Chapter 2 Part B:
Diesel engine in-car repair procedures

Contents

Degrees of difficulty

Easy, suitable for novice with little experience 

Fairly easy, suitable for beginner with some experience 

Fairly difficult, suitable for competent DIY mechanic 

Difficult, suitable for experienced DIY mechanic 

Very difficult, suitable for expert DIY or professional 

Specifications

General

Capacity	1896 cc
Bore	79.5 mm
Stroke	95.5 mm
Engine codes*	ANU, ASZ, ASZ1 and AUY
Maximum power output (at 4000 rpm):*	
Engine code ANU	66 kW (90 PS)
Engine code AUY	85 kW (115 PS)
Engine code ASZ	96 kW (130 PS)
Engine code ASZ1	110 kW (150 PS)
Maximum torque output (at 1900 rpm):	
Engine code ANU	240 Nm
All other engines	310 Nm
Idle speed	900 rpm
Maximum speed (intermittent)	5100 rpm
Compression ratio	18.0 : 1
Compression pressures:	
Standard (new engine)	25 to 31 bar
Minimum compression pressure	Approximately 19.0 bar
Maximum difference between cylinders	Approximately 5.0 bar
Firing order	1 – 3 – 4 – 2
No 1 cylinder location	Timing belt end

* **Note:** *See 'Vehicle identification' at the end of this manual for the location of engine code markings.*

Camshaft

Camshaft endfloat (maximum)	0.15 mm
Camshaft bearing running clearance (maximum)	0.11 mm
Camshaft run-out (maximum)	0.01 mm

Lubrication system

Oil pump type	Gear type, chain-driven from crankshaft
Oil pressure (oil temperature 80°C, at 2000 rpm)	2.0 bar

Torque wrench settings	Nm	lbf ft
Alternator mounting bolts	25	18
Auxiliary drivebelt tensioner securing bolts	25	18
Big-end bearing caps bolts:*		
Stage 1	30	22
Stage 2	Angle-tighten a further 90°	
Camshaft bearing cap nuts:*		
Stage 1	8	6
Stage 2	Angle-tighten a further 90°	
Camshaft cover nuts/bolts	10	7
Camshaft sprocket centre bolt	100	74
Camshaft sprocket outer bolts	25	18
Flywheel/driveplate mounting bolts:*	29	21
Coolant pump bolts	15	11
Crankshaft oil seal housing bolts	15	11
Crankshaft pulley bolts:		
Stage 1	10	7
Stage 2	Angle-tighten a further 90°	
Crankshaft speed/position sensor wheel-to-crankshaft bolts:*		
Stage 1	10	7
Stage 2	Angle-tighten a further 90°	
Crankshaft sprocket bolt:*		
Stage 1	120	89
Stage 2	Angle-tighten a further 90°	
Cylinder head bolts:*		
Stage 1	40	30
Stage 2	60	44
Stage 3	Angle-tighten a further 90°	
Stage 4	Angle-tighten a further 90°	
Driveplate mounting bolts:*	29	21
Engine mountings:		
Left-hand mounting-to-body bolts:		
Large bolts:		
Stage 1	50	37
Stage 2	Angle-tighten a further 90°	
Small bolt	25	18
Left-hand mounting-to-transmission bolts:		
Stage 1	90	66
Stage 2	Angle-tighten a further 90°	
Right-hand mounting:		
Stud	10	7
Bolt	61	45
Nut	54	40
Engine roll restrictor to crossmember:		
Stage 1	60	44
Stage 2	Angle tighten a further 90°	
Engine roll restrictor to transmission	100	74
EGR pipe nuts	25	18
Exhaust manifold nuts	25	18
Exhaust pipe-to-manifold/turbocharger nuts	25	18
Flywheel mounting bolts:*	29	21
Glow plugs	15	11
Injector adjusting locknut	30	22
Injector clamp bolt:*		
Stage 1	12	9
Stage 2	Angle-tighten a further 270°	
Injector rocker arm shafts:*		
Stage 1	20	15
Stage 2	Angle-tighten a further 90°	
Inlet manifold nuts	25	18
Main bearing cap bolts:*		
Stage 1	65	48
Stage 2	Angle-tighten a further 90°	
Oil baffle-to-camshaft cover bolt	5	4
Oil cooler securing plate	25	18
Oil drain plug	30	22
Oil filter cover	25	18
Oil filter housing-to-cylinder block bolts	15	11

Torque wrench settings (continued)	Nm	lbf ft
Oil level/temperature sensor-to-sump bolts	10	7
Oil pick-up pipe securing bolts	15	11
Oil pressure relief valve plug	40	30
Oil pressure warning light switch	20	15
Oil pump chain tensioner bolt	15	11
Oil pump securing bolts	15	11
Oil pump sprocket securing bolt	25	18
Piston oil spray jet bolt	10	7
Sump bolts	15	11
Timing belt idler pulley bolt	20	15
Timing belt outer cover bolts:		
Lower cover	10	7
Upper cover	25	18
Timing belt rear cover bolts:		
Cover-to-cylinder head bolt	10	7
Cover-to-injection pump bolts	30	22
Timing belt tensioner roller securing nut:		
Stage 1	20	15
Stage 2	Angle-tighten a further 45°	
Turbocharger oil return pipe-to-cylinder block	25	18

* **Note:** *Use new bolts*

1 General information

Using this Chapter

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

In Parts A and B, 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 and referred to by the manufacturer's code letters. A listing of all engines covered, together with their code letters, is 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. All are mounted transversely at the front of the vehicle, with the transmission bolted to the left-hand end of the engine.

The crankshaft is of five-bearing type, and thrustwashers are fitted to the centre main bearing to control crankshaft endfloat.

The camshaft is driven via a toothed timing belt from the crankshaft. The camshaft is mounted at the top of the cylinder head, and is secured by bearing caps. Because high pumping forces (up to 2050 bar) are required to drive the unit injectors a broad heavy duty timing belt is fitted with the tension controlled by a hydraulic tensioner.

The valves are closed by coil springs, and run in guides pressed into the cylinder head. The camshaft actuates the valves directly, via hydraulic tappets. The camshaft also features four additional cams to drive the unit injectors via roller cam followers.

The gear-type oil pump is driven via a chain from a sprocket on the crankshaft. Oil is drawn from the sump through a strainer, and then forced through an externally-mounted, renewable filter. From there, it is distributed to the cylinder head, where it lubricates the camshaft journals and hydraulic tappets, and also to the crankcase, where it lubricates the main bearings, connecting rod big-ends, gudgeon pins and cylinder bores. A coolant-fed oil cooler is fitted to the oil filter housing on all engines. Oil jets are fitted to the base of each cylinder – these spray oil onto the underside of the pistons, to improve cooling.

All engines have a tandem pump fitted, incorporating a vacuum pump (for the brake servo and various vacuum-controlled ancillaries) and a fuel pump, driven by the camshaft.

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

Operations with engine in vehicle

The following operations can be performed without removing the engine:

a) Compression pressure – testing.
b) Camshaft cover – removal and refitting.
c) Crankshaft pulley – removal and refitting.
d) Timing belt covers – removal and refitting.
e) Timing belt – removal, refitting and adjustment.
f) Timing belt tensioner and sprockets – removal and refitting.
g) Fuel injectors – removal, refitting and adjustment.
h) Camshaft oil seals – renewal.
i) Camshaft and hydraulic tappets – removal, inspection and refitting.
j) Cylinder head – removal and refitting.
k) Cylinder head and pistons – decarbonising.
l) Sump – removal and refitting.
m) Oil pump – removal, overhaul and refitting.
n) Crankshaft oil seals – renewal.
o) Engine/transmission mountings – inspection and renewal.
p) Flywheel/driveplate – removal, inspection and refitting.

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

2 Compression and leakdown tests – description and interpretation

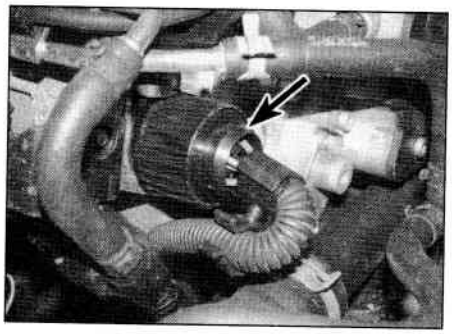
Compression test

Note: *A compression tester suitable for use with diesel engines will be required for this test.*

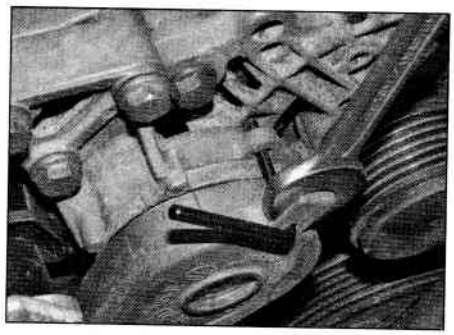
1 When engine performance is down, or if misfiring occurs which cannot be attributed to the ignition or fuel systems, a compression test can provide diagnostic clues as to the engine's condition. If the test is performed regularly, it can give warning of trouble before any other symptoms become apparent.

2 The engine must be fully warmed-up to normal operating temperature, the battery must be fully-charged and you will require the aid of an assistant.

3 Disconnect the injector solenoids by disconnecting the connector at the end of the



2.3 Disconnect the injector solenoids wiring plug connector (arrowed)



3.2 Release the tensioner

cylinder head **(see illustration)**. **Note:** *As a result of the wiring being disconnected, faults will be stored in the ECM memory. These must be erased after the compression test.*

4 Remove the glow plugs as described in Chapter 5C, then fit a compression tester to the No 1 cylinder glow plug hole.

5 Have your assistant crank the engine for several seconds 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.

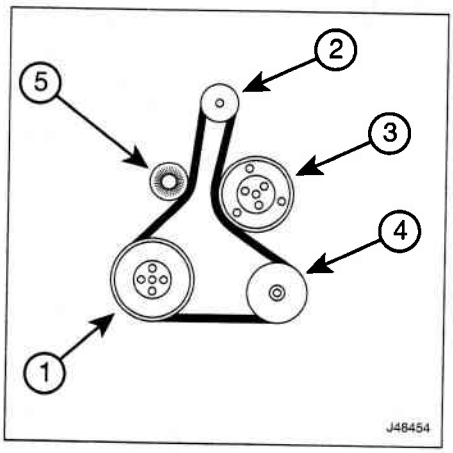
6 Repeat the test on the remaining cylinders, recording the pressure in each.

7 The cause of poor compression is less easy to establish on a diesel engine than on a petrol engine. 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.

8 All cylinders should produce very similar pressures. Any difference greater than that specified 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).

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

10 On completion, remove the compression tester, and refit the glow plugs, with reference to Chapter 5C. Reconnect the electrical supply to the injectors.



3.4 The belt routing

1 Crankshaft
2 Alternator
3 AC compressor
4 Power steering pump
5 Automatic tensioner

Leakdown test

11 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).

12 The equipment required for leakdown testing is widely available and considerably cheaper than a diesel engine compression tester, assuming a supply of compressed air is available.

3 Auxiliary drivebelt – removal and refitting

Removal

1 Remove the engine cover and disconnect the battery.

2 Using a suitable spanner, rotate the automatic tensioner clockwise. Insert a hex key or drill bit into the hole provided and lock the tensioner in place **(see illustration)**.

3 If the belt is to be refitted, mark the direction of rotation before removing it.

4 Note how the drivebelt is routed, then remove it from the crankshaft pulley, alternator pulley, power steering pump pulley, and air conditioning compressor pulley **(see illustration)**.

5 Inspect the belt for cracks and missing sections.

Refitting

6 Locate the new drivebelt on the pulleys, then slowly release the tensioner. Check that the belt is located correctly in the multi-grooves in the pulleys.

7 Refit the engine cover.

4 Engine assembly and valve timing marks – general information and usage

General information

1 TDC is the highest point in the cylinder that each piston reaches as it travels up-and-down when the crankshaft turns. Each piston reaches TDC at the end of the compression stroke and again at the end of the exhaust stroke, but TDC generally refers to piston position on the compression stroke. No 1 piston is at the timing belt end of the engine.

2 Positioning No 1 piston at TDC is an essential part of many procedures, such as timing belt removal and camshaft removal.

3 The design of the engines covered in this Chapter is such that piston-to-valve contact may occur if the camshaft or crankshaft is turned with the timing belt removed. For this reason, it is important to ensure that the camshaft and crankshaft do not move in relation to each other once the timing belt has been removed from the engine.

Setting TDC on No 1 cylinder

Note: *The timing marks on the crankshaft pulley may not be present on all engines. If the marks are absent follow the timing belt renewal procedure as described in Section 8 to locate TDC.*

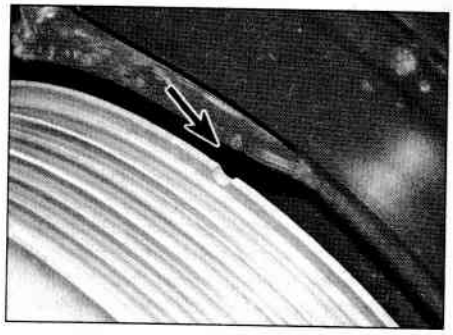
4 Remove the auxiliary drivebelt as described in Section 3.

5 Remove the timing belt upper cover as described in Section 7.

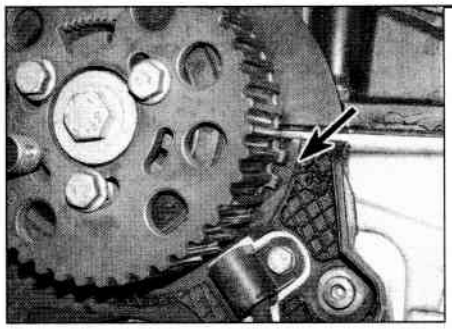
6 Remove the glow plugs, as described in Chapter 5C, to allow the engine to turn more easily.

7 Using a spanner or socket on the crankshaft sprocket bolt, turn the crankshaft in the normal direction of rotation (clockwise) until the alignment mark on the face of the sprocket aligns with the mark on the lower timing belt cover **(see illustration)**.

8 The arrow (marked 4Z) on the rear section



4.7 Align the marks (arrowed)



4.8 Align the arrow on the rear of the timing belt cover (arrowed) between the lugs on the rear of the camshaft hub sender wheel

of the upper timing belt upper cover will be in line with the two lugs on the rear of the camshaft hub sender wheel **(see illustration)**. If the marks do not align, rotate the crankshaft one complete revolution.

9 The engine is now set to TDC on No 1 cylinder.

5 Camshaft cover – removal and refitting

Removal

1 Remove the dipstick, and prise off and remove the engine top cover, then disconnect the breather hose from the camshaft cover.

2 Unclip and then remove the upper timing belt cover.

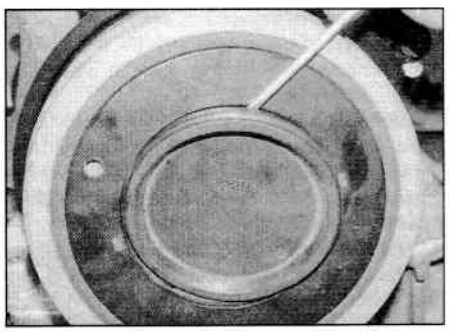
3 Unscrew the camshaft cover retaining bolts and lift the cover away. If it sticks, do not attempt to lever it off – instead free it by working around the cover and tapping it lightly with a soft-faced mallet.

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

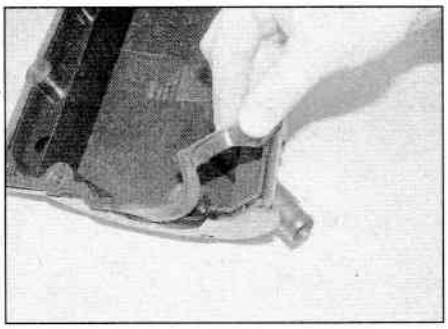
5 Clean the mating surfaces of the cylinder head and camshaft cover thoroughly, removing all traces of oil and old gasket – take care to avoid damaging the surfaces as you do this.

Refitting

6 Refit the camshaft cover by following the removal procedure in reverse, noting the following points:



6.4 Prising out the crankshaft pulley centre cap



5.4 The camshaft cover gasket locates in a groove in the cover

*a) Apply a 5 mm spot of suitable sealant to the points where the camshaft bearing caps contacts the cylinder head **(see illustration)**. The sealant should be applied to both end caps.*

*b) Tighten the retaining nuts/bolts in sequence **(see illustration).***

6 Crankshaft pulley – removal and refitting

Removal

1 Disconnect the battery negative lead (see *Disconnecting the battery* in the Reference Chapter).

2 Jack up and support the front of the vehicle (see *Jacking and vehicle support*). Remove the right-hand roadwheel.

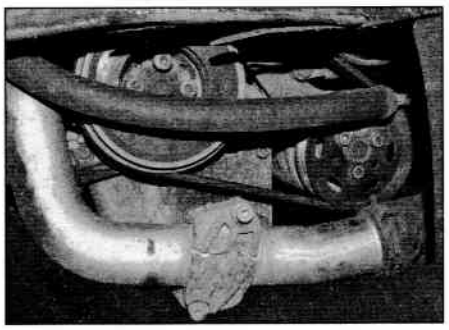
3 Remove the securing screws and withdraw the engine undershield

4 Where applicable, prise the cover from the centre of the pulley to expose the securing bolts **(see illustration)**.

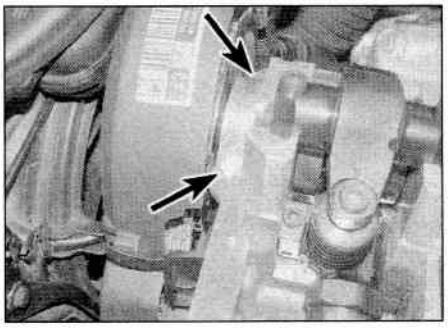
5 Slacken the bolts securing the crank- shaft pulley to the sprocket **(see illustrations)**. If necessary, the pulley can be prevented from turning by counterholding with a spanner or socket on the crankshaft sprocket bolt.

6 Remove the auxiliary drivebelt, as described in Section 3.

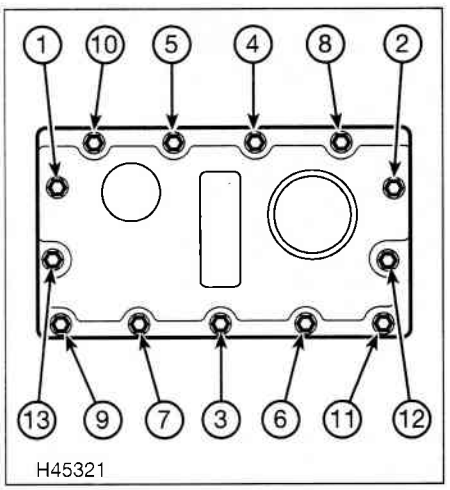
7 Unscrew the bolts securing the pulley to the sprocket, and remove the pulley.



6.5a The power steering pipe can be moved to . . .



5.6a Apply sealant to the points (arrowed) on the cylinder head



5.6b Camshaft cover tightening sequence

Refitting

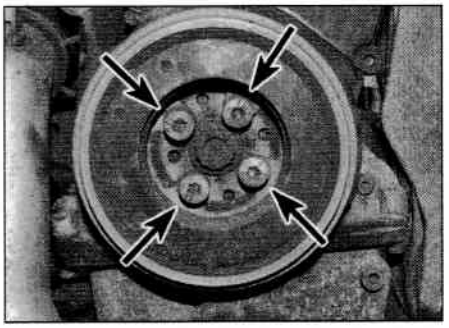
8 Refit the pulley over the locating peg on the crankshaft sprocket, then refit the pulley securing bolts.

9 Refit auxiliary drivebelt as described in Section 3 of this Chapter.

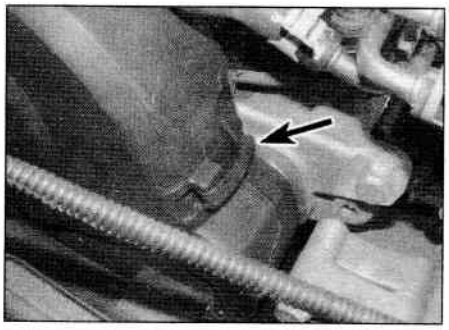
10 Prevent the crankshaft from turning as during removal, then fit the pulley securing bolts, and tighten to the specified torque.

11 Refit the engine undershield.

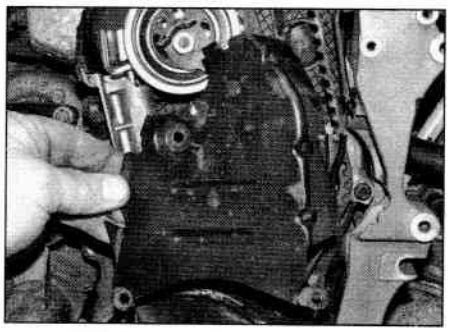
12 Refit the roadwheel, lower the vehicle to the ground, and reconnect the battery negative lead.



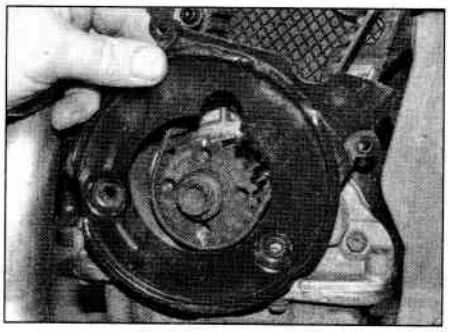
6.5b . . . access the crankshaft pulley bolts (arrowed)



7.2 Release the retaining clips (one arrowed)



7.6 Remove the centre cover



7.10 Remove the lower cover

7 Timing belt covers – removal and refitting

Upper outer cover

1 Where applicable, release the retaining clips and remove the air intake hose from across the top of the timing belt cover.

2 Release the uppermost part of the timing belt outer cover by prising open the metal spring clips, then withdraw the cover away from the engine **(see illustrations)**.

3 Refitting is a reversal of removal, noting that the lower edge of the upper cover engages with the centre cover.

Centre outer cover

4 Remove the auxiliary drivebelt as described in Section 3 and then remove the automatic tensioner.

5 Remove the crankshaft pulley as described in Section 6. It is assumed that, if the centre cover is being removed, the lower cover will be also – if not, simply remove the components described in Section 6 for access to the crankshaft pulley, and leave the pulley in position.

6 With the upper cover removed (paragraphs 1 to 3), unscrew and remove the retaining bolts from the centre cover. Withdraw the centre cover from the engine, noting how it fits over the lower cover **(see illustration)**.

7 Refitting is a reversal of removal.

Lower outer cover

8 Remove the upper and centre covers as described previously.

9 If not already done, remove the crankshaft pulley as described in Section 6.

10 Unscrew the remaining bolt(s) securing the lower cover, and lift it out **(see illustration)**.

11 Refitting is a reversal of removal; locate the centre cover in place before fitting the top two bolts.

Rear cover

12 Remove the upper, centre and lower covers as described previously.

13 Remove the timing belt, tensioner and sprockets as described in Sections 8 and 9.

14 Slacken and withdraw the retaining bolts and lift the timing belt inner cover from the studs on the end of the engine, and remove it from the engine compartment.

15 Refitting is a reversal of removal.

8 Timing belt – removal, inspection and refitting

Note: *A variety of special tools are required to fit the timing belt. Most can be easily fabricated, except Ford tool 310-085. This is essential to lock the crankshaft. These tools are widely available from specialist tool suppliers.*

Removal

1 The primary function of the toothed timing belt is to drive the camshaft, but it also drives the coolant pump. Should the belt slip or break in service, the valve timing will be disturbed and piston-to-valve contact may occur, resulting in serious engine damage. For this reason, it is important that the timing belt is tensioned correctly, and inspected regularly for signs of wear or deterioration.

2 Disconnect the battery negative lead. **Note:** *Before disconnecting the battery, refer to 'Disconnecting the battery' at the rear of this manual.*

3 Remove the air filter, ducting and the air filter housing.

4 Apply the handbrake, then jack up the front of the vehicle and support it securely on axle stands (see *Jacking and vehicle support*).

5 Remove the securing screws and withdraw the engine undershield.

6 Using a suitable jack and a block of wood to spread the load, support the right-hand end of the engine.

7 Remove the auxiliary drivebelt as described in Section 3 and then remove the automatic tensioner.

8 With the engine supported, remove the complete right-hand engine mounting assembly, with reference to Section 19. Also, unbolt the mounting bracket from the cylinder block.

9 Working from below, disconnect and remove the intercooler pipe from the sump. Remove the power steering pipe support from the rear of the engine. **Do not** disconnect the power steering pipe.

10 Set the engine to TDC on No 1 cylinder as described in Section 4.

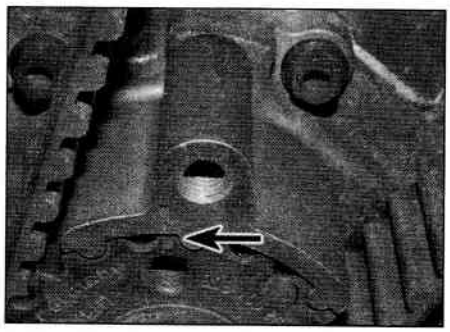
11 Remove the crankshaft pulley as described in Section 6.

12 Remove the timing belt covers, as described in Section 7.

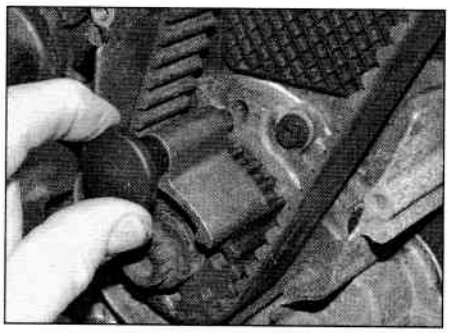
13 Install the special tool onto the crankshaft **(see illustrations)**. **Note**: *There are two versions of this locking tool. Ensure that the version with the index mark at the 12 o'clock position is used.*

14 Fit a 6 mm drill bit into the locking hole on the camshaft sprocket. We used a 6 mm peg, but if you are using a drill bit, tape up the flutes of the drill bit to prevent injury **(see illustration)**.

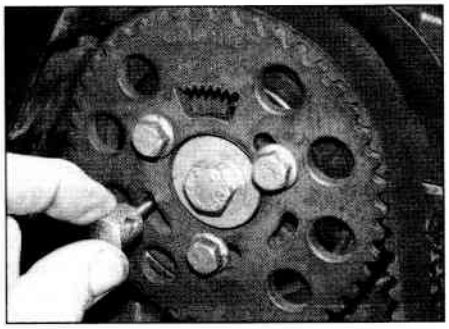
15 Two types of tensioner are fitted to the



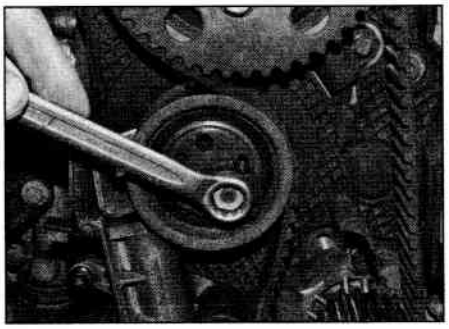
8.13a Align the marks (arrowed) and install the locking tool . . .



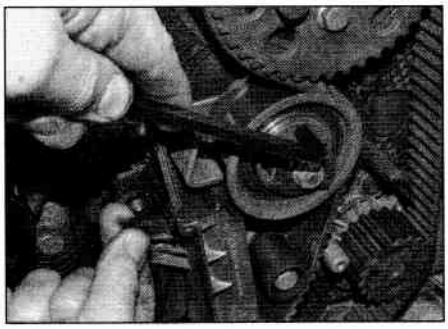
8.13b . . . and fit the pin



8.14 Lock the camshaft in position



8.16a Slacken the locknut . . .



8.16b . . . and fit the damper retaining tool

diesel engines – hydraulic and mechanical. Ford suggest that the hydraulic version must be renewed if it is removed. Note that it is common practice to renew the tensioner and idler if the timing belt is renewed. Indeed, most belt manufacturers will only guarantee the timing belt if the tensioner and idler are renewed at the same time.

Hydraulic tensioner removal

16 Slacken the tensioner locking nut and rotate the tensioner anti-clockwise until the special tool (310-084) can be inserted **(see illustrations)**.

17 With the special tool in position rotate the tensioner clockwise until the belt can be removed. Discard the belt – it must be renewed.

18 Fully remove the locking nut and remove the tensioner **(see illustration)**. If required, the hydraulic part of the tensioner system can be removed.

19 Undo the bolt and remove the idler pulley **(see illustration)**.

Mechanical tensioner removal

20 Using a suitable tool to counterhold the camshaft sprocket, slacken the three camshaft sprocket bolts. **Do not** rely on the drill bit to hold the camshaft sprocket in position.

21 Slacken the tensioner locking nut and then insert special tool 303-1053 into the tensioner. This tool is a peg spanner; a pair of heavy duty 90° circlip pliers are a perfect substitute for this tool.

22 Rotate the tensioner anti-clockwise until the special tool 303-1054 can be inserted. This is a simple pin, easily fabricated from a length of welding rod or similar. Note that new tensioners are normally supplied with this tool in place.

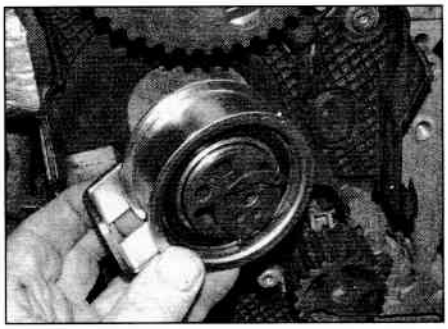
23 Tighten the locking nut and remove the timing belt. Discard the belt – a new one must be fitted.

24 Fully remove the locking nut and remove the tensioner.

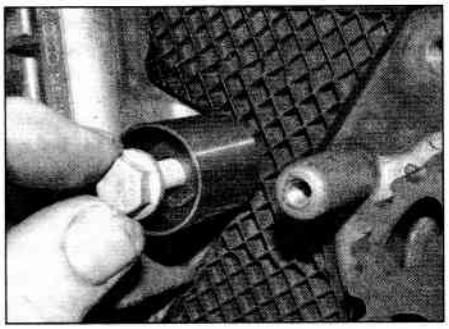
25 Remove the idler pulley.

Inspection

26 Examine the belt for evidence of contamination by coolant or lubricant. If this is the case, find the source of the contamination before progressing any further. Check the belt for signs of wear or damage, particularly around the leading edges of the belt teeth.



8.18 Remove the tensioner

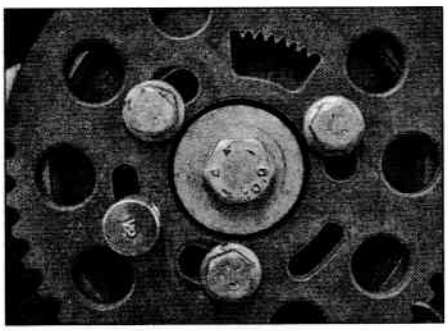


8.19 Remove the idler pulley

27 Replace the timing belt, noting the best practice advised in paragraph 15.

28 With the belt removed, inspect the condition of the coolant pump. Rotate it by hand whilst feeling for any play in the bearings or any undue noise from the bearings or impeller. Because the tension on the coolant pump will change with a new timing belt, it is not uncommon for the coolant pump to leak soon after the belt has been renewed. It is strongly recommended to renew the coolant pump when the timing belt is renewed. The renewal of the coolant pump is covered in Chapter 3.

29 If the timing belt is not going to be refitted for some time, it is a wise precaution to hang a warning label on the steering wheel, to remind yourself (and others) not to attempt to start the engine.



8.30 Rotate the sprocket

Refitting

Hydraulic tensioner refitting

30 Slacken the camshaft sprocket bolts and rotate the sprocket until it stops against the drill bit **(see illustration)**.

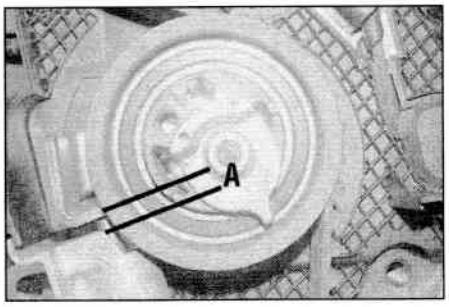
31 Install the idler pulley and new tensioner.

32 Install the new timing belt, starting at the camshaft sprocket followed by the tensioner, crankshaft sprocket and finally the coolant pump.

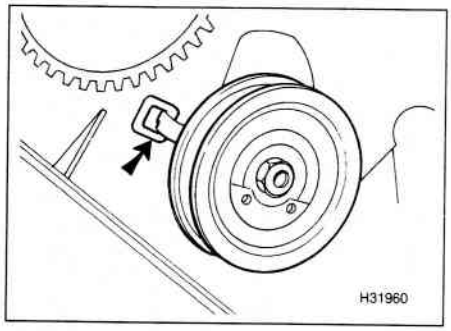
33 Fit the new hydraulic section of the tensioner.

34 Rotate the tensioner anti-clockwise and remove the special tool from the hydraulic section of the tensioner.

35 Rotate the tensioner clockwise so that the 4 mm drill bit can be inserted between the cam and the hydraulic damper **(see illustration)**. Tighten the tensioner locknut to the specified torque.



8.35 The gap between the top edge of the tensioner housing and the tensioner backplate arm (A) must be 4 mm



8.38 Ensure that the lug on the tensioner backplate engages with the cut-out in the rear timing belt cover

36 Use the special tool and tighten the camshaft sprocket bolts to the specified torque.

Mechanical tensioner refitting

37 Rotate the camshaft sprocket anti-clockwise until it stops.

38 Fit the tensioner with the pin installed and then fit the idler pulley **(see illustration)**.

39 Install the new timing belt, starting at the camshaft sprocket followed by the tensioner, crankshaft sprocket and finally the coolant pump.

40 Rotate the tensioner and remove the locking pin.

41 Rotate the tensioner clockwise until the marks align **(see illustration)**.

42 Use the special tool and tighten the camshaft sprocket bolts to the specified torque.

All engines

43 Remove the drill bit and the crankshaft locking tool.

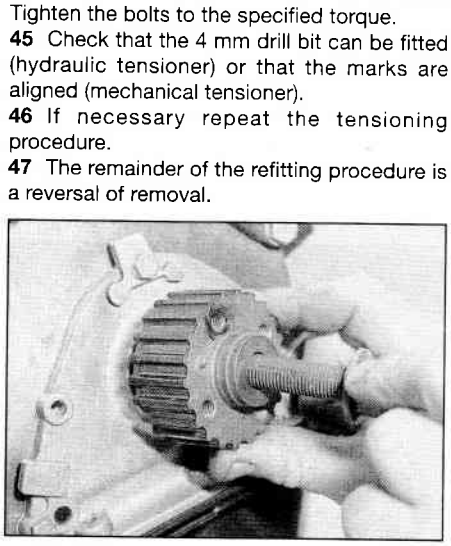
44 Rotate the engine two complete revolutions clockwise and refit the drill bit and crankshaft locking tool.

45 The drill bit must fit easily into the camshaft, if not, slacken the camshaft bolts and turn the hub until the drill bit can be fitted. Tighten the bolts to the specified torque.

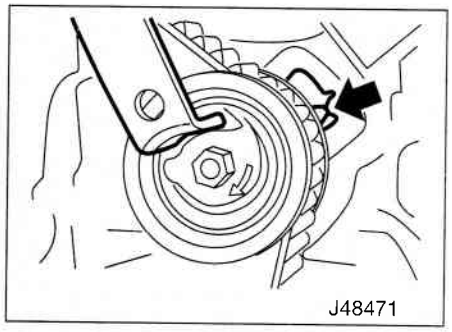
45 Check that the 4 mm drill bit can be fitted (hydraulic tensioner) or that the marks are aligned (mechanical tensioner).

46 If necessary repeat the tensioning procedure.

47 The remainder of the refitting procedure is a reversal of removal.



9.7 Fitting a new crankshaft sprocket securing bolt



8.41 Align the marks

9 Timing belt sprockets – removal and refitting

Crankshaft sprocket

Note: *A new crankshaft sprocket securing bolt must be used on refitting.*

1 Remove the timing belt as described in Section 8 and then remove the crankshaft pulley – see Section 6.

2 The sprocket securing bolt must now be slackened, and the crankshaft must be prevented from turning as the sprocket bolt is unscrewed. To hold the sprocket, make up a suitable tool, and screw it to the sprocket using two bolts screwed into two of the crankshaft pulley bolt holes.

3 An alternative approach is to remove the starter motor (as described in Chapter 5A) and use a broad-bladed screwdriver or pry bar to jam the flywheel ring gear.

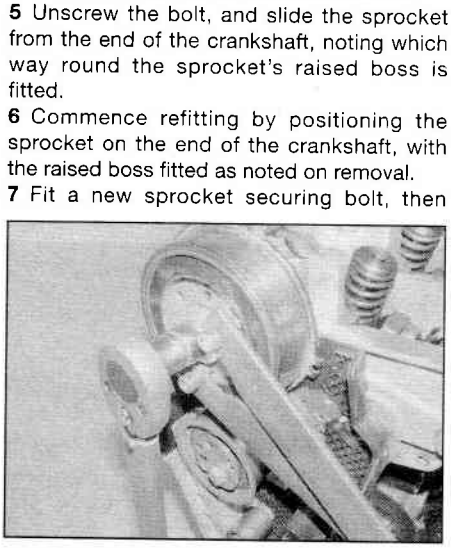
4 Hold the sprocket using the tool, then slacken the sprocket securing bolt. Take care, as the bolt is very tight. Do not allow the crankshaft to turn as the bolt is slackened.

5 Unscrew the bolt, and slide the sprocket from the end of the crankshaft, noting which way round the sprocket's raised boss is fitted.

6 Commence refitting by positioning the sprocket on the end of the crankshaft, with the raised boss fitted as noted on removal.

7 Fit a new sprocket securing bolt, then counterhold the sprocket using the method employed on removal, and tighten the bolt to the specified torque in the two stages given in the Specifications **(see illustration)**.

8 Refit the timing belt as described in Section 8.



9.16 Using a fabricated tool to counterhold the camshaft hub

Camshaft sprocket

9 Remove the timing belt as described in Section 8.

10 The camshaft sprocket bolt(s) must now be slackened. Do not use the timing locking bar to hold the camshaft stationary; it must be removed before loosening the sprocket bolt. In order to eliminate any possibility of accidental piston-to-valve contact, turn the crankshaft 90° anti-clockwise so that all the pistons are halfway up the cylinder bore.

11 Unscrew and remove the three retaining bolts and remove the camshaft sprocket from the camshaft hub.

12 Refit the sprocket ensuring that it is fitted the correct way round, as noted before removal.

13 Refit the sprocket bolt(s), and tighten by hand only at this stage.

14 If the crankshaft has been turned, turn the crankshaft clockwise 90° back to TDC. Refit and tension the timing belt as described in Section 8.

Camshaft hub

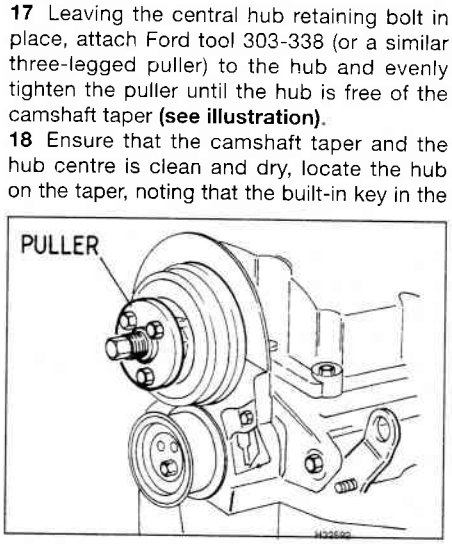
Note: Ford *technicians use special tool 205-072 to counterhold the hub, however it is possible to fabricate a suitable alternative – see below.*

15 Remove the camshaft sprocket as described in this Section.

16 Engage special tool 205-072 with the three locating holes in the face of the hub to prevent the hub from turning. If this tool is not available, fabricate a suitable alternative. Whilst holding the tool, undo the central hub retaining bolt about two turns **(see illustration)**.

17 Leaving the central hub retaining bolt in place, attach Ford tool 303-338 (or a similar three-legged puller) to the hub and evenly tighten the puller until the hub is free of the camshaft taper **(see illustration)**.

18 Ensure that the camshaft taper and the hub centre is clean and dry, locate the hub on the taper, noting that the built-in key in the



9.17 Attach a three-legged puller to the hub, and evenly tighten the puller until the hub is free of the camshaft taper

hub taper must align with the keyway in the camshaft taper **(see illustration)**.

19 Hold the hub in this position with tool 205-072 (or similar home-made tool), and tighten the central bolt to the specified torque.

20 The remainder of refitting is a reversal of removal.

Coolant pump sprocket

21 The coolant pump sprocket is integral with the coolant pump. Refer to Chapter 3 for details of coolant pump removal.

10 Pump injector rocker shaft assembly – removal and refitting

Removal

1 Remove the camshaft cover as described in Section 5. In order to ensure that the rocker arms are refitted to their original locations, use a marker pen or paint and number the arms 1 to 4, with No 1 nearest the timing belt end of the engine. If the arms are not fitted to their original locations, the injector basic clearance setting procedure must be carried out as described in Chapter 4B, Section 5.

2 Starting with the outer bolts first, carefully and evenly slacken the rocker shaft retaining bolts. Discard the rocker shaft bolts, new ones must be fitted **(see illustration)**.

Refitting

3 Carefully check the rocker shaft, rocker arms and camshaft bearing cap seating surface for any signs of excessive wear or damage.

4 Ensure that the shaft seating surface is clean and position the rocker shaft assembly in the camshaft bearing caps, making sure that, if re-using the original rocker arms, they are in their original locations.

5 Insert the new injector rocker shaft retaining bolts, and starting from the inner bolts, gradually and evenly tighten the bolts to the Stage 1 torque setting.

6 Again, starting with the inner retaining bolts, tighten the bolts to the Stage 2 angle as listed in this Chapter's Specifications.

7 Refit the camshaft cover as described in Section 5.

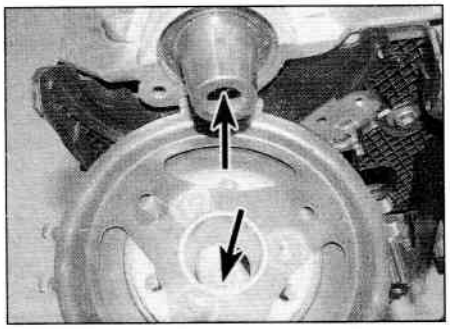
11 Camshaft and hydraulic tappets – removal, inspection and refitting

Note: *A new camshaft oil seal will be required on refitting.*

Removal

1 Turn the crankshaft to position No 1 piston at TDC on the firing stroke, and lock the camshaft and the fuel injection sprocket in position, as described in Section 4.

2 Remove the timing belt as described in Section 8.



9.18 The built-in key in the hub taper must align with the keyway in the camshaft taper (arrowed)

3 Remove the camshaft sprocket as described in Section 9.

4 Remove the brake tandem pump as described in Chapter 4B.

5 Remove the injector rocker arms as described in Section 10.

6 Check the camshaft bearing caps for identification markings. The bearing caps are normally stamped with their respective cylinder numbers. If no marks are present, make suitable marks using a scriber or punch. The caps should be numbered from 1 to 5, with No 1 at the timing belt end of the engine. Note on which side of the bearing caps the marks are made to ensure that they are refitted the correct way round.

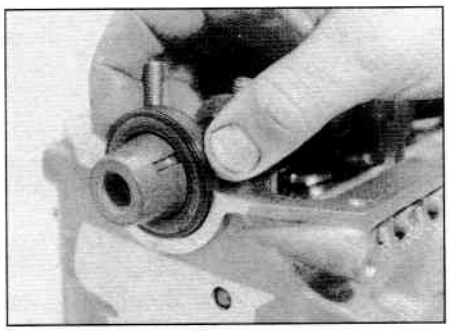
7 On some engines the camshaft rotates in shell bearings. As the camshaft bearing caps are removed, recover the shell bearing halves from the camshaft. Number the back of the bearings with a felt pen to ensure that, if re-used, the bearings are fitted to their original locations. **Note:** *Fitted into the cylinder head, under each camshaft bearing cap, is a washer for each cylinder head bolt.*

8 Unscrew the securing nuts, and remove Nos 1, 3 and 5 bearing caps.

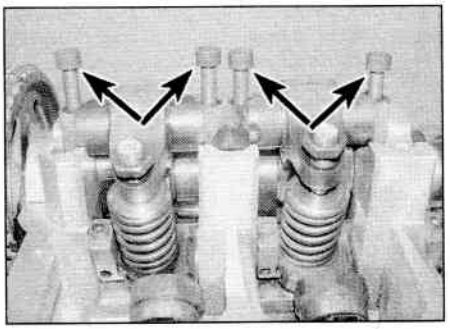
9 Working progressively, in a diagonal sequence, slacken the nuts securing Nos 2 and 4 bearing caps. Note that as the nuts are slackened, the valve springs will push the camshaft up.

10 Once the nuts securing Nos 2 and 4 bearing caps have been fully slackened, lift off the bearing caps.

11 Carefully lift the camshaft from the cylinder head, keeping it level and supported at both



11.11 Remove the camshaft oil seal



10.2 Starting with the outer bolts first, carefully and evenly slacken the rocker shaft retaining bolts (arrowed)

ends as it is removed so that the journals and lobes are not damaged. Remove the oil seal from the end of the camshaft and discard it – a new one will be required for refitting **(see illustration)**.

12 Lift the hydraulic tappets from their bores in the cylinder head, and store them with the valve contact surfaces facing downwards, to prevent the oil from draining out. It is recommended that the tappets are kept immersed in oil for the period they are removed from the cylinder head. Make a note of the position of each tappet, as they must be refitted in their original locations on reassembly – accelerated wear leading to early failure will result if the tappets are interchanged.

13 Where fitted recover the lower shell bearing halves from the cylinder head; number the back of the shells with a felt pen to ensure that, if re-used, the bearings are fitted to their original locations.

Inspection

14 With the camshaft removed, examine the bearing caps and the bearing locations in the cylinder head for signs of obvious wear or pitting. If evident, a new cylinder head will probably be required. Also check that the oil supply holes in the cylinder head are free from obstructions.

15 Visually inspect the camshaft for evidence of wear on the surfaces of the lobes and journals. Normally their surfaces should be smooth and have a dull shine; look for scoring, erosion or pitting and areas that appear highly polished, indicating excessive wear. Accelerated wear will occur once the hardened exterior of the camshaft has been damaged, so always renew worn items. **Note:** *If these symptoms are visible on the tips of the camshaft lobes, check the corresponding tappet, as it will probably be worn as well.*

16 If the machined surfaces of the camshaft appear discoloured or blued, it is likely that it has been overheated at some point, probably due to inadequate lubrication. This may have distorted the shaft, so check the run-out as follows: place the camshaft between two V-blocks and using a DTI gauge, measure the run-out at the centre journal. If it exceeds the figure quoted in the Specifications at the start of this Chapter, renew the camshaft.