R. HAYNES and
M. A. GRIGSBY

Rolls-Royce Small Horsepower Engines

**The overhaul of Rolls-Royce 20 h.p., 20/25 h.p., 25/30 h.p., Bentley 3½ litre and 4¼ litre engines.
With a supplement covering Rolls-Royce Wraith and Bentley Mark V units.**

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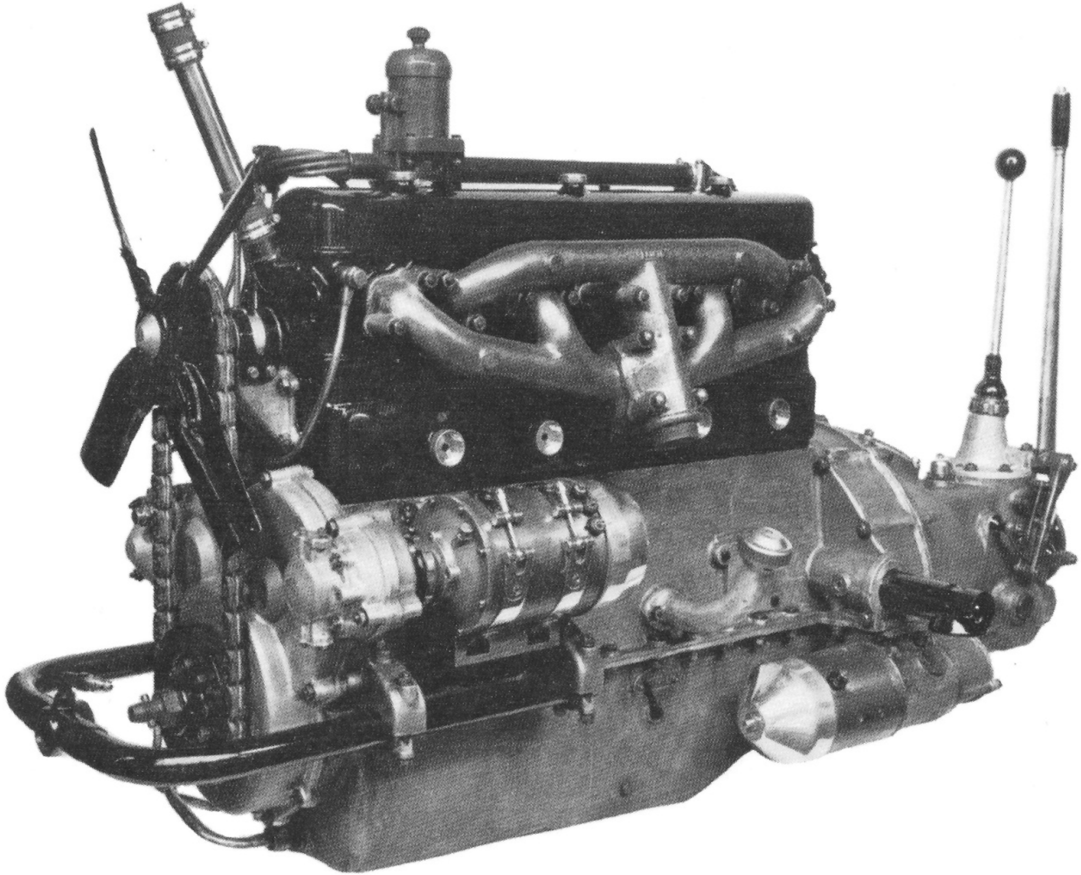
ROLLS-ROYCE ENTHUSIASTS' CLUB

ROLLS-ROYCE

SMALL HORSEPOWER ENGINES



The Rolls-Royce 20 h.p. engine. This is an early example, engine no. G112 (ex chassis 41G4)

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Published by
Rolls-Royce Enthusiasts' Club

Printed in Great Britain by
Burgess & Son (Abingdon) Ltd, Station Road, Abingdon, Oxfordshire

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Introduction

In presenting this book it is the hope of the authors that it contains something of interest for everyone undoing and doing up nuts and bolts on the engines dealt with. It is always difficult to give technical information because of the impossibility of assessing in advance the ability of the one being advised. We therefore apologise if to some we appear patronising and to others insufficiently informative, for this is always a hazard in this kind of writing.

By no means do we intend this to be an instant course in motor engineering, and we have assumed throughout that the reader is already a reasonably competent mechanic, possessing at least some of the tools for doing the job. It has been observed that the amateur can turn out at least as good a job as the professional, suggesting that the prime requirement is time. And so it is. Much of the success of Rolls-Royce cars lies not in their design, which is in some instances inferior to their contemporaries, but in the meticulous care and attention which they received during manufacture and assembly, whether on the original build or in the course of repair. In this respect they are probably superior to any other make of car in the world, and this brings us once more to the question of time. It is, especially nowadays, an expensive commodity, but only by the use of time and patience can a worn-out engine be made to give the satisfaction it did when new.

A full professional restoration of a Rolls-Royce engine could nowadays cost as much as the original chassis. A competent owner, however, can do a great deal of this work himself and derive thereby not only pleasure from his achievements but a profit into the bargain, albeit a notional one.

One has only to look at the brilliant restorations to be seen at car meetings nowadays to see that many professional men, and in particular medical men, would have made wonderful motor fitters had their courses lain in other directions. It is interesting to speculate whether some mechanics, given the opportunity, would have succeeded at brain surgery.

The last of the engines covered in this book was made in 1939, and this was the year when one of the authors was born, the other having already 'arrived'. Most of the men who designed and built these engines have passed on, and this book is therefore based on personal recollection, hard-won experience, and a great deal of research. We have tried to indicate throughout the chassis numbers at which design changes commenced, and such numbers represent, in theory at least, the point of continuous embodiment. It may, however, be found that an earlier chassis has a particular feature out of series, and it should be realised that Derby were good at a lot of things, including 'piloting' on what might be described as experimental chassis.

In the latter connection, there is also the possibility that the engine may have been 'up-dated', either by the Company or elsewhere. For example, on a 20/25 engine a later cylinder head or the later type crankcase end covers may be found. Another point we feel should be mentioned, and that is that many pre-war cars now surviving, apart from exceeding in longevity the wildest dreams of their builders, may have passed through that period when their only value lay in their ability to drag themselves along with the minimum of maintenance. We well remember that not so very long ago the open market value of a Silver Ghost was about £100 if in good running order, and any chassis bearing a limousine body was almost unsaleable. As a consequence, some engines may have had the grossest mechanical indignities performed on them, and their restoration should encompass the recognition and eradication of all such faults.

The supply and availability of spare parts is a problem to the owner of any old car, but the Rolls-Royce owner is more fortunate than others in this respect. For these cars and the Derby Bentleys an amazing variety of spares is still to be had. That this situation should prevail is due in no small measure to the goodwill of the Company, and the efforts of the Rolls-Royce Enthusiasts' Club and the Bentley Drivers' Club on behalf of their members. On the practical side, Appleyard Rippon of Leeds are the fount of all pre-war spares and the excellence of their service continues. The people occupying the unenviable position between the Scylla and Charybdis of supply and demand, respectively, are David Botterill and his staff. They are doing a wonderful job—please be kind to them.

Inevitably, some spare parts are no longer available. Major items such as cylinder heads and blocks ceased to be available many years ago. At the time of writing, main and big-end bearings and damper washers are in short supply for many models. We have tried to take account of this, and substitutes and subterfuges are suggested where we feel they are appropriate. Being realists, we feel that the supply of pre-war spares is bound to get worse rather than better, but on the other hand we have unbounded confidence in the ability of amateurs and the handful of really competent professional engineers to keep these cars on the road for many years to come.

In conclusion, may we say that in common with authors the world over, we feel that we have made the best use of the available material, and we hope we have answered at least some of the questions. We hope and pray that we have not made any mistakes, but we are conscious of a few omissions. These are either due to a lack of authoritative information on such topics or to our own lack of knowledge, which is not boundless. We can at least say that where we pontificate the inspiration springs from conviction rather than duty.

Acknowledgements

We would like to express our gratitude to the many friends without whom this book would certainly not have been written:

Eric Barrass, whose idea it was,
John Schroder, who actually got it published,
Peter Vacher, who did far more than print it,
John Fasal, for some excellent photographs,
Rolls-Royce Motors (of course).
And many others . . .

R. Haynes
January, 1977 M. A. Grigsby

1

Crankcase, Front Cover and Sump

Little attention is normally needed by these components apart from thorough degreasing and cleaning of the oilways. This work can be done by the owner, but it is a long, dirty and thankless task, Most motor engineering firms are equipped nowadays with degreasing facilities, and can achieve an immensely superior result to that obtainable with the 'paraffin and paintbrush' technique. The cost is only a few pounds and fully justified on the grounds of convenience.

Before these parts are degreased, it is a good idea to remove as much of the liquid sludge and oil as possible with paraffin, rags, etc. This will avoid undue contamination of the degreasing chemicals, and does not take long.

Cylinder head studs should be removed. In the 20 h.p. crankcase these are threaded right through into the interior of the crankcase, and are further secured by nuts and lock washers. In all other models the studs simply screw into the blind holes in the top surface of the crankcase. Removal is best effected using a proper stud extraction tool in conjunction with a ½" square socket drive. The stud should be gripped as near to its base as possible to minimise the risk of distortion, or breakage. If you are unlucky enough to break any studs, do not worry; they can be dealt with quite easily after degreasing is completed.

It is assumed that main bearings, caps and shims have been removed. If not, this should be done and careful note taken of markings on these components. Caps are marked with their position (1 to 7), and serial numbers, on the 'camshaft' side of the crankcase and corresponding marks are stamped on flats machined adjacent to each bearing housing. The bearing shells and shims should be similarly marked, but if these have been replaced by other than a Rolls-Royce depot, they may be unmarked. In this case, unless the shells are to be in such a way that no difficulty will be found on re-assembly. The accepted convention is to place marks adjacent to the camshaft and the front of the engine. Remember that a raised area will be created by the number stamps and this should be carefully dressed down with a fine file.

The oil gallery on all 'small' engines consists of brass inserts pressed into the crankcase webs and ends, suitably drilled, and connected by curved copper pipes soft-soldered in. Each end is blanked off by a screwed plug, concealed by an aluminium cover at the flywheel end and the idler wheel bearing spigot at the front end. These should be removed. It was always accepted practice by the Company to remove the oil gallery entirely for degreasing. This may be done, by carefully 'drifting' each insert forward until the whole assembly comes free. In practice, however, it is almost impossible to achieve this without causing damage to the intermediate copper pipes, leading to much needless work and aggravation. Also, after re-assembly, an oil pressure test must be carried out. In view of the foregoing, if the oil gallery can possibly be cleaned *in situ* this should be done, and if the crankcase is professionally degreased no difficulty should be encountered.

The stripped crankcase, sump and timing cover can now be sent for degreasing, not forgetting to remove the cork float from the oil level indicator in the sump. If you forget to do this, it will almost certainly disintegrate in the chemicals used.

Upon completion of the degreasing process all oilways must be checked to see they are clean and free from foreign matter, before replacing blanking plugs, etc. Once satisfaction is achieved on this account the system can be 'closed up' by using corks in female holes and masking tape or similar over male threaded nipples. If new main bearings are to be fitted it is important to do this to prevent the ingress of swarf during the line boring operation.

A word or two about replacing studs. Aluminium seems to have a devilish affinity for steel, and will seize on to it given the slightest opportunity. For this reason, all threads, internal and external, must be carefully cleaned and inspected before assembly. It is not a bad idea to run a tap into all the internal threads, and use a die nut on any external ones which look doubtful. Studs should be assembled dry, or with just a smear of grease on the male thread. Sealing compound may be used where the stud penetrates a water jacket. *Never* squirt oil into a blind stud hole—you will be rewarded by a loud crack when the casting splits under the hydraulic bursting pressure as the stud is screwed home.

Broken studs can now be dealt with. These are invariably of high tensile steel in a softer material such as aluminium or cast-iron. Any attempt to drill these out free-hand is doomed to failure, as the drill will almost certainly wander off into the softer metal and expensive repairs will be necessary.

If drilling is to be resorted to, it will be necessary to fabricate a simple jig to keep the drilled hole concentric with the stud. The exact form this will take depends on the situation and state of the breakage, but in general a hardened steel drilling bush is necessary, preferably with means of location either over the stump of the stud, or in a concentric recess, if one exists, together with means of holding it stationary and vertical. Drilling should be commenced with a small drill, and then the bush changed and a drill equal to the tapping size of the thread substituted. If the operation is successful, the point of a scriber can be used to 'winkle-out' the remains of the old stud, which ideally should come out like a coil spring. The thread can then be cleaned with a tap.

If, in spite of every care being taken, or otherwise, the thread is ruined, the best procedure is to have a 'Heli-Coil' insert fitted. Again, most firms of motor engineers will do this for a small charge.

Tapping size drills are as follows:

3/16” B.S.F. or 2 B.A.	Number 22 drill (.00 mm)
1/4” B.S.F.	Number 5 drill (5.30 mm)
5/16” B.S.F.	Letter 'G' or 17/64" drill (6.75 mm)
3/8” B.S.F.	Letter 'O' drill (8.25 mm)

There is another method of removing steel studs from aluminium, but this entails the use of nitric acid. The stud is drilled through with the largest practicable size and, unless the hole is a blind one, a piece of plasticine used to seal the bottom of the hole. A short length of glass tubing is then sealed on to the top of the hole in the stud, using more plasticine. With a pipette or eye-dropper, the tube and stud is filled with dilute nitric acid. The whole lot is then left for at least 12 hours, or as long as it takes to dissolve the remains of the stud. This method is guaranteed to remove every trace of steel, leaving a practically undamaged thread in the aluminium. Care must, however, be taken, as nitric acid is nasty stuff, and the need for discipline and precautions in its use cannot be over-emphasised.

Neutralise the job afterwards with water, and keep plenty of water handy when using the acid in case of spillage. When diluting acids, remember to add acid to water, never the other way round, and work slowly since considerable heat can be evolved when the two liquids mix.

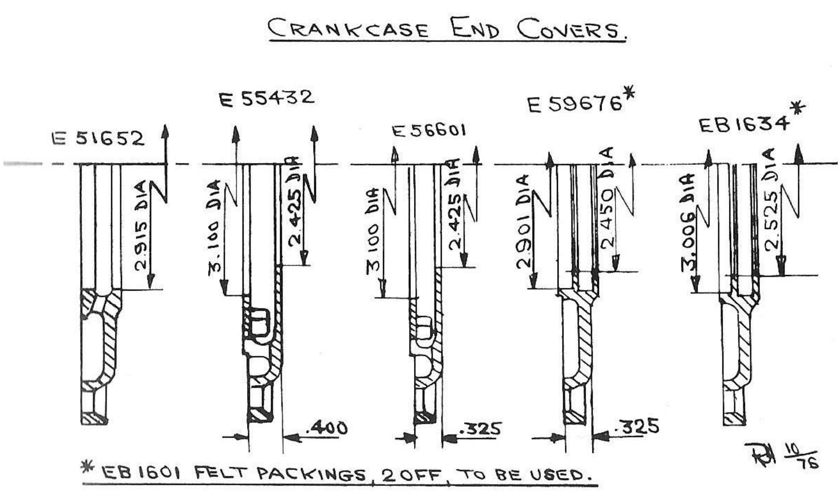
Replacement studs should be made from a good high tensile steel. EN 16 T is ideal for the purpose and should be stocked by any good engineers' supplier. On no account should ordinary mild steel or studding be used, as this will not be strong enough. Neither should 'silver-steel' be used for this or any other purpose on a motor-car. This material, which is easily obtained from most tool shops, is a high carbon steel supplied in accurately ground round, square and flat sizes for the purpose of making hardened tools of various kinds. It can be extremely brittle even in its unhardened state and its use for studs, gudgeon pins or brake rods is very dangerous indeed.

2

Crankcase End Covers

Oil sealing at the rear end of the crankshaft is effected by an oil scroll on the shaft, which registers with the pair of semi-circular covers screwed to the rear end of the crankcase. The lower of these covers is actually attached to the sump, and comes down with that casting. The upper cover is totally inaccessible unless the flywheel is taken down.

On all 20 h.p., and 20/25 h.p. up to the 30th chassis in P-Series, the part numbers of the covers are E51651/52. From the 31st in P-Series, when the heavier crankshaft was introduced, up to Chassis No. GKT21 the part numbers were E55431/32. At Chassis No. GKT22 the balanced crankshaft commenced, and the covers changed to part numbers E56600/01, and these continued up to Chassis No. GXB26. The covers fitted to the subsequent B2-Series and all C2-Series engines were part numbers EB92/93; these were also fitted to A-Series 3½ litre Bentley.



Crankcase end covers.

The final change was at D2-Series, when part numbers EB1633/34, incorporating the felt packings, EB1601, were introduced. These covers, made of Dixtampo, continued on all 25/30 h.p. engines, and were fitted to all Bentley except the A-Series 3½ litre.

Oil leaks from the rear end of the crankshaft do sometimes occur, and to rectify complaints on 20/25 h.p. engines with the balanced crankshaft the practice was to fit covers with felt packings, as on later engines. These covers, part numbers E59675/76, are of bronze and are fitted with 2 off EB1601 felts. This can be done on overhaul and is recommended.

The success of this type of seal depends on the scroll being clean, and concentricity of the covers. Also, crankcase compression, due to poor cylinder condition, will over-ride the wind back.

Fitting of the covers calls for care in ensuring that their end faces are precisely flush with the bolting faces of the crankcase and the sump. When the sump is fitted ensure that the rear ends of the sump joint are nipped by the faces of the covers.

Some difficulty may be found in fitting the felts to the bronze and the Dixtampo covers, and they must be oil soaked before inserting them. The whole length of felt must be worked into the groove, and it must not stand proud of the end faces or the groove lips.

On all 20 h.p. and the early 20/25 h.p., the concentricity of the covers and the scroll can be checked after refitting the sump, by running a feeler around the annulus.

The part numbers of all the covers are cast into the material. Make sure that the cover with the oil drain holes is fitted to the sump, and see to it that the numbers E51651, E55431, E56600, EB92, EB1633, and E59675, as applicable, are fitted to the crankcase.

3

The Crankshaft

This is, together with the connecting-rods, probably the most handsome component of any pre-war Rolls-Royce engine. It is machined and ground all over and the cost of producing such an item nowadays can only be guessed at. Fortunately, in spite of its slender proportions, failure of the crankshaft is very rare. In the event of replacement being necessary the cause is most likely to be that it is worn or ground beyond permissible limits or that it has become cracked due to overheating or undue stress.

All cars manufactured prior to 20/25 GLZ-28 in Z-Series were fitted with unhardened nickel-chromium steel crankshafts. Subsequent to this 'Nitralloy' steel was used. Nitralloy is simply a good quality case-hardening material capable of being nitride-hardened with the minimum of distortion taking place.

Removal of the crankshaft is easily accomplished with the damper assembly and flywheel still in place, the clutch cover assembly and driven plate having first been removed. No difficulty is envisaged in this operation, which merely entails the removal of the oil conduits leading from the oil gallery to the big-end caps, and the removal of the caps themselves. Before lifting the crankshaft out, it is as well to determine the existing end float. This can be measured by a dial gauge against one end of the shaft, or by feeler gauges between the crankshaft thrust faces and side of the rear main bearing, which regulates the end float.

Removal of the damper can be effected following the instructions contained elsewhere in this publication, and with the shaft upright on the flywheel it is easily accessible.

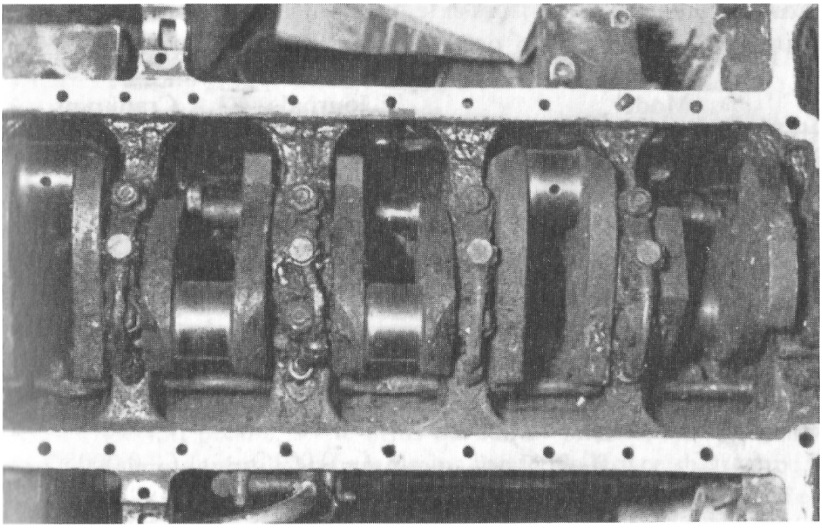
The flywheel will in all cases be fixed to the flange at the rear of the crankshaft by fitted ground bolts, the threaded ends being peened over on initial assembly, or sometimes locked by centre-punching the thread margin between the end of the bolt and the nut. The nuts must be removed using a socket wrench, and will almost certainly have to be discarded. The bolts may be drifted out, and the flywheel will come free from the crankshaft, together with the carrier plate containing the clutch spigot ball bearing. Note that the hole centres in the shaft flange, flywheel, and carrier plate are so arranged that it is only possible to assemble them in one position.

If the threaded ends of the bolts are not too badly damaged they can be restored by careful work with a thread file and a die nut; otherwise they will need to be replaced.

The next job is the removal of the aluminium blanking-off caps from the main and big-end journals. These are held in place by a threaded rod passing right through both caps and secured by a plain nut at one end, peened over, and a castellated nut at the other, secured with a split pin. Each of these nuts has a domed inner face, locating in a corresponding recess in the cap, for oil tightness. On some later engines, and if the caps have been replaced by a later pattern, aluminium washers may be found under the nuts. The easiest way to remove these, once the split pin has been taken out, is to use a ¼" square drive ratchet brace with the appropriate socket (3/16" or ¼" B.S.F.), together with a ring spanner. Unscrew the castellated nut, tap the spindle through the first cap until it comes free, and then use it as a punch to remove the first cap. The other cap can then be pushed out from the 'open' end. This technique will work in every case except the rear main bearing. In this the rearmost cap is almost invariably difficult to remove without damaging the threaded stud, and the inner cap may be gently prised free with a small sharp screwdriver or similar tool. It is not worth trying to remove the rearmost cap if it is stuck in as it is perfectly easy to clean the shaft with it in place. Some shafts do not have a rear cap, the securing spindle being threaded directly into the rear face of the shaft, which is left solid.

From 20/25, TB-Series, balance weights were fitted to the crankshaft, and these should be removed, each being held in place with nuts and locking tab washers. Check that they are numbered for correct re-assembly.

We are now faced with the spectacle of a completely stripped crankshaft, probably containing an unbelievable amount of hard, greyish sludge in the oil-ways, especially inside the big-end journals. The most effective treatment, after initial cleaning, is to have the whole lot degreased and then crack tested. The following tests for straightness and wear should be carried out.



Typically sludged 20/25 engine.

Straightness

The shaft should be supported on Vee blocks at Nos. 1 and 7 main bearing journals, or set up between centres in a lathe or grinding machine. By rotating the shaft and checking with a dial gauge on the centre main journal it may be ascertained whether the shaft is bowed, and by how much. In the very likely event of the shaft being bent, it can be straightened gently in a press and the resulting stresses relieved by peening the radius between the journal and web at the position of the bend. Several attempts are usually required before the shaft is straightened to within, say, 0.002". This is, in practice, the best that can usually be achieved. The above operation should only be entrusted to a properly skilled man and is definitely not a task for the inexperienced.

If the amount of bend is only moderate, say 0.004"-0.006", it may well be best not to attempt to bend it straight but to restore truth by grinding the journals. Whether this latter operation needs to be done, however, depends on the state of wear of the shaft.

Wear

The original dimensions of the various crankshafts are as follows :

Model	Journals	Crankpins
20 h.p. (all chassis)	1.9995" (-0.001")	1.4990" (-0.0005")
20/25 h.p. (GXO-11 to GKT-21)	2.1245" (-0.001")	1.7490" (-0.0005")
20/25 h.p. (GKT-22 to GXB-26)	2.1245" (-0.001")	1.9990" (-0.0005")
20/25 h.p. (GXB-27 to GTK-53)	2.2495" (-0.001")	1.9990" (-0.0005")
25/30 h.p. (all chassis)	2.2495" (-0.001")	1.9990" (-0.0005")
3½ and 4¼ litre Bentley (all chassis)	2.2495" (-0.001")	1.9990" (-0.0005")

End float (all chassis) − 0.0025" ± 0.0005"
Maximum permissible wear limits on original or reground sizes (all chassis):

End float	0.007"
Wear on journal and crankpin	0.003"
Ovality	0.001"
Taper	0.001"

The maximum permissible undersize of both journals and crank-pins is 0.040".

If the shaft has been ground at some time previously it is most likely to have been finished in steps of 0.005" or 0.010" undersize. No difficulty should therefore be encountered in ascertaining the 'nominal' size of the bearing journals and the amount of wear which has taken place.

Provided the shaft is within the above-mentioned limits it will not be necessary to grind it. If, however, it is worn to excess or any of the journals are damaged, scored or badly pitted, grinding must be resorted to. Moderate pitting of the journal surfaces is not serious, and these marks can usually be polished out by having the shaft lapped.

If the decision is taken to grind, it is most important that the work is entrusted to a firm who are known to be capable of doing good work. The following points should be noted:

(i) Only the minimum amount should be ground off the bearing surfaces. This instruction may seem superfluous, but most firms are conditioned to grinding shafts in steps of 0.010" undersize, and there is little point in taking this amount off if 0.005" will achieve a satisfactory result. Obviously, more than 0.010" may well have to be removed, and it is suggested that the operative be instructed to 'grind to clean, lap and polish'.

(ii) The existing radii between journals and webs should be measured and adhered to. Since this entails 'dressing' the grinding wheel to the relevant profile, some firms are lax in this respect. The radii for both main journals and crankpins for Rolls-Royce shafts are:

20 h.p. to 20/25 h.p. GXB 26	0.125"
20/25 h.p. GXB 27 to end of 25/30 h.p. Series	0.093"

For 3½ and 4¼ litre Bentley (all chassis)

Main journals	0.200"
Crankpins	0.125"

(iii) It is important to check the hardness of the shaft if it is made of 'Nitralloy'. The correct hardness figure is 600 VPN. As a rough guide, a smooth file should not make any mark on the surface. If, after grinding to within a 'thou.' or two of the finished size, the shaft appears soft, or if it shows any signs of having been overheated or 'blued', it should be re-nitrided. There seems no hard and fast rule for this. Some shafts are perfectly hard after having had 0.020" ground off them; others lose their hardness with the removal of half this amount.

The correct procedure for re-nitriding is to have the shaft ground to within 0.002" of finished size, then hardened, and then finish-ground, lapped and polished. This should take care of any slight distortion which may occur during the hardening process.

(iv) If the shaft is slightly bent before it is ground, the main journals will of course be straight and true afterwards, but the big-end journals will have slightly differing 'throws'. Unless this is realised and allowed for, quite significant inaccuracies are likely to result which could affect the smooth running of the engine. The firm should be asked to check and, if necessary, correct any discrepancy during the grinding process. This phenomenon is much more noticeable with long-stroke cranks than the modern short-stroke variety.

(v) If it is desired to effect the 'extra-oil' modification on the 4½ litre Bentley crankshaft, this should of course be done before the shaft is ground. The specification is as follows:

(a) In main bearing journals 2, 3, 5, 6 drill 0.218" (7/32") diameter hole diametrically opposite to the existing hole.
(b) In each crankpin, drill 0.125" (1/8") diameter holes diametrically opposite existing hole.
(c) Finish all new holes with a suitable radius to the crankpin.

The hardened shaft can be drilled using a stellite drill.

(vi) If this modification is carried out it will be necessary to fit the large capacity (aluminium bodied) oil pump in order to cope with the increase in oil flow.

(vii) The crankshaft thrust faces either side of No. 7 main bearing journal should not be ground except in the very unlikely event of their having been damaged. If it is absolutely necessary, the bare minimum of metal should be removed from them.

(viii) The bearing surfaces at the front end of the crankshaft, on which the damper and its associated components oscillate, should not be ground, unless they have been damaged or severely corroded, when it will also be necessary to replace the bushes in the damper assembly and crankshaft timing gear.

Reassembly of the crankshaft should not present any difficulties. If any or all of the oil caps are badly corroded or damaged in any way they should be replaced. It should be remembered that the oil-tightness of these components is essential, and their joint faces should be inspected and if necessary trued up before assembly.

Finally, the crankshaft should be stored until required by being stood upright on its flanged end, to minimise the risk of distortion.

4

Main and Big-end Bearings

On all the engines covered by this book, the crankshaft is mounted in seven main bearings, and on all, except from Wraith Chassis No. WRB1 onwards, shims are fitted between the bearing cap abutment faces. The following is a summary of the bearing details throughout the range of engines:

Main bearings

20 h.p. (1st chassis to the end of L-Series): Top half of bearing cast in solid white metal, and lower half bronze with white metal lining. Steel shims.

20 h.p. (from J-Series onwards), all 20/25 h.p., 25/30 h.p., and Bentley 3½ litre: White metal lined steel shells, top and bottom, with steel shims.

Wraith. As above, but shims omitted after Chassis No. WXA109.

Bentley 4¼ litre. Hall's Metal shells, with Hall's Metal shims, except No. 7 bearing which is steel shells, white metal lined, with steel shims.

Big-end bearings

20 h.p. (1st chassis to end of H-Series): White metal run direct on the connecting rod and the cap. Steel shims.

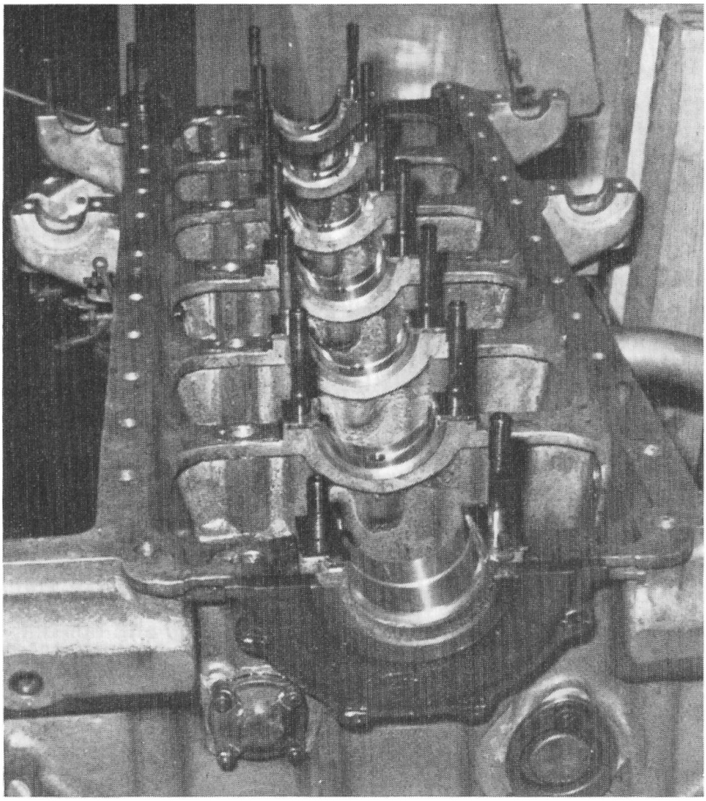
All subsequent 20 h.p., all 20/25 h.p., and Bentley 3½ litre: White metal lined steel shells, with steel shims.

25/30 h.p., and Bentley 4¼ litre: Hall's Metal shells, with Hall's Metal shims.

Wraith: Hall's Metal shells, without shims.

Main bearing housing bore diameters

20 h.p.	2.400"
20/25 h.p. (up to Chassis No. GXB26)	2.475"
20/25 h.p. (from GXB27 onwards), all 25/30 h.p.	2.600"
Bentley 3½ and 4¼ litre	2.600"
Wraith	2.850"



20/25 crankcase with main bearing half shells and shims after line-boring. Note late type end cover with felt oil-seal.

Big-end bearing housing bore diameters

20 h.p. (from J-series onwwards)	1.800” Shim thickness 0.125”
20/25 h.p. (GXO11 to GKT21)	2.000” Shim thickness 0.100”
20/25 h.p. (GKT22 onwards), all 25/30 h.p. Bentley 3½ and 4¼ litre	2.250” Shim thickness 0.100”
Wraith	2.125" No shims

Connecting rod centre to centre dimension, all engines: 7.950".

Mention is made elsewhere in this publication about the ’extra oil’ modification to the crankshaft on 4¼ litre Bentley cars. This was introduced on production chassis during J-Series, but it was recommended that the modification be carried out when an engine needed overhaul. Consequently there are many earlier engines which have already been modified. The authors consider this a most desirable modification to both 4¼ litre and 3½ litre Bentley engines and with the current driving situation, where these cars are sometimes required to cope with prolonged high-speed cruising and traffic conditions for which they were never designed, it is at least comforting to know that one's main and big-end bearings are being fed with the maximum possible quantity of lubricant. However, it is also necessary to fit the high capacity oil pump. This was introduced from Chassis KT-1 and it can be recognised as having an aluminium body instead of the cast bronze variety. Also, to take full advantage of the extra oil flow capacity all main bearings should have a fully circumferential groove machined in them.

All chassis

Replacement main bearing shells now supplied by the Company all have fully circumferential oil grooves already in them, and this would appear to be current practice. However, if re-metalled rather than replacement shells are fitted, it would seem to make sense to duplicate the pre-existing oil groove arrangements, if these have given satisfaction, since the incorporation of fully circumferential grooves in bearings Nos. 2, 3, 5, 6, where these did not exist previously, can do nothing but increase demand from an oil pump which may already by reason of age or infirmity be incapable of delivering its full designed output. Semi-circumferential grooves will improve lubrication to these intermediate bearings without unduly increasing oil demand. Of course, if the 'extra-oil' modification has been carried out on a Bentley engine no difficulty should be experienced in maintaining a good oil pressure and supply from the larger pump. The authors do not intend to recommend that this modification be carried out on Rolls-Royce 20/25 and 25/30 engines, since it was never Company policy to do so.

RECONDITIONING OF MAIN BEARINGS (ALL CHASSIS)

When an engine is completely stripped for overhaul the question of what, if anything, to do to the main bearings is bound to arise. If the bearing surfaces are cracked, damaged, scored, or have lumps missing from them, obviously there is only one course of action and that is to renew the bearings throughout. Likewise if the shaft has to be re-ground by reason of scoring, undue wear or misalignment the same remedy would apply.

If an engine has been carefully looked after, with regular oil changes, or has had a recent bottom-end overhaul, it may well be that its bearings and journal surfaces are quite serviceable and the considerable expense of renewing these can be avoided. In such a case a dimensional check should be carried out.

The correct diametral running clearance for all main bearings is 0.002" for white metal and 0.003" for Hall's Metal. In the case of Bentley engines fitted with a white metalled rear main bearing and Hall's Metal bearings elsewhere the clearance should still be 0.002" and 0.003" respectively. The extra clearance for Hall's Metal is necessary because of the high degree of thermal expansion undergone by this metal and its susceptibility to 'creep' whereby the diametral clearance can decrease as the bearing 'nip' gradually disappears.

How may the existing clearance best be measured? Three methods spring to mind:

(i) The journal diameter and bearing can be measured by external and internal micrometers (or callipers) respectively. Care should be taken to measure the internal bearing diameter in several places since the maximum wear takes place over the lower bearing surface, due to the weight of the crankshaft and flywheel and the directed effort of the connecting rods. This 'ovality' must be taken account of since, in addition to increasing the effective bearing clearance, the timing gear centres may well be affected. If this method is used, no reliance should be placed on the internal micrometer or calliper reading, and this should be checked against the external measuring instrument. In this way a true 'difference reading' will be obtained and this, after all, is the figure that matters.

(ii) There is available a material called 'Plastigauge' consisting of round strips of a deformable polymer which, after having been compressed between a journal and its respective bearing, may be compared in width with a gauge (also supplied) thereby ascertaining the actual clearance existing in the bearing. This is probably the most accurate way of finding the running clearance. The same result may be obtained by using lead or wax 'wires', but in this case a certain amount of research must be carried out using a bearing of known clearance as the control.

(iii) If the bearings and shaft are assembled, clean and lightly oiled, into their correct positions, a good idea of the clearances may be obtained by using small squares of greaseproof paper interposed between the bearing and its journal. This material is usually about 0.002" thick, and using a micrometer a good sample can be obtained. Allowing for its compressibility a 1" square of two-thou. paper under each bearing cap, between bearing face and shaft, should make it just possible for the shaft to be turned by applying a manual torque to the flywheel rim. Weaklings and supermen should of course make the necessary correction. By using slightly thicker paper larger clearances may be tested. Although the above procedure may seem a little hit-and-miss, it does have the advantage that bearing clearances may be tested under dynamic as opposed to static conditions. An experienced mechanic can always tell far more about the condition of a bearing by its 'feel' than by any other method of measurement. Also, by alternatively tightening and loosening individual bearings comparative assessments may be made.

Crankshaft end-float is controlled as has already been mentioned by the clearance between the rear main bearing side and the thrust faces on the rear crankshaft journal. The correct figure for this is between 0.0025" and 0.0030". It may be checked by means of feeler gauges.

PERMISSIBLE LIMITS OF WEAR

Generally speaking main bearing clearances in excess of two-thousandths of an inch above the recommended figures should be regarded as the absolute maximum and this figure is advanced with some trepidation since so many other factors need to be taken into account, not the least of which is the condition of the bearing surfaces themselves. If they are smooth but ingrained with dirt such that an appreciably thick hard surface has been formed on them, the fastidious owner may well consider it necessary to carry out a complete renewal even though the running clearance is in other respects satisfactory. In order to explain this apparent paradox it is necessary to consider the bearing properties of white metal, and, to a lesser extent those of Hall's Metal. These materials have the ability to absorb into themselves smaller particles of abrasive matter and carbon without any deleterious effect to their bearing properties. In time, however, the surfaces become 'overcharged' with extraneous matter and a hard skin is formed which acts as an abrasive surface against the journal. In a 'dirty' engine this skin can build up to a thickness of three or four thousandths of an inch and its hardness can be demonstrated by trying to scrape the skin off.

Another factor needing consideration is the presence or otherwise of bearing 'nip'. For a pair of shells to be held securely in their housing, it is necessary that they be slightly larger in diameter than the housing so that when everthing is securely bolted down a stress is induced in the shell. This has the effect of preventing relative movement and loss of oil pressure from the back of the shell. If this difference in diameter is converted into a feeler gauge measurement between the abutment faces of the shells a figure for 'nip' is obtained. It is measured by bolting up the bearing tightly and then releasing one side. The nip is then measured between the shell faces or between each side of the shim and housing faces where shims are fitted. It is important when taking this measurement to ensure that the bearing cap has no tendency to jam into its recess in the crankcase, as this could affect the reading. Also, in cases of doubt, both sides of the housing should be measured in turn.

The correct figure for main bearing nip is 0.002" for white metal and 0.004" for Hall's Metal. The nip must be equal above and below the shim, e.g., a 0.004" nip must be the sum of 0.002" below the shim and 0.002" above it. Failure to do this could result in one bearing half not being nipped, although the total nip is indicated. In time, these figures will be reduced due to the natural tendency of the metal to settle down under the induced stress, and the effect is marked with Hall's Metal. Where bearings have lost all their nip or it has become less than half the above figures, consideration should be given to replacing the bearings or taking steps to regain that which has been lost. The only practicable way of achieving this latter objective is to remove the appropriate amount of metal from the abutment faces of the bearing caps, and whilst this is a procedure not to be encouraged it is certainly a tempting alternative financially to replacing the bearing shells, especially if they are otherwise satisfactory.

Crankshaft end-float of 0.007" or twice the maximum recommended figure is permissible. Beyond this, however, it is not wise to go since the axial alignment of the timing gears will be upset.

'TAKING-UP' BEARINGS

Provided the surfaces are in good condition and bearing nip exists or can be regained it is possible to take up the clearances in the main bearings where these fall outside the permissible maxima.

Careful measurement will usually reveal that most wear has taken place on the lower bearing half and the 'side-to-side' measurement will be about right. In such a case, by reducing the shims in thickness the bearing may be closed up to restore it to its original circular form, or very nearly so. It is not recommended that more than 0.002" be taken off the shims and if it is apparent before starting that more metal than this needs to be removed it is better to forget it, and renew the bearings in the normal way.

If it is decided to carry out this operation, attention should be paid to the following points:

(i) Only the minimum necessary amount of metal should be removed from each shim, and care taken to match each pair of shims in thickness.

(ii) Although bearing nip should theoretically remain the same after reducing the thickness of the shims, it is as well to check this afterwards and correct as necessary.

(iii) Bearing clearances should be checked after the operation is completed and any high spots carefully removed with a scraper. Do *not* use emery paper on a white metal or a Hall's Metal bearing, as particles of abrasive would tend to become embedded in the soft material, turning it into a very effective lap.

RENEWAL OF MAIN BEARINGS

At the time of writing, Hall's Metal main bearing shells are no longer available from the Company, and there seems little prospect of their ever again being produced. Furthermore, the specification of Hall's Metal appears to have been lost in the mists of antiquity, and although it is known that it is basically an aluminium-tin alloy, and there are various other proprietary bearing metals of this type available, we hesitate to make any specific recommendations as to possible substitutes since we are firmly of the opinion that white metal on steel shells is a better material in any case. Having made that statement, we feel bound to point out that the availability of new white metal shells and shims is also fairly uncertain, but there seems every chance that new stock will eventually be produced. Should this prove not to be the case it is not difficult to make these shells and have them metalled and line bored. Also, of course, the old white metal shells and shims may be remetalled, but this may not give such a satisfactory result as the fitting of new shells, for reasons which will be explained later.

Obviously a worn Hall's Metal bearing cannot be remetalled. The housing diameters are the same as for white metal, so no difficulty need be experienced in their replacement. The aluminium shims used with Hall's Metal will also need replacing with the steel variety, lined on their edges with white metal.

FITTING NEW BEARINGS

All new bearings supplied by the Company are in a prefinished state, the oil grooves being fully-formed together with the radius on the edge of the shell, but the bore is left undersize, so that after being fitted the bearing may be line-bored to the appropriate size.

Originally, bearing shells were supplied 'in the round' consisting of a complete bearing partly milled through on a diameter and needing to be cut through with a hacksaw to make the separate bearing halves.

It is proposed to describe the complete sequence of fitting and line boring a set of main bearings, not because it is anticipated that many owners will have the equipment, skill, or inclination to carry out all the work themselves, but because there is much of the work which a careful and intelligent person *can* do, thereby saving himself expense. Also, a good appreciation of what is involved should stand him in good stead when deciding whether a particular firm is really capable of being entrusted with this exacting task. Dare we suggest that there are some firms whose work is not above reproach and that therefore an owner fully aware of what he requires stands a much better chance of obtaining a satisfactory job of work? The modus operandi is as follows:

(i) Ensure that there is a small clearance between the location peg in the bearing housing and the corresponding hole in the bearing shell. In other words the hole should be a good clearance fit for the peg, and might need to be drilled or lightly reamed. This is so that the shell can move slightly in a circumferential direction to equalise the amount of nip on either side of the bearing.

(ii) If necessary, lightly dress the abutment faces of the shells with a file to bring them smooth and square. Their truth may be checked by placing them face downwards on a surface plate and measuring the overall maximum height of the shell with a dial gauge, first on one side, and then the other. Any out of truth reading can be corrected with a file on the abutment faces, and later on a 'blue reading' can be taken in the same way.

(iii) Temporarily assemble a pair of shells into their housing with their respective shims, and ascertain how much needs to be removed from the abutment faces to bring the bearing nip to the correct figure. This is the most important part of the whole operation, and great care must be taken. It is not, however, overwhelmingly difficult, the essential requirements being a good vice fitted with soft jaws, a 10" second-cut file, and a stout heart.

Trial and error is the order of the day—constant trial to check the nip in the housing and parallelism of the butt faces on the surface plate, and if an error is made, do not make it again—these shells are expensive.

Eventually a stage should be reached when the bearing nip looks about right and seems to be fairly evenly distributed on either side of the shims. This is when the main bearing nuts can be bolted down really tight and left for a few minutes. Lightly tap around the bearing cap with a small hammer just in case the shell wants to move slightly in its housing, and then very gently loosen one of the nuts until it *just* grips the cap. Check the bearing nip again and if necessary correct any discrepancies with a light rub on a piece of fine silicon carbide paper held flat on the surface plate or something similar. Should a mistake be made and too much metal is removed from a shell, the nip may be restored by taking a little off the bearing cap.

(iv) The most tedious part of the work is now over, and there remains to be done the actual boring operation. A Rolls-Royce crankcase, although quite a formidable casting, is really quite flexible, and it is essential that the person entrusted with the boring should understand this, as otherwise it is possible to make a beautiful job of line boring only to find that when the separate cylinder block and head are bolted down, the crankcase distorts slightly and the shaft will not turn. The best way to avoid this mistake is to bore the main bearings with the head and block assembled on the crankcase, and with the stud nuts tightened to their correct poundage. However, this is not always possible if the job is to be done on a horizontal boring machine, but is easy using a. 'portable' type of boring bar.

If the crankcase has to be bored on its own, on a machine, it is important to ensure that it is securely bolted down to the boring table so that its upper surface is held flat and true. The truth of the bolting faces of the head and block should also be tested and corrected if necessary by surface grinding, so that when finally assembled there is no possibility of distortion. These precautions should ensure a perfectly satisfactory result.

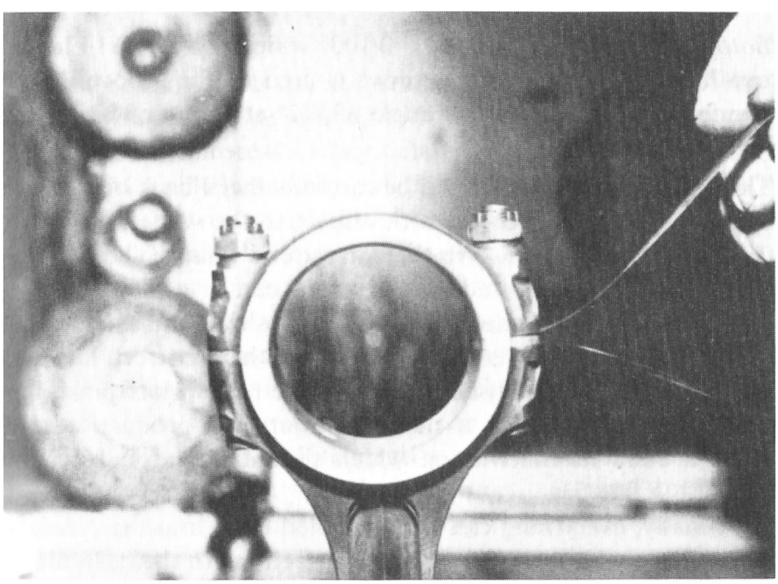
(v) Because of the gear train at the front of the engine, it is absolutely vital to bore the bearings *exactly* in line, so that the centre line of the bearings coincides with that of their housings. Any misalignment will result in the timing gears being out of mesh. Also the clutch spigot could end up being out of line with the flywheel. It is much more important with this type of engine than the majority of others to pay careful attention to this point. The only way to make absolutely certain that the boring bar is truly centred is to turn up 'dollies', which are cylindrical blocks of metal (aluminium is best) bored and honed to a close running fit on the boring bar and with their outside diameters exactly the same as that of the bearing housings. If these are clamped into Nos. 1 and 7 housings and the boring bar inserted, intermediate steadies can then be fitted to maintain the bar in its correct position while the bearings are machined out. The shims should of course be omitted when the dollies are placed in their housings. It is obviously important to ascertain the exact size of the bearing housings, and in order to do this the bearing cap should be assembled with its shims in place and tightened down. Several measurements should be taken, on various diameters. If these are all the same then that is fine. If, however, the shims and/or the caps have been filed down, then there will be ovality in the bore of the housing and the original diameter will have to be interpolated from the micrometer readings. This is not as difficult as it sounds since the 'side to side' measurement will usually give the correct figure unless a lot of metal has been removed from the cap.

Firms who do a lot of line-boring will usually have a series of stepped dollies by means of which an approximate fit can be obtained to almost any bearing housing. Do not permit the use of these. It is worth paying a little extra to have the right ones made.

You will be rewarded by a silent set of timing gears. Silent, that is, unless they have been running out of mesh for so long that they object to being reinstated to their correct centres.

(vi) Now for the boring operation. Depending on the amount of metal to be removed, one or more roughing cuts should be taken to leave the bearings two to four thousandths of an inch undersize. The cutter can then be set to the exact finishing size, which will be 0.002" larger than the measured size of the journal for white metal, or 0.003"' in the case of Hall's Metal. Do not trust the reading of the setting micrometer if one is used to adjust the cutter. A far better scheme is to make up a gauge consisting of a short bush, free to slide on the boring bar, with its outside diameter just a tiny bit smaller than the finished bore of the bearing. This can then be slid into place, without removing the boring bar, to check the size of the bearing.

(vii) Once all the bearings have been bored, they can be removed from their housings unless remetalled, rather than new, shells have been used. In this latter case, a facing cut should be taken to clean up one side of each bearing shell so that when the shells have their



Checking big-end bearing "nip" with feeler gauge either side of shim.

oil grooves and external radii machined on a lathe, an accurate register can be obtained. The radii can, of course, be put on while the shells are still in the crankcase by using the appropriate cutter in the boring bar, but a better finish is obtainable in a lathe. Great care should be taken with the rear main to get a nice flat surface on the side of this bearing since the truth of this will determine the end float of the crankshaft.

(viii) If a bar of aluminium is put up in the lathe, of a diameter rather larger than that of the bearing journal, it can be turned down to the appropriate diameter, with a nice sharp shoulder against which the accurately faced side of the shells can abut. Pairs of shells may be mounted on this and held on to it with a large Jubilee clip while their side radii are machined. Also the shells can be carefully positioned for the internal oil grooves to be machined out, if these do not already exist. The dimensions of these are as follows:

Bearing Nos. 1, 4 and 7

0.030" deep x 0.175" wide.

Bearing Nos. 2, 3, 5 and 6

Bottom halves: 0.030" deep x 0.100" wide. Top halves: Either as above if fully circumferential groove is used or the groove is semi-circumferential subtending an angle of 112° at centre of bearing.

The rear main bearing should be carefully faced back on each side keeping the steel shell central with respect to the white metal thrust faces, until its width will give the correct end float of 0.003" to the crankshaft. The internal radii may then be cut.

(ix) Location marks should be put on the shells and shims so that they can always be assembled back into their correct locations. Inspection of the original shells will give the best way of positioning these. Do not forget that a number stamp will produce a raised portion around its indentation which should be carefully dressed down with a fine file.

(x) Finally, everything can be assembled back into the crankcase and the shaft installed. Any slight imperfections to the radii may be pared away with a sharp bearing scraper, and if paraffin is used as a lubricant, high spots on the bearing surfaces will show up as polished areas and these too can be scraped off.

HALL'S METAL BEARINGS

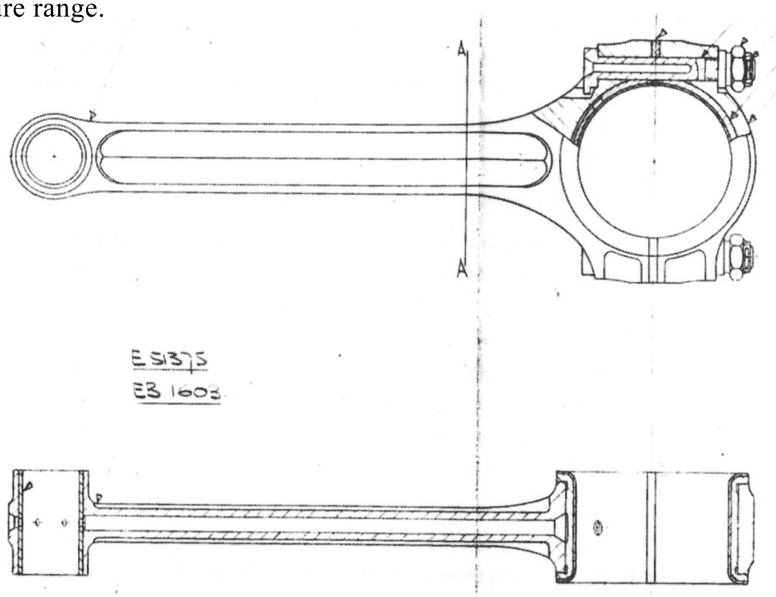
Since these are no longer available, it may seem academic to discuss the fitting of them. However, old stock has a habit of coming to light and who knows whether the Company may not decide to produce a new supply?

The preceding instructions apply generally to these bearings, except in the procedure for obtaining nip. This should first of all be adjusted to 0.016" and then the shells installed, with their shims, into their housings and tightly bolted up. After a decent period of time—say 24 hours—investigation will show the nip to have settled down to substantially less than this figure, usually about 0.008"-0.010". The nip may then be adjusted to 0.004" for each bearing. It is important to carry out the above procedure since the 'pre-crushing' operation causes the metal to 'cold flow' until residual stresses thus induced into the material are sufficient to resist its natural tendency to creep during service, thereby ensuring that bearing nip is maintained. After this, the bearings may of course be bored in the normal way, not forgetting that they require rather more running clearance than white metalled bearings.

REMETALLING BEARINGS

If new bearing shells are not available, or too expensive, then the old ones will have to be re-lined with white metal. It is not proposed to describe this process in any detail, since it is not a job for the amateur. Most likely one firm will do the white metalling, fitting and boring and the owner can do little but acquaint them with the various dimensions required in respect of bearing size, nip, etc. It is important to make sure that a good quality white metal is used such as Hoyt's No. 7 or 11R and in all other respects the instructions contained in the preceding section apply, except that extra care needs to be taken to ensure that the remetalled bearing shells are properly 'expanded' into their housings when the caps are bolted down. Due to the shrinkage of the white metal as it cools down, the shells tend to bow inwards, slightly, and they sometimes need to be gently lapped over a curved mandrel to restore them to approximately the correct curvature.

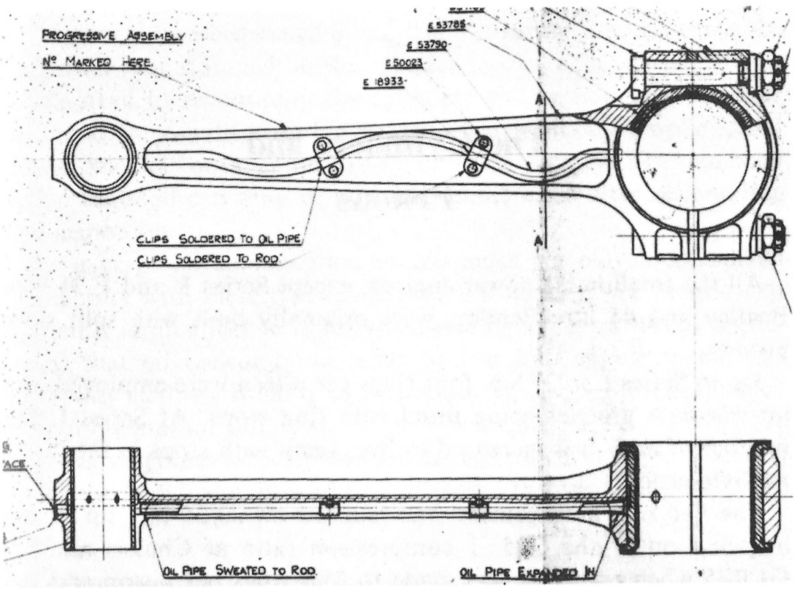
Much trouble is encountered over the remetalling of shims, but if tackled in the right way, it is not really such a difficult job, and one where quite a bit of expensive labour can be saved. If the shim is degreased, and the white metalled edge scraped hard down to clean bright metal, a neat fillet of new white metal can be gently 'welded' around the edge by using a really hot, large electric soldering iron and a stick of white metal. Baker's soldering fluid is the best flux to use. The new metal will form a meniscus standing proud of the face of the shim, and this can be filed flat again, and polished off on a piece of fine paper held on the surface plate. Any firm specialising in white metalling will supply sticks of metal, which are usually made by pouring molten metal along the inside of a piece of angle iron. If it is possible to make a selection from several sticks, bend one gently while holding it close to the ear. If it crackles loudly like a dry cigar it probably contains too much tin. Pick the one which crackles least of all, as this is likely to be the easiest one to work with a soldering iron, the molten metal remaining plastic over a bigger temperature range.



The later type 'drilled up' connecting rod.

BIG-END BEARINGS

The foregoing procedure for main bearings applies also to the big-ends, and here the importance of attaining the correct nip cannot



Connecting rod with external oil pipe. These pipes are soft soldered at their ends and on overhaul must be checked for oil leaks.

be stressed too strongly, especially if Hall's Metal is used. If a big-end catastrophic failure occurs the connecting rod will almost certainly come through the side of the crankcase, as well as breaking into the cylinder block.

Make sure that the nip is correct, and equal on each side of the shim, and that the bearing is bored to the correct running clearance.

On completion of machining the big- and small-ends, jig check the connecting rod for parallelism, absence of twist and bend, and true up as necessary.

The lateral location of the connecting rod is controlled by the piston boss and, when built up, the big-end should lie centrally on the crankpin with about 1/16" total side clearance. If this is not achieved, the truth of the connecting rod must be suspect.

Rods with external oil pipes are built up so that the pipes face towards the centre main bearing, i.e., the front three face backwards and the rear three face forwards. Rods with squirt holes are fitted so that the holes are to the thrust side of the cylinders.

5

The Cylinders and Pistons

All the small horse power engines, except Series E and F 3½ litre Bentley and 4¼ litre Bentley, were originally built with split skirt pistons.

Up to Series L in 20 h.p. four rings per piston were employed, the intermediate grooves being fitted with ring stops. At Series L the number of rings was increased to five, again with stops in the intermediate grooves.

The five ring arrangement was retained on 20/25 h.p. up to the introduction of the 5.25 : 1 compression ratio at Chassis number GLR25 when reversion was made to four rings per piston and the same arrangement was retained on the 5.75 : 1 pistons introduced at Chassis number GXT22. On the earlier type stops were fitted to the intermediate grooves, and on the later types stops were fitted to all four grooves.

All 25/30 h.p. were built with three ring pistons.

The Bentley 3½ litre, Series A to D, were built with four ring pistons, with stops in the top three grooves. Series E and F, 3½ litre, and all 4¼ litre had three rings per piston, no stops being used.

Slotted cast iron scraper rings were fitted to the bottom grooves of all four ring 20/25 h.p., all 25/30 h.p., and all Bentley.

Throughout the range the gudgeon pin diameter was 0.750". Up to Series L, in 20 h.p. the pin was located by a pair of locking screws, threaded 0.250" x 30 t.p.i., which passed through holes in the gudgeon bosses and screwed into the pin itself. On later 20 h.p. these screws were superseded by aluminium end caps pressed into the ends of the pin. On all 20/25 h.p. the pins were located by Seeger clips, and on 25/30 h.p. and Bentley reversion was made to aluminium caps.

The standard cylinder bore sizes are:

20 h.p.	3.000"
20/25 h.p. and Bentley 3½ litre	3.250"
25/30 h.p. and Bentley 4¼ litre	3.500"

Some engines were issued bored 0.010" oversize, and on those the dimension was stamped on the cylinder block joint face.

The need to recondition the cylinders will be indicated by poor compression, usually with blow down, heavy oil consumption, and piston knocks, or a combination of these factors. The remedial action required can only be positively established after dismantling and inspection.

An average oil consumption of 150 miles per pint is considered satisfactory with these types of engine, and it would be pointless to dismantle in an effort to improve on this figure. It should be appreciated that oil consumption tends to rise with engine speed, and motorway running is likely to be prejudicial. Also, oil leaks, which regrettably are not unknown on prewar engines, are a debit, as are worn valve guides which allow oil to be drawn into the cylinders under the high vacuum condition of closed throttle over-run.

INSPECTION

If the work being undertaken is confined to reconditioning the cylinders, as distinct from a complete engine overhaul, it will be necessary to remove the sump and uncouple the connecting rods, in addition to the obvious lifting of the cylinder head and block. The reason for this is the extreme difficulty of refitting the block with the rods coupled up, this being virtually impossible if Duaflex rings are fitted.

The cylinders should be measured with a Mercer gauge set to the nominal bore size, plus the oversize stamped on the piston crowns. From a commercial point of view, if the bore wear is more than 0.0035" reboring is the procedure recommended. If less than this the pistons should be carefully inspected with a view to refitting them.

In examining the pistons pay particular attention to the fit of the rings in their grooves, the fit of the gudgeon pins, the dimension of the bottom of skirt on the thrust axis, and ensure that the piston is totally free from cracks. When new the vertical clearance of all rings in their grooves was in the limits 0.002" to 0.004", and this figure should not be exceeded by more than a thousandth or so. When the piston is cold it should not be possible to push the gudgeon pin through by manual pressure.

Measure the bottom of skirt on the thrust axis with a micrometer; the reading should be the nominal bore size plus any oversize on the piston crown. Insert the bare piston into its bore, and check the skirt clearance at the bottom of the stroke; on the thrust axis the clearance should be nil, and the piston should not fall under its own weight.

Measure the diameter of the gudgeon pins with a micrometer, this should be a uniform 0.750", and check the fit of the pins in the connecting rod eyes. They should be a light push fit. If this requirement is not met by gudgeon pins which are to size, the small ends must be rebushed and finished by diamond boring or honing to match the pins.

The recommended piston ring gaps are 0.008" to 0.010" for top rings, and 0.006" to 0.008" for the intermediates. The slotted oil scraper rings originally fitted to the later 20/25 h.p., 25/30 h.p., and Bentley are no longer supplied, and the current replacements are Wellworthy Duaflex steel rings.

When checking the gaps, which must be done at the bottom of the bore if the cylinders have not been rebored, make allowance for the ring stops if fitted. All stops were 0.075" wide, except those fitted to the bottom grooves of the four ring 20/25 h.p. pistons which were 0.100" wide.

REBORING AND RESLEEVING

The method of reconditioning the cylinder bores is by reboring and hone finishing to size, a process which yields a surface of a minutely scratched appearance having good oil retention properties, and to which the piston rings will bed readily.

Oversize pistons are listed plus 0.015", 0.025", 0.035" and 0.045".

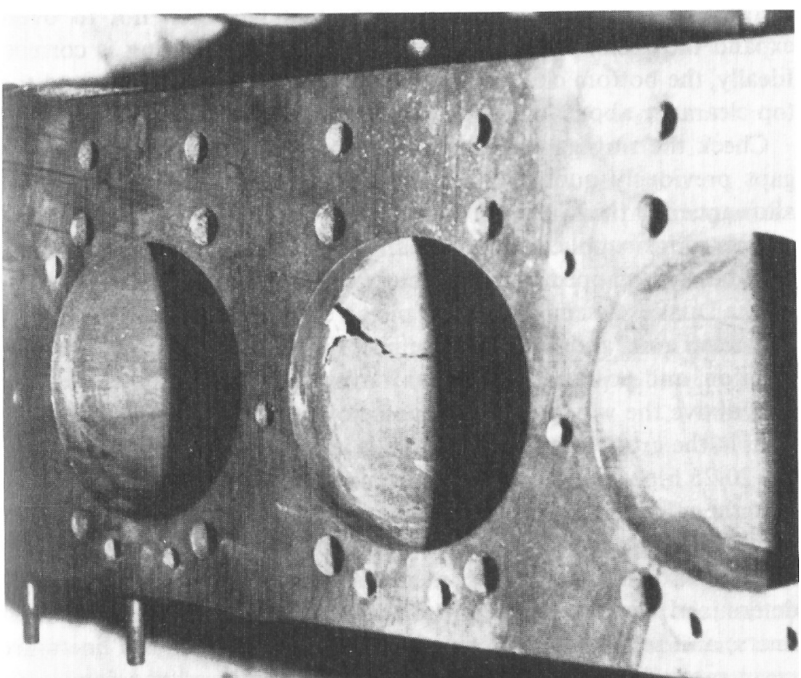
Bores which will not clean up at plus 0.045" are brought back to standard size by fitting full length cast iron liners, which are pressed into the block and then bored and honed to size. Damaged skirt extensions are reclaimed by machining off flush with the bottom face of the block, and press fitting a stepped cast iron liner which, again, is finished to size in position.

Great care must be taken when boring out blocks to accept full-length liners. The portion of the skirt extension left after this operation is very thin and easily cracked by the stress induced by an interference fit. The bore of the skirt extension only should be further relieved so that only the very lightest interference exists between it and the liner when the latter is pressed home.

Parallelism of the boring should be carefully checked. A worn cylinder boring machine might be capable of producing a satisfactory result on a modern short-stroke engine, but could easily bore to a taper in long-stroke engines such as these. The result of forcing a new liner into a tapered bore is very nasty and it is not unknown for a block to be split in two by such an occurrence.

As is well known, to determine the size at which a worn cylinder will clean up, double the wear indicated by the Mercer gauge and then select the next piston size higher than that figure. For example, if the indicated wear is 0.010" that cylinder will rebore to plus 0.025", and not, as might be hoped, plus 0.015". The reason for this is that bores do not wear symmetrically about the longitudinal axis, and in reboring the bar must be set up on the original cylinder centre line.

The bores must be finished exactly to the nominal bore size plus the oversize of the pistons. The boring bar should be set up to machine the bores 0.002" undersize of the required finished diameter. The 0.002" is then taken out by honing, so that a light push is necessary to pass the bare piston through the bore.



Cracked cylinder bore. This block was reclaimed by fitting a full-length liner.

The availability of pistons at the present time is in some cases at variance with the original equipment, but the differences do not create difficulties.

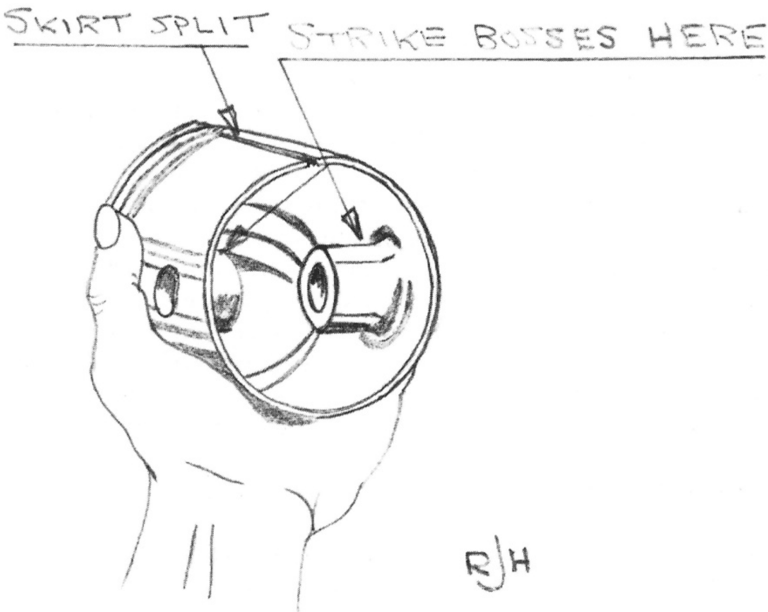
For 20 h.p. engines the only pistons now listed are the later five ring type, and for 20/25 h.p. the only ones available are 5.75 : 1 compression type. The replacement for the Bentley 3½ litre is a three ring split skirt pattern. For 25/30 h.p. and Bentley 4¼ litre the piston supplied is the post-war type used on the 3.500" bore Silver Wraith and the Bentley Mark VI, which, again, is a split skirt type.

The success of reboring depends to a large degree upon the skill and care with which the pistons are matched to their bores. It is a characteristic of split skirt pistons that they can be expanded on the skirt dimensions by peening the gudgeon bosses inside the piston. In this way the dimensions on the thrust axis can be increased by 0.0015" to 0.002". For the purpose a special hammer of about two ounces weight must be made up. The method of doing this is to strike each boss a couple of light blows, and then measure the skirt on the thrust axis with a micrometer. Care must be taken not to over-expand the piston and to ensure that the skirt bedding is correct. Ideally, the bottom clearance against the bore should be nil, and the top clearance about 0.0035".

Check the ring gaps in the bores, and adjust if necessary to the gaps previously quoted. Where ring stops are fitted, make 0.075" allowance for them. For all four ring and three ring pistons the oil scraper rings supplied will be Wellworthy Duaflex with steel rails, and these are gapped in manufacture.

The Duaflex assembly for each piston consists of a hump expander, one wavy rail, and three plain rails. First place the hump ring in position, and position the wavy rail over it. Follow this by two plain rails above the wavy one, and one below it. The rails must be fairly tight in the groove and a ring clamp is used to push them fully home. On 20/25 h.p. the bottom ring stop must be deleted.

If the cylinders will not clean up at the maximum oversize they must be bored out to accept cast iron plain liners. The liners must be fitted with 0.002" to 0.0025" interference, and the machining size is determined by measuring the outside diameter of the individual liners, and setting up the boring bar accordingly. As the liners are never precisely round, take six micrometer readings at various positions and strike the average. A press capacity of about three tons is required to press the liners home.



Method of peening piston bosses to increase the bottom of skirt thrust axis diameter. The weight of the hammer used for this should not exceed two ounces.

The fitting of stepped liners is done in the same manner, after machining off the broken lower extension. To clear the radius at the top of the step a 45° lead in must be machined in the bottom face of the block.

Once the liners have been pressed into position they must be bored and honed to size as in the normal reboring procedure.

REASSEMBLY ON TO THE CRANKCASE

A paper joint is fitted between the cylinder block and the crankcase, and this must be dressed with jointing compound.

First, mount the block on the crankcase and work it down into position. Assemble the pistons on to the connecting rods, after immersing the pistons in hot water, checking that the splits in the pistons are on the same side as the progressive assembly numbers stamped on the big ends. Ensure that the gudgeon circlips are correctly located in their grooves, or if the pins have aluminium plugs that they are properly centralised. Assemble the rings on to the pistons, and lubricate them and the piston skirts with Graphogen or, failing this, engine oil.

Turn the crankshaft so that No. 1 crankpin is at bottom dead centre. Fit a ring clamp to No. 1 piston and lower the big end of the connecting rod into the bore, with the split of the piston facing towards the camshaft side. Thread the piston into the bore and push it down until the ring clamp contacts the joint face. Then, with the end of a hammer handle carefully tap the piston through the clamp and down into the cylinder. From beneath, pull the rod down and engage the big end with the crankpin, and fit the big end cap, ensuring that the numbers on the rod and the cap are juxtaposed, and that they and the piston split are facing the camshaft side of the engine. Pull the engine round on the starting handle, noting that it turns freely.

Fit the remaining five piston and connecting rod assemblies in the same manner. Particular attention must be paid to ensure that the piston splits and the big end assembly numbers all face towards the camshaft side. In doing the work, as in any fitting exercise, make sure the engine will still turn after each sub-assembly is added to it. If it goes tight at any stage rectify it before proceeding.

6

Some Useful Points

BOLT TIGHTNESS

When the engines covered by this book were originally built reliance was placed on the skill of the individual fitters to ensure that the nuts and bolts were correctly tightened. For a given diameter of bolt a particular spanner leverage was stipulated, and it was part of the responsibility of workshop supervisors to see to it that the laid down leverages were not exceeded.

The tool for cylinder head, main bearing, and big-end nuts was a tubular box spanner with a centrally disposed tommy bar. For cylinder heads the bar length was six inches, and for the mains and big-ends it was eight inches. This practice continued until the advent of the S-type motor car, when torque wrenches started to come into use. These wrenches were never used in the Works on the pre-war cars, and no figures were ever laid down for them.

Because of the length of pre-war head studs great care is necessary not to pull them beyond their elastic limit. Although they are of high tensile material, once they have been 'started' they will continue to stretch. Do not use a torque wrench, and do not exceed the recommended bar length. With the present-day use of socket spanners, the tee handle in most of the 3/8" drive socket sets will give satisfactory leverage. On the other hand, the handles in the 1/2" drive sets are too long.

In fitting the cylinder head, dress the gasket with grease, not jointing compound, and tighten the nuts in turn a little at a time, starting at the centre and working outwards and cross-wise to the ends of the casting. After running the engine for the first time, finally check tighten while hot, and then re-check the tappet clearances.

FINISH OF ENGINE COMPONENTS

The cylinder head, cylinder block, inlet manifold, and rocker cover were originally stove enamelled black, and the same process should be applied during overhaul. If the castings are properly degreased before stoving, this finishing should virtually last the overhaul life of the engine.

The crankcase halves and the timing cover were not polished, being used as fettled by the foundry. It is arguable that the 'unsmooth' finish assists heat dissipation.

The petrol and oil pipes were made of copper, with brazed on (not soft soldered) ends, the complete assemblies being nickelled.

As made, the exhaust manifold was oil blacked.

OIL PRESSURE TESTING

At the stage of build where the engine is complete except for the fitting of the sump, timing cover, and rocker cover, an oil pressure test should be made to see that oil bleeds from the mains and big-ends. At the same time, no leak should occur from the crankshaft sealing caps or the oil gallery connections.

The Works equipment for this consisted of a pressure vessel containing about two gallons of oil, and able to work at a pressure of 20-25 p.s.i. The vessel had two unions at the top, one for attachment to an air line and the other for coupling to the main gallery connection on the crankcase. The latter union was brazed to a vertical pipe which extended almost to the bottom of the container. Also tapped into the top was a 0-40 lb pressure gauge.

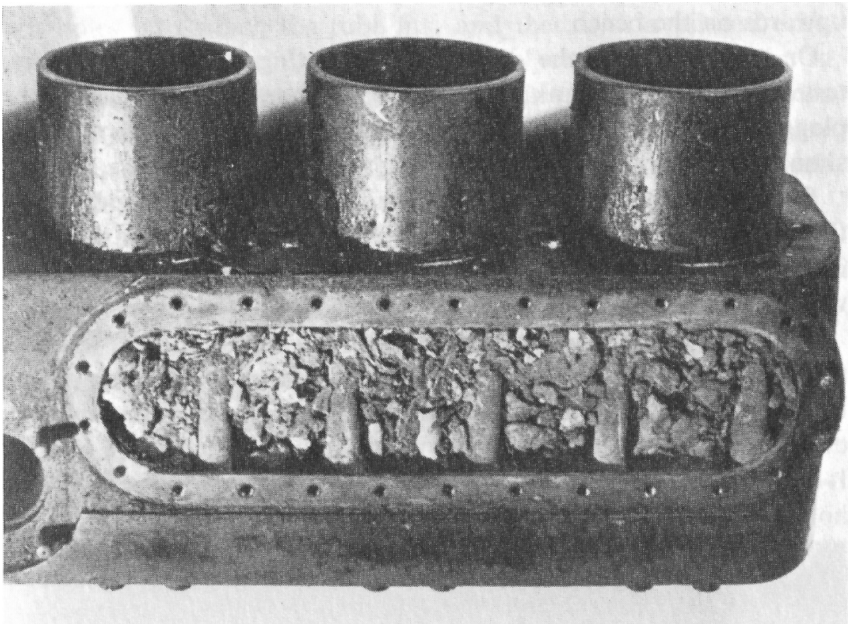
The device worked in much the same way as a soda siphon; the air pressure in the top of the vessel forced the oil up the vertical pipe, and through the connecting hose, thence to the crankshaft. The test oil supply was isolated from the oil pump and the rocker feed, and the latter was checked when the engine was run for the first time.

The check was made with the engine inverted on its stand, when by turning the crankshaft 90° or so, the bleed from all thirteen bottom half bearings and the connecting rod squirt holes (if applicable) could readily be seen. At the same time, any leak from the crankshaft caps or the gallery pipe was detected.

CYLINDER BLOCKS AND HEADS

In the course of engine overhaul consideration must be given to de-scaling the water jackets, a time-consuming and unpleasant job.

The cylinder block side covers are secured by countersunk slot headed screws, and they are always difficult to remove. The use of an impact screwdriver is not recommended because of the risk of



Early 20 h.p. cylinder block showing an accumulation of scale inside the water jacket. The large apertures revealed when the side-plates are removed constitute a structural weakness, and cast-iron 'struts" were fitted to many early blocks, the later ones having them cast-in.

cracking the casting, but rather, the largest possible driver with the blade ground to suit.

With the covers off, the block should be scraped, and the loose debris removed as far as possible. The method of pickling is to lay the block on its side, tappet chest downwards, and drive wooden pegs into the joint face water holes. The jacket is then filled with a 32% hydrochloric acid solution, and left to stand for two or three days. Then drain the casting into a container, by pulling out the wooden plugs. Then replace the plugs, and refill with a strong caustic soda solution, and again leave to stand.

Drain the caustic soda by withdrawing the wooden plugs, and then thoroughly wash out the jacket with running water.

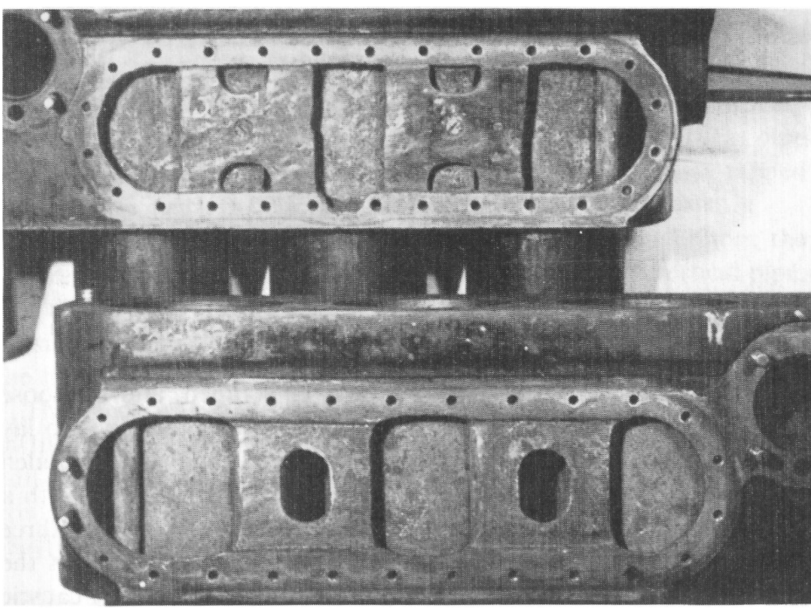
To do this work protective clothing, rubber apron, gloves, etc. is essential, and every care must be taken to protect the skin, and especially the eyes, from the chemicals.

The cylinder head is descaled in the same fashion, laid joint face upwards on the bench.

On completion of the descaling the casting should be pressure tested in a hot water tank, and once again the water holes should be plugged with wooden pegs. At an air pressure of 15 p.s.i. no leaks should be apparent.

Both the cylinder block and the head are fitted with copper tubes through which the cylinder head studs pass. These tubes are driven into position, and their ends swaged with a conical tool to make them watertight.

To remove a faulty tube, drive it out with a piloted drift towards the joint face. If, as does happen, the tube drives part way out and then collapses, the method is to cut off the protruding part and then drive the same end in so that the tube is collapsed inside the casting. It can then be withdrawn through a water cover hole or a core plug hole.

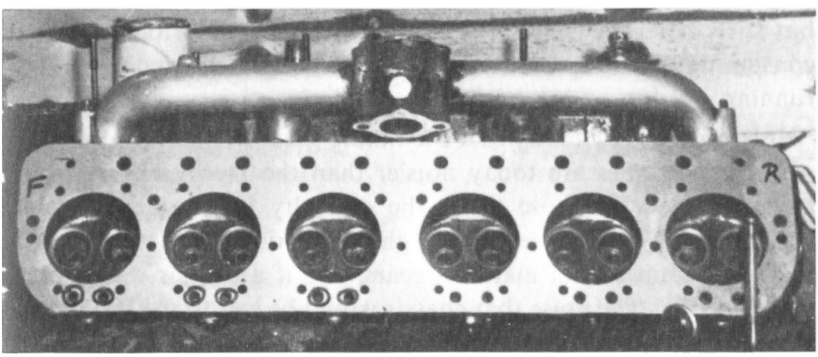


Top: 1926 20 h.p. cylinder block with struts fitted into side-plate apertures.
Bottom: Early (circa 1930) 20/25 h.p. block with cast-in struts.

The greatest care must be taken not to damage these tubes if it is necessary to drill out a broken stud in a casting side face.

Fitting of a new tube is fairly straightforward. First, clean up both holes into which the tube fits, and then with a piloted drift, drive the tube into position from the joint face side. This applies to both the head and the block. With the tube driven in, swage both ends by means of a conical swaging tool in a pillar drill. Finally, pressure test at 15 p.s.i. As received, the tubes should be fairly soft, and annealing should not be necessary.

Complaint is sometimes made that a small horsepower engine runs hot, although there is no obstruction of the radiator. A contributory factor on the early engines was found to be the position of the water pump inlet in the cylinder-block which tended to provide insufficient flow to the rear of the engine. The situation was made visually worse by the position of the temperature gauge in the back of the head.



20/25 cylinder head, showing the front six water holes on the off-side of the engine to be blanked-off to improve water circulation around the rear of the head and block.

It was then appreciated that what was needed was a horizontal flow of coolant through the cylinder head, and a rather elegant solution to the problem was found. It will be seen that there are six pairs of water holes in the cylinder head; one pair adjacent to each combustion chamber on the right hand side of the engine. The horizontal flow was induced by plugging the front three pairs of holes, with driven in aluminium plugs. The rear three pairs were, of course, left open. Later 20/25 h.p., 25/30 h.p., and the Bentleys were delivered new with these front holes blanked off, and it was Service practice to make the alteration on earlier engines.

In the course of decarbonisation or overhaul of the engine, blanking of the water holes is recommended.

7

The Wheelcase

A feature of all the small horse power engines, with the exceptions of Wraith and Bentley V, is the five gear wheelcase, and the detail changes adopted during the production run of these engines did not radically alter the general layout.

Fortunately, in service the gears have proved to be extremely durable, and usually noise complaints can be improved by attention to the various bearings in the train. Should broken or badly worn teeth be found there would be no option but to renew such gears, but such renewal would almost certainly be a laborious and time consuming occupation with no guarantee of subsequent silent running.

It is perhaps fair to say that the timing gears of a good percentage of prewar engines are today noisier than the Derby testers would have accepted. In those years the difficulty in quietening timing gears was fully recognised, although at that time there was recourse to replacement sets of matched gears, and if a chassis was rejected for front of engine noise that chassis would be lost to the Production Department for possibly a quite considerable period of time.

At the present time problems with gears can really only be dealt with by compromise, having regard to the limited availability of replacement parts and what is acceptable in the way of noise level.

Considering the timing gear layout it will be appreciated that the relationship between the crankshaft and camshaft centres cannot be altered, but an error in alignment of main bearing line boring will alter the mesh of the crankshaft gear and the camwheel. Except on the early 20 h.p. the idler gear spindle is located by a pair of dowels for meshing purposes. The centre of the water pump drive gear cannot be altered, and the same is true of the dynamo drive except on the 25/30 h.p. and Bentley. On those engines the journal of the pinion post is made 0.004" eccentric to the flange, which gives sufficient scope to alter the mesh between the camwheel and the dynamo pinion.

Ideally, there should be about 0.003" backlash between adjacent gears in the train. Possibly on building up the best method is to take a blue bedding reading between adjacent gears, and if the bedding is good and the backlash correct the noise level should be acceptable.

The faces of the gears should line up across the wheelcase, and there is provision for small adjustment in this direction.

When dismantling take the greatest care not to damage the gears in any way, and once they are down simply wash them in paraffin and then store them in clean oil until required for rebuilding. Do not wire brush them, or clean the teeth in any other way.

8

The Crankshaft Vibration Damper

Quoting Mr S. H. Grylls, addressing the Institution of Mechanical Engineers: "Every crankshaft and flywheel assembly has a natural frequency of torsional vibration, the node being near the flywheel, but only an in-line six has a disturbing torque due to the motion of its pistons which is not only almost a pure sine wave, but one of considerable amplitude."

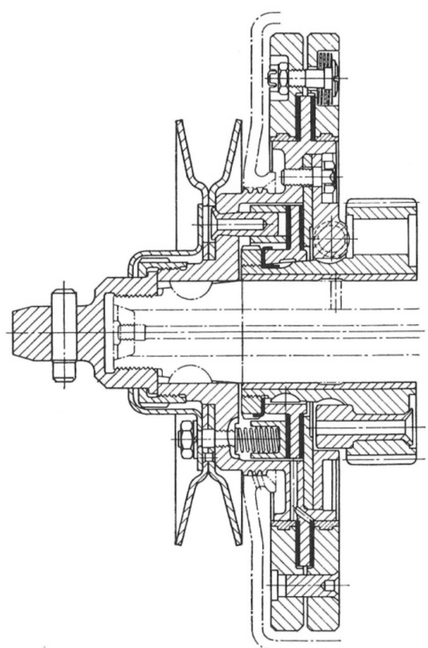
The function of the Crankshaft Damper, with its integral spring drive, is to modify these vibrations through the normal speed range of the crankshaft. Where engine vibrations are found, a change in the damper poundage is a possible cause; this can occur in normal usage, and certainly after a period of storage, of say several months, when the damping washers can adhere to the flywheels.

Two types of damper were fitted to small horsepower engines, which although performing the same function were quite different in design. However, the principle of operation is the same in all cases, and an explanation of this might facilitate the overhaul of the damper assembly.

As has already been stated, torsional crankshaft oscillations give rise to obtrusive vibration periods at certain engine speeds. The exact speeds are difficult to determine at the design stage, but in practice similar engines will have similar characteristics in this respect. Quite early in the development of the motor-car engine, sudden breakage of the crankshaft was a common occurrence, particularly in engines having three, six or twelve cylinders, whose crank dispositions were at 120° to each other. Although many of these failures were no doubt attributable to undue slenderness of a highly stressed component and to unsuitable materials being used, it was soon recognised that the solution to the problem lay in a device to damp out the oscillations produced.

Just as a column of marching men is ordered to 'break step' when crossing a bridge, the introduction of another system of weights and springs, having a different period of natural vibration, is sufficient to damp out the original vibration, and providing such a 'damper' is properly designed, the interaction of one with another will ensure vibration-free running throughout the normal speed range. Because of this, these devices are referred to variously as 'torsional' or 'harmonic' dampers.

The Rolls-Royce engine is certainly not unique in having a damped crankshaft, but it is unusual in having the damper located inside the wheelcase, most other cars having their dampers externally mounted, where they normally give very little trouble. It is this very fact that gives rise to the troubles from which Rolls-Royce dampers suffer. The very nature of their design makes them into unwanted, but efficient, centrifugal oil filters; and sludge accumulates within

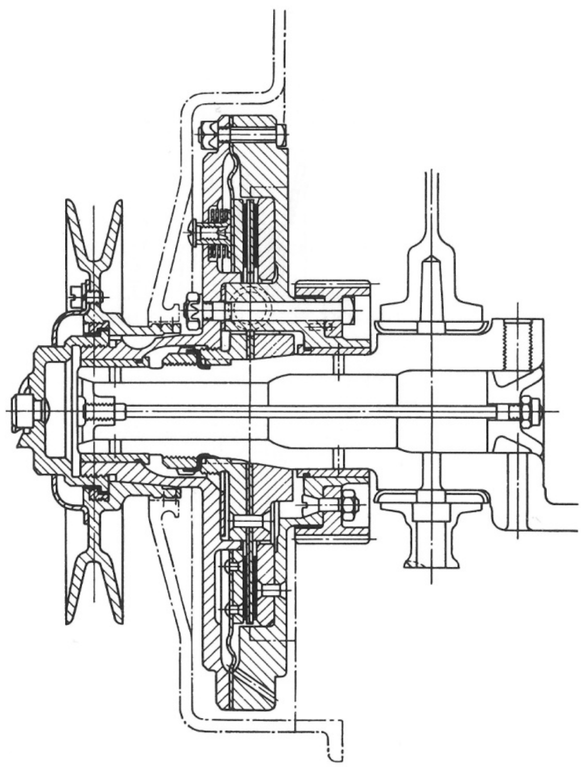


Type of crankshaft damper fitted up to chassis no. GKT21

them, and impregnates the friction material. Frequent oil changes and the use of modern oils should prolong the life of this component.

In all cases damping is achieved by the use of relatively heavy 'flywheels', free to rotate within limits around a central disc. The rotational torque required to achieve relative motion is determined by the friction existing between the flywheels and the disc, and the 'poundage' required for this is the setting figure for the particular damper.

The 'poundage bar' referred to in the ensuing notes is such that the distance from the centre of the test mandrel to the point of application of the effort is 17½" (444.5 mm). Just how this figure was arrived at is difficult to say, but it probably coincided with the length of a scrap length of bar used to make the first one!



Low inertia type damper.

At the time of writing, cotton damper washers are difficult, or impossible, to obtain for some engines. In this case a different friction material must be used, and 'Tufnol' sheet, 1/16" thick, seems to be a good alternative. It is readily available, unaffected by oil, and might even give better service than woven cotton washers, which, in our opinion, have never been entirely satisfactory.

The damper fitted to all 20 h.p. and 20/25 h.p. up to Chassis GKT21 consists of a hub coupled to the timing pinion by a spring drive, oscillation between the two being damped by fibre washers. Mounted on the hub are a pair of inertia flywheels which are damped by cotton duck washers.

From Chassis GKT22 onwards, and on all 25/30 h.p. and Bentley, the Low Inertia Damper was fitted. As before, the hub and the pinion are coupled by a spring drive, but the flywheels are rigidly bolted to the pinion and damping is by means of cotton duck washers between the flywheels and the hub.

Overhaul of the damper is almost certainly the most time consuming and frustrating job on these engines, especially as a positive diagnosis of a damper fault can be difficult. When a complete engine overhaul is undertaken, reconditioning of the damper is essential, and it is relative to such an overhaul that these notes are framed.

REMOVAL OF THE TIMING COVER

20 h.p., and 20/25 h.p. up to Chassis GKT21

Commence by removing the dynamo drive brake housing, as described in the Dynamo and Magneto Drive section.

On 20 h.p., Chassis 1-500, remove the fan pulley securing nuts, take off the lock plate, and pull off the pulley taking care of the springs lying behind it. Scrap the paper washer.

From Chassis 501 to GKT21 remove the fan pulley securing nuts and take off the lock plate. Remove the serrated nut, threaded left hand, which lies behind the lock plate, and pull off the pulley.

Take off the timing cover, noting the positions of the two ream fitted bolts.

LOW INERTIA DRIVES

Take off the lock plate and withdraw the fan pulley by unscrewing the starting dog nut. This nut will be very tight, and difficulty will be found in starting it. The tool for this is a 'slogger' spanner, made from 5/16" steel plate with a hexagon opening to fit the nut, and an arm about 8" long by 1¾" wide. With the crankshaft spragged, a smart blow with a two pound hide faced mallet on this spanner will loosen the nut. Use of a ring spanner or a socket and strong arm bar does not impart the necessary shock.

If fitted, take off the dynamo drive brake covers, and withdraw the brake blocks and their guides.

Take off the timing cover, noting the positions of the four ream fitted 5/16" bolts.

REMOVAL AND STRIPPING OF THE DAMPER

20 h.p., Chassis 1-500

Start by removing the starting dog nut. Again, a slogger spanner will be needed.

The boss of the damper hub, immediately behind the dog nut, is threaded 1.875" x 16 t.p.i., left hand, and it is essential to have an extractor to fit this thread. At this stage bring the engine up to the flywheel TDC mark, and mark the meshing teeth of the camwheel, the idler gear, and the water pump pinion with a scriber. It is particularly desirable to do this if no other work than reconditioning the damper is being done. With the extractor withdraw the complete damper assembly, and collect the Woodruff key.

Take off the inertia flywheels by removing the split pinned nuts, bolts, and the springs. Discard the duck washers.

Pull the pinion out of the back of the damper, unpin the nuts and remove the eight screws securing the rear retaining plate. Lever out the plate, and pull out the internally splined steel friction washer. Collect the two fibre washers and put them on one side.

Pull both halves of the spring drive complete with the springs, and the pressure spring thrust plate, out of the hub.

20 h.p. from Chassis 501, and 20/25 h.p. up to Chassis GKT21

Refit the serrated left hand thread nut to the damper hub, bring the engine up to TDC as described above, and withdraw the damper assembly by unscrewing the starting dog nut, which should have been loosened with a slogger spanner. Collect the Woodruff key as the damper comes clear.

Take off the inertia flywheels as described above. Remove the eight lock tabbed setscrews securing the spring drive cage and the friction disc to the hub, and pull the hub away complete with the presser plate and the springs.

It then remains to separate the timing pinion from the spring drive. To do this push a pair of ½" bolts into opposite holes in the back of the pinion, and nip the bolts firmly in the vice. Unscrew the nut on the pinion nose, remove the tab washer, and tap the pinion through the friction plate and the spring drive; collect the Woodruff key from the pinion nose. Unless the drive springs are seen to be broken or collapsed this part of the job could be omitted.

LOW INERTIA DRIVE

Remove the four nuts in the centre of the damper flywheel, and the ring of nuts at the periphery. Pull off the front half of the flywheel, followed by the spring plate and the front cotton duck washer. Bend back the tab washer and unscrew the serrated nut; this is threaded right hand.

The boss of the damper hub is threaded 1.750" x 16 t.p.i., left hand, and this thread is solely for the purpose of extraction. The correct damper extractor is essential, and if this is not to hand machining facilities are needed to produce a suitable tool.

Again, if no other work than to the damper is in hand, bring the flywheel to TDC and mark the meshing teeth as previously detailed. With the extractor the back half of the damper complete will draw off the crankshaft.

To extract the driving springs mount the part assembly on the test mandrel and attach the poundage test bar to the flywheel. By means of the bar pull the flywheel round as far as it will go against the spring pressure, and lever out the set of springs which are then relaxed. Remove the remaining springs and then pull the hub out of the flywheel and take out the rear duck washer.

OVERHAUL AND RESETTING OF THE DAMPER POUNDAGE

20 h.p., Chassis 1-500

Having washed the dismantled parts in paraffin, carefully inspect them, noting the condition of the presser and drive springs, the two fibre washers and their mating plates, and the friction surfaces of the hub and the flywheels. Examine the white metalling of the bores of the latter, and check that the wheels turn freely on the hub. Check the fit of the timing pinion bush on the crankshaft; the running clearance should be 0.001" to 0.0025". See that all the splined members fit together without binding or excessive backlash.

It is unlikely that the spring drive assembly will need attention, and provided no springs are broken it may be refitted as taken down. The fibre damping washers, also, are usually re-usable.

The hub friction surfaces, and those of the flywheels, will normally require a light grind, and when this is done the inner faces of the flywheels must be reduced by an amount equal to the sum of the material taken off the four friction surfaces. The absolute minimum, consistent with obtaining a uniform matt finish, should be ground off.

To prepare the new cotton duck washers, first of all make sure they are perfectly dry, and then soak them for a day or so in engine oil. Next, nip them up in a fly press for a similar period. The press faces must be dead flat, as must be the steel plate which is sandwiched between the washers in the press. Careful preparation of the washers is vital to the success of the job, and when they come out of the press they should be perfectly flat and free from snags and other surface irregularities.

REASSEMBLY

Commence by slipping the rear retaining plate on to the pinion nose, followed by the smaller inside diameter fibre washer, the internally splined plate with the lip facing forward, the second fibre washer, and the spring drive subassembly. Use plenty of oil on the foregoing. Drop the spring thrust plate into the hub, and then insert the parts assembled on the pinion nose. As one of the eight screws securing these parts is rotationally offset, see to it that all the holes line up when doing this. Fit the eight countersunk head screws, the plain washers and the nuts. Tighten and split pin.

At this stage the hub must be carefully handled so that the pinion does not drop out.

Oil the prepared duck washers and place them in the recesses in the flywheels. Line up the '0' marks and assemble them on to the hub, taking care that the washers do not misplace. Fit the bolts, springs and nuts, and tighten until the springs are fully collapsed.

Mount the assembly on the test mandrel, and back off each of the nuts one half to three quarters of a turn. Attach the poundage bar to the flywheels, and oscillate and pull them round the hub for a few minutes.

Attach the spring balance to the bar, and exert a tangential pull, noting the balance reading at which the flywheels slip. This should be within the limits four to seven pounds.

Almost invariably the poundage reading is too high on the first trial, and this is where the difficulties begin. Initially 'iron' the duck washers by oscillating and rotating the flywheels for a further period. If this fails to bring down the poundage, release the flywheel nuts by a further quarter of a turn. If the poundage cannot be achieved by either means one pair, or even two pairs, of the bolts and springs may be omitted. If this is done the omissions must be diametrically opposed to one another; if four are left out dispose them at intervals of 90°.

Having attained the correct poundage, split pin the flywheel nuts. When the assembly is refitted to the crankshaft, and the starting dog nut fully tightened, check that the pinion has 0.002" to 0.008" end float.

If the timing wheels were marked before taking down the damper, line up the marks before offering up the damper, and check that the flywheel TDC mark is in register with the pointer. Then offer up the damper so that the Woodruff keys are in line, but before engaging the pinion turn the crankshaft and the damper two teeth clockwise to compensate for the helix angle of the gear teeth. With the pinion fully home, it should then be found that if the flywheel is registered on TDC the marks on the gears will be in line, and the valve and ignition timing will be as formerly.

20 h.p., Chassis 501 onwards, and 20/25 h.p., up to Chassis GKT21

The difference between this type and the earlier one is mainly in the design of the spring drive, and much of the previous section refers to this type.

Having washed the parts, inspect them, paying particular attention to the dowel rivets in the pinion, inside the hub, and in the rear flywheel. Those in the pinion and the hub are in tapered holes, and in parallel holes in the flywheel. Any loose ones must be driven out, after cutting away the peening, and replacements fitted and peened up tight.

Place the spring drive complete on the pinion, followed by the friction disc with its recess facing the pinion; one of the bolt holes in these parts is offset 3° and care must be taken to align them. Oil the fibre washers and place one on each side of the friction plate, and fit this over the pinion nose, engaging the Woodruff key. Fit the tab washer and screw on the serrated nut. Fully tighten and lock.

Place the thrust springs in the spring thrust plate, and enter it into the hub, engaging the dowels.

Line up the spring drive flange with the hub, noting the offset hole, fit the eight setscrews and lock washers, tighten and lock.

It then remains to refit the flywheels to the hub and adjust the poundage, and the procedure is exactly as detailed in the previous section. Ensure that the flywheel dowels enter correctly and that the '0' marks are aligned. Split pin the flywheel nuts on completion of the poundage setting.

The damper is fitted to the crankshaft in the same manner as the earlier type.

LOW INERTIA DRIVES

Wash off and inspect the dismantled parts, paying careful attention to the spring diaphragm; if any incipient cracks are present, scrap it. The drive springs must be inspected for collapse and breakage, and renewed accordingly. Check for tightness the short bolts securing the pinion to the back plate. See that the spring retaining screws in the front plate are tight.

The steel friction surfaces will need resurfacing, and all four must be reground to a smooth, pit free condition. Remove the minimum amount of material consistent with this.

The minimum thickness of the hub friction disc is 0.0625", and if the disc has been ground below this figure it must be renewed. The two parts of the hub and the disc are assembled with four ream fitted 0.204" diameter rivets, and these must be driven out to dismantle it. To remove the rivets, drill them 0.187" diameter at their front ends to a depth of 0.125", and then drive them out using a 0.187" diameter steel punch. It will be found that the rivet holes in the new plate are drilled undersize, and they must be reamed out 0.203" diameter. The method of doing this is to clamp together the two halves of the dog with the plate between them, and then ream through. Exact alignment is important, and this may be achieved by temporarily assembling the whole lot to the crankshaft nose, and then reaming the holes *in situ.*

The rivets, Part No. EB740, have conical heads to fit the countersinks in the rear dog, and their front ends must be peened down into the countersinks of the front dog.

Dry, oil soak, and press the cotton duck washers as described for the earlier dampers.

Assemble the parts on the test mandrel. First, slide on the pinion and backplate assembly, and lay in, well oiled, one of the duck washers. Push in the hub and fit and tighten the serrated nut, but do not lock. Lay in the second duck washer, followed by the spring diaphragm, and then the front plate. Balance '0' marks will be found on all the plates; see that they are aligned. Fit and tighten the peripheral nuts and bolts, and the four centre nuts; again, do not lock.

Attach the poundage bar to the flywheels and oscillate them for about one hundred cycles, and then hook up the spring balance and pull tangentially. The wheels should slip at a reading of 11 to 12 lb. Almost certainly on the first trial the poundage will be too high, in which case further oscillation may bring it down. If protracted ironing fails, it is permissible to delete two diametrically opposed presser springs, or even four at 90° intervals.

Getting down to poundage is the trying part of the job. In some cases it can be achieved by transposing the washers, or by substituting another oiled and pressed pair. At the Works a magazine of prepared washers was kept, and it was sometimes found that a pair of washers which would not come down to poundage in one damper would yield the right figure in another damper.

Having obtained the correct poundage, take off the front plate, and insert the drive springs.

Final assembly of the damper can only be completed on the crankshaft, because the serrated nut must be tightened and locked before the front plate is fitted. When fitting the front plate make sure that neither of the duck washers slips out of position and becomes trapped. Finally fit, tighten, and lock the peripheral and centre nuts and bolts.

In refitting the assembly to the crankshaft, first line up the marks made on the timing gears before dismantling, align the crankshaft at TDC, and move the damper and the crankshaft two teeth clockwise before pushing into mesh.

Whilst on the subject of dampers, it might be as well to mention that, when checking the valve or ignition timing of these engines it is important not to turn them by means of the starting handle. This could result in the displacement of the crankshaft pinion relative to the shaft when the damper slips and 'winds up' the spring drive. The consequent timing error could be considerable. If the engine is still in the chassis, it is an easy matter to turn the crankshaft by engaging top gear and rotating one rear wheel when it is jacked up clear of the ground.

9

The Camshaft and Bearings, and Bottom Tappets

On all 20 h.p. and 20/25 h.p., up to part of B2-Series, the camshaft is mounted on six plain bearings, and a ball race immediately behind the camwheel. The five intermediate plain bearings are positioned in the crankcase webs, and each is located by a dowel pin driven into the top face of the crankcase. From B2-Series, and on all 25/30 h.p. and Bentley the ball race was superseded by the cam balancer which incorporated a plain bearing.

The cam balancer consists of three spring loaded plungers, each with a roller foot, which ride on a six lobe cam immediately behind the camwheel. This device was designed to provide damping to the camshaft, and if a light rattle occurs through most of the engine speed range a possible cause is a broken spring in the balancer.

In service the camshafts of all types proved astonishingly durable, and renewal due to worn lobes was rarely necessary. In recent years shafts have been found with extensive corrosion pitting, and if such pits will not polish out the only remedies are to fit a replacement or have the existing one attended to by a camshaft specialist such as Leonard Reece.

As regards the bottom tappets, the guides and plungers give little trouble but the rollers and pins do wear after considerable mileage. The remedy is to fit new parts.

PRELIMINARY DISMANTLING

Before the camshaft can be withdrawn it is first necessary to remove the cylinder block, the bottom tappets, the sump, and, of course, the timing cover.

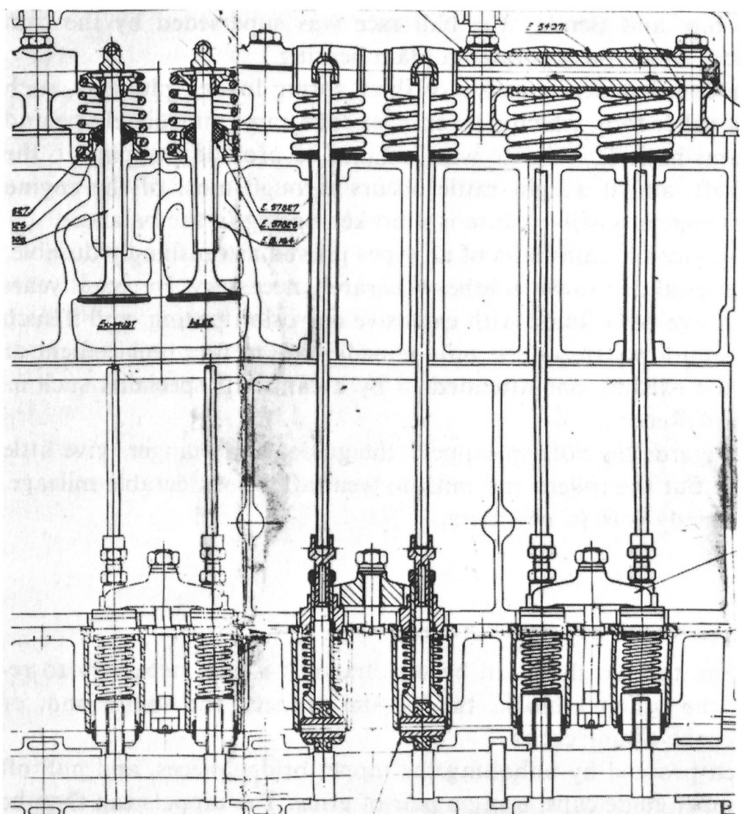
Then proceed by unbolting the tappet bridge pieces, and pull off the tappet guide caps, using a pair of grips. The tappets can then be lifted out together with their springs. At this stage leave the guides in position.

REMOVAL OF THE CAMWHEEL

20 h.p., 20/25 h.p. up to part B2-Series

Take out the split pin and undo the castellated nut securing the camwheel. This nut will loosen and then tighten again as it contacts the retaining nut in the camwheel boss. Further unscrewing will draw the camwheel off its taper; as it comes free, collect the Woodruff key. Next, take out the circlip and unscrew the serrated nut from the camshaft ball race housing.

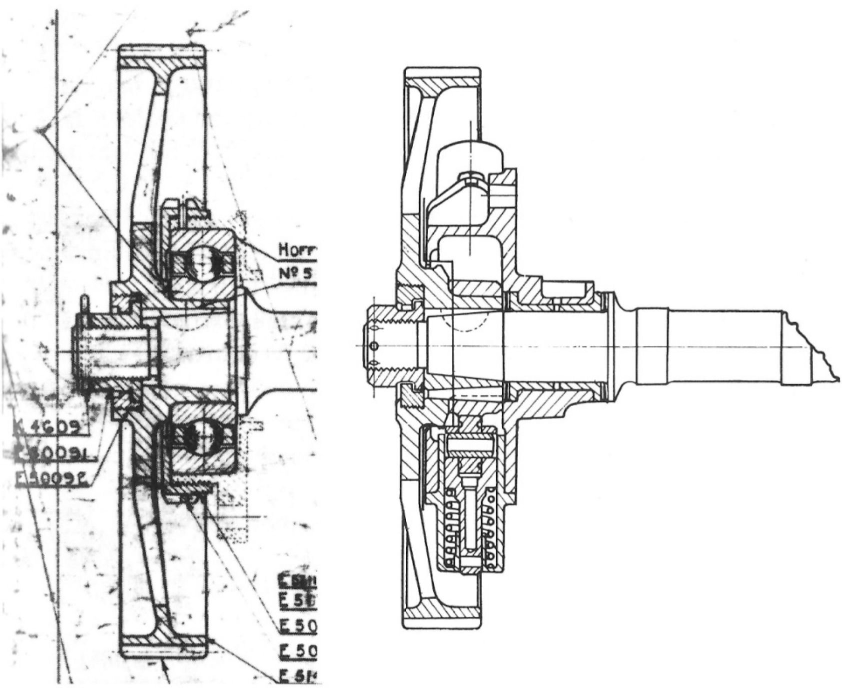
To release the five intermediate camshaft bearings, first withdraw the bearing locating dowels from the crankcase top face. These dowels are threaded ¼" B.S.F. female, and are drawn by means of a simple extractor to fit these threads.



Section through valve operating mechanism.

Withdraw the camshaft by drifting forward the intermediate bearings. Tap each one forward in turn, a little at a time, until they come free from their webs. Take out the four clamping screws in each bearing and take them off the shaft. Screw the halves together again, taking care not to reverse them end for end, and note their web positions.

Pull out the camshaft, and dismantle the ball race and housing.



Left. Camwheel and camshaft front bearing—20 h.p. and 20/25 h.p. up to series B2.

Right. Camwheel and cam balancer assembly.

20/25 h.p., B2-Series onwards, 25/30 h.p. and Bentley 4¼ litre

Before commencing, accurately measure and record the camshaft end float.

The camwheel is self extracting, and will carry with it the balancer cam. Withdraw it, take out the balancer plungers and springs; collect the spacer washer inside the housing and put it on one side.

Unbolt the balancer housing, and draw it out of the timing chest. Take care of the spacer washer between the housing and the camshaft flange.

The camshaft is removed in the same way as for 20 h.p. and earlier series 20/25 h.p.

Bentley 3½ litre

On these the camwheel is not self extracting, and is removed by taking off the camshaft nut, and then removing the six lock tabbed nuts in the wheel boss. The camwheel will then pull off, leaving the balancer cam in position.

Next, remove the six countersunk screws securing the front cover to the housing, and take off the cover. Push the balancer plungers up against their springs and secure them by inserting a split pin in the cross drilling in each plunger. With a small extractor draw the balancer cam off the shaft, and collect the Woodruff key. Pull out the temporary split pins, and take the plungers out of the housing; collect the spacer washer from inside the housing.

Take the balancer housing out of the timing chest, and collect the spacer washer behind it.

Again, the camshaft is withdrawn as detailed above.

REASSEMBLY

As previously stated, the cams are very durable, and unless heavy pitting has occurred no attention other than lightly polishing the lobes is likely to be needed. The bearing journals should be measured; the standard diameter is 0.8985", with a minus limit of 0.0005". Inspect the bearings, the bore of these is 0.900", with a plus limit of 0.0005". From this it will be appreciated that with a new shaft and bearings the running clearance may be between 0.0015" and 0.0025", and allowance must be made for this when assessing wear in used components.

Commence assembly by threading the camshaft through the crankcase, and fit the bearings to it immediately forward of their respective webs; fully tighten the bearing screws. Line the bearings up with the webs and drift them a little at a time, and in turn, until all five are fully home. Ensure that they are fitted with the dowel holes at the 12 o'clock position. Insert the dowels and tap them fully home.

REFITTING THE CAMWHEEL

20 h.p., and 20/25 h.p., up to part B2-Series

Place the ball race in the housing, and carefully tap this sub-assembly into position; fit the housing securing nuts. Fit and tighten the ball race retaining cap nut, and fit the circlip. Insert the Woodruff key, and offer up the camwheel; tighten the securing nut and split pin.

20/25 h.p., B2-Series onwards, 25/30 h.p., and Bentley 4¼ litre

If before dismantling, the camshaft end float was correct at 0.004-0.005", refit the original washers on either side of the balancer housing bearing. Excessive float must be rectified at this stage by selection of increased thickness washers.

Assemble the plungers and springs into the housing, compress the springs and secure the plungers by means of split pins through the cross drillings. Push the housing into position, with the two washers in their correct places, fit the nuts and lock washers, tighten and lock. With the Woodruff key in place, offer up the camwheel, and fully tighten the nut. Check the camshaft end float, and if correct split pin the nut. Finally, pull out the three split pins temporarily inserted in the cam balancer plungers.

Bentley 3½ litre

Again, the correct camshaft end float is 0.004-0.005", and the method of adjustment is the same.

Fit the balancer housing into the timing chest as described in the previous section, and then fit the balancer cam and tighten the nut. At this stage check the camshaft end float, and if correct, pull the split pins out of the balancer plungers; once the camwheel is in position these pins are totally inaccessible. Fit the balancer housing front cover, tighten the six countersunk screws, and lock them by punching the ends of the screwdriver slots. Fit the camwheel to the balancer cam, assemble the nuts and lock washers, tighten and lock. Split pin the camwheel securing nut.

BOTTOM TAPPETS

It is unlikely that the tappet plungers or their guides will require renewal, but the rollers may be found slack on the bearing pins. Check this detail, and, if necessary, fit new parts; the rollers are removed by driving out the pins.

With the camshaft displaced the tappet guides will come out in the upward direction. It will be noted that the cut-away in the top flange of the guide locates on a key formed on the tappet bridge piece stud.

Reassembly of the tappets is straightforward, the guides and tappets being numbered, but firm pressure is needed to push the caps down against the tappet spring pressure, whilst the bridge piece is refitted.

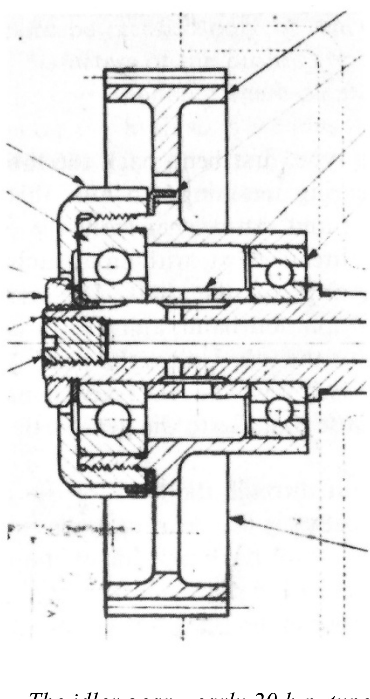
In carrying out the work of assembly detailed in this chapter apply plenty of oil to the bearings, the balancer cam, and the tappets and cam lobes.

10

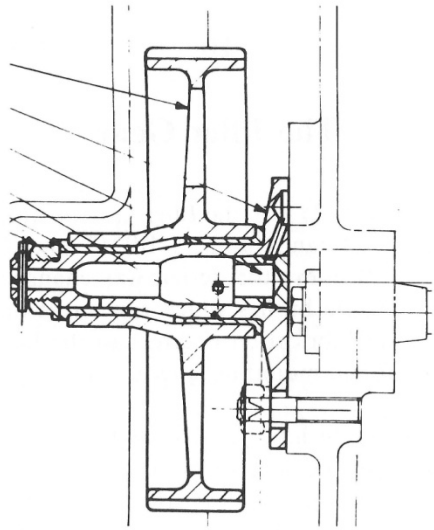
The Idler Gear

On all 20 h.p. and 20/25 h.p. the Idler Gear is mounted on a pair of ball bearings, Hoffman Numbers BB317 and BB117. On the 25/30 h.p. and the Bentleys the design was changed, and the gear mounted on two bronze bushes which run direct on the mounting shaft. On both types lubrication is direct to the hollow shaft from drillings in the shaft and mounting spigot, fed via splash from inside the crankcase.

Up to M-Series on 20 h.p. the shaft is located in a taper in the back of the wheelcase and secured in position by a taper pin. From M-Series onwards, and all Bentleys, the mounting shaft is flanged and secured on three studs, location being by means of two 0.1562" dowels.



The idler gear—early 20 h.p. type.



Idler gear—25/30 h.p. and Bentley.

DISMANTLING

On the ball bearing type, first bend back the tab washer and unscrew the serrated bearing retaining cap nut; this is threaded left hand. Remove the nut and tab washer from the end of the shaft; this one is right hand thread. Next, with an extractor, draw the gear together with the bearings off the shaft. The boss of the gear is threaded 2.125" x 16 t.p.i. left hand, and this thread is engaged by the correct extractor for the job. Unless the bearings have lost their interference fit on the shaft it will be necessary to make up an extractor on these lines because damage to the gear teeth must be avoided at all costs.

Drift the bearings out through the front of the gear, taking care of the distance piece between the bearing inner rings. Take off the three securing nuts, and pull the shaft out of the case. On pre M-Series cars do not take out the shaft.

On 25/30 h.p. and Bentley the gear will pull off after removing the split pinned nut. Then take out the mounting shaft after removal of the securing nuts.

REASSEMBLY

Ball-bearing type

Clean out the oilways of the shaft, smear the flange with jointing compound, and refit to the crankcase. Fit the bearings into the gear, checking that the distance piece is nipped between the bearing inner rings. Offer up the gear to the shaft and tap it fully home, using a piece of tube to match the front bearing inner ring. Fit the castellated nut, tighten and split pin. It then remains to fit the bearing cap nut, which can be fully tightened once the idler gear is meshed with the gear train.

25/30 h.p. and Bentley

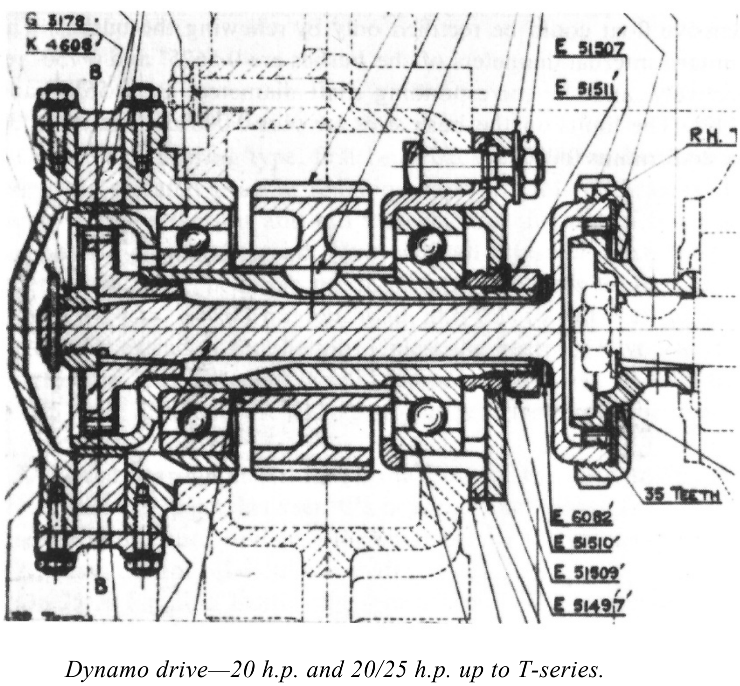
It will be noted that the front end of the shaft is open, and the rear end is closed by a pressed in plug. Clean out the shaft, apply jointing compound to the back of the flange, and fit it to the crankcase. Smear the bushes with engine oil, and push the gear on to the shaft. Tighten the front nut, and check that the end float is 0.003" to 0.005". If this is satisfactory, split pin the nut. As shimming is not feasible excessive float could be rectified only by renewing the bushes. The standard internal diameters of the bushes are 0.5625" and 0.750" respectively, and the corresponding shaft diameters are 0.5615" and 0.749". The limits on the bush sizes are plus 0.00025", and those on the shaft minus 0.00025".

11

The Dynamo and Magneto Drive

On all the 20 h.p. and the 20/25 h.p. up to T-Series the pinion driving the dynamo and the magneto is mounted on a hollow spindle between two ball bearings. The front end of this spindle is bell mouthed and internally splined. The solid spindle, coupled to the dynamo, is coaxial with this arrangement, and the two are joined at the front end by a splined engaging piece.

From T-Series onwards, and on all the 25/30 h.p. and the Bentleys, the design is much simplified. Here the pinion runs on a ball bearing, and a bronze bush which is a press fit in the gear. The coupling between the pinion front flange and the solid spindle is a three point spider. Low pressure lubrication to the drive is supplied by the pipe running across the front of the engine.



Dynamo drive—20 h.p. and 20/25 h.p. up to T-series.

DISMANTLING

All 20 h.p., and 20/25 h.p. up to T-Series

It is first necessary to take down the dynamo and magneto together by uncoupling immediately behind the timing case.

Remove the two covers on the dynamo drive brake housing, and withdraw the brakes and springs. Take off the four nuts securing the housing to the timing cover, and extract the cover by screwing a pair of ¼" B.S.F. bolts into the threaded holes in the housing flange.

Undo the securing nuts and withdraw the timing cover. Undo the castellated nut and knock the solid spindle out of the coupling, taking care of the Woodruff key; and the spring washer at the rear end of the spindle. Prise out the coupling from the front end of the hollow spindle, and then remove the nut and tab washer from its rear end. With a piloted drift knock the spindle forward through the rear ball race, collecting the acme sleeve and the adjusting washer between the ball race and the gear as the spindle comes clear.

Press the spindle forward through the gear and collect the Woodruff key.

Three access holes, 0.201" dia., allow the front ball race to be drifted off the spindle. To remove the rear ball race, its housing and cover, undo the three securing bolts.

REASSEMBLY

On a complete overhaul renew both ball bearings; the front one is a Hoffmann 125, and the rear a Hoffmann 320.

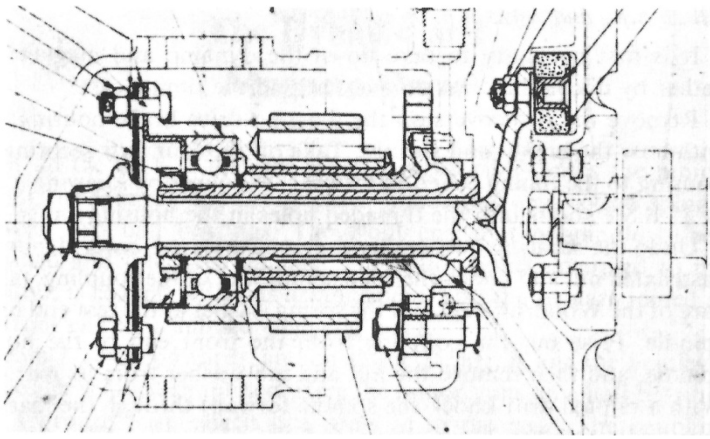
Commence by pressing the front bearing on to the spindle, and follow it by the gear and the Woodruff key. When the gear is in position there should be a clearance of 0.003" to 0.005" between the gear and the bearing.

Assemble the rear bearing into its housing and cover, and bolt this assembly to the crankcase.

Place the adjusting washer behind the gear, and push the spindle through the rear bearing. Fit the acme sleeve, followed by the tab washer and the nut, and tighten and lock.

Slip the spring on to the solid spindle, thread it through the hollow one, and push in the Woodruff key. Engage the front coupling with the two spindles, fit and tighten the castellated nut and split pin.

It then remains to fit the dynamo brake housing, and the brakes, after the timing cover has been refitted.



Dynamo drive—Bentley.

20/25 h.p. from T-Series onwards, all 25/30 h.p. and Bentley

With the timing cover and the dynamo removed, take off the castellated nut from the solid spindle. Support the spider and knock the spindle free from it. On some engines the spindle and coupling are located by a Woodruff key and on the others by splines.

Unbolt the spider from the gear, removing only the split pinned nuts; the plain nuts are peened over. Bend back the tab washer and remove the serrated nut, and with a piloted drift knock the inner hollow spindle out of the pinion post. The gear together with the ball race will then pull off the post. Collect the spacer washer from behind the ball race, and put it on one side.

To remove the post, take off the three securing nuts and pull it free. On 20/25 h.p. the post is located by the fit of its spigot in the hole in the back of the timing chest, and it can be fitted in one position only. On 25/30 h.p. and Bentley the bush journal is 0.004" eccentric to the mounting flange, and location is by a dowel screw in the back face of the flange. Do not remove this screw.

REASSEMBLY

Check the cleanliness of the oilways and refit the pinion post to the timing chest. Push the hollow spindle in from the rear, slide the spacer washer over it, and offer up the gear together with the ball race. Work the spindle fully through the bearing and then fit the tab washer and the serrated nut. Tighten and lock. In doing this ensure that the hollow spindle makes an oil-tight joint with the rear end of the post. Assembled, the gear should turn freely with about 0.003" end float; if necessary, adjust by altering the thickness of the washer behind the ball race.

Assemble the spider on to the gear, making sure the bearing locating cup makes hard contact with the ball race outer ring: fit the nuts and split pin.

Push the solid spindle through, engage it in the spider, fit the tab washer and the nut, and tighten and lock.

12

The Distributor and Water Pump Drive

This drive was altered only in minor detail throughout the whole production run of the small horsepower engines. It consists of a hollow spindle, with which the distributor drive gear teeth are integral, supported by a ball race and a bronze bush at the front and rear ends respectively. The driving pinion, on a taper on the front end of the hollow spindle, is located by a Woodruff key.

The water pump is driven by a solid spindle, coaxial with the hollow one, and the two are coupled together by an externally splined disc which engages the driving gear.

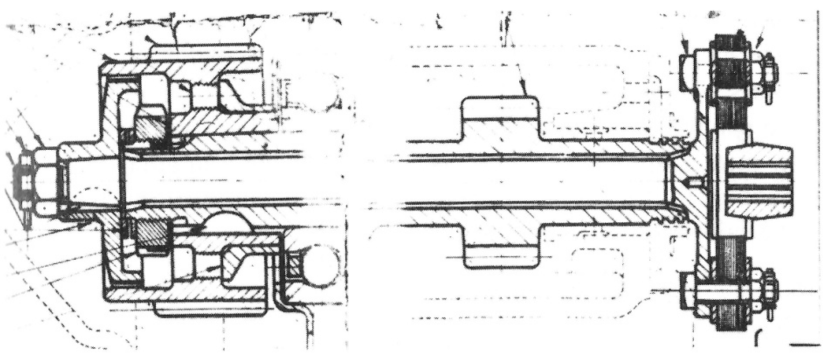
Oil retention at the rear end of the hollow shaft is by means of an acme thread which registers with the square plate attached to the crankcase immediately forward of the water pump. This plate registers with a drainway into the skew gear chamber, which, in turn, drains into the crankcase. Oil leaks from the water pump drive are usually due either to excessive crankcase compression, or to sludging of this oil drain.

If the drain is blocked it can be cleared only by taking down the timing cover, the water pump, and the ignition governor. With these details out of the way, take out the water pump drive spindle, remove the square plate and clean out the drain hole and the acme thread and the drain hole at the bottom of the skew gear chamber. Before reassembling check that the acme has not been fouling the hole in the square plate. This is a lot of work to rectify what might be a quite minor oil leak.

DISMANTLING

With the timing cover, the water pump, and the ignition governor removed, take off the castellated nut and knock the water pump drive spindle through the coupling, and pull the coupling out of the gear collecting the spring which lies behind it. Bend back the tab washer and remove the serrated nut securing the gear to the hollow spindle. The gear is withdrawn by screwing a pair of ¼" B.S.F. bolts into the threaded holes in the web of the gear so that they contact the forcing ring which lies behind the gear. As the gear comes away collect the forcing ring.

Remove the three nuts securing the pressed steel bearing retaining plate. With a piloted drift drive the hollow spindle and the bearing out in the forward direction. Knock the spindle out of the ball race.



Distributor and water pump drive—all chassis.

REASSEMBLY

Check the fit of the hollow spindle in its bush; there should be a running clearance of 0.001". Fit the ball-bearing to the spindle, and tap the bearing outer ring fully home in its housing. Dress up the bearing retaining plate and refit it. Put the forcing ring on to the gear boss, line up the gear with the Woodruff key, and drive it up on the taper. When it is in position, see to it that the shoulder of the spindle is in firm contact with the bearing. Fit the serrated nut and the tab washer, and tighten and lock. Refit the square plate and check its concentricity with the acme thread.

Push the solid spindle through from the rear, and fit the engaging piece, not overlooking the coil spring behind it. Fit, tighten and split pin the castellated nut.

14

The Governor and Oil Pump Drive

On all types the vertical shaft is mounted in two flanged bushes, one directly beneath the skew gear and the other above the ball thrust bearing. The float on the shaft is regulated by a washer beneath the gear, and a second washer below the thrust bearing. The upper washer also controls the height of the skew gear for meshing purposes.

The splined sleeve which couples the gear to the governor spindle has a master spline, and will engage in only one angular position. Because of this, on a complete engine the distributor and governor can be taken off together without losing the ignition timing.

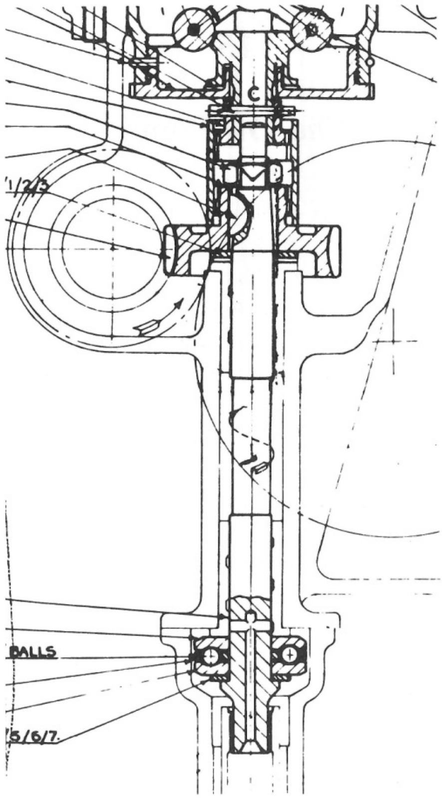
DISMANTLING

It is first necessary to take off the oil pump, the sump, the distributor and governor, and the water pump, and dismantle the water pump drive.

Commence by removing the governor, and loosen the nut at the top of the vertical shaft before the gear train is unmeshed. Then dismantle the remainder of the units detailed above. With these out of the way, take off the nut and tab washer, and with a small extractor draw the skew gear off the shaft. Extract the Woodruff key, and the shaft will come clear in the downward direction. Collect the washers from beneath the gear and the ball thrust, and put them on one side.

REASSEMBLY

Measure the journal diameters of the shaft; these should be 0.498", and check the fit of the shaft in its bushes. The running clearance should be 0.002". If the bushes require renewal they must be line reamed 0.500" after pressing into position. It is important, if this operation is carried out, that a piloted reamer is used, and exact



Ignition governor and oil pump drive—all chassis.

alignment will only be achieved if the pilot is long enough to engage both bushes before the reamer begins to cut.

Reassembly is straightforward, and no difficulty should arise provided the end faces of the bushes, the steel washers, and the thrust bearing are unworn. If possible refit the original washers and in the positions they occupied formerly. With the gear refitted and the nut tightened the shaft must turn freely without detectable end float. Excessive float is eliminated by increasing the thickness of the steel washers, and any needed increment should be divided between the two and particular care must be taken to mesh the gear on the same horizontal plane as the driving gear.

15

The Oil Pump

On all engines the pump, mounted on the offside of the sump, is of the gear type and is coupled by a splined sleeve to the shaft which drives the ignition governor. The pump of all small horsepower Rolls-Royce, all 3½ litre Bentley, and 4¼ litre Bentley up to K-Series is the small capacity type, which is recognisable by its bronze body. The K-, L-, and M-Series 4¼ litre engines were built with the large capacity aluminium body pump.

On Bentley 4¼ litre, when Mod. C, which included extra-oil drillings in the crankshaft, was carried out the aluminium pump was fitted as part of the job, so today most 4¼ litres of all series will be found to have this pump.

Both types of pump have a pressure regulating valve in the casing cover, the small capacity type being a spring loaded mushroom valve, and the large capacity, a steel ball. On the former, spring adjusting washers, up to a maximum of five, were fitted, and the spring was sweated to the mushroom on original build. No washers were used on the ball type valve.

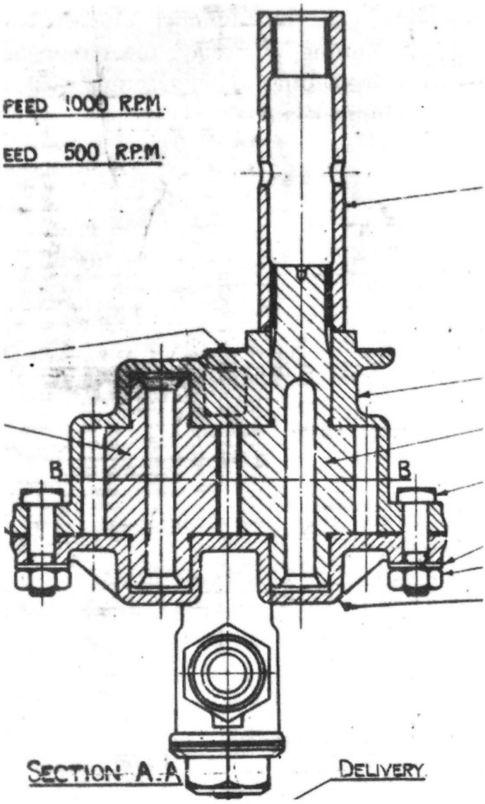
On bronze and aluminium pumps the location of the cover to the body is done by two ream fitted bolts, and on dismantling note must be taken of the positions of these bolts. On the bronze type a paper joint is fitted between the body and the cover, but not on the large capacity pumps which are bolted together metal to metal.

DISMANTLING

To strip the pump take out the bolts, noting the two reamed holes, and remove the cover complete with the pressure regulating valve. Draw out the pump gears.

Remove the cap nut from the cover, and take out the valve and spring; put any adjusting washers on one side. On the bronze type the low pressure connection is soldered and pegged in position; do not remove.

Wash all the parts in paraffin, inspect the gear teeth, and insert them in the pump body. Lay a straightedge across the open end of



Oil pump—all Rolls-Royce, and originally to 3½ litre Bentley.

the body and check the end float of the gears by inserting a feeler under the straightedge. The correct figure is 0.002", and adjustment is effected by dressing the body face with a smooth file. Make allowance for the paper washer on the bronze type.

The correct radial clearance for the gears is 0.002", and this is checked by running a feeler round inside the body.

Reassembly is straightforward. Apply a smear of jointing compound to the joint faces and carefully tighten the nuts.

Generally, these pumps require little attention, and renewal of the gears is seldom necessary. Should new gears be needed it would be essential to lap the replacements with turkeystone and oil so that they turn freely with no hard spots.

On the bronze pumps fit the same number of washers to the valve as were found on dismantling. If needed the oil pressure can be altered, within reason, by adding or subtracting washers, but the maximum permissible number is five.

16

Valves and Fittings

All the small horsepower engines are fitted with overhead valves, mounted parallel in the head, which are pushrod operated with an orthodox arrangement of rockers. In all cases the valves are mounted in detachable cast iron guides, to which are fitted string oil seal grommets held in position by the valve spring bottom caps.

The valve seat angle is 45°. As originally built the seat angle of the very early 20 h.p. engines was 30°, but these were later converted by recutting the seats and fitting the 45° valves.

On all engines the material of the cylinder head is cast iron, and the valve seats are cut direct in the head, inserts not being used.

The rockers are steel forgings, with hardened striking pads and pushrod sockets, running on bronze bushes. Side clearance is regulated by a steel sleeve between each pair of rockers. The pushrods are steel, one piece, with hardened ball ends top and bottom.

The valve spring top caps are retained by a pair of tapered split collets which locate in a tapered groove in the valve stem. On 20/25 h.p., from Chassis GLG1 onwards and in all 25/30 h.p. and Bentley, a retaining circlip is fitted to a machined groove immediately below the collets.

The rockers, pushrods, and valves are lubricated by a low pressure supply from the oil pump, which is distributed by the hollow rocker shaft through drillings in the rockers.

DISMANTLING AND INSPECTION

Before starting the work make up a rack to hold the valves as they are taken out of the head. A piece of three ply with twelve 3/8" holes, numbered one to twelve, is enough, the object being to ensure that the valves are replaced in their former positions. At the same time, arrange to keep the pushrods, rockers etc. in the same order as taken down.

Dismantling is quite straightforward, and no great difficulty should arise. The rocker assembly must be lifted before the cylinder head can be raised, and care is needed to release the rocker pedestal nuts evenly so that the assembly comes away without cross binding. On early series 20 h.p., steel packing plates were fitted beneath the rocker pedestals; take care of these.

With the cylinder head on the bench, using a spring compressor no difficulty should be found in removing the valves. If the spring top caps are found to be stuck on their collets they can be readily freed by placing the head face downwards on the bench with a wooden packing against the valve head. Place a six inch length of one inch diameter steel tube on the spring cap, and give it a smart tap with a mallet. After this, the compressor will pull the spring down readily.

Clean the valve heads by scraping and wire brushing, and clean out the combustion chambers and ports in the same way, using a scraper with a dull edge. If a heavy deposit of carbon is present on the underside of a valve it is probable that the valve guide is excessively worn.

Measure the diameters of the valve stems with a micrometer, check the seats for cracks and the stem ends for indentation.

Examine the valve seats in the cylinder heads for cracks, and carefully check the exhaust ports for the same kind of failure.

At this stage the valve seating inspection is necessarily a cursory one, as hair cracks may not be visible until the valves have been ground. Check the fit of the valves in their guides. On 20 h.p. the diametral clearance for both inlet and exhaust is 0.003"; for 20/25 h.p. up to Chassis GKT21 the clearance is 0002" inlet and 0.003" exhaust; for 20/25 h.p. with the 'heavy' exhaust valves, 0.002" inlet and 0.0025" exhaust; and for 25/30 h.p., 0.002" inlet and 0.0037" exhaust. For all Bentley 0.002" inlet and 0.003" exhaust.

The above quoted figures are design sizes, and if the guides and valves stems are on top and bottom limits respectively 0.0015" can be added to these figures. No maximum wear limits are recorded, but it is considered that a side rock of 0.011" at the valve head, with the valve one inch off its seat, should be acceptable.

Prolonged grinding in of the valves to their seats should be avoided by first of all refacing both with Black and Decker equipment. The valves will then require only a very light lapping with fine grade paste mixed with oil. If the seats are pocketed they must be 'crowned' at 60°, to restore the normal width of seat in the cylinder head. The included angle of the crowning cutter is 120°.

To renew the valve guides, they must be driven out with a piloted drift. On all engines the guides are a tapered interference fit in the head, and it is not necessary to pre-heat the casting. The replacements are fitted in the same fashion, and driven in so that the shoulders abut the top face of the head.

As supplied the guides are undersize in the bores and must be reamed to size in position. After reaming, the seats must be recut with the Black and Decker grinder to restore squareness and concentricity.

After grinding in carefully inspect the seats in the head for hair cracks. If such are found the cylinder head should be pressure tested at 15 lb/in^2, when if no leakage is apparent the casting can be considered serviceable, provided the cracks do not extend greatly into the ports.

THE ROCKERS AND SHAFT

The rockers, pedestals, and distance pieces will draw off the shaft without difficulty; the shaft is located in the front pedestal by a grub screw, which must be taken out. Keep the dismantled parts in their relative order, particularly the front pedestal which is recognisable by the clearance hole for the grub screw. On reassembly do not transpose the front and rear pedestals.

Measure the diameter of the shaft at the twelve stations of the rockers; the standard diameter for all engines is 0.599". The shaft end plugs are screwed and sweated in position and should not be removed, there being sufficient access for cleaning purposes.

The reamed diameter of the rocker bushes is 0.601", the bushes being a press fit in the rocker bores. On all 20 h.p., and 20/25 h.p. up to the 150th Chassis in Series E2, the rocker bushes are one-piece, located by a bronze taper pin. On all other engines each rocker is fitted with two flanged bushes, pressed in from each side.

To remove the taper pins in the earlier type, carefully drill through them with a No. 32 drill, and then shear the shells of the pins by pressing out the bushes. The two piece bushes are driven out by passing a drift down the bore from each end.

In renewing the one piece bushes new bronze taper pins must be fitted and centre popped in position before the reaming operation. On completion assemble the rockers on to the head while still on the bench, and check the alignment with the valves, and the end float of adjacent pairs of rockers; this should be 0.005" to 0.015".

The two piece bushes are made with a dressing allowance on the thickness of the bush flanges, and it is essential to centralise each rocker in relation to its valve by facing off the flanges, and at the same time, obtaining 0.005" to 0.015" side float between adjacent pairs. This is done by assembling the rockers on to the head at the bench. It is a time-consuming job, as it involves trial fitting of each pair of rockers, and facing off at both ends.

It is important that the rocker shaft is not reversed end for end when the engine is built up, and this is avoided by making sure that the pedestal with the grub screw hole is fitted at the front, and that the threaded hole in the shaft registers with it.

The radius of the rocker striking pads is 0.600", and indentation in the pads is dressed out by hand stoning.

It will be seen that the ends of the pushrods are dissimilar; the larger ball end locates in the rocker, and the smaller end in the tappet.

On refitting the rocker assembly to the cylinder head in position on the engine, slacken off the adjusters in the tappets, and tighten the pedestal nuts progressively to avoid bending the pushrods.

Adjust the tappets to the clearances :

20 h.p. and 20/25 h.p.	0.004" inlet and exhaust
25/30 h.p.	0.006" inlet and exhaust
Bentley 3½ and 4¼ litre	0.004" inlet
	0.006" exhaust
Bentley 4¼ litre Series M	0.010" inlet and exhaust

Details of Pushrods

Part No.	*Length*	*Used on*
E51890	8·700″	20 h.p., 1st Chassis to K-Series
E54161	8·925″	20 h.p., Series K to L
E54534	9·100″	20 h.p., Series M onwards, and 20/25 h.p. up to 180th chassis in T-Series
E57226	9·150″	20/25 h.p., 181st chassis in T-Series to K-Series
EB2593	10·200″	25/30 h.p., up to 34th chassis in P-Series
EB3129	10·200″	25/30 h.p., 35th chassis in P-Series onwards
EB632	9·400″	Bentley 3½ litre
EB2593	10·200″	Bentley 4¼ litre, up to 114th chassis in K-Series
EB3129	10·200″	Bentley 4¼ litre, 115th chassis in K-Series onwards

EB2593 and EB3129 have cups at their top ends, for the top adjustment type rockers; these rods are identical except for the material.

Details of Valves

Part No.	*Inlet or Exhaust*	*Stem dia. (in)*	*Length (in)*	*Head dia. (in)*	*Used on*
E53158	Both	0·309	4·362	1·325	All 20 h.p.
E55335	I	0·310	4·325	1·450	20/25 h.p. up to GRF41
E60259	I	0·310*	4·325	1·450	20/25 h.p. GLG1 onwards
R4691	E	0·309	4·362	1·325	20/25 h.p. up to GKT21
R4687	E	0·3412	4·350	1·325	20/25 h.p. GKT22–GRF41
R4686	E	0·3412*	4·350	1·325	20/25 h.p. GLG1 onwards
E60892	I	0·310*	4·422	1·500	All 25/30 h.p.
E60893	E	0·340*	4·448	1·350	All 25/30 h.p.
EB1745	I	0.3412*	4·475	1·500	All Bentley 3½ litre
EB1746	E	0·3417*	4·487	1·425	Bentley 3½ litre up to 150 in F-Series
EB2532	E	0·3412*	4·487	1·425	Bentley 3½ litre 151 in F-Series onwards
EB2793	I	0·3412*	4·510	1·700	All Bentley 4¼ litre
EB2794	E	0·3407*	4·522	1·525	Bentley 4¼ litre up to 176 in K-Series
EB2970	E	0·3407*	4·522	1·525	Bentley 4¼ litre from 177 in K-Series and all replacements

* Circlip groove in valve stem.

Details of Valve Guides

Part No.	*Reamed dia.*	*Used on*
E50217	0·312″	All 20 h.p.—inlet and exhaust
E50217	0·312″	20/25 h.p. up to R-Series—inlet and exhaust
E56053	0·312″	20/25 h.p. S-Series to 180th in T-Series—inlet and exhaust
E57829	0·312″	20/25 h.p. 181 in T-Series to F2-Series—inlet
E57828	0·3437″	20/25 h.p. 181 in T-Series to F2-Series—exhaust
E60266	0·312″	20/25 h.p. G2-Series onwards—inlet
E60267	0·3437″	20/25 h.p. G2-Series onwards—exhaust
E60894	0·312″	All 25/30 h.p.—inlet
E60895	0·3437″	All 25/30 h.p.—exhaust
EB1782	0·3437″	All Bentley—inlet and exhaust

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The Starter Gear Ring

On all the small horsepowers, as originally built the starter gear ring was integral with the flywheel, and rectification of extensively worn or damaged teeth was done by machining off the existing teeth and fitting a replacement ring. It is practicable to repair minor damage by welding the teeth and filing up to profile, using a template which can be generated from an unworn portion of the ring.

Two methods of fixing gear rings are shrink fitting or securing with steel rivets, according to type. The following machining and fitting instructions should be observed.

All 20 h.p., 20/25 h.p., except Series G2, H2, J2, 25/30 h.p., Wraith and Bentley 4¼ litre

The part number of the gear ring is G51081, a 118 tooth ring with an internal diameter of 13.250". Set up the flywheel and machine off the existing teeth, and finish turn to 13.268" dia. to a width of 0.750".

Lay the flywheel on the bench, and uniformly heat the ring in a gas furnace, and quickly position it on the machined diameter with the lead in of the teeth to the rear. The ring will expand sufficiently at black heat to engage the flywheel; do not overheat it. When cold the interference between the ring and the flywheel will be 0.018", and no pegging or tack welding is necessary.

Bentley 3½ litre, Series E and F

The machining and fitting details are exactly as above, but the gear ring is part number GB5220, which has 119 teeth.

20/25 h.p. Series G2, H2 and J2

The gear ring, part number R3676, has 118 teeth, and it is attached to the flywheel, after machining, by twelve 0.187" steel rivets, part number KB2274, equally spaced on a pitch circle 13.245" dia. Set up and machine the flywheel 14.100" dia., and machine off the front face to form a shoulder 0.275" wide on that diameter. Clamp the ring to the flywheel, and using it as a jig, drill the twelve 0.187" holes through the shoulder. Securely rivet the two parts together.

Bentley 3½ litre, Series A, B, C and D

The part number of the gear ring is GB5216, which has 119 teeth, and it is attached in the same way as in the preceding paragraph, but the machining dimensions are different. The flywheel is machined to 14.300" dia., and is then faced off to form a shoulder 0.250" wide. The pitch circle diameter for the 0.187" rivets is 13.875". Again, clamp the ring to the flywheel, drill through, and rivet up.

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Chassis Series And Numbers

20 h.p.

Series A:

40-G-1 to 9; 41-G-0 to 9; 42-G-0 to 9; 43-G-0 to 9; 44-G-0 to 9; 45-G-0 to 9; 46-G-0 to 9; 47-G-0 to 9; 48-G-0 to 9; 49-G-0 to 9; 50-S-1 to 9; 51-S-0 to 9; 52-S-0 to 9; 53-S-0 to 9; 54-S-0 to 9; 55-S-0 to 9; 56-S-0 to 9; 57-S-0 to 9; 58-S-0 to 9; 59-S-0 to 9; 60-S-0 to 9; 61-H-1 to 9; 62-H-0 to 9; 63-H-0 to 9; 64-H-0 to 9; 65-H-0 to 9.

Series B:

65-H-1 to 9; 66-H-0 to 9; 67-H-0 to 9; 68-H-0 to 9; 69-H-0 to 9; 70-H-0 to 9; 70-A-1 to 9; 71-A-0 to 9; 72-A-0 to 9; 73-A-0 to 9; 74-A-0 to 9; 75-A-0 to 9; 76-A-0 to 9; 77-A-0 to 9; 78-A-0 to 9; 79-A-0 to 9; 80-A-0 to 9; 80-K-0 to 9; 81-K-0 to 9; 82-K-0 to 9; 83-K-0 to 9; 84-K-0 to 9; 85-K-0 to 9; 86-K-0 to 9; 87-K-0 to 9; 88-K-0 to 9; 89-K-0 to 9; 90-K-0 to 9.

Series C: GA1 to 81; GF1 to 81; GH1 to 81; GAK1 to 7.

Series D: GAK8 to 81; GMK1 to 81; GRK1 to 81; GDK1 to 15.

Series E: GDK16 to 81; GLK1 to 81; GNK1 to 54.

Series F: GNK55 to 94; GPK1 to 81; GSK1 to 80.

Series G: GCK1 to 81; GOK1 to 81; GZK1 to 37.

Series H: GZK38 to 81; GUK1 to 81; GYK1 to 81.

Series J: GMJ1 to 81; GHJ1 to 81; GAJ1 to 41.

Series K: GAJ42 to 81; GRJ1 to 81; GUJ1 to 81.

Series L: GXL1 to 81; GYL1 to 81; GWL1 to 41.

Series M: GBM1 to 81; GKM1 to 81; GTM1 to 41.

Series N: GFN1 to 81; GLN1 to 81; GEN1 to 41.

Series O: GEN42 to 81; GVO1 to 81; GXO1 to 10.

20/25 h.p.

Series O:	GXO11 to 111.		
Series P:	GGP1 to 81;	GDP1 to 81;	GWP1 to 41.
Series R:	GLR1 to 81;	GSR1 to 81;	GTR1 to 81.
Series S:	GNS1 to 81;	GOS1 to 81;	GPS1 to 81.
Series T:	GFT1 to 81;	GBT1 to 81;	GKT1 to 41.

20/25 h.p.

Series U:	GAU1 to 81;	GMU1 to 21.	
Series V:	GMU22 to 81;	GZU1 to 41.	
Series W:	GHW1 to 81;	GRW1 to 81;	GAW1 to 41.
Series X:	GEX1 to 81;	GWX1 to 81;	GDX1 to 41.
Series Y:	GSY1 to 101.		
Series Z:	GLZ1 to 81;	GTZ1 to 81;	GYZ1 to 41.
Series A2:	GBA1 to 81;	GGA1 to 81;	GHA1 to 41.
Series B2:	GXB1 to 81;	GUB1 to 81;	GLB1 to 41.
Series C2:	GNC1 to 81;	GRC1 to 81;	GKC1 to 41.
Series D2:	GED1 to 81;	GMD1 to 81;	GYD1 to 41.
Series E2:	GAE1 to 81;	GWE1 to 81;	GFE1 to 41.
Series F2:	GAF1 to 81;	GSF1 to 81;	GRF1 to 41.
Series G2:	GLG1 to 41;	GPG1 to 81;	GHG1 to 41.
Series H2:	GYH1 to 81;	GOH1 to 81;	GEH1 to 41.
Series J2:	GBJ1 to 41;	GLJ1 to 81;	GCJ1 to 41.
Series K2:	GXK1 to 81;	GBK1 to 81;	GTK1 to 53.

25/30 h.p.

Series L2:	GUL1 to 81;	GTL1 to 81;	GHL1 to 41.
Series M2:	GRM1 to 81;	GXM1 to 81;	GGM1 to 41.
Series N2:	GAN1 to 81;	GWN1 to 81;	GUN1 to 41.
Series O2:	GRO1 to 81;	GHO1 to 81;	GMO1 to 41.
Series P2:	GRP1 to 81;	GMP1 to 81;	GLP1 to 41.
Series R2:	GAR1 to 81;	GGR1 to 81;	GZR1 to 41.

Wraith

Series A:	WXA1 to 109.		
Series B:	WRB1 to 81;	WMB1 to 81;	WLB1 to 41.
Series C:	WHC1 to 81;	WEC1 to 71;	WKC1 to 24.

BENTLEY

3½ Litre

Series A:	B-AE1 to 203;	B-AH2 to 198.
Series B:	B-BL1 to 201;	B-BN2 to 99.
Series C:	B-CR2 to 200;	B-CW1 to 203.
Series D:	B-DG2 to 200;	B-DK1 to 199.
Series E:	B-EF2 to 200;	B-EJ1 to 203.
Series F:	B-FB2 to 200;	B-FC1 to 159.

4¼ Litre

Series G:	B-GA2 to 260;	B-GP1 to 203.
Series H:	B-HK2 to 200;	B-HM1 to 203.
Series J:	B-JD2 to 200;	B-JY1 to 203.
Series K:	B-KT2 to 200;	B-KU2 to 203.
Series L:	B-LS2 to 200;	B-LE1 to 203.
Series M:	B-MR2 to 200;	B-MX1 to 203.

Bentley Mark V

Chassis numbered in the series B-AW.

The foregoing list was compiled from available information, and is generally correct. However it cannot be confirmed that all the numbers listed were actually issued, but it is thought that this listing will assist in identifying the chassis types. At the same time, the authors apologise for any discrepancies which may be found when scrutinising individual chassis numbers.

The Wraith and Bentley Mark V Supplement

Since the Wraith and Mk. V Bentley engine differ in many ways from other pre-war units it was not thought desirable to include them in the main body of this manual.

At the present time it would be almost impossible to trace completely the original build standards for the Mk. V Bentley, but the Wraith data and drawings exist together with the fund of knowledge of those who worked on them. The large bulk of Wraith information will read across to Bentley Mk. V, the design resemblance between the two types being very marked. It was always difficult to gain experience on the Fives because so few of them were made, and today but a handful of them exist.

The outstanding difference between these engines and all the previous types was the adoption of the three gear wheelcase which has the merit of great simplicity. The dynamo and the water pump are mounted in tandem, and both are driven by a single pinion, which also drives the ignition distributor and the oil pump through a skew gear.

The crankshaft vibration damper was a new design, which was carried on to the Silver Wraith and Bentley Mk. VI until the 'bench' type damper was introduced in 1949. The cam form was an innovation on Rolls-Royce engines, and for the first time rotating tappets were employed.

Hall's Metal big-ends, which had been used on the 25/30 h.p. and the Bentley 4¼ litre, were retained but the shims between the abutment faces were dispensed with. The main bearings were white metal on steel shells, and from Chassis No. WRB1 the shims were deleted from these bearings.

The engine lubrication system was a new design. The gear type pump was retained, but with the oil relief valve remotely mounted on the side of the timing cover. The layout of the main oil gallery was completely changed, the assembly being secured on four studs inside the crank chamber.

THE WHEELCASE

The three gears in the wheelcase consist of a 27-tooth crankshaft pinion which is meshed to a fibre camwheel. The dynamo and the water pump are driven by an 18-tooth steel pinion which meshes with the fibre gear; thus, the dynamo and the water pump rotate at one and a half times crankshaft speed. The distributor and the oil pump are driven at half crankshaft speed by 6T x 18T skew gears which are coupled to the dynamo pinion.

It will be seen that the design of the gear train is a simple one, and renewal of the steel gears is unlikely to be necessary as each meshes with the fibre camwheel. On the other hand, failures of the fibre gear have occurred and the condition of this component should be carefully monitored. Incipient failure of the gear might be indicated by excessive backlash of the dynamo drive coupling; or conversely, by nil backlash due to increase of the chordal width of the fibre teeth due to absorption of moisture.

The timing cover is centralised by a ream fitted bolt immediately below the oil relief valve and a hollow dowel, pressed in position, at 10 o'clock to the crankshaft centre line. A hardened steel thrust button is swaged into the timing cover in line with the camshaft axis to register with the spring loaded button in the camwheel securing nut.

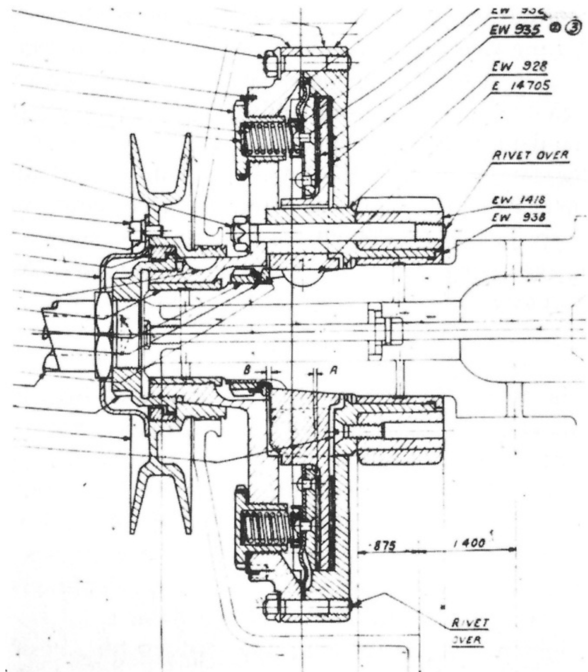
Dismantling

Disconnect the pipes and remove the oil relief valve from the timing cover. Remove the cheese headed screws from the fan pulley and take out the lock plate. Extract the fan pulley by unscrewing the starter dog nut. This nut, which is 1.578" across flats, will be very tight, and a slogger spanner will be needed to start it. As it unscrews it will back up against the externally threaded nut in the pulley boss and draw off the pulley.

Remove the nuts and bolts securing the timing cover, taking care of the ream fitted bolt adjacent to the dynamo drive, and take off the cover.

THE CRANKSHAFT VIBRATION DAMPER

This is the 'Wraith' type damper, which is identical to those fitted to the earlier series post-war six cylinder engines. It performs the same anti-torsional functions as the previous pre-war types but is a quite different design. As before, the damping device is a pair of



Crankshaft damper—Wraith.

cotton duck washers pressed between the flywheel elements which are coupled to the crankshaft pinion by a spring drive.

Diagnosis of vibration complaints can be difficult, but if the period occurs at about 50 m.p.h, in top gear, loss of damper poundage is to be suspected. If the car has been stored for a lengthy period adhesion of the cotton washers and etching of the steel friction surfaces is a real possibility.

Dismantling

Remove the twelve nuts and lock washers from the periphery of the flywheels together with the four at the centre of the front cover. All these nuts are screwed to studs which are peened in position and should not be removed. Lift off the front cover, and take care of the eight presser springs, and their packing washers if fitted. Take off the spring diaphragm plate and discard the front cotton duck washer. Release the lock washer and unscrew the serrated nut. Turn the engine so that the TDC mark on the flywheel is in register, and mark the mating teeth of the camwheel and the dynamo pinion.

The damper is withdrawn by means of the extractor, part number R2860, which picks up on the four studs in the centre of the damper. Draw off the damper and collect the Woodruff key.

Mount the damper 'back half on the test mandrel, and attach the poundage bar. Pull the bar in one direction to compress as far as possible the springs, and lever out the four pairs of relaxed springs. Release the remaining springs by pushing the bar the other way. Lift out the centre plate and discard the rear duck washer.

Overhaul

Prepare the new duck washers in the same way as for the earlier dampers, and similarly grind the four steel friction surfaces. Remove only sufficient metal to restore a smooth ground surface.

With this initial work carried out, mount the back half of the damper on the test mandrel, and lay in one of the duck washers. Follow this by the centre plate, omitting the drive springs. Lay in the second duck washer, and then the spring diaphragm plate. Ensure that the '0' marks on these parts are aligned.

Fit and tighten, but do not lock, the serrated nut. Position the presser springs on their bosses, and lower the front cover into position. Check that its '0' mark is aligned, and that the springs enter the hexagon headed plugs. Fit, tighten, but do not lock the sixteen securing nuts.

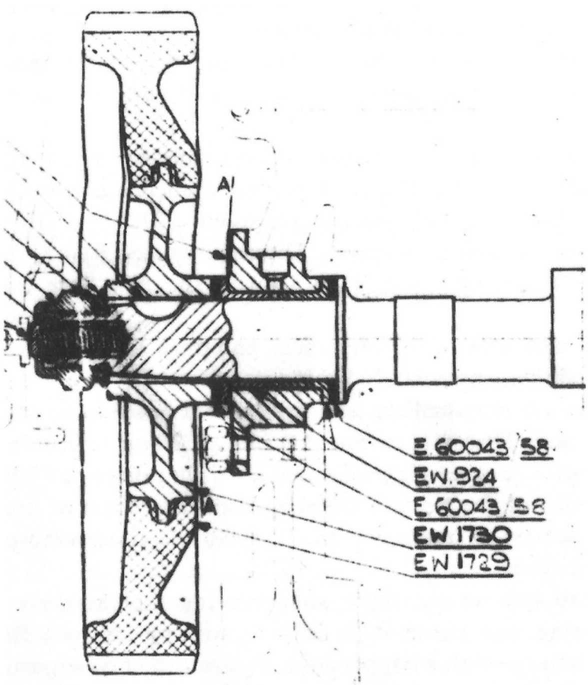
Attach the poundage bar, and oscillate the damper for several minutes, and then hook up the spring balance and check the poundage, which should be 11-12 lb. If, as would be expected, the poundage is too high, oscillate the damper for a further period and then re-test.

This is the most difficult part of the overhaul. Although reversal of the duck washers or substitution of a fresh pair can be resorted to, as there are only eight presser springs it is not feasible to delete a pair of them, as may be done on the earlier dampers. However, if there are packing washers on the presser springs they can be omitted, either the complete set or diametrically opposed pairs.

Having attained the correct poundage, take off the front cover and insert the eight pairs of drive springs, ensuring that they locate properly on their bosses. As before, the method is to pull the damper round with the poundage bar to facilitate entry.

The final tightening and locking of the serrated nut and the nuts on the damper face is, of course, completed when the unit is refitted to the crankshaft. Before offering up the damper check that the marks on the camwheel and the dynamo pinion are in line and that the flywheel TDC mark is in register. Line the damper up with the crankshaft key, and then turn the damper and the crankshaft two teeth clockwise before pushing the pinion into mesh. This compensates for the 'skew' of the gear teeth and ensures that the timing marks are properly aligned.

THE CAMSHAFT AND BEARINGS, AND BOTTOM TAPPETS



Section through camwheel—Wraith.

The camshaft is mounted in seven plain bearings, those at the front and rear being flanged, and the five intermediates located in the crankcase webs by dowel pins driven into the top face of the crankcase. Camshaft end float is controlled by one hardened steel thrust washer on either side of the front bearing.

The camwheel is of fibre, moulded on a steel hub, this component being keyed and tapered to the camshaft. The hub is made with two keyways, one of which is offset 3° 20' to give a setting adjustment of half a tooth. The camwheel securing nut incorporates a spring loaded thrust button which bears on the button in the timing cover.

The bottom tappets are the rotating type, and run in unbushed bores in the crankcase. These bores are offset from the vertical to promote rotation of the tappets. The tappets are of chill cast iron.

Dismantling

It is first necessary to remove the cylinder block, the sump, the timing cover, and the crankshaft damper.

Before commencing dismantling check and record the camshaft end float and check the camwheel backlash through one complete revolution.

Unlock and remove the camwheel securing nut, taking care of the thrust button and spring, and the tab and bevelled washers. On the earlier camwheels the hub boss is threaded 1.3125" x 26 t.p.i., right hand, for extraction purposes. Later camwheels have a pair of holes 0.250" x 26 t.p.i. (i.e. ¼" B.S.F.) in the boss face for the purpose.

Attach the extractor to the camwheel, and draw it off, taking care of the steel washer immediately behind it.

Extract the five intermediate bearing dowel pins from the top face of the crankcase. These are threaded 0.250" x 26 t.p.i., female, and are withdrawn with a simple tool made up with a piece of ¼" B.S.F. studding. Pull out the bottom tappets, and keep them in number order. On Bentley V unscrew, and remove as an assembly, the tachometer drive adaptor.

Unlock and remove the three nuts securing the camshaft front bearing housing, and knock it forward by striking the back face of the camshaft flange with a copper drift. Pull out the housing and put on one side the steel washer behind it.

Drift the five intermediate bearings forward a little at a time and in turn until they come free from the crankcase webs. Prise out the circlips and take the bearings off the shaft. Keep the pairs together, and mark them to ensure refitting in the same stations and the same way round.

Pull the camshaft out through the front of the crankcase.

Inspection

The overall height of the cams is 1.2705", and if the lobes are not worn more than 0.012" the shaft can be considered satisfactory for refitting. This figure refers to Wraith only, the cam height for Bentley V not being on record. The camshaft journal diameter is 0.8735", and the bore of the bearings 0.875". With the journals and the bearings on maximum limits the running clearance with new parts would be 0.003".

Examine the faces of the bottom tappets for pitting. Being made of cast iron, it is not practicable to restore surface condition by grinding, and pitted tappets must be renewed. The barrel diameter is 1.1865", and the tappet bores in the crankcase are 1.1875" diameter. This running clearance of 0.001" can be increased to 0.0025" with new components on maximum limits.

Before dismantling, the camwheel backlash should be 0.004" with both the mating gears at all rotational positions. Examine the fibre teeth very carefully for wear and general condition. Making a decision over the serviceability of the camwheel is difficult because incipient failure cannot always be detected. If excessive, or conversely nil, backlash is found, reject it and fit a replacement.

With a micrometer, measure and record the thickness of the camshaft thrust washers.

Reassembly

Thread the camshaft through the crankcase, and assemble on to it the intermediate bearings immediately forward of their webs. Position the bearings so that the dowel holes are at the 12 o'clock position, and then with a drift tap the bearings into the webs. When they are fully home drive in the dowel pins.

The correct camshaft end float is 0.003". On the basis of the end float recorded before taking down, select a pair of thrust washers to give this figure. Place one washer against the camshaft flange, refit the front bearing housing, tighten the nuts, but do not lock at this stage. Fit the front thrust washer and the Woodruff key, and push the camwheel onto the taper.

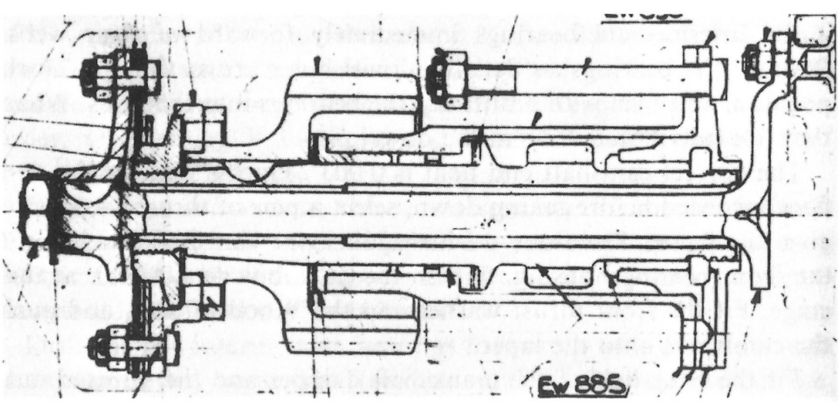
Fit the back half of the crankshaft damper and the serrated nut, and then tighten the camwheel securing nut. Check the camshaft end float, and turn the meshed gears, checking the backlash at all positions. When the requirements have been met, take off the camwheel again and lock the front bearing securing nuts.

Checking or resetting of the valve timing must be deferred until the rocker mechanism has been refitted. Start by setting No. 1 inlet valve to 0.025" clearance, and turn the camshaft until this clearance is just taken up. Pull the back half of the damper off the crankshaft, and turn the flywheel so that the IO mark is in register with the timing pointer. Offer up the back half of the damper again and align the Woodruff key, then turn the shaft and the damper two teeth clockwise and push the damper into mesh. Turn the crankshaft two complete turns and check that the timing clearance is just taken up as the IO mark comes into register again. It is permissible to set the timing up to ½" late, at the flywheel rim, but it should not be set early. Changing from one camwheel keyway to the other will alter the timing by approximately 5/8".

Finally, check that the camwheel nut is fully tight, and the spring and thrust button are in place.

THE DYNAMO AND WATER PUMP DRIVE

The drive pinion is mounted on a hollow spindle which runs in three bronze bushes inside the bearing housing. The housing, closed at the rear end by a cover plate, is secured by three bolts to the back of the timing chest. The skew gear for the distributor and oil pump drive is integral with the hollow spindle, the rear end of which is furnished with an oil wind back to register with the bearing housing cover plate.



The dynamo drive—Wraith.

The solid, dynamo drive spindle is coaxial with the hollow spindle, and the two are joined by a flexible coupling bolted to the front flange of the drive pinion. Both the coupling and the pinion are keyed and tapered to their respective spindles.

The drive is lubricated by a low pressure oil supply from the relief valve, which is mounted adjacent to it.

Dismantling

Commence by undoing the coupling nuts and taking off the dynamo.

Bring the engine up to TDC, and mark the mating teeth of the fibre gear and the drive pinion. Note the position of the distributor rotor, and remove the distributor.

Pull the driving piece off the bronze gear; these components are splined together. Bend back the tab washer and remove the gear securing nut. With a small extractor draw the gear off its taper, taking care of the Woodruff key and the adjusting washer immediately beneath it.

Release the tab washer and remove the coupling securing nut. Dismantle the coupling and knock the solid spindle out to the rear. Unscrew the pinion securing nut, and with a small extractor pull the pinion off its taper. As the pinion comes free take care of the Woodruff key and the spacing washer behind the pinion. Unpin and unscrew the three nuts securing the bearing housing and withdraw the bolts.

Push the hollow spindle out to the rear together with the bearing housing cover. Take care of the spacer washer against the shoulder of the spindle. Finally, push out the bearing housing.

Inspection

Wash all the dismantled parts in paraffin. Measure the journal diameters of the hollow spindle; the front diameter is 0.936" and the rear 0.811". The corresponding bush bore sizes are 0.9375" and 0.8125", thus, the running clearance is 0.0015". The limit on these sizes is 0.0005", which means that with new parts the clearance at maximum would be 0.0025". This should be recognised when assessing wear.

Should renewal of the bushes be necessary they must be bored after pressing in to the dimensions quoted.

Examine the spring rings of the coupling, and renew if cracks are present.

Reassembly

Push the bearing housing into the timing chest, with a new paper washer between the two. Position the original hardened steel washer against the shoulder of the hollow spindle, and push the spindle into the housing. Fit the housing cover and push the three bolts through. A new paper joint is needed between the cover and the flange. Fit and tighten the castellated nuts, but do not split pin at this stage. Position the front hardened washer against the front bush flange, fit the Woodruff key, and fit the drive pinion. Fit and tighten the nut. Check the end float on the spindle which should be 0.003". If this is correct, pull the pinion off again and split pin the housing nuts. Should the float be excessive, measure up the steel washers and increase their thickness as required. When refitting the pinion check that the marks made on the gear teeth are aligned.

Refit the solid spindle, reassemble the coupling, and fit and lock the coupling securing nut.

In refitting the bronze skew gear turn the oil pump drive spindle as required so that when the distributor driving piece and the distributor are refitted the rotor aligns with the same cylinder as when taken down. On A- and B-Series engines, fitted with the Delco-Remy distributor, the driving piece and the skew gear have 28 equally spaced splines, and will re-engage in any angular position. On C-Series engines, with the Rolls-Royce distributor, the engaging parts have one blank spline so that the distributor can be taken off and refitted without upsetting the ignition timing.

THE OIL PUMP DRIVE

The drive consists of a steel shaft mounted in a pair of bronze bushes. The bronze skew gear is keyed and tapered to its upper end, and the lower end is splined to engage the sleeve positioned between it and the oil pump. End float in the assembly is controlled by a pair of steel thrust washers, one beneath the bronze gear and the other above the shoulder at the lower end of the shaft.

It is unlikely that the drive will require dismantling except in the course of a general overhaul, but these notes assume that no other work than dismantling the drive is involved.

Dismantling

Disconnect the pipes from the oil pump, and unbolt the pump, taking care of the splined driving sleeve.

Take down the sump. This is essential because the shoulder of the drive spindle will not pass through the bore in the sump; also, access is required to the spindle lower bush.

Bring the engine up to TDC and note the alignment of the distributor rotor. Take off the distributor and pull the driving piece off the bronze gear. Check and record the end float in the spindle. Remove the gear retaining nut, and extract the bronze gear. Prise out the Woodruff key, and collect the thrust washer immediately below the gear. The spindle will then drop out, together with the lower thrust washer.

Inspection

The spindle journal is 0.499", and the bush bore size 0.500". The dimensions are subject to a limit of 0.0005", thus with new parts the running clearance will be 0.001-0.002".

To renew the bushes they must be driven out with a drift which will pass through the bore and engage the bush inner ends. The new bushes must be driven in with a piloted drift, and line reamed in position with a 0.500" spiral flute reamer. The reamer pilot must be long enough to engage both bushes before starting to cut.

Reassembly

The spindle should turn freely with 0.003" end float. If before dismantling the figure was higher than this, adjust by increasing the thickness of the steel washers. Particular care is essential in selecting new washers if the bushes have been renewed. It will be appreciated that the end float can be checked only with the bronze gear fitted and the nut tight.

Reassembly is straightforward, but take care to position the spindle correctly so that when the bronze gear is fitted the distributor driving piece will line up the rotor with the correct cylinder.

THE OIL PUMP

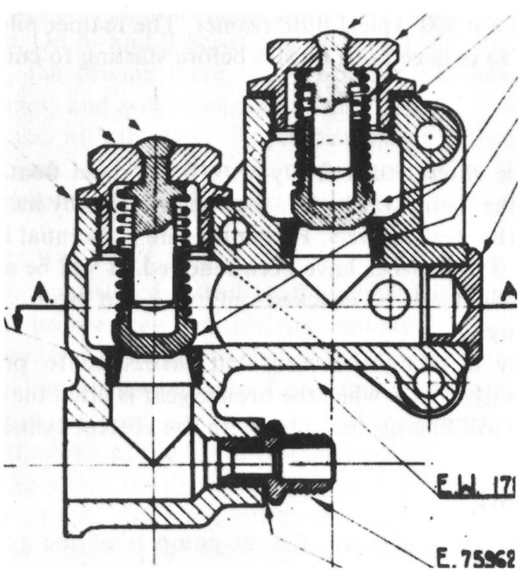
As on the earlier engines, the oil pump is of the gear type. It differs in that the oil relief valve is remote from the pump, and the oil supply from the sump is via an internal drilling in the crankcase, instead of an external pipe. The pump is coupled by a splined sleeve to the distributor drive spindle.

Dismantling

To remove the oil pump, undo the two union nuts, remove the nuts from the four studs, and draw the pump downwards. Take care of the splined driving sleeve.

Take out the two securing bolts, and prise the bottom cover away from the pump body. Draw out the pump gears, and wash the dismantled parts in paraffin. Pay attention to the oil holes in the gears. Slip the gears into the body, and check that their radial clearance is 0.002", and that they turn freely and without backlash. The correct end float is 0.002", which is provided by the paper joint between the cover and the body.

Check that the driving gear has 0.001" running clearance in its bushes, and the driven gear has a similar clearance on its spindle. If renewal of the four bushes is necessary, they must be reamed 0.500" (+ 0.001", -0.000") after pressing into position. The diameters of the driving gear journals and the driven gear spindle are 0.499" (+ 0.001", -0.000").



Oil relief valve— Wraith.

Should new gears be required, they must be lapped in position with turkeystone and oil so that they rotate freely with a complete absence of tight spots. On completion, thoroughly wash in paraffin the gears and the body to remove all traces of the abrasive.

Check the flatness of the joint faces of the body, top and bottom, and the cover, and correct as necessary. On reassembly, treat the paper joint with a non-setting jointing compound. If the pump is not to be refitted to the engine immediately, temporarily fit bolts to two of the vacant holes in the assembly.

When offering up the pump to the engine, smear the paper joint with compound, and position the splined sleeve on the pump gear spindle, ensuring that it engages the drive shaft as the pump is worked up into position.

THE OIL RELIEF VALVE

This assembly consists of a high pressure and a low pressure valve in series, the former regulating the main gallery pressure to the crankshaft, and the latter the low pressure supply to the timing gears and the rocker shaft. The pipe at the rear of the high pressure chamber feeds the by-pass oil filter, whence the oil is piped back into the low pressure system.

The seating of the high pressure valve is slotted to provide a low pressure supply under conditions when the valve is seated.

Dismantling the valve is straightforward, and no difficulty should be encountered. Care must, however, be taken not to transpose the valves, and their caps and springs. A paper joint is fitted between the valve body and the timing cover.