N

Steering

FACTORY

SERVICE INSTRUCTION LEAFLET

ISSUED BY

BENTLEY MOTORS (1931) LTD.

BM/N1

SB/VA. 1/SF.

Subject : TO FIT A NEW CROSS STEERING TUBE - BENTLEY $3\frac{1}{2}$ or $4\frac{1}{4}$ litre.

Date of Issue 28th March, 1949.

IMPORTANT

THE CONTENTS OF THIS DOCUMENT ARE STRICTLY CONFIDENTIAL AND ARE NOT TO BE TRANSMITTED TO ANY UNAUTHORIZED PERSON.

GENERAL:

New cross steering tubes, G-100438a, are supplied, with one end piece, G-100439, unbrazed to the tube because there is usually a variation in the width between the ball end pin centres of the cross steering levers from one chassis to another.

CAUTION:

It is of the utmost importance that no attempt must be made to weld the loose end piece to the tube or braze it with the use of an oxy-acetylene welding plant. The tube and end piece are made from $3\frac{1}{2}$% nickel steel, and this is susceptible to burning and crystallization, the loose end piece must therefore be brazed to the tube by using a coal gas flame or a large paraffin blow lamp.

PARTS NORMALLY SUPPLIED:

Part No:	Title:	No.Off:	Part No:	Title:	No. Off:
G100438a	Cross steering tube.	1	K4819	Taper Pins	2
G100439	End piece(loose)	1	K4602	Split Pins	6
(G100431	Cotter pin	2	(K4608	Split pins	2
(In case the original ones are (damaged during removal.			(For ball end pins.		

TO FIT A NEW CROSS STEERING TUBE:

(i) Remove the cross steering tube complete with ball end pins from the car and collect the locating washer fitted to the underside of each cross steering lever.

(ii) Slacken off the steering joint nut (9, Fig.1), of the original tube from one to two flats and remove the two clamping bolts from the end of the tube and then carefully remove the tapered cotter pin (5) situated between the clamping bolts.

(iii) Unscrew the steering joint nut from the sleeve (12) and remove all parts from the end of the tube taking care to note the position of any packing washers (shims) that may be found to be fitted. Slide or lightly tap the steering joint nut down the tube which will expose the retaining ring (3) fitted beneath it. Remove the retaining ring and the nut. Repeat for the opposite side of the tube. Keep right-hand and left-hand parts removed in separate containers and thoroughly clean all parts.

(iv) The next operation is to assemble all the parts removed(with the exception of the cotter pins) from the original tube to the new tube and loose end piece in order to set a gap of .008" to .015", (as shown at point 'A' Fig.1), at each end of the tube as described below and then drill and ream the tube to take the tapered cotter pins also described below.

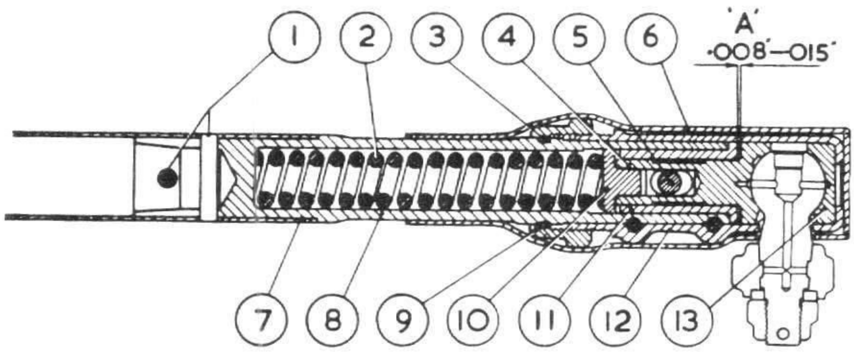

FIG. 1. SECTION THROUGH CROSS STEERING TUBE JOINT.

1. Taper Pins.
2. Spring.
3. Retaining ring.
4. Ball pad-inner.
5. Cotter pin.
6. Leather cover-steering joint.
7. Cross steering tube.
8. Cross steering tube end.
9. Nut.
10. Plunger.
11. Bush-ball pad.
12. Sleeve-steering joint.
13. Ball pad - outer.

a) Place one of the steering joint nuts (9) on the tube or the loose end piece and then fit the retaining ring (3) in the groove provided.

(b) Place the spring (2) into the tube and assemble to the tube the remainder of the parts (including any packing washer/s should they have originally been fitted) in their proper sequence (See Fig.1) including the ball pin.

NOTE: When assembling the steel bush (11) to the tube, it must be placed (rotationally) so that the hole in it will be in line with the cotter pin holes in the sleeve (12) in order to allow a clear passage when drilling the tube to take the cotter pin.

With the outer ball pad (13) in position in the sleeve, slide the sleeve into position on the tube. Engage the threads of the steering joint nut with those of the sleeve and screw up the nut until there is a gap of .008" to .015" at point 'A' Fig.1.i.e., between the rear face of the inner ball pad (4) and the corresponding face of the steel bush (11) into which the ball pad is fitted. This clearance is necessary so that the spring can operate freely. Having obtained the correct gap, then fit the two clamping bolts in position and tighten up the nuts but do not split pin them at this stage. The heads of the bolts must be fitted in the location provided on the sleeve.

(c) Repeat for the opposite end of the tube.

NOTE: The 2-BA nuts of the clamping bolts have a spherical seating, whereas the nuts for the cotter pins are standard.

(d) From the cotter pin holes in the sleeve, mark off the tube and drill two holes i.e. one on either side of the tube to take the cotter pin. Drill one hole .281" dia. (9/32") and the other .218" (7/32"), and finally ream with a 1 in 20 taper, broach or reamer to allow $\frac{1}{8}$" draw on the tapered cotter pin. Fit the cotter pin. (See "Note" below).

(e) Repeat for the opposite side of the tube.

NOTE: The nuts of the clamping bolts at the brazed end of the tube should now be checked for tightness and then split pinned, also tighten up the nut of the cotter pin and secure with a split pin. Ascertain that the steering joint nut is tight, but it should not be overtightened.

Tighten up the nut of the cotter pin in the loose end of the tube, but do not split pin the three 2-BA nuts at this stage because all parts on the loose end piece will have to be removed prior to the brazing operation.

(v) The next operation is to temporarily fit the cross steering tube to the car in order to adjust the tube for correct length to give a toe-in of $\frac{1}{8}$" to the front wheels. Proceed as follows:-

(a) Jack up the front of the car until the tyres only make light contact with the ground.

(b) With the nuts of the cotter pins facing towards the front of the car, temporarily fit the cross steering tube. The locating washer as fitted to the underside of each of the cross steering levers must be correctly positioned. The castellated nut of the ball end pins need not be fully tightened up at this stage.

(c) Check the toe-in of the front wheels. It is usually found when fitting a new cross steering tube that there is too much toe-in. If the toe-in exceeds $\frac{1}{8}$", then it will be necessary to shorten the end of the tube by degrees until the correct amount of toe-in has been obtained.

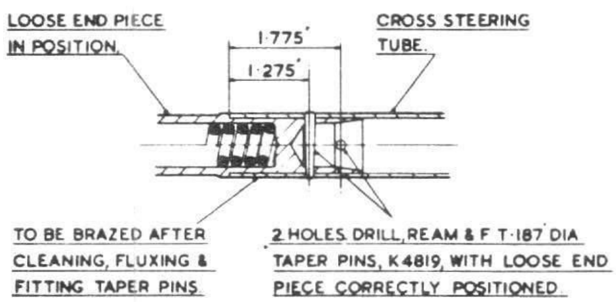

FIG. 2.

(vi) Having adjusted (filed) the tube to correct length, remove all parts from the loose end piece of the tube including the steering joint nut and its retaining ring and peg and braze the loose end piece to the tube as follows:-

(a) Thoroughly clean the inside of the tube and the loose end piece and apply flux as necessary to both parts and then insert the end piece into the tube as far as it will go and rotate until the two grooves in it for the clamping bolts are in line (parallel) with the two similar grooves on the opposite end of the tube. With the end piece in this position, drill and ream for the two taper pins (K4819) as detailed on Fig. 2, (the taper pins have a taper of 1 in 48 on dia:) and braze the end piece to the tube <u>using a coal gas flame or a large paraffin blow lamp</u>.

<u>NOTE</u>: A feeder hole, .160" dia. is drilled in the tube for brazing purposes. Do not drill through this hole into the end piece.

(b) Finish off ends of taper pins flush with tube after brazing and clean up tube as necessary.

(vii) Place the steering joint nut (9) in position on the tube and refit its retaining ring (3). Re-assemble all remaining parts to the tube and split pin the three 2-BA nuts and check the steering joint nut for tightness.

(viii) Fit the tube to the car (with nuts of cotter pins facing to front of car), again making sure that the locating washers as fitted beneath the cross steering levers have been correctly positioned. Fully tighten up the two castellated nuts of the ball end pins and secure with the new split pins (K4608) supplied. Refit the leather covers.

<u>FRICTION (LOAD) TEST:</u>

The friction of the cross steering tube should be tested by clipping a 10" lever to the centre of the tube to determine the load required to twist the tube on the ball pins. This load should be from 8 to 9-lbs. applied to the end of the lever at a 10" radius. The load should be equally divided per ball pin i.e. 4 to $4\frac{1}{2}$-lbs. on each pin. If it is found that there is insufficient load, then make a packing washer or washers .010" thick and fit behind the spring/s. If the load is found to be too high, then remove any packing washers that may have been fitted originally; if none have been fitted, then reduce the large (inner) face of the steel plunger (10) by .005" at a time.

Finally inspect that no split pins have been omitted.

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18.6.35.

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DEPOT SHEET NO. Hd.283.

BENTLEY STEERING.

Origin of information:
Hs/FD14/KW24:4.25.

In the event of complaints of heaviness in the steering on Bentley cars, it will be permissible to lighten the steering by carrying out the following alterations:

(1) The cross steering tube poundage should be reduced to 6 lbs. + or - 1 lb. To obtain this figure it is necessary to fit new contact pieces F.B.2175 in place of the standard contacts G.100434.

(2) The side steering tube poundage should be 3.5 to 4 lbs. To obtain this figure it is necessary to grind .125 off the spring G.100432, and to fit new contacts FB.2175 in place of the standard contacts G.100434. This applies to the front end only.

(3) The rear end of the side steering tube remains unaltered, but owing to the high rating of the springs it is <u>most important</u> that the spring guide FB.722 should protrude .012 beyond the end of the socket before the nut is tightened.

This dimension should be strictly adhered to.

Hd.

Sg.
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11th January 1937.

DEPOT SHEET NO. Hd.324.

STEERING BALL JOINTS.
25/30 HP. and Bentley Chassis.

Origin of information:-
Hd/SB20/HR.31.12.36.

The ball ends in the cross and side steering levers are provided with a locking device which serves two purposes:-

1. It positions the ball ends with the oil holes in the correct angular position.

2. It locks the nut and ball pin against rotation.

This locking device, when properly fitted, is absolutely safe and foolproof, but cases have occurred in service where the ball pin has come loose in the steering lever.

Such cases have been found to be due to incorrect replacement of the parts after dismantling,

-continued-

Continued:-

the usual fault being that the locating washer LW. is so fitted that the locating tab T. rides on the boss instead of fitting into the slot S.

The sketch attached shows the correct method of assembly. It will be seen that the oil holes in the ball pin should be in line with the slot in the steering arm, and the internal tabs in the locking washer are at right angles.

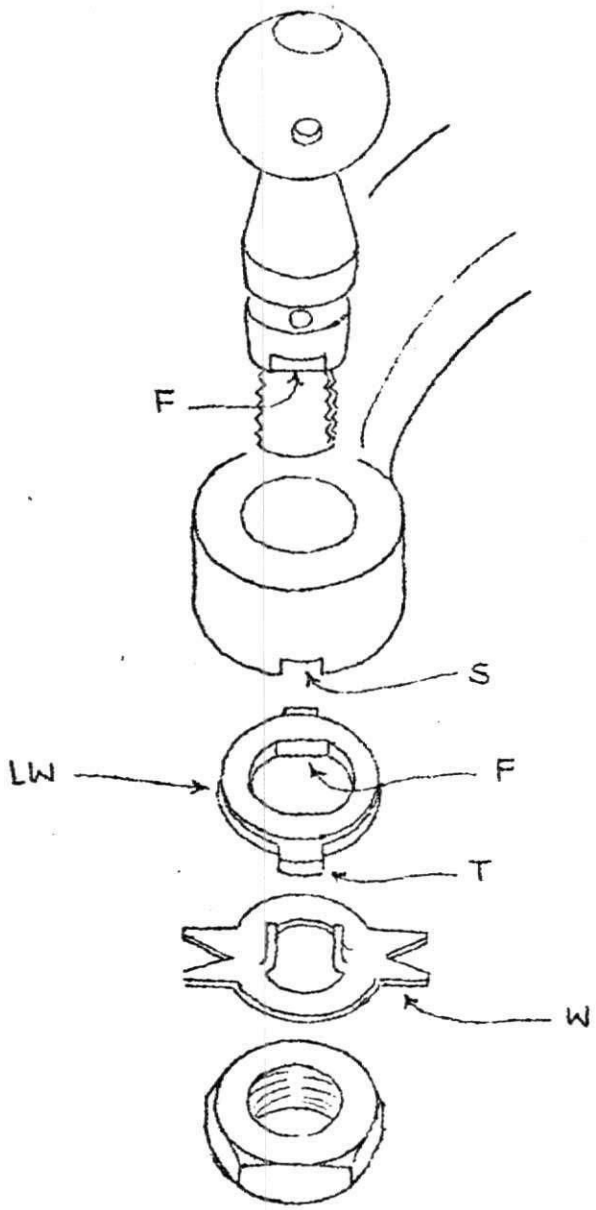
Particular care should be taken to see that the locating tab T. fits snugly into the slot S. before finally tightening up, otherwise the nut will appear to be tight before the ball end is pulled properly into the taper, and the ball pin will work loose in service.

The pin must also be so positioned that the flats F. on the pin and locating washer fit properly into one another.

The design is the same on all cars except that the Bentley has only one tab T. and slot S. on the locating washer and lever. The cross steering lever ball pins have castellated nuts and split pins in place of the locking washer W.

The foregoing should be a routine point of inspection on all cars.

Hd.



LOCKING DEVICE. STEERING BALL PINS

Hd. 324

SB 8.1.37

N

Steering

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.

ADJUSTMENT OF STEERING JOINTS:

Prewar cars without IFS

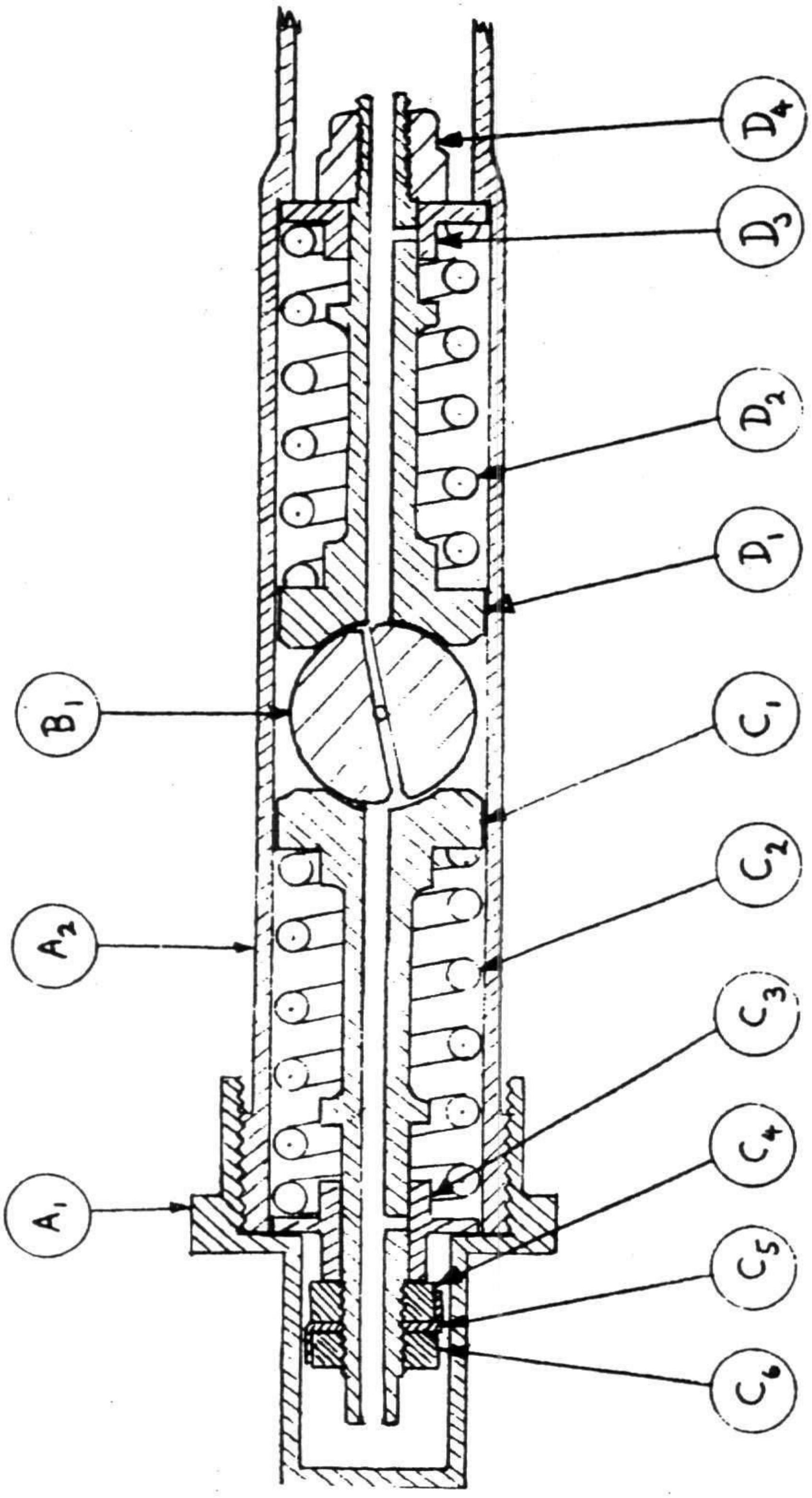
Correspondence received from members and personal experience show that there is a general lack of understanding of the operation and adjustment of the rear ball joint on the side steering tube of most prewar Rolls-Royce chassis. The characteristics of front suspension with a rigid front axle are such that gyroscopic effects from the front wheels can cause very strong kicks on the steering when the car is driven over rough roads. The small degree of reversibility of the worm and nut steering box would allow the kicks referred to above to produce very large shock loadings in the steering mechanism if all the joints were rigid, and the purpose of the side steering tube rear joint is to introduce a controlled amount of flexibility into the system.

The assembly is shown in the diagram. The drop-arm ball-pin B1 and the two spring-loaded pad assemblies C and D are retained in the end of the side steering tube A2 by means of the cap A1. In order that the characteristics of the joint should be correct, it is vital that the spring-loaded pad assemblies are correctly adjusted. Assembly C will be described in detail as assembly D is only slightly different. The assembly is basically a spring strut, consisting of a piston C1 running in a guide C3. The travel of the piston is limited in one direction by the shoulder of the piston rod and in the other direction by the adjustable stop consisting of nut C4. Nut C4 is locked by nut C3 and tab washer C5. Nut C4 is normally held against the end of guide C3 by the pre-load in spring C2. In the case of the spring-loaded pad D, both stops are non-adjustable, the outer stop being a castellated nut D4 which butts against a shoulder on the piston rod D1 and is locked by a split pin (not shown).

The joint is correctly set up when there is a very small clearance between each ball pad and the ball-pin in the rest position. In these circumstances, neither spring strut will deflect until the steering force exceeds the pre-load in one or other spring. Thus, for steering loads up to the pre-load value, the steering will be rigid. However, loads in excess of this will deflect the spring, thus limiting the shock which can be transmitted to the steering box. What is not realised is that if an attempt is made to stiffen up the steering linkage by placing a packing washer, for instance, between the cap A1 and the guide C3, this will have exactly the opposite effect to that desired. Such a washer will cause both pistons to come off their end stops in the rest position, and the pre-load of the springs will now be held by equal and opposite forces between the ball pads and the ball-pin. In effect, each spring is now balancing the pre-load of the other, and in fact there is no longer any pre-load between the ball-pin and the steering tube. Thus the springs deflect for any steering force, however slight, and the steering has been made more sloppy, not stiffer. The cardinal rule in setting up the joint, therefore, is to use the adjusting nut C4 to set the required length of the assembly C so that under rest conditions there is no load between the ball pads and ball-pin. This is best done with the ball-pin removed from the drop arm. Adjustment to the pre-load of the springs can be made without altering the overall length of the spring assemblies by placing adjusting washers between the ends of the springs and the guides. In the writer's opinion, the pre-load should be sufficient to ensure that the joint remains rigid for normal steering loads on the road.

Before starting work on the steering joints it is advisable to buy a steering joint puller. The Sykes no.818 is suitable.

N.H.H.



N.H.H.
2/4/67

SIDE STEERING TUBE

REAR BALL JOINT

20/25 STEERING BOX

We have referred before to the tendency for the steering of the 20/25 with worm and nut steering box to develop a sticky feeling when the box gets hot on a long run. The problem can become so acute that the steering fails to castor back after a turn. The reason for this behaviour is still obscure, but Rolls-Royce try emptying the box and re-filling with Shell Spirax 140 EP oil as a first attempt. I asked whether Castrol Hi-Press 140 EP was satisfactory but R-R replied that they use Shell. They do not promise an instant cure with this treatment but imply that improvement may occur over a period of time.

N.H.

STEERING

Mr. Giles writes to thank the many members who answered his call for help (Bulletin 85, page 33) regarding the rogue steering of his Bentley. He extolls the spirit of the Club that elicits such a response. Here is yet another. We look forward to hearing if his troubles are now over.

In response to Mr. Giles' despairing letter in the Bulletin, I can assure him that the excellent handling qualities attributed to 3½ and 4¼ litre Derby built Bentleys was indeed fact. My qualifications for making this statement are that I have regularly driven both these models from 1939 to date, including competitive driving shortly after the war.

The coachwork on the 4¼ tended to be heavier than that fitted to the 3½ and in certain cases there was a tendency for slight tail wag or 'oversteer', as it is known today, but this could usually be virtually eliminated by increasing the tyre pressures. In fact, I have always 36 psi on all cars fitted with 18" wheels, where handling and high performance were the main requirements. Another point which may be possibly overlooked today is that the handling and general roadholding was only achieved provided the original tyre specification was adhered to: 550 x 18 India Super 6 ply, no other tyre ever satisfied me and in cases where 4 ply tyres had been fitted the handling was invariably dreadful.

Obviously it is very difficult to diagnose Mr. Giles' problem accurately without a close and lengthy examination of his chassis, but one assumes there is no excessive end float in the spring shackles, especially the rear ones, and that the front axle castor,camber and king pin inclinations are correct, likewise the more elementary toe-in (1/8"-3/16"). There is one problem which is now presenting itself of which we heard little when the Rolls-Bentley (as it was commonly known when in production) was in its youth, although it was not, I believe, unknown on certain Rolls-Royce chassis. This problem, which manifests itself in stiff and uncertain steering, is a result of the steering box tightening internally, frequently becoming worse on a hot day or after the car has been driven fairly hard, resulting in high under bonnet temperatures.

The remedy, years ago, would have been to renew the internal steering worm and nut which may have become unserviceable, possibly through lack of regular attention to the oil level in the steering box. I understand that these parts have not been available for very many years and that the special rig required for lapping them was destroyed during the war.

So, what to do if one unfortunately possesses a chassis afflicted with this problem? Some years ago, the late Johnny Curswell at Hythe Road told me that the only remedy which they were now able to try was to ignore the original instructions for filling the steering box with engine oil, and instead, to use a 50/50 mixture of Shell Spirex E.P. 140 gear oil and engine oil (S.A.E.30), the lubricant to be thoroughly mixed before filling. He emphasised that only Shell Spirex EP 140 had been found to be successful and substitute oils had produced no result.

My own experience using the foregoing lubricant in a particularly difficult case showed a significant improvement which encouraged me recently to go a stage further. The steering box was drained and internally cleaned out and then filled with STP oil additive, with outstanding results. So be encouraged, Mr. Giles, you have a chassis with potentially superb qualities, which it should be possible to regain with a little time and patience.

F.M. WILCOCK

ADJUSTING THE 'AT' SPEEDOMETER HEAD

The needle is attached to an aluminium cup, the cylindrical portion of which is inside a rotating circular magnet attached to the speedometer drive. Eddy currents are generated in the aluminium cup, resulting in it being subjected to rotative torque which, depending on the resistance of the hair spring and the speed of the magnet, will indicate the correct speed.

There are two methods of adjustment:

(i) Coarse adjustment is effected by altering the tension of the coil spring, by varying its free length.

(ii) Fine adjustment is effected by turning an eccentrically mounted steel sleeve located between the magnet and the aluminium cup and thus varying the clearance between the sleeve and the cup. If the dial and needle assembly is removed the steel sleeve will be seen located by a screw and spring washer, and it should be possible to turn it without loosening the screw. The original setting is given by two small file nicks opposite the pole gap in the magnet.

M.G.

A 1958 S1 HAS SOME 'FILLINGS'

Seven years ago a strong smell of petrol met me as I entered the garage and subsequent inspection showed a wet petrol tank and a small drip on the floor. Careful examination revealed no fewer than four small punctures, caused presumably by salt corrosion, in the area of the retaining strap on the offside of the car. Removal of this strap revealed two more small holes, and by this time petrol was beginning to escape in significant quantities. Not wishing to impose undue strain on a suspect tank, I drained much of the contents via the pump supply pipe and at the same time jacked the car to tilt the remainder towards the nearside. The holes were found to be somewhat larger than the conventional pin's head, and after all corrosion had been removed would admit a wire of 2mm diameter. After considering various sealing agents, I decided to treat these holes as ordinary dental cavities, and filled them with silver amalgam, the sort most of us have in our back teeth, allowed 24 hours for complete setting, and then replaced the retaining strap and refilled the tank.

Side Steering Tube Adjustment — Rear End

by Will Fiennes

IN THE Club's Technical Manual (1972) pages 92-93, a description of the technique for setting up the balljoint at the bottom end of the steering pendulum lever on most pre-war cars was given. Unfortunately, it would seem that the basic premise used in the article for setting up the joint was incorrect, as reference to both the appropriate TSD and the general arrangement drawings show.

Before describing the procedure for setting up the ball joint, a brief outline of its construction is necessary. This is a repeat of that given in the original article, but it will save you the trouble of digging out your copy. The design of the joint is similar for the majority of prewar cars; the detailed description below is specifically Derby Bentley.

Before starting work on the steering joints it is advisable to buy a steering joint puller. The Sykes No. 818 is suitable.

Referring to the drawing, the ballpin B1 acts upon either of the two spring-loaded pad assemblies C and D. D bears directly on a shoulder in the side steering tube A2, whereas C works against the cap A1, which is tightened against the open end of the tube. Each spring assembly is similar in operation, differing only in the method of adjustment. The pad C1 is able to slide axially, guided at one end by the bore of the steering tube and at the other by the fixed guide C3. The movement of the pad is restricted in one direction by the nut C4, and in the other by the shoulder on the stem of the pad, contacting either side of C3. Assembly D functions similarly.

It goes without saying that C1 and D1 should be a good fit in both the bore of the tube A2 and their respective guides C3 and D3, to avoid any lateral movement of the ballpin relative to the tube. Many cars now have steering tubes which are quite worn internally, giving rise to slop in the steering system.

Adjustment of the balljoint is made by altering the length of the spring and pad assembly C in its fully extended position by adjusting the nut C4 and its locknut C5. Assembly D is essentially non-adjustable. The castellated nut D4 is tightened up to the small shoulder at the foot of the thread on D1.

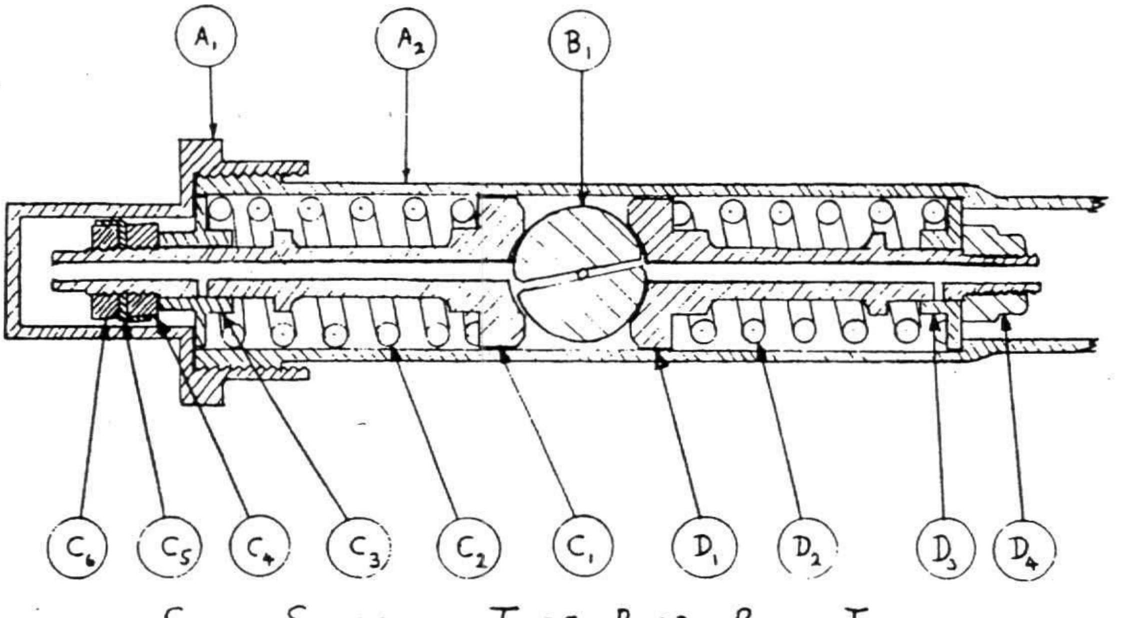
It was stated in the article in the Bulletin that the correct adjustment for the joint was obtained with both pads just contacting the ballpin in its central 'rest' position. The nuts C4 and D4 would then be hard against their respective stops, and the pads would not be exerting any load on the ball. The springs would only begin to deflect when the load on the ball exceeded the pre-load in the spring. However, in this state the balljoint is not self-adjusting in the event of wear, and an excessive amount of one-shot oil will leak from between the ballpin and the pads.

Reference to the relevant general arrangement drawing will show that when correctly adjusted the pads are positively loaded against the ballpin. This is achieved by adjusting the length of the assembly C such that when the two spring assemblies C and D and the ballpin are assembled into the tube, but without the cap A1 being fitted, C3 extends a certain amount from the end of the tube. In the case of the Derby Bentley this amount os 0.012in. When A1 is then fitted and tightened up fully on to the end of the tube the total length of the ballpin plus pad assemblies will be compressed by 0.012in. If the ballpin and pads are in as new condition, and the two springs are equally matched, the design is such that the springs will initially be equally pre-loaded, and when further compressed by A1 the compression will be equally distributed between C and D. For the Bentley, nuts C4 and D4 will each be lifted off their respective stops by 0.006in. Under these conditions the distance between the shoulders on the stems of C1 and D1 and their respective stops C3 and D3 will be 0.025in.

The operation of the joint under driving conditions is now as follows. When there is no load on the steering pendulum lever the two springs are in equilibrium, and there is a clearance of 0.006in between C3 and C4, and D3 and D4 (not shown on the drawing). Because the two assemblies are balancing each other, any slight load on the steering will cause one of the two springs to compress and the other to extend, until the clearance of 0.006in is taken up. Then all the steering load is carried on the more compressed spring, which by virtue of its pre-load will compress further only under a substantial steering load. When this load is achieved a further spring deflection of only 0.019in is possible before the pad is bearing directly against its guide or fixed stop. To the driver, the small amount of compliance around the equilibrium position will be barely noticeable, but will absorb vibration and very small road shocks, whereas the spring deflection under heavy loads will help to catch the wrist-breaking impacts. Admittedly, the Bentley system allows for only a small deflection before the driver is in direct contact with the road.

The adjustment of the balljoint is outlined very briefly in the Rolls-Royce T.S.D. publication 2066. This appears on the first page, which is a folded sheet, of section C entitled 'Maintenance Requirements'. The sheet itself is entitled 'Maintenance Data', and the information is given in the small print in note L. However, the information regarding the initial setting of the springs for the Bentley given in this note is incorrect. The instructions are to adjust assembly D such that the spring is not compressed at all but has no end float in the assembly before fitting to the tube. In practice it will be found that in order to tighten the castellated nut up to its shoulder it is necessary to compress the spring by about 0.2in.

As far as I am aware, the information given in the T.S.D. for the Rolls-Royce chassis is probably correct. However, for exact information in specific cases it would be advisable to refer to the appropriate GA drawing. Given a few more wet evenings I may be able to tabulate the settings and clearances for the steering joints which are shown on the Club microfilms for later publication.



SIDE STEERING TUBE REAR BALL JOINT

Universal joints — needle roller bearings

by Will Fiennes

Recently David Mico (B138) and Donald Bastow (B139) have written on the subject of universal joints. In the course of rebuilding David Mico's universal joints I followed through the design calculations for a needle roller bearing in a universal joint, consisting of 19 rollers with a 2.5mm diameter. These gave a pin diameter of 0.4997in-0.0003in. Subsequently, I located an original Rolls-Royce drawing of the pin, which shows a diameter of 0.4997in-0.0001in. Clearly the design criteria available at the time were in line with current thinking, although it would seem that the Detail Drawing Office, seeking as near perfection as possible, specified a much tighter tolerance. Current thinking on universal joints in which the motion is reciprocating rather than rotating calls for a reduced minimum total circumferential clearance of 0.001in for the rollers, one third of that recommended for a standard needle roller race, and half that which Donald Bastow would have used.

The oversize pin diameter, as in David Mico's universal joint, would appear to be standard for the M-series cars, as is borne out by Norman Burt's letter in B139; indeed, S. Brunt of Silverdale, Staffordshire, has a stock of pins for this series. When I first encountered David's problem I thought that perhaps someone had made an error in machining a batch of the outer trunnions oversize in the bore and, to compensate, oversize pins had been made. Very un-Rolls-Royce! It is clear, however, that these dimensions were achieved by design. Unfortunately, in no way can the design criteria be modified to produce a suitable crowded needle roller bearing with a central race diameter of 0.513in using 2.5mm rollers. The extra circumferential clearance with this race diameter will very likely lead to the needles skewing and jamming at an angle to the axis of the pin as David Mico found. I have no idea why the design change was made.

Finally, new pins for David Mico's universal joints are to be made to the smaller diameter which can be used with trunnion GB911. The pins will be made in EN36 — a case-hardening steel with a final core strength of 55 tons per square inch. There will be a number of pins surplus to requirements, should anyone be in need.

STEERING CLEAR OF TROUBLE

MEMBERS sometimes have a problem with steering boxes of pre-war Rolls-Royces, in that while the steering displays no defects when the wheel is turned, it fails to return to centre after completing a long corner of constant radius. When, subsequently, the front axle is jacked up, the steering appears to be quite smooth and fully reversible.

As has been explained in the *Bulletin*, the cause is the squeezing out of lubricant from the contact faces of the worm and nut caused by static loading. Metal to metal contact results and causes irreversibility of the mechanism. A most unpleasant and potentially dangerous characteristic.

The solution I have seen recommended is the use of EP 140 lubricant in the steering box. This may cure the problem, but there is an even better lubricant, Shell Macoma R1000, though it is only obtainable from suppliers of Shell industrial lubricants and probably in quantities not less than one gallon. EP 140 is formulated to prevent metal to metal contact and local welding of rapidly sliding, highly loaded gear teeth. Such conditions are encountered in hypoid bevel final drives.

Macoma is formulated to prevent metal to metal contact in near static conditions of high loading, e.g. the bearings of steel rolling mills. These latter conditions are of a type more comparable to those in back axles. I experienced this irreversibility in my 20/25, GXO 12, and Macoma R1000 has completely cured it.

This advice was given to me by Cecil Mitchell, a senior engineer in Shell Technical Department, who is also chief scrutineer to the RAC and the owner of a type 43 Bugatti.

H. ORR-EWING

From the Archives.......

A letter to a Bentley owner

Derby Bentley Steering

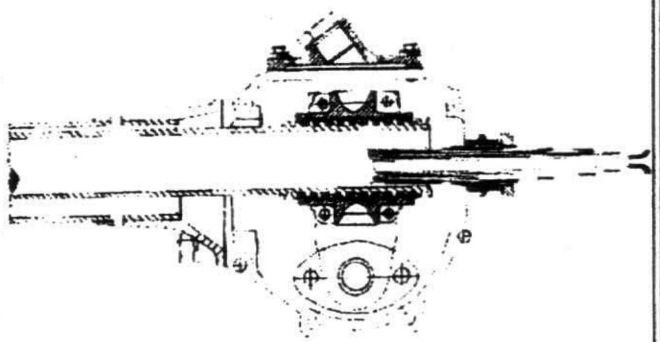
From your letters it would appear that you have checked out all the usual points associated with steering stiffness. However, there is one other point which we feel well worth looking into and this is described below.

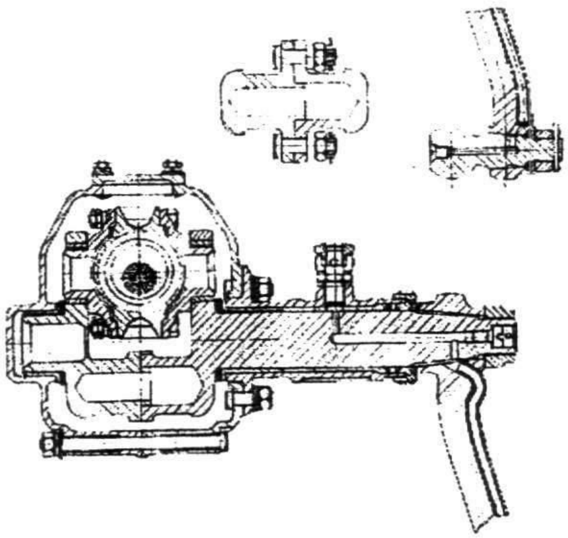
As you are aware, the arms of the front dampers are in connection with a special articulated front axle control anchorage. This is designed to resist torsional displacement of the axle due to brake reaction.

Incorrect adjustment of these units could alter steering geometry (i.e. castor angle) and introduce a heavy steering feel and incorrect self-centring action.

Obviously this could give the appearance of steering stiffness when going from full lock. Furthermore, such a fault may not readily show itself during a steering geometry check.

I would think you are probably right about the problem being associated with a lack of lubrication at the thread surfaces, but I think it does go a little further than this.





As a result of a little research into the matter, I have discovered that part of the problem lies in the wear on the trunion bearing surfaces, which carry the steering nut. I think the problem may well manifest itself in this way:

During original assembly the worm and nut were 'ironed' into each other, with a mild abrasive and then with hot oil. This had the effect of removing the high spots from the 'white metal' surfaces of the nut thread faces, and gave good smooth operation - without excessive backlash.

However, during use wear does take place on the bearing surfaces of the trunnion and backlash will occur between the worm and nut. This in turn could possibly result in the nut 'tilting' on its axis. It is therefore conceivable that the loads at the thread surfaces may be increased under full steering lock conditions and because of this to such an extent that a breakdown in lubrication takes place, to which the 'steering stiffness' may be attributed.

As you know a 'straight' lubricant was originally specified for use in the steering box in these cars. If the stiffness is mild you may be able to overcome this by substituting the original oil for Shell Spirax 140EP. More severe cases will certainly involve removal and dismantling of the unit.

M.T. Donegan
Service Promotion Department

(B222/22)

Two cylinder cars - wheel bearings

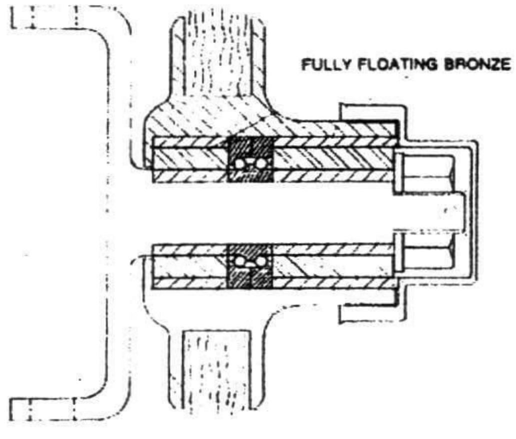
by Graham Ashley-Carter

Years ago I remember reading an early Rolls-Royce works memo advising inspecting engineers of the apparent immovability of two cylinder cars in cold weather. The reason was congealed lubricant in the plain wheel bearings used, and to warrant a works memo on the then obsolete two cylinder cars the condition must have been chronic.

In recent times we were asked to do some general repair work on Rolls-Royce Motors' own two cylinder car, SU13 (Susie), and among this were some rectifications to the wheel bearings.

The arrangement was so unusual that we took the attached sketch for posterity. The central race is for end thrust purposes only, journal loads being taken on the two fully floating bronze rings running on inner and outer hard steel sleeves located endwise, all components being easily and inexpensively replaced in the event of wear or neglect. These undoubtedly caused the above mentioned resistance to movement, to which could also be added the drag of the plain bearings in the axle and gearbox.

It might be argued that with ball bearings for end thrust why not for journals, but these were early days for ball bearings. They were foreign, expensive, hardly proven and usually took the cup and cone form found on bicycles, which have a notoriously poor load carrying capacity, and the world had managed with plain bearings for a thousand years. The use of balls in this unusual way in the assembly demonstrates again the genius of Royce in finding a permanently reliable arrangement when other makers were struggling with half solutions.



Front wheel bearing arrangement.
Rolls-Royce two cylinder. 1904

(B184/36)

Pools of oil from a one-shot pump

by Keith Jay

Having had problems with pools of oil under my 20/25, GXB43, from the one shot, we decided to look at the pump. Having stripped the complete system down some years ago, cleaned out all the pipes, replaced the cones, joints and pipes where necessary, we knew it could not be these.

We removed the pipes from the base of the pump and then removed the pump from the bulkhead. On stripping down the pump we discovered that at some stage in the life of the car, possibly while in America over ten years ago, some ill-informed person had packed over 50% of the reservoir with three different types of grease! The filter was completely blocked, yet the one shot had continued to work when filled with the correct oil. We cleaned out the reservoir and found that, on the base, the valve and seating were distorted, possibly caused by a lump of hard grease becoming jammed and the one shot lever being forced back. This allowed the oil to continuously feed through and ended up dripping pools of oil on the garage floor.

We ground down and reseated the valve into the seating, put Redex in the reservoir and left it overnight to check. No leaks, so we knew the valve and seating were a tight fit. We put it all back together and refitted the one shot pump and at last no more oil pools on the garage floor.

(B183/35)

Steering Box Oil

Our 4 1/4 suffered from the usual 'sticky steering', even when dosed with moly loaded EPI40 oil.

I contacted my oil supplier to see whether they could offer an oil equivalent to Terresso V320, which Ken Lea recommended a few years ago. They sent me samples of 'Steering Box Oil' and the resultant improvement in the steering was astounding. I have now tested this oil over 200 miles and cannot get the steering to stick under any conditions - even after five continuous circles on full lock To my surprise, on straight sections of motorway, the slight backlash in the box is undetectable.

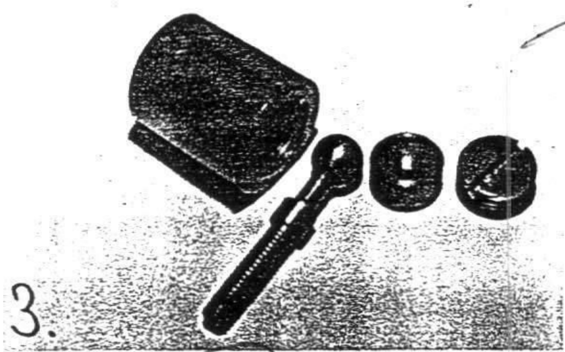
The technical director of Millers Oils, Graham Lord, told me that the oil was not the V32O equivalent but, having learned of the construction of the box, and the trouble, he had asked his laboratory staff to concoct a special blew to suit. He has kindly offered to support the small market for this successful oil.

Try ordering 'Steering Box Oil' from:

Millers Oils
Hillside Oil Works
Brighouse
West Yorkshire HD6 3D
Telephone 01484 713210
Facsimile 01484 721263

I am sure you will he amazed at the results.

H. Ratcliffe (B223/37)



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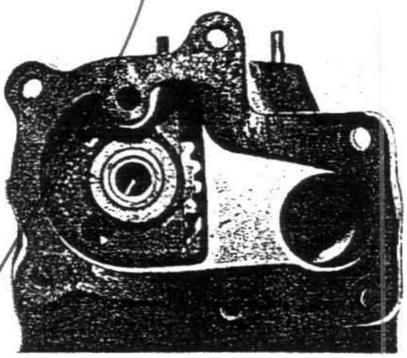


4.

Gearbox Appendages *continued*

left side, at the end of the shaft, the bronze bush was in luck. By drilling just one hole the centralised lubrication could be tapped. However, the right side bush is in an arid area, so it gets no lubricant at all. The thought of two pieces of metal rubbing together dry puts your teeth on edge, so why not fit an oiler, see photograph 2. There are several points in the area requiring the oil can, so an extra one will make no difference.

Now we are on the offside, or right side, moving to the rear. The shaft piece for the power drive for the speedometer and the shock absorber pump is a short square section of soft iron. If, due to very severe neglect, the flexible speedometer drive, or the pump, seizes up; nothing on earth will stop the geared-down power, which then twists up the soft iron piece into knots, hopefully saving all the really vital parts.

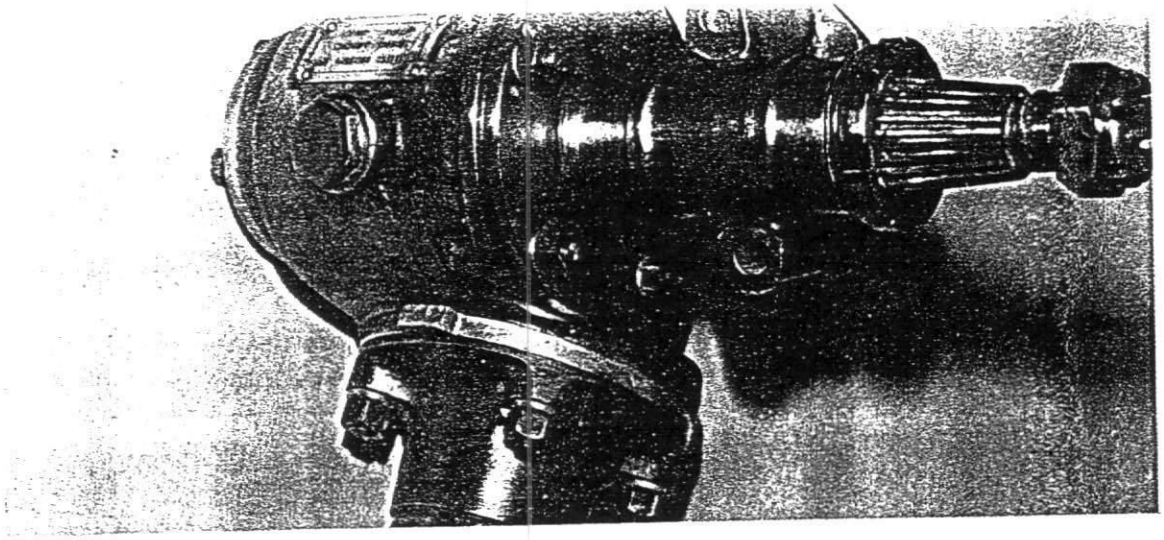
During the past fifty years the shock absorber pump has taken on an extra role. It is now also a mechanical hammer. Its connecting rod has a very big big-end, which will keep fit for ever, but a very small small-end, which is actually a balljoint. See photograph 3. This balljoint is now very loose. Look at the top of the little brass piston. It is covered with soft solder. Melt this off with a butane flame. The Ronson, though rather a toy for many jobs, is ideal for this one. Below is a slotted brass cap. Unscrew it and you have arrived at the balljoint. Put in some carborundum paste and work it around until it is sweet and happy. Set it just right and resolder, but *well.* Clean everything with acetone before soldering, and used killed-spirits flux (Baker's fluid). As you will not look in the pump again for the next fifty years, say about AD 2036, you may as well replace the bearings while you have it opened up.

Finally, we come to the one and only gasket in the world designed to let oil out instead of keeping it in. See photograph 4. The missing centre portion of the gasket, arrowed, leaves a narrow metal slit. The idea is that oil being flung about in the gearbox, on the left, will cascade through the slit on the bottom end of the gear lever, which is busily poking the various gears in and out of mesh. A cascade of oil seems optimistic, but an oil mist is perhaps possible. And here we are at the end of the tour. Except for the gearbox support, down below. After being sat on for fifty years the rubber is as hard as a brick. No one seems inclined to help you and you are tempted to pop the old one back. But do not forget that Henry Royce is looking over your shoulder, appraising the quality of your work, which at this moment is about to drop to zero. Just hang on for a while, an article is coming which contains new information.

The Marles Steering Box

by David Mico

You only need to get one really bright idea and you are made. When it dawned on Mr Marles that two pieces of metal *rolling* together were far superior to two pieces *rubbing* together, he was off and running.



TECHNICAL SECTION *continued*

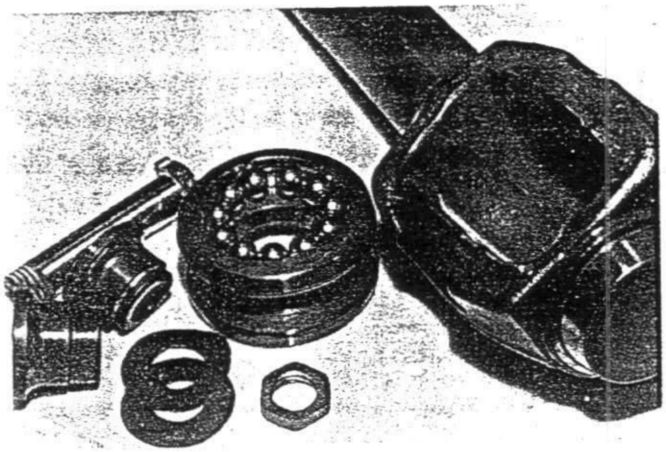
Armed with four UK patents, Adamant Engineering of Luton started production in the early 1930s. By the end of the war they were large, and a combination of Adamant and Western Engineering in 1955 finally resulted in a holding company, the Adwest Group Ltd., at the present address, The Aerodrome, Reading, Berkshire. Some of their companies, such as Bowden Cables and Ross Courtney, are very familiar. They now have subsidiaries all over the world. So that's the way to do it! This type of box is very good at 'irreversibility', i.e. you can turn the front wheels, but the front wheels cannot turn you.

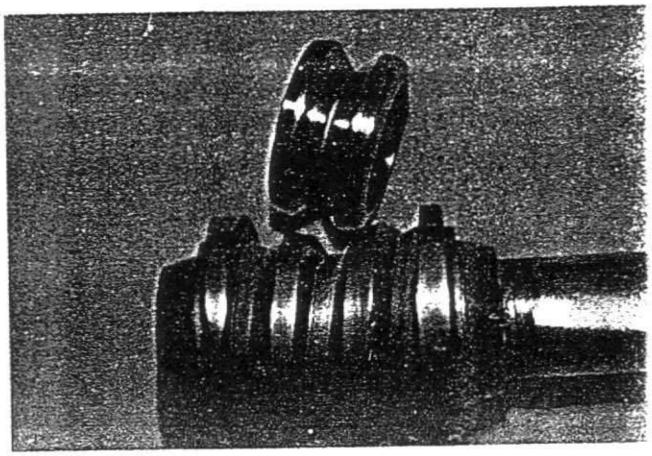
At the beginning, production and road experience brought ways of doing things better, and cheaper. Modifications followed thick and fast. The single roller became a stronger double roller, with the worm living between.

Rolls-Royce could not ignore this advanced steering box and fitted it to the Phantom III, which was indeed a compliment. All of Adamant's literature now screamed their new motto: 'Fitted to the best and nearly all the rest'. Supplied with the box was a cheap metal stamped-out bracket which desecrates the Wraith and Bentley. Fortunately, it is hidden within the chassis frame. Henry Royce would have hit the roof if he had seen it and it was replaced on the Mark VI by an excellent Rolls-Royce cast steel bracket. The modifications continued. The adjustment between the worm and its roller was awkward and irritating. The PIII collected three different modifications on this before a totally new arrangement came, in time for the Wraith and overdrive Bentley. This is the adjusting sleeve on the Mark VI, figure 6, item 25.

It was at this point that Hitler pushed his luck too far, so Wraith and Bentley owners never did get the official instructions. Now, 47 years late, here they are!

To service the box you will require the PIII's instructions, which are both helpful, frustrating and misleading, and the Mark VI instructions, which are likewise. You also have your own drawing, FB3248. Study the diagrams and the names of the parts, so that we all know what we are talking about. Let us start with the rocking shaft. Before the war this was quite long, and in the event of an 'incident' at the front wheels it would function as a torsion bar to absorb





some of the shock. Immediately after the war, exotic alloy steels were hard to come by and you got your ration of utility steel and scrounged around for anything else. So, in the interests of safety, the rocking shaft became short, fat, and stubby, leaving the rest of the steering gear to look after its own problems. However, the prewar rocking shaft had a support sleeve, ph. 3, figure 1, part 20, and you were officially permitted to hold this in the vice while working on the box. As usual, the bearing got what room was left in the design and this resulted in $\frac{19}{64}$ths of an inch balls. This will wipe the smile off the face of your local dealer, but a good firm like Mecro Ltd. (used to be Claude Rye Ltd.) of London will supply.

When you strip the box down, make copious notes. There are many look-alikes, including a host of shim-washers. Don't let them drop out of nowhere. Tie each individual bearing to its shims and *label them,* or you are doomed. The Timken bearings are still available, but you hve to wait for them to arrive from the USA. With new bearings fitted, you have a sporting chance of everything going back nicely. With the box steering straight ahead the contact between worm and roller should be sweet and free of any play. As you turn to either lock the play increases. This is *not wear,* but is design, to guarantee against any seizure of the gears on either lock, with dire consequences.

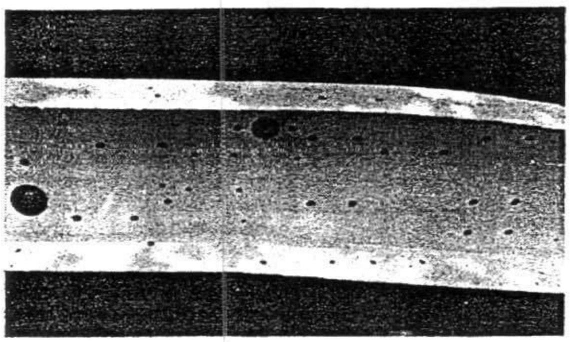
Adwest live in the 1980s. It has not occurred to them to perpetuate their early achievements. But as we expect our cars to last for ever, sooner or later we must consider the problem of parts. But if you are in trouble, ask Derek Fishlock to help you.

Prewar Bentleys and others — 'Don't do as I do. Do as I say.'

by David Mico

The picture shows the channel frame section which is forward of the rear spring fixtures and aft of the front spring fixtures. It is the most heavily stressed part of the frame. All the holes are 'official' holes. Rolls-Royce had a monopoly in holes. If you could discover a place to drill a hole, and drilled it without permission, your guarantee instantly became null and void.

The vertical part of the frame carries the load. The top half of the vertical part is in compression, the bottom half is in tension. If you are feeling depressed, and are looking for trouble, look for cracks along the bottom half because, whereas materials do not mind being squashed, they definitely do not like being pulled apart. The narrow horizontal parts of the channel frame are to prevent side wobble, a job which it only does half-heartedly, and requires considerable backup from massive crossmembers. When a front wheel goes into a pothole the frame dives in after it. And flexes. When independent front suspension came in, it was goodbye for the channel frame and hello to the frame/body unit.



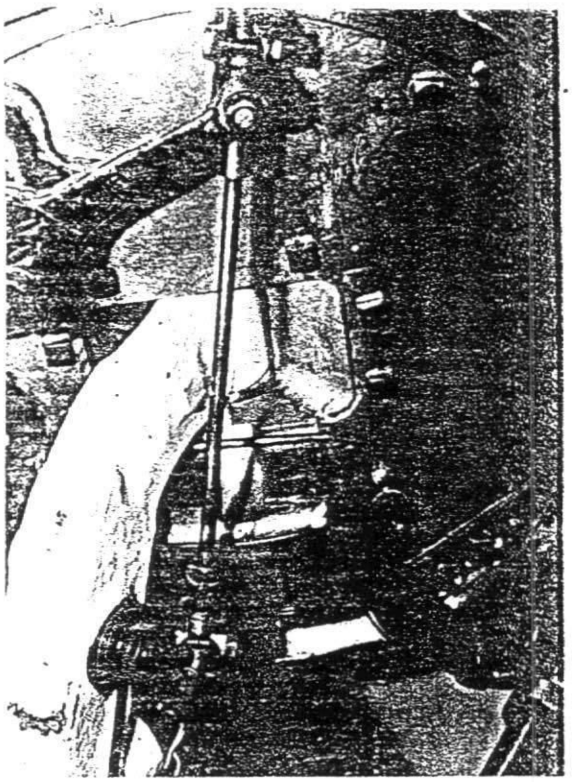
How to stay a current member!

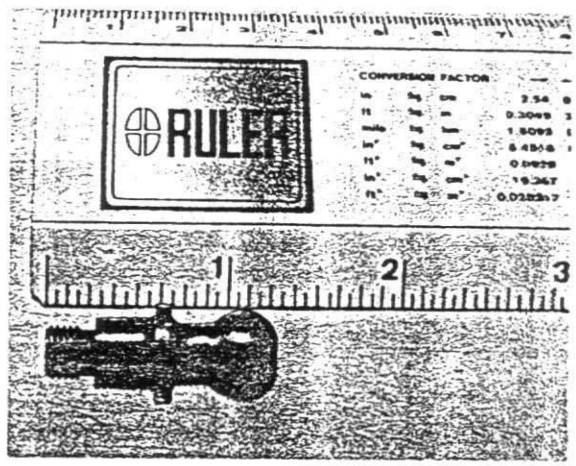
by David Mico

The ex-member was drifting slowly Heavenwards. It was a pleasant enough sensation, yet he was spoiling for an argument with Sir Henry for his early demise.

He found Sir Henry poring over a tome entitled 'Metal Fatigue'. "Ah," said Sir Henry, "I've been expecting you. That balljoint that failed was the one that the Company fitted in 1937. Take a look at this page. You will note that metals are lattices of crystals. In the beginning, if there ever was one, it was ordained that these crystals have enormous strength. This was to stop any stray life forms that might evolve from upsetting the System. However, it actually is possible to introduce elasticity, but it has a time limitation called 'stress and strain'. You overdid it, which is why you are here."

The ex-member, realising that he had lost the argument before he had started it, quickly had to think of another subject. "Your beard seems to be in the fashion up here," he said, furtively looking around. "It'll take me ages to grow one like that." Sir Henry turned over the page to the chapter on 3½% nickel alloys. "That's just what you've got up here," he said. "Ages."





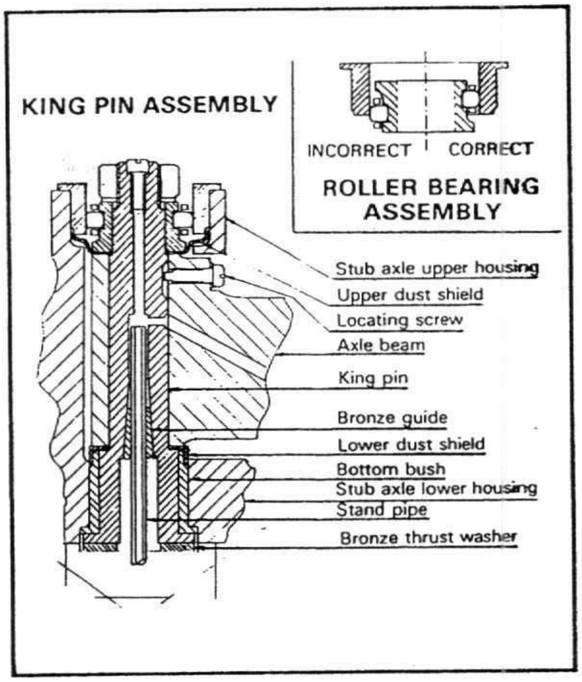
Back on Earth, current members should try to remember when, if ever, they had replaced the two balljoints on the linkage between the front axle and the brake backplate. Putting it politely, these balljoints are rather dainty. Or perhaps the ex-member would have snarled that it was carrying the reduction of unsprung weight to absurdity. These balls have to apply the full power-assisted effort to the brakes, and after fifty years they could well be getting a little tired of the job. So fit some new ones.

Brunt's of Newcastle and Fiennes Engineering have them on their parts lists. The list-less Appleyard may have them, but you will have to find the energy to write a letter to find out.

Derby Bentley kingpins

by Will Fiennes

The upper end of the kingpin as fitted to the Derby Bentley chassis is carried in a special roller bearing. The inner race of the bearing is unusual in that one end is extended to form a flange or lip on the face of the bearing race. When the bearing is assembled correctly the flange is on the underside of the bearing, and it sits in a well in a pressed steel shroud or dust shield, designed to prevent the ingress of grit and moisture. The shroud is nipped between the inner race of the roller bearing and the top face of the axle eye when the nut on the top of the kingpin is tightened. The drawing of the kingpin assembly shows the relationship of the various components, and the right hand half of the detail of the roller bearing shows the correct orientation of the inner race of the bearing. Unfortunately, when a bearing is fitted there is nothing to indicate which is the correct way up for the inner race, either before or after assembly.



Recently I have dismantled several front axles in which the inner race of the roller bearing had been assembled with the flanged face uppermost, as shown on the left hand side of the detail drawing of the bearing. The results of this are twofold. Firstly, as the rollers extend some way below the edge of the outer race they are liable to come in contact with the shroud. They will then form indentations in the shroud as the top nut is tightened, and the kingpin will feel tight and 'notchy' as the stub axle is turned from lock to lock. The rollers will skid on the raceways rather than roll, and if they do succeed in rolling from one indentation to the next they may well destroy the shroud completely. This had occurred in one of the axles dismantled.

Secondly, and this is potentially very much more dangerous, as the rollers protrude below the bottom face of the outer race by about 60% of their length, only a fraction of each roller will be carrying the side thrust exerted by the kingpin. In addition, there will be a stress concentration at the lower edge of the outer race. These factors will lead inevitably to early failure of the bearing. In the case of one of the axles I dismantled I found that the rollers had worn or gouged a large step at the bottom of the outer race. The extra sideways play which had developed at the top of the kingpin had allowed the bottom bush to wear very bell-mouthed, and a comparatively new kingpin assembly had to be replaced after a very short life.

Two further points on the bearing and kingpin assembly. Firstly, great care must be taken when dismantling the bearing. Although there is very little radial clearance in the bearing it is easy for the inner race to tilt relative to the outer, as the rollers are comparatively short. Should this happen and the inner race jams, and if force is then applied in the wrong direction to extract the inner race, the rollers can damage and indent the bore of the outer race which is only case-hardened, thus destroying an otherwise sound bearing.

Secondly, if the dust cover over the top end of the lower bush is missing or is omitted from the final assembly, the kingpin will sit too high in the axle eye. The tapered portion of the kingpin will then extend above the top of the axle eye with the result that the top bearing may not pull down on to the top face. Care must be taken, therefore, to avoid losing the dust cover, as it is easily forgotten or overlooked when the kingpin assembly is dismantled.

Apart from correct assembly, the lubrication of the kingpin is all important, otherwise premature failure can result. Oil is fed via a non-return valve in the axle beam up an inclined drilling to the kingpin; a cross-hole in the kingpin is aligned with the drilling in the axle, and to ensure that the alignment is maintained a locating screw is provided on the inboard side of the axle eye. This screw has an extended nose which engages in a slot machined in the side of the kingpin. However, the slot does not extend to the top of the kingpin. For this reason when the kingpin is removed downwards, the locating screw must be withdrawn by several turns to avoid the nose being removed by the end of the slot as it passes.

The oil is prevented from being lost out of the top of the kingpin by a blanking screw. The majority of the oil passes down a steel standpipe which is soldered into a banjo bolt located in the lower cover of the stub axle. This cover also carries the end thrust of the kingpin, via a bronze thrust washer. Neither the cover nor the banjo bolt is shown in the drawing.

The standpipe has a diameter of 0.185in, and is tinned on the outside. It passes through an 0.187in diameter reamed bore in a bronze guide, which in turn is located in an internal taper inside the kingpin. The function of the small clearance between the pipe and the guide is to meter the flow of oil to the lower bush. From the banjo fitting at the foot of the standpipe the oil is carried in pipework across the face of the brake backplate to a feed to the steering joints, then on to the bearing carrying the brake-operating toggle shaft and finally to the stub axle top cover which feeds the top roller bearing. If the clearance between the standpipe and its guide is too great, allowing more oil to flow to the bottom bush, the pressure from the one-shot pump, which would otherwise have driven oil through the drip plugs feeding the toggle shaft and top roller bearing, will be dissipated and these points will receive less oil than their due.

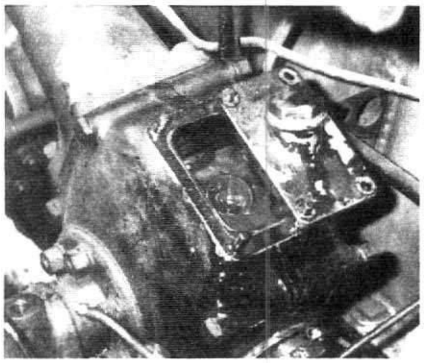
The close fit between the guide and the standpipe means that unless there is a good alignment between the kingpin and the standpipe the guide will bear heavily against the pipe resulting in unnecessary friction and excess wear of the pipe. If the pipe has to be renewed, I have found that it is necessary to solder the pipe to its banjo bolt with both parts mounted in a special jig in order to guarantee the correct alignment.

Stiff Steering in a Derby Bentley

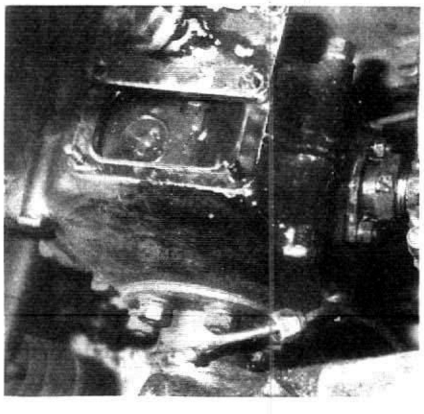
Story and photos by John Utz, NY

The stiffness in the steering in B47LE (see pic. FL4256) which Doug Seibert and I drove to the RROC Derby Bentley tech seminar at Headquarters last September became readily apparent on this 450 mile (each way) journey. In fact, at my advanced age, it was a real pig to wind around normal right angle street corners.

Suspecting low fluid level in the box at the base of the steering column, I removed the filler plug and added several ounces of the recommended engine oil. Immediately below the filler opening I could see oil, indicating that the fluid level was well up. The steering remained 'sticky'. Then Andy Mowbray, RI, recommended using Valvoline Racing 50 wt. oil. Figuring I would be wise to suck out the existing SAE 30 from the chamber before putting in the 50 wt., I removed the steering box cover plate on which the filler cap was mounted in order to ease emptying the box with a syringe. To my surprise, no oil was visible at the top of the box, and the syringe sucked up very little from the bottom. Then it dawned on me how I had been misled.

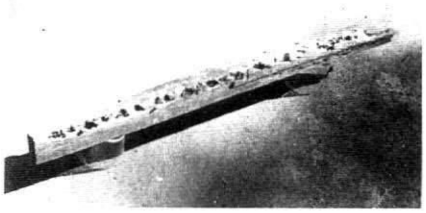


Above: With road wheels straight, the oil seen through the filler plug in the steering box is only a small amount trapped in a depression in the nut surrounding the worm. **Below**: With road wheels turned hard right, the nut moves up and exposes the real oil level. Check it carefully.

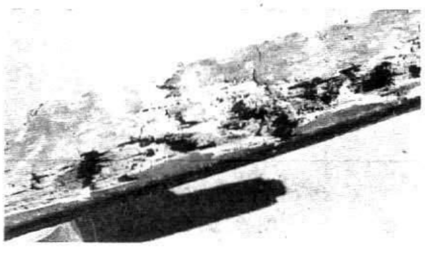


With the steering centered, a cup-shaped depression in the nut surrounding the worm lies directly under the filler plug. Looking down into the hole, what you see is the oil in this depression which has nothing to do with the oil level in the rest of the box. To move the nut (with cup) from under the filler orifice, simply crank the steering wheel onto full right lock. This will raise the nut and allow you to see the actual oil level.

In fact, the tight steering was the reason I was unable to avoid an enormous pothole on Rt. 15 near Blossburg, PA, on the return home. Coming down a long grade at about 50 mph, we hit the pothole, the driver's door popped open, was caught by the wind, and folded back against the rear fender. You can imagine what this did to the wood framing and the door skin. Surprisingly, we were able to shut the door and latch it, but rigged a lashing to secure it more surely. The door has since been repaired, but there was some rotten wood which we have replaced. This sort of invisible damage (rotten wood) can occur to any coachbuilt car.



Above: This rotten wood in the bottom door sill came to light following B47LE's encounter with a vicious pothole. The 'bump' caused the driver's door to fly open, and the damage done required repair to the door. **Below**: Closer view of damaged wood. Let no one say that coachbuilt bodies are without vices of their own.



Nuts, Cheeses & Worms

A Confectionery of Items Needed to Get You(r) Steering Straight

Story and photos © Derek du Toit 1991

We are encouraged to attend to a car's steering and not simply to expect it to be heavy and meandering because it is old. Ghost owner/driver/restorer Derek du Toit looks especially at steering components in a two-part article, explaining how to renovate them and interpreting their design philosophy. At the heart of his work is testing, testing, and testing.

Although these descriptions, illustrations and diagrams refer to the Silver Ghost, fundamentally the same system of steering and front suspension was used from 1906 to as late as 1939. The principles in this article are therefore appropriate for Ghosts, PI's, PII's, Twenties, 20/25's (to GTK42), and Derby Bentleys prior to B2MR.

Lubrication

One of the most difficult parts to keep effectively lubricated on a Ghost is the steering box. This is because the design is such that even a thick liquid lubricant like 600W will dribble out quickly. Yet if you use a light grease, you run the risk of not getting lubricant everywhere; it can even dry out and paste itself onto the walls of the box on a little used car.

There is a cure for all this. First, try to cut down the outflow as much as possible. Fitting a sealed outer bearing, a close fitting leather washer on the oil plate and making sure the surface the oil plate slides on is as flat and smooth as possible all help. (After the Ghost, loss of lubrication was not such a problem because the geometry of the steering system changed, and the control tubes did not move at their bottom end in the same way.) It also helps to assemble the box to the supporting chassis member with enough silicone sealing compound, and a good gasket, to stop leakage around the mounting bolt.

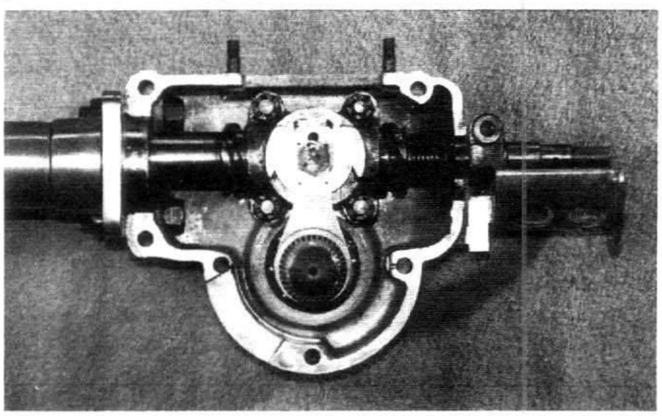
Second, I have a careful system of lubricating the steering box. Using a foundation of the most fluid grease I can find, with which I fill about half the empty steering box, I then top it up with 600W and put the cover back on. With the front axle supported by axle stands, I then turn the front wheels from side to side for some 20 or so cycles to make sure lubricant is everywhere. (Watch the steering column move up and down while this is done to get a feel of why there is a center bearing in the column.) The cover plate is then taken off to top up with enough 600W, while the steering is at full right-hand lock (for right-steer cars), so that it would overflow if the steering were centralized with the cover off. The 20 cycles are repeated after the cover has been replaced. The box is opened up every 500 miles to top up with 600W: because I want to know what is happening, it is not just pumped in with a gun. The rate of loss of lubricant is about half a pint every fortnight. In addition, I try to keep loads on the steering system down to the lowest possible by not forcing the steering at parking speeds – the wheel is turned only after the car is moving. The moment the steering seems to stiffen up, I relubricate everything, even if this occurs earlier than the normal lubrication cycle.

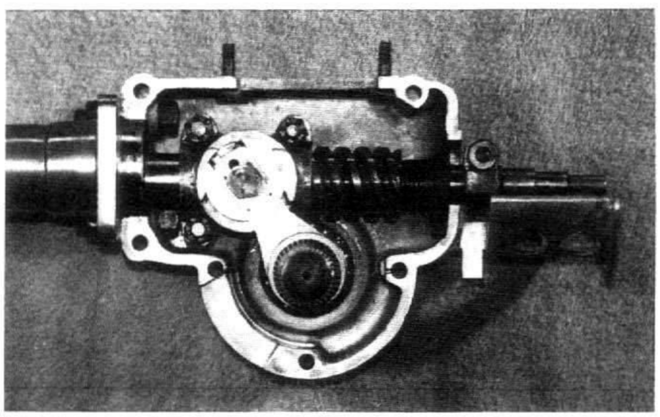
Specification: Only One Way

Not all steering systems have received this kindly treatment over the years and many of them now need complete overhaul. The indication of this is that they suffer from great slackness on straight ahead. This leads to a lurching progress down the highway as you overcorrect from side to side, heaviness in use and sometimes even tightening up on severe turns. Ball bearings and the cheeses that work in the steering nuts are easy to replace and remake, or hard chrome, respectively, when worn. (See "Option Two" for important information regarding the lugs of the nut.) But what is to be done about the worm and the nut, especially since the machinery to do this does not seem readily available?

While a few of the really early Ghosts had a five start nut and worm, most numbered series cars sport a four start thread, with a lead of 1.500". The post-War cars, including the early Springfield cars, had a three start thread with a lead of 1.125", giving a somewhat lower ratio. The later Springfield cars got down to a two start thread, from S211ML at the end of 1925, as the

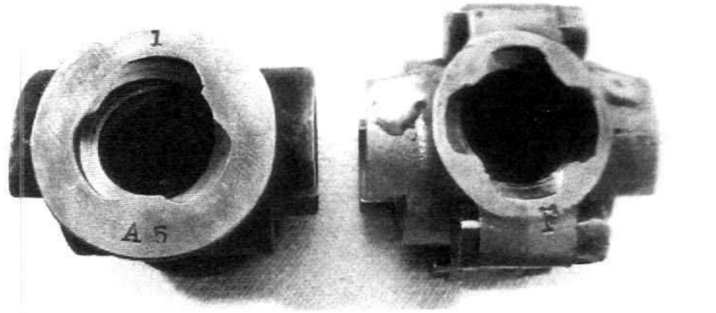
Steering box elements horizontally, left to right:- stationary steering tube, steering worm tube (worm in the steering nut), spring, oil plate, concentric control tubes for ignition, governor, carburetter, and switch which are ingeniously keyed to slide up and down, not twist, and switchbox bracket. Lower center of box:- splined end of the rocking shaft with an arm secured to the slot in the cheese fitted in the steering nut. The front wheels are straight ahead in the left picture, full right in the right picture. The movement of the control tubes is what makes it difficult to seal the Ghost steering box properly.





Factory battled with the problem of greater loads caused by heavier chassis, larger wheels and fatter tires. Then there were the complaints from those who found their steering experiences were not as the starry-eyed advertisements of the day claimed, especially if lubrication had been neglected.

While on this topic, it should be noted that there is only one correct way to mate up the worm and nut. The Factory marked them all carefully, so do not take the worm out of the nut with the steering box in situ unless you can see how to match them up again. This is important, because, though the greatest care was taken during manufacture, the threads are not always exactly symmetrical. So one thread could be indexed at, say, 89°45'30" and another at 180°14'30" for the four-start. Some will claim they have not bothered about this and their steering works fine – Sir Henry would have fired them on the spot. Others will say that you can reduce wear by turning the worm to start in a different thread and thus get a tighter fit. True enough, but this is only because two, and not four, teeth are engaging fully. This stratagem fails because the two teeth that are now doing all the work will wear quickly and you will soon be worse off than before.



Three start solid nut (left) and four start split nut (right) are called three and four start because there are three threads that start engaging simultaneously for the nut on the left; four on the right. The numbers correspond to the numbers stamped on the worm threads. The four start nut is suffering from a crude attempt to repair cracked lips.

Derby Nuts and Worms	
Four start, split nut	1.500" lead - circa 1908 to 1914
Three start, split nut	1.125" lead - 1919 to middle P series
Three start, solid nut	1.125" lead - Middle P series to ?
Two start, solid nut	.750" lead - ? to 1927
Springfield Nuts and Worms	
Three start, split nut	1.125" lead - 1921 to S210ML
Two start, split nut	.750" lead - 211 ML to S400RL

Renovation Options

There are several options available for owners wishing to eliminate wear in a badly-worn worm and nut. The first, and least energy consuming, is to ship the whole car off to someone who has the equipment and expertise to do this work. The second is to have the worm ground undersize by some .040" and then babbitt the nut while it is held in place over the worm. Third, you could have a new nut and/or worm made with a quick start lathe and do the rest of the work yourself. The fourth option is to find an N.O.S. worm and nut and replace. (This is of course not a realistic option and is added only to show that we have tried to cover all bases!) Another cunning wheeze available only to those who have several spare steering assemblies lying around is to mix and match until you have found a perfectly matching nut and worm. (Believe it or not, this can happen because of original manufacturing variances.) I have purposely not dabbled with the suggestion that one could take a couple of thousandths off the split-nut faces. This is a temporary expedient unworthy of *Flying Lady* readers, even though it has been done before.

A tip that will be helpful to the first-time dismantler of a Rolls-Royce steering box is the way to get the steering lever (Pitman arm) off. After the split pin and retaining nut have been removed, it will often seem that the steering lever has grown onto the tapered rocking shaft spline and become an integral part of it. Because it is so close to the housing, it is difficult to get a normal puller in place, especially for the pre-War Ghosts. Use a Pitman arm puller, a specially made tool, on post-War Ghosts, remembering to mark the position of the lever on the taper so reassembly is easy. Otherwise, heating the entire boss of the steering lever up to near red heat will allow it to be tapped off easily. Do not use the bigger hammer technique here, because you can easily damage the outer bearing housing. Watch out also for the melting point of aluminium so you do not wind up with a pool of molten steering box.

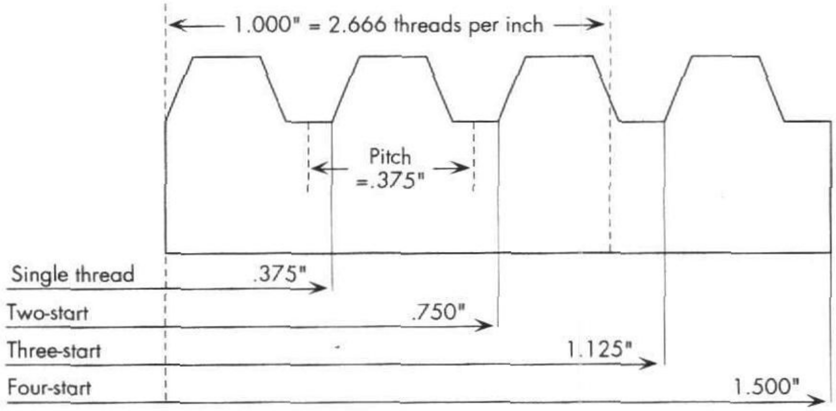
Option Two: Grind and Babbitt

This has a quixotic appeal, not only because it costs less and allows you to take up the indexing differences automatically, but also because PI's had babbitted nuts. Much of this information comes from Club member Phil Ziegler, who was Chief Engineer for the GM Saginaw Steering Gear Division. I have not tried it but would appreciate talking to the hardy soul who gives it a go. The process starts by having the worm ground so that it is some .040" undersize – this gets everything true and eliminates the hourglass wear that worms will inevitably develop. (This is the most difficult part of the whole process to get done, since the machines and the operators to do this kind of work are today few indeed. Try State Tool in Newark, NJ, 201-642-6180.) The threads should then be case-hardened to 60-62 Rockwell, making sure the shaft is held vertically while heat-treating because gravity can cause distortion if held horizontally. Mention the close plated nickel silver on the column to the heat treatment shop, otherwise it will all fall off during the heat treatment process. The steering nut should then be looked over, making sure the cheeses fit in with precision. If they do not, you have the option of making new cheeses or else hard-chroming up the old ones to fit the recesses. The recesses for the cheeses in the nut may have to be attended to as well, boring them out so that they too are completely round. Try to take off as little as possible here because these are one of the few parts of a Ghost that is not over-engineered, and you need all the meat here that you can get. Inspect

Lead and tpi (threads per inch) Explained

At 3.75" pitch	a Worm must turn x times	b to advance nut by:-	c Lead is thus c = b/a	d Turns per inch tpi = 1/c
Single thread	2.666	1.000"	.375"	2.666
Two start	2.666	2.000"	.750"	1.333
Three start	2.666	3.000"	1.125"	.888
Four start	2.666	4.000"	1.500"	.666

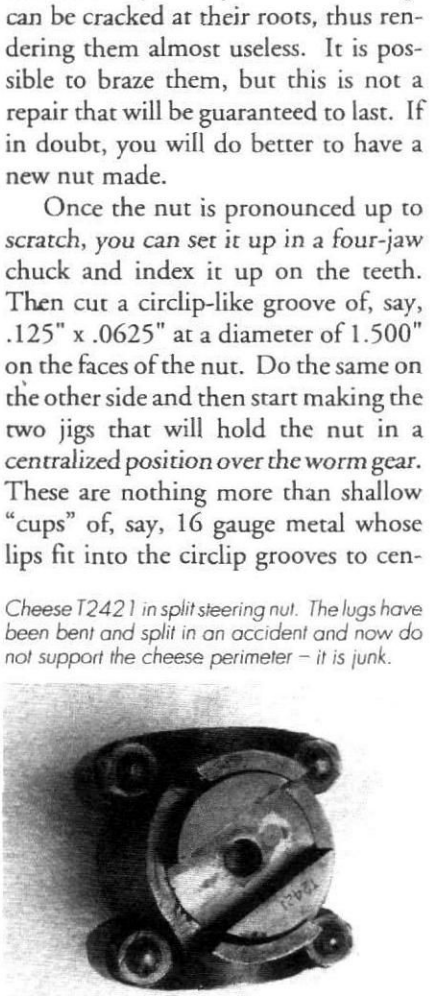
Therefore, the lead of a screw thread is the distance the nut will travel if it is turned one full revolution. The Factory used a constant pitch of .375", using the same dimensions and tooth form, throughout the Ghost production period both in the UK and the U.S.A.



this area very closely because the lugs can be cracked at their roots, thus rendering them almost useless. It is possible to braze them, but this is not a repair that will be guaranteed to last. If in doubt, you will do better to have a new nut made.

Once the nut is pronounced up to scratch, you can set it up in a four-jaw chuck and index it up on the teeth. Then cut a circlip-like groove of, say, .125" x .0625" at a diameter of 1.500" on the faces of the nut. Do the same on the other side and then start making the two jigs that will hold the nut in a centralized position over the worm gear. These are nothing more than shallow "cups" of, say, 16 gauge metal whose lips fit into the circlip grooves to centralize the nut on the worm, so babbitting material can go over the threads evenly. Prepare the worm by having the surface of the threads played with a smoky acetylene flame, depositing a layer of soft carbon. This stops the babbitt from adhering to the worm. The nut is prepared by cleaning really thoroughly, tinning and then offering up the nut to the worm, positioning it with the jigs. When pouring the babbitt, the nut and worm should be almost at the temperature of the molten babbitt. Michael Forrest, GB, suggested a clever alternative by which the babbitt is fed into the bottom of the worm by means of a steel U-tube sealed with clay. A channel allows the molten babbitt to be poured into a lip, which has a passage to the bottom of the worm. This avoids all the problems of airlocks, because the molten babbitt rises from the bottom of the worm. After the babbitt has cooled, wallop the worm from all sides, but mostly fore and aft, with a lead or copper mallet, ensuring optimum bedding in. The ultimate fit is obtained by burnishing the two surfaces. Do this by fitting a 4 foot pipe to the Pitman arm, sans ball end, and then cranking it to and fro whilst holding the assembled steering box firmly in a vise by clamping the lower steering tube. You may well have to start by turning the steering wheel because the nut is too stiff to rotate the worm by the steering lever alone.

Cheese T2421 in split steering nut. The lugs have been bent and split in an accident and now do not support the cheese perimeter – it is junk.

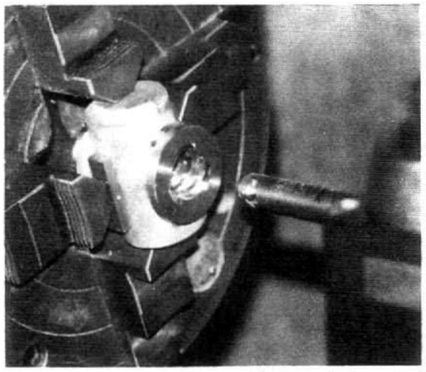


Option Three: Remake the Nut

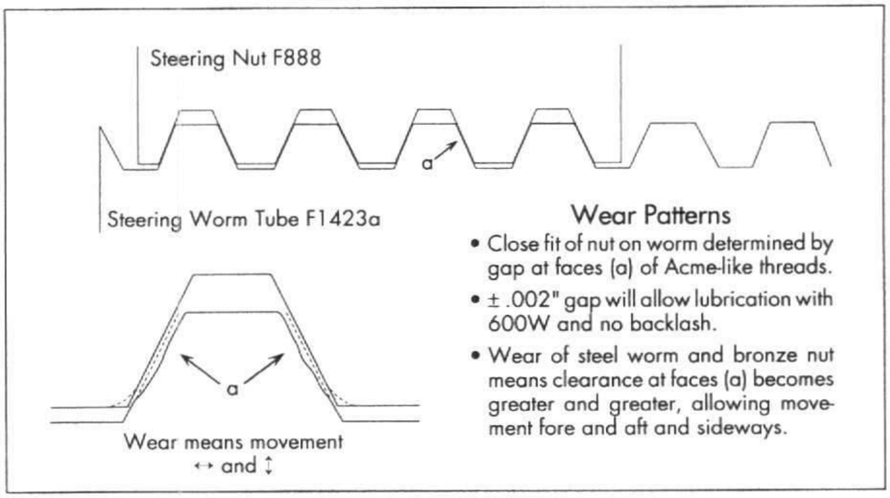
I found the best all round solution was to take the worn nut and worm from 78FW to Karl Furr, a Club member in Orem, Utah. He has a tool shop that does some amazing work, including making scale, working Gatling guns from scratch. He cast up a couple of new nuts and machined them up on his quick start lathe and milling machine to the required dimensions, and voila! – two brand new, perfect nuts. A GA (General Arrangement) drawing exists of a 1920 3-start split nut, but is not reproducible. They needed a bit of burnishing, as above, because we purposely finished with a tight fit but this is probably what was done in the Factory during erection. They would have threaded the nuts with a gigantic tap and then burnished them. But that was beyond the small production run of two nuts. (We had been put off by industry rumors that a special purpose tap to do this would cost $12,000. It turned out that you could get a set of three, two roughers and one finisher, for around $1,000. This is the way to go if we ever have to do this again, or if more than five Ghost owners with three start steering worm tubes write in saying, 'Please help me.') I kept at the burnishing process until the steering wheel would turn with the smallest pressure, having started from a position where it was almost impossible to turn at all. (A quick start lathe is a large, standard lathe that has special gearing that allows one to make very coarse threads that are below the bottom limit that most lathes have of 4 tpi.)

Reassembly

When reassembling the steering box, keep in mind that the outer bearing may well have worn or distorted the aluminium housing so that it now cannot be gripped tightly. (Bad cases will also have worn the shaft as well.) This can be cured by lightly pockmarking the inner surface of the housing with a square cut pin punch and then using Loctite, pressing the bearing squarely in place. If the clearances are too great for this cure, you must sleeve the bearing housing since it is important to maintain absolute rigidity of the rocking shaft lever. (Because the loads on this bearing are so great,



Steering nut casting having the female thread of the worm being cut with the boring bar.



there is a case to be made for using a roller bearing – I used a Consolidated RLS12 and will report in about 150,000 miles. Roller bearings do not come with seals, so I had to get some cutting-edge technology involved to stop the flow of 600W.) Just before you make up a paper gasket for the center joint of the steering box, examine the entire casting closely to make sure there are no pinholes that will leak. Unattended, they will defeat all your oil-proofing efforts.

An indication that the outer bearing is no longer held tightly in its housing is that you will sometimes feel a click in the steering as you manoeuvre while parking. The click comes as the bearing moves within the housing, or the shaft in the bearing, or if a worn nut moves on a dry worm, or if the spherical ball race on the column is not adjusted correctly or is defective, or a combination of all these and maybe some others. Since everything wears over time, you will undoubtedly have to attend to all of them. Once you start feeling the click from the steering box, wear of the nut accelerates because the tilting of the rocking shaft induces a twisting force to the worm that quickly wears both ends of the thread of the nut and where the cheeses fit. The reason the outer bearing eventually loosens up in its housing, or wears the shaft (or both), is that there is a design flaw.

In Royce's defense, it should be said that it would be difficult to arrange otherwise. Whenever a shaft is supported by bearings at each end, provision has to be made for the temperature-induced expansion and contraction of that shaft. If the bearings are held rigidly, something has to give with changes of temperature and so designers arrange that the shaft, or one bearing, can slide at one end. For the steering rocking shaft, this sliding is designed to occur at the outer bearing where most of the load is. (If the inner bearing took the sliding action, it would not wear the shaft so quickly because the loads there are less.) So when you reassemble, do not Loctite everything, unless you want to take the steering assembly out in the future to do the job all over. Make sure the arms of the rocking shaft fit the cheeses properly. They are sometimes worn or twisted and will then need filing and shimming. Test the movement and fit of the nut by holding it in place with the cheeses bolted to the rocking shaft before full assembly.

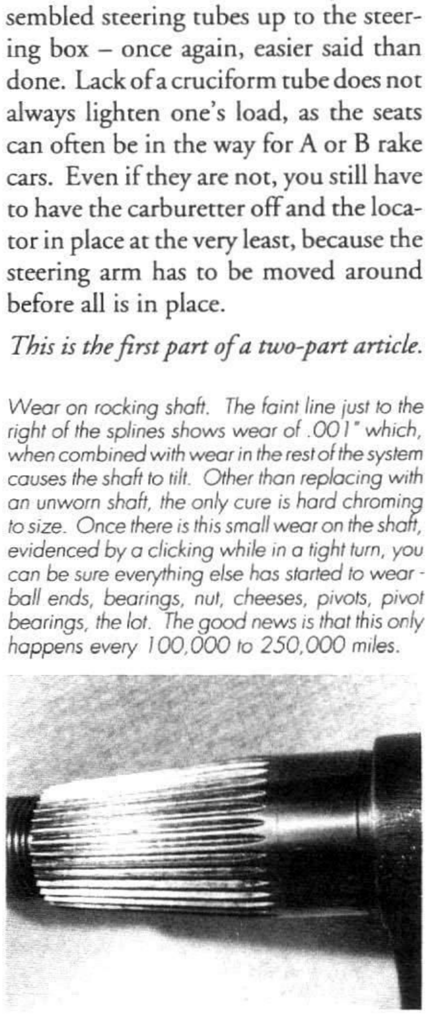
Those interested in Rolls-Royce mechanical minutiae will be impressed to note that the short bolts that hold the cheeses onto the rocking shaft arms (screws for rocking shaft, S1579), are tapered. The tapers act as additional locking mechanisms over and above the locking washers. Each of these screws was hand fitted when the chassis was erected and usually cannot be interchanged.

If you are doing all this work on a chassis, it will be easy to get at things. If the body is in place, there are constraints to taking the steering assembly out and putting it back. The most severe are found in cars with a C or D rake steering (the ones that have a cruciform stationary steering tube). Here are some tips that will help. Undoing the four nuts (easier said than done!) that hold the steering tube to the steering box will mean you can separate these two and withdraw the worm from the nut. Putting this all back onto the chassis (after you have assembled it up for testing) can be done more easily, with the box separated from the worm and steering tubes, if you make up a dummy locator rod for the oil plate. This should be .750" diameter, about 2 inches long, and serves to keep the spring and plate in place while assembling on the chassis. The nut needs to be kept stationary and up against the spring while being installed.

After bolting up, connect the steering lever ball end to the side steering tube to hold the worm steady. Make sure the worm is lining up on the correct start of the nut when offering the assembled steering tubes up to the steering box – once again, easier said than done. Lack of a cruciform tube does not always lighten one's load, as the seats can often be in the way for A or B rake cars. Even if they are not, you still have to have the carburetter off and the locator in place at the very least, because the steering arm has to be moved around before all is in place.

This is the first part of a two-part article.

Wear on rocking shaft. The faint line just to the right of the splines shows wear of .001" which, when combined with wear in the rest of the system causes the shaft to tilt. Other than replacing with an unworn shaft, the only cure is hard chroming to size. Once there is this small wear on the shaft, evidenced by a clicking while in a tight turn, you can be sure everything else has started to wear - ball ends, bearings, nut, cheeses, pivots, pivot bearings, the lot. The good news is that this only happens every 100,000 to 250,000 miles.



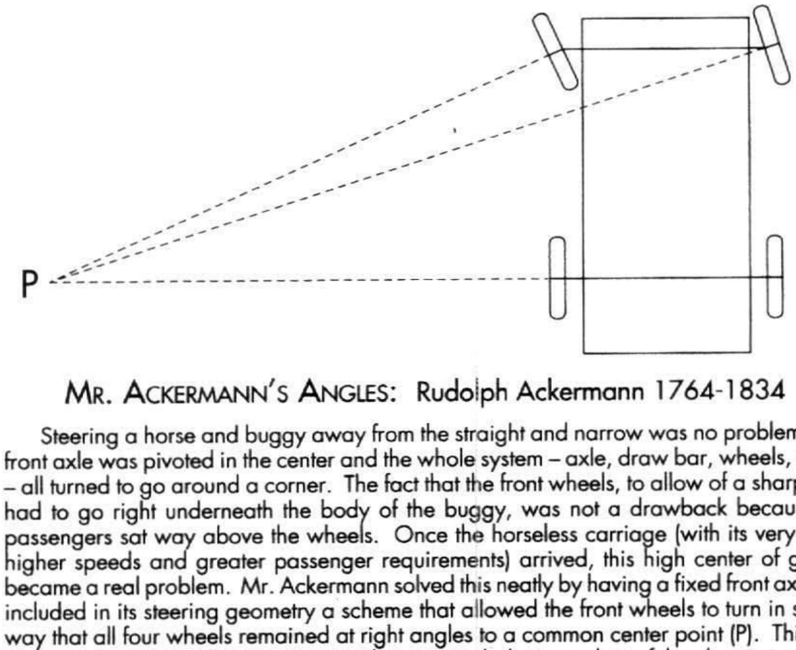
Nuts, Cheeses & Worms Part II

Story and photo © Derek du Toit, NJ 1991

Derek concludes his article on steering with discussion of pivot pins, steering column ball race, thrust bearings and ball ends, castor and shimmy. He invites your questions.

Before you put all your efforts to the test by driving the car, you should make sure that all elements of the steering system are up to scratch. You can often be fooled, in this hobby, into thinking that you are suffering from one thing, while it turns out to be another. (This article, and the thirty month research effort it required, started with the feeling I had that my pivot pins were stiffening up. What was actually causing the problem was that the steering worm tube was slightly bent.) Indeed, you can save yourself much grief by checking the entire system before you rip the steering box out. If any of the ball ends and their contact pieces are less than perfectly round, they will cause stickiness on turning, and accelerated wear; if the pivot pins are set up incorrectly, or worn, you will be less than satisfied with your labours and if the wheel bearings are worn enough to cause the wheels to be out of alignment, the steering will be less than acceptable. The sure indication of worn pins and/or bushes is an erratic and lurching progress, with the car super-sensitive to road surface conditions. It will, for no real reason, suddenly lurch sideways, almost as though a giant blast of wind has pushed it across a lane of traffic, the way the early Volkswagens used to go across the Golden Gate bridge. (In an effort to reduce friction in this area, I made up sintered bronze bushings in place of the worn hardened steel ones, reasoning that if oil was always available, there would be a greater easiness in the steering. There was, and I preened myself over a problem solved. Once those who knew anything about the forces involved got to hear about my 'cure', they were horrified, forecasting that the bronze would deform quickly, causing enormous clearances. They were right and the car became practically undriveable within 3,000 miles!)

Check that you have the correct hubs for your front axle because the really early Dunlop hubs are of a different length than the later cars, and their axles thus have a different camber. Your steering geometry needs to be correct, so check castor, camber and toe-in. You might also check the Ackermann angle to make sure the steering levers (arms) have not been bent. This is unlikely, but your understanding of the steering process will be helped if you know how Herr Ackermann was able to catapult us from the horse and buggy era to the automobile age at the end of the nineteenth century. I am assuming your chassis geometry is correct, but do check it – even early Rolls-Royce cars had accidents.



MR. ACKERMANN'S ANGLES: Rudolph Ackermann 1764-1834

Steering a horse and buggy away from the straight and narrow was no problem – the front axle was pivoted in the center and the whole system – axle, draw bar, wheels, the lot – all turned to go around a corner. The fact that the front wheels, to allow of a sharp turn, had to go right underneath the body of the buggy, was not a drawback because the passengers sat way above the wheels. Once the horseless carriage (with its very much higher speeds and greater passenger requirements) arrived, this high center of gravity became a real problem. Mr. Ackermann solved this neatly by having a fixed front axle that included in its steering geometry a scheme that allowed the front wheels to turn in such a way that all four wheels remained at right angles to a common center point (P). This was arranged by having the steering arms bent towards the centerline of the chassis in such a way that lines drawn, in plan, from the kingpins through the steering arm ball ends would meet at the center of the back axle. This allowed the front wheels to travel without slipping along the arc of the turn, which would happen if they did not turn through different angles.

Pivot Pins

The fit of the pivot pins in the bearing surfaces of the bushings should also be considered. If both the pivot pins and the bushings have been hard-chromed in a previous repair or restoration, they will quickly gall no matter how well or often you lubricate. This is due to similar metals not being the best way to arrange for a bearing application. In fact, any time you see hard-chrome flaking off, it is often the result of this problem rather than wear per se. You could make new pins and bushings out of Springfield specification S/ZN 207, a case hardening nickel steel, and then case-harden. This will duplicate the original construction as closely as possible. Properly lubricated, the hardened steel bushes and pivot pins last forever – the problem is that very few cars are in this state of bliss today. Remember that Derby used parallel pivot pins (F4109) until midway through the O series and tapered pins (F9107) after that. Springfield, as near as I can make out, used tapered pins from the beginning. Take care to set up the pivot pins as advised in Abe Guise's excellent article in *The Silver Ghost Tourer* p. 72. The vertical travel is best kept to the limits set by the Factory of .014" and .025".

The Factory had three different recommendations for lubrication – Springfield's advice for lubrication of pivot pins was different to that of pre-War Derby – but I prefer following the post-War (April, 1922) Derby instructions for all Ghosts, removing the bottom cups and filling them with 600W. If the upper oiling points are filled, while the bottom cups are off, until the oil finally runs out at the bottom of the pivot pins, you will be sure to have pivot pin assemblies that have more oil than they need. (This only works for pivot pins that have oilways drilled through them, which only started as near as I can ascertain, with the post-War Ghosts.) The first time you do this, it will eventually ooze out all over the place, including your wheels. However, you will soon find out what the optimum is and top up appropriately. If grease has ever been used for lubricating the pivot pins, you must strip them to remove every last vestige, because grease here is more than just anathema. All the lubrication recommendations in this article in some way or another contradict those given in FL1444. It has finally dawned on me that the only way to test theories is through exhaustive, hands-on involvement, the way Royce, Hives, and all of the rest of the people at Derby did it.

For those who are dismayed at the thought of 600W dribbling everywhere to ruin the pristine appearance of their cars, there is a solution. Fitting seals will bring several benefits. First, water from driving in the rain (we do this all the time, right?) will no longer displace oil from the bottom cup, thus leading to wear and rusting of steel bearing surfaces. Second, the seals will stop the messy loss of oil all over your clean chassis. But the most important benefit will be that the pivot pins will remain swimming in oil indefinitely. As a result, you will not need to lubricate so often, maybe even not at all, on a tour. This is another one of the upgrades that is arguable for those who drive a lot, if only because no one can see what has been done and because future owners can easily retrofit if they want ultimate authenticity.

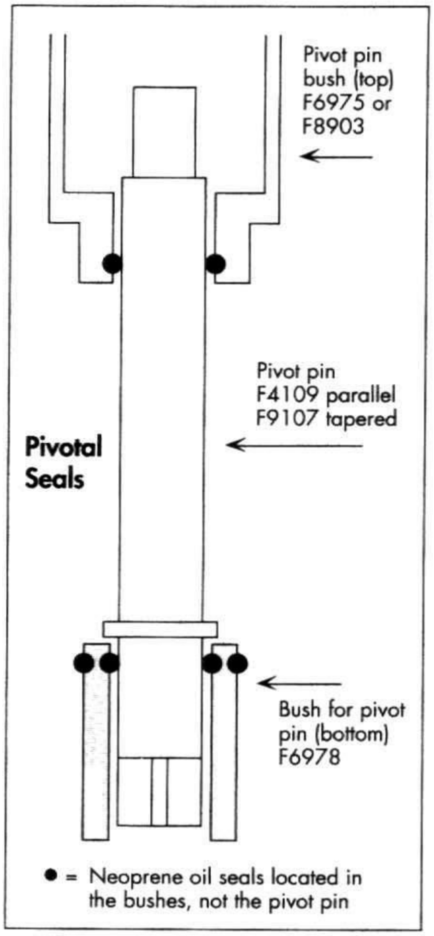
Steering Column Ball Race

Another useful point to check is that you should have the center bearing on the steering column adequately lubricated, clean and properly adjusted. When you are testing the movement at the rim of the steering wheel to see if there is so much slack that you will have to attend to the nut, worm and cheeses, you can easily persuade yourself that this is the case if the center bearing has not been properly lubricated and adjusted, or is worn, or is both. Bad cases even include broken balls mangling the races. Proper care for these oft-neglected ball races includes a frequently forgotten bearing surface – the outer surface contact of the outer ball races (U1296) on the steering tube. Although they normally do not move at all, a wipe of 600W during assembly can help guard against damage if you insist on cranking up the cover too tightly.

The inner and outer ball races must be checked with a high-powered magnifying glass because they are often worn, and sometimes chipped and destroyed – the result of being adjusted too tightly. Repair would mean grinding and hardening, as in FL4126, or else making new ones. The ¼" balls should be replaced as a matter of course. Assemble with light grease to stop the balls falling out during assembly, making sure beforehand that the fit of the ball race cover (F1124) onto its threads is such that it screws on effortlessly. The cover should be adjusted by hand until it only just nips the bearing. Anything tighter makes easy movement of the column difficult and will guarantee the ultimate destruction of the balls and/or the races, since they are subject to some considerable forces. The line between just tight enough and too tight is fine indeed and can only be determined empirically. Assemble the center bearing and the steering worm tube onto the stationary steering tube, holding this in a vise. While moving the worm over its designed arc with your right hand, tighten the cover with your left hand until the arc of movement is restricted at its extremes. Then back off a tad until it is not. Lock the cover in place with the washer, check nut and the correct C spanner. If you want to check the setting on an already assembled car, remember that "less is more" here. It needs only the lightest of hand twists to be sufficient – probably something like half a foot-pound.

Thrust Bearings and Ball Ends

The next area to be considered before you finish the job is the type of thrust bearing used to suspend the weight of the car at the front axle assembly – see Abe Guise's article and RR of America drawing of U.S. Silver Ghost front hub and tie rod FL970. One reason the pre-War Ghosts have such delightfully light steering, when properly set up, is that both the pivot pins have ball-bearinged thrust bearings. The early post-War cars, however, up to the middle of the P series, had a damper put into the system by way of a red fibre thrust washer in place of the offside ball bearing. This cut down on the newly developed front



wheel shimmy by putting extra friction into the system. It also meant the post-War cars would have been noticeably heavier to steer. This was "cured" by using the three start worm and nut with a less acute lead, but they needed more turns at the steering wheel to accomplish the same turn as the earlier cars. The cure worked, by and large, but the really delightful steering of the early cars was never recaptured. From the middle of the P series in 1922 to the end of the production run of the Derby cars in 1926, both thrust bearings had red fibre thrust washers and the lead was reduced even more during this time with a two start worm. The later assemblies would therefore have been inclined to wear differently to the early Ghosts – worms and nuts less quickly, cheeses and bearings more quickly, at least in theory.

In an attempt to determine the factors affecting lightness of steering, I fitted a Torrington NTA 1828 thrust needle roller bearing and two hardened washers (costing $3.78 including tax!) in place of the single fibre washer on 78FW – both were ¼" thick. The washers come in varying sizes so you can get the vertical clearance of the axle pivot to the correct .015". (With the fibre friction thrust washer in place, and using either 33 x 5 or 895 x 135 wheels, I had been unable to induce shimmy, even though the cross steering tube was so loose that there was no friction at all and all bearing surfaces were swimming in oil.) All this made for significantly lighter steering, since there were now two thrust bearings and almost frictionless pivot pins. But it was now finally sensitive to shimmy, thus showing why the fibre washer was there in the first place. The shimmy was eliminated by cranking up the cross steering tube ends a tad so that the ball ends were gripped a trifle more tightly. This was the Factory's way of introducing the friction that acted as a damper for really bad cases of shimmy that are fortunately rarely seen today. The ball ends have to be perfectly spherical for this to work properly, since a close enough fit to get enough friction in the dead-ahead position – where you will be most of the time – will cause noticeable stiffness on turns if the ball ends are out of round by more than .001". This could be a contributory cause of the infamous tightening up on corners that the later cars, with spring-loaded steering tubes, sometimes suffer from.

The steering ball ends on 78FW were not truly round, so I made four new ones from SAE 9310, a high-grade carburizing steel used in the aircraft industry, usually for helicopter gears. (If you are less than enchanted with the thought of making new ball ends, you could turn the existing ones by 90° and spend the next 100,000 miles or so wearing them back to being almost perfectly round!) The compromise to work towards is to get the pivot pins and the thrust washers as frictionless as possible, so that shimmy will be evident. Then work your way backwards, step by step, inserting just enough friction to stop shimmy, making sure the entire system has been properly lubricated and set up. This will give the optimum balance obtainable on your car between lightness and lack of shimmy, and will be maintained until wear introduces enough sloppiness to allow shimmy to reappear. Since it takes about 100,000 miles for ball ends to get out of round by up to .005" (even when clamped up tightly over this period), this should be every 20,000 miles or so.

One way of checking how you are progressing on eliminating friction and drag from the entire system, especially if you are doing this over the winter months and cannot take the car out for a lot of test drives, is to set up a frictionless rotational support under one front wheel tire while the other is held off the ground with an axle stand. This allows the normal weight of the car to be on the pivot pin assembly of only one wheel and yet allows one to turn the steering wheel as though one were on the road. I used the clutch release bearing from another car and found that one could readily decide where the problem was as you moved from wheel to wheel. Have the non-testing wheel off its hub to reduce friction at that axle eye.

> "Steer the car above 20 mph with only two fingers."

For those with pre-1922 cars that cannot quickly get the shimmy out of their system, a temporary cure would be to make up a nylon "doughnut" shaped so as to fit the offside ball race. Removing the balls and replacing them with the doughnut will induce sufficient dampening and allow you to use the car, until you find out just what is causing the problem. If you have 7.00 x 21" wheels and tires on a pre-War chassis, you can expect that your car will be more prone to shimmy than if it had 895 x 135 wheels – there is just that much more mass to build up opposing forces. Your ultimate cure would be to go to the original beaded edge wheels and tires, although you could compromise by using 33 x 5 split-rims that are a more practical heavy-duty touring option. Increasing the tire pressures by 5 or 10 lbs. will sometimes help reduce shimmy, as will balancing the wheels and making sure the treads are smooth and not scalloped. If you want to go about eliminating these problems properly, try each "cure" one step at a time, so you are sure you are getting the proper answers and really know what the true cause is.

Something to check for in steering that does not feel quite right is the tracking (for those that have them) of the ball bearing thrust bearings. The weight of the car is carried on 5/16" balls but they can indent locally on the thrust washers, leading to a strange feeling of knobbly stiffness. Modern needle rollers would be more effective in supporting these loads but this would mean making new top pivot pin bushes and washers for cars up to the middle of the P series. Cars that have two fibre washers could be fitted with one needle thrust washer at first, while you experiment along the lines above. Another point to watch, for those needing new washers (nylon or Delrin will do), is that the fibre washer(s) could have four small radial lubrication grooves cut into one surface, usually the lower one. This will help in getting lubricant where it is needed. This theory has not yet been thoroughly tested and needs to be proven against the Factory's diametrical grooves. My feeling is that they will be marginally more effective if you can manage to keep oil in place with the seals. If not, go the diametrical route.

Specifications for Thrust Washers in Pivot Pins

Derby

Twin ball bearings – 1907 to 1914
Red fibre washer, offside; ball bearing nearside – 1919 to mid P series
Twin fibre washers – mid P series to 1927

Springfield

Fibre washer, offside; ball bearing nearside – 1921 to 275BG
Twin fibre washers – 276BG to 1926

The Dreaded Shimmy

Most of us have experienced shimmy when we have pushed a badly-maintained and loudly-protesting trolley through an airport or a supermarket. Shimmy in an old car often starts at a fairly low speed, from 10 to 25 mph, after the front wheels have been shaken up by going over a less-than-smooth patch in the road. This is nearly always a tar macadam road, since you hardly ever have this phenomenon on dirt roads, surprisingly enough. In the blink of an eye, the steering wheel will start oscillating incredibly rapidly and nothing you can do will stop the front wheels from thrashing from lock to lock, other than stopping the car. If you doubt this point, you can try to accelerate through it, or even to wrap the steering wheel in a grip of steel. However, I have never met anyone who was able to stop this alarming experience of having a Jabberwock by the tail in any way other than by a crash stop. (It can be really bad – there are documented stories of armoured cars losing their turrets from the violence of the shaking. The most difficult-to-trace steering problem I ever came across was a worm that was no longer in line with the shaft. It must have been knocked .040" out of true at one end by a really violent shimmy. Although the nut ran smoothly when unsupported, everything tightened up subtly when in the box. It was a bear to get straight because the .040" was difficult to measure and it was even more difficult to bend accurately.) You will sometimes get advance warning that you are about to have a shimmy attack by a faint tremor – at about two or three cycles a second – that you can feel through the steering wheel when you are doing about 40 mph on a relatively smooth road. Be prepared to throw out all anchors if shimmy strikes at a slower speed. Try also to look in the rear-view mirror before you do so – it would be a pity to avoid an attack of the shimmies only to collect a stoved-in petrol tank in exchange. The low-speed shimmies are not to be confused with the high-speed wobbles, an even more alarming occurrence, which are happily almost unknown in Ghosts, being more prevalent in cars with front wheel brakes.

Castor

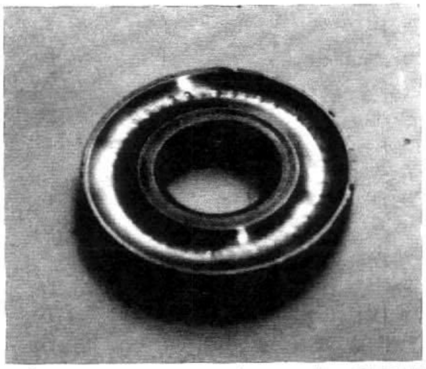
Finally, there are those who recommend curing shimmy by reducing the castor angle with small wedges under the springs. This can sometimes achieve what seems to be a diminution of steering effort, and a reduction of the shimmies – but you are attacking the symptom rather than the disease. What you can gain in ease of steering and fewer shimmies, you can lose in a tendency to wander, unless the cause is sagging springs that have altered the designed castor angle. The vintage Bentley people often advocate reducing castor – even Springfield flirted with this as they moved to larger tires (see FL1366). The reason the Bentley Boys find this works is that their kingpins are now often so stiff and galled through use of similar metals and lack of lubrication over their formative years that the friction in the king pin area is such that they cannot shimmy. (It is also a monster job to get at the Bentley king pins, whereas Ghost pivot pins can be out in fifteen minutes.) If their king pins were as frictionless as possible, they would shimmy more easily, regardless of what the castor angle was. Indeed, the major reason why most vintage cars do not shimmy today is that they have not been lubricated sufficiently over the years and now have a lot of drag and stiffness in the king pin area. The proof of this comes from Hives, who, when he was testing 98NK into the ground in 1924, found on 22/23 March that one sure way to stop the wobble the new front-wheel brakes were inducing was to stop all lubrication to the pivot pins. Imagine having to go back to "Pa" Royce and say that if you wanted front wheel brakes, you had to choose between no lubrication, heavy steering and no shimmies or lubrication to the pivot pins, light steering and uncontrollable shimmies. No wonder Rolls-Royce took so long to advocate front wheel brakes.

There is thus more than one vorpal blade that will snicker-snack to slay the dreaded Jabberwock – the trick is to choose the correct one so that it stays slain. Once slain, you will be as happy as the old man in Lewis Carroll's wonderful poem.

'And hast thou slain the Jabberwock?
Come to my arms, my beamish boy!
O frabjous day! Calloo! Callay!
He chortled in his joy.'

The Exemplary Paradigm

You will know you have got it all right when you have less than ¼" play of the steering wheel circumference at rest – no play at all is the standard – and when you can steer the car above 20 mph with two fingers. There should be no shimmy at any speed and the steering should be so light that you should not feel you have been wrestling with a bear after 12 hours on the road – the car should almost follow your thought pro-



Indentations on pivot pin thrust washer (F6974)

cesses as you think about turning. You should hold the wheel steady with a loose grip, not reacting to every nuance of the road, but rather allowing the car to work beneath you, responding to your direction as a ship at sea when the rudder is turned and the craft swings around steadily and certainly to the direction you want. There is no need to saw away at the steering, correcting every little movement or road tremor. A properly set up, properly lubricated Rolls-Royce steering system is a delight on the road, a frabjous joy indeed, and we should be satisfied with nothing less. Anytime you hear someone suggesting fitting power steering to a pre-WW II Rolls-Royce, you will know they are confusing cause with effect.

Acknowledgements

Parts of this article were influenced by discussions with Frank Allocca, Ron Bonar, Michael Forrest, Karl Furr, Abe Guise, Art Hart, Dave Hemmings, Bob Jefferson, Bob Johnston, Hugh Mearns, Fred Schumacher, Bob Thompson and Phil Ziegler, many of whom helped straighten out queries or make suggestions during a 30 month investigation and research effort. Other sources were: *The American Rolls-Royce, The Rolls-Royce Motor Car, Technical Facts of the Vintage Bentley*, the Wheatley & Morgan books and SGA's *Technical Binder*. Finally, there was much experimentation on 78FW, that patient 1920 chassis who now whinnies and shows the whites of her eyes whenever the word "shimmy" is whispered in her vicinity!

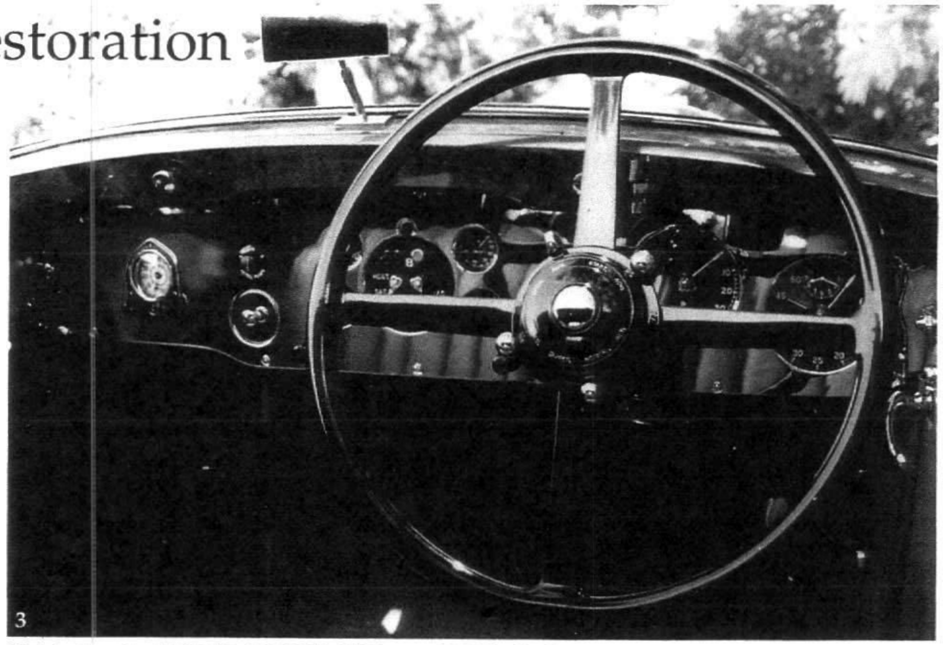
This is the second part of a two-part article

Corrections to Part 1

FL4433: Box below illustration:- Springfield two start nut is solid, not split.
FL4434: 'Lead and tpi Explained', 3.75" should, of course, read .375".

Steering Wheel Restoration

By Neal P. Kirkham (CA)



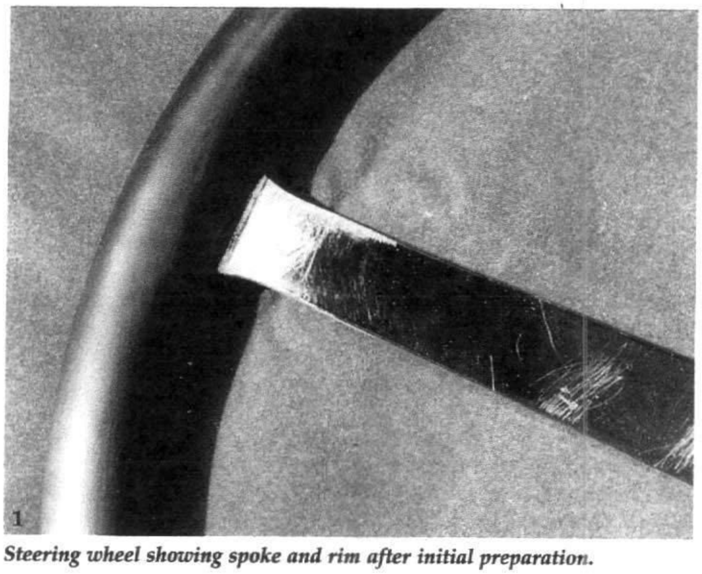
Finished product. B35BL (1934 3½ L) Thrupp & Maberly dhc.

Many prewar cars suffer from cracked steering wheels. This is particularly true of the Derby Bentley wheels since the spokes were relatively thin and flexible. Cracks most frequently occur where spokes join the rim. While they spoil the aesthetics they are not a precursor of structural failure since only the outer covering fails.

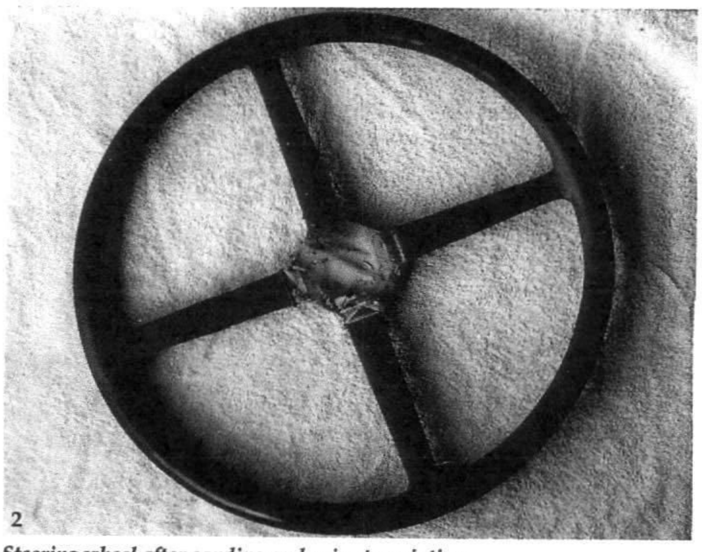
My 3½ L Bentley steering wheel was in terrible shape with cracks at all four spoke/rim joints; spoke coverings peeling, and the chrome on the hub also required replating. I decided to purchase a steering wheel repair kit from The Eastwood Company (1-800-345-1178) for $21.95 and try restoring it myself. The kit includes 1 lb of epoxy and the pamphlet *Steering Wheel Repair Handbook*.

The handbook was of some help but the Bentley wheel presented some special problems the book did not discuss. The first of these was the need for replating the hub. After removal of the spoke covering it was necessary to drill out the rivets that attach the spokes to the splined hub since, if the two are plated together the corrosive chemicals in the plating bath will seep between the riveted surfaces and ooze out over time. While you may be able to neutralize these chemicals with baking soda and water, you will make polishing prior to plating easier for the plater and achieve a higher quality job if you separate the hub. The chrome plater then taped over the rim and spoke/rim junctions before plating. As you might expect, the tape did not totally exclude chemical entry at each spoke joint and a week later the black rim covering began to get a bumpy appearance as these chemicals began to digest some of the innards of the rim. I then drilled dozens of holes in this rim cover near the spoke attachment points and soaked the entire wheel in warm water and baking soda for a day to neutralize the chemicals. After this I waited for a couple of weeks to be sure that no further lifting would occur. At this time the wheel was ready for the epoxy coating. The first step was to thoroughly clean the spoke joints (**photo 1**) with a small grinding wheel in a Dremel grinding tool and then fill the deep areas at each spoke joint (and the many drilled holes) to make a smooth transition to the spoke. Next, I taped off the chrome plated inner spokes and built a $\frac{1}{16}$ in.-high dam at the inner end of each spoke covering and applied a narrow ridge of epoxy against these dams to be later formed into the ridge at the termination of the epoxy covering on the spokes.

The handbook recommends spreading the epoxy onto the surface to be repaired. This inevitably leaves a surface that is uneven and it is very difficult to obtain a uniformly thin, level surface by mechanical spreading. Consequently, we decided to experiment by thinning the epoxy with methyl ethyl ketone and spraying this thinned epoxy on the spokes (we used 70 psi with a suction cup gun). *[Tech Ed. note: Observe all applicable safety precautions when using spray equipment and potentially toxic chemicals.]* Eureka—it worked (**photo 2**)! The resultant orange peel was removed by carefully scraping the surface with a razor blade and then block sanding. The wheel was then painted with a black catalyzed urethane by Deltron and color sanded using water to prevent loading of the grit. I started with 400 grit and ended with 1500. Final polishing with rubbing compound produced the end result, shown in **photo 3**.



Steering wheel showing spoke and rim after initial preparation.



Steering wheel after sanding and prior to painting.