

**Torque wrench settings**

	Nm	lbf ft
Camshaft cover	8	6
Camshaft sprocket	70	52
Cylinder head:		
Stage 1	30	22
Stage 2	Angle-tighten a further 90°	
Stage 3	Angle-tighten a further 90°	
Crankshaft sprocket centre bolt	100	74
Engine mounting bolt:		
M10 x 1.25	59	44
M8	25	18
Engine mounting nut (M10 x 1.25)	60	44
Flywheel/driveplate	44	32
Sump	10	7
Timing belt tensioner	28	21

**1 General information****Using this Chapter**

Chapter 2 is divided into four Parts; A, B, C and D. Repair operations that can be carried out with the engine in the vehicle are described in Part A. SOHC (8-valve) petrol engines, Part B, DOHC (16-valve) petrol engines and Part C, diesel engines. Part D covers the removal of the engine/transmission as a unit, and describes the engine dismantling and overhaul procedures.

In Parts A, B and C, the assumption is made that the engine is installed in the vehicle, with all ancillaries connected. If the engine has been removed for overhaul, the preliminary dismantling information which precedes each operation may be ignored.

**Engine description**

Throughout this Chapter, engines are identified by their capacities. A listing of all engines covered, together with their code letters, is given in the Specifications.

The engines covered in this Part of Chapter 2 are water-cooled, single overhead camshaft, in-line four-cylinder units, with cast iron cylinder blocks and aluminium-alloy cylinder heads. All are mounted transversely at the front of the vehicle, with the transmission bolted to the left-hand side of the engine.

The cylinder head carries the camshaft which is driven by a toothed timing belt and runs in three bearings. It also houses the inlet and exhaust valves, which are closed by single coil springs, and which run in guides pressed into the cylinder head. The camshaft actuates the valves directly via cam followers mounted in the cylinder head. Adjustment of the valve clearances is by means of shims located on top of the followers. The cylinder head contains integral oilways which supply and lubricate the tappets.

The crankshaft is supported by five main bearings, and endfloat is controlled by a thrust bearing fitted to the upper section of the centre main bearing.

Engine coolant is circulated by a pump, driven by the timing belt. For details of the cooling system, refer to Chapter 3.

Lubricant is circulated under pressure by a pump, driven from the front of the crankshaft. Oil is drawn from the sump through a strainer, and then forced through an externally-mounted, replaceable screw-on filter. From there, it is distributed to the cylinder head, where it lubricates the camshaft journals and tappets, and also to the crankcase, where it lubricates the main bearings, connecting rod big and small-ends, gudgeon pins and cylinder bores. On 1242 cc engines, oil jets are fitted to the base of each cylinder bore - these spray oil onto the underside of the pistons, to improve cooling.

**Repair operations possible with the engine in the car**

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

- Compression pressure - testing
- Auxiliary drivebelt - removal and refitting (refer to Chapter 1A)
- Valve clearances - checking and adjustment (refer to Chapter 1A)
- Camshaft cover - removal and refitting
- Timing belt and covers - removal and refitting
- Timing belt tensioner and sprockets - removal and refitting
- Cylinder head - removal and refitting\*
- Camshaft and cam followers - removal and refitting\*
- Camshaft oil seal - renewal
- Crankshaft oil seals - renewal
- Flywheel/driveplate - removal, inspection and refitting
- Engine mountings - inspection and renewal
- Sump - removal and refitting
- Oil pump and pick-up tube assembly - removal, inspection and refitting

\*Cylinder head dismantling procedures are detailed in Chapter 2D, with details of camshaft and cam follower removal.

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 Location of TDC on No 1 cylinder****General information**

1 The camshaft is driven by the crankshaft, by means of sprockets and a timing belt. Both sprockets rotate in phase with each other and this provides the correct valve timing as the engine rotates. When the timing belt is removed during servicing or repair, it is possible for the camshaft and crankshaft to rotate independently of each other and the correct valve timing is then lost.

2 The design of the engines covered in this Chapter are such that potentially damaging piston-to-valve contact may occur if the camshaft is rotated when any of the pistons are stationary at, or near, the top of their stroke.

3 For this reason it is important that the correct phasing between the camshaft and crankshaft is preserved whilst the timing belt is off the engine. This is achieved by setting the engine in a reference position (known as Top Dead Centre or TDC) before the timing belt is removed and then preventing the camshaft and crankshaft from rotating until the belt is refitted. Similarly, if the engine has been dismantled for overhaul, the engine can be set to TDC during reassembly to ensure that the correct shaft phasing is restored.

4 TDC is the highest point in the cylinder that each piston reaches as the crankshaft turns. Each piston reaches TDC at the end of the compression stroke and again at the end of the exhaust stroke. However, for the purpose of timing the engine, TDC refers to the position of No 1 piston at the end of its compression stroke. On all engines in this manual, No 1 piston (and cylinder) is at the timing belt end of the engine.

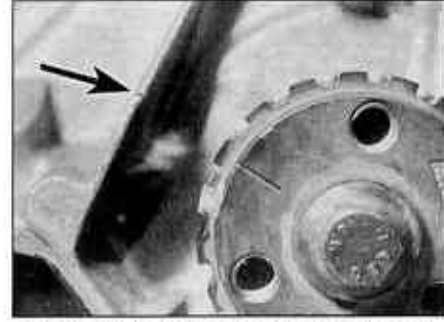
5 The camshaft sprocket is equipped with a marking which, when aligned with a reference marking on the cylinder head, indicates that the camshaft is correctly positioned for cylinder No 1 at TDC on its compression stroke.



2.11 Unscrewing the crankshaft pulley bolts



2.13a Camshaft sprocket and cylinder head TDC timing marks (arrowed) aligned - shown with timing belt removed



2.13b Crankshaft sprocket and oil pump cover TDC timing marks (arrowed) aligned

6 The crankshaft sprocket is also equipped with a timing mark - when this is aligned with a reference marking on the oil pump cover, the engine is set with cylinders No 1 and 4 at TDC. Note that it is the camshaft positioning that determines whether a cylinder is on its compression or exhaust stroke.

#### Location of TDC on cylinder No 1

7 Remove the air cleaner and ducting as described in Chapter 4A or 4B. Remove the spark plug from No 1 cylinder as described in Chapter 1A.

8 Firmly apply the handbrake, then jack up the front of the car and support it securely on axle stands (see *Jacking and vehicle support*).

9 Remove the auxiliary drivebelt(s) as described in Chapter 1A.

10 Unbolt and remove the timing belt cover. Note the bolt located at the bottom of the cover; this can be easily overlooked.

11 Undo the three bolts and remove the crankshaft pulley from the sprocket (see illustration).

12 Turn the engine in its normal direction of rotation (using a socket or spanner on the crankshaft sprocket centre bolt) until pressure can be felt at No 1 cylinder spark plug hole.

**HAYNES HINT** Remove all four spark plugs; this will make the engine easier to turn; refer to Chapter 1A for details.

13 Continue turning the engine until the camshaft sprocket TDC timing mark is aligned with the mark on the cylinder head and the crankshaft sprocket timing mark is aligned with the mark on the oil pump cover (see illustrations).

14 The engine is now set at TDC for No 1 cylinder on compression.

### 3 Cylinder compression test

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 battery must be fully charged, and all the spark plugs must be removed (Chapter 1A). The aid of an assistant will also be required.

3 Disable the ignition system by disconnecting the LT wiring plug to the ignition coils.

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 Have the assistant hold the throttle wide open, and crank the engine on the starter motor; after one or two revolutions, the compression pressure should build up to a maximum figure, and then stabilise. Record the highest reading obtained.

6 Repeat the test on the remaining cylinders, recording the pressure in each.

7 All cylinders should produce very similar pressures; any excessive difference indicates the existence of a fault. Note that the compression should build up 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 reading on the first stroke, which does not build up during successive strokes, indicates leaking valves or a blown head gasket (a cracked head could also be the cause).

8 If the pressure in any cylinder is very low, carry out the following test to isolate the cause. Introduce a teaspoonful of clean oil into that cylinder through its spark plug hole and repeat the test.

9 If the addition of oil temporarily improves the compression pressure, this indicates that bore or piston wear is responsible for the pressure loss. No improvement suggests that leaking or burnt valves, or a blown head gasket, may be to blame.

10 A low reading from two adjacent cylinders is almost certainly due to the head gasket having blown between them; the presence of coolant in the engine oil will confirm this.

11 If one cylinder is about 20 percent lower

than the others and the engine has a slightly rough idle, a worn camshaft lobe could be the cause.

12 On completion of the test, refit the spark plugs and reconnect the ignition LT wiring plug.

### 4 Timing belt and covers - removal and refitting

**Note:** Fiat specify the use of a special timing belt tension measuring tool to correctly set the timing belt tension. If access to this equipment cannot be obtained, an approximate setting can be achieved using the method described below. If the method described is used, the tension must be checked using the special tool at the earliest possible opportunity. Do not drive the vehicle over large distances, or use high engine speeds, until the belt tension is known to be correct. Refer to a Fiat dealer for advice.

#### General information

1 The function of the timing belt is to drive the camshaft and coolant pump. Should the belt slip or break in service, the valve timing will be disturbed and piston-to-valve contact will occur, resulting in serious engine damage.

2 The timing belt should be renewed at the specified intervals (see Chapter 1A), or earlier if it is contaminated with oil, or if it is at all noisy in operation (a scraping noise due to uneven wear).

3 If the timing belt is being removed, it is a wise precaution to check the condition of the coolant pump at the same time (check for signs of coolant leakage). This may avoid the need to remove the timing belt again at a later stage, should the coolant pump fail.

#### Removal

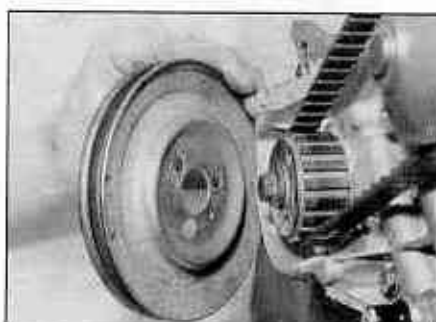
4 Firmly apply the handbrake, then jack up the front of the car and support it securely on axle stands (see *Jacking and vehicle support*). Remove the right-hand front roadwheel.

5 Remove the air cleaner and air ducting as described in Chapter 4A or 4B.

6 Remove the auxiliary drivebelt(s) and the spark plugs as described in Chapter 1A.



4.7 Removing the timing belt cover bottom bolt



4.8 Removing the crankshaft pulley



4.10 Releasing the timing belt tensioner nut

7 Unbolt and remove the timing belt cover. Note the bolt located at the bottom of the cover, this can easily be overlooked (see illustration).

8 Undo the three bolts and remove the crankshaft pulley from the sprocket (see illustration).

9 Set the engine at TDC on No 1 cylinder as described in Section 2.

10 Release the nut on the timing belt tensioner, move the tensioner pulley away from the belt and retighten the nut to hold the pulley in the retracted position (see illustration).

11 If the timing belt is to be re-used, use white paint or chalk to mark the direction of rotation on the belt (if markings do not already exist), then slip the belt off the sprockets. Note that the crankshaft and camshaft must not be rotated whilst the belt is removed.

12 Check the timing belt carefully for any signs of uneven wear, splitting, or oil contamination. Pay particular attention to the roots of the teeth. Renew it if there is the slightest doubt about its condition. If the engine is undergoing an overhaul, renew the belt as a matter of course, regardless of its apparent condition. The cost of a new belt is nothing compared with the cost of repairs, should the belt break in service. If signs of oil contamination are found, trace the source of the oil leak and rectify it. Wash down the engine timing belt area and all related components, to remove all traces of oil.

### Refitting

13 Before refitting, thoroughly clean the timing belt sprockets. Check that the tensioner pulley rotates freely, without any sign of roughness. If necessary, renew the tensioner pulley as described in Section 5.

14 When refitting the new belt, make sure that the sprocket timing marks are still in alignment and fit the belt so that the arrows on the belt point in the direction of engine rotation, and the lines of the belt coincide with the sprocket marks.

15 Engage the timing belt with the crankshaft sprocket first, then place it around the coolant pump sprocket and the camshaft sprocket (see illustration). Finally slip the belt around the tensioner pulley.

16 Release the tensioner nut and insert the jaws of a pair of right-angled circlip pliers (or similar) into the two holes on the front face of the tensioner pulley. Rotate the pulley anticlockwise against the belt until the belt is quite taut. Check that the sprocket timing marks have not moved out of alignment.

17 Maintain the effort applied to the tensioner pulley, then tighten the retaining nut.

18 Turn the crankshaft through two complete turns in the normal direction of rotation and check that when the centre of the longest run of the belt is gripped between finger and thumb it can just be twisted through 90°.

19 If the belt appears too be too slack or too tight, slacken the tensioner nut and repeat steps 16 to 18 until the correct tension is achieved.

**Caution:** The above procedure serves only as a rough guide to setting the belt tension. The tension must be checked accurately by a Fiat dealer using specialised checking equipment, at the earliest opportunity.

20 Refit the timing belt cover, the crankshaft pulley, auxiliary drivebelt(s), spark plugs and the air cleaner/ducting. Adjust the tension of the auxiliary drivebelt(s) as described in Chapter 1A.

21 Refit the front wheel and lower the car to the ground.

### 5 Timing belt tensioner and sprockets - removal, inspection and refitting

#### Timing belt tensioner

##### Removal

1 Firmly apply the handbrake, then jack up the front of the car and support it securely on axle stands (see *Jacking and vehicle support*). Remove the right-hand front roadwheel.

2 Remove the air cleaner and air ducting as described in Chapter 4A or 4B.

3 Remove the auxiliary drivebelt(s) as described in Chapter 1A.

4 Undo the three bolts and remove the crankshaft pulley from the sprocket.

5 Unbolt and remove the timing belt cover. Note the bolt located at the bottom of the cover, this can easily be overlooked.



4.15 Fitting the timing belt

6 Set the engine at TDC on No 1 cylinder as described in Section 2.

7 Loosen the nut on the timing belt tensioner and move the tensioner pulley away from the belt (see illustration). Keep the belt engaged with the sprockets using a cable-tie or string.

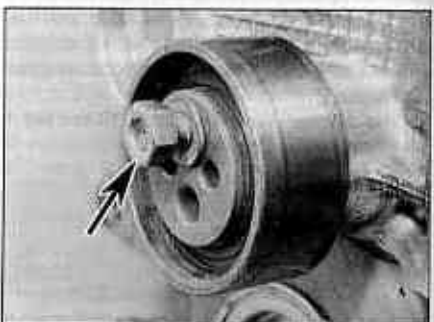
8 Completely unscrew the nut and slide the tensioner off the mounting stud.

### Inspection

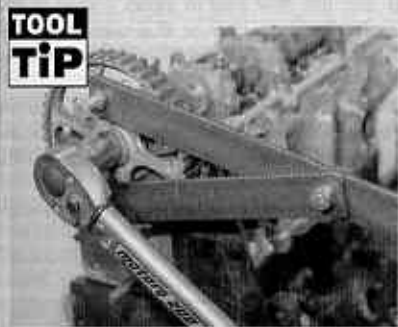
9 Wipe the tensioner clean but do not use solvents that may contaminate the bearings. Spin the tensioner pulley on its hub by hand. Stiff movement or excessive freeplay is an indication of severe wear; the tensioner is not a serviceable component, and should be renewed.

### Refitting

10 Slide the tensioner pulley over the mounting stud and fit the securing nut.



5.7 Timing belt tensioner retaining nut (arrowed) - shown with timing belt removed

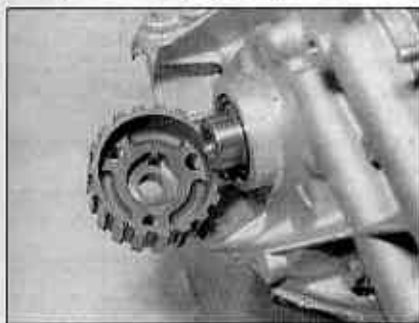
**TOOL TIP**

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, secure a bolt with a nut and a locknut, to act as the fulcrums; these will engage with the cut-outs in the sprocket, and should protrude by about 30 mm

- 11 Check and adjust the tension of the timing belt with reference to Section 4.
- 12 Refit the timing belt cover and tighten the bolts.
- 13 Refit the crankshaft pulley.
- 14 Refit and tension the auxiliary drivebelt(s) as described in Chapter 1.
- 15 Refit the air cleaner and air ducting as described in Chapter 4A or 4B.
- 16 Refit the roadwheel and lower the vehicle to the ground.

**Camshaft sprocket****Removal**

- 17 Remove the timing belt as described in Section 4.
- 18 The camshaft sprocket must now be held stationary while the retaining bolt is loosened. To do this, make up a tool as follows and engage it with the holes in the sprocket (see **Tool Tip**).
- 19 Alternatively pass a rod through one of the holes in the camshaft sprocket to prevent it rotating. Position a pad of rag or a piece of



5.28 Crankshaft sprocket located by integral key



5.20a Unscrew the camshaft sprocket securing bolt and washer . . .

wood under the rod to avoid damaging the cylinder head.

- 20 Unscrew the bolt and slide the sprocket from the end of the camshaft. Note the integral location key on the inner face of the sprocket (see illustrations).

**Inspection**

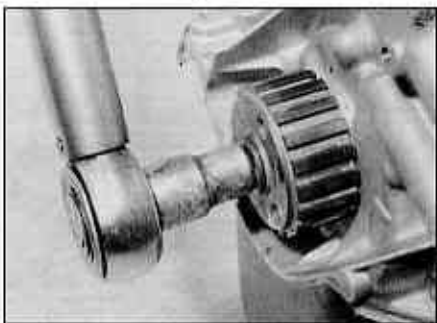
- 21 With the sprocket removed, examine the camshaft oil seal for signs of leaking. If necessary, refer to Section 7 and renew it.
- 22 Check the sprocket teeth for damage.
- 23 Wipe clean the sprocket and camshaft mating surfaces.

**Refitting**

- 24 Locate the sprocket on the end of the camshaft, then refit the bolt and washer and tighten to the specified torque while holding the camshaft stationary using the method described previously.
- 25 Refit the timing belt as described in Section 4.

**Crankshaft sprocket****Removal**

- 26 Remove the timing belt as described in Section 4.
- 27 Working beneath the engine, unbolt and remove the flywheel lower cover, then hold the flywheel stationary preferably using a tool which engages the flywheel starter ring gear (see Section 10). Alternatively have an assistant engage a wide-bladed screwdriver with the starter ring gear.
- 28 Unscrew the crankshaft sprocket retaining bolt and slide the sprocket off the end of the



5.32 Tighten the crankshaft sprocket bolt to the specified torque



5.20b . . . and slide the sprocket from the end of the camshaft. Integral location key (arrowed)

crankshaft. The sprocket may have an integral location key on its inner face (see illustration), or a separate key which locates in a groove in the crankshaft nose may be fitted.

**Inspection**

- 29 With the sprocket removed, examine the crankshaft oil seal for signs of leaking. If necessary, refer to Section 8 and renew it.
- 30 Check the sprocket teeth for damage.
- 31 Wipe clean the sprocket and crankshaft mating surfaces.

**Refitting**

- 32 Slide the sprocket onto the crankshaft making sure it engages the integral key or separate key, then refit the bolt and washer and tighten the bolt to the specified torque while holding the crankshaft stationary using the method described in paragraph 27 (see illustration).
- 33 Refit the timing belt as described in Section 4.

**6 Camshaft cover - removal and refitting**

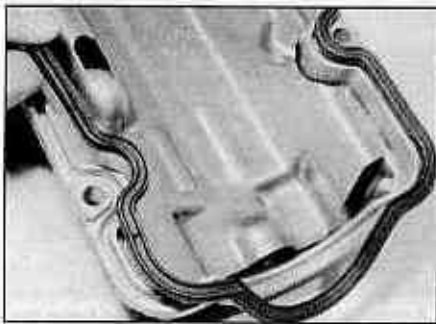
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**Removal**

- 1 Remove the air cleaner assembly and inlet duct as described in Chapter 4A or 4B.
- 2 Progressively unscrew the mounting bolts from the top of the camshaft cover and lift off the cover - note the location of any supports on the bolts (see illustration). If it sticks, do



6.2 Removing the camshaft cover



6.3 Camshaft cover gasket

not attempt to lever it off - instead free it by working around the cover and tapping it lightly with a soft-faced mallet.

3 Recover the camshaft cover gasket (see illustration). Inspect the gasket carefully, and renew it if damage or deterioration is evident.

4 Clean the mating surfaces of the cylinder head and camshaft cover thoroughly, removing all traces of oil and old gasket - take care to avoid damaging the surfaces as you do this.

### Refitting

5 Locate a new gasket on the cylinder head and make sure it is correctly seated.

6 Lower the cover onto the gasket making sure the gasket is not displaced.

7 Insert the mounting bolts and tighten them progressively to the specified torque.

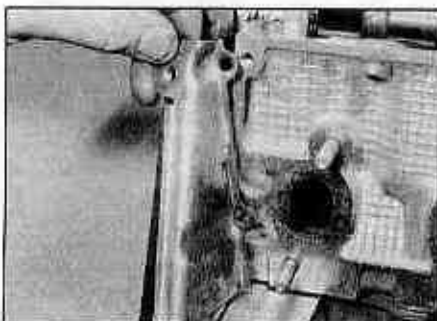
8 Refit the air cleaner assembly and inlet duct with reference to Chapter 4A or 4B.

### 7 Camshaft oil seal - renewal

1 Remove the timing belt and camshaft sprocket as described in Sections 4 and 5.

2 Using a suitable hooked instrument, remove the oil seal from the cylinder head taking care not to damage the surface of the camshaft.

3 Clean the seating in the cylinder head and the end of the camshaft. To prevent damage to the new oil seal as it is being fitted, wrap some adhesive tape around the end of the camshaft and lightly oil it.



9.8 Removing the timing belt inner covers

4 Dip the new oil seal in oil then locate it over the camshaft making sure that the sealing lips are facing inwards.

5 Using a suitable tubular drift, drive the oil seal squarely into the cylinder head. Remove the adhesive tape.

6 Refit the camshaft sprocket and timing belt with reference to Sections 5 and 4.

### 8 Crankshaft oil seals - renewal

#### Front (right-hand side) oil seal

1 The front oil seal is located in the oil pump on the front of the crankshaft. Remove the timing belt as described in Section 4 and the crankshaft sprocket as described in Section 5.

2 Using a hooked instrument, remove the oil seal from the oil pump casing taking care not to damage the surface of the crankshaft.

3 Clean the seating in the housing and the surface of the crankshaft. To prevent damage to the new oil seal as it is being fitted, wrap some adhesive tape around the end of the crankshaft and lightly oil it.

4 Dip the new oil seal in oil then offer it up to the oil pump casing making sure that the sealing lips are facing inwards.

5 Using a suitable tubular drift, drive the oil seal squarely into the casing. Remove the adhesive tape.

6 Refit the crankshaft sprocket and timing belt with reference to Sections 5 and 4.

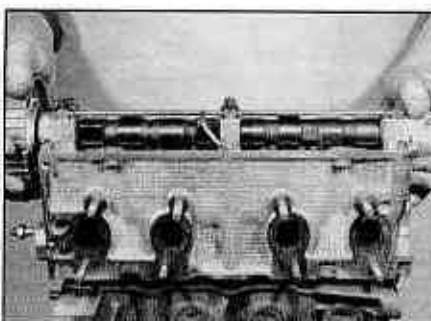
#### Rear (left-hand side) oil seal

**Note:** The following paragraphs describe renewal of the rear oil seal leaving the housing in position. Refer to Chapter 2D for details of removing the housing.

7 Remove the flywheel/driveplate as described in Section 10.

8 Using a suitable hooked instrument, remove the oil seal from the rear oil seal housing taking care not to damage the surface of the crankshaft.

9 Clean the seating in the housing and the surface of the crankshaft. Check the crankshaft for burrs which may damage the sealing lip of the new seal, and if necessary use a fine file to remove them.



9.12 Removing the cylinder head

10 Dip the new seal in clean engine oil and carefully locate it over the crankshaft rear flange making sure that it is the correct way round.

11 Progressively tap the oil seal into the housing keeping it square to prevent distortion. A block of wood is useful for this purpose.

12 Refit the flywheel/driveplate with reference to Section 10.

### 9 Cylinder head - removal and refitting

#### Removal

1 Disconnect the battery negative terminal (refer to *Disconnecting the battery* in the Reference Section of this manual).

2 Drain the cooling system as described in Chapter 1A, then remove the air cleaner and ducting as described in Chapter 4A or 4B.

3 Disconnect the accelerator cable and controls from the throttle housing.

4 Disconnect the fuel hoses.

5 Disconnect the coolant and vacuum hoses from the cylinder head and inlet manifold.

6 Disconnect all electrical leads noting their location.

7 Remove the ignition coils with reference to Chapter 5B.

8 Remove the timing belt as described in Section 4, then unbolt and remove the timing belt inner covers (see illustration).

9 Unbolt and remove the inlet manifold, complete with throttle housing. On MPI models unbolt the fuel rail.

10 Unbolt the exhaust manifold from the cylinder head, and tie it to the front of the engine compartment. If preferred remove the manifold completely by unbolting the downpipe. Also disconnect the downpipe bracket.

11 Unscrew the cylinder head bolts half a turn at a time in the reverse order to that shown in illustration 9.24b. When the bolts are free, remove them with their washers.

12 Lift the cylinder head from the block (see illustration). If it is stuck tight insert pieces of wood into the exhaust or inlet ports, and use them as levers to rock the head off the block. On no account drive levers into the gasket joint, nor attempt to tap the head sideways, as it is located on positioning dowels.

13 Remove and discard the cylinder head gasket and the manifold gaskets.

14 The cylinder head can be dismantled after removing the camshaft and cam followers as described in Chapter 2D.

15 If the valves have been ground-in, the valve clearances will require adjusting, as described in Chapter 1A. This should be done before the cylinder head is refitted to the engine.

**Preparation for refitting**

16 The mating faces of the cylinder head and cylinder block must be perfectly clean before refitting the head. Use a hard plastic or wooden scraper to remove all traces of gasket and carbon; also clean the piston crowns. Take particular care when cleaning the piston crowns as the soft aluminium alloy is easily damaged. 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. 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. Clean all the pistons in the same way.

17 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. 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.

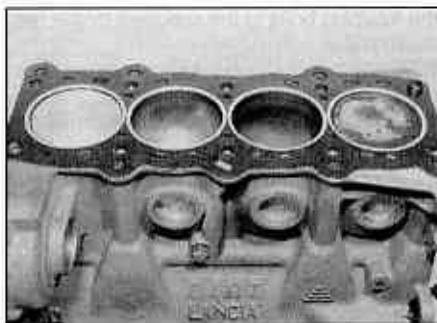
18 Check the condition of the cylinder head bolts, and particularly their threads, whenever they are removed. Wash the bolts in a suitable solvent, and wipe them dry. Check each bolt for any sign of visible wear or damage, renewing them if necessary.

**Refitting**

19 Before refitting the assembled cylinder head, make sure that the head and block mating surfaces are perfectly clean, and that the bolt holes in the cylinder block have been mopped out to clear any oil.

20 Check that the camshaft and crankshaft sprocket timing marks are still aligned with their respective cylinder head and oil pump cover marks as described in Section 2.

21 The new gasket should not be removed from its nylon cover until required for use. Fit the gasket dry, and make sure that the mating surfaces on the head and block are perfectly clean.



9.22a Place the cylinder head gasket on the cylinder block . . .

22 Place the gasket on the cylinder block so that the word ALTO can be read from above (see illustrations).

23 Lower the cylinder head onto the block so that it locates on the positioning dowel.

24 The cylinder head bolt threads must be clean. Dip the bolts in engine oil, and allow them to drain for thirty minutes. Screw the bolts in finger-tight then working progressively and in the sequence shown, tighten all the cylinder head bolts to the Stage 1 torque setting given in the Specifications, using a torque wrench and a suitable socket. With all the bolts tightened to their Stage 1 setting, working again in the specified sequence, first angle-tighten the bolts through the specified Stage 2 angle, then again through the Stage 3 angle, using a socket and extension bar. It is recommended that an angle-measuring gauge is used during this stage of tightening, to ensure accuracy (see illustrations).

25 Refit the inlet manifold and throttle body using a new gasket (refer to Chapter 4A or 4B).

26 Refit the exhaust manifold using a new gasket. Tighten all nuts. Reconnect the exhaust downpipe bracket.

27 Refit the timing belt inner covers and tighten the bolts.

28 Refit the timing belt, and tension it as described in Section 4. Refit the timing belt outer cover.

29 Refit the ignition coils and camshaft cover.

30 Reconnect all hoses, electrical leads and controls referring the relevant Chapters of this manual.

31 Fit the air cleaner and ducting.



9.22b . . . so that the ALTO marking can be read from above

32 Reconnect the battery then fill and bleed the cooling system as described in Chapter 1A.

**10 Flywheel/driveplate - removal, inspection and refitting**

**Removal**

1 Remove the transmission as described in Chapter 7A or 7B. On manual transmission models also remove the clutch (Chapter 6).

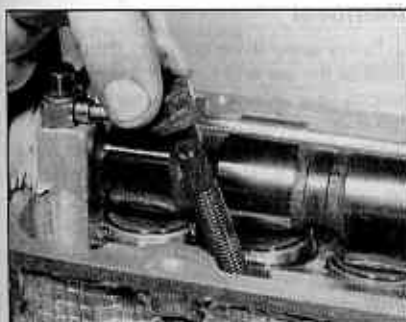
2 Mark the position of the flywheel/driveplate with respect to the crankshaft using a dab of paint. Note that on some models although there is only one location dowel on the flywheel/driveplate there are two holes in the end of the crankshaft and it is therefore possible to locate the flywheel 180° out. The flywheel/driveplate must now be held stationary while the bolts are loosened. A home-made locking tool may be fabricated from a piece of scrap metal and used to lock the ring gear. Bolt the tool to one of the transmission bellhousing mounting holes.

3 Unscrew then remove the mounting bolts then lift off the flywheel/driveplate. Recover the spacer plate on manual transmission models. Discard the flywheel/driveplate bolts; new ones must be used on refitting.

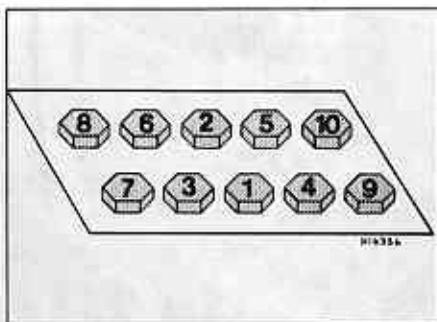
**Inspection**

**Manual transmission models**

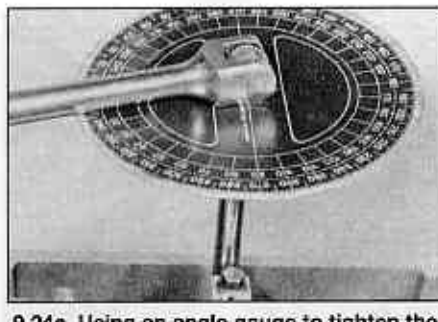
4 If the flywheel's clutch mating surface is deeply scored, cracked or otherwise damaged, the flywheel must be renewed.



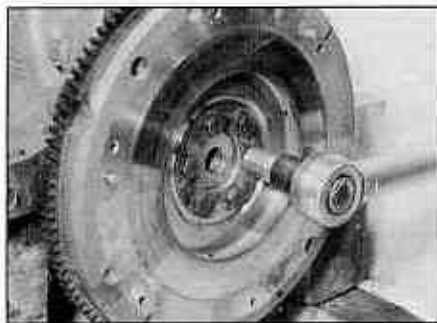
9.24a Oil the cylinder head bolts as described before refitting



9.24b Cylinder head bolt tightening sequence



9.24c Using an angle gauge to tighten the cylinder head bolts to their second and third stage torque settings



**10.10 Tighten the flywheel bolt to the specified torque**

However, it may be possible to have it surface-ground; seek the advice of a Fiat dealer or engine reconditioning specialist.

**5** If the ring gear is badly worn or has missing teeth, the flywheel must be renewed.

#### Automatic transmission models

**6** Check the driveplate for signs of damage and renew it if necessary. If the ring gear is badly worn or has missing teeth, the driveplate must be renewed.

#### Refitting

**7** Clean the mating surfaces of the flywheel/driveplate and crankshaft. Remove any remaining locking compound from the threads of the crankshaft holes, using the correct-size tap, if available.



*If a suitable tap is not available, cut two slots down the threads of one of the old bolts with a hacksaw, and use the bolt to remove the locking compound from the threads.*

**8** If the new retaining bolts are not supplied with their threads already pre-coated, apply a suitable thread-locking compound to the threads of each bolt.

**9** Offer up the flywheel/driveplate to the crankshaft, using the alignment marks made during removal, and fit the new retaining bolts (together with the spacer plate on manual transmission models).

**10** Lock the flywheel/driveplate using the method employed on dismantling, and tighten

the retaining bolts to the specified torque (see illustration).

**11** Refit the clutch on manual transmission models as described in Chapter 6.

**12** Refit the transmission as described in Chapter 7A or 7B.

### 11 Engine mountings - inspection and renewal

#### Inspection

**1** Firmly apply the handbrake, then jack up the front of the car and support it securely on axle stands (see *Jacking and vehicle support*).

**2** Check the mounting rubbers to see if they are cracked, hardened or separated from the metal at any point; renew the mounting if any such damage or deterioration is evident.

**3** Check that all the mounting's fasteners are securely tightened; use a torque wrench to check if possible.

**4** Using a large screwdriver or a crowbar, check for wear in the mounting by carefully levering against it to check for free play. Where this is not possible enlist the aid of an assistant to move the engine/transmission back and forth, or from side to side, while you watch the mounting. While some free play is to be expected even from new components, excessive wear should be obvious. If excessive free play is found, check first that the fasteners are correctly secured, then renew any worn components as described below.

#### Renewal

##### Right-hand mounting

**5** Firmly apply the handbrake, then jack up the front of the car and support it securely on axle stands (see *Jacking and vehicle support*).

**6** Place a trolley jack beneath the right-hand side of the engine, with a block of wood on the jack head. Raise the jack until it is supporting the weight of the engine.

**7** Unscrew the nut securing the engine bracket to the mounting.

**8** Lower the engine slightly then unbolt the mounting from the body.

**9** Locate the new mounting on the body, insert the bolts and tighten to the specified torque.

**10** Raise the engine and locate the bracket on the mounting. Refit the nut and tighten to the specified torque.

**11** Remove the trolley jack and lower the vehicle to the ground.

##### Left-hand mounting

**12** Firmly apply the handbrake, then jack up the front of the car and support it securely on axle stands (see *Jacking and vehicle support*).

**13** Place a trolley jack beneath the transmission, with a block of wood on the jack head. Raise the jack until it is supporting the weight of the engine/transmission.

**14** Unscrew the bolts securing the left-hand mounting to the body.

**15** Unscrew the nut securing the mounting to the transmission bracket and recover the washers.

**16** Lower the transmission sufficiently to remove the mounting from the transmission bracket.

**17** Locate the new mounting in the transmission bracket and refit the nut and washers. Tighten the nut to the specified torque.

**18** Raise the engine and refit the mounting-to-body bolts. Tighten the bolts to the specified torque.

**19** Remove the trolley jack and lower the vehicle to the ground.

##### Rear mounting

**20** Firmly apply the handbrake, then jack up the front of the car and support it securely on axle stands (see *Jacking and vehicle support*).

**21** Working beneath the vehicle, unscrew the bolts securing the rear engine mounting to the underbody.

**22** Temporarily support the weight of the engine/transmission using a trolley jack.

**23** Unbolt the rear mounting assembly from the transmission and withdraw from under the vehicle.

**24** Unscrew the bolt and separate the bracket from the mounting.

**25** Fitting the new mounting is a reversal of the removal procedure.

### 12 Sump - removal and refitting

#### Removal

**1** Firmly apply the handbrake, then jack up the front of the car and support it securely on axle stands (see *Jacking and vehicle support*). Drain the engine oil as described in Chapter 1A.

**2** Unbolt and remove the cover plate from the lower part of the flywheel housing (see illustration).

**3** Refer to Chapter 4D and unbolt the exhaust front pipe from the manifold. Undo the support bracket fastenings and lower the front pipe clear of the sump.

**4** Unscrew the sump securing screws and nuts and pull the sump downwards to remove it (see illustration). The joint sealant will



**12.2 Removing the flywheel housing cover plate**



**12.4 Removing the sump**

require cutting with a sharp knife to release the sump. Clean away all old gasket material.

### Refitting

5 When refitting, a bead of RTV silicone instant gasket 3 mm in diameter should be applied to the sump flange. Fit the sump, screw in the fixing screws and tighten to the specified torque. Note the flange end fixing nuts (see illustrations).

6 Wait one hour for the gasket compound to harden before filling with engine oil.

7 Refit the flywheel housing cover plate and exhaust system front pipe.

8 Lower the vehicle to the ground and fill the engine with oil (see Chapter 1A). Check the oil level after running the engine for a few minutes.

## 13 Oil pump and pick-up tube - removal, inspection and refitting



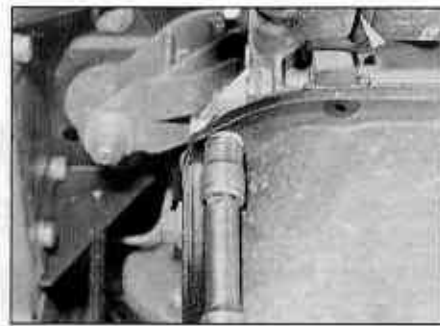
### Removal

1 Drain the engine oil and remove the sump as described in Section 12.

2 Unscrew and remove the oil filter cartridge (see Chapter 1A).

3 Remove the timing belt as described in Section 4.

4 Lock the crankshaft against rotation either by placing a block of wood between a crankshaft web and the inside of the crankcase, or by jamming the flywheel starter ring gear with a suitable tool.



12.5a Tightening a sump fixing screw



12.5b Sump fixing screw and flange end fixing nut

5 Unscrew and remove the crankshaft sprocket bolt and take off the sprocket. If it is tight, use two screwdrivers to lever it off, or use a two or three-legged puller.

6 Unbolt and remove the oil pick-up/filter screen assembly. Note the sealing washer.

7 Extract the oil pump fixing bolts and withdraw the pump. Remove the gasket.

### Inspection

8 The oil pump incorporates a pressure relief valve, which can be removed for examination by depressing the spring plunger and pulling out the keeper plate (see illustrations).

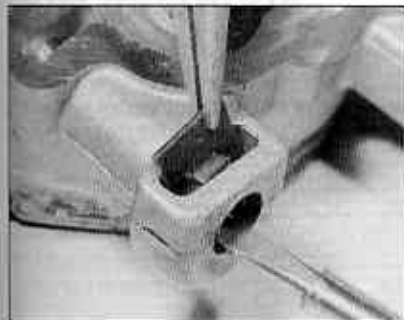
9 If pump wear is suspected, check the gears in the following way. Extract the fixing screws and remove the rear cover plate. The screws are very tight, and will probably require the use of an impact screwdriver (see illustration).

10 Check the clearance between the outer gear and the pump housing using feeler blades. Check the gear endfloat by placing a straightedge across the pump body, and checking the gap between the straight-edge and gear face (see illustrations). If the clearances are outside the specified tolerance, renew the oil pump complete.

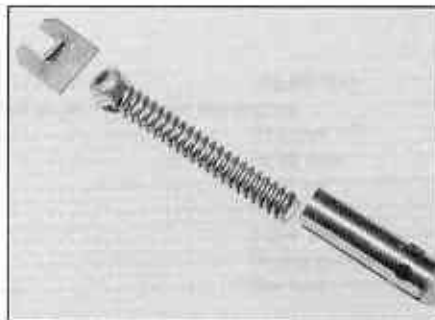
11 If the pump is unworn, refit the rear cover plate and tighten the screws fully.

12 Apply air pressure from a tyre pump to the oil pump oil ducts, to clear any sludge or other material. Prime the pump by pouring clean engine oil into its inlet duct, at the same time turning the oil pump inner gear with the fingers.

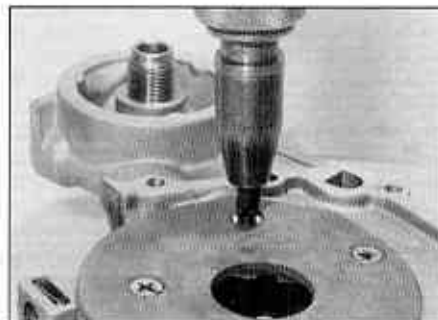
13 Lever out the oil seal and drive a new one squarely into the oil pump casing (see illustrations). Lubricate the oil seal lips.



13.8a Removing the oil pump pressure relief valve



13.8b Components of the oil pump pressure relief valve



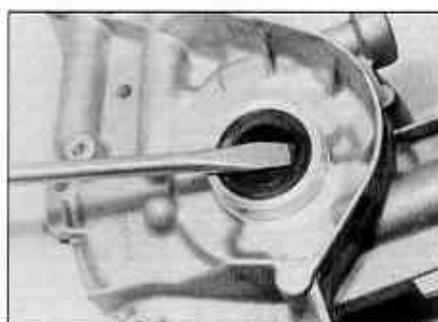
13.9 Using an impact screwdriver to remove the oil pump rear cover plate screws



13.10a Measuring oil pump outer gear-to-pump housing clearance

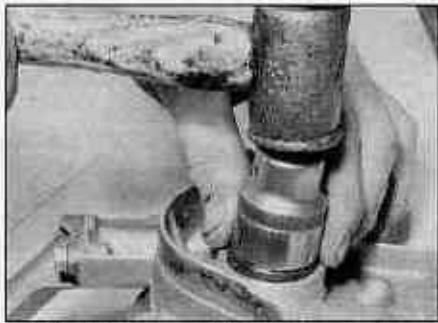


13.10b Measuring oil pump gear endfloat

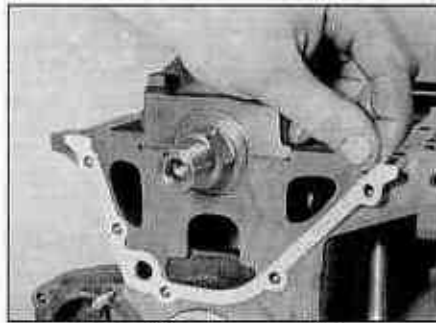


13.13a Removing the oil pump oil seal

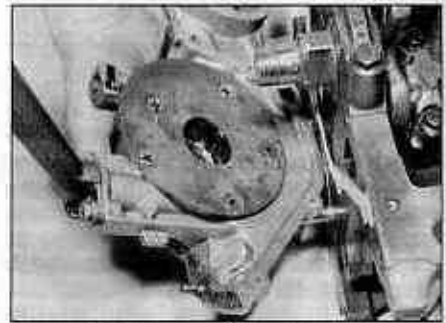




13.13b Using a socket to fit a new oil seal to the oil pump



13.14a Using a new gasket ...



13.14b ... refit the oil pump

### Refitting

14 Bolt the pump into position using a new joint gasket (see illustrations). Note that one bolt is longer than the others.

15 Bolt on the oil pick-up assembly using a

new sealing washer.

16 Lock the crankshaft as described in paragraph 4, then fit the crankshaft sprocket and tighten the bolt to the specified torque.

17 Fit the sump as described in Section 12. Screw on a new oil filter cartridge,

18 Fit and tension the timing belt as described in Section 4.

19 Fill the engine with oil (see Chapter 1A).

20 Run the engine for a few minutes, then check and top-up the oil level (see *Weekly checks*).

# Chapter 2 Part B:

## DOHC (16-valve) petrol engine in-car repair procedures

### Contents

Auxiliary drivebelts - removal and refitting	..... See Chapter 1A	Engine mountings - inspection and renewal	..... 12
Camshaft oil seal - renewal	..... 6	Engine oil and filter - renewal	..... See Chapter 1A
Camshafts and cam followers - removal, inspection and refitting	.. 9	Engine oil level - check	..... See <i>Weekly checks</i>
Crankshaft oil seals - renewal	..... 7	Flywheel - removal, inspection and refitting	..... 11
Cylinder compression test	..... 3	General Information	..... 1
Cylinder head - dismantling and overhaul	..... See Chapter 2D	Oil pump and pick-up tube - removal, inspection and refitting	..... 14
Cylinder head - removal and refitting	..... 10	Sump - removal and refitting	..... 13
Cylinder head extension - removal and refitting	..... 8	Timing belt and covers - removal and refitting	..... 4
Engine assembly/valve timing holes - general information and usage	..... 2	Timing belt tensioner and sprockets - removal and refitting	..... 5

### 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 code*	176.B9.000
<i>*Note: See Vehicle Identification for the location of code marking on the engine.</i>	
Bore	70.8 mm
Stroke	78.86 mm
Capacity	1242 cc
Compression ratio	10.2:1
Firing order	1-3-4-2
No 1 cylinder location	Timing belt end of engine
Timing belt tension	See text

#### Camshaft

Drive	Toothed belt
No of bearings	3
Camshaft bearing journal diameters:	
No 1 bearing	35.000 to 35.015 mm
No 2 bearing	48.000 to 48.015 mm
No 3 bearing	49.000 to 49.015 mm
Camshaft bearing journal running clearance	0.030 to 0.070 mm
Camshaft endfloat	0.15 to 0.34 mm

#### Cylinder head extension

Camshaft bearing diameters:	
No 1 bearing	35.045 to 35.070 mm
No 2 bearing	48.045 to 48.070 mm
No 3 bearing	49.045 to 49.070 mm
Cam follower (tappet) type	Hydraulic
Cam follower (tappet) diameter	28.353 to 28.370 mm
Cam follower (tappet) bore diameter in cylinder head extension	28.400 to 28.421 mm
Cam follower (tappet) running clearance	0.046 to 0.051 mm

**Lubrication system**

Oil pump type	By-rotor driven from front of crankshaft
Outer rotor-to-housing clearance	0.100 to 0.210 mm
Axial clearance	0.025 to 0.070 mm

**Torque wrench settings**

	Nm	lbf ft
Camshaft driven gears	120	89
Camshaft sprocket	120	89
Crankshaft sprocket centre bolt:		
Stage 1	20	15
Stage 2	Angle-tighten a further 90°	
Cylinder head:		
Stage 1	30	22
Stage 2	Angle-tighten a further 90°	
Stage 3	Angle-tighten a further 90°	
Cylinder head extension to cylinder head	15	11
Engine mounting bolt:		
M10 x 1.25	59	44
M8	25	18
Engine mounting nut (M10 x 1.25)	60	44
Flywheel	44	32
Timing belt tensioner	25	18
Sump	10	7

**1 General information****Using this Chapter**

Chapter 2 is divided into four Parts; A, B, C and D. Repair operations that can be carried out with the engine in the vehicle are described in Part A, SOHC (8-valve) petrol engines, Part B, DOHC (16-valve) petrol engines and Part C, diesel engines. Part D covers the removal of the engine/transmission as a unit, and describes the engine dismantling and overhaul procedures.

In Parts A, B and C, the assumption is made that the engine is installed in the vehicle, with all ancillaries connected. If the engine has been removed for overhaul, the preliminary dismantling information which precedes each operation may be ignored.

**Engine description**

Throughout this Chapter, engines are identified by their capacities. A listing of all engines covered, together with their code letters, is given in the Specifications.

The engine covered in this Part of Chapter 2 is a water-cooled, double overhead camshaft, in-line four-cylinder unit, with cast iron cylinder block and aluminium-alloy cylinder head. The unit is mounted transversely at the front of the vehicle, with the transmission bolted to the left-hand side of the engine.

The cylinder head houses the eight inlet and eight exhaust valves, which are closed by single coil springs, and which run in guides pressed into the cylinder head. The two camshafts are housed in a cylinder head extension which is bolted to the top of the cylinder head. The exhaust camshaft is driven by a toothed timing belt and in turn drives the inlet camshaft via a pair of gears located at the left-hand end of the cylinder head extension.

The camshafts actuate the valves directly via self-adjusting hydraulic cam followers mounted in the cylinder head extension.

The crankshaft is supported by five main bearings, and endfloat is controlled by a thrust bearing fitted to the upper section of the centre main bearing.

Engine coolant is circulated by a pump, driven by the timing belt. For details of the cooling system, refer to Chapter 3.

Lubricant is circulated under pressure by a pump, driven from the front of the crankshaft. Oil is drawn from the sump through a strainer, and then forced through an externally-mounted, replaceable screw-on filter. From there, it is distributed to the cylinder head and cylinder head extension, where it lubricates the camshaft journals and cam followers, and also to the crankcase, where it lubricates the main bearings, connecting rod big and small-ends, gudgeon pins and cylinder bores. Oil jets are fitted to the base of each cylinder bore - these spray oil onto the underside of the pistons, to improve cooling.

**Repair operations possible with the engine in the car**

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

- Auxiliary drivebelt - removal and refitting (refer to Chapter 1A)
- Oil pump and pick-up tube assembly - removal, inspection and refitting
- Timing belt and covers - removal and refitting
- Timing belt tensioner and sprockets - removal and refitting
- Cylinder head - removal and refitting\*
- Cylinder head extension - removal and refitting
- Camshaft and cam followers - removal and refitting
- Camshaft oil seal - renewal
- Crankshaft oil seals - renewal

- Flywheel - removal, inspection and refitting
- Engine mountings - inspection and renewal
- Sump - removal and refitting

\*Cylinder head dismantling procedures are detailed in Chapter 2D.

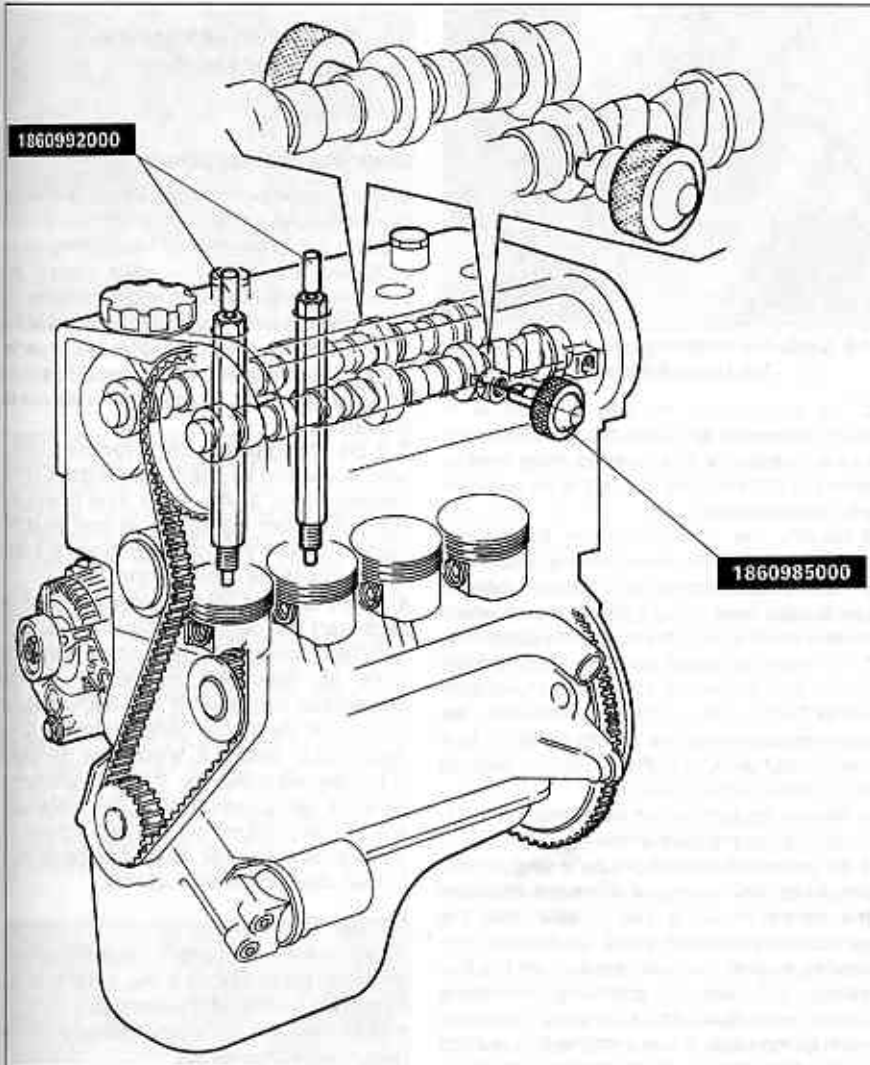
**Note 1:** It is possible to remove the pistons and connecting rods (after removing the cylinder head and sump) without removing the engine. However, this is not recommended. Work of this nature is more easily and thoroughly completed with the engine on the bench, as described in Chapter 2D.

**Note 2:** Many of the procedures in this Chapter entail the use of numerous special tools. Where possible, suitable alternatives are described with details of their fabrication. Before starting any operations on the engine, read through the entire procedure first to familiarise yourself with the work involved, tools to be obtained and new parts that may be necessary.

**2 Engine assembly/valve timing holes - general information and usage**

**Note:** Do not attempt to rotate the engine whilst the camshafts are locked in position. If the engine is to be left in this state for a long period of time, it is a good idea to place suitable warning notices inside the vehicle, and in the engine compartment. This will reduce the possibility of the engine being accidentally cranked on the starter motor, which is likely to cause damage with the locking tools in place.

**1** To accurately set the valve timing for all operations requiring removal and refitting of the timing belt, timing holes are drilled in the camshafts and cylinder head extension. The holes are used in conjunction with camshaft locking tools and crankshaft positioning rods to lock the camshafts when all the pistons are positioned at the mid-point of their stroke. This



2.2a Arrangement of Fiat special tools for setting the piston position and locking the camshafts

arrangement prevents the possibility of the valves contacting the pistons when refitting the cylinder head or timing belt, and also ensures that the correct valve timing can be obtained. The design of the engine is such that there are no conventional timing marks on the crankshaft or camshaft sprockets to indicate the normal TDC position. Therefore, for any work on the timing belt, camshafts or cylinder head, the locking and positioning tools must be used.

2 The special Fiat tools for setting the camshafts and pistons consist of two rods which slide in sleeves that are screwed into No 1 and No 2 cylinder spark plug holes. The rods are pushed down to contact the pistons, and the crankshaft is then turned until both rods protrude from their sleeves by the same amount. With the crankshaft correctly set, two camshaft locking pins are used, one for the inlet camshaft and one for the exhaust camshaft. The pins are screwed into holes on each side of the cylinder head extension so that they engage with slots machined in the

camshafts. The arrangement of the Fiat special tools are shown (see illustrations). The tool numbers are as follows:

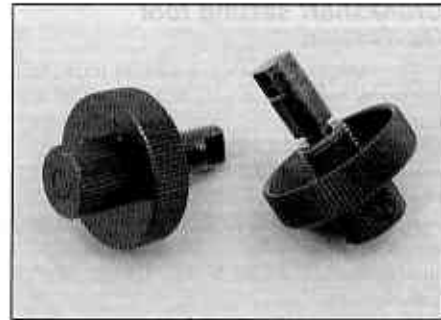
Camshaft locking tools	Tool No
	1860985000
Piston positioning tool	Tool No
	1860992000



2.6a To make an alternative camshaft locking tool ...



2.2b Fiat special tool for setting piston position ...



2.2c ... and locking the camshafts

3 Although the special Fiat tools are relatively inexpensive and should be readily available from Fiat dealers, it is possible to fabricate suitable alternatives, with the help of a local machine shop, as described below. Once the tools have been made up, their usage is described in the relevant Sections of this Chapter where the tools are required.

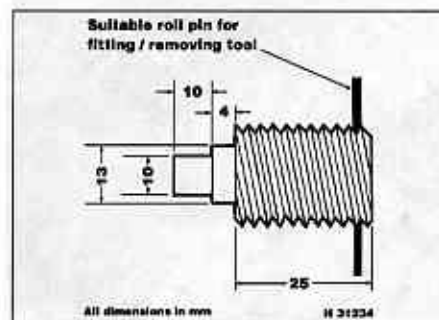
2B

#### Camshaft locking tool fabrication

4 Remove the air cleaner, inlet air duct and resonator as described in Chapter 4B.

5 Unscrew the sealing plug from the front face of the cylinder head extension.

6 Using the sealing plug as a pattern, obtain a length of threaded dowel rod or two suitable bolts to screw into the sealing plug hole. With the help of a machine shop or engineering works, make up the camshaft locking tools by having the dowel rod or bolts machined to the dimensions shown (see illustrations). Note that two will be needed, one for each camshaft.



2.6b ... have suitable dowel rods or bolts machined to the dimensions shown



4.8 Undo the three bolts and remove the crankshaft pulley from the sprocket

### Crankshaft setting tool fabrication

7 To make the crankshaft setting tools, four old spark plugs will be required, together with four lengths of dowel rod. The length of each dowel rod is not critical, but it must be long enough to protrude about 100 mm above the top of the cylinder head extension when resting on top of a piston located half way down its bore. What is critical, however, is that all four dowel rods must be **exactly** the same length.

8 Break off the ceramic upper section of each plug and remove the centre electrode and earth tip. The easiest way to do this is to mount each spark plug in a vice (after removing the ceramic upper plug section) and drill a hole down through the centre of the plug. The diameter of the drill bit should be the same as the diameter of the dowel rod to be used. When finished you should have four spark plug bodies and four equal length dowel rods which will slide through the centre of the spark plugs.

### 3 Cylinder compression test

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.



4.10 Undo the upper timing cover upper retaining bolt, and the rear retaining bolt



4.9 Undo the retaining bolt in the centre of the lower timing cover

2 The engine must be fully warmed-up to normal operating temperature, the battery must be fully charged, and all the spark plugs must be removed (Chapter 1A). The aid of an assistant will also be required.

3 Disable the ignition system by disconnecting the LT wiring plugs to the ignition coils.

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 Have the assistant hold the throttle wide open, and crank the engine on the starter motor; after one or two revolutions, the compression pressure should build up to a maximum figure, and then stabilise. Record the highest reading obtained.

6 Repeat the test on the remaining cylinders, recording the pressure in each.

7 All cylinders should produce very similar pressures; any excessive difference indicates the existence of a fault. Note that the compression should build up quickly in a healthy engine; low compression on the first stroke, followed by gradually increasing pressure on successive strokes, indicates leaking valves or a blown head gasket (a cracked head could also be the cause).

8 If the pressure in any cylinder is very low, carry out the following test to isolate the cause. Introduce a teaspoonful of clean oil into that cylinder through its spark plug hole and repeat the test.

9 If the addition of oil temporarily improves the compression pressure, this indicates that bore or piston wear is responsible for the pressure loss. No improvement suggests that leaking or burnt valves, or a blown head gasket, may be to blame.

10 A low reading from two adjacent cylinders is almost certainly due to the head gasket having blown between them; the presence of coolant in the engine oil will confirm this.

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

12 On completion of the test, refit the spark plugs and reconnect the ignition LT wiring plug.

## 4 Timing belt and covers - removal and refitting

### General information

1 The function of the timing belt is to drive the camshafts and coolant pump. Should the belt slip or break in service, the valve timing will be disturbed and piston-to-valve contact will occur, resulting in serious engine damage.

2 The timing belt should be renewed at the specified intervals (see Chapter 1A), or earlier if it is contaminated with oil, or if it is at all noisy in operation (a scraping noise due to uneven wear).

3 If the timing belt is being removed, it is a wise precaution to check the condition of the coolant pump at the same time (check for signs of coolant leakage). This may avoid the need to remove the timing belt again at a later stage, should the coolant pump fail.

4 Before carrying out this procedure, it will be necessary to obtain or fabricate suitable camshaft locking tools and piston positioning tools as described in Section 2. The procedures contained in this Section depict the use of the home-made alternative tools described in Section 2, which were fabricated in the Haynes workshop. If the manufacturers tools are being used instead, the procedures are virtually identical. Do not attempt to remove the timing belt unless the special tools or their alternatives are available.

### Removal

5 Disconnect the battery negative terminal (refer to *Disconnecting the battery* in the Reference Section of this manual).

6 Remove the auxiliary drivebelt(s) as described in Chapter 1A.

7 Remove the air cleaner, inlet air duct and resonator as described in Chapter 4B.

8 Undo the three bolts and remove the crankshaft pulley from the sprocket (see illustration).

9 Undo the retaining bolt in the centre of the lower timing cover (see illustration).

10 Undo the upper timing cover upper retaining bolt, and the rear retaining bolt located above the alternator (see illustration).

11 Release the crankshaft TDC sensor wiring from the clip on the upper timing cover, then withdraw the cover slightly and slide the wiring plug and socket from the timing cover slot (see illustrations).

12 Release the TDC sensor wiring from the periphery of the upper and lower timing covers and remove both covers (see illustrations).

13 Free the accelerator inner cable from the throttle cam, remove the outer cable spring clip, then pull the outer cable out from its mounting bracket rubber grommet.

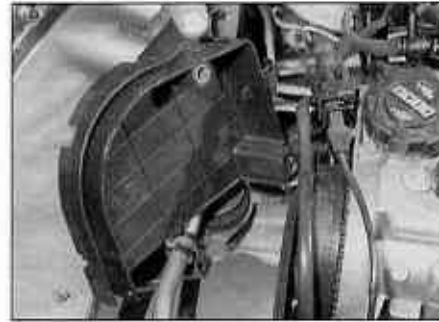
14 From the side of the throttle body, disconnect the wiring connectors from the



**4.11a** Release the crankshaft TDC sensor wiring from the clip on the upper timing cover ...



**4.11b** ... then slide the wiring plug and socket from the timing cover slot



**4.12a** Remove the upper ...

throttle potentiometer and the idle control stepper motor. Disconnect the coolant temperature sensor wiring connector located in the inlet manifold below the throttle body, and disconnect the brake servo vacuum hose. **15** Disconnect the wiring connectors for the fuel injector harness and the intake air temperature/pressure sensor, then disconnect the fuel pressure regulator vacuum hose and the EVAP purge valve hose. **16** Undo the two bolts securing the plastic inlet manifold upper section to the lower section. Release the spark plug HT lead from the location groove in the manifold upper section, then lift the upper section, complete with throttle body, off the engine. Recover the O-rings from the manifold ports. **17** Unscrew the two bolts securing the fuel

rail assembly to the inlet manifold lower section, then carefully pull the injectors from the manifold. Lift the fuel rail and injector assembly, with fuel hoses still connected, and position it to one side.

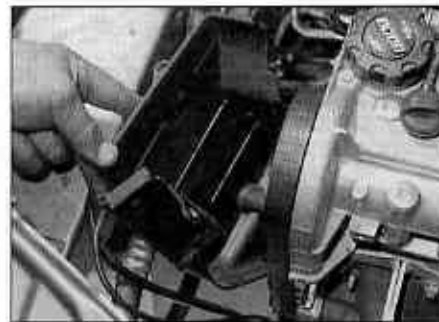
**18** Undo the bolts securing the engine management ECU mounting brackets to the body and move the ECU to one side without disconnecting the wiring connector.

**19** Remove the spark plugs as described in Chapter 1A.

**20** Unscrew the two sealing plugs from the front and rear of the cylinder head extension to enable the camshaft locking tools to be inserted.

**21** Screw the spark plug bodies of the home-made piston positioning tools into each spark plug hole and insert the dowel rods into each body. To keep the dowel rods vertical, locate a suitable washer or similar over the rod and into the recess at the top of the spark plug hole. In the photos shown here, an old valve stem oil seal housing was used but anything similar will suffice (see illustrations).

**22** Using a socket on the crankshaft sprocket centre bolt, turn the crankshaft in the normal direction of rotation until all four dowel rods are protruding from the top of the cylinder head extension by the same amount. As the engine is turned, two of the rods will move up and two will move down until the position is reached where they are all at the same height. The best way to check this is to place a straight edge along the top of the rods and turn the crankshaft very slowly until the



**4.12b** ... and lower timing covers

straight edge contacts all four rods (see illustration).

**23** When all four rods are at the same height, all the pistons will be at the mid-point of their stroke. Using a screwdriver or similar inserted into the front timing hole in the cylinder head extension, check that the timing slot in the exhaust camshaft is approximately aligned with the timing hole. If the camshaft slot cannot be felt, turn the crankshaft through one complete revolution and realign the dowel rods using the straight edge. Check again for the camshaft slot. Note that although the pistons can be at the mid-point of their stroke twice for each cycle of the engine, the camshaft slots will only be positioned correctly once per cycle.

**24** With the pistons correctly set, it should now be possible to screw in the camshaft



**4.21a** Screw the spark plug bodies of the home-made piston positioning tools into each spark plug hole ...



**4.21b** ... place a suitable washer or similar into the recess to keep the dowel rod vertical ...



**4.21c** ... then insert the dowel rods



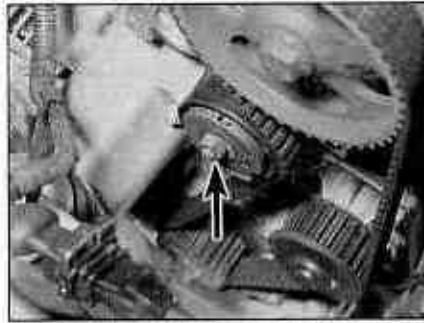
**4.22** Place a straight edge along the top of the rods and turn the crankshaft until the straight edge contacts all four rods



4.24a Screw in the camshaft locking tools into the timing holes in the cylinder head extension



4.24b The tools engage in the camshaft slots when fitted (shown removed for clarity)



4.25 Release the nut on the timing belt tensioner (arrowed)

locking tools into the timing holes in the cylinder head extension. To provide the necessary degree of timing accuracy, the machined end of the locking tools are a very close fit in the slots machined in the camshafts. To allow the tools to be screwed

fully into engagement, it may be necessary to move the crankshaft in one direction or another *very slightly* until the tools are felt to engage fully (see illustrations).

25 Release the nut on the timing belt tensioner to release the tension on the belt (see illustration).

26 If the timing belt is to be re-used, use white paint or chalk to mark the direction of rotation on the belt (if markings do not already exist), then slip the belt off the sprockets (see illustration). Note that the crankshaft must not be rotated whilst the belt is removed.

27 Check the timing belt carefully for any signs of uneven wear, splitting, or oil contamination. Pay particular attention to the roots of the teeth. Renew it if there is the slightest doubt about its condition. If the engine is undergoing an overhaul, renew the belt as a matter of course, regardless of its apparent condition. The cost of a new belt is nothing compared with the cost of repairs, should the belt break in service. If signs of oil contamination are found, trace the source of the oil leak and rectify it. Wash down the engine timing belt area and all related components, to remove all traces of oil.

### Refitting

28 Before refitting, thoroughly clean the timing belt sprockets. Check that the tensioner pulley rotates freely, without any sign of roughness. If necessary, renew the tensioner pulley as described in Section 5.

29 The camshaft sprocket retaining bolt must now be slackened to allow the sprocket to move as the timing belt is refitted and tensioned. To hold the sprocket stationary while the retaining bolt is loosened, make up a tool as follows and engage it with the holes in the sprocket (see Tool Tip). With the sprocket held, slacken the retaining bolt.

30 Check that the pistons are still correctly positioned at the mid-point of their stroke and that the camshafts are locked with the locking tools.

31 Ensuring that the direction markings on the timing belt point in the normal direction of engine rotation, engage the timing belt with the crankshaft sprocket first, then place it around the coolant pump sprocket and the camshaft sprocket (see illustration). Finally slip the belt around the tensioner pulley.

32 Insert the jaws of a pair of right-angled circlip pliers (or similar) into the two holes on the front face of the tensioner pulley (see illustration). Rotate the pulley to tension the belt until the belt is quite taut. Maintain the effort applied to the tensioner pulley, then tighten the pulley retaining nut.

33 Tighten the camshaft sprocket retaining bolt to the specified torque while holding the camshaft stationary using the method described previously (see illustration).

34 Remove the piston positioning tools and camshaft locking tools and turn the crankshaft through two complete turns in the normal direction of rotation.



4.26 Slip the timing belt off the sprockets



**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, secure a bolt with a nut and a locknut, to act as the fulcrums; these will engage with the cut-outs in the sprocket, and should protrude by about 30 mm



4.31 Fit the new belt around the sprockets observing the direction markings



4.32 Using right-angled circlip pliers, turn the tensioner pulley to fully tension the belt

35 Slacken the tensioner pulley retaining nut and reposition the tensioner to align the mobile indicator with the fixed reference mark on the pulley face (see illustration). Hold the pulley in this position and tighten the retaining nut to the specified torque.

36 Turn the crankshaft through a further two complete turns in the normal direction of rotation. Check that the timing is correct by refitting the piston positioning tools and camshaft locking tools as described previously.

37 When all is correct, remove the setting and locking tools and refit the sealing plugs to the cylinder head extension, using new O-rings if necessary. Tighten the plugs securely.

38 Refit the spark plugs as described in Chapter 1A.

39 Refit the ECU and secure with the mounting bolts.

40 Renew the injector O-ring seals, smear them with a little Vaseline then locate the injectors and fuel rail onto the inlet manifold lower section. Secure the fuel rail with the two retaining bolts.

41 Refit the inlet manifold upper section using new sealing O-rings if necessary and secure with the two bolts.

42 Reconnect the wiring connectors for the fuel injector harness and the intake air temperature/pressure sensor, then connect the fuel pressure regulator vacuum hose and the EVAP purge valve hose.

43 Reconnect the wiring connectors for the throttle potentiometer, idle control stepper motor and coolant temperature sensor. Reconnect the brake servo vacuum hose.

44 Refit and adjust the accelerator cable as described in Chapter 4B.

45 Refit the upper and lower timing belt covers together with the TDC sensor wiring.

46 Refit the crankshaft pulley and tighten the three retaining bolts securely.

47 Refit the air cleaner, inlet air duct and resonator as described in Chapter 4B.

48 Refit the auxiliary drivebelt(s) as described in Chapter 1A, then reconnect the battery negative terminal.

## 5 Timing belt tensioner and sprockets - removal and refitting



### Timing belt tensioner

#### Removal

1 Remove the timing belt as described in Section 4.

2 Completely unscrew the tensioner nut and slide the tensioner off the mounting stud.

#### Inspection

3 Wipe the tensioner clean but do not use solvents that may contaminate the bearings. Spin the tensioner pulley on its hub by hand. Stiff movement or excessive freeplay is an indication of severe wear; the tensioner is not a serviceable component, and should be renewed.



4.33 Holding the camshaft sprocket with the tool described previously while tightening the sprocket bolt

#### Refitting

4 Slide the tensioner pulley over the mounting stud and fit the securing nut.

5 Refit the timing belt as described in Section 4.

### Camshaft sprocket

#### Removal

6 Remove the timing belt as described in Section 4.

7 Unscrew the bolt and slide the sprocket from the end of the camshaft.

#### Inspection

8 With the sprocket removed, examine the camshaft oil seal for signs of leaking. If necessary, refer to Section 6 and renew it.

9 Check the sprocket teeth for damage.

10 Wipe clean the sprocket and camshaft mating surfaces.

#### Refitting

11 Locate the sprocket on the end of the camshaft, then refit the retaining bolt finger tight only at this stage.

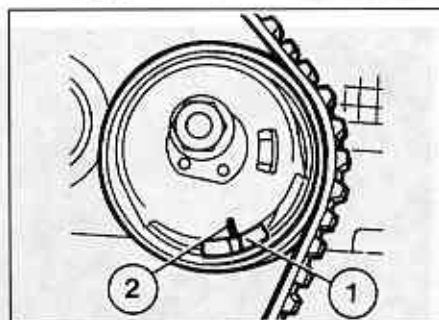
12 Refit the timing belt as described in Section 4.

### Crankshaft sprocket

#### Removal

13 Remove the timing belt as described in Section 4.

14 Working beneath the engine, unbolt and remove the flywheel lower cover, then hold the flywheel stationary preferably using a tool which engages the flywheel starter ring gear.



4.35 Position the tensioner so that the mobile indicator (1) is aligned with the fixed reference mark (2)

Alternatively have an assistant engage a wide-bladed screwdriver with the starter ring gear.

15 Unscrew the crankshaft sprocket retaining bolt and slide the sprocket off the end of the crankshaft. The sprocket may have an integral location key on its inner face, or a separate key which locates in a groove in the crankshaft nose may be fitted.

#### Inspection

16 With the sprocket removed, examine the crankshaft oil seal for signs of leaking. If necessary, refer to Section 7 and renew it.

17 Check the sprocket teeth for damage.

18 Wipe clean the sprocket and crankshaft mating surfaces.

#### Refitting

19 Slide the sprocket onto the crankshaft making sure it engages the integral key or separate key, then refit the bolt and washer and tighten the bolt to the specified torque while holding the crankshaft stationary using the method described in paragraph 14.

20 Refit the timing belt as described in Section 4.

## 6 Camshaft oil seal - renewal



1 Remove the timing belt and camshaft sprocket as described in Sections 4 and 5.

2 Punch or drill a small hole in the oil seal. Screw a self-tapping screw into the hole, and pull on the screws with pliers to extract the seal.

3 Clean the seal housing, and polish off any burrs or raised edges, which may have caused the seal to fall in the first place.

4 Lubricate the lips of the new seal with clean engine oil, and drive it into position until it seats on its locating shoulder. Use a suitable tubular drift, such as a socket, which bears only on the hard outer edge of the seal. Take care not to damage the seal lips during fitting. Note that the seal lips should face inwards.

5 Refit the camshaft sprocket and timing belt as described in Sections 5 and 4.

## 7 Crankshaft oil seals - renewal



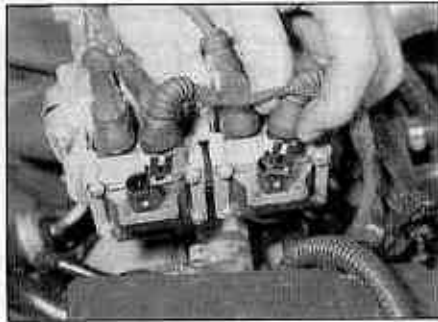
### Front (right-hand side) oil seal

1 The front oil seal is located in the oil pump on the front of the crankshaft. Remove the timing belt as described in Section 4 and the crankshaft sprocket as described in Section 5.

2 Using a hooked instrument, remove the oil seal from the oil pump casing taking care not to damage the surface of the crankshaft.

3 Clean the seating in the housing and the surface of the crankshaft. To prevent damage to the new oil seal as it is being fitted, wrap some adhesive tape around the end of the crankshaft and lightly oil it.





8.3a Disconnect the LT wiring plugs from the two ignition coils . . .

4 Dip the new oil seal in oil then offer it up to the oil pump casing making sure that the sealing lips are facing inwards.

5 Using a suitable tubular drift, drive the oil seal squarely into the casing. Remove the adhesive tape.

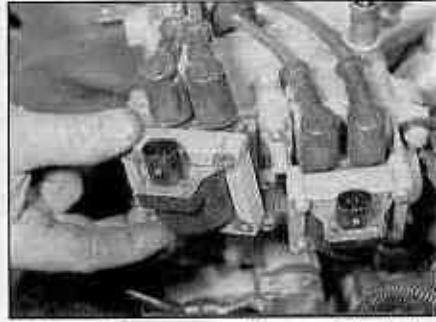
6 Refit the crankshaft sprocket and timing belt with reference to Sections 5 and 4.

### Rear (left-hand side) oil seal

**Note:** The following paragraphs describe renewal of the rear oil seal leaving the housing in position. Refer to Chapter 2D for details of removing the housing.

7 Remove the flywheel as described in Section 11.

8 Using a suitable hooked instrument, remove the oil seal from the rear oil seal



8.3b . . . then unscrew the mounting bolts and remove the ignition coils

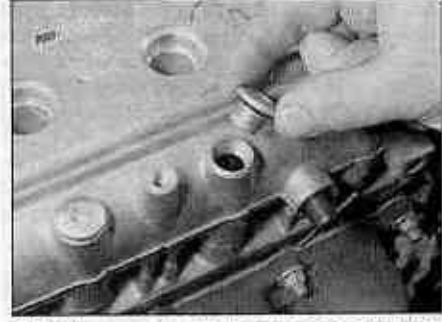
housing taking care not to damage the surface of the crankshaft.

9 Clean the seating in the housing and the surface of the crankshaft. Check the crankshaft for burrs which may damage the sealing lip of the new seal, and if necessary use a fine file to remove them.

10 Dip the new seal in clean engine oil and carefully locate it over the crankshaft rear flange making sure that it is the correct way round.

11 Progressively tap the oil seal into the housing keeping it square to prevent distortion. A block of wood is useful for this purpose.

12 Refit the flywheel with reference to Section 11.



8.5 Unscrew the protective caps covering the cylinder head extension retaining bolts

5 Unscrew the protective caps covering the cylinder head extension retaining bolts (see illustration).

6 To retain the cam followers in place as the cylinder head extension is removed, Fiat special tool No 1860988000 will be required. This tool consists of two strips of suitably slotted thin metal angle which slip between the cylinder head extension and cylinder head mating faces as the extension is lifted off. The tool holds the cam followers in place in the extension allowing the assembly to be withdrawn without fouling the inlet and exhaust valves. The tools are relatively inexpensive and readily available from Fiat dealers. Suitable alternatives can be fabricated, if desired, using thin metal angle strip cut to the dimensions shown (see Tool tip).

7 Progressively slacken and remove the bolts securing the cylinder head extension to the cylinder head.

8 Lift the cylinder head extension up very slightly, keeping it square to the cylinder head. Slip the tools in place to hold the cam followers, then lift the extension off the cylinder head (see illustrations). Recover the gasket between the two assemblies.

9 Dismantling and inspection procedures for the cylinder head extension and camshafts are given in Section 9.

### Refitting

10 Ensure that the mating faces of the cylinder head and extension are thoroughly cleaned, with all traces of old gasket removed, then locate a new gasket on the cylinder head (see illustration).

**TOOL TIP**

To make a cam follower retaining tool, obtain two lengths of thin metal angle and cut both to the dimensions (in mm) shown

### 8 Cylinder head extension - removal and refitting

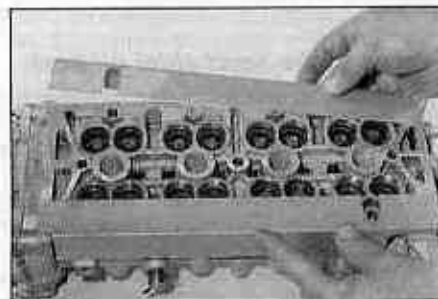
#### Removal

1 Remove the timing belt as described in Section 4.

2 Identify the two HT leads for position then disconnect them from the coil HT terminals.

3 Disconnect the LT wiring plugs from the two ignition coils, then unscrew the mounting bolts and remove the ignition coils from the end of the cylinder head extension (see illustrations).

4 Undo the bolt and remove the resonator support bracket from the top of the cylinder head extension.



8.8a Lift the cylinder head extension slightly and insert the tools (shown with cylinder head removed for clarity) . . .



8.8b . . . then remove the cylinder head extension



8.10 Locate a new gasket on the cylinder head



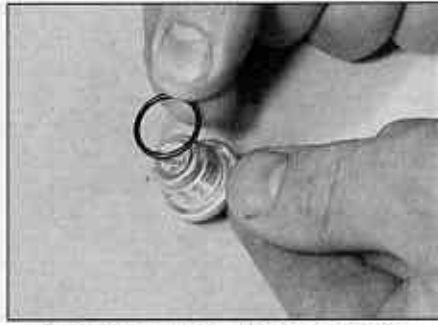
**8.12 Refit the cylinder head extension retaining bolts and tighten them to the specified torque**

11 Locate the cam follower retaining tools in position then lower the extension assembly onto the cylinder head. When all the cam followers have engaged their respective valves, remove the tools.

12 Refit the retaining bolts and tighten them progressively to pull the extension down onto the cylinder head. Do this slowly and carefully as the valve springs will be compressed during this operation and it is essential to keep the extension square and level as the bolts are tightened. Once all the bolts are initially tightened, progressively tighten them further to the specified torque (**see illustration**).

13 If necessary renew the O-ring seals on the protective caps covering the cylinder head extension retaining bolts (**see illustration**). Refit the caps and tighten them securely.

14 Refit the resonator support bracket to the top of the cylinder head extension.



**8.13 Renew the O-ring seals on the protective caps covering the cylinder head extension retaining bolts**

15 Refit the ignition coils and reconnect the wiring.

16 Refit the timing belt as described in Section 4.

## 9 Camshafts and cam followers - removal, inspection and refitting

### Removal

1 Remove the cylinder head extension as described in Section 8.

2 Place the assembly upside down on a bench and lift off the cam follower retaining tools.

3 Remove the cam followers from their locations in the cylinder head extension and place them in an oil tight compartmented box

labelled 1 to 8 (inlet) and 1 to 8 (exhaust) (**see illustration**). Alternatively, place them into individual storage jars or containers suitably marked. Fill the box or the jars with clean engine oil until each cam follower is just submerged.

4 Undo the camshaft sprocket retaining bolt while holding the sprocket with a suitable tool as described in Section 4.

5 Remove the camshaft sprocket, then undo the bolt and nut and remove the cover plate over the inlet camshaft (**see illustrations**).

6 At the other end of the cylinder head extension, undo the nuts and remove the end cover (**see illustration**). Recover the gasket.

7 Undo the two bolts securing the camshaft drive gears to the inlet and exhaust camshafts (**see illustration**). The camshaft locking tools used in the timing belt removal procedure (which should still be in place) are sufficient to prevent the camshafts rotating while the gear retaining bolts are undone. Remove the bolts and withdraw the camshaft gears.

8 Remove the camshaft locking tools.

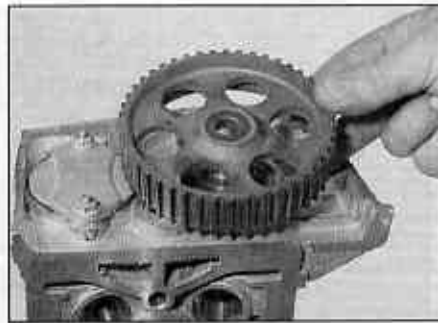
9 Carefully remove the inlet camshaft from the cylinder head extension (**see illustration**). Suitably mark the camshaft IN to avoid confusion when refitting.

10 Punch or drill a small hole in the exhaust camshaft oil seal. Screw a self-tapping screw into the hole, and pull on the screw with pliers to extract the seal (**see illustration**).

11 Carefully remove the exhaust camshaft from the cylinder head extension (**see illustration**). Suitably mark the camshaft EX to avoid confusion when refitting.



**9.3 Remove the cam followers from their locations in the cylinder head extension**



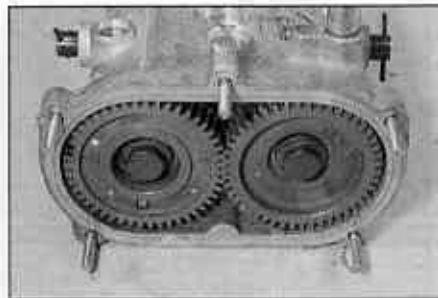
**9.5a Remove the camshaft sprocket ...**



**9.5b ... then undo the bolt and nut and remove the cover plate over the inlet camshaft**



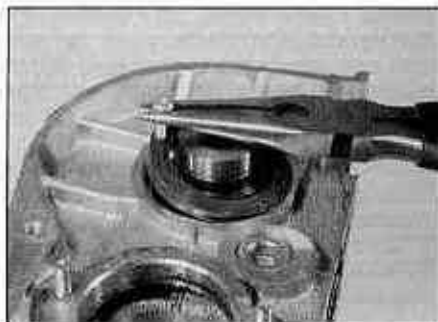
**9.6 Undo the nuts and remove the end cover**



**9.7 Undo the two bolts securing the camshaft drive gears to the inlet and exhaust camshafts**



**9.9 Carefully remove the inlet camshaft from the cylinder head extension**



9.10 Extract the exhaust camshaft oil seal ...



9.11 ... then remove the exhaust camshaft from the cylinder head extension



9.15 Refit the camshaft locking tools

### Inspection

12 Examine the camshaft bearing surfaces and cam lobes for signs of wear ridges and scoring. Renew the camshaft if any of these conditions are apparent. Examine the condition of the bearing surfaces, both on the camshaft journals and in the cylinder head extension. If the head extension bearing surfaces are worn excessively, the extension will need to be renewed. If suitable measuring equipment is available, camshaft bearing journal wear can be checked by direct measurement.

13 Examine the cam follower bearing surfaces which contact the camshaft lobes for wear ridges and scoring. Renew any follower on which these conditions are apparent. If a follower bearing surface is badly scored, also examine the corresponding lobe on the camshaft for wear, as it is likely that both will be worn. Renew worn components as necessary.

### Refitting

14 Liberally lubricate the camshaft journals and cylinder head extension bearings, then locate both camshafts in position. Note that the exhaust camshaft is nearest to the front facing side of the engine.

15 With the camshafts in position, rotate them as necessary until the camshaft locking tools can be re-inserted (see illustration).

16 Lubricate the lips of a new exhaust camshaft oil seal with clean engine oil, and drive it into position until it seats on its locating shoulder (see illustration). Use a suitable tubular drift, such as a socket, which bears only on the hard outer edge of the seal. Take care not to damage the seal lips during fitting. Note that the seal lips should face inwards.

17 Refit the inlet camshaft drive gear and retaining bolt then tighten the bolt to the specified torque (see illustration).

18 Refit the exhaust camshaft drive gear to the exhaust camshaft. As the gear is being fitted, it will be necessary to align the anti-backlash inner gear teeth using a screwdriver to enable the teeth of both the gears to mesh (see illustration).

19 At this stage it is advisable to check the camshaft endfloat using a dial gauge mounted on the cylinder head extension, with its probe in contact with the camshaft being checked. Move the camshaft one way, zero the gauge, then move the camshaft as far as it will go the other way. Record the reading on the dial gauge and compare the figure with that given in the Specifications. Repeat on the other camshaft. If either of the readings exceeds the tolerance given, a new cylinder head extension will be required.

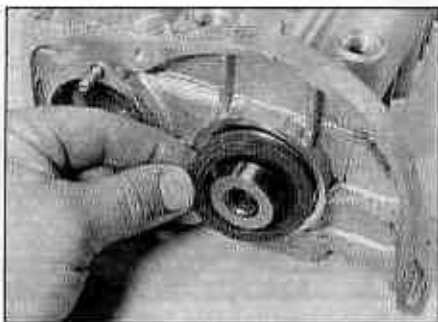
20 Locate a new gasket on the cylinder head extension end cover, then wrap round the protruding tangs on the gasket to retain it in position (see illustrations).

21 Locate the end cover on the cylinder head extension and secure with the retaining nuts securely tightened.

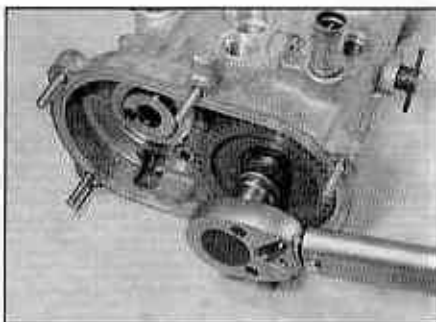
22 Locate a new O-ring on the inlet camshaft cover plate, then apply RTV gasket sealant to the cover plate contact face (see illustrations). Fit the cover plate and secure with the nut and bolt.

23 Refit the camshaft sprocket and secure with the retaining bolt tightened finger tight only at this stage.

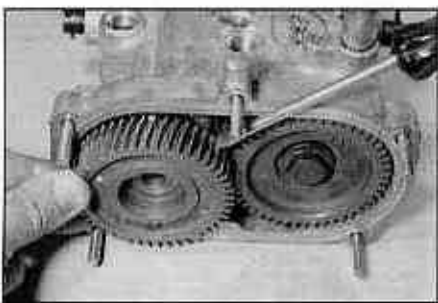
24 Liberally lubricate the cam followers and place them in position in their respective cylinder head extension bores (see illustration).



9.16 Fit a new exhaust camshaft oil seal



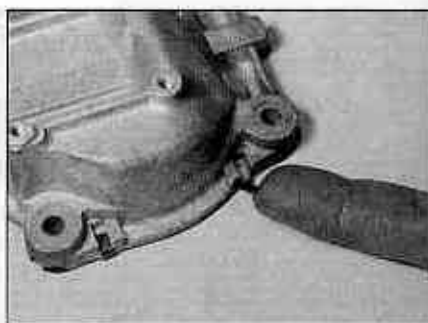
9.17 Tighten the inlet camshaft drive gear retaining bolt to the specified torque



9.18 Refit the exhaust camshaft drive gear while aligning the anti-backlash inner gear teeth



9.20a Locate a new gasket on the cylinder head extension end cover ...



9.20b ... then wrap round the protruding tangs to retain the gasket



9.22a Locate a new O-ring on the inlet camshaft cover plate . . .

25 Locate the cam follower retaining tools in position and refit the cylinder head extension as described in Section 8.



9.22b . . . then apply RTV gasket sealant to the cover plate contact face

12 Refer to Chapter 2D for cylinder head dismantling and inspection procedures.

### Preparation for refitting

13 The mating faces of the cylinder head and cylinder block must be perfectly clean before refitting the head. Use a hard plastic or wooden scraper to remove all traces of gasket and carbon; also clean the piston crowns. Take particular care when cleaning the piston crowns as the soft aluminium alloy is easily damaged. 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. 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. Clean all the pistons in the same way.

14 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. 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.

15 Check the condition of the cylinder head bolts, and particularly their threads, whenever they are removed. Wash the bolts in a suitable



9.24 Lubricate the cam followers and place them in position in their respective bores

solvent, and wipe them dry. Check each bolt for any sign of visible wear or damage, renewing them if necessary.

### Refitting

16 Before refitting the assembled cylinder head, make sure that the head and block mating surfaces are perfectly clean, and that the bolt holes in the cylinder block have been mopped out to clear any oil.

17 The new gasket should not be removed from its nylon cover until required for use. Fit the gasket dry, and make sure that the mating surfaces on the head and block are perfectly clean.

18 Place the gasket on the cylinder block so that the word ALTO can be read from above.

19 Lower the cylinder head onto the block so that it locates on the positioning dowel.

20 The cylinder head bolt threads must be clean and lightly lubricated. Screw the bolts in finger-tight then working progressively and in the sequence shown, tighten all the cylinder head bolts to the Stage 1 torque setting given in the Specifications, using a torque wrench and a suitable socket. With all the bolts tightened to their Stage 1 setting, working again in the specified sequence, first angle-tighten the bolts through the specified Stage 2 angle, then again through the Stage 3 angle, using a socket and extension bar. It is recommended that an angle-measuring gauge is used during this stage of tightening, to ensure accuracy (see illustrations).

21 Reconnect the exhaust system front pipe to the manifold using a new flange gasket.

## 10 Cylinder head - removal and refitting

### Removal

Note: The cylinder head bolts are of special splined design and a Fiat tool should be obtained to unscrew them. A Torx key will not fit however in practise it was found that a close-fitting Allen key could be used as an alternative.

1 Drain the cooling system as described in Chapter 1A.

2 Remove the cylinder head extension as described in Section 8.

3 Disconnect the radiator hose from the thermostat housing on the left-hand end of the cylinder head.

4 Disconnect the heater hose from the outlet at the rear of the cylinder head.

5 Disconnect the coolant temperature sensor and temperature gauge sensor wiring plugs from the left-hand end of the cylinder head.

6 Undo the engine oil dipstick tube bracket retaining bolt and the two bolts securing the wiring harness support clips to the inlet manifold lower section.

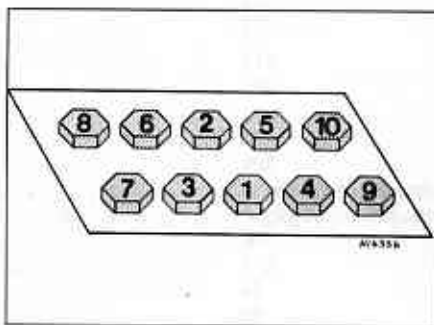
7 Undo the retaining nuts and separate the exhaust system front pipe from the exhaust manifold flange.

8 Check that nothing remains attached to the cylinder head likely to impede removal. It is assumed that the head will be removed complete with exhaust manifold and inlet manifold lower section.

9 Unscrew the cylinder head bolts half a turn at a time in the reverse order to that shown in illustration 10.20a. When the bolts are free, remove them from their locations.

10 Lift the cylinder head from the block. If it is stuck tight rock the head to break the joint by means of the manifolds. On no account drive levers into the gasket joint, nor attempt to tap the head sideways, as it is located on positioning dowels.

11 Remove and discard the cylinder head gasket.



10.20a Cylinder head bolt tightening sequence



10.20b Tighten the cylinder head bolts to the Stage 1 torque setting . . .



10.20c ... then through the Stage 2 and Stage 3 angle

22 Refit the engine oil dipstick tube bracket retaining bolt and the two bolts securing the wiring harness support clips to the inlet manifold lower section.

23 Connect the coolant temperature sensor and temperature gauge sensor wiring plugs.

24 Connect the radiator hose to the thermostat housing and the heater hose to the cylinder head outlet.

25 Refit the cylinder head extension as described in Section 8.

26 On completion, refill the cooling system as described in Chapter 1A.

### 11 Flywheel - removal, inspection and refitting

Refer to Chapter 2A, Section 10.

### 12 Engine mountings - inspection and renewal

Refer to Chapter 2A, Section 11.

### 13 Sump - removal and refitting

Refer to Chapter 2A, Section 12.

### 14 Oil pump and pick-up tube - removal, inspection and refitting

Refer to Chapter 2A, Section 13.

# Chapter 2 Part C:

## Diesel engine in-car repair procedures

### Contents

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Cylinder head - removal and refitting	..... 9	Timing belt tensioner and sprockets - removal, inspection and refitting	..... 5
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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

#### General

##### Engine code:\*

1698 cc non-turbo engine	..... 176.B3.000
1698 cc turbo engine:	
Up to 1997	..... 176.A3.000 or 176.A5.000
1997 onward	..... 176.A3.000 or 176.B7.000

\*Note: See *Vehicle Identification for the location of the code marking on the engines.*

Bore	..... 82.6 mm
Stroke	..... 79.2 mm
Compression ratio:	
Non-turbo engine	..... 20.5:1
Turbo engine	..... 19:1
Firing order	..... 1-3-4-2
No 1 cylinder location	..... Timing belt end of engine
Timing belt tension	..... See text

#### Lubrication system

Oil pump type	..... By-rotor driven from front of crankshaft
Outer rotor-to-housing clearance	..... 0.080 to 0.186 mm
Axial clearance	..... 0.025 to 0.056 mm

#### Torque wrench settings

	Nm	lbf ft
Camshaft cover	10	7
Camshaft sprocket	118	87
Crankshaft sprocket centre bolt	190	140
Cylinder head:		
Stage 1	50	37
Stage 2	100	74
Stage 3	Angle-tighten a further 90°	
Stage 4	Angle-tighten a further 90°	
Cylinder head front bolts	30	22
Flywheel	142	105
Fuel injection pump sprocket	49	36
Inlet and exhaust manifolds	25	18
Sump	10	7
Timing belt tensioner and idler	44	32

## 1 General information

### Using this Chapter

Chapter 2 is divided into four Parts; A, B, C and D. Repair operations that can be carried out with the engine in the vehicle are described in Part A, SOHC (8-valve) petrol engines, Part B, DOHC (16-valve) petrol engines and Part C, diesel engines. Part D covers the removal of the engine/transmission as a unit, and describes the engine dismantling and overhaul procedures.

In Parts A, B and C, the assumption is made that the engine is installed in the vehicle, with all ancillaries connected. If the engine has been removed for overhaul, the preliminary dismantling information which precedes each operation may be ignored.

### Engine description

Both normally aspirated (non-turbo) and turbocharged diesel engines are fitted to the Punto range. The engines together with their codes are given in the *Specifications* at the start of this Chapter.

The engines are water-cooled, single-overhead camshaft, in-line four cylinder units with cast-iron cylinder blocks and aluminium-alloy cylinder heads. The engine is mounted transversely at the front of the vehicle, with the transmission bolted to the left-hand side of the engine.

The cylinder head carries the camshaft which is driven by a toothed timing belt. It also houses the inlet and exhaust valves which are closed by single coil valve springs and run in valve guides pressed into the cylinder head. The valves are operated by cam followers fitted over each valve, and the clearances are adjusted by shims positioned between the followers and the camshaft lobes. The camshaft is supported by four bearings - the end bearings are machined in the cylinder head and the remaining bearings have caps bolted to the cylinder head. The cylinder head contains integral oilways which supply and lubricate the camshaft and followers and it also incorporates renewable swirl chambers.

The crankshaft is supported by five main bearings, and endfloat is controlled by a thrust bearing fitted on the rear main bearing.

All diesel engines are fitted with a brake servo vacuum pump driven from the left-hand end of the camshaft.

Engine coolant is circulated by a pump, driven by the auxiliary drivebelt. For details of the cooling system refer to Chapter 3.

Lubricant is circulated under pressure by a pump, driven from the front of the crankshaft. Oil is drawn from the sump through a strainer, and then forced through an externally-mounted, replaceable screw-on filter. From there, it is distributed to the cylinder head,

where it lubricates the camshaft journals and followers, and also to the crankcase, where it lubricates the main bearings, connecting rod big- and small-ends, gudgeon pins and cylinder bores. Oil jets are fitted to the base of each cylinder bore - these spray oil onto the underside of the pistons, to improve cooling. An oil cooler is also fitted to reduce the temperature of oil before it re-enters the engine.

### 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) Auxiliary drivebelt - removal and refitting (refer to Chapter 1B)
- c) Valve clearances - checking and adjustment (refer to Chapter 1B)
- d) Camshaft cover - removal and refitting
- e) Timing belt and covers - removal and refitting
- f) Timing belt tensioner and sprockets - removal and refitting
- g) Cylinder head - removal and refitting\*
- h) Camshaft and cam followers - removal and refitting\*
- i) Camshaft oil seal - renewal
- j) Crankshaft oil seals - renewal
- k) Flywheel - removal, inspection and refitting
- l) Engine mountings - inspection and renewal
- m) Sump - removal and refitting
- n) Oil pump and pick-up tube assembly - removal, inspection and refitting

\*Cylinder head dismantling procedures are detailed in Chapter 2D, with details of camshaft and cam follower removal.

**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 Location of TDC on No 1 cylinder

### General information

1 The camshaft and fuel injection pump are driven by the crankshaft, by means of sprockets and a timing belt. All three sprockets rotate in phase with each other and this provides the correct valve and injection pump timing as the engine rotates. When the timing belt is removed during servicing or repair, it is possible for the camshaft, injection pump and crankshaft to rotate independently of each other and the correct timing is then lost.

2 It is therefore important that the correct phasing between the camshaft, injection pump and crankshaft is preserved whilst the timing belt is off the engine. This is achieved by setting the engine in a reference position (known as Top Dead Centre or TDC) before the timing belt is removed and then preventing the camshaft, pump and crankshaft from rotating until the belt is refitted. Similarly, if the engine has been dismantled for overhaul, the engine can be set to TDC during reassembly to ensure that the correct phasing is restored.

3 TDC is the highest point in the cylinder that each piston reaches as the crankshaft turns. Each piston reaches TDC at the end of the compression stroke and again at the end of the exhaust stroke. However, for the purpose of timing the engine, TDC refers to the position of No 1 piston at the end of its compression stroke. On all engines in this manual, No 1 piston (and cylinder) is at the timing belt end of the engine.

4 The camshaft and fuel injection pump sprockets are each equipped with a marking which, when aligned with a reference marking on the timing belt inner cover, indicates that the camshaft and pump are correctly positioned for cylinder No 1 at TDC on its compression stroke.

5 The crankshaft sprocket is also equipped with a timing mark - when this is aligned with a reference marking on the oil pump cover, the engine is set with cylinders No 1 and 4 at TDC. Note that it is the camshaft positioning that determines whether a cylinder is on its compression or exhaust stroke.

### Location of TDC on cylinder No 1

6 Remove the air inlet ducting as described in Chapter 4C, Section 2.

7 Remove the heater glow plugs with reference to Chapter 5C. Due to the high compression ratio of diesel engines this is necessary to allow the engine to be turned by hand.

8 Unscrew the mounting bolts and move the coolant expansion tank to one side for access to the timing covers. Release the hose from the clips on the camshaft cover.

9 Release the toggle clips and remove the upper timing cover (see illustration).



2.9 Removing the upper timing cover

10 Firmly apply the handbrake, then jack up the front of the car and support it securely on axle stands (see *Jacking and vehicle support*). Remove the right-hand front roadwheel.

11 Working under the wheelarch, remove the splash guard, then unbolt and remove the outer cover over the crankshaft pulley (see illustration).

12 Remove the auxiliary drivebelt(s) as described in Chapter 1B.

13 Unbolt and remove the lower timing cover from the cylinder block (see illustration). Note that one of the bolts is located at the front of the engine.

14 Unscrew the four socket-headed bolts and remove the pulley from the front of the crankshaft (see illustrations). Recover the spacer plate.

15 Turn the engine in its normal direction of rotation (using a socket or spanner on the crankshaft sprocket centre bolt) until pressure can be felt at No 1 cylinder glowplug hole.

16 Continue turning the engine until the TDC timing marks on the camshaft and fuel injection pump sprockets are aligned with the corresponding marks on the timing belt inner cover, and the crankshaft sprocket timing mark is aligned with the mark on the oil pump cover (see illustration).

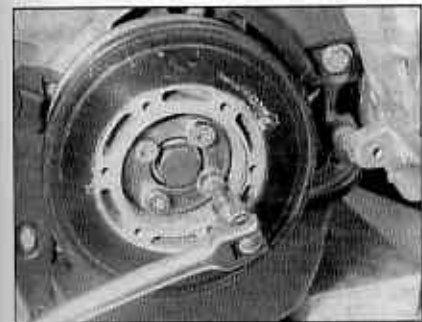
17 The engine is now set at TDC for No 1 cylinder on compression.



2.11 Removing the outer cover over the crankshaft pulley



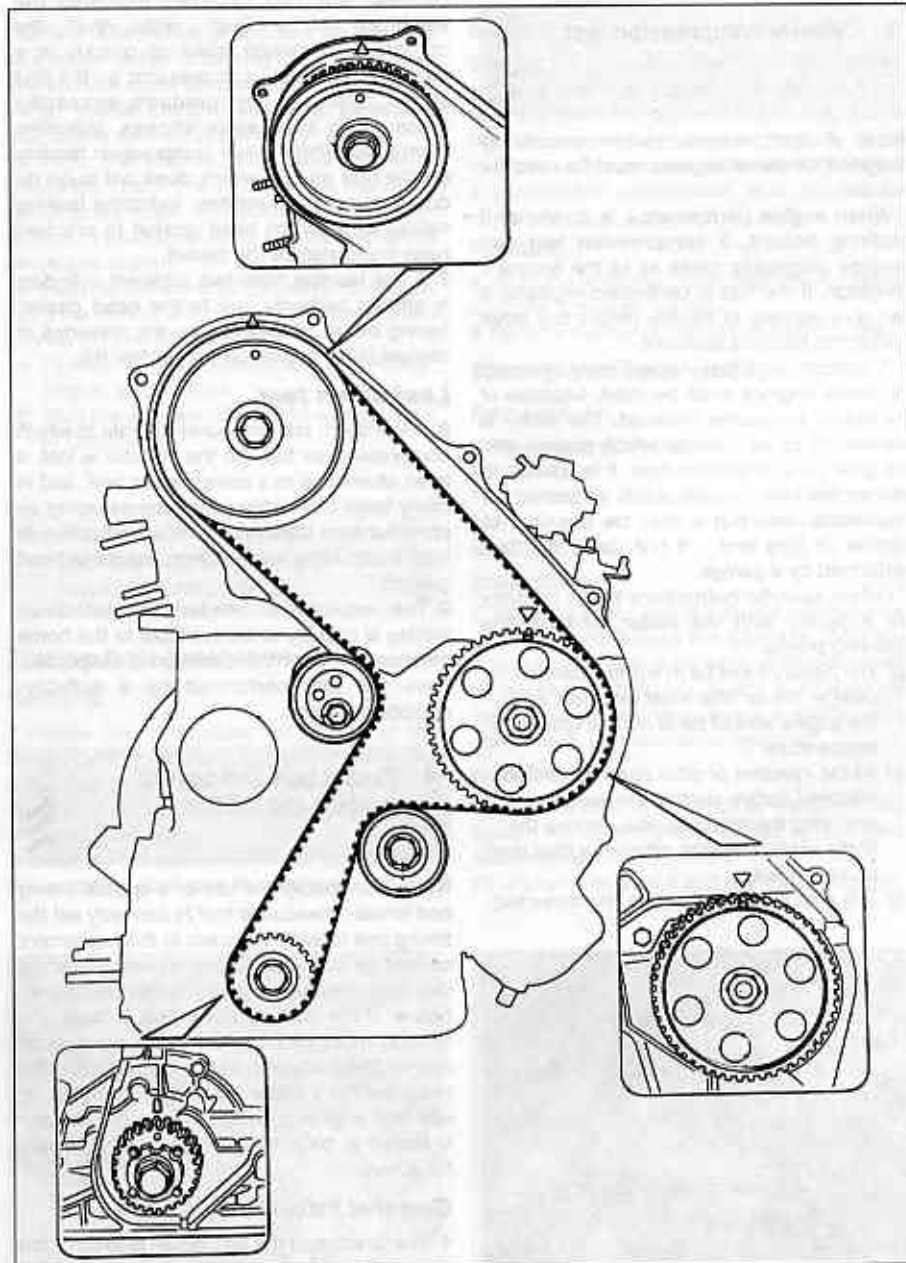
2.13 Removing the lower timing cover



2.14a Unscrew and remove the socket-headed bolts and spacer ...

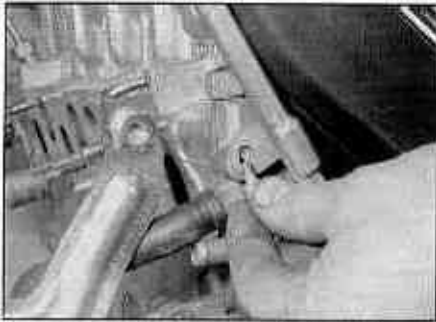


2.14b ... and remove the pulley from the front of the crankshaft



2.16 Sprocket timing mark positioning with No 1 cylinder at TDC





4.4a Unbolt the engine oil dipstick tube . . .

### 3 Cylinder compression test

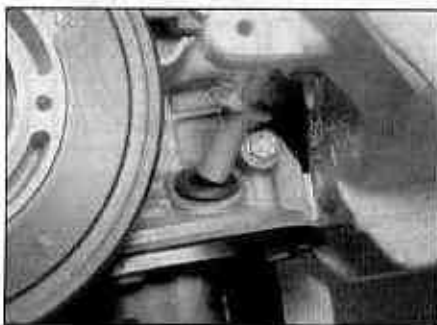
**Note:** A compression tester specifically designed for diesel engines must be used for this test.

1 When engine performance is down, or if misfiring occurs, 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 A compression tester specifically intended for diesel engines must be used, because of the higher pressures involved. The tester is connected to an adapter which screws into the glow plug or injector hole. It is unlikely to be worthwhile buying such a tester for occasional use, but it may be possible to borrow or hire one - if not, have the test performed by a garage.

3 Unless specific instructions to the contrary are supplied with the tester, observe the following points:

- The battery must be in a good state of charge, the air filter must be clean, and the engine should be at normal operating temperature.
- All the injectors or glow plugs should be removed before starting the test. If removing the injectors, also remove the flame shield washers, otherwise they may be blown out.
- The stop solenoid must be disconnected,



4.4b . . . and remove it from the rubber grommet in the oil pump housing

to prevent the engine from running or fuel from being discharged.

4 There is no need to hold the accelerator pedal down during the test, because the diesel engine air inlet is not throttled.

5 The cause of poor compression is less easy to establish on a diesel engine than on a petrol one. The effect of introducing oil into the cylinders (wet testing) is not conclusive, because there is a risk that the oil will sit in the recess on the piston crown, instead of passing to the rings. However the following can be used as a rough guide to diagnosis.

6 All cylinders should produce very similar pressures; a difference of more than 5 bars between any two cylinders indicates the existence of a fault. Note that the compression should build up 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 reading on the first stroke, which does not build up during successive strokes, indicates leaking valves or a blown head gasket (a cracked head could also be the cause).

7 A low reading from two adjacent cylinders is almost certainly due to the head gasket having blown between them; the presence of coolant in the engine oil will confirm this.

### Leakdown test

8 A leakdown test measures the rate at which compressed air fed into the cylinder is lost. It is an alternative to a compression test, and in many ways it is better, since the escaping air provides easy identification of where pressure loss is occurring (piston rings, valves or head gasket).

9 The equipment needed for leakdown testing is unlikely to be available to the home mechanic. If poor compression is suspected, have the test performed by a suitably-equipped garage.

### 4 Timing belt and covers - removal and refitting

**Note:** Fiat specify the use of a special timing belt tension measuring tool to correctly set the timing belt tension. If access to this equipment cannot be obtained, an approximate setting can be achieved using the method described below. If the method described is used, the tension must be checked using the special tool at the earliest possible opportunity. Do not drive the vehicle over large distances, or use high engine speeds, until the belt tension is known to be correct. Refer to a Fiat dealer for advice.

### General information

1 The function of the timing belt is to drive the camshaft and fuel injection pump. Should the belt slip or break in service, the valve timing will be disturbed and piston-to-valve contact

will occur, resulting in serious engine damage.

2 The timing belt should be renewed at the specified intervals (see Chapter 1B), or earlier if it is contaminated with oil, or if it is at all noisy in operation (a scraping noise due to uneven wear).

### Removal

3 Set the engine at TDC on No 1 cylinder as described in Section 2.

4 Unbolt and remove the engine oil dipstick tube and remove it from the rubber grommet in the oil pump housing (see illustration).

5 Before removing the timing belt check its tension by turning the belt through 90° with finger and thumb midway between the injection pump and camshaft sprockets. This will give you an idea of the tension to apply when refitting, assuming the tension is already correct. Also note the position of the tensioner pulley as a reference mark.

6 Release the nut on the timing belt tensioner, move the tensioner pulley away from the belt and retighten the nut to hold the pulley in the retracted position.

7 If the timing belt is to be re-used, use white paint or chalk to mark the direction of rotation on the belt (if markings do not already exist), then slip the belt off the camshaft, crankshaft and injection pump sprockets, and the idler and tensioner pulleys.

**Caution:** If the belt appears to be in good condition and can be re-used, it is essential that it is refitted the same way round, otherwise accelerated wear will result, leading to premature failure.

8 Check the timing belt carefully for any signs of uneven wear, splitting, or oil contamination. Pay particular attention to the roots of the teeth. Renew it if there is the slightest doubt about its condition. If the engine is undergoing an overhaul, renew the belt as a matter of course, regardless of its apparent condition. The cost of a new belt is nothing compared with the cost of repairs, should the belt break in service. If signs of oil contamination are found, trace the source of the oil leak and rectify it. Wash down the engine timing belt area and all related components, to remove all traces of oil.

### Refitting

9 Before refitting, thoroughly clean the timing belt sprockets. Check that the tensioner and idler pulleys rotate freely, without any sign of roughness. If necessary, renew them as described in Section 5.

10 Ensure that the crankshaft, camshaft and injection pump sprockets are still at their TDC positions as described in Section 2.

11 Engage the timing belt with the crankshaft sprocket, then locate it around the idler pulley and onto the injection pump sprocket making sure that it is kept taught. Continue to locate it around the camshaft sprocket and finally around the tensioner pulley (see illustration). Ensure the belt teeth seat correctly on the sprockets.