R HAYNES

# Rolls-Royce Small Horsepower Brake Systems

Overhaul of the brake systems of Rolls-Royce 20 HP, 20/25, 25/30, Wraith, Bentley 3½ & 4¼ chassis.

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ROLLS-ROYCE ENTHUSIASTS' CLUB

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by

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ROLLS-ROYCE ENTHUSIASTS' CLUB

Published by
Rolls-Royce Enthusiasts' Club

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FOREWORD

For many years Ron Haynes had been assisting Rolls-Royce owners in his capacity as Technical Officer for Rolls-Royce at their Hythe Road, London Service Station. He posessed a wealth of knowledge of the older Rolls-Royce cars and was always willing to delve for further information when required.

During the 1970's Ron decided that unless this wealth of knowledge was recorded for posterity it might be lost forever and so set about writing it up. He planned to deal with all sections of the chassis in turn, initially covering the small horsepower models only, and started with the engine. He enlisted the help of a well known Rolls-Royce motor engineer Michael Grigsby and between them produced that most useful book "Rolls-Royce Small Horsepower Engines" in 1977.

Ron immediately started work on the first of a number of planned supplements to this book, covering the small horsepower brake systems. Sadly Ron died in September 1978, just as he was putting the finishing touches to this latest work. After lying dormant for several years the copy was made available to the Rolls-Royce Enthusiasts' Club by his widow Jean Haynes and after a little editing by Dr. Will Fiennes is now available to supplement the book on engines.

Ian W.Rimmer
R.R.E.C. 1983



From the first chassis until the end of E Series, all 20 HP cars were built with brakes on the rear wheels only. On these, as on all later cars, the hand and foot brake systems were entirely independent of each other. Two pairs of shoes were mounted, side-by-side, on each back plate, and one pair from each side was linked by wire ropes, a mechanical equaliser, and a rod to the brake pedal. The other pair were similarly connected to the hand brake lever.

The four wheel brake system introduced on 20 HP cars in 1926 remained in production with only detail changes, except on Wraith, until 1939. The side-by-side arrangement of the rear shoes was retained, as were the two differential type equalisers behind the gearbox. As before, the hand brake equaliser was coupled direct to the hand brake lever, but the foot brake equaliser was connected to a mechanical servo motor mounted on the left hand side of the gearbox. The servo motor was constantly driven by a worm wheel on the third motion shaft of the gearbox. Actuation of the front brakes was by a rod extending forward from the servo motor to a differential equaliser mounted on the bell housing. Two wire ropes connected this equaliser to a pair of toggle shafts in the front axle. The outer ends of these shafts were coupled to the actuating levers on the brake back plates.

The system on Wraith chassis was a complete redesign. The side-by-side shoe arrangement at the rear was replaced by a single pair of shoes in each drum, and these performed both the hand and foot brake functions. From each rear drum a single wire rope ran forward to a relay lever, these relays being connected forward to bell crank levers bracketed on the chassis frame. From the ball cranks, pull rods ran transversely to a vertically pivoted equaliser behind the gearbox. From this equaliser, one rod ran forward to the hand brake lever, and two rods were connected to the servo motor. A rod from the servo motor ran forward to a hydraulic damper, and thence to a vertically pivoted equaliser on the front cross member. This equaliser was connected by transverse pull rods to a bell crank on each of the back plates, and they, in turn, were coupled to the actuating levers.

On Bentley 3½ and 4¼ litre chassis the system is similar to the Rolls-Royce 20/25 HP and 25/30 HP layout of contemporary build.

THE SERVO MOTOR - Principles of operation

This motor, which was fitted to all pre-war four wheel brake systems, is basically a Ferodo lined dry-plate clutch, which, when the brakes are "off", is in a free condition. The driving element is constantly driven, and revolves at a speed proportional to the road speed of the car. The driven element is linked to the servo balance lever by the pair of operating levers on the servo shaft; one lever operates in forward motion and the other in reverse. The balance lever is connected to the front and rear brake equalisers. When the brakes are "off" the driven element remains stationary. Also on the servo shaft are a pair of face cam levers, one of which is linked to the brake pedal, and the other to the rear foot brake equaliser.

When the brake pedal is depressed, the one face cam lever picks up the other, and this pulls on the rear brakes. At the same time, the cam levers exert an axial pull on the servo shaft and take up the clearance between the two elements of the servo, applying a rotational force to the driven element. This, through the operating levers, exerts a pull on the balance lever, which pulls on the front brakes and augments the pull exerted on the rear brakes by the face cam lever.



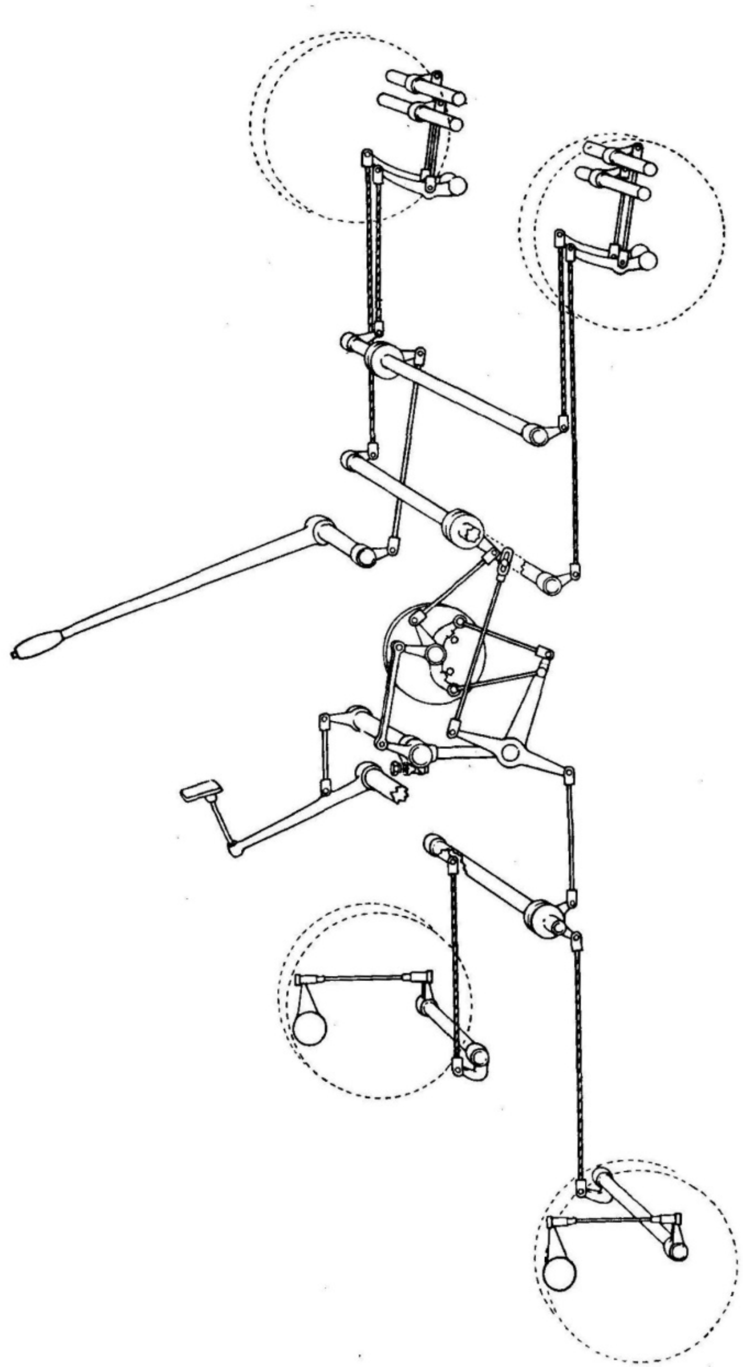

DIAGRAM OF ROLLS-ROYCE FOUR-WHEEL BRAKE SYSTEM.

It will be appreciated from this that the front brakes are entirely operated by the servo motor, whereas the rears are part operated by direct action from the brake pedal.

The degree of assistance provided by the servo motor depends on two things: The pressure applied to the brake pedal, and the road speed of the car, to which the rotational speed of the servo is related.



# The Servo Motor

The unit consists of a dry-plate clutch, made up of two Ferodo-lined driven plates enclosed in a driving drum, bolted to the gearbox cross—shaft. The driven plates are locked together rotationally by three driving pins, and they are separated by a coil spring.

The inner driven plate is a keyed taper fit on the servo shaft, the inner end of which is supported in a ball race in the gearbox cross-shaft. The outer driven plate is integral with a tubular extension which carries the two operating levers and the two cam levers, each of the latter with a ball thrust race. Interposed between the two pairs of levers is a bridge plate, and the extension is supported in this by an internally splined steel bush which is locked in position by a castellated nut. The front end of the bridge plate is located on the servo countershaft, and the rear on a bracket attached to the gearbox shell.

The outer end of the servo shaft extends outwards from the driven plate extension, and keyed to it is the serrated washer which is engaged by the similarly serrated adjusting nut.

The two operating levers are engaged by a pair of studs on the outer driven plate, and their outer ends are connected by rods to the T-shaped balance lever which is pivoted at the lower end of the suspension lever. This lever is pivoted on the servo countershaft. One cam lever is coupled to the brake pedal through the countershaft, and the other to the rear brake equaliser. The upper and lower ends of the servo balance lever are connected to the rear and front brake equalisers respectively.

The foregoing is a brief description of the installation on the first four wheel brake chassis, and the following progressive design improvements were subsequently adopted :

20 HP

At chassis number GA342 the four star shaped springs behind the serrated adjusting washer were introduced.

20/25

At chassis number GNS1 the original tubular suspension lever was superseded by the forged lever. At G0S22 the servo damper commenced, and this consisted of Ferobestos liners in the top of the suspension lever and a pneumatic damper attached to the bridge plate mounting brackets. The purpose of these alterations was to overcome on/off clonks. At the same time, the fixing of the servo linings was changed from hollow rivets to staples. From GAU1 the cam levers were changed to accommodate the interposition of .250" steel balls.
At GBJ1 the fully-floating servo commenced. The main difference of this design is that the linings are not stapled to the plates, but free to float. The steel bush in the bridge plate is superseded by a ball race.

25/30 HP

All these chassis were built with the fully-floating servo.

BENTLEY 3½ and 4¼ LITRE, EXCEPT M-SERIES

On A, B and C-Series, the design is similar to 20/25 HP from chassis number G0S22. From chassis number B-2-DG all 3½ litre, and all 4¼ litre, except M-Series, were built with the fully-floating servo.

BENTLEY 4¼ LITRE, M-SERIES

This is a fully-floating type, but the damper at the top of the suspension lever was dispensed with, and the lever linked to a cotton lined "Andre" type damper mounted on the gearbox shell. The pneumatic damper was retained.

WRAITH

This type differs in a number of ways from the earlier type, although the general configuration is similar. The linings are fully-floating and the driven plates are coupled by a laminated spring, but the linkage layout is quite different. The cam levers are in the lower quadrant, and instead of a reverse operating lever, the link is connected directly to a stud on the driven plate. The rod of the input cam lever is in compression when the brake pedal is depressed. The only damper, fitted to A and B Series only, was a cotton lined "Andre" type mounted on the gearbox shell and linked to the suspension lever.



FAULTS IN OPERATION

In cases of poor braking, where the brakes themselves and the servo are properly adjusted, inefficiency of the servo is a probable cause.

Oil contamination of the linings will reduce their Mu value (coefficient of friction), and the only remedy is to dismantle and reline. If the servo is externally messy and oily, penetration has probably occurred. Glazing of the linings has the same effect, and in such cases roughing up and rebedding may restore normal operation.

Thumps when the brakes are applied, brake judder (jaggers in the Rolls-Royce jargon) and Clonks when the brake pedal is released can be caused, on chassis so fitted, by oil on the Ferobestos lining of the suspension lever. To rectify this, take off the nut, two washers, spring and bolt from the top of the lever, and wipe dry the two "bearing halves" and the shaft. Reassemble, screwing the nut down as far as it will go, and then back off one full turn. Try the car on the road, and finally adjust the nut as necessary. On later chassis with the cotton washer type damper, the washers are oil soaked on assembly, and the method is to tighten the adjusting nut on road test to eliminate the clonk.

DISMANTLING

When dismantling the servo motor do not alter any of the rod lengths. Commence by slacking off the serrated adjusting nut, and take the clevis pins out of the countershaft lever and the balance lever upper and lower ends. Turn the outer cam lever clockwise and withdraw the clevis pin from the inner lever; the cam lever pins are fitted "head to head". Unbolt the pneumatic damper, if fitted, and put it on one side. Remove the circlip from the servo shaft, the adjusting nut, the serrated washer, and the star springs.

Pull off as a group the cam levers, together with the thrust bearings, and, on later types, the four steel balls between the levers. Take off the lever from the countershaft and remove the two hexagon nuts and the serrated nut securing the bridge plate, taking care of the dowel on the rear stud. Remove the bolt securing the suspension lever to the countershaft. Pull off the bridge plate, and then take off together the suspension lever, the T lever, and the servo outer plate with the two levers. Take care of the coil spring inboard of the plate. Remove the eight nuts and bolts from the periphery of the drum, and part it from the driving plate. The inner driven plate will then come away together with the spindle.

IN SEPARATING THE DRUM FROM DRIVING DISC, KEEP THE DISC HARD UP TO THE SIDE OF THE GEARBOX TO AVOID AXIAL DISPLACEMENT OF THE GEARBOX CROSS-SHAFT. If this occurs, the distance pieces and adjusting washers of the shaft inside the gearbox will drop down into the bottom of the gearbox.

On Wraith and Bentley M-Series, the outer driven plate will not come away until the drum has been unbolted from the driving disc. Take out these bolts, and part the drum and at the same time hold the disc up against the gearbox to prevent displacement of the cross shaft. To separate the disc and plate assembly take out the two castellated nuts accessible through the holes in the inner driven plate.

Should it be necessary to separate the inner plate from the spindle, support the plate, short end of shaft downwards, across the jaws of the vice, and with a drift drive out the spindle; collect the Woodruff key.

Do not unbolt the bearing housing from the bridge plate.



INSPECTION AND RELINING

If the linings are oily there is no option but to renew them, but if they are glazed but not excessively worn they may be used again after roughing up and rebedding. The thickness of all linings, when new, is .187 ins., except Wraith which are .162 ins.

To de-glaze linings, or bed in new ones, lightly rub them with fine glasspaper until a uniform, matt, "clean" surface is obtained. With stapled linings this must be done by hand with them in position on the plates, but the floating ones should be lightly bedded with the glasspaper on the surface plate.

In fitting new linings it is essential to pull them down tight on the plates, and for this purpose a suitable staple dolly must be made up, to support the staples while the legs are clenched down. To clench the rivets of the earlier servos make up a pair of punches with pilots to enter the rivet bores.

New stapled linings are supplied with the depressions formed, but are undrilled. Originally they were jig drilled, but with care the holes can be pierced free hand or by using the servo plate as a jig. If the latter is done, remember that the staple depressions are not equally spaced, and all six must be accurately registered with the plate holes before drilling through with a 3/32 in. dia. drill.

To fit the lining to the plate, offer it up so that all six pairs of holes are in line and push the first staple through. Using the dolly press the staple down so that it lies one millimetre below the lining surface; use hand pressure only for this. Put the dolly in the vice, position the staple over it, and clench the legs over. For this work an extra pair of hands is indispensable. Next, similarly fit the diametrically opposed staple, and then fit the remaining four. Check that the lining is properly pulled down on the plate, and lightly dress its surface with fine grade glasspaper.

Push the servo shaft into the cross-shaft ball race; it should be an easy sliding fit. This bearing is a single row ball race, with one raceway groove widened axially to allow extra axial movement of the central race. Extra play in the bearing is not, therefore, indicative of bearing failure. If the bearing feels unusually rough, however, a replacement may be required which will entail modifying a standard bearing.

Check that the pneumatic damper damps in one direction only, that is when the rod is pulled out.

Examine the servo cams. On the steel ball type, slight indentation of the cam ramps can be disregarded. Check that the outer lever slides freely on the support sleeve, which is a press fit in the inner lever. The bronze ball support sleeve and the enclosing sleeve are unlikely to need attention.

Check the star springs for "dish", and freedom from distortion and cracks.

Examine the drum friction surfaces; they should be flat and bright, and free from excessive tramlining.

Check the condition of all the rod yokes, and the fit of the clevis pins in the yokes and the lever holes. The yoke ends on some chassis were hardened and do not ream satisfactorily. To correct a yoke end in which the hole has worn oval honing is recommended.

REASSEMBLY

Fit the Woodruff key to the servo shaft, and press the shaft into position in the inner plate. Assemble the drum and the driven plates, with the coil spring in position. On Wraith and Bentley M-Series, fit the cheese-head screws, and split pin the castellated nuts. Bolt the assembly to the driving disc.

Offer up the operating levers, the balance lever and the suspension lever, as a group. Note that the clevis pin of the inner operating lever is fitted with its head towards the gearbox, and the



outer lever the opposite way. Fit the bridge plate, together with the steel bush or ball race, according to type, and the hollow dowel on the rear stud. Fit the securing nuts, and tighten and lock.

Assemble the cam levers, sticking the balls, if fitted, and the thrust bearings in position with a dab of grease, and push this group into position. Follow up with the star springs, the serrated washer, the adjusting nut and the circlip. Turn the outer cam lever clockwise and fit the rod yoke and the clevis pin. Fit the lever to the countershaft, and connect up the link from the inner cam lever. Correctly fitted, the heads of the cam lever clevis pins are juxtaposed.

Adjust the forward motion tie rod to the balance lever so that there is no lost motion between the operating levers and the driven plate studs. Fit the pneumatic damper, noting that its yoke lines up with the balance lever when the piston is at the bottom of the bore. Adjust the pull rod as necessary.

Screw down the nut at the top of the suspension lever as far as it will go, and then back it off one complete turn.

Carefully screw up the adjusting nut, a click at a time, until the servo drum has about 1/16 in. side play, and then firmly press down the brake pedal several times to generally bed down the components. Then, manually, push the drum hard towards the gearbox, and then measure the axial movement of the drum when the brake pedal is depressed. The drum movement should be 1/32 in., and the adjusting nut must be taken up a click at a time until this is achieved. Moving the nut clockwise reduces the clearance. Finally, check that the brake pedal has 1/2 in. free movement, that is to say that the pedal will move that distance before the inner cam starts to move. Great care is essential in adjusting the servo because if it is too close the brakes will drag, and conversely, if the clearance is excessive the pedal will be too "long" and the brake efficiency will be reduced. Always adjust the rear brakes before adjusting the servo.

It now remains to test the car on the road. Until the servo linings bed themselves in, the brake efficiency will be reduced, and this must be recognised in the early stages of test. An initial bedding can be made by jacking the rear wheels and running the engine in gear, with the rear brake linkage spragged that is, with the linkage held back in the off position with clamps, and depressing hard the brake pedal half a dozen times or so. If this is done the transmission should be run at about 30 m.p.h.

DETAILS OF SERVO LININGS

| | Outside dia. | Inside dia. |
|---|---|---|
| Stapled type | 4.675" | 3.375" |
| Floating type | 4.670" | 3.405" |
| Wraith type (Eight slots .750" wide and .162" deep, on inside dia.) | 4.795" | 3.550" |
| Bentley Series M (Four slots .875" wide and .187" deep, on inside dia.) | 4.665" | 3.000" |

ANGULAR SETTINGS OF SERVOS

On non-floating servos the T-lever is inclined 14½° clockwise from the vertical, and stop plate (rivetted to the outer plate) is inclined 11° clockwise from the same datum.

On Wraith servos the angle of the T-lever is 25½° clockwise from the vertical, and the stop is 10° clockwise. The angular difference between the cam levers is 13½°.



# The Equalising Mechanism

ALL CHASSIS EXCEPT WRAITH

The function of the brake equalisers is to apply the same tension to the pull ropes on each side of the car, and this is done by a bevel differential, identical in principle to that of a rear axle. The mechanisms consist of two shafts, one long and one short, each with an output lever at its outer end and a bevel wheel at its inner end. Between these bevels is a planet carrier trunnion to which is bolted the input lever.

On two wheel brake chassis there are two of these assemblies, one for the footbrake and one for the handbrake, bracketed to the cross member behind the gearbox. These equalisers were retained in the same position on four wheel brake chassis, and a similar assembly for the front brakes passes through the lower part of the bell housing.

As stated above, the purpose of the equaliser is to balance the pull exerted on the two pull ropes, also to compensate minor differences in the length of the ropes and unbalance of brake adjustment from one side of the car to the other. In the design stage the angles of the equaliser levers were carefully calculated to give the optimum mechanical advantage, and it is very important that these angles are set up correctly. Errors will decrease brake efficiency, and unbalance of the output levers will cause the brakes to pull to one side.

CHECKING AND RESETTING

Check and overhaul where necessary the bushes in which the equaliser shafts rotate. In addition the planet carrier housings can wear considerably on the shaft giving rise to lost motion in the form of rocking of the housing rather than rotation. The housings may be bored out and bronzebushed.

If the rear footbrake equaliser shaft is re-conditioned check it for freedom of rotation when reassembled to the crossmember. There should be no tight spots. If these are found, the thickness of the spacer washers under the feet of the central support must be adjusted such that the shaft is free, both when rotating as a whole and when in the "differential mode".

In the course of a brake overhaul, the lever angles should be checked in position on the chassis, in relation to the vertical datum, with the rods and pull ropes connected up.

Using an engineer's combination gauge, first check the angle of the input lever, and, if necessary, rectify by altering the length of the adjacent rod. Then check that the output levers are at the correct angle and in phase (i.e. at the same angle).

If adjustment is necessary the method is to take out the equaliser bevel casing bolts, draw the casing halves apart, and remesh the bevel gears so that the levers are at the correct angles. The front equaliser can be readily dismantled in situ, once the rod and the ropes have been disconnected. But because of their construction the rear and hand brake equalisers must be unbolted from the cross member to gain access. It is a wise precaution, before dismantling any of the equaliser shafts, to mark on the levers, housings and shafts all their relative positions, without disturbing these positions during the marking process. These can then be used for subsequent reassembly.

The simplest way of setting up the rear and hand brakes is to set the angular difference between the inputs and outputs, and then set the input after re-fitting to the cross member. Having done this, adjust the servo pull rod so that the rear end of the slotted yoke is in contact with the clevis pin.

BRAKE ROPE TENSION

As originally built, these ropes were just short of being in tension when the brakes are "off". It is sometimes found that the ropes have stretched in service, resulting in lost motion and clonks when the brakes are applied. It may be possible to take out the slack by altering the mesh of the equaliser by one tooth, but this will alter the relative angles of the levers on the equaliser shaft.

If this is done, check that the output levers do not pass over centres when the brakes are pulled "on". Also check that the front axle levers, or



those on the rear axle, as the case may be, return correctly to their "off" positions. Should these conditions not be met, the remedy is to renew the ropes.

EQUALISER ANGLES (measured in relation to the vertical datum)

| FRONT BRAKES | Input Lever | Output Lever |
|---|---|---|
| 20 HP chassis up to 0A Serie | 29½° | 29½° |
| 20 HP, 0A Series onwards, all 20/25, and all 25/30 HP | 35° | 35° |
| Bentley 3½ and 4¼ litre | 28° | 46° |

| REAR FOOT BRAKES | | | |
|---|---|---|---|
| Two wheel brakes - all chassis | | 20° | 20° |
| Four wheel brakes | *Screw Gear Lever | Servo Lever | Output Lever |
| All chassis up to 20/25 HP Series E2B | 15° | 27½° | 20° |
| 20/25 HP, Series F2 onwards, and 25/30 HP | Angles not recorded | | |
| Bentley 3½ and 4¼ litre | 40° | 30° | 30° |

* The Screw Gear Lever is connected to the Servo motor cam lever.

| HAND BRAKES | Input Lever | Output Lever |
|---|---|---|
| All 20 HP, up to Series 0A | 26° | 26° |
| 20 HP, Series 0A onwards, and 20/25 HP, up to Series TB | 40¾° | 21½° |
| 20/25 HP, Series TB to Series E2B | 21½° | 27°56' |
| 20/25 HP, Series F2A onwards, and 25/30 H | Angles not on record | |
| Bentley 3½ and 4¼ litre | 25° | 38°34¼' |

INTERMEDIATE LEVERS

For 20/25 HP, Series H2A onwards, and 25/30 HP no figure is on record, but for 3½ and 4¼ litre Bentley the levers are set to 23° from the vertical.

As will be seen from the tables, the lever angles for some series of chassis are not recorded on drawings, and the author is at a loss to make positive recommendations in these cases. Obviously, where the figures are known the levers must be set up accordingly in the interest of optimum braking efficiency.

On chassis where they are not known, measure up and record the angles before starting the work, and at the same time make a general mechanical assessment of the pull ropes and the clevis connections.

The prime basic requirement is that none of the levers passes over fulcrum centre when the brakes are pulled on, and the same stricture applies to the intermediate levers. To check this, first adjust the brakes and disconnect the pull rod from the equaliser, and then with a suitable lever, pull on the brakes.

A useable guide to the angle of the front brake output levers is provided by the brake ropes; if these are at the correct length, the output angles will be sufficiently correct for practical purposes. The rear ropes do not provide such a guide because of the variable length of the intermediate lever rods, but they do control the angles of the intermediates.

On the rear foot brake equalisers it will be seen that the two input levers, those connected to the servo cam lever and the servo balance lever, are keyed together and their relationship cannot be altered.

If the equaliser lever angles have been altered during the life of the car, and assuming the rope lengths to be correct, it should be found that the engagement of the rods in the clevis yokes does not



look "right". Inspect the yokes, and see to it that the depth of engagement of the rods is something like twice the diameter of the rod, which is an engineering norm for studs in tapped holes. If a rod is found screwed only two or three turns of thread into a yoke, rectify it and look for the error in other directions. A faulty engaged rod pulling out of a yoke would be disastrous for the whole braking system.

The leverage afforded by the equaliser levers is measured at right angles to the pull rod, or the pull rope, on a line passing through the fulcrum point. From this it will be apparent that the leverage is inversely proportional to the angle of the lever from the vertical datum. Also, the angles are a design part of the front to rear brake ratio.

On all chassis types dealt with here, the equaliser "crownwheels" have twenty eight teeth; thus, remeshing by one tooth alters the lever angle by 13°, or to be precise 12.857°.

BRAKE ROPE LENGTHS (in inches)

| | FRONT | REAR | HAND BRAKE |
|---|---|---|---|
| 20 HP | 44.75 | 62.37* | 56.60* |
| 20/25 (up to G2 Series) | 44.75 | 61.87 | 56.00 |
| 20/25 (H2 Series onwards) | 44.75 | 21.20 | 21.20 |
| 25/30 | 44.75 | 21.20 | 21.20 |
| Bentley 3½ & 4¼ litre | 43.85 | 24.00 | 24.00 |

These dimensions are between centres of clevis fork eyes and are all subject to a manufacturing tolerance of ± 0.050.

* These figures apply to both 2 wheel and 4 wheel brake chassis.

# Front Axle Brake Actuating Cross-shafts

ROLLS-ROYCE

It will be seen that the pull of the front brake ropes is transmitted to the back plates by a pair of actuating shafts, each mounted on a pair of bronze bushes at its inner and outer ends, which are a press fit in the axle beam. Inside the shaft is a spiral spring, its outer end taper pinned to the shaft and the inner end engaged by a key which locks into the adjusting sleeve split pinned in position in the beam.

As originally built, the shafts were an easy running fit in the bushes, but it is now nearly always found that due to wear they have become excessively slack, giving rise to clonks on brake application and release. Rectification of this has for years been a problem, compounded by non-availability of parts and the considerable labour involved. It will be realised that the shafts cannot be withdrawn until the pivot axles have been dismantled.

Because of this, the practice was to first check the fit of the pivot bearings and then make a decision concerning the shafts. Usually, if the pivots were good the car would be let run on until they required overhaul, at which time the shafts would also receive attention.

As stated, new shafts and bushes have not been obtainable since the War, and the repair method is to build up the shafts with white metal and machine and hand finish them to suit the existing bushes. At first sight this may not appear attractive, but it does have the merit of being practical, especially when the difficulty of line reaming new bushes is considered.

With the axle pivots taken down, withdrawal of the shafts is straightforward. Commence by letting down the shaft spring, this being done with a pair of six inch lengths of 1/8" diameter steel bar. Insert one bar into a convenient capstan hole in the adjusting sleeve, and hold it firmly whilst the split pin is withdrawn. Let the bar turn as far as



the slot in the beam will allow. Put the second bar in the next accessible hole, pull out the first bar, and let the engaged one turn. Continue in this manner until the spring is released. Loosen the nut on the inner end of the shaft by wedging it against the axle beam and knocking the lever clock-wise with a mallet. With the inner lever disengaged, the shaft, together with its spring and key, will draw out. It should not be necessary to take the spring and key out of the shaft, but if this is done the end cover must be cut out and the taper pin punched out. As the shafts are "handed", mark them.

Inspect the shaft, noting the degree of wear at the bush stations, then insert the shaft in the axle and check its lift against the bushes. This is really guesstimation of the wear in the bushes; the shaft itself being measured with a micrometer. The next step is to machine back the shaft at the bush stations and then build up with white metal, applied with an iron. Set up the shaft to run true to the lathe, and turn the white metal to a greater dimension than the original diameter. This will be a matter of only a few thousandths, the actual diameter depending on the estimated wear in the bushes, which will of course be out of round. Ideally the bushes should be bored true.

Try the shaft in the axle when, for the work to be successful, it will not pass through the bushes, or at least be too tight. Dress the white metal with a strip of dead emery so that the shaft turns freely in the bushes, with a trace of lift. Next, support the front of the car on stands beneath the axle eyes and again check the freedom of the shafts. It is important to do this because the weight of the car creates slight distortion in the axle beam, which affects the alignment of the bushes. If necessary, rub down the white metalling by another thousandth or so to restore free movement.

Before commencing reassembly check the cleanliness and serviceability of the lubrication passages, and work plenty of ball bearing grease down the axle beam bore. Check the fit of the securing nut on the shaft thread, and clean up as necessary. Thread the shaft through the bushes, the lever, and the tab washer, start the nut, and engage the key in the adjusting sleeve. Tighten the nut by wedging and malleting. Tension the spring by rotating the sleeve with a pair of tommy bars, and split pin.

An alternative method of reclaiming the actuating shafts is to turn them true in the lathe and make up sleeves to fit the shaft, with outside diameter appropriate to the bushes. The sleeves may be a sliding fit on the shaft and retained in place with "Loctite". The sleeves should be in stainless steel to minimise corrosion.

BENTLEY

The Bentley system is somewhat different from the Rolls-Royce. The actuating shaft is solid, and the return spring is a coil-spring through which the shaft passes. One end of the spring is hooked around a taper pin which passes diametrically through the shaft. The other is engaged in a mating slot in the out-board top-hat-section bronze bush. The bush is a good sliding fit in the axle end, and may be rotated with the appropriate peg spanner to tension the spring, and is then locked in position by means of a grub screw on the front of the axle which engages in one of a number of countersunk holes around the circumference of the bush. The remainder of the holes allow oil to enter the bush for lubrication purposes. The return spring should be set to give a force of 10 lbs measured at right angles to the outer lever using a spring balance hooked around the ballpin.

In the fullness of time the spring corrodes, and eventually breaks. The oilways become blocked, and because the outer bush is only a slip fit in the axle end, moisture enters between the bush and its housing. The housing bore in the axle corrodes leaving the bush a very sloppy fit.

Removing the shaft should entail removing the shaft complete with outer bush and return spring as



a unit. However corrosion causes both the spring and the bush to become locked in the axle. The most effective way of freeing the resulting corroded mess is to block up the gap between the outer bush and the shaft with, say, wax or plasticine, open the axle and pour into the axle through the inboard bush a good quality penetrating oil. Leave the axle to soak for a fortnight(!) topping up with penetrating oil at regular intervals. Then wedge the shaft out by driving screwdrivers or cold chisels between the inner end of the shaft and the axle. Keep the nut screwed onto the shaft initially to avoid brutalising the thread on the shaft excessively, the nut taking the force of the wedging.

When refitting, the bore of the axle end will have to be cleaned up to remove the effects of corrosion. Either an expanding reamer, preferably piloted into the less corroded part of the bore, should be used or else the axle can be set up on a turret mill and a skim taken out of the bore to clean up. Care must be taken when refitting the bush not to allow the oilways and holes to become blocked by grease.

# The Hubs

With the exception of Wraith and Bentley all the chassis dealt with here are fitted with the familiar Rolls-Royce centre locking hubs, which commenced their long production run on Silver Ghost cars in 1913. On Wraith and Bentley the wheels are secured by octagonal hub caps, similar in design to the knock on type fitted by a number of other marques before the War. On both types the wheel hub shell and the hub are splined together, the two parts locating on a conical register. All centre lock wheel nuts are threaded right hand, but on Wraith and Bentley the offside nuts are threaded left hand.

The internal details of both types are markedly similar. On the rear hubs the axle shaft and the hub are coupled together by a wheel driver which is internally and externally splined to the two members. The hub bearings are mounted on the axle tube, and the assembly is secured by a nut threaded onto the axle tube. The design of the front hubs is straightforward, each being secured to the stub axle by a castellated nut. Handing of the hub internal threads is general, and this is detailed in the text.

HUB REMOVAL

20 HP, 20/25 HP, and 25/30 HP

Notes on hub removal are given here for completeness. Full details are given in R R Service Instruction leaflets TSD 2066.

FRONT HUBS

With the road wheel removed, depress the serrated locking plunger and prise the circlip out of the hub barrel; the plunger will then come out together with its coil spring. On 20 HP and 20/25 HP up to the end of R Series, and including some chassis in S Series, the face of the grease retainer is threaded 1/4 Gas for the spring compressing tool.

Next, prise the circlip out of the grease retainer securing ring and unscrew it with the six pin spanner. The offside ring is threaded left hand and the nearside is right hand and their faces are so marked. Pull out the grease retainer. Unpin the stub axle castellated nut, and unscrew it; the nearside is threaded left hand, and the offside is right hand. Take care of the washer behind this nut.

It then remains to withdraw the hub, and an extractor which engages the hub thread is available. In the absence of this, usually sufficient purchase to displace the hub can be gained by temporarily refitting the road wheel.



REAR HUBS

As detailed for the front hubs, take out the locking plunger and spring, and the ring nut and grease retainer. On both rear hubs the ring is threaded right hand and is so marked.

Take out the split pin, and unscrew the axle shaft nut, right handed on both sides, and take care of the washer(s) behind it.

With the extractor, pull out the wheel driver. Usually this can be done by pulling on a couple of lengths of 1/4 B S F studding screwed into the holes in the face of the driver. Unscrew the three 2 BA nuts that secure the locking plate to the axle tube nut; take out the three spring washers and the locking plate.

With the three pin spanner, remove the axle tube nut; the nearside is threaded left hand, and the offside is right hand. Pull off the hub by means of the extractor, or by refitting the road wheel.

WRAITH

FRONT HUBS

the procedure is the same as for the earlier cars except that the serrated locking plunger, spring etc., are not fitted to this type. The handing of threads of the ring nut and the stub axle nut are as on the earlier cars.

REAR HUBS

With the road wheel removed, unscrew the grease retainer by means of a socket spanner on its hexagonal head; this is threaded right hand on both sides of the car. Removal of the wheel driver, and the axle tube nut etc. is as on the earlier cars.

BENTLEY

FRONT HUBS

Except on M Series chassis, the method is the same as for Wraith. On M Series the grease retainer screws into the hub and is removed with a socket spanner; the offside retainer is screwed left hand, and the nearside is right hand.

REAR HUBS

The method is the same as for 20 HP, 20/25 HP and 25/30 HP., apart from the locking plunger details. On M Series chassis the grease retainer is screwed into the hub, and is removed with a socket spanner. It is threaded right hand on both sides of the car.



# Relining

On all 20 HP and 20/25 HP prior to Chassis GKT22 the front and rear foot brakes were an orthodox leading/trailing arrangement of two shoes to each drum, all shoes being fitted with a pair of equal length liners. The hand brake shoes were mounted inboard of the rear foot brakes, and each was fitted with two narrow linings. The thickness of all linings was .3125 ins.

At GKT22 the anti-squeak front brakes commenced, consisting of one piece linings together with a short auxiliary lining on a separate shoe pivoted on the main one. At the beginning of H2 Series the anti-squeak rear foot brake shoes commenced, similar in design to the fronts. The inboard mounted hand brakes continued. The lining thickness increased to .375 ins.

All 25/30 HP and all Bentley were built with anti-squeak shoes, front and rear* On Wraith the anti-squeak shoes continued, but the rear shoes performed both the foot and hand brake functions. The Bentley linings were .3125 ins. thick.

Up to Chassis GEX1 all brake drums were of steel, and at that point cast iron rear drums commenced, to be followed by cast iron fronts at Chassis GLZ52. All 25/30 HP Wraith and Bentley drums were cast iron.

DISMANTLING - REARS

20 HP, 20/25 HP and 25/30 HP

Commence by removing the lock plate, and unscrew the nut from the brake shoe pivot bolt. Unscrew the plain nuts from the two brake shoe steady bolts. Unpin and remove the twelve castellated nuts securing the earlier plate and the deflector ring, and pull them off. These bolts are retained in position.

Unpin and pull out the foot brake shoe toggle pins and the pull off springs from one brake shoe. If these pins have rusted in they may be difficult to extract because their heads offer only a limited purchase. If needed, soak them with penetrating oil and use a Mole or similar tool

which will grip them tightly.
Take off the foot brake shoes, and remove the hand brake shoes in the same manner.

WRAITH AND BENTLEY

The method for these cars differs from the foregoing mainly in that the carrier plate is left in position ; on Bentley the carrier plate securing bolts are peened over. First, remove the two brake shoe fulcrum bolts, and then extract the toggle pins from both shoes, and the pull off spring pins from one shoe. On Wraith the brake shoes will then come away together with the fulcrum bolt bushes. On Bentley, having uncoupled the foot brake shoes pull the toggle pins and pull off spring pins from the hand brake shoes. Then manoeuvre the shoes so that the foot brake shoes can be drawn off the fulcrum bolt bushes, and pull the bushes out of the hand brake shoes. It may be found that the bushes have rusted in position and are difficult to extract. In such cases use penetrating oil and manipulate the shoes to free them. Take care not to lose the spacer washers between the hand and foot brake shoes.

DISMANTLING FRONTS

20 HP, 20/25 HP, 25/30 HP AND BENTLEY

Commence by removing the brake shoe fulcrum bolts, and then take off the carrier plate. Take out the split pins and pull out the toggle cotter pins, and unpin the pull off springs from one of the shoes. The brake shoes are then drawn out.

WRAITH

The procedure is as above, except that it is unnecessary to unbolt the carrier plate, and shoe guides are not fitted.
On both the front and rear brakes, mark all shoes and auxiliaries as they are taken down to facilitate refitting in their original positions.



FITTING LININGS

With the shoes on the bench, remove the linings by cutting out the rivet heads with a twist drill. Do not chisel off the rivet heads or the snappings, because by so doing the shoes may be damaged. On anti-squeak shoes, detach the auxiliaries and put the loading springs on one side before removing the linings. Clean up the bedding faces of the shoes, and as far as possible check them for distortion and absence of twist. The shoes are very hard working components, which are subjected to considerable physical pressures and impromptu heat treatment, and distortion will lead to difficulty in rebedding.
With the shoes clean and tidy, the new linings are rivetted on in the normal way, starting at the midway position and working outwards to the ends of the shoes. Use small clamps to pull the linings hard down on the shoes, and the correct snap tool for closing up the rivets. For this work an extra pair of hands is indispensable. The importance of tight rivetting cannot be overstressed, and ideally should be done on a power rivetter.
On auxiliary shoes the rivet holes are conical drilled, and the rivets must be peened down into these tapers, as distinct from the snap ending of the main shoe rivets. The peened over heads of the rivets must then be finished off flush with the surface of the shoe.
Alternatively, the fitting of new linings can advisably be left to a company of specialists such as Ferodo who have the correct clamping equipment to ensure a tight fit over the face of the shoe. This service is not expensive and may reduce the amount of bedding to be done.
Upon completion of the rivetting the linings should, ideally, be concentric with the shoes and free from high spots, but they never are. Hold the shoe in the vice and lightly run a file around the linings, to find where any surface irregularities are. Then, dress down the high spots by the same

method. Considerable care is needed in doing this because the ultimate object is to bed the lining to the brake drum, and the better the surface condition the easier the final process becomes. Use the file lightly and avoid removal of any significant quantity of material.

THE BRAKE DRUMS

All the 20 HP chassis were built with steel drums, which continued into 20/25 HP until the advent of cast iron drums. In K Series of 20 HP damping sectors commenced on steel drums, and were fitted to all subsequent drums in this material. Each drum of this type was fitted with four sectors, held in place on a spigot by a circumferential coil spring. All 25/30 HP, Wraith and all Bentley were fitted with cast iron drums.

The standard drum internal diameters are as follows :-

| | Front | Rear |
|---|---|---|
| 20 HP, 20/25 HP, 25/30 HP | 13.000 ins. | 14.000 ins. |
| Wraith | 13.000 ins. | 13.000 ins. |
| Bentley | 12.000 ins. | 12.000 ins. |

The material thicknesses of steel drums are .125 ins. front and .225 ins. rear. All cast iron drums, except Wraith fronts and Bentley front and rear, have an effective thickness of .225 ins. Wraith fronts are .250 ins. thick and the Bentleys are .187 ins.

It will be seen that all drums are bolted up assemblies, and under no circumstances apart from renewal may the hub and drum be separated. The reason for this is that the drums were finish machined after assembly to the hubs, thus ensuring concentricity between the two. New drums, as drawn from Stores, are internally undersize, and must be machined out after building onto the hubs. On Bentley, and possibly on Rolls-Royce as well, the bolts holding the drums to the hub had a 1 : 50 tapered shank, and the hubs and drums were taper reamed in line to accept this. If the hubs and drums have to be separated, care must be taken in the correct relocation and the



use of the correct bolts for refitting.

When the brakes are relined, grinding of the drums to restore roundness and surface condition is really essential, but the absolute minimum of material should be taken out consistent with this. At maximum the internal diameter should not be increased by more than .040 ins. from standard. This stricture is particularly necessary in the case of the steel front drums which were but .125 ins. thick when new.

To some extent the surface condition after grinding is discretionary, and it may be feasible to leave in (say) an individual groove, rather than gain a 100% finish at the expense of drum life. On completion of grinding the drum should not be more than .002 ins. out of round.

# Reassembly and Bedding
## The Linings

Commence by fully backing off the external adjusters. In the case of the "Easy" adjusters, turn the wing nuts anti-clockwise as far as they will go, and on the early type fronts register the arrow with the zero mark. On the early type rears and the hand brakes unscrew the clevis yokes so that one inch of rod thread is showing.

On the anti-squeak shoes screw down the adjusting screw so that the outer end of the auxiliary is in contact with the main shoe, and lock temporarily.

The building up of the brake shoes onto the back plates is done in the reverse order of dismantling, and is fairly straightforward. Apply a little high melting point grease to the fulcrum bolts and bushes, and the toggle and pull off spring clevis pins. The object of this is rust inhibition rather than lubrication, and should not be overdone. Avoid touching the linings with greasy hands.

At this stage do not alter the toggle settings, but check that five half turns of thread are visible inside the yokes. This is important on anti-squeak shoes to allow scope for final adjustment. Leave the split pins in the toggle and pull off spring pins unspread. On early cars, including 3½ litre Bentley, the toggle and the yoke were locked together by a 1/16 ins. diameter parellel pin, and this must be extracted before alteration can be made. After relining the brakes these pins are to be left out.

Care is necessary to assemble the brake shoe steadies so that the shoe webs slide freely, and are, at the same time, supported.

With the brake assemblies complete, offer up the drum and push it in so that its lip is in contact with the edges of the linings. It is at this stage that an assessment has to be made of the amount of material to be removed to enable the drum to pass over the shoes.

The Works method of bedding brakes was to assemble the relined shoes onto the back plates, and then take light cuts with a hand operated rotary cutter, until,



with the adjuster fully backed off and the auxiliary shoes reset, the drum would pass over the shoes and rotate freely. The cutter was fitted on the bearing journals normally occupied by the hubs, and was thus truly concentric.

Wear a face mask when bedding linings to avoid breathing the asbestos dust.

Without the cutter the only recourse is to filing the linings, a task calling for considerable skill and care. It is essential to equally and uniformly reduce the linings around the whole periphery, and maintain squareness across them. It may be possible to gain a little on this operation by closing up the toggles by one or two half turns, but in the case of anti-squeak shoes two and one half turns must be left for the final adjustment.

Having reached a position where the drum will pass over the shoes and turn freely, lightly smear the drum with marking blue and rub the linings with blackboard chalk. With the aid of an extra pair of hands, rotate the drum with the brake pulled on. Push the road wheel onto the hub to facilitate this.

Draw the drum off again and check the bedding marks on the linings. File off the high marks and repeat the process until, ideally, a uniform end to end bedding is obtained. Once the bedding is satisfactory, clean the marking blue from the drum, refit it and check the travel of the actuating lever. On 20 HP and 20/25 HP with steel drums the brake lever travel (measured at the vertical actuating rod behind the backplate) should be 5/8 ins., and with iron drums, one inch. For 20 HP, 20/25 HP and 25/30 HP the hand brake travel should be 3/4 ins., and for the Bentley 5/8 ins. With the "Easy" adjuster, six half turns of the wing nut should bring the brake firmly on.

On anti-squeak shoes, on completion of bedding set up the auxiliaries to a clearance of .012 ins. at the shoe tip, at which it should be found that the drum will not go on. Compensate this by screwing in the toggles two or three half turns.

Should it be found that the lever travel is excessive the remedy is to open out the toggles; half a turn should be sufficient unless the lining thickness has been drastically reduced in the bedding operation.

Before finally refitting the hubs, check all nuts for tightness and see to it that all the split pins are in and properly spread.

Having finally checked the adjustments of the brakes and the servo it then remains to test the car on the road. This is really the moment of truth when the goodness, or the shortcomings, of the work done becomes manifest. Stating the obvious, the testing should, if possible, be done in light traffic conditions.

The initial efficiency of the brakes will depend on the care with which they were bedded, and the first half dozen applications are likely to indicate what further work is needed. If there is pull to one side or locking of one wheel, taking down of the drums on the affected axle will be required. Before doing this check that the angles of the equalisers and the operating levers are the same on both sides of the car. Errors of this kind must be tracked down and rectified.

It should be remembered that relined brakes tend to improve with usage, up to the point when the bedding is complete. The object of filing the linings is to shorten the "running-in" time, if not to gain maximum retardation at the outset.

If the car pulls up square, and without locking, but short of maximum efficiency, discretion should be used as to whether brake improvement will follow further driving. Unless the answer to this is positive, remove the drums and again go over the bedding.

Brake squeaks and groans are very difficult to deal with. They can be indicative of faulty bedding, but can also arise from a brake showing 100% bedding. Other causes are lack of rigidity in the back plate mechanism and in the shoes themselves, and to condition of the brake drum resulting from ovality or loss of thickness due to over grinding.



It may be found that a brake will squeak when hot and not when cold, and vice versa, or that the weather conditions have an effect. Possibly a squeak will clear itself after a period of running and bedding, but if it does not the only course is to take down the drum and check the bedding and the security of the back plate assembly.

Over the years many cures have been tried, some of which work on some cars and not on others of the same model. They include the fitting of carbon plugs, dressing the linings with graphite, making shallow hacksaw cuts across the linings, topping and tailing, and filing a narrow flat across the linings at the midway position. None of these remedies is offered with any degree of confidence, except perhaps the last one.

Replacement linings supplied are in either Ferodo BZ or MZ material, the mu values of which are very similar, and it is possible that a different grade or make of lining might have better anti-squeak properties. Any such gain could, however, be at the expense of friction value or durability.

A further aspect is that the major work of relining and rebedding has already been completed before the noise is apparent, and scrapping of newly fitted linings cannot be attractive either on material cost or labour. In addition, linings in a different material would have to be specially moulded and drilled, and could not be guaranteed to eliminate the noise.

It is not the intention to play down the squeak because it can and does occur on these cars, and there is no easy and obvious way of dealing with it.

William Fiennes has kindly contributed the following under the heading of "Reassembly and bedding of linings".

If using a rotating cutter it is important to make sure that the brake shoe and its pivot bush are a good fit. If there is slack in the bush when the cutter passes over the counter boring for the rivet heads the shoe tends to rock sideways and vibrate. This has the effect of (a) making it difficult to control the amount of material being removed, (b) leaving brake shoes which are slightly concave in cross-section, (c) making the cutting tool grab and tear small lumps out of the surface of the shoe.

When fitting the drum, the shoes enter the drum before the bearings register on the axle. It is impossible therefore, particularly when hand bedding, to know where to remove material initially such that the shoes will be concentric with the axle and enter the drum. A better method is first to screw the toggles right in such that the drum will pass over the shoes and turn freely. Then lengthen each toggle, half a turn at a time, until by increasing each toggle one more half turn the drum will not pass over the shoes. The length of each toggle is then such that the drum will still pass over the shoes, but by increasing EITHER by one half turn the drum cannot be fitted. Then by manipulating the adjusting wing nut to slightly expand the shoes and simultaneously rotating the drum the high spots on the brake shoes can be picked up.

Then file the shoes until satisfactory bedding is achieved. At this stage, rather than continually adjusting the toggles it is easier to screw down the winged "Easy" adjusters to compensate for the material removed by filing. If the bedding operation has been completed satisfactorily, expanding the shoes by eight to nine half turns from the fully backed-off position of the "Easy" adjuster will make the drum tight when being refitted over the shoes.



The figure, eight to nine half turns arises because six half turns should bring the brakes full on but when new linings have been fitted an extra two to three half turns should be allowed for possible growth in the lining. The text is a little misleading in that it implies that six half turns of the wing nut adjuster can be applied when the drum is already fitted, which is obviously impossible.

Two or three half turns on the toggle is generally very much more than is required to compensate for the 0.012" resetting of the auxiliary shoe. There is no need to reset the toggles if the adjusters are screwed in half a turn at a time during the course of bedding until the eight to nine half turns condition is met, as above, as any compensation is rendered unnecessary as a result of this condition.

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