Section E7

Camshaft and Valve mechanism

This section contains information relating to the camshaft timing gear, distributor drive gear, hydraulic tappets, push rods and rockers.

Refer to Section E8, for information relating to the valves and their associated components.

The camshaft is manufactured from cast iron and has chill cast cam peaks. It is centrally positioned between the two banks of cylinders and runs directly in bores machined in the crankcase.

The camshaft is driven through helical gears from the crankshaft. The camwheel is aluminium and the crankshaft gear is steel.

End thrust is taken on a thrust collar and controlled by the thrust plate situated at the front

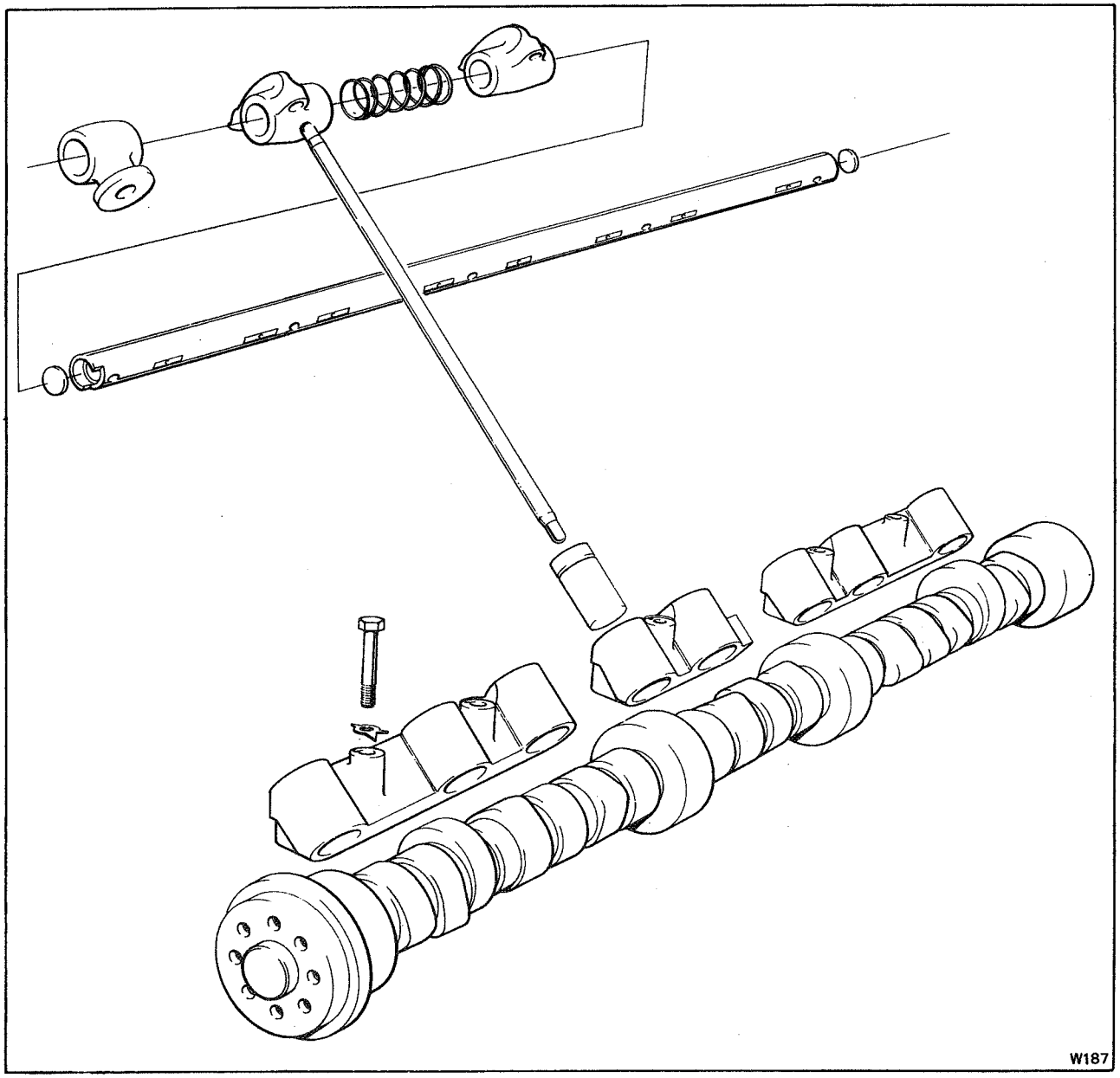

Fig. E26 Camshaft and Valve mechanism

of the camshaft.

Lubrication of the camshaft timing gear and the crankshaft gear is effected by the high pressure oil jet sprayed directly onto the two gears. The feed for this jet is via a tapping block adapter secured to the camshaft thrust plate. This plate is also the oil gallery cover plate.

A skew gear secured by two setscrews to the rear of the camshaft provides the drive for the distributor. The two setscrews are off-set to ensure correct positioning.

The camshaft incorporates two eccentrics to drive the hydraulic system pumps (see Section E11).

The hydraulic tappets are carried in detachable blocks fitted into the crankcase on either side of the camshaft. The tappets are self-adjusting and require no maintenance. The tappet barrels are produced from cast iron and have a spherical base. These seat onto the camshaft where the cams have a slight longitudinal taper that rotates the tappets thus ensuring even wear of the tappet barrel and base.

A longitudinal flat is machined on the tappet barrel, this supplies oil from the groove in the tappet body to the cam face.

The hydraulic tappet (see Fig. E29) comprises a cylindrical barrel, closed at the bottom end that seats onto the camshaft. Inserted into this body is a plunger that is free to slide up and down; the clearance between the body and plunger is very small. At the lower end of the plunger is a one-way valve. The valve is held closed by a wave washer that is housed in a retainer spigot, clipped onto the end of the plunger.

The upper end of the plunger carries a cap that seats the push rod. The complete plunger assembly is spring loaded away from the base of the tappet body and retained by a circlip.

The push rods are hollow tubes with spherical ends. They transmit the movement of the tappets to the rocker arms. Engine oil passes along the hollow push rod to lubricate the ball end at the rocker arm.

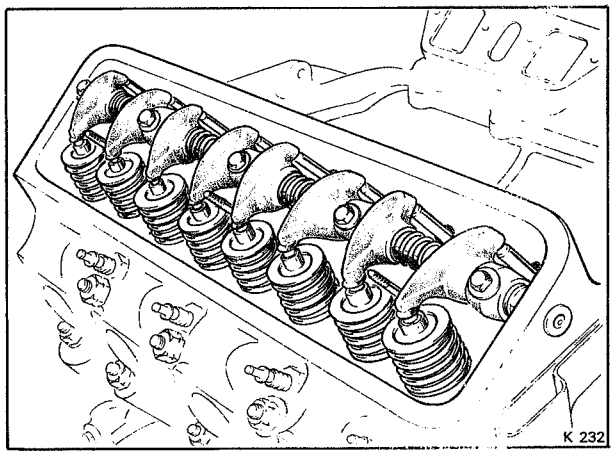

Fig. E27 Rocker shaft assembly

The rocker shafts, rocker arms and spacing springs are carried on five pedestals on each cylinder head. The pedestals are secured by set-screws.

The rocker arms are drilled to provide oil delivery from the rocker shafts to the valve tips and stems.

For details of the valve assemblies refer to Section E8.

Rocker shaft assembly - To remove and dismantle (see Fig. E27)

1. Carry out the usual workshop safety precautions.
2. Unscrew the two cap nuts retaining the ignition harness to the rocker cover.
3. Unscrew the three reach nuts securing the rocker cover to the cylinder head.
4. Carefully prise around the joint face of the rocker cover. Once the joint has been freed, lift the rocker cover from the engine.
5. Unscrew the five setscrews securing the rocker shaft in position. **Do not withdraw the setscrews.**
6. Carefully withdraw the rocker shaft from its position. Leave the setscrews positioned through the pedestals to retain the rocker arms and springs in position on the shaft.
7. Place the rocker shaft assembly on a bench and withdraw the end setscrew whilst holding the pedestal in position. Ensure that the spring does not force any components off the end of the shaft.

Slowly release the hand pressure applied to the end of the rocker shaft and allow the spring to push the pedestal off the rocker shaft.

8. Collect the end pedestal, first rocker arm, spring and second rocker arm.
9. Repeat Operations 7 and 8 to the next pedestal and continue repeating the exercise until both rocker shafts are dismantled.

Rocker shaft assembly - To inspect

1. Examine the pads on the rocker arms for wear and renew any that are badly worn.

Slight 'scuffing' or pitting on the pads may be removed with a smooth stone.

2. Rocker pads are case hardened to a depth of between 0,635 mm. and 0,762 mm. (0.025 in. and 0.030 in.) and the Rockwell hardness value should be between C57 and C65.
3. If the hardness value is below these figures, the rocker arms should be renewed.

Rocker shaft assembly - To assemble and fit

Assemble and fit the rocker shaft by reversing the removal and dismantling procedures, noting the following.

1. The rockers are handed and should be fitted in pairs so that the arms point inwards to the cylinder bore.
2. The cylinder heads have rocker shaft dowel pins fitted. Ensure that the rocker shaft is correctly located on the pins so that the oil feed holes align.

3. When tightening, commence with the centre setscrew and alternate on either side towards the end setscrew.
4. Torque tighten the rocker shaft retaining setscrews to the figure quoted in Chapter P.

Push rods - To remove, inspect and fit
1. Carry out the usual workshop safety precautions.
2. Remove the rocker cover and rocker shaft.
3. Withdraw the push rods. Label each one for identification purposes during assembly.
4. Check the push rods for bow. If any push rod has a total indicator reading of more that 0,51 mm. (0.020 in.) it should be discarded and a new push rod fitted.
5. Ensure that the holes in the ball ends are not blocked by dirt, etc.
6. When fitting the push rods reverse the removal procedure. Always ensure that the push rods are returned to their original positions and that they are correctly seated in both the hydraulic tappets and the rocker arms.

Hydraulic tappets
A tappet which is found to be defective in service should be replaced by a complete assembly. **Individual components must not be renewed.**

Where a tappet is noisy but otherwise appears to be serviceable and replacement tappets are not readily available, it may be worthwhile dismantling the existing tappet and thoroughly washing it in clean paraffin. After cleaning, refit the tappet.

Tappet noise
A defective tappet makes a noise like a 'rifle crack' and is usually caused by one or more tappets collapsing, it can be heard with each revolution of the camshaft. This could be caused by dirt which has infiltrated into the tappet(s) in which case the tappet(s) should be dismantled and cleaned. If cleaning the tappet does not cure the fault, the tappet should be renewed.

The tappet can be isolated by the fact that the noise changes as the rocker arm is depressed manually to take up any 'sponge' while the engine is running.

If the noise is not caused by a collapsed tappet(s) one of the following causes should be suspected.
1. Sometimes air is drawn into the tappets after standing overnight and one of the tappets may be reluctant to clear itself even after 30 minutes hot running.
2. Occasionally a tappet leaks down too quickly at high temperatures causing a knock. This tappet is really a milder case of the 'rifle crack'failure and should be renewed.
3. Occasionally a tappet will stick in the bore of the tappet block at high temperatures causing a knock. This will show itself by being consistently noisy when the engine is very hot but quiet at other times.

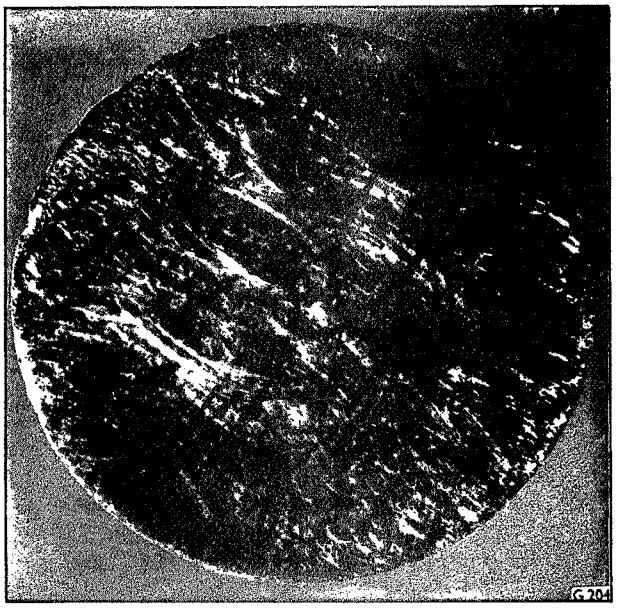

Fig. E28 Severely scuffed tappet base

Should this situation be encountered (and all other tappet rectification measures failed to effect a cure), the suspect tappet block should be checked for incorrect crankcase bedding. Lightly smear the seating face with engineers blue and fit the block in the crankcase. If the check proves conclusively that the tappet block bedding is faulty, the crankcase can be scraped to improve the situation.

Extreme care must be exercised when carrying out this operation and the minimum amount of metal removed from the crankcase.

Tappet wear
There is seldom a cause for rejecting tappets due to an appearance of wear on the bottom face unless the cam peak on the camshaft is also badly worn.

It may be harmful to replace a mildly worn tappet with a new one unless the camshaft is also changed. For this reason only the tappets which are actually causing a problem should be changed.

If it is found necessary to fit a new camshaft to an engine, one complete set of sixteen new tappets must also be fitted.

Hydraulic tappets - To remove
1. Carry out the usual workshop safety precautions.
2. Remove the carburetters or fuel injection system equipment (see either Chapter K or Chapter U).
3. Drain the engine coolant (see Chapter L).
4. Depressurise the hydraulic systems (see Chapter G).
5. Remove the induction manifold.
6. Progressively unscrew the setscrews securing the tappet chest cover to the crankcase. The setscrews must be removed progressively. If the brake pump operating cams happen to be at their peak, distortion could occur to the tappet chest cover.

7. Remove the rocker covers.
8. Progressively unscrew the five setscrews securing the rocker pedestals to each cylinder head, then remove the rocker shaft assemblies.
9. Remove the push rods.
10. Withdraw the hydraulic tappets from the tappet blocks.

Hydraulic tappets - To dismantle

1. Press down the spherical cap situated in the top of the tappet and remove the circlip holding the cap in place. After gradually releasing the pressure from the spherical cap the tappet can be dismantled (see Fig. E29).
2. Remove the plunger and valve from the tappet barrel. The tappet barrel should be examined for any signs of wear on the base.

Hydraulic tappets - To assemble and prime

In order to obtain the high degree of accuracy necessary for efficient operation of the hydraulic tappets, it is essential that extreme precautions are taken when assembling the components to ensure complete cleanliness.

It is therefore most important that particular attention is given to the following.

(a) Due to the highly critical surfaces and dimensions of the hydraulic tappets, great care and cleanliness are of the utmost importance when handling tappet components. If a cloth is to be used ensure that it is lint free.
(b) Ensure that the assembly tank is perfectly clean before adding paraffin; only clean fresh paraffin must be used.
(c) Wash all the tappet components in clean paraffin, taking care that the components of each tappet are retained as an assembly and are not interchanged with parts of another tappet.

1. Commence assembly of the tappet by fitting the wave washer (see Fig. E29) and valve into the retainer.
2. Using 'finger' pressure, carefully press the retainer assembly onto the spigot of the plunger.
3. Fit the spring onto the retainer assembly.
4. Fit the valve assembly (plunger, valve, wave washer, retainer and spring), into the tappet barrel.
5. Fit the cap into the top of the plunger.
6. Using an old push rod press the cap downwards until it is possible to fit the retaining circlip into the groove located inside the top of the barrel.
7. Release the pressure.
8. Submerge the tappet assembly in clean Esso T.S.D. 1047 rust inhibiting paraffin.
9. Using a small probe push the valve off its seat. The probe should be carefully positioned through the small hole in the tappet cap and pushed down into the tappet until it contacts the valve. A slight increase in pressure will then be required to overcome the wave washer loading and open the valve.
10. Continue to hold the valve open and place a small screwdriver into the cap adjacent to the probe.
11. Apply pressure to both the probe and screwdriver. Press the cap downwards in the tappet barrel, compressing the spring. Note the air bubbles that are expelled from the tappet barrel oil inlet hole.
12. When the air bubbles cease, release the pressure from the cap and valve.

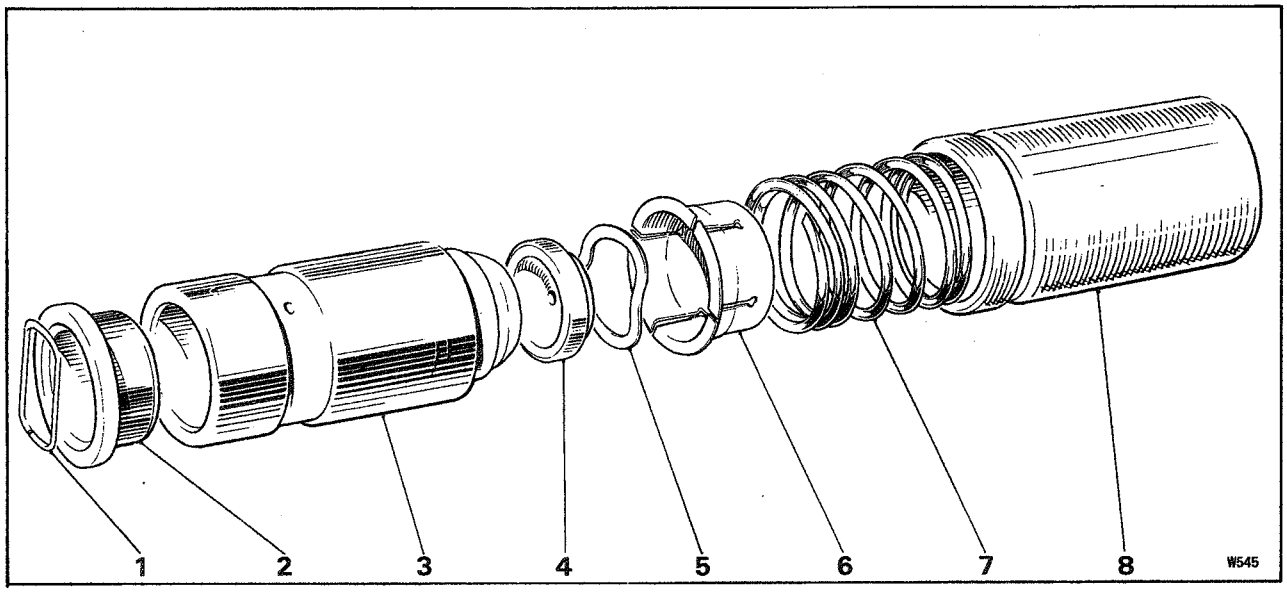

Fig. E29 Hydraulic tappet

1 Circlip
2 Cap
3 Plunger
4 Valve
5 Wave washer
6 Retainer
7 Spring
8 Tappet barrel

13. Repeat Operations 9 to 12 inclusive, until the air bubbles have ceased to appear throughout the cycle of operations.
14. Withdraw the probe from the small hole in the centre of the cap.
15. Again apply pressure to the cap with a small screwdriver. If the assembly feels solid it can be assumed that it is operating satisfactorily, therefore it can be removed from the paraffin.

When tappets are to be fitted immediately after overhaul, they should be primed with clean engine oil.

Hydraulic tappets - To fit
1. Oil the bores of the tappet blocks.
2. Check that if new tappets are being fitted, the grade of each tappet corresponds with the bore of the tappet block. The tappet barrel grading marks are etched onto the top lip of the barrel.
3. Fit the tappets.
4. Fit the push rods to the engine, into the same position from which they were removed.
5. Fit the rocker shafts then progressively tighten the securing nuts.
6. Fit the tappet chest cover.

Tappet chest cover - To fit
1. Rotate the camshaft until the brake pump eccentrics are at approximately B.D.C.
2. To prevent the possibility of hydraulic lock, ensure the brake pumps are drained of fluid.
3. If necessary, check that the position of the two brake pump rods is correct and fit the brake pumps (see Section E11).
4. Wellseal the crankcase tappet cover joint face, then fit a new length of sealing thread to the face. Fit the thread so that its two ends overlay and it surrounds all the tapped holes in the crankcase (see Fig. E30).
5. Wellseal the joint face of the tappet cover.
6. Fit the tappet cover to the crankcase then fit and tighten the setscrews.
7. Complete the engine build by reversing the procedure given for dismantling, noting the following.
8. Fit new joints and sealing rings.
9. Refer to Chapter P for torque tightening figures.
10. Ensure that the brake pipes are not overtightened, otherwise damage to the conical seatings may occur.
11. Any hoses showing signs of deterioration should be renewed.
12. Ensure that the driving belts are adjusted to the correct tension.

Camshaft - To remove
1. Remove the hydraulic tappets (see Section E7).
2. Remove the transmission (see Chapter T).
3. Remove the flywheel.
4. Remove the distributor together with its pedestal (see Chapter M).
5. Remove the pressed steel cover from the rear end of the crankcase to expose the distributor driving gears (see Fig. E31).

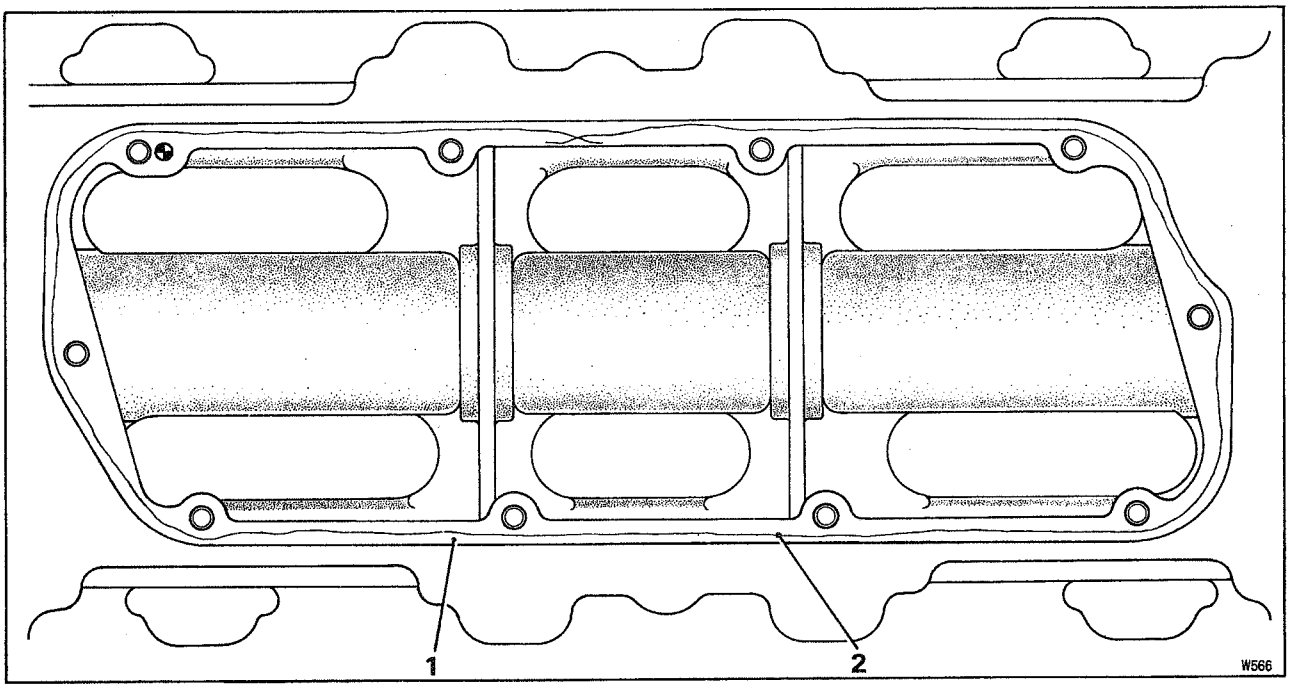

Fig. E30 Crankcase to tappet cover joint
1 Crankcase tappet cover face
2 Silk sealing thread

6. Withdraw the distributor driving shaft together with the locating plug and 'O' ring.
7. Withdraw the distributor driving spindle and integral gear together with the thrust washer.
8. Remove the skew gear from the rear end of the camshaft.
9. Remove the radiator grille, refrigeration condenser and radiator matrix.
10. Remove the coolant pump and lower front cover from the front of the engine (see Section E5).
11. Unscrew the setscrews from the camshaft and withdraw the cam gear.
12. Remove the camshaft thrust plate together with the timing gear lubricating oil pipe assembly. Withdraw the camshaft through the front end of the crank-case. Take care that the bearing bores are not damaged by the cam lobes.

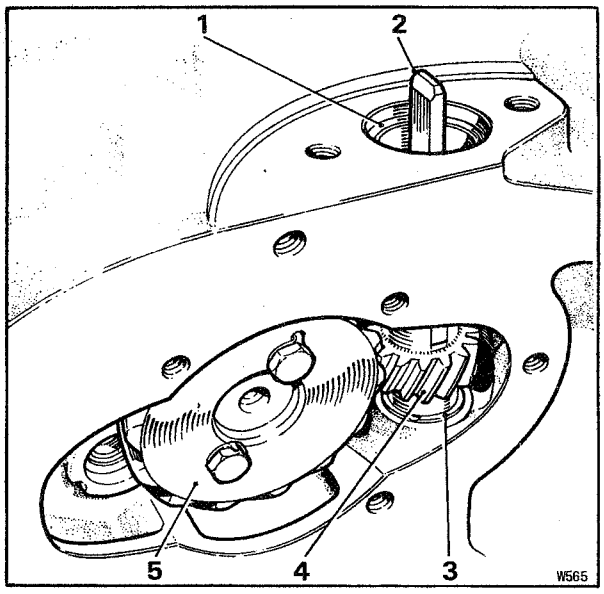

Fig. E31 Distributor driving gears
1 Locating plug
2 Distributor driving shaft
3 Thrust washer
4 Driving spindle and integral gear
5 Skew gear

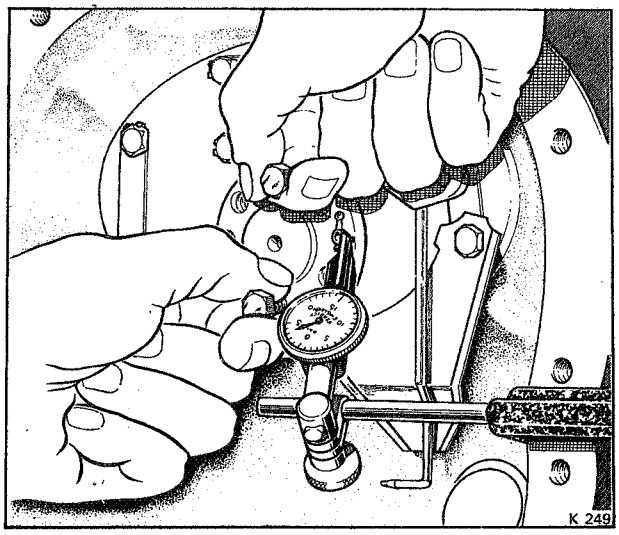

Fig. E32 Checking the camshaft end-float

Camshaft - To inspect
1. Inspect the cams for wear and pitting. The cam lift dimensions are given in Section E3, Dimensional data.
2. If wear is in excess of the figures given, the camshaft must be renewed.

Camshaft - To fit
1. Lightly smear the camshaft bearings with clean engine oil. Lubricate the camshaft lobes with EP (extreme pressure) oil such as Castrol Hipress SC 140. Fit the camshaft through the front end of the crankcase, taking care that the cam lobes do not damage the camshaft bearing bores.
2. Fit the timing gear lubricating jet to the thrust plate and secure it with two setscrews and tab-washers.
3. Fit and secure the camshaft thrust plate to the crankcase; use new tab-washers. Torque tighten the setscrews to the figures quoted in Chapter P; lock the tab-washers.

Camshaft end-float - To check (see Fig. E32)
1. Fit a dial test indicator to the crankcase and set the scale to zero.
2. Fit the two setscrews to the end of the camshaft.
3. Grip the setscrews then move the camshaft backward and forward and note the reading on the dial test indicator.
4. The camshaft end-float should be between the figures quoted in Section E3, Dimensional data.

Valve gear - To time (see Fig. E33)
1. Rotate the crankshaft until the mark on the crank-shaft timing gear is vertical and towards the top of the crankcase.
2. Fit the camshaft timing gear to the camshaft so that the mark on the gear is aligned with the mark on the crankshaft timing gear; do not fit any set-screws at this stage.
3. Carefully rotate the camshaft until the holes in the camshaft timing gear align exactly with the threaded holes in the camshaft (one hole is offset).
4. Fit the end plate cover and secure the timing gear and the cover to the camshaft with eight set-screws. Torque tighten the setscrews to the figure quoted in Chapter P.

Camshaft timing gear backlash and run-out - To check
1. Fit a dial test indicator to the crankcase and set the scale to zero as shown in Figure E34.
2. Rock the cam gear and check the backlash. The backlash should be between the figures quoted in Section E3, Dimensional data.
3. Check the backlash on various teeth around the

circumference of the gear.
4. Check the timing gear run-out as follows (see Fig. E35).
5. Move the indicator pointer so that it touches the front face of the cam gear.
6. Rotate the crankshaft and check the run-out shown on the indicator dial. The run-out should not exceed the figures quoted in Section E3, Dimensional data.

Distributor driving gear - To fit
1. Fit the camshaft distributor driving gear.
2. Rotate the crankshaft until the timing marks on the camshaft and crankshaft gears are in line.
3. Fit the thrust washer to the distributor driving gear spindle then fit the gear into the recess in the crankcase. It will help in fitting this gear if the washer is held to the gear with a light smear of grease.
4. When the gear is fitted, the slot in the top of the gear spindle should be in line with the camshaft (see Fig. E31).

On no account should the setting of the crankshaft and camshaft be disturbed whilst fitting this gear.
5. Fit the distributor driving shaft to the driving spindle then fit the locating plug.
6. If necessary, renew the rubber 'O' ring on the locating plug.
7. Using a dial test indicator in a similar manner to that shown in Figure E34, check the backlash of the distributor driving gear. This should be between the figures quoted in Section E3, Dimensional data.
8. Fit the camshaft rear cover using a new paper joint.

Engine assembly - To complete
Complete the engine assembly by reversing the procedure given for camshaft removal, noting the following.

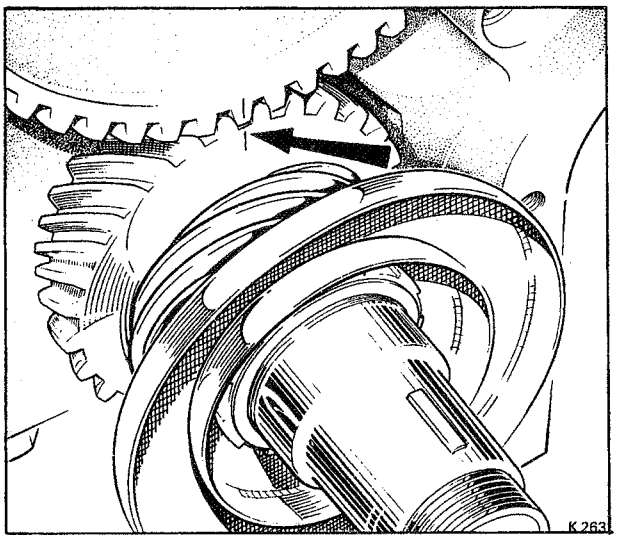

Fig. E33 Valve timing marks

1. All setscrews, nuts and bolts must be torque tightened to the figures quoted in Chapter P.
2. Renew all joints.
3. Fit a new Neoprene seal between the lower front

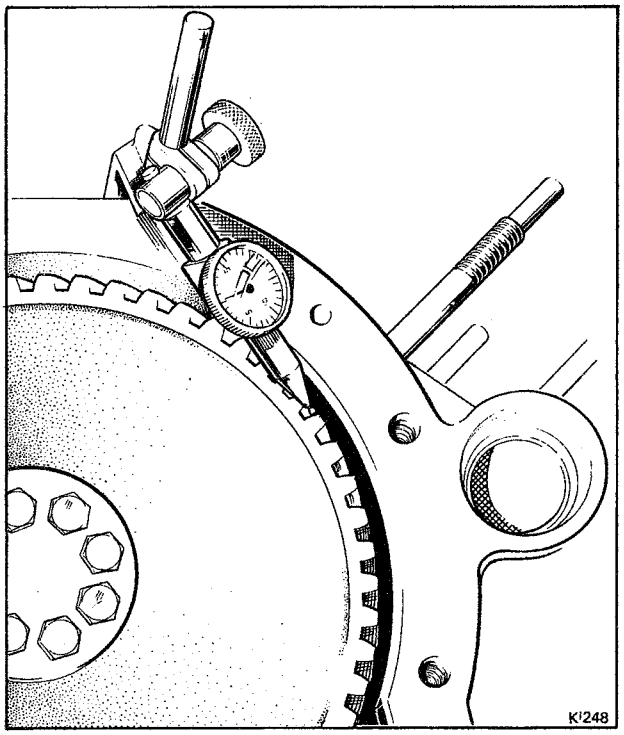

Fig. E34 Checking the timing gear backlash

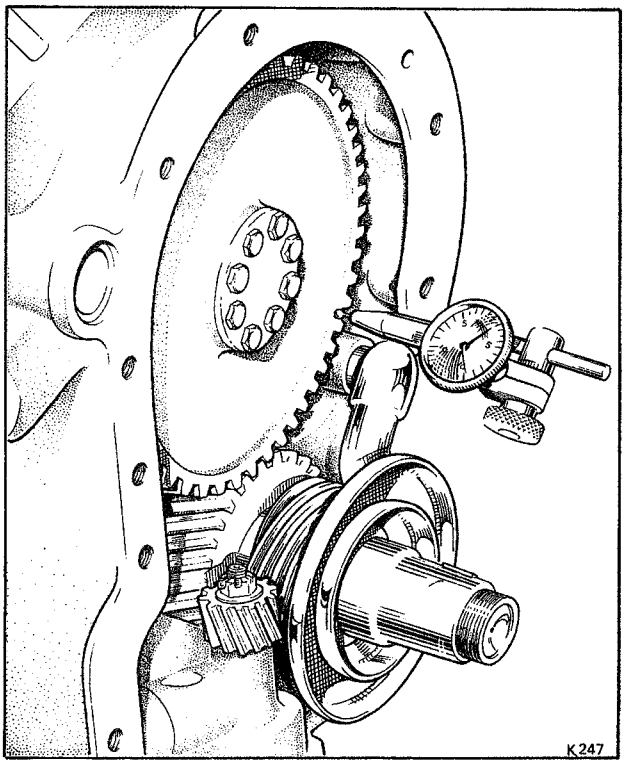

Fig. E35 Checking the timing gear run-out

casing and the coolant pump.
4. Ensure that the tappet cover is fitted correctly.
5. Fit the distributor and time the ignition as described in Chapter M.
6. If a new camshaft is fitted to an engine, one complete set of sixteen new tappets must also be fitted.