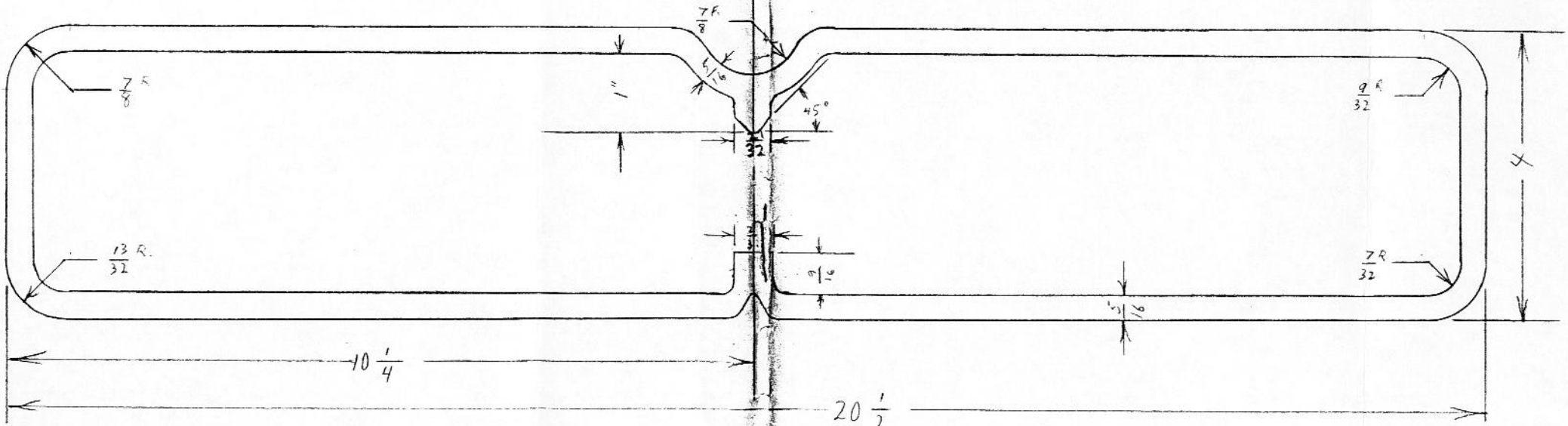
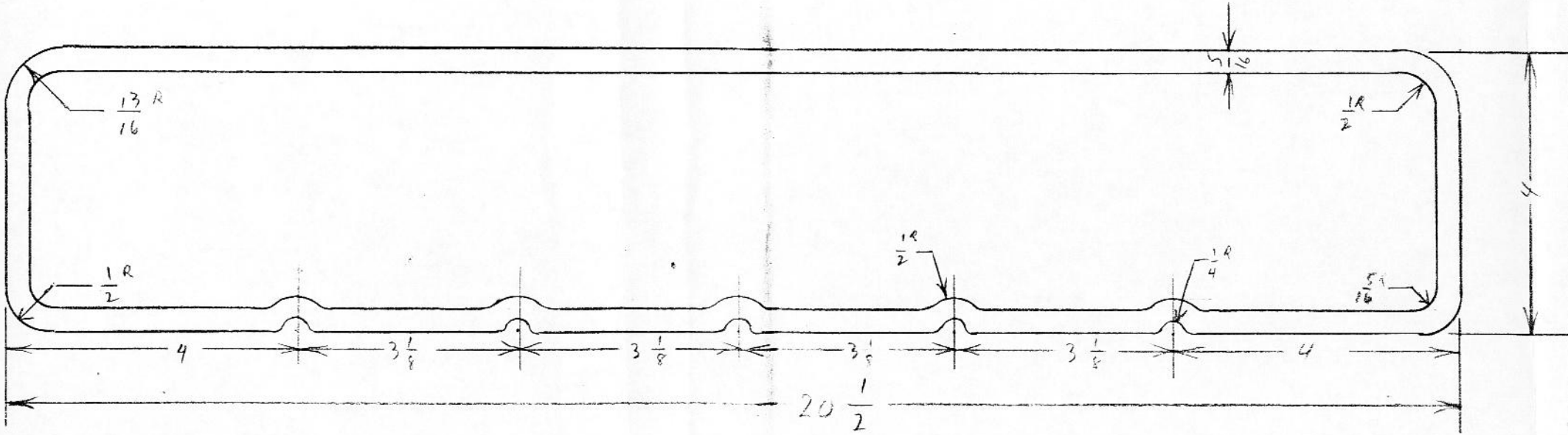
Note - "made from $\frac{3}{32}$ thick imported English cork"





Drawn

SECTION 1

ENGINE

CONTENTS

S E R V I C E B U L L E T I N

R E C O R D S H E E T

No.	Subject	Date	Signature

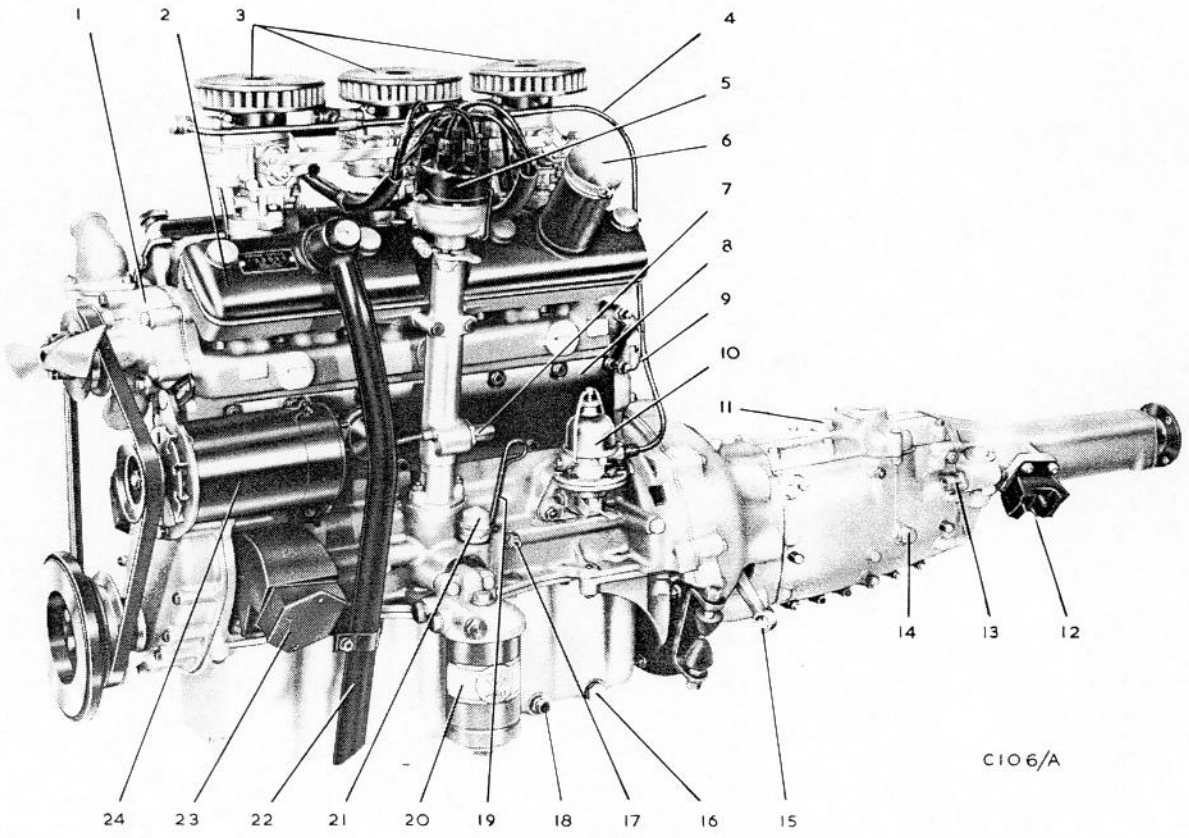


Fig. 1 Left-hand view of engine.

1. Water pump.
2. Inlet rocker box cover.
3. Air filters.
4. Petrol pipe to carburettors.
5. H.T. distributor.
6. Oil filler.
7. Revolution indicator drive.
8. Push rod cover.
9. Oil pipe to rocker mechanism.
10. Petrol pump.
11. Gearbox filler plug.
12. Engine rear mounting.
13. Speedometer drive.
14. Gearbox level plug.
15. Clutch operating lever.
16. Sump drain plug.
17. Oil pressure gauge connection.
18. Oil thermometer connection.
19. Dipstick.
20. Oil filter.
21. Oil pressure relief valve.
22. Breather pipe.
23. Engine front mounting.
24. Dynamo.

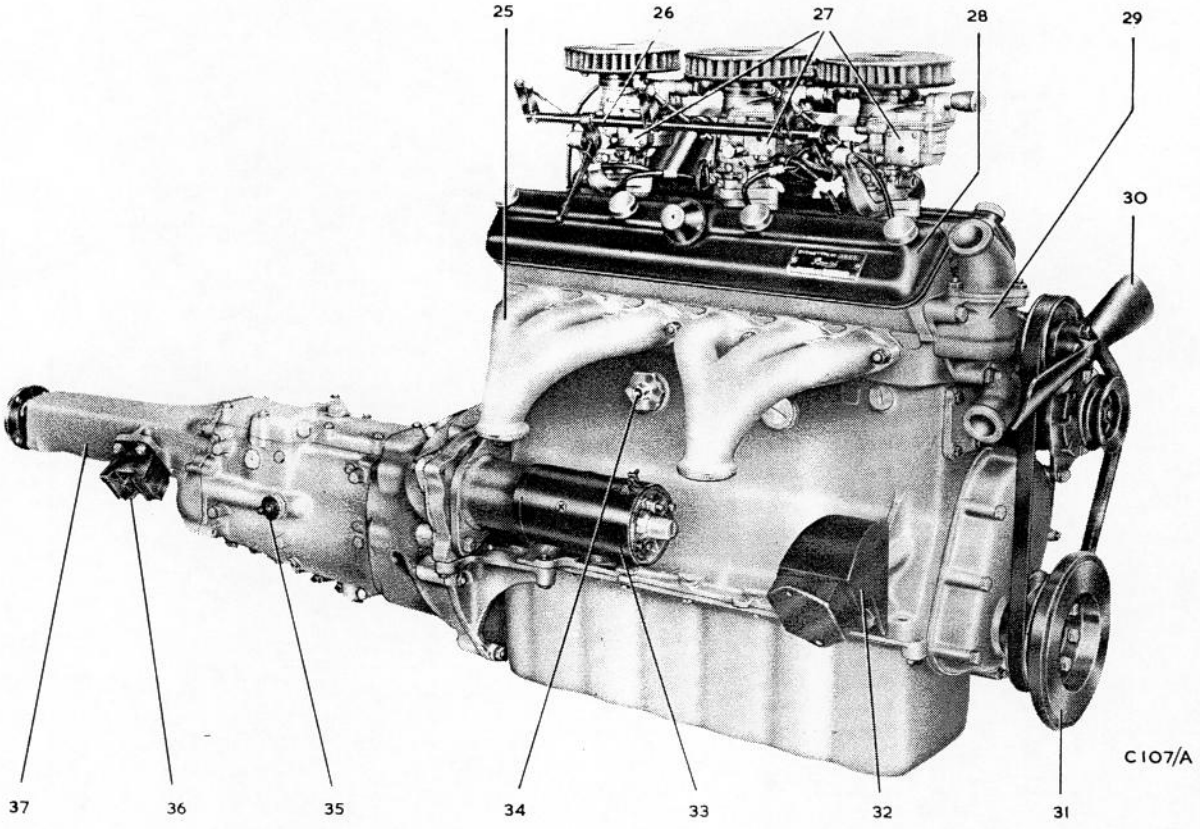


Fig.2 Right-hand view of engine.

25. Exhaust manifold.
26. Throttle control layshaft.
27. Carburettors.
28. Exhaust rocker box cover.
29. Water pump thermostat housing.
30. Fan.
31. Vibration damper.
32. Engine front mounting.
33. Starter.
34. Water thermometer connection.
35. Reverse light switch.
36. Engine rear mounting.
37. Gearbox extension.

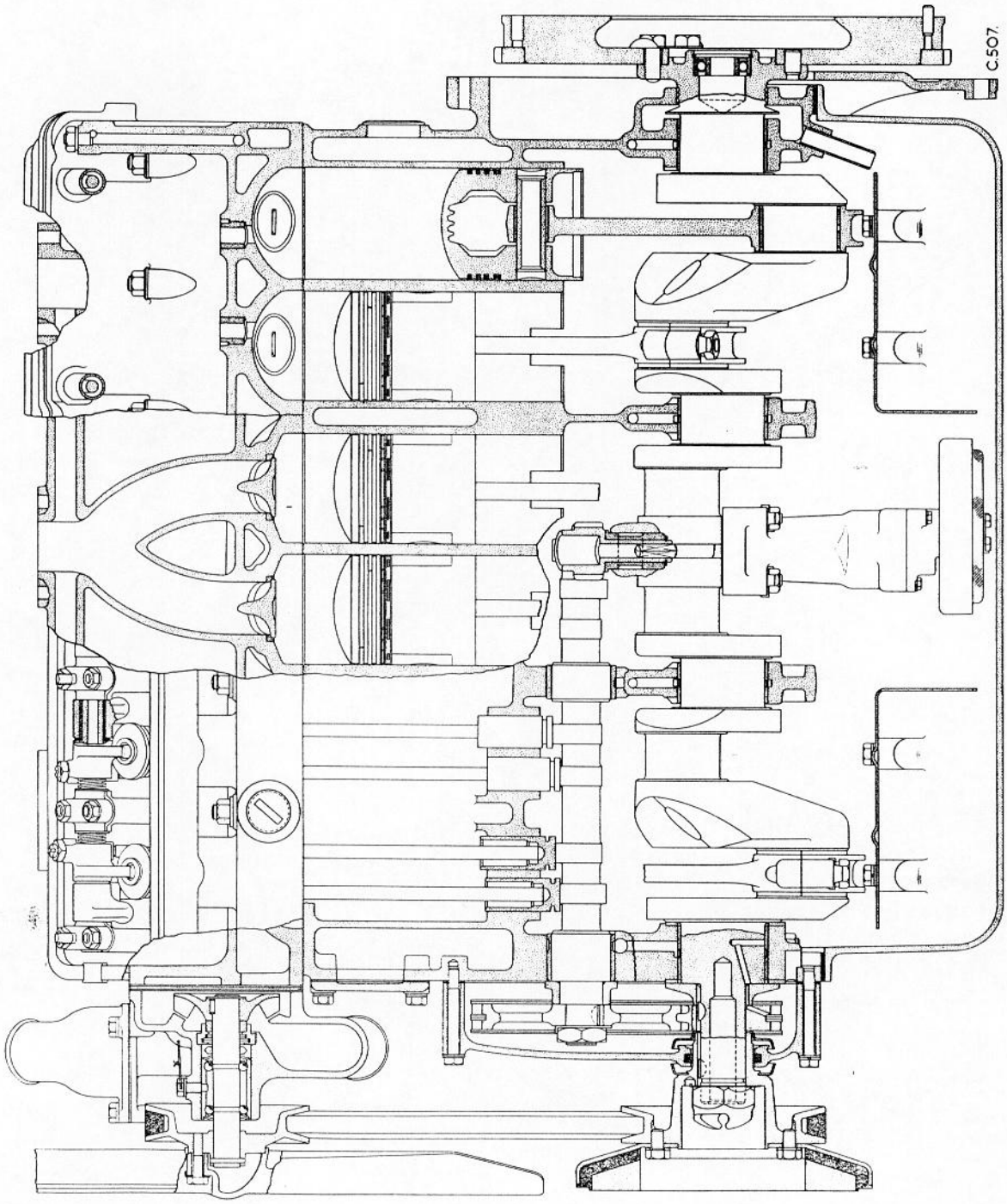


Fig.3 Longitudinal section of engine.

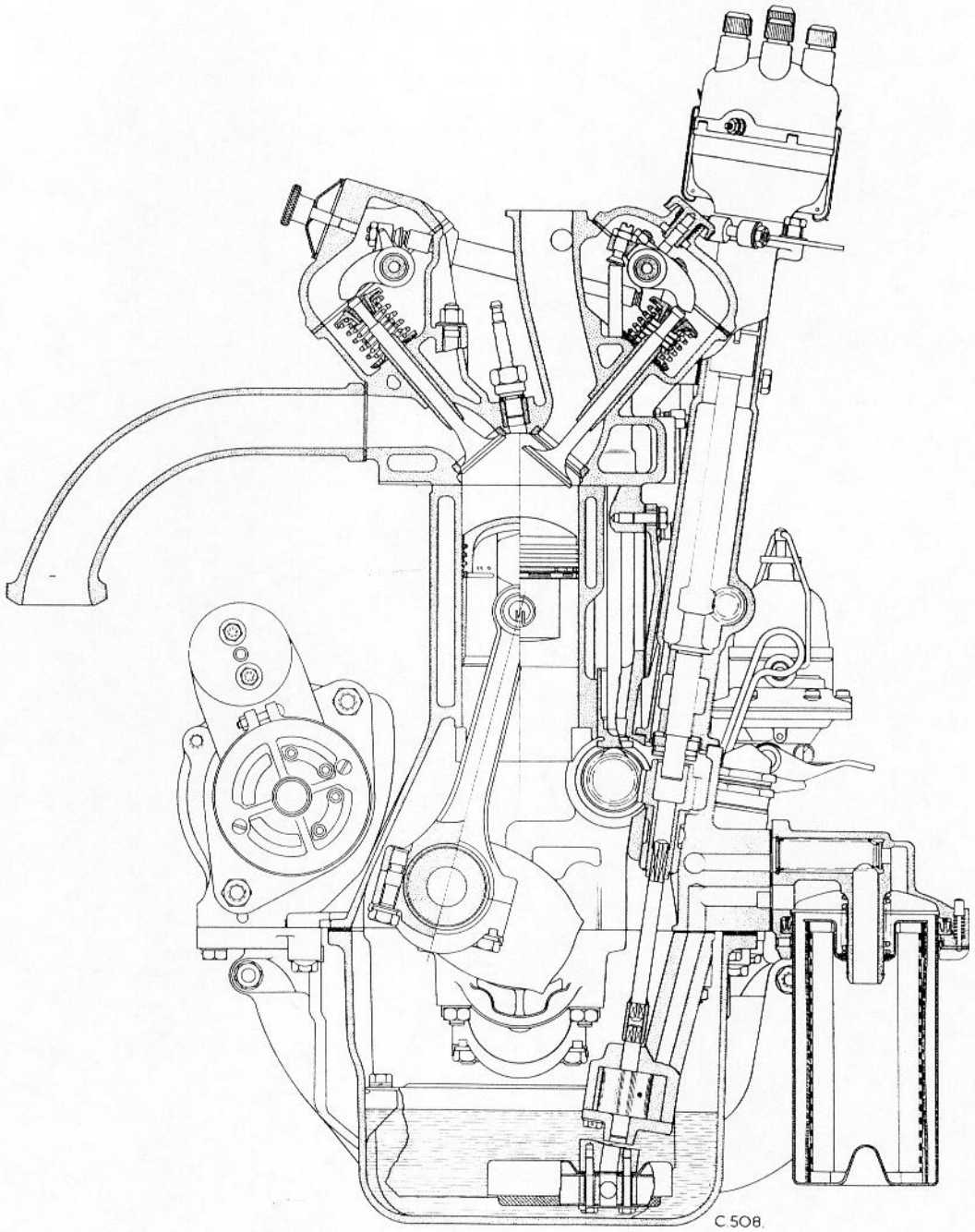


Fig.4 Transverse section of engine.

GENERAL DATA

Engine type.	B.S.1 Mk.II.
Bore..	2·5984in. (66 m.m.).
Stroke	3·779in. (96 m.m.).
Compression ratio.	9 : 1
Piston displacement (cubic capacity)	120·231 cu.in. (1971 c.c.).
R.A.C. rating	16·2 H.P.
Max. power output.	130 B.H.P. (131.8 C.V.) at 5,500 r.p.m.
Max. torque.	128 at 5,000 r.p.m.
Max. permissible r.p.m..	5,500
Oil pressure at 70°C.	60 p.s.i. (4·22 kg/cm.^{2}).
Oil filter..	Vokes.
Valve timing	
Inlet opens	40° before T.D.C.
Inlet closes...	80° after B.D.C.
Exhaust opens..	80° before B.D.C.
Exhaust closes.	40° after T.D.C.
Tappet clearances (cold)	
Inlet	0·002in. (0·05 m.m.).
Exhaust..	0·002in. (0·05 m.m.).
Ignition timing	
Static advance.	23° before T.D.C.
Firing order	1, 5, 3, 6, 2, 4.

Cylinder block

Type	In-line, cast "en-bloc".
Material..	Chrome iron.
Cylinder liners.	"Brivadium" dry.
Interference of liner in bore ...	0·003in. to 0·004in. (0·08 m.m. to 0·1 m.m.).
Load required to press in liners..	4 to 6 tons. (4·06 to 6·09 tonnes).
Tappet in cylinder block, recommended clearance.	0·0005in. to 0·0015in. (0·01 m.m. to 0·038 m.m.).

Oil pump

Type	Positive displacement.

Cylinder head

Material..	Aluminium alloy.
Valve seats	Shrunk in "Brimol" inserts.
Valve seat angle	45^{o}.
Valve seat location in head. Diameter	Ex. 1·437in. + 0·001in. (36·51 m.m. + 0·03 m.m.). In. 1·670in. + 0·001in. (42·41 m.m. + 0·03 m.m.).
Valve seat insert, outside diameter..	Ex. 1·442in. - 0·001in. (36·63 m.m. - 0·03 m.m.). In. 1·675in. - 0·001in. (42·54 m.m. - 0·03 m.m.).
Interference fit of insert in head...	0·003in. to 0·005in. (0·08 m.m. to 0·13 m.m.).

Valve guides and locations in head (inlet and exhaust)

Valve guide location bore in head...	0·4787 in. (12·159 m.m.).

Interference fit of guide in head	0·0008in. to 0·0018in. (0·02 m.m. to 0·04 m.m.).

Replacement valve guides are supplied up to +0·040in. (1·07 m.m.) above 0·481in. (12·21 m.m.). The bore in the cylinder head should be measured and if 0·4787 in. (12·159 m.m.) an oversize guide should be ground to suit. The bore in the head should not be reamed.

Valve guides and valve stems (inlet and exhaust)

Valve guide bore diameter... ...	0·3125in. (7·94 m.m.).
Valve stem diameter...	0·3105in. (7·89 m.m.).
Desired clearance between valve stem and guide - cold. ...	0·002in. to 0·0028in. (0·05 m.m. to 0·07 m.m.).

Inlet valve heads

Seat angle	45°.

Exhaust valve heads

Seat angle	45°.

Valve, spring, outer

Free length (approx.).	1·687in. (42·85 m.m.).
Length when loaded to 47·5 lb. ± 4 lb. ... ... (21·55 kg. ± 1·8 kg.)	1·028in. (26·11 m.m.).

Valve spring, inner

Free length (approx.)	1·625in. (41·28 m.m.).
Length when loaded to 47·5 lb. ± 4 lb. ... ... (21·55 kg. ± 1·8 kg.)	1·028in. (26·11 m.m.).

Rocker spindle and rockers

Rocker spindle diameter	0·509in. (12·93 m.m.).
Rocker bush bore diameter... ...	0·510in. (12·95 m.m.).
Desired working clearance... ...	0·001in. to 0·0018in. (0·03 m.m to 0·04 m.m.).

Crankshaft

Main bearings

Number	4.
Type..	Lead Indium shell type, steel backed.
Torque loading of cap nuts ...	28 to 30 lb.ft. (4·167 to 4·464 kg/m.).

Main bearing journals

Diameter. New...	2·1245in. - 0·0005in. (53·95 m.m. - 0·01 m.m.).
Diameter 0·010in. (0·25 m.m.) undersize... ...	2·1145in. - 0·0005in. (53·45 m.m. - 0·01 m.m.).
Diameter 0·020in. (0·50 m.m.) undersize... ...	2·1045in. - 0·0005in. (53·71 m.m. - 0·01 m.m.).
Running clearance.	0·002in. to 0·0025in. (0·05 m.m. to 0·06 m.m.).
Mal-alignment limit	0·002in. (0·05 m.m.).
Journal hardness..	900 V.P.N.
Length. Front...	1·466in. - 0·002in. (37·24 m.m. - 0·05 m.m.).
Mid front	1·181in. ± 0·010in. (30 m.m. ± 0·25 m.m.).
Mid rear	1·181in. ± 0·010in. (30 m.m. ± 0·25 m.m.).
Rear	1·418in. ± 0·010in. (36·02 m.m. ± 0·25 m.m.).
Thrust taken on...	Thrust plate on front journal.
End-float. New..	0·002in. to 0·008in. (0·05 m.m. to 0·2 m.m.).
Worn.	0·004in. to 0·012in. (0·1 m.m. to 0·3 m.m.).
Thrust bearing - Standard thickness ...	0·093in. - 0·002in. (2·36 m.m. - 0·05 m.m.).

Oversize thickness ...	0·096in. - 0·002in. (2·44 m.m. - 0·05 m.m.).
	0·098in. - 0·002in. (2·5 m.m. - 0·05 m.m.).

Crankpins

Diameter. New...	1·771in. - 0·0005in. (44·98 m.m. - 0·01 m.m.).
0·010in. (0·25 m.m.) undersize	1·761in. - 0·0005in. (44·73 m.m. - 0·01 m.m.).
0·020in. (0·50 m.m.) undersize	1·751in. - 0·0005in. (44·48 m.m. - 0·01 m.m.).
Hardness	900 V.P.N.

Connecting rods and pistons

Connecting rods

Material	Steel forging.
Distance between centres ... (big end and small end)	6·457in. ± 0·002in. (164·01 m.m. ± 0·05 m.m.).

Small end of rod

Gudgeon pin bush location ...	0·830in. + 0·0005in. (21·08 m.m. + 0·01 m.m.).

Gudgeon pin bushes

Material	Phosphor bronze.
Bush bore diameter	0·7097in. + 0·0004in. (18·026 m.m. + 0·01 m.m.).
Interference fit, bush to con. rod	0·001in. to 0·002in. (0·03 m.m. to 0·05 m.m.).
Gudgeon pin to bush	0·0006in. to 0·001in. (0·02 m.m. to 0·03 m.m.).

Big end bearings

Type...	Lead Indium shell type, steel backed.
Running clearance on journals..	0·0015in. to 0·0025in. (0·038 m.m. to 0·06 m.m.).
End-float on con. rod on crankshaft...	0·008in. to 0·0116in. 0·20 m.m. to 2·95 m.m.).
Torque loading of cap nuts ...	28 to 30 lb.ft. (4·167 to 4·464 kg/m.).

Pistons

Material	Aluminium-alloy, press forged.
Clearance in cylinder bore, checked cold on thrust face at bottom of skirt..	0·003in. to 0·0035in. (0·08 m.m. to 0·09 m.m.).

Piston rings

No. fitted to each piston ...	4.
Radial thickness...	0·105in. - 0·005in. (2·667 m.m. - 0·13 m.m.).
Gap when fitted to cylinder ...	0·010in. to 0·015in. (0·5 m.m. to 0·63 m.m.).

Camshaft

No. of journals.	4.
Material..	Phosphor bronze.

Bearing journal diameter

Front..	1·458in. - 0·0005in. (37·03 m.m. - 0·01 m.m.). 1.4607 Brg I.D. 1.676-677 Brg O.D
Mid front	1·438in. - 0·0005in. (36·52 m.m. - 0·01 m.m.). 1.4407 Brg I.D. 1.696-697 Brg O.D
Mid rear	1·418in. - 0·0005in. (36·02 m.m. - 0·01 m.m.). 1.4207 Brg I.D. 1.716-717 Brg O.D
Rear...	1·258in. - 0·0005in. (31·85 m.m. - 0·01 m.m.). 1.2607 Brg I.D. 1.736-737 Brg O.D

Running clearance in bearings ...	0·002in. to 0·003in. (0·05 m.m. to 0·08 m.m.).
Camshaft thrust taken.	Front.
End-float.	0·004 to 0·0062in. (0·1 m.m. to 0·16 m.m.).
Max. mal-alignment of journals ...	0·001in. (0·03 m.m.) to 0·002in. (0·05 m.m.) dial indicator reading.
End-float of distributor drive gear	0·0066in. to 0·016in. (0·17 m.m. to 0·040 m.m.).
Backlash between gear and camshaft gear...	0·003in. to 0·005in. (0·08 m.m. to 0·13 m.m.).
Diametral clearance of gear in bush...	0·0005in. to 0·0018in. (0·01 m.m. to 0·046 m.m.).
Bearing location in cylinder block	
Front..	1·675in. + 0·0007in. (42·55 m.m. + 0·018 m.m.).
Mid front	1·695in. + 0·0007in. (43·05 m.m. + 0·018 m.m.).
Mid rear	1·715in. + 0·0007in. 43·55 m.m. + 0·018 m.m.).
Rear...	1·735in. + 0·0007in. (44·05 m.m. + 0·018 m.m.).
Interference fit of bearings in cylinder block	
Front, mid front and mid rear..	0·0016in. to 0·0028in. (0·04 m.m. to 0·07 m.m.).
Rear...	0·0026in. to 0·0038in. (0·065 m.m. to 0·96 m.m.).

Ignition system

Coil

Type...	Lucas Model B.12.

Contact breaker gap	0·010in. to 0·012in. (0·25 m.m. to 0·3 m.m.).
Distributor drive casing assembly	
Clearance of shaft in casing bearings	0·0003in. to 0·0013in. (0·008 m.m. to 0·03 m.m.).
Shaft end-float	0·002in. to 0·004in. (0·05 m.m. to 0·1 m.m.).
Clearance of tachometer drive shaft in tachometer drive body.	0·0004in. to 0·0016in. (0·01 m.m. to 0·04 m.m.).
Tachometer drive shaft end-float	0·005in. to 0·014in. (0·13 m.m. to 0·35 m.m.).
Backlash between distributor and tachometer drive gears ...	0·006in. to 0·009in. (0·15 m.m. to 0·23 m.m.).
Sparking plugs	
K.L.G. (one piece).	P.Ten. L.80 (Long reach).
Recommended gap	0·018in. to 0·020in. (0·46 m.m. to 0·5 m.m.).

E N G I N E

DESCRIPTION

General

The "Bristol" BS1 Mk.II engine is a 6 cylinder overhead valve in-line water-cooled unit of mono-bloc construction. Three downdraught carburettors are flange-fitted direct to three vertical induction tracts in the cylinder head, each carburettor supplying mixture to two cylinders. There is no balance passage between the induction tracts.

The engine and gearbox unit is flexibly mounted on four bonded-rubber blocks,

those at the front being bolted between the engine mounting brackets and the chassis frame, and those at the rear being secured between the gearbox extension and a chassis cross member. Torque buffers fitted on the left-hand side of the clutch casing limit undue rocking of the engine as, for example, on starting.

Cylinder block

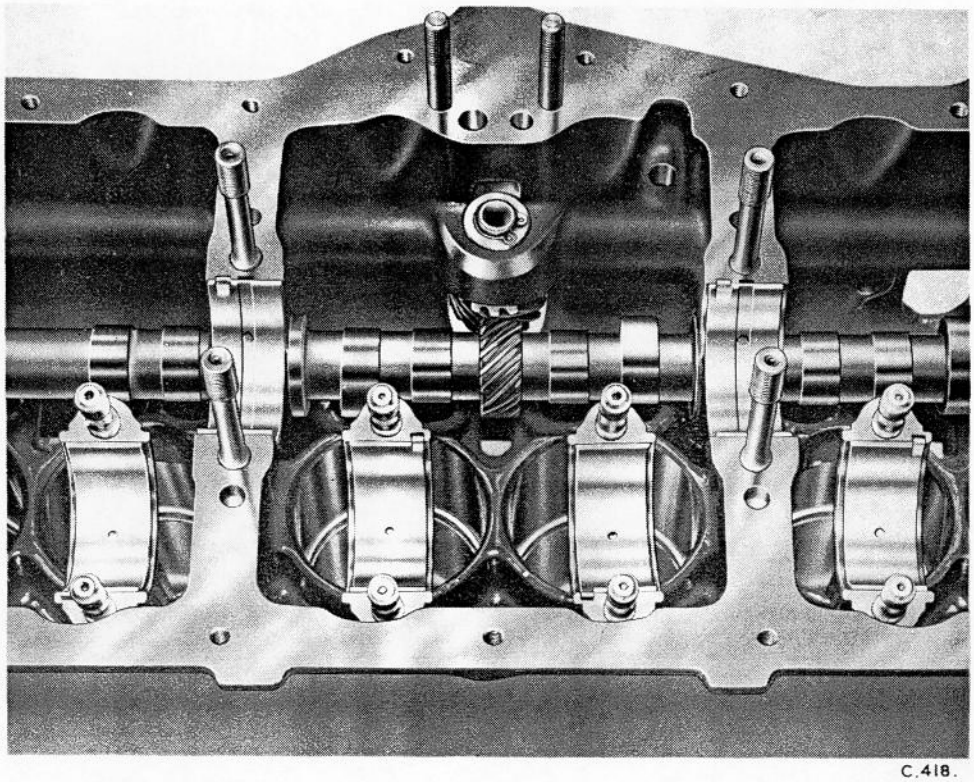
The cylinder block is of fine grade chrome cast iron; the crankchamber incorporated in the lower portion is closed by a cast light-alloy sump. For oil cooling purposes, an air scoop is fitted beneath the sump. The cylinder bores are fitted with "Brivadium" dry liners which are hone-finished after insertion, the cylinder joint face being surface ground.

The crankchamber is divided into three sections by stiffening walls as shown in Fig.5 and houses the four crankshaft bearings. Four bronze bushes support the camshaft in the left-hand side while inverted-piston-type tappets housed in the block, bear on the cams.

Externally-machined faces are provided for ancillary components, and screwed aluminium core plugs are employed throughout the cooling jacket; these plugs should not be removed under normal circumstances.

Cylinder head

The light-alloy cylinder head, illustrated in Figs.6,7 and 8 is fitted with shrunk-in, hardened valve seats, together with bronze valve guides. Bronze sparking plug inserts are screw in and dowelled. The exhaust valves fitted to the right-hand side of the head, and the larger diameter inlet valves on the left-hand side, are retained with split-cone cotters.



C.418.

Fig.5 Crankchamber.

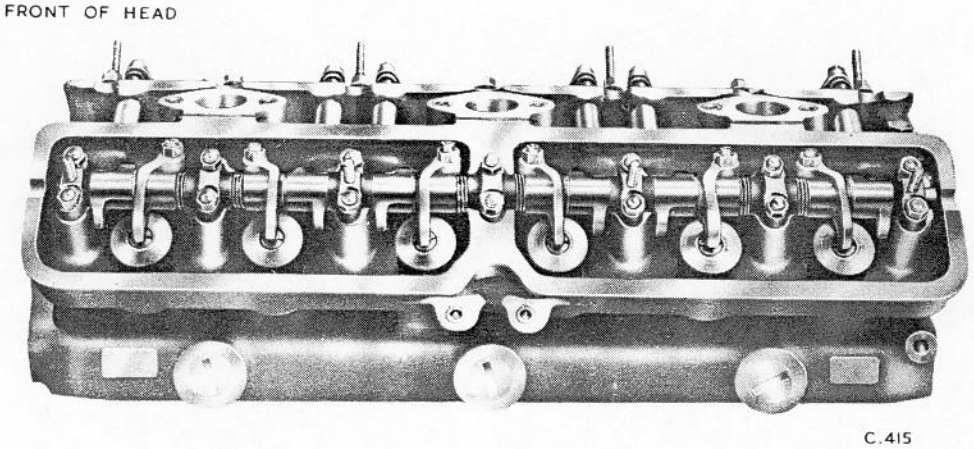


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Fig.6 Cylinder head - L.H. side.

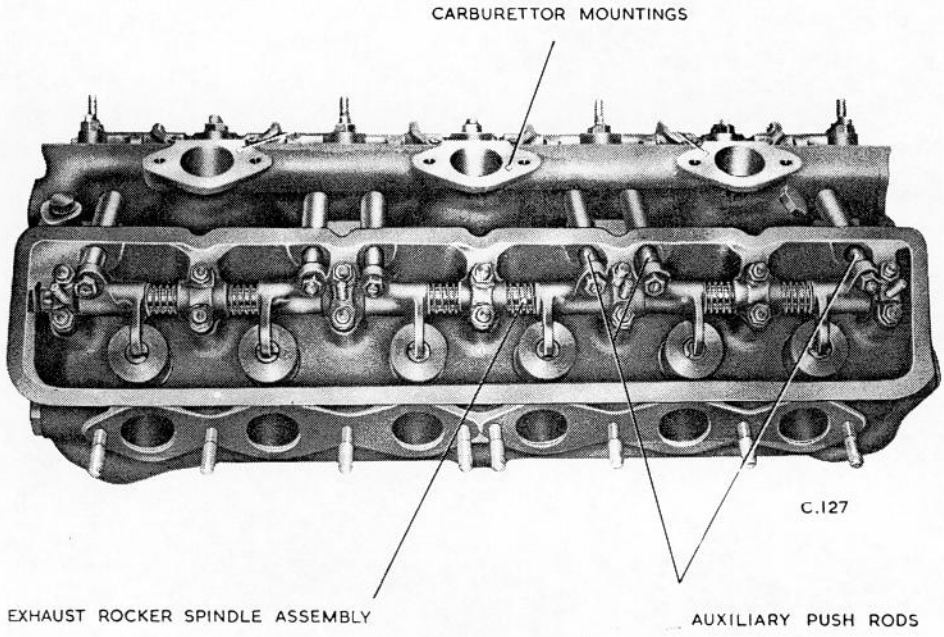


Fig. 7 Cylinder head - R.H. side.

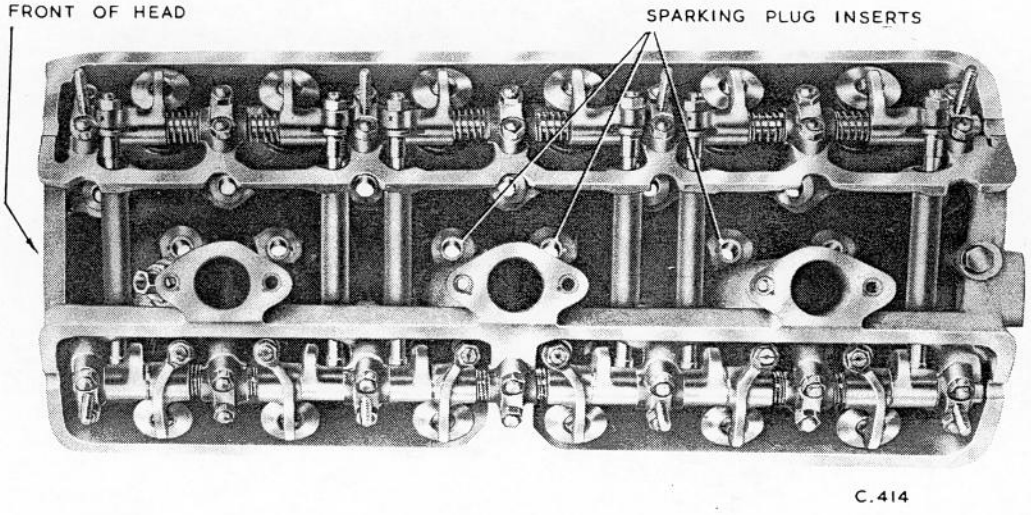


Fig. 8 Cylinder head (plan view).

Variable pitch outer valve springs (close-coiled at one end) are employed and it is essential that they are fitted correctly, i.e. the close-coiled end to the bottom. Bushed rockers are mounted on spindles located one on each side of the head; each spindle is supported in seven split housings and is located by a dowel in the front housing. Compression springs and washers fitted between each exhaust rocker and its adjacent spindle housing locate the rocker longitudinally. On the inlet rocker spindle, shorter compression springs and steel washers locate each pair of inlet and auxiliary rockers, see Fig.6.

The inlet rockers are operated by push rods applying a direct vertical thrust from the tappets. The vertical exhaust push rods operate auxiliary rockers mounted on the inlet rocker spindle and these apply a transverse thrust to the exhaust rockers through short auxiliary push rods, as shown diagrammatically in Fig.9. All the push rods are ball-ended.

A single rocker box cover is employed on the exhaust side but two separate covers are used on the inlet side, the front cover carrying the engine breather pipe union and the rear incorporating the oil filler.

Twin exhaust manifolds are bolted to the right-hand side of the head; each has a screwed outlet to receive the ring nut of a separate exhaust pipe, as shown in Fig.2. The manifolds are not interchangeable.

The carburettors are bolted to the head, throttle control fulcrum brackets being interposed between the two outer carburettors and the head, and an adapter being fitted beneath the centre carburettor. Each carburettor has an individual air cleaner. Attached to the front of the head, a water circulating pump and fan assembly is driven by a belt from the crankshaft pulley. The engine breather pipe is carried downwards from the front inlet rocker box cover and vents to atmosphere in the sump air scoop.

Camshaft

The camshaft is supported in four phosphor-bronze bush bearings fitted in the left-hand side of the cylinder block. An integral helical gear at the centre of the shaft meshes with the distributor and oil pump drive pinion which is mounted vertically in a bush pressed into the cylinder block; the pinion unit is retained by a circlip fitted at its lower end. Between the 10th and 11th cam (i.e. the inlet cam of cylinders No. 5 and 6) is a ground eccentric integral with the shaft; this actuates the operating lever of the fuel pump. The camshaft is located longitudinally by a retaining plate at the face of the front bearing journal. A duplex chain wheel, keyed and secured by a nut to the front end of the shaft, engages the timing chain driven by the crankshaft driving sprocket. The mid front bearing journal has an oil groove part way round its circumference. Once per revolution the groove coincides with an oil feed hole in the bush, which passes oil to an external annular recess formed between the bush and its housing, from which a duct coupled by a short external pipe supplies an intermittent feed to the tachometer drive in the distributor drive case. The rear journal is drilled transversely to provide the intermittent feed to the rocker mechanism. It is also drilled longitudinally to enable any oil behind the journal in the bush to drain back to the sump.

Crankshaft

With the exception of the starter dog locating threads, the chrome molybdenum steel crankshaft is nitrogen-hardened all over. Its rear end is flanged to accommodate the flywheel and is bored to receive the ball bearing of the spigoted gearbox drive shaft, the bearing being retained in position by a circlip. Between the flywheel attachment flange and the rear main bearing journal, an oil-

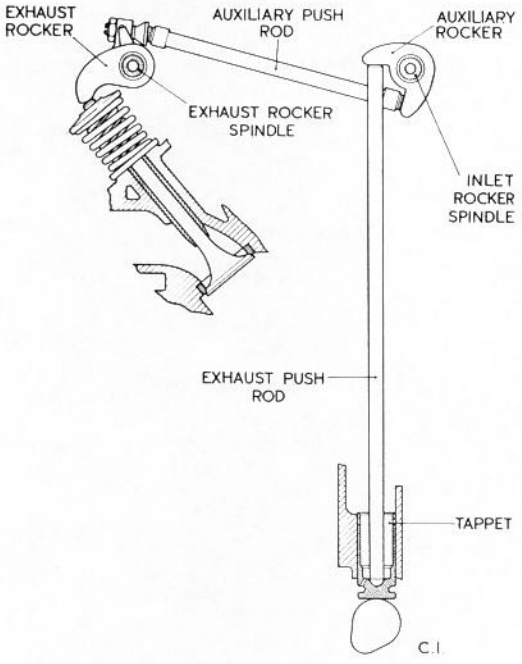


Fig. 9 Diagram of exhaust push rod operation.

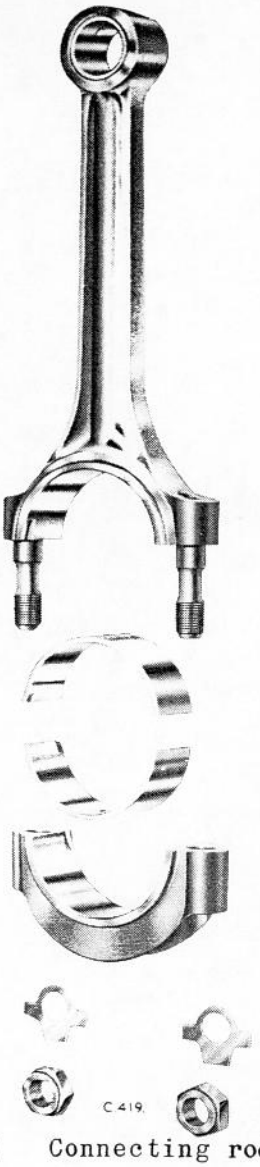


Fig. 11 Connecting rod.

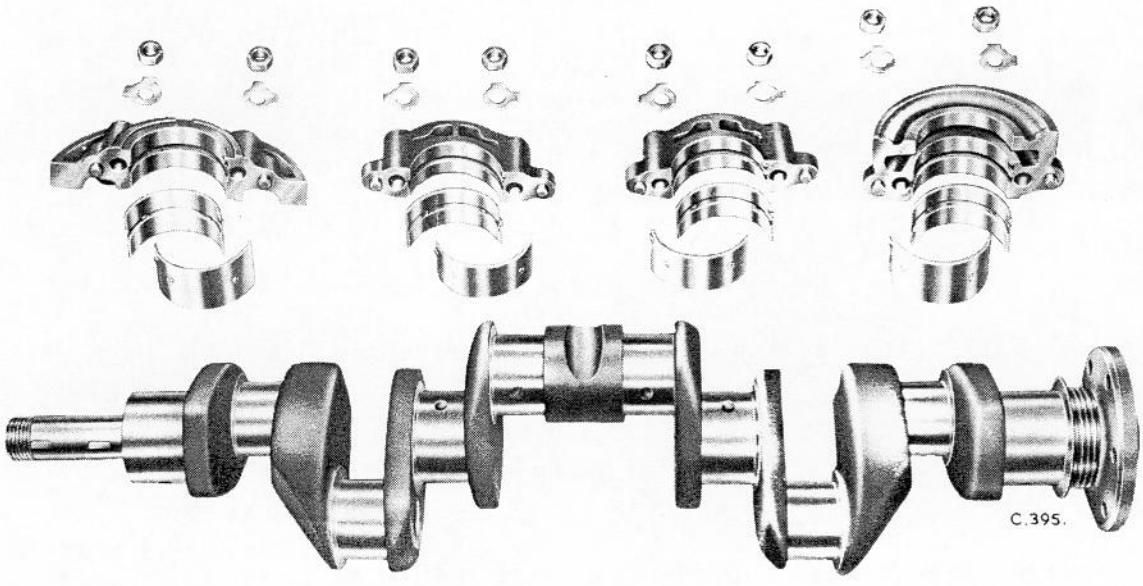


Fig. 10 Crankshaft.

return thread machined in the shaft is screened by an integral oil thrower, see Fig. 10; this prevents oil loss from the rear bearing. At the front end of the shaft, oil loss is prevented by an oil baffle fitted to the shaft inside the camshaft drive cover and one secured to the damper carrier, a felt seal being fitted in the bore of the cover, see Fig. 3. The end-float of the shaft is controlled by split thrust plates fitted to the front and rear of the front main bearing. The four main bearings are "thin wall" steel shells lines with lead-indium bronze, and are located in their housings and their respective caps by tongues engaging corresponding recesses.

Connecting rods and pistons

The steel alloy connecting rods are of "H" section with big end cap securing studs screwed and peened into the rod, see Fig. 11. "Thin wall" steel-backed bearing shells, lined with lead-indium bronze are fitted to the rods and caps. The small ends are fitted with phosphor-bronze bushes.

The pressed aluminium-alloy pistons taper from the bottom to the top of the skirt, the bottom skirt being 0·012in. (0·3 m.m.) greater in diameter than the crown. The pistons are oval-turned on the skirt to produce an ovality of 0·0035in. (0·09 m.m.) to 0·005in. (0·13 m.m.) with a taper of 0·001in. (0·03 m.m.) then finally flash-tinned. Each is fitted with three compression rings and one scraper ring, all rings being granodised prior to fitment. Fully floating, selectively-fitted hollow gudgeon pins are located laterally by circlips.

Ignition system

Ignition is by coil and battery with a 10 m.m. sparking plug fitted centrally

to each combustion chamber, timing control being effected by means of an automatic timing device of the centrifugal governor type incorporated in the distributor assembly. Provision is made for a manual override control if required.

The distributor drive is located vertically on the left-hand side of the cylinder block. At its lower end, it is secured by two studs in the cylinder block at camshaft level, being located in a recess immediately above the oil pump and distributor drive pinion by which it is driven. Its upper end is secured to a machined face on the cylinder head and is retained by two set-bolts with a distance piece interposed between the drive casing and the head.

The casing incorporates an integral bearing at its lower end for the distributor drive shaft which is located vertically on the upper face of the bearing by an integral flange, see Fig. 12. A tongued driving dog is secured to the spigoted lower end of the shaft by a parallel steel driving pin, a thrust washer being interposed between the driving dog and the lower face of the bearing. Immediately above the driving shaft flange is an integral helical pinion which engages with the pinion of the tachometer drive shaft located in a housing screwed into the rear of the distributor drive casing. The upper end of the shaft is fitted with the slotted upper driving dog which is also secured to the shaft with a steel driving pin.

The distributor head is spigoted into the top of the drive casing and retained in its correct timing position by a clamp. The clamp plate incorporates a radial slot and provision is made for the addition of a manual override control. In standard form, a plain set-screw and washer through the radial slot retains the distributor head in position, but when a manual control is fitted, the set-screw is replaced by a shoulder bolt and a small steady spring; the distributor can thus be moved to the limit allowed by the radial slot.

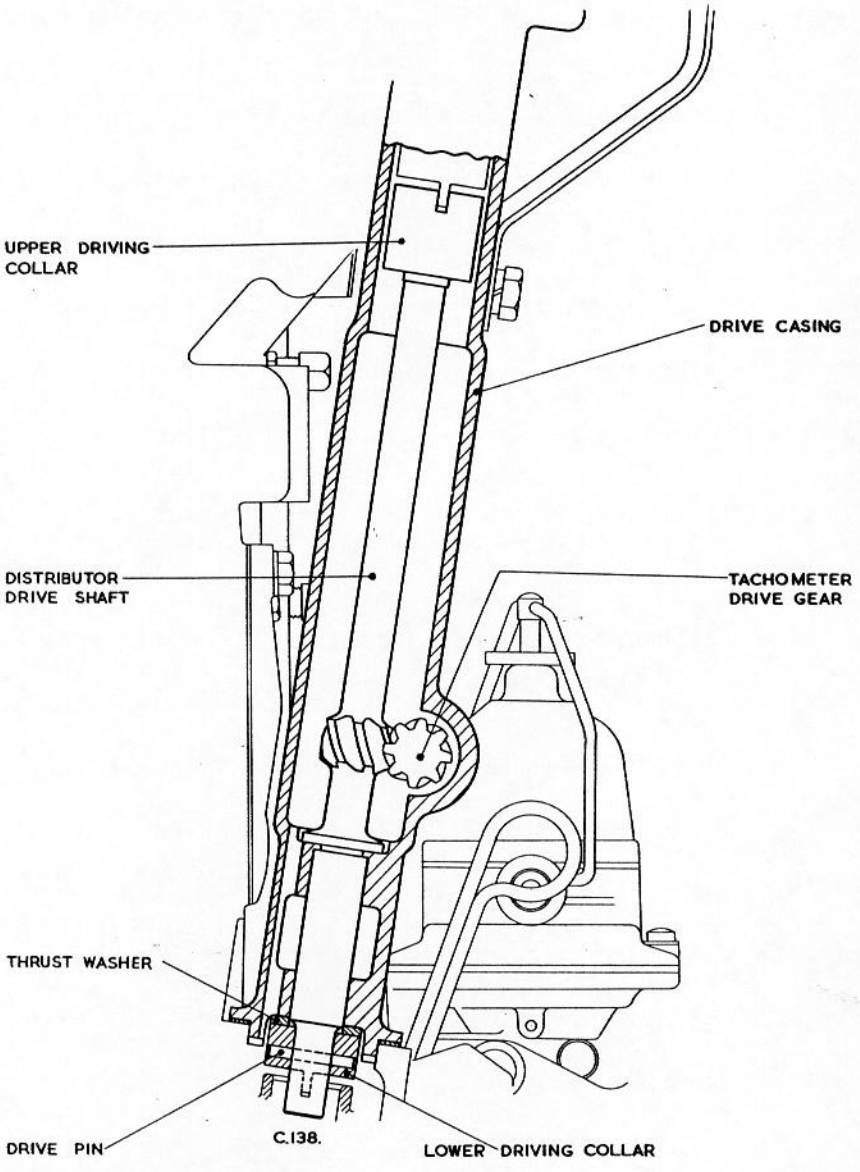


Fig. 12 Distributor drive casing assembly.

Automatic timing device

The automatic timing device is a centrifugally-operated mechanism housed beneath the contact breaker base plate. The construction is shown in Fig. 13. The driving spindle has an integral circular platform through which the spindle extension protrudes vertically. This extension has a spiral oil groove and is a ground finish to permit free oscillating movement of the cam unit which is assembled over the spindle. The end of the spindle is drilled and threaded to accept the cam unit retaining screw.

On the top face of the platform are two diametrally-opposed pins, on each of which a crescent-shaped lead weight pivots at one end. Another pin extends upwards from the centre of each weight about which a small rocking toggle pivots centrally. One end of each toggle is spring-loaded to its respective weight pivot, while the other end is drilled to receive a driving pin extending into the weight. With the engine at rest, the weights are pulled in towards the centre by the action of the toggles and springs thus turning the cam unit to give the retarded ignition setting. With the engine running however, the weights are flung outward against the spring and toggle action, and turn the cam unit on the distributor shaft to give an advanced timing to a degree which depends on engine speed, see Fig. 13.

Lubrication system

This is shown diagrammatically in Figs. 14 and 15. Located on the left-hand side of the cylinder block, the oil pump projects into the sump and takes its drive from the lower end of the distributor and oil pump drive pinion which is in mesh with the helical gear on the centre of the camshaft. A sieve unit at the

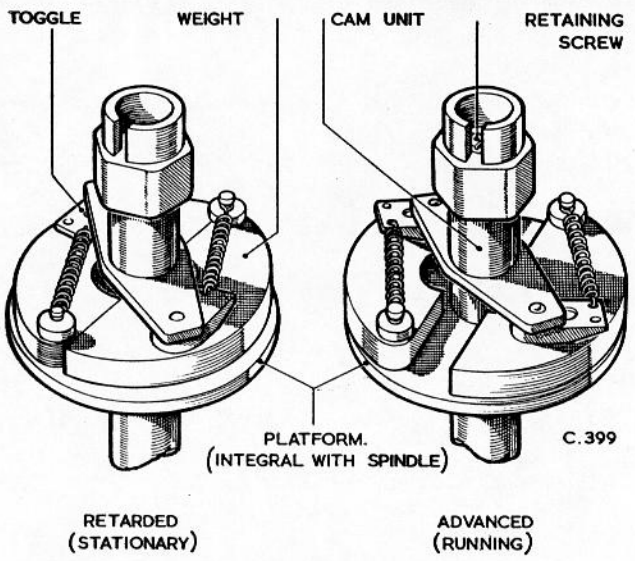


Fig. 13 Operation of automatic timing device.

bottom of the pump cover screens the pump inlet, this being completely submerged in the oil. Pressure oil is delivered through a vertical duct in the pump body (via a mating internal oilway in the cylinder block wall) to the head of a filter mounted externally on the left-hand side of the cylinder block. A branch duct from the pump delivery passage to the filter communicates with a pressure relief valve which is provided with external adjustment, excess oil being returned to the inlet side of the pump through a passage in the cylinder block and a second duct in the pump body, see Fig. 15.

After passing through the filter, the oil re-enters the cylinder block to an annular recess around the distributor and oil pump driving pinion bush (which is drilled to lubricate the pinion journal); this communicates with the main oil gallery which extends longitudinally through the cylinder block immediately below the camshaft. Branch passages from the gallery supply the camshaft bearings and the crankshaft main bearings, drillings in the crankshaft connecting the main bearing journals to the crankpins. The gudgeon pin bushes are lubricated by splash oil and mist.

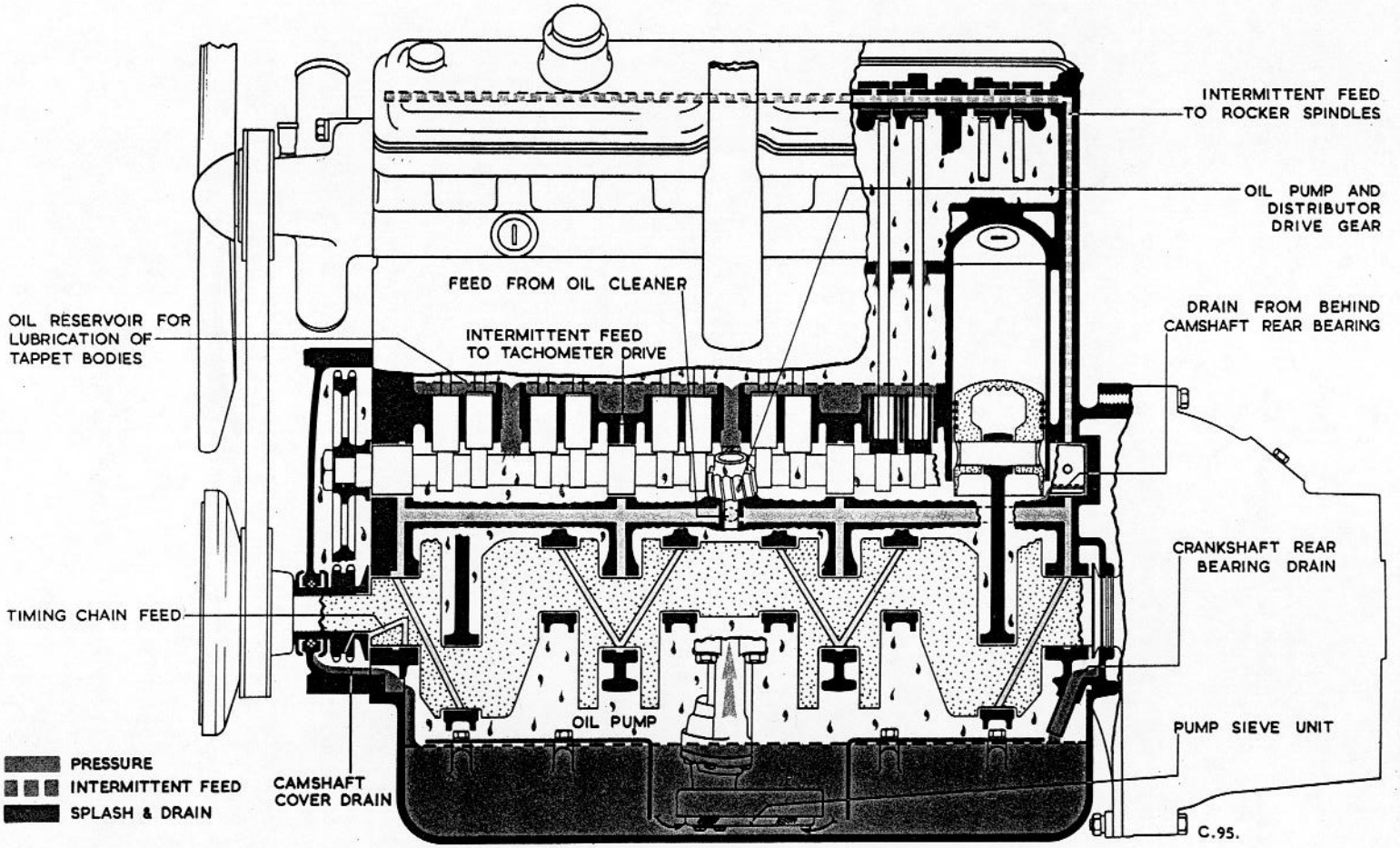


Fig. 14 Engine lubrication diagram.

As a precaution against the filter clogging, the filter insert assembly is spring-loaded against a seating in the head and thus forms a filter by-pass.

An additional longitudinal duct in the crankshaft front main bearing journal receives oil from the annular groove in the front main bearing shell; the duct terminates at the front end of the journal, the oil flowing through one of the two keyways in the front thrust plate to a drilling between the rows of teeth in the timing chain sprocket to lubricate the chain. Four drain holes in the front main bearing cap return oil from the camshaft drive cover to the sump.

An external connection in the left-hand side of the cylinder block leads from the main gallery and accommodates the pipe to the oil pressure gauge.

An intermittent feed to the overhead rocker system is initiated by a transverse drilling in the camshaft rear bearing journal, this registering every half-revolution with an oilway through the bush and in the rear wall of the cylinder block, see Fig. 14. An external pipe conveys the oil to a duct in the cylinder head. Branch ducts from the cylinder head oilways terminate in each rocker spindle rear support location, the oil flowing through the spindles to the rockers, then from the rocker bearings to the push rod ends.

A further intermittent feed from the camshaft mid front bearing is connected by an external pipe to the tachometer drive in the distributor drive casing. The temperature of the oil is registered by a thermometer bulb inserted in the left-hand side of the oil sump, which is coupled to the gauge by a capillary. The cylinders, pistons and remaining drives are lubricated by splash, mist or drain oil.

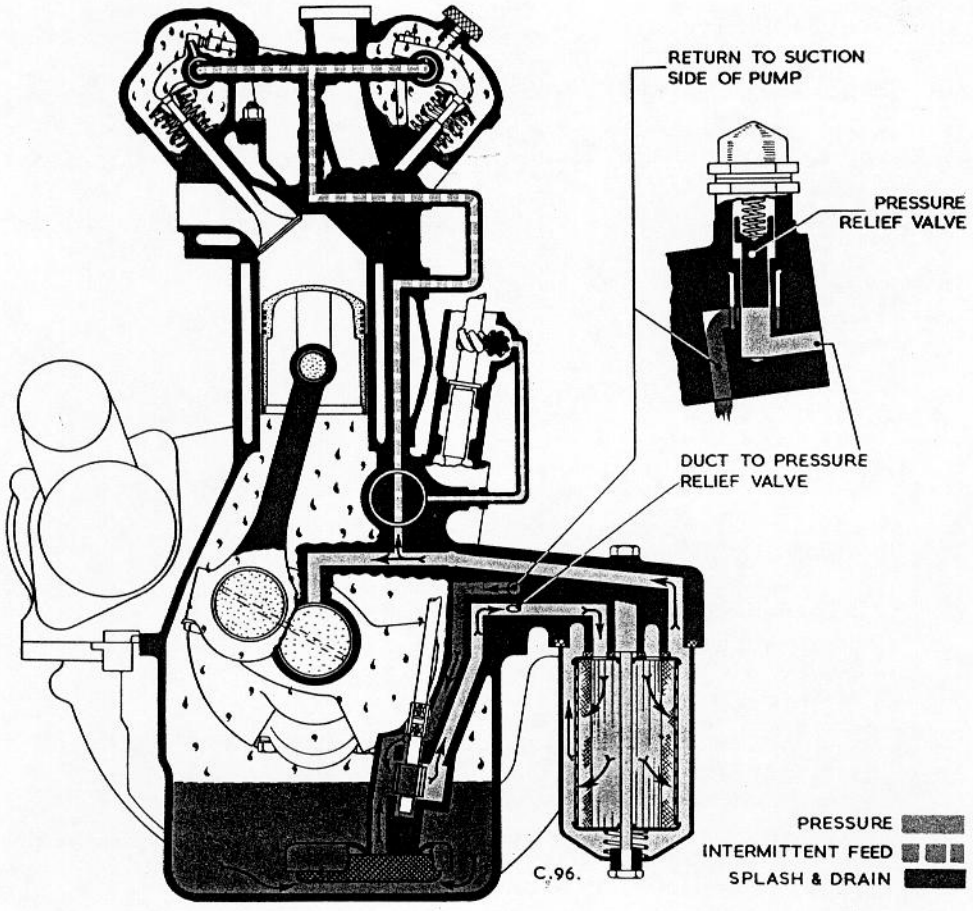


Fig. 15 Diagram of engine lubrication system.

LUBRICATION SYSTEM

Pressure relief valve

Located on the left-hand side of the cylinder block, see Fig. 16, the oil pressure relief valve is interposed in the supply from pump to filter. The assembly comprises the body, relief valve, spring adjusting screw and lock-pin, and is screwed into the cylinder block where it is secured by a locknut, a cap closing the outer end. The valve body has three equally-spaced outlet ports, as shown in Fig. 17; this eliminates valve flutter.

Removing and refitting relief valve

If the operation of the valve is suspect, remove and inspect the assembly as follows :-

1. Slacken the locknut, then tighten it against the cap and unscrew the complete assembly from the cylinder block. Remove the seating washer from the cylinder block.

2. Holding the locknut, loosen the cap, then remove the cap, locknut and sealing washers.

3. Extract the adjustor retaining pin, unscrew the adjusting screw and withdraw the valve and spring, see Fig. 17.

Clean all components thoroughly. Check that the outlet ports in the body are not obstructed and inspect the valve for scoring and hard bearing; if necessary, dress such areas by light stoning. Never lap the valve to the body. Trial-fit the valve in the body; it should be an easy sliding fit. When this is satisfactory, re-assemble as follows :-

1. Fit the valve, spring and adjustor to the body, screwing in the adjusting screw until the retaining pin can be inserted. Fit a new seating washer to the recess in the cylinder block.

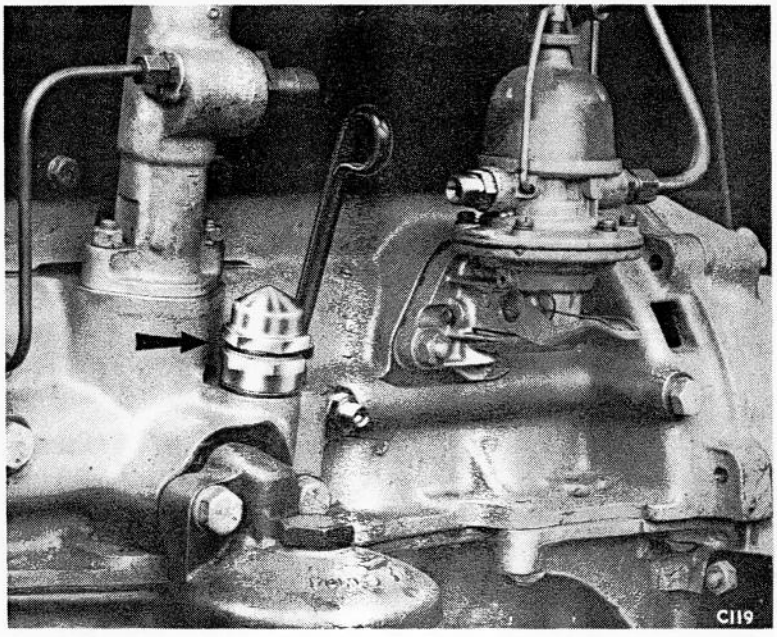


Fig. 16 Pressure relief valve.

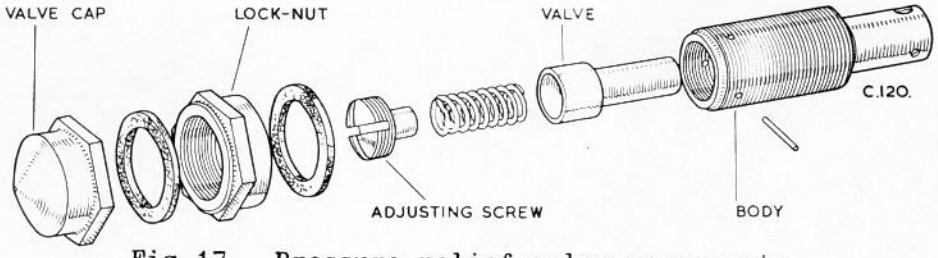


Fig. 17 Pressure relief valve components.

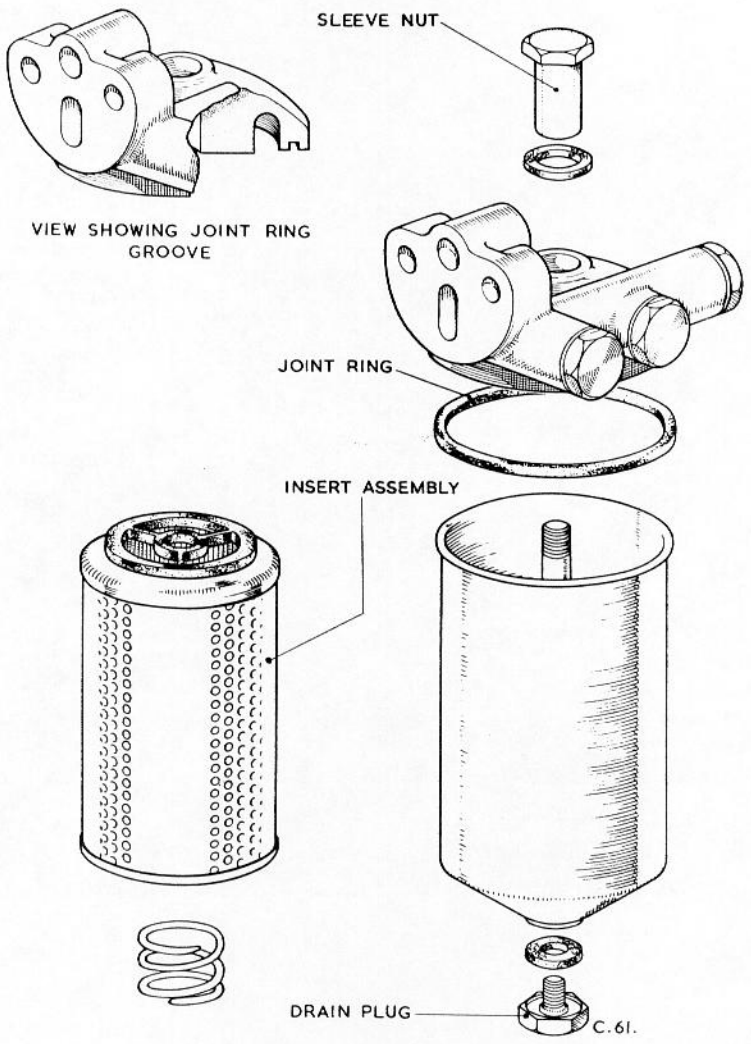


Fig. 18 "Vokes" oil filter.

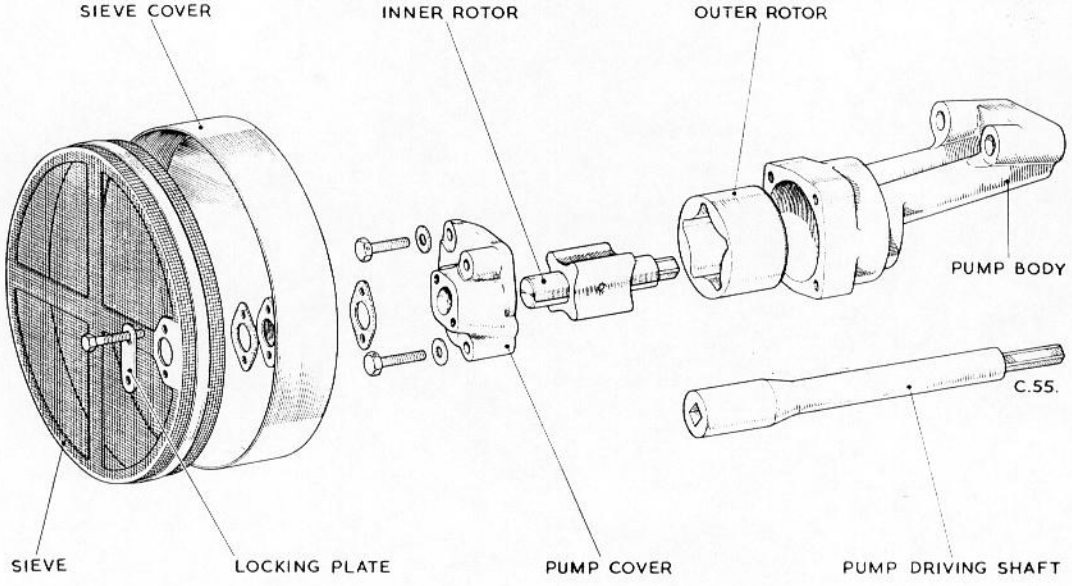


Fig. 19 Oil pump.

2. Fit the locknut and cap to the valve body, lock them together and screw the assembly into the cylinder block; make sure that the valve body is screwed down firmly in its seating or loss of oil pressure may result.

   Note:- The aluminium washer fitted to the cylinder block forms a seating for the body. If there is evidence of any leakage from the seating (and whenever the body is removed), fit a new washer.

3. Separate and remove the locknut and cap. Fit a new sealing washer over the body and lock the assembly in position with the locknut.

Adjusting oil pressure

After removal of the relief valve, or if the pressure is incorrect and cannot be traced to other causes, proceed as follows :-

1. Run the engine until the oil temperature is 70°C., then open up to 3,000 r.p.m.

2. Remove the relief valve cap, sealing washer and retaining pin, then screw OUT the adjusting screw to decrease the pressure, or screw IN to increase the pressure.

3. When the pressure is correct, replace the retaining pin, fit a new sealing washer then screw on and tighten the cap securely.

Engine oil

It is most important to use the recommended grade of oil according to the season and climatic conditions. Never check the oil level with the engine running. If the engine has just been stopped, allow time for the oil to drain to the sump, then make certain that the dipstick is inserted fully. In order to obtain an accurate reading when measuring the oil level, make sure the car is level then wipe the dipstick before insertion. Maintain the level at or near (but not over) the upper mark. Avoid overfilling as this will result in high oil temperature and consumption.

Oil filter (full flow type)

Description

The "Vokes" filter is secured by two set-bolts to the left-hand side of the cylinder block and consists of a casing which houses a replaceable element in a perforated steel frame; this unit is the "insert assembly", see Fig. 18. The casing is attached to a head which provides the attachment point to the cylinder block, the head having an oilway which receives the oil from the pump and one which conveys the filtered oil to the engine system.

Oil enters the bore of the insert assembly and emerges from the casing. A seating washer is attached to the upper end cap of the insert assembly, a spring located beneath the assembly holding this against a seating on the head thus providing a by-pass in the event of the assembly becoming sludged.

Servicing

Remove the drain plug from the bottom of the casing and drain the oil. Slacken the sleeve nut at the top of the head, then hold the casing while the nut is unscrewed; remove the casing complete. Withdraw the insert assembly and spring from the casing. Do not attempt to clean the insert assembly; fit a new one at the period quoted in the maintenance schedule.

If the head is to be removed, release the two retaining bolts and washers and withdraw the head. Discard the joint ring. Before refitting the head, check that the joint faces are clean, then refit the head, using a new joint washer; do not use jointing compound.

Make sure that the casing is clean then check the condition of the spring and seating washer, and the joint washers for the drain plug and sleeve nut. Fit

the drain plug, refit the insert assembly (or fit a new one) then fill the casing with clean approved engine oil to ensure an immediate supply to the engine system when the engine is started. Fit a new joint ring then offer up the assembly and casing to the head and secure with a sleeve nut; tighten the nut firmly.

OIL PUMP

Description

The pump is illustrated in Fig. 19. The pump chamber encloses an inner end outer rotor. The inner rotor is pinned to a spindle which has a square end projecting vertically upwards from the body to engage the lower end of the pump driving shaft, the upper end engaging the distributor and oil pump driving pinion. A delivery duct in the body links the discharge side of the pump with the pump body attachment flange, a second duct in the body linking the return oilway from the pressure relief valve in the side of the cylinder block with the inlet side of the pump.

Removing and refitting

1. Drain and remove the sump.
2. Release the tabwashers, then remove the two nuts and withdraw the pump, together with the driving shaft. Discard the tabwashers.
3. Remove the driving shaft from the external square on the pump driving rotor and remove the joint washer from the pump body. Discard the washer.

To refit the pump to the cylinder block, proceed as follows :-

1. Fit the driving shaft to the external square on the pump driving rotor then assemble a new joint washer to the pump attachment flange.

2. Offer up the pump, engaging the squared upper end of the driving shaft unit with the distributor and oil pump drive gear, fit new tabwashers then screw on and lightly "nip" the retaining nuts.

3. Turn the crankshaft through at least two complete revolutions to allow the drive shaft and pump to align before finally tightening the retaining nuts. Alignment is satisfactory if the end-float of the drive shaft can be felt by hand.

4. Lock the nuts with new tabwashers, then refit and re-fill the sump.

Dismantling

To dismantle the pump after removal from the engine, proceed as follows, referring to Fig. 19 :-

1. Release the tabs of the locking plate, remove the two set-bolts securing the sieve unit then remove the locking plate, sieve and sieve cover. Discard the two joint washers.

2. Cut the locking wire, remove the set-bolts securing the pump cover, then remove the cover and withdraw the inner and outer rotors.

3. Clean and dry the components, paying particular attention to the oilways and sieve.

Inspection

Examine all parts of the pump assembly. Check the mating surface of the rotors for wear or scoring, replacing any worn parts. To check the rotors for excessive wear, fit them into the pump body, then check the clearance between the inner and outer rotors with feeler gauges. If the clearance exceeds 0·010in. (0·25 m.m.), fit a new pump.

Check the end-float of the rotors in the casing with a straight edge and feeler gauges; the clearance should not exceed 0·004in. (0·10 m.m.). Check that the pump and its cover are seating correctly; if necessary, lap the cover to a lapping plate.

Re-assembling

1. Make sure that all components are scrupulously clean, then lubricate the outer rotor and assemble it to the pump body, chamfered edge inwards.

2. Lubricate the inner rotor and fit it in the outer rotor with the squared end of the spindle projecting through the body.

3. Fit the pump cover and secure with its set-bolts and plain washers. No washer or jointing compound is used on the joint face. Test the pump for freedom of rotation. If the pump is tight, release the set-bolts, re-position the cover slightly on the bolts, then re-tighten and re-test.

4. When this is satisfactory, wire-lock the set-bolts.

5. Finally re-assemble a new joint washer, sieve cover, another new joint washer, sieve and locking plate and secure with the two set-bolts. Tighten the bolts and bend the ends of the plate to lock the heads.

CYLINDER HEAD

Removing

1. Disconnect the negative terminal from the battery.

2. Drain the cooling system as described in Section 2, release the hose clips and remove the hoses from the water pump and radiator.

3. Disconnect the lead adaptors from the sparking plugs and detach the leads from the clip between the two front carburettors.

4. Detach the tachometer drive and its oil feed pipe from the distributor drive casing. Release the low and high tension leads from the side and centre respectively of the distributor.

5. Remove the nuts and spring washers securing the distributor drive casing to the cylinder head. Unscrew the nuts securing the drive casing flange to the cylinder block, remove the washers and lift away the casing, distributor and drive shaft. Retain the laminated distance piece fitted between the drive casing and cylinder head, then remove the joint washer from the lower securing flange. Disconnect the petrol pipe from the pump delivery union and release its support bracket from the push rod cover.

6. Remove the carburettors as described in Section 3.

7. Disconnect and remove the oil pipe from the rear of the cylinder block and cylinder head. Detach the breather pipe clip from the oil sump flange, then unscrew the two retaining caps and remove the front inlet rocker box cover and joint washers. Remove the remaining rocker box covers together with their joint washers.

8. Cut the locking wire and unscrew the exhaust pipe ring nuts with the special "C" spanner TFN.5030. Remove the nuts and washers securing the exhaust manifolds to the head and remove the manifolds and gaskets.

9. Slacken the dynamo adjusting and securing bolts to relieve the tension of the fan belt, then remove the belt.

10. Use the special spanners supplied in the tool kit to remove the sparking plugs and the fourteen cylinder head retaining nuts; slacken these in the sequence shown in Fig.20, then remove the nuts and washers carefully and ease the cylinder head off the studs, ensuring that the push rods remain in position in their respective tappets; the rods may be damaged if caught in the head. Mark the push rods to indicate their sequence and position, then twist the rods to free them from the tappet bodies and withdraw them.

Caution:- If the push rods are not freed, the tappet bodies may be lifted out of their locations in the cylinder block; this will involve removal of the push rod cover.

Refitting

1. Lubricate both ends of the vertical push rods and fit them in the previously marked order to the cylinder block. Make sure that the rods are refitted to their correct tappets (and the correct way up) since they are mated together by running; check that they seat squarely.

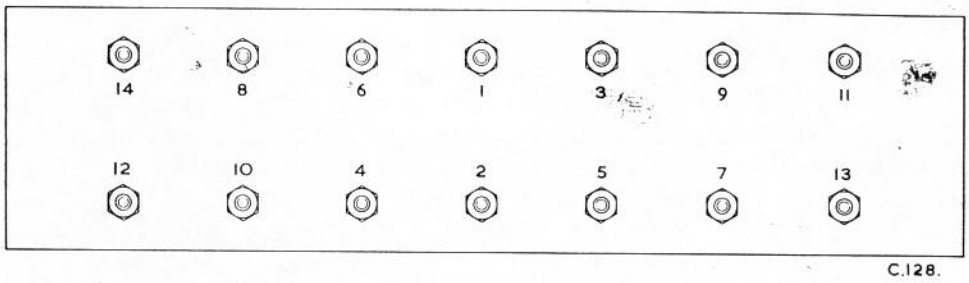


Fig. 20 Sequence for tightening or loosening cylinder head nuts.

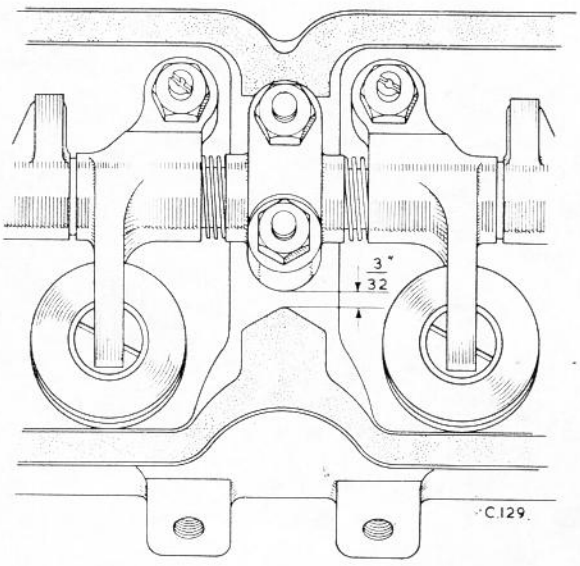


Fig. 21 Rocker cover joint clearance.

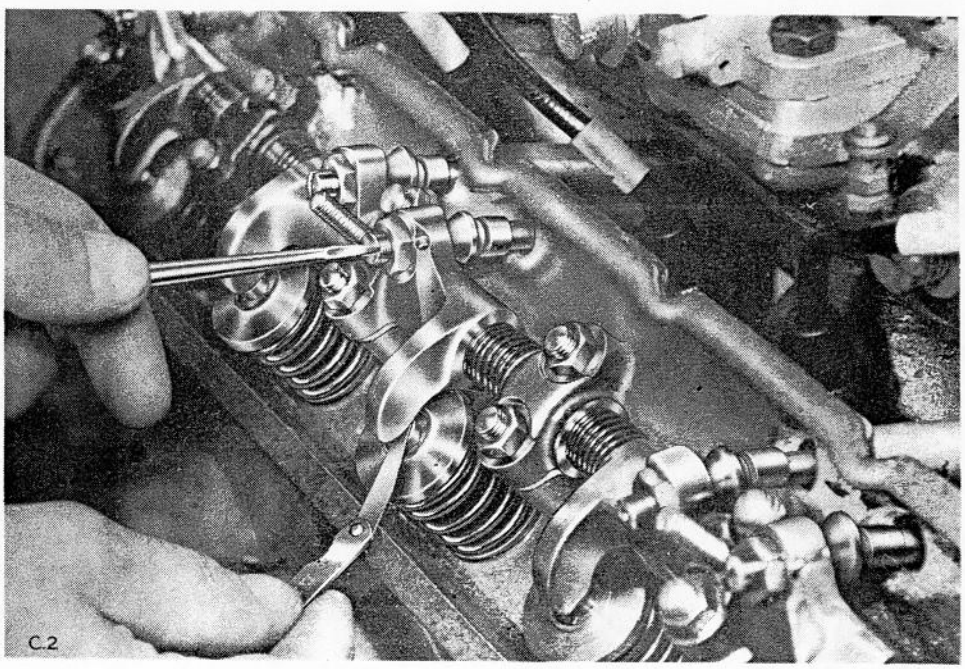


Fig. 22 Adjusting tappet clearances.

2. Slacken the exhaust rocker adjusting screws. Make sure that the cylinder block joint face is quite clean then smear a new cylinder head gasket lightly with grease and place it in position over the retaining studs. Check that the cylinder head joint face is clean then hold the auxiliary push rods against the exhaust rockers and lower the cylinder head carefully over the studs, ensuring that the vertical push rods are not bent or damaged as the head is lowered into position.

3. Fit the washers then screw on and "nip" the fourteen cylinder head retaining nuts. Tighten each nut one sixth of a turn at a time in the sequence shown in Fig. 20 until all nuts are tightened fully. Set the valve clearances as described on page 41.

4. Fit new gaskets and assemble the exhaust manifolds to the cylinder head; tighten the special brass nuts evenly. Connect the exhaust pipes to their respective manifolds, tightening the ring nuts with the special "C" spanner, then wire-lock securely.

5. Fit the belt to the dynamo, fan and crankshaft pulleys and adjust the tension of the belt as described in Section 2.

6. Re-assemble the oil pipe between the rear of the cylinder block and cylinder head; tighten the union connections. Refit the carburettors as described in Section 3, connect the petrol pipe to the pump and its support bracket to the push rod cover.

7. Refit the distributor drive, using a new joint washer on the lower attachment flange and making sure that the laminated distance piece is refitted behind the attachment flange and the cylinder head. Attach the tachometer drive and its oil feed pipe to the distributor drive casing, then re-attach the low and high tension leads. Time the distributor as described later in this Section.

8. Fit the correct type washers to the cleaned and gapped sparking plugs and fit the plugs to the cylinder head; tighten the plugs with the special spanner supplied in the tool kit, then connect the distributor H.T. lead adapters to the plugs. Refit the leads to the support bracket between the carburettors. Connect the negative terminal to the battery.

9. Refit the hoses to the radiator and water pump and tighten the clips securely. Ensure that the cylinder block and radiator water taps are closed then fill the system with water.

10. Replace the rocker box covers, using new joint washers and rubber seals; make sure that there is at least 3/32in. (2·38 m.m.) clearance between the bearing cap and gasket at the inlet rocker box cover as shown in Fig. 21.

11. Attach the breather pipe clip to the oil sump flange. Re-fit the carburettors as described under Section 3, complete with air filters.

Tappet clearances

The correct clearance between the rocker arms and the valve stems is most important. With the engine cold, set the clearances to the dimensions given in the General Data.

Turn the engine with the starting handle until No.6 inlet valve is fully open; No.1 inlet valve will then be fully closed. Slacken the locknut on No.1 inlet valve rocker adjusting screw and, with the correct feeler gauge inserted between the rocker and the valve stem, adjust the rocker adjusting screw; it should just be possible to move the feeler gauge. Check the remaining tappet clearances in a similar manner; the valves "open and closed" positions are as follows :-

Inlet		Exhaust	
Valve open	Valve closed	Valve open	Valve closed
No.6	1	6	1
5	2	5	2
4	3	4	3
3	4	3	4
2	5	2	5
1	6	1	6

Dismantling

Remove the head from the engine as described previously, then remove the water pump, see Section 2. Mark each inlet rocker spindle cap and its location 1 to 7 (No.1 being the front cap) then release the nuts and remove the caps. Holding the rocker at each end of the spindle, lift out the spindle assembly.

Mark each exhaust rocker bearing cap and its location 1 to 7 (No.1 being the front cap) then release the nuts and remove the caps. Retaining the two end rockers in position against their springs, lift out the spindle.

Rockers are marked to facilitate re-assembly; if the markings are not discernible, mark them at the upper end with their cylinder number.

Remove the auxiliary push rods one at a time, marking them to ensure that they are refitted correctly. Compress the valve springs with the valve lifter TFN.5021, then remove the valve cotter to release the springs. Remove the upper valve spring seating, springs, lower valve spring seating and valve; place these assemblies together in a suitably-marked rack so that they are returned to their original positions on re-assembly.

Cleaning

Remove all carbon from the combustion chambers; if decarbonising equipment is not available, use wire wool and white spirit as a substitute. Clean the valve guides with a suitable brush and clean out the sparking plug threads with a 10 m.m. tap; polish the valves. Remove any carbon from the exhaust ports with a bristle brush; if necessary, clean the inlet ports. Clean the rocker spindle assembly components, clear the oil holes to the push rod cups and pressure wash both spindle bores through the oil hole at the end.

After all traces of carbon and sludge have been removed, and prior to re-assembly, subject all apertures and oilways, etc. to a clean air blast.

Inspection and re-conditioning

Examine the cylinder head and valve seat inserts for condition; check that all studs are secure and undamaged and trial-fit the nuts to the studs. Check the bore dimension of the valve guides and the stem diameters of the valves; discard them if worn unduly.

Note:- Since this is a high performance engine and employs multiple carburettors, it is essential that the inlet valves are an excellent working fit in their guides if the designed performance is to be retained.

Clean the face of the cylinder head carefully then check it with marking compound on a surface plate; an all-over marking should be obtained. If necessary, lap the face lightly on a lapping plate to obtain the required contact.

Examine the rocker spindles for cleanliness of the oilways and check that the rocker locations on the spindles and the bushes in the rockers are not worn excessively; renew the rocker bushes if necessary. Check that the rocker compression springs are undamaged and that their end coils have not fretted the spacing washers. Examine the cups of the rocker adjusting screws for flat spots and trial-fit the locknuts; these must be a good fit on the threads. Check the oilways of the rocker adjusting screws for cleanliness. Inspect the valve stem contact faces of the rockers and check that the rods are not bent or otherwise damaged.

Examine the valve springs and their seatings for fretting and check the length of the springs when compressed to the loading quoted in the General Data.

After grinding the valves to their seatings in the head, check that the "land" of the valve stands clear of the insert. If the "land" of the valve "pockets" in the insert, fit a new valve or cut back the insert to restore the valve position.

Replacing valve seat inserts

This is not a practical procedure and it is not recommended. If necessary, the matter should be referred to the manufacturer.

Replacing valve guides

Remove rejected valve guides with a stepped drift and a hammer. Replacement valve guides are supplied in the standard size or up to +0·040in. (1·07 m.m.) on the outside diameter. In many cases, a standard valve guide will prove satisfactory, particularly if the old guide has been removed carefully. When fitting an oversize guide, do not ream or enlarge the bore in the cylinder head or misalignment will occur. Measure the bore in the head, then machine the oversize valve guide to give the interference fit quoted in the "General Data". It is preferable to freeze replacement guides by the "dry-ice" process prior to fitment; when this process is adopted, the bore should provide the desired clearance with the valve stem.

Replacing rocker bushes

Always press out rejected rocker bushes. After pressing the replacement bush into the rocker, trial-fit it to its spindle and, if necessary, ream to produce the required clearance.

Re-assembling

1. Make sure that all components are clean then fit each valve to its correct guide, followed by the lower valve spring seating, inner and outer valve springs and the upper spring seating. Make sure that the variable-pitch outer springs are fitted correctly, i.e. close-coiled end downwards.

2. Using the valve lifter TFN.5021, compress the springs, then fit the valve cotters and release the lifter. Check that the split cotters are seating firmly and squarely on the valve stem and in the upper spring seating.

3. Lubricate the inlet and auxiliary rockers then fit them with their compression (short) springs and washers to the inlet rocker spindle; this spindle can easily be identified by the twelve oil holes drilled to align with the auxiliary rockers and rockers. Both the rockers and auxiliary rockers are numbered in sequence and should be fitted to the spindle as detailed below and shown in Fig. 23. Note that the front end of the spindle carries the dowel hole which is larger than the oil feed hole at its rear end.

4. With the front end of the spindle to the left, fit No.1 L.H. auxiliary rocker to the location shown in Fig.23 then thread the remaining parts over the right-hand end of the spindle in the following order.

> Thick washer, No.1 R.H. inlet rocker, two short compression springs with two pen steel washers interposed, No.2 L.H. inlet rocker, thick washer, No.2 R.H. and No.3 L.H. auxiliary rockers, thick washer, No.3 R.H. inlet rocker, two short compression springs with two pen steel washers interposed, No.4 L.H. inlet rocker, thick washer, No.4 R.H. auxiliary rockers, thick washer, No.5 R.H. inlet rocker, two short compression springs with two pen steel washers interposed, No.6 L.H inlet rocker, thick washer and No.6 R.H. auxiliary rocker.

With the rockers, springs and washers fitted to the rocker spindle, continue as follows, referring to Fig. 24.

1. Position the three plain caps in their correct positions between the pen steel washers.

2. Fit the two centrally-studded caps in their correct positions between the inner pairs of auxiliary rockers.

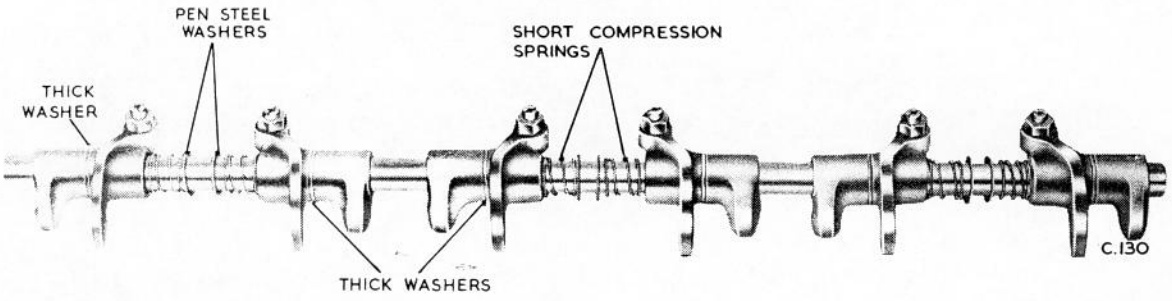


Fig. 23 Fitting inlet rocker spindle assembly (Stage 1)

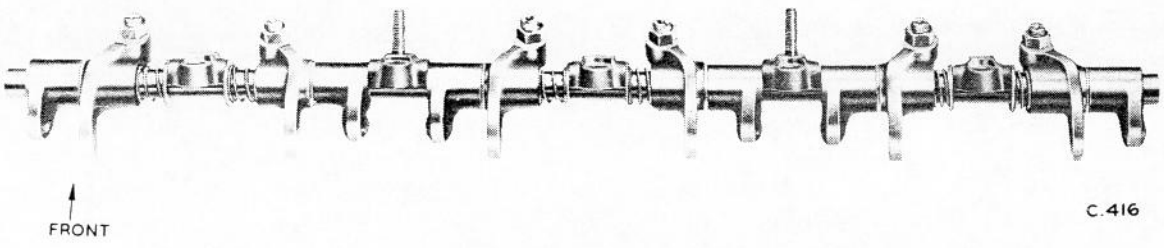


Fig. 24 Fitting inlet rocker spindle assembly (Stage 2)

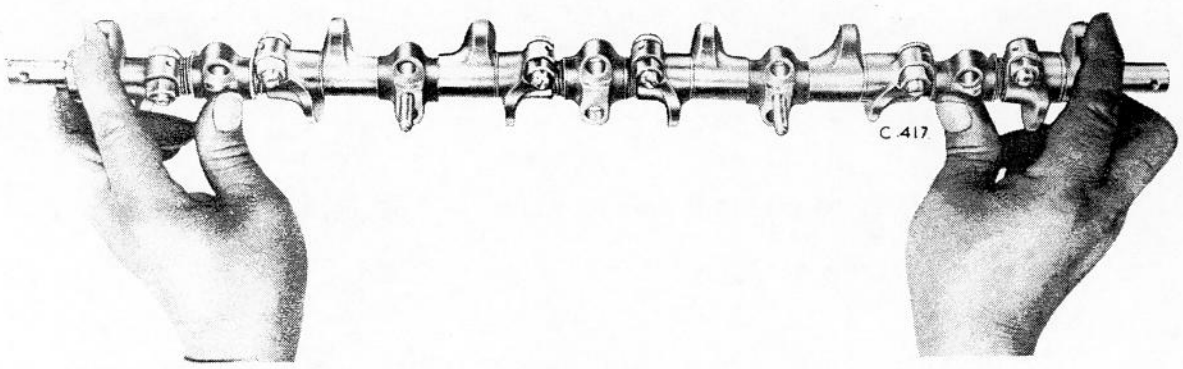


Fig. 25 Fitting inlet rocker spindle assembly (Stage 3)

3. Compress the springs by moving the two outer auxiliary rockers (at each end of the spindle) towards the centre, see Fig. 25.

4. Check that the dowel in No. 1 bearing is positioned correctly, then place the assembly into position.

5. Starting from the rear, use a suitable tool to position the pen steel washers while using the left forearm to prevent the opposite end of the spindle from lifting, see Fig. 26.

6. When this is completed, use a screwdriver in the slot at the front end of the spindle to locate the front of the spindle on the dowel.

7. Fit the off-set studded caps to the correct ends of the spindle with the studs towards the spindle ends, i.e. the longer boss facing inwards.

8. Check that each rocker arm bears centrally on its respective valve stem. If a rocker is off-centre, remove the spindle assembly, fit the requisite number of pen steel washers where necessary and re-assemble.

9. Screw nuts on all the cap securing studs and tighten evenly in the sequence 4, 3, 5, 2, 6, 1, 7 (i.e. working from the centre outwards) until a 0·002in. (0·05 m.m.) feeler gauge can just be inserted between each side of each cap and its mating face on the cylinder head.

After fitting the inlet rocker spindle assembly, fit the exhaust spindle as follows :-

1. Lubricate the exhaust rockers then fit them, together with their compression (long) springs and pen steel washers, to the exhaust rocker spindle; this spindle can be identified by the six oil holes drilled to align with the rockers. Note that the front end of the spindle carries the dowel hole which is larger than the oil feed hole at the rear.

2. With the front end of the spindle to the right, fit No. 1 R.H. exhaust rocker to the location shown in Fig. 27.

3. Thread the remaining parts over the left-hand end of the spindle in the following order :-

   Two long compression springs with two pen steel washers interposed, No. 2 L.H. and No. 3 R.H. exhaust rockers, two long compression springs with two pen steel washers interposed, No. 4 L.H. and No. 5 R.H. exhaust rockers, two long

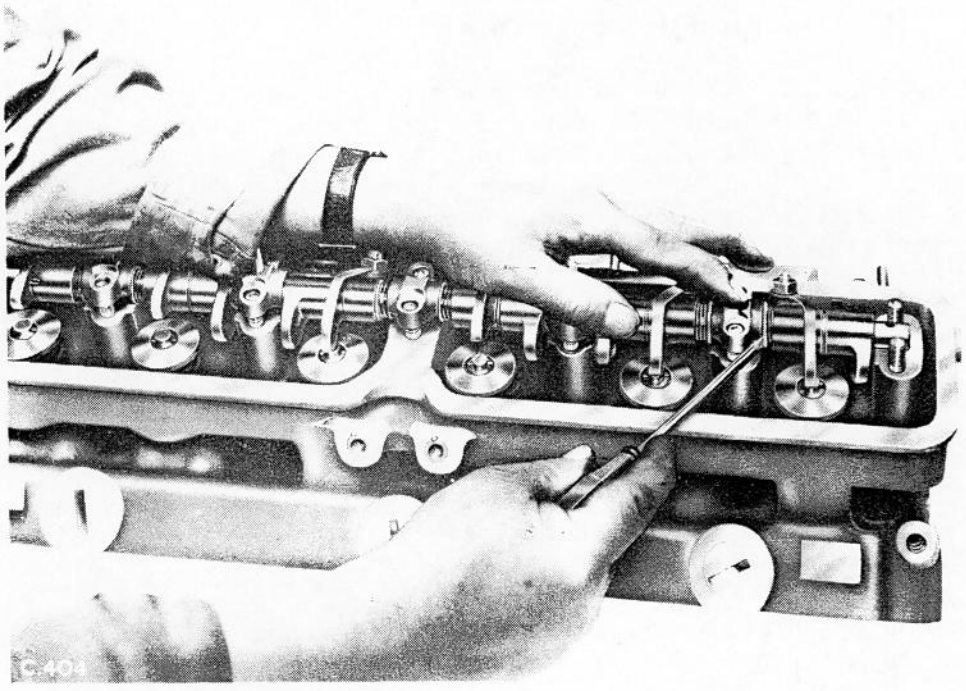


Fig. 26 Fitting inlet rocker spindle assembly (Stage 4)

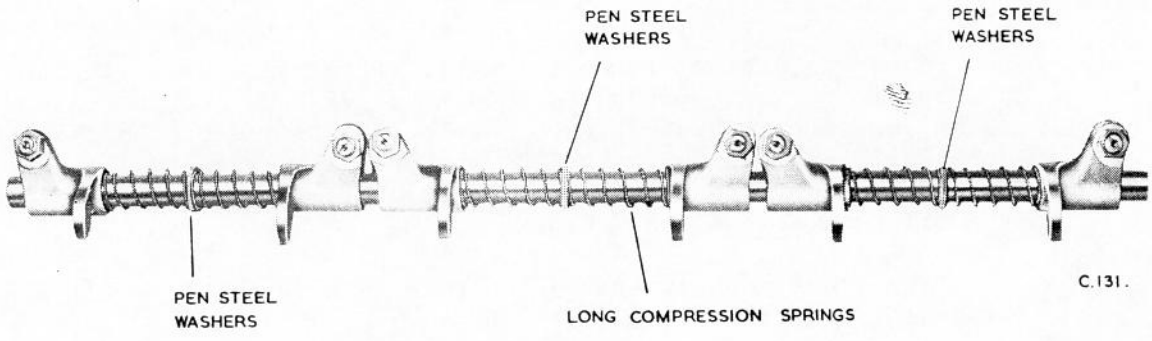


Fig. 27 Exhaust rocker spindle assembly.

compression springs with two pen steel washers interposed and, finally, No.6 L.H. exhaust rocker (see Fig. 27).

In order to fit the rocker assembly to its location in the cylinder head, first mount the assembly tool T.17893 on the rocker spindle as shown in Fig. 28, locating the arms and leaves of the tool as under.

Arm 1 - Before the first rocker.
Arm 2 - Between the first pair of washers.
Arm 3 - Between the second and third rockers.
Arm 4 - Between the second pair of washers.
Arm 5 - Between the fourth and fifth rockers.
Arm 6 - Between the third pair of washers.
Arm 7 - After the sixth rocker.

Lift the complete assembly, the correct way round, over the exhaust side of the cylinder head and lower it into position as shown in Fig. 29, ensuring that the dowel in the front bearing locates correctly in the dowel hole in the rocker spindle. Holding the assembly in position, swing the centre arm (No.4) of the tool outwards, but allow the leaves to remain in position, then fit the correct plain bearing cap in its marked position over its studs between the leaves. Fit the nuts to the studs and screw them down "finger-tight". Swing the two leaves of the tool clear of the cap. Repeat this process on No.2 and No.6, fitting the correct plain caps in their marked positions. Carry out the same procedure on No.1, 3, 5 and 7, fitting the studded caps. Make sure that the caps with the off-set studs go to No.1 and No.7 (i.e. the ends) with the studs off-set to the outer ends. Remove the assembly tool.

Check that each rocker arm bears centrally on its respective valve stem. If a rocker is "off-centre", remove the spindle assembly, fit the requisite number of pen steel washers where necessary and re-assembly.

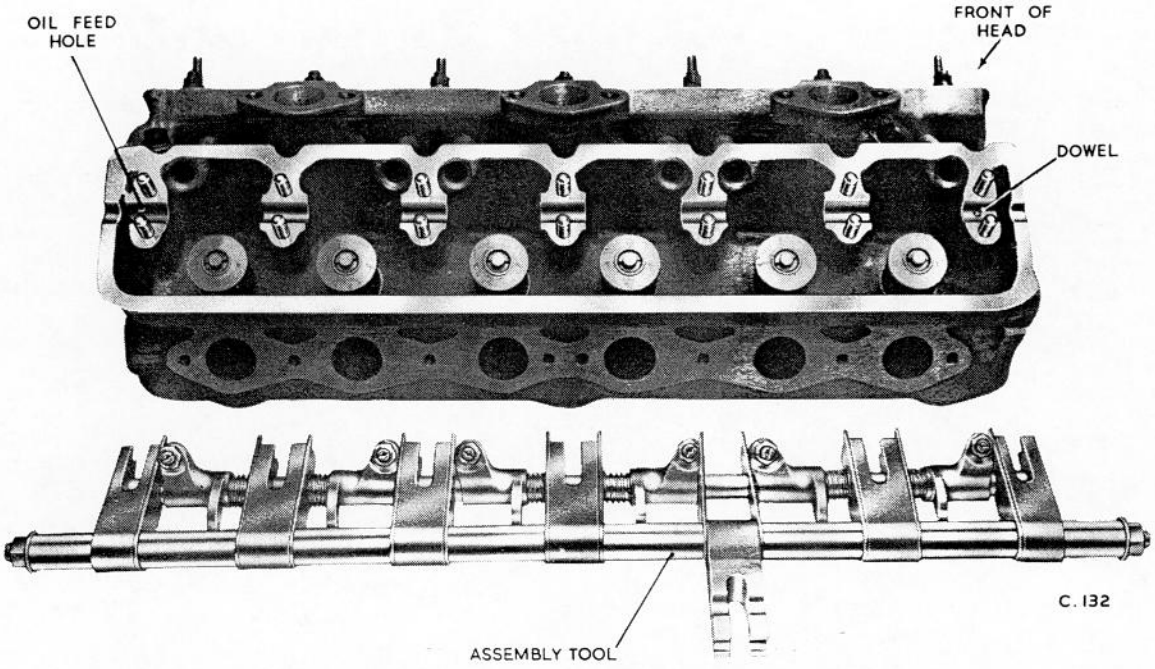


Fig. 28 Exhaust rocker spindle assembly in assembling tool.

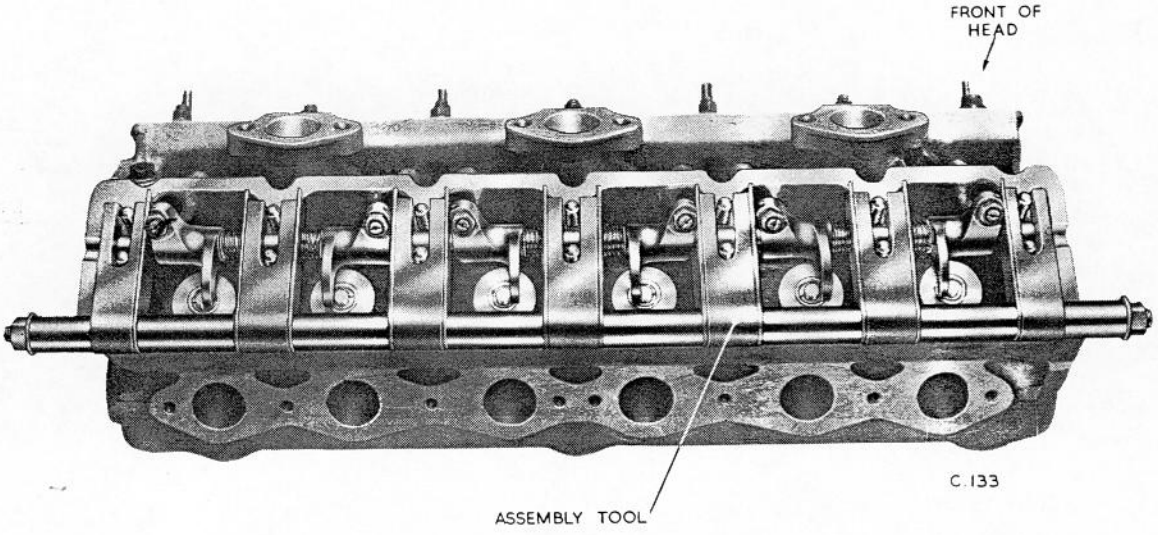


Fig. 29 Exhaust rocker spindle assembly fitted to head.

Tighten all the cap securing nuts evenly in the sequence 4, 3, 5, 6, 1, 7 (i.e. working from the centre outwards) until a 0·002in. (0.05 m.m.) feeler gauge can just be inserted between each side of each cap and its mating face on the cylinder head.

Fit the auxiliary push rods from the exhaust side. Push the rocker along the spindle against its spring, then insert the push rod in its housing the correct way round (as marked on dismantling)then release the rocker. These push rods cannot be located finally until the cylinder head is fitted to the engine.

If the water pump has been removed, fit it to the head as described in Section 2.

CYLINDER BLOCK

Re-boring

The cylinder liners may be re-bored, see "General Data". Replacement pistons 0·005in. and 0·010in. (0·13 and 0·25 m.m.) oversize are available, the latter being the maximum oversize. No dimension is quoted for reboring; this should be ascertained by measuring the oversize pistons supplied and using the clearance figure quoted in the "General Data". When wear of the cylinder bores is too great to permit the fitment of the oversize pistons, remove the liners, then fit replacements and standard pistons as described in the following paragraphs.

Removing cylinder liners

Do not attempt to press out a liner as this method will result in damage to the cylinder block.

Remove all components from the cylinder block, then clamp the block (pump flange downwards) to the table of a boring machine. Check that the bore of the liner is parallel to the boring bar in accordance with standard practice. Set the boring bar in the centre of the liner concerned and adjust the cutter to a radius that will allow the boring bar to rotate within the liner then fix the cutter. Mark the position of the table in relation to that of the bed, or note the position of the table traversing index, dependent upon the type of machine used.

The section of the liner wall is approximately 0·050in. (1·27 m.m.) when new, and where there are no facilities for precision boring, trial-cutting 1½in. (23 m.m.) down the bore of the liner is recommended. When the thickness of the liner shown at "A" in Fig. 30 reaches approximately 0·010in. (0·25 m.m.), a "hairline" will appear between the liner and the cylinder block, indicating the thickness of the remaining section. However, it is recommended that trial-boring is continued until the wall of the liner at the thinnest point can be broken away, before taking the first cut to the bottom of the liner. When boring within 0·025in. (0·63 m.m.) of the cylinder block, progressively reduce the depth of cut until final boring, when the machine speed should be reduced. When the section of the liner at its thinnest point is within 0·0005in. (0·01 m.m.) as shown at "B" it is possible to crack the liner using scriber, or other suitable tool.

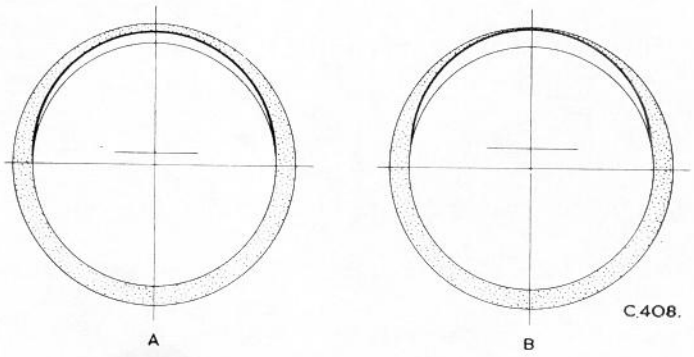


Fig. 30 Machine cuts when removing cylinder liners.

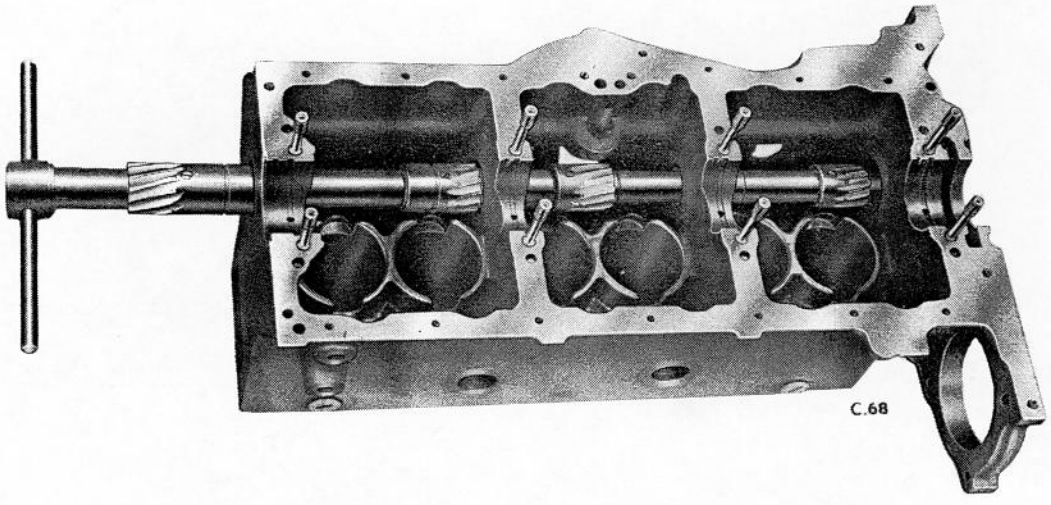


Fig. 31 Line reamer for camshaft bearings.

Fitting new cylinder liners

Check the cylinder bores and, if necessary, carefully stone any scores. Check the internal diameter of the bore and the external diameter of the new liner to ensure that the recommended interference fit is obtained.

Lightly oil the cylinder bore and the external surface of the liner and, with the assembly beneath the ram of a press capable of exerting the load given in the General Data, press the liner steadily into the cylinder bore until the top surface is level with the cylinder block face.

After fitting the liners, skim-grind the top faces of the liners to ensure that they are flush with cylinder block joint face, then carefully blend each valve head cut-away to conform to that in the cylinder block, and machine the two connecting rod slots at the bottom.

Note:- The valve head cut-away is primarily to promote an efficient gas flow to and from the valve throats and it is important to achieve a good finish to the surface.

Bore and hone-finish the liner to give the recommended piston skirt clearance, and finally clean the cylinder block with clean paraffin under pressure and finish off in an air blast, paying particular attention to the cleanliness of oilways.

Note:- When washing the cylinder block, it is advisable to remove the blanking plugs from the ends of the main oil gallery and the plug just in front of the flywheel housing. Replace the plugs when cleanliness is assured, fitting new washers to the rear and side plugs and coating the threads of the front plug with jointing compound.

CAMSHAFT

Removing

With the engine removed from the chassis as described on page 87, remove the cylinder head and the push rod cover, and extract the tappets and retain them in their relative sequence for re-assembly. Remove the sump and camshaft drive cover as given for removing the crankshaft and proceed as follows :-

1. Remove the circlip from the base of distributor and oil pump drive pinion and withdraw the pinion through the distributor drive casing aperture.
2. Remove the timing wheels together with the chain as described on page 60.
3. Remove the two set-screws securing the camshaft retaining plate over the front end of the camshaft. Remove the plate.
4. Withdraw the camshaft from the front of the cylinder block, and remove the timing wheel key.

Refitting

Before refitting the camshaft, check the dimensions of the four bearings in the cylinder block and the journals on the shaft and ensure that the bearing clearances are within the recommended limits. It is most important that the maximum permissible clearance is not exceeded, otherwise a serious loss of oil pressure may result. Check that the recommended end-float is obtained. If the figure is outside the limits, correct it by fitting a new retaining plate.

1. Ensuring that all components are scrupulously clean, lubricate the camshaft bearings and the journals and insert the camshaft from the front of the engine.

2. Fit the retaining plate in position and secure it temporarily with its two set-bolts.

3. Check that the shaft rotates freely.

4. Fit the distributor and oil pump drive pinion to its housing through the distributor drive casing aperture and, from inside the cylinder block, fit a new circlip to the exposed groove on the spindle. Ensure that the circlip is seating around its complete arc and can just be rotated in its groove.

5. Check that the end-float of the pinion is within the recommended limits and, pulling the camshaft forward against the retaining plate, check the backlash between the pinion and the camshaft gear. If it is outside the recommended limit, change the camshaft and/or the pinion.

6. When the above checks are satisfactory, remove the two retaining plate set-screws, fit new tabwashers then fit and finally secure the set-screws.

7. Fit the key to the timing wheel location on the camshaft.

8. Fit the timing wheels and the front end assemblies as given on page 63. (Refitting timing chain).

Inspection

Examine the four camshaft bearing journals, the cam profiles and the helical gear for wear, scoring and hard bearing. Check that the thrust face of the camshaft front bearing journal, front and rear faces of the retaining plate and the thrust face at the back of the timing wheel boss are not scored excessively. Examine the threads, keyway and chain wheel location for burrs and damage. Mount the camshaft in "V" blocks on its front and rear journals and, using a dial indicator, check that any mal-alignment does not exceed the maximum permissible limit.

Inspect the camshaft bearings in the cylinder block for security and general condition. Measure the bore of each bearing and the diameter of its relevant camshaft journal. The difference between each set of readings must be within

the recommended limits of bearing clearance. Check that the teeth of the chain wheels are not worn to sharp points nor "hooked". In this case, the radius at the root of the teeth becomes enlarged and will damage a new chain; reject both wheels.

Check the chain for excessive stretch by fitting the camshaft wheel into the chain and pulling the chain tight around the wheel with fingers and thumb; at a point on the opposite side of the wheel, check that the chain links cannot be lifted from the roots of the teeth. If this can be done, reject the chain.

Replacing bearings

It is recommended that when worn bearings are encountered, the complete set is replaced. When replacing these bearings, it is necessary to remove the crankshaft and connecting rod assemblies, then proceed as follows :-

1. Unscrew the blanking plug from the rear of the rear bearing.
2. Using a suitable drift, drive out the bearings.
3. Check that each bearing location bore is clean and free from scores and burring.
4. Before fitting the new bearings, check the outer diameter of each bush and the bore diameter of its relevant housing and make sure that the recommended interference fit is obtained.
5. Freeze the replacement bearings for 5 to 10 minutes and insert them in their relevant bores (chamfered end first); if necessary, use a soft metal drift to tap them into position. When fitting the mid front bearing, ensure that the oil holes are aligned correctly with the oil ports in the housing; the larger hole must align with the oil feed port at the bottom and the smaller hole with the tachometer drive supply port towards the outer wall of the block. When fitting the rear bearing, ensure that the larger hole is aligned with the rocker mechanism oil feed port at the top.

6. Ream the bearings to size as shown in Fig. 31. When reaming, lubricate the bearings and the reamers with a plentiful supply of clean oil, and insert the reamer assembly through from the front bearing. Continue rotating the reamer in the cutting direction as the reamer assembly is withdrawn, in order to prevent withdrawal scores in the bearings. Details of the line reamer are given under Special Tools at the end of this Section.

7. Unscrew the end plug from the front and rear ends of the main oil gallery (just below camshaft level) and the plug just in front of the flywheel housing.

8. Thoroughly wash out the bearings with paraffin under pressure, paying particular attention to the oilways. Finish off in an air blast.

9. Coat the threads of the front plug with jointing compound and screw it firmly into position. Fit a new aluminium washer to the rear plug and screw it home securely. Fit a new washer to the side plug and tighten it securely in position.

10. Check the internal diameter of each bearing and the diameter of its relevant camshaft journal to ensure that the difference is within the recommended clearance limits.

11. Fit a new blanking plug to the rear of the rear bearing as follows. Coat the threads of the plug with a good quality jointing compound and screw in the plug, leaving $1\frac{1}{2}$ to 2 threads of the plug standing proud. Lightly peen the plug around the thread root diameter. Screw in the plug until about 1 thread is proud, then peen again to lock it finally.

12. Refit the crankshaft and connecting rod assemblies.

Replacing timing chain

The timing chain cannot be replaced with the engine installed; it is therefore recommended that the chain is replaced at such periods as a rebore rather than running it to its limit of life and thus destroying the timing wheel tooth formation. If however, the chain needs replacing at some other period, remove the engine as described on page 87 and dismantle the camshaft drive cover as given under Removing the crankshaft. The engine need not be inverted.

Before withdrawing the chain wheels and the chain, set the timing marks of each wheel to coincide. This is most important, since if the crankshaft is turned with the camshaft stationary, there is the risk of a piston hitting a valve head.

It is also essential to ensure that no backward movement of the crankshaft is permitted when pressing the wheels into position, otherwise the split thrust plates behind the front main bearing can become dislodged or fall into the sump. In the latter case, they cannot be heard to drop.

CRANKSHAFT

Removing

Remove the gearbox from the engine and chassis as described on page 18 of Section 5, remove the engine from the chassis in the manner detailed later in this Section, then proceed as follows :-

1. Remove the cylinder head from the engine, see page 37.
2. Remove the dynamo, then detach the push rod cover and remove the tappets.
3. If a suitable mounting stand is not available to facilitate stripping, arrange wood blocks, then turn the engine so that it rests on the cylinder head face; avoid damage to the machined face.
4. Detach the oil filter.
5. Remove the gearbox bracket followed by the oil sump.
6. Remove the clutch assembly (see Section 4) and the set-bolts securing the flywheel to the crankshaft, then remove the flywheel.

7. Release the tabwasher and remove the starter dog, followed by the engine damper unit complete from the front end of the crankshaft.

8. Unscrew the set-bolts and withdraw the camshaft drive cover.

9. Release the tabwasher and remove the locknut securing the camshaft chain wheel.

10. Remove the oil baffle and withdraw the chain wheel and drive sprocket complete with chain, then remove the "Woodruff" key from the drive sprocket on the front end of the crankshaft. It may be necessary to use a standard claw extractor to withdraw the drive sprocket from its key.

11. Withdraw the thrust retaining plate from the crankshaft, and the split thrust plate from the front main bearing; label these plates "front" to ensure correct re-assembly.

12. Remove the oil pump.

13. Release all tabwashers, then remove the main bearing and big end securing nuts. Remove the main bearing and big end caps. Label all the components for positioning.

14. Detach and label the split thrust plate fitted to the rear of the front main bearing cap, then withdraw the crankshaft from the cylinder block. Remove and label the split thrust plate fitted to the rear of the front bearing housing.

Inspection

Where the necessary equipment is available, magna-flux and electro-flux test the crankshaft for cracks; perform the electro-flux test at 300 amperes and 250 volts. However, where such facilities do not exist, it is advisable to carry out a very careful visual check for cracks. If satisfactory, check all crankshaft journals for condition and wear and ensure that any ovality is not excessive. Inspect the starter dog thread and the keyways at the front; if the ball bearing has been removed, check the crankshaft bore and its circlip groove for condition and fretting. Inspect the face of the thrust plate for cracking or grooving. Mount the shaft on "V" blocks at the front and rear main bearing journals and, using a dial indicator, check the alignment of the shaft.

Refitting

1. Position the connecting rods to allow reception of the crankshaft. Lubricate all bearing surfaces, and fit the correct split thrust plate to the inner face of the front bearing (the grooved bronze face inwards to face the rear).

2. Lower the crankshaft into position, taking care not to dislodge the split thrust plate from the front bearing.

3. Turning the crankshaft as necessary but keeping it pressed against the front bearing to avoid dislodging the split thrust plate, manipulate the big ends into position on the crankpins.

4. With the correct half bearings in their respective caps, lubricate the bearings and fit the four main bearing caps, fitting the split thrust plate to its recess in the rear face of the front cap with the bronze face outwards.

5. With the crankshaft pushed to the front bearing to retain the split thrust plates, fit new tabwashers then fit and tighten the main bearing cap nuts to the torque loading recommended in the General Data. Lock the nuts.

6. Fit the big end half bearings to their respective caps; lubricate the bearings and fit the caps the correct way round to their related connecting rods. Fit new tabwashers, then screw on the nuts and tighten evenly to the torque loading recommended in the General Data. Lock the nuts. During these operations make sure that the crankshaft is not pushed rearwards to release the split thrust plates at the rear face of the front main bearing.

7. Refit the split thrust plates to the front recess of the front main bearing with their bronze facings outwards, locating the tongue of the lower plate in its notch in the bearing cap.

8. Temporarily fit the thrust plate, the drive sprocket and the damper unit, in that order, and secure them with the starter dog, ensuring that the inner split thrust plates are not dislodged in the process. Pull the crankshaft forward until the front main bearing journal abuts the inner split thrust plates, and check that the gap between the face of the thrust plate and the front split thrust plates is within the end-float figures recommended in the General Data. If incorrect, select and fit appropriate split thrust plates to the front face of the front main bearing. These are available +0·0025in. (0·06 m.m.) and +0·005in. (0·12 m.m.) in thickness.

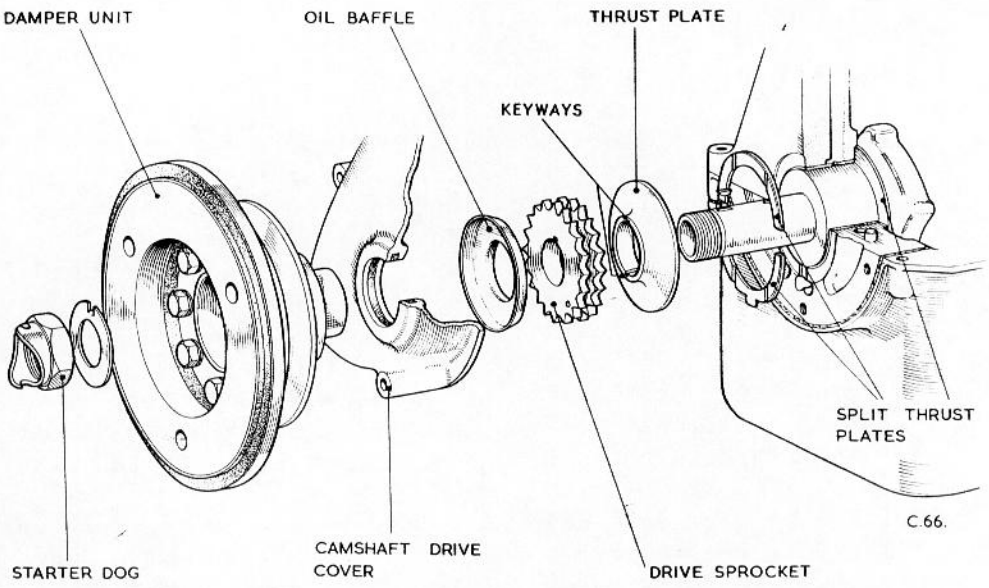
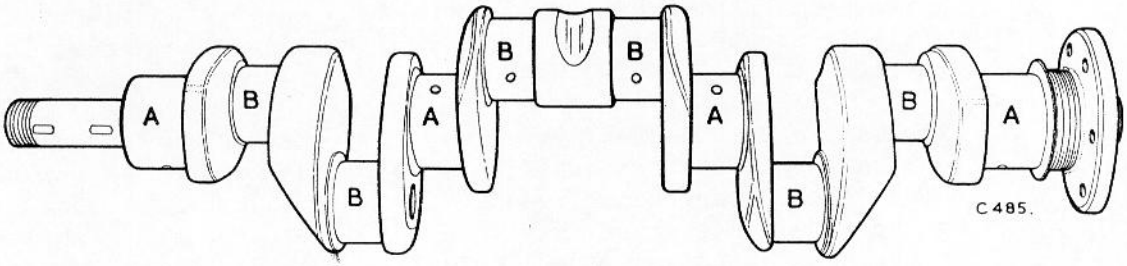


Fig. 32 Front main bearing and thrust components.



1. A – AS STANDARD. —— B – 0·010" UNDERSIZE.
2. B – AS STANDARD. —— A – 0·010" UNDERSIZE.
3. ALL A & B DIAMETERS —— 0·010" UNDERSIZE.
4. A – 0·010" UNDERSIZE. —— B – 0·020" UNDERSIZE.
5. B – 0·010" UNDERSIZE. —— A – 0·020" UNDERSIZE.
6. ALL A & B DIAMETERS —— 0·020" UNDERSIZE.

Fig. 33 Crankshaft regrinding details.

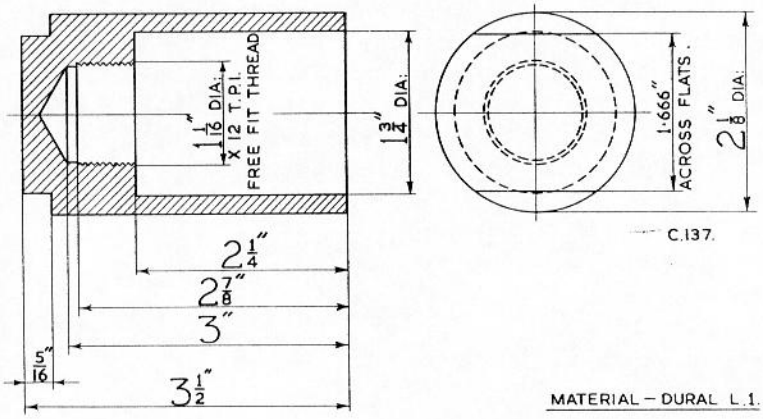


Fig. 34 Anti-nitriding blank for crankshaft.

9. Fit the "Woodruff" key to the inner of the two keyways on the shaft then press home the thrust plate until it abuts the front split thrust plates (about 75% of the key is now exposed in front of the thrust plate). Refit the key to the camshaft, if it has been removed.

10. Fit the drive sprocket and chain wheel inside the chain so that the timing marks on each coincide, then offer the assembly to the crankshaft and camshaft ends. Turn the crankshaft and/or camshaft as necessary to align their respective keys with the keyways in the wheels then fit the wheels. Check that the timing marks on the wheels coincide. If satisfactory, press on both wheels together until they are both right home. Avoid rearward movement of the crankshaft to prevent release of the split thrust plates on the inner face of the front main bearing. Re-check that the timing marks on the wheels coincide. If correct, fit the oil baffle (dished face outwards) then fit the second "Woodruff" key to the other keyway in the crankshaft.

11. Thoroughly oil a new oil retaining felt washer and fit it into the recess in the camshaft drive cover, then insert the damper unit journal into the felt washer.

12. Coat both sides of the cover joint gasket with good quality jointing compound and locate it on the face of the cover. Offer up the assembly to the engine, engage the keyway of the damper unit with the key in the shaft and press the assembly home until the damper unit abuts the oil baffle. During this operation, check that the crankshaft is not moved rearwards to displace the inner split thrust plates of the front main bearing. Fit the eight cover securing bolts and their spring washers and screw them in finger-tight.

13. Turn the crankshaft carefully to ensure concentricity of the felt washer on the damper unit journal then tighten the cover bolts diagonally.

14. Fit a new tabwasher to the end of the crankshaft and screw on the starter dog. When the starter dog is finally tightened, it is important to check that the positioning of the starter handle is correct in relation to the compression stroke of any one cylinder. It is advisable, therefore, not to lock the starter dog at this stage.

15. Fit the oil pump drive shaft into the square socket of the distributor and oil pump drive gear then, ensuring that the flange faces of the oil pump body and the cylinder block are scrupulously clean, fit the oil pump, using a new joint washer. Fit the two securing set-bolts and new tabwashers and screw in the bolts finger-tight so that they just "nip" the pump flange. Turn the crankshaft through at least two revolutions to centralise and line up the drive assembly. Tighten the set-bolts and check that the drive shaft end-float can be felt by hand without stiffness. When satisfactory, lock the bolts.

16. Clean the four sump joint faces, i.e. the two sides and each half-round end then apply an even coating of good quality jointing compound. Allow the compound to dry to a "sticky" stage, then carefully fit two new side joints, and press them evenly against the sump faces. Fit new front and rear joints to their respective half-round faces, and if necessary, trim the two ends of each until they stand proud of the side joints by not less than $\frac{1}{8}$in. (3·17 m.m.).

17. When the jointing compound has completely "set", coat the exposed faces of the joints with grease, fit the sump to the engine and secure it with the nineteen set-bolts and spring washers. Then fit the gearbox bracket to the rear end.

18. Fit the flywheel to its spigoted flange at the rear of the crankshaft, locating it over its dowel pin then secure it with its six set-bolts and three new locking plates. Tighten the bolts to the torque loading given in the General Data then lock them with the locking plates.

19. Fit the clutch assembly to the flywheel as detailed in Section 4.

20. Blank off the oil thermometer bulb union on the left-hand side of the sump and turn the engine over on to its sump.

21. Fit the cylinder head as described on page 38.

22. Re-fit the gearbox as described in Section 5 and re-assemble the engine to the chassis as described on page 87 of this section.

23. Check the position of the starter dog and, if necessary, adjust.

Fitting replacement crankshaft (standard size journals)

Assuming that the cylinder block is prepared to receive the crankshaft, and that the connecting rod and piston assemblies are withdrawn, proceed as follows.

1. Select a set of the correct size big end bearings and fit these to the rods and their caps.

2. Remove any protective tape from the journals, thoroughly clean the crankshaft in paraffin under pressure, and finish off in an air blast, ensuring that all oilways are clear.

3. Mount the crankshaft by the flywheel flange in soft metal clamps in a bench vice, and support the nose in a suitable wood prop.

4. Freely lubricate the big end bearings then fit and secure each big end to its relevant crankpin (as denoted by the cylinder numbers on the caps and rods).

   Note:- With the pistons to the bottom and the front end of the crankshaft towards the operator, the numbers should appear upside down on the left, No.1 being at the operator's end.

5. Check each big end for freedom by rotating the connecting rod assembly about its crankpin, then check that the side clearance of each bearing is not less than the minimum recommended in the General Data. Do not damage the pistons in the process. No hand work is permissible on the bearings; if the minimum side clearance is not obtained, reject the crankshaft.

6. Remove the connecting rod assemblies and retaining the bearing shells in their relevant locations, place the assemblies to one side pending final erection.

7. Fit the thrust plate, the drive sprocket and the damper unit (in that order) to the front end of the crankshaft and secure them with the starter dog, ensuring that the thrust plate firmly abuts the front face of the front bearing journal. This is necessary to enable selection of the split thrust plates.

8. Select a set of the correct size main bearings and fit the appropriate half bearing to each of the main bearing housings in the cylinder block. Lubricate the bearings liberally.

9. Remove the crankshaft from the vice and, ensuring perfect cleanliness of the main bearing journals, lower the crankshaft into position in the cylinder block.

10. Fit the four main bearing caps together with their correct bearings, then secure them with their nuts. Check the shaft for freedom of rotation, then remove the front bearing cap.

11. Select two lower split thrust plates (i.e. with the locating tongues) and fit one to each recess of the cap (bronze facings outwards) and refit the cap.

12. Pull the crankshaft to the front so that the rear face of the front bearing journal abuts the inner split thrust plate, and using feeler gauges, check the gap between the front split thrust plate and the thrust plate. Alternatively, check the end-float with a dial indicator mounted at some convenient location, with the button contacting the end of the crankshaft. If necessary, select split thrust plates to give an end-float within the limit given in the General Data.

13. When satisfactory, remove all bearing caps together with their bearings and select the upper split thrust plates which mate with those already trial-fitted.

14. Fit the ball bearing to the bore at the rear end of the shaft and secure it with a new circlip, ensuring that it is sprung out into its recess around its complete arc. When pressing or driving this bearing into position, use only a tubular drift to bear only on the outer race of the bearing. On no account exert pressure on the inner race, or damage to the tracks or balls may ensue.

Continue with the engine erection as given under the heading "Refitting the crankshaft".

Fitting a re-ground crankshaft

The procedure for fitting a re-ground crankshaft is the same as that given for fitting a standard size replacement shaft, except that particular attention must be paid to ensure that the radii of the crankpins and main bearing journals do not "bite" their respective bearings when side clearances or end-float is checked. If this state is confirmed, the crankshaft must be corrected to remedy the fault. On no account, hand-scrape or interfere in any way with the bearings.

Re-grinding journals and crankpins

Always note the following points if regrinding a crankshaft is contemplated.

1. Crankshafts are nitrogen hardened on the bearing surfaces and they should be re-nitrogen hardened after each re-grinding operation. Nitriding facilities must therefore be available.

2. Grinding more than 0·020in. (0·5 m.m.) below the new diameter of 2·1245in. (53·96 m.m.) on the main journals and 1·751 in. (44·48 m.m.) on the crankpins is not permissible.

3. Bearings are available only in three sizes, i.e. standard size, 0·010in. (0·25 m.m.) undersize and 0·020in. (0·5 m.m.) undersize.

A crankshaft scored or worn to an extent that it cannot be re-ground to the lowest undersize quoted in (2) is not fit for further use. There are therefore three possible stages, see Fig. 33. Take particular care that the correct radii (i.e. 0·060in. (1·5 m.m.)) are maintained at the ends of each journal, especially those of the crankpins, otherwise there is the risk of the big-end shells being damaged when the permissible side clearance is taken up.

When the re-grinding operation is complete, magna-flux or electro-flux test the shaft and inspect it for cracks. Where the necessary equipment is not available, subject the shaft to very careful visual examination.

If no cracks are detected, prepare the shaft for nitriding by painting the starter dog threads with an anti-nitriding agent, or if this is not available, make up and fit a blanking cap to the end of the shaft as shown in Fig. 34.

Nitride the shaft for 12 hours at 495°C. (922°F.) then remove the anti-nitriding agent or the protective cap from the threaded end of the shaft. Lightly polish the "bloom" from all journals, re-check the alignment, then subject the shaft to a further crack detection test. Finally ensure absolute cleanliness of all oil ducts.

Main bearings

Each main bearing cap is secured to the cylinder block with two alloy-steel studs and nuts locked with tabwashers. Off-set dowels locate the caps so that incorrect assembly is impossible. The front main bearing cap is drilled to permit drain oil from the camshaft drive cover to return to the sump and the rear cap is fitted with a short drain pipe which directs drain oil from the rear side of the rear main bearing to the sump. Each half of the main bearings has a

locking tongue which locates in a notch in the bearing cap or cylinder block location, thereby locating and preventing movement of the bearing. Three sizes of bearings are available and are as follows :-

Standard (nominal).
0·010in. (0·25 m.m.) undersize.
0·020in. (0·50 m.m.) undersize.

The two centre bearings are identical and are narrower than the front and rear. It is important that the bearings are kept to their respective positions and that the bearing cap numbers correspond with the numbers stamped on the lower cylinder lock face adjacent to the dowel holes.

Fitting main bearings

All bearings are supplied carefully packed to avoid scratching or damage to the inner bearing faces. The bearings are supplied ready for use; do not attempt to face or scrape them.

Flywheel starter ring

The starter ring is shrunk on a machined location on the forward side of the flywheel rim. If the teeth of the ring become unserviceable, drive the ring from the flywheel with a suitable drift and a hammer. Examine the ring location on the flywheel, and if necessary, dress score marks or burrs. To fit a new ring, proceed as follows :-

1. Heat the new ring in oil at 160°C. (320°F.) for at least 10 minutes.
2. With the flywheel lying on the clutch plate contact face, place the ring (with the cut-away side of the teeth uppermost) on to its location on the flywheel and press it firmly home.

Note:- Carry out this operation as rapidly as possible to ensure that the ring does not tighten on the flywheel before it is in its correct position.

The ring is machined to extremely fine limits and therefore fitment of a new one does not necessitate re-balancing the flywheel unit.

Flywheel

In the event of the flywheel face being scored by a badly worn clutch driven plate, grind it lightly, removing only the minimum amount of metal necessary. The nominal thickness of the flywheel is 1·125in. (28·58 m.m.); under no circumstances should this dimension become less than 1·075in. (27·3 m.m.). Thus, the face can be ground to 0·050in. (1·27 m.m.) below nominal size; if the grinding is done with care, a number of facing operations can take place before the minimum dimension is reached, and the flywheel rendered unfit for further service.

CONNECTING RODS AND PISTONS

Removing pistons and rods with crankshaft removed

With the crankshaft removed from the engine as described previously, withdraw the pistons complete with their connecting rods.

1. Mark each piston for position on its rod and its operating cylinder, preferably on the inside of the skirt or the same side as the big end and cap numbering.

2. Remove the piston rings; keep them in their correct relative sets if they are to be refitted.

3. Remove the circlips from the pistons and withdraw the gudgeon pins. Discard the circlips.

Note:- If a gudgeon pin is an extremely tight fit in the piston, immerse the piston in boiling water for a few moments to ease the pin.

Fitting pistons and rods with crankshaft removed

To re-assemble the connecting rods and pistons to an engine from which the crankshaft has been removed, the following procedure is recommended. After the components have been inspected as described on page 72:-

1. Heat all pistons in boiling water for not less than ten minutes.
2. Remove the pistons in turn from the boiling water, fit a new circlip to one gudgeon pin boss, then locating the piston over the small end of the relevant connecting rod, press home the gudgeon pin until it abuts the circlip already fitted. Then fit a new circlip to the vacant groove.
3. Fit the rings to their relevant pistons, lubricate the pistons freely and fit a piston ring compression clip, ensuring that the piston ring gaps are spaced not to coincide, nor line up to the thrust faces of the piston skirt.
4. Insert the pistons into their respective cylinders from the bottom, ensuring that the number on the big end faces the camshaft. Remove the piston ring compression clip from the assembly as the operation is completed.

   Note:- It is vitally important that the connecting rods are fitted the correct way round, owing to the slight off-set of the small ends.

Complete the assembly as given under "Refitting the crankshaft".

Removing pistons and rods with crankshaft "in situ"

1. Remove the cylinder head as described on page 37.
2. Remove the sump as described on page 74.
3. Unlock and remove the big end nuts and the cap of one rod.

4. Turning the crankshaft as necessary, push this connecting rod into the bore of its cylinder until the piston emerges from the top of the cylinder and exposes the gudgeon pin.

5. Remove the piston rings and the gudgeon pin circlips and press out the gudgeon pin, ensuring that the connecting rod is not dropped in the process.

6. Withdraw the connecting rod from below, taking care not to knock out the bearing shell.

Repeat the above process on each piston and rod in turn. If the pistons and their rings are to be refitted, retain them in their correct positions and relationship, together with their relevant gudgeon pins. Discard the circlips.

Fitting pistons and rods with crankshaft "in situ"

Having inspected the pistons as given on page 72, proceed as follows :-

1. Heat the pistons in boiling water for not less than 10 minutes.

2. Insert a connecting rod into its relevant cylinder bore from the bottom (with its number towards the camshaft) until the small end protrudes through the top of the bore. Set the crank throw to B.D.C.

3. Fit a new circlip to one boss of the relevant piston and, locating the piston over the small end of the rod, push home the gudgeon pin through the vacant boss until it abuts the circlip. Retain the pin with a new circlip in the vacant groove.

4. Fit the relevant rings to the piston, lubricate the piston and rings freely and fit a piston ring compression clip, ensuring that the ring gaps are spaced not to coincide, nor line up with the thrust faces of the piston skirt.

5. Position the connecting rod correctly in relation to the crankshaft, push the piston into the cylinder bore and, with the big end bearings in position, assemble the big end to its crankpin.

6. Fit the other pistons in the same manner.

Inspection

Check the rods for alignment by standard methods. If mandrels to fit the gudgeon pin bush and the big end of the connecting rod (without bearings fitted) are available, fit them to the connecting rods in turn, mount the assembly in "V" blocks and check them for twist and mal-alignment. The maximum permissible error of alignment is given in the General Data. Check the gudgeon pin, bush and piston boss dimensionally to determine whether the fit of the pin will be satisfactory for re-assembly.

Examine the pistons for condition. Check the clearance of a set of new rings or the existing rings in the ring grooves, and check the gaps in the cylinders in which they are to operate. When doing this, level them in the cylinder bore with a piston. Assemble the piston to its cylinder bore in its operating position and check that the clearance between the skirt of the piston (thrust side) and the cylinder wall is within the desired limit.

Inspect the big end bearings for condition and their locating notches for damage. Assemble the bearings, rod and bearing caps to their journals and check that the running clearance on the crankshaft is satisfactory. Prior to fitting any replacement parts, check them thoroughly for dimensions and condition.

Replacing big end bearings

Check that the bearing locations of the connecting rods and caps are clean and undamaged, then fit new bearings into position, ensuring that the locating tongues are located correctly. The bearings are supplied ready for use; no fitting of any sort is necessary or permissible.

Note:- Bearings are available in three sizes, i.e. standard, 0·010in. (0·25 m.m.) undersize and 0·020in. (0·5 m.m.) undersize. Ensure that only the correct bearings are fitted to the rods.

Replacing gudgeon pin bushes

Using a suitable soft metal drift, and with the small end of the connecting rod suitably supported, press out the gudgeon pin bush. Examine the small end eye for condition and, if necessary, polish lightly to remove the tops of withdrawal scores. Standard size and 0·020in. (0·5 m.m.) oversize bushes are available. Standard size bushes are usually suitable for replacement but should the connecting rod eyes be over standard size, grind the 0·020in. (0·5 m.m.) oversize bush to obtain the interference fit given in the General Data. The recommended method of fitting a replacement bush is to freeze it for a short time. If facilities for freezing are not available, lubricate the bush and press it in with a suitable hand press, making sure that the bush is square with the eye of the rod.

Set up the bushed rod on a suitable diamond-boring or reaming machine and machine the bush to size. Make certain that the rod centre is maintained within the specified limits and that the small end and big end are absolutely parallel. Should it be impracticable to use a boring or reaming machine, use a standard type universal connecting rod aligning and reaming jig. Always observe the precautions quoted above and never hand-ream without such a jig. Always maintain cutting rotation when withdrawing the reamer to avoid withdrawal scores in the bush. When the bush bore is to finished size, drill the oil holes then carefully radius the edge of the oil holes to remove any sharp edges.. Clean the rod thoroughly, then check the rod for alignment and parallelism of the bearings.

Oversize pistons

These are available 0·005in. (0·13 m.m.) and 0·010in. (0·25 m.m.) oversize only and are "selectively fitted" with gudgeon pins. Re-boring above 0·010in. (0·25 m.m.) oversize is therefore not permissible and when the dimension has been reached, the cylinder liners should be renewed.

Piston gudgeon pins

These are not supplied as spares since they are selectively fitted by the manufacturer. It is therefore important to retain each gudgeon pin with its piston at all times as they are not interchangeable.

OIL SUMP

Removing (engine installed)

Set the car on a ramp and, working from beneath the car, proceed as follows :-

1. Remove the drain plug from the sump and allow the oil to drain. When drainage is complete, refit the plug.

2. Loosen the nuts of the lowermost bolts securing the clutch casing to the gearbox bracket to release the rear supports of the air scoop. Remove the bolts which will release the exhaust pipe clip on the right-hand side and the lower fixture of the torque buffer bracket on the left.

3. Remove the lower fixture bolts securing the front engine support bracket to the crankcase and remove the air scoop. Refit the bolts for safety.

4. Unscrew the union nut and withdraw the oil thermometer bulb from its location forward of the sump drain plug. Stow the bulb, together with its capillary tube, as a protection against damage, ensuring that the small sealing washer is not lost.

5. Remove the bolt and nut securing the upper end of the torque buffer bracket. Pull the buffers clear of the buffer plate on the chassis and remove the torque buffer bracket. The clutch pedal return spring tabwasher will be released on withdrawal of the bolt.

6. Remove the remaining nut and bolt securing the clutch casing/gearbox bracket flange, and the two set-bolts from each gearbox bracket arm. Withdraw the gearbox bracket.

7. Remove the nineteen set-bolts securing the sump to the engine. Lower the rear end of the sump and pull it rearwards and downwards clear of the engine.

8. Remove and discard the four sump face joints.

Refitting

Before refitting the sump, ensure absolute cleanliness of the sump flange face and its corresponding face on the engine. Note that special spring washers are fitted to the bolts to avoid damage to the sump.

1. Apply an even coating of good quality jointing compound to the joint faces of the sump, and allow it to set "sticky".

2. Fit two new side joints and press them firmly into position, followed by new joints at each end. Ensure that not less than $\frac{1}{8}$in. (3·18 m.m.) of each side of the end joints stands proud of the side joints. Trim the ends if necessary.

3. Smear an even quantity of grease over the exposed surfaces of the sump joints, and offer up the sump into position on the engine.

4. Fit and secure the nineteen set-bolts with their spring washers. Tighten the bolts evenly.

5. Fit the gearbox bracket and secure it with the two vertical bolts and their spring washers to each forward facing arm.

6. Fit the uppermost left-hand side horizontal bolt from the rear, with the clutch return spring tabwasher beneath its head, fit the lower left-hand bolt (from the rear) and position the torque buffer bracket over the ends of the bolts with the buffers embracing the chassis torque plate. Fit a spring washer to the upper bolt and tighten the nut securely.

7. Fit the lower right-hand side horizontal bolt from the rear with the exhaust pipe support clip beneath its head. Fit a plain and spring washer followed by the nut; do not tighten the nut at this stage.

8. Fit the upper right-hand side bolt from the rear and secure it with its spring washer and nut.

9. Fit the oil thermometer bulb unit into its housing in the sump, with the sealing washer interposed, and secure it with the union nut.

10. Remove the lower securing bolt from each front engine bracket (replaced for safety on removing the sump scoop).

11. Offer the sump air scoop into position with its front supports located over the vacant bolt holes of the engine front mounting brackets. Fit the bolts and spring washers.

12. Push the rear end of the air scoop upwards until the slotted ends of its rear supports slide up behind the plain washers of the two lower fixtures of the clutch casing, and tighten the nuts. Tighten the front support bolts securely.

13. Check that the drain plug is secure.

14. Remove the car from the ramp and fill the sump to its correct level with the approved oil.

Note:- Never overfill the sump since this may lead to high oil temperature and leakage.

After running the engine for a time, check for oil leakage and rectify if necessary.

IGNITION

Removing and refitting distributor drive casing assembly

1. Unclip and lift off the distributor cover, lift out the rotor and disconnect the L.T. lead from its terminal at the side of the distributor body.

2. Remove the set-screw securing the clamp plate to the drive casing lug, and lift out the distributor body complete with the clamp plate.

3. Disconnect the tachometer drive cable from the rear of the drive casing and the oil feed pipe from the front. Loosen the pipe at its lower end and swing it clear.

4. Remove the two bolts and spring washers from the flange joint to the cylinder head. Take care not to lose the interposed distance piece.

5. Remove the two nuts and spring washers from the lower attachment flange and lift out the drive casing unit. Blank off the aperture to prevent entry of foreign matter.

Before refitting the assembly, make sure that the attachment flange faces are scrupulously clean and free from burrs or bruising.

1. Remove any blanking device and fit a new joint washer to the lower flange face.

2. Insert the lower end of the distributor drive casing assembly into its location, turning the shaft until the tongue and slot connection are aligned. Push the assembly right home.

3. Fit the two bolts and spring washers to the upper flange and insert the distance piece between the flange and the cylinder head.

4. Tighten the nuts of the lower flange securely and then the bolts of the upper flange.

5. Connect the tachometer drive cable to its drive body at the rear of the drive casing, and the oil feed pipe to the front; tighten all unions securely.

6. Fit the distributor assembly to its spigoted location, fit the rotor and, turning the rotor as necessary to ensure that the tongue and slot engage fully, push the assembly right home.

   Note:- The slot of the driving dog and the tongue of the distributor are off-set from the centre, and will therefore only engage correctly one way round.

7. Fit the set-screw and its washer through the slot of the clamp plate and tighten it securely.

8. Connect the L.T. lead to its terminal.

9. Check and set the ignition timing as described on page 80, and when completed, fit the distributor cover.

Note:- The lower driving dog is not off-set; it can therefore be fitted 180° out of its correct setting. If this has occurred, remove the H.T. leads from the distributor cover and re-position them in their correct "firing" sequence.

Dismantling distributor and automatic timing device

The distributor and the automatic timing device may be dismantled with the distributor drive casing "in situ", and without disturbing the ignition timing. This however, should only be done if the automatic timing mechanism is sluggish in operation.

1. Unclip and lift off the distributor cover, lift off the rotor and disconnect the L.T. lead from the side terminal.
2. Remove the contact breaker assembly (as described under Replacing the contact breaker)and remove the condenser.
3. Remove the two base plate fixture screws (as shown at D in Fig. 36), and lift out the base plate.
4. Mark the position of the rotor key slot of the cam unit in relation to the platform beneath, upon which the lead weights are mounted.
5. Lift out both the crescent-shaped weights, complete with their rocking toggles and springs. Do not dismantle the springs from their fixture studs unless they are to be changed, otherwise there is the risk of upsetting the operational tension.

Inspection

Clean the mechanism in petrol; this is advisable as a precaution against subsequent corrosion. Check all steel parts for corrosion and dress as necessary. The cam must be scrupulously clean and completely free on its spindle.

Re-assembling distributor and automatic timing device

Before assembling the components to the distributor body, clean off all components and dry thoroughly. Proceed as follows :-

1. Lightly oil the bearing hole at one end of each weight and fit them over the pins of the platform. Ensure that movement on the pins is free.

2. Lightly oil the centre hole of each rocking toggle and fit them over the pins of the weights, the chamfered side of the toggle facing downwards, see Fig. 13.

3. Lubricate the spindle extension and the bore of the cam unit and the two vacant holes of the toggles, then fit the cam unit over the spindle with the rotor key slot at the top coinciding with the mark (made on dismantling) on the platform, so that the pins at its base enter the vacant holes of the toggles.

4. Fit the cheese head retaining screw to the top of the spindle and screw it in securely.

5. Check for correct action by twisting the cam and noting that it returns to its original setting when released as indicated by the release of all load on the toggle springs.

6. Fit the contact breaker base plate and secure it with its two screws.

7. Fit and secure the condenser complete with its contact strip, and assemble the contact breaker as described under "Replacing the contact breaker."

8. Finally fit the rotor and the distributor cover.

Dismantling and re-assembling drive casing assembly

1. Remove the complete assembly from the engine as described previously. Referring to Fig. 12, proceed as follows.

2. Unscrew and remove the tachometer drive body and withdraw the tachometer drive shaft.

3. With the drive casing suitably supported, punch out the driving pin securing the lower driving dog. Remove the driving dog and extract the thrust washer beneath it.

4. Withdraw the shaft from the top of the casing and, if necessary, remove the upper driving dog from the shaft in the same manner as described on page 79. No thrust washer is fitted.

5. Rebuild the assembly by reversing the foregoing procedure, but check the fit of the shaft in its casing and the backlash of the gears. Check that the end-float is within the recommended limits, and if necessary select and fit a new thrust washer to give the recommended end-float.

Timing the ignition

Remove No. 1 sparking plug and turn the engine over with the starting handle until No. 1 piston is rising on its compression stroke. This is readily ascertained by counting five compressions and then turning steadily on the sixth phase. Insert a clean feeler rod (not less than 9in. (28 m.m.) in length) into the sparking plug aperture, and adjust the crank position manually by the crankshaft damper until the piston is on T.D.C. as indicated by the rod. If a timing disc is available, attach it to the crankshaft damper, and with a suitable pointer attached beneath a convenient nut or bolt, set the disc and pointer to read 0^{o}. Re-check that the 0^{o} reading agrees with T.D.C. as indicated on the feeler rod. Now turn the crank backwards until 5^{o} is indicated on the disc. With the distributor cover and the rotor removed, check that the contact breaker is just about to open. If correction is necessary, loosen the clamp bolt beneath the distributor (or the set-bolt in the quadrant slot) and turn the distributor body as necessary to achieve this.

Note:- If the distributor assembly has been dismantled and there is doubt as to the correct relative position of the rotor, fit the rotor and note the coinciding H.T. stud in the cover. If necessary, remove and re-position the H.T. leads in the cover in their correct firing sequence, using the "timed" stud for No. 1 cylinder.

When completed, secure the distributor and refit the cover, the sparking plug and the H.T. lead.

If a timing indicator is not available, time the ignition at T.D.C., slacken the clamp bolt and nut or the set-screw in the clamp plate of the distributor body and turn the distributor body $2\frac{1}{2}^{0}$ in the opposite direction to working rotation.

For an alternative method of final adjustment, road test the car on a suitably steep gradient. With the car in top gear pulling hard at about 1,500 r.p.m., it should be possible to induce slight "pinking" but as the speed is increased to about 3,000 r.p.m., the "pinking" should cease; stop the car and turn the distributor body back slightly. The actual settings to induce "pinking" at this r.p.m. will vary according to the fuel used and the general condition of the engine e.g. carbon deposit etc.

Replacing contact-breaker

The contact-breaker assembly is replaceable as a "set" and comprises the fixed plate, the rocker and an insulating washer. The Part No. for ordering purposes is Lucas 407050.

The procedure is as follows :-

1. Unclip and lift off the distributor cover and the rotor.
2. Detach the L.T. lead from the terminal at the side of the distributor body.
3. Referring to Fig.36, slacken the nut "A" to release the slotted end of the rocker spring, and lift off the rocker from its pivot post, and then the insulating washer.

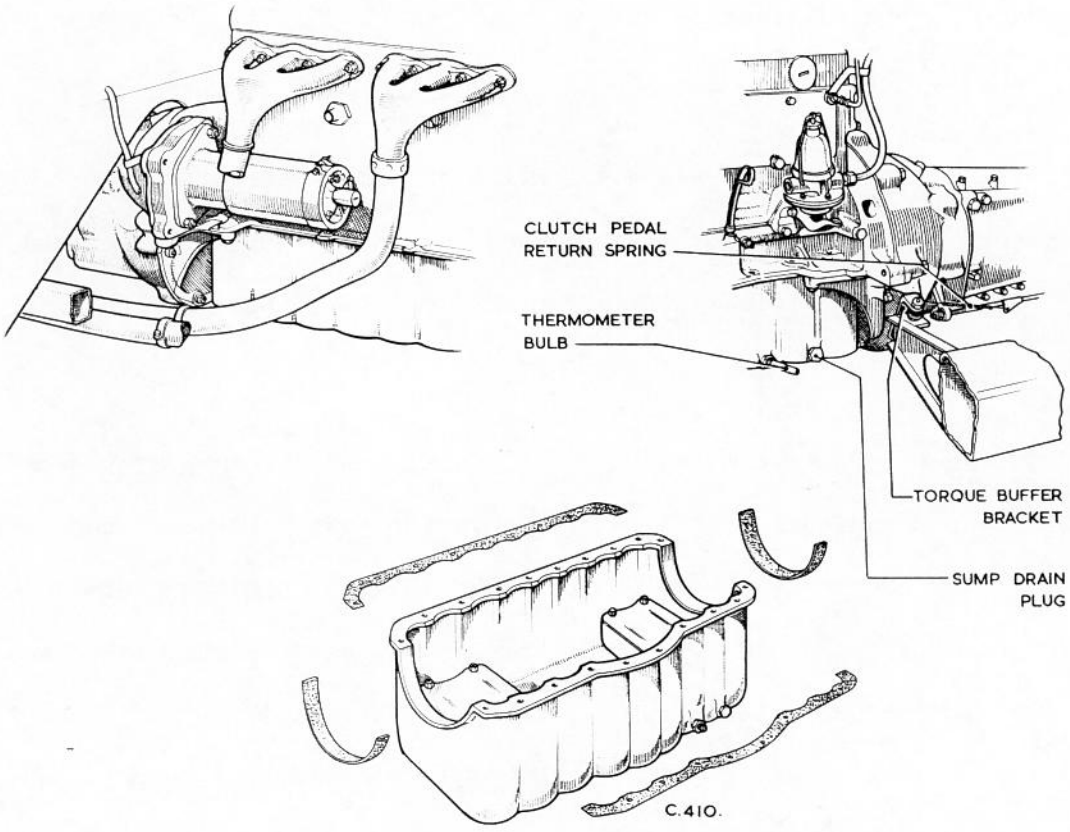


Fig. 35 Removing oil sump.

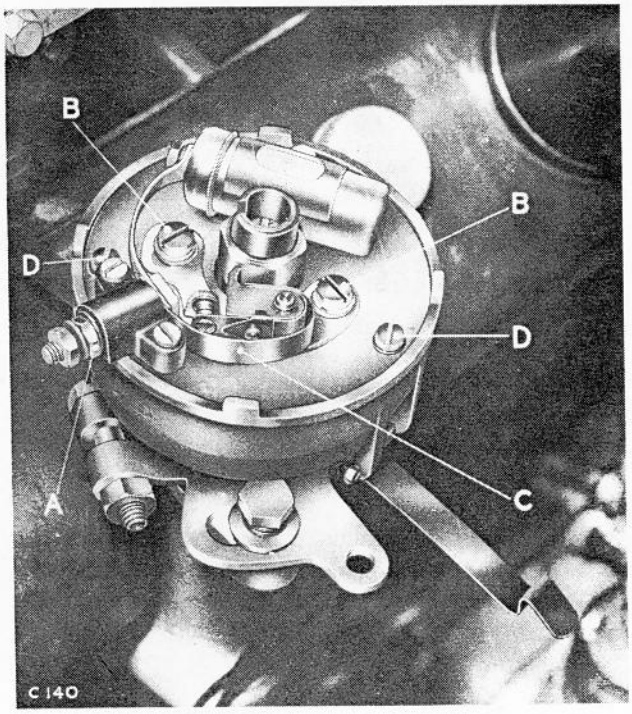


Fig. 36 Distributor details.

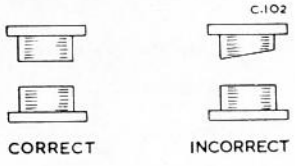


Fig. 37 Correct and incorrect contact faces

4. Unscrew and remove the two screws "B", taking care not to lose the washers.

Before fitting a new contact breaker set, wash the parts in petrol and dry thoroughly to get rid of the protective film of anti-rust compound with which they are coated; pay particular attention to the faces of the contact points.

1. Fit the fixed plate over the rocker pivot post and loosely fit the two screws "B" and their respective washers. Fit the insulating washer over the pivot post.

2. Apply a drop of approved oil to the pivot post and fit the rocker, engaging the slot of the spring behind the condenser connecting strip. Tighten the nut "A".

3. Connect the L.T. lead to its terminal and secure it with its nut and washer.

4. Set the contact breaker gap as described on page 85, then refit the rotor and distributor cover.

Replacing condenser

The condenser is replaceable as a separate unit under the Part No. Lucas 407044.

1. Unclip and lift off the distributor cover and then the rotor.

2. Disconnect the condenser connecting strip at the head of the condenser.

3. Remove the screw and shake-proof washer from the condenser securing clip, and lift out the condenser and its integral clip.

Before fitting a condenser, ensure perfect cleanliness of the electrical connections. Locate the replacement unit in position and secure it in position with its screw and shake-proof washer. Set the connecting strip to the head of the condenser then refit the rotor and the distributor cover.

Sparking plugs and special spanner

Under normal circumstances, do not replace sparking plugs except as a complete set of six and never use an "odd" plug except in emergency. These plugs can be cleaned satisfactorily only in a sandblast cabinet. Ensure that all grit or sand is cleared from plugs so treated, particularly if a plug is inclined to be oily.

Always use the special spanner (N.600011) supplied in the car tool kit for removing and refitting the plugs; it is fitted with a rubber insert which grips the body of the plug and a universal joint which facilitates the operation. When using it, ensure that the spanner is fully engaged over the hexagon of the plug, otherwise there is the risk of straining and cracking the insulator of the plug. When tightening plugs, no more than finger and thumb pressure is necessary on the tommy bar.

Ignition maintenance

General

The maintenance of this type of distributor follows standard practice and, if the optimum performance of the engine is to be maintained, the various checks which follow must be carried out conscientiously.

The tendency to ionise the air within the distributor cover leaves a dust-like deposit which, if neglected, can ultimately lead to "arcing" of the H.T. current and, together with corrosive effect of the spark gap between the rotor and the distributor segments, can lead to rapid erosion of the latter components.

Distributor

At the periods quoted in the Maintenance Schedule on page 94 carry out the following servicing.

1. Unclip and lift off the distributor cover. Clean each of the six H.T. segments with a knife and check the freedom of the centre "pick up" brush in its holder.

2. Wipe out the distributor cover with a clean cloth.

3. Lift off the rotor and clean the tip of the electrode.

Lubricating contact breaker assembly

At the periods quoted in the Maintenance Schedule on page 94, lubricate as follows.

1. Apply 3 or 4 drops of approved oil around the cam retaining screw in the recess below the rotor location.

2. Apply 3 or 4 drops of approved oil through the hole in the base plate through which the cam projects. Replace the rotor and check the automatic timing device for freedom of action. Turn the rotor in the direction of the arrow; when released, it should return smartly to its original position. If stiffness is apparent, dismantle the A.T.D. assembly as described on page 78.

   Note:- Do not confuse the small amount of free movement in the A.T.D. assembly with slackness in the mechanism.

   Remove the rotor and continue.

3. Lightly smear the cam with approved grease.

Cleaning and setting contact breaker points

1. Turn the crankshaft with the starting handle until the contact breaker is closed then remove the contact breaker assembly.

2. With a fine "India" or "Carborundum" slip, dress both contact points until an even, parallel and polished face is achieved, see Fig. 37.

3. Clean off all traces of abrasive dust in petrol and thoroughly dry the components. Do not finger the contact faces after drying.

4. Refit the contact breaker assembly as described on page 83 and reset the points as follows :-

5. If necessary, turn the crankshaft until the contacts are fully open, then check the gap between the contacts with a clean and dry feeler gauge.

6. To adjust the gap to the recommended figure slacken the two screws "B" in Fig. 36 and move the fixed plate about the pivot pin as necessary. Tighten the screws "B" when satisfactory and re-check the setting.

Note:- On an engine that has had much use, it is advisable to check the gap on each individual cam lobe; if the discrepancy between the readings is such that the contacts cannot be set within the limits recommended, trace the cause and replace any worn parts.

Sparking plugs

When cleaning plugs, use a sandblast cabinet and blow out thoroughly in a high pressure air blast; if a plug is inclined to be oily, wash it first in spirit and dry thoroughly before blasting. Reset the gap when completed by manipulating the earth electrode only. Clean the external threads and check that, with the sealing washer in position, each plug will screw down to its limit in the cylinder head by light finger pressure only on the knurled portion of the spanner. If lubrication of the thread is necessary, use only a graphited compound which will not form a crusted carbon deposit on the threads.

Check the condition of the washers whenever the plugs are removed, and fit new ones if any doubt exists as to the efficiency of the old ones.

REMOVING AND INSTALLING ENGINE

The following procedure is recommended for removing the engine from the chassis.

1. (a) Drain the water from the cooling system by the radiator base cock and the cylinder block drain cock.

   (b) Disconnect the battery.

2. From beneath the car.

   (a) Remove the sump air scoop as described under "Removing the sump" on page 74.

   (b) Remove the sump drain plug and allow the oil to drain. Refit the plug when drainage is completed, then remove the oil temperature thermometer bulb and stow it, with its capillary tube, on the chassis to prevent subsequent damage.

3. From the left-hand side of the engine.

   (a) Disconnect the leads from the dynamo.

   (b) Disconnect the coil H.T. and L.T. leads from the distributor and tie them to the bulkhead clear of the engine.

   (c) Disconnect the tachometer drive from the rear end of the distributor drive casing.

   (d) Disconnect the oil pressure gauge pipe from its union just aft of the dipstick.

   (e) Slacken the dynamo mounting and adjusting bolts, press the dynamo as far as possible towards the engine and remove the fan belt. Do not attempt to "ride" the belt off the pulleys or the core of the belt may be damaged. Re-tighten the bolts.

   (f) Disconnect the mixture (Bi starter) control wire and casing from No.3 (rear) carburettor.

   (g) Turn off the fuel cock to prevent possible tank syphoning and disconnect the flexible pipe from the front of the fuel pump.

4. From the right-hand side of the engine.

   (a) Disconnect both radiator hoses from the water pump.

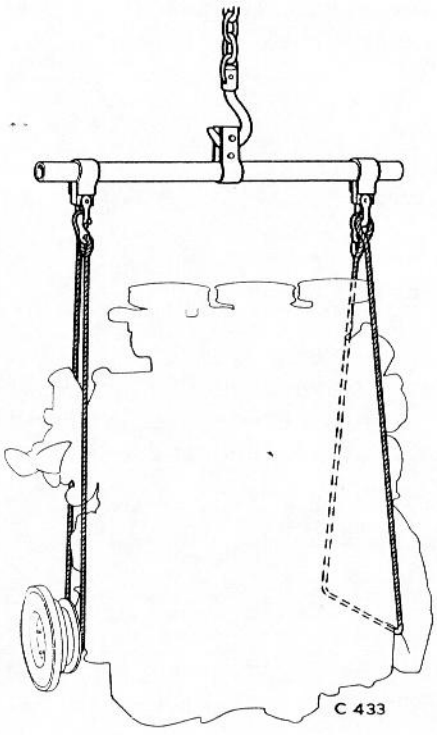


Fig.38 Engine sling.

(b) Break the locking wire and slacken the exhaust down pipe ring nuts with the "C" spanner TFN. 5030. (These ring nuts are to be released later).

(c) Disconnect the water thermometer bulb unit from the side of cylinder block (between the exhaust manifolds) and stow it with the capillary tube on the chassis to prevent damage.

(d) Remove the vertical throttle control rod (passing through the rear manifold) and replace the nuts on their respective ball joints for safe keeping.

(e) Disconnect the cable from the starter motor.

5. Miscellaneous attachments.

(a) Remove the radiator side flange set-screws and detach the radiator from its pedestal mountings. Lift out the radiator from the top.

(b) Unscrew the ring nut from each exhaust manifold to release the down pipes. It is advisable to support these pipes to prevent straining the front silencer joints when the lower clip is released subsequently.

6. Fitting the engine sling.

(a) Fit the engine lifting sling TFN. 5029 to a hoist arranged at a convenient height above the engine. Pass the free end of the short (front) cable around the front end of the crankshaft (behind the pulley) and hook it to the front ring of the lifting bar. Pass the free end of the long (rear) cable through the space between the rear end of the sump and the gearbox bracket then hook the other end to the rear of the lifting bar, see Fig. 38.

(b) Raise the hoist until the weight of the engine is taken on the sling.

7. From inside the car.

Remove the gearbox from the car as described in Section 5, ensuring that no undue strain is permitted at the front silencer joints when the downpipe clip is released.

(a) Remove the nuts and bolts securing the front engine mounting units to the chassis.

(b) Raise the engine carefully from the car, taking care to avoid damage.

(c) Lower the engine into an engine stand, or if a stand is not available, on to wood blocks.

8. Blank off all openings and any exposed mechanism to prevent entry of foreign matter.

To install the engine, reverse the removal procedure and after re-connecting the engine controls etc., check their operation as described in the relevant section.

Note:- If the carburettors have been disturbed at their flange joints it is most important to check very accurately that they are synchronised correctly, since they are a free fit on their respective studs and the original settings will not always be maintained on re-assembly.

D I A G N O S I S O F R U N N I N G F A U L T S

DIFFICULT STARTING

Cold engine

Carburettor or fuel feed defects.	See Section 3.
Condensation on sparking plugs and/or distributor assembly.	Remove components and dry thoroughly.
Battery state of charge low, causing "coil-robbing".	Use starting handle.
Sparking plug gaps too wide.	Re-set plug gaps correctly.

Hot engine

Carburettor or fuel feed defects.	See Section 3.
Sparking plugs worn beyond their useful life.	Renew sparking plugs after checking their gap settings.
Distributor segments and rotor tip corroded.	Remove distributor cover and clean off all corrosion.
Contact breaker excessively pitted or burnt.	Rectify and check for condenser efficiency.

POOR IDLING

Carburettor or fuel feed defects.	See Section 3.
Sparking plug gaps uneven.	Remove plugs and re-set gaps correctly.
Tappet settings uneven.	Re-set tappets correctly.
Contact breaker points incorrectly gapped.	Re-set correctly.
Automatic timing device seized in advanced position.	Dismantle, free and re-assemble A.T.D.

POOR ACCELERATION

Carburettor or fuel feed defects.	See Section 3.
Sparking plug gaps incorrectly set.	Remove plugs and re-set gaps correctly.
"Pinking" or knocking due to inferior fuel, excessive carbon deposit or broken automatic timing device spring (centrifugal weight).	Change grade of fuel. De-carbonise or renew both springs of A.T.D.
Tappet settings incorrect.	Check and rectify tappet settings.
Loss of compression, due to broken piston rings, sticking valve or valves. Pitted valve seats. Tappet settings too close.	Rectify as necessary.

LACK OF POWER

Carburettor or fuel feed defects.	See Section 3.

Overheating.	See Section 2.
Too heavy a grade of oil.	Change oil.
Tappet settings incorrect.	Check and re-set tappet settings.
Incorrect setting of contact breaker points. Faulty condenser (as indicated by condition of contact breaker).	Re-set contact breaker points. Replace condenser.
Low grade fuel.	Change grade of fuel.
See also under "Poor acceleration"	

OVERHEATING

Weak fuel mixture.	See Section 3.
Ignition advance insufficient.	Check action of automatic timing device and initial ignition timing setting.
Cooling system defects.	See Section 2.
High oil temperature, due to overfilled sump.	Drain sump to correct level.

LACK OF MAXIMUM SPEED

Carburettor or fuel feed defects.	See Section 3.
Weak or broken valve spring or springs (causing valve "float").	Dismantle cylinder head and rectify.
Valve seatings pitted.	Dismantle cylinder head and rectify.
Faulty coil.	Replace coil.
Incorrect contact breaker setting.	Re-set contact breaker correctly.
Faulty condenser. Indicated by burning at contact breaker.	Replace condenser and rectify contact breaker.
Contact breaker spring weak or distorted.	Replace contact breaker set.
Distributor cam unevenly worn.	Replace cam unit.
Insufficient ignition advance.	Check action of automatic timing device or re-set initial timing.

Sparking plugs faulty or gaps set incorrectly.	Replace plugs or re-set gaps correctly.
Too heavy a grade of oil.	Change oil to grade recommended for climatic condition.
Excessively worn rocker bushes or rocker shaft.	Replace bushes and/or shaft.

MISCELLANEOUS FAULTS

Cam speed tapping with engine cold, but disappears at working temperature due to:-	
Piston slap	Engine due for re-bore or replace faulty piston.
Valve or valves sticking in guide or guides.	Remove rocker boxes and lubricate valve guides externally. If persistent, remove cylinder head and rectify as necessary.
Rocker tightening on rocker shaft.	As above, but lubricate rockers externally.
Knocking on over-run, due to :-	
Small end or gudgeon pin fitting defect.	Dismantle connecting rod/piston assembly and rectify.
Knocking when running light, due to :-	
Big end bearing failure.	Fit new big end bearing shells as required.
Knocking under heavy load, due to :-	
Crankshaft main bearing failure.	Fit new main bearing shells as necessary.
Banging back in exhaust system on over-run due to :-	
Air leaks in carburettor flanges.	See Section 3.
Air leaks in exhaust system.	Check by running engine and momentarily blocking tail pipe exit; check for leakage in system, and rectify as necessary.
Excessive fuel consumption.	See Section 3.

Excessive oil consumption due to:-

Sump oil level too high.	Drain sump to correct level.
Oil leakage at front or rear main bearing.	Dismantle engine and rectify.
Wrong grade of oil.	Change to recommended grade of oil.
Engine "fumes" or plugs become excessively oily.	Re-bore engine.

MAINTENANCE

In order to maintain optimum engine performance, it is essential to keep the various recommended settings. It is, for example, quite useless to have the ignition in perfect order if carburettor synchronisation is not correct. The following maintenance sequence is given as a guide on a mileage basis.

General

1. Clean all foreign matter from the well of the cylinder head, and keep the external surfaces of the engine clean and free from oil.

2. Check and rectify any oil leakage.

3. Check the security of all union connections and pipe clips.

4. Check the adjustment of the fan belt.

5. Check the security of all nuts and bolts.

6. Check that there is equal compression on all cylinders.

After the first 500 miles (800 k.m.) and the first 1,500 miles (2,500 k.m.)

Change the engine oil.

Change the oil filter insert assembly.

Check the fan belt tension.

Check the tappet clearances.

Check the contact breaker gap setting.

After every 500 miles (800 k.m.)

Check the oil level in the sump.

After every 2,000 miles (3,500 k.m.)

Change the engine oil.

After every 3,000 miles (5,000 k.m.)

Clean and reset the contact breaker points.

Lightly smear the contact breaker cam with grease.

Lubricate the automatic advance and retard mechanism.

Lubricate the contact breaker pivot pin.

Lubricate the distributor shaft.

Clean, gap and test the sparking plugs.

After every 6,000 miles (10,000 k.m.)

Change the oil filter insert assembly.

Check the tappet clearances.

Clean the petrol pump filter and cover.

Clean the filters in the petrol gallery pipe banjos.

Clean the H.T. rotor, segments and cover.

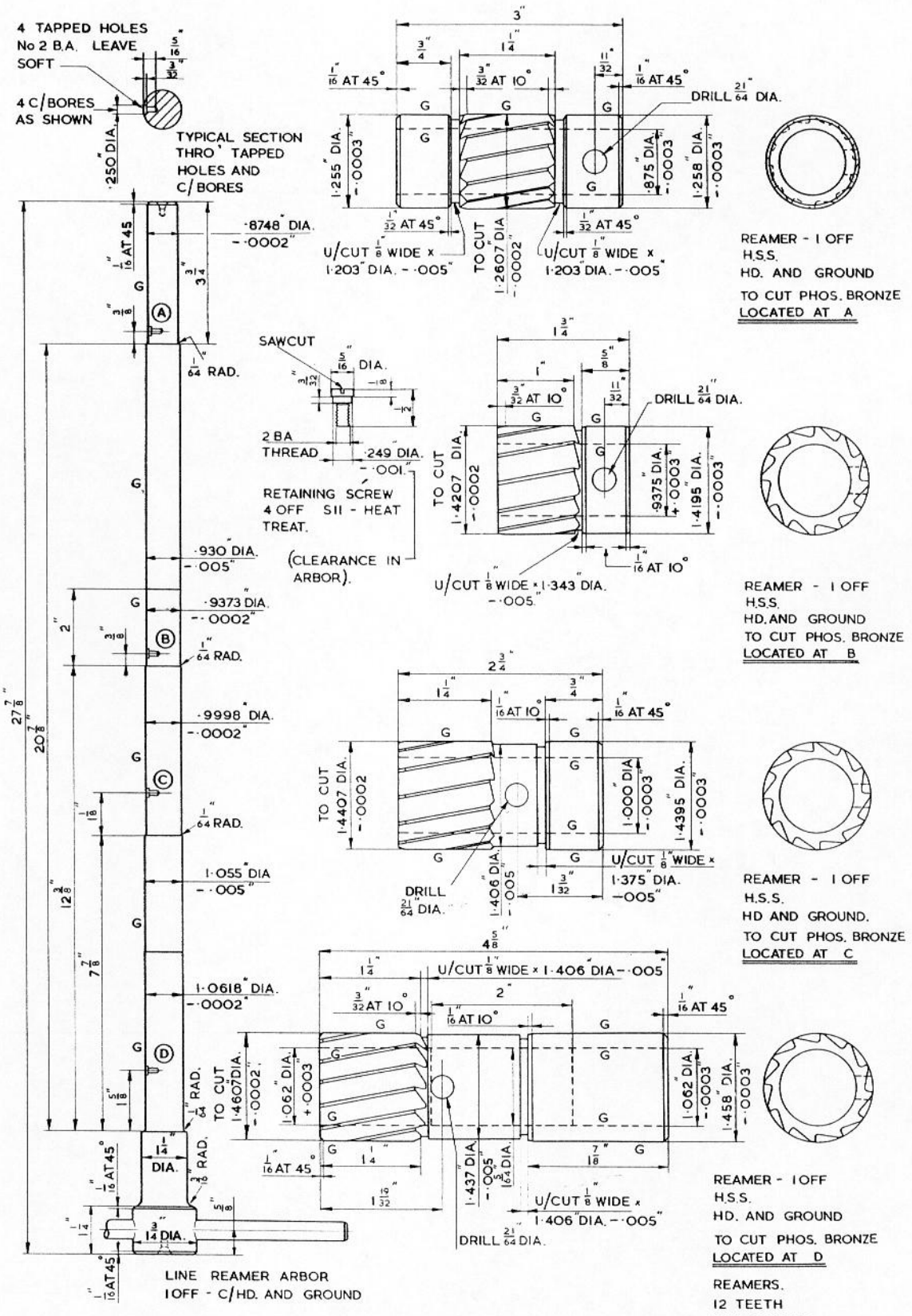
After every 12,000 miles (20,000 k.m.)

Fit new sparking plugs.

Lubricate the dynamo.

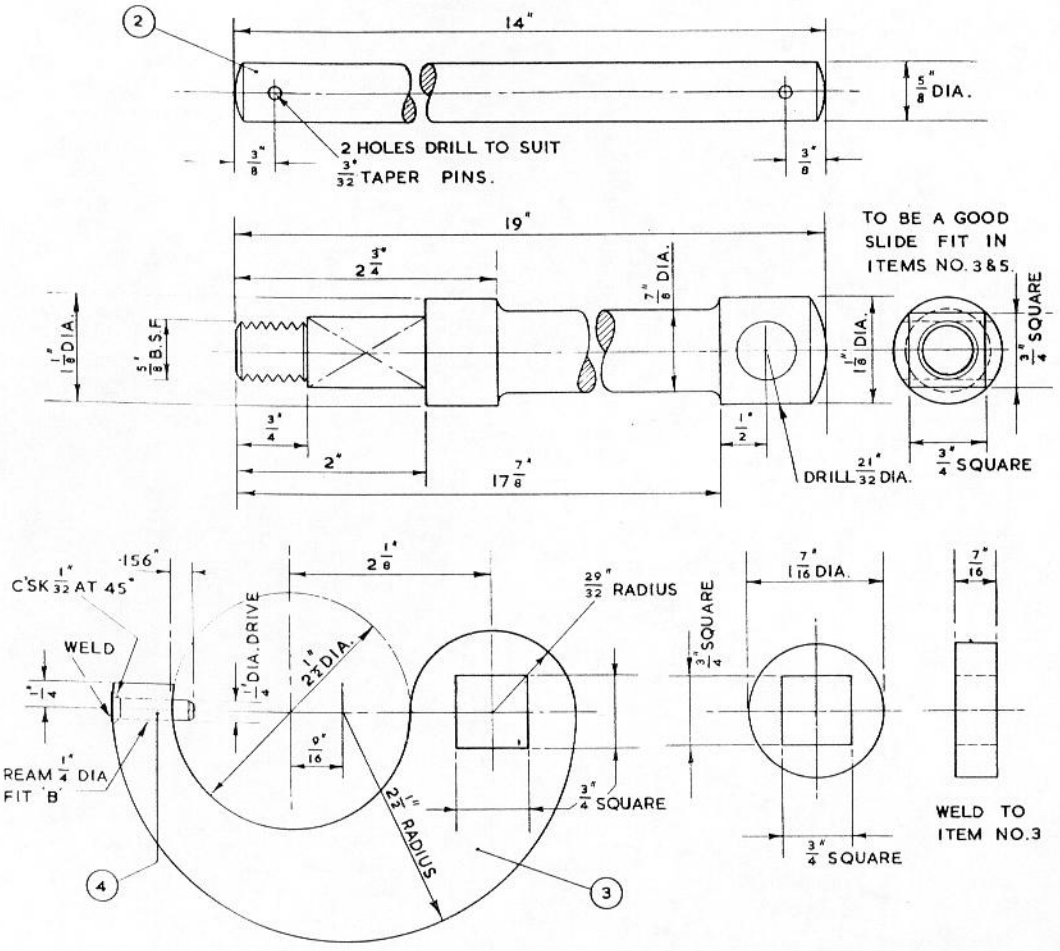
Check the condition of the dynamo brushes.

S P E C I A L T O O L S



REAMER FOR CAMSHAFT BUSHES T. 185379-80-81-82

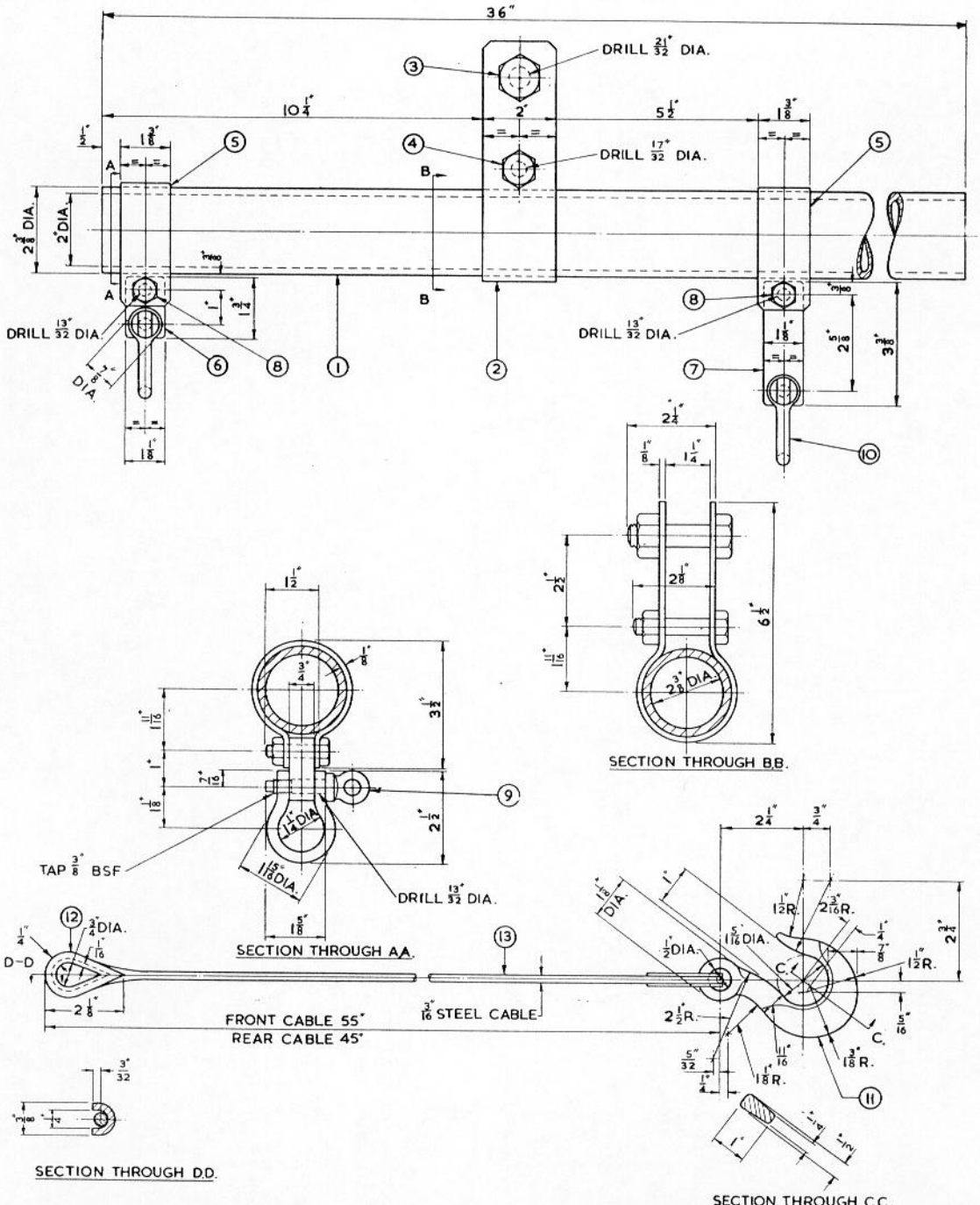
C.465.



ITEM	DESCRIPTION	NO. OFF	MATERIALS
1	SHANK	1	H.T.S.
2	TOMMY BAR	1	M.S.
3	JAW	1	H.T.S.
4	PIN	1	H.T.S.
5	BOSS	2	H.T.S.
6	5/8" B.S.F. NUT	1	H.T.S.
7	5/8" WASHER	1	M.S.
8	3/32" TAPER PIN	2	M.S.

C.464.

"C" SPANNER FOR EXHAUST NUT T.F.N. 5030.

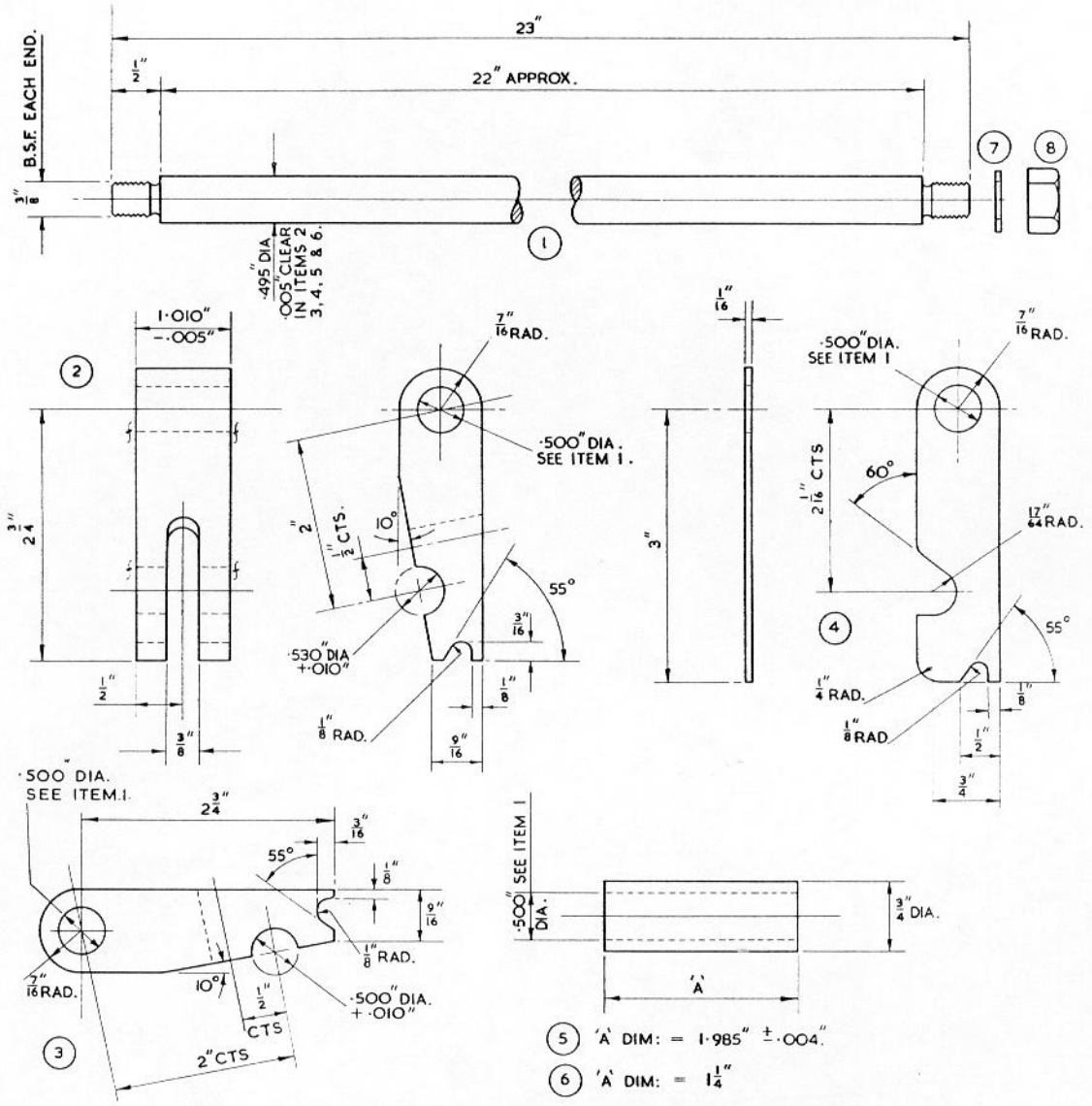


ITEM	DESCRIPTION	Nº OFF	MATERIAL
1	BEAM	1	STEEL TUBE
2	LIFTING LINK	1	M.S.
3	NUT & BOLT	1	M.S.
4	NUT & BOLT	1	M.S.
5	CLAMP	2	M.S.
6	LINK	1	M.S.
7	LINK	1	M.S.

ITEM	DESCRIPTION	Nº OFF	MATERIAL
8	NUT & BOLT	2	M.S.
9	EYE BOLT	2	M.S.
10	SLINGING RING	2	M.S.
11	HOOK	2	H.T.S.
12	EYE ENDS	4	M.S.
13	CABLE	2	H.T.S.

C.466.

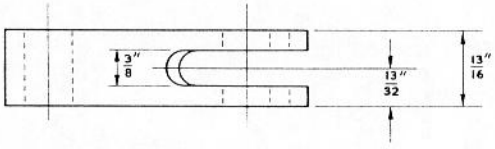
CAR ENGINE SLING T.F.N. 5029.



(5) 'A' DIM: = 1·985" ± ·004"

(6) 'A' DIM: = 1 1/4"

ASSEMBLE THE PARTS TO THE ROD IN THE FOLLOWING ORDER. FIT ITEMS 7 AND 8 TO ONE END THEN ASSEMBLE FROM THE OPPOSITE END ITEMS 6,3,4,5,4,2,4,5,4,2,4,5,4,2,4,5,4,2,4,5,4,2,4,5,4,3,6,7 AND 8.

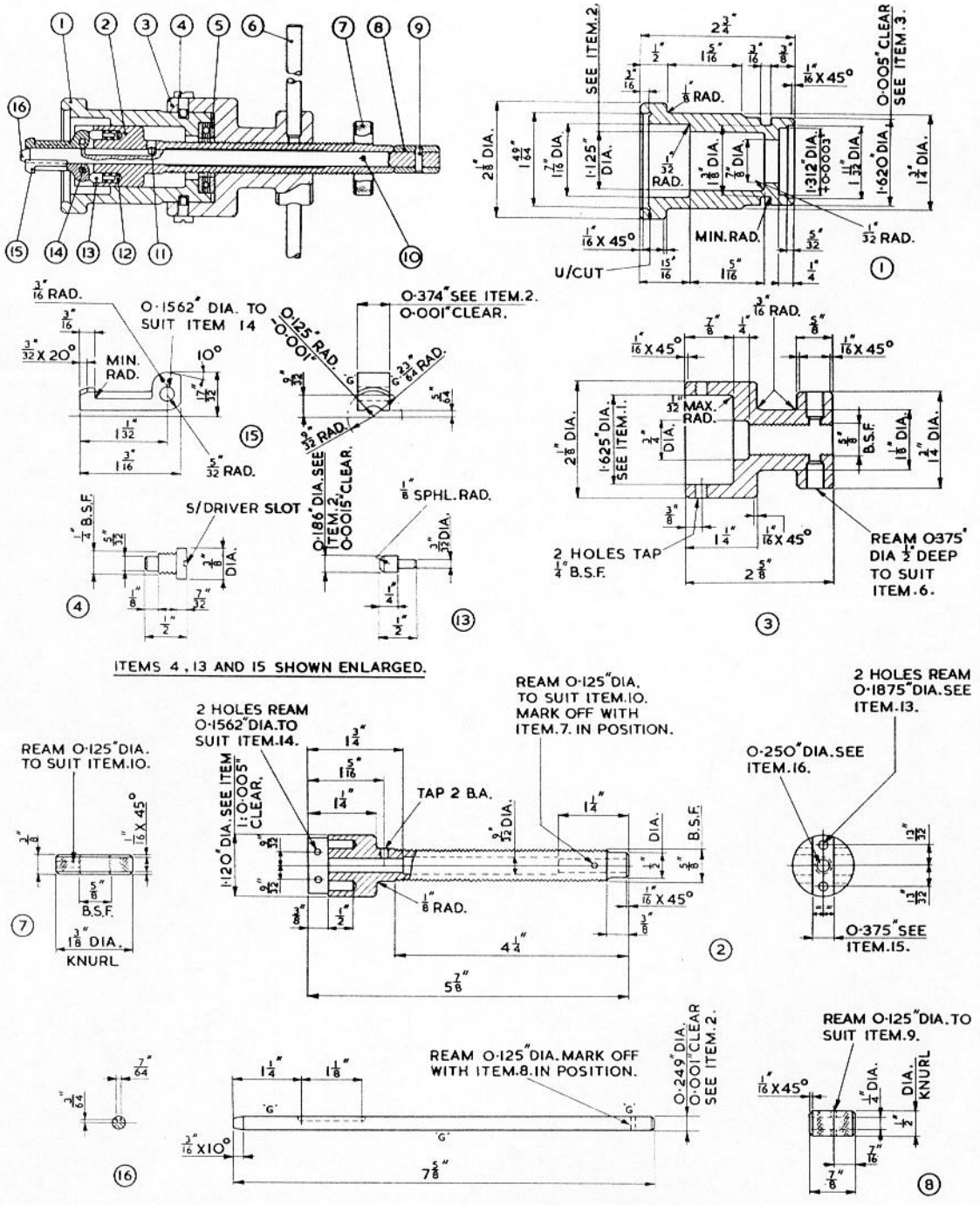


NOTE: MACHINE WHERE MARKED ∮

C.467

ITEM Nº	DESCRIPTION	Nº OFF	MATERIAL
1	ROD	1	M.S.
2	SPACER	5	M.S.
3	SPACER	2	M.S.
4	BLADE	12	M.S.
5	DISTANCE PIECE	6	M.S.
6	DISTANCE PIECE	2	M.S.
7	PLAIN WASHER	2	M.S.
8	3/8" B.S.F. PLAIN NUT	2	M.S.

FIXTURE FOR ROCKER ASSEMBLY T.176893.

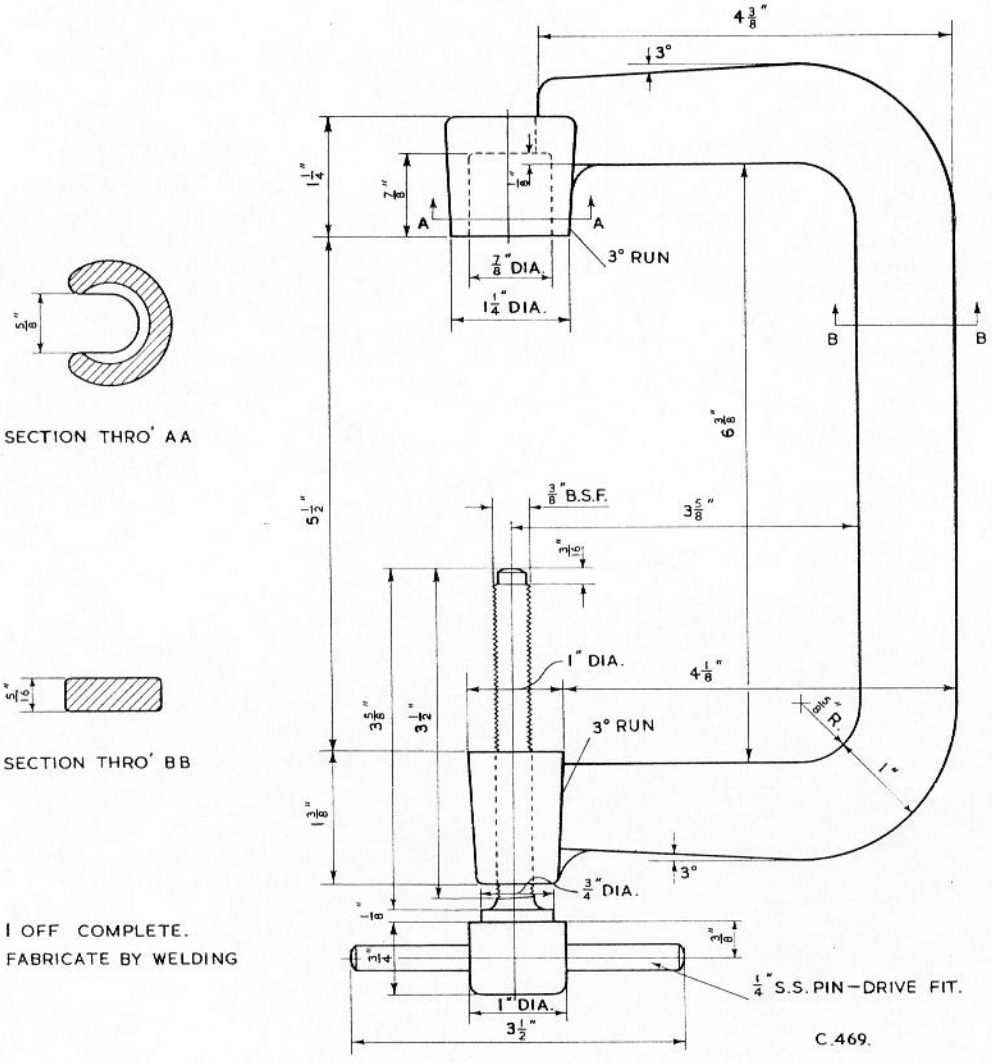


ALL DIMENSIONS WITH LIMITS MUST BE CORRECT. DIMENSIONS IN DECIMALS WITHOUT LIMITS NEED NOT BE TO SIZE BUT DESIRED CLEARANCE FITS ETC. MUST BE MAINTAINED.

C.468.

ITEM No.	DESCRIPTION	No. OFF.	MATERIAL	ITEM No.	DESCRIPTION	No. OFF.	MATERIAL
1	BODY	1	M.S.	9	DOWEL	1	SIL. ST. 1/8" DIA. X 1/2" LG.
2	SCREW	1	M.S.	10	PIN	1	SIL. ST. 1/8" DIA. X 1/2" LG.
3	NUT	1	M.S.	11	GRUB SCREW 2 B.A.	1	ALLEN 1/4" LG (END TO SUIT ITEM.16.)
4	RETAINING SCREW	2	M.S.	12	SPRING (TO SUIT)	2	SP. ST.
5	THRUST BEARING	1	R.&M. F.T. 3/4"	13	PLUNGER	2	M.S.
6	TOMMY BAR	2	SIL. ST. 1/8" DIA. X 3 1/4" LG.	14	PIN	1	SIL. ST. 5/32" DIA. X 7/8" LG.
7	STOP	1	M.S.	15	CLAW	2	S.90. HARDEN
8	ROD END	1	M.S.	16	ROD	1	SIL. ST.

EXTRACTOR FOR CRANKSHAFT BALL BEARING T. 179166.



SECTION THRO' AA

SECTION THRO' BB

1 OFF COMPLETE.
FABRICATE BY WELDING

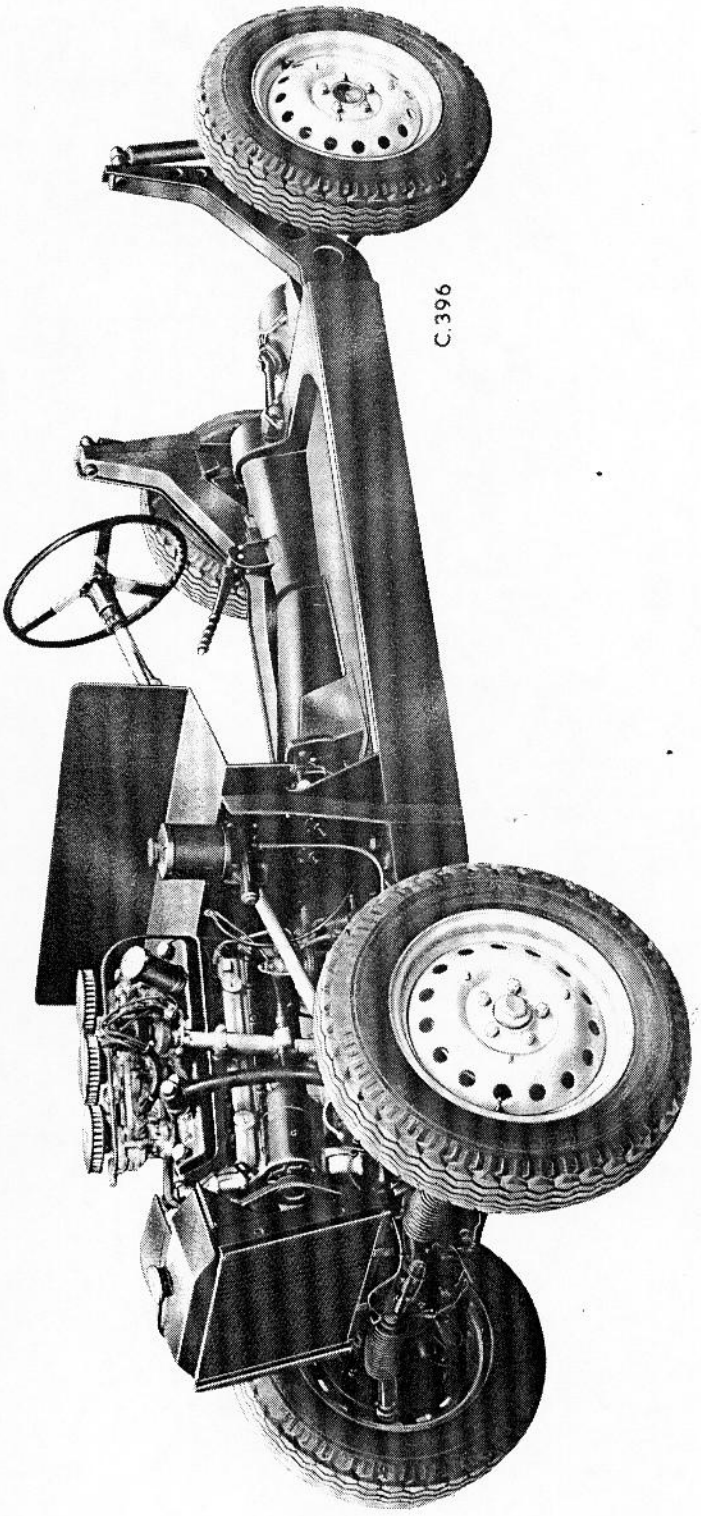
VALVE SPRING LIFTER T.F.N. 5021.

THE

ARNOLT-BRISTOL 2-LITRE CHASSIS

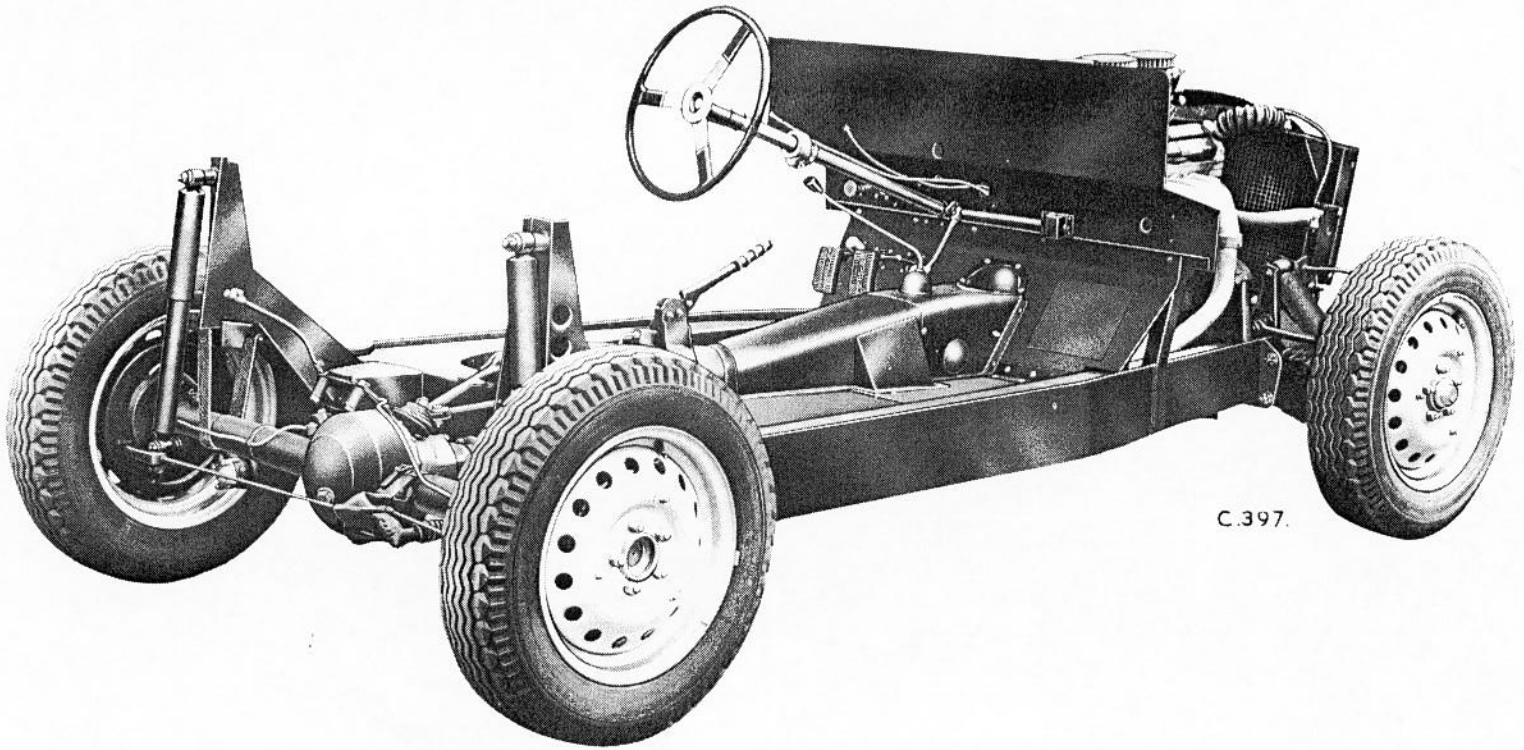
WORKSHOP MANUAL

S. H. ARNOLT INC.
415, EAST ERIE STREET,
CHICAGO 11, ILLINOIS,
U.S.A.



C.396

ARNOLT - BRISTOL 2 LITRE CHASSIS



ARNOLT - BRISTOL 2 LITRE CHASSIS

SPECIFICATIONS

Turning circle	32ft. 10in. (10m.).
Wheel base	8ft. ¾in. (244·5cm.).
Front track...	4ft. 3¾in. (133 cm.).
Rear track	4ft. 6in. (137 cm.).
Frame...	Rigid box section 6½in. deep with integral floor structure.
Front suspension	Independant springing employing a transverse leaf spring and telescopic shock absorbers.
Rear suspension	Torsion bars and telescopic shock absorbers.
Shock absorbers	Telescopic - Complete set of "Girling" or complete set of "Armstrong".
Brakes	
System	Lockhead hydraulic.
Brake pedal acts on	All four wheels.
Hand brake acts on	Rear wheels only.
Wheels..	"Bolt-on" easy clean type.
Tyres...	5·50 x 16.
Tyre pressures	
Front	See Section 10 page 6.
Rear.	See Section 10 page 6.
Steering	Rack and pinion.
Radiator	Marston "Excelsior".
Electrical system...	12 volt.

I N T R O D U C T I O N

This manual is designed to provide information on the General Data, Maintenance and Repair of the ARNOLT-BRISTOL 2 LITRE chassis. For easy reference, the text is grouped under the various unit headings indicated in the "Contents" page. Supplementary information may be isuued from time to time in the form of "Bulletins"; such bulletins should always be regarded as overriding the information given in this manual. The bulletins should be filed numerically at the end of the relevant section of the manual and the bulletin record sheet at the front of each section should be endorsed accordingly.

SERIAL NUMBERS

When ordering replacement parts, always quote the following information :-

1. The engine number.
2. The chassis number.
3. The part number, number of parts required and the full description given in the Spares Handbook. To avoid mistakes and to expedite delivery, use only the wording and part number given in the SparesHandbook.
4. If in doubt, send the old part with the request for the replacement.

Note:- Left-hand or right-hand is always understood as from the driving position. This should be noted carefully when ordering left-hand or right-hand replacements.

Orders by telephone or telegraph should be confirmed in writing as soon as possible.

SERIAL NUMBER LOCATIONS

Engine number plate	Right-hand rocker box cover.
Chassis number plate	Top face of chassis side member in the vicinity of the exhaust manifold.

C O N T E N T S

Engine..	"Bristol" B.S. 1 Mk. II.
Clutch..	"Borg and Beck" type, single dry plate.
Gearbox.	BW. CR. 9.

RECOMMENDED LUBRICANTS

Engine	
Below 10°F.	S.A.E. 10 engine oil.
10°F. to 32°F....	S.A.E. 20 engine oil.
Above 32°F.	S.A.E. 30 engine oil.
Gearbox	
Winter	S.A.E. 30 engine oil.
Summer	S.A.E. 40 engine oil.
Rear axle	
Winter	EP oil S.A.E. 90.
Summer	EP oil S.A.E. 140.
"One-shot" lubricating system... ...	Non-additive gear oil S.A.E. 90.
Suspension units	Non-additive gear oil S.A.E. 90.
Propeller shaft nipples...	EP oil S.A.E. 140.
Front wheel hubs....	Hub grease.
Distributor...	S.A.E. 10.

CAPACITIES

Engine sump...	8½ pints (4·5 litres).
Gearbox	2½ pints (1·5 litres).
Rear axle	3 pints (1·7 litres).

"One-shot" system reservoir	2 pints	(1·2 litres).
Front hubs	4 ozs.	(0·11 kg.).
Radiator	12 pints	(6·8 litres).
Brake system reservoir	1 pint	(0·5 litres).