

E

Engine

FACTORY

SERVICE INSTRUCTION LEAFLET

ISSUED BY

BENTLEY MOTORS (1931) LTD.



BM/E1.

SB/NA.2/DJ.

Subject :

Engine - Tappet Clearances
3½ and 4¼ Litre Bentley.

Date
of
Issue

22nd Nov. 1945.

Owing to the continued use of Wartime Fuel it is important that the Exhaust Valves have adequate clearance.

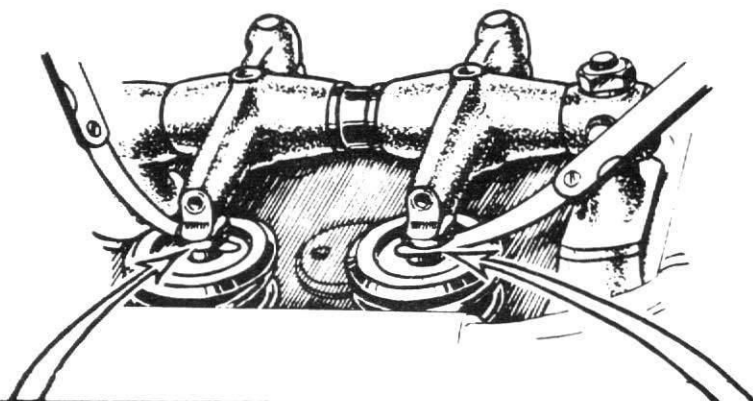
It is recommended, therefore, that the following clearances should be adopted. These figures override any other figures quoted in the relevant Handbooks or in Service Instruction Leaflet BM. 1.

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EXHAUST

INLET



Exhaust Valve.	Series.	Inlet Valve.
.006"	3½ Litre All series	.004"
.006"	4¼ Litre All series except MR and MX	.004"
.010"	4¼ Litre Series MR MX	.010"

ALL COMMUNICATIONS SHOULD BE ADDRESSED TO

BENTLEY MOTORS (1931) LTD., SERVICE STATION, HYTHE ROAD, WILLESDEN, LONDON, N.W.10

SERVICE INSTRUCTION LEAFLET

ISSUED BY

BENTLEY MOTORS (1931) LTD.



BM/E2

SB/CL 2/IP.

Subject :

CONNECTING ROD BIG END BEARINGS.
Bentley $3\frac{1}{2}$ Litre.

Date
of 12th August, 1946.
Issue

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The original 2.000" bore connecting rod big end bearing shells (Part No.E.55613) carried an external oil groove in the upper half which conveyed oil through the shells to the connecting rod for the feed to the gudgeon pin.

In order to avoid cracking of the white metal which might occur due to local distortion in the vicinity of the groove, the original type shells will be no longer manufactured, and for replacement purposes, shell EB.3463* will be used.

This shell has no external groove and it is most important to machine the connecting rod so as to incorporate the necessary oilway as shown in Fig 1.

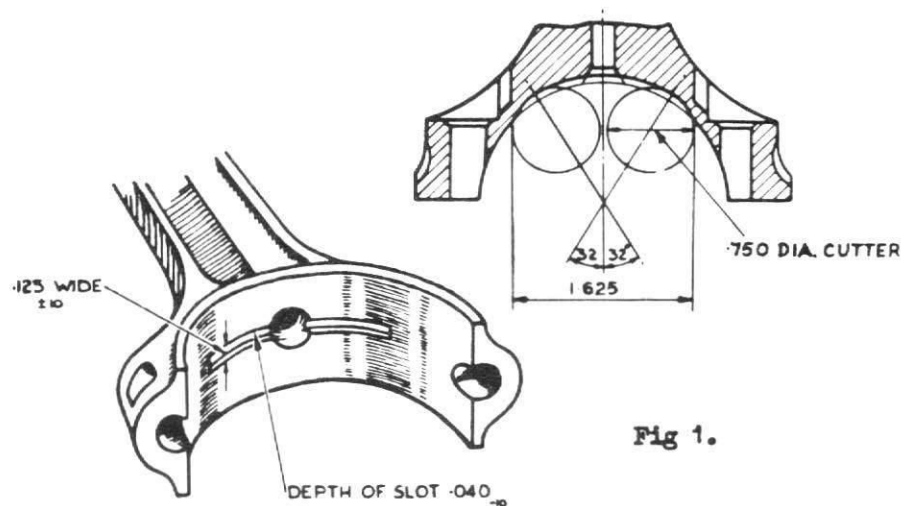


Fig 1.

On connecting rods fitted with an external oil pipe, an additional counterboring operation is necessary to connect the groove with the oil hole. This is shown in Fig 2.

* An alternative shell, Part No. R.3231, may be used. This is sufficiently small in the bore for use with undersize crankpins up to a maximum of .040 on diameter.

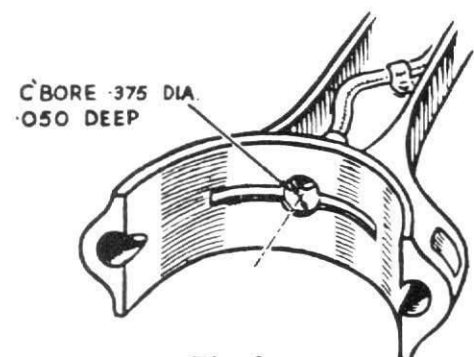


Fig 2.

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SERVICE INSTRUCTION LEAFLET

ISSUED BY

BENTLEY MOTORS (1931) LTD.



BM/E3

SE/GS.2/JM.

Subject :

DISTRIBUTOR DRIVE.
3½ and 4¼ Litre.

Date

of 2nd December, 1946.

Issue

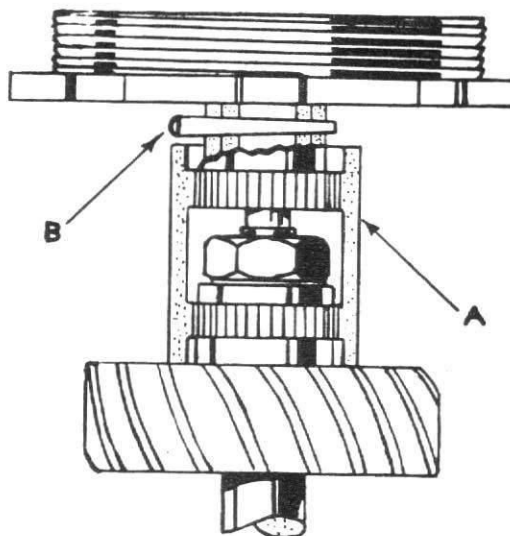
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It is necessary to draw attention to the following point in connection with the distributor drive on the above models. The splined sleeve shown at "A" in the sketch is free to move vertically on the splines, but complete dis-engagement is prevented by the taper pin "B" on which the sleeve butts after a limited amount of vertical travel.

If the pin is short, the condition may arise in which the sleeve ceases to engage the splines, and complete ignition failure will occur on the road.

It is therefore essential, when a distributor is removed or dismantled to make sure that the head of the pin projects to an effective extent. A new pin must be used if the existing one does not project sufficiently when driven into position.



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SERVICE INSTRUCTION LEAFLET

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BENTLEY MOTORS (1931) LTD.



BM/E 4.

SB/LT.1/SF.

Subject :

ENGINE
MAIN AND CONNECTING ROD BEARINGS
BENTLEY $3\frac{1}{2}$ AND $4\frac{1}{4}$ LITRE.

Date
of
Issue

31st March, 1947.

This leaflet is intended to give information relating to the fitting of new main and connecting rod bearings.

POLICY.

Before entering into technical detail, it is thought desirable to lay down a general policy in regard to the overhaul of engines.

In the production of the $3\frac{1}{2}$ and $4\frac{1}{4}$ litre Bentley, a high degree of interchangeability of parts was not an essential factor with the result that minor variations occurred in units nominally of the same type.

Selective assembly and fitting were the accepted procedure. From the Service replacement point of view, this procedure did not, at that time, present undue difficulties, since it was customary to have all chassis repaired at the Company's Service Depots. In the light of the Post-War policy under which our Retailers will undertake reconditioning, this practice now leads to certain difficulties with the supply of suitable spare parts.

Our spare parts stocks, relatively large by comparison with those which our Retailers will consider desirable to hold, enable us to provide for selective assembly in replacements, but it would be impracticable to apply this procedure to individual replacement requirements outside the organization.

It will be clear, therefore, that although the Retailer may be fully equipped to undertake engine overhauls, there still remains the difficulty of obtaining satisfactory spare parts.

This leads us to recommend that engines on which an extensive overhaul is necessary should be returned to the Rolls-Royce Service Depot whenever possible.

This leaflet is for use in cases where this course is difficult or undesirable.

GENERAL.

Reconditioning Period.

Progressive improvements in bearing material and lubrication particularly on the $4\frac{1}{4}$ litre have gradually increased the period to be expected between overhauls.

With normal usage and provided that no lubrication or mechanical failure has occurred, a $4\frac{1}{4}$ litre engine without the latest modifications will probably need reconditioning at about 40,000 - 50,000 miles. An engine built to the present standard will not require overhaul at less than 60,000 - 70,000 miles.

The $3\frac{1}{2}$ litre, in which the bearing stresses are lower, has a "life" which is approximately equal to a fully modified $4\frac{1}{4}$ litre. As will be seen subsequently in the technical data, satisfactory lubrication of the big end bearings, in particular Nos. 2 and 5, is largely dependent on the condition of the main bearings. This is especially the case when Hall's Metal

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Continued:

BM/EL.

bearings are fitted with their increased running clearance. In view of this condition, we strongly advocate that both sets of bearings should be dealt with simultaneously.

When the engine has been dismantled sufficiently for examination of bearings, $3\frac{1}{2}$ litre engines which have White Metal bearings throughout should be inspected for condition of the White Metal. Renewal should be carried out in cases of undue disintegration or separation from the steel shell. On the $4\frac{1}{4}$ litre, which, with the exception of the rear main, has Hall's Metal bearings, a dimensional clearance check should be made. Some earlier types of $4\frac{1}{4}$ litre Bentley were fitted with a Hall's Metal rear main, if one of these is found, it is advisable to fit a White Metal replacement, in which case the remainder will also require reconditioning.

GENERAL SPECIFICATION.

A pressure oil pump, situated externally on the lower half crankcase and taking its supply from the sump through a gauze strainer, feeds oil at a pressure controlled by the relief valve incorporated in the pump, to a connection on the crankcase. From this connection an internal oil gallery takes oil to each of the seven main bearings.

The crankshaft journals and crankpins are bored and act as oil conduits, the ends of the holed being plugged with caps. Communication between the crank journal and crankpin conduits is through smaller holes drilled in the webs. A proportion of the oil to the main bearings passes through radial holes in the journals into the conduits and lubricates the big end bearings through further radial holes in the crankpin. The upper halves of the connecting rod bearings are drilled and communication for oil feed to the gudgeon pin is made through longitudinal holes in the connection rods.

Thus all crankshaft, connecting rod and gudgeon pin bearings are pressure oil fed.

$3\frac{1}{2}$ LITRE ENGINE.

Series: AE. AH. BL. BN. CR. CW.

DG. DK. EF. EJ. FB. FC.

These engines are fitted with White Metal bearings throughout. The rear, centre and front main bearings have circumferential grooves in the bore which align with a hole in each journal to feed the big ends through the conduits. The original intermediate main bearings had no grooves but there was one hole in each journal coinciding once per revolution with the main oil supply giving additional big end lubrication. There was no change in this specification throughout the $3\frac{1}{2}$ litre series, except that the replacement intermediate bearings now have a groove for part of the bore circumference.

The original connecting rods had an external oil feed pipe attached to the rod to supply oil to the small ends, the lower end of this pipe was arranged to coincide with a circumferential groove in the back of the upper half bearing shell. At each end of this groove there was a hole through to the crankpin for oil supply.

The external oil pipe was superseded by an internal drilling in the rod and later a small "squirt hole", was provided which projected oil in to the cylinder wall to assist lubrication of the bores.

All replacement bearings are now supplied without the groove in the back and connecting rods must be modified as indicated in the relevant section.

Continued:

HM/EL.

4 $\frac{1}{2}$ LITRE ENGINE.

Series: GA. GP. HK. HM. JD. JY.
KT. KU. LS. LE. MR. MX.

The present specification on the engines varies considerably from that originally required. We propose therefore to describe this specification followed by a brief outline of earlier requirements. This will clarify the position in regard to the various conditions found on dismantling engines. Most of the changes were made to improve lubrication to the big end and main bearings and are consequently of considerable importance.

CURRENT SPECIFICATION.

Hall's Metal AC7 to main bearings Nos. 1 to 6
White Metal rear main bearing.
Large capacity oil pump.
Extra holes in main journals and crankpins
Hall's Metal AC9 to connecting rod bearings.

Specification of Earlier Series.

Oil Pump.

Original engines were not fitted with a high capacity oil pump; this came in at the beginning of K series but has subsequently been fitted to many earlier engines. The difference between the original pump and the high capacity can be recognized externally, the latter having an aluminium body, the former a phosphor bronze one.

Bearings.

Bearing material was Hall's AC7 for mains and big ends up to K series when a change was made for a short time to Hall's Metal AC2. No bearings of this type will now be found in engines. This was followed in the last series by Hall's Metal AC7 for all main bearings except the rear main which was White Metal and Hall's Metal AC9 for connecting rod bearings. All replacements now conform to this specification.

Connecting Rods.

From the first 4 $\frac{1}{2}$ litre engine to late in K series all connecting rods were internally drilled for the small end oil feed and there was a circumferential groove in communication with the lower end of the hole into which oil was fed through two holes in the bearing shell. From K series onwards the groove was deleted, the bearing shell having a single hole in the upper half, and an oil squirt hole similar to that in the 3 $\frac{1}{2}$ litre was added. Replacements are supplied with one hole or two holes according to requirements, but both types are now in Hall's Metal AC9. A few engines in M series will be found with the grooved connecting rod, but no modification of either type is necessary.

Continued:

BN/EL.

Crankshaft.

Original crankshafts had one hole in each main journal and crankpin for big end oil feed through the conduits. Late in J series and onwards an additional hole was added to improve big end lubrication. This hole was diametrically opposed to the existing one. Concurrently with this change there were modifications to the main bearing shell grooving culminating in a full groove in all main bearings, which is the present practice.

Oil Squirt Hole.

The squirt hole was introduced to improve cylinder lubrication when the tapered skirt piston was fitted in K series and it is essential to retain it with this type although it may be deleted in an engine with parallel skirt pistons.

For recognition purposes it will be found that a tapered skirt piston has a continuous slot behind the scraper ring and the parallel skirt piston has a series of holes behind this ring with a narrow slot just beneath it.

DETAILED SPECIFICATION.

$3\frac{1}{2}$ and $4\frac{1}{2}$ Litre.

Crankshaft.

All Bentley crankshafts are "nitride" treated. This process gives the requisite degree of surface hardness, but owing to changes in manufacturing procedure and conditions at various times, the exact depth of hardness on any particular crankshaft may not be ascertainable.

Therefore, while it is extremely unlikely that penetration of the hard surface will occur on the first regrind, we recommend that the hardness should be checked on all crankshafts reground in excess of .015" below nominal size and that crankshafts should be retreated at .020" below nominal size.

The minimum hardness figure is 600 V.P.N. If a Vickers hardness tester is not available, a test may be made with a smooth file. There should be no tendency for the file to make any impression on the crankshaft. As this method is less accurate than the use of a Vickers machine any shaft which appears doubtful should be "re-nitrided".

The finish must be free from chatter and grinding fur and should be polished.

Nominal Sizes.

Main Journals.	2.2495" (-0.001") dia.
Crankpins.	1.999" (-0.0005") dia.
Radius on Journals.	0.200"
Radius on Crankpins.	0.125"
End float (controlled at No.7 bearing)	0.0025" (± 0.005 ")

Continued:

Permissible Wear Limit.

Maximum ovality and taper.	0.001"
Maximum permissible wear.	0.003"
Maximum permissible crankshaft end float.	0.007"

Regrind.

in stages of 0.005" undersize to a maximum of

0.040" for crankpins.

0.060" for main journals.

Maximum permissible regrind limits are based on the minimum safety factor and do not in any way affect the observation on "Nitride" depth.

Oil Holes.

This information applies to $4\frac{1}{4}$ litre only.
Journals. Nos. 2, 3 5 and 6 must be modified as follows:-

If there is only one hole as in Fig.1, an additional hole must be drilled diametrically opposed as in Fig.2.

Drill .218" dia. with a small radius on the journal.

Some crankshafts may be found with three holes in the journals as in Fig.3, but no alteration is required to these.



FIG 1.

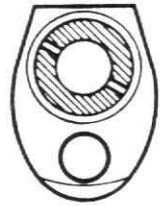


FIG. 2.



FIG 3.

Crankpins.

An additional hole is necessary if only one is found. This must be drilled diametrically opposed.

Drill .125" dia. with a small radius on the crankpin.

Oil Pump.

$4\frac{1}{4}$ Litre Bentley only.

It is essential to fit the large capacity oil pump in conjunction with the latest type bearings and additional crankshaft oil holes.

Note:

It is assumed that the crankshaft will be correctly cleaned during the overhaul, but particular attention must be given to the removal of all "Sludge" from crankpin conduits. It will be found to collect on the outer portion of the bore where it is deposited by centrifugal action and may obstruct the big end feed holes if it is not cleaned out.

Continued:

Connecting Rods.

Alignment.

The following information refers to the maximum permissible mal-alignment in three directions of the small end bore in relation to the big end bore. This operation is done after boring the big ends.

Horizontal Alignment. (See Fig.4)

0.0005" per inch from the gudgeon pin bush centre line measured along the axis of the mandrel.

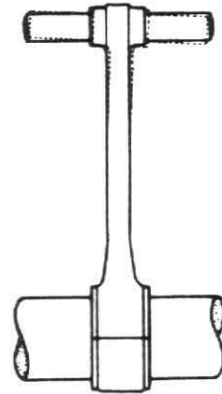


FIG. 4.

Axial Alignment. (Twist see Fig.5)

0.001" per inch from the gudgeon pin bush centre line.

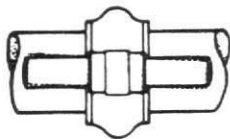


FIG.5.

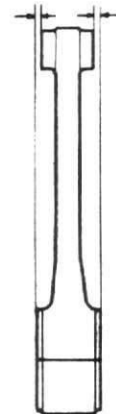


FIG.6.

Vertical Alignment. See Fig.6.

.010" tolerance is allowed as between the vertical centre line of the gudgeon pin bush and that of the big end. This is available for use in centralising the big end on the crankpin during engine assembly.

Small End side clearance.

.005" - .015"

Big End side clearance. (Controlled at the small end)

.040" - .050"

Note: All $3\frac{1}{2}$ litre connecting rods must be modified in accordance with Service Instruction Leaflet EM/E2.

Continued:

Oil Squirt Hole.

The oil squirt hole introduced in K series in conjunction with the tapered skirt piston must not be added when parallel skirt pistons are fitted, otherwise excessive cylinder lubrication may occur. On the $3\frac{1}{2}$ litre, this hole was introduced late in D series and may be deleted as parallel skirt pistons are always fitted to this type.

Gudgeon Pins.

If replacement pistons are fitted during the overhaul, new gudgeon pins will be supplied with each piston. New small end bushes will therefore be required and these should be reamed so that the pin is a push fit and will not drop out when the connecting rod is held horizontally with the gudgeon pin in position.

Bearings.

White Metal.

Running clearance for main journals and Crankpins.	.002" (+.0005")
Bearing shell "nip".	.002"

Hall's Metal AC7 & AC9.

Running clearance for main journals and crankpins.	.003" (+.0005")
Bearing shell "nip" Initial "nip"	.016"
Final "nip"	.004"

BEARING NIP.

The figures given for bearing "nip" represent an amount by which the bearing shell is larger in diameter than its housing, converted into a feeler gauge measurement between the housing butt faces for practical purposes.

This causes the bearing to be squeezed by the housing when tightened down and provides against fretting and loss of oil pressure between the back of the shell and the housing.

Hall's Metal AC7 have certain characteristics which make it necessary to apply a "pre-crushing" operation before fitting with the correct nip. When the material has "settled down" as a result of this operation, the "Final nip" will be satisfactorily maintained, but without it the shells rapidly become loose in the housing and failure occurs.

White Metal does not require "pre-crushing" but the application of the specified "nip" is of extreme importance with this material as well as with Hall's Metal.

The procedure for checking and applying "nip" is as follows:-

Both main and connecting rod bearings are supplied in pairs partly milled through the axial centre-line. The pairs should be divided using a hacksaw with as narrow a kerf as possible. All burrs should be removed and the butt faces cleaned up.

Continued:

Each half shell should then be checked for parallelism of the butt faces in relation to the bore centre-line, by placing it on a surface table face downwards and "clocking" each side of the back adjacent to the flanges at the highest point. Inequalities should be corrected by lightly filing the butt faces, removing as little metal as possible. There should be no perceptible "rock". (See Fig.7)

The shells may then be assembled in pairs in the housings together with the shims.

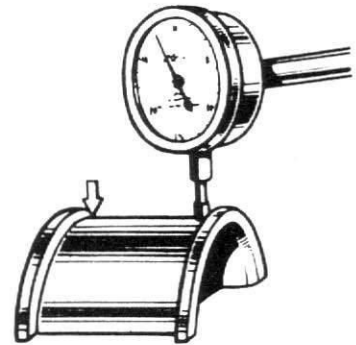


FIG.7.

Hall's Metals AC7 and AC9.

Tighten down normally on both sides, slack off one side completely and re-tighten to finger tightness. A gap will now be apparent between each side of the shim and the housing butt faces. The shim is held centrally by the pressure of the shell on its inner edge. (See Fig.8)

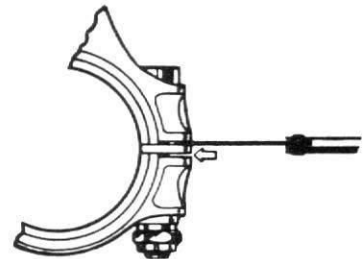


FIG.8.

For the "pre-crushing" operation, these gaps should now be adjusted to .008" each by filing the butt faces of each shell equally taking particular care to maintain parallelism and truth.

The assembly should be retightened on completion of this operation and left for a few hours or overnight, during which period the "settling down" takes place.

When the period has elapsed, undo one side, re-check the gaps and adjust to .002" each, then retighten for boring. The main bearing shell locating dowel may interfere to some extent with the measurement of "nip" if it is too tight a fit in the hole. Slight radial clearance should therefore be given. No lateral movement is permissible.

Whitemetal.

The procedure is precisely the same as for Hall's Metal except that the "pre-crushing" is omitted.

Bolt Tightness.

The tommy bar length recommended for tightening both big-ends and main bearings is 6", and this should be centrally placed in the spanner. On the connecting rods the correct condition can be obtained by measuring the bolt length before and after tightening. The stretch should be .005" - .006". The nut must be tightened to the next split pin hole if the castellations do not register. Direct measurement of the main bearing stud stretch is impracticable, but using the connecting rod as a basis for comparison, the nut should be slightly tighter.

We append the torsion spanner figures for those who prefer to use this method, but our view is that this type of spanner is no substitute for an experienced fitter by whom we would naturally prefer the job should be done.

Big-ends. 225-lbs/ins. + 50.
Main Bearing. 300-lbs/ins. + 50.

Continued:

EM/E4

Boring.

When the "nip" and bolt tightness are correct, main and connecting rod bearings may be line-bored to journal and crankpin dia. plus the running clearance. In this operation, special attention must be given to the concentricity of the bearing bore in relation to the bore in the housing. This will ensure that the engine gear centres will be the same as originally fitted. Discrepancies in this respect will give rise to excessive gear noise, and at the rear, will affect the alignment of the gearbox. After boring, the connecting rods should be given the correct alignment of big-end to small end.

Crankshaft End Float Adjustment.

Face off the rear thrust face of No.7 main bearing sufficiently to produce a good bedding surface and cut the forward face to obtain the required end float, which should be $0.0025" (+ 0.0005")$

Oil Flow Test.

An oil flow test should be carried out after the crankshaft and connecting rods have been assembled in the engine. The purpose of this operation is to prove the oil tightness of the crankshaft conduit blanking caps and the oil gallery connections to each main bearing and to ensure that there is a free flow of oil to all bearings. All leaks found should be corrected.

It may be necessary to rotate the crankshaft to check the oil flow as all the conduit oil holes will not coincide simultaneously with feed holes.

It is more convenient if the test is carried out with the cylinder blocks and pistons assembled as this simplifies the rotation of the engine and controls the small end oil flow.

An oil pump capable of maintaining a pressure of 30-lbs/sq.in should be connected to the main oil supply point of the crankcase and an inspection made with this pressure maintained.

SERVICE INSTRUCTION LEAFLET

ISSUED BY

BENTLEY MOTORS (1931) LTD.



BM/E5a.

SB/VK/JSL/NT.

Subject :

CYLINDER LINERS
DRY LINERS FOR BENTLEY ENGINES.

Date of Issue 6th March, 1953.

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In cases where it is necessary to rebore and fit replacement pistons to an engine which has already been bored to the maximum permissible oversize, a dry liner may be fitted.

This liner may be either:-

- (a) A full-length parallel type to restore the bore diameter to the original size.
- (b) A stepped liner, the lower part of which constitutes a "skirt" or bore extension. This can be used to salvage any block having a broken extension, irrespective of bore size.

MACHINING INSTRUCTIONS FOR BLOCK:

FULL LENGTH LINER - Each liner must be treated individually, and its external diameter measured, taking a micrometer reading across the diameter at six points; then bore to the mean reading, allowing an interference as shown below.

STEPPED LINER - Machine off the broken skirt flush with the bore of the cylinder. Measure the liner and bore out as above. Chamfer the inside edge of the cylinder bores as shown in the diagram.

LIMITS OF INTERFERENCE:

Bentley $3\frac{1}{2}$ litre } 0.002" to 0.0025".
Bentley $4\frac{1}{4}$ litre }

FITTING THE LINER:

The load required for pressing in is (approx.) $2\frac{1}{2}$ to $3\frac{1}{2}$ tons.

BORING OUT LINER:

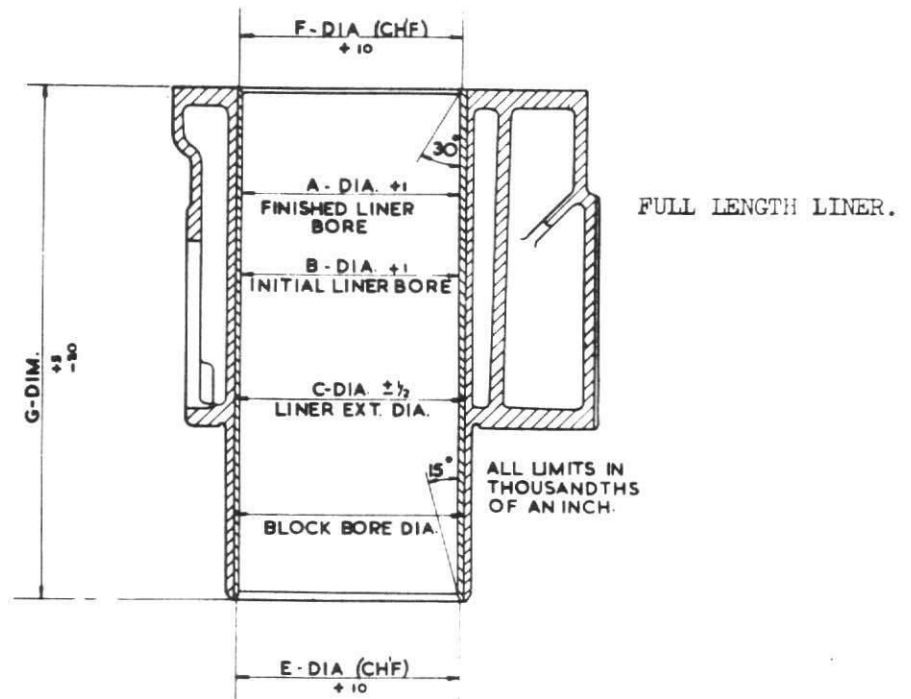
After pressing in the liner, bore it out to 0.002" undersize and hone finish to size, a matt finish being obtained by using FC.320-L-VGN stones or an equivalent.

LUBRICANT:

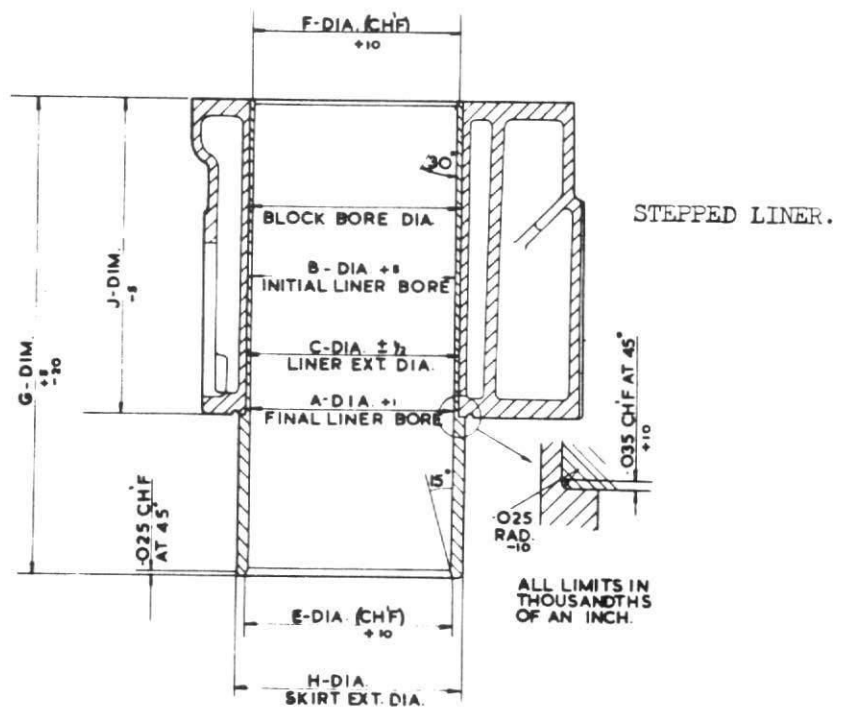
The recommended lubricant is "Dixol Soluble Oil", supplied by:-

W. B. Dick & Co.,
Rotherhithe,
London.

used in proportion 25% Dixol to 75% paraffin.



MODEL	A-DIA	B-DIA	C-DIA	E-DIA	F-DIA	G-DIA	LINER PIECE No.
B 4½ & B 5	3.500	3.480	3.6275	3.550	3.550	7.625	R 3691
B 3½	3.250	3.230	3.3775	3.300	3.300	7.625	R 3690



MODEL	A-DIA	B-DIA	C-DIA	E-DIA	F-DIA	G-DIA	H-DIA	J-DIA	LINER PIECE No.
B 4½ & B 5	3.500	3.480	3.6275	3.550	3.550	7.625	3.750	5.000	R 3699
B 3½	3.250	3.230	3.3775	3.300	3.300	7.625	3.575	5.000	R 3698

Material: Centrifugally Cast Iron.

SERVICE INSTRUCTION LEAFLET

ISSUED BY

BENTLEY MOTORS (1931) LTD.



BM/E6

SB/GF.5/SF.

Subject : PISTONS AND RINGS FOR USE IN BENTLEY ENGINES
TYPES AND SIZES USED.

Date
of
Issue 15th June, 1948.

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The information included in this leaflet is intended to be of assistance in deciding the appropriate replacement pistons and rings required to meet individual requirements.

GENERAL INFORMATION.

PISTON SIZES:-

To obviate the necessity of holding large stocks of pistons for which past experience has proved that there is a limited demand, it has been decided to rationalize the oversize available to the following sizes:- 0.015", 0.025", 0.035", 0.045"

It is recommended that liners be fitted when further re-boring becomes necessary, thereby restoring the cylinder bores to their original sizes.

PISTON RINGS:

A. Although the early four ring split skirt type pistons, originally fitted to all $3\frac{1}{2}$ litre Bentley engines prior to the first chassis in 'E' series, are obsolete, it is believed that there are still a limited number of vehicles operating with this type of assembly fitted, and replacement rings for use with existing old type pistons are available from this Service Depot.

When indenting for these, however, the chassis number should be given, and the size of piston fitted, stated.

B. Rings supplied through this Service Depot, whether separately, or in conjunction with their respective pistons, are not "gapped" to the recommended clearance limits prior to delivery.

These should be "gapped" during the actual assembly of the engine, the tightest portion of the respective cylinder bores being chosen for this purpose.

GUDGEON PINS:

It should be noted that the fitting of gudgeon pins is facilitated if the piston is warmed slightly.

BORING:

The cylinder should be bored to the oversize stated. The necessary clearance is provided for in the piston dimensions.

DETAILED INFORMATION.

Detailed part numbers and recommended piston ring gaps for both the $3\frac{1}{2}$ litre and $4\frac{1}{4}$ litre Bentley engine, are contained in the following pages.

Further assistance is provided by the inclusion of diagrams illustrating the correct assembly of the rings.

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SERVICE INSTRUCTION LEAFLET

ISSUED BY

BENTLEY MOTORS (1931) LTD.



BM/E6.

SB/GF.6/SF.

Subject : Pistons and Rings
for
Bentley $3\frac{1}{2}$ Litre ($3\frac{1}{4}$ " Bore) Engines.

Date
of
Issue 15th June, 1948.

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All Bentley $3\frac{1}{2}$ litre engines prior to the first chassis in 'E' series, i.e. Chassis No: B-2-EF, were originally fitted with four ring split skirt type pistons of Rolls-Royce manufacture. These, however, are obsolete, having been superseded by the present range of three ring Aerolite pistons quoted below.

The additional ring sizes are included to cover those cases where suitable replacement rings are required for use with existing over-size piston assemblies fitted prior to the current system of rationalization.

FOR ALL BENTLEY $3\frac{1}{2}$ LITRE CHASSIS.

Size	Piston	A	B	C
		Top Ring	Inter Ring	Bottom Ring
		1 Off	1 Off	1 Off
Std.	EB.2441	EB.2377	EB.3077	EB.2686
.005 O/S	-	EB.3078	EB.3088	EB.3450
.010 "	-	EB.3079	EB.3089	EB.3451
.015	EB.2441	EB.3080	EB.3090	EB.3452
.020 "	-	EB.3081	EB.3091	EB.3453
.025 "	EB.2551	EB.3082	EB.3092	EB.3454
.030 "	-	EB.3083	EB.3093	EB.3455
.035 "	EB.2441	EB.3084	EB.3094	EB.3456
.040 "	-	EB.3085	EB.3095	EB.3457
.045 "	EB.2441	EB.3086	EB.3096	EB.3458
.050 "	-	EB.3087	EB.3097	EB.3459

All quantities are expressed in terms of one piston.

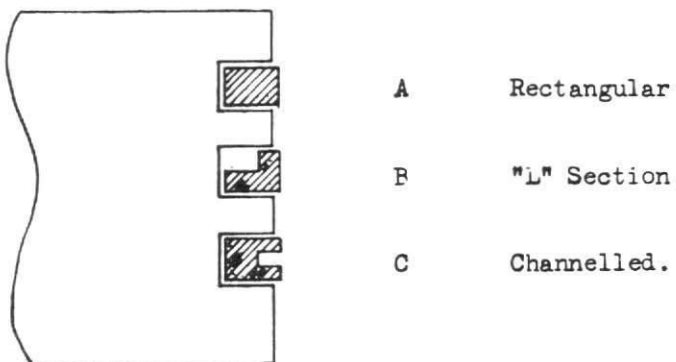
- NOTES:** (1) The same part numbers apply to all the replacement pistons, but the oversize required must also be stated at time of indenting.
(2) All Bentley pistons are supplied complete with rings and gudgeon pins.
(3) Gudgeon pins are NOT supplied separately.
(4) Replacement rings ARE obtainable separately.

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Ring Assembly:

The following diagram illustrates the correct ring assembly:-

Ring Gaps:

Top Ring

.010" to .014" }

Inter and Bottom Rings.

.006" to .008" }

No stops fitted.

SERVICE INSTRUCTION LEAFLET

ISSUED BY

BENTLEY MOTORS (1931) LTD.



BM/E6.

SB/GF.7/SF.

Subject :

Pistons and Rings
for
Bentley $\frac{1}{2}$ Litre ($3\frac{1}{2}$ " Bore) Engines.

Date

of 15th June, 1948.
Issue

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All early Bentley $\frac{1}{2}$ litre engines were fitted with parallel skirt three ring Aerolite pistons in conjunction with connecting rods which were drilled solely for the purpose of small end lubrication.

At Chassis No: B-1-KU, however, an oil hole was added to improve cylinder lubrication, and this coincided with the introduction of the tapered skirt three ring Aerolite piston with its closer limits of clearance.

It is essential, therefore, that these two types of piston are fitted in conjunction with their appropriate connecting rods, for, should parallel skirt pistons be used with connecting rods having oil squirt holes, excessive cylinder lubrication may occur. Conversely, taper skirted pistons fitted to connecting rods without squirt holes may result in piston seizures.

For recognition purposes, it will be found that a tapered skirt piston has a continuous slot behind the scraper ring, and the parallel skirt piston has a series of holes behind this ring, with a narrow slot just beneath it.

The replacement Aerolite pistons and rings suitable for both the early and later types of engines will be found quoted in the following schedules, the additional ring sizes being included to cover those cases where suitable replacement rings are required for use with existing over-size piston assemblies fitted prior to the current system of rationalization.

FOR ALL BENTLEY CHASSIS UP TO B-200-KT incl.

Size.	Piston	A	B	C
		Top Ring 1 Off	Inter Ring 1 Off	Bottom Ring 1 Off
Std.	EB.2844	E.60820	E.61123	E.60821
.005 Q/S	-	E.61152	E.61184	E.61162
.010 "	-	E.61153	E.61185	E.61163
.015 "	EB.2844	E.61154	E.61186	E.61164
.020 "	-	E.61155	E.61187	E.61165
.025 "	EB.2844	E.61156	E.61188	E.61166
.030 "	-	E.61157	E.61189	E.61167
.035 "	EB.2844	E.61158	E.61190	E.61168
.040 "	-	E.61159	E.61191	E.61169
.045 "	EB.2844	E.61160	E.61192	E.61170
.050 "	-	E.61161	E.61193	E.61171

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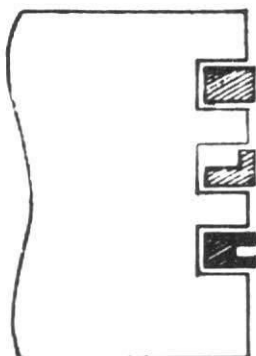
FOR ALL BENTLEY CHASSIS BETWEEN B-1-KU AND B-203-MX INCL.

	Piston	A Top Ring	B Inter Ring	C Bottom Ring
		1 Off	1 Off	1 Off
Std.	EB.3916	E.60820	E.61123	EB.3122
.005 O/S	-	E.61152	E.61184	EB.3353
.010 "	-	E.61153	E.61185	EB.3354
.015 "	EB.3365	E.61154	E.61186	EB.3355
.020 "	-	E.61155	E.61187	EB.3356
.025 "	EB.3367	E.61156	E.61188	EB.3357
.030 "	-	E.61157	E.61189	EB.3358
.035 "	EB.3369	E.61158	E.61190	EB.3359
.040 "	-	E.61159	E.61191	EB.3360
.045 "	EB.3371	E.61160	E.61192	EB.3361
.050 "	-	E.61161	E.61193	EB.3362

- NOTES: (1) Pistons are supplied only complete with rings and gudgeon pins.
 (2) Gudgeon pins are not supplied separately.
 (3) Replacement rings are obtainable separately.

Ring Assembly:

The following diagram illustrates the correct ring assembly for both types of piston:-



- A Rectangular.
 B "L" Section.
 C Channelled.

Ring Gaps:

Top Ring	.010" to .014" }	No stops fitted.
Inter and Bottom Rings	.006" to .008" }	

SERVICE INSTRUCTION LEAFLET

ISSUED BY

BENTLEY MOTORS (1931) LTD.



BM/E7.

SB/GF.1/SF.

Subject : THE OVERHAUL AND ADJUSTMENT
OF
BENTLEY CRANKSHAFT VIBRATION DAMPERS.

Date
of 9th November, 1948.
Issue

The information contained in this leaflet is intended to provide the necessary assistance in connection with the overhaul and adjustment of the Low Inertia Spring Drive crankshaft vibration dampers fitted to Bentley engines.

DESCRIPTION.

Before proceeding with further technical detail, it is thought desirable for the following brief description of the general construction to be given.

LOW INERTIA SPRING DRIVE.

Incorporated in the following Bentley cars.

$3\frac{1}{2}$ litre. All chassis.
 $4\frac{1}{4}$ litre. All chassis.

As its name implies, this design has been developed to reduce, as far as possible, the inertia of the parts rigidly attached to the crankshaft so as to increase the natural frequency of oscillation, and to reduce the amplitude of movement. Thus, the only part directly attached to the crankshaft is the central driving hub of the spring drive which carries a light friction disc. The so-called flywheel is attached rigidly to the crankshaft pinion and is driven through the medium of the radial driving springs. Between these two components is interposed the damping device.

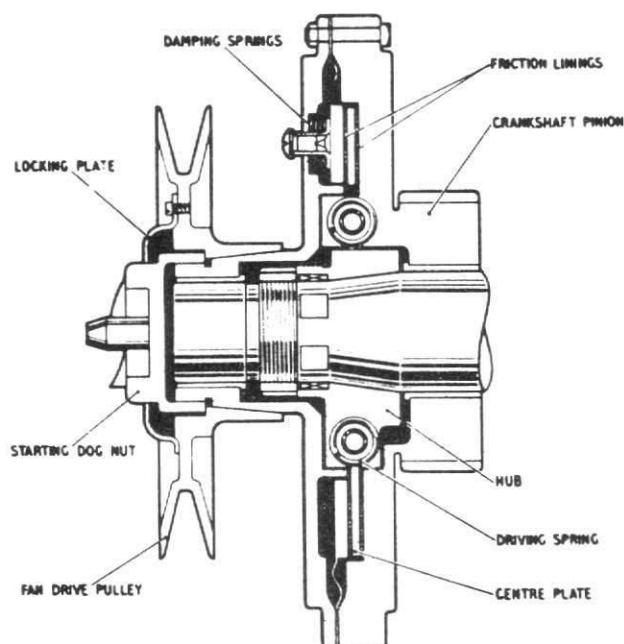


Fig. 1.

DERANGEMENT OF THE DAMPER - REASON AND SYMPTOMS.

Apart from such mechanical reasons as structural breakages, inefficiency of the damper will, in the main, be found attributable to an alteration in the pre-determined slipper drive poundage.

Lengthy periods of idleness, such as car at rage, may result in the cotton duck washers adhering to the damper friction plates, thus preventing the movement between the friction faces so necessary for the absorption of the minute variations in crankshaft angular movement.

This tendency for the cotton duck washers to adhere to the friction plates during a period of idleness, makes it essential, should some considerable time elapse between assembly and actual fitting to the engine, for all assembled dampers to undergo a final poundage test.

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Continued:

BL/27

Loss of movement between the damper friction faces results in the accentuation, rather than the absorption of the minute variations in crankshaft angular movement, thus leading to the introduction of engine vibration periods.

Vibration periods solely resulting from a deranged crankshaft damper will generally be first experienced at 1750 r.p.m. in third gear, and will tend to increase in intensity until reaching a climax at approximately 2,500 r.p.m. in the same gear, after which they will continue to be experienced at intermittent intervals.

A distinct rattle will also frequently be heard in the timing gears at the same time when picking up from slow speeds, but this should not be confused with the fast clicking sound associated with a faulty cam balance assembly.

SPECIAL TOOL SCHEDULE FOR REMOVAL.

The removal and dismantling of these dampers for overhauling necessitates the use of special tools. These are obtainable from this Service Station, and are as follows:-

<u>Model.</u>	<u>Chassis Series.</u>	<u>Spanner for Damper Retaining Nut.</u>	<u>Damper Extractor.</u>
3 $\frac{1}{2}$ litre) 4 $\frac{1}{4}$ litre)	All chassis.	R-2883.	R-2879.

PROCEDURE FOR THE REMOVAL AND DISMANTLING OF DAMPERS.

1. Remove the radiator.
2. Remove the locking plate from in front of the fan pulley and draw off the pulley by unscrewing the large hexagonal nut in the centre.
NOTE: Do NOT remove the serrated locking ring which will be seen located round this nut.
3. Remove the timing gear cover.
4. Bend back the tab washers, remove the four $\frac{1}{4}$ " B.S.F. nuts in the centre of the spring drive, together with the twelve 2-BA. nuts round the outer circumference of the damper flywheels and pull off the front damper plate, spring plate and first cotton duck washer.
5. Bend back the lock washer and remove the serrated retaining nut securing the rear damper plate to the crankshaft.
6. Bring the engine up to TPC. on No. 1 cylinder by means of the flywheel, position the extractor (R-2879) and draw off the rear damper plate. (It is recommended that the mating teeth between the crankshaft and camshaft pinions be suitably marked prior to the complete removal of the damper).
7. Remove the driving springs, centre plate and second cotton duck washer. (These driving springs are retained in position at one end only and require to be compressed before they are free for extraction. To effect this, the blade of a suitable screwdriver should be inserted into the spring at the end adjacent to the driving dog on the hub side, and the spring compressed until this end is clear of the retaining lip or dowel, after which it can be prised out quite easily).

After the damper has been completely dismantled, the following procedure should be carried out:-

1. Examine all the friction faces for scoring, and regrind if necessary.
2. Discard all used cotton duck washers.

SAFE LIMITS OF GRINDING.

Friction Faces:

The diagrammatic sketches appended below, illustrate the limits to which the various friction faces may be safely ground:-

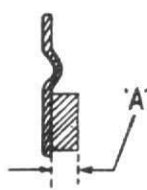


FIG. 2.

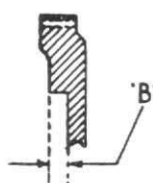


FIG. 3.

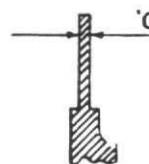


FIG. 4.

Minimum Permissible
Working Thickness for
Presser Plate.
(See Fig. 2 Dimension 'A')

Depth to which the Rear
Damper Friction Face
may be ground.
(See Fig. 3 Dimension 'B')

$3\frac{1}{2}$ litre }
 $4\frac{1}{2}$ litre }

0.107" or 2.72 mm.

0.388" or 9.86 mm.

NOTE: The Presser Plate is the friction ring which is riveted to the corrugated spring plate located between the front damper wheel and the centre friction drum.

The centre friction flange must not be ground below a working thickness of:- 0.062" or 1.57 mm. (See Fig. 4 Dimension 'C').

FRICTION LININGS.

In view of the fact that friction represents the main principle used for the absorption of torsional oscillation, and that this friction is dependent upon the friction linings themselves, it is obvious that the efficient functioning of the damper will be governed by the condition of these linings.

The tendency for these to become hard, ingrained with carbon and superficially glazed, thus losing their original properties, makes it essential for all existing linings to be replaced by new ones at each overhaul period.

Before assembly, all replacement friction linings must be reduced to a state approximating to that in which they will operate when actually assembled, and, as this entails a reduction in material thickness, care should be taken to ensure uniformity in all-round working thickness, particularly at the scarf joint. This is of the utmost importance, as the fitting of unevenly ironed friction linings will only result in the rapid deterioration in damper efficiency.

Continued:

PM/E7

In order to prepare these friction linings for assembly, the following procedure should be carried out:-

1. Soak in oil for approximately 24 hours.
2. Lay the linings between their respective damper flywheel faces and bolt up both flywheels tightly. The damping springs carried by the front damper plate should be retained in position.
3. Fit the assembly on to an appropriate mandrel, secure this in a vice, and oscillate the damper flywheels, using the testing bar as a means of leverage, until the linings have been reduced to a uniform working thickness all round. This is of particular importance and cannot be over-emphasised, as any appreciable difference or local variations in the working thickness of the friction linings will result in the rapid deterioration of the damper efficiency.
4. Carefully trim off all superfluous fringes from round the scarf joints and test for fit relative to the hub. Each lining should lie perfectly flat upon its respective friction surface, at the same time being free to rotate.

NOTE: The springs comprising the spring drive section **MUST** always be omitted for operation No. 3.

RECOMMENDED SLIPPER POUNDAGES.

Each crankshaft damper has a recommended slipper spring pre-loading for operational purposes.

These figures quoted below, represent the force required to overcome the frictional drag between the damper flywheel and centre friction drum, and have been found by experience to produce the correct amount of damping in normal circumstances.

Although these figures represent sufficiently accurate limits to ensure normally efficient damping, variations are permissible to suit individual cases, e.g. in the event of a vibration period developing at low engine speeds, reduction of the recommended spring poundage is permissible as a counteracting measure, and conversely an increase in the recommended spring poundage is permissible should the period be experienced at high engine speeds. At no time, however, should these variations be in excess of 1-lb. (0.45 Kilo), above or below the recommended pre-loading figures quoted below:-

3½ litre)			
&	All chassis	11/12-lbs.	or 4 99/5.44 Kilos.
4½ litre)			

SPECIAL TOOL SCHEDULE FOR ASSEMBLY AND TESTING.

These are obtainable from this Service Station and are as quoted below:-

<u>Tool Piece No:</u>	<u>Description:</u>	<u>To Which Applicable:</u>
R-2986	Mandrel)	All chassis in both series.
R-3138	Poundage Bar)	

SLIPPER POUNDAGE TEST.

The effort required to overcome the frictional drag which is exerted by the damping springs is measured on a spring balance and is obtained in the manner detailed below:- (See Fig.5).

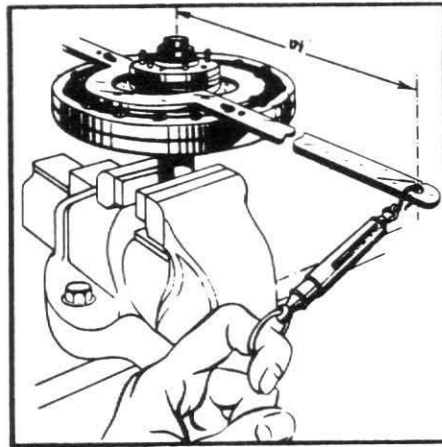


Fig. 5.

1. Fit the damper assembly on to an appropriate mandrel and secure in a vice.
2. Attach the testing bar to the damper flywheel in the manner shown in Fig. 5.
3. Secure the spring balance to the bar at a radial distance of $17\frac{1}{2}$ " (44.45 cms), and pull on the free end of the balance.

If the effort required to move the two flywheels relative to the centre hub after the original inertia has been overcome, is greater than the maximum recommended pre-loading figure, further

ironing of the friction linings should be carried out. Should this not be sufficient, reduction in the spring loading can be effected by the removal of damper springs in pairs, i.e. those diametrically opposite to each other, but at no time should more than two pairs, i.e. four springs be so removed.

NOTE: All driving springs MUST be omitted for this poundage test.

PROCEDURE FOR THE RE-ASSEMBLY OF THE DAMPER.

1. Fit the replacement friction lining to the rear damper plate, ensuring that it lies perfectly flat upon the friction face and is free to rotate, and also that its scarf joint is in line with the assembly mark 'O' which will be seen etched on the face of the damper plate.
2. Line up the assembly mark 'O' on the centre friction drum with that seen on one of the centre pins and then refit.
3. Fit the second friction lining, ensuring that its scarf joint is diametrically opposite to that of the first lining, and that it is both perfectly flat upon the friction face and free to rotate.
4. Fit the spring plate, ensuring that the assembly mark 'O' is coincident with those already assembled.

Continued:

BM /E7

5. Fit the packing plate, again ensuring that its assembly mark is lined-up, and after removing all packing washers from behind the damping springs, replace these springs and fit the front damper plate to the rear plate in the normal manner. Carry out the slipper spring poundage test in the manner described above.
6. Upon the recommended spring loading being obtained, remove the front damper plate, packing plate, spring plate and second friction lining, and re-insert the driving springs. This latter operation may be simplified by leaving the rear damper plate on the mandrel, and after locating the springs alternately, compressing these by means of the testing bar, thus widening the remaining spaces sufficiently for the easy insertion of the remainder of the springs.
7. Having re-positioned the driving springs, remove the rear damper plate from the mandrel and refit to the crankshaft nose, ensuring that the marks already etched on the mating teeth of the crankshaft and camshaft pinions are coincident.
8. Thread on the lockwasher and tighten up the serrated locking nut, using the special box spanner for the purpose.
9. Replace the second friction lining, spring plate, packing plate and front damper plate and secure in position.
10. Check the engine timing. (When carrying this out, the engine should always be turned by means of its flywheel and NOT by the starting handle).

SERVICE INSTRUCTION LEAFLET

ISSUED BY

BENTLEY MOTORS (1931) LTD.



BM/E7A.

SE/GF.1/SF.

Subject: ADDENDUM TO SERVICE INSTRUCTION LEAFLET BM/E7.

Date of Issue 6th December, 1948.

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Subsequent to the publication of BM/E7, it is felt that a certain degree of amplification is necessary in order to ensure that no uncertainty arises regarding the overhaul and dismantling of the Bentley crankshaft damper.

With this in mind, it has been decided that an addendum be issued, containing such additional information as is considered necessary, and to be used in conjunction with the existing leaflet.

Commencing with the second page, it will be noticed that the removal of the timing gear cover is shown as the second operation following that of the radiator. In actual practice however, certain other items require to be dismantled prior to the removal of the timing cover, these items and the order of their removal being as follows:-

- a) Remove the engine undershield, support the engine at its forward end upon a suitable trestle and then remove the engine front suspension cross-member.
- b) Remove the fan bracket, complete with the fan and fan belt.
- c) Disconnect the external oil pipe leading from the oil pump to the top of the timing cover and remove same.
- d) Remove the dynamo drive brake blocks if fitted. These will be located in the front end cover, being situated in an extension on top of and directly underneath the drive itself. (Certain of the early $3\frac{1}{2}$ litre chassis will be found not to have these brake blocks fitted, although provision for their fitting has been made in the design of the front end cover).
- e) Draw off the fan pulley in the manner already described in BM/E7.
- f) Disconnect all leads between the ignition coils and the distributor head, unscrew the front cover securing nuts and remove the timing cover.

The remainder of the dismantling can then be carried out in the manner set down.

The procedure laid down on Page 3 for the examination of the damper components should also include the following:-

"Check for any signs of movement between the centre friction plate and its hub. This is of the utmost importance, as any movement between these parts indicates that the rivets securing this plate to the hub have worked loose, and if this is not rectified, will result in the rapid deterioration in the damper efficiency with possibly a structural breakage occurring at the point of riveting.

In all cases of loose rivets, the assembly must be re-riveted, using replacement rivets for the purpose, but before this is done, it is recommended

"that the friction plate is examined, and if the rivet holes in its webs are unduly elongated, or the webs cracked, then a replacement plate must also be fitted".

In conclusion, an important feature in the re-assembly of the timing cover is to ensure that the radial clearance between the oil thrower and the timing cover is not closer than 0.004", (0.10 mm), this representing the minimum recommended limit of clearance necessary to prevent any contact between the oil thrower and the timing cover under normal conditions.

In view of the fact that it is impossible for the clearance to be accurately measured with the oil thrower in position, it is suggested that a special sleeve or bush of the identical external and internal measurements of the existing oil thrower is locally produced, and is used as a gauge in the assembly of the timing cover relative to the oil thrower. In this way, the radial clearance can be accurately checked and the timing cover correctly assembled to ensure the concentricity of the oil thrower relative to the bore of the hole through which it passes.

In the event however, of the machining of such a sleeve proving to be impracticable, a process of trial and error will be necessary, using "Prussian Blue" on the barrel of the oil thrower to determine whether a definite radial clearance between the oil thrower and the timing cover exists or not. As an accurate measurement of the actual clearance is unobtainable, however, it may be necessary to relocate the timing cover one way or the other several times before a satisfactory setting relative to the oil thrower is obtained.

SERVICE INSTRUCTION LEAFLET

ISSUED BY

BENTLEY MOTORS (1931) LTD.



BM/E8

SB/VA.4/PR

Subject : Duaflex Piston Rings
for
Bentley $3\frac{1}{2}$ & $4\frac{1}{4}$ litre Models.

Date
of 14th May, 1956.
Issue

It has been the practice of the London Service Station for sometime now to fit Wellworthy Duaflex Oil Control Rings to engines where heavy oil consumption has been reported.

As this type of ring has proved very satisfactory, it has now been decided to discontinue the use of the Standard Slotted Oil Control Ring, and all oversize pistons will now be supplied with a Duaflex Oil Control Ring.

A complete list of the Duaflex Rings, which are to supersede the original scraper ring, is given below.

It will be noted that one size Duaflex Ring is suitable for a small range of oversize bores. The actual size is as follows :-

Standard ring is suitable for:- Standard to .019" o/size bores.
.020" o/size ring is suitable for:- .020" o/size to .039" o/size bores.
.040" o/size ring is suitable for:- .040" o/size to .059" o/size bores.

The sizes quoted above are those to which the respective rings are capable of expanding i.e. .019" in each case.

The ring gaps are pre-sized and must therefore not be altered.

TO ASSEMBLE TO A PISTON

NOTE: On existing pistons all grooves and oil drain holes must be thoroughly clean and free from carbon.

- (i) Place the expander in the groove first, and then SPIRAL the rails on one by one, taking care to arrange the gaps all round the piston. The top rail will need a little pressure to enter the groove, as the assembled ring is slightly wider than the groove.
- (ii) Check that the assembled ring, lightly oiled, can be moved round in the groove.
- (iii) Oil with light oil and install with fitting clamp.

NOTE: The three side rails are identical and may therefore be installed either way round. The assembled order on a piston is:-

Expander, two side rails uppermost, centre spring and one side rail at bottom.

<u>MODEL.</u>	<u>PART NO. OF ORIGINAL OIL CONTROL RING.</u>	<u>SIZE.</u>	<u>SUPERSEDED BY.</u>
Bentley $3\frac{1}{2}$ litre $3\frac{1}{4}$ " bore.	EB.2686.	Std.	R.5264.
	EB.3450.	.005 o/s.	R.5264.
	EB.3451.	.010 o/s.	R.5264.
	EB.3452.	.015 o/s.	R.5264.
	EB.3453.	.020 o/s.	R.5382.
	EB.3454.	.025 o/s.	R.5382.
	EB.3455.	.030 o/s.	R.5382.
	EB.3456.	.035 o/s.	R.5382. Contd.

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Continued.

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BM/E8

<u>MODEL.</u>	<u>PART NO. OF ORIGINAL OIL CONTROL RING.</u>	<u>SIZE.</u>	<u>SUPERSEDED BY.</u>
Bentley $3\frac{1}{2}$ litre	EB.3457.	.040 o/s.	R.5398.
$3\frac{1}{4}$ " bore.	EB.3458.	.045 o/s.	R.5398.
Contd.	EB.3459.	.050 o/s.	R.5398.
Bentley $4\frac{1}{4}$ litre	EB.3122.	Std.	RE.21327.
$3\frac{1}{2}$ " bore.	EB.3353.	.005 o/s.	RE.21327.
	EB.3354.	.010 o/s.	RE.21327.
	EB.3355.	.015 o/s.	RE.21327.
	EB.3356.	.020 o/s.	RE.21329.
	EB.3357.	.025 o/s.	RE.21329.
	EB.3358.	.030 o/s.	RE.21329.
	EB.3359.	.035 o/s.	RE.21329.
	EB.3360.	.040 o/s.	RE.22039.
	EB.3361.	.045 o/s.	RE.22039.
	EB.3362.	.050 o/s.	RE.22039.

Hm. - F.B.A.Ltd.
NRC. - Allied Motors Ltd.
Rv. - Madrid.
Mr. De Boeck - Nice.
Sg.
C.
H.
Tr.
Bn.
Cx.
Mr. Evans - Lillie Hall.
Mr. Crawford " "
Mr. Reid - Glasgow.
Instruction School.
D. O. Mr. Walker.
Hs.
Mr. Hancock.

D/BP.
EWT.
Mx.
BY.
EP.
Mr. Robinson - Germany.
Repair Dept.
Bentley Repair Dept. London.
Kellow Falkiner (Pty) Ltd.
Dalgety & Co.
Mr. Ellis - Australia.
Mr. H. C. Rugeroni - Portugal.
Mr. Avis.
Mr. Schmidt - Switzerland.
Sa. - Spain.
R. P. Collyer - Canada.

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15.6.34.

DEPOT SHEET NO. Hd.261.

FAN BELT - 3½ LITRE BENTLEY.

Origin of Information:
BY/Cgh2/G19.5.34.

Some difficulty has been experienced in fitting a new fan belt to Bentley chassis owing to the fact that the space between the starter jaw on the engine and the engine suspension bracket is rather restricted, and also because fan belts have been coming through rather deeper than the drawing dimensions.

It should be noted that all future fan belts will be .425 deep, i.e. from top to bottom of the Vee, and no difficulty will be experienced in fitting these.

It is only intended that these belts should be changed when the old one has to be replaced due to wear and tear or other reasons, and in such cases the old belt should be cut in two for the removal purposes.

Hd.

Sr. - F.B.A.Ltd.
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 Mr. de Boeck - Nice.
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 Tr.
 Bn.
 Cx.
 Mr. Evans, Lillie Hall.
~~Mr. Crawford Lillie Hall.~~
 Br. - N.

Bentley Repair Depot, Glasgow.
 Bentley Repair Depot, London.
 Mr. Reid - Glasgow.
 Instruction School.
 D.O. - Mr. Walker.
 Hs.
 Mr. Hancock.
 D/BP.
 EWT.
 Mx.
 BY.
 EP.
 Mr. Robinson - Holland.
 Repair Department.

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9.5.35.

DEPOT SHEET NO. Hd.279.

Extra Cylinder Lubrication - Bentley Chassis.

Origin of information:
 Hs/Rm9/KW18.4.35.

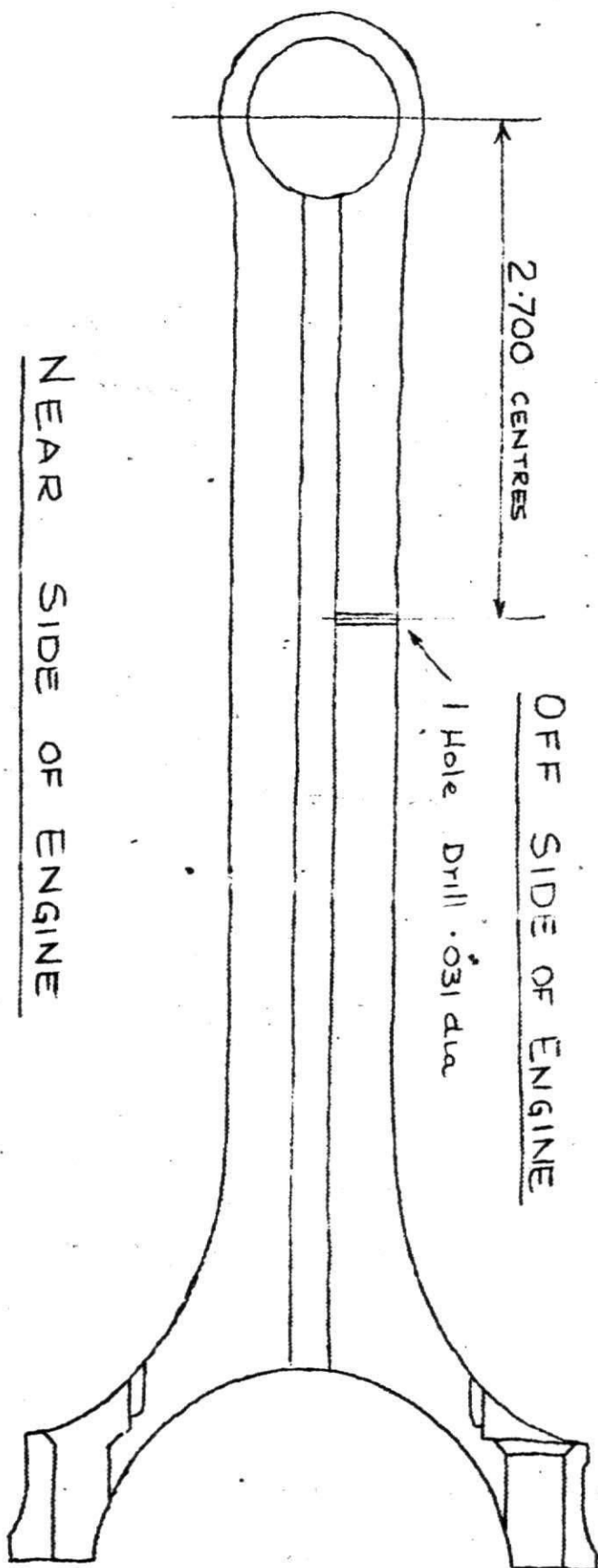
In order to reduce the tendency to piston seizure on the Bentley Chassis a modification has been introduced to increase the supply of lubricant to the cylinder walls. This consists of a small hole drilled in the connecting rod, and which feeds oil to the cylinder wall from the big end supply. This is shown on the attached Blue Print No.B.V.51.

The modification is only possible on cars which have the latest drilled up type of connecting rods which were standardised at the commencement of 'C' Series.

In all cases where a piston seizure has been experienced this additional hole should be drilled in the connecting rods if they are of the drilled up type.

Naturally, the hole is drilled on the pressure side of the connecting rods, i.e. the offside of the engine.

Hd.



MODIFICATION TO CONNECTING ROD TO PROVIDE
EXTRA CYLINDER LUBRICATION, - BENTLEY

1
St. - F.B.A. Ltd.
NRC. - Allied Motors.
RV. - Madrid.
Mr. de Boeck. - Nice.
Sg.
C.
H.
Tr.
Bp.
Cx.
Mr. Evans. - Lillie Hall.
Mr. Crawford. - Lillie Hall.
✓ Br. - N.

Bentley Repair Depot - Glasgow.
Bentley Repair Depot - London.
Mr. Reid. - Glasgow.
Instruction School.
D.O. Mr. Walker.
Hs.
Mr. Hancock.
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EWT.
Mk.
BY.
EP.
Mr. Robinson. - Holland.
Repair Department.

26th June 1935.

Depot Sheet No. Hd.285.

FAN FAILURES.
Bentley Chassis.

Origin of information:-
Hs/Std5/KW.4.6.35.

In connection with the failures which have occurred on Bentley Fans, we have established that the basic cause of failure is lack of balance of the complete fan.

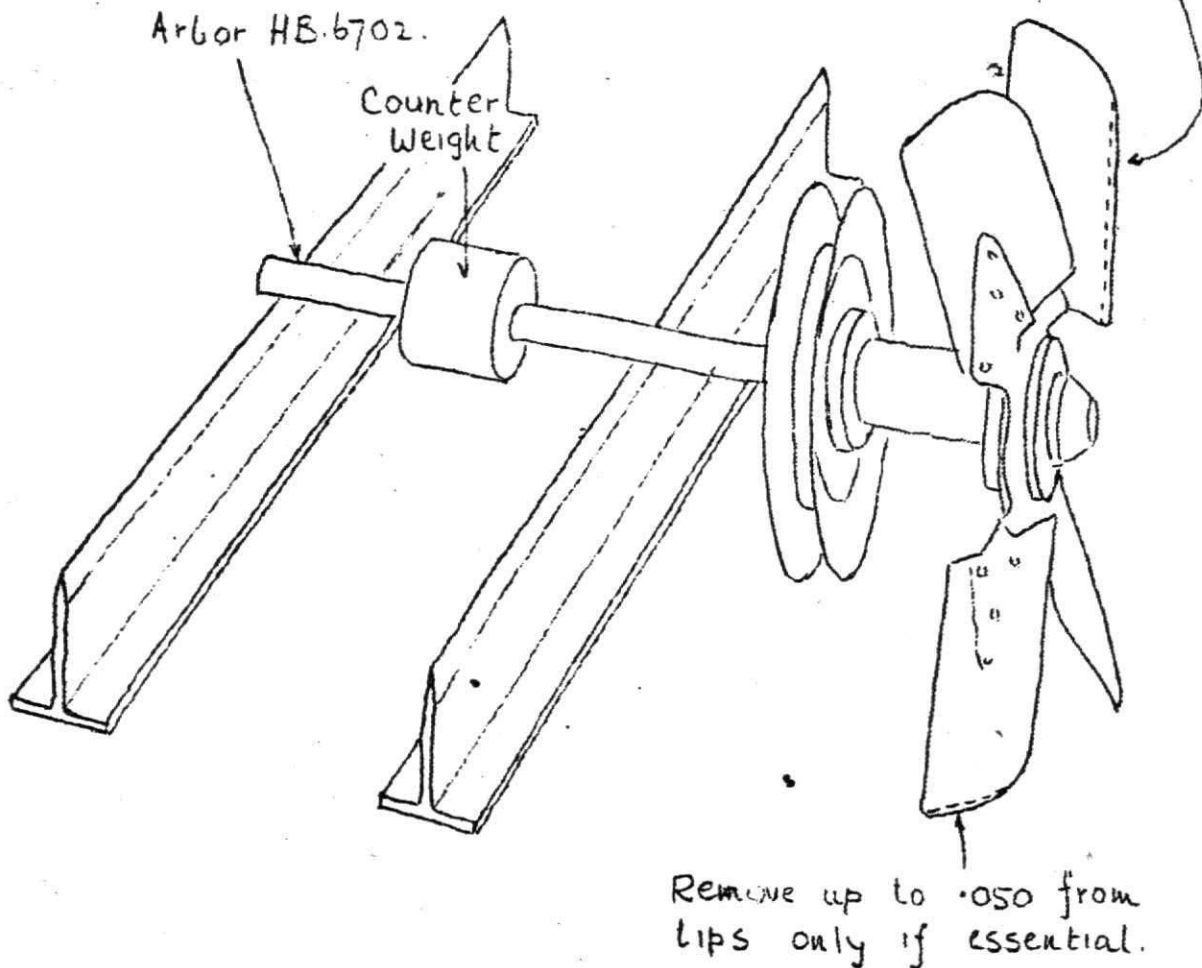
All Bentley fans should be checked for this fault when the cars come in for other work. This should be done as follows:- By mounting the fan hub with blades and ball races complete on an arbor to HB.6702, and rolling it on knife edges to determine whether it is in balance.

Correction of any out-of-balance is done as follows:-

1. By removing metal from the leading edges of the heavy blades. Up to .100" may be removed.
2. If this is insufficient, by removing metal from tips of heavy blades. Up to .050" may be removed.

-contd:-

up to .100" may be removed from leading edge.



SKETCH SHOWING METHOD OF
BALANCING FAN - BENTLEY

Sr. - F.B.A. Ltd.
 NRC. - Allied Motors.
 RV. - Madrid.
 Mr. de Boeck. - Nice.
 SE.
 C.
 H.
 Tr.
 Bp.
 Cx.
 Mr. Evans. - Lillie Hall.
 Mr. Crawford. - Lillie Hall.
 Br. - N.

Bentley Repair Depot. - Glasgow.
 Bentley Repair Depot. - London.
 Mr. Reid. - Glasgow.
 Instruction School.
 D.O. Mr. Walker.
 Hs.
 Mr. Hancock.
 D/BP.
 EWT.
 Mx.
 BY.
 EP.
 Mr. Robinson. - Holland.
 Repair Department.

1st July 1935.

AMENDMENT TO DEPOT SHEET
 NO. Hd.285.

FAN FAILURES.
 Bentley Chassis.

Further to the above-mentioned Depot Sheet, it should be noted that after any Bentley Fan has been balanced, the letter "N" should be stamped on the hub of the fan body.

Chassis numbers should be reported to Works in the usual way after this modification has been carried out.

Hd.

- 2 -

Depot Sheet No.Hd.285.

Continued:-

Attached is a sketch showing the method of balancing.

NOTE. Blades should be built up in same relative position as that in which they were balanced.

Hd.

4

Sr. - FBA. Ltd.
NRC. - Allied Motors,
Rv. - Madrid.
Mr. de Boeck. - Nice.
Sg.
C.
H.
Tr.
Cx.
Mr. Evans. - Lillie Hall.
Mr. Crawford. - Lillie Hall.
✓ Br. - N.
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Bentley Repair Depot, London.
Mr. Reid. - Glasgow.
Instruction School.
D.O. - Mr. Walker.

Hs.
Mr. Hancock.
D/BP.
EWT.
Mx.
BY.
EP.
Mr. Robinson. - Holland.
Repair Department.
Kellow Falkiner (Pty) Ltd.
Dalgetty & Co.
Mr. Ellis. - Australia.
Mr. H. C. Rugeroni. - Portugal.
Mr. Avis.
Perrot Duval & Cie. - Geneva.
Baumberger & Forster. - Zurich.
Sa. - Spain.
R. P. Collyer, Ltd. - Canada.

21st October 1935.

DEPOT SHEET NO. Hd.293.

CRANK CASE DRAIN PLUG.
20/25 HP. and Bentley Chassis.

Origin of information:-
Hd/SBI/HR.3.10.35.

It has been decided to change the crank case drain plugs on a number of cars in service, owing to the material being unsatisfactory.

The new plug to be used is EB.2634, replacing EB.1508.

The change applies to all 20/25 HP. cars commencing at "F" series and to all Bentley cars after the end of "B" series.

Supplies of the new plugs are not yet available but they will be forwarded to Depots as soon as possible.

The plug should be changed on all cars as they become available.

Hd.

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Sg.

C.

H.

Tr.

Cx.

Mr. Evans. - Lillie Hall.

Mr. Crawford. - Lillie Hall.

Br. - N.

Bentley Repair Depot, Glasgow.

Bentley Repair Depot, London.

Mr. Reid, Glasgow.

Instruction School.

D.O., Mr. Walker.

Hs.

Mr. Hancock.

D/BP.

EWT.

Mx.

BY.

EP.

Mr. Robinson. - Holland.

Repair Department.

18th December 1935.

DEPOT SHEET NO. Hd. 294.

ENGINE DETONATION.

3½ Litre Bentley Chassis.

Origin of information:-

Hs/Rm6/KW.11.11.35.

When dealing with complaints of pinking on Bentley chassis, there are several factors which may not be fully appreciated.

In the first place, the most important item in reducing pinking on a car is the fuel. Nowadays, there are on the market, petrols of widely varying knock rating. These are classified according to octane numbers. Car petrols at present available lie between 60 and 80 octane. Most No. 1 petrols are round about 70 octane and Benzol mixtures as sold from pumps are only a little better.

The Bentley is designed so that in a clean condition it will run on these fuels with only light detonation when the ignition is left in the fully advanced position. After about 5,000 miles, detonation will be noticeable, and can be removed by control of the spark. At 10,000 miles detonation will be very marked and the car will have to be de-carbonised. If, on the other hand, it is run on Ethyl, we should expect the engine to be reasonably free from detonation up to 10,000 miles.

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Continued:-

Ethyl petrol is now 80 octane; i.e., very much better than any standard No. 1 for anti-knock value, and as good as a No. 1 spirit mixed with 50% Benzol. Ethyl is obtainable almost everywhere; 50% Benzol mixture is, as far as we know, unobtainable except by special mixing.

Realising the advantage of these petrols with lead in them, such as Ethyl, the Bentley has been specifically designed so that it can run on them. If a Bentley Owner refuses to run on Ethyl for some prejudice, there are two other alternatives:- He can have his car de-carbonised frequently, or he can run with his ignition retarded and so lose performance when he has carbon in the engine.

If a Bentley engine in a clean condition detonates badly on No. 1 petrol, then there is something wrong. Actually, owing to the ignition advance characteristic, pinking is more likely to take place from round about 50 m.p.h. than at any other speed.

If, for any reason, the automatic advance is not functioning satisfactorily, this may cause pinking. For instance, it is possible for the governor spindle to be bent - perhaps as a result of prising off the cam. This would cause the contact breaker points to have a different gap on each of the six cams and would cause some cylinders to be more advanced than others. This may easily be checked by noting whether the gap is consistent on all six cylinders.

It is important that the ignition timing be checked with reference to the fly wheel marking.

Cases have occurred where the timing has been advanced in order to improve performance but the result is usually only an increased tendency to detonation.

Hd.

Sg.
C.
Sr. - FBA.Ltd.
Mln.- Bombay.
Ev. - Madrid.
Mr. de Boeck - Nice.
H.
Tr.
Cx.
Mr. Evans - Lillie Hall.
Mr. Crawford - Lillie Hall.
Br. - N.
PH. C/o Clyde Auto Co.Ltd.
Bentley Repair Depot, London.

Mr. Reid - Glasgow.
Instruction School.
Hs.
BY.
E.
Rm.
RMC.
Mx.
Mr.Hancock.
BY/NW.
D/BP.
Mr.Robinson - Holland.
Repair Department.

23rd June 1937.

DEPOT SHEET NO. Hd.352.

ROCKER SHAFTS.

Bentley, 25/30 HP. and Phantom III.

Origin of information:-
Rm/Swdl.18/JH11.6.37.

One or two instances have occurred where the rocker shaft has cracked through one of the stud holes, and it is evident that this has been due to one of the holding down nuts having been loose, causing the shaft to be subject to bending.

It is therefore recommended that Depots should check over the holding down nuts on each of the rocker pedestals whenever a car is received at a Depot for attention.

Hd.

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C.	Mr. Reid. - Glasgow.
Sr. - FBA. Ltd.	Instruction School.
Mln. - Bombay.	Hs.
Mr. Birkett. - New Delhi.	BY.
Rv. -	Rm.
Mr. de Boeck. - Nice.	RHC.
H.	Mx.
Tr.	LA.
Cx.	Mr. Hancock.
Mr. Evans. - Lillie Hall.	BY/N7.
Mr. Crawford. - Lillie Hall.	D/BP.
Br. - N.	Mr. Robinson. - Holland.
PH. C/o Clyde Auto Co. Ltd.	Repair Department.

13th December 1937.

DEPOT SHEET NO. Hd.367.

BIG END BEARINGS.

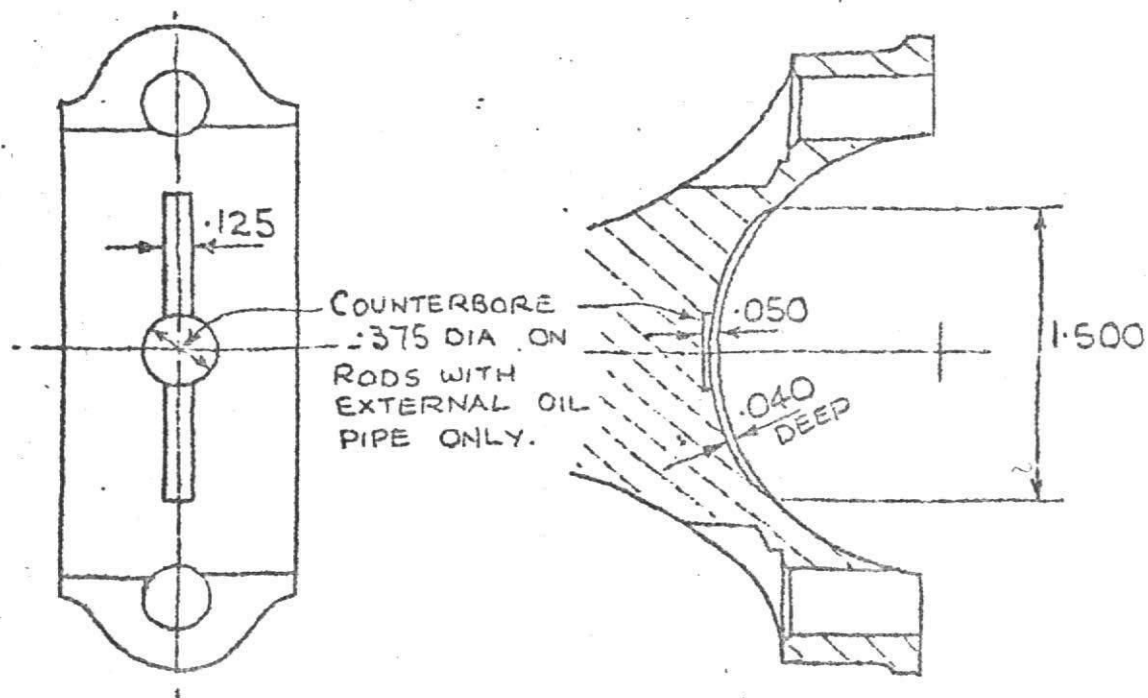
3½ Litre Bentley and 20/25 HP.

Origin of information:-
Hd/SB24/HR.3.12.37.

All replacements of 3½ litre and 20/25 HP. big end bearings are to be in white metal, and not in Hall's Metal as instructed in Depot Sheet No. Hd.333.

It should be noted, however, that the oil groove in the back of the bearing shell is being deleted in order to avoid cracking of the white metal which occurred due to local distortion of the shell in the neighbourhood of the groove. The oil feed to the gudgeon pin is then conveyed by means of a groove which must be machined in the connecting rod in exactly the same manner as is already done with Hall's metal big ends. The existing rods may be modified by machining a groove as shown in the sketch attached. On rods with an external oil pipe, an additional counterboring is necessary to connect the groove with the oil pipe.

The Part Number of the new bearing is EB.3463 replacing E.55613.



MODIFICATION TO CONNECTING ROD

3/2 BENTLEY AND 20/25 H.P.

SA/... Hd. 367

Sg.	Bentley Repair Depot, London.
C.	Mr. Reid. - Glasgow.
Sr. - FBA. Ltd.	Instruction School.
Mln. - Bombay.	Hs.
Mr. Birkett, New Delhi.	BY.
Rv.	Rd.
Mr. de Boeck. - Nice.	RHC.
H.	Mr.
Dr.	LA.
Ex.	Mr. Hancock.
Mr. Evans. - Lillie Hall.	NW.
Mr. Crawford. - Lillie Hall.	D/BP.
Br. - N.	Mr. Robinson. - Holland.
PH. C/o Clyde Auto Co. Ltd.	Repair Department.

7th January 1939.

DEPOT SHEET NO. Hd.400.

EXHAUST MANIFOLD STUDS.
Bentley and 25/30 HP.

Hd/SB20/HR.30.12.38.

Owing to the effects of expansion and contraction of the exhaust manifold, the studs in the end flanges are subjected to bending, frequently resulting in breakage of the studs. As these studs are at present made from an austenitic steel which work hardens when any attempt is made to drill them out, it has been decided to substitute an ordinary nickel steel stud. This, however, has been made longer so as to provide more elasticity, the extra length being compensated for by means of a special nut having the inner portion suitably recessed.

These new studs should be fitted to the two outer facings whenever the cylinder head is removed on Bentley cars, or whenever a stud breaks. In general, the cost of fitting the new studs will be charged to the customer on ordinary decarbonisation jobs.

It is hardly necessary to make a general practice of this on the 25/30 HP. as stud breakages are not very frequent due to the smaller amount of manifold distortion, but the longer studs should, of course, be fitted whenever breakage occurs.

-continued-

Continued:-

The new parts are:-

BENTLEY.

EB.3966.	Stud.	4 off.
EW.1833.	Nut.	4 off.

25/30 HP.

KB.358.	Stud.	4 off.
EW.1833.	Nut.	4 off.

Supplies of these parts are on order, and will be forwarded to Depots when available.

Hd.

Sg.
C.
Sr. - FBA. Ltd.
Mln. - Bombay.
Mr. Birkett, New Delhi.
Rv.
Mr. de Boeck. - Nice.
H.
Tr.
Cx.
Mr. Evans. - Lillie Hall.
Mr. Crawford. - Lillie Hall.
Br. - N.
PH. C/o Clyde Auto Co. Ltd.
Bentley Repair Depot, London.
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Instruction School.

Hs.
BY.
Rq.
REC.
Mx
LA.
Mr. Hancock,
NY.
D/BP.
Mr. Robinson. - Holland.
Repair Department.
Kell w Falkiner Pty. Ltd.
Appl by & Ward.
Perron Duval & Cie, Geneva.
Binelli & Ehrsam, Zurich.
R. P. Collyer, Ltd., Canada.
J. S. Inskip, Inc.
Mr. Ellis, Adelaide.

16th January 1939.

DEPOT SHEET NO. Hd.401.

TAPPET CLEARANCES.
4½ Litre Bentley Chassis.

Origin of Information.
LA7/T.13.1.39.

Please note that the correct tappet clearance for "M" series Bentley engines is .008" for both inlet and exhaust. Some engines have been turned out with the tappets set to .004" inlet and .006" exhaust, and although it is not necessary to take any special action regarding these, they should be re-set to .008" when cars are at Depots.

An alteration is being made in the Instruction Book.

Hd.

Sg.	Hs.
C.	BY.
Sr. FBA. Ltd	Rm.
Mln. - Bombay	RHC.
Mr. Birkett, New Delhi.	Mx.
Rv.	LA.
Mr. de Boeck. - Nice.	Mr. Hancock.
H.	NW.
Tr.	D/BP.
Cx.	Mr. Robinson. - Holland
Mr. Evans. - Lillie Hall.	Repair Department.
Mr. Crawford. - Lillie Hall	Kellow Falkiner Pty. Ltd
Br. - N.	Appleby & Ward.
PH. C/o Clyde Auto Co.Ltd.	Perrot Duval & Cie, Geneva.
Bentley Repair Depot, London.	Binelli & Ehrsam, Zurich.
Mr. Reid. - Glasgow.	R.P.Collyer, Ltd., Canada.
Instruction School.	J.S.Inskip, Inc.
	Mr. Ellis, Adelaide.

16th February 1939

Leck AMENDMENT TO
DEPOT SHEET NO. Hd.401

TAPPET CLEARANCES.
4 1/2 Litre Bentley Chassis

Further to the above Depot Sheet, it has been found that a tappet clearance of .010" is perfectly satisfactory, both as regards noise and slow running. This clearance is therefore being standardised for "MR" Series Bentley.

BY

Derby Bentley Society – technical paper compilation

E

Engine

RREC, RROC & Misc Articles

CHASSIS LUBRICATION

A loose nut at any of the unions will clearly result, on depression of the pedal, in most of the oil escaping there, and practically none going (via the restricted drip plugs) to the points required. In use, on the road, such a fault would not be obvious. It was only by depressing the pedal with the car standing in the garage that I discovered at last why the front swivel-pins were not getting oil satisfactorily. A small pool under a rear shock-absorber led me to the loose union at that point. Half a turn of the nut, and the oil immediately began to exude, top and bottom, from the swivel-pins.

A.F. Deveson

ENGINE VIBRATION

A member reports that engine vibration on his 20-25 was caused by lack of lubrication to the front engine mounting. The lubricator, which takes the R-R oil gun, is hidden away beneath the radiator and is all too easily neglected by the owner who believes the one shot lubrication system looks after everything.

A further item very frequently neglected by owners is the large number of points on the brake and servo linkages requiring attention from the oil can by hand. These are usually utterly dry and well worn where the rest of the chassis is lubricated by the one shot system, whereas on hand lubricated chassis the wear is more evenly distributed throughout.

STEERING BOX PROBLEMS

The pre-war R-R chassis up to, but not including 25/30 and P III, used a worm and nut steering box of R-R manufacture. These boxes usually perform very well, and show very little wear, apparently being designed to last several centuries before achieving ten-year-test standards of backlash. However, sometimes the oil bath type of box fitted to the late 20 HP, 20/25 and P II, and also 3½ Bentley, gives rise to trouble.

The first snag is a tendency to leak oil. Generally the leaks appear round the flange at the front of the box through which the control tubes pass. The flange may be removed by sliding the control levers off their tubes, slackening the nut on the outer tube, removing the flange retaining nuts and the tab washer under the inboard one, and giving the outer tube nut a smart bang towards the steering wheel by means of a soft drift. This last operation frees the outer tube from its taper in the flange, and enables the flange to be drawn off. You can then try to make an oil tight joint between the flange and the box (not easy). The Hythe Road treatment with persistent oil leakers is to fill them with a 50-50 mixture of hub grease and the recommended oil. Warm the mixture and pour it in.

THE REPAIR OF CAST IRON CYLINDER HEADS AND BLOCKS

With the exception of the late Phantom I and Phantom II, all pre-war straight six Rolls-Royce and Bentley engines have cast iron cylinder heads and blocks. And there begins my story - they crack. Not always, it is true, but sometimes. It might even be correct to say 'sometime'. Cast iron, whilst an admirable material in many ways, suffers from the disadvantage of being both brittle, and considerably weaker in tension than in compression. The cylinder heads of our cars, and, to a lesser extent, the blocks, are constructed to a very complex design. The problem of accommodating a large number of holding-down studs, together with passages for pushrods in a relatively small casting, can only be solved by resorting to thin sections and the use of copper tubes to leave enough room for the vital cooling water to circulate.

It is not surprising, therefore, that the depredations of age in the form of corrosion and accumulated silt create circumstances in which these delicate components suffer a sudden and often traumatic loss of integrity. Differential expansion due to uneven cooling, and frost damage are the most usual causes of cracking.

I will resist the temptation to moralise on the wisdom of prophylaxis and concentrate instead on therapeutic measures. The important thing is - once one is landed with a problem of this nature - what is to be done about it? To this question there can only be one answer - NOTHING - until expert advice has been sought or the repair entrusted to someone who is known to be capable of executing it with a good chance of success. There is no place here for the pioneering spirit. These components are far too scarce and valuable to be entrusted to the local welder, no matter how highly he speaks of himself. I know of literally dozens of cases where heads have been ruined beyond redemption by unskilled attention of this sort.

Once the cause has been identified and dealt with, there is a very good case for using passive methods of repair for small external cracks. Modern High Polymer thermosetting plastics such as Araldite will effect a lasting repair and are unlikely to aggravate the situation.

In all other cases something must, of course, be done. A satisfactory permanent repair can usually only be achieved by (i) Welding, or (ii) Metal Stitching. These I will deal with in turn:

WELDING of cast iron components should only be attempted by firms having expert knowledge and the right equipment. One is tempted to add a third requisite - blind faith. The first two are only to be found in companies of the highest repute, such as Angel and Williams. The third, unfortunately seems to be endemic amongst owners, and it is often betrayed.

The most successful welded repairs are achieved by heating the component in a furnace until its temperature approaches

the fusion temperature of cast iron. The crack is then repaired by welding, preferably using gas and a cast foundry stick. Good fusion with the parent metal is thus assured. Now comes the tricky part - the casting must be allowed to cool down very slowly so that the stresses induced by the previous part of the process are dissipated. If this is not done with care, further cracking will undoubtedly occur, and sometimes all the care in the world will not prevent another catastrophe.

Assuming all goes well, some distortion is likely and the bolting faces and rocker shaft pedestals will have to be checked for truth and if necessary corrected by machining. Also the weld itself will need dressing to remove excess metal. Secondary faults sometimes occur, the commonest being leakage at the core plugs due to faulty aluminium sealing washers, and leakage around the tubes which pass through the casting. In the case of the first, the remedy is obvious, whilst the second is more difficult to cure. Originally, the tubes, which are of thin copper, were swaged internally at their ends to achieve a watertight fit. A repetition of this process in unskilled hands is dangerous, but do not despair. The old tube can be removed by gentle persuasion or machining, and the hole cleaned up if necessary by reaming. The replacement tube should have been dull nickel plated, and it can then be secured permanently in place with Loctite (Bearing Fit Grade). Incidentally, dull nickel plating is not simply ordinary nickel left unpolished, but a different process altogether, and a most attractive satin finish on auxiliary components, piping, etc.

If all the core plugs have to be removed the job will be made a lot easier if the aluminium washers are first dissolved away. These will be susceptible to the action of acid as described in the article on descaling, or alternatively the component can be taken to the local plating works, who will immerse it in 'skalene'. This will achieve the twin objectives of removing unwanted internal scale and dissolving the aluminium washers. Care must be taken to protect machined surfaces by coating them with wax or thick grease.

METAL STITCHING differs from the foregoing principally by virtue of its being a cold process. The main objections to welding are thus eliminated 'at a stroke', as somebody once said! There are, however, difficulties which arise due to accessibility, and these will become apparent once the process is understood.

The edges of the crack are first of all drawn together, if necessary, by means of cramps. If any pieces of casting are missing the gaps are machined out and new cast sections shaped to fit the holes. When all is ready, a small hole is drilled and tapped at one end of the crack, and a length of screwed rod inserted. This is cut off flush with the surface and another hole drilled to overlap the first. The process is repeated until the whole length of the crack is filled. Next, at intervals of about one or two inches along the line of repair, and at right angles to it, shaped slots

are machined into which specially formed keys are driven. These have the effect of drawing the edges of the crack together and restoring the tensile strength which has been lost. The materials used for this type of repair are fully compatible with the parent metal and have virtually the same coefficient of expansion. Finally the repaired area is carefully peened to ensure absolute tightness and to work-harden the inserted material, before being ground off flush with the surrounding surfaces. The end effect is not unlike a well-healed surgical scar.

It is most unusual for metal-stitched repairs to give any further trouble and it is in fact claimed that the repair will be stronger than it was originally.

This I can vouch for since I have tested repaired sections under laboratory conditions. None of the specimens failed in the repaired zone and in all cases the ultimate failure stress was at least equal to that of an integral casting of equivalent size.

As previously mentioned, the limitations of this process are those of accessibility, but it is perfectly feasible to repair the inside of cylinder bores, combustion chambers and across valve seats. External cracks are, of course, child's play by comparison, and exhaust manifolds and carburettor hot-spots can also be reclaimed. In the case of an otherwise irreplaceable component, major 'surgery' can be performed by cutting away sections of a casting to get at internal damage and then to stitch back the portions removed. The cost of this could only be justified in extreme cases.

As far as cost is concerned, a metal-stitched repair is normally about a quarter of the price of a welded one, although there is of course no hard and fast rule.

There are two other points to be borne in mind when deciding on the method of repair. Firstly, distortion and subsequent machining is almost inevitable after welding, whereas with metal stitching distortion is most unlikely. Secondly, once a casting has been welded it is difficult to repair subsequent damage by stitching. This is because the welded area usually has 'hard spots' in it, which make drilling and tapping difficult or impossible. In the unlikely event of a metal-stitched repair proving unsatisfactory, the component could, of course, be welded.

M.G.

ENGINE RECLAMATION BY SPECIALISTS

I recently paid a visit to the works of Angel and Williams (Peckham) Ltd., tel: 01-701-2262, who have specialised in the repair and reclamation of cylinder blocks and heads, sumps, crankcases, sump castings, gearboxes, axles, and camshafts of commercial vehicles for 50 years. They repair and save around 150 engine components each week by the fusion welding process, plus machining. Some of these parts were so badly damaged that a repair seemed impossible, and yet I saw blocks

and heads that had been reclaimed from that condition.

On receipt of a cylinder block or head, it is inspected and water pressure tested, to locate defects and cracks. When required by the customer, a report and cost of repair is then given to him, and on his instructions work proceeds. All cracks are cut back to the full thickness of the metal, so that the subsequent fusing will join up 100%. If parts of the component are missing, special cast pieces are made to replace them.

The component is then placed in a muffle furnace, and brought up to a uniform heat, which takes several hours and so prevents any distortion. The muffle furnace is so made that the fusion welding can take place while the component is in the muffle. A very important operation is that the welded metal is well 'puddled' in order to achieve a fine grain. The casting is then reheated and stress-relieved by a slow cooling. Finally it is machined and ground to its original dimensions as shown on the maker's drawings. Cylinder heads and blocks are finally tested to 40lbs PSI as the last operation to ensure soundness. Worn journals, and cams or camshafts, thrust faces on crankshafts are built up by electro-chemical deposit of nickel or chrome and machined to original size within 0.0003 inch.

RAY E. WILLIAMS

RECLAMATION OF CORRODED CASTINGS

I don't have to remind Phantom II and Phantom III owners of the problems caused by corroding aluminium alloy castings. Much repair work can be done by welding, using either Argon arc or gas, but when corrosion uncovers porosity in the walls of a cylinder head or block, it may be very difficult to effect a welding repair. Porosity of castings is a natural hazard, usually overcome during the design stage by making the casting wall thickness great enough to ensure that porosity is unlikely to extend right through the wall. The effects of corrosion can, however, uncover porosity before the casting is so weak as to demand being scrapped.

Casting porosity can now be cured in many cases by vacuum and pressure impregnation with polyester resin. Briefly, the process is this. The defective casting is first thoroughly cleaned, to ensure a continuous bond between the resin and the metal. The part is then washed, rinsed and hot air dried. The casting is next transferred to a pressure vessel and sealed off from the atmosphere. The vessel is now pumped down to a high vacuum, when any air present in the casting pores is removed. Resin is next introduced into the vessel in such a way that the vacuum remains unbroken and then the air pressure is applied to force the resin into the pores. Surplus resin is then drained off, excess resin is washed off before it hardens, and the resin is cured under heat to solidify in the pores.

The resin impregnation technique only works on porosity or very small holes. Enlarged water holes in the joint face of

TORQUE FIGURES

Prior to the V.8 engine, Rolls-Royce Manuals omitted reference to torque figures. Guidance on tightening main, big end, and cylinder head nuts was confined to the statement that: 'A six inch (15cm) tommy bar placed centrally in a box spanner should be used in the hands of an experienced fitter'. Sole exceptions applying to all pre-war models can be seen in TSD 2066 - Service Instructions for Rolls-Royce Cars, section E6, page 6. Quote:

Big Ends	225lbs/ins + 50	2.51 Kg.m + 0.58
Mains	300lbs/ins + 50	3.61 Kg.m + 0.58

From recent experience with a 25/30 engine using 'Plastigage' 25lb/ft gave correct running clearance of main and big ends. 25lb/ft was also found suitable for cylinder head.

The Table below is offered for guidance. Torque values may be found slightly lower than other tables. Experience on both pre and post-war models, working on parts reasonably assumed to have remained untouched since installed by a Rolls-Royce fitter, has shown nuts and bolts to be no more than comfortably tight, and to undo without undue effort. Similarly, one can feel from hard-to-remove parts the later work of a ham-fisted, non RR mechanic.

Inches	Nearest (larger) metric size	lbf.ft	Kg.m
1/4	6.4	8 to 10	.97 to 1.39
5/16	8.0	10 18	2.21 2.49
3/8	9.6	29 32	4.01 4.42
7/16	11.5	42 45	5.80 6.22
1/2	13.0	60 65	8.30 9.00

The figures above give full nut torque, for half nuts use approximately three-quarters (0.75) these figures. Tighten long bolts and studs with discretion, they may stretch.

1933 ROLLS CYLINDER BLOCK SAVED BY METALOCK

Many veteran and vintage cars have had their lives saved by Metalock surgery — one of the most recent operations saved the cylinder block of Dermot Bambridge's Rolls-Royce. Returning from a filming location for BBC TV his car began drinking water, which resulted in a cracked cylinder head!

The only remedy seemed to be a new head, if you could get one for a 1933 20/25. However, after a little research, Dermot came up with Metalock, experts in the cold repair to cast iron, he was told. He contacted the company and they confirmed that a repair was possible and would cost around £200 and take a week. At the Metalock workshops in Erith, crack testing equipment showed three large external cracks and four cracked valve seats, one of which went into the waterways. Three days later he was told his head was ready to be picked up, and the price was £161. This included a pressure test and a guarantee that the repair was sound and leak-proof. Metalock claim to have repaired thousands of cylinder blocks and heads, from massive ships' main engines to modern diesel commercial trucks and buses. Many veteran cars are still on the road, thanks to a timely repair by Metalock. It's good to know that Metalock repairs are approved by Lloyd's, and their experience in shipping repairs puts one's mind at rest regarding reliability.

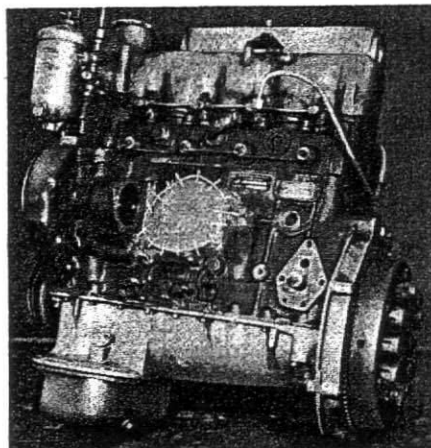
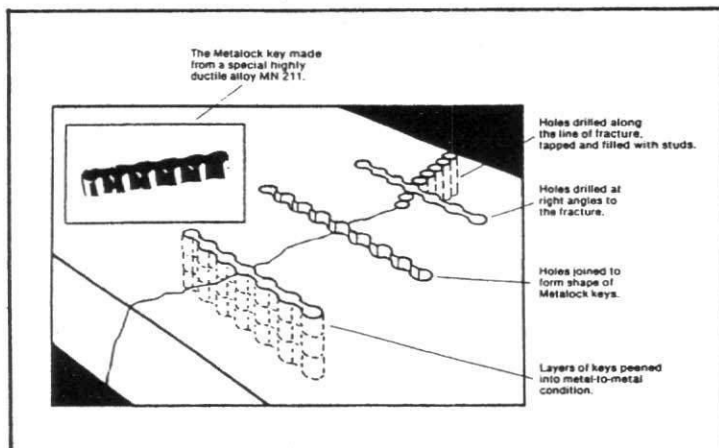
The Metalock repair consists of peening into prepared apertures layers of multi-dumbbell shaped keys. These keys are manufactured from a special highly ductile alloy (MN 211), specifically developed by Metalock's own engineers and unobtainable outside the Metalock organisation.

A series of holes are drilled to predetermined depths at intervals, and at right angles to the fracture. The holes are then joined by the use of pneumatic chisels to take the exact female form of the Metalock keys. Metalock keys size matched to the holes are inserted layer by layer and peened into a metal-to-metal condition into the apertures.

The high tensile strength of the keys ensures the return of a large percentage, if not 100%, of the original lost strength. Holes are then drilled along the line of fracture, tapped and filled with studs. This operation restores rigidity to the casting and ensures a pressure-tight joint essential for vessels subject to high steam or hydraulic pressures.

Hand grinders are used to finish off the repair prior to painting, and every repair is covered by the Metalock guarantee. If you wish to contact this firm, their address is Metalock (Britain) Limited, Metalock House, Crabtree Manor Way, Belvedere, Kent DA17 6AB. Telephone Erith 49121.

These two photographs clearly show the Metalock stitching prior to finishing when, after a lick of paint, the repair is invisible.



REPAIRING VINTAGE ENGINES

The repair of engines and their various parts is a complicated business, and so often we are told that nothing can be done. 'Don't accept it,' advises the writer, 'there is usually a good answer and if you cannot find it, I shall always be pleased to give advice.'

by L. T. DUFF, F.Weld I.

WHAT CAN BE DONE

There is almost no limit to the repair and reclamation of damaged engine parts. Cast iron and aluminium alloy blocks, crankcases and cylinder heads, with smashed sides and pieces missing, cracked and worn valve seats, broken bores, stripped stud holes etc. can all be brought back to more or less new condition. In some cases, the repair can be stronger than before. For instance, strengthening ribs, or reinforcing can be added wherever experienced indicates that repeat damage is likely to occur because of inadequate initial design. Worn journals on camshafts, rear axle casings, hubs, gearboxes etc. can all be saved by modern methods of repair. This applies to almost any part that is broken, cracked or worn, and in all metals.

HOW IT'S DONE

Some of the methods of repair available are: fusion welding, argon, CO₂, stitching, arc welding, brazing, silver soldering, electro-chemical deposit, shield-arc, metal-spraying, power welding, to mention just a few of the methods used. Used unfortunately with very sad results, for no one method is the answer to all problems. A method which is perfectly satisfactory on one job has fatal results when wrongly applied. A typical example is arc welding, wrongly applied on cast iron. The result is similar to applying a blowlamp to a pane of glass — it cracks around the area. When these new cracks are arc welded, further cracks develop, until we have a large, ugly and defective area, completely useless. Metal stitching is a method which consists of drilling a series of holes along a crack, tapping and screwing, or driving in metal plugs. This can often be done in situ, or without dismantling the part. The plugs can be dressed off, to give a neat appearance, but it has its drawbacks. All engines vibrate under stress. Parts of an engine are of course normally under stress, such as from bolts, or studs. Consequently, the stitches may begin to loosen, and the part breaks away again. If stitching is used on a water jacket, the stitches can penetrate through the block and impede the water circulation. A fusion weld would be more satisfactory here, but not if the part was a worn crankshaft, in which case shield-arc is the best method. But if we were considering the build up of a journal on certain shafts that have been heat treated, then we should have to resort to electro-chemical-deposit, of a nickel or chrome, done cold, to avoid a weld and consequent heat damage.

WHAT OWNERS SHOULD LOOK FOR

When the owner is faced with a repair he should look for a firm that has had long experience, has a well equipped machine shop and is able to use and apply all the various methods available nowadays. The local garage who has 'good old Jack, been welding for 20 years' is hardly the man for this work. Neither is the busy welding firm over the way, making and arc welding containers and various sheet metal parts. However willing and helpful they may be, their experience is not what you want.

I am sometimes asked what is feasible in repair, and the answer is, almost anything. Cast iron can be welded 100%. The metal can be joined when broken or cracked. More metal can be added, or built up. The weld metal can be of a fine grain, and free of blow holes, and as strong and often stronger than the original, which in casting often has inclusions of moulding sand and defects, causing weaknesses. Let us take an imaginary cylinder block, or head, and the damage that can occur. We will talk generally, because makes of engines vary considerably in shape and size, and each repair has to be tailored to the particular job.

Mr Duff is managing director of Angell & Williams, welding specialists, of Peckham, south-east London.

WATER JACKET DAMAGED BY FROST

What one can see in this type of damage is like an iceberg: you only see the tip. Often, the main damage can be hidden, because the jacket is pushed outwards, showing fracture or breakage on the outside; but there may also be hidden cracks on the inside. Experience tells you where. Consequently, a much larger area than seems is affected, and the only way to make a satisfactory repair is to cut the whole defective area out and weld in a new sound section: If this area is shielded by another part of the block, this shield can be first removed by cutting away to get at the inner part, and when this has been made sound, the outer shield replaced by similar welding.

CRACKED BORE

A cracked or damaged bore is sometimes repaired by boring out, and fitting a tight sleeve. Boring out to take the sleeve makes the wall of the bore thin — sometimes almost paper thickness. According to the position of the crack, it will extend, and cause a water leak from behind the sleeve. To weld the bore also raises a problem. As the weld progresses in a horizontal position, the molten metal sags, and even if more metal is added, a low place will result, in a bore which has to be perfect. The answer here is to cut away the outside of the jacket and weld the bore from the inside of the block so that the metal sinks into the bore and allows a good bore to be finished.

CRACKED AND WORN VALVE SEATS

These are often repaired by fitting inserted valve seats. The seat is cut out, forming a recess, and the insert pressed in, under an interference fit. If the seat has been cracked it is very doubtful if the whole of the crack will be cut out by the recess, as cracks always extend further than the eye can see. Consequently, the insert is being pressed into a ring of iron which is fractured, and this ring will open and let the insert loose, with resulting damage. Inserted valve seats, often hardened for longer life, are frequently used in various modern engines. But the casting around the seats has been designed and thickened to take them. To fit inserted valve seats haphazardly into all engines, especially the older ones, can lead to trouble. If the surrounding metal is insufficient, the sharp corner of the insert recess can pierce the jacket, giving a water leak. Fusion welding is the most satisfactory answer, in which the metal can be fused, and puddled, to give a fine grain and long wearing seat, the same as originally. In fact, when done properly, the welded seat is of better quality, for when the block was cast all the metal, whether in the jacket or seat, is the same, and on the seat we can do with better quality for wear.

Fusion welding perfectly carried out is the only real answer to the welding of cast iron and aluminium engine parts. Unfortunately, there are very few welders with this experience. Almost all manual welding today is arc welding. Even our schools and training centres mainly teach arc welding because, of course, a man wants to learn a skill that is widely wanted. Consequently, these are the welders that the veteran/vintage owner finds when looking for a welder, and the resulting botched job is inevitable.

Of course fusion welding brings problems. The part to be welded has to be preheated, and the enquiring person asks: 'What about distortion?' Well, of course this problem has to be settled. A cylinder block perfectly welded would be useless if it would not fit. Preheating of castings in preparation for welding, and stress relieving after welding, is a complicated business. Where to put the heat, the type of oven required, the use of expanding jigs to maintain alignment etc. is a life study. Sufficient to say that distortion problems can be avoided and overcome, and the part perfectly aligned. Stress relieving will remove strain and make the casting less likely to crack. In fact, when having a repair, the possibility of improvement should always be considered. I saw a block recently that had obviously been overheated. A large part of the jacket was cut away and, inside, the jacket was blocked solid with deposit. This was chipped and cleaned away to allow full water circulation again. The jacket was replaced by welding in.

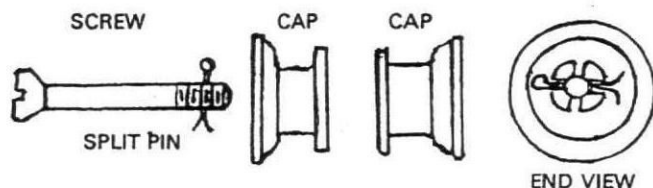
The successful saving and repair of engine parts is usually the combined effort of several craftsmen. An example of how men combine their crafts and meet the problems encountered in the repair of these historic engines is well illustrated in a repair my company carried out on an Alfa-Romeo cylinder block. The block, which was of cast iron, was cracked in the dome of a fixed head cylinder and the cracks extended into the two valve seats. It was carefully placed and supported in a gas muffle and the temperature raised slowly. At the correct temperature, fusion welding commenced,

welding through the full thickness of the metal where cracked, and more metal was added to the valve seats to build them up. Excess metal now had to be rough machined away, to test the welds. A toolmaker now took over, to make necessary form tools and bushes to fit in the bore, and these were taken over by an experienced vertical borer. Machining the valve seats, a blind, and angled, operation was overcome by first making a right handed valve seat cutter, with a left handed internal thread. Testing was the next operation, and on water pressure testing it was found to be leaking behind a liner in the bore. At some earlier time the liner had been pinned and therefore could not be withdrawn. The block was therefore set up on the boring machine and the liner bored out. On examining the bore, the cause of the leak was an old botched repair. This meant more fusion welding and machining. Another test showed leaks from the valve pockets, again from an old repair. These were cut out, and again more fusion welding and further testing. Finally, two defective spark plug holes were filled in with new metal, bored, and rescrewed. The finished job passed a water pressure test of 30 lb per square inch. This is only a rough outline of the work done, but it was a combined effort of eight men, each a specialist in his particular work, that saved this historic car.

REMOVAL OF SLUDGE TRAPS FROM EARLY 20/25 CRANKS

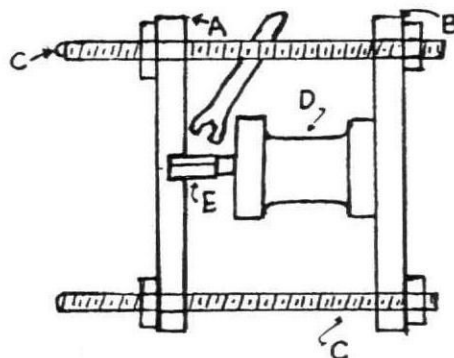
Instead of the usual bolt and nut, the early cars had a bolt passing through one end cap and screwing directly into the other. These bolts had a screw head which, after many years, is difficult to unscrew. Below is a simple tool for the removal of these screws, after which the end caps can be prodded out.

P. JACKSON



SIDE VIEW OF CUPS IN CRANKSHAFT THROW

Milled boss in this end cap to take split pin. This is a solid piece — not, as appears, a castle nut.



- A, B Steel strip in 1in x ½in about 4in long. Bar A is drilled partly through to accept screwdriver bit from impact driver (or grind one up from a length of large allen key).
- C ¾in steel studding and nuts.
- D Crank throw.
- E Screwdriver bit.

This assembly is strapped over each crankshaft throw in turn and after removing the end split pin the screw can be started by using a small spanner on the impact driver bit.

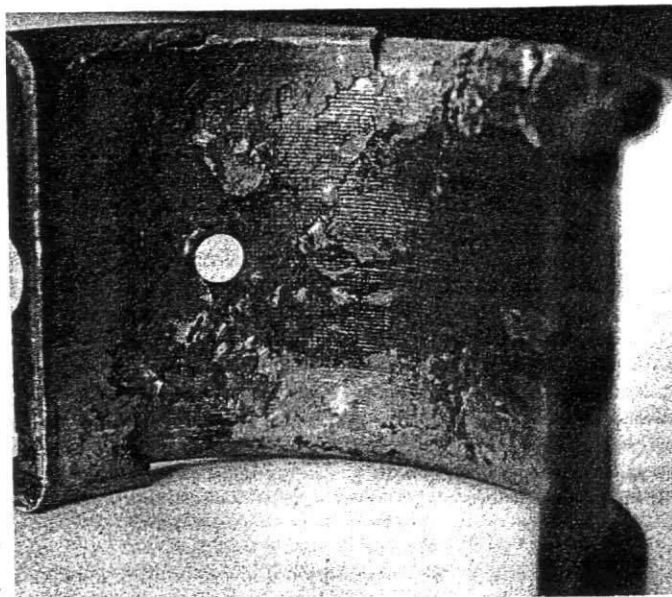
Crankshaft Bearings pre-war cars

by Graham Ashley-Carter

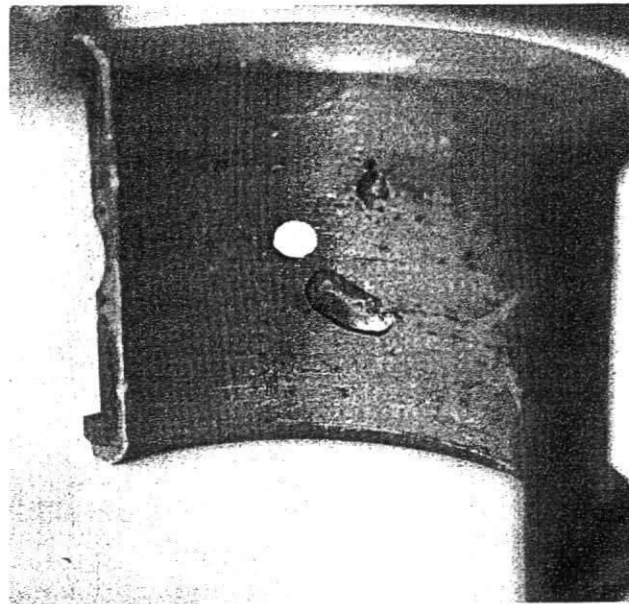
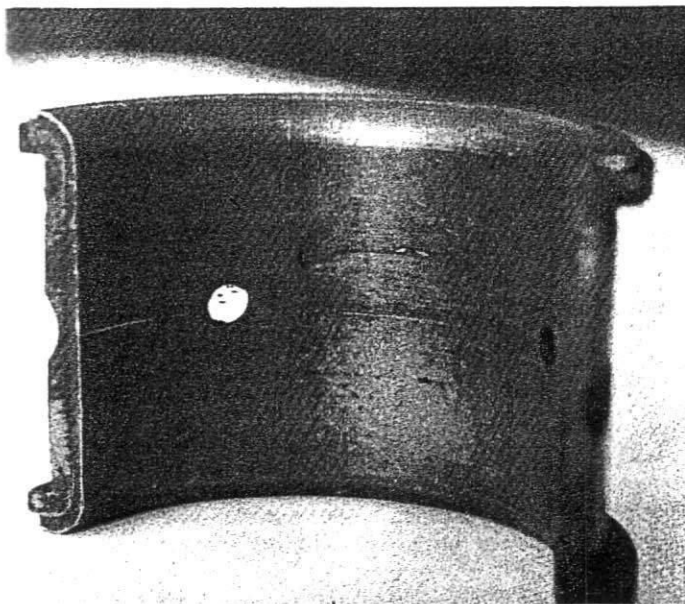
Under the usual conditions in which cars are used in the UK, bearing problems do not normally occur on the road, and it is true to say that these are normally discovered while dismantling for other faults necessitating removal of pistons.

Inspection of big end bearings on these occasions often reveals areas of loose bearing material, mainly in the top half, which either remains on the crankshaft or can be easily detached from the shell. Dimensional clearances are unlikely to be beyond limits but it is normal to find that the bearing has lost its nip. It is not clear why this condition of loss of nip develops, i.e. whether the housing stretches or the bearing itself crushes, but it is known that repairers without access to the necessary tools and service information tend to fit new bearings by filing with the bearing in its housing until the faces are level.

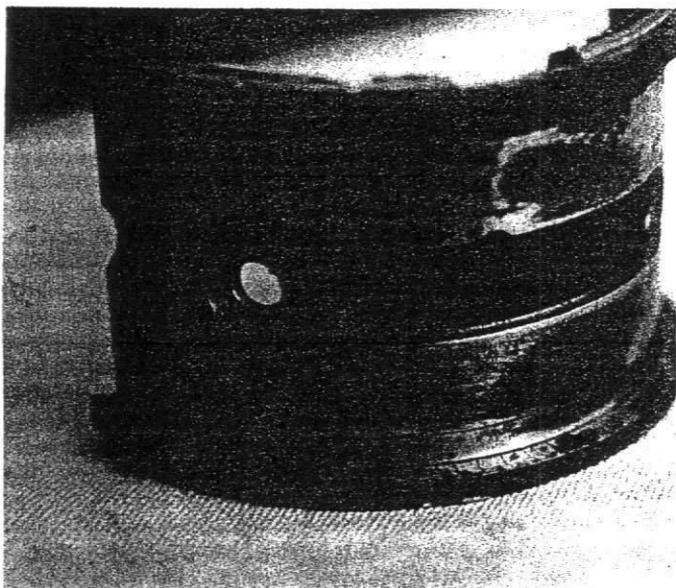
This malpractice is unlikely to result in any immediately noticeable fault and has the apparent advantage of considerably reduced repair costs due to much reduced labour times. In service, however, the



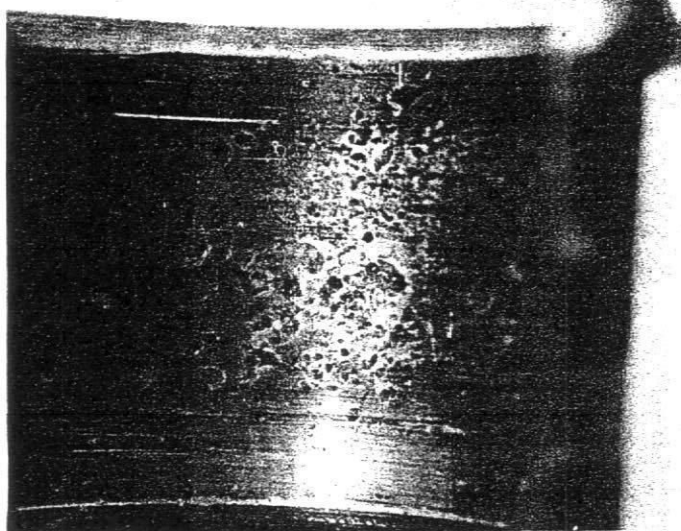
'Run' bearing, overheated due to oil starvation. Note how the lining has melted on the top half and material has been deposited on the surface of the bottom half.



Above left: A big end bearing, top half, early 20/25, showing crack forming in the white metal lining where the oil groove is machined on the back of the shell. Above right: A big end bearing, top half, showing a typical cavity where the lining has broken away.



This bearing shows bad fretting marks on its back, which probably contributed to failure.



Both these bearings were dimensionally within limits and would continue to give service for a while, but could not sensibly be refitted.

bearing shell undergoes minute movements within its housing (known as fretting) and becomes progressively looser, resulting in loss of oil pressure and premature detachment of white metal due to flexing

and inconsistent heat transfer. The damaged housings then make subsequent bearing fitting much more difficult. In assembling a bearing and setting the nip it is important to understand that rigidity is the aim, and correct nip provides a prestressed assembly stronger and more rigid than the sum of its parts in which the bearing shell adds to the structure rather than being supported by it. From this it will also be seen how important it is for the butt faces of both shells and caps to match perfectly, which should be done with marking blue and a surface plate.

In the case of certain 20/25 engines the big end top half shell has an oil groove machined on its back to carry oil to the small end feed hole in the connecting rod. This is an acknowledged point of failure for the white metal lining which will be seen to have cracks and 'shadows' reflecting the position and shape of this groove. To enable reliable future service the modification described in RR/E1, in which this groove is transferred from the shell to the rod, must be carried out.

A few general words on bearing design and fitting may be helpful to owners interested in the subject or considering an overhaul. First, the thickwall type bearing is the most suitable for this application due to its ability to cope with flexing and dirt in the absence of an oil filter. The thickness of the white metal lining is not critical but if excessive the metal will creep and fail due to lack of support, i.e. do not be tempted to avoid the cost of fitting shells by running white metal direct on to the rods. A satisfactory thickness quoted is 0.025in, but this will be exceeded as the crankshaft is ground (maximum 0.04in). An undersize bearing was at one time available to accommodate heavily reground crankshafts and owners faced with having to manufacture new bearings would do well to take into account the finished crankshaft size in arriving at a suitable white metal thickness to cope with maximum loads.

Loading. The most adverse conditions are caused by high rpm rather than high mep and low axle ratios coupled with motorway operation provide little comfort for the bearings. Long strokes and high piston speeds can produce momentary loadings in excess of those exerted on the power stroke at full throttle.

Bearing material. The rule here is to use the softest material capable of withstanding the load, consistent with good adhesion to the backing. This provides maximum conformability to misalignment (which occurs) together with minimum damage to the more expensive component (the crankshaft) in the event of temporary lubrication failure. Hoyts No. 11 seems to fulfil these requirements best and further advice can be obtained from them. Steel provides the best backing material, both from the requirements of

rigidity and adhesion. Silver Ghost owners would therefore benefit in terms of cost and serviceability by having any new bearings made in steel backed form. **Halls metal.** This is an aluminium alloy developed by RR and is used in solid form, i.e. not bonded to any backing. Due to its high thermal expansion, larger clearances are needed or seizure will occur when hot, and it can only be used satisfactorily with a nitrided shaft. Its advantages are high resistance to temperature and fatigue, but with lubrication, wear and fitting problems its main disadvantages.

To avoid loss of nip in service, resulting in low oil pressure and noisy operation, extreme care is required in matching shells to their housings and observing closely the *precursing procedures* and increased bearing nips and clearances. Should these bearings be overheated in service due to temporary lubrication failure it is almost certain that on cooling off they will have lost their nip and deterioration will commence.

Lubrication. The original recommended oils are, of course, no longer available, but in general the thinnest oil applicable should be used. This provides the best bearing coolant due to its better flow and minimises losses due to churning, which in itself generates heat. Viscosity provides the necessary resistance to rupture of the oil film under maximum load. Bearing clearances for white metal are set at 0.002in-0.0025in,

and it is essential that these are observed closely in the interests of adequate oil flow through the bearing and correct film thickness. Bearings correctly machined to these figures will be perfectly free and it is a dangerous fallacy to think that a tight bearing will somehow become 'perfect' with running — they don't — and immediate damage is caused.

As oils deteriorate with use, acids and grit are formed. Theoretically, as long as the grit particles cannot bridge the oil film — 0.001in — damage should occur to the journals, but in the absence of an oil filter or the impracticability of measuring the particles in circulation it would be best to observe the original change intervals or drain and filter the oil every 2500 miles. For many cars, I suspect this will coincide with an annual oil change.

Acid attack is unlikely with modern oils, but was common enough when oils were less developed and cars were grossly neglected. The main features of an attack are blackening of journals and other machined surfaces, in particular hardened parts, plus an extremely hard skin formed on white metal wearing surfaces. Long periods of standing undoubtedly result in the worst damage if cars are not laid up correctly.

The ideal aim is to get everything right first time and ensure an adequate supply of clean oil in all future running, thus avoiding embarrassing failures and expenses.

Crankshaft Bearings and Lubrication

by Dr W. G. T.-W. Fiennes, M.A., Ph.D., M.Inst.P.

THE article in B138 by Graham Ashley-Carter has prompted me to add some further thoughts on the general subject of crankshaft bearings and lubrication.

Without exception, every engine fitted with Halls Metal bearings which I have stripped have had several bearing shells which have lost their nip and have consequently been moving in their housing. Halls Metal is not dimensionally stable, and will deform gradually but permanently under stress — hence the necessity of the 'pre-crush' operation when fitting them. All the engines which I have seen with Halls Metal bearings have clearly not been stripped down for a considerable time. It is my belief that a major contributory factor to the looseness of the shells is the continued slow deformation of the shells during their life in the engine. After initial assembly it is likely that the crankcase would have been stripped for overhaul after a maximum of ten years, probably

somewhat sooner, when the shells were due to be renewed. In, say, five years the loss of nip in the bearings may not have been too apparent. However, with the low mileages that many cars are now driven each year a considerable time will elapse before a rebuilt engine should be due for further overhaul. If the engine is fitted with Halls Metal bearings I think that there is a good chance that some of the bearings will have worked loose some time before the expected lifespan of the engine; clearly the situation will be aggravated by poor initial fitting of the shells.

The indication of loose bearing shells is a bottom end rattle, somewhat lighter than the knock caused by excessive big end clearance, and is caused by the shell hitting the shims. On stripping the engine the butt faces of the loose shells will be seen to have a uniform matt finish, and any filing or fitting marks will have been lost through fretting. Numbers stamped on the butt faces will be transferred to the shim, and where

the shell is in contact the shim will also have lost its original finish. In extreme cases the shim will be reduced in thickness in this area to less than its nominal 0.001in.

I have been told by Alec Harvey-Bailey that, up to the point when Rolls-Royce changed from using white metal lined shells to Halls Metal, the white metal used had been of their own manufacture. With the advent of the Mark V Bentley the main bearings were changed back to white metal, but using a proprietary bearing material supplied by the Hoyt Metal Company. This was found to be superior to the Rolls-Royce white metal and subsequently all white metal lined shells employed Hoyt's material. White metal technology, both in the composition of the material and the manner in which it is cast, has advanced considerably over the past forty years, largely through the demands of the power generating industry. Consequently, modern white metal lined shells, if properly executed, should be considerably more reliable than those manufactured in the 1940s and 1950s, with the caveat already noted by G. A.-C. on increases in bearing metal thickness to compensate for reductions in crankpin diameter through grinding. I have no hesitation in replacing original Halls Metal with a modern white metal shell.

The enemy of white metal is fatigue, which causes it to develop cracks within the material and to separate from the steel backing, particularly if the steel is not adequately tinned. The fatigue life is reduced rapidly as the metal thickness is increased and also as the temperature rises. If continuous high speed motoring is envisaged, serious consideration should be given to using a silver-loaded white metal, such as Hoyt's Eleven Z3. This is harder than the usual Eleven R, but has a much extended temperature range before fatigue becomes a problem. As Eleven Z3 is a harder material an oil filter should be fitted to the engine if possible, as the ability of the white metal to absorb particles of dirt is reduced. Despite the hardened crankshaft there is a greater risk of crankshaft wear without a filter.

On the subject of lubrication, it is important that the correct grade of oil is used. Unscrupulous car salesmen, when trying to sell a car with a noisy gearbox, may fill the box with an oil somewhat thicker than that specified. As well as temporarily quietening the gears, there is an increasing likelihood of gear wear. The oil film separating the gear teeth will tend to overheat instantaneously, due to its higher resistance to shear, i.e. it will not squeeze out of the gap

between the teeth so readily, giving rise in the end to a thinner oil film and a greater possibility of scuffing of the gear teeth.

In the engine the crankshaft journals will not rotate centrally in the bearings. Under load the journals will be offset and, depending upon the effective viscosity of the oil, the relatively surface speeds of the journal and bearing and the loads involved, the oil film at the thinnest point may be of the order of 0.0002in to 0.0003in, emphasising the need to keep the oil clean and free from dirt particles.

Graham Ashley-Carter is quite correct in saying that acid attack of metal surfaces is less likely with modern oils. However, oil manufacturers generally recommend a maximum period of six months between changes, particularly for the older type of engine, and especially if it is worn. Modern oils, particularly of the multigrade variety, contain numerous additives, some of which are intended to maintain the viscosity at the specified figure. However, the performance of the additives deteriorates under prolonged contact with the acids formed as a by-product of combustion, and the viscosity index of the oil is progressively reduced. It is particularly important, therefore, particularly in an engine which has worn bores and valve guides, that the oil is changed regularly. If the engine is run often for only a short period without being thoroughly warmed up the problem will be exacerbated, there being a greater leakage of combustion gases which contain the acids past the rings and up the guides. If the car is allowed to stand over winter with last autumn's oil in the sump, be sure to change it before taking the car out in the spring. It will almost certainly have deteriorated because of oxidation by the combustion acids during the few months of winter idleness.

SLIPPER DRIVE

A comment from Peter Grainge Jackson

I recently tried to fit a set of friction linings made in Tufnol, and supplied by the Club, to a 20/25 belonging to a Club member. Even after all faces had been reground, which in effect provides more room for the new linings, I found on assembly that the damper springs became coil bound or chocabloc as they say. Measuring the thickness of the new linings I found each to be 0.02in thicker than the old ones made from cotton duck. Has anyone fitted the new linings with success? I would very much like to hear from them.

Corrosion — the metal killer

or how to save your engine from slow motion suicide

Part One — by Richard Lowe

Members who attended the Derby Bentley seminar on 19th-20th July, 1980, may remember that I gave a short talk, largely theoretical, on the corrosion problems likely to be found on the water side of the cooling systems of pre-war RR and Bentley engines. Since that time I have had the opportunity to confirm (unfortunately) that what I indicated theoretically might occur, in practice does on occasions occur.

As this subject affects the almost irreplaceable and largely irreparable components of these engines, it might be helpful to repeat the theoretical aspects briefly before recounting some practical experiences. In the case of the latter it will be assumed that those members interested will have read copies of the following:

1. Supplement to Service Instructions for Derby Bentley Cars — Bentley Drivers' Club, 1969.
2. RR Small Horsepower Engines, R. Haynes and M. A. Grigsby, RREC, 1977.
3. Technical Manual, RREC, 1978.

Theoretical comments

Metals are obtained by the application of energy in the form of heat, chemical change, electricity or a combination of these forms, to metal compounds, and this results in the metals produced having a natural desire to return to a compound or low energy state. The degree of this desire is indicated by what is called the 'electromotive force'. This force can be measured in volts, and varies from one metal to another, and also from one surface condition to another of the same metal.

A connection between two dissimilar metals with water (an electrolyte) present produces a galvanic cell or couple, which has the effect of accelerating the desire to change of the 'base' metal and a reduction of that desire of the 'noble' metal in the galvanic series due to a circulating electric current.

This effect is the basis of a corrosion control system called 'cathodic protection', where the item to be preserved is made the 'cathode' of a galvanic cell. The 'anode' of the cell corrodes and is designed to do so. The table that follows shows that the metals most negative are 'base' and those at the positive end are 'noble', and in this case carbon/graphite reacts as a noble metal.

Magnesium and aluminium will corrode with respect to most other metals, particularly cast iron and graphite. Steel will corrode to cast iron and copper will corrode to graphite. Cast iron is an awkward material, mechanically reasonably strong in compression but very weak in tension. When it corrodes the iron migrates, leaving a surface of graphite which may account for up to approximately 4½% of the original volume. The cast iron can then act as graphite and cause bad corrosion of copper and copper alloys.

The well known (worst) example of pre-war engine corrosion is the Phantom III. It is understood that the wet steel cylinder liners were supplied nickel plated, and they are of course surrounded by, and in very close proximity to, aluminium. One could only make this galvanic cell worse by gold plating the liners. From a corrosion control point of view, the solution would seem to be to dismantle the engine, shot blast the outside of the twelve cylinders, aluminium spray them and then seal that spray.

Inhibition of metal corrosion, while generally satisfactory, is up against it if an intense galvanic cell is built in the first place. Furthermore, inhibition is a surface action effect. If the actual metal surface is buried below a mass of corrosion products and water deposits it is quite unreasonable to expect an inhibitor to be effective as it may never reach the metal surface.

Galvanic corrosion of metals is an electro-chemical process and, like most processes, its activity increases with temperature. The rate of corrosion is dependent on the electric current circulating in the corrosion cell and the anodic metal loss is related to its electro-chemical equivalent.

Finally, to indicate its use in cathodic protection, thousands of tons of aluminium alloy 'anodes' are in use controlling the corrosion of offshore steel oil and gas production platforms.

PRACTICAL GALVANIC SERIES — 'BASE' END

Metal	Volts	Metal	Volts
Commercially pure magnesium	-1.75	Mild steel (rusty)	-0.2 to -0.5
Magnesium alloy		Cast iron (not graphitised)	-0.5
(6% Al., 3% Zn., 0.15% Mn.)	-1.6	Copper, brass and bronze	-0.2
Zinc	-1.1	Nickel	-0.1
Aluminium alloy (5% Zn.)	-1.05	Carbon, graphite	+0.3
Commercially pure aluminium	-0.8	Gold	+1.0
Mild steel (clean and shiny)	-0.5 to -0.8		

Corrosion — the metal killer

or how to save your engine from slow motion suicide

Part Two — by Richard Lowe

CYLINDER BLOCKS

These comments will be confined to two engines which I have descaled, as follows:

Phantom II: These engines, developed from earlier 40/50 ones, have quite generous water cooling passages, and as each block of three cylinders is separately supplied, not too much trouble is experienced. The round inspection doors are of aluminium, and these of course corrode, but if the blocks are coated internally with deposits from hard water the corrosion is not catastrophic. The water pump and pipework to the blocks are also of aluminium and, as the pump is built as a galvanic cell with a bronze impellor, the pump body may suffer some attack. The outer radii of the elbows of the aluminium pipework suffer badly.

These blocks can be descaled quite easily, and I experienced no particular problems. They are fitted with copper tubes to protect the long engine studs and these were in good condition. Thorough cleaning out of the water cooling system is vital if boiling and cracking is to be avoided. 72JS was the only Phantom II which did not boil on the 1973 Alpine Rally, as a result of a thorough cleaning of the cooling system.

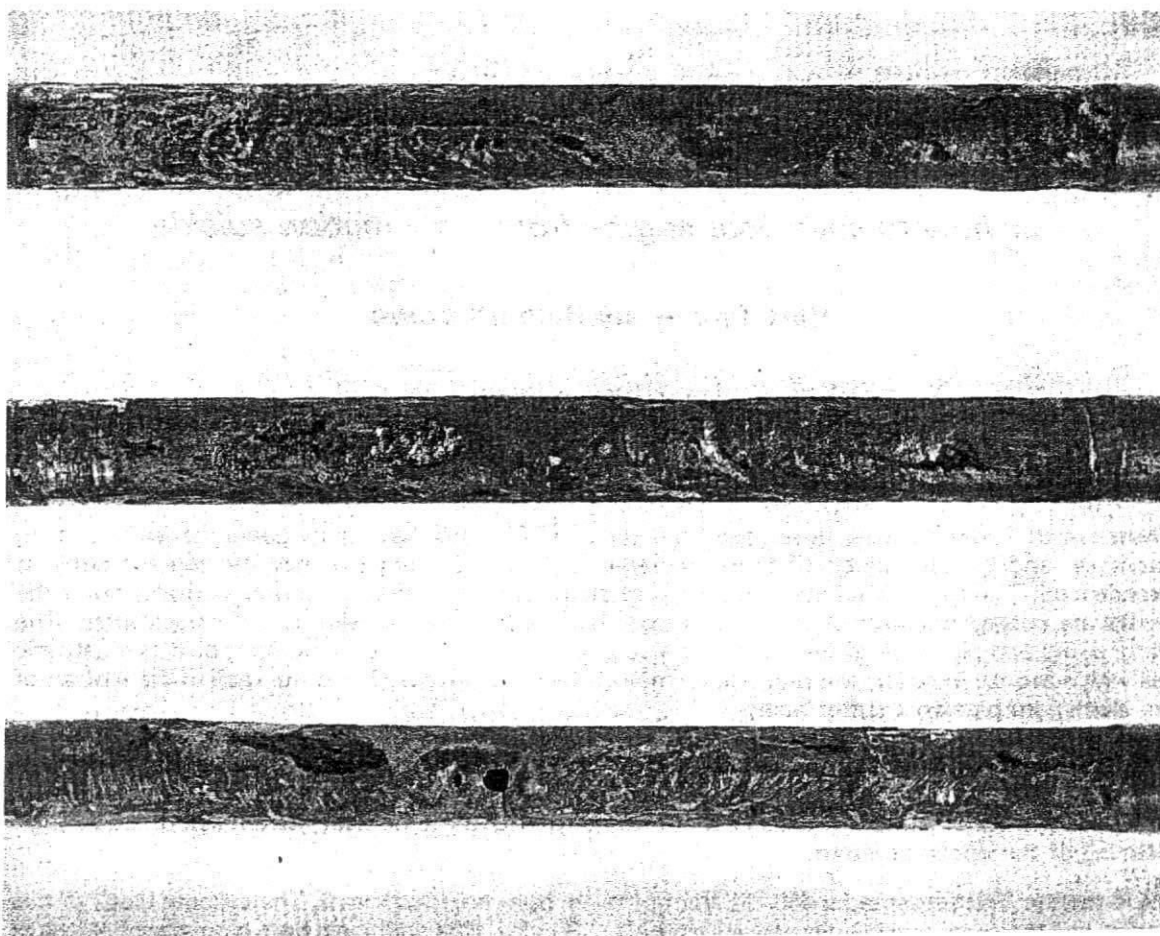
4¼ Bentley: This presented a very different problem from the Phantom II. The cylinder block of this engine has the same outside dimensions as the 3½ Bentley. The additional bore diameter of ¼in is at the expense of the water cooling passages. (This may well apply to the 25/30 RR as well.)

The distance between adjacent bores, ignoring 3 to 4, is about ⅝in. The wall thickness of the bores and the outside of the block seems to be ⅜in. These dimensions would indicate a water passage of ¼in in a perfect casting. However, complicated castings are not necessarily perfect in the location of the core in the original moulding and this in itself could reduce this ¼in to ⅜in very easily. Consequently, there only needs to be a build up of ⅜in of corrosion product on each surface to block that water way. As the corrosion product with carbonates (etc.) from the water can be at least ten times the thickness of the metal lost, a corrosion loss of only ten thou. could conceivably cause a passageway to become blocked.

The problem is not of the block corroding away but of the cooling system becoming so restricted and uneven that the block distorts and cracks due to the inherent tensile weakness of cast iron.

The water passages are, in addition, restricted by 26 copper tubes of $\frac{1}{8}$ in diameter, which protect the engine studs from the cooling water. These tubes are virtually in contact with the outside of the bores and of course constitute a galvanic cell, firstly with the cast iron corroding with respect to the copper. Later, the corroded surface of the cast iron exposes graphite, which reverses this first cell action and causes corrosion of the copper tubes. Now follows what was found and how the block was restored.

On removing the six inspection covers one could hardly see the outside of the bores, apart from No. 2 opposite the pump inlet. After as much as possible of the corrosion product had been dug out, acid descaling was commenced.



Copper tubes from 4 1/4 Bentley block, showing corrosion.

A trial run with water indicated a capacity of about 1 1/2 litres and none would run round the outside of 1 and 6. Acid was poured in and seemed exhausted after 12 hours. The block was washed out, neutralised and inspected. It was decided to repeat this treatment.

After a few hours acid started to come out of a copper tube and, as I was not prepared with wooden plugs for this eventuality, that acid had to be dumped rapidly. After washing, neutralising and cleaning the block was again inspected, with particular reference to the integrity of the copper

tubes. These had obviously remained watertight for years as the corroded holes had been plugged by corrosion products. By probing, at least four were perforated (see photograph). The tubes were plugged and the acid treatment repeated. An anxious watch was kept on the block in case of more acid leaks. When this acid was consumed the block was neutralised, washed and dried. A thorough inspection was made by means of wire probes and it was obvious that the water passages were still far from clear round the outsides of 1 and 6, between 1 and 2, 2 and 3, 4 and 5 and 5 and 6. Also, as far as could be determined, between all cylinders and the valve chest. This was after 30 hours of acid treatment. Furthermore, there was a considerable number of doubtful tubes apart from those perforated.

I decided against more acid treatment as I concluded I would have to replace all the tubes and would then have 52 extra holes into the water passages which would enable me to mechanically remove the remaining corrosion products. An attempt was made to remove the four core plugs in the valve chest, but this was abandoned as they seemed to be quite immovable. Eventually, it was found that only those two adjacent to 1 and 6 caused any trouble in the water passages in any case.

The problem was how to remove the 26 tubes which are swaged into the top and bottom of the block, had not been moved for 46 years, and only 12 could be partially seen. I did not consider it was practical to attempt to drive out a corroded tube from one end as I was sure it would collapse. I consulted the Club experts, firstly Bill Snook, who told me their diameter, his experiences and offered me a few tubes from his stock, and then Carl Sargeant. Carl obviously had faced this problem of complete removal before. He told me how he removed the tubes, how to clean up the holes before fitting new ones and where to obtain copper tube. He also lent me a special punch and drift. Suitably encouraged, I started.

Carl's technique was to screw a taper tap ($\frac{1}{8}$ in BSF) into one end and then, with a long drift, drive the tube out from the other end, in effect pulling it out so avoiding collapse. I used a $\frac{1}{8}$ in Whitworth taper tap. My first efforts were slow and careful. I soon learned that, as the corrosion of the copper tubes was worst at the top (due to higher temperature), it was better to put the tap in the bottom of the tube. This meant a steel tube extension to the tap due to the proximity of the cylinder skirts. When I started, the first tube took me over an hour to remove; when I ended I could remove one in six minutes. The method became as follows:

1. Hand drill $\frac{1}{2}$ in about $\frac{3}{8}$ in into the top end of the tube. This removes about half the wall thickness of the copper and the top and bottom flanges of the block are about $\frac{3}{8}$ in thick.
2. Screw tap into the lower end of the tube, using normal tapping methods, as far as it will go.
3. With $\frac{1}{8}$ in diameter drift and 1 $\frac{1}{2}$ lb hammer, drive tube downwards and out of the block.

When all the tubes were removed much time and effort was devoted to mechanically removing all the remaining scale. Eventually, a minimum of $\frac{1}{8}$ in water passage was achieved round all cylinders for their whole length. I could not get between the two core plugs previously mentioned, and the cylinders, but cleared all round them. The tube requirement is 5 in long, $\frac{1}{8}$ in outside diameter and 22 gauge (0.028 in) wall thickness.

I decided to make my own tools for fitting the 26 tubes as, among other items, I did not know how long it would take and how much time I could devote to it. I turned a tapered drift to fit the holes in the blocks and found that the taper was about two degrees. A straight piloted drift was also made for driving the new tubes into position. This was designed to support the tube when the block was standing on the cylinder skirts. Refitting was carried out as follows: all taper holes were polished and a 12 in length of tube was hand pushed in to see that it entered easily. A 5 in length was then expanded at one end, both ends were then cleaned with emery cloth. The upper hole and the expanded end of the tube were coated with Well Seal. The tube was then pushed in from the bottom with the piloted drift and the latter tapped until the tube just came out at the top. The upper end was then expanded with various tools and finally with the tapered drift. The lower end was also re-expanded with the drift. Both ends of the tube were then cleaned up with a $\frac{1}{2}$ in drill in a wheel brace.

My conclusions from this exercise are as follows:

1. Blocks of 4¼ Bentleys are likely to be in a poor condition unless then have been completely cleaned out and retubed.
2. Acid treatment, while useful, seems unable to remove all corrosion products, particularly between the valve chest and cylinders.
3. Complete cleaning and retubing is not a difficult procedure when one learns how to do it and is very strongly recommended to owners of these cars.
4. Copper tube (and other non-ferrous metals) is available from J. Smith and Sons (Clerkenwell) Ltd. The depots are at Biggleswade, Chelmsford, Maidstone, Horsham, Bracknell, Bristol, Midlands and Nottingham.
5. I would be pleased to advise any member who intends to do this work and lend my two special drifts for it. Also, I have some tube left over.

Corrosion — the metal killer

Part three — by Richard Lowe

CYLINDER HEADS

PHANTOM II

These heads are manufactured from an aluminium alloy and from my experience do not suffer much corrosion in the water passages. This comment must be qualified by the following points:

- (a) I have used a chromate inhibitor in the water for over 29 years.
- (b) There is slight 'bellmouthing' of the water holes where they accept water through the head gasket due to the galvanic cell with the copper of the latter.
- (c) The thermometer bulb had caused slight attack in its vicinity to the head. The worst attack was inside the steel fitting which supports and holds this bulb in the head.
- (d) By far the worst corrosion found was in the removable aluminium fitting connecting the head to the radiator hose. This circular fitting ends in a spout which has an external thread to take a gland nut which clamps the nickel plated copper pipe for the hose to this head fitting. This constituted an intensive galvanic couple with the hottest water at the maximum velocity. It was, therefore, only to be expected that the aluminium would suffer at this location.

The following action was taken to overcome this situation. It was considered unwise to try and dismantle the connection, as it was thought that if much force was applied to the gland nut the aluminium below might well collapse. The corrosion product was, therefore, removed mechanically by hand and small wire brushes in a drill until the whole of the inside was clean. The joint was then covered with an aluminium loaded epoxy putty and this was extended into the copper tube to make the galvanic path through the water about two inches long instead of being in immediate contact. This makes the aluminium comparatively remote from the copper/nickel. No problem has been encountered with this solution. Finally, in order to trap any corrosion product which might cause trouble in the radiator a 'monel' (copper-nickel alloy) wire mesh screen was installed in this fitting and it is inspected every few years. Very little corrosion product is ever found in it, indicating negligible corrosion is taking place.

The water system is drained every winter and it always comes out crystal clear, but of course bright yellow from the chromate inhibitor.

4 1/4 BENTLEY

These heads are made of cast iron and the comments on this material previously given apply. However, compared with the cylinder block they are very accessible castings and if all the core plugs and end covers are removed a comprehensive inspection of the water passages can be made. In order to clarify this remark a list of openings is given below:

Two large end covers; 18 water holes $\frac{1}{8}$ in inside diameter from the block; 18 core plugs which are all $\frac{1}{2}$ in deep, have four insertion/extraction holes $\frac{3}{8}$ in deep and are threaded 16 to the inch.

Details are: 6 rocker box $1\frac{1}{2}$ in outside diameter, $1\frac{1}{8}$ in outside diameter thread, $\frac{1}{4}$ in holes; 10 side (six exhaust, four inlet) $\frac{3}{4}$ in outside diameter, $\frac{3}{4}$ in outside diameter thread, $\frac{5}{8}$ in holes; two end $\frac{3}{4}$ in outside diameter, $\frac{5}{8}$ in outside diameter thread, $\frac{1}{8}$ in holes; one thermometer pocket similar in size to the ten side plugs; two gland holes for water to the inlet manifold.

The above give a total of 41 without counting 16 which could be made available if the eight copper tubes were removed. These tubes are for the pushrods and are about $\frac{1}{2}$ in inside diameter.

It will be noted from the above that while all the plugs are $\frac{1}{2}$ in deep, they all had $\frac{3}{8}$ in deep holes in them. In addition, the 16 larger plugs had holes $\frac{3}{8}$ in deep in the centre from the water side. The function of these centre holes is unknown, but they have their uses as I mention later. All side and end plugs are of stainless steel and I did not expect trouble with them, but those under the rockers were obviously steel and I regarded these with suspicion as they were likely to corrode with respect to the surrounding cast iron.

With holes $\frac{3}{8}$ in deep in them I suspected that they were the most likely source of possible water leak into the sump and so I decided to remove them all for inspection and if necessary replacement. Plug extractors were made in the following manner. Suitably sized hexagon bar was parted off and drilled with holes of the same diameter, depth and position as the plugs. Silver steel rods of $\frac{3}{4}$ in length of the appropriate diameter were pushed into the extractor which was in turn driven into the plug holes. A normal spanner was used on the smaller plugs. This normal arrangement did not work with the large plugs which were well rusted into the head. With the side plugs out it was possible to remove quite a lot of corrosion product, particularly over the inside of the large plugs. The head was then placed upside down and penetrating oil was squirted in until there was a small pool of it over each large plug. After topping up and soaking for some six weeks they came out relatively easily. The method of removal was as follows. The head was placed on a carpet on the floor so that it was free to move. The spanner on the extractor was given gentle blows with a 7lb sledge hammer. This system, while applying a large torque, does not give the casting a real shock as it is only restrained by its own weight and it moved.

With all the plugs removed inspection revealed corrosion 'tubercles' up to $\frac{1}{4}$ in high, in addition to overall corrosion, but nothing like the complete choking up of the waterways as in the cylinder block. However, heat transfer is very severely reduced by layers of corrosion products, quite apart from rendering corrosion inhibition relatively ineffective. When all the visible corrosion product had been removed mechanically, acid descaling was employed to fully clean out the entire head. Incidentally, the copper tubes which are well spaced from the cast iron appeared to be in good condition. The large diameter plugs were given a special treatment. After mechanical cleaning they were placed in an inhibited descaling acid and the result was a clean etched surface.

Some of the plugs were badly corroded and these were built up with epoxy putty. The 'interior' hole was most useful in providing an extra key for this repair. The epoxy putty used was: 'Heatherbond' — 'Plasinium' for aluminium; 'Plasteel' for steel; supplied by Ferguson and Timpson Ltd. of London and Glasgow.

The steel fitting for the thermometer bulb was in exactly the same condition as mentioned under PII (c), that is, badly corroded inside but still usable when cleaned up.

Regarding the modification of the water distribution from the pump, as described on page 47 of the second reference book on page 50, Bulletin 134, I cannot, of course, approve of the use of aluminium plugs in the cylinder head. These will without doubt corrode and might end up in the radiator. I plugged the six holes in the cylinder block as the flange is $\frac{3}{8}$ in thick. The water holes can be threaded $\frac{3}{8}$ in quite easily and $\frac{3}{8}$ in steel plugs can be screwed in and sealed.

To conclude, it is obvious that engines built over forty years ago are remarkable still to be in reasonable working condition, and while pistons, valves, bearings etc. have no doubt all received attention or replacement, the water side of the cooling system has frequently been neglected and this can lead to irretrievable damage. It is a case of 'out of sight, out of mind'.

Once a casting has cracked it is extremely difficult to make a permanently satisfactory repair due to the expansion and contraction experienced by the engine, and the subject is surely a case where 'prevention is so much better than cure'.

CONCLUDED

Oil filtration for pre-war R-R and Bentley engines

by R. A. Lowe

ABOUT ten years ago C. Robertson wrote a very good article on how he fitted an oil filter system to his 20/25 engine. At the same time, a comment was passed by N.H.H., questioning the necessity of such a system with the very thick whitmetal lined bearings used in these engines. It seems to me that oil filtration should be seriously considered by owners as it is now so much easier to carry out such an installation. After all, the Phantom II was fitted with an 'auto-clean' full flow filter in 1932, which is an improvement on the sump strainer, but did not stop excessive wear of the main bearings or the build-up of hard deposits in the crank pin cavities. I suspect it passes anything smaller than about $1\frac{1}{2}$ throw or 38 microns (1 micron equals $1/1000$ th of 1mm). It is now possible to buy standard 'spin-on' filters which can be designed not to pass particles greater than 10 microns. If one regards unfiltered oil as a suspension of fine metal and carbon particles, it assumes the character of a very thin grinding paste — cruelty to engines?

Once again, Carl Sargeant has provided me with a most useful contact on the source of supply of the necessary items as he has made a very neat installation on one of his Bentleys. I also contacted Tecalemit-Chadwick (British Filters) and 'Fram' filters. I wanted a filter that would handle up to about 20 litres/minute (approximately 250 gallons/hour), filter down to 10 microns or less and be fitted with a relief valve. Fram unit PH2857A and Motorcraft (Ford) ESL90 fulfil these requirements. The relief opens when the differential pressure across the element exceeds 20 psi. This last item, which is a bit of an extravagance on a car with a pressure gauge connection on the outlet side of the filter, is at least an insurance against a replacement oversight!

It is possible to use the following systems for connecting up the filter: (1) Copper pipe $\frac{1}{2}$ in outside diameter, using the ends on the existing pipe. The old pipe can be unsoldered or drilled out (Sargeant method) or left short and standard compression fittings used. The new pipes must of course be shaped and this is well covered in the Robertson article. (2) I intend to use an even simpler arrangement which means hydraulic hoses. This allows the filter to be located in the most accessible place for servicing and overcomes relative movement between engine and chassis. Regarding bearings, my 4 $\frac{1}{4}$ litre will be fitted with Mark VI conrods and the thin wall bearings should be good for 75,000 miles, provided the oil is well filtered. The supplier of the remote filter heads and fittings is Think Automotive Ltd., 292 Worton Road, Isleworth, Middlesex TW7 6EL, telephone 01-568 1172. Contact Mr Potter.

A similar system could easily be used on the larger RR engines as, while the filter head is screwed for $\frac{1}{2}$ in pipe connections, couplings are available for larger pipe diameters. Reference: RREC Technical Manual 1978, pages 85-87.

Core Plugs

Re the correction (B138/45) to Richard Lowe's article on corrosion. Cylinder head core plugs are not threaded 19 threads per inch, but 20 tpi; as are most of the non-standard threads around the engine, i.e. pipe fittings, unions etc. If anybody has need of restoring a damaged thread I have the necessary taps. Regrettably, I cannot loan these as they are very expensive, so you would have to bring your hardware to me for rectification.

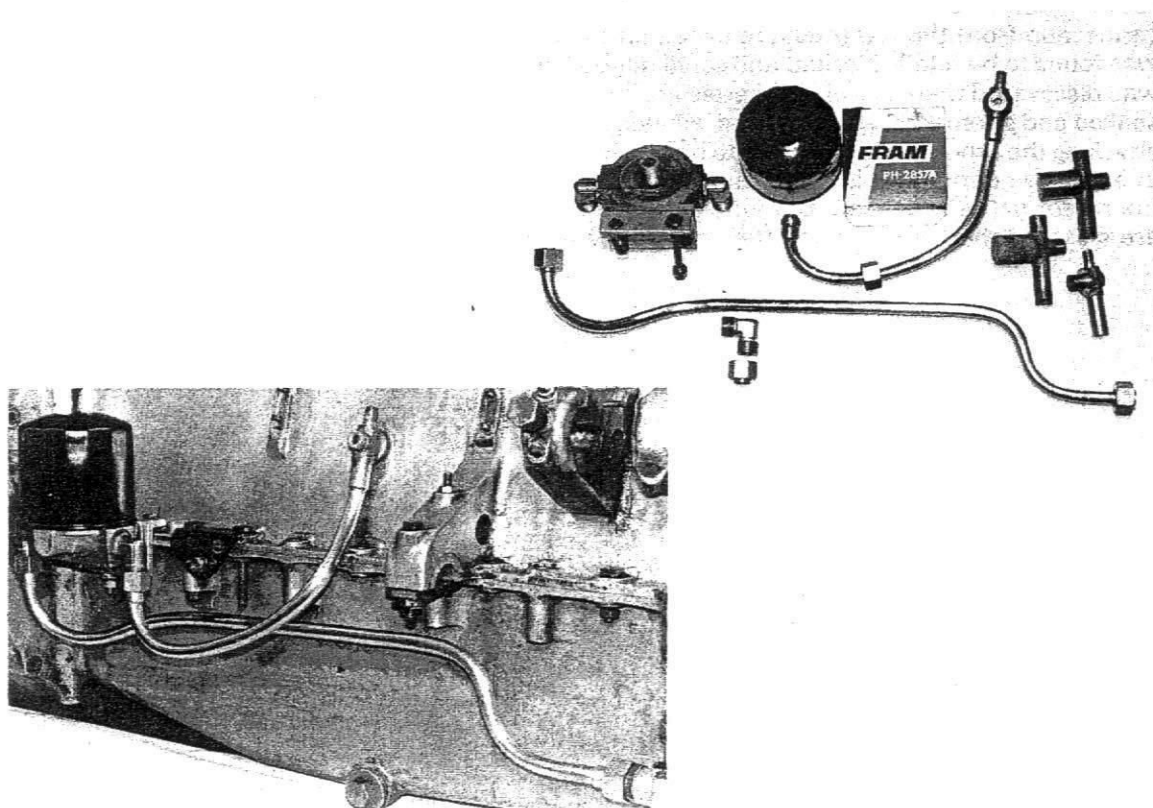
WILL FIENNES

Oil Filtration for Pre-War Bentley Engines

Further Notes by D.R. Grossmark

Following on the article ten years ago by C. Robertson and the subsequent article by R.A. Low in B139 about oil filtration. This is something I have entirely agreed with but have never got round to carrying it out until recently.

After reading R.A. Lowe's article I decided I would not cut up or in anyway interfere with the existing oil pipes, but would start afresh and make up new unions. So I made up a pattern out of available materials around the garage and had it cast by a local foundry very inexpensively in bronze then machined it up in the lathe and cut the appropriate threads. I then managed to get hold of some $\frac{1}{2}$ inch OD copper pipe, (not so easy nowadays, everything is metricated) and used standard $\frac{1}{2}$ inch unions and made up the assembly as illustrated, off the car and on the car, I used a piece of aluminium angle for the mounting bracket for the filter mount obtained from "Think Automotive" using the standard Fram filter PH 2857A, I found it made an entirely satisfactory arrangement. The purist will no doubt comment about mounting the filter upside down. There is a non-return valve built within the filter this does not offer a problem, although some oil will come on the floor when changing the element, not a great deal will be involved. I felt it was the least inconspicuous position particularly when black painted. The new pipe work has yet to be plated and finished but I think it will "fit in" quite satisfactorily. No extra holes have to be cut in the under tray as the input pipe is brought up through the existing oil pipe hole on the undertray.



Further Notes on Fitting Oil Filter to a 3½ Litre Bentley with Ride Control

The previous fitting information will suffice where a car is not fitted with ride control. But however if a car has ride control the following extra steps would have to be taken to position the filter as illustrated.

Remove ride control linkage pivot mounted on off-side rear engine mounting and front rod. Dismantle pivot assembly, remove shaft, dismantle. Then cut off inside tube sleeve, reposition inside lever from shaft and refit back on shaft tight to the off-side lever at 180° to each other. Reposition shaft back in pivot and drill and split-pin shaft onto shorter pivot assembly, cut-off excess shaft, re-fit to vehicle and lengthen front rod control rod, approximately 1½ inches and slightly set to miss steering column. In all other respects the fitting on a later 3½ litre Bentley with ride control are the same, with the exception of the above and in some cases a heater pipe coming out from the back of the water outlet by the pump may have to be contoured to suit.

D.R.G.

Blocked Oilway in 3½ Bentley Head

I recently suffered a noisy rockershaft and on examination found there was no oil getting to the rockershaft. This is fed to the centre rockershaft mounting pedestal via a hole and banjo connection from the low pressure circuit on the off-side centre side of the cylinder head. This was found to be totally blocked and could not be cleared by a wire, even use of acid. In the end it was discovered there is a plug inserted around the cylinder head mounting stud, and this when soaked and persuaded was removed, allowing the oilway to be properly cleared. It is well worth checking the amount of oil coming to the top of the rockershaft as any starvation here will result in expensive damage. It is very difficult to determine as there is no means of knowing this until the noises actually happen. But whenever the rockershaft is off do make sure that the oilways are clear, as they are so small they can easily get silted or corroded up.

D.R.G.

Engine Lubrication for Rolls-Royce and Bentley Cars manufactured before 1935

by Brian Scott

Before the Second World War engine oil technology was at a fairly primitive state compared with the present day. Anti-oxidation and anti-wear additives were not available in engine oils, which now contribute enormously to lubricant life and engine longevity.

Engines manufactured by Rolls-Royce and Bentley were, in those days, designed to function on the available SAE40, and sometimes 50, monogrades, and owners of these vehicles today will usually prefer to adhere to this original recommendation. This does not mean that current advanced technology cannot be used with definite advantages.

Duckhams Fleetol HDX40, meeting the API-SE classification, is an SAE40 monograde. It is blended from selected base oils and is additive treated with the previously mentioned anti-wear and oxidation retarders plus inhibitors to combat corrosion; very important for engines used infrequently, as some of these very valuable engines are.

For engines manufactured after the mid-thirties there is no technical reason why they should not take advantage of present day engine oil technology, and use a top quality 15w-50 or 20w-50 multigrade. These oils offer all the latest additives previously mentioned plus enhanced cold-flow characteristics, ensuring spontaneous crankshaft lubrication and protection.

(B175/40)

Lubricants

Of all the motoring glossies my favourite is the *Automobile*, which cares for cars which more nearly match my age. In the September issue is a fine article entitled 'Modern oils; old engines'. How many of you have peered mystified at multi-coloured plastic containers in garage shops, wondering if their contents are safe for your engine? The author, Graham Orme-Bannister, is a chartered engineer and a member of the lubricants committee of the Technical Council of the Motor and Petroleum Industries, which is good enough for me. You should buy the magazine and read the article, but the punch line is that 'any conventional engine built since 1920 and run on SAE 15W-40, API SF quality oil should be served well and safely between 3,000 mile changes'.

Eric Barrass

(B188/7)

Engine lubrication for Rolls-Royce and Bentley cars manufactured before 1955

by Will Fiennes

May I comment on and expand the brief note on the subject in B175 by Brian Scott.

Firstly, according to the published service data, either SAE20 or SAE30 was generally specified as an engine lubricant, dependent upon engine type. SAE40 and 50 grades are not mentioned in this context.

Secondly, the relevance of the date 1935 is not immediately clear in B175, but it was at about this time that Halls metal bearings were being introduced. However, to the best of my knowledge the lubrication requirements of Halls metal and white metal bearings are the same, provided that there is adequate oil flow to cope with the increased bearing clearances in the Halls metal bearings. Rolls-Royce specified the same oil throughout the thirties for, for example, all Derby Bentleys.

What is extremely relevant when modern oils are considered for use in a prewar engine is the lack of effective oil filtration. Modern multigrades are, in general, detergent oils, which means that debris in the oil remains in suspension, to be removed only as and when the oil passes through a filter or is changed. Oil filtration prewar was in its infancy, and the bypass filters fitted to small horsepower cars (I am unable to comment on others) were, by modern standards, little more than a token. However, something is better than nothing.

In the case of a newly-rebuilt filterless engine which is run on a modern detergent oil, the engine should have its oil changed regularly; I would suggest every 2,000 miles, on the basis that oil is cheaper than an engine overhaul. However, if the engine has not been stripped and very thoroughly cleaned, the introduction of a detergent oil will act, in the fullness of time, as flushing oil. The debris which previously had been centrifuged out in the big end journals, or which sat lurking as a sludge in the base of the sump, will start to circulate through the engine with possible dire results. Full-flow filtration, although not original, must be a cost-effective means of extending the life of the oil.

Finally, may I remind owners, particularly those who do not cover a great annual mileage, that despite low mileage the oil should still be changed regularly, particularly if a multigrade lubricant is employed. The additives which give the oil its multigrade property can be seriously affected by pollutants in the oil, particularly those arising from the by-products of combustion. Thus engines which are a little tired, or which may have sticking rings through lack of use, can suffer from a significant amount of combustion gases escaping past the rings into the crankcase. These will contaminate the oil and can considerably shorten its life time, although the mileage since the previous oil change may be comparatively slight. Thus a low oil pressure may be due as much to oil which has around too long as to engine wear. (B178/41)

Modern Oils and Old Engines

Are they compatible?

by Ken Lea C.Eng., B.Sc.(Hons.), F.I.Mech.E.,
M.I.Mar.E.

What's the problem?

The problem of which oil to use in your engine can cause considerable anxiety, particularly as many oils shown in the owner's hand book are no longer available or are only purchased from specialist sources. However, consideration of a few basic principles can shed some light on the subject.

What we really need to know is can you use modern multigrade lubricating oils in older engines?

An initial appreciation

Let us take the best case first, which is of an engine in good condition whose clearances and tolerances are to specification and which is fully bedded or 'run in'. In broad terms our engines made by the Company were made of the best materials of the day and to fine limits and fits, and this applies to all engines whatever their period of manufacture, but as understanding improved so materials and designs were changed. However, the combination of materials were always compatible. What has been learned over the years is that least wear of the components is primarily dependent on the presence of good quality clean lubricating oil under all operating regimes. What we must understand is how the 'quality' is described and how high standards of cleanliness can be continuously achieved.

To illustrate this I must describe some related design parameters that enable engines to function. For those not trained in engineering, I will try to do this in layman's language and I trust those who are skilled will bear with me and forgive the oversimplification.

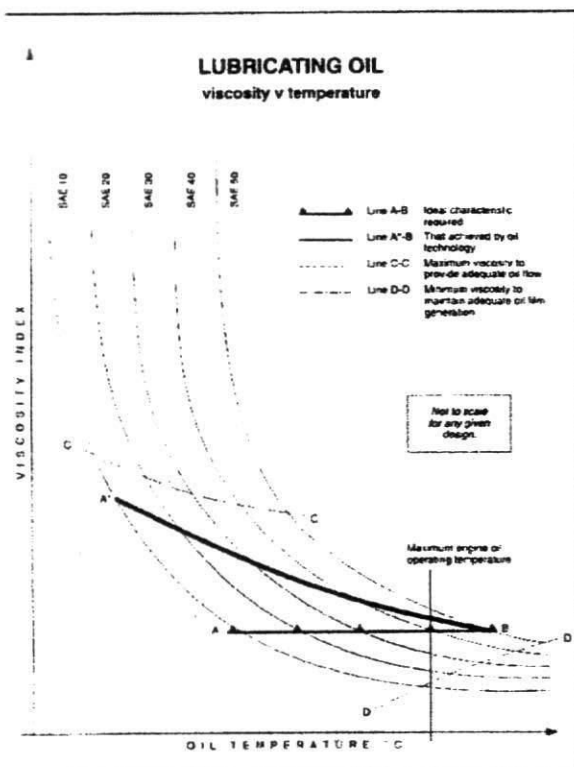
Let us consider the case of plain journal bearings which are lubricated by oil fed under pressure provided through oil galleries by means of the oil pump. Such plain bearings only work by the generation of a stable oil film between the sliding surfaces of the bearing and the journal or shaft. To avoid any possibility of metal to metal contact this film must be maintained under all load conditions to which the bearing is subjected. In a reciprocating engine these loads are cyclical and vary with speed, combustion firing pressures, rotating and reciprocating masses etc. and are also transiently affected by the variable power demanded from the engine under driving conditions. Contrary to what many may think, the generation of the oil film is sustained by the flow of the oil within the interspace or bearing clearance. It is not directly a function of oil pressure. Sufficient oil flow is generated by the supply of oil to each bearing but controlled by the rate of leakage from the bearing. The flow is achieved by a pressurised system provided by the oil pump and a series of closed oil ways within the engine. Oil pressure, therefore, only provides sufficient potential to ensure adequate flow under all conditions to each bearing. There are other important parameters, one of which is the operating temperature of

the bearing components, again under all conditions but for sustained hot operation the stability of the oil film must be achieved in this environment. Thus the oil within the bearing will have to have sufficient viscosity at temperatures of the same order as its surroundings or else the generation of the necessary film thickness through the shear action on the oil will not result in a sustained oil film and metal to metal contact will occur. This description is very much an over simplification of the situation and ignores such things as the expansion of the metals, surface finish and the locus of the crankshaft in motion as it does not rotate about its true centre. Nevertheless, I hope I have given some insight into how the oil has to function within this part of an engine. Naturally, the other parts of the engine require lubrication but simpler lubrication mechanisms generally are at work.

Unfortunately while it is possible to manufacture an oil whose viscosity meets these hot operating requirements within normal driving conditions, the natural relationship of an oil's viscosity characteristic with temperature does not ideally suit the engine's other operating requirement to commence operation from a cold condition without preheating. This is because viscosity varies rapidly with temperature such that at an ambient temperature of 20 degrees centigrade, for example, its viscosity is significantly greater than at, say, 150 degrees centigrade, whereas the characteristic desired by the engine is to have viscosity at a constant value independent of temperature. In general, for a given pressure head and temperature, the higher the viscosity of the oil, the lower the flow.

This is shown in the accompanying sketch and shows that for standard oils of different viscosity indexes (grades) how the characteristics vary. Also shown in the graph is a range of viscosity that at its maximum still provides sufficient oil. However, while the minimum is that which will sustain a stable oil film, from this it can be seen that no oil of a single viscosity index can meet the ideal requirement.

We can now see that if the oil can be made to modify its viscosity temperature characteristic (as shown by the line AB on the sketch) to more closely represent the ideal that the engine desires then the oil film will be present over a wider range of engine operating conditions from cold start to maximum operating temperature. Without going into the details of oil technology, this is the function of a 'multigrade' oil, which allows the oil to be in the desired viscosity range when both hot and cold. This polymer technology has advanced rapidly with even wider ranges of variable viscosity index becoming available and which always aim to provide an oil viscosity characteristic closer to the ideal and this is the reason why its use today is almost universal.



There is a snag, which is that in addition to additives whose function, for example, is to reduce friction losses, resist corrosion and resist combustion products degradation, multigrade oils are formulated to provide a 'detergency', the purpose of which is to allow minute particles of wear products, combustion products (carbon compounds) to be carried in suspension in the oil and away from the sliding surfaces of components. If this potentially good characteristic is to be best utilised, then it demands that these harmful particles are continuously eliminated at least down to a least harmful size and not continuously recirculated around the oil ways, bearings and other parts of the engine. If they are not removed then increased wear rates will result, especially if the bulk or sump oil is not changed very frequently.

Therefore it follows that the use of modern multigrade oils with high levels of 'detergency' is best accompanied by the presence of a fine filtration specification oil filter whose purpose is to remove all debris down to a very small particle size and to allow only 'clean' oil to enter the oil system. Clearly such filters did not feature as standard on Rolls-Royce and Bentley engines until the advent of the 4 1/2 litre engine in 1952 in the Mk. VI and other contemporary models. However, many of the specialists now offer a conversion kit to provide full flow filtration protection, and these are to be directly fitted between the oil pump and main gallery. The filter should be of such a capacity that, when clean, the pressure drop across it should be nominal with the engine at normal operating temperature. All installations should be provided with relief valve across the filter, a safeguard against blockage, e.g. when very cold. This remains closed at all times except in emergency and is there to prevent complete oil starvation and subsequent seizure.

First conclusion

It is clear from the foregoing that if other factors, which I will discuss later, are favourable, then for an engine in clean condition with no sludging or other detritus present and in a 'run in' condition, there are considerable benefits to be gained from using a well formulated multigrade oil when used in conjunction with a full flow filter and irrespective of the age or type of Rolls-Royce or Bentley engine made by the Company. Its use will significantly reduce wear and prolong engine life.

Secondary comments

I have heard people say that the use of such oils makes the engine leak oil to a greater extent and as the oil is inherently less viscous across the temperature range it could well be true to a minor extent as resistance to leakage is viscosity dependent. But surely the answer is to fix the leaks and/or still take advantage of the inherent improvement in engine life between overhauls. I know from many years of experience that older engines can be virtually leak free, but it does take some effort. I have also heard it said that 'it can't be good' as the high oil pressure seen when the engine is cold drops off more quickly. When you think about it so it should, as this means the bearings are receiving adequate flow!

What have I done?

I have run all my various Bentleys as described above, but on two in particular, I have covered tens of thousands of miles. On my 4 1/4 about two years ago I had occasion to dismantle the front end to attend to the dreaded damper (which I cured by reverting to 'cotton duck' washers) and I was well impressed with the total absence of carbon and sludge. Oil pressure is maker's standard when hot and remains stable and oil consumption is about 750 miles per pint. The proof is in the eating of the pudding! (Incidentally, an engine damper operating on well filtered modern oils and fitted with 'cotton duck' friction rings is much less prone to seizing.)

The range of multigrade, in my opinion, should be 5 or 10 W to 40 or even 50. Although expensive, synthetic oils are also to be recommended. The choice is yours - I use a 10 W/50 synthetic.

Other general factors for engines

However, there are a couple of further items that contribute to an extension of engine life.

Running in

Firstly, when the engine is as new and not run in then, for all the engines up until the more recent models, the ring and liner technology of the day demands a fairly long period of bedding or 'break-in'. This sensitivity is not so great on modern engines, but for all others, in spite of the inherent protection advantages provided by multigrade, the running in period should be completed using a straight SAE 30 oil of a good brand and quality. You must also

carefully follow all the other instructions issued by the Company in the handbooks. Once the rings are fairly well on their way to a full bed and the tendency to 'scuff' has been eliminated, then change the oil and filter and commence using multigrade.

Oil change frequency

The second point is that all oils become contaminated with combustion byproducts and, when the engine is subject to short distance running and/or gentle loading, condensation of water from combustion can contaminate the oil. Other combustion contaminants make oil become 'acid' and slow running can lead to fuel dilution. This means that its corrosion protection capabilities are reduced. If the engine is worked reasonably hard then the fuel and condensate tend to evaporate, but the acidity remains. Thus I recommend that oils are changed at 5000 to 6000 miles (or less if desired), together with the filter for engines in the condition described above. If the annual mileage is less than this then the oil and filter should be changed annually and before the car is laid up for the winter season. This prevents contaminated and acidic oil remaining in the engine during long periods of inactivity.

Engines obviously worn with high oil consumption

If we move from the better end of the spectrum to the worst, the same question requires answering. I need to state that these are engines that have been in service and are approaching the need for full overhaul. The high oil consumption is often accompanied by low compression pressures and considerable crankcase pressurisation such that the oil seals leak at the rear and front mains. It is a well known fact that, given reasonable treatment, many engines will survive for some time in this mode, especially if little used or only on short journeys. It is also likely that there is considerable sludge inside the engine coating all parts and that the crankshaft cavities (known as sludge traps to some) are filled with carbon deposits so that oil flow is reduced to the bearings. This may be accompanied by normal oil pressure or higher due to restrictions in the oil system through contamination. The fitment of a full flow oil filter may well prolong life by preventing further deterioration but the use of a 'detergent' multigrade oil is probably not worth the expense. Without the filter being present there are obvious dangers in using such oil, as it will wash the deposits into the oil and circulate them around the engine. If you must use a multigrade as no other is available then the sump oil should be changed every two to three thousand miles. If you have been using multigrade

then there is little point in ceasing, but frequent oil changes when no fine filter is present are recommended. Whatever oil you do use in this situation, change it frequently and certainly before the winter as the rate of contamination of the oil from combustion products is accentuated when the engine bores are worn and the piston rings are less effective in preventing gases reaching the crankcase.

Engines running well but whose history and detail condition is unknown

These engines are the most difficult upon which to provide advice in an article such as this, but a number of simple checks should ascertain if the engine would benefit from the potential advantages of the modern multigrade. Firstly, if no full flow filter is fitted, check the oil suction strainer (prewar), remove the tappet covers (if fitted), remove the rocker cover (if fitted). If the engine has been running cold a typical white sludge will be present. This should be ignored in the assessment as it requires the engine to be run hotter and/or more vigorously! What you are looking for is substantial amounts of black carbon like deposits. If these are not present to any great amount then it should be possible in conjunction with a full flow filter to move to a good multigrade oil. It would be advantageous but not essential to drop the sump and clean it out. If you have not been running on a multigrade then for the first say 6000 miles or annually change both the oil and filter at intervals of, say two to three thousand miles.

Summary

The advice given above is in the broadest terms and it has to be your own judgment as to whether you use a multigrade or not. But clearly given the right engine condition, when used with a full flow filter, there are inherent potential benefits to be gained from using a modern wide range multigrade. However, where condition is poor and the engine has not been operated on multigrade, such a change carries some risk.

For those who not wish to fit a full flow filter in the search for originality, or for reasons not covered here, then you can use it given an engine in good condition, but oil changes should be frequent. Even if you use a 'straight' SAE (e.g. SAE 30) oil, this frequency advice is sound if you wish to conserve engine life.

Frankly, the decision is one for owners, but I hope that the foregoing sheds some light on the subject and makes the decision more enlightened.

(B221/46)

Catalytic Converters

An announcement by Rolls-Royce Motor Cars Ltd.

There has recently been a lot of speculation by the media with regard to mineral based engine oils poisoning catalytic converters and therefore reducing the catalyst's life and efficiency, and the need to use synthetic engine oil to avoid this.

Rolls-Royce Motor Cars Ltd. has no evidence to indicate that the use of mineral based engine oil has any adverse effect upon a catalytic converter and will continue to use Castrol GTX as a factory fill engine oil.

Rolls-Royce Motor Cars has now used catalytic converters and mineral based engine oils together in certain markets since the mid-1970s and our experiences in the development of our range of catalytic equipped motor cars and our experience in service indicate only minimal benefits gained by using synthetic engine oils.

(B193/69)

Slipper drive problems - their identification, causes and cures

(Or, to give its correct name,
Crankshaft Torsional Vibration Damper)
by Graham Ashley-Carter

Much has been written on this subject, most of which is unintelligible to the interested layman, but this article is an attempt to clarify the matter in terms which can be related to road use, material changes and our findings on cars entering these works.

It is an inescapable problem of the in-line six cylinder engine that a natural torsional period of the crankshaft occurs within the useful rev range of the engine which, if unchecked, gives the familiar 'crankshaft roar' - an unpleasant sensation to both driver and passengers. The problem is best understood by imagining the shaft to be anchored by the flywheel mass and free to vibrate over the remainder of its length. This naturally increases towards the front 'free' end, the actual movement being a twisting action as in a torsion bar with the impulses being provided by the pistons.

This occurs at a specific road speed and the equivalent engine speeds in the intermediate gears and is further excited by the motion of the pistons, the result of which is an almost pure sine curve which would align almost exactly with the natural vibration curve of the crankshaft itself, which in turn is a function of its mass, length and rigidity.

There are two main periods, the first occurring within the normal rev range, which is uncomfortable but controllable; and the second just outside the normal rev range which is destructive and uncontrollable by any normal damping device.

The red area on Bentley tachometers signals the approach of this secondary vibration period and is exceeded at your peril; for instance, it is known that the S1 crankshaft will break at 5,200 revs even with the slipper drive in correct adjustment.

Designers generally arrange matters so that this speed cannot be approached by positioning the engine power curve and gear ratios in such a way that the vehicle 'runs

out of steam' before this point is reached.

The primary period, however, is the only one which concerns us as it is the only one we can control by damping. On prewar cars with deranged dampers this period is far more apparent to the driver due to the greater flexibility of the crankshaft and the engine mounting systems then employed. On postwar cars, having more rigid crankshafts, the greater nuisance is an audible timing gear rattle which is damaging to the timing gear tooth faces, causing them to break up in three areas at 120 degrees on the periphery of the aluminium camwheel. This was known as 'plucking' in Rolls-Royce terminology.

The crankshaft damper unit comes in three distinct types: the 'early type' fitted to Silver Ghost, Phantom I, 20hp. early 20/25s, a few early Phantom Is and Phantom III, in which we have twin slipper flywheels of given mass which perform the damping function and a separately damped spring drive whose function is to isolate the timing gear train from the remaining rotational irregularities, or in Rolls-Royce terms 'changes in angular velocity'.

This was followed by the Low Inertia Spring Drive used on the Phantom II, later 20/25 and 25/30, in which the two functions are combined, thus utilising the sprung mass of the damper to stabilise the motion transmitted to the timing gears, at the same time reducing the unsprung or fixed weight of the driving hub and centre plate.

The third type is similar to the second, but has the advantage to service staff that it can be assembled completely on the bench and is therefore known as the 'bench type'. This is fitted to the Wraith and all postwar six cylinder cars with the exception of the engine fitted to the Austin Princess R, which had a Metalastik type damper.

The damping medium of all types is of course friction, set at a predetermined level by spring loading, as in the familiar Andre Hartford suspension damper.

Turning now to the causes of derangement and its cures, it should be made clear that in 99% of cases it is a low friction poundage rather than a high one which causes malfunction. The few cases of high poundage are usually the result of poor laying up and storage conditions which cause the friction faces to corrode and seize to the linings. This was common after the war but is seldom encountered now but its effect is far more severe due to the added mass effectively fixed to the crankshaft.

Long research into the subject of friction linings led to the exclusive use by Rolls-Royce of cotton duck material for all three types of damper in spite of the increased trouble of 'ironing in' the damper until a constant load was achieved. The disadvantage of this material was that it was inclined to hold moisture and corrode the steel friction surfaces on cars which were little used, but cotton duck is now unavailable in this annular weave and Paxolin is supplied as the nearest alternative. With Paxolin, apart from sticktion, which makes it almost impossible to determine the true poundage of the damper using the standard spring balance, its frictional characteristics are affected by conditions of use, the result of which is a reduction of poundage when in operation on the engine.

It is therefore necessary to increase the factory setting by some 25% to obtain satisfactory crankshaft control at speed. In view of the aforementioned problems of measuring this figure, the setting operation becomes something of an art and is best left to those who have the necessary experience and 'feel' on the poundage bar. A late Phantom II can be extremely tedious after the second unsuccessful attempt and it is no use persuading yourself that it will 'bed in' or otherwise improve with use - it won't!

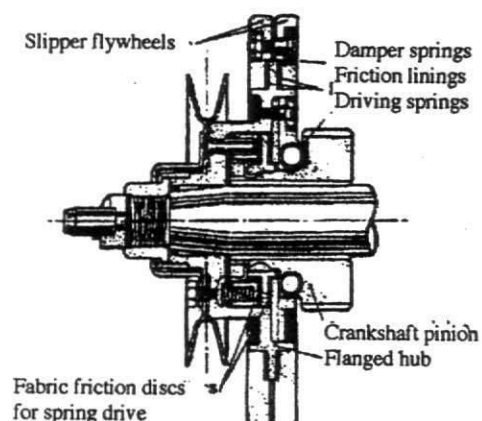
The steel friction faces are usually found corroded and discoloured, but unless this corrosion is severe, or the plates are worn and ridged, there is no advantage in regrinding as not only is this a tricky operation but it is all too easy to go below limits on parts which are no longer available. Lightly polishing with emery tape is often all that is necessary as the damper loading is also sensitive to the thickness of the pack.

Before embarking on all this, however, which will also involve retiming the engine, it is important to be able to distinguish between crank roar and all the other afflictions of engine balance, propshaft balance, misfiring, gear rattle etc.

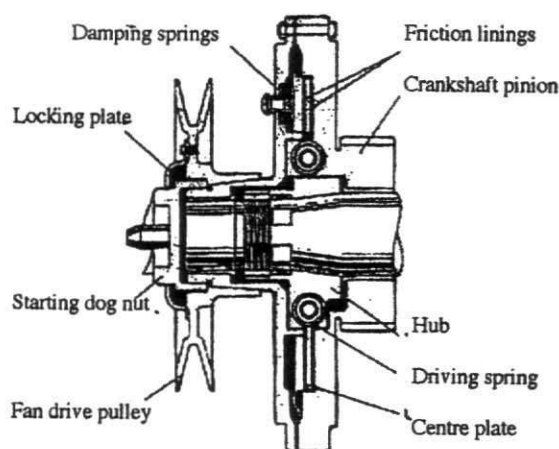
Slipper malfunction occurs when accelerating between 48 mph and 55 mph, depending on model, axle ratio etc., and lasts over only a narrow speed range of some 3-4 mph.

Finally, it is important to check the four centre plate rivets for tightness on the prewar low inertia types. Very close examination is required to detect any small movement between plate and hub and should this be present the only cure is to drill out and re-rivet using tightly fitting rivets in reamed holes. This is best not attempted without the necessary machine shop facilities to do the job.

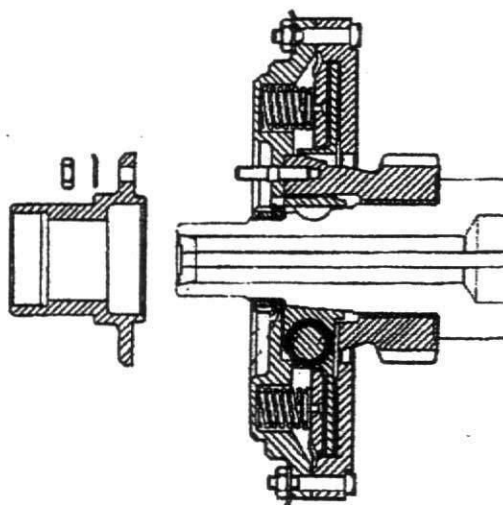
(B177/42)



Early type slipper drive



Low inertia spring drive



**Section 'bench' type crankshaft damper
(spring drive)**

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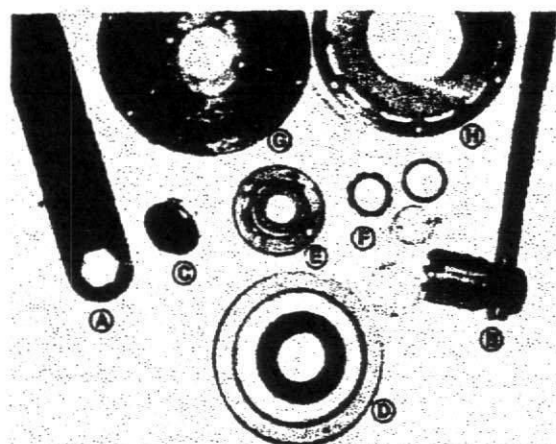
The slipper flywheel - does yours slip?

by John Flockart, Tasmania, Australia

At the dawn of motoring the veteran driver was haunted by the dreaded side-slip. Similarly, I have lived in awe of the Rolls-Royce crankshaft vibration damper. Many, many years ago my father and I embarked upon the overhaul of a very tired 20hp engine. Along the way we decided the crankshaft damper should be checked over. Having removed the fan pulley the first step was to remove the starter dog and damper retaining nut. So far so good. It was soon obvious that no open ended spanner would remove the nut without damage - possibly to both spanner and nut, but most certainly the latter. A further concern was that the nut could be either a right hand or a left hand thread. Which way should we be applying the pressure? This put the whole thing in the too hard basket, so we moved elsewhere.

Since then membership of the Club, plus wider personal contact with other owner/restorers, has gradually provided a clearer picture. Having read various articles and service data, including purchase of the Rolls-Royce Service Manual for postwar cars, I felt confident I knew enough to tackle an overhaul. That was until I actually started the full overhaul of my R-type Bentley.

In the event I realised I was still very much in the dark over construction details and dismantling procedures. So much so that, with a long stem to stern spare time overhaul of the car to tackle, this component was put on the back burner. Thankfully, time was on my side. While slowly



1. Parts and tools: A. Slogger spanner; B. Serrated nut spanner; C. Starting handle dog nut; D. Fan pulley; E. Nose piece flange; G. Front flywheel and presser springs; F. Serrated nut, washer and lock washer; and H. Presser plate

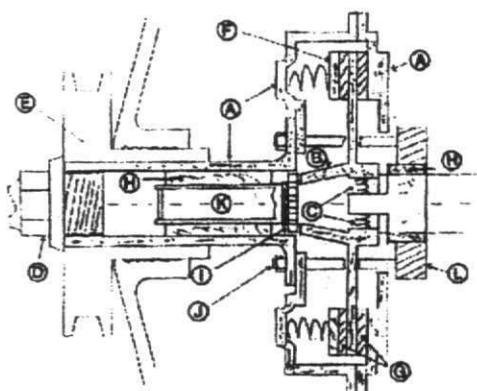
plodding ahead the RREC published that extremely informative book by Grigsby and Haynes, 'Overhaul of Small Horse Power Rolls-Royce Engines'. This was a godsend. The step by step procedures described for the 20hp engine provided the spur I needed. I had almost decided to leave the damper well alone, arguing that a little knowledge is dangerous, when this book came along. The argument further ran that there had been no sign of trouble here when the engine had been running previously. To have made this decision would have surely spoiled the engine overhaul.

Combining the advice of Grigsby and Haynes and the Rolls-Royce Service Manual, I was able to overhaul the unit successfully. True I had to feel my way, and worked with some trepidation. But I felt at least that I was heading in the right direction. This article is simply to put on record my step by step operation in the hope that others in a similar situation may learn something useful.

Many articles have been written on the slipper flywheel but few illustrate and describe the dismantling and overhaul sequence. These notes in no way represent any officially recommended procedure, but rather an individual 'I did it my way' account. It worked for me, hopefully it will for others.

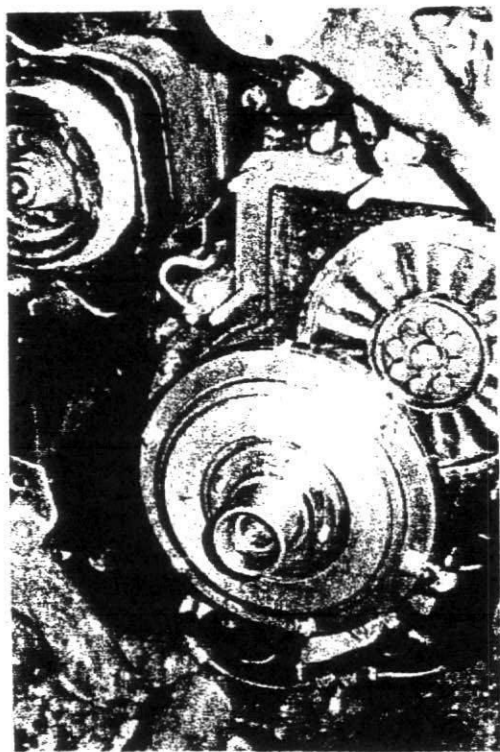
Though I was familiar with the working principles I still had trouble understanding the detail workings of this unit. Even playing about with the bits laid out on the bench it took me a while to work it all out. Presuming others may have the same problem, I have made a sketch (Fig.1) showing the basic arrangement. Essentially the unit is in two pieces, the visible outer section of the two joined flywheels and cam drive gear, and the hidden centre disc keyed to the crankshaft. This may help in understanding the overhaul description.

I have numbered the separate stages to simplify the description. This also suggests that the job is fairly simple. This could be misleading as some stages are tricky, while others are very tedious and time consuming. If the special tools required can be borrowed or hired this will be a great



A. Nose flange and the two flywheels
B. Centre slotted disc keyed to crankshaft
C. Spring drive
D. Starting handle dog nut
E. Fan pulley and scroll oil seal
F. Spring loaded presser plate
G. Friction washers
H. White metal brush supporting unit on crankshaft
I. Serrated nut
J. Bolts holding pinion flywheels and nose flange together
K. Hollow crankshaft
L. Camshaft pinion gear

Figure 1



2. Timing cover removed. Nose piece flange ready for removal.

saver of time. I spent several months on making up the special tools. These I did as the job progressed and each was tailor made for its purpose. Details of these tools I will give at the end to avoid confusion with the overhaul notes.

1. Remove the fan pulley

Assuming the front end is clear of the radiator and preferably mudguards, start by removing the fan belt and fan. The fan driving pulley is held on the nose of the crankshaft by a straight key and the nut incorporating the starting handle dog. This has a right hand thread and is itself secured from movement by a locking plate. Removal of two set screws allows the locking plate to be withdrawn. The starter dog nut can then be removed using a heavy hammer and slogger spanner. It is essential that the slogger spanner is made of heavy material as it is the shock loading from the heavy hammer that breaks the grip of the nut. A light material may have the strength but will spring. The transmission or engine flywheel must be securely locked. I used a bar bolted to the universal flange on the output

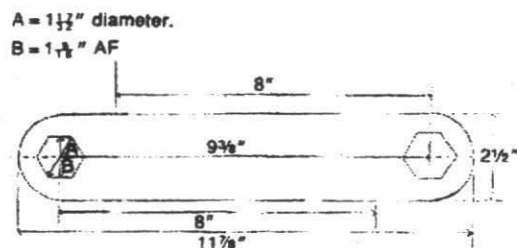


Figure 2

side of the gearbox. This was then jammed solidly on the chassis. Grigsby and Haynes advise that a few heavy blows will release the nut. I found this optimistic. It needed many blows but it came without too much fuss. Possibly an assistant to hold the spanner would have helped. I found I could not get a strong blow with my left hand wielding the hammer. I also found that I needed to hold the spanner in position right down on the starter dog nut. I had allowed extra length in the spanner when I made it up so I could hold it at the outer end. That bright idea just did not work. In consequence I found I was holding the spanner in place on the nut with my left hand and using the hammer with my right. This involved an awkward cross arms position. Still it achieved the result.

The tightness of the nut makes it essential the impact of the hammer is transferred as a solid jolt to the nut. Thus the crankshaft must be held solid, the spanner must have no spring and be firmly held, and the hammer must be heavy. The one I used weighed three pounds. A light hammer would simply bounce on the spanner.

With the nut removed the pulley draws off forward. Make sure to also remove the key lest it fall out later and be lost.

2. Remove the timing cover

The first stage is to remove the front engine mounting support frame. Support the front of the sump on a jack and once the weight of the engine is removed from the rubber mount the four bolts holding the two frame legs to the chassis brackets can be removed. I found that by adjusting the jack slightly, treating each leg separately, the weight could be released and each bolt drifted out. Once freed from the chassis the frame can be removed from the top rubber mount. Two nuts only secure the retaining plate. The frame and moulded rubber mount then pulls off forwards.

The only obstacle now to removing the timing cover is the oil pipe into the top of the cover. This pipe sneaks along unobtrusively behind the generator. The pipe is easily freed and moved out of the way by releasing the union nut from the fitting on the timing cover. Don't be fooled into thinking this completes the job. The pipe fitting to which the union nut screws should now be removed. Since it is a

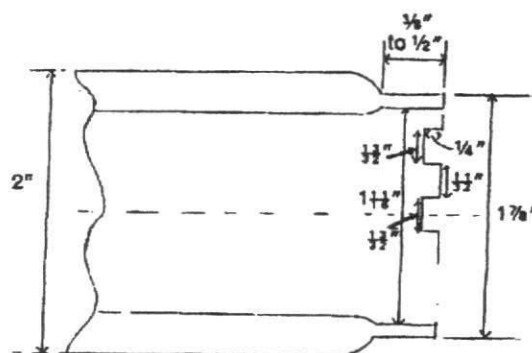
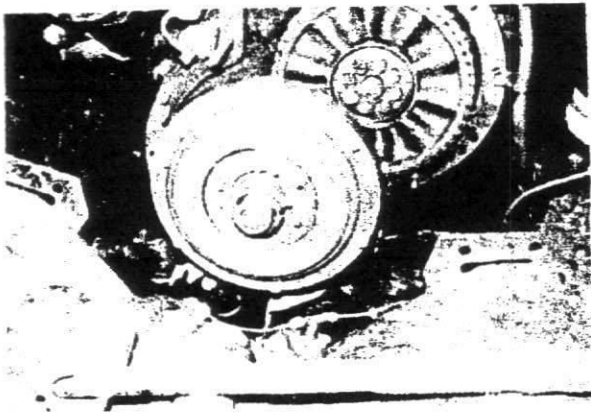


Figure 3



3. Serrated nut and washer removed. Note timing marks. Special serrated nut spanner in the foreground.

very thin hexagon make sure the spanner is a snug fit. The fitting will be tight in all probability and the hexagon is easily burred. Once free it unscrews readily. As it withdraws you will find it is in fact a surprisingly long tube, carrying an oil feed jet lubricating the timing gears. If left in place it will foul on the back of the damper as the cover is pulled forward. That was a trap I neatly fell into.

Now remove from around the outside of the cover the nuts and bolts, nuts from studs, and five set screws that bolt into the front of the sump. Quite a mixture and all different sizes. The cover is now free to be removed. Two studs I seem to recall spigot the cover in place and it takes a little persuasion to ease the cover off. The only other difficulty is getting a spanner on some of the nuts. With the engine sitting in the chassis there are two or three which will try your patience.

Once the cover is off mark the timing. As the photographs show, I marked everything in sight with white paint. It is very difficult to mark across from the slipper flywheel to the cam wheel. I found it most useful to have both aligned separately. The two marks from the cam wheel to the outside of the timing case I found very helpful. Also the one across from the flywheel lining up the edge of the cam wheel. The cam wheel advances two teeth when the damper is withdrawn. Thus the reason for the two marks on the timing case back piece (see photos 3 and 4).

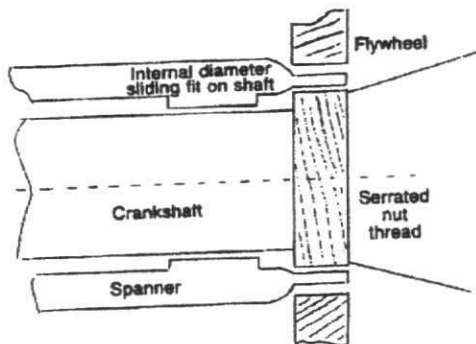
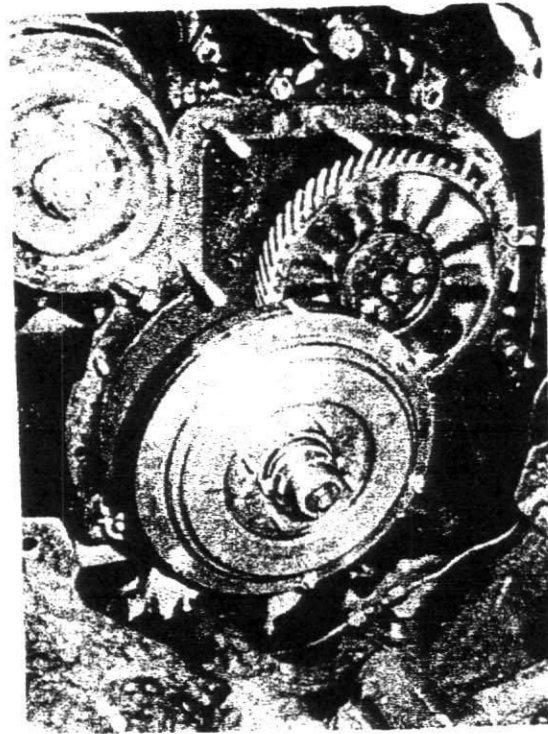
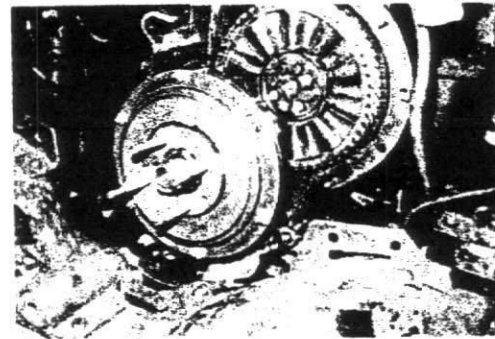


Figure 4



4. As photo 3 from a different angle.



5. Base of puller in place. Note, however, that the serrated nut is still in place. This must be removed before the puller is used.

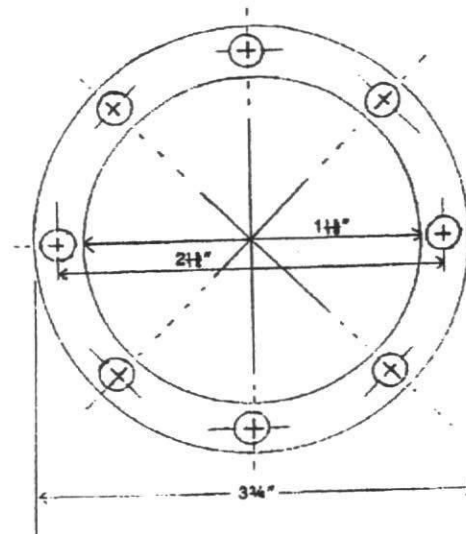


Figure 5. Puller base.

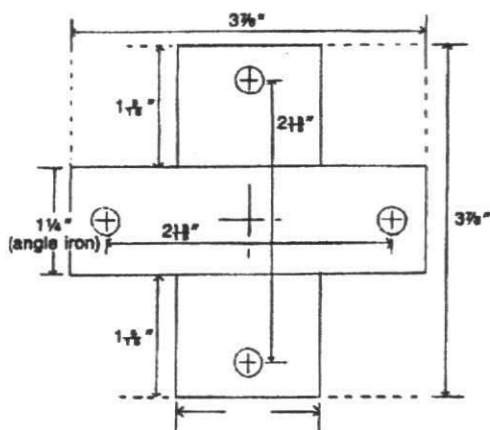


Figure 6. Puller crosspiece, top view

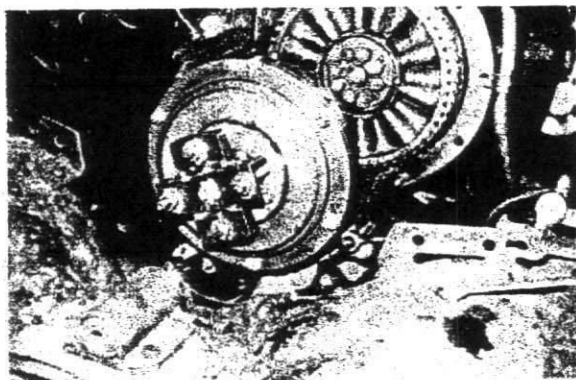
3. Remove the damper nose flange

This is held by four nuts which also hold the slipper flywheel assembly together via four long studs which screw into the boss of the timing gear pinion. Remove the four nuts which will allow the flange to be removed forwards. The hub of the flange contains a white metal bearing which supports the front of the damper assembly and allows movement independent of the crankshaft. The rear portion of the damper is similarly supported by a white metal bearing in the centre of the timing gear pinion.

Since these damper units gradually accumulate a fantastic amount of sludge and mullock inside them you will probably find, as I did, that the nose flange will not budge from its place. As much a problem as anything is the lack of any handgrip. This is sheer frustration. However there is a simple answer. Take some packing pieces, wood, red fibre, metal discs, whatever is handy, and place them inside the nose of the flange and against the end of the crankshaft. Leave some thread uncovered inside the nose piece and then replace the starter dog nut. As this is screwed home the flange will be drawn forward. Once started it will be found that it draws off quite easily. See photo 2.

4. Remove the damper serrated retaining nut

This is a beast of a job. The nut, shown in photos 3 and 4, secures the friction plate and its hub on the tapered nose piece of the crankshaft. The taper also carries three keys



6. Cross piece in place with four nuts to be drawn up evenly to draw damper forward.

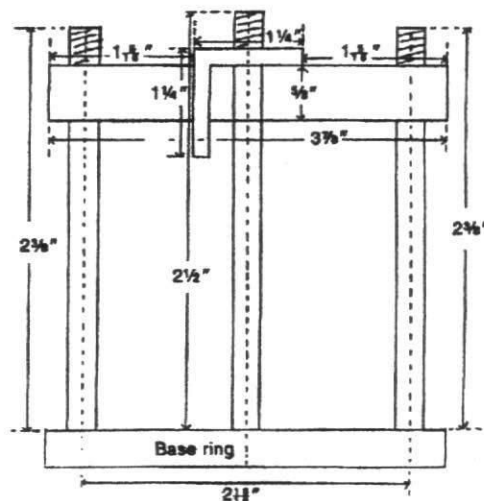
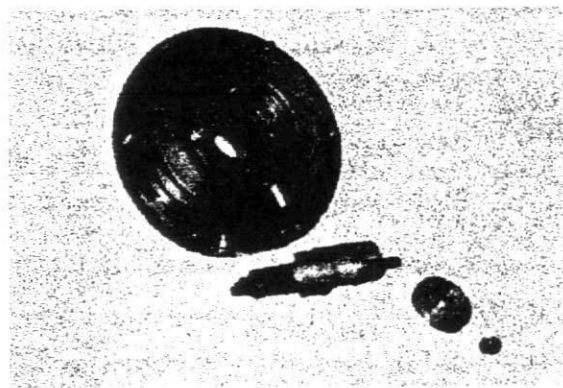
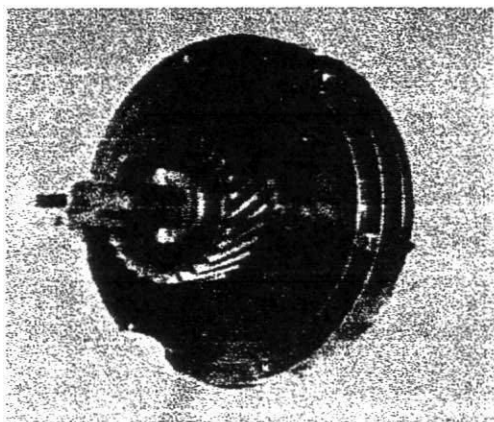


Figure 7. Puller side elevation

which positively locate the hub on the shaft. The serrated nut is locked by a tab washer. The two tabs are easily freed but you need a small screwdriver that fits neatly into the serrations. To remove the nut requires a special spanner. If you make your own, as I did, there are a couple of points to watch. I found it essential that the spanner is an accurate fit in the serrations. The nut, being extremely tight, is subjected to tremendous pressure from the spanner. Mine worked, but I failed to make the spanner serrations deep enough. I also had difficulty holding the spanner squarely in place. As a result, once removed I found the square edges of the nut slightly distorted. Nothing serious, but it demonstrated how easily the nut could be damaged beyond repair. Although Grigsby and Haynes suggest a suitable long turning bar will supply sufficient leverage I was in trouble. I found simply levering on the bar produced no result. I resorted again to the heavy hammer. Eventually the nut freed, but it was touch and go. Again, it would have been simpler with someone to hold the tube spanner firmly in place, pushed hard home against the engine. The second person then wielding the hammer could well have broken the grip of the nut with greater speed and safety than I achieved.



7. Dummy crankshaft nose ready to be assembled in damper boss.



8. Rear view of damper mounted on dummy crankshaft nose

5. Remove damper from crankshaft taper

Attach the base ring of the puller to the front of the damper from where the nose piece flange was previously removed. Use the four nose piece nuts to bolt it securely in place. See photo 5. Mount the front section of the puller over the end of the crankshaft. Photo 6 shows my own puller with a cross piece over the nose. The factory produced item uses a centre cap and bolt through the centre of the outer puller frame. With this unit the pull on the inner ring will always be even. My own puller requires great care in use to keep the pressure even. It does, in compensation, have two advantages. First the load is spread, making the spanner load very light. Second it gives good contact for using a hammer and brass drift to apply a shock load on the end of the crankshaft.

My puller suffered a false start. My habit of picking up odd pieces of material from the workshop scrap box led me into trouble. I turned the inner ring from an old pipe flange without being sufficiently alert to realise I was using a piece of malleable cast iron, not mild steel. To aggravate matters the dimensions of the flange imposed size limitations. The final result was a lightweight ring of minimal dimensions. I should, of course, have thrown it away at that stage, but having got so far decided I might as well give it a go.

In use I eventually found I was distorting the ring, not applying full pressure to the damper. Finally the 3/8in diameter studs broke the ring through the threaded holes. In photo 5 it will be seen that the replacement ring is made to the maximum possible dimensions. The four holding down nuts only just have room to be pulled home with the thread fully on thread on the stud. The material for this later ring was an off cut from a piece of structural steel. This proved very tough indeed. Difficult to work, but no doubt of its reserve strength.

During the first attempts at removal I used the hammer and drift a number of times on the end of the puller. Also, before each attempt to pull the damper off I used the blow

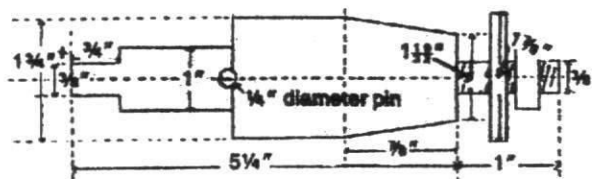


Figure 8. Actual dummy crankshaft nose

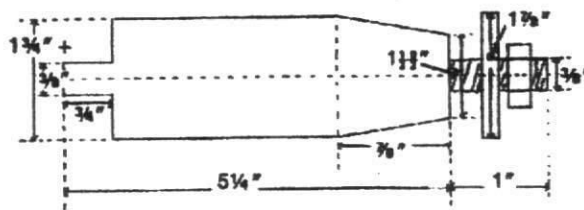


Figure 9. Suggested dummy crankshaft nose.

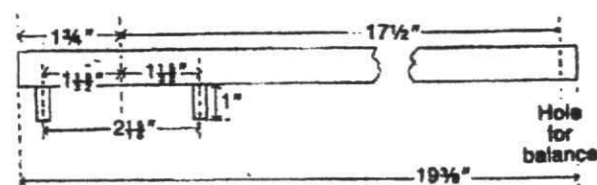
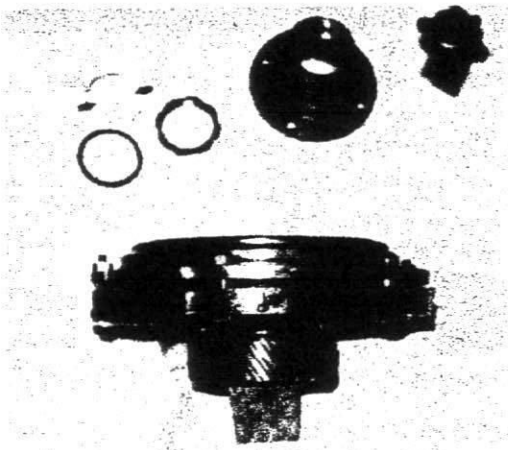


Figure 10.

lamp round the outside of the damper judiciously to try and expand the hub off the taper. All this presumably set the scene for my next attempt with the rebuilt puller. With the heavy duty ring mounted, the damper broke free quite unexpectedly as I was concentrating on pulling up the four nuts on the cross piece evenly. In fact the release was highly dramatic. There was a loud report like a rifle shot close to. This literally took my breath away. It was frightening. Completely bemused, realising only that the report came from the car, not from any outside source, I looked for something broken. I really felt I had done some mortal injury to my prized vehicle. Finding nothing, I returned to tightening down the four nuts. Only when I realised that the nuts required no more than finger pressure to tighten did the penny drop. The damper was free. Incredulous I removed it to the bench, still looking for damage. Be warned, when things go with a bang, don't be surprised.

I had read that when drawing off the damper the crankshaft pinion will advance the cam wheel two teeth clockwise. For this reason I made two marks on the timing case two teeth apart. The photos 3 and 7 clearly show this movement. I found this reference very useful.



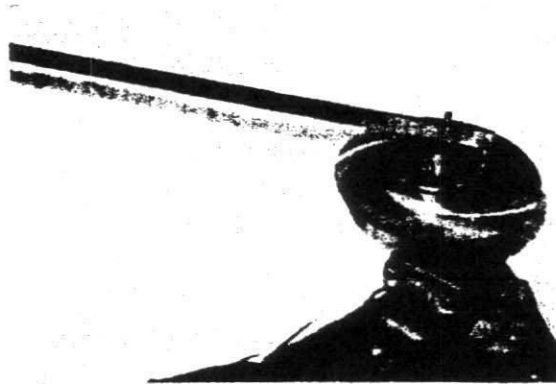
9. Dismantling the damper. Note on left the 1 1/2in bolt replacing standard 1in bolt.

6. Dismantle the damper on the bench

This is fairly straightforward. Again I used numerous correlation marks. Probably unnecessary, but I found it helpful in reassembly, and hopefully it preserved the balance of the unit.

Remove the bolts from around the periphery of the damper. These are locked with tab washers. Once all six have been slackened off I found it helpful to replace two on opposite sides with two 1 1/2in bolts. The standard bolt is one inch long and it will be noted in photo 9 that the nuts are at the end of their threads. The photo also shows one long bolt in place. In the position shown there is still quite considerable compression of the presser plate springs. Without the two long bolts, removal of the last nut will result in the damper assembly springing apart and showering bits everywhere. The two long bolts obviate this. At this stage it also helps to keep the parts together if the damper is turned upside down on the bench, that is with the gear pinion uppermost.

The next job is cleaning, the need for which will be obvious. I say cleaning, not washing, for the initial operation will be to scrape and chip out the muck. Regrettably, the oil sludge is somewhat corrosive and the working surfaces will be found rough and rusty. Optimistically, I tried a scraper and emery cloth as a means of cleaning up the surface. This proved utterly futile. Recently Graham Ashley-Carter suggested this treatment would be sufficient. I wish I had found it so. He must have been far luckier than I was. All I have read says this rusty corrosion is normal and can be corrected by having the surfaces machined. This means the presser plate working surface, both sides of the centre disc and the working surface of the rear flywheel. Note that the Rolls-Royce Manual for Post War Cars stipulates machining limits for these latter two. I found the centre disc was only just above the limit and the rear flywheel right on it. The correct procedure would have been to replace both. I looked into this and decided replacement would be a bigger headache than risking exceeding the recommended limits. So I had



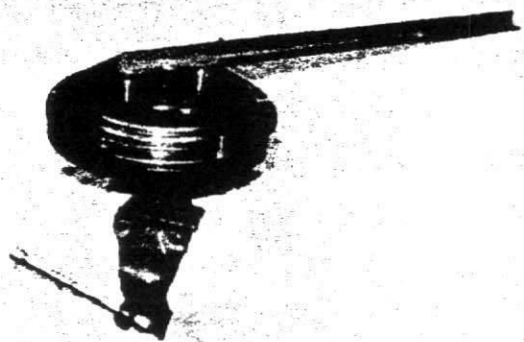
10. Poundage bar in use with driving disc and cam gear pinion mounted on dummy crankshaft nose. The bar used this way allows one spring to be decompressed and the other fully compressed. This way springs can be removed or replaced.

the parts resurfaced. The result was superb. Not so happy to contemplate were the final dimensions. The centre disc came out fractionally below the minimum. Not enough to be of concern. However, the rear flywheel has finished up considerably below the minimum. I just hope the recommendations are on the safe side.

This rather steps ahead in the dismantling procedure. Once the parts are clean the final stage is separating the centre disc from the pinion hub. This is simply achieved with a little patience if the assembly is mounted on the dummy crankshaft nose piece, and held in a vice. Using the poundage bar the springs can be levered out. See photos 7, 8, and 10. Moving the bar from one extreme to the other compresses one set of springs and releases the other. Once the first couple of decompressed springs have been prized free the remainder are easily dealt with.

7. Checking the poundage

With all the parts cleaned and the working surfaces machined the damper should be reassembled with the new friction discs in place but without the driving springs. The instructions I have read all refer to the traditional cotton duck friction washers. The discs I obtained are the later Tufnol plastic friction material. Since the damper unit has its own oil supply I carefully smeared an oil film on all the friction surfaces before assembling and testing. I found that the poundage reading at which the disc slipped was low (10lb) at first try. This is the reverse of the situation that used to occur with the cotton duck washers. These invariably gave a high initial reading. Constant working was required with the bar to smooth and compress them to obtain the correct reading. Using thin brass sheet I made a number of round discs the diameter of the presser plate springs. These fit in the recesses in the front flywheel that position the springs. I made several tries with different combinations of washers. Success was achieved with one thin washer and one thick washer (relatively speaking) behind each spring, giving the correct slip point. The book says 14lb+11lb. I finished with the slip occurring consistently at a little over 14lb.



11. Damper reassembled on dummy crankshaft nose without driving springs. Set up shown ready to check poundage with spring balance

When using the poundage bar take care that the pull applied through the spring balance is applied correctly at right angles to the bar. My bar is probably a little more tricky to use than some. It does not bolt in place. It simply uses two brass tubes soldered into appropriate holes in the bar which slip neatly over two opposite studs. That is two of the four nose flange retaining studs. It works well enough but needs some care in handling as the tubes can easily slip off the studs. Another point to remember is to pull slowly and gently with the balance attached to the end of the bar. A little experimenting will demonstrate that a violent approach will cause the balance needle to surge up the scale to say 20lb or even higher reading, and then drop back to 2lb or 4lb, by which time the damper will have reached the limit of its travel. Anyone who has experience of adjusting the old Hartford friction dampers will know that 'stiction' is almost as important as friction in this type of damper. If you try to set the Hartfords to give a nice, soft, comfortable ride at low speeds you get little damping at normal or high speed. The breakpoint to overcome the stationary inertia requires a much higher loading than that required to maintain the movement. In other words good damping at high speed is bought at the expense of a hard ride at low speeds. With the slipper flywheel a little practice will show that there is a suitably gentle pull which will produce a constant reading avoiding the unwanted surge.

8. Reassembly

This is a reversal of the dismantling routine. The first step is to replace the driving springs between the pinion hub and the centre disc. This I found a little more difficult than removal. The springs tend to slip to one side of the locating knob on the casting. Left that way they will bind up. A little care and persistence, levering with a screwdriver, is needed to seat them correctly. Make sure all the tab washers are renewed. I do not know how other people manage but here in Tasmania small specialised washers have long since ceased to be off-the-shelf items - if ever they were. Rather than phoning round and trudging from store to store, I find it preferable to get down immediately to making these

small items myself. Invariably a long, tedious job, but the simplest answer in the long term.

When assembling check the condition of the white metal bush inside the gear pinion. In drawing off it can easily be scratched or scored on the thread over which the serrated nut screws, or on the edges of the keys if still sitting in their grooves in the taper. Any bad scores can be cleaned up with careful scraping. The surface will probably be very grey. The corrosion from sludge and the limited movement combine to produce this. I scraped the surface of the bush gently to clean off the worst rubbish, checking its fit continually on the crankshaft. Once I found it sliding freely in its accustomed place I ignored the surface colour and reckoned it would continue to operate happily. In refitting be careful passing the bush over the taper and the thread. It is easy to scratch it again.

The white metal bush in the nose flange piece also needs checking. I found this bush very tight. Again with a hard crust of sludge baked to the surface. As with the gear pinion bush, I used a scraper gently to clean the surface.

The cleaned, readjusted and lubricated damper will slide back into place so easily you are left wondering what all the fight was about in taking it off. Those who have looked carefully at the photos will notice they were taken during reassembly, not dismantling. Apart from cleanliness, at this stage I felt the pressure was off. It made for much improved concentration on my indifferent camera technique. One photo shows the puller mounted with the serrated nut still in place. An obvious no no.

I found, when taking the final step of replacing the locking plate over the starter dog nut, that the holes for the set screws did not line up. This concerned me, for I could see no reason why the positions should have changed. Finally I removed the fan pulley and checked its fit and position and tried again. I achieved the same result. The screw holes in the plate were still one-sixteenth of a turn ahead of the holes in the pulley. By that time, convinced that everything was correctly assembled, I drilled new holes in the lock plate. I suppose it is just a matter of how things bed down.

That completes the overhaul notes and brings us to the bits and pieces used to do the job. Most of these are shown in photos 1, 5, 6, 10 and 11. I must stress that a number of these represent improvisations as the materials were mostly gleaned from the scrap box. Anyone following my lead needs to keep in mind the purpose of the tool. So long as the main dimensions are followed the details are of no consequence. Photo 1 shows the slogger spanner at A and the serrated nut spanner at B. The other photos explain themselves.

The tools

Starting with the slogger spanner, I made mine 11 7/8in long, 2 1/2in wide and 5/8in thick. Grigsby and Hayne suggest 8in long, 1 3/4 in wide and 5/16 in thick. I used a heavier piece of mild steel bar simply because it was on hand. The extra length was chosen to provide a hand hold

and a means of producing a double ended spanner. As photo 1 shows, the second end has yet to be cut out. I marked the bar with the appropriate hexagon at each end for the R-type starter dog and 20hp. The additional length allows the hammer to be used at the specified length from the nut centre without endangering the shape of the hexagon on the outer end. Making up this spanner requires a great deal of tedious filing. Considering the job it has to do there is no short cut. It needs to be an accurate fit. Thus the file and check routine is essential, with tons of patience.

The next spanner needed is the tubular or socket spanner for the serrated nut. I tried to make a pattern piece for this from sheet metal. This consisted of a sleeve to slide over the crankshaft, into which I cut matching serrations to the nut. Well it was an idea, but only partially successful. I was left with a basically correct shape tube with the serrations marked out very tentatively. Had the piece of tubing I used for the spanner been of sufficient wall thickness it could have been bored to slide over the nose of the crankshaft, and thus the spanner would have been centred. Another penalty of raiding the scrap box. Compare Figure 3 with Figure 4. To obtain the correct clearance over the base of the nut serrations, the inside diameter of the tube should be 1 11/16in, see Figure 3. The outer dimension should be 1 7/8in. These represent the maximum dimensions that will allow the spanner to fit into the recess formed by the inner diameter of the outer flywheel and the nut, see also Figure 4. The serration sizes shown in the sketch are very approximate only. This spanner requires more of the tedious file and check routine.

The damper puller: this consists of an inner ring and an outer cross piece. The ring is 3 3/4in outside diameter and 1 15/16in inside diameter. The thickness of the ring is 11/32in. These are the maximum dimensions that can be used, otherwise the ring will not fit in place. It has eight equally spaced holes in it. Across the centre of the ring they are 2 15/16in apart, centre to centre. Four are drilled 9/32in diameter, which fit over the studs in the damper pinion gear hub. Four are drilled tapping size for 3/8in diameter studs, tapped to take the four threaded lifting rods. I used 3/8in Whitworth threads. These rods I braze welded into place to add to the strength and rigidity of the puller. See photo 5.

The cross piece I made up from a piece of 2in by 5/8in bar, 3 7/8in in length. Another piece from the slogger spanner bar. To use a second piece of this bar brazed across the first piece I considered would be both unduly heavy and unduly clumsy, so I made up the second piece from angle iron 1 1/4in x 1 1/4in x 3/16in thick. The length is similar to the first piece - 3 7/8in. The angle piece wings are a snug fit against the solid bar and positive contact is maintained by brazing into place. Thus there is no loss of

rigidity compared with the solid bar. The outer end of each of the four arms carries a 3/8in hole spaced at 2 15/16in apart across the centre. This is also shown in Figure 5 and photo 6.

The dummy crankshaft nose: the simplest way of constructing this would be to obtain a piece of 1 3/4in diameter bright shaft and turn the necessary taper on it, and proceed from there. However, since I have included my unit among the photos, and it is so obviously different, I hasten to dispel any confusion. I will, then, describe mine, warts and all, and leave others to read the method across to a simpler unit, see photos 7 and 8. I used a piece of 1in diameter bright shaft - well it was bright originally. This came with a connecting collar drilled and tapped for several set screws. It was all part of a long drive shaft. This explains some of the odd features which can be seen in the photos.

I drilled and tapped one end of the shaft to take a screwed 3/8in rod. This secures the clamping washer which holds the damper tight on to the taper. The taper is turned on the collar to the dimensions shown in the figure. To hold the collar in position the 1in shaft is cross drilled and carries a 1/4in pin through it. This takes the thrust as the washer and nut pull the damper down on to the taper. The end of the 1in shaft opposite the 3/8in rod is cut to provide a 3/8in thick flat, which gives a good vice hold. The overall length is not of course crucial, but this length holds the damper unit comfortably clear of the vice jaws. The clamping washer is turned from a piece of mild steel bar. It is 1 7/8in outside diameter and 5/16in thick. The hole in the centre is drilled 7/16in to give a convenient working clearance.

Finally, the poundage bar. This I made from a piece of mild steel angle, 3/4in x 3/4in and 1/8in thick. This is 19 3/8in in overall length. The centre of the damper is marked 1 3/4in in from one end. From this centre mark, two 5/16in holes are drilled 2 15/16in apart and 1 15/32in from the centre mark. Into these holes I soldered two pieces of 5/16in outside diameter brass tube. These were 1in long and 9/32in inside diameter. These slip nicely over two opposing pairs of damper centre holding down studs.

From the centre mark measure off 17 1/2in towards the other end of the bar. This needs to be measured accurately. I drilled a 3/16in hole at this position for the spring balance hook. The hole is quite essential as it gives a positive location for the spring balance, at the correct distance (17 1/2in) from the centre for measuring the pull. The size hole is not of course crucial as the hook will centre on the side of the hole once any pull is exerted on the balance, see photos 11 and 15.

(B185/41)

Slipper Saga Sequel

by Michael Forrest

Graham Ashley-Carter's overview of the slipper drive and its problems winks me out of the workshop to complicate matters further, to report some confusion, some clarification, some alternatives.

Strongly suspect dampers were troublesome from the start: less so during prolonged trials such as the routine 10,000 mile tests, greatly so during the leisurely trickling round town and pottering from house to station. Suspect also they were frequently reset or renewed, unknown to the owner, when in depots for other reasons. Their own Service Sheets refer to the linings '.... the tendency for these to become hard, ingrained with carbon and superficially glazed, thus losing their original properties, makes it essential for all existing linings to be replaced by new ones at each overhaul period.'

This does not make clear what an overhaul period is - complete rebuild, top overhaul, bottom overhaul (decarbonisation). Given the disgusting properties of early lubricants and fuels, and no filtration, one suspects many a surreptitious replacement.

Uncomfortably aware of the hygroscopic properties of cotton, and seeking an alternative to the clumsy lapped joint I persuaded a local firm, modestly claiming to be manufacturers of 'Elastic and Rigid Narrow Fabrics for Lingerie, Garment, Medical & Surgical, Equestrian, Footware, Industrial and Military usage', to weave me some jointless flat rings of PhantomI size in various materials. This is a formidably difficult task, and they were not able to weave these but produced essentially the same thing by programming an embroidery machine to embroider some for me. For comparison, some were in cotton, some in polyester thread. The latter has a feel just like cotton, but is the least hygroscopic of all the man-made fibres.

John Crofts, a former Rolls-Royce engineer long living in the USA, specialises now in torsional vibration problems and has sent me fascinating factual data on the Mk. VI Bentley installation. You may guess he has a Mk. VI. Now this late six cylinder engine has just the same fundamental problems as the earlier Royce Sixes, with their comparatively flimsy crankshafts, but the magnitudes of vibrations are smaller, while the frequencies and engine speeds of onset are correspondingly higher. He has had recommended to him by Hoerbiger GMBH a friction lining HO-101D, as being suitable for Rolls-Royce type dampers. This is a porous cellulose fibre/Kevlar sheet material with a notably small gap between static and dynamic mu values (i.e. stick and slip are close together). John has kindly sent me samples to try in 37LC. His expertise shows us up for the amateur dabblers some of us are, and if I cannot persuade him to write an article showing with his superb graphics what really happens to a crankshaft under various conditions, then I shall one day attempt to assemble such an article myself from the data he has sent me. As a further

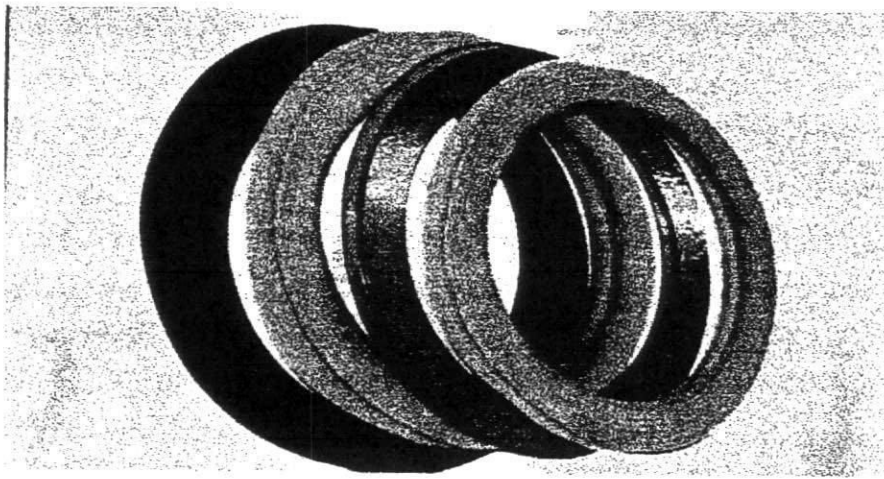
aside, John's father, Jack Crofts, was apprenticed to Eric Platford, and served in the early days with Mr Royce, later serving as part of the team based on Chateauroux. There are several fascinating articles, now in Peter's hands, and they may see print later.

Armed with five different combinations of material, static testing of each, of unbelievable tedium, begins. Oiling, pressing, setting, dismantling - each time that a ring of twenty bolts to be inserted, screwed up, adjusted, removed. Results are dramatically clear, with cotton wicking showing just a dip of about 1/2 lb as it slips, while all the others oscillate rapidly and harshly by several pounds, too quickly and unpredictably to read accurately.

Tufnol remains the worst, although the Hoerbiger HO-101D is almost as bad, which surprised me. The embroidered cotton and polyester behaved similarly, better than Tufnol or HO-101D, but were both poor. These latter results were paradoxical for it suggests that the type of weave is more critical than the material used. I tried to find figures for coefficient of friction of cotton on steel, without success, but found a clue in figures for woodblocks on steel. There is a significant difference between behaviour of wood when movement is parallel to the grain compared to cross-grain or endgrain. In wicking, the grain - threads - are all substantially oriented in the direction of relative movement and parallel to the fine grinding marks. As an example would you rather drag a load along or across the furrows of a ploughed field? And would you rather drag it lengthways or sideways? It is difficult to explain otherwise the difference between circumferential woven cotton and radially woven (embroidered) cotton.

Other possibilities are that the longitudinal threads are mechanically stable, with just a small amount of elasticity to smooth the transition between slip and stick, while the radial threads, having little stability in torsion, start to roll under movement, moving easily initially until fully wound up, when rotation ceases, abruptly locking until further increase of movement promotes slip. The thread unwinds partially, starts rolling again, locks, slips...etc., giving harsh juddering. This suggested that a polyester thread, woven with circumferential pattern would be as good as cotton, but without the water retention. Alas, so far it has not proved to be possible technically to make them this way.

My initial articles on the slipper drive (B212/52-59 B213/40-45, B214/38-46) stressed how important it was to halve precisely the thickness of material at the lapped joint, and to fit it precisely end to end so that thickness and bulk at this joint was exactly as in the parent material. This way, ironing the joint flat becomes redundant and all that is needed is to bolt the flywheels up tight overnight to consolidate the material. Ironing a bodged overlapped joint of double thickness cotton is going to create forever a non-homogeneous area which even if consolidated is of a different density and will always behave erratically



Variations on a theme

Above, left to right, the Hoerbiger GMBH HO-10ID porous damper rings. Note matt, non-directional surface. Next, for those without colour, is the pale blue polyester fibre ring. While there is an apparent circumferential pattern, individual threads run radially, i.e. across the direction of movement.

Third across is the Tufnol rings we all know and hate. Totally devoid of any directional grain, it is almost entirely dependent on fleeting and ever-changing state of the oil film - from fully-floating when oil intervenes between any two surfaces, to harsh binding when it is effectively squeezed/centrifuged out as engine conditions and temperatures change.

Do not forget that damper performance depends on no fewer than eight individual surfaces (four on the

two damper rings, four on the flywheel faces) and any tendency to instability can be cumulative as well as cancelling. As the Service Sheets from the 1920s summarise - smoothness is far more important than extreme accuracy in setting.

Last in the sequence is the cotton damper, of similar radial weave to the polyester damper, and with the same disappointing performance. The fifth sample, the original lampwick jointed ring is back on the engine, because of its greatly superior smoothness in transition from stick to slip.

The logic, of course, is that we must try to find a way of producing a polyester ring with circumferential rubbing surface.

especially as differential wear and settling takes place. Matter can neither be created nor destroyed, and while you may not believe it, that applies even to Rolls-Royce dampers. That bodged joint is never going to go anywhere, so make a carefully lapped joint. I stress this as I have seen on some trade stands since cotton became fashionable again double thickness lapped joints. Unbelievably, they were so made to save the few shillings extra which the half-lap costs. This on cars worth tens of thousands? On damper relines costing . . . ?

On a different tack, I have seen cotton liners cut directly out of flat cotton duck material, with an inevitable and unpredictable change of relationship of radial and circumferential threads around the ring. One wonders not only how they will behave, accepting two and three paragraphs above, but how they will distort in use.

It is significant that those who were dealing with these dampers on an everyday basis when early cars were current made two points:

'The smoothness of action is of course far more important than extreme accuracy in the poundage setting. It is important also that there should be the proper relation between the poundage required to break and the poundage

required to cause the flywheels to turn steadily. If the load required to break is more than two pounds above the sliding load a tendency to stick is indicated which is likely to grow with use.

'In working on a slipper removed from a Phantom car previous to the FM series the friction discs should also be replaced with a set of jointless woven discs such as are now used.' (This applied to Springfield production but the same laws of physics affects Derby chassis. The jointless discs were available in the USA and fitted whenever cars came into the depot. Derby never got around to jointless discs and continued to attempt to destroy matter by obsessional ironing to the end.)

Springfield also did the obvious thing and fitted a plugged hole in the wheelcase. A seized flywheel could be spread with a screwdriver through this hole in seconds. Derby endured the unbelievable labour of dismantling most of the front end of the car to achieve the same. It is, of course, unthinkable that anyone rebuilding a Phantom would discretely incorporate such a plug in the wheelcase or place it in such a position that the slipper can even be readjusted in situ in a few minutes!

Nevertheless, the problem of moisture retention remains

unless it becomes possible to make polyester woven linings behave themselves. There are palliatives: I suspect that modern oils, regular changes, sensible use to avoid short runs will help. While some drivers may have little choice unless a high temperature thermostat is available. New Phantom owners have manual shutters and can choose to run engines at 92 degrees instead of 72 degrees minimising condensation and boiling off minor leakages rather than have moisture condensing in the relatively cool wheelcase.

More radically most early engines are poorly ventilated internally and on major rebuild it would seem prudent to improve ventilation between wheelcase and tappet chest, between individual tappet chests and thus to the rather mean and inadequate breather passing into the induction system. Similarly, drains from the slipper flywheel interior itself must be cleared and even perhaps eased and duplicated.

Perhaps the most helpful aid to keeping the damper dry is full-flow filtration. De-watering systems are available but only separate from filtration and this make an unacceptably obtrusive installation. The makers of most replacement filter elements tell me that while, as far as they are aware, no filter element made will also remove traces of water from oil by filtration, they will remove small but significant quantities by absorption into the paper

of the element itself. In excess this will cause collapse of the element. Moral - change filter elements frequently. An aside on sizing of filters for our engines: a Phantom I pump at maximum engine speed passes 175 gallons/hour if in perfect condition. The little Crosland (now Filtrato) 2021 filter unit, as fitted to the humble Ford Fiesta, has a maximum rated flow of 400 gallons/hour so is amply large for Phantom. Moral - you can afford to buy them a dozen at a time and change frequently to soak up any water which might dampen your cotton damper.

While we are moralising the point is made that you can either fit the very smooth cotton damper and be prepared for more frequent maintenance, but have your car run with incomparable silkiness, or fit a less troublesome damper but be prepared for a rougher ride.

You have to accept that running a Rolls-Royce, old or new, is going to cost rather more than running other makes. You will disappoint yourself and others if your car is not always at its best.

I suspect that the most significant factor is orientation of surface grain with direction of damper movement, coupled with resilience. These qualities are difficult to duplicate in synthetic unwoven materials, although I am happy to be convinced.

PS

The firm of M Wright and Sons Ltd, who made the seamless dampers for me, appear to be as staid as one might wish - their products quoted bringing to mind images of garters, braces and surgical trusses. While this is true, it also hides a high-tech side, having strong links with Rolls-Royce.

Those who strapped early jet engines to their bottoms and were paid to go away and play with them will recall that they frequently flew apart. At speeds measured in tens of thousands of rpm such disruptions were contained by sturdy metal rings, which allegedly prevented said bits from spoiling the pilot's day. As engines became bigger

and more powerful, these containing rings became unacceptably heavy.

One bright spark, clearly a cricketer, realised one day that a light and flexible net was highly effective at stopping a rapidly moving and hard object. The eventual result was that out went great iron rings, in came a thing not unlike a string vest, but made of more suitable materials such as Kevlar or carbon fibre. Such string vests are put around the engines, of course, not the pilot.

M. Wright and Sons Ltd., of Quorn in Leicestershire, make these high tech jumpers for current Rolls-Royce plc engines. (B226/58)

From the Hythe Road files

ROLLS-ROYCE 20/25 HP

CHASSIS No. GED22

Although it is rather difficult to offer a positive diagnosis without actually testing the car, it is thought that the clicking noise complained of is due to derangement of the cam balancer.

The cam balancer consists of three spring loaded plungers mounted in a housing behind the cam wheel, and its function is to damp out minor camshaft oscillations. Normally the balancer requires no attention in service during the overhaul life of the engine, but occasionally over the years cases of spring breakage have been observed. Remarkably, the symptoms have always been described here in the exact words used in your letter.

To gain access to the cam balancer, it is of course necessary to take down the radiator, the timing cover the crankshaft vibration damper and finally the cam wheel. Before extracting the damper the flywheel should be turned to Top Dead Centre and a suitable mark made on the meshing teeth of all gears; the crankshaft pinion is inaccessible and cannot be marked but realignment of the marks on the remaining gears will restore the valve timing at the TDC position.

R. Haynes
(B216/37)

Dynamic adjusting

I was most interested in the article by Marsden B. Robinson, FCA, B209, page 35.

Similar tappet problems have beset my own car, a Mk. VI, N series. With regard to the inlet tappets, I assume Mr Robinson sets his clearances with a stationary engine.

To take up all slackness, and obtain a truly silent tappet, I have seen tappet adjustments carried out with the engine at slow tick over. A two-handed job, since it is advisable to have an assistant poised to switch off the engine should a sudden need arise. However, I noticed results were exceptionally good in terms of silent, smooth running. This was with a heavy commercial petrol engine, where accessibility was difficult, resulting in a 'hot' adjustment being carried out on a fast-cooling engine, and it was the only way of obtaining a fully hot situation.

I am frankly apprehensive about this method since there may be an element of risk attached to it. Yet the prospect of a truly accurate adjustment, allowing for wear in the valve gear seems attractive.

I would very much like to have Mr Robinson's reaction to this 'dynamic' method of adjustment.

John T Dean, Dorset.

(B210/71)

PIII petrol evaporation problems

by Stanley Barraclough

On thinking about this problem that modern, very volatile petrol has thrust upon us, I experimented with one of my cars by stopping the very hot water from the cylinder head water rails going through the inlet manifold below the carburettor.

The result was quite astounding. After running the car for about twenty miles I stopped and felt the water rails. These were very hot indeed, but the induction manifold below the carburettor was only warm and you could easily keep your hand on it. I then returned home and let the car stand about fifteen minutes and checked the temperature again, but the manifold had not absorbed any heat. Thus the whole carburettor stayed cool and I think this must help the evaporation problem.

I cannot detect any difference in the performance of the car, but what I did note was that it was running at about four or five degrees cooler and then I realised that with the normal system the water pump is receiving very hot water from the top rails via the carburettor manifold and mixing it with the cooled water from the radiator, thus making the water hotter than it need be when it is re-entering the block. I shall have to close my shutters a little to get the engine temperature back to normal.

Modern cars do not have heated inlet manifolds and now that petrol is so volatile our old cars do not need them.

The modification is very easy. Drain the water, unscrew the union where the pipe goes into the water pump. Take a 5p piece and hone it with a suitable tool so it fits neatly over the hole in the union. Screw the union back into place and fill with water. Check for leaks and away you go.

(B205/49)

Cylinder Heads

To bring this subject up to date, the project run very successfully by Richard Shaw still produces Twenty hp and 20/25 heads. Philip Fulford has 25/30 heads in production. For some years Frank Cooke in North Brookfield, Massachusetts, USA, has been producing superb heads for 3½ and 4¼ Bentley, 20hp, 20/25, 25/30, P1 and P11. The specification Frank offers is either with all valve gear etc. ready to bolt on and tested on a slave engine (see Advertiser) or to his specification below.

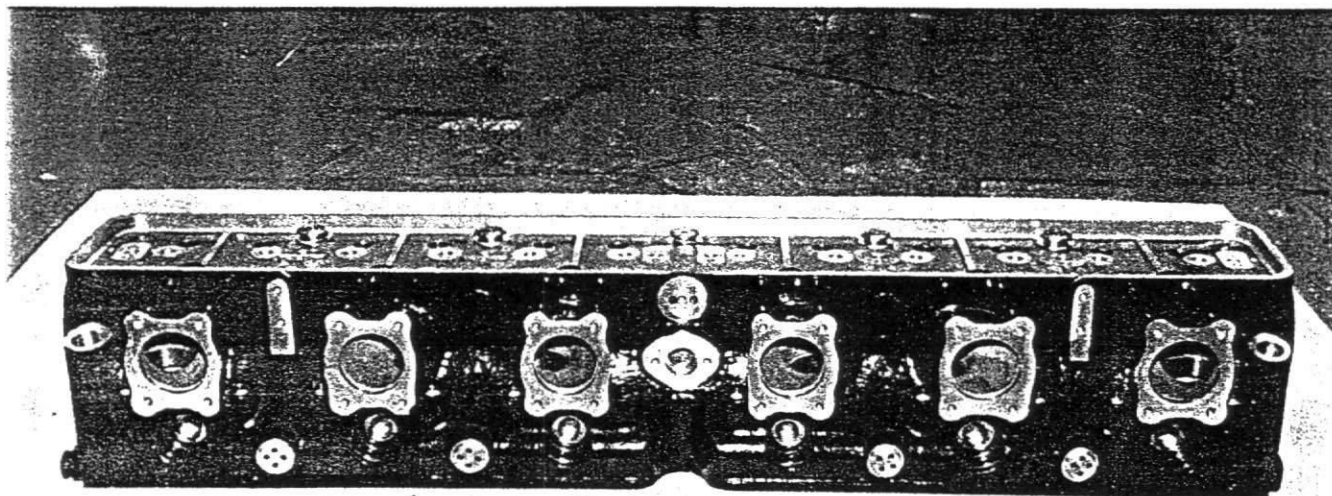
"We offer Phantom I and Phantom II heads completely machined. The contemplated price is \$4,000 (U.S.). All holes threaded to fit original studs. All core plug holes threaded standard. Steel spark plug adapters installed and firmly duckmaned. Twenty-four angulated holes for the twelve pushrods reamed. Twelve stellite valve seats shrunk in tightly and the aluminium is rolled over into top outer bevel. Not machined for the circular lip of your valves. Five-eighths inch diameter hole central to the stellite seats.

You can taper ream this for original guides or open up for modern cylindrical guides with teflon seals. All heads checked for leaks at 20lb. Extra charge for twelve copper tubes, installed and checked for leaks at \$350 (U.S.). We can install modern guides and ream to fit your valves. Also machine the stellite seats, and maybe reface your valves. All this is expensive, so you can save considerably if you can do it yourself." Of course, to the price quoted must be added transportation and import duties, not helped by a weak pound.

Unfortunately, the flier with B141 on blocks and heads carried a typographical error, quoting the price of Nick Whitacker's P11 heads as £1,600. This should have read (as advertised) £2,500. Several have already been sold. The specification is as follows and the photograph indicates the high standard of finish. Nick says:

"The head, which we are producing, is cast in LM25 aluminium and has been produced as an exact copy of the Rolls-Royce head, without modification, so that the whole job looks 100% authentic. I am enclosing a photograph which shows a finished head, although we are also supplying all the studs which are not illustrated. The heads are fully machined and have screwed-in valve seats and guides which will enable buyers to fit their existing Rolls-Royce valves if they wish. However, we are also able to supply valves at £15 each, and end plates if required. Plug inserts and core plugs are also of a Rolls-Royce pattern. The heads are pressure tested

Whitaker/Ellis P11 cylinder head.



and ready to receive valve gear. We have orders in hand which will keep us occupied until about April/May 1984 but will be pleased to receive further orders on which we will be able to quote a delivery date at £2,500, delivered in London."

The PI and PII cylinder *block* project by John Cockayne is going well and details will be published as soon as possible. It is safe to place orders with John Cockayne now. Unfortunately, the returns of the Bulletin flier do not help much as nearly all those received are ticked in the 'possibly' column, which does not encourage heavy investment. The PI *head* project may therefore not get off the ground. No demand — no heads!

EB

Prewar Bentleys and others

Are you missing a bit in the head?

PART ONE by David Mico

There must be three sorts of Club members. Some must be grappling with cracked cylinder heads. Others, perhaps, have got the old girl masquerading as a company car, and she has been treated to a pricey new head. But most of us, fingers crossed, must be soldiering on with the original one.

Over fifty years, however, much hammering by the valves, together with energetic grinding, has pocketed the valves by a considerable amount. As a consequence the valve stem is poking out too much from the top of the head. The rockers are cockeyed and their geometry is awry. They are pushing the valves sideways, and the valve guides are getting much extra wear.

And when the camshaft designer had finished his

deliberations, the valve spring maker had produced a spring which would stop the tappets flying off the cams. With all the valve wear, the 'installed valve spring height' is now a mile out. The correct 'installed valve spring height' is 1.48in (plus 50 thou.). More about the 50 thou. later, in part two.

The idea, therefore, was to make new valves to suit the new conditions. For many and various reasons it was not easy. The official works drawings for the original valves are missing, although they may even yet be found in the still-unsorted archives. There are no stocks, and Appleyard Rippon, instinctively scenting danger, is not making any moves.

So an attempt was made, using some judgment, present-day practice and sacrifices to the goddess of luck, without whose co-operation no human endeavour can succeed. It was at one point, when she happened to be looking the other way, that disaster struck, but more of that anon.

The inlet valve was made of silchrome (EN52), a good acknowledged valve steel based on silicon and chromium. The exhaust valve is 21-4NS, which has been around for twenty years or so, and is an austenitic stainless valve steel. It is extraordinary how metals are like human beings. This one just will not associate with cast iron valve guides. They literally rub each other up the wrong way. 'Scuffing' takes place. On the other hand, chromium and cast iron simply love to work together. So the exhaust valve stems were chromed. And chromium lasts ten times longer than steel, which is another plus point. You could, of course, have chopped the valve in half, and friction welded the top half to a more amenable valve stem, but we won't go into that. Or you could make aluminium bronze guides, but with Rolls-Royce cast iron spares in stock we won't go into that either.

The inlet valve stem end was flame-hardened. The exhaust valve stem end was scooped out and stellited, because you cannot harden the austenitic steels, although they work-harden.

The valve stems below the head were at first undercut by 35 thou., because this improves the charge flow by 10%, until the larger diameter comes out of the valve guides, gets in the way, and spoils things. However, a 35 thou. reduction looked rather frightening, so this was reduced.

Perhaps it should be noted here that austenitic steels such as 21-4N or KE965 (used on Mark VI exhaust valves) require 50% more tappet clearance than the EN52 on the inlets. This is important!

In part two will be shown the fully-dimensioned works drawings for both inlet and exhaust valves, together with how disaster struck the first set of valves made.

Prewar Bentleys and others

Are you missing a bit in the head?

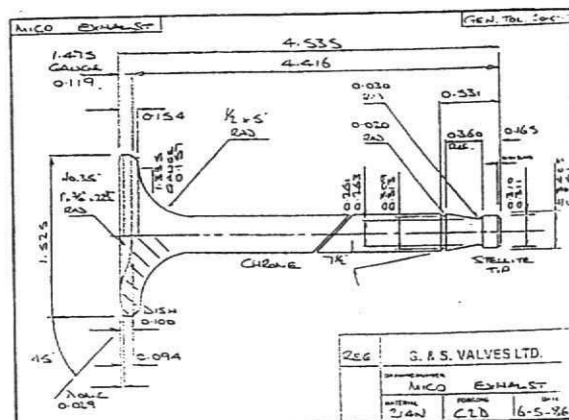
PART TWO by David Mico

Rolls-Royce love 'Arrangements'. Everything has its 'Arrangement'. There are even 'Arrangements' which they forget to tell you about. For instance, you have never heard of 'The Valve-Train Silencing Arrangement', but it is there all right. As it does not seem to have ever been explained before, let us discuss it.

We start with that huge inexplicable boss on top of the valve guide. The diamond-shaped asbestos piece sitting on top of it is usually called a valve seal. But this is a very minor function. In fact some engine designers refuse to have any sort of seal on their exhaust valves. Primarily, the piece of asbestos is a sound-deadening device to minimise the clatter going on in the rocker chamber.

The valve spring cap, unlike any self-respecting cap, which sits on top of the cylinder head, in this case sits on top of the asbestos piece. The asbestos piece has now assumed a much more important role than that of a mere seal. So you must forsake the odd bit of asbestos string wrapped round the valve stem. When new the asbestos 'diamond' is 365 thou. deep, but after some use it settles down at 315 thou., which accounts for the +50 thou. on the 'Installed Valve-spring Height' given on the RR drawing. Appleyard Rippon, please note always to stock these asbestos items!

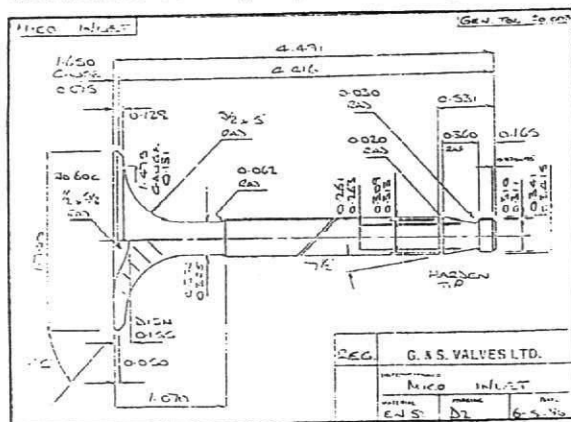
When G. & S. Valves Ltd. made the first set of valves, the length given to them was based on dimensions from a bare cylinder head. The valves were, of course, far too short, because the valve spring cap was found to be sitting atop of the valve guide boss.



It must be emphasised that the second lot of dimensions given on the G. & S. drawings are for one particular cylinder head, but they provide the basis for general thought. Above the valve seat on the valves is a vertically-sided section called the 'margin'. The exhaust valve is longer overall than the inlet valve because above its 'margin' there is a further section called the 'dome'. This is necessary to stop it turning inside out, under its arduous working temperatures.

Regrettably, this particular engine will not burst into life for quite a while, so further comments are delayed for the time being.

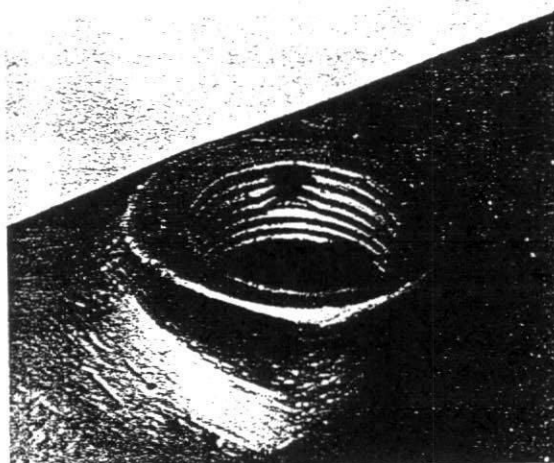
G. & S. Valves Ltd. are at Catteshall Lane, Godalming, Surrey.



Prewar Bentleys and others — cylinder head care

by David Mico

If you had to clean several cylinder heads a week you would quickly detail someone to design a commercial setup to cope. So the concentrated acid treatment evolved. It is dangerous and not very efficient. See Richard Lowe's comments in Bulletin 135: 'Far from clear after 30 hours'. If you have just your 'one and only' to be done, a safer and better job can be done mechanically. And it can be quite amusing. How many holes would you need in order to introduce your sundry weapons, such as pencil wire brushes, screwdrivers and the like? Twenty holes? Or thirty, forty, fifty, sixty? Sixty! That's ridiculous! But not so. Sixty is the number of holes into which you can poke. Not including $\frac{1}{4}$ in threaded stud holes. It might be best to

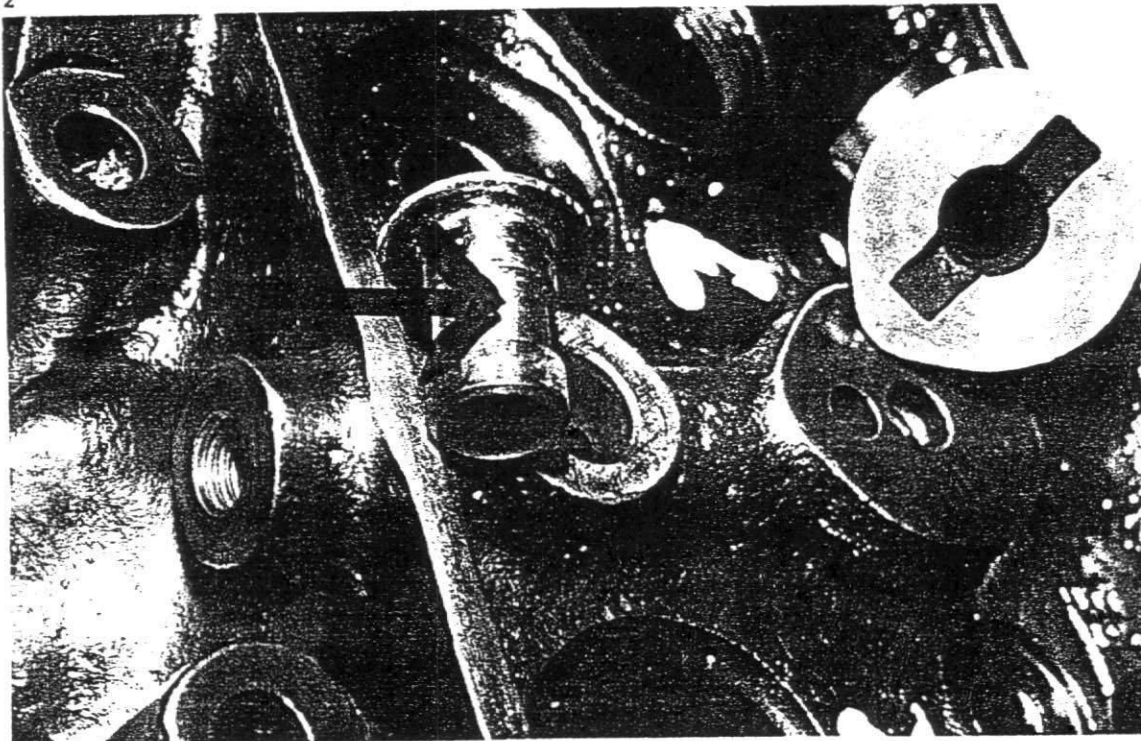


1

leave the two core plugs in the rocker chamber in position, since the handle of your pin spanner would need to be cranked in order to lie flat on the core plug. You can reach the area below the plug from other directions anyway. This also applies to the two plugs in the tappet chamber of the block.

In your battle with the core plugs, as you increase the pin size in your spanner watch carefully that you do not reach the point where you drill into the thread in the head — see photograph one. But do not feel too

2

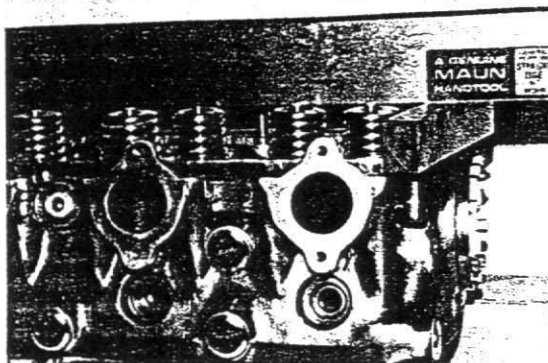


conscience-stricken. The professionals do it too and Hylomar, together with the new aluminium washer, will seal the new coreplug soundly.

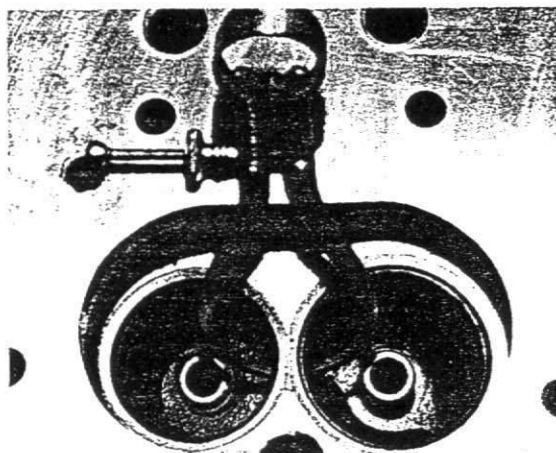
It is also worth levering out the piece shown in photograph two, which is in the oil supply to the rockers. It is not possible to get at this area otherwise.

Coming to the matter of de-pocketing and grinding the valve seats, whatever your instructions, the engineer, unaccustomed to geriatric cylinder heads, will merely give you first class valve seats. If you have new valves, where the distance from the valve seat on the valve to the valve stem tip is identical, you can fit them temporarily without seals or spring clips. Put a precision block at each end of the cylinder head and place a straight edge on them. With a feeler gauge you can now measure the gap between the straight edge and valve stem tip — see photograph three. Variations will be as much as 35 thou. or so. You can now return the head for further treatment, giving specific instructions for each cylinder head valve seat. You will finish up with the same size bang in each combustion chamber! To compensate for the de-pocketing, skim 20 thou. off the cylinder face. But check that someone has not already skimmed it. In an article on Derby Bentleys in *Motor Sport*, dated July 1968, an enthusiastic writer (with the initials of a current member!) suggests machining off 60 thou., and this may perhaps already have been done to yours!

Finally, photograph four shows a small pair of calipers across the wall between the inlet and exhaust passages. The wall is only $\frac{1}{4}$ in thick. The incoming charge on the one side of the wall can be decidedly cold, while the exhaust flame plays on the other side. One must wonder if an aluminium head can endure this treatment in the same way as cast iron. Harry Grylls has said: "One problem never receded, and if anything became more menacing." It was this bridge he was talking about. They sure left it until the last moment before putting the exhaust system down the side!



3



4

Timing gear setting up — 3½ Bentley

The Technical Co-ordinator, Peter Perrow, handles a substantial number of queries dealt with by our technical consultants. Copies of the replies are collated and will be incorporated in future technical manuals. We will publish from time to time relevant extracts. It is apposite here to offer our very sincere thanks to our consultants, many of whom go into great detail and obviously spend much time and thought on their replies to queries. In this case the consultant is Peter Grainge Jackson.

The dynamo drive

Description

The dynamo drive is mounted on a hollow post bolted to the crankcase, and runs in mesh with the cam-wheel. The pinion is bushed and further supported at its front end by a ball race, which is secured by a locked nut to the stationary intermediate spindle passing through the pinion post. The intermediate spindle is flanged at the rear end to provide an oil seal in the pinion post, and is tubular to accommodate the dynamo coupling spindle which is connected by means of flexible couplings to the front end of the dynamo pinion and to the armature shaft.

The dynamo drive brakes, consisting of a pair of spring-loaded Ferodo blocks, are located in guides in the timing cover and bear on the cylindrical front extension of the dynamo pinion. To remove the brakes, the two small covers on the rear side of the timing cover must be taken off, allowing the brakes, guides and springs to be drawn out.

Dismantling

Having removed the timing cover, disconnect the coupling from the front end of the dynamo pinion by undoing the three castellated nuts; the three plain nuts are peened in position and should not be removed. Undo the centre nut and draw the coupling off the driving spindle; the dynamo may now be released and removed complete with the driving spindle and rear coupling. Then, undo the nut in the front recess of the pinion and tap the hollow intermediate spindle out towards the rear. Withdraw the pinion complete with the ball race, taking care of the distance washer behind the bearing inner ring, and drive the ball race and coupling flange forwards out of the pinion.

Unless a seizure of the pinion bush has occurred, it should not be necessary to take out the pinion post, but examination and cleaning of the oilways should be carried out.

Reassembly is the reverse of the foregoing, except

that with new components it will be necessary to adjust the thickness of the distance washer behind the ball race so that the pinion rotates perfectly freely with the minimum of end float.

The distributor and water pump drive

Description

The distributor and oil pump drive spindle is a hollow shaft with an integral skew gear, mounted in a ball race and a bronze bush at its front and rear ends respectively. The driving pinion, which is internally splined at its front end, is keyed to the hollow spindle and secured by a locked nut. The water pump drive spindle passes through the hollow spindle and is keyed to a splined coupling disc engaging the internal splines of the driving pinion.

Oil retention is effected by an Acme thread on the rear end of the hollow spindle running in register with a square plate bolted to the crankcase immediately forward of the water pump flexible coupling. The forward face of the plate is furnished with an annulus registering with an oil drilling communicating with the sump. Oil leakage from the water pump drive can usually be rectified by cleaning out the Acme thread and the oilways, unless the crankcase compression is excessive.

Dismantling

With the timing cover, idler gear, water pump and the distributor (complete with the ignition governor) displaced, remove the castellated nut on the forward end of the water pump drive spindle and tap the spindle out through the rear of the hollow spindle. Pull the splined coupling out of the gear, taking care of the spring washer behind it, undo the nut on the distributor drive spindle and withdraw the pinion by screwing a pair of ¼" BSF forcing screws into the holes provided.

Take off the bearing retaining plate, and the oil finger plate at the rear of the housing, and drive out the hollow spindle together with the ball race in the forward direction.

On reassembling, a clearance of 0.003" to 0.005" must be obtained between the rear face of the pinion and the ball race inner ring, with the forcing sleeve in position on the pinion. Care must be taken to obtain a uniform clearance between the hollow spindle and the finger plate to effect oil control at that point.

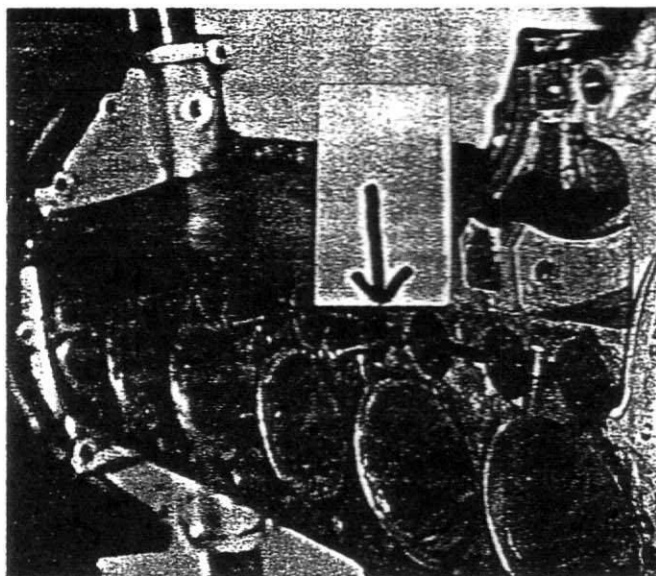
The idler gear

It is unlikely that the idler gear will require attention in the normal course of service, although its removal is necessary if attention is given to the distributor and water pump drive bearings.

To remove the gear, take off the flanged securing nut and pull the gear off the post. It will be observed that the post is mounted on three studs and located by

a pair of $\frac{3}{16}$ " dowels and should it be necessary to relocate the post, the dowel holes in the crankcase must be plugged with aluminium pegs and redrilled using the post as a jig. This work would only be necessary if a replacement idler gear were fitted, and adjustment of the backlash is required.

The correct end float for the gear is 0.003" to 0.005" and the boring sizes for the bush are: rear 0.750" (± 0.00025 ") and front 0.567" (± 0.00025 ").



The confessions of a stud remover

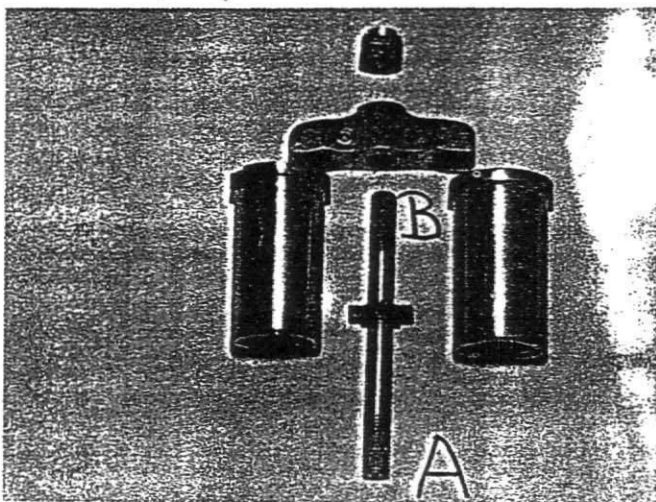
by David Mico

You have reduced your engine to its basic major lumps and it is time to consult the Club's Haynes and Grigsby book again. What is immediately apparent is that your engine looks like a terrified hedgehog, with studs sticking out in all directions, while those in the book are decidedly svelte. Wishing to emulate the mighty, perhaps we should take all these studs out. Caution, however, is called for.

The professionals leave studs where they are. Chiefly because the cost sheet looks extremely sick at the end of the day if you have been unprofitably messing about with broken studs.

Either a stud will come out, or it won't, but whichever way the Sykes Pickavent tool is essential. Unfortunately $\frac{1}{4}$ in is the smallest. Jamming two nuts together on the stud will remove those studs which have already decided to offer no resistance. With the others you will just lose your temper.

So let's look at that inviting row of studs on the top of the crankcase. Turning one of these results in a sharp crack as it snaps. Further investigation reveals that this stud does two other jobs at its other end (see

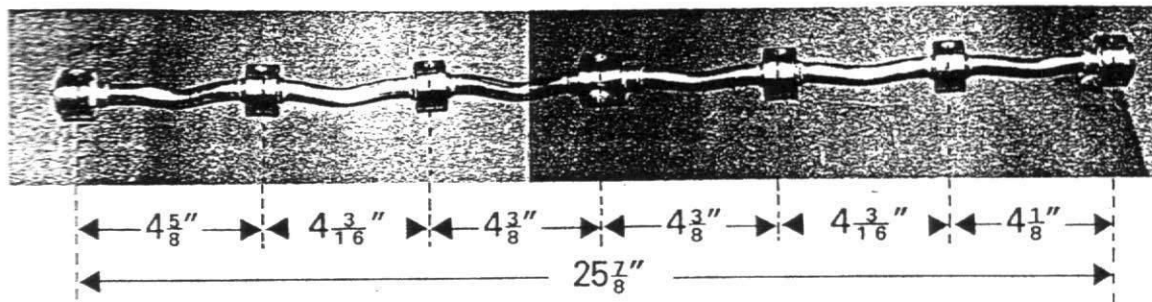


Key to picture:

A. This is the visible end of the stud.

B. A castellated nut screws on this end. The key half way along the stud locates the tappet guides on each side, and the bridge piece holds them down.

picture). It also disappears down its own hole, which is at least original. Let's have a change and look at that row of waisted studs that hold the rocker shaft to the cylinder head. On many modern engines those are pressed into plain holes, where they frequently proceed to loosen off. If you tried to remove these studs on your engine, and it is not recommended, you would only get three out. The holes for these three go through into the exhaust passages. All the others are drilled through into the water chamber and are irretrievably rusted in for good. Why drill right through▷



TECHNICAL SECTION

Prewar Bentleys and others: the oil gallery

by David Mico

There are times in this restoration game when you feel slightly sick. For two reasons. You only half-understand what you are doing, because there is no official technical data whatever. Also you are acutely aware that spares are non-existent.

So let us take a look at that bogey, the oil gallery, which feeds oil to the seven main bearings. Haynes/Grigsby tell you to leave it alone. But what sort of restoration is it if you leave various assemblies to stagger on for another fifty years? If we could understand it in detail, then it would become a straightforward soft-soldering and tube bending exercise. But only if you have all the facts.

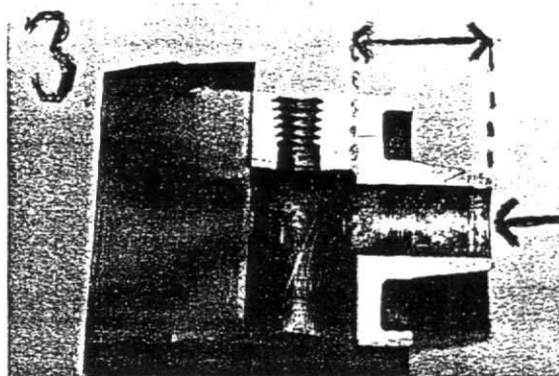
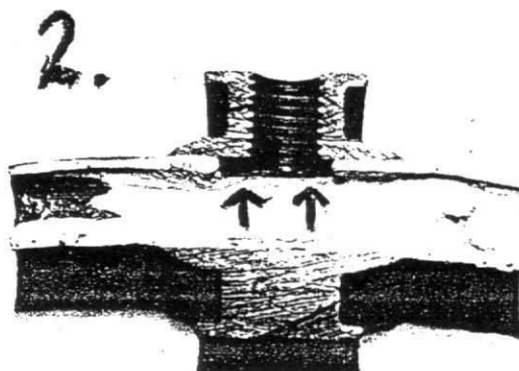
Our armoury consists of a brand new, unused genuine Rolls-Royce oil gallery (now where the heck did he get that from?), plus the one which it replaces, and which has been dissected for this article. The new one should perhaps be in a glass case in a museum, but it will shortly be fitted to CUK99, an MR series car undergoing restoration from the nuts up.

Let us start with the tubing, which is not copper, as stated in 'Small Horsepower Engines'. It is $\frac{7}{16}$ in outside diameter seamless brass, with wall thickness of 18 standard wire gauge, which is 0.048 in. This is freely available from model engineers suppliers, but get the right wall thickness, as others are available.

The next point to note is that there are only two lengths of pipe, one on each side of the centre fitting. Not six, as might appear at first glance. Five eighths of an inch of the pipe is soldered into one side of the centre fitting, but then it goes *straight through* the two intermediate fittings and ends up $\frac{1}{2}$ in into the end fitting. At each intermediate fitting a piece of the pipe is cut out to allow the oil to exit and feed that particular main bearing. Photograph two is of an intermediate fitting slit in half, and the pipe, painted white for clarity, passing through. Photograph three shows one side only of the centre fitting, without a pipe fitted, but showing where it fits. Clearly, the bending

of the pipe has to be done *after* the soldering. Perhaps, as double insurance, an external tube bending tool could be used, with also a spring-type tube bender inside as well. There is also the hole in the outer circumference of each fitting to be arranged accurately in line with the others. In the centre fitting it is the *plain*, smaller hole, which has to be lined up with the *threaded* holes in all the other fittings. And the holes face in exactly the opposite direction to the outward bend in the pipes.

After the pipe has been bent, it then assumes the grandiose title of an 'expansion pipe', or at least a 'mini-expansion pipe', for a steam one has a huge bend in it. However, with our pipe the curve must be limited to something less than the diameter of the fittings, because it has to winkle its way through the



housings for the fittings in the crankcase. The bend on the new Rolls-Royce gallery is fairly freehand, varying between $\frac{1}{4}$ in and $\frac{3}{8}$ in below the outer diameter of the fittings.

The duty of the 'mini-expansion pipes' is a fairly modest one. They have to accommodate the 20 thou. lengthwise expansion of the engine when hot. So each bend has to unbend about 3 thou. when hot. Also working for you are the holes in the crankcase, which give a 30 thou. clearance to the securing tubes which hold each fitting, except the centre one, which is bolted solid, with one bolt.

And now the soft-soldering. It would be nice to make a jig to hold the fittings to the dimensions shown in the photograph. Use a good solder. Ask for 'blow-pipe solder', which will be a 40/60 or 50/50 tin and lead. Pre-tin the pipe ends. Use 'killed spirits' (Baker's Fluid) and wash the job with soapy water afterwards. Use a butane gas flame and get the whole fitting nicely and evenly heated. Both pipes and the centre fitting will need to be done at the same time.

With regard to removing the old oil gallery, concentrate on getting out the seven fittings without damaging them. Remember they are only brass. Cut away the old pipes before any other action. Have you taken out the bolt holding the centre fitting, and the threaded tubes which hold each of the other fittings? Each fitting is numbered. End fitting E50374, centre fitting E50373, and intermediate fittings E55694.

When putting your new masterpiece in, each housing in the crankcase must be such that the gallery can slide freely and sweetly through. There is no point whatever in having a tight fit, so put that drift back in the drawer. Hitting soft-soldered joints is not very clever.

So yet another big panic is over!

Oil filler caps for Rolls-Royce 20/25

by Mervyn C. Woodward

Having taken off the oil filler pipe to remove the starter motor from GZU35, I decided to eliminate the rattling fit of the oil filler cap before replacing it.

I had thought that it would only be necessary to bend up the retaining lugs on either or both of the pipe top fitting and the cap. A close look showed no wear or distortion on these two items, but there was irregular wear on the brass pressure plate in the cap.

I then had the idea that by dishing the pressure plate a close fit could be obtained, and to do this I removed the three 6BA cheesehead thread screws holding down the central brass retaining plate. Underneath there were three small spacers and a thick gunge of what I deduced to be old oil and the remains of a cork gasket.

I therefore cut a new gasket of two inches diameter, with a half inch hole in the centre, from an eighth inch thick sheet of composite cork, because that appeared to have been the original material and because that was the only material I had available. Presumably

neoprene rubber sheet would have a longer life. The three spacer holes were made with a leather punch, using the brass retaining plate as a template. To ease the reassembly these holes were made slightly smaller than the spacers to hold them firmly in place.

I now have a rattling good fit for the oil filler cap.

The crankcase is ventilated by suction applied by the carburettor, fresh air being admitted through the air holes in the two retaining caps of the rocker cover. Some air is also admitted via the two orifices through which the drives to the water pump and the dynamo emerge, as well as through the rear crankshaft bearing, none of which are sealed as such, being provided with baffles and oil return threads only. An unsealed oil filler pipe creates a further entry and, by sealing it properly as described as above, one of three possible results could be expected.

(a) No effect whatever.

(b) With a worn engine and exhaust gases leaking back into the crankcase, excess pressure could have been vented to atmosphere, which a new seal on the filler cap would prevent. These gases could then pass into the clutch housing as oil vapour, creating further problems with both the clutch and starter operations.

(c) With an engine in reasonable order the elimination of the air leak via the oil filler cap would enable the carburettor to suck even more fresh air from the clutch housing, thereby reducing any propensity for oil vapour to contaminate the clutch linings.

I certainly hope that the latter will be the result. Time will tell.

Starter motors on 20/25 models

by Mervyn C. Woodward

In my formative years, the principle of routine preventive maintenance was accepted as the norm, and it irked me that I had not even looked at the starter motor on GZU35, belonging to my son-in-law Graham Langan. This was due entirely to reading the article by N.H.H. in our first Technical Manual 1972, in which he states that it cannot be removed without first taking down the undertrays.

In fact it can be done by first taking off the pinion and clutch unit to allow the starter motor to be drawn forward into the engine compartment, and after removing the oil filler pipe it can be lifted clear. If the weight of the motor is taken by a length of stout cord passed under it and over the Autovac, it will be kept clear of the gunge which accumulates on the under-tray beneath it.

Before commencing the removal of the starter the battery must first be disconnected, because although the starter cable terminal is not live unless the starter switch is pressed, the terminal at the bottom of the oil filled starter switch is connected directly to the battery, and is in close proximity to the starter itself and to any tools used in its removal.

This discovery stemmed from an occasional remark

made over a period by either Graham or his wife Lynne, starting about two years go to the effect that the 'vintage' had 'surprise, surprise, not started at the first stab on the pedal', changing more recently to a very occasional 'surprise, surprise, SHE started first time today'. I had to take the hint and, necessity being the mother of invention, the alternative and considerably easier method evolved.

The overhaul and updating of the Bijur drive and multi-plate clutch unit has been discussed before and is covered by RR Q8 as well. There are several points which have been missed, however, and to ease the effort of anyone contemplating doing the same job I pass on the tips I picked up.

RR Q8 says that the cap at the rear of the unit can be withdrawn after removing the four through bolts. These, incidentally, also hold the starter motor into its mounting recess on the front of the clutch bell. Since this cap is also the housing for the rear pinion bearing, it must not be levered off. If it doesn't come free with a straight pull then two 1BA bolts about 1 1/2 in long will have to be evenly tightened down through the holes, with threaded brass inserts provided for this purpose in the end cap, until the cap is free.

After raising the tab of the lock washer the castellated nut can be undone by tapping it round (normal right hand thread) with either the C spanner D51637 or, failing that, with a small hammer and blunt screwdriver which does less damage than a punch. I say to tap it round because if a steady torque is applied the shaft will turn as well, there being no obvious means of holding it.

In my case the locking tab had been broken off on a previous occasion and the so-called fitter had peened the end of the shaft to prevent the nut working off! As a result of this butchery the bearing mounting and the Bijur sleeve were loose to slide on the splines, causing wear which, if it had continued, would have weakened them so much that they would have broken under the shock loads of starting. That castellated nut must be tightened to prevent all movement before being locked.

After removing the bearing and mount clean it thoroughly, and half pack the race with HMP grease. Although this will probably be the only time it can be greased, resist the temptation to fill it (or any other high speed bearing) because the rapid churning of packed grease creates an enormous amount of heat which can destroy the bearing.

Before dismantling the little clutch unit locate the punch marks on the Bijur sleeve and nut which should indicate a matching land and groove. These lands and grooves have bedded down with use (and where also possibly selectively fitted originally) so that it is wise to re-match them. If you can't find the marks, make your own.

Dismantling is straightforward, and after cleaning dress off all burrs, sharp edges etc. from all the bits, which will save damaged fingers on reassembly, smooth the operation and will make the job look better. This treatment should also apply to all other bits of Rolls-Royce — including nut flats and screw slots.

Since the new Ferodo washers are thinner than the original cork ones I recommend that the locating shoulders be narrowed, as described by Herb Green in his article in our Technical Manual No. 3, 1984, because even if the shoulders do not bind on the steel washers initially they will do so comparatively quickly as the friction washers bed down and wear. After all, who wants to repeat this job within the next fifty years. A word of caution when modifying the central steel washer which has shoulders on both sides. By reducing both shoulders the sliding surfaces of the internal lugs will be reduced, which could accelerate wear at these points. Since one additional washer is required to be inserted to make up the pack thickness, it must go on one side of this central steel disc, which will prevent that shoulder from binding even in its unmodified state. In the unlikely event of having to add another externally lugged steel disc to make up the balance of the pack thickness, then both shoulders will have to be relieved, and in order to maintain the maximum sliding surfaces on the internal lugs the shoulders could be tapered, with a rebate or matching taper on the adjoining steel disc.

Incidentally, if new steel discs have to be used they must be carefully dressed to size, otherwise they will bind in the cap and prevent proper operation of the clutch.

It is believed in some quarters that the last 'thou' should be taken up when refitting the discs into the casing to maximise the friction torque. This is not so, as the torque is produced by the pressure of the big spring which compresses them, added to which is the friction of the collar on the Bijur sleeve when it bears against the buffer spring cover. As a matter of interest, this additional friction can be determined by subtracting from the torque obtained in rotating the sleeve clockwise the torque obtained when rotating it in the opposite direction.

I assumed that my main compression spring had settled over the years, so I increased its free length from 3.88 in to 4.5 in by judicious stretching, which gave me a final torque reading after two dozen bedding down revolutions of 19 ft/lb.

The buffer spring should be removed from its housing for cleaning and the application of HMP grease. To gain access to the locating ring I pressed the brass cover into the body by using a through bolt with washers and a nut. As I could not budge the ring at all, I cut a narrow slot 2 mm deep in the edge of the housing so that I could get a sharp tool behind one end of the ring, in the same manner as the wheel hub centre retaining ring is removed. The ring, which is not heavily sprung, was then easy to remove.

Reassembly of the clutch unit is made easier if the pinion is firmly gripped in an upright position in a vice. The final locking ring can then be inserted, but do not lever or hammer anything as things will bend or buckle. Once fixed it is necessary to measure the torque required to overcome the friction between the Bijur sleeve and the pinion. To avoid using the starter motor drive shaft, which has the heavy motor on the other end, I passed a long bolt through the unit, clamping the sleeve tightly between a nut and

washers. By firmly holding the pinion in the vice, and using a torque wrench on a lock nut on the aforementioned through bolt, torque readings are easily made. I had to dismantle the unit several times before I was satisfied, but if you follow my tips you should need to only do it once.

Before the starter is replaced serious consideration should be given to overhauling the motor. Since anything needing to be done to the electrical bits and pieces requires specialist knowledge and facilities, I will deal only with the mechanical side, which will definitely benefit from a little tender, loving care. As this article will also be rather detailed for the benefit of those who have little experience in electro-mechanics, I will write for the next issue of our magazine.

Rolls-Royce 20/25 starter motor overhaul

by Mervyn C. Woodward

Having removed the motor as described in the earlier article, clean up the outside and remove the brush gear cover.

You will find four equally spaced brushes, each held down by its own coil spring and each connected to a terminal block by two multi-strand tails.

Before the armature is removed, these brushes should be taken off to avoid damaging them. As each brush must be replaced in its original holder a suitable scratch mark should be made on one of the flat faces, with a similar mark on the holder. This will ensure that the brush will be replaced the right way round in relation to the armature rotation, so that by resuming the original bedded down position, sparking will be considerably reduced. This arcing between brush and commutator causes considerable heat, which will burn away the carbon brush and the commutator segments, leading to premature failure of the motor.

To remove a spring, first turn the slotted end of its pivot with a screwdriver, just enough to turn the lug

beneath it to clear the retaining stop. This pivot is not threaded and no attempt should be made to unscrew it because over-rotation will snap the spring. A pull on the pivot will bring it clear, freeing the spring.

To remove the brush, loosen the two set screws with their spring washers and slide the forked terminals from beneath them. Care must be taken not to break the spiral fibre insulation strips which cover the tails because they become brittle with age. Any of the copper strands which may have broken and which protrude must either be tucked back out of harm's way or cut off. If there are many to be done, current carrying capacity will be reduced, and the better way would be to replace the brush. A brush will also have to be replaced if it has worn down to a point where the spring is close to the bottom of its locating slot in the brush holder.

Clean the brushes with a petrol or methylated spirit soaked rag and, to avoid chipping them on hard objects, put them with their springs and spring pivots in the cleaned out brush gear cover.

The armature is best removed complete with the output shaft and end plate. DO NOT undo the set screws around the brush gear end plate as internal electrical connections must first be freed, and unless you know exactly what is required leave well alone. Instead, remove the four thread screws from the brass bearing retaining plate and then the eight 4BA nuts and spring washers from the other or drive end. If the unit does not then come apart, light blows either around the edge of the drive end plate, which stands slightly proud of the body shell, or by a soft metal drift through the threaded hole which receives the brush gear cover fixing bolt, will persuade it to do so. The brass or aluminium drift will not damage the turning centre in the end of the shaft which would be so useful should it be considered that the commutator could benefit from being cleaned up in a lathe.

The armature, complete with the drive-end shaft, bearing and lock rings at one end, and the inner bearing retaining plate and possibly the bearing at the other, will be free.

The bearings need not be removed and can be washed out with petrol and a small brush in situ. When clean, estimate the wear by turning and rocking them on their axes. Some movement is acceptable because they are only used for a few seconds at a time, but if the ball cages are cracked or broken, or if the balls are corroded and rotation is bumpy, replace them.

To inspect the drive end bearing, first remove the cover by means of a C-spanner (or a small hammer and blunt screwdriver). If the bearing needs to be removed, the retaining lock ring must be unscrewed in the same manner.

If the commutator is badly scored, and particularly if the segments have burned edges or flats, light skimming in a lathe is recommended. The trick is to cut at high speed and a light cut and feed with the sharpest edged tool you can produce. Whether or not turning has been carried out, ensure that the insulation between the segments is below the commutator surface as, unlike modern commutators which frequently use

plastics for insulation purposes, the mica used for our starters will rapidly wear the bushes if it comes into contact with them. To clean out these slots I break a standard hacksaw blade and, using the sharp corner so produced by the break and the back of the blade, proceed to clear out the carbon and oil dirt, abrading if necessary the mica back to a depth of about one millimetre. Afterwards it is necessary to polish the commutator to remove any ridges on the segment edges, which the cleaning action may have produced. The trade uses a special abrasive strip up to 1000 grade or finer, but very fine glass paper can be lightly used instead. Do not use wet-or-dry as the abrasive particles, being so hard, can become embedded in the copper of the commutator, and will act as a very efficient and long lasting lap!

After such remedial work, as well as when new brushes are to be used, all brushes must be bedded in using very fine glass paper again, wrapped around the commutator and with light pressure on the brush. Finally, clean up the area behind the commutator and the fixed brush gear with petrol or paraffin. I do not use any other solvent because the varnishes and shellacs used in those days could soften if methylated spirit or paint thinners are used.

Before reassembly, set out all the cleaned parts on the bench and pause for a few moments to admire the craftsmanship used in the production of such a mundane component. It certainly matches up to the rest of the car's machinery.

The rebuild is a reverse of the taking down drill, but there are some points which need to be observed — half fill the bearings with high melting point grease and place that bearing brass inner retaining plate on the front end of the shaft before entering the armature into the body.

Prior to bolting up the end plate make sure that the lubricator on its edge is diametrically opposite to the drain hole on the bottom of the body. Also that the lubrication hole in the outer bearing retaining plate at the brush end of the motor is in line with that lubricator.

After the brushes have been installed it is wise to check the spring pressures with a spring balance. I do

not have the design pressure, but because my commutator was like new I have assumed that the springs had not weakened as this would have resulted in arcing and burning. Measurement showed the pressure to be approximately thirteen ounces. If yours turns out significantly less than this, new springs will be needed as there is no provision for adjustment.

When replacing the motor, using the sling over the Autovac as when dismantling, make sure that the lubricator is at the top (the cable terminal will then be in its proper position) before bolting up the retaining cap from inside the car, after first mounting the multiple plate clutch whose overhaul was described in my earlier article.

Happy starting.

Prewar Bentleys and others

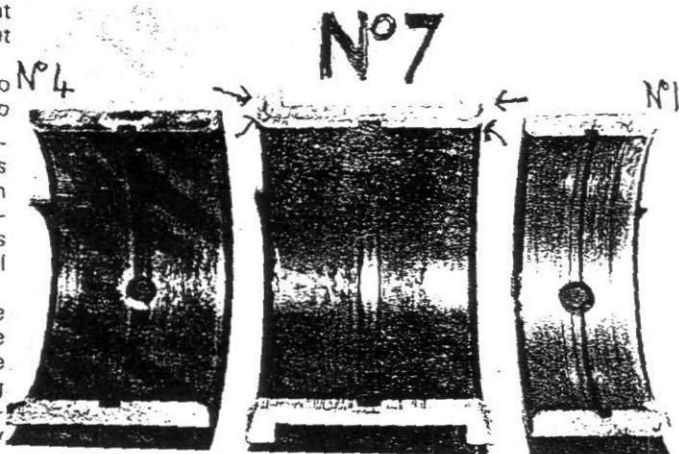
Exploring the end-thrust on the crankshaft

by David Mico

It is odd how some matters are totally ignored because each expert considers it is the province of another. The No. 7 bearing on the crankshaft is such a case. The engine people have nothing to say. 'It is something to do with the clutch.' The clutch boys look round the side of the flywheel and view with horror all those whirling reciprocating masses. The rear race of the flywheel is their chosen boundary.

So we shall have to sort it out for ourselves. Let us start with the pressure plate in the clutch. It is clamped, with a disc, against the flywheel by twelve or so springs which give a total pressure of about 2100lb. When you shove your foot on the clutch pedal you would not like it if you had to use more than 30-35lb of pressure. So by crafty leverage 30-35lb of pressure is arranged to overcome 2100lb of the same.

However, the flywheel has to be used as a base to apply this pressure, but as it has no positioning device it passes the job on to the crankshaft. So we finally come to No. 7 bearing, which has a substantial dollop of white metal on its sides to cope with the very frequent and fairly prolonged applications of a 35lb load. This is all catered for, but if you think that your white metal bearings will last for ever, remember that the side walls of No. 7 bearings will wear. As the pistons cannot move forward in the engine with the crankshaft your chances of a nice set of bent conrods are very good indeed!



contact with the mixture control actuating lever set at 'rich' (sketch 3) to the fully closed position (sketch 1). This was 4mm. I then replaced the plug and rechecked this valve movement and found it to be only 1mm. Four millimetres indicated that the valve in the jet was 'on the taper' when fully up, as in sketch 3, but only 1mm movement meant that it was being prevented from moving into the 'weak' position indicated by sketch 2. The valve was virtually stuck in the fully 'rich' position — either the valve was too long or the plug too high. By a mixture of shortening the jet and putting a thicker fibre washer between the plug and the carburettor body, the full movement was restored.

I then adjusted the mixture as follows. The mixture lever is set to fully 'weak'. The knurled wheel for adjusting the high speed jet is unlocked by releasing the clamp screw and adjusted to give exactly 2mm movement on the valve. This means that the taper on the jet is just starting to open. The knurled wheel is then locked. The lever is moved to 'fully rich' and the valve movement checked again. It should now be about 3.5mm (this indicates that the valve taper is now a further 1.5mm open, implying a richer mix). From then on it is simply a case of gradual adjustment to achieve the full range of CO percentage readings in the exhaust gases to reach optimum mixture setting. As far as I am concerned this is the end of the saga and the car is now smoother, quieter and more economical than I have ever known it.

In my family I have a 'vintage car' law which states simply that when dealing with ailments in older cars no matter what the symptoms are it is the last adjustment that you have made that is the cause of any current problem. This law means that if the last thing you did was to adjust the brakes and the current problem suggests something involving ignition, the first thing to look at is the brake adjustment. In retrospect, I should have picked up my problem years ago when I cleaned the 'plug' of sludge and perhaps inadvertently put it back with an underthickness fibre washer. Nowhere can I find reference to the criticality of the washer thickness!

It is amazing how many different reasons were given by experts for my problem, from worn out Autovac valves (now renewed), causing direct injection of petrol to the engine, to distributor failure, causing exhaust backfiring (new rotor arm fitted), from carburettor float valve sticking to blocked filters.

Once I had removed and measured the valve I appreciated how it all worked and how critical it was to know what movement was required for correct operation of the valve. I have learnt ways of doing things that even the 'great man' would have appreciated. One such, by way of good measure, was to find an easy way of revolving upwards the valve from the jet. A drinking straw threaded on to the bottom of the valve enabled it to be pushed up to the top of the carburettor body and in reverse to get it back into place.

After thirty-three years' ownership, I think I can say that mechanically the Old Lady is in such good shape that I think I can start on the bodywork!

The pre-war Bentley

by David Mico

Consider the following destruction test. Take a hollow steel tube, more hollow than steel, and fix one end solidly and rigidly. To the other end attach a 500lb weight, mounted on rubber, and vibrating unpredictably in every direction. Call the tube your pedal shaft.

The poor unfortunate who was called upon to mitigate these conditions was naturally a little short of ideas, particularly as the area involved was already congested. Staring at the spherical bearings on the equaliser bars alongside, performing their functions impeccably, was it possible to adapt them to cope with movements from every direction, instead of just one, or two, degrees off shaft centre.

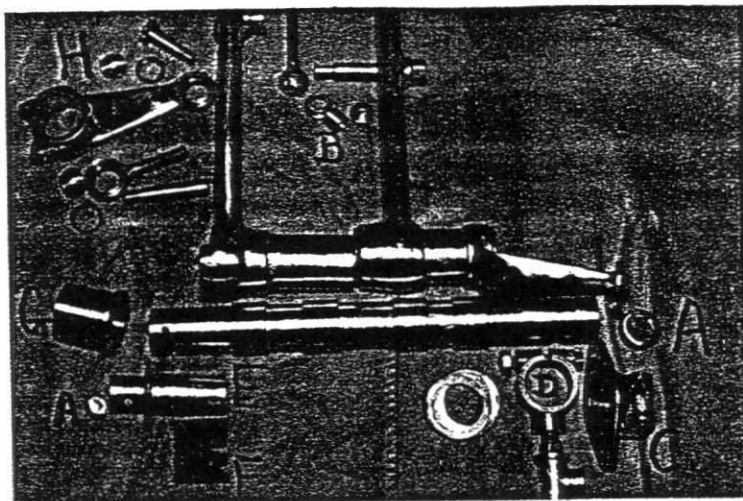
The result was a spherical bearing with one of its half-casings loose, and backed by a spring. The bush containing this is pressed into the clutch bell housing. Movements would cause the half-casing to move away from its fixed mate and thereby accept the vibrations. However, many vibrations arrive at angles which do not trigger off the half-casing. Also, varying the angles, it might be added that at a recent seminar Dr Fiennes pointed out that the engine expands in length by 20 thou when hot. Passing through the spherical bearing unscathed, the vibrations come face to face with the pedal shaft stub bearing. In the ensuing fight the *inside* of the spherical bearing loses 15 thou, after which the vibrations have the space to vibrate as much as they like. However, we now have a pedal shaft which is only fixed at one end, and this is only a slip bronze clip.

Back at the engine end the outside of the spherical bearing, where all the action was intended, is untouched and almost new. Of course, some oil would help, but it has not seen any for the past 35 years. The oil comes in at the chassis end of the pedal shaft, which has got to be over half full of oil before any can reach the stub bearing. Unfortunately, there is no oil in the pedal shaft because the four bronze bushes on the clutch and brake pedals are so worn and slack that they are drains, depositing the oil on the highway.

Eventually that bronze clip at the chassis is going to get fed up with doing all the work, so add this to all the other jobs you have promised yourself you will do this winter.

Photograph key: A, A: a metal cap is pushed into each end, and soft solder poured over it. B: renew small bronze bush on brake pedal stalk. C: bronze clip at chassis end of pedal shaft. D: oil entrance piece. E: stub bearing section is pushed into pedal shaft and fixed with two tapered pins. Grind the bearing surface perfect. F: a wooden plug, shown cut in half, is inside the stub bearing section. Make hole larger where taper pin cuts across it. Use $\frac{3}{8}$ in Tufnol. G: the steel bush, containing bronze spherical bearing, which is pressed into clutch bell housing. H: renew two small spherical bushes on clutch pedal-to-clutch operating shaft connection. PS: Grind the pedal shaft to perfect condition.

A. A metal cap is pushed into each end, and soft solder poured over it. B. Renew small bronze bush on brake pedal stalk. C. Bronze clip at chassis end of pedal shaft. D. Oil entrance piece. E. Stub bearing section is pushed into pedal shaft and fixed with two tapered pins. Grind the bearing surface perfect. F. A wooden plug, shown cut in half, is inside the stub bearing section. Make hole larger where taper pin cuts across it. Use $\frac{1}{8}$ in Tufnol. G. The steel bush, containing bronze spherical bearing, which is pressed into clutch bell housing. H. Renew two small spherical bushes on clutch - pedal - to - clutch - operating shaft connection. PS: Grind the pedal shaft to perfect condition.



They would not accept that Rolls-Royce, the suppliers, could possibly have made such a mistake as producing a mirror image flange, and as this model is now the only one manufactured I also had to make the modifications.

The easiest way is to fit the thermostat on to the long stud first, with the second stud fitting more or less on the opposite side. The other three positions will be found to be in the angle alongside the other stud holes, where it is easy to cut into the flange from the outer edge with a round needle file. Do not file too deeply because there is only a narrow strip left to provide, with a gasket, a watertight joint.

The remaining reassembly is straightforward, but be sure to adjust the threaded eye so that the spring plunger can be inserted when the shutters are closed. After greasing all moving joints and a final tightening down, coolant can be added and the engine warmed up.

It is such a relief to know that the shutters will now open automatically, and that the days of fingernail breakage when opening them manually are over.

In closing, there have been suggestions in previous issues to use ice from defrosting the fridge for topping up the battery and the radiator. A better way is to either obtain a home dehumidifier or make friends with someone who has one. These appliances produce water up to a gallon a day from a normal household, which could even be used to wash down a cherished car.

Retubing Bentley cylinder blocks

by V. C. Allen

We reprint, by courtesy of Flying Lady and at the suggestion of David Mico, this article on which little official information has been forthcoming. Vic Allen spent forty years with Rolls-Royce, retiring in 1958. David Mico has had a set of tools (illustrated) made for this task.

Note: When removing old water tubes and fitting new ones care must be taken not to damage the upper and lower faces of the cylinder head and cylinder block. The 0.575in diameter shoulder of the dolly, Fig. 2, will allow the water tubes of the cylinder head to be inserted 0.52in beneath the gasket joint face. The 0.432in diameter shoulder of the dolly, Fig. 4, will allow the water tubes of the cylinder block to be inserted 0.030in beneath the gasket joint face.

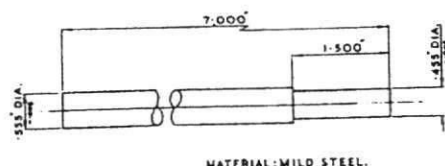


Fig. 1 Bentley 3½ and 4½ litre
Drift for removing water tubes in cylinder head

1. To remove the eight copper water tubes from the cylinder head

(i) Position the cylinder head so that the rocker shaft studs face upwards and with the drift, Fig. 1, drive out the tubes in a downwards direction. Should a tube collapse while removing it proceed as follows: (a) Saw off the protruding part of the tube; (b) With the drift, drive remaining part of tube into the water jacket; (c) Remove nearest large core plug from upper end of cylinder head and with a suitable pair of tweezers remove remaining portion of the tube.

(ii) Thoroughly clean all upper and lower tube holes in head; this is *essential* to ensure a perfect water seal when fitting the new tubes.

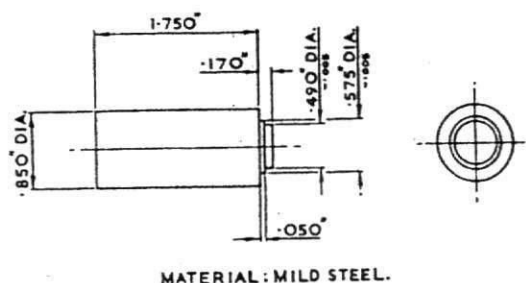


Fig. 2 Bentley 3½ and 4½ litre
Dolly for inserting water tubes in cylinder head

2. To fit new water tubes to the cylinder head

(i) Invert the cylinder head so that the gasket joint face faces upwards and insert the small diameter end of the tubes (EB-128) into the head as far as they will go by hand ensuring that the small diameter end of each tube has entered its corresponding hole at opposite face of head, otherwise the tube(s) will be damaged when finally driving them into position.

(ii) With the dolly, Fig. 2, tap the tubes fully into position.

(iii) Turn over the cylinder head so that the rocker shaft studs face upwards and expand by hand the ends of the tubes with the expanding tool, Fig. 5, by rotating it until it is felt that each tube is fully expanded against its tapered hole in the head; noting that undue pressure on the expanding tool is not necessary. A tap

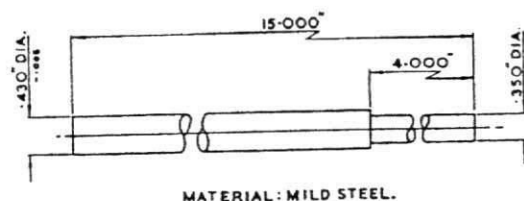
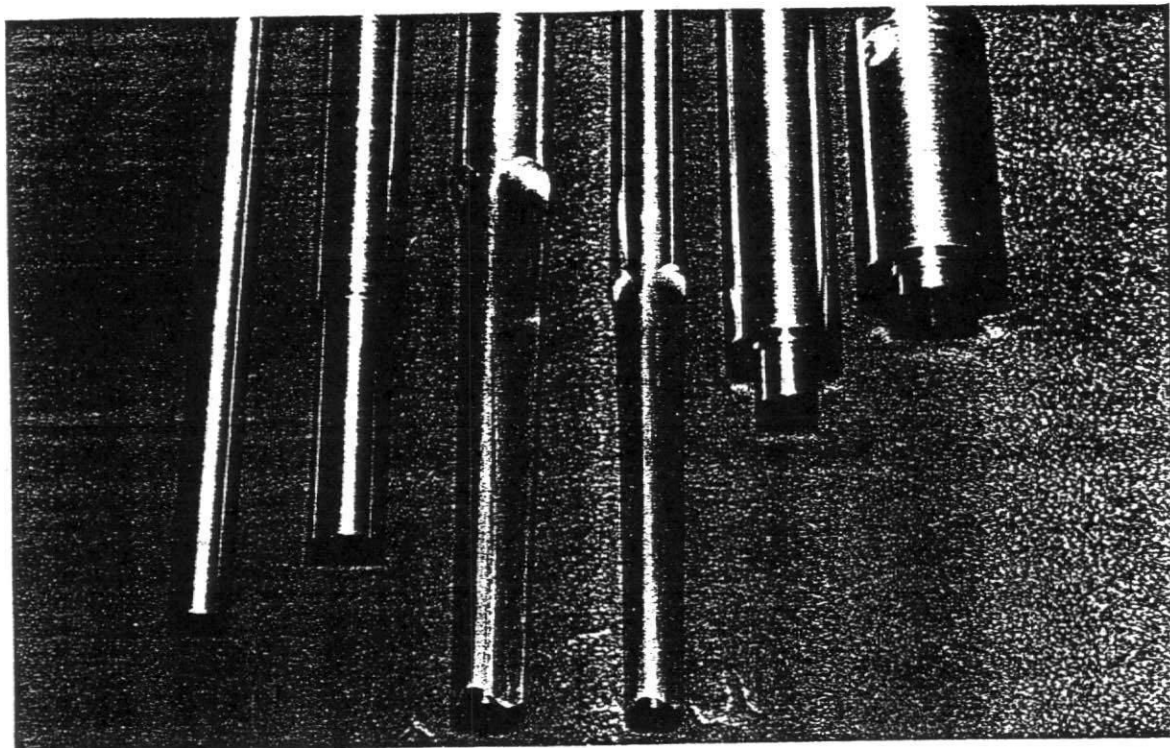


Fig. 3 Bentley 3½ and 4½ litre
Drift for removing water tubes from cylinder block



A set of tools which David Mico had made for retubing Bentley cylinder blocks.

wrench about 9in long will be required for use with the expanding tool.

(iv) With the gasket joint face facing upwards expand the opposite end of the tubes as above.

(v) Test the head for water leakage as explained in SB/VA.1/PR 29-3-56 and remedy any leaking tubes by further expanding them. Apart from the tube also ascertain that there are no other leakages elsewhere in the head.

Material required: 8 EB.128 water tubes.

3. To remove the copper tubes from cylinder block

(i) Position the cylinder block so that the cylinder skirts face upwards and with the drift, Fig. 3, drive out the tubes in a downwards direction. Should a tube collapse while removing it proceed as follows: (a) Saw off the protruding part of the tube; (b) With the drift, drive remaining part of the tube into the water jacket; (c) Remove nearest water jacket cover from side of block and with a pair of tweezers remove remaining portion of tube.

(ii) Thoroughly clean all upper and lower tube holes in the block; this is *essential* to ensure a perfect water seal when fitting the new tubes.

4. To fit new water tubes to the cylinder block

(i) Position the cylinder block so that the cylinder skirts face downwards and insert the small diameter end of the tubes (E.55418) into the block as far as they will go by hand *ensuring* that the small diameter end of each tube has entered its corresponding hole at the opposite end of the block otherwise the tube(s) will be damaged when finally driving them into position.

(ii) With the dolly, Fig. 4, tap the tubes fully into position.

(iii) Invert the cylinder block so that the cylinder skirts face upwards and expand by hand the ends of the tubes with the expanding tool. Fig. 6, rotating it until it is felt that each tube is fully expanded against its tapered hold in the block; noting that undue pressure on the expanding tool is not necessary.

(iv) With the cylinder skirts facing downwards expand the opposite end of the tubes as above.

(v) If it is found that any of the tubes stand proud of the bottom face of the block it is essential that the end of the tube(s) should be carefully reduced in length by

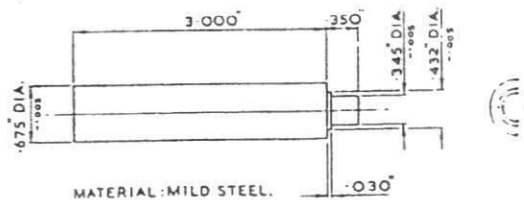


Fig. 4 Bentley 3½ and 4½ litre
Dolly for inserting water tubes in cylinder block

filing until the face of the tube(s) is flush with the face of the block.

(vi) Test the block for water leakage as explained in SB/VA.2?? 20-3-56 and remedy any leaking tubes by further expanding them. Apart from tubes, also ascertain that there are no other leakages elsewhere in the block.

Material required: 26 E.55418 water tubes.

Notes on retubing

by R. H. Goldberg

This article applies to all prewar Rolls-Royce and Bentley models with detachable cylinder head. On these models, except PIII where blocks and lower crankcase are one piece, long studs run from the upper crankcase through head and blocks, anchoring them to the crankcase. We do not have the data available as to whether, on all models, the studs go through the cylinder head water jacket directly or whether, as on the prewar Bentley, they go through cast iron. However, it is likely that all studs through the blocks pass through the water jacket. If water were to be allowed in contact with the stud, it would flow down into the oil. For this reason, where a stud goes through the water jacket, it is made to go through a copper tube, the 'water tube'. The holes for these tubes at the top and bottom faces of the blocks are tapered, and both ends of the tube are flared into the tapered holes, sealing the ends. Water tubes are also used for the pushrod holes in the head, both for a water seal and an oil train.

When head and blocks are off the engine for an overhaul, be sure to check them separately for water tube leakage. The tubes are likely to be eaten away gradually by electrolysis. Leakage can be tested with air pressure and a water tank, as Mr Allen suggests. Lacking this equipment, the water holes can be plugged with corks and kerosene can be poured in. Kerosene has a searching action which should show up even tiny leaks. If a leak is found at the end of a tube, it may be possible to stop this by machining an expander and re-expanding the end of the tube. If the leak is elsewhere in the tube, it must be replaced. Note that hydrochloric acid cleaning may uncover leaks previously sealed by scale.

As for special tools, Mr Allen give dimensions only for the prewar Bentley. He was unable to give us dimensions of water tube tools in time for publication. Also, water tubes are unavailable from Rolls-Royce Ltd. From the dimensions given for Bentley tools, and RHG's experience with retubing B77FC, here are some pointers on tools for other models:

1. Drifts for removing tubes (Figs. 1 and 3):

- Small diameter should allow drift to enter tube.
- Large diameter should allow drift to clear smallest (inner) diameter of tapered hole in face of block or head. This tapered hole must not be damaged.

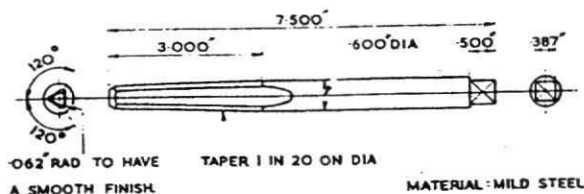


Fig. 5 Bentley 3½ and 4½ litre
Expanding tool — water tubes, cylinder head

(c) For cylinder head tool, length of large diameter greater than length of tube.

(d) For block tool, length of large diameter greater than combined length of water tube and cylinder skirt projection below water jacket. This reduces likelihood of damaging cylinder skirt while driving tube out from bottom face of block.

2. Dollies for inserting tubes (Figs. 2 and 4):

(a) Small diameter should just go into unexpanded tube. Length does not appear critical.

(b) Intermediate diameter should just go into tapered holes in block or head. Length of this diameter must be calculated exactly so that ends of tube are recessed into the hole the same distance at each end.

(c) Large diameter should be bigger than tapered hole. Diameter and length of this diameter do not appear critical.

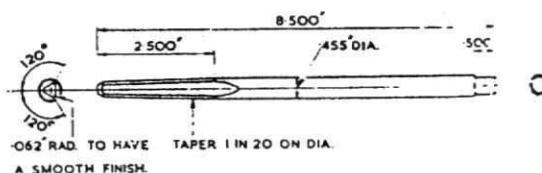


Fig. 6 Bentley 3½ and 4½ litre
Expanding tool — water tubes, cylinder block

3. Expanding tools (Figs. 5 and 6):

(a) Taper 1 in 20 on diameter is likely to apply to all models.

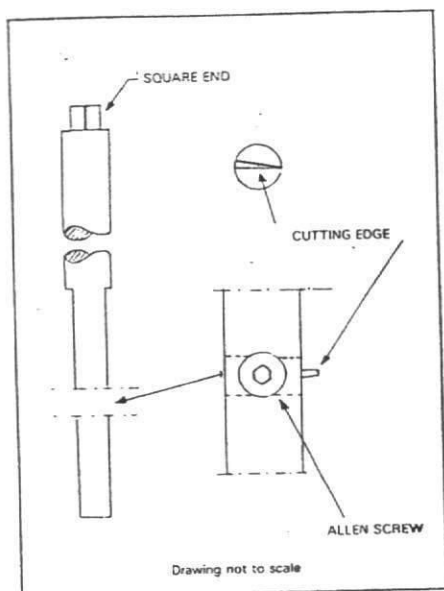
(b) Smallest diameter should be capable of insertion half inch into unexpanded tube.

(c) Largest diameter should be bigger than largest diameter of tapered hole.

(d) Taper required a lathe for machining.

(e) Division of circle and depth of cuts for the three flutes in the taper may not be critical. RHG made the flutes in a milling machine, holding the expander in a milling vise and, lacking an indexing attachment, dividing the circle and judging depth of cut by eye. A bench grinder could possibly have been used.

(f) The 0.062 radius on each ridge requires a special milling cutter. Lacking this, RHG rounded the edges with a bench grinder, being careful not to cut into the straight line of the taper at the top of the ridge. The accuracy of this taper would appear to be critical.



Retubing Bentley cylinder blocks

by S. Svantesson of Sweden

The article in Bulletin 158 on retubing Bentley cylinder blocks was so fascinating that I bought a Derby Bentley (B57KU) to do the job on. In addition to the tools described in the article, I found that an additional tool was needed as the tubes in my block were so corroded that some of them were actually split into various lengths, especially towards the rear of the engine. Also, the tubes were held stationary very hard indeed by the accumulated rock hard deposits in the block, and when I attempted to drive them out with a drift they merely collapsed in a strange pattern, making them thicker, harder and gripping the drift. Trying to get the collapsed tube out of the block with tweezers through the nearest water jacket hole was

Copper tubes, again

by David Mico

These few words may save you a couple of damaged tubes. The fitting of copper tubes is a straightforward procedure. But after fitting two or three, then Murphy's Law takes over. This decrees that, after you have become pleasantly confident, the next tube buckles, and you have to throw it away, for there is no particular reason why the tube should float down through the water chamber and dive straight into the hole at the other side. Sometimes it will arrive ASKEW, see photograph, showing end of tube whitened for clarity. So tap each tube through until resistance is felt. Then turn the block on its side and lever the tube into alignment with its hole. Drive it home.

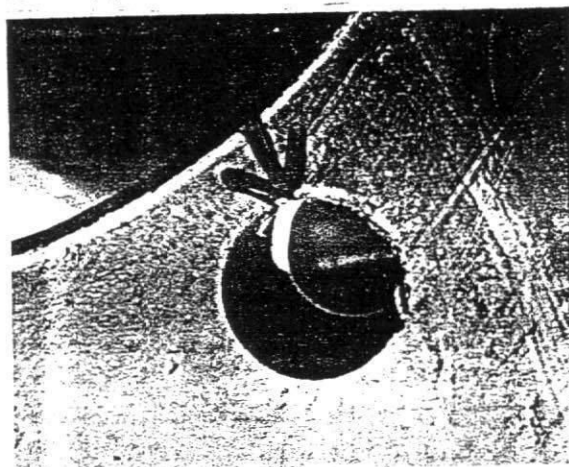
not possible due to the small diameter of the holes on the cam side of the engine, and also the interior of the water passages were very full of rock hard silt.

So I made the tool as shown in the drawing. The big end of this I made a square, for a tap wrench, and made the small end (the narrow part) eight inches long instead of four inches. Half way down the narrow portion I drilled a hole 3mm diameter through the rod, and at 90 degrees to this hole another hole, into the first one. The second hole was 3.5mm and was tapped with an M4 thread. I then took a 3mm diameter hardened steel nail, the sort used for hammering into concrete, and cut off a suitable length on a grinder. (These nails cannot be cut with tongs or a hacksaw.) I then ground a small wedge shaped edge 1mm long on one end of the steel nail and put it in the first hole in the tool, with the edge protruding on one side and the rest of the nail coming out on the other side. A very short Allen screw was then threaded into hole number two and locked on the nail. The rest of the nail was then ground away so that the result was a bar of steel with a small cutter which could be swivelled to any setting.

To get the collapsed tube out, or any of the tubes which will not respond to the tool, proceed as follows. Set the edge to an angle of about two degrees and with the tap wrench screw it very carefully into the tube. If the edge is sufficiently far out the tube will start to come out in the form of a thin spiral band of copper or, if the tube is corroded through, in the form of chips. The entire length of the tube can safely be taken out in this manner, but be very careful not to damage the tapered portions of the casting of the block.

The tool can also be used with the edge set lengthways, and carefully tapped through, splitting the tube along the entire length. The tube can then quite easily be taken out with tweezers using a circular pulling motion.

After all tubes are out have the the interior of the block glass bead blasted at a low pressure. Retubing is totally straightforward, according to the article, and none of the new tubes in my block have leaked a drop for many years.



A Leak Down Test: The Next Step Beyond A Compression Test

Story and Photos by Guy Williams, CA

As part of a Southern California Region tech meet, I selected some tools that I thought were especially useful, and in a price range that would make an excellent investment for a hobbyist. One of those tools is a leak down tester and, even if you don't plan on owning one, you should be aware of what it can do.

A *compression tester* is a pressure gauge and a one way valve which holds the gauge reading at maximum until it is manually released. There are other variations among different types, but these are the essential components.

In simple terms, when the tester is used, the gauge is put in place of the spark plug in the cylinder. The engine is then turned over using the starter, but without actually starting it, and the pressure generated by the piston rising in the cylinder is read on the gauge.

The cylinder pressures are read, one at a time, until all of them have been recorded. When the readings are compared, your fondest hope is that they will all be very close to each other, thereby showing that the mechanical parts of the cylinders are all in the same state of wear, relative to one another.

If one or more of the cylinders reads low, there are only a few more things you can do to get more information. If a lone cylinder is low, you can squirt oil into the hole and repeat the test. An improvement is generally considered to

mean that the cause of the low reading is a bad seal at the rings. If there is no change, then the accepted wisdom is that the problem is with the valves. If two adjacent cylinders are low and the oil does not help, then the chief suspect is a bad gasket or seal between the two.

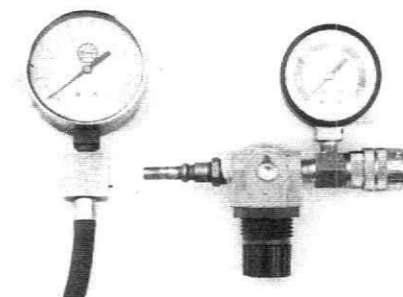
A *leak down tester* consists of a pressure gauge calibrated in a percentage scale from zero to 100, an inlet to the gauge routed through a regulator, and an unregulated outlet through a standard air hose coupling. The other end of the outlet hose will have threads to fit the spark plug hole.

To use the leak down tester, first bring the cylinder to top dead center, at or near the ignition point, so that the valve will be in the closed position, the cylinder sealed as tightly as possible. Then thread the outlet hose into the spark plug hole of that cylinder.

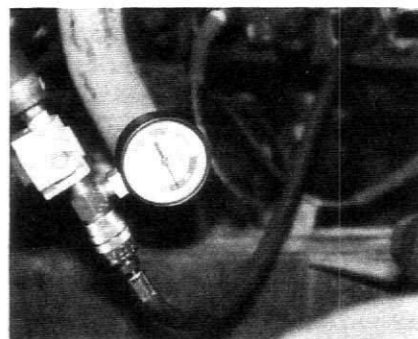
Next hook up the leak down tester to the air compressor hose and gradually open the regulator until the line pressure reads at 100 percent. At this point, you are ready to make the actual test.

Make the test by coupling the outlet hose (which you previously screwed into the cylinder) to the gauge. This forms a tee arrangement with the air from the compressor leaking out through the cylinder, the percentage of the leakage being shown on the gauge. *By listening to where the air is leaking, you know where the cylinder is leaking!* You have established an empirical test to determine the amount and exact cause of any sealing problem with the combustion chamber, and the test will last as long as you leave the tester connected.

Normal cylinders will have a small percentage of leakage past the rings which can be heard by using a piece of small hose as a stethoscope, placing it into the crankcase through the oil filler. If a cylinder shows excessive leakage on the gauge, then the sound of the air leaking into the crankcase will be louder.



Compression tester, left, and Milton Cylinder Leakage Gauge, right.



Leak down gauge during test.

If an intake valve is leaking, it will be heard by listening at the carburettor, an exhaust valve by listening at the exhaust pipe. A couple of examples will show the usefulness of this instrument.

Some Examples

First: Say you own a Silver Dawn or a Silver Wraith with half of the valves being overhead and half being in the block. If you have a compression problem and put oil in the cylinder and there is no improvement, do you pull the head while the motor is still in the car and risk having to pull the whole motor when you discover that the bad valve is not in the head? Or, do you pull the whole motor only to discover that all you had to do was pull the head? With a leak down tester, you would know which valve was bad before you disassembled anything.

Second: Recently, I had a car come to me from out of state. It was a 1976 Silver Shadow which was backfiring intermittently under load out of one carburettor. Here was a car on which I had no history, but it had done some 75,000 miles. The spark plug wires were either original or had been replaced with factory spares with their distinctive ends. The latter is unlikely,

Tester Availability

Leak down testers are available in both single and double gauge versions, ranging in price from \$35 (for the Milton pictured) to \$150 or more (Snap-On). They are also available from Mac, Sun, Manley, and doubtless others. They are sometimes called by a different name. Thus, Mac calls theirs a Differential Cylinder Pressure Tester (p. 297, 1989 catalogue). Since this is a comparative tool, where being a pound or two off is less important than the relationships between cylinders, and since a *leak down tester should never be the sole basis of a diagnosis*, but should be used in conjunction with other information, I recommend the reasonably priced ones.

Small HP Bottom End De-Coke

Gary Phipps (NM) © 2008

The subject of motor oils—as in “what motor oil should I use?”—seems to come up regularly for both modern and prewar cars. You may have read recent articles or postings on the club forum with concerns that modern oils designed for new cars may not necessarily be as good for older engines as some of the older oils. While many oils from 2008 might be less desirable than one from, say, 1998, it’s fairly easy to argue that the latest oils are still much better than those available in 1938 or before. Engine oil in prewar days may have been the best available, but by today’s standards they were marginal. Ignoring their lubricating properties, they tended to form sludge. It is quite convenient that the hollow RR/B crankshafts in prewar engines are very good sludge collectors. So good, in fact, that for optimum engine life it might be necessary, every now and again, to clean the sludge from the crankshaft. This “bottom end de-coke” as it is often called is an exceedingly dirty and disgusting job but one that shouldn’t be completely ignored.

Although a **bottom end de-coke** (BED) is usually thought of in the context of prewar engines, an early post-war crankshaft looks almost identical to a late prewar one. As the engines and oils improved, the problem gradually diminished. However, an engine of *any* age with a hollow crankshaft or a vibration damper can suffer similar sludge buildup.

The maintenance job of de-carbonization, often called a **top end de-coke**, is described in prewar handbooks and was still mentioned in manuals at least as late as the Silver Shadow. This involved essentially removing the cylinder head(s), cleaning carbon from everything, reassembling the engine, and adjusting the valves. But similar official sanction for the BED seems to be lacking; a factory-written procedure for a BED is not known to exist. It is not included in the handbooks nor is it mentioned in the prewar

miles they might have felt that a BED was best done as part of a major overhaul at the factory as opposed to by the owner. That is not to say that it was never performed, only that written details of how to go about it are lacking.

Sludge is a thick/solid aggregation of “stuff” that settles out of engine oil under a variety of conditions. I won’t attempt to describe exactly how, or why it might form but anyone who has opened an old engine will surely have encountered sludge. The relatively low operating temperature of a prewar engine, aggravated by usage that only rarely raises the engine to full operating temperature, makes the situation worse. Add in combustion by-products from leaky rings and the lack of effective oil filtration on most prewar engines, and it’s not difficult to understand why prewar engines are sludge prone. Although oil filters are helpful, the fine particles that form sludge are often small enough to pass through a filter. Even the P III which came with a factory installed full flow oil filter is not immune to the problem. Sludge is also silent: building up quietly with few early symptoms.

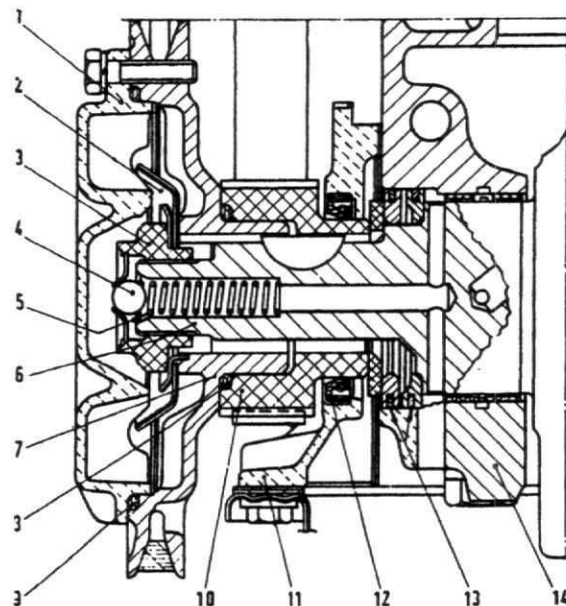
I did not perform a BED on WMB16 prior to returning her to the road although in hindsight I probably should have. When I finally did drop the oil sump for reasons unrelated to oil or sludge, I was dismayed at what I found.

Centrifugal force is a fairly effective method of separating the more dense sludge from the oil. Sludge along with other debris such as bits of metal will collect in any closed cavity rotating with the crankshaft. The collection efficiency improves with distance from the centerline of the crankshaft, which explains why the vibration damper shell makes

service instructions for either RR or Bentley cars. Since the factory intended that prewar engines would return to them for a major overhaul every 40–50,000

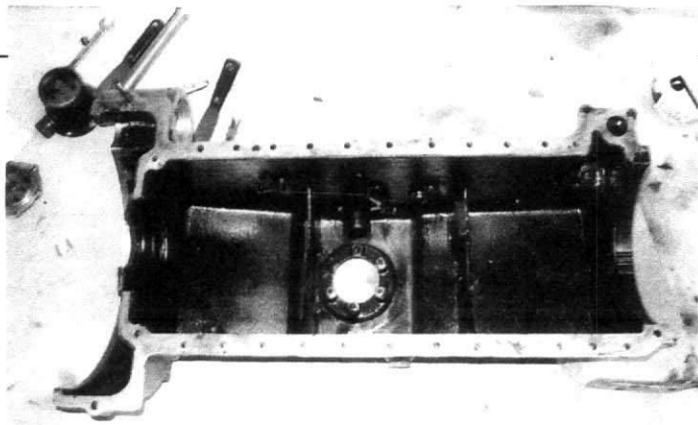
such a good sludge collector. This wasn’t likely an intended damper function but, as **1** illustrates, other makers used a similarly shaped hollow shell at the front of the crankshaft solely to function as an oil filter. (This photo is from *Fiat 124 Sport 1966–70 Autobook* by Kenneth Ball, Autopress Ltd., Brighton, England, 1971, ISBN 0 85147 222 2, p. 26). Drilling escape holes in the periphery of the RR damper drum is sometimes suggested and is probably a reasonable way to keep sludge collection in the damper to a minimum. However, that doesn’t really solve the sludge problem, it only lets the sludge out of the damper—to eventually collect elsewhere.

The real function of the hollow crankshaft journals is to provide oil flow to the big and small end rod bearings but they collect sludge at the same time. Fortunately, the journals are drilled on the sides allowing the centrifuged particles to collect in the bottom of the journal away from the oil passageway. The sludge collects in a safe, out of the way location which does not interfere with the flow of lubricating oil. That is, until the journal approaches half full and the buildup starts to interfere with the oil flow. On the positive side, lightly loaded rod bearings can survive fairly well with only splash lubrication. Many other prewar engines relied solely upon splash lubrication. But knowing that your rod bearings might survive even if their pressure lubrication path is blocked is not the best frame of mind with which to approach this problem.



Section through centrifugal oil filter

Centrifugal oil filter designed for a Fiat 124 Sport.

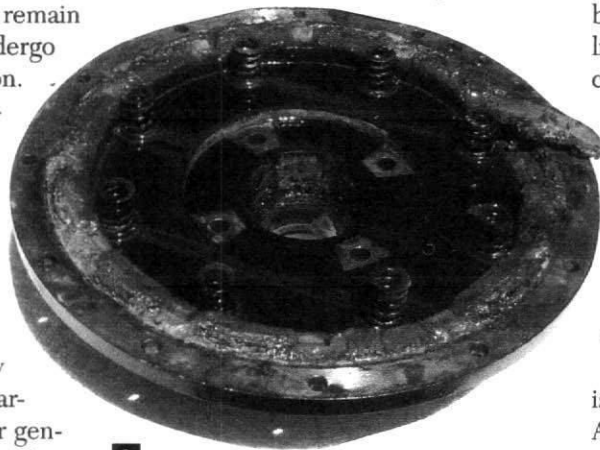


2
Engine sump separated from crankcase.

Oil flowing through a sludged journal tends to form an erosion channel that keeps the oil passage open. At first thought this sounds almost beneficial. Almost. If combustion products remain in engine oil long enough they undergo a process known as flocculation. This chemically turns the relatively soft gunky bits into larger molecules that are more abrasive, i.e. grit particles, which can't do anything good for a bearing. If your engine happens to have an oil filter, these larger particles would eventually be filtered and removed AFTER they have circulated through a few bearings on their way to the filter. For general engine wellbeing it is best to keep whatever collects in the hollow journals inside the journals. But once the sludge deposit builds up enough that journal oil flow erodes the sludge, then additional sludge and grit will not stay in the journal but will circulate with the oil. Even though thick prewar poured bearings can absorb dirt and grit better than modern thin shell bearings, there is a limit to how much dirt protection one should expect.

So much for my cheerful view from inside the engine. It should at least encourage you to continue changing your oil—and filter, if you have one—on a regular basis. But how does one perform a BED to clean the sludge menace that may exist inside the engine? The job I will describe is how it would be performed on a B series Wraith (WMB16). Although any of the Small HP and Derby Bentley engines are surprisingly similar in their basic construction the details for other models may vary slightly. Large HP engines will be different, yet the basic principles are the same.

The obvious first step is to drain the engine oil, otherwise it's going to get really messy later. To gain access to the crankshaft, the previously drained sump has to come off. This is the cast aluminum bathtub that in the US is commonly called an oil pan **2**. The oil pump pickup can, suction tube, etc. have been removed from this sump for oil pump testing purposes that are unrelated to a BED. Although it is not



3
Disassembled vibration damper filled with oil sludge.

an afternoon's job, it is possible to remove and re-install the sump while the engine is in the car. Before you can assess the situation properly, the aluminum undertrays have to be removed. The water pump hardware and all water passages are conveniently well above the sump so the radiator and coolant don't need to be disturbed unless you want to also remove the vibration damper. If damper removal isn't in your plans you can skip the next paragraph.

Although it is optional for a BED, if you are going to this much trouble you may want to remove the damper. Because of the details involved, that procedure is more properly described in a separate article about overhauling the Wraith vibration damper. Interested readers may find it in the March 2004 issue (#64) of *Phantoms*, a publication of the P III (and Wraith) Technical

Society. Very briefly, it involves draining the cooling system, removing the lower radiator hose, removing the side steering tube, supporting the front of the engine, removing the wheelcase cover and finally the vibration damper. The reason you might consider going to that trouble is that the inside of the damper will likely have a thick crust of sludge around the outside like that shown in **3**.

For a Wraith BED, the first section of the exhaust system likely has to come off. At the very least it is bolted to the nearside (the side of the car the curb would be on in England) of the sump with a triangular shaped bracket that must be removed. You might be able to get the sump past the downpipe and expansion chamber but the oil pump at the front corner will likely interfere. Since a later step will put considerable strain on the exhaust pipes if they are solidly bolted to the engine,

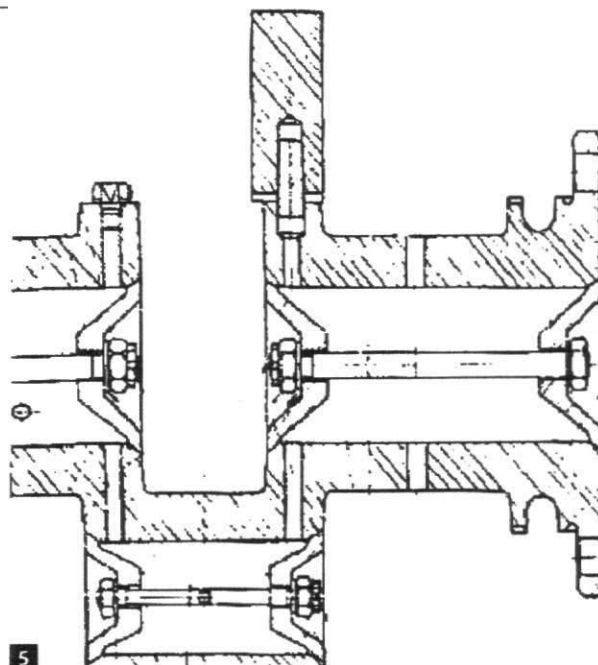
I removed them. Besides the triangular sump bracket there are 3 bolts at the exhaust manifold flange, 4 that connect to the center section silencer, and 4 support straps (2 round ones at the front and 2 flat ones near the rear of the engine).

The oil pump on these engines is bolted to the outside of the sump. Although its removal is not required, it's easy to do and you might want to take it off so that the sump is lighter, smaller, and easier to handle. At the very least, the oil lines require removal or at least detachment from the pump. For the Wraith, the pump is at the front nearside corner of the sump and there are two attached oil lines, but these details will vary for other models. The starter has to come out since its mounting bolts clamp the sump to the bell housing. There are also several pedal and control linkages and attachments that have to come out of the way. Take copious notes and, if possible, photographs of everything so you can more easily get it back together. The Wraith also has a front brake rod linkage on the nearside of the oil sump which will require detachment before proceeding. The only Wraith engine mount is at the front of the cylinder block while the rear of the engine is supported by the gearbox bell housing bolts. There is nothing that can't be removed that is directly below the sump. Once it's free, the sump can drop straight down.

The sump top view in [2] shows the location for the 31 fasteners that pass vertically through the flange of the sump. Some are bolts, some are studs, some are cap screws. Some are easier to remove than others. Note the captive stud over the starter location at the top left of the photo. Not shown are the several horizontal fastener holes at the front and rear used to clamp the sump to the wheelcase cover and gearbox bell housing, respectively. Some of those at the rear are quite long studs with stepped diameters which can only be installed from a particular direction, etc. Since these details are model specific I will only urge caution, to stay alert, pay attention to detail, and take good notes! There will be a connecting link between the oil level float hardware inside the sump and the oil level pointer mounted above on the side of the crankcase. This link passes through an open hole in the sump flange (top left in [2], just to the right of the pliers). This link must be disconnected or removed before detaching the sump.

Even if all of the vertical and horizontal bolts are removed, the sump will likely not budge. There is a gasket at the front between the wheelcase and the sump, which is likely stuck, and the sump is tightly fitted to the adjacent parts at both ends. In order to create some working room you will need to support the bell housing from below (I used a scissors jack) and loosen the bolts in the upper half of the bell housing that still hold the gearbox to the crankcase. Likewise at the front, if you didn't remove the wheelcase cover to remove the vibration damper, you will need to loosen the wheelcase cover bolts enough to move the cover slightly forward and away from the sump. I was able to loosen the wheelcase cover and separate the gasket from the sump without damaging the gasket because that gasket was only a few months old. If that gasket has been there much longer it will likely be stuck, and replacement of at least the lower half will be necessary. Freeing the wheelcase cover while also lowering the bell housing by a fraction of an inch should provide

the needed fore and aft wiggle room that will allow the sump to be worked free. Though cast of aluminum, it's still heavy when it finally drops onto your stomach as you wrestle with it from below. Despite the fact that you drained the oil, you are likely going to get a face full of oil, or worse, as you work yourself and the sump out from under the car. If you attempt to clean the sump interior remember that it should be brownish-red, not a shiny aluminum color. Like most other internal engine surfaces it was originally painted with a sealant to combat casting porosity.

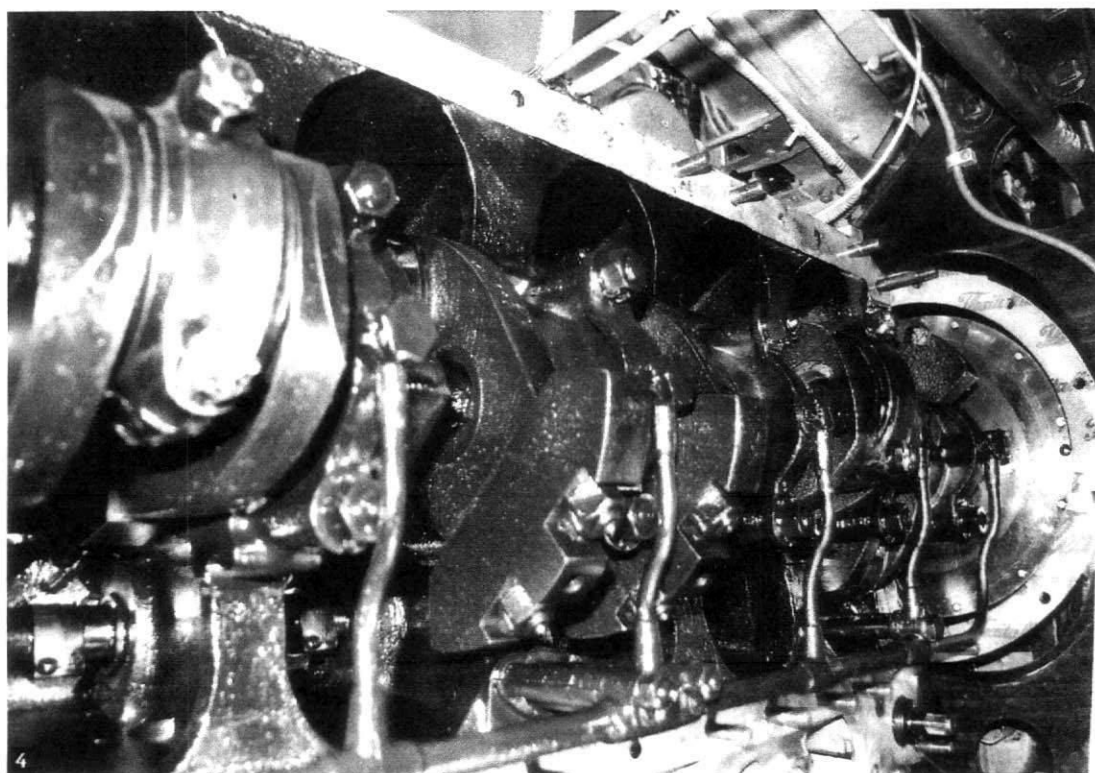


Aluminum crankshaft cap detail.

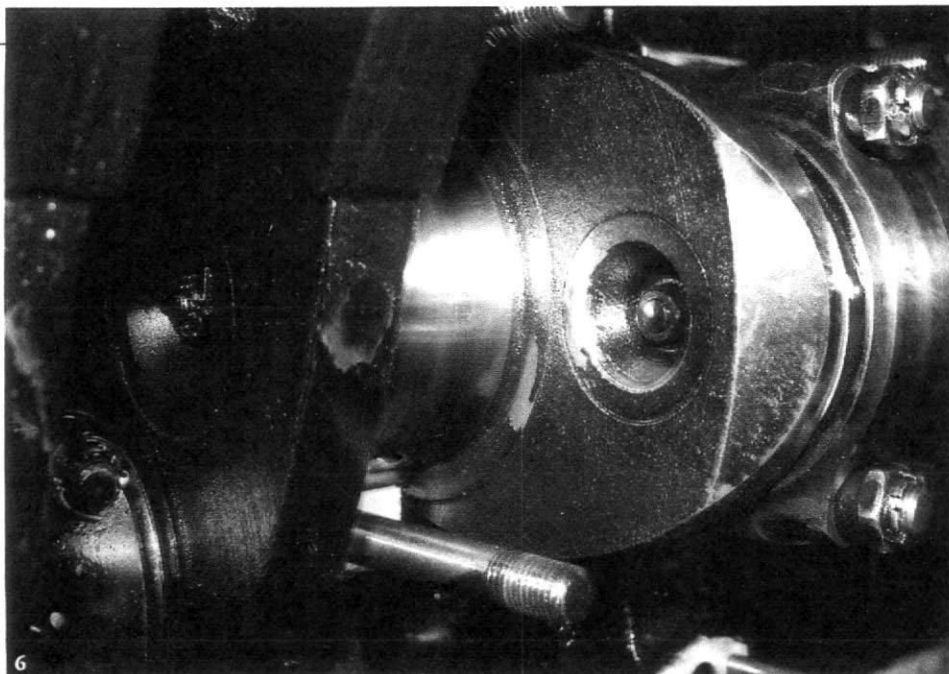
The crankshaft, which is the object of our endeavor is finally exposed. [4] is a view from the rear of the crank looking forward with the back side of the vibration damper being the large-diameter item at the forward end. If you had removed the damper you would instead see the radiator in its place. Just outside the diameter of the damper is the exposed gasket covering the lower, rear edge of the wheelcase cover. The splined bottom end of

the oil pump drive shaft is also visible at the front corner. What is barely visible in this view are the caps in the crankshaft journals. It is these caps that now have to come out so the sludge can be removed.

The details of those caps are shown in [5], part of a GA (general arrangement) drawing copied from the club's Wraith CD. Each journal has a conical cap at each end held in place with a small bolt and nut complete with split pin. Not



Crankshaft and external oil gallery.



Aluminum crankshaft caps on subject engine.

clearly shown are the aluminum sealing washers at each end of all the bolts. Other models will have a similar cap arrangement although not identical. The cap hardware in the main and rod journals is similar except that the rod caps, bolts, and washers are smaller in size. Starting at the right side the figure illustrates the rear main journal (#7), most of the #6 rod journal and the rear half of main bearing journal #6. Each cap pair is secured with a single bolt, one end of which has a nut permanently "riveted over" while the other end has a removable split pin and castellated nut. What is not shown in the figure is the flywheel that is bolted to the rightmost flange. Since the crank remains in the engine with the flywheel attached it will not be possible to totally remove the hardware from #7 main. Similarly we can remove only the rear cap from #1 main journal. For both the #1 and #7 main journals we will only be able to probe, at best, from one end of the cavity to remove any buildup. As we shall see in a later photo this isn't a major problem since the sludge buildup will be predominantly in the rod journals since they are further from the center of crankshaft rotation and subject to more centrifugal force.

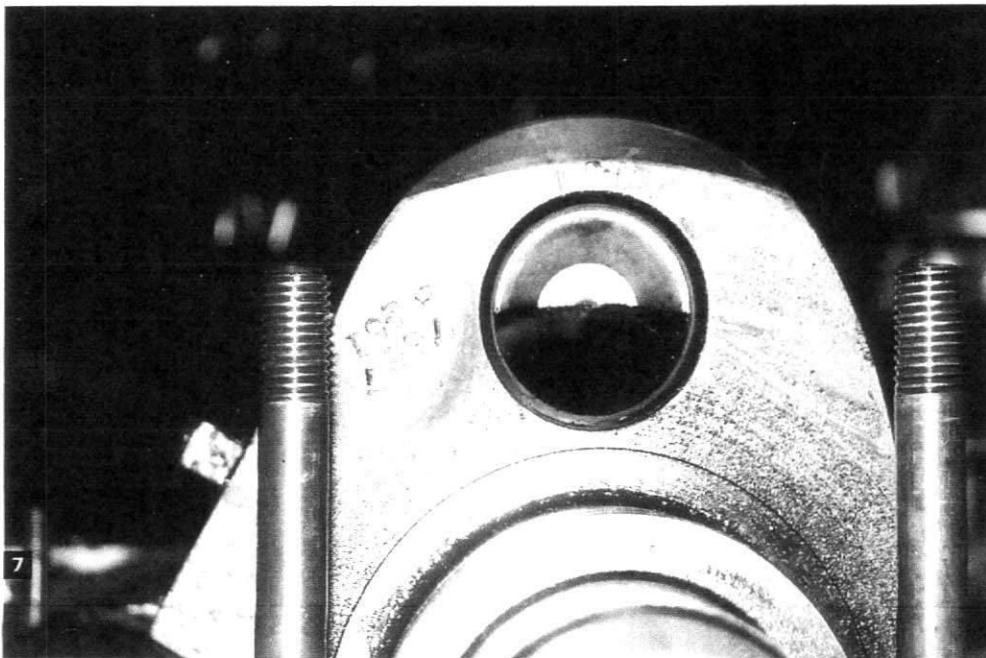
Although a BED does not require removal of the piping that supplies oil to the main bearing caps, the curious owner who has

gone this far will likely want to remove at least some of the caps to assess the condition of the bearing inserts. Removing the piping and a bearing cap does allow for a better view of the other journal caps to be removed. [6] illustrates the typical predicament: the clearances aren't any different or better from other angles. The left journal shows a main cap removable nut and the rightmost journal shows a rod cap viewed from the end with the riveted over nut. Those with a keen eye may also notice that the split pins have been removed from the rod bearing cap since I had previously taken a peek at the Halls metal rod bearing. As a consequence of all of these bearing inspections, combined with other problems encountered on the road home from the Chicago Annual Meet, this BED

turned into a complete engine overhaul. You may or may not have a similar (costly) experience when you try this at home. I personally thought it was better to learn about the problems and correct them now than to be suddenly surprised on the road in the future. (Now that you know "the rest of the story" you will understand why some of the photos are of parts in a state of disassembly far beyond that of a simple BED.)

Great manual dexterity is required to remove the journal caps shown in [6]. Much rotation of the crankshaft will be required to bring things into the proper positions. You may need to selectively remove bearing caps and/or counterweights for access. Keep track of how everything came apart so it goes back the same way. To avoid confusion and since the engine is still mostly assembled you should *avoid* removing more than a couple of the bearing caps at any one time. If you don't still need one off, put it back on so it can give the crankshaft some needed support. Tenacity is the paramount virtue for this job.

What will the deposits in the crank journals look like? [7] is an indication of the typical WMB16 rod journal; the top half of the cavity which is at the largest rotational diameter is packed full. This engine had been running smoothly with normal oil pressures and no known problems. It had been last overhauled only 30K miles previously in London a few years before export to the USA. I thought that they surely would have cleaned the sludge traps as part of that work and that



Half-sludged crankshaft journal on subject engine.



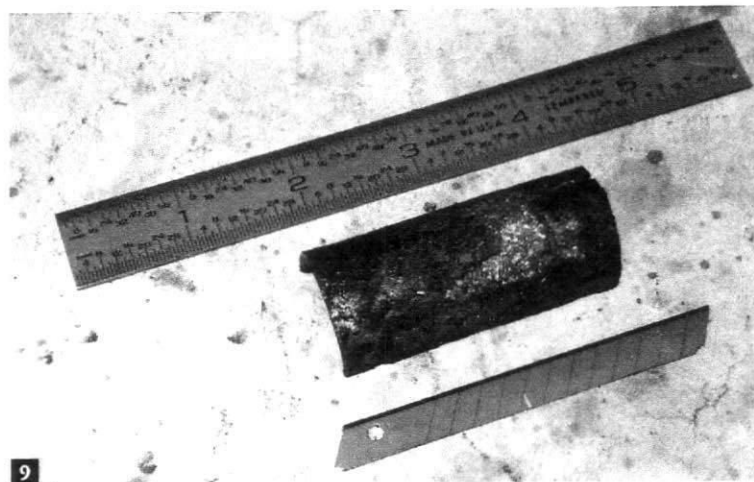
70% occluded crankshaft journal (courtesy Dennison-Jayne Motors).

in the short time since then my engine would not have a sludge buildup. But after opening the sump I could no longer rationalize this as an “out of sight, out of mind” condition.

Even worse deposits are not uncommon. [8], courtesy of Dennison-Jayne Motors, shows a journal 75% full only because Tim Jayne couldn't find photos of the ones he has seen which were 90% full.

How do we go about cleaning? Very carefully. A quick thrust and jab technique could easily break the crud into a million irretrievable pieces that would circulate through the oil system. The goal is to remove as much as possible in intact globs so that the engine will benefit overall instead of suffering. At Bill Vatter's suggestion, a razor knife blade was used for the job. [9] shows the blade, one of the deposits removed, as well as a ruler for size comparisons. The blade is carefully inserted into the open portion of the journal and slid down the wall so that the deposit is coaxed free in a single intact mass. With both journal caps removed it is possible to hold both ends of the blade to guide the blade along the contour of the journal diameter. Once the major chunk has been removed, a general cleanup of the few remaining crumbs may be needed. [10] shows all six rod journal deposits whose contoured ends match the conical caps. What can't be clearly seen in either of these photos are the thousands of tiny, sparkling metal particles distributed throughout the generally black mass. Not that it means anything other than engine parts wear mechanically, but it's another example of things you really didn't want to see in your engine.

With the engine still assembled it is possible to remove both caps from all main journals except #1 and #7. The bolt holding the cap on the rear of #1 main is captive in the front end of the crankshaft. This makes removing and replacing the #1 cap fairly easy. Getting inside the extra long hollow to clean it will be another issue. What is even more problematic is the front cap in #7 since that bolt is free to turn once the nut is loosened. With the engine in place this turning bolt could prevent either complete removal or retightening of the nut. Since engine oil pressure depends upon these caps tightly sealing the crankshaft hollows, it may not be worth the risk to attempt removing the #7 cap. A fairly serious problem arises if lack of access to the rear of the bolt prevents the cap from being re-tightened. At



Razor knife blade makes for a tidy removal process.

the very least the gearbox will have to come out of the car in an attempt to counterhold the loose bolt through the small diameter pilot bearing in the center of the flywheel. If that proves unworkable then the flywheel must come off which means pulling the engine and crankshaft to remove the flywheel. *It would be wise to delay a decision about loosening the #7 cap until the condition of the other six has been assessed.* More than likely the amount of buildup in the main journals will not warrant the risk of attempting to open #7.

With the crankshaft in the engine it is difficult to show accumulation inside the main journals. [11] is a view inside the hollow of #7, rear main with the flywheel removed and the crank resting in the (inverted) crankcase. This would be a view into the right end of the crankshaft in the earlier drawing of [5]. The deposit was relatively limited and nearly fluid unlike the hard, gritty stuff in the rod journals. Such deposits won't come out intact but the larger diameter main journals should allow finger access.

Once you have finished with the cleaning you have to put it all back together. All of the journal caps should be leak free so damaged ones may need to be replaced along with all of the securing bolt split pins and aluminum sealing washers. Installing the split pins will be even more difficult than removing them since you have the added requirement of leaving them in good condition when you are done. Depending upon how much you removed you may need new lock tab washers, more sealing washers, split pins, etc., since none of those items are reusable. The sump mating surfaces are soft aluminum and easy to damage. Any dings or burrs there will only make oil leaks more likely. While you have it accessible you might



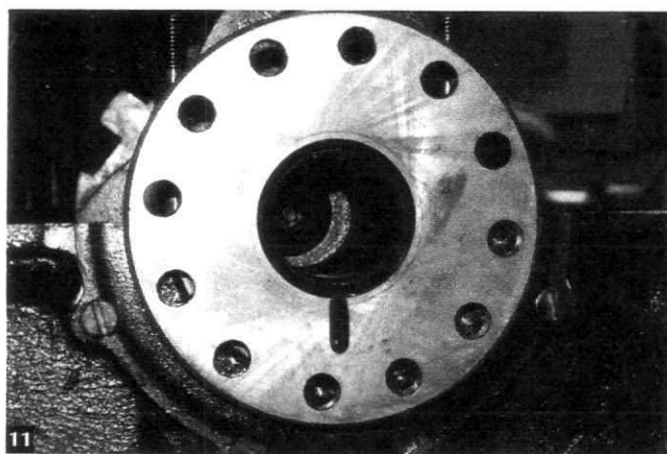
Typical accumulation of detritus.

want to renew the lower half of the rear main felt. In an attempt to reduce oil passing through that half of the rear "seal" I replaced it with a braided PTFE packing material left over from previously repacking the water pump shaft. This is the same material used by hot rodgers to replace rear main rope seals for reduced leakage. Original gaskets were generally of thin paper and you may have to make them yourself if you can't locate a commercial supplier. Its definitely not original but there is always the possibility of using a sealant, silicone or otherwise, if required for

a difficult spot such as the top front of the sump. If you aren't removing the wheel-case but must replace the lower half of its gasket, the gap between the cut ends

of the upper and lower gasket halves will leak without a small bead of sealant.

Afterwards you can be proud of your work, knowing that the crankshaft recesses are clean, not blocking oil flow, and again able to efficiently and safely collect foreign matter from your oil. Just be thankful you didn't have to do this in the winter, on the dirt floor of an unheated garage with the owner expecting to use the car tomorrow.



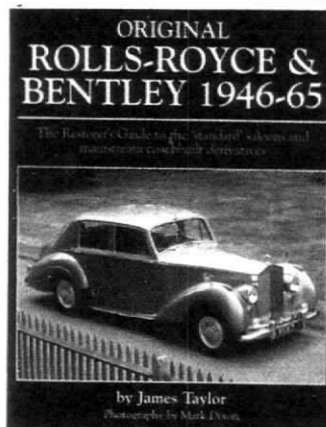
Cap removed from hollow of #7 journal; flywheel has been removed as well.

Books

Original Rolls-Royce & Bentley 1946-65 by James Taylor

Herridge & Sons (in US: MBI, www.motorbooks.com), 2008. 160 p., 259 color photos. Hardcover. ISBN-13: 978-1906133061. \$54.95/£27.50
A straight reprint—as this edition is—of any book containing hard data is almost never a good idea. Not only does this edition contain the same—few—mistakes as the 1999 original, it now contains *new* errors simply by reprinting almost 10-year-old and now often out of date ownership info and even club data (BDC and RROCA addresses have since changed). Ergo, the reader, and especially future researchers, must bear in mind that the ownership data given applies only to the time a particular photo was taken.

Aside from this glitch, the book is clearly useful—unique even—not only to owners/restorers of these models (Mk VI-SC/S; excluding S. Wraith and Phantoms IV-VI) but even more so to judges in these classes who should consider the book an absolutely indispensable tool. The level of detail is vast. Model by model, it lists specs, modifications by serial number and divided by component/assembly, and even



details such as correct surface finishes. All this is supported and illustrated by photos taken just for this purpose, i.e., these are not run of the mill stock or file photos. (Since this sort of set-up photography obviously requires the photographer to travel a lot, all the cars appear to be resident in the UK. This ought to be of particular interest to readers elsewhere who may never have seen these particular specimen before.)

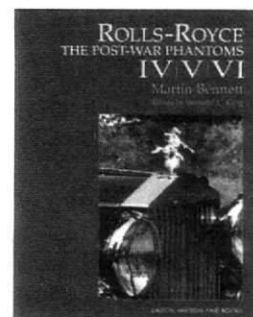
An introductory chapter covers the history and development of the cars in the economic, social, and political conditions of the time. The lead-in to each model does the same but with more specificity. Sidebars enumerate paint/trim options as well as chassis numbers, and series and production dates of both standard and

coachbuilt cars. Every known coachbuilt variant is called out by chassis number and this information is once more tabulated in an appendix that lists, by model, the respective coachbuilders' output by series and chassis. **ED**

While the above book specifically excludes Phantoms IV-VI, it so happens that an entirely new book is devoted to just those models:

Rolls-Royce The Post-War Phantoms IV, V, VI by Martin Bennett

Dalton Watson, 2008. 304 p. 440 illus. Hardcover, slipcase. ISBN: 978 1 85443 220 9. \$115/£59
It may get old to keep saying it, but since the team of Morris/Button revived Dalton Watson only a few years ago they have not turned out a bad-looking or unworthy book yet. This one, too, is a fine example of the book-making craft. In terms of content, this is the first—and only—book to cover these particular models, which represent the epitome of Rolls-Royce's bespoke work, in one opus. Each of the about 1000 cars is listed (P VIs for the first time!), by none other than list-maker Bernard King in a format similar to his *Complete Classics*. (FL readers



will observe that the "Notes" column does not, in fact, list all known previous occurrences of photos, to wit the entire P IV coverage in FL 04-3 and 4, and esp. 4BP7 in 04-2 is omitted.) The P IV section covers each of the 18 known cars in great detail and, a particular treat, lists the 19 H.J.M. and 3 PW proposals that were *not* built. The other two models are covered by design number or other common denominator.

The text is profusely illustrated with mostly period photos, coachwork drawings, and examples of customer correspondence and internal records. Many close-ups show the various unique appointments in these highly individual cars. Extensive photo captions enumerate further details. One chapter is devoted to the actual mechanics of designing and building the bodies as well as a summary of each of the respective coachbuilders' output.

Small Horsepower Seminar

By Gil Fuqua (TN), V.P. Tech-Prewar

a ficionados of small horsepower cars traveled to Mechanicsburg for a hands-on seminar focused on dismantling and evaluating a 20/25 engine for rebuilding. Our instructor, Tim Jayne, is the new proprietor of Dennison Motors, having worked closely with founder John Dennison for over 14 years in the business.

The classroom engine was removed from the author's car the week before the seminar and served as the guinea pig. The engine ran fine and had very good compression in all cylinders, but it overheated intermittently. A full diagnosis was in order to determine the source of overheating and evaluate what else might be amiss. Bob and Reg Thompson also brought another 20/25 engine, hauled all the way from Canada, to serve as their personal classroom subject.

As part of the seminar, Tim had prepared an extensive handout for members that included Lee Haacker's excellent articles in *The Flying Lady* on rebuilding a 20hp and a 25/30 engine ("20hp Rebuild" in FL75-1, 75-2, 75-3, 75-4; "25/30 Rebuild" in FL72-5, 72-6, 73-1). A valuable checklist for engine rebuilding compiled by Will Fiennes on behalf of the Rolls-Royce and Bentley Specialists Association, of which Dennison Motors is a member, was also included. Rolls-Royce service instruction leaflets detailing connecting rod big-end bearings, main bearings, cylinder liners, pistons and rings, slipper flywheel (crankshaft vibration damper), clutches and engine timing information were also included as part of the information that each participant received.

Tim Jayne started the seminar with a general discussion of small horsepower cars, maintenance considerations, and sources for parts required in an engine rebuild. He recommended the addition of a modern oil filter, such as the kits supplied by Fiennes¹ and Ristes² in the UK. The oil



25/30 H.P.

"It is not built primarily for speed but to be smooth, silent, flexible and comfortable AT ALL SPEEDS. No matter how fast you are travelling you can place this car exactly where you want to on the road. A more delicious thing to drive was never created, for it has all the ease of handling of a light car with the added grace and a divine stability and controllability that no light car could conceivably have."—Taiter

filter kits include a replacement oil line that replaces the original that goes from the oil pump to the side of the engine block and incorporates an adaptor for a modern spin-on oil filter. The oil filter kits require no permanent modification of the car, and the process is completely reversible by simply replacing the original oil line.

The addition of the modern oil filter provides enhanced protection for an expensive engine and the soft babbitt bearings used on the mains and connecting rods. A modern filter is clearly better than the original oil "filter" that is contained in the sump. The original oil filter is little more than a wire mesh screen that might catch loose nuts and bolts clanking around the sump. Tim also suggested that owners

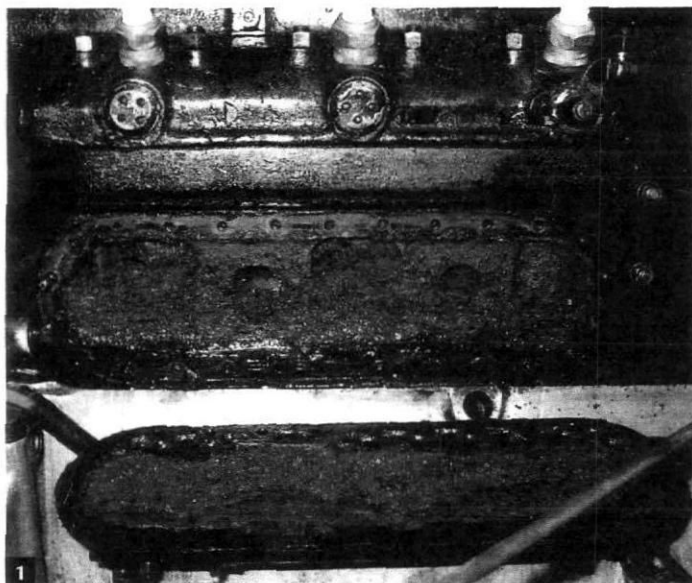
change their oil every 3,000 miles or at least once a year regardless of mileage.

In addition to fitting an oil filter, Tim recommended the installation of an inline water filter, such as the gano filter or water filter sock sold by the RROC. It was noted that even a newly rebuilt engine can benefit from an inline water filter to capture silt that builds up as a result of the chemical reaction of water circulating around different metals in the engine. The water filter protects the radiator, water pump, block and head; all vital and expensive components.

What warrants an engine teardown? There are many clues that might indicate an engine has worn past the point of continued reliable service. Tim suggested a number of symptoms that might hint that a rebuild was in order, including excessive oil consumption (Haynes³ suggests oil consumption of 1 pint per 150 miles as acceptable), smoking exhaust, overheating, disturbing engine noises and knocks that are not characteristic of a fine RR engine, and low or erratic oil pressure. Some potential engine problems can be diagnosed with a compression test and leak down test (more in a later article). Other potential problems can only be investigated by an engine teardown.

This article will not attempt to iterate the complete dismantling procedure since this is covered well in the Haacker articles and in Haynes book. Instead, this article will highlight key points Tim made during the seminar that might assist owners in rebuilding their own engines.

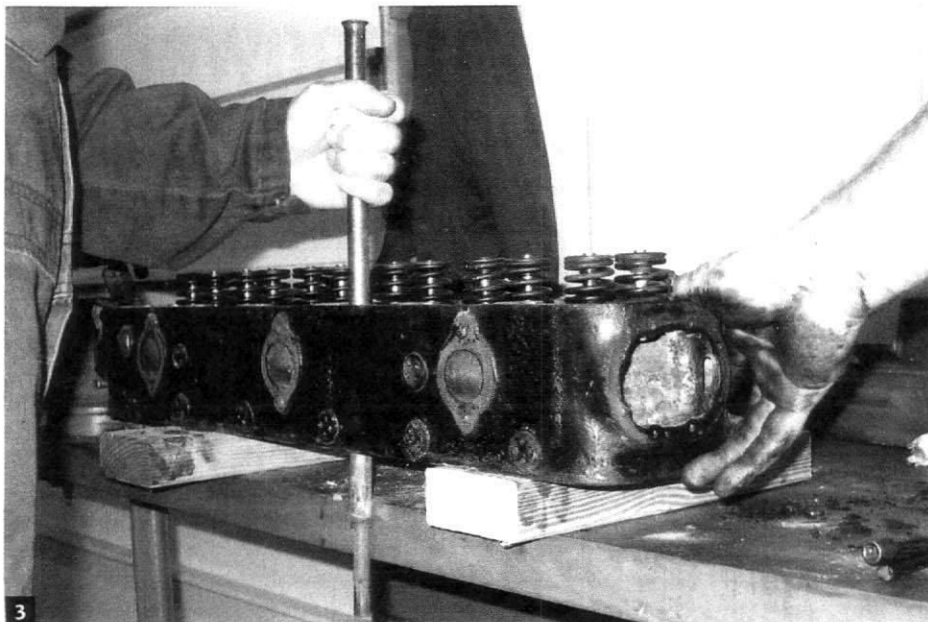
Before starting the disassembly process, be sure you have a container to collect the nuts and bolts as they are removed. Tim uses Ziploc bags



1 The rear side plate on the block was removed and revealed rust and silt build-up that significantly occluded water circulation and cooling in the block.



2 Tim Jayne uses a long screwdriver with tip ground to exactly fit the 2BA screws that hold on the side plates on the block.



3 Copper tubes in the head are removed with a special stepped punch. It is recommended to remove the tubes in the head and block to facilitate more thorough cleaning of silt and rust to improve water circulation after an engine rebuild.

to hold each group of nuts and bolts. Mark the bag with a permanent marker to indicate what's in each bag. Resist throwing all the nuts and bolts into a single pile; it will take you hours to sort them out afterwards. Bag and label each part as it is removed.

Use a camera to document each step of the disassembly process. The photos will help sort out the parts later in the rebuild process. The author recommends a digital camera because of the ability to preview the picture on the camera's LCD screen and the low cost of taking multiple photos compared with a film camera.

The cooling system should be cleaned out to maximize engine performance and engine life. Side plates on the block should be removed

to clean out accumulated silt and rust **1**, **2**. The copper tubes running through the block and head should be removed to gain increased access for cleaning **3**. New copper tubes with annealed ends should be installed and swaged into place after the block and head are thoroughly cleaned. Tim recommended having the block, head and radiator ultrasonically cleaned.

Tim uses a commercial company⁴ to ultrasonically clean radiators, heads and blocks. The company's industrial-sized ultrasonic cleaning tank uses heated sodium hydroxide combined with high amplitude sound waves to vibrate the fluid and clean the parts. Most radiator shops do not have this type of system due to the high cost and the heavy metal sludge that settles out and

is considered as hazardous waste by the EPA. The block and head should be pressure tested before reinstalling. You may find that stop leak is the only thing holding them together.

Consider having the aluminum castings for the crankcase and engine pan vacuum impregnated to seal from oil weepage since the original castings are usually porous. Alternatively, you can use glyptol, a paint-like product made by GE, to seal the inside of the oil sump. Do not use any type of sealer unless the aluminum castings have been thoroughly cleaned and degreased since you don't want them coming loose and circulating with the engine oil. Note that the idler gear has a left-hand thread.

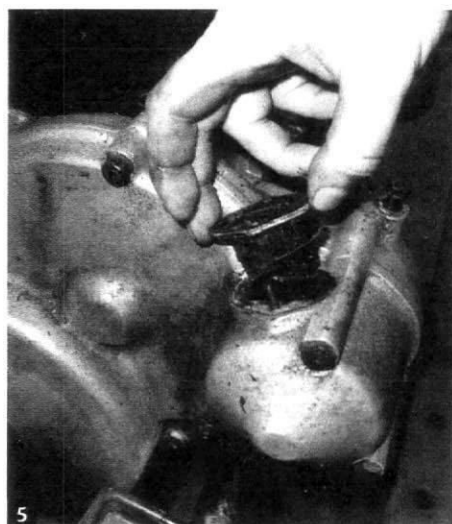
The carburetor side of the engine has a number of rods and linkages. These should be removed as a group, when possible, to maintain the correct position and orientation of the rods. This will significantly aid in the reinstallation process.

In removing the rocker arm, loosen all nuts and remove them evenly. This minimizes stress and distortion of the rocker arm since some arms are under pressure (valve spring) and some are not **4**. Tappet rods are numbered and their positions should be noted on removal. Put them back in their numbered order when rebuilding the engine. Before removing the front timing cover, be sure and remove the two dynamo brakes (top and bottom of timing cover case) **5**. Remove the nuts securing the head by starting at the center and working out to the edges; loosening each nut a quarter turn at a time. This is time consuming but will minimize head distortion. Be careful since a new head costs over \$5,000.

Clean out the petrol tank, Autovac, and inline petrol filters. Don't feed a newly rebuilt engine with dirty petrol. Change the antifreeze/water mixture every two years. The change is important to renew the protective additives in



4 Shop-made tool to compress valve springs. The end is threaded $\frac{1}{16}$ " BSF and screws on to the rocker arm bolts. The handle has a sliding arm to center the tool over each valve spring. This design allows you to remove the two valve springs closest to each rocker arm bolt.



5 Before removing the front timing cover, remove the upper and lower dynamo brakes that are held in place by two nuts. The "bearing" surface of the dynamo brakes is made of *lignum vitae*, a very hard, dense wood that is often used for propeller shaft bearings in boats.



6 Peter Sedmihradsky (ONT) and Phil Birkeland (WA) work on removing the numerous cotter pins securing the castellated nuts on bearing caps.



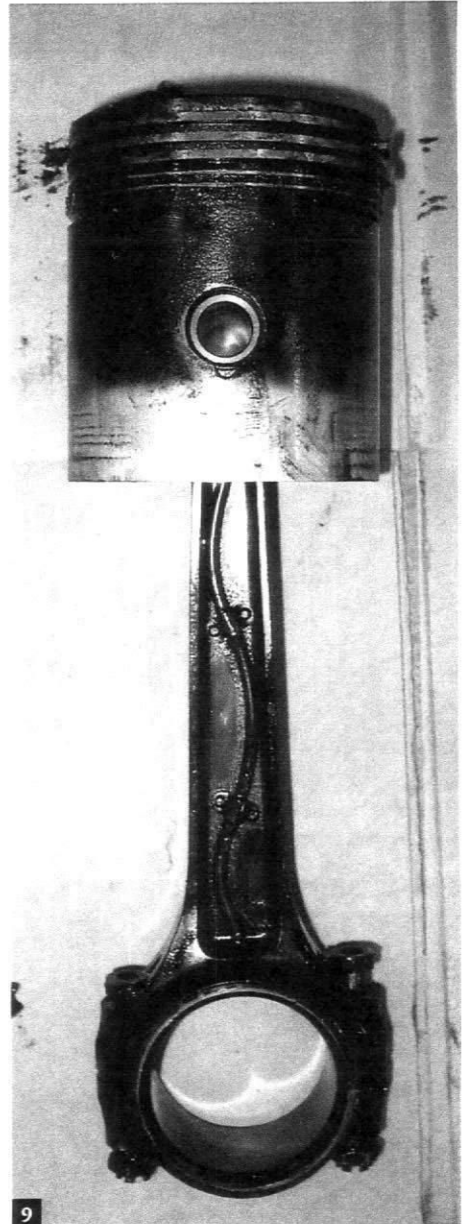
7
The crankshaft has hollow journals that fill with oily sludge as a result of the centrifugal-like action of the spinning crankshaft. Aluminum plugs seal the ends of the journals and are held in place by through-bolts. The plugs should be removed and the sludge cleaned out so that oil flows freely to the big ends of the connecting rods. Note build-up of sludge in journal.



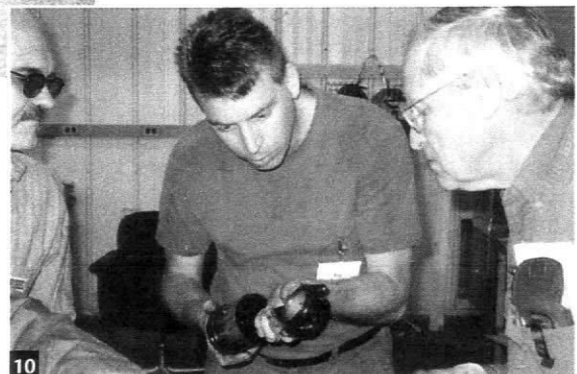
8
Aluminum sludge trap seals showing build-up of oil sludge and plug of sludge (middle) removed from journal.

antifreeze. After removing the radiator from the car, plug the bottom drain and fill the radiator with an antifreeze/water mixture. This prevents corrosion build-up and the old solder from drying out and possibly resulting in pin-hole leaks. Tim uses a torque wrench to remove each nut on main and connecting rods **6**. The torque values required to loosen each nut are recorded,

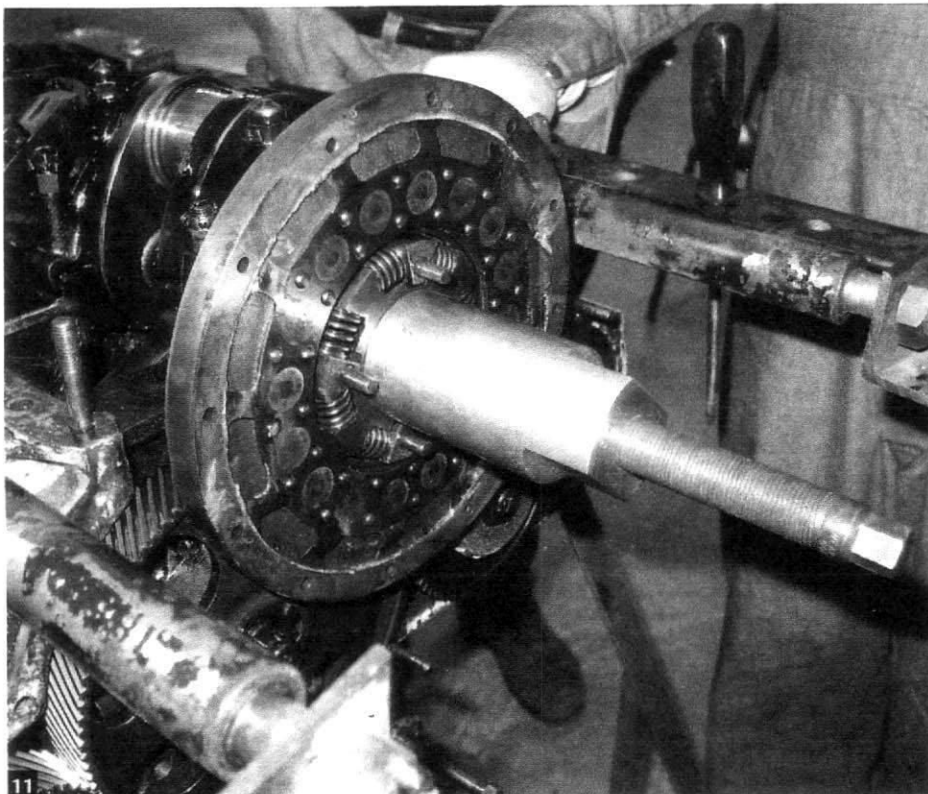
Robert Reynolds (MI), Tim Jayne (PA) and Peter Egeli (MD) inspect a piston for carbon build-up, scuffing, and piston ring integrity after removal from the block.



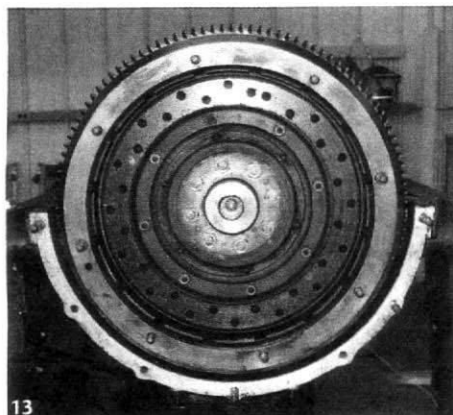
9
The connecting rod has an external oil line that is soldered at the top and bottom of the rod. The solder joints are subject to coming loose and should be pressure tested to insure they do not leak. You can fish a piece of piano wire down each oil line to insure it is clear. The integrity of the oil line is important since it is the sole source of lubrication to the small end of the connecting rods.



10



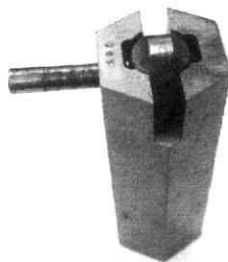
11 Removal of the slipper flywheel requires a left-hand threaded puller.



13 The flywheel bolts are peened over or center-punched to secure them. You have to grind off the bolt edges to remove the nuts. Be sure and use new bolts on the rebuild.

noting the cam side and off side torque values. Comparison of the torque values might highlight potential bearing problems and can be used to reinstall the existing bearings if they do not require new babbitt and line boring [7], [8].

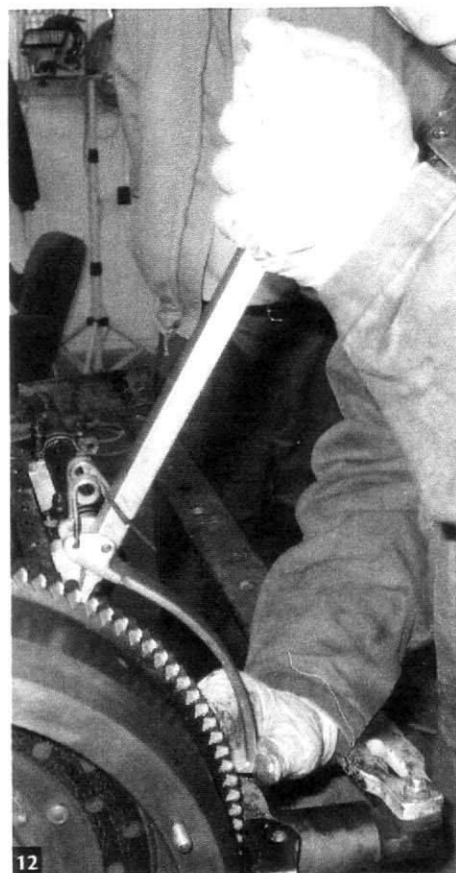
The connecting rods on early cars have an external oil pipe that should face the center of the engine when they are reinstalled [9], [10]. In dismantling the slipper flywheel, look for alignment marks on facing surfaces (usually an "o"). If no such marks can be found, use a punch to mark facing surfaces to assist in reassembly. The puller for the slipper flywheel is left-hand threaded [11]. The bolts attaching the flywheel are peened over the nut or are center-punched to secure



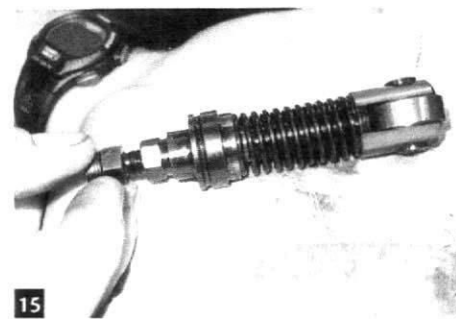
14 Shop-made tool to remove the pin in the cam roller bearing. The hex stock was bored out to accept the cam roller bearing and slotted to hold the wheel in place. A cross-drilled hole allows a punch to be centered on the wheel for removal of the pin.

them in place [12]. You have to grind off the peened-over portion of the bolt flush with the nut before they can be removed. This destroys the bolt, and new ones should be used on reassembly [13]. Tim reassembles the flywheel nuts with Loctite rather than peening over the bolt to secure them in place. The cam is held in place by steel dowels that require a puller to extract them from the block [14]. With the pins removed, the camshaft and cam bearings can be removed intact from the front of the engine [15].

In removing the main bearing caps on the crankshaft, be sure you keep the orientation of the caps the same as removed (do not reverse). After the crankshaft is lifted from the engine,



12 Snap-On makes a generic flywheel tool (A144) that fits the small horsepower flywheel. It can be used to turn the flywheel or hold it in place to remove the flywheel bolts.



15 Cam roller bearings should be removed and closely inspected for pitting of the cam wheel and play in the wheel. The pin and/or wheel should be renewed if worn to assure a smooth running engine.

reinstall bearing caps in the same orientation as removed. 

1 Fiennes Engineering, Clanfield Mill, Little Clanfield, Oxfordshire OX18 2RX, ph 01367 810438, email: enquiries@fiennes.co.uk, Web: www.fiennes.co.uk

2 Ristes Motor Company Limited, Gamble St, Nottingham NG7 4EY, ph 0115 9785834, email: info@ristes.zee_web.co.uk

3 Rolls-Royce Small Horsepower Engines (The overhaul of Rolls-Royce 20 h.p., 20/25 h.p., 25/40 h.p., Bentley 3½ litre and 4½ litre engines.), R. Haynes and M.A. Grigsby, published by Rolls-Royce Enthusiasts Club, 1977

4 Antonini Radiator, Inc., 325 East Railroad St., Pottsville, PA 17901, ph 570-622-3044

The Rolls-Royce Vibration Damper

Photos and text by JAMES PATE, NV

In the Nature of the Beast

Before beginning an examination of the engine vibration damper we need to have at least a basic understanding of the reason for placing this device on the engine. Why is it necessary? Was the engine not balanced? (See also p. 6110.)

The vibration problem goes right back to the earliest days of development with internal combustion engines. Henry Royce considered that an improvement in the smooth running characteristics of the engines should be the highest priority. It is known that he broke several crankshafts during early engine testing, in an effort to balance the rotating mass and reciprocating loads. Eventually, great improvements were made. Certainly all the production R-R engines in our cars were carefully balanced and tested before leaving the factory. This balance requirement should always be kept in mind when working around the engine rotating or reciprocating parts. Any change, say a new set of pistons, should include balancing. Also, the sludge traps in the crankshaft should be regularly cleaned (bottom decoke) to prevent uneven loading there. Even with all this care the engines still need a vibration damper because there is another inherent problem: *torsional vibration*. This condition requires a damper.

The need for an effective engine vibration damper is by no means limited to Rolls-Royce engines. On any engine, particularly on any in-line 6-cylinder engine, the transmission of power impulses to the crankshaft will tend to set up a condition of torsional vibration in the crankshaft. To understand the problem, imagine the force of one connecting rod upon its crank pin during the power stroke and you will be able to visualize how this force will tend to twist the crankshaft in the process of turning it. Think about it for a moment and it will become obvious. In actual fact, the force of the power stroke does actually twist the crankshaft, albeit very slightly. At the end of the power stroke the shaft, having been twisted, will quickly return to its original shape. But in returning, it will also spring slightly past the original shape and twist in the opposite direction. This *oscillating* motion of the crankshaft will repeat itself with every power impulse. Now, think of the other five connecting rods also twisting the shaft during their power stroke. Imagine the combined effect if one crank pin is oscillating back past its original shape just as a pin at the opposite end of the shaft starts its power stroke, and you will have an appreciation for the problem. This is torsional vibration, and unless it is controlled, the succeeding power strokes can add up to destructive oscillations. At certain speeds,

peculiar to the specific engine design, the vibrations will reach sufficient twisting forces to exceed the limits of the crankshaft. The twisting, in this case, will be sufficient to eventually cause fatigue fractures. The crankshaft will then break. Our Service Manual informs us that on the postwar, 6-cylinder engine the half-torsional period of the crankshaft will be reached at 2500 rpm (In my R Type, with a 12/41 rear axle ratio, that equates to about 58 mph in top gear). Any engine gear rattle noise, associated with torsional crankshaft vibrations, will be most noticeable at this engine speed and should immediately alert the driver that the engine vibration damper is not functioning adequately. Even an otherwise preoccupied driver should notice that the floor of the car is vibrating. Continue to operate at this speed, with a dysfunctional vibration damper and the result will be greatly accelerated main bearing wear. Should you accelerate the car, up to the speed for third period vibration (about 4500 rpm), you may very well experience catastrophic engine failure. A faulty damper can undoubtedly cause crankshaft breakage, especially on the more spindly crankshafts of prewar cars. On postwar cars, an engine run with a faulty damper will always take out the main bearings and eventually bend the crankshaft up to about 0.015 in. on the center main. This is no trivial matter. Crankshaft twisting or torsional vibration is serious business indeed.

How the Damper Works

Called *Low Inertial Spring Drives* in R-R language, early postwar cars were fitted with two types of dampers. The earliest cars in this series had a *wraith*-type damper, later cars had what is called the *bench*-type. The principal functioning is the same with both types (indeed, the prewar dampers also function the same way). The wraith dampers must be built up as the parts are fitted to the crankshaft, while the bench type, just as the name suggests, can be first assembled and then offered up to the crankshaft as a complete unit. This article will include photos and descriptions of the bench damper but both types are fully illustrated in the Service Manual. (Actually there were also minor changes to the bench-type damper—the illustration shown is a later R Type damper).

To understand how crankshaft dampers work it helps to imagine the damper as two basic parts, an inertial flywheel (free to rotate at engine speed and like any rotating mass, stable) and a separate part which is rigidly attached to the dynamics of the crankshaft. On the simplest of damper designs that is exactly

what one will find, with the two basic parts bonded to each other by a rubber pad. This is what was at the front end of the Chevrolet stove-bolt six engine, for example. (In that case, the fixed part of the damper also served as the fan pulley.) As the crankshaft twisting forces tend to speed up or slow down the crankshaft end, the stable inertia of the rotating damper flywheel will impose a dragging effect. The rubber bonding pad will absorb the energy and tend to keep the shaft turning at a constant speed. Twisting/untwisting or torsional vibration will thus be reduced. In retrospect, this damper design seems perfectly elegant in its simplicity and reliability. A very similar design (this time called a *harmonic balancer*) is found at the front end of the Rolls-Royce B60 and B80 engines in military vehicles.

The Rolls-Royce damper design on our postwar car engines is just a little more complex (also more expensive to manufacture, more difficult to set up, and more prone to failure). The benefit of all this added complexity is the smoothest running six-cylinder engines that man has yet devised.

Understanding the damper operation is easier if one is able to reflect back on the simpler design described above. The R-R damper also rides at the front of the crankshaft, but inside the timing gear cover rather than at the fan pulley. Instead of rubber pads, the vibration energy is absorbed through the friction action of cotton duck washers sandwiched, under spring pressure, between steel plates. Also, rather than being a single-function device, our crankshaft dampers are actually a composite damper, dealing with two separate engine problems. Observe the breakdown in **Figure 1** and you will note that the damper assembly also includes the pinion gear, which drives the camshaft. Think about turning a camshaft gear by hand and you will realize what an uneven load that is. As the lobes of the cam compress and then release the valve springs, the pressure needed to turn the camshaft is constantly changing, resulting in a decidedly jerky and uneven load. The radial springs (items 11 and 12) located between the dog members of the pinion gear assembly (item 6) and the friction plate (item 3, and called *friction drum* in Rolls-Royce language), provide for a spring-loaded coupling to dampen this uneven camshaft load. Clever indeed, but not without greatly complicating the business of setting the valve timing. This smoothing out of the camshaft load accounts for the use of "spring drive" in the Rolls-Royce name for these damper units.

Careful study of the components in Fig. 1 reveals that only one item, the friction plate (with serrated nut and washers), is actually attached to the engine crankshaft. All other metal components in the illustration are joined together to form the floating mass of the inertial flywheel. Again we have the two basic parts

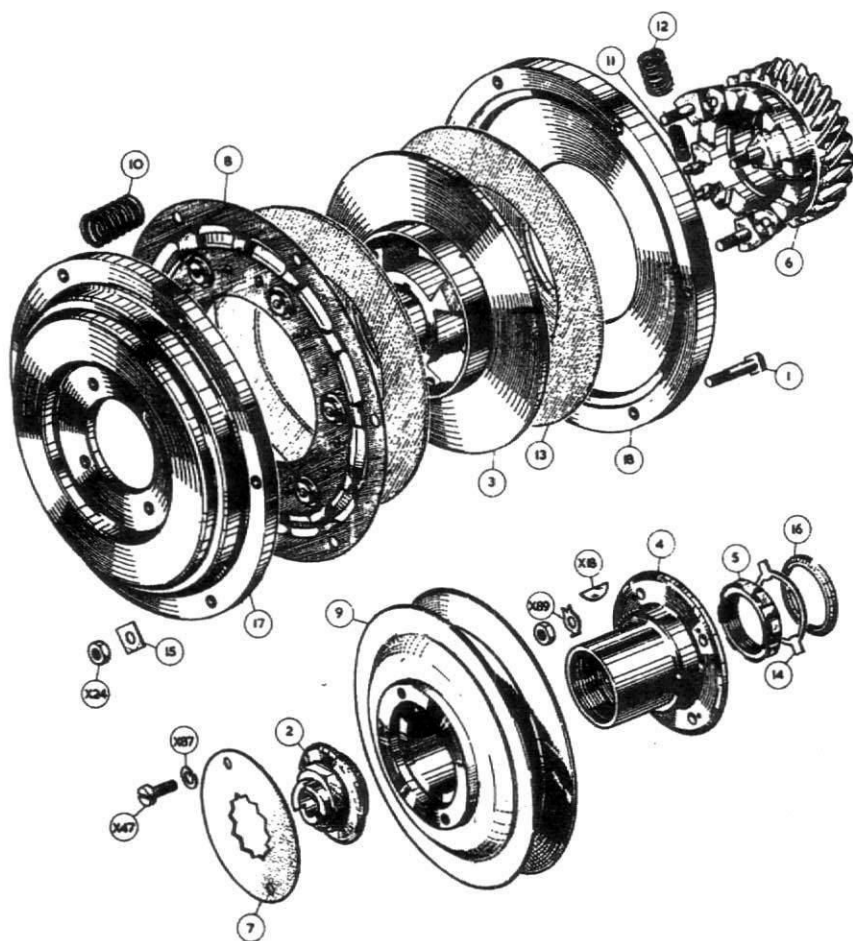


Figure 1

- | | |
|------------------------------------|----------------------------------|
| 1. BOLT, damper wheel | 10. SPRING, damper |
| 2. DOG, starting | 11. SPRING, driving, inner |
| 3. DRUM, friction | 12. SPRING, driving, outer |
| 4. HUB, with bearing | 13. WASHER, friction, cotton |
| 5. NUT, serrated, damper retaining | 14. WASHER, locking, damper nut |
| 6. PINION, with bearing and studs | 15. WASHER, locking, damper bolt |
| 7. PLATE, dog locking | 16. WASHER, plain, damper nut |
| 8. PLATE, spring assembly | 17. WHEEL, damper front |
| 9. PULLEY, fan driving | 18. Wheel, damper rear |

of a damper unit. A study of this arrangement also explains why the starting dog nut on these engines cannot be used to rotate the crankshaft for setting ignition timing. Notice also that the actual movement of the flywheel inertial mass will be limited to that movement within the loading of the radial spring set. The Service Manual says that this arrangement will not place a restriction on the action of the vibration damper because the deflections resulting from torsional vibrations are so very small.

What Can Go Wrong?

The Service Handbook advises that the principal problem to be expected from the R-R damper is a loss of efficiency resulting from changes in the slipper drive poundage. That

may be so, provided the engine has seen regular service, including decoking. The newest of these cars are almost 50 years old. It will be appreciated that to decoke the damper and replace the friction washers would first require removal of the grille, radiator, and timing gear cover. No small job. If this has not been done recently on your engine I would suggest that the "unlikely mechanical failures" so casually mentioned in the Service Manual will be not only likely but inevitable.

Oil from the engine high-pressure circuit, after passing the damper bearings, enters the body of the damper to provide lubrication for the friction plates. Unfortunately, with the engine running, there is no path for the oil to leave the damper. Therefore the damper case becomes a large and very effective sludge trap.



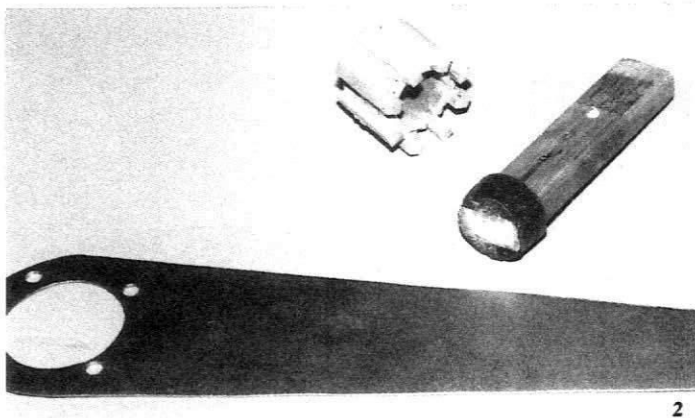
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The centrifugal forces, present there whenever the engine is running, soon begin to deposit carbon and sludge, brought in along with the oil, until the damper is filled rock solid with the exact same deposits which fill the crankshaft sludge traps. As this action is progressing, water (principally from condensation) also finds its way into the damper body where it too is trapped, and quickly goes to work rusting through the very thin fingers of the spring plate. After these fingers are sufficiently weakened they will shear under the friction pull on the plates (see **Photo 1** for an example). Now, with the spring plate out of service, the radial load will transfer to the compression springs which will quickly break up under the side loading. At this point, the slipper drive is totally ineffective and the crankshaft torsional vibrations are no longer being dampened. If you listen to the gear case of your engine at idle with a stethoscope at this stage, you could easily hear the rattling noise of broken spring bits inside the damper case. But an even worse condition than this is also common.

If the car has been allowed to remain out of service for an extended period ("lets block her up for the winter"), it is common for the cotton washers to fuse to the steel plates and halt all action of the slipper drive. When this occurs, the entire mass of damper flywheel weight takes on the exact opposite role from its design intention. Rather than provide a floating inertial mass, to absorb torsional vibrations through the friction plates, the flywheel, now firmly attached to the crankshaft, joins with the torsional oscillations to produce even greater twisting forces. This effect can take a crankshaft beyond its limit and shear it.

What Can be Done?

Well, understanding the condition really explains what must be done. The remainder of the article will revolve around how to do it. I won't repeat the instructions from the Service Manual here. Do familiarize yourself with *all* manual instructions and Service Bulletins aimed at the subject.



First, as so often, you need a few special tools. In order to gain access to the damper it is necessary to remove the timing gear cover, as mentioned earlier. To accomplish this you will first have to deal with the starting dog nut located at the front of the fan pulley (item 2). This particular nut is well known to anyone experienced in overhauling these engines and can be hard to remove unless the correct tool is employed. Do not attempt to rig up a long breaker bar for this job. Instead, contact fellow member Pierce Reid. Pierce already made up a slogger bar just for this particular nut, and the tool is available for loan to RROC members. With the correct tool in place, a single rap from a hammer will usually loosen the nut.

Once access has been gained, a few damper tools will also be needed. **Photo 2** is the rock-bottom special tool requirement for this work. You will need to make them up and, fortunately, the exercise will not be difficult. The tool at the upper left in Photo 2 was built from square key stock filed to size and welded to a socket. I just measure what will be needed and then go to a hardware store tool section to find a socket which will work. This particular monster will easily handle the serrated nut (item 5), which holds the damper friction plate to the crankshaft. With that nut off, you will find that the damper will still need to be pulled from the drive shaft. As you will note, the friction-plate hub is a taper fit on the drive shaft, with three Woodruff keys. The best plan for pulling the damper from the shaft is to rig a puller plate to the four studs, which will be waiting after the hub (item 4) has been removed. Were you to simply slip a puller around the damper case you would risk distorting the friction plate, which is probably going to need grinding anyway (and there are limits).

When the time comes for ironing/testing the cotton duck washers, you will need the other tools. First, a fixture for mounting the friction plate in a vise will be needed. Best would be to pick up a scrap driveshaft and use the cut-off end of the shaft as a mandrel. Second best would be to have a friend with a lathe or mill cut a taper to fit and mill slots for the

Woodruff keys. At the other end of the scale is the tool in the upper right. To make it, first put duct tape across the small end of your friction drum tapered hole. Then take a q-tip and carefully coat the surface of the taper and key grooves with grease. Finally, put in a shaft like the one shown and fill the taper with marine epoxy resin. It

isn't going to see you through a career of R-R damper repairs, but it will be up to the needs of the occasional job on your own engine. (In actual use, the wooden shaft twisted too much and required beefing up, with two layers of fiberglass and resin. Better to use steel or alloy for the shaft.) If the damper repair is to be part of a complete engine overhaul, then the crankshaft itself will be available and can be used for the holding fixture.

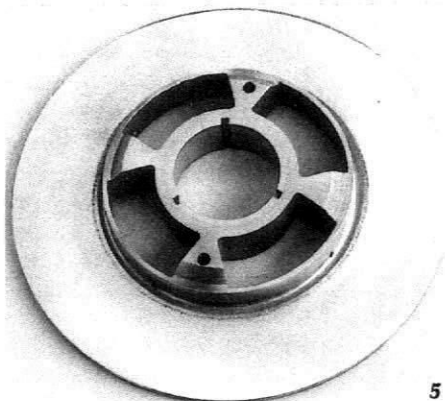
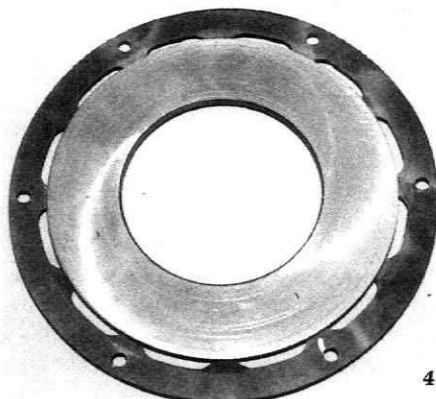
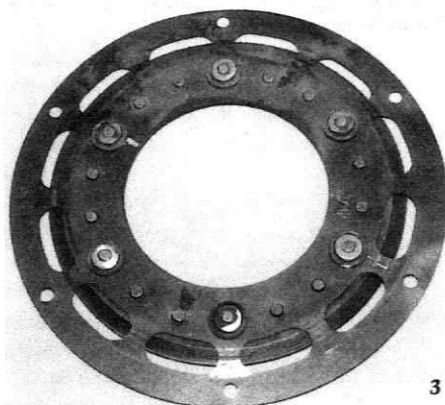
The tool at the bottom is cut from heavy-gauge sheet steel, using the hub (item 4) as a template. You will need this for the flywheel half of the damper assembly as you "work in" the friction washers and test for poundage. The length of the arm from center of the large hole to test pull hole must be 17.5 inch.

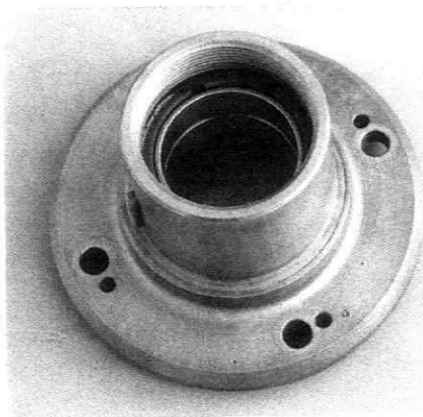
The spring plate in **photo 3** has been fitted as a repair to my old pressure plate assembly. The six large washers are the locators for the pressure springs. **Photo 4** is a view from the opposite side. It will be necessary to first drill out all the old rivets and get the remains of the old spring plate off. The new plate is then riveted in position, and finally, the friction face (with the rivet ends protruding) must be ground smooth and then polished. This work will require the services of a machine shop. An alternate (and more costly) approach is to replace the entire spring-plate/pressure-plate assembly. All the photos in this article are of stone ground surfaces, just back from the ma-

chine shop and before polishing the plates. My own approach was to insist that only stones were used to grind the plates. No cutting in a lathe was acceptable. The reason for this is because of the metal in the discs. Simply put, it is not of a consistent hardness. The surface hardness varies enough to cause a tool cutter to jump and leave an uneven surface. Also, I did not tell the machinists what the limits of the cuts were (they are listed in the Service Manual). My only instruction was to grind to a flat, clean surface, removing no more metal than necessary. That way, I relieve him of worrying about the limits. After the grinding I measure and decide whether the parts can be continued in service. It turns out that these all can, but only by a matter of a few thousands. They must be well maintained from now on—no further grinding will be possible.

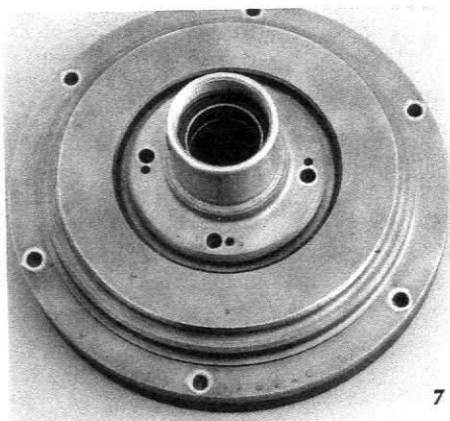
Photo 5 is a look at the only part of the damper assembly that is actually attached to the crankshaft, the friction plate. Notice the grinding swirls on the surface. These must be polished out before the final setup can begin. My reason for going to the trouble of polishing the plates is simple. Under the constant slipping during engine operation they will polish up anyway. So, best to have the polished surface on all the plates before setting up and adjusting the friction washers, in the interest of long damper life with consistent poundage and efficiency.

Before going further, with the friction plate easily accessible, take the time now to check





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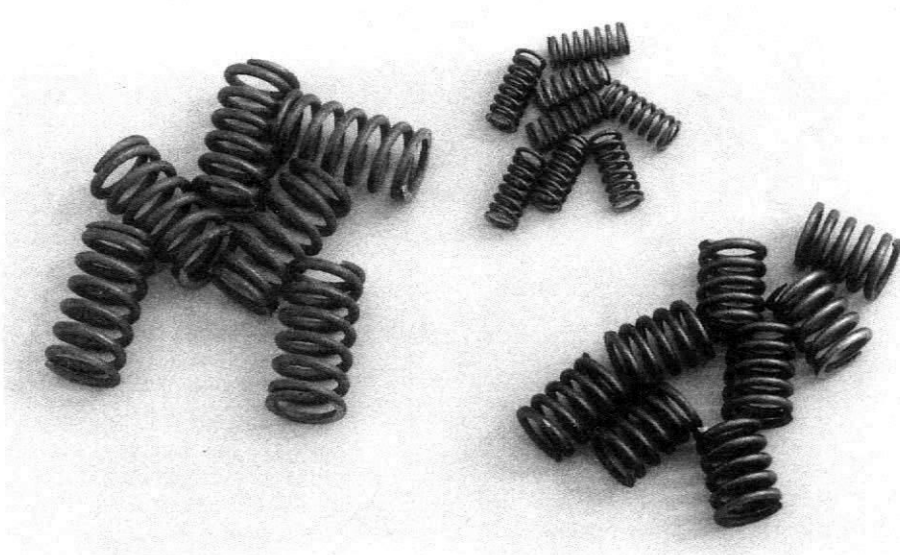


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the fit of the taper surface on the crankshaft. Adjust the angle of the keys and remove any burrs from the keys or grooves. It's easier to do now and will make fitting the damper to the crank a snap when that time arrives.

Photo 6 is a look at the front hub. The internal screw threads, which can be seen in the photo, will later accept the starter dog. This item sports a new bearing, pressed in and honed to size. The same will be needed at the rear of the damper unit, in the pinion drive gear, both bearing surfaces being part of the free flywheel mass. Barely noticeable in the photo are two oil drains milled in the casing on either side of the bearing. This provides a path for pressurized oil to pass out through the forward side of the bearing and then return to the sump. This little bearing will likely be the most worn of all the crankshaft bearings in your engine. Can you imagine why?

Photo 7 illustrates the need to carefully clean all the parts that make up these dampers. After you do so, you will find location marks. I had placed my own temporary marks with paint before anything came apart. Later I found that, as usual with R-R, the factory had already marked the parts. You will find location markers on each of the inertial flywheel components. They are faint and look almost like center punch marks; examine carefully your clean parts. You will find small "zero" markings. Line them up when the assembly goes together. The entire damper assembly is balanced, but only if the parts are placed in the original relationship.



8

What Parts Will Be Needed?

As it turns out, not a lot. This job is going to be a major expense at the machine shop—not at the parts house. **Photo 8** illustrates the springs you'll need. Personally, I would not even consider going through the exercise without replacing all of these. On the left are the six compression springs. If yours is the typical neglected damper, with rusted-through spring plate fingers, then you will have no intact compression springs remaining. On the right side are the inner and outer radial springs. The old ones will likely look OK, but replace them anyway. Don't even think about using old springs, UNLESS you are in the fortunate position of only needing to change the friction washers in a well-maintained engine.

Photos 9 and 10 present a choice, which now must be made. The cotton duck friction washers in **Photo 9** are still available from specialty firms. You won't find them at your local R-R parts desk or, as far as I know, anywhere in the US. In England they still have a loyal following and can be found with some searching.

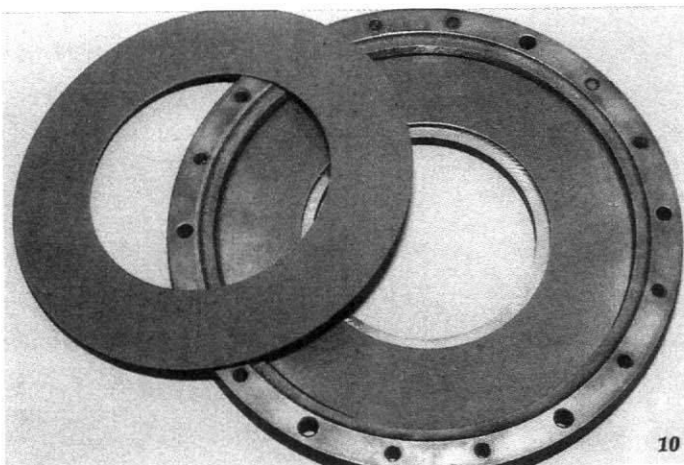
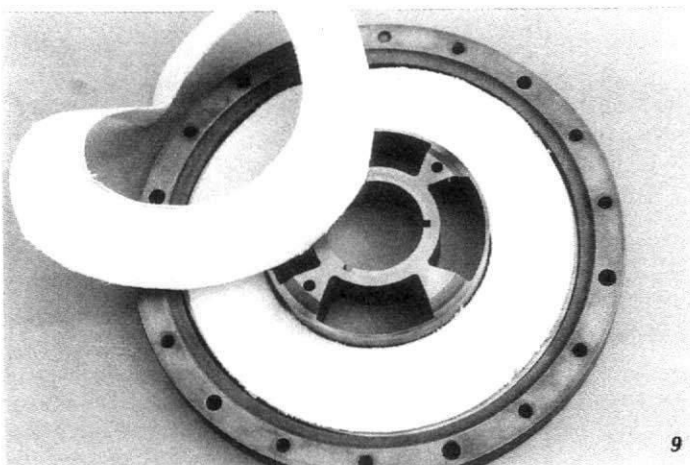
Photo 10 shows what you will receive if you order damper friction washers through the US distribution system for Rolls-Royce parts.

Certainly there are also other types of friction washers available. For quite a span of time these parts were not available through R-R, therefore specialty shops responded in the usual way, by improvising, and making up their own washers. In this country some highly respected engine shops prefer still to manufacture their own friction washers.

Which washers should you use? Not an easy question to answer. Opinions, among the experts (and I discussed this with some TRUE experts) are always at odds on this subject. It is almost like asking fly-fishing aficionados for the best fly to use. I will attempt to distill the many conversations I had on the subject, and to be reasonable, I will limit the choice to either

cotton duck or modern composite. The arguments generally go something like this. Modern composite washers require far less time and labor (\$\$ if someone else will be doing it) to set up. They are simply oiled, placed in position and tested/adjusted for slip poundage. They are also easily available through any R-R parts agent. However, some very respected sources believe these washers have a serious problem. With years of experience and testing under their collective belts, including the great advantage of being able to examine the units, during general engine overhaul, after years of service, the conclusion from these witnesses is that the modern washers suffer from inconsistent slip poundage. The poundage is said to change, not only from bench testing to actual engine service, but also during service. An inconsistent oil film is blamed, allowing the friction to change constantly, depending upon how much oil finds its way under the washers. Some shops cut or mill oil grooves in the composite washers in an attempt to achieve more reliable performance (new R-R type washers have no oil grooves but are smooth). The old style cotton duck washers are said to deliver better performance because they do not have a problem with the oil film. They are made from fabric and will absorb oil rather than ride on an oil film. The result is more constant poundage and a more efficient damper, BUT the cotton duck washers require more labor to set up AND are prone to fuse themselves to the surface of the steel plates if the engine is permitted to go unused for an extended period. As described above, this condition is the worst of all for torsional vibration problems.

So the choice is one of personal preference based upon how the car is likely to be used. I decided, after considerable back-and-forth thinking, to use the composite friction washers currently available from Rolls-Royce.



Other required parts include a set of new locking tab washers and new bearings for the damper nose and pinion gear. If the spring plate looks anything like the one in Photo 1, a new spring plate with rivets will also be needed.

How Do I Handle Those Radial Springs?

The radial springs are the only tricky step in damper (dis)assembly. **Photo 11** was taken after the new springs were in place and is included here to illustrate the close quarters involved. These springs could become a real wrestling match to remove and install. If you plan to do this work yourself notice that the four dogs of the pinion gear assembly have studs as mentioned earlier. Two of the friction plate dogs have plain holes and they will be used, both in getting this unit apart and in rebuilding with new springs. The Service Manual does not explain how this can be done and does not mention any special tool. Certainly it can be visualized how a tool could be made up but that really isn't necessary. The expedient of placing two drift pins in the plain holes and then clamping the pins to a nearest stud will compress half of the springs in the assembly, depending upon which stud is clamped up. Clamp with sufficient force so that the compressed springs are just choc-

a-bloc (**Photo 12**). While half the springs are choc-a-bloc under compression, the other half will be at maximum expansion (the space between the dogs at its greatest). In this way one can work the springs in or out of the assembly. It will still not be easy, but it will at least be possible. Photo 12 was taken while new springs were going in. In this case it will be found helpful if a thin sheet of steel is first placed over the spring-locating recess, as shown at upper left in the photo. After the inner/outer spring pair has been worked into position in the assembly, the strip of steel can be pulled out and both springs will snap into place on their locators.

Photo 13 illustrates why the strip of steel is helpful in the spring fitting operation. This is a view of the pinion gear assembly alone. Notice the four dogs have the spring locators on both sides. The protrusions will locate the inner springs and the recesses will locate the outer springs. Should you attempt to simply work the springs over these locators they will surely foul and make the job very difficult. The strip of metal will solve this problem. The four dogs on the spring plate are smooth. All the spring locators are seen here. The small zero mark seen near the stud in the foreground is one of the location marks described earlier.

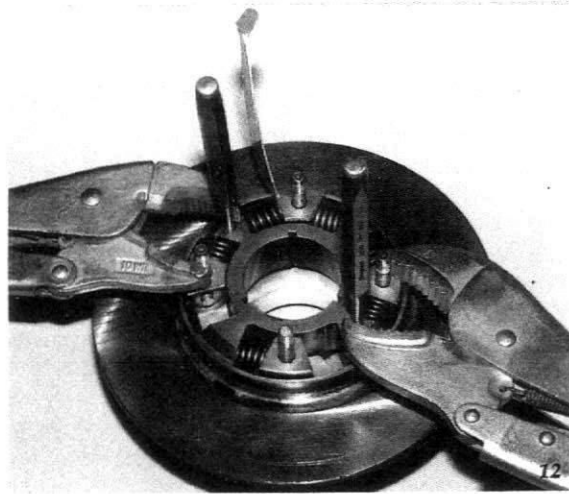
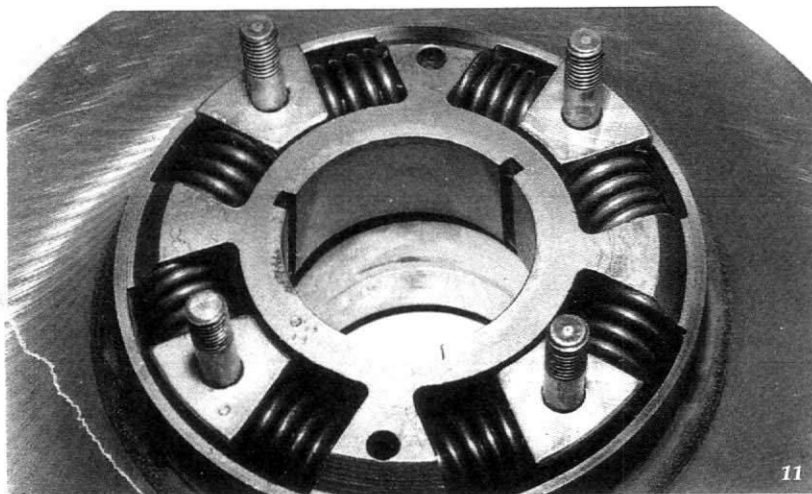
How Do I Test the Poundage?

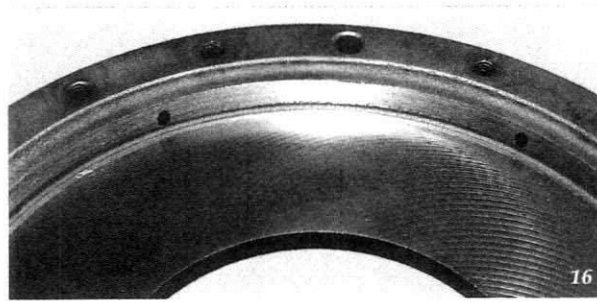
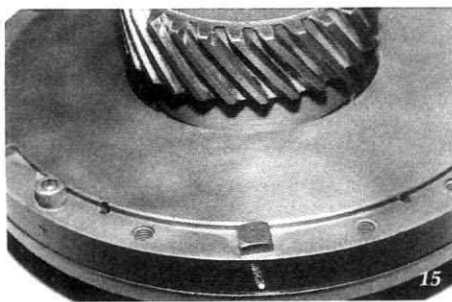
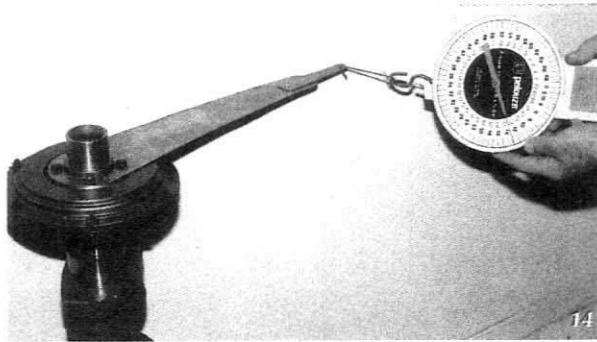
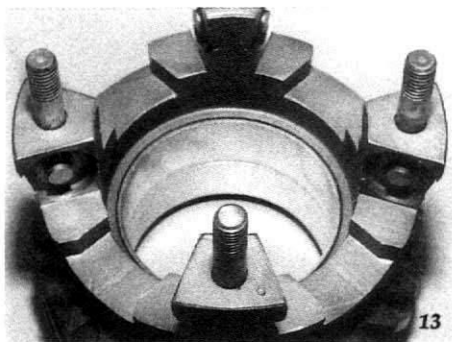
The tool made from sheet steel (Photo 2) is demonstrated in **Photo 14**. Notice that here a complete overhaul is underway, so the crankshaft itself is being used as the holding fixture. 17.5 in. is the distance from the hub center to the attaching hole of the scale. The desired scale reading, while the friction plates are in motion, is 14+1 pounds.

If cotton duck washers are to be used, they will first need to soak in oil for a day. Then they need to be placed between two metal plates, under pressure, for another day.

Whether using cotton or composite washers, the next step will be testing the poundage. For this step the damper is built up with all parts EXCEPT the radial springs. Then using the tool (see Photo 14), the washers can be worked in (ironed, in R-R language). Remember that movement will be limited to the dog-to-dog distance. Even with the springs removed the movement is not great. Just work back and forth for about 15 minutes with all the washers flooded with oil. This will take off any high spots and seat the washers to the steel plates.

Then hook up a scale, as shown, and test the poundage. If it falls between 14 and 15 pounds you are done. If not, adjustment will be needed.





Further ironing of the washers or further polishing of the steel plates will be needed in the case of too much poundage. Placing flat adjusting washers under the compression springs will correct a situation of too little poundage. It will be a trial and error fitting until the correct spring loading is achieved. Then, the damper is again taken apart and the radial springs are fitted as described above. The job is just about finished. But before you lock over those new tab washers there is one more serious consideration.

How Soon Do You Want To Do This Again?

Whether you use cotton duck or composite friction washers let us assume that you have set up this damper to specification, including new parts where needed and with correct poundage on the friction washers. How long do you think this will all last?

The destructive forces described above will immediately start to work on your newly rebuilt engine damper (even with modern oil and full flow filtration.) Again, oil will flood into the damper after the high-pressure circuit forces it past the damper bearings. There it will be trapped. Once the damper is full up, no more oil will enter. The damper body will then become a centrifuge for as long as the engine is running. Any carbon or other particles (heavier than oil) will be deposited around the inside circumference of the damper case.

After engine shutdown, oil (above the ring of entry holes) will drain from the damper, leaving the deposits behind. At the next start-up the cycle will repeat. Soon the case will be full with sludge. Worse, part of that sludge will be water (also heavier than oil). Water is our worst enemy in this case. The spring plate fingers, being small and thin, will soon fail in this corrosive environment, which now includes hot water. No ques-

tion—the damper will self-destruct. You can slow the destruction by regular oil changes and by always running the car long enough to burn off condensation in the engine. But the damper will still self-destruct unless something is done to evacuate the water and sludge.

Looking for a possible solution for this situation brings an obvious question to mind: why not drill drain holes around the outer circumference of the damper? That would allow the oil to pass out and be replaced by fresh oil. This action would allow the carbon/crud/water to exit as well, still in suspension. Seems so simple—why were the holes not already there?

I could not find a definitive answer to this question. Possibly the Crewe engineers believed that it was necessary to have a closed damper case because of the known properties of the cotton friction washers. Maybe there was concern that enough cotton fluff would find its way into, and clog, vital passages or (more likely, I believe) the worry was that cotton washers would tend to fuse to the steel disks unless the case was kept full with oil. Such conjecture is only wild guessing, and in any case, outside the scope of this article.

Two very reliable sources I discussed this matter with seem to remember that there actually was a R-R instruction (to dealers only) issued sometime during S1 production, which suggested drilling just such damper drain holes. Could this have been an effort to achieve longer damper service? A shift to ferodo friction washers had already been made (with the last few 4.5-liter cars in early 1955). It is tempting to suppose that this suggestion to drill damper drain holes was made in the interest of longer damper service intervals. To me, it is also tempting to suppose that a few years' experience with the ferodo washers had convinced Crewe that a solution had been found to the

old fusing problems of the cotton duck. With that problem solved, it would seem reasonable to improve the dampers by providing drain holes. Again, this is only speculation. I did try, without success, to locate a copy of that instruction. Perhaps one of our readers will know the full story.

That is the background. You must decide. For myself, I decided in favor of adding oil drain holes around the outer circumference of my rear damper case, believing that this simple step will greatly extend the service life.

Pay Your Money and Take Your Chances...

Once you decide to provide oil drain holes the question becomes where and how big. The

goal is to achieve the shortest path to the outside while still taking advantage of centrifugal force (and retaining sufficient oil inside the case to lubricate the friction faces). The best path, on my own late model R Type, seemed to be a pattern of six holes, drilled at 60° intervals, with a hole size of 1/8 inch. **Photo 15** shows the rear side of the damper case. Two of the six drain holes can be seen at 4:30 and 7:30. They were drilled from this side, at a 45° angle, to reach the plain face inside the damper.

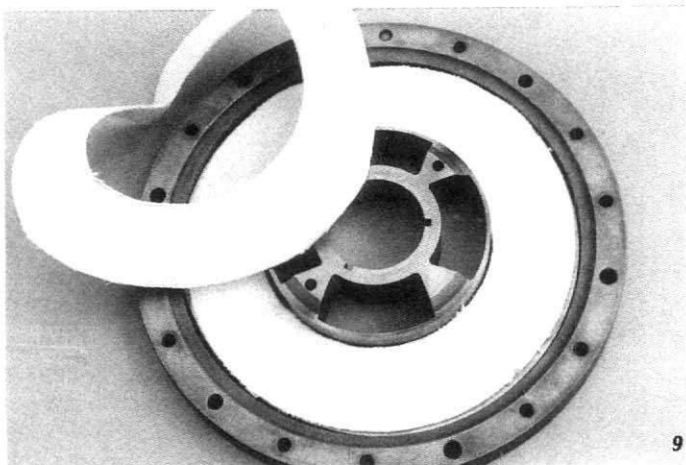
Photo 16 shows the suggested location of the oil drains as seen from inside the case. This is the rear case half and the two holes are located on the extremity, where the centrifugal force will be greatest.

That's It, Best Wishes for Long Engine Life!

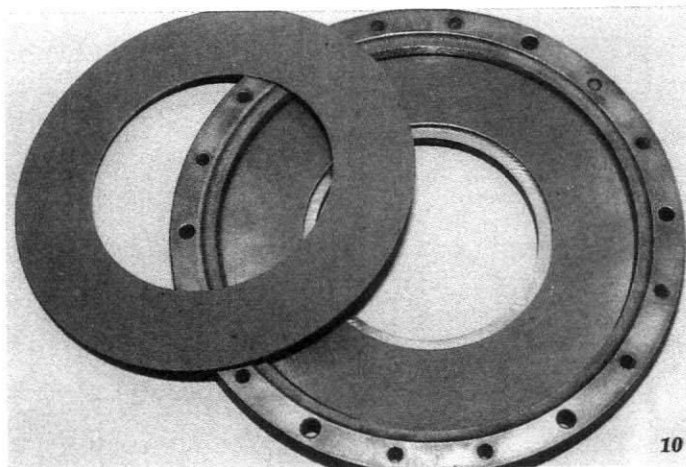
This subject is every bit as controversial as it is interesting and important. Just ask a few "experts" for advice and see what a variety of answers you receive. Should you use cotton duck friction washers as original to your car? Or should you use composite washers as currently being supplied by Rolls-Royce? Rebuild your dampers, as original, and accept the need for frequent overhaul? Or provide oil/water drain holes in order to extend the useful life of the damper? Whether you do the work yourself or direct a mechanic, I do hope that you will consider, carefully, what will be done with the vibration damper on your engine. It's an interesting subject and well worth your time to carefully contemplate the options.

The author will gladly discuss any of these issues with any member (ph. 702-360-4915 or email <JWPATE@CONCENTRIC.NET>).

Drilling a damper is not a Company-approved modification. Before undertaking, check with the author for in-service results. — Tech Editor



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Other required parts include a set of new locking tab washers and new bearings for the damper nose and pinion gear. If the spring plate looks anything like the one in Photo 1, a new spring plate with rivets will also be needed.

How Do I Handle Those Radial Springs?

The radial springs are the only tricky step in damper (dis)assembly. **Photo 11** was taken after the new springs were in place and is included here to illustrate the close quarters involved. These springs could become a real wrestling match to remove and install. If you plan to do this work yourself notice that the four dogs of the pinion gear assembly have studs as mentioned earlier. Two of the friction plate dogs have plain holes and they will be used, both in getting this unit apart and in rebuilding with new springs. The Service Manual does not explain how this can be done and does not mention any special tool. Certainly it can be visualized how a tool could be made up but that really isn't necessary. The expedient of placing two drift pins in the plain holes and then clamping the pins to a nearest stud will compress half of the springs in the assembly, depending upon which stud is clamped up. Clamp with sufficient force so that the compressed springs are just choc-

a-bloc (**Photo 12**). While half the springs are choc-a-bloc under compression, the other half will be at maximum expansion (the space between the dogs at its greatest). In this way one can work the springs in or out of the assembly. It will still not be easy, but it will at least be possible. Photo 12 was taken while new springs were going in. In this case it will be found helpful if a thin sheet of steel is first placed over the spring-locating recess, as shown at upper left in the photo. After the inner/outer spring pair has been worked into position in the assembly, the strip of steel can be pulled out and both springs will snap into place on their locators.

Photo 13 illustrates why the strip of steel is helpful in the spring fitting operation. This is a view of the pinion gear assembly alone. Notice the four dogs have the spring locators on both sides. The protrusions will locate the inner springs and the recesses will locate the outer springs. Should you attempt to simply work the springs over these locators they will surely foul and make the job very difficult. The strip of metal will solve this problem. The four dogs on the spring plate are smooth. All the spring locators are seen here. The small zero mark seen near the stud in the foreground is one of the location marks described earlier.

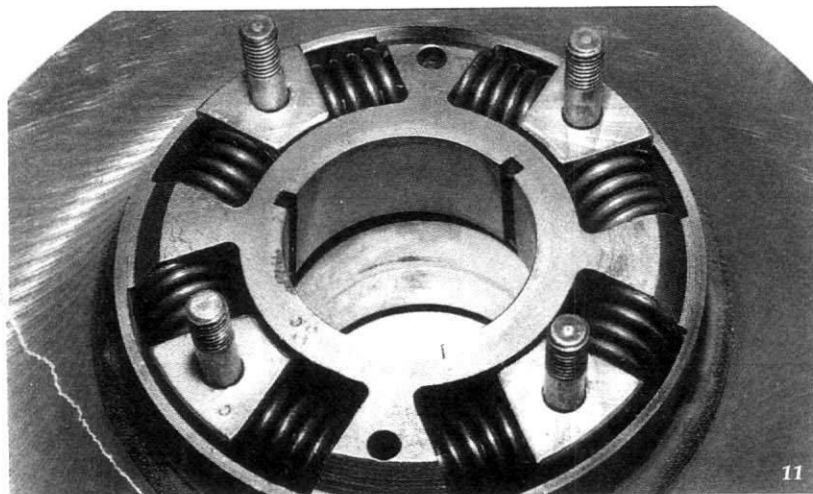
How Do I Test the Poundage?

The tool made from sheet steel (Photo 2) is demonstrated in **Photo 14**. Notice that here a complete overhaul is underway, so the crankshaft itself is being used as the holding fixture. 17.5 in. is the distance from the hub center to the attaching hole of the scale. The desired scale reading, while the friction plates are in motion, is 14+1 pounds.

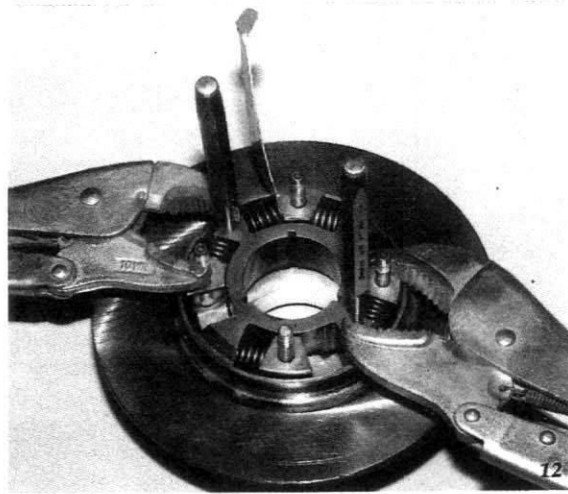
If cotton duck washers are to be used, they will first need to soak in oil for a day. Then they need to be placed between two metal plates, under pressure, for another day.

Whether using cotton or composite washers, the next step will be testing the poundage. For this step the damper is built up with all parts EXCEPT the radial springs. Then using the tool (see Photo 14), the washers can be worked in (ironed, in R-R language). Remember that movement will be limited to the dog-to-dog distance. Even with the springs removed the movement is not great. Just work back and forth for about 15 minutes with all the washers flooded with oil. This will take off any high spots and seat the washers to the steel plates.

Then hook up a scale, as shown, and test the poundage. If it falls between 14 and 15 pounds you are done. If not, adjustment will be needed.



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