness is critical, its length and width are not, but should be approximately 180 to 230 mm by 20 to 30 mm). Check that Nos 1 and 4 cylinders are at TDC - No 1 on the compression stroke - by resting this tool on the cylinder head mating surface, and sliding



7.11 Removing timing belt lower cover - bolt locations arrowed



7.14 Timing belt inner shield fasteners (arrowed)



8.8 Fit camshaft-aligning tool to ensure engine is locked with Nos 1 and 4 cylinders at TDC

it into the slot in the left-hand end of both camshafts (see illustration). The tool should slip snugly into both slots while resting on the cylinder head mating surface; if one camshaft is only slightly out of alignment, it is permissible to use an open-ended spanner to rotate the camshaft gently and carefully until the tool will fit.

9 If both camshaft slots (they are machined significantly off-centre) are below the level of the cylinder head mating surface, rotate the crankshaft through one full turn clockwise and fit the tool again; it should now fit as described in the previous paragraph.

10 With the camshaft aligning tool remaining in place, remove the crankshaft pulley. *Do not* use the locked camshafts to prevent the crankshaft from rotating - use only the locking method described in Section 6.

11 Remove the timing belt lower and middle covers (see Section 7).

12 With the camshaft-aligning tool still in place, slacken the tensioner bolt, and use an Allen key inserted into its centre to rotate the tensioner clockwise as far as possible away from the belt; retighten the bolt to secure the tensioner clear of the timing belt (see illustration).

13 If the timing belt is to be re-used, use white paint or similar to mark its direction of rotation, and note from the manufacturer's markings which way round it is fitted. Withdraw the belt. *Do not* rotate the crankshaft until the timing belt is refitted.



8.17a Fitting tensioner spring retaining pin



8.12 Slacken tensioner bolt, and use Allen key to rotate tensioner away from timing belt

14 If the belt is being removed for reasons other than routine renewal, check it carefully for any signs of uneven wear, splitting, cracks (especially at the roots of the belt teeth) or contamination with oil or coolant. Renew the belt if there is the slightest doubt about its condition. As a safety measure, the belt must be renewed as a matter of course at the intervals given in Chapter 1; if its history is unknown, the belt should be renewed irrespective of its apparent condition whenever the engine is overhauled. Similarly, check the tensioner spring (where fitted), renewing it if there is any doubt about its condition. Check also the sprockets for signs of wear or damage, and ensure that the tensioner and guide pulleys rotate smoothly on their bearings; renew any worn or damaged components. If signs of oil or coolant contamination are found, trace the source of the leak and rectify it, then wash down the engine timing belt area and related components, to remove all traces of oil or coolant.

Refitting and adjustment

15 On reassembly, temporarily refit the crankshaft pulley, to check that the crankshaft is still positioned at TDC for No 1 piston on compression, then ensure that both camshafts are aligned at TDC by the special tool (paragraph 8). If the engine is being reassembled after major dismantling, both camshaft sprockets should be free to rotate

on their respective camshafts; if the timing belt alone is being renewed, both sprockets should still be securely fastened.

16 A holding tool will be required to prevent the camshaft sprockets from rotating while their bolts are slackened and retightened; either obtain Ford service tool 15-030A, or fabricate a suitable substitute (see Tool Tip).

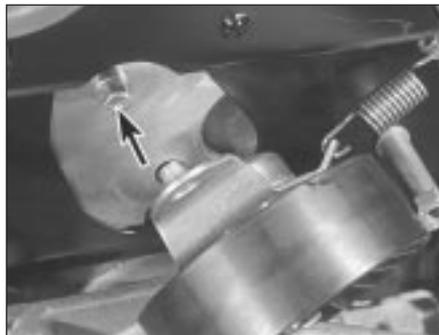
Note: *Do not use the camshaft-aligning tool (whether genuine Ford or not) to prevent rotation while the camshaft sprocket bolts are slackened or tightened; the risk of damage to the camshaft concerned and to the cylinder head is far too great. Use only a forked holding tool applied directly to the sprockets, as described.*

TOOL TIP

To make a camshaft sprocket holding tool, obtain two lengths of steel strip about 6 mm thick by 30 mm wide or similar, one 600 mm long, the other 200 mm long (all dimensions approximate). Bolt the two strips together to form a forked end, leaving the bolt slack so that the shorter strip can pivot freely. At the end of each "prong" of the fork, bend the strips through 90° about 50 mm from their ends to act as the fulcrums; these will engage with the holes in the sprockets. It may be necessary to grind or cut off their sides slightly to allow them to fit the sprocket holes (see illustration 8.23).

17 If it is being fitted for the first time, screw the timing belt tensioner spring retaining pin into the cylinder head, tightening it to the specified torque wrench setting. Unbolt the tensioner, hook the spring on to the pin and the tensioner backplate, then refit the tensioner, engaging its backplate on the locating peg (see illustrations).

18 In all cases, slacken the tensioner bolt (if necessary), and use an Allen key inserted into its centre to rotate the tensioner as far as possible against spring tension, then retighten the bolt to secure the tensioner (see illustration).



8.17b Hook spring onto tensioner and fit as shown - engage tensioner backplate on locating peg (arrowed) . . .



8.18 . . . then use Allen key to position tensioner so that timing belt can be refitted



8.20 Slacken tensioner bolt to give initial belt tension



8.23 Using forked holding tool while camshaft toothed pulley bolt is tightened



8.24 When setting is correct, tighten tensioner bolt to specified torque wrench setting

19 Fit the timing belt; if the original is being refitted, ensure that the marks and notes made on removal are followed, so that the belt is refitted the same way round, and to run in the same direction. Starting at the crankshaft sprocket, work anti-clockwise around the camshaft sprockets and tensioner, finishing off at the rear guide pulley. The front run, between the crankshaft and the exhaust camshaft sprockets, *must* be kept taut, without altering the position either of the crankshaft or of the camshaft(s) - if necessary, the position of the camshaft sprockets can be altered by rotating each on its camshaft (which remains fixed by the aligning tool). Where the sprocket is still fastened, use the holding tool described above to prevent the sprocket from rotating while its retaining bolt is slackened - the sprocket can then be rotated on the camshaft until the belt will slip into place; retighten the sprocket bolt.

20 When the belt is in place, slacken the tensioner bolt gently until the spring pulls the tensioner against the belt; the tensioner should be retained correctly against the timing belt inner shield and cylinder head, but must be just free to respond to changes in belt tension (see illustration).

21 Tighten both camshaft sprocket bolts (or check that they are tight, as applicable) and remove the camshaft-aligning tool. Temporarily refit the crankshaft pulley, and rotate the crankshaft through two full turns clockwise to settle and tension the timing belt, returning the crankshaft to the TDC position described previously. Refit the camshaft-aligning tool; it should slip into place as described in paragraph 8. If all is well, proceed to paragraph 24 below.

22 If one camshaft is only just out of line, fit the forked holding tool to its sprocket, adjust its position as required, and check that any slack created has been taken up by the tensioner; rotate the crankshaft through two further turns clockwise, and refit the camshaft-aligning tool to check that it now fits as it should. If all is well, proceed to paragraph 24 below.

23 If either camshaft is significantly out of line, use the holding tool to prevent its sprocket from rotating while its retaining bolt

is slackened - the camshaft can then be rotated (gently and carefully, using an open-ended spanner) until the camshaft-aligning tool will slip into place; take care not to disturb the relationship of the sprocket to the timing belt. Without disturbing the sprocket's new position on the camshaft, tighten the sprocket bolt to its specified torque wrench setting (see illustration). Remove the camshaft-aligning tool, rotate the crankshaft through two further turns clockwise, and refit the tool to check that it now fits as it should.

24 When the timing belt has been settled at its correct tension, and the camshaft-aligning tool fits correctly when the crankshaft pulley notches are exactly aligned, tighten the tensioner bolt to its specified torque wrench setting (see illustration). Fitting the forked holding tool to the spokes of each sprocket in turn, check that the sprocket bolts are tightened to their specified torque wrench setting. Remove the camshaft-aligning tool, rotate the crankshaft through two further turns clockwise, and refit the tool to make a final check that it fits as it should.

25 The remainder of the reassembly procedure is the reverse of removal, ensuring that all fasteners are tightened to the specified torque.

9 Timing belt tensioner and sprockets - removal, inspection and refitting



Tensioner

Note: If the tensioner is being removed for the first time since the vehicle left the factory, a tensioner spring and retaining pin must be obtained for fitting on reassembly.

1 While it is possible to reach the tensioner once the timing belt upper and middle covers only have been removed, the whole procedure outlined below must be followed, to ensure that the valve timing is correctly reset once the belt's tension has been disturbed.

2 Release the tension from the timing belt as described in Section 8, paragraphs 1 to 12.

3 Unscrew the tensioner bolt and withdraw

the tensioner, unhooking the spring, if fitted (see illustration). Check the tensioner spring, and renew it if there is any doubt about its condition.

4 On reassembly, if it is being fitted for the first time, screw the timing belt tensioner spring retaining pin into the cylinder head, tightening it to the specified torque wrench setting. Hook the spring onto the pin and the tensioner backplate, then refit the tensioner, engaging its backplate on the locating peg.

5 Use an Allen key inserted into its centre to rotate the tensioner as far as possible against spring tension, then tighten the bolt to secure the tensioner.

6 Reassemble, checking the camshaft alignment (valve timing) and setting the timing belt tension, as described in paragraphs 20 to 25 of Section 8.

Camshaft and crankshaft sprockets

7 While it may be possible to remove any of these sprockets once the relevant belt covers have been removed, the complete timing belt removal/refitting procedure (see Section 8) must be followed, to ensure that the valve timing is correctly reset once the belt's tension has been disturbed.

8 With the timing belt removed, the camshaft sprockets can be detached once their retaining bolts have been unscrewed as described in paragraph 16 of Section 8. The crankshaft sprocket can be pulled off the end of the crankshaft, once the crankshaft pulley



9.3 Removing timing belt tensioner



9.8 "FRONT" marking on outside face of crankshaft toothed pulley - note which way round thrustwasher behind is fitted

and the timing belt have been removed. Note the "FRONT" marking identifying the sprocket's outboard face, and the thrustwasher behind it; note which way round the thrustwasher is fitted (see illustration). Note the sprocket-locating Woodruff key; if this is loose, it should be removed for safe storage with the sprocket.

9 Check the sprockets as described in paragraph 14 of Section 8.

10 Refitting is the reverse of the removal procedure.

Timing belt guide pulleys

11 Remove the timing belt covers (see Section 7).

12 Unbolt and withdraw the pulley(s); check their condition as described in paragraph 14 of Section 8.

13 Refitting is the reverse of the removal procedure; tighten the pulley bolts to the specified torque wrench setting.

10 Camshaft oil seals - renewal



Note: While it is possible to reach either oil seal, once the respective sprocket has been removed (see Section 9) to allow the seal to be prised out, this procedure is not recommended. Not only are the seals very soft, making this difficult to do without risk of



10.5 Using socket and toothed pulley bolt to install camshaft oil seal

damage to the seal housing, but it would be very difficult to ensure that the valve timing and the timing belt's tension, once disturbed, are correctly reset. Owners are advised to follow the whole procedure outlined below.

1 Release the tension from the timing belt as described in Section 8, paragraphs 1 to 12.

Note: If the timing belt is found to be contaminated by oil, remove it completely as described, then renew the oil seal (see below). Wash down the engine timing belt area and all related components, to remove all traces of oil. Fit a new belt on reassembly.

2 If the timing belt is still clean, slip it off the sprocket, taking care not to twist it too sharply; use the fingers only to handle the belt. Do not rotate the crankshaft until the timing belt is refitted. Cover the belt, and secure it so that it is clear of the working area and cannot slip off the remaining sprocket.

3 Unfasten the sprocket bolt and withdraw the sprocket (see Section 9).

4 Unbolt the camshaft right-hand bearing cap, and withdraw the defective oil seal. Clean the seal housing, and polish off any burrs or raised edges, which may have caused the seal to fail in the first place.

5 To fit a new seal, Ford recommend the use of their service tool 21-009B, with a bolt (10 mm thread size, 70 mm long) and a washer, to draw the seal into place when the camshaft bearing cap is bolted down; a substitute can be made using a suitable socket (see illustration). Grease the seal lips and periphery to ease installation, and draw

the seal into place until it is flush with the housing/bearing cap outer edge. Refit the bearing cap, using sealant and tightening the cap bolts as described in Section 11.

6 For most owners, the simplest answer will be to grease the seal lips, and to slide it onto the camshaft (until it is flush with the housing's outer edge). Refit the bearing cap, using sealant and tightening the cap bolts as described in Section 11 (see illustration). Take care to ensure that the seal remains absolutely square in its housing, and is not distorted as the cap is tightened down.

7 Refit the sprocket to the camshaft, tightening the retaining bolt loosely, then slip the timing belt back onto the sprocket (refer to paragraphs 16 and 19 of Section 8) and tighten the bolt securely.

8 The remainder of the reassembly procedure, including checking the camshaft alignment (valve timing) and setting the timing belt tension, is as described in paragraphs 20 to 25 of Section 8.

11 Camshafts and hydraulic tappets - removal, inspection and refitting



Removal

1 Release the tension from the timing belt as described in Section 8, paragraphs 1 to 12.

2 Either remove the timing belt completely (Section 8, paragraphs 13 and 14) or slip it off the camshaft sprockets, taking care not to twist it too sharply; use the fingers only to handle the belt. Cover the belt, and secure it so that it is clear of the working area. Do not rotate the crankshaft until the timing belt is refitted.

3 Unfasten the sprocket bolts as described in Section 8, paragraph 16, and withdraw the sprockets; while both are the same and could be interchanged, it is good working practice to mark them so that each is refitted only to its original location (see illustration).

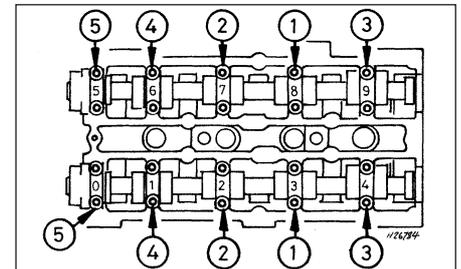
4 Working in the sequence shown, slacken progressively, by half a turn at a time, the camshaft bearing cap bolts (see illustration). Work only as described, to release gradually



10.6 Alternatively, seal can be inserted when camshaft bearing cap is unbolted

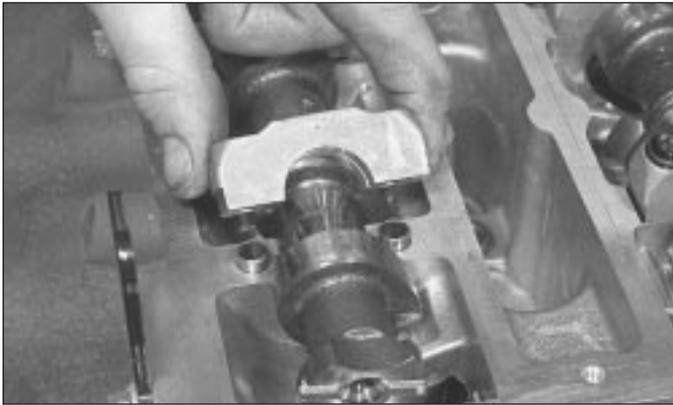


11.3 Using forked holding tool while camshaft toothed pulley bolt is slackened



11.4 Camshaft bearing cap slackening sequence

Note: Viewed from front of vehicle, showing bearing cap numbers



11.5a Note locating dowels when removing camshaft bearing caps



11.5b Inlet camshaft has lobe for camshaft position sensor

and evenly the pressure of the valve springs on the caps.

5 Withdraw the caps, noting their markings and the presence of the locating dowels, then remove the camshafts and withdraw their oil seals. The inlet camshaft can be identified by the reference lobe for the camshaft position sensor; therefore, there is no need to mark the camshafts (see illustrations).

6 Obtain sixteen small, clean containers, and number them 1 to 16. Using a rubber sucker, withdraw each hydraulic tappet in turn, invert it to prevent oil loss, and place it in its respective container, which should then be filled with clean engine oil (see illustrations). Do not interchange the hydraulic tappets, or the rate of wear will be much increased. Do not allow them to lose oil, or they will take a long time to refill on restarting the engine, resulting in incorrect valve clearances.

Inspection

7 With the camshafts and hydraulic tappets removed, check each for signs of obvious wear (scoring, pitting etc) and for ovality, and renew if necessary.

8 Measure the outside diameter of each tappet (see illustration) - take measurements at the top and bottom of each tappet, then a second set at right-angles to the first; if any measurement is significantly different from the others, the tappet is tapered or oval and must

be renewed. If the necessary equipment is available, measure the inside diameter of the corresponding cylinder head bore. Compare the measurements obtained to those given in the Specifications Section of this Chapter; if the tappets or the cylinder head bores are excessively worn, new tappets and/or a new cylinder head will be required.

9 If the engine's valve components have sounded noisy, particularly if the noise persists after initial start-up from cold, there is reason to suspect a faulty hydraulic tappet. Only a good mechanic experienced in these engines can tell whether the noise level is typical, or if renewal of one or more of the tappets is warranted. If faulty tappets are diagnosed, and the engine's service history is unknown, it is always worth trying the effect of renewing the engine oil and filter (see Chapter 1), using *only* good-quality engine oil of the recommended viscosity and specification, before going to the expense of renewing any of the tappets - refer also to the advice in Section 5 of this Chapter.

10 Visually examine the camshaft lobes for score marks, pitting, galling (wear due to rubbing) and evidence of overheating (blue, discoloured areas). Look for flaking away of the hardened surface layer of each lobe. If any such signs are evident, renew the component concerned.

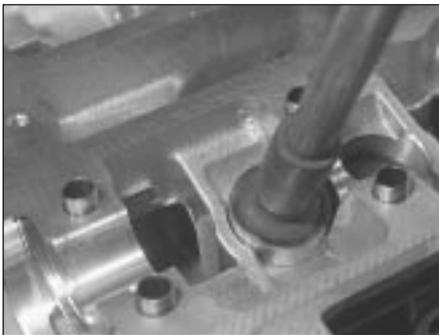
11 Examine the camshaft bearing journals and the cylinder head bearing surfaces for signs of obvious wear or pitting. If any such signs are evident, renew the component concerned.

12 Using a micrometer, measure the diameter of each journal at several points. If the diameter of any one journal is less than the specified value, renew the camshaft.

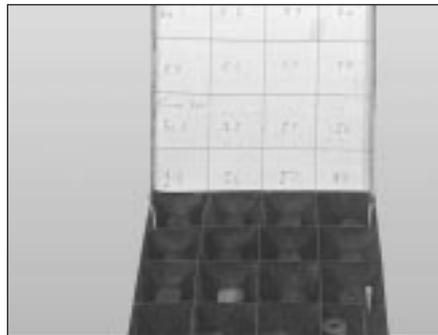
13 To check the bearing journal running clearance, remove the hydraulic tappets, use a suitable solvent and a clean lint-free rag to clean carefully all bearing surfaces, then refit the camshafts and bearing caps with a strand of Plastigauge across each journal. Tighten the bearing cap bolts to the specified torque wrench setting (do not rotate the camshafts), then remove the bearing caps and use the scale provided to measure the width of the compressed strands. Scrape off the Plastigauge with your fingernail or the edge of a credit card - don't scratch or nick the journals or bearing caps.

14 If the running clearance of any bearing is found to be worn to beyond the specified service limits, fit a new camshaft and repeat the check; if the clearance is still excessive, the cylinder head must be renewed.

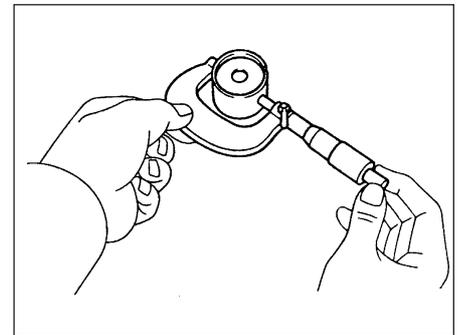
15 To check camshaft endfloat, remove the hydraulic tappets, clean the bearing surfaces carefully, and refit the camshafts and bearing



11.6a Removing hydraulic tappets



11.6b Hydraulic tappets must be stored as described in text



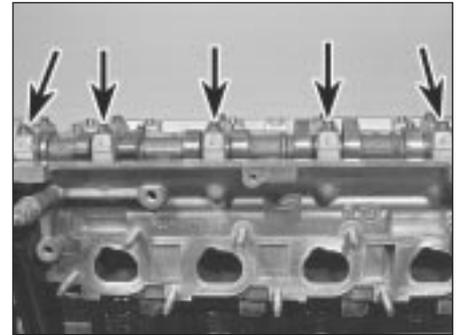
11.8 Use a micrometer to measure diameter of hydraulic tappets



11.17 Oil liberally when refitting hydraulic tappets



11.19 Apply sealant to mating surface of camshaft right-hand bearing caps



11.20 Etched marks on camshaft bearing caps must be arranged as shown, and face outwards

caps. Tighten the bearing cap bolts to the specified torque wrench setting, then measure the endfloat using a DTI (Dial Test Indicator, or dial gauge) mounted on the cylinder head so that its tip bears on the camshaft right-hand end.

16 Tap the camshaft fully towards the gauge, zero the gauge, then tap the camshaft fully away from the gauge, and note the gauge reading. If the endfloat measured is found to be at or beyond the specified service limit, fit a new camshaft and repeat the check; if the clearance is still excessive, the cylinder head must be renewed.

Refitting

17 On reassembly, liberally oil the cylinder head hydraulic tappet bores and the tappets (see illustration). Note that if new tappets are being fitted, they must be charged with clean engine oil before installation. Carefully refit the tappets to the cylinder head, ensuring that each tappet is refitted to its original bore, and is the correct way up. Some care will be required to enter the tappets squarely into their bores.

18 Liberally oil the camshaft bearings and lobes. Ensuring that each camshaft is in its original location, refit the camshafts, locating each so that the slot in its left-hand end is approximately parallel to, and just above, the cylinder head mating surface.

19 Ensure that the locating dowels are

pressed firmly into their recesses, and check that all mating surfaces are completely clean, unmarked and free from oil. Apply a thin film of suitable sealant (Ford recommend Loctite 518) to the mating surfaces of each camshaft's right-hand bearing cap (see illustration). Referring to paragraph 6 of Section 10, some owners may wish to fit the new camshaft oil seals at this stage.

20 All camshaft bearing caps have a single-digit identifying number etched on them (see illustration). The exhaust camshaft's bearing caps are numbered in sequence 0 to 4, the inlet's 5 to 9; see illustration 11.21a for details. Each cap is to be fitted so that its numbered side faces outwards, to the front (exhaust) or to the rear (inlet).

21 Ensuring that each cap is kept square to the cylinder head as it is tightened down, and working in the sequence shown, tighten the camshaft bearing cap bolts slowly and by one turn at a time, until each cap touches the cylinder head (see illustration). Next, go round again in the same sequence, tightening the bolts to the first stage torque wrench setting specified, then once more, tightening them to the second stage setting. Work only as described, to impose gradually and evenly the pressure of the valve springs on the caps. Fit the camshaft-aligning tool; it should slip into place as described in paragraph 8 of Section 8 (see illustration).

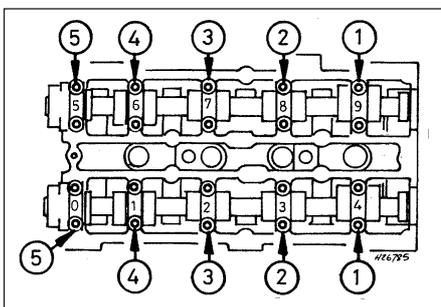
22 Wipe off all surplus sealant, so that none is left to find its way into any oilways. Follow

the sealant manufacturer's instructions as to the time needed for curing; usually, at least an hour must be allowed between application of the sealant and starting the engine.

23 If using Ford's recommended procedure, fit new oil seals to the camshafts as described in paragraph 5 of Section 10.

24 Using the marks and notes made on dismantling to ensure that each is refitted to its original camshaft, refit the sprockets to the camshafts, tightening the retaining bolts loosely. Slip the timing belt back onto the sprockets (refer to paragraph 19 of Section 8) and tighten the bolts securely - use the forked holding tool described in paragraph 16 of Section 8.

25 The remainder of the reassembly procedure, including checking the camshaft alignment (valve timing) and setting the timing belt tension, is as described in paragraphs 15 to 25 of Section 8.



11.21a Camshaft bearing cap tightening sequence

Note: View from front of vehicle - locate bearing caps according to etched numbers, aligned as described in text



11.21b Fit camshaft-aligning tool to set TDC position while camshaft toothed pulleys are refitted

12 Cylinder head - removal and refitting



Removal

Note: The following text assumes that the cylinder head will be removed with both inlet and exhaust manifolds attached. This simplifies the procedure, but makes it a bulky and heavy assembly to handle - an engine hoist will be required, to prevent the risk of injury, and to prevent damage to any delicate components as the assembly is removed and refitted. If it is wished first to remove the manifolds, refer to Chapter 4D, then amend the following procedure accordingly.

- 1** Depressurise the fuel system (see Chapter 4D).
- 2** Disconnect the battery negative (earth) lead (refer to Chapter 5A, Section 1).
- 3** Refer to Chapter 4D and remove the air inlet components.
- 4** Equalise the pressure in the fuel tank by removing the filler cap, then undo the fuel feed and return lines connecting the engine to the chassis (see Chapter 4D). Plug or cap all open fittings.



12.7a Unplug engine wiring loom connector alongside the inlet manifold



12.7b Unplug connectors (arrowed) to disconnect ignition coil wiring



12.13 Disconnect all coolant hoses from thermostat housing

**HAYNES
HINT**

Whenever you disconnect any vacuum lines, coolant or emissions hoses, wiring connectors and fuel lines, 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.

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

6 Remove the auxiliary drivebelt (see Chapter 1).

7 Remove the three screws securing the wiring "rail" to the rear of the manifold. Releasing its wire clip, unplug the large electrical connector (next to the fuel pressure regulator) to disconnect the engine wiring from the main loom (see illustration). Unplug the electrical connectors on each side of the ignition coil, and the single connector from beneath the front of the thermostat housing, to disconnect the coil and coolant temperature gauge sender wiring (see illustration).

8 Marking or labelling them as they are unplugged, disconnect the vacuum hoses as follows:

- a) One from the rear of the throttle housing (only the one hose - there is no need to disconnect the second hose running to the fuel pressure regulator).
- b) One from the union on the inlet manifold's left-hand end.
- c) The braking system vacuum servo unit hose (see Chapter 9 for details).

9 Unbolt the engine earth lead from the cylinder head lifting eye.

10 Unbolt both parts of the exhaust manifold heat shield. Either remove the dipstick and tube, or swing them out of the way.

11 Unscrew the pulse-air filter housing retaining bolt, then disconnect its vacuum hose.

12 Drain the cooling system (see Chapter 1).

13 Disconnect all coolant hoses from the thermostat housing (see illustration).

14 Unscrew the two nuts to disconnect the exhaust system front downpipe from the manifold (Chapter 4B); disconnect the oxygen sensor wiring, so that it is not strained by the weight of the exhaust system.

15 Remove the timing belt and both camshafts (see Sections 8 and 11); if the cylinder head is to be dismantled, withdraw the hydraulic tappets.

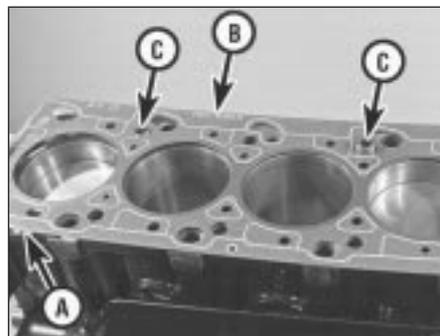
16 Remove the timing belt inner shield (see Section 7).

17 Working in the reverse of the sequence shown in illustration 12.28a, slacken the ten cylinder head bolts progressively and by one turn at a time; a Torx key (TX 55 size) will be required. Remove each bolt in turn, and ensure that new replacements are obtained for reassembly; these bolts are subjected to severe stresses and so **must** be renewed, regardless of their apparent condition, whenever they are disturbed.

18 Lift the cylinder head away; use assistance if possible, as it is a heavy assembly. If necessary, grip the manifolds and rock it free from the location dowels on the top face of the cylinder block. Do not attempt to tap it sideways or lever between the head and the block top face. Remove the gasket, noting the two dowels, and discard it.

Preparation for refitting

19 The mating faces of the cylinder head and cylinder block must be perfectly clean before



12.23 Ensuring protruding tooth (or teeth) "A" are at front and marking "B" is upwards, locate new cylinder head gasket on dowels "C"

refitting the head. Use a hard plastic or wood scraper to remove all traces of gasket and carbon; also clean the piston crowns. Take particular care during the cleaning operations, as aluminium alloy is easily damaged. Also, make sure that the carbon is not allowed to enter the oil and water passages - this is particularly important for the lubrication system, as carbon could block the oil supply to the engine's components. Using adhesive tape and paper, seal the water, oil and bolt holes in the cylinder block.

**HAYNES
HINT**

To prevent carbon entering the gap between the pistons and bores, smear a little grease in the gap. After cleaning each piston, use a small brush to remove all traces of grease and carbon from the gap, then wipe away the remainder with a clean rag.

20 Check the mating surfaces of the cylinder block and the cylinder head for nicks, deep scratches and other damage. If slight, they may be removed carefully with a file, but if excessive, machining may be the only alternative to renewal.

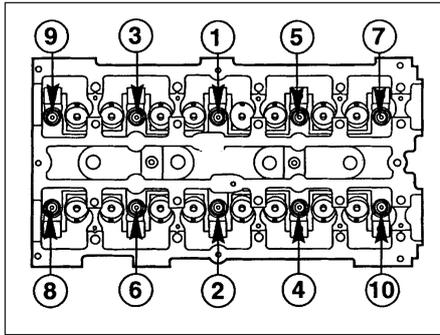
21 If warpage of the cylinder head gasket surface is suspected, use a straight-edge to check it for distortion. Refer to Part D of this Chapter if necessary.

Refitting

22 Wipe clean the mating surfaces of the cylinder head and cylinder block. Check that the two locating dowels are in position in the cylinder block, and that all cylinder head bolt holes are free from oil.

23 Position a new gasket over the dowels on the cylinder block surface, so that the "TOP/OBEN" mark is uppermost, and with the tooth (or teeth, according to engine size) protruding from the front edge (see illustration).

24 Temporarily refit the crankshaft pulley, and rotate the crankshaft anti-clockwise so that No 1 cylinder's piston is lowered to approximately 20 mm before TDC, thus avoiding any risk of valve/piston contact and damage during reassembly.



12.28a Cylinder head bolt tightening sequence

Note: View from rear of vehicle

25 As the cylinder head is such a heavy and awkward assembly to refit with manifolds, it is helpful to make up a pair of guide studs from two 10 mm (thread size) studs approximately 90 mm long, with a screwdriver slot cut in one end - two old cylinder head bolts with their heads cut off would make a good starting point. Screw these guide studs, screwdriver slot upwards to permit removal, into the bolt holes at diagonally-opposite corners of the cylinder block surface (or into those where the locating dowels are fitted); ensure that approximately 70 mm of stud protrudes above the gasket.

26 Refit the cylinder head, sliding it down the guide studs (if used) and locating it on the dowels. Unscrew the guide studs (if used) when the head is in place.

27 Fit the new cylinder head bolts dry (*do not* oil their threads); carefully enter each into its hole and screw it in, by hand only, until finger-tight.

28 Working progressively and in the sequence shown, use first a torque wrench, then an ordinary socket extension bar and an angle gauge, to tighten the cylinder head bolts in the stages given in the Specifications Section of this Chapter (**see illustrations**).

Note: Once tightened correctly, following this procedure, the cylinder head bolts do not require check-tightening, and must **not** be re-torqued.

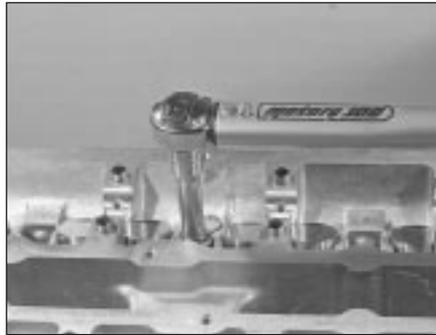
29 Refit the hydraulic tappets (if removed), the camshafts, their oil seals and sprockets (see Sections 11, 10 and 9, as appropriate). Temporarily refit the crankshaft pulley, and rotate the crankshaft clockwise to return the pulley notches to the TDC position described in Section 3.

30 Refit the earth lead to the lifting eye

31 Refit the timing belt and covers, checking the camshaft alignment (valve timing) and setting the timing belt tension, as described in Section 8.

32 The remainder of reassembly is the reverse of the removal procedure, noting the following points:

- a) Tighten all fasteners to the torque wrench settings specified.
- b) Refill the cooling system, and top-up the



12.28b Tightening cylinder head bolts (Stages 1 and 2) using torque wrench . . .



12.28c . . . and to Stage 3 using angle gauge

engine oil (see Chapter 1 and "Weekly Checks").

- c) Check all disturbed joints for signs of oil or coolant leakage, once the engine has been restarted and warmed-up to normal operating temperature.
- d) If the power steering hoses where disconnected, bleed the system as described in Chapter 10 after reconnection.

13 Sump - removal and refitting



Removal

Note: The full procedure outlined below must be followed, so that the mating surfaces can be cleaned and prepared to achieve an oil-tight joint on reassembly, and so that the sump can be aligned correctly; depending on your skill and experience, and the tools and facilities available, it may be that this task can be carried out only with the engine removed from the vehicle. Note that the sump gasket must be renewed whenever it is disturbed.

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

2 Drain the engine oil, then clean and refit the engine oil drain plug, tightening it to the specified torque wrench setting. Although not strictly necessary as part of the dismantling procedure, owners are advised to remove and discard the oil filter, so that it can be renewed with the oil (see Chapter 1).

3 Refer to Chapter 5A and remove the starter motor.

4 Remove the auxiliary drivebelt cover (see Chapter 1).

5 Unplug the electrical connector(s) to disconnect the oxygen sensor.

6 Unscrew the nuts to disconnect the exhaust system front downpipe from the manifold, then either unhook all the system's rubber mountings and withdraw the complete exhaust system from under the vehicle, or remove only the downpipe/catalytic converter (see Chapter 4E for details).

7 Unscrew the sump-to-transmission bolts, also any securing the engine/transmission lower adapter plate.

8 Progressively unscrew the sump retaining bolts. Break the joint by striking the sump with the palm of the hand, then lower the sump and withdraw it with the engine/transmission lower adapter plate (where fitted); note the presence of any shims between the sump and transmission.

9 Remove and discard the sump gasket; this must be renewed as a matter of course whenever it is disturbed.

10 While the sump is removed, take the opportunity to remove the oil pump pick-up/strainer pipe and to clean it (see Section 14).

Refitting

11 On reassembly, thoroughly clean and degrease the mating surfaces of the cylinder block/crankcase and sump, then use a clean rag to wipe out the sump and the engine's interior. If the oil pump pick-up/strainer pipe was removed, fit a new gasket and refit the pipe, tightening its screws to the specified torque wrench setting. Fit the new gasket to the sump mating surface so that the gasket fits into the sump groove (**see illustration**).

12 If the sump is being refitted with the engine/transmission still connected and in the vehicle, proceed as follows:

- a) Check that the mating surfaces of the sump, the cylinder block/crankcase and



13.11 Ensure gasket is located correctly in sump groove