SECTION D

THE ENGINE UNIT

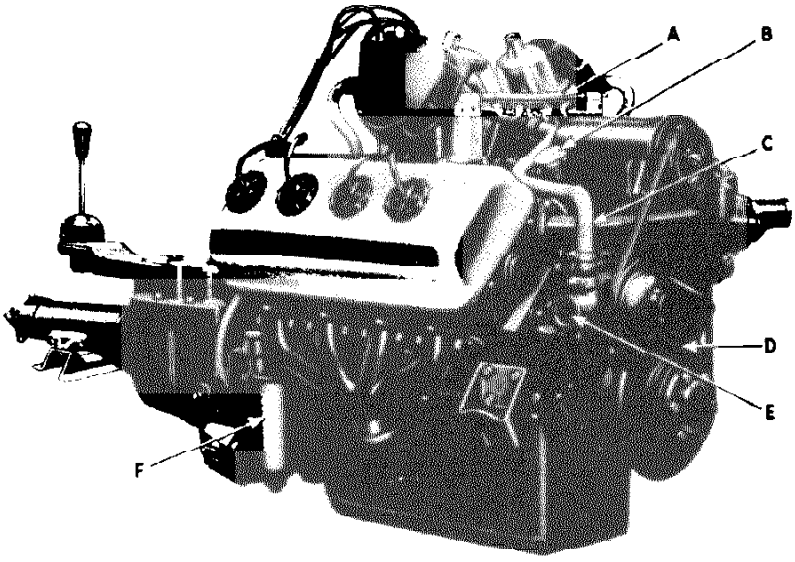

Figure D1.

A. Carburettor petrol interconnection pipe.
B. Engine sump oil filler.
C. By-pass pipe from carburettor mounting.
D. Crankshaft damper.
E. Coolant inlet from radiator.
F. Full flow oil filter.

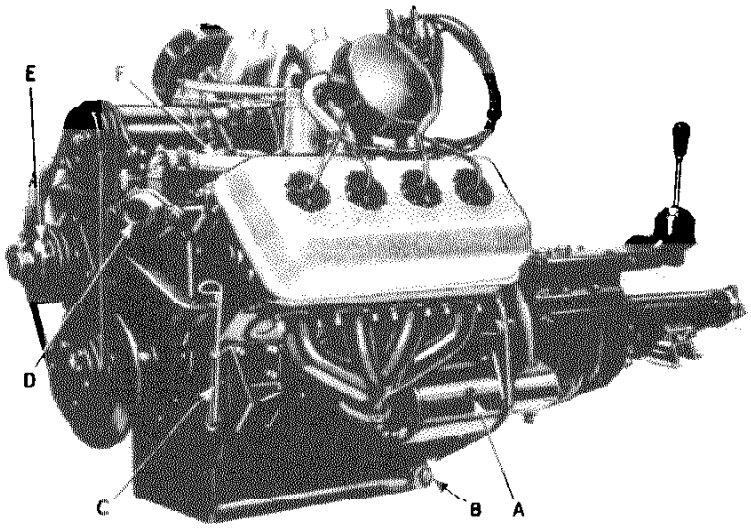

Figure D2

A. Starter motor.
B. Engine sump drain plug.
C. Dipstick.
D. Thermostat housing and coolant outlet to radiator.
E. Coolant pump.
F. By-pass pipe to carburettor mounting.

SECTION D

THE ENGINE UNIT

GENERAL SPECIFICATION

Type	90°Vee Eight, 2½ litre, O.H.V., push rod operated from a chain driven camshaft. Coil ignition. Liquid cooled. Wet sump lubricated. Four point mounted, integral with gearbox.	
R.A.C. Rating	28.80 H.P.	
Bore	3.000"	76.2 mm.
Stroke	2.750"	69.85 mm.
Capacity	152.56 cu. ins.	2.5 litres.
Compression Ratio	8.2 : 1	
Cylinder Disposition	L.H. bank forward of R.H. bank.	
Dry Weight	530 lbs.	240.4 kgs.

PERFORMANCE

Max. B.H.P.	140 @ 5,000 r.p.m.
Max. Torque	155 lbs. ft. @ 3,600 r.p.m. 20.831 kg.m @ 3,600 r.p.m.
B.M.E.P.	150 p.s.i. @ 3,600 r.p.m. 10.55 k.s.m. @ 3,600 r.p.m.
Max. B.H.P./sq.in.piston area	2.48
Max. B.H.P./litre	56
Max. piston speed ft./min.	2658
Max. R.P.M.	5,800
Piston Area	56.6 sq. ins. 365.162 sq. cms.

DESCRIPTION

The Daimler Engine Unit fitted to the SP.250 Sports Car is a 90°Vee Eight having aluminium heads with cast-in inlet and exhaust valve seats, hemispherical shaped combustion chambers and inclined lateral valves. The engine unit with the gearbox attached is mounted in the chassis frame at four points utilizing metal and rubber bonded pads.

The camshaft is mounted centrally in the cylinder block and the space between the camshaft bearings fills with oil to form an oil bath ensuring lubrication of the cam lobes and tappets during the most exacting conditions. The camshaft is driven by a chain, tensioned by a hydraulic chain tensioner and the valves operated by short push rods.

The twin S.U. Carburettors are mounted on a heated inlet manifold designed to keep the ingoing mixture at a constant temperature.

High pressure lubrication, through a full flow oil filter, is provided for the main, crankpin and camshaft bearings; low pressure lubrication for the four valve rocker shaft assemblies and splash for the timing chain, pistons and cylinder walls.

The engine unit is self ventilating, the contaminated gases being consumed by the engine through the carburettor air cleaners.

ROUTINE MAINTENANCE

1. DAILY

   Check the oil level in the engine sump.

2. FIRST 500 MILES (805 Kms.)
   a. Drain and refill engine sump and renew engine oil filter.
   b. Tighten down cylinder head, inlet and exhaust manifolds.
   c. Check engine valve rocker clearances.

3. FIRST 5,000 MILES (8,050 Kms.)

   Decarbonise the engine unit, regrind valves and valve seats.

4. EVERY 5,000 MILES (8,050 Kms.)

   Drain and refill engine sump and renew engine oil filter.

5. EVERY 10,000 MILES(16,100 Kms.)

   Check engine valve rocker clearances.

6. EVERY 15,000 MILES(24,150 Kms.)

   Decarbonise the engine unit, regrind valves and valve seats.

7. EVERY 50,000 MILES(80,500 Kms.)

   Remove and overhaul complete engine unit.

THE CRANKCASE VENTILATION SYSTEM

TYPE

Self ventilating. Rocker covers connected to carburettor air cleaners.

DESCRIPTION. Fig. D5.

Ventilation of the crankcase is effected by connecting the two rocker covers to the two carburettor air cleaners with flexible pipes, thus permitting the contaminated gases to be consumed by the engine. It will be readily appreciated that the crankcase is ventilated immediately the engine is started and does not rely on the movement of the car.

REMOVAL AND REPLACEMENT
ROCKER COVER PIPES Fig. D6.

1. REMOVAL

   Remove the flexible rocker cover pipes from the rocker cover vent pipes and the carburettor air cleaners by slackening the hose clips at each end.

2. REPLACEMENT

   The replacement of the rocker cover pipes is the reversal of the removal sequence; on fitting new pipes ensure that they are the same length as those they replace.

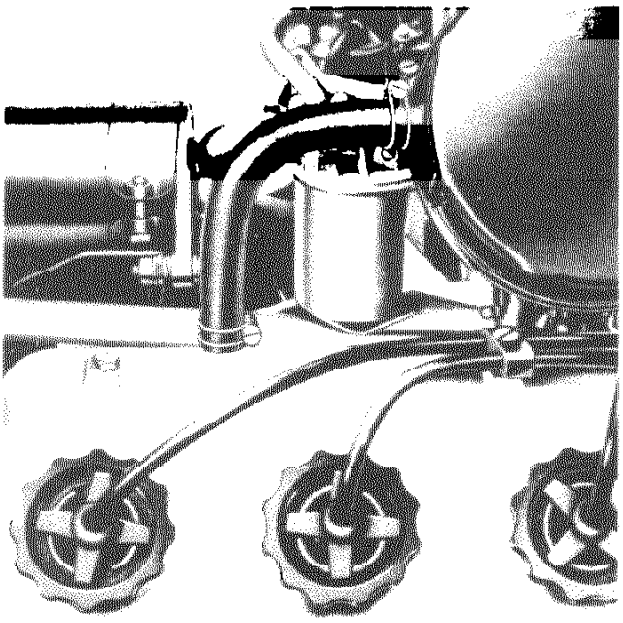

Figure D5

The Flexible Rocker Cover Pipe from Rocker Cover to Carburettor Air Cleaner.

THE ENGINE LUBRICATION SYSTEM

GENERAL

Type	Pressure feed from wet sump.
Oil Pump Type	Twin gear
Oil Pump Drive	From spiral gear at rear end of camshaft.
Main Filter	External, full flow. Expendable cartridge.
Additional Filters	Gauze strainer around oil pump intake at bottom of engine sump.
Oil Level	Measure by blade type dipstick situated at front L.H. corner of engine sump.
Filler Cap and Neck	Situated at front R.H. corner of tappet block.
Drain Plug	Situated in L.H. side of engine sump.

CAPACITIES AND PRESSURES

	English	U.S.A.	Metric
Oil capacity of engine sump and oil filter	12 pints	14½ pts.	6.820 litres.
Idling oil pressure (HOT)	20 p.s.i.	1.406 K.s.Gm.	
Running oil pressure (HOT)	35-45 p.s.i.	2.461-3.164 K.s.Gm.	

DESCRIPTION

The engine lubrication system is of the pressure, filtered type effected by a gear type pump submerged in a wet sump, which is baffled to minimise oil surge when the car is cornering at high speed. Oil is passed through a full flow oil filter by the action of the oil pump into a central gallery running the length of the cylinder block.

Oil at high pressure passes downward through drillings from the central oil gallery to lubricate the main and big end bearings while splash from these bearings lubricates the cylinder bores and piston gudgeon pins. High pressure oil also passes upward through further drillings to lubricate the five camshaft bearings and fills the troughs between these bearings lubricating the

camshaft lobes, tappets, oil pump/ignition distributor drive spiral gears and top bearing before it overflows through transfer holes in the front face of the cylinder block and returns to the engine sump.

An intermittent supply of oil at low pressure passes upward through a cross drilling in the rear camshaft journal through external pipes and matching holes into the four hollow rocker shafts to lubricate the valve operating gear and returns to the engine sump through transfer holes in the front and rear outside corners of the cylinder head and block. To facilitate the interchangeability of the two cylinder head assemblies, both the end faces have oil drillings to the end rocker shaft pedestal mounting faces. The unused oil drillings are blanked off with a bolt when not in use.

The timing chain is lubricated by high pressure oil passing through the slipper head of the hydraulic timing chain tensioner and also by splash from the overflow oil of the camshaft bearings. This oil returns to the engine sump through transfer holes between the front crankshaft bearing cap and the engine sump bridge piece.

LOCATION OF DIPSTICK, OIL FILLER CAP AND ENGINE SUMP DRAIN PLUG
Figs. D6, D7 and D8.

The dipstick is located in the front L.H. corner of the oil sump.

The oil filler cap is located in the front R.H. corner of the tappet block and cover; the cap is attached to the filler neck by a short length of chain for safe keeping.

The engine sump drain plug is located in the L.H. rear corner of the engine sump.

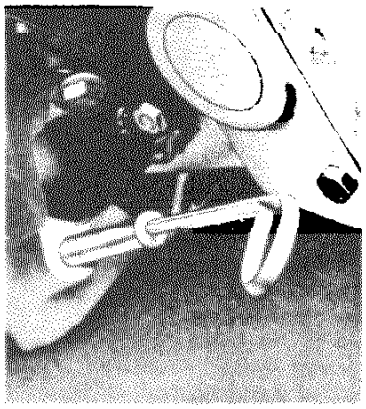

Figure D6

Location of Dipstick.

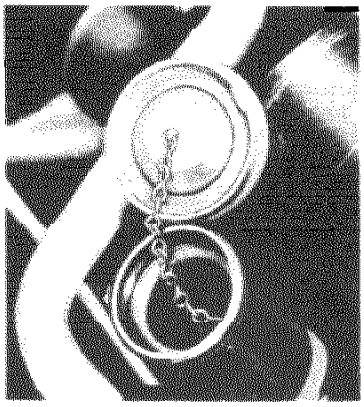

Figure D7

Engine Sump Filler Cap

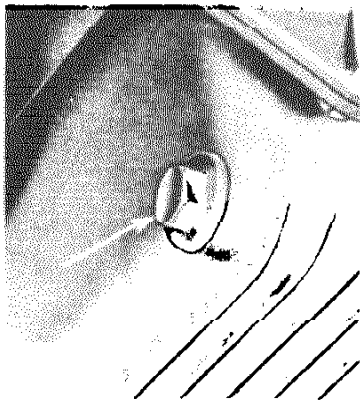

Figure D8

Engine Sump Drain Plug.

CHECKING AND TOPPING UP ENGINE SUMP

A more accurate indication of the oil level in the engine sump will be determined when the engine has been left stationary for some time, for instance overnight, when the oil will have drained into the engine sump and become less aerated.

Have the car standing on level ground, withdraw the engine sump dipstick and wipe it clean. Return it to the engine sump ensuring that it goes right home, and then withdraw it for a second time; observe the "oil wet mark" and return the dipstick to the engine sump.

Remove the oil filler cap and top up with the recommended brand and grade of oil; it should be noted that a little time will elapse before the new engine oil reaches the engine sump. Recheck the oil level and replace the oil filler cap on completion of the operation.

DRAINING AND REFILLING ENGINE SUMP. Fig. D6, D7 and D8

Position the car on level ground, remove the oil filler cap, the engine sump drain plug and allow the used engine oil to drain into a suitable receptacle. Ensure the good condition of the drain plug sealing washer and replace the drain plug.

Exchange the oil filter element as detailed below.

Fill the engine sump with the recommended brand and grade of engine oil. Check the oil level after a short journey, examine the oil filter and engine sump drain plug for leaks and top up when necessary.

THE FULL FLOW OIL FILTER UNIT

DESCRIPTION Fig. D9.

The full flow oil filter unit is situated externally and is attached to the rear R.H. side face of the cylinder block by four bolts.

The filtering element is of the paper type and must be replaced at regular intervals. A by-pass valve incorporated in the oil filter body will open and allow unfiltered oil to lubricate the engine in the event of the filtering element becoming choked. No indication of this event occurring will be given, and the only safeguard is to replace the filter element at the mileage interval specified.

Engine oil flows by the action of the oil pump, through matching holes in the cylinder block, into the oil filter head and is cleaned as it reaches the centre of the oil filter element. It passes upward into the oil filter body and through further matching holes into the main oil gallery.

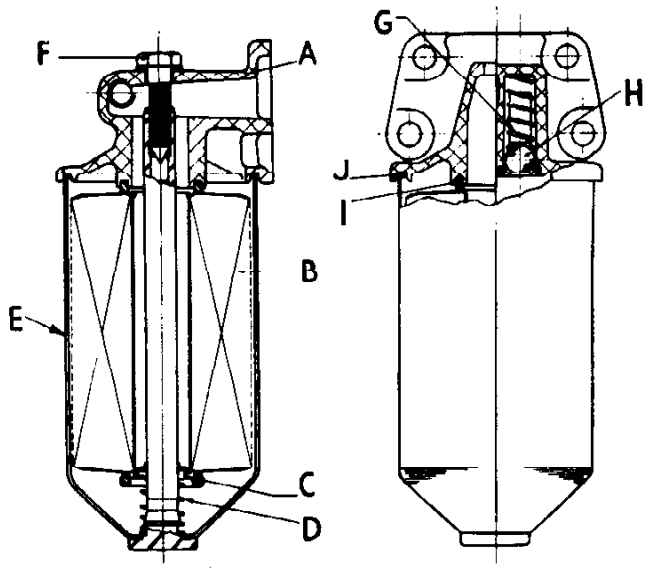

Figure D9. Cross Section Through Full Flow Oil Filter.

A. Oil Filter Body.
B. Filter Element.
C. Rubber Seal.
D. Element Spring.
E. Oil Filter Sump.
F. Centre Bolt.
G. Relief Valve Spring.
H. Relief Valve Ball.
I. Rubber Seal.
J. Large Rubber Ring.

Dependent on the filters condition there is a lower oil pressure on the inside than on the outside of the oil filtering element, and this pressure difference is compensated for by the load of a spring acting upon the inner end of the by-pass valve. It will be appreciated that when oil pressure on the outside of the oil filtering element becomes abnormally high, as when the latter become choked, the by-pass valve will open and allow unfiltered oil to pass directly into the centre of the oil filter body and so into the main oil gallery.

TO CHANGE THE OIL FILTERING ELEMENT Fig. D10.

1. REMOVAL OF FILTER SUMP

Detach the oil filter sump from the underside of the oil filter body situated on the rear R.H. side of the cylinder block, by withdrawing the centre bolt. Withdraw and discard the oil filtering element from inside the filter sump, wash the sump in petrol and dry. Replace the large rubber ring in the underside of the oil filter body with the one accompanying the replacement oil filter element.

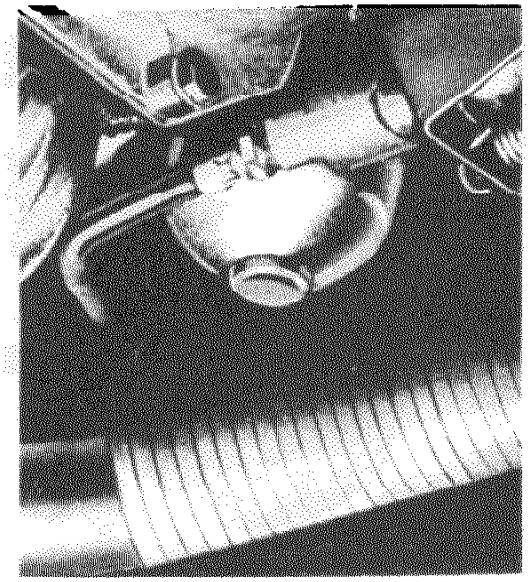

Figure D10
Location of Oil Filter.

2. REPLACEMENT

Insert the oil filter element in the oil filter sump and fill with engine lubricating oil of the same brand and grade as in the engine sump. Fit the oil filter sump to the oil filter body and tighten the centre bolt to effect an oil tight seal.

REMOVAL AND REPLACEMENT
OIL FILTER UNIT

REMOVAL

Remove the oil filter unit from the rear R.H. side of the cylinder block by withdrawing four bolts.

REPLACEMENT

The replacement of the oil filter unit is the reversal of the removal sequence.

THE ENGINE SUMP

DESCRIPTION

The engine sump is an aluminium casting which is finned on its under side to afford the maximum cooling surface. A baffle plate is fitted just above the oil level to reduce oil surge when the car is cornering at high speed.

THE ENGINE SUMP SEALS Figs. D11 and D12.

Interposed between the engine sump bridge piece at the front and the rear bearing cap at the rear end are round cork seals. When the engine unit is being reassembled after an overhaul it is good engineering practice to adhere the cork seals to the engine sump bridge piece and the rear bearing cap.

THE DIPSTICK TUBE

The dipstick tube is a press fit in the front L.H. corner of the engine sump and no useful purpose is served by removing the tube.

REMOVAL AND REPLACEMENT, OIL SUMP Figs. D11 and D12.

1. DRAINING THE ENGINE OIL

Draining the engine oil as detailed on page D6.

2. ENGINE SUMP

Detach the engine sump from the underside of the cylinder block by withdrawing sixteen bolts.

3. REPLACEMENT

The replacement of the engine sump is the reversal of the removal sequence but particular attention must be given to the cork oil seals, one at the engine sump bridge and a second across the rear crankshaft bearing cap.

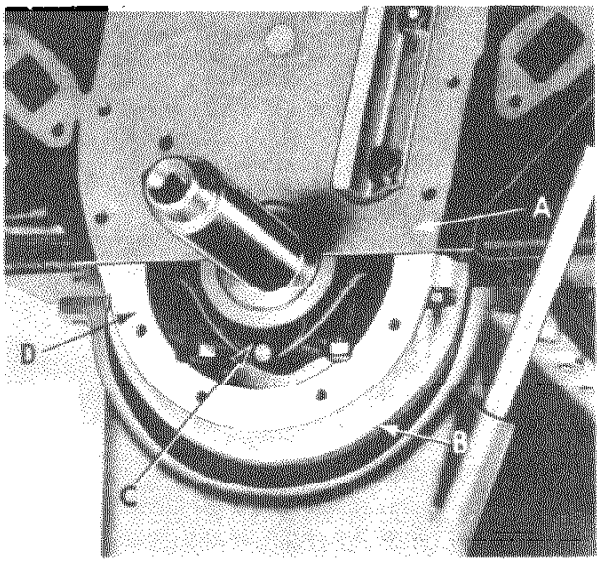

Figure D11 Front Engine Sump Oil Seal.

A. Front Face of Cylinder Block.
D. Cork Seal.
C. Front Crankshaft Bearing Cap.
D. Engine Sump Bridge Piece.

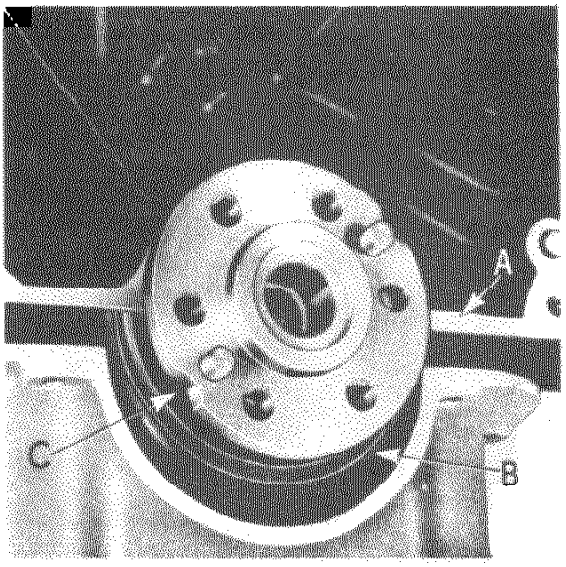

Figure D12 Rear Engine Sump Oil Seal.

A. Rear Face of Cylinder Block.
B. Cork Seal.
C. Rear Bearing Cap.

THE OIL PUMP AND PRESSURE RELIEF VALVE

DESCRIPTION Fig. D13.

The oil pump is of the twin gear self priming type and is attached to the underside of the rear crankshaft bearing cap. These bolts do not effect the security of the bearing cap to the cylinder block.

As the oil pump provides a generous supply of oil under all working conditions, very little wear takes place on the drive or driven gears.

The oil pump is driven by spiral gears from the camshaft by the tongued end of a shaft the top end of which drives the ignition distributor. The driving shaft must only be replaced in accordance with the ignition timing instructions.

A plunger type relief valve is incorporated in the R.H. side of the oil pump body and prevents the oil filter becoming over-loaded by allowing the excess oil to pass back direct into the engine sump. No adjustment is necessary and none is provided.

The driven gear and pin are lubricated by oil from the outside of the gear flowing to its centre by a groove machined in the top face of the oil pump cover.

Oil is drawn from the engine sump through a gauze filter into the front of the oil pump body and is transferred to the rear by the rotation of the driver and driven gears. It flows upward to the oil pressure relief valve and to the R.H. side of the cylinder block through matching holes into the oil filter unit.

When the oil reaches its working pressure, the relief valve plunger maintains a position of float but when it rises too high the plunger moves against the pressure of its spring, uncovers the relief port and the excess oil returns to the engine sump at a point below the baffle plate. A small hole is drilled in the face of the relief valve cap nut and prevents a hydraulic lock in the return spring housing.

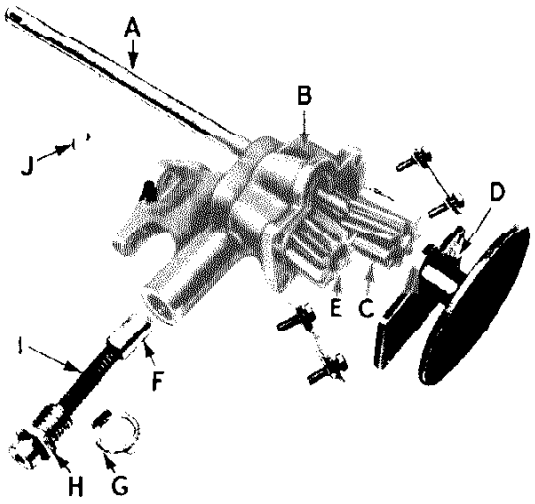

Figure D13.

Oil pump and pressure relief valve assembly.

A. Oil pump drive shaft.
B. Oil pump body.
C. Oil pump driving gear
D. Oil pump cover and strainer.
E. Oil pump driven gear.
F. Oil relief valve plunger.
G. Oil relief valve securing nut lockwasher.
H. Oil relief valve securing nut.
I. Oil relief valve spring.
J. Rubber 'O' ring (fitted between rear crankshaft bearing cap and cylinder block).

REMOVAL AND REPLACEMENT
OIL PRESSURE RELIEF VALVE AND OIL PUMP UNIT

1. ENGINE SUMP

Remove the engine sump from the underside of the engine unit as detailed on page D7.

2. OIL RELIEF VALVE

Withdraw the oil relief valve spring and valve plunger from the housing in the R.H. side of the oil pump body by removing the cap nut.

3. OIL PUMP UNIT

Detach the oil pump unit from the underside face of the rear crankshaft bearing cap by withdrawing three bolts. Remove the oil pump unit by a downward movement.

4. REPLACEMENT

The replacement of the oil pump unit and relief valve is the reversal of the removal sequence, but particular attention must be given to the following points:

(i) That the position of the tongued end of the oil pump driving shaft is observed and the slot of the oil pump drive gear is correctly positioned by turning with a blade of the screwdriver.

(ii) That the the hole in the end face of the relief valve cap nut is unobstructed.

FITTING THE OIL PUMP (New drive shaft. etc.) Fig. D14.

When the oil pump is being fitted after the installation of new bush bearings and/or a new oil pump driving shaft, the following procedure must be adopted.

Before fully tightening the three oil pump securing bolts, insert the oil pump driving shaft to engage the slotted centre of the oil pump driving gear but without the spiral gear when the camshaft is in position. Tighten the three bolts progressively while turning the driving shaft, ensuring that there is no "tight spot". When a "tight spot" is detected the pump securing bolts must be slackened off and the pump body repositioned.

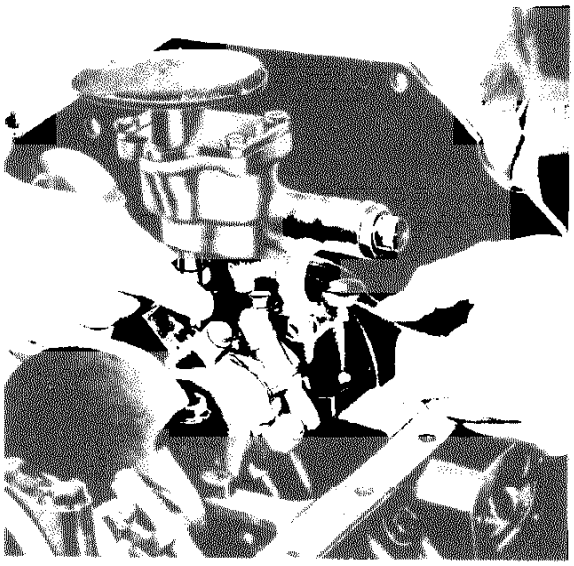

Figure D14.

Securing oil pump and relief valve assembly to underside face of rear crankshaft bearing cap while rotating driving shaft.

OIL PUMP/IGNITION DISTRIBUTOR DRIVING SHAFT

The oil pump/ignition distributor shaft assembly consists of a press fit spiral gear keyed onto the top end of the oil pump driving shaft which has a tongued end locating the oil pump driving gear. To ensure adequate working clearance the oil pump spiral gear, plain end first, is pressed onto the keyed end of the oil pump driving shaft so that the specified length of shaft protrudes.

Unless there is the need to fit a replacement spiral gear or driving shaft no useful purpose is served by dismantling the gear and driving shaft assembly.

REAMING THE OIL PUMP BUSHES

When excessive side play is determined in the oil pump drive shaft, the flanged bush bearing in the rear of the camshaft compartment must be replaced. and it is reasonable to suppose that the driving shaft bush bearing in the oil pump body will also need replacing.

Owing to the abundance of oil at these two bearings very little wear will take place and their replacement can be included in a general engine overhaul for it is necessary to strip the engine unit down as both these bush bearings require reaming after they have been pressed in position.

Press the flanged bush bearing into the top of the cylinder block and the oil pump bush bearing into the oil pump body so that the inside edge is flush with the inside face of the oil pump body.

Fit the rear crankshaft bearing cap to the cylinder block and the oil pump body to the underside face of the bearing cap and ream both the bush bearings at the same time to ensure correct alignment.

DISMANTLING AND ASSEMBLING
OIL PUMP Figs. D13, D15 and D16

1. DISMANTLING

Remove the oil pump cover and strainer assembly from the oil pump body by withdrawing four bolts. Withdraw the driving and driven gears from inside the pump body. Eject the bush bearing from the driven gear when it is badly worn, the ejection of the driven gear pin is not necessary as the renewal of the bush bearing is sufficient. When it is necessary to replace the driving shaft bush bearing in the oil pump body it will be necessary to replace also the flanged bush bearing at the top end of the oil pump driving shaft.

2. ASSEMBLING

The assembly of the oil pump is the reversal of the dismantling sequence but particular

attention must be given to the following points.

(i) That the rear end faces, the contact faces inside the oil pump body and the inside face of the oil pump cover are not ridged or scored.

(ii) That the tongued end of the oil pump driving shaft protruding downward into the crankcase does not have an appreciable amount of side play. When excessive side play is determined the flange bush bearing in the cylinder block, beneath the spiral gear, must be renewed necessitating stripping of the engine unit.

(iii) That the idler gear pin is below the fitting face of the cover and strainer assembly (Fig. D15).

(iv) That when the driving shaft bush bearing in the oil pump body is replaced it is pressed in from the top and its inner end does not protrude into the oil pump body.

(v) That the driven gear bush bearing is pressed in so that the ends are below the end faces of the gear and then reamed to size.

(vi) That with the oil pump inverted, the two gears in position and with a straight edge resting across the oil pump body above the gears, it is not possible to insert a 0.0025" feeler gauge between the straight edge and each gear in turn. Fig. D16.

(vii) That the groove in the oil pump cover is not obstructed.

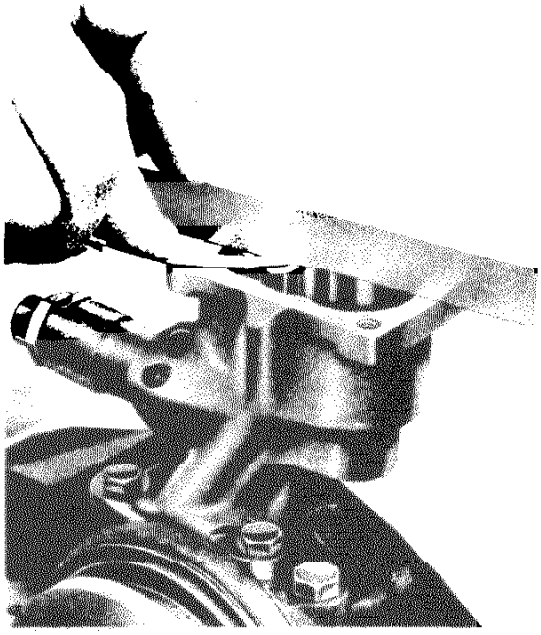

Figure D15.

Checking depth of driven gear pin below fitting face of cover and strainer assembly.

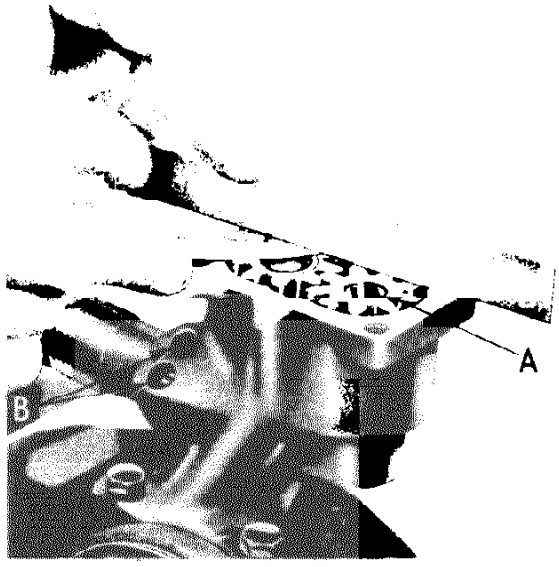

Figure D16.

Checking clearance between driving and driven gears and cover assembly

A. This gear must be fitted as shown.

B. Relief valve vent holes.

OIL PUMP DIMENSIONS	ENGLISH	METRIC
Dia. of bore in oil pump body for driving shaft bush bearing.	0.6290" 0.6280"	15.9766 mm. 15.9512 mm.
Dia. of driving shaft bush bearing.	0.6315" 0.6305"	16.0401 mm. 16.0147 mm.
Dia. of bore in driving shaft bush bearing (after reaming in position)	0.5000" 0.4996"	12.7000 mm. 12.6898 mm.
Dia. of driving shaft.	0.4994" 0.4988"	12.68476 mm. 12.66952 mm.
Depth of oil pump body for driving and driven gears.	1.4008" 1.3994"	35.58032 mm. 35.54476 mm.
Length of oil pump driving and driven gears.	1.3984" 1.3979"	35.51936 mm. 35.50666 mm.
Dia. of bore in oil pump body for driving and driven gears.	1.4650" 1.4638"	37.21100 mm. 37.18052 mm.
Dia. of driving and driven gear.	1.4618" 1.4600"	37.12972 mm. 37.08400 mm.
Dia. of bore in oil pump driven gear for bush bearing.	0.6257" 0.6245"	15.89278 mm. 15.86230 mm.
Dia. of driven gear bush bearing.	0.6257" 0.6245"	15.89278 mm. 15.86230 mm.
Dia. of bore in driven gear bush bearing (after reaming in position)	0.503" 0.502"	12.77620 mm. 12.75080 mm.
Dia. of driven gear pin.	0.5010" 0.5006"	12.72540 mm. 12.71524 mm.
Dia. of oil pump driving shaft	0.4994" 0.4988"	12.68476 mm. 12.66952 mm.
Dia. of bore in oil pump driving shaft spiral gear.	0.4988" 0.4982"	12.66952 mm. 12.65428 mm.
Thickness of spiral gear thrust washer	0.1260" 0.1240"	3.20040 mm. 3.14960 mm.
Length of driving shaft protruding from end of spiral gear.	11.8500"	300.99000 mm.
Depth of driven gear pin below face of oil pump body.	0.0500"	1.27000 mm.
OIL RELIEF VALVE DIMENSIONS		
Dia. of bore in oil pump body for relief valve plunger	0.6255" 0.6245"	15.8877 mm. 15.8623 mm.
Dia. of oil relief valve plunger.	0.6242" 0.6235"	15.85468 mm. 15.83690 mm.
Free length of oil relief valve plunger spring.	3.740" 3.720"	94.996 mm. 94.488 mm.

ROCKER SHAFT LUBRICATION PIPE ASSEMBLY

DESCRIPTION Fig. D17.

The rocker shaft lubrication pipe assembly conveys the intermittent supply of oil from the rear camshaft bearing to the two cylinder heads and the four rocker shaft assemblies mounted thereon. The end faces of the cylinder heads are drilled to the nearer rocker shaft bracket mountings and the oil is conveyed to the hollow rocker shafts through matching drillings in the rear rocker brackets and the front cylinder head oil drillings blanked off by short bolts.

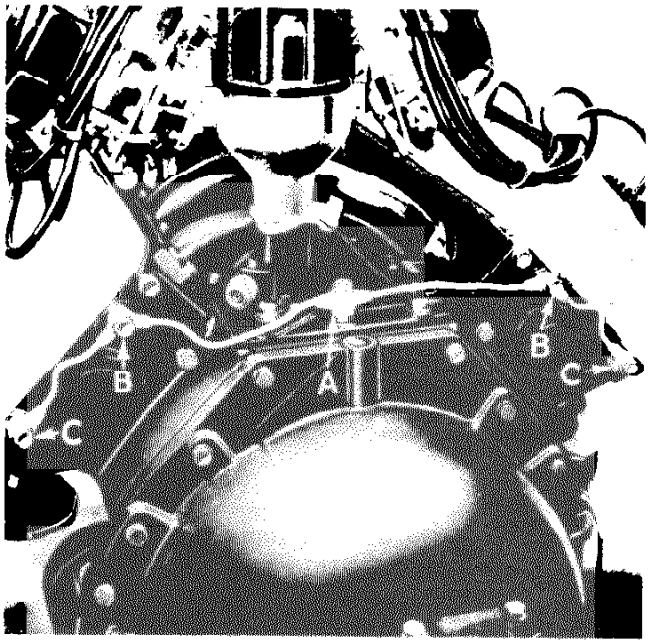

Figure D17.

Rocker shaft lubrication pipe between the two cylinder heads and tappet block and cover.

A. Feed from rear camshaft bearing.
B. Feed to inlet valve operating gear.
C. Feed to exhaust valve operating gear.

REMOVAL AND REPLACEMENT
ROCKER SHAFT LUBRICATION PIPE ASSEMBLY Fig. D17.

1. REMOVAL

Remove the rocker snaft lubrication pipe from the rear top edge of the tappet block cover and the rear faces of the two cylinder heads by withdrawing one large and four small banjo bolts.

2. REPLACEMENT

The replacement of the rocker shaft lubrication pipe is the reversal of the removal sequence but it is essential that the washers positioned either side of the pipe connections are in good condition.

DECARBONISING

INTERVAL

The cylinder heads can be removed for decarbonising, as described on page D18 after the first 5,000 miles (8,050 kms.), when attention after this short running period has the advantage of allowing the initial casting stresses to resolve themselves and permits the consequent valve seat distortion to be counteracted by valve grinding. Failure to carry out this initial valve grinding is a frequent cause of excessive petrol consumption and lack of performance of new engines. Subsequent attention will not normally be required until a considerable amount of running has been done - normally about 15,000 miles (24,150 kms.).

The above mentioned mileages only take into consideration a car which is used under normal conditions. If a car is used for competition or high speed motoring, valve grinding is done as and when necessary.

When the car is continually used on journeys of short distances under lightly loaded conditions, this usage, combined with frequent use of the lower gears, tends to shorten the decarbonising interval specified. Similarly, loss of power, increased petrol consumption and sticking valves will all tend to indicate more precisely when decarboniation and attention to the valves and their seats is necessary.

COMPRESSION PRESSURES

Compression pressures with engine at full working temperature, spark plugs removed, throttle wide open and fully charged battery.	120 - 140 p.s.i. 8.436 - 9.842 K.s.Gm.

DETERMINING COMPRESSION PRESSURES

Before removing either cylinder head check the compression of each cylinder to determine the condition of both the valves and piston rings.

To effect this test with any accuracy it is necessary to ensure that the battery is fully charged and when the engine has run to reach its normal working temperature.

When the compression pressures vary more than 15 p.s.i. (1.055 K.s.Cm.) between cylinders or has dropped to below 85 p.s.i. (5.976 K.s.Cm.) attention to the valves and valve seats is necessary and that cylinder(s) should be investigated when the cylinder head has been removed. Should it be determined on investigation, that the valves and seats are in reasonable condition examination of the piston rings must be considered.

If the compression pressures are border-line, it is wise to run the engine for a second time and again check the compression pressures. In some instances, a small particle of foreign matter may become lodged under the valve giving a low and false reading. This particle may be blown off by running the engine.

The tests should be made twice, the second time in the reverse direction to the first, the mean average of the two readings taken. This will allow for any loss of temperature caused through the engine cooling down.

Warm up the engine to its full working temperature and after switching off the ignition withdraw all the spark plugs, wedge the carburettor butterfly valves (throttles) fully open and fit a fully charged battery.

Insert the pressure gauge in the spark plug tappings and press the rubber cover of the engine starter solenoid switch, note the pressure reading and repeat the operation with the remaining cylinders as quickly as possible.

Repeat the previous sequence of operations with the cylinders in the reverse order. Calculate the average of the two readings.

REMOVING THE CARBON FROM THE CYLINDER HEADS AND PISTON CROWNS

The cylinder head combustion chambers, inlet and exhaust ports are cleaned with suitable scrapers or small powered tools exercising care not to damage the soft aluminium surface. The cylinder heads are then washed and dried off with a compressed air jet to ensure that all carbon particles are removed.

Before cleaning the piston crowns the transfer holes in the cylinder head fitting face must be effectively blanked off and care must be exercised not to damage the soft aluminium piston crown.

While the cylinder head assemblies are in this dismantled state, the condition of the various components should be checked as detailed under THE CYLINDER HEAD ASSEMBLES, Page D18.

THE ROCKER COVERS

DESCRIPTION

The rocker covers are secured by four hand nuts by the outer threads of the spark plug tubes.

A joint washer is adhered to the cylinder head cover fitting face to effect an oil tight seal.

REMOVAL AND REPLACEMENT ROCKER COVERS

1. IGNITION EQUIPMENT

Withdraw the spark plug leads from inside the spark plug tubes as detailed in the IGNITION SYSTEM, SECTION E.

2. CARBURETTOR AIR CLEANERS

Detach the carburettor air cleaners from the two carburettors and the rocker cover vent pipes as detailed in the FUEL SYSTEM, SECTION E.

3. ROCKER COVER

Remove the rocker covers from the top face of the two cylinder heads by withdrawing the eight rocker cover nuts, one at the top of each spark plug tube.

4. REPLACEMENT

The replacement of the rocker covers is the reversal of the removal sequence.

FITTING A NEW ROCKER COVER JOINT

It is important that an effective oil seal is maintained between the cylinder head top face and the rocker cover to prevent the escape of lubricating oil. The joint should be securely adhered to the rocker cover and replaced whenever its condition is in doubt.

Scrupulously clean the underside of the rocker cover and coat with a non-hardening jointing compound, apply a coat to the rocker cover joint and leave until tacky.

Mate the two prepared surfaces together and position joint downward on a flat surface. Weight the top of the cover and leave for a time so the joint may adhere to the rocker cover.

THE VALVE OPERATING GEAR

DESCRIPTION

The valve operating gear consists of push rod operated, spring spaced rocker arms oscillating on hollow shafts; two to each cylinder, the inner assembly operating the inlet valves and the outer operating the exhaust valves. Each rocker shaft assembly is mounted on the top face of the cylinder head by five pedestals utilizing the cylinder head studs and nuts each being located by a ring dowel. Each end of the rocker shafts is closed by a plug and the shaft is locked to one of the end brackets by a locating screw, thus ensuring alignment of the oil drilling of the shaft and bracket to that in the cylinder head.

A metered supply of oil from the rear camshaft bearing is fed into the four rear end brackets by matching holes and an external pipe assembly from the top of the tappet block and drillings in the rear face of the cylinder head. Oil passing through radial drillings in the rocker shaft lubricates the rocker arms and through further drillings in the heel of the rocker arm and ball pin to lubricate the top of the push rods. The rocker arms have drillings to convey oil to the valve stem tips and are also lubricated by the oil mist that exists under the rocker cover. The oil drains back into the engine sump by transfer holes in the outside corners of the two cylinder heads.

The push rods have pressed-on cups at each end, and those for the exhaust rockers are longer than the inlet push rods.

REMOVAL AND REPLACEMENT, ROCKER SHAFT ASSEMBLIES

1. CARBURETTOR AIR CLEANERS

Remove the carburettor air cleaners from the two carburettors as detailed in the FUEL SYSTEM, SECTION E.

2. ROCKER COVERS

Remove the rocker covers from the two cylinder heads as detailed on page D14.

3. DRAINING THE COOLING SYSTEM

Drain the cooling system by opening the radiator drain tap and slackening off the radiator filler cap as detailed in the COOLING SYSTEM, SECTION C.

4. ROCKER SHAFT ASSEMBLIES

Fit a ¼" U.N.F. screw to the front R.H. and rear L.H. rocker shaft pedestals in the tapped hole provided in the top of the pedestals. Tighten down the setscrew to lock the pedestal to the rocker shaft before removing the assembly from the cylinder head. Slacken off the ten cylinder head nuts situated on top of the ten rocker shaft pedestals, whether both rocker shaft assemblies are to be removed or not. Remove the rocker shaft assembly from the five cylinder head studs by detaching the five nuts and lifting the assembly upward and sideways, the second rocker shaft assembly is removed in a similar manner.

WARNING

Do not turn the crankshaft when the rocker shaft assemblies have been removed from either cylinder head. Failure to observe this instruction will mean a lifted cylinder head, necessitating the renewal of the cylinder head gasket, as the nuts securing the rocker shaft assembly also secure the cylinder head.

5. REPLACEMENT

The replacement of the rocker shaft assembly is the reversal of the removal sequence but particular attention must be given to the following points:

(i) That the rocker ball pins in the rocker arms are fully slackened off, this will obviate the possibility of any push rods being distorted as the rocker shaft assemblies and cylinder heads are being tightened down.

(ii) That the nuts are tightened down in by diagonal selection as detailed under "CYLINDER HEAD NUT TIGHTENING SEQUENCE" on page D20.

TO SET VALVE ROCKER CLEARANCES

The four rocker shaft assemblies are secured to the top face of the two cylinder heads utilizing the same studs and nuts that also secure the cylinder heads, therefore, the valve rocker clearances must be checked and reset, if necessary, whenever the cylinder heads are tightened down.

DATA

Running clearance	(COLD)	Inlet	0.011" (0.28 mm.)
		Exhaust	0.014" (0.36 mm.)
Firing order	1L, 4R, 2R, 2L, 3R, 3L, 4L, 1R.		

1. IGNITION SYSTEM

Remove the spark plugs and set the engine so that No. 1L cylinder is at T.D.C. on its compression stroke as detailed in the IGNITION SYSTEM, SECTION E.

2. ROCKER COVERS

Detach the rocker covers from the top face of the two cylinder heads as detailed on page D14 if not removed previously.

3. SETTING THE VALVE ROCKER CLEARANCES

Ascertain the existing clearance with feeler gauges and when incorrect, reset by slackening the ball pin locknut and turning the ball pin; then tighten the locknut and recheck the valve rocker clearance and reset if necessary. Repeat this operation with the remaining cylinders in their firing order by turning the crankshaft 90° each time and checking the position of the ignition distributor.

4. REPLACEMENT OF COMPONENTS

The replacement of the rocker covers, spark plugs and carburettor air cleaners is the reversal of the removal sequence.

DISMANTLING AND ASSEMBLING ROCKER SHAFT ASSEMBLIES

DISMANTLING

Withdraw and identify the four rocker shaft brackets, rocker arms, springs and twelve washers from each rocker shaft assembly by removing the slave bolt fitted to the free end rocker shaft bracket during the removal sequence. Remove the locating rocker shaft bracket from each

rocker shaft by withdrawing the locating screws.

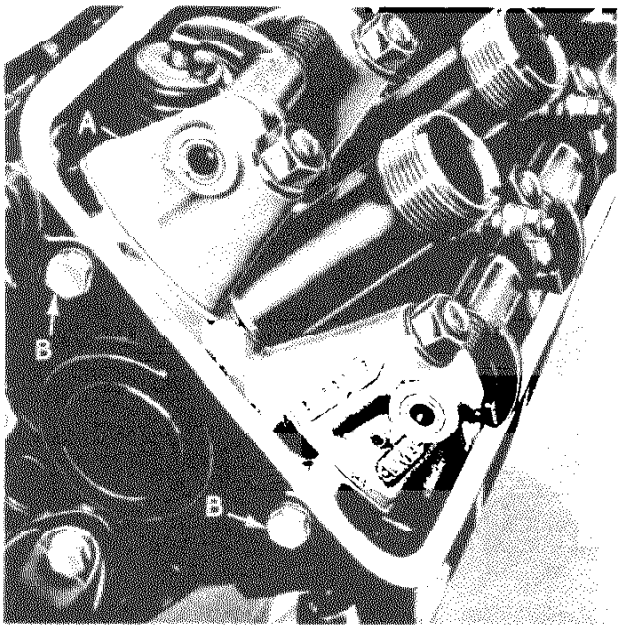

Figure D18

Valve operating gear on top of cylinder head showing the identification mark in the end of the inlet rocker shaft assembly.

A. Identification in inlet rocker shaft.

B. Blanking plugs of rocker shaft oil drillings in front face of each cylinder block.

ASSEMBLING Fig. D18

The assembling of the rocker shaft assembly is the reversal of the dismantling sequence, but particular attention must be given to the following points:

(i) That the two inlet rocker shafts, identified by a groove machined in one end, are selected and worked upon first. Fig. D18.

(ii) That the two locating rocker shaft brackets are attached, one to each shaft, to the shaft end having the two transverse drillings so that the rocker shaft is to the L.H. side of the stud hole, when looking at the end of the shaft and the dowel end of the locating screw locates the shaft drilling having the countersink.

(iii) That the inlet rocker shaft details are fitted to the rocker shaft in the following order, a washer, the inlet valve rocker arm with the ball pin adjacent to the cylinder head stud hole in the rocker shaft bracket, a second washer, a spacing spring, a third washer and a free rocker shaft bracket, so that the cylinder head stud holes align with the locating rocker shaft pedestal. The sequence is repeated three times with the remaining inlet details and the last free rocker shaft bracket held in position with a $\frac{1}{4}$" U.N.F. slave bolt, which is removed when the rocker shaft assembly is fitted to the cylinder head.

(iv) That the exhaust rocker shaft is built up in a similar manner to the inlet rocker shaft assembly, but in this instance the cylinder head stud hole of the locating rocker shaft pedestal is positioned to the R.H. side of the rocker shaft.

DIMENSIONS

Dia. of bore in rocker arm	0.5630" 0.5625"	14.3002 mm. 14.2875 mm.
Dia. of rocker shaft	0.5615" 0.5605"	14.2621 mm. 14.2367 mm.
Free length of rocker spacer spring	2.000"	50.80 mm.
Valve lift	0.295"	7.493 mm.

THE CYLINDER HEAD ASSEMBLIES

DATA

Type	Overhead valve, cast aluminium, two per engine unit, hemispherical combustion chamber.
Valves	Laterally positioned with the inlet valve nearer the engine centre line. Alloy valve steel.
Valve seats	Cast into cylinder head during manufacture.
Valve operation	Push rod operated by ball ended tappets fitted into a central tappet block and spring spaced valve rocker arm.
Inlet ports	Toward centre line of engine unit. Inlet manifold attached by bolts.
Exhaust ports	On outside face of cylinder head away from centre line of engine unit. Exhaust manifold attached by studs.
Cylinder head nut tightening torque	40 - 45 lbs.ft. 6.221 - 6.913 kg.m.
Valve guides	Pressed in from top of cylinder head to shoulder.

DESCRIPTION Figs. D19 and D20

Two cast aluminium alloy cylinder heads having iron inlet and exhaust valve seat inserts cast into the hemispherical shaped combustion chambers and replaceable shouldered valve guides are fitted to each bank of cylinders. The inclined laterally positioned inlet and exhaust valves permit direct and unrestricted valve porting, the inlet manifold being secured to the inside faces of the two cylinder heads by bolts while the exhaust manifold is attached to the outside faces with studs and nuts.

The cylinder head assemblies are fitted to the cylinder block with corrugated steel gaskets and are located on the two centre attachment studs by tubular dowels.

Fitted vertically in the top face of the two cylinder heads are four tubes, through the centre of which the spark plugs are fitted and a handnut on the open end of each tube secures the cast aluminium rocker covers.

REMOVING AND REPLACEMENT, CYLINDER HEADS

1. PROTECTION OF BODYWORK

Remove the engine hood, an advantage but not essential, as detailed in the BODY SECTION. Q, and spread covers over the wings of the car.

2. ELECTRICAL EQUIPMENT

Detach the earthing lead from the battery and remove the dynamo and the electric harness from the engine unit as detailed in the ELECTRICAL EQUIPMENT, SECTION O.

3. IGNITION EQUIPMENT

Remove the ignition H.T. leads from the spark plugs, the spark plugs from the cylinder heads and the vacuum pipe from the carburettor as detailed in the IGNITION SYSTEM, SECTION E.

4. COOLING SYSTEM CONNECTIONS

Drain the cooling system, detach the radiator, cylinder head and inlet manifold connecting pipes as detailed in the COOLING SYSTEM, SECTION C.

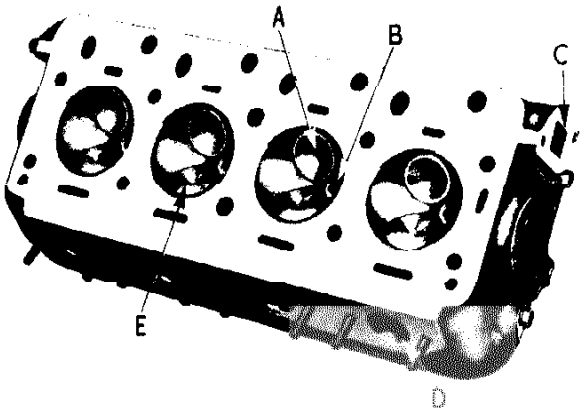

Figure D19

Cylinder head underside showing the hemispherical combustion chambers.
A. Inlet valve
B. Spark plug location
C. Coolant outlet
D. Exhaust manifold fitting face
E. Exhaust valve

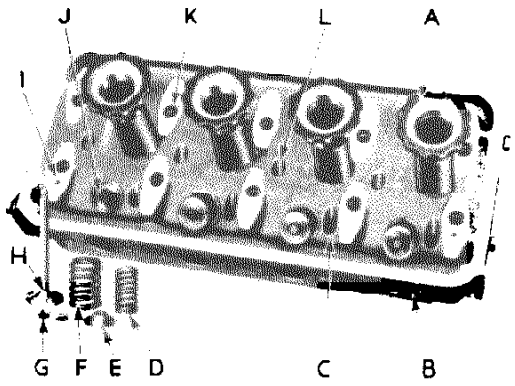

Figure D 20

Cylinder head top side showing one inlet valve removed.
A. Rocker cover hand nut
B. Inlet manifold fitting face
C. Bore for inlet push rod
D. Inner valve spring
E. Valve spring cone washer
F. Outer valve spring
G. Split cones
H. Inlet valve
I. Lubrication drilling for rear rocker bracket
J. Inlet valve guide
K. Spot facing for rocker bracket
L. Bore for exhaust valve push rod

5. CARBURETTOR AND INLET MANIFOLD

Detach the carburettor air cleaners from the carburettor, but leave on the rocker cover ventilation pipes, remove the petrol feed pipes, carburettors and inlet manifold from the two cylinder heads as detailed in the FUEL SYSTEM, SECTION E.

6. EXHAUST PIPES

Detach the front exhaust pipe assemblies from the two exhaust manifolds as detailed in the EXHAUST SYSTEM, SECTION F.

7. ROCKER SHAFT LUBRICATION PIPE ASSEMBLIES

Remove the rocker shaft lubrication pipe assembly from the rear of the engine as detailed on page D13.

8. VALVE OPERATING GEAR

Remove the rocker covers from the tops of the two cylinder heads by withdrawing the hand nuts, one at the top of each spark plug tube. Slacken the twenty nuts, one on top of each rocker shaft pedestal, ten pedestals to each cylinder head, by reversing the order detailed in the cylinder head nut tightening sequence. Withdraw the four rocker shaft assemblies from the top of the two cylinder heads by removing the twenty nuts, followed by the push rods.

9. CYLINDER HEAD ASSEMBLIES

Remove the two cylinder heads and gaskets from the studs in the top of the cylinder head.

10. EXHAUST MANIFOLDS

Remove the two exhaust manifolds and joints from the side face of each cylinder head as detailed in the EXHAUST SYSTEM, SECTION F and clean off carbon deposit.

11. REPLACEMENT

The replacement of the two cylinder heads is the reversal of the removal sequence, but particular attention must be given to the following points:

(i) That the two cylinder head gaskets are well greased on both sides before they are fitted to the cylinder head.

(ii) That the two cylinder heads are offered up and positioned on the tubular dowels of the centre studs.

(iii) That the valve operating gear and the two cylinder heads are tightened down as detailed in Fig. D21.

(iv) That the two carburettors are synchronised as detailed in the FUEL SYSTEM, SECTION E, before the carburettor air cleaners are fitted.

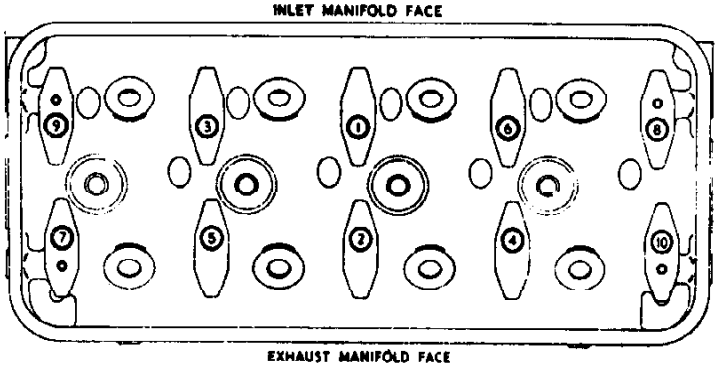

Figure D21

Cylinder head nut tightening sequence.

THE CYLINDER HEAD ATTACHMENT STUDS

The cylinder head attachment studs are of the waisted type and manufactured from high tensile steel and both ends have R.H. threads. It must be realised that the cylinder head attachment studs also secure the valve rocker shaft assemblies and a second tightening of the cylinder head nuts will be necessary after the rocker shaft assemblies have been replaced, although the cylinder head may not have been disturbed.

THE CYLINDER HEAD GASKETS

The cylinder head gasket is a steel pressing with a varnish finish, it can only be fitted one way, with the corrugations downward.

Whenever the rocker shaft assemblies are removed, the cylinder heads will be slackened off as they use common studs, but it will not be necessary to fit replacement gaskets. It will be necessary, however, if ever the seal is broken.

THE SPARK PLUG TUBES

Four spark plug tubes are fitted in the top face of each cylinder head with a copper washer interposed between to effect an oil tight seal. The outer ends of the spark plug tubes are also threaded and these threads accommodate the four rocker cover securing handnuts.

The spark plug tubes can be withdrawn from the cylinder head by turning them anti-clockwise.

THE INLET AND EXHAUST VALVES

The inlet and exhaust valves are positioned laterally in the cylinder head forming an included angle of 70° with the inlet valve nearer the centre line of the engine unit.

The inlet valve can be recognised by its large head and parallel stem. The stem of the exhaust valve however, is tapered from a point approximately midway along its length while the remainder is parallel although slightly smaller in diameter than the inlet valve stem. The reduced diameter and taper ensures adequate working clearance through a wide temperature range.

The inlet and exhaust valve guides are a press fit in the top face of the cylinder heads, their depth being governed by a shoulder and the bores reamed out to size after fitting.

The dual valve springs are located by a centring washer top and bottom and are secured by a cone washer and two split cones each, which register with a groove machined in the end of the valve stems.

The inlet and exhaust valve seat inserts are cast into the cylinder head during manufacture and cannot be replaced. When the inserts have passed their usefulness the cylinder heads must be replaced. It is estimated that they will outlive the engine unit when correctly maintained.

The faces of the vale must be cut on a proprietary valve facing machine and must only be lapped into the valve seat to effect a gas tight seal.

REMOVAL AND REPLACEMENT. VALVE, VALVE SPRINGS AND VALVE GUIDES
Figs. D19 and D20

1. REMOVAL

Compress each valve spring in turn utilizing a valve spring compressor, remove the two split cones, upper valve spring seats, inner and outer valve springs and bottom spring seat; withdraw the valve from inside the combustion chamber. Identify all components to their respective positions.

The valve guide can be removed from the cylinder head after first filling the cylinder head with boiling water to expand the aluminium alloy.

2. REPLACEMENT

The replacement of the valves, valve springs and valve guides is the reversal of the removal sequence, but particular attention must be given to the bottom spring seat to ensure that it is fitted lip upward.

SERVICING THE CYLINDER HEAD VALVES

After cleaning, polish each valve, examine each stem for trueness and wear, the valve faces for burning, pitting and other distortions. Discard all valves having bent and/or worn stems or badly burnt faces and replace with new ones. Pitted faces can often be cleaned up by machining on a proprietary valve refacer, but no attempt must be made to remove the valve face imperfections by excessive valve lapping; this usually removes more valve seat than valve face imperfections.

KNIFE EDGE VALVES

Numerous valve face refacings reduce the thickness of the valve lip, i.e. the periphery between the valve face and the valve head, which becomes incandescent under working conditions, resulting in pre-ignition and in extreme cases, persistent engine running after the ignition has been switched off.

The commencement of the knife edge should be regarded as being half the original thickness of the valve lip, see DIMENSION, page

VALVE GUIDES

When excessive wear necessitates the fitting of replacement valve guides, the worn guides must never be drifted out of the cylinder head with hammer blows. The hammer impacts tend to swell the guide and so score the accommodating bore with which they have an interference fit. Withdraw by utilizing a suitable extractor.

The replacement valve guides are pressed in from the top face of the cylinder head after heating the cylinder head, then reamed out and the valve seat recut.

Worn inlet valve guides are not only detrimental to good slow running but they contribute a larger part in heavy oil consumption than is usually appreciated.

INLET AND EXHAUST VALVE SEATS

The inlet and exhaust valve seats are cut to an angle of 45° and this can be effected by utilizing a cutting tool with a pilot registering accurately with the bore of the valve guide.

Care must be exercised to take only sufficient metal to clean up the valve seat and when it is observed that the seat is becoming too broad it can be reduced by using a special spherical cutter on the outside periphery which helps to blend it into the spherical shaped combustion chamber and a 60° cutter on the inside periphery mounted on the same pilot.

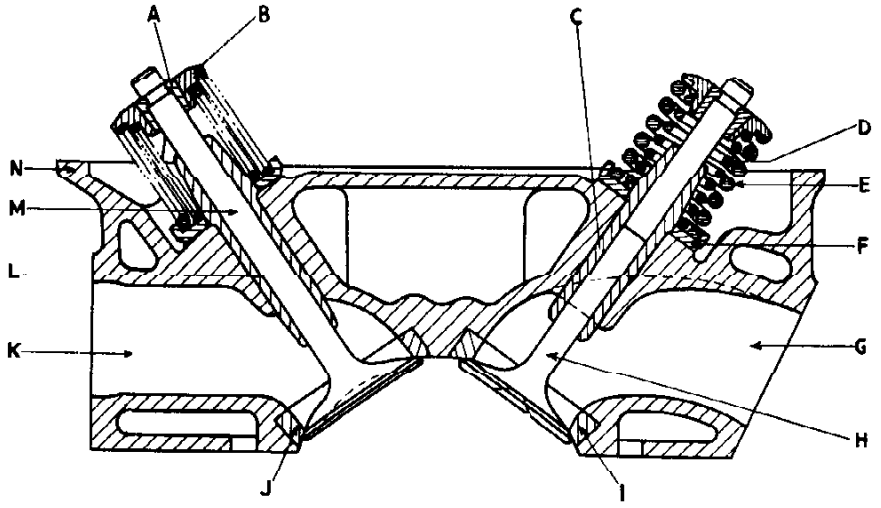

Figure D22. Cross section of valves in cylinder head showing all details.

A. Split cones
B. Cone Washer
C. Exhaust valve guide
D. Inner valve spring
E. Outer valve spring
F. Spring seat
G. Exhaust port
H. Exhaust valve (Line on valve stem indicates end of taper)
I. Exhaust valve seat
J. Inlet valve seat
K. Inlet port
L. Inlet valve guide
M. Inlet valve
N. Cylinder head

VALVE LAPPING

After the valve guides, valves and valve seats have been serviced, each valve must be lapped to its individual seat using a very fine grade carborundum paste.

On completion of the lapping operation all traces of the carborundum paste must be meticulously cleaned away by washing and the use of compressed air. The valve and seat is then tested for leaks, a procedure which takes a little time, but the assurance of knowing the degree of efficiency is well worth while.

When, after lapping, a valve seat is found to be leaking, the valve guide and stem should be re-examined for faults before further lapping takes place. Excessive valve lapping must be avoided.

VALVE SPRINGS

After the valve springs have been thoroughly washed they must be examined for fatigue and distortion.

Fatigue is determined by measuring its free length and distortion by positioning it upright on a surface plate or table and the squareness of each end is determined by utilizing a set square.

All valve springs which have diminished in length and/or are not square must be discarded and new replacements fitted.

TESTING FOR GAS TIGHT VALVE SEATING

1. RECOMMENDED METHOD

Position the cylinder head, cylinder block fitting face upward, so that one line of valves are vertical and that the valve tips do not foul the bench top. Lubricate the valve stems and feed each valve into its appropriate valve guide. Apply thumb pressure to the head of one valve, pressing it on to the seat and run petrol round the head of the valve and seat. By plugging the spark plug tapping a larger quantity of petrol can be used.

Direct a jet of compressed air into the appropriate gas port and observe any air bubbles between the head of the valve and its seat. Reposition the valve a number of degrees several times and observe air bubbles in all positions.

Providing that there are no air bubbles in any position, the valve seat can be passed as gas-tight. Any trace of air bubbles in any position will "fault" that particular valve seat which must be re-examined for faults before re-lapping for a second time.

The foregoing procedure must be repeated with the remaining valves and seats and finally the second cylinder head.

2. ALTERNATIVE METHOD

Position the cylinder head, cylinder block fitting face upward, so that one line of valves are vertical and ensure that the valve tips do not foul the bench top. Apply a thin coating of "mechanics blue" to the valve face and lubricate the valve stem. Feed the valve into its appropriate valve guide and while applying slight downward pressure to the valve head turn it one eighth of a turn, to transfer the "mechanics blue" from the valve face to the valve seat.

Withdraw the valve and examine the valve seat for continuity of colour; when a complete ring of colour is observed on the valve seat, the valve and seat can be considered gas tight. When a break of colour is observed, the tightness of the valve and seat can be "faulted" but before they are re-lapped the valve stem and guide must be examined for irregularities as previously detailed.

The foregoing procedure is adopted with the remaining valves and cylinder head. The valves and valve seats are then washed clean of the "mechanics blue".

DIMENSIONS

Bore in cylinder head for valve guides.		0.4990" 0.4985"	12.6746 12.6619	mm. mm.
Dia. of valve guides (inlet and exhaust).		0.5010" 0.5005"	12.7254 12.7127	mm. mm.
Bore in valve guide for valve stem.	Inlet	0.3129" 0.3121"	Inlet 7.94766 7.92734	mm. mm.
	Exhaust	0.3138" 0.3130"	Exhaust 7.97052 7.9502	mm. mm.
Dia. of inlet and exhaust valve stems.		0.3119" 0.3113"	7.92226 7.90702	mm. mm.
Dia. of inlet valve head.		1.505" 1.500"	38.227 38.1	mm. mm.
Depth of inlet valve face.		0.047"	1.1938	mm.
Dia. of exhaust valve head.		1.4475" 1.4375"	36.6395 36.5125	mm. mm.
Depth of exhaust valve face.		0.047"	1.1938	mm.
Free length of outer valve spring.		1.6000"	40.6400	mm.
Free length of inner valve spring		1.5200"	38.608	mm.
Angle of inlet valve face and seat.		45°		
Angle of exhaust valve face and seat.		45°		
Thickness of inlet valve lip.		0.037" 0.032"	0.9398 0.8128	mm. mm.
Thickness of exhaust valve lip.		0.049" 0.044"	1.2446 1.1176	mm. mm.

THE ENGINE SUMP FILLER NECK ASSEMBLY

DESCRIPTION

The engine sump filler neck is a short length of tube screwed into the front R.H. corner of the tappet block and cover. The oil filler cap is secured, for safe keeping, to the open end of the oil sump filler neck by a short length of chain rivetted at each end to the neck and cap.

REMOVAL AND REPLACEMENT

Withdraw the oil sump filler neck assembly from the front R.H. corner of the tappet block and cover. Remove the filler cap and chain from the filler neck by filing off the head of the rivet.

The replacement of the filler cap and neck assembly is the reversal of the removal sequence.

THE TAPPET BLOCK AND COVER ASSEMBLY

DESCRIPTION Fig. D23.

The tappet block and cover assembly is fitted to the top of the cylinder block between the two cylinder heads. Its front face accommodates the studs for the dynamo mounting bracket and incorporated in the top face, front to rear, is the oil filler neck, the engine speed indicator drive/ ignition distributor mounting and a tapping for the rocker shaft oil feed to the two cylinder heads situated one each side.

The underside of the tappet block and cover is cast so that it forms the housings for the sixteen tappets. The tappets are prevented from revolving by one flat of their head contacting the tappet block and the cam lobe contact face of "stellite". The second end of the tappet has a pressed in ball end which is shouldered, thus retaining the tappet in the tappet block.

The tappet block and cover assembly and joint is located by two dowels and jack tappings are provided to facilitate its removal utilizing 5/16" U.N.C. bolts.

REMOVAL AND REPLACEMENT, TAPPET BLOCK AND COVER ASSEMBLY

1. DYNAMO AND BRACKET

Remove the dynamo and bracket from the top of the engine unit as detailed in the ELECTRICAL EQUIPMENT, SECTION O. Withdraw the four dynamo mounting studs from the front face of the tappet block and cover.

2. ROCKER COVERS AND VALVE ROCKER SHAFT ASSEMBLIES

Remove the rocker covers and rocker shaft assemblies as detailed on pages D14 and D15.

3. CARBURETTORS AND INLET MANIFOLD

Remove the carburettors and inlet manifold as detailed in the FUEL SYSTEM, SECTION E.

4. IGNITION DISTRIBUTOR

Remove the ignition distributor as detailed in the IGNITION SYSTEM, SECTION E.

5. ROCKER SHAFT LUBRICATION PIPE ASSEMBLY

Remove the rocker shaft lubrication pipe assembly from the rear of the tappet block and cover assembly as detailed on page D13.

6. TAPPET BLOCK AND COVER

Remove the tappet block and cover from the top face of the cylinder block by withdrawing twelve bolts and utilizing the two jack tappings provided.

7. REPLACEMENT

The replacement of the tappet block and cover is the reversal of the removal sequence, the two longer attachment bolts secure the two front corners.

DISMANTLING AND ASSEMBLING, TAPPET BLOCK AND COVER

1. OIL FILLER NECK

Detach the oil filler neck as previously detailed.

2. TAPPETS

Withdraw the ball ends from the tappet bodies and remove the latter from the tappet cover and identify all components to their respective positions.

3. ASSEMBLY

The assembly of the tappet block and cover is the reversal of the removal sequence.

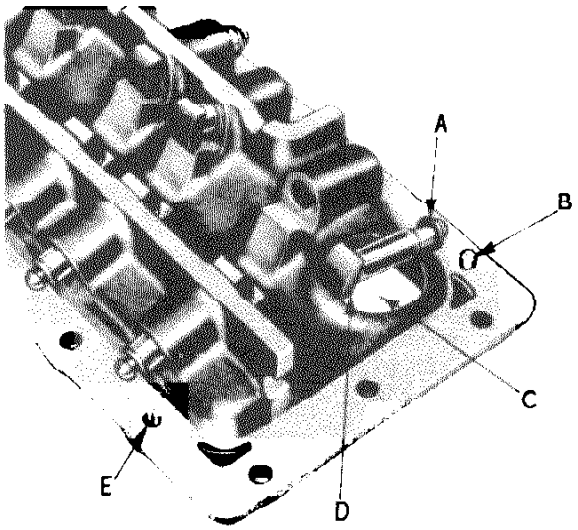

Figure D23

Underside of tappet block and cover with one tappet assembly removed.

A. Ball end
B. Locating dowel
C. Ignition distributor bore
D. Tappet foot
E. Jack tapping for removal

DIMENSIONS, TAPPETS AND TAPPET BLOCK

Dia. of bore in tappet block for tappet	0.5005" 0.5000"	12.7127 mm. 12.7000 mm.
Dia. of tappet body.	0.510" 0.505"	12.954 mm. 12.827 mm.
Bore in tappet body for ball end.	0.3754" 0.3746"	0.9535 mm. 0.9515 mm.
Dia. of tappet ball end spigot.	0.3758" 0.3754"	0.9545 mm. 0.9535 mm.

THE FRONT CRANKSHAFT PULLEY AND DAMPER

DESCRIPTION Fig. D24.

A metal and rubber bonded damper in the shape of a disc is fitted to the front crankshaft to tune out the torsional vibrations of the crankshaft. Unless the rubber becomes detached from the metal hub or outer disc through misuse of oil contamination the damper will last the life of the engine unit.

On the outer periphery, a short line is machined and this is used to set the ignition timing. It will be appreciated, therefore, that this mark just be positioned relatively to the crankshaft pulley keyway and for this purpose one of the six attachment bolt holes in each component is identified, the crankshaft pulley hole on the front face and the one in the damper on the rear face.

REMOVAL AND REPLACEMENT, CRANKSHAFT PULLEY AND DAMPER Fig. D24.

1. CHASSIS FRAME FRONT BRACING MEMBER

Remove the chassis frame front bracing member from the front face of the two suspension pillars, as detailed in the CHASSIS FRAME, SECTION P.

2. VEE DRIVE BELT

Remove the vee drive belt from the front of the engine unit as detailed in the COOLING SYSTEM, SECTION C.

3. COOLING FAN AND EXTENSION

Detach the cooling fan and extension from the front face of the crankshaft pulley by removing the six nuts; after the removal of the extension, replace the nuts to the bolts.

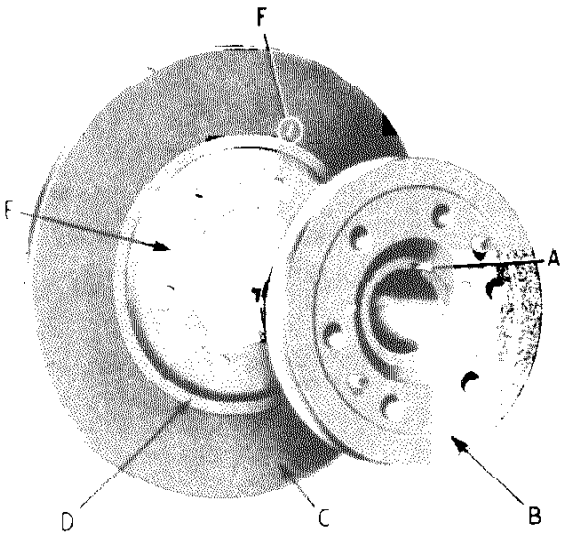

Figure D24

Front crankshaft pulley and damper showing co-relationship of one bolt hole and crankshaft keyway.

A. Keyway in crankshaft pulley
B. Crankshaft pulley showing bolt hole identified on front face
C. Crankshaft damper
D. Rubber insert
E. Crankshaft damper centre
F. Bolt hole identified on rear face

4. CRANKSHAFT PULLEY AND DAMPER

Withdraw the crankshaft pulley and damper from the front end of the crankshaft by removing the nut. Check that the character 1 (numeral one) is stamped adjacent to the same fixing hole of the crankshaft pulley and damper on the front and rear faces respectively. The crankshaft pulley can be detached from the damper by removing the six nuts and bolts.

5. REPLACEMENT

The replacement of the crankshaft pulley and damper is the reversal of the removal sequence, but particular attention must be given to the following points.

(i) That the bolt holes identified (by the numeral 1) are fitted in line.

(ii) That a new crankshaft nut locking washer is used. Fig. D25.

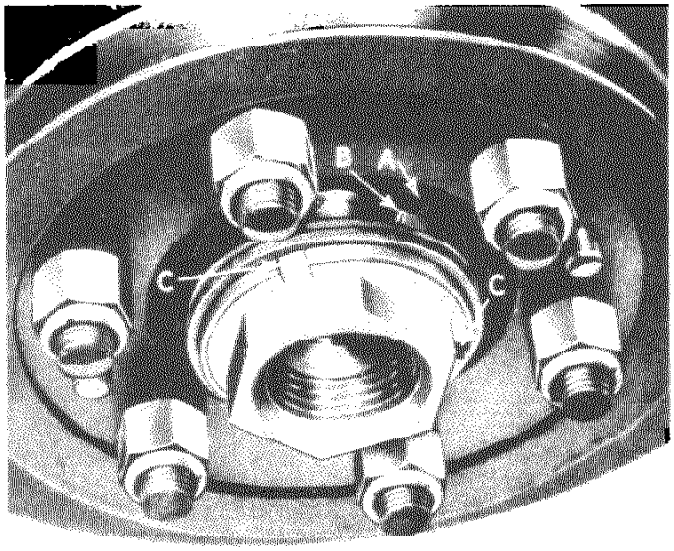

Figure D25

Crankshaft nut and locking washer.

A. Keyway in crankshaft pulley
B. Tag on rear face of locking washer
C. Groove in crankshaft nut in which locking washer rim is located

TIMING CHAIN COVER OIL SEAL

To obtain an oil-tight seal at the bottom half of the timing chain cover during initial assembly of the engine unit, it will be necessary to ensure the flush fitting of the oil sump bridge piece and the front face of the cylinder block and the following sequence should be adopted: Fig. D26.

Slacken off the two bolts securing the engine sump bridge piece beneath the front crankshaft bearing cap. Offer up the timing chain cover and secure with the bottom six bolts, two which tighten into the front face of the cylinder block and four into the front face of the engine sump bridge piece. The four bolts immediately above these bolts, together with the two top bolts adjacent to the dynamo mounting studs are tightened next. The remaining two bolts are tightened when the carburettor drain pipes are attached and the top section of the timing chain cover is secured when the dynamo mounting bracket is fitted. The two engine sump bridge piece bolts are then tightened.

The aforementioned instructions only apply to the fitting of the timing chain cover when the engine sump bridge piece has been refitted, and other instructions will be found under "HYDRAULIC TIMING CHAIN TENSIONER" - "REMOVAL AND REPLACEMENT" page

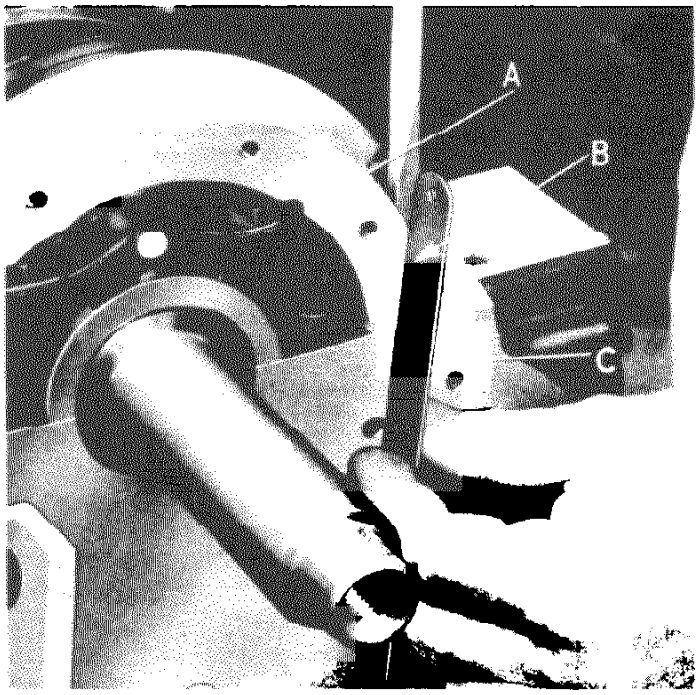

Figure D26

Engine sump bridge piece alignment. to ensure good oil sealing.

A. Engine sump bridge piece

B. Straight edge

C. Front face of cylinder block

THE HYDRAULIC TIMING CHAIN TENSIONER AND TIMING CHAIN VIBRATION DAMPER

THE HYDRAULIC TIMING CHAIN TENSIONER

DESCRIPTION Figs. D27 and D28.

The hydraulic timing chain tensioner is attached by two bolts to the front face of the crankcase adjacent to the R.H. side of the timing chain (the non-drive side)and is operated by high pressure oil from the main oil gallery to front crankshaft bearing drilling. It is fully automatic in use and will require no adjustment. Incorporated in its design is a restraint mechanism which prevents the slipper head from retracting as the timing chain tightens on the non-drive side during an over-run.

Internally it is self lubricating from the high pressure oil supply and the friction face of the tensioner is lubricated by oil from a drilling in the slipper head.

When it is observed that the slipper head has become deeply grooved, the complete tensioner must be replaced.

THE TIMING CHAIN VIBRATION DAMPER

DESCRIPTION Fig. D28.

The timing chain vibration damper is rigidly attached by two bolts to the front face of the cylinder block adjacent to the L.H. side of the timing chain (the drive side). Its purpose is to damp out any vibration that may occur momentarily in the drive side of the timing chain; it is a nylon moulding, silent in operation and will require no adjustment.

It is lubricated by oil mist and spray from the hydraulic chain tensioner and the overflow oil from the crankshaft bearings.

When it is observed that the nylon face has deep grooves the vibration damper must be replaced.

REMOVAL AND REPLACEMENT
HYDRAULIC TIMING CHAIN TENSIONER AND VIBRATION DAMPER Fig. D28.

1. CRANKSHAFT PULLEY AND DAMPER

Remove, but do not separate, the front crankshaft pulley and damper from the front end of the crankshaft as detailed on page D26.

2. COOLING SYSTEM CONNECTIONS

Completely drain the cooling system, detach the radiator connections. Remove the thermostat/cylinder head connection pipe assembly from the two cylinder heads and the coolant pump housing/cylinder block connection pipe assembly from the cylinder head as detailed in the COOLING SYSTEM, SECTION C.

3. DYNAMO BRACKET

Remove the dynamo and mounting bracket from the top of the engine unit as detailed in the ELECTRICAL EQUIPMENT, SECTION O.

4. TIMING CHAIN COVER

Remove the timing chain cover from the front face of cylinder block and four dynamo mounting studs by withdrawing twelve bolts.

5. HYDRAULIC TIMING CHAIN TENSIONER

Render the hydraulic timing chain tensioner inoperative by withdrawing the screwed end plug and utilizing an allen key, through the plug aperture, turn the restraint cylinder clockwise until it is fully retracted; withdraw the allen key and replace the screwed end plug for safe keeping. Remove the hydraulic chain tensioner from the R.H. side of the timing chain by withdrawing two bolts.

6. TIMING CHAIN VIBRATION DAMPER

Detach the timing chain vibration damper from the L.H. side of the timing chain by withdrawing two bolts.

7. REPLACEMENT

The replacement of the timing chain vibration damper, hydraulic timing chain tensioner, timing chain cover, dynamo and mounting bracket, crankshaft pulley and damper is the reversal of the removal sequence, but particular attention must be given to the following points.

(i) That the crankshaft oil thrower disc is in position on the front of the crankshaft.

(ii) That the hydraulic timing chain tensioner and backing plate is attached to the R.H. side of the timing chain in its inoperative condition. Withdraw the screwed end plug and utilizing an allen key, through the screwed plug aperture, turn the restraint cylinder anti-clockwise until a "click" is heard, and then the slipper head will move out of the body under the influence of its spring and contact the timing chain, withdraw the allen key and fit the screwed end plug.

(iii) The timing chain vibration damper must be refitted with a uniform clearance of 0.060" between the damper face and the back of the chain.

DISMANTLING AND ASSEMBLING, HYDRAULIC TIMING CHAIN TENSIONER Fig. D27.

Detach the backing plate and withdraw the slipper head assembly. Utilizing an allen key, turned anti-clockwise, withdraw the restraint cylinder and spring. Clean all parts thoroughly.

The assembling of the hydraulic timing chain tensioner is the reversal of the dismantling sequence, and by utilizing an elastic band the slipper head assembly can be held inside the outer body until refitted.

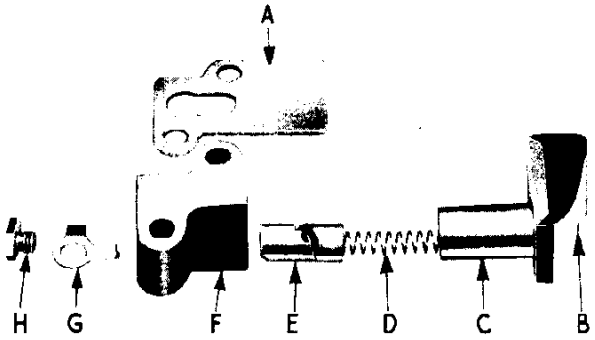

Figure D27

Exploded view of hydraulic chain tensioner
A. Backing plate
B. Oil bleed hole
C. Slipper head assembly
D. Spring
E. Restraint cylinder
F. Chain tensioner body
G. Locking washer
H. Screwed plug

THE TIMING CHAIN AND GEARS

DATA

Position		In separate compartment in front of engine unit by attaching a pressed steel cover to the front face of cylinder block.
Type of drive		Silent, endless duplex chain.
Timing chain tensioner		Hydraulic type from high pressure oil lubricating system.
Timing chain damper		Nylon moulding.
Valve timing	Inlet valve	opens 13°B.T.D.C.) With valve rocker
	Inlet valve	closes 65°A.B.D.C.) clearance set
	Exhaust valve	opens 55°B.B.D.C.) at 0.010"
	Exhaust valve	closes 23°A.T.D.C.) (0.254 mm.)
Timing chain		Renold No. 114038; 3/8" (0.525 mm.) pitch, $\frac{1}{4}$" (6.350 mm.) dia. roller, 66 pitches.

DESCRIPTION

The camshaft is driven from the front end of the crankshaft by an endless silent duplex chain and gears keyed to both the camshaft and crankshaft. The two gears are "timed" to one another by "spot" markings on the teeth and must be fitted to the camshaft and crankshaft with these identification markings correctly aligned.

Two teeth are identified on the camshaft chainwheel while one tooth is identified on the crankshaft sprocket. The identified tooth of the crankshaft sprocket is positioned so that it lies on a line joining the centres of the two gears while the two identified teeth of the camshaft chainwheel lie one each side of the line. Both these gears are located on their respective shafts by keys and so the shafts become co-related, thus timing the piston to the cam lobes on the camshaft.

The timing chain is endless and is fitted to the two gears and then assembly fitted to the crankshaft and camshaft.

The timing of the engine is effected by positioning the crankshaft so that the piston of No. 1L cylinder is at T.D.C. and the inlet and exhaust valves of the same cylinder are at the point of rock, thus when the timing gears and chain are fitted the position of No. 1L piston is set at T.D.C. of the exhaust induction stroke.

REMOVAL AND REPLACEMENT, TIMING GEARS AND CHAIN

1. REMOVAL

Turn the crankshaft so that No. 1L piston is at T.D.C. on its compression firing stroke and proceed as detailed under "REMOVAL AND REPLACEMENT, HYDRAULIC TIMING CHAIN TENSIONER AND VIBRATION DAMPER" as detailed on page D28.

Feed a piece of soft wire through both sides of the timing chain beneath the camshaft chainwheel and secure both ends together so that the chainwheel will not leave the timing chain when the timing gears and chain are removed from the engine unit. Repeat this operation with the crankshaft chainwheel.

Detach the camshaft chainwheel from the camshaft by removing the nut, withdraw it together with the timing chain and crankshaft chainwheel from the front of the crankshaft. Remove the keys from the camshaft and crankshaft if necessary.

When it is known that the timing gears and chain are in good condition they can remain as an assembly and stored. Otherwise the wire can be cut and the gear and chain inspected.

2. REPLACEMENT

The replacement of the timing gears and chain is the reversal of the removal sequence, but particular attention must be given to the following points.

(i) That when new gears are to be fitted, offer them up to their respective shafts and ensure that they are a good smooth fit.

(ii) That the two gears are laid on a clean bench top so that the single identified tooth of the crankshaft chainwheel is between the two similarly identified teeth of the camshaft chainwheel. The timing chain is then fitted to the camshaft chainwheel and the crankshaft chainwheel moved away from the camshaft chainwheel to mesh with the timing chain but ensuring that its single identified tooth remains on an imaginary centre line joining the centres of the two timing gear and between the two identified teeth of the camshaft chainwheel. It will be noted that the single identified crankshaft chainwheel tooth lays between the two identified teeth of the camshaft chainwheel and the keyway of the latter adopts approximately a 20° clockwise position from the centre line while the crankshaft chainwheel keyway adopts a 45° clockwise position from the centre line.

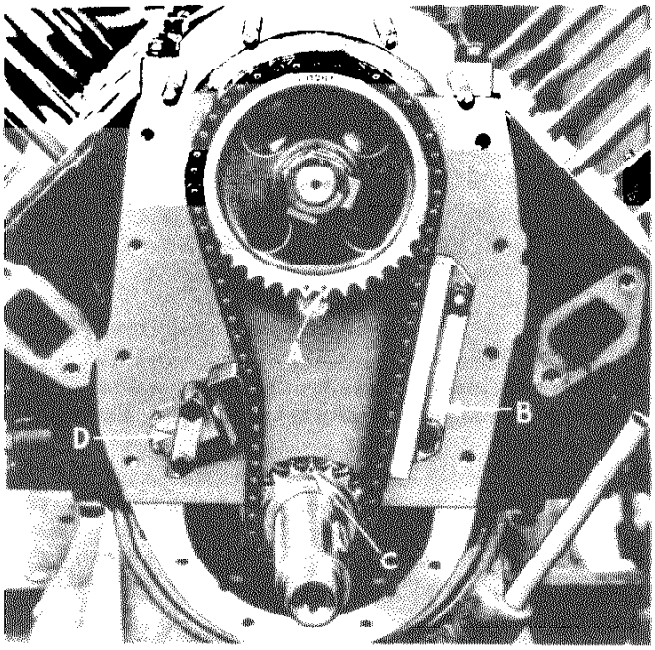

Figure D28

Timing chain and gears showing identified teeth to facilitate valve timing.

A. Two teeth marked on camshaft chainwheel

B. Nylon chain damper

C. One tooth marked on crankshaft chainwheel

D. Hydraulic chain tensioner

DO NOT TURN CRANKSHAFT WITH TIMING CHAIN REMOVED.

TESTING THE TIMING CHAIN STRETCH Fig. D29.

Securely block the crankshaft to prevent any movement clockwise or anti-clockwise and remove the hydraulic timing chain tensioner.

Turn the camshaft clockwise with a torque spanner until 30 lbs. ft. is registered, this will take up any slack in the timing chain and align a rule to one of the chain rivets at the top of the camshaft chainwheel. Apply the same amount of torque in the opposite direction and note the amount of timing chain movement.

When a chain movement of 0.250" (6.350 mm.) is determined, the timing chain must be replaced and the timing gears examined for wear.

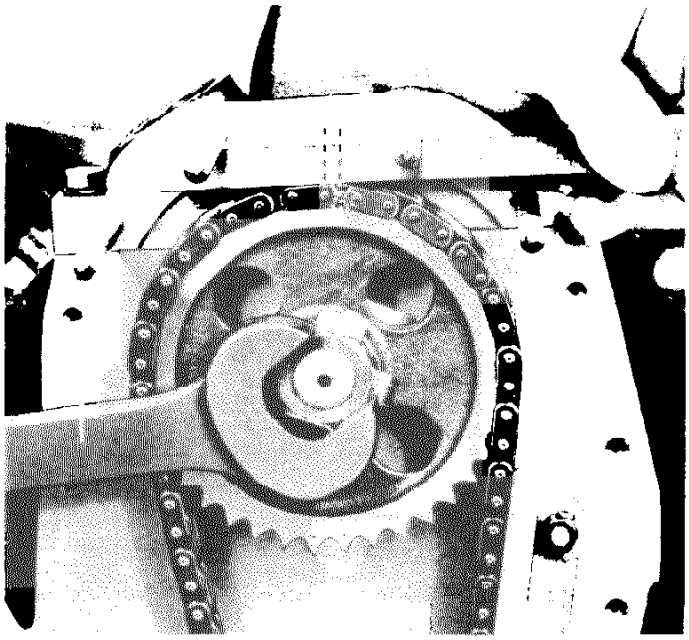

Figure D29

Testing the timing chain for stretch.

Arrow indicates movement of spanner.

Dotted lines indicate maximum wear.

EXAMINE THE TIMING GEAR TEETH FOR WEAR Fig. D30

Examine the driven side of the camshaft chainwheel teeth and the drive side of the crankshaft sprocket teeth alongside un-used components and when any appreciable "hooking" is determined the chainwheel and/or sprocket must be replaced.

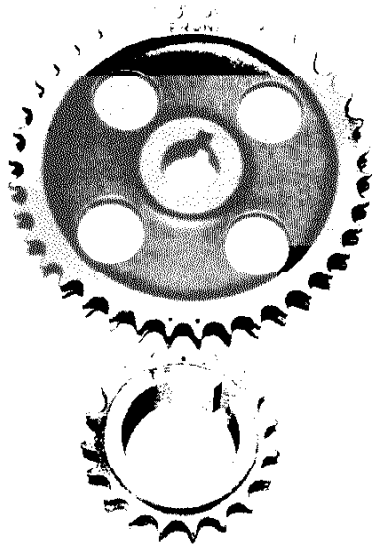

Figure D30

Crankshaft and camshaft chainwheels showing extreme wear on teeth.

THE CAMSHAFT

DATA

Material	Carbon case hardeded steel.
Position	Vertically above crankshaft between banks of cylinder bores.
Drive	Duplex chain and sprockets.
End Thrust	Taken by thrust washer attached to the front face of the cylinder block.
Lubrication	Full pressure feed to each bearing from the main oil gallery which fills a cylindrical reservoir in which the camshaft revolves.
Oil Sealing	Welch washer plug in rear face of cylinder block.
Timing identification markings	Two teeth have "spot" markings on camshaft chainwheel.

DESCRIPTION

The camshaft, machined from carbon case hardening steel, is situated in the top of the cylinder block between the two cylinder head fitting faces vertically above the crankshaft, and is driven by a chainwheel and duplex chain from a sprocket on the front end of crankshaft. These wheels are "timed" together by a single marked tooth on the crankshaft sprocket aligning between two similarly marked teeth of the camshaft chainwheel.

The camshaft is mounted on six replaceable shell type white metal bearings pressed and "dimpled" in the cylinder block front and rear faces and bearing webs, and the spaces between the bearing housings form oil reservoirs. The end thrust is taken by a plate attached to the front face of the cylinder block between a thrust washer behind the chainwheel and the front shoulder of the front camshaft bearing.

A detachable cover plate is fitted to the top of the cylinder block as detailed on page D24.

CAMSHAFT LUBRICATION

The lubrication of the six camshaft bearings is effected by vertical drillings from the main oil gallery which runs the entire length of the cylinder block. The individual cam lobes and tappets are lubricated by oil escaping from the six bearings filling reservoirs formed by the front and rear faces of the cylinder block and the webbed shaped housings of the four intermediate camshaft bearings. The oil drains back into the engine sump through transfer holes in the front face of the cylinder block and lubricates the timing gears, chain, tensioner and damper. Oil escaping from the front camshaft bearing lubricates the thrust plate assembly and passes downward with the camshaft overflow oil under the timing chain cover, through transfer holes between the front crankshaft bearing cap and the engine sump bridge piece into the engine sump.

The rear camshaft journal has a transverse drilling which permits a metered and intermittent supply of oil to pass upward for lubrication of the valve operating gear.

REMOVAL AND REPLACEMENT, CAMSHAFT

1. ENGINE REMOVAL

Remove the engine unit with gearbox attached as detailed on page D52.

When the camshaft bearing liners are to be changed the gearbox unit, clutch and flywheel must be detached as detailed in the GEARBOX AND CLUTCH UNIT, SECTIONS H and G, respectively.

2. HYDRAULIC TIMING CHAIN TENSIONER AND VIBRATION DAMPER

Remove the hydraulic timing chain tensioner and vibration damper from the front face of the cylinder block as detailed on page D27.

3. TIMING GEARS AND CHAIN

Remove the timing gears and chain from the front ends of the camshaft and crankshaft as detailed on page D29.

4. VALVE ROCKER SHAFT ASSEMBLIES

Remove the valve rocker shaft assemblies from the top faces of the cylinder heads as detailed on page D15.

5. TAPPET BLOCK AND COVER

Remove the tappet block and cover from the top of the cylinder block, as detailed on page D24.

6. CAMSHAFT

Withdraw the oil pump/ignition distributor driving shaft and thrust washer from the rear end of the camshaft compartment by lifting it vertically upward. Identify the front face of the camshaft thrust plate and remove it from the front face of the cylinder block by withdrawing two bolts. Withdraw the camshaft through the front face of the cylinder block.

7. CRANKSHAFT

Remove the crankshaft from the cylinder block as detailed on page D47

8. CAMSHAFT BEARING LINERS

Remove the camshaft bearing liners from the cylinder block as detailed on page D34.

9. REPLACEMENT

The replacement of the camshaft bearing liners and camshaft is the reversal of the removal sequence, but particular attention must be given to the following points:

(i) That the camshaft end float is set as detailed on page D34.

(ii) That the fitting of the oil pump/ignition distributor drive is left until the timing gears and chain have been fitted to the front ends of the crankshaft and camshaft.

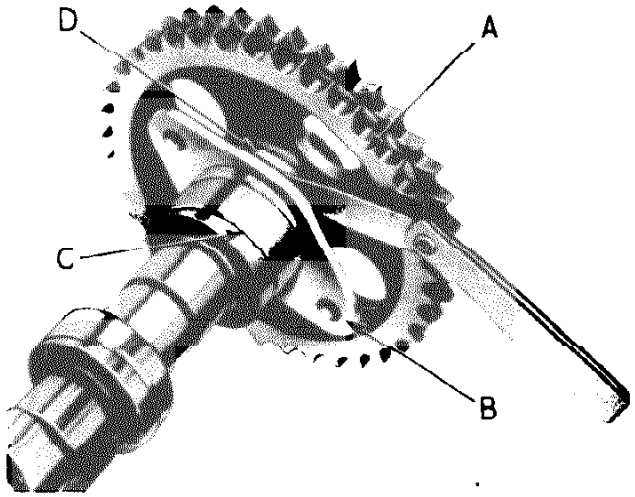

Figure D31

Checking camshaft endfloat with feeler gauges between camshaft thrust plate and thrust washer.

A. Camshaft chainwheel
B. Camshaft thrust plate
C. Camshaft front journal; note oil scroll
D. Camshaft thrust washer

THE CAMSHAFT THRUST AND END FLOAT

DESCRIPTION Fig. D31.

Camshaft thrust is taken by the rear face of a sintered iron thrust washer trapped between the rear of the camshaft chainwheel and a shoulder on the camshaft at the front and by the front face of the front camshaft journal contacting both sides of a sintered iron thrust plate attached to the front face of the cylinder block by two bolts. The thrust plate is fitted by selective assembly to give the specified end float.

Lubrication of the thrust plate is by oil emitting from the front face of the front camshaft bearing and being transferred to the second side of the thrust plate through the material of the thrust plate itself and the clearance between the thrust plate and the camshaft.

When removing the camshaft thrust plate from the front face of the cylinder block it is advisable to identify the front face as this has a larger wearing contact surface than the rear face. If these faces are badly "stepped" the thrust plate must be renewed.

If the rear surfaces of the camshaft thrust washer or plate are observed to be stepped they must be replaced.

REMOVAL AND SETTING, CAMSHAFT END FLOAT Fig. D31.

Grip the camshaft in the protected jaws of a vice and feed on the camshaft thrust plate, when replacing a used thrust plate ensure that it is fitted the correct way round. Follow with the thrust washer and camshaft chainwheel, the chamfered bore end first, and "nip up" with the nut; a distance piece can be used in place of the chainwheel.

Ascertain the end float by inserting feeler gauges between the thrust washer and thrust plate NOT between the thrust plate and the front face of the camshaft journal.

When the determined end float is less than that specified the thrust plate must be removed from the camshaft and its thickness reduced by rubbing it on a sheet of fine emery cloth laid on a surface plate. If the determined end float is too great a thicker thrust plate must be selected.

DIMENSIONS, CAMSHAFT

Dia. of bore in cylinder block for camshaft bearings	1.6905" 1.6895"	42.9387 mm. 42.9133 mm.
Dia. of camshaft bearings	1.6945"	43.0403 mm.
Dia. of bore in camshaft bearings after line boring	1.5633" 1.5622"	39.70782 mm. 39.67988 mm.
Dia. of camshaft journals	1.5609" 1.5601"	39.64686 mm. 39.62654 mm.
Thickness of camshaft thrust plate	0.122" 0.120"	30.988 mm. 30.480 mm.
Camshaft end float	0.003" 0.006"	0.076 mm. 0.152 mm.

THE CAMSHAFT BEARING LINERS

DESCRIPTION

The six camshaft bearings are of the split steel back white metal liner type and owing to the relatively light load and the large bearing surface provided, these bearings are not subjected to very much wear and in some instances may outlive the engine unit. However, it may become necessary to fit replacements when the engine oil and/or filter changes have been neglected.

The bearing liners are pressed into position and then "dimpled" to ensure a locked position, they are line bored with the borer jigged to the crankshaft bearing housings. The front bearing liner must never protrude above the front cylinder block face and the rear face of the cylinder block is sealed with a welch washer plug.

REMOVAL AND REPLACEMENT, CAMSHAFT BEARING LINERS Fig. D32.

It is assumed for this instruction that the cylinder block has been completely stripped of all its components.

1. REMOVAL

Remove the welch washer plug from the rear face of the cylinder block as detailed below. Stand the cylinder block on one of its end faces and eject the camshaft bearing liners, a little force will be required to overcome the "dimpling" but this can be avoided by enlarging the oil drilling in the bearing liner to $\frac{1}{4}$" dia.

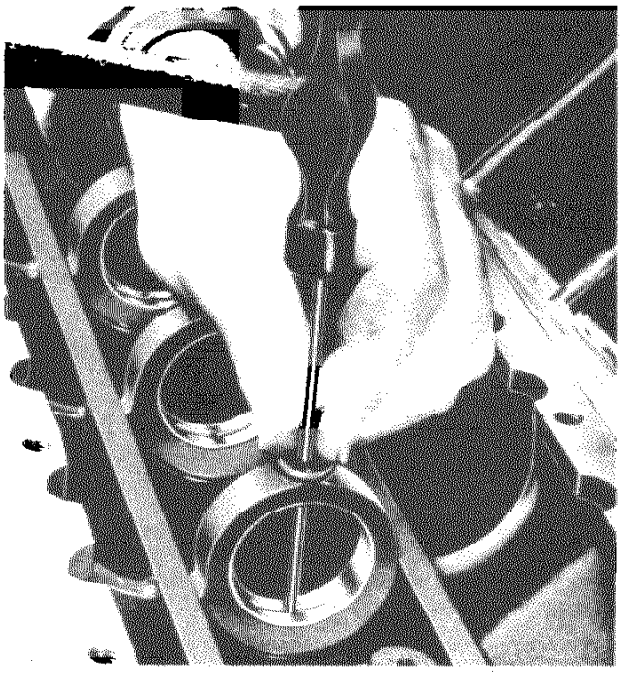

Figure D32

"Dimpling" to locate camshaft bearing liner before line boring

2. REPLACEMENT

Fit the four intermediate bearings first, that is the short ones, so that the split is to the R.H. side of the cylinder block with the small drilling aligning with the oil drilling from the main oil gallery, utilizing the shouldered mandrel.

Fit the rear bearing liner, the smaller of the two remaining, in a similar manner to the intermediate bearings but ensure that the rear edge does not stand proud of the welch washer plug face in the cylinder block rear face.

Fit the front bearing liner, the longer, in a similar manner to the others, but ensure that the front edge does not stand proud of the cylinder block rear face.

The bearing liners are line bored to the dimensions specified with line boring equipment jigged to the crankshaft bearing housings. On completion all traces of machining swarf must be cleaned away.

THE WELCH WASHER PLUG

DESCRIPTION Fig. D33.

The pressed steel welch washer plugs are used to seal apertures in the cylinder block. One seals the rear face of the rear camshaft bearing housing, four more seal core holes in the front and rear faces of the two banks of cylinder bores and a further six, three at each side, seal off core holes in each side of the cylinder block, two nearer the cylinder head fitting face and one nearer the engine sump fitting face at each side.

It must be realised that once the welch washer plug has been removed it must not be replaced in the cylinder head, but a new one fitted.

The welch washer plug is a convex shape plate which is flattened slightly when in position, forcing the outer periphery into the rim of the aperture and so effecting a seal. Care must always be exercised when flattening the convex form as excessive flattening is the method for removal.

REMOVAL AND REPLACEMENT, WELCH WASHER PLUG Fig. D33.

1. REMOVAL

Indent the convex shape of the welch washer plug with a flat ended drift, approximately half the diameter of the washer.

2. REPLACEMENT

Thoroughly clean the welch washer plug and the aperture in the cylinder block and smear the latter with jointing compound. Insert the washer plug in the cylinder block, concave side first and utilizing a drift slightly flatten the convex form.

Slight leakage around the periphery of the welch washer plug can be corrected by utilizing a drift and flattening the convex form still further.

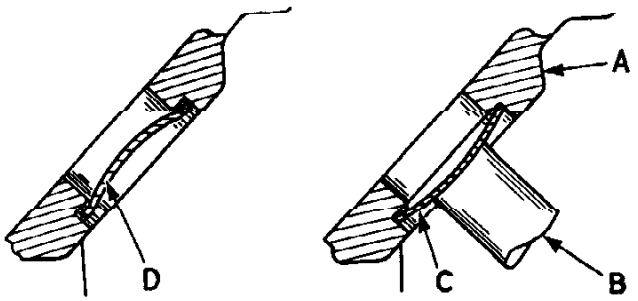

Figure D33

Fitting and removing welch washer plugs

A. Sidewall of cylinder block
B. Concave faced drift
C. New welch washer plug
D. Welch washer plug ready for removal

THE CYLINDER BLOCK AND CRANKCASE

DESCRIPTION

The cylinder block and crankcase are integrally cast in BS.1452 grade 17, cast iron alloy to provide the maximum rigidity between the combustion heads and the crankshaft. A generous coolant jacket is provided, the outside wall of which is sealed with pressed steel welch washer plugs, three each in the two side faces and two in each front and rear face.

The crankshaft bearing caps, front, centre, rear and two intermediates, are fitted to the cylinder block and then line bored in position. The bearing caps are then identified to their respective positions and then by a second number to the cylinder block. Thus, when two or more cylinder blocks are being worked on at any one time the main bearing caps to any one cylinder block can be immediately recognised.

Several oil drillings are made in the cylinder block and should be kept closed when the cylinder block has been stripped and cleaned. An oil way comes up the R.H. face of the oil pump fitting face on the rear crankshaft bearing cap to a second drilling from the oil filter fitting face at the R.H. side of the cylinder block and a third drilling from the oil filter fitting face to the main oil gallery. The main oil gallery runs the whole length of the cylinder block and is plugged at each end by a screwed aluminium plug. Drillings from the crankshaft and camshaft break into the main oil gallery to provide lubrication for those bearings while a further drilling at the front end of the cylinder block supplies oil pressure to the hydraulic timing chain tensioner, the outer end of this drilling is blanked off with a bolt.

The top portion of the rear camshaft bearing housing is tapped for the banjo bolt which attaches the pipe assembly for rocker shaft lubrication.

THE CYLINDER BORES

Eight cylinder bores are made into the cylinder block, four from each side and they are inclined to subtend an angle of 90° between. Their axes cross the axis of the crankshaft main bearings but the L.H. are positioned forward of the R.H. They are identified L. or R. and 1 to 4, number one being at the front.

The bores are graded into two sizes and an identification letter A or B is stamped on the outside face of the cylinder block. Only pistons bearing the same identification letter as that stamped on the cylinder block must be fitted to that particular bore. Oversize cylinder bores are not graded

REBORES

The previous bore size can be ascertained either by cleaning the piston crown for identification markings, observing the plate on the side of the cylinder block which is fitted when the engine unit has been overhauled by The Daimler Company, or by cleaning the carbon from the top of the cylinder bore and measuring it with a micrometer.

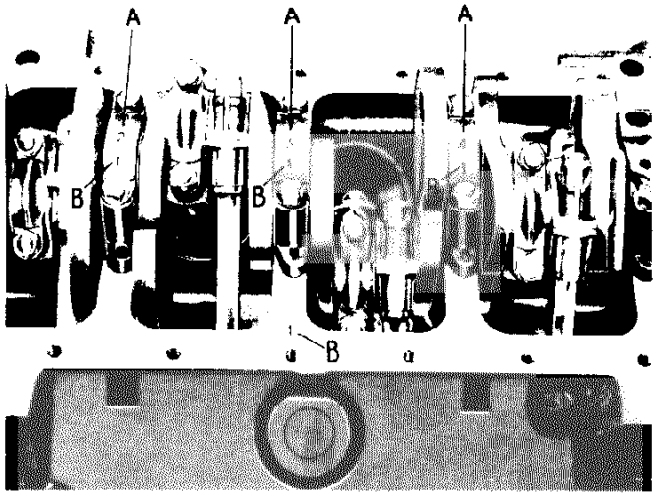

Figure D34

Underside of cylinder block showing identification markings

A. Identification number of main bearing caps.

B. Engine cylinder block identification number.

The decision to rebore, apart from oil consumption considerations, will depend on the maximum bore reading and this with the examiner, who must realise that there are only two oversizes.

About four-fifths of the excess wear reading over the previous bore size can be regarded as ovality and in order to "clean up" this wear, the cylinder must be enlarged by twice the ovality figure.

After reboring the cylinder bores the identification markings A or B will no longer be applicable, it is suggested that these markings are deleted.

MEASURING THE CYLINDER BORES Fig. D35.

Each cylinder bore must be checked by measuring across the gudgeon pin and thrust axes, the latter being 90° removed from the gudgeon axis, with a suitable precision instrument handled according to its manufacturers instructions.

Maximum permissible wear of any cylinder bore measure across the axis of thrust at a point in the cylinder bore where the top compression ring attains the limit of its upward travel (piston at T.D.C.) is 0.007" (0.178 mm.). Similarly where the bottom of the piston skirt attains the limit of its downward travel (piston at B.D.C.) is 0.005" (0.127 mm.).

By determining and comparing the cylinder bore diameters across the aforementioned axes, the amount of ovaility can be calculated. When the amount of ovality exceeds 0.005" (0.127 mm.) the cylinder must be rebored.

By determining and comparing the cylinder bore diameters across the aforementioned axes at various depths in the cylinders, the amount of taper can be calculated. When the amount of taper exceeds 0.020" (0.508 mm.) the cylinder must be rebored.

THE THRUST FACES

The thrust face of any cylinder is that side of the cylinder bore toward the R.H. side of the cylinder block when viewed from the drivers seat.

The thrust face of any piston is that side of the piston toward the R.H. side of the engine unit when viewed from the driver's seat.

The axis of thrust (thrust axis) is 90° removed from the gudgeon pin axis.

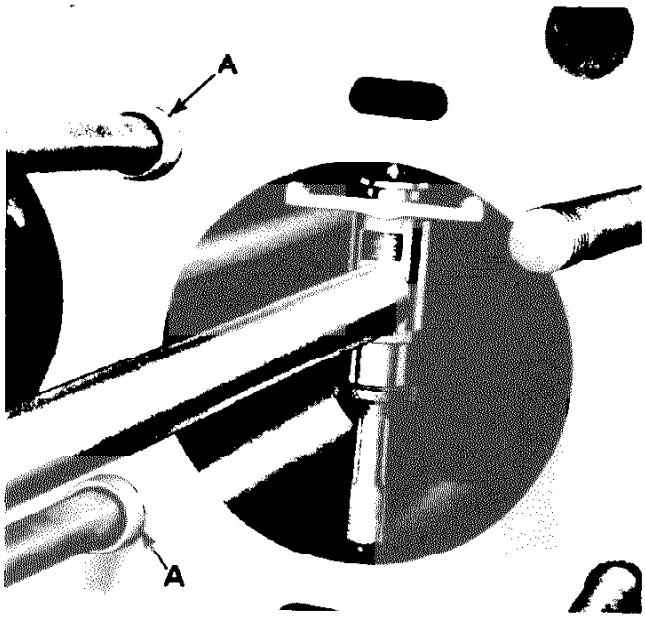

Figure D35

Measuring cylinder block bore on the axis of thrust with Mercier gauge.

A. Cylinder head locating ring dowels.

THE PISTONS, PISTON RINGS, GUDGEON PINS AND CONNECTING ROD ASSEMBLIES

DATA

PISTON

Material	Aluminium alloy.
Type	Solid skirt with high crowns indented to provide adequate clearance for the valve heads.

PISTON RINGS

Number	Three to each piston.
Location	All above the gudgeon pin.
Top	Plain, chromium plated.
Second	Taper faced.
Third	Oil control.

GUDGEON PIN

Type	Steel, floating type, located endwise with circlips.

CONNECTING RODS

Material	Carbon manganese steel.
Bearing cap location	Waisted bolts.
Removal	Through top of cylinder block.

PISTON ASSEMBLIES

The pistons are a solid skirt type machined from an aluminium alloy casting having a built up crown which is recessed on the thrust axis to provide clearance for the valve heads. Provision is made for two compression rings and one oil control ring, all fitted above the floating gudgeon pin which is located endwise by two circlips.

The piston skirt immediately below the gudgeon pin is cut away to provide adequate clearance for the crankpin throws.

The piston is ground to an oval shape below the piston rings, and when finished the diameter on the gudgeon pin axis is 0.010" (.254 mm.) less than the diameter on the thrust axis, i.e. 90°

removed from the gudgeon pin axis. The piston is ground parallel and oval from the bottom of the piston skirt and upward for about 0.750" (19.050 mm.) and then an oval taper upward for approximately 1.000" (25.400 mm.); the upper portion of the piston forming the lands for the piston rings are ground round in two sizes, the land between the top piston rings and the piston crown is the smaller. The piston should, therefore, only be measured at the bottom of its skirt, and when new it can be fitted either way round. It is measured after manufacture and graded into two sizes A and B, but oversize pistons are machined to size.

The piston rings consist of one plain chromium plated ring fitted in the top groove, a tapered piston ring fitted, taper upward, in the groove below and an oil control ring of the slotted type is fitted in the bottom groove.

When replacement piston rings are fitted for service in used cylinder bores, ensure that the ridge at the top of the cylinder bore is honed away. Failure to observe this instruction may result in a tapping noise while the engine unit is running and possible fracture of the land between the top and second piston rings may result in locking the second piston ring in its groove.

The gudgeon pin is manufactured from nickel-chrome case hardened steel. is of the floating type and is located endwise by circlips.

PISTON NOISES

These aluminium pistons will contract in size as the engine cools down and the oil film between the moving parts drains away. Piston noise, when a cold engine is first started, can, therefore, be described as normal and does not always indicate badly fitting pistons, providing the piston noise becomes inaudible when the engine reaches its normal working temperature.

THE CONNECTING ROD ASSEMBLIES

The connecting rod is machined from a carbon manganese steel stamping and is afterward polished for the purpose of crack detection. The big end cap is attached to the connecting rod and both are machined as an assembly, the cap is then identified to the rod.

The bearing liner locating recesses are both positioned on the same side and one side of the bore has a larger chamfer and as one crankpin accommodates two connecting rods, the large chamfers must be positioned adjacent to the crankpin throws.

The connecting rod and cap is weighed, graded and when fitting replacement connecting rods it will be essential that one having the same identification letter is fitted.

THE CONNECTING ROD AND CAP IDENTIFICATION

Each connecting rod and bearing cap has its own identification number stamped on the side of the connecting rod and bearing cap adjacent to its fitting face. The fitting face of connecting rod and cap must never be filed in an attempt to reduce excessive bearing clearance.

THE CONNECTING ROD ALIGNMENT

Before the piston is fitted to the connecting rod the latter must be checked for bend and twist. The "bend fault" will prevent the bottom of the piston skirt being perpendicular to the crankpin journal while the "twist fault" is when the axes of the gudgeon pin and crankpin are not parallel in the same plane.

WEIGHT OF PISTON AND CONNECTING ROD ASSEMBLIES

The maximum variation between the heaviest and lightest connecting rods in a set of eight must not exceed 7 drams(12.39 grams) and for a set of eight pistons 3 drams (5.31 grams).

When fitting the pistons to the connecting rods arrange for the lighter pistons to be fitted to the heavier connecting rods. This is to ensure that the maximum variation between the heaviest and lightest piston and connecting rod assembly in a set of eight does not exceed 4 drams (7.09 grams).

THE GUDGEON PIN BUSH BEARING

The gudgeon pin bearing is a "Clevite" bush bearing pressed into the small end of the connecting rod so that its oil drilling aligns with that in the top of the connecting rod and then reamed to the dimensions specified.

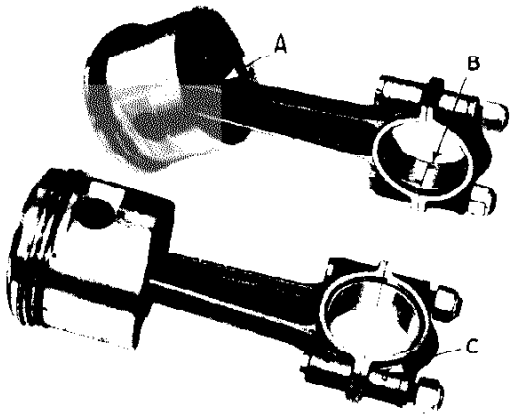

Figure D36

Piston and connecting rod assemblies showing identification markings.

A. Weight identification letter

B. Alignment of bearing shells

C. Cap and rod identification number

REMOVAL AND REPLACEMENT, PISTON AND CONNECTING ROD ASSEMBLIES

1. CYLINDER HEADS

Remove the cylinder head(s) from the cylinder block face as detailed on page D18.

2. ENGINE SUMP

Remove the engine sump from the underside of the cylinder block as detailed on page D7.

3. CONNECTING ROD BEARINGS

Detach the connecting rod bearing caps from the bottom of the rods by removing two nuts each, identify each bottom half of the shell bearings to its bearing cap. Remove the top half of the shell bearings from the connecting rod and identify it to its respective position.

5. REPLACEMENT

The replacement of the piston and connecting rod assemblies is the reversal of the removal sequence, but particular attention must be given to the following points:

(i) That the connecting rods have been examined for bend and twist before the pistons are fitted.

(ii) That the connecting rod bearing clearance is checked to ensure that it is within the specified limits as detailed on page D43.

DISMANTLING AND ASSEMBLING, PISTON AND CONNECTING ROD ASSEMBLIES

1. PISTON RINGS

Remove the piston rings from the pistons identifying each to its groove and piston.

2. GUDGEON PIN AND PISTON

Withdraw the two gudgeon pin locating circlips from each end of the gudgeon pin and stand the piston and connecting rod assemblies, piston downward, in hot oil for a few moments to allow the piston to expand. Eject the gudgeon pin <u>without</u> using any force, remove the piston from the connecting rod and identify all components.

3. CONNECTING ROD SMALL END BEARING

Eject the gudgeon pin bush bearing from the small end of the connecting rod when it is seen to be badly worn.

4. ASSEMBLING

The assembly of the connecting rod and piston assemblies is the reversal of the dismantling sequence. but particular attention must be given to the following points:

(i) That the gudgeon pin bush is pressed into the small end of the connecting rod so that the oilways align and then reamed out to the dimensions specified and the connect-rods are examined for bend and twist.

(ii) That the closed piston ring gaps and their clearance in the piston groove are checked as detailed on page D42.

(iii) That the pistons are checked in the cylinder bores as detailed on page D42.

(iv) That the pistons are fitted to the connecting rods so that their front sides of the L.H. bank are on the same side as the large big end chamfer and those of the R.H. bank on the opposite side as the big end chamfer.

(v) That the ridge at the top of a used cylinder bore is honed away when fitting new piston rings.

(vi) That the connecting rod big end chamfer is fitted so that it is nearer the crankpin throws.

(vii) That the connecting rod end float on the crankpin is between the specified limits.

CHECKING CONNECTING ROD END FLOAT ON CRANKPIN Figs. D37 and D38.

It is important that the specified end float is apparent when the two connecting rods are fitted to the crankpin. It is suggested that it is checked after the bearing lining clearance has been found to be satisfactory and it is determined in the following manner:

Attach the connection rods and bearing liners to the crankpins, large chamfer toward the outside and hold firmly toward one flange of the crankpin journal. Determine the clearance utilizing feeler gauges between the side face of the connecting rod and the flank of the crankpin journal. When the determined clearance is too little it can be increased by rubbing down the four side faces of the connecting rod big end housings on a sheet of fine emery paper laid on a surface plate.

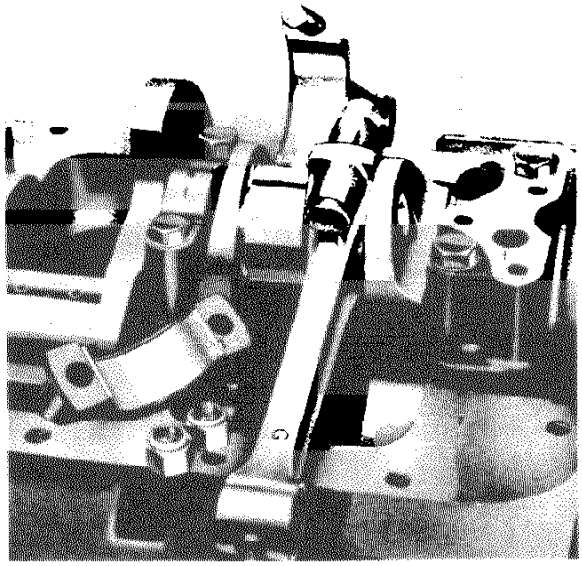

Figure D37
Connecting rods being assembled to crankpin showing position of chamfered details.

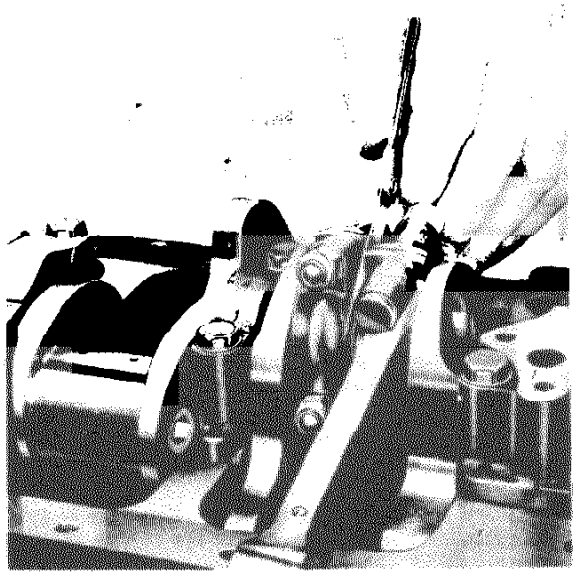

Figure D38
Checking the connecting rods on crankpin for endfloat.

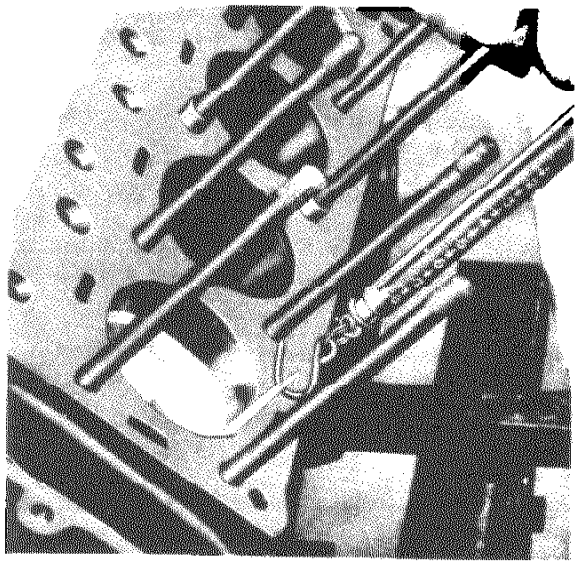

Figure D39

Piston in cylinder bore being checked for skirt clearance.

FITTING PISTONS Fig. D.39

Pistons must be fitted with great care and accuracy and both piston and cylinder bore should be clean and without any lubricant. The clearance between the thrust face of the piston at the top end and cylinder bore can be measured with a micrometer or dial indicator or by utilizing a shim stock of 0.004" (0.1016 mm).

Insert the pistons upside down in the cylinder bore with a feeler gauge, twice the thickness of the clearance between the thrust faces of the piston and cylinder bore, at a point on the R.H. side of the cylinder block 90° removed from the gudgeon pin axis. Hold the piston stationary and withdraw the feeler gauge; a pull of 8 to 14 lbs. should be sufficient. When less or greater pull is required the cause should be ascertained and adjusted.

The pistons, when new, can be fitted either way round in the cylinder bore, but once they have been in use must have their front faces identified before removal.

FITTING GUDGEON PINS

Test the gudgeon pin for fit in the small end of the connecting rod and through both bosses of the piston. In all instances the gudgeon pin must be a tight thumb press fit at normal room temperature.

Assembly of the gudgeon pin to piston and small end of connecting rod is greatly facilitated by submerging the piston crown in boiling water and leaving it long enough to expand the gudgeon pin bore.

In no circumstances whatsoever must the gudgeon pin be driven into the piston and connecting rod.

FITTING PISTON RINGS

Insert the piston ring into its appropriate cylinder bore and position squarely, with the assistance of an inverted piston, no more than half way down the cylinder bore, and ascertain the gap with feeler gauges. When the determined gap is greater than that specified a replacement must be fitted, and when too small, the gap can be increased by filing.

When determining the piston ring clearance in the groove do not fit the piston ring to the piston but inset it so that, with the piston, it forms a figure of eight. The piston ring can be rolled round in the groove and the clearance ascertained with feeler gauges.

When fitting taper face piston rings ensure that the apex of the taper is upward as signified by 'T' or "TOP" engraved on the side face.

The use of proprietary piston ring fitting pliers are most advantageous when fitting piston rings to the pistons.

Before fitting the piston ring compressor prior to fitting the piston and connecting rod assembly to its cylinder bore, ensure that the piston ring gaps are positioned alternatively over the gudgeon pin.

DIMENSIONS, PISTON, PISTON RINGS, GUDGEON PIN and CONNECTING ROD

PISTONS

Diameter of cylinder bore	A	(3.0003"	76.20762 mm.
		(3.0000"	76.200 mm.

Diameter of cylinder bore	B	(3.0000"	76.200 mm.
		(2.9997"	76.19238mm.
Diameter of piston at top of thrust face.	A	(2.9964"	76.10856mm.
		(2.9960"	76.0984 mm.
	B	(2.9960"	76.0984 mm.
		(2.9956"	76.08824mm.
Dia. of bore in piston for gudgeon pin.		(0.7511"	19.07794mm.
		(0.7508	19.07032mm.
Dia. of gudgeon pin.		(0.7510"	19.0754 mm.
		(0.7507"	19.06778mm.
Width of compression piston ring grooves.		(0.0645"	1.6383 mm.
		(0.0635"	1.6129 mm.
Width of oil control ring groove.		(0.1578"	4.00812mm.
		(0.1568"	3.98272mm.

PISTON RINGS

Thickness of compression rings.	(0.0625"	1.5875 mm.
	(0.0615"	1.5621 mm.
Thickness of oil control ring.	(0.1563"	3.977002mm.
	(0.1553"	3.94462mm.
Closed piston ring gap; compression and oil control.	(0.014"	0.3556 mm.
	(0.009"	0.2286 mm.
Clearance of compression rings in piston groove.	(0.0030"	0.0762 mm.
	(0.0010"	0.0254 mm.
Clearance of oil control ring in piston groove.	(0.0025"	0.0635 mm.
	(0.0005"	0.0127 mm.

CONNECTING ROD

Dia. of bore in small end for gudgeon pin bush bearing.	(0.87525"	22.23135mm.
	(0.87475"	22.21865mm.
Dia. of gudgeon pin bush bearing.	(0.878"	22.3012 mm.
	(0.877"	22.2758 mm.
Dia. of finished bore in gudgeon pin bush bearing.	(0.7513"	19.08302mm.
	(0.7511"	19.07794mm.
Length of connecting rod centre to centre.	5.750"	14.605 mm.

THE CRANKSHAFT, MAIN and CRANKPIN BEARING LINERS

CRANKSHAFT DATA

Material	Nickel, chromium molybdenum steel stamping.
Bearings	Five, steel backed liner bearings Lead indium lined.
Main bearing caps	B.S.1452 Grade 17, cast iron, located by two dowels, secured by two bolts.

Thrust	Thrust washers each side of centre bearing cap.
Oil retainers	At front end, oil scroll on crankshaft pulley. At rear end, piston ring type.

DESCRIPTION

The five bearing crankshaft is machined from nickel chromium molybdenum steel stamping and is balanced by large drillings in the webs of Nos. 1 and 8 crankpins and by smaller drillings in the webs of the remaining crankpins.

Oilways are drilled from the main journals through the crankpin webs to provide lubrication for the crankpin journals.

The camshaft driving gear is keyed to the front end of the crankshaft and its keyway aligns with the centre line of No. 1 L. web, crankpin, connecting rod and piston.

Crankshaft main journal and crankpin sizes can be determined by observing the engraved standard figures on the front crankpin web and noting the dimensions given under "DIMENSIONS" on page D49.

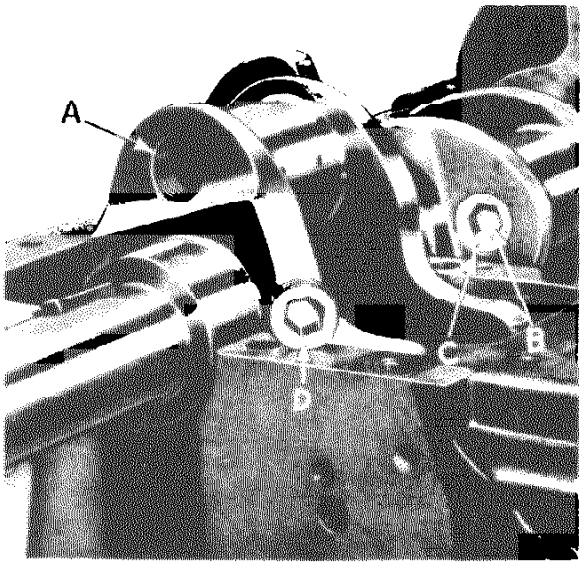

Figure D40

Crankpin sludge trap and plug.
A. Sludge trap. C. Staking.
B. Fitted plug. D. New plug

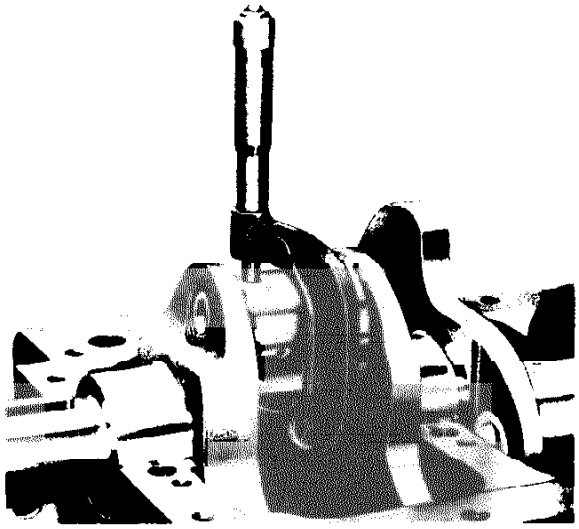

Figure D41

Crankpin being measured with a micrometer.

THE CRANKPIN SLUDGE TRAP Fig. D40.

A sludge trap is provided in the centre of each crankpin, the open end of which is closed by a plug and the crankpin is cross drilled twice, one for each connecting rod. During an overhaul the plugs should be removed and the sludge trap cleaned out. After replacing the plugs they should be staked over.

MEASURING THE JOURNALS Fig. D41.

The main and crankpin journals can be measured utilizing a micrometer and by taking several readings all in one plate, taper wear can be calculated.

By measuring across and along the axes of thrust, ovality can be calculated.

CRANKSHAFT THRUST Fig. D42.

The crankshaft thrust is taken by the ground side faces of the crankshaft centre main journal, and the white metal face of the two "C" shaped thrust washers positioned one each side of the centre main bearing cap. The thrust washers are prevented from revolving with the crankshaft by their ends abutting to the undersize face of the cylinder block.

Lubrication is effected by oil emitting from the centre main journal and passing downward through the grooves machined in the thrust faces of the washers.

The crankshaft thrust washers are available in three sizes as specified in "DIMENSIONS" page D49.

CHECKING CRANKSHAFT END FLOAT Fig. D43.

Utilizing feeler gauges determine the clearance between the side face of the centre main journal and the thrust washer having moved the crankshaft fully endwise. Alternately a dial test indicator can be used by placing its plunger vertically on the front or rear end of the crankshaft.

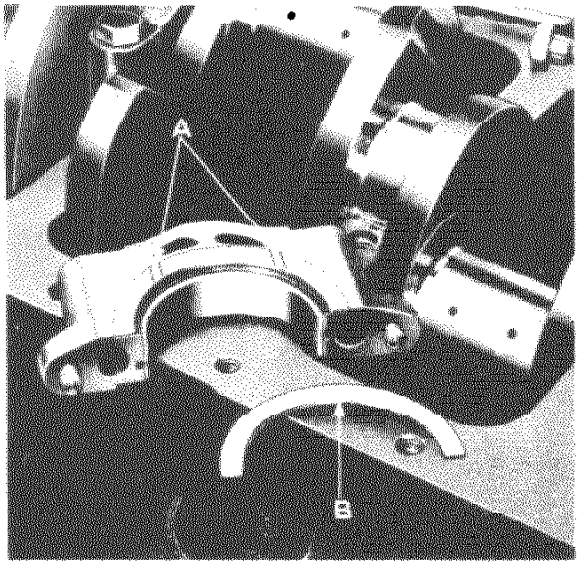

Figure D42

Crankshaft thrust washers and centre main bearing cap.

A. Oil grooves in bearing face.

B. Steel backing face.

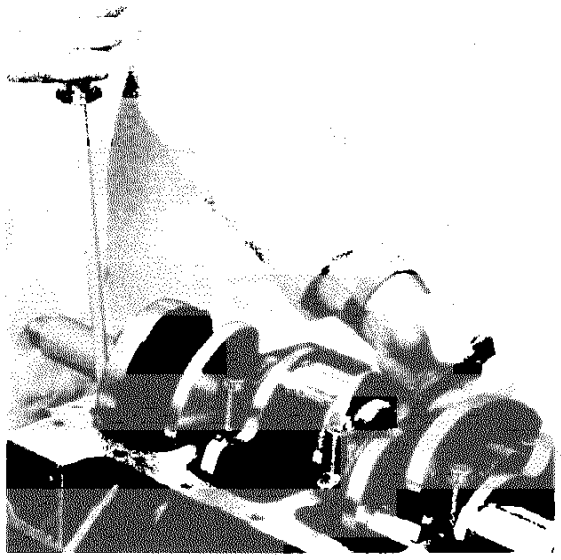

Figure D43

Checking endfloat of crankshaft.

When the determined clearance is found to be insufficient it can be increased by reducing the thickness of the thrust washer by rubbing down the steel backing surface.

When the determined clearance is found to be too great, thicker thrust washers must be fitted.

MAIN AND CRANKPIN BEARING LINERS

The main and crankpin bearings are of the precision finish liner type being machined to very fine limits and so require no fitting. They are located in their housings by raised tongues in their outer peripheries locating recesses machined in both the top and bottom housings.

The front and rear bearing liners are not interchangeable but in their unused condition they are interchangeable between top and bottom. The three intermediate bearing liners, in their unused condition, are interchangeable one with the other and also between top and bottom.

When the bearing liners are removed from their housings they should be identified not only to facilitate assembly, but also for the analysis of working conditions, particularly lubrication.

No attempt must ever be made to reduce excessive bearing clearance by filing the main or connecting rod bearing caps. When it is determined that the bearing clearance is not sufficiently reduced by the fitting of new bearing liners, the bearing journal must be reground and undersize bearing liners fitted or a replacement crankshaft and corresponding bearing liners obtained.

FITTING MAIN BEARING LINERS
CHECKING RUNNING CLEARANCE

Fit the upper half of the main bearing liners in the cylinder block and lubricate with clean engine oil and lay the crankshaft in position squarely in order not to damage or displace the bearing liners.

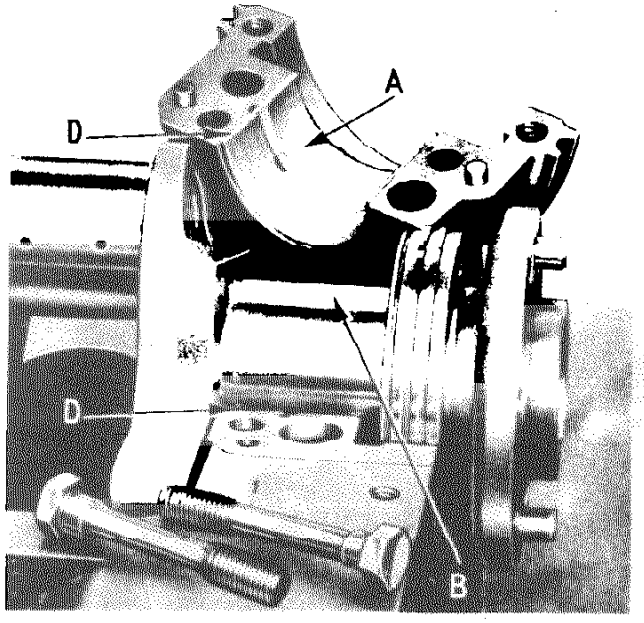

Figure D44

Checking running clearance of crankshaft main bearing liners

A. Bottom crankshaft bearing liner in cap.

B. Shim stock.

D. Plain edges of bearings mate together.

Fit the lower half of the bearing liner to the bearing caps and starting with the centre bearing insert a piece of 0.001" (0.025 mm.) cigarette paper approximately $\frac{1}{2}$" wide and as long as the width of the bearing liner across the width of the bearing liner in the bearing cap. Fit the shim, bearing liner and bearing cap to the cylinder block and fully tighten the two bolts to the specified torque.

When a slight resistance is felt as the crankshaft is turned, the clearance is 0.001" (0.025mm.) or less and can be considered satisfactory. When no resistance is perceived or in extreme instances the crankcase cannot be turned, the bearing liner is either too large or too small and the bearing liners must be replaced with those of the correct size.

The bearing cap, etc., is now removed and the foregoing repeated with the remaining bearing liners and caps utilizing a length of shim the width of the bearing liner. Before finally assembling the bearings the cigarette paper must be removed from the back of the bearing liners.

FITTING CRANKPIN BEARING LINERS
CHECKING RUNNING CLEARANCE Fig. D44.

The sequence for effecting this test is detailed hereafter and is carried out without the piston and piston rod in the cylinder bore, thus eliminating all drag apart from that in the crankpin bearing.

Fit the bearing liners to the connecting rods and bearing caps according to the identification markings and so that their tongues locate the recesses in the connecting rods and caps, then

lubricate with clean engine oil. Position a piece of 0.001" (0.025 mm.) cigarette paper, approximately 0.500" (12.700 mm.) wide and as long as the width of the bearing liner, across the width of the bearing liner in the bearing cap. Fit the shim, bearing shell, bearing cap and connecting rod to its respective position on the appropriate crankpin and fully tighten the two nuts.

When a slight resistance is felt as the connecting rod is moved from side to side, the clearance is 0.001" (0.025 mm.) or less and can be considered satisfactory. When no resistance is perceived or in extreme instances the connecting rod cannot be moved, the bearing liners must be replaced with those of the correct size.

The bearing cap, etc. is now removed and the foregoing repeated with the remaining bearing liners and connecting rods. Before finally assembling the bearings the cigarette paper must be removed from the back of the bearing liners.

REMOVAL AND REPLACEMENT, CRANKSHAFT

1. ENGINE UNIT REMOVAL

   Remove the engine and gearbox unit from the chassis frame as detailed on page D52.

2. ENGINE STARTER MOTOR

   Remove the engine starter motor from the engine and gearbox unit as detailed in the ELECTRICAL EQUIPMENT and INSTRUMENTS, SECTION O.

3. GEARBOX UNIT

   Remove the gearbox from the rear face of the engine unit as detailed in the GEARBOX UNIT, SECTION H.

4. CLUTCH and FLYWHEEL

   Remove the clutch and flywheel from the rear end of the crankshaft as detailed in the CLUTCH UNIT, SECTION G.

5. HYDRAULIC TIMING CHAIN TENSIONER, TIMING GEARS and CHAIN

   Remove the hydraulic timing chain tensioner, timing gears and chain, as detailed on page D27 and D29.

6. ENGINE SUMP

   Remove the engine sump from the undersize of the engine unit as previously detailed.

7. OIL PUMP

   Remove the oil pump from the underside of the rear crankshaft bearing cap as previously detailed.

8. CRANKSHAFT

   Remove the oil sump bridge piece from the underside of the front crankshaft bearing cap by withdrawing two bolts. Detach and identify the five crankshaft bearing caps, bottom halves of the crankshaft bearing shells and the two thrust washers by withdrawing the ten bolts. Remove the crankshaft and the top halves of the bearing liners, identifying the latter to their respective positions.

   NOTE: Do not turn the crankshaft when the rear bearing is removed

9. CONNECTING RODS

   Remove and identify the bearing caps and bottom halves of the connecting rod bearing liners by removing two nuts from each rod. Withdraw and identify the top halves of the connecting rod bearing liners and push the piston and connecting rod assemblies upward into the cylinder bores.

10. REPLACEMENT

The replacement of the crankshaft and bearing shells is the reversal of the removal sequence, but particular attention must be given to the following point:

That when the crankshaft is laid in position with the rear sealing rings in position it is not turned until the rear bearing cap is fitted.

THE CRANKSHAFT OIL SEALS

The crankshaft oil seals are fitted at each end of the crankshaft and are of two types, an oil scroll at the front and two plain scarf ended iron rings at the rear end.

1. FRONT Fig. D45.

The front oil seal comprises an oil scroll of the labyrinth type on the spigot of the front crank shaft pulley running in a plain bore, the body of which is incorporated in the timing chain cover.

2. REAR Fig. D46.

The rear oil seal comprises two plain scarf ended steel rings fitted in grooves machined in the rear side face of the rear main journal. These rings abut their outer peripheries to the cylinder block and rear crankshaft bearing cap. When the engine is running a labyrinth seal is effected by the sealing rings remaining stationary and the crankshaft rotating inside the rings.

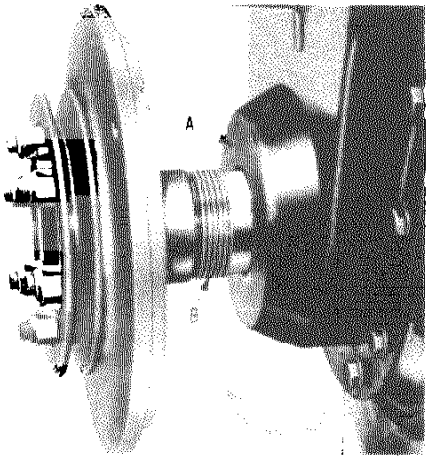

Figure D45

Front crankshaft oil seal.
A. Timing chain cover.
B. Crankshaft pulley oil scroll.

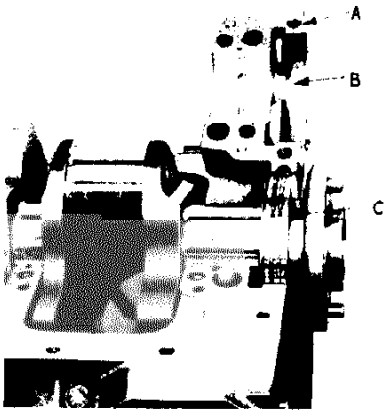

Figure D46.

Rear crankshaft oil seal rings and oil drilling "O" ring.
A. Rear crankshaft main bearing cap.
B. Abutment face in crankshaft main bearing cap for oil sealing rings.
C. Oil sealing rings.

REMOVAL AND REPLACEMENT
REAR OIL SEAL RINGS

When it is judged that this oil seal is passing oil and requires attention it will be necessary to remove the crankshaft from the engine unit. When the crankshaft has been withdrawn from the cylinder block, the oil seal rings can be removed and replaced by observing the following procedure:

REMOVAL

Position a piece of shim steel under one of the oil seal rings and ease it out of the groove, then manoeuvre it over the flywheel fitting flange. While not being a simple operation it can safely be effected without breakage. Repeat with the second oil seal ring.

2. REPLACEMENT

Ease the oil seal ring over the flywheel fitting flange of the crankshaft and into the front groove, utilizing a piece of shim steel and clean engine oil.

NOTE:

When the crankshaft with the oil seal rings fitted is installed in the cylinder block, it must not be turned until the rear bearing cap has been tightened down.

CRANKSHAFT, MAIN and CRANKPIN BEARING DIMENSIONS, CRANKSHAFT and MAIN BEARING LINERS

Dia. of bore in cylinder block and bearing cap.	2.1465"	54.5211	mm.
	1.1460"	54.5084	mm.
Dia. of main bearing liner.	2.1465"	54.5211	mm.
Dia. of bore in main bearing liner	(2.0025"	50.8635	mm.
1st standard	(2.0015"	50.8381	mm.
2nd standard	(1.9925"	50.6095	mm.
	(1.9915"	50.5841	mm.
3rd standard	(1.9825"	50.3555	mm.
	(1.9815"	50.3301	mm.
4th standard	(1.9725"	50.1015	mm.
	(1.9715"	50.0761	mm.
5th standard	(1.9625"	49.8475	mm.
	(1.9615"	49.8221	mm.
Dia. of main crankshaft journal	(2.0000"	50.800	mm.
1st standard	(1.9995"	50.7873	mm.
2nd standard	(1.990"	50.546	mm.
	(1.9895"	50.5333	mm.
3rd standard	(1.9800"	50.292	mm.
	(1.9795"	50.2793	mm.
4th standard	(1.970"	50.038	mm.
	(1.9695"	50.0253	mm.
5th standard	(1.960"	49.784	mm.
	(1.9595"	49.7713	mm.
Running clearance of main crankshaft journal.	(0.0030"	0.0762	mm.
	(0.0015"	0.0381	mm.

THRUST WASHER THICKNESS

1st standard	(0.093"	2.3622	mm.
	(0.091"	2.3114	mm.
2nd standard	(0.0955"	2.4257	mm.
	(0.0935"	2.3749	mm.
3rd standard	(0.098"	2.4892	mm.
	(0.096"	1.4384	mm.
Regrind main crankshaft journals when ovality exceeds	0.0030"	0.0762	mm.
Length of centre crankshaft journal	(0.829"	21.0566	mm.
	(0.827"	21.0058	mm.
Width of centre crankshaft journal bearing cap and two thrust washers.	(0.826"	20.9804	mm.
	(0.820"	20.828	mm.

End float of crankshaft	(0.0090"	0.2286	mm.
	(0.0040"	0.1016	mm.
CRANKPINS AND BEARING LINERS			
Dia. of bore in connecting rod and cap.	(1.8965"	48.1711	mm.
	(1.8960"	48.1584	mm.
Dia. of crankpin bearing liner	1.8965"	48.1711	mm.
Dia. of bore in crankpin bearing liner 1st standard	(1.7522"	44.50588	mm.
	(1.7510"	44.4754	mm.
2nd standard	(1.7422"	44.25188	mm.
	(1.7410"	44.2214	mm.
3rd standard	(1.7322"	43.99788	mm.
	(1.7310"	43.9674	mm.
4th standard	(1.7222"	43.74388	mm.
	(1.7210"	43.7134	mm.
5th standard	(1.7122"	43.48988	mm.
	(1.7110"	43.4594	mm.
Dia. of crankpin journal 1st standard	(1.7495"	44.4373	mm.
	(1.7490"	44.4246	mm.
2nd standard	(1.7395"	44.1833	mm.
	(1.7390"	44.1706	mm.
3rd standard	(1.7295"	43.9293	mm.
	(1.7290"	43.9166	mm.
4th standard	(1.7195"	43.6753	mm.
	(1.7190"	43.6626	mm.
5th standard	(1.7095"	43.4213	mm.
	(1.7090"	43.4086	mm.
Running clearance	(0.0032"	0.08128	mm.
	(0.0015"	0.03810	mm.
Regrind when ovality exceeds	0.0030"	0.0762	mm.
Length of crankpin journal	(1.877"	47.6758	mm.
	(1.875"	47.625	mm.
Width of two connecting rods	(1.865"	47.371	mm
	(1.861"	47.2694	mm.

THE ENGINE MOUNTINGS

DESCRIPTION Figs. D47, D48 and D49.

The engine unit with the gearbox attached is resiliently mounted in the chassis frame at four points, each pair of mountings forming a "VEE".

The front mountings consist of brackets attached to the front side faces of the cylinder block with metal and rubber bonded pads interposed between the engine bracket and the welded chassis frame brackets.

The rear mounting consists of a short metal crossmember attached to the chassis frame which has a "VEE" shaped top face and metal and rubber bonded pads interposed between the rear extension of the gearbox and the chassis cross member.

To facilitate engine removal and replacement the fitting face of the engine brackets are slotted to allow the engine unit to be lowered into position with the mounting rubbers attached to the chassis frame brackets and the gearbox rear extension is fitted to the rear mounting pads by bolts.

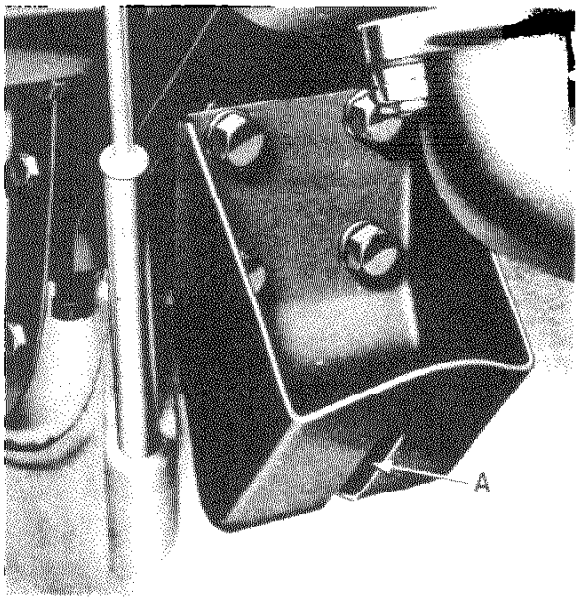

Figure D47

Front engine mounting bracket on cylinder block.

A. Slot in side face of mounting bracket to facilitate engine lifting.

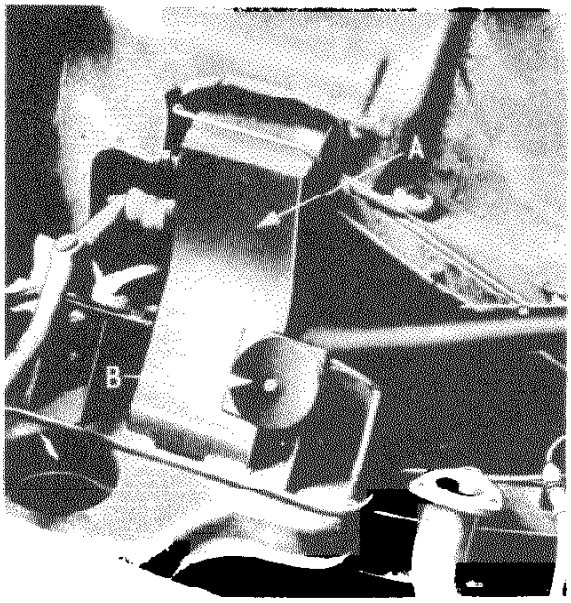

Figure D48

Front engine mounting on chassis frame.

A. Front suspension pillar.

B. Metal and rubber bonded pad

REMOVAL AND REPLACEMENT FRONT ENGINE MOUNTINGS Figs. D47 and D48.

1. REMOVAL

Take the weight of the engine unit and remove the nuts above and below the rubber and metal bonded mounting. Jack up the front of the engine and withdraw the mountings.

2. REPLACEMENT

The replacement of the front engine mountings is the reversal of the removal sequence, but the front engine mountings must only be renewed in pairs.

REMOVAL AND REPLACING REAR ENGINE MOUNTINGS Figs. D49.

1. TRANSMISSION COVER

Detach the transmission cover from inside the car, as detailed in the BODY SECTION Q.

2. REAR ENGINE MOUNTINGS

Take the weight of the gearbox unit with a jack and withdraw the two bolts one either side of the gearbox rear extension. Raise the gearbox a little higher and detach the two rear engine mountings from between the gearbox rear extension and the short chassis cross member by withdrawing two nuts and bolts each.

3. REPLACEMENT

The replacement of the rear engine mountings is the reversal of the removal sequence but the rear engine mountings must only be renewed in pairs.

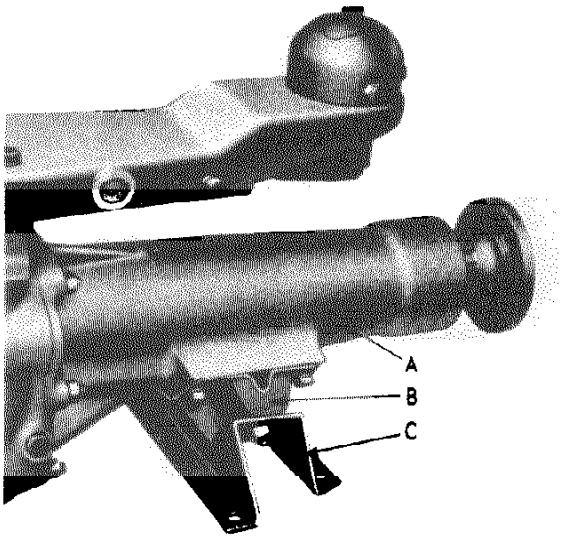

Figure D49

Rear engine/gearbox mounting.

A. Gearbox rear casing.

B. Metal and rubber bonded pad.

C. Gearbox cross member.

THE GEARBOX MOUNTING PLATE

The gearbox mounting plate assists in mounting the gearbox to the rear end of the engine unit, and the electric starter motor is attached to the front L.H. side. The gearbox mounting plate is only removed from the rear of the cylinder block during a complete engine overhaul.

REMOVAL AND REPLACEMENT

1. REMOVAL

Remove the gearbox mounting plate from the rear face of the cylinder block by withdrawing eleven bolts.

2. REPLACEMENT

Locate the gearbox mounting plate on the two dowels in the rear face of the cylinder block and secure with eleven bolts.

REMOVAL AND REPLACEMENT
ENGINE AND GEARBOX FROM CAR Figs. D50 and D51

1. ENGINE HOOD

Detach the engine hood from the top of the engine compartment as detailed in the BODY SECTION.

2. ELECTRICAL EQUIPMENT

Disconnect the battery, all other electrical connections, and the engine speed indicator drive from the ignition distributor drive, as detailed in ELECTRICAL EQUIPMENT, SECTION O.

3. COOLING SYSTEM

Drain and remove radiator, fan assembly, and detach heater connection pipes as detailed in the COOLING SYSTEM, SECTION C.

4. IGNITION SYSTEM

Remove the spark plug leads, H.T. lead from ignition coil, L.T. lead from distributor, ignition - retard vacuum pipe from carburettor and remove the ignition distributor from the engine unit as detailed in the IGNITION SYSTEM, SECTION E.

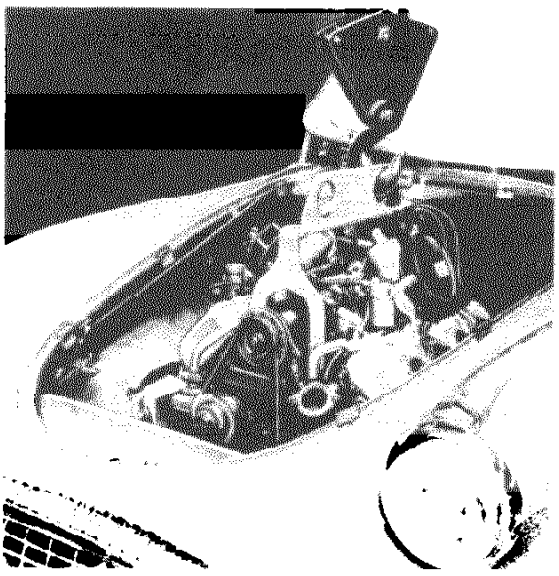

Figure D50

Engine/gearbox unit being removed from car. Here the combined unit is being lifted and brought forward utilizing the rear hole in engine lifting fixture

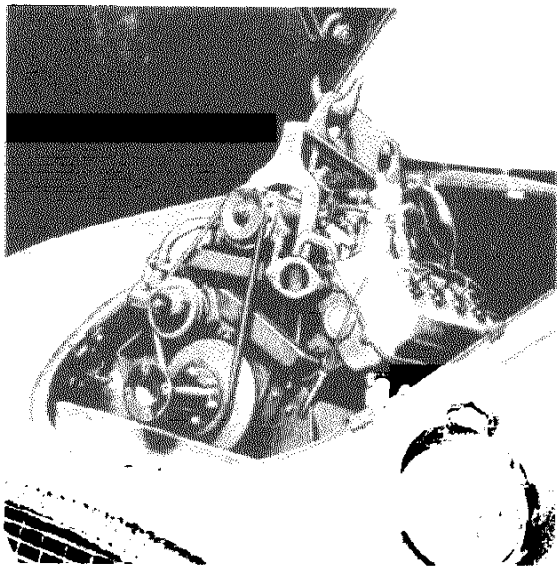

Figure D51

Engine/gearbox unit being removed from car. The lifting hook is now placed in the forward hole and lifted up at the front end clear of the engine compartment.

5. FUEL SYSTEM

Turn off the petrol, disconnect petrol feed pipes and the air cleaners from the carburettors and remove the two carburettors from the inlet manifold as detailed in the FUEL SYSTEM, SECTION E.

6. EXHAUST SYSTEM

Detach the front exhaust pipe assemblies from the two exhaust manifolds as detailed in the EXHAUST SYSTEM, SECTION F.

7. CHASSIS FRAME

Remove the front frame cross bracing member between the two suspension pillars as detailed in the CHASSIS FRAME SECTION P.

8. TRANSMISSION COVER

Detach the transmission cover from inside the cockpit of the car as detailed in the BODY SECTION Q.

9. SPEEDOMETER DRIVE

Withdraw the speedometer drive from the R.H. side of the gearbox rear extension as detailed in the ELECTRICAL EQUIPMENT and INSTRUMENTS SECTION O.

10. ENGINE MOUNTINGS

Detach the top ends of the engine mountings from the four metal and rubber bonded mountings as detailed on page D51.

11. CLUTCH SLAVE CYLINDER

Remove the clutch slave cylinder and bracket from the R.H. side of the gearbox bell housing as detailed in the CLUTCH UNIT SECTION G.

12. PROPELLER SHAFT

Detach the front end of the propellor shaft from the coupling flange at the rear end of the gearbox unit as detailed in the PROPELLER SHAFT, SECTION I.

13. ENGINE REMOVAL

Attach the engine lifting fixture to the top of the engine unit and place in the hook of an hoist. Raise the hoist to clear the engine unit from the front engine mountings and draw the unit forward so that the gearbox rear extension is clear of the gearbox support cross member, change the hoist hook into the front hole and lift. Lower the rear end of the gearbox and hoist the engine and gearbox unit upward and forward from the car.

14. STARTER MOTOR

Remove the starter motor from the R.H. side of the engine unit as detailed in the ELECTRICAL EQUIPMENT SECTION O.

15. GEARBOX UNIT

Detach the gearbox unit from the rear face of the engine unit as detailed in the GEARBOX UNIT SECTION G.

16. REPLACEMENT

The replacement of the engine is the reversal of the removal sequence.

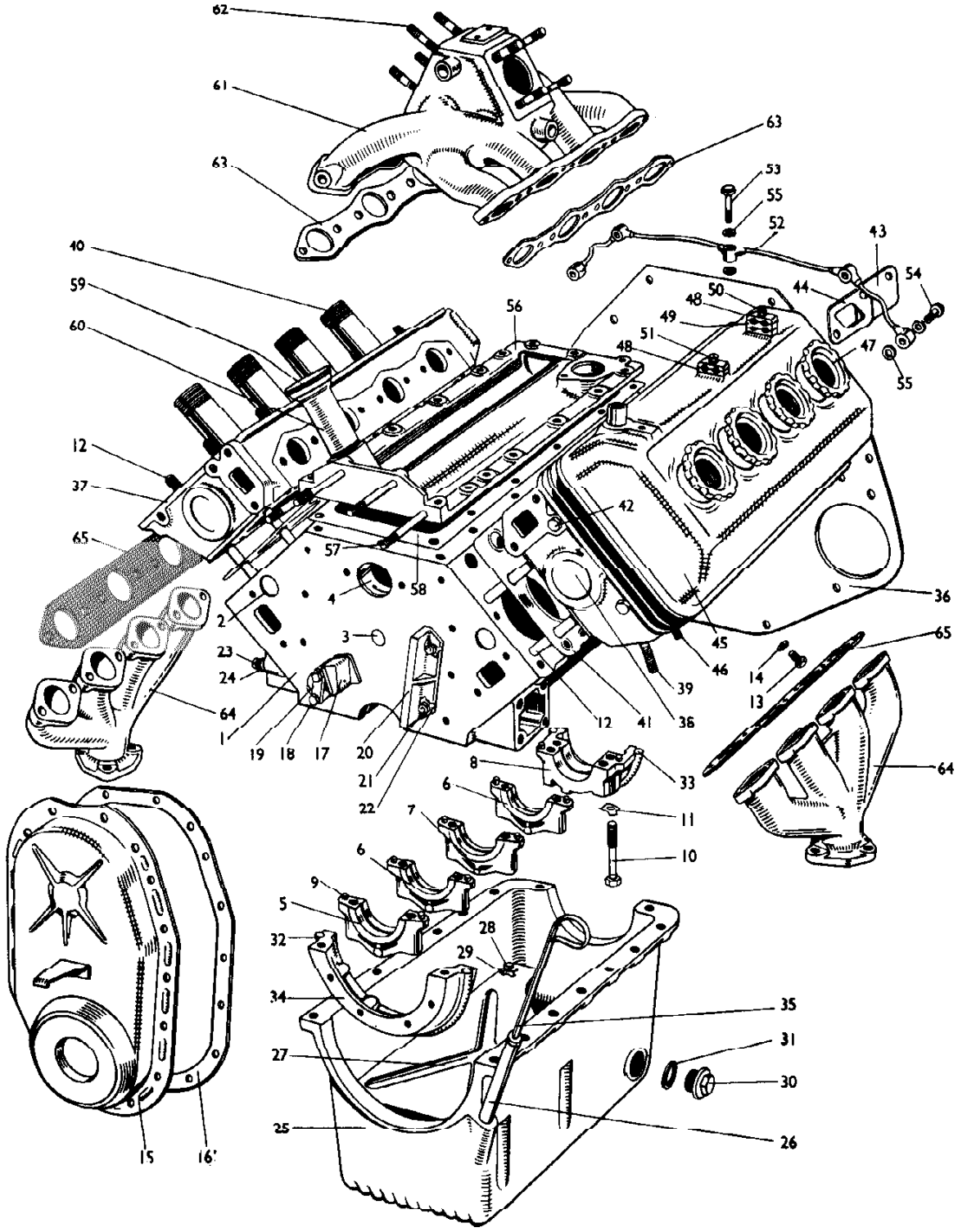

Figure D52 - Exploded View of Engine Unit (Non Moving Components)

1. Cylinder block
2. Welch washer
3. Main oil gallery plug
4. Front camshaft bearing
5. Crankshaft front bearing cap
6. Crankshaft intermediate bearing cap
7. Crankshaft centre bearing cap
8. Crankshaft rear bearing cap
9. Crankshaft bearing cap locating dowel
10. Crankshaft bearing cap bolt
11. Locking plate
12. Cylinder head-rocker bracket stud
13. Cylinder block drain plug
14. Copper washer
15. Timing chain cover
16. Timing chain cover joint washer
17. Hydraulic timing chain tensioner
18. Chain tensioner attachment bolt
19. Lockplate
20. Timing chain vibration damper
21. Vibration damper attachment bolt
22. Lockplate
23. Chain tensioner drilling oil plug
24. Copper washer
25. Engine sump assembly
26. Dipstick tube
27. Engine sump baffle plate
28. Baffle plate attachment bolt
29. Lockplate
30. Engine sump drain plug
31. Copper washer
32. Engine sump front seal
33. Engine sump rear seal
34. Engine sump bridge piece
35. Dipstick
36. Gearbox mounting plate
37. Cylinder head assembly
38. Cylinder head screwed plug
39. Exhaust manifold stud
40. Spark plug tube
41. Cylinder head gasket
42. Rocker oil feed blanking plug
43. Cylinder head coolant blanking plate
44. Blanking plate joint washer
45. Rocker cover
46. Rocker cover joint
47. Rocker cover hand nut
48. Spark plug lead carrier
49. Spark plug lead carrier centre
50. Lead carrier attachment bolt
51. Lead carrier attachment bolt
52. Rocker oil feed pipe assembly
53. Rocker oil feed centre banjo bolt
54. Rocker oil feed outer banjo bolt
55. Copper washer
56. Tappet block and cover
57. Dynamo bracket mounting stud
58. Tappet block and cover joint washer
59. Oil filler cap
60. Oil filler tube
61. Inlet manifold
62. Carburettor attachment stud
63. Inlet manifold gasket
64. Exhaust manifold
65. Exhaust manifold gasket
66. Crankshaft
67. Crankshaft-flywheel locating dowel
68. Crankshaft-gearbox primary shaft bush bearing
69. Crankshaft front bearing liner
70. Crankshaft intermediate bearing liner
71. Crankshaft rear bearing liner
72. Crankshaft centre bearing thrust washer
73. Crankshaft rear oil sealing ring
74. Flywheel and starter ring gear
75. Starter ring gear
76. Clutch cover assembly locating dowel
77. Crankshaft/flywheel attachment bolt
78. Crankshaft key
79. Crankshaft chain wheel
80. Crankshaft oil thrower disc
81. Crankshaft pulley
82. Cooling fan extension tube locating dowel
83. Crankshaft nut
84. Lockplate
85. Crankshaft damper
86. Crankshaft damper, pulley and cooling fan extension attachment bolt
87. Cooling fan and extension tube
88. Connecting rod
89. Little end bush bearing
90. Connecting rod bolt
91. Connecting rod liner
92. Piston
93. Chromium plated piston ring
94. Plain piston ring
95. Oil control piston ring
96. Gudgeon pin
97. Gudgeon pin circlip
98. Camshaft
99. Camshaft thrust plate
100. Camshaft key
101. Camshaft thrust washer
102. Camshaft chainwheel
103. Camshaft chainwheel attachment nut
104. Lockplate
105. Timing chain
106. Tappet body
107. Tapper body ball end
108. Inlet push rod
109. Exhaust push rod
110. Inlet valve
111. Exhaust valve
112. Valve split cone
113. Valve cone washer
114. Outer valve spring
115. Inner valve spring
116. Valve spring seat
117. Inlet valve guide
118. Exhaust valve guide
119. Inlet rocker shaft
120. Exhaust rocker shaft
121. Intermediate rocker bracket
122. End rocker bracket
123. Rocker bracket ring dowel
124. Rocket shaft locating screw
125. Inlet valve rocker
126. Exhaust valve rocker
127. Valve rocker spacing spring
128. Valve rocker spacing washer
129. Valve rocker ball end
130. Valve rocker ball end nut

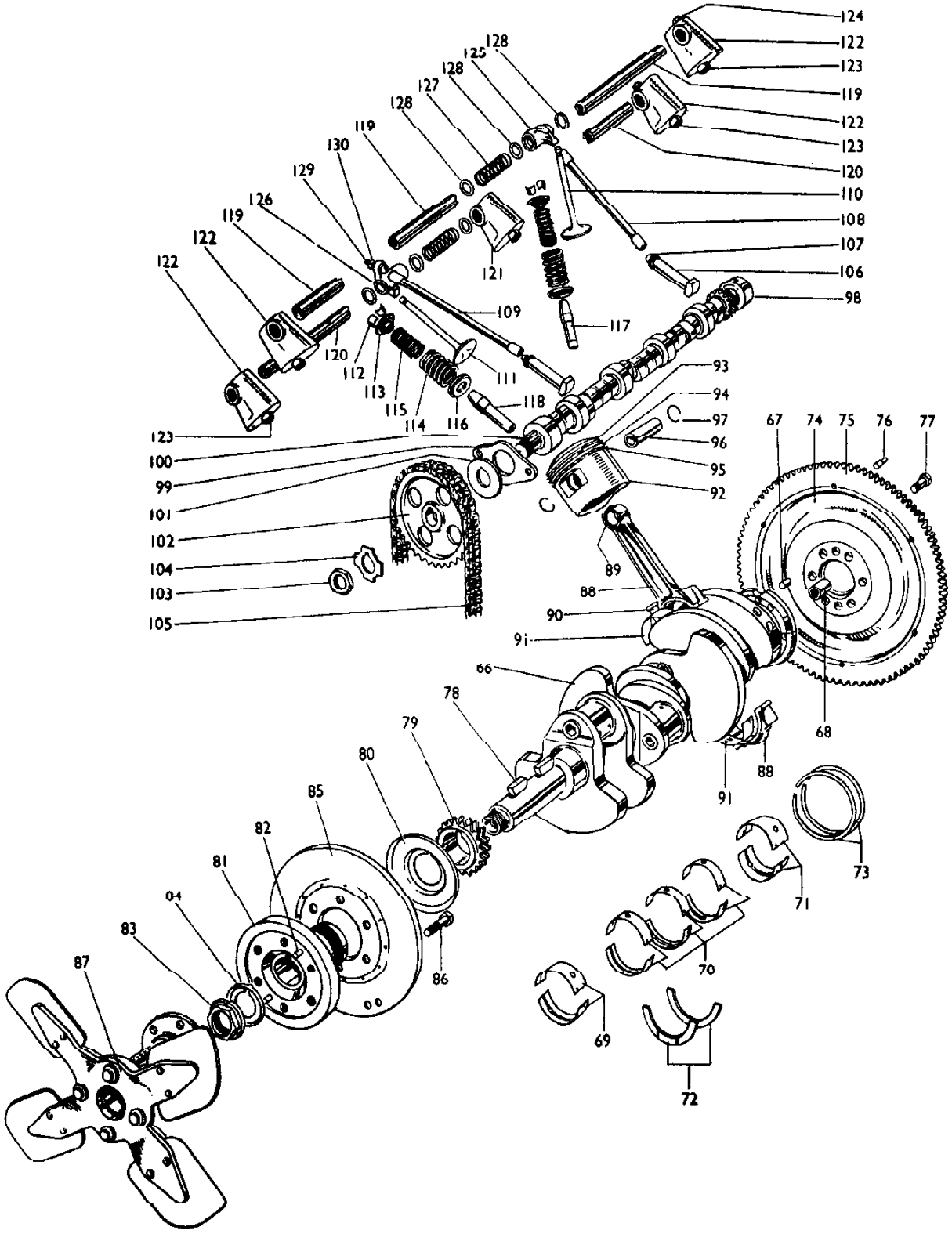

Figure D53 - Exploded View of Engine Unit (Moving Components)