

SECTION E

ENGINE

<u>Section</u>	<u>Description</u>	<u>Page</u>
E.1.	General description	3.
E.2.	Lubrication	3.
E.3.	Engine tune	7.
E.4.	Compression check	8.
E.5.	Camshaft cover	9.
E.6.	Timing chain tension	9.
E.7.	Valve clearances	9.
E.8.	Camshafts sprockets and timing chain	12.
E.9.	Camshafts and bearings	12.
E.10.	Cylinder head	13.
E.11.	Valves	16.
E.12.	Decarbonise cylinder head and pistons	17.
E.13.	Valve seat inserts	18.
E.14.	Valve guides	18.
E.15.	Cam follower sleeves	19.
E.16.	Oil sump	19.
E.17.	Main bearings	19.
E.18.	Connecting rod bearings	21.
E.19.	Pistons, piston rings and connecting rods	21.
E.20.	Crankshaft pulley	24.
E.21.	Oil pump and oil filter	24.
E.22.	Front (timing) cover oil seal	25.
E.23.	Water pump	26.
E.24.	Timing chain tensioner sprocket	29.
E.25.	Engine mountings	29.
E.26.	Engine assembly	30.
E.27.	Flywheel and ring gear	31.
E.28.	Crankshaft sprocket	32.
E.29.	Crankshaft rear oil seal	32.
E.30.	Crankshaft	33.
E.31.	Jackshaft and bearings	36.
E.32.	Cylinder block	37.
E.33.	Reboring	37.
E.34.	Clutch spigot bearing	37.
E.35.	Special tools	39.

All running clearances, fitting tolerances and dimensions are given in 'Technical Data'.

E.1. - GENERAL DESCRIPTION

The engine is a four cylinder, four stroke, twin overhead camshaft unit having a cast aluminium cylinder head which has fully machined hemispherical combustion chambers and separate ports for each valve. The valves, of which the inlets are longer than the exhaust, have replaceable guides and seat inserts and are at an angle of 27° to the vertical. They are operated by the camshafts acting directly on piston type cam followers (tappets). A spring tensioned single row chain drives the camshafts at half engine speed. The camshaft end float and location depends on a shoulder at the front of each shaft bearing in the head. The timing chain also drives the jackshaft which is situated in the right-hand wall of the cast-iron cylinder block and which drives the oil pump, distributor and fuel pump. The jackshaft is located by a thrust plate bolted to the cylinder block front face and runs in three steel-backed white metal bearings, while the camshafts each run in five bearings of this type. The oil pump, distributor and fuel pump are mounted on the right-hand side of the engine, the oil pump and distributor being driven by a single skew gear on the jackshaft and the fuel pump by a cam also on the same shaft.

The crankshaft, of cast iron construction and dynamically balanced, runs in five steel-backed lead bronze lined bearings, end float being controlled by split thrust washers located in the cylinder block on either side of the centre main bearing.

The connecting rods of 'H' section forgings have steel-backed bronze little end bushes and steel-backed copper lead big end liners, the big end bearing caps being located by two dowels and retained by two bolts. Solid skirt aluminium alloy pistons with two compression and one oil control ring situated above the gudgeon pin are used. The gudgeon pins are retained in position by circlips installed in grooves at each end of the gudgeon pin bore.

A cast-iron flywheel incorporating a steel ring gear drive for the starter, is located on the crankshaft flange and retained by six bolts fitted without lockwashers.

E.2. - LUBRICATION

General

The lubrication system is of the forced feed type, the oil being circulated by a mechanically driven oil pump bolted to the right-hand side of the cylinder block. The pump is driven by a skew gear on the jackshaft, and is of the eccentric bi-rotor type which

incorporates a non-adjustable plunger type relief valve.

Oil is drawn from the sump up an inlet pipe attached to the cylinder block and into the pump. When the relief valve opens, oil is passed back into the sump, returning via the base of the sump to prevent aeration. From the pump the pressurised oil flows through the integral full flow filter to a short oil gallery on the right-hand side of the engine. At the forward end of the gallery is a tapped take-off for the oil pressure transmitter. A cross drilling at the rear of this gallery takes the oil to the other side of the engine where the main oil gallery is situated from which all the main bearings are fed. A notch cut in the centre main bearing liner feeds oil to the crankshaft rear thrust washer. Oil is fed to the big end bearings through drillings in the camshaft front, centre and rear journals. Lubrication of the little end bushes, the gudgeon pins and the non-thrust sides of the cylinders is by oil mist and an oil jet forced through a small drilling in each connecting rod web, every revolution of the crankshaft.

The jackshaft bearings are fed from the front, centre and rear main bearings via drillings in the block and a metered jet of oil from a front drilling lubricates the chain and sprockets. Oil fed to the overhead camshafts is controlled by flats machined on the jackshaft front journal, and each camshaft bearing is then fed by a central drilling, blocked at the rear end by a tapered Allen screw. Surplus oil from these bearings then drains back into the sump by way of passages in the head.

Oil Level

The correct level is to the 'FULL' mark on the dipstick, which is located to the left-hand side of the timing cover. When checking the oil level the car must be standing on a level surface and the dipstick withdrawn, wiped, replaced and finally withdrawn and read, the depth of the oil on the end of the dipstick indicating the level of the oil in the sump. If oil needs to be added, remove the oil filler cap on the camshafts cover and pour in clean engine oil of the correct grade (see Section 'O') until the dipstick indicates that the sump is full. Do NOT overfill. Replace the oil filler cap securely (double notch) otherwise an oil loss could occur, with the resultant failure of the entire engine lubrication system. From new the oil should be changed after 500 miles (800 km.) and then after every 3,000 miles (5,000 km.). If the oil appears to be excessively dirty before this distance, it should be changed and a new filter element fitted.

The sump capacity is given in 'Technical Data'. Where possible it is better to drain the oil when the engine is warm (after having just completed a run) and has a lower viscosity to carry away any sediment.

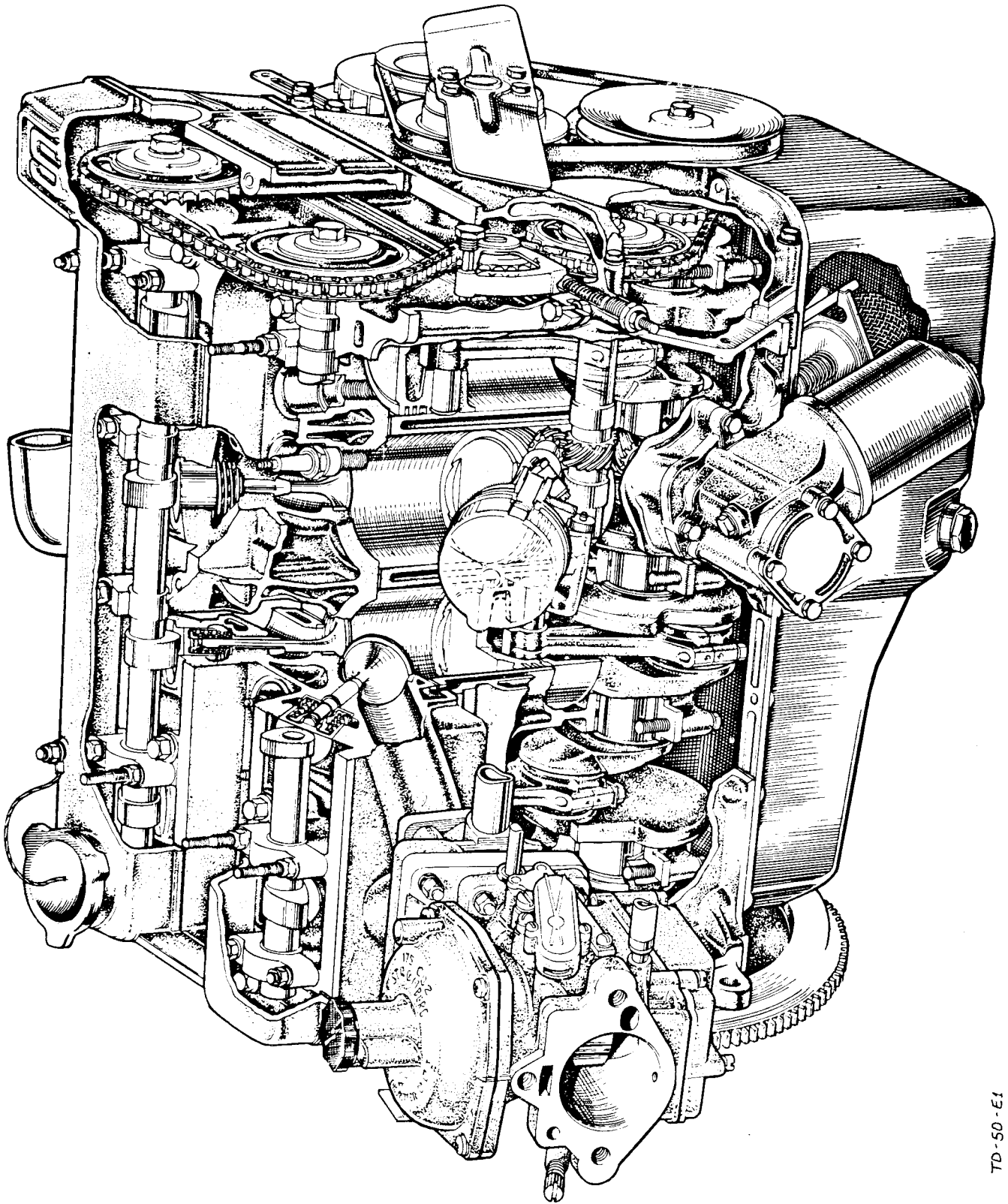


Fig. 1. ENGINE CUTAWAY

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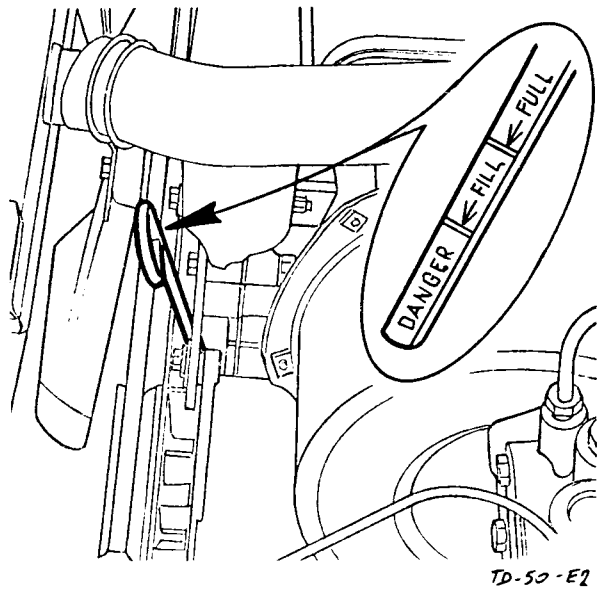


Fig. 2. DIPSTICK

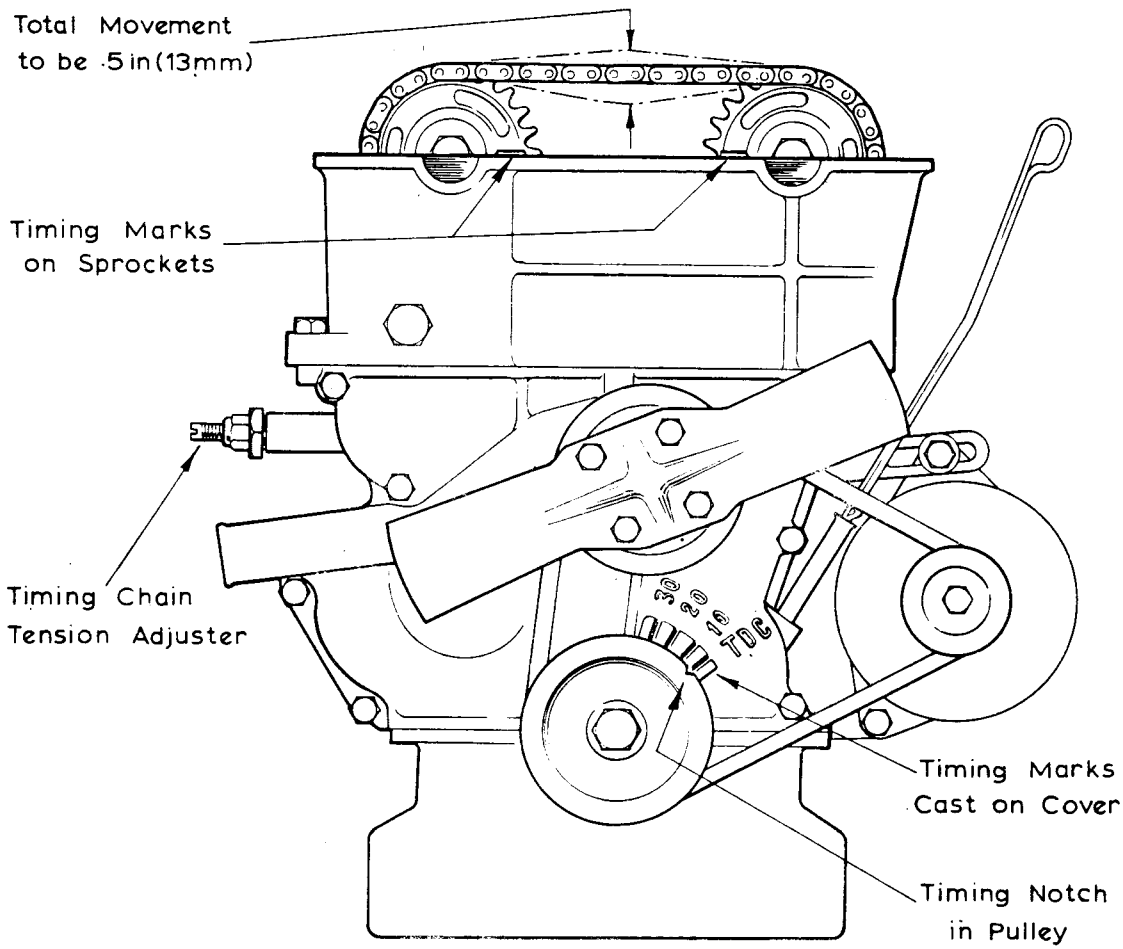


Fig. 3. TIMING MARKS & CHAIN TENSION

TD-50-3E

Oil Filter

A full flow filter is bolted to the pump body to make an integral unit. The oil flows through the filter and passes to the galleries. To remove the filter unscrew the central retaining bolt and withdraw the filter body and element. The element should be replaced at intervals of every 6,000 miles (10,000 km.) or more frequently if there are signs of excessive fouling. Extract the sealing ring and fit the replacement ring supplied with the new element by forcing on at four diametrically opposed points simultaneously. Clean out the filter body and refit the new filter assembly to the pump body.

Oil Sump

The sump is pressed steel construction bolted to the block with 18 bolts, the rear-most pair of which are longer than the others. Spring and thick flat washers are used, the flat washers being of great importance as they distribute the load and prevent distortion.

E.3. - ENGINE TUNE

1. Pull off the sparking plug leads and remove the plugs. Clean the plugs and reset the gaps to the dimensions given in 'Technical Data', or if the electrodes are badly burned, fit new plugs, and reconnect the plug leads.
2. Remove the distributor cap and examine the contact-breaker points. Replace the points if badly burned or excessive metal transfer is evident. Adjust the points gap to the dimension given in 'Technical Data' and refit the distributor cap.
3. Remove the fuel pump sediment bowl and filter screen. Wash both in clean petrol, ensure the gasket is in good condition and refit screen and sediment bowl to the fuel pump.
4. Remove the air cleaner element and clean by shaking through. If very clogged with dust or dirt, replace. Clean filter body of all accumulated dirt, reassemble and refit air cleaner assembly to car.
5. Disconnect the fuel feed pipes at the carburetters.
6. Weber Carburetters - Remove float chamber cover. Withdraw the float arm pivot and remove float and gasket. Unscrew all the jets and blow them clear with an air gun. Do NOT use wire as this will enlarge the jet orifice. Remove the needle valve and the needle valve body, and blow it clean with an air line. Clean the float, float chamber and filter gauze using clean petrol. Replace all the jets, needle valve body and needle valve. Place the gasket on the

carburettor body and fit float assembly. Check float setting (see Section 'L').

Refit float chamber cover.

7. Zenith Stromberg Carburettors - Disconnect air trunking from air box and remove air box. Remove carburettors from engine (see Section 'L') to a clean work bench. Release centre plug from the base of each carburettor. Remove float chambers by releasing the retaining screws, and withdrawing in a vertical motion to avoid damage to the float mechanism. Remove float chamber gasket. Take out floats. Remove needle valve from float chamber cover. Remove 'O' ring from centre plug. Thoroughly clean all removed parts in clean petrol. Refit needle valve into float chamber cover using a new washer. Replace float assembly and check (see Section 'L'). Refit float chambers with new gasket. Fit new 'O' ring to centre plug and replace securely. Refit carburettors to engine using new gaskets. Top up damper reservoirs with oil (see Section 'O').
8. Reconnect the fuel feed pipes at the carburettors.
9. Adjust the valve clearances (see Section 'E').
10. Connect the leads of a timing light in accordance with the manufacturers instructions. Check that the mark on the crankshaft pulley is visible; if not, mark with paint.
11. Start the engine and point the timing light at the crankshaft pulley, adjacent to the timing scale. Progressively increase the engine speed to 2,500 r.p.m. observing the timing mark, with the aid of the timing light to check that the distributor advances the ignition timing.
12. At 2,500 rev./min. adjust the ignition timing if necessary (see 'Technical Data') by slackening the distributor clamp and turning the distributor body as required. After making an adjustment tighten the clamp only sufficiently to hold the distributor in position - DO NOT OVERTIGHTEN. Remove the timing light.
13. Adjust the slow-running speed of the engine (see Section 'L').

E.4. - COMPRESSION CHECK

1. Warm-up the engine to its normal operating temperature then remove all sparking plugs. Set throttles to fully open position.
2. Place the gauge in a convenient position and insert the conical-ended rubber tube into No.1 sparking plug orifice. The normal compression pressure with an engine that has been run in correctly is given in 'Technical Data'. At altitudes above sea-level, proportionally lower pressures will be obtained. Compression is checked

with starter turning engine at 200 r.p.m. Battery and starter should be in good condition.

3. Test the remaining cylinders in a similar manner, replace sparking plugs and connect the plug leads.

E.5. - CAMSHAFT COVER

To Remove

1. Remove the eight nuts and washers retaining the camshafts cover.
2. Remove the cover together with its gasket.

To Replace

When refitting the camshafts cover, it is advisable to use a new gasket.

E.6. - TIMING CHAIN TENSION

1. Remove the camshafts cover (Section 'E.5.').
2. The timing chain tensioner is located at the right-hand side of the engine immediately below the cylinder head flange. Release the locknut and screw in (or out) the tensioner until a minimum noise level is achieved, approximately $\frac{1}{2}$ in. (12.5 mm.) total movement of the chain between the two camshaft sprockets.

E.7. - VALVE CLEARANCES

To Remove

1. Remove the camshafts cover (Section 'E.5.').
2. Turn the camshaft until the heel of the cam is on the cam follower (tappet) then, using feeler gauges, determine the distance between the cam follower and the cam heel. This clearance is given in 'Technical Data'.
3. Check all valve clearances, noting any which require adjustment.
4. Remove the camshaft (Section 'E.9.').
5. Remove the cam followers with the aid of a valve grinding tool, keeping them in their respective order.
6. Remove each adjustment shim now exposed, where the clearance requires adjustment, and substitute shims (one only to each valve) giving the correct clearance. A thinner shim will be required to increase the valve clearance, and a thicker one to reduce the clearance.

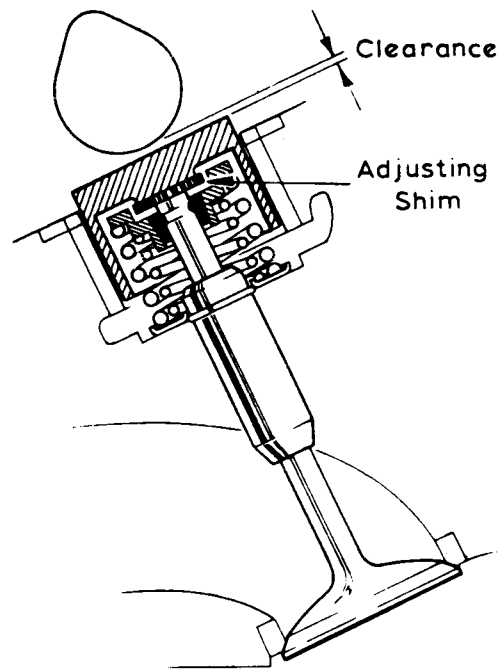


Fig. 4. VALVE ADJUSTMENT TD 50-4E

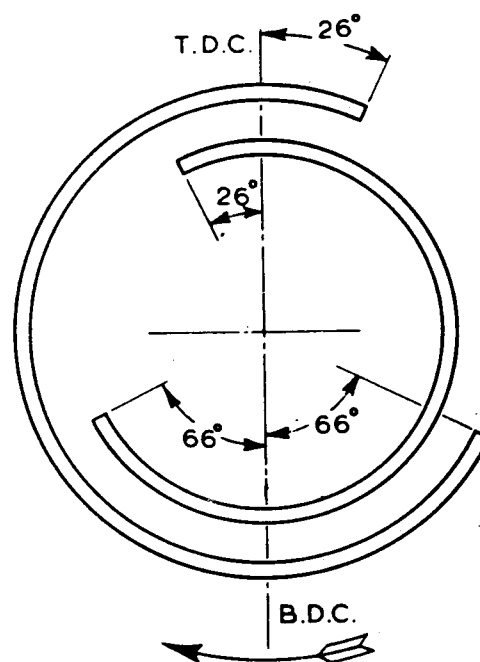


Fig. 5. VALVE TIMING TD 50-5E

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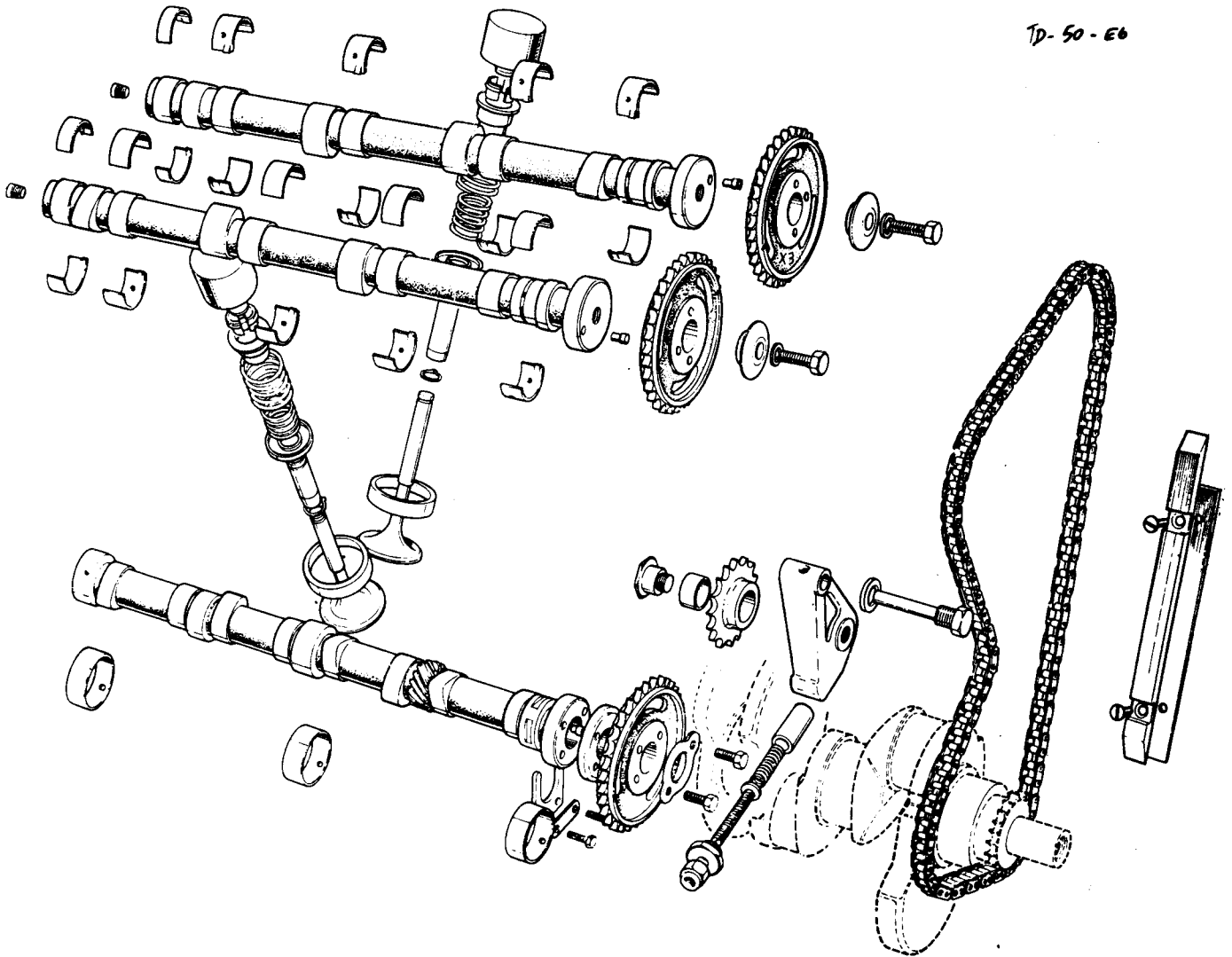


Fig. 6. VALVE GEAR COMPONENTS

Select a shim to give the correct size from the following formula:-

$$\text{Shim thickness required} = \text{A.C.} + \text{E.S.} - \text{C.C.}$$

Where A.C. is actual valve clearance

E.S. is existing shim thickness

C.C. is correct valve clearance

Measure the thickness of the shim accurately with a micrometer, even though the shim's thickness is etched around the periphery or on the underside of the shim.

Any roughness caused by the etching should be removed with fine emery cloth.

To Replace

1. Refit the cam followers in their respective bores.
2. Fit the camshafts and recheck the valve clearances, re-adjusting if necessary.
3. Refit the camshafts cover.

E.8. CAMSHAFTS SPROCKETS AND TIMING CHAIN

To Remove

1. Remove the camshafts cover (Section 'E.5.').
2. Slacken the timing chain tensioner (Section 'E.6.').
3. Set the engine in the timing position by aligning the timing mark on the crankshaft pulley with lower mark (T.D.C.) on the front cover, and the timing marks on the camshafts sprockets adjacent to each other and level with the camshafts cover mounting face.
4. Remove the sprockets by releasing their central retaining bolts, and disconnect the timing chain. To remove the timing chain the front cover (Section 'E.22.')

To Replace

1. Fit the camshafts sprockets and timing chain aligning the timing marks, as set during dismantling. Tighten the retaining bolts to the torque loading given in 'Technical Data'. Ensure correct sprocket replacement.
2. Adjust the timing chain tension (Section 'E.6').
3. Refit the camshafts cover (Section 'E.5').

E.9. - CAMSHAFTS AND BEARINGS

To Remove

1. Remove the camshafts cover (Section 'E.5').
2. Slacken the timing chain tensioner (Section 'E.6').
3. Set the engine in the timing position (Section 'E.8').

4. Remove the camshafts sprockets (Section 'E.8').
5. Remove the bolts securing the camshafts bearing caps, and remove the caps marking them (if not already marked) to ensure replacement in their original position.
Extract the bearing liners.

To Replace

1. Fit new bearing liners, noting that the location tags are correctly positioned in their locations in both cylinder head and bearing caps.
2. Fit the camshafts and their bearing caps, tightening the cap bolts progressively from the centre working outwards, to the torque loading given in 'Technical Data'. Check and adjust the valve clearances (Section 'E.7').
3. Fit the camshafts sprockets and adjust the timing chain tension (Section 'E.8') and finally, fit the camshafts cover (Section 'E.5').

E.10. - CYLINDER HEADTo Remove

1. Drain the cooling system (see Section 'K').
2. Remove the carburetters air box (see Section 'L').
3. Remove the radiator top hose (see Section 'K') and the heater hose (see Section 'P') from their connections at the cylinder head.
4. Disconnect the throttles and choke cables (see Section 'J').
5. Disconnect the water temperature gauge sender unit (see Section 'K').
6. Disconnect the throttles and choke cables (see Section 'L') fuel pipes from carburetters (see Section 'L') and exhaust manifold (see Section 'S').
7. Remove the camshafts cover (Section 'E.5').
8. Remove the camshafts sprockets (Section 'E.8').
9. Pull the leads from the sparking plugs.
10. Release the cylinder head bolts evenly and progressively working diagonally from the centre, and remove the cylinder head together with its gasket. Do NOT lay the cylinder head flat on its face while the camshafts are still fitted as this will CAUSE DAMAGE to the valves.

To Replace

1. Screw into diagonally opposite holes (front left, rear right) in the cylinder block face, two spare cylinder head bolts from which the heads have been removed and screwdriver slots cut. These studs locate the gasket whilst the cylinder head is

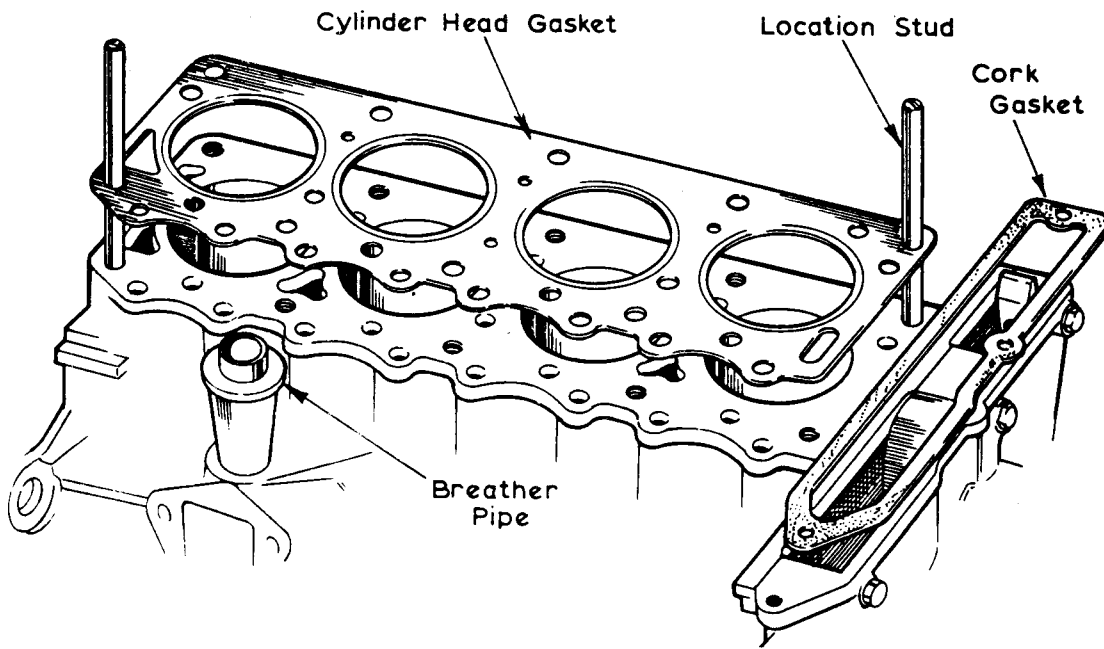


Fig. 7. CYLINDER HEAD LOCATION STUDS & GASKETS

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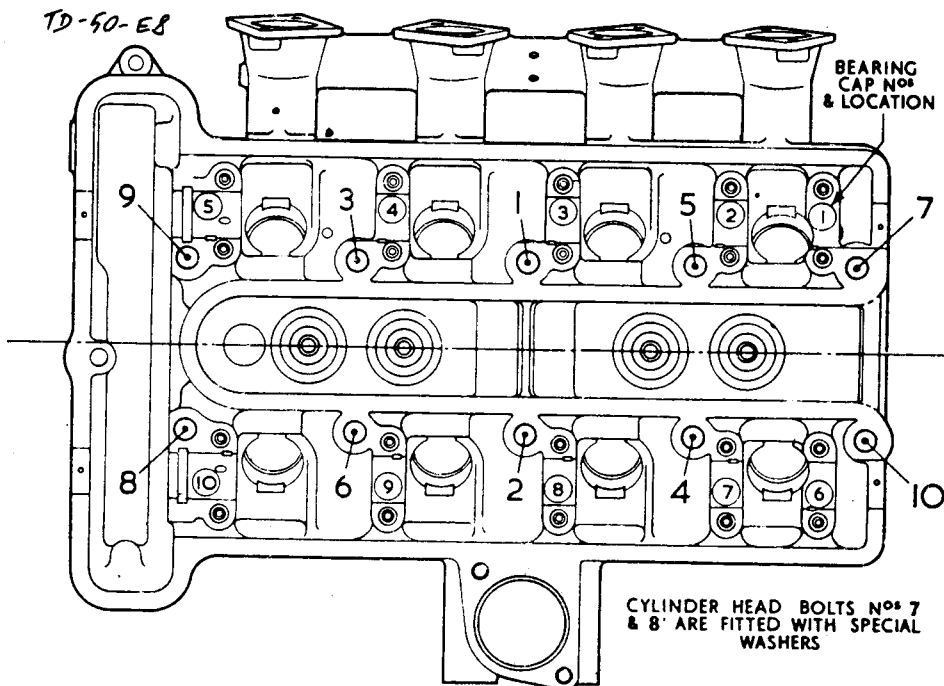


Fig. 8. ORDER OF TIGHTENING HEAD BOLTS

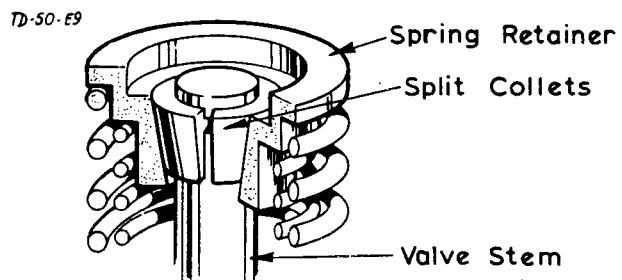


Fig. 9. VALVE SPRING RETAINER

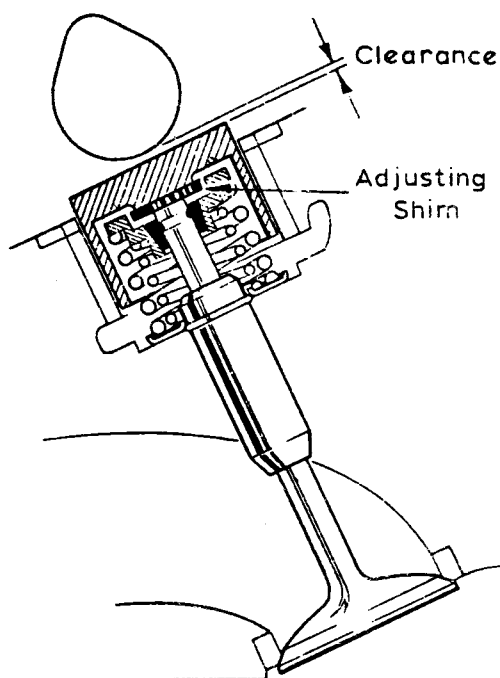


Fig. 10. VALVE ADJUSTMENT TD-50-4E

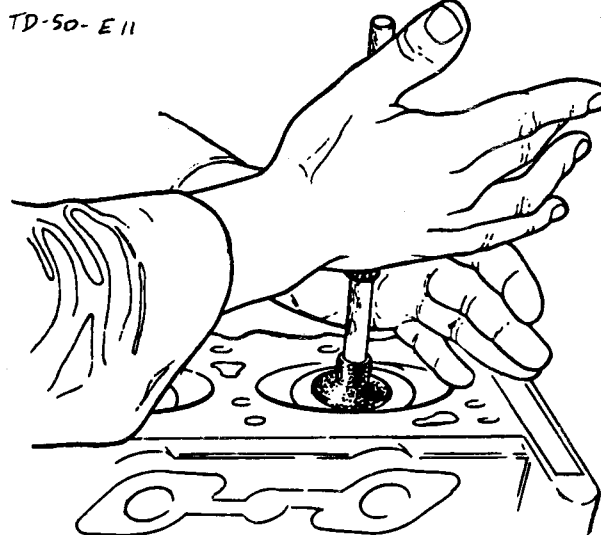


Fig. 11. GRINDING IN VALVES

being fitted. Use a new cylinder head gasket and a new cork gasket on top of the front cover. This cork gasket should have '3M's EC776 applied to its face which is in contact with the front cover, and 'Hylomar' applied to the face which will be in contact with the cylinder head.

2. Fit the cylinder head assembly, ensuring that the breather pipe is engaged in its bore. Loosely replace the cylinder head bolts. Extract the two gasket locating studs and fit the last two bolts. Tighten all bolts to the torque loading given in 'Technical Data' working progressively diagonally outwards from the centre. New cylinder head bolts (Part No. 26 E 027A) have recently been introduced, these having an improved material specification. There is no change to the tightening torque. Old and new bolts are interchangeable, but it is inadvisable to mix old and new bolts on the same cylinder head, as the thread lengths may differ slightly.
3. Fit the camshafts sprockets (Section 'E.8') and camshafts covers (Section 'E.5').
4. Reconnect exhaust manifold, throttle and choke cables, and fuel pipes to carburetters. Refit the brake servo vacuum hose, radiator top hose, water temperature gauge sender unit and the heater hose. Refit the carburetters air box.
5. Finally, refill the cooling system.

E.11. - VALVES

To Remove

1. Remove the cylinder head (Section 'E.10') and the camshafts (Section 'E.9').
2. Remove the cam followers and the adjusting shims (Section 'E.7').
3. Using a valve spring compressor, compress the valve springs and extract the split collets, valve spring retainer, valve springs and spring seat from each valve.
4. Remove the valve.

To Replace

1. Lightly lubricate the stem of the valve and insert into its guide.
2. Fit spring seat, valve springs, valve spring retainer. Place the valve spring compressor in position and compress the valve springs sufficiently to fit the split collets. Remove the valve spring compressor.
3. Replace the cylinder head (Section 'E.10') followed by the camshafts (Section 'E.9').
4. Check the valve clearances (Section 'E.7') and finally fit the camshafts sprockets (Section 'E.8') and the camshafts cover (Section 'E.5').

E.12. - DECARBONISE CYLINDER HEAD AND PISTONS

1. Remove carburettors (see Section 'L').
2. Remove cylinder head (Section 'E.10').
3. Remove the valves (Section 'E.11').
4. Using a suitable implement (such as a blunt scraper), remove all carbon deposits from cylinder head faces, inlet and exhaust ports, piston crowns and valve heads. A ring of carbon should be left around the periphery of each piston crown. The top of the cylinder bores should NOT be touched. It is important to note that loosened carbon is not left where it can contaminate any parts of the engine.
5. Clean each valve thoroughly and carefully examine for pitting. Valves in a pitted condition should be refaced with a suitable grinder or new valves should be fitted. Stamp any new valve with the number of the port to which it is fitted. If the valve seats show any signs of pitting or unevenness they should be trued by the use of service cutting tools. When using a cutting tool take care to remove only as much metal as is necessary to ensure a true surface. The removal of too much metal could cause the spring retainer to foul the cam follower.
6. When grinding a valve onto its seating the valve should be smeared lightly with fine or medium carborundum paste and then lapped in with a suction grinder. Avoid the use of excessive quantities of grinding paste and see that it remains in the region of the valve seating only. A light coil spring placed under the valve head will assist considerably in the process of grinding. The valve should be ground to its seat with a semi-rotary motion and occasionally allowed to rise by the pressure of the light coil spring. This assists in spreading the paste evenly over the valve face and seat. It is necessary to carry out the grinding operation until a dull, even, matt surface free from blemishes is produced on the valve seat and valve face. On completion, the valve seats and ports should be cleaned with a rag soaked in paraffin, dried, and then thoroughly cleansed by compressed air. The valves should be washed in paraffin and all traces of grinding paste removed. Check that no grinding paste has entered the valve guides.
7. Re-assemble the valves to the cylinder head (Section 'E.11').
8. Refit cylinder head (Section 'E.10') and carburettors (see Section 'L').

E.13. - VALVE SEAT INSERTSTo Remove

1. Remove the cylinder head (Section 'E.10') and dismantle as for decarbonising (Section 'E.12').
2. Remove valve seat inserts by inserting a suitable sharp chisel through the port and carefully locating its cutting edge between the base of the insert and the alloy material of the head. The chisel may then be tapped deftly with a hammer. Further similar attempts to dislodge the insert should be made round the periphery of the insert where access is possible. Ensure that the recesses in the cylinder head are ENTIRELY FREE of foreign matter, otherwise the new insert will NOT seat fully in its recess.

To Replace

Valve seat inserts are available in standard and up to .015 (.381 mm.) oversize (see Service Parts List).

1. Heat the whole cylinder head to a temperature NOT EXCEEDING 200° C. (392° F.) and freeze the insert with 'dry ice' to a temperature NOT LESS THAN -80° F. (-112° F.).
2. Press the insert into place using a suitable replacer tool, ensuring that the seat face is towards the combustion chamber. Allow the cylinder head to cool naturally in the air.
3. Rebuild (Section 'E.12') and refit the cylinder head (Section 'E.10').

E.14. - VALVE GUIDESTo Remove

1. Remove the cylinder head (Section 'E.10') and dismantle (Section 'E.12').
2. Remove the valve guide with a suitable drift, knocking upwards into the cam follower bore after heating the cylinder head to 100/150° C. (212/303° F.).

To Replace

Valve guides are available in standard and up to .006 in. (.152 mm.) oversize (see Service Parts List).

1. Heat the cylinder head to 100/150° C. (212/303° F.), locate a new circlip on the new guide and press the guide into its bore until the circlip seats completely in its recess. Care must be taken that the guides are NOT driven beyond this point (see 'Technical Data').

2. Recut the valve seat to ensure that it is concentric with the valve stem bore.
Ream the guide AFTER fitting to the dimension given in 'Technical Data'.
3. Rebuild (Section 'E.12') and refit the cylinder head (Section 'E.10').

E.15. - CAM FOLLOWER SLEEVES

To Remove

1. Cam follower sleeves have been fitted from Engine No. LP 1576. If it is desired to fit them to earlier engines, reference should be made to Fig.13.
2. Remove the cylinder head (Section 'E.10') and dismantle (Section 'E.12').
3. Remove the cam follower sleeve by cutting a groove adjacent to each scallop, taking care that the cylinder head is not damaged. Using a suitable sharp chisel, remove the sleeve from its location, again taking care not to damage the cylinder head.

To Replace

1. Heat the whole cylinder head to 150° C. (302° F.).
2. Press the sleeve into place using a suitable replacing tool, and machine to the dimensions given in 'Technical Data'. Recut the scallops.
3. Rebuild (Section 'E.12') and refit the cylinder head (Section 'E.10').

E.16. - OIL SUMP

To Remove

1. Using a suitable receptacle release the drain plug and allow the sump to drain.
2. Release the setscrews from around the periphery of the sump, noting that the rearmost pair are slightly longer, and remove the sump.
3. Thoroughly remove any accumulated sludge from the sump before refitting.

To Replace

1. When refitting use a suitable jointing compound on each gasket face before bringing into contact with the sump.

E.17. - MAIN BEARINGS

To Remove

1. Remove the oil sump (Section 'E.16').
2. Mark each main bearing cap (if not already marked) with a similar mark on the cylinder block adjacent to the crankshaft, so that each cap when refitted will be in its original position.
3. Remove No.1 (from radiator end) main bearing cap, and release the upper shell

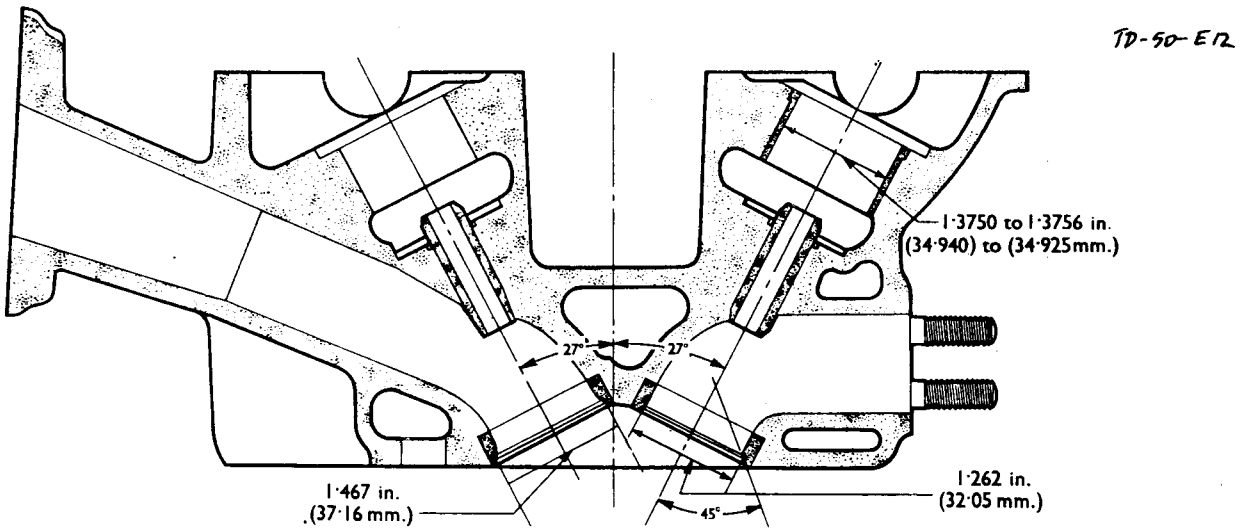


Fig. 12. VALVE SEAT INSERTS, VALVE GUIDES & VALVE FOLLOWER SLEEVE

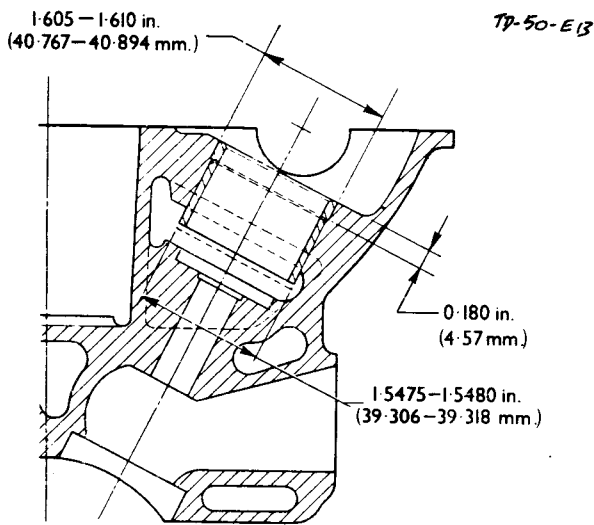


Fig. 13. DIMENSIONS FOR SLEEVE

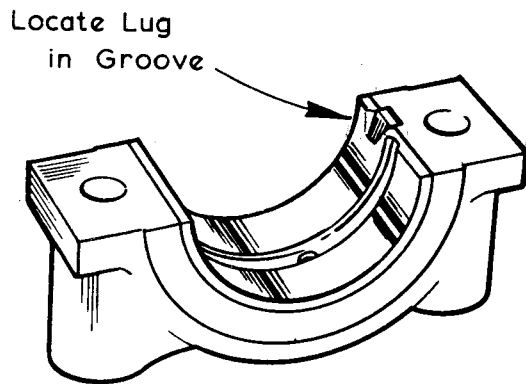


Fig. 14. MAIN BEARING SHELL AND CAP

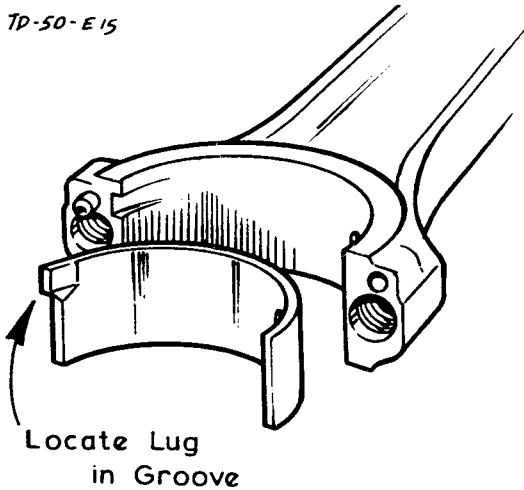


Fig. 15. CONNECTING ROD AND SHELL

bearing from the cylinder block by pushing out, revolving the crankshaft at the same time. Release the lower shell bearing from the cap by lifting out.

To Replace

1. Fit new bearings by reversing the dismantling procedure and refit No.1 bearing cap. Tighten the retaining bolts to the torque loading given in 'Technical Data'.
2. Renew remaining main bearing liners in sequence, tightening each bearing cap to its correct torque loading BEFORE releasing the next one in sequence.

E.18. - CONNECTING ROD BEARINGS

To Remove

1. Remove the oil sump (Section 'E.16').
2. Commencing with No.1 (from radiator end) connecting rod, turn the crankshaft to facilitate removal of cap and mark cap and rod.
3. Release the big-end bolts by two or three turns, and tap them to release the cap. Fully unscrew the bolts and remove the cap.
4. Remove the upper and lower big-end bearing liner from the connecting rod and the lower bearing liner from the connecting rod cap.

To Replace

1. Replace the upper and lower big-end bearing liners in their appropriate locations.
2. Fit the cap to the connecting rod and tighten the bolts to the torque loading given in 'Technical Data'.
3. Renew the big-end bearing liners by repeating the above operation.

E.19. - PISTONS, PISTON RINGS AND CONNECTING RODS

To Remove

1. Remove the cylinder head (Section 'E.10') and the oil sump (Section 'E.16').
2. Release the big-end bolts by two or three turns, and tap them to release the cap. Fully unscrew the bolts and remove the cap. Push the piston out of the bore and remove the assembly to a bench.
3. Remove the piston rings. Extract the gudgeon pin circlips and push the pin out of the piston. Separate the piston and the connecting rod.

To Replace

1. Select the new piston of the appropriate grade required (see 'Technical Data').
2. Fit the piston rings, oil control first, followed by the lower then the upper compression rings. Ensure that the rings are fitted the correct way up.

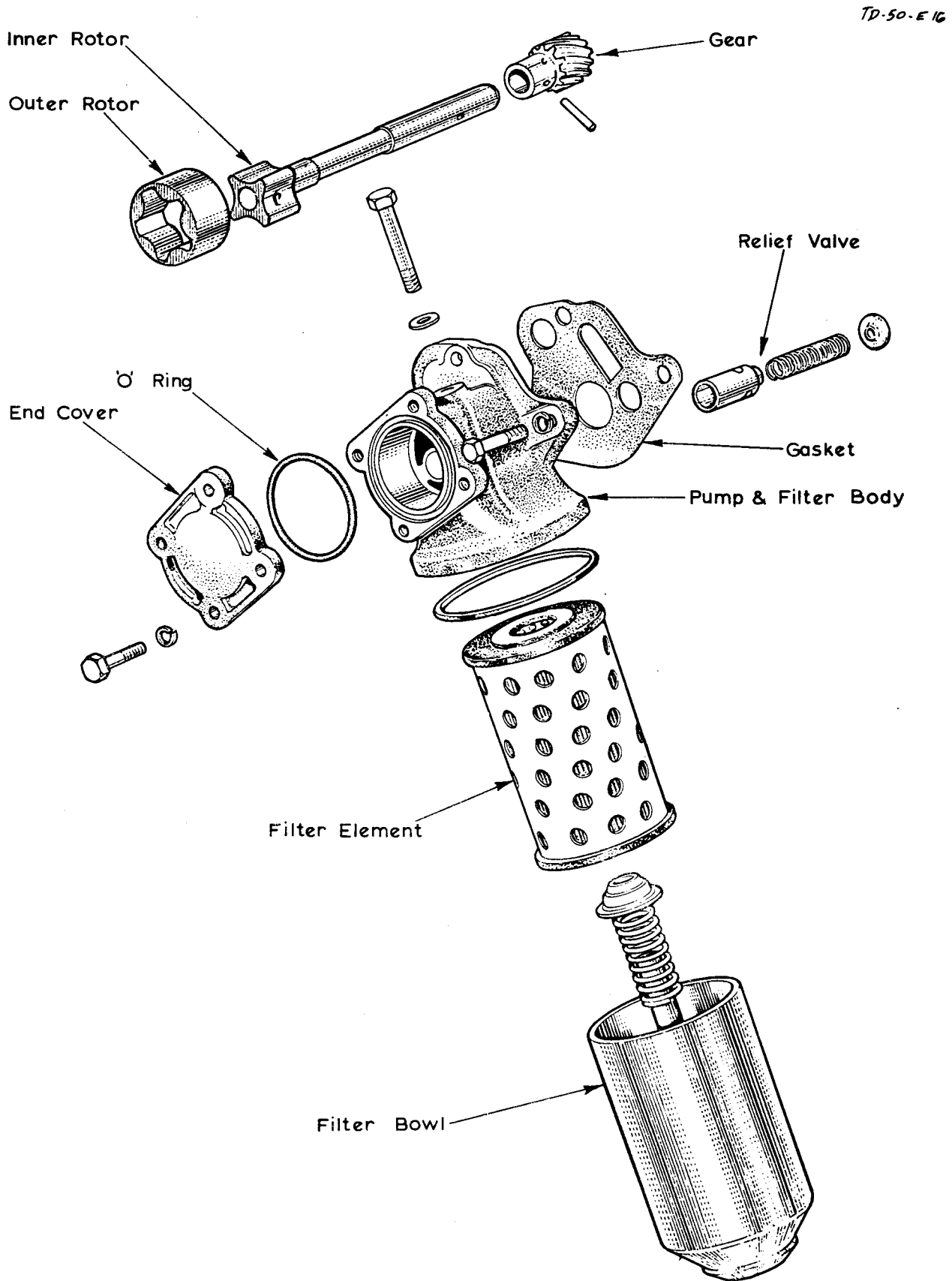


Fig. 16. LUBRICATING OIL PUMP & FILTER COMPONENTS

3. Assemble the piston to the connecting rod, ensuring that the 'front' marking on both parts are on the same side. Heat the piston in water to enable the gudgeon pin to be fitted. Retain the pin with new circlips.
4. Position the oil control ring gap to the rear and the two compression ring gaps to 120° on either side of this. Compress the rings using a suitable piston ring compressing tool and push the piston assembly into its bore with the 'front' mark on the piston towards the front of the engine.
Turn the crankshaft as necessary to fit the connecting rod big-end to the crank pin. Tighten all bolts to the torque loading figures given in 'Technical Data'.
5. Refit the oil sump (Section 'E.16') and the cylinder head (Section 'E.10').

Oil Control Rings

Oil control rings are recommended where oil consumption is excessive (more than 1 pint in 250 miles; 1 litre in 700 kilometres). The rings are available under:-

Part No. 26 E 6003 Standard bore

Part No. 26 E 6004 .015 in. oversize bore

The procedure for fitting the rings is as follows:-

1. Remove the pistons and measure the cylinder bores for wear. If more than .003 in. (.0762 mm.) wear has taken place, the cylinder block **MUST** be bored to .015 in. (.381 mm.) oversize and new pistons fitted. If the engine is already bored .015 in. (.381 mm.) oversize and **MORE** than .003 in. (.0762 mm.) wear is evident, a new cylinder block is required.
2. The new type oil control rings consist of an expander ring and two steel rails which are fitted above and below the expander ring. They **MUST** always be fitted **BEFORE** the compression rings are replaced, working from the piston crown downwards. They **CANNOT** be fitted with a ring compressing tool.
3. Fit the expander ring on the piston, ensuring that the coloured ends are butting.
4. Fit one end of a steel rail into the groove below the expander ring holding the rail end with a thumb, whilst easing the rail over the piston and into its location.
5. Repeat '4' to fit the other steel rail above the expander ring.
6. Position the lower steel rail gap 1 in. (25 mm.) to the **LEFT** of the expander ring gap and the upper steel rail gap, 1 in. (25 mm.) to the **RIGHT** of the expander ring gap. The gaps to piston relationship is immaterial.

Running-in: If oil control rings only have been fitted, a running-in distance of 100 miles (160 km.) is sufficient. If the bores have been honed because new compression rings were fitted in conjunction with oil control rings, then the running-in distance **MUST** be extended to 500 miles (800 km.) Where reboring and fitting of new pistons was required, the running-in period must extend progressively during the **FIRST 1,000 miles (1,600 km.), NOT EXCEEDING 3,000 r.p.m.** in any gear during this period.

E.20. - CRANKSHAFT PULLEY

To Remove

1. Slacken the generator mounting bolts, push the generator towards the engine and remove the fan belt.
2. Release the central retaining bolt and, using a suitable puller, remove the crankshaft pulley.

To Replace

1. Replace the pulley aligning its slot with the crankshaft key. Tighten the retaining bolt to the torque loading given in 'Technical Data'.
2. Replace the fan belt and adjust to the specified tension.

E.21. - OIL PUMP AND OIL FILTER

1. Release the three securing setscrews and remove the pump and filter as an assembly.

To Dismantle

(All clearances are given in 'Technical Data').

1. Remove the filter body and element and extract the sealing ring from the groove.
2. Remove the end plate and withdraw the 'O' ring from the groove in the pump body.
3. Check the clearance between the lobes of the inner and outer rotors. The rotors are supplied as a matched pair only, so that if clearance is excessive a new rotor pair must be fitted.
4. Check the clearance between the outer rotor and the housing. If clearance between the outer rotor and pump body is excessive a new rotor assembly and/or pump body should be fitted.
5. Place a straight edge across the face of the pump body and check the clearance between the face of the rotors and the straight edge. If this clearance is excessive the face of the pump body can be carefully lapped on a flat surface.

6. If it is necessary to renew the rotor or drive shaft, remove the outer rotor, then drive out the retaining pin securing the skew gear to the drive shaft and pull off the gear. Withdraw the inner rotor and drive shaft.

To Reassemble

1. If the pump has been completely dismantled, fit the inner rotor and drive shaft assembly to the pump body. Press the skew gear (if undamaged) onto the drive shaft end supporting the shaft, at the rotor end, on a suitable spacer. Replace the gear retaining pin and peen over the ends securely.
2. Install the outer rotor with its chamfered face inwards, towards the pump body.
3. Place the 'O' ring in the groove in the pump body and fit the end plate with the machined face towards the rotors.
4. Locate a new filter body sealing ring in the groove and fit the filter assembly to the oil pump. Fit a new aluminium washer to the centre bolt and tighten to the torque loading given in 'Technical Data'.

To Replace

1. Place a new gasket on the pump mounting flange, and fit pump filter as an assembly. Tighten the three securing bolts to the torque loading given in 'Technical Data'.

E.22. - FRONT (TIMING) COVER OIL SEALTo Remove

1. Drain the cooling system, disconnect the radiator hoses and remove radiator (see Section 'K').
2. Remove the cylinder head (section 'E.10').
3. Remove the fanbelt, followed by the fan and water pump pulley (see Section 'K').
4. Remove the crankshaft pulley (Section 'E.20'), the sump (Section 'E.16') and the timing chain tension adjuster (Section 'E.6').
5. Remove the front cover by extracting all forward facing bolts, of which there are eleven, and the three bolts which secure the front cover to the cylinder head.
6. Remove the crankshaft oil slinger.
7. Disconnect the timing chain taking care not to rotate the camshafts, or the crankshaft, thus alter the valve timing.
8. Remove the jackshaft sprockets.
9. Remove the front cover backplate with its gaskets by extracting the single retaining setscrew immediately below the water pump aperture.

To Replace

(All bolts should be tightened to the torque loading figures given in 'Technical Data').

1. Locate a new gasket on the cylinder head to timing cover joint (section 'E10'). If a new dipstick tube has been fitted, it is important that the vertical height, measured from the lower (to sump) mounting flange to the top centre of the tube equals 4.10 in (105 mm) on 'Mk I' engines up to engine number 7799 and 4.50 in (115 mm) on 'Mk II' engines, from engine number 7800 onwards.
2. The backplate is fitted with a dry paper gasket to the cylinder block and retained by the single clamp screw. Before tightening, assemble timing cover to cylinder block, locating both the water pump insert in the timing cover and the oil seal on the crankshaft. Move timing cover assembly, backplate and gasket to ensure minimum step between oil sump face on timing cover and cylinder block oil sump face, and also between top faces of timing cover and backplate. This step should not exceed .010 in. (0.25 mm.); measure with feeler gauge.
3. Remove timing cover assembly taking care not to move backplate and tighten clamp screw to the torque loading given in 'Technical Data'.
4. Apply a suitable jointing compound to the front cover joint faces and fit the cover. It is important to align the cover and to replace the bolts in their correct locations, tightening to their torque loadings (see 'Technical Data').
5. Refit the timing chain tensioner, tightening its bolt correctly. Refit the sump. Refit the crankshaft pulley. Replace the water pump and fan together with the fan belt, adjusting to its correct tension.
6. Adjust the timing chain tension. Refit the camshaft cover. Replace the radiator, refit top and bottom hoses and refill the cooling system.

E.23. - WATER PUMPTo Remove

1. Remove cylinder head (section E.10) and water pump (section E.23) from the engine.
2. With the front cover on a bench, withdraw the water pump bearing retainer clip from the slot in the housing.
3. Remove the pump pulley hub from the shaft.
4. Press the impeller, seal, slinger, shaft and bearing assembly out of the housing using a suitable press. Press the impeller off the end of the shaft.

Check Clearance Where
Shown by Arrows

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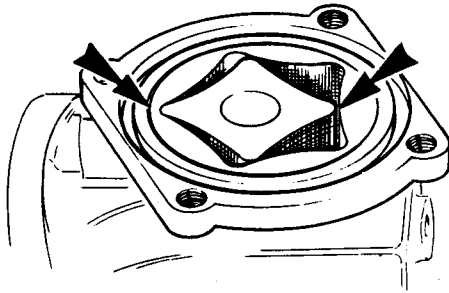


Fig. 17. CHECKING ROTOR SIDE CLEARANCE

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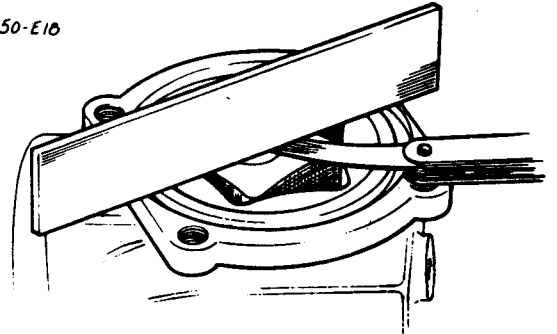
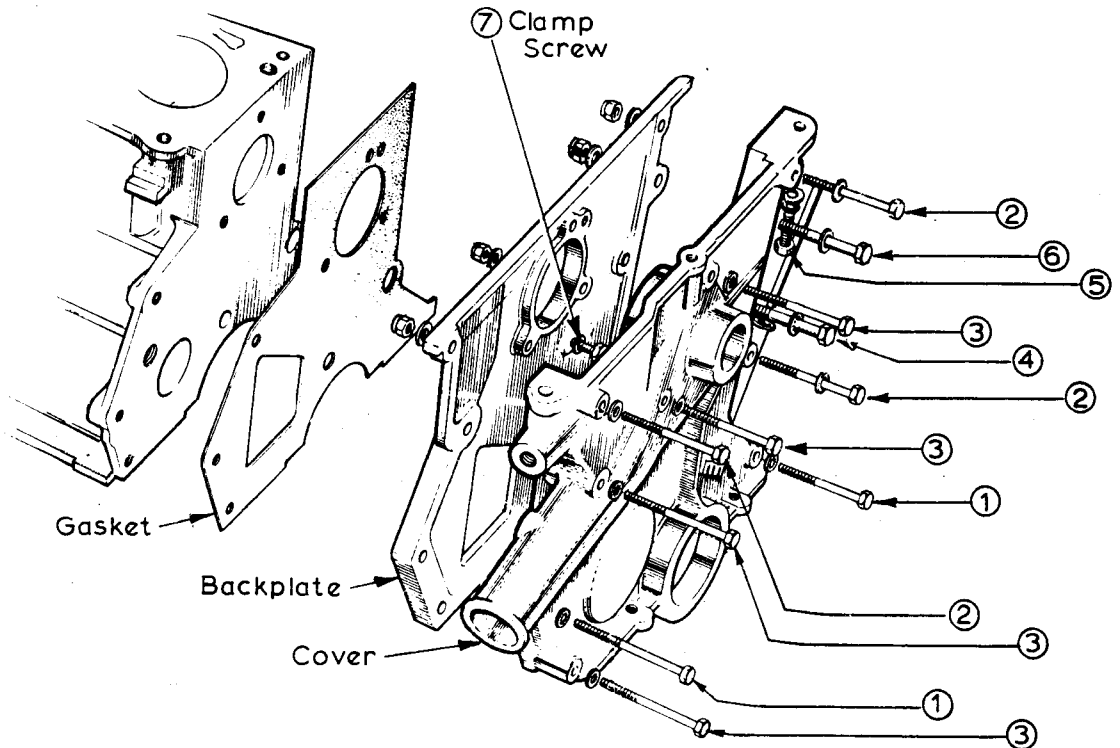


Fig. 18. CHECKING ROTOR FACE CLEARANCE



1. Dowel Bolts $\frac{1}{4}$ in. U.N.C. \times $2\frac{1}{2}$ in. long
2. Bolt $\frac{1}{4}$ in. U.N.F. \times $2\frac{1}{2}$ in. long and nut
3. Bolt $\frac{1}{4}$ in. U.N.C. \times $2\frac{1}{2}$ in. long
4. Bolt $\frac{1}{8}$ in. U.N.C. \times $2\frac{1}{2}$ in. long
5. Bolt $\frac{1}{8}$ in. U.N.C. \times 1 in. long
6. Bolt $\frac{1}{8}$ in. U.N.F. \times $1\frac{1}{2}$ in. long and nut
7. Bolt $\frac{1}{4}$ in. U.N.C. \times $\frac{3}{4}$ in. long

Fig. 19. TIMING CHEST BOLTS

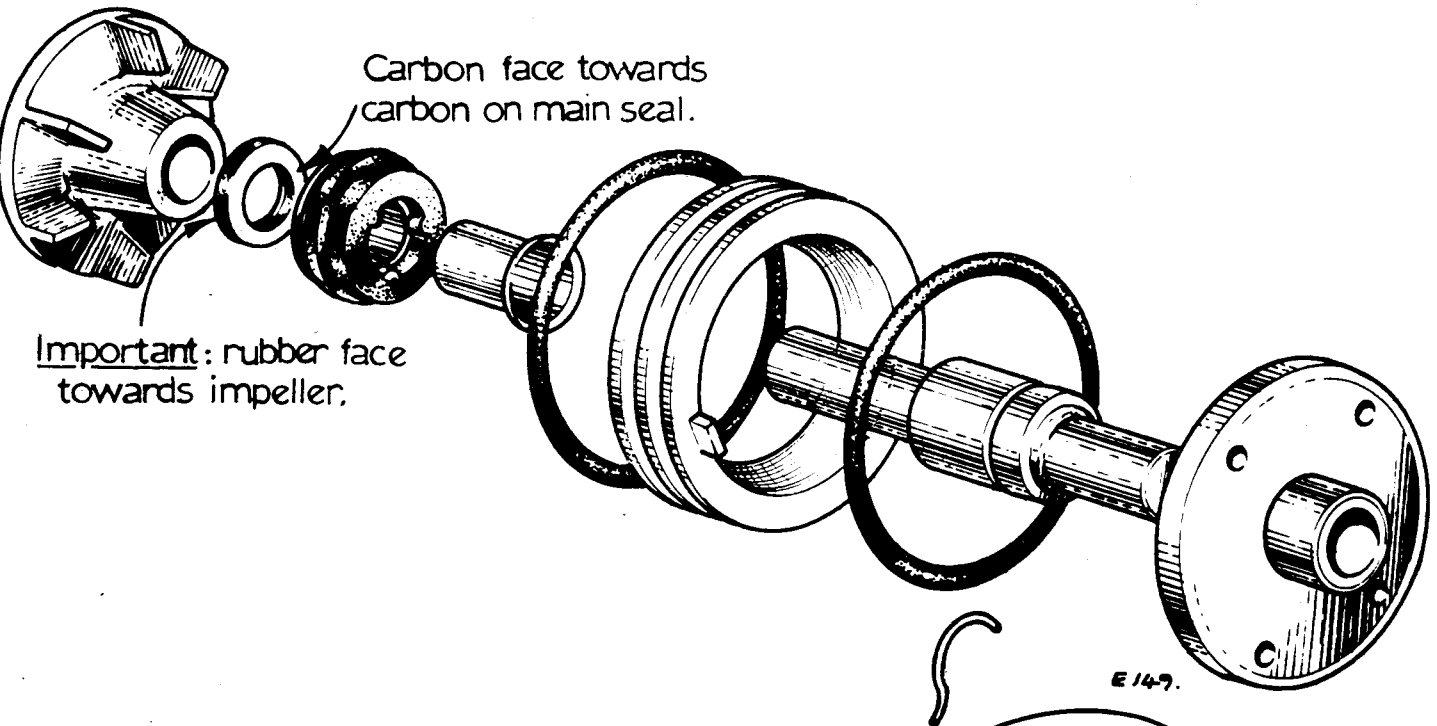


Fig. 20. WATER PUMP INTERNAL COMPONENTS

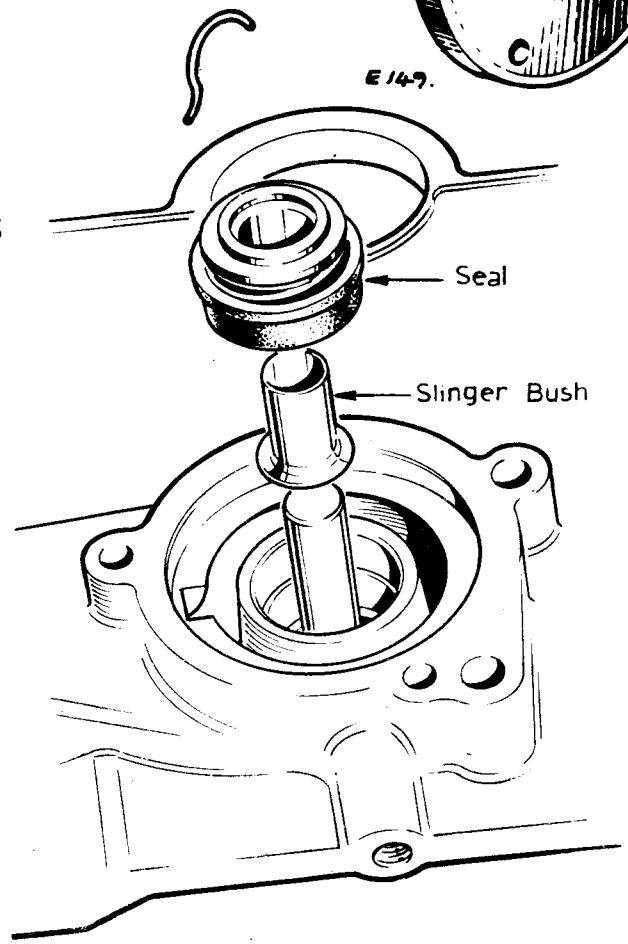


Fig. 21. FITTING WATER PUMP SEAL

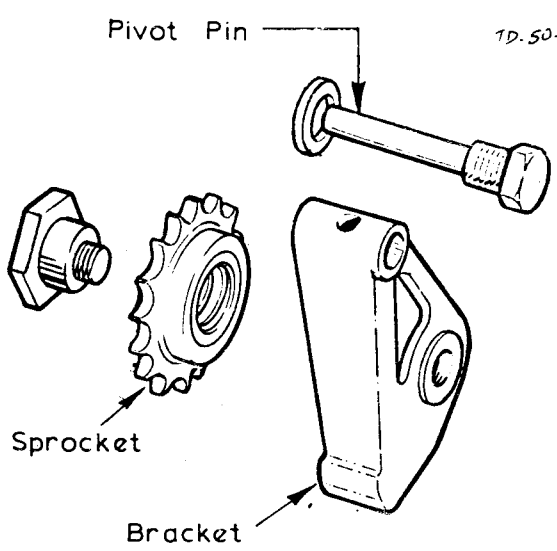


Fig. 22. CHAIN TENSIONER COMPONENTS

5. Remove the pump seal from the shaft.
6. Carefully split the slinger bush with a chisel to detach it from the shaft.
7. Remove the insert from the front cover.

To Replace

1. Press the shaft and bearing assembly into the housing until the groove in the shaft is in line with the groove inside the housing. Fit new bearing retainer clip in the groove of the bearing and housing.
2. Press the pump pulley hub on to the front end of the shaft until the end of the shaft is flush with the end of the hub. Fit new slinger bush (flanged end first) on the rear end of the shaft. Fit new pump seal on the slinger bush with the carbon thrust face towards the impeller, and press into housing.
3. Fit new 'O' rings to insert, fit insert to front cover.
4. Press impeller on to the shaft ensuring that the vanes are not damaged, until the specified clearance given in 'Technical Data' is obtained between the impeller vanes and the insert face.
5. Refit the front cover to the engine.

E.24. - TIMING CHAIN TENSIONER SPROCKETTo Remove

1. Remove the front cover (Section 'E.22') from the engine.
2. Unscrew the sprocket bracket pivot bolt, withdraw bolt and remove bracket.
Unscrew the sprocket pin and remove sprocket.

To Replace

1. Assemble the sprocket to the pin with the boss towards the bracket. Screw the pivot pin into the bracket and tighten to the torque loading given in 'Technical Data'. Stake the threads to prevent loosening.
2. Locate the bracket and insert the pivot bolt. Tighten the bolt to the torque loading given in 'Technical Data'.
3. Replace the front cover (Section 'E.22') and re-adjust timing chain tension (Section 'E.6').

E.25. - ENGINE MOUNTINGS

1. Apply the handbrake, jack-up front of the car and support with chassis stands.
2. Support the engine with a jack.
3. Remove the right-hand engine mounting and replace with new mounting.

4. Repeat the operation (3) for the left-hand mounting, not forgetting to replace the earthing strap.
5. Remove the jack from under the engine, jack-up the front of the car, remove chassis stands and lower car to ground.

E.26. - ENGINE ASSEMBLYTo Remove

1. Remove bonnet (see Section 'B').
2. Disconnect the battery.
3. Drain the cooling system, disconnect the radiator hoses, and remove radiator (see Section 'K').
4. Disconnect the following connections from their attachments on the engine:-
 - a. Water temperature capillary
 - b. Oil pressure pipe
 - c. Generator cables
 - d. Heater hoses at cylinder head and timing cover
 - e. Distributor and HT coil cables
 - f. Starter motor cable
5. Disconnect the brake servo vacuum hose (where fitted), and the headlamps vacuum hose from the rear and front respectively of the cylinder head.
6. Remove the choke and throttle cable. Remove carburetters air box and air trunking. Release the screws (or nuts) securing the down pipe to the exhaust manifold, release the lower fixing and remove the down pipe from the car.
7. Release the clip securing the clutch slave cylinder and pull cylinder away from its location with the fluid pipe still attached. Remove starter motor. Remove fuel feed pipe from fuel pump.
8. Fit a sling and support the engine on suitable tackle.
9. Unscrew the lower clutch housing bolts and remove the cover. Unscrew the clutch housing to the engine bolts. Disconnect the engine mountings (Section 'E.25'). Suitably support the gearbox.
10. Pull the engine unit forward off the mainshaft of the gearbox and lift up and out from the engine compartment.

To Replace

1. Position the engine unit in the engine compartment, and engage the unit on the mainshaft of the gearbox. Ensure that the upper part of the clutch housing is

- located on the dowels. Reconnect the engine mountings. Note that the engine earth strap is attached to the left-hand mounting.
2. Fit the engine to clutch housing securing bolts. Fit the lower clutch housing cover. Remove the sling and lifting tackle and the support beneath the gearbox.
 3. Fit the carburetter air box, air trunking, choke and throttle cables. Refit the starter motor and attach its cables. Refit the clutch slave cylinder.
 4. Refit the exhaust down pipe to the intermediate pipe at its lower end, and to the exhaust manifold at its upper end. The gasket at this joint should be discarded (if fitted) and Holt's 'Firegum' used as a jointing compound.
 5. Re-attach the headlamps vacuum connection to the front of the cylinder head, and the brake servo vacuum hose to the rear of the cylinder head.
 6. Re-attach the distributor and coil cables, the cables to the generator, and the oil pressure pipe and water temperature capillary.
 7. Refit the radiator, reconnect all hoses, close drain taps in engine cylinder block and in radiator, and refill cooling system (see Section 'K').
 8. Fill the engine sump with recommended oil (see Section 'O'), reconnect the battery, start engine and check for leaks. Check and re-adjust the ignition (see Section 'M') and the carburetter slow running (see Section 'L').
 9. Refit the bonnet (see Section 'B').

E.27. - FLYWHEEL AND RING GEAR

To Remove

1. Remove the engine from the car (Section 'E.26'), and mount the engine on a suitable stand.
2. Unscrew the bolts around the periphery of the clutch assembly and remove clutch from flywheel.
3. Release the six bolts and remove the flywheel. Four bolts were used up to Engine No. LP 7799.
4. Cut between two adjacent teeth on the ring gear with a hacksaw and split the gear with a chisel.

NOTE: Under no circumstances must pressure be applied in attempting to remove the gear for re-positioning on the flywheel.

To Replace

1. Heat the new ring gear evenly, to a temperature NOT EXCEEDING 600° F. (316° C)

Do NOT heat beyond this point otherwise the wear resistance properties of the gear will be destroyed. Fit the gear to the flywheel with the chamfers on the leading faces of the teeth relative to the normal direction of rotation. Allow the ring gear to cool naturally in the air. DO NOT QUENCH.

2. Locate the flywheel squarely upon the crankshaft flange, insert the securing bolts and tighten to the torque loading given in 'Technical Data'.
3. Check the flywheel run-out using a proprietary dial gauge. The total run-out should NOT EXCEED the dimension given in 'Technical Data'.
4. Refit the clutch assembly, centralising the driven plate with a dummy gearbox mainshaft. Tighten the bolts to the torque loading given in 'Technical Data'.
5. Remove the engine from the stand and replace into car (Section 'E.26').

E.28. - CRANKSHAFT SPROCKET

To Remove

1. Remove the engine from the car (Section 'E.26') and mount the engine on a suitable stand.
2. Remove the front cover (Section 'E.22').
3. Using a suitable extractor, pull off the crankshaft sprocket.

To Replace

1. Using a new key, press the sprocket on to the crankshaft ensuring that the slot is lined up with the key, and that the long boss is towards the main bearing journal.
2. Refit the front cover.
3. Refit the engine into the car.

E.29. - CRANKSHAFT REAR OIL SEAL

To Remove

1. Remove the engine from the car (Section 'E.26') and mount on a suitable stand.
2. Remove the flywheel (Section 'E.27') and the oil sump (Section 'E.16').
3. Extract the retaining bolts and remove the rear oil seal carrier from its location on the cylinder block.
4. Using an extractor, remove the oil seal from its carrier.

To Replace

1. Fit a new oil seal to the oil seal carrier. (From Engine No. LP 7799 new one-piece seals have been used).
2. Locate a new gasket on the rear oil seal carrier using a suitable jointing compound, insert the retaining bolts, and locate carrier squarely on the cylinder block before

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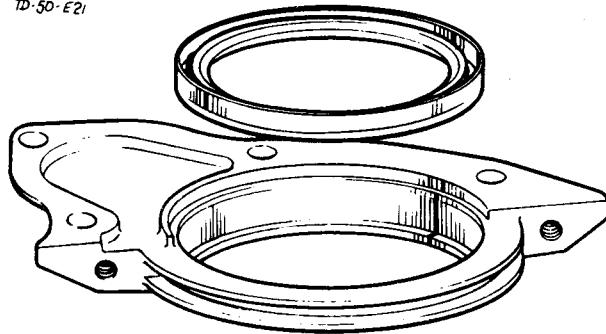
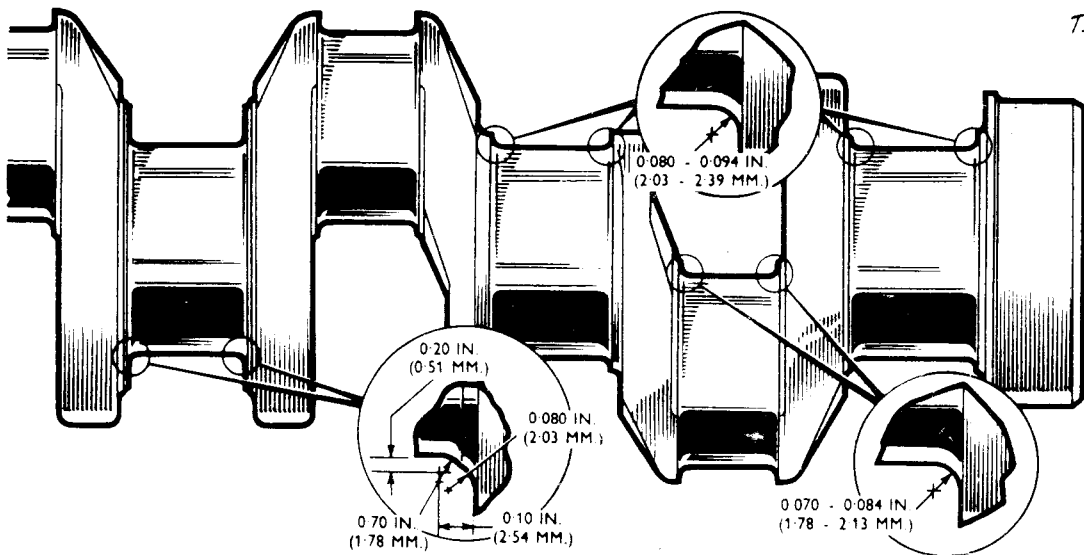


Fig. 23. REAR OIL SEAL & HOUSING
(From Engine No. LP 7799)



TD-50-E22

Fig. 24. CRANKSHAFT FILLET RADII - REGRINDING

tightening to the torque loading given in 'Technical Data'.

3. Refit the flywheel and the oil sump.
4. Refit the engine into the car.

E.30. - CRANKSHAFT

To Remove

1. Remove the engine from the car (Section 'E.26') and mount on a suitable stand.
2. Remove the camshafts cover (Section 'E.5').
3. Set the valve timing marks in the timed position (Section 'E.8') then remove the crankshaft pulley (Section 'E.20').
4. Remove the front cover (Section 'E.22'), crankshaft sprocket, (Section 'E.28'), flywheel (Section 'E.27'), oil sump (Section 'E.16'), release the timing chain tensioner (Section 'E.6'), disconnect the timing chain (Section 'E.8'), and remove the rear oil seal carrier (Section 'E.29').
5. Unscrew the connecting rod bearing cap bolts (the big-ends) two or three turns, and tap them to release the caps. Completely remove the bolts and release the caps. Push the pistons up into the cylinder bores.
6. Remove the main bearing cap bolts evenly and lift off each cap. Lift out the crankshaft and remove the bearing liners and thrust washers.
7. If a reground crankshaft is being fitted, it is important that the existing fillet radius between journals and webs MUST be maintained. These measurements are:-

Crankpin journals	.070/.084 in. (1.77/2.13 mm.)
Main bearing journals	.080/.094 in. (2.03/2.38 mm.)
Centre main bearing journal	- see Fig.22.

To Replace

1. Fit the appropriate clutch spigot bearing into the crankshaft (see also Section 'E.34').
2. Using a new key, fit the crankshaft sprocket.
3. Fit new main bearing liners and replace crankshaft. Fit new crankshaft thrust washers with the oil grooves towards the crankshaft flange. Refit the main bearing caps (Section 'E.17'). Check the crankshaft end float between the crankshaft and the thrust washers. This should be given in 'Technical Data'.
4. Using new bearing liners, refit the connecting rods to the crankshaft (Section 'E.19').
5. Refit the rear oil seal carrier, reconnect the timing chain and re-adjust the tension, refit the oil sump, flywheel, front cover, and the crankshaft pulley.

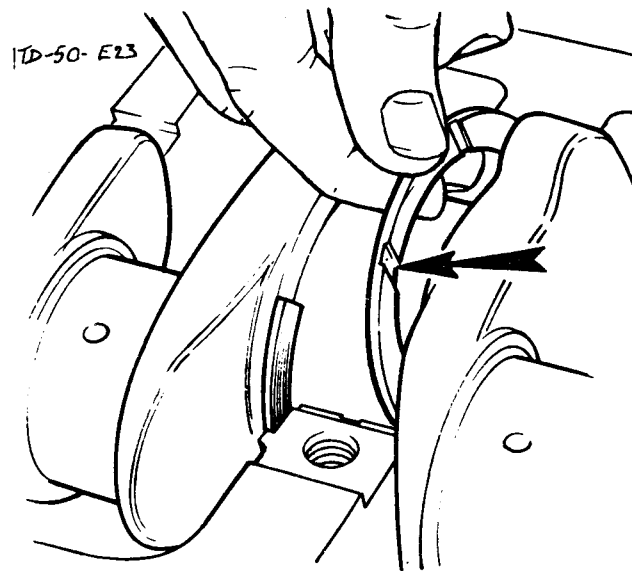


Fig. 25. FITTING THRUST WASHERS

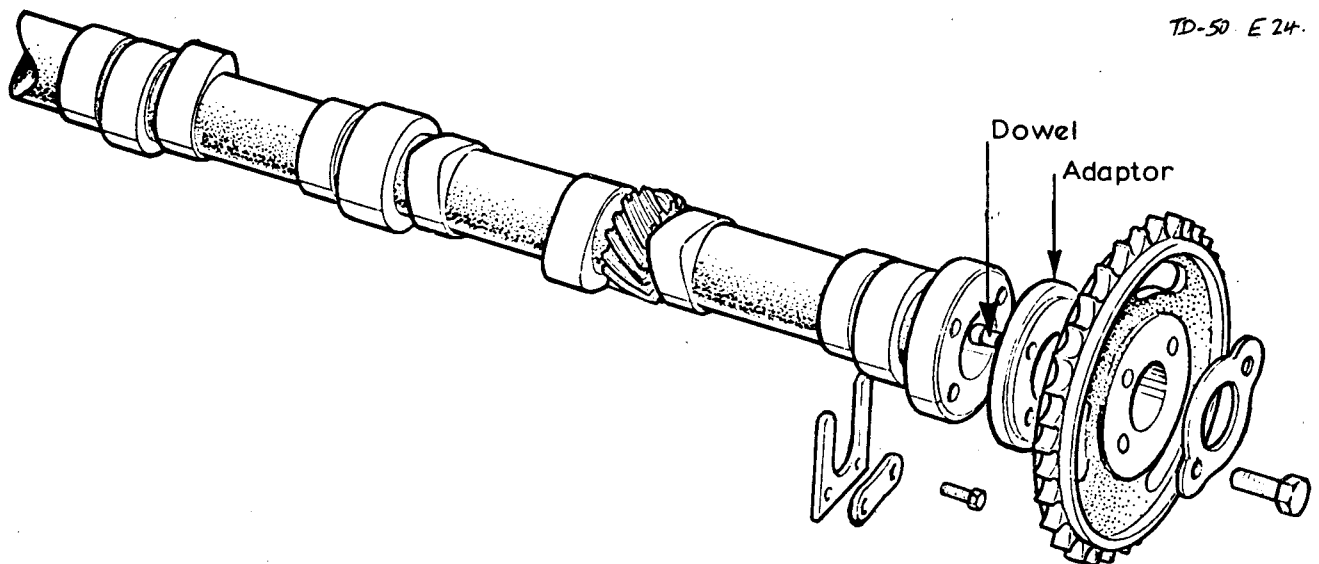


Fig. 26. JACKSHAFT COMPONENTS

6. Recheck the valve timing and fit camshafts cover.
7. Refit the engine into the car.

E.31. - JACKSHAFT AND BEARINGS

To Remove

1. Remove the engine from the car (Section 'E.26') and mount on a suitable stand.
2. Remove the camshafts cover (Section 'E.5').
3. Set the valve timing marks (Section 'E.8'), release the timing chain tension (Section 'E.6'), remove crankshaft pulley (Section 'E.20'), disconnect timing chain (Section 'E.8'), remove oil pump filter assembly (Section 'E.21'), the ignition distributor (Section 'M') and the fuel pump (Section 'L').
4. Remove the jackshaft sprocket and spacer by releasing its securing setscrews, after turning down the locking plate tabs.
5. Remove the jackshafts thrust plate by turning down the locking tabs, then releasing the two setscrews. Withdraw the jackshaft.
6. If it is desired to renew the jackshaft bearing bushes, then use of a special tool for their removal and replacement is essential (Section 'E.35'). Remove the bushes using Tool No. P.6031 with adaptors Tool No. P 6031-3.

To Replace

1. Check all oilways in the cylinder block to see that they are clear. Apply a sealing compound to the oil gallery plugs prior to refitting.
2. Fit new jackshaft bushes using Tool No. P 6031 and P.6031-3. Ensure that the oil holes in the bushes and cylinder block are aligned. The splits in the bushes should be upwards and outwards at 45° to the vertical.
3. Fit a new dowel to the new jackshaft, and slide the shaft into position. Using a new locking plate under the heads of the setscrews, fit the thrust plate in its groove on the jackshaft. Tighten bolts to the torque loading given in 'Technical Data'. Check the shaft end-float with feeler blades between the thrust plate and the shaft flange (see 'Technical Data').
4. Replace the jackshaft sprocket and spacer using a new locking plate beneath the heads of the setscrews, tightening to the torque loading given in 'Technical Data'.
5. Replace the fuel pump, ignition distributor, oil pump and filter assembly, reconnect timing chain, replace front cover and crankshaft pulley, re-adjust timing chain tension.
6. Recheck the ignition timing (see Section 'M') and replace camshafts cover.

7. Refit the engine into the car.

E.32. - CYLINDER BLOCK

To Remove

1. Remove the engine from the car (Section 'E.26') and mount on a suitable stand.
2. Completely strip all components from the engine following the procedures given in the previous chapters.
3. Remove the oil pump filter gauze, oil pump inlet tube and oil return pipe.
4. Remove the cylinder block from the stand.

To Replace

1. Mount the new cylinder block on the stand.
2. Fit the oil pump inlet tube and oil return pipe. Press the pipe fully home to the full depth of the counter-bored hole. Measured along the length of the pipe to the flange of the cylinder block this should read 6.5 in. (16.5 cm.) Fit the filter gauze to the oil inlet tube. (Note that this instruction only applies to engines from LP 7464).
3. Rebuild the remainder of the engine by referring to the previous chapters.
4. Refit the engine into the car.

E.33. - REBORING

When reboring the cylinder block to suit oversize pistons, each bore is machined to the actual diameter of the piston to be fitted, plus the specified clearance in the bore. Maximum recommended oversize bore is + .015 in. (.381 mm.).

To Remove

1. Remove engine from car (Section 'E.26'), mount on a suitable stand and completely strip off all components by following procedures given in previous chapters.

To Rebore

1. Rebore cylinder block using proprietary boring equipment and adhering to the manufacturers instructions.

To Replace

1. Rebuild engine and refit into the car by referring to the previous chapters.

E.34. - CLUTCH SPIGOT BEARING

Commencing at Engine No. 18500, a needle roller spigot bearing (36 E 6019) has been fitted in current Production to all engines.

To accommodate this change, the bore in the crankshaft has been increased from:-

.8252/.8264 in. (20.960/20.990 mm.).

to

.8260/.8270 in. (20.980/21.005 mm.)

The crankshaft part number is unchanged (B26 E 330) and there is no immediate identification mark; the crankshaft can only be distinguished by measuring the spigot bearing bore.

If desired, the new bearing can be fitted to existing crankshafts. The diameter of the gearbox mainshaft is unchanged.

The following special tools are required for fitting and removing the bearing (see also Section 'E.35'):-

P.7137 Insertion tool (clutch plate centraliser)

CP.7600/7 Extraction Tool

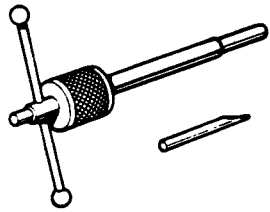


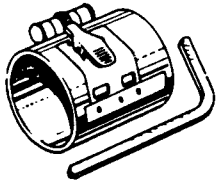
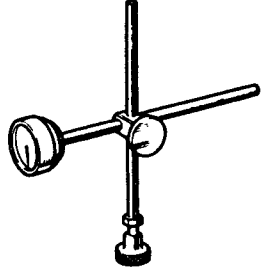
NOTE: The needle roller bearing is pre-packed with grease and requires no further lubrication.

E.35. - SPECIAL TOOLS

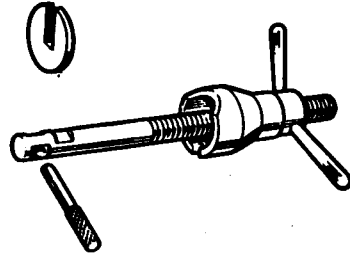
The foregoing sections have all been written without mention of Special Tools, except in the case of jackshaft bearing bushes, where the need for Special Tools is essential for their correct removal and replacement.

If much engine repair work is to be undertaken, it will be found more expedient to use some, if not all, the Special Tools from the following list. These tools have been developed in conjunction with Ford Motor Company Limited and V.L. Churchill Limited from whom they are available. Their address is:-

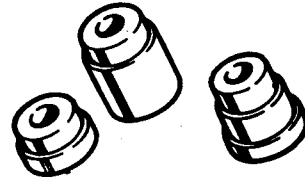
V.L. Churchill & Co. Ltd.,
London Road, Daventry,
Northamptonshire, England.

200A or B	Engine stand	Not illustrated
316X	Valve seat cutter	
316-10	Valve seat cutter pilot	
317-25	Valve seat cutter	
38/U.3	Piston ring compressor	
P.4008	Dial gauge	

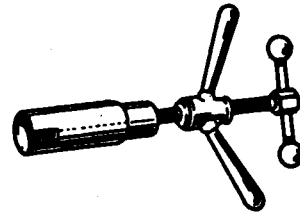
P.6031 Camshaft bearing bush remover/
replacer



P.6031-3 Camshaft bearing remover/replacer
adaptors



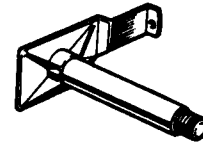
P.6032 Crankshaft sprocket replacer



P.6054 Valve guide remover/replacer

Not illustrated

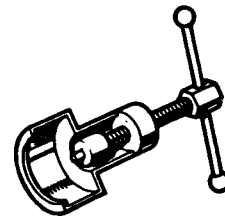
P.6107 Adaptor for engine stand



P.6110 Main bearing liner/remover/
replacer



P.6116 Crankshaft sprocket remover



P.6150 Crankshaft front cover oil seal
aligner



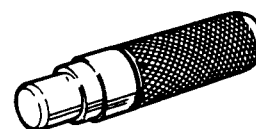
P.6161 Crankshaft front cover oil seal
remover/replacer



P.6165 Crankshaft rear oil seal remover/replacer



P.7137 Clutch plate centraliser



P.8000-4B Water pump overhaul kit

Not illustrated

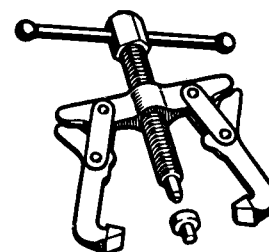
P.80008A Slave ring (use with P.8000-4B)

Not illustrated

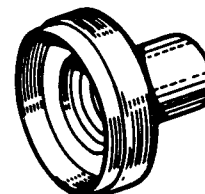
PT.4063A Cylinder head gasket locating studs

Not illustrated

CP.6041 Crankshaft pulley remover



CP.6147 Crankshaft rear oil seal aligner



CP.7600/7 Needle roller spigot bearing (clutch) remover

