SERVICE INSTRUCTION MANUAL

VANGUARD I & II
and
TRIUMPH "RENOWN" MODELS

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Service Instruction Manual

Fourth Issue

STANDARD
VANGUARD

SERIES I AND II
and
TRIUMPH "RENOWN" MODELS

ENGINE

SECTION B

ENGINE

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ENGINE

ILLUSTRATIONS

Series II Supplement

ENGINE — DIMENSIONS AND TOLERANCES

Parts and Description.	Dimensions, new.	Clearance, new.	Remarks.
Crankshaft.			
Journal Dia.	2.4790" 2.4795"	.001" to .002"	
Bearing Internal Dia.	2.4815" 2.4805"		
Internal Dia. of Brg. Housing	2.6250" 2.6255"		
Crankshaft End Float.			
Intermediate Journal Length	1.7507" 1.7498"		
Intermediate Bearing Cap Width Plus thickness of two Thrust Washers	1.7450" 1.7390"	.0048" to .0117"	Clearance of .004" to .006" is specified and is obtained by selective assembly of thrust washers.
Main Bearing Width	1.5050" 1.4950"		
Big End.			
Crank Pin Dia.	2.0866" 2.0861"	.0005 to .0025	max worn diam 2.084
Bearing Internal Dia.	2.0860" 2.0866"		
Internal Dia. of Bearing Housing	2.2327" 2.2335"		
Bearing Width (Big End)	.965" .975"		
Big End Float.			
Crank Pin Width	1.1915" 1.1865"	.007" to .104"	
Con Rod Width	1.1795" 1.1775"		
Ovality and Taper.			
Journals and Crank Pins			Min. diameter to be such that the permissible worn clearance for the bearing is not exceeded.
Small End.			
Bore for Bush	1.0000" .9995"		

ENGINE — DIMENSIONS AND TOLERANCES

Parts and Description.	Dimensions, new.	Clearance, new.	Remarks.
Bush External Dia.	1.0000" .9995"		Press fit in rod.
Internal Dia of Bush	.8752" .8748"	.0002" at 68° Fahr.	
Gudgeon Pin Dia.	.87510" .87485"		
iston Rings.			
Compression Ring Width	.0787" .0777"	.001" to .003"	Allow increase in side clearances of .003" Mean.
Groove Width	.0807" .0797"		
Scraper Ring Width	.1560" .1550"	.001" to .003"	
Groove Width	.1580" .1570"		
Ring Gap in Cylinder Liners		.010" to .015"	

istons and Cylinder Liners.

Parts and Description	F.	G.	H.	Clearance New
Bore Dia. of Liner	Min. 3.3460" 3.3463"	Min. 3.3464" 3.3467"	Min 3.3468" 3.3471"	.002¾" to .003¼"
Top Dia. of Piston Skirt (Pres. Face)	over 3.3430" to 3.3433"	over 3.3433" to 3.3437"	over 3.3437" to 3.3441"	
Bottom Dia. of Piston	over 3.3445" to 3.3448"	over 3.3448" to 3.3452"	over 3.3452" to 3.3456"	.001¼" to .002"

Parts and Description.	Dimensions, new.	Clearance, new.	Remarks.
amshaft.			
Front Journal Dia.	1.8720" 1.8710"	.002¾" to .004¾"	Max. wear on camshaft journal .003" and .003½" in brg.
Front Journal Bearing Bore	1.8757" 1.8752"		
External Dia. of Front Bearing	2.2498" 2.2493"	Push fit in Cylinder Block	
Bore in Block for Front Bearing	2.2507" 2.2498"		
2nd, 3rd and Rear Camshaft Journal	1.7157" 1.7152"	.002½" to .004½"	Max. wear on journal .003" and .003½" in cylinder block.
Bore in Cylinder Block for 2nd, 3rd and Rear Journals	1.7198" 1.7183"		
End Float		.003" to .0075"	

ENGINE — DIMENSIONS AND TOLERANCES

Parts and Description.	Dimensions, new.	Clearance, new.	Remarks.
Valves and Valve Guides.			
Inlet Stem Dia.	.3110" .3100"	.001" to .003"	Distance from top of guide to upper face of cylinder head $\frac{23}{32}$".
Guide Dia.	.3130" .3120"		$\frac{11}{32}$" dia. from V.171250E and TDC.1107E.
Exhaust Stem Dia.	.3400" .3399"	.003" to .005"	Guide height as for Inlet.
Guide Dia.	.3440" .3430"		$\frac{11}{32}$" dia. from V.171250E and TDC.1107E.
Included angle of valve faces	90°		Included angle of seating in cylinder head 89°.
Inlet Valve Head Dia.	1.5020" 1.4980"		
Width of Inlet Valves Seating Face	.0440"		
Exhaust Valve Head Dia.	1.2830" 1.2790"		
Width of Exhaust Valve Seating Face	.0440"		
OIL PUMP. Outer Rotor			
Outside Dia.	1.5975" 1.5965"	.0055" .0075"	
Housing Internal Dia.	1.6040" 1.6030"		
Depth of Rotor	1.4995" 1.4985"	.0005" to .0025"	A combined worn clearance of .004" indicates the necessity for cover and housing face lapping.
Housing Depth	1.5010" 1.5000"		
Inner Rotor.			
Major Dia.	1.1720" 1.1710"		
Minor Dia.	.7310" .7290"		
Rotor Depth	1.4995" 1.4985"	.0005" to .0025"	
Housing Depth	1.5010" 1.5000"		
Clearance on Rotors	Maximum clearance new .001" to .004" Minimum clearance new .0025" to .0005"		Where clearance in excess of .010" exists, new parts should be fitted.

ENGINE — DIMENSIONS AND TOLERANCES

Parts and Description.	Dimensions, new.	Clearance new.	Remarks.
ALVE SPRINGS.			
ıner Spring.			
Fitted Length	1.31″		
Fitted Load	28 lbs. $^{+2 lbs.}_{-1 lb.}$		
Free Length (approx.)	1.81″		
uter Spring.			
Fitted Length	1.63″		
Fitted Load	28 lbs. $^{+2 lbs.}_{-1 lb.}$		
Free Length (approx.)	1.97″		

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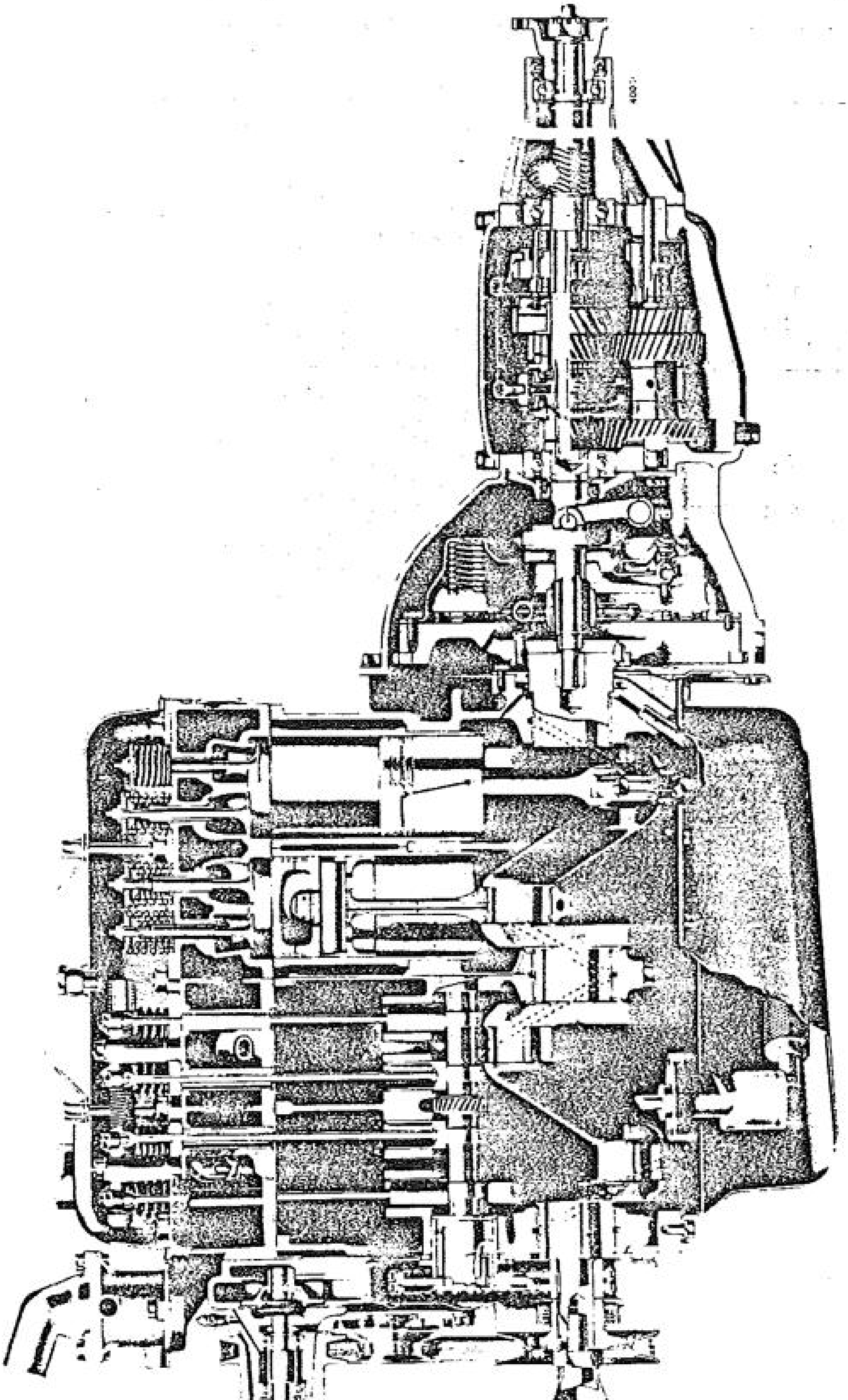


Fig. 1. Longitudinal section of engine and gearbox

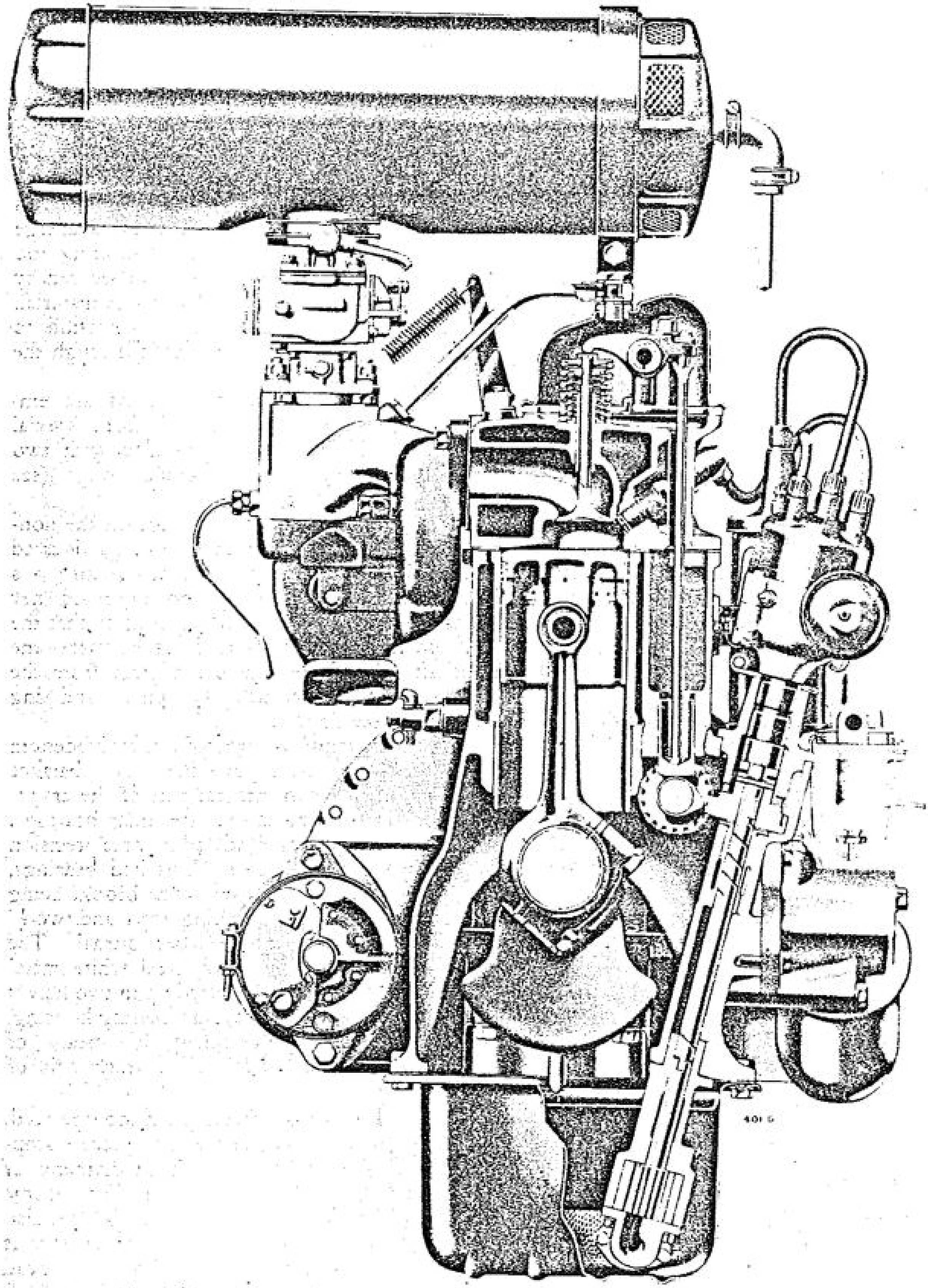


Fig. 2. Cross section of engine

ENGINE

(See Fig. Nos. 1 and 2)

GENERAL DESCRIPTION

The **engine** has four cylinders, 85 mm. bore and 92 mm. stroke, giving a cubic capacity of 2,088 cubic centimetres. The compression ratio is 6.7; the **cylinder block** is of cast iron and is provided with cylinder liners.

The **cylinder sleeves** are of the wet type, being centrifugally cast in nickel chrome iron and provided with flanged upper faces, having two pairs of flats at 90° to one another. These two pairs of flats provide alternative fitting positions to deal with piston slap which normally occurs due to wear along the axis of thrust. The sleeve is shown in Fig. 18.

The sleeves are machined all over and ground on their upper faces. The lower portion of each liner is provided externally with a reduced diameter, surmounted by a flanged face for spigotting into machined recesses in the cylinder block and a water seal provided by a composition packing.

The liners are held in position by the combustion head and gasket, the initial position of the liner allowing this to stand proud of the cylinder block .003" minimum to .0055" maximum. Selective assembly of pistons and liners being adopted, the symbols "F," "G" and "H" being used.

The sleeve bore dimensions are given on Page 2.

The **connecting rods** are manufactured from molybdenum manganese steel being provided with phosphor bronze small end bushes and precision type big end bearings. The connecting rod is drilled from the big end bearing end to the small end to provide for the passage of oil under pressure from the main supply. The big end bearing cap is somewhat unorthodox in design, the cap securing setscrews being inclined at an angle to the centre line of the connecting rod. The caps are dowelled to the connecting rods and located by these bushes. This form of cap provides a more convenient position for tightening and loosening bolts, and also has the added virtue of allowing the bearing caps to be removed progressively from below without the danger of their dropping into the repair pit immediately the nuts are withdrawn. This connecting rod design also permits the assembly to pass through the sleeve bores The arrangement also has an important advantage in reducing the stresses in the connecting rod bolts. The setscrews themselves are secured by a strip tab washer made from 20-gauge material. With the bearing cap removed, it is possible to push the connecting rod and piston through the sleeve.

Aeroflex compensating pistons are employed which are manufactured from special aluminium alloy and each provided with two compression and two oil scraper rings (see Fig. 3).

The **piston** skirt has a $\frac{1}{32}$" slot on the non-pressure side. The gudgeon pin is located endwise in the piston by means of circlips; it is important that when these pistons are fitted they are assembled on the connecting rods so that the split portion of the skirt faces towards the camshaft side of the engine and away from the point of maximum thrust. For piston and ring dimensions see Page 2.

The **crankshaft** is forged from molybdenum manganese steel, being provided with balance weights which are an integral part of the crankshaft throws, adjacent to the three main bearings.

This shaft is accommodated in three precision type, white metal lined, steel backed bearings, which are housed in the **cylinder block,** being secured in position by bearing caps and two $\frac{1}{2}$" setscrews and spring washers per journal. The crankshaft thrust is taken by steel white metal covered washers which are fitted up in two halves on either side of the centre main bearing housing, being located circumferentially by means of projections on the lower half of each pair of washers.

The **valves** are overhead, push rod operated. The push rods are themselves one piece stampings. The **inlet valve** has a head diameter of $1\frac{1}{2}$" and this is manufactured from a silico chrome steel stamping. The stem diameter is $\frac{5}{16}$" (see also Page 3 for later models) and the valve face is inclined at 45°. The **exhaust valve** has a head diameter of $1\frac{9}{32}$" and is manufactured from a XB valve steel stamping having the same face angle as for the inlet. The stem diameter is the same as for the inlet. Inlet valves are provided with two valve springs.

Two inner valve springs are used on the exhaust valves, the centre spring acting as an insurance against damage in case of a spring failure. The intermediate spring fits into the valve collar, which is provided with an elongated hole concluding in a circular opening which embraces the recessed portion of the valve stem (see Fig. 4). The slotted portion is utilised for sliding the valve collar into position and the spring tension locates the collar when it has reached the circular position to which reference has already been made. The outer spring is located by a cap which fits on top of the valve stem and is located in relation to the valve by a recess.

On the upperface of the outer spring collar is a projecting shoulder with a ground face which actually bears against the rocker. Fig. 5 shows the valve rocker clearance being checked. The shouldered projection to which reference has been made is provided with a slot for the insertion of a feeler gauge and thus enables tappet clearances to be checked. It will be seen that this outer spring carries out a double function, quietening the rocker gear and obviating the necessity for push rod springs. The close coiled portion of the outer spring is fitted nearest the combustion head (see Fig. 6).

The **camshaft** is of cast iron having chilled cam faces and is provided with four journals. The front journal is accommodated in a flanged cast iron bearing, whilst the other journals are mounted direct in the cylinder block, a method which we have used for many years very successfully with other models. The camshaft operates directly on flat based hollow cylindrical chilled cast iron tappets which in turn engage hardened spherical-ended push rods, the upper extremities of which are hardened and cup-shaped, accommodating hardened ball ended screws, which are mounted on the outer ends of the respective rockers. Camshaft end thrust is taken by the flanged front bearing, to which reference has been made, against the timing wheel and a shoulder on the shaft itself.

The **rockers** are of case hardened steel and provided with phosphor bronze bushes which are lubricated under pressure from the main oil supply. The eight rockers themselves are carried on a hollow rocker shaft which is in turn mounted on four pedestal brackets, the oil being fed along the rocker shaft to the various rockers.

The **cooling system** is thermostatically controlled with a pump to circulate the water and a generous system of water jacketing with careful consideration given to the important points,

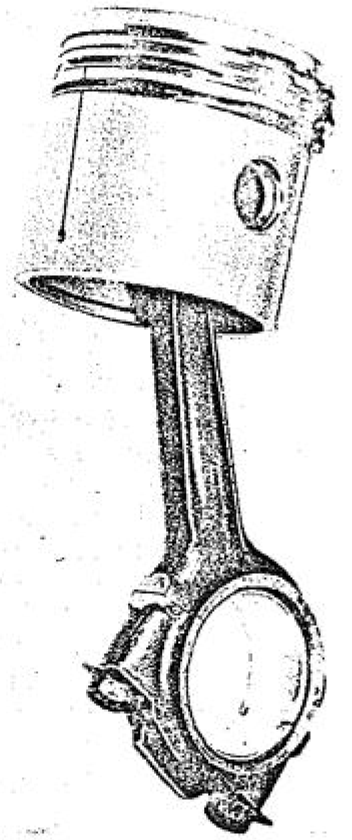


Fig. 3. Piston and connecting rod assembly

such as sparking plugs, etc., where adequate cooling is necessary. The water pump is also supplied with a fan blade assembly which is 14" in diameter and provided with four blades being driven in tandem with the dynamo by the fan pulley on the front end of the crankshaft.

Petrol is supplied by an A.C. mechanically operated pump to the Solex downdraught carburettor, hot spot heating being provided and all air is drawn through the combined air cleaner and silencer.

The **Hoburn-Eaton double rotor oil pump** (shown in Fig. 7) is of the submerged type being self-priming and obtaining its supply from the engine sump through a gauze filter. The oil is fed thence directly through the external filter. A portion of the oil, all of which must pass into the external filter, is forced through the filtering media and passes up an annular space around the holding bolt, and through a restrictor valve and is thence returned to the sump. The remainder of the oil passes into the oil gallery which runs longitudinally the entire length of the cylinder block, from whence it passes to the three main bearings and thence to the big end bearings. In the case of each of the mains,

Fig. 4. Valve springs, collars and cap

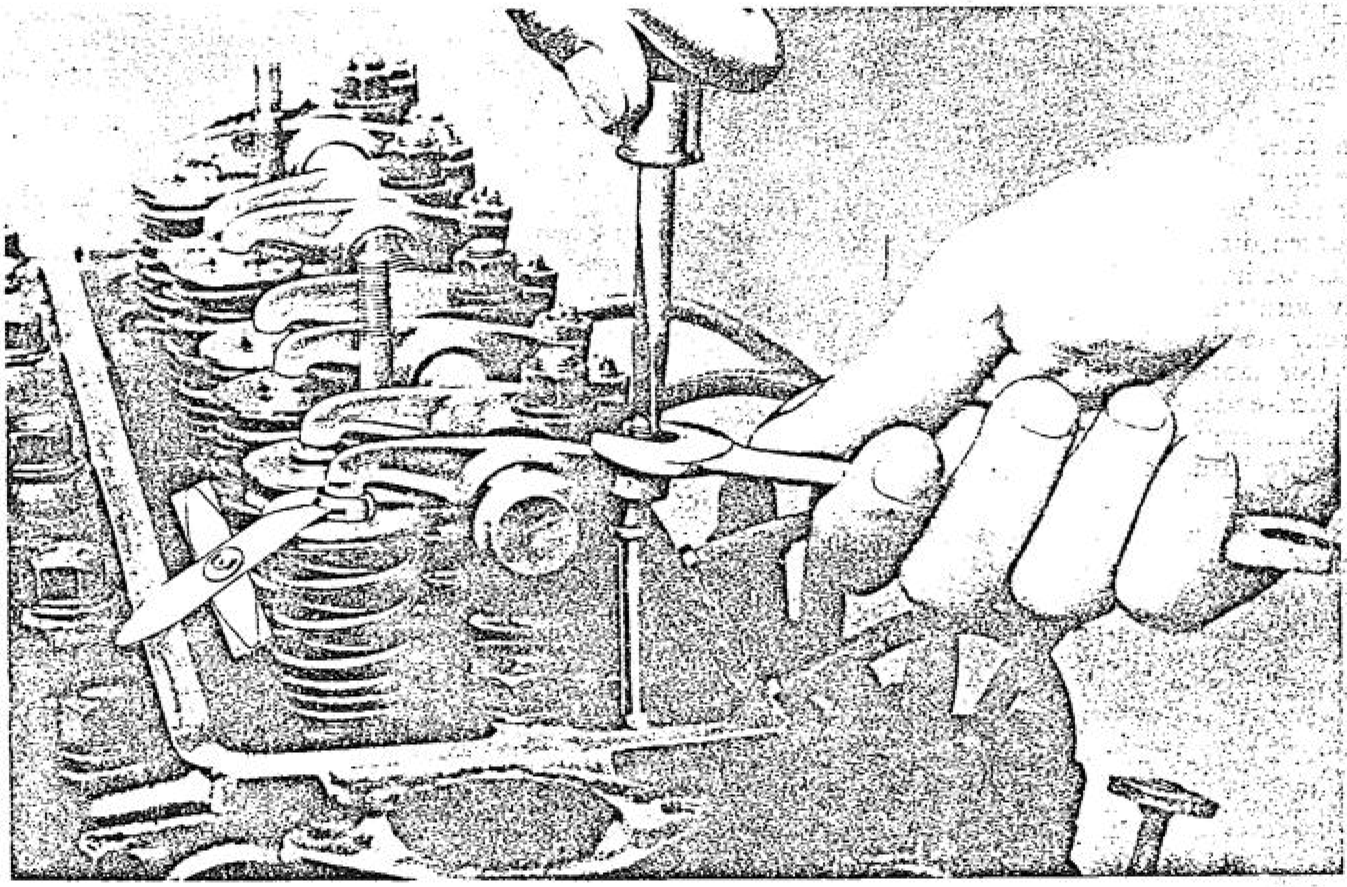
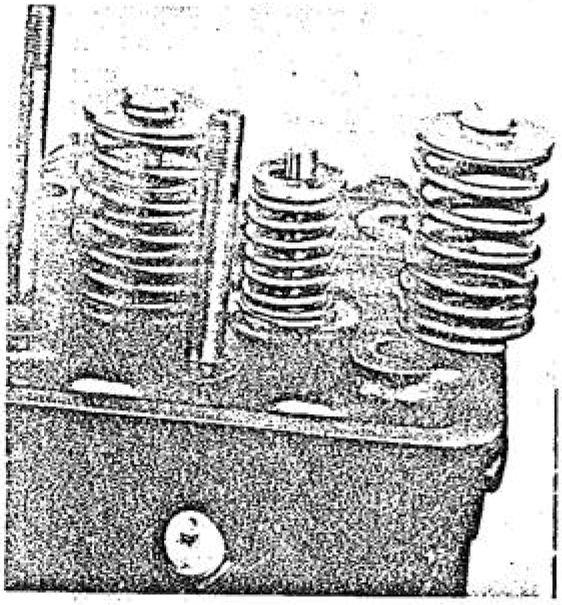


Fig. 5. Checking valve rocker clearance



g. 6. **Showing the position of the close-coiled portion of outer spring against the combustion head**

l is fed through a by-pass, ⅛" in diameter, to e adjacent camshaft bearing. With the rear mshaft bearing, a by-pass passage upwards ads to the overhead rocker gear through a illing in the rear pedestal bracket. The third mshaft bearing is fed directly through a $\frac{3}{32}$" striction, cast in the block, from the oil gallery. he oil pressure is adjustable by means of a setscrew and locknut provided on the exterior of the filter assembly.

The lubrication of the **rocker gear** is provided for by a hollow mounting shaft which is provided with radial drillings to correspond with the position of the eight rockers, oil subsequently passing through a horizontal drilling in each rocker to the push rod cups and ball pins.

Coil ignition is employed, the distributor being supplied with a suction and centrifugal automatic advance, the correct timing allowing ignition to occur at 4° B.T.D.C., or at such earlier setting as the octane value of the fuel available permits.

The distributor is driven off the boss of the helical gear which also provides the drive for the oil pump. The helical gear is secured to this drive shaft by a Woodruff key. The recess in the boss for the distributor shaft dog is offset, thus fixing the position for ignition timing, this point is dealt with later under "Ignition Timing." The distributor is mounted on an adaptor, the bottom being spigotted into the cylinder block and its lower extremity limiting the upward thrust of the spiral gear. A Mills pin through the gear boss limits the downward travel of this part.

The **engine mounting** is of flexible type, the front bearer being assembled on to rubber

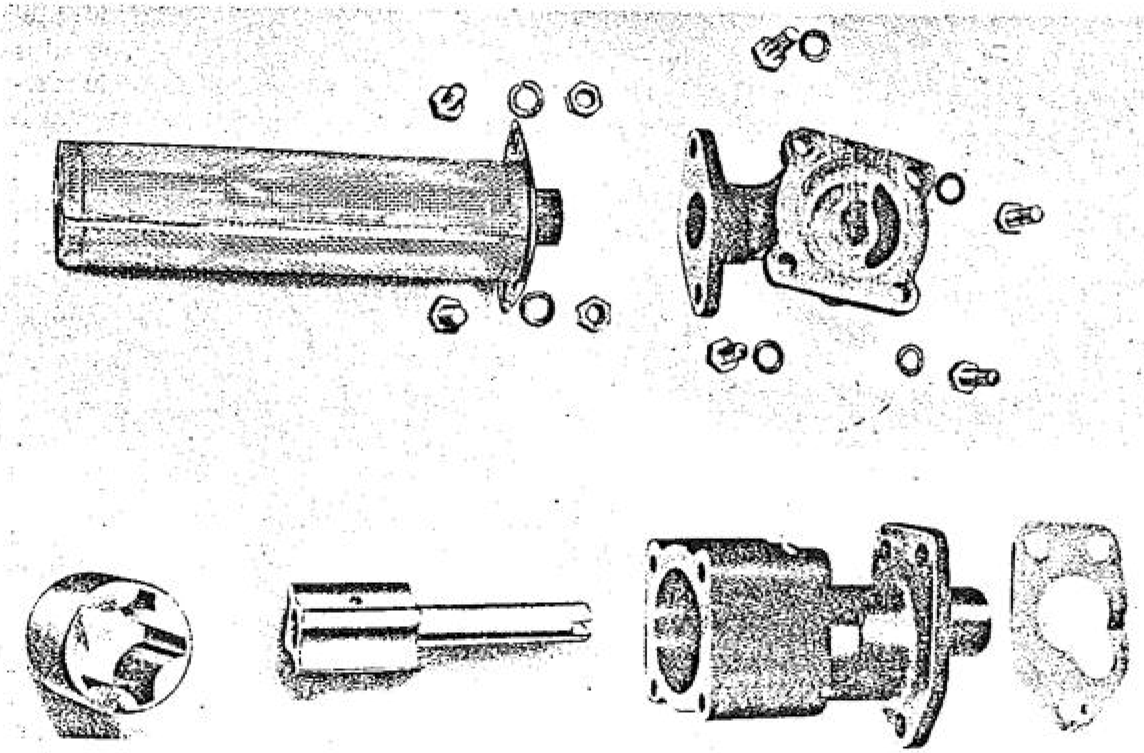


Fig. 7. **Exploded view of oil pump details**

blocks on either side of the frame, the gearbox itself being supported on a rubber pad secured to a cross member of the chassis frame.

The **flywheel** is of cast iron, being provided with a hardened steel starter gear ring which is shrunk on during heat treatment. Replacement starter rings are obtainable from our Spares Department (see Page 49). The flywheel is spigotted on to the end of the crankshaft and is located by means of a $\frac{3}{8}''$ diameter dowel; there being two dowel holes at 90° to each other.

Crankcase ventilation is arranged by means of the depression created in the induction manifold in conjunction with a sealed engine. A depression is created in the crankcase when the engine is running owing to the inter-connection of a special valve in the rocker cover with the induction manifold by means of a pipe attached to an adaptor in the latter. The depression in the induction manifold is conveyed to the crankcase and filtered air relieves this through a pipe connected at its upper end to the carburettor air silencer and at its lower extremity to an adaptor in the cylinder block. This system is discussed later in this manual.

ENGINE LUBRICATION
(See Fig. Nos. 8 and 9)

Description.

Lubrication of the engine is by a double rotor pump which is described in detail and illustrated later in this manual. The oil pump is driven by a short shaft which is mounted in a bush in the cylinder block and provided with a helical gear which engages with one on the camshaft. A boss on the drive shaft helical gear has an offset slot which engages the distributor dog, and a pin to prevent uplift of shaft.

Oil is drawn into the pump through a primary gauze filter and passes thence through a channel in the pump casting to the annular space around the oil pump shaft. The annular space around the drive shaft is closed by the bush, and the oil thus forced through a hole in the cylinder block into an external cleaner. The oil on its way into the cleaner assembly passes over a spring-loaded ball valve which is set to allow an oil pressure of 40-60 lbs. per square inch at normal engine speeds. The oil having been filtered, passes through matched holes in the filter bracket and cylinder block into the oil gallery which extends horizontally along the length of the cylinder block. A portion only of the oil, all of which circulates through the filter assembly, is forced through the filtering media and passes up an annular space around the bowl holding bolt and thence, through a restricter valve, to the engine sump. The Purolator Filter is described in detail on Page 32.

The oil passes from the gallery mentioned above to the three main bearings and thence through drillings in the crankshaft to the big end bearings and through further drillings in the connecting rods to the small end bushes and gudgeon pins. Splash lubrication is further assisted by a drilling into the oil passage between the small end and the big end just below the piston skirt on each connecting rod.

By-passes from the channels leading to the three main bearings convey oil to the front, second and rear camshaft journals. In the case of the remaining camshaft journal, this is fed direct from the oil gallery through a $\frac{1}{8}''$ restriction. A by-pass from the rear camshaft bearing conveys oil upwards to the combustion head and thence through a horizontal drilling to a smaller vertical drilling which is matched by a hole drilled in the rear rocker shaft pedestal bracket.

Oil passes down the hollow rocker shaft and through radial holes to the rockers, leaving each rocker by a hole drilled horizontally to each ball-ended rocker adjuster screw.

Oil from the front camshaft bearing lubricates the timing chain, there being four slots cut at 90° to one another on the face of the flange adjacent to the camshaft timing wheel to allow oil to escape on to the timing wheel. The oil is thrown out by centrifugal force on to the underside of the flanged portion of the wheel on which the teeth are cut. Six $\frac{3}{32}''$ holes are drilled obliquely, alternatively from the back and the front of the wheel, at equal intervals from the underside of the flange into the space between the two toothed rings. These holes allow the oil to be thrown on to the underside of the timing chain, ensuring its lubrication.

OIL PUMP (see Fig. 7)

Description.

The oil pump is of the double rotor type, as shown in Fig. 7.

The smaller or centre rotor is driven by a short shaft on which it is pressed into position and pegged. The two rotors are contained in a housing at the base of the oil pump casting which is provided with a cover plate having a ground face, allowing only sufficient clearance on the two rotors to provide for lubrication. The centres of the two rotors are offset.

The rotor shaft is provided at its upper

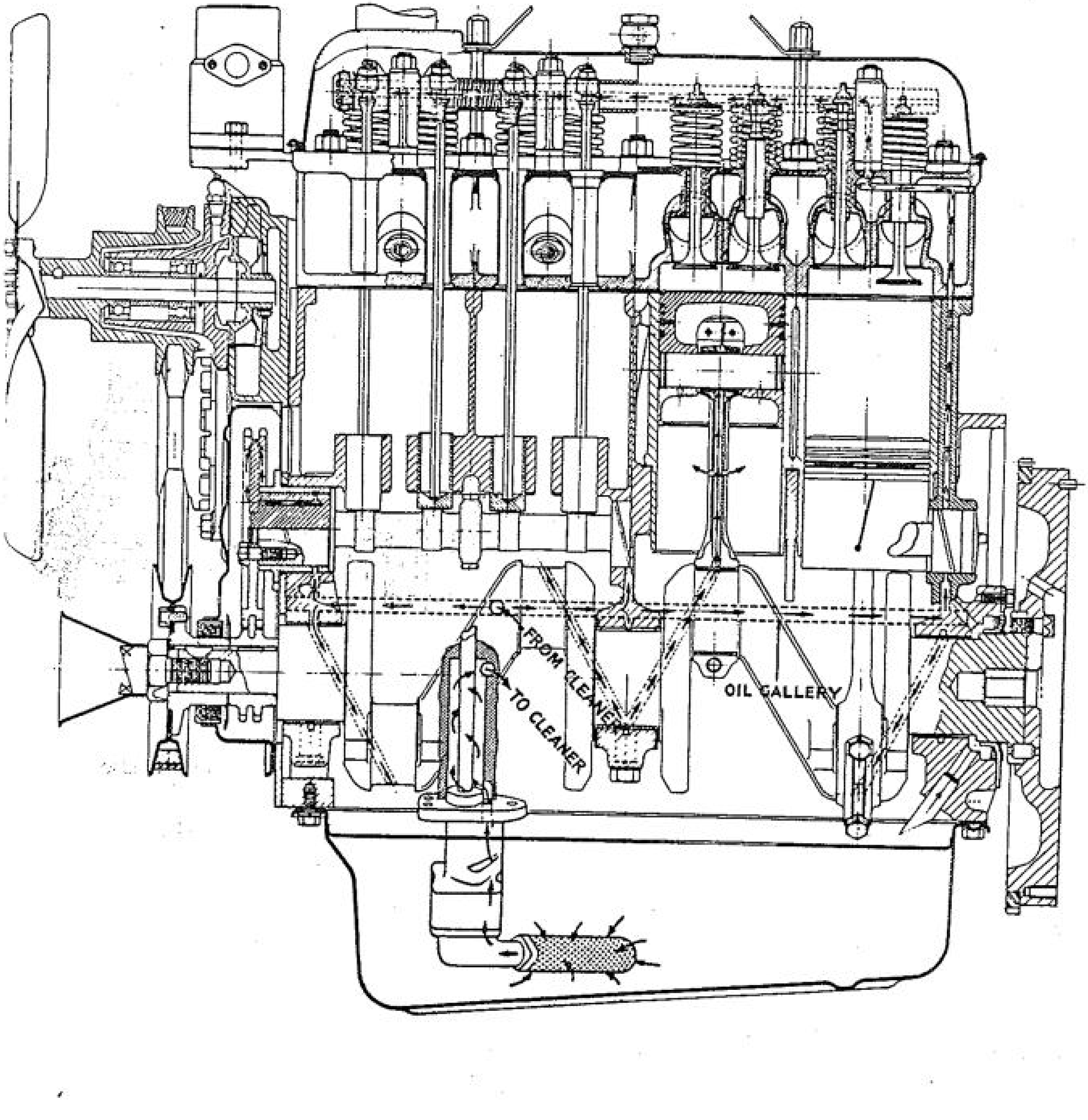


Fig. 8. Longitudinal view of oil circulation

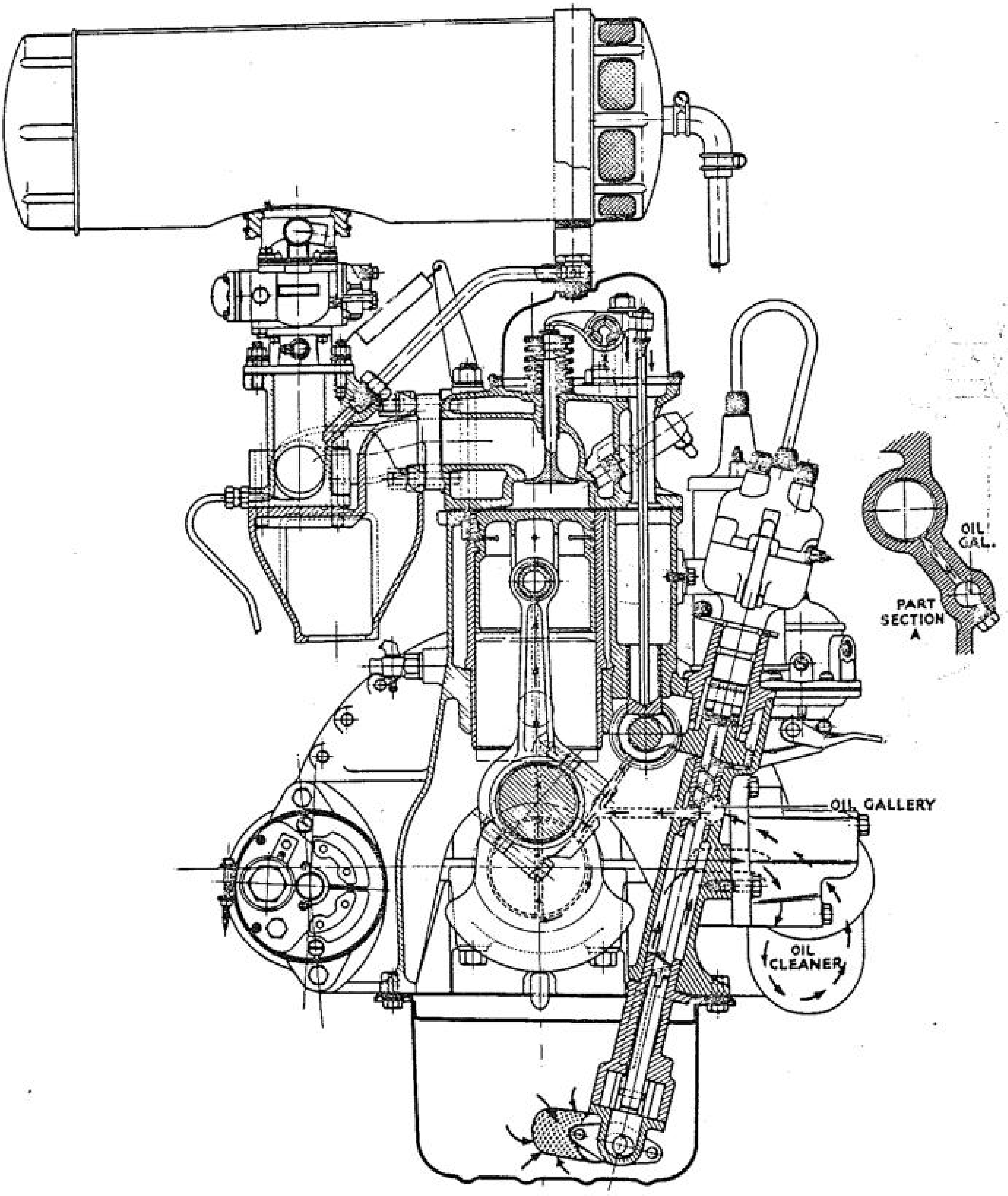


Fig. 9. End view showing oil circulation and Part "A" Section of oil feed to camshaft intermediate bearing

xtremity with a recess, which engages a project-ng tongue on the lower end of the driving shaft. The driving shaft is mounted in a phosphor ronze bush pressed into the cylinder block and t its upper extremity is provided with a helical ear which is secured by a key. The helical gear n this shaft is engaged by a similar gear, which is an integral part of the camshaft. As was nentioned under the description of the "Engine," he boss of the helical gear is provided with an ffset slot, which accommodates the distributor riving shaft.

The small rotor, by its engagement with he outer rotor, drives the latter round at a ightly slower speed owing to the difference in zes.

O ng to the relative movement of the entre rotor around the outer rotor, and the ose fit of the cover plate, oil is forced round etween the arms of the rotor and forced out of hole in the top of the rotor casing and upward rough a drilled passage to the annular space round the distributor driving shaft. From this nnular space the oil is circulated around the ngine as described under "Engine Lubrication."

o remove oil pump from engine.

To remove the oil pump from the engine, e sump should be drained of oil, preferably hen the oil is warm. It is then merely necessary remove the sump and three securing setscrews " A/F spanner) and to withdraw the pump as a nit with its paper packing.

o dismantle oil pump.

Remove the two ¼" bolts (7/16" A/F spanner) curin he primary oil filter to the flange on e oil pump elbow. Take note of the position the primary filter in relation to the elbow for assembly, *i.e.*, the tube projecting inwards ould be as near as possible to the bottom of the mp, thus ensuring that there is clearance on e bottom of the sump.

To complete the dismantling of this unit is merely necessary to remove the four 5/16" tscrews utilizing a ½" A/F spanner for the rpose. The inner rotor and shaft and the ter rotor can now be removed and the dis-ntling of the unit is complete.

rvicing the oil pump.

As this pump provides a generous surplus oil to that which is necessary for the engine's oper lubrication and, owing to the design of e unit, very little wear is likely to occur in vice, few maintenance attentions are required the unit during a car's normal life.

In actual practice, excepting the remote possibility of failures due to defective material, no adjustments are likely to be required until approximately 200,000 miles have been covered and then is likely to be limited to the elimination of end float in the rotors and can be satisfactorily dealt with by lapping the joint faces of the pump body and the cover. The clearance new between the rotors and the cover plate should be from .0005"—.00025" and where a serious drop in oil delivery from the pump is associated with development of excessive end float, steps should be taken to lap the cover plate and body.

ENGAGEMENT OF OIL PUMP AND DISTRIBUTOR DRIVING GEAR

As previously indicated, the boss of the helical gear on the oil pump driving shaft has an offset slot which engages with the driving dog on the lower extremity of the distributor shaft.

The offset is provided to ensure the correct ignition timing when the distributor and adaptor bracket are removed from the engine and such being the case, the correct engagement of the helical gears is important.

When correctly engaged, the slot on the driving gear boss, with the engine at T.D.C. of the compression stroke, *i.e.*, firing point, should assume a position at approximately "Five Minutes to Five" and be offset towards the rear of the engine as shown in Fig. 10. In this position the slot will point directly towards the exhaust valve push rod sealing tube, the distributor rotor will face No. 1 sparking plug, and the keyway in the helical gear will be aligned with the oil dipstick when fitted.

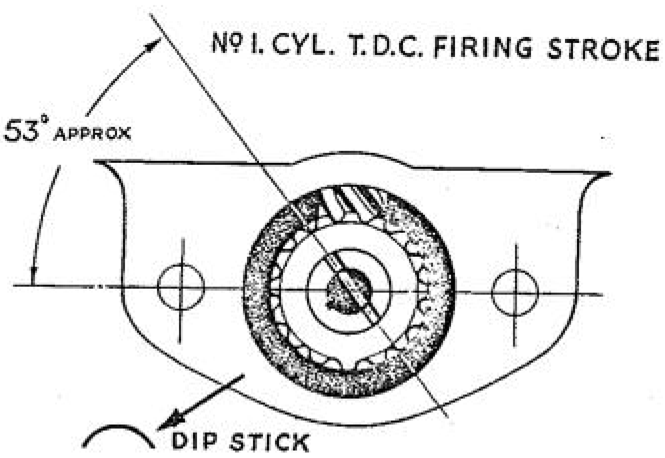


Fig. 10. Position of slot in distributor driving gear for ignition timing

CRANKSHAFT AND MAIN BEARINGS

The crankshaft is of molybdenum manganese forging with ground journals and crankpins.

The main and big end bearings are of the precision type, being steel backed and white metal lined. No hand fitting is required and *under no circumstances should the bearing caps be filed with a view to taking up wear.* The filing of bearing caps will make the caps unserviceable for future use when new bearings are ultimately required.

Where big end bearing caps have been filed, it will be necessary to ream these out to the size given on list of dimensions given on Page 1. Where main bearing caps have been filed, the only satisfactory method of dealing with the difficulty is to have the three bearings "line reamed" to the size given in list of dimensions on Page 1. Where excessive bearing wear has occurred, the only satisfactory cure is to replace worn bearings, ensuring first, however, that the crankshaft journals and pins are in good order and that there is no question of a regrind being required. Where a crankshaft journal or crankpin is worn, scored or tapered in excess of .002", regrinding is necessary (for dimensions of journals see Page 1).

Where a regrind is found to be necessary a decision will have to be made as to the suitable undersize bearings which will meet the particular case. The reduced diameter of journal or crankpin to suit the various undersize bearings may be calculated by subtracting —.020", —.030" or —.040", the sizes of undersized bearings available, from the original dimensions on Page 1 for the journals and crankpins.

Main bearing clearances.

The crankshaft journal diameter and the internal dimensions of the bearings for these is given on Page 1. The clearance new for these bearings is .001"—.002", if the worn clearance exceeds .006", or if the journals have become scored, the crankshaft will require regrinding and undersized bearings will have to be fitted.

The crankshaft should be measured with a micrometer gauge and if the reading is less than 2.477" (for a crankshaft which has not previously been reground) the crankshaft is due for reconditioning.

With regard to the main bearings, when the worn internal dimensions exceed 2.483" (for standard size bearings), replacements should be fitted undersized to suit the amount which has

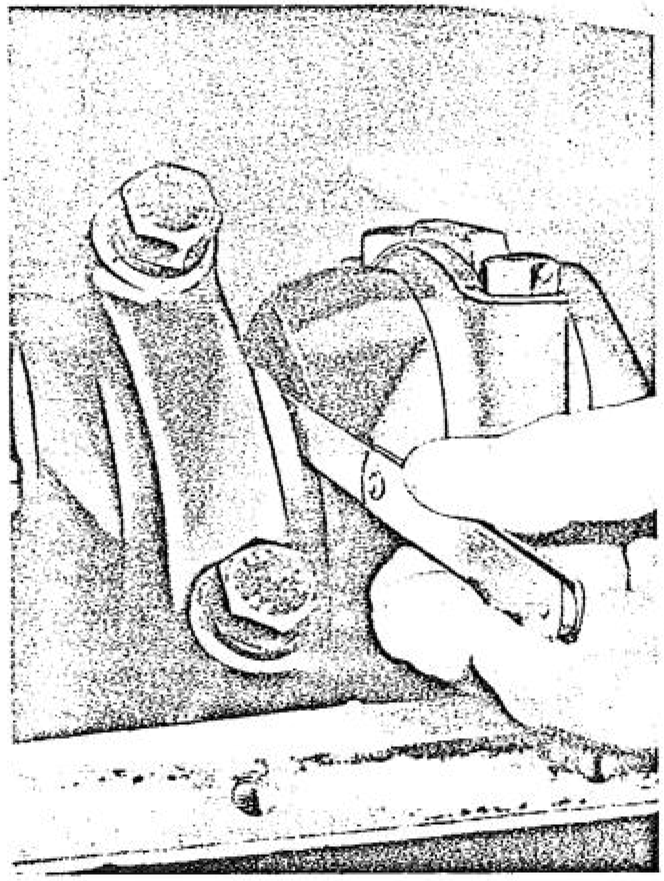


Fig. 11. Measuring crankshaft end float

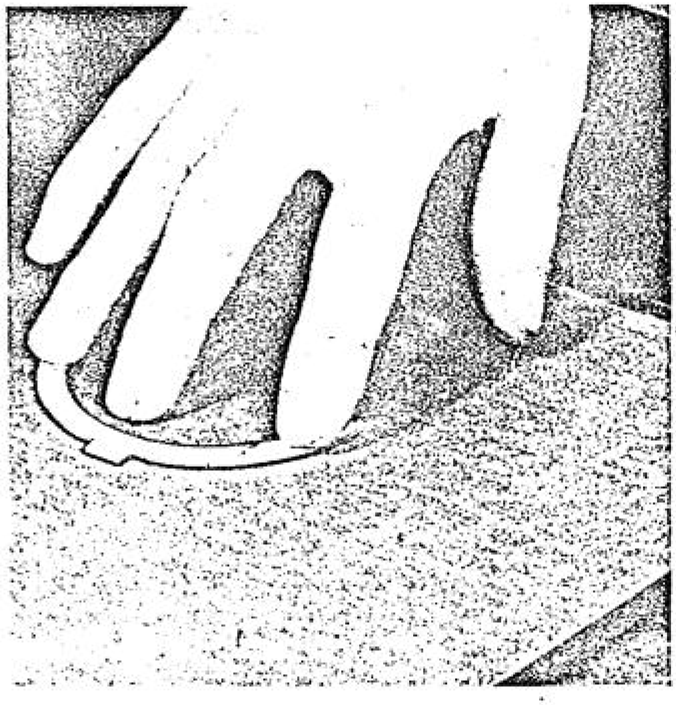


Fig. 12. Reducing thickness of thrust washer

be removed and the undersizes available, *viz.*, .020", —.030" and —.040".

ankshaft end float.

The end float preferred for this crankshaft is 4"—.006" which should be measured as shown Fig. 11. Where, after the fitting of new thrust shers, end float does not reach the figure cified above, the steel face of the thrust sher should be rubbed down on a piece of ery cloth placed on a surface plate as shown Fig. 12.

After a considerable mileage, where wear urs to the face of the crankshaft abutting the ust washer, it may be necessary to fit oversized shers, and although these are very rarely likely be required, they may be obtained +.005", a special order on the Spares Department, ler their normal Detail Number 45918/9, cifying the oversize above mentioned.

end bearing clearances.

The clearance between the crank pin and the big end bearing, when new, should be .0005" to .002½" and the connecting rod side clearance .007½" to .011½".

Where the crankpin dimension is found, on measuring with a suitable micrometer gauge, to be less than 2.084", the pins should be reground and undersized bearings should be fitted. *Under no circumstances should the bearing caps be filed with a view to taking up wear as such procedure renders the connecting rods unfit for further use.*

The small end bushes, the dimensions for which are given on Page 2, should be pressed into the rod and subsequently reamed to ⅞" ± .0005", and the gudgeon pin selected to leave a clearance of .0002" at 68° Fahr. This clearance will be indicated by a light finger push fit, with the piston warmed by immersion in hot water.

The connecting rod centres are 6¼" ± .002" and there is no offsetting of the rod in relation to the bearing housing. The connecting rod cap is located in relation to the rod by means of dowel bushes as can be seen from Fig. 13.

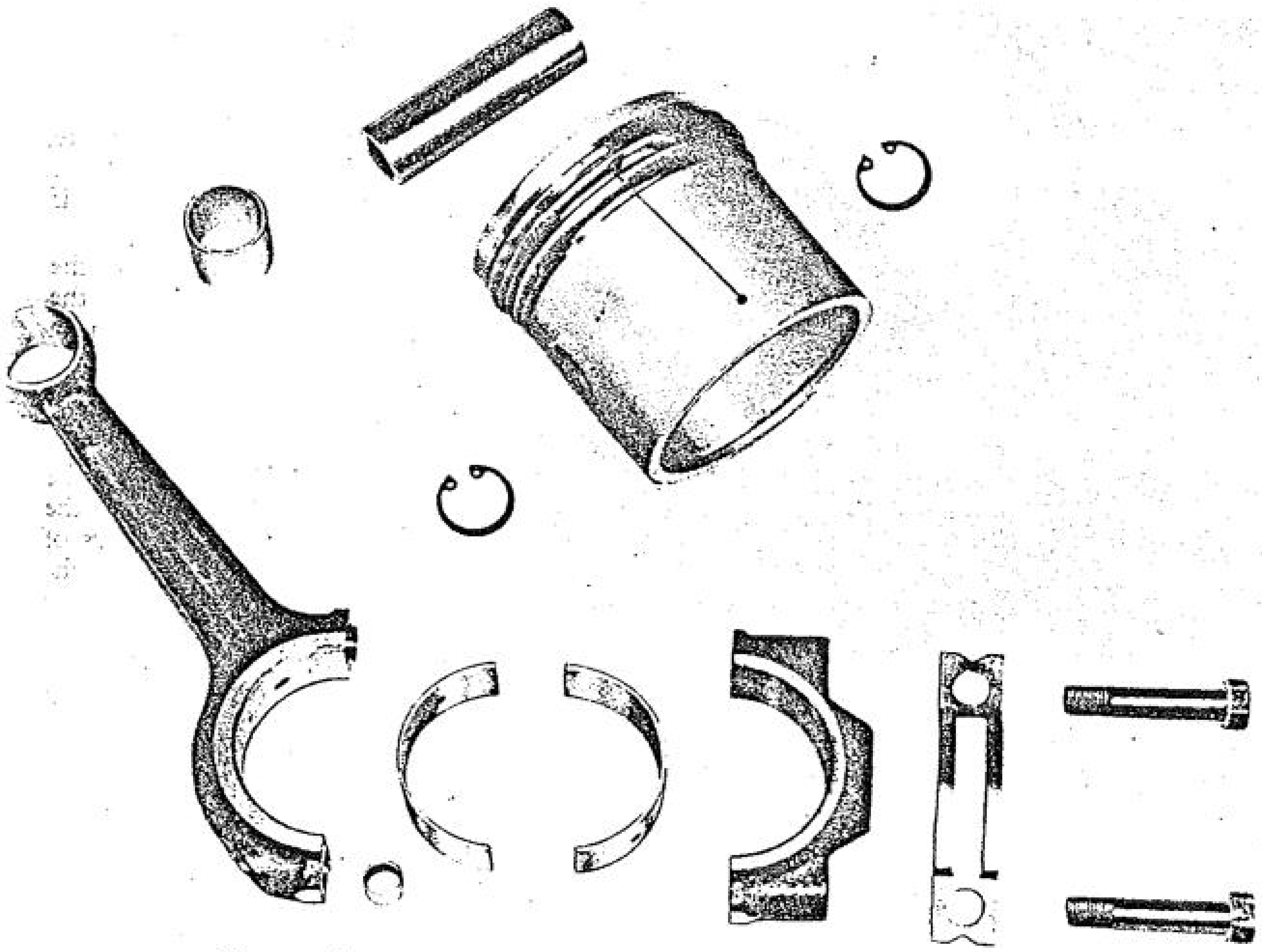


Fig. 13. Exploded view of connecting rod and piston assembly

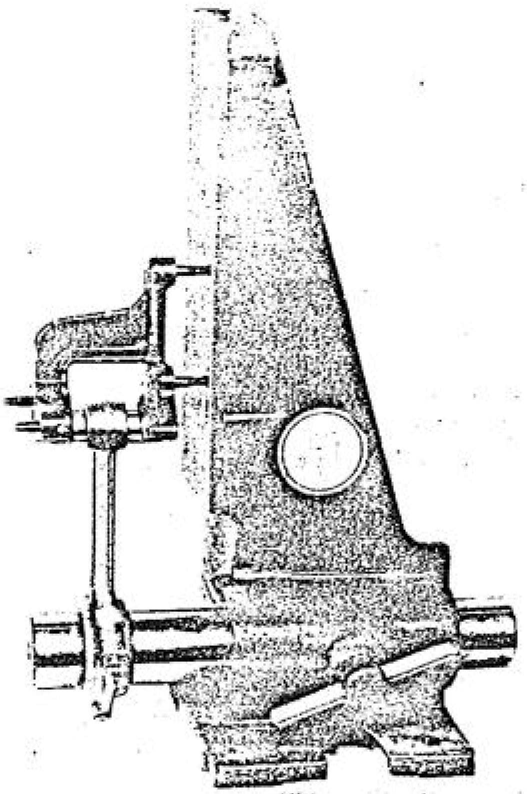


Fig. 14. Testing connecting rod for bend

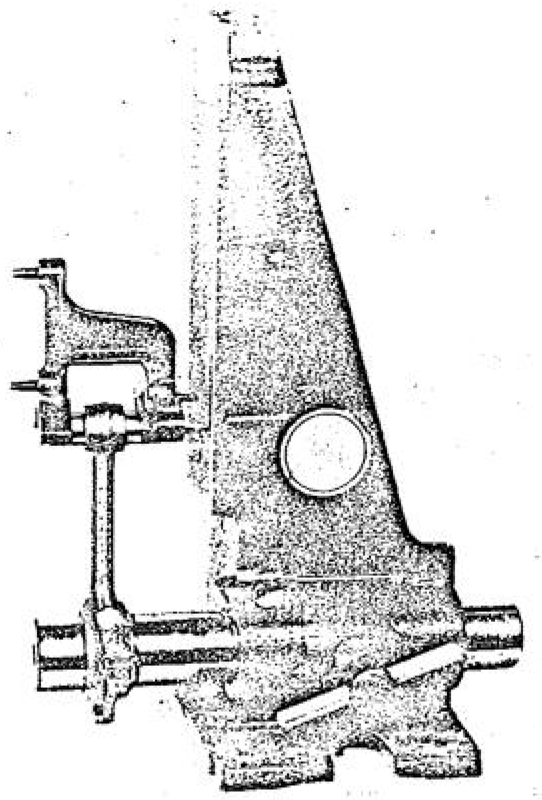


Fig. 15. Checking connecting rod for twist

Before installing a connecting rod it should be checked for alignment after first removing the bearing shell. The rod should be checked for a bend, in which case the piston will not be perpendicular to the crankshaft journal, or if the gudgeon pin is not in the same plane as the journal then the rod is twisted (see Figs. 14 and 15). Appropriate action should be taken to deal with the various causes of misalignment with a suitable bending rod.

The connecting rod and piston aligning fixture which is shown is obtainable from Messrs. V. L. Churchill & Co. Ltd., 27/34 Walnut Tree Walk, Kennington, S.E.11.

PISTON ASSEMBLY AND CYLINDER SLEEVES

The piston and cylinder bore dimensions are given on Page 2. As indicated in this list of tolerances and limits, three sizes of pistons are used in conjunction with suitable bore dimensions. The three sizes of pistons and cylinder sleeves are indicated by the stamping of " F," " G " or " H " on the crown of each piston and on the upper flanged face of each sleeve as shown in Fig. 16.

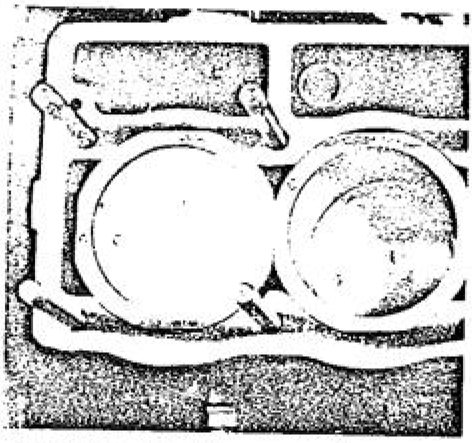
Piston ring dimensions and clearances are given on Page 2. Where the worn clearance between the piston skirt and cylinder sleeve bore exceeds .007" at the top and .005" at the bottom, reboring or replacement becomes necessary if a satisfactory repair is to be executed.

The connecting rod should be fitted to the piston assembly with its bearing cap towards the split portion of the piston skirt, as shown in Fig. 3.

Cylinder sleeves. (Fig. 18)

The pistons and connecting rods should be assembled into the cylinder sleeves with the gudgeon pins in diametrical relation to pairs of opposite flats on the upper flanged faces of the liners. When assembling the sleeve and piston into the cylinder block, position the split portion of the piston and hence also the cap side of the connecting rod towards the camshaft side of the engine, or away from the point of maximum engine thrust. A piston ring compressor should be utilized when fitting pistons into sleeves as shown in Fig. 17.

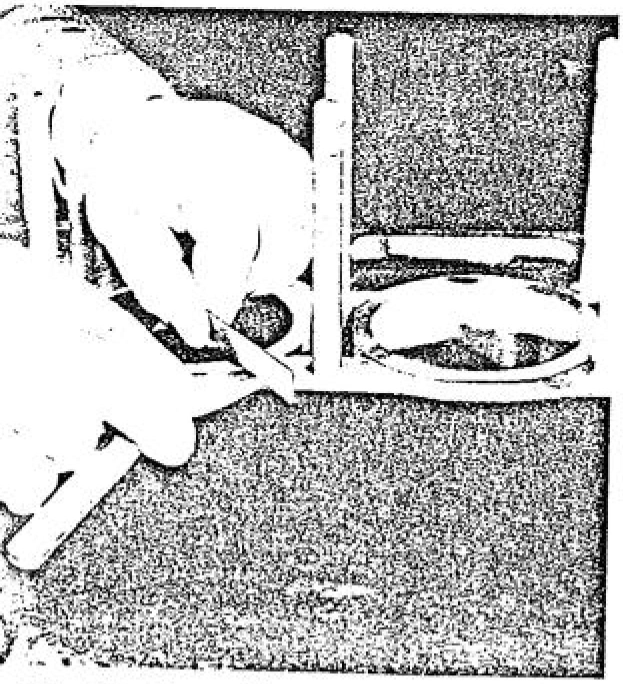
Where cases of light wear occur and cause piston knock, an improvement can be effected by withdrawing the sleeve and rotating this through 90° and employing the alternative pair of flats shown in Fig. 18.



ig. 16. Showing markings on piston crown and cylinder sleeves

The importance of using cylinder sleeve :tainers, to prevent relative movement of these ırts, is stressed. In addition to the danger of eeve movement if retainers are not fitted, when ıe crankshaft is turned, there is the possibility : these moving when the combustion head is :oken, particularly where jointing compound ıs been used on both sides of the gasket.

To minimize the possibility of sleeve move-ent, due to combustion head removal, it is :commended that jointing compound should ıly be used on the underside of the head gasket ıd grease applied to the upper face. The :linder sleeve "figure of eight" packings ıould be similarly treated for the same reason.



. 16A. Checking cylinder liner projection above cylinder block

When the cylinder sleeves are installed in the block, the flanged face should stand proud of the cylinder block face by .003" minimum—.0055" maximum and can be checked as shown in Fig. 16A.

To remove starter motor.

With the left-hand steering models, this is a straightforward operation, but with the right-hand steering cars, owing to the proximity of the starter motor to the steering column, this is a more difficult job. If, however, the following procedure is adopted the removal should present no difficulty :—

1. Jack up the front right-hand side of the car and remove road wheel and disconnect battery.
2. Disconnect the electrical lead connection from the solenoid terminal.
3. Release the starter cable from retaining clips.
4. Disconnect solenoid cable from its push in attachment with rubber sleeve.
5. Remove bolt attaching ⅜" stay rod to bracket on chassis, subsequently slackening the nut at the top of the rod and rotating out of the way for starter's withdrawal.
6. Remove the two starter bolts and manoeuvre the starter out through space between the chassis side member and wing valence.

To top up brake master cylinder.

Access to the brake master cylinder is best obtained by removing the road wheel and utilizing the aperture mentioned under "Starter Motor Removal" on the right-hand or left-hand side of the car, depending on whether this is for a right-hand or left-hand steering model.

Removals of exhaust and inlet manifolds.

To remove this assembly, the employment of the aperture mentioned in the previous two adjustments, to obtain access for the withdrawal of the bottom two rear securing nuts, will greatly facilitate what would otherwise be a difficult task. In other respects this is a straightforward operation.

CAMSHAFT AND TIMING GEARS

Description.

The camshaft is driven by a double roller silent chain which engages with a sprocket on the crankshaft and one which is spigotted on to the end of the shaft and secured thereto by two setscrews.

Four holes are provided in the camshaft timing gear, which are equally spaced, but offset from a tooth centre. When the chain wheel is

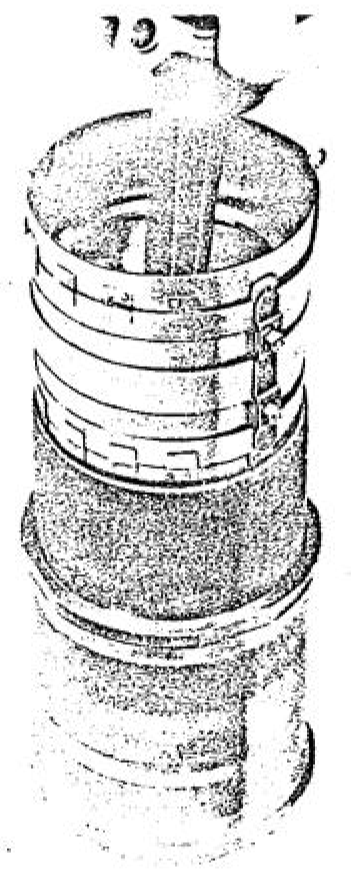
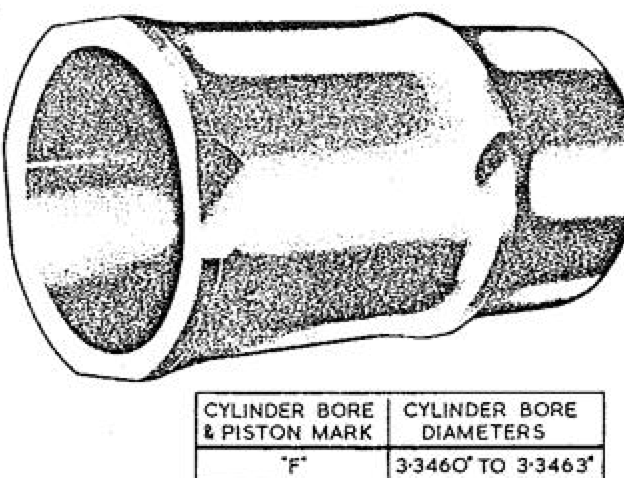


Fig. 17. Fitting piston into cylinder sleeve employing a ring compressor



CYLINDER BORE & PISTON MARK	CYLINDER BORE DIAMETERS
"F"	3·3460" TO 3·3463"
"G"	3·3464" TO 3·3467"
"H"	3·3468" TO 3·3471"

Fig. 18. Cylinder sleeve

fitted at 90° to its initial position, which initial location we will hereafter identify as position "A," a half tooth of adjustment is obtained. If, on the other hand, the wheel is turned "Back to Front" from position "A," a $\frac{1}{4}''$ tooth of adjustment is provided, whilst a 90° movement in the reversed position will give $\frac{3}{4}''$ of a tooth variation from that given by position "A."

When the timing has been correctly set (as explained later under "Valve Timing") the faces of the two gears are marked with a scribed line drawn radially in such a manner that if the lines were produced outwards on the respective gears, they would pass through the centres of the two gears. In addition, to avoid any possibility of the camshaft position being incorrect, a centre punch mark is made on the end of the camshaft through an unoccupied setscrew hole and on the face of the timing wheel adjacent to the setscrew hole; Fig. 19 shows the marking of these timing wheels.

The camshaft used is cast iron, having chilled faces for the cams and journals. With the camshaft a cast iron flanged front bearing is used, the other three journals making direct contact with the cylinder block.

The camshaft, after grinding operations have been completed, is degreased, bonderised and, whilst still warm, immersed in a solution of "Dag" (Colloidal Graphite). This process considerably improves the bearing surfaces and gives additional wearing properties.

The helical gear for the distributor drive, and the cam for operating the petrol pump, are integral parts of the camshaft. The distributor driving gear is copper coated.

End float of the camshaft is taken between a flange on the camshaft, the bearing, and the rear face of the timing wheel.

To remove camshaft.

The camshaft can be removed from the engine with this unit in the chassis, after removal of radiator block in the following manner:—

1. Proceed to remove the cylinder head as described under "Decarbonizing and Valve Grinding" on Page 24, but it is unnecessary to remove the rocker shaft or valves. When removing the cylinder head there is the possibility of cylinder sleeve movement when the head is lifted, particularly if jointing compound has been used on both sides of the gasket. When reassembling engine, jointing compound should be used on one side only of the gasket and grease applied to

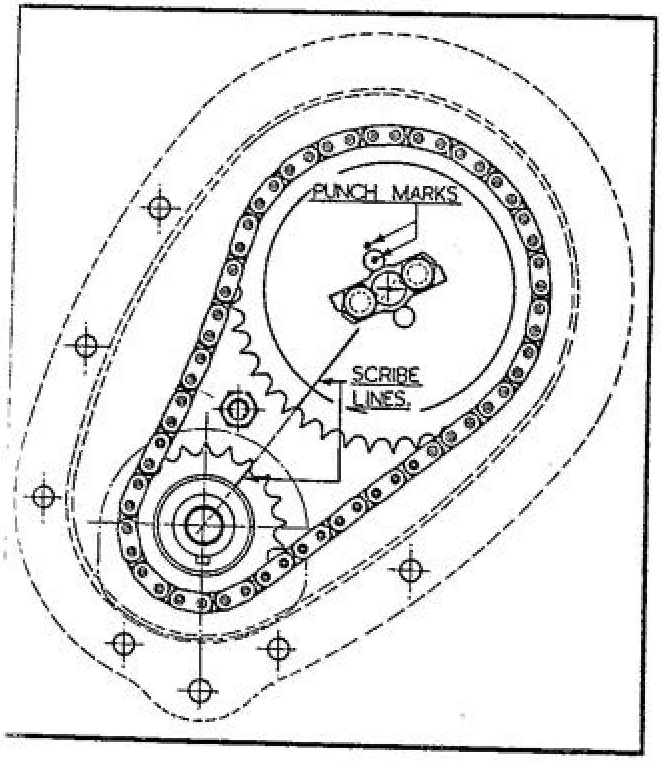


Fig. 19. Showing wheel markings for valve timing

the other face. Immediately after removal of the cylinder head sleeves, retainers should be applied as shown in Fig. 20. In the event of sleeve movement, when the cylinder head is lifted, new figure of eight packings should be fitted, the undersides of which should be treated with jointing compound to prevent their being lifted by sleeve movements, if such movement occur. Remove push rods and tappets.

2. Remove distributor adaptors from cylinder block by detachment of two $\frac{5}{16}$" nuts with $\frac{1}{2}$" A/F spanner. Do not slacken clamp bolt.
3. Remove distributor and oil pump helical driving gear.
4. Detach petrol pump after withdrawal of two $\frac{5}{16}$" nuts ($\frac{1}{2}$" A/F spanner).
5. Remove fan belt.
6. Unscrew starting handle dog nut and guide, utilizing a $1\frac{7}{16}$" A/F spanner.
7. Extract crankshaft fan pulley utilizing a suitable extractor. Fig. 21 shows the employment of Churchill Extractor Tool No. 6312 on fan extension bracket.
8. Remove timing cover by withdrawal of four bolts, one nut and seven setscrews utilizing $\frac{1}{2}$" A/F spanner.
9. Note timing markings on gear-wheels and camshaft as shown in Fig. 19 for reassembly. In the absence of these markings, proceed as directed under "Valve Timing." (Page 21.)
10. Remove camshaft timing wheel and timing chain after releasing locking plate and withdrawing two $\frac{5}{16}$" setscrews, utilizing a $\frac{1}{2}$" A/F spanner.
11. Withdraw two $\frac{5}{16}$" setscrews securing front bearing to cylinder block ($\frac{1}{2}$" A/F spanner).
12. The camshaft can now be withdrawn.

Refitting of camshaft.

Reassembly is the reverse procedure to the foregoing. It is considered desirable, however, to describe certain operations as follows :—

1. When resetting the valve timing, the engine should be turned until the pistons in Nos. 1 and 4 cylinders are at T.D.C., this position exists when the fan pulley and crankshaft timing wheel keyways are pointing vertically downwards as shown in Fig. 19. Now rest the camshaft chain wheel on the camshaft spigot and line up the scribed lines. Turn the camshaft until the centre punch mark on the camshaft end appears at the punch marked hole on the camshaft chain wheel. The setscrew holes of the chain wheel should be exactly aligned with those on the camshaft. Next engage chain with crankshaft chain wheel, afterwards removing camshaft chain wheel, without altering the position of the camshaft, and fit to chain. The camshaft chain wheel should now be positioned on the camshaft so that the scribed lines on the two wheels are in line and the driving side of the chain is tight. The tabwasher can now be fitted and the two setscrews, but *do not bend up* the tabwasher until after

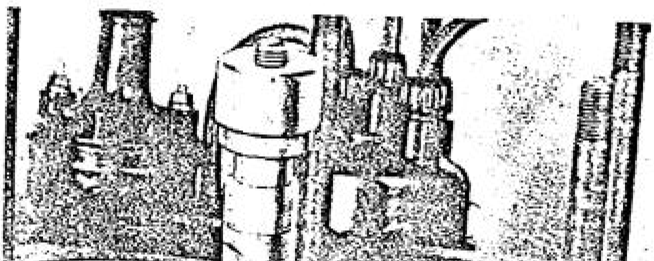


Fig. 20. Showing one of the two retainers required to prevent sleeve movement

re-checking the position of the markings. In the absence of timing wheel markings, proceed as directed under "Valve Timing."

2. When refitting the oil pump and distributor driving helical, ensure that No. 1 cylinder, that cylinder nearest the radiator, is at T.D.C. of the firing stroke. In this position the correct engagement of the helical gear should allow the keyway in the boss to be towards the front of the engine and point in the direction of the dipstick as shown in Fig. 10. Before it is possible for the helical gear to engage with its counterpart on the camshaft, the oil pump driving shaft must be right home in its recess in the oil pump. If the correct procedure has been regarded with the removal of the distributor, and the clamping bolt has not been slackened, the ignition timing is assured by the fact that the slot for distributor driving dog is offset. Where it is necessary to re-time the ignition for any reason, refer to "Ignition Timing."
3. Before refitting the cylinder head, ensure that no movement of the sleeves has occurred and if doubt exists on this point, withdraw such sleeves and replace figure of eight packings, applying jointing compound sparingly to the flanged face in the cylinder block only.
4. When fitting the combustion head, slacken off the valve rocker adjustment screws and ensure the proper location of the outer valve spring caps on their respective valve stems, otherwise the push rods may become bent as shown in Fig. 22. When tightening up cylinder head nuts, regard the sequence for tightening given in Fig. 24.
5. Having refitted the combustion head and rocker shaft, **it is important to apply oil to the ground faces on the valve caps where these contact the rockers. This is necessary as they will not immediately receive a supply of oil from normal system.**

To set valve rocker clearances.

Remove rocker cover and turn engine round until the valve which is to be set has just closed, then continue to turn the engine through a further half revolution, and set inlet valves to a .010" feeler gauge and exhaust valves to .012" (see Fig. 5). Continue in the same manner for the other cylinders. This procedure ensures that the tappet is on the base of the cam when clearance is set, as shown in Fig. 25.

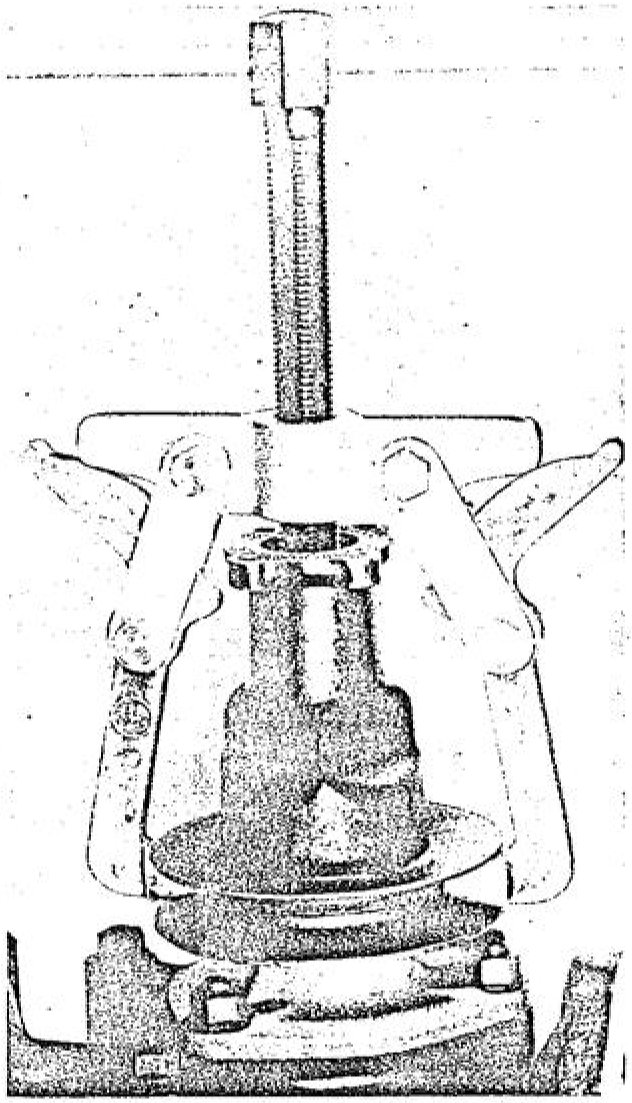


Fig. 21. Drawing fan pulley with Churchill extractor. This extractor may also be used on crankshaft pulley.

To set valve timing in the absence of wheel markings.

It is assumed that for the purpose of this instruction the camshaft, the cylinder head and the valve gear, etc., are already fitted, but the timing gear has yet to be fitted. The following procedure is recommended :—

1. Remove the rocker shaft and withdraw outer valve springs, but not spring caps on Nos. 1 and 4 cylinders. Refit rocker shaft, taking steps to ensure that the outer spring caps register properly with the valve stem as the pedestal brackets are tightened down and that damage is not caused by misplacement of these caps as indicated in Fig. 22.

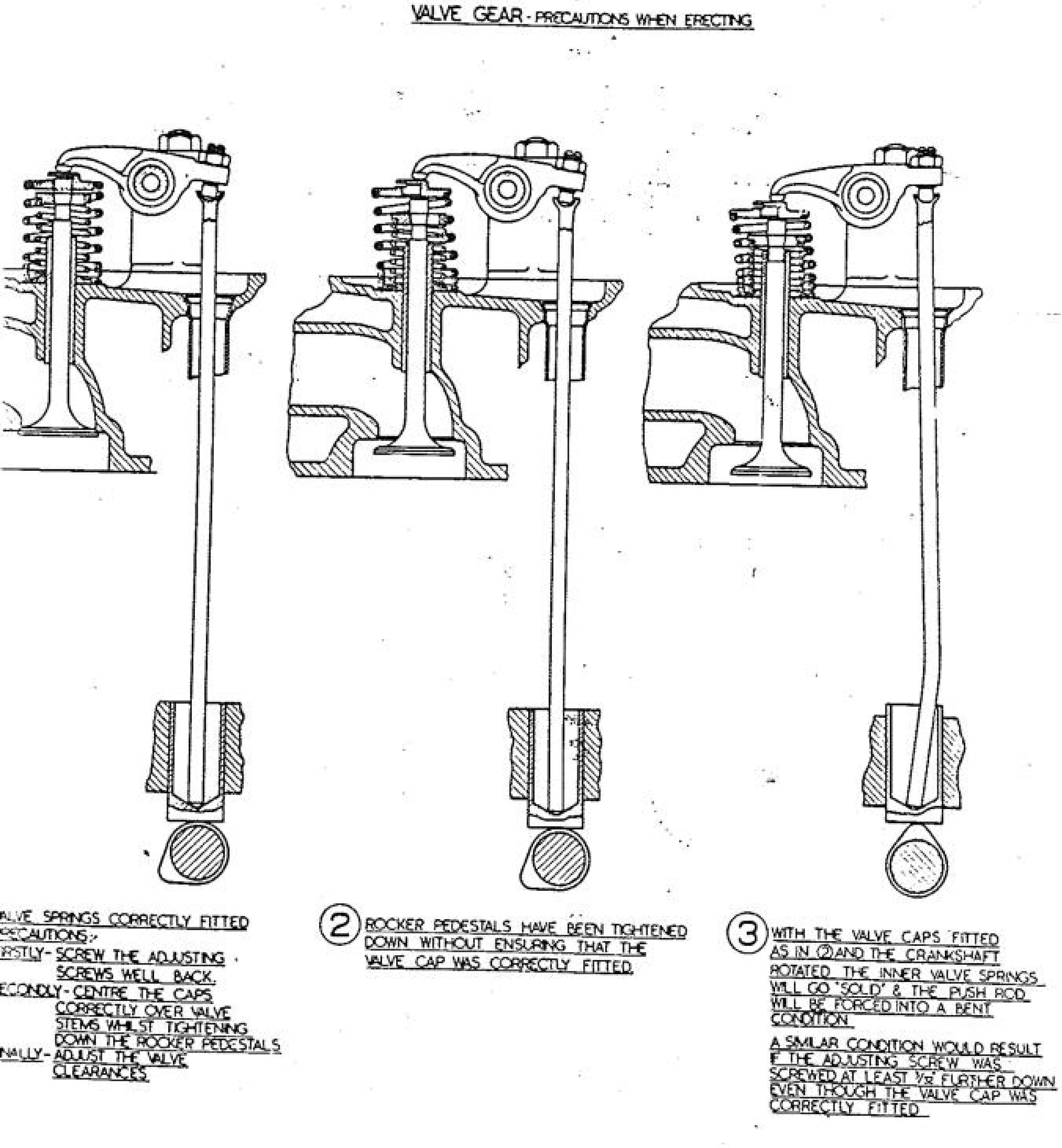


Fig. 22. Precautions required when fitting valve rocker shaft assembly

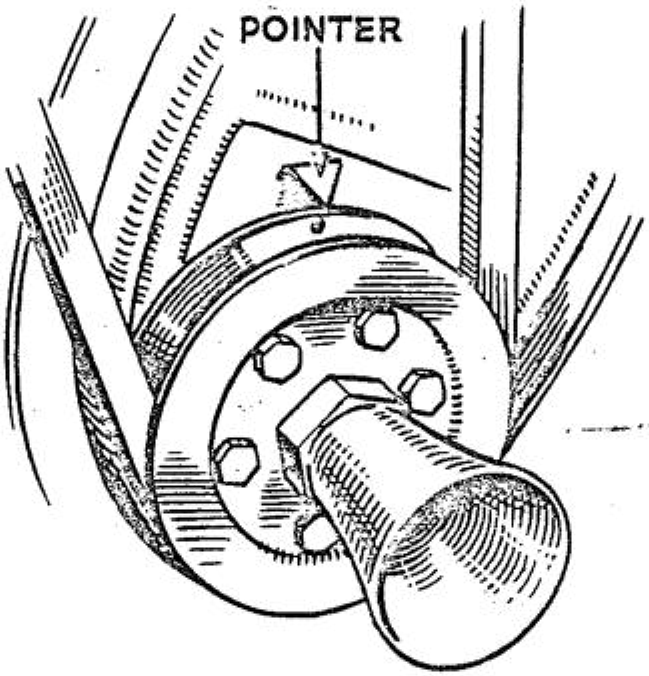


Fig. 23. Top dead centre indicating device

2. Set valve rocker clearances for Nos. 1 and 4 cylinders to .014", which is the valve timing clearance.
3. Turn the crankshaft round until Nos. 1 and 4 pistons are on T.D.C. This position may be found, either by placing the keyway in the crankshaft vertically downwards, or alternatively, placing the hole in the fan pulley at T.D.C. and in alignment with the pointer on timing cover (see Fig. 23).
4. Rotate the camshaft until the exhaust valve and inlet valve are at the point of balance in which the tappets will be in the position shown in Fig. 27. In this position the exhaust valve will just be about to close and the inlet valve be just commencing to open. From Fig. 26, which gives the valve timing diagram, it will be observed that the inlet valve opens 10° before T.D.C. and the exhaust valve closes 10° after that point (.035" on piston stroke).
   When setting the valve timing, the actual opening and closing points for the inlet and exhaust valves respectively is not so important as that these should occur an equal amount before and after T.D.C.
5. Having set the valve timing correctly, the timing gears and camshaft end should be marked as described in operation 32 on Page 43.
6. Having set the timing and marked the gearwheels and camshaft, the engine may be reassembled taking care to ensure the appropriate precautions when refitting the rocker shaft after re-installation of outer valve springs, to prevent damage to the push rods as previously mentioned.
7. Reset valve rocker clearance for Nos. 1 and 4 to working clearances, *viz.*, .010" and .012", inlet and exhaust respectively.

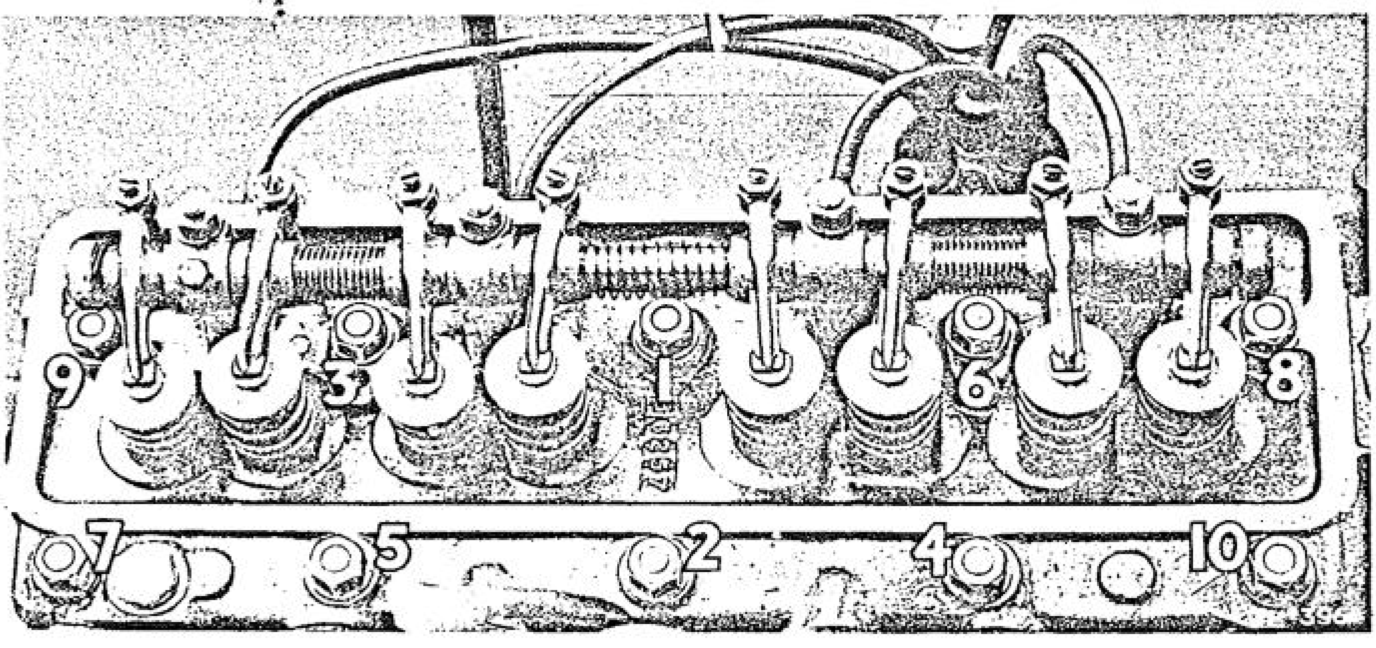
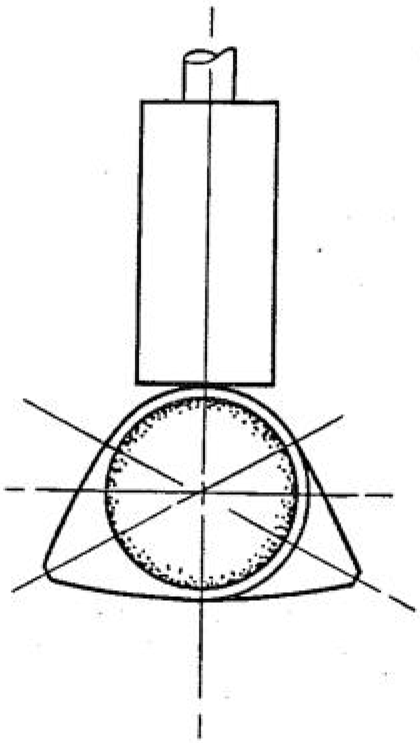


Fig. 24. Order for tightening cylinder head nuts



. 25. **Tappet on base or concentric portion of cams**

set ignition timing.

Under normal circumstances it is rarely cessary to set the ignition timing, providing t when removing the distributor bracket the mp bolt is not slackened. Small variations of ing can be made quite readily by slackening two ¼" nuts which secure the distributor cket to the adaptor ($\frac{7}{16}$" A/F spanner), and ating the head towards "A" or "R", to ance or retard respectively, afterwards re- ntening the nuts. Following an adjustment of ition timing, the car should always be tested the road and any adjustment required attended. ignition should be adjusted to give the best sible performance and to suit the grade of fuel use. Where a new distributor head has to be d, or has been removed for any reason, the owing procedure is recommended :—

Set No. 1 piston on T.D.C. of the firing stroke, *i.e.*, with both valves closed, utilizing timing indicator on chain cover and hole in pulley to find this position.

Remove the distributor adaptor by detachment of two nuts, utilizing ½" A/F spanner, and ensure that with the engine in this position the slot in the helical gear is correctly positioned as indicated on Page 14, under "Engagement of Oil Pump and Distributor Driving Gear." If the slot does not assume the position indicated, the helical gear's engagement is incorrect and should be corrected. The necessity for such an alteration should rarely arise.

3. Having ensured the appropriate position of the slot for the distributor driving dog, fit the distributor into its bracket, leaving the clamp bolt loose. Rotate the distributor head in relation to its bracket until the flat portion of the distributor head, in the bracket's fitted position, will be parallel to the cylinder block and the rotor arm is on No. 1 segment with the points just commencing to open. Fit distributor and bracket into cylinder block adaptor, securing thereto with the two ¼" nuts employing a $\frac{7}{16}$" A/F spanner.
4. Fit distributor and adaptor to cylinder block, engaging the driving dog with the slot in the helical gear, making corrections of relative position by movement of the distributor head permitted by the loose clamping bolt. Having secured distributor assembly to cylinder block, centralize clamping bracket in relation to "A" and "R" and tighten clamp bolt. Test on road and make final adjustments to timing.

TO DECARBONIZE AND GRIND VALVES

We recommend the removal of the cylinder head for decarbonizing and valve grinding

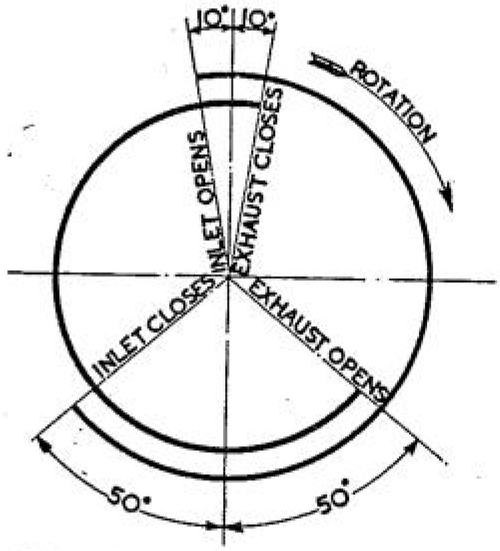


Fig. 26. **Valve timing diagram (10° crank movement before or after T.D.C. is equivalent to 0.035" piston movement)**

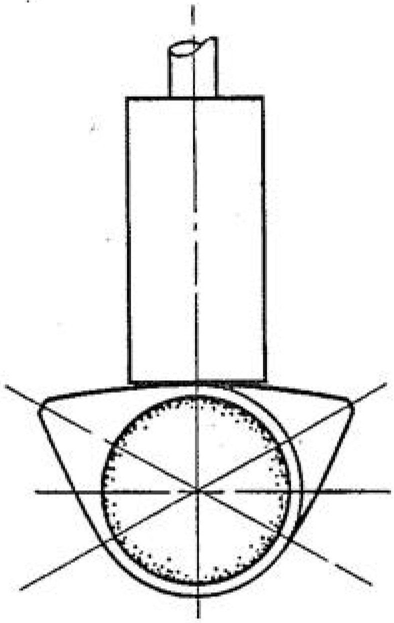


Fig. 27. Tappet at point of rock

after the first 5,000 miles. Attention after this running has the advantage of allowing the initial casting stresses to have resolved themselves and permits the consequent valve seating distortion to be countered by valve grinding. Failure to carry out this initial valve grinding is a frequent cause of excessive petrol consumption on new cars. Subsequent attentions will not normally be required until a further considerable amount of running has been done

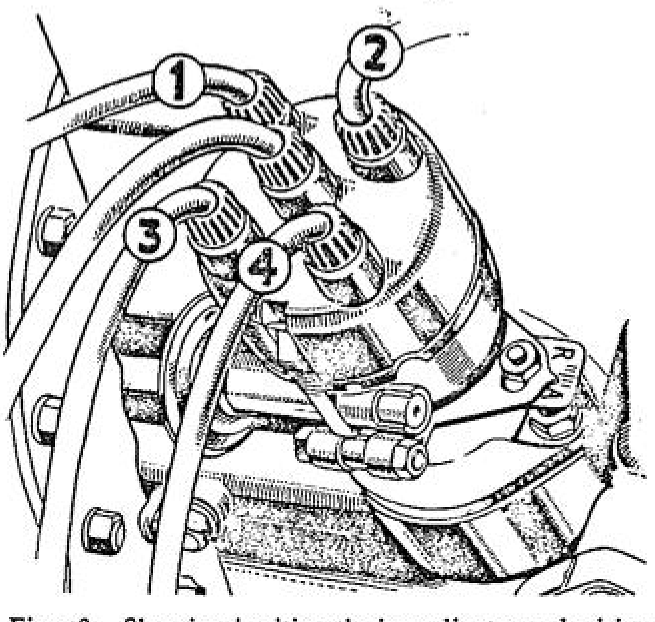


Fig. 28. Showing ignition timing adjuster and wiring of distributor

—normally after 20,000 miles (32,000 kms.). Further attention in this respect may be left until there is a noticeable falling off in power associated with a lack of compression and a marked tendency to "pink." It is permissible to retard the ignition to some extent to deal with a dirty engine, but there is naturally a limit to the amount of retard an engine will stand, and when this point is reached the necessary work should be carried out without further delay in the interests of economy in running and to avoid destruction of valves and/or seatings.

The procedure we recommend is as follows :—

1. Disconnect one of the accumulator leads to prevent the possibility of " shorting " when dismantling the engine.
2. Drain cooling system, preserving any anti-freeze solution for future use.
3. Remove carburettor air silencer after detachment of its connection with crankcase ventilating pipe.
4. Disconnect top water hose pipe and by-pass on thermostat.
5. Remove thermometer bulb from thermostat after unscrewing gland nut.
6. Remove heater hoses where fitted.
7. Detach carburettor controls and fuel pipe.
8. Disconnect inlet manifold drain pipe.

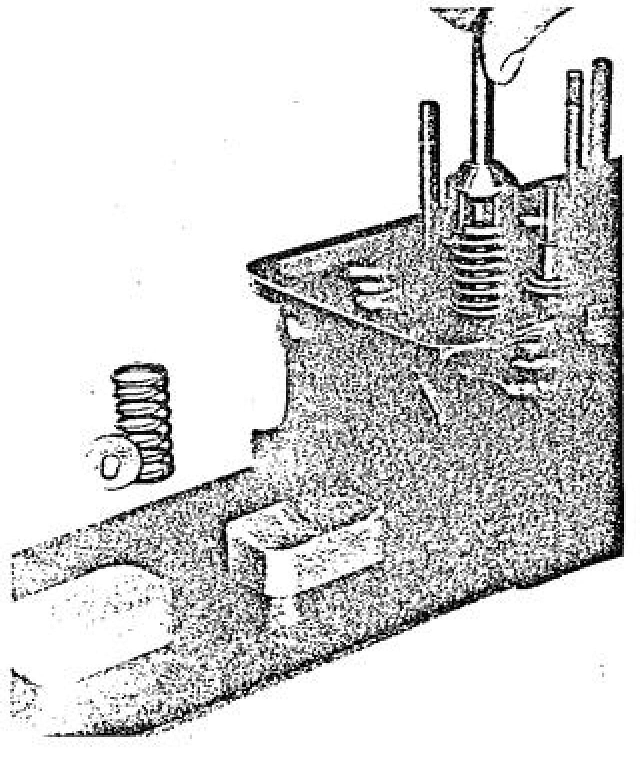


Fig. 29. Showing removal of valve springs

9. Remove sparking plug leads.
0. Remove rocker cover after detachment of crankcase ventilation suction pipe.
1. Remove rocker shaft complete with four pedestal brackets, each bracket being secured by a single nut to the cylinder head ($\frac{9}{16}$" A/F spanner).
2. Remove outer valve springs, valve caps and push rods.
3. Disconnect exhaust pipe from manifold by detachment at flange joint and four $\frac{9}{16}$" A/F nuts.
4. Remove cylinder head by unscrewing ten $\frac{11}{16}$" A/F nuts, watching for any signs of cylinder sleeve movement and where such occurs ensure that damage has not occurred to figure of eight sleeve packings. Deal with sleeve packing damage by fitting replacements and applying jointing compound to the bottom faces to fix in position (see remarks regarding removal of cylinder head gasket under "Reassembly"). Fit cylinder liner retainers shown in Fig. 20 to prevent sleeve movement if, or when, the engine has to be turned by hand. *Do not attempt to "break" the seal of the cylinder head by turning the crank as this will possibly cause the sleeves to move.*
5. Remove inlet and exhaust manifold as a unit from the cylinder head.

'alve grinding.

Proceed to remove the valves and springs. 'he inner valve spring exerts only a light load nd can be compressed by hand to enable collar emoval, or employ the special compressor as iown in Fig. 29. The cylinder head should be laced flat on the bench with suitable packings to ipport the valves whilst the springs and collars re removed (see Fig. 29). The position of the valves should be perpetuated when refitting and they will be found to be numbered from the front of the engine consecutively. Before removing the carbon from the tops of the piston, turn the engine until two cylinders are near their T.D.C. position and fill the remaining two cylinders and push rod chambers with clean rag to prevent any carbon chips entering. It is recommended that a ring about $\frac{1}{8}$" (3 mm.) wide is left round the outside edge of each piston, thus ensuring a good oil seal when the engine is reassembled. An old piston ring inserted into each bore on top of the piston will assist in the preservation of the necessary carbon ring. Do not allow pieces of carbon to enter between the sleeves into the cylinder block.

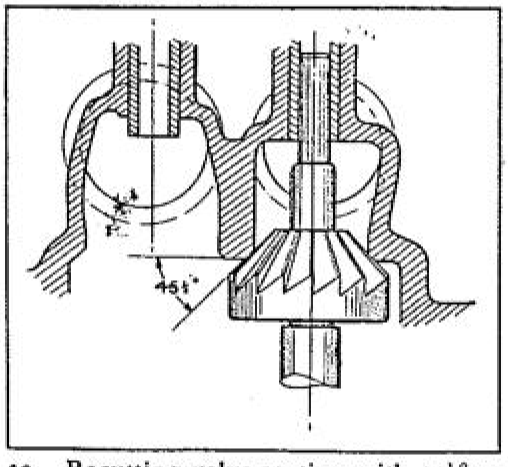


Fig. 30. Recutting valve seating with 44½° cutter

Turn the engine until the other two pistons reach a similar position and treat in a similar manner. Remove the sparking plugs and scrape off the carbon from the combustion head subsequently wiping the chambers clean. Scrape the valve ports clear, being careful, however, not to mark the valve seatings, and when cleared of carbon, use a petrol-moistened rag to wipe clean, having first blown out with a compressed air line. The use of emery cloth, or other abrasive, for polishing purposes is not recommended, as particles of such abrasives may enter the bores after reassembly causing serious damage.

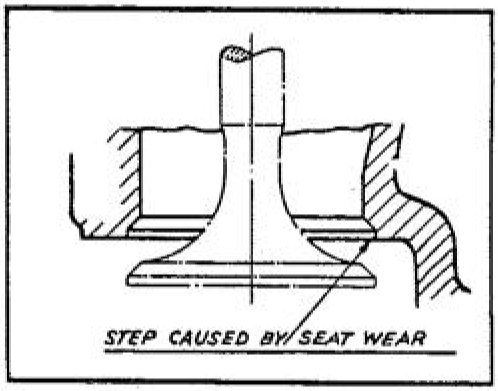


Fig. 31. Embedded valve seating

Clean sparking plugs, test and replace as required. The correct sparking plug gap is .030". The normal life of a sparking plug is 10,000 miles (16,000 kms.).

Clean the carbon off the underside of the valve heads as well as off the top, using a blunt scraper and finishing with a petrol-moistened rag. Where the existing combustion head gasket is to be used again, carbon should be carefully removed from both faces. A new gasket should normally be fitted. Grind the valves into their appropriate seatings, the valves being numbered consecutively from front to rear. Where valve faces are badly pitted, they should either be renewed or refaced. No attempt should be made to grind the badly pitted valve into its seating or this will be unduly reduced.

When refacing valves, only sufficient metal should be removed as is necessary to clean up the valves, otherwise the valve edge will become too thin and tend to curl in service. Where the head thickness above the seat edge is less than $\frac{1}{32}$" (1 mm.) the valve should be replaced.

Where valve seats are badly worn or pitted, they should be re-cut with a seating cutter having an included angle of 89°, utilizing a $\frac{5}{16}$" pilot as shown in Fig. 30. Where a valve seating has become embedded in the cylinder head, as shown in Fig. 31 it will become necessary to employ first a 15° cutter (Fig. 32) to provide a clearance for the incoming and outgoing gases, following this up with one of 44½°. (Fig. 31 shows effect of a sunken valve.)

When the necessity for re-cutting a valve seating arises, it is important that the valve guides are concentric with the valve seatings themselves. In other words, where a valve guide is badly worn it should be replaced before the seating is re-cut.

The valve and valve guide data is given on Page 3. (See also Page 52.)

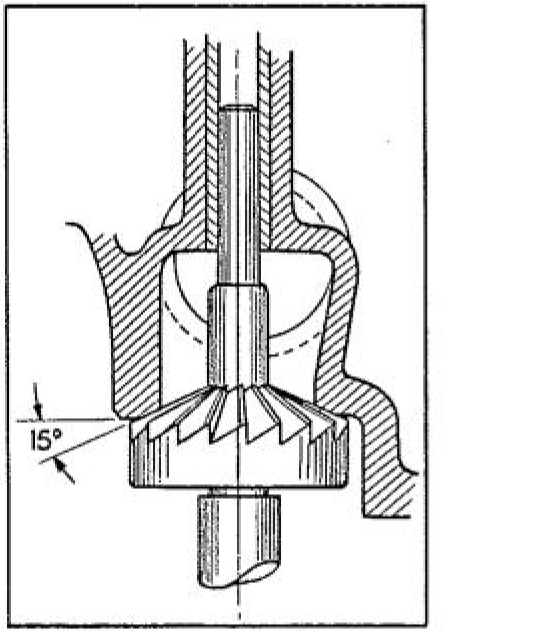


Fig. 32. Use of 15° valve seating cutter to provide clearance of gases

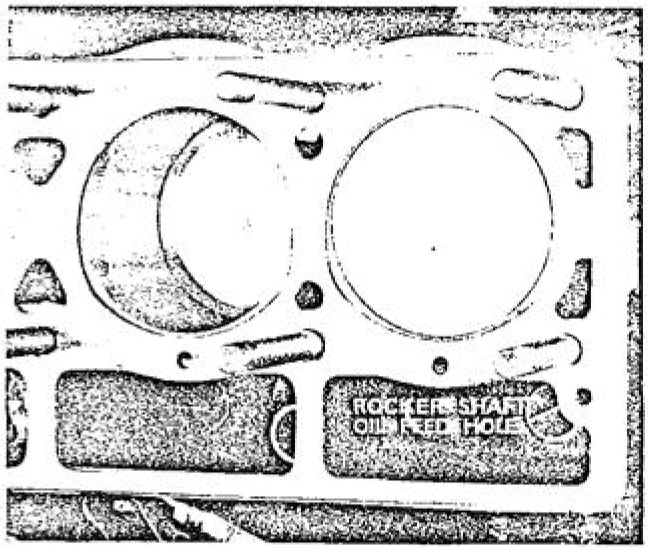


Fig. 33. Showing the correct fitting position for the cylinder head gasket (Eng. Nos. V.1—V.29707E)

REASSEMBLY OF ENGINE

Having paid the requisite attentions to the valves and their seatings, the valves can be re-assembled into the combustion head, first smearing the valve stems with oil. *In the case of the outer springs, one end of these are close coiled as shown in Fig. 6 and it is important that this end is fitted against the cylinder head.*

Before replacing the gasket on the cylinder face, the bottom face should be treated with jointing compound and the upper face with grease. The reason for the use of jointing compound on the lower face only is to minimize the possibility of sleeve movement when subsequent removal of the combustion head is carried out. Where the gasket is not to be replaced, it may be left in position on the cylinder head whilst decarbonizing the engine. Sleeve retainer may be fitted over the gasket.

When fitting the cylinder head gaskets to units prior to Engine No. V.29708, it is important to use only Gasket Detail No. 56759 and to position it with the word " TOP " uppermost, as shown in Fig. 33. A modified gasket, having two oil feed holes, was introduced at the engine number quoted and used in conjunction with a modified lug at the forward end to match that used at the rear end for the oil feed hole. The later gasket should be assembled with the " seamed " side towards the cylinder head.

When refitting the cylinder head nuts, tighten them up progressively and symmetrically as indicated in Fig. 24. The tightness of the nuts should be rechecked after the engine has been

thoroughly warmed up and a further tightening down carried out after a few days' running of the car.

Before re-installing the rocker shaft, slacken the lock nuts and screw back the adjusting screws thus facilitating assembly. *When tightening down the rocker pedestals, ensure that the valve caps are locating properly on the valve stems, thus avoiding damage shown in Fig. 22. Provide for initial lubrication of valve cap ground faces with an oil can.*

Adjust valve rocker clearances as described on Page 21 and when reassembling rocker cover, ensure that the cork washer is in good order, replacing it if doubt exists as to its condition.

The following is a list of the gaskets which will normally be required when decarbonizing.

Detail No.	*No. off*	*Item*
61312	1	Cylinder head gasket.
(56759 before Eng. No. V.29708E).		
60535	1	Carburettor gasket.
57924	1	Exhaust pipe gasket.
60256	2	Manifold gaskets.
56286	2	Sleeve gaskets (only required if sleeves are withdrawn).

CRANKCASE VENTILATION

(Fig. 34) (Series I and early Series II Models)

Description.

Crankcase ventilation is of considerable importance if the maximum possible life is to be obtained from an engine. Such ventilation is necessary to expel "blow-by" gases which contaminate and dilute the oil, create varnish deposits, give rise to corrosion, contribute to engine fumes in the car's body and eject into the crankcase particles of carbon and other foreign matter.

With the "Vanguard," the depression in the induction manifold is employed to operate the system. This system depends on the maintenance of a sealed engine which is provided by careful attention to oil sealing.

With this system a depression is created in the crankcase by suction from the induction manifold. A short pipe connects an adaptor containing a metering orifice, which adaptor is screwed into the rocker cover with another adaptor in the rocker cover induction manifold.

As a depression is created in the crankcase, it is relieved by filtered air drawn through a pipe from a connection fitted in the carburettor air silencer as is shown in diagram in Fig. 34.

The calibration of the metering orifice is of paramount importance and should under no circumstances be tampered with after the car leaves these works. The small pin in the orifice is intended to keep the hole clear of carbon, etc.

Maintenance.

As previously stated, this system's proper working depends upon a sealed engine and for this reason the oil seal in the timing cover and that at the rear of the crankshaft must be properly maintained.

It is further important, quite apart from the question of oil leakage, that all joints should be perfectly made and unions and connections airtight.

Although it will become necessary to clear the metering orifice and clean out accumulations of carbon from time to time, this should not often be required, and on such occasions when it is done no attempt should be made to alter the size of this orifice.

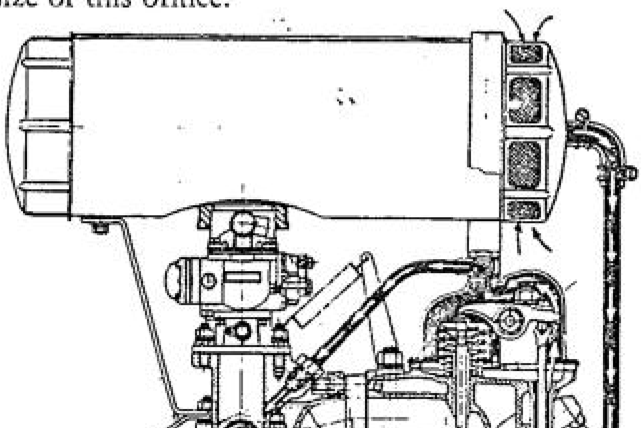


Fig. 34. Showing crankcase ventilation system. (Eng. No. V.152,890 and early to Series II only).

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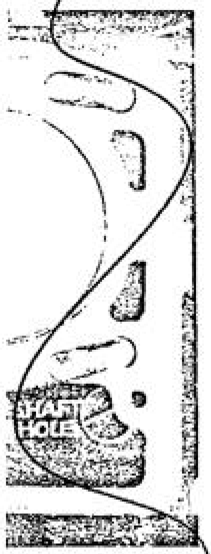

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NGINE

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OIL FILTER ASSEMBLY

Very early Models of the Vanguard employed the Tecalemit Oil Filter Assembly, this Assembly, however, was replaced fairly early in production by the Fram Oil Cleaner which has now, in turn, been replaced by the Purolator Micromic Filter. Details for all three of these arrangements are given in this Manual. (See also Page 50.)

TECALEMIT OIL FILTER (Eng. No. V1E—V311E)

Description (see Fig. 35).

A slightly different form of this filter has been used for some years on various of our models and an understanding of the operation of these will cover the present assembly.

As already described under "Lubrication," oil is forced from the annular space around the oil pump driving shaft, through the filter assembly. The oil entering the filter assembly passes first over the relief valve orifice. This relief valve regulates the oil pressure and when a pressure of 60 lbs. per square inch is exceeded, the ball leaves its seating and oil is returned to the sump unfiltered until the pressure has dropped appropriately.

The delivery of oil from the pump will increase with engine speed. At high engine speeds the engine bearings will not require the total output of the pump and thus cause back-pressure, which is of sufficient magnitude to operate the release valve, returning surplus oil to the engine sump. The bulk of the oil passes under pressure to the outside of the filter element, which is located in a detachable container.

By the design of the cleaner, the oil has to enter the element from its periphery, being forced through the felt material of which it is composed, and leaving sludge on its outer surface. The clean oil passes up the centre of the element, passing round the annular space between centre bolt and bracket, finally leaving by a hole, which is matched by another in the cylinder block, which leads to the main oil gallery.

A spring-loaded balance valve is provided on the underside of the bracket above the element, which is subject to the full pressure of the oil entering the cleaner from the engine. The slightly lower pressure of the clean oil passing out of the filter element acts on the other side of the valve and assists the spring to keep the valve on its seating, resisting the pressure of the oil as it enters the cleaner prior to being filtered. Thus all oil passing to the engine is forced through the element so long as this is not clogged with dirt.

After some thousands of miles the filter becomes clogged with dirt, thereby decreasing its porosity and increasing the pressure required to

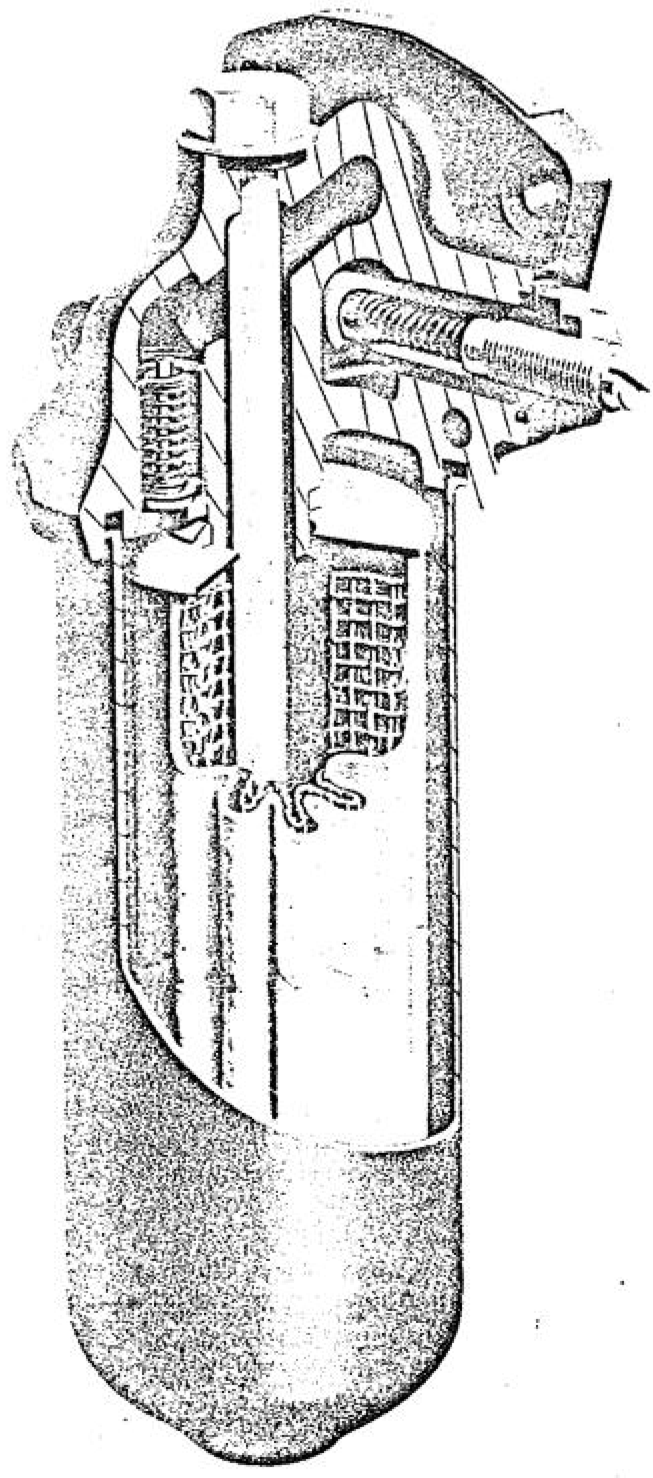


Fig. 35. Tecalemit filter employed on early models

orce oil through it. The result of this decrease n porosity is the lowering of the pressure of the itered oil.

With the progressive drop in pressure of the itered oil a point is finally reached where the ombined resistance offered by the by-pass valve pring and the oil leaving the element is in-ufficient to balance the pressure of the incoming il bearing on the bottom face of the valve, and he valve is lifted off its seat, allowing unfiltered il to be fed direct to the engine.

As can be seen from the previous paragraph, he balance valve ensures that, even where the hanging of the element is neglected, the engine ill get some oil although this will be unfiltered.

Maintenance of oil filter.

The maintenance of the oil filter is limited o the periodic checking of the tightness of the our securing bolts, the elimination of leakages if hey occur and the changing of the filter cartridge ach 10,000 miles.

It is important when removing the filter bracket nd packing washer for any reason to ensure that the acking is refitted so that oil holes are in correct lation to those in cylinder block (see Fig. 36). With e latest type of packing shown the correct assembly foolproof. (See also Page 50.)

g. 36. Correct fitting position for oil cleaner packing washer. The latest type of packing the fitting of which is fool-proof, is inset

FRAM OIL AND ENGINE CLEANER—TYPE FHMS.800 (Eng. No. V312E—V89332E. Less V89283E—V89294E)

Description.

The Fram oil cleaner differs from the Tecalemit in that it is of the by-pass type. It is necessary to understand clearly the precise meaning of the word "by-pass." The cleaner is provided with a restrictor by-pass which is shown in Fig. 37, and is so arranged as to control the quantity of oil actually filtered. The reason for restricting the oil is to ensure that the oil which is actually filtered is cleaned thoroughly and also that the pressure drop in the filtered oil is not too great. The restriction, however, is so arranged that the complete sump is filtered 1½ times in an hour at normal working temperature and a pressure of 60 lbs. per square inch. In this way all the oil in the system is preserved in a thoroughly clean condition.

The selection of size for the restrictor was only made after numerous experiments, which were carried out with a view to obtaining the best possible results on actual engines.

The cleaner contains a removable cartridge element, which is filled with filtering media consisting of closely packed cotton yarn treated with triethanolomene, which latter substance increases the absorbing qualities of the fabric material contained by the element.

From Fig. 37 it will be observed that the oil pressure release valve is contained in the filter bracket casting. The valve is of the spring loaded ball type and is adjusted to blow off at 60 lbs. per square inch.

The operation of the cleaner is as follows :—

All the oil from the annular space around the pump drive shaft (see previous remarks on lubrication) enters at the "inlet" gallery, and as long as the pressure of the oil is below 60 lbs. per square inch, a quantity of this oil flows around the container and leaves the cleaner assembly via the "outlet" gallery, which can be clearly seen in Fig. 37. A proportion of this oil, however, flows through the cleaner and is admitted to the "sump" gallery through the restrictor. When the speed of the engine is such as to deliver oil at a higher pressure than 60 lbs. per square inch, the release valve opens and a certain amount of oil is delivered to the sump through the same port as the filtered oil. The amount of oil so delivered is naturally a function of the pump delivery pressure.

The cleaner is capable of withstanding very high pressure without leaks, and tests have shown that a hydraulic pressure of 600 to 800 lbs. per square inch is required before leakage occurs. The main gasket is located in a recess so arranged that when the body is forced into this recess by the centre bolt, the gasket is fully trapped, thus ensuring a very efficient joint.

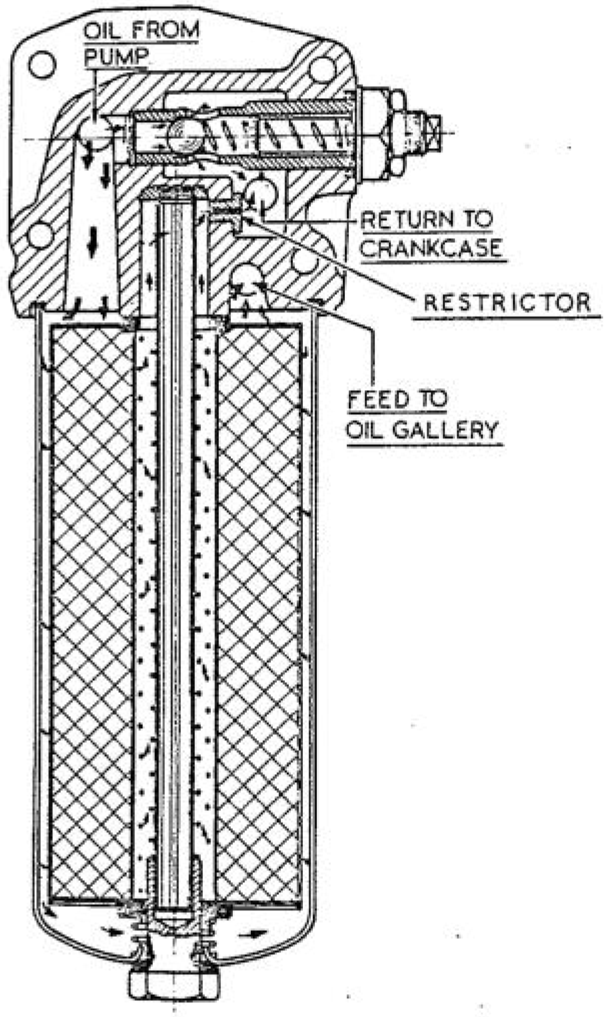


Fig. 37. Diagrammatic section of Fram filter

Maintenance attentions.

Under normal conditions, it has been found that the cartridge will efficiently clean the oil for a mileage of between 6,000 and 8,000. It should be understood that this figure is an arbitrary one and that the element need only be changed when the oil becomes dirty. Our normal recommendation for change of cartridge is 10,000 miles. When changing the element the following procedure is recommended :—

1. Unscrew centre bolt at bottom of container to free it from bracket casting.
2. Extract cartridge with top and bottom sealing washers.
3. Remove spring and centre bolt and wipe out cleaner body with a piece of fluffless cloth. Renew centre bolt gasket (provided in carton with new cartridge). Refit centre bolt and spring.
4. Fit new cartridge, ensuring that top sealing washer is fitting snugly in recess provided in top casting and also see that bottom sealing washer is seated correctly. (Top of cartridge can be identified by transfer.)
5. Refit body to bracket casting. Tighten centre bolt, ensuring that body locates squarely in cover casting and that centre bolt gasket is fitting snugly in recess provided.
6. Ensure that joints are oiltight by running engine for five minutes.

Particular care should be taken to ensure the maintenance of an oiltight fit between the cleaner body and cover casting.

It is scarcely necessary to point out the necessity for absolute cleanliness when changing the cartridge. The cleaner body should be carefully inspected, and the various joint faces cleaned before inserting the cartridge in the container.

It is important that only the Fram C.800 cartridge should be used, and on no account should a Tecalemit replacement element be fitted to this cleaner. The cleaner under consideration is of the by-pass type, whilst the Tecalemit is of the full-flow variety and the use of an element intended for the latter type would cause an excessive drop in pressure and result in no oil cleaning whatever.

It is important to appreciate that top and bottom sealing washers shown in Fig. 37 are of vital importance to the efficient working of the cleaner. If either of these two washers are faulty they should, of course, be changed. It will be seen from Fig. 37 that if either of the washers is faulty, oil could conceivably reach the sump without being filtered.

When the used cartridge is removed, it will be saturated with oil and as removal will result in the loss of approximately one pint, the sump should be correspondingly topped up with new oil. It is recommended, however, that the engine oil should be renewed at the same time as a new cartridge is fitted and hence the topping up process becomes automatic.

WHEN REMOVING FILTER BRACKET AND PACKING FOR ANY REASON, ENSURE CORRECT RELATION OF OIL

HOLES IN PACKING WITH THOSE IN CYLINDER BLOCK (SEE FIG. 36). WITH LATER PACKINGS CORRECT ASSEMBLY IS AUTOMATIC.

THE PUROLATOR "MICRONIC" OIL FILTER. TYPE MF.5102. (Eng. No. V89283E -V89294E and V89333E and future)

The Purolator 'Micronic' Oil Filter consists of a plastic impregnated paper "element" which removes the finest particles of abrasive which inevitably find their way into every engine. A filter of this type will stop not only the smallest micron sized particles of abrasive, but ensures a continuous supply of clean oil to the engine at all times. The only attention which the filter needs is to see that the element is changed at periods not exceeding 8,000 miles. It is essential that this operation be carried out at the specified periods to ensure maximum filtration; to renew the element proceed as follows :—

1. Clean the outside of the filter casing.
2. Unscrew the centre bolt and remove the filter casing and the element.
   Note: The paper element, its perforated outer cover and element tube form a complete element assembly.

   Ensure that the top seal is retained in position in the groove in the filter head.
3. Withdraw the old element and clean the inside of the filter casing.
4. Insert a new element into the filter casing.
5. Fit the filter casing and new element to the head, ensuring that the spigot formed on the head enters the centre tube of the element squarely; tighten the centre bolt only sufficiently to ensure an oil tight joint.
6. Run the engine for a few minutes and inspect the filter for leaks. If leakage is noted between the filter casing and the head, the centre bolt must be unscrewed, and the casing and element withdrawn, a new top seal should then be fitted. If leakage occurs at the bottom of the filter, withdraw the casing and element, remove the circlip from the centre bolt and withdraw the bolt from the casing, collect the element support, bolt seal, washer and spring. Ease the remaining seal out of the bottom of the casing and fit a new seal in its place. Insert the centre bolt and fit the spring, the washer, a new bolt seal and the element support onto the part; fit circlip into its groove in the bolt. Place the element inside the casing and offer up the assembly to the filter head, screw the centre bolt home.

A certain quantity of oil will be lost due to the removal of the filter casing and the sump should be topped up after assembly of the filter.

The filter casing should not be disturbed until element renewal is required, to do so invites the hazard that the accumulated dirt on the outside of the filter may be allowed to contaminate the inside and thus be carried into the bearings when the engine is re-started.

If at any time the entire filter unit is removed from the crankcase, take great care to fit the joint washer correctly, otherwise damage will be caused when next the engine is started, through the "blanking-off" of the oil passages. It is advisable to fit the washer to the crankcase and ensure that the holes in the washer match those in the crankcase before fitting the filter unit.

IMPORTANT.

Do not attempt to re-set the pressure relief valve which is incorporated in the filter head, this is the main engine pressure relief valve and is set by the vehicle manufacturers to a predetermined figure.

OIL CIRCULATION KNOCK.

As a result of a certain number of complaints of this description, with early Models, it was decided to modify the take off for the oil pressure gauge. This modification was advised in our Service Bulletins No. V.52G, copies of which may be had from our Service Department, upon application.

DIFFICULT STARTING OF ENGINE.

1. Insufficient fuel due to :—
   (a) Empty petrol tank.
   (b) Restricted pipe line from tank.
   (c) Dirty petrol pump filter.
   (d) Petrol pump not working properly.
   (e) Choked carburettor jets.
   (f) Incorrect carburettor level.
   (g) Incorrect jet setting. Refer to Page 1 "General Data" Section.
2. Air leaks to the induction system due to :—
   (a) Loose nuts on carburettor and induction manifold or distorted flanges.
   (b) Defective manifold or carburettor gaskets.
   (c) Leakage around crankcase ventilation adaptor in induction manifold.
   (d) Cracked induction manifold.
   (e) Worn throttle valve spindle and/or bearing point in carburettor body.
   (f) Worn valve guides.

3. Unsatisfactory grade or condition of petrol, particularly during cold weather.
4. Overdosing with petrol owing to injudicious use of strangler control or trying to start engine with sparking plug porcelains covered with moisture.
5. Defects in the electrical system as follows :—
   (a) Battery condition poor or this requires charging (see remarks under "Battery" in Electrical Section).
   (b) Incorrect ignition timing.
   (c) Weak or "earthed" condenser.
   (d) Incorrectly adjusted or dirty and pitted contact breaker points (see Electrical Section).
   (e) Sticking contact breaker arm due to seizure, weak or broken springs. Breaker arm "earthed."
   (f) "Earthed" low tension terminal on distributor head.
   (g) Poor ignition switch contacts.

Secondary circuit.

   (a) Poor contact between high tension terminals and sparking plugs.
   (b) Faulty insulation of high tension cables.
   (c) Defective high tension coil.
   (d) Moisture on distributor cover or leaks due to cracks.
   (e) Unsuitable sparking plug or incorrect setting of electrodes (.032").
   (f) Plug porcelains cracked or coated with moisture.
   (g) Corroded rotor contact or distributor segments. "Earthed" rotor.
   (h) Carbon brush for distributor to coil cable missing, damaged or stuck.
   (i) Starter motor in poor condition (see "Starter Motor" under Electrical System).
   (j) Starter motor switch not operating properly.
6. Starter motor pinion not engaging freely with flywheel ring and sticking in this gear.
7. Too heavy grade of engine or gearbox oil, preventing proper turning over of engine (see oil recommendations).
8. Engine compression poor owing to :—
   (a) Loose sparking plugs or defective plug C/A washers.
   (b) Damaged or improperly fitted cylinder head gasket.
   (c) Valves require regrinding and/or refacing. Valve seatings require attention (see Page 26).
   (d) Weak or broken valve springs causing partially sticking valves.
   (e) Bent valve stems.
   (f) Incorrect valve rocker clearances (see Page 21).
   (g) Piston rings broken, stuck or worn.
9. Water in cylinders due to poor cylinder head gasket or cracked cylinder block.
10. Initial tightness of engine due to recent overhaul. Such stiffness can also be explained by improper lubrication of unit.
11. Incorrect valve timing (see Pages 21 and 22).

ENGINE POWER POOR

1. Lack of compression due to following :—
   (a) Valves not closing properly due to inadequate valve rocker clearance (see Page 21).
   (b) Sticking valves due to stem deposits, broken heads or bent stems, and insufficient guide clearances.
   (c) Weak or broken valve springs.
   (d) Valve faces and/or seating in poor condition.
   (e) Worn or damaged cylinder bores, pistons and rings.
   (f) Piston rings improperly gapped and slack in piston grooves.
   (g) Faulty cylinder head gasket or incorrect part.
   (h) Sparking plug copper and asbestos washers defective.
2. Improper ignition timing.
3. Poor carburation.
4. Dirty filter reducing weight of mixture available.
5. Throttle valve not opening fully, owing to faulty adjustment of linkage.
6. Petrol pump not operating properly (see Fuel System).
7. Exhaust system clogged with carbon and causing back-pressure.
8. Engine overheating.
9. Pre-ignition.
10. Tight pistons and/or engine bearings.
11. Clutch slip.
12. Tight wheel bearings and transmission.
13. Brake drag.
14. Unsuitable back axle reduction gear or oversize tyres, indicating adjustments made outside this factory.
15. Incorrect valve timing (see Pages 21 and 22).
16. Speedometer not reading correctly.

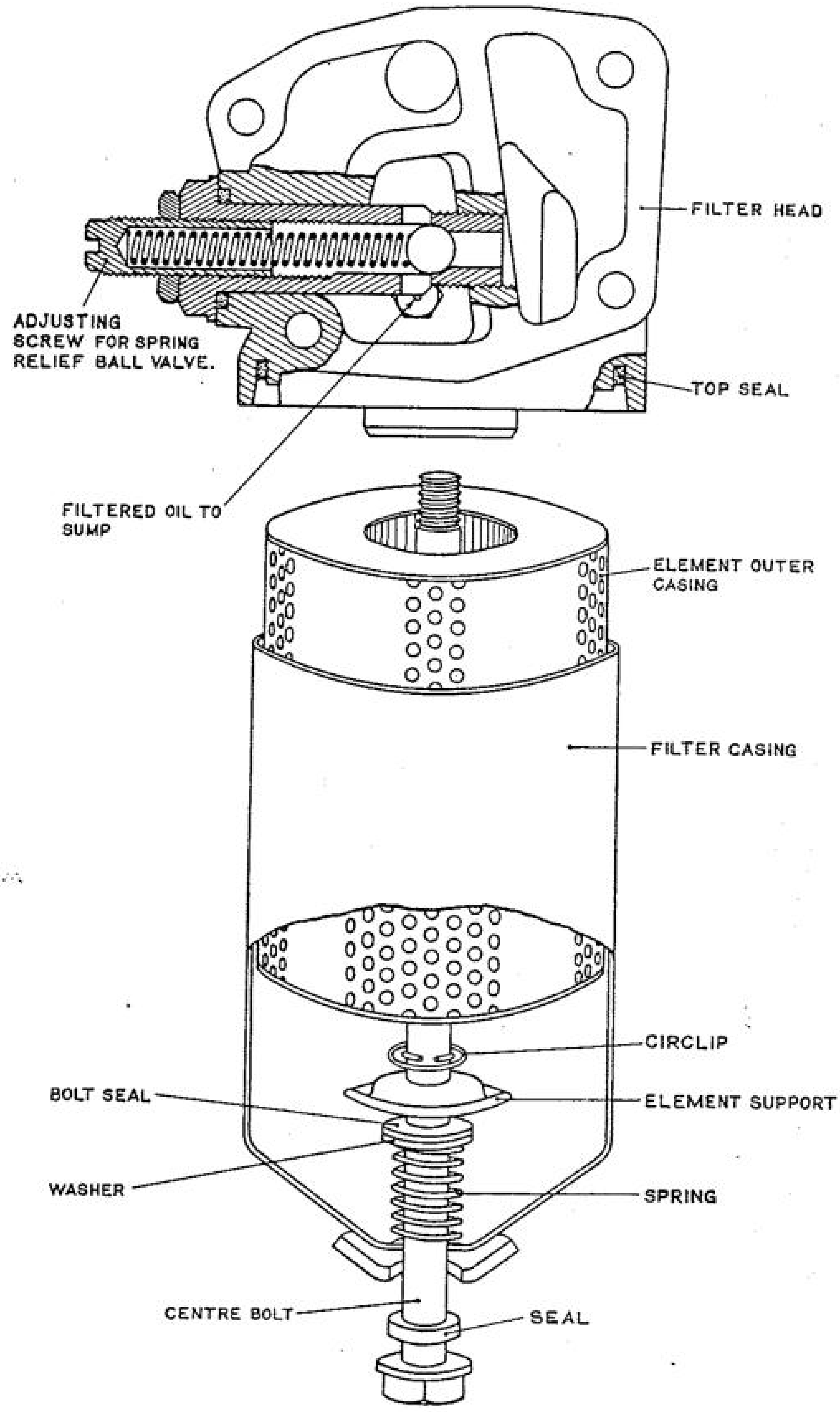


Fig. 38. Purolator "Micronic" oil filter, type MF. 5102

ENGINE MISFIRES AT LOW SPEED AND WHEN IDLING

The following possible causes for the difficulty should be investigated :—

1. Incorrect carburettor level.
2. Partially restricted main jet or pilot and its air bleed.
3. Air leaks due to badly made joints in carburettor or in its attachment to the induction manifold.
4. Badly fitting throttle valve and/or spindle.
5. Air leaks due to badly made manifold joints and defect in crankcase ventilator valve in manifold.
6. Cracked induction manifold.
7. Electrical leakages due to insulation failures.
8. Defective ignition coil.
9. Defects in sparking plugs.
10. Poor engine compressions.
11. Air leaks around inlet valves due to worn guides.
12. Incorrect contact breaker gap and bad condition of points.

ENGINE NOISES

Main bearing knock.

Main bearing knock can usually be identified by its dull heavy metallic sound which increases in frequency as the engine speed and load rises. A bearing knock is also particularly noticeable when the engine is running very slowly and consequently unevenly and is more pronounced with an advanced ignition than when this is retarded.

When main bearing knock is experienced, it can be explained by one of the following, and should be treated accordingly :—

1. Excessive bearing clearance (see Page 1).
2. Worn crankshaft journal and/or bearings.
3. Insufficient oil.
4. Low oil pressure.
5. Unsuitable grade of oil or badly diluted supply.

Crankshaft end float.

Where a knock is being caused by the development of end float, it will be found to be most noticeable when the engine is running at idling speeds. The knock caused by crankshaft end float will be found to be eliminated by operations of the clutch pedal.

Big end bearing knock.

A big end bearing knock is a lighter thud than that experienced with a loose main bearing, being evident with the engine idling and increasing when the engine speed is increased somewhat. A big end bearing knock will probably be found most noticeable at speed corresponding to 30 m.p.h. (48 km.p.h.).

The best test for a big end knock is to detach a lead from each sparking plug in turn, cutting out and reconnecting this whilst flicking open the throttle. On reconnection of lead, a light thud should be heard with the cylinder where bearing slackness or connecting rod misalignment exists and can be investigated accordingly. The following causes for big end bearing knock should be investigated :—

1. Excessive bearing clearance (see Page 1).
2. Worn crankshaft journal and/or bearings.
3. Insufficient oil.
4. Low oil pressure.
5. Unsuitable grade of oil or badly diluted supply.

Piston knock.

Piston " slap " can frequently be cut out by " shorting " the sparking plug relating to the cylinder concerned, but not in every case.

The best method of locating the offending cylinder is to engage a gear, and with the handbrake hard on, just let the clutch in sufficiently to apply a load with the engine running at fast idling speed. By detaching a sparking plug lead and thus putting the cylinder concerned out of action, it is usually possible to cut out the knock on the offending cylinder.

Piston slap will increase with the application of load up to approximately 30 m.p.h. (48 km.p.h.) and only in very bad cases does it continue to be audible over that speed. In some cases piston slap will be evident when the engine is started up from cold, but disappears as the engine becomes warm. In such cases, it is not suggested that any adjustments are necessary.

The following causes for piston and ring noise should be investigated :—

1. Excessive piston clearance (see Page 2 for dimensions and clearances) due to wear on pistons and sleeves or an unsuitable replacement part in use.
2. Connecting rod misalignment.
3. Piston or rings striking ridge at top of sleeve after fitting a replacement. Such ridges should always be removed before fitting new parts.
4. Collapsed pistons.
5. Broken piston rings or excessive clearance in grooves.

Connecting rod small end knocks.

As the gudgeon pin with this model is able to float in the piston and the bearing, a knock may arise owing to slackness in the small end bush or the piston bosses. The knock will make itself heard either under idling conditions or at road speeds between 20-30 m.p.h. (32-48 km.p.h.).

To test for a gudgeon pin knock, cut out each cylinder in turn by disconnecting leads. The offending gudgeon pin will be identified by the fact that a double knock is caused when disconnecting the plug lead referring to the offending cylinder.

In complaints of this nature, the following possible causes should be examined :—

1. Gudgeon pin slack in connecting rod bush or piston bosses (see Page 2 for gudgeon pin clearance).
2. Misalignment of connecting rod allowing connecting rod bush to foul piston bosses.
3. A tight gudgeon pin will cause piston slap.

Noisy valve rockers or tappets.

Noise due to valve rockers may be identified fairly easily owing to the fact that as these are operated by the camshaft, which revolves at half engine speed, it will occur at a lower engine speed that most of the other engine noises. Valve rocker noise has a characteristic clicking sound which increases in volume as the engine speed rises.

Where valve rocker noise is caused by excessive clearance, it can be eliminated by the insertion of a feeler gauge between the stem of the valve and outer spring cap, in the recess provided for checking clearances, with the engine idling. Where this complaint is experienced, and is found to be caused by incorrect rocker clearances, the rockers should be adjusted as indicated on Page 21.

Push rod noise may be caused by worn or rough rocker ball pins and push rod cups.

Worn cams and tappet faces can give rise to noise which will, of course, occur at half engine speed.

Ignition knock.

An ignition knock causes a metallic ringing sound, usually occurring when the engine is labouring or accelerating. It can also be caused by over-heating.

Ignition knocks can be caused either by detonation or pre-ignition. Detonation is caused by a rapid rise in pressure in the explosive mixture, this causing the last portion of the charge in the cylinder to be spontaneously ignited, resulting in this striking the cylinder wall with a ringing sound, this noise being the familiar "pinking," well known to motorists. Pre-ignition may arise as a result of detonation owing to the heat generated thereby, but may also be caused by sharp edges or points in the combustion space and where it arises should be treated accordingly.

Where ignition knock is experienced, the following possible causes should be investigated :

1. Excessive carbon in combustion spaces.
2. Too early an ignition timing.
3. Faulty automatic advance and retard mechanism due to incorrect or weak centrifugal control springs.
4. Incorrect or faulty sparking plugs causing incandescence.
5. Sharp edges or pockets in combustion space.
6. Hot engine valves due to incorrect seating width, insufficient valve rocker clearances, unsuitable valve material, or valve edges thinned excessively by refacing.
7. Engine overheating.
8. Unsatisfactory state or grade of fuel.
9. Too weak a carburettor mixture, causing delayed combustion and consequently overheating.

Engine popping back into carburettor.

It is in order that with a cold engine popping back into the carburettor should sometimes occur, but this should cease when the engine reaches normal working temperature. If back firing persists in spite of warming up, the following possible causes should be investigated :—

1. Incorrect ignition timing (see Page 24).
2. Valves not seating properly, particularly the inlet ones.
3. Valve timing incorrect.
4. Pre-ignition due to various causes.
5. Too weak a mixture or a very rich one.
6. Air leaks into induction system, giving rise to a weak mixture.
7. Defective cylinder head gasket.
8. Poor quality fuel.
9. Incorrect wiring of sparking plugs.
10. Centrifugal advance and retard mechanism not functioning properly.

EXCESSIVE ENGINE OIL CONSUMPTION

Excessive oil consumption is usually associated with a generally dilapidated engine, but can, of course, arise as a result of external leakages and due to other factors with comparatively new engines. (See also Page 51.)

Where an engine is actually burning too much oil it will be indicated by the emission of bluish grey smoke from the exhaust when the engine is " raced " up after a period of idling.

If excessive oil consumption is established before commencing to dismantle the engine, a check for external leakage should be carried out. This check can be conveniently carried out by spreading paper on the garage floor underneath the forward part of the car and running the engine for a few minutes at fast idling speed. In this way it will be possible to locate the position of serious leaks which, without the engine running, otherwise would not be evident.

The following possible causes of excessive oil consumption are recommended for attention as necessary :—

1. External leakages caused by one or more of the following :—
   - (a) Poor sump packing or cracked pressing.
   - (b) Flanged face of sump not true.
   - (c) Drain plug loose or defective plug gasket.
   - (d) Defective filter bracket packing or loose securing bolts or poor joint faces.
   - (e) Timing cover oil seal defective.
   - (f) Rear oil seal defective or badly fitted.
   - (g) Poor timing cover gasket or loose securing bolts. Cracked timing cover.
   - (h) Valve rocker cover gasket defective or distorted flanged face.
   - (i) Petrol pump insecurely mounted or defective packing.
   - (j) Defective front engine plate packing or joint faces.
   - (k) Oil pressure gauge pipe line leaking.
   - (l) Leakage round camshaft welch plug.
2. Unsuitable grade of oil being used or excessive dilution of this.
3. Employment of too high an oil level.
4. Excessive oil pressure.
5. Arduous driving conditions.
6. Excessive piston clearances in sleeves due to incorrect replacement or wear in sleeves and on part itself.
7. Worn or damaged piston rings.
8. Piston rings stuck in grooves.
9. Excessive vertical movement of piston rings in grooves due to wear or unsuitable replacements.
10. Insufficient piston ring end gap (see Page 2).
11. Piston rings exercising insufficient radial pressure.
12. Excessive diameter and axial clearance due to wear associated with the possibility of oval and worn crankpins.
13. Excessive diameter clearance in main bearings and/or worn journals (see Page 1 for dimensions and clearances).
14. Excessively high crankcase temperatures.

Low oil pressure.

The correct oil pressure is 40-60 lbs. per square inch for top gear for road speeds between 30-40 m.p.h. (48-64 km.p.h.). With complaints of low oil pressure the following possible causes should be investigated :—

1. Insufficient oil in engine sump.
2. Use of an unsatisfactory grade of oil.
3. Oil supply badly diluted.
4. Suction oil filter restricted owing to dirty sump oil.
5. Oil release valve out of adjustment.
6. Dirt or grit on release valve seating.
7. Broken or weak release valve spring.
8. Oil pump packing defective or unit securing nuts loose.
9. Badly worn and damaged oil pump rotors or spindle shaft.
10. Loose external oil filter bracket or defective packing washer ; poor joint faces.
11. Loose connections on pressure gauge pipe or defective pipe line and/or flexible connections.
12. Worn engine bearings and/or crankshaft journals and pins.
13. Incorrect oil pressure gauge.

High oil pressure.

1. Use of too heavy a grade of oil.
2. Faulty adjustment of oil pressure gauge, stuck oil pressure release valve or too heavy a relief valve spring.
3. Faulty oil pressure gauge.

MISCELLANEOUS ENGINE NOISES

A number of engine knocks and noises will be experienced which are not covered in this manual, as it is obviously impossible to predict all the possible causes for complaint in this connection.

In view of the possibility of elusive knocks and noises being experienced with an engine unit, the wise repairer will have some form of sound detector available to assist in the location of such sounds.

REMOVAL OF ENGINE

Removal of the engine from the car should be carried out in the following manner :—

1. Remove front carpets. Disconnect one lead from accumulator to break electrical circuit.
2. Disconnect thermometer capillary tube from engine, and petrol pipe from pump. Detach heater connections where fitted.
3. Withdraw the 19 setscrews and the 5 which secure pedal plates, after first disconnecting the dipper switch from the toe-board and likewise the wire fitted to the throttle lever. The removal of the floor pressing requires detachment of seat frame from runners by removal of six nuts and withdrawal of four bolts securing seat adjuster. The withdrawal will be best arranged by pushing the front of this pressing downwards and raising the rear subsequently manipulating it past the brake and clutch pedals.
4. Detach the six bolts (three on each of two brackets) which secure the bonnet to the hinge mechanism and remove the assembly.
5. Disconnect top and bottom water hose connections, the three bolts on each side flange of radiator block and lift out assembly.
6. Detach propellor shaft from gearbox flange by removing four bolts and Simmonds self-locking nuts.
7. Disconnect speedometer cable from gearbox by unscrewing knurled collar.
8. Disconnect the two change speed operating shafts from their attachment to the selector levers, by withdrawing the two bolts from each extremity of the " T " shaped flanges, and then push these shafts outwards towards the chassis frame to provide clearance.
9. Disconnect clutch rods from their attachment to the levers on the clutch housing and tie them together out of the way.
10. Remove front section of the exhaust down-pipe by detachment of four nuts on the flange joint and the pinch bolt gripping the rear end of the pipe.
11. Withdraw the two bolts securing the extension flanged bracket to the rubber mounting on the chassis cross member.
12. Remove the two engine bearer bolts, one on each side member bracket ("$\frac{9}{16}$ A/F spanner), and detach earthing wire.
13. Remove starter motor.
14. Remove the engine by employment of a double sling, one round the fan pulley and the other round the back of the unit as shown in Fig. 39. Alternatively, employ lifting bracket as illustrated by Fig. 40 after removal of rocker cover. The removal of the engine and gearbox will require a certain amount of manipulation if overloading of the gearbox extension, by its pressure on the cross member, is to be avoided when lifting, as it is necessary to clear body details. The removal of the engine will be facilitated by raising the back of the car from floor level. A suitable lifting bracket, as shown in Fig. 40 may be obtained from Messrs. V. L. Churchill & Co.

TO DISMANTLE ENGINE.

1. Detach the clutch housing and then withdraw the clutch from the flywheel after removal of the six $\frac{1}{2}$" A/F headed setscrews. Remove starter motor where still fitted—after withdrawal of two $\frac{3}{8}$" bolts ($\frac{9}{16}$" A/F).
2. Remove the flywheel by complete withdrawal of two of the four $\frac{5}{8}$" A/F headed setscrews and partial slackening of the other two and employment of two levers as shown in Fig. 41.
3. Remove air filter and two brackets by which it is attached to the rocker cover and cylinder block.
4. Remove carburettor and composition packing by detachment of two $\frac{5}{16}$" nuts ($\frac{1}{2}$" A/F) and spring washers, after detachment of suction pipe.
5. Detach fuel pump and packing after removal of two $\frac{5}{16}$" setscrews ($\frac{1}{2}$" A/F) and spring washers.
6. Remove crankcase ventilator adaptor from cylinder block and that screwed into induction manifold.
7. Withdraw rocker cover and gasket after removal of two self-locking nuts ($\frac{1}{2}$" A/F), two fibre and two plain washers.
8. Remove coil and high and low tension leads from distributor.
9. Remove sparking plugs after detachment of distributor leads.
10. Remove distributor complete with cover and sparking plug leads by removal of suction pipe and two nuts ($\frac{7}{16}$" A/F) and spring washers. Do not slacken clamp bolt so that

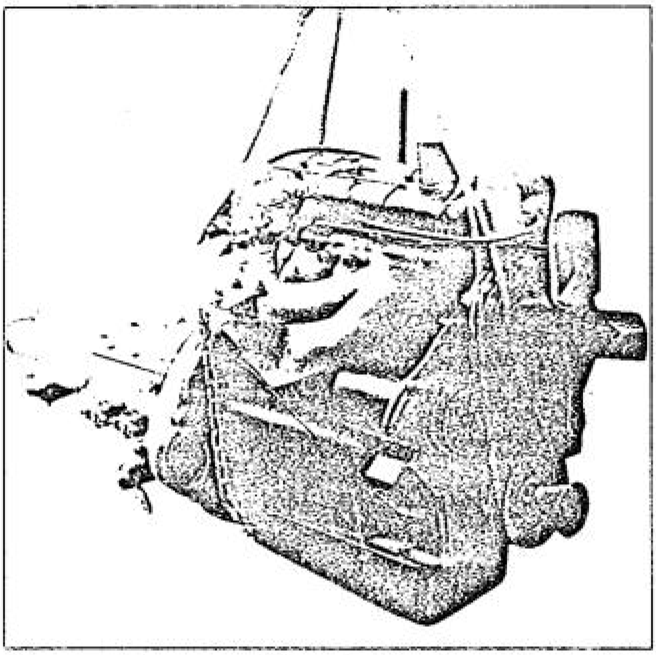


Fig. 39. Correct position of sling for engine lifting

ignition timing may be preserved for reassembly, which can be arranged owing to the offsetting of driving dogs (see instructions on Page 14 for reassembly).

11. Remove distributor drive shaft and helical drive gear.
12. Remove thermostat assembly, hose pipe and thermostat packing after withdrawal of two nuts ($\frac{1}{2}$" A/F).
13. Remove water pump amd packing after withdrawal of three $\frac{3}{8}$" bolts, with $\frac{9}{16}$" A/F heads.
14. Withdraw inlet and exhaust manifolds and gaskets after removal of eight nuts ($\frac{9}{16}$" A/F), and two bolts ($\frac{9}{16}$" A/F).
15. Remove oil filter assembly and packing after withdrawal of four bolts ($\frac{1}{2}$" A/F), and pressure pipe.
16. Withdraw dynamo and bracket after removal of three setscrews and one bolt ($\frac{1}{2}$" A/F). Remove dynamo pedestal ($\frac{7}{8}$" A/F and $\frac{13}{16}$" A/F nut).
17. Remove starter dog nut and handle guide and fan pulley after disengaging tabwasher and unscrewing with a $1\frac{7}{16}$" A/F open-ended spanner. The fan pulley can be extracted with Churchill Tool No. 6312 with "V" shaped claws, as shown in Fig. 21 for fan extension. Note the shims between crankshaft sprocket for gear alignment and those between megaphone attachment and tabwasher for starting handle relation to compression.
18. Remove timing cover with chain tensioner and cover packing. The chain tensioner can be removed if necessary after withdrawal of split pin and distance washer.
19. The oil seal may be removed from the timing cover if the necessity to replace this arises, noting the inward position of the lip of the seal for replacement.
20. Note the radial scribed markings on the face of the camshaft and crankshaft timing wheels, when No. 1 is on T.D.C. of the firing stroke. These markings, when produced in both directions, should pass through the centre of each wheel. A centre punch mark is made on the face of the camshaft wheel adjacent to a similar marking made on the end of the camshaft through a setscrew hole. If these markings are matched up on reassembly, the correct valve timing will be ensured. The appropriate markings are shown in Fig. 19.
21. Remove camshaft timing wheel and timing chain after withdrawing two setscrews with $\frac{1}{2}$" A/F spanner, and also tap off crankshaft timing wheel and place aside shims for reassembly of latter wheel.
22. Withdraw the two Woodruff keys from crankshaft.
23. Remove rocker shaft assembly and push rods after unscrewing four $\frac{9}{16}$" A/F nuts securing pedestal brackets.
24. Remove the combustion head after withdrawal of the ten $\frac{11}{16}$" A/F nuts afterwards removing studs.
25. Remove the eight tappets.
26. Withdraw engine sump and packing after removal of nineteen $\frac{5}{16}$" setscrews employing a $\frac{1}{2}$" A/F spanner.
27. Remove camshaft flanged front bearing by withdrawal of two $\frac{5}{16}$" setscrews employing a $\frac{1}{2}$" A/F spanner, and extract camshaft.
28. Remove two halves of rear oil retainer by withdrawal of the eight $\frac{1}{4}$" setscrews ($\frac{7}{16}$" A/F spanner).
29. Withdraw pump assembly after removal of three $\frac{7}{16}$" A/F nuts and spring washers.
30. Remove front engine plate and packing after withdrawal of four $\frac{5}{16}$" setscrews and spring washers with a $\frac{1}{2}$" A/F spanner.
31. Remove three bearing caps with bottom halves of precision type bearings and thrust washers after unlocking tabwashers and unscrewing six $\frac{1}{2}$" setscrews with $\frac{11}{16}$" A/F spanner.

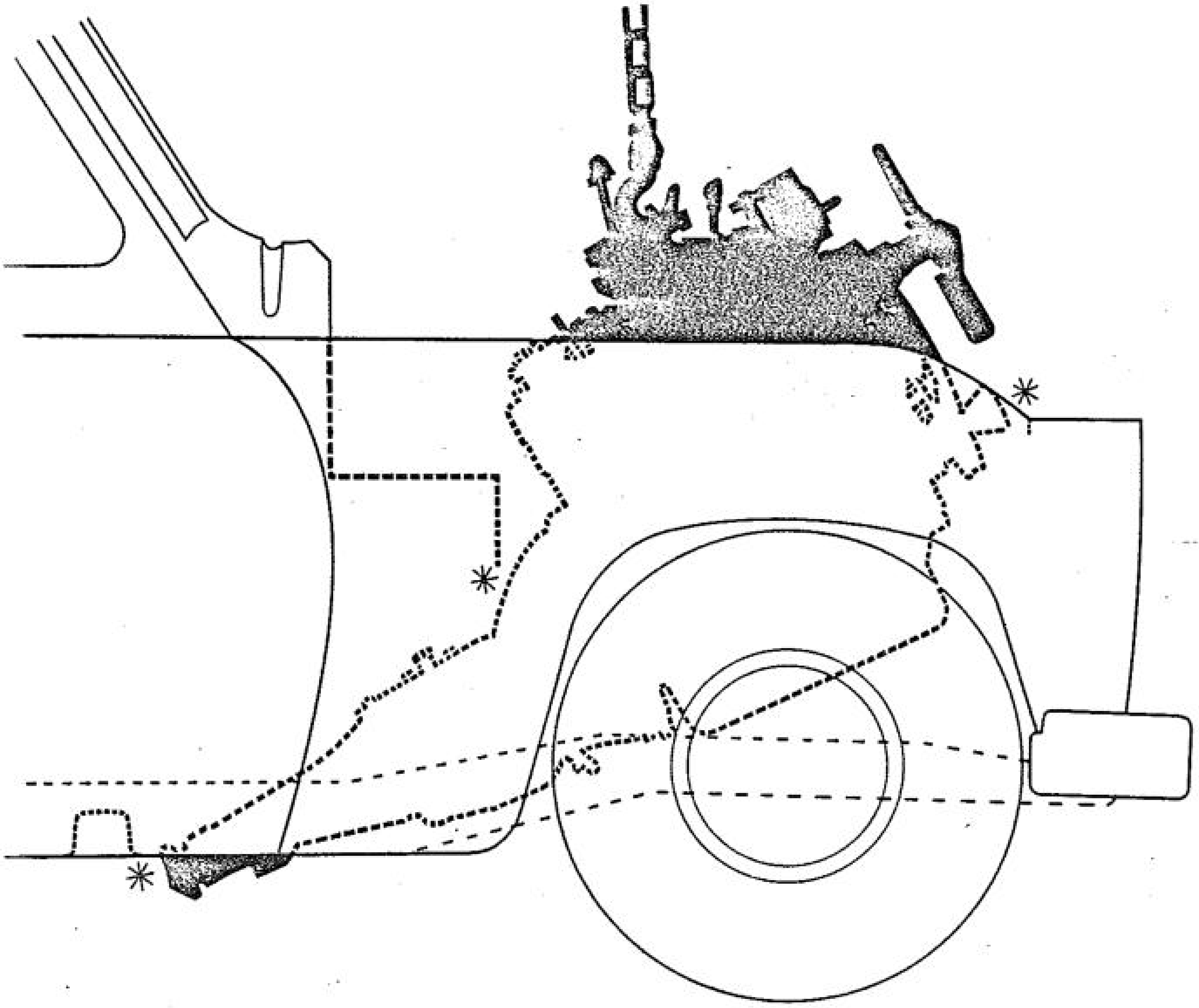


Fig. 40. Removing engine unit with special lifting hook. The asterisks show the points which necessitate the angle of tilt for withdrawal.

Withdraw pistons and connecting rod assemblies with cylinder sleeves after removing the big end bearing cap securing setscrews employing a $\frac{7}{16}''$ A/F spanner. The eight bushings for the connecting rod bolts should be put aside for reassembly into the rods with the caps when the sleeves have been withdrawn from the engine to avoid their being mislaid.

Remove top halves of main bearings and crankshaft. Note relation of numbers on bearing caps with those punched on the cylinder block face.

ASSEMBLY OF ENGINE

he following procedure should be adopted :—

1. Having ensured that the aluminium core plugs at each end of the oil gallery are in position and in good order, and the welch plug at the rear end of the camshaft is similarly fitted, fit the upper halves of the main bearing shells.
2. Shellac face for top half of oil seal and install.
3. Drop the crankshaft into position on the bearings, threading the two bottom halves of the thrust washers into position on each side of the centre main bearing housing. Note location of bearing cap numbers in relation to those on cylinder block flange as shown in Fig. 42.
4. Shellac bottom half of rear oil seal and install with rear bearing cap. (See also Page 51.)

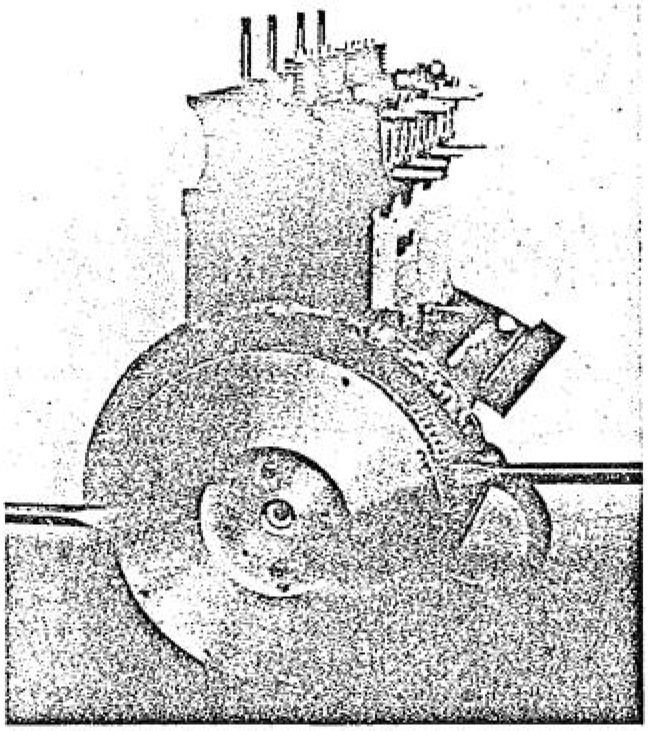


Fig. 41. Method for removal of flywheel

5. Ensure that the two halves of the seal make a proper joint at each extremity, and fit flush with the cylinder block face. (Nut torque 8-10 lbs./ft.)
6. Fit the other two bearing caps with the bottom halves of the thrust washers located on each side of the centre cap.
7. Secure the three bearing caps with $\frac{1}{2}$" set-screws and spring washers ($\frac{11}{16}$" A/F spanner required). Nut torque 90-100 lbs./ft.)
8. Check end float in crankshaft and ensure that this is .004" to .006", selecting thrust washers where necessary to ensure the requisite float, or alternatively rubbing the steel back down on a piece of emery cloth placed on a surface plate to provide the necessary end clearance.
9. Fit front main bearing sealing block and filling pieces, using jointing compound liberally to ensure oil tightness. Tighten up the two round-headed $\frac{5}{16}$" setscrews utilizing a substantial screwdriver, or better still, the proper tool prepared by Messrs. V. L. Churchill & Co. and illustrated elsewhere in this manual. Ensure flush relation of sealing block with cylinder face.
10. Force felt strips into the recess on either side of rear main bearing housing and apply jointing compound to these annular recesses. A special punch, with a blunt nose and about $\frac{3}{16}$" square in section, can be conveniently used for the driving these felts into position. It will be found that about eight pieces of $\frac{3}{4}$" length × $\frac{5}{16}$" section felt will be required to fill each recess. (See also Page 51.)
11. Assemble pistons on to connecting rods in such a way that the split portion of the piston skirt faces towards the cap side of the rod (see Fig. 3). The connecting rod and piston assembly should then be fitted into the respective cylinder sleeves, utilizing a piston slipper for the purpose. The centre line of the connecting rod cap should be in diametrical relation to an opposed pair of flats on each cylinder sleeve upper flange.
12. All roughness should be removed from the cylinder liner spigot faces and after wiping these clean they should be lightly coated with jointing compound for the spectacle packings. Position the two packings in tne cylinder block.
13. Having fitted the figure of eight packings, the cylinder sleeves with the piston and con rod assemblies in position should be fitted into the cylinder block so that the con rods line up with the caps towards the camshaft side of the engine, thus placing the split away from the point of maximum thrust. It will be seen that there are two positions in which the sleeves can be fitted, pairs of flats being provided at 90°, thus, after a period of service, an alternative position of a liner may be provided to deal with piston slap, caused by light wear.
14. It is particularly important that after fitting the sleeves into the cylinder block, the engine should not be turned until some method has been employed to prevent the sleeves moving in relation to the cylinder when the engine is turned. This can be done by employing two special retainers manufactured for this purpose by Messrs. V. L. Churchill & Co. (see Fig. 20). If this precaution is not taken and the engine rotated, the liners will rise from their contact with the figure of eight packings and in most cases damage these joints. A worthwhile precaution is the application of jointing compound to the underside of the figure of eight packing.
15. Fit bearing caps with the bottom half of the shells to the respective rods (the bearing caps, if previous instructions have been regarded, will face to the right of the engine, viewed from the front end of this unit.) Fit

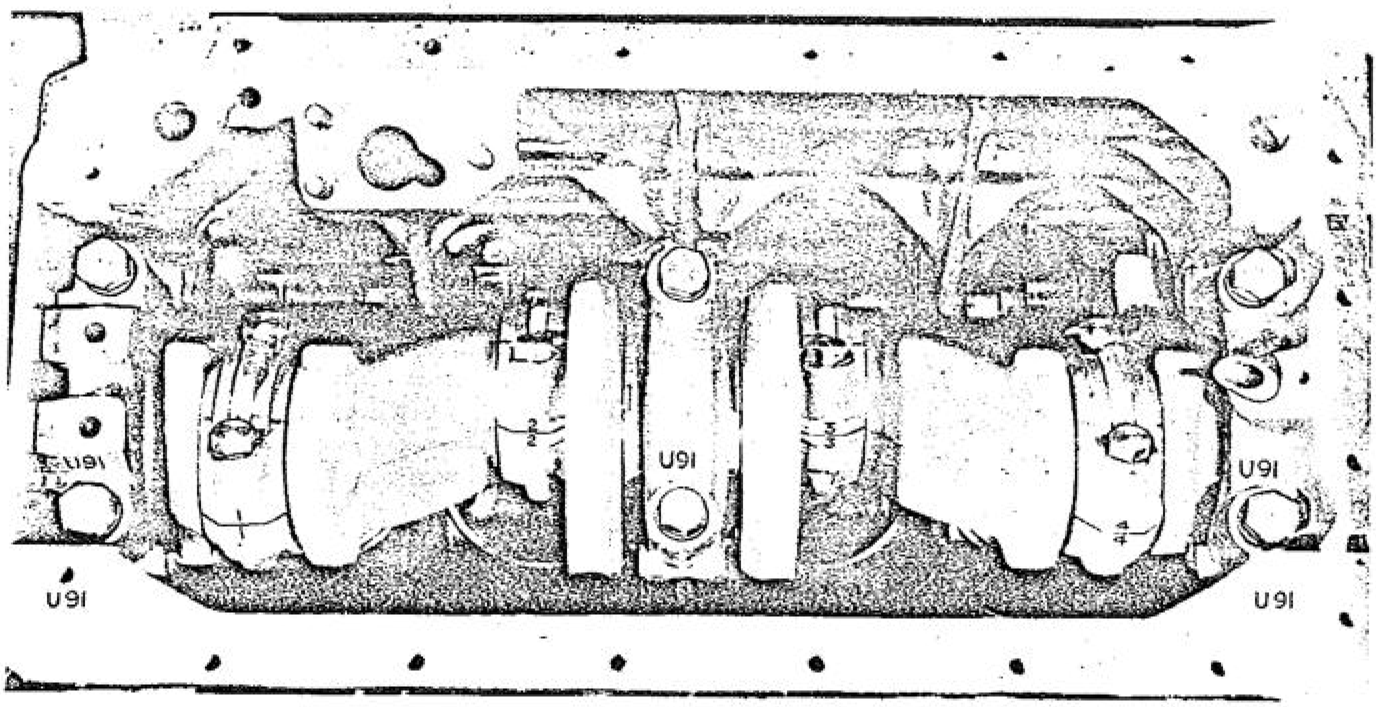


Fig. 42. Showing bearing cap and cylinder block markings

locking plates to setscrews ($\frac{9}{16}$" A/F spanner) Nut torques 42-46 lbs./ft.

16. Fit front engine plate packing, utilizing jointing compound. The plate is located by two $\frac{5}{16}$" dowels and secured by four $\frac{5}{16}$" setscrews and spring washers ($\frac{1}{2}$" A/F spanner).
17. Fit oil pump assembly, securing wih three studs and nuts, locked by spring washers ($\frac{1}{2}$" A/F spanner).
18. Fit two oil seal retainers on the rear of the cylinder block with the eight $\frac{1}{4}$" setscrews and spring washers ($\frac{7}{16}$" A/F spanner).
19. Fit dowel in crankshaft having regard to the markings on the flywheel.
20. Fit flywheel on to crankshaft spigot so that the arrow marking on its periphery lines up with the centre of the cylinder block at 12 o'clock above the assembly when Nos. 1 and 4 pistons are T.D.C. In production, another marking 180° from the arrow is made, and indicates naturally the "top dead" position of the other two cylinders. The flywheel should be secured, utilizing the four $\frac{3}{8}$" setscrews and spring washers for the purpose ($\frac{9}{16}$" A/F spanner).
21. Fit camshaft and flanged front bearing into cylinder block.
22. Fit engine sump and packing, securing with 17—$\frac{5}{16}$" bolts ($\frac{1}{2}$" A/F spanner). The short bolt should be fitted into front sealing block.
23. Install the eight hollow tappets.
24. Fit the 10 combustion head studs which are $\frac{7}{16}$" N.F. at one end and N.C. at the other (the coarse threaded end is screwed into the cylinder block). Take care not to apply too great a leverage to studs when driving these into cylinder block, in particular the second pair of tapped holes from the rear are rather susceptible to damage if this precaution is not regarded.
25. Fit crankshaft timing wheel with necessary shims to align.
26. Fit camshaft wheel temporarily in position, partially tightening the two $\frac{5}{16}$" setscrews which are provided ($\frac{1}{2}$" A/F spanner).
27. Fit combustion head, having ground the valves in and replacing any damaged valves or springs. Tighten up cylinder head nuts symmetrically ($\frac{11}{16}$" A/F spanner) as indicated in Fig. 24.
28. Fit push rods and rocker shaft, taking care not to damage rocker shaft when fitting or to bend push rods by misplacement of outer or rocker spring caps as shown in Fig. 22.
29. Set tappet clearance to .010" on inlet and .012" on exhaust.
30. Where timing wheel markings are present, in order to set the valve timing it is only necessary to align the radially scribed lines on the faces of the two chain wheels and to turn camshaft until centre punch marks are in correct relation. In the absence of such

markings, the procedure suggested in the next two operations should be adopted.

31. Set both rockers to .014" on No. 1 and 4 cylinders, with the outer springs removed, turn camshaft round with the chain removed until the inlet and exhaust valves on No. 1 cylinder are at the point of balance or, in other words, the inlet valve is just opening and the exhaust closing. Next turn engine to T.D.C. on No. 1 cylinder, judging this position by the relation of the arrow on the flywheel periphery with the mark on the cylinder block at 12 o'clock. (Where the engine is in chassis frame, use the hole in the crank shaft pulley and the pointer on the timing cover to find T.D.C.) Fit the timing chain around the crankshaft and camshaft chain wheels in such a manner to allow a pair of setscrew holes in the camshaft wheel to line up with a corresponding pair in the camshaft keeping the driving side of the chain tight. It will be necessary to experiment with the two pairs of setscrew holes provided in the camshaft wheel. The second pair of holes, providing a half tooth adjustment whilst turning the wheel back to front, will allow a ¼" tooth range of variation. Fit camshaft timing wheel, securing two setscrews with ½" A/F spanner (see Valve Timing on Page 21). Tightening torque 24-26 lbs./ft.

32. Having set the timing as detailed in the previous operation, place engine on T.D.C. on No. 1 cylinder (nearest water pump) with both valves closed, *i.e.*, firing point. Take straight edge and lay this across faces of the two timing sprockets and scribe a line radially across faces of these two gears, thus providing the necessary timing marks for future repairs. To ensure correct positioning of the camshaft for future timing operations, make a centre punch mark on the end of the camshaft through a setscrew hole and similarly mark the face of the camshaft wheel adjacently. Having set the valve timing and marked the gears, the outer valve springs should be re-installed, taking suitable steps to avoid push rod damage. DO NOT FORGET TO RESET ROCKER CLEARANCES TO WORKING CLEARANCE OF .010" FOR INLET AND .012" FOR EXHAUST. PROVIDE FOR INITIAL LUBRICATION OF VALVE CAPS BY USE OF OIL CAN.

33. Fit the Woodruffe key for the fan pulley. Centralization of timing cover is ensured by two dowel pegs. Ensure the condition of the oil seal which is fitted with leather lip inwards towards the centre of engine.

34. Fit timing chain tensioner, distance washer and split pin, lock tabwasher on camshaft timing wheel. Fit timing cover joint washer, timing cover and bolt in position.

35. Fit tabwasher and starter dog, secure with dog lock tabwasher. Fit shims between tabwasher and dog nut to provide relation to cylinder compressions.

36. Fit dynamo bracket and dynamo.

37. Fit fuel pump washer and fuel pump.

38. Fit oil filter washer, filter unit and oil pressure pipe. Bolt oil pressure gauge pipe in position.

39. Fit inlet and exhaust manifold washers. Fit manifolds. Tighten up.

40. Fit paper washer and water pump.

41. Fit thermostat washer, body and hose pipe.

42. Fit distributor drive shaft and clamps and time ignition regarding the offset on the distributor dogs (see Fig. 10).

43. Set timing as detailed previously, placing engine on T.D.C. No. 1 cylinder both valves closed. Check distributor points gap which should be .010" to .12" fully opened. Having ensured the correct gap, which is important to give correct timing, rotate distributor in opposite direction until points just begin to separate with rotor arm opposite No. 1 segment on distributor cover. With the timing correctly set at T.D.C. and the oil pump spiral gear properly meshed with the camshaft, the rotor arm should be pointing to No. 1 sparking plug (the plug nearest the radiator). Tighten up clamp bolt and test car on road, advancing ignition as far as possible consistent with freedom from pinking. (See Electrical Section for High Lift Cam.)

44. Fit sparking plugs and connect leads from distributor.

45. Fit coil and H.T. lead to distributor.

46. Fit crankcase ventilator adaptor in rocker cover.

47. Fit rocker cover, washer and cover.

48. Couple ventilator pipe and rocker cover to adaptor in manifold.

49. Fit carburettor and return spring and bracket.

50. Fit clutch assembly.

51. Fit air cleaner clips and air cleaner brackets and air cleaner. Do not finally tighten cleaner

bracket and nuts until cleaner has been mounted on carburettor to avoid damage to this component due to slight misalignment.

12. Fit ventilator pipe from sump to rear of air cleaner.

13. Fit gearbox.

GENERAL MAINTENANCE HINTS

If a car is to give a good performance and the maximum efficiency and economy is to be obtained, there are certain points with regard to the engine and its ancillaries which should be watched and these are set out below. These attentions should be dealt with in accordance with the day-by-day mileage. For average motoring six monthly inspections are recommended.

Engine compression.

An engine which lacks compression cannot develop its proper power and a periodic test of compression should therefore be carried out by either employing a proper compression gauge, or alternatively judging this by manual means with the starting handle. Cylinder compressions should be equal and if there is an appreciable difference in these, steps to investigate—such causes as poorly seated valves, broken or weak valve springs, sticking valves, improper rocker adjustment (these should be .010" inlet and .012" exhaust cold), worn pistons, rings and/or cylinder sleeves, etc.—should be taken.

Ignition system.

Notes on Sparking Plugs

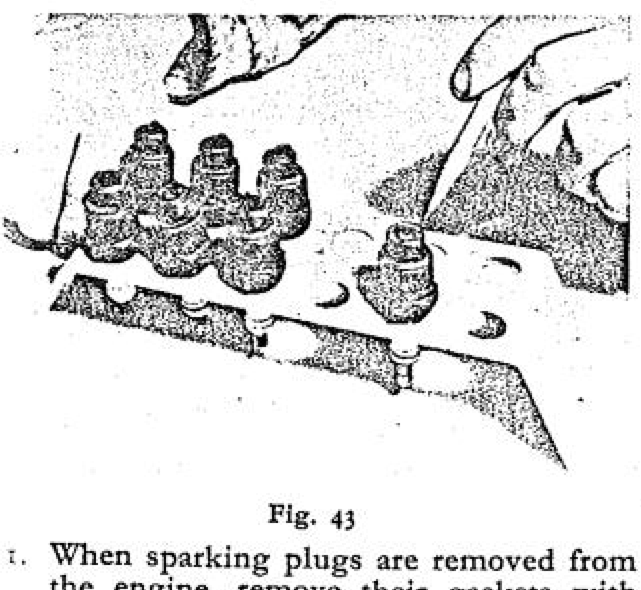


Fig. 43

1. **When sparking plugs are removed from the engine, remove their gaskets with them.** Place the plugs and gaskets in a suitable holder identifying each plug with the cylinder number. The tray shown above is a simple construction with holes drilled to admit the upper end of the plugs. Place a new plug of the proper type beside the others to afford a comparison of relative condition of the plugs in use, to the new plug.

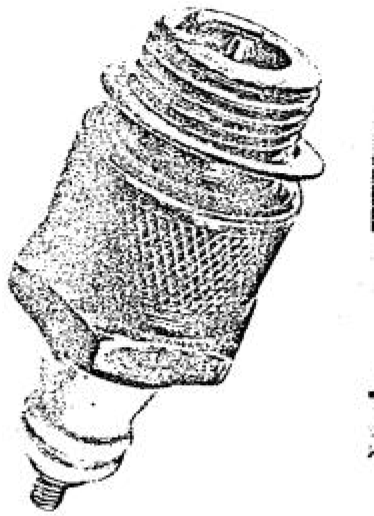


Fig. 44

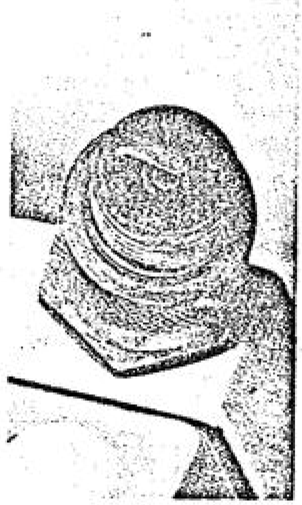


Fig. 45

2. **Look for signs of oil fouling, indicated by wet, shiny, black deposit on the insulator.** Oil pumping is caused by worn cylinders and pistons or gummed-up rings. On the suction stroke of the piston, oil vapour from the crankcase is forced up past the worn rings, where it fouls the plugs and causes sticking valves, with resultant waste of petrol. On the compression stroke, the mixture of oil and petrol vapour is forced past the rings into the crankcase again, contaminating the oil and turning it black with carbon. Carbon deposits in the combustion chamber are formed from burning oil vapour and cause "pinking."
3. **Next, look for petrol fouling indicated by a dry fluffy, black deposit.** This is caused by many things—faulty carburation, ignition system, defect in battery, distributor, coil or condenser, broken or worn-out cable. The important thing is for the petrol consumption to be improved and the customer satisfied. If plugs show suitability for further use, proceed to clean and test.
4. **In preparing for cleaning, remove plug gaskets, and in doing so ascertain their condition.** Note the gaskets illustrated. Upper left shows a gasket not properly compressed. A large proportion of the heat from the insulator is dissipated to the

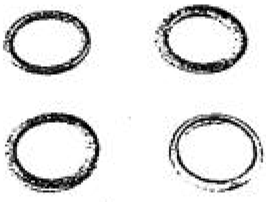


Fig. 46

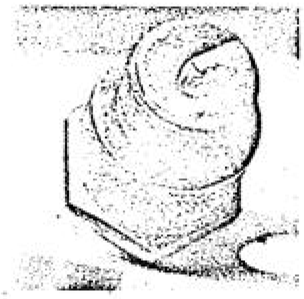


Fig. 47

cylinder head by means of the copper gasket between the plug and the cylinder head. Plugs not down tight can be easily overheated, throwing them out of the proper heat range, causing pre-ignition, short plug life and bringing about so-called "pinking." Don't tighten plugs too much—but be reasonably sure a good seal is made between plug and cylinder head. Lower left shows a gasket on which the plug was pulled down too tight, or had been too long in service. Note the distorted condition. Note evidence of blow-by, also a cause of plug over heating and resulting dangers. Upper right shows a reasonably compressed gasket giving the plug adequate seal and a good path for heat dissipation. All may be compared with the new gasket, at lower right. If gaskets are at all questionable they should be replaced by new gaskets.

5. **Occasionally a blistered insulator or badly burned electrode may be noted when examining plugs.** If the plug is the type normally recommended for the engine and was correctly installed, i.e., down tight on the gasket—the condition may have been brought about by a very "lean" mixture, or overheated engine. It is well to remember that plugs operating in the condition described above are often the cause of poor engine performance and extravagant petrol consumption. It may be, however, that a plug of a "colder" type is required.
6. **After cleaning, examine plugs for cracked insulators or insulator-nose worn away through continued previous cleaning.** In this case we should recommend that the plugs have passed their point of useful life and new plugs should be installed. Look for a deposit on the insulator, under side electrode, which may accumulate heat and act as a "hot spot" in service.
7. **After cleaning and blowing surplus abrasive out of shell recesses** and off plug threads by means of "blow out" nipple—examine threads for carbon accumulation. Use a wire brush to remove carbon and clean the threads. A wire buffing wheel may also be utilised; however, use reasonable care in both operations in order not to injure electrodes or insulator tip. The threaded section of plug shell is often neglected in plug cleaning, even though, like the gaskets, these threads form a means of heat dissipation. When threads are coated with carbon, it retards the even flow of heat to the cooling medium, thereby causing overheating. (When installing plugs, this simple procedure will ensure no binding of threads and avoid unnecessary use of plug spanner.) Screw the plug down by hand as fas as possible, then use spanner for tightening only. Always use a box spanner to avoid possible fracture of the insulator.

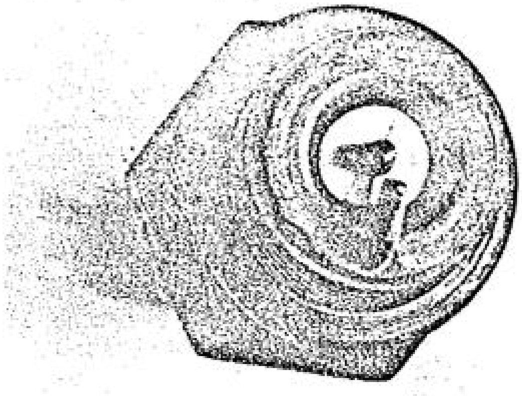


Fig. 48

8. **Next, we are ready for resetting the electrodes.** Remember that electrode corrosion and oxides at gap area vitally affect spark efficiency. The cleaner can remove the oxides and deposits from the insulator, but because of gap location, the cleaner stream cannot always reach this area with full effect, also, the tenacious adhesion of corrosion, etc., would require too much subjection to cleaner blast for removal. Therefore, when plugs are worthy of further use, it is sometimes good practice to dress

the gap area, on both centre and side electrodes, with a small file before resetting to correct gap.

Resetting of electrodes should be part of service during useful life of the plugs. However, the strains of intense heat, pressure mechanical shock, electrical and chemical action, during miles of service, wreak such havoc on the electrodes that molecular construction is affected. Plugs reach a worn-out condition and resetting can serve a good purpose only for a time. When gaps are burned badly, it is indicative the plug is worn to such an extent that further use in unwarranted and wasteful. When resetting, bend the Side Wire only, never bend centre electrode as this may split the insulator tip.

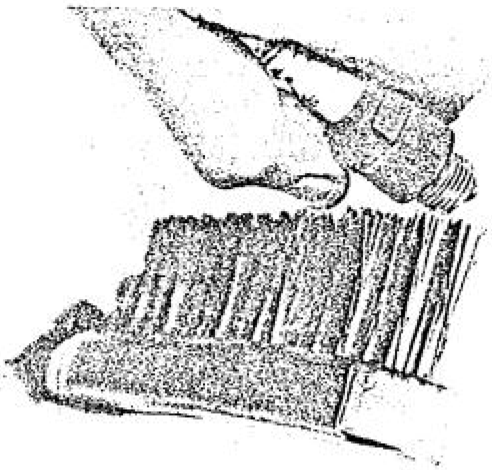


Fig. 49

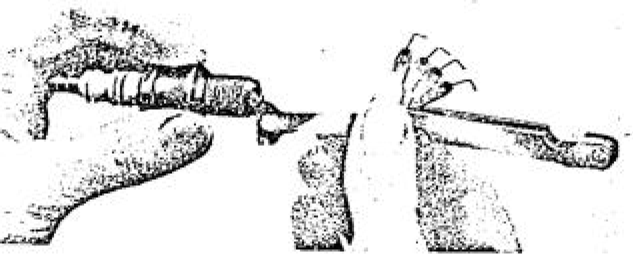


Fig. 50

9. **Inspect for leakage after testing,** by applying oil around the terminal. Leakage is indicated by the presence of air bubbles, the intensity of which will serve to show degree of leakage. Leakage throws the plug out of its proper heat range, as the hot

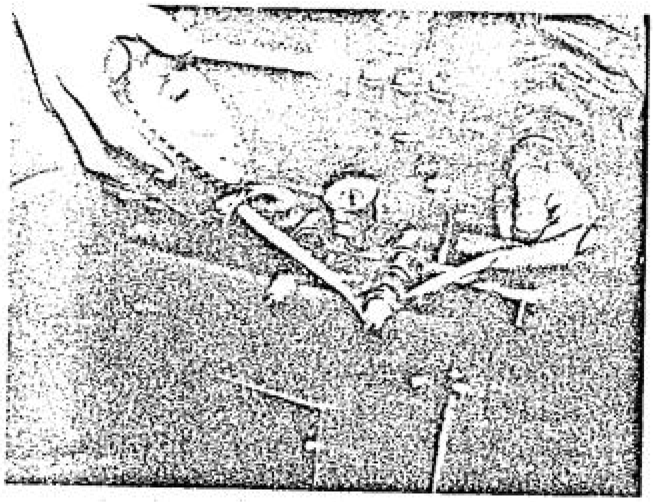


Fig. 51

gas escaping has a " blow torch " effect on the plug, causing compression loss, pre-ignition, rapid electrode destruction and overheating of the insulator tip.

10. **New gaskets have been fitted to the plugs** and the general improvement in appearance is apparent now that the plugs are ready to be installed in the engine. It requires no imagination to know that improved engine performance, better petrol consumption and satisfaction will result. The use of the stand (as illustrated) is evidence of your careful handling of the plugs.

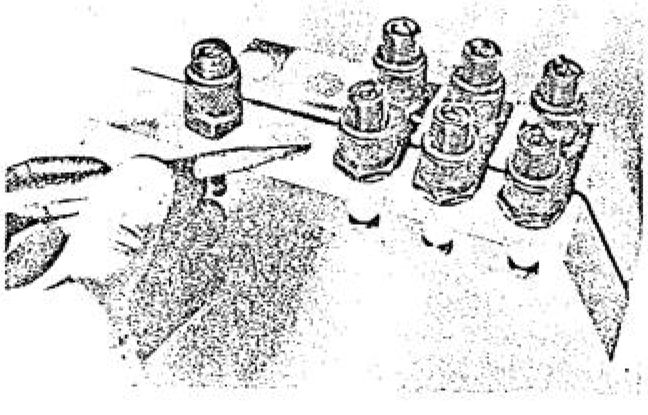


Fig. 52

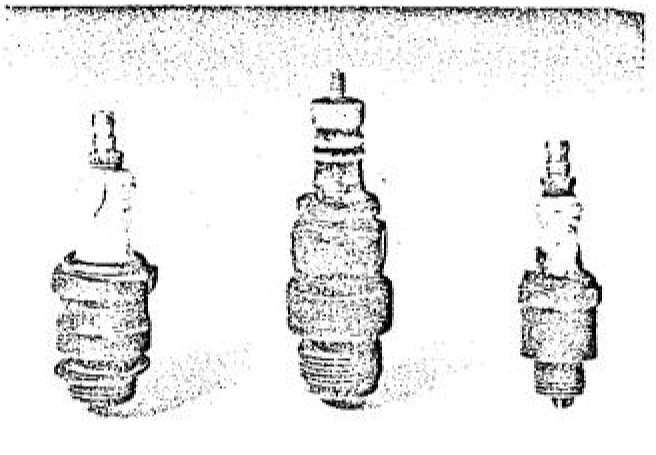
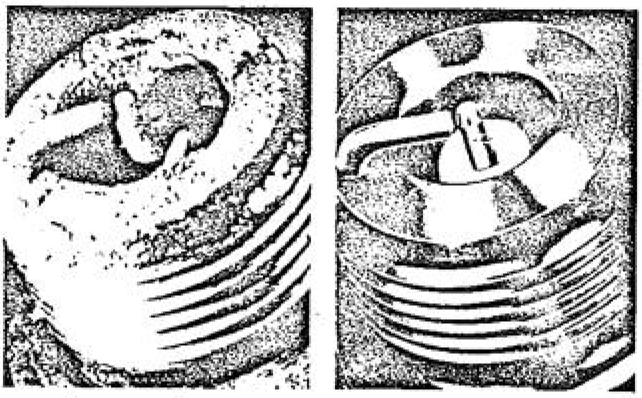


Fig. 53

11. **The top half of the insulator is often responsible for causes of poor plug performance,** namely, paint splashes, accumulation of grime and dust: cracked insulators caused by slipping spanner, or overtightening of terminals. Examine for cracked insulators at shoulder and terminal post. Remove grime and dust. Recommend inspection, cleaning and testing every 5,000 miles.



An unretouched photograph of a CHAMPION Sparking Plug after 25000 miles of service, compared with a new plug. The weak spark given by the former can readily be imagined and amply justifies our recommendation that to save petrol, plugs should be changed before such a stage of wear, as that shown in the photograph is reached

Fig. 54

Clean and replace sparking plugs periodically as necessary. The correct gap for the "Vanguard" plugs should provide a gap of .030" to .032", the Champion L.10 ½" reach plug being specified. The normal efficient life of a sparking plug is 10,000 miles, after which, if full efficiency and economy is desired, the plugs should be replaced by new ones of the type specified.

The distributor cap and rotor should be periodically examined for cracks which will allow electrical leakages.

The contact breaker points should be examined each 5,000 miles, when normal lubrication of this part of the car is recommended, and where these have become burnt or pitted they should, if possible, be squared up with a piece of carborundum stone, so that when the points are closed they fit flush against each other. If the points have become seriously worn they should be replaced by new items. The points should be properly set to provide a gap of .010" to .012" when fully open. (High lift cam .014" to .016".)

The condenser wiring and the low and high tension circuits should be ensured, as should the automatic advance and retard mechanism. Similarly the coil should be ensured.

The ignition timing should be checked and if necessary reset. The normal setting should allow the pointer on the scale shown in Fig. 28 to be in a central position, but in many cases it will be found that a more advanced position can be used without "pinking" and, indeed, the most advanced position consistent with freedom from knocking is recommended. To alter the ignition, it is merely necessary to slacken off the two nuts and to make small arcuate movements of the distributor head towards the marking "A" on plate to advance or vice versa. After an alteration to the ignition timing, the car should always be tested on the road.

Where it is necessary for any reason to fit a new distributor head this can be done as follows:—

Turn the engine round by the starting handle until No. 1 piston is at the top of its stroke (this position may be found by the employment of the hole in the fan pulley flange) and both valves are closed in this position, the slot in the helical gear boss which engages with the dog on the distributor shaft should be inclined at approximately 53° from the vertical position as shown in Fig. 10 with the slot offset towards the rear of the engine.

Accumulators.

The condition and state of charge should be checked at reasonable intervals of time as is recommended in the Electrical Section. Attention should be paid to the possibility of loose connections and corroded terminals. Terminals should be cleaned off and coated with vaseline.

Electrical wiring, dynamo and starter.

The condition of the wiring and the electrical connections under the bonnet should be inspected each six months, as should the operation and condition of the starter motor and dynamo.

Cooling system.

The water circulation and operation of the water impellor and thermostat should be investigated every six months.

Manifold system.

Quite apart from the scheduled first servicing operations, which are carried out free for the retail customers by the vendor, it is important that a six monthly check of the tightness of manifold nuts should be made. The tightening up of these nuts should be carried out with the engine cold in a symmetrical manner.

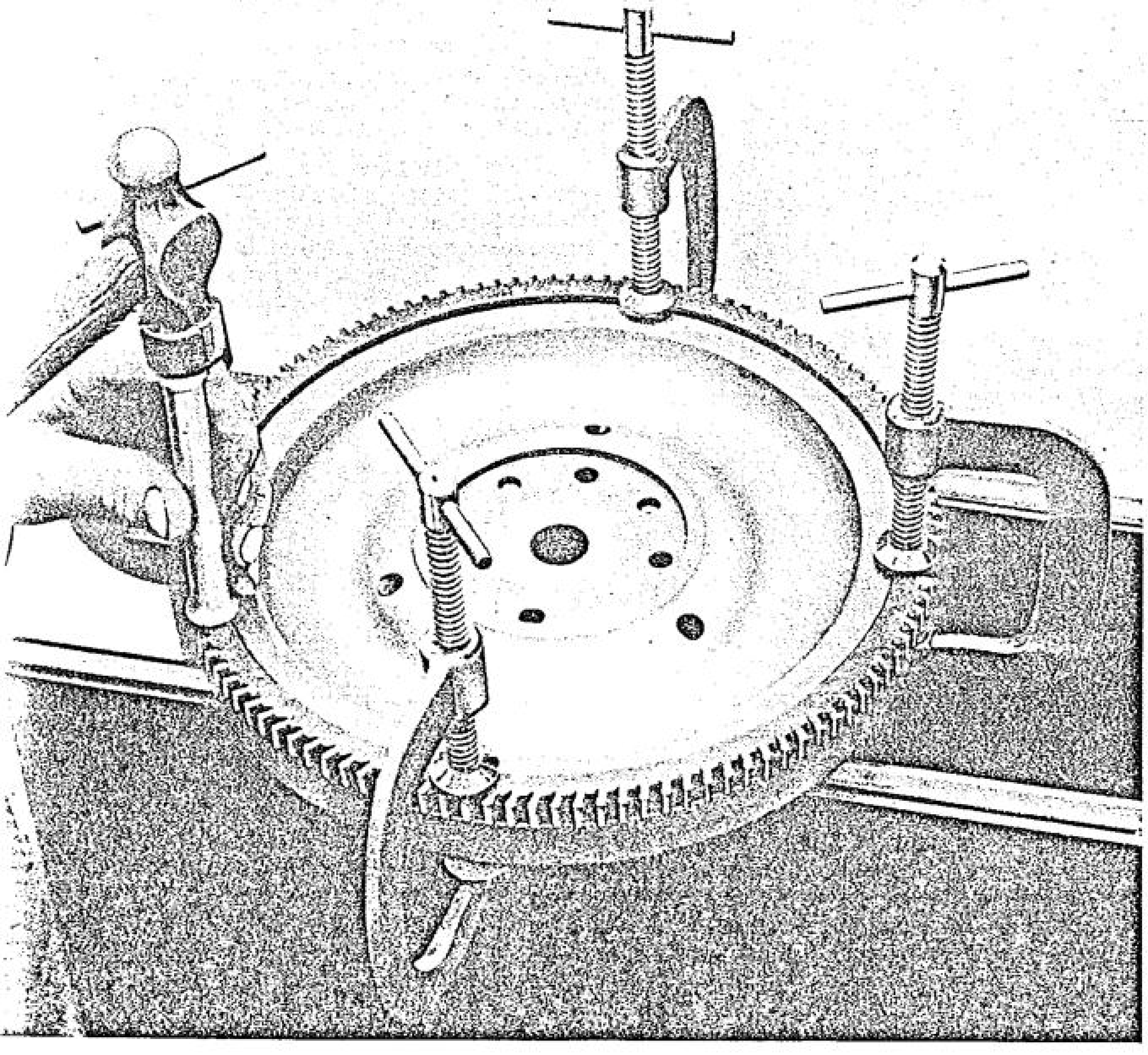


Fig. 55. Indicates the use of "G" Clamps when fitting new starter ring

Petrol system.

Clean out the petrol pump replacing the cork gasket if suspicion as to is condition exists. Ensure that the pump pressure is adequate if facilities exist for testing the pump against a pressure gauge, a figure of 1½ to 2½ lbs. should be registered.

The accelerator controls and linkage should be checked periodically with a view to ensuring that a full range of throttle movements is obtained.

The carburettor should be cleaned out thoroughly and the various jets blown out with compressed air, the use of pieces of wire to clean these out should be avoided.

The carburettor float should be examined for possible leaks and if such exist a replacement should be fitted as soon as possible in the interests of economy and performance.

The carburettor flange joints should be checked and, where necessary, such as where the carburettor is dismantled, new flange joints should be fitted. Having dealt with the possibility of air leaks to the induction system as recommended above, the carburettor volume control and throttle stop should be reset as described for the carburettor in "Fuel System."

Fitting replacement starter rings.

Where it is necessary to fit a replacement starter ring, certain precautions are required if its future life and hardness characteristics are to be ensured.

The method for fitting these ring gears without any danger of destroying the heat treatment is described below and its adoption will assist in ensuring the future life of the ring gear.

The engines fitted to the early Standard and Triumph Roadster Models were equipped with a starter ring ⅜" in width. The ½" wide starter ring, at present fitted, was introduced at Engine No. V.9881E with the Standard Models and at TRA.616E with the Triumph Roadster. All the 2-Litre Triumph Saloon Cars are fitted with the wider ring.

Where it is found necessary to replace one of the ⅜" rings it will become necessary to increase the depth of the flywheel spigot to ½" to accommodate the new gear. A flywheel and starter ring assembly may be obtained under our Service Exchange Scheme, where a repairer is not equipped to carry out the necessary machining of the flywheel to accommodate the wider ring.

The method of fitting the replacement ring gear involves the employment of four "G" clamps as indicated in Fig. 55. The installation of the ring can be quite easily carried out whilst cold, but the immersion of the ring in boiling water or the raising by other means to that temperature will assist somewhat in the operation, but greater heating than this is not recommended.

Before refitting the starter motor, the armature should be checked for end float. Where this is in excess of .010", the assistance of the local Lucas Agent should be sought with a view to having the existing starter motor adjusted, or in supplying a reconditioned unit.

The flywheel should be placed on a solid base and the ring gear offered up squarely and the most favourable position for its entry on the spigot selected and then the four "G" clamps should be fitted equally spaced around the circumference of the ring as shown in illustration The ring gear should then be tapped lightly on to the spigot with a soft metal drift, taking care to keep it square and to follow its progress on to the spigot by tightening up the "G" clamps.

Having thoroughly started the ring on the spigot, the "G" clamps can be dispensed with and the gear driven fully home against its flange on the flywheel.

Pressure oil filter assembly.

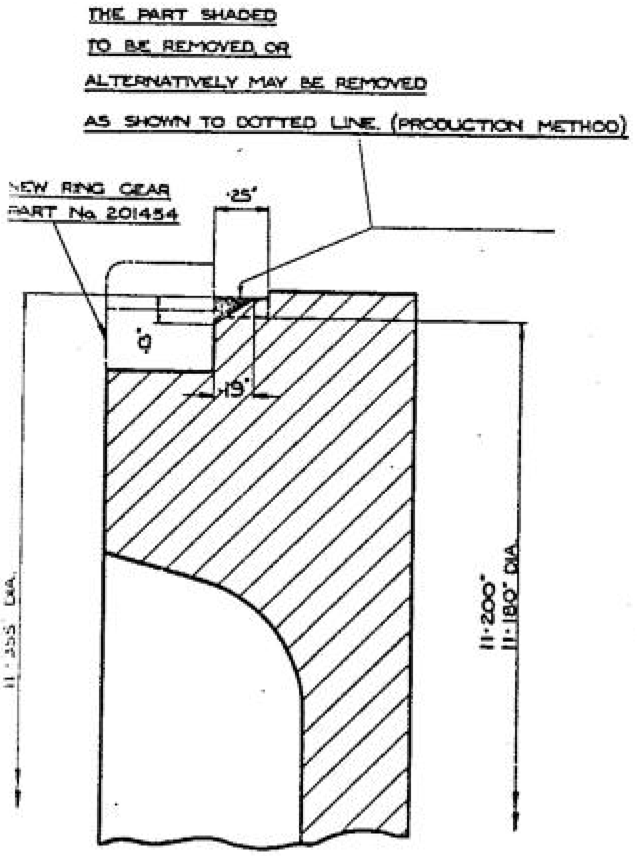
Early models of the Vanguard employed the Tecalemit Oil Filter Assembly, which is a full flow type of filter. A change over to the Fram Filter was made at Eng. No. V.312E, this type being of the by-pass variety, it being described in detail earlier in this Section. Yet another change in filter was made at Eng. No. V.89332E on standard models, when the Purolator was introduced, this also being of the by-pass type. The change to a Purolator filter was made on the Triumph Renown at Eng. No. TDB.2725E. The Purolator type of filter is still in use with Series II models and current Triumph Renown cars.

Oil filter elements.

It is most important that only the element designed for the filter which is fitted is used when fitting a replacement. Failure to regard this instruction may lead to serious engine damage.

Attachment of oil filter assembly.

Four bolts were used for the attachment of this assembly to the cylinder block up to Engine No. V.179369 and Engine No. TDC.1567, for the Standard and Triumph models. With this arrangement spring washers are fitted to three of these bolts and on the bolt which secures the



·g. 56. **Showing modifications required to flywheel to accommodate 8/10 pitch starter gear**

·essure pipe banjo two copper washers only are ·ed, one on either side of the adaptor. The ·o forward attachment bolts are wired, to ·event the one which secures the banjo adaptor ·orking loose.

The tightness of the four holding bolts is of ·nsiderable importance if oil leakages are to be ·oided. Periodic checks should be carried out ·to the tightness of these bolts; this particularly ·plies to the Pre-delivery Check and during ·itial maintenance checks. A nut tightening ·rque of 18-20 lbs./ft. is specified for these bolts. ·o carry out these checks necessitates cutting the ·ire on the two forward bolts and refitting as ·own in the inset in Fig. 59.

In units from the number quoted above, ·e bolt for the pressure pipe adaptor was ·placed by a stud and self-locking nut, the wiring ·ving been dispensed with as no longer neces·ry.

Tightening checks are still necessary with ·e new arrangement and the torque figures given ·ove still apply.

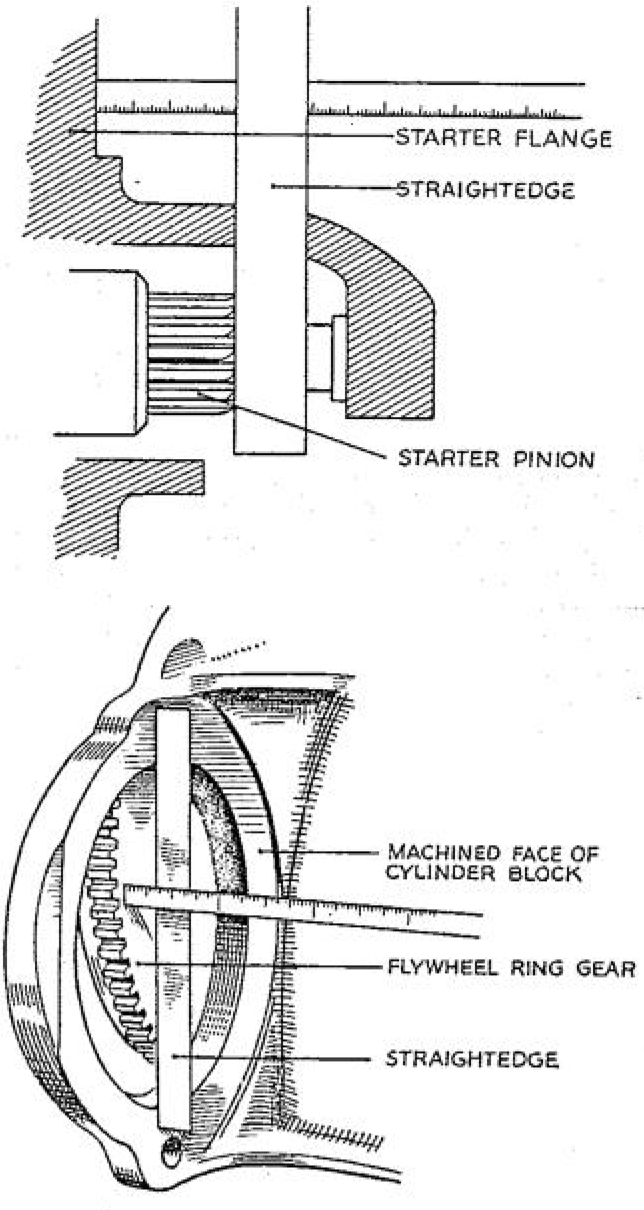


Fig. 57. **Upper illustration shows dimension "B" being measured, the lower sketch shows the measurement of dimension "A"**

To fit 8/10 pitch starter motor pinion and ring gear in place of 10/12 gears.

An alteration to the pitch of the starter motor pinion and gear ring was introduced at Engine No. V.178766E, on the Standard Two Litre models and at Engine No. TDC.1603E on the Triumph "Renown". This alteration entails the replacement of the former 10 tooth pinion and 117 tooth ring gear by gears having 9 and 91 teeth respectively.

In order to accommodate the larger 9-tooth pinion, an additional machining operation on the flywheel was introduced, which consists in a suitable reduction of the flywheel, as shown in Fig. 56. This machining operation requires the use of a lathe with sufficient capacity to conform with the method employed in this factory. The alternative method of providing the clearance which is shaded in the illustration, can be done without the aid of a lathe and, if carefully carried out, with little appreciable effect upon flywheel balance.

Starter motor pinion " out of mesh " dimension.

It is of considerable importance when fitting a new starter motor, or fitting a new pinion to an existing Starter Motor, or fitting a new pinion to an existing Motor, to ensure when assembling the unit on to the engine that the correct " out of mesh " dimension is obtained. It is also necessary when fitting a new pinion to an existing motor to ensure that the armature float is not excessive. The maximum float specified by Messrs. Lucas for armatures on Service Exchange Units is .010".

The correct " out of mesh " dimension for the starter pinion should lie between $\frac{3}{32}$" and $\frac{5}{32}$" and can be calculated, after making the measurements shown in Fig. 57, by subtracting dimension " B " from dimension " A ".

Where the " out of mesh " dimension is inadequate, this can be easily increased by fitting one or more shims, Part No. 102014, between the starter motor and engine mounting flange.

Where the pinion " out of mesh " dimension is excessive, the assistance of a Lucas agent may be necessary to obtain a Service Exchange Unit which will provide a " B " dimension suitable to allow the required pinion position.

Method of making oil seal for rear crankshaft main bearing.

When fitting a rear main bearing cap it is important that the following procedure be adopted :—

1. Apply sealing compound to flange of top half seal, then slide this half seal round the crankshaft into position. Fit the four seal setscrews, tightening these until they are only just binding.
2. Insert a 12" length of .003" feeler strip between the crankshaft seal and rear journal.
3. Tap top seal on to feeler gauge so that this is lightly nipped, then lock the four setscrews. Remove feeler strip.
4. Apply sealing compound to joint face of bottom half seal and sparingly to joint faces. Fit seal to cap with four setscrews just nipping.

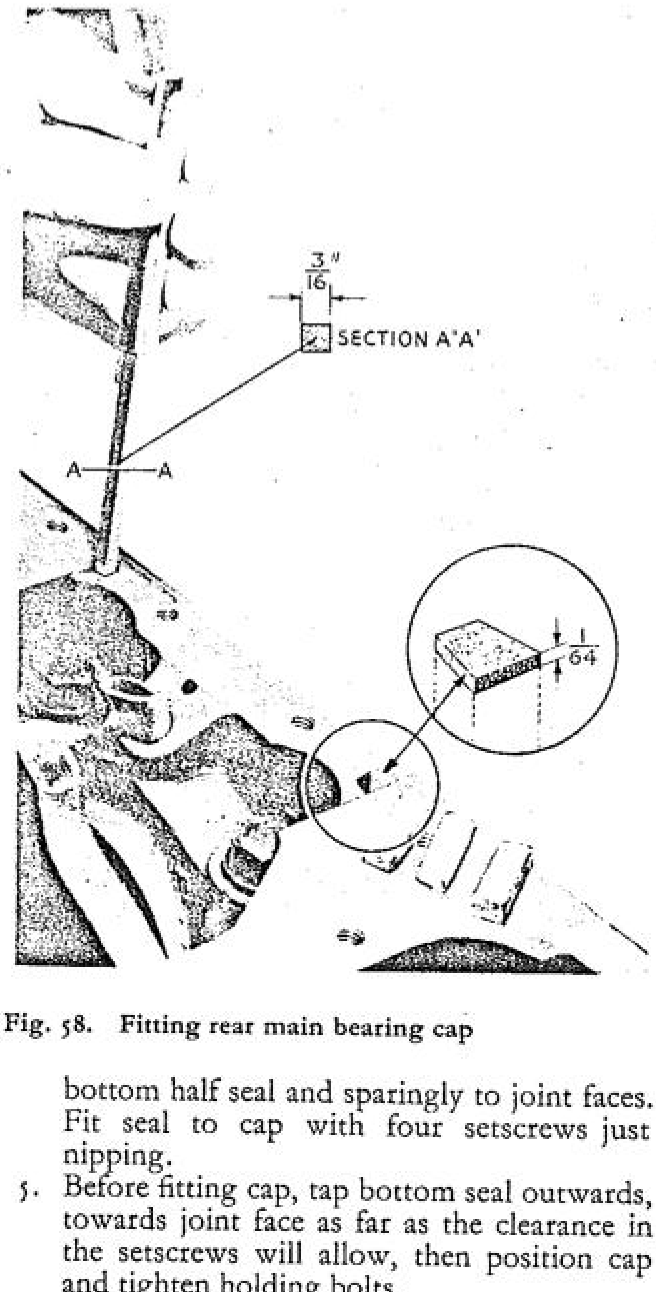


Fig. 58. Fitting rear main bearing cap

5. Before fitting cap, tap bottom seal outwards, towards joint face as far as the clearance in the setscrews will allow, then position cap and tighten holding bolts.
6. Finally tighten the setscrews for the lower seal.
7. (a) Cut packing felt into $\frac{3}{4}$" lengths and soak these in a suitable jointing compound.
   (b) Use a brass punch shaped to fit the felt grooves to drive the felt strips into the two grooves. Having completely filled the grooves, they should be cut off with a sharp knife so as to leave the felts to stand $\frac{1}{64}$" proud, as shown in the illustration (Fig. 58).

Excessive engine oil consumption.

As a result of complaints of heavy oil consumption with small batches of new cars, certain modifications were introduced with the Standard and "Renown" models.

Where difficulties of this description are experienced, where the condition of the engine in other respects is satisfactory, the following points should be investigated in the order given:

1. The oil levels in the engine sump were found to be unnecessarily high and it was decided to lower this with a view to preventing wastage. In order to lower the level, the length of the dipstick from the underside of the collar to the bottom of the rod was increased to 7" in the case of the "Vanguard" and 6½" for the "Renown". This modification was made at Engine No. V.165790E on the "Vanguard" and at Engine No. TDC.713E on the "Renown," decreasing the oil capacity to 11½ and 12 pints respectively for the models mentioned. The oil capacities quoted are those required to bring the level up to the top mark on the dipstick with a perfectly dry engine. The detail numbers for these two dipsticks are 102012 and 102139 for the Standard and "Renown" respectively.
2. The breather valve was originally fitted in the Manifold, but its design and position were altered on Eng. No. V.152890E and Future on Standard models, and at Eng. No. TDC.6469E and Future with "Renown" engines. From tests made an appreciable improvement in oil consumption followed this alteration. To make this change it is merely necessary to remove the split pin from the old valve and to open out its hole to $\frac{9}{32}$", retaining the modified adaptor in the manifold. The new breather valve, Part No. 103816, should be fitted to the banjo end of the connecting pipe in the rocker cover in place of the existing screw.
3. The valve guides fitted, until quite recently, were provided with an internal chamfer on their upper faces and a sharp edge at the lower end. This chamber round the valve stem allowed oil to collect and pass into the combustion head. To deal with this difficulty, the guides should be reversed in the cylinder head and to facilitate their installation an external chamfer should be made on each guide, similar to the one originally supplied for this purpose.
4. A chromium-plated top compression ring was fitted on pistons up to Eng. No. V.178768E on the Standard models and Eng. No. TDC.1603E on "Renown" cars. Owing to the time these rings took to "bed in" it was decided to fit normal cast iron ones, thus eliminating initial complaints of heavy oil consumption, which were experienced when there were any initial slight ring irregularities.
5. Quite apart from the change in position of the breather valve mentioned in (2), a periodic examination of the breather valve should be carried out to provide against the possibility of a restricted valve. A restricted breather valve, by allowing a build up of crankcase pressure, will cause oil seal leakage, which, when it occurs at the rear end, can not only lead to heavy consumption, but also cause damage to the clutch friction faces.

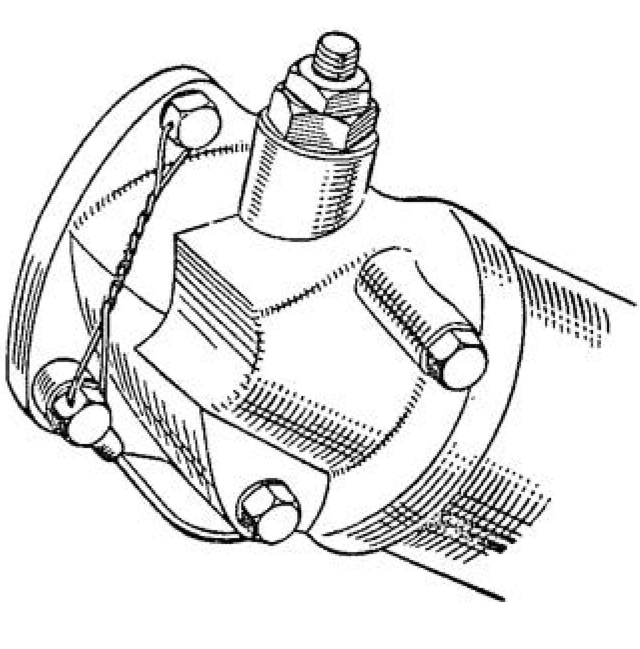


Fig. 59. Showing correct method of wiring filter bracket holding bolts. (Engines up to V179369 and TDC1567.)

"VANGUARD"—SERIES II

ENGINE

SUPPLEMENT

For the " crankcase ventilation " description given on Page 11 for Series I models read :—

" Crankcase ventilation is arranged on all but a few early cars, by means of air entering through two slots in the oil filler cap. The filler cap is located by a bayonet fixing to position the slots to face in a forward direction.

The oil filler cap contains a wire gauze filter through which the incoming air must enter before passing, by way of the rocker cover and push rod tubes, to the engine sump. The filtered air replaces the gases ejected from the sump through the inverted " U "-shaped exhauster pipe, which fits into an adaptor on the left-hand side of the crankcase. The gases are ejected by the combined effects of normal sump pulsations and the slipstream operating on the specially shaped lower end of the exhauster pipe."

On Page 24, to information given for setting ignition timing on Series I models, add the following :—

" With this model a vernier adjuster screw is provided on the distributor for fine adjustment of the ignition. This adjuster screw must be turned anti-clockwise to advance and vice versa to retard. One division on the adjuster screw scale represents 2 degrees movement of the distributor itself and this corresponds to 4 degrees of flywheel movement.

For reference purposes in these Works, the adjuster screw is set on the fourth mark (from the diaphragm) with the contact points just breaking at T.D.C. of No. 1 cylinder's firing stroke. This initial setting should, of course, be treated as a reference point only, as subsequent adjustments may be made after engine build."

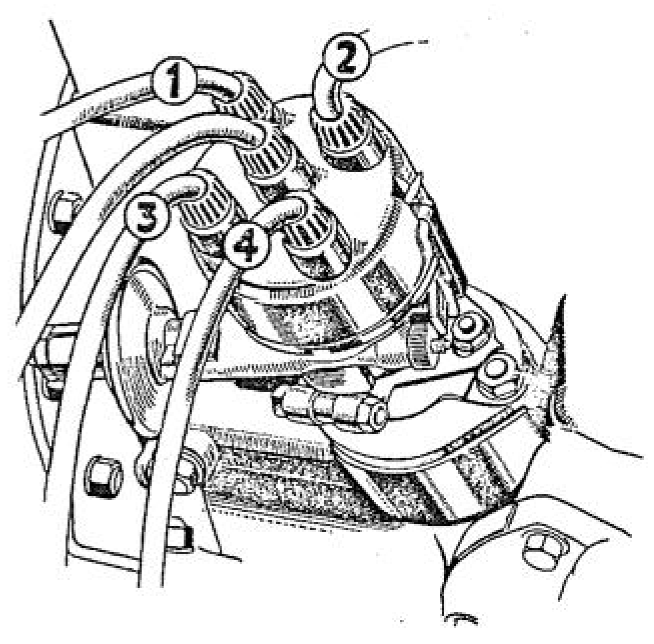


Fig. 1. Showing ignition timing adjuster and wiring of distributor

CRANKCASE VENTILATION

(Fig. 4.)

Description.

The crankcase ventilation system used on these models is somewhat different from that used on the Series I model.

The new arrangement has the virtue of simplicity and requires no maintenance attention, which was necessary with the previous system if this was to function properly.

To enable the ejection of the crankcase gases there is a large bore pipe in the form of an inverted " U " (see Fig. 4), which is fitted into an adaptor in the left-hand side of the crankcase. The adaptor is fitted into a boss which was previously used to accommodate the tapped hole for the breather pipe union used with Series I models. (The adaptor used with this later arrangement may be replaced by one to take the breather pipe union, if it is desired to use the later cylinder block for a Series I engine).

One end of the " U "-shaped outlet pipe fits into the crankcase adaptor and is located therein by a strap from the other branch of the " U " to one of the sump attachment bolts. The exposed end of this outlet pipe is cut off at an angle to provide a large area opening into the slipstream underneath the car.

Air enters the rocker cover through two slots cut in the special rocker cover oil filler cap. This cap has a built-in filter gauze, through which the air passes, and is located on the rocker cover filler pipe by a bayonet fixing to ensure that the two slots face forwards. The filter cap is held down in the rocker cover by a spring clip which grips on the inside of the filler pipe.

The filtered air passes into the sump by way of the push rod sealing tubes.

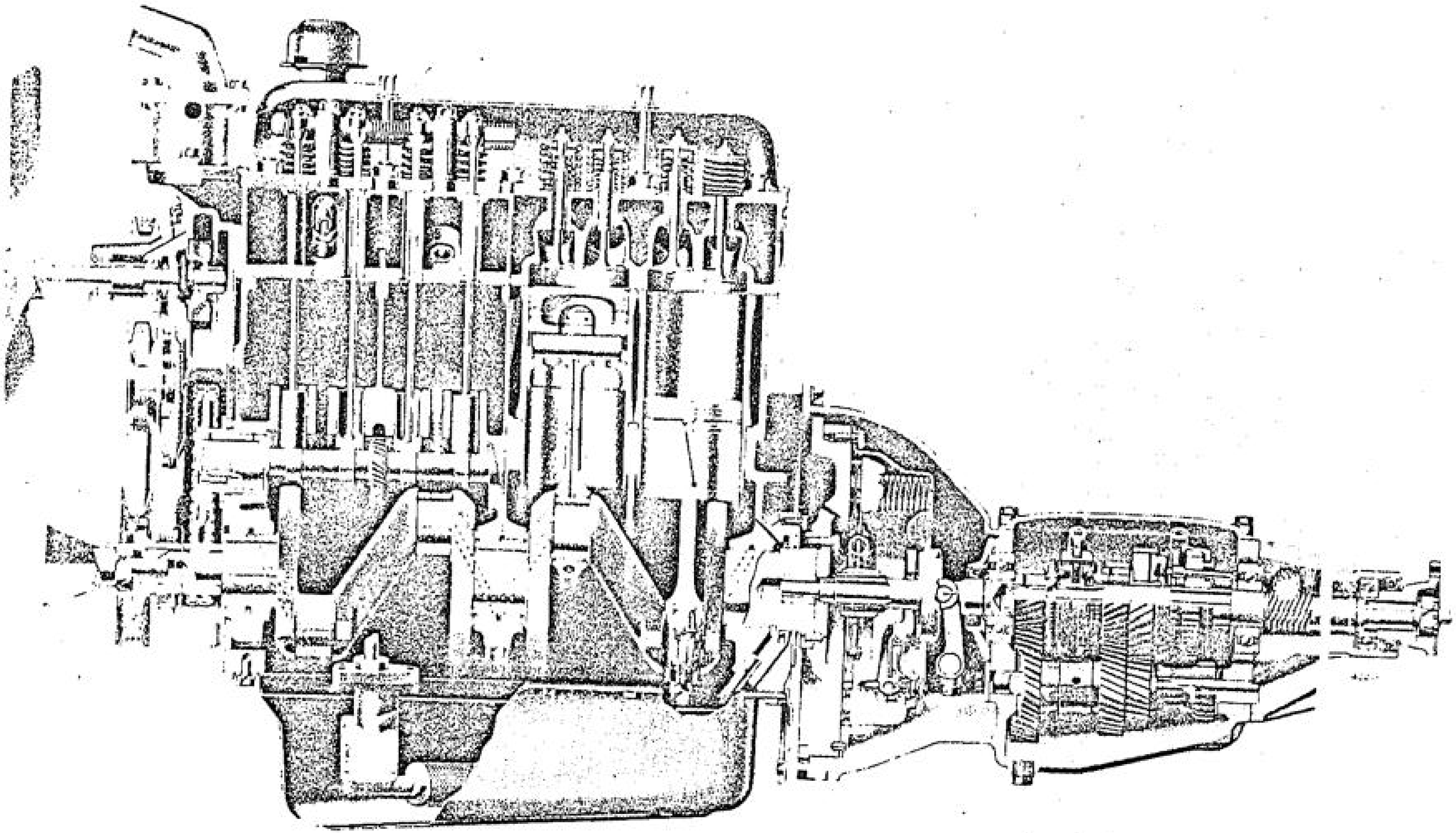


Fig. 2. Longitudinal section of engine and gearbox.

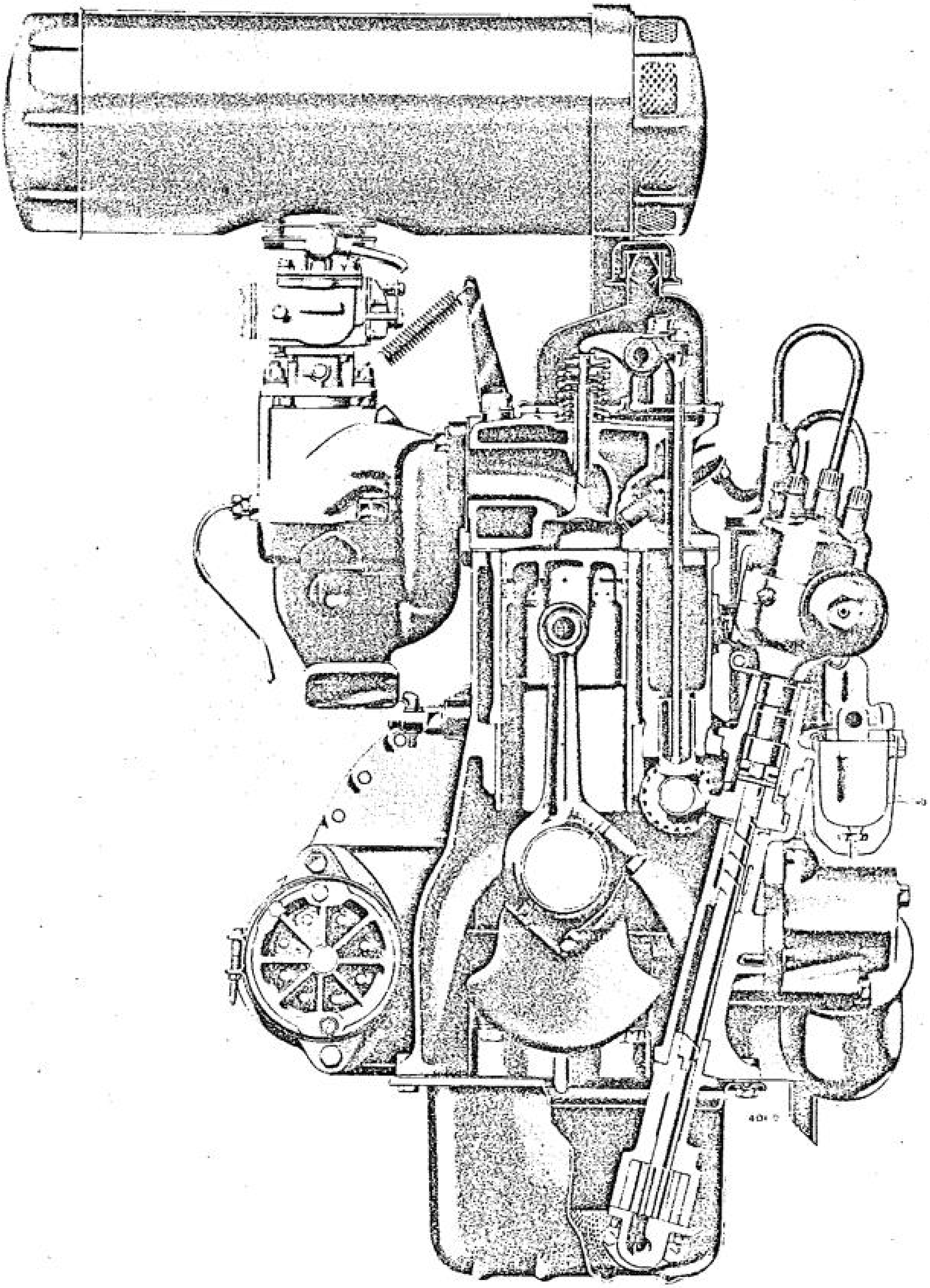


Fig. 3. Cross-section of engine

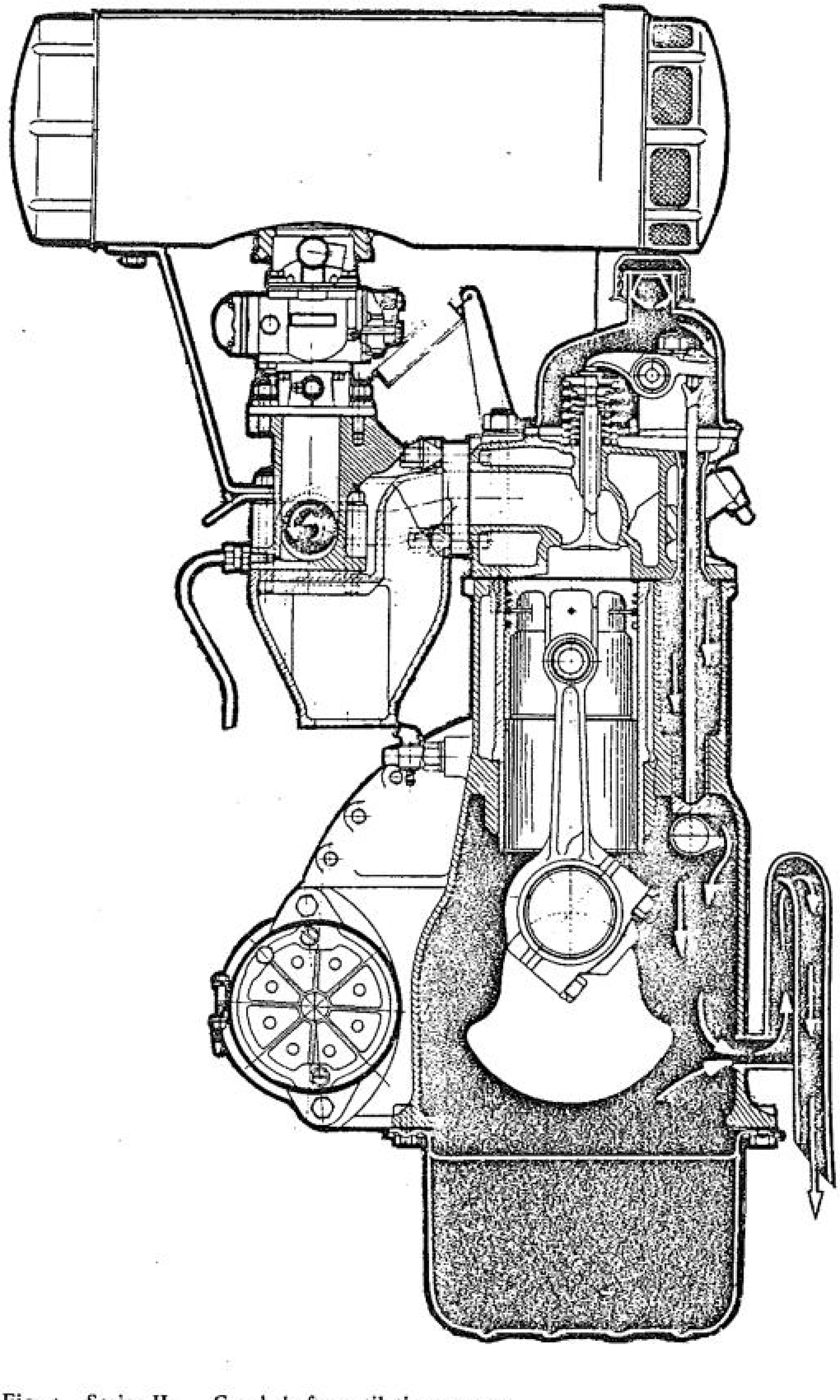


Fig. 4. Series II. Crankshaft ventilation system

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Service Instruction Manual

Fourth Issue

STANDARD VANGUARD

SERIES I AND II

and

TRIUMPH "RENOWN" MODELS

COOLING SYSTEM

SECTION C

COOLING SYSTEM

INDEX

ILLUSTRATIONS

Series II Supplement

COOLING SYSTEM

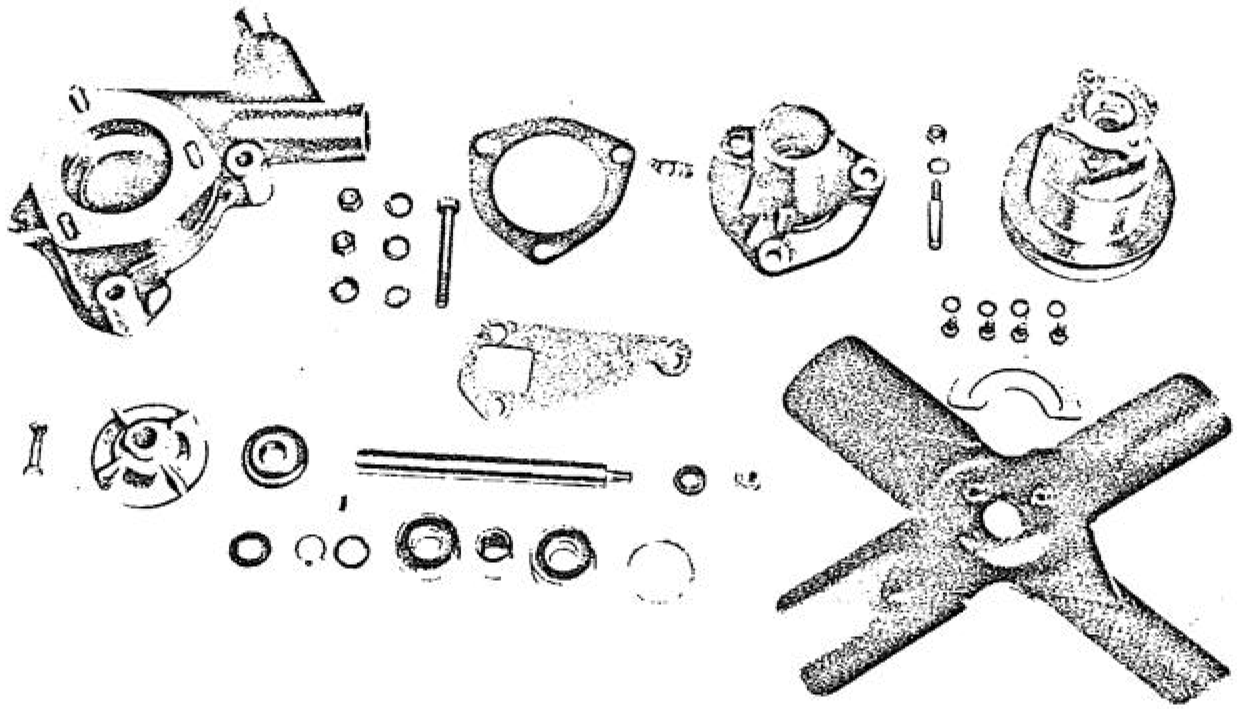

Fig. 1. Exploded view of water pump items—assembly Detail No. 500113 (used on Engine Nos. V46611E and future)

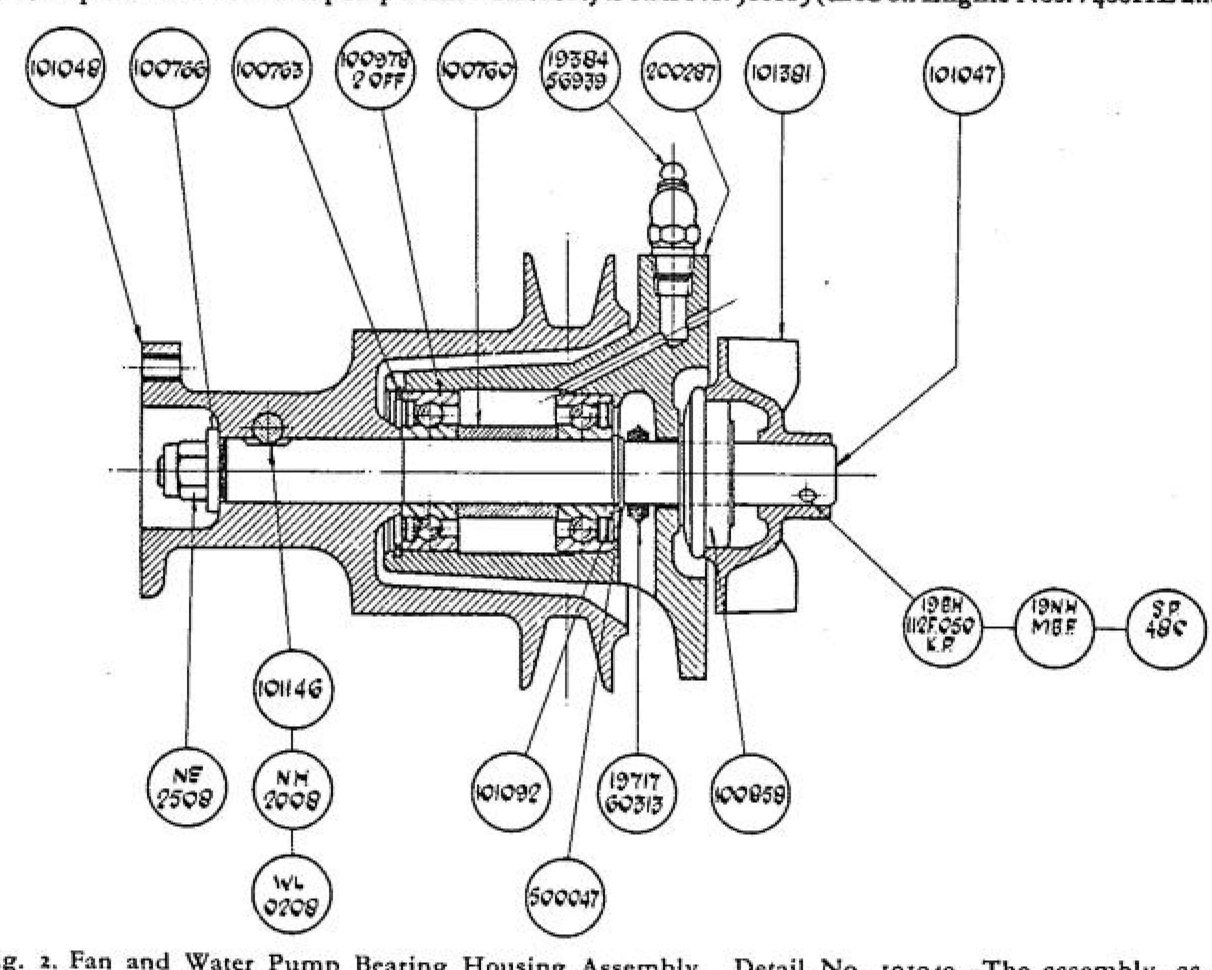

Fig. 2. Fan and Water Pump Bearing Housing Assembly. Detail No. 101049—The assembly, as shown, was introduced at Eng. No. V.46611E, but used from V.42140E and V.46610E with the Seal and Impeller fitted to Water Pump 58910.

COOLING SYSTEM

The cooling system is thermostatically con-
rolled with a pump to circulate the water and
. generous system of water jacketting, with
areful consideration given to the important
oints such as sparking plugs, etc., where
dequate cooling is important.

The water pump, shown in Figs. 1 and 2
s supplied with a fan blade assembly which is 14"
n diameter and provided with four blades being
riven in tandem with the dynamo by the fan
ulley on the front end of the crankshaft.

WATER PUMP AND FAN ASSEMBLY

To remove.

The following procedure is recommended :—

1. Drain cooling system.
2. Disconnect hose connections.
3. Remove fan belt after slackening this by adjustment of dynamo's position. To adjust position of dynamo and hence of the belt tension, slacken off at points "1", "2", "3" and "4" shown in Fig. 3. The correct belt tension should allow ¾"—1" sag in the vertical link with moderate hand pressure. Over-tightening of belt will damage the dynamo bearings (see also page 8).

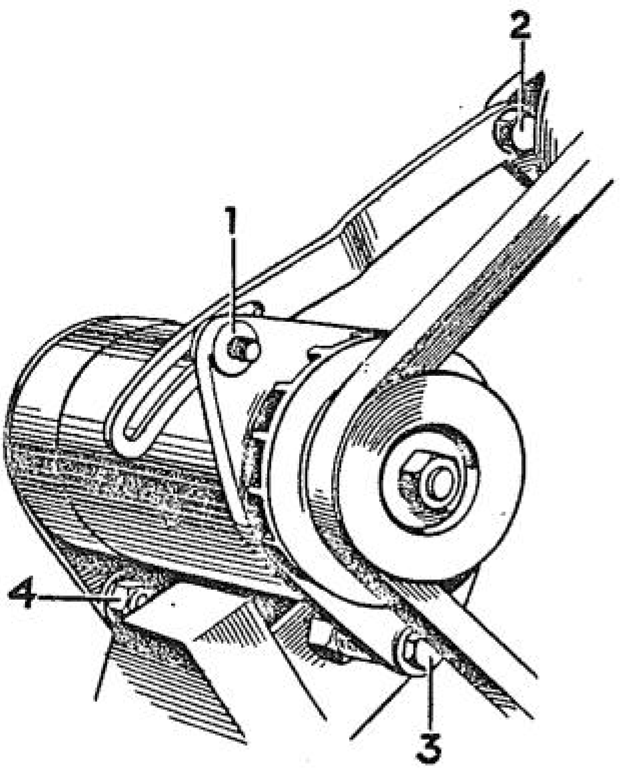

Fig. 3. Points for fan belt adjustment

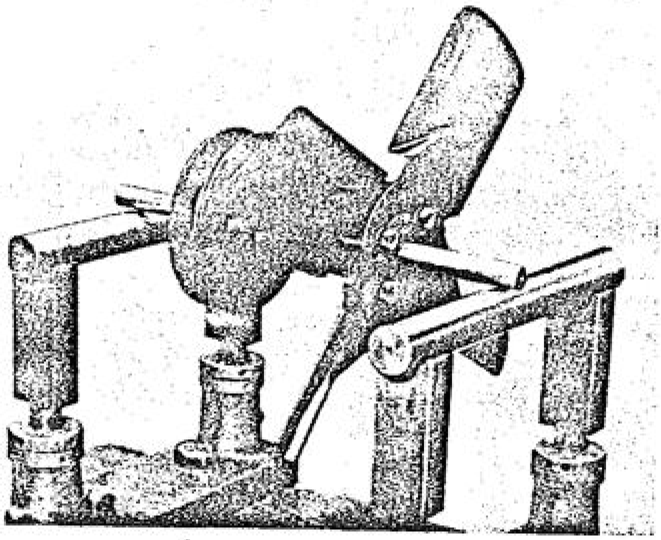

Fig. 4. The balancing of fan blade assembly, also showing the hole to be drilled for location of balancer

4. The water pump can now be removed after withdrawal of the bottom bolt on each side, then unscrewing as far as possible of the second bolt from the bottom on the right-hand side and the removal of the top dynamo link setscrew.

To dismantle water pump and fan assembly.

1. Detach bearing housing from the main body by removal of two $\frac{9}{16}$" A/F nuts. The removal of these nuts will leave one bolt in the bearing housing flange, which cannot be removed until the fan pulley has been extracted, and this bolt will naturally have to be fitted on reassembly before the fan pulley.
2. Remove fan blade assembly after removal of four ¼" bolts, spring washers and balance piece. The fan extension is balanced during manufacture as shown in Fig. 4 and must, therefore, be reassembled in its original position, the balancer position is indicated by the drilling of a small hole through the balancer and into the fan blades.
3. Extract fan pulley extension as shown in Engine Section, after removal of Simmonds nut and washer.
4. Remove bolt securing impeller to bearing spindle and withdraw impeller. The spring, seal and carbon gland are a self-contained unit. (See also "Note", page 3.)
5. Remove bearing retainer circlip and tap out spindle with two bearings, spacer, distance

washer, small circlip and synthetic rubber spinner. Note position of seals on bearing facing outwards for re-assembly.

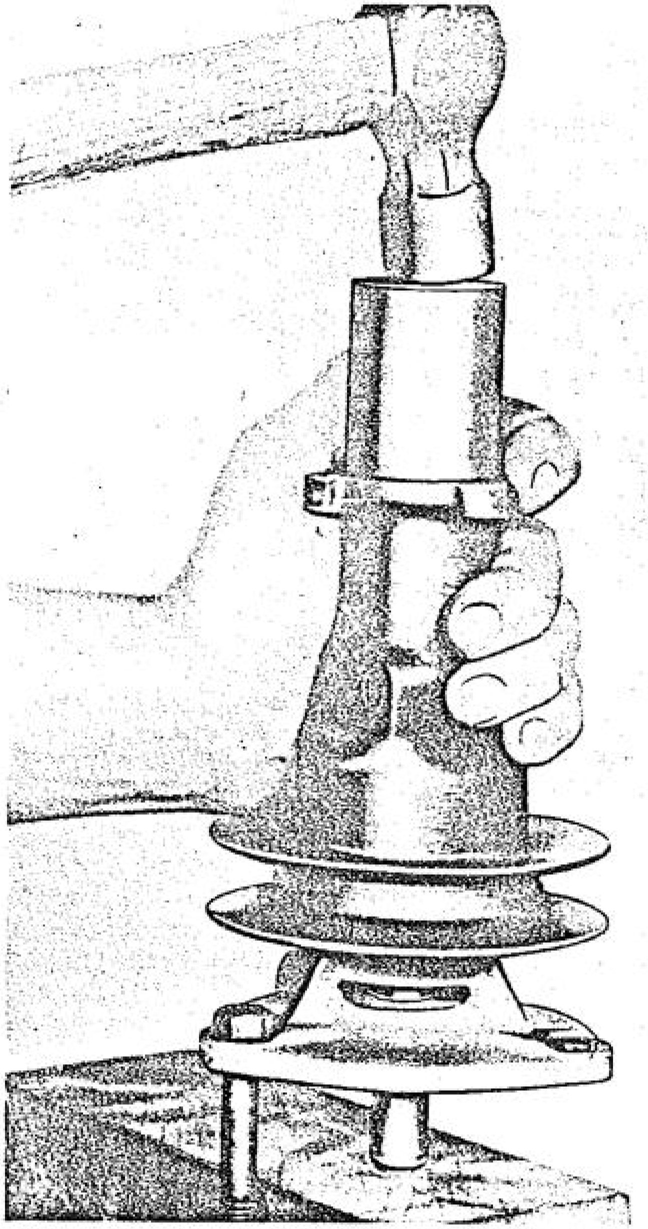

Fig. 5. Fitting fan extension bracket to bearing housing

6. Tap spindle out of ball bearing, thus freeing distance piece, and remove washer circlip and rubber spinner.

Reassembly of water pump and fan assembly.

1. First ensure the condition of the bearings, the water seal and the machined face against which the carbon ring bears, proceed to assemble the Unit as indicated below.
2. Fit small circlip and hardened washer on spindle.
3. Thread synthetic rubber spinner on to rear end of spindle and position against small circlip.
4. Assemble rear spindle bearing, distance sleeve and forward race onto spindle. Place bearings with grease seals outwards.
5. Pack bearings with grease and fit spindle and bearings into housing. Little more than hand pressure should be required to the outer rings of these bearings.
6. Fit bearing retaining circlip into the recess.
7. Centralize the spring in the rubber seal and fit this assembly into impellor.
8. Having tapped the impellor on to the end of the spindle, this is secured thereto with the small bolt, fitting lead linger under head and spring washer. The end of the spindle and the outer face of the impellor end should then be soldered with low melting point solder (minimum 150°C.) to provide a seal against water seepage down the spindle. Care should be taken to avoid overheating. This new method of water sealing for the spindle was introduced in Production at Engine Nos. V.181626E and TDC.1870E, respectively, for the Vanguard and Triumph Models. (See note *re* fitting of "press type impellor now in use".
9. Having fitted loose bolt in housing flange, match cotter pin hole, in fan extension bracket, with flat on spindle, tap assembly into position and secure with cotter pin and $\frac{1}{2}''$ A/F nut. Fit Simmonds Nut and plain washer to spindle.
10. Position fan blades and any balancing pieces on fan extension bracket, matching holes in balancing piece with that drilled in the bracket, with a $\frac{1}{8}''$ dowel. Secure assembly to bracket with four $\frac{7}{16}''$ A/F headed set-screws and spring washers.
11. This completes the assembly of the water pump bearing and fan assembly which must now be fitted to the water housing.

Note:—After Eng. Nos. V.200,970E (Series II) V.184788E—V.200,000 (Series I), and TDC. 2057E, a new impellor and spindle, 105981/2, were introduced with which arrangement the impellor is a press fit on the spindle. When refitting a "press on" type impellor, solder should be used to the end of the spindle to ensure sealing.

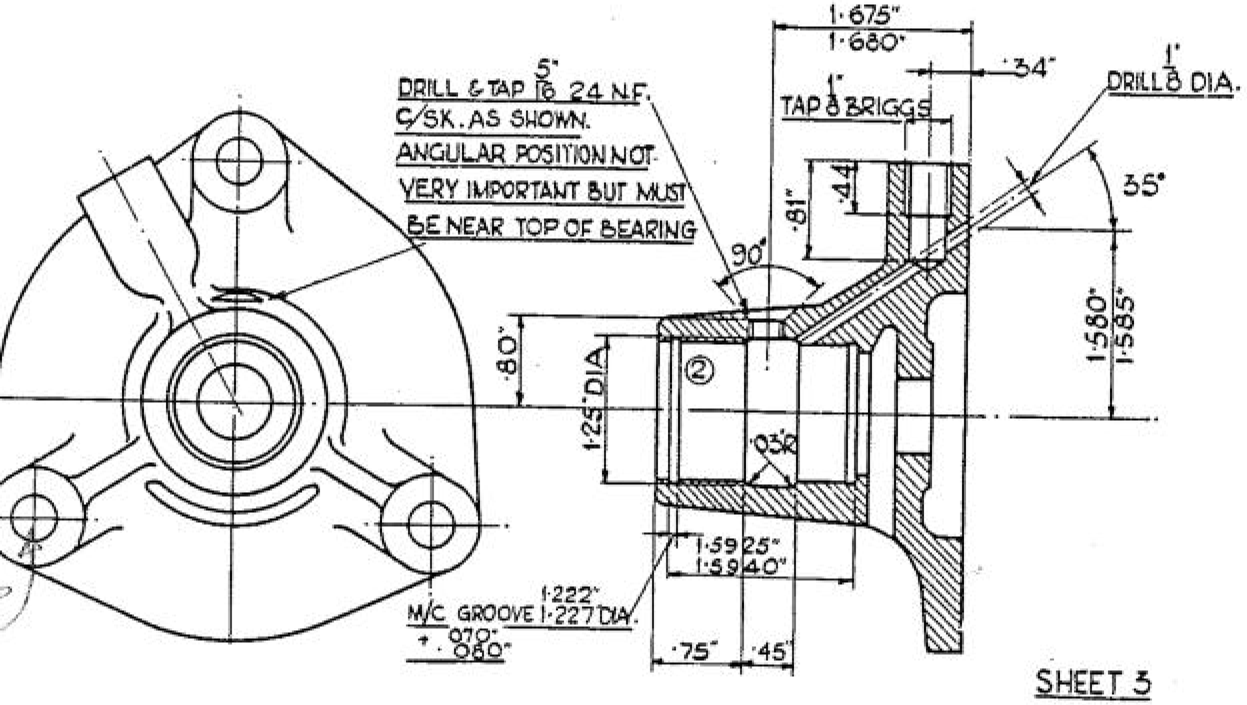

Fig. 6. Service mod. to water pump bearing housing Standard and Triumph 2-litre model

SERVICING WATER PUMP DETAIL No. 58910

When dealing with the reapair, or overhaul, of this type of pump, certain modifications are recommended, which are outlined below.

This pump assembly was fitted with the 2-litre cars, on the engine numbers, for the models as quoted :—

Standard Models—Engine No. V1.E to V.42139E (inclusive).

Triumph Saloons—Engine No. TDA.1E to TDA.1938E (inclusive).

2-Litre Triumph Roadster—All engines.

When servicing this water pump the procedure set out below should be adopted :—

1. Remove fan belt.
2. Remove water pump bearing housing with fan extension bracket. Note the position of the bolt which comes away with the assembly for refitting.
3. Dismantle assembly by removal of :—
   (a) Impeller and seal.
   (b) Fan extension bracket.
   (c) Circlip and/or vent plug.
   (d) Bearing assembly.
4. Drill, countersink, tap, turn undercut and circlip groove (if necessary). For dimensions and details see Fig. 6.
5. Clean and blow through holes.
6. Fit bearing assembly and circlip, hole in bearing must line up with hole in housing.
7. Fit grease nipple Detail No. 56939 and screw vent plug Detail No. 100446 into position "centre popping" opposite slot to locate. Where a vent plug is already fitted it will be necessary to machine, or file, a flat on the small diameter of this plug to allow for the passage of grease into the bearing assembly.
8. The existing water seal and impeller assembly should be replaced by the latest assembly Detail No. 101390.

Precautions to be observed during assembly.

When assembling the impellor on to the bearing spindle, it is important to seal the impellor and spindle against water seepage, as described in operation 8 on page 3. The importance of avoiding excessive heat, which would be injurious to the rubber seal, is emphasized.

When assembling the bearing assembly into its housing, care should be taken to apply pressure on the outer ring of the bearing only whilst supporting the base of the housing. This precaution is necessary to avoid damaging the bearings.

The use of a 5/8" reamer through the fan hub is recommended, as this will greatly assist the fitting of this extension. If such a reamer is not available for this operation, it will be necessary to support the other end of the spindle on a hard piece of wood, whilst tapping the bracket home.

For the purpose of these instructions, it is naturally assumed that the water pump assembly is as originally assembled and fitted in this factory when the car was manufactured.

REMOVAL OF RADIATOR

Drain the radiator by means of the drain tap shown in Fig. 12. Raise the bonnet and disconnect the top and bottom water hoses from the radiator block.

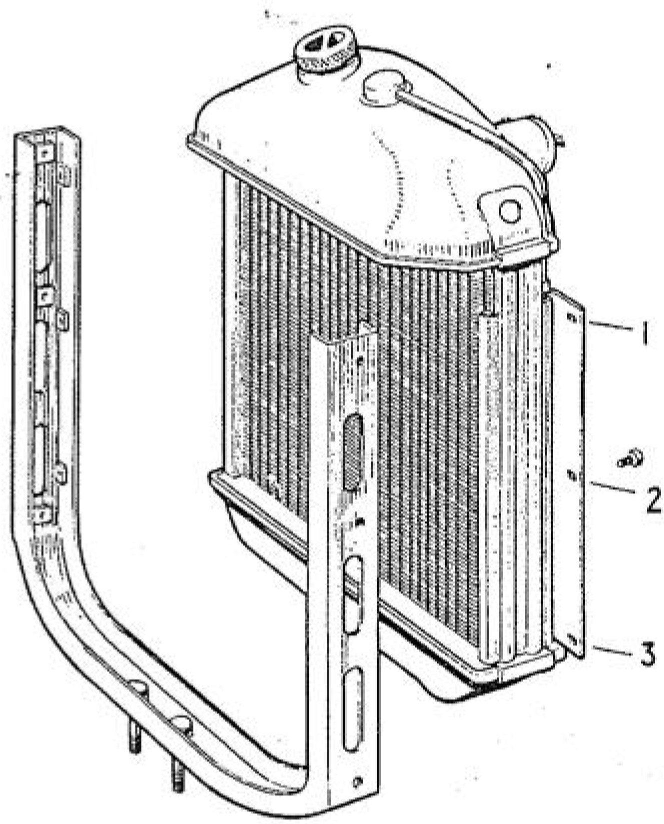

Fig. 7. Showing points of attachment for radiator block

Remove the six $\frac{5}{16}''$ setscrews—there are three to each of the two radiator side brackets, as can be seen in Fig. 7 A $\frac{1}{2}''$ A/F spanner is required for this purpose.

THE THERMOSTAT

(Models up to V.85,000).

With the Two Litre Standard Models up to approximately V.85,000, and for Triumph Cars equipped with this engine up to Commission No. TDB.1962, a thermostat was used, with which the element was an integral portion of the housing. With later Models a "plant in" type of element was introduced, which was used in conjunction with a separate housing.

Arrangements have also been made to cater for sub-zero weather conditions with both types of thermostats.

The normal element setting permits this to start to open at 75° ± 2°C. and to fully open at + 12°C. The element for use under sub-zero conditions starts to open at 85°—87°C. and is fully open at 97°C. It is important that, when using a sub-zero type of element, *a revision is made to the normal setting when temperate weather returns.*

With Standard Cars, up to V.42897 and on all Triumph Models up to the introduction of the "Renown," the thermometer capillary tube union fits into a special adaptor which is screwed into the Thermostat body. With later Models, this union screws directly into the housing. It is important, therefore, when ordering replacement thermometers to service these cars, that the correct item is ordered.

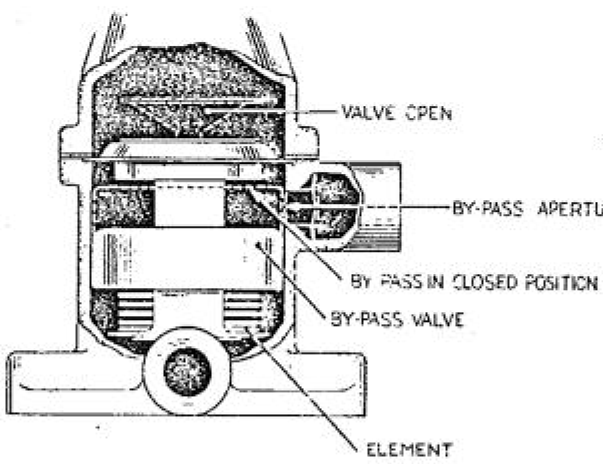

Fig. 8. Sectional view of thermostat

Description. (Fig. 8).

The thermostat is fitted in the cooling system to control the flow of water until the engine reaches its normal working temperature.

COOLING SYSTEM

When the engine is started up from cold, :he water is forced into the cylinder block by the water pump, through matched apertures in the pump housing and cylinder block. The water circulates round the cylinder block and combustion head, leaving the latter through the thermostat. The thermostat valve remains closed until a certain temperature is reached and thus a by-pass is provided connecting the thermostat body to the water pump to complete the water circulation, until the thermostat valve opens. The circulation of the water, when warming up, may be appreciated by reference to Fig. 9. (Fig. 10 shows normal circulation.)

As the cooling water temperature rises, the valve in the thermostat opens correspondingly, until when normal running temperature is reached, the valve is fully open and free passage of water through the outlet hose to the radiator is permitted. The thermostat valve is so set as to commence to open at 75°C. ± 2°C. and the opening operation is complete 12°C. after commencement, for normal climates. For sub-zero conditions an alternative thermostat is available.

With this thermostat, provision is made for the by-pass to be sealed off when the valve is fully open, which will be appreciated by reference to Fig. 10. This sealing of the by-pass avoids loss of cooling capacity when this is most required, *i.e.*, when the engine is very hot.

To test thermostat for valve opening.

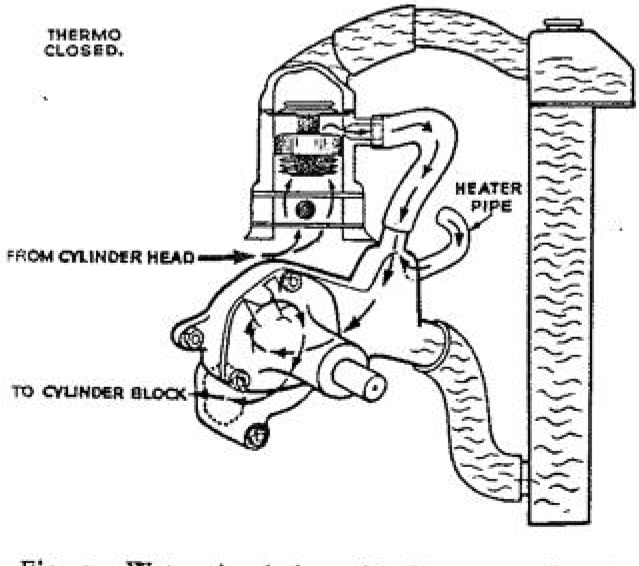

Fig. 9. Water circulation with thermostat closed

If doubt exists as to the correct operation it can quite easily be tested after removal from the combustion head.

Having removed the thermostat unit from the engine, it should be tested in a bowl of water, at a suitable temperature, employing an accurate thermometer to ascertain that the valve does commence to open at the correct temperature. There is no need to check the temperature at which the valve is fully open as this will automatically follow if this opening operation commencement figure falls within the prescribed limits.

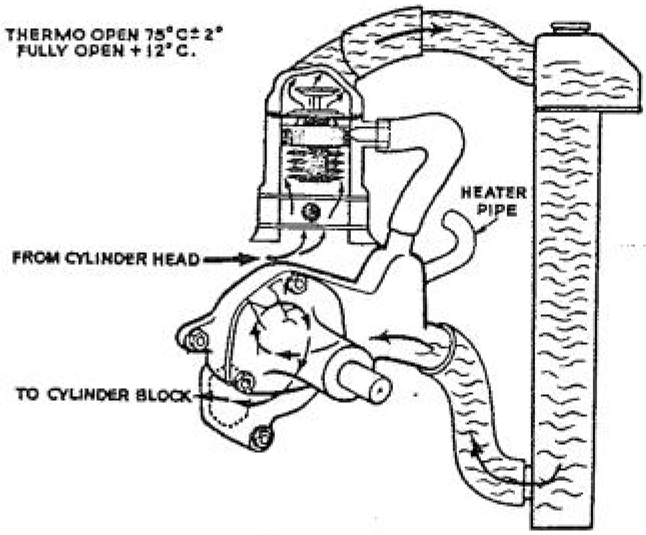

Fig. 10. Water circulation with thermostat open. Sub-Zero thermostat starts to open at 83° C. —87°C. and is fully open at 97°C.

Radiator thermometer.

This is illustrated in Fig. 11 the capillary being connected to the thermostat.

Where doubt exists as to the correctness of the gauge readings, the instrument can be checked by inserting the element in a container of hot water, and the reading of the gauge compared with that shown on an accurate thermometer. The thermometer assembly is non-adjustable and where a test discloses incorrect readings, a new assembly should be fitted.

When ordering a replacement thermometer the Commission Number of the Car should be stated. (See remarks under " Thermostat " above).

ANTI-FREEZE PRECAUTIONS

During frosty weather some precautions must be taken to protect the engine from damage.

The draining of the radiator and cylinder block at the points shown in Fig. 12, although protecting the car against frost in the garage, the use of anti-freeze mixture is strongly recom-

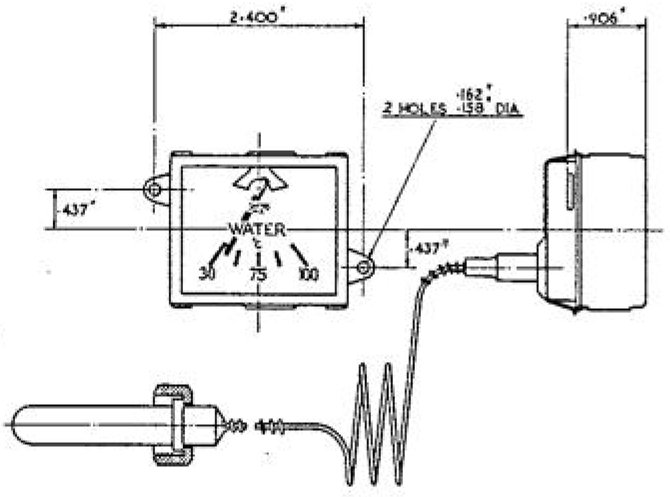

Fig. 11. Radiator thermometer

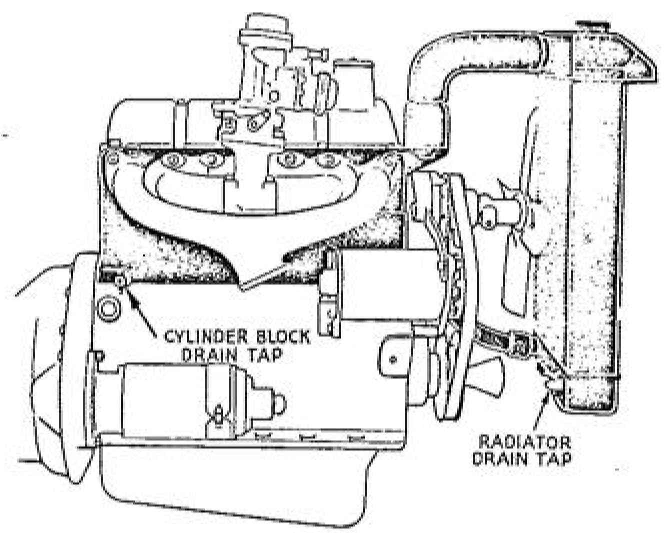

Fig. 12. Showing draining points for cooling system

mended. It is quite possible, under extreme conditions, for the radiator to freeze either when starting with the thermostat valve closed, or when in use on the road.

Bluecol, in common with some other anti-freeze preparations, has a small proportion of a corrosion inhibitor added which is naturally of benefit to the cooling system.

Recommended Bluecol proportions for protection from various degrees of frost are as follows :—

Degrees of Frost (Fahrenheit)	15	25	35
Proportion (Per Cent)	10	15	20
Amount of Bluecol (Pints)	2	3	4
Water Cooling Capacity	18 pints		

Before adding anti-freeze compound, take steps to ensure that all the water hose clips are secure and that the cylinder head nuts are tight. If, owing to a leaky gasket, the solution finds its way into the engine, it may be burnt into a tacky substance which will cause damage to the engine.

The anti-freeze preparation will not itself evaporate, thus apart from loss by leakage, it is only necessary to top up with water as the radiator level drops.

It is a wise precaution, when using anti-freeze mixture, to employ some method of indicating the fact for the enlightenment of other repairers, who may be called upon to carry out adjustments for the customer.

DEFECTS IN COOLING SYSTEM

Engine overheating.

This difficulty may arise owing to a variety of causes, which are as follows :—

1. Ignition timing too late or automatic advance and retard mechanism not operating properly.
2. Fan belt slipping or incorrectly adjusted.
3. Insufficient water in the cooling system due to loss or improper filling.
4. Radiator and/or cylinder block restricted by accumulations of sludge, dirt or other foreign matter. The cooling system should as a matter of routine be properly flushed out once every year.
5. Thermostat not opening at the proper temperature (see notes on " Thermostat ").
6. Pre-ignition which may arise due to a variety of reasons.
7. Weak carburettor mixture caused by incorrect carburettor jet setting or air leaks to the induction system.
8. Cylinder head gasket not fitted properly.
9. High internal resistance in engine caused by :—
   (a) Initial tightness after an overhaul or insufficient clearances.
   (b) Use of incorrect grade of lubricant.
   (c) Inadequate oil level or improper circulation.
10. Dragging brakes or tight wheel bearings.
11. Slipping clutch.
12. Use of certain brands of anti-freeze, which have a lowering effect upon the boiling point of the cooling system, during summer months. " Bluecol " actually slightly raises the boiling point of water.

Loss of water from cooling system.

1. Radiator leaking.
2. Loss of water due to badly made hose connections.
3. Leakage due to defective water pump or thermostat packing washers.
4. Water pump seal defective.
5. Internal or external leakage due to defective combustion head gasket, or loose securing nuts.
6. Loss of water due to boiling owing to one or more of the causes given for "Engine Overheating."

Fan belt adjustment and dynamo mounting details.

To adjust the fan belt it is necessary to partially slacken the three set screws and nut at points 1, 2, 3 and 4 respectively, as shown in Fig. 3.

Having slackened at these points the dynamo can be moved as necessary to provide a $\frac{3}{4}''$—1" hand pressure sag in the vertical portion of the fan belt.

Until recently an ordinary nut and spring washer was fitted at point "4". It was found that if the tightness of this nut was not checked at fairly frequent intervals, there was a tendency for it to work loose. This tendency to looseness also affected the nut on the inner end of the barrel adaptor to which the lower portion of the dynamo forward mounting flange was bolted.

To protect the mounting flange from damage due to loose or lost mounting bolts, a self-locking nut is now fitted at point "4" (Fig. 3) and also on the inner end of the barrel-shaped adaptor. A tab washer is also now fitted to set screw which secures link to water pump.

The self-locking Nyloc nuts were introduced at points "3" and "4" (Fig. 3) in production at Eng. Nos. V.159056 and TDC.453 respectively, for the Standard and Triumph 2-litre models.

The introduction of these Nyloc self-locking nuts requiring the following change of details:—

Nut Detail NH.2001 and Washer No. WL.0211 for point "3" is replaced by Nyloc self-locking nut NT.3211.

For point "4" bolt No. BH.0807, nut No. NH.2008, and washer No. WL.0208, are replaced by bolt No. BH.0808 and Nyloc nut No. NT.3208.

"VANGUARD"—SERIES II

COOLING SYSTEM

SUPPLEMENT

ANTI-FREEZE PRECAUTIONS

The same recommendations are made for the protection of the Engine from the effects of frost as for Series I Models. With the Series II Cars a smaller cooling capacity is required owing to the pressurized system.

The "Bluecol" proportions, which are calculated on the basis that a heater is fitted, required are as follows :—

Degrees of Frost (Fahrenheit)	15	25	35
Proportion (per cent) ..	10	15	20
Amount of "Bluecol" (pints)	2	2½	3½

Water Cooling Capacity 15½ pints (14½ pints without Heater)

PRESSURIZED RADIATOR CAP

The pressurized radiator cap was introduced on the inception of Series II Model Standard, Two Litre Saloons, but will not be used on Estate Cars, Pick-up Utility Trucks or Vans until after approximately 7,000 cars.

The pressurized radiator cap is shown in sectional form in Fig. 1 and the new Radiator in Fig. 2.

The operation of this radiator cap is simple. The pressure release valve is set to operate under a pressure of 4 lbs. and surplus water or steam is released via the overflow pipe.

Apart from the main pressure relief valve a small auxiliary valve working in the opposite direction is provided to release vacuum which would otherwise occur, to the detriment of the system, when a very hot engine was switched off.

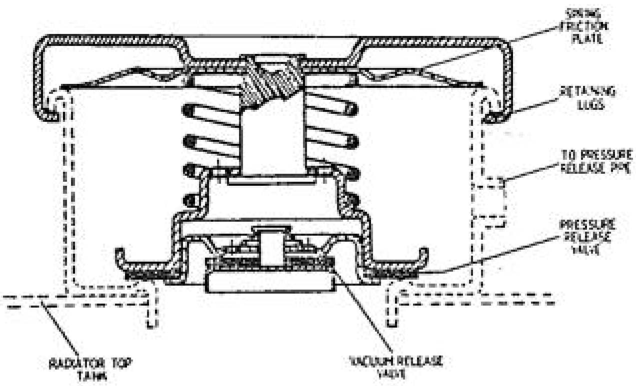

Fig. 1. Pressurized radiator cap

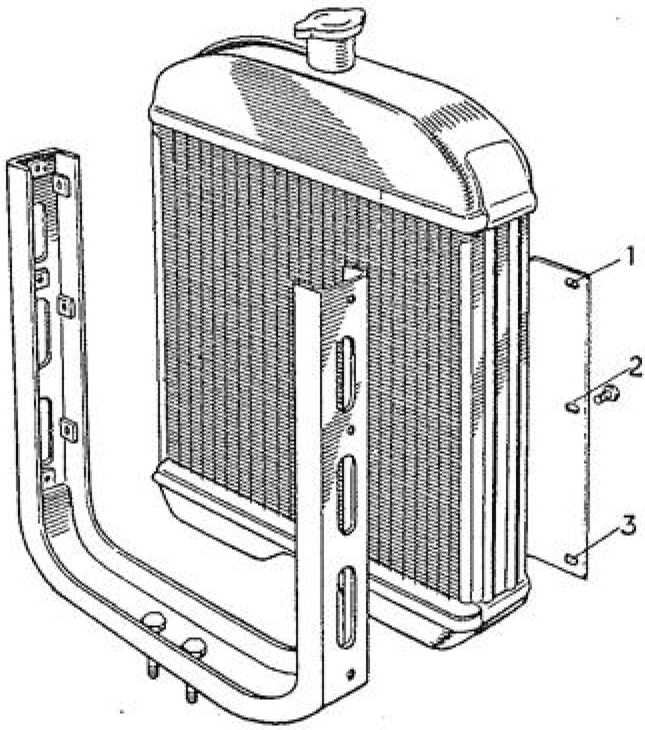

Fig. 2. Showing radiator used on Series II model

Service Instruction Manual

Fourth Issue

SERIES I AND II
and
TRIUMPH "RENOWN" MODELS

CLUTCH

SECTION D

CLUTCH

INDEX

ILLUSTRATIONS

Series II Supplement

CLUTCH

MODEL 9A6-G.

GENERAL DESCRIPTION (See Fig. 1)

The clutch is of the single dry plate type consisting of a driven plate assembly, a cover assembly and a release bearing assembly.

DRIVEN PLATE ASSEMBLY

This is of the Borglite spring type having a splined hub (21) and a disc adaptor (15) fitted with nine cushion segments (14) which carry two facings (23) attached by rivets (24). The hub flange and the disc adaptor are slotted to carry three drive and three over-drive springs (22) positioned by a retaining plate (16) which is secured to the disc adaptor by stop pins (17). The hub flange is drilled to carry three steel balls (20) positioned by two friction plates (18) located by tabs in holes in the hub flanges. A spacer (19) is fitted between the disc adaptor and one friction plate and another spacer is fitted between the retaining plate and the second friction plate.

RELEASE BEARING ASSEMBLY

The release bearing consists of a graphite bearing (5) shrunk into a bearing cup (6), the cup being located by the operating forks and release bearing retainer springs.

COVER ASSEMBLY

The cover assembly consists of a pressed steel cover (1) and a cast-iron pressure plate (2) loaded by nine thrust springs (nine cream, 120-130 lbs.). Mounted on the pressure plate are three release levers (8) which pivot on floating pins (9) retained by eyebolts (10). Adjustment nuts (12) are screwed on to the eyebolts, which pass through the clutch cover and are secured by staking. Struts (13) are interposed between lugs on the pressure plate and the outer ends of the release levers. Anti-rattle springs (11) are fitted between the release levers and the cover and retainer springs (7) connecting the release lever plate (4) to the release levers.

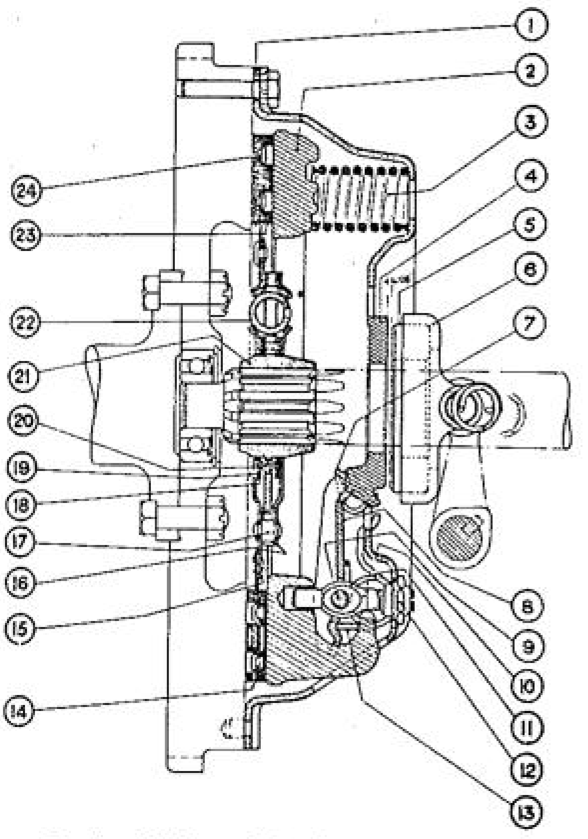

Fig. 1. Sectional view of clutch.

CLUTCH

PEDAL ADJUSTMENT

The only adjustment necessary throughout :e life of the driven plate facings is to restore :riodically the free movement of the clutch :dal, *i.e.*, movement of the pedal before the :lease bearing comes in contact with the release vers and commences to withdraw the clutch. o ensure this free movement, a clearance of not ss than $\frac{1}{16}$" must be provided. As the driven :ate facings wear, the pressure plate moves oser to the flywheel and the outer ends of the :lease levers follow.

This causes the inner ends of the release :vers to travel further towards the gearbox and :ecreases the release bearing clearance or free edal movement.

Adjust the clutch pedal stop until free novement is approximately 1". Press the pedal own and note the distance the release bearing :avels after the release bearing clearance has een taken up. To obtain a clean release, the mer ends of the release levers should be pushed owards the flywheel .50". When the inner ends f the release levers have travelled this amount nd no more, the clutch pedal should be in conact with the pedal stop. If such is not the case, he stop must be adjusted.

Should excessive pedal movement be made o release the clutch, this leads to close coiling of the thrust springs, after which any pedal pressure exerted only .tends to overstress the elease gear and internal parts of the clutch.

REMOVAL OF CLUTCH FROM CHASSIS

1. To remove the clutch from the flywheel of an engine, which is fitted in a chassis, it is unnecessary to lift the engine assembly from the frame. The detachment of the clutch can be effected as described below after withdrawing the clutch housing and gearbox backwards, as far as possible, having first removed the propeller shaft to make such backward motion possible. (See "Removal of Gearbox leaving engine in position" on Page 9 of "Gearbox Section.")

2. Slacken the holding screws (2), Fig. 3, a turn at a time by diagonal selection until the thrust spring pressure is relieved. Remove the screws and lift the complete clutch away from the flywheel. Remove the driven plate assembly.

Note: The adjustment nuts (12), Fig. 1, are correctly set and locked when the clutch is assembled and should not be altered unless the clutch has been dismantled and new parts fitted. Interference with this adjustment will throw the pressure plate out of position and cause the clutch to judder.

DISMANTLING (see Fig. 1)

To dismantle the clutch proceed as follows: —

1. Suitably mark the following parts in such a manner that they can be reassembled in the same relative positions to each other in order to preserve the balance and adjustment: cover (1), pressure plate lugs (2) and the release levers (8).
2. Remove the release lever plate (4) by unhooking it from the retainer springs(7), place the cover assembly under a press with the pressure plate resting on wooden blocks, so arranged that the cover can move downwards when pressure is applied. Place a block of wood across the top of the cover resting on the spring bosses.
3. Compress the cover by means of the ram and, while holding it under compression, remove the adjusting nuts (12) and slowly release the pressure to prevent the thrust springs (3) from flying out. Lift off the cover to expose all parts for inspection.
4. Remove each release lever (8) by holding the lever and eyebolt (10) between fingers and thumb so that the inner end of the lever and the threaded end of the eyebolt are as near together as possible, keeping the release lever pin (9) in position in the lever. Lift the strut (13) over the ridge on the lever and remove the eyebolt from the pressure plate.

ASSEMBLING (see Fig. 1)

Before assembly, thoroughly clean all parts and renew those which show appreciable wear. A very slight smear of grease, such as Duckhams' H.P.2295 or Keenol, should be applied to the following parts during assembly :—

Release lever pins (9), contact faces of struts (13), eyebolt seats in cover (1), drive lugs sides on the pressure plate (2) and the plain end of the eyebolts (10).

1. Assemble the release lever (8), eyebolt (10) and release lever pin (9), holding the threaded end of the eyebolt and the inner end of the lever as close together as possible. With the other hand insert the strut (13) in the slots in the pressure plate lug sufficiently to allow the plain end of the eyebolt to be inserted in the hole in the pressure plate (see

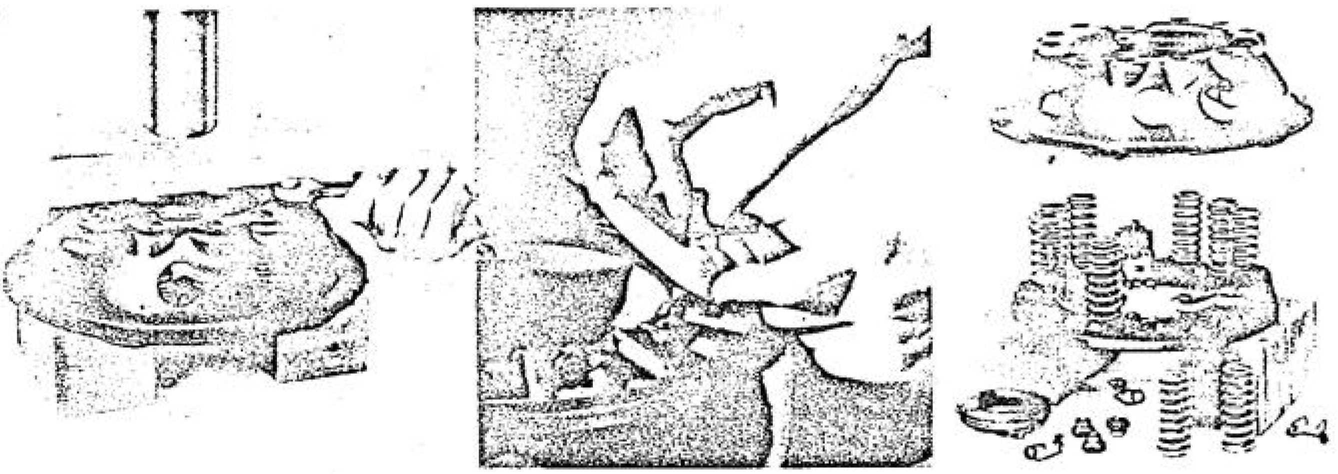

Fig. 2. Dismantling of clutch.

Fig. 2). Move the strut upwards into the slots in the pressure plate lug and over the ridge on the short end of the lever and drop it into the groove formed in the latter. Fit the remaining release levers in a similar manner.

2. Place the pressure plate on the blocks under the press and arrange the thrust springs (3) in a vertical position on the plate, seating them on the bosses provided (Figs. 1 and 2).
3. Lay the cover over the assembled parts, ensuring that the anti-rattle springs (11) are in position and that the tops of the springs are directly under the seats in the cover; also that the machined portions of the pressure plate lugs are under the slots in the cover through which they have to pass. Care should be taken that the parts marked before dismantling are in their correct relative positions.
4. Place the block of wood across the cover, resting it on the spring bosses, and compress the cover by means of the ram, guiding the eyebolts and pressure plate lugs through the holes in the cover.
5. Screw the adjusting nuts (12) on to the eyebolts (10) and secure by staking. Operate the clutch a few times by means of the ram to ensure that the working parts have settled into their correct positions. Connect the release lever plate (4) to the release levers (8) by means of the retainer springs (7).

Note: If new parts have been fitted, which would affect the adjustment, the release levers should be set by using the Borg and Beck Gauge Plate, Part No. CG.192.

REFITTING THE CLUTCH

To reassemble the clutch on the flywheel proceed as follows :—

1. Assemble the driven plate in the flywheel, taking care to place the larger chamfered spline end of the driven plate hub towards the gearbox or rear of the vehicle. Centralize the driven plate by means of a dummy shaft which fits the splined bore of the driven plate hub and the pilot bearing in the flywheel.
2. Fit the cover assembly to the flywheel by means of the holding screws (2), Fig. 3, tightening them a turn at a time by diagonal selection. Do not remove the dummy shaft until all the screws are securely tightened. Remove the dummy shaft.

ADJUSTING THE RELEASE LEVERS
(See Fig. 3)

Satisfactory operation of the clutch is dependent on accurate adjustment of the release levers (5). This must be carried out before the clutch has been assembled to the flywheel and should only be necessary if new parts have been fitted. The maximum difference allowed in the height of the release levers is .015". To obtain this accuracy use the special gauge plate in conjunction with the flywheel which may be mounted on the engine or lying on the bench, whichever is the more convenient.

1. Place the gauge plate (4) centrally in the flywheel in place of the driven plate assembly.
2. Fit the cover assembly to the flywheel by tightening the holding screws (2) a turn at a time by diagonal selection, until fully secured.
3. Place a straight edge across the gauge plate boss and the top of one release lever (5) and adjust the release lever, if necessary, by turning the eyebolt nut (6) until the top of the lever is exactly level with the top of the

gauge plate boss. Adjust the remaining levers in a similar manner.

The setting should be within .005″ if carefully carried out.

4. Slacken the holding screws (2) a turn at a time by diagonal selection, then remove the holding screws and the clutch from the flywheel. Remove the gauge plate.

REFACING THE DRIVEN PLATE

When removing old worn facings, the rivets ıust be drilled, not punched out. Each rivet ttaches one facing only. Using a $\frac{5}{32}$″ dia. drill, ıserted through the clearance hole in the pposite facing, drill out the rivets. After :moving the facings, thoroughly examine the :gments for cracks ; if cracks are found a new riven plate assembly should be used.

1. Place one facing in position with the countersunk holes coinciding with the ones located on the crown or longer side of each segment.
2. Insert the rivets with their heads in the countersunk holes of the facing, and roll the shanks over securely against the segments. If a rolling tool is not available a blunt ended punch will prove satisfactory.
3. Secure the opposite facing in a similar manner, matching the countersunk holes with the remaining holes in the segments. Rivet heads should always face outwards.
4. Place the assembly on a mandrel between lathe centres and spin for run-out ; if more than .015″, prise over as necessary.

The possibility of further use of the friction .cings of the Borg and Beck clutches is some-ımes raised, because they have a polished ɔpearance after considerable service. It is atural to assume that a rough surface will give higher frictional value against slipping, but this not correct.

Since the introduction of non-metallic facings f the moulded asbestos type, in service, a ɔlished surface is a common experience, but it ıust not be confused with a glazed surface hich is sometimes encountered due to conditions iscussed below.

CONDITION OF CLUTCH FACINGS

The ideal smooth or polished condition will :ovide a normal contact, but a glazed surface ay be due to a film or a condition introduced, hich entirely alters the frictional value of the cings. These two conditions might be simply ustrated by the comparison between a polished ood, and a varnished surface. In the former the contact is still made by the original material, whereas in the latter instance, a film of dried varnish is interposed between the contact surfaces.

The following notes are issued with a view to giving useful information on this subject :—

1. After the clutch has been in use for some little time, under perfect conditions (*i.e.*, with the clutch facings working on true and polished or ground surfaces of correct material, without the presence of oil, and with only that amount of slip which the clutch provides for under normal conditions)

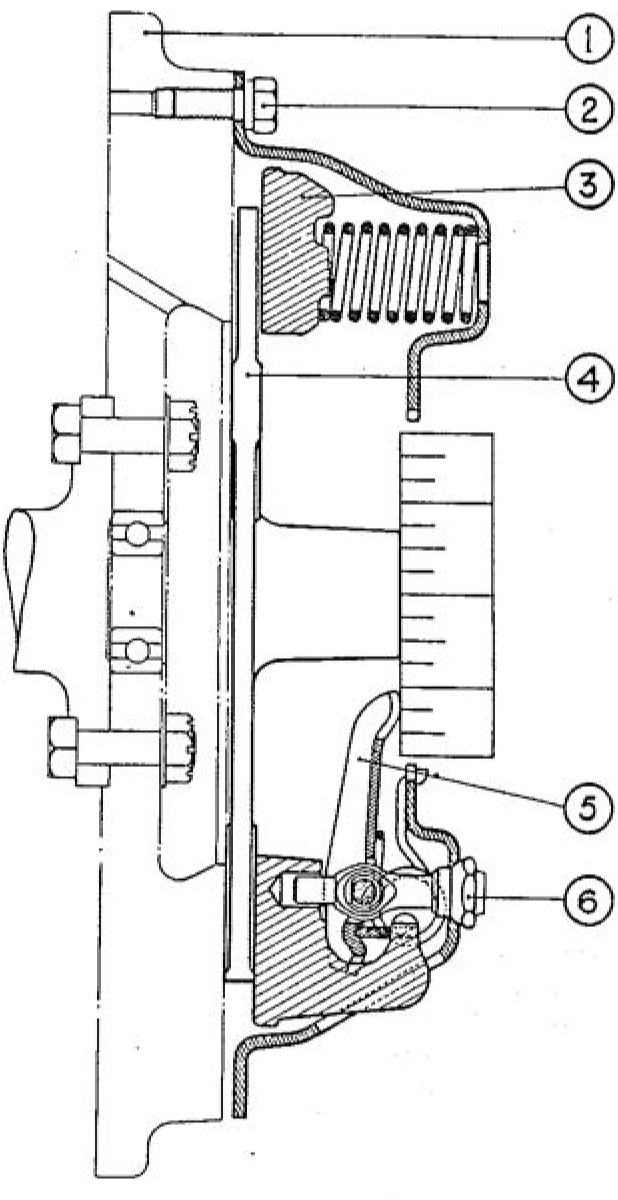

Fig. 3. Adjusting release levers.

then the surface of the facing assumes a high polish, through which the grain of the material can be clearly seen. This polished facing is of a mid-brown colour and is then in a perfect condition, the coefficient of friction and the capacity for transmitting power being up to Borg and Beck standard.

Note: The appearance of wound or woven type facings is slightly different but similar in character.

2. Should oil in small quantities gain access to the clutch in such a manner as to come in contact with the facings it will burn off, due to the heat generated by slip which occurs under normal starting conditions. The burning off of this small amount of lubricant has the effect of gradually darkening the facings, but, provided the polish on the facings remains such that the grain of the material can be clearly distinguished, it has very little effect on clutch performance.

3. Should increased quantities of oil or grease obtain access to the facings, one or two conditions, or a combination of the two, may arise, depending upon the nature of oil, etc.

   (a) The oil may burn off and leave on the surface facings a carbon deposit which assumes a high glaze and causes slip. This is a very definite, though very thin deposit, and in general it hides the grain of the material.

   (b) The oil may partially burn and leave a resinous deposit on the facings, which frequently produces a fierce clutch, and may also cause a " spinning " clutch due to a tendency of the facings to adhere to the flywheel or pressure plate face.

   (c) There may be a combination of (a) and (b) conditions, which is likely to produce a judder during clutch engagement.

4. Still greater quantities of oil produce a black soaked appearance of the facings, and the effect may be slip, fierceness, or judder in engagement, etc., according to the conditions.

If the conditions under (3) or (4) are experienced, the clutch driven plate should be replaced by one fitted with new facings, the cause of the presence of the oil removed and the clutch and flywheel face thoroughly cleaned.

FAULTS AND THEIR REMEDY

SYMPTOM	CAUSE	REMEDY
1. Drag or Spin.	(a) Oil or grease on the driven plate facings.	Fit new facings.
	(b) Misalignment between the engine and splined clutch shaft.	Check over and correct the alignment.
	(c) Improper pedal adjustment not allowing full movement to release bearing.	Correct pedal adjustment.
	(d) Warped or damaged pressure plate or clutch cover.	Renew defective part.
	(e) Driven plate hub binding on splined shaft.	Clean up splines and lubricate with small quantity of high melting point grease such as Duckham's Keenol.
	(f) Pilot bearing or bushing of clutch shaft binding.	Renew or lubricate pilot bearing.
	(g) Distorted driven plate due to the weight of the gearbox being allowed to hang in clutch plate during erection.	Fit new driven plate assembly using a jack to take the overhanging weight of the gearbox.
	(h) Broken facings of driven plate.	Fit new facings.
	(j) Dirt or foreign matter in the clutch.	Dismantle clutch from flywheel and clean the unit, see that all working parts are free. **Caution**—Never use petrol or paraffin for cleaning out clutch.
2. Fierceness or Snatch.	(a) Oil or grease on driven plate facings.	Fit new facings and ensure isolation of clutch from possible ingress of oil or grease.
	(b) Misalignment.	Check over and correct the alignment.
	(c) Binding of clutch pedal mechanism.	Free and lubricate journals.
	(d) Worn out driven plate facings.	New facings required.
3. Slip.	(a) Oil or grease on the driven plate facings.	Fit new facings and eliminate cause of foreign presence.
	(b) Binding of clutch pedal mechanism.	Free and lubricate journals.
	(c) Improper pedal adjustment indicated by lack of the requisite 1" free or unloaded foot pedal movement. Incorrectly replaced floorboards preventing complete rearward movement of the pedal.	Correct pedal adjustment and/or clearances.

SYMPTON	CAUSE	REMEDY
4. Judder.	(a) Oil, grease or foreign matter on the driven plate facings.	Fit new facings and eliminate cause of foreign presence.
	(b) Misalignment.	Check over and correct alignment.
	(c) Pressure plate out of parallel with flywheel face in excess of the permissible tolerance.	Re-adjust levers in plane and, if necessary, fit new eyebolts.
	(d) Contact area of friction facings not evenly distributed. Note that friction facing surface will not show 100% contact until the clutch has been in use for some time, but the contact area actually showing should be evenly distributed round the friction facings.	This may be due to distortion, if so fit new driven plate assembly.
	(e) Bent splined shaft or buckled driven plate.	Fit new shaft or driven plate assembly.
	(f) Unstable or ineffective rubber engine mountings.	Replace and ensure elimination of endwise movement of power unit.
	(g) Chassis to engine tie bar out of adjustment.	Correct to ensure that power unit is held against endwise travel.
5. Rattle.	(a) Damaged driven plate, *i.e.*, broken springs, etc. (b) Worn parts in release mechanism. (c) Excessive back lash in transmission. (d) Wear in transmission bearings. (e) Bent or worn splined shaft. (f) Graphite release bearing loose on throw-out fork.	Fit new parts as necessary.
6. Tick or Knock.	(a) Hub splines badly worn due to misalignment.	Check and correct alignment, then fit new driven plate.
	(b) Worn pilot bearing.	Pilot bearing should be renewed.
7. Fracture of Driven Plate.	(a) Misalignment distorts the plate and causes it to break or tear round the hub or at segment necks in the case of Borglite type.	Check and correct alignment and introduce new driven plate.
	(b) If the gearbox during assembly be allowed to hang with the shaft in the hub, the driven plate may be distorted, leading to drag, metal fatigue and breakage.	Fit new driven plate assembly and ensure satisfactory reassembly.
8. Abnormal Facing Wear.	Usually produced by overloading and by the excessive slip starting associated with overloading.	In the hands of the operator.

CLUTCH

SUPPLEMENT

CLUTCH SLAVE CYLINDER

Descriptive and maintenance notes.

A convenient way to expel the internal parts of the unit, after removal from the vehicle, is to blank off one connection and to apply a low air pressure to the other.

The rubber cup (1) and the boot (2) must be in good condition or replaced by new ones.

Bleeding the slave cylinder.

"Bleeding," or expelling air, is not a routine operation and should only be necessary when some portion of the hydraulic equipment has been disconnected or when fluid has been drained off.

1. Fill the supply tank with fluid and keep at least a quarter full throughout the operation, otherwise air will be drawn in, necessitating a fresh start.
2. Attach a rubber tube to the bleeder screw and allow the free end to be submerged in a little Lockheed brake fluid in a clean glass jar. Open the bleeder screw one complete turn.
3. Depress the clutch pedal slowly and whilst fluid issues and before the pedal reaches the end of its stroke, tighten the bleeder screw securely.
4. Repeat (3) until air bubbles cease to appear from the tube in the jar.

MASTER CYLINDER ASSEMBLY

See instructions and Fig. 1 in Brakes Section Supplement.

FITTING TWIN TYPE MASTER CYLINDER

When fitting this type of Master Cylinder to a car, it is important to provide .030″ clearance between each push rod and the piston which operates it. This clearance is necessary to allow each piston to return to its stop on its cylinder and thus prevent the possibility of the lip of the main cup covering the by-pass port.

If such a condition were to arise, the excess fluid drawn into the cylinder during the return stroke of the piston will find no outlet and pressure will build up in the system, causing all brakes to drag or remain "on" and the clutch to "slip".

The correct pedal adjustment is set when the vehicle is assembled and should never need alteration unless it is necessary to replace the cylinder or brake assembly.

FITTING SLAVE CYLINDER ASSEMBLY

This assembly is connected to the appropriate cylinder in the Master Cylinder Assembly (see details above) by a pipe through which fluid is fed.

The assembly is mounted on a plate which is attached to two of the bottom clutch housing bolts on the left of the engine unit. A steady bracket also is supplied which is attached to an engine sump bolt.

When attaching the push rod to the clutch pedal, it is particularly important that a certain amount of lost movement exists between the rod and the piston. This is necessary to provide clearance at the release bearing.

The lost movement required in the push rod is .075″, which provides the necessary $\frac{1}{16}$″ clearance at the release bearing face.

The method to adopt when setting this push rod is to force the piston to the bottom of the cylinder with the push rod and, with any lost movement in the operating lever on the cross shaft used up, screw the fork end on the rod until the hole in this is aligned with the top (three holes exist) hole in the operating lever. Screw the clevis pin into fork end leaving the locknut loose on the rod.

The adjuster nut should next be screwed back until a gap of .075" exists between this nut and the fork end. The rod and nut should then be screwed into the fork end, thus using up the .075" and providing that amount of lost movement. The locknut should then be tightened and a final check of lost movement carried out with a short rule resting on the slave cylinder attachment flange, at right angles to this face, with its graduations aligned with the shoulder of the push rod fork end.

A convenient method of measuring the .075" on the rod is to make up a fork gauge that thickness which can be inserted between the nut and fork end.

As the clutch plates wear, the inner ends of the toggle levers will move towards the release bearing, thus reducing the clearance at this point. It will consequently be necessary to restore this clearance by suitably shortening the push rod as lost movement is decreased.

It is most important that the lost movement in the clutch should be maintained. The combined free movement in the master and slave cylinders will give an approximate lost movement of $\frac{7}{8}$" at the pedal pad. Owing to the light pedal pressure required with this system, it is difficult to estimate the free movement at the pedal pad and this is best checked by measuring the .075" on the Slave Cylinder push rod as already described.

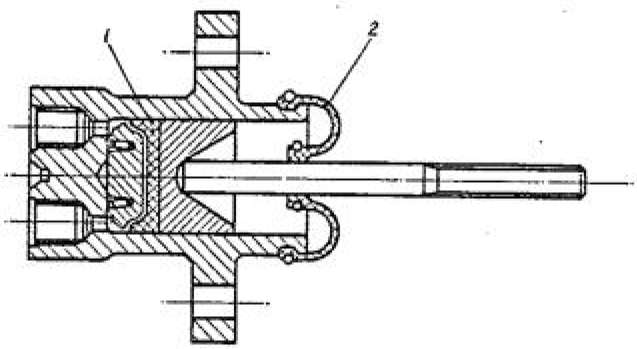

Fig. 1. Slave cylinder assembly